

Middle Fork Salmon River Subbasin Assessment and Total Maximum Daily Loads



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Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
μ	micro, one-one thousandth
§	Section (usually a section of federal or state rules or statutes)
AU	assessment unit
AWS	agricultural water supply
BAG	Basin Advisory Group
BLM	United States Bureau of Land Management
BMP	best management practice
Btu	British thermal unit
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
cm	centimeters
CWA	Clean Water Act
CWAL	cold water aquatic life
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DWS	domestic water supply
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act

F	Fahrenheit
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
I.C.	Idaho Code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDWR	Idaho Department of Water Resources
INFISH	the federal Inland Native Fish Strategy
km	kilometer
km²	square kilometer
LA	load allocation
LC	load capacity
m	meter
m³	cubic meter
mi	mile
mi²	square miles
MBI	Macroinvertebrate Biotic Index
MOS	margin of safety
MWMT	maximum weekly maximum temperature
n.a.	not applicable
NA	not assessed
NB	natural background
nd	no data (data not available)

NFS	not fully supporting
NPDES	National Pollutant Discharge Elimination System
ORV	off-road vehicle
ORW	Outstanding Resource Water
PACFISH	the federal Pacific Anadromous Fish Strategy
PCR	primary contact recreation
RHCA	riparian habitat conservation area
SBA	subbasin assessment
SCR	secondary contact recreation
SFI	DEQ's Stream Fish Index
SHI	DEQ's Stream Habitat Index
SMI	DEQ's Stream Macroinvertebrate Index
SS	salmonid spawning
STATSGO	State Soil Geographic Database
T&E	threatened and/or endangered species
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
U.S.	United States
U.S.C.	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WLA wasteload allocation

WQS water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses the water bodies in the Middle Fork Salmon River Subbasin. It corrects certain inaccuracies related to this subbasin on Idaho's current §303(d) list, in which some streams have been listed in error. It also develops needed TMDLs for streams that were not previously listed.

This subbasin assessment (SBA) and TMDL analysis have been developed to comply with Idaho's TMDL schedule. The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Middle Fork Salmon River Subbasin, located in central Idaho.

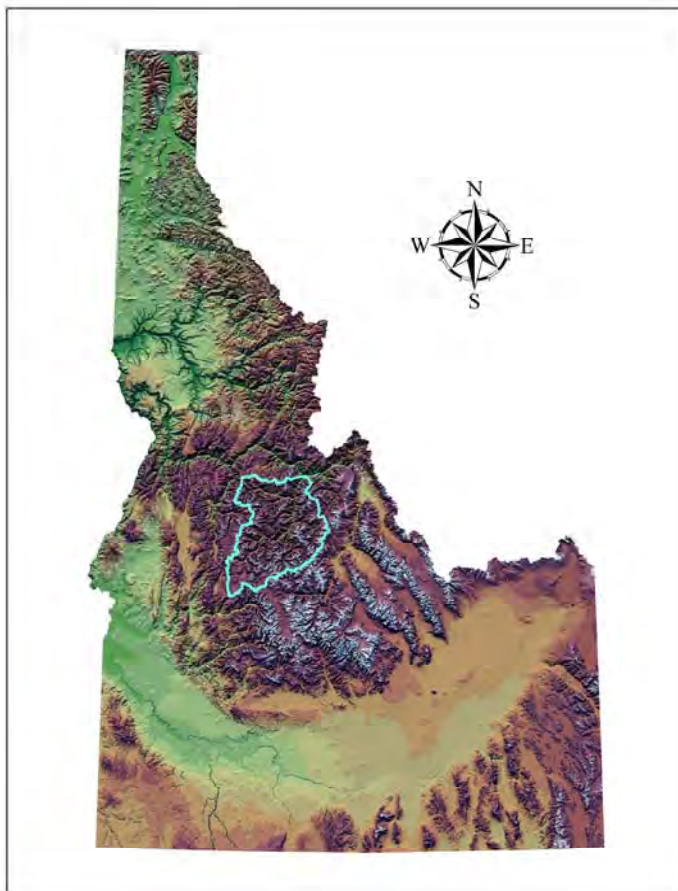
The first part of this document, the SBA, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's 2002 §303(d) list of water quality limited water bodies, which is currently the official list. Four assessment units of the Middle Fork Salmon River Subbasin within the Idaho Falls DEQ Region and 7 assessment units from the Boise DEQ Region were listed on the 2002 list.

The SBA examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. Several listed segments on the 1998 §303(d) list were carried forward to 2002. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards and supporting beneficial uses.

Subbasin at a Glance

The Middle Fork of the Salmon River (Middle Fork) is a tributary watershed, or subbasin, of the Upper Salmon River Basin. The Middle Fork Salmon River flows primarily through the Frank Church—River of No Return Wilderness. It is divided into two hydrologic units: the Upper (southern), which covers 1,500 square miles (mi²), and the Lower (northern), which covers 1,373 mi² (Figure A). Their hydrologic unit codes (HUCs) are 17060205 (Upper) and 17060206 (Lower). On their eastern sides, these two hydrologic units are separated from each other by the watershed divide between Cache Creek (17060205) and the next unnamed downstream tributary in the eastern watershed (17060206). On the western side, they are separated from each other by the watershed divide between Jack Creek (17060205) and Tom Creek (17060206).

The upper and lower HUCs are divided between two DEQ regions (Boise and Idaho Falls), as well, by the Middle Fork of the Salmon River. The eastern watershed tributaries are within the Idaho Falls Region and the western tributaries are within the Boise Region. The Middle Fork Salmon River watershed is located in Custer, Lemhi, Valley, and Idaho Counties and is contained in portions of the Boise, Salmon, Challis, Nez Perce, and Payette National Forests.



Middle Fork Subbasins

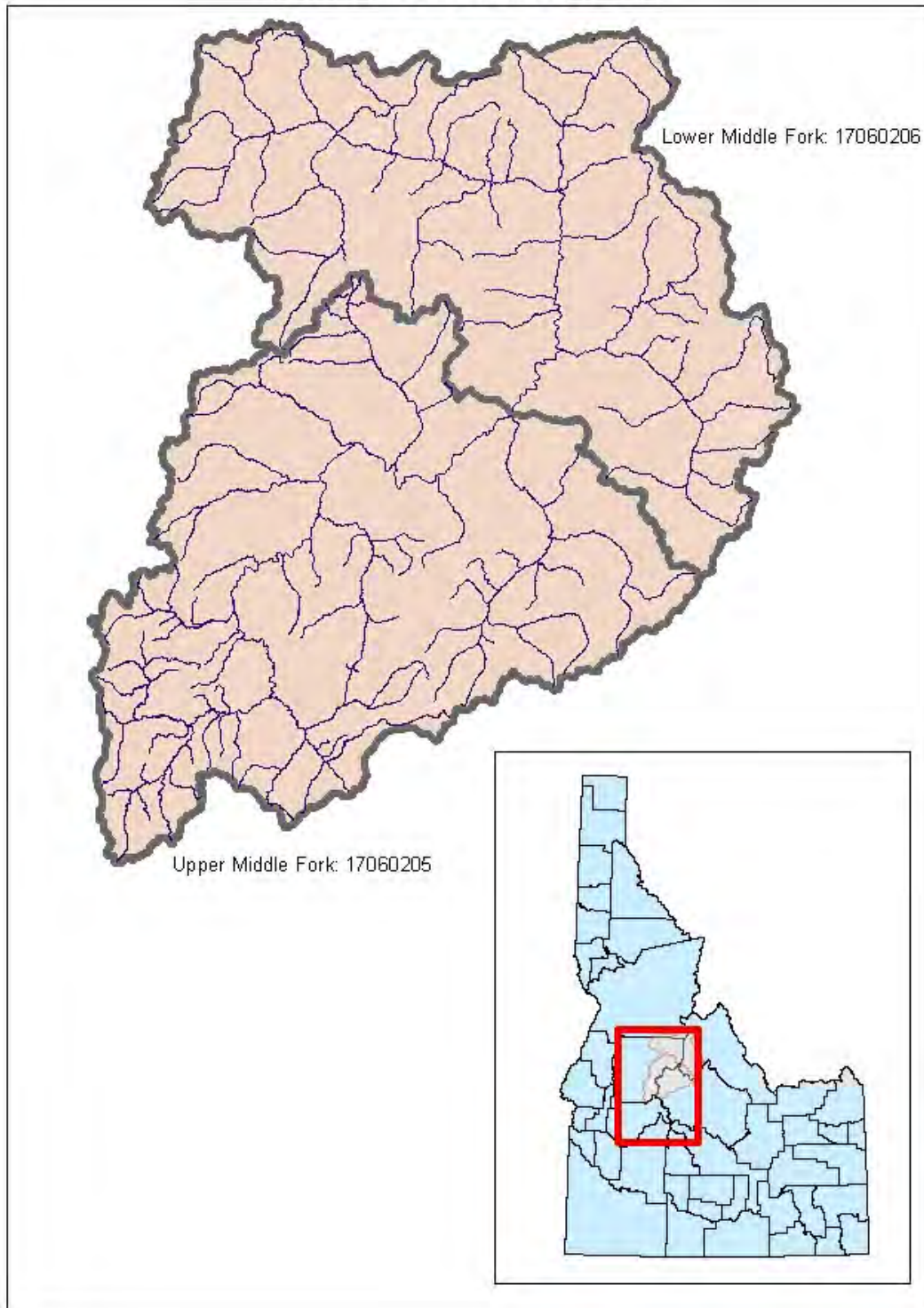


Figure A. Middle Fork Salmon River subbasins and associated Hydrologic Unit codes.

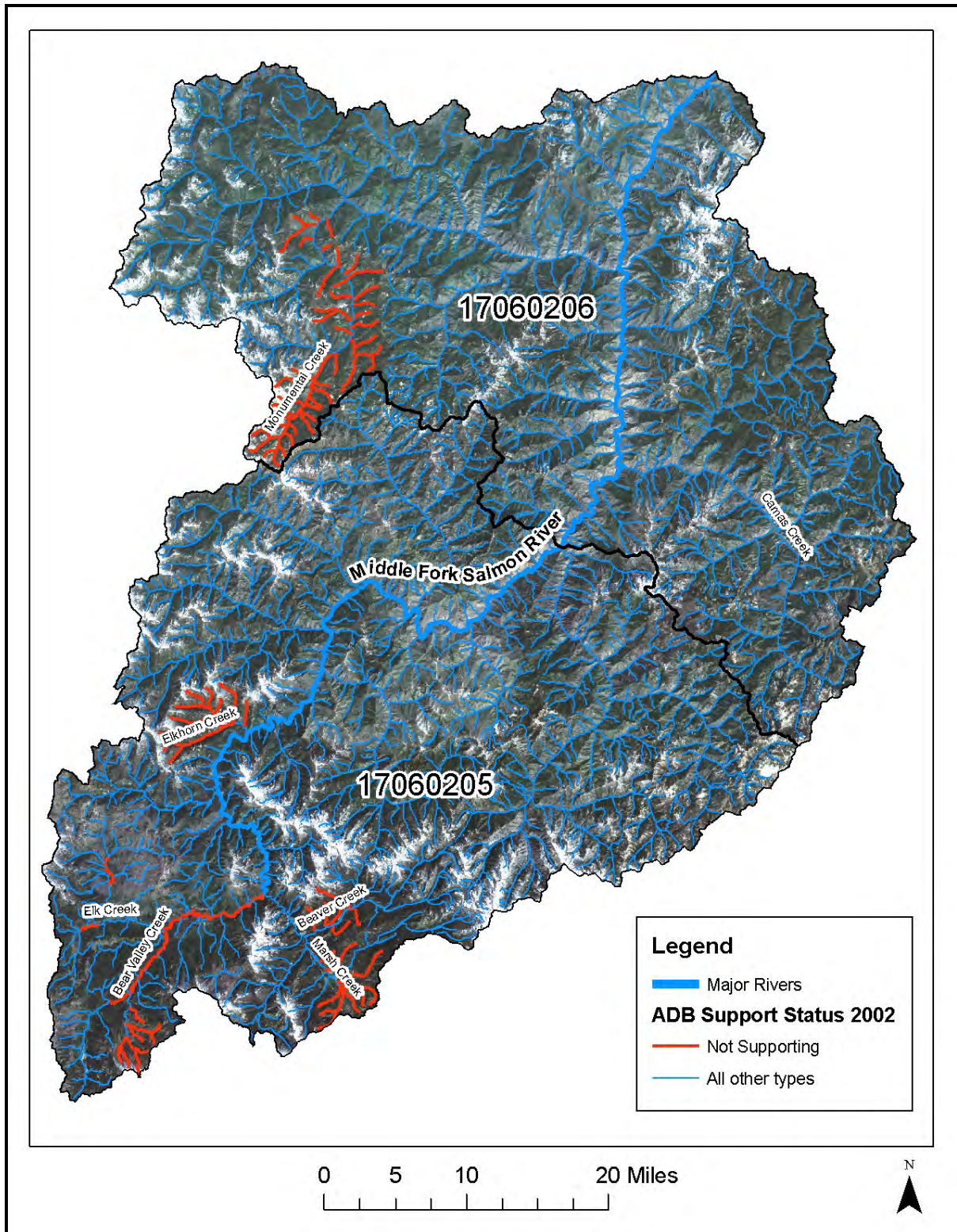


Figure B. 2002 303(d) listed Streams in the Upper and Lower Salmon River Watershed

The watershed is located primarily in the Frank Church-River of No Return Wilderness and is essentially one of the most pristine watersheds found in Idaho. There are no major population centers contained within the watershed, and the nearest towns include Stanley, Challis, and Salmon, Idaho, all located along the mainstem Salmon River upstream of the Middle Fork confluence.

The water quality limited segments (303(d)-listed reaches) that occur within the subbasin are listed in Table A. The Middle Fork of the Salmon River is designated for cold water aquatic life (CW), primary contact recreation (PCR), domestic water supply (DWS), and Special Resource Water SRW. All the tributaries are undesignated.

Table A. 2002 303(d)-listed waterbodies in the Middle Fork Salmon River Watershed.

Waterbody Name	Assessment Unit ID	Pollutants	TMDL Completed
Marsh Creek	ID17060205SL024_02	Unknown	Yes, Temperature
Asher Creek	ID17060205SL026_02	Unknown	No
Beaver Creek and 2 nd order tributaries to Beaver Creek including Shake Creek and Laidlow Creek	ID17060205SL028_02	Unknown	No
Unnamed Tributary/Camp Creek (T12NR11ESec 11)	ID17060205SL027_02	Unknown	No
Bear Valley Creek	ID17060205SL012_03	Unknown	No
Bear Valley Creek	ID17060205SL012_04	Sediment	No
Bear Valley Creek	ID17060205SL012_05	Sediment	No
Elk Creek	ID17060205SL013_03	Sediment	No
Elkhorn Creek	ID17060205SL008_02	Temperature and Sediment	No
Monumental Creek	ID17060206SL012_02 ID17060206SL012_03	Sediment	No

Data has been collected and analyzed to evaluate the scope of the water quality limiting issues on the 303(d)-listed reaches and many of the non-listed reaches in the Middle Fork Salmon River. TMDLs for temperature are based on this data.

Key Findings

Temperature TMDLs were developed for Marsh, Knapp, Beaver, Winnemucca, Camas, Castle, Silver, Duck and Yellowjacket Creeks. Effective shade targets were established for Marsh Creek, Knapp Creek, Beaver Creek, and Winnemucca Creek in the upper watershed (17060205), and Camas Creek, Castle Creek, Silver Creek, Duck Creek, and Yellowjacket Creek in the lower watershed (17060206). Shade targets are based on the concept that maximum shading under potential natural vegetation equals natural background temperature levels (Table B). Shade targets were derived from effective shade curves for similar vegetation types in the Northwest. Existing shade was determined from aerial photo interpretation, which was field-verified with Solar Pathfinder data.

Beaver Creek and Winnemucca Creek show the greatest lack of shade with both streams needing more than 50% reduction in solar loads. Both of these streams suffer from increased channel width as a result of morphological instability. The riparian vegetation is not necessarily lacking in any of these streams, however, channel widths are excessively wide,

resulting in less shade provided to the channel by the riparian vegetation. Knapp Creek is somewhat better off with a 32% reduction needed to meet target loads and the lowest excess load of the four streams examined. Marsh Creek was in the best condition of the four with a 26% reduction in solar loading needed.

Camas Creek and four of its tributaries (Silver, Yellowjacket, Castle and Duck Creek) were suspected of having problems with temperature pollution and were analyzed through TMDL development (Table A). Overall, streams in the Camas Creek watershed are in better condition with respect to riparian shade. Three streams (Camas Creek, Castle Creek, and Yellowjacket Creek) had average lack of shade values below 10%. Duck Creek had the highest solar load percent reduction needed at 32%, however, as the smallest stream, Duck Creek contributes little excess solar load to Camas Creek. Silver Creek had the second highest excess load and percent reduction needed to achieve target loads. Silver Creek is paralleled by the most prominent road in the watershed and has experienced some loss of shade. With a percent reduction needed greater than 20%, Silver Creek should be prioritized for any implementation efforts to improve shade.

Streams that were listed in error on the 2002 §303(d) list and will be removed from the list of impaired waters are shown in Table B, which summarizes the outcomes of all assessments for the Middle Fork Salmon River.

The TMDLs prescribed in this document will likely provide a net conservation benefit for species listed under the Endangered Species Act (ESA), including chinook salmon (*Oncorhynchus tshawytschka*), steelhead trout (*Oncorhynchus mykiss*), and bull trout (*Salvelinus fontinalis*).

Table B. Summary of assessment outcomes.

Water Body Segment/AU	303 (d) listed Pollutant	Stream Name	TMDL Completed	Recommended Changes to Integrated Report	Justification
ID17060205SL008_02	Sediment	Elkhorn Creek	No	Delist	Assessed Full Support
ID17060205SL012_04 ID17060205SL012_05	Sediment	Bear Valley Creek	No	Move to category 4b	Meets 4b criteria
ID17060205SL012_03	Sediment	Bear Valley Creek	No	Delist	Assessed Full Support
ID17060205SL013_03	Sediment	Elk Creek	No	Move to category 4b	Meets 4b criteria
ID17060205SL024_03 ID17060205SL018_05 ID17060205SL025_02 ID17060205SL028_03 ID17060205SL028_04 ID17060205SL030_02 ID17060205SL019_04 ID17060205SL019_03 ID17060205SL024_02 *	1 AU listed for Unknown* and remaining AUs not listed	Marsh Creek	Temperature	List in category 4a	TMDL Completed
ID17060205SL026_02	Unknown	Asher Creek	No	Delist	Low flow
ID17060205SL027_02	Unknown	Camp Creek/unnamed tributary	No	Delist	Low flow
ID17060205SL028_02	Unknown	Beaver Creek/Shake Creek/Laidlow Creek/Unnamed 1 st and 2nd Order Tributaries	No	Delist	Full Support
ID17060205SL028_04	Not Listed	Beaver Creek (4 th order AU)	Temperature	List in category 4a	TMDL Completed
ID17060205SL031_03	Not Listed	Beaver Creek (3 rd order AU)	Temperature	List in category 4a	TMDL Completed
ID17060205SL030_03	Not Listed	Winnemucca Creek	Temperature	List in category 4a	TMDL Completed
ID17060205SL025_02	Not Listed	Knapp Creek	Temperature	List in category 4a	TMDL Completed
ID17060206SL020_04 ID17060206SL021_04 ID17060206SL022_04 ID17060206SL023_04 ID17060206SL025_04 ID17060206SL026_04 ID17060206SL027_04 ID17060206SL028_04 ID17060206SL030_03 ID17060206SL030_02	Not Listed	Camas Creek	Temperature	List in category 4a	TMDL Completed
ID17060206SL033_02	Not Listed	Castle Creek	Temperature	List in category 4a	TMDL Completed
ID17060206SL034_02 ID17060206SL034_03	Not Listed	Silver Creek	Temperature	List in category 4a	TMDL Completed
ID17060206SL035_02	Not Listed	Duck Creek	Temperature	List in category 4a	TMDL Completed

ID17060206SL037_03 ID17060206SL038_03 ID17060206SL039_03 ID17060206SL041_03 ID17060206SL043_03 ID17060206SL043_02	Not Listed	Yellowjacket Creek	Temperature	List in category 4a	TMDL Completed
ID17060206SL012_02 ID17060206SL012_03	Sediment	Monumental Creek	No	Delist	Assessed Full Support

Public Involvement

The Challis Experimental Stewardship Group serves as the watershed advisory group while the Upper Salmon Basin Watershed Program Technical Team is providing any necessary technical oversight. Idaho Falls DEQ consulted with the Challis Experiment Stewardship Group about going out for public comment in February 2008 and did not receive any objections to doing so. In addition, the Shoshone Bannock Tribe and Boise National Forest have also been consulted regarding this TMDL.

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1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.)

This document addresses the water bodies in the Upper and Lower Middle Fork Salmon River Subbasin that have been placed on Idaho's current §303(d) list.

The overall purpose of the subbasin assessment (SBA) and TMDL is to characterize and document pollutant loads within the Upper and Lower Middle Fork Salmon River Subbasin. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Upper and Lower Middle Fork Salmon River Subbasin (Section 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the

CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards). Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. An SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. *The Middle Fork Salmon River Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the Middle Fork Salmon River Subbasin.

The SBA section of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Middle Fork Salmon River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution, but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation—primary (swimming), secondary (boating)
- Water supply—domestic, agricultural, industrial

- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

An SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

1.2 Physical and Biological Characteristics

This section discusses the general physical and biological characteristics of the Middle Fork Salmon River watershed (Figure 1). The Middle Fork of the Salmon River runs approximately 102 miles from its source at the confluence of Marsh Creek and Bear Valley Creek to its confluence with the Salmon River. It is a fairly high-gradient river throughout its course, running through the moderate to high elevation Salmon River mountains.

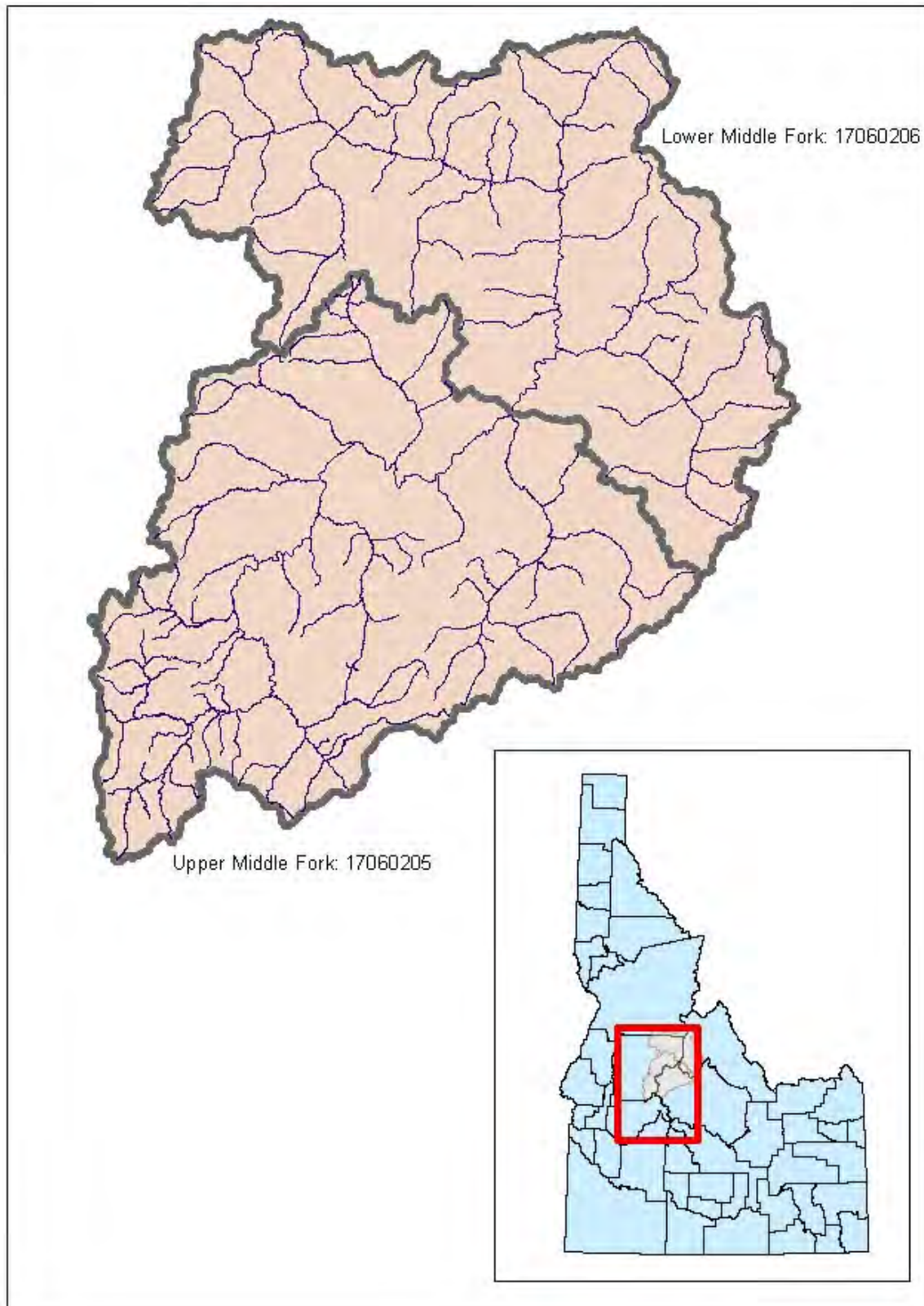


Figure 1. Middle Fork Salmon River subbasins and associated hydrologic unit codes.

Land ownership in this sparsely populated watershed is diverse, with a large amount of federal land interspersed with very little private land. Public land within the Middle Fork Salmon River watershed is managed by the Payette National Forest, the Boise National Forest, and the Salmon-Challis National Forest. Private inholdings are found in the Seafoam Mining District in the Rapid River Watershed, the Loon Creek Mining District on Loon Creek, the Myers Cove Mining District on Camas Creek, and the Yellowjacket Mining District on Yellowjacket Creek.

The Sawtooth Mountains delineate the northern boundary of this watershed, with the remaining watershed within the Salmon River Mountains, which include the Bighorn Crags and the Yellowjacket Mountains. The Salmon River Mountains are the second largest of the Idaho Batholith mountain groups and the largest within the Middle Fork Salmon River Watershed. The Middle Fork of the Salmon River flows predominantly from south to north, and the tributaries generally flow east and west. The tributaries are primarily low-volume forested streams, many of which are intermittent or ephemeral.

The Middle Fork Salmon River provides habitat for 366 wildlife species: 75 mammals, 242 birds, 19 fish, 21 reptiles, and nine amphibians. This watershed provides habitat for several threatened, endangered, and sensitive species. Native resident and anadromous fishes include steelhead trout and chinook salmon, cutthroat trout, bull trout, rainbow trout, whitefish, and sculpin. Brook trout, California golden trout, and arctic grayling have been introduced into some lakes and streams.

The predominant landscape-changing force within the watershed is fire. Approximately 95 wildfires occur per year in the Frank Church River of No Return Wilderness (FC-RONRW). Most (88%) are lightning caused. While most fires have been suppressed to less than one acre, major fires average 60 acres per fire. Historically, there have been numerous fires that have involved thousands of acres.

Climate

The Middle Fork Salmon River subbasin has a broad climatic gradient, ranging from a prevalent Pacific maritime regime in the western watershed to a more continental regime in the eastern area (Table 1 and Table 2). The Pacific maritime-influenced climate of the western portion of the subbasin is primarily affected by the seasonal movement of two opposing weather systems (Ross and Savage 1967). From the late fall to early spring months, the climate is influenced by cool and moist Pacific maritime air. Periodically, this westerly flow of air is interrupted by outbreaks of cold, dry, continental air from Canada normally blocked by mountain ranges to the east. During the summer months, the westerly winds weaken, and a Pacific high-pressure system becomes dominant, resulting in decreased precipitation and more continental climatic conditions. The region is generally characterized by warm summers and mild or cool winters (Table 3). Across the Middle Fork Salmon River subbasin, most precipitation occurs as snow during winter and early spring, while summers are comparatively dry.

Table 1. Weather stations in the Middle Fork Salmon River Subbasin area.

Station Name	Station ID #	Period of Record	Latitude	Longitude	Elevation
Stanley	108676	1963-2005	44° 13'	114° 56'	6,240' amsl ¹
Deadwood Dam	102385	1929-1975	44° 19'	115° 38'	5,380' amsl
Taylor Ranch	109000	1974-2005	45° 06'	114° 51'	3,840 amsl
Yellow Pine	109951	1970-2005	44° 55'	115° 29'	5,050 amsl
Middle Fork Lodge	105897	1971-2005	44° 43'	115° 01'	4,480 amsl

¹Above mean sea level.**Table 2. Average monthly precipitation (ml) and average monthly snowfall (ml) at Middle Fork area weather stations.**

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Stanley	a.m.p. ¹	1.64	1.33	1.02	1.02	1.17	1.16	0.59	0.59	0.80	0.92	1.46	1.55	13.26
	a.m.s. ²	16.9	13.2	10.2	3.4	0.9	0.2	0.0	0.0	0.4	1.7	10.4	14.6	71.9
Deadwood Dam	a.m.p.	5.23	3.93	3.43	1.97	1.89	1.98	0.56	0.69	1.04	2.29	3.74	5.52	32.6
	a.m.s.	49.8	33.2	25.0	8.1	1.3	0.0	0.0	0.0	0.1	3.8	21.6	43.7	186.5
Taylor Ranch	a.m.p.	1.03	0.79	1.03	1.52	2.08	1.78	1.21	1.01	0.81	1.01	1.2	0.94	14.42
	a.m.s.	10.5	5.6	3.7	1.1	0.1	0.0	0.0	0.0	0.0	0.2	4.8	8.2	34.2
Yellow Pine	a.m.p.	3.2	2.59	2.4	1.98	2.00	1.94	1.08	1.03	1.59	1.77	3.45	3.61	26.65
	a.m.s.	24.1	17.4	11.1	5.8	0.9	0.1	0.0	0.0	0.1	2.3	15.7	26.1	103.6
Middle Fork Lodge	a.m.p.	1.61	1.26	1.22	1.42	1.64	1.55	0.99	0.90	1.02	1.14	1.66	1.57	15.99
	a.m.s.	12.3	7.7	3.5	1.6	0.1	0.0	0.0	0.0	0.0	0.7	5.7	10.1	41.7

¹Average monthly precipitation, ²average monthly snowfall.

Table 3. Average maximum and minimum temperature (°F) at Middle Fork area weather stations.

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Stanley	Max. ¹	27	33.7	42.5	50.3	59.9	68.4	78.7	78.4	68.6	56.6	38.1	26.0	52.4
	Min. ²	-0.5	0.3	9.7	20.3	28.3	33.9	36.0	34.0	27.3	20.6	12.0	-0.8	18.4
Deadwood Dam	Max.	29.8	37.0	42.4	51.4	62.5	70.5	82.5	81.8	72.0	59.3	41.3	31.3	55.1
	Min.	4.7	8.4	11.8	21.1	28.5	35.0	38.8	36.8	31.1	25.6	17.8	9.2	22.4
Taylor Ranch	Max.	30.4	37.9	49.3	59.4	68.1	76.1	86.7	85.3	75.1	58.3	39.8	29.3	58.0
	Min.	14.9	17.3	25.6	31.8	38.1	43.8	48.7	46.9	39.6	31.1	23.6	15.2	31.4
Yellow Pine	Max.	33.3	38.7	45.0	51.7	61.3	69.6	80.0	80.1	70.1	57.8	40.2	32.5	55.0
	Min.	9.1	11.2	18.1	23.9	30.3	35.5	39.1	37.3	30.5	24.6	18.2	9.7	24.0
Middle Fork Lodge	Max.	34.5	41.1	50.8	58.9	67.3	76.5	86.1	85.3	75.9	62.4	43.4	33.3	59.6
	Min.	13.3	15.7	23.7	29.0	35.5	41.3	46.0	44.2	36.6	28.6	21.3	13.1	29.0

¹Average maximum temperature, ²average minimum temperature.

The easternmost portion of the subbasin is characterized by warm summers and cold winters. Mean annual precipitation is typically one-half the amount received in the west of the subbasin. The Salmon River Mountains and Sawtooth Range create a rainshadow effect, allowing only an occasional influx of moisture-laden winter air from the Pacific. Precipitation patterns in the rain shadow differ from those found across the rest of the subbasin. In areas outside the rain shadow, precipitation frequently occurs in the early summer when convective showers are common; winters are relatively dry. Geographic differences in the seasonal distribution of precipitation influence the characteristics of terrestrial and aquatic habitats. Occasionally, lengthy frontal rainstorms can produce as much as 25 cm (10 inches) of precipitation. These events are a critical factor in flooding and landslides during winter and spring (Platts 1974). Some areas are covered with snow for more than eight months of the year, while other areas receive only minor amounts. Above 1,210 m (3,970 ft), most of the annual precipitation occurs as snow, with maximum accumulation occurring by about the first week in April.

In Idaho, data showing the percent of potential sunlight is only collected in Boise and Pocatello. Differences in elevation, precipitation, terrain, and moisture regime prevent drawing any conclusions from this data. Percent potential sunlight data is included in Table 4 as a reference to show that the percent incident sunlight over the Middle Fork watershed is not likely greater than that shown for Boise and Pocatello.

Table 4. Percent possible sunlight for two weather stations in Idaho.

Weather Station	Years of Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Boise	56	40	51	62	68	70	75	87	85	82	69	43	38	64
Pocatello	49	40	53	61	66	67	75	83	81	80	71	46	40	64

Precipitation and temperature patterns throughout the year, based on a 30-year average (1971 – 2000), are shown for three of the five previously mentioned weather stations in Idaho in Figure 2, Figure 3, and Figure 4.

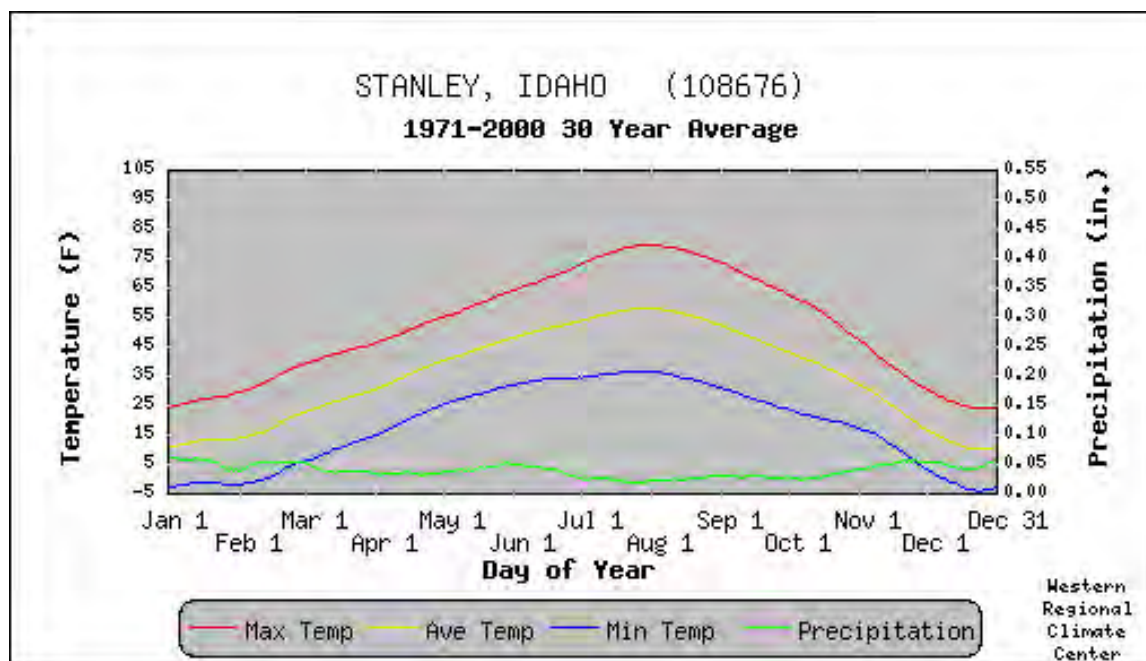


Figure 2. Average monthly temperature and average monthly precipitation at Stanley weather station, 1971-2000.

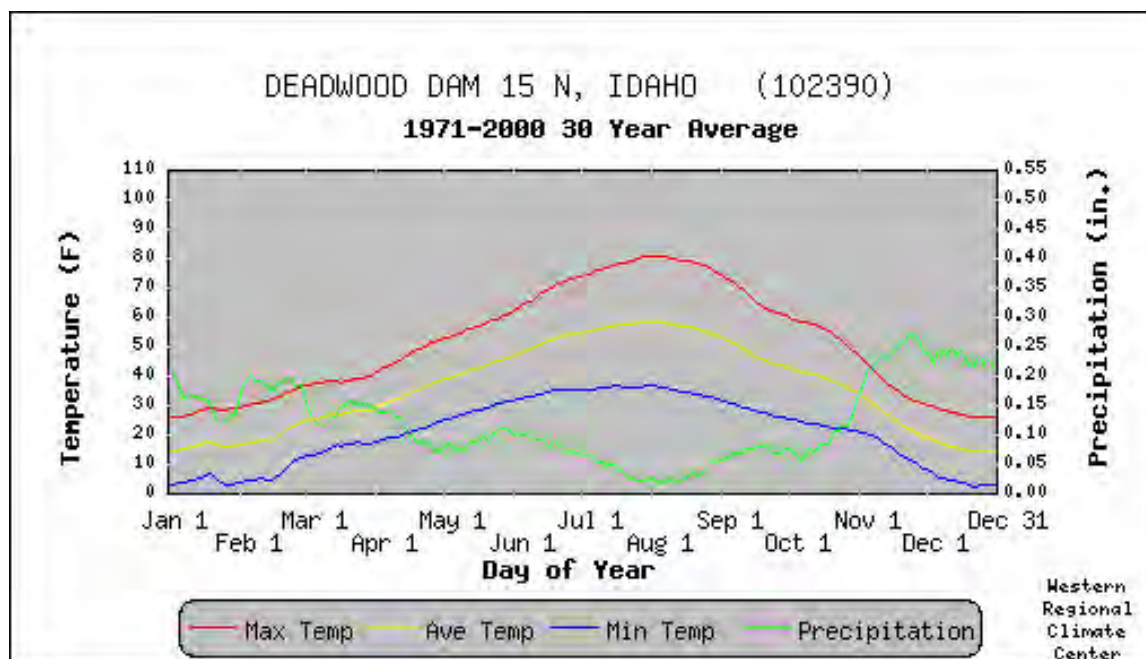


Figure 3. Average monthly temperature and average monthly precipitation at Deadwood Dam weather station, 1971-2000.

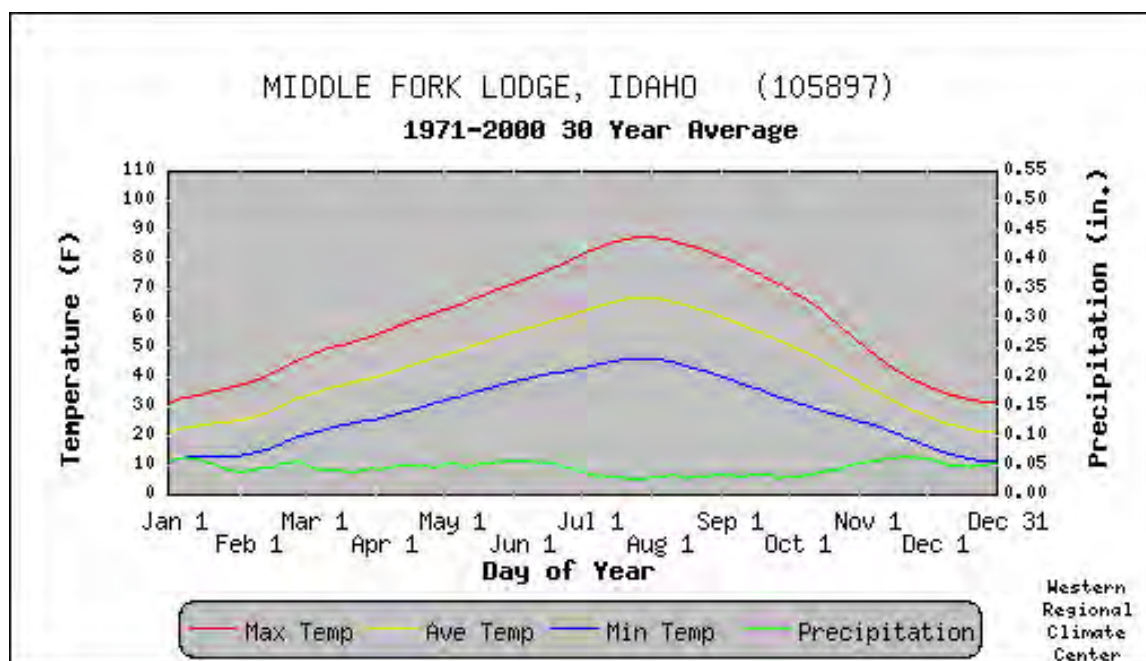


Figure 4. Average monthly temperature and average monthly precipitation at Middle Fork Lodge weather station, 1971-2000.

Subbasin Characteristics

Hydrography

Most of the subbasin is characterized by an intricate mosaic of moderate to high elevation mountain ranges combined with deeply cut valleys of the Salmon River Mountains. The Middle Fork of the Salmon River is composed of two hydrologic units (Table 5) and encompasses 13 major subwatersheds. There are numerous smaller perennial and ephemeral watersheds that enter the Middle Fork directly from side canyons.

Table 5. Major subwatersheds of the Middle Fork of the Salmon River.

Subwatershed	Hydrologic Unit Code (HUC)	Drainage Area (square miles)	Number of Named Streams	Total Stream Miles
<i>Upper Middle Fork Salmon Watershed</i>	<i>17060205</i>	<i>1,349.27</i>	<i>234</i>	<i>1,979</i>
Bear Valley Creek	17060205	191.34	12	145.48
Elk Creek	17060205	79.17	10	105.19
Marsh Creek	17060205	148.75	23	198.67
Sulphur Creek	17060205	153.05	5	102.69
Rapid River	17060205	122	24	157.77
Pistol Creek	17060205	113.73	21	153.9
Indian Creek	17060205	83.15	14	106.2
Marble Creek	17060205	130.26	21	173.76
Loon Creek	17060205	355.41	53	453.52
<i>Lower Middle Fork Salmon Watershed</i>	<i>17060206</i>	<i>1,361.48</i>	<i>185</i>	<i>1,571</i>
Wilson Creek	17060206	247.96	2	38.93
Camas Creek	17060206	397.87	43	458
Big Creek	17060206	595	105	645
Papoose Creek	17060206	29.45	2	31.92
Totals		2,710.75	419	3,550

Table 6 and Table 7 give mean annual flow statistics for the Middle Fork Salmon River.

Table 6. Mean annual flow statistics for the Middle Fork Salmon River at the lower US Geological Survey gaging station at the mouth near Shoup, Idaho.

USGS Gage 0.3 mi above Salmon River	Year	Average Annual Flow	Peak Annual Flow ¹	Minimum Annual Flow
Lower Middle Fork (17060206) Gage #13310199 Elevation 3,040' Drainage Area = 2,830 mi ²	1994	1,477	8,250	400
	1995	3,427	19,700	450
	1996	4,198	28,500	700
	1997	4,595	28,600	700
	1998	2,923	11,600	500
	1999	3,363	22,600	550
	2000	2,232	11,500	650
	2001	1,392	7,930	500
	2002	2,155	14,200	349
	2003	2,542	24,100	513
	2004		9,630	550
Average		2,978	16,965	533

¹Bankfull discharge (12,500 cfs) or greater shown in bold type.

Table 7. Mean annual flow statistics for the Middle Fork Salmon River at the upper US Geological Survey gaging station near Capehorn.

USGS Gage at Middle Fork Lodge	Year	Average Annual Flow	Peak Annual Flow	Minimum Annual Flow
Upper Middle Fork (HUC 17060205) Gage #13309220 Elevation 4,380' Drainage Area = 1,040 mi ²	1973	No data	5,560	No data
	1974	2,665	20,900	360
	1975	1,624	11,100	403
	1976	1,674	9,060	260
	1977	567	1,930	249
	1978	1,647	9,350	312
	1979	853	6,180	249
	1980	1,156	9,320	306
	1981	No data	9,680	424
	1999	No data	13,300	No data
	2000	1,151	6,130	320
	2001	624	3,750	190
	2002	1,096	7,010	190
	2003	1,366	14,300	240
	2004	No data	4,730	280
Average		1,059	8,820	244

Geology and Soils

The subbasin lies within the Northern Rocky Mountain and Columbia Intermontane geomorphic provinces (Ross and Savage 1967). Major geologic formations include Cretaceous calc-alkaline intrusive rocks of the Idaho Batholith and Eocene silicic and basaltic rock of the Challis Volcanics (Figure 5). Soils over much of the area have developed from granitic parent materials and include the quartz monzonites of the Idaho Batholith, the closely related gneissic rocks bordering the Batholith, and the true granitics of a younger geologic age. Volcanic rocks and tuffs cap rather extensive areas in the west-central portion of the wilderness.

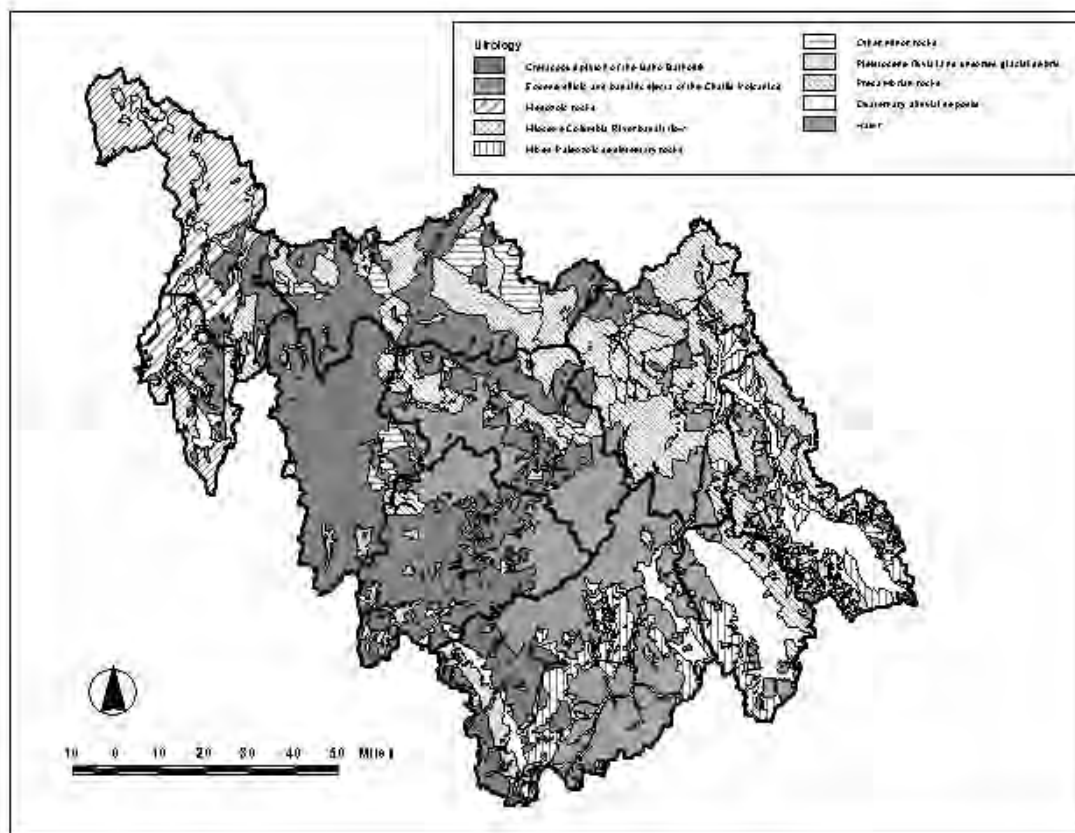


Figure 5. Major geological formations within the Salmon River Subbasin, (adapted from Northwest Power Planning Council 2001).

Soils are generally shallow, coarse, and highly erodible. The uplands and valley bottom landforms vary greatly in their soil types. The soil in the upland areas is generally poorly productive and exhibits coarse textures. Soil types on gentle and moderate mountain slopes can be rocky but are somewhat more productive. Valley bottom soil types vary. Some poorly-drained meadows exist that are flooded in spring, with deep loam and clay loam textures over coarse sand layers. There are also coarse to medium textures on “island” moraines and old stream terraces that range from sandy loam to loam. The combination of these soils, steep topography, and climatic stresses give rise to significant base surface erosion, slumping, and debris avalanche hazards (Megahan 1975).

Topographical relief is reflective of a terrain that once attained a mature erosional level (by the Middle Tertiary) and subsequently uplifted, thus re-initiating stream erosional processes (Ross and Savage 1967). Large-scale glacially-derived physiographic features (e.g., broad U-shaped valleys) are prominent in the upstream portions of the Upper Middle Fork. Localized evidence of alpine glaciation (e.g., pothole lake systems and glacial cirques) is common and dispersed throughout the subbasin on upper slope and ridge top positions of higher elevation ridge systems. Stream erosion, however, has played the predominant role in shaping the physiography of the subbasin. Stream erosion since the Middle Tertiary has given rise to a topography characterized by relatively narrow, V-shaped valleys, steep valley side slopes, and relatively narrow ridge systems.

Topography

Within the Middle Fork Salmon River watershed, topography is generally extreme. Due to the sheer size of the watershed and the fact that the headwaters are not very far removed from the headwaters of the main Salmon River, it can be expected that relief is extreme. There is 7,380 feet of relief between the highest flowing connected tributary and the confluence with the Salmon River (Table 8). Average elevation within the watershed is 7,090 ft, with extremes of 10,400 ft on Sheep Mountain and 3,030 ft at the confluence with the Main Salmon River. Average percent slope calculated from 30m DEM (Digital Elevation Model) is 45.4%, and the average percent of area with slope greater than 30% is 75.8% (USGS StreamStats 2006). The percent of area on north-facing slopes with slope greater than 30% is 25.1% (Table 8).

Table 8. Middle Fork Salmon River topography and aspect values.

Parameter	Value
Watershed Area (mi ²)	2,870
Relief (ft)	7,380
Average elevation (ft)	7,090
Maximum elevation (ft)	10,400
Minimum elevation (ft)	3,030
Average area slope (percent)	45.4
Percent area slope greater than 30%	75.8
Percent of north-facing slope area with slope greater than 30%	25.1

Vegetation

Vegetation is important in its function as habitat for upland and aquatic species. The role of vegetation in relation to water quality is diverse. Vegetation acts as a buffer for runoff to alleviate flash flooding and destructive erosive force and is important both for shading surface water to reduce thermal input and for stabilizing the landscape and balancing sediment inputs to streams.

Species composition, seral status, potential natural vegetation, plant distribution, and ecological function are affected by climate, soil, land management, disturbance, and time. Within the Middle Fork Salmon River, factors such as extreme topography in the watershed, reduced frost-free periods, low to moderately productive soils, periods of low precipitation, and a wide range of temperature extremes combine to limit vegetative production potential. In general, vegetation at lower elevations is typically grasslands, shrublands, ponderosa pine, and Douglas-fir on south and west aspects, and Douglas-fir and grand fir forests on north and east aspects. Mid elevations are dominated by forest communities of Douglas-fir, grand fir, and subalpine fir, with pockets of lodgepole pine and aspen. Subalpine fir and whitebark pine are found at higher elevations. Vegetation land cover for the Upper and Lower Middle Fork Salmon River hydrologic units is shown in Figure 6 and Figure 7.

Upper Middle Fork Salmon River Land Cover

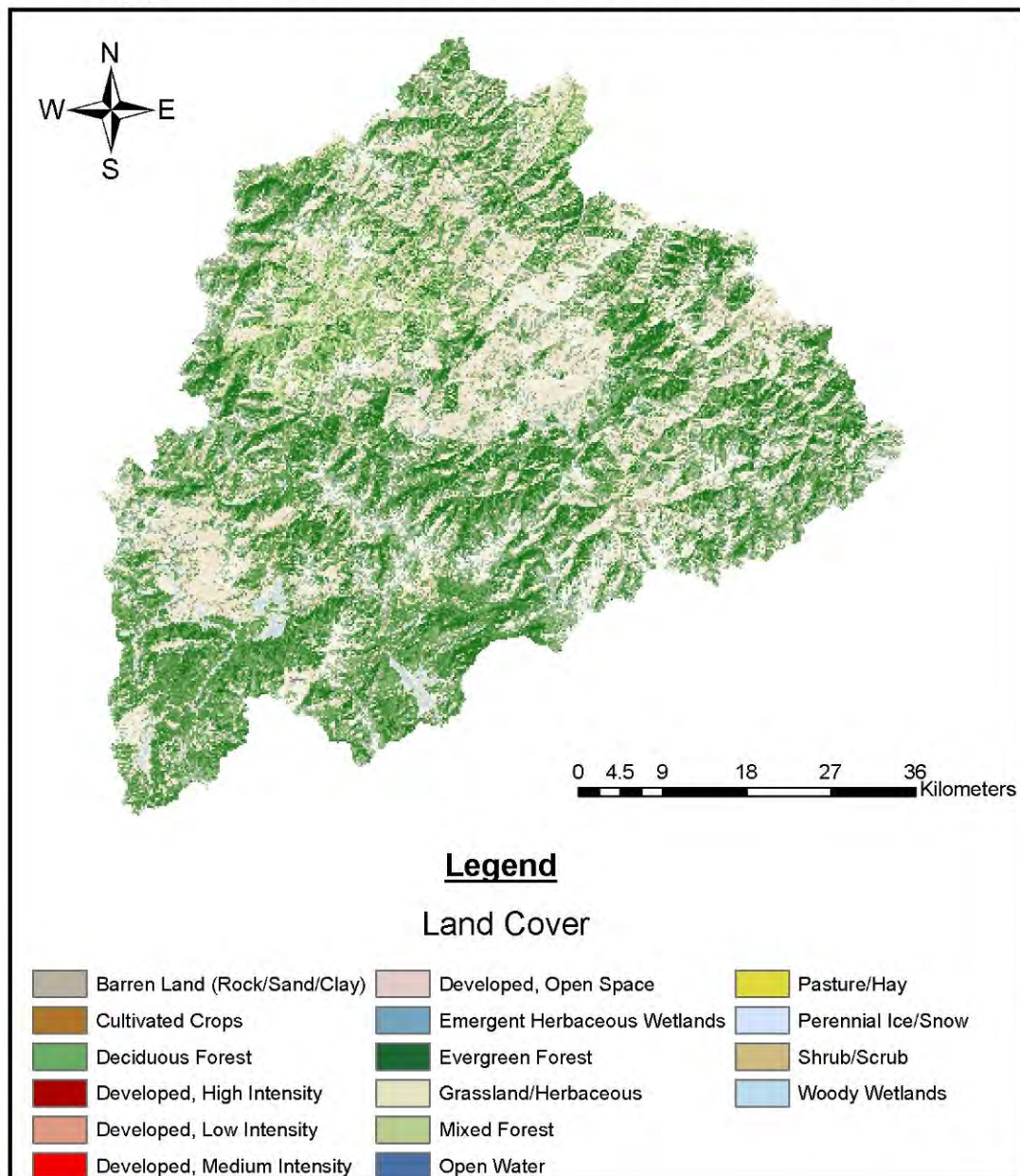


Figure 6. Upper Middle Fork Salmon River Land Cover.

Figure 6. Upper Middle Fork Salmon River Land Cover.

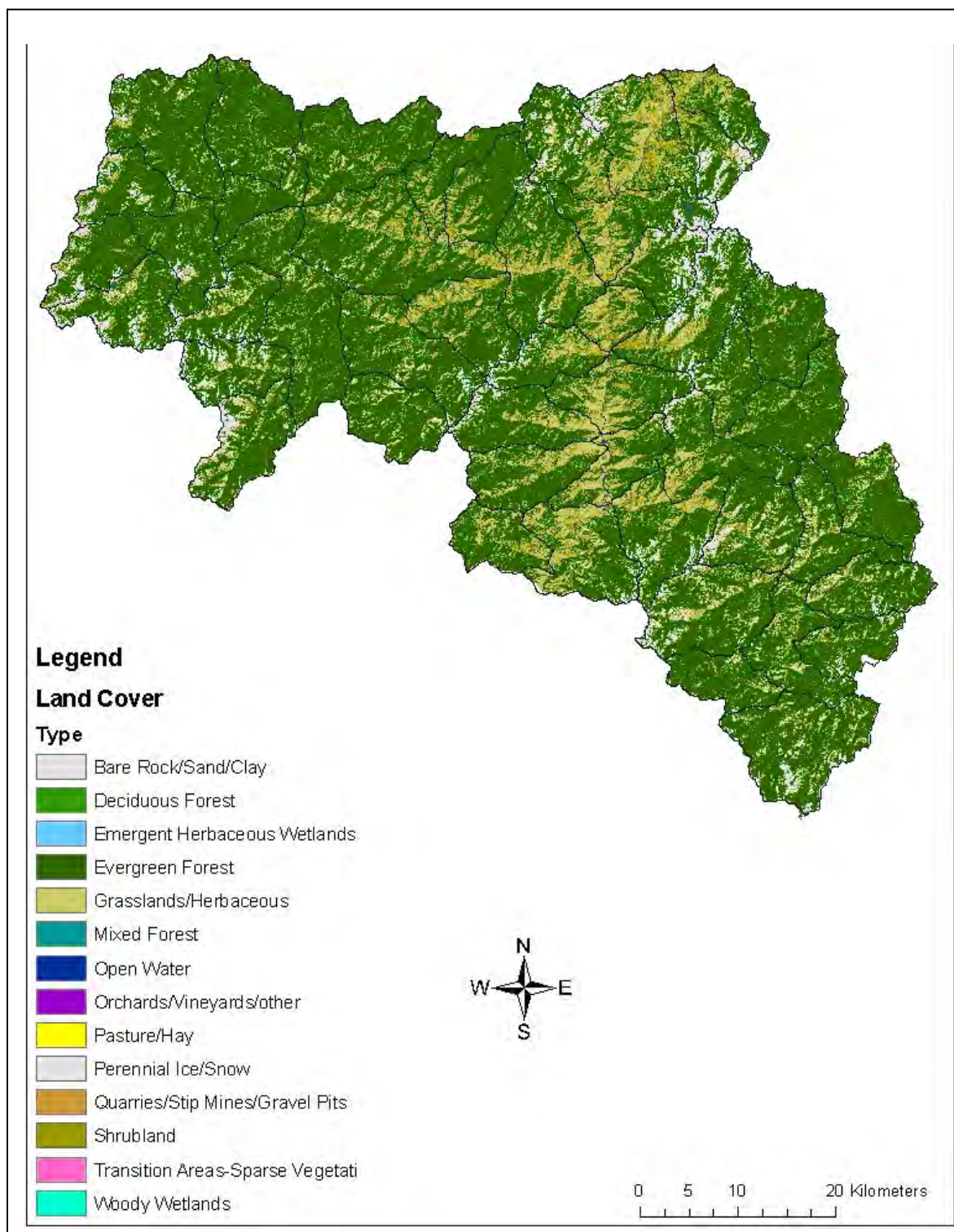


Figure 7. Lower Middle Fork Salmon River Land Cover.

There are no known plant species within the Middle Fork watershed (FS 2003) that are threatened or endangered according to the Endangered Species Act (ESA). A number of noxious weeds and invasive species are present within the watershed. However, the expansion of exotic invasive weeds (noxious weeds) no longer poses a threat to the integrity of native plant communities (USFS 2003).

Fisheries

The Middle Fork Salmon River Watershed is known to support 24 species of fish, of which 19 are native and five are non-native (introduced) (Table 9). Of the 19 native fish species present in the subbasin, four are federally listed under the ESA as threatened (bull trout, spring chinook salmon, summer chinook salmon, and steelhead trout). A recent broad-scale assessment of the entire Interior Columbia River Basin ecosystem (ICBEMP 1997) found that the Salmon River Subbasin, including the Middle Fork of the Salmon River, provides a core of remaining connected habitat for five species of salmonids: bull trout, westslope cutthroat trout, redband trout (sympatric with steelhead trout), chinook salmon, and summer steelhead trout (Rieman et al. 1997, Thurow 2000). The subbasin contains designated critical habitat for the listed Snake River spring/summer chinook as well as large connected habitats for Pacific anadromous lamprey and other native nongame fishes. Critical habitat for bull trout is found in much of the Middle Fork Salmon River Subbasin.

Table 9. Fish known to inhabit the Middle Fork Salmon River Subbasin.

Species ¹	Origin ²	Status ³	Presence ⁴ in MFU ⁵	Presence in MFL ⁶
Arctic grayling (<i>Thymallus arcticus</i>)	I	R	X	
Bridgelip sucker (<i>Catostomus columbianus</i>)	N	C	X	
Brook trout (<i>Salvelinus fontinalis</i>)	I	O	X	X
Bull trout (<i>Salvelinus confluentus</i>)	N	T	X	X
Chiselmouth (<i>Acrocheilus alutaceus</i>)	N	C	X	
Golden trout (<i>Oncorhynchus aquabonita</i>)	I	R		X
Largescale sucker (<i>Catostomus macrocheilus</i>)	N	C	X	X
Longnose dace (<i>Rhinichthys cataractae dulcis</i>)	N	C	X	SW
Mottled sculpin (<i>Cottus bairdi semiscaber</i>)	N	C	X	X
Mountain sucker (<i>Catostomus platyrhynchus</i>)	N	C	X	?
Mountain whitefish (<i>Prosopium williamsoni</i>)	N	C	X	X
Northern pikeminnow (<i>Ptychocheilus oregonensis</i>)	N	C	X	X
Pacific lamprey (<i>Lampetra tridentata</i>)	N	S	H/U	X
Rainbow trout (<i>O. mykiss</i>) unknown origin	I	C	X	X
Rainbow x cutthroat trout hybrid	I	C		
Redband trout (<i>Oncorhynchus mykiss gibbsi</i>)	N	S	X	X
Redside shiner (<i>Richardsonius balteatus balteatus</i>)	N	C	X	
Shorthead sculpin (<i>Cottus confusus</i>)	N	U	X	SW
Speckled dace (<i>Rhinichthys osculus</i>)	N	C	X	
Spring Chinook (<i>Oncorhynchus tshawytscha</i>)	N	T	X	X
Summer Chinook (<i>Oncorhynchus tshawytscha</i>)	N	T		X
Summer steelhead (<i>Oncorhynchus mykiss</i>)	N	T	X	X
Torrent sculpin (<i>Cottus rhotheus</i>)	N	C		X
Westslope cutthroat (<i>Oncorhynchus clarki lewisi</i>)	N	S	X	X

¹Federally listed species are identified in bold; ²Origin: N=Native, I=Introduced; ³Status: C=Common, O=Occasional, R=Rare, S=Sensitive, T=Threatened, E=Endangered, U=Unknown; ⁴Presence: X=present, H=Historical, SW=present according to Simpson and Wallace (1982), U=Unknown; ⁵MFU = Upper Middle Fork Salmon River; ⁶MFL = Lower Middle Fork Salmon River.

Spring chinook salmon are distributed throughout the Upper and Lower Middle Fork Salmon River Watersheds, primarily in the mainstem and larger tributaries. Fall chinook are distributed primarily in the mainstem Middle Fork Salmon River and Big Creek. Steelhead trout are widely distributed and extend more into smaller tributaries than do spring chinook. Westslope cutthroat trout are found throughout the Middle Fork

watersheds and are capable of occupying first and second order streams and larger. The least widely distributed of the ESA species is the bull trout, though the Middle Fork Salmon River Watershed is considered a core area in reference condition for this species. Bull trout display wide yet patchy distribution throughout their range. Within the entire Columbia Basin, the Central Idaho Mountains (more than half of which falls within the Salmon Subbasin) support the most secure populations of bull trout (USFS 2002).

Historically, the Middle Fork of the Salmon River is reported to have supported 27% of Idaho's chinook harvest (Mallet 1974). This estimate was made at a time when the runs had already been substantially depressed by fisheries outside the Salmon River Subbasin as well as a variety of disturbances within other areas of the subbasin. The Middle Fork spring chinook is a purely wild run with a strong age five component. Summer chinook currently constitute a minor component of the runs in this watershed. The entire Middle Fork is currently serving as a study area for research evaluating the factors influencing spatial dynamics and persistence of chinook salmon within the FCRONR Wilderness (Thurow 2000). This research included a complete census and assessment of the spawning distribution of these fish from 1995 through 1998.

Spawning of steelhead and rainbow trout in the Middle Fork Salmon River Watershed is estimated to begin in early March and go through mid-May (Keifer et al. 1992). Summer chinook are estimated to spawn from September to mid-October, and spring chinook are estimated to spawn beginning in August and ending around early September. Cutthroat Trout are estimated to begin spawning in May and end in June (White and Cochnauer 1975). Bull trout, in general, are estimated to spawn between September 1 and April 1.

Subwatershed Characteristics

This section discusses the subwatersheds that comprise the upper and lower Middle Fork Salmon River Subbasins. To facilitate better understanding of the following discussion, an explanation of the Rosgen geomorphological stream classification system and stream order is given.

Rosgen Stream Types

The Rosgen Stream Classification system is useful in describing general stream characteristics like channel shape, channel patterns (i.e. braided), valley types that a stream is found in, etc. Based on the geomorphological characteristics of streams, the Rosgen classification scheme delineates expected ranges for width/depth ratios, entrenchment, substrate materials, sinuosity, and gradient. When dealing with streams impaired by sediment, the Rosgen Stream Classification system is an important tool in determining whether a stream is stable or not and whether that instability is leading to contribution of excess sediment to the stream.

General stream classes are broken out by an A-G lettering scheme which can be further subdivided in each letter grouping by numbers (i.e. C1, C2 ... C6). The following section is an overview of the geomorphic stream categories found throughout the watershed (Figure 8).

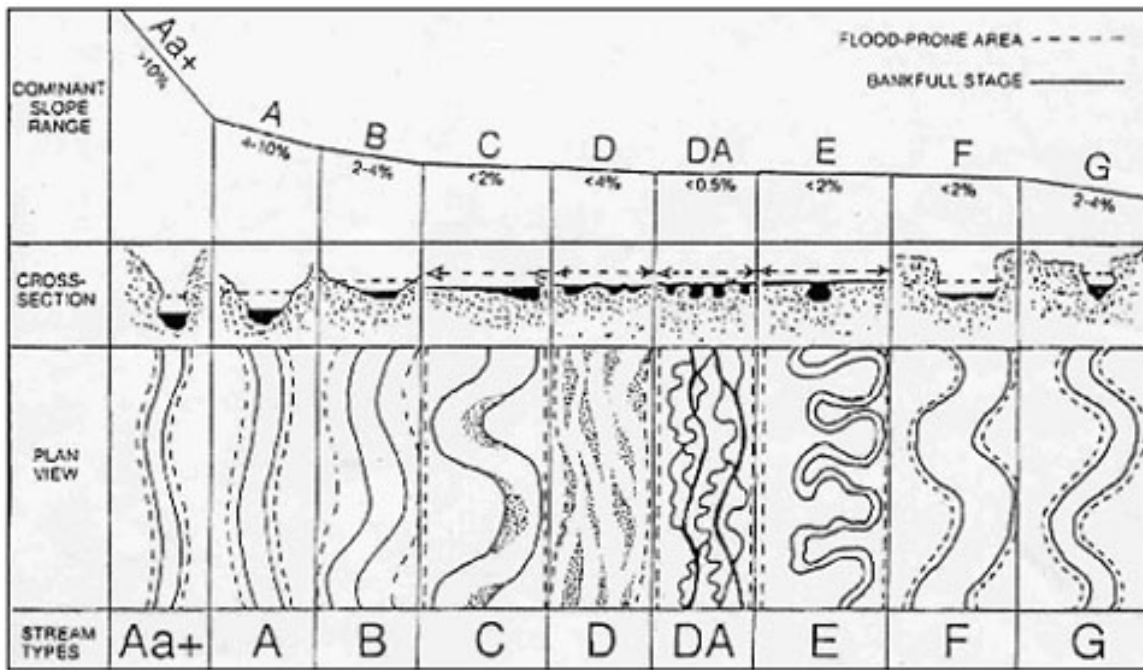


Figure 8. Rosgen stream characteristics. Rosgen 1996

Headwater streams and smaller tributary streams are typically A channel types (Rosgen 1996) because they course through steeper terrain. These are steep-gradient, low sinuosity, confined channels, with high sediment transport capacity. Channel gradients are greater than 4% and have a cascading, step/pool morphology. These streams have low width to depth ratios.

Type B streams generally occupy stable channels with moderately stable banks. These streams tend to occur in narrow, gently sloping valleys in areas of moderate relief. They may be moderately entrenched in low gradient channels. Channel gradients typically range from 2-4%, but may be lesser or greater. Width-to-depth ratios are moderate and bed forms are predominantly riffle with infrequently spaced pools.

Moderate gradient and moderately to well confined type B channels are predominantly associated with mainstem and tributary reaches within moderate relief landforms.

Type C streams typically occupy low gradient (less than 2%) alluvial channels with broad, well defined floodplains located in broad valleys. These streams are slightly entrenched within a well-defined meandering channel. Generally, they have a riffle-pool bed morphology with point bars typically developed at meander bends.

Stream Order

Stream order is a hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Higher order streams result from the joining of two streams of the same order. Figure 9 shows the stream order hierarchy.

Stream order is a hierarchical ordering of streams based on the degree of branching. As shown in Figure 18, a first-order stream is an unforked or unbranched stream. Two first-order streams flow together to form a second-order stream, two second-order streams combine to make a third-order stream, etc. Use a 1:100,000 map to determine stream order. This is a single selection field, choose only one.

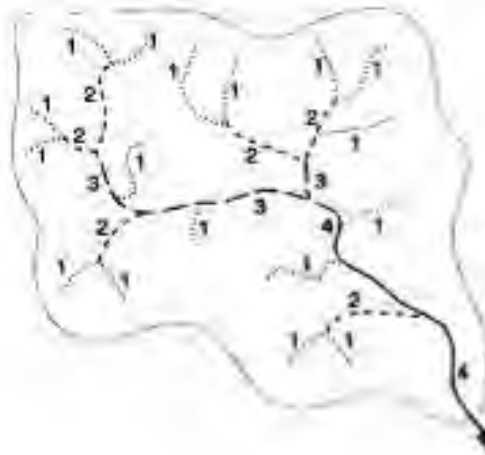


Figure 9. Stream order. (DEQ 2004)

Upper and Lower Middle Fork Salmon River Subbasins

Middle Fork Salmon River Subbasins that comprise the watershed are grouped by upper and lower Middle Fork Salmon River Hydrologic Unit Codes (HUCs). The upper and lower HUCs are broken down into 5th field resolution (Table 10 and Table 11). Within the 5th field hydrologic units are administrative divisions used by EPA and DEQ for accounting of similar streams called assessment units (AUs). Because of the remote wilderness nature of the Middle Fork Salmon River subwatershed, little actual assessment has been completed except where access is convenient or practical.

Table 10. Upper Middle Fork Salmon River 5th field hydrologic units.

Stream Name	5 th Field HUC	Area (acres)	Included Streams
Bear Valley	1706020501	71,785.8	Wyoming, Fir, Cache
Elk Creek	1706020502	50,670.1	Bearskin
Marsh Creek	1706020503	95,200.5	Beaver, Knapp, Cape Horn
Upper Middle Fork Tributaries	1706020504	130,889.2	Elkhorn, Soldier, Sulphur
Rapid River	1706020505	78,154.8	Seafoam
Middle Fork Salmon	1706020506	97,413	Little Loon
Pistol Creek	1706020507	72,784.7	Little Pistol
Indian Creek	1706020508	53,217.6	
Marble Creek	1706020509	83,368.3	Trail
Upper Loon Creek	1706020510	10,5582.0	Canyon, Cottonwood, Mayfield
Warm Springs Creek	1706020511	61,622.9	Trapper
Lower Loon Creek	1706020512	60,261.5	Cache
Total Area		960,950.4	

Table 11. Lower Middle Fork Salmon River 5th field hydrologic units.

Stream Name	5 th Field HUC	Area (acres)	Included Streams
Lower Middle Fork Tributaries	1706020601	158,700.2	Waterfall, Wilson, Soldier, Brush, Sheep
Upper Camas Creek	1706020602	85,418.4	Castle, Furnace, S. Fk. Camas, White Goat
Lower Camas Creek	1706020603	99,906.6	Silver, Woodtick, Duck, W. Fk. Camas
Yellowjacket Creek	1706020604	69,313.7	Hoodoo
Upper Big Creek	1706020605	61,612.0	Smith, Logan, Little Marble
Big Creek-Beaver Creek	1706020606	85,520.9	Beaver, Big Ramey, Crooked, Little Ramey
Monumental Creek	1706020607	80,493.5	Holy Terror, Snowslide, W. Fk. Monumental
Big Creek-Cabin Creek	1706020608	84,714.5	Cave, Cabin, Coxey
Rush Creek	1706020609	60,115.2	
Lower Middle Fork-Papoose	1706020606	85,537.9	Goat, Stoddard, Roaring, Ship Island
Total Area		871,332.9	

The total area of the Upper and Lower Middle Fork Salmon HUCs combined is 2,862.4 mi² (1832283.3 acres).

The Upper Middle Fork of the Salmon River is formed by the confluence of Bear Valley Creek and Marsh Creek. The Middle Fork flows approximately 102 miles to its confluence with the Salmon River downstream of Shoup, Idaho. The Lower Middle Fork Hydrologic Unit begins at the watershed divide of Cache Creek to the East and Jack's Creek to the West at the terminus of the Upper Middle Fork Salmon River Hydrologic Unit.

Subbasins will be discussed from the headwaters of Marsh Creek and Bear Valley Creek downstream to the confluence of the Middle Fork of the Salmon River with the main-stem Salmon River. In subsequent sections the subbasin streams will be grouped by Assessment Units (AUs) for further discussion of important features related to water quality. The FCRONR Wilderness AUs do not have significant data that allows for assessment of beneficial uses. It is assumed that these subwatersheds represent natural background conditions with minimal disturbance related to human management and that beneficial uses are fully supported unless shown otherwise by existing data.

Upper Middle Fork Major Subwatersheds

Bear Valley Creek Subwatershed

Bear Valley Creek flows 20 miles in a northerly direction before it joins Marsh Creek to form the Middle Fork Salmon River (Figure 11). This fifth order stream is an important spawning and rearing stream for chinook salmon, steelhead, and bull trout. Bear Valley Creek's watershed area comprises about 23% of the upper Middle Fork watershed and less than 4% of the Middle Fork subbasin. Its drainage area is approximately 342 square miles and contains about 393 total stream miles. The high point in the watershed is 9,526 feet at the summit of Cape Horn Mountain while the low point is 6,300 feet at the mouth of Bear Valley Creek. Bear Valley Watershed is divided by Bear Valley Creek nearly down the middle. Valley sides rise moderately steep to steeply to the upland mountains. Alluvial, colluvial and glacial outwash deposits of highly erosive sandy soils characterize the valley depositional bottoms. Twenty miles of trail are present in the watershed (USFS 2000).

This section will discuss the Bear Valley Watershed in general. Boundaries and data for the specific assessment units will be discussed in Section 2. These assessment units are differentiated based upon stream order (i.e. the first and second order assessment unit is in the headwaters region of Bear Valley Creek whereas the fifth order assessment unit is at the mouth).

The history of Bear Valley Creek Watershed has greatly influenced the stream conditions found today. Mining and livestock grazing were the primary factors that brought excess sediment into the system. While both of these activities are no longer occurring today, the legacy effects, particularly of the mining, are still seen today in channel and substrate conditions.

Geology

The Bear Valley Creek watershed lies within the Idaho batholith. Weathering, glaciation, and fluvial and hillslope erosion have shaped the granitic parent material into the variety of landforms observed in the watershed today. The deep valley fill of lower mainstem Bear Valley Creek is composed of material translocated from upland sources by glacial or fluvial processes. Bear Valley Creek descends from the mouth of Fir Creek through a steep, incised canyon to the Middle Fork Salmon (USFS 2000).

Roads

Approximately 154 total miles of Forest System and County roads are in the watershed. Road densities throughout the watershed are low, the highest density being in Upper Bear Valley (1.6 miles/square mile). Road 582 takes a southwesterly route along lower Bear Valley Creek and is the longest road in the watershed.

Existing roads are usually located on gentle relief; therefore, their capability to route or concentrate any surface flow resulting in sediment delivery is limited. Because of the low road density and the watershed's inherent ability to attenuate peak flows, roads have limited influence on hydrologic response at both the subwatershed and watershed scale.

Wilderness and Inventoried Roadless Areas

The watershed contains 37,576 acres of the southernmost portion of the FC-RONR Wilderness. This portion of the wilderness comprises 31% of the Bear Valley Watershed, and, with the exceptions of grazing and outfitter permits, is managed by the adjacent

Salmon-Challis National Forest. All or portions of six roadless areas, totaling 29,174 acres, are within the Bear Valley Creek watershed. Four of the areas are adjacent to the FC-RONR Wilderness.

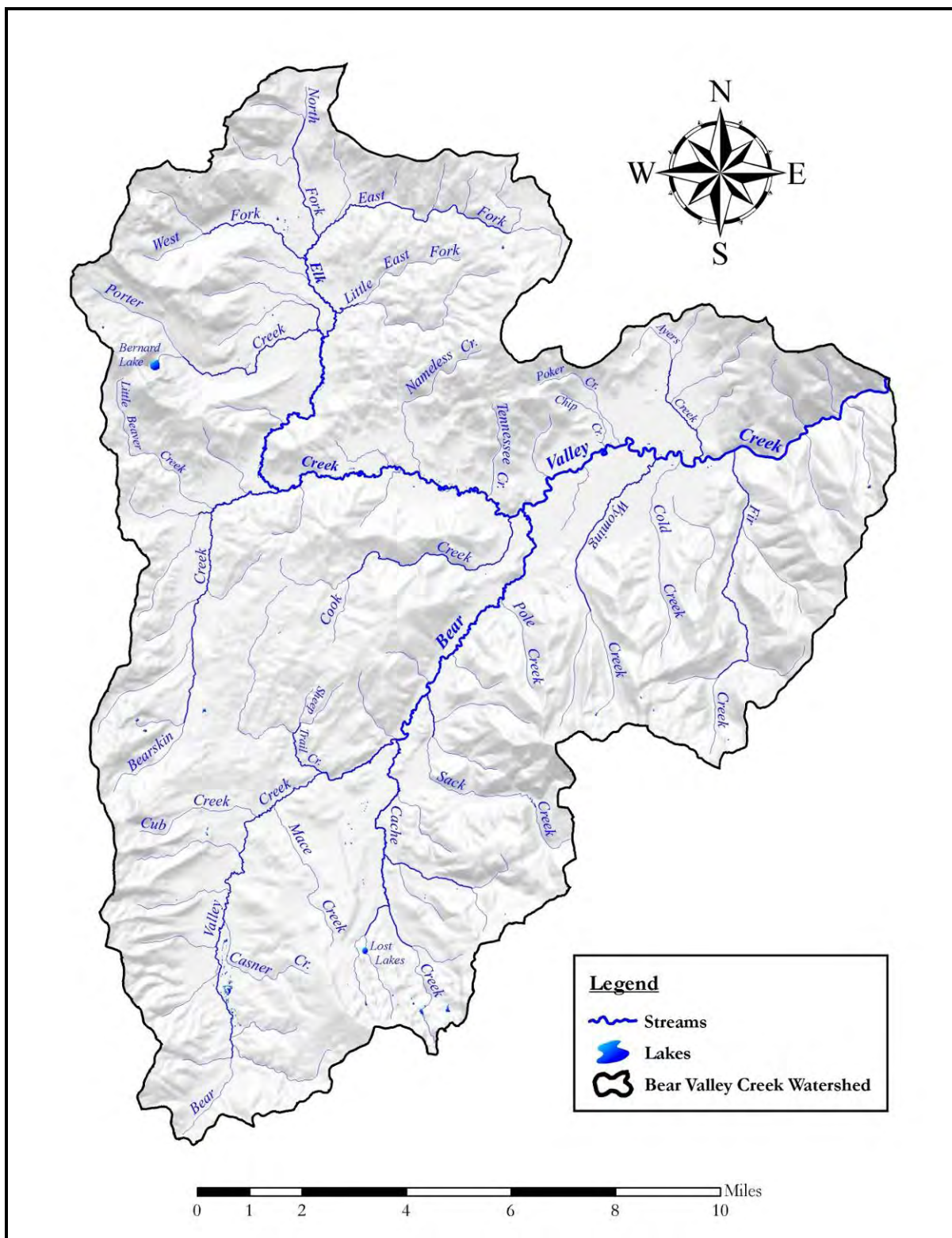


Figure 10. Bear Valley Creek watershed.

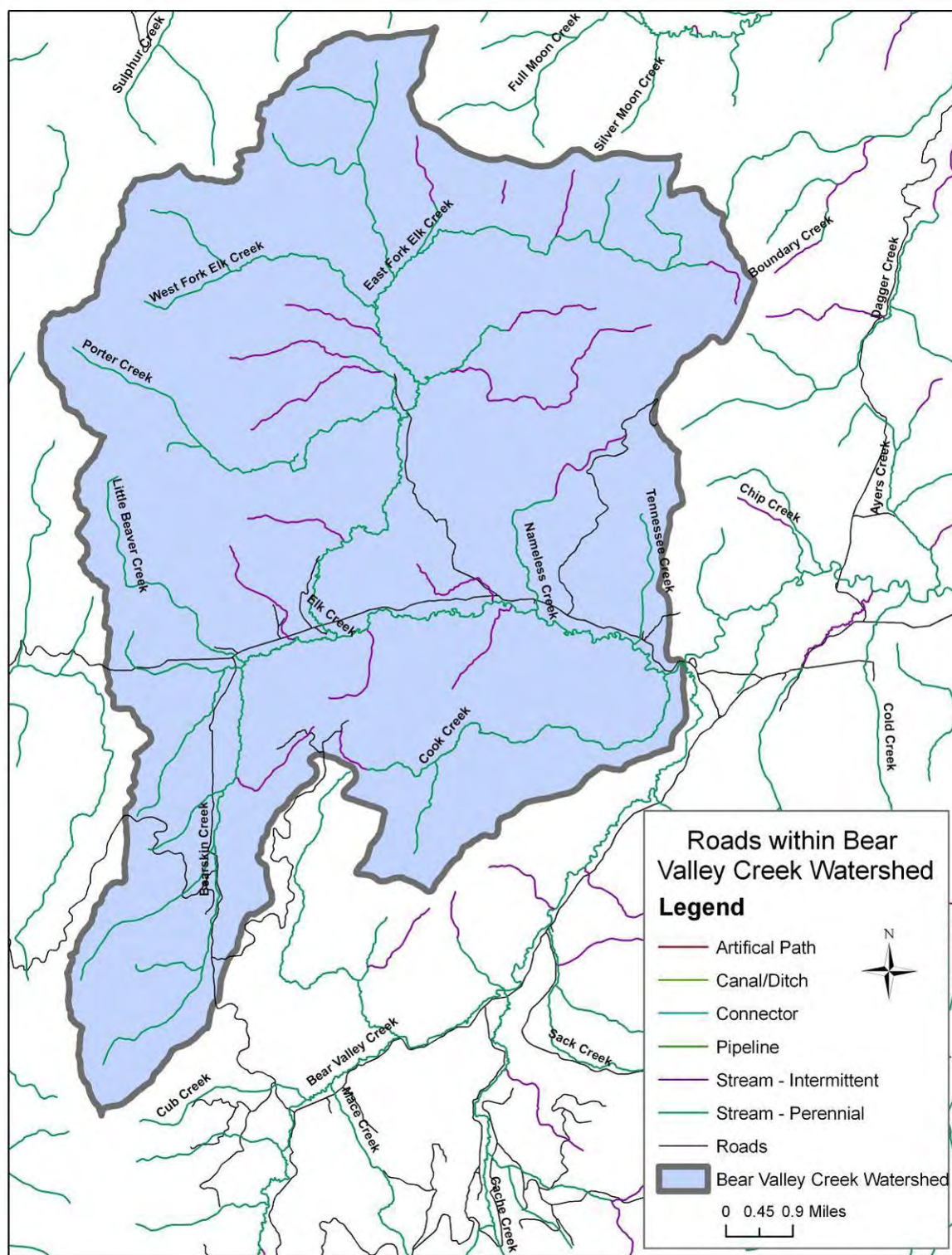


Figure 11. Bear Valley Creek watershed roads.

Hydrology

Bear Valley Creek is a perennial stream with an average gradient of 21 feet per mile. A moderately to highly sinuous creek, Bear Valley Creek has an unconfined to moderately confined channel. Oxbows and abandoned channels are evident in aerial photographs. The

main valley reaches are Rosgen C3, C4 and C5 channel types. Major tributaries include Elk Creek (discussed in the following section), Fir, Cub, Sheep Trail, Wyoming, Sack, Cache, and Casner Creeks. None of these creeks serve as substantial spawning or rearing areas for chinook salmon (USFS 2000).

Meadows and valley bottom riparian areas receive much of their water from deep seepage and interflow from upland slopes. Many of these areas become completely saturated during spring thaw, and then slowly drain during summer and fall. As water drains from these areas in the summer through mid-fall, water tables near the surface drop progressively lower.

Mean monthly streamflow for the period of record is illustrated in Figure 12. The streams in the watershed experience peak flows related to snowmelt, which occurs in the late spring and early summer months. Base flows dominate the remainder of the year. Rain and rain-on-snow events contribute an estimated 25% of the annual runoff. Groundwater influences are estimated to contribute 5% of annual runoff. Base flow in the summer is maintained by groundwater, and the effects of precipitation are minimal.

Most of upper Bear Valley Creek is a source reach, meaning that this steeper gradient (4% or greater) creek is where initial entrainment of bedload materials begins. Overall in the Bear Valley watershed, 41% of the stream miles are response reaches, which are the areas where transported sediment is deposited. Transport reaches only comprise about 12% of the watershed stream miles. These are intermediate gradient (1.6% to 4%) streams that function to transport material from the high gradient source reaches to the low gradient response reaches. The high proportion of response reaches makes this watershed sensitive to disturbance.

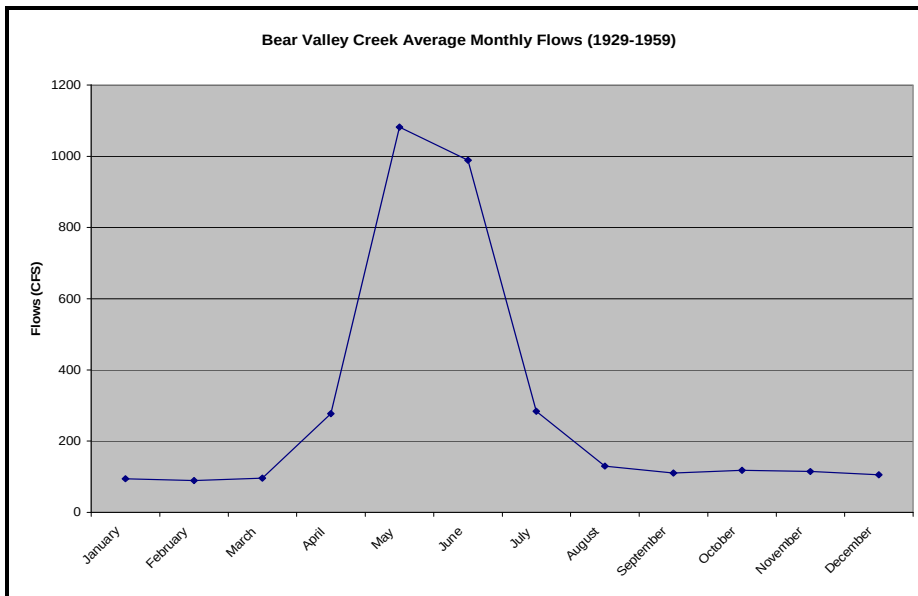


Figure 12. Bear Valley Creek average monthly flow.

Channel Characteristics

The majority of low-gradient response reaches are located in the valley bottom meadows and riparian areas of mainstem Bear Valley and Elk Creeks (USFS 2000). Floodplain and terrace landforms dominate much of the length of Bear Valley Creek along the relatively broad, unconfined main valley. Floodplain features are typically two to four times wider

than bankfull width. Bear Valley Creek is low gradient, falling approximately 750 feet in 36.3 stream miles. It exhibits a moderate to high degree of sinuosity along much of its length. The channel is generally unconfined to moderately confined, and banks are moderately stable to unstable. Below Fir Creek, the reach near the mouth has a higher gradient than the meadow reach, because Bear Valley Creek flows down through a narrower canyon before joining Marsh Creek.

Between 1956 and 1959, dredge mining of private land occurred in Upper Bear Valley Creek, resulting in the obliteration of 17,000 linear feet of Bear Valley Creek and 10,000 linear feet of tributary channels. In 1969, an attempt to correct a portion of the dredged area was made. The lower reaches of Casner Creek and the dredged section of Bear Valley Creek were diverted and channelized. However, this diversion failed several times, most notably in a flood event in 1984 that resulted in massive downstream erosion and erosion of tailing materials. The 1984 event resulted in the involvement of the Shoshone-Bannock tribe in a more comprehensive remediation project. Fortunately, the 1984 to 1989 rehabilitation effort has brought about an upward trend in water quality (USFS 2000).

Table 12. Bear Valley Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B/C
Area in Square miles	191
Relief in feet	3,350
Average elevation in feet	7,080
Average area slope in percent	21.2
Percent of area with slope greater than 30%	26.9
Percent of area with slope greater than 30% and North Facing Slope	8.44
Percent of area covered by forest	70.2
Mean annual precipitation in inches	30
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	1,890
Q10 (CFS 10 year estimate of peak flow)	3,320
Base Flow (CFS 20 year minimum estimate of low flow in February)	107

Source: USGS StreamStats <http://streamstats.usgs.gov>

Fisheries

The Bear Valley watershed is one of the few remaining areas left that has only wild salmon (spring/summer chinook) with essentially no hatchery influence. This area is designated as critical habitat for chinook salmon and is also considered an aquatic stronghold for steelhead trout and bull trout. Bear Valley Creek is an important traditional use area for the Shoshone-Bannock Tribes.

Major fish-bearing tributaries to Bear Valley Creek include Ayers, Chip, Poker, Tennessee, Cook, Nameless, Elk, East and West Fork Elk, Little East Fork Elk, Porter, and Little Beaver Creeks. In general, chinook salmon, steelhead, westslope cutthroat, and possibly fluvial bull trout, and mountain whitefish are found in mainstem Bear Valley Creek. Resident bull trout are found in upper, relatively undisturbed reaches of most tributaries. Chinook salmon and steelhead spawn and rear in mainstem Bear Valley Creek from the mouth upstream through Big Meadows/Cache Creek. Bearskin, Casner, Cub, Mace, Sheep Trail, Cache, Sack, Pole, Wyoming, Cold, and Fir creeks are also spawning and rearing areas (USFS, 2000).

Historically, the watershed accounted for 49% of the chinook salmon redds in the Salmon River Basin and 65% in the Middle Fork Salmon River. Increases in sediment and loss of

pool habitat are the biggest changes in the Bear Valley watershed from historic to current aquatic habitat conditions. Current chinook salmon and steelhead redd, parr, and smolt numbers in the Bear Valley watershed are less than 1% of potential historic numbers. Grazing and past mining activities have had the biggest impact on aquatic habitat. The primary factors limiting fish productivity are: negative competition with introduced fish (brook trout), excess substrate fines, and local disconnection between overwintering and spawning habitats. Smolt-to-adult survivals are much lower than egg-to-smolt survivals for anadromous fishes, suggesting that factors external to Bear Valley are most limiting to productivity (USFS 2000).

Both the Shoshone Bannock Tribes and the Idaho Fish and Game conduct annual surveys of chinook salmon redds. The survey dates overlap somewhat, but generally the Shoshone-Bannock surveys are at the beginning of the spawning season and the IDFG surveys are towards the middle and end of the spawning season. The Shoshone-Bannock tribes have conducted fish surveys in Bear Valley Creek for a number of years. They found the following:

- 38 chinook salmon redds in 2006,
- 251 redds in 2003,
- 240 in 2002,
- 59 in 2000, and
- 26 in 1999.

Idaho Fish and Game has also conducted salmon redd surveys and their results were:

- 75 chinook Salmon redds in 2007,
- 31 in 2006
- 88 in 2005
- 109 in 2004
- 364 in 2003
- 245 in 2002,
- 172 in 2001, and
- 69 in 2000.

Fish density has shown a significant increase since the habitat enhancement project in the headwaters of Bear Valley Creek. Chinook salmon were observed throughout Bear Valley Creek in 2003, and were most abundant in the second and fourth order sections. The surveys found no rainbow trout in 2003. The greatest species and age-class diversity was found in the fourth and fifth order sections.

Spawning of steelhead and rainbow trout in the Middle Fork Salmon watershed is estimated to begin in early March and go through Mid-May. Spring/Summer chinook are estimated to spawn from September to mid-October. Cutthroat Trout are estimated to begin spawning in May and end in June. Bull trout, in general, are estimated to spawn between September 1 and mid-October (Grafe et al. 2002).

The entire watershed is public land managed by the National Forest System. Most of the land is administered by the Lowman Ranger District of the Boise National Forest although some road segments are administered by the Salmon-Challis National Forest. Forest roads 579 and 568 provide access to the FC-RONR Wilderness Area, particularly for those recreationists that are floating the Middle Fork of the Salmon River. Camping takes place both in dispersed sites and established campgrounds (Fir Creek and Bear Valley Campgrounds).

Livestock grazing has historically been of importance in the Bear Valley Creek area. Early records of exact numbers and locations of livestock grazing do not exist. By 1930 there already were reports of over grazing (Boise and Challis National Forests 1975). The grazing section of the 1975 Land Use Plan for the Bear Valley Planning Unit concludes with this statement: "Grazing and anadromous fish do pose some conflicts. The economic value of both is important. The loss of vegetation and trampling damage caused by cattle grazing of streambanks along Bear Valley and Elk Creeks has an undetermined adverse effect on fishery values." In the 1960s, a deferred rest rotation system of pasture management was initiated on the Bear Valley C&H Allotment. During the mid-60s to mid-70s sheep grazing declined, and in 1995 the area grazed by sheep was converted into a cattle allotment.

In 1991, the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service received a petition to list Pacific Northwest salmon runs under the Endangered Species Act (ESA). Spring, summer, and fall run chinook were listed as threatened species in the Salmon River basin in 1992. Snake River basin steelhead trout were listed as a threatened species in 1997. The ESA listings of anadromous fish prompted a review of current habitat management practices on federal lands by NOAA Fisheries. As part of the Section 7 consultation process with the Forest Service, NOAA Fisheries issued a biological opinion on the adequacy of land and resource plans to protect anadromous fish habitat. One of the commitments identified in the opinion was to monitor grazing strategies to determine if current grazing practices were meeting riparian management objectives established by the federal Pacific Anadromous Fish Strategy (PACFISH).

This monitoring resulted in stricter livestock grazing allotment requirements for the permittees in the Bear Valley and Elk Creek areas, which made it more difficult for the permittees to continue grazing in this area. There has been no grazing in the watershed since 2001, when the Bonneville Power Administration purchased and then retired the livestock allotments.

In the 1950s, dredge mining for uranium and other rare earth elements near the headwaters of Bear Valley Creek left large amounts of unconsolidated overburden along 2.3 kilometers (km) of the stream's floodplain. As a result, over 500,000 cubic meters of fine sediment has entered the stream since the mining activities began. Specifically, from 1956 to 1959, a major dredging operation was undertaken on approximately 180 acres of mining claims in the upper reaches of the creek. Over the four-year period, approximately 180 acres were dredged by two floating dredges resulting in about 17,000 lineal feet of the original Bear Valley Creek channel being obliterated. The natural channel of the creek that was not obliterated by dredging was dewatered for 45,000 lineal feet. The artificial channels that were created were not suitable for salmon habitat. Since then, Bear Valley Creek has downcut through 2.3 km of unconsolidated overburden in the mined area.

To reduce the amount of sediment entering the stream and enhance salmonid habitat, the Shoshone-Bannock Tribes initiated an enhancement effort within the mined area. During

the construction phase from 1985 to 1989, the high cut banks were graded and vegetated to create a new floodplain along 2.5 km of stream. The rehabilitation of the dredged area and the immediate surroundings was completed in 1989 at a final cost of \$2.8 million. The Bonneville Power Administration provided funding for this restoration project. In 1989, the owners of the mineral resources sold the land to the US government. The restoration effort protects Bear Valley Creek from an additional 200,000 to 400,000 cubic meters of mining overburden that is still present in the area from entering the stream. Prior to the completion of the project, an estimated 600 to 1100 cubic meters of sediment entered the creek each year from the overburden area

Vegetation

Forest cover types dominate the Bear Valley Watershed with nearly three-fourths of the area occupied by trees. Six major potential vegetation groups are found in the watershed; five of those are found in the Upper Bear Valley Creek area. In descending order of prevalence, they are: warm, dry subalpine fir; persistent lodgepole pine; cool, moist Douglas fir; cool, dry Douglas fir; hydric subalpine fir. Subalpine fir vegetation, a high altitude group, is found in higher altitudes in the watershed. The predominant shrubs in wet meadows are willows. Grasses and sedges are the predominant herbaceous vegetation. Non riparian meadows include a variety of forbs and grasses. Shrubs in these drier meadows include shrubby cinquefoil, currants, willows, and some sagebrush.

Elk Creek

Elk Creek, part of the Bear Valley Creek watershed, originates at approximately 7,400 feet and drains a 50,671 acre watershed (141 square miles). Generally, a sinuous, low gradient stream, Elk Creek meanders through meadows before feeding into Bear Valley Creek.

Elk Creek is the largest tributary to Bear Valley Creek and is roughly the same volume as Bear Valley Creek at the point where the two join together. Tributaries to Elk Creek include the North Fork, West Fork, and East Forks of Elk Creek, Bearskin Creek, and Porter Creek. General watershed characteristics are listed in Table 13.

Table 13. Elk Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B/C
Area in Square miles	41
Relief in feet	2,020
Average elevation in feet	7,110
Average area slope in percent	20.4
Percent of area with slope greater than 30%	24
Percent of area with slope greater than 30% and North Facing Slope	7.44
Percent of area covered by forest	61.9
Mean annual precipitation in inches	32.3
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	515
Q10 (CFS 10 year estimate of peak flow)	926
Base Flow (CFS 20 year minimum estimate of low flow in February)	44.6

Source: USGS StreamStats <http://streamstats.usgs.gov>

Roads

Upper Elk Creek lacks roads since it is predominantly in the wilderness area. Road 579 is a popular recreational road that parallels much of the stream through the meadows area. However, the stream is generally only close to the road in a few areas.

Fisheries

Bull trout are present at places within the drainage (IDFG 2004). Chinook Salmon redd surveys showed 88 redds in 2007, 53 redds in 2006, 74 redds in 2005, 72 redds in 2004, 331 redds in 2003, 377 redds in 2002, 219 redds in 2001 and 83 redds in 2000. Spring chinook spawning occurs between August and September. Westslope cutthroat trout, steelhead, redband, and brook trout have also been observed throughout the watershed.

Grazing

No grazing has occurred in the Elk Creek drainage since 2000. The Elk Creek C and H allotment was retired in 2000, and the Stanfield Allotment has not been used since 1996. The Bonneville Power Administration purchased the allotments and stopped grazing use as a mitigation measure. Prior to this, both sheep and cattle grazing occurred. In the 1970s sheep operations were gradually converted into cattle operations. While a sheep allotment still existed in the 1990s, no sheep were grazed from 1985 onwards until the allotment was retired in 2000.

During the period of grazing, 6,000 feet of barriers were erected to prevent trailing of cattle along the streambanks of Elk Creek in the Stanfield Unit. A 4,500 acre riparian pasture was established to prevent access to critical portions of Elk Creek. With the biological opinion issuance for chinook salmon and bull trout in the 1990s, grazing utilization requirements became stricter and permittees eventually opted to discontinue grazing.

Boundary Creek

Boundary Creek is a second order tributary to the Upper Middle Fork Salmon Watershed, entering the Middle Fork Salmon River at an elevation of 5,670 feet in the upper part of the watershed. This watershed contains a campground and launch site for the Middle Fork Salmon River. Throughout the summer months, there are both commercial and private raft trips leaving from this location. It is also a trailhead for the Middle Fork Salmon River trail, and both hikers and horse packers utilize this trail. This watershed has burned both historically and as recently as 2006. The watershed lies within the Idaho batholith zone. Watershed attributes are shown in Table 14.

Table 14. Boundary Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	7
Relief in feet	2,200
Average elevation in feet	6,670
Average area slope in percent	32.8
Percent of area with slope greater than 30%	62.7
Percent of area with slope greater than 30% and North Facing Slope	23.4
Mean annual precipitation in inches	57.3
Hydrologic regime	29.6
Q1.5 (CFS estimated bankfull discharge)	33.7
Q10 (CFS 10 year estimate of peak flow)	79.6
Base Flow (CFS 20 year minimum estimate of low flow in January)	2.06

Source: USGS StreamStats <http://streamstats.usgs.gov>

Other 1st and 2nd order tributaries to the Middle Fork Salmon River include (from upstream to downstream in Valley County): Prospect, Rams Horn, Spike, Deer Horn, Lake, Dome, Artillery, Mortar, Cannon, Cap, Ranch, Garden, Pungo, Teapot, Sunflower, Range, Cameron, Mahoney, Pine, Bacon, Foundation, White, Bridge, Jack, Tom, Cub, Tappan Gulch, Bear, Little Bear, Bernard, Short, Sammy Gulch, Survey, Kimmel, Wall, Golden, Nugget, Cradle, Reese, Nolan, and Color Creeks. These streams tend to be lower volume, steep Rosgen A and B type streams that flow only several miles from their point of origin into the Salmon River. Second order streams tend to originate within five miles of the mouth of the stream.

Marsh Creek Subwatershed

The Marsh Creek subwatershed has a watershed area of 385.26 km² with major tributaries consisting of Beaver, Knapp, and Cape Horn Creeks. The confluence of Marsh Creek, and Bear Valley Creek, that originates to the west, form the Middle Fork of the Salmon River. These two source streams have the greatest multiple use land management interface of all of the Middle Fork watersheds. This is because they are outside of the designated FCRONR Wilderness, and they are very accessible by road.

Numeric watershed attributes important to water quality include relief ratio which is a measure of slope of the longest surface water in the watershed. Average slope of topography gives an insight into potential sediment load from hill slope erosion. The percent area with slope greater than 30% can give an indication of the potential for mass wasting or land slides. The percent of North Facing Slope greater than 30% allows a relative comparison of direct sustained runoff from snowmelt to peak annual flow. The percent of forested area can give a vision of low flow characteristics due to slower snowmelt and improved moisture regime. Where dense forest cover is associated with steep slopes, there is increased potential for hill slope erosion and land slides after catastrophic fires. In dryer precipitation regimes, with fewer trees but steep slopes and the potential for extreme thunderstorm activity, higher rates of mass wasting can result. These subbasin parameters are shown in Table 15 for Marsh Creek.

Table 15. Physical characteristics for the Marsh Creek subwatershed.

Parameter	Value
Area in Square miles	144
Relief in feet	3460
Relief Ratio (percent)	0.0043
Average elevation in feet	7490
Average area slope in percent	28.2
Percent of area with slope greater than 30%	43.2
Percent of area with slope greater than 30% and North Facing Slope	12.4
Percent of area covered by forest	70.3
Mean annual precipitation in inches	28.5
Hydrologic regime	Spring source

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

The source of Marsh Creek is multiple low gradient springs in a large open meadow on the east side of the area known as Cape Horn. The wet meadow character of the first-order reach also limits the diversity and structure of riparian vegetation though the riparian zone is extensive. The upper reach of Marsh Creek is characterized in Table 16. The first streams that are tributary to Marsh Creek are ephemeral streams that can carry significant

bed load during snowmelt runoff and then only flow during extreme storm events. They are generally dry more than 4 months per year, and in the case of Dry Creek only flow for several weeks during snowmelt. Knapp Creek combines with Marsh Creek to more than double the flow and the gradient remains constant below this confluence to provide much more morphological diversity.

Table 16. Stream characteristics for Marsh Creek at three BURP sites.

Parameter	Value
Channel types (Rosgen) found at BURP Sites	E, C
Width/Depth ratio	10.9, 10.5, 57.4
% Surface fines	55.7, 7.8, 3.1
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Upper Meadow
Q1.5 (estimated bankfull discharge)*	990
Q10 (10 year estimate of peak flow)*	1890
Base Flow (20 year minimum estimate of low flow in December)*	71.2

*Source: USGS StreamStats <http://streamstats.usgs.gov>

There are 3 monitoring sites located on the upper reach of Marsh Creek, above Cape Horn Creek. The upper-most site is near the source and is characterized as a Rosgen E channel (Rosgen 1996). The upper monitoring site on Marsh Creek occurs at 6,644 feet elevation and is typical of a first-order mountain meadow spring creek. The middle site occurs at 6,608 feet, just above the confluence of Knapp Creek. At this site, the channel has changed to a C channel with a low width to depth ratio indicating high sediment transport competency. At the lower site, at elevation 6,532 feet, the channel remains a C channel, but the width to depth ratio increases to 57.4 as a result of increased flow and bed load from Knapp Creek.

The other significant tributaries to Marsh Creek include Knapp, Cape Horn, and Beaver Creeks, in order of elevation at their confluence (highest to lowest) (Figure 13). Knapp Creek is formed by the outlets of glacial kettle lakes south of the Beaver Creek headwaters.

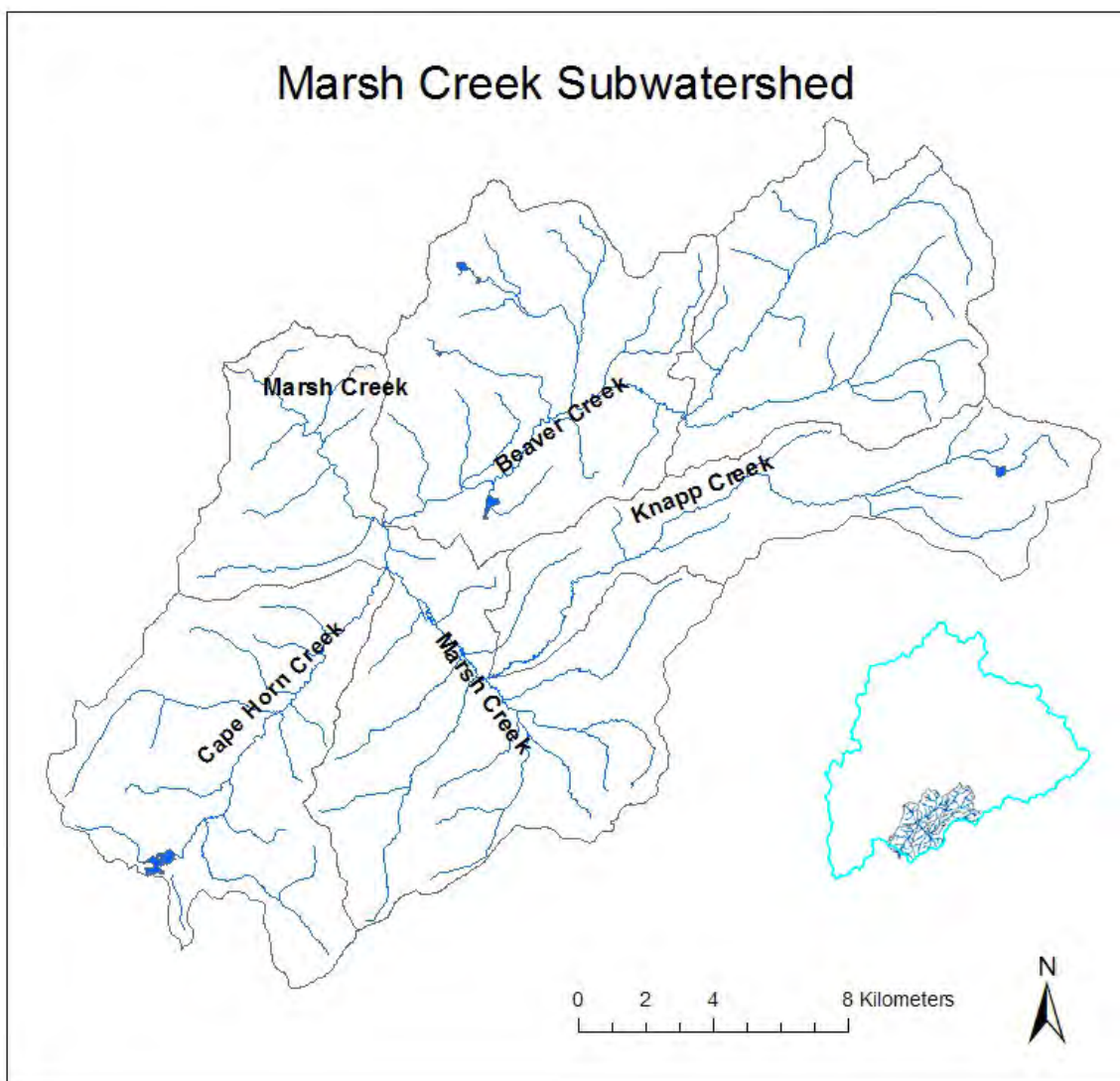


Figure 13. Marsh Creek Subwatershed.

Cape Horn Creek has its source in the Sawtooth Mountains and is primarily snowmelt driven in Rosgen A and B channels to the lower reach where it becomes a C channel. Beaver Creek is the most significant tributary with the longest course through the watershed. Beaver Creek carries a high level of bedload that comes primarily from Winnemucca Creek. Winnemucca Creek receives significant sediment from steep hill slopes along its lower reach above the Beaver Creek confluence.

Sulphur Creek

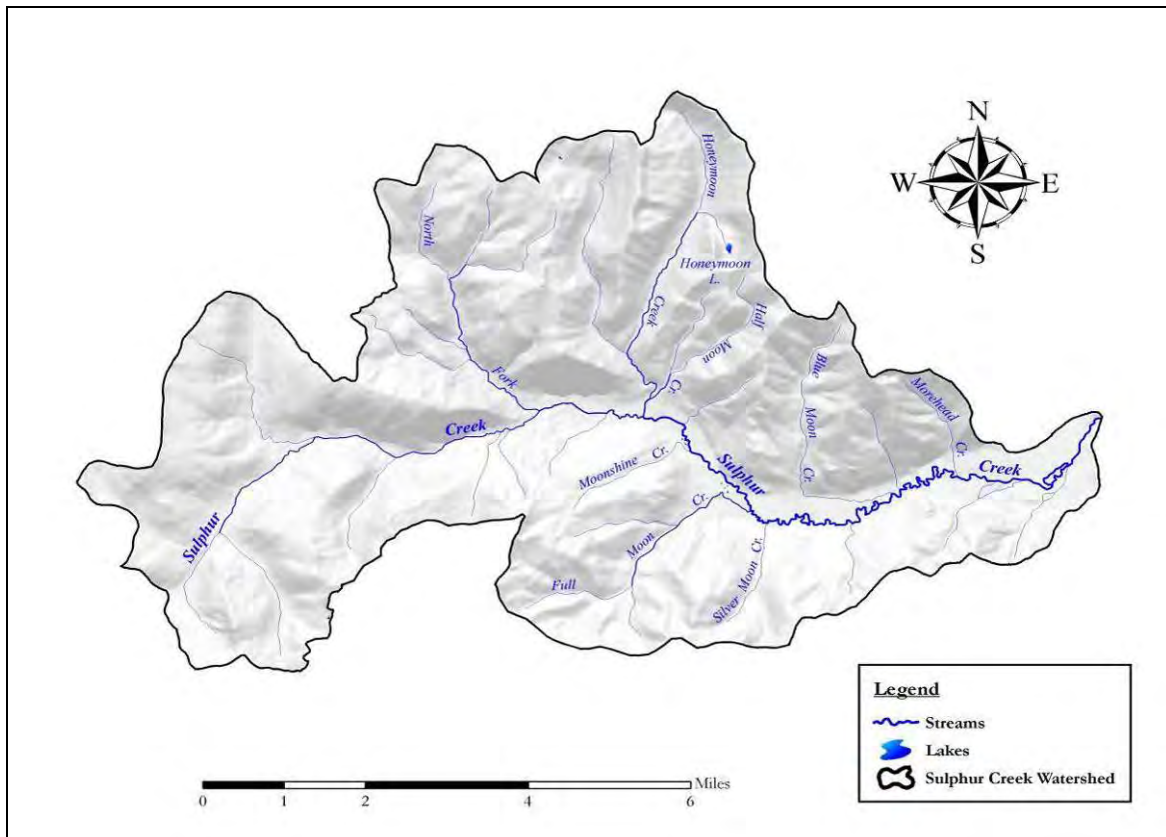
Sulphur Creek originates at about 7,500 feet and flows through steep canyon areas and meadows before entering the Middle Fork Salmon River at 5,560 feet. Major tributaries include North Fork Sulphur Creek, Moonshine Creek, Honeymoon Creek, Full Moon Creek, Half Moon Creek, Blue Moon Creek, and North Fork Elk Creek. Trails and two landing strips make this watershed accessible to recreationists. The last four to five miles of Sulphur Creek are within the FC-RONR Wilderness. Stream attributes are shown in Table 17, and the watershed is shown in Figure 14.

Table 17. Sulphur Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B /C
Area in Square miles	54.3
Relief in feet	3,040
Average elevation in feet	7,120
Average area slope in percent	30.5
Percent of area with slope greater than 30%	48.6
Percent of area with slope greater than 30% and North Facing Slope	15.2
Percent of area covered by forest	69.8
Mean annual precipitation in inches	36.7
Hydrologic regime	Snowmelt/rain
Q1.5 (CFS estimated bankfull discharge)	586
Q10 (CFS 10 year estimate of peak flow)	1,050
Base Flow (CFS 20 year minimum estimate of low flow in February)	26.2

Source: USGS StreamStats <http://streamstats.usgs.gov>

Idaho Fish and Game (IDFG) counted 5 salmon redds in Sulphur Creek in 2000, 38 in 2001, 93 in 2002, and 86 in 2003. A snorkel survey in 2003 showed 33.6 to 47.9 fish/100 m². Spring chinook spawning is estimated to occur between August and September each year (Grafe et al. 2002).

**Figure 14. Sulphur Creek watershed.**

Elkhorn Creek

The Elkhorn Creek watershed is 25.4 mi² of which 89%, or 22.7 mi², lies in the FC-RONR Wilderness. Characterized by Rosgen type A/B channels, Elkhorn Creek flows through steep terrain before entering the Middle Fork Salmon River. Elkhorn Creek originates at

about 7,500 feet in the Salmon River Mountains. Tributaries include Middle and North Fork Elkhorn Creek, Lucky Creek, and Mine Creek. Watershed attributes are shown in Table 18, and the Elkhorn watershed is shown in Figure 15.

Table 18. Elkhorn Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	25.4
Relief in feet	3,770
Average elevation in feet	7,450
Average area slope in percent	41.9
Percent of area with slope greater than 30%	71.8
Percent of area with slope greater than 30% and North Facing Slope	22.2
Percent of area covered by forest	68
Mean annual precipitation in inches	34.9
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	188
Q10 (CFS 10 year estimate of peak flow)	377
Base Flow (CFS 20 year minimum estimate of low flow in February)	15.8

Source: USGS StreamStats <http://streamstats.usgs.gov>

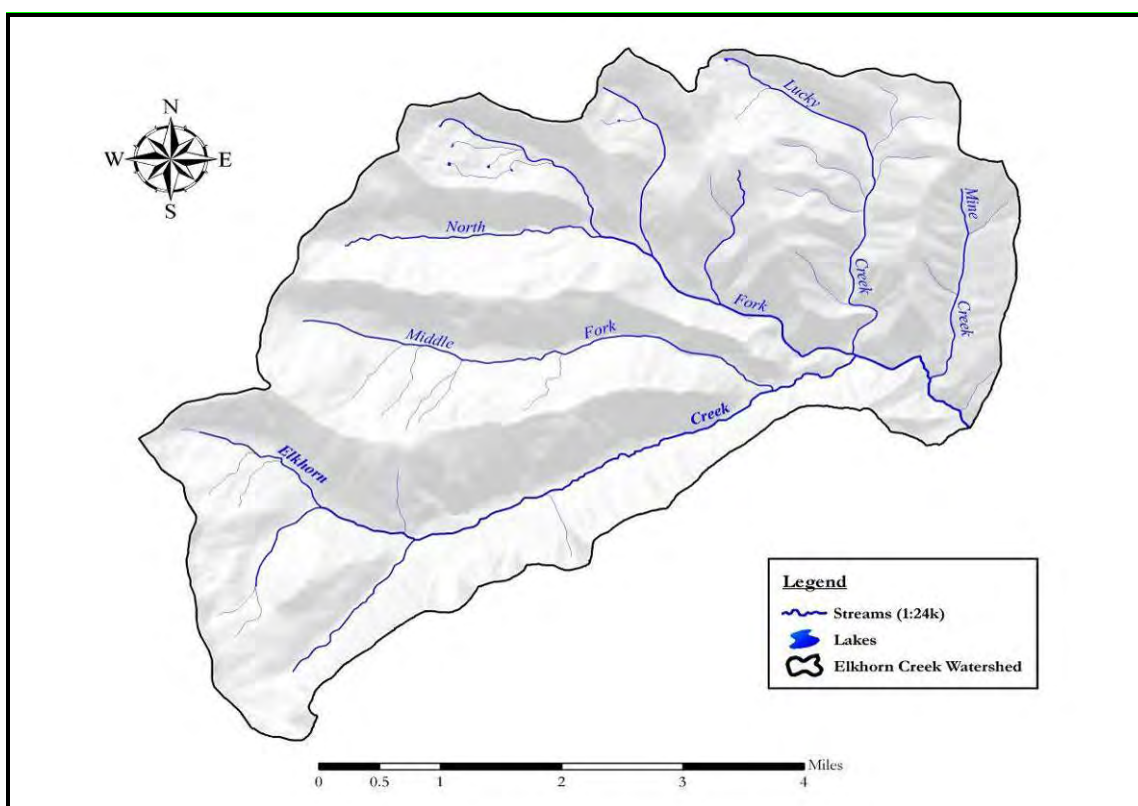


Figure 15. Elkhorn Creek watershed.

Rapid River Subwatershed

The Rapid River subwatershed has an area of 316.28 km² with major tributaries consisting of Float Creek, Seafoam Creek, Vanity Creek, and Sheep Creek. There is road access to the upper reach of Rapid River over Vanity Summit from the Beaver Creek Road in the Marsh Creek subwatershed to the south. The primary purpose of the road access is for recreation

though it is also important access to the Greyhound Mine north of the Rapid River Subwatershed as well as the Forest Service Seafoam Guard Station just above the confluence of Seafoam Creek and Rapid River. The subbasin parameters for Rapid River are shown in Table 19.

Table 19. Physical characteristics for the Rapid River subwatershed.

Parameter	Value
Area in Square miles	122
Relief in feet	4,880
Relief Ratio (percent)	0.029
Average elevation in feet	7,430
Average area slope in percent	45.6
Percent of area with slope greater than 30%	81.7
Percent of area with slope greater than 30% and North Facing Slope	27
Percent of area covered by forest	64.4
Mean annual precipitation in inches	27.2
Hydrologic regime	Snowmelt

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Headwater streams that form Rapid River are primarily snowmelt driven though there are springs and seeps throughout the Middle Fork watershed that are important to stream flow. Headwaters are high gradient 1st and 2nd order Rosgen A channels that coalesce into a main B channel as the valley enlarges (Table 20). Uplands within the watershed are primarily vegetated with some barren peaks and headwalls in granitic source areas. Bedload is assumed to be large and voluminous due to the physiography of this and most other subwatersheds in the Middle Fork Salmon River watershed. The Rapid River valley is moderately steep with gentle to moderate side slopes coursing through colluvial channel material. In the Rosgen Classification System this would be characteristic of Valley Type II which is continuous to the confluence with the Middle Fork of the Salmon River downstream of Soldier and Greyhound Creeks.

Table 20. Stream characteristics for Rapid River.

Parameter	Value
Channel types (Rosgen) found	A,B
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub & Conifer
Q1.5 (CFS estimated bankfull discharge)	450
Q10 (CFS 10 year estimate of peak flow)	974
Base Flow (CFS 20 year minimum estimate of low flow in December)	64.9

Source: USGS StreamStats <http://streamstats.usgs.gov>

Channel characteristics have not been documented due to high flow conditions in Rapid River. Monitoring sites established by DEQ are located on tributary streams near roads in the upper watershed where higher gradient conditions predominate. Stream characteristics that have been identified for Rapid River are shown in Table 20. Streams are typically A channel (high gradient with low sinuosity with step pools) in upper reaches and B channels (slightly lower gradient and riffle dominated) with narrow flood plains due to narrow valleys and moderately incised channels. Rapid River tributaries are shown in Figure .

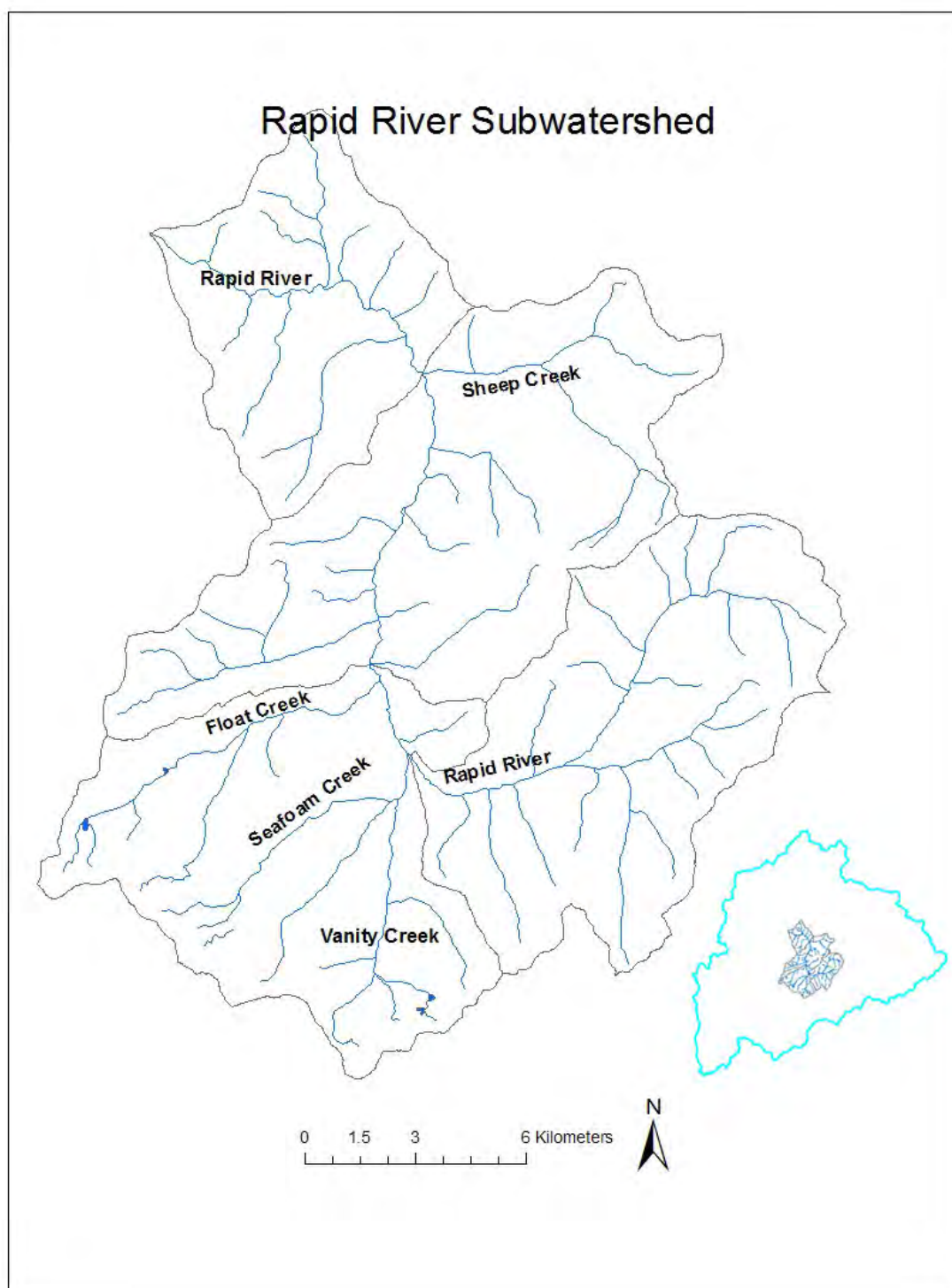


Figure 16. Rapid River subwatershed.

Greyhound Creek Subwatershed

Greyhound Creek drains directly to the Middle Fork. Greyhound Creek begins at the outlet of several ephemeral cirque lakes on the watershed divide with the Rapid River, to the east. It has several intermittent tributaries, all unnamed. The 11mi² watershed area of Greyhound Creek is small by comparison to others included in this assessment but is significant because of historic mining activities in the upper watershed. Most of the

watershed is within the FCRONR Wilderness, however, it is not as densely forested as other watersheds, potentially from historic fires. Patented mining claims in existence prior to the wilderness designation have retained private ownership and access, unless otherwise negotiated with the Forest Service. Greyhound Creek flows through a narrow colluvial Type II valley. The parameters for the Greyhound Creek subwatershed are shown in Table 21.

Table 21. Physical characteristics for the Greyhound Creek subwatershed.

Parameter	Value
Area in Square miles	11
Relief in feet	3,460
Average elevation in feet	7,490
Relief Ratio (percent)	0.119
Average area slope in percent	45.3
Percent of area with slope greater than 30%	78.6
Percent of area with slope greater than 30% and North Facing Slope	29.4
Percent of area covered by forest	52.5
Mean annual precipitation in inches	28.1
Hydrologic regime	Snowmelt

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Greyhound Creek has one of the highest relief ratio values of Middle Fork tributaries. Headwaters are classified as a Rosgen A channel with B channel type to the confluence with the Middle Fork Salmon River. Reduced forest cover combined with moderate to high average area slope indicates that Greyhound Creek would be a flashy watershed with large substrate. It would have elevated bedload combined with high transport competency and large substrate. Table 22 lists Greyhound Creek stream characteristics and Figure 17 shows its location.

Table 22. Stream characteristics for Greyhound Creek.

Parameter	Value
Channel types (Rosgen) found	A, B
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub & Sedge
Q1.5 (CFS estimated bankfull discharge)	40.3
Q10 (CFS 10 year estimate of peak flow)	98.5
Base Flow (CFS 20 year minimum estimate of low flow in December)	8.73

Source: USGS StreamStats <http://streamstats.usgs.gov>

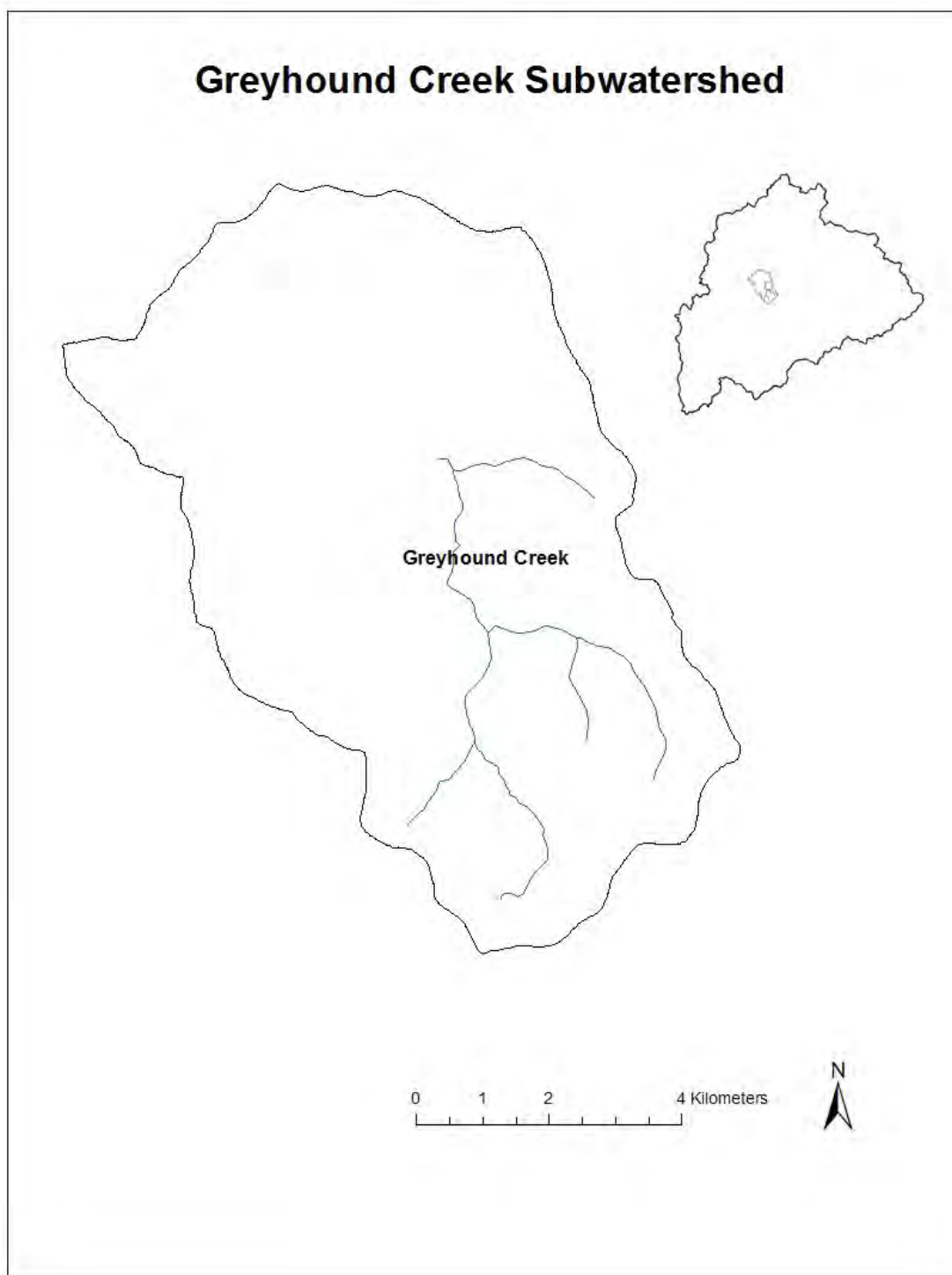


Figure 17. Greyhound Creek subwatershed.

Loon Creek Subwatershed

Loon Creek is the largest watershed of the Upper Middle Fork Salmon River Hydrologic Unit at 355 mi² (Table 23). It gets its source water from a crescent of headwall cirque lakes to the east of Winnemucca Creek in the Marsh Creek subwatershed. It has one of the largest contributions of flow to the Middle Fork Salmon River in the Upper Middle Fork Hydrologic Unit as well. Topography is steep and rugged with over 85% of slopes greater

than 30 degrees. There is road access to the central reach of Loon Creek, to the historic mining settlement of Casto, which originated as a wagon road to haul ore out to Cape Horn. There is also road access between Warm Springs Creek/Loon Creek, and Camas Creek, along the ridge of the watershed divide. There is a significant percentage of forest cover to stabilize hill slopes and prolong snowmelt runoff in the upper watersheds of Warm Springs Creek and Loon Creek, however, significant catastrophic fire has resulted in removal of much of this cover along the northern area of the watershed. There has been a history of large fires within this watershed as well as landslides into the main river valley from side tributaries. Currently the Loon Creek trail to the Middle Fork Salmon River is blocked by a landslide just above the Falconberry Ranch and Forest Service Guard Station, about 11 miles above the Middle Fork confluence. Major tributaries to Loon Creek include Mayfield, Canyon, Cottonwood, Cache, Indian, and Warm Springs Creeks. The lower watershed has a belt of geothermal inputs from emergent springs. It is uncertain what the degree of impact to surface water temperatures are, but it is likely minimal as evidenced by the importance of Loon Creek and Warm Springs Creek to anadromous fish and bull trout spawning. Table 23 shows Loon Creek subwatershed characteristics.

Table 23. Physical characteristics for the Loon Creek subwatershed.

Parameter	Value
Area in Square miles	355
Relief in feet	6,390
Relief ratio (percent)	.023
Average elevation in feet	7,500
Average area slope in percent	51.1
Percent of area with slope greater than 30%	86.8
Percent of area with slope greater than 30% and North Facing Slope	29.1
Percent of area covered by forest	65.8
Mean annual precipitation in inches	24.9
Hydrologic regime	Snowmelt & Geothermal

Source: USGS StreamStats <http://streamstats.usgs.gov>

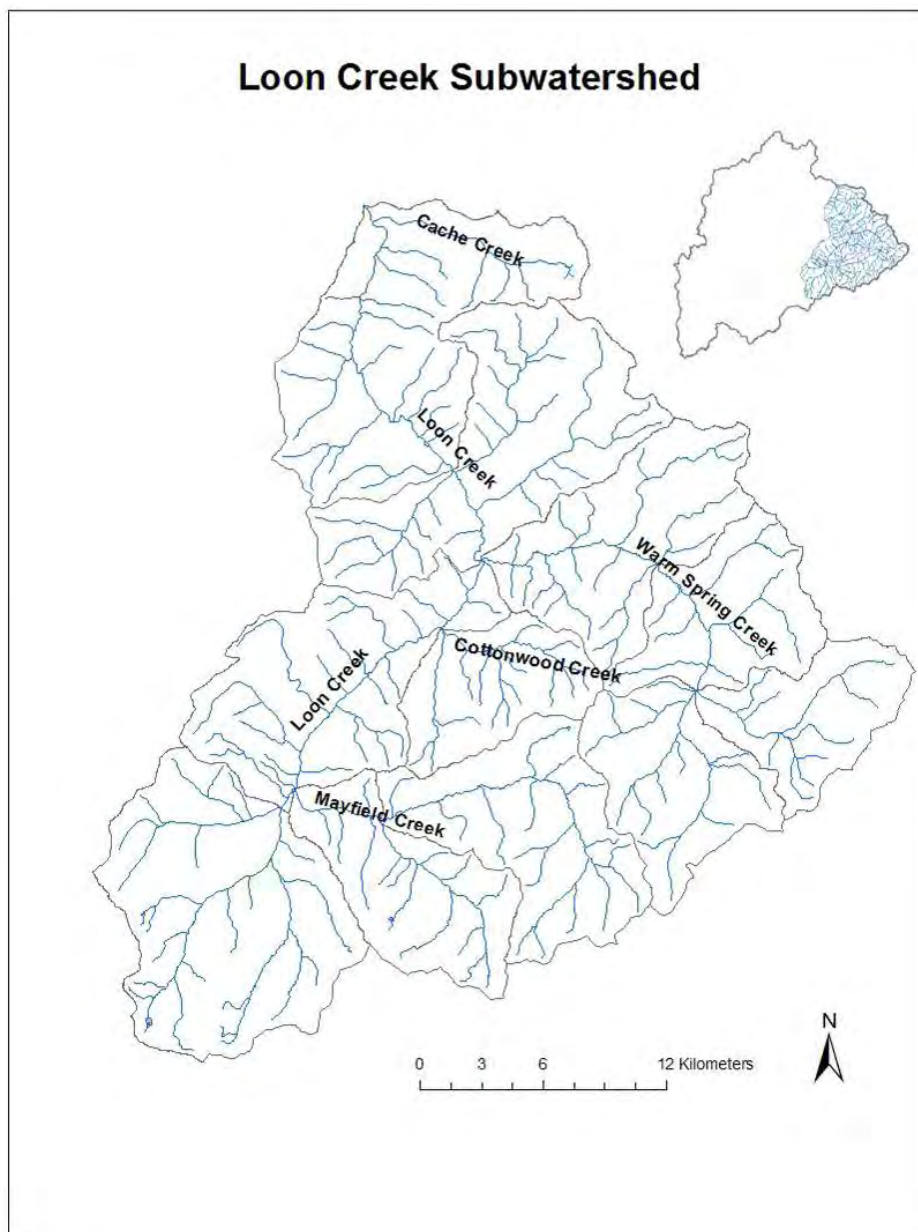
Stream Characteristics

As with all of the Middle Fork Salmon River tributaries, source reaches are high gradient A and Aa reaches (Rosgen 1997). When the channel reaches the main valley, it becomes a B channel, with the characteristic narrow flood plane and moderately incised channel. The main valley, though larger than most in the upper Middle Fork watershed, would still be considered a narrow gradual sloping Type II valley through colluvium. Riparian areas include thick shrubs with coniferous overstory that provides good shading and stability. Table 24 includes Loon Creek's stream characteristics and Figure 18 shows its location and tributaries.

Table 24. Stream characteristics for Loon Creek.

Parameter	Value
Channel types (Rosgen) found	A, B, C
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Conifer & Shrub
Q1.5 (CFS estimated bankfull discharge)	1020
Q10 (CFS 10 year estimate of peak flow)	2220
Base Flow (CFS 20 year minimum estimate of low flow in December)	269

Source: USGS StreamStats <http://streamstats.usgs.gov>

**Figure 18. Loon Creek subwatershed.**

Lower Middle Fork Major Subwatersheds***Sheep Creek and Brush Creek***

Sheep and Brush Creeks are both third order streams that flow through deeply dissected canyons before entering the Middle Fork Salmon around 3,600 feet in elevation. Watershed attributes for these creeks can be found in Table 25 and Table 26, and they are both shown in Figure 19.

Table 25. Sheep Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	26.4
Relief in feet	5,160
Average elevation in feet	6,780
Average area slope in percent	51.8
Percent of area with slope greater than 30%	88.8
Percent of area with slope greater than 30% and North Facing Slope	38.2
Percent of area covered by forest	67.5
Mean annual precipitation in inches	26.12
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	69.4
Q10 (CFS 10 year estimate of peak flow)	174
Base Flow (CFS 20 year minimum estimate of low flow in February)	22.6

Source: USGS StreamStats <http://streamstats.usgs.gov>

Table 26. Brush Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	27.8
Relief in feet	5,730
Average elevation in feet	6,760
Average area slope in percent	52.1
Percent of area with slope greater than 30%	91.1
Percent of area with slope greater than 30% and North Facing Slope	30.8
Percent of area covered by forest	68.8
Mean annual precipitation in inches	27.1
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	91.6
Q10 (CFS 10 year estimate of peak flow)	219
Base Flow (CFS 20 year minimum estimate of low flow in February)	21.7

Source: USGS StreamStats <http://streamstats.usgs.gov>

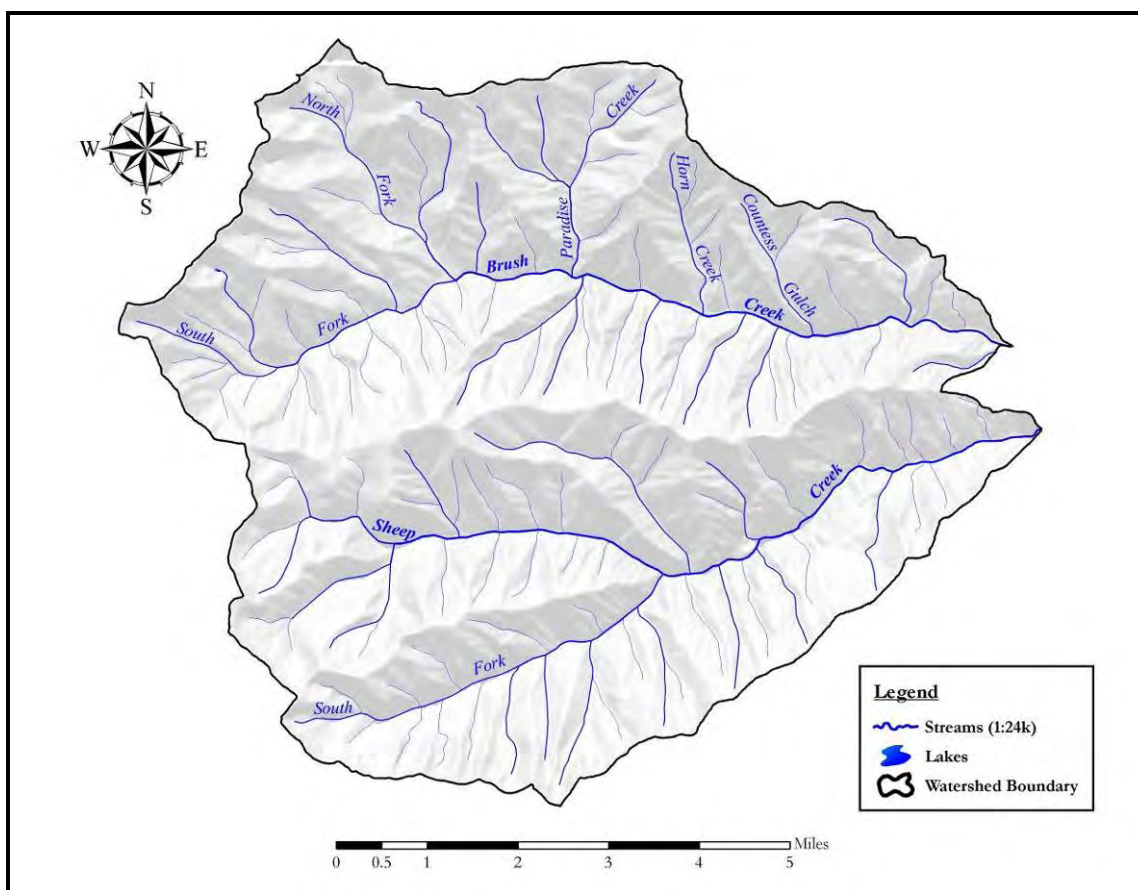


Figure 19. Sheep and Brush Creek watersheds.

Soldier Creek Subwatershed

Soldier Creek lies entirely within the FCRONR Wilderness and is slightly larger than Greyhound Creek with a watershed area of 21 mi², and also drains directly into the Middle Fork of the Salmon River. It is a compound watershed with Thicket Creek and Muskeg Creek as named constituent tributaries. The source of 8.2 mile long Soldier Creek is an interconnected series of glacial cirque lakes formed along headwalls in the upper watershed. The outlets of these lakes coalesce into a single thread channel that forms Soldier Creek. The catchment is primarily snowmelt driven within rugged topography that is heavily forested (Table 27).

Table 27. Physical characteristics for the Soldier Creek subwatershed.

Parameter	Value
Area in Square miles	21.1
Relief in feet	4,000
Relief ratio (percent)	0.069
Average elevation in feet	7,390
Average area slope in percent	46.9
Percent of area with slope greater than 30%	76.8
Percent of area with slope greater than 30% and North Facing Slope	23.1
Percent of area covered by forest	74.7
Mean annual precipitation in inches	28.3
Hydrologic regime	Snowmelt

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Soldier Creek flows primarily in a steep B channel through colluvial valley fill with the exception of the reach at the confluence of Muskeg Creek, where the gradient lessens due to increased deposition from Muskeg Creek.. The combination of narrow valley and higher percent forest cover would moderate stream temperature to create potential thermal refuge from the mainstem Middle Fork during the warm season. Figure 20 shows creeks in the Soldier Creek subwatershed and Table 28 shows stream characteristics.

Table 28. Stream Characteristics for Soldier Creek.

Parameter	Value
Channel types (Rosgen) found	B, C
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub/conifer
Q1.5 (CFS estimated bankfull discharge)	93.1
Q10 (CFS 10 year estimate of peak flow)	212
Base Flow (CFS 20 year minimum estimate of low flow in December)	22

Source: USGS StreamStats <http://streamstats.usgs.gov>

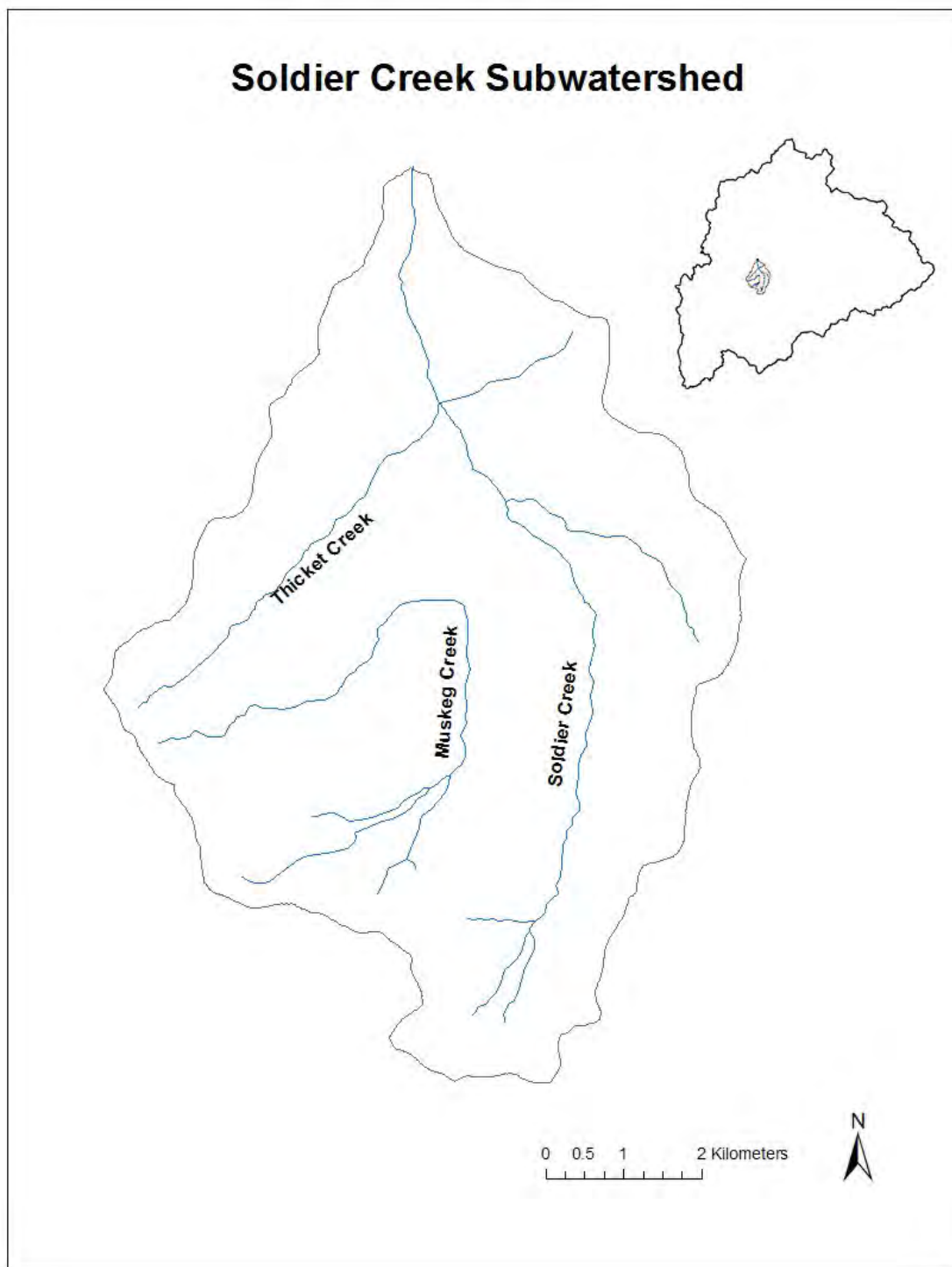


Figure 20. Soldier Creek subwatershed.

Little Loon Creek Subwatershed

Little Loon Creek lies entirely within the FCRONR Wilderness and has a watershed area of 43 mi², and also drains directly into the Middle Fork of the Salmon River. It is a compound watershed with the West Fork of Little Loon Creek and Castle Creek as named

constituent tributaries. The source of 11.7 mile long Little Loon Creek is snowfield drainage along headwalls in the upper watershed north of the source of Rapid River and west of the Loon Creek subbasin. The catchment is primarily snowmelt driven within rugged topography that is only 37% forested (Table 29).

Table 29. Physical characteristics for the Little Loon Creek subwatershed.

Parameter	Value
Area in Square miles	43
Relief in feet	5150
Relief ratio (percent)	0.062
Average elevation in feet	6970
Average area slope in percent	50.3
Percent of area with slope greater than 30%	87.9
Percent of area with slope greater than 30% and North Facing Slope	33.1
Percent of area covered by forest	37
Mean annual precipitation in inches	26.3
Hydrologic regime	Snowmelt

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Little Loon Creek originates in a headwall canyon through precipitous A channel over the first mile of its course, then flows in a steep B channel with nearly 7% average gradient through colluvial valley fill. The combination of narrow valley and higher percent forest cover would moderate stream temperature to create potential thermal refuge from the mainstem Middle Fork during the warm season (Table 30). The location of Little Loon Creek and its tributaries are shown in Figure 21.

Table 30. Stream characteristics for Little Loon Creek.

Parameter	Value
Channel types (Rosgen) found	Aa, A, B
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub/conifer
Q1.5 (CFS estimated bankfull discharge)	126
Q10 (CFS 10 year estimate of peak flow)	302
Base Flow (CFS 20 year minimum estimate of low flow in December)	32

Source: USGS StreamStats <http://streamstats.usgs.gov>

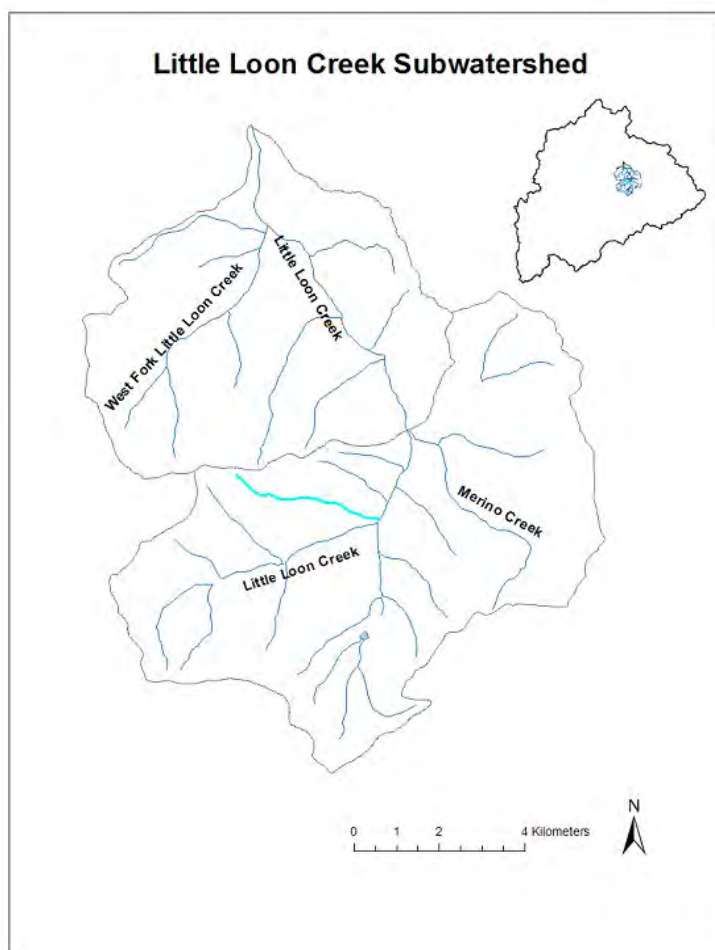


Figure 21. Little Loon Creek subwatershed.

Pistol Creek

Pistol Creek originates off of Snowshoe Summit at about 7,200 feet and flows into the Middle Fork Salmon River at 4,760 feet. Tributaries to Pistol Creek include Little Pistol Creek, Thirty Eight Creek, Forty Four Creek, Twenty Two Creek, Forty Five Creek, and Thirty Two Creek. The watershed drains 114 square miles of forest and meadow area and is part of the Idaho batholith. Watershed attributes are shown in Table 31, and the watershed is shown in Figure 22.

Table 31. Pistol Creek subwatershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	114
Relief in feet	4,920
Average elevation in feet	7,340
Average area slope in percent	46.1
Percent of area with slope greater than 30%	78.7
Percent of area with slope greater than 30% and North Facing Slope	25.3
Percent of area covered by forest	72.4
Mean annual precipitation in inches	32.7
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	675

Parameter	Value
Q10 (CFS 10 year estimate of peak flow)	1320
Base Flow (CFS 20 year minimum estimate of low flow in February)	68.7

Source: USGS StreamStats <http://streamstats.usgs.gov>

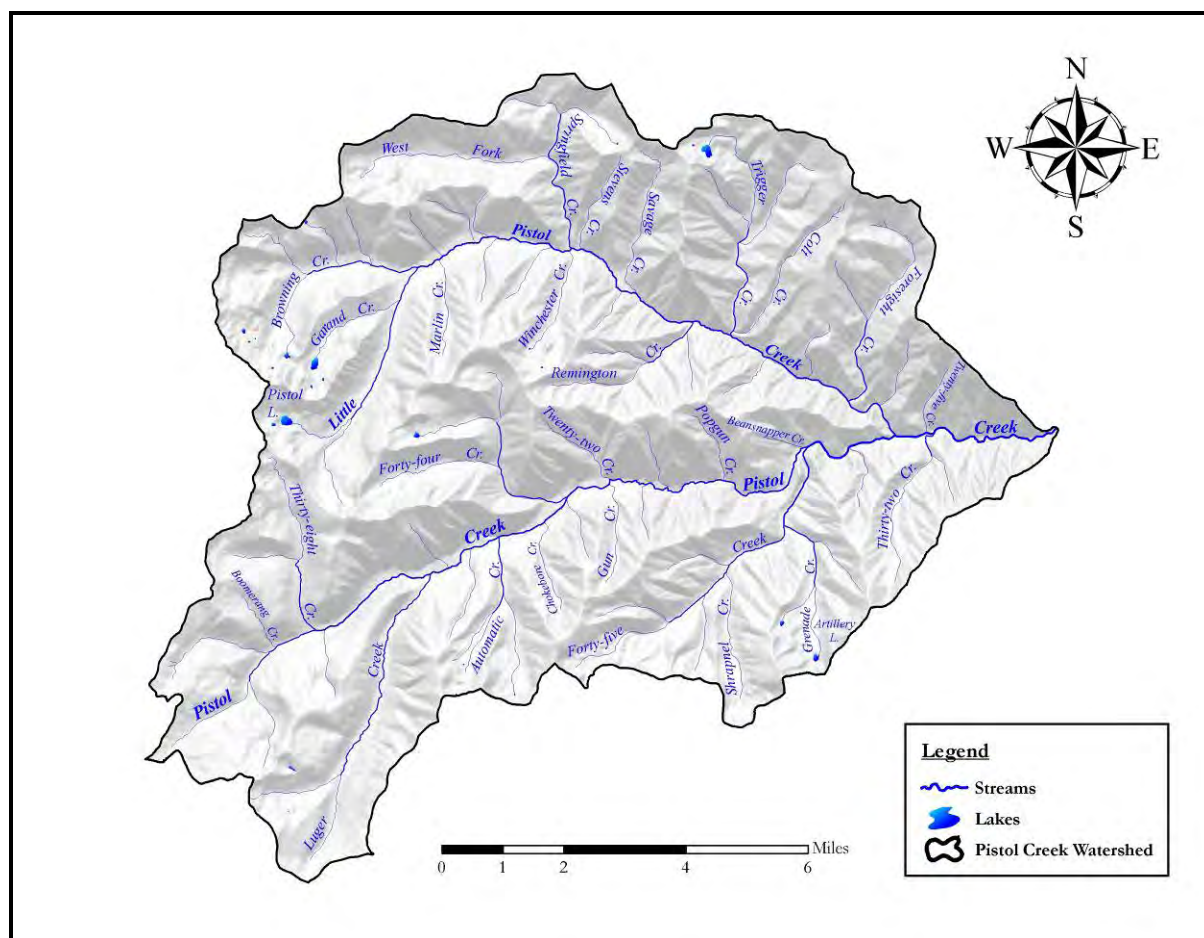


Figure 22. Pistol Creek watershed.

Indian Creek

Indian Creek originates at approximately 8,200 feet off of Meadow Ridge in the Salmon River mountains and flows into the Middle Fork Salmon River at 4,600 feet. Indian Creek serves as a popular wilderness launch site for the Middle Fork Salmon River when boaters are no longer able to easily launch from Boundary Creek. There is an airstrip, boat launch, and Forest Service Guard station at the mouth of the Indian Creek watershed. The watershed lies entirely within the FC-RONR Wilderness. Big Chief Creek, Papoose Creek, and Little Indian Creek are among the many tributaries to Indian Creek. Watershed attributes are shown in Table 32, and the watershed is shown in Figure 23.

Table 32. Indian Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	83.2
Relief in feet	5,080
Average elevation in feet	7,170
Average area slope in percent	47.1

Parameter	Value
Percent of area with slope greater than 30%	84.1
Percent of area with slope greater than 30% and North Facing Slope	25.6
Percent of area covered by forest	69.2
Mean annual precipitation in inches	32.9
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	494
Q10 (CFS 10 year estimate of peak flow)	978
Base Flow (CFS 20 year minimum estimate of low flow in February)	43.5

Source: USGS StreamStats <http://streamstats.usgs.gov>

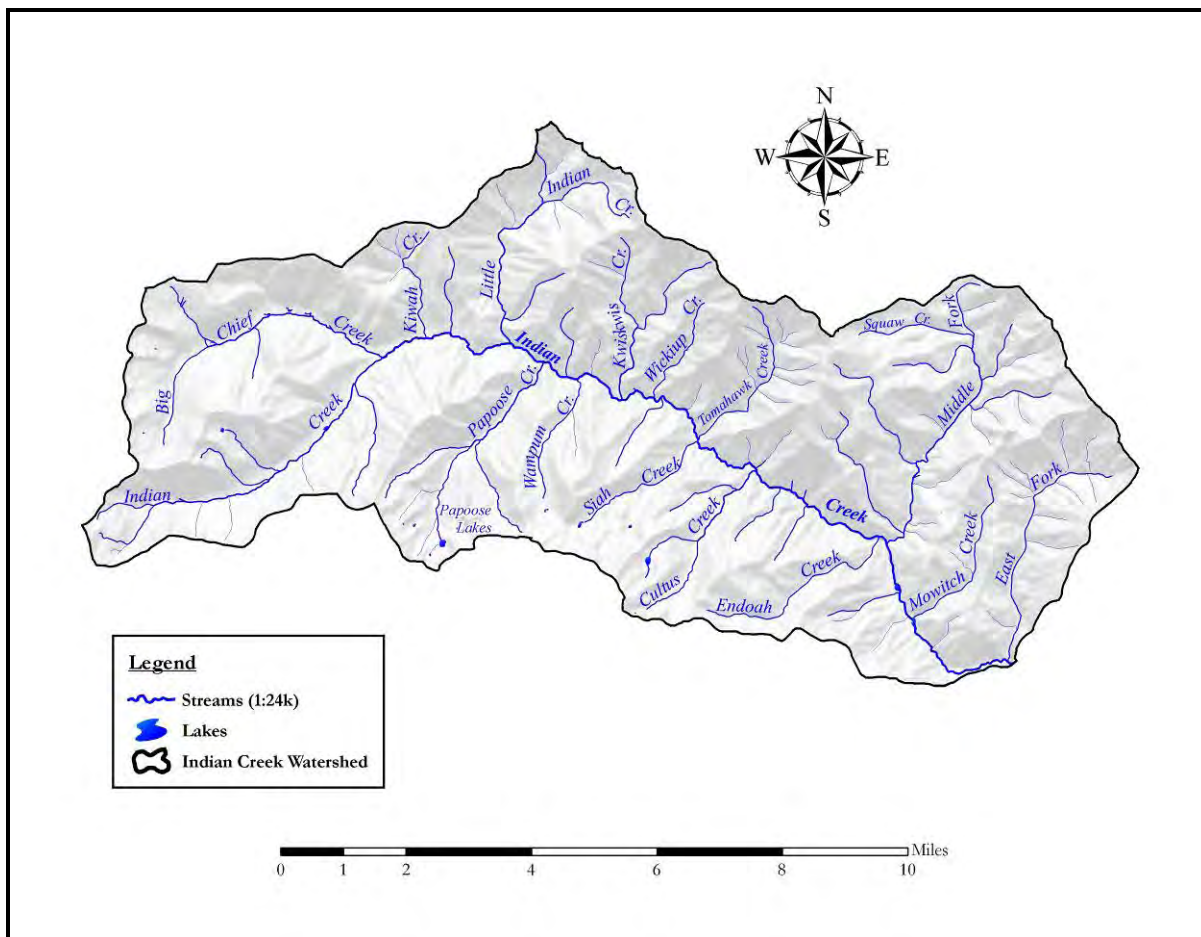


Figure 23. Indian Creek watershed.

Marble Creek

Marble Creek, a fourth order stream, originates at 7,500 feet off of Lookout Mountain Ridge and flows between steep hillsides before entering the Middle Fork Salmon River at 4,430 feet. Tributaries include Little Cottonwood Creek, Big Cottonwood Creek, Buck Creek, Trail Creek, and Dynamite Creek. Historically, mining took place in the headwater region. Watershed attributes for Marble Creek are shown in 3, and the watershed is shown in Figure 24.

Table 33. Marble Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square Miles	130
Relief in feet	5,060
Average elevation in feet	6,990
Average area slope in percent	50.1
Percent of area with slope greater than 30%	87.9
Percent of area with slope greater than 30% and North Facing Slope	29
Percent of area covered by forest	68.7
Mean annual precipitation in inches	24.7
Hydrologic regime	Snowmelt/rainfall
Q1.5 (CFS estimated bankfull discharge)	365
Q10 (CFS 10 year estimate of peak flow)	837
Base Flow (CFS 20 year minimum estimate of low flow in February)	76.8

Source: USGS StreamStats <http://streamstats.usgs.gov>

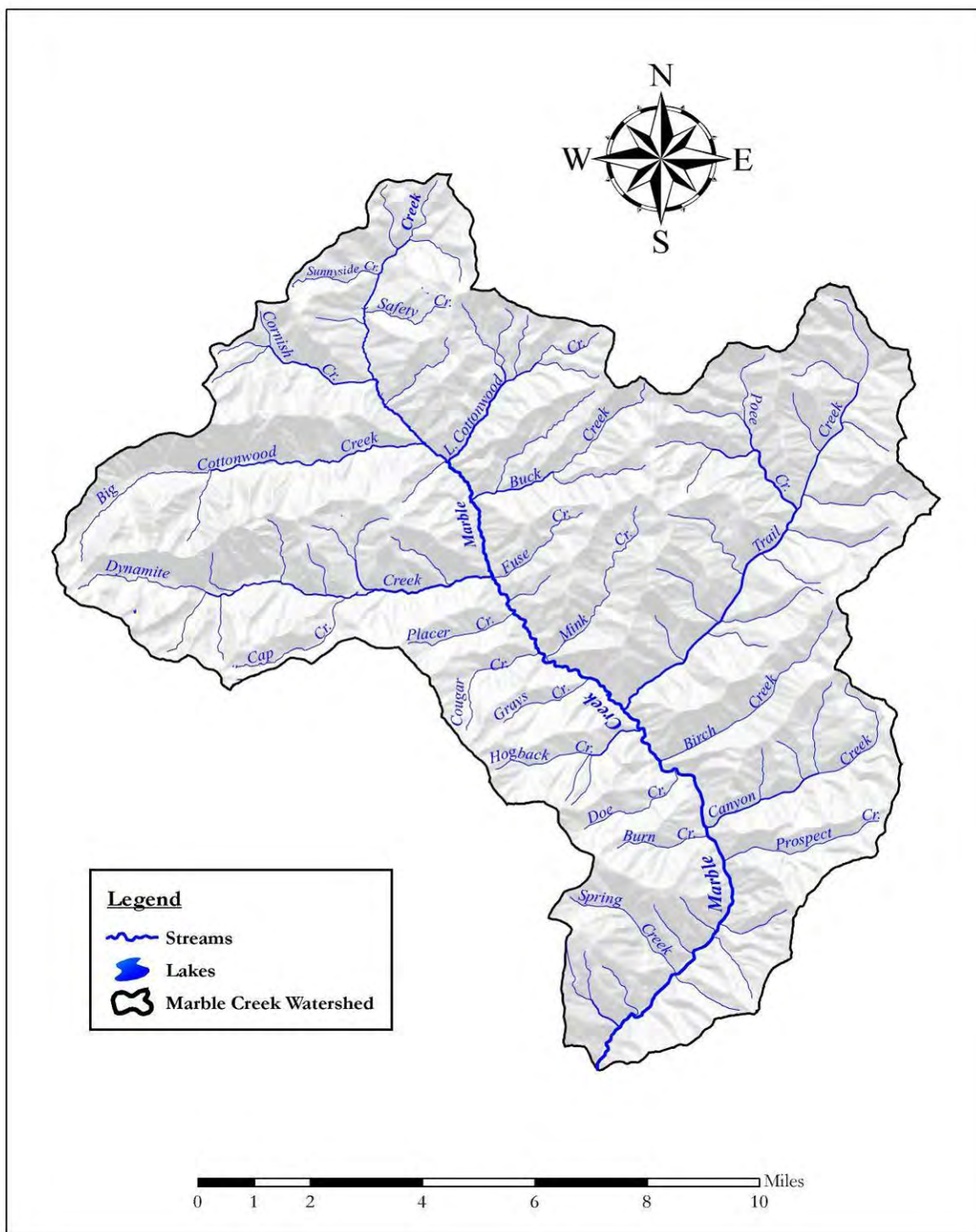


Figure 24. Marble Creek watershed.

Camas Creek Subwatershed

Camas Creek accounts for 29% of the Lower Middle Fork Salmon River Hydrologic Unit. It is the largest tributary in the eastern Middle Fork watershed, the 2nd largest subwatershed, behind Big Creek, which is on the western side of the Lower HUC

17060206. The middle reach of Camas Creek is outside of the FCRONR Wilderness and is part of the Myers Cove Mining District, which is accessible along the road from Panther Creek along Silver Creek. The source of Camas Creek is a broad perched alpine valley at the foot of White Goat Mountain known as Camas Meadows. Topography is varied with some high meadows, and areas of broad valleys, however, much of the watershed is steep and rugged. The headwaters of Yellowjacket Creek border the Wilson Creek watershed and the Bighorn Crags. There is road access along the watershed divide with Loon Creek/Warm Springs Creek, primarily along the ridges from J Fell Creek through Fly Creek, and Spider Creek to the South Fork of Camas Creek. There is a poorly maintained road along Camas Creek from Myers Cove to a private inholding near the mouth of White Goat Creek. There have been significant wildfire impacts to the South Fork of Camas Creek and the canyon reach of Yellowjacket Creek with the near complete removal of forest cover in the upper South Fork Camas watershed. Mass wasting was not observed, but could reasonably be expected in this watershed. Table 34 gives the parameters for the Camas Creek subwatershed.

Table 34. Physical characteristics for the Camas Creek subwatershed.

Parameter	Value
Area in Square miles	398
Relief in feet	6,240
Relief ratio (percent)	.026
Average elevation in feet	7380
Average area slope in percent	45.6
Percent of area with slope greater than 30%	78.8
Percent of area with slope greater than 30% and North Facing Slope	26.8
Percent of area covered by forest	76.7
Mean annual precipitation in inches	26.9
Hydrologic regime	Snowmelt

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Tributaries to Camas Creek are generally steep through A and B Channels, though the lower portions of the West Fork of Camas Creek, Silver Creek, and the South Fork of Camas Creeks flow through short reaches of C channels between valley constrictions (Table 35). Yellowjacket Creek is the main tributary from the northern watershed and flows through a steep and narrow canyon in B channel before its confluence. Riparian habitat is diverse and lush through most of the Camas Creek watershed with coniferous and deciduous woody species and shrub and sedge species. The exception is the reach between Castle Creek and Duck Creek. Here Camas Creek enters a wider alluvial valley where the gradient lessens and heavy bed load deposits from upstream high gradient reaches. Where the valley widens there has also been a history of cattle grazing, riparian road building, and streambank alteration adjacent to the Myers Cove Mining District Fluorspar mines and settling ponds at Duck Creek. Here there is a reach that is moderately laterally unstable between alluvial terraces above and below the confluence of the West Fork of Camas Creek. Below this point, about 4 miles downstream, at the confluence of Little Dry Gulch, Camas Creek is bed rock controlled and it re-enters Wilderness to its confluence with the Middle Fork of the Salmon River. Figure shows the location of Camas Creek and its tributaries.

Table 35. Stream characteristics for Camas Creek.

Parameter	Value
Channel types (Rosgen) found	A, B, C4
Width/Depth ratio	10.3 to 52.4
% Surface fines	8 to 26
Width of Floodplain	180 ft.
Predominant riparian vegetation type and extent	Conifer/Shrub
Q1.5 (CFS estimated bankfull discharge)	1450
Q10 (CFS 10 year estimate of peak flow)	2970
Base Flow (CFS 20 year minimum estimate of low flow in December)	214

Source: USGS StreamStats <http://streamstats.usgs.gov>

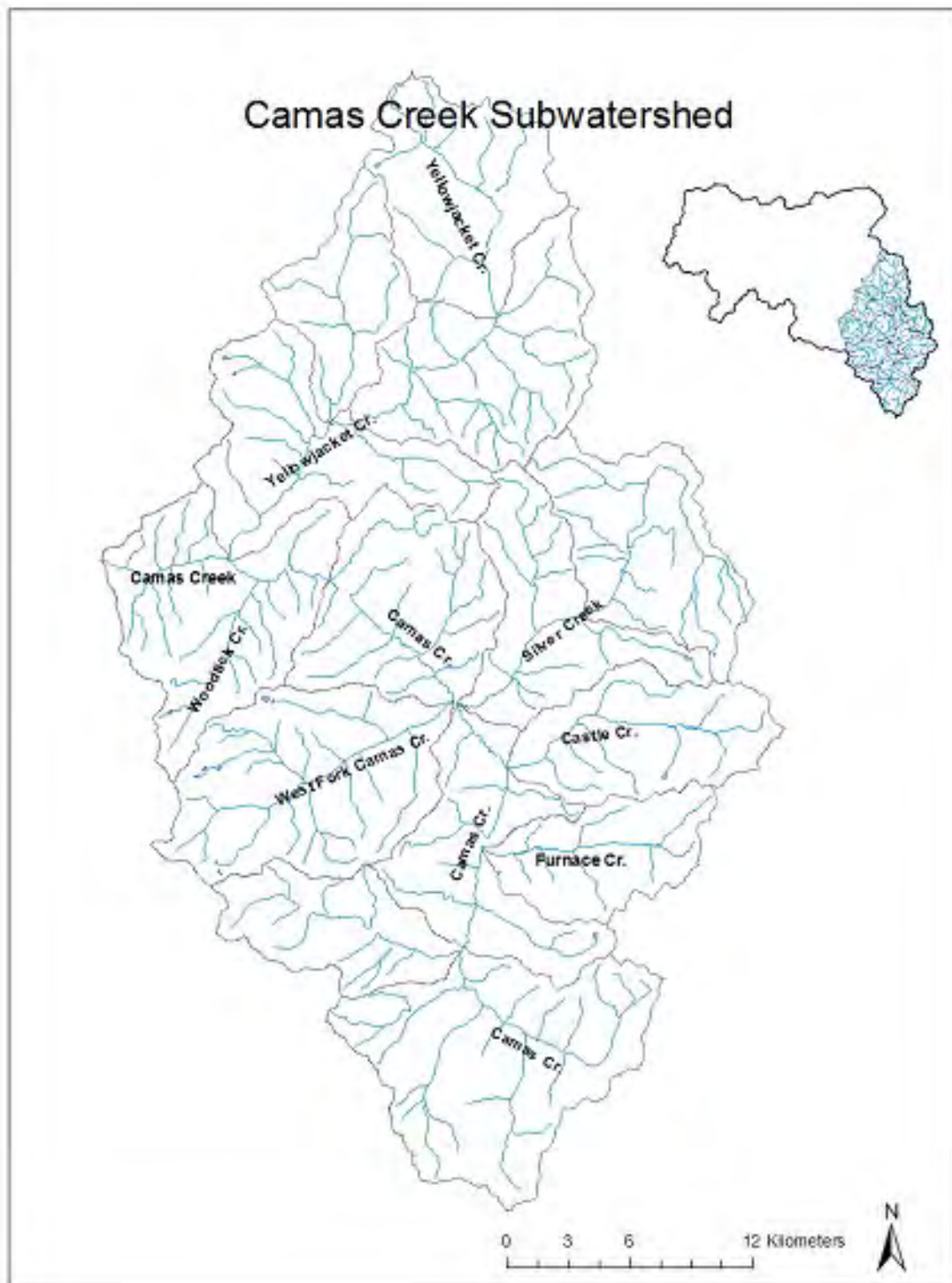


Figure 25. Camas Creek Subwatershed

Monumental Creek and Big Creek

Monumental Creek is a tributary to Big Creek and is part of the Big Creek subwatershed (Figure 26). The Big Creek watershed drains about 595 square miles of wilderness, historical and present mining activities, private summer residences, two guest outfitter lodges, water diversions, hydropower sites, five airstrips, a Forest Service guard station,

about 6,000 acres of State/private land, 53 miles of Forest Service system roads, and 400 miles of system trails. Big Creek flows into the Middle Fork Salmon River at 3,420 feet. The upper portions of Big Creek, its tributary of Monumental Creek, and the headwaters of Marble Creek have been influenced by human activity, primarily through mining and mining related activities such as road building and tree clearing. Table 36 shows watershed attributes for Monumental Creek and Table 37 shows attributes for the Big Creek watershed.

Monumental Creek drains approximately 229 square miles and flows 20 miles before entering Big Creek. Recently, 525 acres of privately owned land was given to the U.S. Forest Service. These 525 acres include the Thunder Mountain-Dewey Mine. Aside from mine-related effects, the subwatershed is in near-natural condition, because a large portion of it is within the FC-RONR Wilderness boundary.

Geology

The Monumental Creek watershed is dominated by volcanic rock from the Challis Volcanics formation that does not produce the sandy sediment typical of granitic watersheds. Instead, the stream substrate is made up of coarse, angular colluvium.

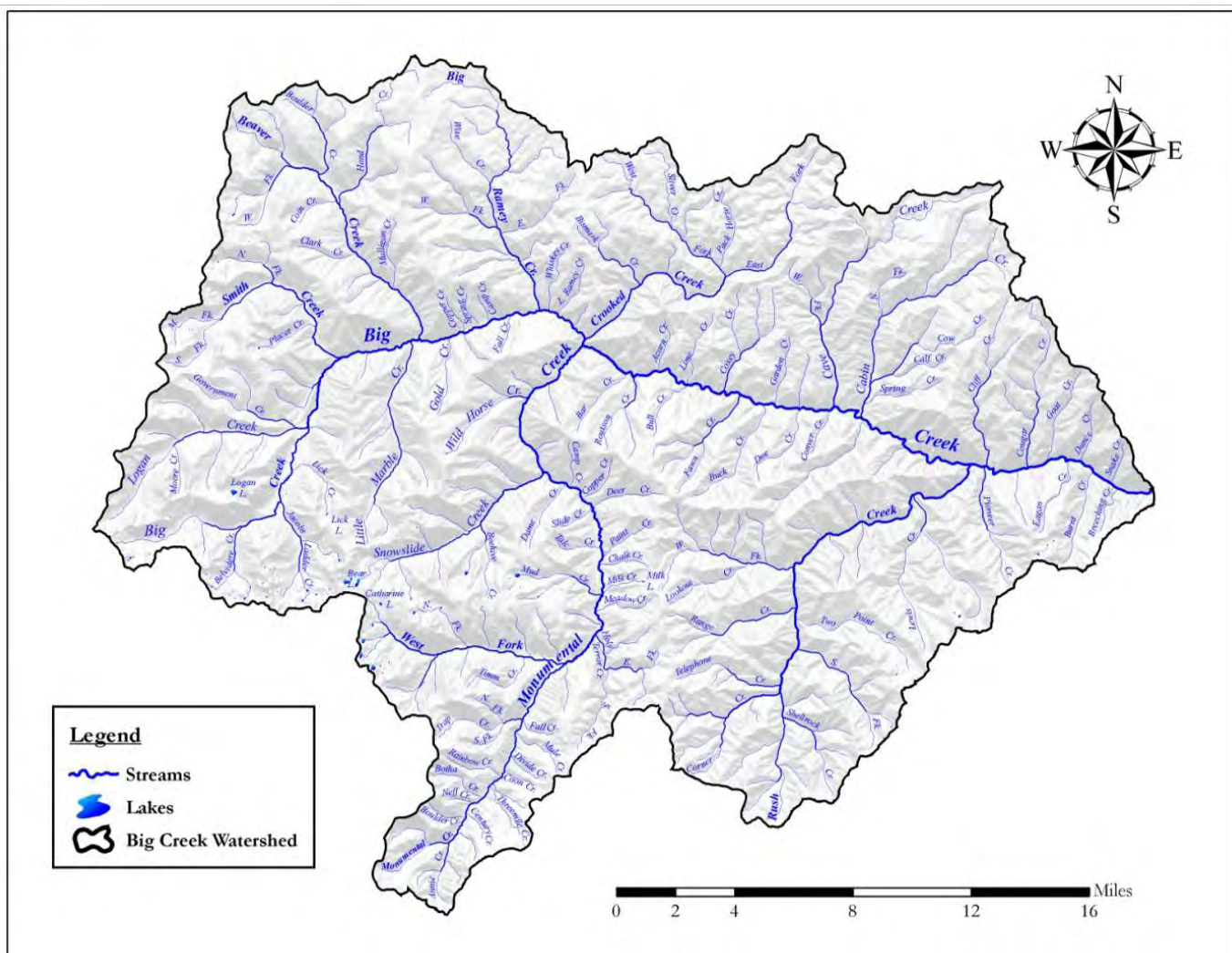


Figure 26. Big Creek subwatershed, including Monumental Creek.

Table 36. Physical and Stream Characteristics for the Monumental Creek Watershed

Parameter	Value
Channel Types (Rosgen) Found	A/B/C
Area in Square miles	229
Relief in feet	4,730
Average elevation in feet	7,160
Average area slope in percent	42.4
Percent of area with slope greater than 30%	70.3
Percent of area with slope greater than 30% and North Facing Slope	23
Percent of area covered by forest	81.8
Mean annual precipitation in inches	31.4
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	1,320
Q10 (CFS 10 year estimate of peak flow)	2,510
Base Flow (CFS 20 year minimum estimate of low flow in February)	127

Source: USGS StreamStats <http://streamstats.usgs.gov>

Table 37. Physical and Stream Characteristics for Big Creek Watershed

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	595
Relief in feet	6,080
Average elevation in feet	6,900
Average area slope in percent	46.4
Percent of area with slope greater than 30%	77.5
Percent of area with slope greater than 30% and North Facing Slope	26
Percent of area covered by forest	77.1
Mean annual precipitation in inches	27.6
Hydrologic regime	Snowmelt/Rain
Q1.5 (CFS estimated bankfull discharge)	2,360
Q10 (CFS 10 year estimate of peak flow)	4,650
Base Flow (CFS 20 year minimum estimate of low flow in February)	324

Source: USGS StreamStats <http://streamstats.usgs.gov>

Roads

Monumental Road (also known as Thunder Mountain Road or Road 375) is largely within the riparian conservation area of Monumental Creek and is surfaced with native volcanic rock that is angular and very clean. In 2003, Monumental Creek, which parallels the road, undercut the road after heavy rains, resulting in road failures at six individual sites along a two mile section of road. The road failures resulted in about 540 yards of material entering the creek and being moved downstream.

Repair work was necessary because of safety issues, continued erosion, delivery of material into Monumental Creek, and lack of access to private property. The treatments at the six locations consisted of resloping the road and placing riprap to stabilize and re-establish the slope. Generally, the repairs did not result in increased encroachment on the stream channel (PNF 2004). No in-stream work with heavy machinery occurred.

Road repair work, however, may have had a direct impact on bull trout and young of the year steelhead/redband trout present at the time. It may have also caused some habitat modification. A fish biologist was on site during the activities, performing fish surveys, moving fish that might be affected by the work, placing block nets, and guarding against encroachment by equipment.

Vegetation

Vegetation at lower elevations includes ponderosa pine/bluebunch wheatgrass, Douglas fir, ninebark, and snowberry at lower elevations. Mid elevations are dominated by forest communities of lodgepole pine, grand fir, and subalpine fir with pockets of aspen. Subalpine fir and whitebark pine are found at upper elevations. Fires have continually influenced the succession patches and variations in the age and structure of vegetation.

Mining

Mining activities have occurred in the headwaters of Monumental Creek (Thunder Mountain area) for over a century. Four defunct mines are in the Monumental Creek drainage, including the 40-acre Dewey Mine and the 235-acre Sunnyside Mine.

Fisheries

Chinook salmon are known to spawn and rear in Monumental Creek as far upstream as Roosevelt Lake. Good populations of spawning and rearing chinook are reported in Monumental Creek, the West Fork of Monumental Creek, and Snowslide Creek. Monumental Creek supported the largest number of steelhead spawners in the Big Creek subwatershed in a study in 1983. Bull trout are widespread throughout Monumental Creek, both resident and fluvial life history forms. Data from snorkel surveys in 1994, 1999, 2002 – 2004, and spawning surveys from 2003-2004 indicate that bull trout are abundant in Big Creek tributaries and Marble Creek, and that all life stages are represented (USFS 2006).

Snorkel surveys by IDFG also documented cutthroat trout in Monumental Creek. No brook trout are currently in the Monumental Creek drainage (USFS 2006).

Results of 2005 DEQ electrofishing showed the presence of bulltrout, cutthroat, and sculpin in upper Monumental Creek and sculpin and rainbow trout in lower Monumental Creek.

Papoose Creek

Papoose Creek originates at approximately 8,200 feet and drains 29 square miles of the FC-RONR Wilderness before flowing into the Middle Fork Salmon River at 3,270 feet in elevation. Several lakes are found in the headwaters of the watershed. Papoose Creek flows through both forested and open areas as it makes its way through steep canyons to the Middle Fork Salmon River. Watershed characteristics are shown in Table 38, and the watershed is shown in Figure 27.

Table 38. Papoose Creek watershed characteristics.

Parameter	Value
Channel Types (Rosgen) Found	A/B
Area in Square miles	29.45
Relief in feet	5,780
Average elevation in feet	7,050
Average area slope in percent	50.9
Percent of area with slope greater than 30%	80.6
Percent of area with slope greater than 30% and North Facing Slope	22.6
Percent of area covered by forest	61.9
Mean annual precipitation in inches	26.5
Hydrologic regime	Snowmelt/Rain

Parameter	Value
Q1.5 (CFS estimated bankfull discharge)	113
Q10 (CFS 10 year estimate of peak flow)	263
Base Flow (CFS 20 year minimum estimate of low flow in February)	28.4

Source: USGS StreamStats <http://streamstats.usgs.gov>

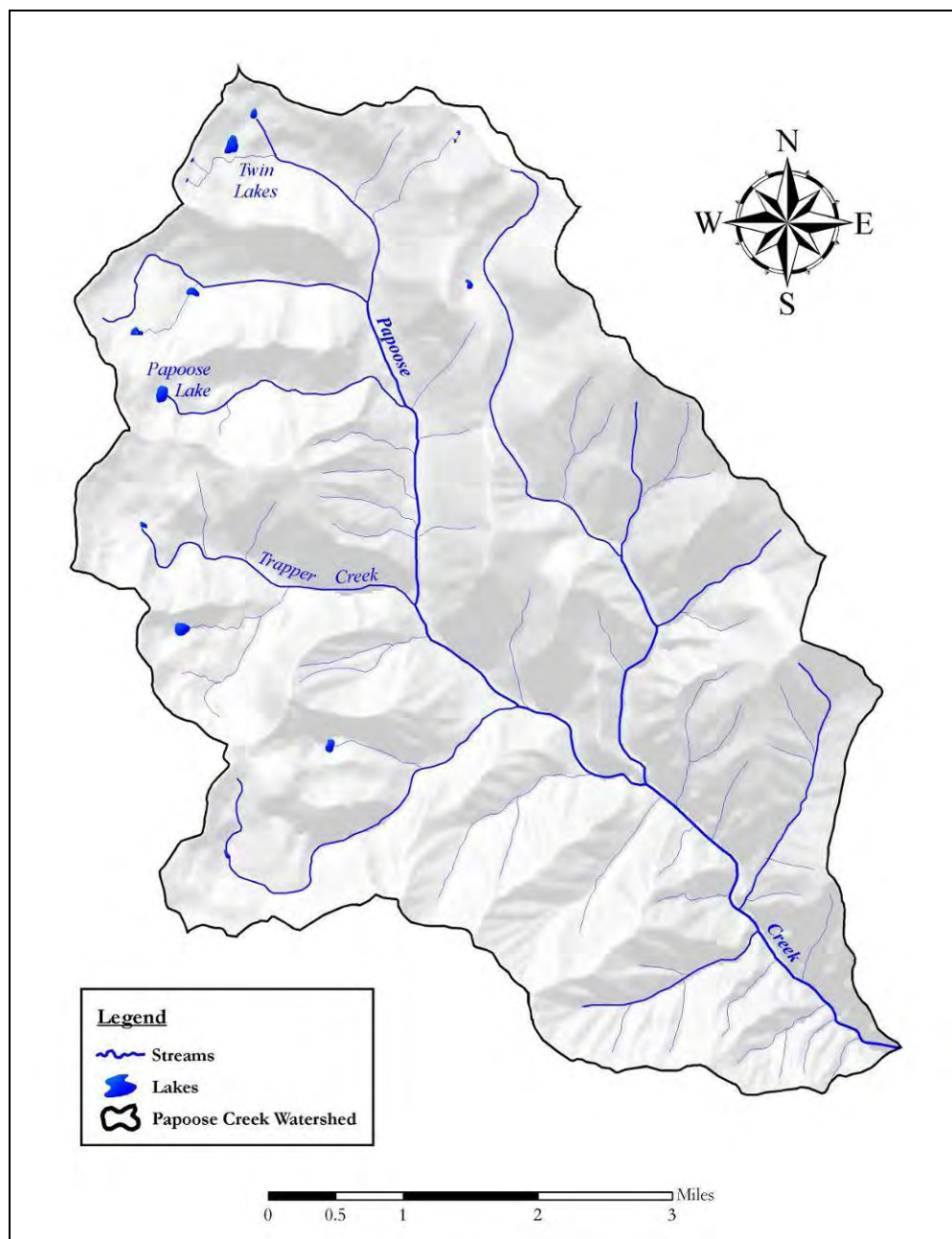


Figure 27. Papoose Creek watershed.

Wilson Creek Subwatershed

The Wilson Creek subwatershed consists primarily of weathered outcrops of granite known as the Bighorn Crags. Wilson Creek begins at Wilson Lake, a glacial cirque lake, in the northern part of the 'J' shaped subwatershed. Tributaries are small, flowing through oversized U-shaped valleys from alpine glaciation. Alpine Creek is the only named tributary that enters Wilson Creek. There is a constellation of glacial pothole lakes in the

upper subwatershed, just south of Wilson Lake. Timber cover is more sparse than in watersheds in volcanic or mixed geology (Table 39). The remaining subwatersheds, to the Main Salmon River confluence have some of the highest relief ratios found on the eastern Lower Middle Fork subwatersheds. These are short, high gradient streams with flashy hydrographs.

Table 39. Physical characteristics for the Wilson Creek subwatershed.

Parameter	Value
Area in Square miles	37.8
Relief in feet	6,240
Relief ratio (percent)	0.065
Average elevation in feet	7,380
Average area slope in percent	53.6
Percent of area with slope greater than 30%	80.9
Percent of area with slope greater than 30% and North Facing Slope	25
Percent of area covered by forest	58.4
Mean annual precipitation in inches	27.3
Hydrologic regime	Snowmelt / Lake outlet

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Wilson and Alpine Creeks originate in A channels from alpine lake outlets then flow in B channels to their respective confluence (Table 40). Riparian areas are some of the thickest vegetation in the watershed with shrub species including coniferous and deciduous woody species and shrub and sedge species. Weathered granitics such as those found in the Wilson Creek subwatershed produce significant amounts of fine sediment, however, the transport efficiency of B channels prevents fine sediment from aggrading the channel. It is not likely that spawning habitat is available in more than isolated pockets throughout the subwatershed. Large woody debris and boulders would provide instream habitat diversity for resident and migratory fish species. The locations of Wilson Creek and Alpine Creek are shown in Figure

Table 40. Stream characteristics for Wilson Creek.

Parameter	Value
Channel types (Rosgen) found	A,B
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub /Sedge
Q1.5 (CFS estimated bankfull discharge)	146
Q10 (CFS 10 year estimate of peak flow)	333
Base Flow (CFS 20 year minimum estimate of low flow in December)	91.6

Source: USGS StreamStats <http://streamstats.usgs.gov>

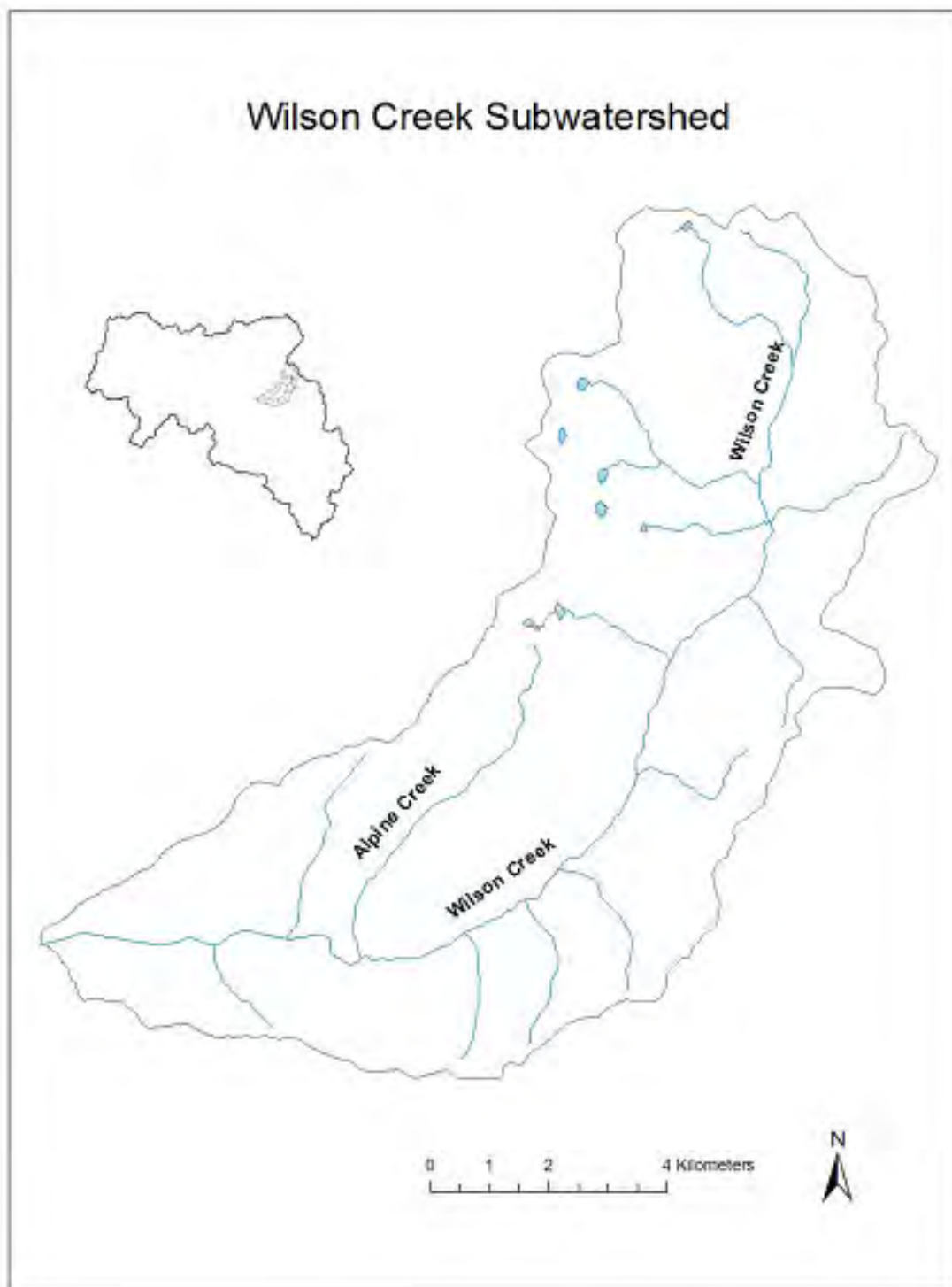


Figure 28. Wilson Creek subwatershed.

Waterfall Creek Subwatershed

Waterfall Creek starts from the outlet of Terrace Lakes at an elevation of 8,442 feet. There are several small unnamed tributaries that evolve in short, steep side canyons, but do not contribute significant flow compared to the source flow from the lake outlets. The only named tributary is the South Fork of Waterfall Creek that enters just above the confluence

with the Middle Fork. The cascade for which Waterfall Creek is named occurs just above the mouth and presents a barrier to migrating fish. Waterfall Creek, as with Wilson Creek, is located within the Bighorn Crags and has similar glaciated geological features (Table 41).

Table 41. Physical characteristics for the Waterfall Creek subwatershed.

Parameter	Value
Area in Square miles	20.7
Relief in feet	6,340
Relief ratio (percent)	0.122
Average elevation in feet	7,380
Average area slope in percent	48.5
Percent of area with slope greater than 30%	79.9
Percent of area with slope greater than 30% and North Facing Slope	25.2
Percent of area covered by forest	63
Mean annual precipitation in inches	23.6
Hydrologic regime	Snowmelt/Storm

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Waterfall Creek originates in an A channel from alpine lake outlets then flows in a B channels to its confluence with the Middle Fork Salmon River (Table 42). Riparian areas are some of the thickest vegetation in the watershed with shrub species including coniferous and deciduous woody species and shrub and sedge species. Weathered granitics such as those found in the Wilson Creek subwatershed produce significant amounts of fine sediment; however, the transport efficiency characteristic of B channels prevents fine sediment from aggrading the channel. It is not likely that spawning habitat is available in more than isolated pockets throughout the subwatershed. Large woody debris and boulders would provide instream habitat diversity for resident fish species. Figure 29 shows Waterfall Creek and South Waterfall Creek.

Table 42. Stream characteristics for Waterfall Creek.

Parameter	Value
Channel types (Rosgen) found	A,B
Width/Depth ratio	N/A
% Surface fines	N/A
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub/Conifer
Q1.5 (CFS estimated bankfull discharge)	56.3
Q10 (CFS 10 year estimate of peak flow)	144
Base Flow (CFS 20 year minimum estimate of low flow in December)	27.3

Source: USGS StreamStats <http://streamstats.usgs.gov>

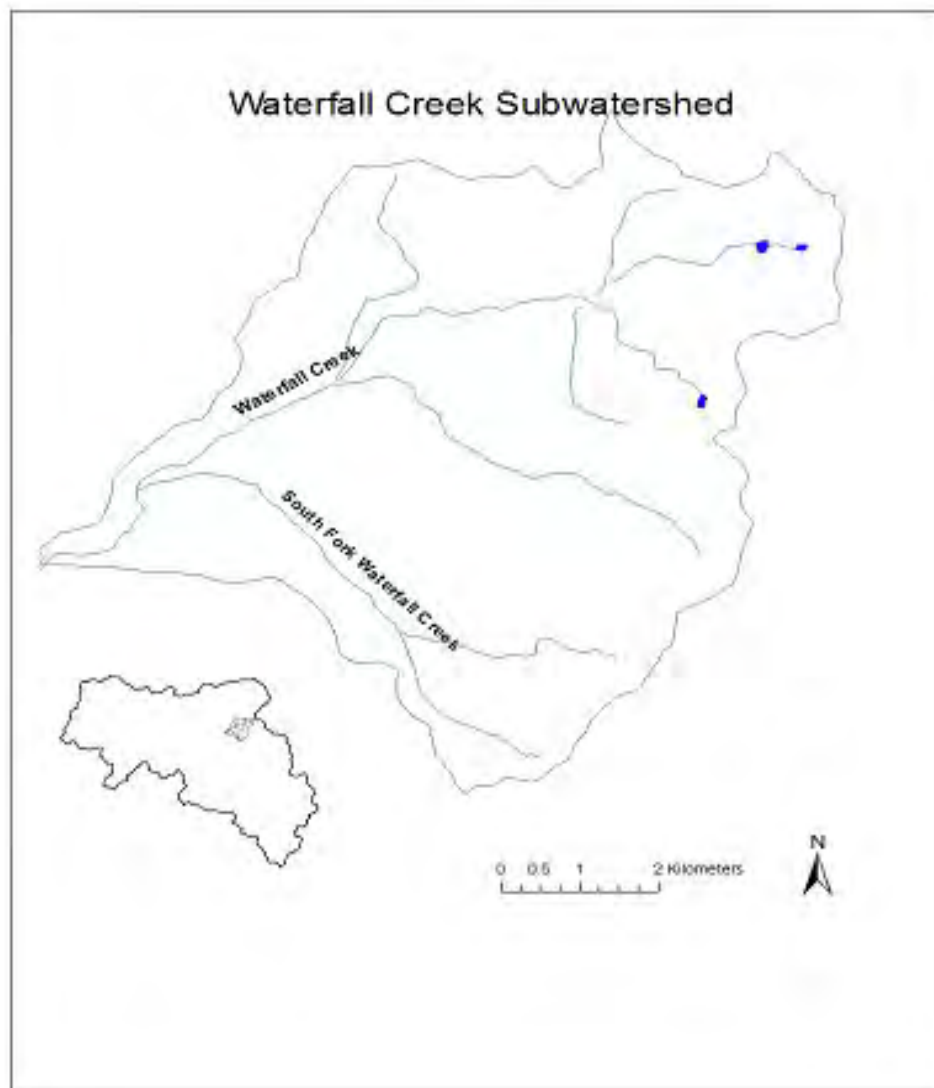


Figure 29. Waterfall Creek subwatershed.

Ship Island Creek Subwatershed

The source of Ship Island Lake is the outlet from Sheepeater Lake, the uppermost alpine lake in a series of four lakes that culminates in Ship Island Lake, the largest alpine lake in the Middle Fork Salmon River watershed. Ship Island Lake is a catastrophic lake, a lake caused by the damming of Ship Island Creek by a landslide. The Ship Island Creek subwatershed is small with one unnamed tributary that enters from a glacial side valley just above the confluence with the Middle Fork of the Salmon River (Table 43).

Table 43. Physical characteristics for the Ship Island Creek subwatershed.

Parameter	Value
Area in Square miles	23.3
Relief in feet	6,710
Relief ratio (percent)	0.131
Average elevation in feet	7,510
Average area slope in percent	61.5
Percent of area with slope greater than 30%	82.9
Percent of area with slope greater than 30% and North Facing Slope	33.4
Percent of area covered by forest	64.7
Mean annual precipitation in inches	25.1
Hydrologic regime	Snowmelt/Rain

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Ship Island Creek is a steep A channel below the outlet of Ship Island Lake. The lowest gradient occurs between Airplane Lake and Ship Island Lake. Riparian areas consist of moderate density of coniferous overstory with shrubs and sedges over the upper 2/3 of the watershed with the lower reach bedrock controlled with lower vegetation densities and overhead cover. Table 44 give the stream characteristics for Ship Island Creek.

Table 44. Stream Characteristics for Ship Island Creek.

Parameter	Value
Channel types (Rosgen) found	A,B
Width/Depth ratio	N/A
% Surface fines	Low
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub/Conifer
Q1.5 (CFS estimated bankfull discharge)	N/A
Q10 (CFS 10 year estimate of peak flow)	83.5
Base Flow (CFS 20 year minimum estimate of low flow in April)	31.8

Source: USGS StreamStats <http://streamstats.usgs.gov>

Weathered granitics such as those found in the Wilson Creek subwatershed produce significant amounts of fine sediment; however, the transport efficiency characteristic of A and B channels prevents fine sediment from aggrading the channel. It is not likely that spawning habitat is abundant in the subwatershed. Large woody debris and boulders would provide instream habitat diversity for resident fish species that may seek thermal refuge in Ship Island Lake during the heat of summer. Figure 30 shows the location of Ship Island Creek.

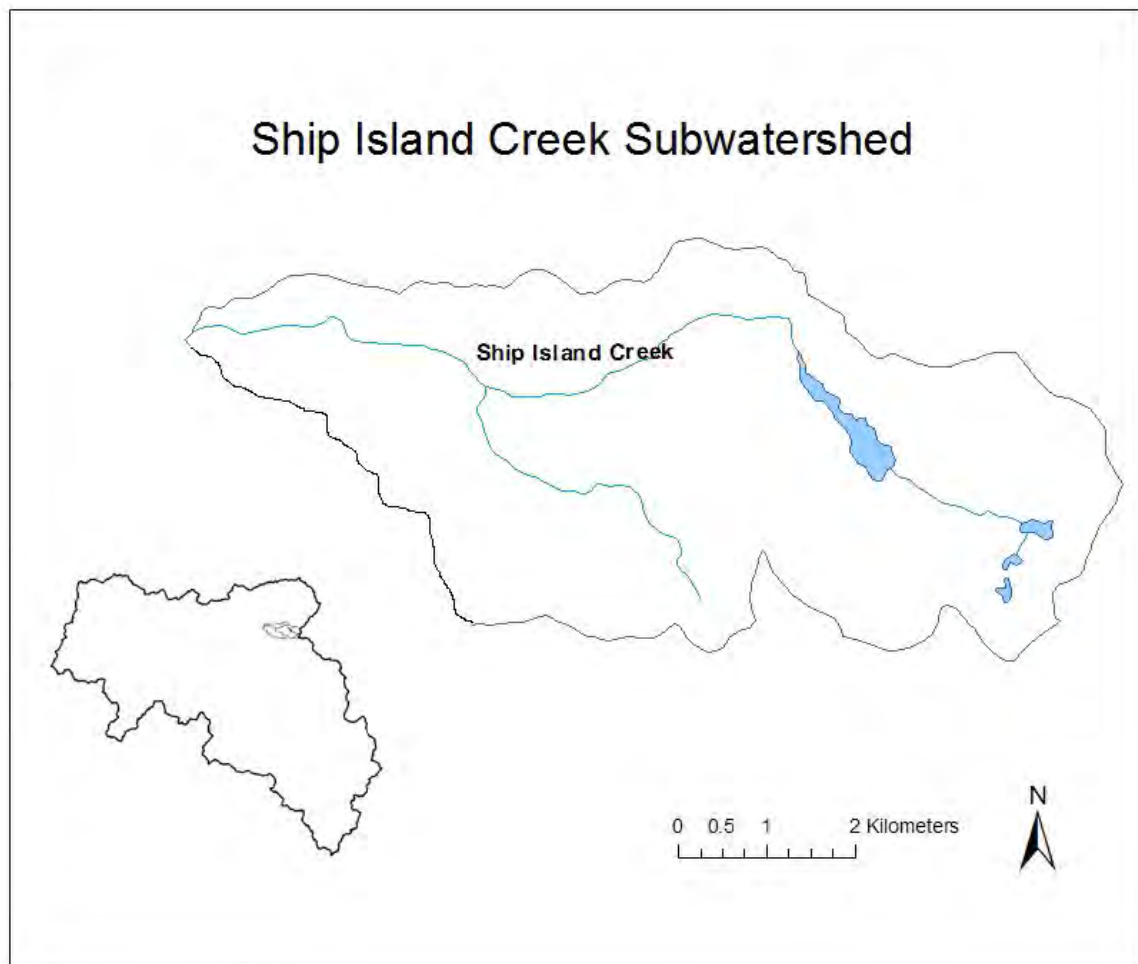


Figure 30. Ship Island Creek subwatershed.

Roaring Creek Subwatershed

Roaring Creek and Goat Creek are the lowest elevation watersheds on the eastern Middle Fork Salmon River watershed above the confluence with the main Salmon. They descend through glacial valleys with minimal contributed flow from tributaries. Roaring Creek originates in a cirque on the eastern flank of Mt. McGuire. It flows in a crescent shape to its confluence with the Middle Fork of the Salmon 3.7 miles above the main Salmon. Goat Creek makes its confluence 1.1 miles above the main Salmon River. Goat Creek is small and, though it is morphologically similar, only the Roaring Creek Subwatershed is characterized here (Table 45). There are a couple small alpine lakes in the tributary watershed to the east.

Table 45. Physical characteristics for the Roaring Creek subwatershed.

Parameter	Value
Area in Square miles	16.3
Relief in feet	6,860
Relief ratio (percent)	0.125
Average elevation in feet	7,610
Average area slope in percent	58.9
Percent of area with slope greater than 30%	87
Percent of area with slope greater than 30% and North Facing Slope	30.5
Percent of area covered by forest	54.7
Mean annual precipitation in inches	26.3
Hydrologic regime	Snowmelt/Rain

Source: USGS StreamStats <http://streamstats.usgs.gov>

Stream Characteristics

Roaring Creek has a lower gradient below the confluence of an unnamed tributary that enters in the middle reach, for a short distance, due to channel aggradation from high bedload. Above and below this reach, the channel would be considered a high gradient A channel. Riparian condition, like that of Ship Island and Wilson Creek is coniferous and shrub dominated with reduced density where the valley narrows and becomes bedrock controlled (Table 46). The location of Roaring Creek is shown in Figure 31.

Table 46. Stream characteristics for Roaring Creek.

Parameter	Value
Channel types (Rosgen) found	A,B
Width/Depth ratio	N/A
% Surface fines	Low
Width of Floodplain	N/A
Predominant riparian vegetation type and extent	Shrub/Conifer
Q1.5 (CFS estimated bankfull discharge)	50.1
Q10 (CFS 10 year estimate of peak flow)	125
Base Flow (CFS 20 year minimum estimate of low flow in February)	37.1

Source: USGS StreamStats <http://streamstats.usgs.gov>

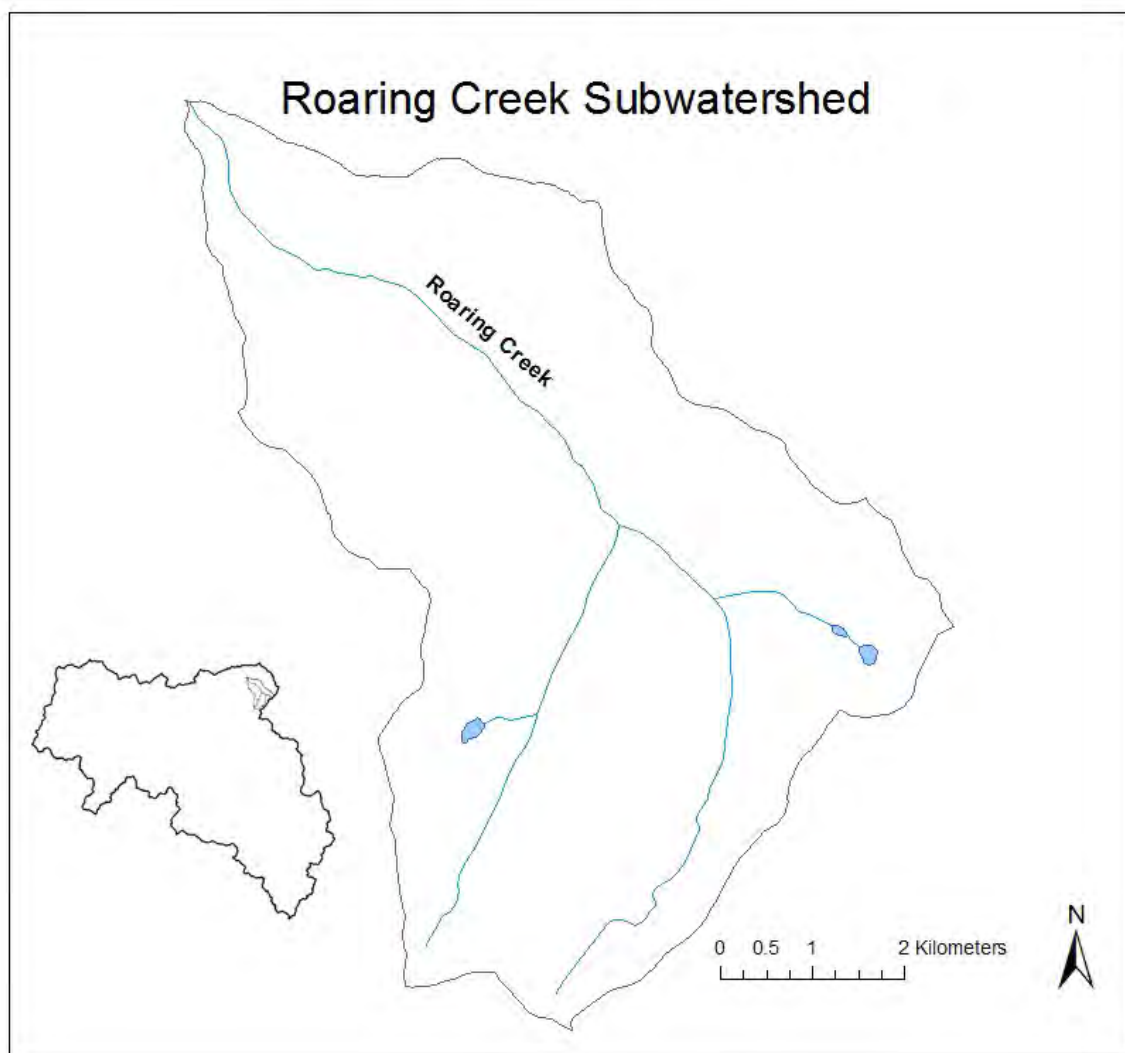


Figure 31. Roaring Creek subwatershed.

1.3 Cultural Characteristics

The Middle Fork of the Salmon River flows primarily within the Frank Church River of No Return Wilderness. The Frank Church Wilderness comprises the largest contiguous wilderness within the lower 48 United States (USDA FS, 2003). The Frank Church River of No Return Wilderness was designated by Congress in 1980. It is named for Idaho Senator Frank Church who was instrumental in the passage of the Wilderness Act of 1964. Prior to designation as a Wilderness Area, this region of central Idaho was known as the Idaho Primitive Area.

The area contained within the Middle Fork Salmon River watershed has historically had little impact from human endeavors. Protected by sheer ruggedness as well as wilderness designation and adjoining roadless areas, much of the land within the Middle Fork Salmon River exhibits some of the most ecologically intact land in the nation. This region provides habitat to species that are rare in other areas including the Canada lynx, wolverine, gray wolf, bull trout, and anadromous fish species including chinook and steelhead.

Native Americans utilized the area as a source of food and protection. The Turikina Shoshone, also known as Sheepeater Indians, were a clan of the Northern Shoshone tribe that utilized bighorn sheep as a staple in their diet. These Native Americans were protected from other tribes and European settlers, yet were displaced by the U.S. Army when the Sheepeaters were accused of murdering Chinese miners near Oro Grande in the Loon Creek watershed. The unobtrusive ways of Native Americans were replaced by the combination of mining and resource exploitation including grazing, timber harvest, and settlement which intensified with the discovery of gold in the Boise Basin and Yankee Fork of the Salmon River in 1862. Conflict was inevitable, resulting in intervention by the U.S. Army, culminating in what has come to be called the Sheepeater War of 1879.

Since that time, mining enterprises have come and gone throughout the Middle Fork Salmon River watershed. The scale has varied from individuals operating placer operations such as panning and sluice boxes to hydraulic guns, and in the case of upper Bear Valley Creek, dredge mining as recent as the 1950s. Ultimately, underground mines were developed with associated mills scattered throughout the wilderness on rugged roads built to accommodate ore wagons and teams of draft animals. There currently are no active mines in the Middle Fork Salmon River watershed, though historically mining production was robust within the Loon Creek, Rapid River, and Camas Creek subwatersheds.

Historically, livestock was raised adjacent to mining camps to provide meat and milk and to supply draft animals for packing and hauling. Any areas that provided open pasture were utilized for grazing, though winter livestock production was not possible in the upper watersheds. Lower watersheds, below Camas Creek, were often too rugged and dry with thin soils to produce suitable pasture for season-long grazing.

There are no significant population centers affiliated with the Middle Fork of the Salmon River. Gateway communities such as Challis, Stanley, Yellowpine, and Salmon, Idaho are situated on the periphery of the watershed.

Land Use

Today, recreation is the most pervasive land use within the Middle Fork of the Salmon River watershed. The USDA Forest Service manages the public land within the designated wilderness for a diversity of recreational access including boating, backpacking, horse packing, vehicle travel, and public landing strips. There are a number of private landing strips affiliated with private inholdings. These features provide access for camping in upland areas and along the Middle Fork of the Salmon River and its tributaries. Activities include hunting, fishing, hiking, whitewater rafting, and vacationing at private resorts.

There are over 1,000 miles of trails within the Middle Fork watershed (2,600 miles within the FCRONRW) with limited road access to the interior of the wilderness including the Boundary Creek Road, Loon Creek Road, Seafoam Road, Sleeping Deer Road, Bighorn Crag Road, and the roads to upper Elkhorn Creek, Thunder Mountain Mine in the Monumental Creek watershed, and into the upper reaches of Big Creek past Yellowpine. There are 24 airfields, 33 fire lookouts, 15 guard stations/patrol cabins, and over 100 trail bridges (USFS 2003).

There are 61 parcels of private or state-owned land within the FCRONRW (USDA FS 2003), many of which occur within the Middle Fork Salmon River watershed. Many of these inholdings feature resort type developments such as the Middle Fork Lodge at Thomas Creek, the Tappan Ranch near Camas Creek, the Diamond D Ranch on Loon Creek, and The Flying B Ranch near Brush Creek.

Grazing today is limited to areas around guest ranches for pack animals. There is some limited grazing that occurs along the middle reach of Camas Creek at Myers Cove, though it will likely be discontinued in the future due to logistical constraints and poor utilization management in riparian areas. Grazing permits have been purchased by the Bonneville Power Administration in the Bear Valley Creek subwatershed as reparation for degradation to riparian and instream habitat by previous lessees.

There has been no sanctioned timber harvest within the wilderness, however, limited post and pole, firewood, and minimal commercial harvest has occurred around the periphery of the wilderness. The primary force affecting timber stands within the Middle Fork watershed is natural fire.

Land owners/managers in the Middle Fork Salmon River watershed are shown in Figure 32 for the upper watershed and in Figure 33 for the lower.

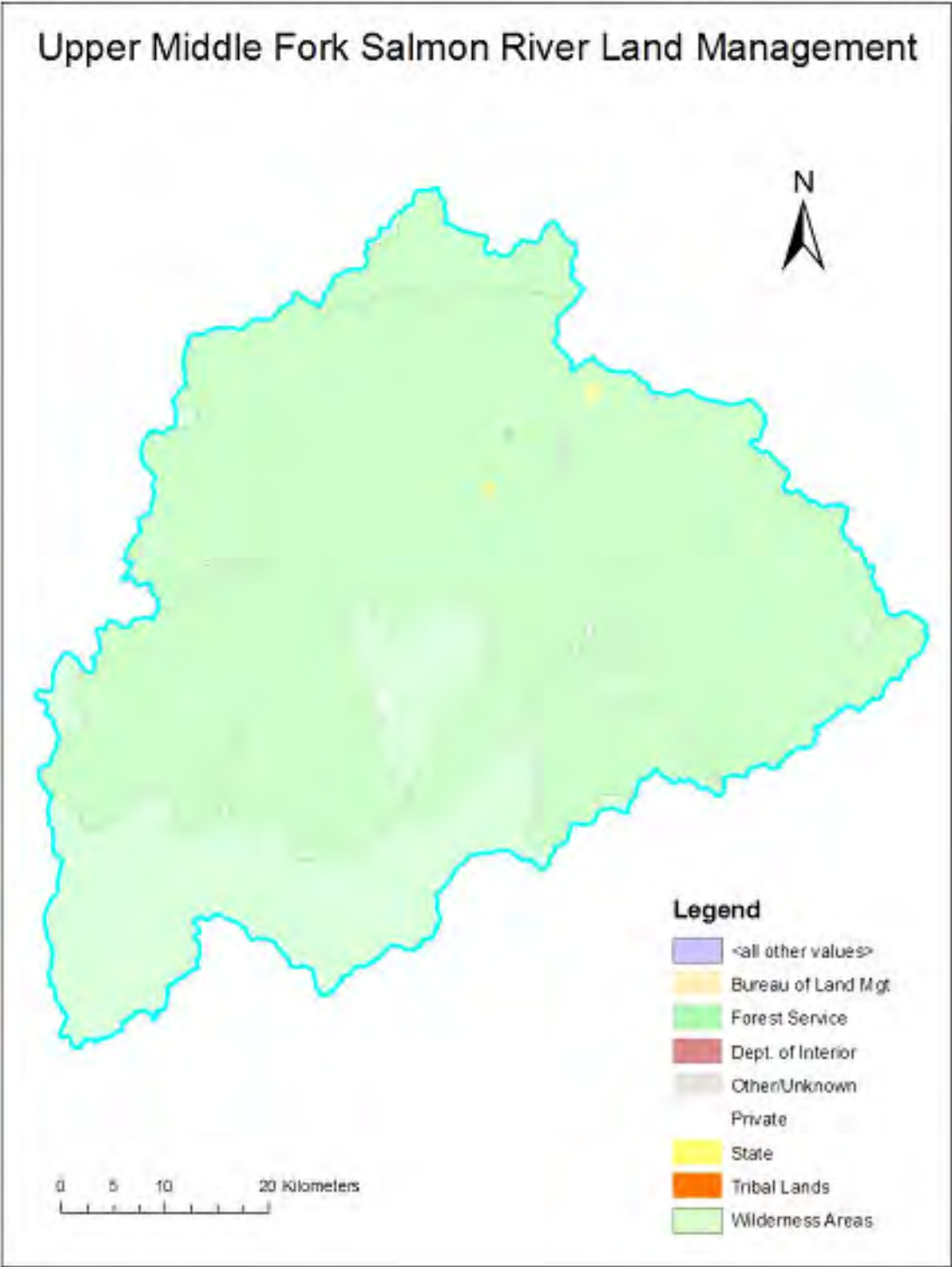


Figure 32. Upper Middle Fork Salmon River land management

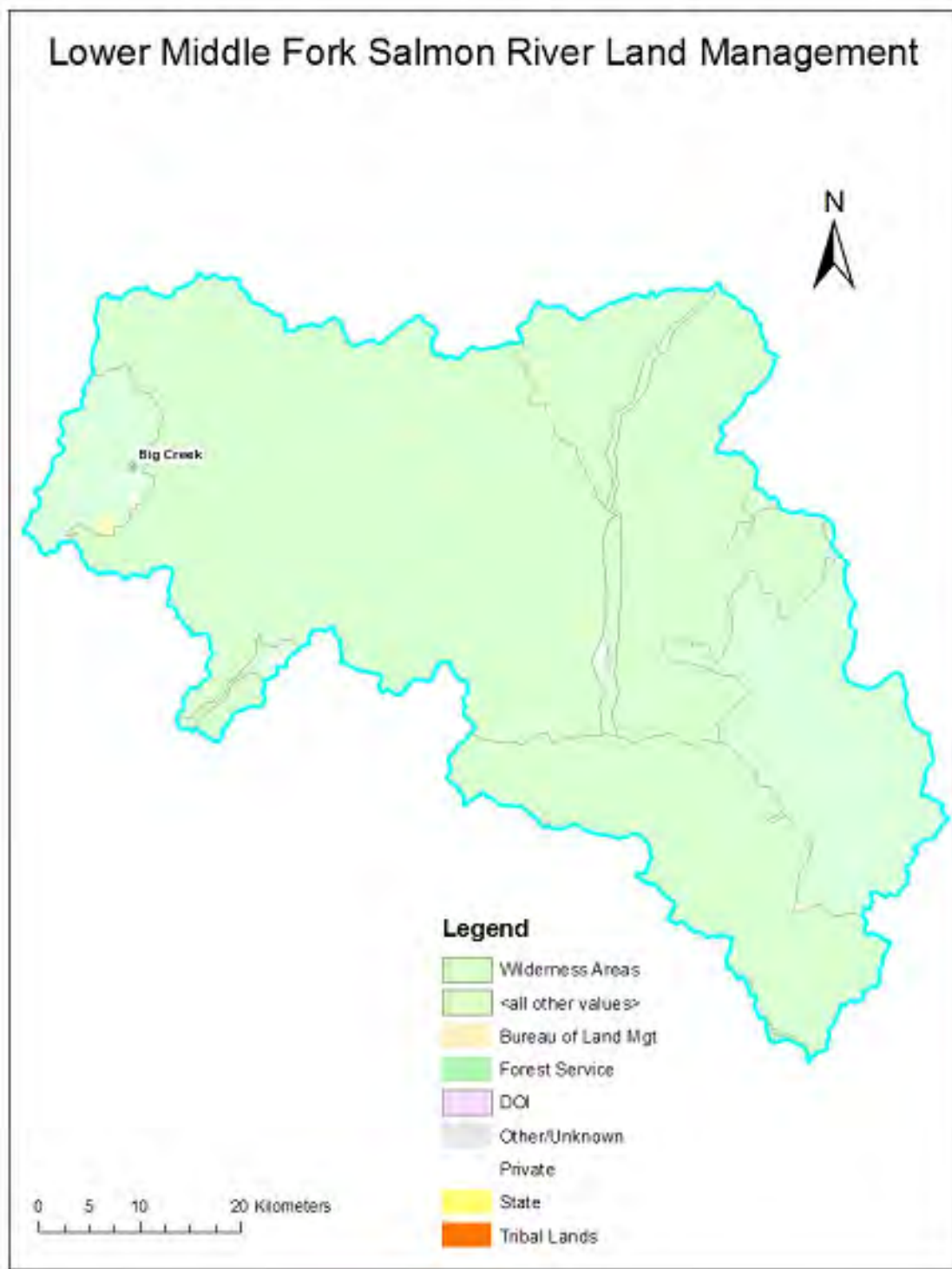


Figure 33. Lower Middle Fork Salmon River Land Management

Land Ownership, Cultural Features, and Population

There are very few people that live within the Middle Fork Salmon River watershed as residents. Population centers are non-existent though there are individuals that occasionally reside for extended periods as off-season caretakers at wilderness ranches. During the recreation season, however, it would be possible to tally thousands of people within the

watershed, primarily in pursuit of recreational activities such as whitewater rafting, hiking, horse packing, camping, fishing, and sightseeing, as well as those individuals affiliated with providing such services. There are numerous guest ranches that are accessed by remote backcountry air strips that were in existence before the watersheds were included in designated wilderness (Figure 34 and Figure 35). Myers Cove in the Camas Creek watershed at the Silver Creek confluence, and the Diamond D Ranch in the Loon Creek watershed below the Mayfield Creek confluence, are accessible by Forest Service road as well as by airstrip.

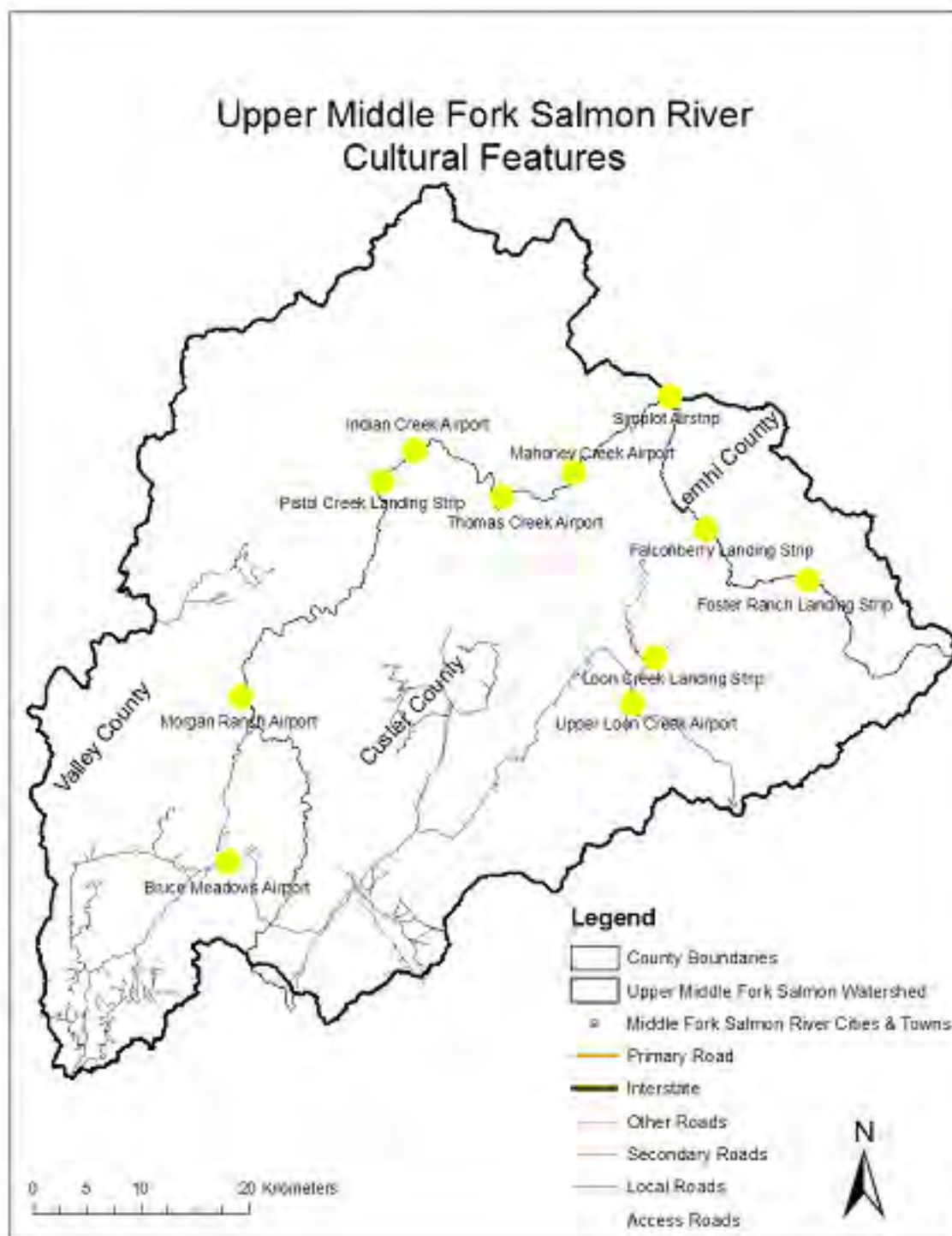


Figure 34. Upper Middle Fork cultural features including back country landing strips and roads.

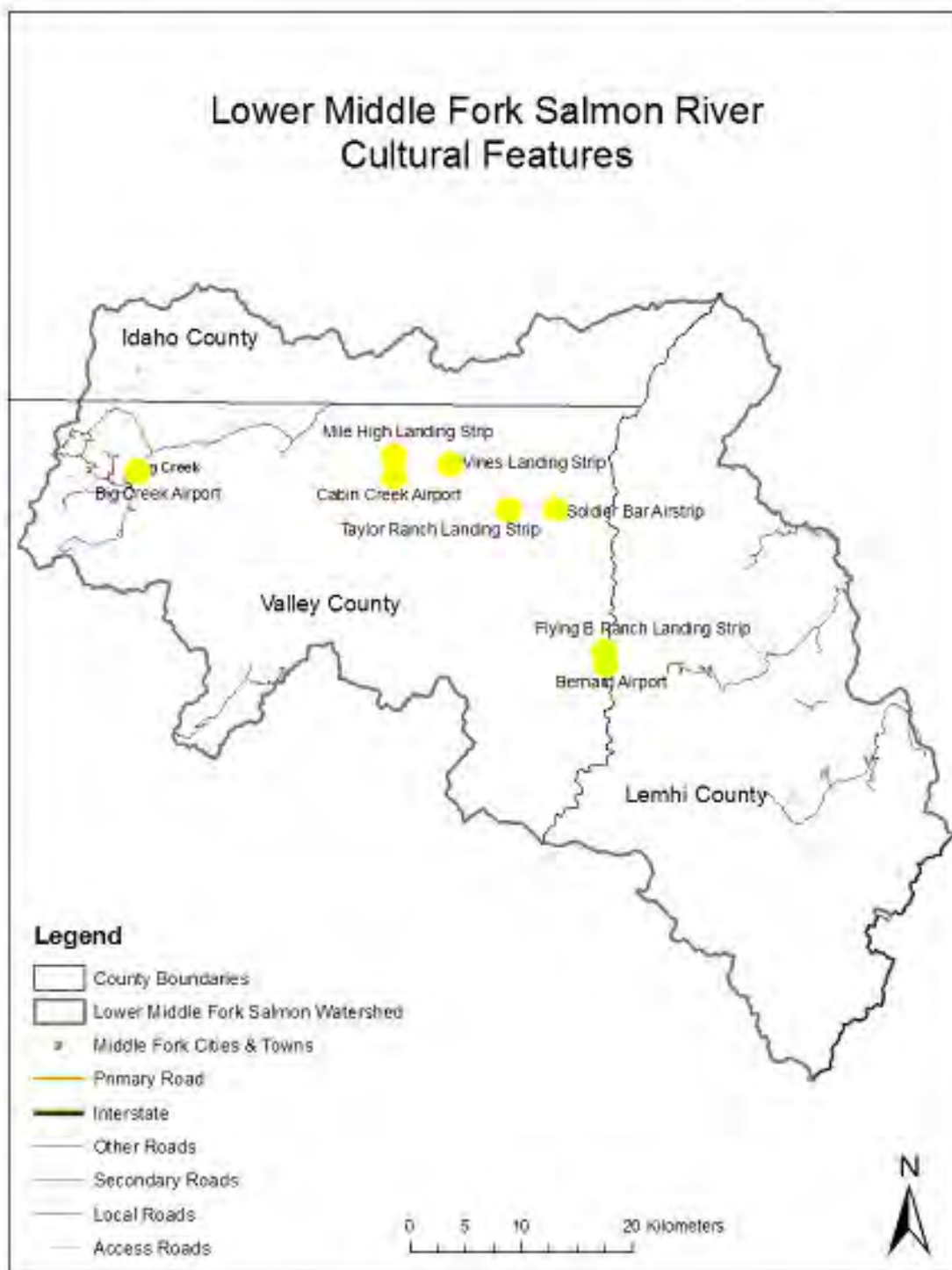


Figure 35. Lower Middle Fork cultural features including back country landing strips and roads.

Historical cultural resources include standing buildings and ruins of ranching, homesteading, mining, hunting, trapping operations, and early Forest Service operations. These buildings have associated trails and 19th and 20th century human burials. Forest Service cultural features include: administrative guard stations, fire lookouts, bridges, landing strips, and trails.

Land ownership is primarily public with the majority of public land managed by the USDA Forest Service at over 99 % (Table 47). There are some private inholdings that are primarily used as guest ranches. State of Idaho land within the watershed is managed as adjacent lands or by the Idaho Department of Fish and Game for enhancement of wildlife resources.

Table 47. Middle Fork Salmon River land ownership and management.

Upper Middle Fork Salmon River Land Management		
Owner/Manager	Acres	Percent of Watershed
Private	2,213.8	0.23%
Public: State	1,524.2	0.16%
Public: Forest Service	955,513.0	99.61%
Total	959,251	52.2
Lower Middle Fork Salmon River Land Management		
Owner/Manager	Acres	Percent of Watershed
Private	3731.6	0.43%
Public: State	2859.9	0.32%
Public: Forest Service	872,433.8	99.25%
Total	879,025.3	47.8%
<i>Combined Total</i>	<i>1,838,276.3</i>	<i>100%</i>

History and Economics

The economic history of the Middle Fork Watershed is closely tied to mining. Mining production in the Middle Fork Salmon River has totaled tens of millions of dollars since the discovery of mineral resources in the watershed. A significant proportion of the mining economy included livestock production, commercial fisheries, and produce marketing to feed miners. Timber, iron, and steel production in adjacent areas were important to supply materials for mine construction. The freight industry developed throughout the area to transport ore to mill sites using ore and freight wagons and eventually railway development. Mining oriented settlements have come and gone as deposits played out and what remains today is a vast wilderness that is important to the natural heritage of Idaho.

The primary product of wilderness seems to be recreation. Wilderness outfitters provide white water rafting for tens of thousands of visitors, extended trail rides for camping and fishing, back country hunting trips, and wildlife viewing. Guest ranches cater to a variety of vacation needs, and the affiliated airstrips are important to supplying the ranches and outfitters as well as providing an emergency network for administering to the needs of thousands of visitors each year.

Even the presence of land and resource management agencies can be considered a boon to the local economies. Numerous research and management personnel require access and logistical support to manage public lands. Wildlife and fisheries research is ongoing and at times intense given that the Middle Fork of the Salmon River is one of the last bastions of truly self-sustaining wild populations of resident and anadromous native fish.

Increasingly, recreationists are specialized with objectives to site-specific rare species of birds and mammals such as wolves, wolverines, and large cats such as Canada Lynx. The economic value of self-supported day use visitors cannot be overestimated, though it is difficult to track where the economic benefits accrue.

The recreation industry within this primarily designated wilderness is certainly the most pervasive industry within the Middle Fork Watershed. It has a distributed impact that is not currently significant to water quality. Recreation management must be emphasized in the future to insure that environmental impacts do not accrue to impair water quality or pose risks to human health.

There are no directed citizen based groups that work specifically with water quality issues within the Middle Fork watershed, though many conservation groups are involved in oversight of environmental issues related to wilderness, water quality, and resource conservation and management.

There are no directed citizen-based groups that work specifically with water quality issues within the Middle Fork watershed, though many conservation groups are involved in oversight of environmental issues related to wilderness, water quality, and resource conservation and management.

2. Subbasin Assessment – Water Quality Concerns and Status

Streams situated around the periphery of the wilderness area are subject to more land management related impacts than wilderness streams. However, considering recent catastrophic fires within the wilderness area, water quality impacts from sediment and associated runoff and debris have been greater in wilderness areas than in the more accessible non-wilderness managed areas. Water quality impacts from wildland fire are within the range of natural variability and have the potential to change hydrology, channel morphology, and habitat for extended periods of time. Impacts from land management are also variable when related to climate, geology, and land use. The difference is that managed lands are expected to be managed with natural variability and watershed sensitivity in mind. An important aspect to management is aquatic habitat and water quality monitoring to distinguish between impacts related to natural variability versus land use.

In 1991, the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service received a petition to list Pacific Northwest Salmon Runs under the Endangered Species Act (ESA). Spring, summer and fall run chinook were listed as threatened species in the Salmon River basin in 1992. Snake River basin steelhead trout were listed as a threatened species in 1997. The listings of anadromous fish prompted a review of current habitat management practices on federal lands by NOAA Fisheries. As part of the Section 7 consultation process with the Forest Service, NOAA Fisheries issued a biological opinion on the adequacy of land and resource plans to protect anadromous fish habitat. One of the commitments identified in the Opinion was to monitor grazing strategies to determine if current grazing practices were meeting the federal Pacific Anadromous Fish Strategy (PACFISH) riparian management objectives.

The U.S. Department of Agriculture (USDA) Forest Service and NOAA Fisheries Service met in 1998 to develop a plan for monitoring the condition of aquatic habitat in grazed lands. Goals for this plan include developing a coordinated effort with a defensible sample design, maximizing the effectiveness of limited monitoring funds, identifying appropriate scales and levels of monitoring, and identifying how monitoring results should be used to make management adjustments (USDA FS, 1998).

Beginning in 1998, the Forest Service National Fish and Aquatic Ecology Unit began an Effectiveness Monitoring Pilot Project for Streams and Riparian Areas within the Upper Columbia River Basin, which included select streams in the Middle Fork Salmon River watershed on the Salmon-Challis National Forest. Sampling was conducted on Forest Service managed public lands with the federal Inland Native Fish Strategy (INFISH) and PACFISH designated objectives. The primary objective was to develop effectiveness monitoring to answer the question: “Are key biological, chemical, and physical attributes, processes, and functions of aquatic and riparian communities maintained, degraded, or restored as a result of grazing management in the range of the steelhead and bull trout within U.S. Forest Service Region 4 (which includes the Middle Fork Salmon River)?” Between chinook habitat and steelhead habitat, steelhead are the more distributed and would represent conditions found within the Middle Fork Salmon River watershed managed lands.

Water quality concerns within this document involve land use outside of wilderness areas within the Middle Fork hydrologic units, the results of monitoring, the evaluation of existing conditions, and comparing those data with known reference conditions to determine whether water quality concerns related to land use management are founded and correctable. The primary pollutant of concern is thermal loading related to exposed streambanks. In most systems, sediment from streambank erosion would be of primary concern. To a large degree, these streams are protected by high stream gradient and abundant flow to produce stream power adequate to transport fine sediment through the system. Streambank erosion still exists, but the manifestation is a widened channel with reduced canopy cover that results in elevated temperature during the warmest period of the summer. This also happens to be during the migration and spawning period of anadromous fish. Fall spawning fish, particularly bull trout, are buffered by cooling autumn air temperatures in all but the warmest years.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

About Assessment Units

Assessment units (AUs) now define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the *Water Body Assessment Guidance, Second Edition* (WBAG II) (Grafe et al 2002).

Assessment units are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—even if ownership and land use change significantly, an AU remains the same.

Using AUs to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs meets the fundamental requirement of EPA's 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of 303 (d) listed streams. Due to the nature of the court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from “headwater to mouth.” In order to deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ set about writing TMDLs at the watershed scale (HUC), so that all the waters in the drainage are and have been considered for TMDL purposes since 1994.

The boundaries from the 1998 303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in any listed segment were carried forward to the 2002 303(d) listings in Section 5 of the Integrated Report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list. This was necessary to maintain the integrity of the 1998 303(d) list and

to maintain continuity with the TMDL program. These new AUs will lead to better assessment of the needs for water quality listing and de-listing.

When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (de-listed) from the 303(d) list (Section 5 of the Integrated Report).

Listed Waters

In the Middle Fork Salmon River subbasin, some waters were once listed as water quality limited, but are now known to be unimpaired. The initial listings, and adjustments already made or still needed, are discussed in this section.

Within the Idaho Falls DEQ Region portion of the Middle Fork Salmon River watershed, there are four AUs assumed to be water quality limited that are on the 2002 303(d) list (Table 48). Within these AUs, listed streams that are first order and ephemeral streams, will not have TMDLs developed (Table 49). The streams with flows less than 1cfs were all monitored in 1997 following a winter with snow packs well above average that resulted in above average flows. Normally these streams would be dry from July through March at the locations where monitoring occurred and would otherwise not be targeted for monitoring. These streams were remonitored and a determination was made regarding whether they were ephemeral or springbrooks. These streams will not have TMDLs developed for them and are referred to in Table 49 as nontargeted waters. The streams with flows greater than 1 cubic foot per second (cfs) were found to be in full support of beneficial uses and, therefore, to have been listed in error. The listed streams occur in the Upper Middle Fork within the Idaho Falls Region (HUC 17060205). There are, however, water quality concerns with several other perennial streams in the upper and lower Middle Fork Watersheds.

Table 48 also shows the 303(d) listed AUs occurring in the Boise Region. These AUs contain Bear Valley Creek, Elk Creek, Elkhorn Creek, Monumental Creek and Cache Creek.

Table 48. Water quality limited Assessment Units occurring in the Middle Fork subbasin (HUC 17060205).

Water Body Name	Assessment Unit ID Number	303(d) Boundaries	Pollutant(s)	Data for Listing Basis
Marsh Creek	ID17060205SL024_02	Source to Knapp Cr.	Unknown	BURP
Flat Creek	ID17060205SL024_02	Source to Marsh Cr.	Unknown	BURP
Vader Creek	ID17060205SL024_02	Source to Marsh Cr.	Unknown	BURP
Camp Creek	ID17060205SL027_02	Source to Marsh Cr.	Unknown	BURP
Asher Creek	ID17060205SL026_02	Source to Marsh Cr.	Unknown	BURP
Shake Creek	ID17060205SL028_02	Source to Beaver Cr.	Unknown	BURP
Laidlow Creek	ID17060205SL028_02	Source to Beaver Cr.	Unknown	BURP

Water Body Name	Assessment Unit ID Number	303(d) Boundaries	Pollutant(s)	Data for Listing Basis
Bear Valley Creek	ID17060205SL012_03	Sheep Trail Creek to Cache Creek	Sediment	BURP
Bear Valley Creek	ID17060205SL012_04	Cache Creek to Elk Creek	Sediment	BURP
Bear Valley Creek	ID17060205SL012_05	Elk Creek to Mouth	Unknown	BURP
Elk Creek	ID17060205SL013_03	Bearskin Creek third order section	Sediment	USFS
Elkhorn Creek	ID17060205SL012_02	2 nd order section of Elkhorn Creek	Sediment Temperature	USFS

Table 49. Listed streams and assessment units that will not have TMDLs developed.

Water Body Name	Assessment Unit ID Number	303(d) Boundaries	Reason No TMDL Developed
Camp Creek	ID17060205SL027_02	Source to Marsh Cr.	Non Targeted Water: Springbrook
Asher Creek	ID17060205SL026_02	Source to Marsh Cr.	Non Targeted Water: Springbrook
Shake Creek	ID17060205SL028_02	Source to Beaver Cr.	Full Support
Laidlow Creek	ID17060205SL028_02	Source to Beaver Cr.	Full Support
Bear Valley Creek	ID17060205SL012_03	3 rd Order Section	Full support
Bear Valley Creek	ID17060205SL012_04	4 th Order Section	Category 4b
Bear Valley Creek	ID17060205SL012_05	5 th Order Section	Category 4b
Elk Creek	ID17060205SL013_03	3 rd Order Section of Elk Creek (does not include section in wilderness)	Category 4b
Elkhorn Creek	ID17060205SL012_02	2 nd Order Section of Elkhorn Creek	Full Support
Monumental Creek	ID17060206012_03	3 rd Order Section of Monumental Creek	Full Support

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses or that do not meet numeric water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to comply with water quality standards.

4b Assessment

EPA lists specific circumstances in which a waterbody can be placed in section 4b of the Integrated Report. This section is for those water bodies which have already implemented some or all of certain measures that will result in attainment of water quality standards in that waterbody in a reasonable time.

This includes:

A waterbody that is impaired by nonpoint sources which have already implemented some or all of certain measures that will result in attainment of WQS in that waterbody in a reasonable time. The controls are unlikely to be removed or reversed (e.g., watershed restoration measures pursuant to 319 grant).

• A waterbody is impaired by nonpoint sources within federal lands where a forest management plan has been developed and is being implemented. In this case, certain elements are included in the forest management plan emphasizing BMP certification programs, require adaptive adjustments of practices, and specify monitoring options needed to demonstrate compliance with state water quality standards.

DEQ's assertion is that Bear Valley Creek AUs ID17060205SL012_04 and ID17060205SL012_05 meet the above criteria. Both the Boise Forest Management Plan and the Bear Valley Watershed Analysis (USFS 2000) contain directives to reduce nonpoint source loading to this watershed. Furthermore, the US Forest Service and its partners have implemented a substantial amount of these controls. And they have already implemented the measures that would have the largest benefit to water quality (rehabilitation of the dredge mining site and cessation of grazing).

Bear Valley Creek has been largely impacted by historic dredge mining activities and to a lesser extent grazing. Impacts from roads and recreation were identified as not being significant sources of sediment. The main pollutant stressor in both of these creeks is sediment. Both mining and grazing have ceased in the watershed and water quality improvement projects were implemented to address habitat problems that these activities caused. These AUs are dealt with in a separate document, Middle Fork Salmon River 4b Justification that is currently under development.

If these AUs do not meet the following 6 criteria for 4b then a TMDL will be developed: 1) A statement of the problem; 2) a description of the proposed implementation strategy and supporting pollution controls necessary to achieve water quality standards, including the identification of point and nonpoint source loadings that when implemented assure the attainment of all applicable water quality standards; 3) an estimate or projection of the time when water quality standards will be met; 4) a reasonable schedule for implementing the necessary pollution controls; 5) a description of and schedule for monitoring milestones for tracking and reporting progress to EPA on the implementation of the pollution controls and 6) a commitment to revise as necessary the implementation strategy and corresponding pollution controls if progress towards meeting water quality standards is not being shown.

2.2 Applicable Water Quality Standards

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The WBAG II (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

Existing Uses

Existing uses under the CWA are “those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards.” The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the CWA are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the state. In Idaho these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called “presumed uses,” DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, there is an additional existing use (e.g., salmonid spawning), because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for the additional existing use(s) would additionally apply (e.g., for salmonid spawning, the criteria for intergravel dissolved oxygen and temperature would

apply). However, if for example, cold water aquatic life is not found to be an existing use, a use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Beneficial Uses in the Middle Fork Salmon River

Beneficial uses for §303(d)-listed streams are shown in Table 50. Beneficial uses of streams that are not §303(d)-listed but have been assessed are shown in Table 51 for the upper watershed and Table 52 for the lower watershed.

Table 50. Middle Fork Salmon River Subbasin beneficial uses of §303(d) listed streams.

Water Body	Uses^a	Type of Use
Marsh Creek – source to Knapp Creek	CW, SS, PCR, AWS	Existing
Flat Creek – source to mouth	CW, SCR, AWS	Presumed
Vader Creek – source to mouth	CW, SCR, AWS	Presumed
Camp Creek – source to mouth	CW, SCR, AWS	Presumed
Asher Creek – source to mouth	CW, SCR, AWS	Presumed
Shake Creek – source to mouth	CW, SS, PCR, AWS	Presumed
Laidlow Creek – source to mouth	CW, SCR, AWS	Presumed
Bear Valley Creek – source to mouth	CW, SS, PCR, AWS	Existing
Elk Creek – source to mouth	CW, SS, PCR, AWS	Existing
Monumental Creek – source to mouth	CW, SS, PCR, DWS, SRW	Designated
Elkhorn Creek – source to mouth	CW, SS, PCR, AWS	Existing

^a CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply

Table 51. Upper Middle Fork Salmon River Subbasin beneficial uses of assessed, non-§303(d) listed streams.

Water Body	Uses^a	Type of Use
Middle Fork Salmon River – confluence of Bear Valley Creek and Marsh Creek to Loon Creek	CW, SS, PCR, DWS, SRW	Designated
Marble Creek – source to mouth	CW, SS, PCR, AWS	Existing
Trail Creek – source to mouth	CW, SS, PCR, AWS	Existing
Big Cottonwood Creek –source to mouth	CW, SS, PCR, AWS	Existing
Dynamite Creek – source to mouth	CW, SS, PCR, AWS	Existing
Indian Creek – source to mouth	CW, SS, PCR, AWS	Existing
Pistol Creek – source to mouth	CW, SS, PCR, AWS	Existing
Sulphur Creek – source to mouth	CW, SS, PCR, AWS	Existing
Boundary Creek – source to mouth	CW, SS, PCR, AWS	Existing
Dagger Creek – source to mouth	CW, SS, PCR, AWS	Existing
Sheep Trail Creek – source to mouth	CW, SS, PCR, AWS	Existing
Cub Creek – source to mouth	CW, SS, PCR, AWS	Existing
Fir Creek – source to mouth	CW, SS, PCR, AWS	Existing
Marsh Creek – Beaver Creek to Mouth	CW, SS, PCR, AWS	Existing
Marsh Creek – Knapp Creek to Beaver Creek	CW, SS, PCR, AWS	Existing
Cape Horn Creek –Banner Creek to mouth	CW, SS, PCR, AWS	Existing
Cape Horn Creek – source to Banner Creek	CW, SS, PCR, AWS	Existing
Banner Creek – source to mouth	CW, SS, PCR, AWS	Existing
Swamp Creek – source to mouth	CW, SS, PCR, AWS	Existing

Water Body	Uses ^a	Type of Use
Knapp Creek – source to mouth	CW, SS, PCR, AWS	Existing
Asher Creek – source to mouth	CW, SS, PCR, AWS	Presumed
Unnamed Tributary – source to mouth (T12N, R11E, Sec. 11)	CW, SS, PCR, AWS	Presumed
Beaver Creek – Bear Creek to mouth	CW, SS, PCR, AWS	Existing
Beaver Creek –Winnemucca Creek to Bear Creek	CW, SS, PCR, AWS	Existing
Winnemucca Creek –source to mouth	CW, SS, PCR, AWS	Existing
Beaver Creek– source to Winnemucca Creek	CW, SS, PCR, AWS	Existing
Bear Creek – source to mouth	CW, SS, PCR, AWS	Existing
Soldier Creek – source to mouth	CW, SS, PCR, AWS	Existing
Greyhound Creek – source to mouth	CW, SS, PCR, AWS	Existing
Rapid River – Bell Creek to mouth	CW, SS, PCR, AWS	Existing
Bell Creek – source to mouth	CW, SS, PCR, AWS	Existing
Rapid River – Lucinda Creek to Bell Creek	CW, SS, PCR, AWS	Existing
Rapid River – Float Creek to Lucinda Creek	CW, SS, PCR, AWS	Existing
Float Creek – source to mouth	CW, SS, PCR, AWS	Existing
Rapid River – Vanity Creek to Float Creek	CW, SS, PCR, AWS	Existing
Vanity Creek – source to mouth	CW, SS, PCR, AWS	Existing
Rapid River – source to Vanity Creek	CW, SS, PCR, AWS	Existing
Lucinda Creek – source to mouth	CW, SS, PCR, AWS	Existing
Sheep Creek – confluence of North and South Fork Sheep Creek to mouth	CW, SS, PCR, AWS	Existing
South Fork Sheep Creek – source to mouth	CW, SS, PCR, AWS	Existing
North Fork Sheep Creek – source to mouth	CW, SS, PCR, AWS	Existing
Little Loon Creek – source to mouth	CW, SS, PCR, AWS	Existing
Loon Creek – Cabin Creek to mouth	CW, SS, PCR, AWS	Existing
Loon Creek –Warm Springs Creek to Cabin Creek	CW, SS, PCR, AWS	Existing
Loon Creek –Cottonwood Creek to Warm Springs Creek	CW, SS, PCR, AWS	Existing
Loon Creek – Shell Creek to Cottonwood Creek	CW, SS, PCR, AWS	Existing
Shell Creek – source to mouth	CW, SS, PCR, AWS	Existing
Loon Creek – Grouse Creek to Shell Creek	CW, SS, PCR, AWS	Existing
Grouse Creek – source to mouth	CW, SS, PCR, AWS	Existing
Loon Creek – Canyon Creek to Grouse Creek	CW, SS, PCR, AWS	Existing
Canyon Creek – source to mouth	CW, SS, PCR, AWS	Existing
Loon Creek – Pioneer Creek to Canyon Creek	CW, SS, PCR, AWS	Existing
Trail Creek – source to mouth	CW, SS, PCR, AWS	Existing
Loon Creek – source to Pioneer Creek	CW, SS, PCR, AWS	Existing
Pioneer Creek – source to mouth	CW, SS, PCR, AWS	Existing
No Name Creek – source to mouth	CW, SS, PCR, AWS	Existing
Mayfield Creek – confluence of East and West Fork Mayfield Creek to mouth	CW, SS, PCR, AWS	Existing
West Fork Mayfield Creek – source to mouth	CW, SS, PCR, AWS	Existing
East Fork Mayfield Creek – source to mouth	CW, SS, PCR, AWS	Existing
Cottonwood Creek – source to mouth	CW, SS, PCR, AWS	Existing
South Fork Cottonwood Creek – source to mouth	CW, SS, PCR, AWS	Existing
Warm Springs Creek – Trapper Creek to mouth	CW, SS, PCR, AWS	Existing
Trapper Creek – source to mouth	CW, SS, PCR, AWS	Existing

Water Body	Uses ^a	Type of Use
Warm Springs Creek – source to Trapper Creek	CW, SS, PCR, AWS	Existing

^a CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – Special Resource Water

Table 52. Lower Middle Fork Salmon River Subbasin beneficial uses of assessed, non-§303(d) listed streams.

Water Body	Uses ^a	Type of Use
Middle Fork Salmon River – Loon Creek to mouth	CW, SS, PCR, DWS, SRW	Designated
Papoose Creek – source to mouth	CW, SS, PCR, AWS	Existing
Big Creek – source to mouth	CW, SS, PCR, DWS, SRW	Designated
Cabin Creek – source to mouth	CW, SS, PCR, AWS	Existing
Cave Creek – source to mouth	CW, SS, PCR, AWS	Existing
Crooked Creek – source to mouth	CW, SS, PCR, AWS	Existing
Big Ramey Creek – source to mouth	CW, SS, PCR, AWS	Existing
Beaver Creek – source to mouth	CW, SS, PCR, AWS	Existing
Smith Creek – source to mouth	CW, SS, PCR, AWS	Existing
Logan Creek – source to mouth	CW, SS, PCR, AWS	Existing
Little Marble Creek – source to mouth	CW, SS, PCR, AWS	Existing
Snowslide Creek – source to mouth	CW, SS, PCR, AWS	Existing
West Fork Monumental Creek – source to mouth	CW, SS, PCR, AWS	Existing
Rush Creek – source to mouth	CW, SS, PCR, AWS	Existing
Two Point Creek – source to mouth	CW, SS, PCR, AWS	Existing
Soldier Creek – source to mouth	CW, SS, PCR, AWS	Existing
Brush Creek – source to mouth	CW, SS, PCR, AWS	Existing
Sheep Creek – source to mouth	CW, SS, PCR, AWS	Existing
Camas Creek – Yellowjacket Creek to mouth	CW, SS, PCR, AWS	Existing
Camas Creek – Forge Creek to Yellowjacket Creek	CW, SS, PCR, AWS	Existing
Camas Creek – Duck Creek to Forge Creek	CW, SS, PCR, AWS	Existing
West Fork Camas Creek – source to mouth	CW, SS, PCR, AWS	Existing
Camas Creek – Castle Creek to Silver Creek	CW, SS, PCR, AWS	Existing
Camas Creek – Furnace Creek to Castle Creek	CW, SS, PCR, AWS	Existing
Camas Creek – White Goat Creek to Furnace Creek	CW, SS, PCR, AWS	Existing
Camas Creek – South Fork Camas Creek to White Goat Creek	CW, SS, PCR, AWS	Existing
South Fork Camas Creek – source to mouth	CW, SS, PCR, AWS	Existing
Camas Creek – source to South Fork Camas Creek	CW, SS, PCR, AWS	Existing
White Goat Creek – source to mouth	CW, SS, PCR, AWS	Existing
Furnace Creek – source to mouth	CW, SS, PCR, AWS	Existing
Castle Creek – source to mouth	CW, SS, PCR, AWS	Existing
Silver Creek – source to mouth	CW, SS, PCR, AWS	Existing
Duck Creek – source to mouth	CW, SS, PCR, AWS	Existing
Forge Creek – source to mouth	CW, SS, PCR, AWS	Existing
Yellowjacket Creek – Jenny Creek to mouth	CW, SS, PCR, AWS	Existing
Yellowjacket Creek – Hoodoo Creek to Jenny Creek	CW, SS, PCR, AWS	Existing
Yellowjacket Creek – Little Jacket Creek to Hoodoo Creek	CW, SS, PCR, AWS	Existing
Little Jacket Creek – source to mouth	CW, SS, PCR, AWS	Existing
Yellowjacket Creek – Trail Creek to Little Jacket Creek	CW, SS, PCR, AWS	Existing
Trail Creek – source to mouth	CW, SS, PCR, AWS	Existing
Yellowjacket Creek – source to Trail Creek	CW, SS, PCR, AWS	Existing
Hoodoo Creek – source to mouth	CW, SS, PCR, AWS	Existing
Jenny Creek – source to mouth	CW, SS, PCR, AWS	Existing
Wilson Creek – source to mouth	CW, SS, PCR, AWS	Existing
Waterfall Creek – source to mouth	CW, SS, PCR, AWS	Existing
Ship Island Creek – source to mouth	CW, SS, PCR, AWS	Existing
Roaring Creek – source to mouth	CW, SS, PCR, AWS	Existing
Goat Creek – source to mouth	CW, SS, PCR, AWS	Existing

^a CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – Special Resource Water

Criteria to Support Beneficial Uses

Beneficial uses are protected by applying a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250) (Table 53).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): “Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.”

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: “Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses.”

Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: “Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.”

DEQ’s procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

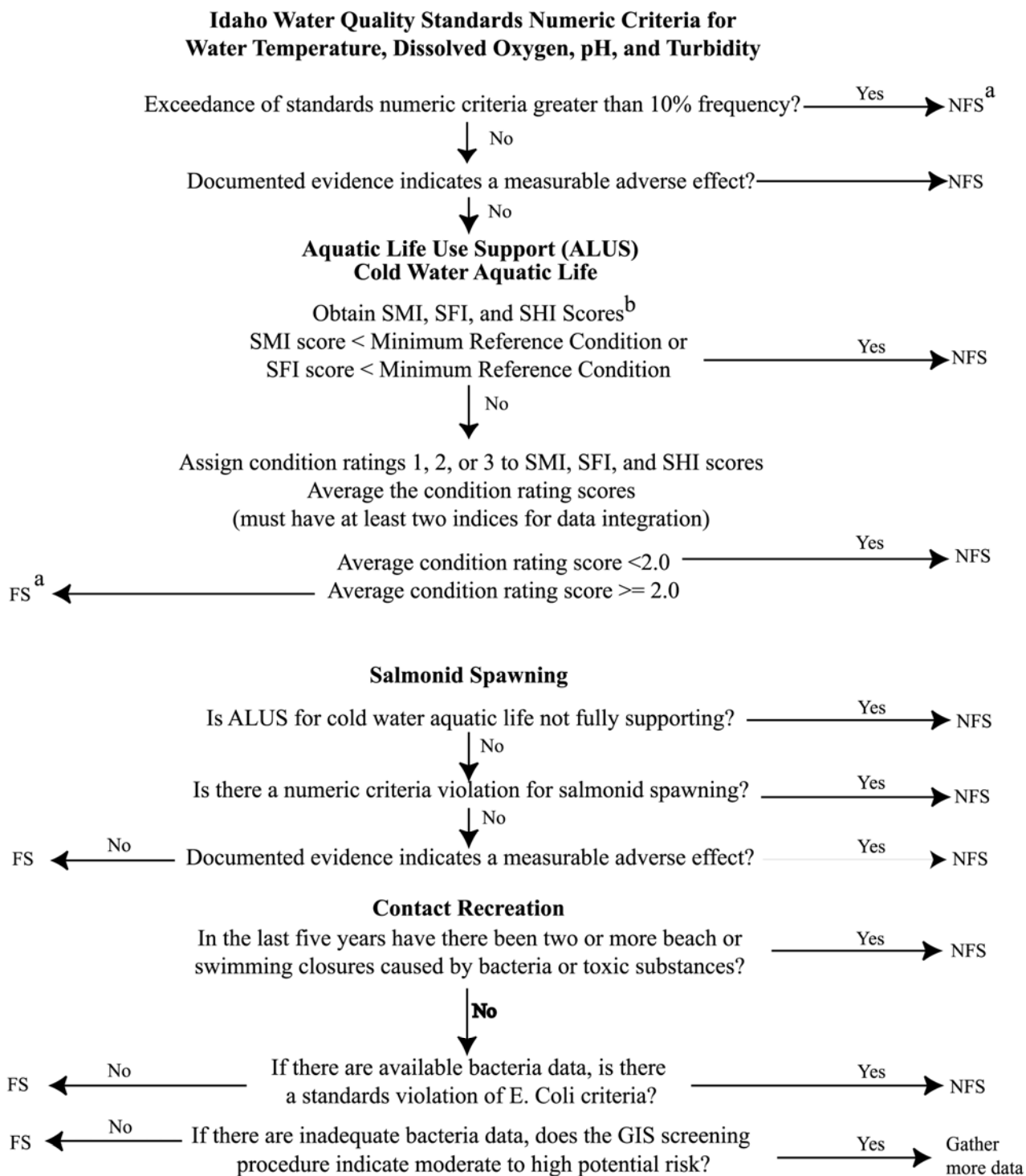
Table 53 includes the most common numeric criteria used in TMDLs.

Figure 36 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 53. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, pH, and Dissolved Oxygen	Less than 126 <i>E. coli</i> /100 ml ^a as a geometric mean of five samples over 30 days; no sample greater than 406 <i>E. coli</i> organisms/100 ml	Less than 126 <i>E. coli</i> /100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 <i>E. coli</i> /100 ml	pH between 6.5 and 9.0 DO ^b exceeds 6.0 mg/L ^c	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average
Temperature^d			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October
Turbidity			Turbidity shall not exceed background by more than 50 NTU ^e instantaneously or more than 25 NTU for more than 10 consecutive days.	
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature				7 day moving average of 10 °C or less maximum daily temperature for June - September

^a *Escherichia coli* per 100 milliliters^b dissolved oxygen^c milligrams per liter^d Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.^e Nephelometric turbidity units



^a FS = fully supporting, NFS = not fully supporting

^b SMI = Stream Macroinvertebrate Index, SFI = Stream Fish Index, SHI = Stream Habitat Index

Figure 36. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance, Second Addition* (Grafe et al. 2002)

2.3 Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans. That is, streams naturally have sediment, nutrients, and the like, but when anthropogenic (human-made) sources cause these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream.

Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or coldwater aquatic community is present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar kinds of effects may occur to aquatic invertebrates, amphibians and mollusks, although less is known about them.

Sediment

Both suspended (floating in the water column) and bedload (moves along the stream bottom) sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases eventually lead to death.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel DO through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45- μ m (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller TSS, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

2.4 Summary and Analysis of Existing Water Quality Data

Data related to water quality in the Upper and Lower Middle Fork of the Salmon River is sporadic and scant with regard to tributaries and much of the mainstem. In 1996, and again in 2001 -- before and after the Clear Creek, Little Pistol, and Shellrock wildfires of 2000 in central Idaho -- the US Geological Survey (USGS), in cooperation with the Forest Service, collected geochemical data for stream sediment and surface water samples from the Middle Fork of the Salmon River. Samples were collected at major confluences and at several locations on the main Middle Fork. The sampling effort was intended as a reconnaissance effort to establish background values for elemental materials that are generally of geologic interest.

Temperature data has been collected at a number of locations by the Forest Service and DEQ. A study implementing forward-looking infrared thermal imaging was funded by DEQ in 1999 that shows daily thermal loading throughout the mainstem channel.

Riparian habitat monitoring has been conducted in the past at several locations in the upper Middle Fork Salmon watershed by the Forest Service, however, the most recent data is generalized matrix scores generated for comparison of managed sheep and cattle grazing and unmanaged lands without specific relevance to water quality related to beneficial use support.

There are two active USGS gages on the main middle Fork: one at the Middle Fork Lodge near the downstream boundary of the Upper Middle Fork watershed, and one just above the confluence with the main Salmon River, representing the lower watershed. There is a historical gage near the confluence of Bear Valley Creek and Marsh Creek, near Cape Horn.

DEQ has conducted BURP monitoring in the upper and lower watersheds in the headwaters tributaries that are accessible by road. Attempts to collect BURP data along the main Middle Fork and at the confluence of select tributaries over two separate years, 1999 and 2000, has not yielded useful data at this time.

Flow Characteristics

The flow regime within the Middle Fork Salmon watersheds is primarily snowmelt driven. Streams tend to be high gradient with the exception of headwater streams within Marsh and Bear Valley Creeks where lower gradient meandering streams prevail. The headwaters of Marsh Creek are spring creeks that are generally Rosgen type E channels flowing through wet meadows. Many of the headwater tributaries to Marsh Creek are spring brooks that are ephemeral and are not targeted waters within this subbasin assessment; though they are of high water quality, they provide little usable habitat for fish and macroinvertebrates found in higher gradient cascading streams. At the confluence of Knapp Creek the Marsh Creek channel becomes more sinuous with increased substrate diversity and particulate size. Knapp Creek is the driving force to channel geometry because it has increased stream power and bed load due to increased peak flow.

As part of the analysis of flow characteristics in the Middle Fork of the Salmon River, recurrence intervals were developed from historic annual peak flow data from three sites. Recurrence intervals are a ranking of peak flows over the years for which data is available with the net result being the probability that a particular flow will occur within a certain time period. The significance of the recurrence interval is that it shows approximately what the bankfull discharge of a particular stream may be because bankfull flow occurs with a recurrence interval of about 1.5 years. At bankfull flow, sediment transport is at its highest efficiency, and streambank erosion is at its highest in streams that exhibit good flood plain access. In streams with flood plain access diminished by incision of the channel streambank, erosion continues to increase with increasing flow. This flow also correlates with the greatest efficiency for moving nutrients and contaminants, though loading from and to the flood plain can be higher at flows above bankfull.

The upper gage site, which is no longer active, was located at the Lolo Campground on Marsh Creek below Beaver Creek. The USGS refers to this site as the Middle Fork Salmon River near Cape Horn, Idaho. The watershed area above this gage is 138 square miles, with elevation 6,435 feet above mean sea level (AMSL). Data for this site still gives a vision of the water yield per unit area. The middle gage is located at the Middle Fork Lodge, near Yellowpine, Idaho. The watershed area above this gage is 1,040 square miles at elevation 4,380 feet AMSL. The lower Middle Fork Gage is about 1/4 mile above the confluence with the Main Salmon River. The drainage area above this gage is 2,830 square miles at elevation 3,040 feet AMSL. Recurrence intervals for the upper, middle and lower gage locations are shown in Figure 37, Figure 38, and Figure 39, respectively.

Peak Flow is seen in Figure 40, Figure 41, and Figure 42 for the upper, middle and lower gage locations, respectively. The magnitude of peak discharge increases commensurate with watershed area and channel features such as point bars, pool volume, and bankfull

width become correspondingly larger. As channel features increase in size the surfaces exposed to solar loading, deposition, and erosion also increase.

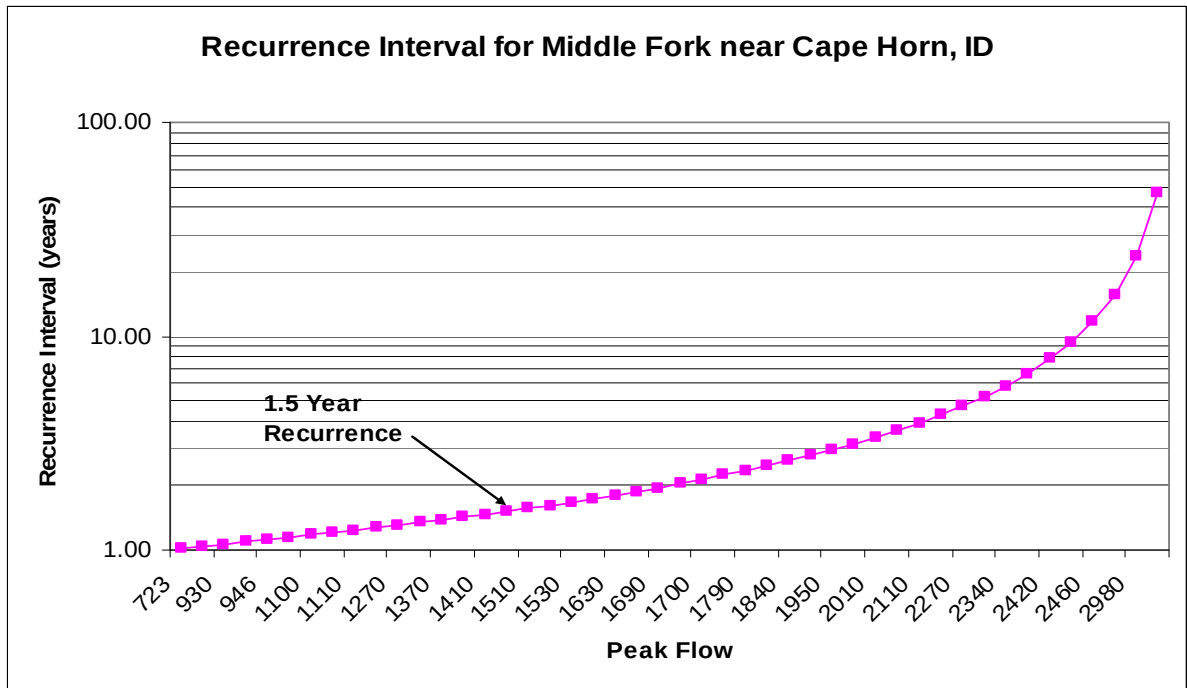


Figure 37. Recurrence Interval for the Middle Fork Salmon near Cape Horn, ID.

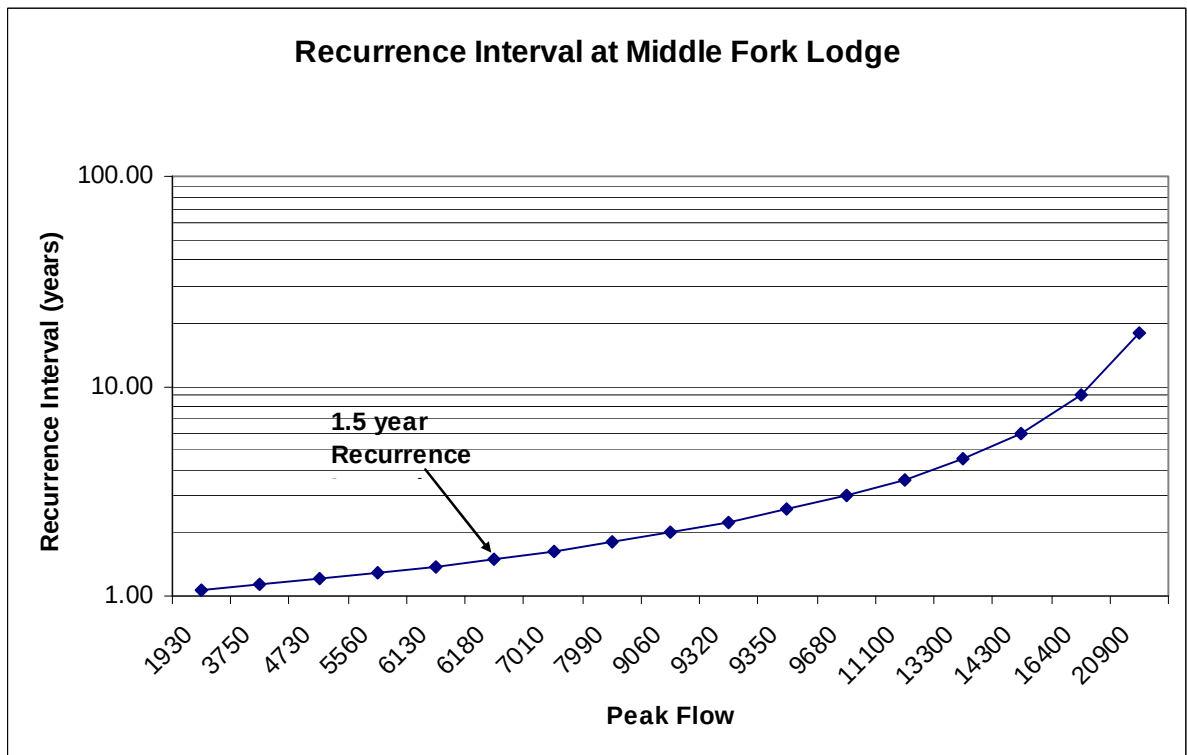


Figure 38. Recurrence Interval for the Middle Fork Salmon at Middle Fork Lodge.

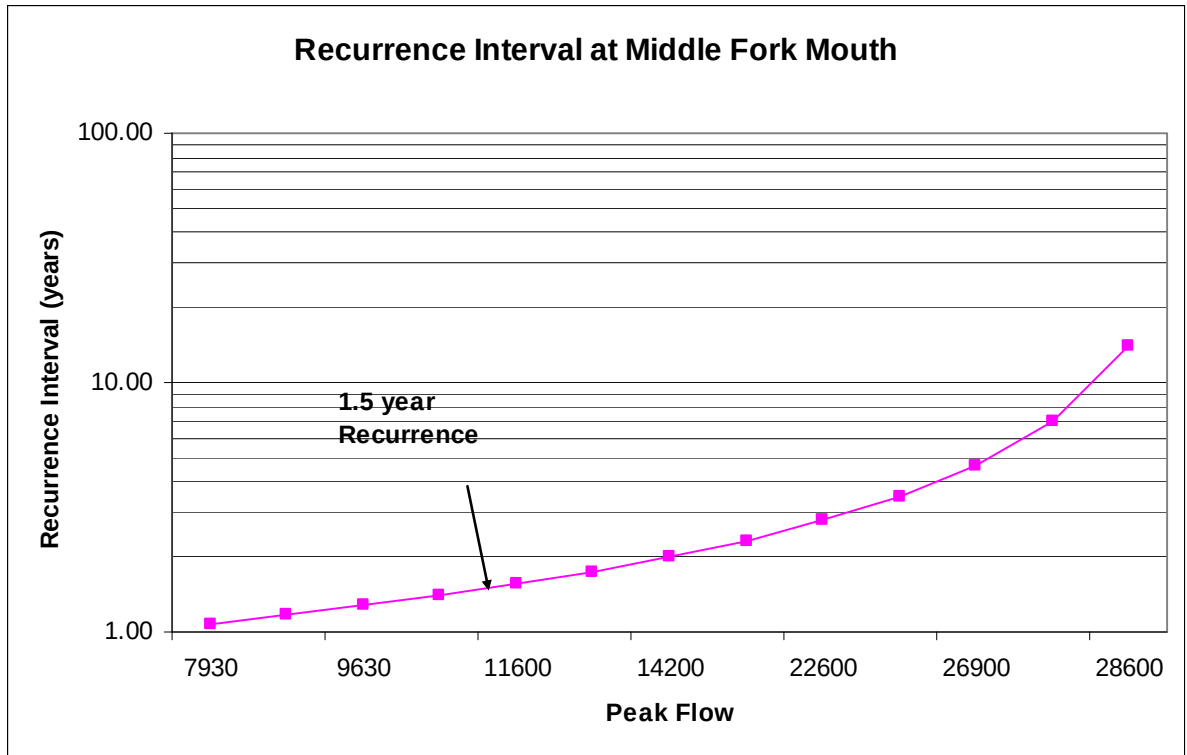


Figure 39. Recurrence Interval for the Middle Fork Salmon at the confluence with the Main Salmon River.

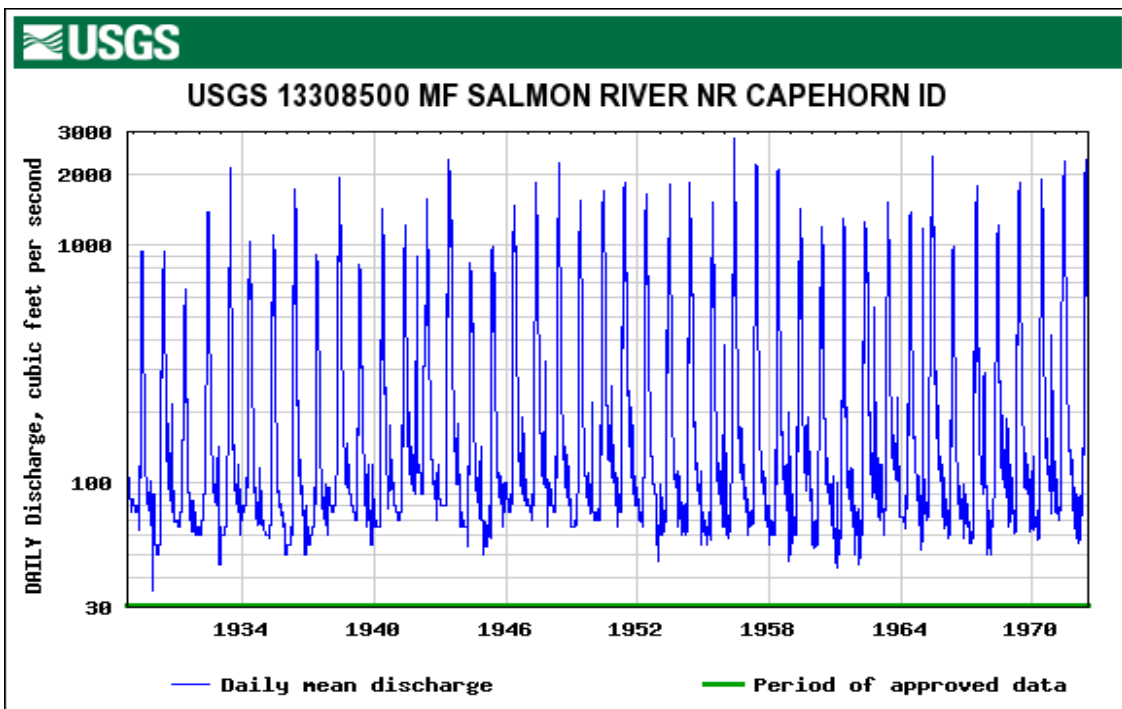


Figure 40. Peak flows at the uppermost historic Middle Fork Salmon River gage site.

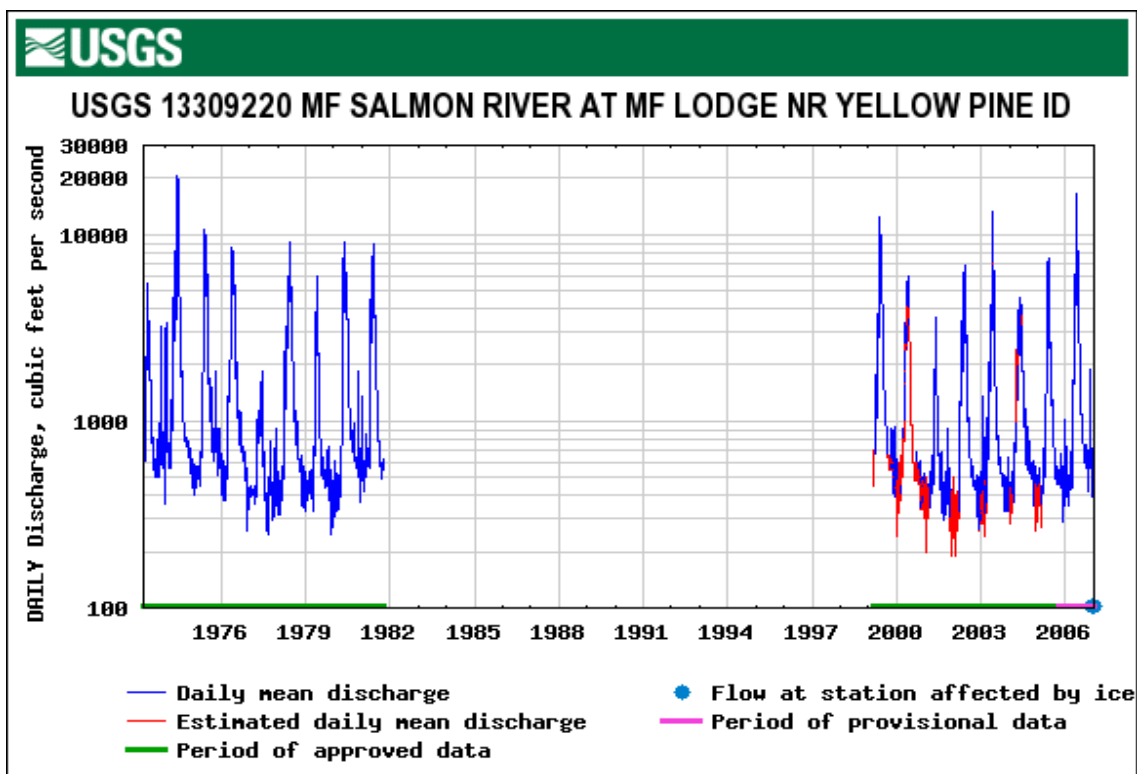


Figure 41. Peak flows at the Middle active Middle Fork Salmon River gage site.

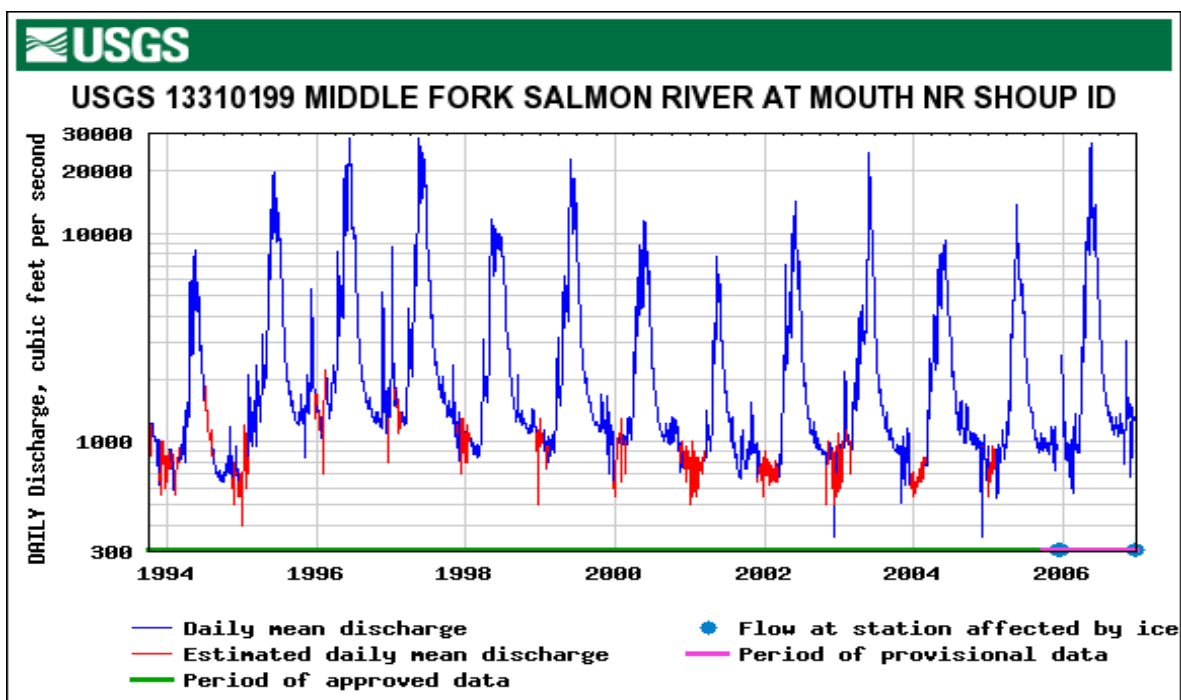


Figure 42. Peak flows at the lower active Middle Fork Salmon River gage site.

Monthly average discharge shows the relationship to high flow from runoff and minimum, or base flow. The lowest average flow periods can be critical to thermal loading and habitat availability for fish migration, spawning, and outmigration of smolts and fry, as well as potential winter habitat and thermal loading during the warm season. Average monthly flow is seen in Figure 43, Figure 44, and Figure 45 for the upper, middle and lower gage locations, respectively.

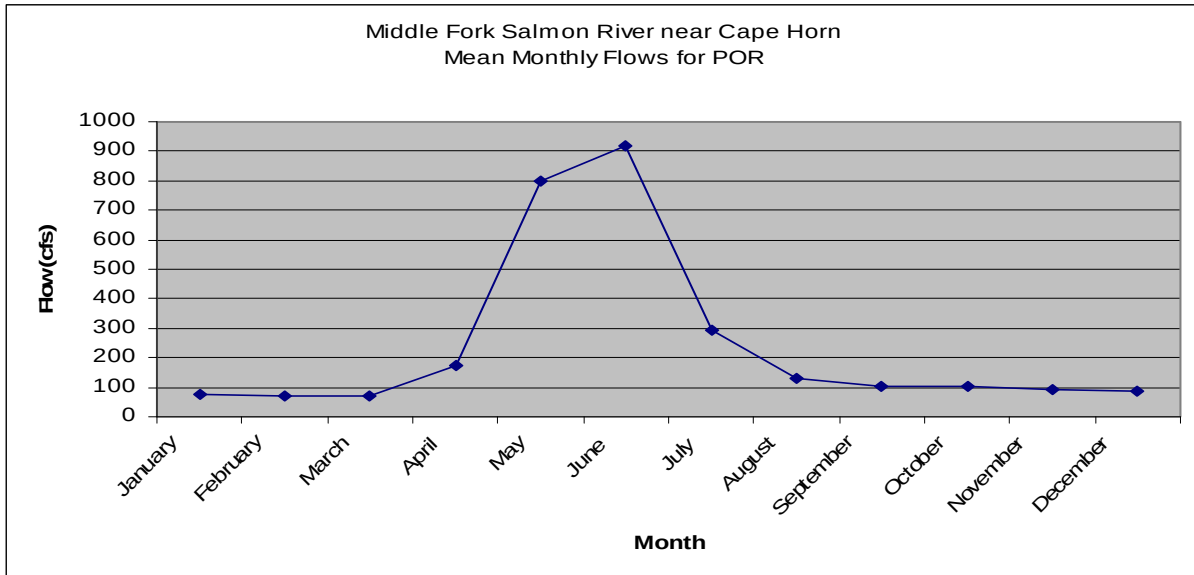


Figure 43. Mean monthly flow at the upper historic Middle Fork Salmon River gage site.

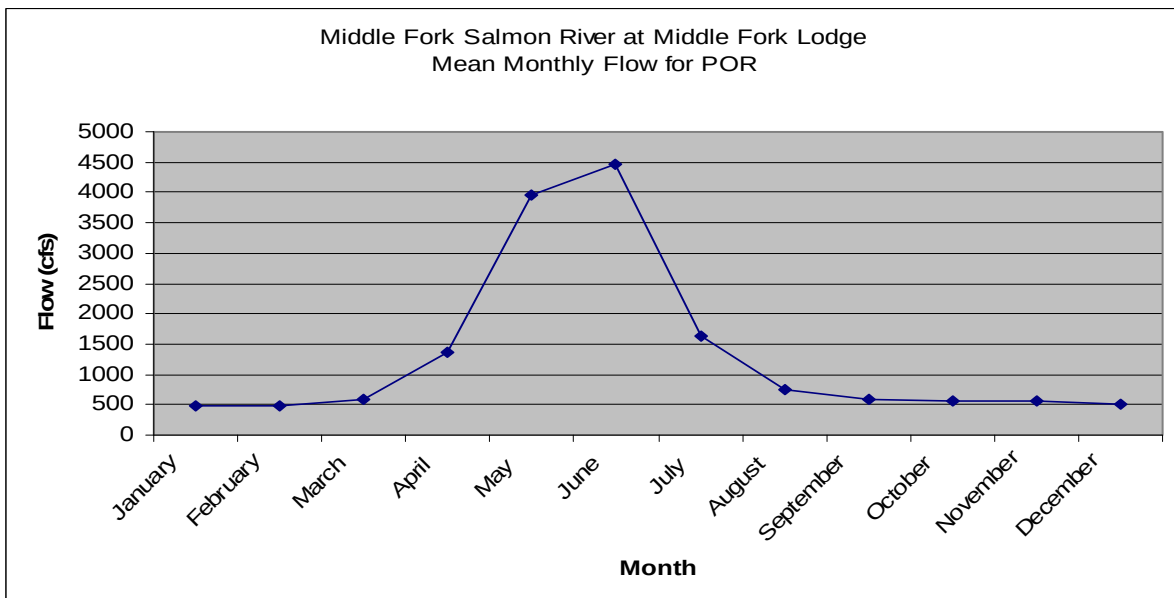


Figure 44. Mean monthly flow at the middle active Middle Fork Salmon River gage site.

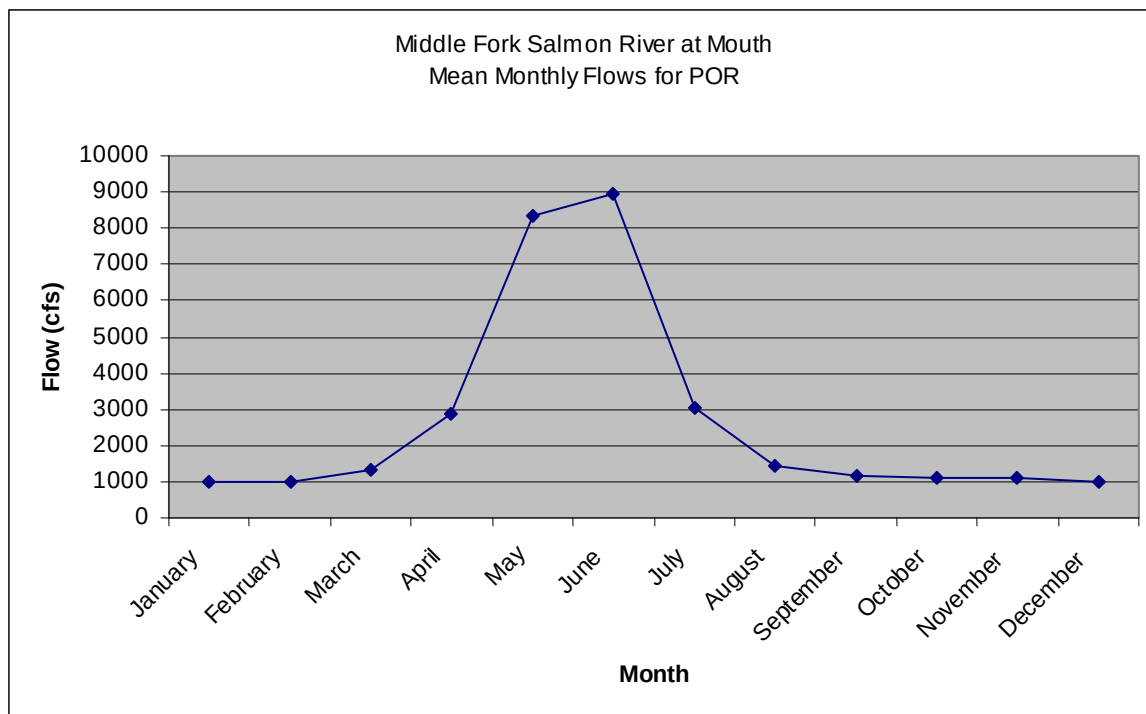


Figure 45. Mean monthly flow at the lower active Middle Fork Salmon River gage site.

Water Column Data

Water column data for the Middle Fork Salmon watersheds includes sampling by the USGS on the Middle Fork of the Salmon River and some of its tributaries in 1996 and 2001, before and after the widespread fires of 1999 and 2000 (USGS 2003). There was no exceedance of existing water quality standards noted in the analysis of data from streams in the upper and lower Middle Fork Salmon River watersheds summarized for this subbasin assessment. Nutrient parameters that were sampled included total phosphorus, orthophosphate, total nitrogen, total Kjeldahl nitrogen (TKN), and ammonia. In unfiltered samples, concentrations of total phosphorus and total Kjeldahl nitrogen were in excess of EPA suggested nutrient criteria for total phosphorus (0.0325 mg/l), and total Kjeldahl nitrogen (0.14mg/l) in the Northern Rockies ecoregion (Table 54). These samples were collected on the receding limb of the hydrograph after the extensive fires of 2000. Recommended criteria are based on the 25th percentile of all seasons data for the Decade of sampling. It is not unusual for a stream draining a watershed that has experienced an extreme fire, such as those in the Middle Fork watershed in 2000 to show elevated phosphorus and nitrogen. These elevated concentrations derived from once-only grab samples are not considered to be water quality exceedances that warrant intervention.

Geochemistry sampling included silver (Ag), arsenic (As), cadmium (Cd), copper (Cu), iron (Fe), nickel (Ni), lead (Pb), selenium (Se), zinc (Zn), mercury (Hg), and ammonia (NH₃), with no exceedances of water quality standards observed.

Table 54. Nutrient values for select streams sampled during 2001 by USGS.

Stream	Total P (mg/l)	Ortho P (mg/l)	Total N (mg/l)	TKN (mg/l)	Ammonia (mg/l)
Marble Creek	0.25	0.005	0.010	0.45	0.005
Loon Creek	0.184	0.007	0.10	0.45	0.005
Camas Creek	0.184	0.007	0.010	0.45	0.005
Cape Horn Creek	0.004				
Wilson Creek	0.005				
Vanity Creek	0.003				
Ship Island Creek	0.011				
Papoose Creek	0.01				
Previous EPA Recommended Criteria (Goldbook)	0.1	0.01	0.3	N/A	N/A
EPA Recommended Criteria – Northern Rockies Ecoregion	0.0325	N/A	0.15	0.14	4.6

DEQ sampled for the same metals constituents listed above plus aluminum (Al), barium (Ba), beryllium (Be), uranium (U), on March 15 and 16, 2005, on Marsh Creek and Bear Valley Creek. All concentrations were below detection limits for the laboratory methods used except for dissolved mercury, which was present at 0.013 µg/l at the Lolo Campground on Marsh Creek. On March 23, 2005, samples were collected from Camas Creek up-gradient and down-gradient of Duck Creek, and at the mouth of Duck Creek, where the historic Fluorspar Mine was located. Total copper was present at 0.001 µg/l at the mouth and down-gradient. Dissolved mercury was at 0.012 µg/l up-gradient on Camas Creek. Concentrations of all other parameters were below detection limits. Overall, no criteria exceedance was noted and follow-up sampling was not warranted.

Water Temperature Data

Water temperature data has been collected by the Forest Service and DEQ at numerous locations on managed and unmanaged waters within the Upper and Lower Middle Fork Salmon River Watershed. The DEQ policy for allowing what would otherwise be exceedance of water quality standards on streams entirely contained within wilderness areas is that surface water quality reflects background condition and no reasonable management activity would result in a net improvement of stream or river temperatures, as described in the “Natural Conditions” provisions of the Idaho Water Quality Standards (DEQ 2003). Some of that data is represented here, though no change in beneficial use support status or management for primarily-wilderness waters will be recommended.

For those waters where land management does not support improvements in stream temperature regime, data will be presented that will result in load allocations made to reduce temperature loading regardless of beneficial use support status. Stream temperature data for the Upper Middle Fork Salmon River watershed (HUC 17060205) is shown in Table 55. Stream temperature data for the Lower Middle Fork Salmon River watershed (HUC 17060206) is shown in Table . For Yellowjacket Creek, temperature data and exceedances of salmonid spawning criteria are shown in Table 57.

Table 55. Upper Middle Fork temperature data and number of days water temperature exceeded salmonid spawning numeric criteria.

Stream Name	Sample Period (season)	# Days Evaluated	Salmonid Spawning					
			13 Inst.			9°C Daily Ave.		
			# Days Over	Max Temp	Max Date	# Days Over	Max Temp	Max Date
Upper Marsh Creek Near Source	06/29/06-9/27/06 (Fall)	44	0 (0%)	12.55	8/18/06	0 (0%)	8.75	8/16/06
Upper Marsh Creek Near Source	06/29/06-9/27/06 (Spring)	17	12 (71%)	15.23	7/03/06	13 (76%)	10.41	7/03/06
Marsh Creek above Knapp Creek	06/29/06-9/27/06 (Fall)	44	0 (0%)	12.90	8/28/06	0 (0%)	8.9	8/16/06
Marsh Creek above Knapp Creek	06/29/06-9/27/06 (Spring)	17	12 (71%)	15.20	7/03/06	17 (100%)	11.42	7/03/06
Marsh Creek above Knapp Creek	06/15/05-10/17/05 (Fall)	64	3 (5%)	14.09	8/20/05	2 (3%)	9.43	8/18/05
Marsh Creek above Knapp Creek	06/15/05-10/17/05 (Spring)	16	20 (65%)	16.38	7/13/05	22 (71%)	11.68	7/08/05
Upper Knapp Creek below Lakes	06/29/06-9/27/06 (Fall)	44	0 (0%)	10.99	8/28/06	0 (0%)	8.52	8/15/06
Upper Knapp Creek below Lakes	06/29/06-9/27/06 (Spring)	17	0 (0%)	12.93	7/15/06	12 (71%)	9.84	7/03/06
Knapp Creek above Marsh Creek	06/29/06-9/27/06 (Fall)	44	18 (41%)	16.7	8/19/06	28 (64%)	12.67	8/16/06
Knapp Creek above Marsh Creek	06/29/06-9/27/06 (Spring)	17	17 (100%)	19.0	7/15/06	17 (100%)	14.59	7/15/06
Knapp Creek above Marsh Creek	06/15/05-10/17/05 (Fall)	64	25 (39%)	17.4	8/20/05	26 (41%)	13.55	8/22/05
Knapp Creek above Marsh Creek	06/15/05-10/17/05 (Spring)	31	22 (71%)	20.5	7/13/05	27 (87%)	16.49	7/13/05
Upper Beaver Creek	06/16/05-10/17/05 (Fall)	64	1 (2%)	13.3	8/15/05	10 (16%)	10.62	8/22/05
Upper Beaver Creek	06/16/05-10/17/05 (Spring)	30	7 (23%)	15.20	7/13/05	9 (30%)	11.72	7/13/05
Beaver Creek above Marsh Creek	06/16/05-10/17/05 (Fall)	64	25 (39%)	18.2	8/15/05	25 (39%)	12.38	8/21/05
Beaver Creek above Marsh Creek	06/16/05-10/17/05 (Spring)	30	20 (67%)	19.8	7/13/05	21 (70%)	14.24	7/13/05

There were no noted exceedances of cold water aquatic life criteria; only exceedances of salmonid spawning criteria were documented on monitored streams. Data highlighted in yellow shows exceedances of greater than 10% of days observed.

Table 56. Lower Middle Fork temperature data and number of days water temperature exceeded salmonid spawning numeric criteria.

Stream Name	Sample Period (season)	# Days Evaluated	Salmonid Spawning					
			13 Inst.			9°C Daily Ave.		
			# Days Over	Max Temp	Max Date	# Days Over	Max Temp	Max Date
Camas Creek above enclosure	4/27/01-10/23/01 (Fall)	70	30 (43%)	18.66	8/27/01	38 (54%)	14.44	8/18/01
Camas Creek above enclosure	4/27/01-10/23/01 (Spring)	77	34 (44%)	19.42	7/01/01	34 (44%)	14.63	7/06/01
Camas Creek above enclosure	5/02/02-10/16/02 (Fall)	63	23 (37%)	17.9	8/15/02	33 (52%)	13.44	8/15/02
Camas Creek above enclosure	5/02/02-10/16/02 (Spring)	75	22 (29%)	19.81	7/14/02	25 (33%)	15.53	7/14/02
Camas Creek above enclosure	5/02/03-9/12/03 (Fall)	29	25 (86%)	19.42	8/16/03	28 (97%)	15.75	8/16/03
Camas Creek above enclosure	5/02/03-9/12/03 (Spring)	75	25 (33%)	19.42	7/11/03	26 (35%)	14.53	7/12/03
Camas Creek above enclosure	6/28/05-10/05/05 (Fall)	21	23 (44%)	17.9	8/21/05	26 (50%)	13.57	8/21/05
Camas Creek above enclosure	6/28/05-10/05/05 (Spring)	18	15 (83%)	19.04	7/13/05	16 (89%)	14.24	7/13/05
Camas Creek above Duck Creek	4/27/01-10/24/01 (Fall)	71	46 (65%)	20.57	8/18/01	48 (68%)	15.38	8/18/01
Camas Creek above Duck Creek	4/27/01-10/24/01 (Spring)	80	38 (48%)	20.19	7/02/01	38 (48%)	15.69	7/06/01
Camas Creek above Duck Creek	5/05/02-10/16/02 (Fall)	63	34 (54%)	19.04	8/15/02	37 (59%)	14.39	8/15/02
Camas Creek above Duck Creek	5/05/02-10/16/02 (Spring)	72	27 (38%)	20.95	7/14/02	32 (44%)	16.42	7/14/02
Camas Creek above Duck Creek	5/9/03-9/12/03 (Fall)	29	27 (93%)	20.95	8/16/03	29 (100%)	16.71	8/16/03
Camas Creek above Duck Creek	5/9/03-9/12/03 (Spring)	68	31 (46%)	20.19	7/11/03	34 (50%)	15.49	7/12/03
Camas Creek above Duck Creek	8/10/05-10/05/05 (Fall)	52	31 (60%)	19.81	8/18/05	34 (65%)	14.43	8/21/05
Camas Creek above Duck Creek	8/10/05-10/05/05 (Spring)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Camas Creek at Middle Fork	9/21/00-9/17/01 (Fall)	90	31 (34%)	18.86	8/17/01	38 (42%)	16.7	8/18/01
Camas Creek at Middle Fork	9/21/00-9/17/01 (Spring)	92	41 (45%)	19.66	7/03/01	54 (59%)	17.47	7/03/01
Silver Creek near Rabbits Foot Pass	5/03/02-10/16/02 (Fall)	63	15 (24%)	17.52	8/15/02	17 (27%)	11.91	8/16/02
Silver Creek near Rabbits Foot Pass	5/03/02-10/16/02 (Spring)	74	24 (32%)	20.95	7/14/02	23 (31%)	16.09	7/14/02
Silver Creek near Rabbits Foot Pass	5/02/03-9/12/03 (Fall)	29	25 (86%)	20.57	8/16/03	25 (86%)	15.39	8/16/03
Silver Creek near Rabbits Foot Pass	5/02/03-9/12/03 (Spring)	75	28 (37%)	20.57	7/12/03	25 (33%)	14.38	7/12/03
Silver Creek near Rabbits Foot Pass	6/28/05-10/05/05 (Fall)	52	21 (40%)	17.14	8/21/05	19 (37%)	12.08	8/21/05

		Salmonid Spawning						
		# Days Evaluated	13 Inst.			9°C Daily Ave.		
Stream Name	Sample Period (season)		# Days Over	Max Temp	Max Date	# Days Over	Max Temp	Max Date
Silver Creek near Rabbits Foot Pass	6/28/05-10/05/05 (Spring)	18	13 (72%)	19.04	7/13/05	14 (78%)	13.84	7/13/05
Silver Creek at Lost Spring Creek	5/02/02-10/16/02 (Fall)	63	41 (65%)	21.33	8/15/02	43 (68%)	15.70	8/15/02
Silver Creek at Lost Spring Creek	5/02/02-10/16/02 (Spring)	75	34 (45%)	24.01	7/14/02	46 (61%)	19.41	7/14/02
Silver Creek at Lost Spring Creek	5/02/03-9/12/03 (Fall)	29	28 (97%)	22.48	8/20/03	29 (100%)	18.27	8/16/03
Silver Creek at Lost Spring Creek	5/02/03-9/12/03 (Spring)	75	42 (56%)	23.63	7/11/03	52 (69%)	18.00	7/12/03

Table 57. Yellowjacket Creek, Loon Creek and MF Salmon River temperature data and number of days water temperature exceeded salmonid spawning numeric criteria.

		Salmonid Spawning						
		# Days Evaluated	13 Inst.			9°C Daily Ave.		
Stream Name	Sample Period (season)		# Days Over	Max Temp	Max Date	# Days Over	Max Temp	Max Date
Yellowjacket Creek above Tin Cup Mine	5/15/01-10/24/01 (Fall)	71	24 (34%)	17.52	8/17/01	30 (42%)	13.69	8/17/01
Yellowjacket Creek above Tin Cup Mine	5/15/01-10/24/01 (Spring)	62	31 (50%)	19.04	7/03/01	35 (56%)	14.76	7/06/01
Yellowjacket Creek above Tin Cup Mine	5/21/02-9/30/02 (Fall)	47	9 (19%)	15.62	8/15/02	24 (51%)	12.37	8/15/02
Yellowjacket Creek above Tin Cup Mine	5/21/02-9/30/02 (Spring)	56	22 (39%)	19.04	7/12/02	25 (45%)	15.40	7/14/02
Yellowjacket Creek above Tin Cup Mine	6/19/03-9/14/03 (Fall)	31	24 (77%)	17.52	8/16/03	26 (84%)	14.85	8/16/03
Yellowjacket Creek above Tin Cup Mine	6/19/03-9/14/03 (Spring)	27	20 (74%)	17.9	7/11/03	21 (78%)	13.57	8/12/03
Yellowjacket Creek above Lake Creek	5/15/01-10/24/01 (Fall)	71	23 (32%)	16.76	8/17/01	33 (46%)	13.66	8/17/01
Yellowjacket Creek above Lake Creek	5/15/01-10/24/01 (Spring)	62	28 (45%)	17.9	7/03/01	36 (58%)	14.51	7/05/01
Yellowjacket Creek above Lake Creek	5/21/02-9/30/02 (Fall)	47	9 (19%)	16.0	8/15/02	29 (62%)	12.58	8/15/02
Yellowjacket Creek above Lake Creek	5/21/02-9/30/02 (Spring)	56	22 (39%)	19.04	7/14/02	26 (46%)	15.42	7/14/02
Yellowjacket Creek above Lake Creek	6/19/03-10/01/03 (Fall)	48	24 (50%)	17.14	8/16/03	27 (56%)	14.69	8/16/03
Yellowjacket Creek above Lake Creek	6/19/03-10/01/03 (Spring)	27	19 (70%)	17.52	7/12/03	21 (78%)	13.87	7/12/03
Loon Creek at Middle Fork Salmon	9/21/00-9/16/01 (Fall)	33	32 (97%)	20.14	8/17/01	33 (100%)	17.72	8/15/01
Loon Creek at Middle Fork Salmon	9/21/00-9/16/01 (Spring)	92	38 (41%)	20.63	7/12/01	64 (70%)	18.25	7/12/01

Stream Name	Sample Period (season)	# Days Evaluated	Salmonid Spawning					
			13 Inst.			9°C Daily Ave.		
			# Days Over	Max Temp	Max Date	# Days Over	Max Temp	Max Date
Middle Fork Salmon at Boundary Creek	9/30/00-10/11/01 (Fall)	5 8	32 (55%)	18.24	8/17/01	46 (79%)	15.32	8/18/01
Middle Fork Salmon at Boundary Creek	9/30/00-10/11/01 (Spring)	92	41 (45%)	18.53	7/13/01	50 (54%)	16.95	7/03/01
Middle Fork Salmon below Indian Creek	9/21/00-9/14/01 (Fall)	31	31 (100%)	21.67	8/17/01	31 (100%)	16.79	8/17/01
Middle Fork Salmon below Indian Creek	9/21/00-9/14/01 (Spring)	92	45 (49%)	21.15	7/02/01	48 (52%)	17.27	7/12/01

Biological and Other Data

DEQ evaluates beneficial use support using indices for stream habitat, fisheries and insects (macroinvertebrates): SHI, SFI, and SMI, respectively. Values are derived from habitat measures and specimens collected during standardized sampling in accordance with Beneficial Use Reconnaissance Project (BURP) protocol (DEQ 1999).

The status of Full Support of Beneficial Uses is assigned for streams that average a condition rating above 2.

DEQ has determined that 80% discrimination efficiency (DE) is acceptable to distinguish impairment in relation to the reference condition. This is to say that at the 10th percentile of the measured reference condition parameters, approximately 85% percent of impaired streams are correctly identified. The average of condition ratings for habitat, fish and macroinvertebrates (SHI, SFI, and SMI) above 2 is full support and below 2 is impaired. A condition rating of 3 is assigned at the 25th percentile of reference condition with DE above 90%. Scores falling between the 10th percentile and the minimum reference condition score are assigned a condition rating of 1, which represents significant impairment (Table 58).

Summary index score results and select physical parameters for BURP sites in the Lower and Upper Middle Fork Salmon River watersheds are shown in Table 59 and Table 60, respectively. Beneficial use support status determination is evaluated from comparison with reference conditions measured in similar bioregions. Index values are assigned based on the percentile range of the particular score in relation to the reference condition.

Table 58. Condition Category scoring criteria for Northern Forested bioregions.

Condition Category	SHI	SFI	SMI	Condition Rating
Above 25th percentile of reference condition	≥ 66	≥ 81	≥ 65	3
10th to 25th percentile of reference condition	58-65	67-80	57-64	2
Minimum to 10th percentile of reference condition	< 58	34-66	39-56	1
Below Minimum of reference condition	N/A	< 34	< 39	Minimum Threshold

Table 59. Lower Middle Fork Salmon River summary of select BURP data.

BURPID	17050206 AU	Stream	Sample Date	SHI	SFI	SMI	%Surface Fines	%Stable Bank
1997SIDFM089	033_02	CASTLE CREEK	04-Aug-97	71	66	81	1.1	100
1997SIDFM090	025_04	CAMAS CREEK	04-Aug-97	65	63	83	1.0	92.5
1997SIDFM091	024_03	WEST FORK CAMAS CREEK	04-Aug-97	61	21	67	0.0	78.5
1997SIDFM092	034_02	RAMS CREEK	05-Aug-97	62		71	7.2	91
1997SIDFM093	03_02	BIRDSEYE CREEK	05-Aug-97	77	95	77	6.4	100
1997SIDFM094	034_02	SILVER CREEK	05-Aug-97	58	59	74	20.2	95
1997SIDFM095	034_03	SILVER CREEK	05-Aug-97	51		89	3.7	67.5
1997SIDFM100	035_02	DUCK CREEK	11-Aug-97	71		83	1.8	90
1997SIDFM101	034_03	SILVER CREEK	11-Aug-97	63	70	64	2.3	0.9
1997SIDFM112	043_02	YELLOW JACKET CREEK	14-Aug-97	73	63	90	2.2	0.7
1997SIDFM113	048_02	SHOVEL CREEK	14-Aug-97	61	58	84	9.2	97.5
1997SIDFM114	038_02	LAKE CREEK	18-Aug-97	72	69	85	8.8	100
1997SIDFM115	044_02	HOODOO CREEK	18-Aug-97	76	78	83	20.6	91.5
1997SIDFM116	044_02	BLACKEAGLE CREEK	18-Aug-97	79		82	1.7	100
1997SIDFM117	043_02	BEAGLE CREEK	19-Aug-97	72	68	78	9.9	70.5
1997SIDFM118	044_02	HOODOO CREEK	19-Aug-97	63		55	6.0	100
1997SIDFM119	043_02	NORTH FORK YELLOWJACKET CREEK	19-Aug-97	77		53	0.0	100
1998SIDFB142	043_02	MEADOW CREEK	19-Aug-98	77	94	89	16.3	86.5
1998SIDFB143	042_02	SLAUGHTERHOUSE GULCH	18-Aug-98	68		84	14.3	100
1998SIDFB144	042_02	TRAIL CREEK	19-Aug-98	80		89	11.6	100
1998SIDFB145	040_02	LITTLE JACKET CREEK	19-Aug-98	85	79	96	1.6	100
1998SIDFB146	043_02	SHOVEL CREEK	19-Aug-98	73	69	86	24.3	83.5
1998SIDFC009	034_02A	ARRASTRA CREEK	15-Sep-98	62		65	30.0	89
2000SIDFW001	046_02	WILSON CREEK	18-Sep-00		96		0.0	0
2000SIDFW002	048_03	SHIP ISLAND CREEK	20-Sep-00		80		0.0	0
2001SIDFW013	048_02	SHIP ISLAND CREEK	21-Sep-01			84	0.0	0
2001SIDFW017	046_03	WILSON CREEK	19-Sep-01			73	0.0	0
2002SIDFA051	044_02	HOODOO CREEK	13-Aug-02	75	80	81	7.4	1
2002SIDFA052	043_02	YELLOWJACKET CREEK	14-Aug-02	74		77	5.1	96
2002SIDFA053	043_03	YELLOWJACKET CREEK	14-Aug-02	73	77	72	10.8	92
2002SIDFV003	044_02	HOODOO CREEK	31-Jul-02	79		72	11.5	100
2003SIDFA128	044_02	HOODOO CREEK	13-Aug-03	81	97	79	10.7	100
2003SDEQA007	044_02	HOODOO CREEK	20-Aug-04	78	60	83	8.0	98
2004SIDFA036	038_02	TRIB TO YELLOWSTONE CREEK	22-Jul-04	10			0.0	0
2004SIDFA086	044_02	HOODOO CREEK	11-Aug-04	81		82	6.6	99
2001SBOIW012	002_02	PAPOOSE CREEK	21-Sep-01			79	0.0	0
2000SBOIW002	002_03	PAPOOSE CREEK	20-Sep-00		78		0.0	0
2004SBOIA001	001_02	KIMMEL CREEK	21-May-04	10			0.0	0
2004SBOIA113	003_02	BIG CREEK	18-Aug-04	79	90	79	1.4	100
2004SBOIA114	003_02	JACOB LADDER CREEK	18-Aug-04	10			0.0	0
2004SBOIA146	012_02	MUD CREEK	13-Sep-04	10			0.0	0

Table 60 Upper Middle Fork Salmon River summary of select BURP data.

Upper Middle Fork Salmon River summary of select BURP data.

BURPID	17050205AU	Stream	Sample Date	SHI	SFI	SMI	%Surface Fines	%Stable Banks
1997SIDFL107	028_02	SHAKE CREEK	12-Aug-97	64	52	61	5.3	0.87
1997SIDFL108	032_02	BEAR CREEK	12-Aug-97	67	83	73	1.2	0.79
1997SIDFL109	029_02	CRYSTAL CREEK	12-Aug-97	61	41	62	51.9	1
1997SIDFL110	027_02	CAMP CREEK	12-Aug-97	54	94	36	82.6	1
1997SIDFL111	026_02	ASHER CREEK	12-Aug-97	56	32	52	8.9	0.93
1997SIDFL112	026_02	KNAPP CREEK	12-Aug-97	65	69	66	18.2	1
1997SIDFL113	018_02	LOLA CREEK	12-Aug-97	81	83	83	6.7	1
1997SIDFL114	023_02	SWAMP CREEK	12-Aug-97	61	66	70	9.0	0.94
1997SIDFL115	041_02	SEAFOAM CREEK	13-Aug-97	88	67	79	1.9	0.965
1997SIDFL116	041_02	BALDWIN CREEK	13-Aug-97	87	67	82	1.7	0.865
1997SIDFL117	041_02	VANITY CREEK	13-Aug-97	86	67	77	12.1	0.93
1997SIDFL118	062_02	EAST FORK MAYFIELD CREEK	18-Aug-97	79		53	6.1	1
1997SIDFL119	006_02	CHINA CREEK	18-Aug-97	70		66	0.0	1
1997SIDFL120	062_02	NELSON CREEK	19-Aug-97	85		41	4.3	0.96
1997SIDFL121	063_02	MYSTERY CREEK	19-Aug-97	82	79	81	0.0	0.85
1997SIDFL123	031_02	BEAVER CREEK	20-Aug-97	74	69	76	4.1	0.9
1997SIDFL124	047_02	CLIFF CREEK	20-Aug-97	66	93	71	12.0	1
1997SIDFL125	024_02	BENCH CREEK	20-Aug-97	58	66	64	26.0	1
1997SIDFL126	024_02	VADER CREEK	20-Aug-97	58	22	66	44.0	1
1997SIDFL127	019_02	THATCHER CREEK	21-Aug-97	65	92	73	3.1	0.9
1997SIDFL128	024_02	FLAT CREEK	21-Aug-97	56	50	51	45.8	1
1997SIDFM097	067_02	MAHONEY CREEK	06-Aug-97	78		57	21.1	1
1997SIDFM142	021_03	CAPE HORN CREEK	16-Sep-97	81	54	76	3.5	1
1997SIDFM143	022_02	BANNER CREEK	16-Sep-97	82	91	92	2.3	1
1997SIDFM144	021_02	CAPE HORN CREEK	16-Sep-97	65	83	88	1.8	1
1997SIDFM145	024_02	MARSH CREEK	17-Sep-97	52	72	48	55.7	0.98
1997SIDFM146	024_03	MARSH CREEK	17-Sep-97	60	89	53	7.8	0.78
1997SIDFM147	019_03	MARSH CREEK	17-Sep-97	53	75	60	3.1	0.955
1997SIDFM148	031_02	LAILOW CREEK	17-Sep-97	60		57	1.4	0.99
1997SIDFM149	030_03	WINNEMUCCA CREEK	17-Sep-97	47	78	64	0.0	0.85
1997SIDFM150	031_03	BEAVER CREEK	17-Sep-97	72	68	69	0.0	0.9
2004SIDFA111	034_02	TRIBUTARY TO GREYHOUND CREEK	18-Aug-04	10			0.0	0
2004SIDFA113	021_02	CAPE HORN CREEK	18-Aug-04	79	76	80	4.2	1
2000SBOIW001	006_02	INDIAN CREEK	15-Sep-00		93		0.0	0
2000SBOIW003	002_03	MARBLE CREEK	16-Sep-00		88		0.0	0
2001SBOIW001	006_02	INDIAN CREEK	14-Sep-01			52	0.0	0
2001SBOIW003	002_03	MARBLE CREEK	15-Sep-01			56	0.0	0
2004SBOIA047	012_02	BEAR VALLEY CREEK	14-Jul-04	57	69	75	10.8	0.975
2004SBOIA048	009_04	SULPHUR CREEK	14-Jul-04	56	47	76	1.9	0.98
2004SBOIA122	002_03	MARBLE CREEK	09-Aug-04	10			0.0	0
2004SDEQA006	011_02	DAGGER CREEK	12-Jul-04	57	74	65	27.5	0.73
1997SBOIA063	012_04	BEAR VALLEY CREEK(LOWER)	12-Aug-97	46		38	8.8	0.75
1997SBOIA064	016_02	CACHE CREEK	12-Aug-97	59		67	9.1	1
1997SBOIA065	013_03	PORTER CREEK	13-Aug-97	66		78	9.6	0.805
1997SBOIA066	013_03	ELK CREEK	13-Aug-97				0.0	0
1997SBOIA067	024_02	COOK CREEK	13-Aug-97	28		50	1.0	1
1997SBOIA068	014_02	SHEEP TRAIL CREEK	14-Aug-97	56		78	12.0	0.995
1997SBOIA069	017_02	FIR CREEK	14-Aug-97	76		66	16.4	0.965
1997SBOIB068	012_02	BEAR VALLEY CREEK(UPPER)	13-Aug-97	49		59	30.6	1
1997SBOIB069	013_02	BEARSKIN CREEK	13-Aug-97	81		67	3.0	1
1997SBOIB070	015_02	CUB CREEK	14-Aug-97	69		52	6.4	1
1997SBOIB071	011_02	DAGGER CREEK	14-Aug-97	64		68	17.3	0.98

The USDA Forest Service has measured physical habitat parameters that relate to Riparian Management Objectives (RMOs) established in Forest Management Plans. Though parameters measured and scores assigned are not used to assign Index or Condition Rating scores, comparing RMO with measured values provides insight into the direction and trend of habitat features in relation to land management (Table 61).

Table 61. Summary of Forest Service Upper and Lower Middle Fork PacFish/Infish habitat measurements (USDAFS 2004).

			Pools/ mile		W/D (wetted)		Lower Bank Angle		% Bank Stabi-lity		Large Woody Debris	
Stream	Reach	Year	PACFISH RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured
WF Camas	WFCAMACHIK-I301	2001	26	57 +	<10	107.4 -	>75	w	>80	w	>20	0 -
Meadow	MEADOWCOI-I299	1999	96	198 +		34.3 -		14 -		50 -		m
Meadow	MEADOWCOI-I301	2001	96	265 +		37.8 -		21 -		100 +		m
Meadow		1998	96	109		33 -		N/A				
Meadow		1998	96	158		22 -		N/A				
Shovel	SHOVELCOI-I301	2001	96	231 +		60.2 -		w		w		19 -
Silver	SILVERCOIK-I400	2001	56	91 +		51 -		21 -		95 +		m
Bench	BENCH-YFI-I201	2001	56	115 +		28.6 -		w		w		49 +
Bench	BENCH-YFI-I100	1999	56	110 +		25.4 -		w		w		0 -
Bench	BENCH-YFI-I400	2000	56	134 +		23.7 -		w		w		0 -
Bench		1 1998	96	68 -		35 -		17		71		N/A
Bench		2 1998	96	66 -		35 -		47		87		N/A
Cape Horn		1 1998	96	75 -		19 -		12		65		N/A
Cape Horn		2 1998	96	86 -		31 -		N/A		N/A		N/A

Notes: w denotes wooded reach; m denotes meadow reach.

U.S. Forest Service Riparian Management Objectives

The USFS has measured physical habitat parameters that relate to Riparian Management Objectives (RMOs) established in Forest Management Plans. Overton et al. (1995) has established mean values of for habitat values based on reference reaches in the Salmon River watershed. These values shown below are used as sediment targets for 303 (d) listed streams (Table 62).

Though parameters measured and scores assigned are not used to assign Index or Condition Rating scores, comparing RMO with measured values provides insight into the direction and trend of habitat features in relation to land management. Table 63 shows these measurements for streams that fall within the Idaho Falls DEQ region.

Table 62. Mean values for habitat values based on reference reaches in the Salmon River watershed*

Habitat Variable	B Channel Transport	C Channel (Response) 1.5-7.6 m	C Channel (Response) 7.6-30.5
Bank Stability (%)	88	84	84
Surface Fines (%)	23	37	37

Table 63. Summary of Forest Service Upper and Lower Middle Fork PacFish/Infish habitat measurements (USDAFS 2004).

			Pools/ mile		W/D (wetted)		Lower Bank Angle		% Bank Stabi-lity		Large Woody Debris	
Stream	Reach	Year	PACFISH RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured	RMO	Meas-ured
WF Camas	WFCAMACHIK-I301	2001	26	57 +	<10	107.4 -	>75	w	>80	w	>20	0 -
Meadow	MEADOWCOI-I299	1999	96	198 +		34.3 -		14 -		50 -		m
Meadow	MEADOWCOI-I301	2001	96	265 +		37.8 -		21 -		100 +		m
Meadow		1998	96	109		33 -		N/A				
Meadow		1998	96	158		22 -		N/A				
Shovel	SHOVELCOI-I301	2001	96	231 +		60.2 -		w		w		19 -
Silver	SILVERCOIK-I400	2001	56	91 +		51 -		21 -		95 +		m
Bench	BENCH-YFI-I201	2001	56	115 +		28.6 -		w		w		49 +
Bench	BENCH-YFI-I100	1999	56	110 +		25.4 -		w		w		0 -
Bench	BENCH-YFI-I400	2000	56	134 +		23.7 -		w		w		0 -
Bench		1 1998	96	68 -		35 -		17		71		N/A
Bench		2 1998	96	66 -		35 -		47		87		N/A
Cape Horn		1 1998	96	75 -		19 -		12		65		N/A
Cape Horn		2 1998	96	86 -		31 -		N/A		N/A		N/A

Notes: w denotes wooded reach; m denotes meadow reach.

Bear Valley Creek AUID17060205SL012 03

The 3rd, 4th and 5th order sections of Bear Valley Creek comprise the three different assessment units that are on the 2002 303(d) list as shown in Table 48. Table 51 shows the designated beneficial uses associated with these assessment units.

The 3rd order AU of Bear Valley Creek starts where Sheep Trail Creek enters the creek and runs to where Cache Creek enters Bear Valley Creek. This AU is listed for sediment. The 4th order AU encompasses the subwatershed downstream from Cache Creek to the confluence with Elk Creek and the 5th order AU runs from downstream of the confluence with Elk Creek to where Marsh Creek and Bear Valley Creek join to form the Middle Fork Salmon River. These AUs are proposed for Integrated Report Section 4b listing and are addressed in a separate document: Bear Valley Creek 4b Justification, which is currently under development. In the following section, the data that is presented is referenced to the appropriate assessment unit wherever possible.

Habitat Data

In 2004, a DEQ BURP assessment near Cache Creek showed that AU ID17060205SL012_03, which is listed on the 303(d) list for sediment, fully supported beneficial uses (Table 64). Older data from 1997 showed that the 5th order AU of Bear Valley Creek (ID17060205SL012_05) did not support beneficial uses while the 2nd order AU of Bear Valley Creek (ID17060205SL012_02) and the 3rd order AU of Cache Creek showed full support of beneficial uses. The Bear Valley Watershed Analysis (USFS

2000) indicates that sediment is the pollutant most likely causing beneficial use impairment.

Table 64. DEQ Waterbody Assessment Scores for Bear Valley Creek

DEQ Stream Site ID	SHI	SMI	SFI	Assessment Score	Beneficial Use Support Status
	(maximum score= 3)				
2004SBOIA047 (3rd order Bear Valley Creek ID17060205SL0 12_03)	1	3	2	2	Full Support
1997SBOIA063 (5 th order Bear Valley Creek ID17060205SL0 12_05))	1	1	ND	1	Not Full Support
1997SBOIA068 (2 nd Order Bear Valley Creek) (ID17060205SL 012_02)	1	3	ND	2	Full Support
1997SBOIA064 Cache Creek (IS17060205SL 016_03)	2	3	ND	2.5	Full Support

Sediment

As discussed in Section 1, excess sediment in Bear Valley Creek is primarily attributed to the historic dredge mining that took place in the 1950's and the failed reclamation attempt in the 1960's that resulted in large sediment inputs to the creek, most notably in a flood in 1984. To a lesser extent, grazing, which has not occurred since 2001, contributed to unstable streambanks and diminished riparian areas which resulted in streambank erosion and subsequent excess sediment delivery to the watershed. A sediment source inventory indicated that streambank erosion is the greatest contributor of sediment in this watershed.

Since the state of Idaho has narrative sediment criteria, it is necessary to develop numeric targets for sediment. The most critical time period for instream bank erosion and mobilization of excess sediment in Bear Valley Creek is during high flows in May and June. Since sediment delivery is primarily from mobilization of excess sediment already in the system and continued sediment inputs from unstable banks, the parameters of

concern are % fines (surface and depth fines) and % bank stability or erosion rate. Based on the reference conditions database developed by Overton et al (1995), the target for bank stability is 84% for a Rosgen C Channel and 88% for a Rosgen B Channel, the targets for percent fines are 37% and 23% respectively. If the sediment targets were not met, a bank erosion hazard inventory was conducted.

Substrate in the third order and fourth order assessment units of Bear Valley Creek is composed predominantly of gravel sized materials in many reaches with sand dominating lower gradient reaches. Substrate in the first and second order assessment unit is largely gravel and cobble dominated.

2004 DEQ BURP results for AU ID17060205SL012_03 showed an average of 20% surface fines and 97% stable banks, which are comparable to reference conditions. Additional wolman pebble counts and bank stability measurements in 2007 in Bear Valley Creek downstream of Sheep Trail Creek in this AU showed an average of 23% fines and 97% stable banks in the third order reach. Again, these measurements are comparable to reference conditions. Both 2004 and 2007 width/depth measurements were higher than reference conditions, indicating that Bear Valley Creek is wider and shallower than a more pristine stream, likely due to sediment related perturbation. Currently, in this section, sediment is being transported through this reach without excess amounts accumulating in potential spawning areas. The streambanks are stable and are not contributing excess sediment to either this reach or downstream reaches.

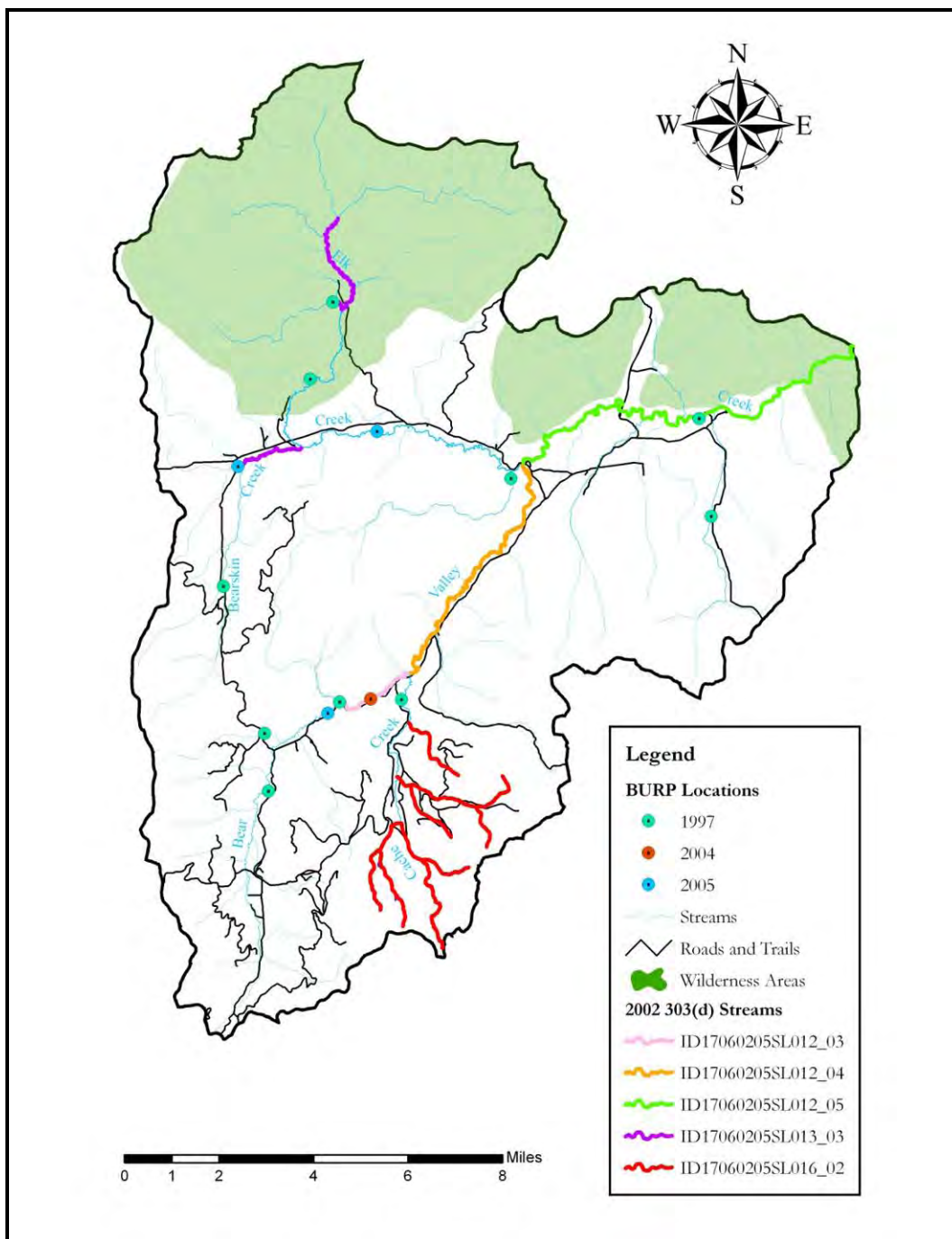


Figure 46. Bear Valley Watershed DEQ Monitoring Sites (The 3rd order AU stream segment is shown in pink)

Sediment from Mining

The first and second order section of Bear Valley Creek (headwaters to Sheep Trail Creek, AU ID17060205SL012_02)) contains the section of Bear Valley creek rehabilitated (also called the enhancement area) following the historic dredging

operation. The USFS found that this section met their objectives for bank stability and percent fines. Figures 47-49 show pre and post monitoring conditions for chinook salmon redds, macroinvertebrates, and percent fines. All parameters generally show an upward trend. While trends in fishery abundance are particularly hard to link to habitat improvement because factors outside the Bear Valley watershed greatly influence the fish populations, it is clear that greater utilization of habitat in the enhancement area is taking place.

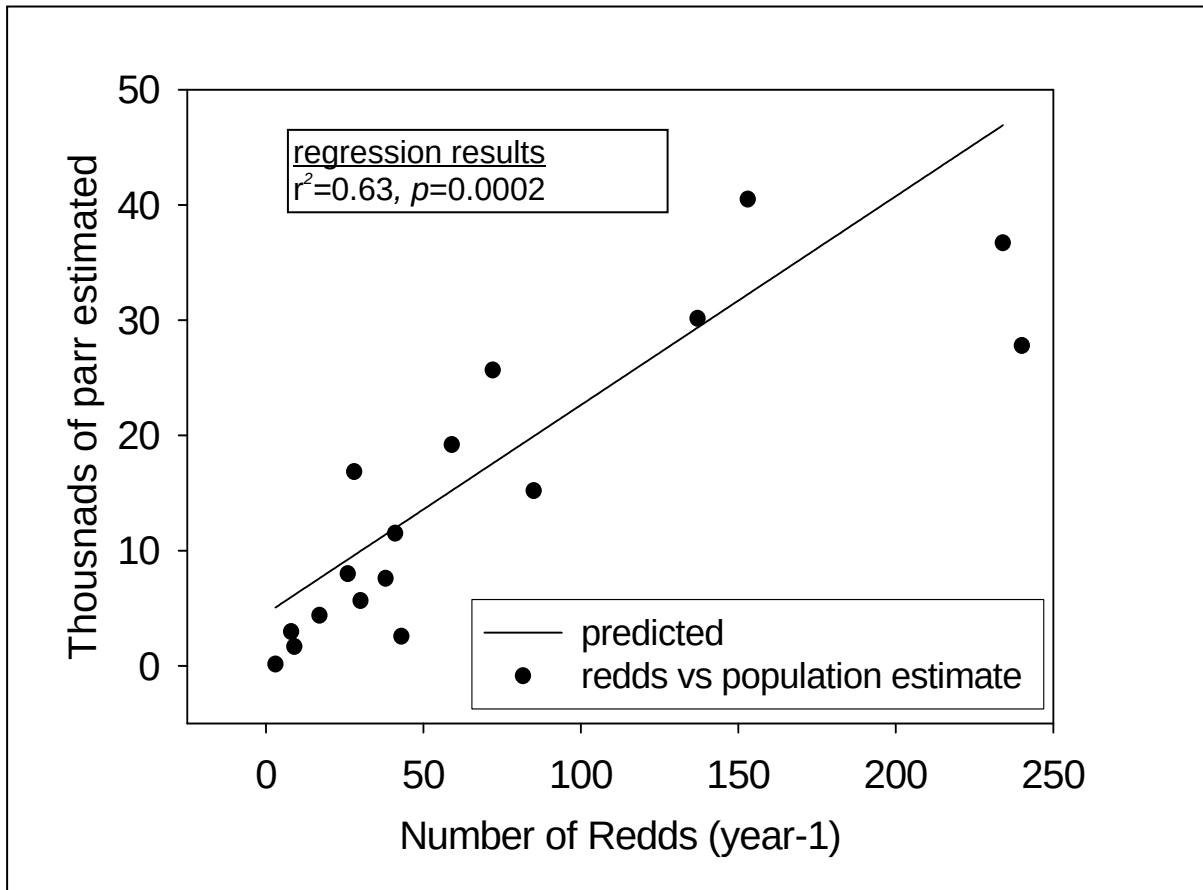


Figure 47. Relationship between the number of age 0+ Chinook salmon parr and the number of redds the previous year from 1989-2003 in Bear Valley Creek AU ID17060205SL012_02.

Macroinvertebrate sampling by the Shoshone Bannock tribe has shown that since rehabilitating the dredged area that the relative abundance of macroinvertebrate species intolerant to fine sediment has increased. A significant increase in EPT species, a more favored food species for salmonids, has also occurred (Figure 48).

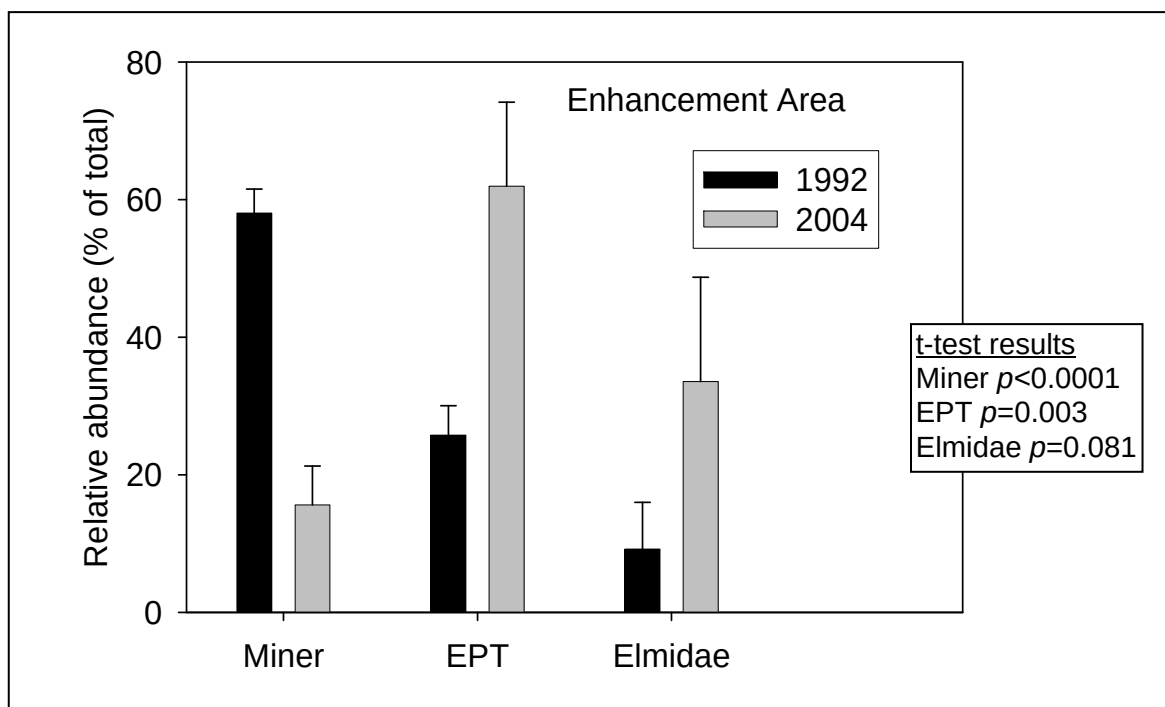


Figure 48. Relative abundance of macroinvertebrate groups within the enhancement area pre (1992) and post (2004) enhancement in Bear Valley Creek

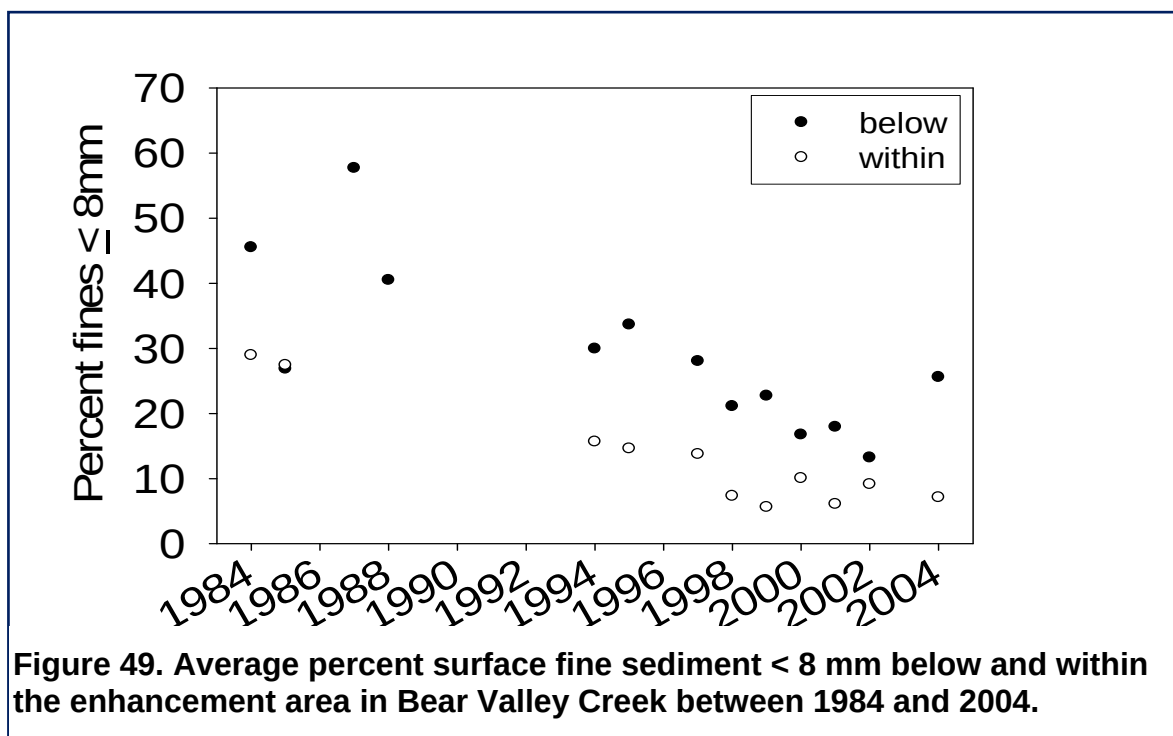


Figure 49. Average percent surface fine sediment $< 8\text{ mm}$ below and within the enhancement area in Bear Valley Creek between 1984 and 2004.

Sediment from Roads

Within the entire Bear Valley Creek watershed, there are 26 miles of road that are within 200 feet of streams or other types of water sources. Most of these segments are located along the mainstem of Bear Valley Creek between Sack Creek and Big Meadows. BOISED modeling has shown that these roads are estimated to account for an increase in sediment production of about 1% over reference levels, indicating that roads are not a significant source of sediment to the stream (USFS 2000).

Metals

DEQ sampled Ag, As, Cd, Cu, Fe, Ni, Pb, Se, Zn, Hg, Al, Ba, Be, U, and Fe on March 15 and 16, 2005 in Bear Valley Creek. All metals constituents were below detection limits for the laboratory methods used. USFS sampling also did not find metals or radioactive materials (USFS 2000).

Conclusion

In summary, the 3rd order AU of Bear Valley Creek (ID17060205SL012_03) is meeting sediment targets and BURP data shows that it supports beneficial uses. This AU is proposed for delisting in the MF Salmon TMDL

Monumental Creek

The third order AU of Monumental Creek (ID17060206SL012_03) is 303(d) listed for sediment. This AU is made up of Monumental Creek from the confluence with Annie Creek downstream to West Fork Monumental Creek (Figure 50). Monumental Creek AU ID17060206SL012_02 is also listed for sediment. This AU is comprised of all the 1st and 2nd order tributary subwatersheds of Monumental Creek in the watershed (this also includes the 1st and 2nd order section of Monumental Creek itself). Figure 51 shows the locations of mines in the watershed.

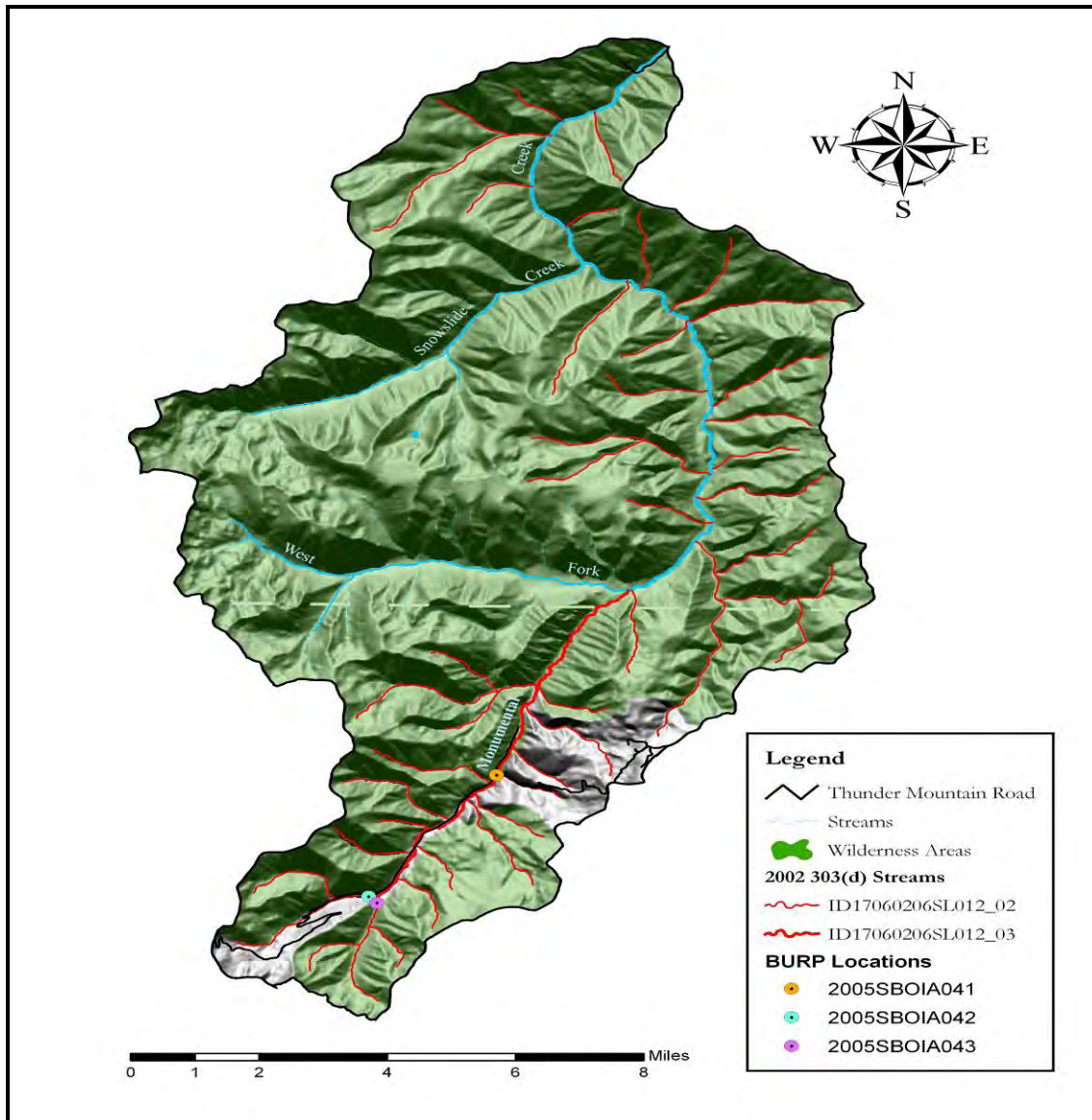


Figure 50. Monumental Creek DEQ Monitoring Locations

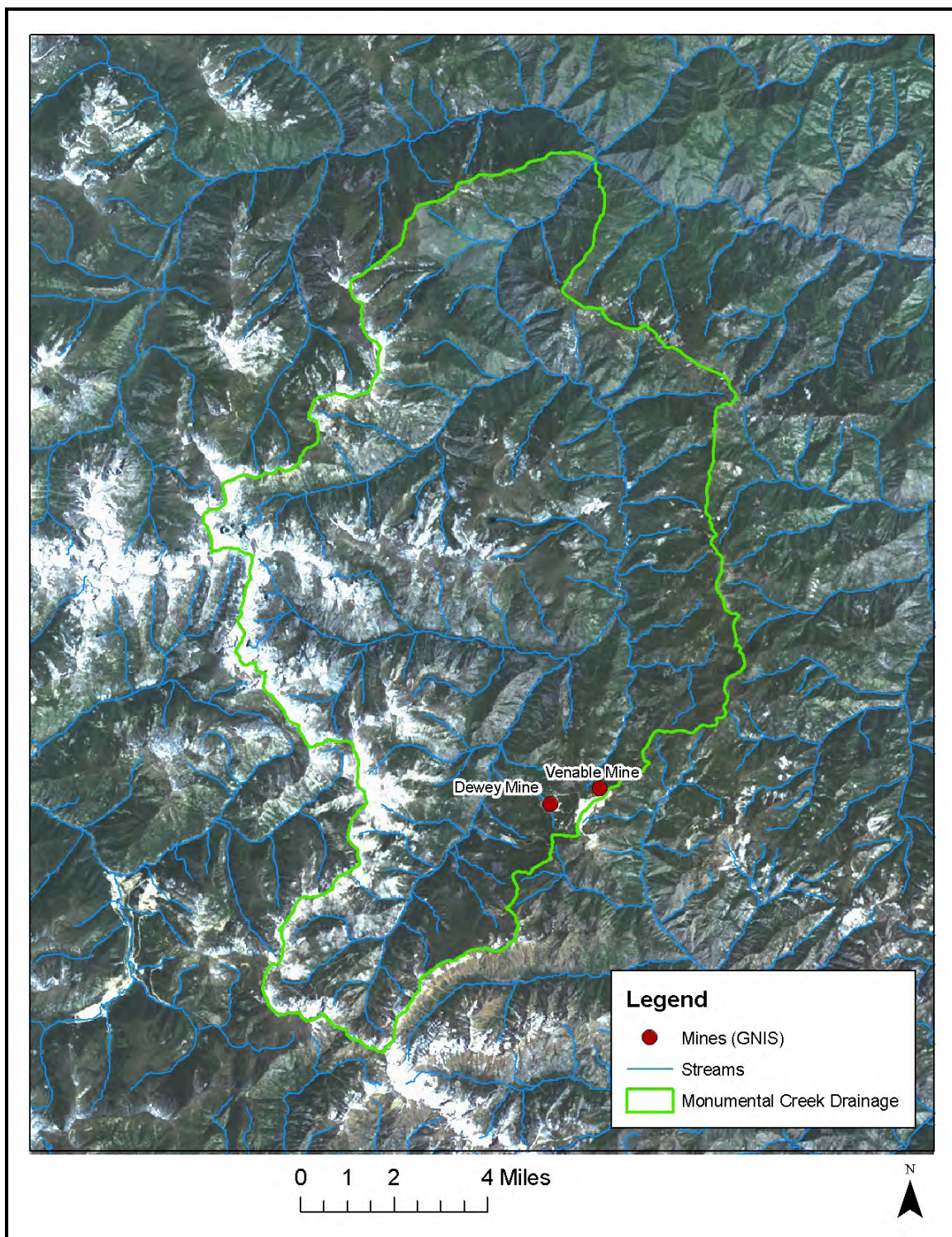


Figure 51. Mine locations in the Monumental Creek Watershed

Habitat Data

The DEQ waterbody assessment scores in Table 65 show that AU ID17060206SL012_03 of Monumental Creek and AU ID17060206SL012_02 of Monumental Creek fully

support beneficial uses. The waterbody assessment scores for each creek are the maximum scores available in each category.

Table 65. Monumental Creek 1st and 2nd Order Tributary Waterbody Assessment Scores

DEQ Stream Site ID	SHI	SMI	SFI	Assessment Score	Beneficial Use Support Status
	(maximum score= 3)				
2005SBOIA041 (Monumental Creek at Rainbow Creek) (ID17060206SL012_03)	3	3	3	3	Full Support
2005SBOIA042 (Monumental Creek at Annie Creek) (ID17060206SL012_02)	3	3	3	3	Full Support
2005SBOIA043 (Annie Creek) (ID17060206SL012_02)	3	3	3	3	Full Support

Mallet (1974) identified detrimental conditions in Monumental Creek (AU ID17060206SL012_03) due to mining pollution and siltation. In 1981, activities at the Golden Reef Joint Venture Mine resulted in an influx of sediment pond wastewater into Monumental Creek and Mule Creek (AU ID17060206SL012_02), a Monumental tributary.

In October 1983, several tons of settling pond sludge from the Dewey Mine spilled into Mule Creek. A fish habitat survey conducted by IDFG and USFS identified extremely turbid conditions, severely degraded fish habitat (50% less habitat as a result of the spill), and 51% embeddedness (twice the value found in undisturbed sites).

High flows in 1986 flushed fine sediments, reducing embeddedness to 19% in Monumental Creek (AU ID17060206SL012_03) downstream of the contaminant source in 1986. Ries and Burns (1989) documented an improving trend in substrate conditions, but identified sediment effluent as continuing to degrade habitat.

More recently, Nelson et al. (1996) noted a highly significant decreasing trend in cobble embeddedness over the 1983 -1994 study period, which indicates improving sediment conditions. Generally, sediment conditions in the Thunder Mountain area appear stable. Trends in fine sediment are generally down. No clear-cut differences were found in present sediment conditions between sites in the Monumental Creek area and those in the FC-RONR Wilderness (Nelson et al. 1996). Cobble embeddedness determined in 2003 ranged from 2% to 20% which was determined to be functioning appropriately. More recent DEQ BURP data also showed percent fines within reference condition values.

Currently, migratory corridors and rearing habitat are considered in good to excellent condition in Monumental Creek. Roosevelt Lake is a barrier to chinook salmon

spawning. Steelhead are found above Roosevelt Lake. The exception would be the area of the Thunder Mountain access road and several stream crossings that may not allow fish passage at all flows and life stages. The Thunder Mountain area is inactive for mining and is currently slated for a rehabilitation project, which should occur within the next five years. Historical mining activities may have also changed active channel length in localized areas, according to a judgment made by Jim Fitzgerald, USFS Payette National Forest (PNF) Hydrologist in unpublished riparian inventories of Big Creek tributaries, 2004. Related data is on file at the PNF Supervisor's Office, McCall, Idaho.

Most of AU ID17060206SL012_02 lies in the FC-RONR Wilderness area (roughly the area from W. Fork Monumental Creek to the mouth of Monumental Creek). These streams in the wilderness area are assumed to support beneficial uses and/or be representative of natural background conditions due to the lack of human disturbance.

Large Woody Debris

Large woody debris in the West Fork of Monumental Creek averaged 15 pieces/mile, WF Monumental Creek averaged 38 pieces/mile. The amount of large woody debris is close to or exceeds the values for average counts of large woody debris in plutonic streams with similar average wetted width in the Natural Conditions database (Overton et al. 1995; data on file at PNF Supervisors Office, McCall, Idaho), which means that the large woody debris found in the creek is similar to that found in pristine streams or streams with minimal human impact.

Pool Frequency

Generally, in the Big Creek watershed, pools have good cover and cool water for bull trout and chinook/steelhead habitat. There is only a minor reduction of pool volume by fine sediment. Specifically for Monumental Creek, for all reaches surveyed in 1995, the mean from upstream of Annie Creek area downstream to Roosevelt Lake was 7.8 pools/100m (data on file at PNF supervisor's office, McCall, Idaho).

Width to Depth

Width to depth ratios in Monumental Creek appear to be functioning appropriately (professional judgment based on personal observations October 2004 and August 1997, PNF staff).

Bank Stability

Stream bank stability for upper Big Creek tributaries is greater than 90%, relative to the percent of inherent stable streambanks associated with a similar unmanaged stream system. Specifically, stream bank stability for both Monumental Creek and West Fork (WF) Monumental Creek were rated from 93% to 96%, which means that the contribution of sediment from streambank erosion is minimal. These values exceed the reference reach targets shown in Table 65. 2005 DEQ BURP surveys in upper and lower Monumental Creek found that banks were greater than 95% stable at the inventory site. A 2005 BURP survey showed that AU ID17060206SL012_03 had 96% stable banks.

Percent Fines

A 2005 BURP survey of Lower Monumental Creek (AU ID17060206SL012_03) found 18% average percent fines and 12% average percent fines in upper Monumental Creek (AU ID17060206SL012_02), which is similar to reference conditions.

Riparian Area

Riparian vegetation is at or near properly functioning condition for most of the area with localized areas having impacts from mining, roads and recreation. Those localized areas are functioning at risk (Payette Forest Plan III-260).

Fisheries

For Monumental Creek, migratory corridors and rearing habitat for Bull Trout are in good to excellent condition with the exception of where the Thunder Mountain access road and historical mining have adversely affected the streams. Additionally, several stream crossings may not allow fish passage at all flows and life stages (data on file at PNF Supervisors Office, McCall, Idaho).

Sediment from Roads

Sediment delivery from roads can adversely affect stream health. In 2003, road failure resulted in about 540 yards of sediment entering Monumental Creek. Since this occurred, the road has been repaired to prevent road failure from occurring in the future. Sedimentation effects were estimated to be short term (3 years).

While the evidence is clear that Monumental Creek supports beneficial uses, DEQ investigated the possibility of excess sediment delivery from roads using the Geomorphic Road Analysis Inventory method. This analysis was conducted because the preliminary review of the watershed using maps showed that the road was close to the stream in the upper portion of 17060206SL012_03. However, actual ground-truthing showed that the stream is generally buffered from the road, and sediment delivery was only 3% over natural background. However, the survey also showed that a berm present on the road alongside Coon Creek on the way up to the Thunder Mountain Mine area routed sediment into Monumental Creek. Springbrooks present in the upper part of the drainage also may route significant amounts of sediment. While this sediment may currently not be at levels that adversely affect Monumental Creek, any road related efforts to reduce sediment should be focused in these two areas.

Mine Remediation

The Thunder Mountain Mine Restoration Project will include the clean-up of mining operations in the Monumental Creek drainage area. Currently, the USFS is in the preliminary conceptual design phase of the Thunder Mountain Mine Restoration Project. The proposed restoration project includes the removal of the ford at the confluence of Monumental Creek and Coon Creek, which will improve fish habitat and decrease sediment delivery. The proposed project also specifies removal of structures/equipment and reshaping/re-vegetation in the Dewey Mine area. The final step in the restoration calls for the removal of road sections leading to the Dewey and Sunnyside Mines (exact sections are not known at this time). All these plans are preliminary and are subject to change during the design process. This project is slated to occur within the next five years.

Conclusions

As shown in both DEQ and USFS data, Monumental Creek supports beneficial uses. The watershed has been altered due to mining activities but sediment is not impairing water quality. Monumental Creek is recommended for delisting from the 303(d) list for sediment for AUs ID17060206SL012_03 and ID17060206SL012_02.

Elkhorn Creek

Elkhorn Creek (AU ID17060205SL008_02) is listed for both sediment and temperature on the 303(d) list. This assessment unit is comprised of the first and second order tributaries of Elkhorn Creek. Figure 52 shows the watershed.

Habitat Data

Eighty-nine percent of Elkhorn Creek, including all of the mainstem and Middle Fork of Elkhorn Creek, is in the FC-RONR Wilderness area and is fairly inaccessible. A DEQ stream reconnaissance in 2006 near the headwaters of North Fork Elkhorn Creek (AU ID17060205SL008_02) outside the wilderness area found over 98% stable banks and 21% fines, which is comparable to reference conditions. Three age classes of bull trout were found during a fish survey of the stream at that time.

Access to the stream site was by all-terrain vehicle (ATV)—the road was not passable with a 4-wheel-drive vehicle. The road appeared to get little use, and it was necessary for the field crew to use a chain saw to get their ATV past the deadfall. An ATV bridge is in place at the stream crossing. Good in-stream cover was noted by the field crew during that survey and the field notes state that the stream area is notably lush when compared to the more arid upland surroundings. DEQ results showed full support of beneficial uses with SHI, SMI and SFI scores all scoring the highest level of 3.

An old mine site was approximately 100 meters from the stream upstream of the BURP site but was not in use and there was no sediment impact to the stream from the site.

Aerial photo analysis does not show any significant mass wasting events or human influenced sources of sediment. Elkhorn Creek (AU ID17060205SL008_03) near the mouth has greater than 90% stable banks, good riparian cover, and ocularly-estimated low percent fines.

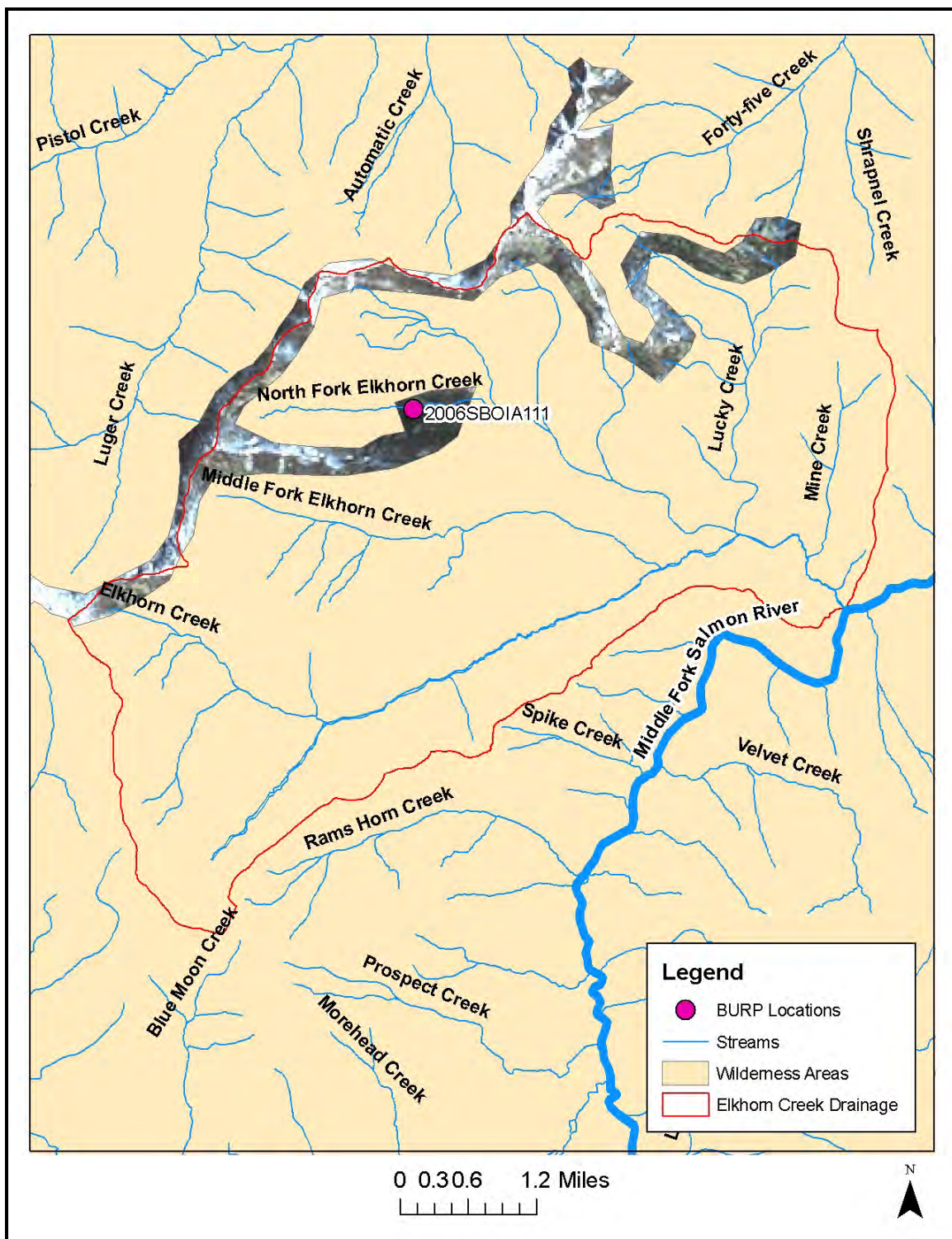


Figure 52. Elkhorn Creek Watershed Map

Temperature

Temperature data at the mouth (Figure 53) shows that Elkhorn Creek meets the state criteria for temperature for cold water aquatic life. Data was collected at the mouth of the

stream, because that was the easiest access point for the study. DEQ presumed that temperatures higher in the watershed would be cooler than those collected at the mouth. An aerial photo analysis of shade showed that shade in the upper and middle reaches of Elkhorn Creek in the FC-RONR wilderness was similar to the roughly $\frac{1}{2}$ mile of North Fork (NF) Elkhorn Creek that lies outside the wilderness. NF Elkhorn Creek appeared to have had a fire affect the middle reach of the stream within the wilderness area. The lower reaches generally had lower shade targets but flow through a naturally more open area entirely within the wilderness area.

Spawning for the MF Salmon River drainage for steelhead and redband trout is from early March to Mid-May (Grafe et al. 2002). Elkhorn Creek meets the state temperature criteria for spawning during those times. Spring chinook are estimated to spawn from mid-August to mid September and Summer chinook are estimated to spawn from September to mid-October.

Bull trout are estimated to spawn between September 1 and April 1. Idaho Bull trout and chinook spawning temperature criteria are met for all these spawning periods. The federal standard for bull trout is not met from June –September. The USGS (2001) found that 100% of 33 surveyed streams in the Salmon River basin that were determined to be in the least disturbed category did not meet bull trout temperature criteria. Elevation was determined to be the most significant predictor for in-stream temperatures in that study.

Since 89% of the watershed lies in a wilderness area and the non-wilderness portions of Elkhorn Creek are within the same range of existing shade as the wilderness area, it is presumed that Elkhorn Creek meets the criteria for natural background temperature.

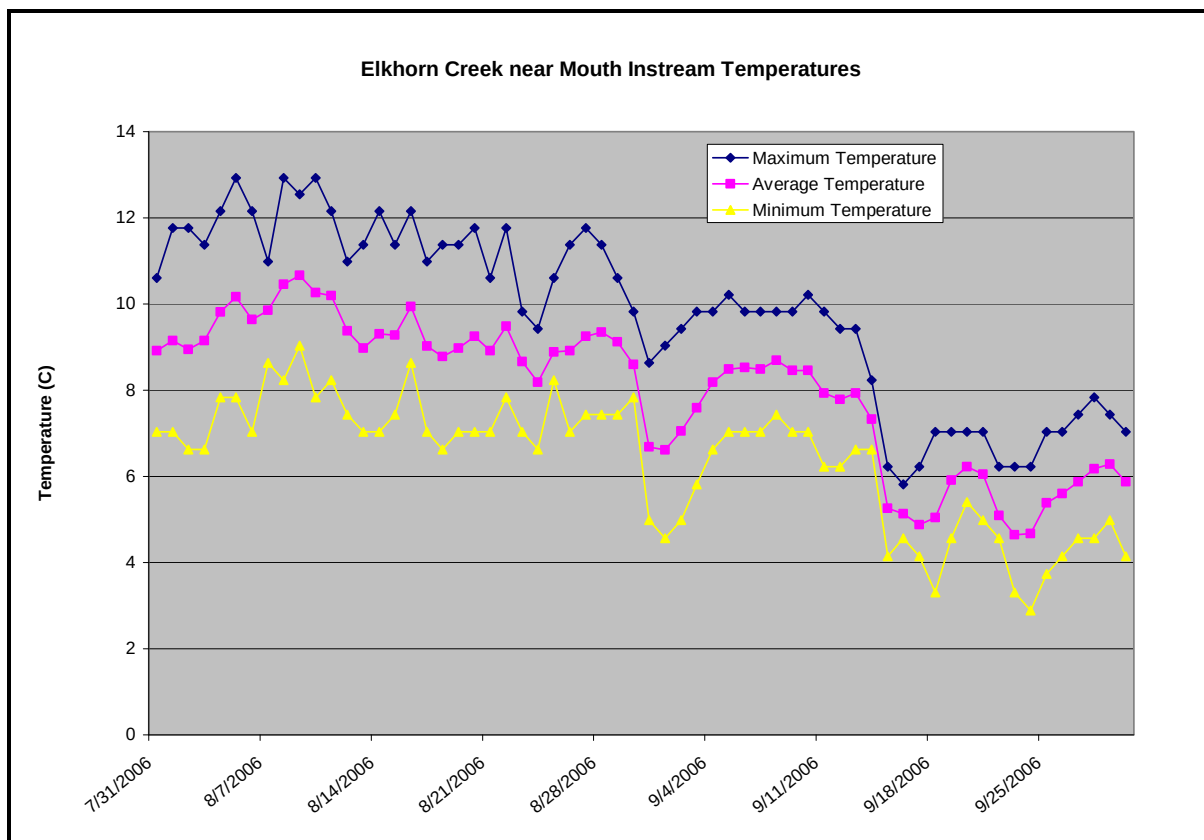


Figure 53. Elkhorn Creek Daily Stream Temperatures**Conclusions**

Due to the inaccessibility of Elkhorn Creek and its location predominantly in a wilderness area, human influence is minimal. In NF Elkhorn Creek, in the reach outside of the FC-RONR Wilderness, fish, shading, and sediment parameters as well as high BURP metric scores show full support of beneficial uses. Difficult access to the area, due to nearby road closures from fire and the necessity of using ATVs to get to the non-wilderness area, prevented follow up visits. Since the watershed is largely undisturbed by human influence, conditions in the watershed are comparable to wilderness conditions. Elkhorn Creek (AU17060205SL008_2) is recommended for delisting for sediment and temperature.

Status of Beneficial Uses

Beneficial uses within the Middle Fork Salmon River watershed are fully supported with few exceptions. The Middle Fork watershed is largely pristine wilderness and it is the bastion of the largest population of wild anadromous fish that makes the longest inland run in the Pacific Northwest. It is also the most pristine key watershed for resident migratory bull trout westslope cutthroat trout in Idaho. Most of the streams are in reference condition that could serve as the standard by which streams could be measured. Even within an environment with such a protective buffer there are cataclysmic events such as wild fire, land slides, extreme drought, and flooding that can impact water quality. The impacts to water quality from such natural perturbances include siltation, increased nutrient loading, loss of physical habitat, increased temperature regime, and increased turbidity. Additionally, biological populations can be affected, isolated, and, in extreme cases, extirpated from watersheds. It is important to distinguish between natural transitions and anthropogenic sources of disturbance. It is not cost effective or rational to attempt to improve natural environmental conditions beyond the background levels of nonpoint source pollutants or to limit the natural range of variability of these conditions. DEQ has compiled concepts to discern if natural background water quality conditions exceed numeric criteria (DEQ 2003). With regard to natural watersheds, DEQ regards watersheds located in designated wilderness, or *de facto* wilderness such as in wilderness study areas or in roadless or nearly roadless areas, as natural. Within the range of natural variability, conditions exhibited in surface waters that evolve in and are primarily contained in wilderness areas are presumed to exhibit natural background conditions. If no new potential nonpoint or point source human-linked pollutant sources are proposed, no quantification is necessary to determine regulatory compliance with natural conditions.

Within the Middle Fork Salmon River watershed, there are several headwater and peripheral streams that flow, at least partially, outside of wilderness. They may flow through public lands that are managed by the USDA Forest Service that include private in-holdings where land management creates the potential to impact surface water quality. The streams that are actually detected in the assessment process as being impaired are streams that have intermittent flow, or extremely low base flow, in all but the most extreme hydrologic years. These streams do not have gages installed because it has not proven economically feasible to install gages on intermittent or low flow streams. These

determinations are made by observations in successive years by field crews, by observations from land management personnel, and by direct observations of channel conditions that indicate streams cannot be perennial. Such observations include; sage brush growing in the channel, channels that are commonly used as recreational roads and trails, and channel geometry that precludes the potential for significant flow, such as spring brooks and seeps that drain emergent wetlands and wet meadows. These streams have been identified in this document as either being listed in error or being non-target streams. There are streams in managed peripheral public lands that exceed numeric criteria for temperature and that do not have the potential complement of natural vegetation in riparian zones for shading. These waters have been documented to fully support beneficial uses, however the exceedance of numeric criteria necessitates the development of a pollution load allocation because they occur outside of wilderness land and water quality conditions can be linked to anthropogenic sources such as livestock grazing. These streams have not received adequate utilization monitoring to guide management prescriptions and TMDLs will be developed to restore compliance with state and federal water quality standards.

Conclusions

The only exceedance of numeric water quality standards observed in managed watersheds has been temperature during spring and fall spawning periods. These exceedances occur in waters that have been determined to fully support beneficial uses. As previously described, listed waters in the Marsh Creek watershed and tributary Beaver Creek watershed have been determined to be non-targeted waters because they are ephemeral, or they are seeps that evolve from wet meadows that do not provide adequate flows or substrate for salmonid spawning or macroinvertebrates that would populate perennial streams with greater flow regimes.

Within the Marsh Creek watershed, the temperature loading analysis shows that exceedance occurs from the upper source reach to the confluence with Bear Valley Creek. Normally the observed thermal regime would be considered natural background. Because the riparian vegetation community has been determined to be significantly less than its potential for stream shading, the thermal load will be allocated in relation to potential natural vegetation. Conditions on Knapp Creek, Beaver Creek, and Winnemucca Creek are similar. Solar load allocations have been prepared for the entire reaches of these streams. The extent of water quality criteria exceedance is seen in Table 56, Table 57, and Table 58 above. Cause and effect of water quality criteria exceedances are likely related to historic grazing practices, though lack of monitoring related to grazing management has masked cumulative impacts.

2.5 Data Gaps

Data collection over the entire range of wilderness streams is not logistically or economically feasible. Data collection related to water quality has been focused in managed areas on the periphery of wilderness and is directed at detecting impacts related to grazing, recreation and mining. The coverage of BURP sampling is generally adequate with sample sites weighted toward areas with reasonable access, which happen

to be areas with a higher likelihood of potential anthropogenic impacts related to this increased access. Data is adequate to determine impacts to beneficial uses within the non-wilderness areas. Flow regime is natural and critical time periods for pollutant loading are not applicable within the wilderness areas or their periphery. There are no NPDES point sources within this watershed for which additional data would be required to evaluate impacts.

In September 2004, DEQ contracted with the S.M. Stoller Corporation to collect flow data, depth fine data, and percent shade data on listed streams in the Marsh Creek watershed. None of the 303(d) streams had measurable flow or suitable substrate for depth fine measurement. Further refinement of assessment methodology is needed for assessment of wet meadows, seeps, and spring brooks. At the other end of the spectrum, large river assessment may be useful to evaluate Marsh Creek and Bear Valley Creeks above their confluence to affirm that they are in full support of beneficial uses, though data to the contrary is not available.

3. Subbasin Assessment–Pollutant Source Inventory

Potential sources of pollutants were evaluated as described in the Water Column Data, section 2. No discernable exceedance of water quality standards was assigned to mining related issues. Sediment from stream bank erosion has not been determined to limit cold water aquatic life beneficial uses in the Marsh, Beaver, or Camas Creek watersheds where this pollutant would be most likely to have an impact. Thermal loading from alteration of riparian vegetation and/or channel geometry is the primary pollutant source within the watershed. Potential impacts to primary and secondary contact recreation from disbursed recreation including camping and boating have not been shown to impair beneficial uses related to pathogens. Pollutant sources that potentially affect water quality in the managed areas of the Middle Fork watershed are related to shading of surface water by riparian vegetation.

3.1 Sources of Pollutants of Concern

Sources of pollutants of concern within the Marsh and Camas Creek watersheds involve increased channel size accompanied by decreased riparian vegetation. Within Bear Valley, Elk, Marsh, Knapp, Beaver, Winnemucca, and Camas Creeks, there is evidence of accelerated stream bank recession rate resulting in increased channel width. This channel change is likely driven by elevated channel deposition resulting in elevated coarse sediment inputs.

Historic land use has contributed to reduction of riparian vegetation, which, in turn, increases bank erosion and hill slope erosion when faced with extreme hydrologic events. Hydrologic inputs include rain on snow events, heavy runoff from snowmelt, and severe thunderstorms combined with reduction of ground cover from grazing overutilization. This predisposition to bank recession from increased coarse sediment inputs produces channel aggradation which increases near-bank current velocity which further widens the channel, setting the stage for increased solar loading from the reduction in stream shading. This process is manifested in elevated stream temperatures during spawning and rearing periods which are greater than natural background condition and would be considered nonpoint source pollution.

Nonpoint Sources

The land use relationship for nonpoint source solar loading occurs primarily within the riparian zone or, in some cases, the immediate uplands adjacent to riparian areas. The riparian corridor within the Middle Fork Salmon River watershed is generally characterized by narrow, steep canyons. The exception to this would be found in the upper Marsh Creek and Bear Valley Creek watersheds, where broad valleys are found. Land use within this narrow corridor is particularly sensitive to vegetation removal. Impacts from grazing and recreation must be monitored closely to evaluate impacts over time. There are few roads and associated road crossings.

Pollutant Transport

The accumulation of thermal inputs can be viewed as pollutant transport because a stream that warms inordinately in reaches without shade could potentially carry the thermal load to lower elevation reaches that would be expected to increase in temperature as well. Thermal loading that occurs in the non-wilderness periphery of the Upper and Lower Middle Fork Salmon River watersheds can be transferred to wilderness reaches that are presumed to have natural background loading. For this reason, it is important to manage for potential natural vegetative stream shading above protected wilderness reaches that are important to listed anadromous and resident fish species. Figure 54 shows the digital thermal infrared image of the Middle Fork of the Salmon River at its source: the confluence of Bear Valley and Marsh Creeks (with Bear Valley on the left). Upper reaches of Bear Valley Creek are more open with less vegetation. From this image, it is evident that Bear Valley Creek contributes a greater overall temperature than Marsh Creek, however, the important relationship is thermal mass based on flow. It appears that elevated temperature is attenuated by the combined effect of flow of Marsh Creek and spring input over a relatively short reach.

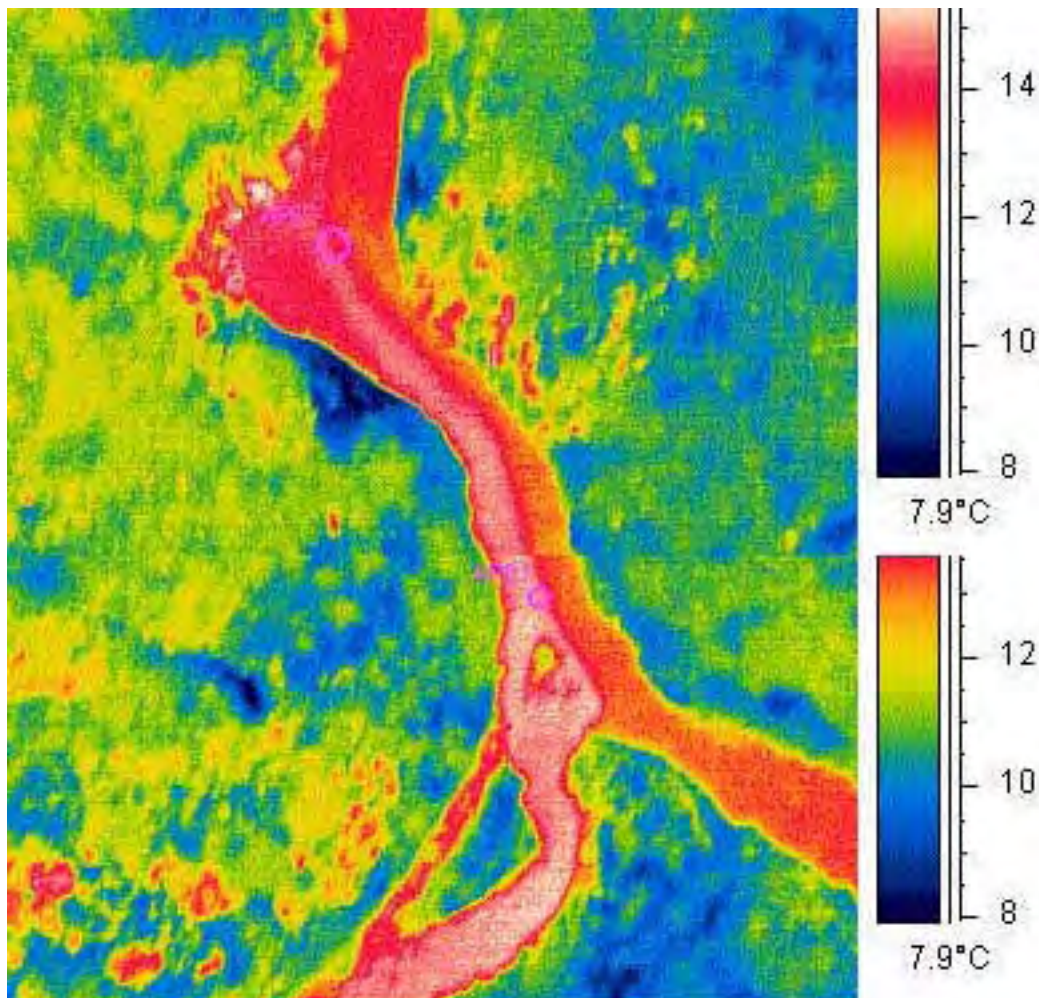


Figure 54. Relative thermal contribution of Bear Valley and Marsh Creeks to the Middle Fork Salmon River at its origin. (IRZ 2000)

The resulting flow is only slightly warmer than source streams, likely due to groundwater inputs. This simply shows the complexity of thermal transport with relation to factors beyond shade alone. The underlying premise remains that riparian vegetation, as well as channel geometry, is important to thermoregulation of fluvial systems. The importance of riparian thermal buffers is important during the warmest season of the year, but it is also very important during winter months. Without riparian vegetation to buffer thermal radiation to sky, super cooling can occur, forming ice blockages of the channel and scouring aquatic habitat, or initiating out-of-channel flow, which leads to channel instability and elevated sediment load.

3.2 Data Gaps

Data gaps pertaining to determining beneficial use support status on streams within the Middle Fork Salmon River are most strongly correlated with access to streams within managed areas. It is possible that the resolution of data associated with these streams is adequate to determine that they are in full support of beneficial uses. The effort to initiate preliminary loading analysis as a first step toward developing a load allocation in these streams is based on determination that there are exceedances of numeric water quality criteria for temperature. With regard to the streams identified in Tables 56, 57, and 58 in the Middle Fork Salmon River watershed, there is adequate temperature data collected by the Forest Service and DEQ over several years to proceed with building a load allocation related to potential natural vegetation to address the exceedance of numerical water quality criteria. A potential data gap may be the need for development of more localized plant assemblages and associated shade values to develop load allocations. Existing data, however, is considered adequate to address temperature issues in the short term, while working to develop more region-specific shade curves.

Point Sources

There are no identified point sources of pollutants within the Middle Fork Salmon River associated with streams that are not fully supporting beneficial uses.

Nonpoint Sources

Nonpoint source pollution with this assessment would be considered a discrete substance that accrues within a water body that would impact designated or existing beneficial uses in great enough quantity to limit beneficial use support. Within the Middle Fork of the Salmon River watershed the most pervasive nonpoint source pollutants determined by this assessment would be temperature and sediment loading. Within the eastern portion of the watershed these pollutants are not limiting beneficial use support. The exceedance of numeric water quality criteria for temperature has required development of a loading analysis and subsequent load allocation for thermal loading. This nonpoint source pollutant has not been directly associated with limitation of beneficial uses. The greatest uncertainty affiliated with this source would include the potential impact of geothermal inputs to surface water, the effect of natural seasonal flow variability on stream reaches identified as exceeding numeric water quality standards, and the source of alteration of riparian plant communities. The assumptions related to the loading analysis may be refined over time to more accurately reflect the appropriate natural background loading that will be identified in this document.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

The basic premise of pollution control efforts is to identify a potential problem related to management and implement practices to reduce or eliminate the source of pollution or to improve the assimilative capacity of the particular water. The issues for which this chain of events has played out involve grazing management on the Upper and Lower Middle Fork watershed, recreation management on the main Middle Fork Salmon River, road maintenance in the Big Creek watershed, particularly Monumental Creek, and stream alteration permitting on the Myers Cove reach of Camas Creek. Outside of these discrete source and impact relationships, there has been little effort toward pollution control of human-made sources within the wilderness area or periphery. It may be possible to identify fire control measures as a past pollution control effort, but seldom is fire human-caused within the Middle Fork Salmon River Watershed.

In the Upper watershed, particularly within the Bear Valley Creek watershed, including Elk Creek, the Bonneville Power Administration has negotiated a buyout of grazing allotments that were identified as a significant cause of sediment loading from streambank erosion. This buyout began in 1998 and was completed in 2001, and a significant improvement has accrued in some areas. Additionally, the Shoshone-Bannock (ShoBan) Tribes have initiated streambank stabilization projects and riparian planting to alleviate excess erosion.

Within the Marsh Creek watershed, pollution control efforts have not been implemented to this extent. Some culverts have been improved, or removed all together, however, monitoring of grazing impacts are lacking. The last known greenline data was collected by the Forest Service' Challis Ranger District in 1996 (Barry Dopp, personal communication, 2006), and is outdated, though riparian data is slated for collection in the future.

Within the Camas Creek watershed, a riparian exclosure system in conjunction with four hardened stream crossings was established in the mid-90s by the Forest Service and Idaho Department of Fish and Game, with funding provided by Bonneville Power Administration, to partially compensate for downstream fish losses occurring at hydro-electric developments. This project, though well intended, has been largely negated by lack of maintenance and unwillingness of grazing permit holders to prevent access of livestock within the enclosure. Stream channel improvements have been slow to accrue, if at all, within this project.

Downstream of the exclosure, on Camas Creek, there have been efforts to stabilize the stream channel adjacent to the Seaforth Mine on Duck Creek and along Camas Creek. Much of this work has been done without permits and has been accompanied by unauthorized road building within the riparian area of Camas Creek, which has resulted in increased erosion. Permits have been submitted for additional channel hardening, though review of the potential impacts of this work has not been completed at this time.

Pollution control projects tend to be implemented outside the designated wilderness area, which limits the amount of area involved because much of the watershed lies within the

designated wilderness area. Mitigation projects related to mining, grazing and roads are the most common types of projects implemented. Table 66 is a summary of representative pollution control projects in the Middle Fork Salmon River watershed.

Table 66. Past and Present Pollution Control Efforts

Agency/Party	Water Pollution Control Objective	Action	Status
Shoshone Bannock Tribe/BPA 1989	Bear Valley Creek Big Meadows Mine Rehabilitation	Stabilize, create floodplain and revegetate dredging site Stream channel realignment on approximately 7500 feet of channel to provide a floodplain and meandering channel. 500,000 cubic yards of material was excavated. 16,000 willows, lodgepole pine and spruce planted. 680 Carex sp. planted along stream \$2.8 million	Completed
USFS/BPA (1987)	Bearskin Creek Oxbow	A cutoff channel was constructed to bypass the existing oxbow of Bearskin Creek in order to reduce headcutting and also create juvenile rearing habitat	Completed
USFS/BPA 1987	Lower Elk and Cache Creek juniper revetment	Control streambank erosion of upland vegetation types by anchoring 1900 juniper onto 1573' of eroding banks. Constructed 1291 feet of hitching rail fence. Filled one 40 foot gully with junipers. Estimated to be 30% effective in slowing erosion processes.	Completed
USFS/BPA 1988	Bearskin Wet Meadows	Installed rock structures to dissipate energy and raise ground water structure to reduce headcutting	Completed
USFS/BPA 1989	Wyoming Creek	Installed two rock barbs to reduce instream erosion	Completed
USFS/BPA 1989	Elk Creek	Installed 5 rock and large wood structures to increase instream habitat complexity and treat sediment sources	Completed
USFS/.BPA 1989	Elk Creek	A 217 foot channel was constructed at narrowest part of the point bar to relieve high flow pressure on a 600 foot eroding bank.	Completed
USFS/BPA 1989-90	Bear Valley Creek	2500 Willows planted in the Big Meadows area	Completed
USFS/BPA 1990	Bearskin	Controlled headcutting action of creek	Completed
USFS/BPA 1990	Wyoming Creek	Rehabilitated gully erosion and stabilized active headcutting	Completed

Agency/Party	Water Pollution Control Objective	Action	Status
USFS/Trout Unlimited/IDFG 1990	Upper Bear Valley Creek and Cache Creek	Stabilized sediment source adjacent to Bear Valley Creek between Mace and Sheep Trail Creek and planted willow cuttings behind revetments for 300 feet.	Completed
USFS/BPA 1990	Upper Bear Valley Creek	Put in 21 log and rock structures on Bear Valley Creek between Cub Creek and Sheep Trail Creek. Increased bank stability and decreased channel widening.	Completed
USFS/BPA 1990	Lower Bear Valley Creek	Constructed 3 large barbs on an outside meander to control excess streambank erosion and allow for establishment of riparian species.	Completed
USFS/BPA 1990-1991	Bear Valley Creek	4,576 willows were cut, rooted and planted on Bear Valley Creek in the Cub Creek area to increase riparian density and bank stability.	Completed
USFS/BPA 1991	Elk Creek	Sedge and willow planting in streambanks of new channel	Completed
USFS/BPA 1991	Bear Valley Creek	Tree deflectors on 400 ft of streambank near Mace Creek to deflect flow away from streambanks	Completed
USFS/BPA/DEQ/TU/IDFG 1991	Bear Valley Creek	Adopt a Stream program planted willow cuttings and anchored logs along Bear Valley Creek between Poker Meadow Bridge and Fir Creek	Completed
BPA 1991	Bear Valley Creek	57 rock and log structures were installed on Bear Valley Creek downstream from Sheep Trail to create habitat complexity.	Completed
USFS/BPA 1991	Cold Creek Wyoming Creek	2 rock check dams constructed in Cold Creek. Relocated 300 feet of Wyoming Creek road to prevent sediment transport to stream	Completed
USFS/BPA 1992	Bear Valley Creek	2.25 miles of fence constructed in Ayers Meadow to protect sensitive channel	Completed
USFS/BPA 1992	Bear Valley Creek	5.25 miles of fence constructed to protect stream channel during grazing.	Completed
USFS/BPA 1993	Bear Valley Creek	2.3 miles of fence constructed in Poker meadows	Completed
TU/IDFG/USFS 1993-1994	Bear Valley Creek	Willow, sedge and rush planting	Completed
1997-1998 USFS/TU	Lower Elk Creek and Bear Valley Creek	Log barbs installed along cutbank in 2 reaches on Elk Creek and 4 reaches on Bear Valley Creek to encourage bank building and vegetative recolonization	Completed
2000 IDFG, Shoshone/Bannock	Bear Valley and Elk Creek	Protection of salmon spawning habitat (\$310,000)	Completed
2001 BPA/USFS	Bear Valley and	All grazing allotments retired	Completed

Agency/Party	Water Pollution Control Objective	Action	Status
	Elk Creeks	(e.g. Elk Creek allotment retired in 2000, 48,000 acres in allotment-grazing permit purchased by BPA for \$145,000 and then allotment retired)	
2003 USFS	Bear Valley Roads Improvement Project	Improvement and maintenance of Bear Valley roads	Completed
2004 IDFG, TU, Borah High School, USFS, NOAA,	Bear Valley Creek	Planted willows and potentilla on 10 hardened livestock stream crossings to enhance streamside vegetation and improve streambank stability (Five Star Restoration Project/NOAA Community based Restoration Program)	Completed
2004 USFS	Bear Valley Creek	Fir Creek Campground fence constructed to prevent trampling of banks	Completed
2005 USFS	Bear Valley Creek riparian restoration	Planting of hardened crossings (\$125,000)	Completed
2005 USFS/Valley County	Casner Creek/Cub Creek	Culvert replacement to restore fish passage to 4 miles of stream habitat	Completed
2006 USFS	Bear Valley Creek	Burn area mitigation	Completed
2007	Casner Creek Stream Mitigation	Project to mitigate prior straightening of creek during dredge mining era	In Process
2008	FS Road 579 and 582 Road Work	Relocation of 0.1 mile road of Road 582, install 9-14 new culverts, inslope 500 feet of road at milepost 22.76 to prevent sediment delivery to stream, Align 0.2 miles of road at milepost 24.83. Inslope about 400' of road on FS Road 579 at milepost 12.39, inslope 300' of road at milepost 12.67 and install two new culverts.	Scheduled for 2008

5. Total Maximum Daily Loads

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources. This can be summarized symbolically as the equation: $LC = MOS + NB + LA + WLA = TMDL$. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 In-stream Water Quality Targets

For the Marsh Creek and Camas Creek temperature TMDLs, we utilize a potential natural vegetation (PNV) approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature which results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. See Appendix B for further discussion of water quality standards and background provisions. The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section. For a more complete discussion of shade and its effects *on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL* (IDEQ 2004).

Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The parameters that affect or control the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade that are most likely to have been influenced by anthropogenic activities, and which can be most readily corrected and addressed by a TMDL.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a Solar Pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is that riparian plant community that has grown to an overall mature state, although some level of natural disturbance is usually included in our development and use of shade targets. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing)

or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade-producing vegetation. Anything less than PNV results in the stream heating up from anthropogenically created additional solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what potential there is to decrease solar gain. Streams disturbed by wildfire require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing Shade Estimates

Existing shade or cover was estimated from visual observations of aerial photos for Marsh, Knapp, Beaver, and Winnemucca Creeks in the Upper Middle Fork Salmon River watershed as well as Camas, Castle, Silver, Duck, and Yellowjacket Creeks in the Lower Middle Fork Salmon River watershed. These estimates were field-verified by measuring shade with a Solar Pathfinder at systematically located points along the streams (see below for methodology). PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities in other TMDLs.

A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the plant community is able to provide more shade at any given channel width.

Existing and PNV shade was converted to solar load from data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, data from the Boise, Idaho station was used. If the existing load is greater than PNV, the difference between existing and potential solar load is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria.

Pathfinder Methodology

The Solar Pathfinder is a device that shows the shadow outline of shade-producing objects on monthly solar path charts, allowing the user to trace the outline. Once the outline is traced, the percentage of the sun's path covered by these objects, which is the effective shade on the stream at the spot that the tracing is made, can be identified. In order to adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location the Solar Pathfinder should be placed in the middle of the stream about the bankfull water level. The manufacturer's instructions for taking traces

are followed (orient to true south and level). Systematic sampling is easiest to accomplish without biasing the sampling locations. For systematic sampling, the user starts at a unique location such as 100 meters from a bridge or fence line and then proceeds upstream or downstream stopping to take additional traces at fixed intervals (e.g., every 100 meters, every 100 paces, every degree change on a GPS, every 0.1 mile change on an odometer, etc.). Points of measurement can also be randomly located by generating random numbers and using them as interval distances.

It is a good idea to measure bankfull widths and make notes of observations while taking Solar Pathfinder traces, and to photograph the stream at several unique locations, paying special attention to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade-producing ones) are present. Additionally or as a substitution, the user can take densiometer readings at the same locations as Solar Pathfinder traces. This provides the potential to develop relationships between canopy cover (based on densiometer readings) and effective shade (based on Solar Pathfinder traces) for a given stream.

Aerial Photo Interpretation

For estimates of shade level, the stream is not divided into uniform lengths; instead it is divided between natural breaks in vegetation density based on plant type and density, and these segments are marked out on a 1:100K or 1:250K hydrography. Each stream segment (interval) is then assigned a single-integer value representing the bottom of a 10% shade class as described below (adapted from the CWE process, IDL 2000). For example, if we estimate that shade for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. The typical vegetation type listed below show what kind of landscape is usually observed where each particular shade class is usually found, for a stream 5 meters or less in width. For example, if a section of a 5m-wide stream is identified as being in the 20% cover class, the landscape along that section of stream is usually in agricultural land, meadows, open areas, or clear-cut. However, that does not mean that the 20% cover shade class cannot occur in shrublands and forests, because it does on wider streams.

<u>Cover class</u>	<u>Typical vegetation type on 5m-wide stream</u>
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 – 19%	ag land, meadows, open areas, clear-cut
20 = 20 – 29%	ag land, meadows, open areas, clear-cut
30 = 30 – 39%	ag land, meadows, open areas, clear-cut
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 – 100%	forested

It is important to note that the visual estimates made from the aerial photos are strongly influenced by canopy cover. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. Our assumption that canopy coverage and shade are similar is based on research conducted by Oregon DEQ. The visual estimates of “shade” in the Marsh Creek TMDLs were field-verified with a Solar Pathfinder. The pathfinder measures effective shade and accounts for other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of “shade” made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

Stream Morphology

Measures of current bankfull width or near-stream disturbance zone (NSDZ) width may not reflect widths that were present under PNV. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallow. Shadow length produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

The only factor not developed from the aerial photo work presented above is channel width (i.e., NSDZ or Bankfull Width). Accordingly, this parameter must be estimated from available information. To estimate natural bankfull width, we use regional curves for the major basins in Idaho, based on data compiled by Diane Hopster of Idaho Department of Lands (Figure 55).

For each stream evaluated in the loading analysis, natural bankfull width is estimated based on drainage area as indicated by the Salmon Basin curve from Figure . Additionally, existing width is evaluated from available data or is estimated from aerial photos (as was done for the mouths of Marsh Creek and Beaver Creek) (Table 67). If the stream’s existing width is wider than that predicted by the Salmon Basin curve in Figure 53, then the curve-based estimate of bankfull width is used for natural width in the loading analysis. If existing width is smaller, then existing width is used for natural width in the loading analysis. In most cases, the regional curve-based estimate is the smaller width and is used for natural width in this analysis. Only Knapp Creek had smaller existing widths (Table 67). Thus, natural widths are smaller than existing widths for Marsh, Beaver, and Winnemucca Creeks, and the same for Knapp Creek.

Existing bankfull widths were smaller than curve-based estimates for Duck Creek, Silver Creek, Castle Creek, and Yellowjacket Creek (Table 68). Hence, existing values were used as natural stream widths for these three streams. The existing width for Camas Creek at its mouth was crudely estimated from aerial photos, but is not likely to be different from regional curve estimates. This seems likely since curve estimates equal existing measurements on Camas Creek near Castle Creek. Therefore, the regional curve estimate of bankfull width is used as the natural width for Camas Creek.

Idaho Regional Curves - Bankfull Width

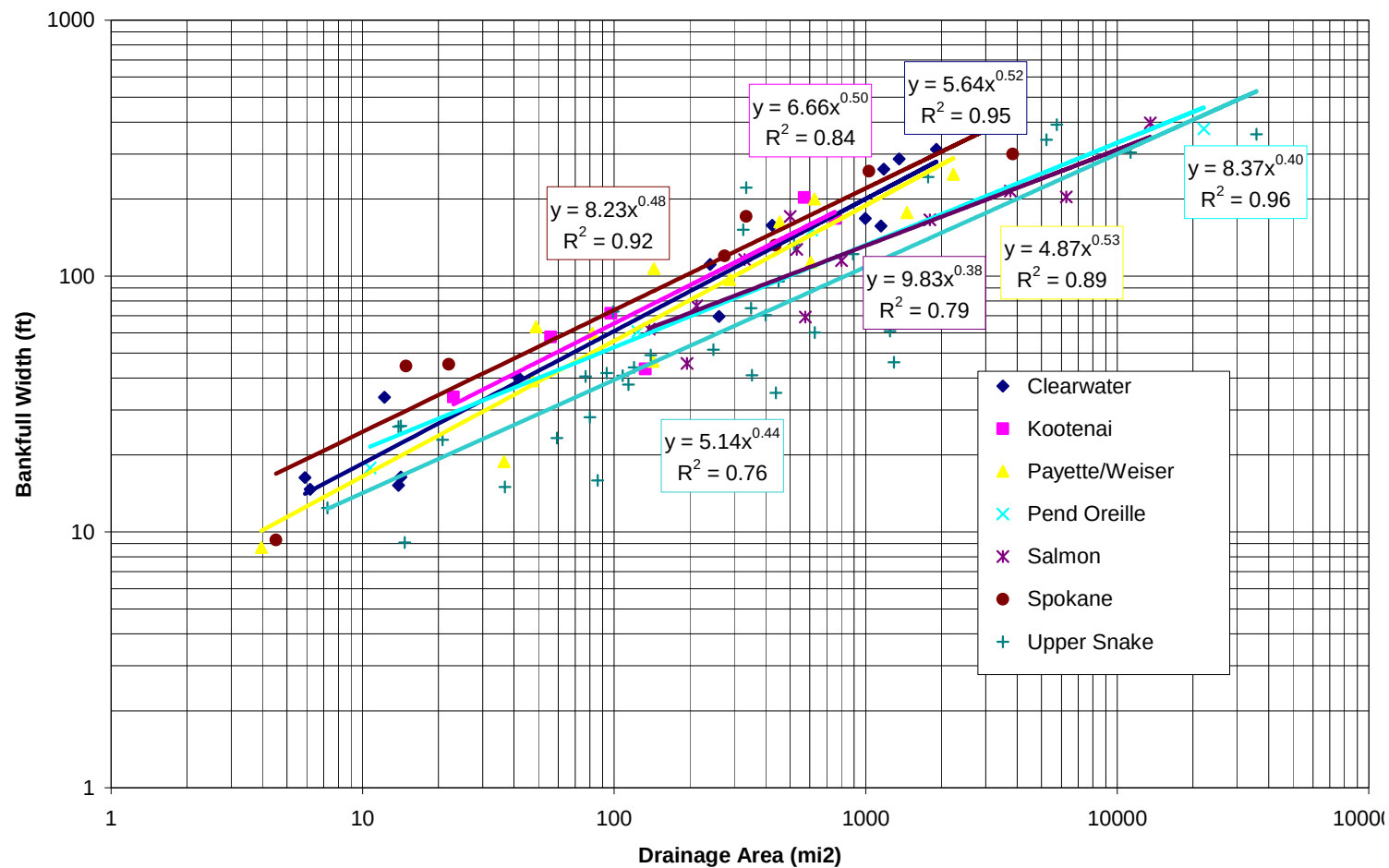


Figure 55. Regional Bankfull width as a function of drainage area for major basins in Idaho.

Table 67. Marsh Creek Watershed Bankfull Width Estimates From the Salmon Drainage Area Regional Curve and in Existing Measurements

Location	area (sq mi)	Salmon (m)	existing (m)
Marsh @ mouth	144	20	~25
Marsh btwn Knapp and Beaver	48.5	13	17.83
Beaver @ mouth	55.2	14	~20
Beaver above Winnemucca	13.3	8	7.9
Winnemucca @ mouth	11.5	8	12
Knapp @ mouth	24.3	10	7

Salmon is the Salmon Basin regional curve that gives bankfull width as a function of drainage area.

Table 68. Camas Creek watershed Bankfull Width in Meters as Estimated From the Salmon Basin Regional Curve and in Existing Measurements

Location	area (sq mi)	Salm (m)	existing (m)
Camas @ mouth	398	29	~25
Camas below Yellowjacket	384	29	
Camas above Yellowjacket	276	25	
Camas @ Castle Creek	129	19	19.1
Duck @ mouth	8.07	7	2.43
Silver @ mouth	52.2	13	6.4
Castle @ mouth	24.1	10	8.27
Yellowjacket @ mouth	108	18	~15
Yellowjacket below Hoodoo	85.9	16	
Yellowjacket above Hoodoo	68.2	15	9.7
Yellowjacket above Shovel	28.1	11	7.4

Salm is the Salmon Basin regional curve that gives bankfull width as a function of drainage area.

Source: USGS StreamStats <http://streamstats.usgs.gov>

Design Conditions

Marsh Creek begins in grass-dominated wetlands of the Cape Horn region of the Stanley Basin north of the glacier-carved Sawtooth Mountains and associated moraines. Marsh Creek is unusually wide (2-3m) at its headwaters as a result of its spring-fed nature. The marsh, acting like a giant sponge, probably retains large volumes of water only to release it suddenly into the Marsh Creek channel. Instead of starting as a small trickle of water, Marsh Creek begins with larger volumes. Marsh Creek flows in a northwesterly direction to its confluence with Bear Valley Creek where the Middle Fork Salmon River is formed. The first half of Marsh Creek is predominantly flat marsh, and the second half is forested canyon.

Knapp Creek and Beaver Creek descend hilly terrain at the edge of the FCRONR Wilderness to the northeast of Marsh Creek. Knapp Creek joins Marsh Creek midway through the flat terrain. Beaver Creek joins Marsh Creek just above the canyon area. Winnemucca Creek is a tributary to Beaver Creek.

Knapp Creek, Beaver Creek, and Winnemucca Creek are all forested watersheds with riparian areas dominated by mixed conifers or by a conifer/meadow mix where grasses and shrubs dominate the stream banks and the forest is set back, but close enough to provide some shade at low sun angles. Marsh Creek begins in grass-dominated meadows, then transitions to meadows with a conifer backdrop, and then a conifer/grass or conifer/shrub

community dominates the riparian area as the stream descends into the canyon to the Middle Fork Salmon River. A lower elevation conifer/meadow vegetation type is used for Marsh Creek as compared to the higher elevation conifer/meadow type used for the tributaries, and 10% is added to vegetation-based shade level targets in the canyon area to account for increased topographic shade in that area.

The Camas Creek watershed originates in the Idaho Batholith Level III Ecoregion with the majority of the watershed lying in the Southern Forested Mountains Level IV Ecoregion and the lower portion of Camas Creek in the Hot, Dry Canyons Level IV Ecoregion (McGrath et al. 2001). Southern Forested Mountains typically have droughty soils on granitic rocks that harbor primarily open Douglas fir forests with grand fir and subalpine fir common at higher elevations. The Hot, Dry Canyon is warmer and drier than the Southern Forested Mountains and ponderosa pine, sagebrush and grass are more common. Douglas fir occurs in the Hot, Dry Canyons but is less common.

The Camas Creek watershed drains a portion of the Salmon River Mountains northwest of Challis to the Middle Fork Salmon River. Castle Creek, Silver Creek, Duck Creek, and Yellowjacket Creek are east-side tributaries that sit in a portion of the watershed outside of the FCRONR Wilderness. Camas Creek and its four tributaries examined here have headwaters in coniferous near-stream vegetation (presumably Douglas fir, lodgepole pine, and subalpine fir are the most common) that transitions through mixtures of conifers and deciduous shrubs at mid elevation and then to open Ponderosa pine canyons with deciduous shrub riparian at lower elevations. Wider portions of Camas Creek, from Castle Creek to Duck Creek, harbor stands of cottonwood trees and willows. Deciduous riparian vegetation in narrow stream valleys is primarily birch, alder, and dogwood.

To describe shade targets for these streams, six general vegetation types were developed. They are: 1) a conifer vegetation type where coniferous trees are close to the streambank and are the dominant shade-producing vegetation, 2) conifer/meadow type where high elevation grass meadows exist next to the stream with conifers in the background but still providing substantial shade, 3) a conifer/shrub type where shrubs are the dominant near-stream vegetation and conifers are close by to contribute to shading, 4) a high elevation medium shrub type where alder, birch, and dogwood are the predominant shading vegetation, 5) a lower elevation medium shrub type along lower Camas Creek that is heavily dominated by willows, and 6) a cottonwood/shrub type for the wider portion of Camas Creek where cottonwoods provide substantial shade.

Target Selection

To determine PNV shade targets for Marsh Creek, Camas Creek, and the affected tributaries, effective shade curves from several existing temperature TMDLs were examined. These TMDLs had previously used vegetation community modeling to produce these shade curves. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis, representing the fact that as a stream becomes wider, a given vegetation type loses its ability to shade the middle portion of the stream. Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at the same stream width were remarkably similar. For Marsh Creek and Camas Creek, curves for the most similar vegetation type were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves

available. Thus, the selected shade curves represent a range of shade conditions that presumably the riparian community of interest in this TMDL falls into.

The effective shade calculations are based on a 6-month period from April through September. This time period coincides with the critical time period when temperatures affect beneficial uses such as spring and fall salmonids spawning and when cold water aquatic life criteria may be exceeded during summer months. Late July and early August typically represent a period of highest stream temperatures. Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but solar loadings affect salmonids spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

Target Selection for Creeks in the Marsh Creek Subwatershed

The riparian vegetation along Marsh Creek and associated tributaries was lumped into four general categories based on dominant shade-producing vegetation. Streams are generally in a mixed conifer or conifer meadow type vegetation with the exception of upper Marsh Creek which is dominated by a grass and low shrub dominated meadow. Shade targets were developed for a mixed conifer type, a higher elevation conifer/meadow type, a lower elevation conifer/meadow type, and a grass-dominated meadow type.

Mixed Conifer

For the mixed conifer community (Table 69), three shade curves were used to make targets for Marsh Creek. The subalpine fir type from the Salmon-Chamberlain (Crooked Creek) TMDL (IDEQ 2002) has an average height of 83 feet and an average canopy cover of 80%. The vegetation response unit (VRU) #6 from the South Fork Clearwater TMDL (IDEQ 2004) was comprised of lodgepole pine, western larch, Douglas fir, Engelmann spruce, and grand fir that was 20% large trees, 10% non-forest, 40% medium, and 30% pole trees. The conifer zone from the Walla Walla TMDL had an average height of 24 meters (79 ft) and an average density of 80%.

Table 69. Shade Targets for the Marsh Creek Mixed Conifer Vegetation Type at Various Stream Widths

Mixed Conifer	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m
subalpine fir (IDEQ, 2002)	95	95	93	92	90	88	86	85	82	81	80	78	76	74
VRU#6 (IDEQ, 2004)	98	96	94	92	90	88	86	85	82	79	76	74	72	70
Conifer zone (ODEQ, 2004b)	94	93	92	90	88	86	85	83	81	79	76	74	72	69
Average	95.667	94.667	93	91.333	89.333	87.333	85.667	84.333	81.67	79.667	77.333	75.333	73.333	71
Target (%)	96	95	93	91	89	87	86	84	82	80	77	75	73	71

Higher Elevation Conifer/Meadow

In addition to the subalpine fir type and the conifer zone type described above, for the higher elevation conifer/meadow vegetation type (Table 70) a low-growing graminoid/willow shade curve from the Alvord Lake TMDL (ODEQ 2003) was added in. The co-dominant mesic graminoid/willow community from the Trout Creek Mountains ecological province has an average height of 8.5 feet and a canopy density of 10%. An example of the higher elevation Conifer/Meadow Vegetation Type is shown on lower Beaver Creek in Figure 56.

Table 70. Shade Targets for the Marsh Creek Higher Elevation Conifer/Meadow Vegetation Type at Various Stream Widths

High Conifer Meadow	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m
subalpine fir (IDEQ, 2002)	95	95	93	92	90	88	86	85	82	81
Conifer zone (ODEQ, 2004b)	94	93	92	90	88	86	85	83	81	79
graminoid/willow-Trout (ODEQ, 2003)	39	26	18	14	10	9	6	5	4	3.5
Average	76	71.333	67.667	65.333	62.667	61	59	57.667	55.67	54.5
Target (%)	76	71	68	65	63	61	59	58	56	55

High Conifer Meadow	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m
subalpine fir (IDEQ, 2002)	80	78	76	74	72	70	69	68	67	66
Conifer zone (ODEQ, 2004b)	76	74	72	69	66	64	62	60	59	57
graminoid/willow-Trout (ODEQ, 2003)	3	3	2.5	2	2	2	1.5	1.5	1	1
Average	53	51.667	50.167	48.333	46.667	45.333	44.167	43.17	42.33	41.33
Target (%)	53	52	50	48	47	45	44	43	42	41

**Figure 56. Higher elevation Conifer/Meadow Vegetation Type on lower Beaver Creek.**Lower Elevation Conifer/Meadow

The lower elevation conifer/meadow plant community is largely mixed conifer in the background with a narrow meadow of predominantly willows or grass next to the stream. To describe targets for this type (Table 71), we used the lodgepole pine dominated vegetation response unit 2 (VRU2) from the South Fork Clearwater TMDL as well as two willow- and willow/grass-dominated shade curves from the Alvord Lake TMDL (ODEQ 2003). The VRU2 shade curve uses a subalpine fir, lodgepole pine, and Engelmann spruce community with 10% large trees, 25% non-forest vegetation, 15% medium trees, and 50% pole-size trees. The willow community from the Trout Creek Mountains ecological province has an average canopy height of 18 feet and an average canopy density of 60%. The graminoid/willow community from the same province has an average height of 8.5 feet and

an average canopy density of 10%. An example of the lower elevation Conifer/Meadow Vegetation Type along lower Marsh Creek is shown in Figure 57.

Table 71. Shade Targets for the Marsh Creek Lower Elevation Conifer/Meadow Vegetation Type at Various Stream Widths

Low Conifer/Meadow	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m
VRU2 (IDEQ, 2004)	92	90	89	83	80	78	75	71	69	67
willow-Trout (ODEQ, 2003)	85	80	70	61	54	44	40	35	30	27
graminoid/willow-Trout (ODEQ, 2003)	39	26	18	14	10	9	7	6	5	4
Average	72	65.333	59	52.667	48	43.667	40.667	37.333	34.67	32.667
Target (%)	72	65	59	53	48	44	40	37	34	33

Low Conifer/Meadow	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m
VRU2 (IDEQ, 2004)	64	61	59	55	51	49	47	45	43	41
willow-Trout (ODEQ, 2003)	24	22	21	19	17	15	15	14	13	12
graminoid/willow-Trout (ODEQ, 2003)	3	3	2.5	2	2	2	1.5	1	1	1
Average	30.333	28.667	27.5	25.333	23.333	22	21.167	20.00	19.00	18.00
Target (%)	30	29	28	25	23	22	21	20	19	18



Figure 57. Lower elevation Conifer/Meadow Vegetation Type on lower Marsh Creek.

Meadow

Two shade curves were useful in describing shade targets for the meadow vegetation type (Table 72). Used were the tufted hairgrass meadow type from the Crooked Creek TMDL in the Salmon basin (average height is 2 feet and canopy cover is 42%) and the co-dominant mesic graminoid-willow community from the Alvord Lake TMDL (average height is 8.5 feet and density is 10%). Table 72 below shows target shade levels (%) for a 1-m through a 15-m wide stream. An example of the Meadow Vegetation Type on upper Marsh Creek is shown in Figure 58.

Table 72. Shade Targets for the Marsh Creek Meadow Vegetation Type at Various Stream Widths

Grass Meadow	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m
tufted hairgrass (IDEQ, 2002)	43	30	17	15	12	10	9	8	7	6	5	4	3	3	3
graminoid/willow-Trout (ODEQ, 2003)	39	26	18	14	10	9	7	6	5	4	3	3	2.5	2	2
Average	41	28.00	17.5	14.5	11.00	9.5	8	7	6	5	4	3.5	2.75	2.5	2.5
Target (%)	41	28	18	15	11	10	8	7	6	5	4	4	3	3	3

**Figure 58. Meadow Vegetation Type on upper Marsh Creek.*****Target Selection for Creeks in the Camas Creek Subwatershed***

The riparian vegetation along Camas Creek and associated tributaries was grouped into five general categories based on dominant shade-producing vegetation. Shade targets were developed for mixed conifer, conifer/shrub, high elevation medium shrub, low elevation medium shrub, cottonwood/shrub vegetation types.

Mixed Conifer

Shade targets for the mixed conifer vegetation type found in Camas Creek (Table 73) were designed to represent a mixed conifer community with Douglas fir, lodgepole pine and subalpine fir as the dominant constituents. Targets were developed from an average of two shade curves, the Douglas fir community in the Salmon-Chamberlain (Crooked Creek) TMDL (IDEQ 2002) and the VRU2 from the South Fork Clearwater TMDL (IDEQ 2004). The Douglas fir shade curve is based on a plant community with an average height of 83 feet and an average canopy cover of 64%. The VRU2 shade curve uses a subalpine fir, lodgepole pine, and Engelmann spruce community with 10% large trees, 25% non-forest vegetation, 15% medium trees, and 50% pole-size trees.

Table 73. Shade Targets for the Camas Creek Mixed Conifer Vegetation Type at Various Stream Widths

Mixed Conifer	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	15m	16m	17m	18m
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79	77	75	66	64	62	60
VRU2 (IDEQ, 2004)	92	90	89	85	80	75	73	71	69	63	51	49	47	45
Average	91.5	89.5	87.5	85	82	78.5	76.5	75	73	69	58.5	56.5	54.5	52.5
Target (%)	92	90	88	85	82	79	77	75	73	69	59	57	55	53

The Camas Creek conifer/meadow plant community is largely mixed conifers in the background with a narrow meadow of predominantly grass next to the stream. To describe targets for this type (Table 74) we used the VRU2 shade curve described above as well as a willow/grass-dominated shade curve from the Trout Creek Mountains ecological province that was used in the Alvord Lake TMDL (ODEQ 2003). The graminoid/willow community from the Trout Creek Mountains ecological province has an average height of 8.5 feet and an average canopy density of 10%.

Table 74. Shade Targets for the Camas Creek Mixed Conifer/Meadow Vegetation Type at Various Stream Widths

Conifer/Meadow	1m	2m	3m	4m	5m	6m	7m	8m	9m	19m	23m	25m
VRU2 (IDEQ, 2004)	92	90	89	83	80	78	75	71	69	43	38	35
graminoid/willow-Trout (ODEQ, 2003)	39	26	18	14	10	9	6	5	4	1	1	1
Average	65.5	58	53.5	48.5	45	43.5	40.5	38	36.5	22	19.5	18
Target (%)	66	58	54	49	45	44	41	38	37	22	20	18

Conifer/Shrub

The Camas Creek conifer/shrub plant community is largely conifers in the background with a narrow meadow of predominantly shrubs next to the stream. To describe targets for this type (Table 75), again, we used the VRU2 shade curve described above as well as a willow-dominated shade curve from the Alvord Lake TMDL (ODEQ 2003). The willow community from the Trout Creek Mountains ecological province has an average canopy height of 18 feet and an average canopy density of 60%.

Table 75. Shade Targets for the Camas Creek Conifer/Shrub Vegetation Type at Various Stream Widths

Conifer/Shrub	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m
VRU2 (IDEQ, 2004)	92	90	89	83	80	78	75	71	69	67	64
willow-Trout (ODEQ, 2003)	85	80	70	61	54	44	40	35	30	27	24
Average	88.5	85	79.5	72	67	61	57.5	53	49.5	47	44
Target (%)	89	85	80	72	67	61	58	53	50	47	44

Conifer/Shrub	12m	13m	14m	15m	16m	17m	18m	19m	23m	25m
VRU2 (IDEQ, 2004)	61	59	55	51	49	47	45	43	38	35
willow-Trout (ODEQ, 2003)	22	21	19	17	15	15	14	13	9	8
Average	41.5	40	37	34	32	31	29.5	28	23.5	21.5
Target (%)	42	40	37	34	32	31	30	28	24	22

High Elevation Medium Shrub

High elevation medium shrub shade targets (Table 76) are an average of three shade curves. Curves included the mountain alder type (average height is 25 feet and density is 30%) from the Willow-Whitehorse unit and the Trout unit willow/alder type (average height is 24 feet and density is 75%) communities from the Alvord Lake TMDL, and the sagebrush/bunchgrass vegetation response units (VRU 12/16) from the South Fork Clearwater TMDL (average height 8.4 feet, composition is 80% shrub and 20% grass).

Table 76. Shade Targets for the Camas Creek High Medium Shrub Vegetation Type at Various Stream Widths

High Medium Shrub	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m
mountain alder-WW (ODEQ, 2003)	91	89	85	80	72	63	60	54	50	47
willow/alder (ODEQ, 2003)	90	86	79	70	65	57	51	50	44	40
VRU12/16 (IDEQ, 2004)	87	71	45	37	33	26	23	21	19	17
Average	89.333	82	69.667	62.333	56.667	48.667	44.667	41.667	37.67	34.667
Target (%)	89	82	70	62	57	49	45	42	38	35

High Medium Shrub	11m	12m	13m	14m	15m	16m	17m	18m	19m	20m
mountain alder-WW (ODEQ, 2003)	45	42	40	39	38	36	35	34	33	32
willow/alder (ODEQ, 2003)	36	33	30	28	26	25	24	23	22	21
VRU12/16 (IDEQ, 2004)	16	14	13	12	11	10	10	10	10	9
Average	32.333	29.667	27.667	26.333	25	23.667	23	22.333	21.67	20.667
Target (%)	32	30	28	26	25	24	23	22	22	21

Low Elevation Medium Shrub

The low elevation medium shrub vegetation type (Table 77) represents willow communities of medium stature between 6 feet and 18 feet in height. We used three shade curves for target development, all from the Alvord Lake TMDL (ODEQ 2003). The willow community from the Trout Creek mountains ecological province was described above under the conifer/shrub type. The willow community from the Willow-Whitehorse ecological province had an average height of 18 feet and an average canopy density of 30%. The East Steens (ES) willow community had an average height of 20 feet and an average canopy density of 50%.

Table 77. Shade Targets for the Camas Creek Low Medium Shrub Vegetation Type at Various Stream Widths

Medium Shrub	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
willow-Whitehorse (ODEQ, 2003)	91	90	81	72	64	55	50	46	40	38	36	33	31
willow-Trout (ODEQ, 2003)	85	80	70	61	54	44	40	35	30	27	24	22	21
willow mix-ES (ODEQ, 2003)	75	70	63	55	48	41	37	32	28	25	23	20	18
Average	83.667	80	71.333	62.667	55.333	46.667	42.333	37.667	32.67	30	27.67	25	23.33
Target (%)	84	80	71	63	55	47	42	38	33	30	28	25	23

Medium Shrub	14m	15m	16m	19m	20m	21m	22m	23m	24m	25m	27m	29m
willow-Whitehorse (ODEQ, 2003)	29	27	25	23	22	22	21	21	20	20	19	18
willow-Trout (ODEQ, 2003)	19	17	15	13	12	10	9	9	8	8	7	6
willow mix-ES (ODEQ, 2003)	17	15	14	12	11	10	9	8	8	7	6	5
Average	21.667	19.667	18	16	15	14	13	12.667	12	11.67	10.67	9.67
Target (%)	22	20	18	16	15	14	13	13	12	12	11	10

Cottonwood/Shrub

Shade curves used to describe the cottonwood/shrub plant community of the middle portion of Camas Creek reflect the more open, cottonwood-dominated nature of this lower elevation plant community (Table 78). Again, three shade curves were averaged for target development. Two curves, the willow/cottonwood/aspen community and the alder/cottonwood/willow community, are from the Alvord Lake TMDL (ODEQ 2003). The willow/cottonwood/aspen community comes from the East Steens ecological province with a system potential of 25 feet average height and 65% average canopy density. The alder/cottonwood/willow community comes from the Pueblo Mountains ecological province with a system potential of 28 feet average height and 75% average canopy density. The third shade curve used in the analysis was the willow community from the Willow-Whitehorse province described above.

Table 78. Shade Targets for the Cottonwood/Shrub Vegetation Type at Various Stream Widths found in Camas Creek

Cottonwood/Shrub	20m	21m	22m
willow-Whitehorse (ODEQ, 2003)	22	22	21
willow/cottonwood/aspen-ES (ODEQ, 2003)	16	15	14
alder/cottonwood/willow-Pueblo (ODEQ, 2003)	19	18	17
Average	19	18.333	17.333
Target (%)	19	18	17

Monitoring Points

The accuracy of the aerial photo interpretations was field-verified with 45 Solar Pathfinder traces taken at six sites. The average difference between the original aerial photo interpretations and the pathfinder measurements of shade was $2\% \pm 8.1$ (mean $\pm$ 95% C.I.). Because this difference is slight, the original aerial photo interpretation was retained unchanged in this document.

Effective shade monitoring can take place on any reach throughout the Marsh Creek or Camas Creek watersheds and compared to estimates of existing shade. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with Solar Pathfinders to determine whether the existing shade level estimates are accurate and to determine progress towards meeting shade targets. It is important to note that many existing shade estimates have not been field-verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Ten equally spaced Solar Pathfinder measurements taken within a segment and averaged together should suffice to determine new shade levels in the future.

5.2 Load Capacity

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the reaches within that stream. These loads are determined by multiplying the solar load to a flat plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade, which gives the “percent open” (1 minus “percent shade”). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% (0.4) of the load hitting the flat plate collector under full sun.

The solar loading capacities used in this TMDL are based on solar load data for flat plate collectors from National Renewable Energy Laboratory (NREL) weather stations nearby. In this case, data from the Boise, Idaho station was used. The solar loads used in this TMDL are spring/summer averages, thus, we average the load for the 6-month period from April through September. These months coincide with the time of year that stream temperatures are increasing and when deciduous vegetation is in leaf. Table through Table 87 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kilowatt hours per square meter per day [kWh/m²/day] and kilowatt hours per day [kWh/day]) that serve as the loading capacities for the streams.

Marsh Creek is the largest stream examined, thus it has the largest loading capacity of the four streams in the upper watershed, at a little over 1.4 million kWh/day (Table 79). Winnemucca Creek is the smallest stream examined and has a loading capacity of 105,217 kWh/day (Table 82).

In the lower watershed, loading capacities vary from 4.3 million kWh/day on Camas Creek (Table 83) to 13,619 kWh/day on Duck Creek (Table 85).

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings “...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading.” (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presented in Table 79 through Table 87. Like loading capacities (potential loads), estimated existing loads in Table through Table are presented on an area basis (kWh/m²/day) and as a total load (kWh/day).

Existing and potential loads in kWh/day can be summed for the entire stream or portion of stream examined in a single loading table. These total loads are shown at the bottom of their respective columns in each table. The difference between potential load and existing load is also summed for the entire table. When existing load exceeds potential load, this difference

becomes the excess load to be discussed next in the load allocation section. The percent reduction shown in the lower right corner of each table represents how much total excess load there is in relation to total existing load.

Within the Upper Middle Fork Salmon River watershed, Marsh Creek has the greatest existing solar load at a little over 1.9 million kWh/day (Table 79), and Winnemucca Creek has the smallest existing load at 238,567 kWh/day (Table 82). Within the Lower Middle Fork Salmon River watershed, existing loads vary from 4.5 million kWh/day on Camas Creek (Table 83) to 19,918 kWh/day on Duck Creek (Table 85).

Table 79. Existing and Potential Solar Loads for Marsh Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Marsh Creek
3480	0.1	5.742	0.18	5.2316	-0.51	3	3	10440	59946.48	10440	54617.904	-5328.576	-8	meadow
7320	0	6.38	0.04	6.1248	-0.26	14	11	102480	653822.4	80520	493168.896	-160653.504	-4	
950	0	6.38	0.23	4.9126	-1.4674	20	15	19000	121220	14250	70004.55	-51215.45	-23	Low Conifer/Meadow
150	0.1	5.742	0.23	4.9126	-0.8294	20	15	3000	17226	2250	11053.35	-6172.65	-13	
490	0	6.38	0.23	4.9126	-1.4674	20	15	9800	62524	7350	36107.61	-26416.39	-23	
1190	0.2	5.104	0.23	4.9126	-0.1914	20	15	23800	121475.2	17850	87689.91	-33785.29	-3	
3580	0.3	4.466	0.31	4.4022	-0.0638	22	17	78760	351742.16	60860	267917.892	-83824.268	-1	Low Conifer/Meadow (+10)
680	0.3	4.466	0.3	4.466	0	23	18	15640	69848.24	12240	54663.84	-15184.4	0	
390	0.2	5.104	0.29	4.5298	-0.5742	24	19	9360	47773.44	7410	33565.818	-14207.622	-9	
460	0.3	4.466	0.29	4.5298	0.0638	24	19	11040	49304.64	8740	39590.452	-9714.188	0	
790	0.2	5.104	0.29	4.5298	-0.5742	24	19	18960	96771.84	15010	67992.298	-28779.542	-9	
200	0.3	4.466	0.29	4.5298	0.0638	24	19	4800	21436.8	3800	17213.24	-4223.56	0	
810	0.2	5.104	0.28	4.5936	-0.5104	25	20	20250	103356	16200	74416.32	-28939.68	-8	
500	0.3	4.466	0.28	4.5936	0.1276	25	20	12500	55825	10000	45936	-9889	0	
1030	0.2	5.104	0.28	4.5936	-0.5104	25	20	25750	131428	20600	94628.16	-36799.84	-8	
						Total		365,580	1,963,700	287,520	1,448,566	-515,134	-7	

Table 80. Existing and Potential Solar Loads for Knapp Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Knapp Creek
140	0.2	5.104	0.76	1.5312	-3.57	1	1	140	714.56	140	214.368	-500.192	-56	high conifer/meadow
120	0	6.38	0	6.38	0	1	1	120	765.6	120	765.6	0	0	lake
80	0.8	1.276	0.96	0.2552	-1.0208	1	1	80	102.08	80	20.416	-81.664	-16	conifer
50	0	6.38	0	6.38	0	1	1	50	319	50	319	0	0	lake
260	0.8	1.276	0.96	0.2552	-1.0208	1	1	260	331.76	260	66.352	-265.408	-16	conifer
90	0	6.38	0	6.38	0	1	1	90	574.2	90	574.2	0	0	lake
400	0.8	1.276	0.96	0.2552	-1.0208	1	1	400	510.4	400	102.08	-408.32	-16	conifer
120	0.4	3.828	0.41	3.7642	-0.0638	1	1	120	459.36	120	451.704	-7.656	-1	meadow
1200	0.8	1.276	0.96	0.2552	-1.0208	1	1	1200	1531.2	1200	306.24	-1224.96	-16	conifer
70	0.6	2.552	0.76	1.5312	-1.0208	1	1	70	178.64	70	107.184	-71.456	-16	high conifer/meadow
640	0.9	0.638	0.96	0.2552	-0.3828	1	1	640	408.32	640	163.328	-244.992	-6	conifer
290	0	6.38	0	6.38	0	1	1	290	1850.2	290	1850.2	0	0	lake
4150	0.9	0.638	0.95	0.319	-0.319	2	2	8300	5295.4	8300	2647.7	-2647.7	-5	conifer
760	0.6	2.552	0.68	2.0416	-0.5104	3	3	2280	5818.56	2280	4654.848	-1163.712	-8	high conifer/meadow
420	0.7	1.914	0.93	0.4466	-1.4674	3	3	1260	2411.64	1260	562.716	-1848.924	-23	conifer
790	0.5	3.19	0.68	2.0416	-1.1484	3	3	2370	7560.3	2370	4838.592	-2721.708	-18	high conifer/meadow
260	0.7	1.914	0.93	0.4466	-1.4674	3	3	780	1492.92	780	348.348	-1144.572	-23	conifer
470	0.4	3.828	0.68	2.0416	-1.7864	3	3	1410	5397.48	1410	2878.656	-2518.824	-28	high conifer/meadow
880	0.7	1.914	0.93	0.4466	-1.4674	3	3	2640	5052.96	2640	1179.024	-3873.936	-23	conifer
560	0.9	0.638	0.91	0.5742	-0.0638	4	4	2240	1429.12	2240	1286.208	-142.912	-1	
680	0.6	2.552	0.65	2.233	-0.319	4	4	2720	6941.44	2720	6073.76	-867.68	-5	high conifer/meadow
480	0.1	5.742	0.65	2.233	-3.509	4	4	1920	11024.64	1920	4287.36	-6737.28	-55	
1040	0.5	3.19	0.65	2.233	-0.957	4	4	4160	13270.4	4160	9289.28	-3981.12	-15	
380	0.9	0.638	0.91	0.5742	-0.0638	4	4	1520	969.76	1520	872.784	-96.976	-1	conifer
220	0.4	3.828	0.65	2.233	-1.595	4	4	880	3368.64	880	1965.04	-1403.6	-25	high conifer/meadow
340	0.9	0.638	0.91	0.5742	-0.0638	4	4	1360	867.68	1360	780.912	-86.768	-1	conifer
520	0.7	1.914	0.89	0.7018	-1.2122	5	5	2600	4976.4	2600	1824.68	-3151.72	-19	
440	0.3	4.466	0.63	2.3606	-2.1054	5	5	2200	9825.2	2200	5193.32	-4631.88	-33	high conifer/meadow
240	0.7	1.914	0.89	0.7018	-1.2122	5	5	1200	2296.8	1200	842.16	-1454.64	-19	conifer
680	0.4	3.828	0.63	2.3606	-1.4674	5	5	3400	13015.2	3400	8026.04	-4989.16	-23	high conifer/meadow
270	0.5	3.19	0.63	2.3606	-0.8294	5	5	1350	4306.5	1350	3186.81	-1119.69	-13	
410	0.2	5.104	0.63	2.3606	-2.7434	5	5	2050	10463.2	2050	4839.23	-5623.97	-43	
220	0.5	3.19	0.63	2.3606	-0.8294	5	5	1100	3509	1100	2596.66	-912.34	-13	
320	0.6	2.552	0.63	2.3606	-0.1914	5	5	1600	4083.2	1600	3776.96	-306.24	-3	
480	0.3	4.466	0.63	2.3606	-2.1054	5	5	2400	10718.4	2400	5665.44	-5052.96	-33	
170	0	6.38	0.61	2.4882	-3.8918	6	6	1020	6507.6	1020	2537.964	-3969.636	-61	
750	0.1	5.742	0.61	2.4882	-3.2538	6	6	4500	25839	4500	11196.9	-14642.1	-51	
430	0	6.38	0.61	2.4882	-3.8918	6	6	2580	16460.4	2580	6419.556	-10040.844	-61	
180	0.1	5.742	0.61	2.4882	-3.2538	6	6	1080	6201.36	1080	2687.256	-3514.104	-51	
380	0.7	1.914	0.87	0.8294	-1.0846	6	6	2280	4363.92	2280	1891.032	-2472.888	-17	conifer
270	0.5	3.19	0.61	2.4882	-0.7018	6	6	1620	5167.8	1620	4030.884	-1136.916	-11	high conifer/meadow
1070	0.4	3.828	0.61	2.4882	-1.3398	6	6	6420	24575.76	6420	15974.244	-8601.516	-21	
290	0.2	5.104	0.59	2.6158	-2.4882	7	7	2030	10361.12	2030	5310.074	-5051.046	-39	
2870	0	6.38	0.08	5.8696	-0.5104	7	7	20090	128174.2	20090	117920.264	-10253.936	-8	meadow
Total								96,820	369,491	96,820	250,525	-118,966	-20	

Table 81. Existing and Potential Solar Loads for Beaver Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Beaver Creek
1500	0.8	1.276	0.96	0.2552	-1.02	1	1	1500	1914	1500	382.8	-1531.2	-16	conifer
920	0.7	1.914	0.96	0.2552	-1.66	1	1	920	1760.88	920	234.784	-1526.096	-26	
1800	0.8	1.276	0.95	0.319	-0.96	2	2	3600	4593.6	3600	1148.4	-3445.2	-15	
870	0.6	2.552	0.93	0.4466	-2.11	3	3	2610	6660.72	2610	1165.626	-5495.094	-33	
1220	0.7	1.914	0.93	0.4466	-1.47	3	3	3660	7005.24	3660	1634.556	-5370.684	-23	
450	0.6	2.552	0.91	0.5742	-1.98	4	4	1800	4593.6	1800	1033.56	-3560.04	-31	
250	0.5	3.19	0.91	0.5742	-2.62	4	4	1000	3190	1000	574.2	-2615.8	-41	
880	0.8	1.276	0.91	0.5742	-0.70	4	4	3520	4491.52	3520	2021.184	-2470.336	-11	
520	0.6	2.552	0.89	0.7018	-1.85	5	5	2600	6635.2	2600	1824.68	-4810.52	-29	
230	0.2	5.104	0.11	5.6782	0.57	5	5	1150	5869.6	1150	6529.93	660.33	0	meadow
300	0.8	1.276	0.89	0.7018	-0.57	5	5	1500	1914	1500	1052.7	-861.3	-9	conifer
280	0.7	1.914	0.89	0.7018	-1.21	5	5	1400	2679.6	1400	982.52	-1697.08	-19	
210	0.8	1.276	0.89	0.7018	-0.57	5	5	1050	1339.8	1050	736.89	-602.91	-9	
160	0.1	5.742	0.11	5.6782	-0.06	5	5	800	4593.6	800	4542.56	-51.04	-1	meadow
70	0.6	2.552	0.87	0.8294	-1.72	6	6	420	1071.84	420	348.348	-723.492	-27	conifer
210	0.7	1.914	0.87	0.8294	-1.08	6	6	1260	2411.64	1260	1045.044	-1366.596	-17	
730	0.8	1.276	0.87	0.8294	-0.4466	6	6	4380	5588.88	4380	3632.772	-1956.108	-7	
1730	0.7	1.914	0.86	0.8932	-1.0208	7	7	12110	23178.54	12110	10816.652	-12361.888	-16	
650	0.6	2.552	0.84	1.0208	-1.5312	8	8	5200	13270.4	5200	5308.16	-7962.24	-24	
320	0.4	3.828	0.58	2.6796	-1.1484	8	8	2560	9799.68	2560	6859.776	-2939.904	-18	high conifer/meadow
290	0.5	3.19	0.58	2.6796	-0.5104	8	8	2320	7400.8	2320	6216.672	-1184.128	-8	
290	0.4	3.828	0.56	2.8072	-1.0208	9	9	2610	9991.08	2610	7326.792	-2664.288	-16	
790	0.2	5.104	0.56	2.8072	-2.2968	10	9	7900	40321.6	7110	19959.192	-20362.408	-36	
530	0.1	5.742	0.56	2.8072	-2.9348	10	9	5300	30432.6	4770	13390.344	-17042.256	-46	
360	0.2	5.104	0.56	2.8072	-2.2968	11	9	3960	20211.84	3240	9095.328	-11116.512	-36	
580	0.1	5.742	0.56	2.8072	-2.9348	11	9	6380	36633.96	5220	14653.584	-21980.376	-46	
510	0	6.38	0.55	2.871	-3.509	11	10	5610	35791.8	5100	14642.1	-21149.7	-55	
130	0.1	5.742	0.55	2.871	-2.871	12	10	1560	8957.52	1300	3732.3	-5225.22	-45	
670	0.2	5.104	0.8	1.276	-3.828	12	10	8040	41036.16	6700	8549.2	-32486.96	-60	conifer
130	0	6.38	0.55	2.871	-3.509	12	10	1560	9952.8	1300	3732.3	-6220.5	-55	high conifer/meadow
230	0.1	5.742	0.55	2.871	-2.871	12	10	2760	15847.92	2300	6603.3	-9244.62	-45	
160	0.2	5.104	0.8	1.276	-3.828	13	10	2080	10616.32	1600	2041.6	-8574.72	-60	conifer
240	0.1	5.742	0.55	2.871	-2.871	13	10	3120	17915.04	2400	6890.4	-11024.64	-45	high conifer/meadow
540	0.2	5.104	0.53	2.9986	-2.1054	13	11	7020	35830.08	5940	17811.684	-18018.396	-33	
190	0.1	5.742	0.53	2.9986	-2.7434	13	11	2470	14182.74	2090	6267.074	-7915.666	-43	
610	0.2	5.104	0.53	2.9986	-2.1054	14	11	8540	43588.16	6710	20120.606	-23467.554	-33	
290	0.1	5.742	0.53	2.9986	-2.7434	14	11	4060	23312.52	3190	9565.534	-13746.986	-43	
390	0	6.38	0.53	2.9986	-3.3814	15	11	5850	37323	4290	12863.994	-24459.006	-53	
290	0.1	5.742	0.53	2.9986	-2.7434	15	11	4350	24977.7	3190	9565.534	-15412.166	-43	
200	0.2	5.104	0.52	3.0624	-2.0416	15	12	3000	15312	2400	7349.76	-7962.24	-32	
1760	0.1	5.742	0.52	3.0624	-2.6796	16	12	28160	161694.72	21120	64677.888	-97016.832	-42	
490	0	6.38	0.52	3.0624	-3.3176	17	12	8330	53145.4	5880	18006.912	-35138.488	-52	
1020	0.1	5.742	0.5	3.19	-2.552	17	13	17340	99566.28	13260	42299.4	-57266.88	-40	
540	0	6.38	0.03	6.1886	-0.1914	18	13	9720	62013.6	7020	43443.972	-18569.628	-3	meadow
290	0.1	5.742	0.5	3.19	-2.552	18	13	5220	29973.24	3770	12026.3	-17946.94	-40	high conifer/meadow
790	0.2	5.104	0.48	3.3176	-1.7864	18	14	14220	72578.88	11060	36692.656	-35886.224	-28	
370	0.1	5.742	0.48	3.3176	-2.4244	19	14	7030	40366.26	5180	17185.168	-23181.092	-38	
470	0	6.38	0.48	3.3176	-3.0624	19	14	8930	56973.4	6580	21829.808	-35143.592	-48	
790	0.1	5.742	0.48	3.3176	-2.4244	20	14	15800	90723.6	11060	36692.656	-54030.944	-38	
190	0.2	5.104	0.71	1.8502	-3.2538	20	14	3800	19395.2	2660	4921.532	-14473.668	-51	conifer
Total								260,080	1,278,629	214,410	550,029	-728,600	-32	

Table 82. Existing and Potential Solar Loads for Winnemucca Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Winnemucca Creek
1250	0.8	1.254	0.96	0.2508	-1.00	2	1	2500	3135	1250	313.5	-2821.5	-16	conifer
590	0.9	0.627	0.95	0.3135	-0.3135	4	2	2360	1479.72	1180	369.93	-1109.79	-5	
2330	0.8	1.254	0.9	0.627	-0.627	7	4	16310	20452.74	9320	5843.64	-14609.1	-10	
640	0.5	3.135	0.61	2.4453	-0.6897	9	5	5760	18057.6	3200	7824.96	-10232.64	-11	high conifer/meadow
1210	0.8	1.254	0.83	1.0659	-0.1881	10	7	12100	15173.4	8470	9028.173	-6145.227	-3	conifer
710	0.6	2.508	0.57	2.6961	0.1881	10	7	7100	17806.8	4970	13399.617	-4407.183	3	high conifer/meadow
280	0.5	3.135	0.57	2.6961	-0.4389	11	7	3080	9655.8	1960	5284.356	-4371.444	-7	
610	0.7	1.881	0.83	1.0659	-0.8151	11	7	6710	12621.51	4270	4551.393	-8070.117	-13	conifer
200	0.5	3.135	0.57	2.6961	-0.4389	11	7	2200	6897	1400	3774.54	-3122.46	-7	high conifer/meadow
360	0.7	1.881	0.83	1.0659	-0.8151	11	7	3960	7448.76	2520	2686.068	-4762.692	-13	conifer
690	0.4	3.762	0.55	2.8215	-0.9405	11	8	7590	28553.58	5520	15574.68	-12978.9	-15	high conifer/meadow
170	0.2	5.016	0.55	2.8215	-2.1945	12	8	2040	10232.64	1360	3837.24	-6395.4	-35	
550	0.3	4.389	0.55	2.8215	-1.5675	12	8	6600	28967.4	4400	12414.6	-16552.8	-25	
1450	0.6	2.508	0.82	1.1286	-1.3794	12	8	17400	43639.2	11600	13091.76	-30547.44	-22	conifer
320	0.4	3.762	0.55	2.8215	-0.9405	12	8	3840	14446.08	2560	7223.04	-7223.04	-15	high conifer/meadow
						Total		99,550	238,567	63,980	105,217	-133,350	-13	

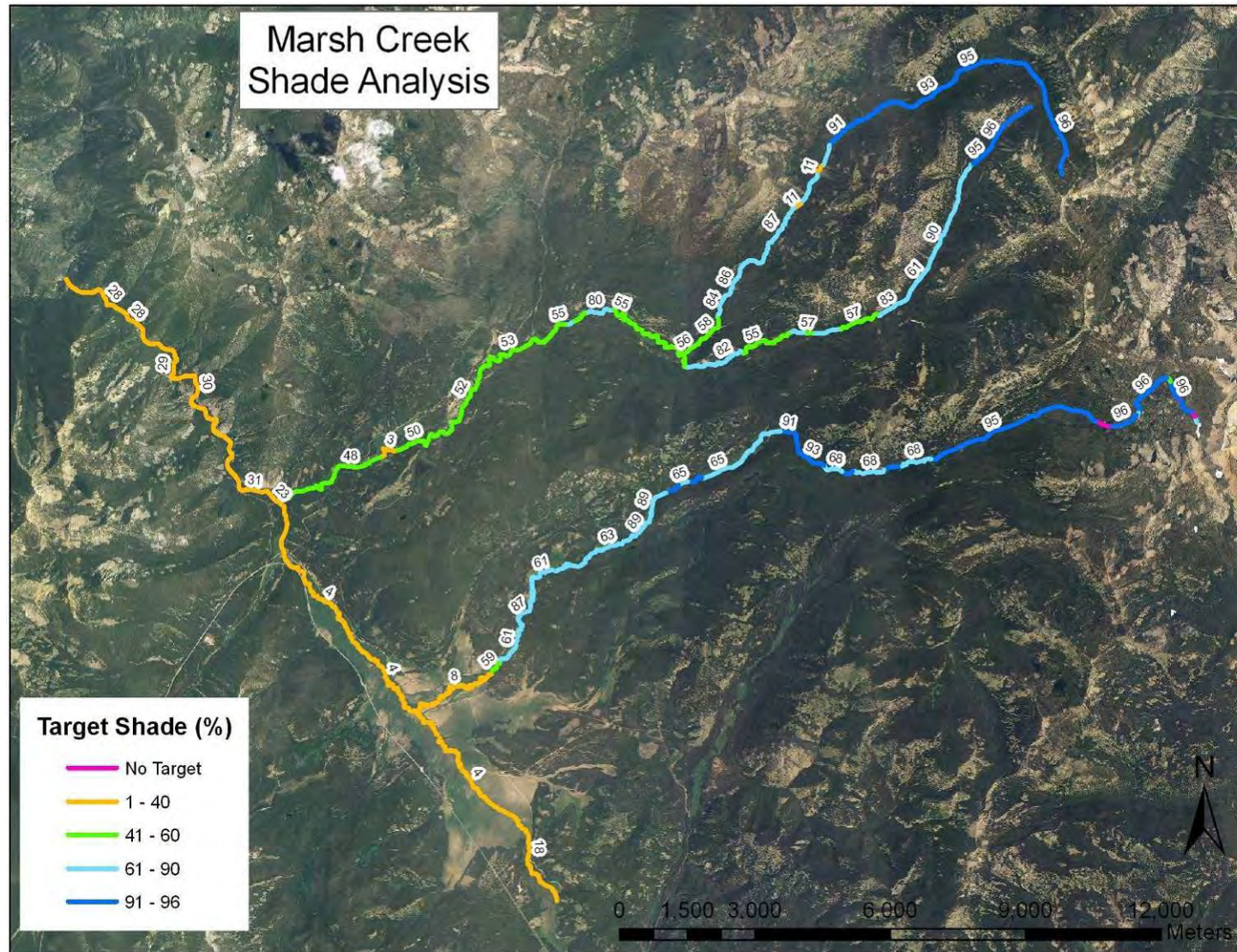


Figure 59. Target Shade for Marsh Creek.

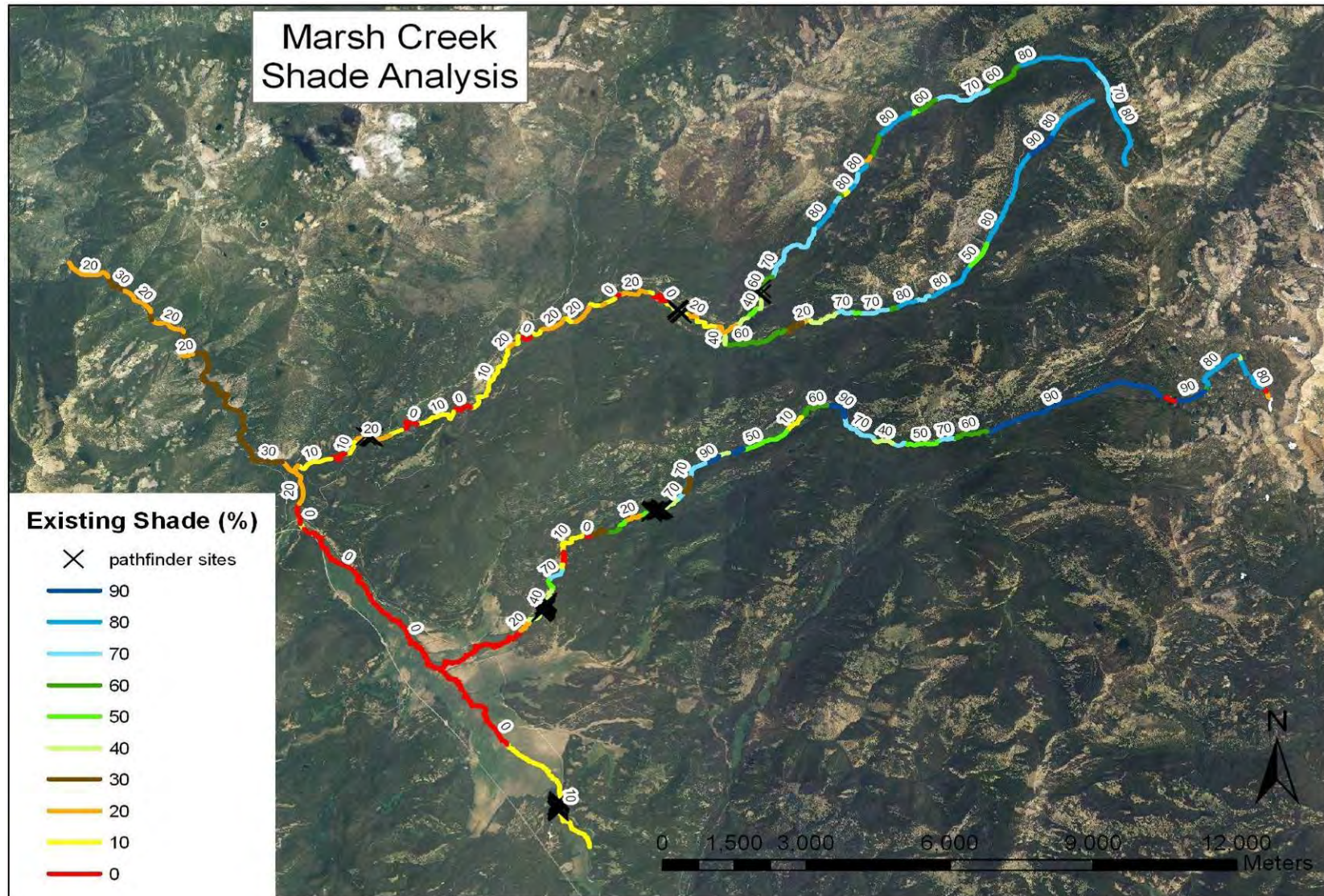


Figure 60. Existing Cover Estimated for Marsh Creek by Aerial Photo Interpretation.

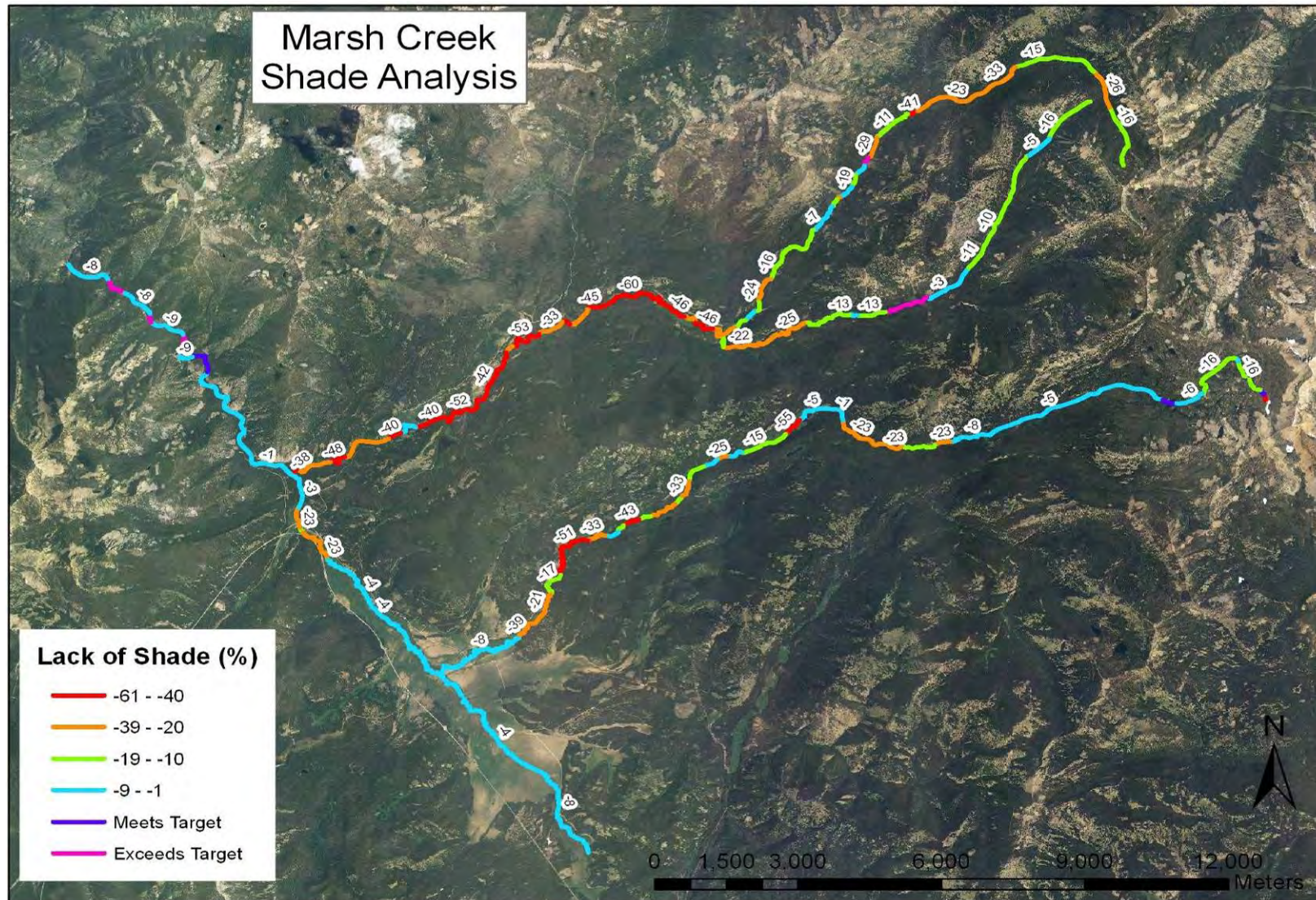


Figure 61. Lack of Shade (Difference Between Existing and Target) for Marsh Creek.

Table 83. Existing and Potential Solar Loads for Camas Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Camas Creek
360	0.8	1.276	0.92	0.5104	-0.77	1	1	360	459.36	360	183.744	-275.616	-12	conifer
830	0.4	3.828	0.66	2.1692	-1.6588	1	1	830	3177.24	830	1800.436	-1376.804	-26	conifer/meadow
310	0.5	3.19	0.58	2.6796	-0.5104	2	2	620	1977.8	620	1661.352	-316.448	-8	
560	0.8	1.276	0.9	0.638	-0.638	2	2	1120	1429.12	1120	714.56	-714.56	-10	conifer
400	0.8	1.276	0.88	0.7656	-0.5104	3	3	1200	1531.2	1200	918.72	-612.48	-8	
510	0.7	1.914	0.8	1.276	-0.638	3	3	1530	2928.42	1530	1952.28	-976.14	-10	conifer/shrub
380	0.8	1.276	0.85	0.957	-0.319	4	4	1520	1939.52	1520	1454.64	-484.88	-5	conifer
800	0.7	1.914	0.85	0.957	-0.957	4	4	3200	6124.8	3200	3062.4	-3062.4	-15	
180	0.6	2.552	0.72	1.7864	-0.7656	4	4	720	1837.44	720	1286.208	-551.232	-12	conifer/shrub
1360	0.7	1.914	0.82	1.1484	-0.7656	5	5	6800	13015.2	6800	7809.12	-5206.08	-12	conifer
190	0.6	2.552	0.67	2.1054	-0.4466	5	5	950	2424.4	950	2000.13	-424.27	-7	conifer/shrub
1460	0.7	1.914	0.61	2.4882	0.5742	6	6	8760	16766.64	8760	21796.632	5029.992	0	
220	0.8	1.276	0.77	1.4674	0.1914	7	7	1540	1965.04	1540	2259.796	294.756	0	conifer
410	0.6	2.552	0.58	2.6796	0.1276	7	7	2870	7324.24	2870	7690.452	366.212	0	conifer/shrub
590	0.7	1.914	0.58	2.6796	0.7656	7	7	4130	7904.82	4130	11066.748	3161.928	0	
1580	0.4	3.828	0.42	3.7004	-0.1276	8	8	12640	48385.92	12640	46773.056	-1612.864	-2	high medium shrub
200	0.5	3.19	0.5	3.19	0	9	9	1800	5742	1800	5742	0	0	conifer/shrub
480	0.3	4.466	0.38	3.9556	-0.5104	9	9	4320	19293.12	4320	17088.192	-2204.928	-8	high medium shrub
90	0.5	3.19	0.5	3.19	0	9	9	810	2583.9	810	2583.9	0	0	conifer/shrub
290	0.4	3.828	0.47	3.3814	-0.4466	10	10	2900	11101.2	2900	9806.06	-1295.14	-7	
210	0.6	2.552	0.69	1.9778	-0.5742	10	10	2100	5359.2	2100	4153.38	-1205.82	-9	conifer
740	0.3	4.466	0.35	4.147	-0.319	10	10	7400	33048.4	7400	30687.8	-2360.6	-5	high medium shrub
190	0.4	3.828	0.32	4.3384	0.5104	11	11	2090	8000.52	2090	9067.256	1066.736	0	
510	0.3	4.466	0.32	4.3384	-0.1276	11	11	5610	25054.26	5610	24338.424	-715.836	-2	
540	0.5	3.19	0.44	3.5728	0.3828	11	11	5940	18948.6	5940	21222.432	2273.832	0	conifer/shrub
430	0.4	3.828	0.42	3.7004	-0.1276	12	12	5160	19752.48	5160	19094.064	-658.416	-2	
230	0.5	3.19	0.42	3.7004	0.5104	12	12	2760	8804.4	2760	10213.104	1408.704	0	
710	0.4	3.828	0.42	3.7004	-0.1276	12	12	8520	32614.56	8520	31527.408	-1087.152	-2	
1290	0.3	4.466	0.4	3.828	-0.638	13	13	16770	74894.82	16770	64195.56	-10699.26	-10	
350	0.4	3.828	0.4	3.828	0	13	13	4550	17417.4	4550	17417.4	0	0	
730	0.3	4.466	0.37	4.0194	-0.4466	14	14	10220	45642.52	10220	41078.268	-4564.252	-7	
780	0.2	5.104	0.37	4.0194	-1.0846	14	14	10920	55735.68	10920	43891.848	-11843.832	-17	
330	0.3	4.466	0.34	4.2108	-0.2552	15	15	4950	22106.7	4950	20843.46	-1263.24	-4	
1090	0.4	3.828	0.59	2.6158	-1.2122	15	15	16350	62587.8	16350	42768.33	-19819.47	-19	conifer
490	0.3	4.466	0.32	4.3384	-0.1276	16	16	7840	35013.44	7840	34013.056	-1000.384	-2	conifer/shrub
700	0.4	3.828	0.57	2.7434	-1.0846	16	16	11200	42873.6	11200	30726.08	-12147.52	-17	conifer
510	0.2	5.104	0.31	4.4022	-0.7018	17	17	8670	44251.68	8670	38167.074	-6084.606	-11	conifer/shrub
780	0.3	4.466	0.55	2.871	-1.595	17	17	13260	59219.16	13260	38069.46	-21149.7	-25	conifer
3720	0.4	3.828	0.53	2.9986	-0.8294	18	18	66960	256322.88	66960	200786.256	-55536.624	-13	
2360	0.2	5.104	0.28	4.5936	-0.5104	19	19	44840	228863.36	44840	205977.024	-22886.336	-8	conifer/shrub
460	0.1	5.742	0.22	4.9764	-0.7656	19	19	8740	50185.08	8740	43493.736	-6691.344	-12	high medium shrub
600	0.2	5.104	0.21	5.0402	-0.0638	20	20	12000	61248	12000	60482.4	-765.6	-1	
320	0.1	5.742	0.21	5.0402	-0.7018	20	20	6400	36748.8	6400	32257.28	-4491.52	-11	
820	0.2	5.104	0.19	5.1678	0.0638	20	20	16400	83705.6	16400	84751.92	1046.32	0	cottonwood/shrub
2040	0.1	5.742	0.19	5.1678	-0.5742	20	20	40800	234273.6	40800	210846.24	-23427.36	-9	
420	0.2	5.104	0.18	5.2316	0.1276	21	21	8820	45017.28	8820	46142.712	1125.432	0	
740	0.1	5.742	0.18	5.2316	-0.5104	21	21	15540	89230.68	15540	81299.064	-7931.616	-8	
290	0.2	5.104	0.18	5.2316	0.1276	21	21	6090	31083.36	6090	31860.444	777.084	0	
250	0.1	5.742	0.18	5.2316	-0.5104	21	21	5250	30145.5	5250	27465.9	-2679.6	-8	
2820	0.2	5.104	0.17	5.2954	0.1914	22	22	62040	316652.16	62040	328526.616	11874.456	0	
800	0.2	5.104	0.13	5.5506	0.4466	22	22	17600	89830.4	17600	97690.56	7860.16	0	low medium shrub
1010	0.1	5.742	0.13	5.5506	-0.1914	23	23	23230	133386.66	23230	128940.438	-4446.222	-3	
690	0.2	5.104	0.24	4.8488	-0.2552	23	23	15870	81000.48	15870	76950.456	-4050.024	-4	conifer/shrub
2640	0.1	5.742	0.12	5.6144	-0.1276	24	24	63360	363813.12	63360	355728.384	-8084.736	-2	low medium shrub
1500	0.2	5.104	0.22	4.9764	-0.1276	25	25	37500	191400	37500	186615	-4785	-2	conifer/shrub
450	0.2	5.104	0.12	5.6144	0.5104	25	25	11250	57420	11250	63162	5742	0	low medium shrub
8480	0.1	5.742	0.11	5.6782	-0.0638	27	27	228960	1314688.32	228960	1300080.672	-14607.648	-1	
420	0	6.38	0.1	5.742	-0.638	29	29	12180	77708.4	12180	69937.56	-7770.84	-10	
Total								906,760	4,541,960	906,760	4,302,119	-239,841	-6	

Table 84. Existing and Potential Solar Loads for Castle Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Castle Creek
300	0.8	1.276	0.92	0.5104	-0.77	1	1	300	382.8	300	153.12	-229.68	-12	conifer
350	0.6	2.552	0.66	2.1692	-0.3828	1	1	350	893.2	350	759.22	-133.98	-6	conifer/meadow
790	0.9	0.638	0.9	0.638	0	2	2	1580	1008.04	1580	1008.04	0	0	conifer
430	0.7	1.914	0.9	0.638	-1.276	2	2	860	1646.04	860	548.68	-1097.36	-20	
3840	0.9	0.638	0.88	0.7656	0.1276	3	3	11520	7349.76	11520	8819.712	1469.952	0	
1880	0.8	1.276	0.72	1.7864	0.5104	4	4	7520	9595.52	7520	13433.728	3838.208	0	conifer/shrub
220	0.6	2.552	0.67	2.1054	-0.4466	5	5	1100	2807.2	1100	2315.94	-491.26	-7	
110	0.2	5.104	0.57	2.7434	-2.3606	5	5	550	2807.2	550	1508.87	-1298.33	-37	high medium shrub
1640	0.5	3.19	0.61	2.4882	-0.7018	6	6	9840	31389.6	9840	24483.888	-6905.712	-11	conifer/shrub
1420	0.6	2.552	0.58	2.6796	0.1276	7	7	9940	25366.88	9940	26635.224	1268.344	0	
430	0.4	3.828	0.53	2.9986	-0.8294	8	8	3440	13168.32	3440	10315.184	-2853.136	-13	
410	0.5	3.19	0.53	2.9986	-0.1914	8	8	3280	10463.2	3280	9835.408	-627.792	-3	
500	0.4	3.828	0.5	3.19	-0.638	9	9	4500	17226	4500	14355	-2871	-10	
380	0.5	3.19	0.5	3.19	0	9	9	3420	10909.8	3420	10909.8	0	0	
2370	0.4	3.828	0.47	3.3814	-0.4466	10	10	23700	90723.6	23700	80139.18	-10584.42	-7	
						Total		81,900	225,737	81,900	205,221	-20,516	-8	

Table 85. Existing and Potential Solar Loads for Duck Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Duck Creek
370	0.6	2.552	0.66	2.1692	-0.38	1	1	370	944.24	370	802.604	-141.636	-6	conifer/meadow
430	0.8	1.276	0.92	0.5104	-0.7656	1	1	430	548.68	430	219.472	-329.208	-12	conifer
1480	0.9	0.638	0.92	0.5104	-0.1276	1	1	1480	944.24	1480	755.392	-188.848	-2	
1480	0.9	0.638	0.9	0.638	0	2	2	2960	1888.48	2960	1888.48	0	0	
1460	0.8	1.276	0.85	0.957	-0.319	2	2	2920	3725.92	2920	2794.44	-931.48	-5	conifer/shrub
170	0.6	2.552	0.8	1.276	-1.276	3	3	510	1301.52	510	650.76	-650.76	-20	
1280	0.7	1.914	0.8	1.276	-0.638	3	3	3840	7349.76	3840	4899.84	-2449.92	-10	
420	0.6	2.552	0.8	1.276	-1.276	3	3	1260	3215.52	1260	1607.76	-1607.76	-20	
						Total		13,770	19,918	13,770	13,619	-6,300	-9	

Table 86. Existing and Potential Solar Loads for Silver Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Silver Creek
4080	0.9	0.638	0.92	0.5104	-0.13	1	1	4080	2603.04	4080	2082.432	-520.608	-2	conifer
1130	0.8	1.276	0.92	0.5104	-0.7656	1	1	1130	1441.88	1130	576.752	-865.128	-12	
420	0.7	1.914	0.85	0.957	-0.957	2	2	840	1607.76	840	803.88	-803.88	-15	conifer/shrub
330	0.6	2.552	0.85	0.957	-1.595	2	2	660	1684.32	660	631.62	-1052.7	-25	
930	0.8	1.276	0.9	0.638	-0.638	2	2	1860	2373.36	1860	1186.68	-1186.68	-10	conifer
90	0.7	1.914	0.9	0.638	-1.276	2	2	180	344.52	180	114.84	-229.68	-20	
740	0.8	1.276	0.9	0.638	-0.638	2	2	1480	1888.48	1480	944.24	-944.24	-10	
610	0.7	1.914	0.85	0.957	-0.957	2	2	1220	2335.08	1220	1167.54	-1167.54	-15	
160	0.8	1.276	0.9	0.638	-0.638	2	2	320	408.32	320	204.16	-204.16	-10	
140	0.7	1.914	0.9	0.638	-1.276	2	2	280	535.92	280	178.64	-357.28	-20	
390	0.8	1.276	0.9	0.638	-0.638	2	2	780	995.28	780	497.64	-497.64	-10	
200	0.7	1.914	0.85	0.957	-0.957	2	2	400	765.6	400	382.8	-382.8	-15	
470	0.8	1.276	0.88	0.7656	-0.5104	3	3	1410	1799.16	1410	1079.496	-719.664	-8	
170	0.6	2.552	0.8	1.276	-1.276	3	3	510	1301.52	510	650.76	-650.76	-20	conifer/shrub
1060	0.7	1.914	0.8	1.276	-0.638	3	3	3180	6086.52	3180	4057.68	-2028.84	-10	
150	0.4	3.828	0.8	1.276	-2.552	3	3	450	1722.6	450	574.2	-1148.4	-40	
90	0.6	2.552	0.8	1.276	-1.276	3	3	270	689.04	270	344.52	-344.52	-20	
1150	0.8	1.276	0.88	0.7656	-0.5104	3	3	3450	4402.2	3450	2641.32	-1760.88	-8	conifer
1480	0.7	1.914	0.85	0.957	-0.957	4	4	5920	11330.88	5920	5665.44	-5665.44	-15	
1830	0.6	2.552	0.72	1.7864	-0.7656	4	4	7320	18680.64	7320	13076.448	-5604.192	-12	conifer/shrub
270	0.5	3.19	0.72	1.7864	-1.4036	4	4	1080	3445.2	1080	1929.312	-1515.888	-22	
2250	0.6	2.552	0.67	2.1054	-0.4466	5	5	11250	28710	11250	23685.75	-5024.25	-7	
690	0.5	3.19	0.67	2.1054	-1.0846	5	5	3450	11005.5	3450	7263.63	-3741.87	-17	
560	0.6	2.552	0.67	2.1054	-0.4466	5	5	2800	7145.6	2800	5895.12	-1250.48	-7	
240	0.5	3.19	0.67	2.1054	-1.0846	5	5	1200	3828	1200	2526.48	-1301.52	-17	
1000	0.7	1.914	0.82	1.1484	-0.7656	5	5	5000	9570	5000	5742	-3828	-12	conifer
100	0.6	2.552	0.61	2.4882	-0.0638	6	6	600	1531.2	600	1492.92	-38.28	-1	conifer/shrub
1070	0.4	3.828	0.49	3.2538	-0.5742	6	6	6420	24575.76	6420	20889.396	-3686.364	-9	high medium shrub
900	0.5	3.19	0.61	2.4882	-0.7018	6	6	5400	17226	5400	13436.28	-3789.72	-11	conifer/shrub
80	0.2	5.104	0.49	3.2538	-1.8502	6	6	480	2449.92	480	1561.824	-888.096	-29	high medium shrub
400	0	6.38	0.49	3.2538	-3.1262	6	6	2400	15312	2400	7809.12	-7502.88	-49	
560	0.5	3.19	0.61	2.4882	-0.7018	6	6	3360	10718.4	3360	8360.352	-2358.048	-11	conifer/shrub
450	0.4	3.828	0.49	3.2538	-0.5742	6	6	2700	10335.6	2700	8785.26	-1550.34	-9	high medium shrub
240	0.6	2.552	0.61	2.4882	-0.0638	6	6	1440	3674.88	1440	3583.008	-91.872	-1	conifer/shrub
1210	0.4	3.828	0.45	3.509	-0.319	7	7	8470	32423.16	8470	29721.23	-2701.93	-5	high medium shrub
450	0.5	3.19	0.58	2.6796	-0.5104	7	7	3150	10048.5	3150	8440.74	-1607.76	-8	conifer/shrub
330	0.4	3.828	0.45	3.509	-0.319	7	7	2310	8842.68	2310	8105.79	-736.89	-5	high medium shrub
320	0.5	3.19	0.58	2.6796	-0.5104	7	7	2240	7145.6	2240	6002.304	-1143.296	-8	conifer/shrub
1430	0.4	3.828	0.45	3.509	-0.319	7	7	10010	38318.28	10010	35125.09	-3193.19	-5	high medium shrub
510	0.3	4.466	0.45	3.509	-0.957	7	7	3570	15943.62	3570	12527.13	-3416.49	-15	
300	0.2	5.104	0.45	3.509	-1.595	7	7	2100	10718.4	2100	7368.9	-3349.5	-25	
230	0.3	4.466	0.45	3.509	-0.957	7	7	1610	7190.26	1610	5649.49	-1540.77	-15	
						Total		116,780	343,155	116,780	262,762	-80,392	-14	

Table 87. Existing and Potential Solar Loads for Yellowjacket Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Yellowjacket Creek
1380	0.9	0.638	0.92	0.5104	-0.13	1	1	1380	880.44	1380	704.352	-176.088	-2	conifer
80	0.6	2.552	0.58	2.6796	0.1276	2	2	160	408.32	160	428.736	20.416	0	conifer/meadow
50	0.9	0.638	0.9	0.638	0	2	2	100	63.8	100	63.8	0	0	conifer
50	0.6	2.552	0.58	2.6796	0.1276	2	2	100	255.2	100	267.96	12.76	0	conifer/meadow
360	0.8	1.276	0.9	0.638	-0.638	2	2	720	918.72	720	459.36	-459.36	-10	conifer
3470	0.9	0.638	0.88	0.7656	0.1276	3	3	10410	6641.58	10410	7969.896	1328.316	0	
420	0.8	1.276	0.85	0.957	-0.319	4	4	1680	2143.68	1680	1607.76	-535.92	-5	
3730	0.9	0.638	0.82	1.1484	0.5104	5	5	18650	11898.7	18650	21417.66	9518.96	0	
4830	0.8	1.276	0.79	1.3398	0.0638	6	6	28980	36978.48	28980	38827.404	1848.924	0	
1280	0.6	2.552	0.58	2.6796	0.1276	7	7	8960	22865.92	8960	24009.216	1143.296	0	conifer/shrub
590	0.4	3.828	0.42	3.7004	-0.1276	8	8	4720	18068.16	4720	17465.888	-602.272	-2	high medium shrub
270	0.3	4.466	0.42	3.7004	-0.7656	8	8	2160	9646.56	2160	7992.864	-1653.696	-12	
1670	0.1	5.742	0.42	3.7004	-2.0416	8	8	13360	76713.12	13360	49437.344	-27275.776	-32	
410	0.3	4.466	0.42	3.7004	-0.7656	8	8	3280	14648.48	3280	12137.312	-2511.168	-12	
430	0.5	3.19	0.53	2.9986	-0.1914	8	8	3440	10973.6	3440	10315.184	-658.416	-3	conifer/shrub
930	0.6	2.552	0.5	3.19	0.638	9	9	8370	21360.24	8370	26700.3	5340.06	0	
800	0.4	3.828	0.38	3.9556	0.1276	9	9	7200	27561.6	7200	28480.32	918.72	0	high medium shrub
240	0.2	5.104	0.38	3.9556	-1.1484	9	9	2160	11024.64	2160	8544.096	-2480.544	-18	
310	0.4	3.828	0.38	3.9556	0.1276	9	9	2790	10680.12	2790	11036.124	356.004	0	
680	0.2	5.104	0.38	3.9556	-1.1484	9	9	6120	31236.48	6120	24208.272	-7028.208	-18	
370	0.3	4.466	0.38	3.9556	-0.5104	9	9	3330	14871.78	3330	13172.148	-1699.632	-8	
810	0.5	3.19	0.5	3.19	0	9	9	7290	23255.1	7290	23255.1	0	0	conifer/shrub
700	0.4	3.828	0.35	4.147	0.319	10	10	7000	26796	7000	29029	2233	0	high medium shrub
260	0.5	3.19	0.47	3.3814	0.1914	10	10	2600	8294	2600	8791.64	497.64	0	conifer/shrub
380	0.4	3.828	0.35	4.147	0.319	10	10	3800	14546.4	3800	15758.6	1212.2	0	high medium shrub
680	0.3	4.466	0.35	4.147	-0.319	10	10	6800	30368.8	6800	28199.6	-2169.2	-5	
510	0.5	3.19	0.47	3.3814	0.1914	10	10	5100	16269	5100	17245.14	976.14	0	conifer/shrub
1630	0.4	3.828	0.47	3.3814	-0.4466	10	10	16300	62396.4	16300	55116.82	-7279.58	-7	
420	0.3	4.466	0.32	4.3384	-0.1276	11	11	4620	20632.92	4620	20043.408	-589.512	-2	high medium shrub
310	0.2	5.104	0.32	4.3384	-0.7656	11	11	3410	17404.64	3410	14793.944	-2610.696	-12	
620	0.3	4.466	0.32	4.3384	-0.1276	11	11	6820	30458.12	6820	29587.888	-870.232	-2	
1890	0.3	4.466	0.3	4.466	0	12	12	22680	101288.88	22680	101288.88	0	0	
720	0.4	3.828	0.38	3.9556	0.1276	12	12	8640	33073.92	8640	34176.384	1102.464	0	conifer/shrub
620	0.3	4.466	0.28	4.5936	0.1276	13	13	8060	35995.96	8060	37024.416	1028.456	0	high medium shrub
180	0.1	5.742	0.28	4.5936	-1.1484	13	13	2340	13436.28	2340	10749.024	-2687.256	-18	
250	0.2	5.104	0.28	4.5936	-0.5104	13	13	3250	16588	3250	14929.2	-1658.8	-8	
940	0.3	4.466	0.28	4.5936	0.1276	13	13	12220	54574.52	12220	56133.792	1559.272	0	
150	0.2	5.104	0.26	4.7212	-0.3828	14	14	2100	10718.4	2100	9914.52	-803.88	-6	
250	0.1	5.742	0.26	4.7212	-1.0208	14	14	3500	20097	3500	16524.2	-3572.8	-16	
270	0.2	5.104	0.26	4.7212	-0.3828	14	14	3780	19293.12	3780	17846.136	-1446.984	-6	
2540	0.3	4.466	0.25	4.785	0.319	15	15	38100	170154.6	38100	182308.5	12153.9	0	
Total								296,480	1,055,482	296,480	1,027,962	-27,519	-5	

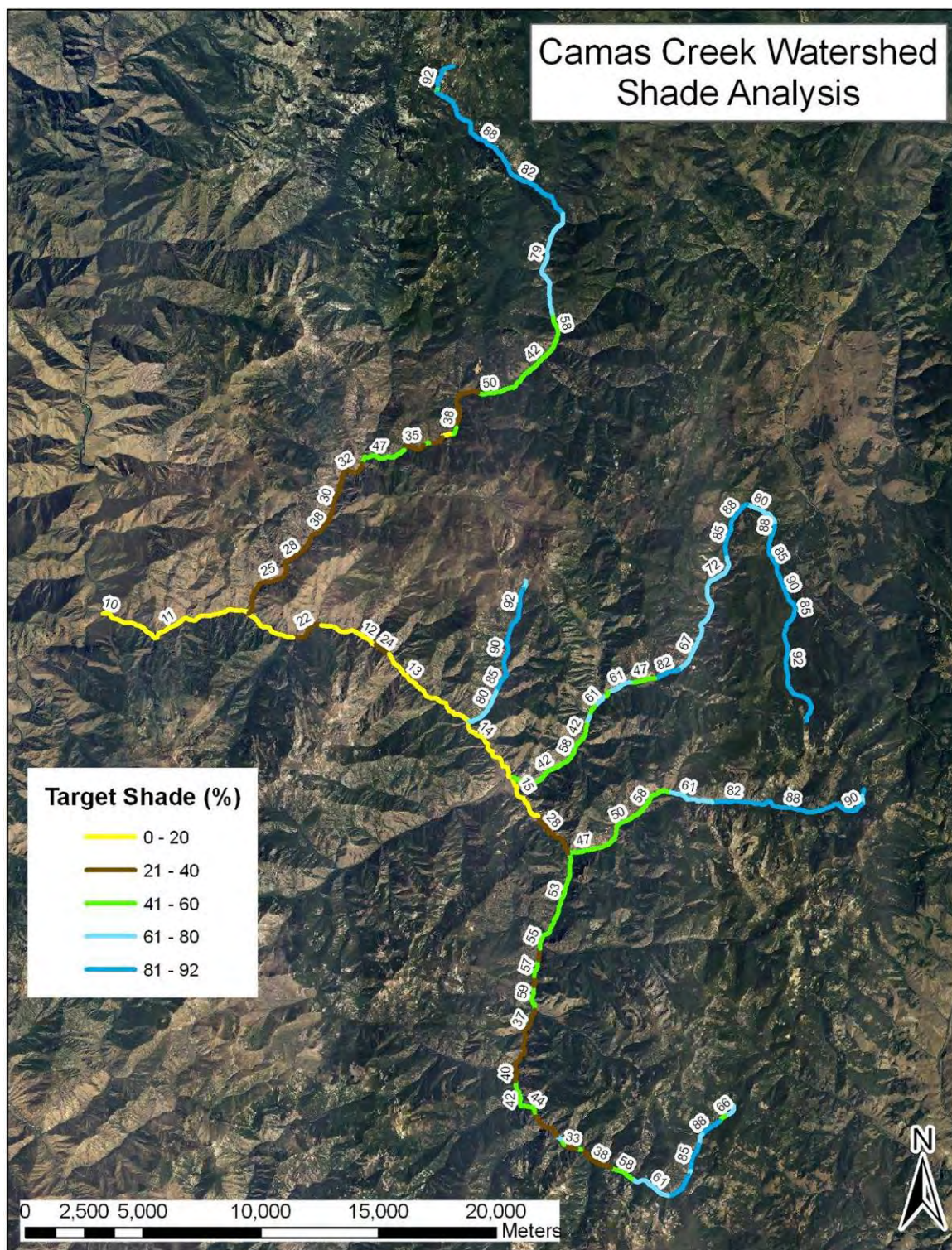


Figure 62. Target Shade for the Camas Creek Watershed.

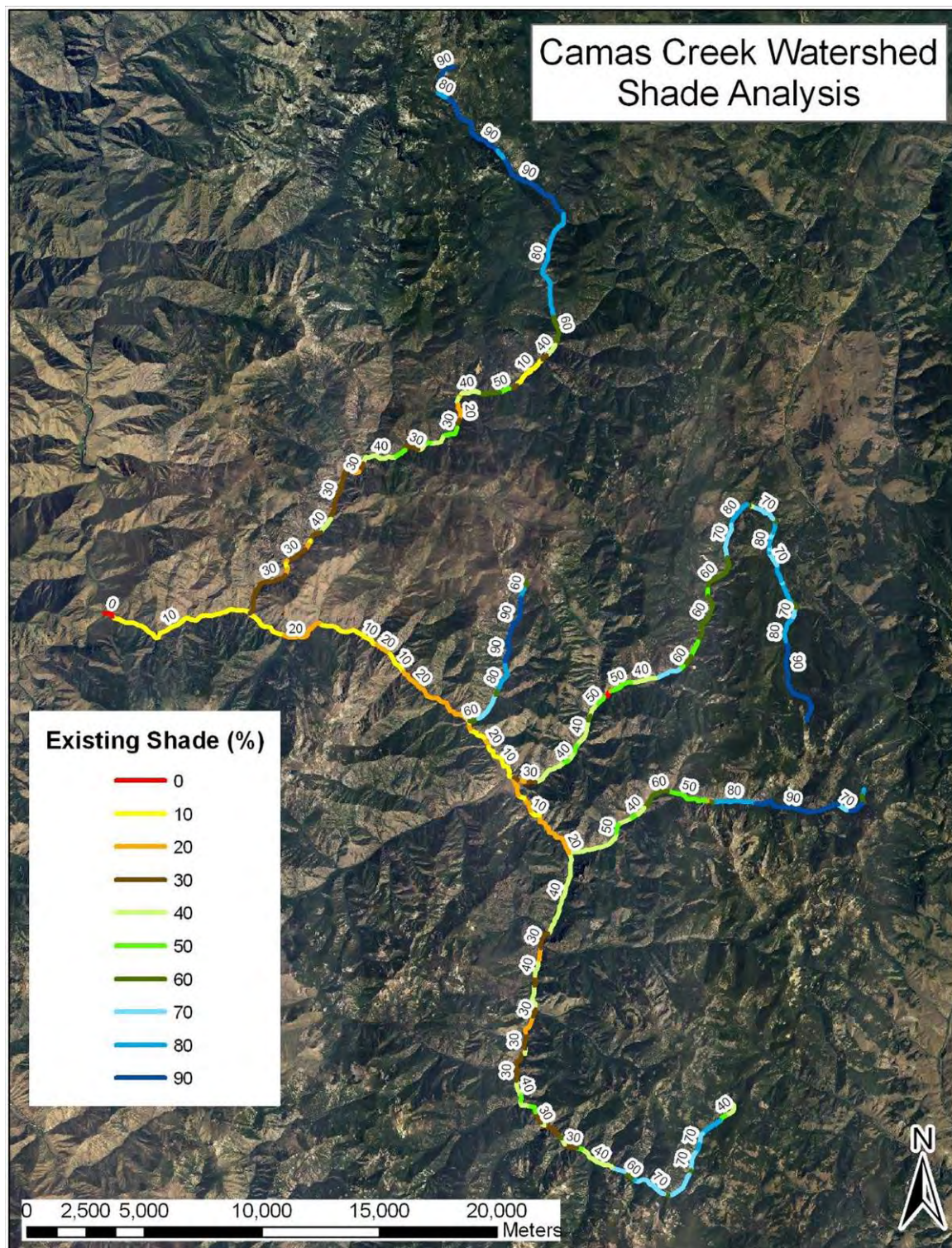


Figure 63. Existing Cover Estimated for the Camas Creek Watershed by Aerial Photo Interpretation.

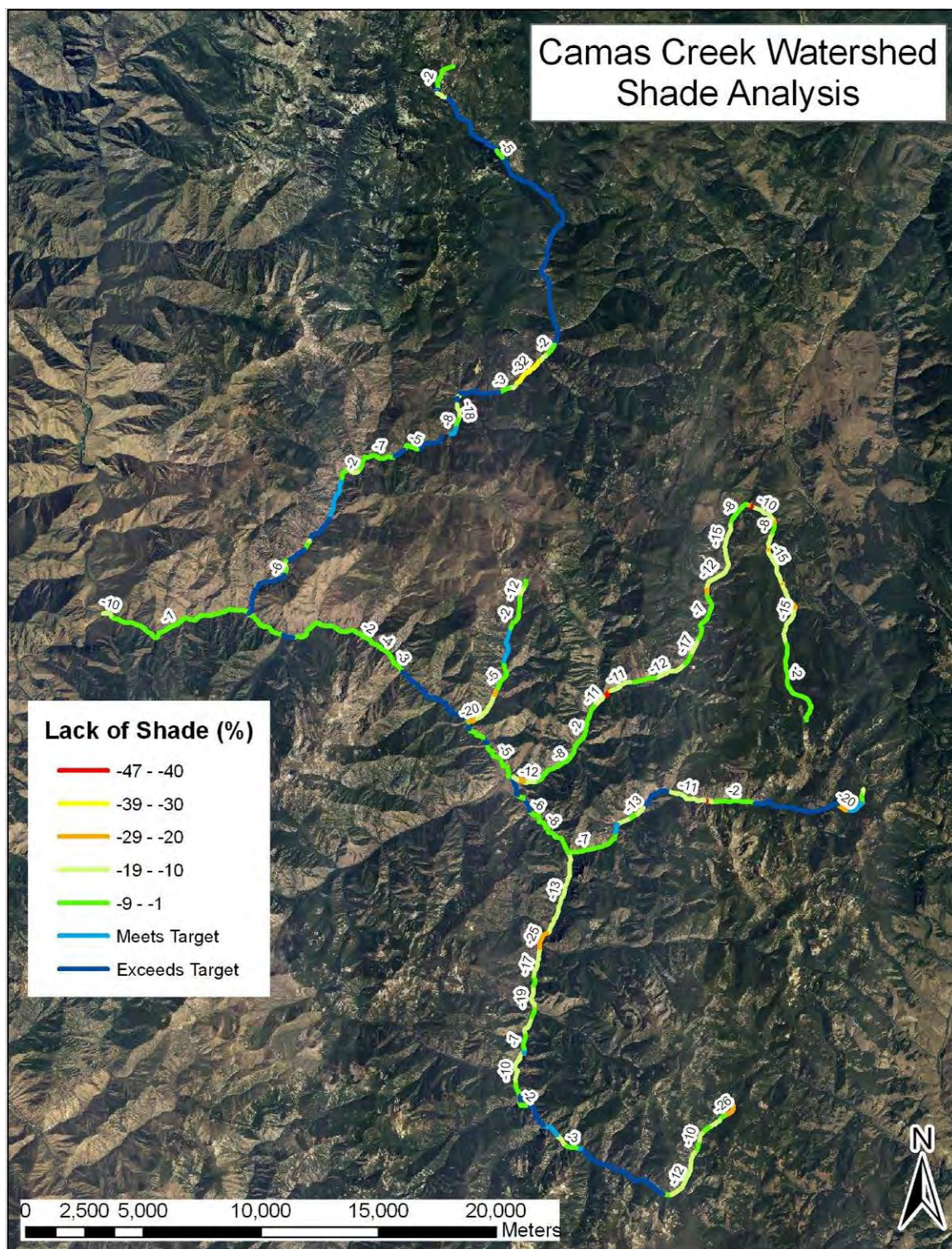


Figure 64. Lack of Shade (Difference Between Existing and Target) for the Camas Creek Watershed.

5.4 Load Allocation

Because this TMDL is based on loading that does or would occur under potential natural vegetation (PNV), which is equivalent to background loading, the load allocation essentially expresses the desire to achieve background conditions. However, in order to reach that objective, load allocations are assigned to non point source activities that have affected or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach-specific and are dependent upon the target load for a given reach. In Table 79 through Table 87, the target or potential shade is shown, which is converted to a potential summer load by taking the average of total loads recorded on a flat plate collector under full sun for the months of April through September and multiplying it by the “percent open,” which is calculated as described above. The inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That equals the loading capacity of the stream and reducing the amount of existing load until it matches loading capacity is necessary to achieve background conditions. There is no opportunity to remove any more shade from the stream by any activity without exceeding its loading capacity. Additionally, because this TMDL is dependent upon background conditions for achieving WQS, all tributaries to the waters examined here need to be in natural conditions in order to prevent excess heat loads to the system.

Table 88 shows the excess heat (solar) load (kWh/day) experienced in each Marsh Creek water body examined and the average lack of shade (%) or average difference between existing and target shade for all segments on the stream. Table 89 shows the excess heat load (kWh/day) experienced by each Camas Creek water body examined and the average lack of shade (%). The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams.

Although the following analysis dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Lack of Shade Figures and in loading tables, are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each loading table contains a final column that lists the difference between existing and target shade or lack of shade for each segment of the stream. It is derived from subtracting the target shade (%) from the existing shade (%) for each segment. Thus, stream segments with the largest lack of shade are in the worst shape regarding riparian canopy conditions. Average lack of shade values are shown in Tables 88 and 89 strictly for the purpose of comparison among streams.

Table 88. Excess Solar Loads and Percent Reductions for All Marsh Creek Tributaries

Water Body	Excess Load (kWh/day)	Average Lack of Shade
Beaver Creek (ID17060205SL028_03-04)	728,600	32
Marsh Creek (ID 17060205SL024_02-03)	515,134	7

Winnemucca Creek (ID17060205SL030_03)	133,350	13
Knapp Creek (ID17060205SL025_02)	118,966	20

Table 89. Excess Solar Loads and Percent Reductions for All Camas Creek Tributaries

Water Body	Excess Load (kWh/day)	Average Lack of Shade (%)
Camas Creek (ID17060206SL025_04)	239,841	6
Silver Creek (ID17060206SL034_02-03)	80,392	14
Yellowjacket Creek (ID17060206SL038_03)	27,519	5
Castle Creek (ID17060206SL033_02)	20,516	8
Duck Creek (ID17060206SL035_02)	6,300	9

Table 88 lists Marsh Creek tributaries that were examined in order of their excess loads, highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last. Average lack of shade values vary from 7% to 32% and are generally larger than that of Camas Creek tributaries Table 89 lists the Camas Creek tributaries in order of their excess loads highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last. Average lack of shade values vary from 5% to 14%.

All streams lack shade in certain segments which should be addressed. Some prioritization may be necessary based on relative severity of shade conditions. In the case of the Upper Middle Fork Salmon River watershed, the largest stream, Marsh Creek, did not have the highest excess load, but is second on the list in Table 88, reflecting the relatively good shade condition of Marsh Creek compared to the second largest stream examined, Beaver Creek, which has the highest excess load. Both Beaver Creek and Winnemucca Creek show higher average lack of shade values (as did Knapp Creek). Both of these streams suffer from increased channel width as a result of morphological instability. The riparian vegetation is not necessarily lacking in any of these streams, however, channel widths are excessively wide resulting in less shade provided to the channel by the riparian vegetation. Figure 61 shows the lack of shade or shade needed to meet target values. The lack of shade problem seems to be concentrated in lower Beaver Creek where hydraulics has widened that stream. There are a few spots on Knapp Creek and the mouth of Winnemucca Creek where the difference between existing shade and target shade exceeds 20%.

Camas Creek is the largest of the five streams examined in the Lower Middle Fork Salmon River watershed and has the largest excess load at 239, 841 kWh/day (Table 89). However, that excess load is only 5% of the total load to Camas Creek. Duck Creek is the smallest

creek examined and it has the lowest excess load at 6,300 kWh/day. Duck Creek's excess load is only 0.1% of the total load experienced by Camas Creek. Yellowjacket Creek is the second largest stream examined, but its excess load is small in comparison. Silver Creek appears to be the stream contributing the most heat to Camas Creek due to a relatively high excess load and higher average lack of shade. Silver Creek has likely suffered the most impacts to riparian shade due to two impoundments and its main road (Forest Road 108). Other streams, with the possible exception of Duck Creek, appear to not lack much shade and are in near wilderness condition.

Wasteload Allocation

There are no known NPDES permitted point sources in the affected watersheds. Thus, there are no wasteload allocations, either. Should a point source be proposed that would have thermal consequence on these waters, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% class interval, which likely underestimates actual shade in the loading analysis. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance.

Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the 6- month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period includes June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loading should incorporate the loading tables presented in this TMDL. These tables need to be updated, first, to field-verify the existing shade levels that have not yet been field-verified, and second, to monitor progress towards achieving reductions and the goals of the TMDL. Using a Solar Pathfinder to measure existing shade levels in the field is important to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the loading tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to

simultaneously field-verify the TMDL and mark progress towards achieving desired reductions in solar loads.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

Implementation Plans are due within 18 months of the approval of a TMDL. Implementation of first-cut BMPs to restore compliance with water quality standards should be completed within 10 years. Restoration of PNV characteristics may take 50 years for more mature and slow-growing coniferous-oriented vegetation assemblages. Channel geometry improvements associated with riparian revegetation, improved channel stability, and reduced sediment loading should be detectable within this time frame. Overall restoration of numeric water quality standards should be complete within 65 years, give or take a decade.

Approach

It is anticipated that by improving riparian management practices, overall riparian zone recovery will precipitate streambank stabilization, reduce sedimentation, increase canopy cover, and lower stream temperatures, all of which will precipitate overall stream habitat improvements. Such improvements will contribute to an overall improvement in stream morphology and habitat, shifting stream health towards compliance with water quality standards.

Responsible Parties

The Salmon-Challis National Forest is the federal land management agency that will be responsible for implementing the riparian improvements identified as necessary in this TMDL on federal lands. Implementation projects on private land are voluntary.

Monitoring Strategy

It is presumed that instream temperatures will continue to be monitored to evaluate improvements or declines in temperature regimes. Ongoing BURP monitoring will also provide insight regarding beneficial use support status. In the TMDL review cycle, after completion of BMP implementation phase, Solar Pathfinder readings will be reassessed to determine progress toward potential natural vegetation within riparian areas.

Public Involvement

The Challis Experimental Stewardship Group serves as the watershed advisory group while the Upper Salmon Basin Watershed Program Technical Team is providing any necessary technical oversight. Idaho Falls DEQ consulted with the Challis Experiment Stewardship Group about going out for public comment in February 2008 and did not receive any objections to doing so. In addition, the Shoshone Bannock Tribe and Boise National Forest have also been consulted regarding this TMDL. The public comment period extended from May 5 through June 9, 2008

5.6 Conclusions

Existing shade on Marsh Creek and three of its tributaries (Knapp Creek, Beaver Creek, and Winnemucca Creek) were estimated from aerial photos and compared to target shade values generated for four vegetation types. Beaver Creek and Winnemucca Creek show the greatest lack of shade with both streams needing more than 50% reduction in solar loads. Both of these streams suffer from increased channel width as a result of morphological instability. The riparian vegetation is not necessarily lacking in any of these streams, however, channel widths are excessively wide resulting in less shade provided to the channel by the riparian vegetation. Knapp Creek is somewhat better off with a 32% reduction needed to meet target loads and the lowest excess load of the four streams examined. Marsh Creek was in the best condition of the four with a 26% reduction in solar loading needed.

Although not a great deal can be done about the lack of shade on streams that are morphologically altered (widened channels), management practices should focus on techniques and plans that minimize hydrologic changes in these watersheds. Less vegetation manipulation and reduction in the uplands should benefit the streams by decreasing the rapid release of water from the overall watershed. A summary of the assessment outcomes for the streams in the Marsh Creek subwatershed is shown in Table 90.

Table 90. Summary of assessment outcomes for the Marsh Creek subwatershed, Upper Middle Fork Salmon River

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Marsh Creek ID17060205SL028_03 ID17060205SL028_04 ID17060205SL019_04 ID17060205SL019_03 ID17060205SL018_05 ID17060205SL024_03 ID170600205SL024_02 ID17060205SL030_02 ID17060205SL025_02	Temperature	Yes	Move to section 4a	Existing shade

In the Lower Middle Fork Salmon River watershed, temperature TMDLs were completed for Camas Creek and four of its tributaries (Castle Creek, Silver Creek, Duck Creek, and Yellowjacket Creek) using a PNV shade approach. Existing shade was estimated from aerial photos and target shade was determined from shade curves produced for other northwest TMDLs. Overall, streams in the Camas Creek watershed are in relatively good shape with respect to riparian shade. Three streams (Camas Creek, Castle Creek, and Yellowjacket Creek) had average lack of shade between 5% and 8%. Duck Creek had the highest percent reduction in solar load (32%) and a slightly higher average lack of shade (9%), however, as the smallest stream Duck Creek contributes little excess solar load to Camas Creek. Silver Creek had the second highest excess load and the highest average lack of shade (14%) of the Camas Creek tributaries. Silver Creek, paralleled by the most prominent road in the watershed has experienced some loss of shade, and with a percent reduction in solar load needed greater than 20%, it should be prioritized for any implementation efforts to improve

shade. In Table 91, a summary of the assessment outcomes for the streams in the Marsh Creek subwatershed is shown.

Table 91. Summary of assessment outcomes for the Camas Creek subwatershed, Lower Middle Fork Salmon River

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Camas Creek/ ID17060206SL020_04 ID17060206SL021_04 ID17060206SL022_04 ID17060206SL023_04 ID17060206SL025_04 ID17060206SL026_04 ID17060206SL027_04 ID17060206SL028_04 ID17060206SL030_03 ID17060206SL030_02	Temperature	Yes	Move to section 4a	Existing Shade
Castle Creek/ ID17060206SL033_02	Temperature	Yes	Move to section 4a	Existing Shade
Silver Creek/ ID17060206SL034_03 ID17060206SL034_02	Temperature	Yes	Move to section 4a	Existing Shade
Duck Creek/ ID17060206SL035_02	Temperature	Yes	Move to section 4a	Existing Shade
Yellowjacket Creek/ ID17060206SL037_03 ID17060206SL038_03 ID17060206SL039_03 ID17060206SL041_03 ID17060206SL043_03 ID17060206SL043_02	Temperature	Yes	Move to section 4a	Existing Shade

References Cited

- American Geological Institute. 1962. Dictionary of geological terms. Doubleday and Company. Garden City, NY. 545 p.
- Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society. Bethesda, MD. 136 p.
- Batt, P.E. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. State of Idaho, Office of the Governor. Boise, ID. 20 p + appendices.
- Clean Water Act (Federal water pollution control act), 33 U.S.C. § 1251-1387. 1972.
- Denny, P. 1980. Solute movement in submerged angiosperms. *Biology Review*. 55:65-92.
- EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water. Washington, DC. 162 p.
- Franson, M.A.H., L.S. Clesceri, A.E. Greenberg, and A.D. Eaton, editors. 1998. Standard methods for the examination of water and wastewater, twentieth edition. American Public Health Association. Washington, DC. 1,191 p.
- Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002. The Idaho Department of Environmental Quality water body assessment guidance, second edition-final. Department of Environmental Quality. Boise, ID. 114 p.
- Hughes, R.M. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis, W.S. and T.P. Simon, editors. *Biological assessment and criteria: tools for water resource planning and decision making*. CRC Press. Boca Raton, FL. p 31-48.
- ICBEMP 1997 fish populations
- Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.
- Idaho Code § 39.3615. Creation of watershed advisory groups.
- IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.
- IDEQ 2002 Salmon-Chamberlain (Crooked Creek) TMDL
- IDEQ 2004 South Fork Clearwater TMDL
- IRZ 2000 thermal imaging of Marsh Creek and Bear Valley Creek confluence
- Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. *Ecological Applications* 1:66-84.
- Keifer et al. 1992 steelhead rainbow spawning
- Mallett 1974 historic fish populations
- McGrath et al. 2001 ecoregions
- Megahan 1975 soils

- Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. Volume 16(4): 693-727.
- NWPPC map credit
- ODEQ 2003 Alvord Lake TMDL
- OWEB 2001 canopy and shade are similar
- Platts 1974 climate, rain
- Poole and Berman 2001 contributors of heat to a stream
- Rand, G.W., editor. 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Taylor and Francis. Washington, DC. 1,125 p.
- Rieman et al. 1997, remaining connected habitat for salmonids
- Rosgen 1996
- Ross and Savage 1967 climate geology
- Simpson and Wallace 1982 fish presence
- Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions American Geophysical Union 38:913-920.
- Thurrow 2000, remaining connected habitat for salmonids
- USDA. 1999. A procedure to estimate the response of aquatic systems to changes in phosphorus and nitrogen inputs. National Water and Climate Center, Natural Resources Conservation Service. Portland, OR.
- USDA FS 2003 land use/management
- USFS 2002 bull trout populations
- USFS 2003 noxious weeds invasive species
- USGS StreamStats
- USGS. 1987. Hydrologic unit maps. Water supply paper 2294. United States Geological Survey. Denver, CO. 63 p.
- Water Environment Federation. 1987. The Clean Water Act of 1987. Water Environment Federation. Alexandria, VA. 318 p.
- Water Quality Act of 1987, Public Law 100-4. 1987.
- Water quality planning and management, 40 CFR Part 130.
- Wetzel, R.G. 1983. Limnology. Saunders College Publishing. New York, NY.
- White and Cochnauer 1975 cutthroat spawning

GIS Coverages

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Glossary

305(b)

Refers to section 305 subsection “b” of the Clean Water Act. The term “305(b)” generally describes a report of each state’s water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§303(d)

Refers to section 303 subsection “d” of the Clean Water Act. 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

Acre-foot

A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.

Adsorption

The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules

Aeration

A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic

Describes life, processes, or conditions that require the presence of oxygen.

Adfluvial

Describes fish whose life history involves seasonal migration from lakes to streams for spawning.

Alevin

A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.

Algae

Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Alluvium	Unconsolidated recent stream deposition.
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Ambient	General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).
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Anadromous	Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the saltwater but return to fresh water to spawn.
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Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).
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Aquatic	Occurring, growing, or living in water.
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Aquifer	An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.
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Assemblage (aquatic)	An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
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Assessment Unit (AU)	A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.
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Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
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Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
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Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
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Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
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Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers
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Benthic	Pertaining to or living on or in the bottom sediments of a water body
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Benthic Organic Matter.	The organic matter on the bottom of a water body.
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Benthos	Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.
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Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
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Best Professional Judgment	A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.
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Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as
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mass of oxygen per volume of water, over some specified period of time.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biota

The animal and plant life of a given region.

Biotic

A term applied to the living components of an area.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.

Coliform Bacteria

A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. Coli*, and Pathogens).

Colluvium

Material transported to a site by gravity.

Community

A group of interacting organisms living together in a given place.

Cretaceous

The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.

Criteria

In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per

year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Culturally Induced Erosion

Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).

Debris Torrent

The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition

The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).

Designated Uses

Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Discharge

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO)

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance

Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

E. coli

Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Ecology

The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.

Ecological Indicator

A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.

Ecological Integrity

The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).

Ecosystem

The interacting system of a biological community and its non-living (abiotic) environmental surroundings.

Endangered Species

Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment

The complete range of external conditions, physical and biological, that affect a particular organism or community.

Ephemeral Stream

A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or

other sources. Its channel is at all times above the water table (American Geological Institute 1962).

Erosion

The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).

Exotic Species

A species that is not native (indigenous) to a region.

Extrapolation

Estimation of unknown values by extending or projecting from known values.

Flow

See *Discharge*.

Fluvial

In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.

Focal

Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and existing beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

Fully Supporting but Threatened

An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in

water quality conditions, which if not addressed, will lead to a “not fully supporting” status.

Geographical Information Systems (GIS)

A georeferenced database.

Grab Sample

A single sample collected at a particular time and place. It may represent the composition of the water in that water column.

Gradient

The slope of the land, water, or streambed surface.

Ground Water

Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Growth Rate

A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Basin

The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle

The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.

Hydrologic Unit

One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a

cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Impervious

Describes a surface, such as pavement, that water cannot penetrate.

Inorganic

Materials not derived from biological sources.

Instantaneous

A condition or measurement at a moment (instant) in time.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Key Watershed

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Load(ing) Capacity (LC)	A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Lotic	An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Mass Wasting	A general term for the down slope movement of soil and rock material under the direct influence of gravity.

Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Median	The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11.
Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per Liter (mg/L)	A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
Monitoring	A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.
Mouth	The location where flowing water enters into a larger water body.
Natural Condition	The condition that exists with little or no anthropogenic influence.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)	A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.
Not Attainable	A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the <i>Water Body Assessment Guidance</i> (Grafe et al. 2002).
Not Fully Supporting Cold Water	At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.
Nuisance	Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Oligotrophic	The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature,

dissolved oxygen, and fish populations are parameters of a stream or lake.

Perennial Stream

A stream that flows year-around in most years.

pH

The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Population

A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.

Quantitative

Descriptive of size, magnitude, or degree.

Reach

A stream section with fairly homogenous physical characteristics.

Reconnaissance

An exploratory or preliminary survey of an area.

Reference

A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.

Reference Condition

1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site

A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Representative Sample

A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.

Resident

A term that describes fish that do not migrate.

Riffle

A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian

Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

Riparian Habitat Conservation Area (RHCA)

A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:
300 feet from perennial fish-bearing streams
150 feet from perennial non-fish-bearing streams
100 feet from intermittent streams, wetlands, and ponds in priority watersheds.

River

A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.

Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.
Subbasin	A large watershed of several hundred thousand acres. This is the name commonly given to 4 th field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.

Surface Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Tertiary

An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

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Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Wasteload Allocation (WLA)

The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of

pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution

Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality

A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria

Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited

A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Limited Segment (WQLS)

Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

Water Quality Modeling

The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input

variables such as climate, stream flow, and inflow water quality.

Water Quality Standards

State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Watershed

1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller “subwatersheds.” 2) The whole geographic region which contributes water to a point of interest in a water body.

Wetland

An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Young of the Year

Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

Table A-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft ²) Square Miles (mi ²)	Hectares (ha) Square Meters (m ²) Square Kilometers (km ²)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft ² = 0.09 m ² 1 m ² = 10.76 ft ² 1 mi ² = 2.59 km ² 1 km ² = 0.39 mi ²	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft ² = 0.28 m ² 3 m ² = 32.29 ft ² 3 mi ² = 7.77 km ² 3 km ² = 1.16 mi ²
Volume	Gallons (gal) Cubic Feet (ft ³)	Liters (L) Cubic Meters (m ³)	1 gal = 3.78 L 1 L = 0.26 gal 1 ft ³ = 0.03 m ³ 1 m ³ = 35.32 ft ³	3 gal = 11.35 L 3 L = 0.79 gal 3 ft ³ = 0.09 m ³ 3 m ³ = 105.94 ft ³
Flow Rate	Cubic Feet per Second (cfs) ^a	Cubic Meters per Second (m ³ /sec)	1 cfs = 0.03 m ³ /sec 1 m ³ /sec = 35.31 cfs	3 ft ³ /sec = 0.09 m ³ /sec 3 m ³ /sec = 105.94 ft ³ /sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L ^b	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

^a 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

^b The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix B. Additional Data

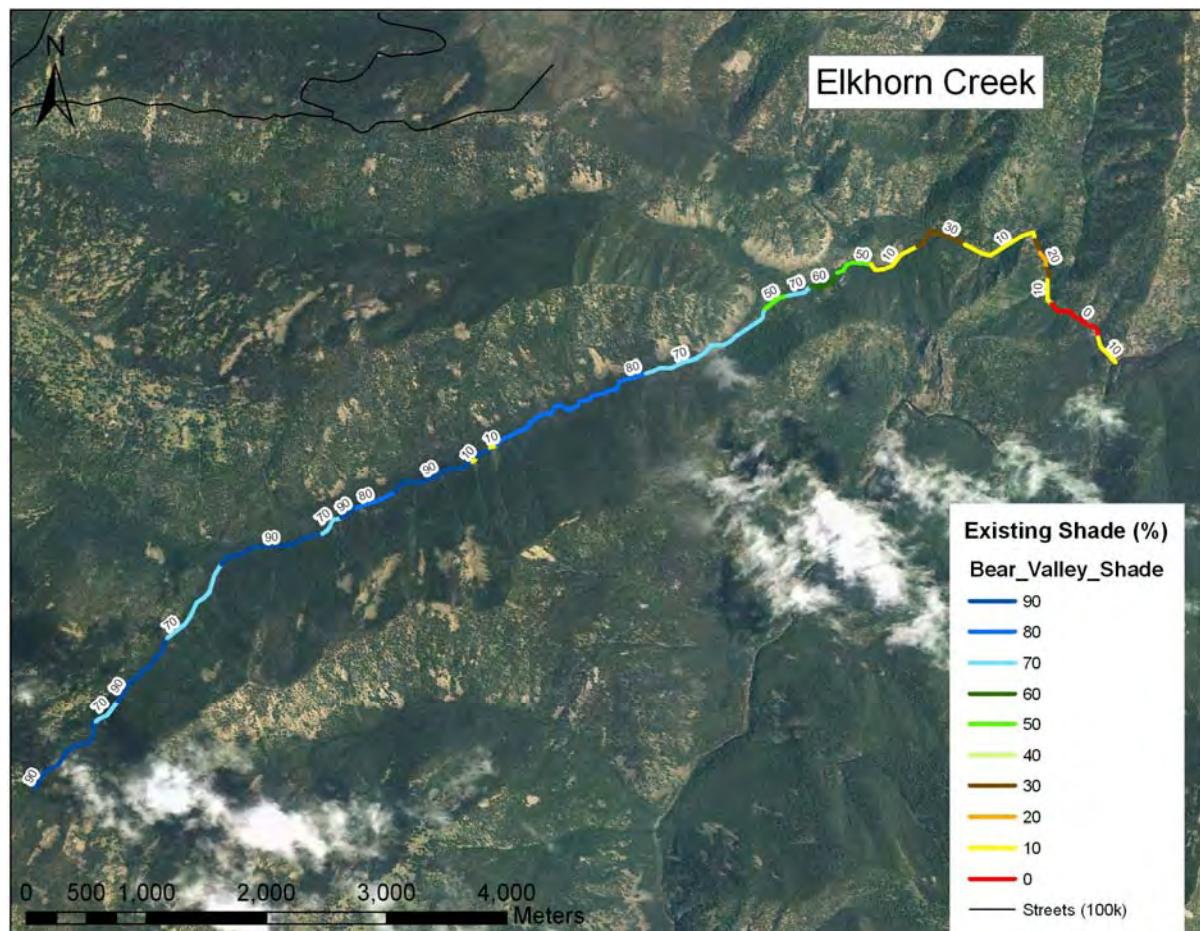


Figure B.1 Elkhorn Existing Shade

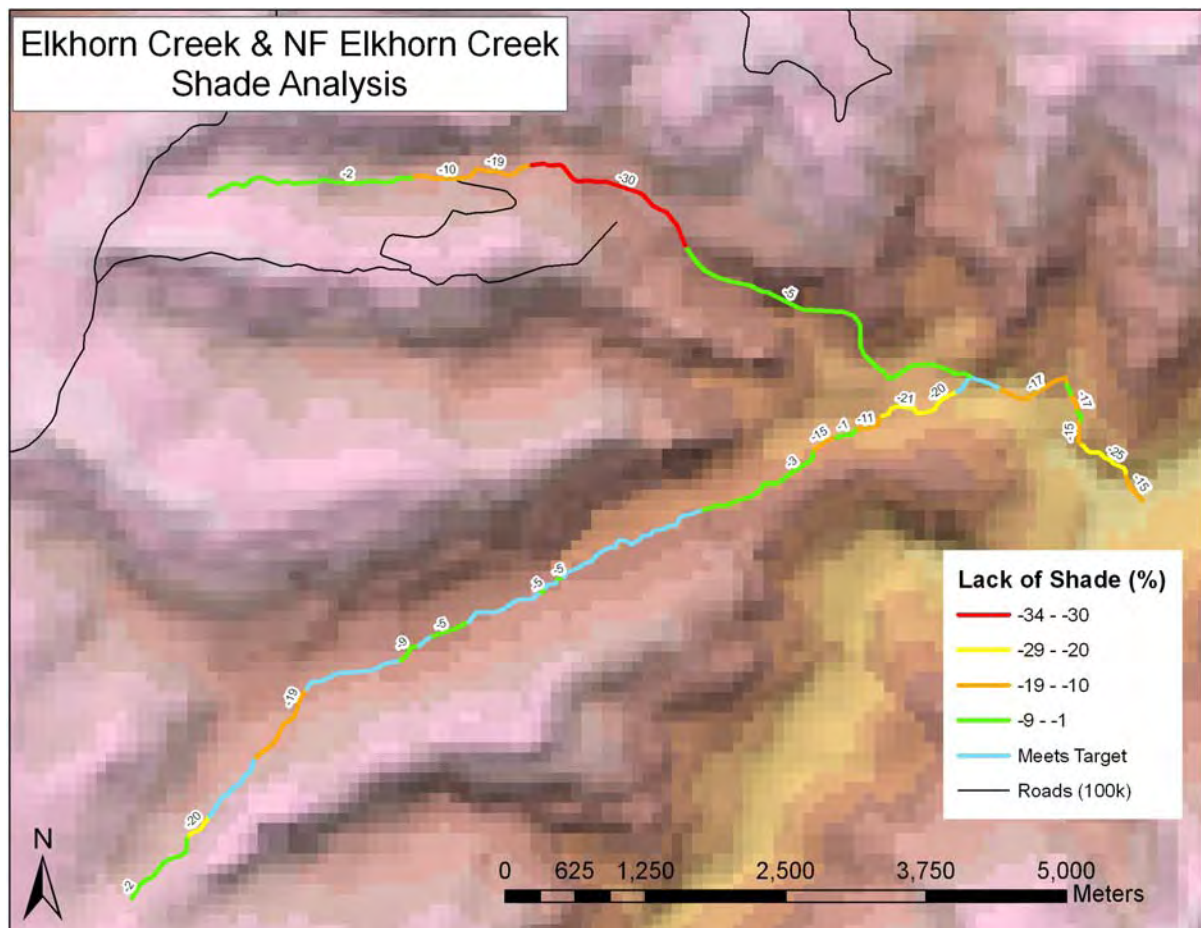


Figure B.2 Elkhorn Lack of Shade

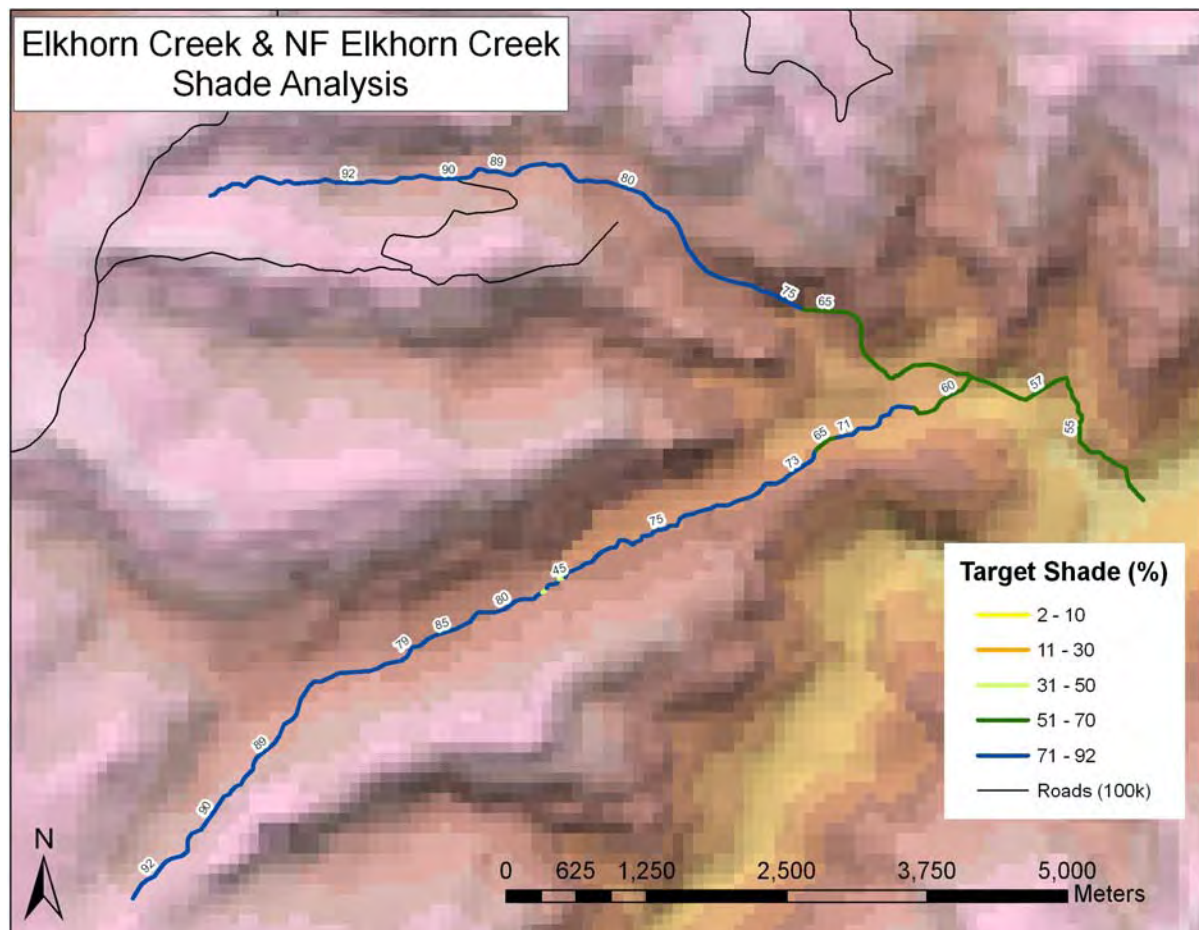


Figure B.3 Elkhorn Creek Target Shade

Appendix C. Data Sources

Table C-1. Data sources for Middle Fork Salmon River Subbasin Assessment.

Water Body	Data Source	Type of Data	When Collected
Upper Middle Fork Salmon River Watershed	Flow Stream Characteristics	USGS	
Upper Middle Fork Salmon River/Lower Middle Fork Salmon River Watershed	BURP	DEQ	1995-present
Bear Valley and Elk Creeks	USFS/IDFG	Redd Counts	2000-2007
Elkhorn Creek	DEQ	Temperature	2006-7
Monumental Creek	USFS	R1/R4	1995-present
Camas and Marsh Creeks	DEQ	PNV	2006

Appendix D. Distribution List

Challis Library
Idaho City Library
Salmon Library
Challis Experimental Stewardship Group

Appendix E. Public Comments

Comment	Response
Donna Walsh, EPA <u>Additional Information Needed before Waters are Delisted</u> Intermittent or Ephemeral Streams A number of waters are proposed to be delisted because they are “low flow”, “ephemeral”, or “Non Targeted Water: Springbrook”. These ephemeral and springbrook waters are not discussed in the text other than a brief statement on page 77 stating that the streams were monitored in 1997 when the winter snow pack was above average. More specific information is needed on each of these waters before they can be delisted. EPA understands that BURP results for springbrook waters will not show the usual biological diversity near the spring source. EPA believes it is reasonable to not list and de-list such waters where biological diversity is low near the spring source and biological conditions and diversity increase downstream such that water quality standards are achieved. However, just the fact that the stream is a springbrook is not enough information on which to delist the water. More information is also needed on the intermittent and ephemeral streams. These streams are still waters of the U.S. and must comply with water quality standards. Narrative standards such as the narrative standard for sediment still apply even when flows are below optimum. Delisting an intermittent stream must be based on an analysis which shows that criteria are being achieved for the relevant pollutant; it is not sufficient to delist the water simply because it is intermittent.	These streams are Rosgen E type meadow streams characterized by low gradient, narrow channels with very low flow and often, no flow. DEQ asserts that these streams should not have been inventoried using BURP. These streams were looked at again by Idaho Falls DEQ personnel in 2006-2007 and flow was nonexistent or below 1 cfs. There is very little human disturbance associated with these streams and no significant source of pollutant loading. DEQ’s best professional judgment is that there is no pollutant source nor do these streams contribute pollutants to downstream waters. Low BURP scores are reflective of low flow conditions not anthropogenic influence. However, a mistake was made in the table for Marsh Creek, which have a TMDL for temperature and that has been corrected.

We recognize the technical difficulty in assessing and writing TMDLs for such waters, and offer to discuss options for delisting or writing TMDLs for these waterbodies.

Monumental Creek

Additional information should be provided before this water can be taken off of the 303(d) list. The text references several mines in the watershed, and past sediment issues and changes in the active channel length caused by the mining. The text also mentions springbrooks that “route significant amounts of sediment” into the creek and a berm on the road by Coon Creek that routes sediment into Monumental Creek. It is not clear where the mining activity and sediment problems have occurred in relation to where the BURP data was collected. Please identify where the mines (Golden Reef Joint Venture Mine, Dewey Mine, Thunder Mountain area, others?) in this watershed are located on the map and show that the BURP data collected captured the effects of the mines and past sediment issues.

Elkhorn Creek

More information is needed before Elkhorn Creek is taken off of the 303(d) list. It sounds like BURP testing was done in the watershed, but the data is not yet available. The results of this BURP testing should be analyzed before the water is delisted. Also, a map of Elkhorn Creek identifying the part of the watershed that is outside of the wilderness area and showing the location the

A map showing the mines has been added. Dewey Mine and Venable mine area actually the only mines in the Thunder Mountain area that are in the watershed.

The BURP locations are all below the springbrooks. However, the BURP location by the road crossing was above Coon Creek. Depth fines measurements were taken at a pool 100 yards below the Coon Creek crossing and showed depth fines of 24% indicating that fine sediment is not excessively accumulating in this reach. Downstream of that pool, less than a ½ mile was Roosevelt Lake which effectively settles all sediment.

Additional data was collected by hiking downstream of Roosevelt Lake below Mule Creek to measure percent fines in Monumental Creek. This section of the stream had 10% fines. Previous USFS information indicated good fisheries habitat both in the mine area and below it as well as improving sediment trends. Monumental Creek is recommended for delisting for sediment.

A map has been added, the mine site is just upstream of the BURP site.

The BURP scores showed an overall waterbody assessment score of 3, the highest possible score. Narrative to this effect has been added to the text. Elkhorn is recommended for delisting.

BURP data was collected should be provided. The location of the old mine site should also be shown. Marsh Creek More information is needed on Marsh Creek. On page xxii, Table B shows the justification for its removal from the list to be “Assessed Full Support”. However, it is noted as “listed in error” on page 77. If Marsh Creek was originally listed in error, the error that was corrected should be described. If these pages describe different sections of Marsh Creek, that should be made clear. <u>TMDL Comments</u> Map It would be helpful if the document included a map showing the whole watershed and identified the 303(d) listed streams as well as the streams where TMDLs are being done. If possible this map should include the names of the major waters and tributaries so the subwatersheds can be identified. Lack of allocations to tributaries Due to the cumulative effects of temperature increases and the potential impacts of the tributaries on the temperatures of the mainstem waters, Potential Natural Vegetation (PNV) shade targets should be set for the tributaries or the tributaries should be shown to be in a natural state to ensure natural stream temperatures will be achieved. To be complete, the TMDL should have allocations to all sources of heat loading to the waterbody, including the tributaries. This can be in the form of specific quantitative shade allocations to individual tributaries, or narrative allocations to tributaries in general with a target allocation of achieving natural stream temperatures in all of the tributaries. Shade curves. It is difficult to connect the	Marsh Creek has been removed from this table because it has a temperature TMDL. The map has been added. Additional language has been added to the load allocation section to indicate that tributaries are assumed to be at PNV until proven otherwise Regional shade curves are being used when available in TMDLs. These regional curves are not available for this TMDL at this time.
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shade curves currently chosen to the vegetation in the TMDL watersheds. Reviewing the local information and literature (BLM, USFS, NRCS, etc.) on the type, height and density of local natural vegetation could improve the selection of the shade curves. This local information could be used to select which existing shade curve(s) from regional TMDLs best represent local natural conditions. This method of choosing a shade curve, rather than the current method of averaging numerous shade curves which are often comprised of very different vegetation communities with very different underlying assumptions of PNV height and canopy density, should result in a more accurate estimate of natural shade for the specific watershed. Averaging needed shade improvements. Averaging the needed shade improvements for a watershed can completely mask areas of needed restoration. For example, some areas in Marsh Creek are shown to be lacking 40-61% of the expected natural shade, though the average for the watershed is 26%. Even in Camas Creek, where the overall shade reduction needed is fairly low, some areas are shown to be lacking 30-47% of the expected natural shade. However, these problematic areas are ignored with the proposed averaging method if only the average conditions are used as an evaluation criterion for attainment of the PNV approach. Identifying a range of shade reductions needed among the various reaches of the watershed would provide more helpful information than identifying the average reduction needed for the entire watershed. For example, in the Castle Creek watershed, the percentage reductions needed in each segment range from 6% to 67%. Since the percentage improvement needed in each segment is so different, identifying the range of reductions provides a more accurate understanding of the shade issues in the	Tables 88 and 89 have been modified to reflect an average lack of shade. Additional text has been added to explain that all reaches need to be at PNV. Since information is available in the TMDL in tabular form on the full range of reaches, this shouldn't prevent land managers from prioritizing restoration efforts accordingly. See comments above.
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watershed. Providing a map showing reach specific values of lack of shade (as you do now) is good. However, the percent solar load reductions for each of the reaches in Tables 79 through 87 should also be shown, rather than the summed solar load reduction for the whole watershed. This would give the land owner the ability to focus on the reach specific shade improvement needed. It is reasonable to suggest that land managers might want to initially target restoration on areas with the greatest departure from natural shade. However, it should be made clear, that to meet water quality standards, all areas which show any deviation from natural would need improvement.	See comments above.
Discussion of solar load reduction required The issue of averaging the shade reductions needed is compounded by language suggesting that the average allocation shows the water as a whole to be in “good shape” or “in near pristine conditions” (pages xxi and 162), when some reaches in the watershed are severely impaired and far from natural. This language masks the specific reaches with much higher deviations which are important to address and sends the message that restoration isn’t needed in these waters which will be an impediment to achieving any implementation within the watershed. In order for a PNV TMDL to effectively meet WQS, <u>all</u> reaches must be brought close to a natural state.	See comments above.
<u>Specific Subbasin Assessment Comments</u> Page xvii, Executive Summary and page 77, Listed Waters The number of 303(d) listed waters is not clear. Though the text on page xvii states that “Eleven segments of the Middle Fork	Clarification has been made in the text.

Salmon River Subbasin ... and 7 assessment units... were on the 2002 list” the text on page 77 states “...four AUs comprised of 11 waterbodies” were on the 2002 303(d) list. However, Table A on page xx shows 10 waters and 10 assessment units listed on the 2002 303(d) list. Also, because the waters that are combined in Table A are listed separately in Table 48 (page 77-78), Table 48 shows 16 water segments. Please clarify the number of waters and AUs on the 2002 303(d) list. Page xxii, Table B The sixth and seventh lines in this table show the same AU number, and different waterbody names. Is this correct? Also, the sixth line for Marsh Creek shows “yes” in the TMDL Completed column, but “Delist” in the Recommended Changes to 2002 303(d) List column and “Assessed Full Support” in the Justification column. These do not match up. The Recommended Changes to 2002 303(d) List column heading should be changed since it implies that all the waters in the table were on the 2002 303(d) list. 10 of the waters shown, were not on the 2002 303(d) list, but were found to be impaired during the TMDL assessment. Page 21, Upper Middle Fork Major Subwatersheds It is not clear how these watersheds are ordered and it is difficult to find a particular watershed of interest without paging through the document. Including an introductory paragraph explaining in what order the subwatersheds are discussed as well as showing the pages where each water is discussed in the Table of Contents would be helpful. Page 101 and 102, Tables 59 and 60 The AU numbers for the waters should be	The table has been corrected for Marsh Creek. Table A lists the streams on the 303(d) list. Table B lists changes recommended to the Integrated Report Page 20 described how the watershed are ordered and the Table of Contents has been edited to make it easier to find subwatersheds. AU numbers have been added
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shown in these Tables so the waters can be more easily matched to the 303(d) listed waters and the conclusions	
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