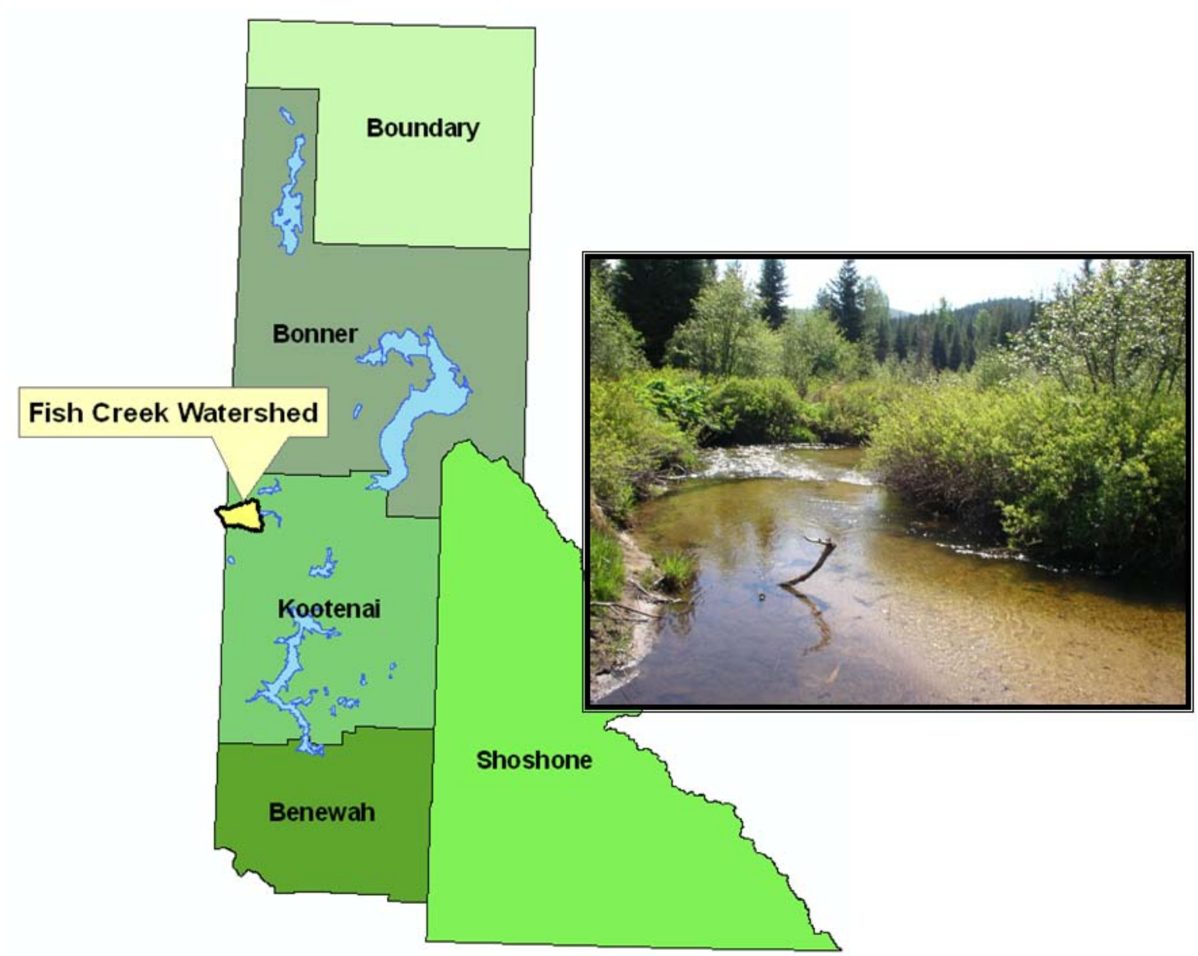
Fish Creek Watershed Assessment and Total Maximum Daily Loads



Final

Department of Environmental Quality

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The cover photo shows Fish Creek up-stream from the confluence with Swanson's Chute.

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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)

ARU aquatic response unit

AU assessment unit

AWS agricultural water supply

BMP best management practice

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

cfu colony forming unit

cm centimeters

CWA Clean Water Act

CWE cumulative watershed effects

DEQ Department of Environmental Quality

DNA deoxyribonucleic acid

DO dissolved oxygen

DWS domestic water supply

EPA United States Environmental Protection Agency

F Fahrenheit

FPA Idaho Forest Practices Act

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

IDL Idaho Department of Lands

IEPC Inland Empire Paper Company

km kilometer

km^2 square kilometer

LA load allocation

LC load capacity

m meter

m^3 cubic meter

µm micrometer

mi mile

mi^2 square miles

ml milliliter

mg milligram

mg/L milligrams per liter

mm millimeter

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
NILAC	North Idaho Lake Association Coalition
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
PNV	potential natural vegetation
PCR	primary contact recreation
ppm	part(s) per million
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
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TLIA	Twin Lakes Improvement Association
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
TS	total solids
TSS	total suspended solids
t/a/y	tons per acre per year
t/y	tons per year
U.S.	United States
U.S.C.	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
VRU	vegetation response unit
WAG	Watershed Advisory Group
WBAG	*Water Body Assessment Guidance*
WBAG II	*Water Body Assessment Guidance, second edition - final*
WLA	wasteload allocation
WSA	watershed assessment
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 one water body in the Upper Spokane River Subbasin that has been identified as impaired in Section 5 of Idaho's 2002 Integrated Report, commonly referred to as the "303(d) list". This watershed assessment (WSA) and TMDL analysis has 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 Fish Creek watershed, located in northern Idaho.

Sediment, temperature and bacteria TMDLs are addressed in this document for the Fish Creek watershed. This document address two assessment units and three pollutants within the Idaho portions of the Fish Creek watershed. Throughout this document, the mention of the Fish Creek watershed will be in reference to the portion within the state of Idaho unless otherwise noted.

The WSA examines the current status of listed water bodies and defines the extent of impairment and causes of water quality limitation throughout the Idaho portion of the watershed. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting Idaho water quality standards. Streams for which this document was developed include the two assessment units: Fish Creek mainstem and all named and unnamed tributaries to Fish Creek (Table A).

The following are major, human-caused, nonpoint sources for each pollutant:

> Sediment: roads, agriculture, grazing, and silviculture activities.
>
> Temperature: increased solar radiation due to reduction in shade provided to the stream from the adjacent plant community.
>
> Bacteria: wild animals, domesticated animals (farm animals), and human (homes and/or recreation).

Table A. Idaho's 2002 Integrated Report Section 5 listing in the Fish Creek watershed.

Stream Name	Assessment Unit	Stream segment boundaries	Pollutant
Fish Creek mainstem	ID17010305PN014_03	Third order portion of Fish Creek, from approximately 650 meters up-stream of Johnson Creek/Fish Creek confluence to mouth	Unknown, Sediment, Temperature
Fish Creek tributaries	ID17010305PN014_02	13 first and second order tributaries to Fish Creek mainstem	Temperature

Table B is a complete list of the pollutants and streams for which TMDLs were developed in the Fish Creek watershed.

Table B. Streams and pollutants addressed in this document.

Stream Name	Assessment Unit	Pollutants
Fish Creek mainstem	ID17010305PN014_03	Sediment, Temperature, and Bacteria
Fish Creek tributaries	ID17010305PN014_02	Sediment and Temperature

Subbasin at a Glance

The Fish Creek watershed is contained within the Upper Spokane Subbasin. The Upper Spokane Subbasin hydrologic unit (hydrologic unit code [HUC] 17010305) is located in northern Idaho, downstream of Lake Coeur d'Alene, and drains from Athol, Idaho to downtown Spokane, Washington (Figure 1). The subbasin includes four lakes; Upper and Lower Twin Lakes, the northernmost lakes; Hauser Lake, southwest of Twin Lakes; and Hayden Lake, north of Lake Coeur d'Alene (Figure 1). The Twin, Hauser, and Hayden Lake watersheds are the largest within the subbasin. The Spokane River flows through the southern portion of the subbasin, out of Lake Coeur d'Alene and west into Washington state. There are only a few small tributaries draining from the south into the Spokane River.

This document addresses the Fish Creek watershed, located northeast of Coeur d'Alene, Idaho (Figure 1). Fish Creek drains east from across the Idaho/Washington border into Twin Lakes. Ownership in the watershed is almost entirely private land. The Inland Empire Paper Company, the Idaho Department of Lands, and a few small private landowners are the primary land holders within the watershed. The majority of the stream is forested, intermixed with shrubs, grass meadows, and pastureland near its mouth before draining into upper Twin Lakes.

A TMDL was developed for the Upper Spokane Subbasin in 2000 by DEQ, titled *Sub-basin Assessment and Total Maximum Daily Loads of Lakes and Streams Located on or Draining to the Rathdrum Prairie (17010305)* (IDEQ 2000). The TMDL developed in 2000 did not directly address excess pollutant loads within the Fish Creek watershed.

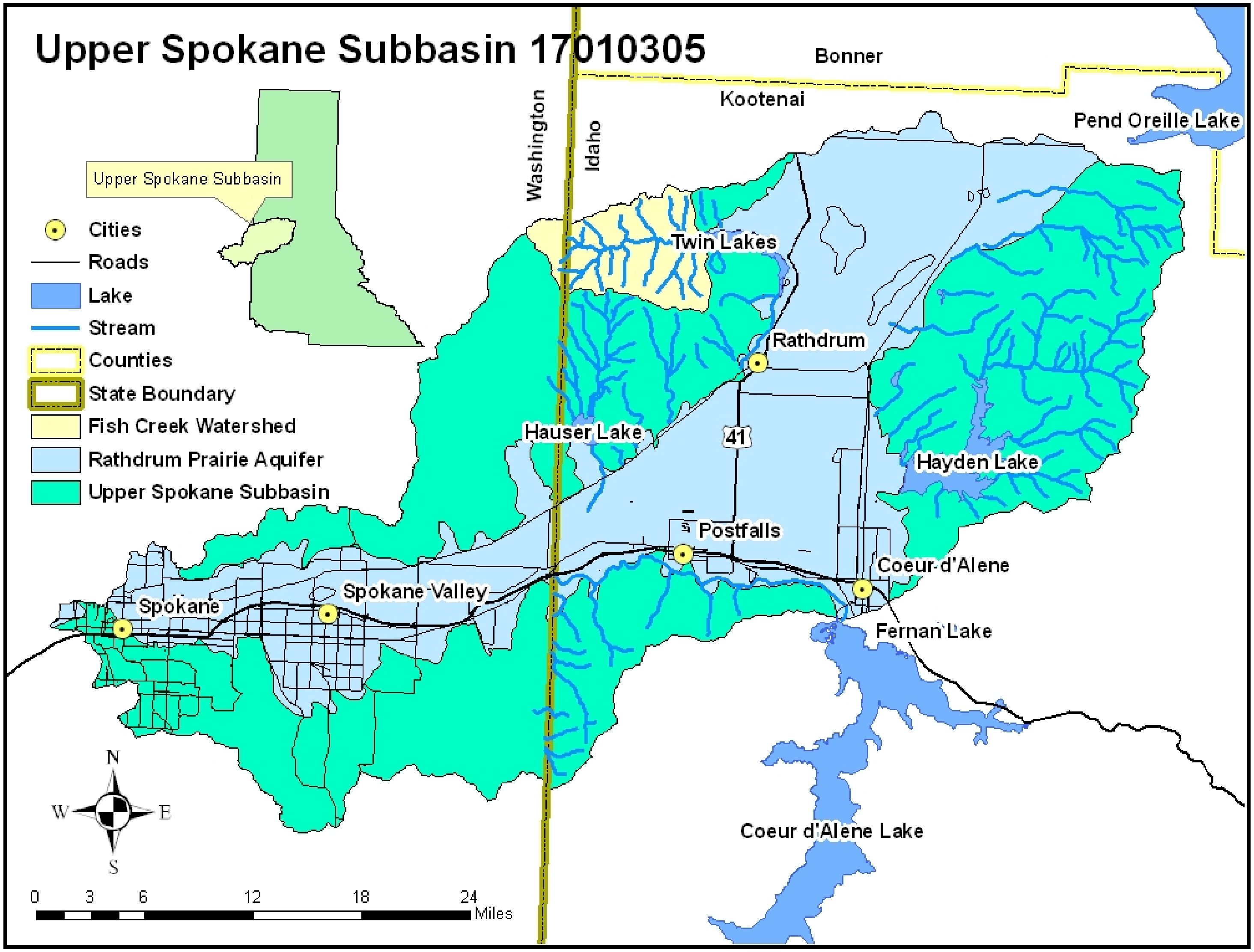

Figure 1. Subbasin at a glance.

History of Fish Creek water quality impairments

Below is a summary of the water quality listing history of Fish Creek as part of the State of Idaho's pursuit to meet the requirements of the Clean Water Act.

1992

- In 1992, Fish Creek (designated from the Washington/Idaho border to Twin Lakes) was included in Appendix D of the *Idaho Water Quality Status Report*. Appendix D, The Impaired Streams Segments Requiring Further Assessment, identified agricultural water supply, cold water biota, and primary contact recreation beneficial uses as being partially supported. Pollutants of concern were nutrients and sediment. (IDHW-DEQ 1992).

1994 – 1996

- Fish Creek water body listings in the 1992 *Idaho Water Quality Status Report, Appendix D* were later included in the 1994/1996 §303(d) list. In 1994/1996, nutrients and sediment were again identified as pollutants impairing Fish Creek (IDHW-DEQ 1994, 1996).

1998

- Fish Creek was listed on the 1998 §303(d) list for nutrients and sediment (IDHW-DEQ 1998).

2002 – 2004

- In addition to the impairments identified in the 1998 303(d) list, the 2002 Integrated 303(d)/305(b) Report added temperature and causes unknown as impairments for Fish Creek (IDEQ 2005a).

Key Findings

The Fish Creek Watershed Assessment and TMDLs document was written with the goal of restoring all beneficial uses, including aquatic life and primary contact recreation, within the watershed. Key findings of the analysis include the following:

- Assessments of data collected during ten (10) Beneficial Use Reconnaissance Program (BURP) surveys reveal that index scores failed to consistently indicate support of beneficial uses. Beneficial uses of the surface waters include cold water aquatic life, salmonid spawning (SS), and primary contact recreation (PCR). Most failures were due to low macroinvertebrate and fish numbers despite good habitat index scores. Failure to support beneficial uses was also due to temperature criteria violations and elevated in-stream *E. coli* concentrations. TMDLs are completed for sediment, bacteria, and temperature due to Idaho water quality criteria violations.
- Numeric targets for TMDLs include 68% above natural background sediment generation, shade targets developed from intact potential natural vegetation riparian communities, and 126 *Escherichia coli* (*E. coli*) cfu/100ml for bacteria.
- Loading capacities, existing loads, and load allocations for all three pollutants are outlined: for temperature (Table 19), sediment (Table 24), and bacteria (Table 25). A

33% reduction in current sediment load has been identified as needed to support beneficial uses. Percent reductions in summer solar load vary from 37-45% for the mainstem Fish Creek, 35-81% for the south-side tributaries to Fish Creek, and 33-83% for the north-side tributaries to Fish Creek. Bacteria load reductions in Fish Creek vary considerably over time and range from 10,217% to 190,376%.

- Although Fish Creek is not included on Idaho's 2002 Integrated Report as nutrient-impaired, nutrient samples were collected to characterize the current nutrient load within Fish Creek and compare current data to previously collected data. Nutrient concentrations collected in the summer of 2007 were similar to nutrient concentrations collected in late 1985 and 1986. The similarities in the values led to the determination that nutrient concentrations within the watershed have remained relatively constant. *The Subbasin Assessment and Total Maximum Daily Loads of Lakes and Streams Located on or Draining to the Rathdrum Prairie* (IDEQ 2000) allocated a total phosphorus (TP) reduction goal of 271 kilograms/year (597.4 pounds/year), a 47.7% reduction (IDEQ 2000). A nutrient TMDL will not be developed for the Fish Creek watershed at this time. Achievement of the nutrient load reductions identified in the previous TMDL efforts will meet Idaho water quality standards and improve beneficial use support status.

Sediment TMDLs

Sediment TMDLs were developed for both Fish Creek assessment units. Sediment amounts generated from roads, agriculture, and silviculture activities were characterized to determine the amount of sediment load reduction needed in order to restore all beneficial uses. Idaho's water quality standard IDAPA 58.01.02.08 states:

> *"Sediment shall not exceed quantities specified in section 250 or 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 section 350."*

Sediment was determined to be in excessive quantities and impairing the cold water aquatic life use designation. The target load capacity was set at 68% above natural background, based on reference conditions. Sediment loading values are displayed in Table C.

Table C. Current sediment load, background load and load capacity for Fish Creek.

Estimated existing load (tons/year)	Natural background (tons/year)	Load capacity at 68% above natural background (tons/year)	Load Reduction Required (tons/year)	% Load Reduction Required
827	327	549	278	33%

Temperature TMDLs

Temperature TMDLs were developed for the mainstem of Fish Creek and tributaries to Fish Creek because stream temperatures exceeded Idaho's numeric water quality temperature standard and beneficial use impairment is attributed to these exceedances. Salmonid spawning and rearing are adversely impacted by elevated stream temperatures. Solar radiation was determined to be the factor most manageable in reduction of stream temperatures. A decrease in solar radiation requires an increase in shading of the stream (Table D).

Table D. Solar loading reductions needed within the Fish Creek watershed.

Water Body	Excess Load (kWh/day)	Percent Reduction
Fish Creek mainstem	72,872 (12,116 MD)	37 – 45%
South-side Tributaries	37,179 (21,031 MD)	35 – 81%
North-side Tributaries	17,319 (10,359 MD)	33 – 83%

Using the potential natural vegetation (PNV) method, estimated potential natural shade was selected as the desired target for this TMDL. If PNV targets are achieved, yet stream temperatures are warmer than numeric criteria, it may be assumed that the stream's temperature is natural (provided there are no point sources or human-induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply. As per IDAPA 58.01.02.200.09:

> *"When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401."*

Bacteria TMDL

A bacteria TMDL was developed for one assessment unit within the Fish Creek watershed, the Fish Creek mainstem, because water quality monitoring data indicated that the beneficial use of primary contact recreation was not fully supported. The source of bacteria is unknown. Further monitoring will be needed to determine the source of contamination. Known possible sources include domesticated and wild animals, and/or human contributions.

The bacteria water quality standard is a concentration-based standard. The target for the bacteria TMDL is the Idaho water quality standard (IDAPA 58.01.02.251.01a), which states:

> *"Waters designated for primary or secondary contact recreation are not to contain E. coli bacteria in concentrations exceeding a geometric mean of one hundred twenty-six (126) E. coli organisms per one hundred (100) ml based on a minimum of five (5) to seven (7) days over a thirty (30) day period."*

E. coli is used as an indicator of human pathogens, disease-causing organisms. *E. coli* is also used because it is relatively more abundant than other pathogens, easy to test for, and relatively harmless. Table E contains the calculated load capacity and existing load for *E. coli*, based on flow information collected during sampling.

Table E. The *E. coli* colony forming units (cfu) load capacity in Fish Creek based on measured discharge and *E. coli* concentration and the reduction necessary to achieve the loading capacity.

Fish Creek ID17010305PN014_03					
Measured *E. coli* Concentration (cfu/100mL)	Discharge (cfs) at sample collection	Load Capacity (cfu/100mL)	Current Load (cfu)	Reduction (cfu)	Reduction (%)
>2,400[1]	5.82	207,653	395,529,761	395,322,108	190,376
1,400	1.93	68,861	76,512,129	76,443,268	111,011
980	1.06	37,820	29,415,544	29,377,724	77,678
1,300	3.2	114,174	117,798,096	117,683,922	103,075
260	1.5	53,519	11,043,572	10,990,053	20,535
130	1.59	56,730	5,853,093	5,796,363	10,217

[1] Quantity of *E. coli* cfu in sample were at the method detection and reporting limit.

Summary

Recommended changes to the Integrated Report are included in Table F for the two assessment units addressed in the *Fish Creek WSA and TMDL*.

Table F. Summary of assessment outcomes.

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Fish Creek	ID17010305PN014_02	Temperature	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek	ID17010305PN014_02	Sediment	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek	ID17010305PN014_03	Temperature	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek	ID17010305PN014_03	Sediment	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek	ID17010305PN014_03	Bacteria	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed

[1] Section 4a of the Integrated Report includes rivers with EPA-Approved TMDLs.

Public Input and Meetings

In compliance with Idaho Code §39-3611(8), the development of the *Fish Creek Watershed Assessment and TMDL* included extensive public participation by the Fish Creek Watershed Advisory Group (WAG) and other interested parties from within the watershed. The Coeur d'Alene regional office of Idaho DEQ solicited participation in a WAG in March 2007. A letter, map, and documentation explaining the TMDL and WAG process were sent to land owners/managers, residents, environmental groups, and state and federal agencies. Eight written response were received, and the first Fish Creek WAG meeting was held on April 17, 2007.

Public meetings were held in April, May, July, September, and October of 2007 and January 2008. All meetings were open to the public and advertised at least one week prior to the meeting. Meeting announcements were noted on the public meeting calendar on DEQ's Web site, posted at the DEQ regional office in Coeur d'Alene, and advertised in local newspapers.

WAG participants reviewed beneficial use designations in the watershed, Idaho water quality standards, and water quality information collected within the watershed. The WAG reviewed several drafts of the *Fish Creek Watershed Assessment and TMDL* document and submitted comments to DEQ throughout the WAG meeting period. The comments submitted to DEQ by the WAG were incorporated into the final document.

On April 17, 2007, an initial WAG meeting was held to discuss the study area and water quality status of the Fish Creek watershed. Discussion also revolved around data that have been collected and the water quality impairment history of the watershed. Idaho water quality standards and beneficial uses were also discussed in detail. WAG operating procedures were briefly reviewed.

On May 22, 2007, a WAG meeting was held at the Twinlow Day Camp. The meeting was better attended than the previous one and many of the same topics from the first meeting were revisited. Idaho water quality temperature criteria were discussed, and Mark Shumar from the DEQ technical services staff presented the potential natural vegetation temperature TMDL and the methods involved in the document development. The WAG operating procedures were adopted by the WAG.

The third WAG meeting was held on July 17, 2007. Meeting discussion revolved around review of the draft temperature TMDL, TMDL document outline, and the proposed methodology for characterizing excess sediment within the watershed.

The fourth WAG meeting was held on September 25, 2007, at the Rathdrum Public Library. The draft temperature TMDL was reviewed and WAG members attending the meeting agreed that DEQ has properly identified the cause of increased stream temperatures and has characterized the needed steps to reduce temperatures to an appropriate level. The WAG also discussed nutrient and bacteria water quality data that were collected by DEQ during summer 2007. DEQ provided the WAG with monitoring results, an explanation of what the results mean and how DEQ intends to proceed. The WAG was supportive of DEQ's monitoring efforts and proposed TMDL actions taken because of monitoring results.

On October 16, 2007, a WAG meeting was held at the Rathdrum Public Library. Sediment impairment was discussed, along with the sediment model approach that was utilized in this TMDL effort. The WAG was in support of DEQ's efforts to model sediment input and helped to refine the GIS coverage that was used in the modeling process.

On January 15, 2008, a WAG meeting was held at the Idaho DEQ Coeur d'Alene regional office. The TMDL findings were discussed and the WAG gave consent to open a thirty day public comment period.

Throughout the public involvement process, Idaho DEQ maintained a Web page devoted to the Fish Creek WAG, http://www.deq.idaho.gov/about/regions/fish_creek_wag/index.cfm. Presentations given at WAG meetings, documents handed out for review, and other related materials were placed on the Web page for review by anyone at any time. DEQ also provided information and documentation in "hard-copy" form when requested, throughout the public comment process.

1. Watershed 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 streams within the Fish Creek watershed in the Upper Spokane River Subbasin that are included in Idaho's current §303(d) list of impaired water bodies (IDEQ 2005a).

The overall purpose of the watershed assessment (WSA) and TMDL is to characterize and document pollutant loads within the Fish Creek watershed. The first portion of this document, the WSA, 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 was then used to develop a TMDL for each pollutant of concern for the Fish Creek watershed (Section 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act (CWA). 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 CWA 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, which must also be approved by EPA. 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, also referred to as Section 5 of the Integrated Report, identifies water bodies that do not meet water quality standards. Waters included on this list require further analysis. A WSA and TMDL provide a summary of the water quality status and allowable pollutant loads for water bodies on the §303(d) list. The *Fish Creek Watershed Assessment and Total Maximum Daily Load* provides this summary for the currently listed waters of the Fish Creek watershed.

The WSA portion of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and pollutant control actions that have been taken and are currently in place for the Fish Creek watershed 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 sets pollutant targets aimed at improving 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 specific to individual water bodies and pollutants. The TMDL also includes allocations of allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA considers some human-caused conditions "pollution," although the conditions are not caused by the discharge of specific pollutants. These conditions include flow alteration, human-caused lack of flow, and habitat alteration. A TMDL is only required when a pollutant can be identified and 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 in Idaho include the following:

- Aquatic life support: cold water, seasonal cold water, warm water, salmonid spawning, modified
- Recreation: primary contact (swimming), secondary contact (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 or secondary contact recreation are used as additional default designated uses when water bodies are assessed.

A WSA 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

Fish Creek originates in the mountain slopes of Mount Spokane State Park, Washington and flows east approximately 5.5 miles until it reaches upper Twin Lake (Figure 1). Fish Creek is the largest tributary flowing into upper Twin Lake and, consequently, lower Twin Lake. The Fish Creek watershed drains approximately 14,200 acres, most of which is mountainous and forested terrain that is managed for timber production and agriculture (IDL 2001).

The following background information about the watershed will help with better understanding the current and potential causes of water quality impairment.

Climate

This region is characterized by warm, dry summers and cool, wet winters. Both pacific maritime air masses from the west and northern continental air masses from Canada influence the local climate. These air masses effectively control the warmth of the summers and winters depending upon their direction. The lower elevations (below 3,000 feet) receive precipitation in the form of rain, while in the adjacent mountains precipitation falls in the form of snow in the winter months, at elevations above 4,500 feet. Average annual snowpack in the upper watershed approaches 3.3 feet (CLCC 1991). There is a transitional zone between 3,000 and 4,500 feet that holds a transient snow pack. This snow pack is subject to rapid melting when warm wet pacific air masses predominate, resulting in high discharge rain on snow events (IDEQ 2000).

Climatic parameters have been measured at the headwaters of Fish Creek, from 1953 to 1972, at a weather monitoring station located at the summit of Mount Spokane in Washington. The weather experienced at the summit of Mount Spokane directly affects the hydrologic regime of the Fish Creek watershed. The average total monthly precipitation measured at the Mount Spokane summit is detailed in Figure 2. The average monthly values reflect the wet winters, dry summers, and transition periods between the seasons.

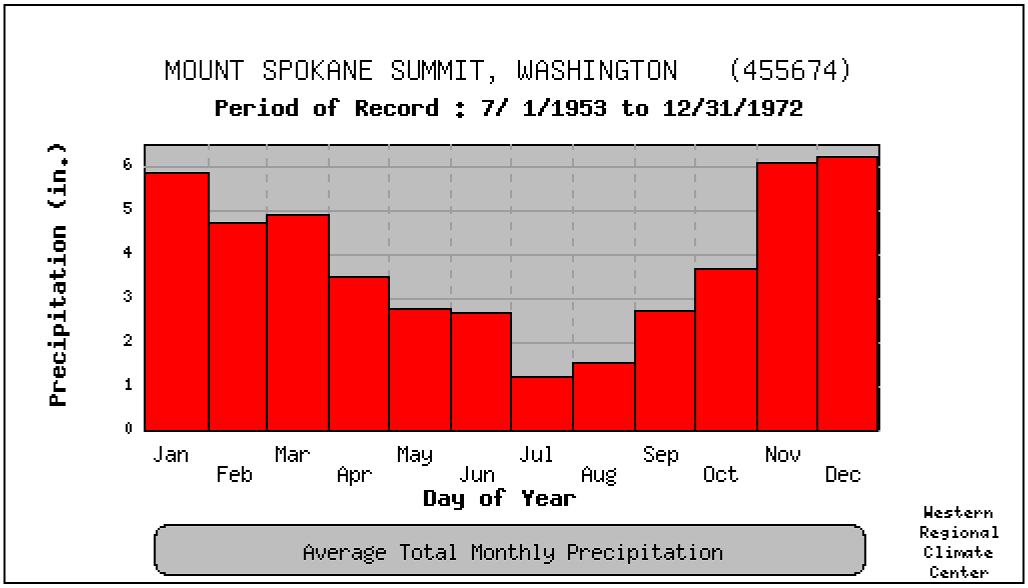

Figure 2. Average total monthly precipitation measured at Mount Spokane summit from July 1, 1953 to December 31, 1972.

The average daily precipitation has been relatively stable throughout the year, with precipitation during the summer months ranging from 0 to 2.1 inches, while the winter precipitation ranging within 0.1 to 3.4 inches (Figure 3). Records indicate extreme precipitation events have been highly variable, with the largest daily precipitation events reaching 3.5 inches (Figure 3) (WRCC 2007).

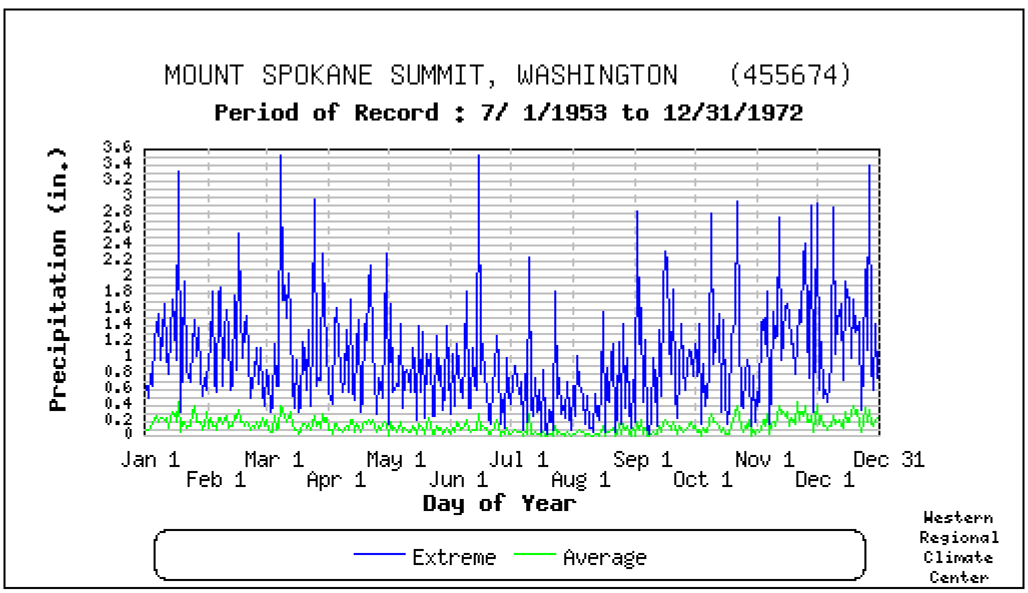

Figure 3. Average and extreme daily precipitation measured at Mount Spokane summit from July 1, 1953 to December 31, 1972.

Average air temperatures appear stable with an average maximum temperature of 59.1 ^{o}F and an average minimum temperature of 30 ^{o}F. However, air temperature extremes can reach 90+ ^{o}F in August and 30 ^{o}F below zero in December (Figure 4) (WRCC 2007).

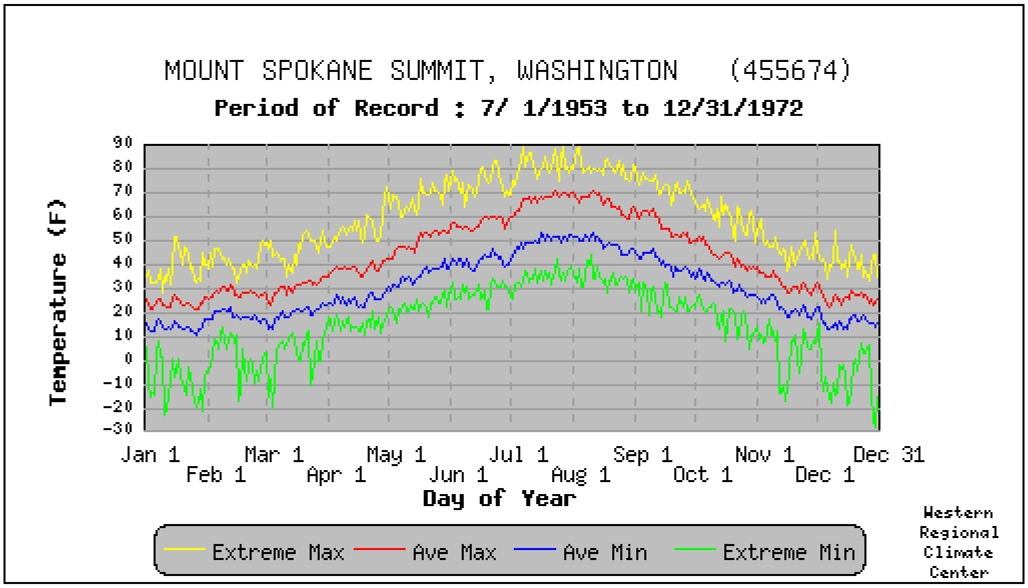

Figure 4. Air temperature trends at Mount Spokane summit from July 1, 1953 to December 31, 1972.

Fish Creek Watershed Characteristics

Hydrography

Originating in Washington, the Fish Creek watershed drains approximately 14,200 acres, approximately 1,500 of which are located in Washington, as it flows into Idaho and drains into Twin Lakes. Fish Creek is a third order tributary with a dendritic stream feeder pattern. The drainage is oriented in an easterly direction with side tributaries draining mostly from the north, northwest, south and southwest (IDL 2001). Tributaries draining into Fish Creek, especially in the headwaters, are likely to be Rosgen type (1996) A and B, characterized by a gradient ranging from 2.5% to 4%. The mainstem of Fish Creek, as it loses elevation, is primarily a Rosgen type C stream with a gradient ranging from less than 1% to 2%.

Presently, no long term discharge data exists for the Fish Creek watershed. Falter and Hallock (1987) recorded inflows from the tributaries into Twin Lakes. There are 13 surface inflows to Twin Lakes, however, Fish Creek is by far the largest contributor. During the Falter and Hallock study, peak runoff for Fish Creek occurred between February 25, 1986 and April 5, 1986, with flows recorded at 56.5 cfs (Falter and Hallock 1987). Summer flows were 9.8 cfs.

To give an idea of the yearly hydrological regime for the Upper Spokane Subbasin, discharge data taken from the USGS gaging station located on Hayden Creek (12416500) are shown below. These discharge data reflect the high flows during spring melting events that are characteristic of the subbasin (Figure 5).

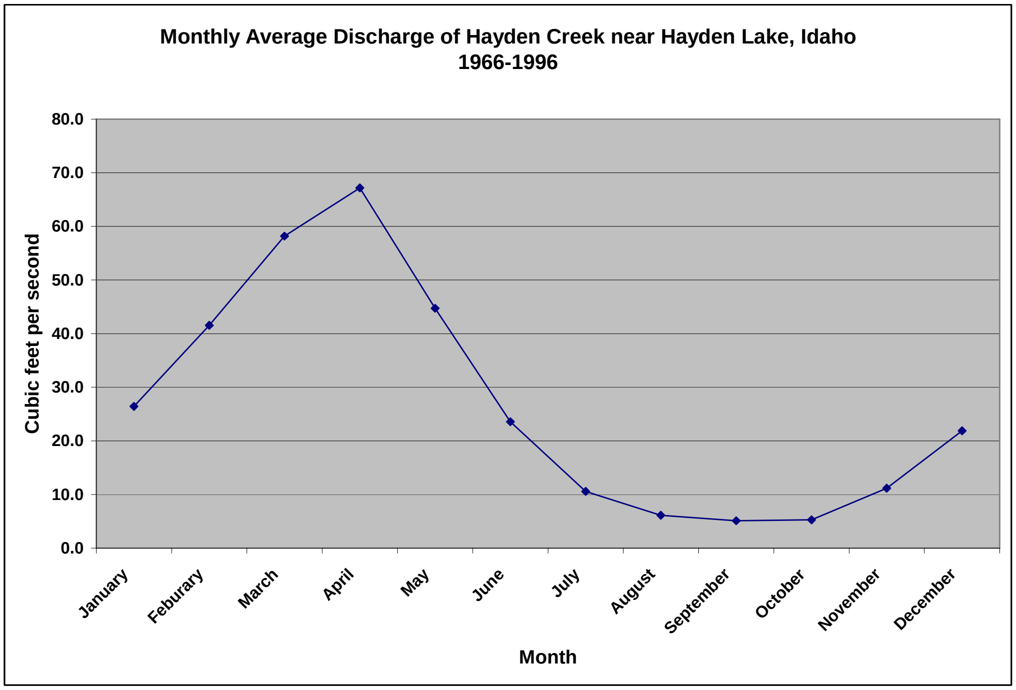

Figure 5. Monthly average discharge of Hayden Creek near Hayden Lake, Idaho from 1966 to 1996.

Monthly averages and peak flows are highly variable from year to year; factors contributing to the variability include snow pack, the prevalence of rain-on-snow events, and spring rain. The graph in Figure 6 gives a representative outlook on the historic discharge of Hayden Creek, which is used as an example to represent discharge patterns for Fish Creek.

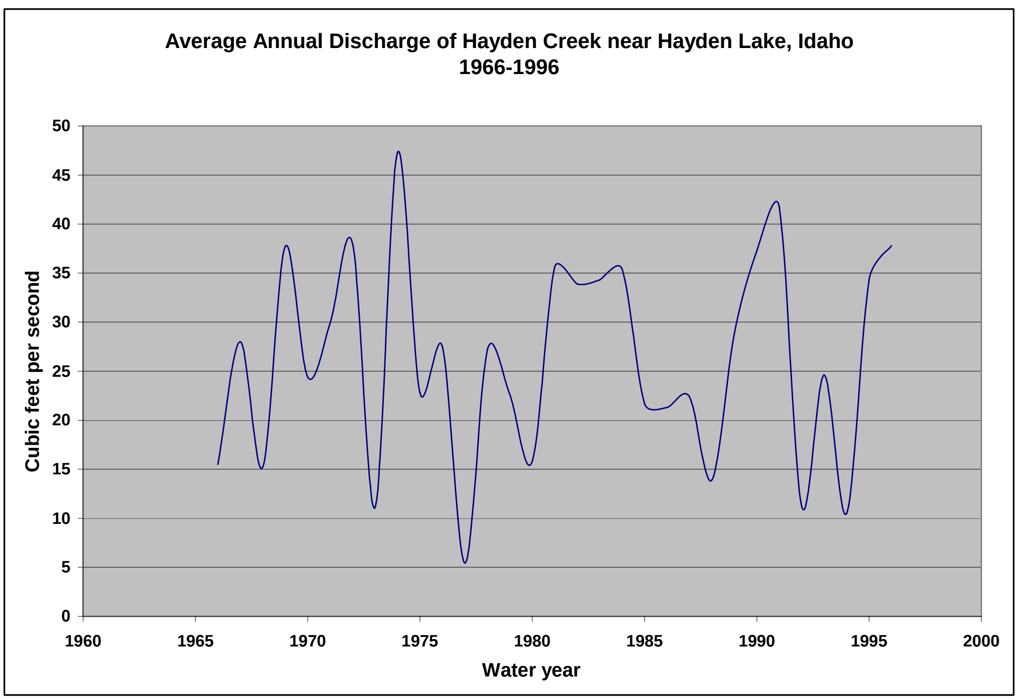

Figure 6. Average annual discharge of Hayden Creek near Hayden Lake, Idaho from 1966 to 1996.

Geology

The Fish Creek watershed is mostly underlain with highly and weakly weathered schist and gneiss of the Belt Supergroup rock series (Figure 7). Highly and weakly weathered granitic rocks of the Kaniksu Batholith are also found within the drainage. The lower reaches near the mouth of the creek are comprised of course textured alluvium (IDL 2001). The granitic substrates ultimately weather to sandy substrates and comprise the majority of the bedload found in streams. Deposition of flood and glacial lake gravels can be found in small pockets throughout the Fish Creek watershed. These gravels were deposited by the repeated and massive glacial outburst floods near the present day location of Lake Pend Oreille that occurred late in the Pleistocene. Flood gravels comprise the majority of the Rathdrum Prairie which lies to the east of the Fish Creek watershed and constitutes the matrix of the Spokane Valley-Rathdrum Prairie Aquifer (IDEQ 2000, SAJB 2004). Approximately 10,000 years ago, Fish Creek was dammed by glacial moraine, consequently forming Twin Lakes (Falter and Hallock 1987).

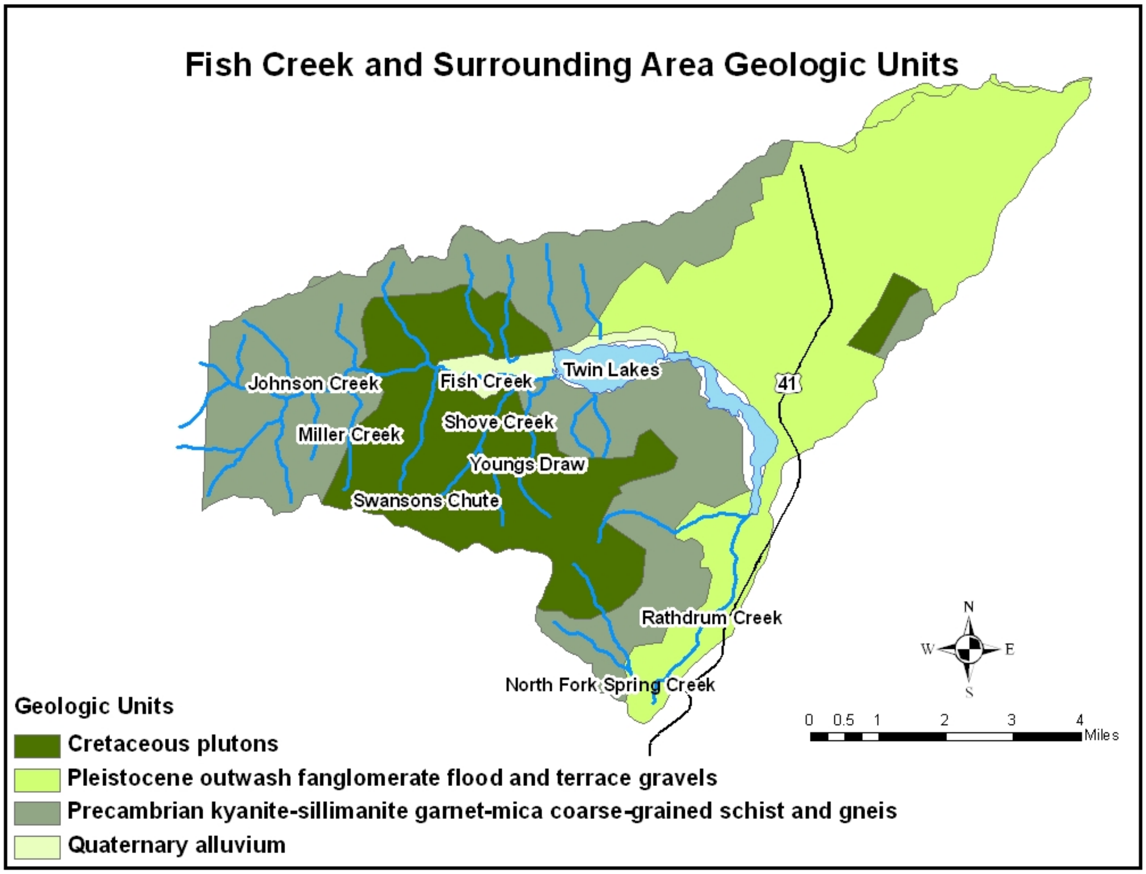

Figure 7. Fish Creek and surrounding area geologic units.

Soils

For the Fish Creek area, soil units included in the State Soil Geographic Database (STATSGO) are shown in Figure 8. All soils observed in the area are discussed below.

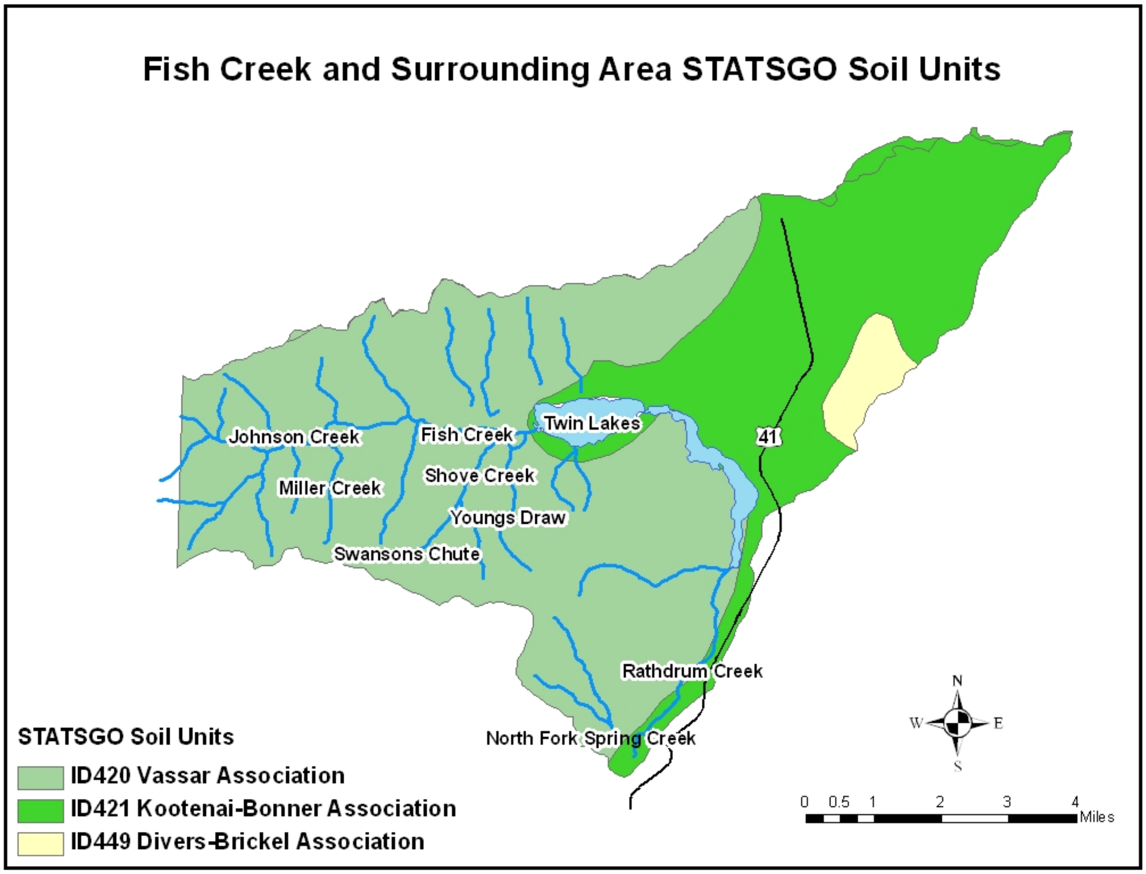

Figure 8. Fish Creek and surrounding area STATSGO soil units.

Soils bordering Twin Lakes to the east include The Kootenai-Bonner Association (Figure 8). This soil group is comprised of nearly level to moderately steep, well drained soils that were formed in glacial outwash mantled with loess and volcanic ash. Woodlands are the primary land use for this soil group, with a few small areas used for hay, grain, and pasture; however, farming is not ideal due to the coarseness of the soil profile and rapid permeability of the substratum. These soils have good potential for woodland wildlife habitat and also urban and suburban development (Weisel 1981).

The Vassar Association includes very steep, deep soils formed in volcanic ash and loess over weathered granitic rock, and is found west of Twin Lakes within the Fish Creek watershed (Figure 8). The primary use of these soils is woodland, however, some areas are cleared for grazing. The steep slopes and high hazard of erosion are the main limitations for timber production and harvesting. These soils provide good woodland wildlife habitat, but have poor potential for residential and urban development because of inaccessibility and steep slopes (Weisel 1981).

The Pywell-Cald-Cougarbay Association is found in a relatively small pocket near the mouth of Fish Creek. This soil group includes level and nearly level, very poorly drained and poorly drained peat and stratified mineral soils that formed in alluvium and organic materials. The primary use of this soil group is hay, pasture, and small grain. Flooding and wetness limit any practical residential development. Wetlands and rangeland wildlife habitats have the best potential for utilizing these soils (Weisel 1981).

The Slickens-Xerofluvents Association is found in a relatively small pocket to the south of Fish Creek. This soil group is comprised of slickens, nearly level, poorly drained stratified soils that formed in alluvium. The soils are used for some woodland and grazing; farming is not feasible due to the continuous overflowing and the composition of soil materials. Urban and residential development is also limited due to the flooding and a high water table. Wetland wildlife habitat has the greatest potential under these soil conditions and woodland habitat has fair potential (Weisel 1981).

The Divers-Brickel Association is found in the upper reaches of the Fish Creek watershed, they comprise the soils found at the surrounding mountain summits (Figure 8). Characteristics include sloping to very steep, moderately deep, and deep soils that formed in material weathered from metasedimentary and granitic rock mantled and mixed with loess and volcanic ash. These soils are used for woodland habitat, recreation, watershed, and limited grazing. Slope, cold climate, and erosive characteristics limit most if not all development (Weisel 1981).

In 1983, Kootenai County prepared an erosion risk map and categorized the soils of the watershed as high to moderately erosive, based upon the soil types and slopes (Kootenai County Lakes Master Plan as cited in CLCC 1991).

Topography

Fish Creek originates in the mountainous terrain just across the Idaho border in Washington. Mountain elevations in the Fish Creek watershed range from 4,880 to 5,100 feet. Elevations of the downstream reaches of Fish Creek as it approaches Twin Lakes range from 3,200 to 2,800 feet. Elevation at the mouth of the stream is approximately 2,300 feet.

Vegetation

Vegetation in the Fish Creek watershed varies with elevation and aspect. The higher elevations support a mixed coniferous forest, including Ponderosa pine, grand fir, Douglas fir, larch, western red cedar, hemlock, lodgepole pine, western white pine, and at the highest elevations, spruce. The south- and west-facing aspects support more xeric species that are tolerant of dry conditions. The lowlands typically support the cedar/hemlock habitat types. The riparian areas support cottonwood, aspen, alder, willow, and other water-tolerant species (IDL 2001).

Fisheries and Aquatic Fauna

During Beneficial Use Reconnaissance Program (BURP) electrofishing efforts of Fish Creek and tributaries to Fish Creek (2007, 2001, 1999, 1996, and 1995), fish species have been recorded that include rainbow (*Oncorhynchus mykiss*), cutthroat (*O. clarki*), and brook trout (S*alvelinus fontinalis*), slimy sculpin (*Cottus cognatus*), shorthead sculpin (*C. confusus*), and other species. During these sampling events, brook trout were sampled in the largest numbers.

The native salmonids of the Upper Spokane Subbasin's streams are cutthroat trout, whitefish, and bull trout (IDEQ 2000). Sculpin, shiners, and bullhead catfish are the non-salmonid native species. Fish fauna of the lakes and some streams have been greatly altered by the introduction of several trout, salmon, and warm-water species. From 1979 through 1984, Upper Twin Lake was stocked with an average of 11,900 rainbow trout each year. In addition, 12,100 kokanee (*O. nerka*), Kamloops rainbow trout, and brook trout were stocked in this 6-year period.

Despite the introduction of different species, some headwater streams retain the complement of native species except for the addition of brook trout and the loss of bull trout. Amphibian and reptile species include Coeur d'Alene salamander, Rocky Mountain salamander, American bullfrog, tailed frog, painted turtles, terrestrial and common garter snake, western skink, and tree frog.

Subbasin Characteristics

The Fish Creek watershed is located within the Upper Spokane hydrologic unit (hydrologic unit code [HUC] 17010305). Other major water bodies located within the Upper Spokane Subbasin include the Spokane River from Lake Coeur d'Alene to the Idaho/Washington border, Hayden Lake, Hayden Creek, Rathdrum Creek, Hauser Lake, Hauser Creek, and Upper and Lower Twin Lakes (Figure 1).

The Upper Spokane Subbasin landscape is dominated by the Rathdrum Prairie. The Rathdrum Prairie encompasses an area of approximately 125,000 acres in Idaho and is made up of glacial outwash deposits generated during flooding from glacial lakes. Beneath the Rathdrum Prairies lies the Rathdrum Prairie Aquifer. The aquifer was designated in 1978 by the EPA as a sole source aquifer. Currently, the aquifer, which stretches into Washington state, is estimated to supply drinking water to 400,000 residents living in the area.

Streams flowing over the Rathdrum Prairie dissipate into the ground and are a major source of ground water recharge. Lakes located near the Rathdrum Prairie also contribute to ground water recharge.

Rathdrum Butte, 5,000 feet above mean sea level, is the highest point in the Idaho portion of the Upper Spokane Subbasin and the Spokane River at the Idaho/Washington state line is the lowest at about 2,000 feet above mean sea level. The Rathdrum Prairie is relatively flat with some rolling hills.

Stream Characteristics

Fish Creek is a third order tributary to Upper Twin Lake and progresses from a Rosgen type A channel in the headwater reaches, transitions into a Rosgen type B and C channel, and then to a Rosgen type F channel near the confluence with the lake. Lower reaches of Fish Creek have a stream gradient generally greater than 1% but no greater than 3%. The stream wetted width in the lower reaches is generally 8 to 10 meters.

Tributaries to the mainstem of Fish Creek include Johnson Creek, Miller Creek, Swanson Creek, Shove Chute, and Youngs Draw. Numerous other first and second order tributaries exist but are unnamed. Tributaries to Fish Creek generally exhibit Rosgen A channel types with widths no greater than 2 meters. Table 1 outlines specific stream measures taken at BURP locations in the Fish Creek watershed used to determine site-specific stream characteristics.

The majority of the watershed is forested with a small amount of land actively managed for agriculture and grazing located near the mouth of Fish Creek. Riparian vegetation within the upper reaches of the Fish Creek watershed consists of coniferous species. Riparian vegetation in the lower reaches of Fish Creek is more diverse and consists of a mix of coniferous and deciduous species. See section 5 of this report for further discussion of riparian vegetation.

Table 1. Stream channel characteristics at Fish Creek Watershed BURP sites.

BURP ID	Average Bankfull Width (m)	Average Bankfull Height (m)	Average Wetted Width (m)	Average Wetted Depth (m)	Gradient (%)	Rosgen Channel Type	Stream Order
2006SCDAA007	5.6	0.34	4.6	0.22	1	C	3
2001SCDAA001	7.4	0.6	5.8	0.14	2	B	3
1999SCDAA001	5.5	0.37	4.14	0.85	3	B	3
1998SCDAA001	5.9	0.27	5.4	0.91	1	C	3
1997SCDAA003	10	0.61	5.4	0.47	4	B	3
1997SCDAA002	15.5	0.69	6.1	0.27	2.5	B	2
1996SCDAA001	NA	NA	6.6	0.63	3.5	B	3
1995SCDAA003	6.3	0.45	5.3	0.35	1.5	B	3

1.3 Cultural Characteristics

The Fish Creek watershed harbors a rural residential community. Most people living within the watershed reside around the peripheries of Upper and Lower Twin Lakes. The closest city is Rathdrum, which is approximately 6 miles south of the Fish Creek watershed. Coeur d'Alene, the largest city within proximity to the watershed, is located 17 miles southwest of Fish Creek.

Land use

The predominant land use activity in the Fish Creek watershed is timber harvesting, with some grazing on small pastures and hay crop along the stream valleys (Figure 9). Historically, the watershed was utilized for timber production. Heavy timber harvest in the past has resulted in degraded terrestrial and aquatic habitats. Many of the legacy land use activities that are no longer occurring are still influencing Fish Creek. One of these legacy land uses was a railroad located adjacent to Fish Creek and utilized for transporting natural resources.

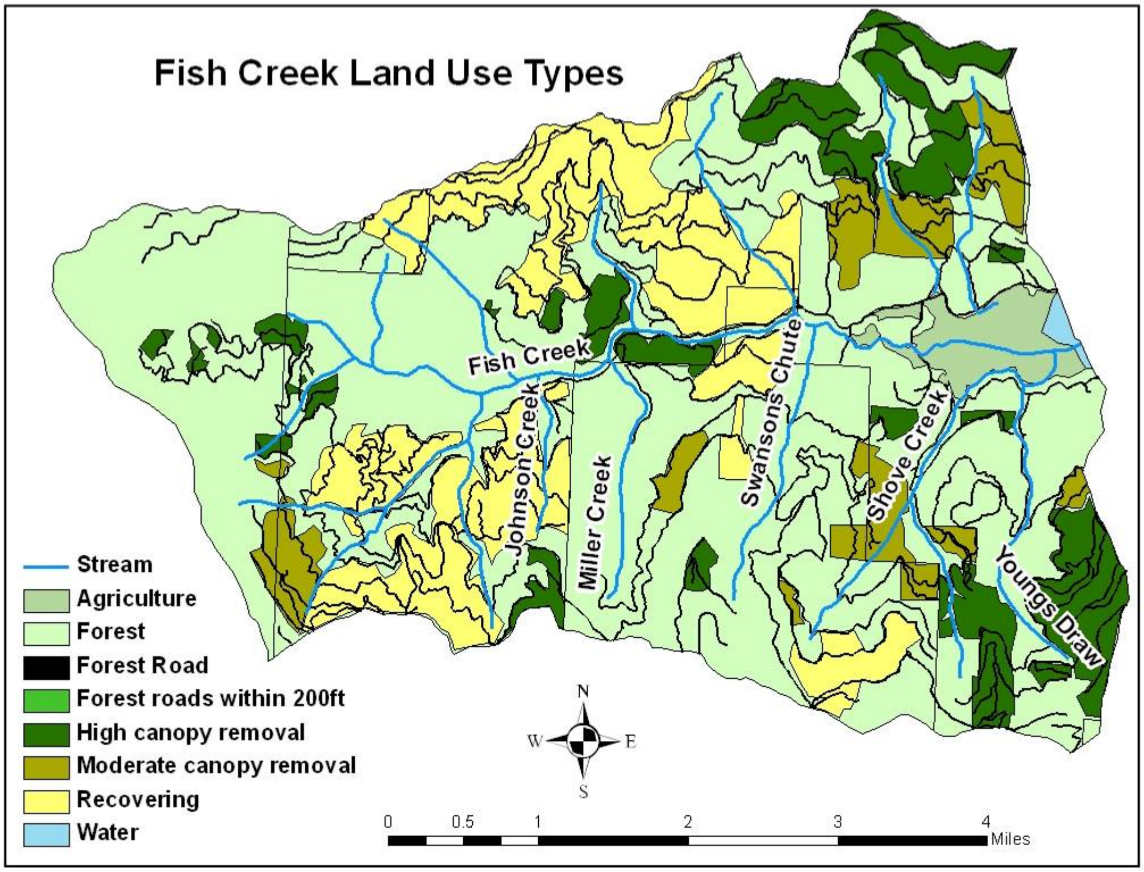

Figure 9. Fish Creek land use types.

Land Ownership, Cultural Features, and Population

Residential and commercial development is rapidly increasing, as evidenced by changes between the 1990 and 2000 censuses; nearly a 56% population increase occurred in Kootenai County, Idaho (Caldwell and Bowers 2003). Most of the housing is located around Upper and Lower Twin Lakes. Restricted residential zoning allows for development within 25 feet from the lake shore and allows five dwellings per acre. This configuration of development allows for greater stormwater runoff and more readily carries contaminants into the lake due to the impermeable surfaces (CLCC 1991).

Land ownership within the Fish Creek watershed is primarily private. Small sections of land are owned and managed by the State of Idaho (Figure 10). Timber companies own approximately 90% of the watershed (Figure 10) and manage the land for timber harvest.

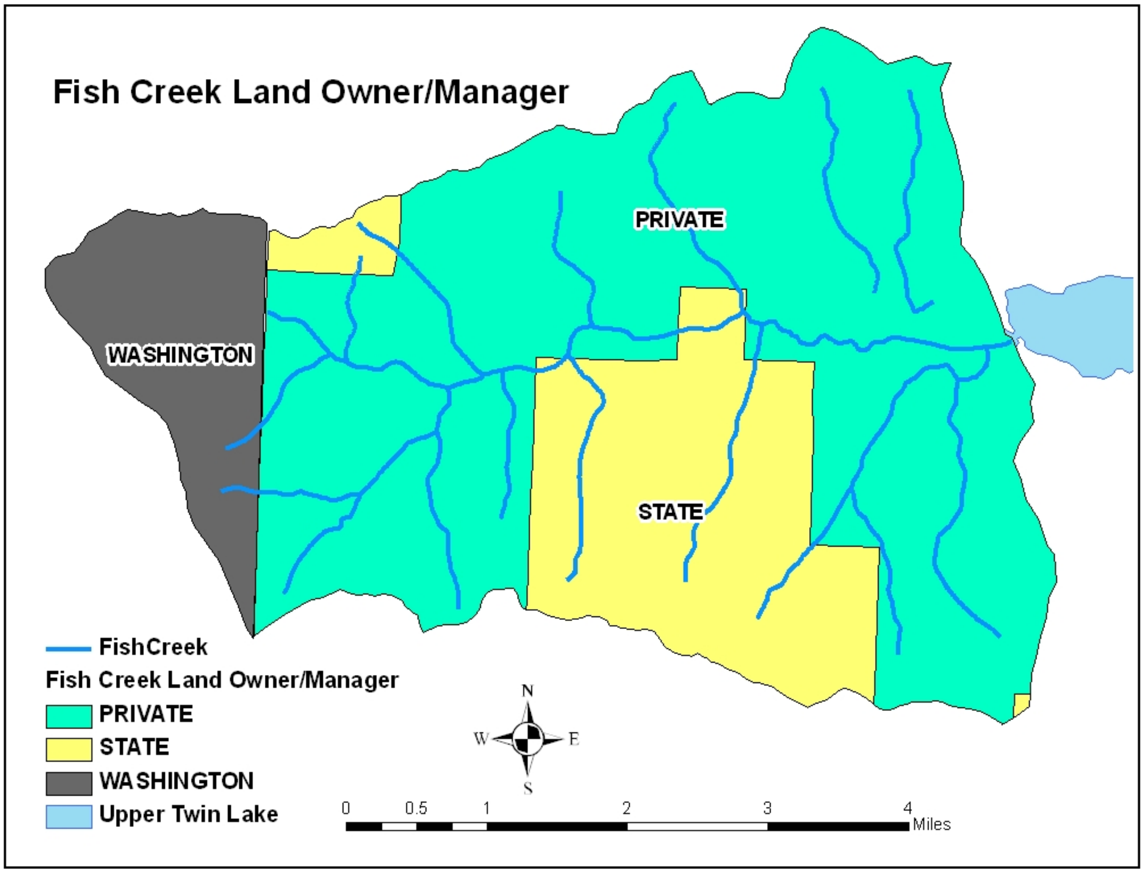

Figure 10. Fish Creek land ownership.

History and Economics

Prior to Euro-American settlement, Native American tribes (Coeur d'Alene, Spokane, Colville, and Kalispell) subsisted off the abundant natural resources found in the area. During the 1800s, resource extraction took hold of the region as resources were believed to be infinite. Mountains were logged, valleys were mined, and prairies were cultivated. By the 1880s, the town of Rathdrum was a major supply point for the Coeur d'Alene mining district and was also home to a very prosperous rail center that connected eastern Washington to Canada and Montana. There were four major rail lines and six lumber mills in the area by 1930, and the majority of the resources were exported. Since the 1950s, the recreation and tourism industry has become more of a focal point for the area. The 1970s brought on great growth and development surges. In the 1980s, growth slowed, including in the mining and logging industries. Today, however, the area is growing steadily, with recreation and tourism still being a predominant industry for the area (KCPC 1993). Presently, logging is the most predominant activity occurring within the Fish Creek watershed, with a few small, dispersed agricultural operations . The Inland Empire Paper Company (IEPC) owns the vast majority of land in the Fish Creek watershed.

There are three county recreation sites located on both Upper and Lower Twin lakes, and one site between the two lakes. These sites are popular throughout the summer months for fishing and boating activities. The IEPC also allows the public to use their land for recreational activities such as hiking and wildlife viewing. Camping and motorized vehicles off the main roads are not allowed on IEPC land.

Landowner involvement in water quality issues in the Fish Creek watershed began as early as 1957 with the formation of the Twin Lakes Improvement Association (TLIA). This non-profit group worked to defend the water rights of lake users and has grown to include general management of the lakes use and protection of the lakes as a valuable resource. The North Idaho Lake Association Coalition (NILAC), created in 1985, focuses on lake management problems of mutual concern and ways to enhance their legislative power. Residents of the area are specifically concerned with degraded water quality of Twin Lakes. The TLIA funded a limnological study of Twin Lakes to collect baseline data and propose management objectives based upon said data (Falter and Hallock 1987).

Currently, there are two active citizen groups working within the Twin Lakes watersheds. Twin Lakes Homeowners Association is actively working to improve water quality in Upper and Lower Twin Lakes through public education and restoration projects. Twin Lakes Citizen Volunteer Monitoring Program is actively collecting data on Upper and Lower Twin Lakes in an effort to monitor trends in water quality.

2. Watershed Assessment– Water Quality Concerns and Status

Water quality problems have been monitored and documented within the Twin Lakes watershed since at least 1985 and possibly earlier. The watershed has experienced impacts from agriculture, silviculture, and rural development. Substantial work has been done Upper and Lower Twin Lakes to characterize the trophic status of the lakes. From this research, Fish Creek has been identified as an area of concern.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

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

Fish Creek and its tributaries are listed in section 5 of Idaho's 2002 Integrated Report (also known as the 303(d) list) for impairment due to sediment, temperature, and causes unknown (Table 2). A discussion of the pollutants, available data, beneficial uses, and exceedances of Idaho water quality standards is presented in the following sections.

Table 2. Integrated Report Section 5 (303(d)-listed) segments in the Fish Creek watershed.

Water Body Name	Assessment Unit ID Number	Watershed Boundaries	Pollutant(s)	Listing Basis
Fish Creek, tributaries	ID17010305PN0014_02	First and second order tributaries to Fish Creek	Temperature	DEQ Assessment
Fish Creek, mainstem	ID17010305PN0014_03	Third order portion of Fish Creek, from approximately 650 meters up-stream of Johnson Creek/Fish Creek confluence to mouth	Unknown, Sediment, and Temperature	DEQ Assessment

<u>About Assessment Units</u>

Assessment units (AUs) 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).

AUs 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 fulfills the fundamental requirement of the 305(b) report required by EPA, 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.

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 subbasin assessments (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. Assessment units help to better track surface water quality status within Idaho.

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

Table 2 shows the pollutants and the listing basis for each §303(d)-listed AU in the Fish Creek watershed. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections.

The mainstem of Fish Creek is identified as not supporting beneficial uses and is impaired by causes unknown, sediment, and temperature. This portion of Fish Creek (ID17010305PN0014_03) is the third order portion of the stream, which begins approximately 650 meters (2,130 feet) up-stream from the Fish Creek/Johnson Creek confluence and continues to its confluence with Upper Twin Lake (its mouth) (Figure 11).

Tributaries to Fish Creek (ID17010305PN0014_02) include Young's Draw, Shove Creek, Swanson Chute, Miller Creek, Johnson Creek, and eight other first- and second-order unnamed tributaries (Figure 11). This AU is not supporting beneficial uses and is impaired by elevated water temperatures.

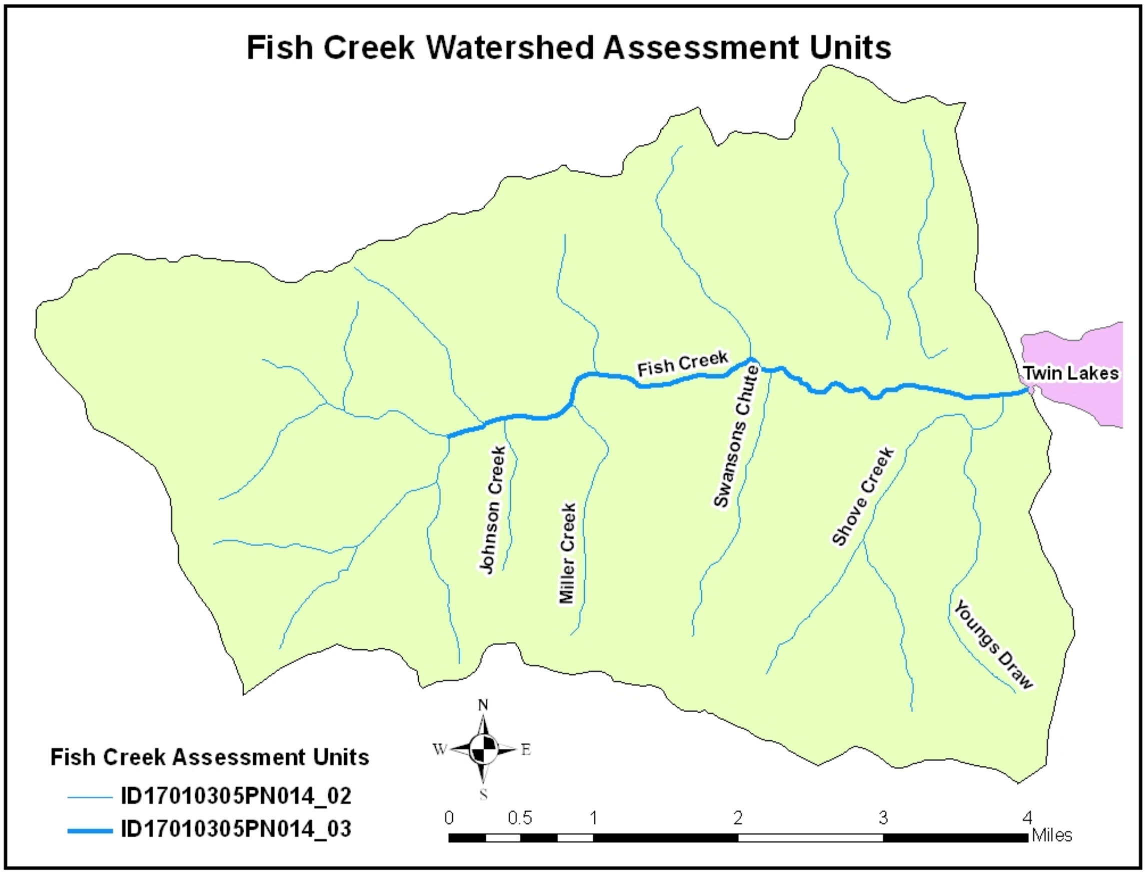

Figure 11. Fish Creek watershed assessment units.

Fish Creek and its tributaries were first identified as impaired in 1992 and included in Idaho's water quality status report. Pollutants of concern in 1992 were identified as nutrients and sediment. Fish Creek was carried from the 1992 report and included on Idaho's 1994/1996 §303(d) list and 1998 §303(d) list as being impaired due to excess nutrients and sediment. In 2002, the Fish Creek mainstem (ID17010305PN0014_03) was listed for temperature, sediment, and causes unknown. In addition, tributaries to Fish Creek (ID17010305PN0014_02) were added to the 2002 list for temperature exceedances.

2.2 Applicable Water Quality Standards

Beneficial uses within the Fish Creek watershed from the Idaho/Washington border to Twin Lakes have been presumed. Salmonid spawning in the Fish Creek watershed is an existing use. Below is a detailed discussion of beneficial existing, designated, and presumed uses.

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, designated, or presumed, 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 body that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Sampling efforts support the application of salmonid spawning water quality criteria within the Fish Creek watershed and the existing use designation. During electro-fishing efforts conducted by DEQ in 1995, 1996, 1999, 2001, and 2007, multiple age classes of salmonids were collected. The presence of multiple age classes indicates that salmonid spawning is occurring within the Fish Creek watershed. Refer to section 2.4 for fisheries information.

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, 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

If beneficial uses are not otherwise designated, and lacking 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 "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), then because of the requirement to protect levels of water quality for existing uses, the additional numeric criteria for the additional existing use(s) would 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 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 of Fish Creek from the Idaho/Washington state line are presumed and existing (Table 3). Cold water aquatic life, primary contact recreation, agricultural water supply, and domestic water supply are all presumed uses for the Fish Creek watershed. The presence of multiple age classes of native salmonid species supports the establishment of salmonid spawning as an existing beneficial use.

Table 3. Beneficial uses of §303(d)-listed streams within the Fish Creek watershed.

Water Body	Uses[1]	Type of Use
Fish Creek, mainstem and tributaries	CW, PRC, AWS, DWS	Presumed
Fish Creek, mainstem and tributaries	SS	Existing

[1]CW – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply

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 4).

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 4 includes the most common numeric criteria used in TMDLs. Figure 12 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 4. Selected numeric criteria in Idaho water quality standards (IDAPA 58.01.02.250).

	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)**
Bacteria, pH, and Dissolved Oxygen	Less than 126 *Escherichia coli* per 100 milliliters as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 Dissolved Oxygen (DO) exceeds 6.0 mg/L[a]	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[b]			22 °C or less daily maximum; 19 °C or less daily average Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °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[c] instantaneously or more than 25 NTU for more than 10 consecutive days.	
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	

[a] mg/L - milligrams per liter

[b] 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.

[c] NTU - nephelometric turbidity units

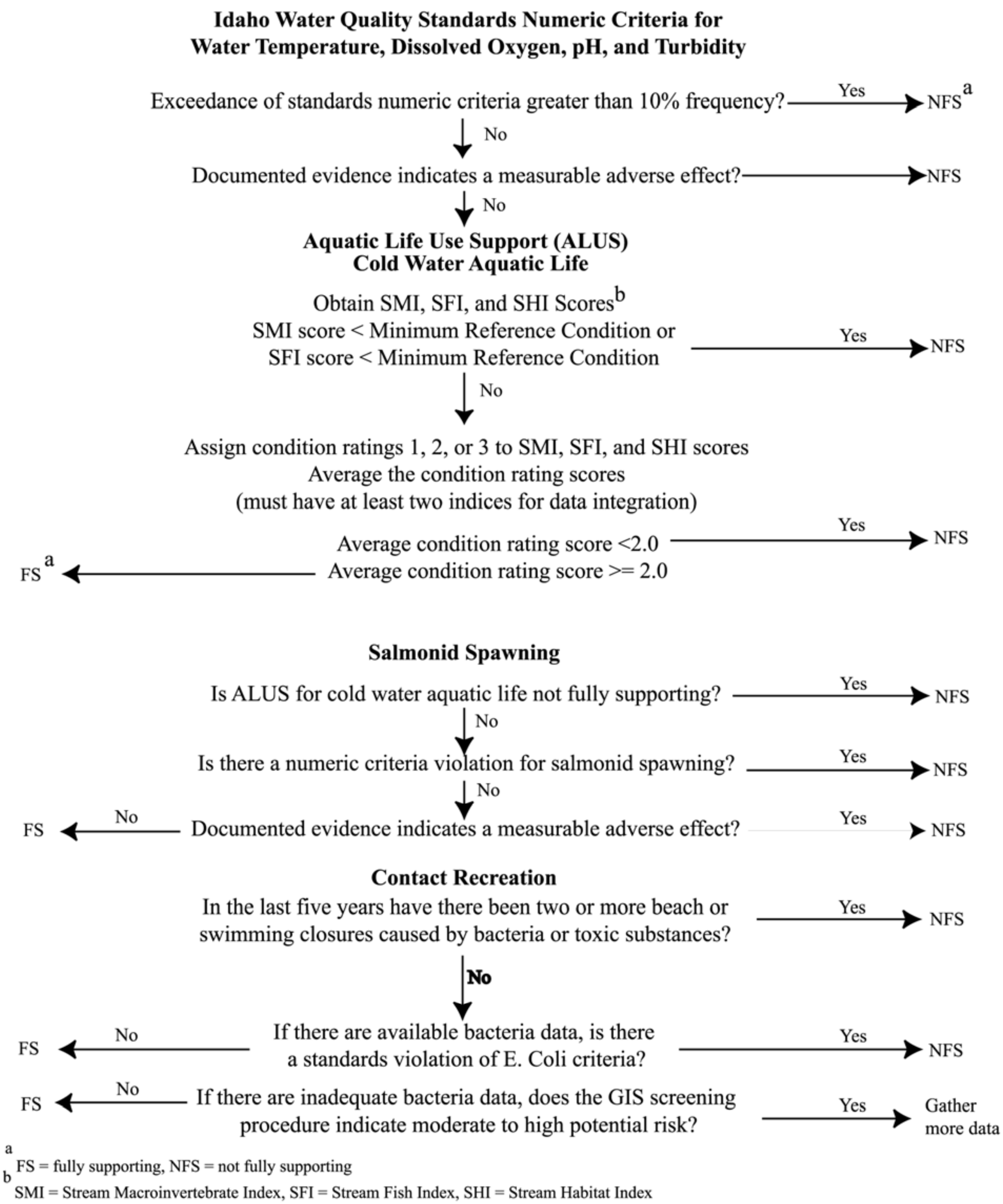

Figure 12. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance*, Second Addition (Grafe *et al*. 2002).

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. For example, streams naturally have sediment and nutrients, 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. Water temperature dictates whether a warm, cool, or cold water aquatic community is present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors influencing stream temperature 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. Acute high temperatures can result in death. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower temperature changes than the adults, manifesting in retarded growth rates. Temperature also strongly affects embryonic development of fish. Similar kinds of effects may occur to aquatic invertebrates, amphibians, and mollusks, although less is known about them.

Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen (the remainder) is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

Dissolved oxygen concentrations of 6 mg/L and greater are considered optimal for aquatic life. When DO falls to less than 6 mg/L, organisms are stressed, and if DO remains less than 3 mg/L for a prolonged period, these organisms may die. Dissolved oxygen that remains at less than 1-2 mg/L for a few hours can result in large fish kills. Conditions with dissolved oxygen less than 1 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO. Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they may be less able to seek more oxygenated water).

The amount of dissolved oxygen reflects the health or the balance of the aquatic ecosystem. Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water from photosynthesis and from the atmosphere. Where water is more turbulent (e.g., in riffles and cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering the water is called aeration. In addition, oxygen is necessary to fuel microbial decomposition of organic matter in the water and bottom sediments. Water bodies with extensive aquatic plant communities can have significant DO fluctuations throughout the day. A sag in dissolved oxygen will typically occur once photosynthesis stops at night and respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with the advent of daylight.

Temperature, flow, nutrient loading, and channel alteration all impact the amount of DO in the water. Colder waters hold more DO than warmer waters. As flows decrease, the amount of aeration typically decreases and the in-stream temperature increases, resulting in decreased DO. Channels that have been channelized or altered for water conveyance often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before the alteration. Nutrient-enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower in-stream DO levels.

Sediment

Excessive sediment of all sizes can have negative effects on aquatic life communities, including suspended sediment (floating in the water column) and bedload sediment (moves along the stream bottom). 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 datasets are more limited. 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 some 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 (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-µm (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.

Bacteria

Escherichia coli or *E. coli*, a species of fecal coliform bacteria, is used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. Pathogens are a small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa), which, if taken into the body through contaminated water or food, can cause sickness or even death. Some pathogens are also able to cause illness by entering the body through the skin or mucous membranes. *E. coli* is often measured in colony forming units (cfu) per 100 ml (cfu/100ml).

Direct measurement of pathogens in surface water is difficult because they usually occur in very low numbers and analysis methods are often unreliable and expensive. Consequently, indicator bacteria that are often associated with pathogens, but which generally occur in higher concentrations and are thus more easily measured, are assessed.

Coliform bacteria are unicellular organisms found in feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (National Pollution Discharge Elimination System [NPDES] permits), but may also be monitored for nonpoint sources. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, and diarrhea to acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically required to obtain permits and offer bacteria-reducing water treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact on bacteria concentrations in water bodies. This is particularly the case in urban storm water and agricultural areas.

Nutrients

While nutrients are a natural component of aquatic ecosystems, natural cycles can be disrupted by increased nutrient inputs from anthropogenic activities. The excess nutrients result in accelerated plant growth and can result in a eutrophic or enriched system.

The first step in identifying a water body’s response to nutrient flux is to define which of the critical nutrients is limiting. A limiting nutrient is one that is normally in short supply relative to biological needs. The relative quantity affects the rate of production of aquatic biomass. Either phosphorus or nitrogen may be the limiting factor for algal growth, although phosphorus is most commonly the limiting nutrient in Idaho waters. Ecologically speaking, a resource is considered limiting if the addition of that resource increases growth of aquatic plants.

Total phosphorus (TP) is the measurement of all forms of phosphorus in a water sample, including all inorganic and organic particulate and soluble forms. In freshwater systems, typically more than 90% of the TP present occurs in organic forms as cellular constituents in the biota or adsorbed to particulate materials (Wetzel 1983). The remainder (10% or less of the total phosphorus) is mainly soluble orthophosphate, a form of phosphorus more biologically available than TP, which consequently leads to a more rapid growth of algae. In impaired systems, a larger percentage of the TP fraction is composed of orthophosphate. The relative amount of each form measured can provide information on the potential for algal growth within the system.

Nitrogen may be a limiting factor at certain times if there is substantial depletion of nitrogen in sediments due to uptake by rooted macrophyte beds. In aquatic systems limited by nitrogen, blue-green algae may dominate the phytoplankton community due to their high ability to metabolize nitrogen.

Total nitrogen to TP ratios greater than 7.0 are indicative of a phosphorus-limited system while those ratios when less than 7.0 are indicative of a nitrogen-limited system. Only biologically available forms of the nutrients are used in the ratios because these are the forms that are used by the immediate aquatic community.

Nutrients primarily cycle between the water column and sediment through nutrient spiraling. Aquatic plants rapidly assimilate dissolved nutrients, particularly orthophosphate. If sufficient nutrients are available in sediments or the water column, aquatic plants will store an abundance of such nutrients in excess of the plants' actual needs through a chemical phenomenon known as luxury consumption. When a plant dies, the tissue decays in the water column and the nutrients stored within the plant biomass are either restored to the water column or the detritus becomes incorporated into the river sediment. As a result of this process, nutrients (including orthophosphate) that are initially released into the water column in a dissolved form will eventually become incorporated into the river bottom sediment. Once these nutrients are incorporated into the river sediment, they are available once again for uptake by yet another life cycle of rooted aquatic macrophytes and other aquatic plants. This cycle is known as nutrient spiraling. Nutrient spiraling results in the availability of nutrients for later plant growth in higher concentrations downstream.

Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The USDA (1999) determined that besides harvesting and chemical treatment, the best and most efficient method of controlling growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient warehouse under aerobic conditions. However, when dissolved oxygen is depleted, sediments release phosphorus into the water column. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is generally a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This results in a lesser amount of nitrogen oxides (NO_x) being lost to the atmosphere.

Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae have negative impact on beneficial uses, the algae are considered a nuisance aquatic growth. The excess growth of phytoplankton, periphyton, and/or macrophytes can adversely affect both aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support their growth. In addition to nutrient availability, algae (and macrophyte) growth are affected by flow rates, velocities, water temperatures, and penetration of sunlight in the water column. Low velocity conditions allow algal concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algal growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support normal algal growth, excessive blooms may develop.

Commonly, algae blooms appear as extensive layers or algal mats on the surface of the water. When present at excessive concentrations in the water column, certain blue-green algae may produce toxins that can result in skin irritation to swimmers and illness or even death in organisms ingesting the water. The toxic effect of blue-green algae is worsened when an abundance of blue-green algae accumulate in high concentrations. Algal blooms also often create objectionable odors and coloration in water used for domestic drinking water and can produce intense coloration of both the water and shorelines as cells accumulate along the banks. In extreme cases, algal blooms can also result in impairment of agricultural water supplies due to toxicity. Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The effect is dependent on both the type(s) of algae present and the size, extent, and timing of the bloom.

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the bottom. Low DO in these areas can lead to decreased fish habitat as fish avoid areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various compounds during respiration and photosynthesis. Additionally, low DO levels caused by decomposing organic matter can lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations with excess algal growth within the water column, combined with the direct effect of the algal life cycle on DO and pH within aquatic systems. Therefore, reducing phosphorus loading can improve water quality, particularly in surface-water systems dominated by blue-green algae, which can acquire nitrogen directly from the atmosphere and the water column. Phosphorus management within these systems can potentially result in improvement in nutrients (phosphorus), eutrophic state, nuisance algae, DO, and pH.

2.4 Summary and Analysis of Existing Water Quality Data

Water quality has been monitored in the Twin Lakes watershed since at least 1985 (Falter 1987). During this study, Falter collected baseline data in an attempt to characterize the trophic status of Upper and Lower Twin Lakes. In 1991, the Twin Lakes Management Plan was developed by the Clean Lakes Coordinating Council (CLCC 1991). The management plan outlined 29 action items to improve water quality within the lakes.

Together with lake water quality monitoring, extensive water quality monitoring has been conducted on streams within the Fish Creek watershed. In 1993, DEQ collected water quality samples on Fish Creek to determine if grazing was impacting the primary contact recreation beneficial use. Results indicated that bacteria concentrations (fecal coliform) immediately upstream from the grazed area did not exceed the Idaho water quality standard, and concentrations downstream and adjacent to the grazed area did exceed the water quality standard. Findings of the study initiated an effort by local agencies and area residents to limit cattle access to the stream and lake. A grazing management plan was developed by the landowner in conjunction with the Natural Resources Conservation Service (NRCS) to restrict cattle access to surface water.

Idaho DEQ conducted Beneficial Use Reconnaissance Program (BURP) monitoring on Fish Creek during 1995 through 2006 (Figure L). Data collected using BURP protocols has outlined biological, chemical, and physical parameters. Stream temperature information was also collected during the summer of 1997 by the Idaho Department of Lands and evaluated by DEQ (Figure 13).

Nutrient and bacteria (*E. coli*) concentrations were monitored in the summer of 2007. Laboratory analysis of the water samples showed no change in nutrient concentrations compared to the nutrient data collected in water year 1986 by Falter as part of the lakes study (Falter 1987). Water samples collected adjacent to the pastureland and analyzed for *E. coli* concentration exceeded Idaho water quality criteria. Water samples were also collected in Upper Twin Lake near the mouth of Fish Creek and in the forested areas upstream from the pastureland. Water samples collected above the pastureland and in the lake did not exceed Idaho water quality criteria.

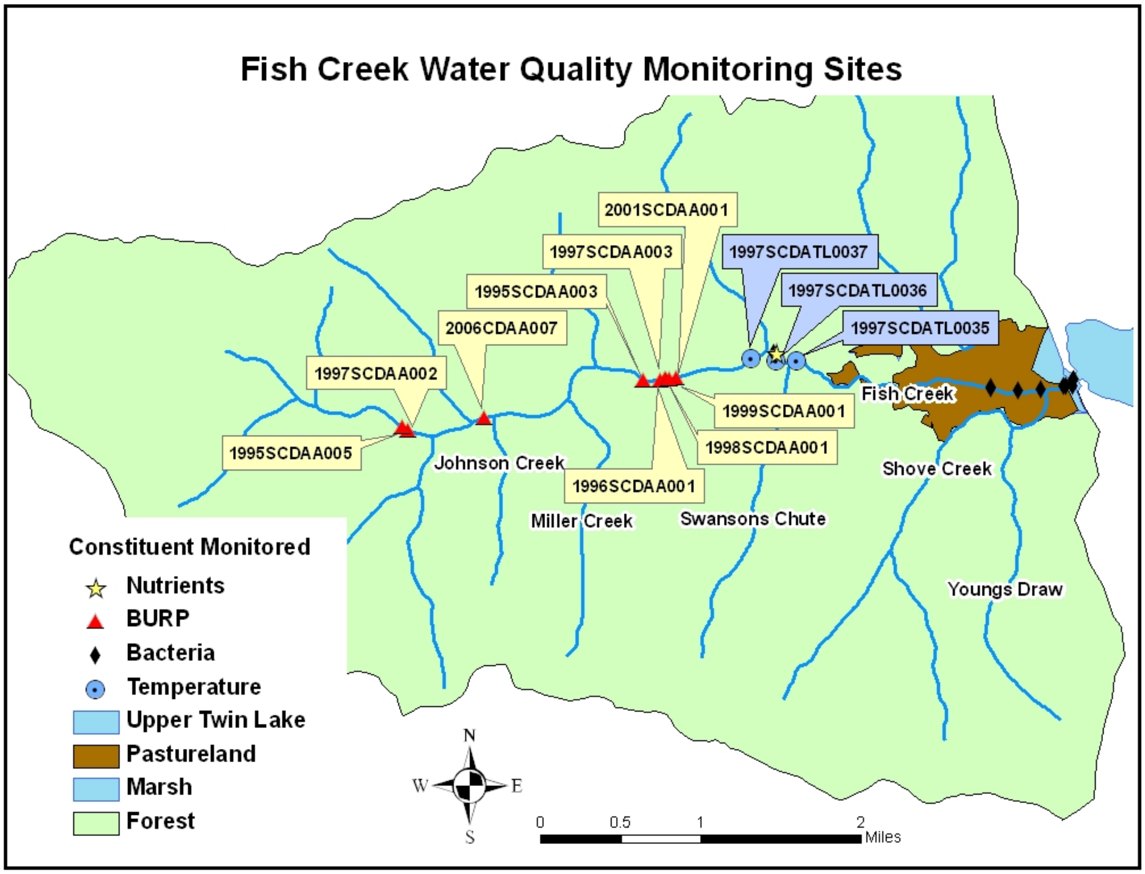

Figure 13. Water quality monitoring site locations within Fish Creek watershed.

Flow Characteristics

No long-term monitoring of stream discharge has been recorded for the Fish Creek watershed. Flow has been measured during BURP surveys (Table 5) and during other water quality sampling events.

Table 5. Measured discharge (cfs) at BURP sites within the Fish Creek watershed.

Stream Name	BURP Site ID	Date	Measured Discharge (cfs[a])
Fish Creek	1995SCDAA003	06/13/1995	11.08
Fish Creek	1996SCDAA001	06/10/1996	5.65
Fish Creek	1997SCDAA003	06/13/1997	33.5
Fish Creek	1998SCDAA001	06/12/1998	20.09
Fish Creek	1999SCDA0001	07/07/1999	9.99
Fish Creek	2001SCDAA001	07/03/2001	6.41
Fish Creek	2006SCDAA007	07/19/2006	7.47

[a] cubic feet per second

Due to the lack of long-term flow recordings, Fish Creek stream flows were modeled using the USGS StreamStats modeling tool. This tool allows for a better understanding of discharge patterns within the selected watershed. Three different stream discharge statistics are represented in the graph: Q20, Q50, and Q80 (Figure 14). Flows recorded during BURP surveys are consistent with flows modeled using the USGS StreamStats tool.

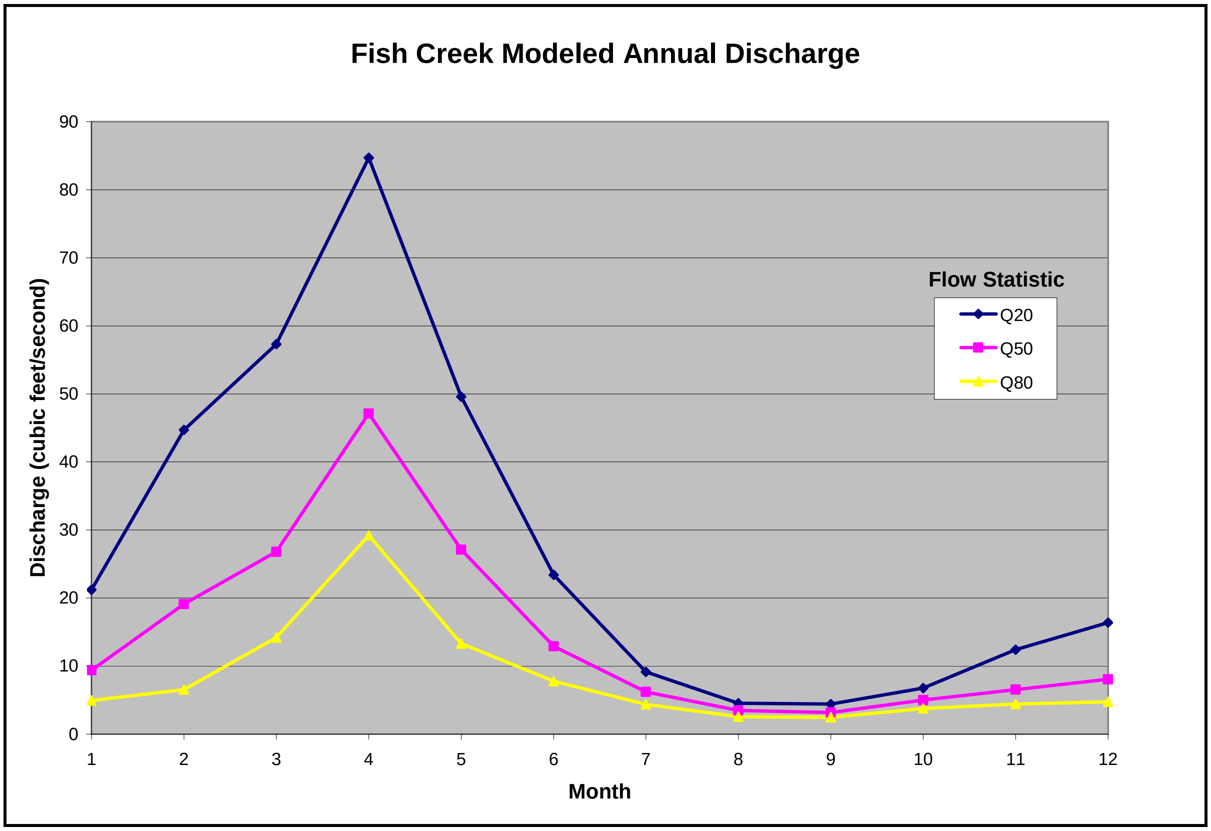

Figure 14. Modeled annual stream flow using USGS StreamStats modeling tool.

The outflow from lower Twin Lake is regulated by a small dam. The original dam, built in 1906, was constructed on the outlet of lower Twin Lake (Rathdrum Creek) to provide irrigation storage for downstream water users and to maintain the lake level for summer recreation. In 2005 a new dam was built down stream of the original dam. The old dam was beginning to fail and needed to be replaced. Most of the outflow from the lakes enters the Rathdrum Prairie Aquifer and has been estimated to be around 87% (CLCC 1991). Fish Creek is the largest tributary to Twin Lakes, with an estimated 78% of the total inflow to the lakes (CLCC 1991).

Water Column Data

Temperature

Stream temperature has been recorded within the Fish Creek watershed at three locations near the confluence of Swanson's Chute and Fish Creek (Figure 13). Temperature data recorders continuously collected data from July 27 to September 24, 1997. Temperature recorders were deployed and recorded the hottest portion of the year when Idaho water quality standard salmonid spawning criteria are most likely to be violated.

Temperature data collected during the summer period of June 21 through September 21, 1997, was evaluated to determine whether there were violations of the cold water aquatic life use criterion. This time period (93 days) acknowledges the natural pattern of water temperatures in which peak water temperatures typically occur between July 15 and August 15, with water temperatures warming before July 15 and water temperatures progressively cooling after August 15. All temperature data recorded during the 1997 monitoring campaign meet cold water aquatic life daily maximum (22°C or 71.6°F) and average (19°C or 66.2°F) temperature criteria.

Recorded water temperatures in Fish Creek exceed Idaho water quality salmonid spawning criteria (IDAPA 58.01.02.250.02.f.ii.). To support salmonid spawning, water temperatures are not to exceed 13°C (55.4°F) instantaneous or a maximum daily average of 9°C (48.2°F). Temperatures recorded during the 1997 monitoring event did not include the spring salmonid spawning window. Future temperature monitoring should include the period of May 1 through July 1 to evaluate the spring salmonid spawning window. All three temperature recorders deployed within Fish Creek from July 27, 1997 through September 24, 1997, showed exceedances of fall salmonid spawning criteria (Table 6). The fall salmonid spawning window spans from August 1 to October 15.

Table 6. Recorded violations of Idaho water quality fall salmonid spawning temperature criteria in Fish Creek in 1997.

Temperature Logger ID	Days Monitored Within Spawning Window	Number of Monitored Days Exceeding Criteria		% of Monitored Days Exceeding Criteria	
		13 ºC Instant.	9 ºC Ave.	13 ºC Instant.	9 ºC Ave.
1997SCDATL0035	55	15	51	27%	93%
1997SCDATL0036	55	23	51	42%	93%
1997SCDATL0037	55	27	50	49%	91%

Nutrients

Fish Creek was identified as the largest contributor of nutrients to Upper Twin Lake in the *Twin Lakes Management Plan* (CLCC 1991), and Fish Creek is also the largest tributary to Upper Twin Lake. A total phosphorus budget developed in 1986 for Upper Twin Lake allocated 70% of the existing TP loading to tributaries, 10% to precipitation, 8% to grazing, 5% to wastewater, 4% to internal loading, and 3% to logging activities. Most of the phosphorus is assumed to be entering the watershed attached to soil particles (CLCC 1991). Control of soil erosion throughout the watershed is therefore necessary to reduce phosphorus loading to the lakes (CLCC 1991).

Water samples were collected on Fish Creek in water year 1986 during a study conducted by the University of Idaho (Falter et al. 1987). Eleven samples were collected on Fish Creek and analyzed for total phosphorus (TP) and total nitrogen (TN) (Table 7). Based on the results of this sampling, annual TP and TN loads were estimated for Fish Creek (CLCC 1991) (Table 7).

Table 7. Fish Creek nutrient data and estimated annual loads during water year 1986.

Date	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Measured Flow (cfs)
October 3, 1985	28	140	6.48
January 28, 1986	24	230	11.95
March 20, 1986	23	220	52
March 29, 1986	30	500	56
April 3, 1986	27	160	58
May 10, 1986	9	130	33
May 22, 1986	13	190	24
June 12, 1986	25	165	17.7
July 3, 1986	24	140	9.2
August 20, 1986	44	260	6.51
September 25, 1986	25	180	7.2
Estimated annual load	**995 pounds**	**8,803 pounds**	

Tributaries to Upper and Lower Twin Lakes accounted for the highest percentage of nutrients entering each basin (Upper and Lower Twin Lakes), but they also accounted for the greatest water volume (Falter et al. 1987).

DEQ conducted nutrient sampling in Fish Creek during May through August 2007. Samples were analyzed for TP and TN concentrations. Total phosphorus concentrations in 2007 (Table 8) are similar to TP concentrations during water year 1986 (Table 7), while TN concentrations have decreased. During 2007 sample collection, stream flow was also measured.

Table 8. Fish Creek nutrient data during summer 2007.

Date	Total Phosphorus (µg/L)	Total Nitrogen (µg/L)	Measured Flow (cfs)
May 22, 2007	22	<100	Not collected
June 8, 2007	24	<100	10.62
July 3, 2007	27	<100	6.55
July 27, 2007	35	<100	4.69
August 28, 2007	29	102	2.59

Samples were collected during the summer months to best characterize nutrient concentrations within Fish Creek when exceedances of Idaho water quality standards are most likely to occur. Summer months are critical because aquatic plant growing conditions are optimal. Elevated nutrient concentrations during this time can result in excess plant growth and exceedances of Idaho water quality standards.

Total phosphorus has been identified as the primary nutrient of concern within the Twin Lakes watershed (CLCC 1991). The *Subbasin Assessment and Total Maximum Daily Loads of Lakes and Streams Located on or Draining to the Rathdrum Prairie* (IDEQ 2000) identified a TP load reduction of 35% to Upper Twin Lake needed to improve lake water quality. In The Upper Twin Lake study, conducted in 1987, a phosphorus load of 568 kilograms/year (1,252.2 pounds/year) was allocated to the tributaries, which accounted for 76.8% of the total phosphorus load entering Upper Twin Lake (Falter et al. 1987).

Tributaries to Upper Twin Lake were also allocated a TP reduction goal, of 271 kilograms/year (597.4 pounds/year), a 47.7% reduction (IDEQ 2000).

Total phosphorus concentrations in Fish Creek observed during the two sampling campaigns, 1986 and 2007, have remained relatively unchanged. While TP may be the limiting nutrient in lake systems, nitrogen can limit plant productivity in streams. The reduction in TN observed between 1987 and 2007 indicate an improving trend in nitrogen concentrations (Table 7 and 8). Because no violation of Idaho nutrient water quality standards has been observed in Fish Creek and nutrient sampling conducted in 2007 is similar to nutrient values observed in 1986, a nutrient TMDL addressing Fish Creek will not be developed at this time. For load reductions allocated to Upper Twin Lake tributaries, refer to the *Subbasin Assessment and Total Maximum Daily Loads of Lakes and Streams Located on or Draining to the Rathdrum Prairie* (IDEQ 2000).

Bacteria

Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in intestines of animals and aid in the digestion of food. A specific subgroup of this collection is fecal coliform bacteria, the most common member being *Escherichia coli* (*E. coli*). *E. coli* is a more specific indicator of potential pathogen contamination than fecal coliform counts.

Bacteria contamination within the Fish Creek watershed was investigated by DEQ in 1993. Water samples collected in 1993 were analyzed for fecal coliform bacteria (Table 9).

Table 9. Fecal coliform concentrations in the Fish Creek watershed in 1993.

Sampling location	Date	Fecal coliform concentration /100ml
Above grazing area	August 5, 1993	17
Below grazing area near mouth of stream	August 5, 1993	440
Above grazing area	August 19, 1993	11
Below grazing area near mouth of stream	August 19, 1993	430
Above grazing area	August 23, 1993	60
Below grazing area near mouth of stream	August 23, 1993	730
Above grazing area	August 27, 1993	11
Below grazing area near mouth of stream	August 27, 1993	240
Above grazing area	September 1, 1993	40
Below grazing area near mouth of stream	September 1, 1993	500

At the time of the 1993 study, the Idaho water quality standards were written to address fecal coliform concentrations. In years following, the state of Idaho adopted new water quality standards that target *E. coli* concentrations.

In 1999 and 2001, water samples were collected on Fish Creek within the forested region of the watershed and analyzed for the presence of *E. coli* bacteria. During these sampling events, *E. coli* concentrations did not exceed the Idaho water quality criterion of 126 colony forming units (cfu) per 100 ml of water. In 1999, a single sample yielded 115 *E. coli* cfu/100 ml; in 2001, a single sample yielded 86 *E. coli* cfu/100ml

In 2007, DEQ collected water samples upstream from the pastureland, adjacent to pastureland in the lower reaches of Fish Creek, and in the lake near the mouth of Fish Creek, and analyzed the samples for the presence of *E. coli*. These results exceeded the Idaho water quality criterion (Table 10).

Table 10. *E. coli* concentrations in the Fish Creek watershed during summer 2007.

Location description	GPS Coordinates	Date	*E. coli* concentration (cfu/100ml)
Upper Twin Lake – near the mouth of Fish Creek	N 47° 53’ 9.1” W -116° 55’ 41.6”	August 14, 2007	22 *E. coli*/100 ml
Upper Twin Lake – near the mouth of Fish Creek	N 47° 53’ 9.1” W -116° 55’ 41.6”	August 17, 2007	6 *E. coli*/100 ml
Upper Twin Lake – near the mouth of Fish Creek	N 47° 53’ 11.3” W -116° 55’ 41.5”	August 24, 2007	1,300 *E. coli*/100 ml
Upper Twin Lake – near the mouth of Fish Creek	N 47° 53’ “14.5 W -116° 55’ 37.5”	August 28, 2007	6 *E. coli*/100 ml
Fish Creek – forest	N 47° 53’ 15.3” W -116° 58’ 10.1”	July 27, 2007	38 *E. coli*/100 ml
Fish Creek – forest	N 47° 53’ 15.3” W -116° 58’ 10.1”	August 14, 2007	1 *E. coli*/100 ml
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	July 27, 2007	>2,400 *E. coli*/100 ml
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	August 14, 2007	1,400 *E. coli*/100 ml[A]
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	August 17, 2007	980 *E. coli*/100 ml[A]
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	August 21, 2007	1,300 *E. coli*/100 ml[A]
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	August 24, 2007	260 *E. coli*/100 ml[A]
Fish Creek – adjacent to pastureland	N 47° 53’ 7.4” W -116° 56’ 20.9”	August 28, 2007	130 *E. coli*/100 ml[A]
		5-sample geometric mean	**570 *E. coli*/100 ml**

[A] Sample used to calculate 5 sample geometric mean for evaluation and comparison to Idaho water quality criteria. The 5-sample geometric mean is used to help reach the central tendency when the data being evaluated has the possibility of being highly skewed

In response to the initial sample, for which the *E. coli* concentration violated Idaho’s single sample maximum water quality standard, five additional water samples were collected and analyzed for the presence of *E. coli* bacteria.

During sample collection in July through mid August, 2007, 100-200 head of cattle were seen actively grazing adjacent to Fish Creek. During sample collection on August 17, it was observed that the cattle were removed from the grazing area, loaded onto trucks and moved off site. Cattle or other domesticated animals were not seen grazing after August 17. After the cattle were removed from the grazing area, *E. coli* concentrations gradually diminished. A spike in *E. coli* concentrations occurred on August 21 shortly after a considerable rain event. Following the rain event, *E. coli* concentrations continued to decline.

Although no direct comparison can be made between the 1993 (fecal coliform) and 2007 (E. coli) test results, both sampling events showed concentrations greater than the water quality standard applicable at the time of sampling.

Sediment

Very little sediment data has been collected within the Fish Creek watershed. At each BURP survey site (Figure 13), stream substrate size was measured. These measurements help to evaluate sedimentation within the watershed by evaluation of substrate size composition. Figure 15 illustrates the particle size distribution for the Fish Creek substrate measured at BURP survey locations.

Evaluation of the substrate size distribution suggests that fine particle sizes (< 6.35mm) are interfering with salmonid spawning and other aquatic life species. Fine sediment (< 6.35mm) includes silt/clay, sand, and very fine pebble. Fine sediment (< 6.35mm) in excess of 20-25% of total substrate has been shown to reduce embryo survival and fry emergence by 50% (Figure 17) (Bjornn and Reiser 1991). At all BURP survey locations, fine sediment (< 6.35mm) is in greater abundance than other substrate size classes combined (> 6.35mm) (Table 11 and Figure 15).

Table 11. Particle size distributions of substrate measured at BURP sites within the Upper Spokane Subbasin.

BURP ID	Total # of Particles Sized < 6.35mm	Total # of Particles Sized > 6.35mm	Total # of Particles Measured	% of Particles Sized < 6.35mm	% of Particles Sized > 6.35mm
Fish Creek BURP survey locations					
2006SCDAA007	76	91	167	45.51	54.49
2001SCDAA001	55	104	159	34.59	65.41
1999SCDAA001	84	81	165	50.91	49.09
1998SCDAA001	140	57	197	71.07	28.93
1997SCDAA003	144	71	215	66.98	33.02
1997SCDAA002	81	37	118	68.64	31.36
1996SCDAA001	71	138	209	33.97	66.03
1995SCDAA003	146	73	219	66.67	33.33
1995SCDAA005	61	117	178	34.27	65.73
Streams supporting aquatic life beneficial uses					
2004SCDAA001	11	167	178	6.17	93.82
2004SCDAA059	13	210	223	5.82	94.17
2004SCDAA004	25	218	243	10.28	89.71
2004SCDAA003	48	166	214	22.42	77.57

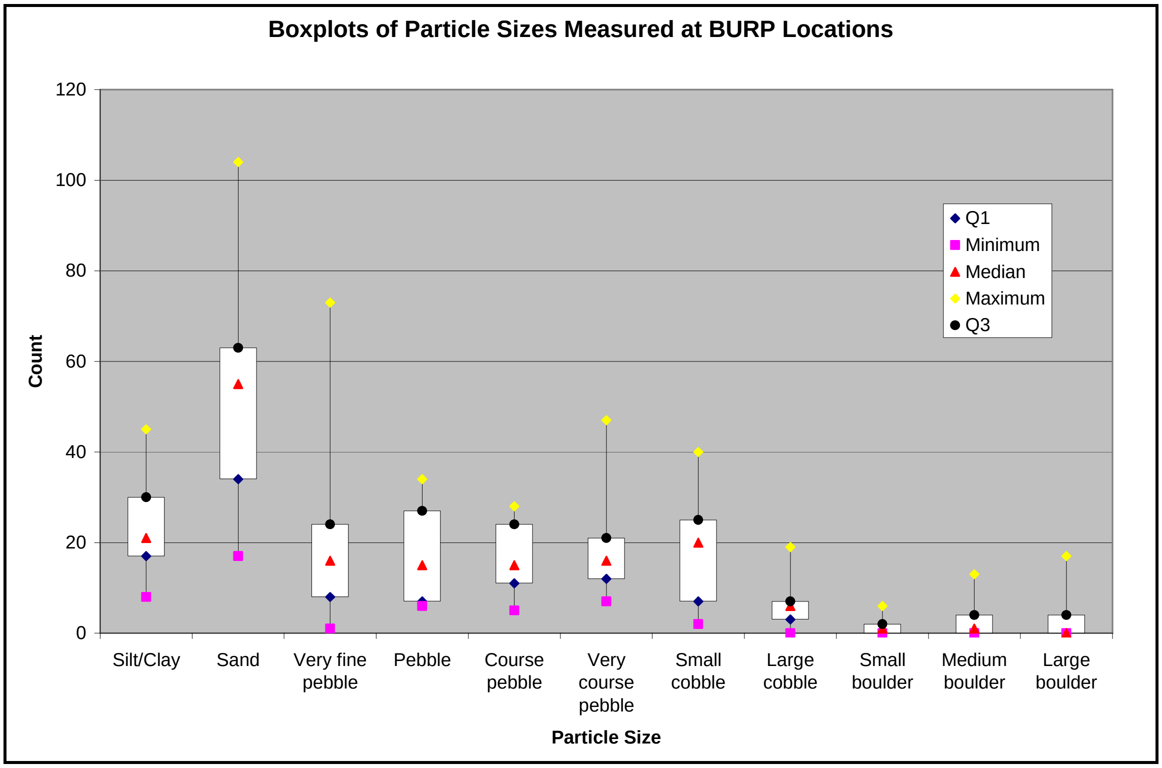

Figure 15. Particle size distribution of substrate measured at BURP survey locations within the Fish Creek watershed.

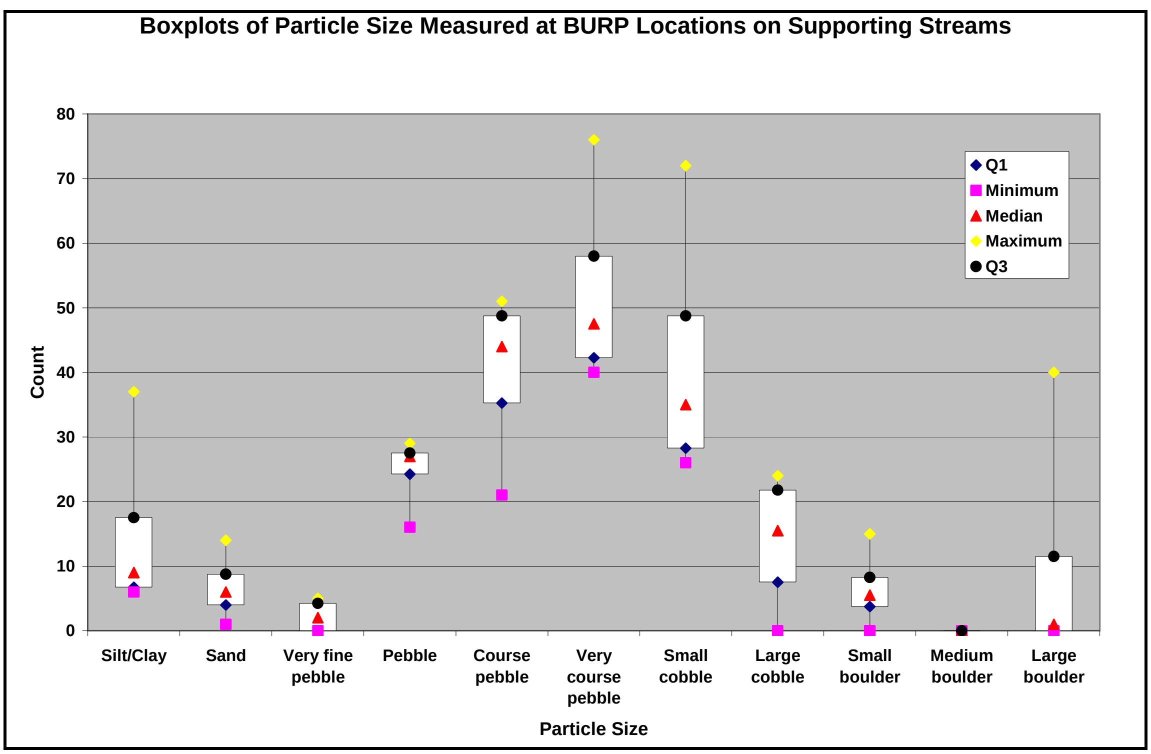

Figure 16. Particle size distribution of substrate measured at BURP survey locations on streams within the Upper Spokane Subbasin that support aquatic life beneficial uses.

Within the same subbasin, the Upper Spokane, streams that support all beneficial uses have a much greater percentage of larger substrate (>6.35mm) (Figure 15, Figure 16, and Figure 17). The absence of excessive fine sediment is beneficial to salmonid spawning and rearing and yields a more productive aquatic macroinvertebrate habitat. Streams dominated by fine particle substrate develop macroinvertebrate communities more adapted to burrowing resulting in reduced density of macroinvertebrates needed to support healthy fish populations.

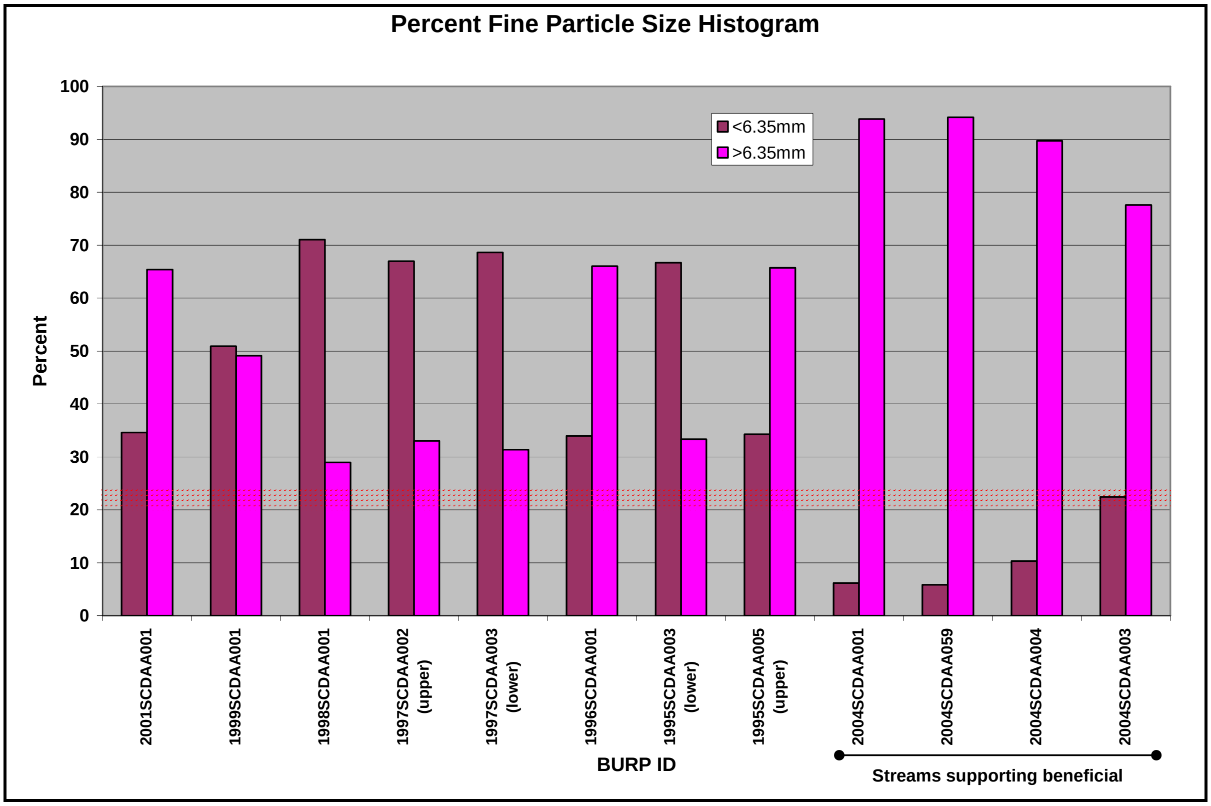

Figure 17. Particle size histogram.

Channel Stability

Channel stability assessments were conducted by DEQ staff in June 2000. Surveys were conducted to evaluate the stability of the stream banks and channel bottom. Three different stream reaches were surveyed. Each reach received roughly the same total score, indicating moderately stable channels. Surveyors noted minor amounts of bank sloughing and adequate amounts of large woody debris adding to channel stability.

Biological and Other Data

Idaho DEQ has been conducting BURP surveys within the Fish Creek watershed since 1995. To date, Idaho DEQ has completed eight BURP surveys and two electro-fishing trainings within the Fish Creek watershed. Table 12 summarizes the biological and habitat assessments completed during the eight surveys. The relationship between the stream macroinvertebrate index (SMI), stream fish index (SFI), and stream habitat index (SHI) can be found in Idaho DEQ's WBAG II (Grafe et al. 2002). Data from the most recent BURP survey, conducted in 2006, has not yet been analyzed.

Table 12. Water body assessment scores for BURP surveys completed within the Fish Creek watershed (1995-2007).

BURP ID	SMI	SMI Score	SFI	SFI Score	SHI	SHI Score	Average Score
2007 Crew Training Fish Creek[2]	NA	NA	1	62	NA	NA	NA
2007 Crew Training Miller Creek[2]	NA	NA	1	54.98	NA	NA	NA
2001SCDAA001	2	61.33	1	53.34	3	67	2
1999SCDAA001	3	65.43	2	70.36	2	64	2.33
1998SCDAA001[1]	1	49.63	NA	NA	2	65	NA
1997SCDAA003[1]	2	60.57	NA	NA	2	65	NA
1997SCDAA002[1]	2	59.08	NA	NA	3	75	NA
1996SCDAA001	1	47.61	1	59.44	2	65	1.33
1995SCDAA003[1]	1	44.35	NA	NA	1	50	NA
1995SCDAA005	1	46.48	1	56.17	1	52	1

[1] Electro-fishing was not conducted during the 1995SCDAA003, 1997SCDAA002, 1997SCDAA003, and 1998SCDAA001 BURP surveys.

[2] Crew training only consisted of electro-fishing training; macroinvertebrates and habitat were not assessed.

SMI, SFI, and SHI scores calculated from information gathered during BURP surveys are evaluated to help determine beneficial use support status. Evaluation of these scores helps to determine aquatic life use support. An average score less than 2 is considered an indication of impairment, an average score of more than 2 is considered an indication of aquatic life beneficial use support, and a score of 2 is borderline. Although a stream may exhibit an average score of 2 or more, indicating full support, other data adhering to stringent DEQ standards as outlined in the WBAG II (Grafe et al. 2002) may indicate that the water body is not supporting all beneficial uses.

Electro-fishing efforts conducted within the Fish Creek watershed support the use of salmonid spawning criteria. Fish populations have been sampled by DEQ using BURP protocol six times over a twelve year period. Collection of multiple salmonid age classes throughout the sampling efforts supports the conclusion of salmonid spawning (Figure 18).

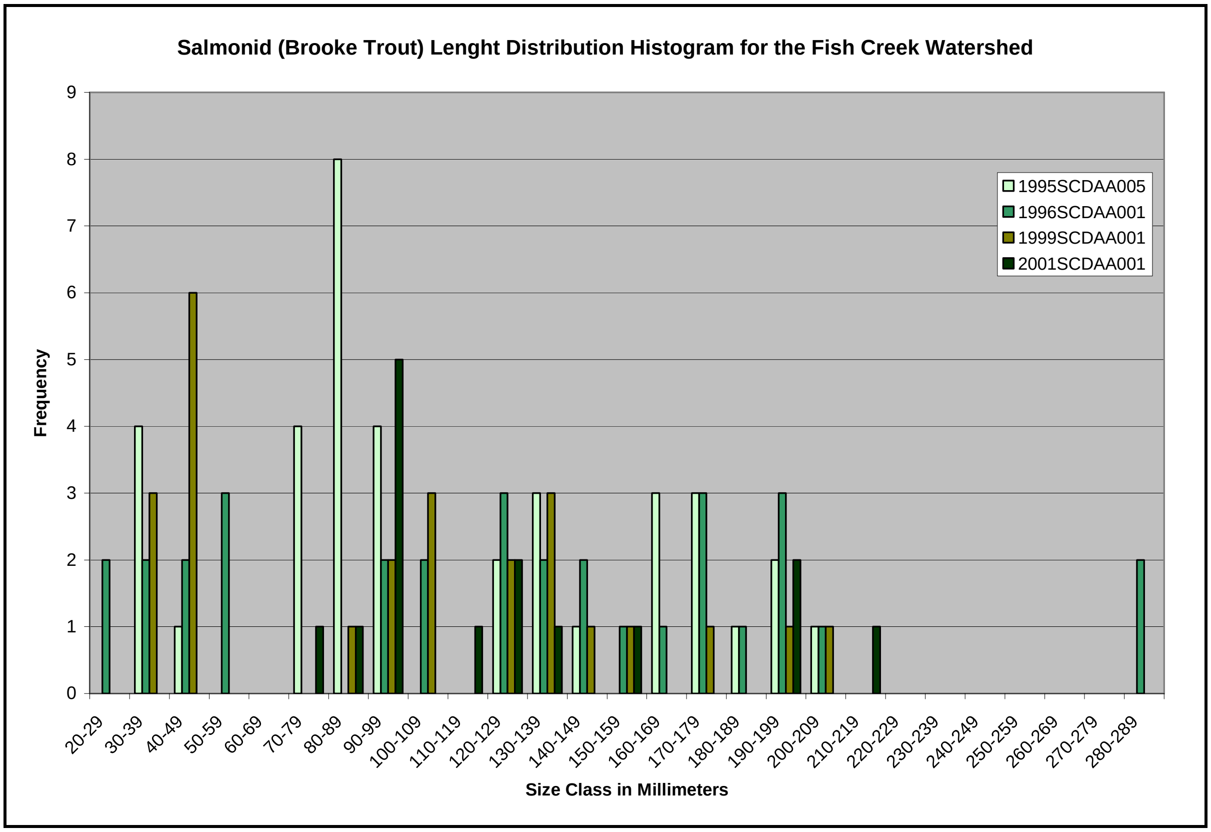

Figure 18. Salmonid (Brook trout) length distribution histogram for the Fish Creek watershed.

Two electro-fishing monitoring efforts were conducted in the summer of 2007, but results are not included in Figure 18. Electro-fishing was conducted on the mainstem of Fish Creek and on Miller Creek, a tributary to Fish Creek. Fish collected in 2007 were not identified to the proper scale to be comparable with the Brook trout results displayed in Figure 18. Although the fish collected were not identified to the proper identification level, they were identified as salmonids. A total of one hundred and ninety nine (199) salmonids were collected in 2007 and ranged in size from 195 mm to 35 mm. The majority of those, one hundred and fifty six (156), were identified as either young of the year or salmonid and ranged in size from 86 mm to 35 mm. The identification as young of the year or salmonids is due to the small size and difficulty in accurately distinguishing between salmonid species at a small size while in the field.

Salmonids large enough for field identification were Brook trout and Cutthroat trout. A total of thirty eight (38) Brook trout were collected and ranged in size from 195 mm to 75 mm. Five (5) Cutthroat trout were collected and ranged in size from 158 mm to 65 mm.

Status of Beneficial Uses

The mainstem of Fish Creek is listed in Section 5 of Idaho's 2002 Integrated Report as impaired due to causes unknown, sediment, and temperature. The first and second order tributaries to the mainstem of Fish Creek are listed on this report for temperature impairment. Although the 2002 Integrated Report is Idaho's current list of impaired waters, it is not the first time Fish Creek has been recognized as impaired or water quality limited. Fish Creek was originally recognized as impaired in 1992 and included in subsequent impaired waters lists (refer to the Executive Summary for a complete history of Fish Creek's water quality impairments).

The WBAG II (Grafe et al. 2002) describes DEQ's methods for determining beneficial use support. The only beneficial uses considered in this Watershed Assessment and TMDLs document are aquatic life beneficial uses and recreational contact uses. Cold water aquatic life use support is determined by water quality criteria compliance and multimetric indices calculated from macroinvertebrates, fish, and physical habitat monitoring data. In addition to looking at biological monitoring data, aquatic life use and salmonid spawning beneficial uses were determined through numeric temperature criteria compliance. Support of recreational contact beneficial uses are determined by in-stream *E. coli* concentrations. *E. coli* concentrations exceeding 126 *E. coli* cfus/100 ml do not support contact recreation beneficial uses.

Conclusions

After review of DEQ BURP, nutrient, bacteria, and temperature data, DEQ concluded that sediment, temperature, and bacteria TMDLs would be completed for Fish Creek and tributaries to Fish Creek.

2.5 Data Gaps

This document is written to comply with current state and federal guidelines and utilizes all available data to date. The document was also written using the most sound and applicable scientific methods practical. Even though ample data is available for the completion of this document, additional data would be helpful in evaluating current sediment and bacteria concentrations and stream temperature experience within Fish Creek throughout the year.

No water column data evaluating sediment trends has been collected within the Fish Creek watershed. Future monitoring of sediment should focus on depth of fine sediment in spawning gravels and on sediment yield rates from land use activities.

Continued bacteria monitoring should be conducted to better characterize the seasonal trends in *E. coli* concentrations. *E. coli* concentrations are anticipated to be greatest during the summer months when grazing in the lower reaches is at its highest and stream flows are at their lowest. Additional *E. coli* monitoring could also include DNA analysis to help differentiate between natural (wild animals) and anthropogenic (domesticated animals or septic system inputs) sources. Properly identifying the source or sources of *E. coli* contamination will help to develop best management practices (BMPs) aimed at reducing in-stream concentrations.

Temperature data collected and analyzed in this report did not include the spring salmonid spawning windows. Future temperature monitoring should incorporate the spring salmonid spawning period of May 1 through July 1. Although the spring spawning windows were not evaluated during temperature logger deployment, the temperature TMDL is written to address elevated stream temperatures throughout the year. Future data collected during the spring spawning window will help to determine the effectiveness of implementation actions and compliance with Idaho water quality standards.

3. Watershed Assessment–Pollutant Source Inventory

3.1 Sources of Pollutants of Concern

The Fish Creek watershed, above Upper Twin Lake, is largely forested, with timber harvesting activities being the predominant land use. Lower reaches of Fish Creek are used for livestock grazing and agricultural practices. A few homes and outbuildings do exist within the watershed but mainly occur along the lower, flatter reaches of the watershed, and are not anticipated to contribute pollutant loads.

Point Sources

A point source of pollutants is characterized by having a discrete conveyance to surface water, such as a pipe, ditch, or other identified "point" of discharge into a receiving water body. There are no point source dischargers permitted or otherwise known to DEQ within the Fish Creek watershed.

Nonpoint Sources

Nonpoint sources of pollutants are generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered to surface water. Streams naturally assimilate pollutant quantities above natural conditions to a certain point. Beneficial use impairment begins when pollutant amounts exceed the streams' ability to process these elevated pollutant amounts.

Sources of sediment within the Fish Creek watershed include forest roads, activities associated with timber harvesting, livestock grazing, and other agricultural practices. The primary source of increased stream temperatures is shade reduction caused by riparian vegetation alteration and removal. *E. coli* concentrations can originate from wild or domesticated animals, septic systems, and/or recreational usage. Elevated *E. coli* concentrations are most likely due to wild and domesticated animals. Further analysis is needed to definitively identify the source of *E. coli* contamination.

Pollutant Transport

Pollutant transport typically occurs during the months of high stream flow (April through June); however, elevated pollutant levels exist throughout the year, causing impairment of beneficial uses. Quantities of sediment generated from forest roads, timber harvest areas, and agricultural practices are increased during the wet spring months. It is anticipated that runoff from roads as well as from timber harvest activities increases hydrologic inputs which can accelerate in-stream erosion.

Elevated stream temperatures are highest during the warm summer months. The IDL 2000 Cumulative Watershed Effects (CWE) assessment determined that there is a high likelihood that vegetation cover is inadequate to maintain stream temperatures for salmonid spawning (IDL 2001).

3.2 Data Gaps

Data gaps related to pollutant sources do exist within the confines of this water quality investigation. Additional data would better define sources of pollution and facilitate later loading estimates.

Nonpoint Sources of Sediment

A considerable amount of information is needed to better quantify actual sediment loads occurring within the Fish Creek watershed and land use activities generating excessive sediment loads. Stream bank stability and erosion surveys are needed to assess the in-stream sediment delivery potential. Additional in-stream monitoring data from the mainstem and tributaries would be useful in further calibration of the sediment model.

BMP Effectiveness

Investigation into BMP effectiveness would also be of considerable value. The effectiveness of BMPs in improving water quality is critical to the successful development of a TMDL implementation plan.

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

Pollution control efforts within the Fish Creek watershed have been implemented by landowners on a voluntary and mandatory basis. Pollution control efforts on timber harvest and grazing areas within the Fish Creek watershed are described below. Only timber harvest and grazing are discussed below because they are the two dominant land use activities within the watershed.

Forestry

Inland Empire Paper Company (IEPC), the major landowner within the Fish Creek watershed, manages the land for timber production. The Forest Practices Act (FPA) governs timber harvest practices in Idaho (IDAPA 20.02.01). All commercial timber harvest activities in the state must comply with FPA rules and regulations. Rules and regulations of the FPA outline best management practices (BMPs) that will be taken by the timber harvester to mitigate impacts to surface water and the surrounding ecosystem. Idaho's FPA identifies standards for logging, road building, reforestation, streamside protection, and other forestry practices. The Idaho Department of Lands (IDL) is the Idaho state agency tasked with overseeing the FPA. The IDL conducts routine site inspections of harvested areas to check for compliance with FPA rules and regulations. Those operators not in compliance are subject to penalty (work stoppage or fines).

Inland Empire Paper Company

Access to IEPC land in the Fish Creek watershed is restricted to day use only during the summer months. A gate is maintained at the entrance to IEPC land and vehicles traveling in and out are required to pass a check-station. The check-station is watched by a gate host and a work permit or a recreational pass is required by persons entering the watershed during the months of April through October. The gate is closed for the season in November and the area is patrolled for violators during December through May. Overnight camping, campfires, and off-road travel are prohibited throughout the year.

Road rocking, along with road smoothing, outsloping, and waterbar repair, is conducted on an annual basis on all main silviculture haul roads. Rolling dips have also been constructed on main haul roads to drain water from the road surface to the forest floor. Rock surfacing of roads near culverts and stream crossings has also been implemented to reduce sediment transport to streams. Forest haul road obliteration has been completed on roads no longer needed for access or transport. In addition to road obliteration approximately 5 to 10 miles of road have been abandoned in the Fish Creek watershed since 1988. Many of the roads obliterated or abandoned were located near streams or perched on steep hill slopes. During road obliteration and abandonment, culverts are removed to restore fish passage and natural stream flow.

In conjunction with road maintenance efforts, use of forest roads has been restricted by gates and tank-traps (a tank-traps is a large ditch cut across (perpendicular to) a road that generally succeeds in making the road impassable for motorized vehicles). All-terrain vehicles are only allowed on designated roads and off-road travel of any vehicle type is prohibited. On

IEPC land, vehicles are not allowed on any roads during the spring thaw, which usually runs from sometime in March through sometime in May.

Timber harvesting practices have also been altered by IEPC to help reduce pollutant export to surface water. Timber harvesting has been concentrated so that fewer roads need to be constructed and are used for shorter periods of time. After timber harvest activities, prompt reforestation is implemented. Approximately 300 seedlings per acre are planted on all harvested areas within two to three years after harvesting. Currently, the IEPC is promoting healthy timber stands by trying to regenerate the historical mix of white pine, western larch, and ponderosa pine.

Idaho Department of Lands

Idaho Department of Lands (IDL) administers approximately 3,317 acres of endowment land within the Fish Creek watershed for the purpose of generating revenue for the trust beneficiaries (public schools and charitable institutions). Administration of this land meets and exceeds the FPA rules. Stream crossing structures are engineered to meet 50-year peak flows. Roads are inventoried and inspected on a periodic basis. Sediment management problems are identified and repaired as soon as weather conditions and funding permits.

The IDL has under taken a number of capital improvements projects expressly to reduce potential sediment generation from existing forest roads. These include applying crushed rock surfacing and/or drainage upgrades to Miller Creek Roads (4.00 miles).

In addition the IDL has abandoned approximately (0.5) mile of substandard spur road. The IDL also routinely regulates public access and limits timber purchasers use of roads using a variety of closure measures at times when potential is greatest for damage from running surface water, in order to control erosion and sediment production. Purchases of timber sales are required to maintain active roads over the duration of individual timber sale contracts. Inactive roads are identified and erosion control measures installed seasonally and/or prior to a timber sale completion. At other times, the IDL uses deferred road maintenance monies to fund road maintenance projects in order to keep drainage structures operational and correct problems as they are detected.

Grazing

In the early 1990s, the lowland portion of the Fish Creek watershed was the center of an investigation conducted by the Idaho Department of Health and Welfare, Division of Environmental Quality (now the Department of Environmental Quality). The investigation was initiated because of complaints by local residents over cattle access to Upper Twin Lake and Fish Creek. The sampling conducted during the investigation revealed fecal coliform bacteria concentrations violating Idaho water quality law that protects recreational contact beneficial uses.

Following the investigation, an agriculture plan was developed to reduce instream and lake bacteria levels. A cooperative effort by the Kootenai Shoshone Soil Conservation District, the Soil Conservation Service, and the University of Idaho College of Forestry, Wildlife, and Range Science made recommendations to the land owner for improved grazing practices. Electric fence was installed in 1991 by the land owner along the pasture adjacent to upper Twin Lake, in an effort to exclude cattle from the lake.

During field water sampling efforts by DEQ in the summer of 2007, exclusionary fencing was noted paralleling Fish Creek. Personal communication with residents of the area identified that the land owner of the pastureland has been actively installing and maintaining exclusionary fencing along Fish Creek, and the lower pasture adjacent to upper Twin Lake is no longer used for cattle grazing.

Conclusion

The efforts put forth thus far by land owners and managers have helped to reduce pollutant loads within the Fish Creek watershed. Many years may be needed to see the cumulative effects and net pollutant reductions of active pollutant reduction efforts. Continued monitoring will ultimately determine the achievement of TMDL targets and restoration of all beneficial uses.

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 considered individually 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) as 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.

This portion of the report (section 5) contains TMDLs for three pollutants: temperature, sediment, and bacteria. Subsections dealing with in-stream water quality targets (numbered 5.1), load capacities (5.2), estimates of existing loads (5.3), and load allocations (5.4) are repeated, with an added *A* for temperature, *B* for sediment, and *C* for bacteria. So, for example, the subsection dealing with load capacities for temperature is 5.2*A*, with load capacities for sediment, it is 5.2*B*. Sections 5.5 – 5.7, each pertain to all three pollutants.

5.1A Temperature In-stream Water Quality Targets

In-stream water quality targets for TMDLs are variable depending on the nature of the pollutant. For impairment caused by pollutants regulated by a narrative water quality standard, DEQ relies upon surrogate targets or pollutant modeling to determine an amount of pollution reduction necessary to achieve full support of beneficial uses. Although numeric temperature criteria exist, the use of riparian shade targets is a much more practical approach to achieve desirable stream temperatures and compliance with Idaho water quality standards. The goal of the selected water quality targets is to restore full support of beneficial uses.

The potential natural vegetation (PNV) approach was utilized to complete the Fish Creek temperature TMDLs. 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 becomes the target of the TMDL. The in-stream 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 used 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)

<u>Potential Natural Vegetation for Temperature TMDLs</u>

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 surrounding vertical elevation, vegetation further 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 stream shade 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 from anthropogenic 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.

Existing shade was estimated for Fish Creek from visual observations of aerial photos. 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 using data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations. In this case, data from the Spokane, Washington 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 are taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder is 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 50m, every 50 paces, 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 the estimate of shade for a particular stream segment is somewhere between 50% and 59%, we assign the value of 50% to that segment. The estimate is based on observations about the kind of vegetation present, its density, and the width of the stream. The typical vegetation types listed below show what kind of landscape is usually observed where each particular shade class is found, for streams 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 agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% shade class cannot occur in shrublands and forests; also, it does occur on streams wider than 5 meters.

Shade class	Typical vegetation type on 5m-wide stream
0 = 0 – 9%	agricultural land, denuded areas
10 = 10 – 19%	agricultural land, meadows, open areas, clearcuts
20 = 20 – 29%	agricultural land, meadows, open areas, clearcuts
30 = 30 – 39%	agricultural land, meadows, open areas, clearcuts
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 landforms. Our assumption that canopy coverage and shade are similar is based on research conducted by Oregon DEQ (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of shade in this TMDL were field-verified with a Solar Pathfinder. The Solar 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).

Stream Morphology

Measures of current bankfull width or near-stream disturbance zone width may not reflect widths that were present during PNV analyses. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase as streams become wider and shallower. 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 removed by erosion.

Channel width is used in PNV methods, but is not determined from aerial photographs. To estimate natural bankfull width in the Panhandle region of Idaho, DEQ uses regional curves (Figure 19) that relate bankfull width with drainage area. These curves are based on data compiled by Diane Hopster of Idaho Department of Lands.

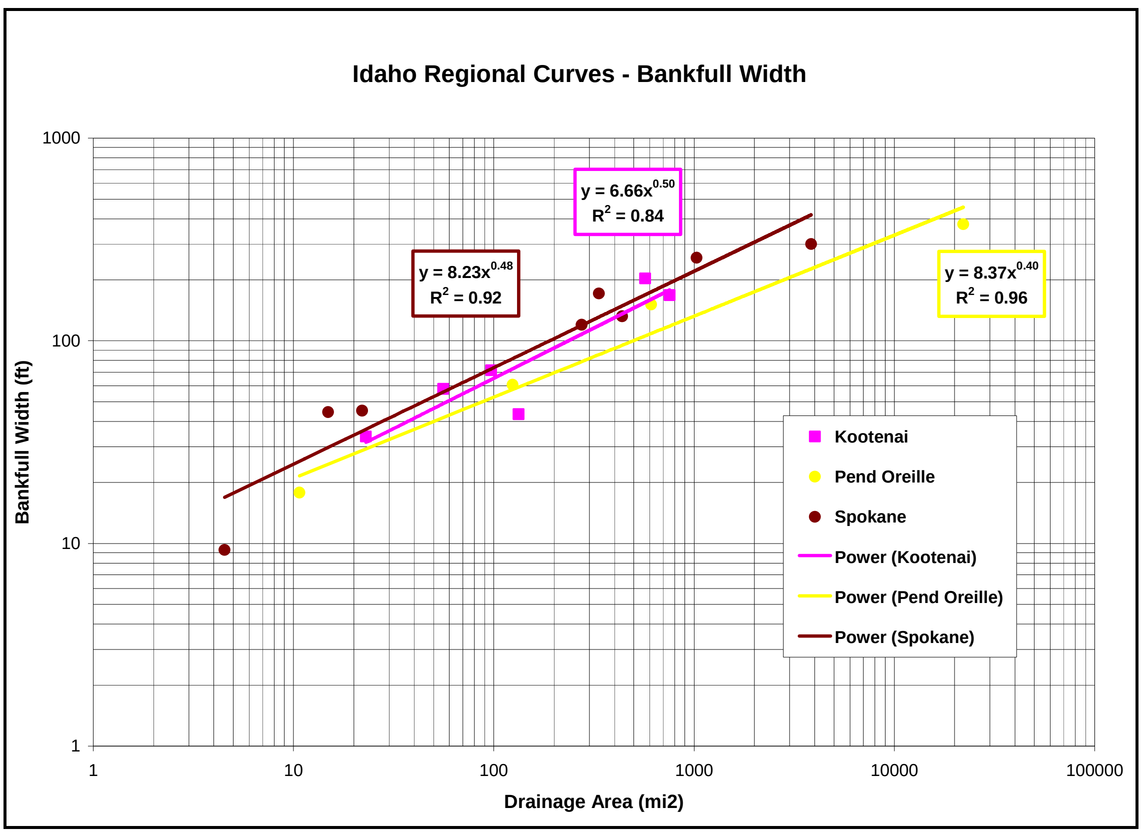

Figure 19. Bankfull Width as a Function of Drainage Area, Idaho Regional Curves

For each stream in the Fish Creek watershed evaluated in the loading analysis, bankfull width is estimated by comparing its drainage area to the Spokane Basin curve shown in Figure 19. Additionally, existing width as measured in the field is evaluated from available data, to see if whether curve-based estimated width or existing width as measured should be used as natural width in the loading analysis. If the stream's existing width is wider than that estimated based on the Spokane curve in Figure 19, then the estimated bankfull width is used as natural width in the loading analysis. If existing width is smaller than estimated, then existing width is used as natural width in the loading analysis.

A number of field measurements of bankfull width were available for Fish Creek in a location downstream of Miller Creek (Table 13). Existing stream width matched estimated width (7m) at that location. Another field measurement on Fish Creek above the meadows area was also measured as approximately 7 meters. Existing width estimated from aerial photos for the mouth of Fish Creek was found to be slightly smaller than widths estimated from the regional curve, which may be a result of the stream's channelization and/or use for irrigation through this meadow area. Therefore, in the Fish Creek loading analysis, bankfull widths estimated from regional curves are used for natural bankfull widths for the majority of the stream above the meadow, and existing width is used for natural bankfull width in the lower portion of Fish Creek.

Table 13. Bankfull Width (m) as Estimated From the Spokane Regional Curve and Existing Measurements.

Location	area (sq mi)	Spokane (m)	existing (m)
Fish Creek Mainstem			
Fish Creek @ mouth	19.4	10	~8
Fish Creek ab meadow	14.8	9	6.9
Fish Creek bl Miller Creek	9.3	7	7.1, 5.5, 7.4, 5.9, 10, 5.6
Fish Creek @ ID/WA border	1.7	3	
South-side Tributaries			
Youngs Draw @ mouth	1.84	3	
Shove Creek @ mouth	2.72	4	
Swansons Chute @ mouth	0.85	2	
Miller Creek @ mouth	1.14	3	1.7*
Johnson Creek @ mouth	0.35	2	
Unnamed complex (west of Johnson)	2.61	4	
east fork	0.6	2	2.8
middle fork	0.62	2	
west fork	1.75	3	
Unnamed (western most)	0.55	2	
North-side Tributaries			
1st Unnamed (eastern most)@mouth	0.58	2	
2nd Unnamed @ mouth	0.91	2	
3rd Unnamed (opposite Swansons)@ mouth	1.23	3	1.1*
4th Unnamed (opposite Miller)@mouth	1.08	3	
5th Unnamed (opposite Johnson)@mouth	1.05	3	
6th Unnamed (western most)@mouth	0.24	1	

*headwaters sampling locations

Very little existing bankfull width data was available for the Fish Creek tributaries. Only one existing measurement, on the east fork of the tributary complex west of Johnson Creek, was available for comparison to estimated width based on the regional curve (Table 13). The measured value was 2.8 meters and the estimated value was 2 meters. Other existing bankfull measurements on tributaries were in headwaters locations and are not directly comparable to estimates for the mouths of these tributaries. Although most of these tributary measurements occurred closer to headwaters than to mouths, there does not appear to be any information suggesting that existing stream widths would differ from streams widths estimated using the regional curve. Therefore, the estimate of bankfull width, based on the regional curve for a similar drainage area, is used for both natural bankfull width and existing bankfull width.

Design Conditions

The Fish Creek watershed is found in the Western Selkirk Maritime Forest Sub-ecoregion (Level IV) of the Northern Rockies Level III Ecoregion (McGrath et al. 2001). The sub-ecoregion is dominated by Douglas fir with grand fir, western redcedar, and western hemlock as major components. The Fish Creek watershed is largely a mixed conifer-western redcedar forest with a deciduous tree/shrub component becoming prominent along streambanks as streams widen. Lower Fish Creek opens onto a meadow area of shrubs and grasses before it enters Twin Lakes. Tributaries to Fish Creek are largely first order streams with just a few second order sections. Fish Creek itself is a third order stream below the unnamed tributary west of Johnson Creek.

Target Selection

Time Period

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).

Shade Curves

To determine PNV shade targets for Fish Creek and its tributaries, effective shade curves were examined. These curves were developed for the Panhandle region of Idaho (see Appendix X), based on vegetation response units (VRUs). The effective shade curves show percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade the center of the stream that is increasingly distant from the bank. So as width increases, percent shade decreases. Appendix X provides an explanation of how shade curves were developed for the Panhandle region of Idaho.

To use the various shade curves provided in Appendix X, an aquatic response unit (ARU) filter (see Table X-3) is applied. Applying the correct ARU filter tells us, for example, that for a stream order between 1st and 4th and a gradient greater than or equal to 3%, one of the Forest Group shade curves is used for that section of stream. The decision about which of Forest Group shade curves to use for a particular section of stream depends on the predominant VRUs surrounding the stream in that section. The VRUs encountered in this analysis were predominantly VRU 4 (moderately warm/moist forest) and VRU 5 (moderately cool/moist forest), thus only Forest Group B shade curves were utilized. Table 14 shows shade percentages for Forest Group B Vegetation Types with VRUs of 4, 5, or 6, at stream widths from 1 meter to 9 meters. For each stream width, Table 14 shows a value for each of three different flow directions – one for each of the cardinal directions (0/180 and 90/270) and one for a 45-degree angle (45/135/225/315). The shade target values result from averaging the three flow direction-based values taken from the shade curves (see Appendix X). Table 14 does not show values for VRU 2 (moderately warm/dry forest – Forest Group A), although it did occasionally occur along streams in this watershed, because it occurred only for small portions of reaches or in the lower elevations where the Nonforest Group was utilized. Forest Groups C and D did not occur on any streams in this analysis.

Table 14. Shade Percentages for Forest Group B Vegetation Type at Various Stream Widths and Target Shade Percentages

Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m
Group B - VRUs 4,5,6 0/180	98	97	95	93	90	87	83	78	74
45/135/225/315	98	98	96	93	90	87	82	78	73
90/270	98	98	97	96	94	92	85	78	71
Target (%)	**98**	**98**	**96**	**94**	**91**	**89**	**83**	**78**	**73**

If stream orders are between 1st and 4th, but the gradient is less than 3%, then the stream falls into the Nonforest Group 1 category based on the ARU filter (Appendix X, Table X-3). Only the lower portion of Fish Creek and a small portion of Young's Draw fall into this category. Shade curves developed for this group include a variety of coniferous and deciduous vegetation (see Table X-7). Shade percentages for this vegetation type are displayed in Table 15. Because percentages for Nonforest Group 1 are given only for stream widths that are even-numbered (in meters), the target percentages for streams with odd-numbered widths are the halfway points between those for even-numbered widths.

Table 15. Shade Percentages for Nonforest Group 1 Vegetation Type at Various Stream Widths and Target Shade Percentages

Non-Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m
Group 1 - Hardwoods 0/180		93		75		61		53		47
45/135/225/315		93		77		64		55		49
90/270		95		82		69		57		47
Target (%)	**97**	**94**	**86**	**78**	**72**	**65**	**60**	**55**	**52**	**48**

When stream orders increase to the 5th and 6th level, streams and their associated floodplains become wider and a second group of nonforest vegetation is needed for describing shade targets (Nonforest Group 2). However, no streams in this analysis were of orders higher than 3rd, thus Group 2 shade curves were not needed.

Tables 16 – 18, provide existing shade, target shade, and the difference between them for Fish Creek and its tributaries. This information is presented graphically for Fish Creek and tributaries in Figure 20 (target shade), Figure 21 (existing shade), and Figure 22 (difference between existing and target). Although each total percent reduction identified in Tables 16, 17, and 18 is displayed as a negative number it does not indicate an increase in solar radiation load. The negative number represents a decrease in solar radiation load.

Table 16. Existing and Potential Solar Loads for Fish 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)	**Fish Creek**
470	0.8	1.14	0.96	0.228	-0.91	3	3	1410	1607.4	1410	321.48	-1285.92	Forest Group B
1970	0.9	0.57	0.94	0.342	-0.23	4	4	7880	4491.6	7880	2694.96	-1796.64	
ID17010305PN014_02							**Subtotal**	**9,290**	**6,099**	**9,290**	**3,016**	**-3,083**	
1480	0.9	0.57	0.91	0.513	-0.06	5	5	7400	4218	7400	3796.2	-421.8	
1580	0.9	0.57	0.83	0.969	0.399	7	7	11060	6304.2	11060	10717.14	4412.94	
800	0.8	1.14	0.83	0.969	-0.171	7	7	5600	6384	5600	5426.4	-957.6	
500	0.2	4.56	0.6	2.28	-2.28	7	7	3500	15960	3500	7980	-7980	Nonforest Group 1
580	0.2	4.56	0.55	2.565	-1.995	8	8	4640	21158.4	4640	11901.6	-9256.8	
460	0.1	5.13	0.55	2.565	-2.565	8	8	3680	18878.4	3680	9439.2	-9439.2	
1840	0	5.7	0.55	2.565	-3.135	8	8	14720	83904	14720	37756.8	-46147.2	
ID17010305PN014_03							**Subtotal**	**50,600**	**156,807**	**50,600**	**87,017**	**-69,790**	
							Total	**59,890**	**162,906**	**59,890**	**90,034**	**-72,872**	**-45 % Reduction**

Table 17. Existing and Potential Solar Loads for the South-side Tributaries to Fish 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)	**South-side Tributaries**
2890	0.9	0.57	0.98	0.114	-0.46	1	1	2890	1647.3	2890	329.46	-1317.84	*Youngs Draw*
250	0.7	1.71	0.96	0.228	-1.482	3	3	750	1282.5	750	171	-1111.5	Forest Group B
200	0.9	0.57	0.96	0.228	-0.342	3	3	600	342	600	136.8	-205.2	
90	0.8	1.14	0.96	0.228	-0.912	3	3	270	307.8	270	61.56	-246.24	
290	0.7	1.71	0.86	0.798	-0.912	3	3	870	1487.7	870	694.26	-793.44	Nonforest Group 1
310	0.2	4.56	0.86	0.798	-3.762	3	3	930	4240.8	930	742.14	-3498.66	
2080	0.9	0.57	0.98	0.114	-0.456	1	1	2080	1185.6	2080	237.12	-948.48	*Shove Creek*
1100	0.9	0.57	0.98	0.114	-0.456	1	1	1100	627	1100	125.4	-501.6	Forest Group B
780	0.7	1.71	0.98	0.114	-1.596	2	2	1560	2667.6	1560	177.84	-2489.76	
1260	0.8	1.14	0.96	0.228	-0.912	3	3	3780	4309.2	3780	861.84	-3447.36	
880	0.6	2.28	0.94	0.342	-1.938	4	4	3520	8025.6	3520	1203.84	-6821.76	
3200	0.9	0.57	0.98	0.114	-0.456	2	2	6400	3648	6400	729.6	-2918.4	*Swansons Chute*
2850	0.9	0.57	0.98	0.114	-0.456	2	2	5700	3249	5700	649.8	-2599.2	*Miller Creek*
1760	0.9	0.57	0.98	0.114	-0.456	2	2	3520	2006.4	3520	401.28	-1605.12	*Johnson Creek*
540	0.9	0.57	0.94	0.342	-0.228	4	4	2160	1231.2	2160	738.72	-492.48	*Unnamed (west of Johnson)*
2160	0.9	0.57	0.98	0.114	-0.456	2	2	4320	2462.4	4320	492.48	-1969.92	*east fork*
420	0.9	0.57	0.98	0.114	-0.456	1	1	420	239.4	420	47.88	-191.52	*west fork*
340	0.8	1.14	0.98	0.114	-1.026	1	1	340	387.6	340	38.76	-348.84	
2050	0.9	0.57	0.98	0.114	-0.456	2	2	4100	2337	4100	467.4	-1869.6	
470	0.8	1.14	0.98	0.114	-1.026	1	1	470	535.8	470	53.58	-482.22	*middle fork*
1050	0.9	0.57	0.98	0.114	-0.456	2	2	2100	1197	2100	239.4	-957.6	
140	0.8	1.14	0.98	0.114	-1.026	1	1	140	159.6	140	15.96	-143.64	*Unnamed (western most)*
340	0.4	3.42	0.98	0.114	-3.306	1	1	340	1162.8	340	38.76	-1124.04	
1200	0.9	0.57	0.98	0.114	-0.456	2	2	2400	1368	2400	273.6	-1094.4	
							Total	**50,760**	**46,107**	**50,760**	**8,928**	**-37,179**	**-81 % Reduction**

Table 18. Existing and Potential Solar Loads for the North-side Tributaries to Fish Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	**North-side Tributaries**
150	0.9	0.57	0.98	0.114	-0.46	1	1	150	85.5	150	17.1	-68.4	*eastern-most tributary*
370	0.5	2.85	0.98	0.114	-2.736	1	1	370	1054.5	370	42.18	-1012.32	
610	0.9	0.57	0.98	0.114	-0.456	1	1	610	347.7	610	69.54	-278.16	
200	0.7	1.71	0.98	0.114	-1.596	1	1	200	342	200	22.8	-319.2	
550	0.8	1.14	0.98	0.114	-1.026	2	2	1100	1254	1100	125.4	-1128.6	
710	0.9	0.57	0.98	0.114	-0.456	2	2	1420	809.4	1420	161.88	-647.52	
140	0.7	1.71	0.98	0.114	-1.596	2	2	280	478.8	280	31.92	-446.88	
240	0.5	2.85	0.98	0.114	-2.736	2	2	480	1368	480	54.72	-1313.28	
1120	0.9	0.57	0.98	0.114	-0.456	1	1	1120	638.4	1120	127.68	-510.72	*2nd tributary*
960	0.7	1.71	0.98	0.114	-1.596	2	2	1920	3283.2	1920	218.88	-3064.32	
410	0.9	0.57	0.98	0.114	-0.456	2	2	820	467.4	820	93.48	-373.92	
1140	0.9	0.57	0.98	0.114	-0.456	1	1	1140	649.8	1140	129.96	-519.84	3rd tributary
290	0.8	1.14	0.98	0.114	-1.026	2	2	580	661.2	580	66.12	-595.08	
1020	0.9	0.57	0.98	0.114	-0.456	2	2	2040	1162.8	2040	232.56	-930.24	
210	0.8	1.14	0.96	0.228	-0.912	3	3	630	718.2	630	143.64	-574.56	
100	0.6	2.28	0.96	0.228	-2.052	3	3	300	684	300	68.4	-615.6	
110	0.8	1.14	0.96	0.228	-0.912	3	3	330	376.2	330	75.24	-300.96	
1770	0.9	0.57	0.98	0.114	-0.456	2	2	3540	2017.8	3540	403.56	-1614.24	4th tributary
470	0.8	1.14	0.98	0.114	-1.026	1	1	470	535.8	470	53.58	-482.22	5th tributary
1890	0.9	0.57	0.96	0.228	-0.342	3	3	5670	3231.9	5670	1292.76	-1939.14	
1280	0.9	0.57	0.98	0.114	-0.456	1	1	1280	729.6	1280	145.92	-583.68	western-most tributary
							Total	**24,450**	**20,896**	**24,450**	**3,577**	**-17,319**	**-83** **% Reduction**

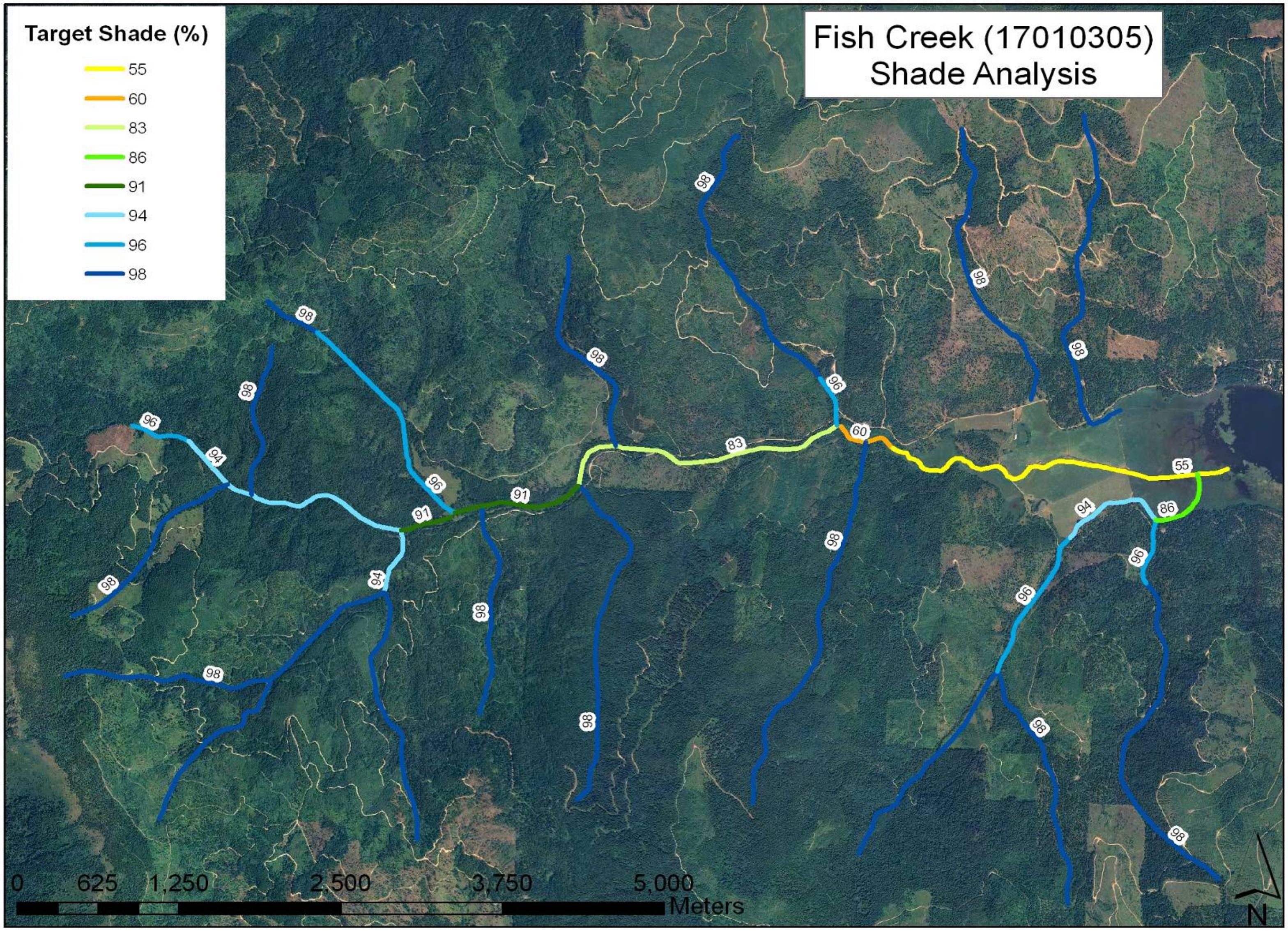

Figure 20. Target Shade for Fish Creek.

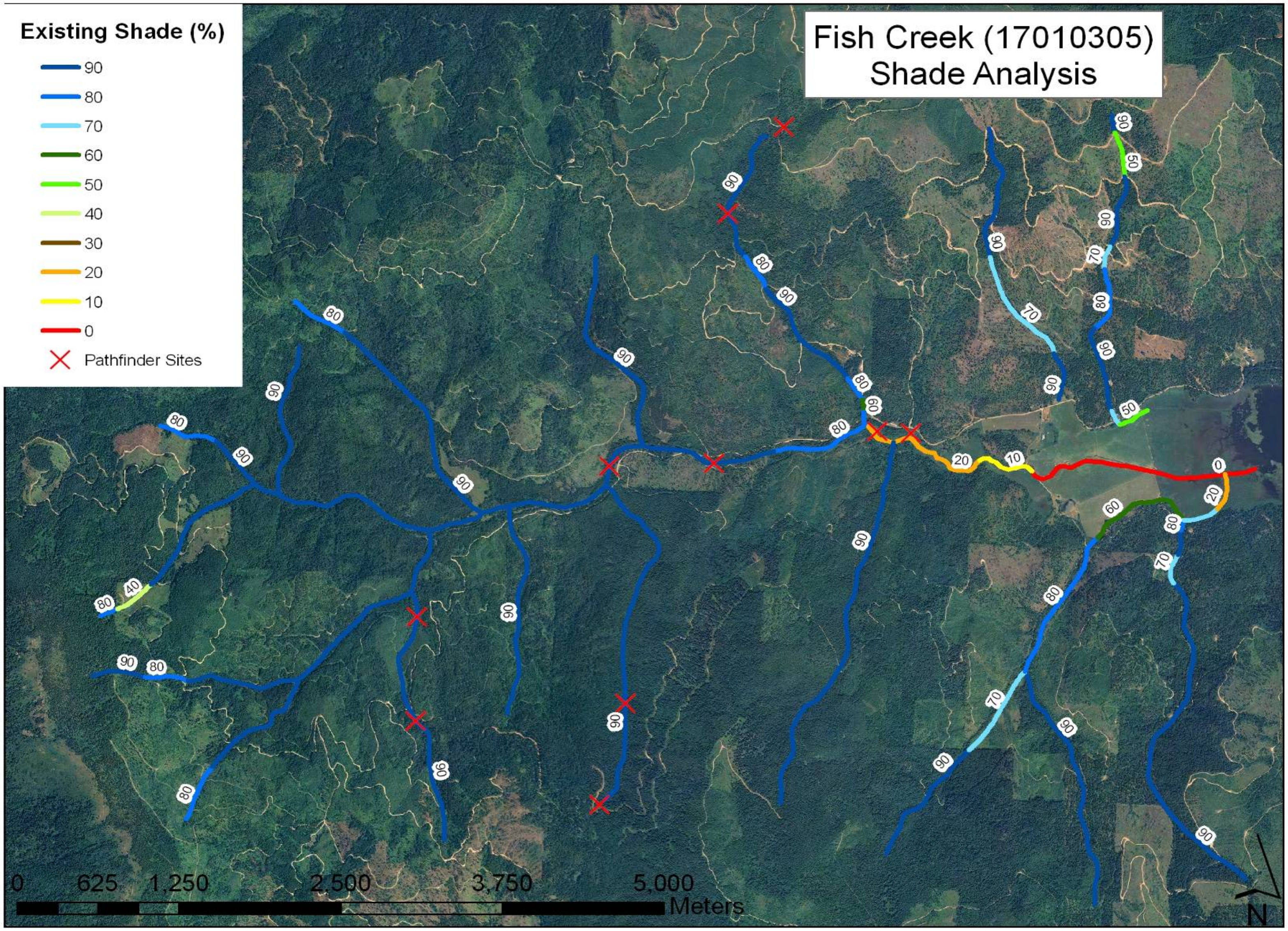

Figure 21. Existing Shade Estimated for Fish Creek by Aerial Photo Interpretation.

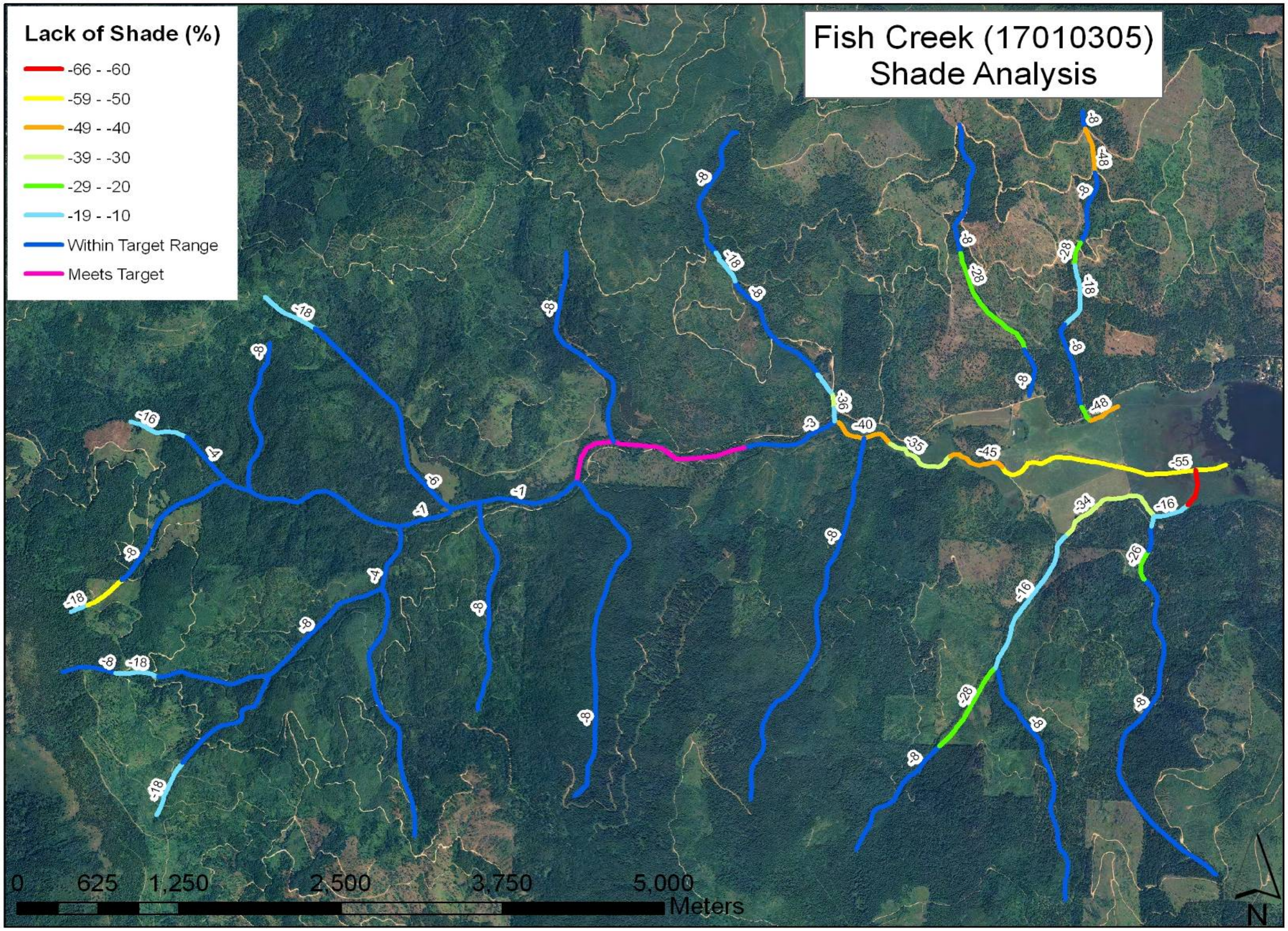

Figure 22. Lack of Shade (Difference Between Existing and Target) for Fish Creek.

Monitoring Points

The accuracy of the aerial photo interpretations was field-verified with 40 Solar Pathfinder traces at four locations: one on Fish Creek and three on tributaries. These data were used to recalibrate the visual observations, and revise the initial aerial photo interpretation. Effective shade monitoring can take place on any reach throughout the creek and compared to estimates of existing shade listed in Tables 16, 17 and 18. 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 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 TMDL implementation process. There is no uniform length for each stream segment with a different estimated level, rather, the length depends on land use or landscape that has affected the level of shade. Some tributaries to Fish Creek have the same shade class for their entire length, while others have one shade class for most of their length but also have several short segments with different shade classes. It is appropriate to monitor within a given segment to see if existing shade in that segment has increased its toward target levels. Ten equally spaced Solar Pathfinder measurements taken within a segment and averaged together will suffice to determine new shade levels in the future.

5.2A Temperature Load Capacity

The loading capacity for a stream under PNV is essentially the solar loading allowed under the target levels of shade specified for that stream (target levels may be different for different stream segments). These potential/target loads are determined by multiplying the total solar radiation load recorded on a flat plat collector under full sun by the part of the total solar radiation load that is not blocked by shade (i.e., it is "open"). To find the "percent open" value, subtract the "percent shade" value (converted to decimal form) from 1.0. The equation for this can be expressed as

- 1.0 minus "percent (decimal) shade" = "percent (decimal) open," or
- 100% - %shade = %open.

For example, if a shade target is 60% (or 0.6), then the solar load hitting the stream if that target is achieved would be 40% (0.4) of the load hitting the flat plate collector under full sun, calculated as 1.0 – 0.6 = 0.4. Therefore, in this case, the load recorded under full sun would be multiplied by 0.4.

The solar loading capacities in this TMDL are based on solar load data collected at a National Renewable Energy Laboratory (NREL) weather station in Spokane, Washington, using flat plate collectors under full sun. In this TMDL, spring/summer averages are used; thus, we average the NREL-collected load data for the 6-month period from April through September. These months coincide with times of year that stream temperatures are increasing and when deciduous vegetation is in leaf. Tables 16 through 18 show the PNV shade targets (identified as Potential Shade in Tables 16-18) and their corresponding potential summer load (in kilowatt hours per square meter per day [kWh/m^2/day] and kilowatt hours per day [kWh/day]) that serve as the loading capacities for the streams.

Loading capacities were calculated for Fish Creek and for all its south-side tributaries added together and all its north-side tributaries added together. The load capacities are as follows:

- Fish Creek has a loading capacity of 90,034 kWh/day (Table 16).
- The south-side tributaries have a total loading capacity of 8,928 kWh/day (Table 17).
- The north-side tributaries have a total loading capacity of 3,577 kWh/day (Table 18).

5.3A Estimates of Existing Temperature 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 estimates were converted to solar loads by taking the solar radiation measured on a flat plate collector at the NREL weather stations (under full sun) and multiplying by the fraction of stream open to the sunlight. Existing shade data are presented in Tables 16 through 18, along with potential load data. Like loading capacities (potential loads), estimated existing loads in Tables 16 through 18 are presented on an area basis (kWh/m^2/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 analysis. The data tables presenting these analyses (Tables 16 – 18) include total loads, which are shown at the bottom of their respective columns. The difference between potential load and estimated existing load is also summed for the entire table. When existing load exceeds potential load, this difference becomes the excess load, as discussed next in the load allocation section (section 5.4A). The percent reduction shown in the lower right corner of each table represents the amount of total excess load in relation to total existing load.

The existing loads are as follows:

- Fish Creek has an existing load of 162,906 kWh/day (Table 16).
- The south-side tributaries have a total existing load of 46,107 kWh/day (Table 17).
- The north-side tributaries have a total existing load of 20,896 kWh/day (Table 18).

5.4A Temperature 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 nonpoint 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. Target or potential shade (Tables 16 through 18) 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. 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.

Table 19 shows the excess heat (solar) load (kWh/day) experienced in each stream segment examined and the percent reduction necessary to bring that water body back to its target load level. 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.

The excess load may include a Method Difference (MD) amount that can result from classifying the existing shade into a 10% class interval and recording it as the lowest integer value in that class, while identifying target shade level as a unique integer (i.e., existing shade is effectively estimated to within 10% but target shade is calculated to within 1%). For example, say a particular stretch of stream has a target shade level of 86%. If existing shade on that stretch of stream were at target level, it would be recorded as 80% existing shade in the loading analysis (it falls into the 80-89% existing shade class, which is recorded as 80%). There is an automatic difference of 6%, attributable to the MD. In reality, existing shade may be somewhere within the 80-89% interval. Thus, existing shade could be 81% or 82% or 83%, etc. Table 19 presents excess solar loads and the amount of each that may be attributable to MD, along with percent reductions necessary to reach target levels.

Because excess load and percent reduction necessary values are calculated for Fish Creek and for two aggregated groups of its tributaries, comparisons cannot be made among individual tributaries. The south-side tributaries have a total excess load of 37,179 kWh/day with the potential of up to 21,031 kWh/day of that total excess load attributable to MD. The north-side tributaries have a 17,319 kWh/day total excess load with the potential for 10,359 kWh/day of that load resulting from the MD. Fish Creek itself has the largest excess load at 72,872 kWh/day with the potential for up to 12,116 kWh/day of that to be considered as MD.

Table 19. Excess Solar Loads and Percent Reductions for Fish Creek and Tributaries.

Water Body	Excess Load (kWh/day)	Percent Reduction Necessary
Fish Creek	72,872 (up to 12,116 as MD)	37 – 45%
South-side Tributaries	37,179 (up to 21,031 as MD)	35 – 81%
North-side Tributaries	17,319 (up to 10,359 as MD)	33 – 83%

MD = Method Difference, explained in text.

The high end of each range of percent reduction necessary, shown in Table 19, results from dividing the total excess load by the total existing load (x 100) listed in Tables 16 through 18. The low end of each range of percent reduction necessary, shown in Table 19, results from subtracting the maximum excess load that could be attributed to the MD from the originally-calculated total excess load and recalculating the percent reduction. The loading analyses for the tributaries show large percent reductions potentially needed to achieve target levels (reductions greater than 80%). However, a major portion of these reductions may result from the MD. Tables C-2 through C-4 in Appendix C show the results of the loading analysis if existing shade were exactly equal to the value assigned (the assigned value is based on the shade class, which represents a range of 10%). For example, if target shade were 96% and existing shade were assigned a value of 90%, a method difference of 6% would result. Table C-2 shows that the south-side tributaries would have an excess load of 21,031 kWh/day even if existing shade were exactly at the levels assigned based on the 10% shade classes of their targets. Table C-3 shows that north-side tributaries would have an excess load of 10,359 kWh/day in that case. Table C-4 shows that the excess load calculated for Fish Creek itself has includes up to 12,116 kWh/day attributable to MD.

Figure 22 shows that a small portion of the Fish Creek and several tributaries adjacent to the Idaho/Washington border (left side of figure) and the grass meadows area with associated tributaries (right side of figure) have some of the larger disparities between existing and target shade with differences of about -16% to -55%. Most of the conifer vegetation type region is has shade near target levels (-8% or less difference). The transition in conifer/shrub vegetation from one target level to another is more gradual in real life compared to the sudden break we have created between the targets of 91% and 83% for the Forest Group. Thus, there is a region on Figure 21 where existing shade is shown as slightly greater (by 7%) than the target for the conifer type (pink line). In reality, the stream is gradually increasing in width and the conifers are becoming more distant from the stream. Our break point between the two targets is thus somewhat less distinct and creates this see-saw between target and existing shade levels. The real lack of shade appears to begin further downstream in the Nonforest Group zone where pasturing or other similar land use has removed most of the streamside vegetation.

Wasteload Allocation

There are no known National Pollutant Discharge Elimination System (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 (MOS) 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 six 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 is 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.

Background

The background stream temperatures in Fish Creek and tributaries to Fish Creek occur when the riparian vegetation is at pre-anthropogenic levels. Pre-anthropogenic shade levels were modeled using riparian communities that have been able to grow naturally without impact.

5.1B Sediment In-stream Water Quality Targets

The goal of the sediment TMDL is to restore impaired waters to "full support of designated beneficial uses" (Idaho Code 39.3611.3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The sediment TMDL analysis developed loading capacities in terms of mass per area per unit time (tons/acre/year). Daily load targets are included in Appendix F. The interim goals will be based on conditions in a watershed that is supporting all beneficial uses. The final goal will be established when biological monitoring demonstrates full support of the cold water aquatic uses and there are positive trends in fisheries populations are seen. Sources contributing sediment can be reduced, but a substantial period (perhaps up to 30 years) will be required before beneficial use recovery is noticeable.

Design Conditions

Modeled sources of sediment to Fish Creek and tributaries to Fish Creek are all nonpoint sources. This TMDL addresses the nonpoint source sediment yield to surface water. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. High discharge events typically occur between November and May, but may not occur every year. These events typically coincide with critical conditions (critical conditions are described near the beginning of Section 5 on page 55).

Target Selection

The Idaho water quality standard addressing sediment impairment is a narrative standard. To best address impairment caused by excess sediment, a numeric target was selected for this analysis and a load capacity was set accordingly. Throughout the state, the load capacity at which full support is exhibited has varied in sediment TMDLs developed by DEQ. These have ranged from an interim load capacity set at the background level for some watersheds in the Coeur d'Alene Lake Subbasin and the Pend Oreille Basin, to a load capacity set at more that 200% above background in some areas of the state. Evidence suggests that a target of 68% above background is protective of the beneficial uses in the Fish Creek watershed. This approach and target are consistent with load capacities set for other Idaho Panhandle TMDLs.

Although it is well understood that streams have the ability to process sediment levels greater than natural background levels, it is not well understood exactly what level is possible before impairment occurs. A multitude of options were explored when developing the sediment model and sediment target used in this TMDL. To determine the most appropriate target, each watershed must be evaluated on an individual basis.

Sediment Model Development

A paired watershed approach was utilized to select the sediment target for this TMDL. A reference watershed (a watershed supporting all beneficial uses) was selected using local knowledge from the Watershed Advisory Group (WAG) and DEQ monitoring data. Hayden Creek was selected as a reference watershed because of its land use, climatic, geologic, and geographic similarities to Fish Creek (Table 20) and its current biological condition.

Table 20. Fish Creek and Hayden Creek watershed characteristics.

<table>
<tr><th></th><th colspan="2">Fish Creek</th><th colspan="2">Hayden Creek</th></tr>
<tr><td>Subbasin</td><td colspan="2">Upper Spokane</td><td colspan="2">Upper Spokane</td></tr>
<tr><td>Watershed type</td><td colspan="2">Third order dendritic stream
Rosgen A channel type in headwaters transitioning into Rosgen B channel type in lower reaches</td><td colspan="2">Third order dendritic stream
Rosgen A channel type in headwaters transitioning into Rosgen B channel type in lower reaches</td></tr>
<tr><td>Watershed size (acres)</td><td colspan="2">14,237</td><td colspan="2">18,183</td></tr>
<tr><td>Level 3 Ecoregion</td><td colspan="2">Northern Rockies</td><td colspan="2">Northern Rockies</td></tr>
<tr><td>Elevation</td><td colspan="2">5,100 ft to 2,306 feet</td><td colspan="2">6,650 feet to 3,466 feet</td></tr>
<tr><td>Mean Precipitation</td><td colspan="2">30-50 inches</td><td colspan="2">30-60 inches</td></tr>
<tr><td>Geologic Setting</td><td colspan="2">Metasediments of the Belt Supergroup, and
Granitics of the Kaniksu Batholith</td><td colspan="2">Metasediments of the Belt Supergroup</td></tr>
<tr><td>Vegetation</td><td colspan="2">Lower elevations – Cedar/Hemlock
Uplands – mixed conifer of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, western pine
Higher elevations – spruce
Riparian areas - willow</td><td colspan="2">Lower elevations – Cedar/Hemlock
Uplands – mixed conifer of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, western pine
Higher elevations – spruce
Riparian areas - willow</td></tr>
<tr><td>Aspect</td><td colspan="2">West – East</td><td colspan="2">North – South</td></tr>
<tr><td>Flow Regime</td><td colspan="2">High-volume runoff during spring associated with rain on snow events
Q2 flows 251 cfs[1]</td><td colspan="2">High-volume runoff during spring associated with rain on snow events
Q2 flows 413 cfs[1]</td></tr>
<tr><td rowspan="3">Land Use Types</td><td colspan="2">Forest Road –
road density 6.2miles/square mile</td><td colspan="2">Forest Road –
road density 3.3miles/square mile</td></tr>
<tr><td colspan="2">Timber Harvest</td><td colspan="2">Timber Harvest</td></tr>
<tr><td colspan="2">Agriculture in lowland reaches of mainstem</td><td colspan="2">Agriculture in lowland reaches of mainstem and minor occurrences on tributary streams</td></tr>
<tr><td>Ownership</td><td colspan="2">Mixed ownership includes the state of Idaho and private</td><td colspan="2">Mixed ownership includes the federal government (USFS) and private</td></tr>
<tr><td rowspan="4">WBAG II Scores[2]</td><td>SMI</td><td>2</td><td>SMI</td><td>3</td></tr>
<tr><td>SHI</td><td>2.25</td><td>SHI</td><td>3</td></tr>
<tr><td>SFI</td><td>1</td><td>SFI</td><td>2</td></tr>
<tr><td>Average</td><td>1.75</td><td>Average</td><td>2.67</td></tr>
<tr><td>Comment</td><td colspan="2"></td><td colspan="2">Passing WBAG II scores, supports robust cutthroat trout population</td></tr>
</table>

[1] Flows information obtained from USGS StreamStats (http://streamstats.usgs.gov/idstreamstats/index.asp)

[2] WBAG II Scores are explained in detail in DEQ's *Water Body Assessment Guidance, Second Edition-Final* (Grafe et al. 2002).

To determine the existing sediment conditions, all land use types were identified and mapped. Stringent attempts were made to characterize all land use types using satellite imagery, field-verified Global Information System (GIS) data, field tours, and suggestions from the WAG. Characterizing all known land use types will allow for land use-specific allocations and guide implementation actions.

Once all known land uses were mapped, the area for each land use was determined using GIS software. Sediment yield coefficients were then applied to the appropriate land use type and multiplied by the associated acreage. A natural background value was determined by multiplying the acreage of the watershed by the natural background sediment yield coefficient. Percentage above natural background was derived by determining the difference between current condition and natural conditions divided by natural conditions. The percentage above natural background value of Hayden Creek was then compared to Fish Creek.

The current sediment yield condition (percentage above natural background) of Hayden Creek was analyzed to determine the most appropriate sediment yield target for the Fish Creek watershed. As modeled, Hayden Creek is currently functioning and supporting all beneficial uses at sediment yields 68% above natural background. This TMDL sets the sediment yield target at 68% above natural background for the Fish Creek watershed.

Monitoring Points

The points of compliance for Fish Creek will be located at the previous BURP sites. Beneficial use support status will be determined using the current assessment methodology accepted by DEQ at the time the water body is re-assessed. Monitoring will be completed using BURP protocols and DEQ will utilize any other habitat assessments by the Idaho Department of Fish and Game (IDFG) and the United States Forest Service (USFS) to help assess support status of beneficial uses. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised, if necessary, to reflect the established supporting sediment yield.

5.2B Sediment Load Capacity

The load capacity of a TMDL designed to address sediment-caused water quality impairment is complicated by the fact that the state's water quality standard is a narrative standard rather than a quantitative standard. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to ascertain. Attempts to model sediment yield within the basin are designed to achieve relative rather than exact sediment estimates.

The natural background sediment rate is the sediment yield within a watershed prior to anthropogenic influences. It was calculated by multiplying watershed acres by the natural background coefficient. The natural background sediment yield coefficient applied within the Fish Creek watershed was developed assuming a predominantly Belt Supergroup geology. The natural background estimate assumes that the entire watershed was vegetated by coniferous forest prior to anthropogenic activities.

The load capacity (target condition) was developed by adding an additional 68% sediment yield to the modeled natural background sediment yield, based on the modeled target discussed in Appendix E. Table 21 shows current sediment load, background load, and load capacity for the Fish Creek watershed.

Table 21. Sediment current load, background load, and load capacity for the Fish Creek watershed.

Assessment Units	Water-shed acreage	Estimated existing load (tons/year)	Natural background (tons/year)	Load capacity at 68% above natural background (tons/year)	Load Reduction Required (tons/year)	% Load Reduction Required
ID17010306PN014_03 ID17010306PN014_02	14,237	827	327	549	278	33

5.3B Estimates of Existing Sediment 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.

Point sources of sediment do not exist within the Fish Creek watershed. All sources of sediment to surface water within the watershed are nonpoint sources. Loading rates are based on modeled land use types (Figure 23). Forest roads and canopy removal were the land use types which contribute the largest amount of non-natural material to surface waters, according to modeling. Estimated sediment loads for Fish Creek are detailed in Table 22.

Table 22. Estimated existing sediment loads from nonpoint sources in the Fish Creek watershed.

Land Use Type	Acres of land use type	Load (tons/year)	Estimation Method
Agriculture	345	14	Modeled
High Canopy Removal	1,447	304	Modeled
Medium Canopy Removal	826	58	Modeled
Recovering Harvest	2,431	61	Modeled
Forest (natural background)[1]	8,504	195	Modeled
Forest road	583	38	Modeled
Forest road within 200 feet of stream	67	157	Modeled
Water	34	0	Modeled
Total Acres	**14,237**	**827**	**-**

[1]Naturally occurring land use type, contributing load was not allocated for reduction.

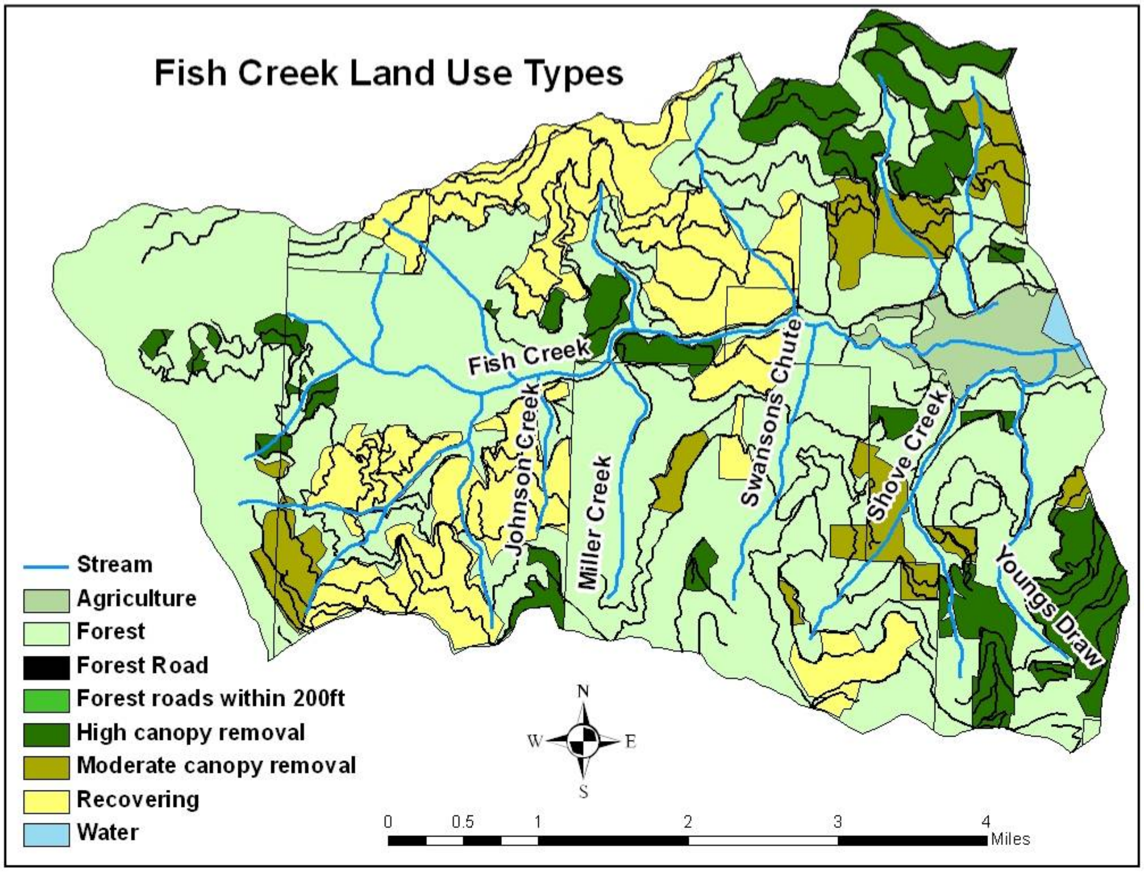

Figure 23. Fish Creek land use types.

5.4B Sediment Load Allocation

The sediment load allocation is the load capacity minus the natural background load. The natural background load has been calculated for the entire watershed and represents an estimate of sediment generation under natural or pre-anthropogenic conditions. No load reduction allocations are provided for lands classified as natural.

Since there are no known point sources of sediment in the Fish Creek watershed, the wasteload allocation (WLA) is zero. The sediment TMDL only includes load allocations for nonpoint sources. The amount of sediment load reduction required is shown in Table 23. The allocations are based on the modeled estimates of nonpoint source sediment contributions and a reduction to a level 68% greater than natural background conditions.

Table 23. Sediment existing load, target load, and load reduction for the Fish Creek watershed.

Watershed	Existing Load (tons/year)	Target Load (tons/year)	Load Reduction (tons/year)	Percent Load Reduction (%)
Fish Creek	827	549	278	33

The Fish Creek watershed requires a sediment reduction of 33%. Reducing sediment input by 33% will achieve the sediment target set in this TMDL of 68% above natural background. Sediment generation is currently modeled at 827 tons per year. The sediment generation goal was modeled at 549 tons per year and generated by using a paired watershed approach (Appendix E). Table 23 allocates sediment loads annually; Appendix F relates the annual loads to daily loads.

Wasteload Allocation

There are no known National Pollutant Discharge Elimination System (NPDES) permitted point sources in the Fish Creek watershed. Thus, there are no wasteload allocations, either. Should a point source be proposed that would generate sediment, all possible actions should be taken to mitigate against sediment yield to surface water. All future land use activities resulting in a point source discharge will be subject to agency review, compliance with TMDL pollutant loads, and state and federal regulations.

Margin of Safety

A margin of safety (MOS) is calculated into each TMDL to help account for any inaccuracies in pollutant load calculations. The MOS can be implicit in the design of the TMDL load calculations and target selection, or the MOS can be an explicit reduction taken from the load calculations. The MOS is derived from conservative assumptions and estimates made in the model construction and application. Conservative estimates were made in the development of the land use sediment yield coefficients. In this TMDL, the implicit MOS for the sediment model is built into the coefficients used and the target selected (see Appendix E for more details).

Seasonal Variation

Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions and occur during November through May, generally during the rising limb of the annual hydrograph. Due to the geologic, geographic, and weather conditions experienced within the Fish Creek watershed, rain-on-snow events pose the greatest risk for sediment generation. Such events may not occur for several seasons. Within the Panhandle region of Idaho, the return time for large events is approximately 10-15 years.

The method used to generate sediment loads in this TMDL do not account for seasonal variation. Although it is anticipated that sediment is load during high discharge events the sediment load capacity and load reduction is applied throughout the year.

Background

The background sediment load for Fish Creek can be found in Table 21. Natural background sediment yield was calculated by multiplying the watershed acreage by the forest coefficient developed for a Belt Supergroup geologic setting. The background is treated as part of the load capacity and is allocated as part of the load capacity.

5.1C Bacteria In-stream Water Quality Targets

The goal of the bacteria TMDL is to restore impaired water to “full support of designated beneficial uses” (Idaho Code 39.3611.3615). Specifically, *E. coli* must be reduced to a level at which full support of contact beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The numeric in-stream water quality target was set at the numeric water quality standard of 126 colony forming units (cfu)/100ml of *E. coli* (IDAPA 58.01.02.251.01.a). Achieving *E. coli* concentrations to comply with Idaho water quality standards will support contact recreational uses.

Design Conditions

In the case of bacteria and recreation uses, the warmer months of the year including late spring, summer, and early fall are considered the critical time periods to protect recreational users of surface waters from bacterial contamination. Bacteria data used in this TMDL were collected during the summer months so little is known about bacteria contamination in spring following runoff or in the fall. Bacterial contamination is also highly affected by flow volume. Thus, in this TMDL, bacteria loads are developed based on stream flow.

Target Selection

Bacteria targets are set at the water quality standard for recreation uses of 126 cfu/100ml of *E. coli*. For any given flow volume, the number of colonies the water body can contain and still meet this target is derived from multiplying the flow (converted to milliliters) by 1.26 cfu.

At 1 cubic foot per second (cfs), the number of *E. coli* that could be present and still meet Idaho water quality criteria is equal to 35,679 cfu. An example of how this was calculated is:

$$(1\ ft^3) \times (28{,}316.85\ \text{milliliters}) \times (1.26\ \textit{E. coli}\ \text{cfu}) = 35{,}679\ \textit{E. coli}\ \text{cfu}/ft^3$$

Monitoring Points

Increased monitoring is needed to ascertain the source(s) and extent of bacterial contamination in the watershed. Future monitoring should include a larger seasonal window to help determine possible contamination occurring outside of the summer months. Monitoring locations should be placed throughout the watershed to better estimate the source or sources of contamination.

Two compliance points for bacteria monitoring will be set. The first will be upstream from the cattle grazing operation located within the forested portion of the watershed. Because *E. coli* concentrations at these locations are supporting contact recreational uses, continued monitoring at this location will be used to track changes in water quality.

The second compliance point is located in the lower reach of Fish Creek and is adjacent to the pastureland, approximately 800 meters upstream from the confluence of Fish Creek and Upper Twin Lake. This location is located far enough upstream so that lake water has no influence on the stream.

5.2C Bacteria Load Capacity

The bacteria loading capacity is based on stream flow and the *E. coli* water quality standard of 126 cfu/100ml. Flow (cfs) was converted to milliliters and then multiplied by 1.26. A flow of 1 cfs can contain 35,679 cfs of *E. coli* at load capacity. Figure 24 illustrates the relationship between target loads and existing bacteria loads in Fish Creek based on sample concentrations observed in summer 2007 for recorded flow volumes.

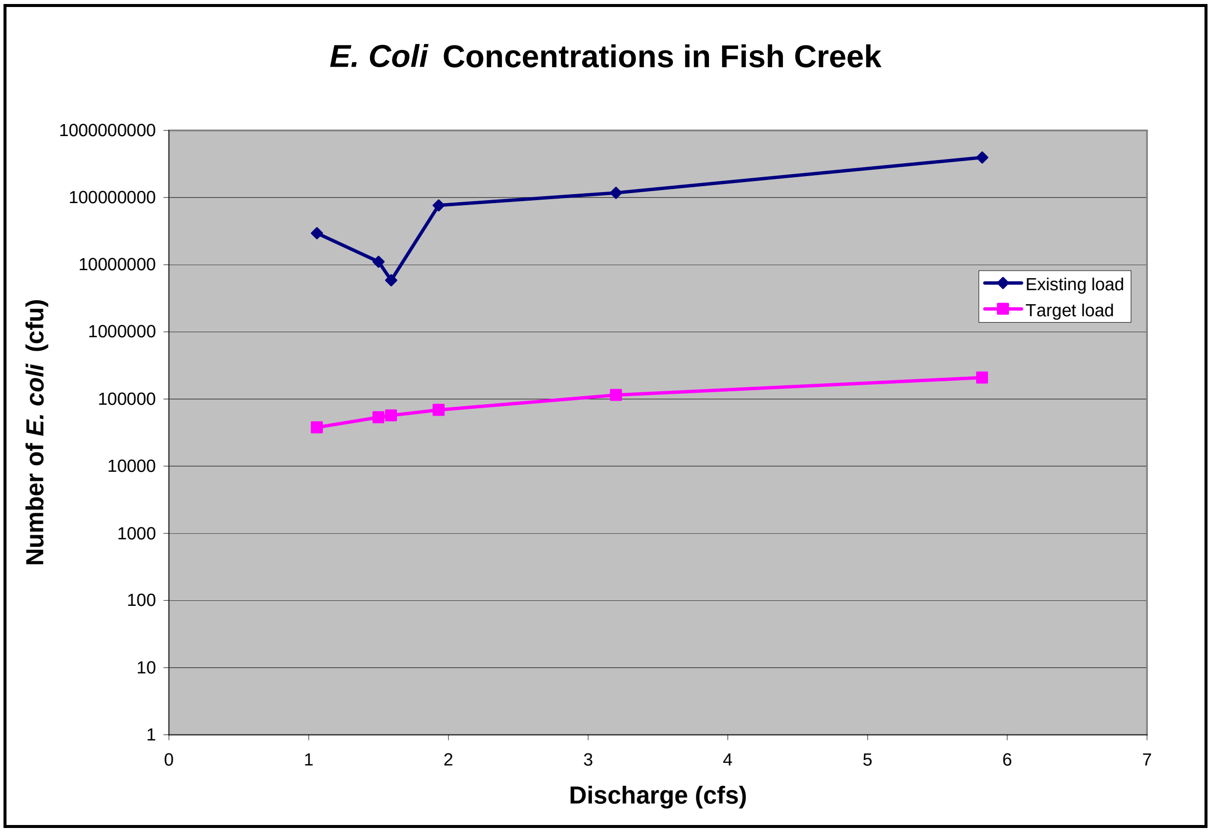

Figure 24. *E. coli* concentrations in Fish Creek at the compliance point adjacent to pastureland.

5.3C Estimates of Existing Bacteria Loads

There are no permitted point source dischargers within the Fish Creek watershed. Sources are attributed to background loading (wild animals) and anthropogenic sources (domesticated animals and/or human contributions). Twelve (12) water samples were collected on Fish Creek over a 2- month period from July 27, 2007, to August 28, 2007 (Table 24), to be analyzed for *E. coli*. During sample collection, stream discharge was measured (Table 24). Daily bacteria load estimates are detailed in Appendix G. Daily loads were calculated for Fish Creek using estimated annual discharge calculated from long-term discharge data collected within the Hayden Creek watershed, and comparing discharge measurements collected within the Fish Creek watershed. The interim goals will be based on conditions in a watershed that meet Idaho water quality standards (IDAPA 58.01.02.251.01.a).

Table 24. Numbers of *E. coli* colonies at load capacity (minus 10% MOS), existing load, and reduced load, and percent load reduction necessary for the Fish Creek watershed.

Measured *E. coli* concentration	Discharge (cfs) at sample collection	Load at Water Quality Standard (cfu/100ml)	10% MOS (cfu/100ml)	Load Capacity at time of bacteria sampling minus 10% MOS (cfu/100ml)	Existing Load (cfu/100ml)	Reduction Necessary (cfu/100ml)
>2,400[1]	5.82	207,653	20,765	186,888	395,529,761	395,342,873
1,400	1.93	68,861	6,886	61,975	76,512,129	76,450,154
980	1.06	37,820	3,782	34,038	29,415,544	29,381,506
1,300	3.20	114,174	11,417	102,756	117,798,096	117,695,340
260	1.50	53,519	5,352	48,167	11,043,572	10,995,405
130	1.59	56,730	5,673	51,057	5,853,093	5,802,036

[1] The upper bound of the lab reporting limit of *E. coli* is 2,400 cfu/100ml.

5.4C Bacteria Load Allocation

With no point sources in the watershed, the wasteload allocation in this TMDL is zero. Because the wasteload allocation is zero, the entire bacteria load is available for load allocation. The calculated load allocation is attributed to background loading (wild animals) and anthropogenic sources (domesticated animals and/or human contributions).

Wasteload Allocation

There are no known National Pollutant Discharge Elimination System (NPDES) permitted point sources in the affected watershed. Thus, there are no wasteload allocations. Should a point source be proposed that would increase bacteria concentrations, all possible actions should be taken to mitigate against yield to surface water. All future land use activities resulting in a point source discharge will be subject to agency review, compliance with TMDL pollutant loads, and state and federal regulations.

Margin of Safety

E. Coli loading analysis included a ten percent (10%) margin of safety by removing 10% of the loading capacity.

Seasonal Variation

Elevated *E. coli* concentrations are most likely to impact recreational uses during the warm summer months. During these months, warmer water temperatures allow for bacteria to be more long-lived in the water column and persons are most likely to come into contact with and ingest surface water during recreational activities such as boating, swimming, or fishing.

Bacteria contamination in streams can be highly variable depending on types of releases, the bacteria's short lived nature, and seasonal hydrology. The summer sampling results that have been used in this loading analysis may be the result of summer low flow condition or seasonal land use activities. One cannot conclude from these data that *E. coli* contamination is high during other times of the year. More sampling would be needed to adequately characterize the nature of bacterial contamination throughout the year. *E. coli* concentrations my vary throughout the year, but the target identified in this TMDL and in the Idaho water quality standards applies year-around.

Background

The bacteria TMDL is based on existing water quality standards to protect recreational uses of Fish Creek. Background bacteria conditions are unknown but should be investigated. *E. coli* TMDL levels should be adjusted based on the source or sources of the bacteria.

5.5 Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain a permit or permits covering their discharge of storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past, storm water was treated as a nonpoint source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit, operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically, and maintain the best management practices (BMPs) through the life of the project.

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed, DEQ now incorporates a gross wasteload allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate BMPs.

Typically, there are specific requirements an operator must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* (IDEQ 2005b) is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site-specific standards that are applicable.

Remaining Available Load

No part of the load allocations are held for additional load. All new infrastructure should be constructed or mitigated to allow no net increase in temperature, sediment, or bacteria yield to Fish Creek and tributaries to Fish Creek.

5.6 Temperature, Sediment, and Bacteria Implementation Strategies

Implementation actions or projects aimed at reducing pollutant loads should be conducted in a manner consistent with Idaho water quality law. Before beginning any activities, all of the proper permits need to be obtained and the local management agencies notified. DEQ and other designated management agencies (DMAs) responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designated to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost-efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the DMAs will continue to evaluate suspected sources of impairment and develop management actions appropriate to deal with these issues.

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

Increases in shade provided to the stream from the riparian vegetation communities may only take a few years to establish. Once implementation actions have been established, twenty years will allow for a diverse and mature vegetation community to become well established.

Thirty (30) years has been allotted for reductions in sediment yield to Fish Creek once all appropriate implementation actions have been established. This time frame should allow for two to three high flow, channel-forming events to occur. It is anticipated that high flow events will transport and deposit sediment out of the stream channel and improve stream habitat.

After identification of the bacteria sources, reductions in bacteria concentrations are anticipated to be seen within one or two seasons after installment of best management practices.

Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the watershed. The designated WAG, DMAs, local organizations, and other appropriate public process participants are expected to:

- Develop best management practices (BMPs) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analysis of management measures.
- Adhere to measurable milestones for progress.

- Develop a timeline for implementation, with reference to cost and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations are being met, and whether or not water quality standards are being met.

The DMAs will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct 5-year reviews of progress toward TMDL goals.

Responsible Parties

In addition to the DMAs, the public, through the WAG and other equivalent organizations or processes, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. The Idaho DMAs responsible for management activities include the Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; the Idaho Soil Conservation Commission for grazing and agricultural activities; the Idaho Transportation Department for public road construction; the Idaho Department of Agriculture for aquaculture; and the Idaho Department of Environmental Quality for all other activities.

Reasonable Assurance

All load allocations are directed at nonpoint source activities. There are no known point sources of pollutants in this watershed. In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. This citizen participation will result in the completion of on-the-ground actions designed to reduce pollutant loads within the watershed.

The cumulative effect of implementation projects addressing the multiple pollutant load reductions developed in this TMDL will ultimately reduce loads from all pollutant loads jointly. An example of this can be seen when implementing projects to increase shade and reduce stream temperatures. The increase in riparian vegetation will help to filter and reduce sediment and bacteria concentrations. The same can be said when addressing bacteria concentrations. Exclusionary fencing will reduce cattle access to the stream, reducing bacteria concentrations and stream bank erosion and stimulating riparian vegetation colonization, thereby increasing shade.

Reserve

No reserve is held in this TMDL for future pollutant additions. Future activities in the area should be consistent with the water quality goals outlined in this TMDL.

Monitoring Strategy

Monitoring conducted within the Fish Creek watershed to evaluate the effectiveness of BMPs and ambient water quality will be done using DEQ-approved monitoring procedures at the time of sampling.

Pollutant Trading

Pollutant trading (aka water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is voluntary. Parties trade only if both are better off as a result of the trade. Trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements. The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is recognized in Idaho's Water Quality Standards at IDAPA 58.01.02.054.06. Currently, DEQ's policy is to allow for pollutant trading as a means to meet total maximum daily loads (TMDLs), thus restoring water quality limited water bodies to compliance with water quality standards. The Pollutant Trading Guidance (IDEQ 2003a) document sets forth the procedures to be followed for pollutant trading.

Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Additionally, ratios are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database through the Idaho Clean Water Cooperative, Inc.

Both point and nonpoint sources may create marketable credits. Credits are a reduction of a pollutant beyond a level set by a TMDL. Point sources create credits by reducing pollutant discharges below NPDES effluent limits which are set initially by the wasteload allocation. Nonpoint sources create credits by implementing approved BMPs that reduce the amount of pollutant run-off. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP, apply discounts to credits generated if required, and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit), is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

Watershed Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL are protected. To do this, hydrologically-based ratios are developed to provide that trades between sources distributed throughout the TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. In addition, localized adverse impacts to water quality are not allowed.

Trading Framework

In order for pollutant trading to be authorized it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG, must develop a pollutant trading framework document as part of an implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ's Pollutant Trading Guidance (IDEQ 2003a) available on the Web at http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf. As of this writing, the only two watersheds for which pollutant trading frameworks have been developed are the Lower Boise River watershed and the Upper Snake Rock/Mid Snake.

5.7 Conclusions

The methods used to quantify pollutant loads (sediment, temperature, and bacteria) for development of this TMDL are not intended to be used to quantify site-specific pollutant reductions associated with TMDL implementation activities. Rather, the best available method shall be used when calculating load reductions.

The goal of the method used to quantify sediment was to estimate pollutant loads as of August 2007 and existing shade in June 2006. Water samples collected and analyzed for bacteria concentrations were noted as occurring during July through August 2007. Load reductions made after August 2007 addressing sediment and bacteria, and June 2006 addressing temperature, can be applied towards the Fish Creek TMDL implementation goals.

Temperature

Fish Creek in the Upper Spokane River Subbasin was examined for riparian shade in this temperature TMDL. A comparison between existing shade levels (estimated) and target shade levels was utilized to determine excess solar loading to this stream. Reductions in heat load ranging from 37% to 45% are needed in Fish Creek itself. Although tributaries as a whole have somewhat large percent reductions needed, major portions of that reduction may be accounted for by the Method Difference (difference between existing shade as a 10%-class interval and target shade as a specific integer, as explained within section 5.3A). Thus, ranges in percent reductions for the tributaries vary from near 30% to near 80%.

Fish Creek is a forested watershed with the lower portion entering shrub and grass dominated meadows before the stream enters Twin Lakes. Shade in the meadows region is less than target levels as it is in a small region in the headwaters. The transition area between conifer/shrub vegetation and shrub meadow vegetation is more gradual than is depicted by our break point between the two vegetation types. Tributaries lack shade in the vicinity of the meadows and near the headwaters of several western tributaries. In general, shade on Fish Creek and its tributaries is reasonably high, near target levels for major portions.

Sediment

A paired watershed approach was used to develop the Fish Creek sediment TMDL. A paired watershed approach utilizes an existing watershed which is supporting beneficial uses and compares this watershed to a watershed not supporting beneficial uses. Hayden Creek was chosen as the target watershed for comparison with Fish Creek because of its similar land use activates, geologic setting, geography, and climate.

Land use activities were mapped for both watersheds using GIS software, field visits, and local knowledge supplied by the WAG. Sediment yield coefficients were then assigned to the land use types mapped and were multiplied by the associated acreage for each, which yielded the sediment TMDL target and the TMDL load reductions for Fish Creek.

Sediment loading in the Fish Creek watershed was estimated at 154% above natural background. The target set in the TMDL is 68% above natural background, and Fish Creek requires a reduction of 33% to meet the TMDL target. Sediment load reductions were allocated to land owner/manager and to specific land use types. The reductions outlined in this document are intended to give relative rather than exact sediment load reduction goals.

Bacteria

The *E. coli* target in this TMDL was set to comply with Idaho water quality standards. Samples analyzed to characterize the *E. coli* concentrations occurring within Fish Creek were collected in July and August of 2007. Violations of Idaho water quality standards during this time were the basis for development of the *E. coli* TMDL. *E. coli* concentrations and associated reductions are highly variable depending on stream discharge, precipitation, and the adjacent land use activity. Reductions specified in the TMDL are set for each sampling collection and allocated to nonpoint sources.

Summary of Assessment Finding

Five (5) TMDL assessment unit/pollutant combinations have been developed for the Fish Creek watershed (Table 25).

Table 25. Summary of assessment outcomes.

Stream	Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Fish Creek, tributaries	ID17010305PN014_02	Temperature	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek, tributaries	ID17010305PN014_02	Sediment	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek, mainstem	ID17010305PN014_03	Temperature	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek, mainstem	ID17010305PN014_03	Sediment	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed
Fish Creek, mainstem	ID17010305PN014_03	Bacteria	Yes	Move to section 4a[1] of Integrated Report	TMDL Completed

[1] Section 4a of Integrated Report, Rivers with EPA Approved TMDLs.

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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.

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.

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).

Anaerobic
Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.

Anthropogenic
Relating to, or resulting from, the influence of human beings on nature.

Aquatic
Occurring, growing, or living in water.

Aquifer

An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

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).

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.

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.

Bedload

Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

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.

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

Benthic

Pertaining to or living on or in the bottom sediments of a water body

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

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).

Community

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

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 (cfs)

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.

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).

DNA

Deoxyribonucleic acid, which can be used to differentiate between species, and between wild and captive-bred individuals of the same species

Dissolved Oxygen (DO)

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

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.

Ecosystem

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

Effluent

A discharge of untreated, partially treated, or treated wastewater into a receiving water body.

Environment

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

Erosion

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

Eutrophic

From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.

Eutrophication

1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.

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).

Fecal Coliform Bacteria
Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, *E. coli*, and Pathogens).

Flow
See *Discharge*.

Fully Supporting
In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting 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.

Geometric Mean
A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

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.

Habitat
The living place of an organism or community.

Headwater
The origin or beginning of a stream.

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.

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.

Limiting Factor

A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology

The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

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.
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.
Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly 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.
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).

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.

National Pollution Discharge Elimination System (NPDES)

A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nitrogen

An element essential to plant growth, and thus is considered a nutrient.

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 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 *Water Body Assessment Guidance* (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.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Pathogens	A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.
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.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
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.
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.
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.
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.
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.

Storm Water Runoff

Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.

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 6^{th} field hydrologic units.

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.

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.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Total Dissolved Solids (TDS)

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

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 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Tributary

A stream feeding into a larger stream or lake.

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.

Water Table

The upper surface of ground water; below this point, the soil is saturated with water.

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.

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 = 35.31cfs	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. State and Site-Specific Standards and Criteria

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al., 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

13 ^{o}C as a daily maximum water temperature,

9 ^{o}C as a daily average water temperature.

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of highest annual maximum weekly maximum temperature (MWMT) air temperatures) is compared to the daily maximum criterion of 13 ^{o}C. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For potential natural vegetation (PNV) temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during these time periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply. As per IDAPA 58.01.02.200.09:

> *When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.*

Section 401 relates to point source wastewater treatment requirements. In this case if temperature criteria for any aquatic life use is exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3 ^{o}C (IDAPA 58.01.02.401.03.a.v.).

Appendix C. Data Sources

Table C-1. Data sources for the Fish Creek Temperature TMDL.

Water Body	Data Source	Type of Data	When Collected
Fish Creek	DEQ Regional Office	Pathfinder effective shade and stream width	July 2006
Fish Creek	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	December 2006
Fish Creek	DEQ IDASA Database	Temperature	1997
Fish Creek	DEQ Regional Office	Beneficial Use Reconnaissance Program outlining biological and physical properties of stream reach.	1995-2007
Fish Creek	DEQ Regional Office	Water samples collected and analyzed for *E. Coli* concentrations.	2007
Fish Creek	DEQ Regional Office	Water samples collected and analyzed for total phosphorus and total nitrogen concentrations.	2007
Fish Creek and Upper Spokane Subbasin	DEQ Regional Office and State Office	Geographical Information System data	2007

Table C-2. Method Difference Solar Loads for the South-side Tributaries at Target Levels.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	South-side Tributaries
2890	0.9	0.57	0.98	0.114	-0.46	1	1	2890	1647.3	2890	329.46	-1317.84	*Youngs Draw*
250	0.9	0.57	0.96	0.228	-0.342	3	3	750	427.5	750	171	-256.5	Forest Group B
200	0.9	0.57	0.96	0.228	-0.342	3	3	600	342	600	136.8	-205.2	
90	0.9	0.57	0.96	0.228	-0.342	3	3	270	153.9	270	61.56	-92.34	
290	0.8	1.14	0.86	0.798	-0.342	3	3	870	991.8	870	694.26	-297.54	Nonforest Group 1
310	0.8	1.14	0.86	0.798	-0.342	3	3	930	1060.2	930	742.14	-318.06	
2080	0.9	0.57	0.98	0.114	-0.456	1	1	2080	1185.6	2080	237.12	-948.48	*Shove Creek*
1100	0.9	0.57	0.98	0.114	-0.456	1	1	1100	627	1100	125.4	-501.6	Forest Group B
780	0.9	0.57	0.98	0.114	-0.456	2	2	1560	889.2	1560	177.84	-711.36	
1260	0.9	0.57	0.96	0.228	-0.342	3	3	3780	2154.6	3780	861.84	-1292.76	
880	0.9	0.57	0.94	0.342	-0.228	4	4	3520	2006.4	3520	1203.84	-802.56	
3200	0.9	0.57	0.98	0.114	-0.456	2	2	6400	3648	6400	729.6	-2918.4	*Swansons Chute*
2850	0.9	0.57	0.98	0.114	-0.456	2	2	5700	3249	5700	649.8	-2599.2	*Miller Creek*
1760	0.9	0.57	0.98	0.114	-0.456	2	2	3520	2006.4	3520	401.28	-1605.12	*Johnson Creek*
540	0.9	0.57	0.94	0.342	-0.228	4	4	2160	1231.2	2160	738.72	-492.48	*Unnamed (west of Johnson)*
2160	0.9	0.57	0.98	0.114	-0.456	2	2	4320	2462.4	4320	492.48	-1969.92	*east fork*
420	0.9	0.57	0.98	0.114	-0.456	1	1	420	239.4	420	47.88	-191.52	*west fork*
340	0.9	0.57	0.98	0.114	-0.456	1	1	340	193.8	340	38.76	-155.04	
2050	0.9	0.57	0.98	0.114	-0.456	2	2	4100	2337	4100	467.4	-1869.6	
470	0.9	0.57	0.98	0.114	-0.456	1	1	470	267.9	470	53.58	-214.32	*middle fork*
1050	0.9	0.57	0.98	0.114	-0.456	2	2	2100	1197	2100	239.4	-957.6	
140	0.9	0.57	0.98	0.114	-0.456	1	1	140	79.8	140	15.96	-63.84	*Unnamed (western most)*
340	0.9	0.57	0.98	0.114	-0.456	1	1	340	193.8	340	38.76	-155.04	
1200	0.9	0.57	0.98	0.114	-0.456	2	2	2400	1368	2400	273.6	-1094.4	
							Total	**50,760**	**29,959**	**50,760**	**8,928**	**-21,031**	**-70** **% Reduction**

Table C-3. Method Difference Solar Loads for the North-side Tributaries at Target Levels.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	**North-side Tributaries**
150	0.9	0.57	0.98	0.114	-0.46	1	1	150	85.5	150	17.1	-68.4	*eastern-most tributary*
370	0.9	0.57	0.98	0.114	-0.456	1	1	370	210.9	370	42.18	-168.72	
610	0.9	0.57	0.98	0.114	-0.456	1	1	610	347.7	610	69.54	-278.16	
200	0.9	0.57	0.98	0.114	-0.456	1	1	200	114	200	22.8	-91.2	
550	0.9	0.57	0.98	0.114	-0.456	2	2	1100	627	1100	125.4	-501.6	
710	0.9	0.57	0.98	0.114	-0.456	2	2	1420	809.4	1420	161.88	-647.52	
140	0.9	0.57	0.98	0.114	-0.456	2	2	280	159.6	280	31.92	-127.68	
240	0.9	0.57	0.98	0.114	-0.456	2	2	480	273.6	480	54.72	-218.88	
1120	0.9	0.57	0.98	0.114	-0.456	1	1	1120	638.4	1120	127.68	-510.72	*2nd tributary*
960	0.9	0.57	0.98	0.114	-0.456	2	2	1920	1094.4	1920	218.88	-875.52	
410	0.9	0.57	0.98	0.114	-0.456	2	2	820	467.4	820	93.48	-373.92	
1140	0.9	0.57	0.98	0.114	-0.456	1	1	1140	649.8	1140	129.96	-519.84	3rd tributary
290	0.9	0.57	0.98	0.114	-0.456	2	2	580	330.6	580	66.12	-264.48	
1020	0.9	0.57	0.98	0.114	-0.456	2	2	2040	1162.8	2040	232.56	-930.24	
210	0.9	0.57	0.96	0.228	-0.342	3	3	630	359.1	630	143.64	-215.46	
100	0.9	0.57	0.96	0.228	-0.342	3	3	300	171	300	68.4	-102.6	
110	0.9	0.57	0.96	0.228	-0.342	3	3	330	188.1	330	75.24	-112.86	
1770	0.9	0.57	0.98	0.114	-0.456	2	2	3540	2017.8	3540	403.56	-1614.24	4th tributary
470	0.9	0.57	0.98	0.114	-0.456	1	1	470	267.9	470	53.58	-214.32	5th tributary
1890	0.9	0.57	0.96	0.228	-0.342	3	3	5670	3231.9	5670	1292.76	-1939.14	
1280	0.9	0.57	0.98	0.114	-0.456	1	1	1280	729.6	1280	145.92	-583.68	western-most tributary
							Total	**24,450**	**13,937**	**24,450**	**3,577**	**-10,359**	**-74** **% Reduction**

Table C-4. Method Difference Solar Loads for Fish Creek at Target Levels.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	**Fish Creek**
470	0.9	0.57	0.96	0.228	-0.34	3	3	1410	803.7	1410	321.48	-482.22	Forest Group B
1970	0.9	0.57	0.94	0.342	-0.23	4	4	7880	4491.6	7880	2694.96	-1796.64	
ID17010305PN014_02							**Subtotal**	**9,290**	**5,295**	**9,290**	**3,016**	**-2,279**	
1480	0.9	0.57	0.91	0.513	-0.06	5	5	7400	4218	7400	3796.2	-421.8	
1580	0.8	1.14	0.83	0.969	-0.171	7	7	11060	12608.4	11060	10717.14	-1891.26	
800	0.8	1.14	0.83	0.969	-0.171	7	7	5600	6384	5600	5426.4	-957.6	
500	0.6	2.28	0.6	2.28	0	7	7	3500	7980	3500	7980	0	Nonforest Group 1
580	0.5	2.85	0.55	2.565	-0.285	8	8	4640	13224	4640	11901.6	-1322.4	
460	0.5	2.85	0.55	2.565	-0.285	8	8	3680	10488	3680	9439.2	-1048.8	
1840	0.5	2.85	0.55	2.565	-0.285	8	8	14720	41952	14720	37756.8	-4195.2	
ID17010305PN014_03							**Subtotal**	**50,600**	**96,854**	**50,600**	**87,017**	**-9,837**	
							Total	**59,890**	**102,150**	**59,890**	**90,034**	**-12,116**	**-12** **% Reduction**

Appendix X. Idaho Panhandle Shade Curves

Appendix X, Idaho Panhandle Shade Curves, was written by Peter Leinenbach an Aquatic and Landscape Ecologist from the US Environmental Protection Agency Region 10 Office of Environmental Assessment.

Appendix X – System Potential Effective Shade

This document is contains estimates of "system potential landcover" conditions for riparian areas for both "forested" and "non-forested" areas within the Pend Oreille Basin. Methods used to delineate between forest and non-forest riparian areas is presented in **Section X-1**. Subsequently, methods to further delineate these groups into various subcategories are presented for both "forest" and "non-forest" riparian groups (Presented in **Sections X-2**, and **X-3**, respectively). "System potential effective shade" conditions were calculated for the individual subcategories for each group.

Section X-1. "Forest/Non-forest" Delineation Method

Background - System Potential Effective Shade Defined

Primary factors that affect shade are near stream vegetation height and channel width (i.e. bankfull width). The maximum level of shade practical at a particular site is termed the "system potential" effective shade level. System Potential Effective Shade occurs when:

1. Near stream vegetation is at a mature life stage
    - Vegetation community is mature and undisturbed from anthropogenic sources;
    - Vegetation height and density is at or near the potential expected for the given plant community;
    - Vegetation is sufficiently wide to maximize solar attenuation; and
    - Vegetation width should accommodate channel migrations.

2. Channel width reflects a suitable range for hydrologic process given that near stream vegetation is at a mature life stage
    - Stream banks reflect appropriate ranges of stability via vegetation rooting strength and floodplain roughness;
    - Sedimentation reflects appropriate levels of sediment input and transport;
    - Substrate is appropriate to channel type; and
    - Local high flow shear velocities are within appropriate ranges based on watershed hydrology and climate.

It is important to distinguish between site potential shade, and system potential shade. System potential shade is a broad scale view of shade conditions along a stream. It could be expected that site potential shade would be greater than system potential shade because over a large area, such as a river reach, it is unlikely that all sites will be at their potential due to localized natural disturbances (e.g., fire, flood, landslide, disease), causing some fraction of the area to be in a less than a "mature" condition. Accordingly, a disturbance component is included in the development "system potential landcover", which is subsequently used to calculate "system potential effective shade" conditions.

Background - Landcover and Riparian Conditions

Currently, approximately 72% of landcover within the Pend Oreille Basin is categorized as "forest" by the National Landcover Dataset (**Figure X-1**). These "forest" areas are located throughout the basin. The remaining "non-forest" areas are primarily located in low elevation, and low surface gradient areas of the basin.

The following discussion on historic riparian vegetation conditions for both upland (i.e., "forest") and lowland (i.e., "non-forest") areas within the Pend Oreille basin was obtained from the Fish and Wildlife subbasin plan.[1]

> *"Historic vegetation patterns in the Upper Pend Oreille Subbasin were largely influenced by wildfire. Early accounts and photographs of the Subbasin indicate that old-growth stands of western red cedar, Thuja plicates, and other species were common in riparian zones and floodplains. Large cedar stumps can still be found in many riparian areas along Subbasin streams. Uplands were more typically dominated by seral species in various stages of succession, with age and composition dependent largely on fire cycles, elevation, slope, and aspect.*
>
> *Low elevation riparian zones near tributary mouths include areas with and without tree canopy cover. Along stream corridors where tree overstory does not exist or is thin, vegetation includes shrubs and small trees such as thin-leaf alder, Alnus sinuate; willows, Salix spp.; snowberry, Symphoricarpos albus; mountain maple, Acer glabrum; red-osier dogwood, Cornus stolonifera; blue elderberry, Sambucus cerulea; and black hawthorn, Crataegus douglasii. Where tree canopy is present, tree species include black cottonwood, Populus trichocarpa; water birch, Betula occidentalis; quaking aspen, Populus tremuloides; and a mix of conifer species including western red cedar, Thuja plicates; western hemlock, Tsuga heterophylla; Douglas fir, Psuedotsuga menziesi; grand fir, Abies grandis; and western white pine, Pinus monticola."*

As can been seen in the description above, a higher proportion of upland vegetation is present within the riparian zone for streams within the "forested" areas. Accordingly, there is a need to account for this variability in the landscape when developing ***system potential effective shade*** conditions for the Pend Oreille basin.

Methods used to estimate system potential riparian landcover for "forested" areas of the basin are presented in Section X-2, and "non-forest" areas are presented in Section X-3. ***Aquatic Response Units (ARU)*** was used to designate between these two groups and methods are presented in the following pages.

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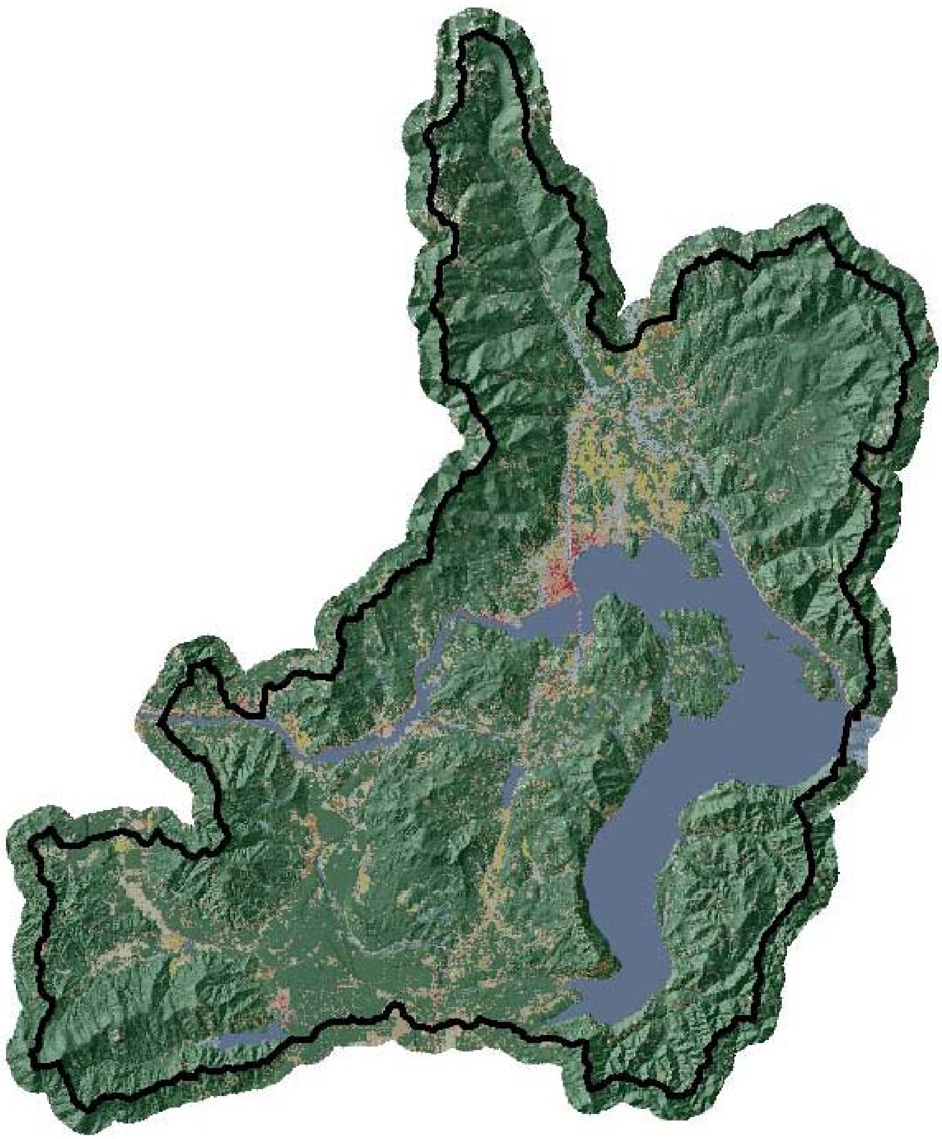
[1] Obtained from - http://www.nwcouncil.org/fw/subbasinplanning/admin/level2/intermtn/plan/

Figure X-1. Landcover Designations in the Pend Oreille Basin.
(Forested areas illustrated by green)
[Source – National Landcover Dataset 2000]



Aquatic Response Unit (ARU)

The Aquatic Response Unit (ARU) is a method which the USFS uses to understand the composition, structure, and function of riparian vegetation. ARUs are determined by temporal and spatial patterns of hydrologic and geomorphic processes within defined valley bottoms of predetermined widths. Departure from a range of variability and/or a proper functioning condition can be determined by either comparison to reference stream reaches within a given valley bottom type (or ARU) undisturbed by human influence or from an understanding of aquatic processes developed through ARUs.

The Kootenai National Forest has developed an ARU classification and inventory. The ARUs were grouped based on overall similar descriptive characteristics. Summary description for allocated ARUs classes is presented in **Table X-1**. As can be seen in Table X-1, there are four groups associated with ARU classifications -

1. Group 1: Steep Headwater Streams
2. Group 2: Moderate Gradient , Small to Mid-sized Streams
3. Group 3: Low Gradient, Small to Mid-sized Streams, and
4. Group 4: Low Gradient, Large Streams.

These groups are subsequently subdivided into the individual ARUs. Each ARU is coded so the first number reflects the dominant stream order. The second and third letters reflect the overall gradient (stream gradient) where "A" is the highest gradient and "C" is the lowest gradient. Additional detailed information can be found in the draft ARU document on file at the Supervisor's Office in Libby. The Idaho Panhandle National Forest (IPNF) has developed input parameters associated with ARU development (sinuosity, gradient, Rosgen, stream order, valley bottom width), but has not yet completed the final classification work.

This input data was obtained from IPNF staff and was used to develop an "ARU filter" for the Pend Oreille basin. The "ARU filter" was used to delineate between "forest" and "non-forest" riparian classes within the Pend Oreille basin. Specifically, general conditions presented in the KNF ARU document for the four ARU Groups (**Table X-2**) were used to establish the benchmarks (**Table X-3**) used in the development of the "ARU filter" groups for the Pend Oreille.

As can be seen in Table X-3, stream order (**Figure X-2**) and stream gradient are the parameters used to develop the "ARU filter" groupings (**Figure X-3**). These parameters were found to efficiently delineate areas of "forest" riparian areas vs. "non-forest" riparian areas. Specifically, "ARU filter Group A" are small to medium sized streams with a moderate to high stream gradient. These areas are more likely to have a higher proportion of forest type upland vegetation within the riparian zone. "ARU filter Group B" are low gradient reaches of small and medium sized streams. Similarly "ARU filter Group C" are also low gradient streams, but are large in size.

Table X-1. Summary of ARUs on the Kootenai National Forest.				
Group	ARU	Proportion of the KNF	Description	Vegetation
1	1A	33%	First and some second order, very steep streams. Commonly found at elevations between 3000-5500'. Major landtype groups are 300 and 400 series. Valley bottoms are narrow.	Grand fir, Black Cottonwood, Western Redcedar, Western Hemlock, Common Snowberry,
1	1AB	19%	First and 2nd order, steep streams. Commonly found at elevations between 2500-5500'. Major landtype group is 300 series. Valley bottoms are fairly narrow.	Western Redcedar, Mountain Alder, Sitka Alder, Fools's Huckleberry, Drummond Willow, Arnica
1	3AB	1%	Third order, steep streams. Commonly found at elevations below 4500'. Major landtype groups are 300 and 400 series, followed by 100 series. Valley bottoms are fairly narrow.	Grand fir, Western Redcedar, Rocky Mountain Maple, Common Prince's-pine, Twinflower, Thimbleberry
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000'. Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, Sphagnum sp., Ticklegrass, Oak-fern
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000'. Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, Sphagnum sp., Ticklegrass, Oak-fern
2	3B	4%	Third order, moderate gradient streams. Mainly found at elevations between 2500-4500'. Most common landtype group is the 300 series, followed by the 100 and 400 series. Valley bottoms are moderately wide.	Grand fir, Paper Birch, Western Redcedar, Western Hemlock, Sitka Alder, Fools's Huckleberry, Devil's Club,
2	4B		Characteristics of this group include 1st, 2nd, and 3rd order streams with low gradient, higher sinuosity, and wide valley bottoms.	
3	1C	7%	First and second order, low gradient streams. Commonly found at elevations between 2000-4000'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Spruce, Sitka Alder, Thimbleberry, Reedgrass, Ladyfern,
3	3C	5%	Third order, low gradient streams. Commonly found at elevations between 2000-4500'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Grand fir, Engelmann Spruce, Black Cottonwood, Red-osier Dogwood, Douglas Spiraea, Ticklegrass,
4	4C	6%	Fourth order, low gradient streams. Mainly found at elevations below 4000'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Paper Birch, Paper Birch, Balsam Poplar, Scouler Willow, Bentgrass, Beaked Sedge, Reed Canarygrass, Fowl Bluegrass
4	5C	2%	Fifth order, low gradient streams. Commonly found at elevations below 3500'. Major landtype group is the 100 series. Valley bottoms are wide.	Black Cottonwood, Western Redcedar, Shrubby Cinquefoil, Reed Canarygrass, Ladyfern
4	6C	1%	Average gradient is 1%. Gradient and sinuosity were computer generated and may differ from actual measurements. Sixth order streams are large and typically occur in the lowest reaches of the watershed at elevations under 3000'. The average width of the valley bottom in ARU 6C is 355 meters.	Paper Birch, Western Larch, Engelmann Spruce, Western Redcedar, Western Hemlock, Common Snowberry
5	LT32	1%	These streams are within landtype group 325. Streams are generally low to moderate gradient and occur in fairly wide valley bottoms. Stream order is generally 3rd order or smaller.	Engelmann Spruce, White Spruce, Rocky Mountain Maple, Alder, Alder Buckthorn, Redtop, Field Horsetail

Table X-2. Summary Stream Characteristics for ARU Groups
Group 1 - Steep Headwater Streams
The Kootenai National Forest describes this group as small (1^{st} and 2^{nd} order), fairly low sinuosity, and high gradient streams within narrow valley bottoms.
Riparian vegetation is characterized by upland coniferous forest.
Group 2: Moderate gradient, small to mid-sized streams
The Kootenai National Forest describes this group as small (1^{st} and 2^{nd} order) to mid-sized (3^{rd} to 4^{th} order) streams with moderate gradient and fairly low sinuosity.
Riparian vegetation is characterized by upland coniferous forest.
Group 3: Low gradient, small to mid-sized streams
The Kootenai National Forest describes this group as small (1^{st} and 2^{nd} order) to mid-sized (3^{rd} order) streams with low gradient and slight sinuosity.
Riparian Vegetation - 1^{st} and 2^{nd} Order Streams - Along lower gradient streams, valley bottom vegetation is shrub wetland, mountain alder community type on low alluvial terraces and upland coniferous forest on glacial outwash terraces. Along slightly higher gradient streams, vegetation is commonly upland coniferous forest and coniferous wetland. 3^{rd} Order Streams - Along lower gradient streams, valley bottom vegetation is herbaceous and shrub wetlands on low alluvial terraces and wetland coniferous forest such as spruce/red osier dogwood, spruce/field horsetail, or western redcedar/bracken fern on alluvial terraces. Along moderate gradient streams, valley bottom vegetation is dominated by upland coniferous forest and coniferous wetland.
Group 4: Large, low gradient streams
The Kootenai National Forest describes this group as mid-sized (4^{th} order) to large (5^{th} and 6^{th} order) streams with low gradient and fairly sinuous.
Low alluvial terraces support a complex pattern of herbaceous and shrub vegetation and upland coniferous forest on glacial outwash terraces.

Table X-3. Summary ARU filter Group Characteristics
ARU filter Group A - Forest Riparian Group • Stream Order – 1st, 2nd, 3rd and 4th • Stream gradient ≥ 3 percent
ARU filter Group B - Non-Forest Riparian Group 1 • Stream Order – 1st, 2nd, 3rd and 4th • Stream gradient < 3 percent
ARU filter Group C - Non-Forest Riparian Group 2 • Stream Order – 5th and 6th

Only thirteen percent of stream miles for 1st order streams had a gradient less than 3%. These areas were primarily located in the lower elevation valley locations with the basin (see Figure X-2). "ARU filter Group B" would be applied to these areas. The remaining 87% of stream miles for first order streams would be within the "ARU filter Group A" (e.g., Forest Riparian Groups). Similarly, the proportions of stream miles having a gradient less than 3% for 2nd, 3rd and 4th order streams is 33%, 54%, and 87%, respectively. (Once again, "ARU filter Group B" would be applied to these areas.)

Once again, Section X-1 will present methods used to estimate system potential riparian landcover for forested areas of the basin, and Section X-2 will present methods used for "non-forested" areas of the basin.

Figure X-2. Stream Order in the Pend Oreille Basin.

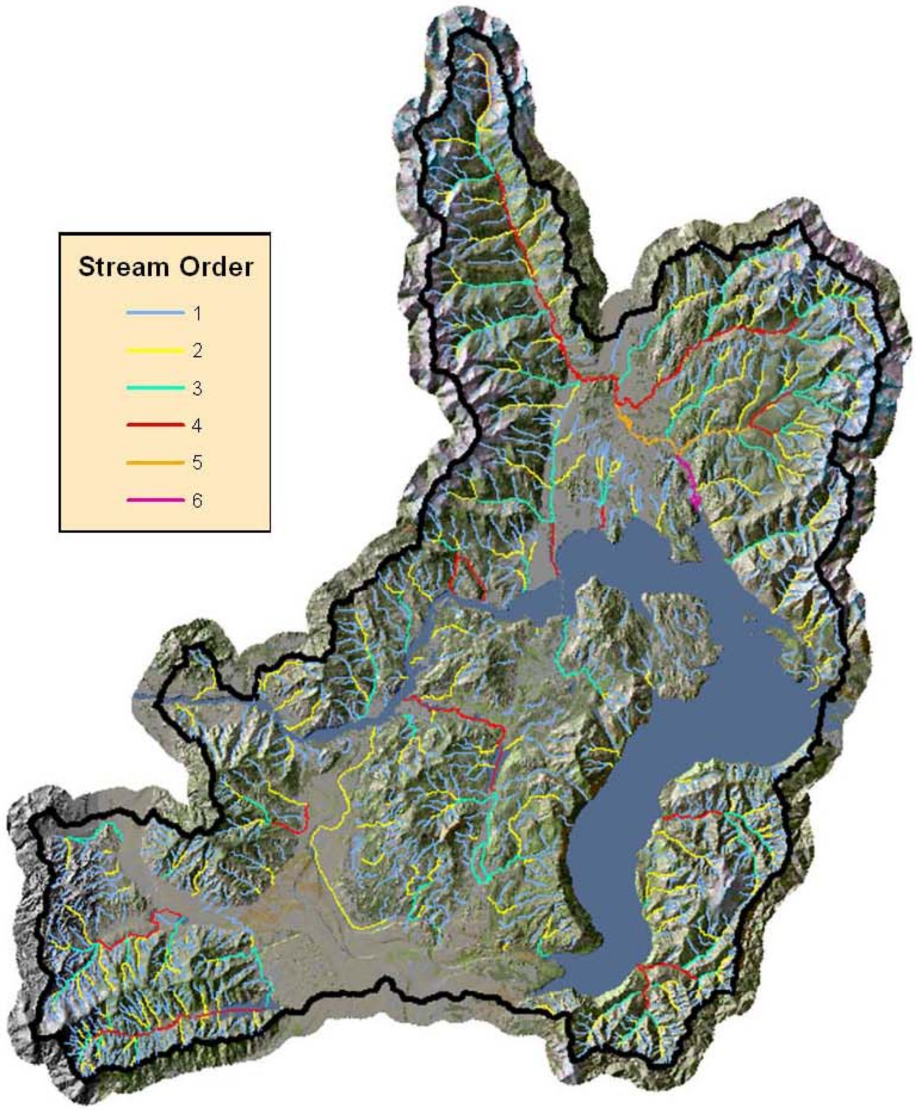
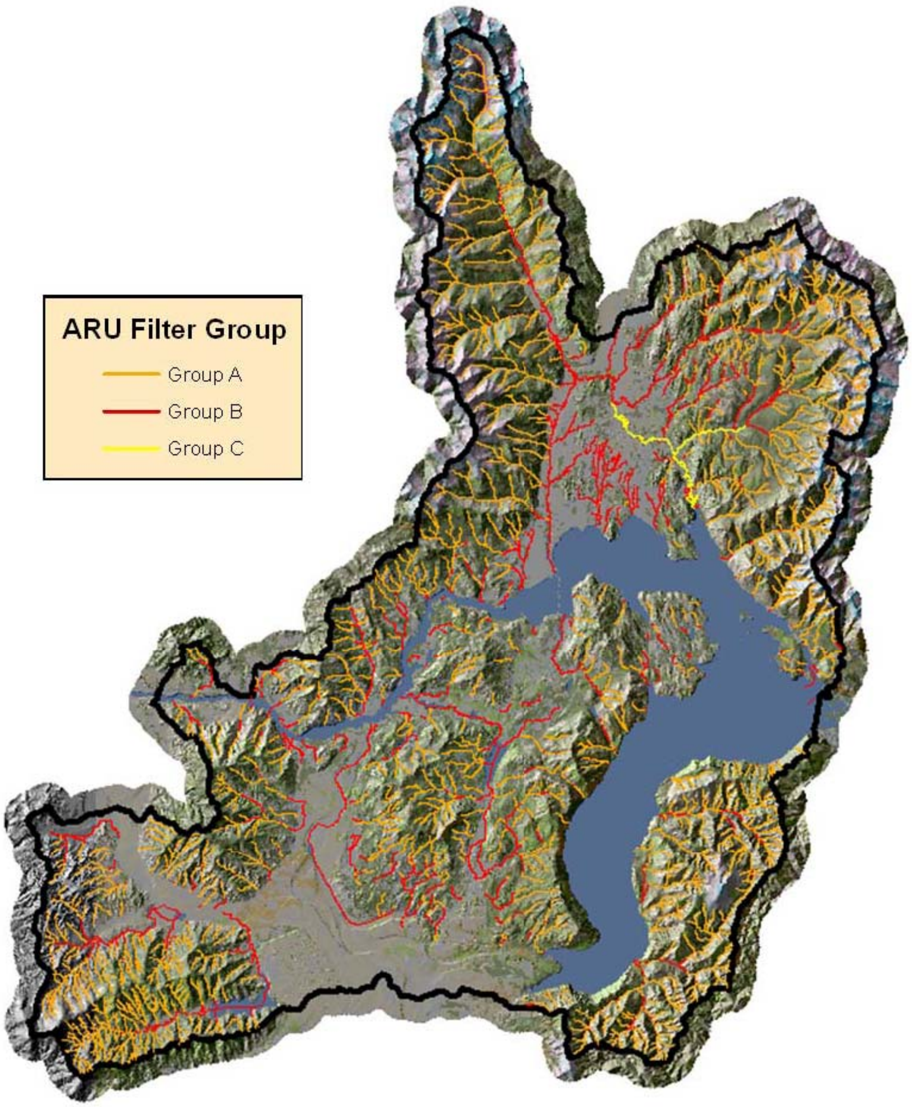


Figure X-3. "ARU filter" Groups in the Pend Oreille Basin.



X-2. System Potential "Forest" Vegetation Landcover Estimates

The United States Forest Service manages signification portions of land within the Pend Oreille Basin. Accordingly, the Idaho Panhandle National Forest (IPNF) has developed detailed analysis of current and historic forest conditions within the basin. The "Historic Range of Variability" (HRV) was the method which the IPNF incorporated the concept of historical/natural conditions and processes as a reference for understanding ecosystem potential[2].

Historic Range of Variability is defined as the range of variation in spatial, structural, compositional, and temporal characteristics of ecosystem elements as ***affected by minor climatic fluctuations and disturbances***. This range is measured using a reference period prior to intensive resource use and management. The HRV is the baseline for comparison with current conditions to assess the degree of past change.

Existing and historic conditions and vegetation response to disturbance vary by ecological or biophysical setting. Each biophysical setting has characteristic potential natural communities, soils, hydrologic function, landform and topography, climate, air quality, and natural processes (nutrient and biomass cycling, succession, productivity, and fire regimes). Each setting also includes moisture and temperature gradient, resulting in growing conditions that are more similar within than between each setting.

Vegetation Response Units and Habitat Type Groups[3]

The IPNF used the concept of "Vegetation Response Units" (VRUs) and "Habitat Type Groups" (HTGs) as the method to describe the biophysical settings associated with historic and current forest vegetation conditions.

Vegetation Response Units VRUs are aggregations of land having similar capabilities and potentials for management. These ecological units have similar patterns in potential natural communities; soils; hydrologic function; landform and topography; lithology; climate; air quality; and natural processes (nutrient and biomass cycling, succession, productivity, and fire regimes). Each VRU has an associated description of its ecological structure, composition, and function. Detailed description of VRUs categories can be obtained from the following report – "Vegetative Response Unit Characterizations and Target Landscape Prescriptions".[4]

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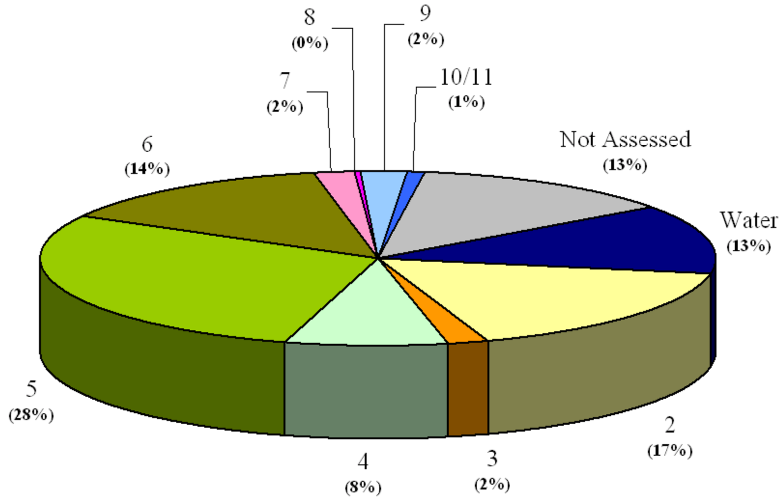
[2] A detailed discussion about the "Range of Variability" concept is contained in Appendix B of the following report - "Draft Comprehensive Evaluation Report for the Kootenai and Idaho Panhandle Proposed Land Management Plans", and can be downloaded from the following website (http://www.fs.fed.us/kipz/documents/plmp/CER). In addition, the Technical Report – "Analysis of the Management Situation for the KIPZ Forest Plan Revisions" (March 2003) contains information on HRV for the planning zone. This report can be downloaded from the following website (http://www.fs.fed.us/kipz/documents/ams).

[3] The primary source of information about VRU and HTG proportion, structure and composition was obtained from technical work associated the 2003 Analysis of Management Situation (AMS) for the Panhandle and Kootenai National Forests (http://www.fs.fed.us/kipz/documents/ams/).

[4] Document downloaded from – (http://www.fs.fed.us/r1/kootenai/projects/planning/documents/vru_doc/).

There are 11 designated VRU/HTG groups in the IPNF[5]. The distribution and location of VRU/HTG groups in the Pend Oreille Basin are illustrated in **Figures X-4 and X-5**, respectively. These 11 VRU/HTG groups were merged during the AMS process into four (4) "Assessment Groups" in order to incorporate biophysical settings to describe the historic distributions of vegetation composition and size class structure (**Tables X-4 through X-6**[6]).

Figure X-4. Distribution of VRU/HTG Groups in the Pend Oreille Basin.



Measured Vegetation Conditions - Sandpoint Ranger District

Over the past 26 years, forest vegetation conditions within the Sandpoint Ranger District[7] has been collected and this information has been stored within the FSVeg database (Natural Resource Information System: Field Sampled Vegetation database). This database currently contains measured information for over 150,000 individual trees within the Pend Oreille Basin.

The relationship between measured tree height and Diameter Breast Height (dbh) for the individual tree species are illustrated in **Figure X-6**. (Only "live" trees were included in this analysis.) Also included is this figure are tables summarizing measured height conditions for the different seral age classes. These "age class" groups for the IPNF were defined on page B-4 (i.e., Appendix B) of the KIPZ Draft Comprehensive Report (http://www.fs.fed.us/kipz/documents/plmp/CER).

[5] Vegetation on the Idaho Panhandle National Forest is summarized by Habitat Type Groups, which are fairly synonymous with VRUs (e.g., HTGs and VRUs are used unchangeably by IPNF staff).
[6] Information contained in Tables X-5 and X-6 was obtained directly from IPNF staff.
[7] The Sandpoint Ranger District Boundaries correspond to approximately Pend Oreille Basin boundary.

Figure X-5. Vegetation Response Units in the Pend Oreille Basin

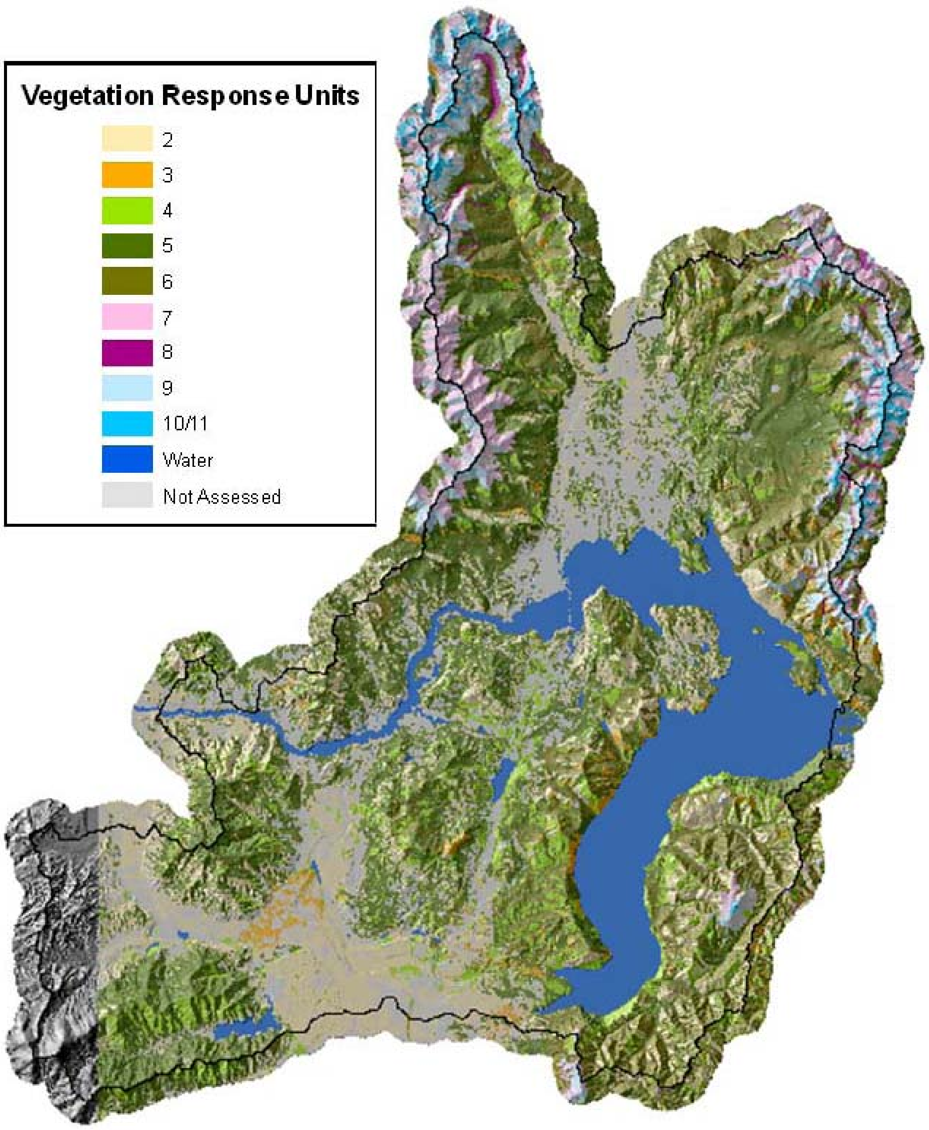


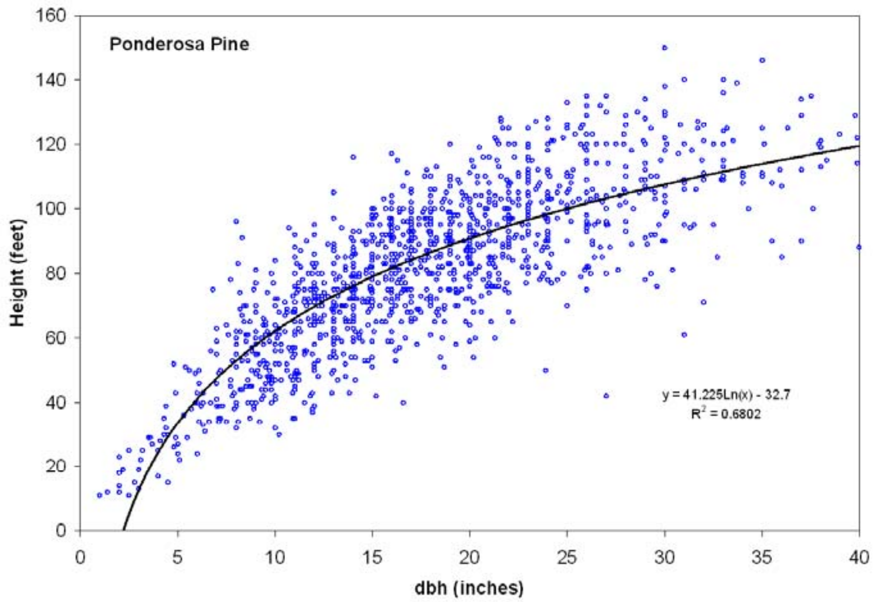
Table X-4. VRU/HTG Assessment Groups in the Pend Oreille Basin (KPIZ 2003)

Assessment Group	Description
Group A: VRU 1/HTG 1 (Warm/Dry), VRU 2/HTG 2 (Moderately Warm/Dry), and VRU 3/HTG 3 (Moderately Warm/ Moderately Dry).	This group contains the more warm and dry habitat types with VRU 1 being the warmest and driest to the more moderate conditions of VRU 3. These sites include warm, dry grasslands to moderately cool and dry upland sites. The dry, lower elevation open ridges are composed of mixed Douglas-fir and ponderosa pine in well-stocked and fairly open-grown conditions. Moderately moist, upland sites and dense draws also include larch and lodgepole pine, with lesser amounts of ponderosa pine. Tree regeneration occurs in patches and is largely absent in the understory, particularly in the driest sites. Annual precipitation ranges from 14" to 30", about 75% of that falling as rain. While the growing season is fairly long, high solar input and moderately shallow soils often result in soils that dry out early in the growing season, which results in low to moderate site productivity.
Group B: VRU 4/HTG 4 (Moderately Warm/Moist), VRU 5/HTG 5 (Moderately Cool/Moist), and VRU 6/HTG 6 (Moderately Cool/Wet).	This group occupies most of the moist sites along benches and stream bottoms. The moderating effects of the inland maritime climate ecologically influence this group. This group includes the more moderate sites of VRU 4 and scattered riparian and wet sites of VRU 6. This group is widespread throughout the forest and has the most biological productivity. Precipitation is moderate to high ranging from 30" to 55" per year.
Group C: VRU 7/HTG 7 (Cool/Moist) and VRU 8/HTG 8 (Cool/Wet).	This group occurs in the moist, lower subalpine forest setting and is common on northwest to east facing slopes, riparian and poorly drained subalpine sites, and moist frost pockets. This landscape is typically bordered by warmer sites (Group B) and cool, drier subalpine sites (Group D). This group includes characteristics of each. Average precipitation is estimated between 35" and 55" per year, less than half as rain. Vegetative productivity is moderate to high as a result of the high moisture-holding capacity and nutrient productivity of loess deposits, adequate precipitation, and a good growing season.
Group D: VRU 9/HTG 9 (Cool/ Moderately Dry), HTG 10 (Cold/Moderately Dry) and HTG 11 (Cold).	This group is typified by cool and moderately dry conditions with moderate solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 35"-70", mostly in the form of snow. Due to generally shallow soils (low water holding capacity), slope position, and aspect, soil moisture is often limited during late summer months. It is generally found on rolling, ridges and upper reaches of convex mountain slopes.

Table X-5. Pend Oreille Basin Historical Forest Vegetation Structure Estimates						
Assessment Group	**% of Area**	**Shrub/Seed/ SAP**	**Small/ Pole**	**Medium/ Immature**	**Large/ Mature**	**Old Growth**
Warm/Dry (Group A)	17%	20%	8%	12%	17%	43%
Moist (Group B)	56%	25%	15%	27%	21%	12%
Cool/Moist (Group C)	16%	22%	13%	22%	23%	20%
Cool/Dry (Group D)	11%	22%	13%	22%	23%	20%
Historical Weighted Avg.		23.3%	13.3%	23.1%	20.9%	19.4%
National Forest Current		*28.4%*	*4.4%*	*39.2%*	*20.7%*	*7.4%*
% Change from Historic		*21.7%*	*-67.1%*	*69.7%*	*-0.8%*	*-62.1%*
Current as % of Historic		*121.7%*	*32.9%*	*169.7%*	*99.2%*	*37.9%*

Table X-6. Pend Oreille Basin Historical Forest Vegetation Composition Estimates									
Assessment Group	**PP**	**WP**	**WL**	**DF**	**GF/WH**	**WRC**	**LP**	**SAF**	**WBP**
Warm/Dry (Group A)	60%	- -	10%	20%	- -	- -	10%	- -	- -
Moist (Group B)	1%	40%	25%	20%	5%	5%	3%	1%	- -
Cool/Moist (Group C)	- -	12%	15%	1%	- -	- -	12%	60%	- -
Cool/Dry (Group D)	- -	- -	- -	- -	- -	- -	20%	65%	15%
Historical Weighted Avg	10.8%	24.3%	18.1%	14.8%	2.8%	2.8%	7.5%	17.3%	1.7%
National Forest Current	2.2%	2.0%	3.8%	36.5%	16.9%	7.9%	4.5%	25.6%	0.2%
% Change from Historic	-80%	-91.8%	-79%	147.3%	503.6%	182.1%	-40%	47.9%	-88%
Current as % of Historic	20.4%	8.2%	21.0%	247.3%	603.6%	282.1%	60.0%	147.9%	12.1%

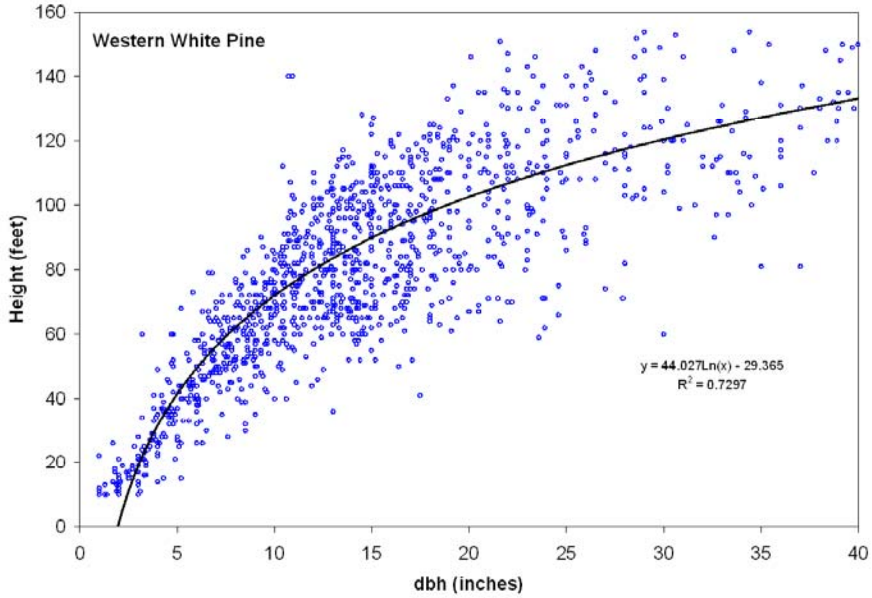
Figure X-6. Measured Ponderosa Pine Height - Sandpoint Ranger District.



Measured Ponderosa Pine Height (feet) by Size Classification Groups.

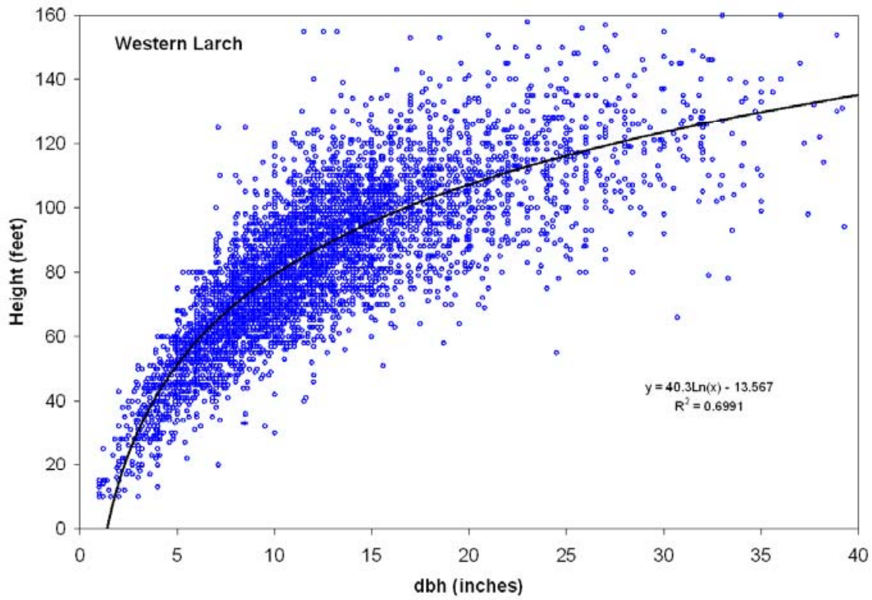
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	34	73	103	120	124
75th	23	60	93	106	112
50th	14	43	81	95	99
25th	7	36	70	80	83
10th	5	30	58	66	67
Number of Measurements	119	820	1039	378	415

Figure X-6 (cont.). Measured Western White Pine Height - Sandpoint Ranger District.



Measured Western White Pine Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	30	85	111	121	157
75th	17	72	98	108	137
50th	8	56	80	91	120
25th	6	39	67	73	102
10th	5	24	55	62	83
Number of Measurements	152	325	650	198	313

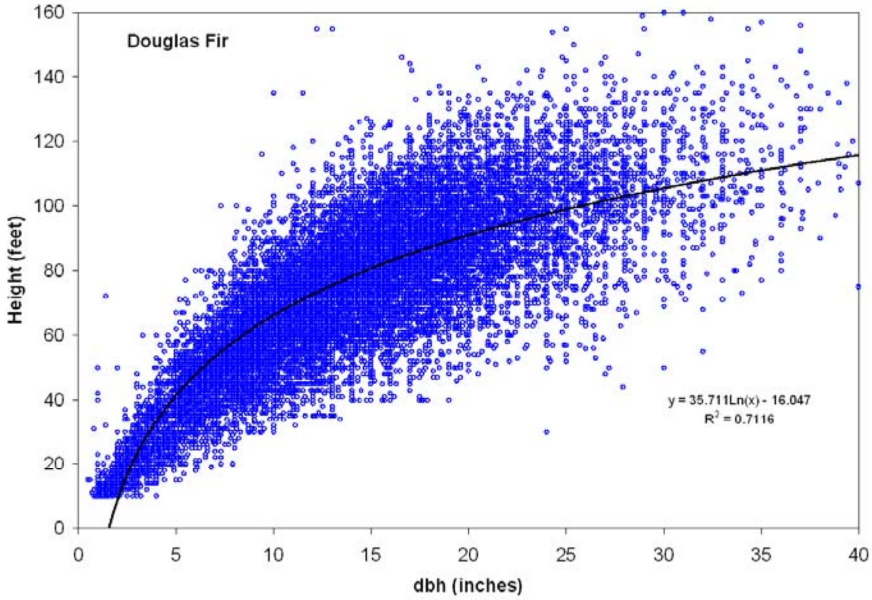
Figure X-6 (continued). Measured Western Larch Height - Sandpoint Ranger District.



Measured Western Larch Height (feet) by Size Classification Groups.

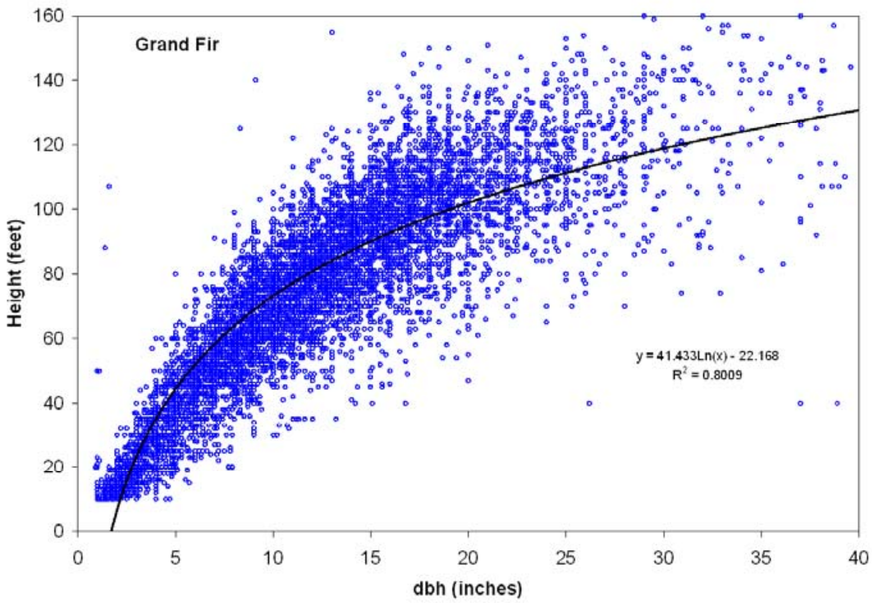
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	47	85	108	120	136
75th	32	74	96	110	122
50th	18	62	84	99	110
25th	9	51	72	88	95
10th	6	40	61	78	85
Number of Measurements	129	1358	3377	758	827

Figure X- 6 (continued). Measured Douglas Fir Height - Sandpoint Ranger District.



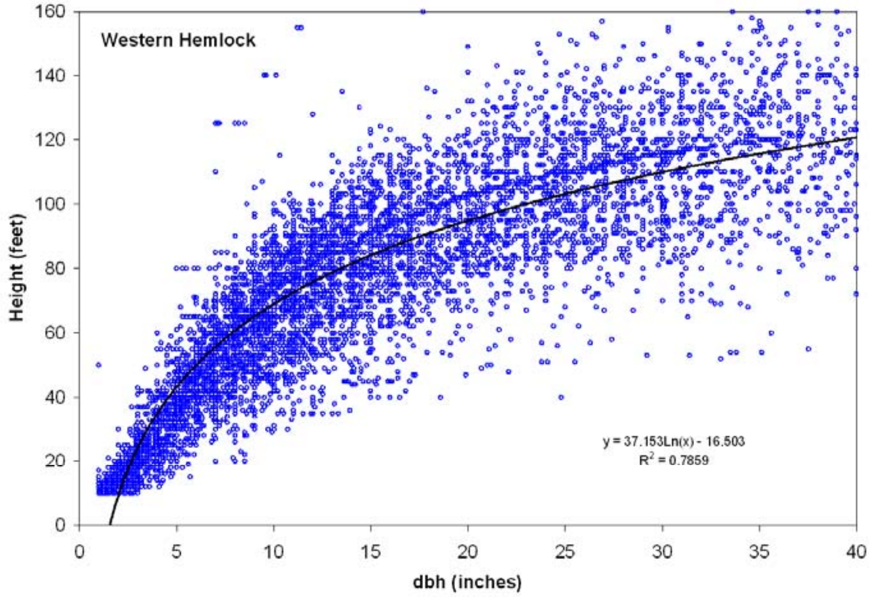
Measured Douglas Fir Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	40	78	101	115	123
75th	25	67	91	103	110
50th	13	55	80	91	96
25th	7	41	67	78	83
10th	6	25	54	64	70
Number of Measurements	1866	6323	15983	3029	1600

Figure X-6 (continued). Measured Grand Fir Height - Sandpoint Ranger District.



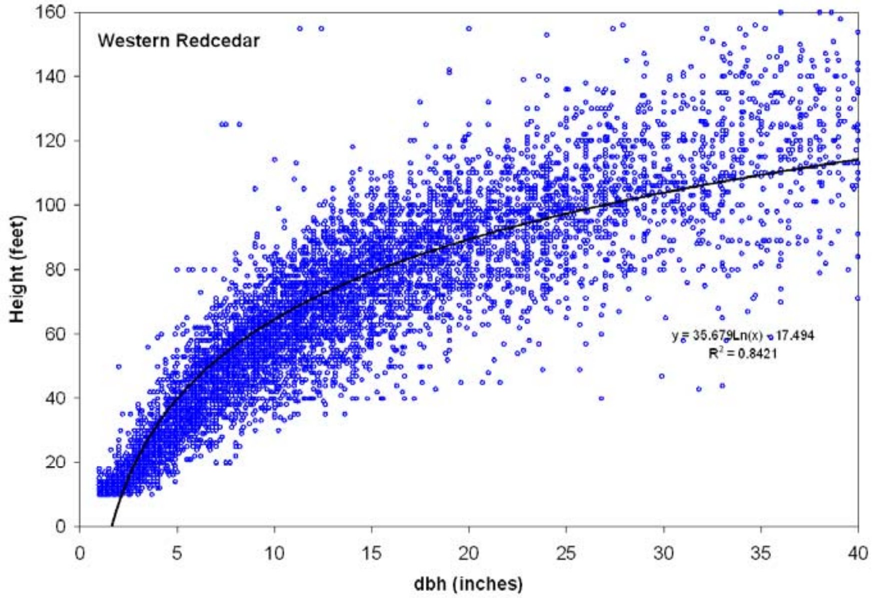
Measured Grand Fir Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	22	84	110	128	145
75th	15	70	97	115	130
50th	9	47	81	100	114
25th	6	25	65	85	97
10th	5	13	46	69	87
Number of Measurements	1267	2288	6861	1384	342

Figure X-6 (cont.). Measured Western Hemlock Height - Sandpoint Ranger District.



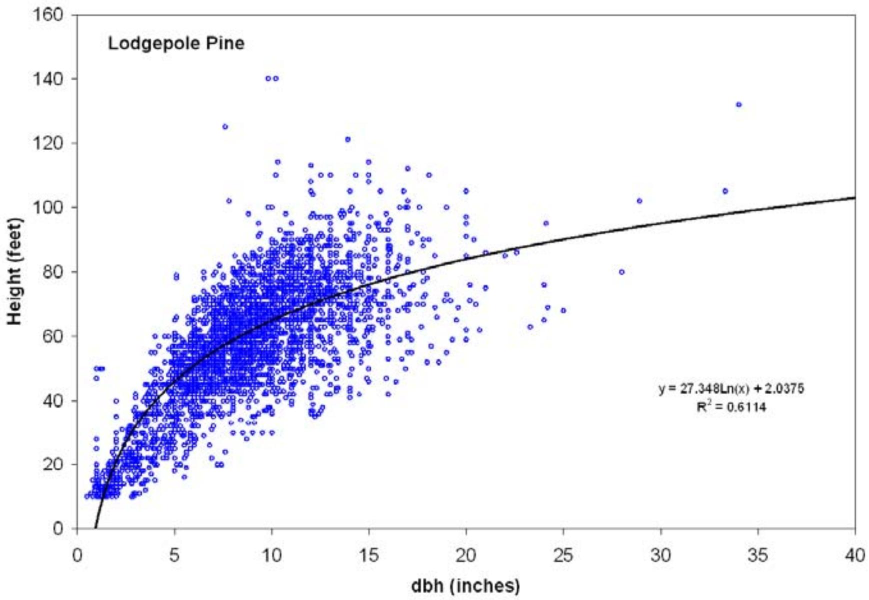
Measured Western Hemlock Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	21	65	96	112	135
75th	14	52	85	100	121
50th	8	35	70	85	107
25th	6	16	53	70	92
10th	5	9	36	50	78
Number of Measurements	895	1378	2575	1365	2850

Figure X-6 (cont.). Measured Western Redcedar Height - Sandpoint Ranger District.



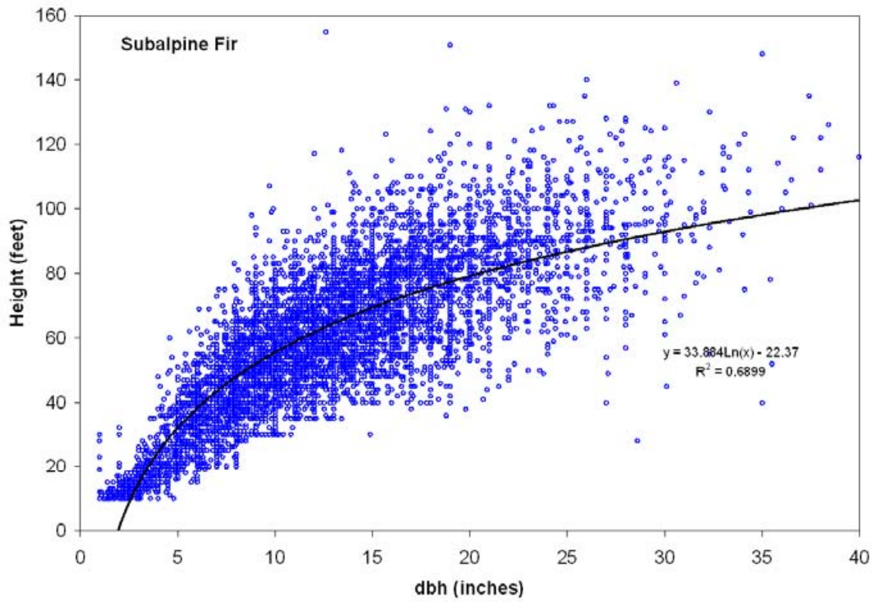
Measured Western Redcedar Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	19	65	91	110	140
75th	13	53	80	100	125
50th	8	36	66	87	109
25th	6	18	50	73	94
10th	5	11	35	58	80
Number of Measurements	2183	2622	3965	1498	1772

Figure X-6 (cont.). Measured Lodgepole Pine Height - Sandpoint Ranger District.



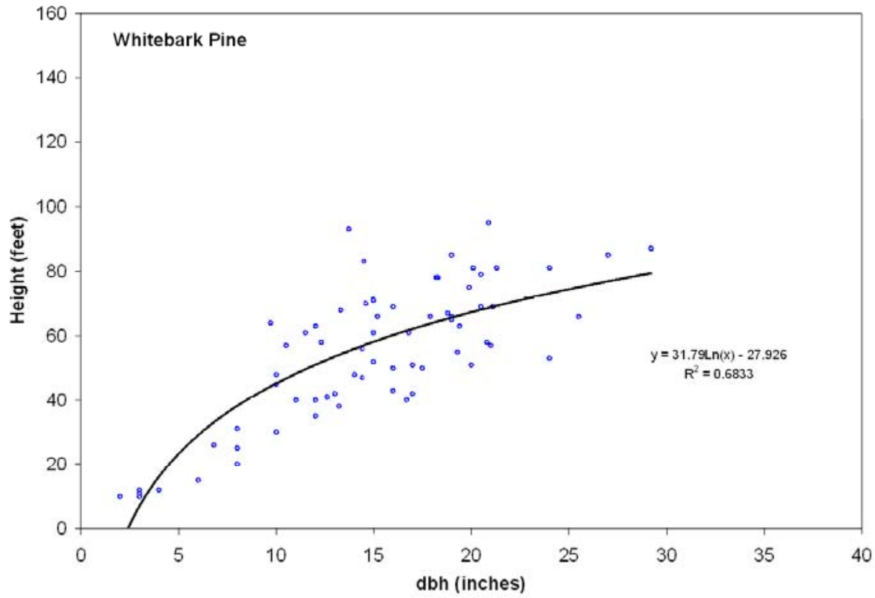
Measured Lodgepole Pine Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	32	67	83	90	100
75th	24	60	74	82	88
50th	15	52	67	74	77
25th	10	44	59	65	66
10th	6	36	52	57	55
Number of Measurements	560	1297	1830	136	102

Figure X-6 (continued). Measured Subalpine Fir Height - Sandpoint Ranger District.



Measured Subalpine Fir Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	21	61	82	90	104
75th	13	47	71	77	91
50th	8	30	58	63	78
25th	6	11	44	51	63
10th	5	6	30	40	52
Number of Measurements	768	1515	3707	2770	1222

Figure X-6 (cont.). Measured Whitebark Pine Height - Sandpoint Ranger District.



Measured Whitebark Pine Height (feet) by Size Classification Groups.					
	Size Class (Group Name and Year Range)				
Percentile	**Seed/Sap** Less than 35	**Small** 35 through 59	**Medium** 60 through 99	**Large** 100 through 149	**Oldest** Greater than 150
90th	10	12	53	68	85
75th	8	12	48	61	78
50th	5	10	42	51	66
25th	3	7	36	43	56
10th	2	7	23	27	42
Number of Measurements	30	10	8	13	40

Methods used to estimate "system potential landcover" for Forest Areas

As described above, "system potential landcover" is necessary to achieve "system potential effective shade" and is defined for purposes of the TMDL as "the potential near stream land cover condition which can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology and hydrologic processes." It is also important to point out again that "system potential does not consider management or land use as limiting factors."

In essence, system potential is the design condition used for TMDL analysis that meets the temperature standard by minimizing human-related warming. In other words, system potential is an estimate of the condition where anthropogenic activities that cause stream warming are minimized. However it is import to point out again that a "natural disturbance" component was included with the estimate for "system potential landcover" conditions. This analysis produces a weighted average estimate of "system potential land cover" condition for each Assessment Group. This information is subsequently used to calculate "***system potential effective shade condition***".

The following parameters were used to develop "system potential land cover conditions":

- "System Potential Land Cover" conditions were defined for the four (4) VRU/HTG "Assessment Groups" (see Table X-1);
- Forest Vegetation Structure for each of the "Assessment Groups" were assigned as weighted average historical level (see Table X-2);
- Forest Vegetation Composition for each of the "Assessment Groups" were assigned as weighted average historical level (see Table X-3);
- Vegetation height conditions were assigned to the 50th percentile (median) of measured vegetation conditions within the Sand Point Ranger District for each of the size class groups (see Figure X-5); and
- Vegetation Canopy Cover Conditions was assigned to 80%.

Calculated System Potential Effective Shade Values for Forest Areas

Calculated System Potential Effective Shade values for the four "Assessment Units" are presented in **Figures X-7** though **X-10**. The corresponding energy loading associated with these targeted conditions is presented in **Figure X-11**. Although this TMDL allocates a specific "target" condition (e.g., "system potential effective shade"), a range of values can be expected to occur as a results of "natural" variability of riparian land cover. In other words, although the individual measurements may not be at the "dot", average condition over a distance must be at or above the "dot".

Figure X-7. System Potential Effective Shade for "Assessment Group A" (Warm/Dry) at Various Stream Aspect and Stream Width Conditions.

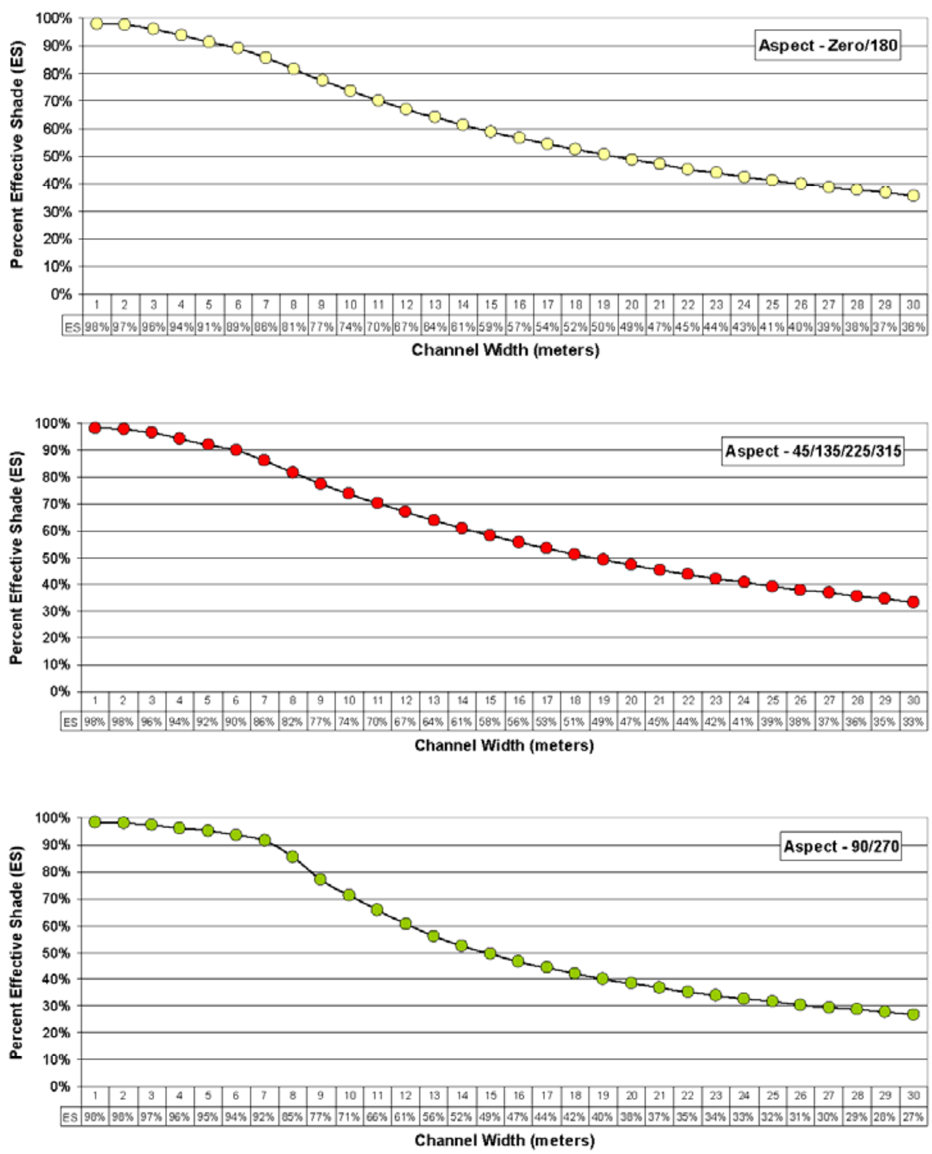


Figure X-8. System Potential Effective Shade for "Assessment Group B" (Moist) at Various Stream Aspect and Stream Width Conditions.

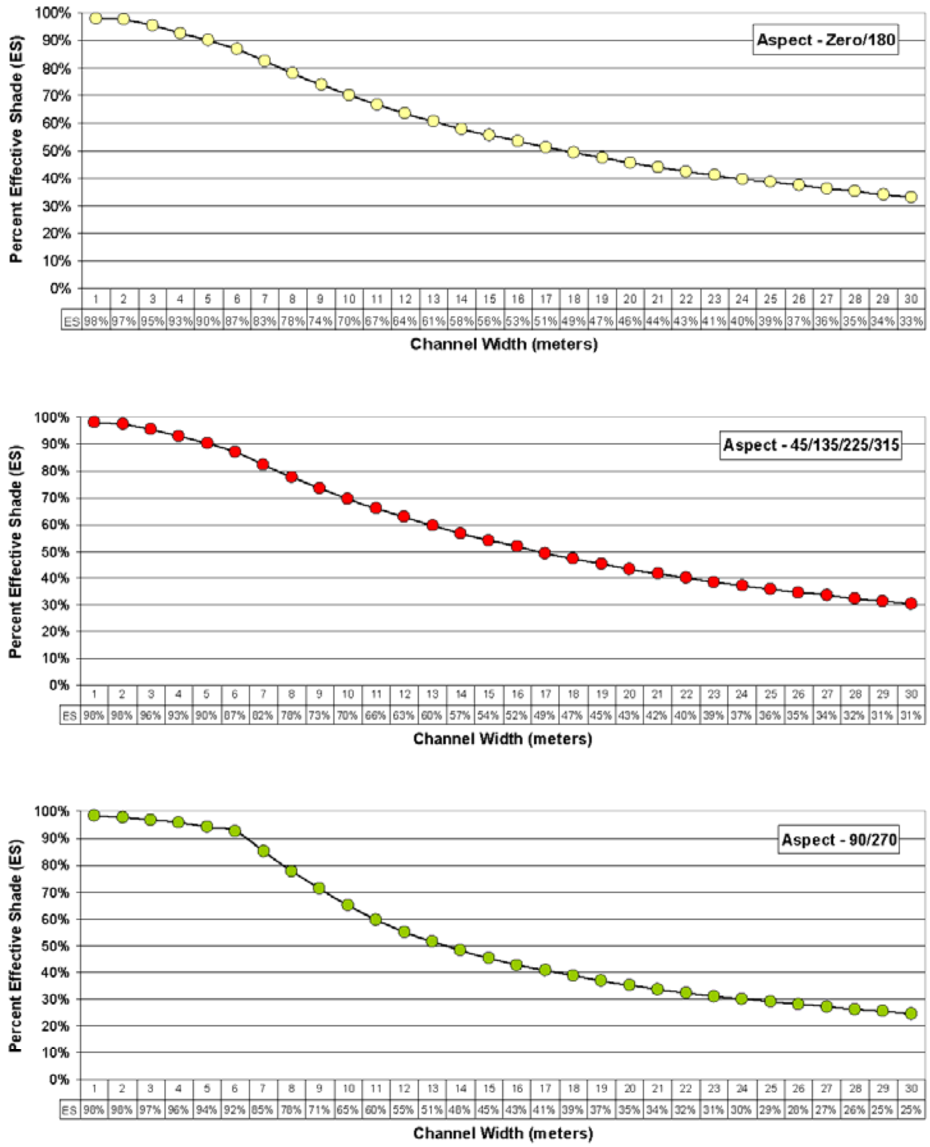


Figure X-9. System Potential Effective Shade for "Assessment Group C" (Cool/Moist) at Various Stream Aspect and Stream Width Conditions.

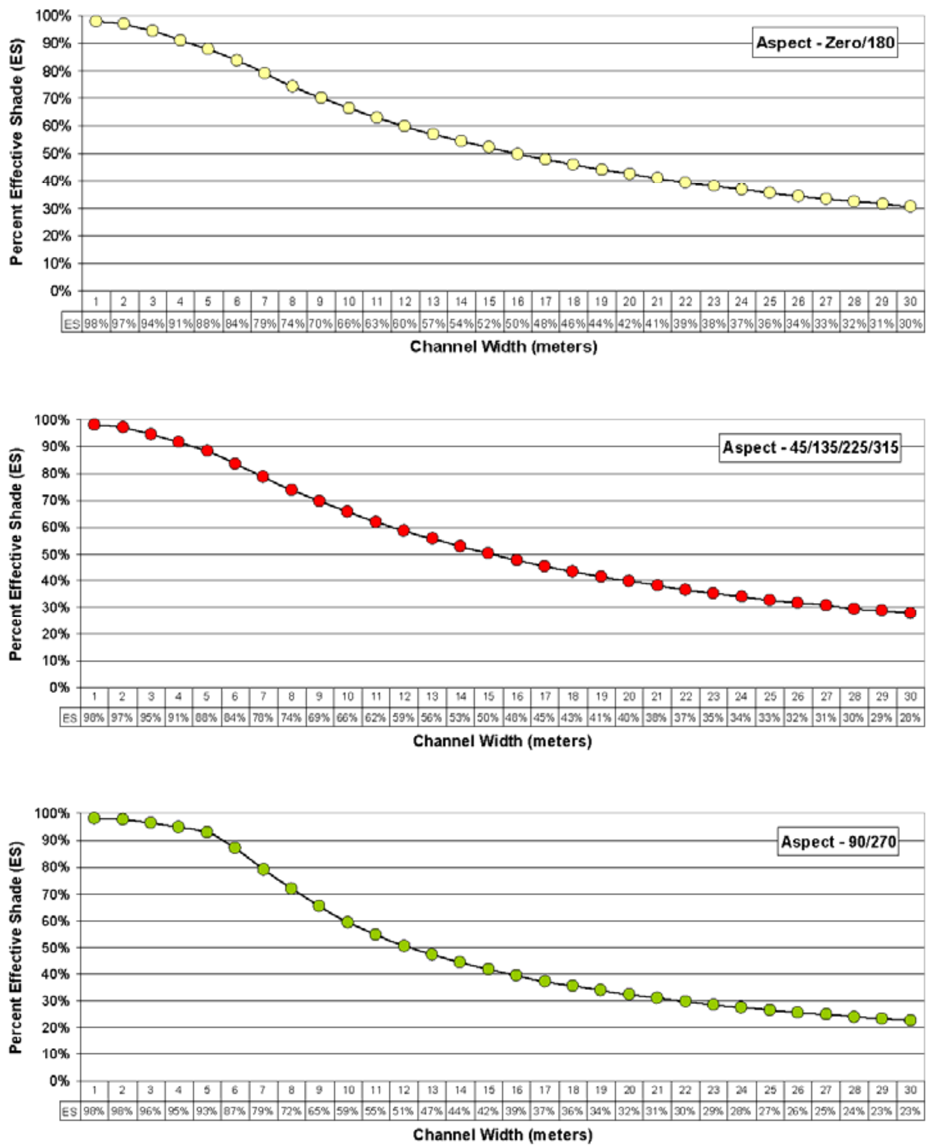


Figure X-10. System Potential Effective Shade for "Assessment Group D" (Cool/Dry) at Various Stream Aspect and Stream Width Conditions.

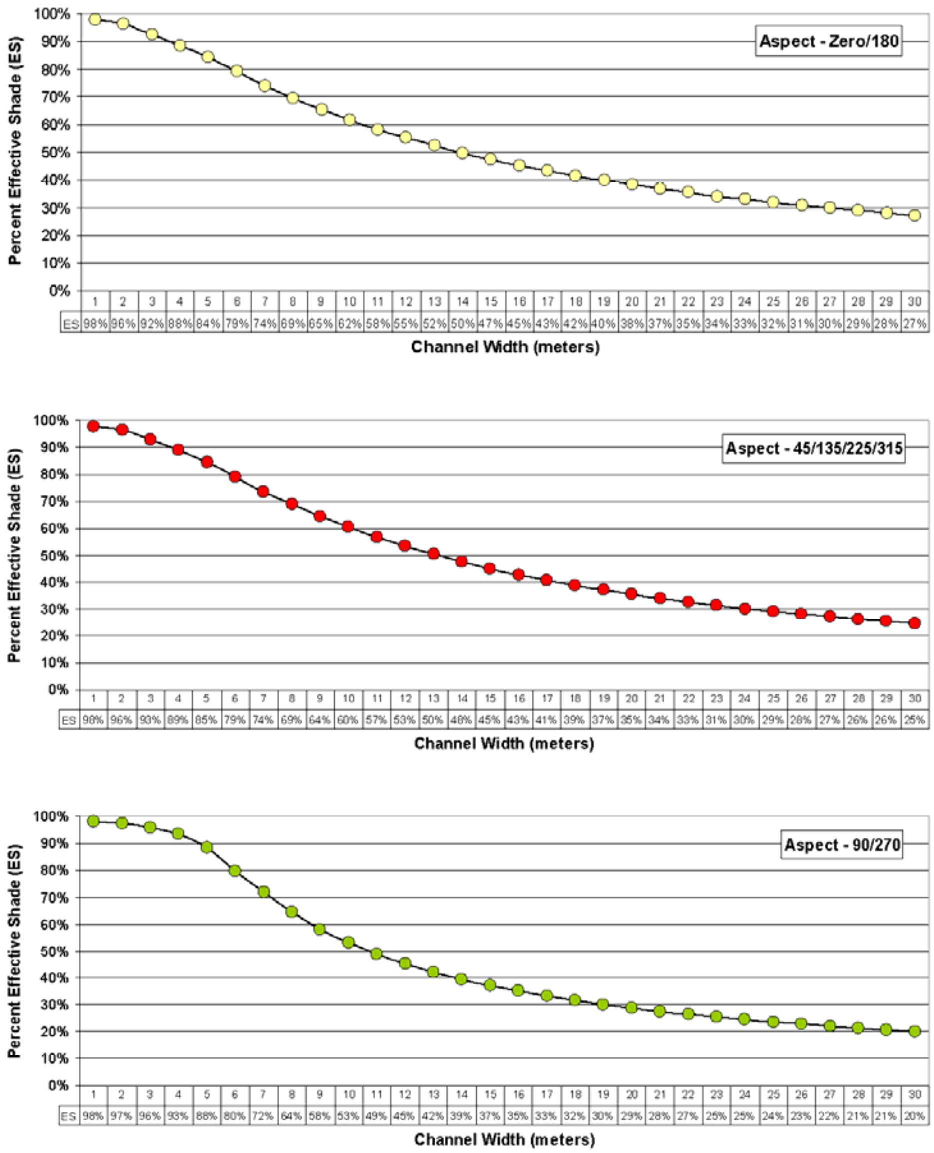
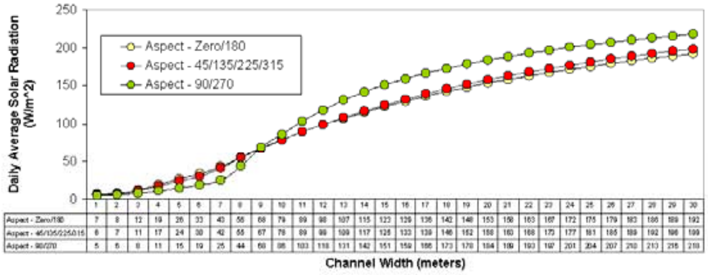


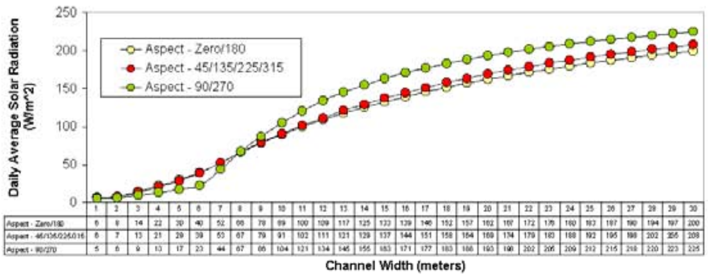
Figure X-11. Daily Average Solar Radiation Loading at System Potential Effective Shade Conditions for the four "Forest" Riparian Groups in the Pend Oreille Basin.

Group A – Warm/Dry



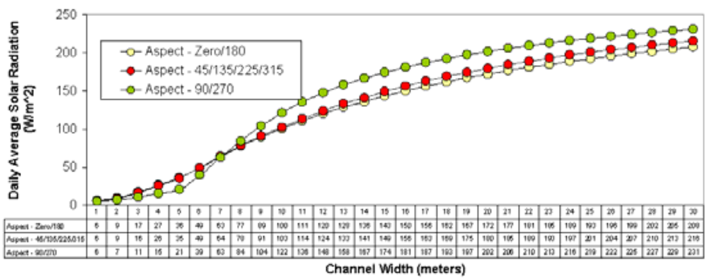
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	7	8	12	19	26	33	40	56	68	79	89	98	107	115	123	129	136	142	148	153	158	163	167	172	175	179	183	186	189	192
Aspect - 45/135/225/315	6	7	11	17	24	30	42	55	67	78	89	99	109	117	125	133	139	146	152	158	163	168	173	177	181	185	189	192	196	199
Aspect - 90/270	5	6	8	11	15	19	25	44	68	86	103	118	131	142	151	159	166	173	178	184	189	193	197	201	204	207	210	213	215	218

Group B – Moist



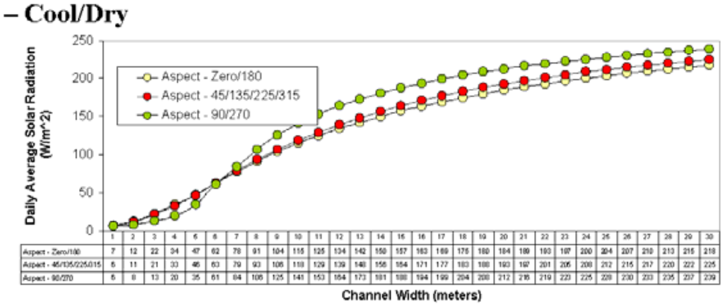
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	6	9	14	22	30	40	52	66	78	89	100	109	117	125	133	139	146	152	157	162	167	172	176	180	183	187	190	194	197	200
Aspect - 45/135/225/315	6	7	13	21	29	39	53	67	79	91	102	111	121	129	137	144	151	158	164	169	174	179	183	188	192	195	198	202	205	208
Aspect - 90/270	5	6	9	13	17	23	44	67	86	104	121	134	145	155	163	171	177	183	188	193	198	202	206	209	212	215	218	220	223	225

Group C – Cool/Moist



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	6	9	17	27	36	49	63	77	89	100	111	120	129	136	143	150	156	162	167	172	177	181	185	189	193	196	199	202	205	209
Aspect - 45/135/225/315	6	9	16	26	35	49	64	78	91	103	114	124	133	141	149	156	163	169	175	180	185	189	193	197	201	204	207	210	213	216
Aspect - 90/270	6	7	11	16	21	39	63	84	104	122	138	148	158	167	174	181	187	193	197	202	206	210	213	216	219	222	225	227	229	231

Group D – Cool/Dry



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	7	12	22	34	47	62	78	91	104	115	125	134	142	150	157	163	169	175	180	184	189	193	197	200	204	207	210	213	215	218
Aspect - 45/135/225/315	6	11	21	33	46	63	79	93	106	118	129	139	148	156	164	171	177	183	188	193	197	201	205	208	212	215	217	220	222	225
Aspect - 90/270	6	8	13	20	35	61	84	106	125	141	153	164	173	181	188	194	199	204	208	212	216	219	223	225	228	230	233	235	237	239

X-3. System Potential "Non-Forest" Vegetation Landcover Estimates

This section will discuss methods used to develop system potential landcover estimates for riparian areas of the Pend Oreille basin located within "non-forest" areas. These areas are primarily located within low elevation and low surface gradient areas. It is important to point out that these "non-forest" riparian areas still have an upland forest component, but at lower levels than "forest" riparian areas described in the previous section.

These "non-forest" areas are often located in areas that have been exposed to anthropogenic changes over the past several decades. Accordingly, these areas often deviate dramatically from "potential" landcover conditions. It is important to point out once again that "system potential landcover" is necessary to achieve "system potential effective shade" and is defined for purposes of the TMDL as "the potential near stream land cover condition which can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology and hydrologic processes." In addition, "system potential does not consider management or land use as limiting factors."

Recently, there have been efforts to assess riparian areas for "non-forest" areas in the Pend Oreille basin. For example, a detailed survey of stream channel conditions was recently developed for the Pack River system. As part of this effort, riparian vegetation conditions were assessed, including estimates of "vegetation reference conditions". In addition, the Bonner Soil and Water Conservation District conducted riparian vegetation surveys along several stream reaches located within the Pend Oreille basin lowlands. This effort included estimates for "Potential Natural Vegetation" for these assessed reaches. Information provided from these efforts will provide insight into riparian vegetation conditions for areas located within "Non-Forest Riparian Group 1" and "Non-Forest Riparian Group 2" (see Table X-3).

Pack River Stream Channel Assessment

Discussions included in the Pack River Stream Channel Assessment (Pack River Technical Advisory Committee Report 10/7/2003) described reference riparian vegetation along the Pack River as the following

> *"The reference sub-reaches for riparian vegetation on the Pack River can be found in Reaches A and B. Sub-reaches 5 and 17 both contain a high percentage of late-seral Western redcedar vegetation type (88 and 90 percent, respectively).*
>
> *The locations of these sub-reaches within more confined portions of the valley appear to have limited their exposure to the Sundance fire effects. The riparian habitat is less disturbed in these sub-reaches than in others on the Pack River. Based on these reference sub-reaches, it is likely that more stable, larger substrate B-type streams have alder as a subdominate species (as in subreach 5), while the more dynamic C and F-type stream reaches are likely to contain willow as a subdominate species (as in sub-reach 17).*

Sub-reach 5 likely represents the reference vegetation condition for B channel types within the watershed. Despite elevational differences between the lower and upper watershed, it is likely that sub-reach 17 is indicative of reference conditions for C and F channel types within Reaches C, D, and E of the watershed as indicated by the presence of Western redcedar trees and stumps."

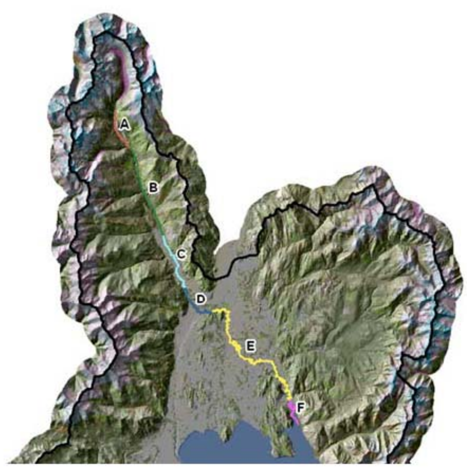
Photographs for subreaches 5 and 17 are presented in **Figure X-12** (These images were obtained from the Pack River Report). River reach designations used for the Pack River within this report are illustrated in **Figure X-13**.

Figure X-12. Photographs of available reference riparian areas along the Pack River.

Subreach 5

Subreach 17

Figure X-13. Reach Designations along the Pack River[8]



[8] Reach A contains subreaches 1 through 8, Reach B contains subreaches 9 through 21, Reach C contains subreaches 22 through 30, Reach D contains subreaches 31 through 39, Reach E contains subreaches 40 through 52, and Reach F contains subreaches 53 and 54.

2006 Riparian Vegetation Surveys in Pend Oreille Basin Lowlands

In the summer of 2006, staff at the Bonner Soil and Water Conservation District conducted riparian vegetation surveys along several stream reaches located within the Pend Oreille basin lowlands. The locations areas for these sampling sites are highlighted in **Figure X-14**. These surveys were for the purpose of identifying priority areas for agricultural TMDL implementation plan development in the Pack River watershed. Given this focus, the areas that were surveyed were chosen based on the presence of agricultural activity. As part of this effort, descriptions of "potential natural vegetation" was estimated by the field crew for many of the sampling reaches.

Recall that these riparian areas associated with these sites are currently modified by landuse activities, and thus estimates of **"potential natural vegetation"** conditions could be problematic to accurately establish. However, this information is the best estimate considering available information at the site. In addition, descriptions of **current vegetation** conditions can also be valuable in developing "system potential landcover" estimates for these areas of the basin. This information is summarized in **Figure X-15.**

Figure X-14. Riparian Vegetation Survey Locations in the Pend Oreille Basin Lowlands.

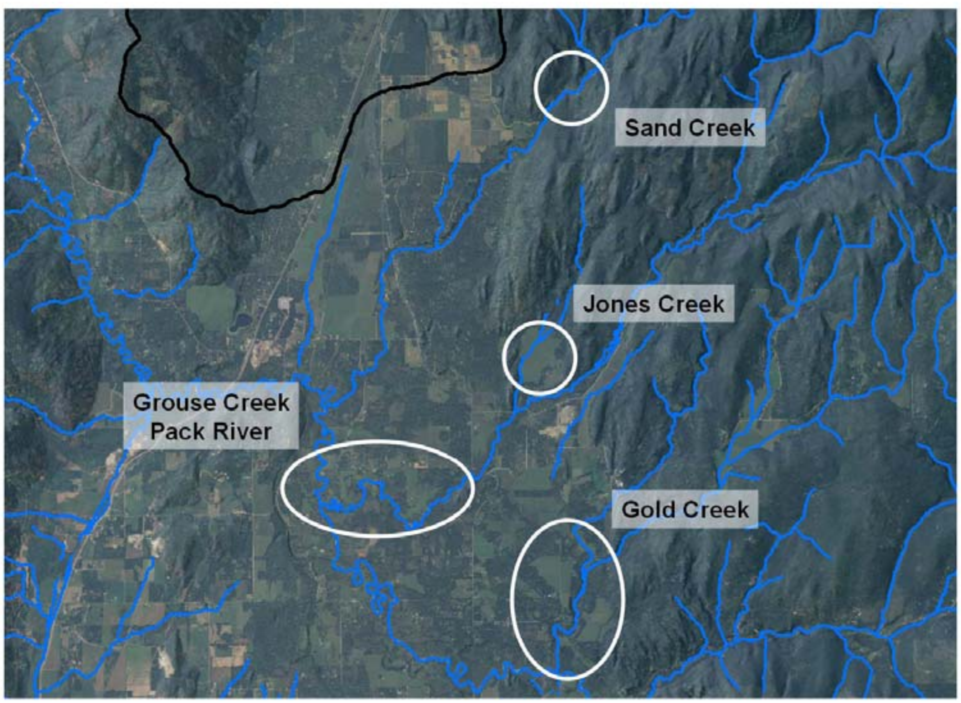
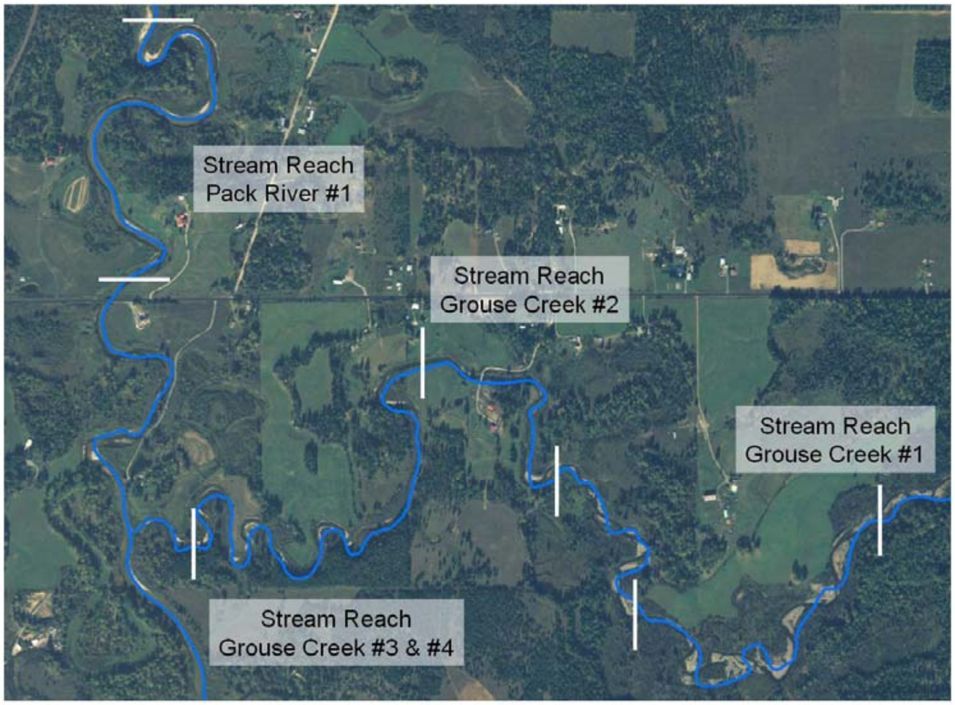
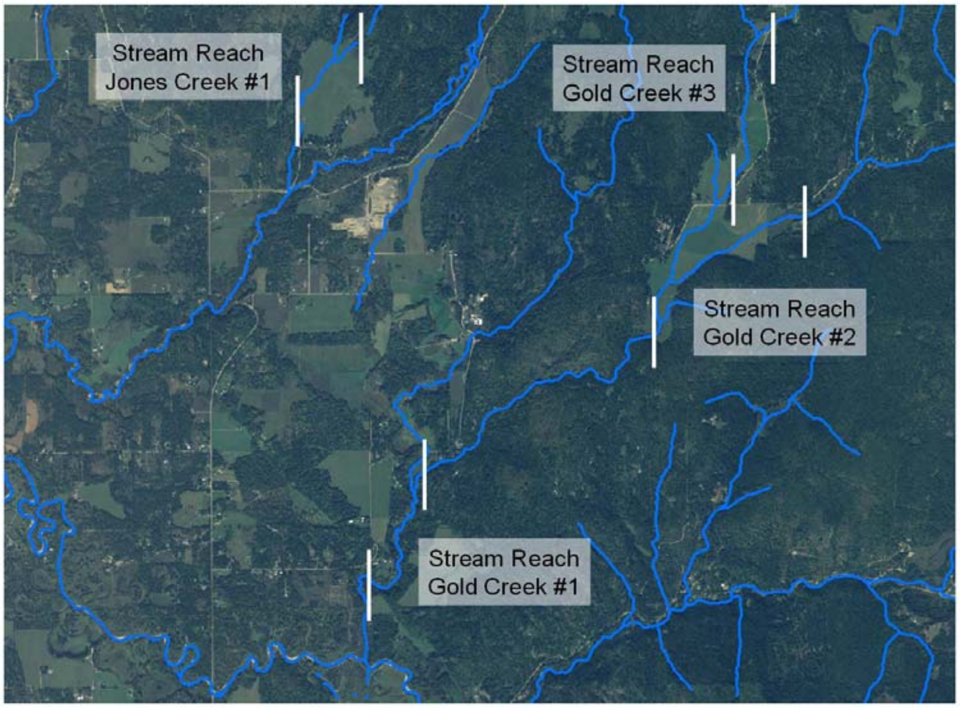


Figure X-15. Pack River and Grouse Creek Reaches



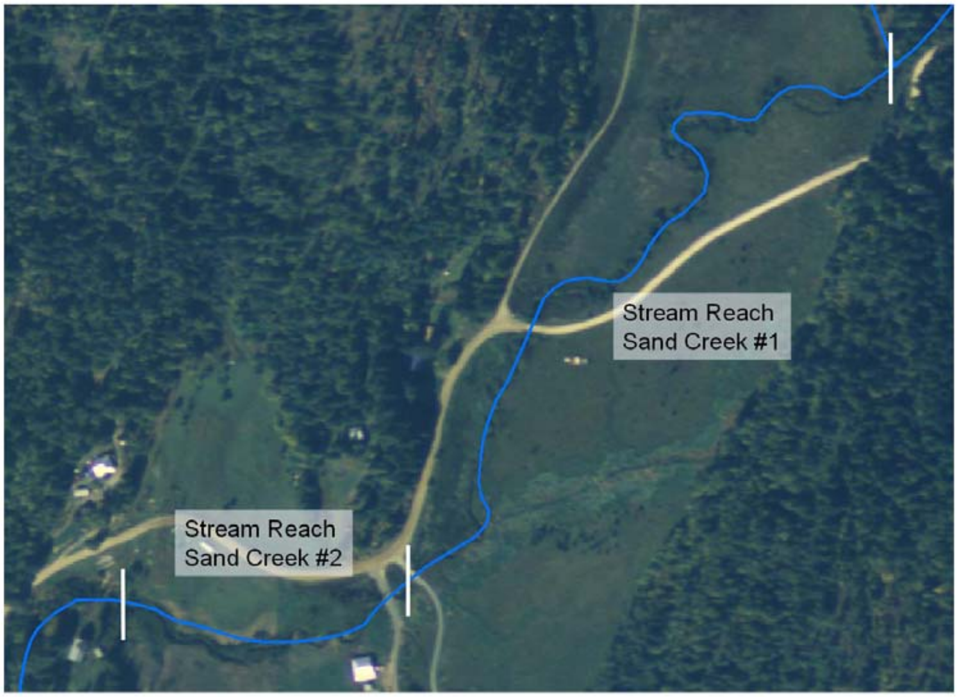
Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed "Woody" Vegetation
Pack River #1	Cottonwoods Willow Cedar	Cedar Cottonwoods	Abundant - Cedar Common – Hawthorn, Alder, Willow, Cottonwood, Douglas fir, Grand fir, Larch
Grouse Creek #1	Cottonwoods Willow Alder	Alder	Abundant – Alder Common – Hawthorn Trace - Cottonwood
Grouse Creek #2	Cedar Cottonwood Willow Sedges	Alder (Very little shade currently)	Abundant – Alder Common – Willow Trace – Grand fir, Douglas fir, larch
Grouse Creek #3 & #4	Birch Cedar Conifers Cottonwood Willows	Lodgepole Douglas fir Larch	Hawthorn, Alder, Larch, Lodgepole Pine, Birch, Willow, Cottonwood, Cedar,

Figure X-15 (continued). Jones Creek and Gold Creek Reaches



Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed "Forest" Vegetation
Jones Creek #1	Alder Willow	Grasses Sedge Invasive Weeds	Trace - Alder
Gold Creek #1	Not Completed	Not Completed	Abundant – Alder Common – Willow, Cottonwood, Cedar Trace - Hawthorn
Gold Creek #2	Alder Willows, Cedars Cottonwood	Alder Willows Reeds	Common – Alder, Cottonwood, Cedar Trace – Hawthorn, Douglas fir, Grand fir
Gold Creek #3	Not Completed	Alder	Common – Alder, Cottonwood, Cedar Trace – Hawthorn, Douglas fir, Grand fir

Figure X-15 (continued). Sand Creek Reaches



Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed "Woody" Vegetation
Sand Creek #1	Spirea Alder	Spirea Alder	Common – Alder, Willow
Sand Creek #2	Spirea	Spirea Alder	Common – Alder Trace - Willow

As can be seen from riparian survey results, riparian habitat within lowland areas of the Pend Oreille basin is comprised of mixture of deciduous and conifer vegetation. Similarly, the Pend Oreille subbasin plan[9] states that historical riparian habitat varied greatly in structure, including multi-canopy forest, woodlands, and shrublands. In addition, it is proposed that black cottonwood, quaking aspen, paper birch and other deciduous trees were a historic riparian vegetation component of lowland areas.

Methods used to estimate "system potential landcover" for "Non-Forest" Areas

Riparian vegetation descriptions for the Aquatic Response Units (ARU) in the Kootenai basin was used as the framework to develop estimates of height and canopy cover conditions for the "non-forest" riparian groups in the Pend Oreille Basin (see Table X-3). This analysis produced a weighted average estimate of "system potential land cover" condition for each Assessment Group. This information is subsequently used to calculate "***system potential effective shade condition***".

"Non-forest" Riparian Group 1- Ecodata plots collected along streams of this group describe a very diverse group of plant communities. The different communities include late-successional cedar-hemlock, black cottonwood, mixed conifer and riparian shrubs. Measured constancy and canopy cover conditions for significant shade producing riparian vegetation (i.e., Overstory) within the "Non-forest " Riparian Group 1 are presented in **Table X–7**.

"Non-forest" Riparian Group 2 - Ecodata plots collected along streams of this group describe an area that is subject to flooding disturbance, indicated by the common presence of black cottonwood. Shrubs and grasses are also common and reflect the dynamic nature of these areas. Although conifer tree species are present in many plots, the average canopy cover is low. Measured constancy and canopy cover conditions for significant shade producing riparian vegetation (i.e., Overstory) within the "Non-forest " Riparian Group 2 are presented in **Table X–8**.

Calculated System Potential Effective Shade Values for Forest Areas

Calculated System Potential Effective Shade values for the two "non-forest" riparian groups are presented in **Figures X-16** and **X-17**. The corresponding energy loading associated with these targeted conditions is presented in **Figure X-18**. Although this TMDL allocates a specific "target" condition (e.g., "system potential effective shade"), a range of values can be expected to occur as a results of "natural" variability of riparian land cover. In other words, although the individual measurements may not be at the "dot", average condition over a distance must be at or above the "dot".

[9] Obtained from - http://www.nwcouncil.org/fw/subbasinplanning/admin/level2/intermtn/plan/

Table X-7. Canopy Cover and Constancy Conditions for Riparian "Overstory" Vegetation along VRU3C and VRU4C Streams.

Common Name	Canopy Cover (CC)	Constancy	Weighted CC[10]	System Potential (SP) Height[11]	Weighting Factor[12]	Weighted SP Height
VRU 3C (n = 43 Ecodata plots)						
Grand Fir	20	51	10	100	14%	14
Engelmann Spruce	16	33	5	90	9%	8
Black Cottonwood	15	30	5	100	8%	8
Douglas Fir	8	35	3	91	10%	9
Western Redcedar	30	40	12	87	11%	10
Western Hemlock	19	56	11	85	16%	13
Rocky Mountain Maple	8	65	5	30	18%	5
Mountain Alder	21	21	4	30	6%	2
Sitka Alder	11	28	3	30	8%	2
Total			**58**	**Total**		**72**
VRU 4C (n = 34 Ecodata plots)						
Grand Fir	6	35	2	100	10%	10
Subalpine Fir	5	18	1	63	5%	3
Paper Birch	40	9	4	70	3%	2
Engelmann Spruce	13	44	6	90	13%	11
Balsam Poplar	30	3	1	80	1%	1
Black Cottonwood	16	24	4	100	7%	7
Douglas Fir	16	50	8	91	14%	13
Western Red Cedar	32	26	8	87	7%	6
Western Hemlock	5	26	1	85	7%	6
Rocky Mountain Maple	11	56	6	30	16%	5
Mountain Alder	34	35	12	30	10%	3
Sitka Alder	21	24	5	30	7%	2
Total			**58**	**Total**		**70**

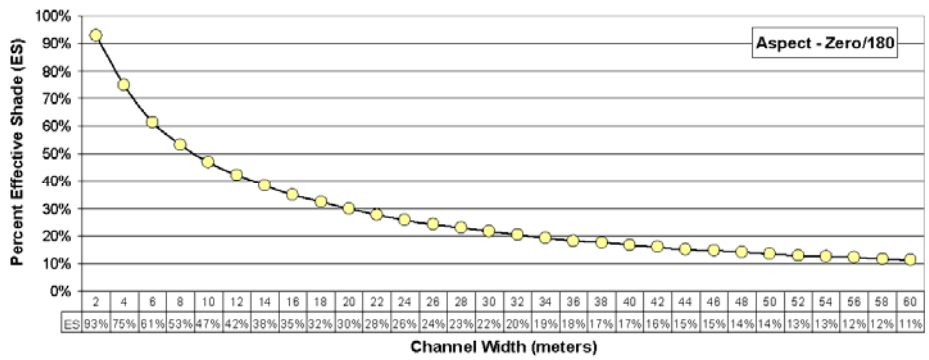
[10] Calculated as Canopy Cover times Constancy
[11] Heights were assigned as the median of measured "large" trees in Figure X-6. Tree species not included in the FSVeg database (i.e., deciduous) were assigned maximum height values obtained from the following NRCS webpage - http://plants.usda.gov/
[12] Calculated as relative weight that the species was observed (i.e., observed divided by total constancy)

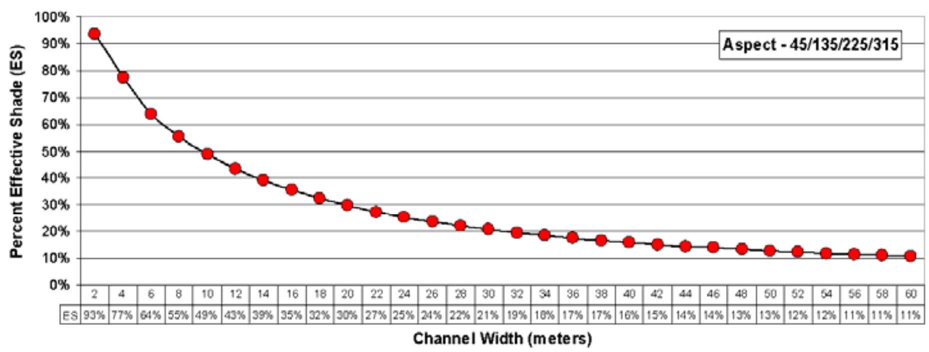
Table X-8. Canopy Cover and Constancy Conditions for Riparian "Overstory" Vegetation along VRU5C Streams.

Common Name	Canopy Cover (CC)	Constancy	Weighted CC[13]	System Potential (SP) Height[14]	Weighting Factor[15]	Weighted SP Height
VRU 5C (n = 9 Ecodata plots)						
Grand Fir	16	50	8	100	15%	15
Paper Birch	12	31	4	70	10%	7
Engelmann Spruce	5	31	2	90	10%	9
Black Cottonwood	28	63	18	100	19%	19
Douglas Fir	2	38	1	91	12%	11
Western Red Cedar	18	44	8	87	13%	12
Western Hemlock	6	25	2	85	8%	7
Mountain Alder	20	44	9	25	13%	3
Sitka Alder	11	28	3	30	8%	2
Total			**50**	**Total**		**82**

[13] Calculated as Canopy Cover times Constancy
[14] Heights were assigned as the median of measured "large" trees in Figure X-6. Tree species not included in the FSVeg database (i.e., deciduous) were assigned maximum height values obtained from the following NRCS webpage - http://plants.usda.gov/
[15] Calculated as relative weight that the species was observed (i.e., observed divided by total constancy)

Figure X-16. System Potential Effective Shade for "Non-Forest" Assessment Group 1 at Various Stream Aspect and Stream Width Conditions.





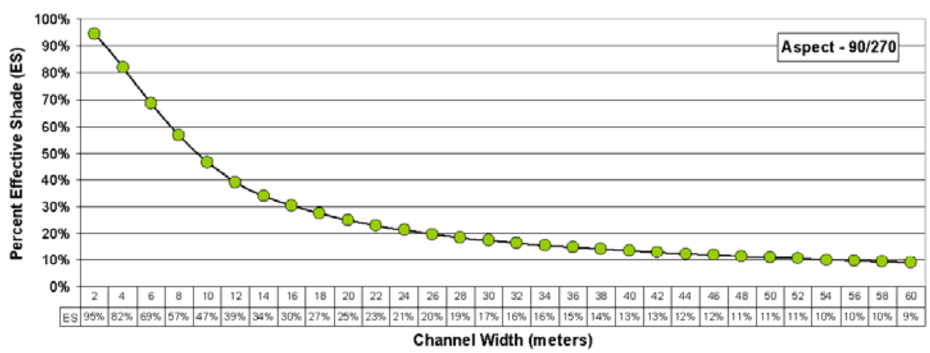


Figure X-17. System Potential Effective Shade for "Non-Forest" Assessment Group 2 at Various Stream Aspect and Stream Width Conditions.

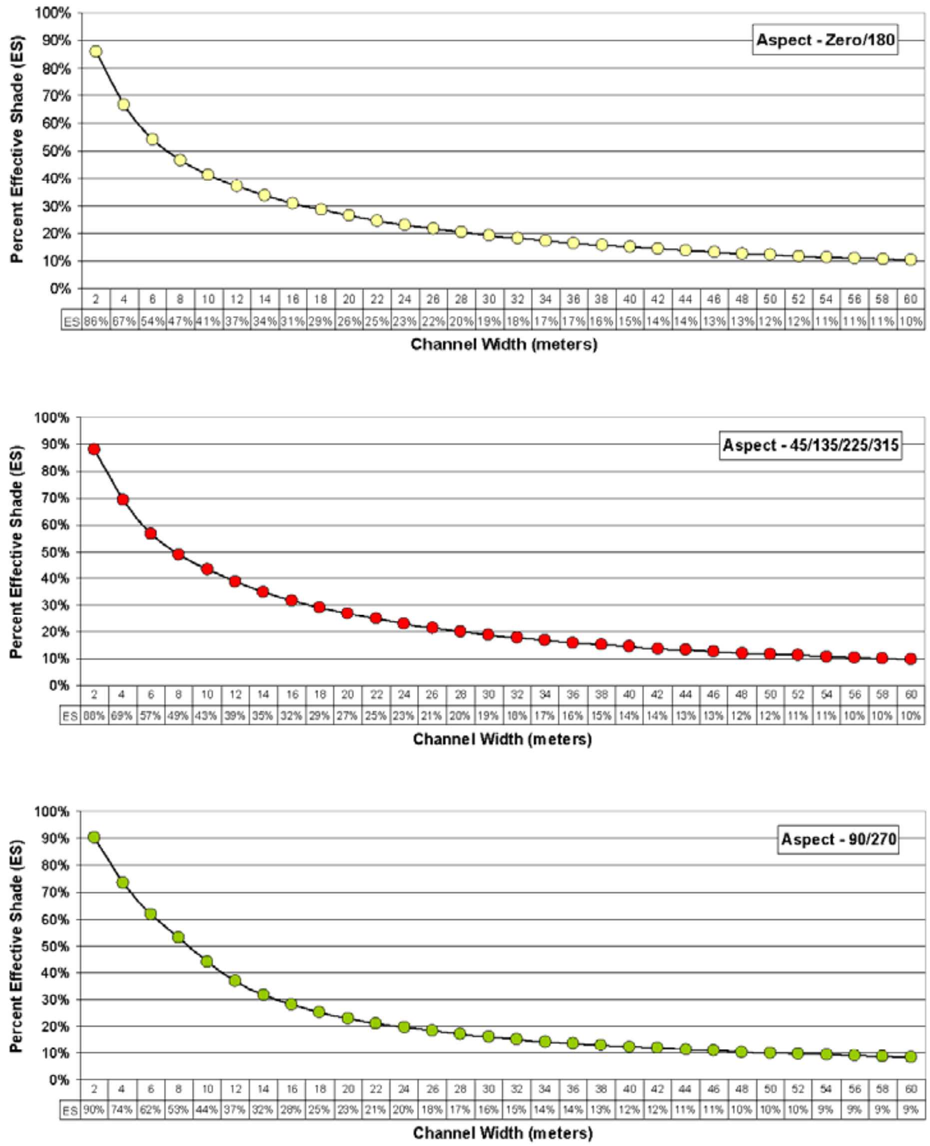


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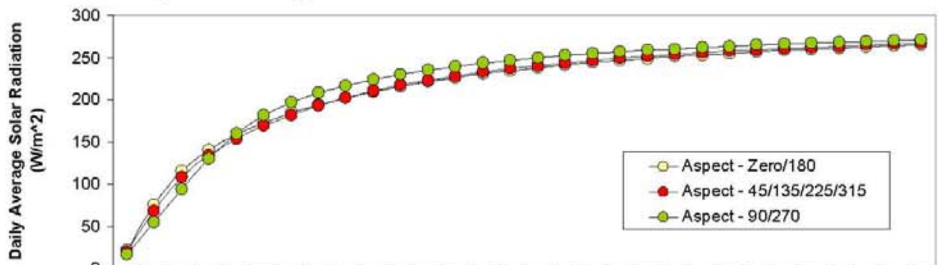
Figure X-18. Daily Average Solar Radiation Loading at System Potential Effective Shade Conditions for the two "Non-Forest" Riparian Groups in the Pend Oreille Basin.

Non-Forest Riparian Group 1

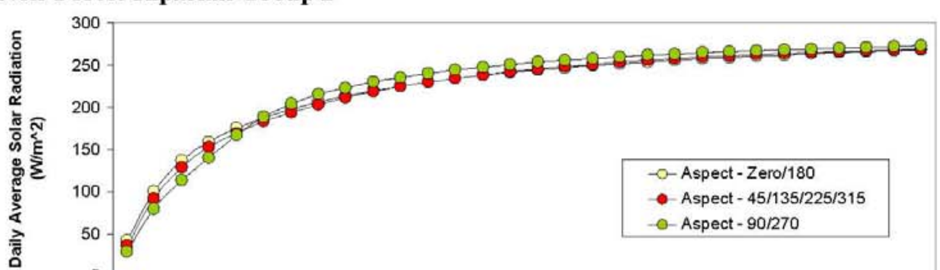


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Aspect - Zero/180	21	76	115	140	158	173	184	194	202	210	216	221	226	230	234
Aspect - 45/135/225/315	20	68	108	134	153	169	182	193	202	210	217	223	228	233	237
Aspect - 90/270	16	54	94	130	160	182	197	208	217	224	230	235	240	243	247

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	238	241	244	246	249	251	253	255	257	258	260	261	262	264	265
Aspect - 45/135/225/315	241	244	247	249	252	254	256	257	259	261	262	263	265	266	267
Aspect - 90/270	250	252	254	257	258	260	262	263	265	266	267	268	269	270	271

Channel Width (meters)

Non-Forest Riparian Group 2



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Aspect - Zero/180	42	100	137	159	175	188	199	206	213	220	225	230	234	238	241
Aspect - 45/135/225/315	36	92	129	152	169	183	194	203	211	218	224	230	235	239	242
Aspect - 90/270	29	79	114	140	167	188	204	215	223	230	235	240	244	248	251

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Aspect - Zero/180	244	247	249	252	254	256	258	259	261	262	263	265	266	267	268
Aspect - 45/135/225/315	245	248	251	253	256	258	259	261	263	264	265	266	268	269	270
Aspect - 90/270	253	256	258	260	262	263	265	266	267	268	270	271	271	272	273

Channel Width (meters)

Appendix E. Sediment Model Documentation

In the Panhandle region of Idaho, sediment is the pollutant of concern in the majority of water quality limited streams. The lithology, or terrain, of the region most often governs the form the sediment takes. Two major types of terrain dominate in northern Idaho. These are the meta-sedimentary Belt Supergroup and granitics present either in the Kaniksu Batholith or in smaller intrusions such as the Round Top Pluton and the Gem Stocks. In some locations Columbia River Basalt formations are important, but these tend to be to the south and west; primarily on the Coeur d'Alene Indian Reservation. Granitics mainly weather to sandy materials, but also weather to pebbles or larger-sized particles. The Belt terrain produces silt size particles, pebbles, and larger particles. Silt particles are transported to low gradient reaches, while the larger particles comprise the majority of the higher gradient stream bedload. Basalts erode to silt and particles similar in size to the Belt terrain. Large basalt particles are less resistant and weather to smaller particles.

A sediment model was developed specific to the Fish Creek watershed. The model was developed to try and quantify the state of Idaho's narrative sediment water quality standard. The model attempts to account for all land use types separately. By estimating the existing contributing sediment load by land use types implementation strategies may be developed to address these site-specific issues. All attempts to model sediment were intended to provide a relative rather than an exact sediment yield.

Land Use Types

Land use types for the Fish Creek watershed and the reference watershed, Hayden Creek, were mapped using a satellite image collected in the summer of 2006 (Figure E-A and E-B). The land owner/manager GIS coverage for the Fish Creek watershed was developed by the Bureau of Land Management, Idaho state office, and generated on February 28, 2005 (Figure E-C). Land ownership/management was not needed in the Hayden Creek watershed because sediment loads were not allocated to owner/manager for reduction.

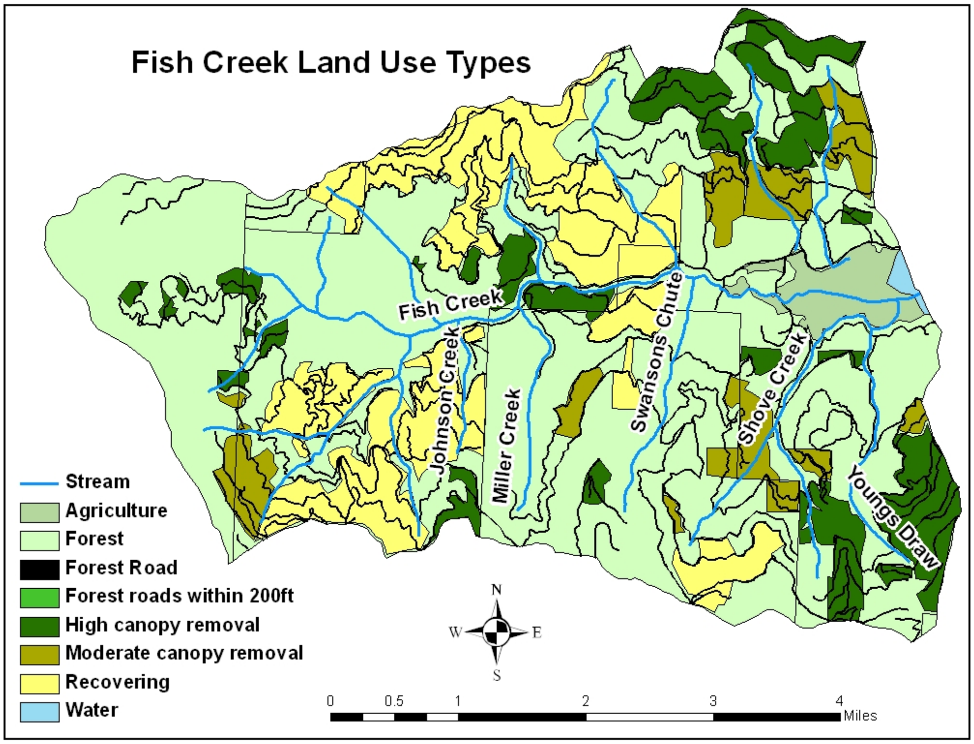


Figure E-A. Fish Creek land use types.

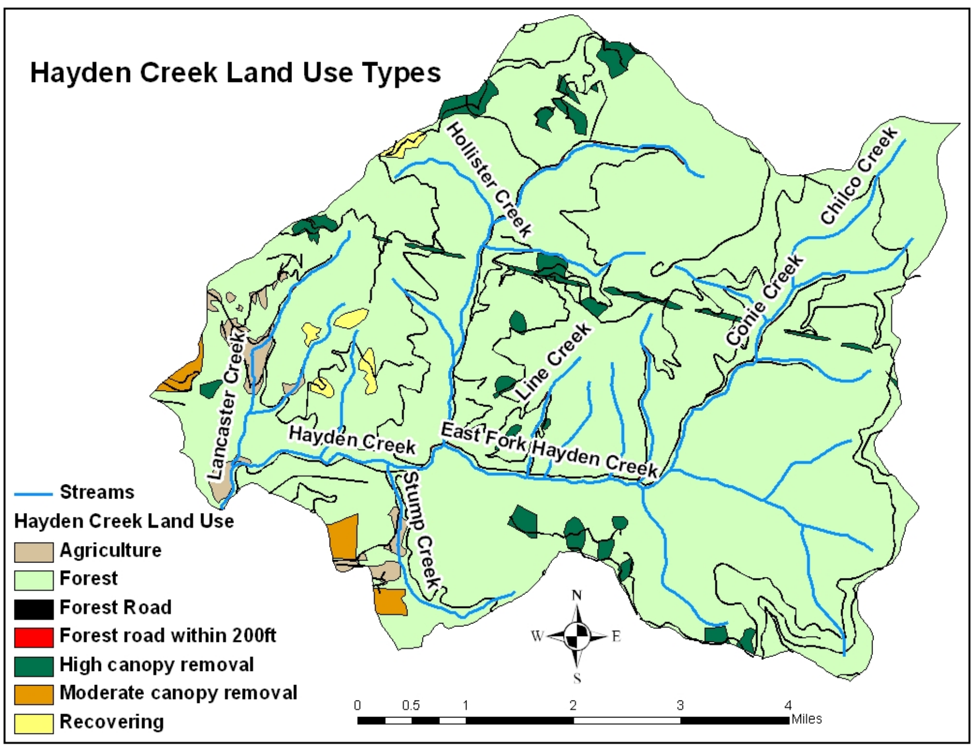


Figure E-B. Hayden Creek land use types.

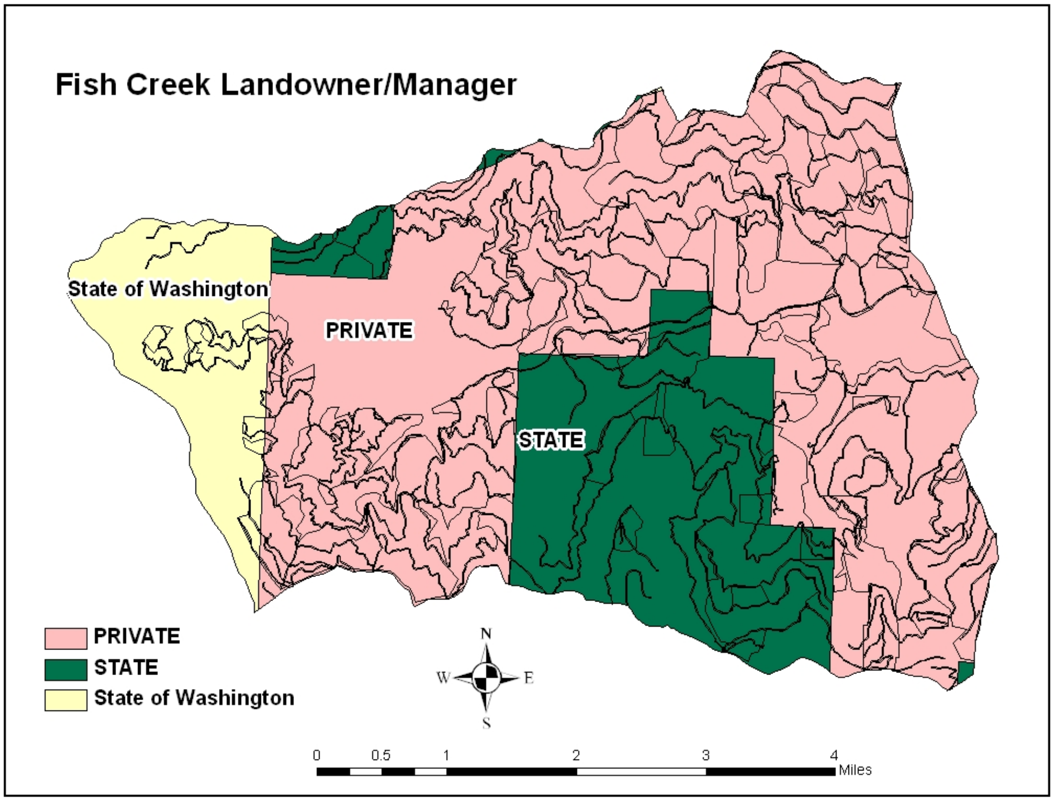


Figure E-C. Fish Creek landowner/manager.

Forest (natural background)

The natural background sediment yield coefficient was measured in-stream on geologies in north central Idaho and covers production and delivery from forested areas. This sediment yield coefficient reflects both fine and coarse sediment.

Forested areas were assigned a sediment yield coefficient for metasediment Belt Supergroup geologies. Forested areas included fully stocked and naturally non-stocked areas. Applying this sediment yield coefficient to all forested areas provided for a conservative estimate (i.e., sediment amount was overestimated).

The Water and Sediment yield (WATSED) model was used to develop natural background sediment yield coefficients for forested land use type within a metamorphic Belt Supergroup geology setting for the Priest River Subbasin Assessment and Total Maximum Daily Load (DEQ 2001). Similar sediment yield coefficients were used in the development of the St. Joe River Subbasin Assessment and Total Maximum Daily Loads (IDEQ 2003b), Assessment of Water Quality in Kootenai River and Moyie River Subbasin (IDEQ 2006), and The Lower Clark Fork Subbasin Assessment and Total Maximum Daily Load (IDEQ 2007).

The sediment yield coefficient applied to the Priest River subbasin was 0.02 tons/acre/year. The sediment yield coefficient used in the St. Joe River TMDL was 0.023 tons/acre/year with an expected range of 0.019 tons/acre/year to 0.027 tons/acre/year. These two coefficients are consistent with the 0.023 tons/acre/year used in the Fish Creek sediment model.

Forest Roads

Road erosion scores from the Cumulative Watershed Effects (CWE) program were applied to all road scores within the subbasin. A 40-foot buffer was applied to all roads. A 40-foot buffer was chosen to account the entire typical road prism of an active timber road (DEQ 2001). The number of miles of forest roads was multiplied by the 40-foot buffer and then converted to acres for use in calculating sediment yield in tons per acre.

Sediment from forest roads was modeled using data developed in accordance with the CWE protocol (IDL 2000). Erosion from the road surface was estimated based on CWE "road scores." The CWE protocol develops scores for several types of conditions, one of which is "the total score for roads" or road score. Forest road sediment yield was estimated based on a known relationship between a CWE road score and sediment yield per mile of road (Figure E-D). The relationship was developed for roads on a Kaniksu granitic terrain in the LeClerc Creek watershed (McGreer 1997). Its application to roads on a Belt terrain conservatively estimates (overestimates) sediment yields from these systems. The CWE road score for the Fish Creek watershed was used to develop sediment tons per acre, which was multiplied by the estimated acres of road within the watershed.

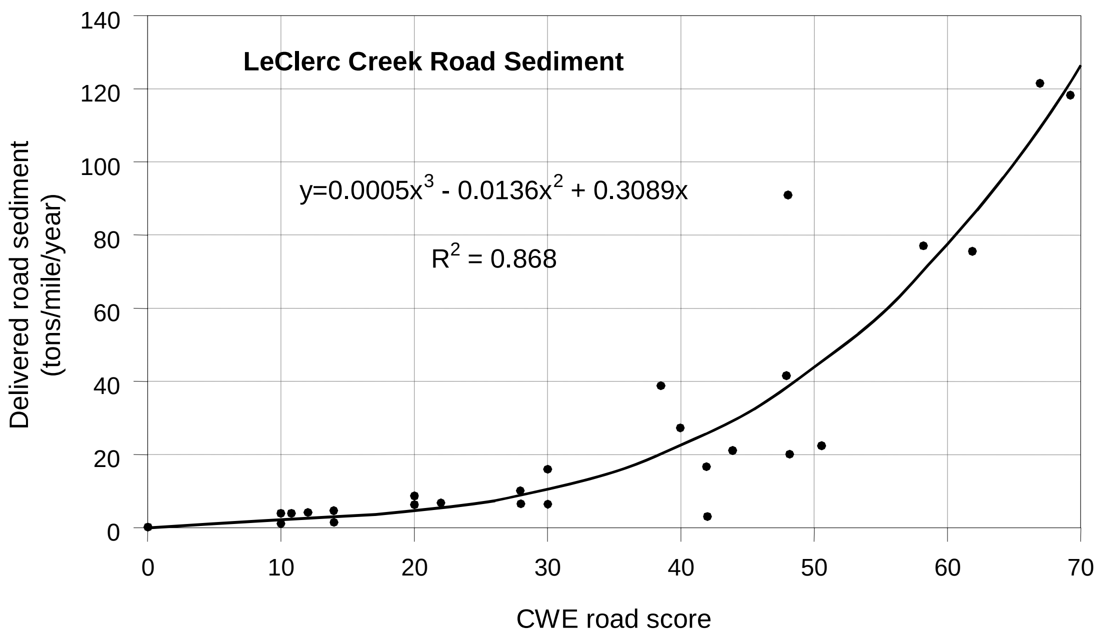


Figure E-D. Sediment export from roads based on CWE scores.

Roads within the 200-foot stream corridor were allocated 100% of the sediment yield coefficient. It was assumed that all sediment from roads within the 200-foot corridor was delivered to the stream system. This is a conservative estimate of actual delivery. Roads not within the 200-foot stream corridor were allocated 10% of the sediment yield coefficient. Roads which were not scored using the CWE process were assigned the lowest CWE score noted within the watershed, and allocated 10% of the sediment yield coefficient. The allocation of sediment yield to forest roads outside of the 200-foot stream corridor and roads that were not originally scored is a conservative estimate of sediment yield.

Roads cause stream sedimentation by another mechanism in addition to simple erosion. The presence of roads in the floodplain of a stream often interferes with the stream's natural tendency to seek a steady state gradient. During high discharge periods, the constrained stream often erodes at the roadbed, or, if the bed is armored, erodes at the opposite bank or its bed. The erosion resulting from a road-imposed gradient change results in stream sedimentation. The bulk of this erosion is assumed to occur during large discharge events which occur on a 10 - 15-year return period (McClelland et. al 1997).

Agriculture

Revised Universal Soil Loss Equation Version 2 (RUSLE 2) is the correct model for agricultural land within the basin as it accounts for production and delivery of fine-grained sediment. Agricultural activities modeled were relatively small in area. Agricultural areas are located within the historic floodplain of Fish Creek. The lowland portion of Fish Creek was the only area modeled to reflect agricultural activities.

Sediment yields from agriculture lands that received any tillage are modeled with RUSLE 2.

Equation 1: $A = (R)(K)(LS)(C)(D)$ tons per acre per year,

where: A is the average annual soil loss from sheet and till erosion
R is climate erosivity
K is the soil erodibility
LS is the slope length and steepness
C is the cover management
D is the support practices

RUSLE 2 does not take into account stream bank erosion, gully erosion, or scour erosion. RUSLE 2 applies to cropland, pasture, hayland or other land that has some vegetation improvement by tilling or seeding. Sediment yields were developed based on the soils, the characteristics of the agriculture, and the slope. The RUSLE 2 model develops values that reflect the amount of sediment eroded and delivered to the active channel of the stream system annually.

Harvested areas

Harvested areas were classified into three land use type classes, High canopy alteration, Moderate canopy alteration, and Recovering canopy alteration. Classes were determined by ground-truthed visual interpretation of satellite imagery. By classifying harvested areas into different land use types an attempt was made to recognize the landscapes ability to revegetate and slow or stop erosional processes. Because erosion from harvest areas is likely to have diminished a few years after harvest, assigning any sediment yield coefficient to historic harvest areas is a conservative influence on estimate.

Sediment Coefficients

All attempts were made to use the most applicable and accurate data available to determine sediment yield coefficients. Coefficients were developed from a mixture of sources including literature review, EPA-approved TMDLs, group discussion, and professional judgment. The processes used attempted to characterize all known sediment-contributing land activities separately. Coefficients were designed to provide a relative rather than an exact estimate of sediment yield within the basin.

All sediment yield coefficients are expressed as tons per acre per year (t/a/y) and are applied to the acreage of each land use type, determined using Geographical Information System (GIS) software (Table E-1). See Figures E-A and E-B for modeled land use types within the Fish Creek watershed. All land uses are displayed with estimated sediment delivery.

Table E-1. Sediment yield coefficients used in the Fish Creek watershed sediment TMDL.

Land use	Coefficient (tons/acre/year)	Reference
High Canopy Alteration	0.21 t/a/y	Within ranges recorded for harvest activities.
Medium Canopy Alteration	0.07 t/a/y	Within ranges recorded for harvest activities.
Low Canopy Alteration	0.025 t/a/y	Within ranges recorded for harvest activities.
Recovering	0.024 t/a/y	Within ranges recorded for harvest activities.
Forest Roads	McGreer equation used to determine sediment export from forest roads based on CWE scores, given 10% delivery.	Road scores obtained from CWE reports.
Forest Roads within 200 feet of stream	McGreer equation used to determine sediment export from forest roads based on CWE scores, given 100% delivery.	Road scores obtained from CWE reports.
Forest (Natural background)	0.023 t/a/y	Developed based on geology of the watershed and used in previously approved TMDL in northern Idaho.
Agriculture	0.04 t/a/y	Developed with RUSLE2, data supplied by IASCD

Sediment yield was quantified to obtain a relative understanding of sediment yield to surface water based on different types of land use activity. The following assumptions were made when applying the sediment yield coefficients:

- There is 100% delivery from forestlands with sediment yield coefficients measured in-stream on geologies of north central Idaho.
- There is 100% delivery from agriculture lands estimated with RUSLE 2.
- Fine and coarse materials are delivered at the same rate from erosion resulting from road encroachment.
- There is 100% delivery from roads within 200 feet of streams.
- There is 10% delivery from all roads outside of any 200-foot stream corridor.

Target Selection

Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. To determine the most appropriate target level, each subbasin must be evaluated on an individual basis.

A reference condition stream was chosen to determine the appropriate sediment target to be used. A reference watershed, a watershed supporting beneficial uses or assumed to be biologically functioning, was selected using local knowledge provided by the Watershed

Advisory Group (WAG), DEQ water quality assessment data, and other monitoring data sources. The reference condition is based on a stream that is considered least impacted. Hayden Creek was used as the reference watershed (Table E-2). Land use activities within Hayden Creek were mapped using a Geographical Information System (GIS) software package. Once the land uses (Table E-1) were mapped, the acreage for each land use type was determined. Sediment yield coefficients were then applied to the appropriate land use and multiplied by the associated acreage. A pre-anthropogenic value was generated by multiplying the acreage of the watershed by the natural background sediment coefficient. The percentage above natural background was then derived by subtracting natural background conditions from current conditions, dividing by natural background conditions, and then multiplying by 100. The current sediment yield condition (percentage above natural background) of the reference stream was then analyzed to determine the most appropriate sediment yield target for the Fish Creek watershed.

Table E-2. Detailed breakdown of reference watershed modeled land use types.

	Fish Creek		Hayden Creek	
Subbasin	Upper Spokane		Upper Spokane	
Watershed type	Third order dendritic stream Rosgen A channel type in headwaters transitioning into B type in lower reaches		Third order dendritic stream Rosgen A channel type in headwaters transitioning into B type in lower reaches	
Watershed size (acres)	14,237		18,183	
Level 3 Ecoregion	Northern Rockies		Northern Rockies	
Elevation	5,100 ft to 2,306 feet		6,650 feet to 3,466 feet	
Mean Precipitation	30-50 inches		30-60 inches	
Geologic Setting	Metasediments of the Belt Supergroup and Granitics of the Kaniksu Batholith		Metasediments of the Belt Supergroup	
Vegetation	*Lower elevations* – Cedar/Hemlock *Uplands* – mixed conifer of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, western pine *Higher elevations* – spruce *Riparian areas* - willow		*Lower elevations* – Cedar/Hemlock *Uplands* – mixed conifer of Douglas fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, western pine *Higher elevations* – spruce *Riparian areas* - willow	
Aspect	west/east		*North Fork* – north/south *East Fork* – east/west	
Flow regime	High-volume runoff during spring associated with rain on snow events Q2 flows 251 cfs[1]		High-volume runoff during spring associated with rain on snow events Q2 flows 413 cfs[1]	
Land use Types	Forest Road – road density 6.2miles/square mile		Forest Road – road density 3.3miles/square mile	
	Timber Harvest		Timber Harvest	
	Agriculture in lowland reaches of mainstem		Agriculture in lowland reaches of mainstem and minor occurrences on tributary streams	
Ownership	Mixed ownership includes the state of Idaho and private		Mixed ownership includes the federal government (USFS) and private	
WBAG II Scores[2]	SMI	2	SMI	3
	SHI	2.25	SHI	3
	SFI	1	SFI	2
	Average	1.75	Average	2.67
Comment			Passing WBAG II scores, supports robust cutthroat trout population	

[1]Flows information obtained from USGS Streamstats (http://streamstats.usgs.gov/idstreamstats/index.asp)

[2] WBAG II Scores are explained in detail in DEQ's *Water Body Assessment Guidance, Second Edition-Final* (Grafe et al. 2002).

Assessment of Model's Margin of Safety

The margin of safety is implicit in the model design. Several conservative estimates were made in the model construction, which cause it to develop conservatively high estimates of sediment yield to surface water. Conservative estimates were made in the development of all land use type sediment yield coefficients.

The component of the model that accounts for forest roads within the 200-foot stream corridor assumes 100% delivery of fine sediment from the 200 feet on either side of a stream crossing and road encroachment of 200 feet upon the stream channel. It is more likely that some fine sediment remains in ditches. A reasonable level of delivery is 80%. The model is likely 20% conservative in this component.

Because erosion from harvest areas is likely to diminish a few years after harvest, assigning any sediment yield coefficient to historic harvest areas is a conservative influence on the estimate.

On Belt terrain, use of the McGreer model, which is based on Kaniksu granitics, is conservative. Since the sediment yield coefficients measured in-stream for Kaniksu granites are 167% of the coefficient for Belt terrain, this factor is estimated to be 67% conservative.

Appendix F. Daily Sediment Loads

Traditionally, DEQ has assigned loads and load reductions for sediment on an annual basis, but recent guidance from the EPA has focused on assigning daily pollutant loads. This appendix adjusts annual TMDL targets in section 5.1B to reflect daily loads. However, for implementation of TMDLs, DEQ believes it is still more practical to assess impact of load reductions on an annual basis.

It is well understood that pulses of pollutants, in this case sediment, occur during high discharge events. To better relate target sediment loads to this phenomenon, daily sediment loads were developed using stream flow data obtained from the USGS and individual stream flow measurements. Stream flow information has been collected at the Hayden Creek gaging station (USGS gaging station 1241600) near the East Fork and North Fork Hayden Creek confluence, which collected stream discharge information from 1948 through 1997.

Because there is not an extended stream discharge record for the Fish Creek watershed, stream discharge information collected at the Hayden Creek gaging station (1241600) was used to extrapolate stream discharge for Fish Creek. Recorded flow data for Fish Creek was compared to discharge data collected on Hayden Creek during the same days and projected throughout the annual hydrograph. Although this may not be the exact stream discharge for Fish Creek, it is representative of the annual hydrograph noted within northern Idaho (Figure E-A).

After determining the monthly flow average, the percentage of flow occurring during each month was calculated. The flow percentage for each month was then multiplied by the sediment load target and divided by the number of days in the month. The end result was a flow-based daily sediment load target, current load, and load reduction for Fish Creek.

Flows from April through June are the highest as are the target sediment loads. Flows in August and September are the lowest as are the target sediment loads. Figure E-B outlines the daily sediment load targets by month. By reducing the existing sediment load to the amounts listed below, it is expected that sediment will be reduced in sufficient quantities to support beneficial uses.

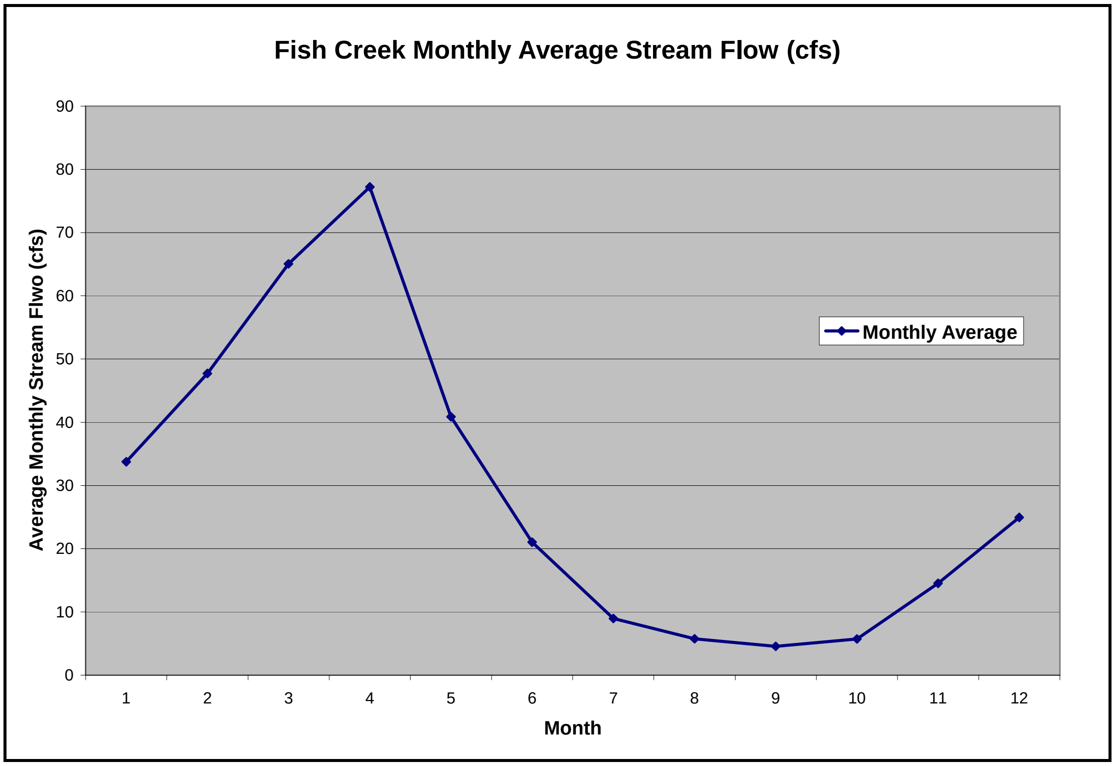


Figure F-A. Fish Creek monthly average stream flow (cfs).

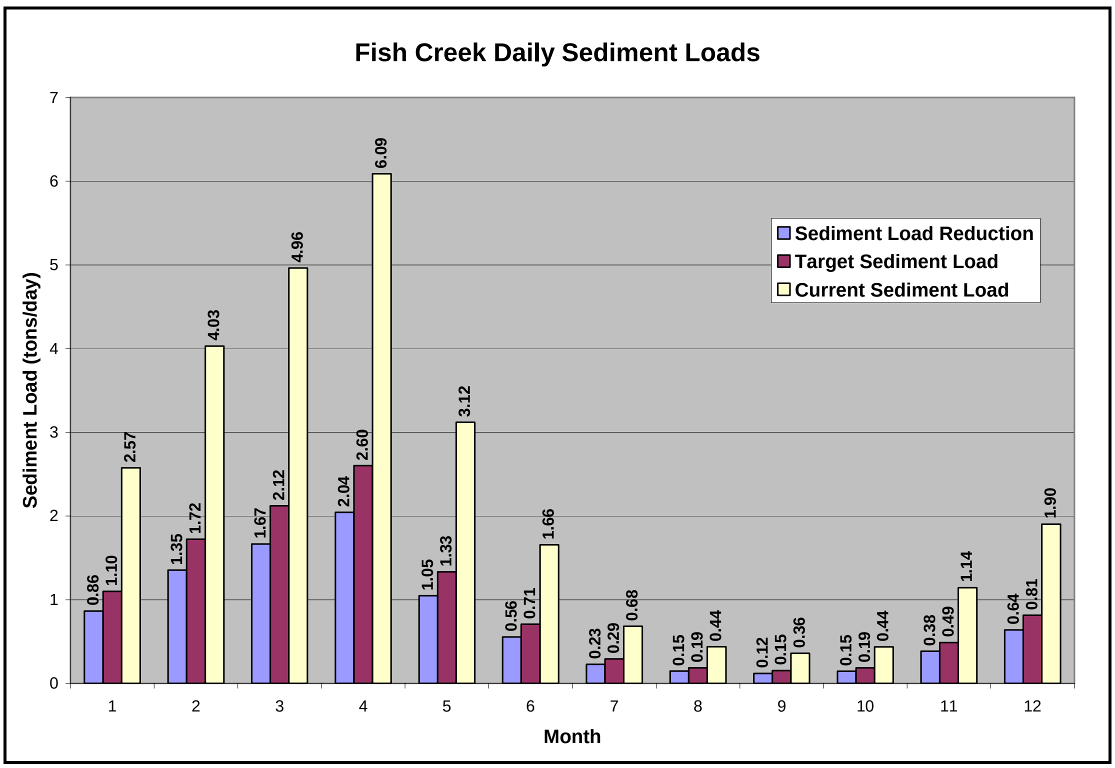


Figure F-B. Fish Creek daily sediment loads.

Appendix G. Daily Bacteria Loads

Daily Bacteria Load Targets

Recently the Idaho Department of Environmental Quality (DEQ) has had to reevaluate TMDL targets and adjust targets to reflect daily loads. Historically the DEQ has assigned loads and load reductions on a yearly basis, but recent guidance from the EPA has focused on assigning daily loads.

Estimated *E. coli* at load capacities, the amount of *E. coli* (cfu) allowable in a stream as to assure water quality standards are met, were calculated for Fish Creek. Flow data for this portion of the watershed was limited to information collected during BURP surveys and other data collection efforts. To estimate the *E. coli* at load capacity flow information from USGS gaging station 1241600, located on Hayden Creek was used to extrapolate flows for Fish Creek.

Estimated stream flows resemble the flow measurements made during BURP surveys. Flow is highly variable and can change greatly from year to year and season to season. During future evaluation of bacteria contamination in Fish Creek flow measurements should be taken during sample collection.

To determine the approximate daily bacteria load the Idaho water quality standard (IDAPA 58.01.02.251.01a) of 126 *E. coli* cfu/100ml was first converted to cubic feet. After calculating the amount of *E. coli* allowed per cubic foot of water (35,679 *E. coli* cfu/1 cubic foot as per IDAPA 58.01.02.251.01a) the estimated flow (cfs) was then multiplied by this amount. Because flow is recorded in seconds, the number calculated from the previous calculation was then multiplied by 86,400 seconds. See below for calculation details.

Converting Idaho Water Quality Standard to a daily load.

1 cubic foot = 28,316.85 milliliters

1 day = 86,400 seconds

28,316.85 milliliters / 100 milliliters = 283.1685 milliliters

126 E. coli (cfu) x 283.1685 milliliters = 35,679.231 E. coli (cfu)/1 cubic foot of water

Example January calculation for Fish Creek

35,679.231 E. coli (cfu) x 40.09 cfs x 86,400 seconds = 126,115,002,458.8 E. coli/day

Table G-1 contains the estimated flow (cfs) and *E. coli* (cfu) at load capacity for Fish Creek.

Table G-1. Fish Creek estimated flow and *E. coli* at load capacity (*E. coli* (cfu)/day).

Month	Estimated Flow (cfs)	*E. coli* (cfu) at load capacity per day
January	34	93,596,660,894
February	48	132,421,334,666
March	65	180,445,110,202
April	77	214,244,390,449
May	41	113,418,845,644
June	21	58,313,770,958
July	9	24,858,624,348
August	6	15,931,753,796
September	5	12,679,308,797
October	6	15,844,181,232
November	15	40,270,688,754
December	25	69,225,650,338

Figure G-1 represents estimated *E. coli* (cfu) at load capacity using the estimated stream discharge data from Appendix F.

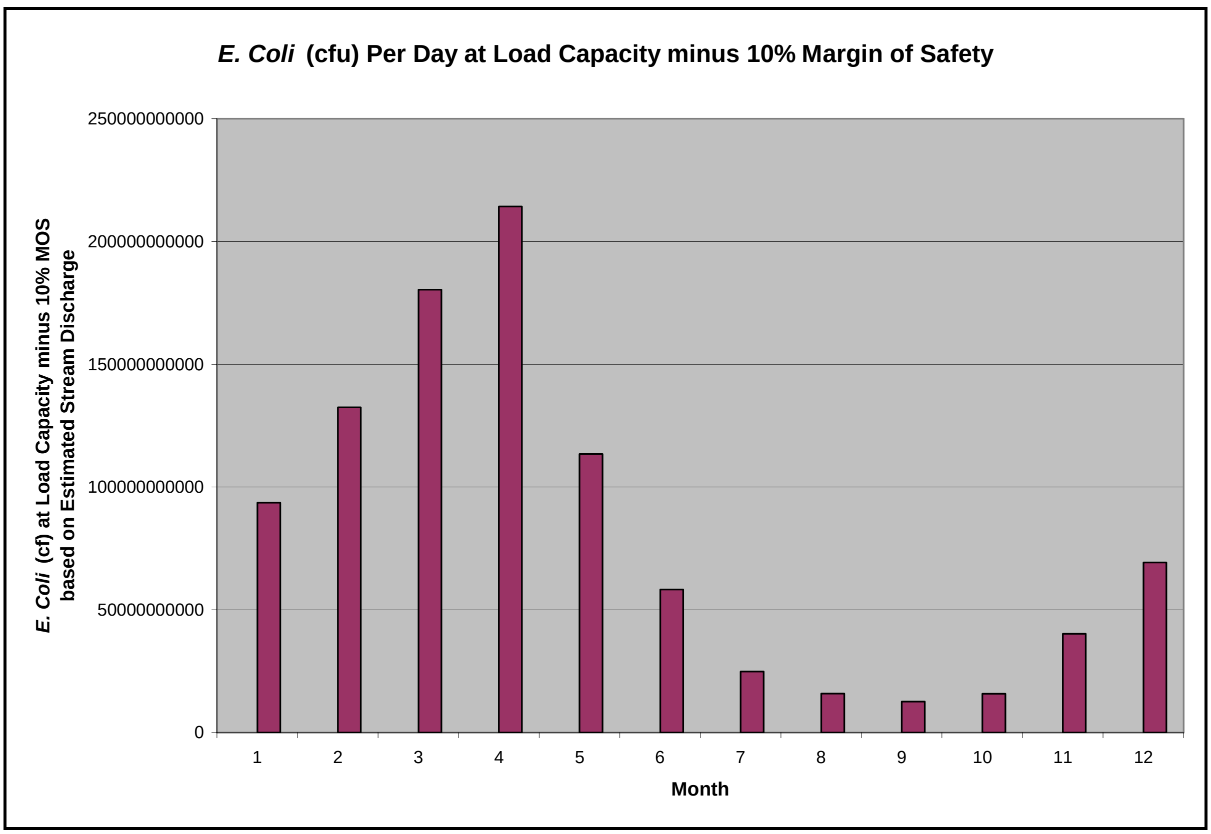


Figure G-1. Estimated Fish Creek *E. coli* (cfu) Per Day.

Appendix H. Distribution List

Copies of the final document will be provided to the Idaho Department of Environmental Quality state office, U.S. Environmental Protection Agency, and the Fish Creek Watershed Advisory Group participants.

Fish Creek Watershed Advisory Group Participants

Dennis Parent	Inland Empire Paper Company
Ron Fryzowski	Idaho Department of Lands
Gregg Durkee	Twin Lakes Homeowner's Association
John Sylte	Local Resident
Gordon Sylte	Local Resident
Mike Mihelich	Kootenai Environmental Alliance
Robert Flagor	Kootenai-Shoshone Soil and Water Conservation District
Dan and Sue Park	Local Resident and members of the Twin Lakes Water Board
Michael A. Nelson	Local Resident and president of the Twin Lakes Citizen Monitoring Program

Copies of the final document can be obtained by contacting the Idaho Department of Environmental Quality, Coeur d'Alene Regional Office, at:

2110 Ironwood Parkway

Coeur d'Alene, ID 83814

Phone: (208) 769-1422

Fax: (208) 769-1404

Appendix I. Public Comments

A thirty day public comment period was open from January 28, 2008 through February 27, 2008. During this period the document was viewable through the Idaho DEQ webpage, hardcopies of the document were provided to the Coeur d'Alene, Hayden, and Rathdrum Public Libraries, and copies were also available at the Idaho DEQ Coeur d'Alene Regional Office. Public notice of the public comment period were printed in the Spokesman Review and Coeur d'Alene Press newspapers on January 28, 2008. No comments were submitted to DEQ during the thirty day public comment period.