# BIG LOST RIVER WATERSHED SUBBASIN ASSESSMENT AND TMDL

**Final**

**Department of Environmental Quality**

**May 6, 2004**

# Big Lost River Subbasin Assessment and TMDL

**May 6, 2004**

**Prepared by:**
**Thomas Herron**
**Idaho Falls Regional Office**
**Department of Environmental Quality**
**900 N Skyline, Suite B**
**Idaho Falls, Idaho 83402**

## Acknowledgments

Acknowledgment goes to the Idaho National Environmental and Engineering Laboratory for supporting the Science Action Team to help with data collection. Special acknowledgment goes to Troy Blanford, Michael Jackson, Ron Rope and Chris Staley of the INEEL for organizing and implementing the Science Action Team. Particular appreciation goes to the students of Arco and Mackay High School who participated in the Science Action Team, and to Heather Ray and Dr. G. Wayne Minshall of Idaho State University for their interest and assistance with the Science Action Team and the Big Lost River in general. Acknowledgment goes to Bart Gamett of the Forest Service for providing fish sampling data and temperature data. Acknowledgment goes to Melissa Thompson of DEQ for help with fieldwork, and to Kimberly Ball of the University of Idaho for help with East Fork Big Lost fieldwork and for developing recurrence interval data. Also acknowledgment and appreciation to Troy Saffle of DEQ for administrative support.

# Table of Contents

## List of Tables

## List of Figures

# List of Appendices

# Abbreviations, Acronyms, and Symbols

| | |
|---|---|
| **§303(d)** | Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired waterbodies required by this section |
| **µ** | micro, one-one thousandth |
| **§** | Section (usually a section of federal or state rules or statutes) |
| **ADB** | assessment database |
| **AWS** | agricultural water supply |
| **BAG** | Basin Advisory Group |
| **BLM** | United States Bureau of Land Management |
| **BMP** | best management practice |
| **BOD** | biochemical oxygen demand |
| **BOR** | United States Bureau of Reclamation |
| **Btu** | British thermal unit |
| **BURP** | Beneficial Use Reconnaissance Program |
| **C** | Celsius |
| **cfu** | colony forming units |
| **CFR** | Code of Federal Regulations (refers to citations in the federal administrative rules) |
| **cfs** | cubic feet per second |
| **cm** | centimeters |
| **CWA** | Clean Water Act |
| **CWAL** | cold water aquatic life |
| **CWE** | cumulative watershed effects |
| **DEQ** | Department of Environmental Quality |
| **d** | day |
| **DO** | dissolved oxygen |
| **DOI** | U.S. Department of the Interior |
| **DWS** | domestic water supply |
| **EMAP** | Environmental Monitoring and Assessment Program |
| **EPA** | United States Environmental Protection Agency |
| **ESA** | Endangered Species Act |
| **F** | Fahrenheit |
| **FPA** | Idaho Forest Practices Act |
| **FWS** | U.S. Fish and Wildlife Service |
| **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

**IDWR** Idaho Department of Water Resources

**INFISH** The federal Inland Native Fish Strategy

**IRIS** Integrated Risk Information System

**km** kilometer

**km$^2$** square kilometer

**LA** load allocation

**LC** load capacity

**m** meter

**m$^3$** cubic meter

**mi** mile

**mi$^2$** square miles

**MBI** macroinvertebrate index

**MGD** million gallons per day

**mg/L** milligrams per liter

**mm** millimeter

**mo** month

**MOS** margin of safety

**MRCL** multiresolution land cover

**MWMT** maximum weekly maximum temperature

**n.a.** not applicable

**NA** not assessed

**NB** natural background

**nd** no data (data not available)

**NFS** not fully supporting

**NPDES** National Pollutant Discharge Elimination System

**NRCS** Natural Resources Conservation Service

**NTU** nephlometric turbidity unit

**ORV** off-road vehicle

**ORW** Outstanding Resource Water

**PACFISH** The federal Pacific Anadromous Fish Strategy

**PCR** primary contact recreation

**PFC** proper functioning condition

**ppm** part(s) per million

**QA** quality assurance

**QC** quality control

**RBP** rapid bioassessment protocol

**RDI** DEQ's river diatom index

**RFI** DEQ's river fish index

**RHCA** riparian habitat conservation area

**RMI** DEQ's river macroinvertebrate index

**RPI** DEQ's river physiochemical index

**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

**SRP** soluble reactive phosphorus

**SS** salmonid spawning
suspended sediment

**SSOC** stream segment of concern

**STATSGO** State Soil Geographic Database

**TDG** total dissolved gas

**TDS** total dissolved solids

**T&E** threatened and/or endangered species

**TIN** total inorganic nitrogen

**TKN** total Kjeldahl nitrogen

**TMDL** total maximum daily load

**TP** total phosphorus

**TS** total solids

**TSS** total suspended solids

**t/y** tons per year

**U.S.** United States

**U.S.C.** United States Code

**USDA** United States Department of Agriculture

**USDI** United States Department of the Interior

**USFS** United States Forest Service

**USGS** United States Geological Survey

**WAG** Watershed Advisory Group

**WBAG** *Waterbody Assessment Guidance*

**WBID** waterbody identification number

**WET** whole effluence toxicity

**WLA** wasteload allocation

**WQLS** water quality limited segment

**WQMP** water quality management plan

**WQRP** water quality restoration plan

**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 waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., waterbodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the waterbodies in the Big Lost River Subbasin that have been placed on what is known as the "§303(d) list."

This subbasin assessment and TMDL analysis has been developed to comply with Idaho's TMDL schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Big Lost River Subbasin located in south central Idaho (Figure A). The first part of this document, the subbasin assessment, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited waterbodies. Nine segments of the Big Lost River Subbasin were listed on this list. The subbasin assessment portion of this document examines the current status of §303(d) listed waters (Table A), and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

### Subbasin at a Glance

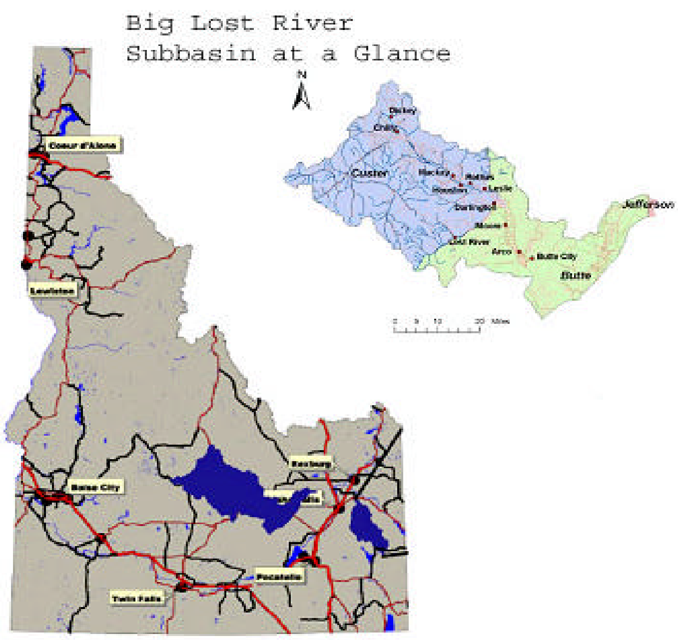


**Figure A. Big Lost River Subbasin**

**Table A. 303(d) listed waters in the Big Lost River Watershed**

| Waterbody Name | Segment ID Number | 1998 §303(d)[1] Boundaries | Pollutants | Listing Basis |
|---|---|---|---|---|
| Big Lost River | 2161 | Moore Diversion to Hwy 20 | Low Oxygen, Flow Alteration, Excess Nutrients, Excess Sediment, Elevated Temperature | Low SMI, SFI, and SHI scores |
| Big Lost River | 2164 | Chilly Buttes to Mackay Reservoir | Nutrients, Sediment | Low SMI, SFI, and SHI scores |
| Spring Creek | 2167 | Springs to Big Lost River | Dissolved Oxygen, Flow Alteration, Nutrients, Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Antelope Creek | 2168 | Spring Creek to Big Lost River | Flow Alteration, Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Twin Bridges Creek | 2176 | Headwaters to Big Lost River | Nutrients, Sediment | Low SMI, SFI, and SHI scores |
| East Fork Big Lost River | 2179 | Starhope Creek to Forks | Habitat Alteration | Low SMI, SFI, and SHI scores |
| East Fork Big Lost River | 2180 | Headwaters to Starhope Creek | Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Little Boone Creek | 5236 | Headwaters to East Fork Big Lost River | Undetermined Pollutants | Low SMI, SFI, and SHI scores |
| Warm Springs Creek | 5237 | (Hamilton) Spring to Mackay Reservoir | Undetermined Pollutants | Low SMI, SFI, and SHI scores |

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

The Big Lost River subbasin of south central Idaho is a watershed isolated from surface connection with the Snake River in Idaho. The Big Lost River watershed is one of four watersheds known in central Idaho as the Sinks Drainages. Surface flow that is not utilized for irrigation sinks, or infiltrates, to groundwater that is conducted in a southwest direction toward the Thousand Springs reach of the Snake River near Hagerman, Idaho where spring flow emerges.

Native fish populations, water quality, and riparian habitat conditions are issues of concern in the subbasin. The cumulative effects of irrigation diversion, alteration of vegetation by grazing in riparian areas, human-caused stream alterations, historic mining practices, roads, residential and municipal development, and past timber harvest have combined to impact water quality and aquatic life in the watershed.

The level of impact is important within the TMDL framework; has beneficial use support been reduced to the point that streams do not support beneficial uses including salmonid spawning or coldwater aquatic life or are these beneficial uses supported at levels that do not require restorative action through a TMDL. If numeric water quality standards are not met then the level of beneficial use support is not factored into determining whether or not a TMDL is required. The issue is not restoration of beneficial uses, but compliance with numeric water quality standards. Production and survival of aquatic species may be limited in some waters but not to the extent that a TMDL is required.

Rainbow trout, cutthroat trout, and brook trout have been documented in the watershed. There is uncertainty as to which, if any species are native to the watershed, however it is felt by some, and not by others that cutthroat trout, mountain whitefish, and bull trout are native. Others feel that only mountain whitefish are native.

Designated Beneficial Uses are listed in Idaho Water Quality Standards for The Big Lost River and include cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, domestic water supply, and special resource water. Undesignated uses within the Big Lost River Watershed are implied to be supported and are not specifically listed in the State water quality standards. Undesignated beneficial uses include cold water aquatic life and primary and secondary contact recreation for the remainder of the watershed with perennial flow above 1 cfs.

Limited biological assessments at discrete locations conducted by the Idaho Department of Environmental Quality (DEQ) have shown that several streams in the subbasin are water quality limited. Elevated water temperature prevents some streams from meeting water quality standards, and is the primary nonpoint source pollutant of concern. A number of streams that are on the 303(d) list for sediment impairment show full support for salmonid spawning, and cold water aquatic life support status has not been adequately determined through the Beneficial Use Reconnaissance Program (BURP) sampling. Where these streams exceed water quality standards for temperature TMDLs for temperature and sediment have been prepared because the two pollutants are closely related.

Discharge of settleable solids above levels specified in NPDES permits is a specific concern along with temperature exceedence on Warm Springs Creek. Natural and anthropogenic (man-caused) flow alteration has also been identified as the primary source of perturbation in the main Big Lost River subbasin from Chilly Buttes to Mackay Reservoir, and from the Moore Diversion to US Highway 20/26 at Arco, Idaho.

Data has been collected and analyzed to evaluate the water quality limiting issues on the §303(d) list of water quality impaired streams and a number of nonlisted streams within the Big Lost

River watershed. Existing data submitted to DEQ in adequate time for evaluation was also used to assess water quality.

Three wasteload allocations were prepared for point source discharges within the Big Lost River subbasin. Two hatcheries on Warm Springs Creek received four waste load allocations that reduce discharge of settleable solids from their effluent and allocate effluent temperatures to not exceed water quality standards. The City of Mackay receives a waste load allocation that reflects the draft NPDES permit for discharge from the Waste Treatment Facility that is currently under review.

Twelve Total Maximum Daily Loads (TMDLs) have been developed to address issues of temperature exceedence of water quality standards on eleven streams (two segments on Antelope Creek). Sediment TMDLs have been prepared for the streams with temperature exceedence with the exception of Warm Springs Creek and the main Big Lost River from its origin at the confluence of the North and East Forks of the Big Lost River to Chilly Buttes. Warm Springs Creek is covered under the Waste Load Allocation and has a temperature TMDL. Sediment TMDLs were prepared for two additional streams that did not have sufficient temperature date to determine a TMDL for thermal loading; Twin Bridges Creek and Thousand Springs Creek. Table B provides a summary of the TMDLs developed for the Big Lost River subbasin.

**Table B. Streams and pollutants for which TMDLs were developed.**

| Stream | TMDL Pollutant(s) |
|---|---|
| East Fork Big Lost River | Sediment, Temperature |
| Corral Creek (East Fork Big Lost tributary) | Sediment, Temperature |
| Starhope Creek | Sediment, Temperature |
| Wildhorse Creek | Sediment, Temperature |
| North Fork Big Lost River | Sediment, Temperature |
| Summit Creek | Sediment, Temperature |
| Big Lost River: Source to Chilly Buttes | Temperature |
| Twin Bridges Creek | Sediment |
| Thousand Springs Creek | Sediment |
| Warm Springs Creek | Temperature |
| Antelope Creek | Sediment, Temperature |
| Bear Creek | Sediment, Temperature |
| Cherry Creek | Sediment, Temperature |

TMDLs for sediment are quantified through streambank erosion inventories. Sediment loading targets were developed based on the assumption that 80% streambank stability is an attainable natural condition described in frequency distributions developed in central Idaho by land management agencies. This is a conservative assumption and gives a margin of safety adequate to assure adequate sediment reduction and channel geometry that reduces thermal loading. Irrigation return flow to surface waters was not identified as a significant source of sediment because there is little flow that returns to surface waters. Hill slope erosion is assumed to be within the range of natural background in relation to affected streams. Sediment loading from irrigated cropland does not occur in areas where sediment loads are identified as limiting beneficial use support or is not identified as a significant source of sediment in relation to the impact of flow alteration. In the language of Anti-Degradation legislation the allocation becomes the current load.

Targets for substrate sediment are adopted from land management agency targets derived from goals established in monitoring plans intended to guide management of public lands to improve salmonid egg and fry survival. Target values established in this assessment will be used to indicate trends related to channel morphology and streambank recovery. Beneficial use support status and compliance with state water quality standards will be used to determine the need for additional best management practices to improve water quality.

Temperature TMDLs have been developed for streams where temperature data has been collected and shows exceedence of temperature criteria in greater than 10% of observation days during spring or fall spawning periods. Thermograph data established that temperature TMDLs were necessary to meet the numeric salmonid spawning criteria [IDAPA 58.01.02.250(02)]. Temperature TMDL load reductions were developed by quantifying the maximum temperature exceedence for data collected during spring and fall spawning periods and subtracting that from the spawning temperature criteria to formulate the load reduction (allocation). The margin of safety factored into temperature TMDLs is implicit because the highest temperature recorded is the basis for the TMDL. Table B also summarizes the streams that have had temperature TMDLs developed.

Sediment TMDLs are intended to support a reduction in temperature loading and are based on 80% streambank stability. This proportion of streambank stability is assumed to be at average natural background conditions and would result in improved channel geometry and riparian vegetation to reduce sediment and thermal loading. Cold water aquatic life and salmonid spawning are expected to be fully supported at 80% streambank stability within the watershed. The margin of safety for sediment TMDLs is implicit.

Instream sediment targets have been identified from literature values that are supportive of salmonid spawning and cold water aquatic life. These target values are set at 28% fine sediment less than 6.35 mm (1/4 in.) in diameter in spawning habitat. Monitoring of instream sediment targets over the implementation period will be used to track the effectiveness of management practices and may be used to indicate the need for additional or more effective best management practices to improve water quality in the Big Lost River subbasin.

Reduced riparian vegetation contributes to accelerated streambank erosion, which results in increased sediment and thermal loading which, combined with associated changes in channel morphology due to sediment deposition, are the primary causes of temperature loading in affected streams.

Streams listed as having altered flow have been determined to be flow altered for significant periods of the year. Altered flow is not a pollutant as defined by the Clean Water Act (CWA) Section 502(6). Since TMDLs are not required to be established for waterbodies impaired by effects other than pollutants, TMDLs will not be developed for flow-altered streams. They will be listed in categories on the Integrated Report that reflect that they are primarily affected by flow alteration.

There are nine 303(d)-listed stream segments on 6 waters in the Big Lost River subbasin. Below is a tabular description of the issues related to the listed stream segments and the disposition of that stream segment according to categories described in the 2002 Water Body Assessment Guidance for Idaho (Table B).

A summary of temperature TMDL load reductions is shown in Table C. Elevated stream temperature is tied to streambank erosion related to reduction in density diversity and vigor of riparian vegetation. The load reduction is based on the highest observed temperature exceedence during the salmonid spawning period. The exceedence used could have occurred during the spring or fall spawning period. Only two accumulated days data during this period is required to establish a minor exceedence of water quality criteria.

**Table C. Summary of assessment outcomes for listed streams and TMDL streams in the Big Lost River subbasin.**

| Waterbody Segment | Assessment Unit of HUC 17040218 | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List | Justification |
|---|---|---|---|---|---|
| Big Lost River (WQLS 2161) Moore Diversion to Hwy 20/26 | SK002 | Low Oxygen, Flow Alteration, Excess Nutrients, Excess Sediment, Elevated Temperature | No | List for Flow Alteration, remove from list for other pollutants | Flow Altered (Natural and Anthropogenic) |
| Big Lost River (WQLS 2164) Chilly Buttes to Mackay Reservoir | SK015 | Excess Nutrients, Excess Sediment | No | List for Flow Alteration, remove from list for other pollutants | Flow Altered (Natural and Anthropogenic |
| Spring Creek (WQLS 2167) Springs to Big Lost River | SK003 | Dissolved Oxygen, Flow Alteration, Nutrients, Sediment, Temperature | No | List for Flow Alteration, remove from list for other pollutants | Flow Altered (Natural and Anthropogenic |
| Antelope Creek (WQLS 2168) Spring Creek to Big Lost River | SK046 | Flow Alteration, Sediment, Temperature | Yes: Sediment, Temperature | List for Flow Alteration from Lower Diversion to Big Lost River, list for sediment and temperature from Forest Boundary to Lower Diversion | TMDL Developed |

| | | | | | |
|---|---|---|---|---|---|
| Twin Bridges Creek (WQLS 2168) Headwaters to Big Lost River | SK026_03 | Nutrients, Sediment | Yes: Sediment | List for sediment remove from list for other pollutants | TMDL Developed |
| East Fork Big Lost (WQLS 2180) Headwaters to Cabin Creek | SK039 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| East Fork Big Lost (WQLS 2179) Cabin Creek to Mouth | SK033 | Habitat Alteration | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| Little Boone Creek (WQLS 5236) Headwaters to East Fork Big Lost | SK033_02 | Undetermined Pollutants | No | Listed in error. Remove from list: flow less than 1 cfs | Flow Altered (Natural and Anthropogenic) |
| Lead Belt Creek (WBID US58) Source to Antelope Creek | SK058 | Temperature | No | Listed in error. Remove from list: flow less than 1 cfs | Flow Altered (Natural and Anthropogenic) |
| Warm Springs Creek (WQLS 5237) Hamilton Spring to Mackay Reservoir | SK043 | Undetermined Pollutants | Yes: Temperature, NPDES Waste Load Allocation | List for temperature | TMDL Developed |
| Big Lost River (WBID US24) Forks to Chilly Buttes | SK024 | Temperature | Yes: Temperature | List for temperature | TMDL Developed |
| Thousand Springs Creek (WBID US16) Chilly Slough to Big Lost River | SK016 | Sediment | Yes: Sediment | List for sediment | TMDL Developed |
| Corral Creek (WBID US41) Coyote Creek to East Fork Big Lost River | SK041 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| North Fork Big Lost River (WBID US27) Zipper Creek to Forks | SK027 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |

| | | | | | |
|---|---|---|---|---|---|
| Summit Creek (WBID US28) Phi Kappa Creek to Mouth | SK028 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| Bear Creek (WBID US53) Right Fork to Mouth | SK053 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| Cherry Creek (WBID US49) Forest Boundary to Mouth | SK049 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| Starhope Creek (WBID US35) Muldoon Creek to East Fork Big Lost | SK035 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |
| Wildhorse Creek (WBID US30) Fall Creek to Mouth | SK030 | Sediment, Temperature | Yes: Sediment, Temperature | List for sediment and temperature | TMDL Developed |

An exceedence of 10% of observation days is required to constitute a major exceedence. A summary of sediment load reductions in support of temperature TMDLs is shown in Table D. Load reductions are derived from the current load estimation taken from the expected sediment load that would occur at approximately 80% streambank stability. Where negative numbers appear, as in the case of Warm Springs Creek, over 80% streambank stability is estimated. Warm Springs Creek is covered under a wasteload allocation as a point source operating under an NPDES permit issued by EPA. Where erosion rates were calculated based on multiple samples the Existing Erosion Rate and Total Erosion Rate show Composite in Table D.

## Table D. Temperature TMDL load reductions for streams in the Big Lost River Watershed.

| Stream | Temperature Statistic | Highest Recorded Temperature (Current Load) | Criteria (Loading Capacity) | Load Reduction (Degrees C) | % Reduction |
|---|---|---|---|---|---|
| East Fork Big Lost River | Max Daily | 21.3 | 13°C | -8.3 | 39.0 |
| | Daily Ave | 15.2 | 9°C | -6.2 | 40.8 |
| Corral Creek | Max Daily | 21.7 | 13°C | -8.7 | 40.1 |
| | Daily Ave | 14.39 | 9°C | -5.39 | 37.5 |
| Starhope Creek | Max Daily | 20.6 | 13°C | -7.6 | 36.9 |
| | Daily Ave | 13.6 | 9°C | -4.6 | 33.8 |
| Wildhorse Creek | Max Daily | 16.7 | 13°C | -3.7 | 22.2 |
| | Daily Ave | 11.33 | 9°C | -2.33 | 20.6 |
| North Fork Big Lost River | Max Daily | 19 | 13°C | -6 | 31.6 |
| | Daily Ave | 12.92 | 9°C | -3.92 | 30.3 |
| Summit Creek | Max Daily | 17.8 | 13°C | -4.8 | 27.0 |
| | Daily Ave | 11.6 | 9°C | -2.6 | 22.4 |
| Big Lost River at Howell Ranch | Max Daily | 14.6 | 13°C | -1.6 | 11.0 |
| | Daily Ave | 11.1 | 9°C | -2.1 | 18.9 |
| Warm Springs Creek | Max Daily | 20.9 | 13°C | -7.9 | 37.8 |
| | Daily Ave | 14.5 | 9°C | -5.5 | 37.9 |
| Antelope Creek at Forest Boundary | Max Daily | 19 | 13°C | -6 | 31.6 |
| | Daily Ave | 13.86 | 9°C | -4.86 | 35.1 |
| Antelope Creek at Diversion | Max Daily | 23.2 | 13°C | -10.2 | 44.0 |
| | Daily Ave | 15.1 | 9°C | -6.1 | 40.4 |
| Cherry Creek | Max Daily | 18.68 | 13°C | -5.68 | 30.4 |
| | Daily Ave | 16.47 | 9°C | -7.47 | 45.4 |
| Bear Creek | Max Daily | 19.4 | 13°C | -6.4 | 33.0 |
| | Daily Ave | 14.15 | 9°C | -5.15 | 36.4 |

## Table E. Erosion load allocations for Big Lost River subbasin.

| Stream | Estimated Current Load | | Load Capacity/Load Allocation | | Reductions | | |
|---|---|---|---|---|---|---|---|
| | Existing Erosion Rate (t/mi/yr.) | Total Erosion (t/yr.) | Erosion Rate (t/mi/yr.) | Total Erosion (t/yr.) | Total Erosion Reduction (t/yr.) | Total Erosion Rate Reduction (t/mi/yr.) | Total Erosion % Reduction to Meet Load Capacity |
| **East Fork Big Lost River** | Composite | 1218 | --- | 172 | 1046 | Composite | 85.9 |
| **Corral Creek** | 36 | 250 | 6.0 | 39 | 211 | 30 | 84.4 |
| **Starhope Creek** | 26 | 249 | 7.0 | 69.0 | 180 | 19 | 72.3 |
| **Wildhorse Creek** | 21 | 103 | 6.0 | 28.5 | 74.5 | 15 | 72.3 |
| **North Fork Big Lost River** | Composite | 285 | --- | 54.3 | 230.7 | Composite | 80.9 |
| **Summit Creek** | 11 | 45 | 4 | 14.0 | 31 | 7 | 68.9 |
| **Twin Bridges Creek** | 115 | 536 | 7 | 33.1 | 502.9 | 108 | 93.8 |
| **Thousand Springs Creek** | 10 | 13 | 3 | 3.5 | 9.5 | 7 | 73.1 |
| **Warm Springs Creek** | Composite | 12.8 | --- | 26.6 | -13.8 | Composite | -107.8 |
| **Antelope Creek** | Composite | 888 | --- | 118 | 770 | Composite | 86.7 |
| **Bear Creek** | 11 | 52 | 4.0 | 17.0 | 35 | 7 | 67.3 |
| **Cherry Creek** | Composite | 156 | --- | 53.2 | 102.8 | Composite | 65.9 |

# 1. Subbasin Assessment – Watershed Characterization

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

The overall purpose of this subbasin assessment and TMDL is to characterize and document pollutant loads within the Big Lost River Subbasin. The first portion of this document, the subbasin assessment, 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 (Chapters 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Big Lost River Subbasin (Chapter 5).

## 1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "Swimable 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, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the waterbodies to meet their designated uses. These requirements result in a list of impaired waters, called the "§303(d) list." This list describes waterbodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for waterbodies on the §303(d) list. The *Big Lost River Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the Big Lost River Subbasin.

The subbasin assessment section of this report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in Big Lost River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a waterbody and still allow that waterbody to meet water quality standards (Water quality planning and management, 40 CFR 130). Consequently, a TMDL is waterbody- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." TMDLs are not required for waterbodies impaired by pollution, but not specific pollutants. 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 waterbodies and/or pollutants within a given watershed.

### 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 waterbody 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 waterbodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

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

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

A subbasin assessment entails analyzing and integrating multiple types of waterbody data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the waterbody (i.e., attaining or not attaining water quality standards).

- Determine the degree of achievement of biological integrity.

- Compile descriptive information about the waterbody, particularly the identity and location of pollutant sources.

- When waterbodies are not attaining water quality standards, determine the causes and extent of the impairment.

## 1.2 Physical and Biological Characteristics

### Setting and Topography

The topography of southern Idaho is varied and dramatic. The fundamental reasons for this diversity are geological: the recency of volcanism and uplift of ranges along normal faults. This rough topography reflects a complex geologic past.

The Big Lost River Watershed is the western-most of the local Central Valleys watersheds that collectively make up the Sinks Drainages. The Little Lost River, Birch Creek, Medicine Lodge Creek, and Beaver-Camas respectively, are located to the east and make up the remaining watersheds of the Sinks Drainages. These watersheds are contained within the Basin and Range province, which occupies a small area of southern Idaho between the Middle Rocky Mountains and the Snake River Plain, west of the northern bound of the Central Rocky Mountains. These are the watersheds that disappear into valley fill material of the longitudinal valleys formed by the Pioneer Range, White Knob Mountains, Lost River Range, Lemhi Range, and the Beaverhead Range of the Basin and Range province.

The Big Lost River Watershed drains an area of 4835 $km^2$ (1867 $mi^2$) bounded by the Pioneer Mountains to the west and south, the Boulder Mountains in the northwest, and the Salmon River Mountains to the north. The White Knob Range in the central and south- central watershed and the Lost River Range to the East complete the mountainous enclosure.

The Big Lost River gets its name because it naturally sinks into the Snake River Plain before it has a confluence with any other river. During average hydrologic years it disappears north of Arco, Idaho, before it reaches the Snake River Plain. During high precipitation years it flows past Arco, Idaho onto the Idaho National Engineering and Environmental Laboratory (INEEL) where it sinks into what are locally known as The Playas, east of Arco.

The Big Lost River watershed lies on the northern edge of the Snake River Plain. The Snake River Plain was formed by the Yellowstone Hot Spot. This is an ancient system of volcanic formations resulting from the North American Plate moving southwest over a stationary-melting anomaly in the earth's mantle commonly referred to as the Yellowstone Hot Spot.

The Hot Spot is characterized by high topography, related to high subsurface heat flow and volcanic activity. The melting anomaly in the mantle results in the inflation, or elevation of the earth's crust, which produces the Continental Divide and also produces other features important to the surrounding hydrology such as active fault zones, earthquakes, and hot springs (Link 2003). In the wake of the Hot Spot is a path of subsided/deflated terrain that forms the Snake River Plain. This subsidence was due to cooling of the crust and the volcanic infusion of heavy material into the lower and middle crust, resulting in sinking of the Plain relative to the surrounding topography.

As the North American Plate migrated over the Hot Spot the surface hydrology radiated away from the area of the melting anomaly. This can be seen today in the present day location of the Hot Spot in the Yellowstone area. The location of the Hot Spot approximately 6.5 to 10 million years ago would have caused the waters of the Central Valleys, including the Big Lost River, to drain northward into the historic Salmon River drainage. This relationship may have caused the Big Lost to drain into the ancestral Salmon River drainage. The Little Lost would have flowed into the ancestral Pahsimeroi subwatershed, and Birch Creek would have flowed into the ancestral Lemhi watershed. In the wake of the Hot Spot the topography subsided, or deflated, changing the predominant valley slope aspect from north to south and the adjacent Central Valley drainages were captured. The flow from the captured drainages changed to the south, toward the Snake River Plain, isolating the drainages from the ancestral Salmon River creating what we know today as the Sinks Drainages (Link 2003).

Approximately 6,000 years ago a wetter climate prevailed in this region and in conjunction with glacial melt off and higher average precipitation, lakes were present in troughs that resulted from the subsidence of the earth's crust. Lake Terreton formed in what is known as the Big Lost Trough. It received the flow of the Big and Little Lost Rivers. Mud Lake formed in the Mud Lake Basin and received flow from Birch, Medicine Lodge and Camas Creek. During flood years the lakes were likely connected with the headwaters of the ancestral Henry's Fork of the Snake River. These connections between the various surface waters of the region could have been the mechanism that inoculated the Sinks Drainages with fish as recently as 5,000 to 6,000 years ago. Today, due to dryer conditions, all that remains of these lakes are the ephemeral playa systems that can be seen from the air over the northern Snake River Plain. The Playas, or lakebeds, as they exist today have been essentially unchanged for approximately 1,000 years (Link 2003).

Volcanic Rift Zones developed when lava flowed down along the axis of the longitudinal valleys of the Big Lost and Little Lost Rivers into the basins in the Snake River Plain that eliminated the connectivity between the trough lakes. The Rift Zones are the linear features that are oriented north to south along the normal faults that form their respective valleys. To the south of the Volcanic Rift Zones are rhyolitic domes that form the buttes that are prominent in the Snake River Plain south of the Lost Rivers. These rhyolitic domes squeezed up through the basaltic lava flows along a feature called the axial volcanic high. The axial volcanic high is 1 million years old, and separates the Sinks drainages from the Snake River Plain and subsequently the Snake River.

The eastern watershed is bounded by the Lost River Range, which run north to south. Elevations of the Lost River Mountains range from 1944m (6260 ft) at the Thousand Springs Sinks to 3859 m (12662 ft) at the pinnacle of Mt Borah, the highest point in Idaho. Much of the Lost River Range is over 3352 m.

The northern watershed boundary is within the southern extreme of the Salmon River Mountains and the Boulder Mountains where the North Fork of the Big Lost River has its origin. Elevations range from 3570 m (11,714 ft) on Ryan Peak to 2088 m (6,850 ft) at the confluence with the East Fork of the Big Lost River. The Pioneer Mountains form the western watershed boundary. Elevation here ranges from 3660 m (12008 ft) on Hyndman Peak to 2088 m (6,850 ft) at the confluence with the East Fork of the Big Lost River.

## Climate

The Valley bottom of the Big Lost River watershed can be characterized as a high desert. Average annual precipitation is less than 10" per year over much of the valley. Winters are long and cold while summers are brief and hot. Precipitation rises in the surrounding mountains to 25 inches or more, falling mostly as snow. Periodic heavy thunderstorms are not uncommon during June and July. Average annual temperature and precipitation is summarized in Table 1. Precipitation, temperature and accumulated precipitation are summarized for the Lost River Wood River watershed divide Snotel monitoring Site from 1996 through 2003 in Figure 1. A general decrease in precipitation is seen since 1996 in the Big Lost River watershed. The nearest high elevation climate monitoring is Galena, Idaho, and this station is assumed to be representative of the higher elevations in the watershed.

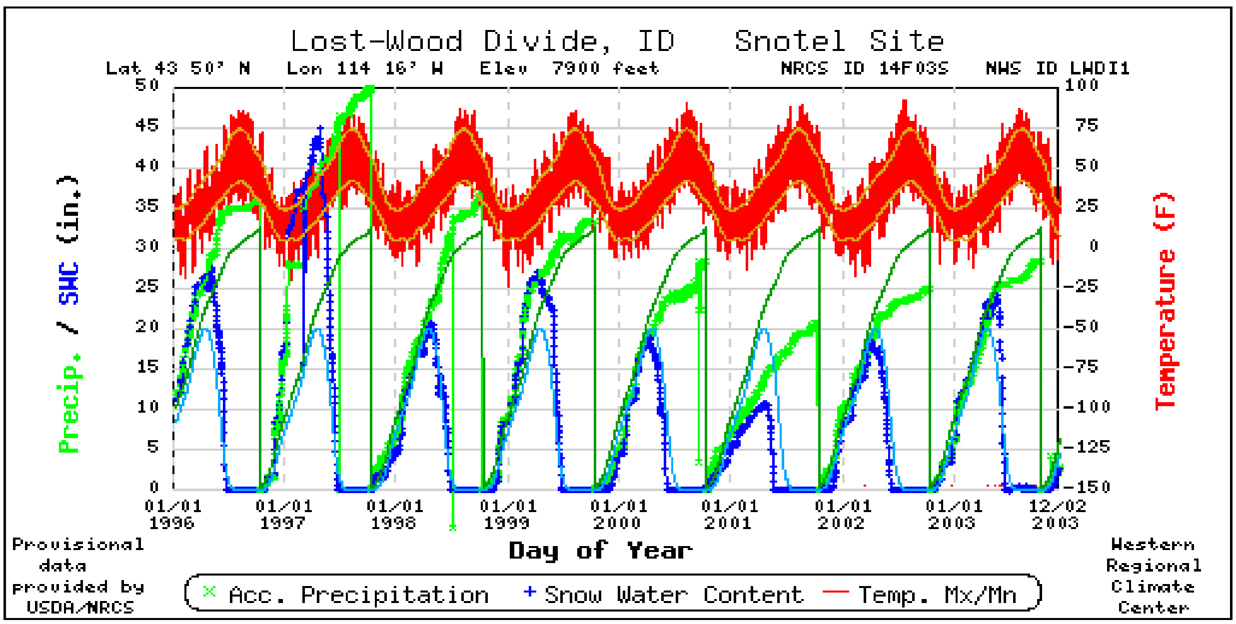


**Figure 1. Precipitation summary for the Lost-Wood divide monitoring location**

**Table 1. Annual climate summary for stations in, or near the Big Lost River watershed with range of daily extremes.**

| Location (elevation) | Galena (7300 ft.) | Chilly (6200 ft.) | Grouse (6110 ft.) | Mackay (6,000 ft.) | Arco (5330 ft.) |
|---|---|---|---|---|---|
| Average Annual Maximum Temperature | 51.3 F (Range 98º F to 38º F) | 54.5 (Range 95º F to 40º F) | 53.6 (Range 95º F to 38º F) | 54.4 (Range 96º F to 35º F) | 57.3 (Range 103º F to 40º F) |
| Average Annual Minimum Temperature | 18.6 (Range 32º F to -40º F) | 23.6 (Range 36º F to -42º F) | 20.6 (Range 32º F to -42º F) | 27.9 (Range 36º F to -35º F) | 27.1 (Range 42º F to -45º F) |
| Average Annual Total Precipitation | 24.74 Daily Range 0 to 2.75in.) | 8.27 Daily Range 0 to 2.15in.) | 12.75 Daily Range 0 to 1.9in.) | 10.07 Daily Range 0 to 1.7in.) | 9.76 Daily Range 0 to 2.4in.) |
| Average Annual Total Snowfall | 182.8 Daily Range 0 to 25in.) | 19.0 Daily Range 0 to 12 in.) | 61.4 Daily Range 0 to 20in.) | 32.9 Daily Range 0 to 14in.) | 31.3 Daily Range 0 to 25in.) |
| Average Annual Snow Depth (in.) | 17 Daily Range 0 to 122in.) | 0 Daily Range 0 to 20 in. | 4 Daily Range 0 to 42in.) | 1 Daily Range 0 to 37in.) | 1 Daily Range 0 to 37in.) |

## Subbasin Characteristics

### Hydrography/Hydrology

The Big Lost River, the largest stream in the subbasin, flows toward the northeast from the confluence of the two largest tributaries: the East Fork and North Fork Big Lost Rivers (known as The Forks). Thus the Big Lost River begins at the confluence of the East Fork and North Fork Big Lost Rivers, about 11 miles southwest of Chilly Buttes.

At the base of the Lost River Range, about 2 miles east of Chilly Buttes, the River flows to the southeast within the longitudinal valley formed between the Lost River Range and the White Knob Range. The River course continues southeast until it reaches the axial volcanic high described above, where it arcs to the east and then northeast to where it sinks into the northern edge of the Snake River Plain about 6 miles east of Howe, Idaho.

The headwaters of the East Fork Big Lost River are located in the southwest corner of the subbasin in Copper Basin. Copper Basin lies between the Pioneer Range and the White Knob Range. The East Fork Big Lost River flows northwestward to its confluence with the North Fork Big Lost River. Major tributaries to the East Fork of the Big Lost River include Star Hope Creek, and Wild Horse Creek.

The Headwaters of the North Fork Big Lost River are located in the northwest corner of the subbasin along the watershed divide with the East Fork Salmon River. The headwaters of the North Fork form in the southern bound of the Boulder Mountains and Salmon River Mountains and the northern bound of the Pioneer Mountains. The flow is predominantly eastward to its confluence with its major tributary, Summit Creek, and subsequently the East Fork of the Big Lost River.

As the Big Lost River passes the Chilly Buttes it looses its flow to irrigation diversions and infiltration into the substrate. After spring snowmelt the river is often dry between Chilly Buttes and Mackay Reservoir except for isolated pools and scant inflow from Thousand Springs.

Recent work has determined that the Big Lost River flooded one or more times, carrying boulders from the Copper Basin area all the way to the Snake River Plain at Box Canyon south of Arco (Rathburn, 1993). The last of these floods occurred about 16,000 years ago, at the same time as the Lake Missoula floods in northern Idaho and over two thousand years before the Lake Bonneville Flood in southern Idaho (O'Connor, 1992, 1993). Such Pleistocene floods are part of the mythology of cultures from around the world.

### Geology

The Pioneer Mountain Range is situated in the southeastern quadrant of the watershed. This is a roughly circular mountain range consisting of many low foothills and a rugged high core of peaks built of hard igneous and metamorphic rocks. The highest peak in the Pioneers is 12,009-foot Hyndman Peak. There are many other summits well over 11,000 feet in elevation including Old Hyndman, Cobb, and the Devil's Bedstead.

The Pioneer Mountain foothills rise directly out of the vast basalt-covered Snake River Plain to the south. The Pioneers lie between the Big Wood River Valley to their west (Hailey, Ketchum), the headwaters of the Big Lost River on their east, and Summit Creek/Trail Creek on their north. Despite the heavy snow and great variations in elevation, there is very little timber in these mountains.

The Pioneer Mountains are the oldest mountains of the watershed. The core of the Pioneers is Paleoproterozoic gneiss west of Copper Basin. Above the gneiss are Proterozoic and Paleozoic metasedimentary rocks, all intruded by an Eocene pluton. The core complex is uplifted on the Wildhorse detachment fault, which forms a domal pattern and which moved from Eocene until Oligocene time. There is thick Lower Paleozoic black shales, such as the Devonian Milligen formation, which occupies much of the low country east and west of the Wood River Valley (Link, 1989).

At the same time as the Challis volcanic rocks were erupted, the Pioneer Mountains metamorphic core complex was rising. Low-angle extensional and strike-slip faults formed in the Boulder and Pioneer Mountains northeast of Ketchum. The general sequence of events was: 1) Cretaceous intrusion ending by 70 million years ago; 2) formation of northwest-striking high angle faults as well as low-angle oblique-slip faults, ending about 45(?) million years ago; this faulting stripped sedimentary cover from the Pioneer Mountains; 3) volcanic activity of the Challis volcanic episode and faulting of the northeast-striking Trans Challis fault system; intrusion of the Summit Creek stock in the core of the Pioneer Mountains at about 48 million years ago; 4) intrusion of late-stage granite plutons (Sawtooth, Boulder, Pioneer and Smoky Mountains) and related rhyolite volcanism about 44 million years ago, 5) final uplift and unroofing of Pioneer Mountains core complex (37 to 34 million years ago); the Summit Creek stock was beheaded by this faulting and its upper portion moved northwestward by as much as 23 km (Link, 1996).

The Lost River Range forms the eastern boundary of the watershed. The highest peak in the Lost River Range is 12,668 ft. Borah Peak, also Idaho's highest elevation. There are other summits near 12,000 feet in elevation including Leatherman and Breitenbach.

The Lost River Range contains one of the best continuous exposures of Paleozoic sedimentary rocks in Idaho. The rocks of the range are tilted eastward, and the range is bounded on the west by the segmented Lost River normal fault, which was last active in October, 1983, at Borah Peak. The interior of the range is rugged and forbidding. There are few roads and fewer perennial streams, since the porous limestone generally soaks up the snow melt and any summer rain (Link, 1996).

The range is made up of folded Proterozoic and Paleozoic sedimentary rocks. The Lost River normal fault runs along the base of the mountains, and has been active over the last few million years. Huge alluvial fans radiate from the steep canyons and spread out over the valley. The Range is underlain by the Silurian Laketown Dolomite and Devonian Jefferson Formation (Link 1989).

The Boulder Mountains exhibit a normal fault that runs through the low hills along the western range that has uplifted the mountains above the Wood River Valley. The white rocks in the cliffs at the base of the range are Eocene granite. The dark rocks on the summits are Devonian Milligen Formation and Pennsylvanian and Permian Wood River Formation. The Boulder Mountains occur in the northeast quadrant of the watershed. This portion of the Boulder Mountain Range extends far to the east, to the Herd Peak Highlands. It is composed of high, nearly treeless mountains. The Boulder Mountains rise at the head of North Fork of the Big Lost River in the southeastern portion of that range.

The White Knob Mountains are a compact group of sedimentary peaks located west of Mackay. The range's west to east trending crest is about 30 miles in length and 10 miles in width. The East Fork Big Lost River and the Big Lost River almost completely encircle the White Knob Mountains, forming the range's southern, western, northern and eastern boundaries. Antelope Creek completes the circle along the range's southern boundary as it flows east from Antelope Pass to the Big Lost River.

The White Knob Mountains are located to the west of the Lost River Range and have some summits over 11,000 feet. The White Knob mountains have a core of limestone through which there are intrusions of granite. The north and the south ends of the range are overlain by Challis volcanics, primarily rhyolite, that erupted out of vents now plugged by the granite dikes.

This geology is known for mineral deposits, and the eastern slope of the White Knob Mountains have many old mines and shafts. There is copper ore here that provided the nearby town of Mackay an important source of income. There is a small roadless area in the core of the range. Although steep, the mountains are open with little timber and long fields of talus and scree.

The Salmon River Mountains are located along the north central part of the North Fork Big Lost River watershed. They comprise a small portion of the watershed though this range extends far to the north into the Salmon River Watershed, and are primarily considered Eocene Challis Volcanics. The Salmon River Mountains are the second largest of the Idaho Batholith mountain groups. These mountains are named for the Salmon River, which encircles nearly the entire range, forming its boundary from Riggins, ID in the northwest, to Salmon in the northeast, to Challis in the southeast and Stanley to the southwest. Within the North Fork Big Lost River watershed The highest point within the Salmon River Mountains is Meridian Peak at 10,285 ft.

### Glacial History

The Pleistocene (the last 2 million years) has been a time of climatic conditions alternating between glacial and non-glacial, with a periodicity of about 100,000 years. There are also smaller cycles with periodicity of a few thousand years. In conjunction with a lowering of the earth's temperature by a few degrees, snow fields have built up, and reflectivity and cloudiness have increased.

During the cooler and wetter parts of the cycles, glaciers formed in the higher mountains of Idaho. The Yellowstone Plateau and Jackson Hole areas were extensively glaciated, as were the Sawtooths, Pioneers, the high Lost River, Lemhi, and Beaverhead Ranges to the east and the Albion Range south of the Snake River Plain. In the Copper Basin area the last two glacial advances are termed "Copper Basin" and "Potholes" (Figures 2 and 3).

During glacial advances, ice builds up and flows down valleys. At the terminus and sides of valley glaciers, poorly sorted sediment is deposited in moraines. In front of the glaciers, abundant meltwater flows downstream. This sediment-charged water deposited the high-level river terraces present today in the valleys of the Big Lost

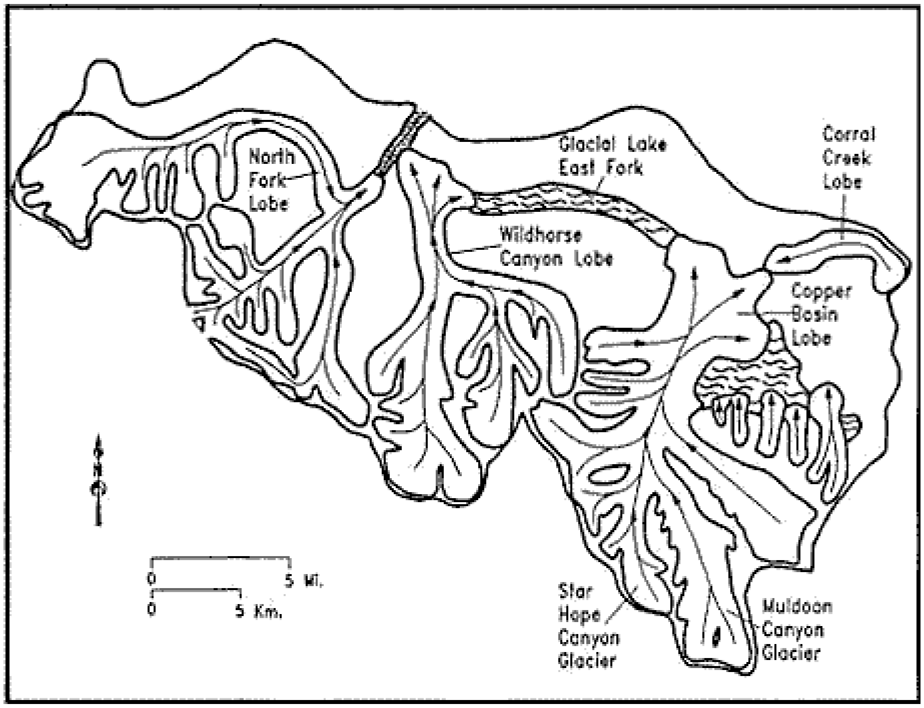


**Figure 2. Reconstruction of ice margins and fluvial systems at the latest and smallest of the glacial advances of the Potholes glaciation, about 20,000 years ago in the Big Lost River subbasin (redrawn from Evenson and others, 1982).**

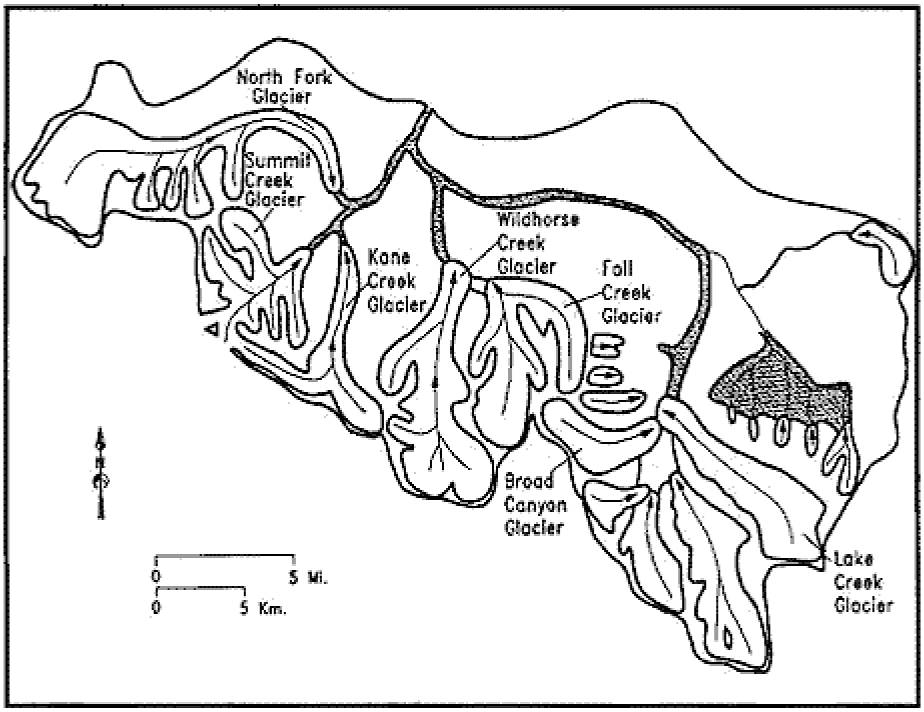


**Figure 3. Reconstruction of ice margins, fluvial, and lacustrine systems at the maximum of Copper Basin glaciation, probably about 120,000 years ago (redrawn from Evenson and others, 1982).**

## Soils

In the Big Lost River Subbasin, the surface soil is predominately gravelly loam. There is some loam, stony sand, stony loam, gravelly sand, silt, and unweathered bedrock in the subbasin. The Pioneer and Whiteknob mountain ranges contain unweathered bedrock and fragmented material with gravelly loam covering the slopes and gravelly silt in the river valleys. In the Lost River Range there is unweathered bedrock and fragmented material on its peaks and stony loam on its slopes to the valley floor where there is more gravelly loam. The southeast corner is predominately very stony silt along with some loam in the northern edge.

The soil depths range from 35 to 60 feet deep. The shallowest layer sits in the south west corner of the subbasin with an average depth of 35 feet. Several soils are about 60 feet deep.

The K-factor is the soil Erodibility factor in the Universal Soil Loss equation. The factor is comprised of four soil properties: texture, organic matter content, soil structure, and permeability. The K-factor values range from 1.0 (most erodible) to 0 (least-erodible). The K-factors for this subbasin range from 0- .49. The majority of the basin ranges from .1-.15 which are low K-factors for an arid climate. The highest K-factors are found in the southeast portion of the basin as well as along the Big Lost River near Chilly and the area between Antelope Creek and Arco. The lowest values are found in the areas containing unweathered bedrock and fragmented material in and closest to the mountain ranges

The average soil slope provides a measurement of potential soil erosion, or Erodibility risks. Soil slope, a calculation of slope length and rise, was averaged for the various soil units. The average slopes of the subbasin range from 1 to 52.4. The lowest slope of .57 is found at the very tip of the most eastern border. Most of the low slopes are found along the river corridor and in the valley bottom. Obviously, the highest slopes are found in and along the mountain ranges.

## Vegetation

Vegetation in the Big Lost River watershed varies by altitude and moisture regime. Valley bottoms include sagebrush and grassland ecotype in valley uplands. Riparian areas include mature cottonwood, alder, willow and shrubs. Sagebrush and grasslands extend into higher elevations and include aspen and juniper stands where soil moisture permits. Higher subalpine elevations feature lodgepole pine, Douglas Fir, whitebark pine, subalpine fir, and spruce. The highest elevations tend to be scree and barren rock with only lichen and shallow-rooted short grasses. An important function of vegetation is land cover to reduce erosion. This is very important on highly erodable soils such as lakebed deposits and stratified glacial soils found in Copper Basin and the North Fork Big Lost watershed and the associated alpine elevations (Figure 4). Higher density land cover can be riparian vegetation such as willow, crops such as alfalfa, wheat, or potatoes as well. Cropland is associated with valley bottoms and generally displaces riparian vegetation and upland sagebrush/grassland vegetation.

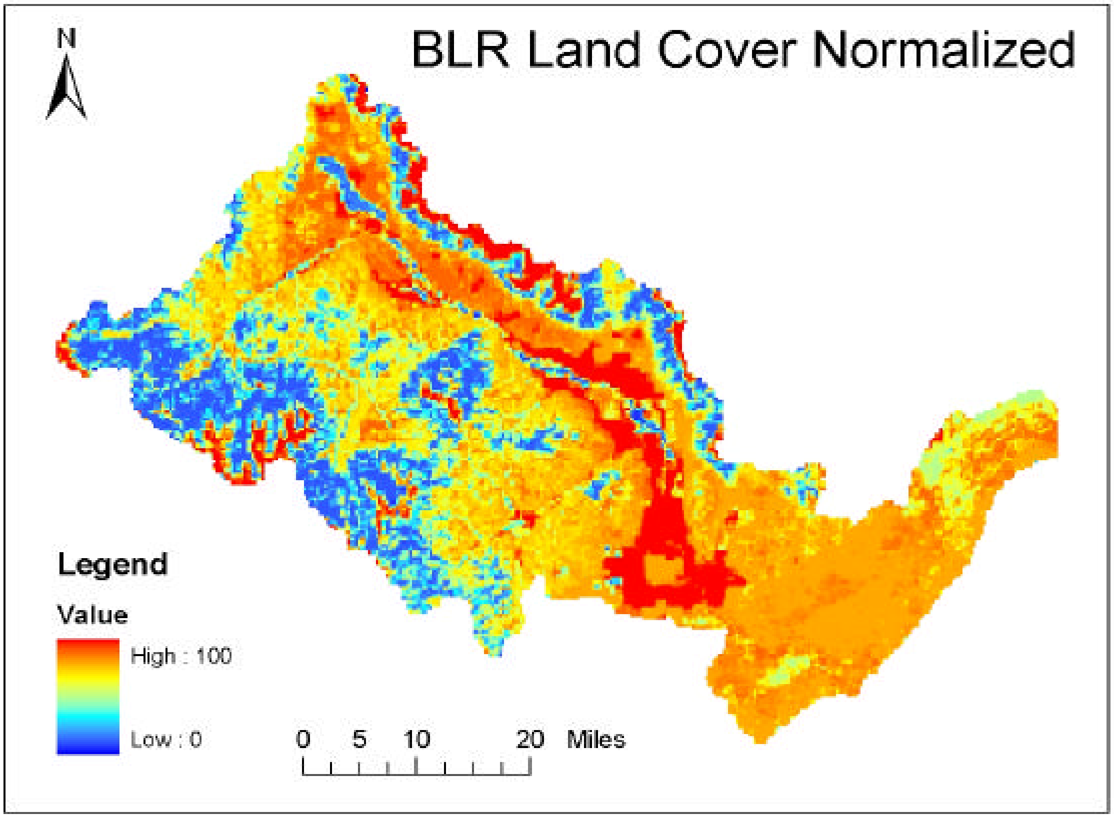


**Figure 4. Big Lost River subbasin land cover.**

## Fisheries

In 1944 Hubbs and Miller (1948) described three species of fish that were described as indigenous to the Lost Rivers watersheds of south-central Idaho: cutthroat trout (Oncorhynchus mykiss), dolly varden char (also known as bull trout) (Salvelinus malma), and the mottled sculpin (Cottus Bairdi Girard). In 1963 nomenclature for the genus Cottus was revised by Bailey and Bond (1963), and the common name mottled sculpin was changed to shorthead sculpin. The mountain whitefish (Prosopium williamsoni) is also found in the watershed, and was reported by Overton (1977), along with cutthroat trout, bull trout, and the shorthead sculpin, to be the four native fish of the Big Lost River watershed.

Overton (1977) reported six species of fish in the lower Big Lost River (downstream of Arco): rainbow trout (Oncorhynchus mykiss), brook trout (Salvelinus fontinalis), dolly varden char (bull trout), kokanee salmon (Oncorhynchus nerka), mountain whitefish, and the shorthead sculpin. Cutthroat trout were not observed in the reported sampling, though evidence of their hybridization with rainbow trout was described as apparent. It was speculated by Overton (1977) that the absence of cutthroat in the lower river reflected their “disappearance” as the result of introduction of brook and rainbow trout combined with degraded water quality. Overton states that no “other families of fishes have been observed or reported in the Big Lost River”. Introduced species identified by Overton (1977) included rainbow trout, brook trout, and kokanee Salmon. Abundance of fishes, in Overton (1977), is identified as being dependent upon waterflow.

The federal Fish and Wildlife Service has not included the Big Lost River watershed in its recovery plan for bull trout restoration because the species is not currently present in the watershed. A number of people feel that bull trout were never present in the watershed. Introduction of exotic salmonid species and non-game species has made it difficult to determine definitively which fish are native to the collective watersheds known as the Sinks Drainages (Behnke, 2002) which includes the Big Lost River watershed.

The distribution of fishes in the Big Lost River watershed is related to habitat. Kokanee salmon require a pelagic habitat for rearing adjacent to accessible spawning habitat. This combination is found in Mackay Reservoir with the lower reaches of Warm Springs Creek providing adequate spawning habitat. The Big Lost River from Chilly Buttes to Mackay Reservoir is primarily dry channel with the exception of the limited inflow from Thousand Springs Creek, just below the Chilly Buttes. This makes Warm Springs Creek extremely important to the fishery below Chilly Buttes and above the reservoir. It is essentially the only viable fishery resource in this reach other than the reservoir. Below Mackay Reservoir rainbow trout and whitefish are the predominant species. Rainbow trout are stocked into the reservoir and when the reservoir is drawn down they entrained to the river fishery between Mackay Reservoir and the Moore Diversion. Below the Moore Diversion the channel is primarily dry and provides no sustainable fishery resource.

Above Chilly Buttes, where the Big Lost River and its major tributaries flow perennially, rainbow trout are the primary species. Brook trout and cutthroat trout are found in larger tributaries such as Wildhorse Creek and Starhope Creek and in the upper East Fork, above

Starhope Creek, and North Fork of the Big Lost River. The Idaho Department of Fish and Game began stocking cutthroat trout into the upper Starhope Creek watershed in 2000. Rainbow trout are still stocked into the East Fork of the Big Lost River and North Fork of the Big Lost River.

## Subwatershed Characteristics

### Subbasin Characteristics

Big Lost River Subbasins that comprise the watershed are grouped by subwatersheds that are comprised of administrative subunits called Assessment Units devised by the Environmental Protection Agency for accounting of water quality issues. Subbasins are grouped by major tributaries that include the East Fork of the Big Lost River, the North Fork of the Big Lost River, the Upper Big Lost River, Antelope Creek, and the Lower Big Lost River (Figure 5). The East Fork and North Fork of the Big Lost River form the headwaters of the Big Lost River. The form of the watershed is similar to the shape of a question mark. The East Fork of the Big Lost flows north to northwest then picks up the flow from Summit Creek and the North Fork to form the Big Lost River mainstem which wraps around the White Knob Mountains into the valley formed with the Lost River Range to flow south. A significant feature in the watershed is Mackay Reservoir, an irrigation impoundment that is the keystone to fisheries in the mainstem and Warm Springs Creek.

Subbasins will be discussed from the headwaters of the East Fork and North Fork Big Lost River downstream and within the subbasins streams will be grouped by Assessment Units for further discussion of important features related to water quality. The lower Big Lost River assessment units do not have streams that regularly flow to the Big Lost River except under extreme hydrologic events. There are limited BURP sites over the lower subbasin assessment units. BURP data is shown in Appendix F.

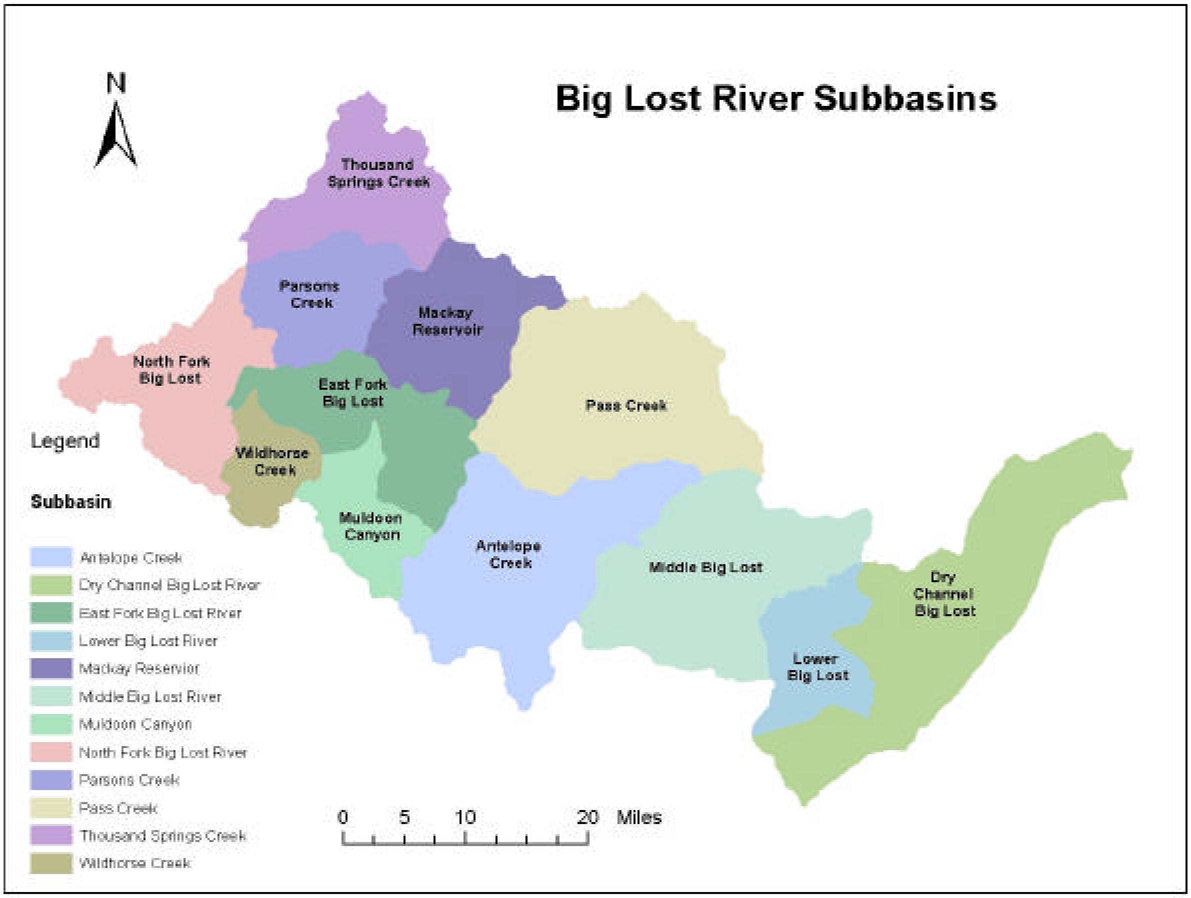


**Figure 5. Subbasin names and locations in the Big Lost River watershed.**

## East Fork of the Big Lost River

The East Fork of the Big Lost River has a watershed area of 687 km$^2$ with major tributaries consisting of Wild Horse Creek, Pole Creek, Deer Creek, Rider Creek, Little Boone Creek, Willow Creek, Boone Creek, Fox Creek, Road Creek, Star Hope Creek, Corral Creek, Coal Creek, Steve Creek and Anderson Canyon Creek. The East Fork of the Big Lost River is on the 303(d) list of impaired water bodies for major pollutants that include sediment, temperature and habitat alteration. Much of the sub-watershed is located in Copper Basin, shown in brown in Figure 6. Copper Basin is a large glaciated basin on the watershed divide that separates the East Fork from Antelope Creek, to the south, in the Pioneer Mountains. The majority of flow in the sub-basin is derived from Star Hope Creek and Wild Horse Creek.

The upper 303(d) listed reach extends from the headwaters to the confluence of Star Hope Creek (West Fork of the Big Lost River). This reach is listed for sediment and temperature. The lower listed reach, listed for habitat alteration, extends from the confluence of Star Hope Creek to the confluence with the North Fork of the Big Lost River, where the main Big Lost River begins. The only other 303(d) listed stream in this sub-watershed is Little Boone Creek, an ephemeral stream that sporadically drains a wetland for only brief periods during snowmelt.

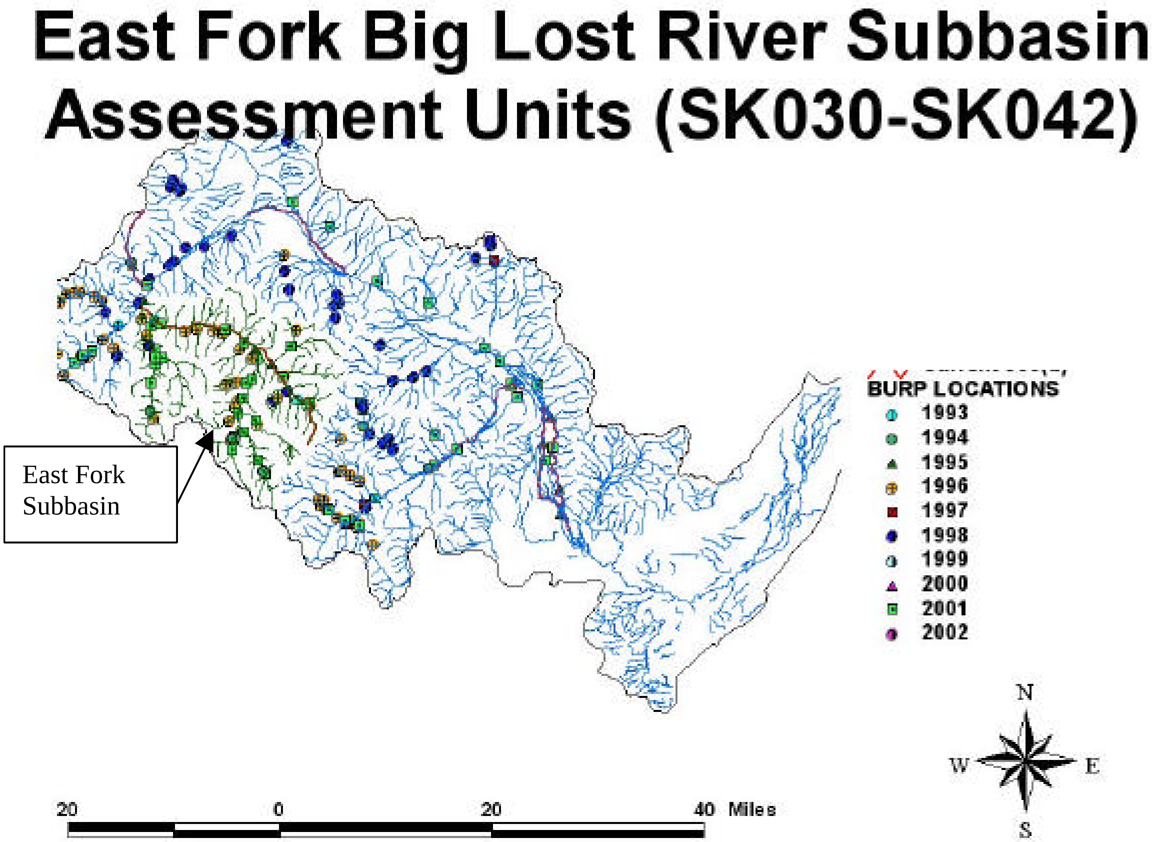


**Figure 6. Location of the East Fork subbasin within the Big Lost River watershed.**

Springs, snowmelt runoff, and storm events drive flow in the upper East Fork. The source of the East Fork is a complex of springs with beaver dams in the upper watershed within Copper Basin known as The Swamps (Figure 7). It becomes 2nd order at the confluence of Coal Creek and 3rd order at the confluence of Corral Creek just below the Burma Road Bridge. Anderson Canyon is an ephemeral stream that flows as a second order stream during peak runoff and remains dry for the remainder of the year. The upper reach from the swamps to the Copper Basin Guard Station, several miles downstream, is said to be undisturbed. Flow is perennial throughout the course of the East Fork of the Big Lost.

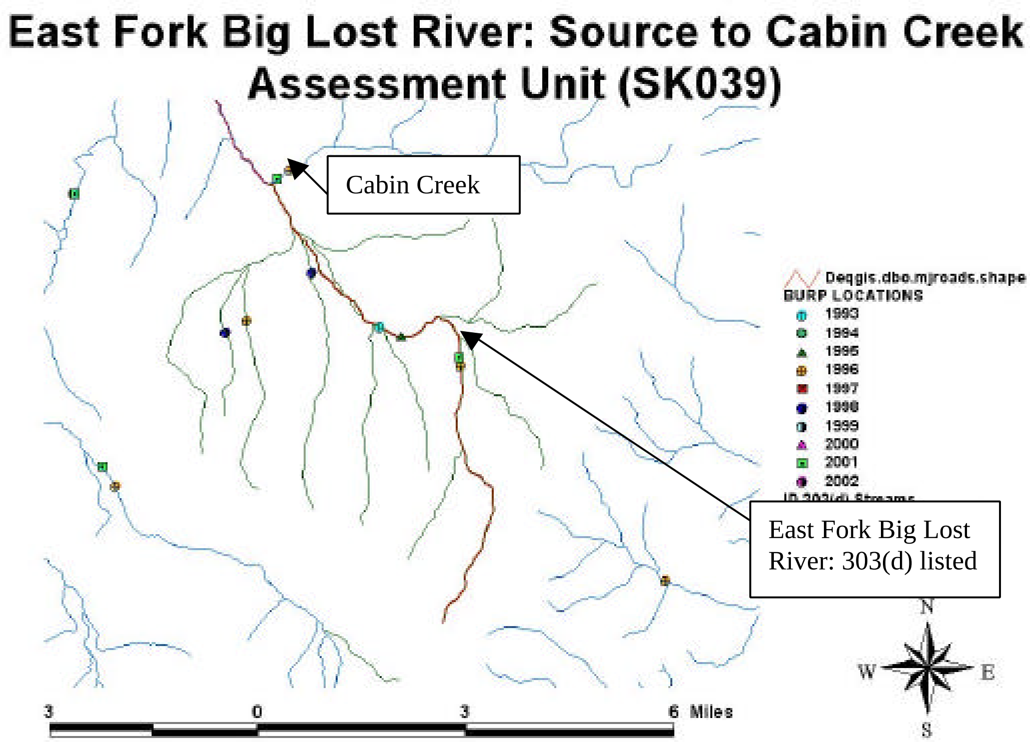


**Figure 7. Upper East Fork assessment unit.**

Property ownership over the upper listed reach is primarily public land managed by the USDA Forest Service. There are several private in-holdings along the stream above the confluence with Star Hope Creek, primarily recreational homes. Management emphasis of public lands on this reach is livestock grazing. There is a riparian management demonstration project below Corral Creek, which creates a 1200-acre riparian pasture that has been in place since the early 1980s. Over utilization of this demonstration project on shallow glacial soils stratified over cobble and boulder layers, however, has negated the potential improvement in riparian condition and streambank integrity and stability. Riparian fencing has not been implemented elsewhere within the watershed. Recreation use consists of dispersed camping and fishing access. Road density is less than 1 mile per square mile in the watershed though the density of roads within riparian areas is greater than 1 mile per square mile. There are several road crossings within this reach, primarily affiliated with grazing management and fishing access. There is an emergency aircraft landing strip associated with the Copper Basin Guard Station.

The upper watershed, above Star Hope Creek is characterized by a Rosgen B channel in valley type VIII (Rosgen 1996), with multiple alluvial and glacial river terraces laterally along the broad valley with gentle, down-valley elevation relief. Copper Basin has been extensively sculpted by Holocene glaciating. Eventually, below the Copper Basin Guard Station, the stream transitions to a C channel to the confluence of Cabin and Corral Creek. This segment exhibits a marked reduction in riparian vegetation, density and vigor. However, due to the hydrologic regime of a spring creek, it has maintained some of its streambank integrity. This may be due to past implementation of in-stream grade control structures. Many of these structures are failing resulting in side cutting and accelerated lateral migration of the stream channel. Once the channel is exposed to the snow melt driven peak flow regime of Corral Creek streambank integrity diminishes. The combined effect of increased sediment supply from Corral Creek and beaver activity in depositional areas, channel integrity further degrades due to streambank erosion. The channel progressively degrades to an F channel to the confluence of Star Hope Creek, where the lower assessment unit begins. The lower East Fork Assessment unit is shown in Figure 8.

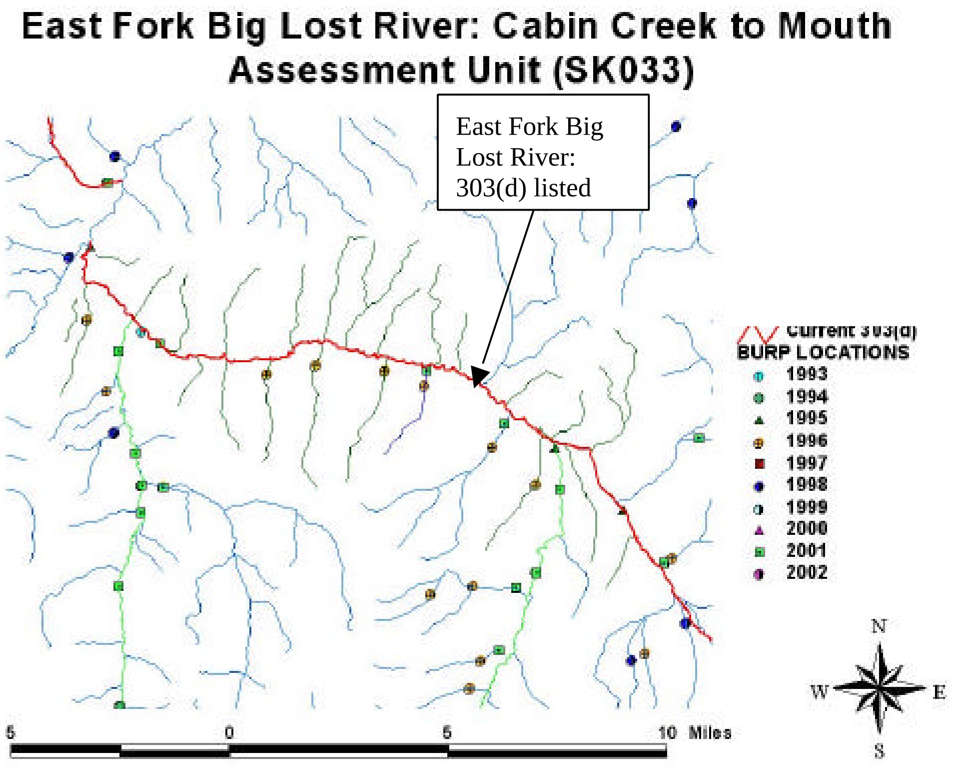


**Figure 8. Lower East Fork assessment unit.**

Star Hope Creek emerges from its upper type II valley in an A channel. It quickly picks up the flow of Bear Canyon Creek, a 2nd order stream which transitions from an A to a G channel when it enters the type VIII valley from its type II upper valley. The G channel is deeply incised into depositional material comprised of an unconsolidated and heterogeneous mixture of gravel, small cobble and sand. It has moderate channel gradient and low width to depth ratio and low sinuosity. They have high sediment supply and are typically unstable (Rosgen 1996).

Star Hope Creek flows in a C channel after entering the main type VIII valley. Riparian vegetation is primarily willow with some alder. Soils are glacially derived and are shallow and sandy overlying gravel and cobble with some boulder size material, which increases the potential for erosion. These soils are fragile and depend upon riparian vegetation to help anchor them in place. With good riparian vegetation the stream channel can withstand peak flow that results during snowmelt or concentrated thunderstorms. Channel stability is fair in Star Hope Creek until it picks up flow from Muldoon Canyon, approximately 1.25 miles below Bear Canyon Creek where the stream widens, substrate particle size increases, bank erosion increases with vertical bare banks and increasing depositional features. These characteristics are indicative of channel instability resulting from elevated bed load resulting from riparian vegetation alteration coupled with hydrologic erosive energy.

Muldoon Creek, and Lake Creek are 2nd order streams that flow through parallel, course glacial trough valleys, valley type V, in B channels, to their confluence with Star Hope Creek. These valleys are the result of glacial scouring where the resultant trough is a wide "u"-shaped valley with wide valley floor slopes generally less than 4 percent (Rosgen 1996). High bedload from Muldoon Creek and Lake Creek, which enters 1.75 miles below Muldoon Creek, combined with progressive streamside degradation of channel stabilizing riparian vegetation have aggraded, or raised the stream channel through deposition of course materials, and created accelerated lateral instability in the Star Hope Channel. Rain-on-snow events in winter of 1997, 1998, and spring of 2002, coupled with the reduced streamside riparian diversity and vigor have significantly eroded predisposed stream channels and increased the width to depth ratio of Muldoon Creek, and Star Hope Creek. Increased width and reduced depth result in increased deposition of course materials from the erosion of streambanks in tributaries and streambanks in the Star Hope channel further worsening stability problems. Fine sediment, and sand must accumulate on gravel and cobble to give stabilizing vegetation a foundation as the stream re-establishes its flood plain. Recovery can take a number of years and must be managed carefully to not increase sediment loads and allow propagation of riparian vegetation.

Bellas Canyon Creek (1st order), Broad Canyon Creek (2nd order), and Ramey Creek (2nd order) enter from northern type II valleys in A, B, and A channels respectively. Flow is low in these tributaries compared with Muldoon and Lake Creeks, and their stability is much higher with less contribution of bed materials. The Starhope Creek assessment units are shown in Figure 9.

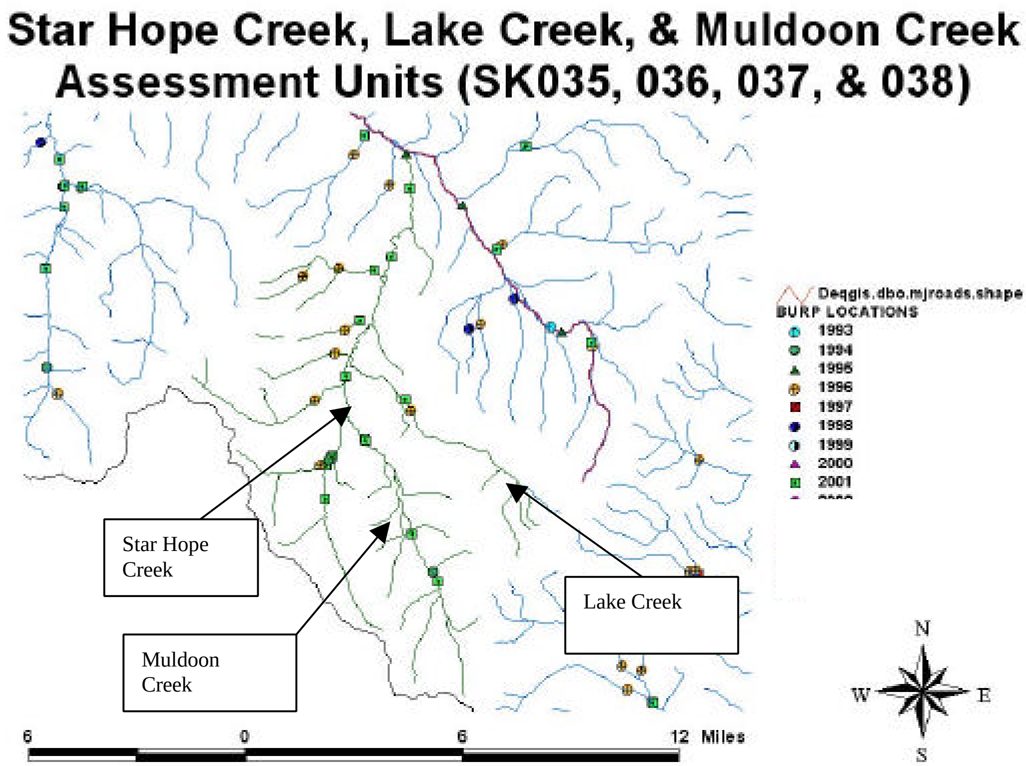


**Figure 9. Starhope Creek subbasin assessment units.**

Channel conditions remain remarkably consistent in Star Hope Creek to its confluence with the East Fork of the Big Lost River and on to the confluence with the North Fork of the Big Lost River. The flow in Star Hope Creek is significantly greater than in the upper East Fork throughout the hydrologic cycle. Water quality conditions below the confluence are primarily a function of conditions in Star Hope Creek.

Land use in the Star Hope Creek sub-watershed consists of livestock grazing and recreation. There is an abandoned mine in the headwaters reach of Star Hope Creek but it does not appear to have a hydrologic connection with the stream. There is a developed campground at the mouth of Star Hope Creek Canyon and Bear Canyon Creek Canyon. Effects of recreational use are visible here. There are off road vehicle trails up Star Hope Creek Canyon, and a hiking and pack trail up Bear Canyon Creek Canyon. Muldoon Creek Canyon hosts a four wheel drive road to the upper valley. There are multiple road crossings across the loose alluvial channel that have contributed to channel braiding and increased instability. Lake Creek Canyon, Bellas Canyon Creek Canyon, and Broad Canyon Creek Canyon host hiking and pack trails to higher elevations. Lake Creek and Muldoon Creek feature alpine lakes in the headwaters reach that are very popular with anglers. There is a cow camp with associated corrals on Star Hope Creek near the confluence of Bellas Canyon Creek, and there are two angler access points between the developed Star Hope Campground and the Cow Camp. The Copper Basin Loop Road traverses the mouths of the major canyons and extends from the Copper Basin Guard Station to the mouth of Star Hope Creek and intersects the Copper Basin Forest Road just below the confluence of

Star Hope Creek and the East Fork of the Big Lost River. Road density averages less than 1 mile per square mile on the watershed scale, however road density in riparian areas is greater.

Below the confluence of Star Hope Creek the East Fork flows northwest through a narrower composite valley constrained by high relief rocky hill slopes to the east and pronounced Holocene terraces to the west. The major tributary in this reach is Wild Horse Creek, which enters from the west just above the North Fork Big Lost River confluence. Boone Creek is the largest tributary that enters from the east. Fox Creek is the only other eastern tributary that is 2nd order over this reach. Rider Creek is diverted just above the Copper Basin Road to private land below the road.

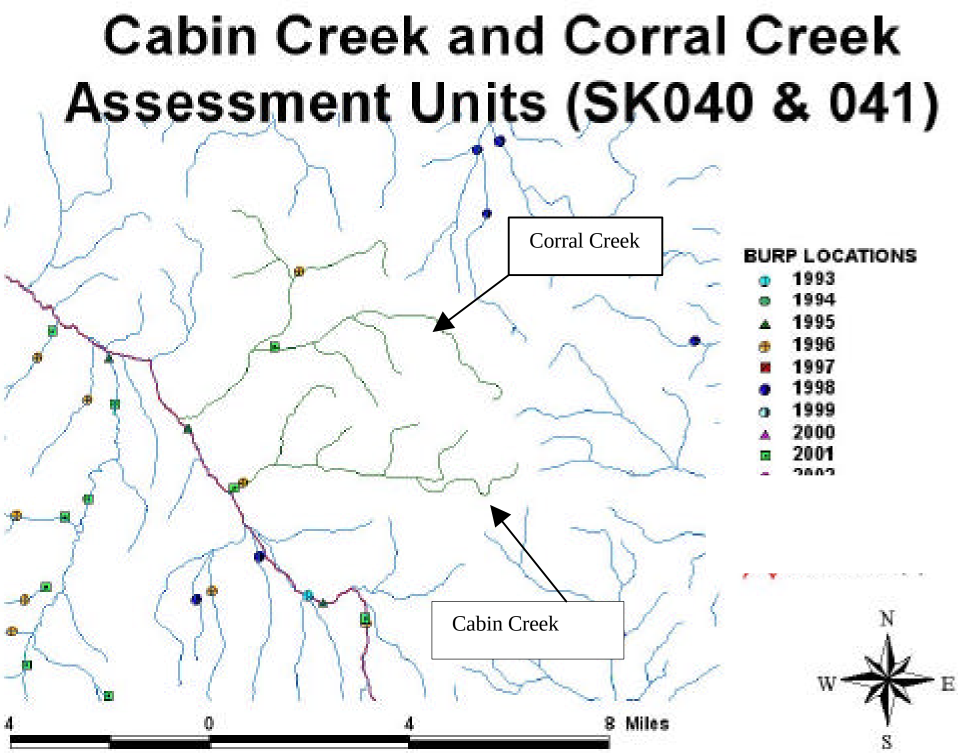


**Figure 10. Upper East Fork tributary assessment units.**

Little Boone Creek is the remaining 303(d) listed stream over the lower reach (Figure 11). It is a fishless ephemeral stream that flows only during snowmelt. Its source is a wetland that has been degraded by grazing. The water table has been lowered in the wetland by the formation of hummocks that has greatly reduced the storage capacity of this feature eliminating surface flow.

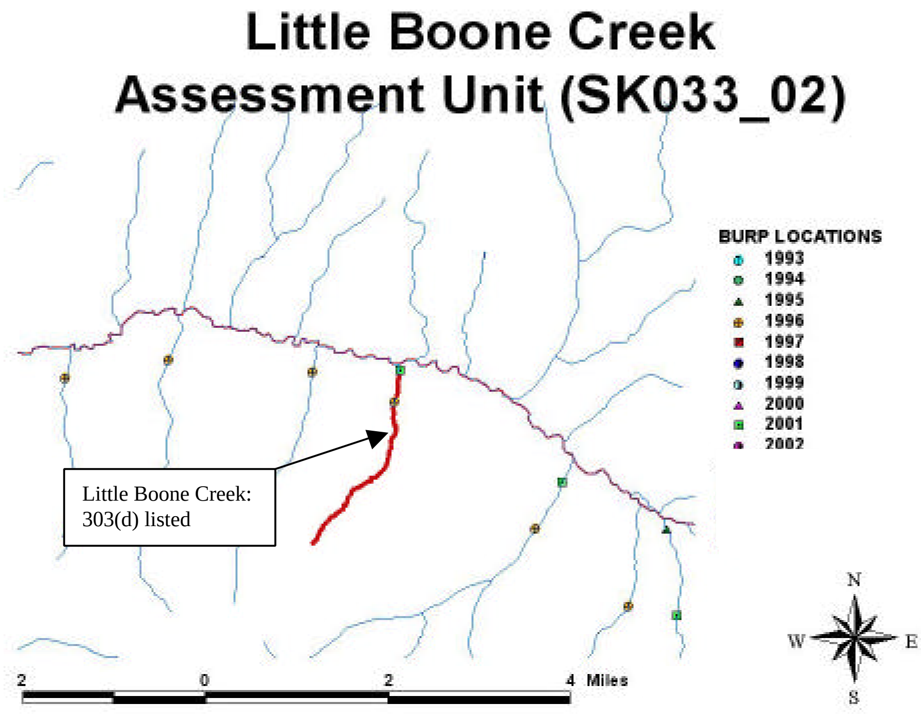


**Figure 11. Little Boone Creek assessment unit.**

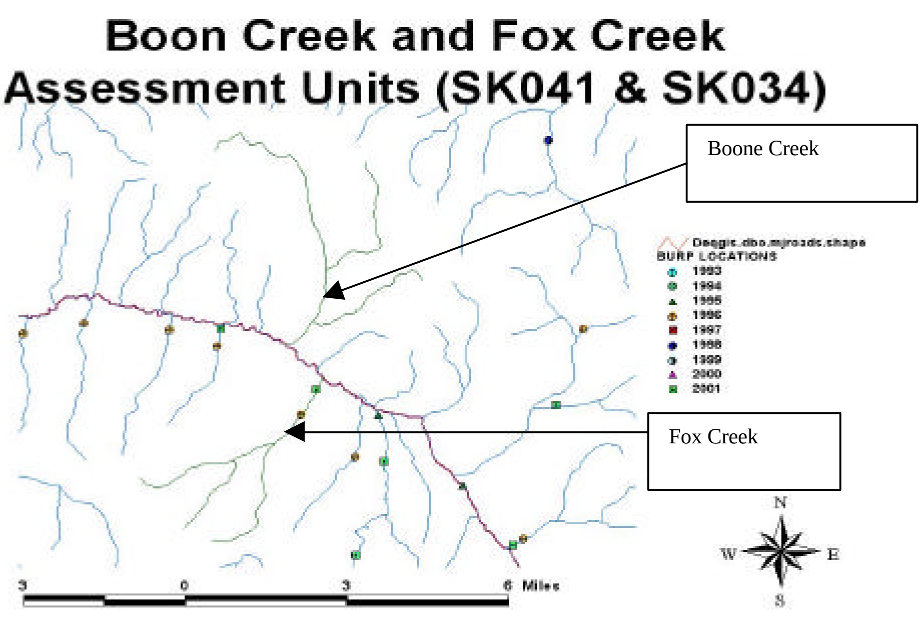


**Figure 12. Boon and Fox Creek assessment units.**

The Wild Horse Creek subbasin (Figure 13) bears similar geology and morphology to the Star Hope Creek subbasin. Fall Creek and Burnt Aspen Creek contribute flow from glacial trough valleys in B and Aa+ channels. The Aa+ channel describes a single thread entrenched channel with low width to depth ratio (<12) with low sinuosity and gradient over 10% (Rosgen 1996). Wild Horse Creek flows in an A channel and transitions into a B channel after picking up the 1st order A channel flow from the Left Fork of Wild Horse Creek. The valley is type VIII. The Wild Horse stream channel is less aggraded than the Star Hope Creek channel though significant streambank erosion is evident.

Land use is comprised of livestock grazing and recreation. There are trails in each of the major tributaries to alpine lakes. Roads extend to the upper reach of the main canyon, and there is a developed campground in the upper reach. There is a Forest Service Guard Station just above the mouth of the canyon. Land ownership is primarily public land managed by the Forest Service with a private cow camp inholding.

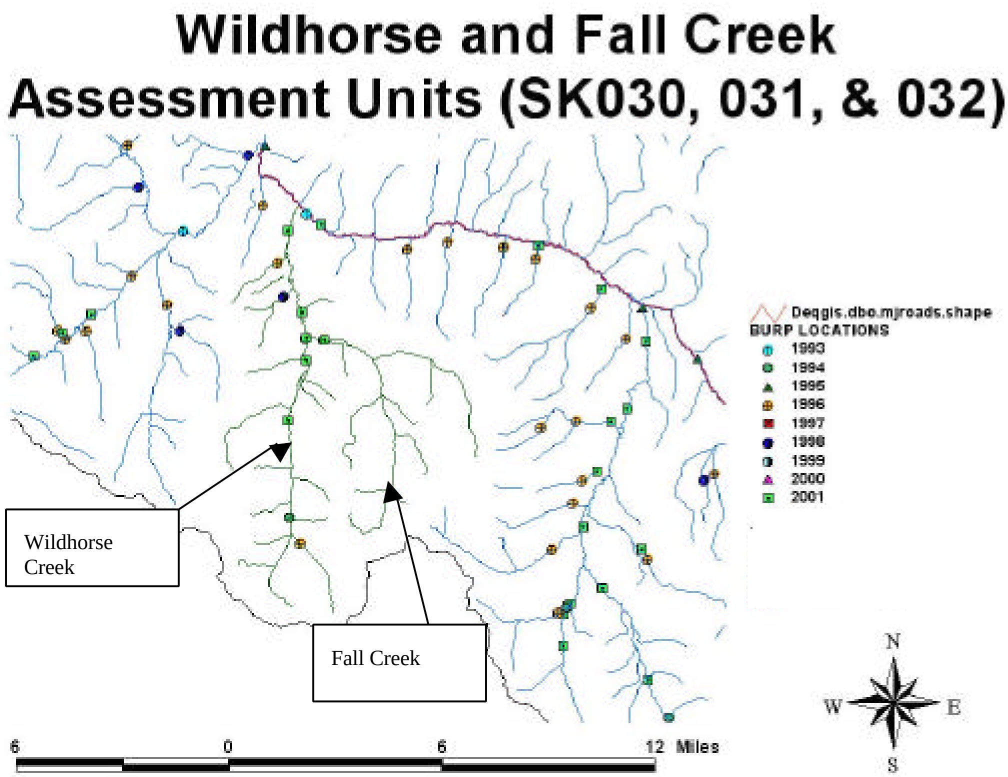


**Figure 13. Wildhorse Creek assessment units.**

## North Fork Big Lost River

The North Fork of the Big Lost River has a watershed area of 345 $km^2$ with major tributaries consisting of Bartlett Creek, Creek, Bear Canyon, Chicken Creek, Corral Creek, Grasshopper Creek, Horse Creek, Hunter Creek, Miller Canyon Creek, Park Canyon Creek, Slide Canyon Creek, Toolbox Creek, and Summit Creek. The location of the North Fork subbasin is shown in Figure 14. Summit Creek contributes the greatest flow to the North Fork Big Lost River and has major tributaries that include Kane Creek, Phi Kappa Creek, Little Fall Creek, and Park Creek. The subbasin is located in the northwest of the Big Lost River watershed.

Springs, snowmelt runoff, and storm events drive flow in the North Fork Big Lost River watershed. There are no 303(d) listed streams in the North Fork Big Lost River watershed. Tributaries to the upper North Fork start in the small segments of the Boulder Mountains and Salmon River Mountains within the watershed.

The Right Hand and Left Hand Forks of the North Fork of the Big Lost River begin in alpine cirques near the watershed boundary. They flow through Type II valleys in A and subsequently B channels. They combine as 2$^{nd}$ order streams to create the North Fork Big Lost River in a 3$^{rd}$ order B channel stream in a Type II valley to the confluence of Hunter, Blind, Bear, Squib, and Miller Canyon Creeks. The valley widens slightly below this series of confluences, but remains Type II to just above the confluence with Summit Creek.

Hunter, Blind, Bear and Squib Creeks come in as 1$^{st}$ order A channels, and Miller Canyon comes in as a 2$^{nd}$ order B channel. Park Canyon Creek comes in from the north as a 1$^{st}$ order A channel and Slide Canyon enters as a 2$^{nd}$ order A channel from the south.

The result of the succession of high gradient snowmelt driven channels is a rapid increase in stream power under runoff conditions. Riparian vegetation changes with an increasingly wide valley from lodge pole and Douglas fir with shrubs and herbaceous understory to predominantly willows with some alder. The valley remains relatively narrow, however increasing beaver activity is noted.

Below Park Canyon and Corral Creek the valley widens further and Toolbox Creek and Chicken Creek come in as 1$^{st}$ and 2$^{nd}$ order A channels respectively. The valley transitions to greater width with lower gradient, which increases the sinuosity of the North Fork Big Lost River. With increasing sinuosity and lower gradient deposition increases. The Stream channel becomes a C channel with gravel and cobble point bars. Degradation of riparian vegetation from grazing over utilization has reduced stream bank stability below Toolbox Creek, Chicken Creek and Zipper Creek. Below Zipper Creek increased sediment load from streambank erosion has caused instability in beaver impoundments and has resulted in lateral migration of stream channels and overall down valley meander migration due to aggradation of the stream channel. The resulting in increased instability and channel migration have further removed riparian vegetation which has resulted in elevated sediment and temperature loading.

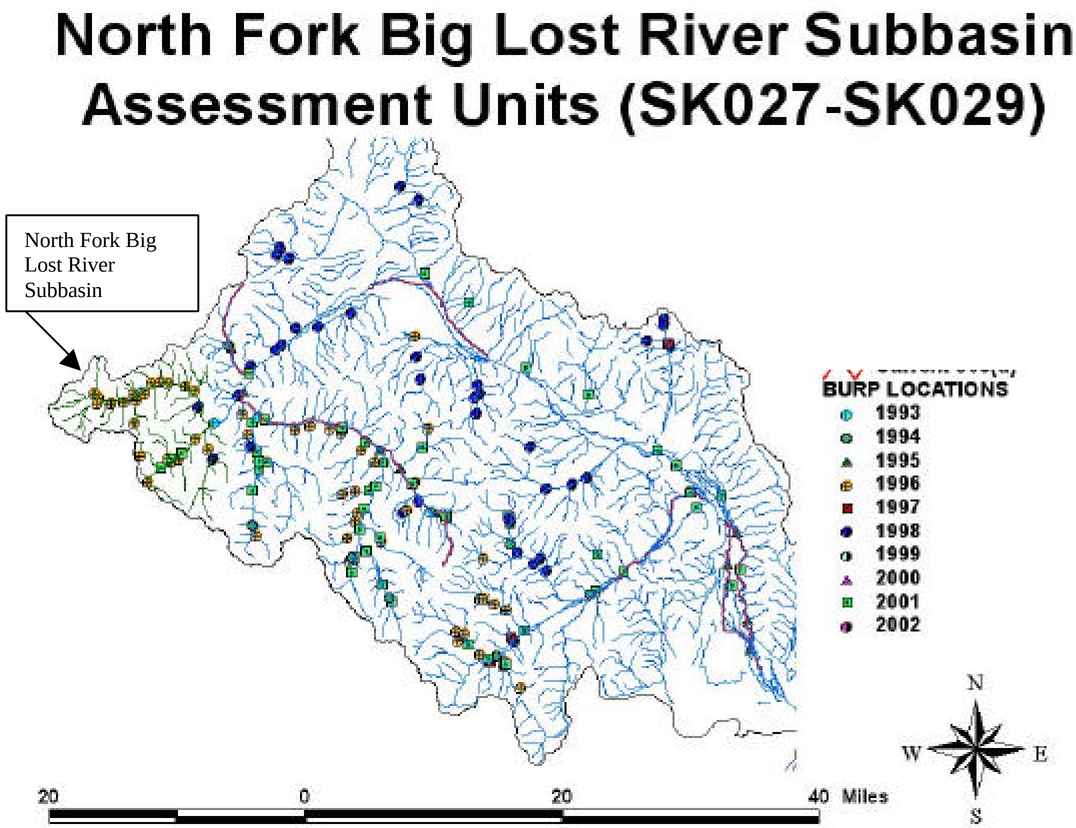


**Figure 14. Location of the North Fork Big Lost River subbasin in the Big Lost watershed.**

Land use in the North Fork canyon is primarily grazing with recreation focused on the upper watershed. There is a trailhead at Toolbox Creek that leads to the watershed divide with East Pass Creek in the East Fork Salmon River watershed. Road density is moderate within the valley bottom though most of the canyon spur roads are gated. Timber harvest has been limited in the watershed due to the steep nature of the watershed though historic timber harvests have been conducted in the upper watershed. Mining is limited to historic activity with a number of addits present in the middle to upper elevations. The North Fork Big Lost River assessment unit is shown in Figure 15.

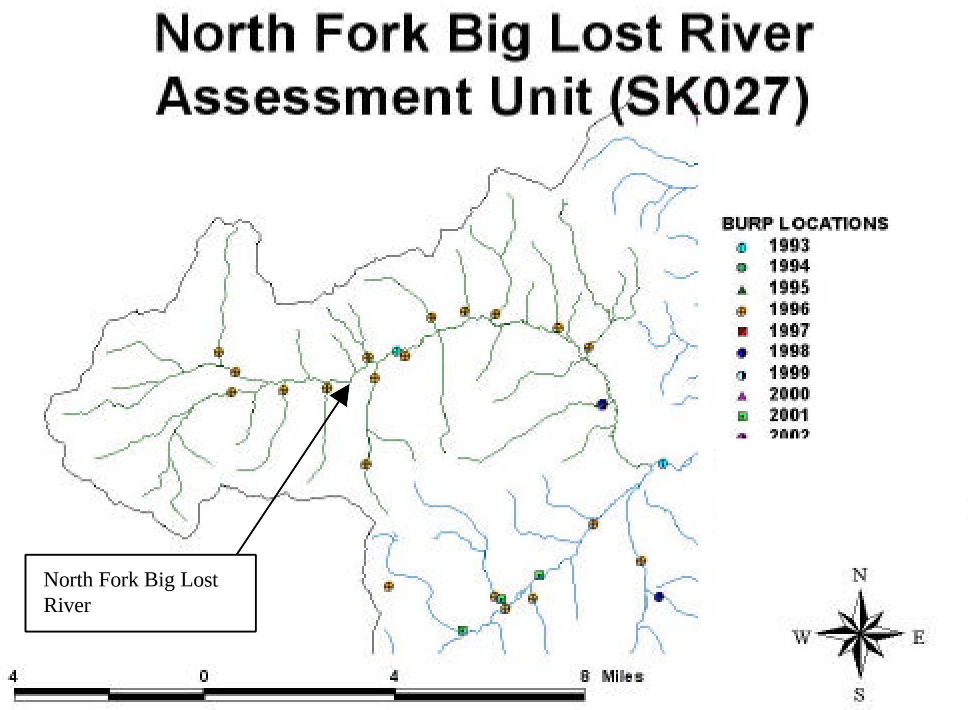


**Figure 15. North Fork Big Lost River assessment unit.**

Summit Creek makes its confluence with the North Fork Big Lost below the mouth of the North Fork canyon (Figure16). The orientation of the Summit Creek watershed is parallel to the North Fork Big Lost River and has similar geomorphology. Its origins lie in the flanks of the Boulder Mountains to the North in Summit Creek, and in the Pioneer Mountains. Summit Creek enters the main valley as a 3rd order B channel and flows eastward toward its confluence with the North Fork. Other tributaries to Summit Creek include Kane Creek (Figure 17), Phi Kappa Creek, Little Fall Creek, Big Fall Creek, and Park Creek. These tributaries all flow through glacial trough canyons in 1st order A channels with the exception of Kane Creek which transitions to a 2nd order B channel before making its confluence.

Land use in the Summit Creek watershed includes livestock grazing and recreation. Recreation land use consists of fishing access, a developed campground, off-road vehicle trails and hiking trails. Historic mining was more prevalent in the Summit Creek watershed than the North Fork watershed, though little remains of previous activities. Land ownership is exclusively public and managed by the USDA Forest Service.

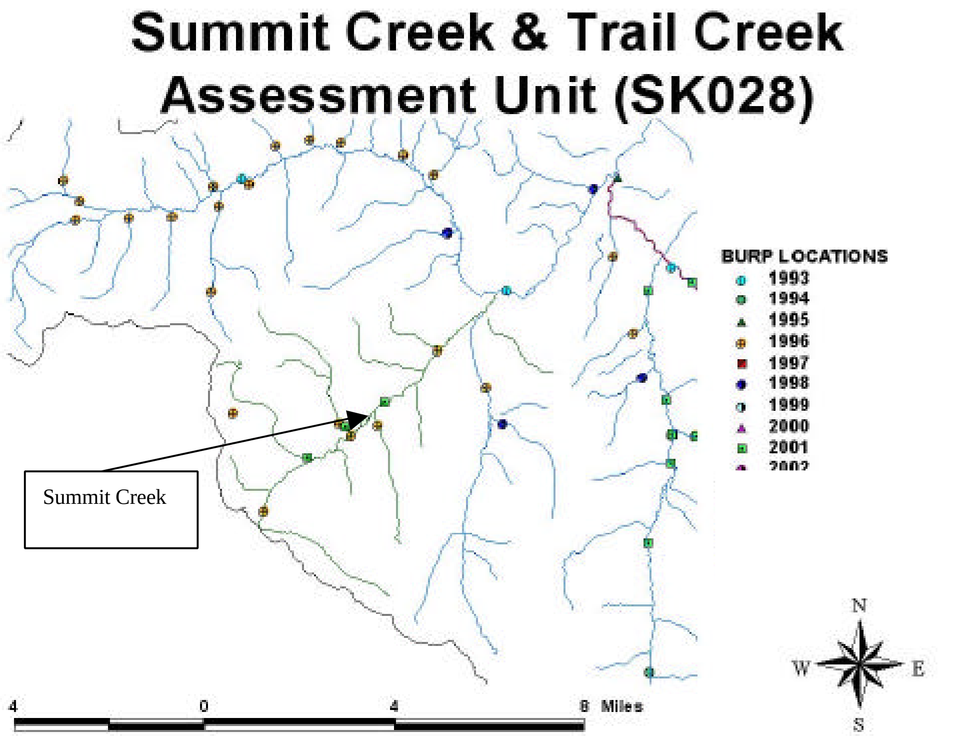


**Figure 16. Summit Creek assessment unit.**

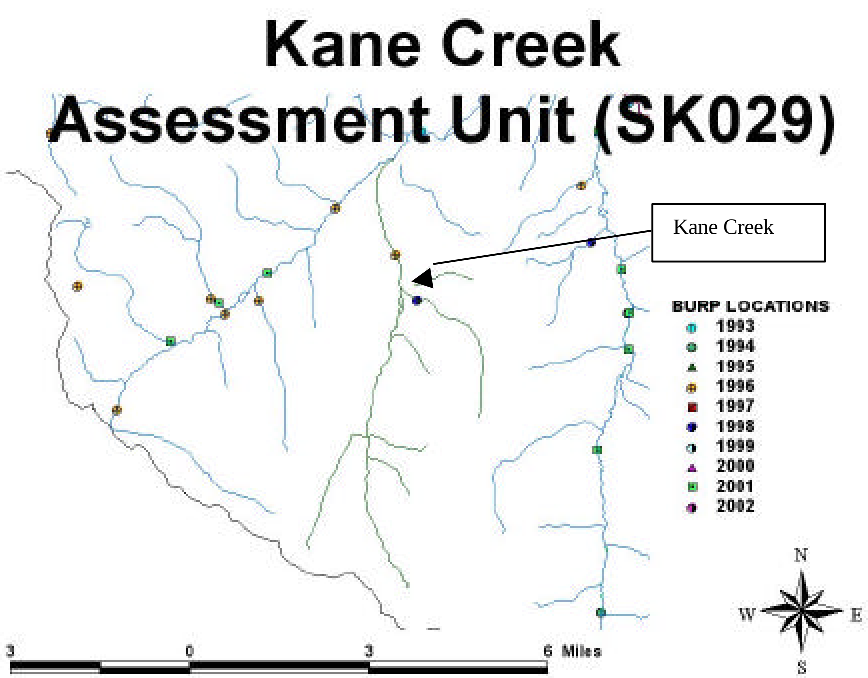


**Figure 17. Kane Creek assessment unit.**

## Upper Big Lost River

The upper Big Lost River includes the watershed above Mackay Dam (Figure 18). For the purpose of this assessment the watershed will be dealt with in two groupings. This grouping is to address the issues of the listed reach, from Chilly Buttes to the Reservoir, but also to separate the reach that is not listed, from Mackay Reservoir Dam to the Moore Diversion. This lower reach from Mackay Reservoir to the Moore Diversion has been determined to fully support its Cold Water Aquatic Life Beneficial Use including the macroinvertebrate community and salmonid spawning. It will be dealt with in the Lower Big Lost River Subwatershed section. Below the Moore Diversion the Big Lost River is a dry channel that only sporadically carries water to the sinks, located on the lava flows. Flow duration and frequency are not adequate to support aquatic life and the impairment is flow alteration.

The upper Big Lost River watershed has an area of 2385 $km^2$ and includes the Big Lost River from the confluence of the North Fork and East Fork to the Mackay Reservoir. This reach includes the tributaries of Burnt Creek, Twin Bridges Creek, Pinto Creek, Garden Creek, Burnt Creek, Bartlett Creek, Grant Creek, Thousand Springs Creek, Sage Creek, Lone Cedar Creek, Upper Cedar Creek, and Lower Cedar Creek. The Big Lost River is impounded by Mackay Dam to create Mackay Reservoir, which has a primary perennial source of water from Warm Springs Creek, which enters from the western upper Big Lost River subwatershed. Navarre Creek is intermittent and sporadically contributes flow to the Reservoir. Tributaries will be presented according to assessment units and the nature of flow conditions will be described.

Land use throughout the upper Big Lost River Subwatershed is primarily agricultural with grazing and forage crop production the main use followed by animal feeding operations and CRP lands. Grazing occurs throughout the Subbasin with limited identifiable riparian-directed grazing management or best management practices on public or private land. Recreation land use occurs in 1 developed BLM campground near Garden Creek, with dispersed camping throughout the watershed. The heaviest recreational use is related to the Mt. Borah trailhead near Rock Creek. Off-road vehicle use is evident throughout the Subbasin on private and public land as evidenced by improvised trails and hill slope roads in most drainages. There is a proposal by the Idaho Department of Parks and Recreation, the Bureau of Land Management and Forest Service to establish the Lost River Trail System for off road vehicles in the watershed. Residential use is generally affiliated with ranches with home sites distributed throughout the area including riparian areas. Most tributaries are on public land.

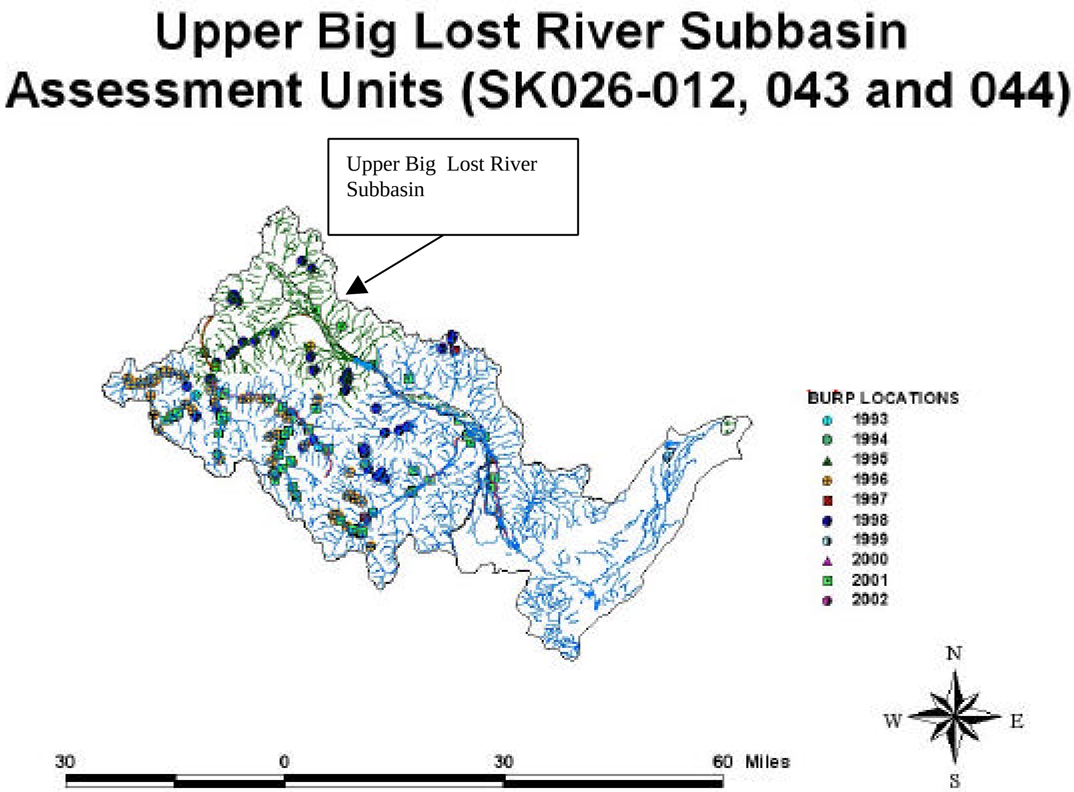


**Figure 18. Location of the upper Big Lost River subbasins in the Big Lost watershed.**

Twin Bridges Creek has its confluence with the main Big Lost River 1.5 miles below the confluence of the North Fork and East Fork of the Big Lost River (The Forks) (Figure 19). Its watershed is composed of two assessment units within the Bridges Creek Assessment Unit: SK026_02 which corresponds to the upper ephemeral watershed and SK026_03 which corresponds to the lower single thread discharge below a narrow wetland complex on private land above the mouth of the canyon. Flow across public land managed by BLM has been short duration with flow below 1 cfs much of the year. In 2002 BLM measured flow in Twin Bridges Creek below the private property boundary (Table 2) using a specialized weir to quantify low flow. Flow regime in 2003 was similar with the stream channel dry by 8/15/2003. The middle private reach of Twin Bridges Creek extends approximately 4 miles above the BLM/private boundary, through the wetland reach, to the confluence of an unnamed ephemeral tributary.

**Table 2. Flow Measurements in Twin Bridges Creek.**

| Location | Date | Time (hrs) | Flow (cfs) |
|---|---|---|---|
| **Twin Bridges Creek** | 7/2/2002 | 14:00 | 1.44 |
| | 7/8/2002 | 11:15 | 0.89 |
| | 7/17/2002 | 11:00 | 0.46 |
| | 7/30/2002 | 11:05 | 0.18 |
| | 8/11/2002 | 12:15 | Too low to measure |

Twin Bridges Creek is a third order C channel that flows through a narrow valley bottom that has historically had beaver dams before infiltrating into the alluvium above the mouth of its canyon on private land.  Historic grazing practices have resulted in downcutting and incision of the stream channel.  This has led to a drop in the water table that has reduced off channel storage that would likely provide flow for longer periods of the year and better habitat for riparian vegetation and aquatic life.  Combined with the effects of surface diversion for livestock watering, flow vanishes by mid to late August after initiating in early to mid May.  Between May and June flow may be above 1 cfs but does not have enough duration to benefit aquatic life communities throughout the year.

Land ownership in the Twin Bridges Assessment Unit is BLM over the lower 1.25 miles to the confluence.  Private land extends approximately 4 miles above the BLM boundary, and the Forest Service manages the upper 4 miles above private land.  Grazing occurs throughout the watershed and is the primary land use.

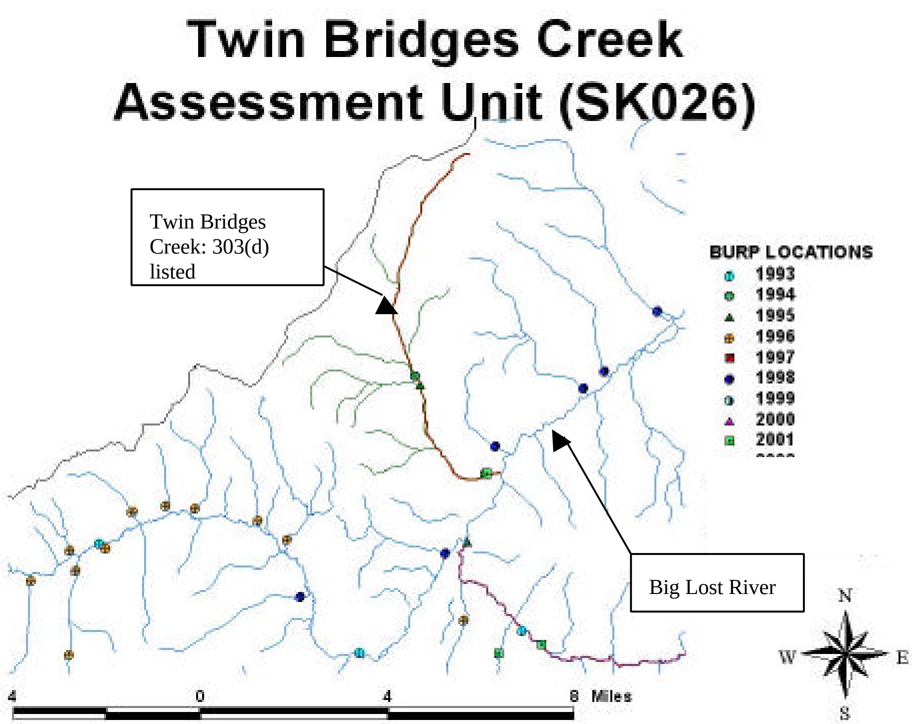


**Figure 19.  Twin Bridges Creek assessment units.**

Burnt Creek and Garden Creek are included in assessment unit SK025, with Deep Creek, and Lake Creek (Figure 20).   All of these creeks are ephemeral with short duration flows less than 1cfs throughout their course for all but the peak of snowmelt runoff.  Their connection with the Big Lost River is limited and sporadic.  In 2002 BLM measured flow in Burnt Creek, Deep Creek, and Garden Creek (Table 3) using a specialized weir to quantify low flow.  Flow regime in 2003 was similar with the stream channel dry by 8/15/2003.  Public land grazing occurs throughout the year in each of the subbasins.

Land management over the lower mile of Burnt Creek is BLM. Forest Service manages approximately two miles of stream above BLM. Grazing occurs throughout the watershed.

**Table 3. Flow Measurements in Assessment Unit SK025.**

| Location | Date | Time (hrs) | Flow (cfs) |
|---|---|---|---|
| **Burnt Creek** | 7/8/2002 | 12:00 | 0.44 |
| | 7/30/2002 | 11:25 | 0.09 |
| | 8/11/2002 | 12:30 | Too low to measure |
| **Deep Creek** | 7/08/2002 | 10:45 | 0.14 |
| | 7/17/2002 | 14:00 | 0.08 |
| | 7/30/2002 | 11:15 | Too low to measure |
| **Garden Creek** | 7/08/2002 | 11:45 | Dry |
| | 7/30/2002 | 11:20 | Dry |

The Forest Service manages approximately 3 miles of land adjacent to the main channel above the confluence of Deep Creek and BLM manages approximately 5 miles to the confluence of Burnt Creek where private land begins. Land use in this Assessment Unit is primarily grazing. There are two developed recreation sites in this reach: The Deep Creek Recreation Area and the Garden Creek Recreation area.

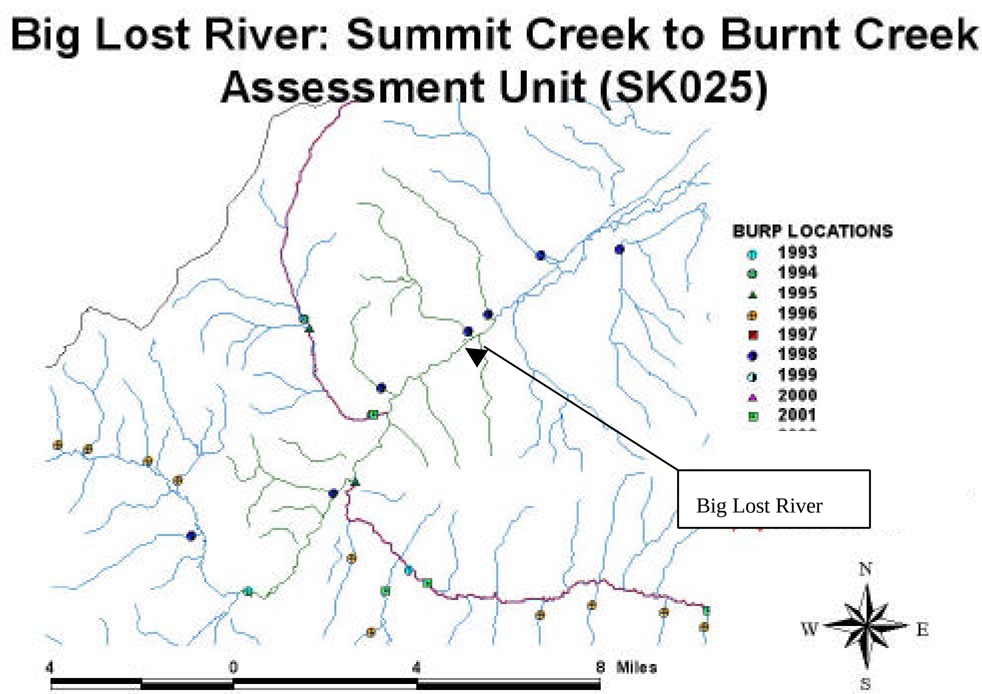


**Figure 20. Big Lost River Summit Creek to Burnt Creek assessment units.**

The Big Lost River from the confluence of Burnt Creek to Thousand Springs Creek comprises the Big Lost River-Burnt Creek to Thousand Springs assessment unit, SK024. This includes Bady Creek, Grant Creek, Pinto Creek, Rock Creek, Talman Creek and Bartlett Creek. These tributaries exhibit similar flow pattern to the streams in SK025: they are ephemeral with flow duration of not more than four months of the year, however they exhibit lower annual flow. The Pinto Creek watershed enters from the north through a steep walled canyon as an A channel that becomes a B channel about ½ mile above the mouth of the canyon. Pinto Creek does support a viable fish population in the upper watershed, protected by the steep canyon. Bady, Grant, Rock and Bartlett Creeks have similar channel transitions and enter the Big Lost River Valley from the White Knob Mountains from the south. Each of the southern watersheds is intercepted by an ephemeral ditch system before they contribute seasonal runoff to the Big Lost River.

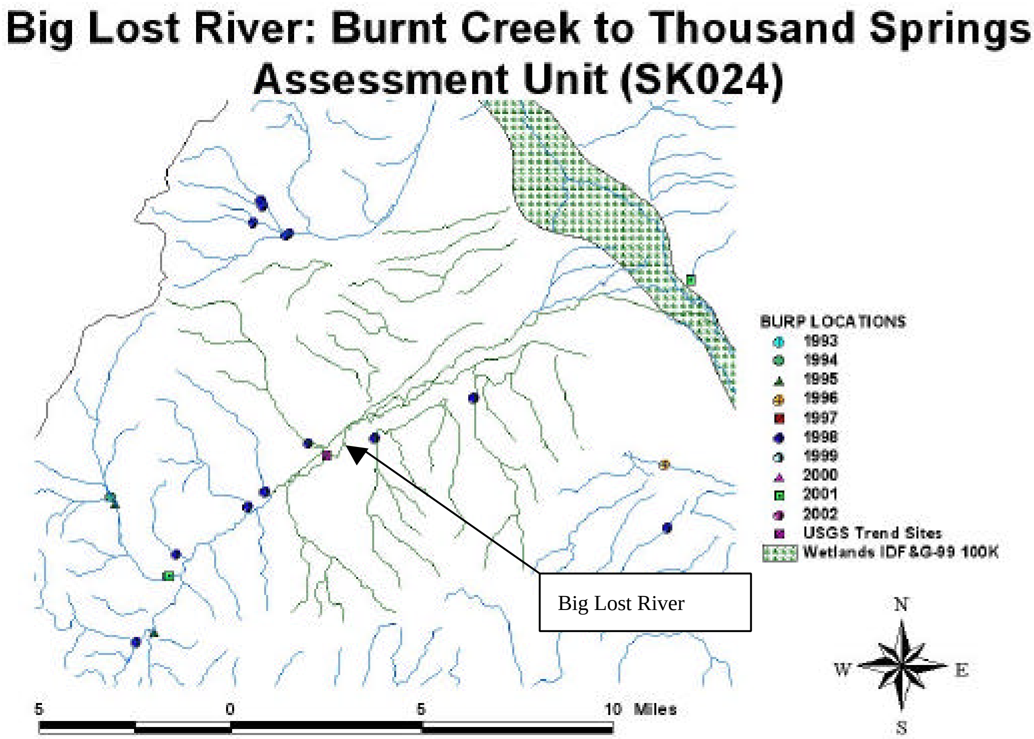


**Figure 21. Upper Big Lost River, Burnt Creek to Thousand Springs assessment unit.**

Land management is primarily private along the main channel with approximately 4 miles of BLM management interspersed with private. The lower 1.25 miles of Bady Creek is privately owned. BLM manages much of the land adjacent to tributaries.

Further downstream the Parsons Creek channel of the Big Lost River splits from the main channel (Figure 22). This is the Parson's Creek Assessment Unit. Parson's Creek is an ephemeral reach below source springs that produce a short flowing reach that is actually a cutoff channel of the Big Lost River and it only carries water to its confluence with Warm Springs Creek during peak flow from snowmelt runoff. It has some ground water recharge to the channel over short reaches and it functions as an irrigation delivery conduit for a short period when the Big Lost River is at peak flow. Like the Big Lost River below Chilly Butte the flow in Parson's Creek infiltrates beyond a subsurface geologic feature in the alluvium between Bartlett Point and the upper Chilly Butte, and the channel is dry for 8 or more months per year. Management is mostly private.

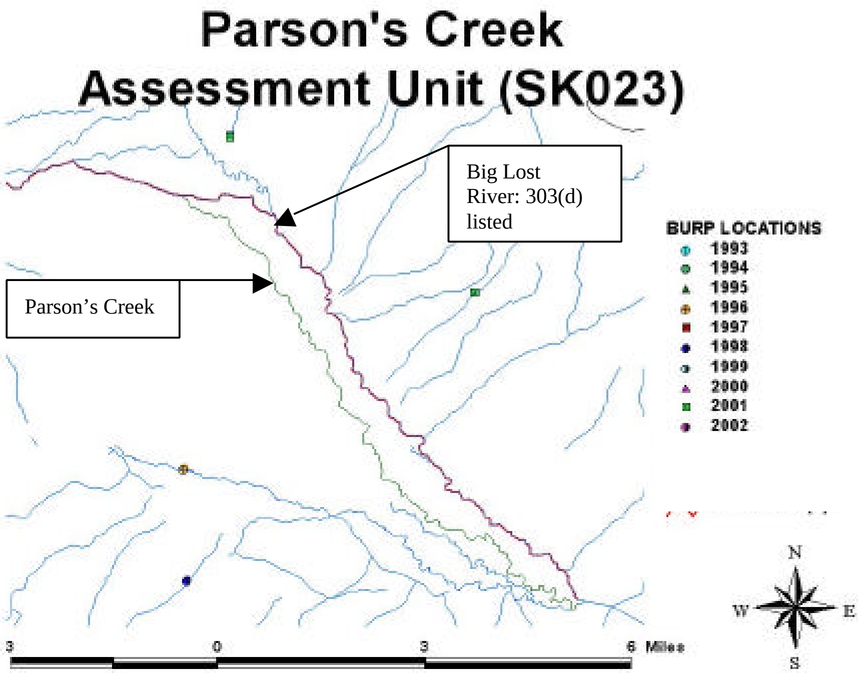


**Figure 22. Parson's Creek Channel of the Big Lost River assessment unit.**

Below the Parsons Creek cutoff channel the flow from the Thousand Springs subwatershed comes in to the Big Lost River Channel (Figure 23). The primary source of water to Thousand Springs Creek is the complex of springs that flow in Chilly Slough. Chilly Slough is a marsh complex that covers approximately 9,110 acres and the through-flow is referred to as Thousand Springs Creek. Below upper Chilly Butte this is usually the only flow available to the Big Lost River between Chilly Butte and Mackay Reservoir, where the perennial flow from Warm Springs Creek enters the Reservoir. Thousand Springs Creek would be important refuge to any aquatic species that would populate the main channel, though the Thousand Springs Creek channel and riparian habitat are highly degraded from over grazing. Land ownership along the main channel is primarily private with interspersed BLM management along the main channel and lower tributaries. Grazing occurs around the periphery of the marsh and extends onto wet meadows surrounding the marsh. Season-long livestock grazing occurs on the private land below the marsh to the confluence of Thousand Springs Creek with the main Big Lost River.

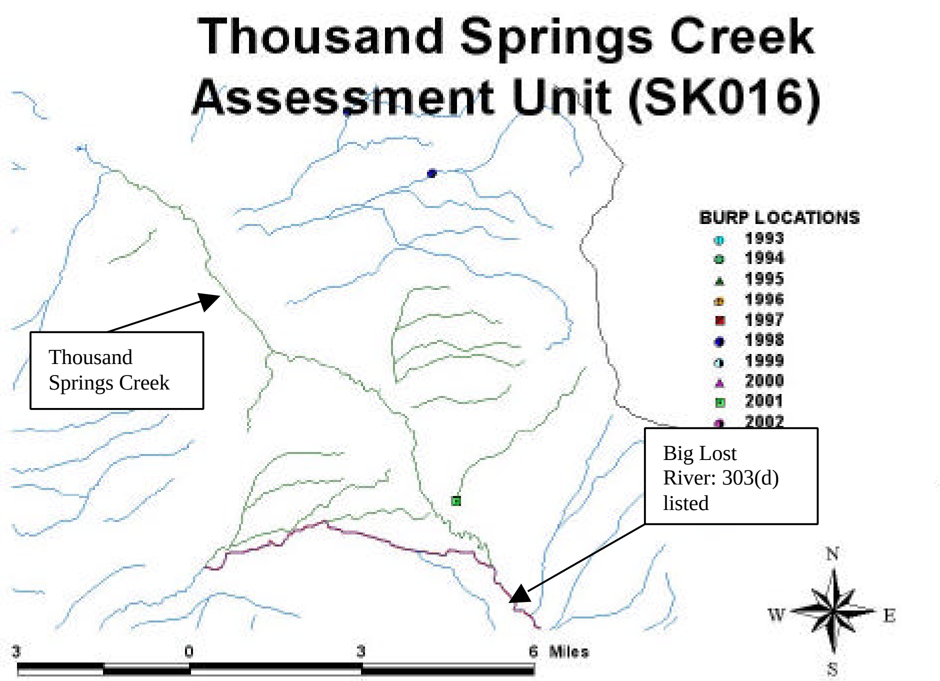


**Figure 23. Thousand Springs assessment unit.**

Above Thousand Springs Creek and Chilly Slough is an ephemeral subwatershed that centers on Sage Creek (Figure 24). The Sage Creek watershed is primarily managed by BLM. Flow seldom extends below the confluence of the North Fork of Sage Creek, Sage Creek and Corral Creek (Table 4). A permanent diversion takes flow above 1 cfs throughout the year. This area is heavily grazed with visible impacts to streambanks and riparian vegetation. The North Fork of Sage Creek is included in a Wilderness Study Area that is roaded and grazed. A significant timber sale was conducted in the Sage Creek watershed in the 1950s resulting in sediment impacts that have been compounded by grazing practices since that period with channel downcutting and bank erosion. Though the sum of flows shown in Table 4 below is greater than 1cfs, the flow is heavily diverted and any remaining flow rapidly infiltrates below the confluence of the two streams before the channel reaches Chilly Slough and Thousand Springs Creek.

**Table 4. Flow Measurements in Assessment Unit SK022.**

| Location | Date | Time (hrs) | Flow (cfs) |
|---|---|---|---|
| **Sage Creek** | 7/1/2002 | 13:00 | 0.96 |
| | 7/8/2002 | 13:30 | 0.65 |
| | 7/30/2002 | 12:10 | 0.19 |
| | 8/11/2002 | 12:30 | 0.17 |
| **North Fork Sage Creek** | 7/1/2002 | 13:30 | 0.61 |
| | 7/08/2002 | 13:15 | 0.5 |
| | 7/30/2002 | 12:00 | 0.24 |
| | 8/11/2002 | 13:00 | 0.31 |

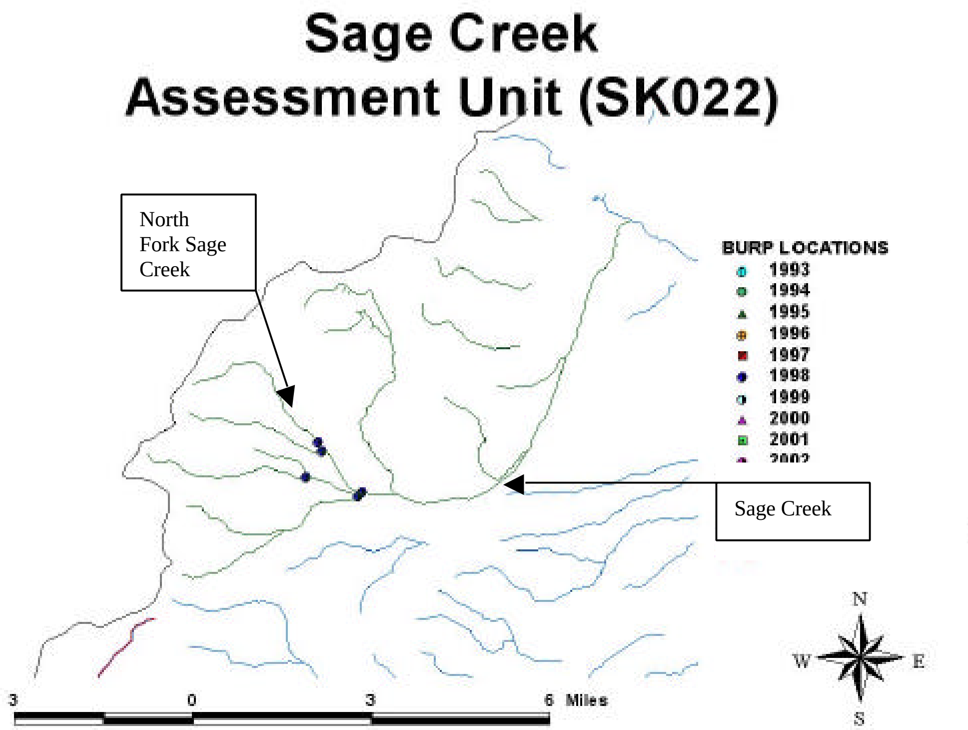


**Figure 24. Sage Creek assessment unit.**

In the Northern-most part of the watershed there are ephemeral seasonal washes and isolated spring seeps affiliated with Arentson Gulch (Figure 25). These Arroyo type channels are defined by high width to depth ratio with little or no riparian vegetation, other than sedges affiliated with spring seeps. Land ownership adjacent to the channels is primarily private with BLM managed lands outside the private corridor. Actual surface flow is for brief periods during early snowmelt and significant summer thunderstorms. These streams are primarily B channels that drain dry gulches over alluvial fans and infiltrate long before any confluence is made with perennial flow. Any available surface flow is captured in water tanks or livestock watering depressions in the spring and early summer. Grazing occurs throughout the subbasins of Arentson Gulch and Willow Creek and is the primary land use in addition to transportation along Highway 93 and the Doublesprings Pass Road. There is an Earthquake Visitor Center along Doublesprings Pass Road. Recreational use is primarily dispersed camping and off-road vehicle use.

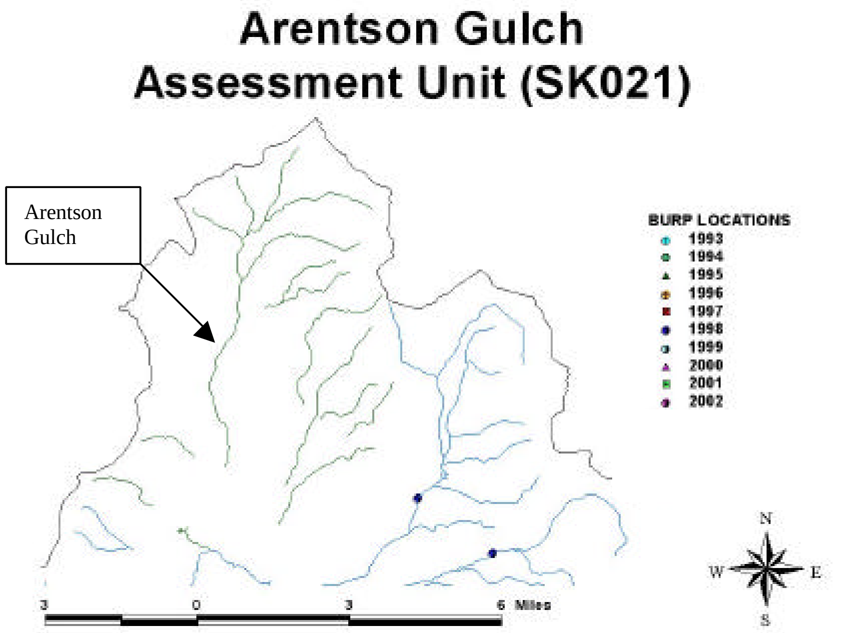


**Figure 25. Arentson Gulch assessment unit.**

Double Springs Pass joins the Big Lost River watershed with the Pahsimeroi watershed. Willow Creek flows from springs on the Big Lost River side of Double Springs Pass. Willow Creek is completely diverted about a mile below its source and flows from the Pass toward Thousand Springs Creek in a system of ditches below the point of diversion until it is consumed. Any available flow after diversion during the runoff period of peak flow infiltrates before a confluence is made with Thousand Springs Creek. The subwatersheds in the eastern section of the Big Lost River watershed drain the flanks of the Lost River Range over large alluvial fans in A and B channels. Flow below the point of infiltration is during brief periods of early snowmelt and intense sporadic thunderstorms. These ephemeral streams do not support aquatic life other than areas adjacent to the springs and seeps. Many of the ephemeral streams are fishless, while some that are close to roads have been stocked with brook trout in upper perennial reaches. Brook trout are no longer stocked and any brook trout populations within the watershed are self-sustaining.

Land management in the Willow Creek subbasin is an even split between BLM and Forest Service. Land use is primarily grazing. The Willow Creek assessment unit is shown in Figure 26.

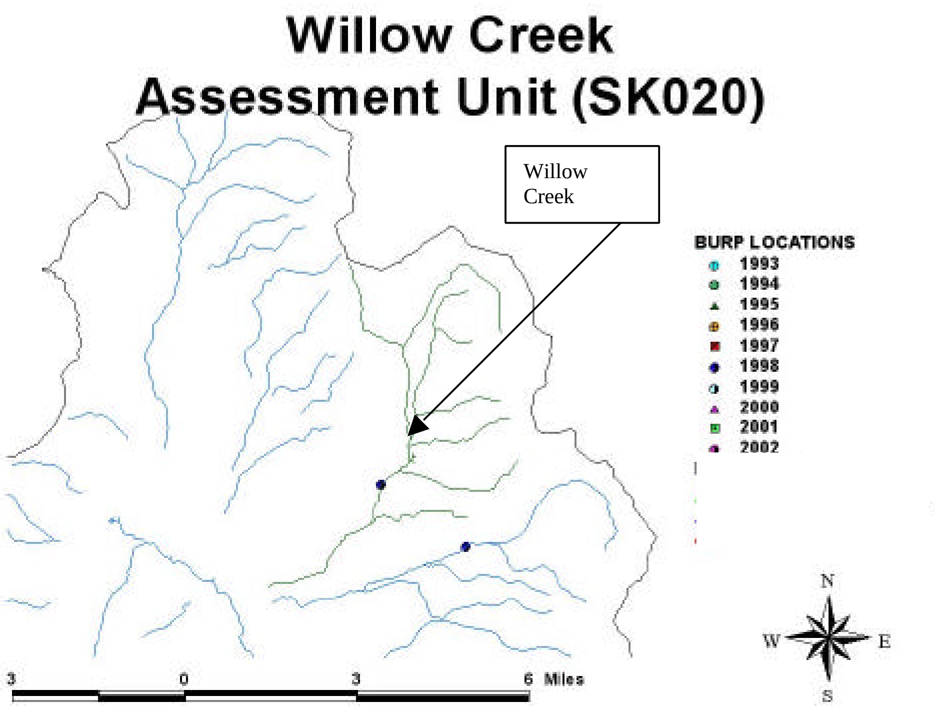


**Figure 26. Willow Creek assessment unit.**

Rock Creek is a perennial stream that flows from the flanks of Mount Borah, then infiltrates into alluvium long before it makes a confluence with the Big Lost River (Figure 27). It is not to be confused with the Rock Creek in Assessment Unit 024. Flow below the point of infiltration lasts for brief periods during early snowmelt and thunderstorms. The upper channel is an A channel that transitions to a B channel at the top of the alluvial fan and then infiltrates before any confluence is made with the Big Lost River.

Land management is primarily Forest Service with BLM managing the lower ephemeral reach. Land use is primarily grazing with recreation occurring at the Mt. Borah trailhead. Off-road vehicle trails and pioneered ghost roads branching through the subbasin.

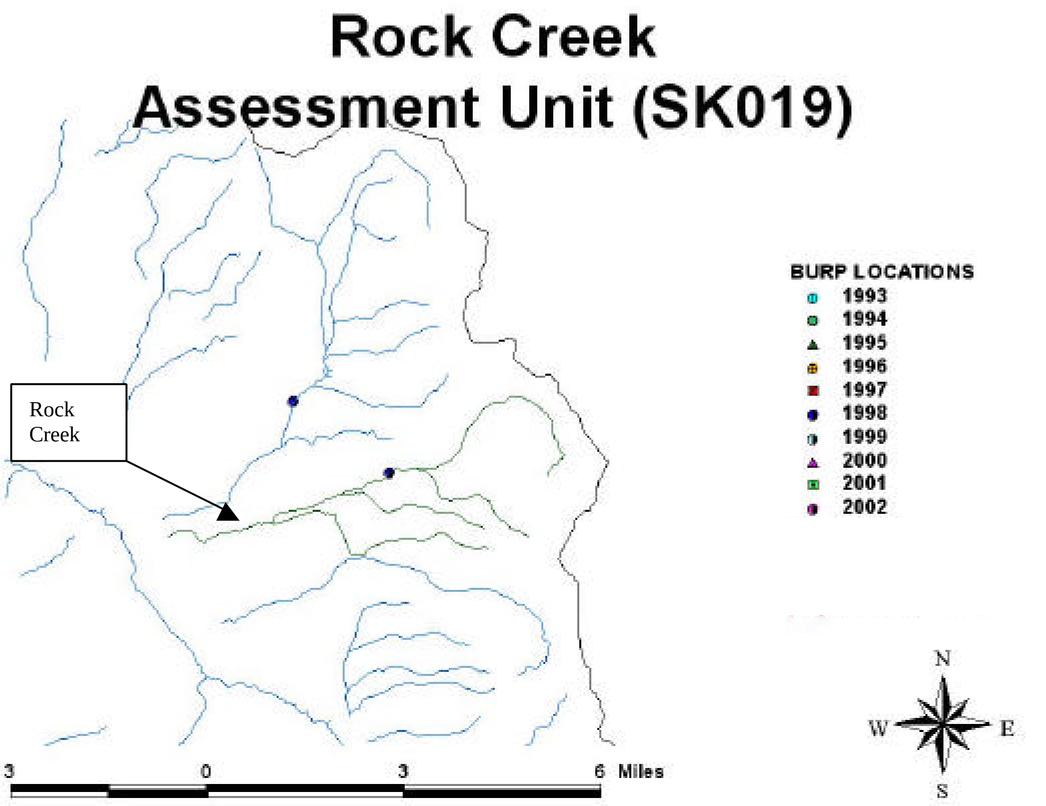


**Figure 27. Rock Creek assessment unit.**

Lone Cedar Creek is a perennial stream that infiltrates into alluvium well above its confluence with the Big Lost River (Figure 28). It doesn't connect during other than extreme runoff events. At 6780 ft elevation there are juniper trees growing in the stream channel. Land management is primarily BLM over the ephemeral reach and Forest Service over the upper elevations in tight canyons. Land use is primarily grazing on BLM and lower Forest Service.

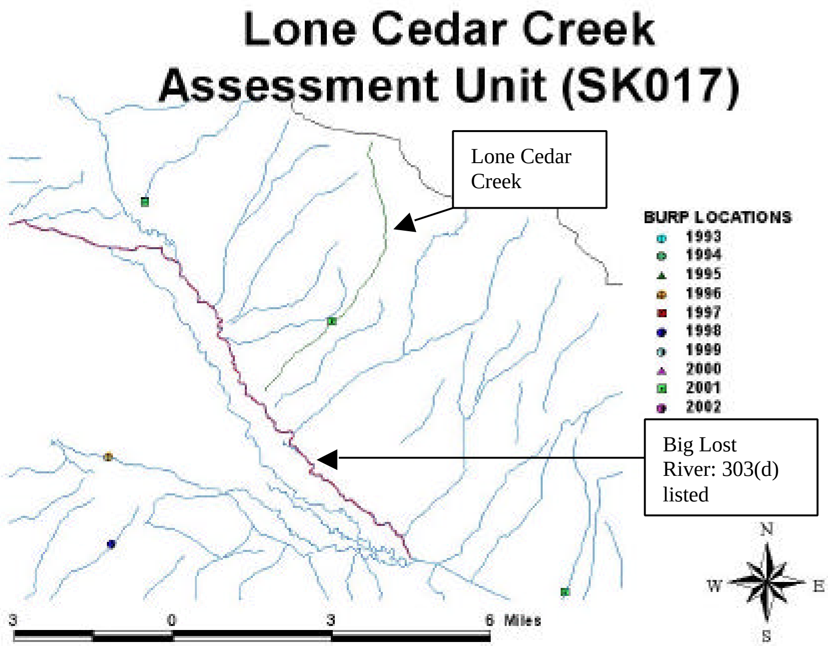


**Figure 28. Lone Cedar Creek assessment unit.**

The Big Lost River infiltrates into alluvium at Chilly Butte, at the Chilly Sinks, and the Big Lost River Channel remains dry to the confluence of Thousand Springs Creek throughout the majority of year when snowmelt runoff is not at its peak. The Big Lost River from Thousand Springs to Jones Creek does not have any perennial surface connection with tributaries other than Thousand Springs Creek. Surface water inflow from Thousand Springs Creek quickly infiltrates after its confluence with the Big Lost River. Land management is private along the main Big Lost River channel and BLM manages the uplands. The valley widens below Chilly Buttes and land use becomes slightly more diversified along this reach with forage crop production increasing. Groundwater pumping combined with surface diversion irrigation provides potential for irrigated pasture, alfalfa, and livestock watering. Residential developments are not common, but smaller tracts of land are found within the matrix of working ranches and farms. Recreational properties are being marketed, but the majority of residences are season long. Population density remains low and is not having a significant impact on water quality in the valley above Mackay Reservoir.

The remaining Assessment Unit watersheds of the upper Big Lost River subwatershed that originate in the Lost River Range above Mackay Reservoir are ephemeral. Surface water over the lower reaches infiltrates into alluvium and does not contribute flow to the Big Lost River. Land management is primarily BLM and land use is primarily grazing (Figures 29, 30 and 31). At Mackay Reservoir there are a number of boat ramps and developed camping facilities operated by the Bureau of Reclamation. One campground is managed by BLM. Mackay Reservoir is shown in Figure 32. Access is from Highway 93 and fishing and camping are the primary recreational activities as well as off-road vehicles, hiking and mountain biking.

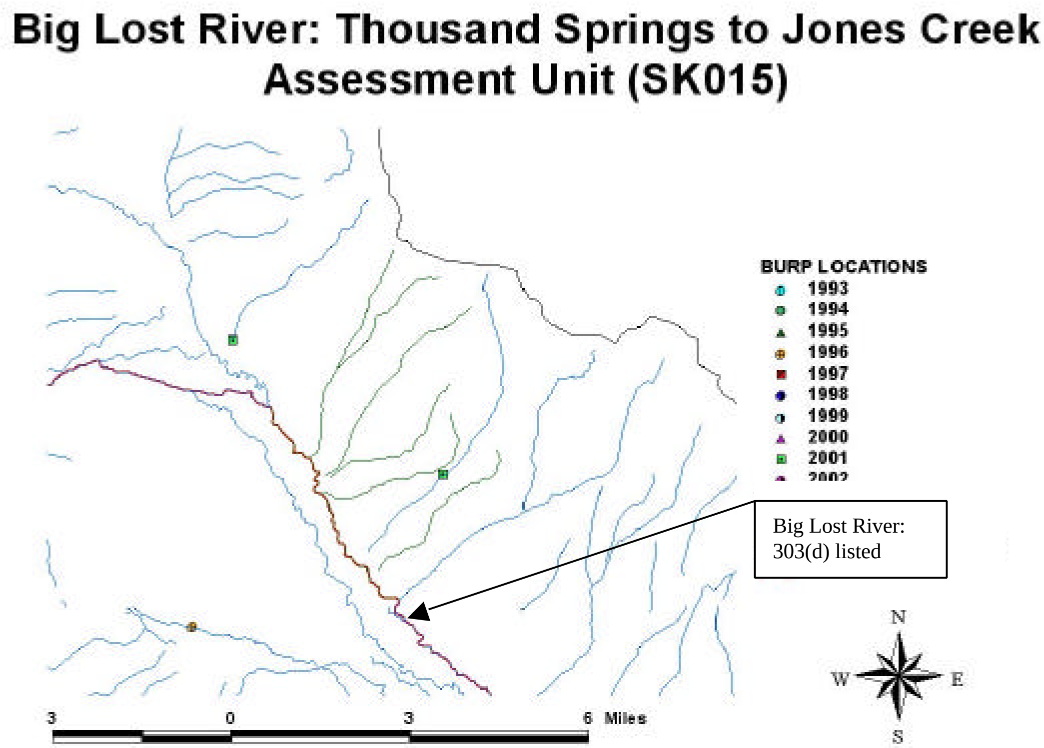


**Figure 29. Big Lost River from Thousand Springs to Jones Creek assessment unit.**

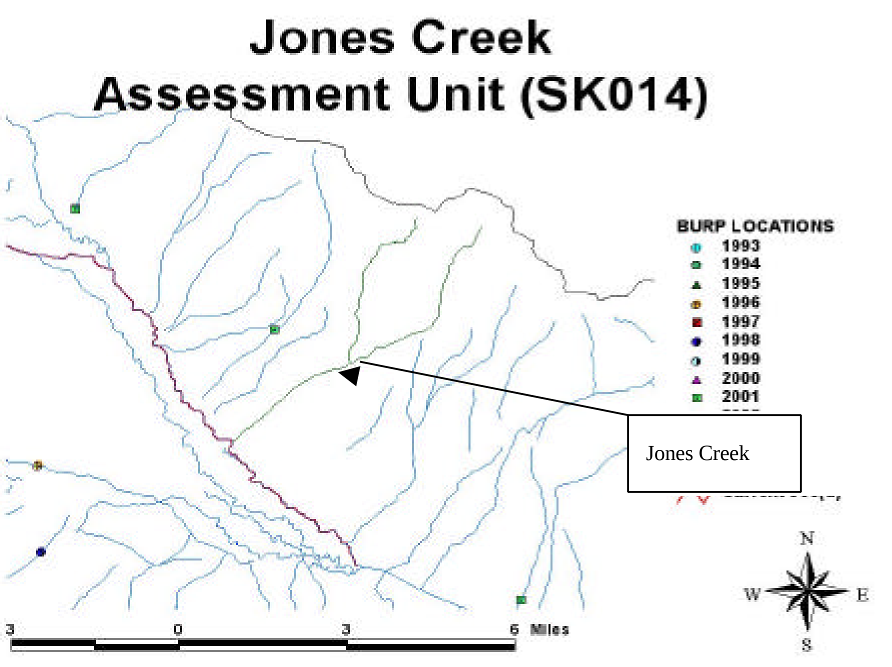


**Figure 30. Jones Creek assessment unit.**

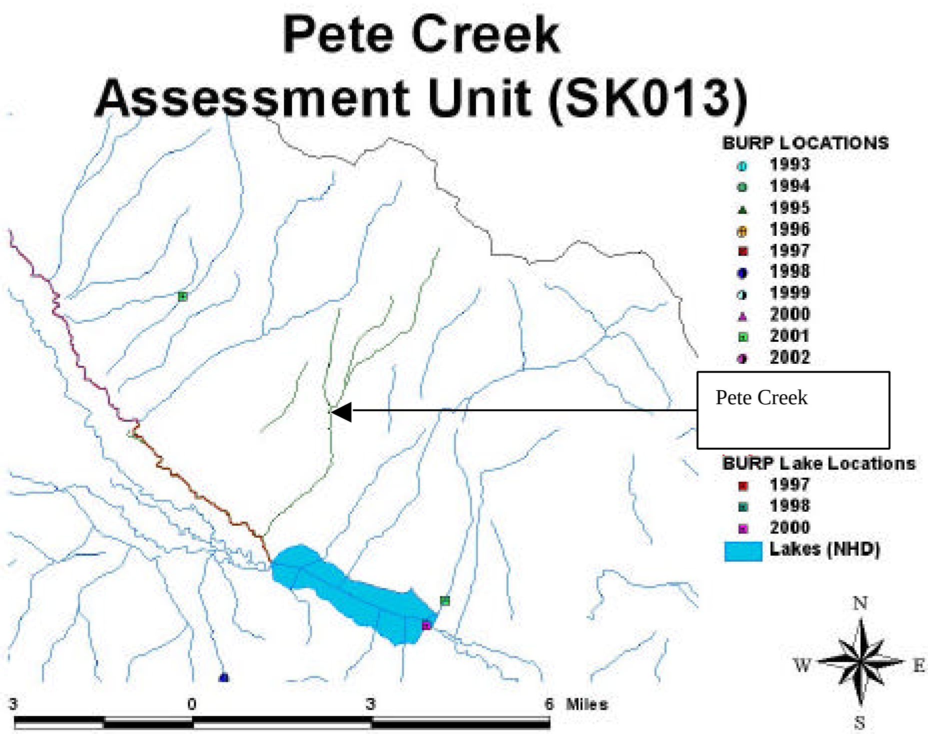


Figure 31. Pete Creek assessment unit.

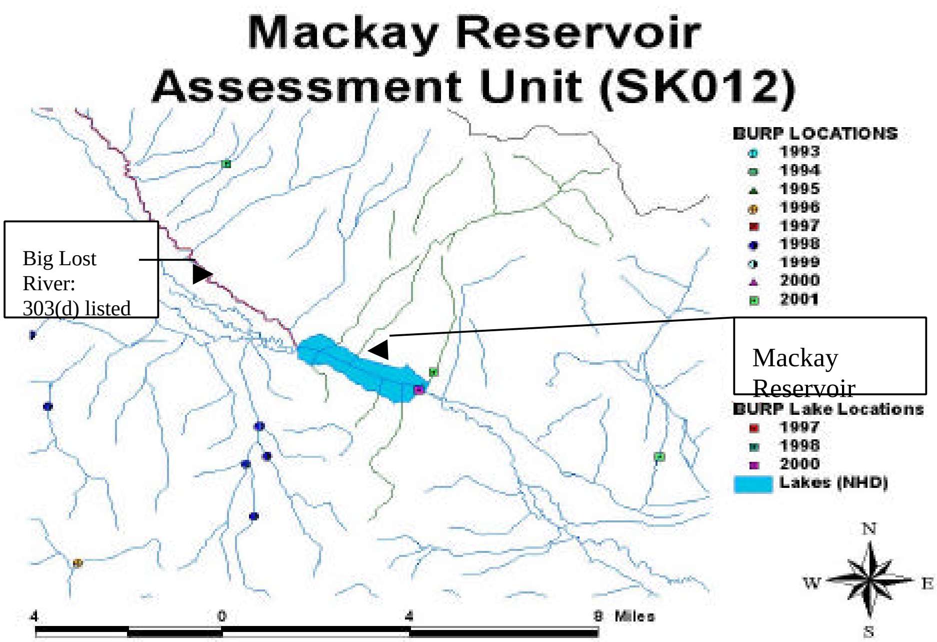


Figure 32. Mackay Reservoir assessment unit.

Warm Springs Creek originates at Hamilton Springs on the western side of the valley. This channel is also referred to as the North Channel, with the South Channel being Whiskey Springs, where the Idaho Fish and Game Hatchery (Mackay Hatchery) is. Flow from Hamilton Springs is remarkably variable in flow, but consistent in temperature at the source with flows over 36 cfs and temperature around 48°F making it an ideal resource for aquaculture. The majority of flow is immediately directed through a series of collection pipes through the Lost River Hatchery, a commercial trout hatchery. The effluent from the Lost River Hatchery combines with additional springs and forms the source of Warm Springs Creek which flows to the west to Mackay Reservoir across agricultural land that is used for grazing, forage crop production and residences. The major tributary to Warm Springs Creek is Whiskey Creek. Whiskey Creek, like Warm Springs Creek supplies water to the Mackay State Fish hatchery, a conservation and recreation oriented hatchery operated by the Idaho Department of Fish and Game. Flow ranges from 18cfs to 24 cfs with an average temperature of 52°F.

Warm Springs Creek is the only perennial stream that connects with the Big Lost River below Thousand Springs Creek above Mackay Reservoir (Figure 33). It functions as important spawning habitat and refuge to fish in Mackay Reservoir as well as resident species in Warm Springs Creek.

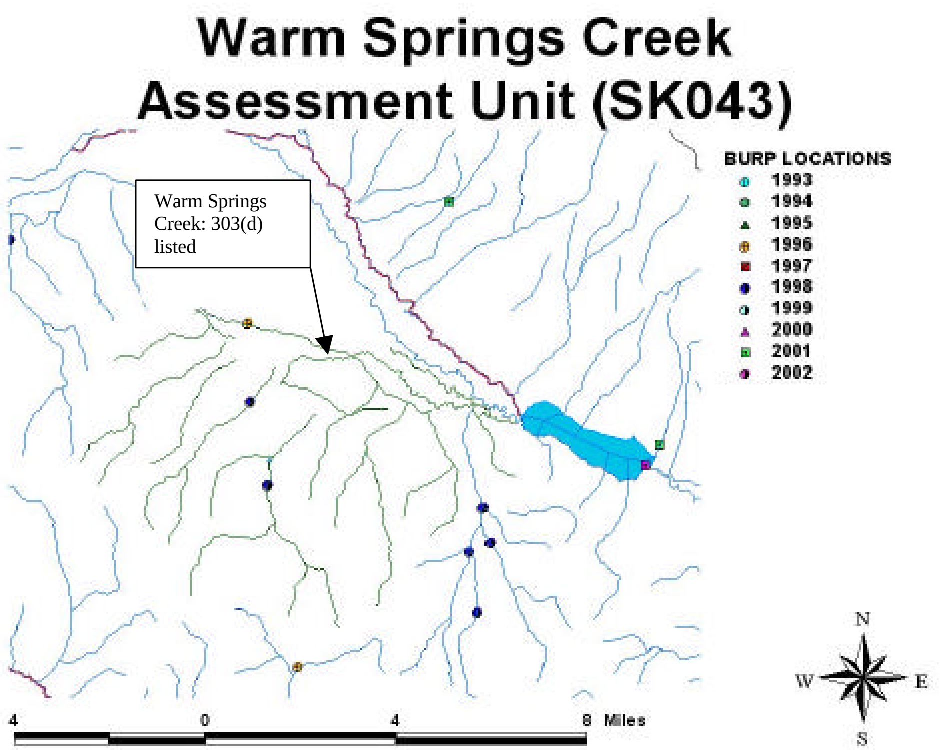


**Figure 33. Warm Springs assessment unit.**

Navarre Creek is a tributary to lower Warm Springs Creek just above the confluence with the Mackay Reservoir (Figure 34). It enters Warm Springs Creek in an area of wetlands and wet meadows that is also managed privately for grazing. The lower 1.5 miles of stream occurs on private land. The Middle 1.5 mile reach is on public land managed by BLM. The upper reaches of the West, Middle and East Fork are on public land managed by Forest Service. Land use includes dispersed recreation and grazing.

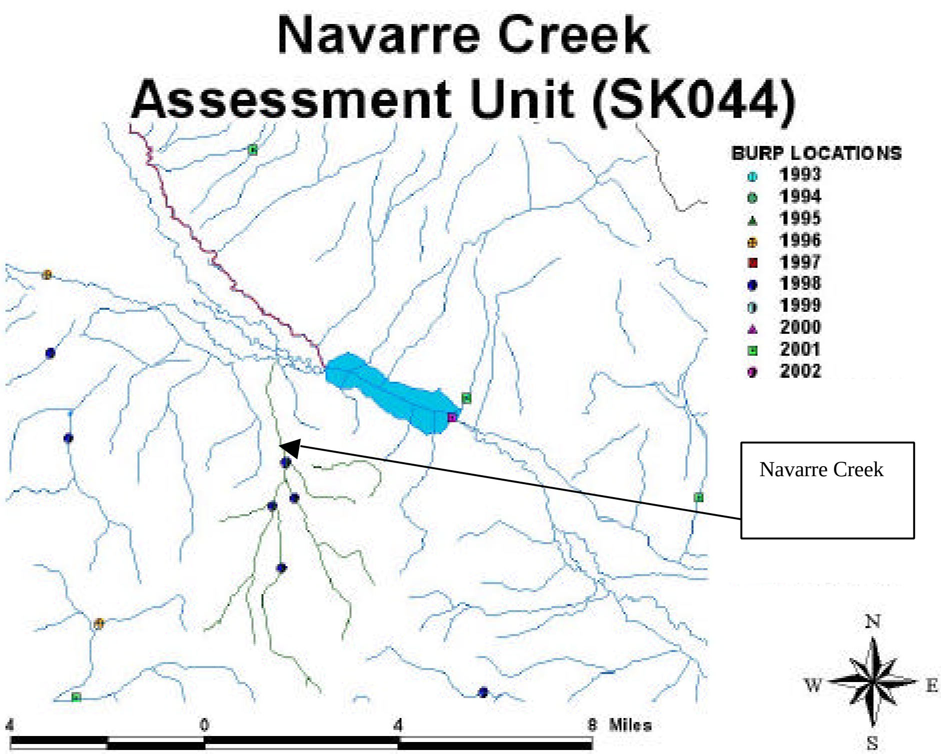


**Figure 34. Navarre Creek assessment unit.**

## Antelope Creek

Antelope Creek has a watershed area of 657.5 km$^2$ with major tributaries consisting of Bear Creek, Cherry Creek, Dry Fork Creek, Spring Creek, Iron Bog Creek, Trail Creek, Timber Creek, and Leadbelt Creek (Figure 35). Flow is the result of snowmelt runoff and storm events. There is no consistent or significant irrigation return flow to the creek. Antelope Creek is formed by the confluence of Timber Creek and Trail Creek at an elevation of 7,289-ft AMSL (Figure 37). Antelope Creek is on the 303(d) list of impaired waters for major pollutants that include sediment, temperature and flow alteration. The 303(d) listed reach extends from the confluence of Spring Creek to the confluence of Antelope Creek with the Big Lost River. Flow is perennial only to the permanent diversion approximately 4.5 miles below the confluence of Cherry Creek, approximately 12 miles above the confluence with the Big Lost River. Over a short reach at this location the flow infiltrates into valley fill material, other than during peak runoff, when the point of infiltration moves downstream approximately 1 mile. Flow may occasionally reach the lower Antelope Creek Road bridge during above average runoff.

Property ownership over the listed reach is private. The floodplain and riparian zone has been heavily altered by conversion to irrigated pasture with limited irrigated crop production, primarily livestock feed. Winter range of livestock is a major land use along the listed reach.

Willows have been eradicated over much of this reach to increase forage production. Burning of riparian willows was observed over the upper listed reach as recent as fall 2002. There are numerous diversion structures that have resulted in head cutting. Recreation is limited to the upper watershed, above the listed reach, and consists of dispersed camping, off-road vehicles, and fishing. There is one developed campground near the confluence of Iron Bog Creek.
The upper watershed includes Trail and Timber Creek as well as Fox Canyon and Hurst Canyon Creeks and is characterized as a Rosgen B Channel in valley type II. This translates to a less sinuous moderately entrenched channel with a gradient between 2 and 4 percent in a valley with moderate relief and side slope gradients with a valley floor gradient less than 4% (Rosgen 1996).

Iron Bog Creek consists of Assessment Units SK054, 55 and 56 (Figure 36). At the confluence of Iron Bog Creek, just above Horsethief Creek, at elevation 6,790 feet, the valley begins to widen into a glacial outwash plain, valley type IX. Bear Creek makes its confluence about 3.75 miles below Iron Bog Creek. The Cherry Creek confluence is about 2 miles below Bear Creek and the channel transitions to a more sinuous C channel. The channel crosses the Antelope Creek Road and rapidly degrades to a less stable D channel as a result of willow eradication combined with the effects of grazing impacts and increased flow energy from the confluence of Cherry Creek and the Dry Fork Creek (Figure 42). The valley constricts below the Dry Fork Creek confluence over a distance of about a mile forcing the channel back into a B channel and then opens into valley type IX again where the channel emerges as an F channel to its infiltration zone where it is a 4th order stream.

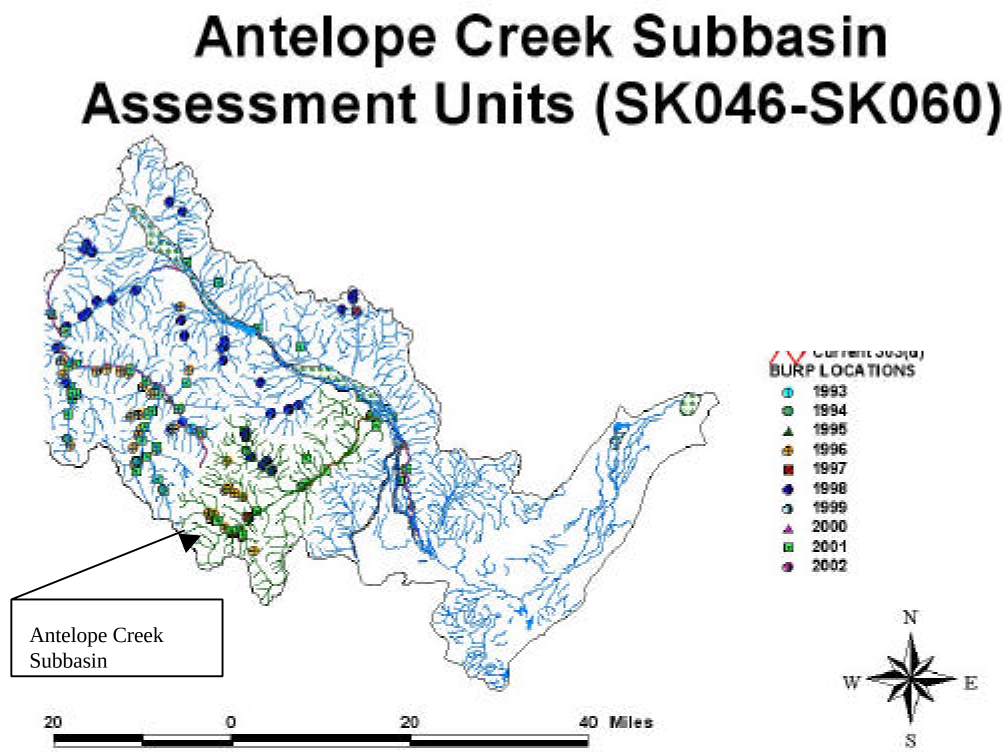


**Figure 35. Location of the Antelope Creek subbasin in the Big Lost watershed.**

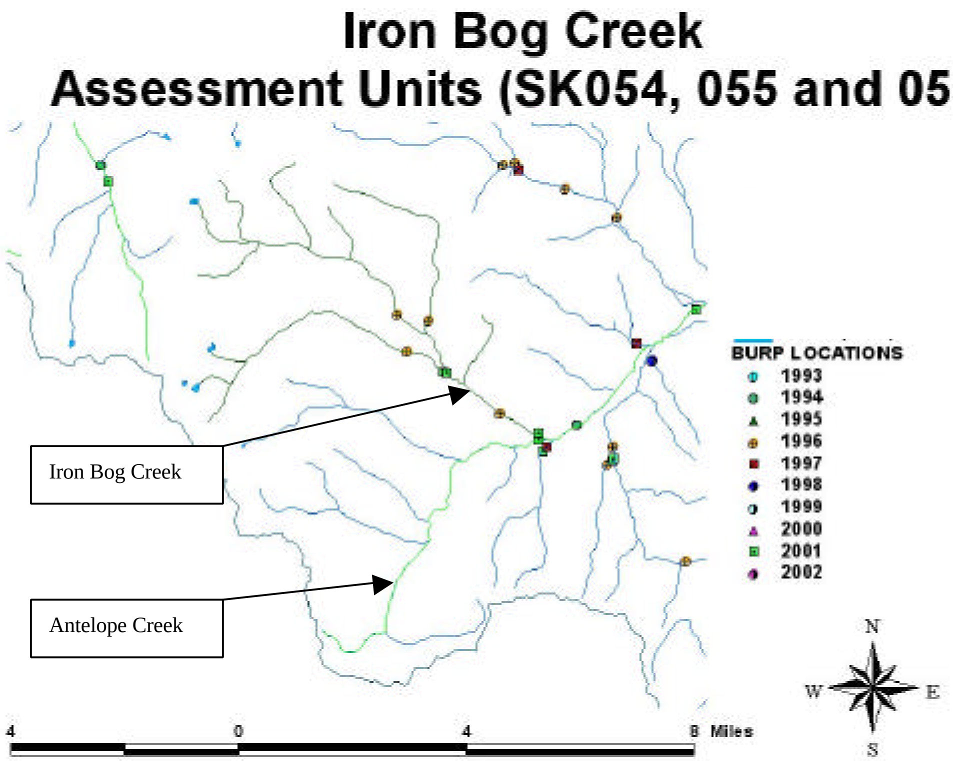


**Figure 36. Iron Bog Creek assessment units.**

Soils throughout the Iron Bog Creek watershed are derived from glaciated volcanics and sedimentary limestone. Sandy silt, poorly cemented silt and bentonite fractions of the outwash lakebed sediments and deposits of glacial till are prolific sediment sources to the river, particularly where riparian vegetation has been altered.

Bear Creek drains similar glaciated volcanic and sedimentary limestone subwatersheds from type II valleys transitioning from channel type A, with 4 to 10% slopes in entrenched confined channels, to B channels, and braided D channels as the valley broadens to the point of confluence with Antelope Creek (Figure 40) . Cherry Creek emerges from a type II valley which transitions to a type IX valley (Figure 41). Channel type progresses from B, at upper elevations, where it hosts a series of senescent beaver dams, goes through a short valley constriction and transitions to an entrenched C channel on private land where the valley broadens to the confluence with Antelope Creek. Bear Creek is a 3rd order stream at its confluence.

Leadbelt Creek, 303(d) listed for sediment and temperature, enters the valley just upstream from Bear Creek (Figure 38). Leadbelt Creek is an ephemeral spring creek with flow less than 1 cfs that infiltrates shortly after it originates after flowing through a series of beaver dams. It only sporadically makes its confluence with Antelope Creek during periods of peak runoff. It is a 2nd order stream where it infiltrates.

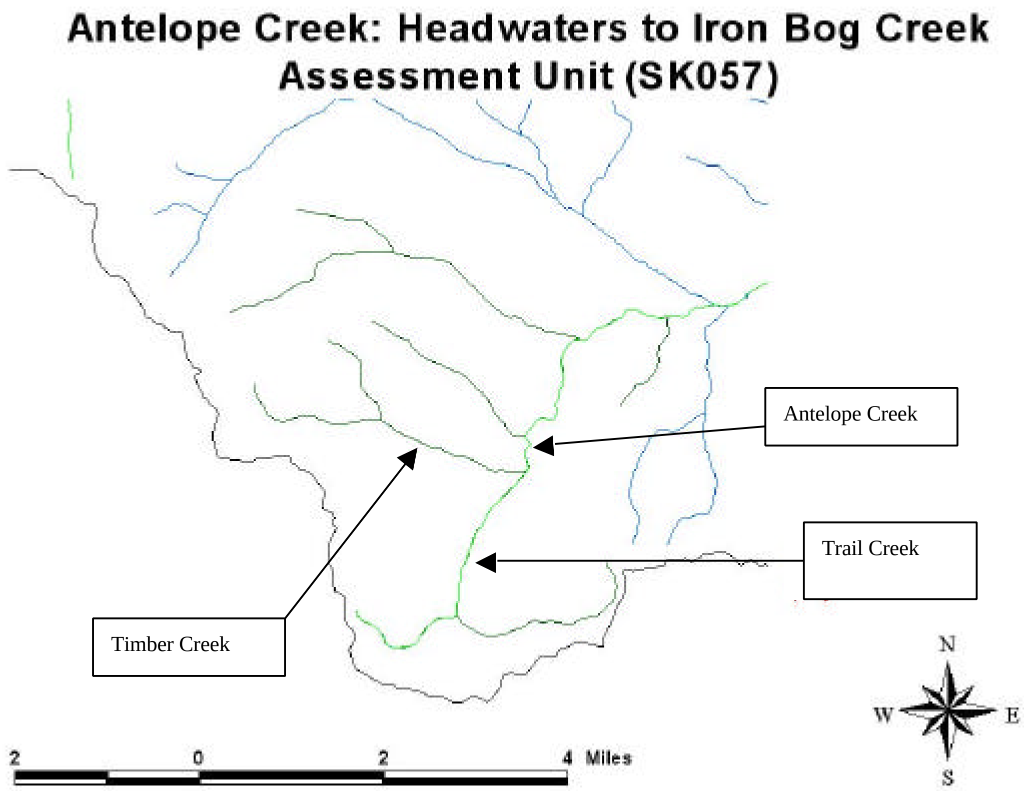


**Figure 37. Upper Antelope Creek assessment unit.**

Iron Bog Creek originates in alpine cirque lakes in volcanic geology and pours through A and B channels through type II valleys to its Confluence to form Antelope Creek. It is perennial and attains 3rd order at its confluence. On public land, managed primarily by the USDA Forest Service, land use is grazing and recreation. Grazing occurs throughout the upper watershed from June through October. Bank trampling, shearing, and widened stream channels are evident in all of the watersheds. Off-road vehicles have pioneered trails on hillsides and throughout riparian areas. These trails often lead to dispersed campsites primarily used during hunting seasons. There are numerous stream crossings with rills and gullies associated with hillslope trails. Mining has been limited in the watershed and primarily exploratory. There are no identified issues with mine waste rock or tailings.

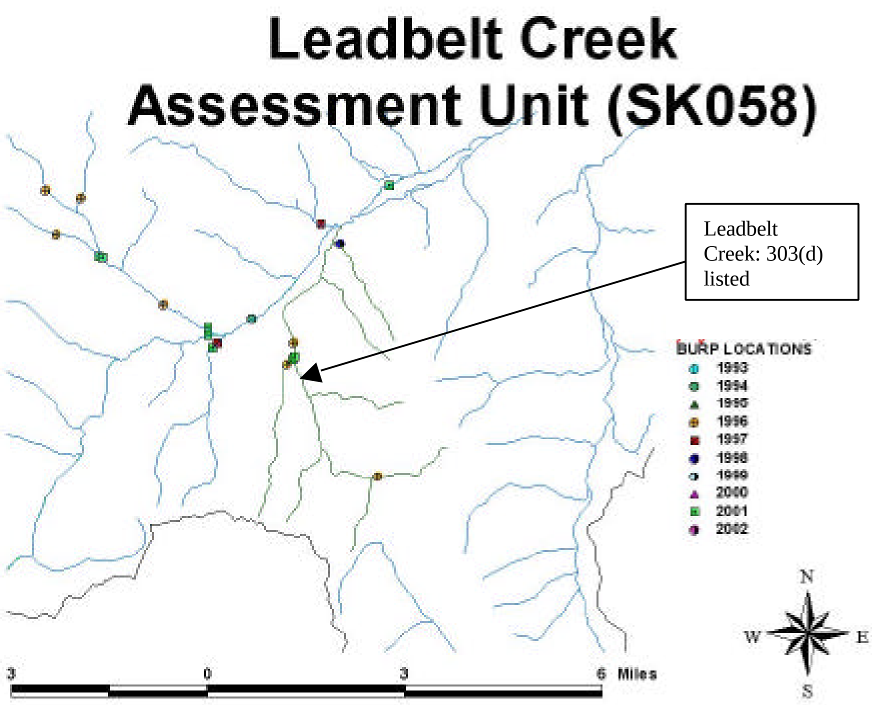


Figure 38. Leadbelt Creek assessment unit.

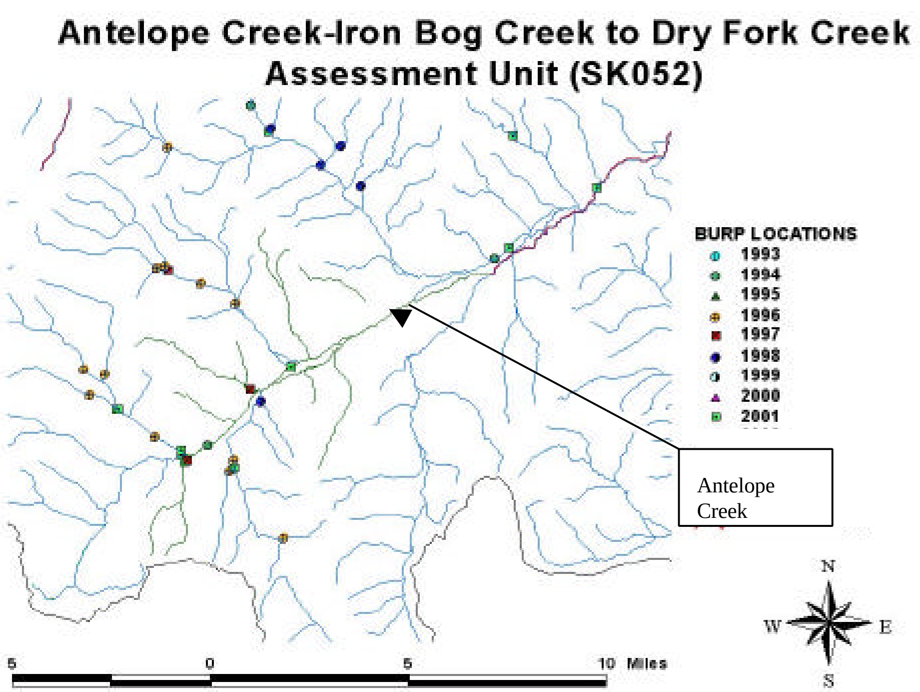


Figure 39. Antelope Creek Iron Bog Creek to Dry Fork assessment unit.

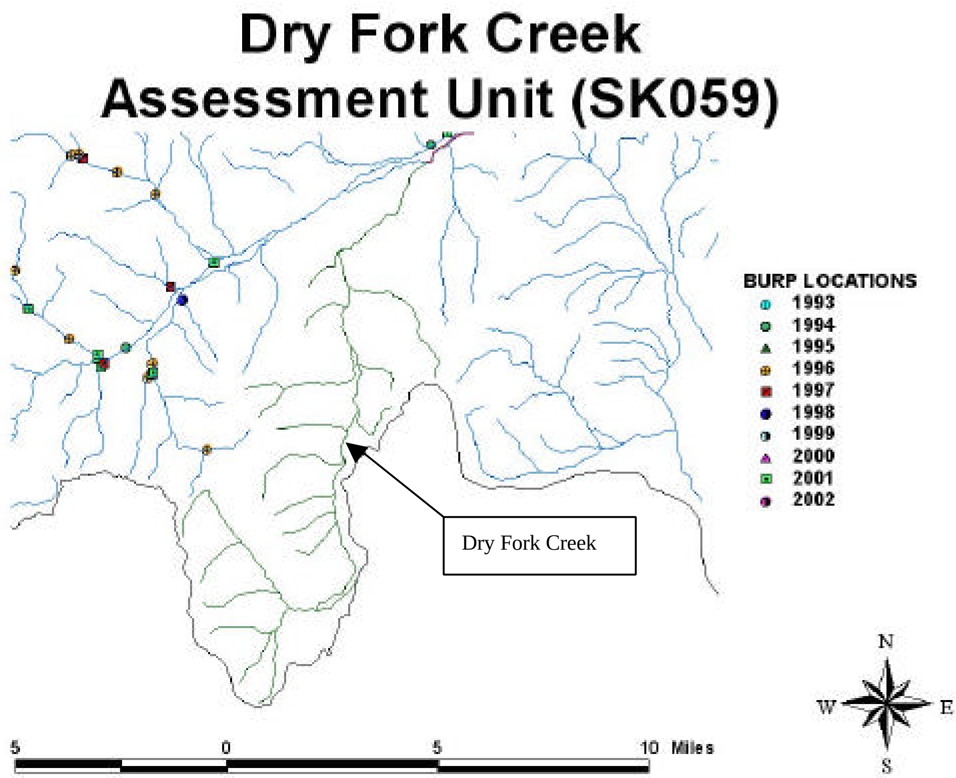


Figure 40. Dry Fork Creek assessment unit.

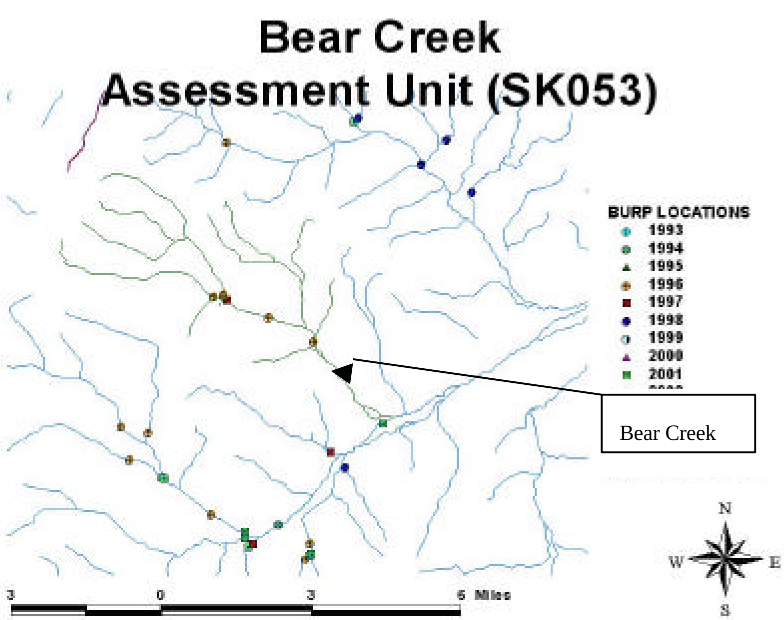


Figure 41. Bear Creek assessment unit.

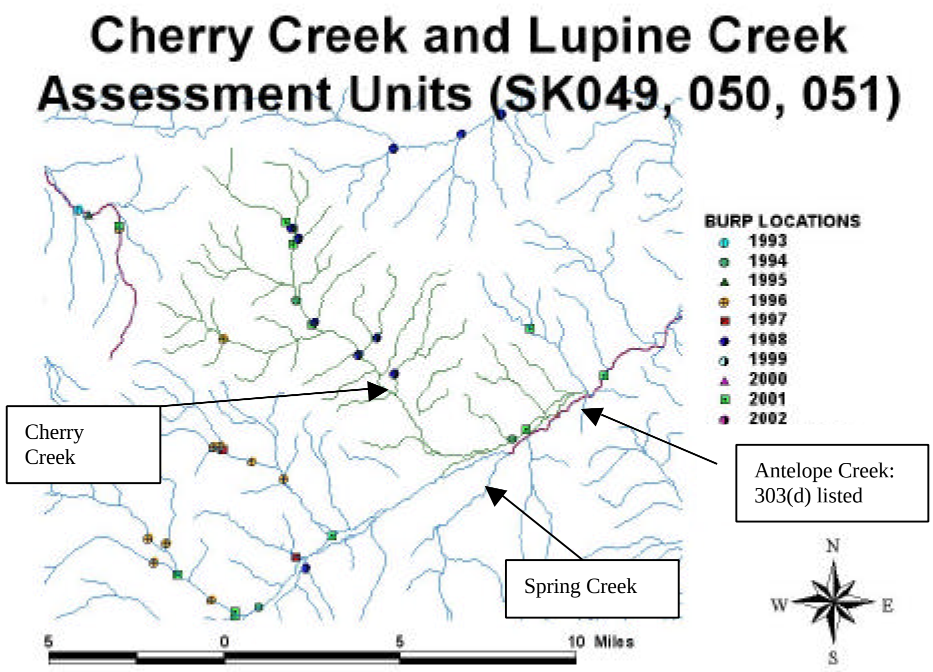


Figure 42. Cherry Creek assessment unit

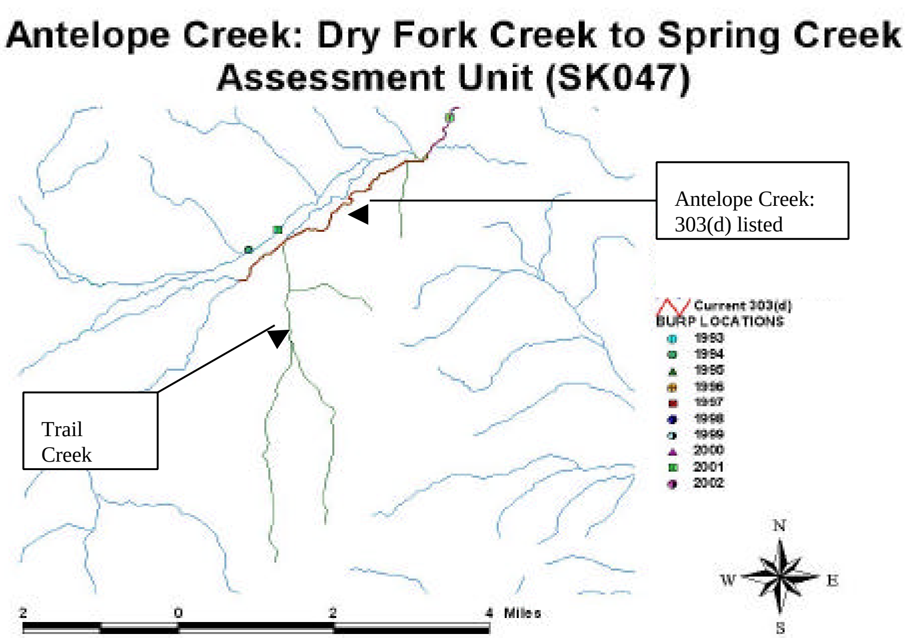


Figure 43. Antelope Creek Dry Fork Creek to Spring Creek AU.

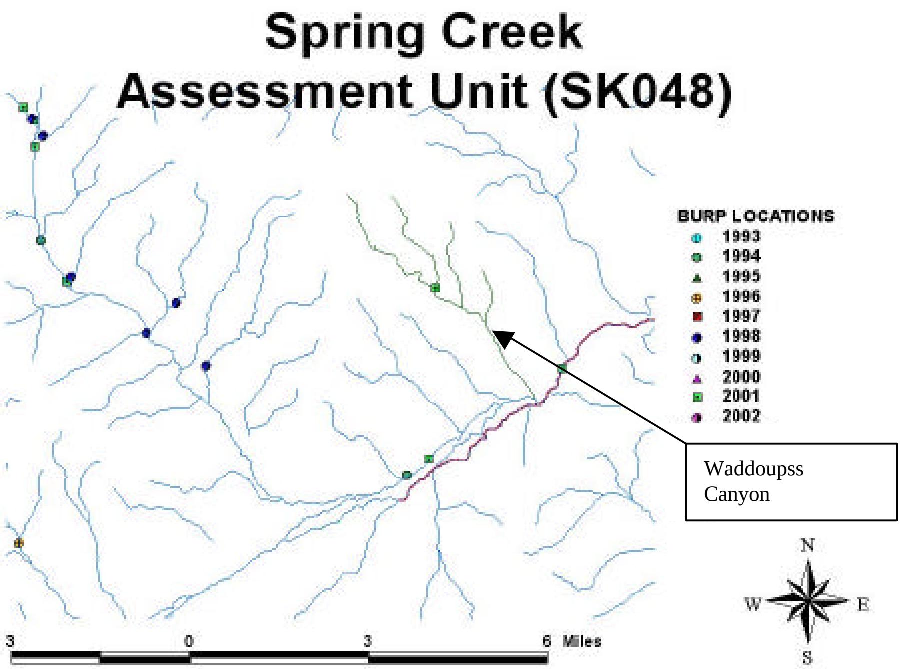


**Figure 44. Spring Creek assessment unit.**

From the confluence of Spring Creek (Dry Fork Creek) to the diversion structure where the South Fork of Antelope Creek begins is increasingly degraded. Alteration of riparian habitat is extensive in places and the effects are obvious. Vertical eroding streambanks dominate this reach. There is a short reach of improved riparian vegetative structure at a constriction several miles below Spring Creek. Below this constriction is the last diversion that sees perennial flow. This is where Antelope Creek breaks with a southern ephemeral channel that is known as the South Fork of Antelope Creek (Figure 45). This is actually a historic channel of Antelope Creek prior to the diversion and channelization of today. Below the diversion flow is of short duration and sporadic to the confluence with the Big Lost River (Figure 46).

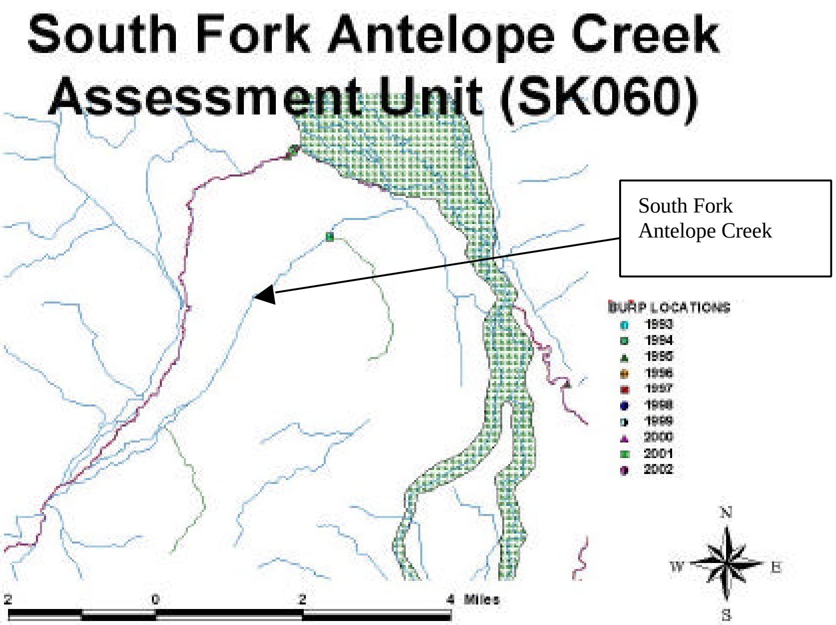


**Figure 45. South Fork of Antelope Creek assessment unit.**

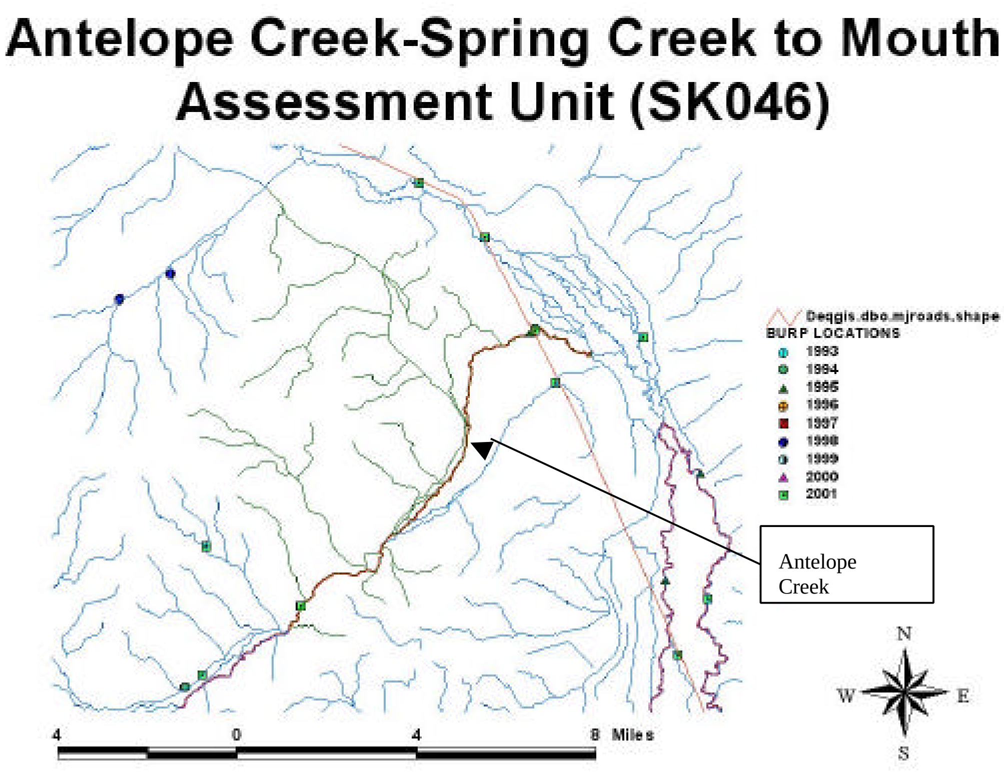


**Figure 46. Lower Antelope Creek assessment unit.**

## Lower Big Lost River

The Lower Big Lost River Assessment Units include the segment of the river that is in full support of cold water aquatic life beneficial uses from the Mackey Dam to the Moore Diversion and the segment that is effected by flow alteration below the Moore Diversion (Figure 47). The City of Mackay is on the upper reach approximately 4 miles downstream of the Mackay Dam. The Moore Diversion occurs approximately 22 miles downstream of the Mackay Dam Below the Moore Diversion the river is primarily dewatered for irrigation for 8 or more months per year. At the Moore Diversion there is an overflow channel that diverges from the primary channel known as Spring Creek. Spring Creek is actually an abandoned channel of the Big Lost River and will be addressed as the Big Lost River below the Moore Diversion in this document. The Spring Creek channel of the Big Lost River occasionally has surface flow when water is not entirely consumed for irrigation at the Moore Diversion and flow is high in the Big Lost River.

Below Mackay Dam there is a zone of spring recharge to the main flow of the Big Lost River, probably affiliated with the valley constriction at the location of the dam and groundwater recharge associated with the dam (Figure 48). Mackay Dam is operated exclusively as an irrigation reservoir though recreational uses exist. The volume of the reservoir is 45,000 acre feet with a surface area of 1,392 acres. The height of the dam is 67 feet. The original design was for a height of 120 feet, however during construction seepage at the toe of the dam became a concern and construction stopped short of the original design height. Seepage at the toe of the dam is monitored and measured through a weir. Concrete deterioration in the outlet control structure has required many repairs in past years. Repairs to outlet structures were made during the summer and fall of 2003. The outlet tunnel and area around the gates is inspected at least once per year.

Land management over the lower Big Lost River Assessment Units parallels that of the upper Assessment Units below Chilly Butte in that the valley bottom is privately owned with the exception of about 5 sections of land around Leslie Butte which is managed by the BLM. The intermediate elevations are managed by BLM with higher elevations managed by the Forest Service. Land use is primarily agricultural with increased diversity of crop production to include grains and potatoes as well as forage crops for livestock. Grazing is the most distributed agricultural land use in upland areas above the valley bottom. Historically mining has been a significant land use throughout the lower though there are no active mine operations other than gravel pits today. Irrigation diversion structures are numerous within the Big Lost River Channel below the Mackay Dam. There are no known fish screens within the valley, as required by Idaho law, above or below the dam. Many of the irrigation diversion structures in the main channel and tributary streams are fish passage barriers.

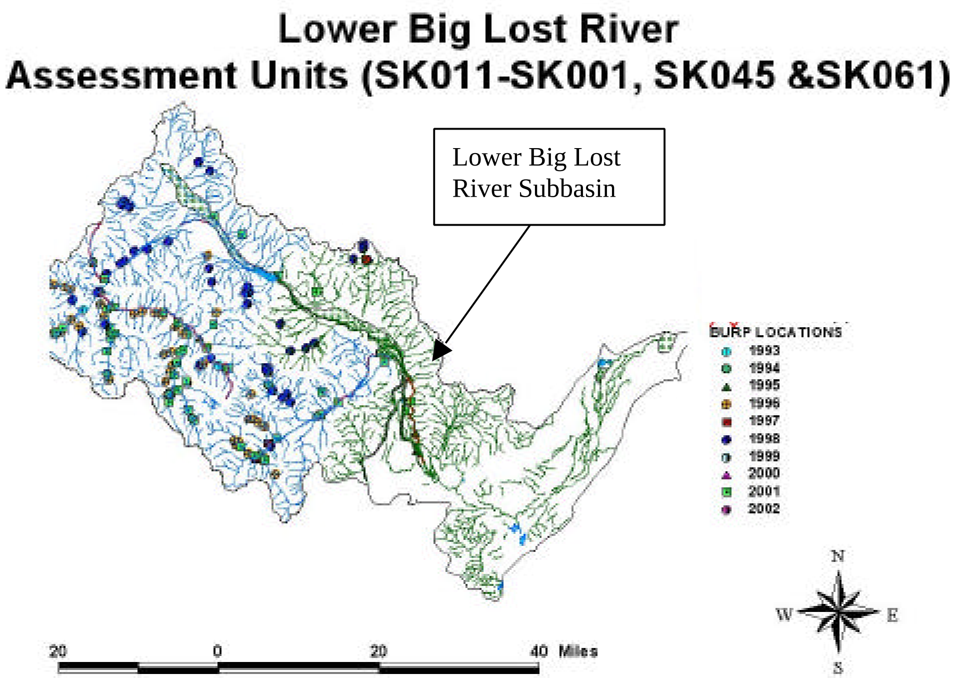


**Figure 47. Lower Big Lost River assessment units in the Big Lost River watershed.**

The Big Lost River below Mackay Dam is a regionally famous tailwater fishery that benefits from improved temperature regime and reduced sediment load below the reservoir. There is a population of naturally producing rainbow trout on this reach that is augmented by entrainment of stocked hatchery fish from the reservoir. This is the most populated (and popular) reach of the river. Density of residences within the riparian area greatly increases below the dam and the river flows at the edge of Mackay, Idaho (Figure 49).

**Figure 48. Mackay Dam, Mackay Reservoir, and the tailwater section of the Big Lost River.**

The City of Mackay has a population of 566 based on the 2000 Census. City infrastructure includes a waste treatment facility and stormwater collection is incorporated into sewer lines. The point of discharge of the waste treatment facility is into a wetland, known as Swauger Slough, that is isolated from the Big Lost River, though it is located within the flood plain. Stormwater is discharged through the waste treatment facility as well. The only NPDES permit associated with the City is for the waste treatment facility. Impervious surfaces are limited to a few side streets and Highway 93. Most precipitation and snowmelt associated with city streets runs off to ditches that infiltrate the storm runoff water. There are a few dispersed residences between the dam and the city but development is limited.

Above the City of Mackay on the eastern slope of the White Knob Mountains (on the western side of the valley) there is a grouping of old mines no longer in production. The mines are located in the Taylor Canyon and Rio Grande Canyon and Alder Creek Canyon region of the White Knob Mountains. Products affiliated with these mines include tungsten, gold, silver, zinc, copper, molybdenum, lead, and iron. Milling and smelter operations were located near the town of Mackay, near the Big Lost River, at the mouth of Rio Grande Canyon. Tailings and slag piles affiliated with the mills and smelters are present, but IDEQ and USDA FS water quality sampling indicate no water quality impacts. Mines are located on Forest Service and private land.

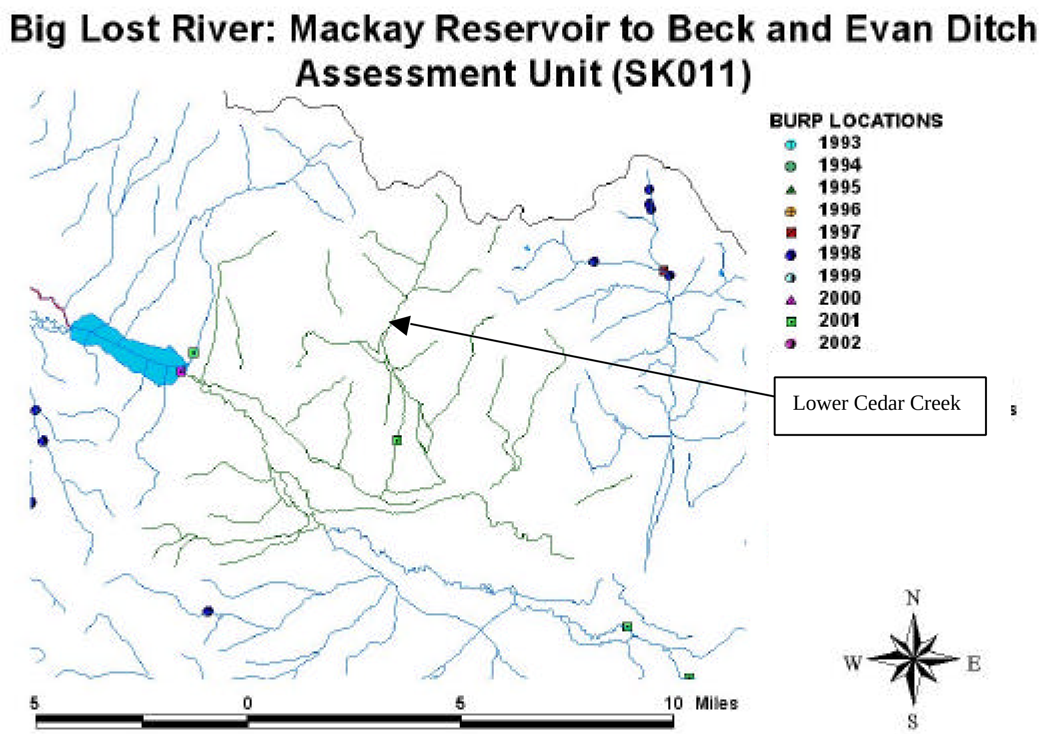


**Figure 49. Mackay Reservoir to Beck and Evan Ditch assessment unit.**

Lower Cedar Creek evolves in the Lost River Range on the east side of the valley in this Assessment Unit. It is an ephemeral stream that is on Forest Service and BLM managed lands with small private land in-holdings on BLM. Land use in the Lower Cedar Creek subbasin is primarily grazing with some crop production above the Holocene terrace.

Alder Creek, like Taylor Canyon and Rio Grande Canyon has experienced historic mining in its upper reaches with the same products and processing systems and facilities. Alder Creek is a perennial stream that does not connect to the Big Lost River during periods of peak flow because it is consumed for irrigation by the Darlington Ditch (Figure 50 and 51). Land management is largely Forest Service over the network of headwater tributaries that include the South Fork of Alder Creek and Trail Creek. As the name implies Alder Creek has a thick riparian zone that includes alder trees and aspen above private land. Below the Forest Service boundary Land management is private along a narrow buffer that includes the creek to its confluence and BLM outside of that. Present day land use includes recreation in the form of camping, fishing and hunting, and off-road vehicle use. Grazing occurs throughout the watershed and there is forage crop production on private land.

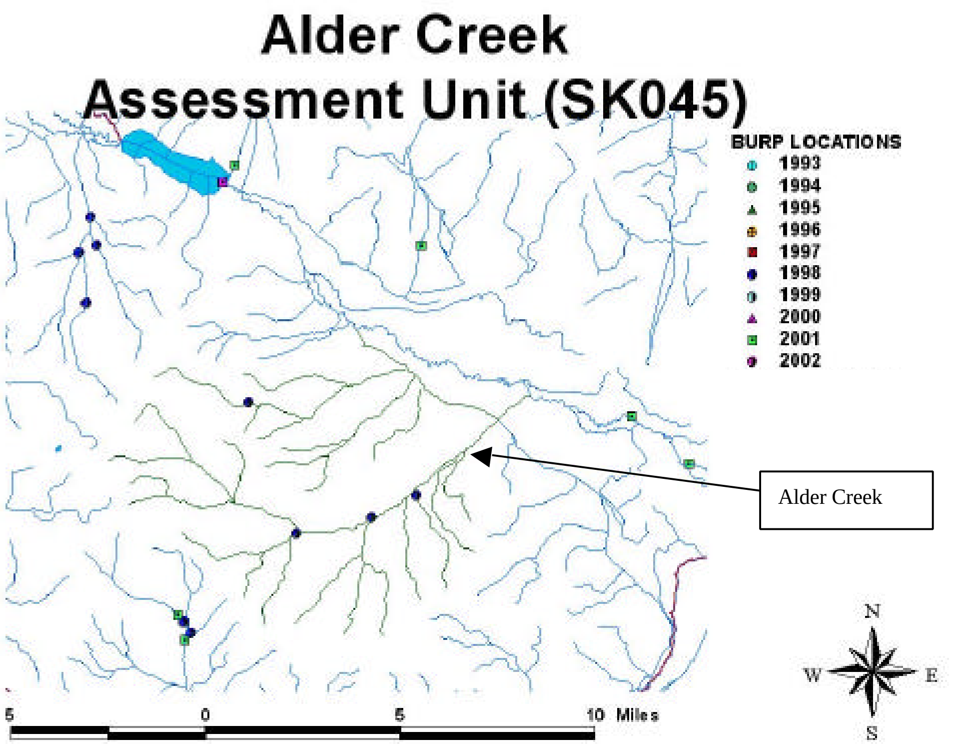


**Figure 50. Alder Creek assessment unit.**

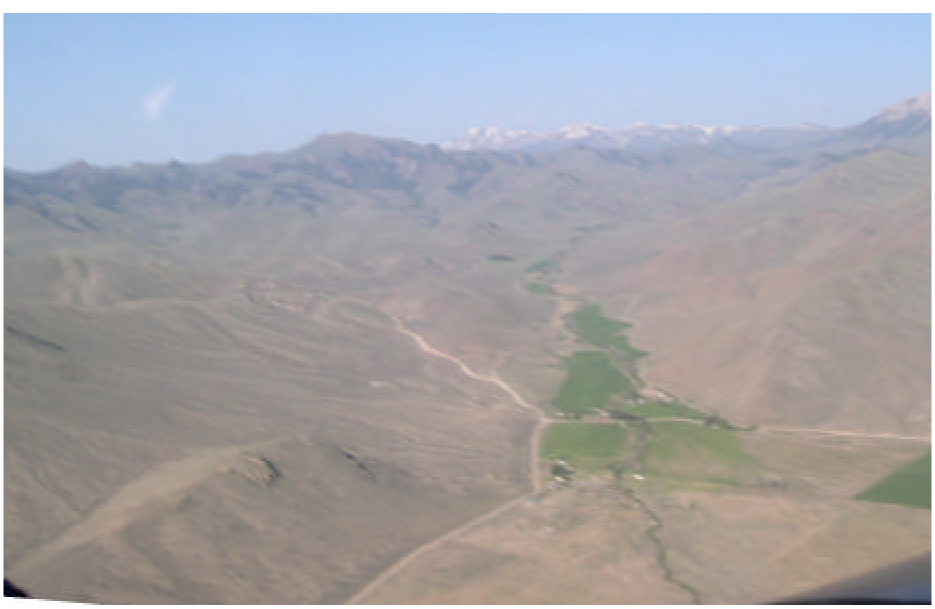

**Figure 51. Alder Creek Valley looking west toward historic mines.**

The Big Lost River below the Beck and Evan Ditch has perennial flow and continues within an area that includes irrigated agriculture and low density residences (Figure 52). Flow decreases over this reach during the irrigation season and in the off season when the reservoir is filling. Tributary in-flow is largely intercepted along this reach by diversions and in-stream habitat quality progressively degrades as a result of altered flow regime though fishing remains good through this reach at times. Land management is exclusively private.

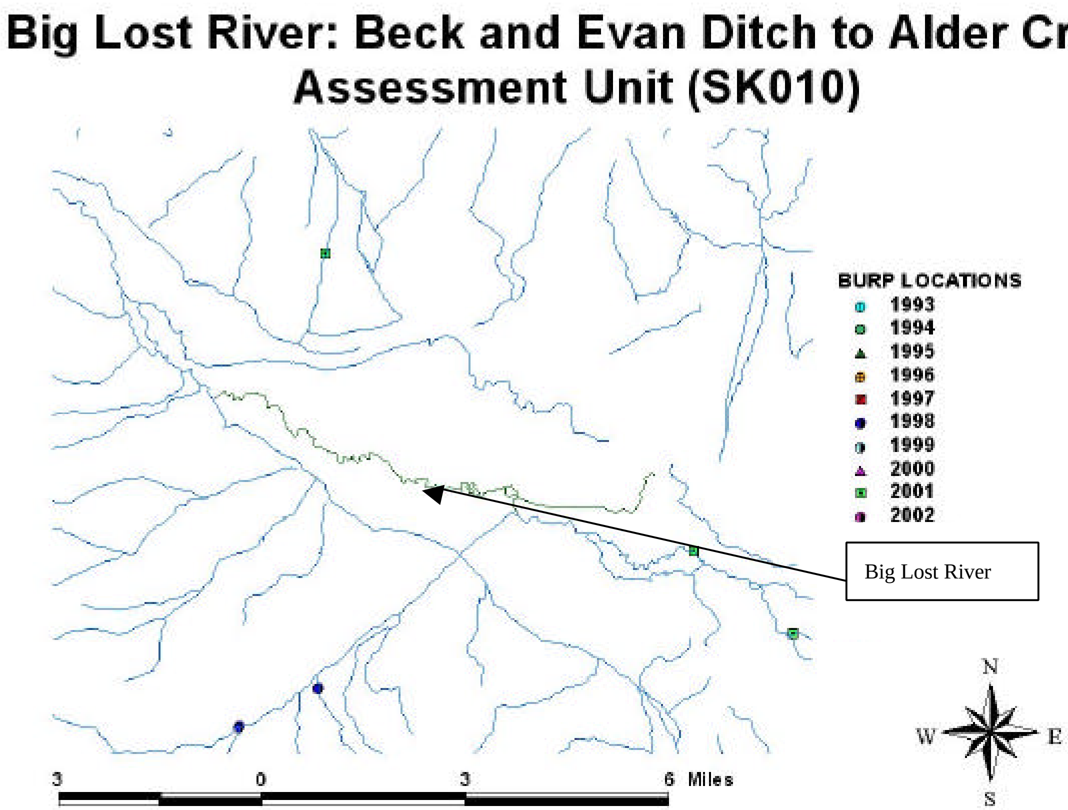


**Figure 52. Big Lost River Beck and Evan Ditch to Alder Creek assessment unit.**

Antelope Creek rarely flows to its confluence with the Big Lost River as it too infiltrates into the deep alluvium of the valley floor (Figure 53). The Darlington Sinks occur just above the Antelope Creek channel confluence and the Big Lost River is largely a loosing channel below this point to the Moore Diversion. Riparian vegetation progressively looses vigor and diversity throughout the reach and the stream becomes ephemeral to the Moore Diversion where flow seldom passes in the natural channel due to the combined effect of infiltration and irrigation diversion. Land management remains private and agricultural land use dominates along this reach. Recreation is limited due to access across private land and sporadic flow conditions. Irrigation becomes increasingly dependent upon groundwater pumping below this reach. There are few perennial streams below this Assessment Unit other than Pass Creek and no streams that are perennial consistently contribute flow to the Big Lost River below this point.

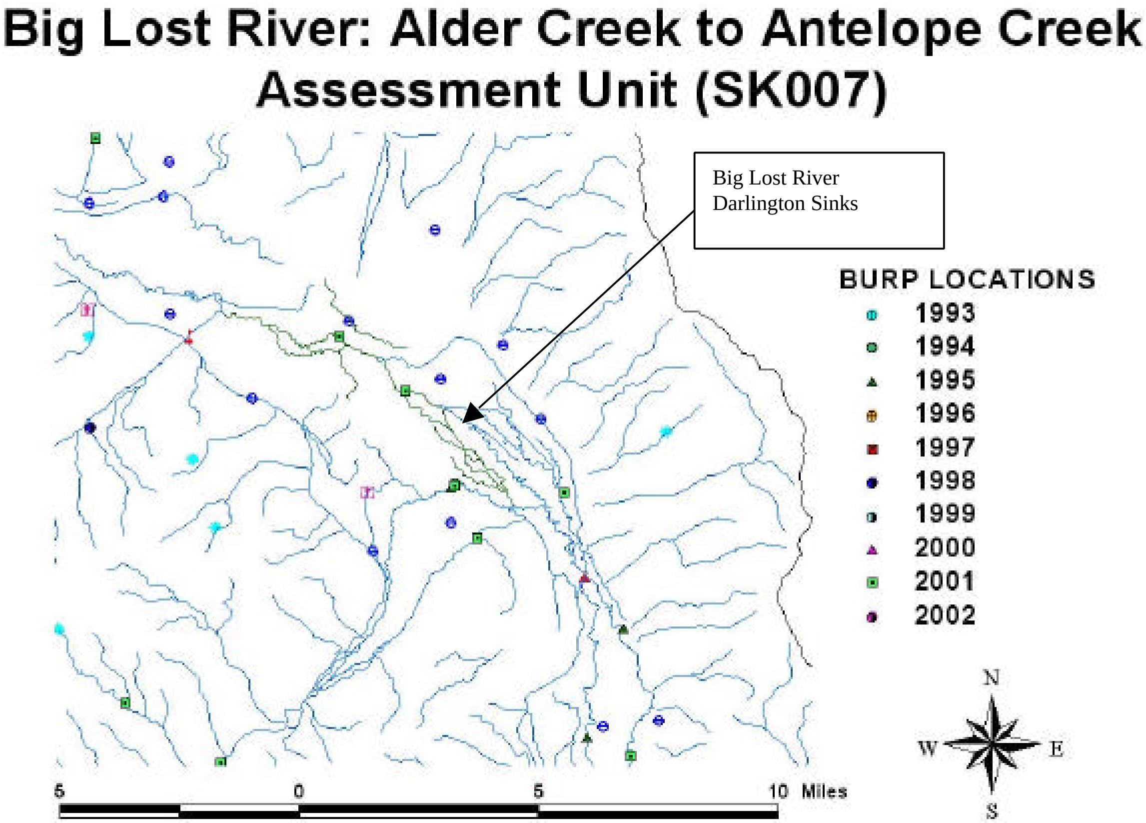


**Figure 53. Big Lost River Alder Creek to Antelope Creek assessment unit.**

The Lower Pass Creek Assessment Unit (Figure 54) consists of a number of springs that evolve at the toe of the Holocene terrace of the Big Lost River channel combined with historic channels of the Big Lost River. Flow from the springs is largely made up of aquifer recharge from irrigation on the bench above the terrace. This is a common situation that is seen in other watersheds of the Central Valleys of Idaho such as the Lemhi River, Pahsimeroi River and the Little Lost River to the east. Flow varies throughout the year and depends upon application rates of irrigation water and the lag time to surface expression at the base of the terrace. Surface irrigation return water is also a contributor to this flow.

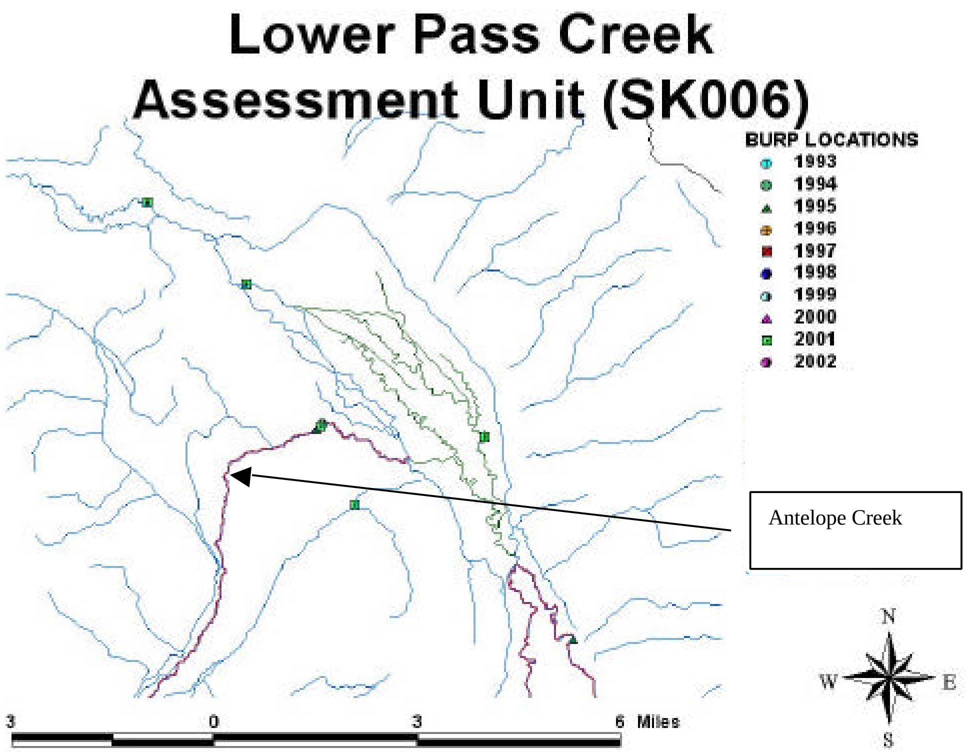


**Figure 54. Lower Pass Creek assessment unit.**

Pass Creek is the most significant perennial flow that originates in the Lost River Range within the Big Lost River watershed (Figure 55). It is named because it flows within the canyon that creates the Pass between the Big Lost River and Little Lost River watersheds. Pass Creek Road parallels Pass Creek from its lowest point of surface flow at the mouth of its canyon, to the watershed divide. Pass Creek is completely consumed for irrigation at the mouth of the canyon and does not connect with other natural surface flow below this point. Land management is almost exclusively Forest Service with the exception of a small private parcel below the confluence of Methodist Creek and private land at the mouth of the canyon where Pass Creek is completely diverted. Land use above the point of permanent diversion is a combination of livestock grazing, transportation and recreation. There are no developed campgrounds in the watershed. Recreation is dispersed camping, hiking, hunting, fishing, and motorized and nonmotorized trail riding as well as horseback riding.

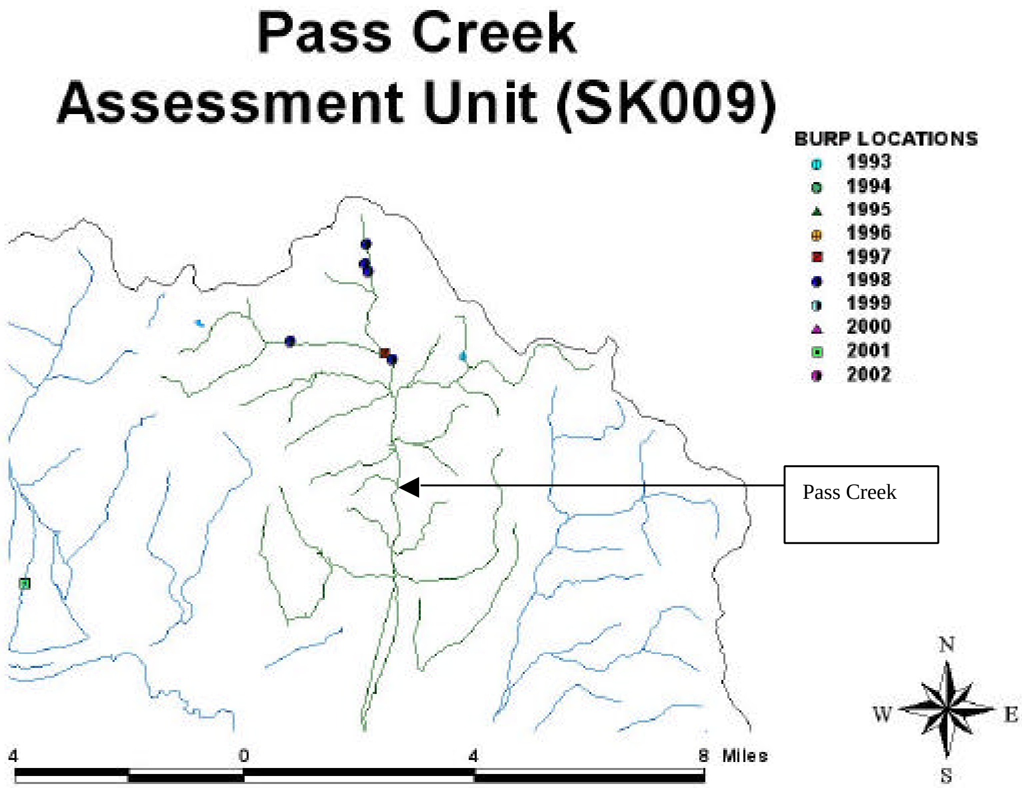


**Figure 55. Pass Creek assessment unit.**

The Elbow Creek to Jaggles Creek Assessment Unit refers to a collection of ephemeral drainages that originate in the Lost River Range and are affiliated with small canyons that open to the valley floor uplands above the flow altered segment of the Big Lost River (Figures 56 through 62). There are no fisheries or aquatic life values to these features. There are no BURP sites other than on the mainstem Big Lost below the Spring Creek side channel (Figure 59). In fact there are no aquatic systems that evolve from the Lost River Range over the remaining course of the Big Lost River to the Big Lost River Sinks on the lava plain desert. Any flow that did make it to the valley floor would be intercepted by the Beck and Evan Ditch or the East Side Ditch before connecting to the Big Lost River. Land management over the remainder of the lower watershed maintains the proportion of Forest Service in the upper elevations, BLM in the intermediate elevations, and private along the channel in the valley bottom. Land use is agricultural over the remaining lower watershed and includes crop production, livestock grazing, livestock feeding operations and residential development. Groundwater pumping and surface diversion facilitate agriculture

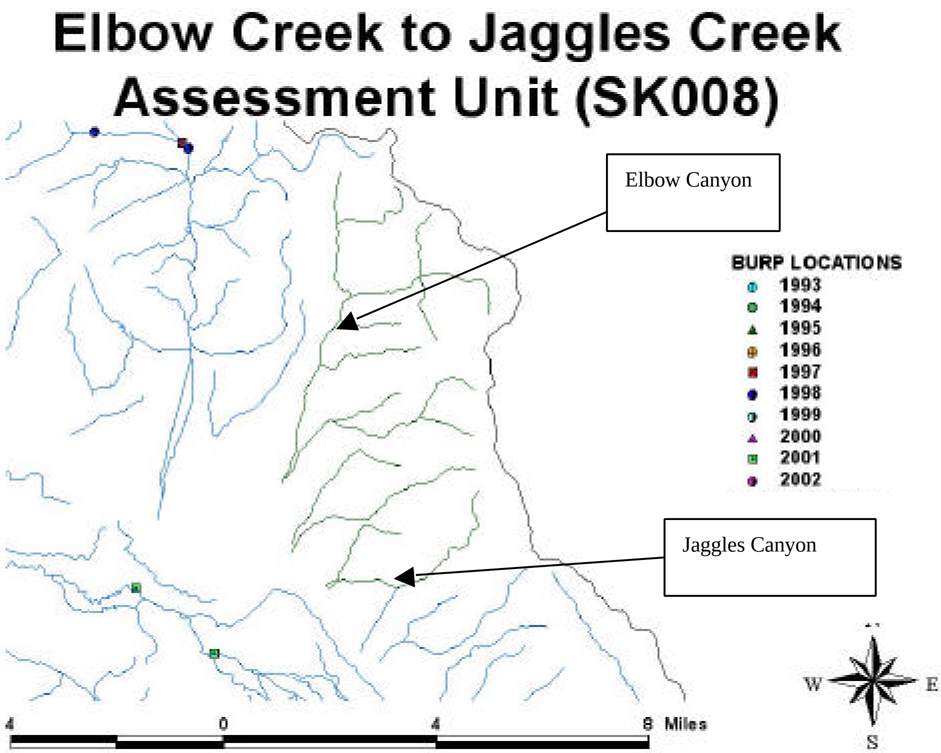


**Figure 56. Elbow to Jaggles Creek assessment unit.**

Flow alteration is dramatic in the Big Lost River at the Moore Diversion Structure and the 303(d) listed reach corresponds to the dry channel from the Moore Diversion to Highway 26. This reach would be naturally dry due to infiltration of flow into alluvium, combined with the lack of surface flow from tributaries to the Big Lost River Channel. Riparian vegetation is greatly diminished below this point and generally corresponds to places where surface irrigation water is returned to the dry channel for aquifer recharge. Below Highway 26 the Big Lost River is historically ephemeral to the Playas, or Sinks as they are locally known.

**Figure 57. Moore Diversion showing irrigation ditches on the left and right and the dewatered natural channel and "Spring Creek" in the middle.**

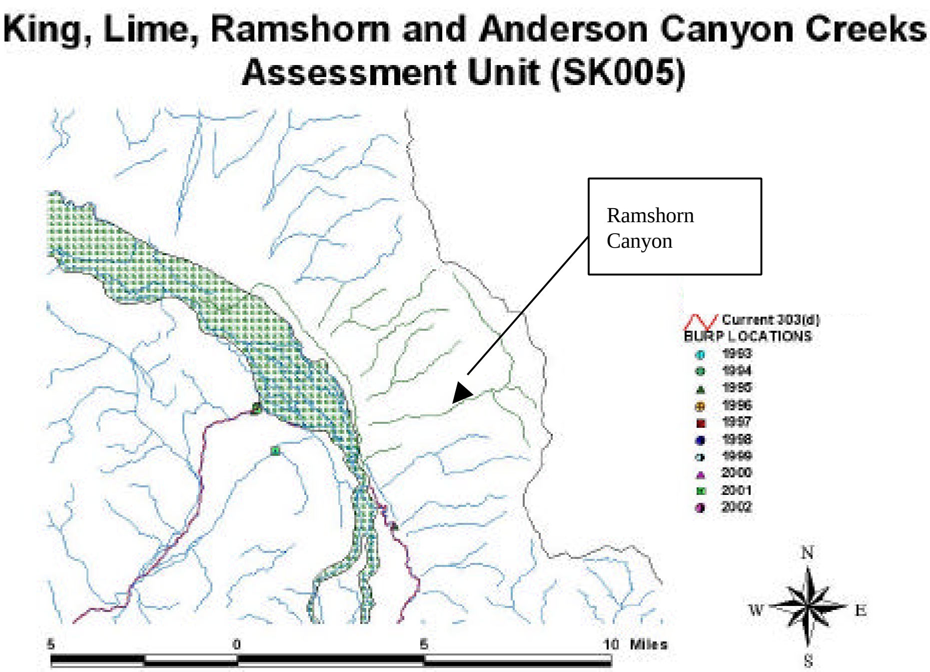


**Figure 58. King, Lime, Ramshorn and Anderson Canyon assessment units.**

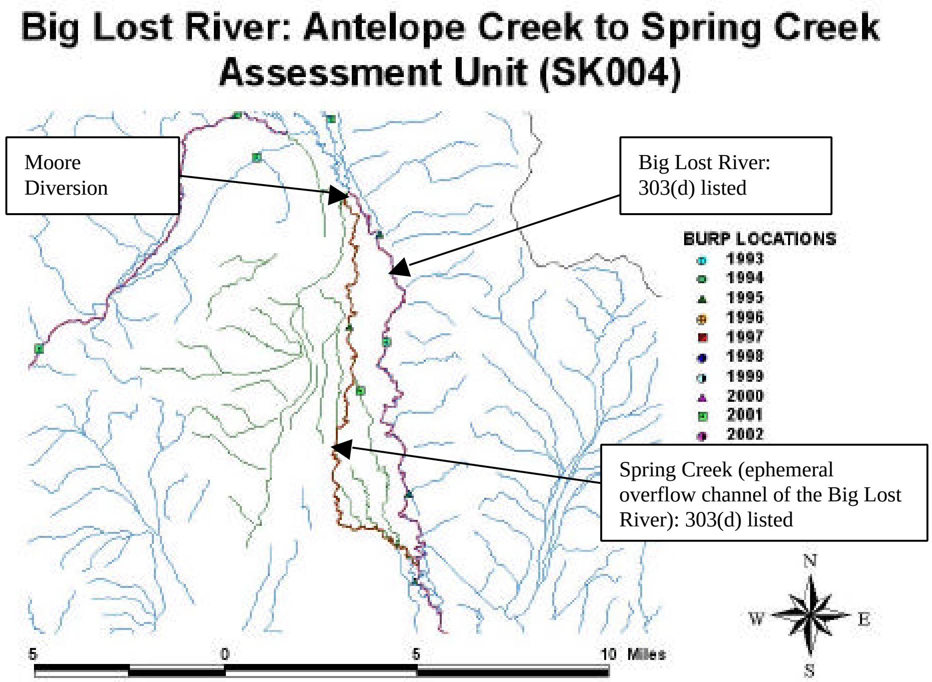


**Figure 59. Big Lost River Antelope Creek to Spring Creek assessment unit.**

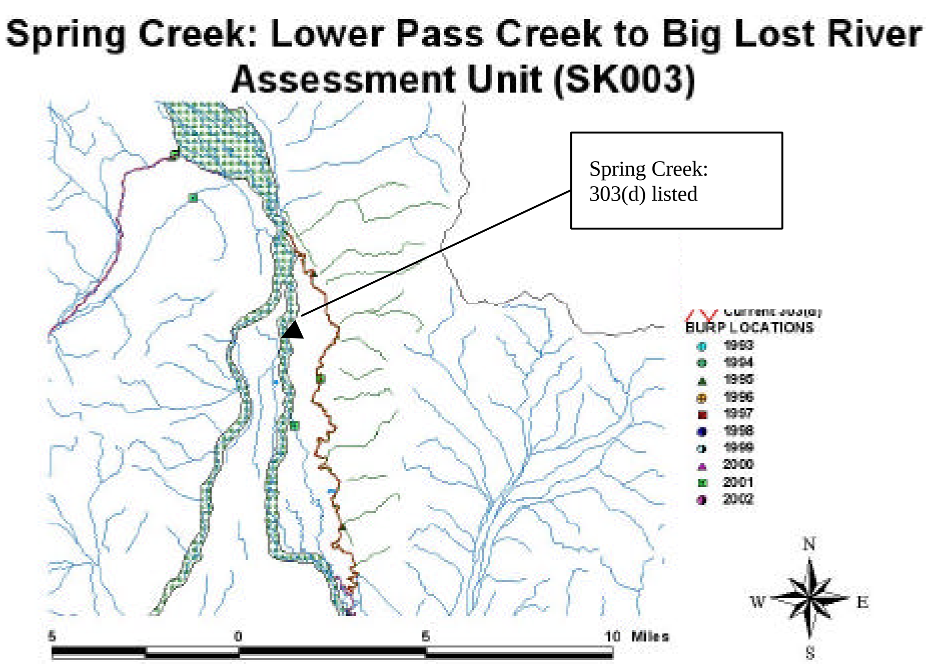


**Figure 60. Spring Creek channel of the Big Lost River assessment unit.**

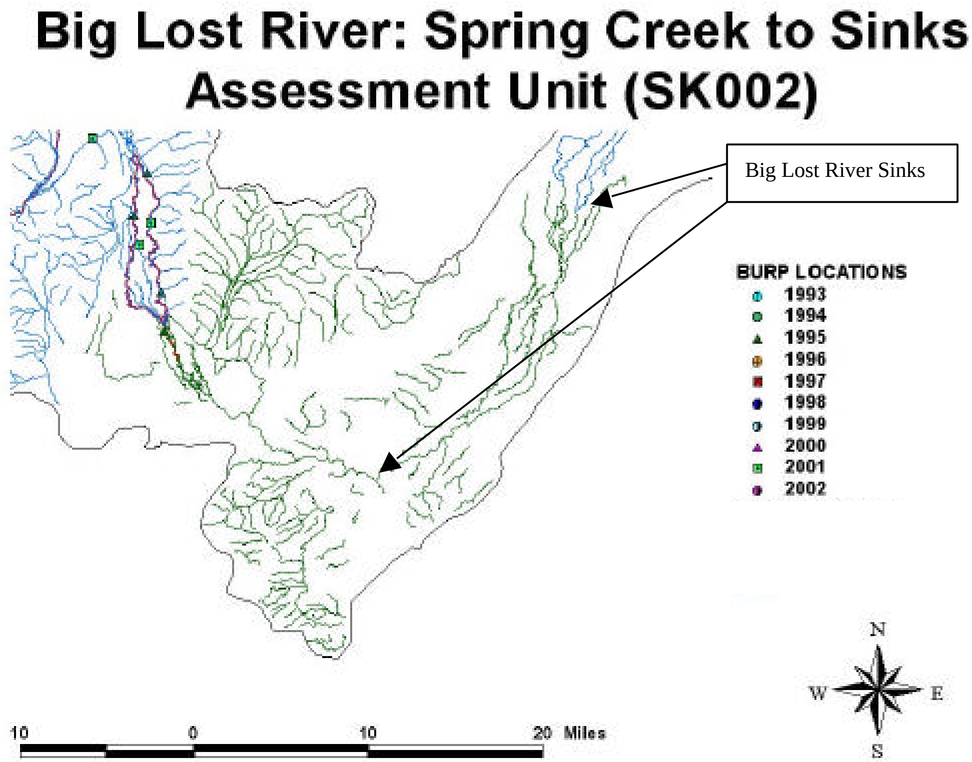


**Figure 61. Spring Creek Channel to Sinks assessment unit.**

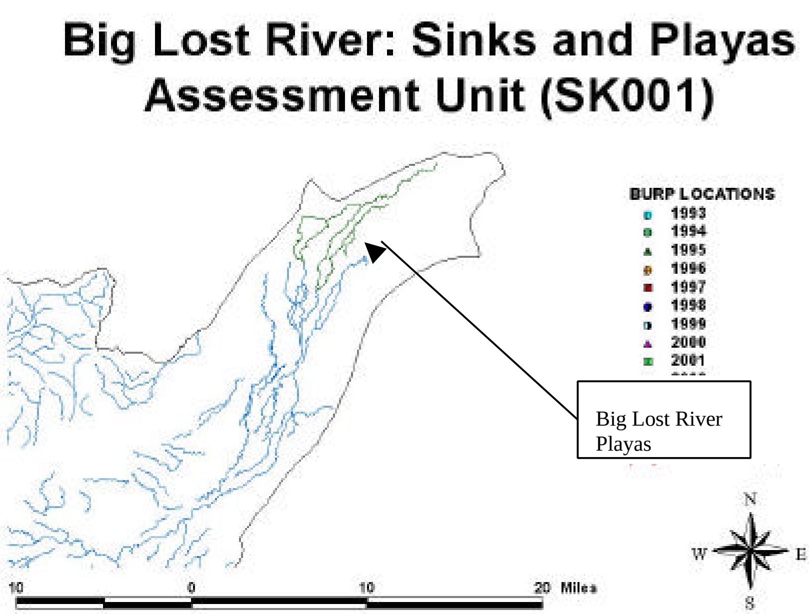


**Figure 62. Sinks and Playas assessment unit.**

## 1.3 Cultural Characteristics

The Big Lost River watershed lies within Butte and Custer Counties, and like the adjacent Central Valleys of Idaho is sparsely populated. The City of Arco, Idaho is the largest population followed by the City of Mackay, Idaho. Three State Highways serve the watershed. Highway 20 runs east and west from Idaho Falls to Mountain Home and 93 connects with 20 in Arco and connects with Challis and Salmon to the north. Just south of Arco Highway 33 makes its Junction with Highway 20 and connects to Rexburg through Howe, Mud Lake and Terreton. At Mud Lake Highway 28 splits off to the north to connect with Salmon, Idaho through the Birch Creek and Lemhi Watersheds. The Big Lost River watershed lies to the northwest of the Idaho National Environmental and Engineering Laboratory, which is the largest employer in the region with over 7,000 employees.

### History

The Big and Little Lost River valleys have seen many visitors who left no traces of their presence. Each of these Central Valleys was a route for fur trapping parties between 1813 and the 1840s. For a number of years after the trappers left, little took place in the area, but after European visitors came again, this time to search for precious metals, some stayed and small farming communities began to form.

Native Americans were known to use the area of the Big Lost River for probably 10,000 years prior to settlement by European-Americans (Hatzenbuehler, 2003). The Big Lost River Valley was primarily a seasonal migration corridor for the Shoshone and less numerous Bannock and Paiute Native Americans as they moved to and from the Salmon River watershed. Within the Salmon River watershed they hunted trout and salmon and big game animals for food and related animal products such as bone tools and rendered oil. The Big Lost Valley, with harsh winters and arid climate did not offer sufficient resources throughout the year to allow for permanent settlement there (Hatzenbuehler, 2003).

The Lewis and Clark Expedition discovered what is present day Idaho, in 1805. They noted large herds of horses, up to 700 animals, in a Shoshone village in the Lemhi Valley. They estimated that there were thousands more in the hills (Galbraith and Anderson, 1969).

Shortly after the Lewis and Clark Expedition, trappers exploited the area for furs to supply the growing demand in Europe and the eastern United States for garment furs and hats. In 1810 the Missouri Fur Company established Fort Henry near present day St. Anthony, Idaho, which was the first American trading post in the west. By 1834 a trading post was established near present day Fort Hall. It was sold to the Hudson Bay Company in 1837 (Kempthorne, 2000). Both of these posts were within range of trading furs harvested in the Big Lost River Valley. Fort Hall acted as a hub for trails and roads to the western parts of the United States, and to the central part of Idaho through the Big Lost River Valley.

By the 1840's Idaho's fur resources were becoming depleted and the demand for furs was in decline. A few trappers began to settle in the Oregon Territory, in what is now the Central Valleys of Idaho. Eastern newspapers painted a flowery picture of the Oregon Territory.

People from the eastern United States began to pass through the area and increasing numbers of pioneers decided to settle. By 1843 the Oregon Trail was established in Idaho, which passed by Fort Hall. Combined with the discovery of Gold, in California, and subsequently in other areas of the Northwest, including Pierce, Idaho on Orofino Creek in 1860, the flow of people increased. The area north of the 42nd parallel and east of the Oregon Territory became the Idaho Territory in 1863.

In the 1880s railroads were constructed across Idaho spurring the expansion of mining and later the development of lumbering. This in-turn resulted in the development of farming and ranching in Idaho to supply food to the mining and lumbering camps (Hatzenbuehler, 2003).

A stage line, started by Alexander Toponce, connected the Salmon River mines and Challis with the railroad at Blackfoot. A stage station was established on the Big Lost River to serve this line. It was known as Kennedy Crossing and was about 5 miles south of the present town of Arco. Because the Challis route and another leading to the Wood River joined here, application was made for a post office, to be named Junction. There were too many places named Junction and the postal service did not want another one. The U.S. Post Office suggested the name of Arco, to honor a visiting Count, who had never been to Idaho. The citizens needed postal service and accepted the name. In 1880, the stage station moved to another site south of the present town and remained there until the Mackay Branch of the Oregon Short Line Railroad Company was built through the area in 1901 (Link 1996).

The railroads also provided access to eastern markets for beef. During the 1840s and 1850s cattle multiplied rapidly in the Pacific Northwest, particularly in western Oregon. Mass movements of cattle took place from western Oregon to east of the Cascades during the 1860s. The range conditions of the central valleys of Idaho were considered excellent for production of beef and subsequently sheep. Great cattle drives from Texas supplied base stock for herds in Wyoming and Montana in the 1850s and 1860s. Cattle from the Northwest were considered by Wyoming buyers to be superior to Texas cattle as a base to build herds. After 1876 the majority of cattle were supplied from Nevada, Utah, and Idaho (Galbraith and Anderson, 1969).

By 1885 the cattle industry had overexpanded in Washington, Oregon, and Idaho (Galbraith and Anderson, 1969). Overgrazing had resulted in degraded range conditions, extensive erosion, and replacement of bunchgrass with sagebrush. Sheep grazing was on the increase during this time. Sheep could be grazed less expensively than cattle and were often put on the range before conditions were good, furthering the degradation of range conditions and increasing erosion. This led to the belief that sheep were the chief cause of range deterioration (Galbraith and Anderson, 1969) though much of the damage was already done by cattle. In 1884 a railhead was established in Hailey, Idaho and became the largest depot in the state for shipping mining supplies and sheep. Sheep were commonly herded over Trail Creek summit into the Big Lost River watershed for grazing in spring and summer and then herded out to Hailey for shipping. By 1910 grazing laws were developed and put into effect in National Forests to try and control the damage being done to rangeland throughout the region (Galbraith and Anderson, 1969).

The demands, resulting from World War I, for wheat resulted in conversion of range land in some areas of the United States to wheat production. Ultimately this resulted in the increased price for cattle and sheep. This prosperity resulted in animosity toward the control of rangeland grazing. Combined with the depression of the 1930's, countrywide drought, and the visible destruction of rangeland brought about a change in public attitude. By the mid-1930s the public was ready for meaningful controls of grazing management (Galbraith and Anderson, 1969). This led to the creation of the Soil Conservation Service in 1935. In 1934, Congress passed the Taylor Grazing Act, which placed administration of unappropriated public lands under the Division of Grazing, which later became the Grazing Service and then the Bureau of Land Management under the Department of the Interior.

Irrigation development came late in the 1800s as the population increased and a railhead was established in Mackay, Idaho in 1901. During its mining heyday, Mackay boasted a population of over 5,000 people with businesses to match. The Mackay Reservoir was started in 1906 and completed in 1930 following a tumultuous history of water wars. In the 1920s and early 1930s much thought went into building canals and ditches to get surface flow past the natural sinks where surface water would infiltrate to ground water. The primary sinks were at Chilly Buttes, Darlington, and at the Moore Diversion on the Big Lost River. Antelope Creek sinks were located above the mouth of the canyon. Rarely would the Big Lost River, or Antelope Creek flow beyond the sinks, and that was for the short duration of the heaviest runoff. Irrigators viewed this as wasted or lost water and were continually evaluating the cost effectiveness of pumping groundwater back to the surface, or constructing ditches that would prevent the loss of water. One of the major constraints was cost, but the volume of water during heavy runoff was also a limiting factor. It was felt that much of the infiltrated water of the Big Lost would "reappear" at the valley constriction where Mackey Dam is now located, though there were differing views among hydrologists and irrigation groups.

## Land Use

Today approximately 80% of the subbasin is under BLM and Forest Service management and 16% DOE. State and Private land total 4%. Much of the DOE land includes rangeland and most of the remaining 84% of land ownership would be considered rangeland (Table 5), which can be considered grassland and sagebrush habitat on much of the federal and private land. However, on private land sagebrush is often removed to the extent possible to produce pasture. Land use closely parallels land ownership with agriculture the most widespread land use in the watershed. Irrigated cropland and pasture would occur within the remaining portion of Private land (less than 2%). Figure 63 shows the wide distribution of federal rangeland throughout the subbasin. Evergreen Forest and mixed forestland are the next most major land cover, though this is also used mostly for grazing. Steep terrain and low-density, poor quality stands limit logging opportunity in the watershed. Mining is no longer active in the watershed, and at its historical peak would have involved less than 1% of the land.

## Land Ownership, Cultural Features, and Population

Most of the Big Lost River subbasin falls within Custer County with about 25% in Butte County with a small area at the most eastern edge in Jefferson County. Table 5 shows that 98% of land ownership is public with the majority of land being managed by the BLM (30%) and the USFS (50%). The state of Idaho (2%) manages small parcels scattered throughout BLM land. The

Department of Energy's (16%) boundaries are located at the most south eastern end of the subbasin.   Private land only accounts for 2% of the land ownership in the subbasin.

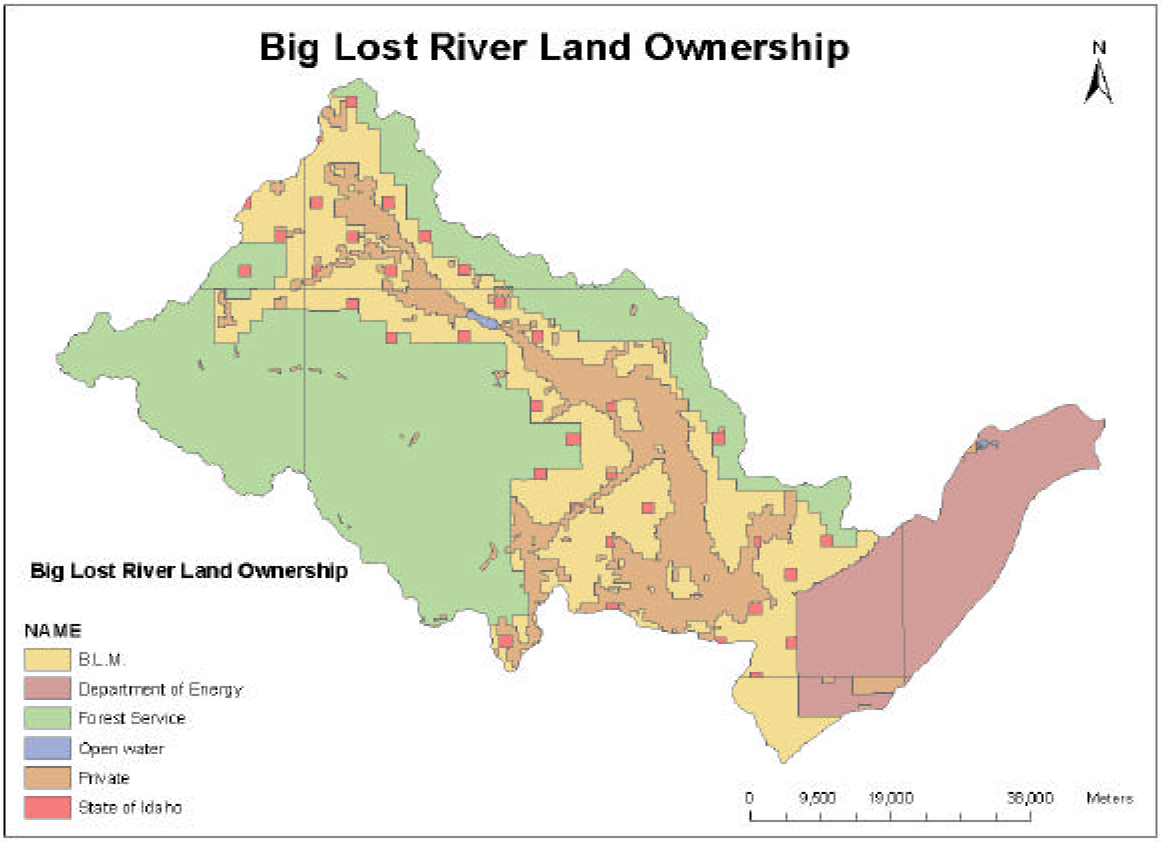


**Figure 63.  Land ownership in the Big Lost River watershed.**

**Table 5.  Land ownership within the Big Lost River Watershed.**

| Landowner | Acres | Sq. Miles | Sq. Km | % of Total |
|---|---|---|---|---|
| Private | 18,404 | 29 | 74 | 2% |
| | | | | |
| Public | | | | |
| BLM | 327,130 | 511 | 1,323 | 30% |
| Department of Energy | 177,011 | 276 | 716 | 16% |
| USFS | 534,316 | 834 | 2,162 | 50% |
| State of Idaho | 19,219 | 30 | 77 | 2% |
| Open Water | 1,652 | 3 | 7 | <1% |
| Sub-total | 1,059,328 | 1,654 | 4,285 | 98% |
| | | | | |
| Total | 1,077,732 | 1,683 | 4,359 | 100% |

## Economics

Today, the cities of Arco and Mackay are the largest population centers located in the Big Lost River Watershed. Many of the residents work at the Idaho National Engineering and Environmental Laboratory (INEEL) operated by the Department of Energy. Service related jobs and management and professional occupations make up the majority of occupations within the subbasin. Agriculture and natural resource related jobs are important in rural areas with 17.5% and 29.2% of workers in Butte and Custer Counties, but 60% in the unincorporated areas represented as Lost River in Table 6.

Historically mining and ranching provided the economic incentive for settlement. As the west was settled agriculture provided the majority of economic opportunity. Diversification of the regional economy has provided increased opportunity within the watershed for professional and managerial occupations. Tourism is expected to become increasingly important in the future. There have been numerous business proposals for the future in this area. Potential projects range from private space oriented launch and recovery facilities to reestablishing mining ventures.

**Table 6. Profile of Selected Economic Characteristics for the Big Lost River Valley.**

| | Arco | Atomic City | Lost River | Mackay | Moore | Butte County | Custer County |
|---|---|---|---|---|---|---|---|
| **Population** | 1,026 | 25 | 26 | 566 | 165 | 2,899 | 4,342 |
| **Unemployed (percent)** | 4.4 | - | - | 5.5 | 4.2 | 3.5 | 3.9 |
| **Occupation (percent)** | | | | | | | |
| Management, Professional | 29.2 | 33.3 | 60 | 27.6 | 35.0 | 36.7 | 35.1 |
| Service | 22.5 | - | 20 | 17.1 | 13.8 | 16.2 | 13.1 |
| Sales and Office | 21.8 | 33.3 | - | 25.0 | 28.8 | 20.1 | 20.4 |
| Farming,Natural Resources | 1.2 | - | - | 2.6 | - | 4.3 | 5.2 |
| Construction/Extraction/ Maintenance | 13.9 | - | - | 14.9 | 13.8 | 10.8 | 17.2 |
| Production/Transportation | 11.5 | 33.3 | 20 | 12.7 | 8.8 | 12.0 | 9.1 |
| **Industry (percent)** | | | | | | | |
| Agriculture/Natural Resources | 4.1 | - | 60 | 10.5 | - | 17.5 | 29.2 |
| Construction | 10.8 | 33.3 | - | 13.2 | 20.0 | 8.0 | 8.6 |
| Manufacturing | 1.7 | - | 20 | 4.4 | 5.0 | 3.8 | 2.9 |
| Wholesale Trade | 1.4 | - | - | 3.1 | 2.5 | 2.0 | 0.9 |
| Retail Trade | 8.6 | - | - | 7.0 | 22.5 | 9.2 | 10.5 |
| Transportation/ Warehousing/Utilities | 5.3 | - | - | 13.6 | 2.5 | 8.5 | 8.0 |
| Information | 1.2 | - | - | 0.9 | - | 1.0 | 1.6 |
| Finance, insurance, real estate, and rental | 4.8 | - | - | 3.9 | 8.8 | 3.4 | 3.0 |
| Professional, scientific, management, administrative/waste management | 11.2 | 66.7 | - | 7.0 | 10.0 | 8.8 | 4.1 |
| Educational, health and social services | 26.6 | - | 20 | 19.7 | 17.5 | 20.1 | 15.6 |
| Arts, Entertainment, Food Service, Accommodation | 10.3 | - | - | 9.2 | 8.8 | 6.4 | 8.2 |
| Other Services | 3.3 | - | - | 3.5 | - | 3.8 | 3.0 |
| Public Administration | 10.8 | - | - | 3.9 | 2.5 | 7.3 | 4.4 |

Source: U.S. Bureau of the Census, Census 2000

# 2. Subbasin Assessment – Water Quality Concerns and Status

Past land use practices combined with natural hydrology and fluvial geomorphology have resulted in water quality concerns within the Big Lost River watershed. Water quality monitoring has been scarce until recent years when overallocation of irrigation water combined with overutilization of public and private grazing lands has impinged upon the intent of the Federal Clean Water Act that waters of the United States be Fishable and Swimable. Water quality monitoring by the DEQ, and evaluation of water quality and fisheries data collected by other state and federal agencies has identified several waters in the Big Lost River watershed that are of concern with regard to water quality. Water quality concerns are directed toward compliance with numeric state water quality standards and beneficial uses of surface waters that include the effectiveness with which fish species are able to spawn and perpetuate their species as well as the population of other aquatic life related to the success of fisheries, particularly Salmonid Spawning and Cold Water Aquatic Life. Human safety with regard to direct (primary) contact with surface waters in the course of recreation can also be of concern where toxic substances and pathogens are involved.

## 2.1 Water Quality Limited Segments Occurring in the Subbasin

The Big Lost River subbasin has nine water quality limited segments that are included on the Idaho 1998 §303(d) list. Seven of the nine segments were brought forward from the 1996 §303(d) list. Two segments, Warm Springs Creek and Little Boone Creek were added by the DEQ in 1998 due to water quality concerns. The Beneficial Use Reconnaissance Program is conducted by the DEQ to evaluate water quality through the use of scores derived from sampling streams. The scores represent the quality of fish populations (SFI score), populations of aquatic macroinvertebrates (primarily insects) (score), and character of stream habitat that supports aquatic populations (SHI score). The scores for key BURP sites are shown in Appendix F. The scores are based on the second edition of the Water Body Assessment Guidance, a peer reviewed analytical tool to guide individuals through evaluation of surface water quality (DEQ 2002). Table 7 summarizes the §303(d) listed waters within the subbasin. Figure 64. shows the location of the §303(d) listed waters within the subbasin.

**Table 7. §303(d) Segments in the Big Lost River Subbasin.**

| Waterbody Name | Segment ID Number | 1998 §303(d)[1] Boundaries | Pollutants | Listing Basis |
|---|---|---|---|---|
| Big Lost River | 2161 | Moore Diversion to Hwy 20 | Low Oxygen, Flow Alteration, Excess Nutrients, Excess Sediment, Elevated Temperature | Low SMI, SFI, and SHI scores |
| Big Lost River | 2164 | Chilly Buttes to Mackay Reservoir | Nutrients, Sediment | Low SMI, SFI, and SHI scores |
| Spring Creek | 2167 | Springs to Big Lost River | Dissolved Oxygen, Flow Alteration, Nutrients, Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Antelope Creek | 2168 | Spring Creek to Big Lost River | Flow Alteration, Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Twin Bridges Creek | 2176 | Headwaters to Big Lost River | Nutrients, Sediment | Low SMI, SFI, and SHI scores |
| East Fork Big Lost River | 2179 | Starhope Creek to Forks | Habitat Alteration | Low SMI, SFI, and SHI scores |
| East Fork Big Lost River | 2180 | Headwaters to Starhope Creek | Sediment, Temperature | Low SMI, SFI, and SHI scores |
| Little Boone Creek | 5236 | Headwaters to East Fork Big Lost River | Undetermined Pollutants | Low SMI, SFI, and SHI scores |
| Warm Springs Creek | 5237 | (Hamilton) Spring to Mackay Reservoir | Undetermined Pollutants | Low SMI, SFI, and SHI scores |

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

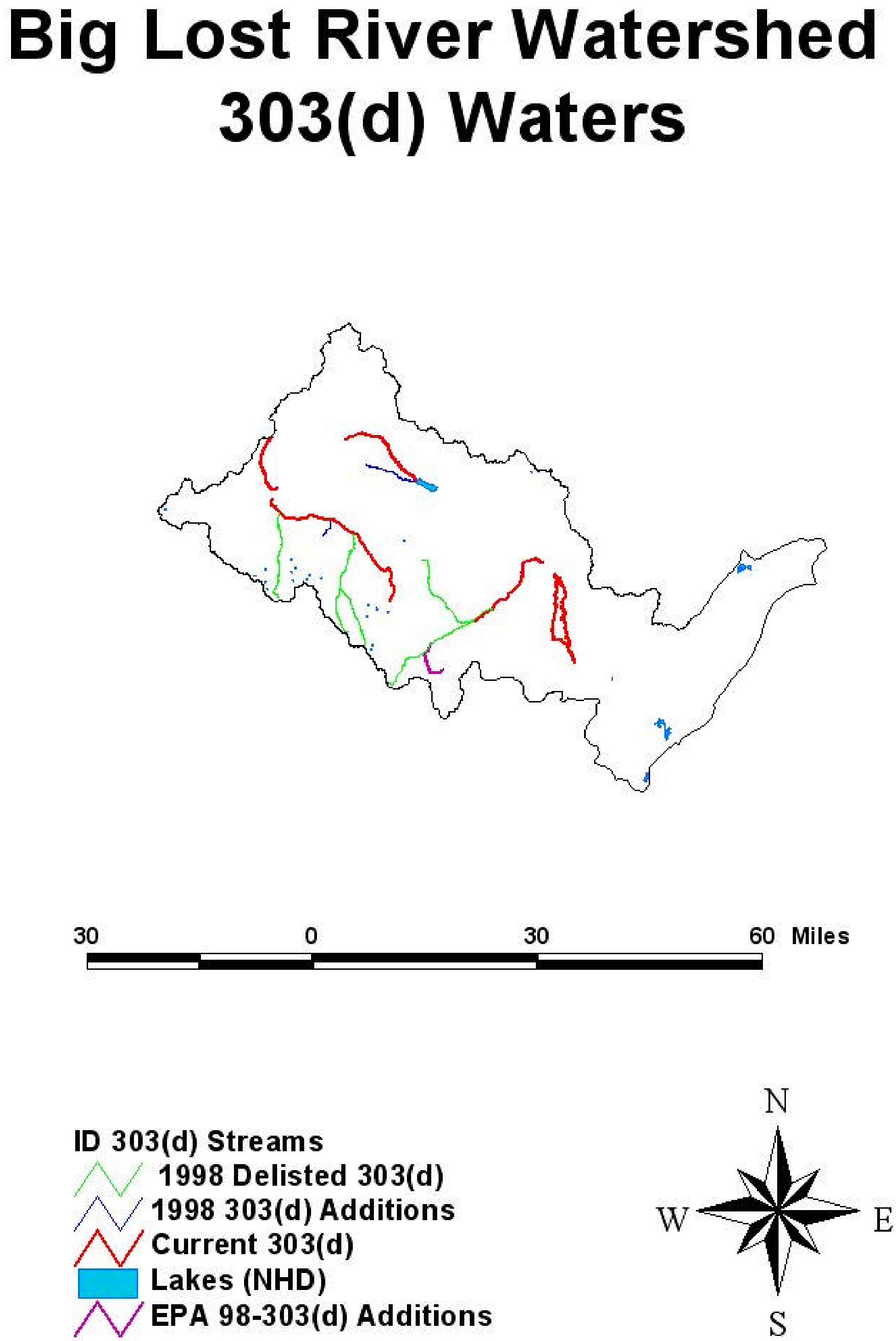


**Figure 64. Big Lost River Watershed §303(d) listed Waters.**

## 2.2 Applicable Water Quality Standards

Idaho water quality standards are published in Idaho's rules at IDAPA 58.01.02. They require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). Beneficial uses (BU) are the characteristics of Idaho's streams to be utilized for various purposes, and support status is defined at IDAPA58.01.02.053. The Water Body Assessment Guidance, second edition (Grafe et al. 2002) gives a more detailed description of the procedure for assessing beneficial uses. Beneficial uses are categorized as existing uses, designated uses, and presumed uses. See appendix C applicable water quality standards in their entirety.

### Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and "presumed" uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (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 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a water could support salmonid spawning, but salmonid spawning is not yet occurring.

#### Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each waterbody or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include cold water aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. 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 waterbodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses.) Table 8 identifies the designated uses for waterbodies in the Big Lost River subbasin.

**Table 8. Big Lost River subbasin designated beneficial uses.**

| Waterbody | Water Body Unit (WBID) | Boundaries | Designated Uses[1] | 1998 §303(d) List[2] |
|---|---|---|---|---|
| Big Lost River | US-1 | Sinks (playas) and Dry Channel | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-2 | Spring Creek to Big Lost River Sinks (playas) | CW,SS,PCR,DWS, SRW | Yes |
| Big Lost River | US-4 | Antelope Creek to Spring Creek | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-7 | Alder Creek to Antelope Creek | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-10 | Beck and Evan Ditch to Alder Creek | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-11 | Mackay Reservoir Dam to Beck and Evan Ditch | CW,SS,PCR,DWS, SRW | No |
| Mackay Reservoir | US-12 | Mackay Reservoir | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-13 | Jones Creek to Mackay Reservoir | CW,SS,PCR,DWS, SRW | Yes |
| Big Lost River | US-15 | Thousand Springs Creek to Jones Creek | CW,SS,PCR,DWS, SRW | Yes |
| Big Lost River | US-24 | Burnt Creek to Thousand Springs Creek | CW,SS,PCR,DWS, SRW | No |
| Big Lost River | US-25 | Summit Creek to and including Burnt Creek | CW,SS,PCR,DWS, SRW | No |

[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, SRW – Special Resource Water.

[2]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

## Presumed Uses

In Idaho, most waterbodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria. (IDAPA 58.01.02.101.01). Table 9 identifies the presumed uses for waterbodies in the Big Lost River subbasin.

**Table 9. Big Lost River subbasin existing/presumed beneficial uses.**

| Waterbody | Water Body Unit (WBID) | Boundaries | Existing/Presumed Uses[1] | 1998 §303(d) List[2] |
|---|---|---|---|---|
| Spring Creek | US-3 | Lower Pass Creek to Big Lost River | CW and PCR or SCR | Yes |
| King, Lime Kiln, Ramshorn, and Anderson Canyon Creek | US-5 | Source to Mouth | CW and PCR or SCR | No |
| Lower Pass Creek | US-6 | Source to Mouth | CW and PCR or SCR | No |
| Elbow, Jepson, Clark, Maddock, and Jaggles Canyon Creek | US-8 | Source to Mouth | CW and PCR or SCR | No |
| Pass Creek | US-9 | Source to Mouth | CW and PCR or SCR | No |
| Jones Creek | US-14 | Source to Mouth | CW and PCR or SCR | No |
| Thousand Springs Creek | US-16 | Source to Mouth | CW and PCR or SCR | No |
| Lone Cedar Creek | US-17 | Source to Mouth | CW and PCR or SCR | No |
| Cedar Creek | US-18 | Source to Mouth | CW and PCR or SCR | No |
| Rock Creek | US-19 | Source to Mouth | CW and PCR or SCR | No |
| Willow Creek | US-20 | Source to Mouth | CW and PCR or SCR | No |

| | | | | |
|---|---|---|---|---|
| Arentson Gulch and Unnamed Tributaries | US-21 | Source to Mouth | CW and PCR or SCR | No |
| Sage Creek | US-22 | Source to Mouth | CW and PCR or SCR | No |
| Parsons Creek | US-23 | Point of perennial flow north of road to Mackay Reservoir | CW and PCR or SCR | No |
| Twin Bridges Creek | US-26 | Source to Mouth | CW and PCR or SCR | No |
| North Fork Big Lost River | US-27 | Source to Mouth | CW and PCR or SCR | No |
| Summit Creek | US-28 | Source to Mouth | CW and PCR or SCR | No |
| Kane Creek | US-29 | Source to Mouth | CW and PCR or SCR | No |
| Wildhorse Creek | US-30 | Fall Creek to Mouth | CW and PCR or SCR | No |
| Wildhorse Creek | US-31 | Source to Mouth | CW and PCR or SCR | No |
| Fall Creek | US-32 | Source to Mouth | CW and PCR or SCR | No |
| East Fork Big Lost River | US-33 | Cabin Creek to Mouth | CW and PCR or SCR | Yes |
| Fox Creek | US-34 | Source to Mouth | CW and PCR or SCR | No |
| Star Hope Creek | US-35 | Lake Creek to Mouth | CW and PCR or SCR | No |
| Star Hope Creek | US-36 | Source to Lake Creek | CW and PCR or SCR | No |
| Muldoon Canyon Creek | US-37 | Source to Mouth | CW and PCR or SCR | No |
| Lake Creek | US-38 | Source to Mouth | CW and PCR or SCR | No |
| East Fork Big Lost River | US-39 | Source to Cabin Creek | CW and PCR or SCR | Yes |
| Cabin Creek | US-40 | Source to Mouth | CW and PCR or SCR | No |
| Corral Creek | US-41 | Source to Mouth | CW and PCR or SCR | No |
| Boone Creek | US-42 | Source to Mouth | CW and PCR or SCR | No |
| Warm Springs Creek | US-43 | Source to Mouth | CW and PCR or SCR | Yes |
| Navarre Creek | US-44 | Source to Mouth | CW and PCR or SCR | No |
| Alder Creek | US-45 | Source to Mouth | CW and PCR or SCR | No |
| Antelope Creek | US-46 | Spring Creek to Mouth | CW and PCR or SCR | Yes |
| Antelope Creek | US-47 | Dry Fork Creek to Spring Creek | CW and PCR or SCR | No |
| Spring Creek | US-48 | Source to Mouth | CW and PCR or SCR | No |
| Cherry Creek | US-49 | Confluence of Left Fork Cherry and Lupine Creeks to Mouth | CW and PCR or SCR | No |

| | | | | |
|---|---|---|---|---|
| Lupine Creek | US-50 | Source to Mouth | CW and PCR or SCR | No |
| Left Fork Cherry Creek | US-51 | Source to Mouth | CW and PCR or SCR | No |
| Antelope Creek | US-52 | Iron Bog creek to Dry Fork Creek | CW and PCR or SCR | No |
| Bear Creek | US-53 | Source to Mouth | CW and PCR or SCR | No |
| Iron Bog Creek | US-54 | Confluence of Left and Right Fork Iron Bog Creek to Mouth | CW and PCR or SCR | No |
| Right Fork Iron Bog Creek | US-55 | Source to Mouth | CW and PCR or SCR | No |
| Left Fork Iron Bog Creek | US-56 | Source to Mouth | CW and PCR or SCR | No |
| Antelope Creek | US-57 | Source to Iron Bog Creek | CW and PCR or SCR | No |
| Leadbelt Creek | US-58 | Source to Mouth | CW and PCR or SCR | No |
| Dry Fork Creek | US-59 | Source to Mouth | CW and PCR or SCR | No |
| South Fork Antelope Creek | US-60 | Antelope Creek to Mouth | CW and PCR or SCR | No |
| Hammond Spring Creek Complex | US-61 | Spring Complex | CW and PCR or SCR | No |

[1]CW – Cold Water, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply, SRW – Special Resource Water.
[2]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

## 2.3 Summary and Analysis of Existing Water Quality Data

Data related to water quality in the Big Lost River watershed is sporadic and scant with regard to tributaries and much of the mainstem flow. Land management agencies have collected the majority of data, outside of DEQ's efforts, and that data primarily relates to water temperature and fish presence. Fish abundance data is available for a number of locations. Historic for comparison is limited to anecdotal accounts that have been reviewed in the Fisheries section of this report. Water column data has been collected by USGS at one location near the Howell Ranch but has limited application to determining trends due to frequency of sampling and parameters sampled. Idaho State University has conducted studies to evaluate sampling techniques in lotic (flowing) systems. Riparian habitat monitoring has been conducted at several locations by the Forest Service within the watershed, however this data has limited use to determine past or existing water quality conditions because it has never been assimilated by the agency or applied to any form of land management or effectiveness monitoring. The BLM has contributed some flow measurements on tributary streams that have been included in the Subwatershed Description section of this report. DEQ has conducted BURP monitoring throughout the watershed. Erosion inventory and substrate sediment evaluation has been done on several listed streams and their tributaries.

## Flow Characteristics

The temporal and spatial distribution of flow in the Big Lost watershed has been a defining characteristic of human use and natural conditions in the watershed. Flow here is related to climate, like most of the watersheds in the region, however geology, and particularly geomorphology has the most influence. During years of average or above average precipitation streams are often dry for a significant portion of the year because their flow seeps in to the substrate (infiltration). The alluvial substrate in much of the Big Lost River valley is thousands of feet deep in places and rapidly absorbs huge volumes of flow. This characteristic is difficult to see in any statistical analysis of flow, however, in the process of water quality monitoring and direct observations in the watershed it has been observed where streams are dry and for what seasons of the year. This information has been included into this report in subwatershed descriptions and summaries.

As part of the analysis of Big Lost River flow, data recurrence intervals were established to show the frequency of various peak flow rates over time. Streams that have proper channel dimension, pattern, and profile in watersheds at this latitude generally experience bankfull conditions at a rate of about every 1.7 years or less. Bankfull flow is important because it is the flow that sediment is transported most efficiently within the stream channel and subsequently within the network of streams that comprise the watershed. Bankfull flow is also the event that erodes streambanks at the highest rate of the season. This erosion is greatly accelerated if streambank stability has been reduced by management activities related to land use (Rosgen 1996).

The 1.5 year recurrence interval flow from measurements at the Howell Ranch (USGS Site #13120500), the upper-most gage on the Big Lost River, is 1700 cfs (Figure 65). Streams that are changing channel dimension or are loosing flow to infiltration or diversion would experience bankfull conditions at an increasing interval related to the extent of flow loss. Additionally the 1.5-year recurrence flow would be less. This is because greater flow would be required to achieve bankfull flow in a channel with increasing volume and less flow would be available from year to year. Additionally, since recurrence intervals are based on peak flow they give no information on how long streams are dry. The USGS has placed flow gages for the purpose of measuring flow, not dryness. To place a gage at a location where the stream channel is dry would not be a good use of resources. The river reach from the Howell Ranch gage to the channel just above Mackay Reservoir is generally dry. Some stream flow accrues just above the reservoir from groundwater seepage back into the channel. This is strongly related to groundwater levels. Ground water levels are related to inflow from other streams as well as removal by ground water pumping for irrigation.

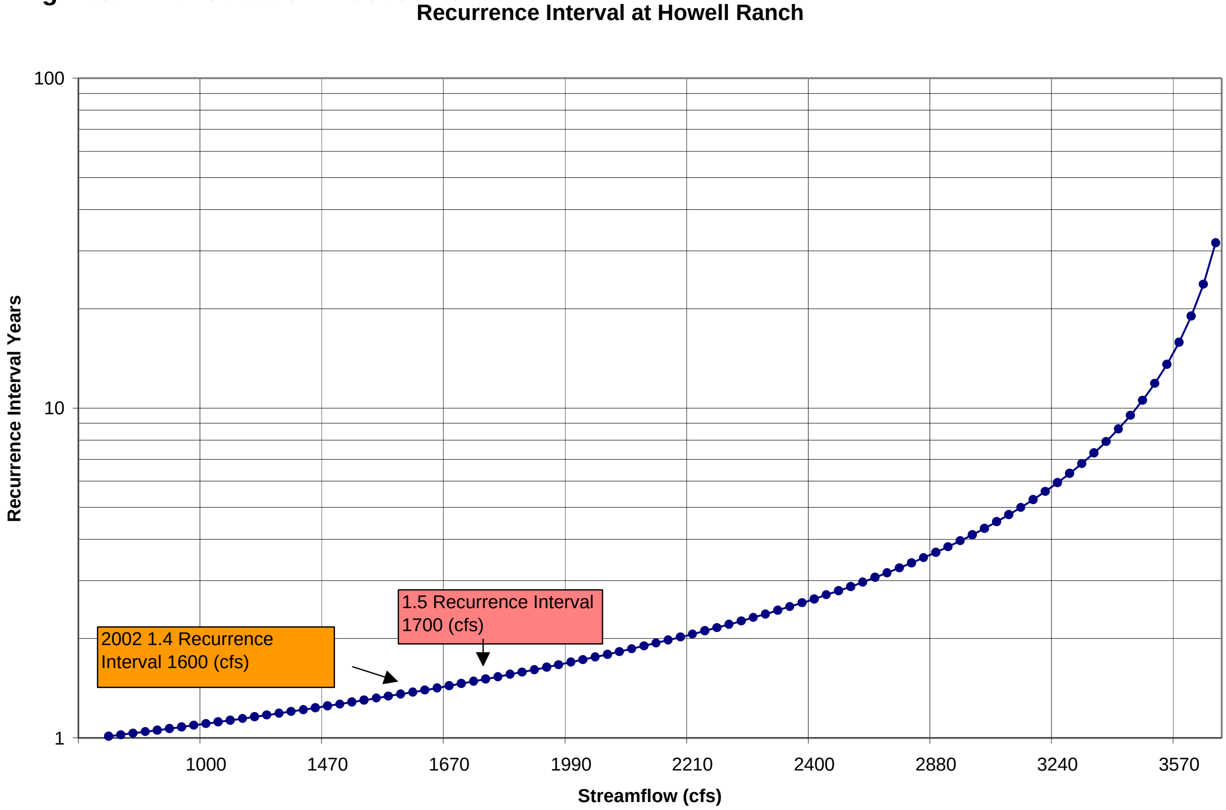


**Figure 65. Peak flow recurrence interval for the Big Lost River at the Howell Ranch.**

The 1.5-year recurrence interval flow from the gage just above Mackay Reservoir Ranch (USGS Site #13123500) is 597 cfs (Figure 66). It is markedly less than the upstream estimate for the Howell Ranch.

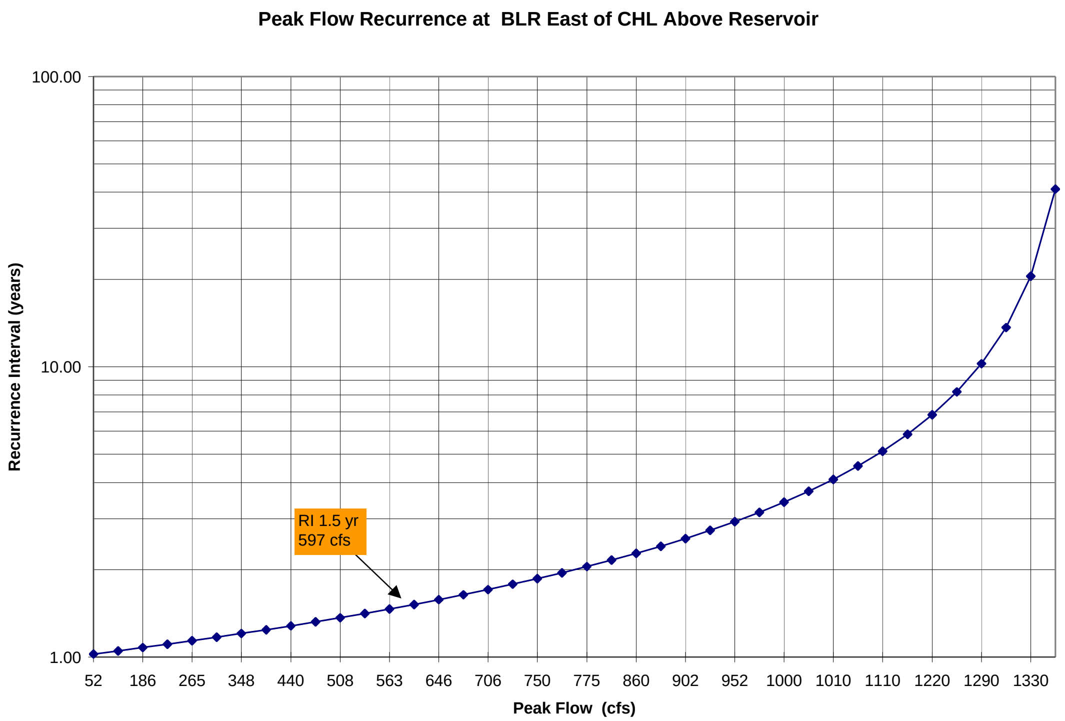


**Figure 66 Peak flow recurrence interval for the Big Lost River above Mackay Reservoir.**

The 1.5 year recurrence interval flow from measurements at the gage below Mackay Reservoir (USGS Site #13127000) is 1,120 cfs (Figure 67). This peak flow recurrence is influenced by the reservoir and is a function of demand for irrigation water. Much of the inflow and storage water in Mackay Reservoir is derived from Warm Springs Creek. Spring Creeks typically exhibit a much more consistent flow pattern than that of streams with hydrologic curves driven by snowmelt and storm events and recurrence interval is not as meaningful.

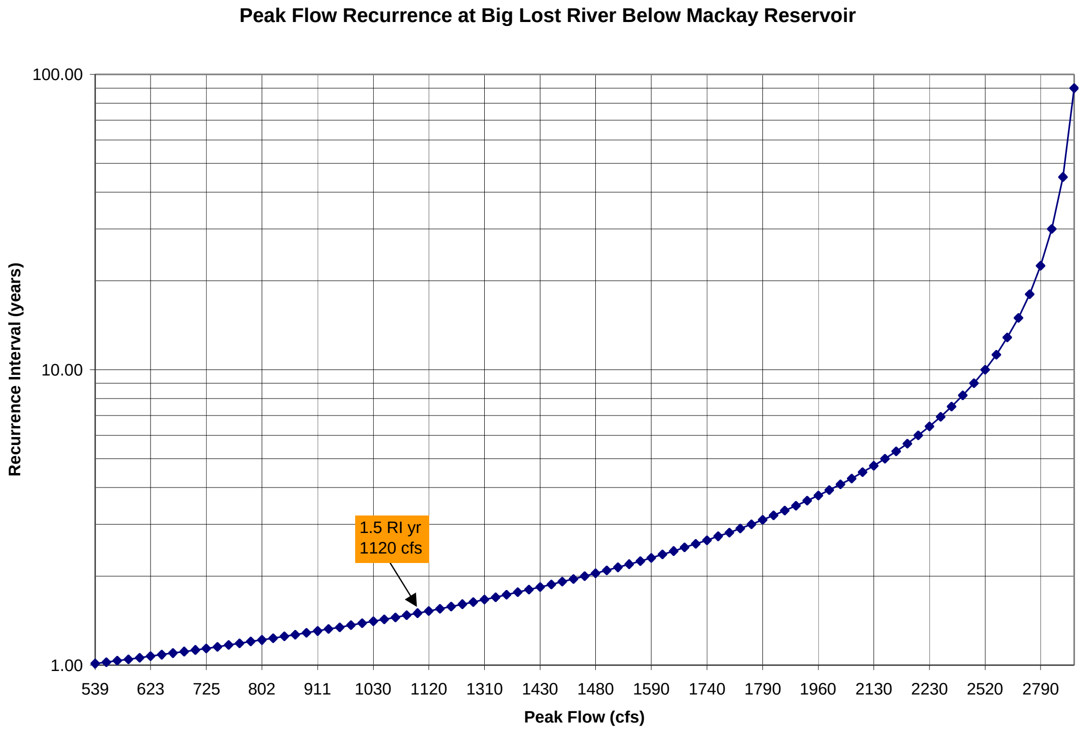


**Figure 67. Peak flow recurrence interval for the Big Lost River below Mackay Reservoir.**

Peak flow is shown for the Howell Ranch in Figure 68. and mean monthly Flow is shown in Figure 69. The frequency and magnitude of peak flow can be seen from 1904 to 2002, the years that the gage has been in operation. Mean monthly flow is averaged from data of the same period.

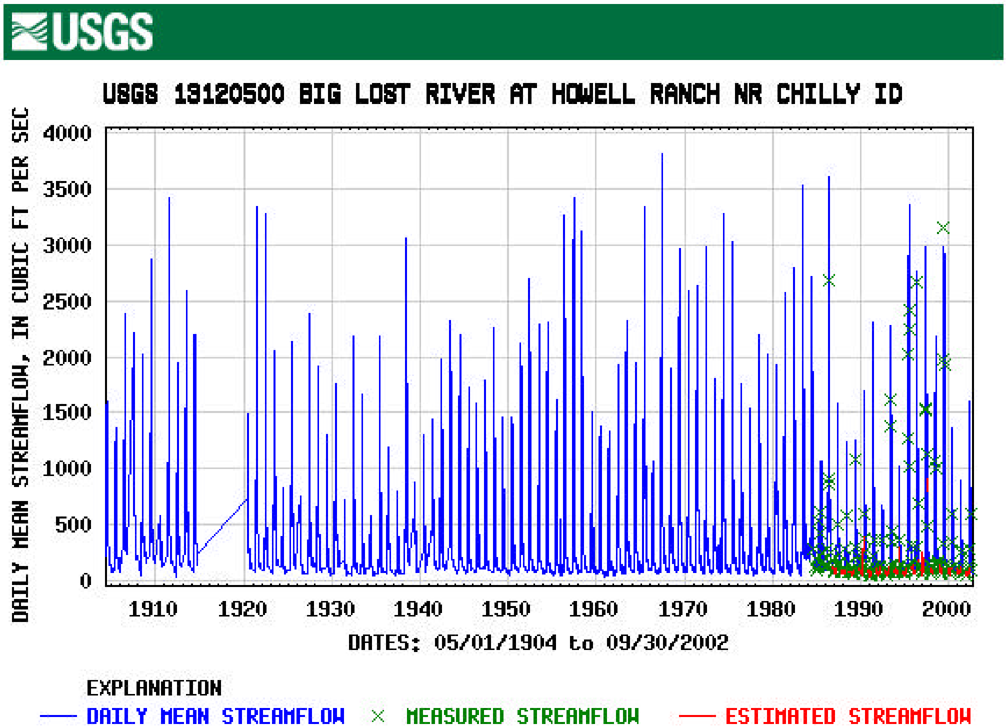


**Figure 68 Peak flow of the Big Lost River measured at the Howell Ranch USGS gage (USGS, http://water.usgs.gov/nsip/) .**

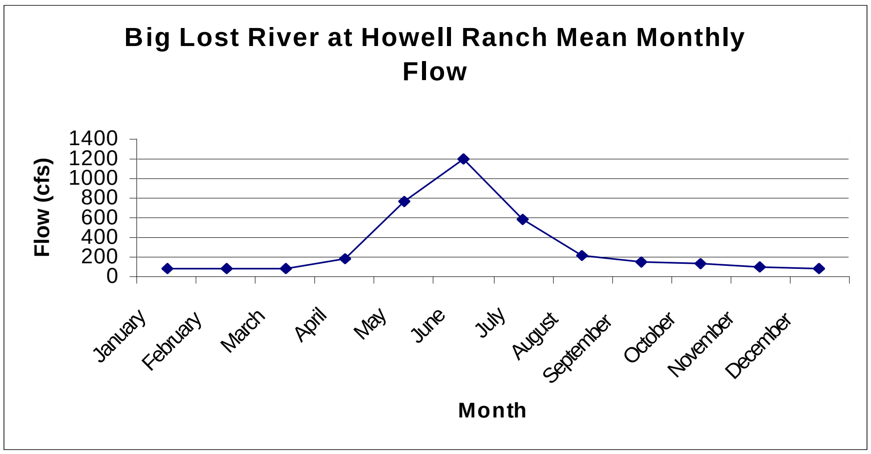


**Figure 69. Mean monthly flow of the Big Lost River measured at the Howell Ranch gage.**

Peak flow for the USGS gage above Mackay Reservoir is shown in Figure 70. and mean monthly flow is shown in Figure 71. The frequency and magnitude of peak flow can be seen from 1919 to 1959, the years that the gage has been in operation. Mean monthly flow is averaged from data of the same period. Annual intervals of zero flow are apparent.

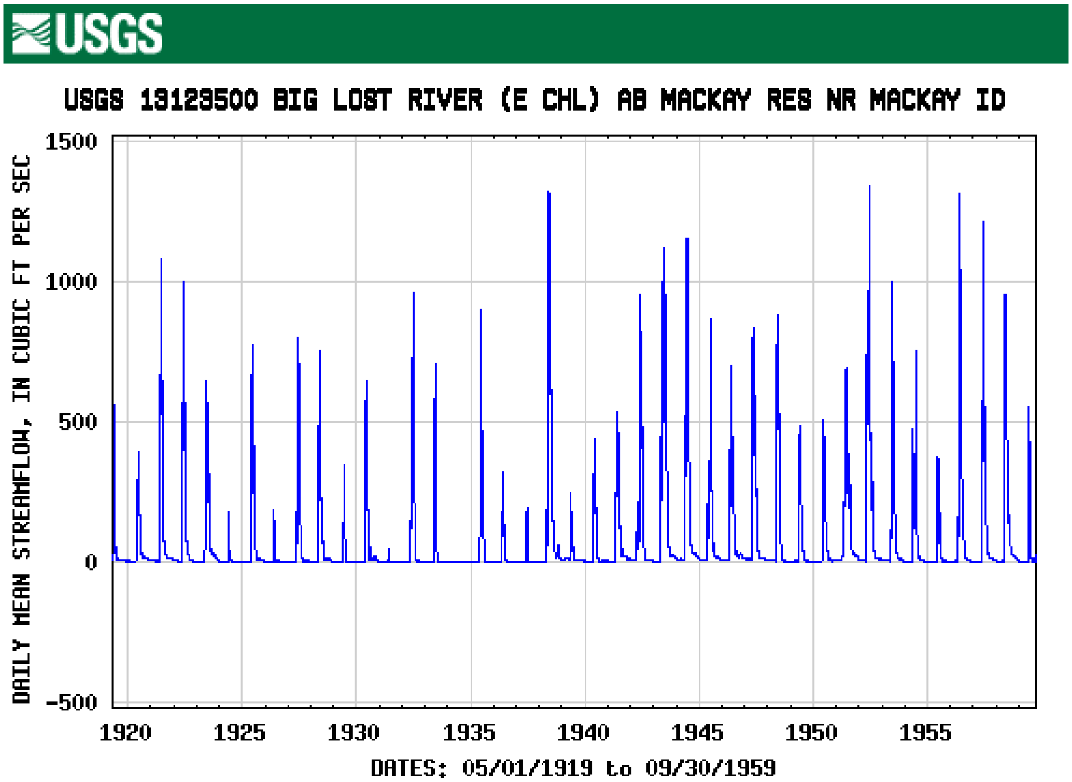


**Figure 70 Peak flow of the Big Lost River measured above Mackay Reservoir (USGS, http://water.usgs.gov/nsip/).**

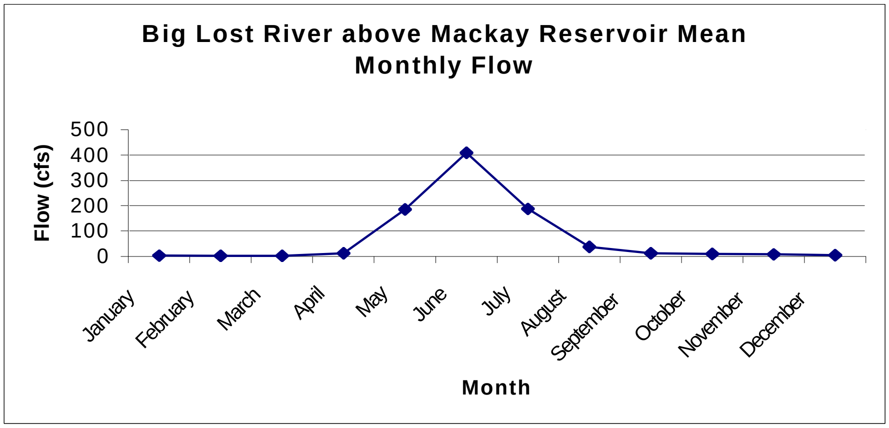


**Figure 71. Mean monthly flow of the Big Lost River measured above Mackay Reservoir.**

Peak flow for the USGS gage below Mackay Reservoir is shown in Figure 72. and mean monthly flow is shown in Figure 73. The frequency and magnitude of peak flow can be seen from 1903 to 2002, the years that the gage has been in operation.  Mean monthly flow is averaged from data of the same period.

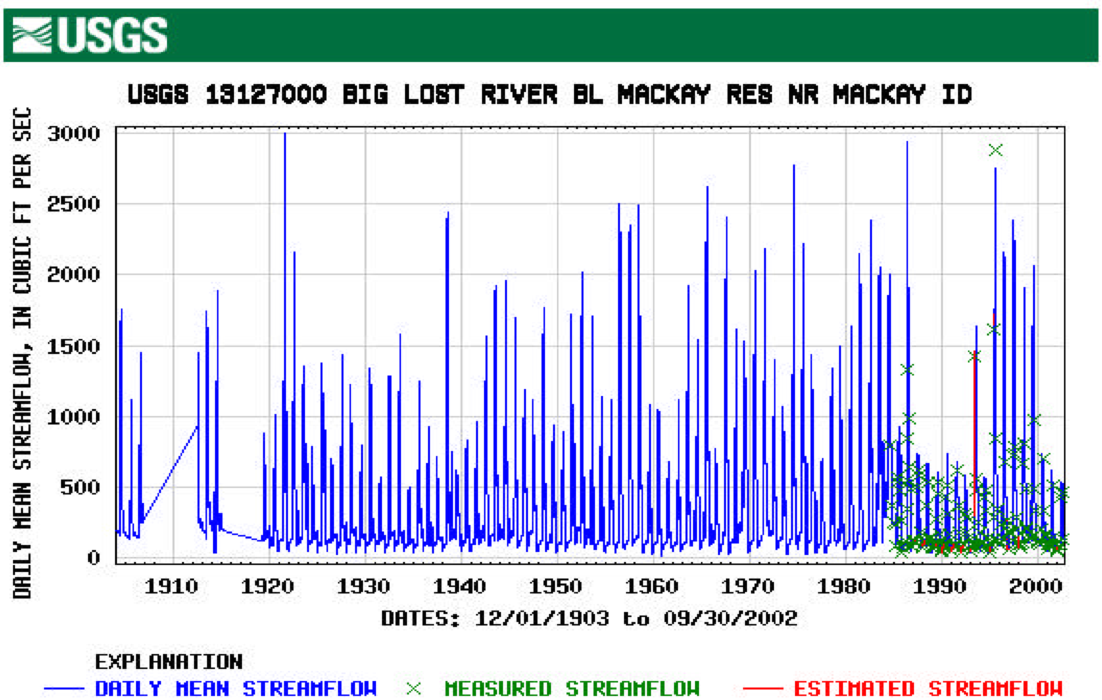


**Figure 72.  Peak flow of the Big Lost River measured below Mackay Reservoir(USGS, http://water.usgs.gov/nsip/).**

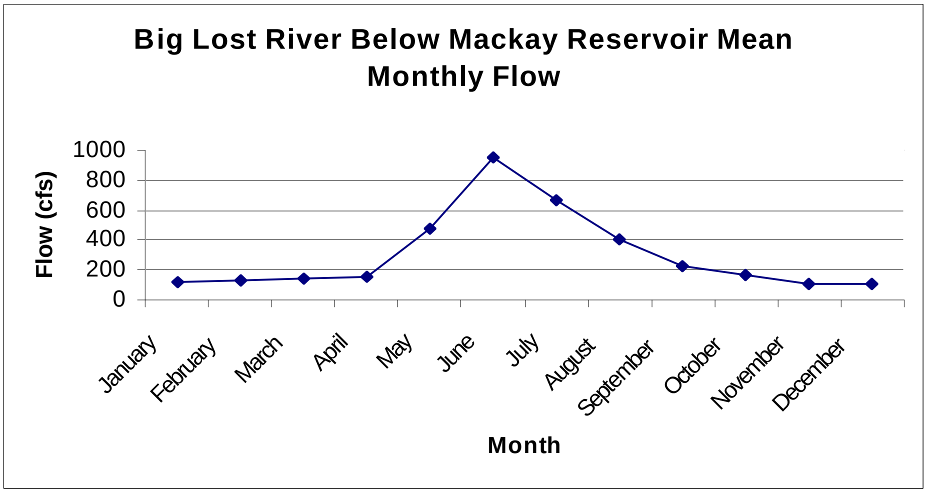


**Figure 73. Mean monthly flow of the Big Lost River measured below Mackay Reservoir.**

Peak flow for Warm Springs Creek at the USGS gages(USGS Site #13124500 east channel,#13125000 west channel) above Mackay Reservoir is shown in Figure 74 and Figure 75. and mean monthly flow is shown in Figure 76. Gages were located on two split channels. The frequency and magnitude of peak flow can be seen from 1919 to 1959, the years that the gages were in operation. Combined mean monthly flow is averaged from data of the same period.

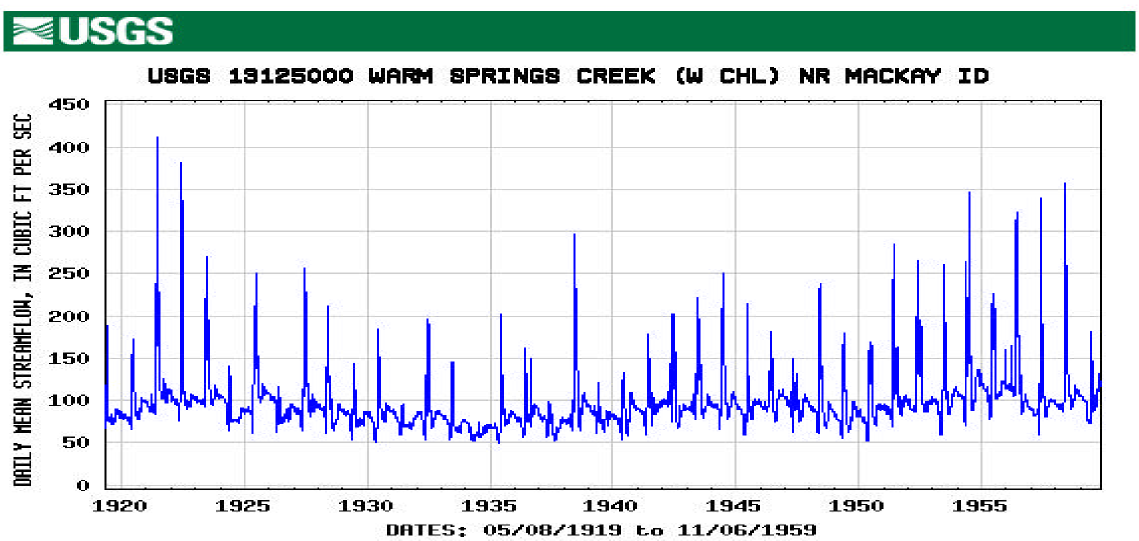


**Figure 74. Peak Flow of west channel gage on Warm Springs Creek (USGS, http://water.usgs.gov/nsip/).**

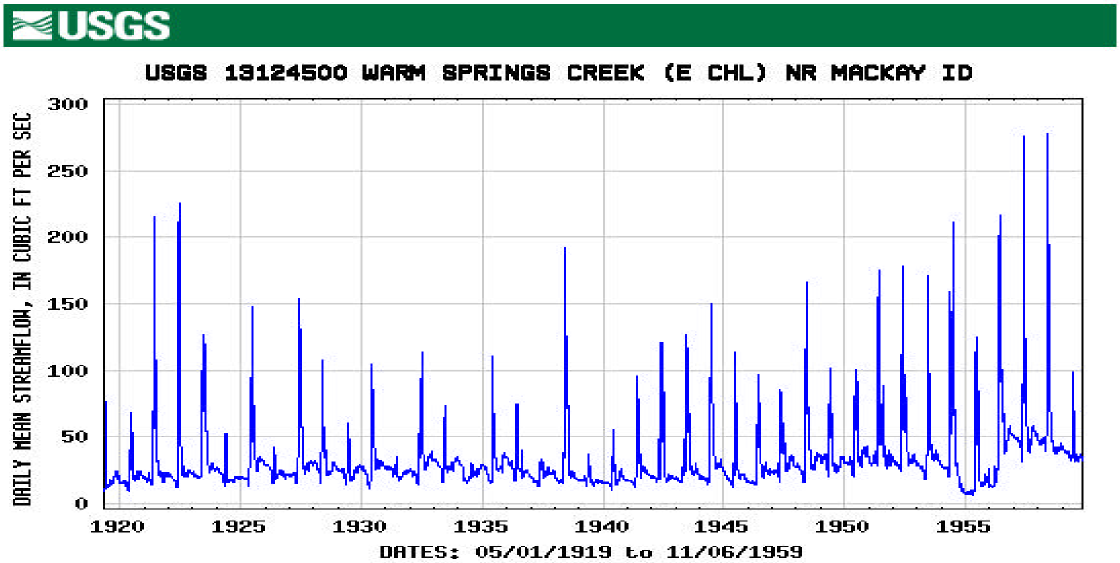


**Figure 75. Peak Flow of east channel gage on Warm Springs Creek (USGS, http://water.usgs.gov/nsip/) .**

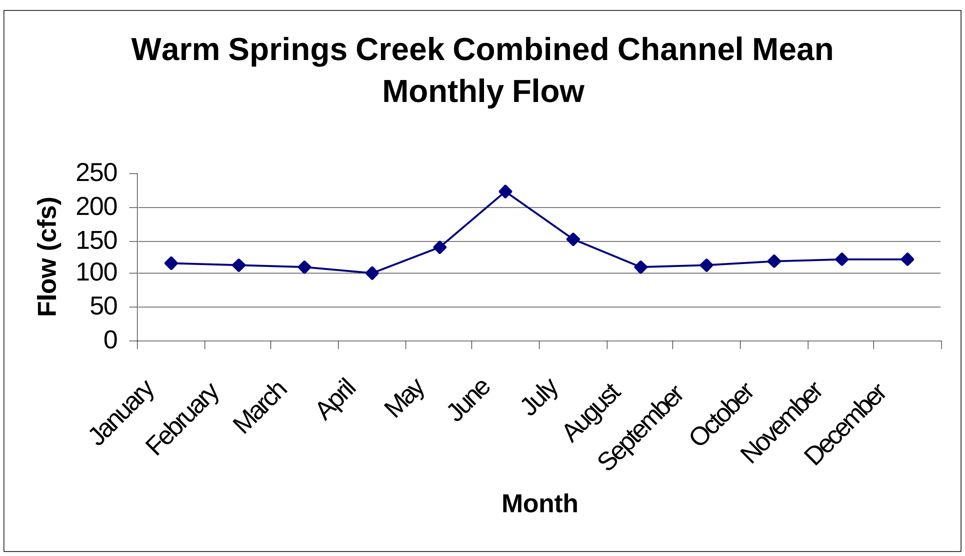


**Figure 76. Combined channel mean monthly flow in Warm Springs Creek.**

## <u>Water Column Data</u>

Temperature data has been collected with increased intensity by the Forest Service since 1999 when meetings were held to discuss the future development of the Big Lost River Subbasin Assessment and TMDL. DEQ has also conducted temperature monitoring at several locations on

303(d) listed streams. Data was collected using submersible data loggers with the emphasis placed on locations just above the mouths of streams for analysis.

Streams temperature data was summarized according to cold water aquatic life criteria periods from June 22nd to September 21st for exceedence of criteria (not greater than 22ºC instantaneous and daily average not greater than 19ºC). Streams temperature regime was also summarized according to salmonid spawning criteria (not greater than 13ºC instantaneous and daily average not greater than 9ºC). Salmonid spawning periods used for temperature evaluation were March 15th through June 30th for spring spawning cutthroat and rainbow trout and September 15th through November 15th for fall spawning brook trout. Temperature was collected at two hour intervals for varying periods depending upon deployment timing, when flow ceased, or when data was corrupted by other means, undetermined, but reflected in the data.

In addition to in-stream temperature monitoring DEQ contracted IRZ consulting of Hermiston, Oregon to conduct paired color infrared and thermal infrared imaging and analysis for select streams in the Big Lost River watershed. Flights were made on September 4th of 2002 and in the early part of the day when waters were relatively cool and again in the afternoon on the Big Lost River above Chilly Buttes, including the East Fork of the Big Lost River. Other sections of the Big Lost River below Chilly Buttes were dry. Other streams were flown one time in the afternoon to evaluate temperature loading. Single flight streams were Alder Creek, Antelope Creek, and the North Fork of the Big Lost River. Cherry Creek and Sage Creek were scheduled to be flown but were dry at the time the flights were to have taken place. This data will be used primarily for implementation of BMPs since it was not available in adequate time to direct sample loacations in 2003.

Water column data was collected during two 1996 and 1999 from May through September at the Howell Ranch on the Big Lost River at Chilly Buttes. This sampling was a part of routing monitoring affiliated with the gage station there. Data that pertains to water quality parameters important to aquatic life were summarized. DEQ collected water column data above and below a tailings pile affiliated with the Empire Mine on the Big Lost River to evaluate metals loading.

## Stream Temperature Data

Temperature data is displayed from headwaters sections of the Big Lost River and their tributaries downstream in Table 10 through 31. Temperature is considered in exceedence of water quality criteria if 10% or more of the measurements are above the particular water quality criteria under consideration. A minimum of two measurements must be collected for evaluation to determine if criteria are exceeded. Each criteria exceedance is highlighted in yellow and bold print. Spawning exceedence is based on number of days evaluated between March 15 and June 30 for spring spawning and September 15 to November 15 for Fall Spawning, Cold water aquatic life criteria is evaluated from June 22 – September 21. Temperature data for the East Fork of the Big Lost River is summarized in Table 10 and 11 from upstream locations to downstream sample sites. Data was collected from 1999 through 2000.

### Table 10. East Fork Big Lost temperature data and number of days where water temperatures exceeded the cold water aquatic life water quality standards.

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over (%)** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| East Fork Above Guard Station | 07/11/02-10/08/02 | 90 | 2 (2%) | 22.4 | 7/11/02 | 0 | 13.8 | 7/14/03 |
| East Fork at Burma Bridge | 6/29/02-10/06/02 | 100 | 8 (8%) | 23.6 | 7/11/02 | 0 | 16.9 | 7/15/03 |
| East Fork Above Exclosure | 6/9/99-10/19/99 | 132 | 0 | 18.8 | 7/13/99 | 0 | 13.4 | 7/7/99 |
| East Fork Above Exclosure | 5/24/00-10/10/00 | 132 | 0 | 20.2 | 7/29/00 | 0 | 12.9 | 8/2/00 |
| Above Starhope | 6/14/01-10/16/01 | 125 | 4 (3%) | 22.5 | 7/2/01 | 0 | 16.2 | 7/6/01 |
| Above Starhope | 7/11/02-10/8/02 | 90 | 2 (2%) | 22.4 | 7/11/02 | 0 | 13.8 | 7/14/02 |
| Above Wildhorse | 6/10/99-10/18/99 | 131 | 0 | 19.0 | 8/24/99 | 0 | 13.6 | 8/24/99 |
| Above Wildhorse | 5/25/00-10/3/00 | 132 | 0 | 19.4 | 8/11/00 | 0 | 15.1 | 8/11/00 |
| Above Wildhorse | 6/15/01-10/25/01 | 133 | 0 | 20.2 | 8/6/01 | 0 | 16.0 | 7/5/01 |
| Above Wildhorse | 7/3/02-10/2/02 | 92 | 1 (1%) | 22.0 | 7/11/02 | 0 | 16.7 | 7/15/02 |
| Above North Fork | 7/13/03-9/24/03 | 74 | 0 | 20.2 | 8/14/03 | 0 | 15.6 | 7/25/03 |

### Table 11. East Fork Big Lost Temperature data and number of days where water temperatures exceeded the salmonid spawning water quality standards.

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| East Fork Above Guard Station | 07/11/02-10/08/02 (Fall) | 24 | **8 (33%)** | 14.8 | 9/19/02 | 2 (8%) | 9.27 | 9/16/02 |
| East Fork at Burma Bridge | 6/29/02-10/06/02 (Fall) | 22 | **8 (36%)** | 15.4 | 9/15/02 | 2 (9%) | 9.9 | 9/15/02 |
| East Fork Above Exclosure | 6/10/99-10/19/99 (Spring) | 21 | **21 (100%)** | 18.1 | 6/20/99 | **20 (95%)** | 11.2 | 6/24/99 |
| East Fork Above Exclosure | 6/10/99-10/19/99 (Fall) | 35 | **7 (20%)** | 14.3 | 9/15/99 | **6 (17%)** | 9.6 | 9/15 &24/99 |
| East Fork Above Exclosure | 5/24/00-10/10/00 (Spring) | 38 | **34 (89%)** | 19.4 | 6/28/00 | **35 (95%)** | 12.4 | 6/28/00 |
| East Fork Above Exclosure | 5/24/00-10/10/00 (Fall) | 26 | **6 (23%)** | 15.6 | 9/15 &16/00 | **4 (21%)** | 10.3 | 9/15 &16/00 |
| Above Starhope | 6/14/01-10/16/01 (Spring) | 17 | **17 (100%)** | 21.3 | 6/21/01 | **16 (94%)** | 15.2 | 6/29/01 |
| Above Starhope | 6/14/01-10/16/01 (Fall) | 32 | 2 (6%) | 13.7 | 9/24/01 | **11 (34%)** | 10.15 | 9/24/01 |
| Above Starhope | 7/11/02-10/802 (Fall) | 24 | **8 (33%)** | 14.8 | 9/19/02 | 2 (8%) | 9.27 | 9/16/02 |
| Above Wildhorse | 6/10/99-10/18/99 (Spring) | 21 | **4 (19%)** | 13.7 | 6/20/99 | **11 (52%)** | 9.74 | 6/20/99 |
| Above Wildhorse | 6/10/99-10/18/99 (Fall) | 34 | **11 (32%)** | 14.5 | 9/16/99 | **10 (29%)** | 10.0 | 9/24/99 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Above Wildhorse | 5/25/00-10/3/00 (Spring) | 37 | **23 (62%)** | 16.7 | 6/28-30-01 | **29 (78%)** | 13.35 | 6/30/00 |
| Above Wildhorse | 5/25/00-10/3/00 (Fall) | 19 | **6 (32%)** | 16.3 | 9/15-16/00 | **8 (42%)** | 12.1 | 9/16/00 |
| Above Wildhorse | 6/15/01-10/25/01 (Spring) | 16 | **16 (100%)** | 19.8 | 6/29/01 | **16 (100%)** | 14.9 | 6/29/01 |
| Above Wildhorse | 6/15/01-10/25/01 (Fall) | 41 | **10 (24%)** | 14.4 | 9/24/01 | **16 (39%)** | 10.7 | 9/24/01 |
| Above Wildhorse | 7/3/02-10/2/02 (Fall) | 18 | **2 (11%)** | 13.98 | 9/15/02 | **8 (44%)** | 11.04 | 9/15/02 |
| Above North Fork Big Lost River | 7/13/03-9/24/03 (Fall) | 10 | **2 (20%)** | 13.3 | 9/22-23/03 | 0 (0%) | 8.57 | 9/22/03 |

There was no exceedence of cold water aquatic life criteria noted at sites evaluated on the East Fork, though exceedence of salmonid spawning criteria were numerous. The number and percent of days in exceedence are highlighted in yellow (total days greater than 10% of days evaluated).

Temperature data for Corral Creek is summarized in Table 12 and 13. Corral Creek is the most upstream tributary monitored with perennial flow. Data was collected in 1999 and 2000 by the Forest Service.

### Table 12. Corral Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Corral Creek above East Fork | 6/10/99-10/19/99 | 132 | 0 | 20.1 | 7/13/99 | 0 | 15.0 | 7/13/99 |
| Corral Creek above East Fork | 5/25/00-10/3/00 | 132 | 1 (1%) | 22.4 | 7/29/00 | 0 | 15.1 | 7/2/00 |

### Table 13. Corral Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Corral Creek above East Fork | 6/10/99-10/19/99 (Spring) | 21 | **20 (95%)** | 16.86 | 6/20/99 | **20 (95%)** | 12.15 | 6/24/99 |
| Corral Creek above East Fork | 6/10/99-10/19/99 (Fall) | 35 | **6 (17%)** | 13.25 | 9/21/99 | **4 (11%)** | 9.33 | 9/24/99 |
| Corral Creek above East Fork | 5/25/00-10/3/00 (Spring) | 37 | **34 (92%)** | 21.7 | 6/28/00 | **37 (100%)** | 14.39 | 6/29/00 |
| Corral Creek above East Fork | 5/25/00-10/3/00 (Fall) | 19 | **6 (32%)** | 17.1 | 9/16/00 | **5 (26%)** | 11.44 | 9/16/00 |

There was no exceedence of cold water aquatic life criteria noted in Corral Creek above the East Fork of the Big Lost River. Exceedence of salmonid spawning criteria occurred at the monitoring location in both monitoring years for spring and fall spawning periods.

Temperature data for Star Hope Creek is summarized in Table 14 and 15. Star Hope Creek is the most voluminous tributary to the East Fork of the Big Lost River. Data was collected in 2001 by the Forest Service and in 2002 by DEQ.

**Table 14. Temperature data and number of days where water temperatures exceeded the cold water aquatic life water criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over (%)** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Starhope above East Fork | 6/13/01-10/25/01 | 135 | 0 | 21.3 | 7/26/01 | 0 | 14.9 | 7/5/01 |
| Starhope above East Fork | 6/28/02-10/6/02 | 101 | 10 (10%) | 26.9 | 7/15/02 | 0 | 16.0 | 7/12/02 |

**Table 15. Temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Starhope above East Fork | 6/13/01-10/25/01 (Spring) | 18 | **18 (100%)** | 20.6 | 6/13/01 | **17 (94%)** | 13.6 | 6/29/01 |
| Starhope above East Fork | 6/13/01-10/25/01 (Fall) | 41 | **17 (41%)** | 16.4 | 9/23-24/01 | **11 (27%)** | 10.32 | 9/24/01 |
| Starhope above East Fork | 6/28/02-10/6/02 (Fall) | 22 | **15 (68%)** | 19.76 | 9/23/02 | **3 (14%)** | 11.42 | 9/15/02 |

There was no exceedence of cold water aquatic life criteria noted in Starhope Creek though 2002 was marginally within criteria with 10% of observation days in exceedence. Monitoring was conducted just above the East Fork of the Big Lost River. Exceedence of salmonid spawning criteria occurred at the monitoring location in both monitoring years for spring and fall spawning periods.

Temperature data for Wild Horse Creek is summarized in Table 16 and 17. Wild Horse Creek is the overall coolest temperature tributary, of significant flow, to the East Fork of the Big Lost River. Data was collected in 1999 through 2002 by the Forest Service and in 2002 by DEQ.

**Table 16. Wildhorse Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Wildhorse Creek above East Fork | 6/10/99-10/19/99 | 132 | 0 | 15.2 | 8/29/99 | 0 | 11.9 | 8/24/99 |
| Wildhorse Creek above East Fork | 5/25/00-10/3/00 | 132 | 0 | 18.2 | 8/8/00 | 0 | 13.4 | 8/2/00 |
| Wildhorse Creek above East Fork | 6/15/01-10/23/01 | 131 | 0 | 18.2 | 8/6/01 | 0 | 13.1 | 8/4/01 |
| Wildhorse Creek above East Fork | 6/29/02-10/6/02 | 100 | 0 | 18.9 | 7/12/02 | 0 | 13.9 | 7/14/02 |

**Table 17. Wildhorse Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Tem** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Wildhorse Creek above East Fork | 6/10/99-10/19/99 (Spring) | 21 | 0 | 10.23 | 6/11/99 | 0 | 6.8 | 6/24/99 |
| Wildhorse Creek above East Fork | 6/10/99-10/19/99 (fall) | 35 | 1 (3%) | 13.13 | 9/15/99 | 1 (3%) | 9.15 | 9/24/99 |
| Wildhorse Creek above East Fork | 5/25/00-10/3/00 (Spring) | 37 | **11 (30%)** | 15.2 | 6/29/00 | **8 (22%)** | 10.37 | 6/30/00 |
| Wildhorse Creek above East Fork | 5/25/00-10/3/00 (fall) | 19 | **4 (21%)** | 15.2 | 9/16/00 | **5 (26%)** | 10.6 | 9/16/00 |
| Wildhorse Creek above East Fork | 6/15/01-10/23/01 (Spring) | 16 | **13 (81%)** | 16.7 | 6/29/01 | **10 (63%)** | 11.33 | 6/29/01 |
| Wildhorse Creek above East Fork | 6/15/01-10/23/01 (fall) | 39 | **14 (36%)** | 14.4 | 9/24/01 | **8 (21%)** | 9.8 | 9/17/01 |
| Wildhorse Creek above East Fork | 6/29/02-10/6/02 (fall) | 22 | **8 (36%)** | 14.14 | 9/19/02 | **5 (23%)** | 9.37 | 9/18/01 |

There was no exceedence of cold water aquatic life criteria noted in Wild Horse Creek. Monitoring was conducted just above the East Fork of the Big Lost River. Exceedence of salmonid spawning criteria occurred at the monitoring location in the 2000 through 2002 monitoring years for spring and fall spawning periods.

Temperature data for North Fork of the Big Lost River is summarized in Table 18 and 19. The North Fork of the Big Lost River originates in the northwest area of the subbasin and is slightly lower in flow to the East Fork of the Big Lost River. Data was collected in 1999 through 2002 by the Forest Service.

**Table 18. North Fork Big Lost River temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| North Fork above Summit Creek | 6/10/99-10/19/99 | 132 | 0 | 16.5 | 8/26/99 | 0 | 12.3 | 8/24/99 |
| North Fork above Summit Creek | 5/25/00-10/3/00 | 132 | 0 | 21.7 | 8/2/00 | 0 | 13.9 | 8/2/00 |
| North Fork above Summit Creek | 6/14/01-10/21/01 | 130 | 0 | 19.8 | 8/29/01 | 0 | 13.9 | 7/4/01 |
| North Fork above Summit Creek | 6/29/02-10/6/02 | 100 | 0 | 21.4 | 7/12/02 | 0 | 14.6 | 7/12/02 |

**Table 19. North Fork Big Lost River temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| North Fork above Summit Creek | 6/10/99-10/19/99 (Spring) | 21 | 0 | 12.5 | 6/30/99 | 0 | 8.65 | 6/30/99 |
| North Fork above Summit Creek | 6/10/99-10/19/99 (Fall) | 35 | 2 (6%) | 13.13 | 9/15-16/99 | 3 (9%) | 9.13 | 9/15-16/99 |
| North Fork above Summit Creek | 5/25/00-10/3/00 (Spring) | 37 | **23 (62%)** | 16.7 | 6/28-30/01 | **15 (41%)** | 11.5 | 6/30/00 |
| North Fork above Summit Creek | 5/25/00-10/3/00 (Fall) | 19 | **6 (32%)** | 16.3 | 9/15-16/00 | **5 (26%)** | 10.6 | 9/16/00 |
| North Fork above Summit Creek | 6/14/01-10/21/01 (Spring) | 17 | **16 (94%)** | 19.0 | 6/29/01 | **16 (94%)** | 12.92 | 6/29/01 |
| North Fork above Summit Creek | 6/14/01-10/21/01 (Fall) | 37 | **15 (41%)** | 14.4 | 9/23/01 | **6 (16%)** | 9.62 | 9/24/01 |
| North Fork above Summit Creek | 6/29/02-10/6/02 (Fall) | 22 | **9 (41%)** | 15.6 | 9/15/02 | 2 (9%) | 9.84 | 9/15/02 |

There was no exceedence of cold water aquatic life criteria noted in the North Fork of the Big Lost River. Monitoring was conducted just above Summit Creek. Exceedence of salmonid spawning criteria occurred at the monitoring location in the 2000 through 2001 monitoring years for spring and fall spawning periods and during spring monitoring in 2002.

Temperature data for Summit Creek is summarized in Table 20 and 21. Summit Creek originates in the western area of the North Fork Big Lost River subbasin and is the largest tributary to the North Fork. Data was collected in 1999 through 2002 by the Forest Service.

### Table 20. Summit Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Summit Creek above North Fork | 6/10/99-10/19/99 | 132 | 0 | 16.8 | 8/26/99 | 0 | 12.0 | 8/24/99 |
| Summit Creek above North Fork | 5/25/00-10/3/00 | 132 | 0 | 18.6 | 8/2/00 | 0 | 13.4 | 8/2/00 |
| Summit Creek above North Fork | 6/14/01-10/25/01 | 134 | 0 | 19.4 | 8/6/01 | 0 | 13.5 | 8/8/01 |
| Summit Creek above North Fork | 6/29/02-10/3/02 | 97 | 0 | 19.8 | 8/12/02 | 0 | 13.9 | 8/12/02 |

### Table 21. Summit Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Summit Creek above North Fork | 6/10/99-10/19/99 (Spring) | 21 | 0 | 11.66 | 6/12/99 | 0 | 7.19 | 6/30/99 |
| Summit Creek above North Fork | 6/10/99-10/19/99 (Fall) | 35 | 2 (6%) | 13.3 | 9/16-17/99 | 0 | 7.95 | 9/25/99 |
| Summit Creek above North Fork | 5/25/00-10/3/00 (Spring) | 37 | **12 (32%)** | 15.9 | 6/28-30/00 | **10 (27%)** | 10.42 | 6/30/00 |
| Summit Creek above North Fork | 5/25/00-10/3/00 (Fall) | 19 | **4 (21%)** | 15.2 | 9/16/00 | **5 (26%)** | 10.52 | 9/16/00 |
| Summit Creek above North Fork | 6/14/01-10/25/01 (Spring) | 17 | **15 (88%)** | 17.8 | 6/29/01 | **14 (82%)** | 11.64 | 6/29/01 |
| Summit Creek above North Fork | 6/14/01-10/25/01 (Fall) | 41 | **7 (17%)** | 14.1 | 9/24/01 | 4 (10%) | 9.53 | 9/15/01 |
| Summit Creek above North Fork | 6/29/02-10/3/02 (Fall) | 19 | **3 (16%)** | 14.02 | 9/15/02 | **3 (16%)** | 10.07 | 9/15/02 |

There was no exceedence of cold water aquatic life criteria noted in Summit Creek. Monitoring was conducted just above the North Fork of the Big Lost River. Exceedence of salmonid spawning criteria occurred at the monitoring location in the 2000 through 2001 monitoring years for spring spawning and the spring spawning period in 2001. Both spring and fall periods were in violation of criteria in 2002.

Temperature data for the Big Lost River at the Howell Ranch is summarized in Table 22 and 23. The Big Lost River originates at the confluence of the North Fork Big Lost River and the East Fork of the Big Lost River. Data was collected in 1996 and 1999 by the USGS.

**Table 22. USGS Big Lost River at Howell Ranch Temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Big Lost at Howell Ranch | 6/18/96-9/15/96 | 90 | 0 | 17.3 | 8/10/96 | 0 | 13.9 | 8/11-13/96 |
| Big Lost at Howell Ranch | 5/28/99-9/30/99 | 122 | 0 | 17.2 | 8/26/99 | 0 | 14.3 | 8/24/99 |

**Table 23. USGS Big Lost River at Howell Ranch temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Big Lost at Howell Ranch | 6/18/96-9/15/96 (Spring) | 13 | **2 (15 %)** | 14.6 | 6/30/96 | **3 (23%)** | 11.1 | 6/30/96 |
| Big Lost at Howell Ranch | 6/18/96-9/15/96 (Fall) | 1 | 0 | 9.9 | 9/15/96 | 0 | 8.0 | 9/15/96 |
| Big Lost at Howell Ranch | 5/28/99-9/30/99 (Spring) | 34 | 0 | 13.0 | 6/23-24/99 | 3 (8%) | 9.6 | 6/30/99 |
| Big Lost at Howell Ranch | 5/28/99-9/30/99 (Fall) | 16 | 1 (6%) | 13.3 | 6/15/99 | **11 (73%)** | 10.4 | 9/15/99 |

There was no exceedence of cold water aquatic life criteria noted in the Big Lost River at the Howell Ranch. Exceedence of salmonid spawning criteria occurred at the monitoring location in the 1996 monitoring period for spring spawning and the fall spawning period in 1999. There was no major exceedence of temperature criteria for the fall spawning period in 1996 or the spring spawning period in 1999.

There is no meaningful temperature data for the remaining reach of the Big Lost River to the Mackay Reservoir. Dry channels throughout the majority of critical time periods for salmonid spawning below Chilly Buttes, during the evaluation period, precluded assessing the temperature regime. From data at the Howell ranch it can be projected that during brief periods of flow there would not be temperature issues related to cold water aquatic life standards.

Temperature data for lower Warm Springs Creek is summarized in Table 24 and 25. Warm Springs Creek originates at Hamilton Springs. There is a hatchery located at the source of the springs. Data was collected by DEQ in 2002 and 2003.

**Table 24. Warm Springs Creek Temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Warm Springs Creek above Reservoir | 7/12/2002-11/13/2002 | 125 | 0 | 21.7 | 7/12/02 | 0 | 15.4 | 7/12/02 |
| Warm Springs Creek above Reservoir | 5/7/03-9/24/03 | 141 | 0 | 20.9 | 7/22/03 | 0 | 14.7 | 8/21/03 |

**Table 25. Warm Springs Creek Temperature data and number of days where water temperatures exceeded the Salmonid Spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13°C Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Warm Springs Creek above Reservoir | 7/12/2002-11/13/2002 (Fall) | 60 | **14 (23%)** | 15.2 | 9/19/02 | **12 (20%)** | 10.9 | 9/15/02 |
| Warm Springs Creek above Reservoir | 5/7/03-9/24/03 (Spring) | 55 | **52 (95%)** | 20.9 | 5/24/03 | **49 (89%)** | 14.5 | 6/29/03 |
| Warm Springs Creek above Reservoir | 5/7/03-9/24/03 (Fall) | 10 | **5 (50%)** | 14.8 | 9/23/03 | **5 (50%)** | 9.88 | 9/23/03 |

There was no exceedence of cold water aquatic life criteria noted in Warm Springs Creek at the Gregory Ranch above Mackay Reservoir. Exceedence of salmonid spawning criteria occurred at the monitoring location in the 2002 and 2003 monitoring period for spring and fall spawning periods.

Temperature data for Antelope Creek is summarized in Table 26 and 27. Antelope Creek is a tributary to the Big Lost River just above the Moore Diversion where the Big Lost River is generally diverted for irrigation. Antelope Creek, like the Big Lost River is ephemeral over its lower reach. Data was collected from 1999 through 2002 by the Forest Service and in 2003 by DEQ.

**Table 26. Antelope Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Antelope Creek at Forest Boundary | 6/12/99-10/19/99 | 130 | 0 | 17.4 | 8/23/99 | 0 | 13.2 | 8/24/99 |
| Antelope Creek at Forest Boundary | 5/25/00-10/20/00 | 149 | 0 | 19.4 | 8/2/00 | 0 | 16.1 | 8/2/00 |
| Antelope Creek at Forest Boundary | 6/14/01-10/23/01 | 132 | 0 | 20.9 | 8/5/01 | 0 | 16.4 | 8/5/01 |
| Antelope Creek at Forest Boundary | 6/29/02-10/6/02 | 100 | 0 | 21.0 | 8/12/01 | 0 | 15.7 | 8/15/01 |
| Antelope Creek 0.25 mi. below Forest Boundary | 5/7/03-9/24/03 | 141 | 0 | 20.9 | 8/21/03 | 0 | 15.6 | 8/21/03 |
| Lower Antelope Creek at South Fk Diversion | 5/7/03-6/13/03 | 35 | 3 (8%) | 23.2 | 6/6&8 /03 | 0 | 15.1 | 6/9/03 |

**Table 27. Antelope Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Antelope Creek at Forest Boundary | 6/12/99-10/19/99 (Spring) | 19 | 1 5%) | 13.13 | 6/30/99 | 0 | 8.72 | 6/30/99 |
| Antelope Creek at Forest Boundary | 6/12/99-10/19/99 (Fall) | 35 | 2 (6%) | 13.13 | 9/15 &17/99 | 0 | 8.9 | 9/17/99 |
| Antelope Creek at Forest Boundary | 5/25/00-10/20/00 (Spring) | 37 | **22 (59%)** | 17.8 | 6/30/00 | **20 (54%)** | 12.78 | 6/30/00 |
| Antelope Creek at Forest Boundary | 5/25/00-10/20/00 (Fall) | 36 | 3 (8%) | 15.2 | 9/15/00 | **8 (22%)** | 12.24 | 9/16/00 |
| Antelope Creek at Forest Boundary | 6/14/01-10/23/01 (Spring) | 17 | **16 (94%)** | 19.0 | 6/29/01 | **16 (94%)** | 13.86 | 6/29/01 |
| Antelope Creek at Forest Boundary | 6/14/01-10/23/01 (Fall) | 39 | **9 (23%)** | 15.6 | 9/15/01 | **12 (31%)** | 10.7 | 9/15/01 |
| Antelope Creek at Forest Boundary | 6/29/02-10/6/02 (Fall) | 22 | 2 (9%) | 14.09 | 9/15/02 | 2 (9%) | 10.02 | 9/15/02 |
| Antelope Creek 0.25 mi. below Forest Boundary | 5/7/03-9/24/03 (Spring) | 55 | **17 (31%)** | 17.4 | 6/30/03 | **14 (25%)** | 12.78 | 6/30/03 |
| Antelope Creek 0.25 mi. below Forest Boundary | 5/7/03-9/24/03 (Fall) | 10 | **5 (50%)** | 14.4 | 9/22-24/03 | **4 (40%)** | 9.63 | 9/23/03 |
| Lower Antelope Creek at South Fk Diversion | 5/7/03-6/13/03 (Spring) | 38 | **30 (8%)** | 23.2 | 6/6&8 /03 | **27 (77%)** | 15.1 | 6/9/03 |

There were 3 days exceedence of cold water aquatic life criteria temperature in Antelope Creek at the South Fork of Antelope Creek Diversion, however, the exceedence did not occur between June 22nd and September 21st. The natural stream channel was dry below the diversion on May 19th and the temperature logger was removed from the water after June 13th and draped over the fence at the sample location. Exceedence of salmonid spawning criteria occurred at the South Fork of Antelope Creek Diversion monitoring location prior to corruption of data collection in the 2003 monitoring period.

Spawning temperature criteria were exceeded in Antelope Creek at the Forest Boundary monitoring location used by the Forest Service during spring 2000 and 2001. Fall spawning criteria were exceeded at this location in 2000 for daily average temperature and for instantaneous temperature and daily average temperature in 2001. There was no exceedence of temperature criteria for salmonid spawning in spring or fall of 1999 or 2002 at the Forest Service monitoring location. Spring and fall Criteria were exceeded 0.25 mi. below the Forest boundary, at the DEQ monitoring location in 2003.

Temperature data for Bear Creek is summarized in Table 28 and 29. Bear Creek is a tributary to Antelope Creek above the Forest Boundary. The majority of flow is across lands managed by the Forest Service, however the lower mile of flow is across private land. The Forest Service collected data from 1999 through 2002 above the confluence with Antelope Creek at the Forest Boundary.

**Table 28. Bear Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| Stream Name | Sample Period | # Days Evaluated | # Days Over | Max Temp | Max Date | # Days Over | Max Temp | Max Date |
| Bear Creek at Forest Boundary | 6/9/99-10/19-99 | 133 | 0 | 18.1 | 8/24/99 | 0 | 13.9 | 8/24/99 |
| Bear Creek at Forest Boundary | 5/25/00-10/3/00 | 132 | 0 | 21.7 | 8/2/00 | 0 | 16.6 | 8/2/00 |
| Bear Creek at Forest Boundary | 6/14/01-10/25/01 | 134 | 0 | 21.3 | 8/7/01 | 0 | 16.6 | 7/5/01 |
| Bear Creek at Forest Boundary | 6/29/02-10/6/02 | 100 | 1 (1%) | 22.1 | 7/12/02 | 0 | 16.9 | 7/15/02 |

**Table 29. Bear Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Bear Creek at Forest Boundary | 6/9/99-10/19-99 (Spring) | 22 | 0 | 12.83 | 6/24/99 | 0 | 9.0 | 6/24/99 |
| Bear Creek at Forest Boundary | 6/9/99-10/19-99 (Fall) | 35 | **8 (23%)** | 13.72 | 9/16 &21/99 | **8 (23%)** | 9.74 | 9/24/99 |
| Bear Creek at Forest Boundary | 5/25/00-10/3/00 (Spring) | 37 | **22 (59%)** | 17.4 | 6/30/00 | **26 (70%)** | 12.77 | 6/30/00 |
| Bear Creek at Forest Boundary | 5/25/00-10/3/00 (Fall) | 19 | **6 (32%)** | 16.7 | 9/16/00 | **8 (42%)** | 12.39 | 9/16/00 |
| Bear Creek at Forest Boundary | 6/14/01-10/25/01 (Spring) | 17 | **15 (88%)** | 19.4 | 6/29/01 | **16 (94%)** | 14.15 | 6/30/01 |
| Bear Creek at Forest Boundary | 6/14/01-10/25/01 (Fall) | 41 | **16 (39%)** | 15.2 | 9/24/01 | **19 (46%)** | 11.05 | 9/15/01 |
| Bear Creek at Forest Boundary | 6/29/02-10/6/02 (Fall) | 22 | **6 (27%)** | 15.62 | 9/15/02 | **5 (23%)** | 11.16 | 9/15/02 |

There was no major exceedence of cold water aquatic life criteria noted in Bear Creek at the Forest boundary. Exceedence of salmonid spawning criteria occurred at the monitoring location in the fall of 1999 but there was no exceedence during the spring monitoring period at that location. Spring and fall spawning criteria were exceeded in 2000, 2001, and 2002 at the monitoring location.

Temperature data for Cherry Creek is summarized in Table 30 and 31. Cherry Creek is a tributary to Antelope Creek below Bear Creek. The majority of flow is across lands managed by the Forest Service, however the lower 3 miles of flow is across private land. The Forest Service collected data from 1999 through 2002 at the Forest Boundary.

**Table 30. Cherry Creek temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria.**

| | | Cold Water Aquatic Life | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 22°C Inst. | | | 19°C Daily Ave. | | |
| **Stream Name** | **Sample Period** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Cherry Creek At Forest Boundary | 6/9/99-10/19/99 | 133 | 0 | 18.8 | 7/13/99 | 0 | 15.6 | 8/24/99 |
| Cherry Creek At Forest Boundary | 5/25/00-10/4/00 | 133 | 0 | 19.4 | 8/2/00 | 0 | 17.6 | 8/2/00 |
| Cherry Creek At Forest Boundary | 6/14/01-10/24-01 | 133 | 0 | 20.6 | 7/5/01 | 0 | 18.2 | 7/5/01 |
| Cherry Creek At Forest Boundary | 6/30/02-10/6/02 | 99 | 0 | 21.6 | 7/12/02 | 2 (2%) | 19.5 | 7/15/02 |

**Table 31. Cherry Creek temperature data and number of days where water temperatures exceeded the salmonid spawning criteria.**

| | | Salmonid Spawning | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 13 Inst. | | | 9°C Daily Ave. | | |
| **Stream Name** | **Sample Period (season)** | **# Days Evaluated** | **# Days Over** | **Max Temp** | **Max Date** | **# Days Over** | **Max Temp** | **Max Date** |
| Cherry Creek At Forest Boundary | 6/9/99-10/19/99 (Spring) | 22 | **19 (86%)** | 17.12 | 6/20/99 | **20 (91%)** | 12.89 | 6/21/99 |
| Cherry Creek At Forest Boundary | 6/9/99-10/19/99 (Fall) | 35 | 2 (6%) | 13.13 | 9/15& 24/99 | **11 (31%)** | 10.94 | 9/24/99 |
| Cherry Creek At Forest Boundary | 5/25/00-10/4/00 (Spring) | 37 | **36 (97%)** | 18.2 | 6/4/00 | **37 (100%)** | 15.62 | 6/29/00 |
| Cherry Creek At Forest Boundary | 5/25/00-10/4/00 (Fall) | 20 | **5 (25%)** | 14.10 | 9/15-16/00 | **11 (55%)** | 13.2 | 9/17/00 |
| Cherry Creek At Forest Boundary | 6/14/01-10/24-01 (Spring) | 17 | **16 (94%)** | 18.28 | 6/22/01 | **16 (94%)** | 16.44 | 6/29-30/01 |
| Cherry Creek At Forest Boundary | 6/14/01-10/24-01 (Fall) | 40 | 0 | 12.93 | 9/15/01 | **21 (53%)** | 12.35 | 9/15/01 |
| Cherry Creek At Forest Boundary | 6/30/02-10/6/02 (Spring) | 1 | 1 (100%) | 18.68 | 6/30/02 | 1 (100%) | 16.47 | 6/30/02 |
| Cherry Creek At Forest Boundary | 6/30/02-10/6/02 (Fall) | 22 | 0 | 12.97 | 9/15/02 | **11 (50%)** | 12.12 | 9/15/02 |

There was no major exceedence of cold water aquatic life criteria noted in Cherry Creek at the Forest boundary. Exceedence of salmonid spawning criteria occurred at the monitoring location in the Spring of 1999, 2000, and 2001. Fall spawning criteria were exceeded 2001at the monitoring location.

## Water Chemistry Data

The USGS collected water chemistry and nutrient samples at the Howell Ranch stream gage in 1996 and 1999. That data is summarized in Table 32 and 33.

**Table 32. USGS water column data pertaining to water quality from 1996.**

| Date | Time | Flow (cfs) | Conductivity (µS/cm) | pH | Turbidity (NTU) | Dissolved Oxygen (mg/L) | Hardness Total (mg/L as $CaCO_3$) | Alkalinity Total (mg/L as $CaCO_3$) |
|---|---|---|---|---|---|---|---|---|
| 6/3/96 | 1053 | 1,160 | 125 | 8.0 | 3.5 | 10.2 | | |
| 6/17/96 | 1315 | 2,000 | 94 | 7.9 | 16 | 11.1 | | |
| 7/15/96 | 1308 | 563 | 130 | 8.2 | 0.7 | 9.3 | | |
| 8/19/96 | 1330 | 1,480 | 183 | 8.1 | 0.3 | 8.6 | | |
| 9/16/96 | 1215 | 154 | 195 | 8.1 | 1.3 | 9.5 | 91 | 83 |

**Table 33. USGS water column data pertaining to water quality from 1999.**

| Date | Time | Flow (cfs) | Conductivity (µS/cm) | pH | Turbidity (NTU) | Dissolved Oxygen (mg/L) | Hardness Total (mg/L as $CaCO_3$) | Alkalinity Total (mg/L as $CaCO_3$) |
|---|---|---|---|---|---|---|---|---|
| 5/27/99 | 1452 | 1,860 | 106 | 8.2 | 55 | 11.1 | | |
| 6/24/99 | 1240 | 1,770 | 97 | 8.3 | 9.5 | 10.2 | | |
| 8/6/99 | 1120 | 359 | 148 | 8.3 | -- | 9.5 | | |
| 9/22/99 | 1155 | 120 | 194 | 8.3 | 0.50 | 10.2 | | |
| 10/7/99 | 1340 | 123 | 195 | 8.3 | 0.50 | 9.8 | 89 | -- |

State water quality criteria specify a limit of 50 NTU above background for turbidity below an applicable mixing zone. There is no background data to compare with turbidity values, and the Howell Ranch monitoring location is not an applicable mixing zone related to any particular feature so a reading of 55 NTU on May 27th 1999 is not a significant exceedence of water quality criteria. The chronic criteria for turbidity is not to exceed 25 NTU for greater than 10 days. It is undetermined what the 10-day duration of turbidity was to relate to the chronic criteria limit of 25 NTU. The turbidity data from 1996 and 1999 are within state water quality standards set for turbidity. No other water quality parameters were exceeded.

As part of an ongoing evaluation of mine tailings affiliated with the Empire Mine, near Mackay, Idaho, the DEQ collected upgradient and downgradient samples for water column dissolved metals. Mine tailings are partially situated in the flood plain of the Big Lost River on the western valley bottom. Results of that sampling are summarized in Table 34 and 35. At total hardness of 100 mg/L the standard for copper is 11 micrograms per liter. The upgradient sample for copper was below criteria at 9.6 micrograms per liter at 100 mg/L hardness. No hardness sample was collected at the time metals samples were collected. Hardness would likely increase progressively downstream and is likely over 100, which would increase the criteria threshold. All other parameters sampled were below detection limits for the methodologies used.

**Table 34. Water column metals sample in the Big Lost River upgradient of Empire Mine tailings pile in flood plain.**

| Date | Metal (dissolved) | Result (µg/L) | Method |
|---|---|---|---|
| 8/26/03 | Silver | <0.0050 | 200.7 |
| 8/26/03 | Arsenic | <0.0030 | 206.2 |
| 8/26/03 | Beryllium | <0.0020 | 200.7 |
| 8/26/03 | Cadmium | <0.0020 | 200.7 |
| 8/26/03 | Chromium | <0.0060 | 200.7 |
| 8/26/03 | Copper | 0.0096 | 200.7 |
| 8/26/03 | Mercury | <0.00020 | 245.1 |
| 8/26/03 | Nickel | <0.010 | 200.7 |
| 8/26/03 | Lead | <0.0030 | 239.2 |
| 8/26/03 | Antimony | <0.0050 | 200.7 |
| 8/26/03 | Selenium | <0.0030 | 270.2 |
| 8/26/03 | Thallium | <0.0020 | 279.2 |
| 8/26/03 | Zinc | <0.0050 | 200.7 |

**Table 35. Water column metals sample in the Big Lost River downgradient of Empire Mine tailings pile in flood plain.**

| Date | Metal (dissolved) | Result (µg/L) | Method |
|---|---|---|---|
| 8/26/03 | Silver | <0.0050 | 200.7 |
| 8/26/03 | Arsenic | <0.0030 | 206.2 |
| 8/26/03 | Beryllium | <0.0020 | 200.7 |
| 8/26/03 | Cadmium | <0.0020 | 200.7 |
| 8/26/03 | Chromium | <0.0060 | 200.7 |
| 8/26/03 | Copper | <0.0030 | 200.7 |
| 8/26/03 | Mercury | <0.00020 | 245.1 |
| 8/26/03 | Nickel | <0.010 | 200.7 |
| 8/26/03 | Lead | <0.0030 | 239.2 |
| 8/26/03 | Antimony | <0.0050 | 200.7 |
| 8/26/03 | Selenium | <0.0030 | 270.2 |
| 8/26/03 | Thallium | <0.0020 | 279.2 |
| 8/26/03 | Zinc | <0.0050 | 200.7 |

Nutrient Data was also collected by the USGS at this location at the same time and is summarized (Table 36 and 37).

**Table 36. USGS water column data pertaining to nutrients from 1996.**

| Date | Time | Nitrite-N Dissolved, (mg/L as N) | $NO_2$+$NO_3$ Dissolved (mg/L as N) | Organic Ammonia (mg/L as N) | Total Phos. (mg/L as P) | Dissolved Ortho Phos. (mg/L as P) | Total Suspended Sediment mg/L | TSS Discharge (T/Day) |
|---|---|---|---|---|---|---|---|---|
| 6/3/96 | 1053 | <0.01 | <0.05 | <0.015 | <0.01 | 0.01 | 136 | 426 |
| 6/17/96 | 1315 | <0.01 | 0.08 | 0.03 | 0.06 | 0.02 | 198 | 1070 |
| 7/15/96 | 1308 | <0.01 | 0.07 | 0.03 | 0.01 | 0.01 | 12 | 18 |
| 8/19/96 | 1330 | <0.01 | <0.05 | <0.015 | 0.01 | <0.01 | 1 | 4.0 |
| 9/16/96 | 1215 | <0.01 | <0.05 | <0.015 | <0.01 | 0.01 | 2 | 0.83 |

**Table 37. USGS water column data pertaining to nutrients from 1999**

| Date | Time | Nitrite-N Dissolved, (mg/L as N) | $NO_2$+$NO_3$ Dissolved (mg/L as N) | Organic Ammonia (mg/L as N) | Total Phos. (mg/L as P) | Dissolved Ortho Phos. (mg/L as P) | Total Suspended Sediment mg/L | TSS Discharge (T/Day) |
|---|---|---|---|---|---|---|---|---|
| 5/27/99 | 1452 | <0.01 | 0.086 | 0.90 | 0.250 | 0.018 | 132 | 663 |
| 6/24/99 | 1240 | <0.01 | 0.073 | 0.17 | 0.106 | 0.013 | 102 | 487 |
| 8/6/99 | 1120 | <0.01 | <0.05 | 0.16 | <0.05 | 0.017 | 5 | 4.8 |
| 9/22/99 | 1155 | <0.01 | <0.05 | <0.10 | <0.05 | <0.010 | 1 | 0.32 |
| 10/7/99 | 1340 | <0.01 | <0.05 | <0.10 | <0.05 | <0.010 | 1 | 0.33 |

Excessive concentrations of nutrients in fresh water, particularly nitrogen and phosphorous, may diminish water quality and impair beneficial uses through the process of eutrophication or excessive growth of aquatic plants or algae. According to IDAPA 58.01.02.200.06, surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growth impairing designated beneficial uses. There is not nutrient data available for the mouth of the Big Lost River at Mackay Reservoir, however, it should be noted that there are no indications of nuisance levels of aquatic plants in the reservoir or issues with oxygen depletion in the reservoir. During runoff conditions total phosphorus is elevated above suggested criteria for waters flowing into reservoirs but concentrations drop to below that level during non-runoff periods when the Big Lost River does not normally make a confluence with the reservoir.

Nutrient data was collected by DEQ at several locations on Warm Springs Creek and below the Idaho Fish and Game Hatchery on Whiskey Springs (a tributary to Warm Springs Creek) during the subbasin evaluation. That data is summarized in Table 38, 39, and 40.

**Table 38. Nutrient data from select tributaries above Mackay Reservoir in May 2003.**

| Date | Location | $NO_2$+$NO_3$ (mg/L as N) | Total Phos. (mg/L as P) |
|---|---|---|---|
| 5/8/03 | Whiskey Creek | 0.082 | 0.110 |
| 5/8/03 | Upper Warm Springs | 0.088 | 0.032 |
| 5/8/03 | Lower Warm Springs Creek | 0.092 | 0.018 |
| 5/8/03 | Twin Bridges Creek | <0.005 | 0.039 |

**Table 39. Nutrient data collected at select Big Lost River sites in August 2003.**

| Date | Location | $NO_2$+$NO_3$ (mg/L as N) | Total Kjeldahl N | Total Phos. (mg/L as P) |
|---|---|---|---|---|
| 8/26/03 | Big Lost at Bartlett Point | <0.005 | 0.09 | 0.01 |
| 8/26/03 | Warm Springs Creek (lwr) | 0.112 | 0.18 | 0.014 |
| 8/26/03 | Pass Creek (lower) | 0.078 | 0.16 | 0.049 |
| 8/26/03 | Big Lost at Empire Mine | 0.007 | 0.17 | 0.016 |

**Table 40. Nutrient data from Warm Springs Creek and Whiskey Creek in June 2002.**

| Date | Location | $NO_2$+$NO_3$ (mg/L as N) | Total Phos. (mg/L as P) |
|---|---|---|---|
| 6/26/02 | Whiskey Creek | 0.077 | 0.023 |
| 6/26/02 | Upper Warm Springs | 0.086 | 0.027 |
| 6/26/02 | Lower Warm Springs Creek | 0.133 | 0.134 |
| 6/26/02 | Warm Springs at source | 0.113 | 0.015 |

Nutrient analysis was conducted by Idaho State University in 2000. It was determined that the Big Lost River is phosphorus limited and N levels are extremely low except at the Arco Bridge, near Arco, where the Big Lost exhibited elevated levels of nitrate during a short period of flow probably due to irrigation return water (Myler and Minshall, 2001).

Nutrient levels monitored in Warm Springs Creek show slight elevation of phosphorus in relation to EPA recommended criteria for reservoir inflow. During assessments, however, nuisance levels of aquatic plants were not observed in Warm Springs Creek or Whiskey Creek. There is no apparent issue with algae concentrations or oxygen depletion in Mackay Reservoir. This may be due to high turnover rates and cool temperatures as evidenced by monitoring below Mackay Dam.

## Biological and Other Data

### Streambank Erosion Assessments

The DEQ utilizes streambank erosion inventories (SEI) as means to assess current erosion conditions within a stream. This method is very useful in identifying load reductions necessary to achieve desired future conditions that are expected to restore beneficial uses to a stream. Other erosional features are evaluated during SEI data collection. Other significant sediment sources were not identified including roads, mass wasting and hillslope erosion. Mass wasting and hill slope erosion are included in natural background and are not considered to be above the level of natural background loading.

DEQ SEIs are conducted in accordance with methods outlined in proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS 1983). The NRCS technique evaluates streambank/channel stability by estimating length of stable and active eroding banks, and bank slope height. Streambank and channel stability field measurements are combined with a standardized rating of streambank character and the bank character rating is used to ascertain the long-term lateral recession rate of stream banks. The recession rate is determined from field evaluation of six streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categorical ratings are summed to a cumulative rating. From the cumulative rating a lateral recession rate is assigned ranging from slight at 0.01 feet per year to very severe at 0.5 + feet per year. An average volume of eroded bank is obtained with the estimated recession rate. By applying a measured or estimated standard bulk density based on composition of streambank material an estimate of tons of sediment from streambank erosion is obtained for comparison to other reaches or for applying a load allocation based on a prescribed reference condition. Appendix G outlines the method for conducting SEIs.
During 2002 and 2003 DEQ completed streambank erosion inventories on 303(d) listed streams, other than the Big Lost River, to evaluate stream bank stability and sediment loading from streambank erosion, a major source of sediment to rangeland streams. In Copper Basin the East Fork of the Big Lost River was inventoried from the Burma Bridge, below the source at The Swamps to below Starhope Creek. An additional reach was inventoried below Wild Horse Creek. Warm Springs Creek was inventoried from its source to just above the Mackay Reservoir, to the upper 6X Ranch boundary. In the Antelope Creek watershed streambank erosion inventories were conducted on Antelope Creek and Cherry Creek.

Substrate fine sediment composition was evaluated on the East Fork of the Big Lost River and on Star Hope Creek using the McNeil Sediment Core methodology. This evaluation aids in determining impacts to spawning habitat resulting from fine sediment less than 6.35 mm (¼ inch).

Stream bank erosion inventories and McNeil sediment core sampling was also done by the Science Action Team (SAT), a group of Arco and Mackay High School students and Idaho State University students. The Science Action Team was sponsored and supervised by the Idaho National Environmental and Engineering Laboratory in a cooperative effort with DEQ to collect data for this report. Streams evaluated by the Science Action Team included lower and middle Antelope Creek, Warm Spring Creek above Mackay Reservoir, The East Fork of the Big Lost

River, and the Spring Creek channel of the Big Lost River. Table 41 and 42 summarizes results from streambank erosion inventories conducted by SAT and DEQ respectively.

### Table 42. Science Action Team Streambank Erosion Inventory Summary

| Reach Location | Total Inventoried (ft) | Eroding (ft) | % Eroding | Extrapolated Length | Tons of Sediment per mile | Tons of Sediment per year |
|---|---|---|---|---|---|---|
| **Big Lost River** | | | | | | |
| Warm Springs Creek | 690 | 164 | **24** | 330 | 4.5 | 0.6 |
| **East Fork Big Lost River** | | | | | | |
| **Exclosure below Corral Cr.** | **1250** | **493** | **39** | 350 | 49 | 9 |
| **Spring Creek** | | | | | | |
| **North Section of Private Land** | **460** | **428** | **93** | 150 | 324 | 23 |
| Antelope Creek | | | | | | |
| Below S. Fk. Diversion | 4046 | 2105 | **52** | 1000 | 170 | 97 |

### Table 41. DEQ Streambank Erosion Inventory Summary

| Reach Location | Total Inventoried (ft) | Eroding (ft) | % Eroding | Extrapolated Length | Tons of Sediment per mile | Tons of Sediment per year |
|---|---|---|---|---|---|---|
| **East Fork Big Lost River** | | | | | | |
| Above Burma Bridge | 2994 | 347 | 12 | 11,616 | 3 | 7 |
| Above Starhope Creek | 4481 | 1154 | **26** | 16,896 | 11 | 40 |
| Below Starhope Creek | 9002 | 4612 | **51** | 41290 | 113 | 980 |
| Below Wildhorse Creek | 2972 | 1916 | **64** | 2768 | 230 | 185 |
| **Warm Springs Creek** | | | | | | |
| Source to Lost River Ranch Rd. | 2150 | 150 | 7 | 0 | 1 | 0.21 |
| Lost River Ranch Rd to BR Ranch | 900 | 50 | 6 | 0 | 1.2 | 0.1 |
| Broken River Ranch to F Ranch | 808 | 20 | 2 | 0 | 0.33 | 0.03 |
| Freeman Ranch to Old Chilly Rd. | 1800 | 20 | 1 | 0 | 0.24 | 0.04 |
| Old Chilly Rd. to 5480 W. | 14044 | 2808 | 20 | 0 | 3.8 | 5.05 |
| 5480 W. to Gregory Ranch | 19852 | 1985 | 10 | 10560 | 1.9 | 7.38 |
| **Antelope Creek** | | | | | | |
| Forest Boundary to Cherry Cr. | 45408 | 6810 | 15 | 0 | 5 | 23 |
| Cherry Cr. to Antelope Rd. | 23020 | 6906 | **30** | 0 | 26 | 56 |
| Antelope Rd. to Wood Canyon | 40022 | 20012 | **50** | 0 | 193 | 732 |
| Wood Canyon to S. Fk. Antelope Creek Diversion | 31660 | 12672 | **40** | 0 | 26 | 77 |
| **Cherry Creek** | | | | | | |
| Middle Fork to Private land | 14361 | 2154 | 15 | 9293 | 3.96 | 12 |
| Private boundary to Diversions | 25133 | 10053 | **40** | 1901 | 16 | 44 |
| Diversions to Confluence | 21437 | 9646 | **45** | 2112 | 41 | 100 |

The objective of inventorying streambank erosion is to quantify the relationship between the percentage of bank stability and the tons of sediment from streambank erosion. This establishes a load based on the present condition and, using a future desired reference condition, a load reduction to restore beneficial use support is identified, if existing or beneficial uses are not fully supported at the time of evaluation. The future desired condition is not a water quality standard or criteria, but a guidepost or target based on frequency distribution of natural conditions found in central Idaho. The minimum desired streambank stability condition for streams has been set at 80% in previous subbasin assessments throughout the region. Looking at erosion inventories within the Big Lost River watershed with this condition in mind a strong relationship is seen between 303(d) listed streams and streams with more than 20% eroding streambanks (less than 80% streambank stability). Streams with greater than 20% eroding streambanks that do not support aquatic life beneficial uses can be identified as sediment impaired from streambank erosion. This information can be combined with fine sediment data to further illuminate impairment issues.

### Fine Sediment Assessments

Fine sediment deposited in spawning habitat can reduce the survival and emergence of fish eggs and fry respectively (Hall 1986, Chapman 1988, Reiser and White 1988, McNeil and Ahnell 1964). According to Bjornn, Peery, and Garmann (1998) "Salmonid embryo survival and fry emergence are inversely related to the amount of fine sediment in stream substrates. Fine sediment can decrease the amount of dissolved oxygen (DO) available to developing embryos by impeding flow of water through the substrate and through oxidation of organic material in fine sediment. Low oxygen availability from excess fine sediment has been associated with smaller and less developed emergent fry."

Spawning habitat in streams is found in a substrate feature that is called a glide, or a pool tail-out. This is where the substrate gradient is upward, or adverse, and the surface water slope is constant or flat. This relationship provides the hydrodynamic upwelling necessary to bring oxygenated water into the nests that fish deposit eggs into, called redds. When fine sediment increases above 20% there is a measurable effect on egg and fry survival. The Forest Service has identified fine sediment less than 6.35 mm (1/4 inch) in spawning habitat at a depth of 4 inches in concentrations over 30% in volcanic watersheds and 25% in granitic watersheds as being impaired spawning habitat of poor quality. When the trend over time shows increasing percentage of subsurface fines less than 6.35 mm it is an indication that conditions for fish survival and propagation are worsening and a change in riparian management may be necessary to support aquatic life beneficial uses. Sometimes under elevated fine sediment conditions fish numbers are adequate to indicate a stable population, but aquatic insects or macroinvertebrates are impacted. This can lower the overall fish productivity of the water. This can be identified by a shift in macroinvertebrates toward a higher proportion of sediment tolerant species.

Determining percent composition of surface and depth fine sediment in spawning habitat is used as a complimentary target to track changes in sediment loading over time. McNeil and Ahnell (1964) state that, "size composition of bottom materials greatly influences water quality by affecting rates of flow within spawning beds and rates of exchange between intragravel and stream water".

McNeil Sediment Core samples can describe size composition of bottom materials in identified salmonid spawning locations. McNeil Sediment Core samples are collected by isolating a small area of the stream bottom in a glide from the current with an open stainless steel cylinder (12 inches in diameter). The cylinder is worked to a depth of approximately 4-6 inches into the spawning habitat substrate. Substrate is then removed from the cylinder, washed through a series of ten sieves (63 to .053 mm diameter openings), and then measured via volumetric displacement. Three sediment core samples are obtained (Forest Service collects five) for each site and averaged to calculate the percentage of depth fines at the sample location. The percentage of intergravel fines less than 6.35 mm (1/4 inch) in diameter is correlated with expected fry survival. Tables 43 through 45 describe sediment core sample data accumulated by DEQ, the INEEL Science Action Team (SAT), and the Forest Service.

**Table 43. DEQ McNeil Sediment sample locations and percentage depth fines.**

| Stream | Collection Date | Location | Average % of fine material <6.35mm |
|---|---|---|---|
| East Fork Big Lost | 6/24/03 | 30 m Above Burma Bridge | **35** |
| East Fork Big Lost | 6/24/03 | Just Above Starhope Creek Confluence | 19 |
| Starhope Creek | 6/23/03 | ¼ mi. Below Lake Creek Confluence | **30** |
| Warm Springs Creek | 6/25/03 | Below Culvert on Gregory Ranch | **38** |

**Table 44. SAT McNeil Sediment sample locations and percentage depth fines.**

| Stream | Collection Date | Location | Average % of fine material <6.35mm |
|---|---|---|---|
| Spring Creek | 8/2/01 | By Bridge on North Section of Private | **53** |
| Big Lost River | 8/6/01 | Big Lost Ranch above Reservoir | **61** |
| Antelope Creek | 7/17/01 | Below S, Fk. Diversion | 27 |
| Antelope Creek | 7/24/01 | Above Bridge at Antelope Guard Station | **49** |

**Table 45. Forest Service McNeil fine sediment trend monitoring for Big Lost River**

| Stream/Station | 1995 %Fine | 1996 %fine | 1997 %fine | 1998 %fine | 1999 %fine | 2000 %fine | 2001 %fine | 2002 %fine | 95-02 Trend |
|---|---|---|---|---|---|---|---|---|---|
| Antelope | 18.9 | - | 25.0 | 22.1 | 24.1 | 25.5 | 25 | 24.3 | Increase |
| Cherry | 28.0 | - | **47.2** | 25.3 | **42.8** | 24.3 | **40.7** | **44.2** | Increase |
| East Fork BLR 1R | 10.6 | 24.8 | **36.7** | 25.6 | **30.4** | **30.0** | **29.7** | **40.9** | Increase |
| East Fork BLR 2R | 21.9 | 23.4 | **32.3** | 17.5 | **30.6** | 23.0 | 22.9 | 24.6 | Increase |
| East Fork BLR 3R | 23.5 | **28.7** | **28.9** | 24.4 | 23.7 | 22.7 | 20.5 | 22.6 | Reduce |
| Muldoon | 27.2 | - | 27.5 | 11.7 | 20.5 | 16.0 | 22.3 | 24.5 | Reduce |
| North Fork BLR 1R | 24.8 | 21.9 | **28.6** | 16.0 | **31.3** | **28.2** | **32.2** | **33.3** | Increase |
| North Fork BLR 2R | **32.1** | **29.1** | **36.0** | 25.3 | **32.9** | **37.1** | 25.3 | **39.0** | Increase |
| Pass 1R | 17.0 | - | - | 16.0 | 24.5 | **28.4** | **28.2** | 23.7 | Increase |
| Star Hope 1R | 21.0 | - | **29.4** | **30.1** | 25.5 | **29.1** | 27.6 | 27.4 | Increase |
| Wildhorse | 24.5 | - | **36.0** | 18.5 | 30.2 | 28.0 | 32.8 | 37.8 | Increase |

## Fisheries Sampling Data

Electrofishing has been conducted throughout the Big Lost River watershed since the middle 1980's. Overall fisheries conditions are described in the Fisheries section of the Watershed Characterization of the Subbasin Assessment. In 2003 a concerted effort was made to collect fisheries data at key locations in Copper Basin, on the North Fork of the Big Lost River, the upper Big Lost River, and important tributaries. Summaries of that data for the larger waters will be shown here with more dispersed data for smaller waters included in Appendix F with BURP summaries.

Figure 77 shows the length frequency distribution for fish collected on the upper East Fork of the Big Lost River in August 2003 by a combined group of IDFG and Forest Service fisheries personnel. Multiple age classes of brook trout were collected in good abundance.

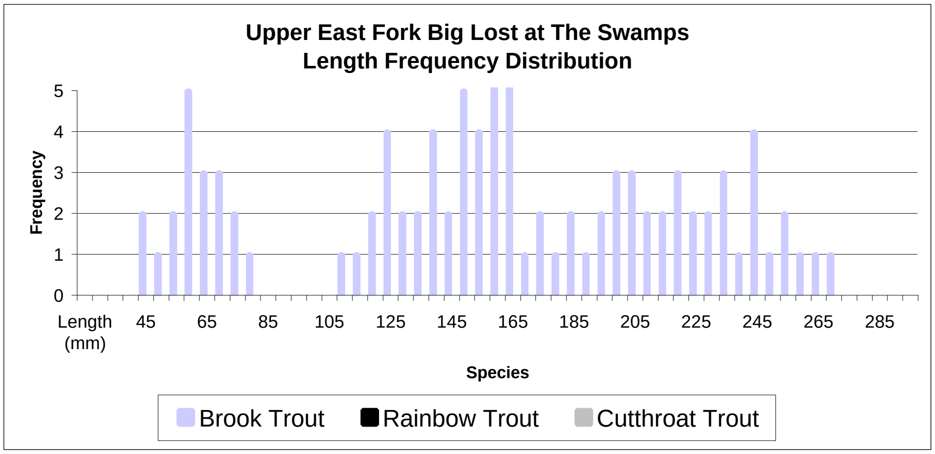


**Figure 77. Upper East Fork Big Lost River length frequency distribution for fish collected near the source just below The Swamps.**

Figure 78 shows the length frequency distribution for fish collected on the upper section of the East Fork of the Big Lost River. Multiple age classes of brook trout and hatchery rainbow trout were collected in good abundance.

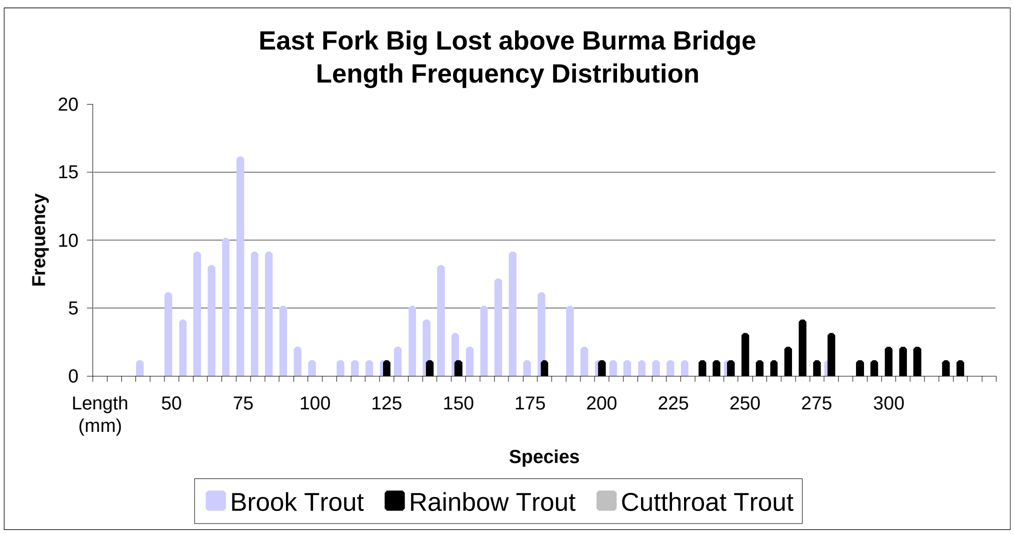


**Figure 78. Upper East Fork Big Lost River length frequency distribution for fish collected above the Burma Rd. Bridge.**

Figure 79 shows the length frequency distribution for fish collected on the middle section of the East Fork of the Big Lost River below the confluence of Star Hope Creek. Multiple age classes of brook trout and hatchery rainbow trout were collected., however in decreasing abundance relative to other collection sites.

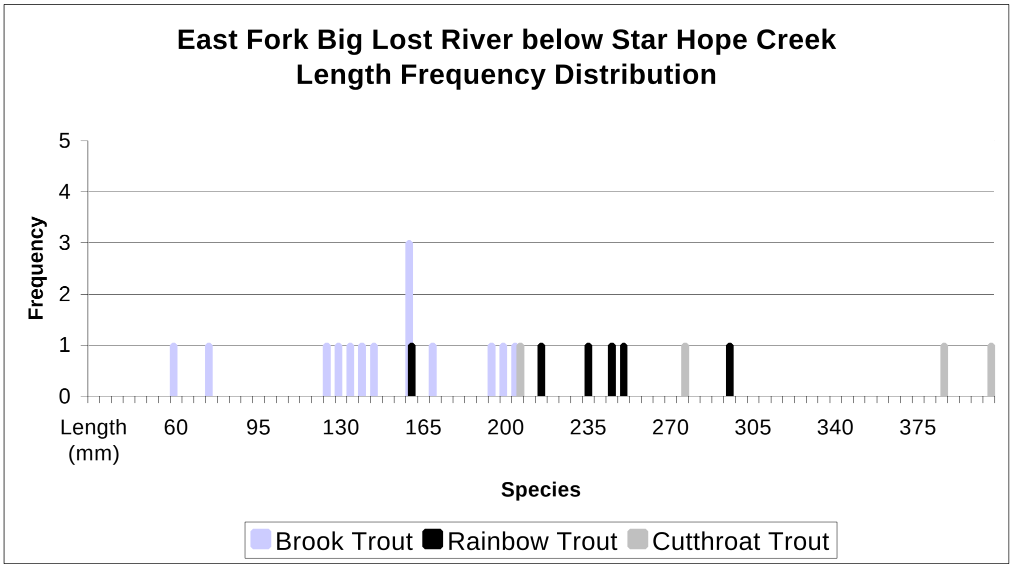


**Figure 79. Middle East Fork Big Lost River length frequency distribution for fish collected below Star Hope Creek.**

Figure 80 shows the length frequency distribution for fish collected on the lower section of the East Fork of the Big Lost River 1 mile above the confluence of Wild Hors Creek, ½ mile below private land. Multiple age classes of brook trout and wild and hatchery rainbow trout were collected. Fewer brook trout were found, but wild rainbow trout were more abundant.

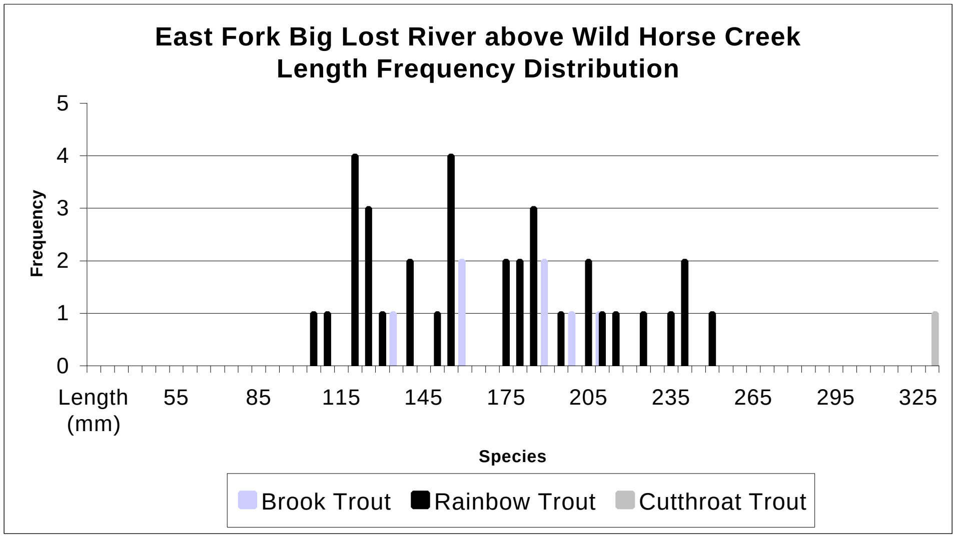


**Figure 80. Lower East Fork Big Lost River length frequency distribution for fish collected above Wild Horse Creek.**

Figure 81 shows the length frequency distribution for fish collected on the upper section of the North Fork of the Big Lost River at Squib Canyon. Multiple age classes of brook trout and 1 rainbow trout were collected.

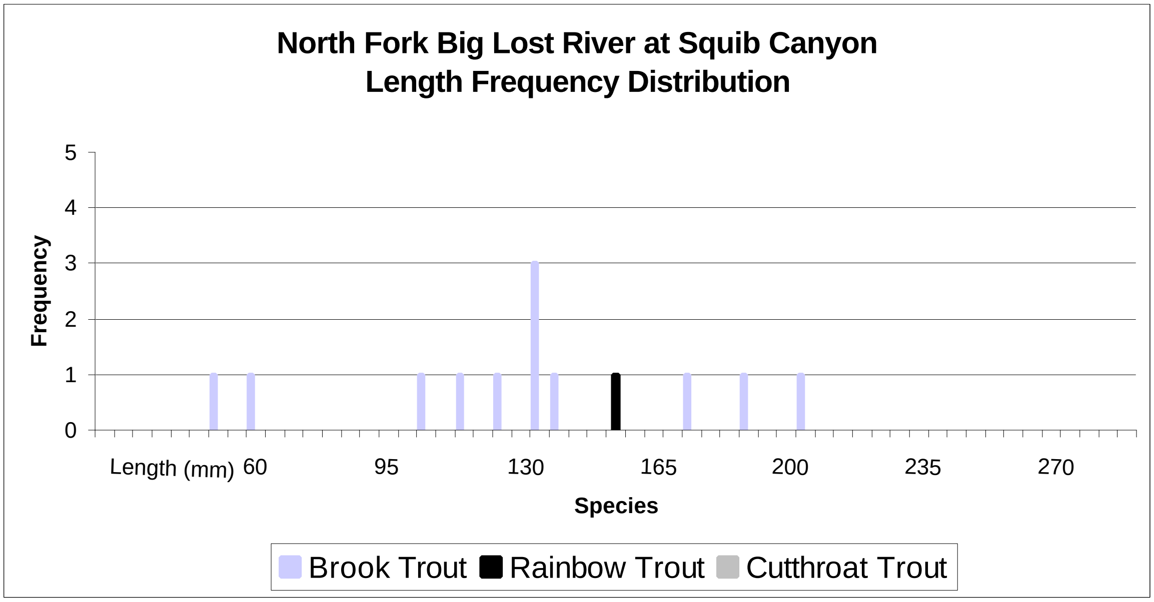


**Figure 81. Upper North Fork Big Lost River length frequency distribution for fish collected at Squib Canyon.**

Figure 82 shows the length frequency distribution for fish collected on the middle section of the North Fork of the Big Lost River below Burnt Creek. Multiple age classes of brook trout and rainbow trout were collected.

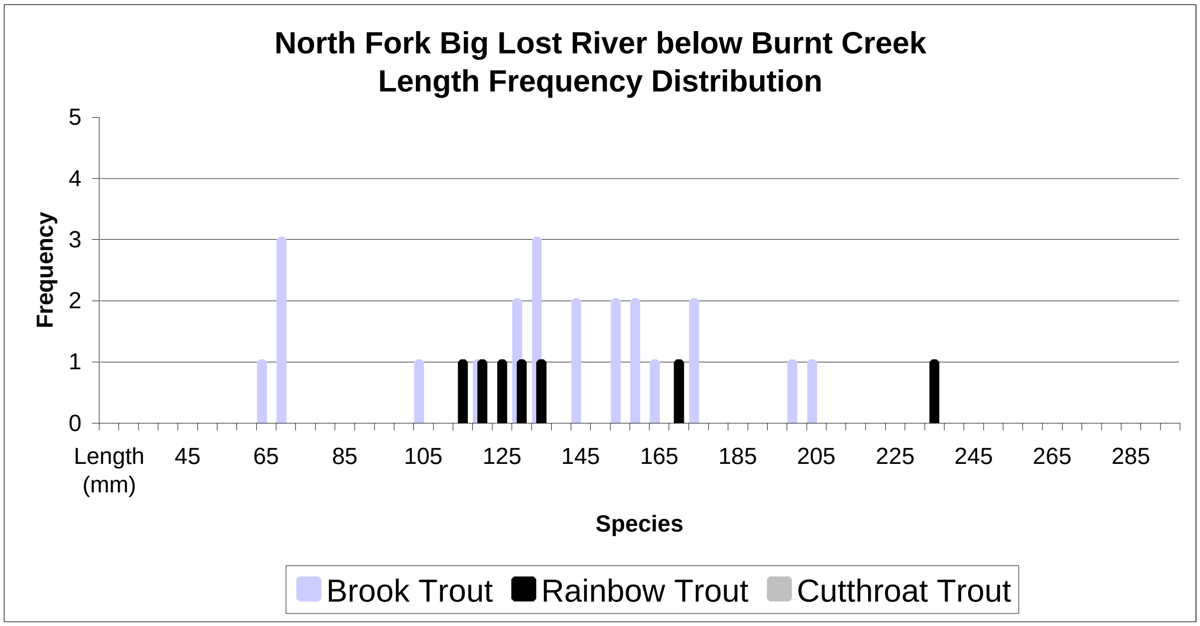


**Figure 82. Middle North Fork Big Lost River length frequency distribution for fish collected below Burnt Creek.**

Figure 83 shows the length frequency distribution for fish collected on the lower section of the North Fork of the Big Lost River just above Deep Creek. Multiple age classes of brook trout and rainbow trout were collected. Fish above 145 mm were hatchery rainbow trout stocked that year.

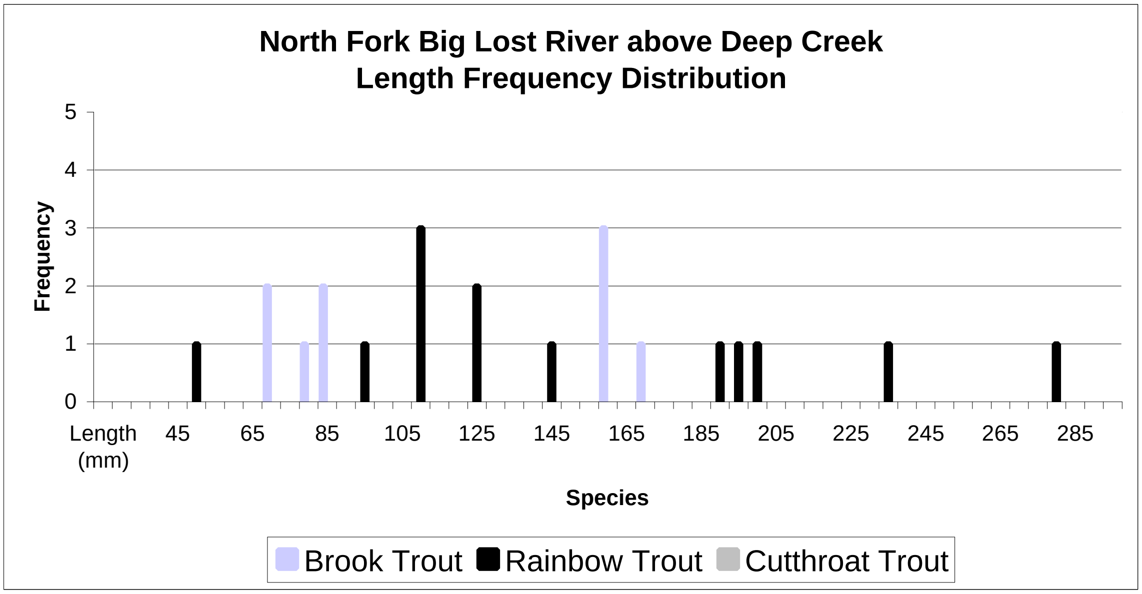


**Figure 83. Lower North Fork Big Lost River length frequency distribution for fish collected just above Deep Creek.**

Figure 84 shows the length frequency distribution for fish collected on the upper Big Lost River at Bartlett Point. Multiple age classes of brook trout and rainbow trout were collected. Fish above 145 mm were hatchery rainbow trout stocked that year.

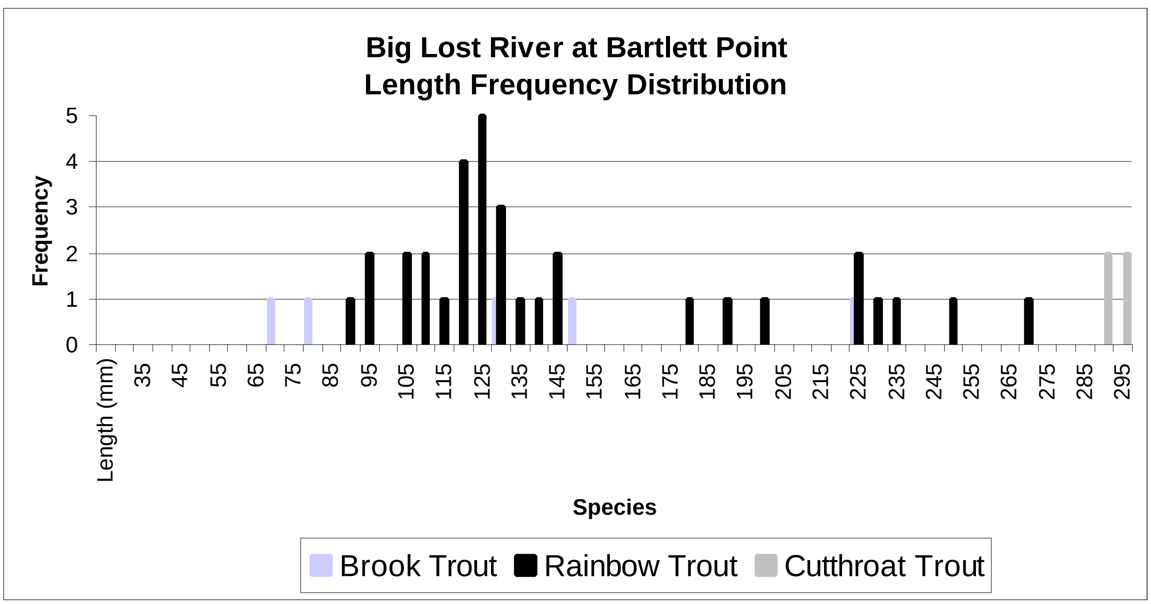


**Figure 84. Big Lost River length frequency distribution for fish collected at Bartlett Point.**

Figure 85 shows the length frequency distribution for fish collected on upper Antelope Creek above Horsethief Creek in 1996. Multiple age classes of brook trout were collected.

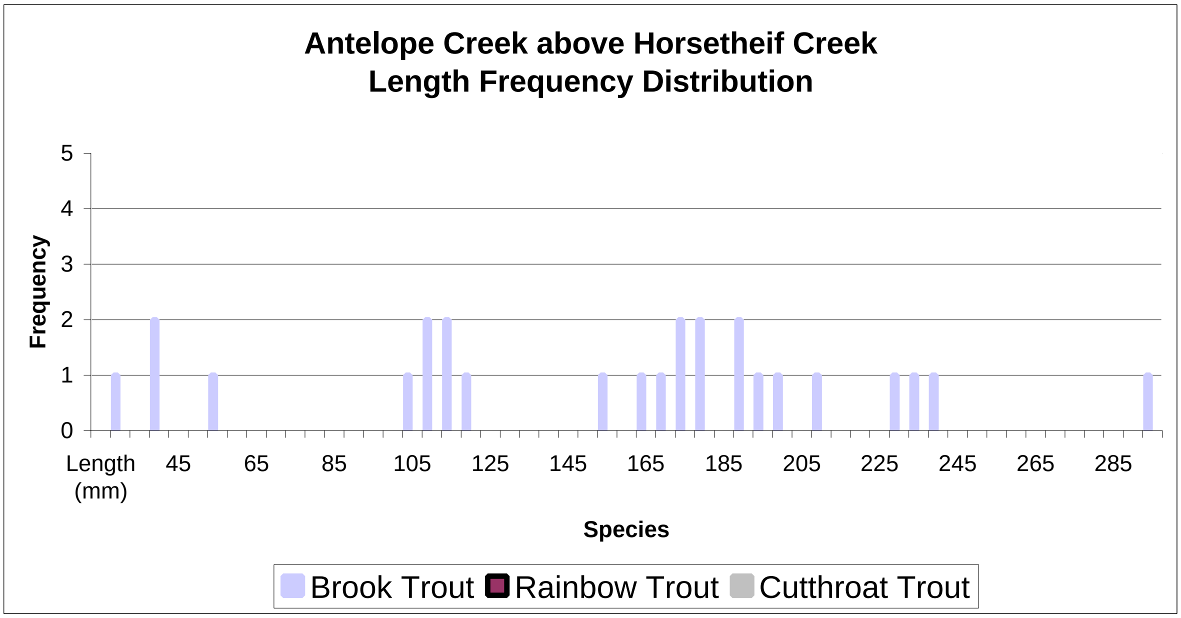


**Figure 85 Antelope Creek length frequency distribution for fish collected above Horsetheif Cr.**

Figure 86 shows the length frequency distribution for fish collected on Bear Creek 2 mi. above Antelope Pass Rd. Multiple age classes of brook trout were collected.

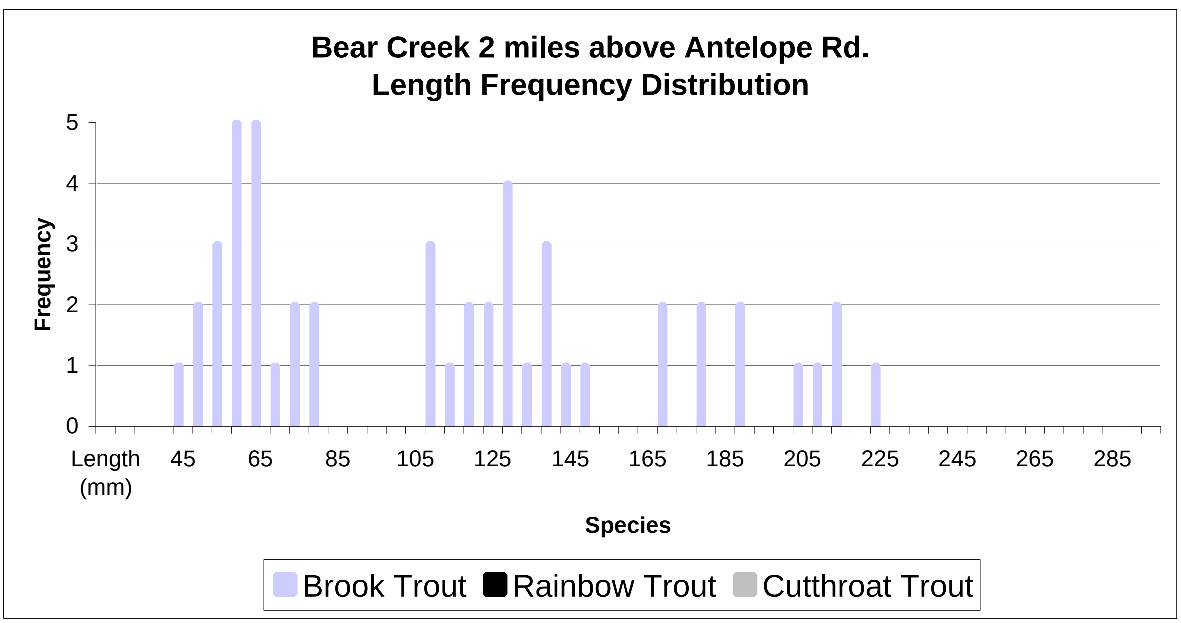


**Figure 86. Bear Creek length Frequency distribution for fish collected 2 mi. above Antelope Rd.**

Figure 87 shows the length frequency distribution for fish collected on Bear Creek 1.1 mi. above Antelope Pass Rd. Multiple age classes of brook trout were collected.

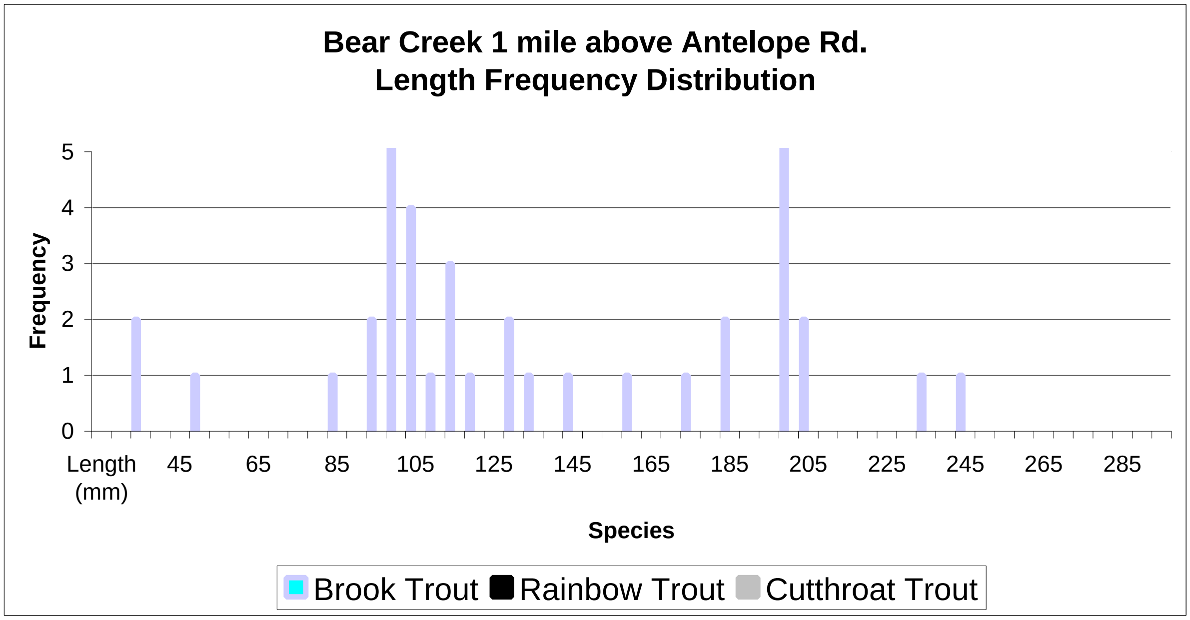


**Figure 87. Bear Creek length frequency distribution for fish collected 1 mi. above Antelope Rd.**

## Beneficial Use Reconnaissance Program Data

Data for streams in the Big Lost River watershed are shown in Appendix F. Assessment data is shown in this section in Tables 46 through 54 for streams appearing on the 1998 303(d) list, and/or for which a TMDL is prepared in this document for temperature criteria exceedence and for which there is BURP data assessed under the current guidance. BURP sites not assessed show scores under the previous assessment guidance system (MBI, HI). Streams previously listed on the 1998 303(d) list were evaluated according to The 1996 *Water Body Assessment Guidance* (DEQ 1996). In this document streams were assessed according to guidelines in The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) (WBAGII) to determine coldwater aquatic life and salmonid spawning support status.

Assessment based on the WBAGII utilizes indexes to evaluate support status of streams. The Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI) and Stream Habitat Index (SHI) are evaluated using BURP—compatible data. The SMI is a direct biological measure of cold water aquatic life. The scoring criteria are derived from percentile categories of the reference condition. Reference condition is based on a number of sites that are considered minimally disturbed for a particular bioregion (Grafe et al. 2002).

The breakpoints for the SMI are a condition rating of 1 assigned to streams with an index score of less than the 10$^{th}$ percentile of the reference condition, but greater than the minimum of reference condition. Streams with a condition rating between the 10$^{th}$ and 25$^{th}$ percentile of reference condition receive a score of 2, and a score of 3 is given to streams scoring above the

25th percentile of the reference condition. The minimum of reference condition is less than the minimum threshold, a condition rating that identifies significant impairment. DEQ uses this as a signal from individual indexes to ensure protection of cold water aquatic life. DEQ concludes not fully supporting beneficial coldwater aquatic life uses if a water body has even one index result below a minimum threshold.

The breakpoints for the SFI are a condition rating of 1 assigned to streams with an index core of less than the 5th percentile to the 25th percentile. Streams with a condition rating between the 25th percentile and the median of the reference condition for fish populations receive a score of 2, and a score of 3 is given to streams scoring above the median percentile of the reference condition. The minimum of reference condition is less than the minimum threshold, a condition rating less than the 5th percentile that identifies significant impairment.

The SHI scoring system is based on similar concepts used for the SMI and SFI indexes, however DEQ does not use a minimum threshold for this index. This is because there is significant variability among physical habitat measures, and non—biological components are not a direct measure of the aquatic life use.

The breakpoints for the SHI are a condition rating of 1 assigned to streams with an index score of less than the 10th percentile of the reference condition. Streams with a condition rating between the 10th and 25th percentile of reference condition receive a score of 2, and a score of 3 is given to streams scoring above the 25th percentile of the reference condition.

**Table 46. East Fork Big Lost River BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 300 m above N. Fk. Big Lost River | | N/A | N/A | Too High to Sample | 8/1/95 |
| 1.75 mi. above Wildhorse | | N/A | N/A | 56.4 | 8/14/01 |
| At Confluence of Starhope | | N/A | N/A | Too High to Sample | 7/31/95 |
| 400 m above Corral Cr. | 039_03 | 1 | 1 | 33.26 | 7/3/95 |
| 1 mi. above Smelter Canyon Cr. | 039_02 | 0 | 3 | 49.08 | 7/5/95 |

**Table 47. Little Boone Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | Habitat Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 1 m above E. Fk. Rd. | N/A | N/A | N/A | .043 | 8/13/01 |
| 0.4 mi above E.Fk. Rd. | N/A | 0 | 1 | 0.44 | 7/17/96 |

**Table 48. Wild Horse Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| Left Fork above confluence | 031_02 | 1 | 1 | 1.5 | 9/11/96 |
| 100 m above Fall Cr. Bridge | 031_02 | 1 | 1 | 23.7 | 7/13/94 |
| 100 m above Fall Cr. Bridge | | N/A | N/A | 15.35 | 8/14/01 |
| 0.25 mi below forks | 031_02 | 2 | 1 | 14.8 | 7/13/94 |

**Table 49. North Fork Big Lost River BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi below Hunter Cr. | 027_02 | 3 | 2 | 2.3 | 9/10/96 |
| 0.25 mi above Hunter Cr. | 027_02 | 4.41 (MBI) | 112 (HI) | 4.7 | 9/10/96 |

**Table 50. Summit Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Park Creek Rd. | 028_02 | 3 | 1 | 2.2 | 9/6/96 |
| 100 m above Big Fall Cr. | 028_03 | 3 | 1 | 6.2 | 9/6/96 |
| 0.2 mi. below Phi Kappa Cr. | | N/A | N/A | 4.7 | 8/7/01 |
| 0.25 mi above Kane Cr. | 028_03 | 3 | 1 | 7.9 | 9/10/96 |

**Table 51. Twin Bridges Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Just below middle tributary | 026_03 | 0 | 1 | 30.74 | 6/21/95 |
| At Trail Cr. Rd. | | N/A | N/A | No Flow | 8/20/01 |
| At Trail Cr. Rd. | 026_03 | 0 | 1 | 47.2 | 6/21/95 |
| At Trail Cr. Rd. | 026_03 | 2 | 1 | 0.37 | 7/14/94 |

**Table 52. Antelope Creek BURP Data: 7/18 sample listed as Cherry Cr. actually Antelope Creek.**

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.5 mi. below Iron Bog Cr. | 052_04 | 3 | 1 | 13.57 | 7/11/94 |
| 1 mi. below Cherry Cr. | | 4.11 (MBI) | 60 (HI) | 7.90 | 7/18/94 |
| At Hwy. 93 | | | | Dry | 8/15/01 |
| 100 m below Hwy. 93 | | | | Dry | 7/18/94 |
| At Hwy. 93 | Intermittent | 3.45(MBI) | 56 (HI) | 33.73 | 7/20/95 |

**Table 53. Bear Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| At Forks | 053_03 | 3 | 3 | 15.3 | 7/2/97 |
| 1 mi. below Forks | 053_03 | 3 | 3 | 11.73 | 7/10/96 |
| 2 mi. above Antelope Cr. | 053_03 | 3 | 1 | 14.6 | 7/10/96 |
| Right Fork 25 m above 2nd Rd xing | 053_02 | 3 | 1 | 14.6 | 7/10/96 |
| Middle Fork 300 m above confluence | 053_02 | 3 | 3 | 11.9 | 7/11/96 |

**Table 54. Cherry Creek BURP Data.**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| L.Fk Cherry, 3mi. above Cherry Cr. | 051_02 | 3 | 1 | 4.93 | 7/11/94 |
| 0.75 mi. above Richardson Canyon | 050_04 | 1 | 1 | 0.08 | 7/11/94 |

## Status of Beneficial Uses

### Big Lost River Subbasin Above Chilly Buttes

The data presented in the previous section indicates that, on 303(d) listed streams, where flow is perennial, beneficial uses for salmonid spawning are supported (see Figures 76 through 86 above). Multiple year classes including young of the year were collected on listed reaches.

Coldwater aquatic life support status is determined by assessment of BURP data. Data from BURP sites is not conclusive in-and-of itself, but generally indicates support of coldwater aquatic life (Tables 46 through 54). BURP sites on the East Fork and North Fork of the Big Lost River are clustered around headwaters reaches. Large river assessments have not been conducted on the lower East Fork, lower North Fork, or the Big Lost River above Chilly Buttes.

This is partly because of accessibility for BURP data collection crews and partly because flow at lower sections (between the Forks and Chilly Buttes) were elevated at the time that wadable stream samples were being collected. There is no DEQ BURP data for the Big Lost River in sections that are not flow altered. This is also related to flow volume at lower sections that can be accessed and assessed because flow is diminished at times. Access to optimal sample locations is also limited by private property. The problem is often that after stream flow is diminished so the stream can be reasonably sampled flow disappears for significant periods of time. Segments that are usually dry do not assess very well with regard to cold water aquatic life. The hydrology and land use on upper watershed streams are similar and water quality conditions are similar where there is flow. Coldwater aquatic life is generally supported were there is perennial flow.

Streams that are ephemeral are required to meet numeric water quality criteria during the periods of optimal flow. The periods of flow are strongly correlated with snowmelt runoff and numeric water quality criteria that are most applicable are temperature standards. During runoff conditions cold water temperature standards on ephemeral and perennial streams are generally met.

After peak runoff, and in some cases before peak runoff, however, many of the mainstem waters become warm in excess of water quality criteria for spring and fall spawning. This does not necessarily preclude beneficial use support, particularly if fish are able to migrate into thermal refuge during warm water periods of the year. Fish have evolved under these conditions of variable temperature regimes in nature. However, Perennial streams are required to meet numeric water quality standards without regard to beneficial use support status.
Water temperature becomes a greater problem when fish migration to thermal refuge is blocked due to dry channels and obstacles to fish migration such as culverts, irrigation diversion structures and thermal barriers. Fish migration conditions are good within mainstem sections of the Big Lost River above Chilly Buttes to the East Fork and North Fork of the Big Lost Rivers. Within the East Fork and North Forks of the Big Lost River migration conditions are good to upper sections of the streams. Bridges are used instead of culverts on the mainstem waters to upper reaches where culverts are in use. Culvert barriers on tributaries have not been documented by land management agencies, however none were observed during field work related to this report on other than ephemeral streams.

Areas that fish would use as thermal refuge in upper watersheds warm beyond water quality standards, but not beyond the range of tolerance of fish. This is evidenced by the fact that no streams have major exceedence of aquatic coldwater aquatic life temperature criteria, but exceedence of salmonid spawning criteria are widespread throughout streams where monitoring has been conducted (Tables 10 through 31). The exceedence is generally limited to the fringe of spawning periods though. Exceedence of salmonid spawning criteria is generally clustered around the end of June and the middle of September. Again, fish are able to migrate to cooler waters where conditions often favor spawning, and fish are able to shift their spawning periods locally to take advantage of optimal conditions, where optimal conditions exist. Herein can be the problem when headwater streams are not optimally managed.

Streambank stability is diminished over much of the East Fork and North Fork of the Big Lost Rivers (Tables 41 through 45). This results in increased stream width and a reduction of riparian vegetation vigor and diversity at the streambank to shade the stream and prevent further erosion. Hill slope erosion is not considered to be above natural background levels here, and road sediment inputs are isolated. As riparian conditions are continually degraded at the streams edge streambank erosion is accelerated. This results in further widening of the stream and a reduction of shading which results in greater thermal inputs to the stream which results in increasing stream temperature throughout the day and throughout the season. Materials incorporated into streambanks, such as cobble and fine sediment enter the stream and fill instream habitat features and interstitial spaces important in spawning gravel and displacing aquatic insects. Left unchecked, by adaptive management, water quality is impacted. This is evidenced in the temperature data exhibited in this report during spring and fall spawning seasons.

The only other listed tributary stream above Chilly Buttes is Twin Bridges Creek. There is fish data to indicate that salmonid spawning is likely supported above the dewatered reach, however macroinvertebrate scores are low. Cold water aquatic life is not likely supported due to sediment loading from failing streambanks and elevated stream temperature.

### Big Lost River Subbasin: Chilly Buttes to Mackay Dam

The lack of flow in the Big Lost River from Chilly Buttes to the Mackay Reservoir occurs naturally, however it is exacerbated by past and present human activity. Diversion of water for irrigation is based on water rights and is not subject to the Clean Water Act. Activities related to diversion of water for irrigation, such as maintaining diversion structures and ditches and streambed alteration to aid diversion of surface water are governed under laws administered by the Army Corps of Engineers and the Idaho Department of Water Resources. Flow alteration is not a pollutant that is recognized for development of TMDLs and the effect of flow alteration on beneficial use support is not subject to developing a load allocation to restore beneficial uses. It is not likely that beneficial uses for cold water aquatic life or salmonid spawning in the Big Lost River would be fully supported in the absence of surface diversion of irrigation water due to the natural dewatering of the stream channel. Dewatering of the stream channel from Chilly Butte to Mackay Reservoir occurs with enough frequency and duration to preclude restoration of beneficial uses. Flow duration and frequency must be adequate to sustain riparian vegetation and the natural pattern and profile of the stream.

Flow characteristics places particular importance on aquatic systems that do have the potential to support beneficial uses that are perennially connected to the Big Lost River channel. These systems become refuge for fish and aquatic life when there is no flow in the Big Lost River so that during periods of sustained flow recolonization may occur within the channel. Thousand Springs Creek, Warm Springs Creek and Mackay Reservoir are the only identifiable systems above the perennial segment of the Big Lost River (from Mackay Dam to the Moore Diversion) that provide refuge for aquatic organisms and fisheries.

There are no BURP sites on Thousand Springs Creek to show status of coldwater aquatic life support, nor are there fish data to show that this water is in full support of salmonid spawning. There is data to show that Chilly Slough has good populations of brook trout and it can be inferred that there is adequate spawning habitat to support the population there. Thousand Springs Creek, however is a discrete body of water below Chilly Slough. Riparian conditions on Thousand Springs Creek are severely degraded by grazing practices. The Idaho State University data shows that the substrate is composed of 100% silt size fines at their sample location, and cobble imbededness is 100%. The riparian community below Trail Creek Road is composed primarily of grass species. The Thousand Springs macroinvertebrate community is characteristic of outlet flow from a wetland. Given this condition coldwater aquatic life beneficial uses are likely supported at the level of their potential and Thousand Springs Creek functions as a migratory pathway to overwintering habitat and thermal refuge in Chilly Slough. Salmonid spawning however is not fully supported in Thousand Springs Creek from the Big Lost River to Chilly Slough due to streambank erosion and temperature loading related to loss of riparian vegetation.

Warm Springs Creek supports a wild population of kokanee salmon found in Mackay Reservoir by providing spawning habitat and rearing habitat. The Department of Fish and Game no longer stock these fish into Mackay Reservoir, however they are an important component of the Mackay Reservoir fishery. There are good populations of rainbow trout and kokanee salmon in lower Warm Springs Creek based on personal observation and anecdotal information. The upper segment of the stream hosts two fish hatcheries that are a source of fish to the system as well. Salmonid Spawning is supported within Warm Springs Creek though cold water aquatic life may be impaired throughout Warm Springs Creek’s course as evidenced by macroinvertebrate data from the only BURP monitoring site near the headwaters. Temperature loading exceeds water quality criteria for salmonid spawning during spring and fall spawning periods as well.

### Big Lost River: Mackay Dam to Moore Diversion

Beneficial uses for salmonid spawning and coldwater aquatic life through this reach are likely supported. Mackay Reservoir buffers this lower reach from the effects of natural and anthropogenic dewatering during the period when the river is dry above the dam. Irrigation release moderates stream temperature and the reservoir, to a certain degree, reduces sediment inputs to this segment of the river. The fishery below Mackay Dam is regionally very popular and is self-sustaining. Fish are present throughout the reach despite the abundance of unscreened diversion structures and progressively degraded instream habitat due to diminishing flow downstream. BURP sites are also absent along this reach due to constraints of access and flow, however Idaho State University data points toward beneficial use support that becomes marginal downstream due to flow issues. Below the Moore Diversion flow alteration precludes support of beneficial uses.

### Antelope Creek

Antelope Creek is ephemeral below the South Fork of Antelope Creek Diversion. Based on fish and macroinvertebrate data it likely fully supports salmonid spawning and coldwater aquatic life above the confluence of Spring Creek. The 1994 BURP site listed for lower Cherry Creek is actually on a split channel of Antelope Creek just above Spring Creek and this site shows strong full support for coldwater aquatic life. Below the Antelope Creek Road crossing, below Cherry Creek, however riparian habitat is severely degraded with severe erosion and impacted substrate.

This reach is primarily on private land but receives flow throughout the year to the diversion. Hillslope erosion is considered within natural background. Road sediment inputs are isolated and do not compare with loading from streambank erosion.

### Moore Diversion to the Sinks

The lower watershed lacks connectivity and adequate flow in tributaries to support beneficial uses in the mainstem Big Lost River. Tributaries will remain isolated to other than introduced species of fish. The unique aquatic system of the Playas and Sinks is at the mercy of natural conditions and agricultural flow management.

## Conclusions

### Water Quality Limited Segments

Load allocations will be developed for the East Fork of the Big Lost River, and its major tributaries; Corral Creek, Starhope Creek and Wildhorse Creek to address exceedence of water quality standards for temperature. The load allocation will include sediment because the mechanism by which stream temperature is increasing is strongly related to streambank erosion and the resulting changes in channel morphometry. The load allocation for temperature will apply to all waters in the watershed.

The North Fork of the Big Lost River will receive a load allocation for temperature and sediment as well because the same mechanisms effecting the East Fork of the Big Lost River are at play in this watershed. There is no evidence that a nutrient load allocation is required for the upper subbasin at this time because deleterious levels of aquatic growth have not been observed and receiving waters do not appear to be nutrient impaired. Reducing sediment will further buffer nutrient issues, however.

The Big Lost River from the confluence of the North Fork and the East Fork to Chilly Buttes will receive a load allocation for temperature. Reduction of sediment loads in the upper watershed will reduce nutrients and sediment to this reach of river as well. Twin Bridges Creek will receive a gross allocation for sediment and temperature to address the lack of support for beneficial uses. The load allocation for Twin Bridges Creek will be directed at segments with perennial flow that will ultimately extend flow to the current ephemeral segment below private land.

Warm Springs Creek will receive a load allocation for temperature and the discharge from the two hatcheries on Warm Springs Creek and Whiskey Creek will receive Waste Load Allocations to eliminate deleterious discharge of fish waste into Warm Springs Creek that limits beneficial use support throughout the streams coarse.
Antelope Creek and its major tributaries Bear Creek and Cherry Creek will receive load allocations for temperature. Antelope Creek will receive a load allocation for sediment from the confluence of Bear Creek to the South Fork of Antelope Creek Diversion.

The time periods for critical flow are related to the times when erosion is highest, particularly during snowmelt at bankfull conditions. Raw streambanks, however, can also be exacerbated during periods of ice build up during winter months. Ice buildup has been noted on Antelope Creek below Cherry Creek and on the East Fork Big Lost River below Starhope Creek and the North Fork Big Lost River below Chicken Creek. Ice damming increases as streams loose riparian cover and width to depth ratios increase from excessive streambank erosion. Streams radiate heat to the sky, instead of riparian vegetation, a well known thermodynamic principal of streams. Water becomes super-cool, below the freezing point, and ice forms in the channel backing up flow. This causes abrasion of streambanks and when the ice dam releases scouring can take place causing further erosion.

The time periods of critical temperature exceedence are of moderate duration, during spring and fall spawning periods, however the magnitude of exceedence is variable as a function of climate and streambank erosion manifested by width and depth and riparian cover.

Since most streams support salmonid spawning and coldwater aquatic life the key indicator for temperature standard compliance will be stream temperatures monitored above confluence points. These points will become points of compliance for monitoring in the future.

Starhope and Wildhorse Creek will have to be within temperature criteria above the point of confluence with the East Fork. The East Fork and North Fork will have to be within temperature criteria above the point of confluence. The Big Lost River will have to be within criteria above Chilly Buttes. Twin Bridges will have to be within criteria at the private/BLM boundary, or the lowest point of flow greater than 1cfs.

Antelope Creek will have to be within criteria to the South Fork Antelope Creek Diversion. Bear Creek and Cherry Creek will have to be within criteria above Antelope Creek. Key indicators of sediment impairment on Antelope Creek will be reflected in beneficial use support for cold water aquatic life and salmonid spawning as outlined in Water Body Assessment Guidance (DEQ 2002).

The Big Lost River below the Moore Diversion is impacted by flow alteration. The Big Lost River from Chilly Buttes to Mackay Reservoir is also impacted by flow alteration. Antelope Creek from the South Fork Antelope Creek Diversion to the confluence with the Big Lost River is impacted by natural and anthropogenic flow alteration as well. Spring Creek, that begins at the Moore Diversion, is an overflow channel to a natural stream channel that seldom sees flow in enough quantity or duration to support beneficial uses for aquatic life. Parsons Creek, also an overflow channel, has some seasonal channel recharge from ground water and periodically has flow during runoff, but not of enough duration or quantity to support aquatic life beneficial uses above the level required to show full support. Few of the streams that evolve from the Lost River Range, or the eastern front of the White Knob range actually flow to a confluence with the Big Lost River. The cause of flow alteration is a combination of natural causes and human management. These streams will not have load allocations prepared or minimum flows recommended.

## 2.4 Data Gaps

There is adequate data to determine temperature criteria exceedence at existing monitoring points in the Big Lost River. There is adequate data to show that flow alteration exists below critical zones of infiltration on the Big Lost River and Antelope Creek. There is adequate data to show that beneficial uses for salmonid spawning and cold water aquatic life are supported where perennial flow is found on public land. What is not known with adequate resolution is beneficial use support status at key locations on privately managed lands. Access for monitoring has been an obstacle to more accurately determining beneficial use support at specific locations over time. As long as beneficial use support drives water quality status it will be important to gain access to private segments of land.

There are important data gaps with regard to water quality status, pollution loading, and beneficial use support status on private land. There are a number of agencies that assist with private land management issues. Many of the services that agricultural management agencies offer can be related to improving water quality on private land. Few services are related to assessing water quality or aquatic life. Some agencies provide very basic qualitative characterization of riparian vegetation and channel condition. This data is often of limited value to meeting the quantitative needs of water body assessment to determine beneficial use support status or the compliance with water quality standards. This does not prevent inferential determination of support status and application of gross allocations of pollutants to restore beneficial uses, or to ultimately show that beneficial uses are in fact supported where there has not been data. If stronger relationships between beneficial use support status and pollution loading are going to be established monitoring on private land must be achieved by agencies affiliated with that management and that data has to be made available for evaluation.

Given the rich mining history of the Big Lost River watershed it can be assumed that there could be numerous environmental liabilities with regard to mine tailings, mill sites and waste rock. Water quality monitoring for metals contamination has been limited within the watershed. Evaluation of known concentrations of mining activity have not identified areas with obvious potential for impacts to water quality related to human health or aquatic life. Sampling resources must be allocated to address known issues first. Limited water quality monitoring has not shown chronic or acute exceedence of water quality criteria for substances related to mining. Monitoring should continue though no particular issues have been identified.

The impact of riparian grazing on water quality has been well documented. Methodologies for monitoring of riparian condition are well established and should be implemented by land management agencies. The data that accrues from monitoring must be utilized to guide management of riparian areas to protect water quality. Priority must be given to assess conditions and manage accordingly to enhance water quality where needed and to protect existing water quality. Monitoring must be quantitative and periodic to be of value to track changes over time.

# 3. Subbasin Assessment – Pollutant Source Inventory

Pollution within the Big Lost River is related to land use and is primarily from excess sediment from streambank erosion. Sediment occurs naturally as a geologic process. Streams function to move sediment from source areas of high gradient and friable soil material through intermediate elevations and gradients to depositional reaches where sediment is incorporated into the flood plain or transported to larger waters and ultimately to the ocean. Land management practices have the potential to accelerate erosion or to alter depositional processes. This is when sediment becomes pollution. Sediment in excess of a stream's ability to transport it is pollution. Sediment pollution interferes with natural processes that aquatic life depends on and it can result in increased instability of natural stream channels further accelerating erosion.

Altering the dimension, pattern and profile of stream channels effects the transport and deposition of sediment as well as morphology of streams and rivers. To address one aspect of sediment pollution without regard to others on a watershed scale has little potential to successfully reduce sediment or improve water quality or fisheries on a meaningful scale. Initiating an increase in erosion or change in flow pattern can have grave consequences over many years. Many of the processes that are creating excessive amounts of sediment were initiated before these relationships were understood. Today, a number of land management practices are perpetuating the problems of the past and contributing to an increasing deficit of water quality and fisheries values.

## 3.1 Sources of Pollutants of Concern

The primary source of sediment pollution to water quality impaired streams within the Big Lost River watershed is streambank erosion. Other potential sources of sediment pollution, in any watershed, can include roads built too close to streams or improperly maintained, return of water from ditches laden with sediment to natural waters, erosion from cultivated fields, mass wasting or landslides related to improper engineering techniques and urban runoff. Streambank erosion is often significantly greater than these potential sources in the long term. Excess sediment has been determined to be primarily attributable to streambank erosion within the Big Lost River. Other sources of sediment to perennial reaches of listed streams do not compare with quantities of sediment from streambank erosion.

Sediment from streambank erosion is delivered directly to the stream channel without attenuation or deposition, as is often the case with natural hillslope erosion. Depositional features that result from streambank erosion often further accelerate erosion by redirecting flow into formerly stable banks. Eventually streambank stability is greatly reduced. As streambanks erode the width of the stream increases, riparian vegetation and the resultant shading to the stream channel provided by the vegetation decreases further decreasing the stability of streambanks and increasing the thermal load to the stream, another important pollutant related to streambank stability. This type of pollution accrues over a wide area and is considered nonpoint source pollution. Other sources can be considered point sources.

## Point Sources

Point sources of pollution are affiliated with known discrete discharges, such as those from pipes or smoke stacks. They are regulated through several processes including the National Pollution Discharge Elimination System (NPDES). The NPDES is a process of permitting a discrete quantity of a pollutant under defined conditions that is felt to not impair water quality beyond the tolerance of aquatic organisms to support beneficial uses. There are three such sites in the Big Lost River watershed (Table 46). Two of them are hatcheries; the Idaho Department of Fish and Game Hatchery located at the source of Whiskey Creek, a tributary to Warm Springs Creek, and the Lost River Hatchery at the source of Warm Springs Creek, at Hamilton Springs. The remaining facility is the waste treatment plant operated by the City of Mackay. The waste treatment plant discharges to a wetland on a reach of the Big Lost River that is not listed as water quality impaired (§303(d) listed)

**Table 55. NPDES permits in the Big Lost River Watershed.**

| Facility | Surface Water | NPDES Permit # | Exp. Date | Location | Effluent Limits | Discharge Volume |
|---|---|---|---|---|---|---|
| Lost River Hatchery | Warm Springs Creek | IDG130073 | 09/10/04 | Hamilton Springs of Warm Springs Creek (N. Channel) | TSS<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>Settleable Solids<br>0.1 ml/l Daily Ave. | 19 cfs min<br>23 cfs max |
| Mackay Fish Hatchery | Whiskey Creek | IDG130030 | 09/10/04 | Whiskey Springs of Warm Springs Creek (S. Channel) | TSS<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>Settleable Solids<br>0.1 ml/l Daily Ave. | 26 cfs |
| City of Mackay Waste Treatment Facility | Swauger Slough (Near the Big Lost River at Mackay, Idaho) | ID-002302-7 | 5/6/91 | Mackay, ID | BOD 5d 20ºC<br>63mg/l 30d Ave.<br>95 mg/l 7d Ave max<br>pH<br>6.0 min / 9.0 max<br>TSS<br>70 mg/l 30d Ave<br>105 7d Ave max<br>FC (per 100 ml)<br>100 cfu 30d geo mn<br>200 cfu 7d geo mn<br>Flow<br>Report 30dAve<br>Chlorine(tot.resid)<br>1.2 mg/l max<br>BOD 5d % removal<br>65% mo Ave min | |

### Nonpoint Sources

The primary source of nonpoint source pollution to streams in the Big Lost River subbasin is sediment from streambank erosion. Hillslope erosion, mass wasting roads and irrigation return flow have not been identified as significant sources of sediment to TMDL or listed streams. The primary cause of streambank erosion is alteration of stabilizing vegetation on streambanks that results in unstable streambanks. As streambank erosion progresses depositional features form in the channel that redirect current and further reduce bank stability. This process continues until the stream forms a new flood plain and deposition forms new streambanks that become colonized with stabilizing vegetation. This process can take many years to play out once channel alteration begins.

Land use, as previously discussed is primarily agricultural adjacent to streams impaired by temperature and sediment. The agricultural use that has the greatest effect on streambank stability is grazing. Grazing occurs throughout the subbasin in riparian areas.

Other sources of nonpoint source sediment pollution can include roads and erosion from cultivated fields.

### Pollutant Transport

Pollutant transport related to sediment is primarily a function of particle size, channel type, channel width and channel gradient. Effected streams in the Big Lost River are primarily low gradient C channels with elevated fine particle composition above 6.35mm. Transport of sediment is farther for small particle sizes related to stream energy. Streambank composition in Starhope Creek and the East Fork of the Big Lost River below Starhope Creek includes a significant amount of large cobble to boulder size material and substrate composition reflects this. Above the confluence of Starhope Creek channel substrate is primarily sand and small gravel with some cobble size material.

## 3.2 Data Gaps

There are 3 NPDES permits within the Big Lost River watershed. They are discrete sources that incorporate monitoring that is outlined in the permit. Water quality conditions below the point of discharge do not reflect the conditions of the permits for the Hatcheries on Warm Springs Creek. The NPDES permit for the City of Mackay Waste Treatment Plant is adequate to maintain water quality on the Big Lost River near and below Mackay, particularly since the point of discharge is into a wetland area of Swauger Slough and gains the added removal benefit inherent to wetland function. Nonpoint sources described above relate to streambank erosion. Other sources include roads, cultivated fields, and natural background erosion. It is not necessary to complete a sediment budget for the watershed to identify the primary sources of sediment from erosion.

### Point Sources

There are not pollutants generated by existing point sources not currently monitored. Better data is needed to show the actual discharge from the point sources on Warm Springs Creek to identify the precise load reduction necessary to support coldwater aquatic life beneficial uses there. Current monitoring has not been effective in identifying the actual load leaving these facilities. There have been numerous complaints about sludge discharged from the hatchery, and water quality and substrate effects below the hatchery. There have been numerous follow up inspections and investigations by DEQ and EPA to evaluate the problem. Discharge monitoring reports do not reflect the conditions observed in the stream. This is indicative of inadequate settling systems or use of existing systems.

### Nonpoint Sources

The greatest areas of uncertainty of nonpoint source pollution relate to identifying the precise load that a stream can assimilate and still support beneficial uses. There are guidelines for intergravel fine sediment, and evaluation of frequency distributions of riparian and streambank data show that 80% streambank stability is common in natural streams that support aquatic life beneficial uses. There are other variables related to stream channels dimension, pattern, and profile, at various elevations that buffer beneficial use support. These characteristics must be further evaluated.

With regard to temperature loading there is uncertainty about assimilative capacity of surface waters in relation to groundwater inputs, optimum riparian community, and the ability of fish to adapt to temperature increases over time. As stream order increases changes in channel dimension, pattern, and profile increase the loading of temperature naturally. A one-size-fits-all approach to temperature loading based exclusively on temperature standards without regard to river function related to the River Continuum Theory is a stop gap measure at best. Developing loads based on input of energy units is simplistic because it does not take into consideration groundwater inputs, stream channel geometry or vegetative potential. Large rivers warm and fish migrate to cooler water in tributaries. When tributaries at higher elevations are disturbed to the point that they exceed temperature criteria a warning is sounded that must be recognized and heeded.

This is not a matter of collecting more stream temperature data. More data is required to show that riparian and stream channel systems that are already stressed must be managed appropriately to facilitate recovery. Current management techniques do not appear to be improving conditions on streams in the upper Big Lost River watershed. Resting riparian areas for an adequate time to allow improvement of vegetation and subsequently streambank and channel condition appears to be the most effective way to bring about improvements to water quality here. The data exists within land management agencies that are needed to identify effective management techniques to allow for the needed improvements. That information simply needs to be utilized to improve management.

.

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

DEQ was unable to obtain specific data on nonpoint source pollution control projects within the Big Lost River watershed from the agencies that administer these programs including the Natural Resources Conservation Service, the Agricultural Extension Program of the University of Idaho, or the State Soil Conservation Commission. There is at least one known project on lower Antelope Creek that involves planting riparian vegetation to improve streambank stability and provide shading to the stream. It is assumed that there are other projects of this nature in the watershed that are undocumented. Data was not submitted by the Nature Conservancy, BLM or Idaho Department of Fish and Game regarding the Thousand Springs project in the upper watershed.

Programs that would reduce nonpoint source pollution that could be implemented include:

- The Conservation Reserve Program (CRP) reduces erosion and enhances wildlife habitat by encouraging farmers to convert highly erodable cropland to vegetative cover in exchange for an annual rental payment.
- Environmental Quality Incentives Program (EQUIP) was established in the 1996 Farm Bill to provide assistance for farmers and ranchers for improvement projects. The program was specifically designed for areas with serious threats to soil and water quality.
- The Resource Conservation and Development Program (RCRD) program is funded through grants authorized by the Idaho Legislature to finance projects focused on improving rangeland and riparian areas.
- The Water Quality Program for Agriculture (WQPA), formerly known as State Agriculture Water Quality Program (SAWQP), provides financial incentives to owners and operators of agriculture lands to apply conservation practices to protect and enhance water quality and fish and wildlife habitat.
- Long Term Agreements (LTA) are binding agreements between the NRCS or the conservation districts and landowner participants that provides cost-sharing for a conservation project aimed at protecting water, soil, and related resources.

The Forest Service has a 1,200 acre riparian management demonstration project on the East Fork of the Big Lost River below Corral Creek. There has been no expansion of this demonstration project to other areas on the East Fork, or to other subbasins in the watershed.

The City of Mackay Waste Treatment Facility has applied for an NPDES permit to replace the expired permit that they are operating under. Approval and implementation of this permit is expected in March, 2004. The Mackay State Fish Hatchery, and the Lost River Hatchery are operating under a General NPDES permit for aquaculture facilities. The general permit was implemented in 1999 and requires facilities to develop a specific monitoring plan and quality assurance plan to meet the requirements of the General Permit.

# 5. Total Maximum Daily Loads

A Total Maximum Daily Load (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, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the load allocation, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS 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 LC is determined. Then the LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation is completed we have a TMDL, which must equal the LC.

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. Also a required part of the loading analysis is that the LC 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 LC and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

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

## 5.1 Instream Water Quality Targets

The goal of the TMDL is to restore “full support of designated beneficial uses” on all 303(d) listed streams within the Big Lost River subbasin and to bring waters into compliance with state water quality standards. Water quality pollutants of concern for which a TMDL will be written are sediment and temperature. A TMDL will not be written for streams listed with flow alteration as a pollutant. Flow (or lack of flow) is not a pollutant as defined by CWA Section 502(6). The objective of this TMDL is to establish a declining trend in sediment and subsequently temperature loading. Monitoring of the pollutant load and beneficial use support will occur as part of the implementation phase of the TMDL. Pollutant reductions can be attained, in part, by improving channel dimension, vegetative buffers, and improving stream bank stability for attainment of beneficial use support.

The current state of science does not allow specific identification of streambank stability, a sediment load or load capacity to meet the narrative criteria for sediment and to fully support beneficial uses for coldwater aquatic life and salmonid spawning. All that can be said is that the load capacity lies somewhere between current loading and levels that relate to natural streambank erosion levels. We presume that beneficial uses were, or would be, fully supported at natural background sediment loading rates that are assumed to involve at least 80% bank stability. This is also assumed to support temperature regimes that would meet state water quality targets for temperature. In order to attain beneficial use support, 80% bank stability will determine the erosion conditions to be used as the sediment target for this TMDL. Streambank erosion estimates are derived using NRCS methodologies adapted by DEQ as outlined in section 2.3 of the subbasin assessment portion of this document.

To improve the quality of spawning substrate and rearing habitat in the Big Lost River subbasin, it is necessary to reduce the component of subsurface fine sediment (<6.35 mm) to below 28% for improved survival and emergence of trout eggs and fry. Less than 28% subsurface fines will be the sediment target for this TMDL. This will be determined using a modified McNeil sediment sampling procedure that has previously been utilized by the Forest Service and DEQ in the watershed (McNeil and Ahnell 1964).

The temperature TMDL target is the numeric salmonid spawning criteria listed in the state water quality standards [IDAPA 58.01.02.250.02.b]. Instream targets shall be less than the instantaneous temperature 13°C (55.4°F) and the maximum daily average temperature below 9°C (48.2°F) during salmonid spawning periods.

## Design Conditions

This sediment loading analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. Annual erosion and sediment delivery are functions of climatic variability where above average water years typically produce higher erosion and subsequently higher sediment loads from unstable streambanks. Stable streambanks that provide access of peak flow to the flood plain are able to withstand extreme hydrologic events without becoming unstable. Additionally, the annual average sediment load is not distributed equally throughout the year. To quantify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. Erosion typically occurs during a few critical months during spring runoff when bankfull flow occurs.

The temperature critical time periods for salmonid spawning in the Big Lost River subbasin are identified as March 15th through June 30th for rainbow trout and Yellowstone cutthroat trout; and September 15th through November 15th for brook trout.

## Target Selection

### Temperature

Temperature TMDL criteria is based on Idaho's existing numeric criteria for salmonid spawning. Instream targets shall be less than the instantaneous temperature of 13°C and the maximum daily average temperature below 9°C during salmonid spawning periods.

### Sediment

Target selection of sediment is supported by existing narrative criteria of [IDAPA 58.01.02.200.08].

Sediment targets for this subbasin are based on streambank erosion related to streambank stability of 80%. Loading rates are quantitative allocations expressed in tons/year and rates are identified in units of tons per mile per year. Reduction in streambank erosion prescribed in this TMDL is directly linked to the improvement streambank stability related to riparian vegetation vigor and density adequate to armor streambanks thereby reducing lateral recession. Over time stream channels are expected to regain equilibrium and provide natural mechanisms for trapping sediment and reducing stream energy which in turn reduces stream erosivity and instream sediment loading. It is assumed that by reducing chronic sediment, there will be a decrease in ambient stream temperature that will comply with water quality standards. Additionally, improved streambank stability will reduce subsurface fine sediment and improve instream habitat features that will ultimately improve the status of beneficial uses and the quality of the fishery.

It is assumed that natural background sediment loading rates from bank erosion equate to 80% bank stability as described in Overton and others (1995), where banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally 80% or greater for Rosgen A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Therefore, an 80% bank stability target based on streambank erosion inventories shall be the target for sediment load reduction.

Stream substrate sediment size composition can directly impair spawning success, egg survival to emergence, rearing habitat, and fish escapement from streambed spawning gravels. It is necessary to reduce the component of subsurface fine sediment less than 6.35 mm to below 28% to achieve management objectives outlined in the annual Forest Service Monitoring Completion Reports (SCNF 2002). This sediment particle size parameter should continue to be considered as part of target monitoring by the Forest Service to evaluate any significant shift in subsurface fine particle frequency distribution and to guide riparian management.

Monitoring Points

### Subsurface Sediment

Substrate sediment monitoring sites are already established in spawning habitat determined suitable for salmonid spawning within listed stream segments using the McNeil core sediment sampling method. Those sites should continue to be monitored and the results used to refine management practices to protect water quality, coldwater aquatic life and salmonid spawning

### Streambank Stability

Streambank erosion inventories/assessments should be conducted on sediment impaired streams to evaluate overall bank stability. Erosion inventories should be combined with riparian vegetation and instream habitat monitoring using established Forest Service protocols. The results of this monitoring should be used to refine management practices to protect water quality, cold water aquatic life and salmonid spawning and to assure that waters remain within water quality criteria identified by state and federal water quality criteria.

### Temperature Monitoring

Stream temperatures should continue to be monitored with an instream temperature logger at previously established monitoring locations to maintain consistency. Additional sites may require monitoring to ascertain compliance of other waters with water quality standards.

## 5.2 Load Capacity

A load capacity is “the greatest loading a waterbody can receive without violating water quality standards” [40 CFR §130.2]. This must be at a level to meet “...water quality standards with season variations and a margin of safety which takes into account any lack of knowledge...” (Clean Water Act § 303(d)(C)). Likely sources of uncertainty include lack of knowledge of assimilative capacity, uncertain relation of selected target(s) to beneficial use(s), and variability in target measurement.

### Sediment

The load capacity for sediment from streambank erosion shall be based on assumed natural streambank stability of greater than or equal to 80% (Overton et al 1995). Since it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading from natural streambank erosion.

- Natural background loading rates are not necessarily the loading capacities. An adaptive management approach will be used to provide reductions in sediment loading based on best management practice (BMP) implementation coupled with data from monitoring to determine the loading rate at which beneficial uses are supported.

- The estimated capacity is directly related to the improvement of riparian vegetation characteristics and streamchannel conditions within the range of natural variability for desirable potential channel types. Increased vegetative cover provides a protective covering of streambanks, reduces lateral recession, traps sediment, and reduces erosive energy of the stream.
- Keeping other nonpoint sources of sediment in check will be important as well. This includes maintenance of roads and places where trails and roads make stream crossings. Evaluation of land management practices to minimize erosion and sediment transport into streams must also occur. Hillslope and mass wasting erosion are considered to be within the range of natural background variability because explicit significant sediment sources from these features were not observed and no data relating to these features was submitted.

#### Temperature

The loading capacities for streams exceeding water quality criteria for temperature are based on Idaho's temperature criteria for salmonid spawning. Water temperatures must be less than the criteria for instantaneous temperature of 13°C (55.4°F) and the maximum daily average temperature of 9°C (48.2°F) during salmonid spawning periods.

- The loading capacity is season specific and should apply during salmonid spawning periods.
- The use of the highest recorded temperature rather than the average maximum to compare to criteria to determine load reduction provides an implicit margin of safety to assure compliance with water quality criteria.
- Since 2001-2003 were exceptionally hot and dry years, setting load reductions based on the maximum observed temperature provides an additional implicit margin of safety.

## 5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads. Table 47 summarizes point source permitted discharges in the Big Lost River watershed. Temperature loads are summarized in Table 48, and sediment loads are summarize in Table 49.

## Table 56. Existing wasteloads from point sources in the Big Lost River Subbasin.

| Wasteload Type | Location | Load | NPDES[1] Permit Number |
|---|---|---|---|
| Lost River Hatchery | Upper Warm Springs Creek (North Channel) | **TSS**<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>**Settleable Solids**<br>0.1 ml/l Daily Ave. | IDG130073 |
| Mackay Fish Hatchery | Upper Warm Springs Creek (South Channel) | **TSS**<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>**Settleable Solids**<br>0.1 ml/l Daily Ave | IDG130030 |
| City of Mackay Waste Treatment Facility | Swauger Slough (Near the Big Lost River at Mackay, Idaho) | **BOD** 5d 20ºC<br>63mg/l 30d Ave.<br>95 mg/l 7d Ave max<br>**pH**<br>6.0 min / 9.0 max<br>**TSS**<br>70 mg/l 30d Ave<br>105 7d Ave max<br>**FC** (per 100 ml)<br>100 cfu 30d geo mn<br>200 cfu 7d geo mn<br>**Flow**<br>Report 30dAve<br>**Chlorine**(tot.resid)<br>1.2 mg/l max<br>**BOD** 5d % removal<br>65% mo Ave min | ID002302-7 |

[1]National Pollutant Discharge Elimination System

**Table 57. Current temperature Loads from nonpoint sources in Big Lost River Subbasin.**

| Location | Load | | | |
|---|---|---|---|---|
| East Fork Big Lost River 17040218SK039 17040218SK033 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 21.3°C | 15.2°C | 16.3°C | 12.1°C |
| Corral Creek 17040218SK041 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 21.7°C | 14.39°C | 17.1°C | 11.44°C |
| Starhope Creek 17040218SK035 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 20.6°C | 13.6 | 19.76°C | 11.42°C |
| Wildhorse Creek 17040218SK030 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 16.7°C | 11.33°C | 15.2°C | 10.6°C |
| North Fork Big Lost River 17040218 SK027 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 19.0°C | 12.92°C | 16.3°C | 10.6°C |
| Summit Creek 17040218SK028 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 17.8°C | 11.6°C | 15.2°C | 10.52°C |
| Big Lost River at Howell Ranch 17040218SK024 | No Data | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 14.6°C | 11.1°C | 13.3°C | 10.4°C |
| Warm Springs Ranch 17040218SK043 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 20.9°C | 14.5°C | 15.2°C | 10.9°C |

| Location | Load | | | |
|---|---|---|---|---|
| Antelope Creek<br>17040218SK052<br>17040218SK047 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 19.0°C | 13.86°C | 15.6°C | 12.24 |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 23.2°C | 15.1°C | N/A | N/A |
| Cherry Creek<br>17040218SK050 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 18.68°C | 16.47°C | 14.1°C | 13.2°C |
| Bear Creek<br>17040218SK053 | Spring Spawning | | Fall Spawning | |
| | Max Daily | Daily Ave | Max Daily | Daily Ave |
| | 19.4°C | 14.15°C | 16.7°C | 12.39°C |

**Table 58. Current sediment loads from nonpoint sources in Big Lost River Subbasin.**

| Load Type | Location | Load | Estimation Method |
|---|---|---|---|
| Sediment Load Reduction Based on Average Annual Loading Rate: tons/year | East Fork Big Lost River Headwaters to Confluence with North Fork | 1212 Tons per Year | Percent Reduction from Observed Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Corral Creek Headwaters to Confluence with East Fork | 250 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Starhope Creek Headwaters to Confluence with East Fork | 249 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Wildhorse Creek Headwaters to Confluence with East Fork | 103 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | North Fork Big Lost River Headwaters to Confluence with North Fork | 163 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Summit Creek Headwaters to Confluence with East Fork | 45 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Twin Bridges Creek Headwaters to Confluence with East Fork | 536 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Estimated Average Annual Loading Rate: tons/year | Thousand Springs Creek Headwaters to Confluence with East Fork | 13 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Average Annual Loading Rate: tons/year | Antelope Creek Forest Boundary to S. Fk. Antelope Creek Diversion | 888 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Average Annual Loading Rate: tons/year | Bear Creek Headwaters to Confluence with North Fork | 52 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |
| Sediment Load Reduction Based on Average Annual Loading Rate: tons/year | Cherry Creek Headwaters to Confluence with North Fork | 144 Tons per Year | Percent Reduction from Estimated Erosion Rate Based on 80% Bank Stability |

## 5.4 Load Allocation

Wasteload Allocation

There will be a wasteload allocation for both of the hatcheries on Warm Springs Creek (North and South Channel), and the Waste Treatment Plant in Mackay. The wasteload for the waste treatment plant will reflect the new NPDES permit that is in review for the facility and will likely become effective in March 2004 (Table 50). Since the Mackay Waste Treatment Facility discharges to a wetland (Swauger Slough) this is considered an added measure of safety and accounts for a margin of safety.

The wasteload allocation for the hatcheries will provide for 5 mg/l TSS maximum discharge during pond cleaning and loading. The daily average will be set at 2 mg/l daily average TSS and settleable solids. This will effectively remove any discharge from the hatcheries to Warm Springs Creek. The effects of current permit levels on effluent loading have not been effective to protect aquatic life in upper Warm Springs Creek. Sludge from effluent has been noted as far downstream as the Big Lost Ranch and the 6X Ranch above the Reservoir. Adequate settling facilities have been designed to eliminate discharge from the Lost River Hatchery and the owner is willing to aid in installing the best management practices to effect this reduction. The Mackay State Fish Hatchery already has in place a settling system that infiltrates effluent during cleaning and use of this system will be extended to other periods when discharge may be impacted.

The wasteload allocation for temperature from the hatcheries will be set to not exceed current Idaho water quality standards for temperature for cold water aquatic life and salmonid spawning. Presently these regulations are set for cold water aquatic life, to not exceed 22° C instantaneous or 19° C daily average. For salmonid spawning, from March 1 through June 30, and September 15 through November 15 standards are set for 13° C daily maximum, and 9° C daily average.

Load Allocation

Temperature load allocations are based on the percent reduction of the highest observed temperature exceedence for the spring or fall spawning period, whichever is greater, to attain water quality standards (Table 51). Sediment load allocations are intermediate targets that are felt to result in attainment of water quality standards for temperature. Improving streambank erosion is assumed to also result in the channel morphological changes required to bring the temperature regime into compliance with spawning temperature criteria (Table 52).

Margin of Safety

Reducing the wasteload allocation to zero during the activities that create the greatest discharge of effluent adequately provides a conservative explicit margin of safety for hatcheries. With regard to the Mackay Waste Treatment Facility the combination of utilizing more restrictive permit limits and the fact that the facility discharges to a wetland adjacent to a water that is not considered impaired provides an adequate and conservative implicit margin of safety.

Spawning criteria are the most restrictive criteria and will provide an adequate margin of safety to account for compliance. Taking the greatest exceedence during the dry periods over which the temperature data has been accumulated accounts for an additional margin of safety that is adequate to restore compliance with water quality standards. The margin of safety (MOS) factored into sediment load allocations is implicit. The MOS includes the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include: 1) desired bank erosion rates are representative of assumed natural background conditions; 2) water quality targets for percent depth fines are consistent with values measured and set by local land management agencies based on established literature values and incorporate an adequate level of fry survival to provide for stable salmonid production.

<u>Seasonal Variation</u>

Seasonal variability was built-in to this TMDL by developing sediment loads using annual average rates determined from empirical characteristics that developed over time within the influence of runoff events and peak and base flow conditions. Streambank erosion inventories take into account that most bank recession occurs during peak flow events, when the banks are saturated. The estimated annual average sediment delivery is a function of bankfull discharge. It is assumed that the accumulation of sediment within dry channels is continuous until flow resumes and the accumulated sediment is transported and deposited.

Seasonal variability was integrated into temperature TMDLs by taking into account the critical timeframes associated with salmonid reproduction.

<u>Background</u>

Natural background loading rates are assumed to be the natural sediment loading capacity of 80% or greater streambank stability and 28% or less subsurface fine sediment. Therefore natural background is accounted for in the load capacity. Hillslope and mass wasting are considered to be within the range of natural variability for natural background sediment sources because anthropogenic exacerbation that impacts water quality was not identified. The load allocation becomes the current load and must not be increased by management activities.

Natural background conditions for temperature can exceed the criteria. This is seen today in wilderness waters that are relatively unperturbed, however natural temperature regimes in the Big Lost River subbasin have not been isolated. As research accumulates on natural background temperature for flowing water in the Big Lost River Subbasin the TMDL may be adjusted, or site specific criteria may be developed.

<u>Reserve</u>

If it is determined that full beneficial use support is achieved and standards are being met at temperature and sediment loading rates higher that those set forth in this TMDL then the TMDL will be revised accordingly. Conversely, within a reasonable time after full implementation of best management practices, if it is determined that full beneficial use support is not forthcoming and or standards are not being met then additional best management practices will be required.

### Table 59. Wasteload allocation from point sources in the Big Lost River Subbasin.

| Wasteload Type | Load | Load Allocation | NPDES[1] Permit Number |
|---|---|---|---|
| Lost River Hatchery | **TSS**<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>**Settleable Solids**<br>0.1 ml/l Daily Ave. | **TSS**<br>2mg/l Daily Ave<br>2 mg/l Daily Max<br>**Settleable Solids**<br>2 ml/l Daily Ave<br>**Temperature**<br>Comply with current state standards for CWAL and SS | IDG130073<br>36 months to meet allocation |
| Mackay Fish Hatchery | **TSS**<br>5 mg/l Daily Ave,<br>15.0 mg/l Daily Max,<br>**Settleable Solids**<br>0.1 ml/l Daily Ave | **TSS**<br>2mg/l Daily Ave<br>2 mg/l Daily Max<br>**Settleable Solids**<br>2 ml/l Daily Ave<br>**Temperature**<br>Comply with current state standards for CWAL and SS | IDG130030<br>36 months to meet allocation |
| City of Mackay Waste Treatment Facility | **BOD** 5d 20ºC<br>63mg/l 30d Ave.<br>95 mg/l 7d Ave max<br>**pH**<br>6.0 min / 9.0 max<br>**TSS**<br>70 mg/l 30d Ave<br>105 7d Ave max<br>**FC** (per 100 ml)<br>100 cfu 30d geo mn<br>200 cfu 7d geo mn<br>**Flow**<br>Report 30dAve<br>**Chlorine**(tot.resid)<br>1.2 mg/l max<br>**BOD** 5d % removal<br>65% mo Ave min | **BOD** 5d 20ºC<br>45mg/l 30d Ave.<br>65 mg/l 7d Ave max<br>**pH**<br>6.0 min / 9.0 max<br>**TSS**<br>45 mg/l 30d Ave<br>65 7d Ave max<br>**E Coli** (per 100 ml)<br>126/100ml 30d geo mn<br>406/100ml inst. max<br>**Flow**<br>Report 30dAve<br>**Chlorine**(tot.resid)<br>0.5 mg/l 30d Ave<br>0.75 mg/l 7d Ave max | ID002302-7<br>Allocations effective upon approval of NPDES permit for the City of Mackay |

[1]National Pollutant Discharge Elimination System

## Table 60. Temperature load allocations for Big Lost River subbasin.

| Stream | Temperature Statistic | Highest Recorded Temperature (Current Load) | Criteria (Loading Capacity) | Load Reduction | % Reduction |
|---|---|---|---|---|---|
| East Fork Big Lost River | Max Daily | 21.3 | 13°C | -8.3 | 39.0 |
| | Daily Ave | 15.2 | 9°C | -6.2 | 40.8 |
| Corral Creek | Max Daily | 21.7 | 13°C | -8.7 | 40.1 |
| | Daily Ave | 14.39 | 9°C | -5.39 | 37.5 |
| Starhope Creek | Max Daily | 20.6 | 13°C | -7.6 | 36.9 |
| | Daily Ave | 13.6 | 9°C | -4.6 | 33.8 |
| Wildhorse Creek | Max Daily | 16.7 | 13°C | -3.7 | 22.2 |
| | Daily Ave | 11.33 | 9°C | -2.33 | 20.6 |
| North Fork Big Lost River | Max Daily | 19 | 13°C | -6 | 31.6 |
| | Daily Ave | 12.92 | 9°C | -3.92 | 30.3 |
| Summit Creek | Max Daily | 17.8 | 13°C | -4.8 | 27.0 |
| | Daily Ave | 11.6 | 9°C | -2.6 | 22.4 |
| Big Lost River at Howell Ranch | Max Daily | 14.6 | 13°C | -1.6 | 11.0 |
| | Daily Ave | 11.1 | 9°C | -2.1 | 18.9 |
| Warm Springs Creek | Max Daily | 20.9 | 13°C | -7.9 | 37.8 |
| | Daily Ave | 14.5 | 9°C | -5.5 | 37.9 |
| Antelope Creek at Forest Boundary | Max Daily | 19 | 13°C | -6 | 31.6 |
| | Daily Ave | 13.86 | 9°C | -4.86 | 35.1 |
| Antelope Creek at Diversion | Max Daily | 23.2 | 13°C | -10.2 | 44.0 |
| | Daily Ave | 15.1 | 9°C | -6.1 | 40.4 |
| Cherry Creek | Max Daily | 18.68 | 13°C | -5.68 | 30.4 |
| | Daily Ave | 16.47 | 9°C | -7.47 | 45.4 |
| Bear Creek | Max Daily | 19.4 | 13°C | -6.4 | 33.0 |
| | Daily Ave | 14.15 | 9°C | -5.15 | 36.4 |

**Table 61. Erosion load allocations for Big Lost River subbasin.**

| Stream | Estimated Current Load | | Load Capacity/Load Allocation | | Reductions | | |
|---|---|---|---|---|---|---|---|
| | Existing Erosion Rate (t/mi/yr.) | Total Erosion (t/yr.) | Erosion Rate (t/mi/yr.) | Total Erosion (t/yr.) | Total Erosion Reduction (t/yr.) | Total Erosion Rate Reduction (t/mi/yr.) | Total Erosion % Reduction to Meet Load Capacity |
| **East Fork Big Lost River** | Composite | 1218 | --- | 172 | 1046 | Composite | 85.9 |
| **Corral Creek** | 36 | 250 | 6.0 | 39 | 211 | 30 | 84.4 |
| **Starhope Creek** | 26 | 249 | 7.0 | 69.0 | 180 | 19 | 72.3 |
| **Wildhorse Creek** | 21 | 103 | 6.0 | 28.5 | 74.5 | 15 | 72.3 |
| **North Fork Big Lost River** | Composite | 285 | --- | 54.3 | 230.7 | Composite | 80.9 |
| **Summit Creek** | 11 | 45 | 4 | 14.0 | 31 | 7 | 68.9 |
| **Twin Bridges Creek** | 115 | 536 | 7 | 33.1 | 502.9 | 108 | 93.8 |
| **Thousand Springs Creek** | 10 | 13 | 3 | 3.5 | 9.5 | 7 | 73.1 |
| **Warm Springs Creek** | Composite | 12.8 | --- | 26.6 | -13.8 | Composite | -107.8 |
| **Antelope Creek** | Composite | 888 | --- | 118 | 770 | Composite | 86.7 |
| **Bear Creek** | 11 | 52 | 4.0 | 17.0 | 35 | 7 | 67.3 |
| **Cherry Creek** | Composite | 156 | --- | 53.2 | 102.8 | Composite | 65.9 |

## 5.5 Implementation Strategies

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals for restoring full beneficial use support or restoring compliance with water quality standards are not being met or significant progress is not being made toward achieving the goals. Conversely, goals may be met through improvement of riparian management techniques.

IASCD has provided engineering design support to developing plans for a settling basin to be implemented at the Lost River Hatchery that would result in eliminating discharge of total suspended solids and settleable solids. The owner/operator has expressed interest in cost sharing to implement this structural improvement. Funding sources will be sought for this project by Designated Management Agencies and interested parties to effect this improvement.

The Mackay State Hatchery, operated by the Idaho Department of Fish and Game already has an effluent system that should result in elimination of discharge of total suspended solids and settleable solids. If monitoring should show that this is not the case then structural improvements would be required to effect the load allocation prescribed in this TMDL.

Several state designated land management agencies are involved where watershed implementation of riparian management is concerned. The largest portion of the watershed is under federal management. The valley bottom below Chilly Butte is a mosaic of private, state and federal land. Idaho Department of Lands and IASCD will provide implementation strategies for riparian management on State Endowment lands and private lands. Implementation plans may also be developed by federal land management agencies for public land managed by federal agencies.

### Approach

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

### Time Frame

The expected time frame for attaining water quality standard and restoring beneficial use is a function of management intensity, climate, ecological potential, and natural variability of environmental conditions. If implementation of best management practices is embraces enthusiastically some improvements may be seen in as little as several years. Even with aggressive implementation, however, some natural processes required for satisfying the requirements of this TMDL may not be seen for many years. The deleterious effects of historic land management practices have accrued over many years and recovery of natural systems may take longer than administrative needs allow for.

### Responsible Parties

IASCD, IDL, BLM, and FS are identified as the state and federal entities that will be involved in or responsible for developing BMP implementation plans and implementing the TMDL. The Idaho Department of Agriculture is the Designated Management Agency responsible for developing implementation programs for aquaculture.

### Monitoring Strategy

It is presumed that instream temperatures will continue to be monitored with temperature loggers to evaluate improvements or declines in temperature regimes. Streambank erosion inventories are intended for rapid assessment, but will allow for the evaluation of streambank condition in the absence of more rigorous evaluation by established federal land management assessment protocol. Stream subsurface fine sediment should continue to be assessed through McNeil sediment core sampling at established intervals to identify trends toward meeting sediment targets. Beneficial Use Reconnaissance Program monitoring will continue to be conducted by DEQ and should also provide insight regarding implementation effectiveness and developing steam conditions.

## 5.6 Conclusions

The Big Lost River watershed is naturally diverse in conditions that favor aquatic life in some areas and not in others. The upper watershed exhibits the potential to support quality fisheries and recreation opportunities and multiple land uses related to agriculture and mining. These multiple land uses are compatible and sustainable if managed in balance. Equal consideration must be given to the natural sensitivity of environmental conditions if the diverse land use practices that have been a part of the Big Lost River Watershed are to be sustained in areas that can support aquatic life.

There are a number of mechanisms by which the full support of aquatic life can be extended to areas that are marginal due to natural variability of flowing water. An important consideration is to create viable refuge in key tributaries for fish and other aquatic species when the flow regime is naturally altered in mainstem waters. In other cases man manages flow for agricultural production and this management has been the established priority over many years prior to the laws that govern environmental quality. The right to divert water for economic benefit is protected as a property right in the laws of the state of Idaho. The potential synergism between natural and anthropogenic flow alteration can severely limit the potential for fisheries and aquatic life in natural systems. The potential also exists, however, for voluntary and cooperative projects to enhance water quality and aquatic life beneficial uses, while concurrently enhancing the availability of water for economic use. This is the overall optimum scenario that should be sought in areas that are today marginal for both uses.

The direct relationship between stream erosion and stream temperatures is apparent with the coupling of sediment and temperature 303(d) listings. Stream channel migration is a natural process that occurs at a slow rate under conditions of sediment equilibrium. Lateral recession is a natural process accompanied by depositional mechanisms that are balanced in a system that is stable and in equilibrium. Streambank erosion, however, can be accelerated by reducing/eliminating riparian vegetation and the detachment of bank material (clumping and sloughing), all of which disrupt the natural stream system contributing to elevated stream sediment and elevation of stream temperature.

# References Cited

American Geologic Institute. 1962. Dictionary of geologic terms. Garden City, NY: Doubleday and Company. 545 p.

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. Bethesda, MD: American Fisheries Society. 136 p.

Bailey, R.M. and C.E. Bond. 1963. Four new species of freshwater sculpins, genus Cottus, from western North America. Occasional papers of the Mus. Of Zool., Univ. of Mich., No. 634.

Batt, PE. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. Boise, ID: State of Idaho, Office of the Governor. 20 p + appendices.

Behnke, R. J. 2003.Evolution and Historical Distribution of Fishes in Western North America in Relation to the Sinks Drainages. P. 8 *in*
Van Kirk, R.W., J. M. Capurso, and B. L. Gamett, editors. The Sinks symposium: exploring the origin and management of fishes in the Sinks Drainages of southeastern Idaho. Idaho Chapter American Fisheries Society, Boise, ID.

Clean Water Act (Federal water pollution control act), U.S.C. § 1251-1387 (1972).

DEQ. 1996. 1996 Water Body Assessment Guidance – A Stream to Standards Process. Boise, ID: Department of Environmental Quality. 109p.

EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. Washington, DC: U.S. Environmental Protection Agency, Office of Water. 162 p.

EPA. 1997. Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates: supplement. EPA-841-B-97-002B. Washington, DC: U.S. Environmental Protection Agency. 105 p.

Evenson, E.B., Cotter, J.F.P., and Clinch, J.M., 1982, Glaciation of the Pioneer Mountains: A proposed model for Idaho: *in* Bonnichsen, Bill, and Breckenridge, R.M.,editors, Cenozoic Geology of Idaho, Idaho Bureau of Mines and Geology Bulletin 26, p. 653-665.

Galbraith, W.A. and Anderson, E.W. 1969. Grazing History of the Northwest. Joint Publication: Bonneville Power Administration and Oregon Soil Conservation Service, Portland, Oregon.

Grafe CS, Mebane CA, McIntyre MJ, Essig DA, Brandt DH, Mosier DT. 2002. The Idaho Department of Environmental Quality water body assessment guidance, 2nd ed. Boise, ID: Department of Environmental Quality. 114 p.

Greenborg AE, Clescevi LS, Eaton AD, editors. 1992. Standard methods for the examination of water and wastewater, 18th edition. Washington, DC: American Public Health Association. 900 p.

Hatzenbuehler, R. 2003.The Settlement of Southeastern Idaho Before 1900. Pp. 14-15 *in* Van Kirk, R.W., J. M. Capurso, and B. L. Gamett, editors. The Sinks symposium: exploring the origin and management of fishes in the Sinks Drainages of southeastern Idaho. Idaho Chapter American Fisheries Society, Boise, ID.

Hubbs, C.L. and R.R. Miller. 1948. The zoological evidence: correlation between fish distribution and hydrographic history in the desert basins of western United States. IN Blackwelder, T. (ed.) The Great Basin—with emphasis on glacial and postglacial times. Bull. Univ. Utah 38:29-32, 76-77.

Hughes RM. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis WS, Simon TP, editors. Biological assessment and criteria: tools for water resource planning. Boca Raton, FL: CRC Press. p 31-48.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Code § 3615. Creation of watershed advisory groups.

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

Karr JR. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Kempthorne, D. 2000. State of Idaho Office of the Governor. FYI Idaho: Idaho History http://www2.state.id.us/gov/fyi/history/

Link, P. K. 2003. Geologic and hydrologic history of the Sinks Drainages. Pp. 4-7 *in* Van Kirk, R.W., J. M. Capurso, and B. L. Gamett, editors. The Sinks symposium: exploring the origin and management of fishes in the Sinks Drainages of southeastern Idaho. Idaho Chapter American Fisheries Society, Boise, ID.

Link, P.K., and Hackett, W.R. editors, 1989. Guidebook to the Geology of Central and Southern Idaho: Idaho Geological Survey Bulletin 27, p. 201-244.

Link, P.K., and Phoenix, C. E. 1996. Rocks, Rails & Trails 2nd ed. Idaho Museum of Natural History

Myler, C. D. and Minshall, G. W. 2001. Development of Assessment Tools for Lotic Ecosystems and Their Application to Streams in the Big Lost River Drainage. Idaho State University.

O'Connor, J.E. and Baker, V.R., 1992, Magnitudes and implications of peak discharges from Glacial Lake Missoula: Geological Society of America Bulletin, v. 104, p. 267-279.

O'Connor, J.E., 1993, Hydrology, hydraulics, and geomorphology of the Bonneville flood: Geological Society of America Special Paper 274, 83p

Overton, C.K., McIntyre, J.D., Armstrong, R., Whitwell, S.L., and Duncan, K.A. 1005. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. USDA FS Intermountain Research Service. General Technical Report INT-GTR-322. 142 p.

Rand GW, editor. 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Washington, DC: Taylor and Francis. 1125 p.

Rathburn, Sara L., 1993, Pleistocene cataclysmic flooding along the Big Lost River, east central Idaho: Geomorphology, v. 8, p. 305-319.

Rosgen, D.L. 1996. Applied river morphology. Wildland Hydrology. Pagosa Springs, CO. 378 p.

Strahler AN. 1957. Quantitative analysis of watershed geomorphology. American Geophysical Union Transactions 38:913-920.
SCNF. 2002. Watershed and Fisheries Monitoring Completion Report. Salmon-Challis National Forest. Robert Rose, Fisheries Biologist.

USGS. 1987. Hydrologic unit maps. Denver, CO: United States Geological Survey. Water supply paper 2294. 63 p.

Water Pollution Control Federation. 1987. The Clean Water Act of 1987. Alexandria, VA: Water Pollution Control Federation. 318 p.

Water Quality Act of 1987, Public Law 100-4 (1987).

Water quality planning and management, 40 CFR 130.

**GIS Coverages:**

Restriction of liability: Neither the state of Idaho nor the Department of Environmental Quality, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Department of Environmental Quality may update, modify, or revise the data used at any time, without notice. GIS coverages are listed as figures.

## Glossary

**305(b)** Refers to section 305 subsection "b" of the Clean Water Act. 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 waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

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

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

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

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

**Assessment Database (ADB)** The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of waterbodies, and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.

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

**Adjunct** In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

| | |
|---|---|
| **Alevin** | A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a waterbody, 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. 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 (Armantrout 1998, EPA 1996). |
| **Anadromous** | Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the salt water but return to fresh water to spawn. |
| **Anaerobic** | Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen. |
| **Anoxia** | The condition of oxygen absence or deficiency. |
| **Anthropogenic** | Relating to, or resulting from, the influence of human beings on nature. |
| **Anti-Degradation** | Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.56). |
| **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 waterbody; for example, a fish assemblage, or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996). |
| **Assimilative Capacity** | The ability to process or dissipate pollutants without ill effect to beneficial uses. |
| **Autotrophic** | An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis. |

| | |
|---|---|
| **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 waterbodies 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 waterbody |
| **Benthic Organic Matter**. | The organic matter on the bottom of a waterbody. |
| **Benthos** | Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms. |
| **Best Management Practices (BMPs)** | Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants. |
| **Best Professional Judgment** | A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information. |
| **Biochemical Oxygen Demand (BOD)** | The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time. |
| **Biological Integrity** | 1) The condition of an aquatic community inhabiting unimpaired waterbodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic life (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991). |
| **Biomass** | The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter. |
| **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 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. Measured in Colony Forming Units (CFU), Colonies per 100 ml of sample. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria). |
| **Colluvium** | Material transported to a site by gravity. |
| **Community** | A group of interacting organisms living together in a given place. |
| **Conductivity** | The ability of an aqueous solution to carry electric current, expressed in micro (µ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample. |
| **Cretaceous** | The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago. |
| **Criteria** | In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria. |
| **Cubic Feet per Second** | A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day. |
| **Cultural Eutrophication** | The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication). |
| **Culturally Induced Erosion** | Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion). |
| **Debris Torrent** | The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains. |

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

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

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

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

**Dissolved Oxygen (DO)** The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

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

***E. coli*** Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.

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

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

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

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

**Effluent** A discharge of untreated, partially treated, or treated wastewater into a receiving waterbody.

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

| | |
|---|---|
| **Environment** | The complete range of external conditions, physical and biological, that affect a particular organism or community. |
| **Eocene** | An epoch of the early Tertiary period, after the Paleocene and before the Oligocene. |
| **Eolian** | Windblown, referring to the process of erosion, transport, and deposition of material by the wind. |
| **Ephemeral Stream** | A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table. (American Geologic Institute 1962). |
| **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). |
| **Exotic Species** | A species that is not native (indigenous) to a region. |
| **Extrapolation** | Estimation of unknown values by extending or projecting from known values. |
| **Fauna** | Animal life, especially the animals characteristic of a region, period, or special environment. |
| **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). |
| **Fecal Streptococci** | A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals. |
| **Feedback Loop** | In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress. |
| **Fixed-Location Monitoring** | Sampling or measuring environmental conditions continuously or repeatedly at the same location. |

| | |
|---|---|
| **Flow** | See Discharge. |
| **Fluvial** | In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning. |
| **Focal** | Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species. |
| **Fully Supporting** | In compliance with water quality standards and within the range of biological reference conditions for all designated and 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 (EPA 1997). |
| **Fully Supporting but Threatened** | An intermediate assessment category describing waterbodies 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. |
| **Grab Sample** | A single sample collected at a particular time and place. It may represent the composition of the water in that water column. |
| **Gradient** | The slope of the land, water, or streambed surface. |
| **Ground Water** | Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow. |
| **Growth Rate** | A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population. |
| **Habitat** | The living place of an organism or community. |
| **Headwater** | The origin or beginning of a stream. |
| **Hydrologic Basin** | The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed). |

| | |
|---|---|
| **Hydrologic Cycle** | The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle. |
| **Hydrologic Unit** | One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively. |
| **Hydrologic Unit Code (HUC)** | The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units. |
| **Hydrology** | The science dealing with the properties, distribution, and circulation of water. |
| **Impervious** | Describes a surface, such as pavement, that water cannot penetrate. |
| **Influent** | A tributary stream. |
| **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. |
| **Interstate Waters** | Waters that flow across or form part of state or international boundaries, including boundaries with Indian nations. |
| **Irrigation Return Flow** | Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams. |

| | |
|---|---|
| **Key Watershed** | A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations. |
| **Knickpoint** | Any interruption or break of slope. |
| **Land Application** | A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge. |
| **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 waterbody'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. |
| **Loading Capacity (LC)** | A determination of how much pollutant a waterbody can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load. |
| **Loam** | Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use. |
| **Loess** | A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible. |
| **Lotic** | An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth. |
| **Luxury Consumption** | A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a waterbody, 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 waterbody's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving waterbody. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution. |
| **Mass Wasting** | A general term for the down slope movement of soil and rock material under the direct influence of gravity. |
| **Mean** | Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people. |
| **Median** | The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 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, essentially equivalent to parts per million (ppm). |
| **Million gallons per day (MGD)** | A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second. |
| **Miocene** | Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks. |
| **Monitoring** | A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a waterbody. |
| **Mouth** | The location where flowing water enters into a larger waterbody. |
| **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** | A condition indistinguishable from that without human-caused disruptions. |

| | |
|---|---|
| **Nitrogen** | An element essential to plant growth, and thus is considered a nutrient. |
| **Nodal** | Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish. |
| **Nonpoint Source** | A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites. |
| **Not Assessed (NA)** | A concept and an assessment category describing waterbodies that have been studied, but are missing critical information needed to complete an assessment. |
| **Not Attainable** | A concept and an assessment category describing waterbodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning). |
| **Not Fully Supporting** | Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *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 (EPA 1997). |
| **Nuisance** | Anything which 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). |
| **Oligotrophic** | The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity. |
| **Organic Matter** | Compounds manufactured by plants and animals that contain principally carbon. |

**Orthophosphate** — A form of soluble inorganic phosphorus most readily used for algal growth.

**Oxygen-Demanding Materials** — Those materials, mainly organic matter, in a waterbody that consume oxygen during decomposition.

**Parameter** — A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

**Partitioning** — The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.

**Pathogens** — Disease-producing organisms (e.g., bacteria, viruses, parasites).

**Perennial Stream** — A stream that flows year-around in most years.

**Periphyton** — Attached microflora (algae and diatoms) growing on the bottom of a waterbody or on submerged substrates, including larger plants.

**Pesticide** — Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

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

**Phased TMDL** — A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a waterbody. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.

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

**Physiochemical** — In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the terms “physical/chemical” and “physicochemical.”

| | |
|---|---|
| **Plankton** | Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans. |
| **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. |
| **Pretreatment** | The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant. |
| **Primary Productivity** | The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour. |
| **Protocol** | A series of formal steps for conducting a test or survey. |
| **Qualitative** | Descriptive of kind, type, or direction. |
| **Quality Assurance (QA)** | A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996). |
| **Quality Control (QC)** | Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995, EPA 1996). |
| **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 waterbody that is minimally impaired and is representative of reference conditions for similar waterbodies.

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

**Resident** A term that describes fish that do not migrate.

**Respiration** A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

**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 waterbody.

**Riparian Habitat Conservation Area (RHCA)** A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:

- 300 feet from perennial fish-bearing streams
- 150 feet from perennial non-fish-bearing streams
- 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.

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

**Runoff** The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

**Sediments** Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

**Settleable Solids** The volume of material that settles out of one liter of water in one hour.

**Species** 1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.

**Spring** Ground water seeping out of the earth where the water table intersects the ground surface.

**Stagnation** The absence of mixing in a waterbody.

**Stenothermal** Unable to tolerate a wide temperature range.

**Stratification** A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).

**Stream** A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.

**Stream Order** Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.

**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.

**Stressors** Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

**Subbasin** A large watershed of several hundred thousand acres. This is the name commonly given to $4^{th}$ field hydrologic units (also see Hydrologic Unit).

**Subbasin Assessment (SBA)** A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

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

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

| | |
|---|---|
| **Surface Runoff** | Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow. |
| **Surface Water** | All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water. |
| **Suspended Sediments** | Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins. |
| **Taxon** | Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998). |
| **Tertiary** | An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs. |
| **Thalweg** | The center of a stream's current, where most of the water flows. |
| **Threatened Species** | Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. |
| **Total Maximum Daily Load (TMDL)** | A TMDL is a waterbody's loading 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. TMDL = Loading Capacity = Load Allocation + Wasteload Allocation + Margin of Safety. 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 waterbodies and/or pollutants within a given watershed. |
| **Total Dissolved Solids** | 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 (Greenborg, Clescevi, and Eaton 1995) 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.

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

**Tributary** A stream feeding into a larger stream or lake.

**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** 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 (Greenborg, Clescevi, and Eaton 1995) 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.

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

**Tributary** A stream feeding into a larger stream or lake.

**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.

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

**Vadose Zone** The unsaturated region from the soil surface to the ground water table.

**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 waterbody.

| | |
|---|---|
| **Waterbody** | 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 waterbodies 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 Management Plan** | A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act. |
| **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 EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody 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 waterbody. |
| **Waterbody Identification Number (WBID)** | A number that uniquely identifies a waterbody in Idaho ties in to the Idaho Water Quality Standards and GIS information. |
| **Wetland** | An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes. |
| **Young of the Year** | Young fish born the year captured, evidence of spawning activity. |

# Appendix A. Unit Conversion Chart

**Table B1. Metric - English unit conversions.**

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

[1] 1 $ft^3$/sec = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 $ft^3$/sec.
[2] 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

**003. DEFINITIONS.**

For the purpose of the rules contained in IDAPA 58.01.02, "Water Quality Standards and Wastewater Treatment Requirements," the following definitions apply: (4-5-00)

**01. Acute**. Involving a stimulus severe enough to rapidly induce a response; in aquatic toxicity tests, a response measuring lethality observed in ninety-six (96) hours or less is typically considered acute. When referring to human health, an acute effect is not always measured in terms of lethality. (3-20-97)

**02. Acute Criteria**. Unless otherwise specified in these rules, the maximum instantaneous or one (1) hour average concentration of a toxic substance or effluent which ensures adequate protection of sensitive species of aquatic organisms from acute toxicity resulting from exposure to the toxic substance or effluent. Acute criteria will adequately protect the designated aquatic life use if not exceeded more than once every three (3) years. The terms "acute criteria" and "criterion maximum concentration" (CMC) are equivalent. (3-15-02)

**03. Acute Toxicity**. The existence of mortality or injury to aquatic organisms resulting from a single or short-term (i.e., ninety-six (96) hours or less) exposure to a substance. As applied to toxicity tests, acute toxicity refers to the response of aquatic test organisms to a concentration of a toxic substance or effluent which results in a LC-50. (3-20-97)

**04. Beneficial Use**. Any of the various uses which may be made of the water of Idaho, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics. The beneficial use is dependent upon actual use, the ability of the water to support a non-existing use either now or in the future, and its likelihood of being used in a given manner. The use of water for the purpose of wastewater dilution or as a receiving water for a waste treatment facility effluent is not a beneficial use. (8-24-94)

**05. Available**. Based on public wastewater system size, complexity, and variation in raw waste, a certified wastewater operator must be on site or able to be contacted as needed to initiate the appropriate action for

**050. ADMINISTRATIVE POLICY.**

**01. Apportionment Of Water**. The adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees, or to interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure, or to interfere with water quality criteria established by mutual agreement of the participants in interstate water pollution control enforcement procedures. (7-1-93)

**02. Protection Of Waters Of The State**. (7-1-93)

**a.** Wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic life; (4-5-00)

**b.** In all cases, existing beneficial uses of the waters of the state will be protected. (7-1-93)

**03. Annual Program**. To fully achieve and maintain water quality in the state, it is the intent of the Department to develop and implement a Continuing Planning Process that describes the on-going planning requirements of the State's Water Quality Management Plan. The Department's planned programs for water pollution control comprise the State's Water Quality Management Plan. (4-5-00)

**04. Program Integration**. Whenever an activity or class of activities is subject to provisions of these rules, as well as other regulations or standards of either this Department or other Governmental agency, the Department will seek and employ those methods necessary and practicable to integrate the implementation, administration and enforcement of all applicable regulations through a single program. Integration will not, however, be affected to the extent that applicable provisions of these rules would fail to be achieved or maintained unless the Department's role in these cases is limited by state statute or federal law. (7-1-93)

**05. Revisions**. These rules are subject to amendment as technical data, surveillance programs, and technological advances require. Any revisions made to these rules shall be in accordance with Sections 39-101, et seq., and 67-5201, et seq., Idaho Code. (8-24-94)

**051. ANTIDEGRADATION POLICY.**

**01. Maintenance Of Existing Uses For All Waters**. The existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. (7-1-93)

**02. High Quality Waters**. Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the Department finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the Department's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the Department shall assure water quality adequate to protect existing uses fully. Further, the Department shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and cost-effective and reasonable best management practices for nonpoint source control. In providing such assurance, the Department may enter together into an agreement with other state of Idaho or federal agencies in accordance with Sections 67-2326 through 67-2333, Idaho Code. (7-1-93)

**100. SURFACE WATER USE DESIGNATIONS.**

Waterbodies are designated in Idaho to protect water quality for existing or designated uses. The designated use of a waterbody does not imply any rights to access or ability to conduct any activity related to the use designtion, nor does it imply that an activity is safe. For example, a designation of primary or secondary contact recreation may occur in areas where it is unsafe to enter the water due to water flows, depth or other hazardous conditions. Another example is that aquatic life uses may be designated in areas that are closed to fishing or access is not allowed by property owners. Wherever attainable, the designated beneficial uses for which the surface waters of the state are to be protected include: (3-15-02)

**01. Aquatic Life**. (7-1-93)

**a.** Cold water (COLD): water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species. (4-5-00)

**b.** Salmonid spawning: waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes. (7-1-93)

**c.** Seasonal cold water (SC): water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent during, or tolerant of, seasonally warm temperatures. (4-5-00)

**d.** Warm water (WARM): water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species. (4-5-00)

**e.** Modified (MOD): water quality appropriate for an aquatic life community that is limited due to one (1) or more conditions set forth in 40 CFR 131.10(g) which preclude attainment of reference streams or conditions. (4-5-00)

**02. Recreation**. (7-1-93)

**a.** Primary contact recreation (PCR): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving. (4-5-00)

**b.** Secondary contact recreation (SCR): water quality appropriate for recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur. (4-5-00)

**03. Water Supply**. (7-1-93)

**a.** Domestic: water quality appropriate for drinking water supplies. (4-5-00)

**b.** Agricultural: water quality appropriate for the irrigation of crops or as drinking water for livestock. This use applies to all surface waters of the state. (4-5-00)

**c.** Industrial: water quality appropriate for industrial water supplies. This use applies to all surface waters of the state. (4-5-00)

**04. Wildlife Habitats**. Water quality appropriate for wildlife habitats. This use applies to all surface waters of the state. (4-5-00)

**05. Aesthetics**. This use applies to all surface waters of the state. (7-1-93)

**101. NONDESIGNATED SURFACE WATERS.**

**01. Undesignated Surface Waters**. Surface waters not designated in Sections 110 through 160 shall be designated according to Section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Prior to designation, undesignated waters shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. (3-23-98)

**a.** Because the Department presumes most waters in the state will support cold water aquatic life and primary or secondary contact recreation beneficial uses, the Department will apply cold water aquatic life and primary or secondary contact recreation criteria to undesignated waters unless Sections 101.01.b and 101.01c. are followed. (4-5-00)

**b.** During the review of any new or existing activity on an undesignated water, the Department may examine all relevant data or may require the gathering of relevant data on beneficial uses; pending determination in Section 101.01.c. existing activities will be allowed to continue. (3-23-98)

**c.** If, after review and public notice of relevant data, it is determined that beneficial uses in addition to or other than cold water aquatic life and primary or secondary contact recreation are appropriate, then the Department will: (4-5-00)

i. Complete the review and compliance determination of the activity in context with the new information on beneficial uses, and (3-23-98)

ii. Initiate rulemaking necessary to designate the undesignated water, including providing all necessary data and information to support the proposed designation. (3-23-98)

**02. Man-Made Waterways**. Unless designated in Sections 110 through 160, man-made waterways are to be protected for the use for which they were developed. (7-1-93)

**03. Private Waters**. Unless designated in Sections 110 through 160, lakes, ponds, pools, streams and springs outside public lands but located wholly and entirely upon a person's land are not protected specifically or generally for any beneficial use. (7-1-93)

**250. SURFACE WATER QUALITY CRITERIA FOR AQUATIC LIFE USE DESIGNATIONS.**

**01. General Criteria**. The following criteria apply to all aquatic life use designations. Surface waters are not to vary from the following characteristics due to human activities: (3-15-02)

**a.** Hydrogen Ion Concentration (pH) values within the range of six point five (6.5) to nine point zero (9.0); (3-30-01)

**b.** The total concentration of dissolved gas not exceeding one hundred and ten percent (110%) of saturation at atmospheric pressure at the point of sample collection; (7-1-93)

**02. Cold Water**. Waters designated for cold water aquatic life are not to vary from the following characteristics due to human activities: (3-15-02)

**a.** Dissolved Oxygen Concentrations exceeding six (6) mg/l at all times. In lakes and reservoirs this standard does not apply to: (7-1-93)

i. The bottom twenty percent (20%) of water depth in natural lakes and reservoirs where depths are thirty-five (35) meters or less. (7-1-93)

ii. The bottom seven (7) meters of water depth in natural lakes and reservoirs where depths are greater than thirty-five (35) meters. (7-1-93)

iii. Those waters of the hypolimnion in stratified lakes and reservoirs. (7-1-93)

**b.** Water temperatures of twenty-two (22) degrees C or less with a maximum daily average of no greater than nineteen (19) degrees C. (8-24-94)

**c.** Temperature in lakes shall have no measurable change from natural background conditions. Reservoirs with mean detention times of greater than fifteen (15) days are considered lakes for this purpose. (3-15-02)

**d.** Ammonia. The following criteria are not to be exceeded dependent upon the temperature, T (degrees C), and pH of the water body: (3-15-02)

**251. SURFACE WATER QUALITY CRITERIA FOR RECREATION USE DESIGNATIONS.**

**01. Primary Contact Recreation**. Waters designated for primary contact recreation are not to contain E.coli bacteria significant to the public health in concentrations exceeding: (4-5-00)

**a.** For areas within waters designated for primary contact recreation that are additionally specified as public swimming beaches, a single sample of two hundred thirty-five (235) E. coli organisms per one hundred (100) ml. For the purpose of this subsection, "specified public swimming beaches" are considered to be indicated by features such as signs, swimming docks, diving boards, slides, or the like, boater exclusion zones, map legends, collection of a fee for beach use, or any other unambiguous invitation to public swimming. Privately owned swimming docks or the like which are not open to the general public are not included in this definition. (3-15-02)

# Appendix C. Data Sources

**Table C1. Data sources for Big Lost River Subbasin Assessment.**

| Waterbody | Data Source | Type of Data | When Collected |
|---|---|---|---|
| Big Lost River Subbasin | Bart Gamett, USDA FS Lost River Ranger District | Temperature, Fish | August 2003 |
| East Fork, North Fork Big Lost and associated subbasins | Dan Garren, IDFG, Upper Snake Regional Office | Fish | August 2003 |
| East Fork, Antelope Cr., Warm Springs Cr., Bear Cr. | Ron Rope, INEEL Environmental Section | Erosion Inventory, Depth Fines | October 2002 |
| Big Lost River | Idaho State University | Nutrient, Flow, Macroinvertebrate | October 2002 |
| Deep Creek, Sage Creek, Garden Creek, Lake Creek, Burnt Creek, Twin Bridges Creek | Patty Jones, DOI BLM, Challis Resource Office | Flow | November 2003 |

# Appendix D. Distribution List

| | |
|---|---|
| Deanna Braun<br>Bechtel | William Stewart<br>Idaho Operations Office<br>Environmental Protection Agency |
| Patty Jones, Hydrologist<br>Challis Field Office<br>Bureau of Land Management | Bart Gammet, Fisheries Biologist<br>Lost River Ranger District<br>Department of Agriculture Forest Service |
| Heath Hancock, Range Conservationist<br>Idaho Department of Lands | Dan Kotansky, Hydrologist<br>Idaho Falls Office<br>Bureau of Land Management |
| Ivalou O'Dell, Information Specialist<br>USGS Water Resources of Idaho | Water Quality Conservationist<br>Idaho Association of Soil Conservation Districts |
| Seth Beal<br>Butte County Commissioner | Harvey Walker<br>Arco, Idaho |
| Dick Smith<br>Lost River Hatchery | City of Mackay<br>City Clerk |
| Richard May<br>San Francisco, CA  94127 | Greg and Cheri Webster<br>Mackay, ID |
| Phil Coonts<br>Hatchery Supt.<br>Mackay State Fish Hatchery | Mark Stauffer<br>Butte County Commissioner |
| John Traughber<br>Butte County Commissioner | Leann & Dwayne Moates<br>Arco, Idaho |
| James P. Fredericks,<br>Regional Fisheries Manager<br>Idaho Department of Fish and Game<br>Upper Snake Region | Jim Gregory<br>Mackay, ID  83251 |

# Appendix E. Public Comments

Note: Comments are in normal type and responses are in **bold**.

## EPA General Comments Received March 15, 2004

1) On Page 102 in the first paragraph, reference is made to the old EPA Gold Book suggested criteria for nutrients in streams, reservoirs and lakes. There are new nutrient criteria guidance available that are based on ecoregion numbers that you may want to check your data against.
**The new suggested criteria are based on aggregate ecoregions that bisect the Big Lost River below Arco. The reach below Arco is not 303d listed. The upper river, represented by nutrient data in the TMDL, is covered under the Western Forested Mountains aggregate ecoregion. This aggregate ecoregion includes the Idaho Batholith, and the wetter northern Idaho/Northern Rockies ecoregion, which is a sterile granitic hydrology compared to the volcanic geology found in the Big Lost River above the sample points represented in the document. There are important differences between the Snake River Plain Ecoregion, to the south, that include lower precipitation and lower gradient watersheds. Idaho has not adopted numeric criteria because of the geologic differences between streams and watersheds. A single value for nutrient criteria does not work for the Big Lost River watershed due to varying geology, fragmentation of flowing water, and the absence of nuisance levels of aquatic plants in listed streams. Reference to EPA suggested criteria will be removed from the document and a reference to state narrative criteria will be inserted.**

2) On page 119, in Section 3.1, other sources of sediment are discussed, such as erosion from cultivated fields, mass wasting, irrigation return flows, roads, etc. It isn't evident in the document that any of these sources were analyzed for their contribution to the sediment issues in the streams. How was it determined that streambank erosion is the main source of sediment over all sources? Was there modeling done?
**The Document identifies the primary source of sediment as streambank erosion. This was determined by evaluation of Land Use adjacent to listed reaches, field evaluation of potential sources; on the ground, in aircraft, and from aerial photos, and data submitted to DEQ. Based on field evaluation of potential sources and land use/ownership data it has been determined that sediment inputs are primarily related to rangeland grazing and the source is streambank erosion. TMDLs in this document are for streams adjacent to irrigated pasture and range and are primarily for temperature exceedance. It is stated that sediment TMDLs are in support of temperature TMDLs to improve channel geometry and riparian vegetation. Sedimentation is not identified as limiting beneficial uses in streams effected by temperature exceedances. Streams listed for sediment include the upper East Fork of the Big Lost River, Twin Bridges Creek, and Antelope Creek. Land use adjacent to these reaches does not include significant cultivated land, road issues, mass wasting or irrigation return flow. Other streams that had TMDLs prepared were not listed for sediment but had TMDLs for numeric exceedance of temperature criteria. Return flow from irrigation is minimal.**

3) The first two sentences in the last paragraph on page 122 seem to be contradicting each other. You may want to rephrase what you are stating here.

**The wording here will be made more clear that the primary source has been determined to be streambank erosion… and other potential sources include… and ultimately that the potential sources don't compare with the identified primary source.**

4) On page 134 in the second paragraph, mention is made of road sediment using the WEPP model. WEPP is again discussed in Appendix G. I haven't been able to find any results or discussion on the use of this model anywhere else in the report. Was this an oversight?
**WEPP, as explained in this section, is part of an erosion inventory process that is described as a whole in the Appendix. It was not specifically employed in any load allocations in the Big Lost River Watershed SBA/TMDL because there were no particular roads that were identified as major sediment sources to listed or impaired waters. It is not essential to the document, but it explains a method of evaluation and assessment that could be used if needed in the future.**

5) On page 135, it appears that the wasteload allocations for the Lost River Hatchery and the Mackay Fish Hatchery have been set at zero. This means that they will not be allowed any discharge to the receiving water, period. This doesn't seem possible. While it is understood that there are BMPs either planned or in place for these facilities, they will certainly discharge something. You may want to reconsider this.
**Discharge is in regard to solids, not flow. The intent is to reduce the discharge of solids to below detection limits (essentially zero discharge). There has been a litany of complaints about solids discharged into Warm Springs Creek from the Lost River Hatchery since at least 1997. The ranch immediately downstream has to use a suction dredge to remove hatchery sludge from the ditches and troughs on an annual basis. The current NPDES permit is based on the previous permit that should never have been approved by EPA because it didn't incorporate adequate settling capability in the settling pond to attain the discharge limit of 3.4 mg/L. EPA has been notified of the complaints, but has not been able to enforce the existing general NPDES permit after several inspections that should have identified the inadequacy of settling systems. Over the history of operation of this facility fine sediment has accumulated in the channel in sufficient quantities to impair cold water aquatic life, as evidenced by BURP results. Because this condition has been allowed to persist there is no remaining assimilative capacity to identify a lower discharge level that would be protective of water quality, salmonid spawning and coldwater biota. It will take time under very stringent discharge regulation to allow the spring creek to recover its proper function. The Waste Load Allocation will be set to the detection limit of 2 mg/l if that will facilitate EPA enforcement of the NPDES permit that they administer. With improved settling capacity to eliminate discharge of solids EPA will have a clearer threshold to enforce, and prevent further degradation of the stream channel and aquatic life.**

**DEQ has worked with the owner/operator and state Agriculture Department to design a settling pond with adequate efficiency to reduce discharge to less than detection limits. DEQ has applied, through EPA, for an implementation grant to enable the hatchery owner/operator to install the needed structure. EPA has regected this grant and other funding sources will be sought.**

6) There was no discussion of temperature in the wasteload allocations. If these receiving waters are impaired by temperature, they will need a wasteload allocation.
**The riparian habitat adjacent to the hatchery is pristine. It has not been grazed in over 25 years. It serves as a reference condition for the stream below the hatchery. The mechanism to eliminate settleable solids from the stream is a settling pond that will be planted with woody species that will provide shade over time. The majority of temperature loading occurs below the hatchery on private land above the reservoir. Temperature loading in Warm Springs Creek is not identified as an impairment in the TMDL because fish can migrate to thermal refuge. The temperature TMDL is included only because of the exceedance of numerical standards during spawning periods. Temperature loading is minimal at the hatchery due to the flow and residence time of water. The waste load allocation will be set at the state temperature standard with the point of compliance at the hatchery effluent.**

7) Even though it is stressed that streambank erosion is the primary source of sediment to the streams, load allocations should have been considered for other nonpoint sources of sediment such as cropland erosion, irrigation return flows, etc.
**DEQ did consider load allocations for listed/impaired reaches based on existing/obtainable data, observed conditions and land use adjacent to listed reaches. Load allocations were based on erosion inventories that did not identify other significant nonpoint sources in relation to streambank erosion. Irrigation return flow to surface waters is practically nonexistent and cropland is minimal along listed reaches above the reservoir. Where irrigated pasture occurs adjacent to listed reaches the issue is streambank erosion notirrigation return flow.**

8) In setting the load allocations for temperature found in Table 51, page 136, the highest recorded temperature was compared to the standard criteria and a load reduction was given, it seems a bit simplistic for a watershed of this size. More specific heat source identification and a load given in heat energy unit may have been appropriate.
**Idaho temperature standards are not expressed in heat energy units. The TMDL is written to meet state water quality standards for temperature. Temperature based TMDLs take into account shading and channel geometry. Given the fragmented nature of flow in this watershed the scale of the watersheds where temperature load allocations were made is smaller than watersheds, like the Pahsimeroi River, that have been approved using the same methodology. This type of load allocation meets all of the TMDL requirements that have been set forth by EPA. Additionally, implementation efforts are a better use of heat loading in energy units to evaluate the effect of channel geometry and shade to guide selection of best management practices, particularly given the associated error of this methodology. DEQ feels it is important to retain that flexibility for Designated Management Agencies to determine implementation strategy based on available best management practices. Lack of coordination by EPA with federal land management agencies regarding TMDL responsibilities drastically limited the amount of time available to develop the temperature TMDLs. Federal agencies refusing to submit requested riparian and water quality data to hinder TMDL development is not a tactic that will be rewarded by DEQ.**

## BLM General Comments Received April 12, 2004

1) For mixed-ownership stream reaches with load allocations, expectations are unclear whether lands with Federal ownership will be expected to provide recovery similar to that which is expected of private land owners, or if greater efforts are expected on public lands.
**Please refer to Section 313 of the Clean Water Act. It essentially says that federal agencies have to follow federal law…TMDL implementation is not optional for public land management agencies. TMDL implementation is on a voluntary and cooperative basis on private land. Federal land managers must meet state and federal water quality standards on land that they manage. In the few cases where BLM manages land downstream of private ownership it is apparent that water quality conditions at the upstream boundary are outside of the influence of the BLM management. Management here should foster optimal riparian conditions for streambank stability and solar shading to the extent possible. If it is determined through implementation monitoring that attaining prescribed load reductions is not possible due to loading on private land then the TMDL can be ammended . This option would not be explored prior to implementation efforts on private and federal land by designated management agencies, which include the Soil Conservation Commission and the respective land management agencies.**

**Additional laws that govern federal land management include NEPA, Taylor Grazing Act of 1934, Federal Land Policy and Management Act of 1976, and The Public Range Lands Improvement Act of 1978.**

2) The BLM suggests a subbasin-wide map of a larger scale. Due to the size of the subbasin, this may require a fold out page. The subbasin-wide map should also include general land ownership: National Forest, Public Lands, and private lands. Colors should be more distinct on the subbasin unit maps; on many maps the critical difference between blue and green is indistinct. Increased line width to identify items might be a better choice than closely related colors. The subbasin unit maps also need either township or range, or other locating device. From pages 16 through 61, pages 79 through 82, and page 107, seek to put the map figure on the same page as the description. The current spacing and page breaks in this section easily confuse the reader.
**The subbasin-wide map of a larger scale that you refer to describes the BLM issued Surface Management Status maps. To re-create these maps is outside of the scale of this document. Perhaps BLM could supply 50 administrative copies of this map to distribute to readers. Description based on stream confluence is adequate to identify reaches that have load allocations. When BLM develops a specific Implementation Plan document then perhaps use of the Surface Management Status 30X60 minute quadrangle maps can be employed. Map figure references will be added to figures where needed.**

3) The BLM questions whether an "additional margin of safety" (page 132 and 137) is appropriate in the assigned temperature load reductions.
**A Margin of Safety (MOS) is required under the Clean Water Act for load allocations relating to particular pollutant loads. It is necessary to identify the margin of safety related to temperature standards, and the margin of safety related to temperature standards specific to spawning periods. The MOS identified as additional is still part of the overall margin of safety and helps assure that reasonable efforts will be made to meet temperature standards**

**during the transition into the spawning period when temperatures are warmest. In BLM's favor DEQ did not extend the spring spawning period until the middle of July for cutthroat, or begin the spawning period on the first of September for brook trout. Using the entire cutthroat spawning period could be an additional MOS that may be considered if implementation projects are not adequate to improve riparian conditions and channel geometry to effectively reduce stream temperatures.**

4) Although the temperature TMDL criteria apparently is based on salmonids other than bull trout, the issue of whether or not bull trout are or were extant within the Big Lost subbasin was raised. While Bailey and Bond (1948) and Overton (1977) believe they identified bull trout or bull trout hybrids within the Big Lost system, researchers at the 2002 Sinks Symposium, including Bart Gamett of the US Forest Service, believe bull trout are not and were not extant in the Big Lost subbasin. Please refer to written comments on the Big Lost TMDL supplied by Bart Gamett regarding bull trout absence in the Big Lost.
**The Forest Service did not submit comments on this TMDL. Citations of Bailey and Bond (1948) and Overton (1977) are of fisheries literature that has been published. In the Sinks Symposium Proceedings Dr. Robert Behnke of Colorado State University made the statement that based on records of distribution…only the shorthead sculpin *Cottus confusus*, mountain whitefish *Prosopium williamsoni*, and Paiute sculpin *C. beldingi* appear to be native to the Big Lost River. Dr. Behnke went on to say, however, that "Introductions by humans, deliberate and accidental, recorded and unrecorded over the past 120 years adds to the difficulty of any attempt to make a definitive determination of the native fish fauna of the Sinks Drainages.**

**In the process of listing bull trout as a threatened species the Fish and Wildlife Service did not include the Big Lost River watershed in its recovery plan or list of critical habitat because it was accepted that bull trout were not currently present in the Big Lost watershed. DEQ will add the paraphrased statement by Dr. Behnke, and the FWS designation to the fisheries section of the Big Lost River Subbasin Assessment and TMDL. DEQ is not trying to make a case one way or the other, but simply citing available literature and submitted data.**

5) In the unit description of the Upper Big Lost River page 27, it is noted, "Grazing occurs throughout the Subbasin with no identifiable riparian-directed grazing management or best management practices on public or private land." Since mid-1997, Public Lands grazing activities in Idaho have been required to comply with the Idaho Standards for Rangeland Health and Guidelines for Livestock Grazing Management. Challis Field Office Resource Management Plan (1999) standards are applied to grazing permits through the NEPA process. While drought has been a serious problem for three of the six summer seasons since the Standards and Guides were issued, rangeland practices have made improvements on Public Lands riparian areas in the Big Lost subbasin.
**While compliance with the Idaho Standards for Rangeland Health and Guidelines for Livestock Grazing Management, the Challis Field Office Resource Management Plan, and the NEPA process imply rangeland management improvement there is no specific consideration given to riparian management or water quality concerns beyond residual stubble height. Stubble height management has not been shown to be a meaningful recovery**

**strategy when applied to areas already over utilized. Guidelines for riparian recovery identify resting periods in excess of the period of time since mid-1997. Observations during the development of this subbasin assessment revealed numerous areas that were not in compliance with residual stubble height standards. Numerous areas observed left residual forage below the standards that you cite. Additionally, no data was submitted to demonstrate the recovery referred to as improved grazing practices. It does not appear that drought conditions have altered grazing practices for the purpose of improving riparian conditions, though possibly for reducing degradation of rangeland conditions.**

6) The description of Chilly Slough on page 32 should also address the cooperative habitat conservation efforts of The Nature Conservancy, Idaho Fish and Game, the BLM, US Fish and Wildlife Service, Rocky Mountain Elk Foundation, and Ducks Unlimited in Chilly Slough. Public lands in the Chilly Slough area are managed for wildlife and recreation. Wetland fencing is an important part of management of Public Lands in Chilly Slough.
**DEQ sent information request letters to all of the agencies you mention including The Nature Conservancy in November 2002. The type of information that you provide in your comment was specifically requested of each of the agencies. No information was provided related to Chilly Slough or cooperative habitat conservation efforts or pollution control efforts.**

7) The description on page 38 of recreation opportunities on Public Lands at Mackay Reservoir should be changed to reflect the following: The BLM manages one campground and no boat ramps at Mackay reservoir.
**This change will be made to the document.**

8) On page 53, the description of the White Knob Mining District should also include mention of historic mining on Public Lands in the area.
Historic mining practices on public lands in the White Knob mountains is mentioned under the Geology section, in the History section and the last sentence in the second paragraph on page 53.

9) The discussion on page 64 of Big Lost history should mention the beaver eradication policy of the Hudson Bay Company in contested areas such as east central Idaho. The complete removal of beaver by HBC and the Missouri Fur Company in the early 19$^{th}$ century would have had severe impacts on streams in the Big Lost. The "little took place", describing the time period between the trapping era in the Big Lost and the advent of settlers and miners, should be removed Lewis and Clark explored Idaho but did not "discover" Idaho.
The severe impacts to streams come from elevated sediment supply combined with the lack of beaver. During the period of market trapping sediment supply would have been considered at levels of natural background prior to exacerbation of sediment supply from grazing, mining, cultivated agriculture, urban development and timber harvest. These are the severe impacts to streams that precipitate the statement that "little took place" during the period following Lewis and Clark's exploration and subsequent development of market fur trade. The discussion of history refers to the discovery of the area by Lewis and Clark, not the outward discovery of the area. The Lewis and Clark expedition was referred to as the Corps of Discovery. It's relative. They gave Euro-Americans the first descriptions of many plants, animals, birds, rivers, and what the Rocky Mountains were like. Some animals discovered include grizzly bears, bison (which had lived in the east long before), prairie dogs, bighorn sheep, pronghorn antelope, magpies, Clark's nutcracker and

Lewis's woodpecker. Plants discovered include bitterroot, camas, and wapato, all root vegetables that Indians used as easterners used potatoes. The captains also made careful notes about the Indian nations they met, describing how they lived and some of their beliefs, along with some of their language.

10) On page 66, in the discussion of land use, please add that 16% of the subbasin is Department of Energy land. Viewing the map of land ownership on page 67 it appears that private lands are greater than 2% of the subbasin. Please check this figure.
**Land ownership within the Big Lost River watershed was calculated by the University of Idaho from established GIS coverages, and private land actually represents 1.7%, but for the convenience of the reader is rounded up to 2%. It is shown on the map and stated in the text and in Table 5 that the Department of Energy ownership is 16%. Land ownership is delineated by Landowner (Private and Public), acres, sq. miles, sq. Km, and percent of total in Figure 5. Land use within the DOE land incorporates rangeland as well as facilities. This will be added to the text on page 66.**

11) In the discussion on page 77 of existing water quality data please include mention of BLM's riparian monitoring: stubble height, greenline, lotic and lentic functionality, woody browse, and streambank alteration. BLM uses these data to determine when livestock movement from one location to another should occur.
**BLM did not submit any of this data to DEQ to be included in the document. DEQ requested this data in a letter to the BLM Hydrologist in the BLM Challis office on November 22$^{nd}$ 2002. Follow-up discussions about the Data Request Letter and TMDL development after the letter was sent did not result in submission of the data that you refer to above to DEQ.**

12) On page 84, the Figure 71 description does not match the title on the graph. There is also no narrative for this graph.
**The description will be changed to show that the data is from the gage just above the Reservoir.**

13) In the section on Water Column Data, pages 87 through 102 please note what the yellow highlighting identifies. Please also identify which data were measured on the ground and which were inferred from infrared aerial photos. For charts noting "spring" and "fall" data collection, please give the actual dates of data collection.
**Text will be added to show that the yellow highlighting identifies exceedance of water quality standards for temperature in 10% or more of the observances. There was no data inferred from infrared aerial photos. There is no mention of use of infrared aerial photos for interpreting temperature in the document. Forward Looking Infrared temperature data was collected, but was not used in setting temperature loads. The actual dates of data collection are identified for spring and fall under the column titled _**Sample Period.**_**

14) On page 101, nutrient data was identified as being collected "at the same time" as the water column metals data, but the dates in the tables do not reflect this.
**Table 32 is titled USGS water column data pertaining to water quality from 1996. This table matches Table 36 that is titled USGS water column data pertaining to nutrients from 1996.**

**The dates match for each sampling event. The same is true of table 33 and 37. The wording: "at this location" will be replaced by "The Howell Ranch" on page 101.**

15) On Table 41, page 104, please spell out the names of the ranches.
Ranch names will be included in the table: LR Ranch is Lost River Ranch, BR is Broken River Ranch, and F Ranch is Freeman Ranch.

16) The use of the word "erosive", as used on page 105, should not be used to mean "erodible". "Erosive" denotes a quality of an agent of erosion, where "erodible" describes a quality of a material being eroded.
**Erosive will be changed to erodible in this application of the term on page 105, top paragraph.**

17) Page 107 through 112: The bar colors do not match the legend colors on some of the fish frequency histograms.
**This is an artifact of printing we will watch for this when the final document is printed. Reference to the fish data in the text, combined with the different patterns retains the full information in these figures.**

18) On page 115, the numbers look too high for two flow measurements of Twin Bridges Creek, Table 51. Are flows on all the tables in units of cfs?
**Those flows are correct as written on those dates for those locations. June 21, 1995 can often be during the peak of spring runoff. The units are cfs and the tables will be edited to reflect this.**

19) Regarding reference to Thousand Springs Creek riparian grazing on page 118: Are the mentioned degraded conditions south of Chilly Slough? Public Lands along Thousand Springs Creek within the slough area are fenced to exclude livestock and are not within a grazing allotment.
**The text discussion describes conditions below Trail Creek Road, and Below Chilly Slough, as stated. That would be south of Chilly Slough. No pollution prevention data such as riparian fencing or monitoring was provided to DEQ by BLM as a result of the data request submitted to the BLM hydrologist in Challis. The season-long wetland/wet meadow grazing observed in both years during the development of the Subbasin Assessment must have occurred on private land, according to your comment.**

20) On page 122,-second paragraph: Please note that the BLM does monitor riparian condition on streams within allotments and uses those data to guide management of riparian grazing.
**Noted. See 3$^{rd}$ sentence in comment response 19.**

21) On page 124, the table needs footnotes to explain the abbreviations used in the Effluent column.
**The abbreviations and acronyms used in Table 55 on page 124 are described in the Abbreviations, Acronyms, and Symbols section on page xiii in the front of the document with the exception of: d (day) mo (month). These abbreviations will be added to this section. TSS is covered in the Glossary section on page 163. Colony Forming Units (cfu) will be added to the glossary under the definition for coliform bacteria and to the list of abbreviations and acronyms.**

22) In the Data Gaps section, pages 125 through 126, there are comments that are not specific to identification of data gaps. Please either delete the comments or provide citations for the comments made in this section.
**This statement is intended to demonstrate that lack of assimilated riparian data is not considered a data gap. Data has been collected on streams managed by the Forest Service, but not analyzed, and/or not used to guide management, or data was not submitted when requested. Yet grazing in riparian habitat that is already degraded continues as if data were actually used to guide management. The erosional conditions that were observed in the development of this document can not be said to be improving, nor can it be said that riparian management is guided by data. Not using available data does not constitute a data gap.**

23) The BLM has programs to monitor streambank stability and instream temperature. However, McNeil core sampling of subsurface sediment has not been part of our monitoring protocol. The BLM protocol for monitoring instream sediment is the modified pebble count described in Bauer and Burton (1993), which is less disturbing to the substrate. It is unclear whether, as part of IDEQ's TMDL requirements on page 131, the BLM is being instructed to monitor subsurface sediment through the use of a McNeil protocol. Please clarify.
**DEQ and the Forest Service monitor subsurface sediment because it is a direct indicator of spawning success (or egg/fry mortality). There is no correlation between surface fines monitored by Wolmann Pebble counts and subsurface sediment monitored by McNeil sediment core samples. Surface fines may give an indication of cobble embeddedness, however to truly evaluate potential for spawning success in salmonid species temperature and subsurface fine sediment must be examined. Disturbance of substrate on the scale of the McNeil sediment core sampling methodology (12 inch diameter X 4 inches deep X 3 replicates) is minimal and inconsequential to the wellbeing of the stream compared to the data that it renders about the effectiveness of land management. It should primarily be used in monitoring that will follow implementation of BMPs that are identified in the Implementation Plan that will be developed by federal land management agencies as required by the federal Clean Water Act. BLM may opt to not use McNeil sediment core sampling to demonstrate BMP effectiveness, but it will be inconsistent with other monitoring and should be justified in the BLM Implementation Plan.**

24) On page 131 IDEQ states, "An adaptive management approach will be used to provide reductions in sediment loading based on best management practice (BMP) implementation coupled with data from monitoring to determine the loading rate at which beneficial uses are supported." What is the estimated timeframe on this adaptive management process?
**An Implementation Plan document will be required within 18 months of approval of the TMDL. The Implementation Plan will identify Best Management Practices that will be initiated by land management entities to effect temperature and sediment load reductions. Implementation is expected to be completed within 10 years of TMDL approval. Implementation monitoring will be conducted as outlined in the Implementation Plan, and will show reduction of pollution loads and status of Beneficial Use Support and compliance with numeric water quality standards. The timeline for restoring beneficial uses will depend upon the adequacy of the Implementation Plan but should not exceed 15 years from completion of implementation projects. Implementation monitoring will determine if implementation projects are adequate to restore beneficial uses, as stated on page 131, and compliance with numeric water quality standards.**

25) It is not clear what is indicated by the "implicit margin of safety" and the "additional implicit margin of safety" identified on page 132, and the "additional margin of safety" identified on page 137.
**The Margin of Safety can be explicit, such as an additional 5% reduction from the load capacity, or it can be implicit, such as selecting the highest observed temperature during the evaluation period to set the load reduction. Margin of Safety is cumulative and explicit or cumulative and implicit. MOS can be compounded to achieve an additional MOS. The MOS is required in the federal Clean Water Act and must demonstrate that uncertainty in the load allocation is compensated for to insure restoration of beneficial uses.**

26) The table on page 136 would be clearer if there was a column identifying "Tons per mile per year".
**EPA requires that the current load be explicitly stated. Tons per mile per year for each of the loads identified in the table on page 136 appear in table 61 on page 141. This representation of the erosion rate facilitates comparison between reaches and between reductions.**

27) Seasonal variation as calculated by WEPP from the 30-year climatic and hydrologic events, discussed on page 138, represents an average year's runoff and sediment delivery. The 30-year climatic and hydrologic record, however, does not include the full range of potential events, and modeling based solely on these data would give a rate that is substantially less than the actual erosion rate. The probability distribution of sediment delivery is skewed to the right, with infrequent large events that are orders of magnitude greater than frequent events.
**In cases where greater than 30-year climatic data is available for affected reaches it would be used. However, if sediment load reduction is optimized for the 30-year event it is likely that the overall load reduction would be adequate to effect a dramatic reduction in sediment loading. Perhaps when BMPs are adequate to address the 30-year probability curve there will be sufficient improvement to assess whether the 50-year probability is significant.**

28) In the "Reserve" section on page 138 the phrase "within a reasonable time" is mentioned in reference to the non-attainment of full beneficial use. Please define the timeframe.
**Please refer to the response to comment 24 above.**

29) Research papers that are mentioned in the text but not listed in the References Cited, pages 144 through 146, are: Overton et al (1995), Hubbs and Miller (1948), and Bailey and Bond (1963).
**Those references will be added to the Literature Cited section.**

## Non-Agency Comment on Big Lost River Subbasin Assessment and TMDLs Received 2/29/04

In my opinion, there has not been enough data for a long enough time period to suggest Total Maximum Daily Loads should be imposed upon any of the Big Lost River Drainage. Most of the temperature data has been obtained only for the last couple of drought years, and of course the temperatures have been higher. If the data were correlated to % of normal precipitation for the year, I think it might be revealed that during "normal precipitation" years, the temperatures are acceptable. During drought years, the riparian areas are hit just as hard as the surrounding areas, and vegetation dries up and dies, just as the vegetation throughout the valley has done! I have lived in this valley for 18 years now, and we have been mostly in a drought cycle that time, with only a few years out of 18 with "normal" precipitation, and even then there have been "floods". The valley has had a tough time for this entire period, and imposition of administrative rules to try to control stream bank erosion, when it really has been "nature" itself to blame does not provide benefit to anybody or anything.
**Temperature data includes data from 1999. Figure 1 shows the relative precipitation summary from 1996 through 2003. There was some spawning temperature exceedance in 1999, which had the highest precipitation of the 5 most recent years. The TMDL court settlement does not provide for sampling only during the most optimistic years, and TMDLs do not include data in exceedance of the 10 year 90$^{th}$ percentile of climatic maxima. Riparian vegetation condition and channel geometry should be adequate to buffer stream temperatures in years with above average temperature and below average precipitation if these areas are properly managed. There is no evidence that riparian management has been given increased consideration by land management agencies during periods of climatic extremes to offset impacts to water quality.**

Use of the terms, "over allocated" and "overgrazed" with regard to water resources and cattle numbers is subjective and inflammatory, since nobody can predict the amount of water or grass available during these drought years.
**Over allocation and overgrazing have been well documented in this watershed for many years. Evaluation of streambank conditions show this.**

Fish populations remain at "fishable" levels primarily due to hatchery planting. Adding screens across diversions would obviously help with fish numbers, but almost certainly would not be cost effective. The only "true" native fishes in the Big Lost River are the mountain whitefish and the sculpin, so all the fish studies are for introduced fish species, anyway. There is a reason there historically were no trout, they cannot make it in this drainage without human intervention.
**TMDL regulations require protecting fishery resources that were in place in the late 70's (November 1975). There are self sustaining populations of salmonids in the watershed, and it is clear that there could be improvement in fisheries resources with improved land management. Relying on planted fish to sustain fisheries is not cost effective or desirable.**

I am in favor of doing what we reasonably can to maintain and improve our valley and in particular our river and streams, but we need to make sure we don't create more economic problems than we solve. Fencing cattle away from stream banks is always helpful to the riparian areas, but fences are expensive and wildlife like the streams as well, and can sometimes be even worse than cattle.

**There are grants available to implement best management practices that require minimal cost sharing. TMDL implementation is voluntary on private lands. Areas in the Big Lost River where wildlife have had a comparable impact on riparian vegetation or streambank stability on a scale observed from other land management uses have not been identified.**

# Appendix F. BURP and Fish Data

Streams in the Big Lost River watershed that are perennial are presented for their relevance to fisheries and water quality. Water quality data that is available for evaluation in this subbasin assessment includes Beneficial Use Reconnaissance Project data collected by the Idaho Department of Environmental Quality. Scores are in SMI and SHI format where available, otherwise are presented in the older MBI and HI format. Temperature data and fisheries data collected by the Forest Service, and fisheries data collected by the Idaho Department of Fish and Game are also presented. The objective of evaluating the data is to determine if streams are fully supporting designated or existing beneficial uses that include coldwater aquatic life and salmonid spawning. Streams that are ephemeral or have flow less than 1 cfs throughout the year are not evaluated as part of the Subbasin Assessment or with regard to narrative water quality standards.

## East Fork Big Lost River BURP and Fish Data

**East Fork Big Lost River BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 300 m above N. Fk. Big Lost River | | N/A | N/A | Too High to Sample | 8/1/95 |
| 1.75 mi. above Wildhorse | | N/A | N/A | 56.4 | 8/14/01 |
| At Confluence of Starhope | | N/A | N/A | Too High to Sample | 7/31/95 |
| 400 m above Corral Cr. | 039_03 | 1 | 1 | 33.26 | 7/3/95 |
| 1 mi. above Smelter Canyon Cr. | 039_02 | 0 | 3 | 49.08 | 7/5/95 |

East Fork Big Lost River Fish Data: 8/13/03 1 mi. above Smelter Canyon Cr. confluence (just below Swamps)

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 96 | 100 | 167.8 | 50 | 275 |
| Cutthroat | | | | | |
| Other | | | | | |

East Fork Big Lost River Fish Data: 8/13/03 above Burma Rd. Bridge

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 33 | 17.6 | 264.5 | 130 | 330 |
| Brook | 154 | 82.4 | 120.1 | 45 | 285 |
| Cutthroat | | | | | |

East Fork Big Lost River Fish Data: 8/13/03 1 mi. below Starhope Creek (overlapping Fox Cr. confluence)

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 5 | 22.7 | 286.0 | 165 | 300 |
| Brook | 14 | 63.7 | 152.1 | 65 | 210 |
| Cutthroat | 3 | 13.6 | 430.0 | 210 | 410 |
| Other | | | | | |

East Fork Big Lost River Fish Data: 8/13/03 0.5 mi. above Willow Creek (below private inholding)

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 34 | 81 | 173.7 | 110 | 255 |
| Brook | 7 | 17 | 182.9 | 140 | 215 |
| Cutthroat | 1 | 2 | 335.0 | 335 | 335 |
| Other | | | | | |

**Anderson Canyon Creek** BURP Data: 2nd Order

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| At Antelope Pass Road | 039_02 | 1 | 1 | 0.07 | 7/17/96 |
| At Antelope Pass Road | N/A | N/A | N/A | Dry | 8/7/01 |

Fish Data: 7/10/1996

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | | 189 | 189 | 189 |
| Brook | 4 | | 210.25 | 174 | 271 |
| Cutthroat | | | | | |
| Other | | | | | |

**Newton Creek BURP Data: 1st Order**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| ¼ mi. above E. Fk. Big Lost River | 033_02 | 3 | 1 | 0.32 | 7/1/98 |

**Coal Creek BURP Data: 1st Order**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| At Copper Basin Rd. | 039_02 | 3 | 1 | 0.42 | 7/1/98 |

Coal Creek Fish Data: 7/8/1996

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 35 | 100 | 107.7 | 32 | 206 |
| Cutthroat | | | | | |
| Other | | | | | |

**Cabin Creek BURP Data: 1st Order**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| Upstream of FS Rd 142 Bridge | 040_02 | 2 | 1 | 4.81 | 7/18/96 |
| Upstream of FS Rd 142 Bridge | N/A | N/A | 84 | 3.76 | 7/1/98 |

Cabin Creek Fish Data: 7/15/1996

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 46 | | 88.1 | 71 | 208 |
| Brook | 43 | | 107.6 | 67 | 246 |
| Cutthroat | | | | | |
| Other | | | | | |

**Pole Creek BURP Data: 1st Order**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| .3 mi above confluence | 02 | 2 | 1 | 0.431 | 9/12/96 |

Pole Creek Fish Data: Pole Creek. No fish collected

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |

**Deer Creek BURP Data: 1st Order**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi above E.Fk Rd. | 02 | 3 | 1 | 0.43 | 9/12/96 |

Deer Creek Fish Data: 7/7/97

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 10 | 100 | 148.8 | 69 | 207 |
| Cutthroat | | | | | |
| Other | | | | | |

**Rider Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 0.35 miles above E. Fk. Road | 02 | 3 | 1 | 0.387 | 9/12/96 |

Rider Creek Fish Data: 7/7/97 No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Little Boone Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | Habitat Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 1 m above E. Fk. Rd. | N/A | N/A | N/A | .043 | 8/13/01 |
| 0.4 mi above E.Fk. Rd. | N/A | 0 | 1 | 0.44 | 7/17/96 |

Little Boone Creek Fish Data: 7/7/97 No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Boone Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| Not Assessed | | | | | |

Boone Creek Fish Data: 7/22/97

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 8 | 72.73 | 157 | 82 | 205 |
| Brook | 3 | 27.27 | 109.3 | 53 | 149 |
| Cutthroat | | | | | |
| Other | | | | | |

**Boone Creek: East Fork BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| Not Assessed | | | | | |

East Fork Boone Creek Fish Data: 7/22/97

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 1 | 3.7 | 200 | 82 | 205 |
| Brook | 3 | 96.29 | 67.6 | 35 | 212 |
| Cutthroat | | | | | |
| Other | | | | | |

**Fox Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 0.65mi above E.Fk. Rd. | 034_02 | 3 | 1 | 2.29 | 7/17/96 |
| 1m above E.Fk. Rd. | | | | 0.07 | 8/13/01 |

Fox Creek Fish Data: 7/8/96

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 2 | 66 | 143 | 130 | 157 |
| Brook | 1 | 33 | 164 | 164 | 164 |
| Cutthroat | | | | | |
| Other | | | | | |

**Road Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| | 02 | 1 | 1 | 0.26 | 7/17/96 |

Road Creek Fish Data: No Fish Data: Road Creek

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |

**Star Hope Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| At Bear Cr. | | 4.62 | 102 | 3.3 | 7/12/94 |
| At Ramey Cr. | | 4.29 | 82 | 31.8 | 7/13/94 |
| At Broad Canyon Cr | N/A | N/A | N/A | 14.8 | 8/13/01 |
| At Ramey Cr. | N/A | N/A | N/A | 22.7 | 8/20/01 |

Star Hope Creek Fish Data: Date: 7/18/96 2.9 mi. above Copper Basin Loop Rd on Starhope Canyon Rd.

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 3 | 100 | 212 | 206 | 222 |
| Cutthroat | | | | | |
| Other | | | | | |

Star Hope Creek Fish Data: Date: 7/18/96 0.6 mi below Starhope Campground

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 3 | 100 | 103.3 | 83 | 137 |
| Cutthroat | | | | | |
| Other | | | | | |

Star Hope Creek Fish Data: Date 8/14/03 0.6 mi below Starhope Campground

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 147 | 91 | 129.3 | 49 | 222 |
| Cutthroat | 14 | 9 | 277.5 | 93 | 369 |
| Other | | | | | |

Star Hope Creek Fish Data: Date 8/14/03 Above Cow Camp 1.25 mi.

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 1 | | 240 | 240 | 240 |
| Brook | 155 | | 169.5 | 110 | 245 |
| Cutthroat | 13 | | 286.5 | 225 | 415 |
| Other | | | | | |

Star Hope Creek Fish Data: Date 8/14/03 0.25 mi above East Fork Road

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 5 | 83 | 250 | 200 | 290 |
| Brook | | | | | |
| Cutthroat | 1 | 17 | 300 | 300 | 300 |
| Other | | | | | |

**Ramey Creek BURP Data**:

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 0.6 mi. above Forks | 035_02 | 4.25 (MBI) | 95 (HI) | 1.17 | 7/16/96 |
| 50 m below lowest trib. | 035_02 | 3 | 2 | 5.1 | 7/16/96 |
| 1 mi. above Copper Basin Rd. | | N/A | N/A | 1.5 | 8/7/01 |

**Bellas Canyon Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 2 mi. up Rd. | 035_02 | 3 | 3 | 6.8 | 7/16/96 |

**Bear Canyon BURP Data**:

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Starhope Campground | 036_02 | 2 | 3 | 4.4 | 7/17/96 |
| At Copper Basin Rd. | | N/A | N/A | 0.7 | 8/8/01 |

Bear Canyon Creek Fish Data: DEQ data:

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 10 | 100 | 147.9 | 90 | 229 |
| Cutthroat | | | | | |
| Other | | | | | |

**MuldoonCreek** BURP Data:

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 300 m above Green Lake outlet | 037_02 | 3 | 1 | 5.74 | 7/12/94 |
| 40 m above Muldoon Canyon Rd. | 037_02 | 3 | 1 | 11.67 | 7/12/94 |
| At Copper Basin Loop Rd. | | | | 9.49 | 8/8/01 |

MuldoonCreek Fish Data: Date: 7/17/96 300 m above upper Right Fork of Muldoon Creek

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 28 | 100 | 114.42 | 29 | 185 |
| Cutthroat | | | | | |
| Other | | | | | |

MuldoonCreek Fish Data: Date: 7/25/96 . 100 m above Copper Basin Loop Rd.

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 41 | 100 | 129.2 | 42 | 223 |
| Cutthroat | | | | | |

**Broad Canyon Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 25 m below trail head | 036_02 | 3 | 1 | 28.1 | 7/15/96 |

**Lake Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 250 m above Copper Basin Rd. | 038_02 | 3 | 2 | 20.8 | 7/15/96 |
| At Copper Basin Rd. | | | | 3.6 | 8/8/01 |

Lake Creek Fish Data: 7/16/96 .3 mi below Copper Basin Loop Rd.

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 79 | 100 | 97.5 | 27 | 279 |
| Cutthroat | | | | | |
| Other | | | | | |

Lake Creek Fish Data: 7/16/96 300 m above trailhead

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 40 | 100 | 150.4 | 31 | 230 |
| Cutthroat | | | | | |
| Other | | | | | |

Lake Creek Fish Data: 8/6/97 lower meadow

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 35 | 100 | 113.6 | 38 | 190 |
| Cutthroat | | | | | |
| Other | | | | | |

Lake Creek Fish Data: 8/5/97 above Rough Lake

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 35 | 100 | 113.6 | 38 | 190 |
| Cutthroat | | | | | |
| Other | | | | | |

**Steve Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| At Copper Basin Road | 039_02 | 0 | 2 | 3.51 | 7/2/98 |

Steve Creek Fish Data: Date 7/10/96

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 5 | 100 | 166.6 | 145 | 194 |
| Brook | | | | | |
| Cutthroat | | | | | |

**Wild Horse Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| Left Fork above confluence | 031_02 | 1 | 1 | 1.5 | 9/11/96 |
| 100 m above Fall Cr. Bridge | 031_02 | 1 | 1 | 23.7 | 7/13/94 |
| 100 m above Fall Cr. Bridge | | N/A | N/A | 15.35 | 8/14/01 |
| 0.25 mi below forks | 031_02 | 2 | 1 | 14.8 | 7/13/94 |

Wild Horse Creek Fish Data: 7/12/96 1.1 mi. above campground

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 7 | 100 | 125.6 | 20 | 278 |
| Cutthroat | | | | | |
| Other | | | | | |

Wild Horse Creek Fish Data: 7/12/96 1.8 mi. above campground

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 3 | 100 | 205 | 166 | 255 |
| Cutthroat | | | | | |
| Other | | | | | |

Wild Horse Creek Fish Data: 7/15/96 1 mi. above guard station at Burnt Aspen Creek.

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 1 | 100 | 150 | 150 | 150 |
| Cutthroat | | | | | |
| Other | | | | | |

Wild Horse Creek Fish Data: 8/14/03 above campground

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 1 | 1 | 195 | 195 | 195 |
| Brook | 75 | 99 | 115.2 | 45 | 260 |
| Cutthroat | | | | | |
| Other | | | | | |

Wild Horse Creek Fish Data: 8/14/03 above guard station at Burnt Aspen Creek

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 4 | 50 | 216.25 | 130 | 260 |
| Brook | 4 | 50 | 176.25 | 140 | 205 |
| Cutthroat | | | | | |
| Other | | | | | |

**Bailey Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 500 m above Wildhorse Rd. | 030_02 | 1 | 1 | 4.23 | 7/1/98 |

**Burnt Aspen Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | HBI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 500 m above Wildhorse Rd. | 030_02 | 3 | 3 | 4.23 | 7/1/98 |

Burnt Aspen Creek Fish Data: No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Fall Creek BURP Data:**

| BURP Site Location | Assessment Unit | MBI Score | HI Score | Flow (cfs) | Date Sampled |
|---|---|---|---|---|---|
| 0.35 mi. above Wildhorse Rd. | 032_02 | 4.26 | 90 | 9.5 | 9/11/96 |
| 0.35 mi. above Wildhorse Rd. | 032_02 | N/A | N/A | 21.8 | 8/14/01 |

Fall Creek Fish Data: 7/24/96 below forks

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 2 | 100 | 164 | 50 | 278 |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

Fall Creek Fish Data: 7/24/96 below first bridge on Moose Lake trail

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 1 | 25 | 167 | 167 | 167 |
| Brook | 3 | 75 | 209.3 | 170 | 243 |
| Cutthroat | | | | | |
| Other | | | | | |

Fall Creek Fish Data: 8/14/03 0.25 mi. above Wildhorse Creek

| Species | Total Captured | Percent Composition | Mean Length(mm) | Minimum Length(mm) | Maximum Length(mm) |
|---|---|---|---|---|---|
| Rainbow | 7 | 35 | 206.4 | 130 | 260 |
| Brook | 13 | 65 | 173.1 | 80 | 235 |
| Cutthroat | | | | | |
| Other | | | | | |

## North Fork Big Lost River BURP and Fish Data

**North Fork Big Lost River** BURP Data:

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi below Hunter Cr. | 027_02 | 3 | 2 | 2.3 | 9/10/96 |
| 0.25 mi above Hunter Cr. | 027_02 | 4.41 (MBI) | 112 (HI) | 4.7 | 9/10/96 |

North Fork Big Lost River Fish Data: 11/27/96 at mouth of Squib Canyon

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 5 | 100 | 149.4 | 82 | 205 |
| Cutthroat | | | | | |

North Fork Big Lost River Fish Data: 11/27/96 .65 mi. above Jim Canyon

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 4 | 17.4 | 219.25 | 202 | 244 |
| Brook | 19 | 82.6 | 121.16 | 73 | 87 |
| Cutthroat | | | | | |
| Other | | | | | |

North Fork Big Lost River Fish Data:7/30/96 1 mi. above Hunter Creek at Road crossing

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 6 | 100 | 143.7 | 68 | 215 |
| Cutthroat | | | | | |
| Other | | | | | |

North Fork Big Lost River Fish Data: 8/13/03 mouth of Squib Canyon

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 7 | 165 | 165 | 165 |
| Brook | 13 | 93 | 130 | 60 | 215 |
| Cutthroat | | | | | |
| Other | | | | | |

North Fork Big Lost River Fish Data: 8/13/03 .25 mi. below Burnt Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 7 | 24 | 152 | 120 | 240 |
| Brook | 22 | 76 | 140 | 70 | 210 |
| Cutthroat | | | | | |
| Other | | | | | |

North Fork Big Lost River Fish Data: 8/13/03 0.25 mi. above Deep Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 13 | 59 | 156.5 | 55 | 285 |
| Brook | 9 | 41 | 120.5 | 75 | 175 |
| Cutthroat | | | | | |
| Other | | | | | |

**Bartlett Creek BURP Data: 1$^{st}$ order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Just Above Forest Rd | 027_02 | N/A | 127 (HI) | 19.69 | 7/1/98 |

Bartlett Creek Fish Data: 8/5/96 just above forest road

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 19 | 100 | 90.6 | 34 | 165 |
| Cutthroat | | | | | |
| Other | | | | | |

Bartlett Creek Fish Data: 8/11/97 1 mi above N. Fk. Rd. No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Bear Creek BURP Data: 1st order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Squib Rd | 027_02 | 2 | 3 | 1.37 | 9/4/96 |

**Chicken Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 300 m above N. Fk. Rd.. | 027_02 | 3 | 1 | 0.8 | 8/27/96 |

Chicken Creek Fish Data: 7/31/96 450 m above N. Fk. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 3 | 37.5 | 116 | 72 | 171 |
| Brook | 5 | 62.5 | 158 | 116 | 207 |
| Cutthroat | | | | | |
| Other | | | | | |

**Corral Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 700 m above N. Fk. | 027_02 | 2 | 2 | 0.41 | 9/4/96 |

Corral Creek Fish Data: 8/2/96 250 m above N. Fk.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 1 | 100 | 201 | 201 | 201 |
| Cutthroat | | | | | |
| Other | | | | | |

**Grasshopper Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.2 mi above N. Fk. Rd. | 027_02 | 3 | 1 | 0.34 | 8/26/96 |

Grasshopper Creek Fish Data: 7/30/96 150 m above N. Fk. Rd. No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Horse Creek BURP Data: 1st order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi. above N. Fk. Rd. | 027_02 | 3 | 1 | 0.51 | 8/26/96 |

Horse Creek Fish Data: 7/30/96 300 m above N. Fk. Rd. No Fish collected

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Hunter Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.2 mi. above N. Fk. Confluence | 027_02 | 2 | 2 | .49 | 9/5/96 |

Hunter Creek Fish Data: 7/30/96 0.2 mi. above N. Fk. confluence

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 3 | 100 | 85 | 81 | 91 |
| Cutthroat | | | | | |
| Other | | | | | |

**Miller Canyon Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Near Headwaters | 027_02 | 3 | 1 | 1.2 | 8/27/96 |
| 0.2 mi above N. Fk. Confluence | 027_02 | 3 | 1 | 2.38 | 8/27/96 |

Miller Canyon Creek Fish Data: 300 m above N. Fk. Big Lost River

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 25 | 295 | 295 | 295 |
| Brook | 3 | 75 | 129.6 | 98 | 171 |
| Cutthroat | | | | | |
| Other | | | | | |

**Park Canyon Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi. above N. Fk. Rd. | 027_02 | 3 | 1 | 1.46 | 8/26/96 |

Park Canyon Creek Fish Data: 7/31/96 above 1st culvert on FS Rd. 043 70 m below N. Fk. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 2 | 100 | 77 | 39 | 115 |
| Cutthroat | | | | | |
| Other | | | | | |

**Slide Canyon Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi. above N. Fk. confluence | 027_02 | 3 | 1 | 0.31 | 9/4/96 |

Slide Canyon Creek Fish Data: 7/31/96

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 50 | 272 | 272 | 272 |
| Brook | 1 | 50 | 163 | 163 | 163 |
| Cutthroat | | | | | |
| Other | | | | | |

**Toolbox Creek BURP Data:** 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi. above N. Fk. confluence | 027_02 | 3 | 2 | 0.44 | 8/26/96 |

Toolbox Creek Fish Data: 7/31/96 300 m above N. Fk. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 5 | 100 | 50.4 | 46 | 55 |
| Cutthroat | | | | | |
| Other | | | | | |

**Squib Canyon Creek BURP Data: 1st order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi. above N. Fk. confluence | 027_02 | 3 | 3 | 0.7 | 9/4/96 |

Squib Canyon Creek Fish Data: 8/2/96 15m above FS Rd. 601

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 8 | 100 | 156.6 | 115 | 201 |
| Cutthroat | | | | | |
| Other | | | | | |

**Summit Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Park Creek Rd. | 028_02 | 3 | 1 | 2.2 | 9/6/96 |
| 100 m above Big Fall Cr. | 028_03 | 3 | 1 | 6.2 | 9/6/96 |
| 0.2 mi. below Phi Kappa Cr. | | N/A | N/A | 4.7 | 8/7/01 |
| 0.25 mi above Kane Cr. | 028_03 | 3 | 1 | 7.9 | 9/10/96 |

Summit Creek Fish Data: 8/5/96 at trailhead near summit

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 8 | 100 | 152.1 | 116 | 185 |
| Cutthroat | | | | | |
| Other | | | | | |

Summit Creek Fish Data: 7/25/96 2.5 mi. above Kane Cr.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 35 | 100 | 134.1 | 52 | 214 |
| Cutthroat | | | | | |
| Other | | | | | |

Summit Creek Fish Data: 7/25/96 210 m above Big Fall Cr.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 98 | 100 | 114.8 | 33 | 197 |
| Cutthroat | | | | | |
| Other | | | | | |

Summit Creek Fish Data: 8/13/03 0.1 mi. below Phi Kappa Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 9 | 45 | 164.4 | 110 | 230 |
| Brook | 106 | 55 | 139.6 | 50 | 250 |
| Cutthroat | | | | | |
| Other | | | | | |

**Phi Kappa BURP Data: 1st order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.2 mi. above Summit Cr. | 028_02 | 3 | 2 | 0.65 | 9/5/96 |

Phi Kappa Fish Data: 8/11/97 No Fish Collected.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Kane Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 1 mi. above Summit Cr. | 029_02 | 2 | 1 | 7.8 | 9/11/96 |

Kane Creek Fish Data: 7/26/96 1 mi. above Summit Cr.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 2 | 20 | 231 | 212 | 250 |
| Brook | 8 | 80 | 109.1 | 44 | 182 |
| Cutthroat | | | | | |
| Other | | | | | |

Kane Creek Fish Data: 7/9/97 70 m above Rt. Fk.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 2 | 100 | 72 | 29 | 115 |
| Cutthroat | | | | | |
| Other | | | | | |

Kane Creek Fish Data: 8/13/03

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 2 | 4.5 | 190 | 170 | 210 |
| Brook | 42 | 95.5 | 124.4 | 45 | 230 |
| Cutthroat | | | | | |
| Other | | | | | |

**Little Kane Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Kane Cr. | 029_02 | 3 | 2 | 21.08 | 7/1/98 |

**Big Fall BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.2 mi. above Trail Cr. Rd. | 028_02 | 3 | 1 | 1.7 | 9/12/96 |
| 5m above Trail Cr. Rd. | | N/A | N/A | 06.6 | 8/6/01 |

Big Fall Fish Data: 8/5/96 0.175 mi. above rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 12 | 100 | 100.5 | 31 | 161 |
| Cutthroat | | | | | |
| Other | | | | | |

**Little Fall Creek BURP Data: 1st order**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.55 mi up Little Fall Cr. Rd | 028_02 | 3 | 2 | 1.4 | 9/5/96 |
| At rd xing | | | | Dry | 8/6/01 |

## Upper Big Lost River BURP and Fish Data

**Upper Big Lost River BURP Data:** No BURP Data Available.

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

Upper Big Lost River Fish Data: Date 0.1 mi above Burnt Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 32 | 65 | 158 | 95 | 275 |
| Brook | 5 | 10 | 136 | 75 | 230 |
| Cutthroat | 4 | 9 | 297 | 295 | 300 |
| White Fish | 8 | 16 | N/A | N/A | N/A |

**Burnt Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 150 m above Trail Cr. Rd. | 025_02 | 2 | 2 | 2.73 | 6/30/98 |

Burnt Creek Fish Data: 0.9 mi. above Trail Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 100 | 172 | 172 | 172 |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Twin Bridges Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Just below middle tributary | 026_03 | 0 | 1 | 30.74 | 6/21/95 |
| At Trail Cr. Rd. | | N/A | N/A | No Flow | 8/20/01 |
| At Trail Cr. Rd. | 026_03 | 0 | 1 | 47.2 | 6/21/95 |
| At Trail Cr. Rd. | 026_03 | 2 | 1 | 0.37 | 7/14/94 |

Twin Bridges Creek Fish Data: 6/20/96 immediately below Trail Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 6 | 54.5 | 127.3 | 78 | 196 |
| Brook | 5 | 45.5 | 143 | 103 | 193 |
| Cutthroat | | | | | |
| Other | | | | | |

**Pinto Creek BURP Data**:

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Trail Cr. Rd. | 024_02 | 1 | 3 | 3.93 | 6/30/98 |

Pinto Creek Fish Data: 7/23/96 1.05 mi. above Trail Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 8 | 100 | 115.4 | 74 | 189 |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Rock Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| FS Rd 603 xing | 024_02 | 0 | 1 | 0.03 | 7/14/98 |

**Garden Creek BURP Data:** 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 220m above Trail Cr. Rd. | 025_02 | 0 | 1 | 0.79 | 6/30/98 |

Garden Creek Fish Data: 8/11/97 No fish collected

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Lake Creek BURP Data**: 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 300 m above Trail Cr. Rd. | 025_02 | 2 | 1 | 0.265 | 6/30/98 |

**Deep Creek BURP Data:** 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 60 m above Big Lost | 025_02 | 1 | 3 | 1.31 | 6/30/98 |

**Burnt Creek BURP Data:** 1st order

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 150 m above Trail Cr. Rd. | | 2.77 | 90 | 2.73 | 6/30/98 |

Burnt Creek Fish Data: 8/11/97 0.9 mi. above Trail Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 100 | 172 | 172 | 172 |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Bartlett Creek BURP Data:** 1st order

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 500m above Big Lost confluence | | 3.18 | 127 | 19.69 | 7/1/98 |

Bartlett Creek Fish Data: 8/5/96 Just above Forest Rd. 444

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 19 | 100 | 90.6 | 34 | 165 |
| Cutthroat | | | | | |
| Other | | | | | |

Bartlett Creek Fish Data: 8/11/97 1 mi. above Bartlett Pt. Rd. No Fish Collected

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Grant Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| At Bartlett Rd. Crossing | 024_03 | 1 | 1 | 2.35 | 7/14/98 |

Grant Creek Fish Data: 7/8/97 0.75 mi. above Bartlett Pt. Rd. No Fish Collected.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Chilly Slough BURP Data:** No BURP Data

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |

Chilly Slough Fish Data: 6/25/97 At Whiskey Spring

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 41 | 100 | 51.9 | 40 | 78 |
| Cutthroat | | | | | |
| Other | | | | | |

**Sage Creek BURP Data:** 1$^{st}$ order N. Fork and Main Sage above Corral.

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 1 mi. above Forks | 022_02 | 3 | 3 | 8.16 | 6/29/98 |
| Below Corral Cr. | 022_02 | 3 | 2 | 2.56 | 6/29/98 |
| North Fk. 200m above Forks | 022_02 | 2 | 3 | 2.75 | 6/29/98 |

Sage Creek Fish Data: 6/14/96 at point of diversion: No Fish Collected (no fish collected 7/22 99 by DEQ)

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Bradshaw Creek BURP Data:** 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 80 m above N.Fk SageCr | 022_02 | 2 | 1 | 1.15 | 6/29/98 |

**Lone Cedar Creek BURP Data:** 1st order No BURP Data: Dry

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 10 m below private ranch | 017_02 | | | Dry | 8/15/01 |

Lone Cedar Creek Fish Data: No Fish Data

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Upper Cedar Creek BURP Data:** No BURP Data: Dry

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| At Hwy 93 | | | | Dry | 8/15/01 |

Upper Cedar Creek Fish Data: 6/7/96 No fish collected above diversion

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Lower Cedar Creek BURP Data:** No BURP Data: stream completely diverted at canyon mouth.

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| At Lower Cedar Rd. below private | | | | Dry | |

Lower Cedar Creek Fish Data: 7/2/96 No Fish collected above diversion

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |

**Willow Creek BURP Data:** 1st order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.5 mi. below spring | 020_03 | 1 | 1 | 1.05 | 7/14/98 |

Willow Creek Fish Data: 6/13/96 below forks in Section 33

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 48 | 100 | 138.7 | 44 | 235 |
| Cutthroat | | | | | |
| Other | | | | | |

**Rock Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 2 mi. above Willow Cr. | 019_02 | 2 | 3 | 14.3 | 7/14/98 |

**Warm Springs Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 50 m below Lost River Ranch | 043_02 | 2 | 1 | 36.1 | 8/2/96 |

Warm Springs Creek Fish Data: No Fish Data: multiple year classes of rainbow trout present

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | | | | | |
| Cutthroat | | | | | |
| Other | | | | | |

**Navarre Creek BURP Data:** Main stem, N., W., Middle Forks

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| (main) 0.25 mi. below Forks | 044_03 | 2 | 2 | 11.27 | 7/8/98 |
| (mid)0.8 mi. above Forks | 044_02 | 3 | 3 | 5.97 | 7/8/98 |
| (west) 40 m above Forks | 044_02 | 1 | 3 | 1.34 | 7/8/98 |
| (east)0.5 mi. above main stem. | 044_02 Intermittent | 2.4 (MBI) | 99 (HI) | 2.5 | 7/8/98 |

Navarre Creek Fish Data: 6/1/96 Main Stem at Forest Boundary

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 3 | 100 | 126.3 | 99 | 140 |
| Cutthroat | | | | | |

Navarre Creek Fish Data: DEQ data No fish collected in East or Middle Forks, 1 fish each in main stem and West Fk.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 2 | 100 | 150 | 145 | 155 |
| Cutthroat | | | | | |
| Other | | | | | |

## Antelope Creek BURP and Fish Data

**Antelope Creek BURP Data:** 7/18 sample listed as Cherry Cr. actually Antelope

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.5 mi. below Iron Bog Cr. | 052_04 | 3 | 1 | 13.57 | 7/11/94 |
| 1 mi. below Cherry Cr. | | 4.11 (MBI) | 60 (HI) | 7.90 | 7/18/94 |
| At Hwy. 93 | | | | Dry | 8/15/01 |
| 100 m below Hwy. 93 | | | | Dry | 7/18/94 |
| At Hwy. 93 | Intermittent | 3.45(MBI) | 56 (HI) | 33.73 | 7/20/95 |

Antelope Creek Fish Data: 8/7/96 Antelope Creek Above Horsethief Cr., 0.3 mi. up FS Rd. 574

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 3.45 | 131 | 131 | 131 |
| Brook | 28 | 96.55 | 162 | 36 | 312 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Antelope Creek Fish Data: July 1991: IDFG Data Antelope Creek: location of 6 transects not stated

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 15 | 27 | 208.6 | 58 | 320 |
| Brook | 41 | 73 | 169 | 95 | 286 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Bailey Corral Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Just above Cherry Cr. Rd | 049_02 | 0 | 1 | 0.32 | 7/6/98 |

**Flower Garden Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 80m above Forks | 049_02 | 0 | 1 | 0.68 | 7/6/98 |

**McKey Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 20 m above Cherry Cr. | 049_02 | 3 | 1 | 0.23 | 7/6/98 |

**Bear Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| At Forks | 053_03 | 3 | 3 | 15.3 | 7/2/97 |
| 1 mi. below Forks | 053_03 | 3 | 3 | 11.73 | 7/10/96 |
| 2 mi. above Antelope Cr. | 053_03 | 3 | 1 | 14.6 | 7/10/96 |
| Right Fork 25 m above 2nd Rd xing | 053_02 | 3 | 1 | 14.6 | 7/10/96 |
| Middle Fork 300 m above confluence | 053_02 | 3 | 3 | 11.9 | 7/11/96 |

Bear Creek Fish Data: 8/8/96 2 mi. above Antelope Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1 | 1.85 | 86 | 86 | 86 |
| Brook | 53 | 98.15 | 120.5 | 52 | 230 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Bear Creek Fish Data: 8/8/96 1.1 mi. above Antelope Cr. Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 40 | 100 | 141.0 | 39 | 251 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Cherry Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| L.Fk Cherry, 3mi. above Cherry Cr. | 051_02 | 3 | 1 | 4.93 | 7/11/94 |
| 0.75 mi. above Richardson Canyon | 050_04 | 1 | 1 | 0.08 | 7/11/94 |

Cherry Creek Fish Data: 10/11/96 Left Fork Cherry Creek (largest flow) 1.3 mi. above Antelope Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 56 | 44.8 | 105 | 22 | 243 |
| Brook | 69 | 55.2 | 155 | 73 | 244 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Cherry Creek Fish Data: 8/13/96 Cherry Creek 0.1 mi. above Forest/private boundary

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 72 | 100 | 94.9 | 41 | 251 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Richardson Creek BURP Data:** 1st Order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 250 m above Cherry Cr. | 050_02 | 3 | 3 | 1.33 | 7/6/98 |

**Lupine Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Just above Rt. & L Fks. | 050_02 | 2 | 3 | 1.13 | 7/6/98 |

**Carcass Creek BURP Data:** 1st Order

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 150 m above Lupine Cr. | 050_02 | 0 | 1 | 0.29 | 7/6/98 |

**Iron Bog Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 1 mi. above Antelope Cr. | 054_03 | 3 | 1 | 58.5 | 7/10/96 |
| 100 m above confluence | | N/A | N/A | 6.12 | 8/16/01 |

Iron Bog Creek Fish Data: August 1996 in RNA 2 mi. above Antelope confluence

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 2 | 4.2 | 144 | 98 | 190 |
| Brook | 46 | 95.8 | 124.9 | 34 | 230 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Left Fork Iron Bog Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 1 mi. above Forks confluence | 056_02 | 3 | 3 | 28.03 | 7/9/96 |
| 5 m above Forks confluence | | N/A | N/A | 4.84 | 8/21/01 |

Left Fork Iron Bog Creek Fish Data: 6/25/96 600 m above Right Fork Iron Bog Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 8 | 100 | 154.4 | 85 | 188 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Left Fork Iron Bog Creek Fish Data: 6/25/96 1.75 mi. above campground at upper RNA

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 12 | 100 | 132.6 | 95 | 218 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Right Fork Iron Bog Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 1 mi. above Forks confluence | 055_02 | 2 | 3 | 23.5 | 7/9/96 |
| 5 m above Forks confluence | | N/A | N/A | 4.7 | 8/21/01 |

Right Fork Iron Bog Creek Fish Data: 9/9/96 R. Fk. Iron Bog 50 m above gate at trailhead

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 19 | 100 | 149.6 | 46 | 249 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Smiley Creek BURP Data:**

| BURP Site Location | Assessment Unit | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 500 m above Antelope Cr. | 055_02 | 3 | 3 | 3.68 | 7/9/96 |

**Horsethief Creek BURP Data:**

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi. above Antelope Cr. | 052_02 | 3 | 1 | 5.75 | 7/2/97 |

Horsethief Creek Fish Data: 7/99 DEQ 0.25 mi. above Antelope Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 4 | 100 | 150 | 125 | 185 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Dry Canyon Creek BURP Data:**

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi. above Antelope Cr. | 052_02 | 1 | 1 | 0.052 | 7/2/97 |

**Leadbelt Creek BURP Data:**

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 2 mi. above Cabin Cr. | 047_02 | N/A | Beaver Dams | Not Measured | 7/8/96 |
| 0.5 mi below Cabin Cr. | | N/A | N/A | Dry | 8/21/01 |
| 25 m below Deer Cr. | 047_02 | 3.52 | 63 | 0.68 | 7/8/96 |

Leadbelt Creek Fish Data: 9/9/96 at Beaver complex 200 m above Fish Creek Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 31 | 84 | 57.1 | 36 | 71 |
| Brook | 6 | 16 | 107.8 | 89 | 127 |
| Cutthroat | | | | | |
| White Fish | | | | | |

## Lower Big Lost River BURP and Fish Data

**Lower Big Lost River** Big Lost River BURP Data: 2001 is 4 miles above Moore Diversion

| BURP Site Location | Assessment | MBI Score | Habitat Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| Hwy 93 between Leslie & Darlington | | N/A | N/A | No Flow | 8/15/01 |
| 3.5 mi. below Moore Diversion | | 2.29 | 61 | 83.26 | 8/29/95 |
| Challis Rd. Bridge near Arco | | 1.81 | 48 | 33.85 | 8/29/95 |

Lower Big Lost River Fish Data: 1991 Idaho Fish and Game Data: Near Mackay, ID

| Species | Total Estimated | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 1730 | 85.9 | 285 | 45 | 575 |
| Brook | 284 | 14.1 | 200 | 95 | 370 |
| Cutthroat | | | | | |
| White Fish | 12% of sample | N/A | N/A | N/A | N/A |

Lower Big Lost River Fish Data: 1991 Idaho Fish and Game Data: Near Leslie, ID

| Species | Total Estimated | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 344 | 47.9 | 250 | 75 | 525 |
| Brook | 373 | 52.1 | 180 | 60 | 300 |
| Cutthroat | | | | | |
| White Fish | 20% of sample | N/A | N/A | N/A | N/A |

**South Fork Alder Creek BURP Data:**

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 15 m above Forks | 045_02 | 3 | 3 | 5.28 | 7/7/98 |

South Fork Alder Creek Fish Data: 9/9/97 300 m above Alder Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 22 | 100 | 103.7 | 73 | 178 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Fish Data: 9/9/97 Alder Creek 100 m above private property

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | 4 | 4.54 | 78.5 | 46 | 171 |
| Brook | 84 | 95.45 | 135.58 | 60 | 225 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Fish Data: 9/9/97 Alder Creek Between Sawmill and Trail Creeks at road crossing culvert

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 31 | 100 | 143.2 | 51 | 260 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Cliff Creek BURP Data:** 1st Order

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| ¼ mile below end of Rd. | 045_02 | 1 | 3 | 4.72 | 7/15/98 |

**Trail Creek BURP Data:**

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 50 m above Alder Cr. | 045_02 | 3 | 3 | 5.81 | 7/7/98 |

Trail Creek Fish Data: 9/9/97 Trail Creek 300 m above Alder Creek Rd.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 20 | 100 | 179.5 | 90 | 248 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Pass Creek BURP Data:**

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.25 mi. above Lime Cr. | | 3.96 (MBI) | 94 (HI) | 0.17 | 7/13/98 |
| 0.25 mi. below Lime Cr. | | 5.16 (MBI) | 96 (HI) | 0.7 | 7/13/98 |
| 20 m below Bear Cr. | 009_03 | 3 | 3 | 10.93 | 7/13/98 |

Pass Creek Fish Data: 7/21/99 DEQ Data Pass Creek 1.5 mi. below Bear Creek.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 13 | 100 | 177.3 | 95 | 225 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Pass Creek Fish Data: 7/21/99 DEQ Data Pass Creek 0.25 mi. below Lime Cr.

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 9 | 100 | 127.2 | 45 | 235 |
| Cutthroat | | | | | |
| White Fish | | | | | |

**Lime Creek BURP Data:** 1st Order

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 100 m above Pass Creek | 009_02 | 3 | 3 | 0.32 | 7/13/98 |

**Bear** Creek BURP Data:

| BURP Site Location | Assessment | SMI Score | SHI Score | Flow | Date Sampled |
|---|---|---|---|---|---|
| 0.1 mi. above Pass Cr. | 009_02 | 2 | 3 | 4.1 | 7/1/97 |
| 1.4 mi. above Pass Cr. | 009_02 | 0 | 3 | 2.49 | 7/13/98 |

Bear Creek Fish Data: 7/21/99 DEQ Data: just above Bear Creek confluence with Pass Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 13 | 100 | 208 | 195 | 235 |
| Cutthroat | | | | | |
| White Fish | | | | | |

Bear Creek Fish Data: 7/21/99 DEQ Data: 1.4 mi. above Bear Creek confluence with Pass Creek

| Species | Total Captured | Percent Composition | Mean Length | Minimum Length | Maximum Length |
|---|---|---|---|---|---|
| Rainbow | | | | | |
| Brook | 11 | 100 | 185 | 165 | 215 |
| Cutthroat | | | | | |

# Appendix G. Erosion Inventory Methodology

# Erosion Inventory Methods

February 25th, 2003

Prepared by

Thomas Herron: Senior Water Quality Analyst
Idaho Department of Environmental Quality
Idaho Falls Regional Office
900 N Skyline, Suite B
Idaho Falls, Idaho 83401

## Abstract

Water quality managers often are faced with difficult decisions on how to satisfy needs of states to meet court ordered schedules to develop Total Maximum Daily Loads while establishing meaningful load allocations and targets to improve water quality and meeting the public need to maintain diversity in land use. Such decisions are fraught with complexity and uncertainty associated with ecological systems, perturbance of water quality by anthropogenic nonpoint sources, such as sediment, and implementation of affordable best land management practices. Quantitative erosion inventory provides a means to formalize these complexities into a framework consisting of sediment load estimates from primary sources and relating loads to undisturbed conditions of bank stability, bank height and length and beneficial use support to identify load allocations that are expected to restore impacted beneficial uses. Determining percent composition of surface and depth fine sediment in spawning habitat is used as a complementary target to track changes in sediment loading over time.

Methodology for streambank erosion inventory is presented to determine existing sediment load, desired future sediment load, and monitoring feedback to guide implementation of best management practices to restore full support of beneficial uses related to coldwater aquatic life and salmonid spawning. This inventory is intended for waters determined to be primarily degraded by sediment or the combination of sediment and elevated temperature. The primary supposition is that as streambanks are managed for stability the morphological and riparian changes facilitate reduced thermal loading. The erosion inventory was developed to identify sediment loading at existing erosion rates and to identify future desired sediment loading based on erosion rates predicted after implementation of best management practices. This methodology was applied to the Lemhi River Subbasin to quantify streambank erosion on 303(d) listed streams to develop Total Maximum Daily Loads to meet the requirements of the Federal Clean Water Act.


## Introduction

Water quality managers are increasingly faced with difficult decisions on how to balance the legal requirements of the Federal Clean Water Act for quantitative Total Maximum Daily Loads (TMDLs) with socioeconomic needs of the public. Streams that do not fully support aquatic life beneficial uses due to degraded water quality require that a TMDL be developed to restore aquatic life beneficial uses. The need for sustainable agriculture is important to rural economies and implementation of excessive best management practices is not affordable or desirable. Court ordered timelines for development of TMDLs for particular streams require that load allocations be meaningful to restoration of desirable aquatic conditions and be completed in a short time. Budgets for environmental regulatory agencies preclude extensive analysis of pollutant loading to develop load allocations. Federal law requires only gross allocations of pollutant loads in the absence of existing data of high precision. To aid the decision-making process, managers need tools that formalize the collection of sediment loading data, are quantitative and relate present day erosion conditions to future target conditions that are expected to restore beneficial uses. These methodologies must be cost effective and time efficient, while providing realistic implementation alternatives to ranchers and farmers. The streambank erosion inventory is a rapid and inexpensive assessment of current erosion conditions and identifies load reductions needed to achieve desired future conditions that are expected to restore beneficial uses. The implementation alternatives identified by the erosion inventory are generally inexpensive and attainable in a reasonable time to effect improvements in water quality and subsequent aquatic life beneficial use support. This methodology was used to quantify bank erosion over 28 segments of tributaries to the Lemhi River to develop a TMDL for the Lemhi River Subbasin to restore aquatic life beneficial uses. It has also been successfully used in the Pahsimeroi River and Little Lost River subbasins to identify load reductions to restore beneficial aquatic life uses and reduce thermal loading.

The analytical techniques and data used to develop the gross sediment budget and instream sediment measures used in rangeland TMDLs in the Salmon River and Upper Snake River Basins is described. The methods, data, and results for: 1) streambank erosion inventory; 2) gully erosion and mass wasting inventory; and 3) surface and subsurface fine sediment data collection techniques are reviewed. These data are intended to first characterize the natural and existing condition of the landscape, and second to estimate the desired level of erosion and sedimentation, and third provide baseline data which can be used in the future to track the effectiveness of TMDL implementation. For example, the streambank erosion and gully inventories can be repeated, as can evaluation of depth or surface fine sediment composition to ultimately provide an adaptive management or feedback mechanism.

## Methods

### Streambank Erosion Inventory

The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS, 1983). Using the direct volume method, sub-sections of 1996 §303(d) watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS Stream Bank Erosion Inventory is a field based methodology, which measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson, 1994). The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating the factors and rating scores are:

**Bank Stability:**
- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

**Bank Condition:**
- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

**Vegetation / Cover On Banks:**
Predominantly perennials or rock-covered - 0
Annuals / perennials mixed or about 40% bare - 1
Annuals or about 70% bare - 2
Predominantly bare – 3

**Bank / Channel Shape:**
V - Shaped channel, sloped banks - 0
Steep V - Shaped channel, near vertical banks - 1
Vertical Banks, U - Shaped channel - 2
U - Shaped channel, undercut banks, meandering channel - 3

**Channel Bottom:**
Channel in bedrock / noneroding - 0
Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active downcutting - 2

**Deposition:**
No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

**Cumulative Rating**
Slight (0-4) Moderate (5-8) Severe (9+)

From the Cumulative Rating, the lateral recession rate is assigned.

| | |
|---|---|
| 0.01 - 0.05 feet per year | **Slight** |
| 0.06 - 0.15 feet per year | **Moderate** |
| 0.16 - 0.3 feet per year | **Severe** |
| 0.5+ feet per year | **Very Severe** |

Streambank stability can also be characterized through the following definition and the corresponding streambank erosion condition rating from Bank Stability or Bank Condition above are included in italics.

Streambanks are considered stable if they do not show indications of any of the following features:

- **Breakdown** - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank** - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture** - A crack is visibly obvious on the bank indicating that the block of bank I about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding** - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*

- At least 50% of the bank surfaces are protected by logs of 4 inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring streambank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (non-erosional).** Streambanks are Over 50% Covered as defined above. Streambanks are Stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*
- **Mostly covered and unstable (vulnerable).** Streambanks are Over 50% Covered as defined above. Streambanks are Unstable as defined above. Such banks are typical of ?false banks" observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and stable (vulnerable).** Streambanks are less than 50% Covered as defined above. Streambanks are Stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Streambanks are less than 50% Covered as defined above. They are also Unstable as defined above. These are bare eroding streambanks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS, 1983). As a result, the lower stream segment of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types) (Rosgen,1996). Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically between 10 and 30 percent of streambank needs to be inventoried. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property.

Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the field crew leader.

Field Methods

Streambank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people and are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a Global Positioning System (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying field crews photograph key problem areas.

**Bank Erosion Calculations**

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * \rho_B ]/2000 \text{ (lbs/ton)}$$

where:

E = bank erosion over sampled stream reach (tons/yr/sample reach)

$A_E$ = eroding area ($ft^2$)

$R_{LR}$ = lateral recession rate (ft/yr)

$\rho_B$ = bulk density of bank material (lps/$ft^3$)

The bank erosion rate ($E_R$) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:
$E_R$ = bank erosion rate (tons/mile/year)
E = bank erosion over sampled stream reach (tons/yr/sample reach)
$L_{BB}$ = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al, 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50 year flood event might cause five feet of bank erosion in one year and over a ten year period this events accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* ($A_E$) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* ($R_{LR}$) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates: for example, aerial photo interpretation, anecdotal data, bank pins, and channel cross-sections.
To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates. For the Lemhi River, anecdotal data were used to estimate bank recession rates. Table 1 summarizes the results and recession rates are in

Table 1. Bank lateral recession rates measured in Lemhi River Subbasin using anecdotal data.

| Site | Lateral Recession (ft) | Time (yr) | Recession Rate (ft/yr) | Comments |
|---|---|---|---|---|
| 18 - mile Creek (silt-clay) | 2.5 | 2 | 1.25 | Bank erosion results from cattle trampling bank rather than stream discharge. Likely not a good measure for other streams. |
| Kitley Creek (clay-silt) | 14 | 37 | 0.38 | Fence posts exposed, Fence built in late 1950s. Assume 1960 for rate calculation. Two feet lost in 1997 flood event. |
| Geertson Creek (silt-sand) | 15 | 52 | 0.29 | Cedar fence built in 1945. |

general agreement with the NRCS (1983) categories. Additionally, Table 2 is included to compare estimated recession rates to rates measured in recent research projects.

The *bulk density* ($\rho_B$) of bank material is measured occularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

## Gully Erosion and Mass Wasting

Table 2. Bank lateral recession rate measured in various research projects.

| Reference | Average Migration Rate (ft/yr) | | Comments |
|---|---|---|---|
| From Burckhardt and Todd (1998) | forested | unforested | Data collected in North Central Missouri in glacial deposits. |
| | 0.7 | 5.3 | Included here to show extreme values in highly |
| | 1.9 | 5.6 | unstable sand-gravel bank material. |
| | 1.4 | 3.1 | |
| | 2.3 | 7 | |
| | 0.3 | 1.7 | |
| | 0.9 | 5.6 | |
| | 2.3 | 10.5 | |
| | 4.5 | 8.6 | |
| | 0.6 | 0.9 | |
| From Trimble (1997) | 0.65 | | Urbanized watershed. Sand-silt bank material |
| | 13 | | |

Two methods were used to estimate the natural and anthropogenic frequency of gully erosion and mass wasting. First, field inventories were conducted to quantify the present level of gully formation and mass wasting occurrence. Second, historic aerial photos were used to document the spatial and temporal characteristics of gully formation and mass wasting.

The gully erosion field inventory followed methods outlined in the proceedings from the Natural Resource Conservation Service Channel Evaluation Workshop (1983). Much like the streambank erosion inventory technique, the direct volume method is used to quantify the amount and rate of sediment erosion and delivery from gullies.

The mass wasting inventory was conducted using similar techniques, however, because these features tend to be discrete sources of sediment the average annual sediment input was not quantified. Rather, the total volume and mass delivered to the stream channel were estimated.

Active features were surveyed using standard surveying equipment. The geometry of each feature was surveyed and sediment samples were collected. The sediment samples were sieved and weighed to quantify the cumulative grain size distribution of the sediment sources. These data are reported in Plate 9.

The aerial photos were interpreted using standard techniques described by Compton (1996). Resource aerial photos, taken by the BLM, from 1946, 1960, 1974, 1992, and 1993 were used to characterize the location of features and to quantify the approximate time of gully and mass wasting initiation. The photos were also used to characterize changes in land use, riparian cover, and bank condition where possible.

## Subsurface Fine Sediment Sampling

McNeil Sediment Core samples were collected to describe size composition of bottom materials in salmonid spawning beds of streams on the 303(d) list for sediment. Research has shown that subsurface fine sediment composition is important to egg and fry survival, Hall (1986), Reiser and White (1988). Data gathered as part of the TMDL and other studies relevant to the Lemhi River Subbasin are presented in Plate 10.

*Site Selection*

Sample sites selected displayed characteristics of gravel size, depth and velocity required by salmonids to spawn and were determined to be adequate spawning substrate by an experienced fisheries biologist. Samples were collected during periods of low discharge, as described in McNeil and Ahnell (1964) to minimize loss of silt in suspension within the core sampling tube. Sample sites were generally in the lower reach of streams where spawning habitat was determined to exist.

## Field Methods

A 12 inch stainless steel open cylinder is worked manually as far as possible, at least 4 inches, into spawning substrate without allowing flowing water to top the core sampling tube. Samples of bottom materials were removed by hand, using a stainless steel mixing bowl, to a depth of at least 4 inches and placed into buckets. After solids were removed from the core sampling tube and placed into buckets, the remaining suspended material was discarded. It is felt that this fine material would be removed through the physical action of excavating a redd and would not be a significant factor with regard to egg to fry survival. Additionally, rinsing of sieves to process the sample results in some loss of the fraction below the smallest (0.053 mm) mesh size.

Samples were placed wet into a stack of sieves and were separated into 10 size classes by washing and shaking them through nine standard Tyler sieves having the following square mesh openings (in mm): 63, 25, 12.5, 6.3, 4.75, 2.36, .85, .212, .053. Silt passing the finest screen was discarded.

The volume of solids retained by each sieve was measured after the excess water drained off. The contents of each of the sieves were placed in a bucket filled with water to the level of a spigot for measurement by displacement. The water displaced by solids was collected in a plastic bucket and transferred to a 2,000 ml graduated cylinder and measured directly. Water displaced by solids retained by the smaller diameter sieves was also collected in a plastic bucket and measured in a 250 ml graduated cylinder. Variation in sample volumes was caused by variation in porosity and core depth. All sample fractions were expressed as a percentage of the sample with and without the 63 mm fraction.

Three sediment core samples were collected at each sample site and grouped together by fractions 6.3 mm and greater and 4.75mm to 0.53mm. The results for a particular site are the percentage of 4.75mm to 0.53mm as a percent of the total sample. Standard deviation is calculated for estimates including and excluding particles 63 mm and above.

**Results**

The output from the erosion inventory gives tons per year per sample reach, tons per mile per year and extrapolated total tons of sediment per year from streambank erosion over the length of stream identified as having similar management and erosion conditions. Estimates for the same parameters are calculated for the same stream segments at the desired streambank stability. The difference of the two estimates becomes the load allocation from which the TMDL is developed. A summary table of streambank erosion estimates is shown in Table 3.

Table 3. Example of sediment load allocations and reductions by inventory reach.

| Reach Name/Number (from downstream to upstream) | Existing Erosion Rate (t/mi/y) | Total Erosion Rate (t/y) | Proposed Erosion Rate (t/mi/y) | Load Allocations (t/y) | Erosion Rate Percent Reduction | Percent of Total Erosion |
|---|---|---|---|---|---|---|
| Landslide | N/A | 195 | N/A | 146 | 25 | 19 |
| Upper | 71 | 318 | 36 | 159 | 49 | 31 |
| 3 (Upper Middle) | 10 | 46 | 6 | 28.5 | 40 | 5 |
| 2 (Middle) | 5 | 6 | 6 | 8 | 0 | <1 |
| 1 (Lower) | 96 | 422 | 71 | 313 | 26 | 42 |
| 5 Road | 9 | 24 | 5 | 14 | 44 | 2 |
| **Totals** | **----------** | **1011** | | **668** | **34** | **100** |

The output from the McNeil Sediment Core Sample shows the percent composition of fine sediment less than ¼ inch diameter for each sample site. The target for volcanic, granitic and sedimentary watersheds is less than 28% fine sediment less than ¼ inch diameter in identifiable spawning habitat. Spawning habitat primarily consists of pool tail-outs. Channel morphology provides flow dynamics that result in fine sediment levels less than 28% in unperturbed conditions. Excessive fine sediment inputs or disturbed channel morphology are indicated by fine sediment composition above 28%. Target levels set by the USDA Forest Service Salmon-Challis National Forest set target levels at less than 20% fine sediment to a depth of 6 inches in streams with anadramous fish and to a depth of 4 inches in streams with exclusively resident fish species. A summary table of fine sediment composition from core samples is shown in Table 4.

Table 4. Example of sediment core sampling data.

| Core Sampling Sediment Trends - 1995 to 1999 - Mean Percent (%) Fines | | | | | |
|---|---|---|---|---|---|
| Stream/Station | 1995 | 1996 | 1997 | 1998 | 1999 |
| Morgan Cr.1A | 38.5 | 34.3 | 29.3 | 22.8 | 24.8* |
| Morgan Cr.2A | 34.4 | 34.5 | 31.7 | 22.0 | 23.8* |
| Morgan Cr.3A | 42.3 | 27.7 | 41.3 | 31.4 | 39.4 |
| Morgan Cr. | 36.2 | 33.0 | 23.4 | 11.4 | 25.6* |
| Challis Cr.1A | 44.1 | 41.1 | 17.4 | 13.0 | 21.3* |
| **Challis Cr.2A** | - | - | 29.2 | - | 22.0 |
| **Garden Cr.1A** | 22.4 | - | 19.0 | 12.3 | 18.0* |
| E. Pass Cr.1A | 27.1 | 31.9 | 31.2 | 37.9 | 38.8# |
| Herd Cr. | 30.1 | 31.0 | 32.5 | 28.4 | 30.7 |
| WF Herd Cr.1A | 20.4 | 27.2 | 27.2 | 27.2 | 25.2# |
| Squaw Cr.1A | 25.9 | 24.2 | 27.4 | 23.5 | 30.5# |
| Trail Cr.1A | - | 27.0 | - | - | - |
| Thompson Cr.1A | 25.1 | 20.2 | 25.4 | 16.5 | -* |
| **Yankee Fork 1A** | 27.1 | 20.5 | 19.6 | 27.8 | 24.1 |
| **Yankee Fork 2A** | 15.6 | 29.5 | 14.9 | 22.6 | 27.5# |
| **Yankee Fork 3A** | 13.2 | 29.1 | 5.3 | 14.7 | 24.2# |
| **Yankee Fork 4A** | 40.6 | 36.1 | 27.4 | 25.2 | 32.7* |
| **Yankee Fork 5A** | 31.5 | 29.7 | 23.6 | 21.0 | 15.7* |
| WF Yankee Fork | 21.9 | - | 27.5 | 18.1 | 25.1 |
| Jordan Cr.0A | 26.2 | 32.1 | 18.4 | 13.9 | 15.3* |
| Jordan Cr.1A | 17.6 | - | - | - | - |
| Jordan Cr.2A | 16.0 | 22.5 | 18.0 | 17.5 | 21.1# |
| Jordan Cr.3A | 14.3 | 23.5 | 16.7 | 10.9 | 23.1# |
| Jordan Cr.4A | 13.5 | - | - | - | - |
| Fivemile Cr.1A | 14.3 | - | 20.8 | 28.8 | 11.7 |
| Tenmile Cr.1A | 32.3 | - | 36.9 | 28.5 | 33.7 |
| McKay Cr.1A | 19.0 | - | 29.3 | 33.2 | 30.1# |
| Basin Cr.1A | 33.3 | 28.5 | 22.3 | 13.5 | 32.4 |
| Valley Cr.1A | 41.1 | - | - | - | - |

*Significant decrease over the five-year period (1995-1999).
#Significant increase over the five-year period (1995-1999).
Streams in **bold** are 303(d) listed for sediment.

### Discussion

Sediment loading above the level that a water body can assimilate is the most frequently observed perturbance to cold water aquatic life beneficial use support in waters that occur in areas where the primary land use is livestock grazing. Unmanaged or undermanaged grazing in riparian areas results in degradation of riparian vegetation, which in turn results in unstable streambanks which increases sediment loading from eroding streambanks. Over time channel morphology changes, increasing width, decreasing depth and increasing deposition of fine sediment and increasing thermal loading.

Establishing an efficient method of evaluating streambank erosion and depth fine deposition gives water quality managers a quantitative tool to set pollutant loads, prioritize implementation of best management practice projects, and monitor implementation effectiveness. Combined with monitoring aquatic life beneficial uses and follow-up monitoring of fine sediment targets and channel morphology a valuable tool is gained to restore water quality while providing impetus to implement best management practices that are cost effective and assure sustainable agriculture for the future.

**References**

Compton, R.R. 1996. Interpretation of aerial photos.

Flanagan, D.C., and M.A. Nearing (Editors). USDA Water Erosion Prediction Project Hillslope Profile and Watershed Model Documentation. NSERL Report No. 10. USDA-ARS National Soil Erosion Laboratory, W. Lafayette IN. 9.1-9.16

Hall, T.J. 1986. A laboratory study of the effects of fine sediments on survival of three species of Pacific salmon from eyed egg to fry emergence. National Council of the Paper Industry for Air and Stream Improvement. Technical Bulletin 482. New York.

IDEQ. 1999b. 1998 303(d) List. Idaho Division of Environmental Quality. Surface Water Program. January. 473 pp.

Leopold, L.B., M.G. Wolman and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman. San Francisco, CA.

Lohrey, M.H. 1989. Stream channel stability guidelines for range environmental assessment and allotment management plans. U.S. Forest Service, Northwest Region (unpublished).

McNeil W.J. and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. US Fish and Wildlife Service, Special Scientific Report-Fisheries No. 469.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. U.S. Forest Service, Northern Region. Missoula, MT.

Reiser, D.W. and R.G. White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. North American Journal of Fisheries Management. 8: 432-437.

Rosgen, D.L. 1996 Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO. 378pp.

Stevenson, T.K. 1994. USDA-NRCS, Idaho. Channel erosion condition inventory description. Memorandum to Paul Shelton, District Conservationist, Montpelier FO, Idaho, 5/24/94: describing estimation of streambank, road and gully erosion.

USDA NRCS. 1983.Channel evaluation Workshop, Ventura, California, November 14-18, 1983. Presented at U.S. Army Corps of Engineers Hydrologic Engineering Center training session by Lyle J. Steffen, Geologist, Soil Conservation Service, Davis, CA. December 14,1982.

USDA FS. 1997. Challis Creek Watershed Analysis. Salmon-Challis National Forest, Challis Ranger District. June 1997.