# Middle Salmon River-Panther Creek

# Subbasin Assessment and TMDL

**March 2001**

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# EXECUTIVE SUMMARY

The Middle Salmon River-Panther Creek Subbasin Assessment and TMDL is a compilation of watershed characteristics, water quality standards, water quality concerns, and conclusions and recommendations for this watershed. The Draft Subbasin Assessment was completed in April 2000 and included information on 24 sub-waterhseds that identified water quality concerns and status for 8 water bodies that included Big Deer Creek, Blackbird Creek, Bucktail Creek, Panther Creek, Diamond Creek, Dump Creek, Williams Lake, and the Salmon River.

The 1998 Idaho §303(d) list includes five streams brought forward from the 1994 §303(d) list. These streams are Big Deer Creek, Blackbird Creek, Bucktail Creek, and Panther Creek—all associated with metals contamination from the Blackbird Mine. Dump Creek is listed for sediment, and the Salmon River from the confluence of the Pahsimeroi to the confluence of the North Fork of the Salmon River is listed for unknown pollutants. Carmen Creek and that portion of Blackbird Creek above Blackbird Creek Reservoir were removed from the 1998 §303(d) list because they fully support their beneficial uses and the Salmon River is listed for unknown pollutants. Water bodies added to the 1998 §303(d) list are Williams Lake (listed for nutrients and low dissolved oxygen) and Diamond Creek (listed for unknown pollutants).

The Middle Salmon River-Panther Creek Subbasin Assessment makes recommendations to remove the Salmon River along its previously listed reach because it is in full support of its beneficial uses as evidenced by its fish community structure. It is in full support of its salmonid spawning and coldwater biota beneficial uses. Additionally the Subbasin Assessment identifies that Diamond Creek will not have a TMDL developed because it was listed in error based on a BURP site that was intermittent with a flow less than 1 cfs. Numeric water quality criteria do not apply to streams with less than 1 cfs (cubic ft. per second) flow, and Diamond Creek flow was recorded at 0.1 cfs at the time of sampling. Diamond Creek will be monitored further to determine its support status at lower elevation. If necessary the TMDL for Diamond Creek will be developed in 2006.

The Subbasin Assessment also identifies the ongoing EPA sponsored process that will ultimately result in a TMDL for metals contamination from the Blackbird Mine on Blackbird Creek, Big Deer Creek, Bucktail Creek, and Panther Creek and for pH and sediment on Big Deer Creek and Blackbird Creek. The Blackbird Mine sits in the saddle of a mountain ridge with mined areas affecting drainages on both sides. Because of the nature of the rock ore that has been mined, cobalt, arsenic, copper, iron and acid drainage are water quality concerns in the drainages. Past investigations at the Blackbird Mine Site by the State of Idaho, the U.S. Forest Service, the National Marine Fisheries Service, and others, done in part to support a claim of damages to natural resources, led to the conclusion that past and continuing releases of mining wastes produced by operation of the Blackbird Mine have resulted in unacceptable risks to human health and the environment. This resulted in decisions by EPA to prepare a Remedial Investigation/Feasibility Study (RI/FS) and to conduct non time-critical removal actions to alleviate or reduce continuing threats to human health and the environment. The RI/FS and the non time-critical removal actions were governed by two Administrative Orders on Consent (AOC) between the Federal Government and responsible parties, the Blackbird Mine Site Group (BMSG). A Separate Consent Order was signed in September 1995 between the Natural Resource Trustees and the BMSG resulting from the Natural Resources Damage Assessment (NRDA) claims. The Consent Decree established natural resources restoration goals for Panther and Big Deer Creeks. This group manages the removal and restoration actions agreed upon in the AOC, through the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This process seeks to find and implement long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening.

The BMSG is completing data collection for the RI/FS. A Record of Decision (ROD) will be drafted and negotiated after the completion of the RI/FS. This ROD will set the final concentrations of metals that the BMSG will then clean up to. The BMSG is also currently removing contaminated tailings piles at the site in accordance with the consent decree. The ROD was originally slated for signature in 2000. This was the assumption when DEQ and EPA agreed to do this Subbasin Assessment and TMDL in the 1996 court settlement. The ROD has been delayed because of the complex negotiations involved in the early removal action and preliminary work on the RI/FS. The ROD will set metals concentration for the impacted streams. The TMDL will result from these actions. DEQ will convert these concentrations into loads for the TMDL, and the actions outlined in the ROD will serve as the Implementation Plan for this aspect of the TMDL. When the ROD is signed by all parties involved and approved by EPA, the DEQ will amend the Middle Salmon Panther Creek Subbasin Assessment and TMDLs to reflect these changes.

The Subbasin Assessment also describes the water quality best management practices (BMPs) that, as of 1988, have been fully implemented by the USFS on Dump Creek prior to its §303(d) listing in 1994. Significant water quality improvements have been noted, and sediment recruitment has been greatly reduced. The Subbasin Assessment also identifies that the potential water quality improvements that these projects will bring to Dump Creek will take many years to be fully realized. Best management practices have been fully implemented on Dump Creek and no TMDL will be developed for Dump Creek.

Section two contains the Total Maximum Daily Load for Williams Lake that identifies load reductions for phosphorus from nonpoint sources in the Lake Creek watershed and from septic systems associated with recreational residences around the lake and the USFS campground on Williams Lake. In the typical year phosphorus loading to Williams Lake is estimated to be 2,850 kg of phosphorus, for an annual aerial loading rate of 3.9 $g/m^2/yr$ (3900 $mg/m^2/yr$). Internal loading of phosphorus from sediment storage within the lake accounts for the vast majority of phosphorus loading in the lake at 76% (2175 kg). External sources had loads of: 16% (447 kg) from the inlet stream, 5% (133 kg) from septic systems, and 3% (70 kg) from overland flow and direct precipitation. External Phosphorus loading from recreational residences, Williams Lake Resort and the USFS campground on Williams Lake directly to the lake must be eliminated (100% reduction) to eventually restore beneficial uses within Williams Lake. Additionally, a 30% reduction of phosphorus from the Lake Creek watershed above Williams Lake is allocated to restore beneficial use support within Williams Lake.

Implementation of improved septic systems on Williams Lake is nearing completion with homes on the shoreline already connected to combined or centralized systems, or having approved plans for construction of a combined system during 2001. Only the Williams Lake Resort and the USFS campground on Williams Lake are yet to be upgraded, or have plans developed to remove septic inputs from the lake. District 7 Health Department estimates the Resort phosphorus load to be in the excess of 20 homes (TMDL Comments). With completion of the Williams Lake Resort and USFS Williams Lake Campground upgrade a net reduction of 133 kg Total Phosphorus per year, or 4.7% of the total phosphorus load will be realized in accordance with load reductions identified in the Williams Lake Phase I Restoration Study. This equates to 50% of the deleterious phosphorus load reduction into the lake. The remaining 133 kg reduction (50%) is expected to come from the watershed with streambank stabilization, improvements in dispersed camping regulation, grazing and irrigation management, and road and trail maintenance. Other land management improvements may also be possible over time.

The Middle Salmon River- Panther Creek subbasin is not without natural disturbance that is difficult to anticipate or manage. During development of the Subbasin Assessment and TMDL a significant event occurred that effected access to the watershed and introduced uncertainty into the existing conditions being described in the assessment. On July 10$^{th}$, 2000 a lightning caused wildfire began in the Clear Creek subwatershed that grew to be one of the largest wildfires in Idaho's recent history. Known as the Clear Creek Fire, it grew to encompass approximately 206,379 acres in the heart of the Panther Creek watershed. The Clear Creek fire was not declared to be 100% contained until October 13$^{th}$, 2000 and was not declared to be controlled until snows fell in early November. On July 14$^{th}$ the Fernster Fire began with a lightning strike that eventually involved the lower Diamond Creek watershed. The Fernster fire totals 2,862 acres and was relatively quickly contained and controlled (USFS S-CNF, 2000).

Rehabilitation of known suppression disturbed sites within the Clear Creek Fire complex was completed and Burned-Area Emergency Rehabilitation (BAER) was mostly completed before weather conditions ended rehabilitation efforts for the 2000 season in mid-November 2000. The emphasis of rehabilitation efforts has been to prepare the land to mitigate the effects of spring runoff. The main rehabilitation goals are to enhance soils ability to absorb water and hold soil on the slopes, stabilize stream channels, and improve road drainage. Rehabilitation efforts within the Clear Creek Fire complex have included knapweed treatment, planting of riparian species along lower Panther Creek; spreading grass and forb seeds in identified areas; cross slope felling/placing of trees in steep areas; laying straw wattles that intercept silt and fine debris; and road work that includes clearing culverts and ditches. The Fernster complex has received knapweed treatments, seeding and limited channel clearing (USFS S-CNF 2000).

Of the total 206,379 acres burned approximately 70% of the fire area was unburned or burned at a low severity. Generally areas mapped as low burn severity have black ashes, intact grass, forb and shrub root systems, and no soil crusting. Approximately 25% of the fire area burned at a moderate severity. These areas would exhibit gray or mixed ash color, partially compromised root systems and some soil crusting. Approximately 5% of the area had a high burn severity. Areas of high burn severity have white or red ashes, completely compromised root systems, and significant amount of soil crusting. A review of the fire area by soil scientists showed that water repellency was exhibited to some degree in unburned sites and in areas that burned at varying intensities. Water repellency at many of these sites was judged to be due to high surface tension due to extremely dry soils. Very little hydrophobic soils were observed in the fire area. The water repellent and hydrophobic conditions are expected to have broken down as a result of the fall rains that occurred in the fire area in September and October. Only 1% of the area of the Fernster Fire complex was severely burned with no water-repellent soils created (USFS S-CNF 2000). Of special concern is protection of sediment basins that may contain toxic chemicals at the Blackbird mine.

Within the Clear, Trail and Big Deer Creek, and Blackbird Mine areas the fire was considered stand replacing. Many south slopes outside of these areas appeared to have been light to moderately burned. Over much of the area, fires burned leaving a mosaic pattern of (50:50) live and dead trees. Also, large blocks of understory burns were observed west of the Beartrack mine (IDFG 2000). Many of the south and west slopes were either lightly burned or unburned in the lower Panther Creek critical winter range. Some of the north and east timbered slopes in lower Garden Creek were burned out. The timbered areas of Hot Springs Creek, which were prescribed burned about 6 years ago, showed an understory burn (IDFG 2000).

Follow-up effectiveness monitoring will be conducted in accordance with a monitoring plan that will be developed by the USFS S-CNF. Monitoring will include water quality, riparian habitat, and instream fisheries habitat and stream channel dynamics. The Idaho Department of Environmental Quality will continue to conduct Beneficial Use Reconnaissance Program (BURP) monitoring on streams within the Panther Creek and Middle Salmon watershed.

## MIDDLE SALMON RIVER B PANTHER CREEK
## SUBBASIN ASSESSMENT AND TMDL

Figure 1. Middle Salmon River - Panther Creek Subbasin Location Map

**Middle Salmon River–Panther Creek Subbasin at a Glance:**

| | |
|---|---|
| *Hydrologic Unit Code* | 17060203 |
| *1998 Water Quality Limited Segments* | Blackbird Creek, Bucktail Creek, Big Deer Creek, Panther Creek, Dump Creek, Diamond Creek, Salmon River, Williams Lake |
| *Beneficial Uses Affected* | Cold Water Biota, Salmonid Spawning, Recreation |
| *Pollutants of Concern* | Sediment, pH, Metals, Dissolved Oxygen, Nutrients |
| *Major Land Uses* | Agriculture, Mining, Recreation |
| *Area* | 1810 sq. miles |
| *Population (1990)* | ~8,000 |

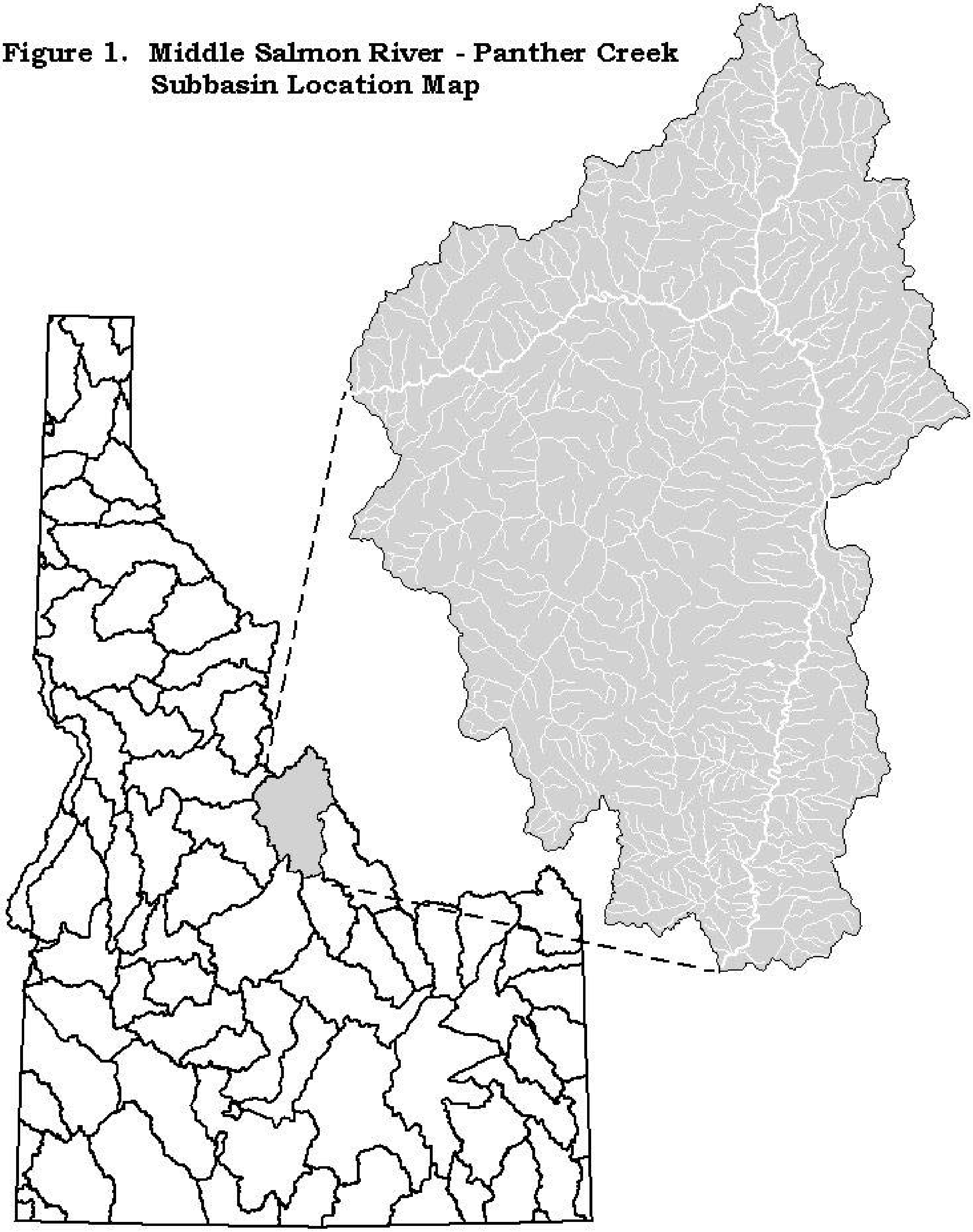
## 1.0 Characterization of the Watershed

The Middle Salmon River–Panther Creek (from here on referred to as “Salmon-Panther”) subbasin is located in East-Central Idaho on the Idaho-Montana Border (Figure 1). This subbasin (HUC #17060203) encompasses 1,810 square miles with 1,957.95 stream miles. The northern extent of the subbasin is bounded by the continental divide, which also delineates the boundary between Idaho and Montana. The southern boundary of this subbasin ends at the town of Ellis located north of the city of Challis. On the northwest corner, there is a small portion of the Frank Church River of No Return Wilderness within the subbasin. Elevations of the area range from 2,085 feet within the Salmon River Valley, to an elevation of 10,985 feet (Lem Peak) along the Lemhi Range in the southern portion of the subbasin.

### 1.1 Climate Description

The climate of the Salmon-Panther subbasin varies from a near desert environment to an almost alpine environment. These variations in climate are due to the wide range of elevation, local topography, and aspect. Eastward movement of Pacific Maritime air masses moving over the area also influence its climate. These air masses cause a rain shadow effect over the basin, making the lower elevations along the Salmon River a more desert-like environment

**Figure 1. Middle Salmon River - Panther Creek Subbasin Location Map**



(Abramovich et al, 1998). Maximum temperature and precipitation for three stations found in the subbasin are presented in Tables 1 and 2.

Cold winters and warm dry summers characterize the area. In the summer months, maximum average monthly temperatures reach the upper 80s (°F) while in the winter months the minimum average temperatures can drop to less than 10° F (Table 1). Along the lower elevations of the Salmon River at Shoup, the average annual temperature is 46° F while in the upper elevations along the continental divide; the average annual temperature is approximately 25° F. Temperature extremes range from 106° F to -37° F at Salmon (Western Regional Climate Center @ http://www.wrcc.sage.dri.edu/summary/climsmid.html. January, 2000).

The majority of the annual precipitation occurs in the late fall and early spring. The predominant form of precipitation occurs as snow with infrequent thunderstorms in the summer months. The average precipitation ranges from 10 inches in the lower elevations in Salmon to 16 inches at the middle elevations near Gibbonsville (Table 2). Maximum precipitation in the higher elevations of the subbasin range from 28 inches to as high as 44 inches in the Bitterroot Mountains (NRCS, January 1998 data).

**Table 1 Summary of Temperature Data Collected from 12/01/67 to 10/31/99 at Salmon and 1/1/66 to 10/31/99 at Shoup and 9/1/63 to 10/31/99 at Gibbonsville.**

| | Average Maximum Temperature °F | | | Average Minimum Temperature °F | | |
|---|---|---|---|---|---|---|
| Period | Salmon | Shoup | Gibbonsville | Salmon | Shoup | Gibbonsville |
| January | 30.3 | 31.3 | 28.9 | 11.8 | 15.5 | 9.6 |
| February | 38.8 | 39.5 | 36.1 | 17.5 | 19.8 | 12.9 |
| March | 51.0 | 51.6 | 46.2 | 26.1 | 27.3 | 21.0 |
| April | 61.2 | 61.9 | 56.4 | 32.3 | 33.0 | 27.9 |
| May | 70.2 | 71.6 | 66.3 | 39.5 | 39.4 | 34.3 |
| June | 78.7 | 79.8 | 74.4 | 46.2 | 45.7 | 40.8 |
| July | 88.0 | 89.6 | 84.8 | 50.8 | 50.9 | 45.0 |
| August | 86.7 | 88.3 | 83.6 | 48.9 | 49.6 | 43.6 |
| September | 75.7 | 77.2 | 73.1 | 40.6 | 42.3 | 36.4 |
| October | 60.9 | 60.7 | 59.2 | 31.1 | 33.0 | 28.2 |
| November | 42.6 | 42.3 | 40.4 | 23.3 | 25.6 | 21.2 |
| December | 30.7 | 30.7 | 28.4 | 13.1 | 16.4 | 9.5 |
| Annual | 59.6 | 60.4 | 56.5 | 31.8 | 33.2 | 27.5 |

Source: Western Regional Climate Center @ http://www.wrcc.sage.dri.edu/summary/climsmid.html

**Table 2 Summary of Precipitation Data collected from stations located at Salmon, Shoup, and Gibbonsville.**

| Period | Average Total Precipitation (in.) | | | Average Total Snowfall (in.) | | |
|---|---|---|---|---|---|---|
| | Salmon | Shoup | Gibbonsville | Salmon | Shoup | Gibbonsville |
| January | 0.68 | 1.35 | 2.14 | 8.0 | 11.6 | 26.3 |
| February | 0.47 | 1.28 | 1.18 | 4.1 | 5.1 | 12.0 |
| March | 0.54 | 0.88 | 1.02 | 2.1 | 1.2 | 6.7 |
| April | 0.77 | 1.14 | 1.18 | 1.2 | 0.1 | 2.7 |
| May | 1.43 | 1.56 | 1.60 | 0.1 | 0.0 | 0.4 |
| June | 1.46 | 1.80 | 1.80 | 0.0 | 0.0 | 0.0 |
| July | 1.02 | 0.94 | 0.88 | 0.0 | 0.0 | 0.0 |
| August | 0.84 | 0.88 | 1.04 | 0.0 | 0.0 | 0.0 |
| September | 0.77 | 1.08 | 1.00 | 0.0 | 0.0 | 0.0 |
| October | 0.59 | 0.92 | 0.82 | 0.1 | 0.0 | 0.8 |
| November | 0.77 | 1.42 | 1.61 | 4.2 | 3.0 | 13.0 |
| December | 0.75 | 1.58 | 1.95 | 8.0 | 13.4 | 23.6 |
| Annual | 10.08 | 14.82 | 16.22 | 27.7 | 34.4 | 85.5 |

Source: Western Regional Climate Center @ http://www.wrcc.sage.dri.edu/summary/climsmid.html

Diverse snowmelt patterns within the watershed cause significant runoff events in early spring through late summer. Snowmelt in the lower reaches begins in the early spring while snowmelt on the higher reaches occurs in early to mid-summer. The greater snow pack in the higher elevations causes greater runoff in the summer months, thus causing larger stream flow discharge in the mid to late summer.

## 1.2 Hydrology

Several flow gaging stations were scattered throughout the subbasin (Figure 2), very few of which remain active. Average flows in the Salmon River at the city of Salmon are less than 2,000 cubic feet per second (cfs) (Table 3). By the time the Salmon River has reached Shoup, and has received flow contributions from the Lemhi River, the North Fork Salmon River, and many smaller tributaries, its average flow has increased by half to almost 3,000 cfs. Maximum flows during the period of record have reached between 17,000 and 25,000 cfs (Table 3). The highest average annual flows occurred in 1965 and were between 3,000 and 4,500 cfs (Table 4). Peak flows in the Salmon River near Shoup can exceed 20,000 cfs at intervals of 10 years or greater (Table 5).

The North Fork Salmon River contribution is considerably smaller, with an average flow of 90 cfs. However, the period of record for this data is short and during a significant drought so the North Fork's contribution may be slightly larger. Panther Creek, the largest tributary in the subbasin, contributes an average of 258 cfs. Panther Creek would be expected to reach its highest flows near 3,000 cfs every 10 years.

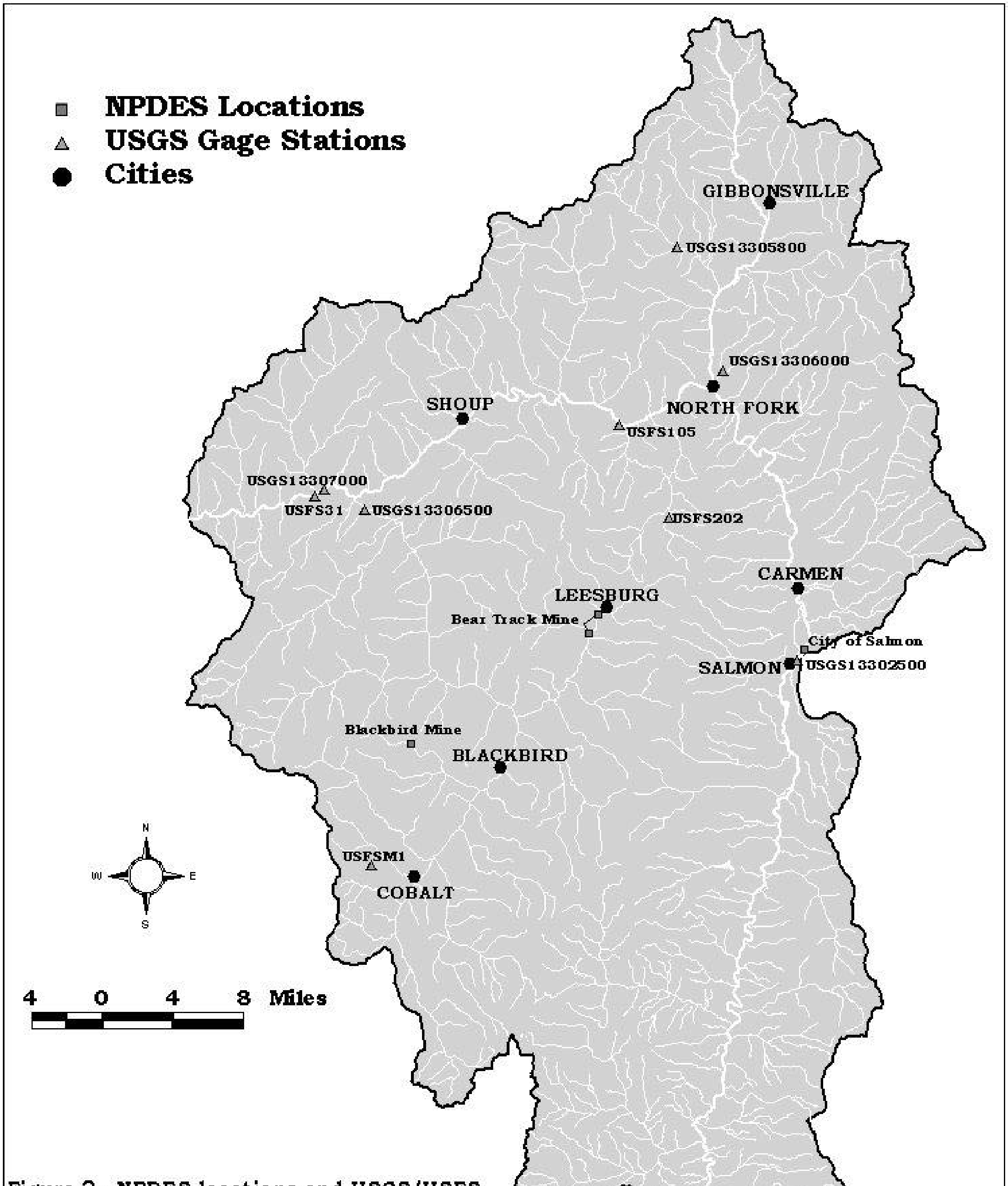



Figure 2. NPDES locations and USGS/USFS gage stations in the Middle-Salmon Panther subbasin.

**Table 3 Flow Statistics for Data of Record.**

| Station Name | Station # | Data Years | Average Flow (cfs) | Minimum Flow (cfs) | Maximum Flow (cfs) |
|---|---|---|---|---|---|
| Salmon R. at Salmon | 13302500 | 1913-1916, 1919-1996 | 1941 | 328 | 17400 |
| Salmon R. near Shoup | 13307000 | 1945-1982 | 3033 | 720 | 25400 |
| NF Salmon R. at North Fork | 13306000 | 1930-1940 | 90 | 11 | 901 |
| Panther Cr. near Shoup | 13306500 | 1945-1978 | 258 | 22 | 2850 |
| Napias Cr. above Arnett | 13306375 | 1989-1992 | 10 | 2 | 114 |
| Napias Cr. below Arnett | 13306385 | 1991-1996 | 25 | 4.5 | 660 |

**Table 4 Mean, Maximum, and Minimum Average Annual Flow.**

| Station Name | Station # | Data Years | Average Annual (cfs) | Highest Annual (cfs) | Lowest Annual (cfs) |
|---|---|---|---|---|---|
| Salmon R. near Shoup | 13307000 | 1944-1981 | 3037 | 4513 (1965) | 1813 (1977) |
| Salmon R. at Salmon | 13302500 | 1913-1916, 1919-1996 | 1934 | 3163 (1965) | 1024 (1994) |
| NF Salmon R. at North Fork | 13306000 | 1930-1940 | 90 | 113 (1933) | 58 (1931) |

The major streams within the subbasin are presented in Figure 3. The upper Salmon River section of the subbasin, from the Pahsimeroi River to the North Fork Salmon River, includes some 487 miles of perennial streams (SCNF, 1993). Stream flow regimes are typical of central Idaho mountain streams with peak flows in May or June from snowmelt. Low flows occur in late summer through winter. Rosgen stream channel types within this section of the subbasin include A-, B-, and C-type channels. The upper Salmon River watershed is composed of steep,

**Table 5 Magnitude and Frequency of Instantaneous Peak Flow.**

| Station Name | Station # | Period of Record | Discharge (cfs) by Frequency of Occurrence (years) and Probability of Exceedance (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2 (50%) | 5 (20%) | 10 (10%) | 25 (4%) | 50 (2%) |
| Panther Cr. near Shoup | 13306500 | 1945-1977 | 1,740 | 2,500 | 2,980 | 3,550 | 3,960 |
| Salmon R. near Shoup | 13307000 | 1945-1981 | 13,400 | 18,200 | 21,000 | 24,400 | 26,700 |

narrow, canyonlands with V-shaped drainages. The floodplain of the Upper Salmon River itself is fairly broad as compared to the canyonlands in the lower Salmon River further downstream. Some pasture land and irrigated agriculture exists on the river's floodplain in the upper part of the subbasin.

The North Fork Salmon River watershed has a branched, dendritic pattern (SCNF, 1998). Surface hydrologic features include perennial, intermittent, and ephemeral streams, seeps, wetlands, and small ponds, especially in headwaters. The North Fork watershed is dominated by snowmelt runoff with peak flows occurring in May and June and low flows occurring in late fall and winter. The most prevalent stream channel type in the watershed is one efficient at sediment transport.

The Panther Creek watershed includes some 400 miles of perennial streams, which drain into the lower Salmon River section downstream of Shoup (SCNF, 1993). Stream flow patterns are typical snowmelt runoff driven, with peaks in May or June and lows in fall and winter.

Stream flow patterns and Rosgen channel types in streams on the north side of the lower Salmon River are typical of most others in the subbasin (SCNF, 1993). However, streams in this area may be more influenced by heavy precipitation events common to regions of Idaho north of the Salmon River. Intense summer thunderstorms can produce flashy, flooding flows and mud/rock debris torrents. This region of the subbasin tends to have canyonlands closer to the Salmon River with some breakland reaches.

Extensive flooding of the Salmon River occurs frequently in the Deadwater Area between Dump Creek and North Fork. Dump Creek has created a large alluvial fan that pinches the Salmon River against the opposite bank. Ice jams form through the slow water area between Dump Creek and the braided channel wetland area upstream (Reichmuth et al., 1985). Flooding occurs 26 miles upstream in the city of Salmon.

The large Dump Creek alluvial fan, although exacerbated in the last 100 years due to mining and logging in the watershed, has existed for perhaps thousands of years (Reichmuth et al., 1985).

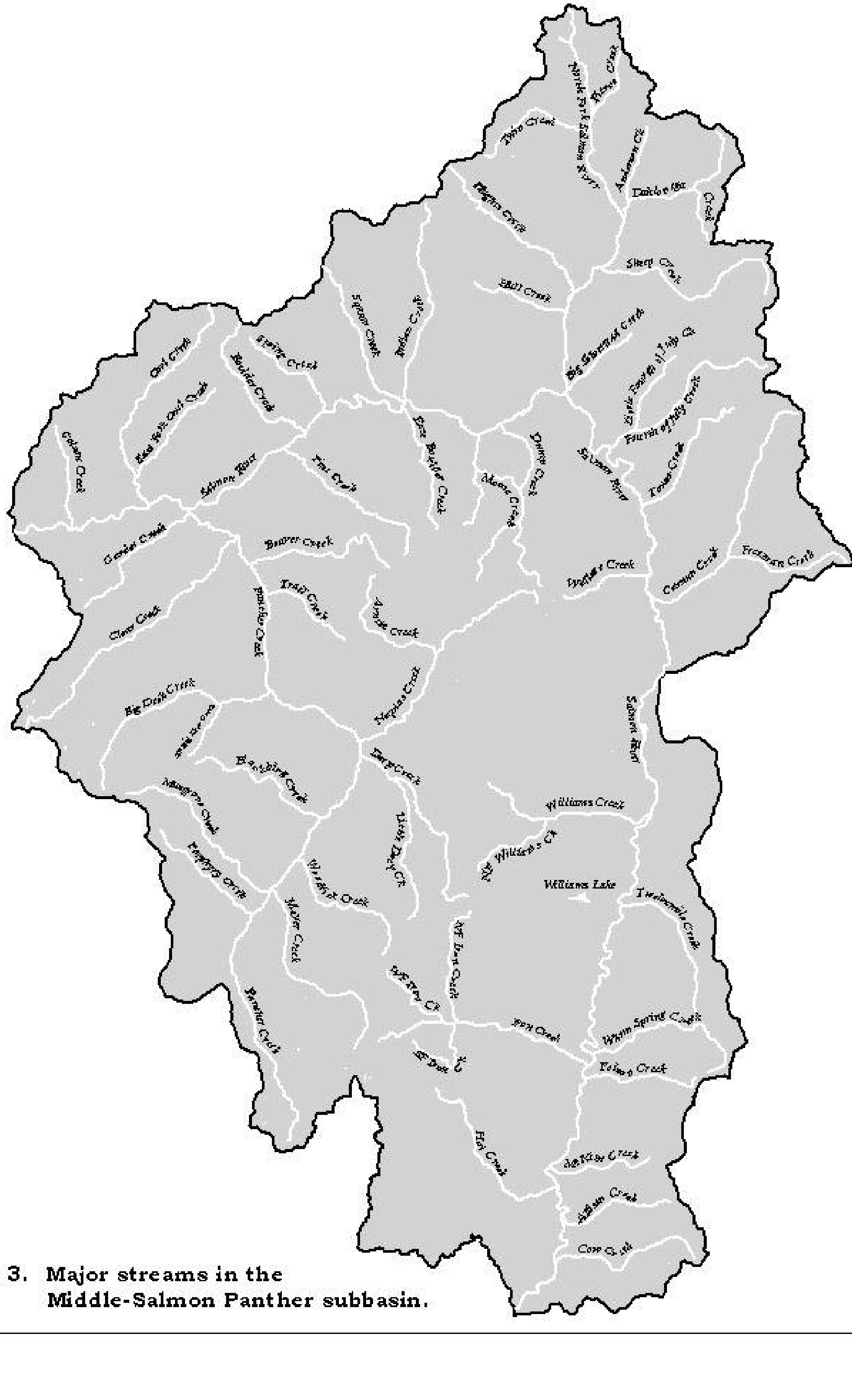



**Figure 3. Major streams in the Middle-Salmon Panther subbasin.**

The Deadwater Area is a 4,000 feet-long section of river with slow currents, flat bottom, and almost complete shading from surrounding landforms. Thus, resembling a long, narrow lake, the section freezes over completely in most winters.

The braided channel wetland area is created by sedimentation, which results from the slowing of river flows behind the Dump Creek fan. The sedimentation would normally extend all the way to the fan if it were not for the scouring that occurs beneath the ice dam in the Deadwater section. Thus, this area of the Salmon River acts as a catch and slow release point for sediment in the river generated by upstream sources.

**1.3 Geology and Geomorphology**

The geology of this watershed is variable and patchy (Figure 4). Throughout the major portion of the watershed underlies the Precambrian basement complex. This complex is considered to be old continental crust that separates the northern and southern parts of Idaho. It is comprised of 1,500 million-year-old gneiss and schists, metamorphosed from much older rock under intense heat and pressure (Maley, 1987).

Another rock type found in patches throughout the subbasin originated from the Challis Volcanics. The Challis Volcanics are a thick series of rhyolitic flows and tuffs that comprise a majority of the subbasin (Maley, 1987). This rock type was formed close to 50 million years ago and overlies much of the Precambrian basement complex and some of the Idaho batholith found in the area. Some of the Challis Volcanics are interbedded with Precambrian lake bed and fossiliferous sediments that eroded between the series of volcanic flows.

The erosion potential of the Challis Volcanics is greater than that of the Precambrian basement rocks. Areas that experience active slides due to erosivity of the Challis Volcanics include the 1998 303(d) listed Dump Creek. The general erosion and stability problems are related to the Challis Volcanics and the granitic-based soils. The Precambrian basement rocks are less erosive and more rugged in appearance due to their metamorphic nature (SNF, 1988).

There are numerous faults in the area related to the Trans Challis fault. The Trans Challis fault appears to originate from the Idaho City area and runs through portions of the subbasin. Portions of the fault system can be seen in Panther Creek, Big Deer Creek, and along the North Fork of the Salmon River (SCNF, 1993).

A variety of mountain ranges are located within the subbasin. On the southeastern edge of the watershed lies the Lemhi Mountain range. The Lemhi range is characterized by steep-sided, narrow mountain ranges sloping into the flatter Salmon River Valley (SCNF, 1993). The Lemhi range is part of the Basin and Range geologic complex located throughout east-central Idaho. This Basin and Range fault block complex was formed more than ten million years ago and has the highest elevations of the subbasin (Alt & Hyndman, 1989). This range is characterized by

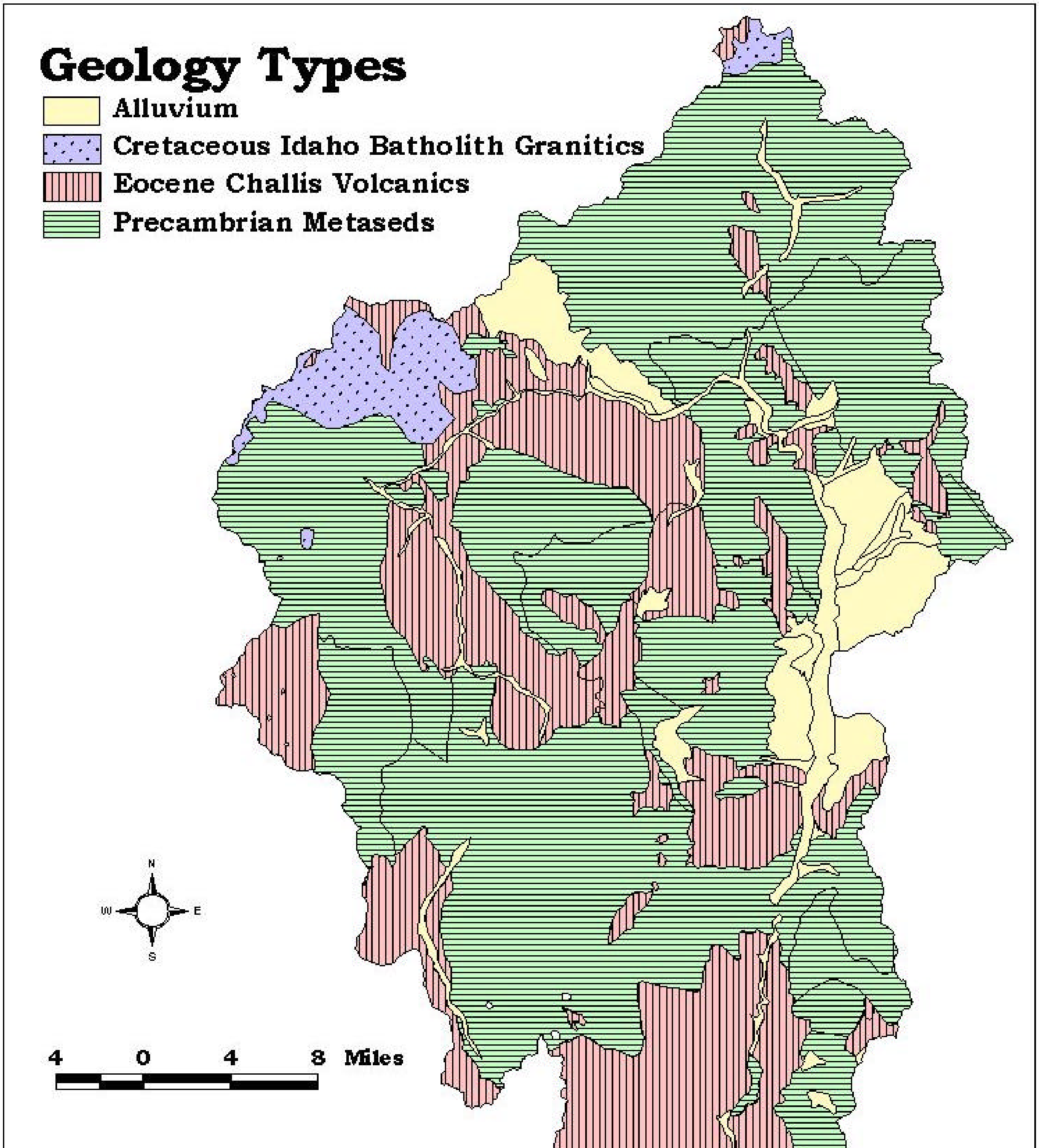



Figure 4. Geology of the Middle-Salmon Panther subbasin.

Precambrian Quartzite with the Challis Volcanics overlying the lower portions. The Precambrian sediments differ in this area due to their finer grain.

Along the western boundary are the Yellowjacket Mountains, the Blackbird range, Big Horn Crags, and Beartrap Ridge. Flat-topped mountains with steep V-shaped drainages characterize the Western portion (SCNF, 1993). Elevations in this area reach 8,450 feet. The Yellowjacket and Blackbird ranges are mainly made up of Precambrian metasediments and some intrusives that have undergone faulting (USDA, 1982). The rock types found in this area include garnet schist, phyllite, and quartzites. Cobalt, copper, and iron deposits are common throughout this area.

Along the northern edge of the watershed reside the Bitterroot Mountains. The Bitterroot Mountain range borders the north and north-eastern portions of the subbasin along the Idaho-Montana Border. The elevations along this boundary vary from 9,154 feet (Allan Mountain) to 5,734 feet along Lost Trail Pass. The dominant rock type is quartzite parent material made up of the Precambrian basement complex. A small intrusion of granite that makes up part of the Idaho Batholith is also located along this northern boundary. Landtypes of this area include steep canyonlands with a 60-90 percent gradient, mountain slopelands with V-shaped valleys, and Cryic uplands including those mountain ranges greater than 6,500 feet. Soils tend to be shallow to moderately deep in the mountains and moderately deep to deep in valley bottoms (SCNF, 1993).

### 1.4 Vegetation (from SNF, 1988)

Elevational range within this subbasin is very large, extending from less than 2,100 feet along the lower Salmon River to greater than 10,000 feet in the Lemhi Mountain Range. Thus, vegetation patterns are quite variable, from dry sagebrush/bunchgrass communities to typical western alpine flora. The Salmon River valley is typically rangeland with some irrigated agriculture.

In the lower Salmon River section of the subbasin, steepness and aspect strongly influence the vegetation type at lower elevations. South-facing exposures are typically composed of bluebunch wheatgrass, curly-leaved mountain mahogany, rabbitbrush, and sagebrush. North-facing aspects can be timbered with ponderosa pine and Douglas fir as well as lodgepole and aspen or cottonwood.

Farther up the Salmon River in the southern and eastern portions of the Salmon-Challis National Forest, lower elevations are less steep. Sagebrush/bunchgrass communities are found on south aspects, while north-facing aspects are dominated by Idaho fescue with a sparse overstory of Douglas fir.

Throughout the subbasin lower elevation shrub-dominated communities are highly intergraded with higher-elevation coniferous forests. There are no distinct lines between these two types of communities. For example, Douglas fir and lodgepole pine can be found growing on cooler aspects down into the sagebrush zone. Conversely, mountain big sagebrush communities reach up into the spruce/fir zone.

Precambrian Quartzite with the Challis Volcanics overlying the lower portions. The Precambrian sediments differ in this area due to their finer grain.

Along the western boundary are the Yellowjacket Mountains, the Blackbird range, Big Horn Crags, and Beartrap Ridge. Flat-topped mountains with steep V-shaped drainages characterize the Western portion (SCNF, 1993). Elevations in this area reach 8,450 feet. The Yellowjacket and Blackbird ranges are mainly made up of Precambrian metasediments and some intrusives that have undergone faulting (USDA, 1982). The rock types found in this area include garnet schist, phyllite, and quartzites. Cobalt, copper, and iron deposits are common throughout this area.

Along the northern edge of the watershed reside the Bitterroot Mountains. The Bitterroot Mountain range borders the north and north-eastern portions of the subbasin along the Idaho-Montana Border. The elevations along this boundary vary from 9,154 feet (Allan Mountain) to 5,734 feet along Lost Trail Pass. The dominant rock type is quartzite parent material made up of the Precambrian basement complex. A small intrusion of granite that makes up part of the Idaho Batholith is also located along this northern boundary. Landtypes of this area include steep canyonlands with a 60-90 percent gradient, mountain slopelands with V-shaped valleys, and Cryic uplands including those mountain ranges greater than 6,500 feet. Soils tend to be shallow to moderately deep in the mountains and moderately deep to deep in valley bottoms (SCNF, 1993).

### 1.4 Vegetation (from SNF, 1988)

Elevational range within this subbasin is very large, extending from less than 2,100 feet along the lower Salmon River to greater than 10,000 feet in the Lemhi Mountain Range. Thus, vegetation patterns are quite variable, from dry sagebrush/bunchgrass communities to typical western alpine flora. The Salmon River valley is typically rangeland with some irrigated agriculture.

In the lower Salmon River section of the subbasin, steepness and aspect strongly influence the vegetation type at lower elevations. South-facing exposures are typically composed of bluebunch wheatgrass, curly-leaved mountain mahogany, rabbitbrush, and sagebrush. North-facing aspects can be timbered with ponderosa pine and Douglas fir as well as lodgepole and aspen or cottonwood.

Farther up the Salmon River in the southern and eastern portions of the Salmon-Challis National Forest, lower elevations are less steep. Sagebrush/bunchgrass communities are found on south aspects, while north-facing aspects are dominated by Idaho fescue with a sparse overstory of Douglas fir.

Throughout the subbasin lower elevation shrub-dominated communities are highly intergraded with higher-elevation coniferous forests. There are no distinct lines between these two types of communities. For example, Douglas fir and lodgepole pine can be found growing on cooler aspects down into the sagebrush zone. Conversely, mountain big sagebrush communities reach up into the spruce/fir zone.

Forests follow typical zonation patterns with ponderosa pine and Douglas fir at lower elevations and a spruce/fir zone at higher elevations. In this subbasin, the spruce/fir zone is heavily dominated by lodgepole pine giving way to Douglas fir at lower portions of this zone. High- elevation forests typically have Engelmann spruce, subalpine fir, whitebark pine, and limber pine. The alpine zone starts at elevations ranging from 9,500 - 10,000 feet. Open parks and wet meadows, with species such as sedges, tufted hairgrass, bluegrass, American bistort, groundsel, fleabane, and geranium, are common throughout the forest.

The 2.4 million acres of Lemhi County are divided into 1.4 million acres of forest land and 1 million acres of nonforest land (Table 6). The majority of the forestland (approximately 1.3 million acres) is considered merchantable timberland. Of that 1.3 million acres of timberland, only 100,000 acres is found in ownership other than national forest (Table 7). Fifty percent of the timberland is in the Douglas fir forest type with another quarter of the area in lodgepole pine (Table 8). The remaining quarter of the timberland area includes spruce/fir, and ponderosa and other pines.

### 1.5 Fisheries

Bull Trout and Brook Trout

The entire Salmon-Panther subbasin is included in bull trout key watersheds as delineated by the State of Idaho Bull Trout Conservation Plan (Batt, 1996) (Figure 5 and 6). Key watersheds within the subbasin are called Owl Creek, Indian Creek, North Fork Salmon River, Panther Creek, Carmen Creek Area, and Hat/Iron Area.

**Table 6 Land class area (in acres) for Lemhi County.**

| | Forest Land | | | | Nonforest |
|---|---|---|---|---|---|
| All Land | Total | Timberland | Other Forest | Reserved | |
| 2,410,300 | 1,390,200 | 1,313,500 | 76,700 | 0 | 1,020,100 |

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig/)

**Table 7 Timberland ownership acreage in Lemhi County.**

| All Owners | National Forest | BLM | State | Farmer/ Rancher | Private Corp. | Private Individual |
|---|---|---|---|---|---|---|
| 1,313,500 | 1,214,200 | 66,600 | 13,000 | 6,200 | 3,600 | 9,900 |

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig/)

**Table 8 Area (acres) of timberland by forest type and ownership in Lemhi County.**

| | | National | Other Public | |
|---|---|---|---|---|

| Forest Type | All Owners | Forest | (BLM and State Land) | Private |
|---|---|---|---|---|
| Spruce / Fir | 114,500 | 114,500 | 0 | 0 |
| Douglas fir | 676,600 | 619,900 | 53,100 | 3,600 |
| Ponderosa Pine | 65,000 | 65,000 | 0 | 0 |
| Lodgepole Pine | 334,100 | 330,400 | 0 | 3,600 |
| Other Pines | 102,700 | 76,100 | 26,500 | 0 |
| Conifer Total | 1,292,900 | 1,206,000 | 79,600 | 7,300 |
| Elm-Ash-Cottonwood | 12,400 | 0 | 0 | 12,400 |
| Nontyped | 8,200 | 8,200 | 0 | 0 |
| All Types Total | 1,313,500 | 1.214,200 | 159,200 | 19,700 |

Source: FIA Database Retrieval System (www.srsfia.usfs.msstate.edu/scripts/twig/)

In the Allison Creek subwatershed, bull trout are found in the north and south forks as well as Poison, McKim, and Cow Creeks. In the Iron Creek subwatershed, bull trout have a strong resident population in Iron Creek as well as its north, south, and west forks. They are cut off from migration by private land diversions at lower elevations. A strong resident population is also found in Twelvemile Creek of the subwatershed by the same name. Upstream migration of bull trout in Twelvemile creek may still be precluded by one or more diversion structures below the Forest boundary. Brook trout have not been documented as present in Twelvemile Creek.

In the Lake Creek subwatershed, two resident bull trout populations exist; both are isolated from each other and from migration. One population exists in tributaries above and in Williams Lake; the other exists in Lake Creek between a natural barrier (falls) near the Salmon River and the dam/slide at the lake. These populations are experiencing risks due to sediment in the upper tributaries, development along the lake and irrigation diversions in lower reaches. Bull trout are also found in Williams Creek and its north and south forks.

In the Carmen Creek subwatershed, a strong resident population of bull trout is in Carmen Creek and may be present in Freeman Creek. Migration to and from the Salmon River is questionable due to irrigation diversions. As stated in bull trout Biological Assessment documentation done by federal land management agencies and cited in the Upper Salmon Bull Trout Problem Assessment (SBTA, 1998): "Fluvial population [of bull trout] may be present, but if lacking, is

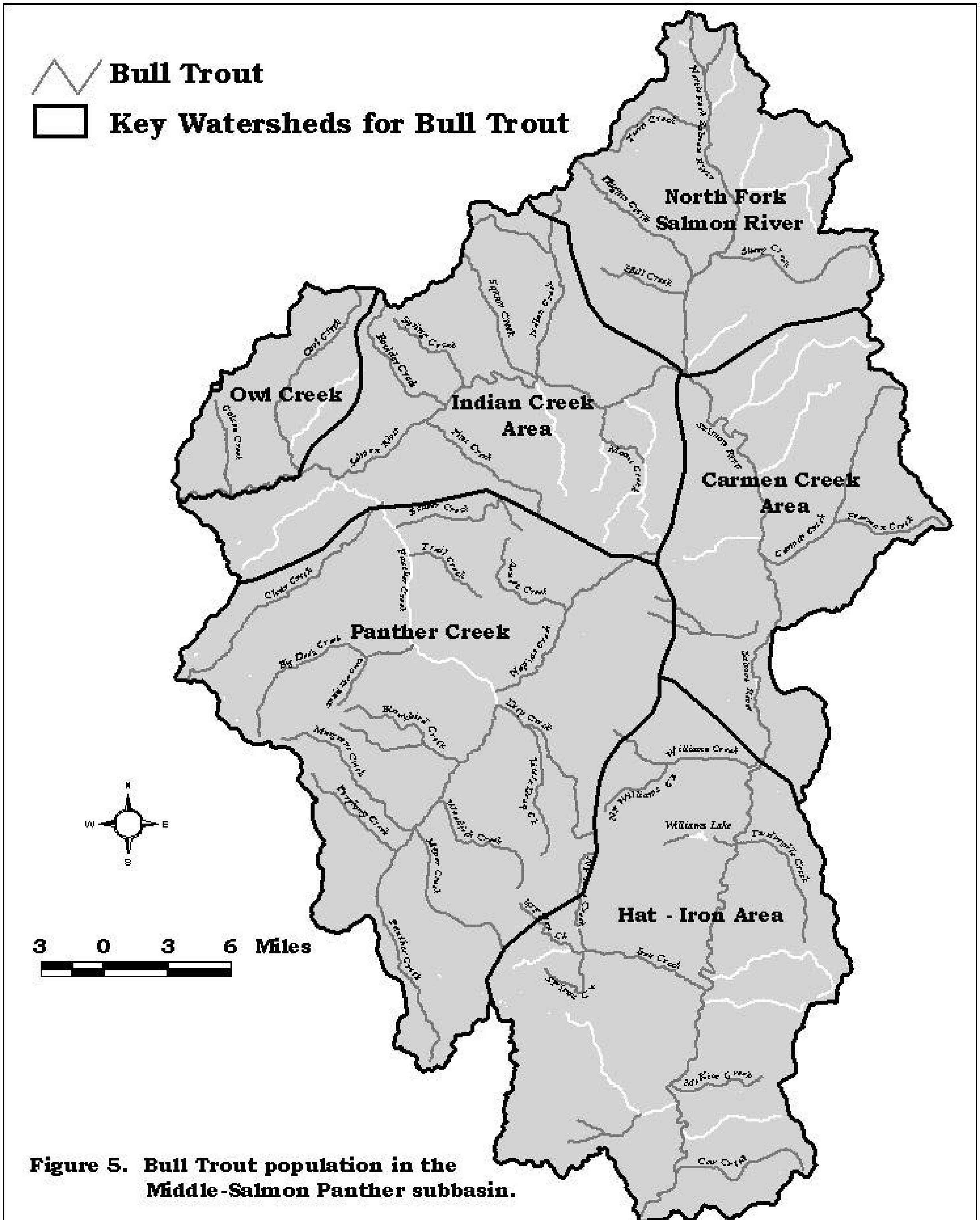



**Figure 5. Bull Trout population in the Middle-Salmon Panther subbasin.**

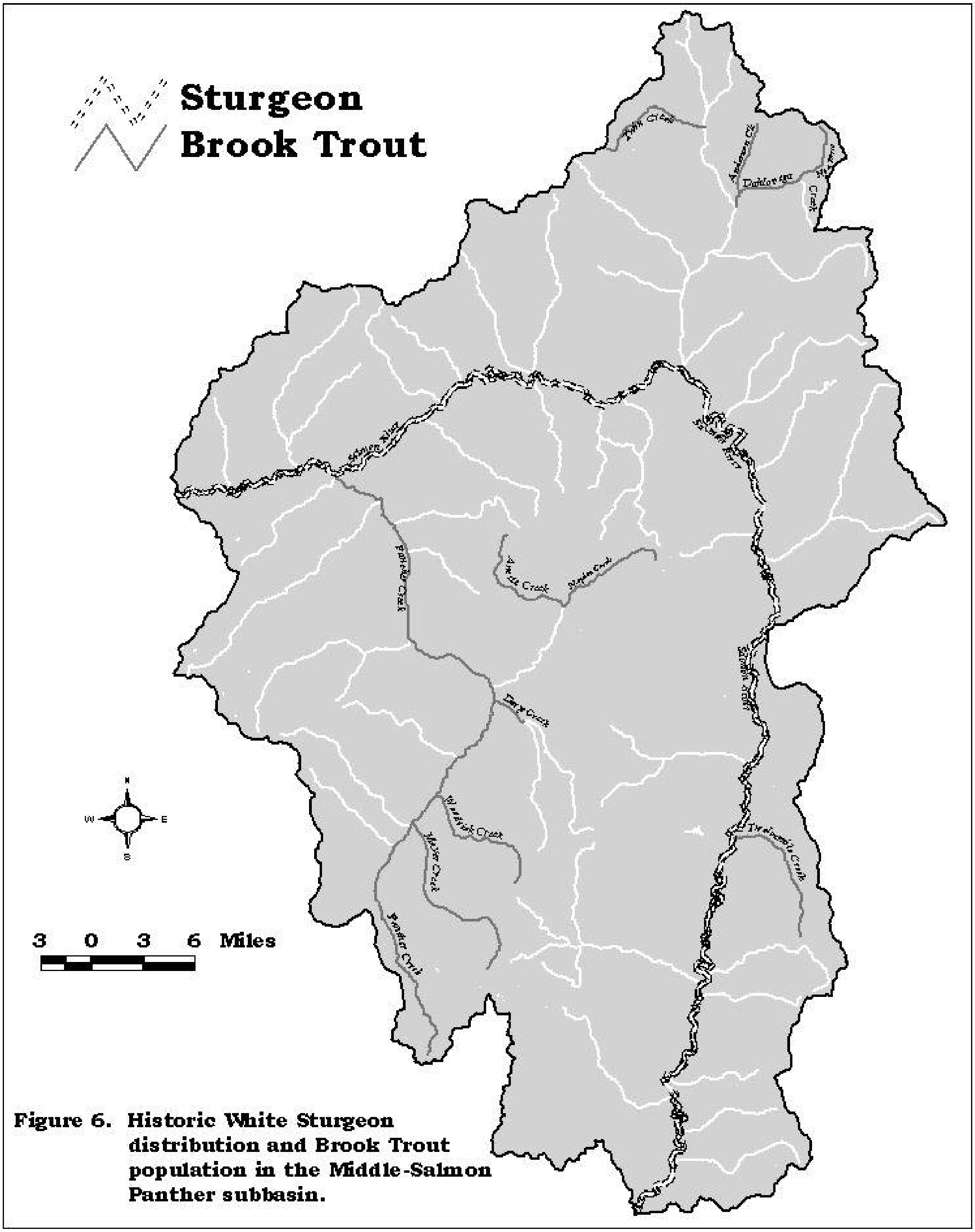



**Figure 6. Historic White Sturgeon distribution and Brook Trout population in the Middle-Salmon Panther subbasin.**

due to dewatering for irrigation purposes on private. Physical barriers, unscreened diversions, exist that create seasonal dewatering for irrigation purposes. Flow is impacted by water diversions on private lands and federal actions have no effect." There are no brook trout in the Carmen Creek system; however, resident cutthroat and rainbow trout are present.

The Tower Creek subwatershed groups Tower Creek, Fourth-of-July Creek, and Wagonhammer Creek together, though all are separate tributaries to the Salmon River. Fourth-of-July Creek and its tributary Little Fourth-of-July Creek probably contain a strong resident population of bull trout; however, none of the other streams do. Migration may be hampered by diversion structures in Fourth-of-July Creek.

The North Fork Salmon River watershed includes a number of tributaries, some of which have bull trout populations. The headwaters subwatershed includes that portion of the North Fork Salmon River from Johnson Gulch to Lost Trail Pass. Within this subwatershed, the very headwaters of the North Fork and Moose Creek contain bull trout; however, other tributaries do not. Hull Creek contains no bull trout as a five-acre pond on private land acts as a barrier. In the Sheep Creek watershed, Sheep Creek and its north and south forks all have bull trout. Bull trout are also found in Twin Creek. No bull trout are found in Hughes Creek and Dahlonega Creek watersheds. Dahlonega and Threemile Creeks have brook trout.

In the lower Salmon River section of the subbasin all the subwatersheds contain bull trout. In Middle Salmon subwatershed Boulder, East Boulder, Pine, and Spring Creeks contains bull trout. It is unknown whether or not Moose or Dump Creek have bull trout. In Indian Creek subwatershed, Indian, WF Indian, Corral, McConn, and Squaw Creeks all have bull trout in them. The remaining subwatersheds of Lower Salmon and Owl Creek contain bull trout.

Most major tributaries within the Panther Creek drainage contain bull trout. Exceptions include the lower Panther Creek below Deep Creek and Garden Creek. Brook trout are found in the entire length of Panther Creek and in Moyer and Woodtick Creeks. The upper Napias Creek and Arnett Creek also contain brook trout.

<u>Salmon</u>

The Salmon River is used as a migration corridor through the subbasin for anadramous fish including steelhead trout, sockeye salmon, and spring/summer Chinook salmon (SCNF, 1993). Most streams that are tributary to the Salmon River are critical habitat for Chinook. Various tributaries that are accessible are used, or were used when they were accessible, for spawning and rearing areas or as cold water refugia by steelhead and Chinook. The lower reaches of tributary creeks currently provide marginal habitat for anadramous fish as cold water refugia or in some cases limited spawning and/or rearing habitat for Chinook and steelhead. For example, recently juveniles of Chinook and steelhead have been seen in Moose, Dump, and East Boulder Creeks. The Salmon River provides migration pathways for non-anadramous salmonids such as cutthroat and bull trout. Specific details regarding past and/or present access are discussed in the subwatershed characteristics section of this report. Sockeye migrating through the subbasin are extremely limited, with only one fish making it to Redfish Lake in 1998.

Rainbow/Steelhead

Rainbow/steelhead trout were at one time most widely distributed in the upper Salmon River portion of this subbasin (SBTA, 1998). Some headwater populations have become resident rainbows and no longer migrate to the river. Currently, most wild steelhead are entering tributaries down river from the North Fork Salmon River to spawn, including Shell, Long Tom, Colson, Garden, Owl, Panther, Pine, Spring, and lower Indian Creeks (USFS, 1999). Resident rainbow trout are strongest in the Pahsimeroi River, Lemhi River, and that section of the Salmon River near Challis. Overall, the Salmon River population of rainbows is low and somewhat limited in extent.

Cutthroat Trout

Westslope cutthroat trout, once found throughout the subbasin (Figure 7), are primarily limited to small headwater resident populations within the subbasin (SBTA, 1998). The migratory form of cutthroat trout is believed extinct. Westslope cutthroat trout are found primarily in the Panther Creek subwatershed, the North Fork Salmon River drainage and tributaries to the lower Salmon River (SBTA, 1998), including Colson, Owl, Garden, Clear, Panther, Pine, Spring, and lower Indian Creeks (USFS, 1999). Up river from the town of Salmon, cutthroat are also found in Twelvemile Creek, McKim Creek, and Allison Creek. Cutthroat are also found in Carmen and Freeman Creeks.

Other Fishes

Resident salmonids in the Salmon River include rainbow, cutthroat, and bull trout, and mountain whitefish. Mountain whitefish have relatively healthy populations throughout the subbasin. Non-salmonids in the vicinity include northern pikeminnow, redside shiner, chiselmouth, and several species of sculpin and suckers. According to the Forest Service, carp have been seen as far up-river as the Deadwater Area of the Salmon River, and smallmouth bass were caught near McKim Creek (Rose, 1999).

The upper reaches of East Boulder, Moose, and Dump Creeks are isolated from migratory fishes by high gradient breakland reaches that preclude movement (Rose, 1999). East Boulder Creek has an isolated population of cutthroat trout in the upper reaches that were introduced in the 1930s. It is believed that they are not Westslope cutthroat. The upper reaches of Moose Creek have an isolated population of rainbow trout possibly introduced at about the same time.

Recent Fish Collections

USGS collected fish through electro-fishing on the Salmon River near Cottonwood Campground just upstream from the Pahsimeroi River and near Fourth of July Creek (Maret, 1999) (see Appendix G).

USGS collected, measured and weighed Chinook, rainbow/steelhead, mountain whitefish, largescale sucker, mottled sculpin, shorthead sculpin, chiselmouth, longnose dace,

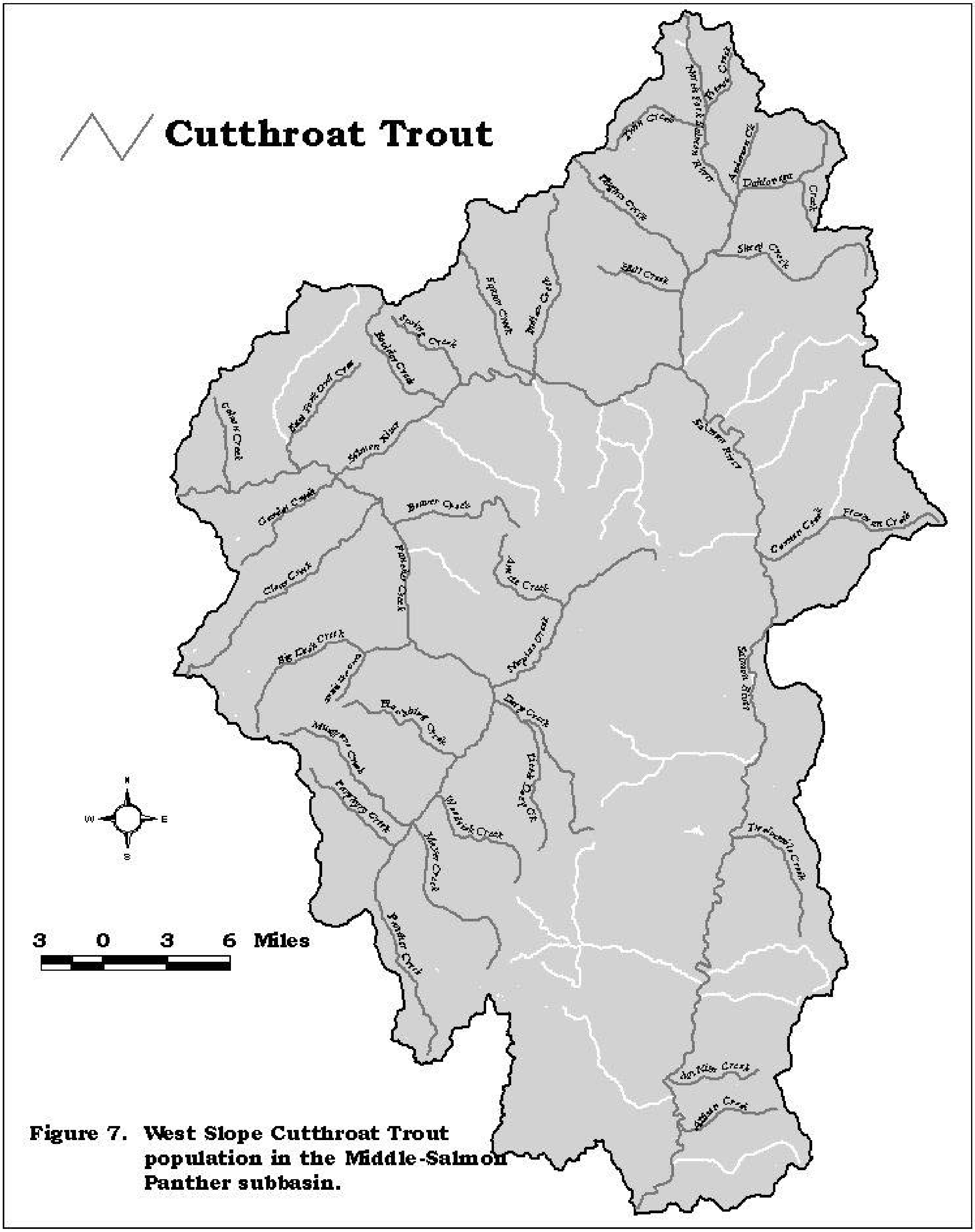



**Figure 7. West Slope Cutthroat Trout population in the Middle-Salmon Panther subbasin.**

speckled dace, northern pikeminnow, and redside shiner at the Cottonwood Campground location. At the Fourth of July Creek location, USGS collected, measured and weighed Chinook, cutthroat, rainbow/steelhead, mountain whitefish, largescale sucker, largescale x bridgelip sucker hybrid, mountain sucker, bridgelip sucker, mottled sculpin, shorthead sculpin, chiselmouth, leatherside dace, longnose dace, speckled dace, northern pikeminnow, and redside shiner.

Snorkel data collected by Idaho Department of Fish and Game (IDFG) from five sites on Panther Creek from Clear Creek to Moyer Creek during 1993-1999 show ranges of overall fish densities as follows:

| | |
|---|---|
| Rainbow/steelhead | 0.5 - 4.1 fish/100 square meters ($m^2$) |
| Cutthroat Trout | 0.01 - 0.03 fish/100 $m^2$ |
| Brook Trout | 0.2 - 1.4 fish/100 $m^2$ |
| Bull Trout | 0.02 - 0.1 fish/100 $m^2$ |
| Whitefish | 0.3 - 2.4 fish/100 $m^2$ |
| Chinook (juveniles) | 0.02 - 0.05 fish/100 $m^2$ |

IDFG also documented the presence of dace, sculpin, and suckers; however, none were identified by species.

## 1.6 Land Ownership and Land Use

The majority of the subbasin is public land. The Salmon-Challis National Forest occupies 76% of the land area and 11% belongs to the Bureau of Land Management (BLM) (Figure 8). Private ownership within the subbasin constitutes approximately 6%. Private ownership of the area is generally concentrated in the Salmon River Valley near the city of Salmon.

The largest city located in this subbasin is Salmon, with a population of 3,393 (Idaho Department of Commerce, 2000). Smaller towns include North Fork, Carmen, Gibbonsville, and Shoup. The subbasin is completely included within Lemhi County (population: 8,030 people). Lemhi County includes area outside of this subbasin such as the Lemhi River subbasin and parts of Pahsimeroi River, Middle Fork Salmon River, Birch Creek and Little Lost River subbasins.

On average, the subbasin has had a 15% increase in population from 1990 to 1998 (Idaho Department of Commerce, 2000). Most of the population is concentrated within the Salmon River Valley. The lowlands are used primarily for agriculture (Figure 9). The agriculture lands are mainly used for livestock and hay production. Agriculture has been a major part of the economic base of the subbasin since the beginning of the century and continues to be a key industry in the area (SNF, 1982).

The increase in population has resulted primarily from the recreational opportunities the area provides: hunting, fishing, hiking, camping, and river rafting. As a result of this increase, some

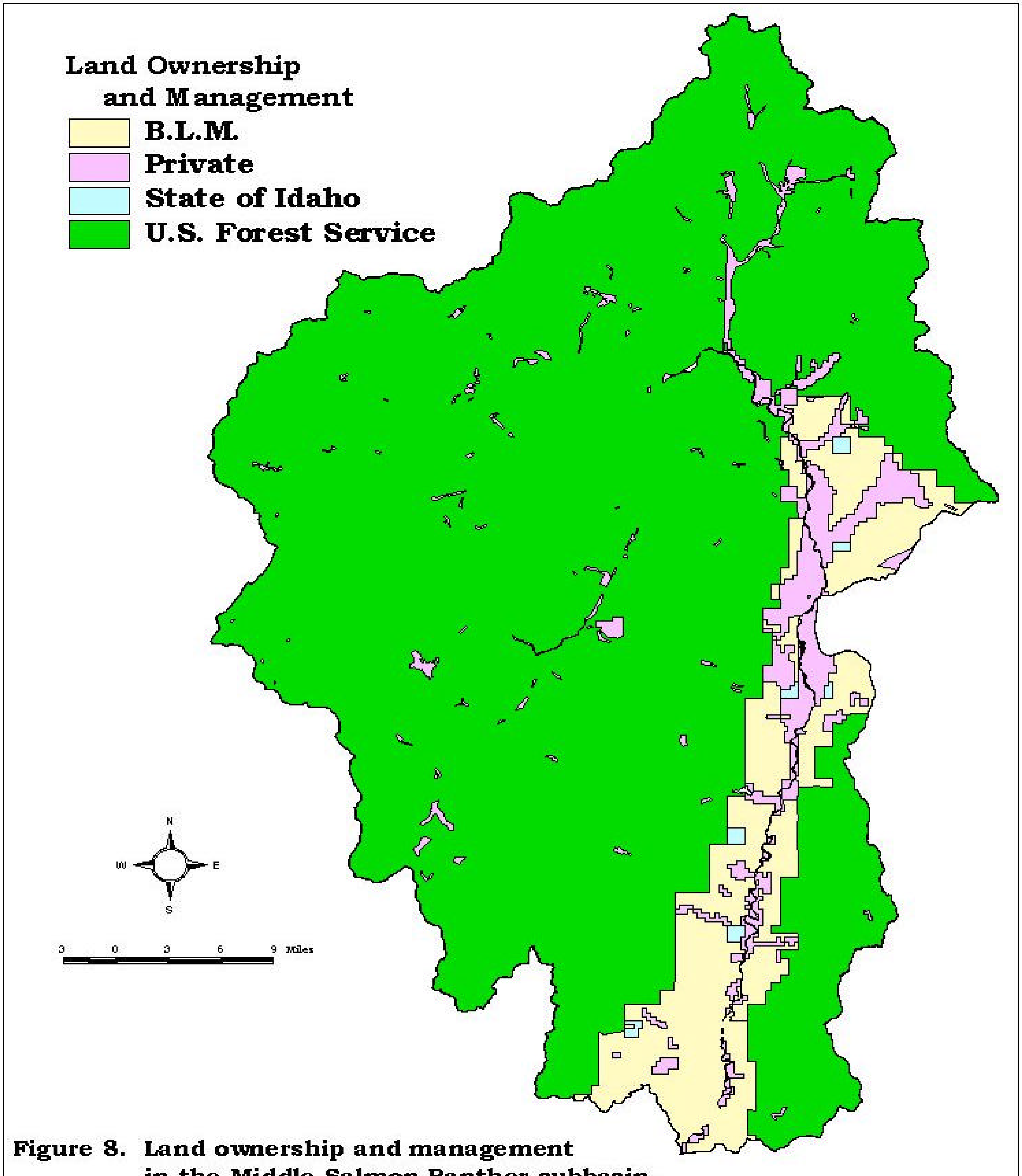



**Figure 8. Land ownership and management in the Middle-Salmon Panther subbasin.**

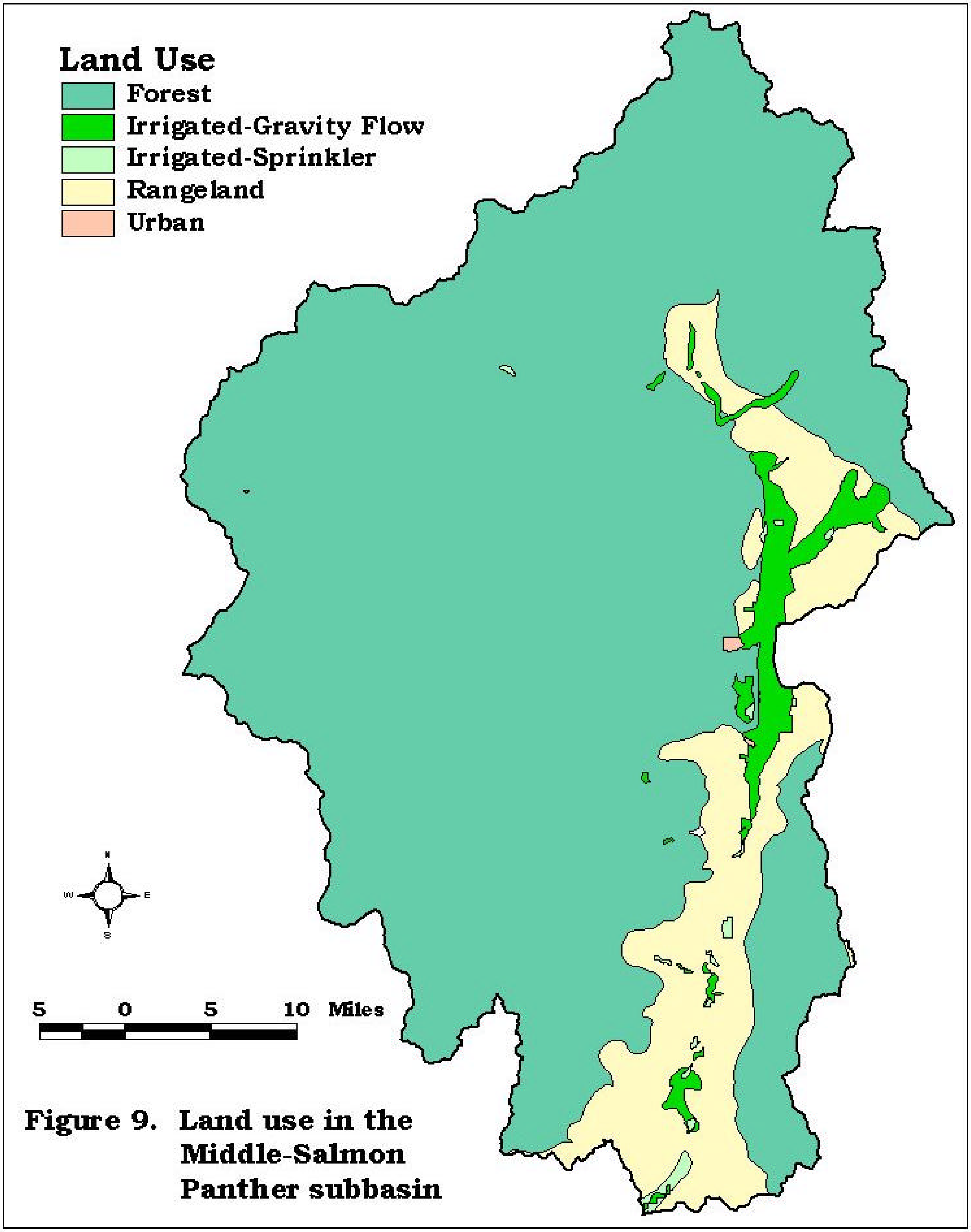



**Figure 9. Land use in the Middle-Salmon Panther subbasin**

agricultural lands in the subbasin have been converted into urban or residential areas. Recreational activities now constitute an important part of the economy.

Mining companies have been another employer in the subbasin. In the past, there have been many areas explored for mining. Currently mining has ceased at the Beartrack mine. The cyanide heap leach is still operating and will continue as long as gold recovery is economical. The Beartrack mine is moving into the reclamation/closure phase. There are a few small claims scattered about the subbasin. Beartrack Mine employment is currently less than 50 people.

The Blackbird mine, a major supplier of cobalt during World War II, ceased operations in 1982 and is now undergoing regulated cleanup. The area of Blackbird Mine is one of the largest cobalt deposits in North America (Mebane, 1994). Cobalt and copper were mined and milled at the site from 1917 to 1967 (SCNF, in prep.). The main period of extraction followed World War II, from 1949 to 1967. No commercial mining has occurred at Blackbird Mine since 1967. The mine is comprised of about 15 miles of underground workings, a 12-acre open pit, and approximately 84 acres of exposed waste rock (Mebane, 1994).

There is little timber harvesting occurring in the subbasin. In the past, timber production was a major contributor to the Salmon economy. Since the 1960s, logging activities have been on the decline throughout the subbasin. There is currently one timber product plant, located in Lemhi County, that is primarily used for the production of beams.

A small portion of the subbasin lies within the Frank Church River of No Return Wilderness. The entire Frank Church River of No Return Wilderness encompasses 2.3 million acres of Idaho's land. The small portion of the Wilderness in this subbasin includes Clear Creek and the headwaters of the 1998 303(d) listed Big Deer Creek, and borders the southern edge of the Salmon River from Panther Creek to the Middle Fork Salmon River.

## 2.0 Watershed Descriptions

This subbasin can be divided up into 23 fifth field HUCs or subwatersheds (Figure 10). On the eastern side of the subbasin along the Salmon River are Warm Springs Creek, Iron Creek, Hat Creek, Rattlesnake Creek, Williams Creek, Salmon, Carmen Creek, Tower Creek, Napoleon Hill, and the North Fork of the Salmon River. The subwatersheds on the western side include Indian Creek, Middle Salmon River, Owl Creek, Lower Salmon River, Lower Panther Creek, Clear Creek, Deer Creek, Big Juneau Creek, Napias Creek, Deep Creek, Middle Panther Creek, Upper Panther Creek, and Moyer Creek. Those subwatersheds with 1998 303(d) listed waters are identified in Table 9.

Tributaries to the Salmon River within this subbasin tend to be mountainous, high-gradient, high- energy streams dominated by snowmelt runoff.  The streams tend to be in V-shaped

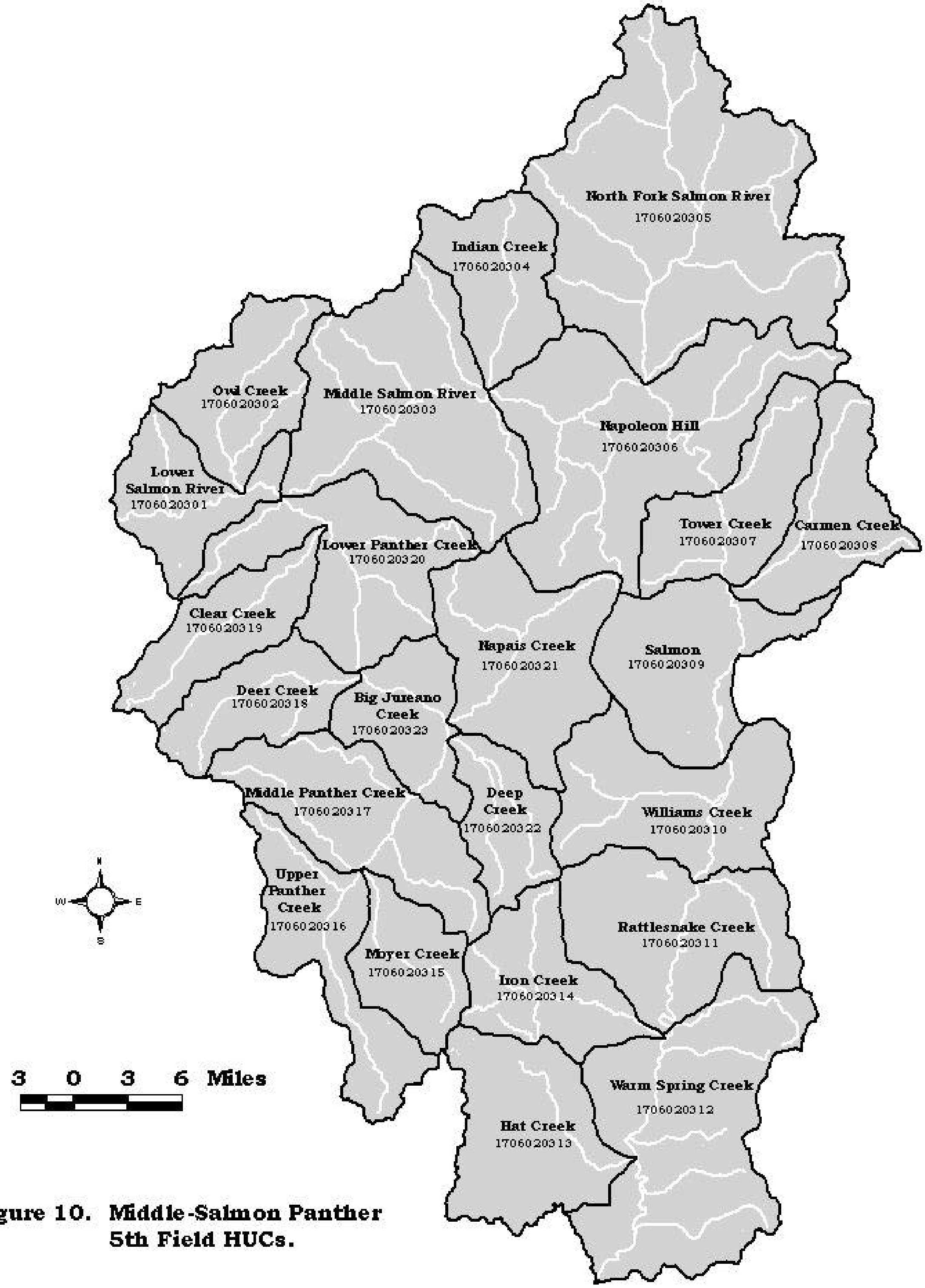



**Figure 10. Middle-Salmon Panther 5th Field HUCs.**

**Table 9 Quick Reference to 1998 303(d) Listed Waters by Subwatershed.**

| Subwatershed | 1998 303(d) Listed Water | Pollutant of Concern | Potentially Affected Beneficial Use(s) | Page Number |
|---|---|---|---|---|
| Middle Panther Creek | Blackbird Creek (below mine) | Sediment, pH, metals | cold water biota, salmonid spawning, primary contact recreation, secondary contact recreation | 30 |
| Deer Creek | Bucktail Creek | Sediment, pH, metals | cold water biota, salmonid spawning | 32 |
| Deer Creek | Big Deer Creek (below South Fork Big Deer Creek) | Sediment, pH, Metals | cold water biota, salmonid spawning | 32 |
| Big Jureano, Lower Panther Creek | Panther Creek (below Blackbird Cr.) | Sediment | cold water biota, salmonid spawning | 31,33 |
| Napoleon Hill | Dump Creek | Sediment | cold water biota | 33 |
| Tower Creek | Diamond Creek | unknown | cold water biota | 35 |
| Tower Creek, Salmon, Williams Creek, Rattlesnake Creek, Warm Spring Creek | Salmon River (Pahsimeroi R. To NF Salmon R.) | unknown | cold water biota | 35-41 |
| Rattlesnake Creek | Williams Lake | Dissolved Oxygen, Nutrients | cold water biota | 38,39 |

valleys, classified as a Rosgen class A type stream. A class A stream has a gradient greater that 4% with channels that are high gradient, low sinuosity, and a low width-to-depth ratio. Substrates common to Class A streams are boulders (A-2 channel type) and cobble (A-3 channel type). These channel types are stable due to the large substrates and high bank rock content. Class A channels have little meandering and are moderately confined (SCNF, 1993).

In areas where stream gradients decrease to between 2 to 4 percent, Rosgen channel types change to a class B-type channel. Class B stream channels have moderate sinuosity and moderate width-to- depth ratio. The predominant substrates in Class B type streams include cobble (B-3 channel type) and gravel (B-4 channel type). These channel types are moderately confined and exhibit some lateral movement or meandering (SCNF, 1993).

Streams that have low gradients (less than 2%), wide, flat-floored valley bottoms are considered Rosgen Class C type channels. Class C channel types are sinuous, have a high width/depth ratio, and are highly susceptible to stream bank damage. The Class C channels also exhibit high lateral movement or meandering throughout erodible soils.

The following is a description of the 23 subwatersheds located within this subbasin. Much of the material used in these descriptions is found in the 1993 Watershed Characterizations, by the Salmon-Challis National Forest (SCNF, 1993), or as otherwise cited.

## 2.1 Owl Creek

The Owl Creek subwatershed is located along the lower mainstem of the Salmon River. It is a high-energy, third-order stream that enters into the Salmon River from the North. Owl Creek subwatershed originates at an approximate elevation of 8,350 feet. The perennial stream miles total 92.4, with a mean annual flow of 51.8 cfs (SCNF, 1993). The USFS owns 91.4 miles along the stream while 1.0 mile is owned privately. Approximately 48% of the stream is between 4-10% gradient, and 38% of the stream is greater than 10% gradient.

Logging activities have taken place in this watershed since the early 1930s up to the late 1980s. The Long Tom fire dramatically influenced the watershed in 1985 (SCNF, 1993). A total of 27,000 acres were burned in this drainage, thus creating larger-than-normal sediment loads. Sediment sampling in 1999 shows that the upper reaches of the creek are improving (see Assessments). The survey results rated Owl Creek Agood@ with 16.6% fine sediment, 85 % stream bank stability, and a 100% rating for biotic potential. Fishery habitat improved in 1989,
when three migration barriers were removed.

## 2.2 Lower Salmon River

The streams located in this subwatershed include Colson Creek, Ebeneezer Creek, and Long Tom Creek. The area of the entire subwatershed is 30,079 acres (47 miles$^2$). The major stream of this watershed is Colson Creek. Colson Creek is high energy, with a Rosgen channel type of A3, that is a high-gradient, single entrenched stream channel with a low width-to-depth ratio and
low sinuosity. The mean annual flow for the watershed is 6 cfs with its peak mean monthly flow at 24 cfs in June and its low mean monthly flow at 2 cfs from November to March. Sixty-six percent (66%) of the stream is between 4-10% gradient, and 34% of the stream is greater that 10% gradient.

The total length of the streams in the subwatershed is 35 miles. The USFS owns 34.3 miles while 0.7 mile is owned privately. There have been timber harvesting activities in the subwatershed since the 1930s. Most of these activities have occurred since the 1960s.

Fires occurring in 1969, 1986, and 1992 have minimally influenced the watershed. The largest fire occurred in 1986, when a total of 2070 acres were burned out of this drainage (SCNF, 1993). Fishery habitat improvements occurred in 1991; six culverts in the watershed were rehabilitated to enhance fish passage.

## 2.3 Middle Salmon River Subwatershed

The Middle Salmon River subwatershed is a large drainage on the North side of the lower Salmon River. The major steams in this watershed include Spring Creek, Squaw Creek, Boulder Creek, Sage Creek, and Pine Creek. The area of the entire subwatershed is 83,762 acres (130.9 miles$^2$). Approximately 140 major stream miles are within the watershed and are mostly Rosgen Class A streams. Flow data for the larger streams of this watershed are located in Table 10.

Logging activities have taken place throughput the watershed since the 1900s with the majority occurring after 1960. Most of the logging was done by tractor and cable with a few scattered clearcuts throughout the basin. The Marlin Springs Fire burned in the headwaters of Squaw Creek during the 2000 fire season. A small livestock grazing allotment lies along the Sage Creek Watershed. Some placer mining activities have taken place along East Boulder Creek (Rose, 1999). As a result of damage from the mining activities, restoration efforts are currently taking place to restore streambank stability and vegetation along the East Boulder Creek Watershed (see Pollution Control Efforts).

## 2.4 Indian Creek Subwatershed

The Indian Creek subwatershed is located on the North side of the Salmon River. Indian Creek is the only major stream in the subwatershed, which covers approximately 34,392 acres (53.7 miles$^2$) with 33.3 total stream miles. Indian Creek is a third-order stream and is primarily described as a Rosgen Class A stream with Class B characteristics in the lower reaches. The mean annual flow for Indian Creek is 27.5 cubic feet per second (cfs). Streamflow can get as high as 110 cfs in the high-water season and as low as 9 cfs in the low-water season (see Table 10).

Timber harvest has occurred since the 1900s, with most occurring during the 1950s and 1960s. Minor fires (less than 10 acres in size) have occurred throughout the watershed. A fire caused by human activity that burned over 1000 acres in 1960 caused the majority of the forest openings seen today. During the 2000 fire season the Marlin Springs Fire burned in the McConn Creek drainage. McConn Creek is a headwater tributary of Indian Creek.

Habitat improvements were made in 1991 to the lower reaches of the stream to enhance salmonid spawning and rearing habitat. Improvements included building 12 rock dams to enhance pool frequency and repair stream channels.

## 2.5 North Fork Salmon River Subwatershed

The North Fork Salmon River subwatershed is located on the northern-most extent of the subbasin along the Idaho-Montana border. The subwatershed encompasses Moose Creek, Pierce Creek, Twin Creek, Anderson Creek, Dahlonega Creek, Sheep Creek, Hughes Creek, Hull Creek, Big Silverlead Creek, Lick Creek, Ditch Creek, and the North Fork of the Salmon River.

**Table 10  Flow Data for Various Streams in the Salmon-Panther Subbasin.**

| Subwatershed | Stream | Mean Annual Flow (cfs) | Max. Mean Monthly Flow in cfs (June) | Min. Mean Monthly Flow in cfs (January) |
|---|---|---|---|---|
| Lower Salmon River | Colson Creek | 6.0 | 24 | 2 |
| Owl Creek | Owl Creek | 51.8 | 208 | 1 |
| Middle Salmon River | Pine Creek | 13.2 | 53 | 4 |
| | Squaw Creek | 5.0 | 20 | 2 |
| | East Boulder Creek | 5.5 | 22 | 2 |
| | Spring Creek | 7.0 | 28 | 2 |
| | Big Squaw Creek | 17.2 | 68 | 5 |
| | Little Squaw Creek | 8.7 | 36 | 3 |
| | Boulder Creek | 13.0 | 52 | 4 |
| Napoleon Hill | Forth of July Creek | 23.2 | 54 | 4 |
| | Moose Creek | 17.8 | 85 | 4 |
| Indian Creek | Indian Creek | 27.5 | 110 | 9 |
| North Fork Salmon River | N Fk Salmon River | 90.0 | 314 | 33 |
| | Hull Creek | 3.5 | 14 | 1 |
| | Hughes Creek | 22.3 | 89 | 7 |
| | Ditch Creek | 7.6 | 31 | 2 |
| | Lick Creek | *** | | |
| | Sheep Creek | 27.4 | 110 | 9 |
| | Dahlonega Creek | 23.0 | 92 | 7 |
| | Anderson Creek | 4.5 | 18 | 1 |
| | Threemile Creek | 2.5 | 10 | 1 |
| | Twin Creek | 18.0 | 72 | 6 |
| | Pierce Creek | 4.5 | 18 | 1 |
| | W Fork of N Fork | 3.0 | 12 | 1 |
| | Moose Creek | 4.1 | 17 | 1 |
| Clear Creek | Clear Creek | 34.0 | 1057 | 11 |
| Lower Panther Creek | Panther Creek at Mouth | 265.0 | 136 | 83 |
| | Beaver Creek | 10.0 | 40 | 3 |
| Deer Creek | Big Deer Creek | 36.0 | 144 | 11 |
| Middle Panther Creek | Blackbird Creek | 12.0 | 48 | 4 |
| | Panther Creek | 30.0 | 120 | 9 |
| Napias Creek | Napias Creek | 39.0 | 160 | 12 |
| | Phelan Creek | 8.0 | 32 | 3 |
| | Arnett Creek | 12.0 | 48 | 4 |
| Deep Creek | Deep Creek | 20.0 | 80 | 6 |
| Upper Panther Creek | Woodtick Creek | 9.0 | 36 | 3 |
| | Musgrove Creek | 13.0 | 52 | 4 |
| | Porphyry Creek | 6.0 | 24 | 2 |

**Table 10 (Cont.) Flow Data for Various Streams in the Salmon-Panther Subbasin.**

| Subwatershed | Stream | Mean Annual Flow (cfs) | Max. Mean Monthly Flow in cfs (June) | Min. Mean Monthly Flow in cfs (January) |
|---|---|---|---|---|
| Moyer Creek | Moyer Creek | 19.0 | 77 | 6 |
| | S Fork Moyer | 8.0 | 32 | 3 |
| Hat Creek | Big Hat Creek | 7.5 | 30 | 2 |
| | Hat Creek | 15 | 60 | 5 |
| Iron Creek | Iron Creek | 18.9 | 76 | 6 |
| | N Fork Iron Creek | 9.4 | 38 | 3 |
| | S Fork Iron Creek | 3.8 | 15 | 1 |
| | W Fork Iron Creek | 6.3 | 25 | 2 |
| Warm Springs Creek | Warm Springs Creek | 5.1 | 21 | 2 |
| | Allison Creek | 5 | 20 | 2 |
| | Cow Creek | 17 | 69 | 5 |
| | McKim Creek | 16 | 64 | 5 |
| | Poison Creek | 3 | 20 | 1 |
| | S Fork Poison Creek | 5 | 33 | 2 |
| Rattlesnake Creek | Rattlesnake Creek | 3.4 | 13 | 1 |
| | Twelvemile Creek | 8.2 | 33 | 3 |
| Williams Creek | Williams Creek | 10 | 40 | 3 |
| | S Fk Williams Cr | 4 | 16 | 1 |
| | Lake Creek | 6.7 | 27 | 2 |
| Salmon | Jesse Creek | 5 | 20 | 2 |
| Tower Creek | Wallace Creek | 3 | 12 | 1 |
| Carmen Creek | Carmen Creek | 17.1 | 70 | 6 |

USDA. SCNF, 1993. Streamflow data is from Salmon-Challis National Forest Snake River Adjudication Files.

The area of the North Fork Salmon River subwatershed is approximately 136,981 acres (214 $miles^2$) and there are roughly 230 steam miles in this watershed with 83% controlled by the Salmon-Challis National Forest and 17% privately owned. The streams are predominantly Rosgen Class A-type streams with some changing to Class B as they enter the valley bottoms. Chinook salmon habitat is limited in some areas of the watershed but it is improving. Flow data for the major streams of this subbasin are located in Table 10.

Human activities affecting this subwatershed include timber harvesting, mining, livestock grazing, and recreation. Private land development along the North Fork of the Salmon River has significantly increased in recent years. Numerous stream crossings have been installed to access homesites. Various wetland assets have been impacted by development as well. Logging activities have occurred in this watershed since the early 1800s (SCNF, 1993). Most of the logging occurred after the 1950s. Current harvest methods used within this watershed include partial removals and clearcut logging in dense mature or diseased stands. There are many small mining claims scattered throughout the subwatershed. These claims have varying degrees of activity from year to year. Livestock grazing allotments occur within Hughes Creek, and Hull Creek drainages. The three allotments are designated for approximately 230 cow-calf pairs. Impact from these activities on the subwatershed are described as on the decline in recent years (SCNF, 1993).

There is an increasing demand for recreational opportunities throughout the subwatershed. The Lost Trail Ski Area and Twin Creek Campground are two developed recreational sites, with a variety of smaller sites throughout. Highway 93 that runs through the subbasin along the NF Salmon River is classified as the Salmon River Scenic Byway, and is a popular route for recreationists. This highway was under major construction in the area of Twin and Moose Creek at the time of this writing.

Few habitat improvements have occurred within the watershed. Stream habitat improvements that have been made include rehabilitating culverts on Twin Creek and Sheep Creek and placing instream structures in the North Fork Salmon River and Twin Creek (SCNF, 1993). During reconstruction of Highway 93 numerous culverts that were previously fish migration barriers were replaced with larger culverts that have improved migration capability. These rehabilitation efforts were made to improve fish passage for spring and summer Chinook salmon habitat.

## 2.6 Upper Panther Creek Subwatershed

Upper Panther Creek is located on the southeastern side of the subbasin. The major streams in this subwatershed include the headwaters of Panther Creek, and Porphyry Creek. Streams that flow into Upper Panther Creek also include Fourth of July Creek and Opal Creek. There are no 303(d) listed waters in this watershed, although Panther Creek is listed for metals in its lower reaches below Blackbird Creek. The area of Upper Panther Creek is 40,877 acres (63.9 miles$^2$) with approximately 58 miles of streams, primarily Rosgen Class A-type streams (SCNF, 1993). Flow data for the major streams of this subwatershed are located in Table 10.

Upper Panther Creek subwatershed is predominantly composed of National Forest Lands with only a small portion privately owned. Activities in this watershed include a few timber harvest activities, small mining exploration activities, small agricultural operations, and recreation at summer cabins.

Spawning and rearing habitat for the Chinook salmon is limited due to a migration barrier in Porphyry Creek. It is unknown if Chinook salmon historically inhabited the Upper Panther Creek reaches (SCNF, 1993). Recent habitat improvement activities include fencing a half-mile portion of Panther Creek near Opal Creek (USFS, 1998). This was done to improve bank stability and enlarge an existing riparian pasture.

## 2.7 Moyer Creek Subwatershed

Moyer Creek subwatershed includes Moyer Creek and the tributary South Fork of Moyer Creek. The watershed is 26,637 acres (41.6 miles$^2$) in size with approximately 20 stream miles (SCNF, 1993). Moyer Creek is a Rosgen Class A-type stream with 88 % of the creek having greater than 10% stream gradient.

The primary uses in this watershed include recreation. There are few documented problems with the Moyer Creek subwatershed. Habitat improvement on Moyer Creek has included placing boulders in the lower Moyer Creek drainage to improve instream cover, and culvert rehabilitation for fish passage. A tributary to Moyer Creek has been fenced to protect riparian vegetation and stream bank stability from livestock (USFS, 1998).

### 2.8 Middle Panther Creek Subwatershed

The Middle Panther Creek subwatershed encompasses Panther Creek (from Musgrove Creek to Blackbird Creek), Blackbird Creek, Woodtick Creek, Musgrove Creek, and the first order stream Copper Creek. The watershed area is 58,581 acres (91.5 miles$^2$) with approximately 44 stream miles. Stream gradients for the majority of the streams classify them as Rosgen Class A, with small portions classified as Class B (SCNF, 1993).

The 1998 303(d) listed stream in the Middle Panther Creek subwatershed is Blackbird Creek (listed for pH, metals, and sediment). Blackbird Creek also contains elevated levels of iron that may violate narrative water quality standards for toxic and deleterious substances. A complete description of impacts from the Blackbird Mine can be found in section 6: Blackbird Mine Impacted Waterbodies.

### 2.9 Deep Creek Subwatershed

Deep Creek subwatershed has an area of 24,051 acres (37.6 miles$^2$) and includes Deep Creek and Little Deep Creek. Deep Creek subwatershed has 26.9 stream miles entirely on National Forest Lands. Deep Creek is characterized as a Rosgen Class A-type stream (SCNF, 1993). Approximately 43% of the stream has a gradient less than 4% and 54% of the stream has a gradient between 4 and 10%. The average annual flow of Deep Creek is 20 cfs with a maximum mean monthly flow of 80 cfs and a minimum mean monthly of 6 cfs (see Table 10).

Human uses in this watershed include livestock grazing from the Williams-Napias Allotment, firewood cutting, and some recreation uses such as hunting (SCNF, 1993). The lower two miles of Deep Creek are suitable for Chinook spawning and rearing but due to upstream contamination in Panther Creek from the Blackbird mine site. This contamination has resulted in an avoidance of lower Panther Creek (and thus its tributaries) by migrating anadromous fish.

Past habitat improvements include culvert rehabilitation to improve fish passage and the planting of native riparian species along the stream banks (SCNF, 1993). Riparian plantings in Deep Creek were completed in 1997 to replace lost vegetation, stabilize erosive banks, and restore thermal insulation in the stream (USFS, 1998).

### 2.10 Big Jureano Creek Subwatershed (1998 §303(d) Listed for Metals)

Big Jureano Creek subwatershed has an area of 28,162 acres (44 miles$^2$) and includes Panther Creek

(1998 303(d) listed for metals) from Blackbird Creek to Big Deer Creek, and Big Jureano Creek, Little Jureano Creek, Trail Creek, and Hot Springs Creek. Big Jureano Creek and Hot Springs Creek are perennial, Little Jureano Creek is an intermittent stream, and all have steep gradients with peak flows less than 3 cfs (SCNF, 1993). Trail Creek is also a small stream but has stream flow year-round. The lower 1/10 of Trail Creek is considered potential Chinook salmon habitat but there are no historic accounts of Chinook salmon being present within the stream.

Historic placer mining operations have taken place in this watershed. There are no active mines currently. An inactive horse grazing allotment lies along Panther Creek, containing 7,630 suitable (in terms of productivity of forage, unsuitable acres are of low productivity) acres for grazing. There has not been any livestock grazing in this area for a significant number of years.

### 2.11 Napias Creek Subwatershed

Napias Creek subwatershed includes Napias Creek, Arnett Creek, Phelan Creek, and the smaller intermittent streams including Moccasin Creek, Pony Creek, Rabbit Creek, Sharkey Creek, Jefferson Creek, and Camp Creek. The entire watershed is 54,929 acres (85.8 miles$^2$) with 69.4 miles of stream (SCNF, 1993). Approximately 59 miles of stream reside on National Forest Lands. Streams found in the Napias Creek Watershed are primarily Rosgen Class A-type streams. Napias Creek has very little Chinook salmon habitat due to the high-gradient cascades (Napias Falls) located 0.5 miles upstream. Napias Creek above Napias Falls has been de-designated as critical habitat for anadromous fish by the National Marine Fisheries Service due to the passage barrier that results from this high gradient reach. Flow data for Napias Creek, Phelan Creek, and Arnett Creek are found in Table 10.

Human uses in this watershed include mining, grazing, and minimal timber harvesting. Historic placer mining operations in the area include the Ringbone Mine, Haidee Mine, and the Leesberg Mine. Some associated disturbances caused by the historic mines sites have been revegetated. Active mining at Beartrack Mine ceased in 2000 and it is moving into a reclamation/closure phase. Beartrack mine is located along the Napias Creek between Jefferson Creek and Arnett Creek. Beartrack Mine has been in operation since 1994 and has a NPDES permit for discharge to Napias Creek though EPA is in the process of revising the NPDES permit.

As part of the stream habitat improvement efforts in the Napias Creek watershed, riparian fencing was installed in 1996 to enhance bank stability along Moccasin Creek (USFS, 1998). The fencing was installed to keep livestock from the stream, thus allowing recovery of the stream channel. Other improvement efforts in the Napias Creek Watershed include several riparian/wetland exclosures that were built along Napias Creek as part of the wetland mitigation for the Beartrack mine. Additional improvements also include beaver planting along Arnett Creek in 1989, installation of culverts on logging roads in 1992, and development of a stream habitat reclamation plan in 1992 (SNF, 1993).

### 2.12 Deer Creek Subwatershed (1998 §303(d) Listed for pH, Metals, and Sediment)

Major streams located within this subwatershed include Big Deer Creek, with the smaller segments of South Fork Big Deer Creek and Bucktail Creek. The headwaters of Big Deer Creek reside in the Frank Church River of No Return Wilderness. The 1998 303(d) listed segments in this subwatershed include Bucktail Creek, South Fork Big Deer Creek, and Big Deer Creek from the confluence of South Fork Big Deer Creek to Panther Creek.

The Deer Creek subwatershed has an area of 28,701 acres (44.8 $miles^2$) with 29.6 stream miles on National Forest Lands (SCNF, 1993). Classifications for the streams in the Deer Creek subwatershed are predominantly Class A-type streams with 48% of the streams being less than 4% gradient and 48% of the streams being 4-10% gradient. Big Deer Creek average annual discharge is approximately 36 cfs. Peak flows average 144 cfs in June and low flows average 11 cfs in January (Table 10). Big Deer Creek is not considered spawning and rearing habitat for Chinook salmon due to a migration barrier located 0.5 miles upstream from the mouth of Big Deer Creek and degraded water quality associated with the Blackbird mining activities.

Human uses of this subwatershed include mainly mining activities. Historic mining at the Blackbird mine resulted in a discharge of sediments containing high levels of heavy metals into streams. Clean-up efforts are currently in place to remediate the waterbodies affected by the Blackbird Mine. Remediation activities include collection and storage of contaminated water in Bucktail Creek for treatment at the Blackbird Creek drainage collection pond (USFS, 1998).

### 2.13 Clear Creek Subwatershed

The Clear Creek subwatershed is approximately 30,992 acres (48.4 $miles^2$) in size with 61.9 stream miles. Streams located within this watershed include Clear Creek, and the smaller first-order streams Deadhorse Creek, Dry Gulch, and Gant Creek. There are no 303(d)-listed streams within this subwatershed. The headwaters of Clear Creek begin in the Frank Church River of No Return Wilderness. Approximately 65% of the streams are Class A-type streams with portions characterized as Class B (SCNF, 1993). The average monthly flow for Clear Creek is 34 cfs with 136 cfs in the peak flow season and 11 in the low flow season (Table 10). Suitable Chinook salmon habitat is located within the first mile of Clear Creek from the mouth. A migration barrier is located 1 mile up Clear Creek, restricting further Chinook salmon habitat.

Human uses within the Clear Creek subwatershed include a historic horse grazing allotment on lower Panther Creek and ongoing recreation (SCNF, 1993). Rehabilitation efforts include placing boulders in the stream in the lower end of the watershed to improve instream cover and bank stability. Clear Creek overall has been rated in good condition. The Clear Creek Fire of 2000 burned the majority of this subwatershed. Significant sediment inputs into Clear Creek are anticipated for the next 3-5 years until vegetative recovery is adequate to stabilize sediment sources.

### 2.14 Lower Panther Creek Subwatershed (1998 §303(d) Listed for Metals)

The Lower Panther Creek subwatershed is approximately 53,255 (83.2 $miles^2$) acres in size and includes Panther Creek, Trail Creek, Beaver Creek, and Garden Creek. The subwatershed extends from the Deer Creek subwatershed to the mouth of Panther Creek at the Salmon River. Flow data for Beaver Creek and the Lower Panther Creek appear in Table 10. Panther Creek is the only 1998 303(d)- listed stream segment within this watershed. Panther Creek is listed for metals due to poor water quality associated with Blackbird mine upstream from this subwatershed. Streams within this watershed are principally Rosgen class A-type streams. There is suitable Chinook salmon habitat in the lower reaches of Beaver Creek. The upper reaches of Beaver Creek and Garden Creek are not as suitable, primarily because of low stream flows in the summer months (August) (SCNF, 1993).

Uses throughout the watershed include historic livestock grazing, historic mining, and recreation. An inactive horse grazing allotment is found at the upper end of the subwatershed (SCNF, 1993). This allotment extends into the Clear Creek subwatershed along Panther Creek. The Mayflower and the Copper King Mines historically operated in this area. These were placer mine operations and disturbances related to their operation still exist.

**2.15 Napoleon Hill Subwatershed (Salmon River, Dump Creek - 1998 §303(d) listed)**

The Napoleon Hill subwatershed is one of the largest in the subbasin at 96,147 acres (150.2 $miles^2$). This subwatershed includes that portion of the Salmon River from Indian Creek to Tower Creek. Included within the subwatershed are Moose Creek, Dump Creek, Sage Creek, Wagonhammer Creek, Fourth of July Creek, Napoleon Gulch, Comet Creek, and the confluence with the North Fork Salmon River subwatershed. Flow data for Fourth of July and Moose Creeks are summarized in Table 11. Of the 32.9 miles of Moose Creek, a little more than half are of low gradient (<4%), with the remaining half somewhat equally divided between moderate gradients (4-10%) and high gradients (>10%) (SCNF, 1993). One mile of moderate gradient Moose Creek was considered historically accessible to Chinook salmon (SCNF, 1993). The 15.3 miles of Fourth of July Creek are divided as 11%, 58%, and 31% for low, moderate, and high gradient reaches, respectively. Forty-one percent or 6.3 miles of Fourth of July Creek was considered historically accessible to Chinook. Wagonhammer Creek has very low flows and goes underground for some length.

In the Sage Creek drainage, logging activities have taken place since the early 1900s with the most logging occurring in the 1950s and 1960s. In the past 30 years, 3.6% of the drainage has received human-caused disturbances (SCNF, 1993), and there are 1.99 $mi/mi^2$ of road density (see Appendix D). In the Moose/Dump Creeks watershed, logging has occurred since the 1960s, most of it before 1980. Six point two percent (6.2%) of the watershed has openings less than 30

**Table 11 Mean Flow Data for Two Streams in Napoleon Hill Subwatershed (SCNF, 1993).**

| Stream Name | Mean Annual Flow (cfs) | Highest Mean Monthly Flow (cfs) | Lowest Mean Monthly Flow (cfs) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Fourth of July Creek | 13.5 | 54 (June) | 4 (Jan.-Feb.) |
| Moose Creek | 17.8 | 85 (June) | 4 (Nov.-Feb.) |

years old and the road density is 1.76 to 1.86 mi/mi$^2$ (see Appendix D). The 1979 Moose Creek fire was a human-caused fire that burned 2,700 acres in the Sage Creek watershed, mostly dry, southerly, non-timbered slopes (SCNF, 1993). There are several grazing allotments which are likely within this subwatershed (SCNF, 1993). The Sage Creek allotment is 12,638 acres, of which 1,659 are suitable. The Diamond/Moose allotment contains 40,960 acres in the subwatershed, of which 9,256 are suitable. The Fourth of July Creek and Burns Basin allotments include 22,600 acres with 10,153 suitable acres.

Several developed recreation sites exist in the subwatershed, including Deadwater Area and Wagonhammer Picnic Area, as well as many dispersed recreational activities (SCNF, 1993). Private lands include: 174 acres adjacent to the Salmon River between the North Fork and Burns Gulch used for residences and some agriculture; 83 acres developed adjacent to the Salmon River south of the Wagonhammer Picnic Area; 36 acres of patented mining claims in the upper Fourth of July Creek drainage; 1,690 acres along the lower Fourth of July Creek used for residential, agriculture and pasture; 102 acres of patented mining claims in Comet Creek and Napoleon Gulch; 195 acres adjacent to the Salmon River between Comet Creek and Napoleon Gulch used for agriculture; 157 acres adjacent to the Salmon River at the mouth of Napoleon Gulch used for agriculture and residences; a 21 acre patented mining claim at the head of Bobcat Gulch; 334 acres of homestead entry lands adjacent to the Salmon River at the mouths of Maxwell, Dry and Aspen Gulches; and 67 acres in Kriley Gulch for residential subdivision.

Historic mining activity in the Moose Creek and Dump Creek drainages, long before the creation of the Clean Water Act, has done much to alter these areas (SCNF, 1993). Water from upper Moose Creek was diverted into Dump Creek at one time. As a result, channel down-cutting and massive slope failures have occurred in Dump Creek, creating a deep chasm and the alluvial deposits in the Salmon River (see Hydrology above for details). Prior to the water diversion Dump Creek had a drainage area of approximately eight square miles with natural flows in the range of 0.5 to 10 cubic feet per second (cfs). In contrast upper Moose Creek has a drainage area of approximately 25 square miles with flow volumes ranging from several cfs during base flow periods to over 100 cfs during snowmelt runoff. Flood flows in excess of 400 cfs have been measured on upper Moose Creek (Rieffenberger, 1999).

With the increased flows from upper Moose Creek, Dump Creek downcut through the unconsolidated sedimentary and volcanic materials in the watershed creating a deep chasm. Channel downcutting caused the side slopes along Dump Creek to be undercut resulting in massive slope failures. In places the existing chasm is up to one-half mile wide and 300 feet deep. The massive slope failures deposited large volumes of materials large volumes of material in the Dump Creek channel that would flush out during snowmelt runoff and high intensity storms into the Salmon River. The coarse bedload from Dump Creek formed a large alluvial fan at the mouth of Dump Creek and bar formations in the Salmon River from Dump Creek downstream to Pine Creek. As of 1974 an estimated 9 million cubic yards of material had been transported from Dump Creek into the Salmon River (Rieffenberger and Baird, 1990).

In 1979, the Forest Service diverted the upper Moose Creek water back into the lower Moose Creek channel to essentially halt the sediment loading from Dump Creek to the Salmon River. The unstable slopes of the Dump Creek channel continue to erode. However, the small volume of water flowing through Dump Creek is incapable of carrying the material once transported down Dump Creek. Because of their steepness, it has never been considered feasible to rehabilitate these slopes (SCNF, 1993).

The Forest Service has recently evaluated Moose and Dump Creeks, as well as East Boulder Creek, for their habitat potential for anadramous fish (Rose, 1999). East Boulder Creek is in the Middle Salmon River subwatershed, but will be described here in the context of this recent study. All three streams have migration barriers caused by steep breakland reaches. Barriers are located at 3.2, 2.3, and 3.0 miles for Moose Creek, Dump Creek, and East Boulder Creek, respectively. In addition to the potential gradient barrier, the sediment dam, approximately 0.5 miles below the USFS road bridge, on East Boulder Creek presents a strong physical barrier to fish migration. The sediment dam has been installed to reduce sediment transport to the lower, high gradient reach of East Boulder Creek and subsequently the Salmon River.

### 2.16 Tower Creek Subwatershed (Salmon River, Diamond Creek - 1998 §303(d) listed)

The Tower Creek subwatershed includes that portion of the Salmon River from Tower Creek to approximately Carmen Creek, and includes Tower Creek, Bird Creek, Diamond Creek, Badger Spring Gulch, and Wallace Creek. The Salmon River and Diamond Creek are 1998 303(d) listed for unspecified pollutants within this subwatershed. The subwatershed is approximately 37,728 acres (58.9 $miles^2$) in size. Wallace Creek, the largest creek on the west side of the Salmon River in this subwatershed, has a mean annual flow of 3 cfs and a mean monthly flow range of 12 cfs (June) to 1 cfs (September-March) (SCNF, 1993). Wallace Creek is primarily (74%) high gradient (>10%), and the half-mile below the National Forest boundary is moderate gradient (4-10%). Forty-seven percent (47%) of Tower Creek is high gradient and on Forest lands. Another 42% of Tower Creek is of moderate gradient, 1.5 miles (10% of total) of which are on Forest lands. All low gradient (<4%) sections of Tower Creek are below Forest lands (1.6 miles or 11%). Portions of Tower Creek historically accessible to Chinook salmon include almost the entire stream below the Forest boundary (SCNF, 1993).

Within the Tower Creek subwatershed described by SNF (1993), which includes Fourth of July Creek drainage (described in Napoleon Hill section above), 74 acres were clearcut, 250 acres were partial cut equivalent clearcut acres, and 59 equivalent clearcut acres were burned. Road density varies from 0.42 $mi/mi^2$ in Tower Creek to 2.59 $mi/mi^2$ in Wallace Creek (see Appendix D). That same subwatershed includes 22,600 acres of grazing allotments, 10,153 acres of which are suitable acres. On the Wallace Creek side, there are several roads (Moose Creek Road, Diamond Creek Road) that cross Wallace and Diamond Creeks and their tributaries in several places.

Dispersed recreation is predominant throughout our Tower Creek subwatershed, and there is one developed recreation site, Wallace Lake Campground. Wallace Lake is a popular fishing location and receives moderate to heavy use in summer months (SCNF, 1993). There is a 20-acre mining claim in the Diamond Creek road area (McKinley Lode) (SCNF, 1993), however the mine is not in the Diamond Creek watershed or hydrological connected to surface water. Bird Creek drainage contains a portion of the Shoofly patented mining claim (~8 acres) and portions (29 acres) of the patented mining claims in the Bird Creek/Wickam area. Within the Tower Creek drainage there are two private agricultural areas, 33 acres in Tower Creek and 302 acres in the EF Tower Creek, as well as a 60-acre patented mining claim in the Gold Star Gulch area.

Five and one-half miles (5.5) of Tower Creek were historic spawning and rearing areas for Chinook salmon (SCNF, 1993). East Fork Tower Creek contained two miles of historic rearing areas. There was no access to Wallace Creek or other streams on the west side of the Salmon River in this subwatershed.

### 2.17 Carmen Creek Subwatershed

The Carmen Creek subwatershed includes Carmen Creek and its tributaries. The subwatershed is 35,089 acres (54.8 $miles^2$) in size. The major tributary to Carmen Creek is Freeman Creek. Carmen Creek has a mean annual flow of 17.5 cfs, and a mean monthly flow range of 70 cfs in June to 6 cfs in December through March (SCNF, 1993). Of 35.1 miles of stream, 50% is high gradient (>10%), and the remaining 50% is evenly divided between low (<4%) and moderate gradient (4-10%). Roughly half of the total stream miles are below the National Forest boundary and are privately owned. All of the low to moderate gradient stream miles below the Forest boundary (12.4 miles) were historically accessible to Chinook salmon (SCNF, 1993). Historic Chinook spawning and rearing habitat includes 8 miles of Carmen Creek and 3 miles of Freeman Creek.

In the National Forest, 55 acres of the subwatershed were clearcut, while 242 are partial cut equivalent clearcut acres (SCNF, 1993), and road density varies from 0.42 to 1.63 $mi/mi^2$ (see Appendix D). Grazing allotments include 14,687 acres, 795 of which are suitable acres. Dispersed recreation occurs in the subwatershed; however, there are no developed recreation sites. The lowest reaches of Carmen Creek are periodically de-watered for irrigation (SBTA, 1998). In years of above average precipitation there may be sufficient flow for anadramous fish passage.

### 2.18 Salmon Subwatershed (Salmon River - 1998 §303(d) listed)

Because of differences in the way subwatersheds are delineated, the Salmon-Challis National Forest did not recognize a Salmon subwatershed (SCNF, 1993). Instead, this section of the subbasin is divided between their Williams and Wallace subwatersheds. The majority of the streams listed in the paragraph below are found in their Williams subwatershed, the general characteristics of which will be discussed in more detail in the Williams Creek subwatershed below. The Wallace subwatershed general characteristics were discussed above in the section on Tower Creek subwatershed.

The Salmon subwatershed is 48,100 acres (75.2 $miles^2$) which includes the Salmon River from Carmen Creek to, and including, Perreau Creek. Included within this subwatershed are numerous small tributaries (Fenster, Moore, Jesse, Turner Gulch, Pollard Canyon, Chipps, Gorley, and Spring Creeks), the confluence with the Lemhi River subbasin, and the city of Salmon. The Salmon River is the only 1998 303(d)-listed water within the subwatershed. Mean annual flows for Perreau and Jesse Creeks are 4.5 and 5.0 cfs, respectively (SCNF, 1993). Their mean monthly flows vary from 18-20 cfs to 1-2 cfs. Most (66%) of Jesse Creek is high gradient (>10%), whereas Perreau Creek is mostly (62%) of moderate gradient (4-10%). There are 41 acres of patented mining claims in the headwaters of Bob Moore Creek (U.P. Lands) which have been inactive for many years (SCNF, 1993). There are 103 acres of patented mining claims in the headwaters of Perreau Creek and 78 acres of patented claims in Tormay Creek, a tributary to Perreau Creek. Lands in Tormay Creek were actively mined in the 1970s, but have been inactive ever since. Exploration activity occurred in the Perreau claim from the late 1980s to early 1990s. None of the streams in the Salmon subwatershed were known to have anadramous fish because of their lowland intermittent nature and low flow (SCNF, 1993). Moose Creek Road and legacies of several historic mining activities are present in the Deriar Creek drainage between Fenster Creek and Wallace Creek. It is not clear if these are in this subwatershed or in the Tower Creek subwatershed described above.

### 2.19 Williams Creek Subwatershed (Salmon River - 1998 §303(d) listed)

The Williams Creek subwatershed includes the Salmon River above Perreau Creek, Williams Creek, and several small tributaries. The subwatershed has a drainage area of 53,717 acres (84 $miles^2$). Williams Creek has a mean annual flow of 10 cfs, and a range of mean monthly flows from 40 cfs (June) to 3 cfs (December-February) (SCNF, 1993). The 16.1 miles of Williams Creek can be divided into 4 miles of low gradient (<4%) stream, most of which are off National Forest lands, 8.5 miles of moderate gradient (4-10%) stream, mostly on Forest land, and 3.6 miles of high gradient (>10%) stream, all on Forest lands. Forty percent of these stream miles were historically accessible to Chinook salmon, including all portions below the Forest boundary and two miles on Forest lands.

The Williams Creek subwatershed described by the Salmon/Challis National Forest (SCNF, 1993) includes streams to the north included in our Salmon subwatershed. They describe that subwatershed as having 6 clearcut acres, 418 partial cut equivalent clearcut acres, 2,086 equivalent clearcut acres burned, and 44 acres disturbed by mining. Additionally, that subwatershed had 27,953 acres in grazing allotments with 7,779 acres suitable. Williams Creek has two developed recreation areas, Cougar

Point Campground and Williams Creek Picnic Area, and year-round dispersed recreational use. Use is heavy at times due to its proximity to the city of Salmon. The South Fork Williams Creek drainage contains 160 acres of homestead lands used primarily for hay cultivation and grazing. Road densities are approximately 1.7 $mi/mi^2$ for both William Creek and Perreau Creek watersheds (see Appendix D).

Williams Creek has 7 miles of historic potential spawning and rearing areas for Chinook salmon (SCNF, 1993). The creek is dewatered in its lowest reaches for irrigation, but may contain sufficient flow for fish passage in some years.

The mainstem Salmon River through the Williams Creek, Rattlesnake Creek, and Warm Spring Creek subwatersheds is considered to be a migration corridor for sockeye and Chinook salmon, including juvenile Chinook that may travel during summer months to the mouths of tributaries that otherwise are considered unsuitable spawning habitat (SCNF, 1993). This segment is also a migration corridor for steelhead trout. The mean summer temperature, measured with continuous recording data loggers from July 15 to October 15, 1993, was $14.4^o$ C above the Lemhi River (see Water Quality Assessments). The maximum temperature recorded during that period was $20.3^o$ C in late July. The Salmon River is paralleled by Highway 93, a two-lane, paved surface highway, through these subwatersheds.

**2.20 Rattlesnake Creek Subwatershed (Salmon River, Williams Lake - 1998 §303(d) listed)**

The Rattlesnake Creek subwatershed includes that portion of the Salmon River and its tributaries from Warm Spring Creek to, and including, Lake Creek (Williams Lake). The Salmon River and Williams Lake are the only 1998 303(d)-listed waters in the subwatershed. The subwatershed is approximately 56,771 acres (88.7 $miles^2$) in size, and includes Rattlesnake Creek, Twelvemile Creek, Lake Creek, and numerous smaller drainages. Rattlesnake Creek has a mean annual flow of 3.4 cfs, and mean monthly flows range from 13 cfs in June to 1 cfs throughout late fall and winter months (SCNF, 1993). Lake Creek has a mean annual flow of 6.7 cfs, with mean monthly flows varying from 27 cfs (June) to 2 cfs (December-March). Twelvemile Creek is the largest of the three with a mean annual flow of 8.2 cfs and a mean monthly range of 33 cfs (June) to 3 cfs (October-March).

Twelvemile Creek on and off National Forest lands is predominantly of moderate gradient (4-10%) (Table 12). The entire one-mile stretch off the Forest was historically accessible to Chinook salmon. Approximately three miles of Twelvemile Creek on the Forest were also accessible to Chinook. Lake Creek above Williams Lake is predominantly high gradient

**Table 12 Miles of Stream in Rattlesnake Creek Subwatershed On and Off National Forest Lands by Gradient Categories and Historical Accessibility to Chinook Salmon (SCNF, 1993).**

| Stream | Total | Gradients On Forest (mi.) | | | Gradients Off Forest (mi.) | | | Chinook On Forest (mi.) | | | Chinook Off Forest (mi.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Miles | <4% | 4-10% | >10% | <4% | 4-10% | >10% | <4% | 4-10% | >10% | <4% | 4-10% | >10% |
| Twelvemile Cr. | 10.5 | 1.3 | 5.0 | 3.2 | 0.2 | 0.8 | | 1.0 | 1.9 | | 0.2 | 0.8 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake Cr. above lake | 7.4 | 0.6 | 2.1 | 4.7 | | | | | | | | | |
| Lake Cr. below lake | 1.7 | | | | 1.1 | 0.6 | | | | | | | |
| Rattle-snake Cr. | 7.4 | 0.3 | 1.5 | 1.7 | 0.2 | 1.9 | 1.8 | | | | 0.2 | 1.9 | 1.3 |

(>10%); below the lake the stream is mostly low gradient (<4%). Apparently none of Lake Creek was historically accessible to Chinook. The 7.4 miles of Rattlesnake Creek are fairly evenly distributed between moderate and high gradients and on and off the National Forest. Only a half-mile of stream is low gradient. Most of Rattlesnake Creek off Forest land was historically accessible to Chinook.

During the late 1960s and early 1970s, prior to the Clean Water Act, the Lake Creek portion of this subwatershed has had 82 acres of clearcut, 1,252 acres of partial equivalent clearcut, and 27.3 miles of road built (0.9 mi/mi$^2$) (SCNF, 1993; Barnes et al., 1994). The Salmon-Challis National Forest analyzed Twelvemile Creek together with Warm Spring Creek because of differences in boundary conventions for subwatersheds. Their Twelvemile Creek subwatershed (which included Warm Spring Creek discussed below) had 6 acres of clearcut, 1,169 acres as partial-cut equivalent clearcut acres, and 44 acres of mining disturbance (SCNF, 1993). That same Twelvemile Creek subwatershed had 33,862 acres in grazing allotments, 6,867 acres of which were suitable (SCNF, 1993). Lake Creek subwatershed had 19,318 acres in grazing allotments, 4,998 acres of which were suitable. There are no developed recreational sites within Twelvemile Creek; however, Lake Creek has two, Williams Lake Campground and Williams Lake Boating Site (boat docks). Lake Creek drainage has 82 acres of homestead lands within the National Forest. Road densities vary from 0.42 mi/mi$^2$ in the Warm Spring Creek drainage to 1.95 mi/mi$^2$ in the Lake Creek drainage (see Appendix D). Rattlesnake Creek appears to have
some rearing habitat for Chinook salmon from its mouth to the National Forest boundary, but no spawning habitat due to steep gradients (SCNF, 1993). Juvenile Chinook were identified in Twelvemile Creek in 1991; however, diversion structures below the Forest boundary prevent any further migration upstream (SCNF, 1993).

### 2.21 Williams Lake (1998 §303(d) Listed for Nutrients and Dissolved Oxygen)

The Williams Lake watershed is located on the south end of the Salmon River in the southern portion of the subbasin. Williams Lake is the largest and most utilized lake in the subbasin (Barnes et al., 1994). The lake is approximately 1 mile long and 0.5 mile wide, with a maximum depth of 179 feet. The lake was formed more than 8,000 years ago from a massive landslide that dammed up Lake Creek. The inlets to the lake include Lake Creek and a few other small springs on the western shore of the lake. There is no direct outlet from the lake, but there are several seeps just below the landslide area where Lake Creek reforms. This makes Williams Lake a closed system with an approximate flushing rate of nine years.

Upper Lake Creek, the inlet to Williams Lake, originates at an elevation of about 9,000 feet and is classified as a Rosgen class B stream. The drainage area for Lake Creek above Williams Lake is close to 15 square miles (9,600 acres). Lake Creek enters Williams Lake at an elevation of 5,250 feet and has a mean annual flow of 6.7 cfs at that point. Seepage below the lake occurs at approximately 4,850 feet elevation. The lower segment of Lake Creek enters the Salmon River at 4,200 feet. The streamflow into the lake is dominated by snowmelt and bankful flows are present during May through June (Barnes et al., 1994).

Approximately 98% of the Williams Lake watershed is federally owned (Barnes et al., 1994) with small portions privately owned. Much of the federally owned land is leased to ranchers for livestock grazing in the bottomlands and hillsides above the lake. There were extensive timber harvests in the early 1970s but very little since then. A Watershed survey conducted in 1992 showed little continuing effect of the harvesting on water quality in the watershed (USFS, 1992). Additional harvests have occurred on 75 acres in 1983, for a total of 905 acres for the whole watershed since 1971. The majority of land surrounding the lake is used for recreation and grazing with many summer homes surrounding the area. There are no point sources of pollution. Non-point sources of the watershed include septic systems along the shoreline, roads, past timber harvesting, and livestock grazing (Barnes et al., 1994). The majority of roads used for timber harvest have been closed and revegetated and are not considered a source of non-point source pollution (Barnes et al., 1994). Plans are in place to upgrade septic systems by installing a combined system for 22 homes in one project and 9 homes in another project on Williams Lake during 2001. A number of homes have recently made improvements to septic systems, and two lakeshore homes and the Williams Lake Lodge on the eastern shore remain to be upgraded. Other homes removed from the lakeshore will also need to have improved systems installed within the 10-year implementation period of the TMDL. Road density for the Lake Creek watershed (1.95 mi/mi$^2$) reported in 1998 (Appendix D) is still considered high.

**2.22 Iron Creek Subwatershed**

The Iron Creek subwatershed includes 35,714 acres (55.8 miles$^2$), and consists of Iron Creek and its tributaries including NF Iron Creek, WF Iron Creek, SF Iron Creek, Badger Creek, and Slide Creek. Iron Creek has a mean annual flow of 18.9 cfs, with mean monthly flows that vary from 76 cfs in June to 6 cfs in January and February (SCNF, 1993). Mean annual flows for the NF, WF, and SF Iron Creeks are 9.4, 3.8, and 6.3 cfs, respectively. On the Salmon-Challis National Forest the 35.8 miles of stream are relatively evenly divided among low gradient (<4%), moderate gradient (4-10%), and high gradient (>10%), with high gradients slightly more prominent. The same is true for the 8.1 miles of off-Forest gradients, except low gradients are slightly more prominent. Those stream miles historically accessible to Chinook salmon include 15.6 miles on Forest lands and 5.4 miles off. Most of these stream miles (14 miles) are low gradient.

The Iron Creek subwatershed has had 191 acres of clearcut, 3,023 partial-cut equivalent clearcut acres, and 4 acres of mine disturbance (SCNF, 1993). There are 138 acres of private inholdings as patented mining claims in the North Fork Iron Creek drainage, which include three adits, exploration roads and drill sites. There has been very little work at these sites since the early 1980s. There are 160 acres of homestead land in the North Basin section of Warm Spring Creek drainage. Grazing allotments included the 30,100-acre Deer-Iron Creek allotment and the 650-acre Cabin Creek allotment. 7,865 acres of these allotments were considered suitable acres (SCNF, 1993). Dispersed recreation use within the subwatershed is considered light to moderate. Fishing occurs predominantly on Iron Lake, Lower Iron Lake, and lower reaches of Iron Creek. There is one developed recreation site in the subwatershed, Iron Lake Campground, an 8-unit campground on the east and south sides of the lake. Road densities vary from 1.78 to 2.34 mi/mi$^2$ (see Appendix D).

In 1990 there were five culverts modified to allow anadramous fish passage within the Iron Creek subwatershed. In 1991, ten instream structures—seven in the South Fork Iron Creek and three in the North Fork Iron Creek—were placed to improve stream stability and habitat (SCNF, 1993). Nineteen miles of stream within the Iron Creek subwatershed are believed to have had historically suitable Chinook salmon habitat. Now, however, complete de-watering of the lower reaches of Iron Creek for irrigation presents a migration barrier to salmon during the summer months. The Northwest Power Planning Council in 1991 indicated that the Iron Creek drainage had the potential for an annual production of 17,022 Chinook smolts (SCNF, 1993). Subsequent (1993) sediment core sampling results are presented in the assessment portion of this subbasin assessment (see Appendix F for data).

### 2.23 Warm Spring Creek Subwatershed (Salmon River - 1998 §303(d) listed)

The Warm Spring Creek subwatershed is approximately 88,700 acres (138.6 miles$^2$), and includes the upper portion of the Salmon River from the Pahsimeroi River to Iron Creek. On the west side of the river are the drainages above and below Hat Creek subwatershed including Dry Gulch, Ezra Creek, Ringle Creek, and Cabin Creek. On the east side of the river this subwatershed includes Cow Creek, Allison Creek, McKim Creek, Poison Creek, and Warm Spring Creek. Within this subwatershed only the Salmon River is 1998 303(d) listed. The Salmon-Challis National Forest used a different boundary convention for their analyses of subwatersheds (SCNF, 1993). The Forest included Allison, Cow, McKim, and Poison Creeks in an Allison Creek subwatershed, and placed Warm Spring Creek with Twelvemile Creek into a Twelvemile Creek subwatershed. We have discussed Twelvemile Creek in the Rattlesnake Creek subwatershed section above. Because of these differences in boundaries, drainage areas and stream miles may not be directly transferable from Forest documents. We will limit our discussion to general characteristics of named creeks and avoid geographic data that may be confused by these boundary differences.

Flows vary from a mean annual of 3 cfs for Poison Creek to 17 cfs for Cow Creek (Table 13) (SCNF, 1993). Cow and McKim Creeks are the largest in terms of flow with mean monthly flow ranging from 5 to >60 cfs. The remaining creeks in Table 13 have smaller mean monthly flows, varying from 1-2 cfs to approximately 20 cfs. Allison Creek has five miles of stream, 2.6 miles of which are high gradient

(>10%) and on the Salmon-Challis National Forest. Off the Forest, 2.2 miles are of moderate gradient (4-10%) and 0.2 miles are high gradient. Cow Creek has 15.7 stream miles, 12.4 miles of which are on National Forest lands. Most (10.6 miles) of Cow Creek is high gradient (>10%), with the remainder as moderate gradient. Approximately two miles of moderate gradient Cow Creek off the Forest was deemed historically accessible to Chinook salmon. McKim Creek has 14.5 miles of stream, 9.3 miles of which are high gradient and mostly on Forest lands. The remaining 5.2 miles are of moderate gradient and found both on and off the Forest. 2.6 miles of moderate gradient McKim Creek, mostly off Forest, was historically accessible to Chinook. Poison Creek is 26.4 miles long and is primarily high gradient (20 miles). Poison Creek has 6 miles off of Forest land with 0.9 miles of low gradient (<4%), 2 miles of moderate gradient, and 3.1 miles of high gradient stream. Warm Spring Creek is 13.1 miles long
with only 1.8 miles off of Forest lands. Warm Spring Creek has a more equal distribution of low, moderate, and high gradient stream miles (5.8, 5.1, and 2.2 miles respectively).

**Table 13 Mean Annual/Monthly Flows for Selected Streams in the Warm Spring Creek Subwatershed (SCNF, 1993).**

| Stream Name | Mean Annual Flow (cfs) | Highest Mean Monthly Flow (cfs) | Lowest Mean Monthly Flow (cfs) |
|---|---|---|---|
| Allison Creek | 5.0 | 20 (June) | 2 (Sept-March) |
| Cow Creek | 17.0 | 69 (June) | 5 (January) |
| McKim Creek | 16.0 | 64 (June) | 5 (Dec-Feb) |
| Poison Creek | 3.0 | 12 (June) | 1 (Sept-March) |
| SF Poison Creek | 5.0 | 20 (June) | 2 (Sept-March) |
| Warm Spring Creek | 5.1 | 21 (June) | 2 (Sept-March) |

The McKim Fire of July 1991 was a high-intensity, stand-replacement fire that burned approximately 900 acres in this subwatershed (SCNF, 1993). McKim Creek has received some riparian revegetation following the fire and some instream structures for stabilization and cover. The Salmon-Challis National Forest's Allison Creek subwatershed has had an additional 40
acres clearcut in the last 30 years, and a road density of 1.1 $mi/mi^2$. The Forest's Twelvemile
Creek subwatershed, which includes Warm Spring Creek, has had 1,169 partial-cut equivalent clearcut acres, 6 clearcut acres, and 44 acres of mining disturbance. Both of these subwatersheds have grazing allotments, totaling 72,678 acres, of which 15,700 acres are suitable. Recreational use is light in these areas with no developed recreation sites. McKim Creek is the only drainage with secondary roads near

streambeds in this subwatershed (SCNF, 1993). Road densities for these watersheds vary from 0.2 $mi/mi^2$ for Cow Creek to 1.54 $mi/mi^2$ for Cabin Creek (see Appendix D).

**2.24 Hat Creek Subwatershed**

The Hat Creek subwatershed includes Hat Creek and its tributaries Little Hat Creek, Big Hat Creek, Middle Fork Hat Creek, and North Fork Hat Creek. There are no 303(d)-listed waters within this subwatershed. The Hat Creek subwatershed includes 50,399 acres (78.7 sq. mi.) (SCNF, 1993). The drainage contains 34.6 miles of streams, 55% of which are on National Forest lands. The remaining stream miles are on BLM land (27%) and private land (18%). Hat Creek has a mean annual flow of 15 cfs; mean monthly flows range from a high of 60 cfs in June and 5 cfs during winter months. On National Forest lands, the majority of streams (39% of total stream miles) have a gradient between 4 and 10%. Twelve percent (12%) of the stream miles have slopes greater than 10%, and 4% of stream miles have a slope less than 4%. Off of National Forest lands the majority of stream miles (30%) are less than 4% slope. Chinook salmon historically had access to approximately 20 miles of stream on and off the National Forest lands. The Salmon National Forest considers 10 miles of Hat Creek to have provided spawning and rearing habitat for Chinook, historically. Big Hat Creek, North Fork, and Middle Fork Hat Creek provided 1.8, 2.5, and 1.0 miles of historic rearing habitat. Other streams in this subwatershed are not considered suitable for Chinook spawning or rearing due to high gradients and/or low flows. Little Hat Creek is a very small stream with very low flows.

In the past 30 years, Big Hat Creek watershed has had 1,771 acres disturbed, primarily as partial- cut equivalent clearcut acres (SCNF, 1993). Road densities vary from 0.63 to 2.13 $mi/mi^2$ (see Appendix D). The Hat Creek subwatershed contains three grazing allotments totaling more than 30,000 acres, 10,000 of which are suitable for grazing. The Big Hat Creek portion of the subwatershed experiences light to moderate recreation activities, including hunting, fishing, camping, picnicking, hiking, sightseeing, and day-use outfitter/guide operations. Fishing and sightseeing are popular at Hat Creek Lakes and on the Middle Fork and North Forks of Hat Creek. There are no developed recreation sites in the subwatershed.

# 3.0 Water Quality Concerns and Status

## 3.1 Water Quality-limited Waters

In 1998, DEQ established a new 303(d) list (Figure 11 and Table 14) based on assessments performed through the Beneficial Use Reconnaissance Project (BURP) and other pertinent material regarding use status and water quality standards violations. The 1998 list makes some changes to water bodies listed for the Salmon-Panther subbasin in previous 303(d) lists. In particular, Carmen Creek and that portion of Blackbird Creek above Blackbird Creek Reservoir were removed from the list because they fully supported their beneficial uses. Additionally, Williams Lake and Diamond Creek were added to the list. Other previously-listed waters in the subbasin were retained on the 1998 list. Although Diamond Creek was identified through BURP as not supporting its aquatic life uses, the cause of that impairment was unknown at the time of listing. Likewise, the Salmon River is listed for unknown pollutants.

Previous 303(d) Listing History

As a result of a lawsuit, EPA listed as water quality-limited over 960 waterbodies in the State of Idaho in 1994. For the Salmon-Panther subbasin, that list included six tributary streams and the Salmon River itself from the Pahsimeroi River to the North Fork Salmon River (Table 15). The tributaries included Big Deer Creek, Blackbird Creek, Bucktail Creek, Panther Creek—all associated with metals contamination from the Blackbird Mine—and Carmen and Dump Creeks.

Idaho’s 1994 303(d) list did include Big Deer, Blackbird, Bucktail, and Panther Creeks. These streams were listed as high priority for metal pollution because of Blackbird Mine. Subsequently, clean-up of the Blackbird Mine site has begun. Big Deer, Blackbird, and Panther Creeks were also identified in the DEQ’s 1992 305(b) report for the same reasons. Although clean-up at the mine is well under way, these streams have remained on the 1998 303(d) list.

## 3.2 Water Quality Standards

Water Quality standards are legally enforceable rules and consist of three parts: the designated use of waters, the numeric or narrative criteria to protect those uses, and an antidegradation policy. Water quality criteria used to protect these beneficial uses include narrative “free from” criteria applicable to all waters (IDAPA 16.01.02.200), and numerical criteria, which vary according to beneficial uses (IDAPA 16.01.02.250). Typical numeric criteria include bacteriological criteria for recreational uses, physical and chemical criteria for aquatic life (e.g. pH, temperature, dissolved oxygen (DO), ammonia, toxics, etc), and toxics and turbidity criteria for water supplies. Idaho's water quality standards are published in the state’s rules at *IDAPA 16.01.02* ***B*** *Water Quality Standards and Wastewater Treatment Requirements.* Designated beneficial uses for waters in the Salmon-Panther subbasin are listed in Table 16.

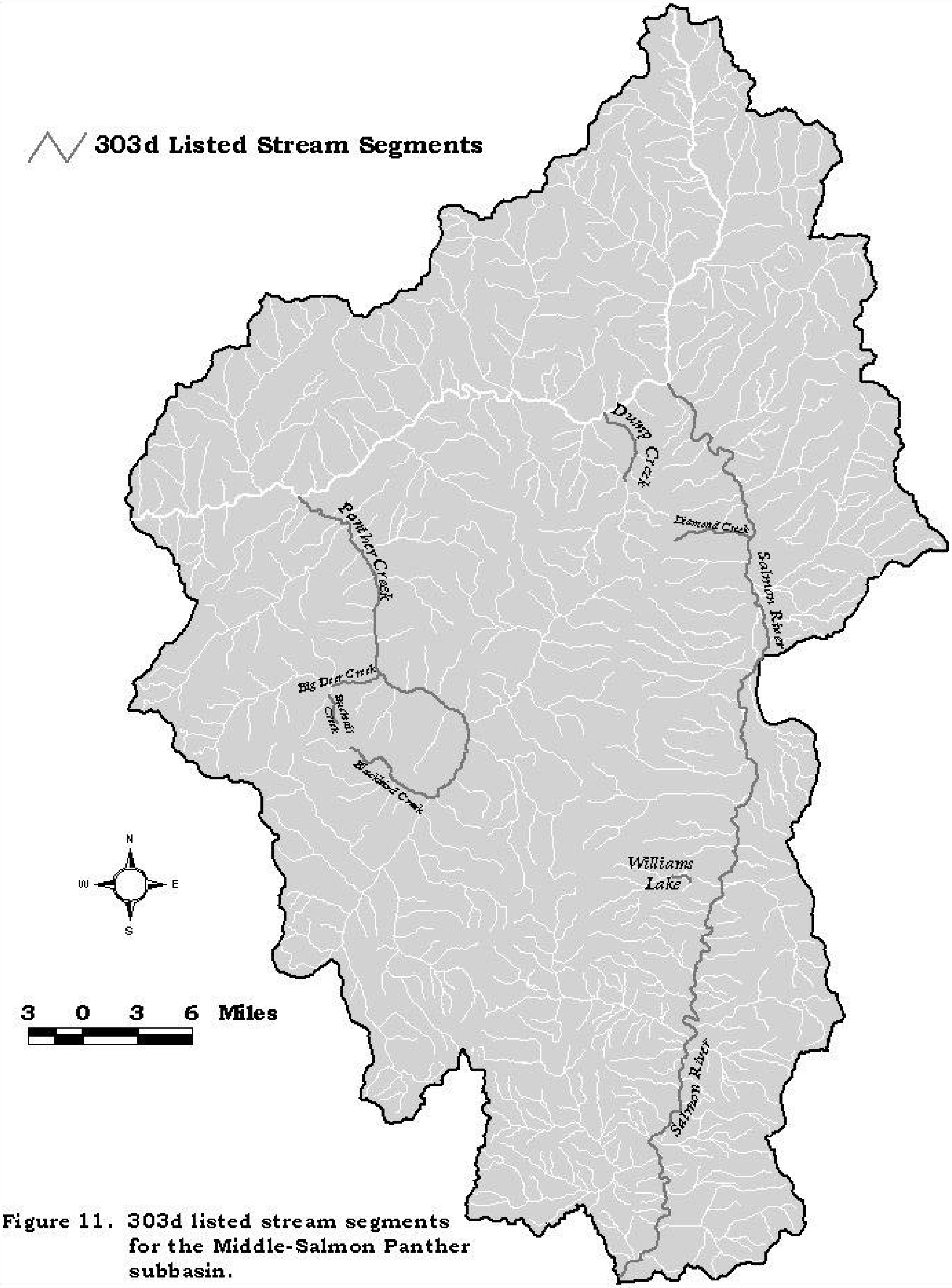



Figure 11. 303d listed stream segments for the Middle-Salmon Panther subbasin.

**Table 14  DEQ 1998 303(d) List for the Middle Salmon-Panther Subbasin.**

| Water Body | Location | Pollutants |
|---|---|---|
| Big Deer Creek | SF Big Deer Creek to Panther Creek | sediment, pH, metals |
| Blackbird Creek | Blackbird Reservoir to Panther Creek | sediment, pH, metals |
| Bucktail Creek | Headwaters to Big Deer Creek | metals |
| Panther Creek | Blackbird Creek to Salmon River | metals |
| Diamond Creek | Headwaters to Salmon River | unknown |
| Dump Creek | Headwaters to Salmon River | sediment |
| Salmon River | Pahsimeroi River to NF Salmon River | unknown |
| Williams Lake | Lake Creek subwatershed | DO, nutrients |

**Table 15  EPA listed 303(d) Water Bodies for the Middle Salmon-Panther Subbasin.**

| Water Body | Location | Pollutants | Source of Listing |
|---|---|---|---|
| Big Deer Creek | SF Big Deer Creek to Panther Creek | sediment, pH, metals | 305(b), appendix D; Idaho 94 list |
| Blackbird Creek | Headwaters to Panther Creek | sediment, pH, metals | 305(b), appendix D; Idaho 94 list; Basin Status Report; CRITFIC |
| Bucktail Creek | Headwaters to Big Deer Creek | metals | Idaho 94 list |
| Panther Creek | Blackbird Creek to Salmon River | metals | 305(b), appendix D; Idaho 94 list; Basin Status Report; CRITFIC |
| Carmen Creek | Freeman Creek to NF Salmon River | sediment | 305(b), appendix D |
| Dump Creek | Headwaters to Salmon River | sediment | 305(b), appendix D |
| Salmon River | Pahsimeroi River to NF Salmon River | unknown | 305(b), appendix D |

Sources: 305(b), appendix D = Appendix D of Idaho’s 1992 Water Quality Status Biennial Report; Idaho 94 list = Idaho’s 1994 303(d) list of impaired waters; Basin Status Report = DEQ (1991) Basin Status Reports, produced by Idaho Division of Environmental Quality; CRITFIC = Columbia River Intertribal Fish Commission.

**Table 16  Waters with Designated Beneficial Uses in the Idaho Water Quality Standards.**

| Map Code | Water Body | Designated UsesDesignated Uses |
|---|---|---|
| SB-30 | Salmon River B Pahsimeroi River to Lemhi River | Domestic Water Supply, Agricultural Water Supply, Cold Water Biota, Salmonid Spawning, Primary Contact |

| | | |
|---|---|---|
| | | Recreation, Secondary Contact Recreation, Special Resource Water |
| SB-40 | Salmon River B Lemhi River to Middle Fork Salmon River | Domestic Water Supply, Agricultural Water Supply, Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Special Resource Water |
| SB-410 | North Fork Salmon River B source to mouth | Domestic Water Supply, Agricultural Water Supply, Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Special Resource Water |
| SB-420 | Panther Creek B source to Blackbird Creek | Domestic Water Supply, Agricultural Water Supply, Cold Water Biota, Salmonid Spawning, Primary Contact Recreation, Secondary Contact Recreation, Special Resource Water |
| SB-421 | Blackbird Creek B source to, and including Blackbird Creek Reservoir | Cold Water Biota, Salmonid Spawning, Secondary Contact Recreation |
| SB-4211 | Blackbird Creek B Blackbird Creek Reservoir dam to mouth | Secondary Contact Recreation |
| SB-4212 | West Fork of Blackbird Creek B concrete channel to mouth | Secondary Contact Recreation |
| SB-4213 | West Fork of Blackbird Creek B source to but not including the concrete channel | Cold Water Biota, Salmonid Spawning, Secondary Contact Recreation |
| SB-430 | Panther Creek - Blackbird Creek to mouth | Agricultural Water Supply, Cold Water Biota, Secondary Contact Recreation |

Of particular importance regarding listed water bodies in this subbasin are the criteria for pH, metals, sediment, nutrients, and dissolved oxygen. The narrative criterion for sediment is as follows:

> "Sediment shall not exceed quantities specified in section 250, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determination of impairment shall be based on water quality monitoring and surveillance and the information utilized in section 350.02.b."

Quantities specified in Section 250 refer to turbidity criteria identified for cold water biota use and small public domestic water supplies. Turbidity must be measured upstream and downstream from a sediment input in order to determine violation of criteria. Indirectly, specific sediment criteria also include intergravel dissolved oxygen measures for salmonid spawning uses. Intergravels filled with sediment cannot hold enough dissolved oxygen for successful incubation. Intergravel dissolved oxygen measurement requires the placement of special apparatus in spawning gravels. Turbidity and intergravel DO are rarely measured as part of routine reconnaissance-level monitoring and assessment. These measurements are usually conducted in special cases during higher-level investigations of potential problems. Because of access difficulty, such techniques are rarely used in the back-country settings comprising most of this subbasin.

The criteria for pH are as follows:

> "Hydrogen Ion Concentration (pH) values [must be] within the range of six point five (6.5) and nine point five (9.5)."

If pH values in streams are less than 6.5 or greater than 9.5, the pH value will violate the requirements and will need to be ameliorated.

The narrative criterion for Nutrients is as follows:

> "Excess Nutrients. Surface Waters of the State shall be free from excess nutrients that can cause visible slime growth or other nuisance aquatic growths impairing designated beneficial uses."

The excess nutrient that will be examined for this subbasin is phosphorus loading in Williams Lake. Although there is no maximum level specified by law, it is often recommended that total phosphorus as phosphorus should not exceed 50 micrograms per liter (ug/l) (0.05 mg/L) at the point where the stream enters the lake or reservoir, nor 25 ug/l (0.025 mg/L) within the lake or reservoir (EPA Goldbook, 1986). The desired goal associated with these limits is to prevent eutrophication or nuisance algal growths in the waterbody.

Arsenic, copper, and cobalt are the three metals of concern in this subbasin. The numeric criteria for arsenic are incorporated into the state's standards by reference from 40CFR131.36, as 360 ug/l (0.36 mg/L) for acute toxicity and 190 ug/l (0.19 mg/L) for chronic exposure, both expressed as dissolved concentrations. If dissolved (0.45 micron filtered) arsenic levels in the surface water exceed the 190 ug/l (0.19 mg/L) standard, the stream may be in violation of the required standard.

The numeric criteria for copper are also incorporated by reference from 40CFR131.36, and presented as an equation based on stream water hardness. The acute criterion is:

$$(0.96)e^{(0.9422(\ln H)-1.464)}$$

and the chronic criterion equation is:

$$(0.96)e^{(0.8545(\ln H)-1.465)}$$

where "lnH" equals the natural log of the surface water's hardness. The hardness of the waterbody is measured as milligrams of $CaCO_3$ and put into the equation for H. The standard for copper is calculated based on the hardness number entered and is expressed as a dissolved concentration. If dissolved (0.45 micron filtered) copper levels in the surface water exceed the calculated standard, the stream may be in violation of the required standard.

Cobalt is considered a deleterious material and excess concentrations in a waterbody will impair designated uses. EPA has not developed an ambient water quality criterion for cobalt due to its rarity of occurrence and limited toxicological data (Mebane, 1994). Elevated concentrations of cobalt have been known to occur in association with copper ores. In the waters in question in this subbasin, it is believed that if copper concentrations are reduced to meet ambient water quality standards within a watershed where cobalt and copper co-occur, it is most likely that cobalt concentrations will decrease to acceptable levels also through the same mitigative processes (Mebane, pers. comm.).

The narrative criteria for metals without numerical criteria (e.g. cobalt) are as follows:

> "Deleterious Materials. Surface Waters of the state shall be free from deleterious materials in concentrations that impair designated beneficial uses. These materials do not include suspended sediment produced as a result of nonpoint source activities."
>
> "Toxic Substances. Surface waters of the state shall be free from toxic substances in concentrations that impair designated beneficial uses. These substances do not include suspended sediment produced as a result on nonpoint source activities."

The criteria for dissolved oxygen are as follows:

> "Dissolved oxygen concentrations [must be] exceeding 6mg/L at all times. In lakes and reservoirs this does not apply to:
>
>> The bottom twenty percent (20%) of water depth in natural lakes and reservoirs where depths are thirty-five meters or less.
>>
>> The bottom seven meters of water depth in natural lakes and reservoirs where depths are greater than thirty five meters.
>>
>> Those waters of the hypolimnion in stratified lakes and reservoirs."

If dissolved oxygen concentrations are above 6 mg/L, the waterbody is not in violation of water quality standards. If detected concentrations are below 6 mg/L in a lake or reservoir, the waterbody shall be assessed to determine if the above exceptions apply to those layers of the waterbody described above.

### 3.3 Water Body Assessments

Since 1993, 112 streams (150 sites) have been assessed in this subbasin through the DEQ Beneficial Use Reconnaissance Project (BURP). The table in Appendix A lists the site characteristics for these streams. The majority of the BURP sites are on first and second order streams with elevations varying from 3,100 to 7,600 feet and Rosgen channel types of A, Aa+, and B. Percent fines vary from 0 to 99% with an average of 35%. Percent bank stability and vegetative cover are fairly high, around 90%, and width/depth ratios average around 15.

The support status of a stream is determined through the assessment of BURP data as identified in the 1996 Water Body Assessment Guidance (DEQ, 1996). Streams that become 303(d) listed are not considered to be in full support of their beneficial uses and do not meet state water quality standards. Streams are removed from the 303(d) list only when they are demonstrated to support their beneficial uses. The beneficial uses for streams in this subbasin have been described previously. Support status assessments for the DEQ 1998 303(d) list determined that Williams Lake and Diamond Creek should be added to the water quality-limited list, and Carmen

Creek should be removed from the list (Table 17). Diamond Creek was errantly added to the DEQ 1998 §303(d) list.

The location of the BURP assessment site was located at the extreme headwaters of the watershed on an intermittent reach of the stream with only 0.1 cfs flow on July 22nd 1996. These flow characteristics would account for low MBI scores and a rating of Not Full Support for Coldwater Biota (Table 17). There is no fish data for Diamond Creek because it is considered naturally fishless due to low base flow, particularly in winter, and there is a natural fish barrier at the mouth of Diamond Creek that prevents even seasonal use of the stream by rearing fish (Rieffenberger, B. USFS SCNF November 6, 2000, personal communication).

Additionally, two sites on the Salmon River in the vicinity of this subbasin were assessed in DEQ's new river BURP process, and two sites on East Boulder Creek and four sites on Panther Creek sampled in 1998 were recently assessed (see Appendix E). The river sites were located upstream from the confluence with Pahsimeroi River just outside of the subbasin, and at the confluence with Fourth of July Creek near North Fork. Both of these sites are considered reference conditions for large rivers, and, in fact, produced high River IBI (fish index) scores of 93 and 84 for the Pahsimeroi River confluence and Fourth of July Creek confluence locations, respectively. The River IBI takes into account a suite of indices addressing numbers and/or percentages of cold water species, sensitive natives, sculpin age classes, tolerant fish, non-indigenous species, salmonid age classes, anomalies, and carp presence (DEQ, 1999).

The two sites on East Boulder Creek were recently assessed (as per DEQ, 1996) amid information that suggested this creek may be affected by sediment pollution (see National Forest Assessments). Macroinvertebrate scores (in Appendix E) for East Boulder Creek were generally high enough to be considered "not impaired," however, habitat scores (in Appendix A) were lower in the "needs verification" level. In such circumstances, the water body assessment

**Table 17 BURP Assessments of 1998 303(d) Listed Waters.**

| Water Body | Support Status* | Criteria Violations | Comments |
|---|---|---|---|
| Blackbird Creek (below mine) | NFS for CWB, SS, PCR, SCR | copper (acute & chronic aquatic life); deleterious materials (cobalt); pH | cutthroat above, no fish below Meadow Cr.; Blackbird Cr. Reservoir used as drinking water source for mine in past |
| WF Blackbird Creek | Full Support | | last 100 meters in culvert over tailings pile |
| Bucktail Creek | NFS for CWB, SCR | copper (acute & chronic aquatic life); deleterious materials (cobalt); pH | very low MBI score |
| Big Deer Creek (below SF Big Deer Creek) | NFS for CWB, SS | copper (acute & chronic aquatic life); deleterious materials (cobalt) | low MBI score |
| Big Deer Creek (above SF) | Full Support | | |

| | | | |
|---|---|---|---|
| Panther Creek (below Blackbird Cr.) | NFS for CWB, SS | copper (acute & chronic aquatic life); deleterious materials (cobalt) | low MBI score, hatchery rainbow and mountain whitefish observed; managed by IDFG as put&take fishery; Chinook redds observed in 1990-1991 |
| Panther Creek (above Blackbird Cr.) | Full Support | | multi-year classes bull trout, rainbow/steelhead, mountain whitefish |
| Dump Creek | NFS for CWB | | low to moderate MBI score, no fish data |
| Diamond Creek | NFS for CWB | | low MBI score, no fish data |
| Carmen Creek | Full Support | | rainbow/steelhead, bull trout, sculpin collected in 1994 |
| Williams Lake | NFS for CWB | dissolved oxygen, nutrients | 1994 report - P loading causes excess algae, oxygen depletion, winter fish kill; sources include internal cycling, watershed, septic |

*NFS = not full support, CWB = cold water biota, SS = salmonid spawning, PCR = primary contact recreation, SCR = secondary contact recreation, MBI = macroinvertebrate biotic index.

guidance (DEQ, 1996) directs the assessor to review other sources of information. Other information available to us includes National Forest assessments and additional information accumulated through the BURP process. Both sources indicate percent fines levels between 50% and 80%. In light of these data, we suggest that East Boulder Creek should receive an overall status determination of "needs verification." This implies that East Boulder Creek should be 303(d) listed, however, restoration of the watershed is being addressed through a water quality management plan/Forest Service restoration plan.

Four additional sites on Panther Creek sampled in 1998 were likewise recently assessed (Appendix E.). Macroinvertebrate Biotic Index scores (in Appendix E) for East Boulder Creek were 4.6 and 4.1. Samples were collected at two sites: immediately above the USFS forest road bridge and on the western tributary to East Boulder Creek just above the confluence with East Boulder Creek, above the same bridge approximately 0.5 miles (not East Boulder Creek proper). Flows in the western tributary to East Boulder Creek were measured at 0.5 cfs on the sampling date of August 11$^{th}$ 1998. These MBI scores are well above the threshold for "not impaired" water quality.

The USGS has measured dissolved solids and temperature at two stations on the Salmon River in this subbasin. Dissolved solids data are presented in Appendix B. Dissolved solids were measured several times a year from 1970 to 1998 in the Salmon River at Salmon station. At this station dissolved solids concentration ranged from 47 to 214 mg/L with an average of 129.8 mg/L. At Salmon River near Shoup, dissolved solids ranged from 42 to 217 mg/L with an average concentration of 138.7 mg/L for years 1971 to 1981. Dissolved solids are those particles capable of passing through a 0.45 micron filter; thus sand and most silt are excluded from this measure. Water temperatures measured during the same time periods were instantaneous recordings, which never exceeded 21.5$^{o}$ C.

DEQ Assessments

The Division of Environmental Quality sampled salmonids by electrofishing at two sites above the bridge on USFS Rd 023 on August 28$^{th}$ 1999. The uppermost site was a 100-meter transect at 6,640 ft amsl on the western tributary to East Boulder Creek just above the confluence with East Boulder Creek (not East Boulder Creek proper). This site was sampled in one pass that collected cutthroat trout in 3 age classes (n=3) that included young-of-the-year. The downstream site was a 100-meter transect at 6,625 ft amsl immediately above the USFS Rd 023 bridge. This site was sampled in one pass that collected cutthroat trout in 3 age classes (n=7) that did not include young-of-the-year. The composites of fish data for these two sites show full support for salmonid spawning in East Boulder Creek.

A streambank erosion inventory was conducted by DEQ above and below the USFS Rd 023 bridge on July 11$^{th}$ 2000. The upper erosion inventory overlapped the western tributary to East Boulder Creek and East Boulder Creek. The erosion estimate extrapolates downstream to the FR 023 bridge and represents 1.3 miles of stream. Overall this section was categorized as having slight streambank erosion. The estimated streambank stability over this reach is 96% with an erosion rate of 5 tons per mile per year and total stream bank erosion over the upper section estimated at 6 tons per year. This represents very little sediment from streambank erosion. Through the course of conducting the erosion inventory it was noted that instream fine sediment deposited on the surface appears to be the result of historic down-cutting on the western tributary to East Boulder Creek above the confluence with East Boulder Creek. Substrate within East Boulder Creek above this confluence appears to have far fewer surface fines. The down-cutting over this section may be related to historic grazing practices, placer mining and extreme hydrologic events.

The lower erosion inventory was conducted from the USFS sediment dam that is part of the East Boulder Creek restoration project, upstream to a point 0.26 miles above the dam. From the upstream bound of this erosion inventory reach to the bridge, erosion conditions are similar to those identified above the bridge. Overall this section was categorized as having localized severe to extreme erosion related to historic placer mining, possibly combined with extreme hydrologic events. The estimated streambank stability over this reach is 19% with an erosion rate of 688 tons per mile per year and total stream bank erosion over the lower 0.26 mile section estimated at 179 tons per year. This is an exceptional amount of sediment that is directly related to historic placer mining. Surface fines are very high over this reach associated with upstream sources and localized erosion.

The sediment dam appears to be functioning, as conditions below the dam appear much improved as the stream gradient increases significantly. Sediment appears to have accumulated to a depth of approximately 15 ft (5 m) immediately above the dam (the approximate height of the dam above stream grade). The dam appears to be in need of maintenance, though it was stabilized with large rock in the fall of 1999 to prevent its failure and the subsequent release of large quantities of sediment downstream into East Boulder Creek and ultimately the Salmon River. The objective of the dam stabilization was to stabilize the stream gradient of East Boulder Creek to prevent further downcutting of the stream into the valley above. Dredging of the accumulated sediments above the dam would prevent stabilization of the stream gradient and rebuilding of the valley bottom. Engineered bank-barbs are present with stakes to evaluate recession of stream banks. Revegetation of streambanks is progressing over parts of this reach with annual grass species and some sedges colonizing bare banks, though overall erosion and bank angle are not capable of supporting shrubs or larger woody species at this time.

There is no road access to this area. The dam stabilization required walking an excavator down the stream channel to access the site. This complicates future maintenance of the sediment dam and precludes dredging and disposing of accumulated sediment. The objective remains accumulation of sediment to stabilize the stream gradient and valley bottom with future sediment transported down East Boulder Creek to the Salmon River.

DEQ had scheduled additional erosion inventories and sediment core samples during the 2000 field season, however access to the stream was prevented by the Clear Creek Fire that began shortly after the streambank erosion inventory was conducted.

National Forest Assessments

The Salmon-Challis National Forest has monitored sediment core samples on a number of streams throughout the subbasin every year since 1993 and has reported results yearly in Salmon-Challis Monitoring Completion Reports. Mean percent depth fine sediment for these years are presented in Appendix F (from SCNF, 1999).

A total of 72 stations on 47 streams were sampled within the subbasin. Of those sites sampled, 29% of the stations surveyed from 1993 to 1999 had a significant increase in percent depth fine sediment and 11% of the stations sampled had a significant decrease. Sites with significant increases in depth fines include Moyer Creek, Napias Creek (three sites), Panther Creek, Woodtick Creek, Twin Creek, and the WF Iron Creek (see Appendix F). Depth fines for these sites rarely exceeded 30%, and only the Panther Creek site is associated with a 1998 303(d) listed stream. Road densities for these watersheds vary from 0.58 mi/mi$^2$ (Napias Creek) to 2.1 mi/mi$^2$ (WF Iron and Napias Creeks) (see Appendix D). These sediment increases may be influenced by increases in flow. Flows in the early 1990s were lower than flows occurring in the late 1990s (see Appendix H). As flow increases in wet years, sediment may be re-distributed within watersheds resulting in these fluctuating sediment depths.

Acceptable conditions for percent depth fines can be variable and are often dependent upon hydro-geologic processes and the objectives for the waterbody. In general, we have called attention to any waters with core sampling results exceeding 30% and not showing a significant decreasing trend. Two streams of concern are noted based on the results of this survey. East Boulder Creek, although not 1998 303(d)-listed, ranged from 52% to 62% depth fines with a small but not significant reduction in percent depth fines since 1993. Lake Creek is another stream of concern. Sampling results for this stream ranged from 53% to 35% depth fines with a small but not significant reduction trend. Lake Creek is a tributary to Williams Lake, which is 1998 303(d)-listed for dissolved oxygen and nutrients. Lake Creek may be a contributor to the pollutants found in Williams Lake. Warm Spring Creek had depth fines greater than 30%; however, data were remarkably consistent near 40% through all years sampled. This consistency suggests a system in equilibrium with its surrounding geology. Panther Creek was the only 1998 303(d)-listed stream sampled for percent depth fine sediment from 1993 to 1999. There were five stations along Panther Creek that were sampled. Trends of the data collected from each of these stations range from significant increases to significant decreases in the percentage of depth fine sediment. Other 1998 303(d)-listed streams in the subbasin were not sampled in this survey.

In 1993, River Masters Engineering produced a road sediment inventory for Panther Creek (RME, 1993). This report identified a number of different types of roads and their potential for impacting streams. Roads within the Panther Creek drainage were divided into segments and then inventoried for road type and assessed for impacts by measuring cobble embeddedness in the nearby stream. The study identified areas of most concern for future road improvements. Cobble embeddedness for all road segments were compared to a pristine headwater location and found not to be significantly different using a one-way analysis of variance. However, the general trend was for cobble embeddedness to increase with downstream segments. The study did not address waters 303(d)-listed for sediment. Table 18 shows summary data of habitat characteristics for tributaries up-river from North Fork.

<u>Moose Creek Watershed Assessment</u>

Moose Creek, Dump Creek, and East Boulder Creek were assessed recently by the Forest Service to evaluate their potential as habitat for anadramous fish (Rose, 1999). Core sampling for percent fine sediment, stream habitat measures, and water temperatures were evaluated to varying degrees for these three streams. Stream channel and habitat information are presented in Tables 19 and 20. McNeil core sampling took place on Moose and East Boulder Creeks between 1993 and 1998. This sampling discovered “highly elevated levels of depth fines (53-67%) within the upper reaches of East Boulder Creek.” The author attributed these levels to impacts from past placer mining within an erosive granitic geology. Upper Moose Creek sediment levels were much lower throughout the monitoring period with 1997 and 1998 data at levels less than 18.5% fines. Trends showed a significant reduction in levels of depth fines on Moose Creek, and no statistically significant change in levels in East Boulder Creek.

Evaluations of the Dump Creek problem date back to 1950. In 1956 the Army Corps of Engineers (COE) worked on removing part of the alluvial fan at the mouth of Dump Creek to widen the Salmon River channel in hopes of eliminating the slack water above Dump Creek to stop the ice buildup and the upstream flooding resulting from the ice dams. They moved 12,500 cubic yards before winter weather shut down their operations before they could start up in the spring high flows from Dump Creek washed out their workings and rebuilt the alluvial fan to a size larger than before they had started dredging. After further study the COE decided that further work on Dump Creek was not economically justified for flood control purposes (Rieffenberger, 1999).

In the 1960s the concern over Dump Creek surfaced again and a study was initiated to determine the most feasible alternative to correct the watershed problems. Four alternatives were reviewed: 1) Diverting Moose Creek back into its original channel. 2) Construction of drop structures and retaining walls in Dump Creek to control velocity and store sediment. 3) Construction of a flood control reservoir to store water during periods of high runoff and slowly release it over the summer. 4) Diverting the water back into Moose Creek plus mechanical treatment of the slopes adjacent to the Dump Creek chasm to speed up slope stabilization.

In 1974 an Environmental Analysis of the problem was completed. The analysis of the four alternatives concluded that Alternative 1 was the most effective and economically feasible alternative. The underlying assumption of Alternative 1 was that diverting the water would

**Table 18 Summary data for streams in the upper Salmon River section of the Salmon-Panther Subbasin (SCNF, 1993).**

| Stream Name | Pool Frequency (pools/mile) | Large Woody Debris (pieces/mile) | % Bank Stability | Width/Depth Ratio | Mean Summer Temperature (degrees C) |
|---|---|---|---|---|---|
| Hat Creek (above Forest boundary) | 19.4 | 46.7 | 95 | 22 | |
| Hat Creek (below Forest boundary) | 35.7 | 30.5 | 72 | 33 | |
| Big Hat Creek | | | | | 10 |
| Iron Creek (above Forest boundary) | 19.5 | 37 | 93 | 25 | 6.7 |
| NF Iron Creek | 53.6 | 79 | 85 | 15 | 7.3 |
| SF Iron Creek | 73.6 | 72.9 | 98 | 15 | 7.1 |
| McKim Creek | | | 91 | 20 | |
| Cow Creek | | | | | 8.4 |

| | | | | | |
|---|---|---|---|---|---|
| Twelvemile Creek | 26.3 | 292.3 | 84 | 18 | |
| Williams Creek | | | | | 7.5 |
| Fourth of July Creek (below Forest boundary) | | | | | 11.2 |
| Salmon River (above Lemhi River) | | | | | 14.4 |

remove the transport mechanism for carrying the eroded material to the Salmon river. Without the erosive high flows the constant slope undercutting could be arrested and that over time the unstable slopes in Dump Creek would slough to an angle of repose and begin to stabilize. A project plan was completed and a campaign to secure funding for the Dump Creek Project was begun in 1974.

Unfortunately, no sediment sampling was reported for Dump Creek. However, Rose (1999) describes Dump Creek as "dramatically impacted by past mining activities within its upper drainage." Due to extensive scouring of Dump Creek's channel, suitable fish habitat is limited to the lowermost reach that flows through an expansive alluvial fan at the stream's mouth (see description of Dump Creek alluvial fan in Hydrology section above). Water temperatures were monitored in Moose and East Boulder Creeks from 1995 through 1998 (Rose, 1999). Cold water biota temperature criteria were met during all years. Salmonid spawning temperatures were exceeded in the fall in both creeks in all years with data. The author notes that the observed minor exceedance of spawning temperature criteria during the fall spawning season (Sept 1 - Oct 30) have no bearing in these streams because they contain spring spawning fish. Spring

**Table 19 Channel Characteristics within the Moose Creek Watershed Assessment (Rose, 1999).**

| Stream/Reach | Rosgen Channel Type | Width/Depth | Gradient | Bank Stability |
|---|---|---|---|---|
| Dump Cr. Reach 1 | A3a+ | <12 | >10% | unstable |
| Dump Cr. Reach 2 | B3a | 13 | 4-5% | (alluvial fan) |
| Moose Cr. Reach 1 | E4 - C3b | 8-14 | 1-4% | 33-71% |
| Moose Cr. Reach 2 | E4 & E4b | 10-12 | 1-4% | 49-64% |
| Moose Cr. Reach 3 | C3b & B3c | 12-18 | 1-4% | 42-69%(1997) 78% (1998) |
| Moose Cr. Reach 4 | G3c | 8-10 | <2% | stable |
| Moose Cr. Reach 5 | F3 | 19 | <2% | unstable |
| Moose Cr. Reach 6 | A2a+ | <12 | 10%+ | stable (large substrate) |
| Moose Cr. Reach 7 | B2a | 28 | 4-10% | stable |
| | | | | |

| | | | | |
|---|---|---|---|---|
| Hornet Cr. Reach 1 | C3a | 9-10 | 5-6% | 84% |
| Daly Cr. Reach 1 | A2a+ | 9 | 15% | 84% |
| Daly Cr. Reach 2 | C4 | 15 | <2% | 59% |
| Little Moose Cr. Reach 1 | E4b | 2.6 | 2-3% | 80% |
| East Boulder Cr. Reach 1 | E4 | 7 | 1-2% | 76% |
| East Boulder Cr. Reach 2 | A2 | <12 | >4% | stable (large substrate) |
| East Boulder Cr. Reach 3 | B5c | 12 | 1-2% | 82% (1994)<br>63-66% (1997)<br>83% (1998) |
| East Boulder Cr. Reach 4 | F5 | - | <2% | highly unstable |
| East Boulder Cr. Reach 5 | B2a+ | 14 | >10% | stable (large substrate) |

**Table 20 Habitat Features within the Moose Creek Watershed Assessment (Rose, 1999).**

| Habitat Element | Stream | | | | |
|---|---|---|---|---|---|
| | Lower Moose Creek | Upper Moose Creek | Lower East Boulder Cr. | Upper East Boulder Cr. | Dump Creek |
| Pool Frequency | Frequent | Frequent to Uncommon | Frequent | Infrequent to Frequent | Infrequent |
| Pool Quality | Fair to Good | Fair to Good | Fair to Good | Fair to Good | Poor to Fair |
| Woody Debris | Abundant | Generally Frequent | Infrequent | Infrequent Small | Virtually Absent |
| Streambank Stability | Stable Rocky | Good to Poor | Stable Rocky | Fair to Poor | Inherently Unstable |
| Stream Shading | Excellent | Good to Excellent | Excellent | Fair | Poor |

spawning temperatures were not recorded because of snow-related access problems. Water temperatures were also measured in the mainstem Salmon River near Newland Ranch during 1995, 1997 and 1998. Water temperatures were reported as being below 64$^{o}$ F (17.8$^{o}$ C) during 1995, but exceeded this value in 1997 and 1998 (type of measurement unknown). Maximum temperatures were not presented, so we cannot determine if cold water biota criteria were exceeded in the Salmon River during this sampling event. It is noted that under reference conditions the mainstem Salmon River near Moose Creek would have met cold water biota temperatures in all but the hottest years, but we suspect that salmonid spawning temperatures (<13$^{o}$ C) would not have been historically achievable during late spring or early fall spawning periods for species present in these waters.

Williams Lake

Williams Lake was assessed in 1994 and classified as a meromictic lake (Barnes et al., 1994). Biogenic meromixis is a phenomenon where a lake has a combination of characteristics which prevents complete mixing and allows the build up of an anoxic layer high in hydrogen sulfide (Cole, 1979). The combination of morphological, topographic, and meteorologic characteristics hinders overturn and allows the accumulation of materials of biogenic origin. In Williams Lake case, the lake is deep (179 feet) in relation to its surface area and is protected from wind by high topography and forests. The lake was formed by a landslide that blocked the Lake Creek drainage and allowed the water to accumulate behind the landslide dam. The hypolimnion of Williams Lake is anoxic and is anticipated to have high hydrogen sulfide concentrations, although this has never been measured. The lake as assessed again in 1998 through the DEQ BURP-Lakes process (B. Hoelscher, pers. comm.). A synopsis of these assessments is presented in Appendix C. Hoelscher describes water samples from the deeper layers of the lake as smelling of sulpher suggesting high levels of hydrogen sulfide.

Further additions of nutrients and organic matter would be expected to exacerbate the meromictic condition of the lake. Partial turnover, which bring anoxic conditions and hydrogen sulfide to surface layers causing fish kills and loss of available habitat volume of upper layers, can result in detrimental effects on aquatic biota. Preliminary conclusions of the BURP process suggest the lake is not likely to support its cold water biota beneficial use and would corroborate the results of the earlier assessments. Phosphorus loadings and dissolved oxygen depletion appear to be the primary cause of impairment (see Appendix C).

In 1997, a follow up to the 1994 Restoration Study containing additional information was generated (see Appendix C). This follow up study indicated that, not only have phosphorus loading increased, but pathogens, not identified in the initial study, may also be a risk to human health. These risks are linked to the increases of recreational uses and septic systems around the lake. It was concluded that little or no barriers or treatment systems exist to remove pathogens from septic systems before wastes enter the lake.

Blackbird Mine

The area of Blackbird Mine is one of the largest cobalt deposits in North America, rich with sulfide ores of cobaltite (CoAsS), chalcopyrite ($CuFeS_2$), pyrite ($FeS_2$), and pyrrhotite (FeS) (Mebane, 1994). Gold and other precious metal mining has occurred in the area since 1893, and cobalt and copper were mined and milled at the site from 1917 to 1967 (SCNF, in prep.). The main period of extraction followed World War II, from 1949 to 1967. No commercial mining has occurred at Blackbird Mine since 1967. The mine is comprised of about 15 miles of underground workings, a 12-acre open pit, and approximately 84 acres of exposed waste rock (Mebane, 1994). It is estimated that all disturbed areas—including roads, facilities, tailings ponds, and other mining areas—total 535 acres, the majority of which is on 837 acres of private land (SCNF, in prep.).

Blackbird Mine sits in the saddle of a mountain ridge with mined areas affecting drainages on both sides. Drainage on the Blackbird side flows from the mined area into Blackbird Creek near its headwaters. Blackbird Creek then flows into Panther Creek about midway through the drainage. The West Fork Blackbird Creek enters Blackbird Creek below the mine and is relatively undisturbed except for a large tailings impoundment at its mouth. The West Fork Blackbird Creek was re-routed through a concrete culvert on top of the tailing pile to avoid contact between the creek and the waste rock. On the other side of the mountain, the open pit was started in 1954. Bucktail Creek headwaters in the waste rock below this pit and flows to the South Fork Big Deer Creek for the last 1/4 of its length. South Fork Big Deer Creek flows into Big Deer Creek at 2/3 of its length, and Big Deer Creek flows into Panther Creek 10 or more miles downstream from Blackbird Creek.

Because of the nature of the rock ore being mined, cobalt, arsenic, copper, iron, and acid drainage are water quality concerns in this drainage (Mebane, 1994). The sulfide ores react uniquely with the snow accumulations in these mountains and produce a first flush of acid mine drainage with metal-laden water during early snowmelt. Contamination decreases through the snowmelt process, but increases again in summer when base flow from the mountain's groundwater brings more contaminants out. As a result, Blackbird Creek, Bucktail Creek, Big

Deer Creek, and Panther Creek are 303d-listed for metals contamination. Blackbird Creek and Big Deer Creek are also listed for pH and sediment concerns.

### 3.4 Assessment Data Gaps

Diamond Creek

The status of beneficial uses have been determined for Diamond Creek through BURP. Diamond Creek's failure to achieve adequate macroinvertebrate and habitat scores is due to the poor selection of the BURP assessment site. As previously stated the assessment site was at the extreme headwaters of the watershed on an intermittent reach of the stream with only 0.1 cfs flow on July 22nd 1996. A pollutant source inventory conducted in early July of 2000 did not reveal human activities or associated features that would influence sediment loading to Diamond Creek beyond the stream's ability to assimilate them. This drainage needs a BURP site below the Diamond Creek Road or at the lower boundary of BLM property to adequately determine its beneficial use support status. Existing data does not show that the expected status would be less than full support if appropriately assessed. Salmonid spawning beneficial use is not an appropriate use designation for Diamond Creek and a concerted presence/absence salmonid survey should be conducted to definitively show that the stream is naturally fishless.

Williams Lake

Williams Lake was assessed prior to 1994, and, more recently the status of beneficial uses has been determined for Williams Lake through BURP. However, continuing monitoring data is necessary to provide verification of water quality findings in Williams Lake. It is also necessary to further assess load reduction to the epilimnion from recent and upcoming implementation of septic system BMPs.

## 4.0 Pollutant Source Inventory

Roads

Road densities and road density ratings are presented in Appendix D. The Hull Creek watershed, a tributary to the North Fork Salmon River, was the only watershed rated "extreme" with a density greater than 4 mi/mi$^2$. Dump Creek and Moose Creek are rated "high" with densities of 1.86 and 1.76 mi/mi$^2$, respectively. East Boulder Creek has a "moderate" road density of 0.96 mi/mi$^2$. The Lake Creek watershed has a "high" road density at 1.95 mi/mi$^2$. Diamond Creek, although not specifically listed in the table in Appendix D, is likely within the Wallace Creek watershed, one with a "high" road density of 2.59 mi/mi$^2$. Over 20 other sixth-field watersheds also have a "high" density rating.

Mining

Placer mining effects in Moose, Dump, and East Boulder Creeks are well documented and described elsewhere in this report. These activities occurred many years ago, although restoration of affected streams is still a long-term process.

Blackbird Mine

Pollution sources at the mine have been well documented as a result of the regulated clean-up activity.

Williams Lake

Pollution sources to Williams Lake have been described by Barnes et al., 1994 and others (see Appendix C). In the 1994 Restoration Study, both point and non-point sources of pollution to Williams Lake were identified. The major point source of contamination to the lake at the time of the study included grey-water outfall pipes from homes on the lakeshore of Williams Lake. Non-point sources include septic systems located near the lakeshore, past timber harvesting, public and private grazing allotments upstream and surrounding the lake, and a naturally erosive basin located above Lake Creek. The majority of roads used for timber harvest have been closed and revegetated and are not considered a source of non-point source pollution (Barnes et al., 1994). Road density for the Lake Creek watershed (1.95 mi/mi$^2$) reported in 1998 (Appendix D) is still considered high. The recorded dissolved oxygen concentrations within the lake ranged from 11.4 mg/L to 0.1 mg/L. The low dissolved oxygen concentrations have been linked to fish kills within the lake. Phosphorus concentrations were also determined to be unacceptable within Williams Lake. Total phosphorus concentrations were recorded to be as high as 0.371 mg/L and soluble reactive phosphorus levels of 0.317 mg/L. The major sources of phosphorus entering the lake were determined to be internal loading within the lake, inlet streams, and septic systems surrounding the lake. The majority of phosphorus contamination, approximately 76% in a typical year, originated from internal loading. Inlet streams account for 16%, and 5% is from the surrounding septic systems. The large percentage of internal loading is characteristic of stratified deep lakes with a hypolimnetic layer such as found in Williams Lake (NRCS, 1999). This characteristic will make Williams Lake difficult to restore. The conclusion of the Barnes et al. (1994) study suggested that implementation of basin-wide Best Management Practices (BMP), along with lake remediation activities, such as hypolimnetic aeration or stratified circulation, would improve the quality of Williams Lake.

## 4.1 Pollutant Source Data Gaps

Diamond Creek

No information is available on pollutants or their sources.

Williams Lake

Actual loading rates have not been determined from individual septic systems for Williams Lake. More recent data needs to be collected to identify current epilimnetic loading limits for Williams Lake. Although pathogens were identified as a potential concern, reducing the load of phosphorus and increasing dissolved oxygen rates would most likely also address pathogen concerns.

## 4.2 Summary of Pollution Control Efforts

Moose/Dump Creeks Water Quality Management Plan

Moose Creek and Dump Creek channels are very close to one another. In the late 1800s during the placer mining of Dump Creek, water from Moose Creek was routed into the Dump Creek channel (Rieffenberger, 1999). Over the years, this higher volume of water has created substantial change in channel condition and erosion of the banks in Dump Creek. The water diversion resulted in channel downcutting that caused side slopes to be undercut, resulting in massive slope failures. The Dump Creek restoration project, in which water was re-routed to

Moose Creek, was implemented in 1979. Several small tributaries below the diversion continued to contribute water to Dump Creek to maintain a small flow (SCNF, 1993). The sediment loading to the Salmon River from Dump Creek was essentially stopped at this point (Rieffenberger, 1999). The unstable slopes in the Dump Creek drainage will continue to slump until some equilibrium is achieved. No massive slope failures have been observed in the last 10 years, although there is still potential for slope failures from numerous unstable land blocks. In the upper chasm above the waterfall a stable channel with vigorous riparian vegetation is developing.

The proposed Dump Creek watershed restoration project consisted of the following components:

1) Construction of a water diversion structure with control gates to divert upper Moose Creek back into the Moose Creek drainage and an emergency spillway to divert flood flows in excess of the design capacity of the new channel back into Dump Creek
2) Construction of about 6,700 feet of stream channel below the diversion structure. This was necessary because the historic Moose Creek channel in this reach had been obliterated by placer mining.
3) Vegetation removal in the historic Moose Creek channel that had encroached on the channel in the past 75 years since upper Moose Creek had been diverted down Dump Creek.

Because of the proximity of the new channel to the Dump Creek chasm about 4,000 feet of the new channel was lined with an impermeable liner to reduce subsurface seepage from the new channel. The concern was that subsurface seepage might lubricate the unstable side slopes in Dump Creek causing additional slope failures (Rieffenberger, 1999).

It was necessary to purchase or exchange several parcels of private land that were in the project area or were in threat of flooding due to the proposed water diversion. In addition the project area was withdrawn from mineral entry to protect the improvement project from future mining activities (Rieffenberger, 1999).

Construction activities commenced in the fall of 1978 and were completed by the fall of 1979. These activities included construction of the diversion structure, the new channel, and the drop structures in the channel that were designed to control the channel gradient. Also included in the project package was construction of a treated timber bridge across Moose Creek to provide access to the project area during high water, an access road and fencing around the project area to exclude livestock. The construction contract totaled $525,063.00. Total costs including property acquisition, design and contract administration and repair work on the gabion drop structures that was done in 1980-1982 came to $919,203.00.

Grade control structures in Moose Creek have deteriorated over time. To maintain the channel grade new rock vortex weirs will be constructed in 2000. Part of the Dump Creek Restoration Project involved the construction of a jack fence to exclude livestock from the restoration area. In 1999, it was determined that the fence needed re-construction after deterioration led to livestock breaking into the exclosure. Fence reconstruction is also planned for 2000. Additionally in 2000, fisheries habitat improvement structures (low profile log drop structures and artificial undercut bank log structures) are planned for the lowermost stretch of Dump Creek that has access to the Salmon River migration corridor.

East Boulder Creek Water Quality Management Plan

Portions of East Boulder Creek were placer mined around the turn of the previous century. As a result portions of the creek had channel downcutting and unstable banks. At the lower end of this reach a wooden crib filled with stone was placed to act as grade control and to stabilize the valley bottom and prevent further downcutting/headcutting in an upstream direction. To prevent failure of this structure and release of sediment to the channel, a restoration project was completed in 1999 that placed large boulders below the crib dam to stabilize it. Boulders were also placed along the bank for stabilization. Additional channel stabilization work was completed and the floodplain was revegetated with native riparian species to enhance recovery. The USFS S-CNF has plans to maintain the sediment dam/wooden crib structure; however there are no plans remove accumulated sediment from above the dam. Streambank erosion and sediment transport is expected to continue until streambanks stabilize naturally. Previous best management practices installed in the section above the USFS Rd 023 include streambank stabilization and revegetation at a number of sites over the placer mined area. These implementation projects appear to be mature and functioning well with significant willow regeneration and greatly improved streambank stability. There does not appear to be a need for additional best management practice implementation above this reach at this time.

Indian Creek Stream Restoration

In April of 1999, a restoration project was completed to improve habitat conditions for resident trout. The project consisted of placing 12 log structures within the stream in the lower quarter mile of Indian Creek. This project will help in the restoration of resident and anadramous spawning and rearing habitat.

In 1997, a portion of Indian Creek overflowed its streambank. This resulted in a washout of a section of Indian Creek Road. In 2000 a thorough interdisciplinary review of the road washout in Indian Creek showed no significant fishery or watershed benefits to restoring the original stream channel and the previously proposed restoration project was dropped from the current watershed restoration program. The proposed project would have restored the original stream channel and taken measures to prevent further washout of the adjacent road. Road reconstruction of the washed out portion may yet occur.

Williams Lake

Plans are in place to upgrade septic systems by installing a combined system for 22 homes in one project and 9 homes in another project on Williams Lake during 2001. A number of homes have recently made improvements to septic systems, and two lakeshore homes and the Williams Lake Lodge on the eastern shore remain to be upgraded. Other homes removed from the lakeshore will also need to have improved systems installed within the 10-year implementation period of the TMDL.

# 5.0 Williams Lake TMDL

## 5.1 Background

Williams Lake is a popular lake in the Middle Salmon River watershed that is on the Idaho §303(d) list of water quality impaired water bodies for dissolved oxygen concentrations below levels prescribed in Idaho Water Quality Standards. It is also listed for nutrients above levels described in the narrative water quality standards that pertain to nuisance levels of aquatic plants.

Williams Lake was formed when a landslide impounded the flow of Lake Creek thousands of years ago. The newly formed lake was relatively narrow and deep and located in an area relatively sheltered from the wind. These conditions result in an anomaly that significantly reduces the circulation of Williams Lake waters between upper water column (epilimnetic) and lower water column (hypolimnetic) waters. This allows for the natural accumulation of nutrients, particularly phosphorus.

The Williams Lake watershed is composed primarily of silty loam soils with silty clay soils in the steep upper watershed (Barnes et al. 1994). These soils are naturally erosive and high in phosphorus. The result of this combination of factors was a naturally productive lake delicately balanced just below excessive productivity (eutrophic) with limited ability to tolerate additional nutrients and maintain its fisheries habitat and water quality.

Historically Williams Lake has supported a prolific rainbow trout and bull trout fishery that was supported by natural reproduction. Native Americans used Williams Lake as a base camp for hunting and fishing and prospectors also used the lake as a source of fish (Barnes et al. 1994). The U.S. Fish and Wildlife Service used Williams Lake as a brood stock lake during the 1940s and 1950s with annual egg production between 800,000 and 3.5 million eggs (Barnes et al. 1994). The Lake is currently managed as a wild trout fishery though fish were stocked into Williams Lake from 1938 to 1984 (Barnes et al. 1994).

Williams Lake gained popularity as a recreational fishery and in the early 1950s the primitive road that connected the Salmon River Road to Williams Lake was improved resulting in increased use. In 1969 the US Forest Service further improved the road to facilitate extensive timber harvests that continued into early 1970s that included large clearcuts. The watershed was heavily grazed from at least the 1920s until 1968 when grazing was reduced by 40 percent based on results from a forage utilization study conducted by the US Forest Service. The study was conducted over a four-year period that indicated the allotment that included the Williams Lake watershed was being overgrazed (Barnes et al. 1994).

Subdivisions were platted with homes and a lodge built on the shore of the lake in the mid 1960s. Additional homes have been built along the lakeshore since the late 1960s, to total approximately 58 homes in 1992. In October DEQ counted 34 homes on the immediate shoreline of Williams Lake. Williams Lake homes are primarily used as summer recreation homes though yearlong use is increasing (Barnes et al. 1994).

Increased algae production was noted as early as 1965 by IDFG during studies conducted in 1952, 1958, and 1965 (Barnes et al. 1994). By 1971 there were concerns that septic systems were contributing to declining water quality in Williams Lake. This was evidenced by a study conducted by the Idaho Division of Environmental Quality, which noted raw sewage flowing on the ground as a result of broken lines from septic tanks (Barnes et al. 1994). The 1971 DEQ study also showed the nutrient load of Lake Creek was sufficient to drive a significant algal bloom. Subsequent studies by IDFG, DEQ, and the District Seven Health Department were unable to establish a relationship between recreation and home development though continued water quality decline was noted in reports that documented increased nutrients, increasing algal blooms, declining dissolved oxygen and increased signs of eutrophication.

Due to water quality concerns DEQ initiated a Clean Water Act §314 Phase I Lake Restoration Study in December 1991 that was completed in 1994 to identify the nutrient sources and dynamics of nutrients that are currently affecting water quality and beneficial use support within Williams Lake. The Study was conducted by KCM, Inc., of Seattle, Washington, an environmental studies contractor. The Study involved a watershed-based assessment that characterized the physical and chemical characteristics of the Williams Lake watershed, Lake Creek and Williams Lake. Hydrologic, limnologic and water quality monitoring were conducted during 1992 to develop a nutrient budget and identify restoration and management alternatives and make recommendations.

The Study concludes that the greatest perturbation of water quality is the reduction of dissolved oxygen that results from decay of algae and other organic material that is in increased abundance due to elevated phosphorus loading. Mixing of anoxic water in the lower water column (hypolimnion) with the oxygenated water in the upper water column (epilimnion) reduces oxygen in the epilimnion, which is the only habitat that fish can survive in. Oxygen is further reduced by decomposition of abundant organic material in the epilimnion that is fueled by phosphorus from the hypolimnion, phosphorus from Lake Creek and runoff from residential and recreational facility sources, parking areas and septic systems.

In defining the critical loading to the lake the Williams Lake Phase I Restoration Study further describes the most meaningful way to view loading of phosphorus as looking at the epilimnion separately from the hypolimnion. This is due to the lack of complete and regular circulation of hypolimnetic and epilimnetic waters within Williams Lake. The major source of phosphorus to the epilimnion is from diffusion and direct entrainment by vertical migration of algae from the hypolimnion. Hypolimnetic loading is primarily by internal loading from sediments that are rich in particulate phosphorus that become dissolved under the anoxic conditions that prevail in the hypolimnion. The availability of phosphorus in the epilimnion results in the higher production of algae and plankton that further deplete oxygen. There are also external sources of phosphorus to the epilimnion (and hypolimnion) from stream flow, surface runoff and septic systems that further contribute to epilimnetic productivity.

Improper land use practices involving timber, grazing and road building and subsequent development around Williams Lake likely increased nutrient rich sedimentation of Williams Lake, particularly in the 1950s and 1960s. It is also likely that direct nutrient inputs, above natural background levels, increased significantly during the same time resulting in the increased levels of aquatic plants and algae in Williams Lake seen today.

In 1996 the US Forest Service published a summary report of limnological monitoring conducted in 1994 and 1995 by members of the Williams Lake Citizens Monitoring Committee. This summary of monitoring data identified variability between survey years for values of temperature, pH and nitrite + nitrate nitrogen and seasonal trends in inlet flow. Epilimnetic water was variable in dissolved oxygen, non-filterable residue, alkalinity, total phosphorus, dissolved orthophosphate, and total ammonia. Outlet waters were variable in flow between 1994 and 1995. Hypolimnion waters showed similar values and trends between the two years for all parameters between the two years. The monitoring summary stated “An important verification of the KCM survey was the observation during both WLCMC survey years of inlet orthophosphate levels which exceeded limits recommended to avoid eutrophication of receiving waters” (USFS 1996). Similar confirmation is observed for total phosphorus in both survey years.

On July 23, 1998 DEQ sampled Williams Lake using the Beneficial Use Reconnaissance Project-Lake and Reservoir (BURP L/R) protocol (Beneficial Use Reconnaissance Project Lake and Reservoir Committee 1998), summarized in Appendix C. Based on the six measures of this sampling protocol, the cold water biota beneficial use in Williams Lake would likely be assessed as not fully supported (Hoelscher 1999).

In November 1998 the Idaho Department of Fish and Game reported a fish kill in Williams Lake. It was hypothesized that low dissolved oxygen concentrations in the hypolimnion was the cause of the fish kill when the epilimnion and hypolimnion circulated in the fall. The odor of hydrogen sulfide was also noted at the time and it could have contributed to the fish kill.

The sediment and nutrient inputs from historic land use have likely been reduced by revegetation of bare hill slopes, improved grazing management, improved road maintenance, improved construction site maintenance and improved septic systems/reduced recreational home us as well as improved public education. DEQ has approved plans to connect 22 lakeshore homes to a centralized septic disposal system that will pump to a sand filter mound that will be dozed to a large soil absorption system. The Williams Lake Resort has had plans submitted for the use of an existing drainfield, however the owner has not, at this time, agreed to the conditions of the sewage disposal permit. The Resort is beginning a two-year effluent monitoring study to determine if further improvements are necessary. Currently all of the buildings, including the lodge, are disposing of waste into a system that has been covered with soil to a depth exceeding 20 feet. Septic tank sizing and drainfield sizing are unknown, but are located in close enough proximity to the lake to be of concern. Engineer estimated maximum daily flows for all facilities affiliated with the resort exceeds 3,500 gallons, and equivalent of more than 20 homes when BOD and nutrient loading are considered (District 7 Health Department, 2000). Recently constructed homes are required by District 7 of the Idaho Health Department to pump to off-site/up-gradient land disposal sites.

There are, however, additional improvements that can be made to septic systems and land use practices. Not all lakeshore homes are connected to a centralized disposal system and space for additional disposal systems is very limited. Land use practices have not yet incorporated riparian buffer zones for grazing on public or private land. Flood irrigation continues on pasture and crop production land. Though no timber harvests/sales have been planned for the immediate future, there may be opportunities for additional best management practices to limit sediment production from road surfaces and steep, sparsely vegetated hillsides adjacent to Williams Lake and Lake Creek.

Unfortunately internal loading of phosphorus from historically accelerated deposition of sediment and nutrients will continue for years to come without restorative efforts. External nutrient loading from natural and anthropogenic sources also continues and the combined effect further degrades water quality in Williams Lake.

**5.2 Existing Conditions**

Lake Creek

Lake Creek is the primary surface flow into Williams Lake. The source of Lake Creek is in a cirque that is located in the southwest extreme of the watershed. It flows 5.7 miles to its confluence with Williams Lake after picking up flow from the North Fork of Lake Creek (3.5 mile length), South Fork of Lake Creek (1.3 mile length), an unnamed tributary approximately 1.5 miles above the confluence of the South Fork (2 mile length), Tincup Creek (3 miles length), and an unnamed tributary 0.33 miles above Williams Lake. Tincup is the largest tributary to Lake Creek with regard to flow and it has 3 ephemeral tributaries of approximately 3 miles cumulative length.

Lake Creek is efficient at transporting the sediment that it receives from its tributaries to Williams Lake. The efficiency of sediment transport is indicated by the sediment transport coefficient, which is a dimensionless number. Lake Creek has a high sediment transport coefficient of 0.93. The sediment transport coefficient is the product of relief ratio, drainage density and the ratio of bankful discharge of the watershed to that of the analysis area bankful discharge divided by depositional stream density (miles of stream < 1.5% gradient). This is a result of high average stream gradient of 12 % with little relative depositional area (the lower 8.5% of Lake Creek considered depositional to the mouth of Williams Lake). Lake Creek tributaries are also high gradient with little or no depositional area. The result of the observed watershed characteristics for Lake Creek is that it efficiently transports the sediment yield of its watershed to Williams Lake.

The Department of Environmental Quality conducted Beneficial Use Reconnaissance Program sampling on Lake Creek approximately 1 mile above the confluence with Williams Lake. Lake Creek is determined to fully support it's beneficial uses of Salmonid Spawning and Coldwater Biota, though it is a distinct source of sediment and nutrients to Williams Lake. The Macroinvertebrate Biotic Index (MBI) score for Lake Creek is 4.29 with a Habitat Index (HI) score of 114. MBI sores above 3.5 and HI scores above 85 indicate non-impaired macroinvertebrate communities and habitat conditions respectively. Percent surface fines were 48%, which is elevated for high gradient streams indicating a potentially heavy sediment load.

Williams Lake was sampled using the Beneficial Use Reconnaissance Project-Lake and Reservoir protocol (Beneficial Use Reconnaissance Project Lake and Reservoir Committee 1998) on July 23, 1998. The results of this sampling are contained in Appendix C. Through the BURP-L/R sampling Williams Lake beneficial use support status was determined to be Not Full Support for Cold Water Biota due to low dissolved oxygen resulting from excessive nutrient loading (phosphorus).

The Idaho Department of Environmental Quality also contracted a streambank erosion inventory and nutrient and pathogen sampling for Lake Creek during the summer of 2000. The streambank erosion inventory extended from approximately 500 meters above Williams Lake to

**Table 21 Lake Creek watershed geomorphic risk characteristics.**

| Dominant | Area | Elevation | Relief | Drainage | Depositional | Bankful Flow | Sediment |
|---|---|---|---|---|---|---|---|

| Aspect | (Acres) | Range (ft) | Ratio | Density ($mi/mi^2$) | Stream Density | Ratio | Transport Coefficient |
|---|---|---|---|---|---|---|---|
| East | 9,600 | 9,132 to 5,250 ft | 0.13 | 0.38 | 0.05 | 1 (44 cfs/44 cfs) | 0.98 |

approximately 500 meters below the confluence of the South Fork of Lake Creek, over 3,805 ft (12.6%) of Lake Creek on one reach. Nutrient and pathogen samples were collected at the campground on Lake Creek just above Williams Lake.

The streambank erosion inventory is a qualitative evaluation of channel shape, bank stability and riparian vegetation developed by the Natural Resources Conservation Service (NRCS) as a tool to evaluate erosion condition on streambanks, gullies and roads. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition and management to estimate direct annual sediment inputs to the stream. Used in conjunction with other available sediment data such as total suspended sediment, surface fines, and depth fines the erosion inventory can be a useful tool to allocate sediment from streambank erosion and to prioritize stream reaches for implementation of BMPs to reduce stream sedimentation or to track the effectiveness over time of BMPs already implemented. Streambank erosion estimates are based on the erosive condition and area of streambanks that are eroding and the rate of lateral recession, or how much of a streambank erodes into the stream. The estimates are given as annual average erosion and are expressed in tons of sediment per sample reach or in tons per mile per year based on the sample reach. Observed conditions are the result of flow conditions that the stream experiences over time, natural channel migration, and adjacent land use and management.

For Lake Creek, erosive conditions over the sampled reach were rated as severe resulting in a high erosion estimate of 342 tons per year. This equates to an estimated erosion rate of 475 tons per mile per year. During the erosion inventory significant downcutting of the stream was noted above the sample reach. If the erosion rate is extrapolated upstream over similarly managed areas with erosion rates that are likely higher, the estimate would likely be double. The issue of sediment transported through Lake Creek and its tributaries is not a matter of its effect to beneficial use support to the creek but to Williams Lake through the bound phosphorus that it carries into the lake and the effect of that phosphorus to water quality. The particulate phosphorus that is bound to or associated with sediment from Lake Creek is ultimately contributing to the internal loading of phosphorus in Williams Lake, as it becomes incorporated into sediments on the lake bottom.

Total phosphorus and total nitrogen (TKN) samples were collected from Lake Creek at approximately two-week intervals between June 8th and August 17th during the 2000 field season. The average value for phosphorus during this period was 0.0767 mg/L (76 ug/L) with a range of 0.03 mg/L to 0.11 mg/L with the peak occurring on June 21st and the minimum on August 17th (Table 22). Results were generally similar to results for inlet phosphorus levels, with regard to magnitude and relative range of variation observed in the KCM study (Barnes et al. 1994) and the Williams Lake Citizens Monitoring Committee data (SCNF 1996). Bacterial sampling results are also listed in Table 22.

McNeil Sediment core samples were collected on Lake Creek in August of 2000 by the DEQ contractor at the campground at the lower bound of the erosion inventory reach. Fish were observed spawning at the sample site in early June. Sediment core data evaluates subsurface fine sediment to a depth of 4 inches for resident fish species, and indicates expected fry survival as it relates to percentage of intragravel fines less than 0.25 in (6.35 mm). The mean % fines less than 6.35 mm excluding substrate larger than 63.5 mm was 33%. The USFS-SCNF has conducted sediment core sampling from 1993 through 1999 and the average percent depth fines from that period are 45% in lower Lake Creek (SCNF 1999). There was not a significant reduction of depth fines during this monitoring period.

### 5.3 Load Capacities and Targets

The current state of the science does not allow specification of sediment or nutrient load capacities that are known in advance to meet the numeric criteria for dissolved oxygen in lakes or the narrative criteria for sediment or nutrients and support beneficial uses for coldwater biota. All that can be said is that the load capacity lies somewhere between the current loading and levels that approach natural loading of sediment and phosphorus. Prior to past and current land use activities within the Williams Lake watershed, Williams Lake was likely a moderately productive or oligotrophic/mesotrophic lake that would become highly productive or eutrophic over a much longer time frame. The impact of human activities in the Williams Lake watershed greatly accelerated the eutrophication of the Lake (Barnes et al. 1994).

Coldwater biota beneficial uses may be fully supported at higher rates of sediment and nutrient loading than historic (pre-settlement) loading. If it is determined through implementation

**Table 22 Nutrient and bacteria sampling results for Lake Creek.**

| Date | TKN mg/L | Total P mg/L | Fecal Coliforms cfu/100 ml | E coli cfu/100 ml | Observations |
|---|---|---|---|---|---|
| 6/8/00 | 0.1 | 0.04 | 172.8 | 5.2 | |
| 6/21/00 | 0 | 0.11 | | | Fish spawning. Camp sites on banks used heavily. |
| 7/5/00 | 0 | 0.09 | | | No fish observed spawning. Heavy use of numerous campsites over the holiday weekend. |
| 7/17/00 | 0.1 | 0.09 | | | Lots of garbage at site. Heavy recreation use continues. |
| 8/2/00 | 0.1 | 0.1 | | | Garbage in creek – picked out. Large cottonwood gallery with Douglas fir. |
| 8/17/00 | 0.2 | 0.03 | 866.4 | 7.2 | |

monitoring that beneficial uses are fully supported at loading levels above the target levels described within this TMDL, the targets and load allocations will be revised within the TMDL. It is assumed that loading rates below the level that shifted Williams Lake into the productivity range of eutrophic from oligotrophic/mesotrophic would likely have induced periodic limited winterkill under extreme conditions as well. It is likely that Williams Lake naturally exhibited an anoxic layer of water within the hypolimnion given its observed limited mixing and surface to volume ratio, albeit likely less than the 55% of anoxic water volume observed today (water below 40 feet deep < 1 ppm oxygen).

The target for phosphorus loading within the Williams Lake TMDL will be a TSI value of 45 for the mean epilimnetic total phosphorus samples collected during summer stratification (June through September) that equates to the mid range of mesotrophy as defined using Carlson's (1977) trophic state indices (TSI) (Figure 12). The equation for calculating TSI for total phosphorus is:

$$TSI_{TP} = 14.42 \ln TP\ (mg/m^3) + 4.15$$

Cooke et al. (1986) associated TSI values between 40 and 50 with mesotrophic lakes. Values above 50 indicate highly productive, or eutrophic, conditions (Barnes 1994). This equates to a mean epilimnetic total phosphorus level of 33 $mg/m^3$ (0.33 mg/L) for samples collected during summer stratification (June through September). During the Phase I Restoration Study the mean summer epilimnetic total phosphorus concentration was 0.33 mg/L (Barnes 1994).

Critical Loading

The maximum loading of phosphorus to maintain conditions below eutrophic was calculated in the Phase I Restoration Study using a model from Vollenweider (1968) based on the assumption that critical phosphorus loading ($L_C$) is directly proportional to mean depth (Z) and, to some extent, indirectly proportional to the hydraulic residence time (flushing rate). Critical loading is expressed as milligrams of phosphorus per square meter of surface area and equates to the cumulative average amount of phosphorus loading in the water column subtended by a square meter of surface water. Vollenweider (1968) in Barnes (1994) related nutrient supply to mean depth using the equation:

$$L_C\ (mg/m^2/yr) = 50\ Z^{0.6}$$

This equation yields a critical aerial loading for eutrophication in Williams Lake of approximately 199 $mg/m^2/yr$ (per square meter of surface area per year), assuming the epilimnion mean depth is 10 m and the lake remains meromictic (doesn't completely circulate).

### 5.4 Loading Summary

Existing Phosphorus Sources

The sources of phosphorus to Williams Lake were identified within the Phase I Restoration

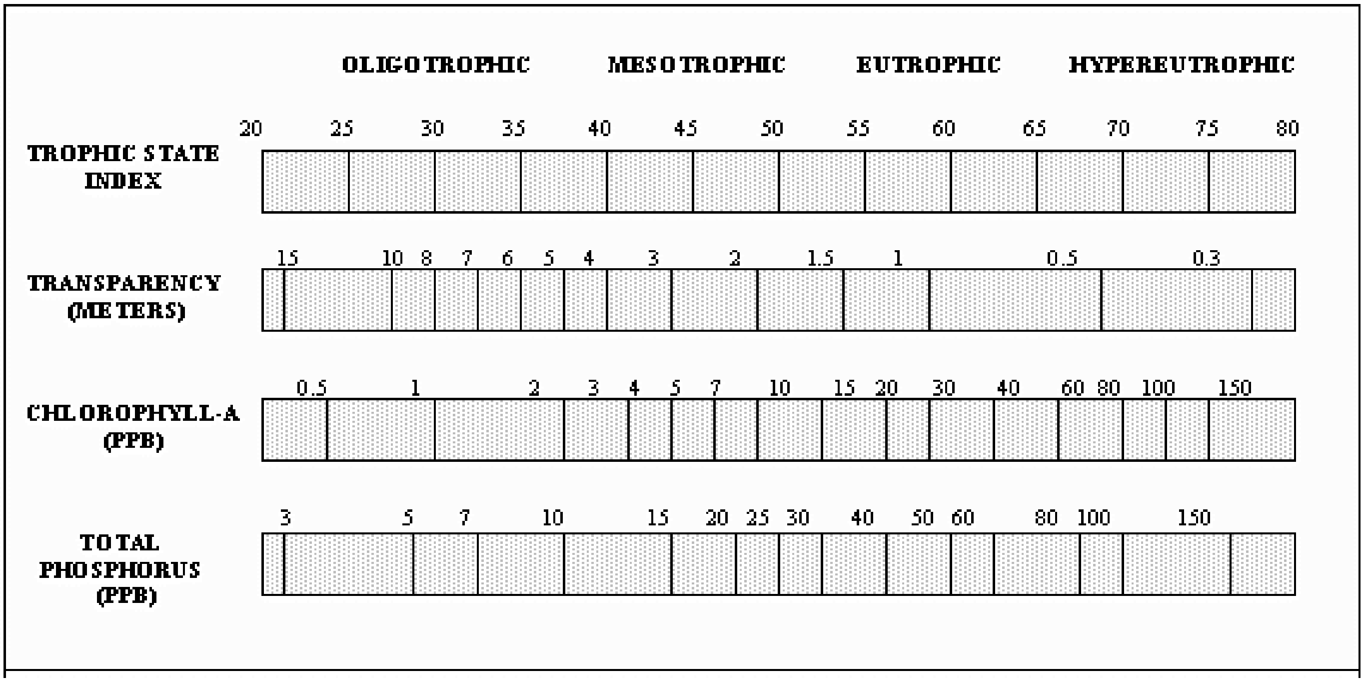



**Figure 12 Trophic State Indices (from Carlson 1977).**

Study for Williams Lake by KCM, Inc. (Barnes 1994). Sources and loading from various sources were calculated using a mass balance equation model for the study year and the typical water year with external and internal sources quantified. Nutrient loading was estimated based on the lake's water budget and on nutrient concentrations measured in the lake at various depths, in the lake's outlet, inlet and in precipitation. Within the Phase I Restoration Study Phosphorus was identified as the limiting nutrient thus a loading analysis was conducted for phosphorus alone, not nitrogen. The Phase I Restoration Study divides phosphorus sources into seven components: internal loading, direct precipitation to the lake surface, groundwater, inlet stream flow, overland flow, natural springs, and septic systems. Direct precipitation to the lake surface, groundwater inflow, inlet stream flow, overland flow, natural springs, and septic systems are considered external sources. Phosphorus losses from the lake were identified as outlet flow, groundwater flow out of the lake and sedimentation of phosphorus.

Within the inlet stream flow component potential sources of phosphorus considered within this TMDL, beyond natural loading, include: streambank erosion below 80% streambank stability, animal waste, human waste, road erosion, irrigation return flow, and agricultural fertilizer residue. These sources represent the potential reductions in phosphorus loading to Williams Lake from Lake Creek. Inlet flow loading was estimated by multiplying the inlet flow volume by the concentration of phosphorus measured at the time of sampling.

Groundwater, spring and overland flow loading is derived from the monthly phosphorus concentration within upper Lake Creek (assumed to represent base flow above the level of land-use influence) multiplied by the groundwater, spring and overland flow volume calculated for the Williams Lake hydrologic budget (Barnes 1994). Groundwater flow associated with Williams Lake removes phosphorus because groundwater outflow is greater than groundwater inflow.

Precipitation phosphorus loading was estimated from monthly precipitation volume multiplied by the concentration found in the precipitation sample collected during the study year.

Septic tanks used by residences and the Williams Lake Lodge were considered a significant source of phosphorus. Loading assumptions include occupancy of the facilities from June 1 through September 15 (107 days). Internal loading and sedimentation were estimated as the residual of the mass balance equation for each month. Positive residuals were assigned to internal loading and negative residuals were assigned to sedimentation losses. In reality, either residual represents the net result of internal cycling. Both sedimentation and internal phosphorus inputs are ongoing processes, but the lesser component is masked by the model (Barnes 1994).

Estimates of Existing Phosphorus Load

In many years epilimnetic and hypolimnetic (surface and bottom) waters do not mix completely. For this reason a phosphorus budget for the epilimnion of Williams Lake was calculated for the study year in the Phase I Restoration Study. Additionally, phosphorus loading to Williams Lake was calculated for the study year and the typical year because phosphorus loading is greater in the typical hydrologic year than for the study year due to differences in precipitation during the study year. The study year was considered a drought year and climatologic and hydrologic averages used to develop the hydrologic budget for the typical year were different (Barnes 1994).

Existing phosphorus loading was estimated in the Phase I Restoration Study using a simple mass balance model. Within the model, phosphorus input equals phosphorus loss from the lake plus or minus the change in phosphorus storage. The mass balance model is expressed with the equation:

$$\triangle P = IF + DP + Int + SS + OL + Spr \pm G - O - Sed$$

where $\triangle P$ = Change in phosphorus mass (storage) within the lake
IF = Inlet flow inputs of phosphorus
DP = Direct precipitation of phosphorus to the lake surface
Int = Internal input of phosphorus from sediments over and above Phosphorus loss due to sedimentation
SS = Septic system inputs of phosphorus
OL = Overland flow inputs of phosphorus
Spr = Springs inputs of phosphorus
G = Groundwater input/losses of phosphorus
O = Outlet loss of phosphorus
Sed = Loss of phosphorus to sediments minus phosphorus sediment/water exchange

The mass balance model described by this equation was used to calculate phosphorus loading for the study year and a typical hydrologic year.

The existing phosphorus load is assumed to be essentially unchanged since the Phase I Restoration Study was completed. Though plans are underway to implement some phosphorus reducing management practices they are yet un-implemented.

Phosphorus loading to Williams Lake was calculated to be approximately 16 percent greater in the typical year than the study year. In the study year total phosphorus loading was 2,390 kg, which amounts to an areal loading rate of 3.3 $g/m^2$/yr (3,300 $mg/m^2$/yr). Internal loading from the sediments accounted for most of the phosphorus entering the lake at approximately 86 percent of the nutrients in the lake. The remaining 14 percent came from external sources including the inlet stream (7 percent), septic systems (5 percent), and overland flow plus direct precipitation (2 percent) (Barnes 1994).

In the typical hydrologic year phosphorus loading to Williams Lake was 2,850 kg of phosphorus, for an annual areal loading rate of 3.9 $g/m^2$/yr (3900 $mg/m^2$/yr). Internal loading from the sediments accounted for the vast majority of phosphorus in the lake at 76 percent. External sources had loads of 16 percent from the inlet stream, 5 percent from septic systems, and 3 percent from overland flow plus direct precipitation.

Actual phosphorus loading in Williams Lake (areal loading) was calculated from the mass balance model as 1$g/m^2$/yr (1,000 $mg/m^2$/yr). The critical loading for eutrophication in Williams Lake is estimated based on the assumed epilimnion depth of 10m, using the equation from Vollenweider (1968). Critical loading is estimated to be approximately 199 $mg/m^2$/yr. The actual loading from all sources is estimated to be 1,000 $mg/m^2$/yr based on the typical hydrologic year. Actual loading is five times the level of critical loading. Epilimnetic loading from the hypolimnion is two and a half times the critical loading of the hypolimnion. Of the 1,000 $mg/m^2$/yr actual (areal) loading, 570 $mg/m^2$/yr is from internal (hypolimnetic) loading. Therefore, internal loading alone was more than two times the critical areal loading for eutrophication (Barnes 1994). Even if all external loading were eliminated, internal loading would still result in a eutrophic productivity level in Williams Lake, at least initially. The assumption of this TMDL is that through eliminating anthropogenic phosphorus loading eventually internal loading would be reduced to a level that would improve water quality to target levels identified above. This reduction may take many years to achieve. Implementation monitoring will track load reduction effectiveness in reducing the productivity of the lake.

Load Allocation

Using water quality targets identified in the Williams Lake TMDL, phosphorus load allocations or phosphorus load reductions are described in this section. Because the primary chronic external anthropogenic (man-caused) source of phosphorus loading to Williams Lake is contained within stream flow from Lake Creek and septic systems directly into Williams Lake quantitative allocations are developed. These load reductions are designed to eventually meet the established in-lake water quality target of 0.22 mg/L mean seasonal epilimnetic phosphorus that equates to $TSI_{TP}$ of 45. Phosphorus load reductions are quantitatively linked to reducing septic tank loading to zero and reducing the phosphorus load within Lake Creek by 30% (Table 25).

An inferential link is identified to show that hypolimnetic loading from phosphorus contained in sediment would ultimately decrease as a result of decreasing external loading to the epilimnion and achieve the epilimnetic target of 0.22 mg/L mean total phosphorus sampled between June and September.

Margin of Safety

The Margin of Safety (MOS) factored into load reductions for phosphorus is explicit by identifying the end-point target of 0.22 mg/L which is 10% below the eutrophic threshold identified by Cooke et al. (1986). This represents an eventual reduction of 33% in mean total epilimnetic phosphorus sampled between June and September. The MOS is implicit by the conservative assumptions used to develop existing phosphorus loads. Conservative assumptions made as part of the sediment loading analysis include: 1) Desired septic tank loading rates represent elimination of this source of phosphorus loading to Williams Lake. 2) Desired phosphorus loading from Lake Creek represent elimination of the anthropogenic sources of phosphorus loading to Williams Lake identified in this TMDL.

**Table 23 Williams Lake nutrient budget for December 1991 through November 1992 (kg phosphorus).**

| Month | Stream Flow[a] | Overland Flow[b] | Springs[c] | Septic | Precip | Groundwater | Outlet | Storage Change | Internal Loading[d] | Sediment[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| Dec[e] | 6.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.8 | -796 | 0.0 | -797.4 |
| Jan[e] | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.9 | 443.2 | 442.0 | 0.0 |
| Feb[e] | 5.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -4.6 | 443.2 | 442.3 | 0.0 |
| March | 10.2 | 0.9 | 0.5 | 0.0 | 0.3 | -0.4[f] | -6.4 | -102.3 | 0.0 | -107.4 |
| April | 19.6 | 1.9 | 1.5 | 0.0 | 0.3 | -1.1 | -7.0 | -113.2 | 0.0 | +128.4 |
| May | 28.4 | 2.5 | 1.8 | 0.0 | 0.4 | -2.6 | -7.9 | -380.4 | 0.0 | -403.0 |
| June | 24.3 | 1.9 | 1.3 | 37.1 | 0.7 | -2.2 | -12.0 | -337.7 | 0.0 | -338.8 |
| July | 18.3 | 1.5 | 1.2 | 38.4 | 0.8 | -3.1 | -10.3 | -227.2 | 0.0 | -274.0 |
| Aug | 10.7 | 0.8 | 0.5 | 38.4 | 0.1 | -10.0 | -8.3 | 240.3 | 208.1 | 0.0 |
| Sep | 8.6 | 0.7 | 0.8 | 18.6 | 0.2 | 5.1 | -6.6 | 169.6 | 142.2 | 0.0 |
| Oct | 11.5 | 0.9 | 0.6 | 0.0 | 0.6 | -3.7 | -6.0 | -174.2 | 0.0 | -178.1 |
| Nov | 9.2 | 0.7 | 0.6 | 0.0 | 0.2 | 1.6 | -6.7 | 834.7 | 829.1 | 0.0 |
| **Total** | **158.6** | **11.8** | **8.8** | **132.5** | **3.6** | **-16.4** | **-85.5** | **0** | **2,063.7** | **-2,277.1** |

a. All values in kilograms of total phosphorus.
b. Overland flow from ungaged area represents 6.5 percent of USFS total inflow estimate.
c. Spring flow is estimated at 5 percent of gauged inflow.
d. Internal/sediment input is solved by difference from other terms
e. In December, January and February the lake is frozen; inflow = outflow = estimates ranging from 1 cfs.
f. March TP estimated as equal to April TP concentration.

**Table 24 Williams Lake nutrient budget for the typical hydrologic year (kg phosphorus).**

| Month | Stream Flow[a] | Overland Flow[b] | Springs[c] | Septic | Precip | Groundwater | Outlet | Storage Change | Internal Loading[d] | Sediment[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| Dec[e] | 12.7 | 1.8 | 0.4 | 0.0 | 0.0 | 0.0 | -11.0 | -870.3 | 0.0 | -874.3 |
| Jan[e] | 11.4 | 1.7 | 0.4 | 0.0 | 0.0 | 0.0 | -10.4 | 444.4 | 441.3 | 0.0 |
| Feb[e] | 10.2 | 1.5 | 0.4 | 0.0 | 00.0 | 0.0 | -9.6 | 444.4 | 442.0 | 0.0 |
| March | 11.9 | 1.8 | 0.6 | 0.0 | 0.7 | -2.3 | -10.3 | -102.6 | 0.0 | -105.0 |
| April | 23.6 | 3.7 | 2.0 | 0.0 | 0.9 | -6.2 | -9.5 | -89.0 | 0.0 | -103.5 |
| May | 105.8 | 15.5 | 7.5 | 0.0 | 1.3 | -41.8 | -14.4 | -321.6 | 0.0 | -395.5 |
| June | 150.8 | 20.6 | 8.9 | 37.1 | 1.5 | -38.8 | -62.9 | -320.6 | 0.0 | -437.8 |
| July | 49.6 | 6.7 | 3.6 | 38.4 | 0.7 | -14.2 | -17.3 | -230.0 | 0.0 | -297.4 |
| Aug | 21.8 | 2.8 | 1.2 | 38.4 | 0.7 | -42.0 | -13.9 | 226.9 | 217.9 | 0.0 |
| Sep | 15.5 | 2.2 | 1.7 | 18.6 | 0.6 | -46.5 | -10.3 | 161.8 | 180.1 | 0.0 |
| Oct | 17.3 | 2.2 | 1.1 | 0.0 | 0.6 | -20.6 | -8.6 | -198.2 | 0.0 | -190.1 |
| Nov | 16.6 | 2.0 | 1.2 | 0.0 | 0.7 | -50.3 | -8.3 | 854.8 | 892.9 | 0.0 |
| **Total** | **447.3** | **62.5** | **29.0** | **133.0** | **7.7** | **-262.7** | **-186.5** | **0** | **2,175.0** | **-2,403.6** |

a. All values in kilograms of total phosphorus.
b. Overland flow from ungaged area represents 6.5 percent of USFS total inflow estimate.
c. Spring flow is estimated at 5 percent of gauged inflow.
d. Internal/sediment input is solved by difference from other terms
e. In December, January and February the lake is frozen; inflow = outflow = estimates ranging from 1 cfs.
f. March TP estimated as equal to April TP concentration.

**Table 25 Williams Lake epilimnetic phosphorus load allocations.**

| Source | Existing Percent of Total | Existing Total Load | Proposed Total Load | Percent Reduction | After Reduction Percent of Total |
|---|---|---|---|---|---|
| Lake Creek | 15.7% | 447.3 kg | 313 kg | 30% | 11% |
| Septic Systems | 4.7% | 133 kg | 0 kg | 100% | 0% |
| **Total** | **20.4%** | **580.3** | **313 kg** | **46%** | **11%** |

<u>Seasonal Variation and Critical Time Periods of Phosphorus Loading</u>
To qualify the seasonal and annual variability and critical timing of phosphorus loading, climate and hydrology must be considered. This phosphorus analysis characterizes phosphorus loads using average annual rates determined from climatological records from 1951 to 1986 (35 years). Hydrologic (flow) regime for Lake Creek was estimated based on a regression equation used by the USFS to estimate mean annual discharge. This mean annual discharge was converted into a monthly distribution by the USFS, using the flow relationships between measured volumes and staff gauge readings from the Panther Creek Gauge 25 miles northwest of Williams Lake. Additionally, within the study year of 1992 flow measurements were collected at the time of sampling within Lake Creek. Sampling within Williams Lake was done at a frequency adequate to detect seasonal changes in chemical and limnological conditions as well. Considerations were made to account for the seasonality of occupancy of recreational residences as well.

## 6.0 Blackbird Mine Impacted Waterbodies

### 6.1 Description

The Blackbird Mine is located in the mountains of central Idaho within the Salmon River watershed. The area is one of the largest cobalt deposits in North America, rich with sulfide ores of cobaltite (CoAsS), chalcopyrite ($CuFeS_2$), pyrite ($FeS_2$), and pyrrhotite (FeS) (Mebane, 1994). Gold and other precious metal mining has occurred in the area since 1893, and cobalt and copper were mined and milled at the site from 1917 to 1967 (SCNF, in prep.). The main period of extraction followed World War II, from 1949 to 1967. No commercial mining has occurred at Blackbird Mine since 1967. The mine is comprised of about 15 miles of underground workings, a 12-acre open pit, and approximately 84 acres of exposed waste rock (Mebane, 1994). The Mine consists of underground workings and an open pit. The open pit (Blacktail Pit) is located in the headwaters of Bucktail Creek which drains the north side of the mine site. Most of the underground workings are located on the southern portion of the mine site to the east of Meadow Creek and Blackbird Creek. The large volumes of mine rock (waste rock) that were produced from the open pit and underground workings were placed on the hillsides near the Blacktail pit and the mine portals. It is estimated that all disturbed areas—including roads, facilities, tailings ponds, and other mining areas—total 535 acres, the majority of which is on 837 acres of private land (SCNF, in prep.).

Blackbird Mine sits in the saddle of a mountain ridge with mined areas affecting drainages on both sides. Drainage on the Blackbird side flows from the mined area into Blackbird Creek near its headwaters. Blackbird Creek then flows into Panther Creek about midway through the drainage. The West Fork Blackbird Creek enters Blackbird Creek below the mine and is relatively undisturbed except for a large tailings impoundment at its mouth. The West Fork Blackbird Creek was re-routed through a concrete culvert on top of the tailing pile to avoid contact between the creek and the tailings. On the other side of the mountain, the open pit was started in 1954. Bucktail Creek headwaters in the waste rock below this pit and flows to the South Fork Big Deer Creek for the last 1/4 of its length. South Fork Big Deer Creek flows into Big Deer Creek at 2/3 of its length, and Big Deer Creek flows into Panther Creek 10 or more miles downstream from Blackbird Creek.

Because of the nature of the rock ore being mined, cobalt, arsenic, copper, iron, and acid drainage are water quality concerns in this drainage (Mebane, 1994). The sulfide ores react uniquely with the snow accumulations in these mountains and produce a first flush of acid mine drainage with metal-laden water during early snowmelt. Contamination decreases through the snowmelt process, but increases again in summer when base flow from the mountain's groundwater leaches more contaminants. As a result, Blackbird Creek, Bucktail Creek, Big Deer Creek, and Panther Creek are 303d-listed for metals contamination. Blackbird Creek and Big Deer Creek are also listed for pH and sediment concerns. Blackbird Creek and West Fork Blackbird will not be addressed in this document; the Department of Environmental Quality submitted a Use Attainability Analysis (UAA) for Blackbird Creek. EPA Region 10 approved the UAA on June 5, 2000, agreeing with DEQ that there are not cold water biota or salmonid spawning uses currently in these streams. DEQ is required to monitor these streams every three years to verify or refute the existence of these uses.

Past investigations at the Blackbird Mine Site by the State of Idaho, the U. S. Forest Service, the National Marine Fisheries Service, and others, done in part to support a claim of damages to natural resources, led to the conclusion that past and continuing releases of mining wastes produced by operation of the Blackbird Mine have resulted in unacceptable risks to human health and the environment. This resulted in decisions by EPA to prepare a Remedial Investigation/Feasibility Study (RI/FS) and to conduct non time-critical removal actions to alleviate or reduce continuing threats to human health and the environment. The RI/FS and the non time-critical removal actions were governed by two Administrative Orders on Consent (AOC) between the Federal Government and responsible parties, the Blackbird Mine Site Group (BMSG). The AOC governing the RI/FS was signed in November 1994, while the AOC governing the non time-critical removal actions was signed in June 1995. A separate Consent Order was signed in September 1995 between the Natural Resource Trustees and the BMSG resulting from the Natural Resources Damage Assessment (NRDA) claims. The Consent Decree established natural resources restoration goals for Panther and Big Deer Creeks. This group manages the removal and restoration actions agreed upon in the AOC, through the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In the case of the Blackbird Mine site, the process seeks to find and implement long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening (http://www.epa.gov/superfund/action/law/cercla.htm).

The US EPA, US Forest Service, the National Oceanographic and Atmospheric Administration (NOAA), and the Department of Environmental Quality (DEQ) are the regulatory agencies participating in the clean up actions. The purpose of this agreement was to, "restore the injured or destroyed natural resources and compensate the public for interim losses resulting from injury to or destruction of natural resources…"(AOC 1995). Most of the early action removals have been completed. Monitoring of removal actions, water and sediment quality, and populations and communities of benthic invertebrates has been done, and will continue to be done, to assess the effectiveness of the early action removals at reducing threats to human health and the environment (Lang 2000). The activities included various measures to divert runoff that had not contacted waste rock or the mine workings; and to collect, store, and treat surface water, mine water, and ground water that had contacted waste rock and mine workings. In the Blackbird Creek watershed, a reservoir was constructed in Meadow Creek for storage of water prior to treatment. Major modifications were made to the existing treatment plant, increasing the treatment capacity to 800 gallons per minute. Concrete channels and a low permeability cover were constructed over waste rock in Meadow Creek and upper Blackbird Creek to separate surface water runoff from the waste rock deposits. A groundwater cutoff wall was installed at the downstream end of the cover to collect ground water for treatment. Waste rock piles that were outside of the collection area of the 7100 dam, including several large piles in Hawkeye Gulch, were relocated to within the capture area for treatment.

A diversion dam was constructed below the waste rock piles in Bucktail Creek and a tunnel was installed to convey contact water to the underground mine workings for storage and treatment at the treatment plant in Blackbird Creek. A collection and pumping system was installed for collection and treatment of seeps located downstream of the dam. Large drain holes were drilled in the bottom of the Blacktail Pit to convey contact water from the pit to the mine workings for treatment. Waste rock from the west lobe area of Bucktail Creek, outside the collection area for the dam, was relocated to the Blacktail Pit. Numerous drainage controls, including sediment dams, debris traps, and ditches, were installed to control surface water runoff, reduce erosion, and contain sediment.

During the course of the early action work, the EPA identified what it considered to be a potential threat to human health posed by arsenic contained in streambank deposits along Blackbird and Panther Creeks. These deposits were apparently formed when tailings were transported downstream following spills. Past erosion and transport of waste rock particles may also contribute to the deposits. Additional characterization and removal efforts were required for these deposits, which were excavated and hauled to the surface of the West Fork tailings impoundment. The BMSG is completing data collection for the Remedial Investigation and Feasibility Study (RI/FS), the next step in the process. A Record of Decision (ROD) will be drafted and negotiated after the completion of the RI/FS. This ROD will set the final concentrations of metals that the BMSG will then clean up to. The BMSG is also currently removing contaminated tailings piles at the site in accordance with the consent decree.

DEQ also is actively involved in the Biological Restoration and Compensation Plan (BRCP). This agreement seeks to restore anadramous fish populations to impacted streams through the building and managing of a fish hatchery to stock the waterbody once water quality is sufficiently high to maintain populations. By working with the BMSG and the BRCP, the DEQ is protecting and restoring the resources impacted by historic disturbance to the best of its staffing and resource ability. DEQ is devoting the equivalent of an entire full-time employee to participate in these activities, a significantly higher portion of time than any other single drainage in the Idaho Falls Region. Water quality will be restored to the extent technologically feasible, through the processes described above. The AOC is addressing all the water quality concerns in this area impacted by the Blackbird Mine.

**6.2 TMDL Deferrals**

IDEQ will defer up to the year 2005 TMDLs for Panther Creek (listed for metals), Big Deer Creek (listed for sediment, metals, pH) and Bucktail Creek (listed for metals). The reason these TMDLs will be deferred is to allow for completion of the Blackbird Mine Site ROD. The ROD was originally slated for signature in 2000. This was the assumption when DEQ and EPA agreed to do this subbasin and TMDL in the 1996 court settlement. The ROD has been delayed because of the complex negotiations involved in the early removal action and preliminary work on the RI/FS. The ROD will set metals concentration for the impacted streams. The TMDL will result from these actions. DEQ will convert these concentrations into loads for the TMDL, and the actions outlined in the ROD will serve as the implementation plan. When the ROD is signed by all parties involved and approved by EPA, the DEQ will amend the Middle Salmon Panther Creek Subbasin TMDLs to reflect these changes. Several volumes have documented this process from its inception. All material can be viewed by contacting the Idaho Falls DEQ office.

The Administrative Order on Consent established for the Blackbird Mine Site discussed in Section 6.1 resulted in early actions to address the major sources of contamination along Blackbird Creek and Panther Creek, primarily to address human health concerns. These actions have consisted of the removal of overbank sediments and soils contaminated with arsenic, with disposal at the West Fork Tailings Facility. Because the quality of the surface water has improved significantly as a result of early actions, an Ecological Risk Assessment (ERA) for aquatics will be conducted using surface water and other data collected since the implementation of early action activities. The objective of the ERA for aquatics at the Blackbird Mine Site is to both determine the effectiveness of early actions, and to evaluate the potential effects of site-related contamination on ecological receptors. This ERA will then provide EPA with the information needed to make further risk-management decisions.

Upon issuance of the Blackbird Mine Site Record of Decision and full implementation of required clean up activities, IDEQ will reassess Blackbird Creek, Big Deer Creek and Bucktail Creek to determine if water quality standards are being met with respects to listed pollutants. If it is determined that water quality standards are not being met, TMDLs will be completed for these waterbodies. The existing water quality monitoring occurring at the Blackbird Mine Site will allow IDEQ to continuously assess Panther Creek, Blackbird Creek, Big Deer Creek and Bucktail Creek to determine if water quality standards are met.

## 7.0 Public Participation

The involvement of the public in the development of the Middle Salmon River-Panther Creek Subbasin Assessment initially was linked to the Lemhi County Riparian Conservation Agreement Working Group and Salmon River Basin Advisory Group. Early discussions of the development schedules and strategy for the Middle Salmon River-Panther Creek Subbasin Assessment and TMDL occurred concomitant with development of the Lemhi River Subbasin Assessment and TMDL. Prior to this, during development of the Williams Lake Phase I Restoration Study, during 1992, a citizens group was formed to have input into the Clean Lakes Study and to assist with follow-up monitoring of water quality. This citizens group was composed of a representative from the Williams Lake Water Board, the Williams Lake Property Owners Association, the Lemhi County Commission and Williams Lake Resort. In September 1999, a meeting of the Williams Lake Property Owners Association and the Idaho Department of Fish and Game was held to discuss the Williams Lake fishery and several potential implementation projects to improve water quality in Williams Lake. At this same meeting the background of the Clean Water Act was discussed and the schedule and strategy for development of the Subbasin Assessment and TMDL for Williams Lake was discussed including the strategy for reducing phosphorus was discussed.

The Middle Salmon River-Panther Creek Subbasin Assessment and Williams Lake TMDL has been distributed to the Williams Lake Property Owners Association during the public comment period. Additionally, during the public comment period for the Middle Salmon River-Panther Creek Subbasin Assessment and Williams Lake TMDL, a public meeting was conducted in Salmon, Idaho on December 12$^{th}$, 2000 to present the Subbasin Assessment and TMDL and to solicit comments. Fourteen attendees signed the roster at that meeting and a variety of agencies and Williams Lake homeowners were present including representatives from the Williams Lake Water Board and the Williams Lake Property Owners Association. The public comment period was announced in local newspapers prior to the beginning of the comment period, draft copies of the document were placed in local libraries and copies were mailed to persons affiliated with Williams Lake and persons requesting copies. The comment period spanned 30 calendar days and the need for additional or follow-up meetings was determined to not be necessary after the comment period.

Further, the Salmon River Basin Advisory Group was provided with copies of the document for their review and comment during the public comment period. Following the public comment period comments were considered and responded to and necessary revisions made to the Middle Salmon River-Panther Creek Subbasin Assessment and TMDL prior to final submittal of the document to EPA.

### 7.1 Response to TMDL Comments

Response to EPA Comments—General Comments

**1) Blackbird Mine Administrative History-The Blackbird Mine site has a complex legal and administrative history. I have attached several pages from an administrative order on consent (AOC) that summarizes site (See Administrative Order on Consent for Removal Action and Recovery of Cost). This summary (agreed to by the government and the mining companies) should be used as the basis for the summary of legal and administrative history**

**of the site. It is important to note that the 1995 settlement of natural resource damage claims is related to but is independent of the superfund remedy selection process and ongoing cleanup being conducted at the site. The superfund work is being done consistent with the National Contingency Plan (NCP) and AOCs signed in 1994 (for conducting an RI/FS) and 1995 (for implementation of early actions).**

DEQ has incorporated these materials into a stand-alone section on Blackbird Creek.

**2) There is unnecessary repetition of information pertaining to Blackbird Mine throughout the document. I suggest including a summary of the mining, legal, and administrative history of the mine in a single location and referring to it, as needed, rather than repeating aspects of the information in several sections. Suggest including a separate chapter on Blackbird Mine.**

DEQ has grouped the segments that pertain to the specifics of Blackbird Mine, while the segments that pertain to Blackbird Creek remain in the document to preserve the structure of the document as written by DEQ Technical Services.

**<u>3) Reference to the Blackbird Mine Clean-up is Underway</u>-There are several instances in the draft citing that clean-up of the Blackbird Mine site is underway. Care should be taken so as not to imply that the clean-up will result in achievement of water quality standards in all waterbodies impacted by the mine site. Part of the superfund remedy selection process is to determine whether and the extent to which achievement of water quality and ecological goals are feasible.**

The Subbasin Assessment and TMDL is careful to point out that the immediate clean-up activities are to protect human health and safety and the environment. While clean-up activities should not be delayed, it is not stated that the initial or subsequent clean-up efforts have, or will achieve water quality standards on the effected streams.

**<u>4) Language Needed to explain the Relationship between the Superfund process and the TMDL development</u>-The TMDL should include a good description of the relationship between the superfund process at Blackbird, and the TMDL process. It should summarize who does what and when (in terms of decision-making), and provide enough information to temper expectations. EPA will work with IDEQ on developing language to explain the linkage between the Superfund process and Total Maximum Daily Load development.**

The Subbasin Assessment and Total Maximum Daily Load (TMDL) contains an expanded description of the approved Use Attainability Analysis (UAA), Remedial Investigation/Feasibility Study (RI/FS), Administrative Orders on Consent (AOC), Natural Resource Damage Assessment claims (NRDA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Record of Decision (ROD), and Biological Restoration and Compensation Plan (BRCP). The Subbasin Assessment and TMDL explains how it is reasonably expected that from the above outlined processes, that have incorporated the federal government, the State of Idaho, and responsible parties into the Blackbird mine Site Group (BMSG), that loads will be identified to compile a suitable TMDL.

Specific EPA Comments [on the Subbasin Assessment]

**1) I suggest that the executive summary contain a separate paragraph summarizing status and future plans for completing a TMDL for impaired waterbodies in the vicinity of the Blackbird Mine. This is probably the most significant water quality issue in the watershed and should be recognized as such in the executive summary.**

The Executive Summary will be updated to contain a separate summary of the status of TMDL development for streams listed in relation to the Blackbird Mine. The relationship of TMDL development to Record of Decision (ROD) development will be included in the summary. DEQ recognizes the significance of water quality issues relating to the Blackbird Mine and it is anticipated that the timeline for the ROD will also reflect the priority and significance of this water quality issue.

**2) Section 1.6, fourth paragraph, page 22. Note that Beartrack Mine is now inactive and is in the process of being reclaimed. It is not currently a large employer in the area, and the employment figures are incorrect.**

This paragraph will be edited to reflect that Beartrack Mine is now undergoing Reclamation and is not actively being mined. The statement that mining companies are another large employer in the subbasin will be stricken from the document. The employees involved in reclamation of the Beartrack Mine is variable and currently estimated at approximately 20 including the number of employs that continue to operate the leach heap. The number of persons employed in Lemhi County in 1990 was 2,776 according to U.S. Census data. The average number of employees per industry was 160. Mining operation and support ranked 15$^{th}$ out of the 17 industries analyzed in Lemhi County with 56 employees (2%) of the workforce. Census data for 2000 is not yet available.

**3) Section 1.6, fourth paragraph pages 22-24. This section also summarizes the legal and administrative history of cleanup operations at the Blackbird Mine. The information provided is not entirely correct.**

The updated summary of the legal and administrative history of cleanup operations should be more precise.

**4) Section 2.8, second paragraph. Note that Blackbird Creek also contains elevated levels of iron and thus likely violates narrative "free from" standards for toxic and deleterious substances.**

Iron will be added to the list of metals that likely exceed standards. Iron occasionally is elevated above 1 mg/L in its dissolved form, and total iron more frequently is above 1 mg/L in Blackbird Creek. It is uncertain at what concentration it becomes toxic or deleterious in relation to narrative "free from" requirements that waters be free from deleterious or toxic substances in concentrations that impair beneficial uses. The EPA along with its consultants and in consultation with the site trustees will assess the effects of iron in surface waters and aquatics in the "Blackbird Mine Aquatic Ecological Risk Assessment." This study is being completed under the Remedial Investigation and Feasibility Study (RI/FS) process which is part of the Blackbird Mine Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) clean up effort.

**5) Section 2.11, second paragraph. Note again that Beartrack mined (mine) is closed and is undergoing reclamation. Also note that EPA is in the process of revising the NPDES permit for the mine.**

It will be noted that the NPDES permit is being revised by EPA.

**6) Page 70-71. Please revise this section in light of general comments above regarding repetition and site history.**

Noted above.

**7) Section 5.0 Williams Lake TMDL, page 75-78. This section contains three pages of narrative on Blackbird Mine. This section is inappropriate for a chapter on the Williams Lake TMDL. See general comment above on creating separate chapter on Blackbird.**

We will remove the Blackbird material from this section and create a separate Blackbird section.

**8) The public notice for the Middle Salmon River-Panther Creek Subbasin TMDL did not inform the public that the TMDL package also included a proposal to delist Dump Creek, Diamond Creek, and Salmon River for the 303(d) list.**

**Because a Water Quality Management Plan (i.e. other pollution control requirement) has been developed by the Salmon-Challis National Forest (which includes Dump Creek, Moose Creek and East Boulder Creek) prior to the development of the 1994 Section 303(d) list, IDEQ should consider public noticing a delisting package which would include information on the status of the water quality management plan.**
**The subbasin assessment indicates that a TMDL for Diamond Creek will not be developed because the pollutant of concern has not been identified and also because the watershed was burned in this summers fires. Because the pollutant of concern is unknown (likely sediment, SBA, May 24,2000), and because the existing BURP survey concluded that the waterbody was not full support (low MBI, no fish, SBA, May 24, 2000) EPA proposes that this stream be reevaluated using the new Waterbody Assessment Guidance Process.**

Your comment is based on the press release that EPA obtained from the DEA State Office. The ads that actually appeared in the local newspapers did inform the public that the TMDL package includes a proposal to delist Dump Creek, Diamond Creek, and the Salmon River from the 303(d) list.

With regard to the first item under this comment, the revised Subbasin Assessment and TMDL includes information on the status of the water quality management plan. The second item is incorrect in that the reason a TMDL is not being completed on Diamond Creek is that it was listed in error, not because a pollutant of concern has not been identified, and not because there was a relatively low intensity fire in the watershed. It was speculated in the May Draft of the Subbasin Assessment that sediment would likely be the pollutant of concern, however, this statement has been revised since significant sediment sources were not identified. Additional discussion of the BURP survey on Diamond Creek identifies that the survey does not establish that the waterbody was not full support, but that the sample site was located on a reach that had flow below the 1 cfs threshold that negates numeric water quality standards.

Specific EPA Comments on Williams Lake TMDL

**Williams Lake was 303(d) listed for dissolved oxygen and nutrients, which pertain to nuisance aquatic algal growth in the lake. Based on the information presented in the TMDL assessment, the following are question(*s*) pertaining (*to*) the TMDL.**

The relationship between dissolved oxygen and nutrients is developed throughout the TMDL. Though there are areas of elevated densities of aquatic macrophytes and algae at varying times through the productivity season, it has not been established that the macrophytes and algae in and of themselves are at a nuisance level. The water quality perturbance is low dissolved oxygen related to nutrient driven Biological Oxygen Demand (BOD) below the epilimnion. The depth of the epilimnion may ultimately be increased to improve conditions for aquatic biota. This will occur as the thickness of the anoxic hypolimnion decreases from reduced nutrient loading which drives organic sedimentation and subsequent BOD in the hypolimnion. This will be determined through monitoring identified in the implementation phase as identified in the TMDL. Because of the catastrophic origin of Williams Lake and its resulting morphometry it is unlikely that dissolved oxygen standards that apply to natural lakes or reservoirs will ever be met in Williams Lake. This will be determined in the implementation monitoring phase of the TMDL also. If the need is determined through implementation monitoring, site specific criteria or a Use Attainability Analysis will ultimately be developed to be incorporated into the TMDL.

**1) No TMDL was developed for dissolved oxygen for Williams Lake. The TMDL should link the required reduction in total phosphorus to the attainment of the Idaho water quality criteria for dissolved oxygen.**

The relationship of nutrients to productivity is well documented within the Phase I Restoration Study for Williams Lake. Reducing nutrients can be equated to a reduction of epilimnetic algae which is primarily responsible for Biological Oxygen Demand (BOD). The catastrophic origin of Williams Lake and resulting morphometry are the limiting factor for lake circulation and aeration. These factors are beyond the realm of land management activities. Reducing nutrient inputs into the lake is within the sphere of influence of land management within the Williams Lake watershed, and will result in an optimal potential improvement in water quality over time. Through the implementation phase of the TMDL it is possible that management practices will be identified that will ultimately improve the concentration of dissolved oxygen at depth, but it is impossible to allocate a load for wind or water temperature that would result in eventual aeration of the hypolimnion. In fact it is likely that artificial circulation in the presence of an extreme wind event might trigger a mixing of epilimnetic and hypolimnetic waters that could result in an extinction event for salmonids within the lake.

**2) Section 5.0 Williams Lake TMDL, page 75-78. This section contains three pages of narrative on Blackbird Mine. This section is inappropriate for a chapter on the Williams Lake TMDL.**

See general comment above on creating separate section on Blackbird noted above.

**3) The nutrient TMDL identifies two different mean seasonal targets for Williams Lake (22 µg/l-Page 82/83 and 33 µg/l-Page 79) to meet the trophic state indices of forty five. Which mean seasonal target is right.**

This typographical error will be corrected to show 22 µg/l as the mean seasonal target.

**4) The phosphorus TMDL identifies two critical loadings. The first critical loading is the critical aerial loading for eutrophication of 199 mg/m$^2$/yr. The second critical loading of 1000 mg/m$^2$/yr was developed using a mass balance model. Which critical loading was used to derive the TMDL?**

The TMDL is based on the trophic status of the epilimnetic mass balance equation and the critical loading within the TMDL is based on the epilimnetic and whole-lake mass balance equation respectively. The critical loading identified for these two scenarios are included for informational purposes and were not used to calculate the load reduction of phosphorus. It would be possible to show the relationship of the load reduction to the critical aerial loading rate as a percentage. The load reduction results from eliminating phosphorus loading from septic systems, and an equivalent phosphorus load reduction was allocated to the watershed in the form of a gross allocation. The aerial loading rate for the epilimnetic mass balance equation load reduction is well below the aerial critical loading rate for either mass balance scenario, and including the aerial critical loading rate calculated in the Phase I Restoration Study is to show this. We will clarify this relationship within the TMDL.

**5) The TMDL indicates that anthropogenic sources of nutrients into Lake Creek include: streambank erosion, animal waste, human waste, road erosion, irrigation return flow and agricultural fertilizer residue. How does the TMDL factor animal waste, road erosion, irrigation return flow and agricultural fertilizer residue into the loading analysis and the development of the phosphorus load allocation for Lake Creek.**

This is a gross allocation in the absence of more specific land use data and management practices within the Phase I Restoration Study for the watershed. It is set equal to the load reduction from septic systems around the lake identified within the study.

**6) How much reduction in phosphorus, from the various sources, is needed to meet the TMDL target. Presently, as stated above, the TMDL has two different aerial loadings (199 mg/m$^2$/yr and 1000 mg/m$^2$/yr). It is unclear which is the critical loading thus it is difficult to determine the reduction required from the varying sources. Under the load allocation section (page 82) the TMDL gives a "zero" allocation to the Lake Creek [Williams Lake]**

**septic systems and requires a 30% reduction in phosphorus, but fails to prescribe a phosphorus load reduction from some sources (i.e. phosphorus from overland flow – who is the nutrient contributor) identified in table 23. Without factoring in the other sources (Table 23), does this ensure that the phosphorus target (22 µg/l or 33 µg/l) will be met? It is unclear how the margin of safety is factored into these calculations.**

It is identified within the TMDL that the reduction in phosphorus, the load allocation, as described under Load Allocation and in Table 25, is 133 kg from septic systems and 133 kg from the Lake Creek watershed. The Lake Creek watershed allocation is a gross allocation, and is not broken out to exact quantities by source. The detail of data within the Phase I Restoration Study did not allow for associating particular loads to specific non-point sources within the watershed. Potential sources are listed. The Implementation Plan will evaluate potential BMPs and the corresponding reductions that may accumulate to 133 kg of phosphorus. Through the phased nature of the TMDL implementation monitoring will determine if the potential reductions within the Lake Creek watershed will be adequate to restore water quality. If load reductions are not adequate to improve water quality, in consideration of the natural idiosyncrasies of a catastrophic and meromictic lake, site specific criteria or a use attainability analysis will be done on the lake. Wording within the TMDL will be adapted to make this more clear.

The aerial loading identified within the TMDL from the mass balance equation is 1000 $mg/m^2/yr$. The critical loading estimated from the Phase I Restoration Study for Williams Lake uses the Vollenweider (1968) equation identified under Critical Loading to estimate the aerial loading that might result in eutrophic conditions in Williams Lake. The subsequent discussion that relates the observed **aerial** loading of 1000 $mg/m^2/yr$, (that includes internal/hypolimnetic loading), and the
**critical** loading of 199 $mg/m^2/yr$ is intended to show that the internal loading alone within Williams Lake (570 $mg/m^2/yr$) is enough to put Williams Lake into the productivity range if eutrophic. The point being that given the natural conditions found within Williams Lake, it will likely take many years of reduced phosphorus inputs to effect any change in water quality. We will try to reword these sections to make the distinction between overall aerial loading and critical loading more clear.

**7) The TMDL should use a single weight measure (µg/l $mg/m^2$, $kg/m^2$, kg) to allow the reader to track through the document. Tables 23-25 should be converted into the same units as the loading capacity ($mg/m^2/yr$ or $mg/m^2$).**

The units used within the TMDL reflect those used within the Phase I Restoration Study. We will convert weight measures to milligrams throughout the document, however raw phosphorus loading is better left in kilograms as it appears in Tables 23-25. Kilograms are the appropriate unit as used here.

**8) In developing the nutrient TMDL for Lake Creek, the TMDL should consider using the same approach taken on the Antelope Creek and Bear Creek in the Palisades Subbasin Assessment/Total Maximum Daily Load. By using this approach, one can link the prescribed sediment reductions to a reduction in phosphorus.**

This type of linkage was not included in the Antelope Creek and Bear Creek TMDLs within the Palisades Subbasin Assessment. After reviewing the data from the Technical Appendices of the Phase I Restoration Study and Forest Service monitoring reports DEQ did not equate the potential sediment reduction from streambank erosion to phosphorus reduction from soil due to inconsistencies with literature values.

<u>Comments on Potential 303(d) Listing for Lake Creek</u>

**1) Information/data presented for Lake Creek (Page 74, Second Paragraph) indicates that particulate phosphorus bound to/associated with sediment from Lake Creek is contributing to the internal phosphorus loading problem in Williams Lake. Phosphorus loading to Williams Lake will not be controlled until sediment loading from streambank erosion is fixed. Lake Creek should be 303(d) listed for sediment.**

It is stated within the TMDL that particulate phosphorus affiliated with the sediment load from Lake Creek contributes to the internal loading in Williams Lake. The internal loading of phosphorus from historically accelerated deposition of sediment and nutrients into William's Lake from land management practices in the 50s and 60s and the recreational residential development of the early to mid 70s will continue for many years, as also stated in the TMDL. Phosphorus loading will continue from Lake Creek to William's Lake even in the absence of streambank erosion. The watershed is naturally high in phosphorus and erosive. A 303(d) listing for Lake Creek implies targets that are affiliated with restoring beneficial use support. Lake Creek has been evaluated through the Beneficial Use Reconnaissance Project sampling to be in full support of its beneficial uses. Within the Williams Lake TMDL a gross allocation/load reduction is assigned to Lake Creek to reduce sediment loading to Williams Lake. If Williams Lake were not naturally meromictic, there would not be a need to assign a load reduction to Lake Creek due to its Full Support status. It is adequate to attempt to reduce the phosphorus load from Lake Creek without listing it as an impaired water body. It is not impaired. Williams Lake is impaired, primarily by natural phenomena and historic land use. Listing Lake Creek would not afford Williams Lake any additional benefit. Load reductions from private or federal property would not be any more binding than they currently are. Implementation monitoring will be adequate to detect a downward trend in beneficial use support for Lake Creek if it occurs, however the trend is currently upward for Lake Creek.

<u>Response to Health Department Comments—Specific Comments</u>

**1) Executive Summary: Upon implementation of the proposed sewer projects <u>all homes</u> on the shoreline will have upgraded individual systems or be connected to the central system.**

**The Williams Lake Resort is not mentioned in your summary of having a loading that exceeds 20 homes and has not made improvements to their sewage disposal system. As such, your statement of 100% reduction can not be achieved until this issue is addressed.**

The statements in your comment will be added to the Executive Summary.

**2) Background: Background-page 74-paragraph 4**

**While it is true that the newly constructed Williams Lake Lodge has had plans submitted for the use of an existing drainfield, the owner has not, at this time, agreed to the conditions of the sewage disposal permit.**

**The actual situation as of this date is that all the buildings, including the lodge, are disposing of waste into a system that has been covered with soil to a depth exceeding 20 feet. Septic tank sizing and drainfield sizing are unknown, but are located in close enough proximity to the lake to be of concern.**

Engineer estimated maximum daily flows for all facilities exceeds 3,500 gallons, an equivalent of more that 20 homes when BOD and nutrient loading are considered.

The Background section will be updated to reflect your comments.

**3) Recommendations and Conclusions-page 90-paragraph 3-sentence 3 Recommended sentences:**

**Nine shoreline homes have made improvements to their septic systems. Plans for the construction of a central collection system to serve 22 shoreline homes have been approved by DEQ with construction slated for 2001. The Williams Lake Resort facility remains to be upgraded.**

**An additional concern that is not addressed in you report is stormwater. Plans submitted by the engineer for the Williams Lake Resort show a storm drain directed to the lake. This and other parking areas such as the Forest Service boat ramp are items that, while not TDL related, need to be addressed.**

**Should you have any questions do not hesitate to contact me at the above telephone number.**

The sentences that you suggest will be incorporated into the Recommendations and Conclusions section

Stormwater:
It was assumed in the TMDL that the 3% of phosphorus loading attributed to overland flow and direct precipitation around Williams Lake included stormwater runoff. The load assigned to overland flow was 62.5 kg as estimated in the typical year mass balance equation. This loading parameter is listed separately from stream flow so it implies that this is direct runoff into the lake. It is stated within the KCM Phase I Restoration Study that "surface runoff from the ungaged [soils] area near the lake was determined using the SCS rational method analysis of runoff for several example storms (USDA 1975). Calculations indicate that approximately 6.5% of the gaged [soil] inflows occur as overland flow in the near-lake ungaged areas. The ungaged area includes approximately 1,560 ac (631 ha), comprising approximately 13 percent of the watershed area." The estimates for gaged soils use a coefficient to represent surfaces "dominated by rocky soils with high potential evapotranspiration and low infiltration." Areas of this type are estimated at approximately 6.5% of the gaged inflows in the near-lake ungaged

areas. It is likely that this adjustment would approximate runoff from impermiable surfaces, though in the implementation plan it will be possible to specifically evaluate impermeable surface and improve the estimated loading from this source.

If there are load reductions possible from stormwater runoff from impermeable surfaces, those load reductions can be assigned to the load reductions in the TMDL, or they can be assigned as additional reductions to further improve water quality. The Implementation phase of the TMDL will identify these potential sources of phosphorus as possible reductions, and make recommendations for best management practices.

Response to comments by Kenneth John: Williams Lake Resident

**Septic Loading**

**Mentioned throughout the KCM study, Phosphorus loading is a primary concern with the lake. I will address this portion of the study only.**

**Phosphorus loading in a typical year is as follows:**

| | | |
|---|---|---|
| **1.** | **Internal Loading** | **76%** |
| **2.** | **Inlet Streams** | **16%** |
| **3.** | **Septic Loading** | **05%** |
| **4.** | **Precipitation** | **03%** |
| | **Total Natural Loading** | **95%** |
| | **Septic Loading** | **05%** |

**Septic Loading: This figure was derived using the following assumptions:**

**Assuming full occupancy of the Facilities (65 homes) and Lodge from June 1, through September 15 (107 days). A flow rate of 110 gallons per capita day.**

**As your Draft Assessment stated, the Lodge is installing a new septic system that will be studied and monitored for the next two years.**

**In reality, there are only 22 homes within 300 feet of the lake that are not in compliance to code. Of these 22 homes only around five are occupied the full 105 days. The rest of the homes are occupied for weekends or part time through the summer.**

**Assuming all 22 homes are fully occupied through the period would result in 1.5% septic contribution toward phosphorus loading of the lake.**
**Assuming only five homes are occupied through the period would result in .4% septic contribution toward phosphorus loading of the lake.**

**Conclusion: Only .4% to 1.5% of the total phosphorus loading of the lake should be contributed to septic systems.**

**It is presently planned to start construction of the sewer system for these 22 homes, as soon as the ground has thawed and dried in the spring of year 2001.**
**The sewer system should be operational during the summer of year 2001.**

**The Idaho Department of Environmental Quality is cautioned when considering the contributions of Septic systems when setting Total Maximum Daily Loads (TMDL) for Williams Lake. Rather than the construction of the sewer system decreasing the Phosphorus Loading in the lake by 5%, the real amount would only be between .4% and 1.5%.**

**Natural Loading:**
**It is stated Internal Loading (76%) in the lake is the primary problem, followed by Inlet Streams (16%), Septic (.4%-5%, and last Precipitation (3%).**
**Since Septic Loading in being addressed, and controlling precipitation is out of the question, I would like to crawl up this analysis rather than walk down it as we have all been taught.**

**Inlet Loading: The KCM study states that 62% of the natural sediment loading is from Tin Cup Creek. Thus, 10% of the TOTAL phosphorus loading of the lake is from Tin Cup Creek. Addressing this portion of the Inlet Loading would be the first priority.**

**This leaves us with the largest portion of the problem, Internal Loading (76%). The KCM study recommends Hypolimnetic Aeration as one of the recommended solutions. After discussing this with the Idaho Fish and Game personnel, I personally have reservations with this technique. It is one of the most expensive of the options; also bringing up water from below the themocline would bring high levels of Phosphorus and Hydrogen Sulfide. This could very easily cause a complete fish kill of the entire lake.**

**One of the other options for addressing Internal Loading, is Hypolimnetic Withdrawal. Disposing of the withdrawn water is a problem. If this one problem can be addressed, Hypolimnetic Withdrawal is by far the most feasible of all solutions suggested. The Idaho Fish and Game is presently looking into this technique for addressing the Internal Loading of the Lake. A signed Petition from the Williams Lake Homeowners Association has been sent to the Idaho Fish and Game supporting any and all efforts to improve water quality at Williams Lake.**

**In conclusion, Septic Loading is being addressed. Internal Loading is the simplest least intrusive and one of the least expensive solutions to this problem.**

**Kenneth H. John**
**Williams Lake Home Owner**
**Member of Williams Lake Water and Sewer district**

The assumptions stated in the KCM Williams Lake Phase I Restoration Study are as you have stated in your comment. Additional assumptions include an effluent concentration of 24 mg/l, and soil removal rates of 0 percent for primary lots (those located on the shore of Williams Lake), and 70 percent for secondary lots (located away from the lake shore).

The assumptions related to occupancy and flow rates were derived from a survey conducted by KCM with 26 respondents (Appendix G of the KCM Technical ). The survey included estimates of the number of days of occupancy, floorplan characteristics of the residence, estimated number of occupants, facilities/appliances in the home, and detergents used. The survey also asked respondents to sketch an overview of their property and facilities with distances between buildings, water and estimated drainfield/disposal location.

If there is less occupancy and/or duration of occupancy today than estimated in the study, it may be identified as a load reduction through the implementation plan and it should eventually be recognized in water quality monitoring. The reduction of load would eventually be realized in water quality improvements if use were consistently less, but it may take many years to manifest itself. Additional reductions are possible in the watershed though, as noted in the TMDL. Natural erosion and sediment loads are higher in the Tin Cup subwatershed than other William's Lake subwatersheds and there may be fewer opportunities in the Tin Cup drainage than others. The identification of potential BMPs, cost analysis, cost to benefit and practicality of BMPs will be evaluated in the implementation phase of the TMDL.

It is not likely that an artificial circulation system is a workable alternative for William's Lake for the reasons that you point out in your comment. Hypolimnetic withdrawal is a lake restoration measure that will be evaluated in the implementation phase as well. It is important to identify that this is also an expensive restoration mechanism, as opposed to a load reduction mechanism. The phosphorus load has accumulated in sediments and will continue to contribute to water replaced by hypolimnetic withdrawal. Additionally, there are many factors to consider with regard to water quality in Lake Creek below William's Lake and in the Salmon River. Numerous permits will be required for this restorative project.

<u>Response to comments by USFS S-CNF—Specific Comments</u>

**1) Pg 3 Paragraph 2 – The minimum temperatures referred to in the table are average minimums. The sentence in paragraph 2 referring to a 10 degree minimum should be rewritten to indicate this as an average minimum, since low temperatures well below zero are a regular occurrence within the Subbasin during the winter months.**

Your comment is correct. The text will be changed to reflect the actual range of temperatures from meteorological data.

**2) Pg 13 Paragraph 4 – Forest fisheries personnel question the indicated distribution of brook trout within the Subbasins streams and lakes. This information needs verification, as it runs counter to what Forest presence/absence files indicate, particularly with regard to brook trout presence within the lower reaches of mainstream Panther Creek (ie below Big Deer Creek).**

Your comment is valid.  We attempted to make this edit from previous Forest Service comments on the Subbasin Assessment.  We will remove the statement about brook trout and mountain lakes.

**3) Pg 14 Paragraph 1 – While passage capabilities above the Highway 93 culvert have been improved in recent years, upstream migration of bull trout in Twelvemile Creek may still be precluded by one or more diversion structures below the Forest boundary.**

We will add to this paragraph that bull trout migration may still be precluded by diversion structures and that fish passage should be evaluated.

**4) Pg 18 Paragraph 5 – The USFS source material upon which salmon distributions are based is in error.  This reach of the Salmon River supports spring and summer run chinook only.  Fall run chinook salmon have never been present within this Subbasin.**

We will remove fall Chinook from this paragraph.

**5) Pg 74 Paragraph 2 – The cited reference is not listed in the References section.**

We will add Hoelsher 1999 to literature cited.

Response to Lemhi Soil and Water Conservation District Comments—Specific Comments (Page #, Paragraph)

**1) 12,4 North-facing aspects can also have Lodgepole with Aspen and Cottonwood near streams.**

Slope aspect and vegetation:  There are a number of potential plants that could be added to the characterization provided by the Salmon National Forest (1988).  We will add the particular species that you identify to this paragraph.

**2) 13,4 Which high mountain lakes contain 100% brook trout?  Many high mountain lakes contain cutthroat.**

This comment noted above.

**3) 14,3 Show proof that "migration is questionable due to irrigation diversions".**

This is not an absolute statement about migration barriers to bull trout (and other salmonids) in Carmen Creek as stated in the Middle Salmon-Panther Creek Subbasin Assessment, only that the potential exists.  It is a succinct summery of the discussion of Carmen Creek based on best professional judgement from the federal bull trout consultation and biological assessment process that was incorporated into the Upper Salmon River Key Watershed Bull Trout Problem Assessment (SBTA 1998, in the Mid Salmon-Panther Subbasin Assessment and TMDL).

The section on Carmen Creek includes: "*The fluvial population* [of bull trout] *may be absent due to dewatering for irrigation.  It is the PJ* [professional judgment] *that growth and survival are due to the high quality habitat and lack of disturbance combined with potential for access to the*

*Salmon River. Fluvial population may be present, but if lacking, is due to dewatering for irrigation purposes on private. Physical barriers, unscreened diversions, exist that create seasonal dewatering for irrigation purposes. Flow is impacted by water diversions on private lands and federal actions have no effect. The potential exist for fluvial populations. Private diversions at lower end impact potential for fluvial populations and some processes such as flow and hydrology. Habitat survey and temperature data are available to support most of the conclusions reached in this evaluation."*

We will add the citation that identifies the source of this statement in your comment as the Upper Salmon River Key Watershed Bull Trout Problem Assessment and expand the text to more completely reflect the Professional Judgment (PJ) of the federal fisheries biologists that interpreted fish passage conditions in Carmen Creek. We will change the wording from "questionable" to "physical barriers exist."

**4) 14, Table 8 is the "other public" column State Lands?**

A query of the FIA Database Retrieval Systems puts State ownership of timberland by forest type at 13,000 acres. The category "Other Public" includes BLM as queried for the Subbasin Assessment.

**5) 22,4 Where is the proof that recreation is decreasing the importance of agriculture and other industries. With the fire season of 2000 it was evident that there was less tourists, making this an unreliable segment of the local economy. Agriculture is a year-round industry.**

We will remove the reference to the importance of agricultural land.

**6) 22,5 Plenty of gold is left. The phasing out of the Beartrack mine has more to do with economics and permitting than it does with availability of ore.**

The text in this section will be revised to reflect that the supply of "heap leachable" gold that corresponds to the oxide deposits of gold have been depleted. Below the oxide layer, the mining of sulfide affiliated gold ore is not economically feasible at this time. The mine has been permitted to operate as it has and permits have not been the limiting factor in continued mining at
Beartrack.

**7) 25,1 Mining occurred from 1979-1982.**

During this period there may have been some exploration and permitting by Noranda, however, review of the dates within the Subbasin Assessment by persons directly affiliated with the Blackbird Mine show that the dates are correct as written.

**8) 25,2 There are no mills in Salmon. QB is not a mill they produce laminated beams from lumber, they do not saw any raw timber.**

We will change to text to show that there are currently no lumber mills in Salmon, and that there is one factory that produces timber products.

**9) 29,3 Point of Information the paragraph is repeated.**

Noted above.

**10) 46,2 Harmony mine is located in the headwaters of Withington Creek in the Lemhi Subbasin. "There are 160 acres of homestead land in the North Basin section of Warm Springs Creek drainage." This should probably be 12-mile Creek not Warm Springs.**

"Harmony Mine" will be removed from this sentence. "160 acres of homestead land": We will replace Warm Creek with 12mile Creek.

Response to Williams Lake Recreational Water & Sewer District Comments—Specific Comments

**In response to comments on the Draft Middle Salmon River -- Panther Creek Subbasin Assessment and TMDL, the Board of Directors of the Williams Lake Recreational Water District have reviewed the Assessement and TMDL referred to hereinabove and would like to comment as follows:**

**1) Within the Williams Lake Recreational Water and Sewer District, the 22 homes located along the edge of the lake are included in the plans for a new cluster sand filter septic system and once in place, all of the homes within the District will be in compliance and have adequate septic/sewer systems.**

In October, 2000 DEQ reviewed shoreline conditions at Williams Lake. 34 homes were counted on the shoreline. It is our understanding that with the upgrades that you are describing in your comment that the shoreline residences will be fully implemented to effect much of the phosphorus load reductions assigned in this TMDL. The load reductions are based on the Phase I Restoration Study for Williams Lake, and incorporate the assumptions outlined in that study. The implementation of improved septic systems reduce the load of phosphorus outlined in the Restoration Study and make great progress toward implementation of the TMDL.

**2) Regarding cross-connections, it is the goal of the Board of Directors of the District to complete on-site inspections and to bring all of the homes into compliance of its ordinance requiring backflow devices and the prevention of cross-connections.**

We will note this for incorporation into the implementation monitoring section of the Implementation Plan.

**3) The District is concerned about the lodge and motel at the Williams Lake Resort, whose sewer system is presently located directly above the District's groundwater source springs and the possible leaching of the sewer system and contamination of the District's water system.**

This is also a concern of the District 7 Health Department and the Department of Environmental Quality Source Water Assessment Program. It is hoped that through the implementation phase of the Williams Lake TMDL that potential solutions to this problem will be identified and that funding will be made available through the 319 grant program to assist with improvements.

On 2000-12-11 at 06:36:39,
The following information was submitted:
From Host: 63.227.247.158
Name = DAVE SANDERSFELD
Email_Address = fnature@hotmail.com
Affiliation = Previous Favorite Residence
**Comments = Dear Tom:**
**I would like to thank You and the Idaho DEQ for finally taking the initiative to help improve the water quality in the few water quality deterioration-spots in this area that has always been a favorite of mine.**
**The Sewage pollution around Williams Lake was a concern of mine back in 1973 - when I left my "home town"!**
**Moreover, the streambank stabilization around Dump Creek had been an ignored problem before 1900!**
**I concur with removal of Diamond Creek, Dump Creek and some segments of the Salmon River from the list of "Concern".**
**The mine tailing areas of concern should be lessened in Blackbird Creek(Blackbird Mine) headwaters by the EPA "Superfund Cleanup". I was satellite surveying this project in 1995. Has this project started yet?**
**The proposed TMDLs on Panther, Big Deer, Bucktail, and Blackbird Creeks should be maintainable after the "Super Fund Cleanup".**
**This region and Idaho, in general, is very fortunate to have so few spoiled nest spots that we can focus upon and clean up relatively easy - compared to other States!**
**THANK YOU, DAVE SANDERSFELD 208-461-1142**

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‡ Also admitted in Washington
◊ Also admitted in South Dakota

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February 6, 2001

Thomas Herron
Sr. Water Quality Analyst
Idaho Department of Water Quality
900 North Skyline, Suite B
Idaho Falls, ID 83402-1718

*Re Draft Middle Salmon River – Panther Creek Subbasin Assessment and TMDL*

Dear Mr. Herron

The Blackbird Mine Site Group (BMSG), which represents the parties working on cleanup activities at the Blackbird Mine, has reviewed the Draft Middle Salmon River – Panther Creek Subbasin assessment. The BMSG found the draft document appropriately describes the efforts to address water quality that are underway. In particular, the BMSG concurs with the Department of Environmental Quality's approach in deferring the development of a TMDL in recognition of the current on-going cleanup process under the Consent Decree. EPA, IDEQ and the BMSG are obligated to follow the process under the Consent Decree, which was approved by the Court following public notice. Under the Consent Decree, the BMSG is addressing water quality issues under the oversight of the IDEQ and EPA. Significant water quality improvements are already evident. Superimposing a TMDL process on top of that would be a duplication of effort at best and might inadvertently conflict or interfere with the consent decree process.

Sincerely

Bruce M. Smith

BMS/to

# 8.0 Recommendations And Conclusions

Conditions in Dump Creek have been adequately addressed in a water quality management plan/restoration plan conducted by the Salmon-Challis National Forest (Rieffenberger, 1999; Rose, 1999). A TMDL is not warranted for Dump Creek, and it is recommended that Dump Creek be removed from the 303(d) list. It is unlikely that a TMDL for Dump Creek will provide any realistic additions to the restoration work already addressing problems experienced in that drainage. The drainage has been assessed over a number of years and the general conclusion is that slumping of the canyon will continue until it reaches an equilibrium condition. Since Moose Creek has been re-routed back to its own channel, little sediment is being carried out of Dump Creek into the Salmon River. We recommend that the Forest Service continue to monitor the situation and to control the water in Moose Creek so that it does not migrate back to Dump Creek.

Since implementation of the Dump Creek Project significant changes have occurred in the Dump Creek channel. In the upper chasm adjacent to the constructed channel a stable channel with vigorous riparian vegetation is developing. The slopes adjacent to the channel are still relatively bare, but no new slope movement has been observed in the last ten years. Recently there has been evidence of livestock use in this area via an old stock driveway from the meadow to the east of the channel down into the bottom of the chasm. Headcuts from the Dump Creek channel into the meadow east of the upper chasm are still eroding though at a reduced rate. Illegal placer mining activity has been occurring in this reach in the last several years. In 1999 the area was signed and patrolled to ensure that the mineral withdrawal is observed for watershed protection (Rieffenberger, 1999).

Below the upper chasm there is a long waterfall below which the chasm depth goes from less than 30 feet to over 300 feet in places. No massive slope movement has been observed in this area for approximately ten years, but there is still a potential for additional slope failures. Numerous unstable land blocks, some several acres in size, are still evident in this reach. Fissures behind these blocks are lubricated by precipitation and it is just a matter of time until some of these slopes fail. Even with the potential for additional slope failures in the Dump Creek chasm the enormous sediment transport mechanism that once existed is no longer available to transport the material downstream. It was accepted at the time that the project was designed that it would take time, probably centuries, until the slopes in Dump Creek stabilized (Rieffenberger, 1999).

Probably the most obvious change as a result of the Dump Creek Project has been the change in the alluvial fan at the mouth of Dump creek. Prior to the water diversion back from Dump creek into Moose Creek the alluvial fan was characterized by braided channels that were in a constant state of change preventing the establishment of vegetation on the fan. Each spring the fan would extend out into the Salmon River delivering tremendous quantities of suspended and bedload material to the river turning the entire river a brown color. Several years after the water was diverted a stable channel developed on the fan. Since then a riparian corridor has developed along the channel and the banks are stabilizing. An extensive cottonwood forest is growing in the coarse material that comprises the alluvial fan. Some trees are currently over 15 feet tall. Juvenile steelhead have been found using the lower Dump Creek channel for rearing habitat.

Over time the river has removed the toe of the alluvial fan and the fan no longer encroaches on the river channel during high water in May and June. Despite the reduction in the size of the alluvial fan there has been no change in the characteristics of the Deadwater Reach of the Salmon River that is located immediately upstream of the fan. This leads credence to the theory that the Deadwater Reach is caused by geologic faulting and bedrock gradient controls. Another theory on the formation of the Deadwater Reach is that it was caused by the encroachment of the Dump Creek alluvial fan on the Salmon River.

Restoration activities are continuing in Moose Creek and East Boulder Creek. Although not specifically listed on the 303(d) list in 1998, East Boulder Creek has significant levels of fine sediment and lower habitat scores. Like Dump Creek, East Boulder Creek restoration is being addressed through a water quality management plan conducted by the Salmon-Challis National Forest. East Boulder Creek is in full support of its existing beneficial uses and an extensive restoration project is underway to improve conditions that developed prior to the Clean Water Act. Continued monitoring of conditions within East Boulder Creek are recommended. Maintenance of the sediment dam below US FR 023 is strongly recommended and eventual replacement should be considered. Additionally, re-sloping of streambanks, installation of geofabric, and more aggressive revegetation should be considered adjacent to the most erosive reach above the sediment dam. Ultimately in-stream fisheries habitat improvement projects could be considered as part of the restoration project.

Diamond Creek was §303(d)-listed in 1998 after BURP assessment showed reduced habitat and macroinvertebrate scores for the upper extreme of the watershed on an intermittent reach of the stream. No pollutants were identified in the 1998 §303(d) listing and no pollutant sources were identified during the pollutant source inventory conducted along Diamond Creek in early July 2000. Shortly after the inventory a wildfire swept through the area that prevented access for much of the remaining field season. Of 3.5 miles of perennial stream watershed area 1.07 miles was exposed to low intensity fire and is expected to recover fully. None of the 4.54 miles of the upper stream that is intermittent was exposed to fire. Rehabilitation projects have been determined by the USFS-SCNF to not be necessary within the Diamond Creek watershed. Diamond Creek will be removed from the 1998 §303(d) list, pending public comment. BURP monitoring will be conducted at an appropriate site to better determine the support status of Diamond Creek.

Metals and pH contamination in the four streams associated with the Blackbird Mine are well documented, and clean-up activities are underway to restore the water quality and beneficial uses of Panther Creek and Big Deer Creek. It is likely that these activities will also reduce metals contamination in Bucktail Creek and Blackbird Creek. The original settlement agreement, the Biological Restoration and Compensation Program (BRCP), and the Remedial Investigation and Feasibility Study (RIFS) are sufficient planning activities to constitute a water quality management plan for the four streams. Since restoration activities have already been planned and implemented for the mine, developing a TMDL for these waters would be a duplication of efforts, and thus is not recommended.

Williams Lake requires the implementation of a TMDL for phosphorus to restore, if possible, water quality in the lake. Additional data is needed to identify current epilimnetic and hypolimnetic conditions, including the hydrogen sulfide characteristics. A number of homes have recently made improvements to septic systems, and two lakeshore homes and the Williams Lake Lodge on the eastern shore remain to be upgraded. Other homes removed from the lakeshore will also need to have improved systems installed within the 10-year implementation period of the TMDL. Much of the phosphorus loading in the lake is from internal recycling. That condition will likely take a long time to restore, especially in a closed system. However, it is imperative that controls be put in place to limit any further introductions of phosphorus into the lake if water quality is to be restored in the long term.

The Salmon River was identified as an impaired water on the 1998 303(d) list, but no pollutants were identified. Information regarding pollution in the Salmon River is very sparse, and no known water quality problems were identified in this assessment. Large river BURP identified sites on the Salmon River as being reference-type conditions suggesting that the river has no water quality problems. The river's key role in the passage of anadramous and migratory resident salmonids makes it an obvious concern, and it should continue to be monitored by the appropriate land management agencies. At this point, however, no demonstrated violations of any state water quality criteria have been established. We recommend that no TMDL be completed for the Salmon River at this time.

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# APPENDIX A
## Summary Beneficial Use Reconnaissance Project (BURP) Data

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank Left | % Stable Bank Right | % Covered Bank Left | % Covered Bank Right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allan Creek | NR | 4480 | 1 | A | 70 | 3.89 | 10 | 20 | 99 | 28 | 13 | 25 | 35 | 100 | 100 |
| Allen Creek | NR | 7120 | 1 | A | 96 | | 10 | 130 | 99 | 31 | 16 | 100 | 100 | 100 | 99 |
| Allison Creek | NR | 7500 | 1 | A | 117 | 3.65 | 50 | 40 | 99 | 47 | 9.3 | 100 | 100 | 100 | 100 |
| Anderson Creek | NR | 4800 | 2 | B | 106 | 4.79 | A | A | 99 | 27 | 8.4 | 85 | 95 | 100 | 100 |
| Arnett Creek | NR | 6400 | 2 | B | 101 | | 20 | 20 | 99 | 10 | 23 | 100 | 100 | 100 | 100 |
| Badger Creek | SR | 4940 | 2 | A | 74 | | 10 | 10 | 99 | 61 | 11 | 99 | 98 | 93 | 92 |
| Beaver Creek | NR | 4120 | 2 | B | 122 | 4.63 | 20 | 20 | 99 | 31 | 12 | 80 | 80 | 90 | 90 |
| Big Deer Creek | NR | 5120 | 3 | B | 110 | 4.67 | | | | 41 | 19 | 85 | 85 | 100 | 85 |
| Big Deer Creek | NR | 4232 | 4 | A | 104 | 2.68 | | | | 11 | 18 | 95 | 100 | 2 | 3 |
| Big Juneano Creek | NR | 4600 | 1 | Aa+ | 106 | | 10 | 10 | 99 | 11 | 13 | 100 | 97 | 100 | 97 |
| Blackbird Creek | NR | 6680 | 1 | B | 51 | 1.08 | | | 97 | 34 | 5.7 | 90 | 80 | 0 | 0 |
| Blackbird Creek | NR | 5400 | 2 | B | 92 | 3.00 | | | 97 | 42 | 11 | 100 | 100 | 90 | 75 |
| Blacktail Creek | NR | 7240 | 1 | Aa+ | 107 | 3.80 | | | | 80 | 7.6 | 100 | 100 | 100 | 100 |
| Boulder Creek | NR | 3360 | 2 | A | 130 | | 10 | 10 | 99 | 6 | 9.4 | 100 | 100 | 100 | 100 |
| Briney Creek | SR | 4320 | 1 | A | 110 | | 10 | 10 | 99 | 30 | 13 | 100 | 100 | 100 | 100 |
| Bucktail Creek | NR | 6700 | 1 | A | 43 | 0.55 | | | | 71 | 17 | 0 | 0 | 0 | 0 |
| Bucktail Creek | NR | 5500 | 1 | A | 44 | 0.34 | | | | 73 | 7.3 | 0 | 0 | 0 | 0 |
| Cabin Creek | NR | 6240 | 2 | B | 100 | 5.08 | 30 | 20 | 99 | 29 | 8.6 | 30 | 40 | 100 | 100 |
| Cabin Creek | SR | 4670 | 1 | A | 98 | 4.15 | 20 | 20 | 99 | 53 | 17 | 100 | 96 | 98 | 94 |
| Camp Creek | NR | 7240 | 1 | B | 135 | | 10 | 10 | 99 | 14 | 1 | 100 | 100 | 100 | 100 |
| Carmen Creek | NR | 5760 | 2 | A | 96 | 4.95 | | | | 0 | 14 | 100 | 75 | 25 | 25 |
| Carmen Creek | SR | 4390 | 3 | B | 98 | 4.77 | | | | 8 | 33 | 80 | 85 | 55 | 45 |
| Carmen Creek | SR | 3920 | 3 | D | 89 | 4.55 | | | | 0 | 49 | 85 | 85 | 25 | 40 |
| Clear Creek | NR | 3440 | 2 | B | 102 | 4.84 | 20 | 10 | 99 | 34 | 16 | 65 | 65 | 100 | 100 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank | | % Covered Bank | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Left | Right | Left | Right |
| Clear Creek | NR | 3440 | 2 | C | 112 | | 20 | 10 | 99 | 23 | 30 | 100 | 100 | 100 | 100 |
| Colson Creek | NR | 4480 | 2 | A | 107 | 3.99 | | | | 62 | 16 | 100 | 100 | 96 | 100 |
| Copper Creek | NR | 5400 | 1 | A | 101 | 4.90 | 10 | 10 | 99 | 28 | 9.2 | 100 | 100 | 100 | 100 |
| Corral Creek | NR | 6040 | 1 | Aa+ | 96 | 4.15 | 20 | 40 | 99 | 42 | 13 | 100 | 100 | 100 | 100 |
| Cove Creek | NR | 3200 | 1 | F | 72 | | 10 | 10 | 99 | 65 | 15 | 100 | 100 | 100 | 100 |
| Cow Creek North Fork | SR | 7000 | 1 | A | 80 | 2.65 | 30 | 10 | 99 | 42 | 29 | 100 | 100 | 100 | 100 |
| Dahlonega Creek | NR | 5100 | 1 | B | 93 | 4.84 | 10 | 10 | 99 | 27 | 16 | 75 | 75 | 100 | 100 |
| Daly Creek | NR | 7620 | 1 | Aa+ | 114 | | 10 | 10 | 99 | 16 | 11 | 100 | 100 | 100 | 100 |
| Daly Creek | NR | 7160 | 1 | A | 106 | | A | A | 99A | 13 | 21 | 100 | 100 | 100 | 100 |
| Daly Creek East Fork | NR | 7520 | 1 | Aa+ | 101 | | 10 | 10 | 99D | 27 | 11 | 100 | 100 | 100 | 100 |
| Daly Creek Middle Fork | NR | 7640 | 1 | Aa+ | 87 | | 20 | 10 | 99D | 56 | 7 | 100 | 100 | 100 | 100 |
| Deep Creek | NR | 4960 | 3 | Aa+ | 102 | 5.10 | 10 | 10 | 99 | 17 | 29 | 80 | 80 | 80 | 80 |
| Deep Creek | NR | 5600 | 1 | A | 113 | 5.28 | 10 | 10 | 99 | 33 | 7.3 | 100 | 100 | 100 | 100 |
| Deer Creek | SR | 4555 | 2 | B | 101 | 5.16 | 10 | 10 | 99 | 46 | 17 | 74 | 64 | 62 | 44 |
| Deriar Creek | NR | 6200 | 1 | B | 59 | | 60 | 50 | 99 | 87 | 5 | 100 | 100 | 96 | 93 |
| Diamond Creek | SR | 7120 | 1 | Aa+ | 73 | 1.35 | | | | 99 | 15 | 100 | 100 | 100 | 100 |
| Ditch Creek | NR | 4480 | 2 | A | 108 | 5.09 | 10 | 10 | 99 | 20 | 24 | 100 | 100 | 100 | 100 |
| Dump Creek | NR | 6280 | 3 | F | 46 | 3.42 | | | | 19 | 23 | 60 | 55 | 40 | 25 |
| Dump Creek | NR | 3428 | 3 | B | 86 | 2.37 | | | | 19 | 19 | 100 | 100 | 0 | 0 |
| Dump Creek | NR | 3428 | 3 | | | | | | | | | | | | |
| East Boulder Creek | NR | 6640 | 2 | C | 89 | | 40 | 10 | 99 | 68 | 29 | 100 | 100 | 96 | 96 |
| East Boulder Creek | NR | 6625 | 2 | C | 98 | | 10 | 10 | 99 | 78 | 11 | 100 | 100 | 100 | 96 |
| Elk Creek | NR | 5060 | 1 | B | 103 | 4.66 | 10 | 10 | 99 | 49 | 5.2 | 100 | 100 | 100 | 100 |
| Fourth of July Creek | NR | 5600 | 2 | A | 106 | 5.06 | | | | 37 | 17 | 100 | 100 | 90 | 90 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank | | % Covered Bank | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Left | Right | Left | Right |
| Fourth Of July Creek | NR | 5920 | 2 | B | 89 | 5.27 | 60 | 10 | 99 | 28 | 14 | 95 | 85 | 100 | 100 |
| Freeman Creek | NR | 4880 | 2 | A | 105 | 5.29 | 10 | 40 | 99 | 8 | 18 | 73 | 100 | 100 | 100 |
| Gant Creek | NR | 3966 | 1 | Aa+ | 115 | | 10 | 10 | 99D | 8 | 3.1 | 100 | 100 | 100 | 100 |
| Hammerean Creek | NR | 5440 | 1 | A | 106 | 5.30 | 10 | 80 | 99 | 27 | 17 | 100 | 100 | 100 | 100 |
| Hat Creek | NR | 5035 | 3 | B | 122 | 4.58 | 40 | 40 | 99 | 52 | 9.7 | 100 | 100 | 76 | 58 |
| Hornet Creek | NR | 6880 | 1 | A | 102 | | 90 | 60 | 99 | 14 | 20 | 100 | 100 | 100 | 100 |
| Hot Springs Creek | NR | 4280 | 1 | A | 97 | 4.26 | D | D | 99D | 52 | 4.7 | 100 | 100 | 100 | 100 |
| Hot Springs Creek | SR | 4050 | 2 | B | 89 | 3.26 | 10 | 10 | 99 | 81 | 5.6 | 100 | 100 | 100 | 100 |
| Hughes Creek | NR | 4070 | 3 | B | 115 | 5.38 | 10 | 10 | 99 | 13 | 9.7 | 100 | 100 | 100 | 100 |
| Hughes Creek West Fork | NR | 4600 | 2 | A | 89 | 4.20 | 10 | 30 | 99 | 21 | 15 | 100 | 92 | 100 | 100 |
| Hull Creek | NR | 5340 | 1 | A | 99 | 4.67 | | | | 70 | 10 | 100 | 100 | 100 | 100 |
| Hull Creek West Fork | NR | 4800 | 1 | | | | | | | | | | | | |
| Hull Creek (Below S. Fk) | NR | 4160 | 2 | A | 111 | 3.45 | | | | 63 | 20 | 100 | 100 | 100 | 100 |
| Hull Creek (Lake-S. Fk) | NR | 4550 | 2 | | | | | | | | | | | | |
| Hyde Creek | SR | 4500 | 2 | B | 68 | 3.24 | 10 | 10 | 99 | 93 | 41 | 100 | 100 | 92 | 95 |
| Hyde Creek | SR | 4360 | 2 | A | 82 | | 10 | 10 | 99 | 40 | 13 | 100 | 96 | 93 | 84 |
| Indian Creek | NR | 4100 | 3 | B | 109 | 4.81 | A | A | 99A | 26 | 16 | 100 | 100 | 100 | 100 |
| Iron Creek | NR | 5800 | 1 | A | 127 | | 480 | 450 | 99 | 14 | 2 | 100 | 100 | 98 | 98 |
| Iron Creek | SR | 4440 | 2 | C | 110 | 4.41 | 10 | 10 | 99 | 25 | 9.8 | 92 | 95 | 93 | 94 |
| Iron Creek North Fork | NR | 6580 | 1 | B | 114 | | 10 | 10 | 99 | 21 | 5.3 | 100 | 100 | 92 | 100 |
| Iron Creek North Fork | NR | 6200 | 2 | A | 122 | | 10 | 10 | 99 | 7 | 2.3 | 100 | 100 | 100 | 100 |
| Iron Creek South Fork | NR | 6000 | 1 | A | 107 | | 10 | 10 | 99 | 39 | 3.5 | 100 | 100 | 100 | 98 |
| Iron Creek South Fork | NR | 5720 | 2 | A | 112 | | 10 | 20 | 99A | 13 | 12 | 100 | 100 | 100 | 100 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank Left | % Stable Bank Right | % Covered Bank Left | % Covered Bank Right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iron Creek West Fork | NR | 5800 | 2 | A | 123 | | 10 | 10 | 99 | 13 | 16 | 100 | 100 | 98 | 100 |
| Jackass Creek | SR | 6070 | 1 | Aa+ | 113 | | 10 | 10 | 99 | 30 | 5.4 | 100 | 100 | 100 | 100 |
| Jefferson Creek | NR | 6640 | 1 | A | 87 | | 10 | 10 | 99 | 48 | 1 | 100 | 100 | 100 | 100 |
| Kriley Creek | NR | 4072 | 2 | | | | | | | | | | | | |
| Lake Creek | NR | 5320 | 2 | B | 114 | 4.29 | 10 | 10 | 99 | 48 | 11 | 100 | 96 | 95 | 96 |
| Lick Creek | NR | 4600 | 1 | B | 86 | 4.27 | D | D | 99D | 41 | 24 | 100 | 100 | 100 | 100 |
| Little Deer Creek | NR | 4344 | 1 | Aa+ | 119 | | 10 | 30 | 99 | 2 | 13 | 100 | 100 | 100 | 100 |
| Little Juneano Creek | NR | 4520 | 1 | Aa+ | 93 | | 10 | 10 | 99 | 78 | 7.3 | 100 | 100 | 100 | 100 |
| Long Tom Creek | NR | 3120 | 1 | A | 95 | 3.79 | | | | 64 | 11 | 100 | 100 | 80 | 80 |
| Mackinaw Creek | NR | 6120 | 1 | Aa+ | 111 | | 10 | 20 | 99D | 9 | 5.8 | 100 | 100 | 100 | 100 |
| McKim Creek | SR | 5280 | 3 | A | 120 | | 20 | 20 | 99 | 36 | 16 | 100 | 100 | 100 | 100 |
| Mink Creek | NR | 7000 | 1 | Aa+ | 115 | | 10 | 10 | 99 | 14 | 15 | 100 | 100 | 100 | 100 |
| Moccasin Creek | NR | 6960 | 1 | A | 98 | 4.19 | | | | 42 | 30 | 100 | 100 | 100 | 100 |
| Moose Creek | NR | 6560 | 3 | A | 108 | | 100 | 150 | 99 | 46 | 16 | 100 | 100 | 100 | 93 |
| Moose Creek | NR | 6540 | 1 | B | 135 | 4.80 | 10 | 10 | 99A | 29 | 6.2 | 100 | 100 | 100 | 100 |
| Moose Creek | NR | 6120 | 2 | B | 123 | 5.00 | 10 | 10 | 99 | 30 | 10 | 100 | 100 | 100 | 100 |
| Moyer Creek | NR | 6120 | 3 | B | 107 | 5.98 | 10 | 10 | 99 | 21 | 17 | 60 | 60 | 70 | 70 |
| Moyer Creek South Fork | NR | 7160 | 2 | A | 121 | 4.78 | 10 | 10 | 99 | 28 | 13 | 90 | 90 | 100 | 100 |
| Musgrove Creek | NR | 5560 | 2 | A | 105 | 5.72 | 10 | 10 | 99 | 31 | 17 | 89 | 98 | 100 | 100 |
| Napias Creek | NR | 6726 | 2 | B | 84 | 3.95 | | | | 41 | 22 | 71 | 89 | 68 | 50 |
| Napias Creek | NR | 6680 | 2 | B | 98 | 2.77 | | | | 15 | 19 | 90 | 90 | 95 | 95 |
| Napias Creek | NR | 6680 | 2 | B | 110 | 3.99 | | | | 36 | 14 | 100 | 100 | 89 | 70 |
| Napias Creek | NR | 6340 | 2 | B | 97 | 4.31 | | | | 25 | 22 | 100 | 100 | 84 | 64 |
| Napias Creek | NR | 4880 | 3 | B | 91 | 4.63 | | | | 12 | 30 | 100 | 100 | 35 | 25 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank Left | % Stable Bank Right | % Covered Bank Left | % Covered Bank Right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Opal Creek | NR | 6800 | 1 | A | 101 | 4.62 | 10 | 10 | 99 | 43 | 10 | 100 | 100 | 100 | 100 |
| Otter Creek | NR | 7000 | 2 | A | 119 | 4.54 | 1 | 10 | 98 | 22 | 13 | 100 | 100 | 100 | 100 |
| Owl Creek | NR | 3166 | 3 | A | 103 | | 20 | 20 | 99 | 16 | 17 | 100 | 100 | 100 | 100 |
| Panther Creek | NR | 6600 | 3 | B | 89 | 5.09 | 20 | 50 | 98 | 26 | 15 | 100 | 100 | 75 | 95 |
| Panther Creek | NR | 5500 | 3 | C | 118 | | 10 | 20 | 99 | 11 | 10 | 100 | 100 | 100 | 100 |
| Panther Creek | NR | 5150 | 3 | F | 95 | | 6 | 1 | 99S | 10 | 49 | 100 | 100 | 100 | 100 |
| Panther Creek | NR | 5120 | 4 | A | 82 | 1.61 | 10 | 10 | 97 | 6 | 24 | 96 | 100 | 50 | 35 |
| Panther Creek | NR | 4280 | 3 | F | 90 | | 20 | 20 | 99S | 10 | 39 | 100 | 100 | 100 | 100 |
| Panther Creek | NR | 3440 | 4 | C | 96 | | 20 | 10 | 99S | 14 | 55 | 95 | 95 | 90 | 90 |
| Panther Creek | NR | 3200 | 4 | B | 71 | 1.29 | 10 | 10 | 99S | 7 | 32 | 100 | 20 | 40 | 90 |
| Perreau Creek | SR | 4460 | 2 | B | 99 | 5.04 | | | | 46 | 17 | 100 | 100 | 89 | 93 |
| Phelon Creek | NR | 6037 | 2 | C | 86 | | 10 | 10 | 99 | 20 | 4.5 | 84 | 90 | 72 | 89 |
| Pine Creek | NR | 3980 | 2 | A | 103 | 4.24 | | | | 38 | 13 | 100 | 100 | 92 | 74 |
| Pony Creek | NR | 6280 | 1 | B | 103 | | 10 | 10 | 99D | 27 | 2 | 100 | 100 | 98 | 98 |
| Porphyry Creek | NR | 6380 | 1 | B | 105 | 4.93 | 10 | 10 | 99 | 23 | 11 | 100 | 100 | 100 | 100 |
| Porphyry Creek | NR | 6080 | 2 | B | 120 | 5.34 | 10 | 10 | 99 | 36 | 8 | 100 | 100 | 100 | 100 |
| Quartz Creek | NR | 5920 | 1 | A | 120 | 4.97 | 10 | 10 | 99 | 34 | 9.6 | 100 | 100 | 100 | 100 |
| Rabbit Creek | NR | 6320 | 1 | A | 105 | | 10 | 10 | 99 | 11 | 24 | 94 | 85 | 90 | 85 |
| Rapps Creek | NR | 6600 | 1 | B | 99 | | 10 | 10 | 99 | 14 | 16 | 100 | 100 | 100 | 100 |
| Rattlesnake Creek | SR | 4300 | 2 | B | 114 | 4.67 | 10 | 10 | 99 | 35 | 3.8 | 100 | 96 | 80 | 90 |
| Sage Creek | NR | 4900 | 3 | B | 93 | 3.90 | | | | 60 | 38 | 100 | 100 | 96 | 100 |
| Sage Creek East Fork | NR | 5180 | 2 | A | 96 | 3.59 | | | | 62 | 13 | 100 | 100 | 100 | 100 |
| Sage Creek West Fork | NR | 5360 | 2 | Aa+ | 105 | 4.11 | | | | 68 | 8.7 | 100 | 100 | 100 | 100 |
| Salmon River North Fork | NR | 5880 | 2 | B | 111 | 5.39 | 10 | 10 | 99 | 20 | 20 | 100 | 100 | 100 | 100 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank Left | % Stable Bank Right | % Covered Bank Left | % Covered Bank Right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salmon River North Fork | NR | 4980 | 3 | C | 107 | 4.73 | 10 | 30 | 99S | 16 | 19 | 100 | 100 | 100 | 100 |
| Salmon River W-Fork N-Fork | NR | 5680 | 2 | A | 121 | 5.24 | 10 | 10 | 99 | 33 | 15 | 100 | 100 | 100 | 100 |
| Salt Creek | NR | 6200 | 1 | A | 113 | 4.54 | 10 | 10 | 99 | 21 | 9.2 | 100 | 100 | 65 | 65 |
| Salzer Creek | NR | 5180 | 2 | A | 112 | 5.16 | 10 | 20 | 99A | 20 | 14 | 100 | 100 | 100 | 100 |
| Second Creek | SR | 4280 | 1 | Aa+ | 120 | | 10 | 10 | 99 | 32 | 6.7 | 94 | 99 | 83 | 80 |
| Sevenmile Creek | SR | 4080 | 1 | Aa+ | 105 | 3.85 | 1158 | ### | 99D | 29 | 33 | 67 | 70 | 69 | 67 |
| Sharkey Creek | NR | 6680 | 1 | A | 89 | | 10 | 10 | 99 | 28 | 22 | 100 | 100 | 100 | 100 |
| Smithie Creek | NR | 4760 | 1 | A | 114 | 4.71 | 10 | 20 | 99 | 27 | 10 | 100 | 100 | 100 | 100 |
| Spring Creek | NR | 5080 | 1 | A | 99 | | 10 | 20 | 99A | 33 | 8.2 | 100 | 100 | 100 | 100 |
| Spring Creek | NR | 4500 | 2 | A | 113 | 4.72 | 10 | 10 | 99 | 69 | 13 | 100 | 100 | 100 | 100 |
| Spring Creek | NR | 3800 | 3 | B | 107 | 4.62 | 10 | 10 | 99 | 27 | 18 | 100 | 100 | 100 | 100 |
| Spring Creek East Fork | NR | 4180 | 2 | A | 106 | 4.87 | 10 | 30 | 99 | 45 | 14 | 100 | 96 | 100 | 96 |
| Spring Creek East Fork | NR | 4120 | 2 | B | 98 | 4.70 | 10 | 10 | 99 | 25 | 14 | 80 | 65 | 100 | 100 |
| Squaw Creek | NR | 4080 | 2 | A | 104 | 3.78 | | | | 47 | 15 | 100 | 94 | 98 | 88 |
| State Creek | NR | 5400 | 1 | A | 117 | 4.58 | 10 | 10 | 99 | 36 | 12 | 100 | 100 | 100 | 100 |
| Three Mile Creek | NR | 4940 | 1 | C | 98 | 5.04 | 10 | 140 | 99 | 18 | 14 | 40 | 45 | 100 | 100 |
| Tin Cup Creek | NR | 5380 | 1 | A | 103 | 5.04 | 10 | 10 | 99 | 68 | 9.6 | 49 | 63 | 33 | 38 |
| Tower Creek | SR | 3810 | 3 | C | 98 | 5.49 | | | | 74 | 24 | 100 | 100 | 81 | 79 |
| Trail Creek | NR | 3660 | 2 | Aa+ | 115 | 3.66 | 10 | 10 | 99 | 37 | 9.7 | 70 | 70 | 100 | 100 |
| Twelvemile Creek | NR | 4360 | 2 | B | 106 | 4.52 | 10 | 10 | 99 | 31 | 18 | 100 | 98 | 94 | 87 |
| Twin Creek | NR | 5360 | 2 | B | 119 | 5.13 | 10 | 10 | 99 | 9 | 18 | 100 | 100 | 100 | 100 |
| Waddington Creek | SR | 4320 | 2 | A | 84 | | 10 | 10 | 99D | 47 | 7.5 | 100 | 100 | 95 | 96 |

| Stream Name | Eco-Reg | Elev Feet | Stream Order | Rosgen Type | Habitat Index | Macro Index | Fecal Coliform | e-coli | Year Fished | % Surface Fines | W/D Ratio | % Stable Bank Left | % Stable Bank Right | % Covered Bank Left | % Covered Bank Right |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wagonhammer Creek | NR | 3680 | 2 | A | 99 | | 10 | 10 | 99 | 32 | 10 | 100 | 100 | 100 | 100 |
| Wallace Creek | SR | 6160 | 1 | A | 91 | 4.84 | | | | 58 | 13 | 100 | 100 | 100 | 100 |
| Weasel Creek | NR | 6780 | 1 | A | 114 | 3.70 | 10 | 10 | 99 | 55 | 8.3 | 100 | 100 | 100 | 100 |
| Webfoot Ceek | NR | 6910 | 1 | D | 76 | | 60 | 50 | 99D | 84 | 5.6 | 100 | 100 | 100 | 100 |
| Williams Creek | SR | 4840 | 3 | A | 108 | 5.00 | | | | 46 | 9.6 | 100 | 100 | 80 | 100 |
| Williams Creek North Fork | NR | 6040 | 1 | A | 95 | 4.29 | | | | 57 | 36 | 100 | 100 | 100 | 100 |
| Williams Creek South Fork | NR | 5710 | 2 | B | 98 | 4.01 | | | | 43 | 20 | 100 | 100 | 85 | 79 |
| Woodtick Creek | NR | 5354 | 2 | A | 126 | | 10 | 30 | 99 | 16 | 18 | 100 | 100 | 100 | 100 |

# APPENDIX B
# USGS Dissolved Solids Data

Dissolved Solids Sum of Constituents
Both Sites

| mg/L | tons/day | tons/ac-ft |
|---|---|---|
| 112 | 490 | 0.14 |
| 79 | 1350 | 0.11 |
| 168 | 620 | 0.23 |
| 76 | 2010 | 0.1 |
| 93 | 1160 | 0.13 |
| 155 | | 0.21 |
| 86 | 1160 | 0.12 |
| 73 | 2780 | 0.1 |
| 164 | 607 | 0.22 |
| 105 | 414 | 0.14 |
| 184 | 468 | 0.25 |
| 94 | 1070 | 0.13 |
| 153 | 711 | 0.21 |
| 171 | 614 | 0.23 |
| 148 | 346 | 0.2 |
| 47 | 935 | 0.06 |
| 153 | 649 | 0.21 |
| 214 | 361 | 0.29 |
| 83 | 1190 | 0.11 |
| 142 | 659 | 0.19 |
| 88 | 803 | 0.12 |
| 183 | 351 | 0.25 |
| 174 | 578 | 0.24 |
| 80 | 940 | 0.11 |
| 89 | 769 | 0.12 |
| 154 | 603 | 0.21 |
| 136 | 430 | 0.18 |
| 126 | 466 | 0.17 |
| 159 | 607 | 0.23 |
| 141 | 407 | 0.2 |
| 98 | 515 | 0.14 |
| 201 | 412 | 0.27 |
| 168 | 359 | 0.22 |
| 134 | 417 | 0.19 |
| 66 | 1790 | 0.1 |
| 164 | 485 | 0.23 |
| 143 | 529 | 0.19 |
| 79 | 3220 | 0.11 |
| 103 | 1560 | 0.14 |
| 182 | 1110 | 0.25 |
| 88 | 1970 | 0.12 |
| 75 | 3620 | 0.1 |
| 184 | 1010 | 0.25 |
| 117 | 597 | 0.16 |
| 208 | 792 | 0.28 |
| 107 | 1550 | 0.15 |
| 191 | 1090 | 0.26 |
| 171 | 1390 | 0.23 |
| 188 | 964 | 0.26 |
| 166 | 861 | 0.23 |
| 84 | 3220 | 0.11 |
| 172 | 1130 | 0.23 |
| 217 | 515 | 0.3 |
| 86 | 1870 | 0.12 |
| 173 | 1180 | 0.24 |
| 83 | 1310 | 0.11 |
| 201 | 988 | 0.27 |
| 42 | 688 | 0.06 |
| 102 | 1200 | 0.14 |
| 182 | 1060 | 0.25 |
| 129 | 630 | 0.18 |

| | mg/L | tons/day | tons/ac-ft |
|---|---|---|---|
| Mean | 133.344 | 1026.333 | 0.181967 |
| Maximum | 217 | 3620 | 0.3 |
| Minimum | 42 | 346 | 0.06 |
| variance | 2144.36 | 531582.2 | 0.003976 |
| stnd.dev. | 46.3073 | 729.0968 | 0.063056 |

Salmon River at Salmon 13302500

| | mg/L | tons/day | tons/ac-ft |
|---|---|---|---|
| | 112 | 490 | 0.14 |
| | 79 | 1350 | 0.11 |
| | 168 | 620 | 0.23 |
| | 76 | 2010 | 0.1 |
| | 93 | 1160 | 0.13 |
| | 155 | | 0.21 |
| | 86 | 1160 | 0.12 |
| | 73 | 2780 | 0.1 |
| | 164 | 607 | 0.22 |
| | 105 | 414 | 0.14 |
| | 184 | 468 | 0.25 |
| | 94 | 1070 | 0.13 |
| | 153 | 711 | 0.21 |
| | 171 | 614 | 0.23 |
| | 148 | 346 | 0.2 |
| | 47 | 935 | 0.06 |
| | 153 | 649 | 0.21 |
| | 214 | 361 | 0.29 |
| | 83 | 1190 | 0.11 |
| | 142 | 659 | 0.19 |
| | 88 | 803 | 0.12 |
| | 183 | 351 | 0.25 |
| | 174 | 578 | 0.24 |
| | 80 | 940 | 0.11 |
| | 89 | 769 | 0.12 |
| | 154 | 603 | 0.21 |
| | 136 | 430 | 0.18 |
| | 126 | 466 | 0.17 |
| | 159 | 607 | 0.23 |
| | 141 | 407 | 0.2 |
| | 98 | 515 | 0.14 |
| | 201 | 412 | 0.27 |
| | 168 | 359 | 0.22 |
| | 134 | 417 | 0.19 |
| | 66 | 1790 | 0.1 |
| | 164 | 485 | 0.23 |
| | 143 | 529 | 0.19 |
| Mean | 129.8378378 | 779.305556 | 0.177027 |
| Maximum | 214 | 2780 | 0.29 |
| Minimum | 47 | 346 | 0.06 |
| variance | 1806.750751 | 273118.161 | 0.0033381 |
| stnd.dev. | 42.50589078 | 522.607081 | 0.0577766 |

Salmon River near Shoup 13307000

| | mg/L | tons/day | tons/ac-ft |
|---|---|---|---|
| | 79 | 3220 | 0.11 |
| | 103 | 1560 | 0.14 |
| | 182 | 1110 | 0.25 |
| | 88 | 1970 | 0.12 |
| | 75 | 3620 | 0.1 |
| | 184 | 1010 | 0.25 |
| | 117 | 597 | 0.16 |
| | 208 | 792 | 0.28 |
| | 107 | 1550 | 0.15 |
| | 191 | 1090 | 0.26 |
| | 171 | 1390 | 0.23 |
| | 188 | 964 | 0.26 |
| | 166 | 861 | 0.23 |
| | 84 | 3220 | 0.11 |
| | 172 | 1130 | 0.23 |
| | 217 | 515 | 0.3 |
| | 86 | 1870 | 0.12 |
| | 173 | 1180 | 0.24 |
| | 83 | 1310 | 0.11 |
| | 201 | 988 | 0.27 |
| | 42 | 688 | 0.06 |
| | 102 | 1200 | 0.14 |
| | 182 | 1060 | 0.25 |
| | 129 | 630 | 0.18 |
| Mean | 138.75 | 1396.875 | 0.189583 |
| Maximum | 217 | 3620 | 0.3 |
| Minimum | 42 | 515 | 0.06 |
| variance | 2715.7609 | 709224.723 | 0.005048 |
| stnd.dev. | 52.112963 | 842.154809 | 0.071047 |

# APPENDIX C
# Williams Lake Assessments (Brian Hoelscher and KCM)

# BENEFICIAL USE RECONNAISSANCE PROJECT SYNOPSIS FOR WILLIAMS LAKE

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## Introduction

Williams Lake, located in Lemhi County, is listed as a Clean Water Act §303(d) water-quality limited water. A Clean Water Act §314 Phase I study was completed in 1994 (Barnes et al. 1994). The lake was sampled using the Beneficial Use Reconnaissance Project-Lake and Reservoir protocol (Beneficial Use Reconnaissance Project Lake and Reservoir Committee 1998) on July 23, 1998.

## Findings and Discussion

Williams Lake has a surface area of 174 acres and a 179 feet maximum water depth. The lake thermally stratifies and dissolved oxygen is rapidly depleted in the hypolimnion. The lake is anoxic (<1 ppm) below about 40 feet and anoxic waters comprise 55% of the lake volume. Only about one-quarter of the lake's volume is considered habitable to cold-water fishes. This stratum is determined by the State's instantaneous temperature and dissolved oxygen surface water standards (Idaho Department of Health and Welfare 1999). Williams Lake deep water samples smelled strongly of sulfur. Hydrogen sulfide gas can be produced under anoxic conditions (Goldman and Horne 1983). Either low dissolved oxygen concentrations or hydrogen sulfide gas can cause fish kills when the lake fully mixes (Skille 2000). Hydrogen sulfide gas is quickly dissipated under aerobic conditions (Goldman and Horne 1983). Water clarity is sufficient to see about 15 feet into the water. Roads, recreation, and residential development affect about one-half of the shoreline resulting is sparse riparian vegetation. Sparse to moderate macrophyte growth covered about 45% of the littoral shoreline and moderate to thick periphytic algal growth was observed on littoral bottom substrate.

Euphotic zone (2.5X secchi depth) total phosphorus concentration was less than detection (0.05 mg/L) and bottom total phosphorus concentration was 0.22 mg/L. Less than detection values are likely more a challenge with laboratory analytical methods than with low concentrations.

Phytoplankton community dynamics are associated with trophic status, that is, phytoplankton respond to nutrient enrichment. Dillion and Rigler (1974), Carlson (1977), Oglesby (1997), and Lee and Jones (1984) found phosphorus to be correlated to the concentration of chlorophyll *a*. Chlorophyll *a* concentration in Williams Lake was 0.0084 mg/L. This value is on the boundary between mesotrophic and eutrophic waters based on a scaling proposed by Carlson (1977). Phytoplankton density was relatively high at 35,700 cells/ml. The literature indicates densities as high as $10^4$ cells/ml are rare (Goldman and Horne 1983), however, four southern Idaho reservoirs exceeded this value; one by three-fold. The phytoplankton community was represented by seven taxa of which "blue-green" algae comprised nearly 100% of the community. Certain cyanophyte species are noted as being distinctly eutrophic and whose mid-summer blooms are known to cause recreation use impairment. These species are: *Aphanizomenon flos-aquae*, *Anabaena spirodes*, *Anabaena circinalis*, *Microcystis aeruginosa*, and *Oscillatoria* sp. (Goldman and Horne 1983, Sweet 1986, Sweet 1987, Rothrock 1995, Bacon 1999, Good 1999). These species accounted for 64% of the phytoplankton community by density in Williams Lake. Other researchers have reported including all euglenoids (Wetzel 1983, Amand 1995, U.S. EPA 1998, Good 1999) and two diatom species: *Fragilaria crotonensis* and *Melosira granulata* (Wetzel 1983, Sweet 1987, Good 1999) as being indicators of eutrophic conditions. These species did not occur in Williams Lake.

Two chironomidae taxa, *Endochironomus subtendens* and *Procladius* sp., and one oligochaeta taxon, *Tubifex tubifex*, were collected. No species were represented by more than a few individuals. Macroinvertebrates are collected in the profundal zone (2.5X secchi depth) as specified in the Beneficial Use Reconnaissance Project lake and reservoir workplan (1998). Dissolved oxygen concentrations were nearly anoxic at this depth and may explain the low taxa richness and density.

The use of zooplankton as a biological indicator of water quality has not been extensively developed. Use as a fisheries management tool has had more application. Mills and Schiavore (1982) reported a mean crustacean zooplankton length greater than one millimeter indicates a planktivorous fish community in a predator-prey "balance" successfully controlling planktivore density. Crustacean zooplankton length in Williams Lake was 0.63 mm. Yule (1998) reported rainbow trout grow poorly on small zooplankton. They tend to be skinny with little mesenteric fat and anglers seldom catch fish greater than 14 inches in length.

## Conclusion

Hoelscher et al. (in press) are developing an Idaho lake and reservoir ecological assessment framework. This framework proposes using pH, percent cold water habitat, Carlson's Trophic State Index, phytoplankton taxa richness, aquatic macroinvertebrate taxa richness, and percent noninsect aquatic macroinvertebrates as an index to assess whether the cold water biota beneficial use is being supported. Based on these six measures, the cold water biota beneficial use in Williams Lake would likely be assessed as not fully supported. It must be cautioned these are preliminary conclusions. This finding may be substantiated with zooplankton data. Mean crustacean zooplankton size may indicate a planktivorous fish community not in "balance" with it's prey. Only rainbow trout and bull trout have been reported in Williams Lake and rainbow trout comprised greater than 90% of the fish community (Idaho Department of Fish and Game 1993). Rainbow trout are invertivores (Zaroban et al. 1999) and could likely act as the planktivore in this community. Idaho Department of Fish and Game (1998) reported a fish kill in November 1998. It was hypothesized low dissolved oxygen concentrations in the hypoliminion was the cause when the lake overturned in the fall. The presence of hydrogen sulfide gas indicates it may also be responsible.

The trophic status of Williams Lake was described as eutrophic (Barnes et al. 1994). Recent Beneficial Use Reconnaissance Project data would corroborate these findings. There was severe dissolved oxygen depletion in the hypolimnion and this anoxic condition would likely facilitate internal total phosphorus loading from the lake sediments. Planktonic algae was relatively high and the observers subjectively rated the periphytic algal growth as moderate to thick. Their recommendation of hypolimnetic aeration could possibly reduce internal total phosphorus loading and definitely increase the percent of liveable cold water habitat.

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# APPENDIX D
# Salmon-Challis National Forest Road Density Data

Middle Salmon Panther 11/27/98

17060203

| Huc5name | Huc5 | Huc6name | Huc6 | Data | acres | DA mi² | Road Density mi/mi² | R.D. Ratings |
|---|---|---|---|---|---|---|---|---|
| Colson-Owl | 01 | Long Tom | 01 | 0101 | 11852.01 | 18.5 | 0.35 | LOW |
| Colson-Owl | 01 | Colson | 02 | 0102 | 6847.46 | 10.7 | 2.53 | HIGH |
| Colson-Owl | 01 | Cove | 03 | 0103 | 12143.38 | 19.0 | 0.98 | MOD |
| Colson-Owl | 01 | Owl | 04 | 0104 | 26332.25 | 41.1 | 0.97 | MOD |
| Colson-Owl | 01 | East Fork Owl | 05 | 0105 | 8087.68 | 12.6 | 1.25 | MOD |
| Shoup | 02 | Sheepeater | 01 | 0201 | 12551.84 | 19.6 | 0.71 | MOD |
| Shoup | 02 | Dutchler | 02 | 0202 | 12557.31 | 19.6 | 1.17 | MOD |
| Shoup | 02 | Boulder | 03 | 0203 | 9013.33 | 14.1 | 2.41 | HIGH |
| Shoup | 02 | Spring | 04 | 0204 | 12114.59 | 18.9 | 1.75 | HIGH |
| Shoup | 02 | Pine | 05 | 0205 | 18958.39 | 29.6 | 1.13 | MOD |
| Indianola | 03 | Squaw | 01 | 0301 | 10965.90 | 17.1 | 1.10 | MOD |
| Indianola | 03 | Lower Indian | 02 | 0302 | 11188.26 | 17.5 | 3.05 | HIGH |
| Indianola | 03 | McConn | 03 | 0303 | 9763.13 | 15.3 | 0.20 | LOW |
| Indianola | 03 | Upper Indian | 04 | 0304 | 13748.30 | 21.5 | 1.01 | MOD |
| Deadwater | 04 | Donnelly | 01 | 0401 | 16285.12 | 25.4 | 0.97 | MOD |
| Deadwater | 04 | Sage | 02 | 0402 | 5185.83 | 8.1 | 1.99 | HIGH |
| Deadwater | 04 | Dump | 03 | 0403 | 7593.75 | 11.9 | 1.86 | HIGH |
| Deadwater | 04 | Moose | 04 | 0404 | 25386.70 | 39.7 | 1.76 | HIGH |
| Deadwater | 04 | East Boulder | 05 | 0405 | 8562.15 | 13.4 | 0.96 | MOD |
| North Fork | 05 | Lower North Fork | 01 | 0501 | 13844.59 | 21.6 | 1.37 | MOD |
| North Fork | 05 | Hull | 02 | 0502 | 8419.13 | 13.2 | 4.40 | EXTREME |
| North Fork | 05 | Hughes | 03 | 0503 | 20819.03 | 32.5 | 2.09 | HIGH |
| North Fork | 05 | Ditch | 04 | 0504 | 5289.46 | 8.3 | 2.20 | HIGH |
| North Fork | 05 | Lick | 05 | 0505 | 7029.63 | 11.0 | 3.57 | HIGH |
| North Fork | 05 | North Gibbonsville | 06 | 0506 | 10080.12 | 15.8 | 2.57 | HIGH |
| North Fork | 05 | Twin | 07 | 0507 | 7681.12 | 12.0 | 0.45 | LOW |
| North Fork | 05 | North Fork Headwaters | 08 | 0508 | 16616.70 | 26.0 | 1.28 | MOD |
| North Fork | 05 | Dahlonega | 09 | 0509 | 17264.68 | 27.0 | 0.96 | MOD |
| North Fork | 05 | Anderson | 10 | 0510 | 3741.30 | 5.8 | 0.51 | LOW |
| North Fork | 05 | Sheep | 11 | 0511 | 24523.69 | 38.3 | 0.28 | LOW |
| Red Rock | 06 | Kriley | 01 | 0601 | 19556.65 | 30.6 | 1.16 | MOD |
| Red Rock | 06 | Wagonhammer | 02 | 0602 | 5983.61 | 9.3 | 0.83 | MOD |
| Red Rock | 06 | 4th of July | 03 | 0603 | 14929.60 | 23.3 | 0.63 | LOW |
| Red Rock | 06 | Tower | 04 | 0604 | 13718.89 | 21.4 | 0.42 | LOW |
| Red Rock | 06 | Badger | 05 | 0605 | 19830.82 | 31.0 | 1.80 | HIGH |
| Red Rock | 06 | Lower Carmen | 06 | 0606 | 12252.57 | 19.1 | 1.63 | MOD |
| Red Rock | 06 | Upper Carmen | 07 | 0607 | 10994.52 | 17.2 | 0.42 | LOW |
| Red Rock | 06 | Freeman | 08 | 0608 | 12111.90 | 18.9 | 1.00 | MOD |
| Red Rock | 06 | Wallace | 09 | 0609 | 4886.11 | 7.6 | 2.59 | HIGH |
| Salmon | 07 | Blackrock | 01 | 0701 | 20507.89 | 32.0 | 2.31 | HIGH |
| Salmon | 07 | Salmon City | 02 | 0702 | 27604.80 | 43.1 | 2.70 | HIGH |
| Salmon | 07 | Williams | 03 | 0703 | 18055.50 | 28.2 | 1.70 | MOD. |
| Salmon | 07 | Perreau | 04 | 0704 | 9263.60 | 14.5 | 1.67 | MOD |
| Salmon | 07 | Jesse | 05 | 0705 | 13020.87 | 20.3 | 0.97 | MOD |
| Twelve/Lake | 08 | Henry | 01 | 0801 | 14698.35 | 23.0 | 1.43 | MOD |
| Twelve/Lake | 08 | Twelvemile | 02 | 0802 | 14248.61 | 22.3 | 1.75 | HIGH |
| Twelve/Lake | 08 | Elk Bend | 03 | 0803 | 22597.21 | 35.3 | 1.29 | MOD |
| Twelve/Lake | 08 | Warm Springs | 04 | 0804 | 13325.55 | 20.8 | 0.42 | LOW |
| Twelve/Lake | 08 | Rattlesnake | 05 | 0805 | 6237.60 | 9.7 | 1.42 | MOD |
| Twelve/Lake | 08 | Lake | 06 | 0806 | 12912.80 | 20.2 | 1.95 | HIGH |
| Iron Creek | 09 | Cabin | 01 | 0901 | 17452.97 | 27.3 | 1.54 | MOD |
| Iron Creek | 09 | Poison | 02 | 0902 | 11624.76 | 18.2 | 0.49 | LOW |
| Iron Creek | 09 | McKim | 03 | 0903 | 10120.79 | 15.8 | 0.41 | LOW |
| Iron Creek | 09 | Lower Iron | 04 | 0904 | 13496.12 | 21.1 | 1.78 | HIGH |

| Huc5name | Huc5 | Huc6name | Huc6 | Data | acres | mi 2 | ROAD Density mi/mi 2 | RATING |
|---|---|---|---|---|---|---|---|---|
| Iron Creek | 09 | Upper Iron | 05 | 0905 | 11794.26 | 18.4 | 2.16 | HIGH |
| Iron Creek | 09 | North Fork Iron | 06 | 0906 | 11838.35 | 18.5 | 2.34 | HIGH |
| Hat Creek | 10 | Allison | 01 | 1001 | 21989.76 | 34.4 | 1.10 | MOD |
| Hat Creek | 10 | Cow | 02 | 1002 | 17351.51 | 27.1 | 0.20 | LOW |
| Hat Creek | 10 | Lower Hat | 03 | 1003 | 8461.10 | 13.2 | 0.63 | LOW |
| Hat Creek | 10 | Little Hat | 04 | 1004 | 19327.39 | 30.2 | 0.86 | MOD |
| Hat Creek | 10 | Big Hat | 05 | 1005 | 9505.17 | 14.9 | 2.13 | HIGH |
| Hat Creek | 10 | Upper Hat | 06 | 1006 | 11760.88 | 18.4 | 1.67 | MOD |
| Lower Panther Creek | 11 | Hot Springs | 01 | 1101 | 13061.71 | 20.4 | 1.04 | MOD |
| Lower Panther Creek | 11 | Beaver | 02 | 1102 | 11560.93 | 18.1 | 0.60 | LOW |
| Lower Panther Creek | 11 | Trail | 03 | 1103 | 8510.64 | 13.3 | 0.23 | LOW |
| Lower Panther Creek | 11 | Fritzer | 04 | 1104 | 11349.49 | 17.7 | 0.30 | LOW |
| Lower Panther Creek | 11 | Clear | 05 | 1105 | 32300.19 | 50.5 | .002 | LOW |
| Lower Panther Creek | 11 | Garden | 06 | 1106 | 6958.47 | 10.9 | .006 | LOW |
| Middle Panther | 12 | Jureano | 01 | 1201 | 21194.57 | 33.1 | 0.32 | LOW |
| Middle Panther | 12 | Cobalt | 02 | 1202 | 9178.74 | 14.3 | 1.46 | MOD |
| Middle Panther | 12 | Blackbird | 03 | 1203 | 7969.92 | 12.5 | 1.55 | MOD should be high |
| Middle Panther | 12 | West Fork Blackbird | 04 | 1204 | 5317.30 | 8.3 | 1.20 | MOD |
| Middle Panther | 12 | Lower Big Deer | 05 | 1205 | 9101.24 | 14.2 | 0.36 | LOW |
| Middle Panther | 12 | Upper Big Deer | 06 | 1206 | 20323.66 | 31.8 | 0.02 | LOW |
| Napias | 13 | Lower Napias | 01 | 1301 | 5978.08 | 9.3 | 1.36 | MOD. |
| Napias | 13 | Pony-Rabbit | 02 | 1302 | 7998.98 | 12.5 | 0.58 | LOW |
| Napias | 13 | Arnett | 03 | 1303 | 12099.21 | 18.9 | 1.14 | MOD |
| Napias | 13 | Leesburg | 04 | 1304 | 5948.26 | 9.3 | 1.62 | MOD |
| Napias | 13 | Upper Napias | 05 | 1305 | 8014.11 | 12.5 | 0.96 | MOD |
| Napias | 13 | Phelan | 06 | 1306 | 10179.63 | 15.9 | 1.36 | MOD. |
| Napias | 13 | Moccasin | 07 | 1307 | 6169.99 | 9.6 | 2.1 | HIGH |
| Deep-Moyer | 14 | Deep | 01 | 1401 | 14812.60 | 23.1 | 1.95 | HIGH |
| Deep-Moyer | 14 | Little Deep | 02 | 1402 | 8925.80 | 13.9 | 2.00 | HIGH |
| Deep-Moyer | 14 | McDonald | 03 | 1403 | 5322.14 | 8.3 | 1.53 | MOD |
| Deep-Moyer | 14 | Copper | 04 | 1404 | 5250.20 | 8.2 | 1.99 | HIGH |
| Deep-Moyer | 14 | Woodtick | 05 | 1405 | 10309.96 | 16.1 | 1.39 | MOD |
| Deep-Moyer | 14 | Moyer | 06 | 1406 | 19485.06 | 30.4 | 0.58 | LOW |
| Deep-Moyer | 14 | South Moyer | 07 | 1407 | 7085.45 | 11.1 | 1.06 | MOD |
| Upper Panther | 15 | Forney | 01 | 1501 | 10382.39 | 16.2 | 1.47 | MOD |
| Upper Panther | 15 | Panther Headwaters | 02 | 1502 | 13398.99 | 20.9 | 0.68 | LOW |
| Upper Panther | 15 | Cabin = [illegible] | 03 | 1503 | 5213.20 | 8.1 | 0.52 | LOW |
| Upper Panther | 15 | Fourth of July | 04 | 1504 | 4410.77 | 6.9 | 1.63 | MOD |
| Upper Panther | 15 | Porphyry | 05 | 1505 | 7635.73 | 11.9 | 1.89 | HIGH |
| Upper Panther | 15 | Musgrove | 06 | 1506 | 15173.70 | 23.7 | 1.61 | MOD |

# APPENDIX E
# Macroinvertebrate Biotic Integrity Report

# Middle Salmon River-Panther Creek Subbasin (HUC 17060203)

## Lemhi County, Idaho

## Biotic Integrity (Macroinvertebrates)

**Idaho Division of Environmental Quality**

State Technical Services Office

2000

Printed on recycled paper

# Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho

## Biotic Integrity (Macroinvertebrates)

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*22 March 2000*

### Abstract

The macroinvertebrates of six sites (two on East Boulder Creek and four on Panther Creek) in the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, were sampled as part of the Beneficial Use Reconnaissance Project (BURP) by the Idaho Division of Environmental Quality (DEQ) during August, 1998. Portions of Panther Creek are listed on DEQ's 1998 303(d) list and East Boulder Creek is suspected to have sediment problems. Based on the macroinvertebrate data examined for this study and the resultant Macroinvertebrate Biotic Index (MBI) scores obtained, these six sites have macroinvertebrate assemblages that are not-impaired. East Boulder Creek scored higher than Panther Creek for most variables examined.

### Introduction

The macroinvertebrates of six sites (two on East Boulder Creek and four on Panther Creek) in the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, were sampled as part of the Beneficial Use Reconnaissance Project (BURP) by the Idaho Division of Environmental Quality (DEQ) during August, 1998.

Panther Creek is listed on the 1998 303(d) list for metals (unknown)(MTU) (Idaho Division of Environmental Quality 1999). East Boulder Creek was not listed on the 1998 303(d) list (Idaho Division of Environmental Quality 1999) but has been observed by DEQ and the U.S. Forest Service to have high sediment loads. The present report is an analysis of the macroinvertebrate data available from the BURP sampling efforts.

Much research on the macroinvertebrate assemblages of this area have been conducted by the Stream Ecology Center, Idaho State University (see Minshall et al. 1992 for a review). The macroinvertebrate biotic integrity was recently examined for an adjacent area, the Main Salmon River-Chamberlain subbasin (Clark 1999b).

## Materials and Methods

### Study Area

East Boulder Creek and Panther Creek in Hydrologic Unit Code (HUC) 17060203 in the Middle Salmon River-Panther Creek Subbasin, Lemhi County, Idaho (Table 1) were studied. The area lies within the Salmon National Forest. The area is located in the Northern Rockies ecoregion (Omernik and Gallant 1986).

### Methods

Macroinvertebrate sample methods follow Clark and Maret (1993) and Beneficial Use Reconnaissance Project Technical Advisory Committee (1997). Three Hess samples were taken and combined for each of three separate riffles. Macroinvertebrates were processed by EcoAnalysts, Inc. of Moscow, Idaho. Voucher specimens of the macroinvertebrates have been deposited in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell.

The macroinvertebrate metrics currently used by DEQ to calculate the Macroinvertebrate Biotic Index include: percent Ephemeroptera, Plecoptera, and Trichoptera (EPT), modified Hilsenhoff Biotic Index (HBI), percent scrapers, percent dominance, EPT index, taxa richness, and Shannon's H' diversity index. In addition to those metrics, I have also examined six additional (total abundance, percent Ephemeroptera, percent Plecoptera, percent Trichoptera, number of Ephemeroptera taxa, and number of Plecoptera taxa) that provide additional information concerning the sites studied. The metrics examined can be separated into four categories: richness, composition, tolerance, and trophic/habitat.

Richness (or community structure)

Taxa Richness reflects the health of the assemblage through a measure of the variety of taxa (total number of distinct genera or species) present. Taxa Richness can be equated to biodiversity. Taxa Richness generally increases with increasing water quality, habitat diversity, or habitat suitability. Barbour *et al.* (1992) and Karr and Chu (1999) report that Taxa Richness is a reliable indicator of human influence in the Pacific Northwest and will generally decrease with an increase in such influence. The EPT (Ephemeroptera, Plecoptera, Trichoptera) Index is a metric which summarizes the taxa richness of these three orders of insects that are generally considered to be sensitive to pollution (including temperature and fine sediment). Barbour *et al.* (1992) reports that EPT Index is a reliable indicator of human influence in the Pacific Northwest

**Table 1 Locations of macroinvertebrate collections for the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, August, 1998.**

| STREAM | SITE | SITE ID |
|---|---|---|
| East Boulder Creek | Above road | 1998SIDFB118 |
| East Boulder Creek | Above confluence | 1998SIDFB119 |
| Panther Creek | Above confluence Clear/Panther Creeks | 1998SIDFB138 |
| Panther Creek | Above Little Deer Creek | 1998SIDFB139 |
| Panther Creek | Above Deep Creek | 1998SIDFB140 |
| Panther Creek | Above confluence Musgrove/Panther Creeks | 1998SIDFB141 |

and will generally decrease with an increase in such influence. It follows then that the number of Ephemeroptera Taxa and the number of Plecoptera Taxa will likewise be good indicators of temperature and fine sediment pollution. It is sometimes helpful to look at these taxa separately even though they are considered in the two previously mentioned metrics. Karr and Chu (1999) show that these three metrics are reliable indicators of human influence across the Pacific Northwest, including Central Idaho. Another way to measure diversity is with Shannon's H' Diversity Index. This metric is based on the observation that relatively undisturbed environments support communities having great taxa richness with no individual species present in overwhelming abundance. It has been one of the most popular diversity indices used for water quality assessment.

Composition

Percent EPT increases as water quality increases, since these groups generally contain taxa that are considered more sensitive to temperature and fine sediment pollution. Karr and Chu (1999) show that these taxa decreased with increased human influence in the Pacific Northwest. They show the same relationship between intolerant taxa (which include EPT). It likewise follows, that each of the EPT groups examined separately (Percent Ephemeroptera, Percent Plecoptera, and Percent Trichoptera) will also show the same trend in relation to temperature and fine sediment pollution. It may be useful to examine these metrics separately at times. Total Abundance of macroinvertebrate organisms in a sample can also serve as an indicator of stream health. Generally greater Total Abundance will indicate a stream of decreased impact and increased water quality. There comes a point (this is dependent on the particular stream, impacts,

**Table 2 Macroinvertebrate "Cold Water Indicators" for the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, August, 1998.**

| STREAM | SITE ID | # COLD WATER TAXA | % COLD WATER TAXA |
|---|---|---|---|
| East Boulder Cr. | 1998SIDFB118 | 9 | 8.0 |
| East Boulder Cr. | 1998SIDFB119 | 7 | 10.6 |
| Panther Creek | 1998SIDFB138 | 1 | 0.3 |
| Panther Creek | 1998SIDFB139 | 2 | 6.3 |
| Panther Creek | 1998SIDFB140 | 1 | 1.2 |
| Panther Creek | 1998SIDFB141 | 1 | 0.4 |

and taxa present) where larger Total Abundance indicates a decrease in water quality. This condition is evident when pollution (which includes temperature and fine sediment) has reduced or eliminated the sensitive species and the remaining tolerant species thrive with the resulting reduced competition.

Tolerance

The Hilsenhoff Biotic Index (HBI) was originally a measure of organic pollution. It has been modified several times. Each taxon is assigned a tolerance value relating to the response to organic and toxic pollutants. These have also been shown to be useful for evaluating both point and nonpoint source affects. U.S. Environmental Protection Agency (1997) and Barbour *et al.* (1999) indicate that the HBI is useful in determining the impacts of nonpoint source pollution. Percent Dominance represents the percent contribution of the numerically dominant taxon to the total number of individuals in the community. It provides an indication of community balance at the lowest positive taxonomic level (usually genus or species). A community (assemblage) dominated by relatively few species would suggest environmental stress. Percent Dominance will increase with the impacts of human influence on streams in the Pacific Northwest (Karr and Chu 1999).

**Table 3 Macroinvertebrate data (taxa richness, total abundance, HBI (modified Hilsenhoff Biotic Index), H' (Shannon's H' Diversity Index), percent scrapers) for the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, August, 1998.**

| Water Body | Taxa Richness | Total Abundance | HBI | Percent Dominance | H' | Percent Scrapers |
|---|---|---|---|---|---|---|
| East Boulder Cr. (B118) | 51 | 475 | 3.6 | 30.0 | 1.3 | 9.0 |
| East Boulder Cr. (B119) | 44 | 498 | 3.3 | 41.8 | 1.1 | 2.4 |
| Panther Cr. (B138) | 44 | 311 | 4.4 | 20.6 | 1.2 | 0 |
| Panther Cr. (B139) | 32 | 205 | 4.1 | 49.8 | 0.9 | 2.9 |
| Panther Cr. (B140) | 48 | 510 | 5.0 | 39.6 | 1.1 | 0 |
| Panther Cr. (B141) | 44 | 544 | 3.8 | 17.3 | 1.2 | 8.5 |

Trophic/Habitat

Percent Scrapers uses the functional feeding group approach to assessment. The relative abundance of scrapers provides an indication of the riffle community food base (periphyton or primary production composition). Scrapers increase with increased abundance of diatoms and decrease as filamentous algae and aquatic mosses increase. Scrapers decrease in relative abundance following increases in fine particle sedimentation in coarse particle substrate stream beds. Percent Scrapers has been shown to be sensitive to human influence in Central Idaho (Karr and Chu 1999).

The Macroinvertebrate sample metrics were interpreted consistent with current literature. Clark (1997) provides a draft list of cold water macroinvertebrate indicators for Idaho. Hafele and Hinton (1996), Oregon Watershed Enhancement Board (1999), Relyea (1999), and Wisseman (1996) were especially helpful in determining the tolerance of the invertebrates collected to fine sediment. Tables 3 and 4 list a variety of metrics examined for this study.

**Table 4 Macroinvertebrate data (percent EPT, EPT Index, percent Ephemeroptera, percent Plecoptera, percent Trichoptera, number of Ephemeroptera, number of Plecoptera taxa) for the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, August, 1998.**

| Water Body | Percent EPT | EPT Index | Percent Ephem | Percent Plecop | Percent Trichop | Number Ephem Taxa | Number Plecop Taxa |
|---|---|---|---|---|---|---|---|
| East Boulder Cr. (B118) | 38 | 26 | 19.2 | 13.0 | 5.9 | 9 | 10 |
| East Boulder Cr. (B119) | 36 | 25 | 17.1 | 16.9 | 2.2 | 11 | 10 |
| Panther Cr. (B138) | 44 | 20 | 17.4 | 8.7 | 18.0 | 6 | 10 |
| Panther Cr. (B139) | 69 | 12 | 57.1 | 7.8 | 3.9 | 4 | 5 |
| Panther Cr. (B140) | 23 | 15 | 10.6 | 10.0 | 2.5 | 3 | 5 |
| Panther Cr. (B141) | 57 | 23 | 33.6 | 8.1 | 15.6 | 11 | 5 |

The Macroinvertebrate Biotic Index (MBI) scores were calculated using Idaho Division of Environmental Quality (1996) water body assessment guidance process. The MBI uses the seven metrics discussed in detail above (taxa richness, EPT index, percent EPT, percent scrapers, percent dominant taxa, the Hilsenhoff Biotic Index, and Shannon's H' diversity index. In summary, this process was developed by DEQ as a non-arbitrary, objective water body

**Table 5 Macroinvertebrate "Macroinvertebrate Biotic Index (MBI)" scores for the Middle Salmon River-Panther Creek Subbasin (HUC 17060203) Lemhi County, Idaho, August, 1998. MBI scores were calculated using Idaho Division of Environmental Quality (1996).**

| STREAM | SITE ID | MBI | MACROINVERTEBRATE ASSEMBLAGE DETERMINATION |
|---|---|---|---|
| East Boulder Cr. | 1998SIDFB118 | 4.6 | Not-Impaired |
| East Boulder Cr. | 1998SIDFB119 | 4.1 | Not-Impaired |
| Panther Creek | 1998SIDFB138 | 4.2 | Not-Impaired |
| Panther Creek | 1998SIDFB139 | 3.6 | Not-Impaired |
| Panther Creek | 1998SIDFB140 | 3.6 | Not-Impaired |
| Panther Creek | 1998SIDFB141 | 4.7 | Not-Impaired |

assessment tool. An MBI score of 2.5 or less renders an impaired call for aquatic life (cold water biota in most cases). An MBI score of 3.5 or greater is determined to be not impaired. If a score falls between 2.5 and 3.5 the site was considered to close to determine and given a rating of "needs verification" (Idaho Division of Environmental Quality 1999).

Cold water indicators (Table 2) are compared with a draft list prepared for Idaho (Clark 1997) and Hafele and Hinton (1996). Essig (1998) is a good reference for examination of the dilemma associated with temperature criteria in Idaho. Clark (1999a) provides information useful for determining the identification and distribution of aquatic macroinvertebrates in Idaho.

## Results and Discussion

The following is a list of the six sampled sites (two on East Boulder Creek and four on Panther Creek), and a summary of the macroinvertebrate data as they relate to those two streams and as a whole (composite). Emphasis is on macroinvertebrate tolerances and responses to metals and sediment.

The macroinvertebrates of both sites give a bit of a mixed message. They both have a relatively high taxa richness as well as other attributes and thus all have MBI scores that exceed 3.5 which places them in the higher "not-impaired" category (Table 5). On the other hand many of the taxa seem to be the more pollution tolerant types as indicated by the relatively low EPT values for most sites (Table 4). Most sites, especially on Panther Creek, have a very low percentage of cold water taxa present (Table 2). East Boulder Creek has a much lower percentage of scrapers as compared to many of the streams examined by Clark (1999b) and this may reflect some impact from sediment (Table 3). Panther Creek, likewise, has very low percentage of scrapers (Table 3). It is possible that metals or sediment could be contributing to this on Panther Creek.

**East Boulder Creek (above road)(B118)**

This site had a good number of cold water indicator taxa present (9) but they amounted to eight percent of the total taxa present (Table 2). This site had the highest taxa richness of all in this study (51)(Table 3) which was near the ecoregional high of 53 (Idaho Division of Environmental Quality 1996). The site had a high of 10 Plecoptera taxa (Table 4). The percent scrapers is the highest for this study (9)(Table 3) but still low compared to other streams in this region (Clark 1999b).

**East Boulder Creek (above confluence)(B119)**

This site had a good number of cold water indicator taxa present (7) but they amounted to 10.6% of the total taxa present (Table 2). This site had a high taxa richness value (44)(Table 3). The stream had a high of 10 Plecoptera taxa (Table 4). The percent scrapers is low for this study (9)(Table 3) and very low compared to other streams in this region (Clark 1999b).

**East Boulder Creek (composite)**

East Boulder Creek had a good number of cold water indicator taxa present (mean of 8) but they amounted to 9.3% of the total taxa present (Table 2). This stream had a high taxa richness value (mean of 47.5)(Table 3). East Boulder Creek had relatively high total abundance numbers (nearly 500)(Table 3). The stream also had a high of 10 Plecoptera taxa (Table 4). The percent scrapers is low for this study (Table 3) and very low compared to other streams in this region (Clark 1999b).

The macroinvertebrate data examined and the MBI scores calculated indicate that East Boulder Creek macroinvertebrate assemblage is not-impaired.

**Panther Creek (above confluence Clear/Panther Creeks)(B138)**

This site had a very low number of cold water indicator taxa present (one) and they amounted to less than one percent of the total taxa present (Table 2). This site had a high taxa richness value (44)(Table 3). This site had a high, for the Panther Creek sites, of 10 Plecoptera taxa (Table 4). There were no scrapers found in the samples for this site (9)(Table 3).

### Panther Creek (above Little Deer Creek)(B139)

This site had a very low number of cold water indicator taxa present (two) and they amounted to 6.3% of the total taxa present (Table 2). This site had a lower taxa richness value (32)(Table 3). This site had five Plecoptera taxa present (Table 4). The percent scrapers is low for this study (2.9)(Table 3) and very low compared to other streams in this region (Clark 1999b).

### Panther Creek (above Deep Creek)(B140)

This site had a very low number of cold water indicator taxa present (one) and they amounted to approximately one percent of the total taxa present (Table 2). This site had a high taxa richness value (48)(Table 3), the second highest for this study. This site had five Plecoptera taxa present (Table 4). There were no scrapers found in the samples for this site (Table 3).

### Panther Creek (above confluence Musgrove/Panther Creeks)(B141)

This site had a very low number of cold water indicator taxa present (one) and they amounted to less than one percent of the total taxa present (Table 2). This site had a high taxa richness value (44)(Table 3). This site had five Plecoptera taxa present (Table 4). The percent scrapers is the second highest for this study (8.5)(Table 3) but still low compared to other streams in this region (Clark 1999b).

### Panther Creek (composite)

This stream had a very low number of cold water indicator taxa present (mostly one per site) and most amounted to near one percent of the total taxa present (Table 2). This stream had a high taxa richness value (mean of 42)(Table 3). Panther Creek has fewer Plecoptera (mean of 6.25) as compared to East Boulder Creek (Table 4). The percent scrapers is low for this study (Table 3) and very low compared to other streams in this region (Clark 1999b).

The macroinvertebrate data examined and the MBI scores calculated indicate that Panther Creek macroinvertebrate assemblage is not-impaired. This site had a high taxa richness value (44)(Table 3). For most variables, Panther Creek scored lower than East Boulder Creek (Tables 2-4).

## Conclusions and Recommendations

The following conclusions and recommendations are based on the macroinvertebrate data examined.

1. East Boulder Creek and Panther Creek have low numbers of scrapers, which may indicate some sediment and/or metals impacts.

2. The macroinvertebrate assemblage for East Boulder Creek had MBI scores of 4.1 and 4.6 and as such are considered not-impaired.

3. The macroinvertebrate assemblage for Panther Creek had MBI scores ranging from 3.6 to 4.7 and as such are considered not-impaired.

4. East Boulder Creek appears to have a macroinvertebrate assemblage of slightly higher biotic integrity as compared to Panther Creek.

5. Additional sampling and analysis would be useful to determine if there are no scrapers present at the two Panther Creek sites (B138 and B140) and to attempt to determine the cause for the lack of this trophic group.

## Acknowledgments

EcoAnalysts, Inc. provided the macroinvertebrate identifications presented here. The Idaho Falls DEQ Regional Office BURP crew took the field samples. Thanks to Steve Robinson for coordinating the field work. Mark Shumar, Barry Burnell, and Michael Edmondson assisted with data summary.

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# APPENDIX F
## Salmon-Challis National Forest Depth Fines Data

**Percent Fines from Core Sampling in Streams Throughout the Subbasin (SCNF, 1999).**

| Stream | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Trend |
|---|---|---|---|---|---|---|---|---|
| Colson Creek | 19.9 | 12.2 | 21.2 | 20.3 | 13.4 | 8.6 | 15.0 | Reduction/ Not Significant |
| East Boulder Creek | 61.2 | 67.0 | - | - | 52.9 | 59.5 | 62.3 | Reduction/ Not Significant |
| Indian Creek 1 | 16.6 | 15.5 | 20.6 | 20.6 | 31.6 | 14.6 | 18.8 | Increase/ Not Significant |
| Indian Creek 2 | 7.5 | 14.2 | 17.2 | 21.5 | - | | | |
| Moose Creek | 27.3 | 22.8 | - | - | 13.2 | 15.3 | 10.1 | Reduction/ alpha= 0.1 & 0.05 |
| Owl Creek 1 | 19.5 | 19.4 | 13.0 | 17.4 | 16.1 | 17.8 | 16.6 | Reduction/ Not Significant |
| Owl Creek 2 | 38.3 | - | - | - | - | | | |
| Owl Creek 3 | 25.5 | 25.6 | - | - | - | | | |
| Pine Creek | 21.6 | 19.9 | - | 40.2 | 12.9 | 39.5 | 21.5 | Reduction/ Not Significant |
| Spring Creek 1 | 14.0 | 25.6 | 16.2 | 12.8 | 13.6 | 5.6 | 16.6 | Increase/ Not Significant |
| Squaw Creek | 26.5 | 23.0 | 30.0 | 16.3 | 19.3 | 15.1 | 14.8 | Reduction/ alpha = 0.1 & 0.05 |
| Arnett Creek (Res) | 19.2 | - | 21.7 | 17.6 | 13.1 | 12.0 | 22.2 | Increase/ Not Significant |
| Arnett Creek (Anad) | - | 22.1 | - | 21.5 | 19.9 | | | |
| Beaver Creek | 37.8 | 14.8 | - | - | - | 10.9 | - | |
| Big Deer Creek | 9.7 | 15.3 | 29.4 | - | 26.9 | - | - | |
| Clear Creek 1 | 34.3 | 31.2 | 14.3 | 24.8 | 5.5 | 8.7 | 17.2 | Reduction / alpha = 0.1 & 0.05 |
| Clear Creek 2 | 40.4 | 29.5 | - | - | - | - | - | |

**Percent Fines from Core Sampling in Streams Throughout the Subbasin (SCNF, 1999).**

| Stream | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Trend |
|---|---|---|---|---|---|---|---|---|
| Deep Creek | 14.8 | 8.2 | 10.4 | 19.7 | 8.3 | 13.9 | 12.0 | Reduction/ alpha = 0.1 Only |
| Garden Creek | 15.7 | 20.1 | - | - | - | - | - | |
| Moyer Creek 1 | 19.0 | 22.9 | 22.0 | 23.3 | 18.8 | 17.4 | 14.7 | Reduction/ Not Significant |
| Moyer Creek 2 | 17.0 | 25.7 | - | 26.7 | 15.4 | 12.7 | 23.4 | Increase/ alpha = 0.1 & 0.05 |
| Napias Cr. 1 (Res) | 31.4 | - | 31.5 | 37.1 | 46.5 | 34.9 | 31.0 | Reduction/ Not Significant |
| Napias Cr. 1 (Anad) | - | 39.4 | - | 40.4 | 51.7 | 38.0 | 35.2 | Reduction/ Alpha = 0.1 & 0.05 |
| Napias Cr. 2 (Res) | 22.5 | - | 23.3 | 27.1 | 13.1 | 24.4 | 25.8 | Increase/ Not Significant |
| Napias Cr. 2 (Anad) | - | 25.1 | - | 31.3 | 18.0 | 27.9 | 30.2 | Reduction/ Not Significant |
| Napias Cr. 3 (Res) | 29.2 | - | 34.1 | 23.1 | 26.5 | 24.3 | 33.2 | Increase/ Alpha = 0.1 Only |
| Napias Cr. 3 (Anad) | - | 25.5 | - | 24.6 | 30.0 | 27.5 | 33.0 | Increase/ alpha = 0.1 only |
| Napias Cr. 4 (Res) | 21.1 | - | 22.1 | 18.3 | 18.9 | 19.4 | 21.0 | Reduction/ Not Significant |
| Napias Cr. 4 (Anad) | - | 11.5 | - | 19.8 | 24.1 | 24.7 | 22.7 | Increase/ alpha = 0.1 & 0.05 |
| Napias Cr. 5 (Res) | 41.5 | - | 32.5 | 24.9 | 24.9 | 27.1 | 20.2 | Reduction/ alpha = 0.1 & 0.05 |
| Napias Cr. 5 (Anad) | - | 40.6 | - | 27.6 | 25.9 | 31.7 | 28.5 | Increase/ alpha = 0.1 & 0.05 |
| Panther Creek 1 | 32.8 | 25.2 | 23.8 | 23.0 | 16.4 | 25.2 | 31.5 | Reduction/ Not Significant |

**Percent Fines from Core Sampling in Streams Throughout the Subbasin (SCNF, 1999).**

| Stream | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Trend |
|---|---|---|---|---|---|---|---|---|
| Panther Creek 2 | 25.2 | 27.8 | 28.7 | 26.0 | 23.2 | 27.4 | 29.8 | Increase/ alpha = 0.1 & 0.05 |
| Panther Creek 3 | 27.7 | 24.2 | 28.0 | 30.3 | 19.6 | 18.0 | 23.6 | Reduction/ alpha = 0.1 only |
| Panther Creek 4 | 23.7 | 27.1 | - | - | - | 14.5 | 13.5 | Increase/ Not Significant |
| Panther Creek 4a | - | - | 9.1 | 24.6 | 11.0 | 13.7 | 16.4 | Reduction / alpha = 0.1 & 0.05 |
| Phelan Creek (Res) | 34.8 | - | - | 24.7 | 32.4 | 23.8 | 15.8 | Reduction/ alpha = 0.1 & 0.05 |
| Phelan Creek (Anad) | - | 28.9 | - | 25.3 | 33.0 | 23.8 | 15.8 | Reduction/ alpha = 0.1 & 0.05 |
| Porphyry Creek | 20.8 | 19.9 | - | - | - | 10.4 | 15.3 | Reduction/ alpha = 0.1 & 0.05 |
| SF Moyer Creek | 26.2 | 23.6 | - | - | - | - | - | |
| Trail Creek | 9.9 | 26.5 | - | - | - | - | - | |
| Woodtick Creek | 9.7 | 9.0 | 10.8 | 10.6 | - | - | 17.2 | Increase/ alpha = 0.1 & 0.05 |
| Dahlonega Creek | 30.7 | 34.0 | - | 27.0 | 24.8 | 16.1 | 14.3 | Reduction/ alpha = 0.1 & 0.05 |
| Hughes Creek | 17.6 | 30.8 | 20.0 | 20.7 | 15.4 | - | - | |
| Hull Creek | 17.6 | 14.4 | 26.8 | 23.7 | - | 18.6 | - | |
| NF Salmon River 1 | 16.2 | 20.5 | 17.6 | 22.0 | 10.2 | 13.8 | - | |
| NF Salmon River 2 | 21.3 | 22.7 | 26.0 | 48.6 | 17.5 | 19.7 | 7.3 | Reduction/ alpha = 0.1 & 0.05 |
| NF Salmon River 3 | 24.6 | 19.5 | 22.5 | 28.4 | 17.2 | 16.5 | 12.5 | Reduction/ alpha = 0.1 & 0.05 |
| Pierce Creek | 31.2 | 29.0 | - | - | - | - | - | |

**Percent Fines from Core Sampling in Streams Throughout the Subbasin (SCNF, 1999).**

| Stream | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Trend |
|---|---|---|---|---|---|---|---|---|
| Sheep Creek | 21.0 | 16.5 | 13.5 | 19.1 | 17.2 | 9.7 | 15.0 | Reduction/ alpha = 0.1 & 0.05 |
| Twin Creek | 10.4 | 7.9 | - | 20.3 | 10.6 | 13.6 | 10.9 | Increase/ alpha = 0.1 & 0.05 |
| Big Hat Creek | 33.5 | 30.0 | - | 30.1 | - | - | - | |
| Carmen Creek | 16.7 | 13.9 | 21.2 | 21.8 | 14.5 | 13.5 | 17.1 | Increase/ Not Significant |
| 4th of July Creek | 20.6 | 24.9 | - | 13.9 | 12.0 | 11.8 | 11.5 | Reduction/ alpha = 0.1 & 0.05 |
| Hat Creek | 16.7 | 21.8 | - | - | - | - | 15.1 | Reduction/ Not Significant |
| Iron Creek 1 | 22.9 | 17.2 | 18.7 | 16.8 | 15.8 | 6.4 | 16.2 | Reduction/ alpha = 0.1 & 0.05 |
| Jesse Creek | 19.7 | 33.5 | - | - | - | 22.6 | - | |
| Lake Creek | 42.7 | 52.0 | 53.8 | 39.7 | 50.0 | 44.6 | 35.9 | Reduction/ Not Significant |
| McKim Creek | 15.5 | 19.7 | - | 20.2 | - | 11.3 | 17.4 | Increase/ Not Significant |
| NF Iron Creek | 20.7 | 19.7 | 19.2 | 19.0 | 21.9 | 9.6 | 22.4 | Reduction/ Not Significant |
| Perreau Creek | 22.9 | 20.5 | 19.0 | - | - | - | - | |
| SF Iron Creek 1 | 40.0 | 27.2 | - | 42.8 | 32.8 | 25.3 | 22.2 | Reduction/ alpha = 0.1 & 0.05 |
| Twelvemile Creek 1 | 19.6 | 29.4 | - | 26.9 | - | 12.6 | - | |
| Wagonhammer Cr. | 17.0 | 6.7 | 16.4 | 19.0 | 30.4 | 24.5 | 16.3 | Reduction/ Not Significant |
| Warm Spring Creek | 41.1 | 40.1 | 41.7 | 40.9 | - | 39.2 | - | |

**Percent Fines from Core Sampling in Streams Throughout the Subbasin (SCNF, 1999).**

| Stream | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Trend |
|---|---|---|---|---|---|---|---|---|
| WF Iron Creek | 11.5 | 10.7 | - | 18.1 | 21.7 | 16.0 | 16.7 | Increase/ alpha = 0.1 only |
| Williams Creek | 34.1 | 24.8 | 16.1 | 20.6 | 14.6 | 6.6 | 14.4 | Reduction/ alpha = 0.1 & 0.05 |

# APPENDIX G
# USGS Fish Data Collection

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
230 Collins Road
Boise, Idaho 83702-4520

November 2, 1999

Chris Mebane
Idaho Division of Environmental Quality
1410 North Hilton
Boise, Idaho 83706-1255

Dear Chris,

Enclosed are the fish data collected at four river sites (3-Salmon and 1-S Fk Snake). The work is in partial fulfillment of our cooperative agreement (IDEQ contract QC054000/ USGS JFA ID0000400). We have received the amended agreement to sample one additional site (Salmon River near Riggins) and have made arrangements with Steve Robinson to meet him November 17, to sample this site. Once we have completed this work we will send you the data for this site.

Entering the fish data into electronic format will be completed later this year. We will also be publishing this data in our annual Water Resources Data Report. If you have any questions, please feel free to contact me at 387-1328.

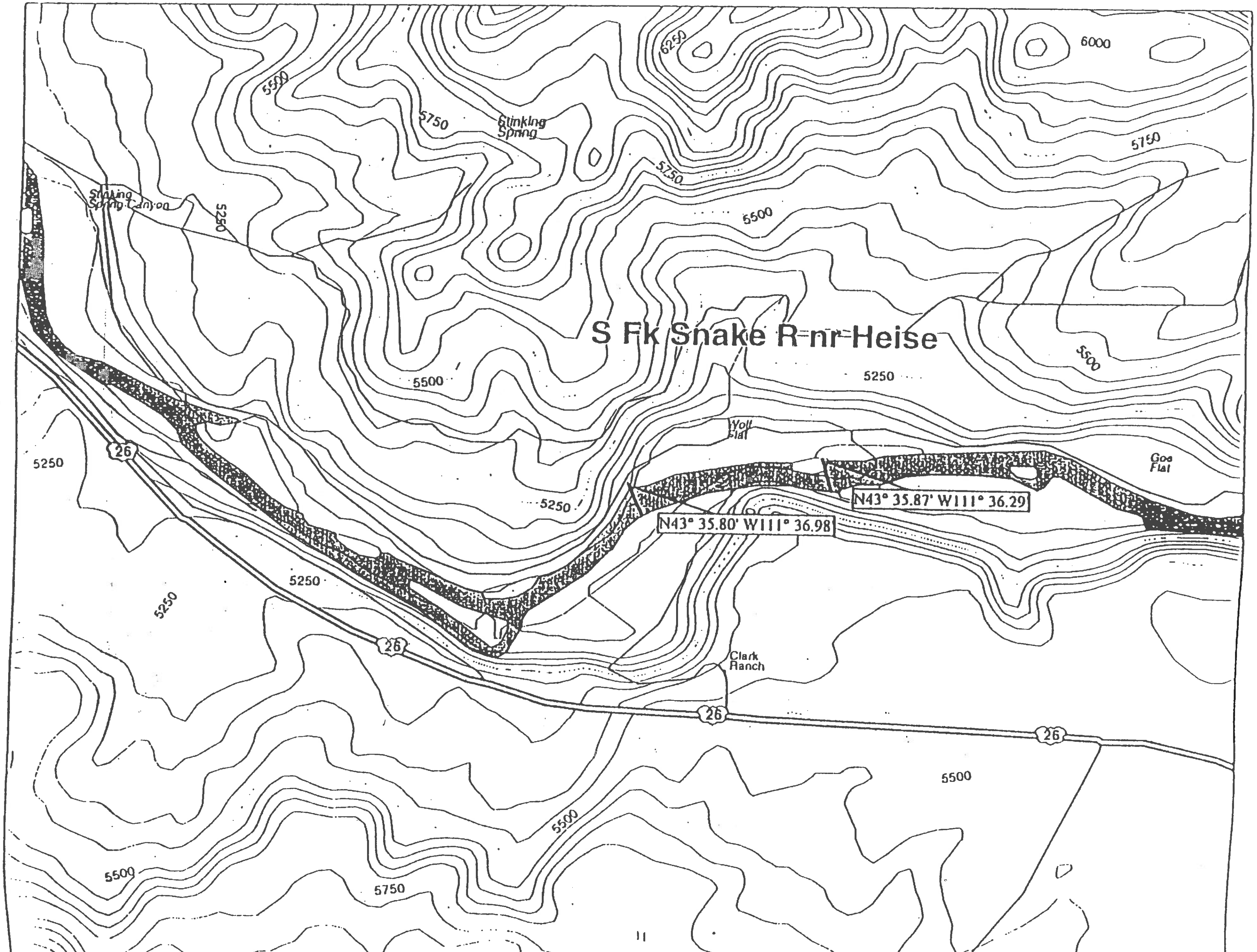
Sincerely,

Terry R. Maret
Biologist

Enclosures

Copy to: Steve Robinson, IDEQ, Idaho Falls

RECEIVED
NOV - 4 1999
DEQ-IDAHO FALLS



USA 2.0 Copyright © 1999 DeLorme Yarmouth, ME 04096 Scale: 1 : 24,000 Detail: 12.5

# Fish Sampling Equipment

IDEQ Study

1. Study Unit ________ 2. Date 9 -- 16 -- 99 (Month -- Day -- Year) Page 1 of 6

3. Station Name S FK Snake nr Heise 4. Station Identification Number ____________

5. Investigators Maret Landon Heidi Hansen (HFF)

6. Reach Conditions flow higher than normal for this time of year

7. Reference Location Stream widths up 112 ~~[illegible]~~ 129 down 90 meters
Latitude ____ deg ____ min ____ sec Longitude ____ deg ____ min ____ sec

8. Reach Length 940 m 9. Water Quality: Discharge 8380 cfs 9-16-99
$\overline{w}$ = 110.3 m Conductivity ✓ Temperature ______ Dissolved oxygen ______
WQ taken frequently at gage below

10. Sampling gear:

ELECTROFISHING (CODE)

✓ BACKPACK-First Pass (11A) Model _____ Output voltage 600 Seconds 30 Hz
Beginning Time _____ Ending Time 905

____ BACKPACK-Second Pass (11B) Model _____ Output voltage _____ Seconds _____
Beginning Time _____ Ending Time _____

____ TOWED-First Pass (12A) Model _____ Output voltage _____ Seconds _____
Beginning Time _____ Ending Time _____

____ TOWED-Second Pass (12B) Model _____ Output voltage _____ Seconds _____
Beginning Time _____ Ending Time _____

✓ BOAT-First Pass (13A) Both shorelines all habitats Model _____ Output voltage 354 Seconds _____
Beginning Time 0 Ending Time 1436

____ BOAT-Second Pass (13B) Model _____ Output voltage _____ Seconds _____
Beginning Time _____ Ending Time _____

4 pulse width 30 Hz 4 amps both shorelines w/ [illegible]

SEINING (CODE)

____ HAUL (21A) Number of _____ Beginning Time _____ Ending Time _____
____ KICK (22A) Number of _____ Beginning Time _____ Ending Time _____
____ BEACH (23A) Number of _____ Beginning Time _____ Ending Time _____

GILL NETTING (CODE)

____ EXPERIMENTAL (31A) Number of _____ Beginning Time _____ Ending Time _____

HOOP NETTING (CODE)

____ (41A) Number of _____ Beginning Time _____ Ending Time _____

ADDITIONAL METHODS (CODE)

____ (method 1) (51A) Number of _____ Beginning Time _____ Ending Time _____

COMMENTS Fish abundant – particularly trout/whitefish
Backpack collection at upper end of reach in side channel riffles on right bank next to island

Boat GPS right bank
Launch downstream end 43 35 47.92 ± 5.6m 111 36 58.99

upstream end large riffle 43 35 52.36 ± 7.8m 111 36 17.61 (right bank)

all [illegible] – sculpins were not abundant

BT brown trout
WF MT whitefish
SKU Utah sucker
CB rainbow Acct 01300

Study

# Fish Species

1. Study Unit ________ 2. Date 9 - 16 - 99 (Month Day Year) Page 2 of 6

3. Station Name S Fk Snake nr Heise 4. Station Identification Number ________

5. Investigators Maret Lendon Hansen

6. Taxonomic Specialist Maret 7. Sampling gear code ________

Boat - Scbecat 3 pass

| SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|
| WF | 345 | | 351 | AA | 1 |
| WF | 354 | | 429 | " | |
| WF | 283 | | 216 | " | |
| WF | 385 | | 528 | " | |
| WF | 380 | | 419 | ER/FU | |
| WF | 315 | | 330 | AA | |
| WF | 385 | | 420 | " | |
| WF | 352 | | 360 | " | |
| WF | 346 | | 377 | " | |
| WF | 350 | | 370 | " | |
| CT | 312 | | 328 | AA | |
| WF | 340 | | 331 | " | |
| WF | 258 | | 155 | " | |
| WF | 291 | | 225 | " | |
| WF | 342 | | 345 | " | |
| WF | 351 | | 408 | " | |
| WF | 250 | | 161 | " | |
| WF | 322 | | 360 | AA | |
| WF | 256 | | 164 | " | |
| WF | 255 | | 183 | " | |
| WF | 346 | | 382 | " | |
| WF | 405 | | 534 | " | |
| WF | 257 | | 163 | " | |
| WF | 270 | | 206 | " | |
| DS | 90 | | 5 | AA | |
| BT | 301 | | 273 | " | |
| CT | 335 | | 322 | " | |
| CT | 220 | | 121 | " | |
| CT | 305 | | 281 | " | |
| CT | 270 | | 205 | " | |
| CT | 262 | | 164 | AA | |

FS

FS - Fine Spot

(Back)

Snake nr Heise 9-16-99 Boat Collection

| SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|
| SKU | 525 | | 1839 | AA | 1 |
| WF | 355 | | 364 | " | |
| WF | 345 | | 367 | " | |
| WF | 301 | | 284 | " | |
| WF | 369 | | 411 | " | |
| WF | 320 | | 312 | " | |
| WF | 261 | | 175 | " | |
| WF | 335 | | 369 | " | |
| WF | 346 | | 343 | " | |
| WF | 262 | | 172 | " | |
| WF | 338 | | 411 | AA | |
| BT | 412 | | 809 | " | |
| RB | 440 | | 964 | " | |
| CT | 391 | | 574 | " | |
| CT | 335 | | 372 | " | |
| CT | 388 | | 465 | " | |
| WF | 347 | | 390 | " | |
| WF | 345 | | 345 | " | |
| WF | 371 | | 412 | AA | |
| WF | 341 | | 378 | " | |
| WF | 242 | | 140 | " | |
| WF | 379 | | 469 | " | |
| WF | 361 | | 472 | " | |
| WF | 320 | | 342 | " | |
| WF | 258 | | 169 | " | |
| WF | 351 | | 359 | " | |
| CT | 280 | | 215 | AA | |
| RB | 348 | | 462 | " | |
| CT | 325 | | 382 | " | |
| CT | 335 | | 409 | " | - FS |
| CT | 315 | | 335 | " | |
| BT | 234 | | NA (lost) | " | |
| WF | 365 | | 414 | AA | |
| WF | 290 | | 277 | " | |
| WF | 259 | | 175 | " | |
| WF | 346 | | 402 | " | |
| WF | 370 | | 482 | " | |
| WF | 295 | | 274 | " | |
| WF | 355 | | 394 | " | |
| WF | 386 | | 520 | " | |
| WF | 335 | | 316 | " | |

FS = Fine Spot

all others yellowstone cuts

Study

1. Study Unit ________ 2. Date 9 - 16 - 99 (Month -- Day --Year) Page 4 of 6

3. Station Name S FK Snake nr Heise 4. Station Identification Number ____________

5. Investigators

Maret Landon Heidi Hansen (HFF)

6. Taxonomic Specialist Maret 7. Sampling gear code Boat - Saber cat 3 perc

| SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|
| WF | 300 | | 285 | AA | 1 |
| WF | 280 | | 221 | " | |
| WF | 230 | | 118 | " | |
| WF | 350 | | 313 | " | |
| WF | 360 | | 413 | " | |
| WF | 335 | | 349 | " | |
| WF | 336 | | 133 | " | |
| WF | 212 | | 102 | " | |
| WF | 241 | | 149 | " | |
| WF | 263 | | 181 | " | |
| WF | 255 | | 181 | " | |
| WF | 220 | | 104 | " | |
| WF | 320 | | 341 | " | |
| WF | 269 | | 185 | " | |
| WF | 228 | | 119 | " | |
| WF | 254 | | 166 | " | |
| WF | 278 | | 220 | " | |
| WF | 194 | | 87 | " | |
| WF | 265 | | 185 | " | |
| WF | 250 | | 158 | " | |
| WF | 374 | | 478 | " | |
| WF | 315 | | 310 | " | |
| WF | 370 | | 446 | " | |
| WF | 292 | | 223 | " | |
| WF | 248 | | 135 | " | |
| WF | 245 | | 154 | " | |
| WF | 202 | | 96 | " | |
| WF | 255 | | 181 | " | |
| WF | 256 | | 179 | " | |
| WF | 350 | | 354 | " | |
| WF | 115 | | 12 | " | |

(Back)

nr Heise 9-16-99 Boat Collection

| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| | WF | 105 | | 11 | AA | 1 |
| | WF | 225 | | 160 | AA | |
| | WF | 110 | | 11 | AA | |
| | WF | 115 | | 12 | " | |
| | WF | 110 | | 11 | AA | |
| | CTxRB | 320 | | 314 | | |
| | CTxRB | 280 | | 233 | | |
| | BT | 315 | | 305 | | |
| | BT | 302 | | 250 | | |
| | BT | 187 | | 67 | | |
| | WF | 110 | | 13 | | |
| | SKU | 595 | | 2440 | | |
| | SKU | 582 | | 2485 | | |
| | WF | 110 | | 13 | | |
| V | WF | 195 | | 87 | | |
| V | WF | 245 | | 170 | | |
| V | WF | 220 | | 110 | | |
| V | WF | 135 | | 26 | | |
| V | WF | 105 | | 12 | | |
| V | SKU | 176 | | 64 | | |
| V | CT | 58 | | 3 | | |
| V | CT | 57 | | 2 | | |

V = voucher specimen -

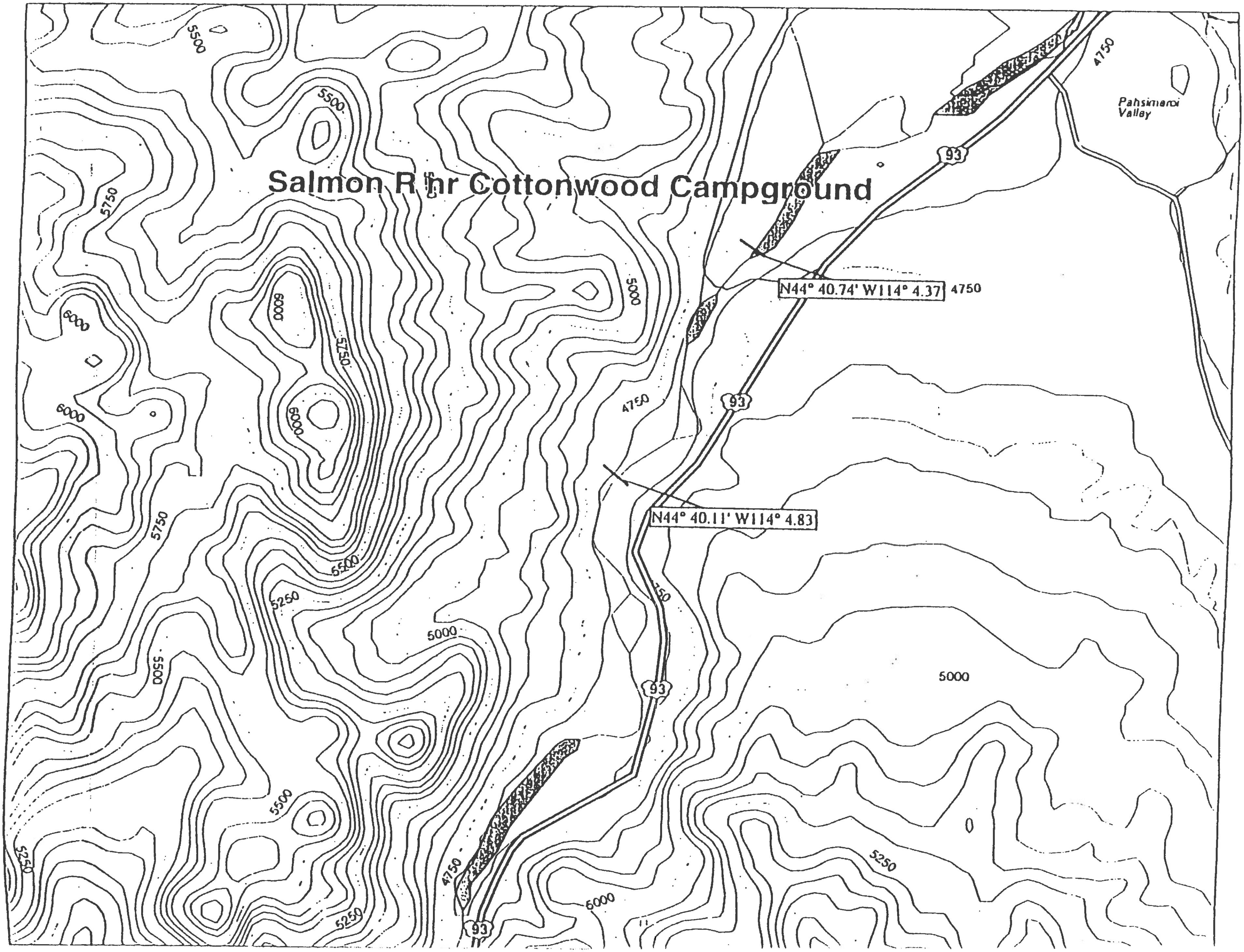
Snake N. Hea... Collection ONLY

| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| V | SD | 45 | | 1 | AA | 1 |
| V | DS | 85 | | 7 | | |
| V | DS | 92 | | 12 | | |
| V | DS | 60 | | 2 | | |
| V | DS | 46 | | 1 | | |
| | SH | 26 | | <1 | | |
| V | SH | 100 | | 15 | PA | (Blackspot) |
| V | SH | 78 | | 10 | | |
| V | SH | 72 | | 7 | | |
| V | SH | 68 | | 5 | | |
| V | SH | 72 | | 6 | | |
| | SH | 76 | | 8 | | |
| | SH | 60 | | 4 | | |
| | SH | 62 | | 4 | | |
| | SH | 67 | | 5 | | |

NOTE: Back pack collection only 3 people

V = Vouchered

V= voucher specimen



Salmon R nr Cottonwood Campground
N44° 40.74' W114° 4.37
N44° 40.11' W114° 4.83
Pahsimeroi Valley
93
4750
5000
5250
5500
5750
6000

Acct 01300

# Fish Sampling Equipment

1. Study Unit Salmon R
2. Date 10 -- 6 -- 99 (Month Day Year)



3. Station Name nr Cottonwood Camp ground (MP 262)
4. Station Identification Number ____________
5. Investigators Maret, Ott, Short, Robinson, Mebane
6. Reach Conditions ____________

Stream widths
37.6 m
45.4 m
41.0 m

7. Reference Location ____________
Latitude ___ deg ___ min ___ sec Longitude ___ deg ___ min ___ sec
8. Reach Length 1310 m
9. Water Quality: Conductivity ______ Temperature ______ Dissolved oxygen ______
10. Sampling gear: W̄ 41.3 m

Cataraft collection 3 people

**ELECTROFISHING (CODE)**

| | | | |
|---|---|---|---|
| ___ BACKPACK-First Pass (11A) | Model ___ | Output voltage ___ | Seconds ___ |
| | Beginning Time ___ | Ending Time ___ | |
| ___ BACKPACK-Second Pass (11B) | Model ___ | Output voltage ___ | Seconds ___ |
| | Beginning Time ___ | Ending Time ___ | |
| ___ TOWED-First Pass (12A) | Model ___ | Output voltage ___ | Seconds ___ |
| | Beginning Time ___ | Ending Time ___ | |
| ___ TOWED-Second Pass (12B) | Model ___ | Output voltage ___ | Seconds ___ |
| | Beginning Time ___ | Ending Time ___ | |
| ✓ BOAT-First Pass (13A) | Model VIA | Output voltage 884 | Seconds 6.5 ms 30 Hz |
| | Beginning Time 0 | Ending Time 1597 | |
| ___ BOAT-Second Pass (13B) | Model ___ | Output voltage ___ | Seconds ___ |
| | Beginning Time ___ | Ending Time ___ | |

**SEINING (CODE)**

| | | | |
|---|---|---|---|
| ___ HAUL (21A) | Number of ___ | Beginning Time ___ | Ending Time ___ |
| ___ KICK (22A) | Number of ___ | Beginning Time ___ | Ending Time ___ |
| ___ BEACH (23A) | Number of ___ | Beginning Time ___ | Ending Time ___ |

**GILL NETTING (CODE)**

___ EXPERIMENTAL (31A) Number of ___ Beginning Time ___ Ending Time ___

**HOOP NETTING (CODE)**

___ (41A) Number of ___ Beginning Time ___ Ending Time ___

**ADDITIONAL METHODS (CODE)**

___ (method 1) (51A) Number of ___ Beginning Time ___ Ending Time ___

COMMENTS: All habitats sampled - fish more abundant than upstream site near Torrey's Hole
Cataraft worked in riffle habitat to sample Sculpins & dace

up end (RB) at boat ramp
44 40 06.76
114 04 49.53 ± 6 m

downstream end (LB)
44 40 44.26
114 04 22.20 ± 8 m below old bridge 200 m

nr Cottonwood Campground 10-6-99

(2 of 5)

| | SPECIES | (Na) | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|---|
| | WF | 1 | 125 | | 21 | AA | 1 |
| | WF | 1 | 286 | | 234 | | |
| | RB | 1 | 225 | | 114 | | |
| * | RB | 1 | 214 | | 88 | | |
| | RB | 1 | 196 | | 63 | | |
| | WF | 1 | 139 | | 25 | | |
| • | WF | (10) | — | | 1811 | | (10) |
| * | RB | 1 | 277 | | 198 | | 1 |
| | RS | 1 | — | | — | lost while measuring | 1 |
| | RS | 1 | 111 | | 15 | AA | 1 |
| • | WF | (11) | — | | 1278 | | (11) |
| | CS | 1 | 116 | | 18 | | 1 |
| | CS | | 97 | | 10 | | |
| | CS | | 109 | | 11 | | |
| | CS | | 107 | | 11 | | |
| | CS | | 110 | | 13 | | |
| ✓ | CS | | 121 | | 22 | | mortality |
| | CS | | 121 | | 16 | | |
| | CS | | 98 | | 9 | | |
| | CS | | 93 | | 8 | | |
| | CS | | 106 | | 11 | | |
| | CS | | 90 | | 7 | | |
| • | WF | (5) | — | | 1813 | | (5) |
| • | WF | (5) | — | | 2190 | | (5) |
| • | WF | (5) | — | | 1530 | | (5) |
| | CS | 1 | 112 | | 15 | | 1 |
| | CS | 1 | 93 | | 9 | | 1 |
| • | SKL | (5) | — | | 6700 | | (5) |
| • | SKL | (5) | — | | 6700 | | (5) |
| • | SKL | (4) | — | | 5500 | | (4) |
| • | SKL | (2) | — | | 2750 | | (2) |
| | SF | 1 | 530 | | 1600 | | 1 |
| ✓ | WF | | 85 | | 5 | | |
| ✓ | WF | | 120 | | 17 | | |
| ✓ | WF | | 135 | | 22 | | |
| ✓ | WF | | 110 | | 13 | | |
| | WF | | 115 | | 13 | | |
| | WF | | 105 | | 12 | | |
| | WF | | 80 | | 5 | | |
| ✓ | SKL | | 172 | | 58 | | |
| ✓ | SKL | | 110 | | 16 | NA | |

* Hatchery

• Composite weight

✓ = voucher specimen

Note: Chinook salmon in jar are already weighed & measured

Salmon River nr Challis (Site #2) 10/6/99
Cottonwood Campground

| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER | |
|---|---|---|---|---|---|---|---|
| * | RB | 340 | | 365 | AA | 1 | |
| * | RB | 305 | | 280 | ER | | |
| * | RB | 270 | | 192 | ER | | |
| | RB | 210 | | 92 | FF | | |
| | RB | 205 | | 86 | | | |
| | RB | 209 | | 95 | | | |
| V | CS | 112 | | 17 | | | |
| V | CS | 111 | | 14 | | | mortality |
| | CS | 115 | | 14 | | | " |
| | CS | 108 | | 11 | | | |
| | CS | 105 | | 12 | | | |
| V | CS | 110 | | 13 | | | mortality |
| | WF | 356 | | 470 | | | |
| | WF | 365 | | 450 | | | |
| | WF | 366 | | 492 | | | |
| | WF | 341 | | 420 | | | |
| | WF | 338 | | 408 | | | |
| | WF | 330 | | 385 | | | |
| | WF | 281 | | 208 | | | |
| | WF | 222 | | 112 | | | |
| | WF | 237 | | 124 | | | |
| | WF | 230 | | 94 | | | |
| | WF | 380 | | 596 | | | |
| | WF | 374 | | 505 | | | |
| | WF | 338 | | 354 | | | |
| | WF | 251 | | 143 | | | |
| | WF | 225 | | 121 | | | |
| | WF | 228 | | 108 | | | |
| | WF | 287 | | 242 | | | |
| | CS | 98 | | 7 | | | |
| | WF | 225 | | 115 | | | |
| | WF | 233 | | 121 | | | |
| | WF | 230 | | 124 | | | |
| | WF | 241 | | 138 | | | |
| | WF | 270 | | 211 | | | |
| | WF | 229 | | 112 | | | |
| | WF | 230 | | 134 | | | |
| | WF | 224 | | 100 | | | |
| | WF | 210 | | 80 | | | |
| | WF | 142 | | 25 | | | |
| | WF | 130 | | 18 | | | |

* Hatchery

V = voucher specimen

Salmon River nr. Cottonwood [illegible]

10/6/99

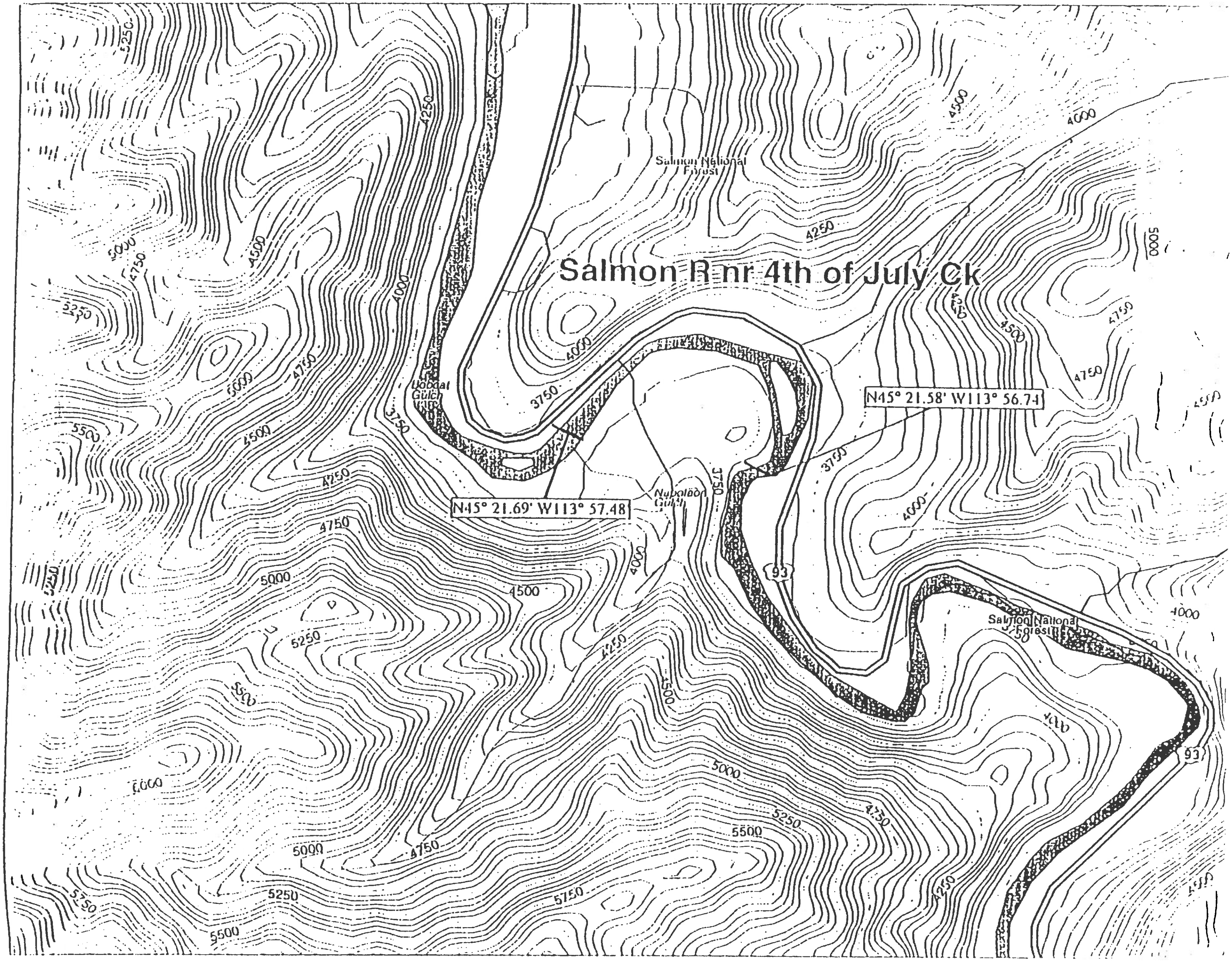
| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| V | RB | 158 | | 39 | AA | mortality |
| V | SKL | 90 | | 9 | | |
| V | SKL | 81 | | 7 | | |
| V | SKL | 80 | | 6 | | |
| V | CM | 125 | | 18 | | |
| V | DS | 72 | | 4 | | |
| V | DS | 56 | | 2 | | |
| V | RS | 70 | | 4 | | |
| V | RS | 66 | | 3 | | |
| V | RS | 68 | | 4 | | |
| V | RS | 65 | | 4 | | |
| V | RS | 56 | | 2 | | |
| | RS | 60 | | 3 | | |
| V | SD | 73 | | 5 | | |
| V | SD | 66 | | 4 | | |
| V | SD | 52 | | 2 | | |
| V | SD | 51 | | 2 | | |
| V | SD | 50 | | 2 | | |
| | SD | 55 | | 2 | | |
| | SD | 36 | | 1 | | |
| | SD | 50 | | 2 | | |
| V | SH | 100 | | 15 | | |
| V | SH | 104 | | 20 | AA | |
| V | SH | 96 | | 17 | PA | (blackspot) |
| V | SH | 79 | | 8 | AA | |
| V | SH | 85 | | 10 | | |
| V | SH | 80 | | 8 | | |
| | SH | 82 | | 9 | | |
| | SH | 100 | | 16 | | |
| | SH | 92 | | 12 | | |
| | SH | 100 | | 14 | | |
| | SH | 80 | | 8 | | |
| | SH | 85 | | 10 | | |
| | SH | 72 | | 7 | | |
| | SH | 84 | | 11 | | |
| | SH | 80 | | 9 | | |
| | SH | 68 | | 6 | AA | |
| | SH | 98 | | 13 | PA | blackspot |
| | SH | 81 | | 8 | AA | |
| | SH | 77 | | 6 | | |
| | SH | 68 | | 5 | | |
| | SH | 72 | | 7 | | |
| | SH | 79 | | 6 | AA | |

V= voucher specimen

Salmon River nr Cottonwood Campground

10/6/99

| SPECIES (No) | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|
| SH | 76 | | 7 | AA | 1 |
| SH | 84 | | 8 | ↓ | ↓ |
| SH | 84 | | 10 | | |
| SH | 36 | | 1 | | |
| SH | 58 | | 3 | | |
| SH | 40 | | 2 | | |
| SH | 37 | | 1 | | |
| SH | 62 | | 4 | | |
| SH | 74 | | 6 | | |
| SH | 25 | | <1 | | |
| SH | 42 | | 1 | | |
| SH (24) | — | | 129 | ↓ | (24) |



Salmon R nr 4th of July Ck
N45° 21.58' W113° 56.74
N45° 21.69' W113° 57.48
Salmon National Forest
Dobbal Gulch
Napoleon Gulch
93

Acct 01300

# Fish Sampling Equipment

1. Study Unit ________ Salmon R

2. Date 10 -- 7 -- 99 (Month Day Year)

Page 1 of 6

3. Station Name nr 4th of July access MP 320

4. Station Identification Number ________

5. Investigators Maret Ott Short Robinson Mebane

6. Reactions Conditions ________

Stream widths 68 m 52 m 122 m

7. Reference Location ________
Latitude ___ deg ___ min ___ sec  Longitude ___ deg ___ min ___ sec

8. Reach Length 977

9. Water Quality: Conductivity ________ Temperature ________ Dissolved oxygen ________

10. Sampling gear: $\bar{W}$ = 80.7 m

Cataraft collection

ELECTROFISHING (CODE)

____ BACKPACK-First Pass (11A) Model ____ Output voltage ____ Seconds 3 people
Beginning Time ____ Ending Time ____

____ BACKPACK-Second Pass (11B) Model ____ Output voltage ____ Seconds ____
Beginning Time ____ Ending Time ____

____ TOWED-First Pass (12A) Model ____ Output voltage ____ Seconds ____
Beginning Time ____ Ending Time ____

____ TOWED-Second Pass (12B) Model ____ Output voltage ____ Seconds ____
Beginning Time ____ Ending Time ____

✓ BOAT-First Pass (13A) Model ____ Output voltage ____ Seconds ____ 5 amp
Beginning Time ____ Ending Time 1843 30 Hz

____ BOAT-Second Pass (13B) Model ____ Output voltage ____ Seconds ____ 1061 v
Beginning Time ____ Ending Time ____ 6 pv

SEINING (CODE)

____ HAUL (21A) Number of ____ Beginning Time ____ Ending Time ____

____ KICK (22A) Number of ____ Beginning Time ____ Ending Time ____

____ BEACH (23A) Number of ____ Beginning Time ____ Ending Time ____

GILL NETTING (CODE)

____ EXPERIMENTAL (31A) Number of ____ Beginning Time ____ Ending Time ____

HOOP NETTING (CODE)

____ (41A) Number of ____ Beginning Time ____ Ending Time ____

ADDITIONAL METHODS (CODE)

____ (method 1) (51A) Number of ____ Beginning Time ____ Ending Time ____

COMMENTS: Fish similar in abundant to cottonwood site upstream Numerous large suckers & pikeminnows Cataraft worked in riffles to sample sculpins & dace

up end (RB)
4th of July access
45 21 34.92
113 56 44.49 ± 5 m

lower end (LB)
45 21 41.42
113 57 28.62 ± 6 m

nr 4th of July access



| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER | |
|---|---|---|---|---|---|---|---|
| | CS | 121 | | 18 | BA | 1 | |
| | CT | 325 | | 340 | | | |
| | RB | 224 | | 101 | | | |
| | RB | 204 | | ~~473~~ 87 | | | |
| | ~~RB~~ | ~~[illegible]~~ | | — | | | |
| | RB | 208 | | 84 | | | |
| | RB | 189 | | 59 | | | |
| | RB | 193 | | 74 | | | |
| | CS | 122 | | 19 | | | |
| √ | CS | 120 | | 17 | | | mortality |
| | CS | 125 | | 20 | | | |
| √ | CS | 112 | | 14 | | | mortality |
| | WF | 222 | | 103 | | | |
| | WF | 135 | | 21 | | | |
| | WF | 145 | | 32 | | | |
| | WF | 142 | | 24 | | | |
| | WF | 151 | | 30 | | | |
| | WF | 147 | | 31 | | | |
| | WF | 138 | | 24 | | | |
| | WF | 143 | | 31 | | | |
| | WF | 123 | | 20 | | | |
| | WF | 110 | | 14 | | | |
| | WF | 127 | | 18 | | | |
| | CS | 112 | | 14 | | | |
| | CS | 120 | | 18 | | | |
| | CS | 126 | | 19 | | | |
| | ~~CS~~ WF | 141 | | 26 | | | |
| | RB | 193 | | 59 | | | |
| | CS | 116 | | 16 | | | |
| | CS | 124 | | 20 | | | |
| | CS | 121 | | 18 | | | |
| | CS | 114 | | 16 | | | |
| | CS | 115 | | 12 | | | |
| | CS | 105 | | 12 | | | |
| | CS | 115 | | 14 | | | |
| | WF | 148 | | 29 | | | |
| | WF | 130 | | 24 | | | |
| | WF | 140 | | 25 | | | |
| | WF | 142 | | 26 | | | |
| | WF | 122 | | 17 | | | |
| | WF | 121 | | 16 | | | |
| | WF | 110 | | 19 | | | |
| | CS | 112 | | 13 | | | |
| | CS | 110 | | 12 | | | |

√ = voucher specimens

nr 4th of July Access 10-7-99 

| SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|
| WF | 120 | | 21 | AA | 1 |
| WF | 346 | | 421 | ↓ | ↓ |
| WF | 270 | | 201 | | |
| WF | 320 | | 352 | | |
| WF | 291 | | 227 | | |
| * RB | 565 | | 2100 | | |
| WF | 228 | | 116 | | |
| WF | 336 | | 368 | | |
| WF | 342 | | 375 | | |
| WF | 228 | | 118 | | |
| WF | 326 | | 378 | | |
| WF | 245 | | 142 | | |
| WF | 237 | | 127 | | |
| WF | 155 | | 34 | | |
| WF | 281 | | 216 | | |
| WF | 347 | | 440 | | |
| WF | 323 | | 398 | | |
| WF | 242 | | 135 | | |
| WF | 245 | | 121 | | |
| WF | 340 | | 406 | | |
| WF | 236 | | 114 | | |
| WF | 310 | | 245 | | |
| WF | 225 | | 94 | | |
| WF | 132 | | 21 | | |
| RB | 181 | | 66 | | |
| WF | 226 | | 93 | | |
| WF | 222 | | 106 | | |
| WF | 140 | | ~~[illegible]~~ 22 | | |
| WF | 140 | | 24 | | |
| WF | 165 | | 38 | | |
| WF | 151 | | 29 | | |
| • SKL (10) | — | | 7800 | | (10) |
| • SKL (10) | — | | 7600 | | (10) |
| hybrid → SKL X SKB | 387 | | 618 | | |
| • SKL (5) | — | | 3550 | | (5) |
| CM | 280 | | 252 | | 1 |
| WF | 238 | | 120 | | ↓ |
| WF | 234 | | 123 | | |
| WF | 152 | | 30 | | |
| SKL | 385 | | 530 | | |
| CM | 296 | | 78 | ↓ | ↓ |

* Hatchery

• composite weight

Salmon n. 4th of July access/



| | SPECIES (No.) | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| | CS. | 120 | | 19 | AA | 1 |
| • | SF (10) | — | | 5000 | ↓ | (10) |
| | SF 1 | 452 | | 923 | DE | 1 |
| | CM 1 | 300 | | 304 | AA | 1 |
| • | SF (10) | — | | 3050 | | (10) |
| | CM 1 | 270 | | 170 | | 1 |
| | SKL | 251 | | 170 | | |
| | SKL | 370 | | 482 | | |
| | SF | 180 | | 50 | | |
| | SF | 285 | | 189 | | |
| | SF | 315 | | 287 | | |
| | SF | 340 | | 388 | | |
| | RB | 125 | | 14 | | |
| | RB | 110 | | 13 | | |
| V | WF | 109 | | 11 | | |
| V | RS | 71 | | 4 | | |
| V | RS | 60 | | 2 | | |
| V | SF | 73 | | 4 | | |
| V | SF | 65 | | 3 | | |
| | SF | 64 | | 3 | | |
| | SF | 66 | | 3 | | |
| | SF | 67 | | 3 | | |
| | SF | 61 | | 3 | | |
| | SF | 60 | | 3 | | |
| | SF | 35 | | 1 | | |
| V | DS | 81 | | 6 | | |
| V | DS | 83 | | 6 | | |
| V | DS | 78 | | 5 | | |
| V | DS | 54 | | 2 | | |
| V | DS | 71 | | 4 | | |
| | DS | 71 | | 4 | | |
| | DS | 65 | | 3 | | |
| | DS | 62 | | 3 | | |
| | DS | 65 | | 3 | | |
| | DS | 74 | | 5 | | |
| | DS | 51 | | 1 | | |
| | DS | 50 | | 1 | | |
| | DS | 52 | | 1 | | |
| | DS | 66 | | 5 | | |
| | DS | 51 | | 3 | | |
| | DS | 50 | | 2 | | |
| | DS | 50 | | 3 | | |

All chinook kept due to incidental mortality - all were measured in the field

V = voucher specimen

So 4th of July



10-7-99

| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| | DS | 51 | | 3 | AA | 1 |
| | DS | 46 | | 2 | ↓ | ↓ |
| | DS | 35 | | 1 | | |
| | DS | 35 | | 1 | | |
| | DS | 50 | | 3 | | |
| | DS | 31 | | 1 | | |
| | DS | 30 | | 1 | | |
| | DS | 35 | | 1 | | |
| V | LD | 82 | | 6 | | |
| V | LD | 44 | | 2 | | |
| V | SD | 85 | | 8 | | |
| V | SD | 78 | | 6 | | |
| V | SD | 55 | | 2 | | |
| V | SD | 70 | | 4 | | |
| V | SD | 56 | | 2 | | |
| | SD | 53 | | 2 | | |
| | SD | 36 | | 1 | | |
| | SD | 60 | | 2 | | |
| | SD | 54 | | 2 | | |
| | SD | 54 | | 2 | | |
| | SD | 46 | | 2 | | |
| | SD | 36 | | 1 | | |
| | SD | 56 | | 2 | | |
| | SD | 50 | | 2 | | |
| | SD | 57 | | 2 | | |
| | SD | 55 | | 2 | | |
| | SD | 54 | | 2 | | |
| | SD | 40 | | 1 | | |
| | SD | 53 | | 1 | | |
| | SD | 26 | | <1 | | |
| | SD | 50 | | 2 | | |
| | SD | 36 | | 1 | | |
| | SD | 36 | | 1 | | |
| | SD | 30 | | <1 | | |
| V | SH | 85 | | 12 | | |
| V | SH | 80 | | 7 | | |
| V | SH | 72 | | 6 | | |
| V | SH | 55 | | 3 | | |
| V | SH | 50 | | 3 | | |
| | SH | 46 | | 2 | | |
| | SH | 42 | | 2 | ↓ | ↓ |

V = Voucher specimen

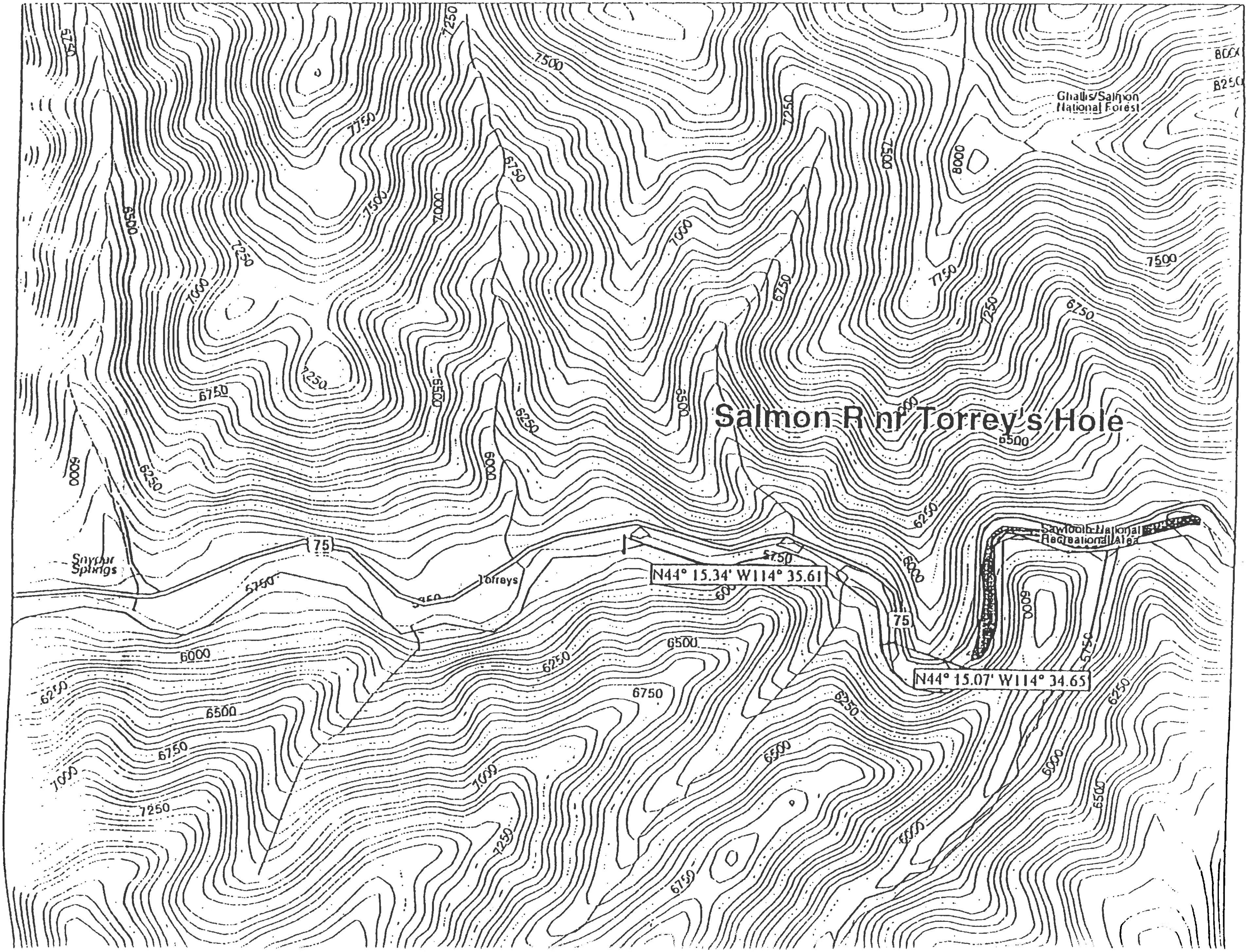
[illegible]

10-7-99



| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| | SH | 42 | | 2 | AA | 1 |
| | SH | 38 | | 1 | | |
| | SH | 45 | | 2 | | |
| | SH | 45 | | 2 | | |
| | SH | 40 | | 2 | | |
| | SH | 40 | | 2 | | |
| | SH | 46 | | 2 | | |
| V | SKL | 196 | | 76 | | |
| V | SKL | 180 | | 57 | | |
| V | SKL | 105 | | 13 | | |
| | SKL | 165 | | 47 | | |
| | SKL | 83 | | 10 | | |
| | SKL | 71 | | 4 | | |
| | SKL | 91 | | 10 | | |
| | SKL | 90 | | 8 | | |
| | SKL | 54 | | 2 | | |
| V | SKM | 90 | | 9 | | |
| V | SKM | 65 | | 4 | | |
| V | SKM | 85 | | 7 | | |
| V | SKM | 104 | | 13 | | |
| V | SKM | 68 | | 4 | | |
| V | SKB | 164 | | 47 | | |
| V | SKB | 95 | | 12 | | |
| V | SKB | 86 | | 8 | | |
| V | SKB | 85 | | 8 | | |
| V | SKB | 76 | | 6 | | |
| V | SKB | 80 | | 6 | | |
| V | SKB | 66 | | 4 | | |

V: voucher specimen


Challis/Salmon National Forest
Salmon R nr Torrey's Hole
Sawtooth National Recreational Area
Snyder Springs
Torreys
75
N44° 15.34' W114° 35.61
N44° 15.07' W114° 34.65

Acct. 01300

1. Study Unit ________ Salmon R

2. Date 10 -- 5 -- 99 (Month -- Day -- Year)



3. Station Name ① Torrey Hole mp 210.5

4. Station Identification Number ____________

5. Investigators Maret Ott Short; Robinson; Mebane

6. Reach Conditions normal low flow

7. Reference Location ________

Latitude ____ deg ____ min ____ sec Longitude ____ deg ____ min ____ sec

Stream widths 43.4 m up 44.7 down 38.0 middle

8. Reach Length 1365 m

9. Water Quality: Conductivity ______ Temperature ______ Dissolved oxygen ______

10. Sampling gear: $\overline{w}$ = 42.0 m

Cataraft collection 3 people

ELECTROFISHING (CODE)

____ BACKPACK-First Pass (11A) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time ____

____ BACKPACK-Second Pass (11B) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time ____

____ TOWED-First Pass (12A) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time ____

____ TOWED-Second Pass (12B) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time ____

✓ BOAT-First Pass (13A) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time 1526

30 Hz 6.5 pw 1061 4 amps

____ BOAT-Second Pass (13B) Model ____ Output voltage ____ Seconds ____ Beginning Time ____ Ending Time ____

SEINING (CODE)

____ HAUL (21A) Number of ____ Beginning Time ____ Ending Time ____

____ KICK (22A) Number of ____ Beginning Time ____ Ending Time ____

____ BEACH (23A) Number of ____ Beginning Time ____ Ending Time ____

GILL NETTING (CODE)

____ EXPERIMENTAL (31A) Number of ____ Beginning Time ____ Ending Time ____

HOOP NETTING (CODE)

____ (41A) Number of ____ Beginning Time ____ Ending Time ____

ADDITIONAL METHODS (CODE)

____ (method 1) (51A) Number of ____ Beginning Time ____ Ending Time ____

COMMENTS

No cutthroats collected - should be here!

Sabercat used as tote barge to sample riffle habitats

GPS

upper end boat ramp (LB)
44 15 20.10
114 35 36.48 ± 6 m

lower end (RB)
44 15 04.02
114 34 38.98 ± 8 m

Torrey's Hole



| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| | WF | 360 | | 468 | AA | 1 |
| | WF | 352 | | 461 | | |
| | WF | 342 | | 442 | | |
| | WF | 374 | | 550 | | |
| | WF | 376 | | 627 | | |
| | WF | 370 | | 500 | | |
| | WF | 271 | | 196 | | |
| | WF | 358 | | 422 | | |
| | WF | 345 | | 381 | | |
| | WF | 368 | | 495 | | |
| | WF | 365 | | 548 | | |
| | WF | 282 | | 219 | | |
| | WF | 266 | | 171 | | |
| | WF | 366 | | 489 | | |
| | WF | 350 | | 418 | | |
| | WF | 337 | | 438 | | |
| | WF | 292 | | 232 | | |
| | WF | 269 | | 185 | | |
| | WF | 391 | | 609 | | |
| | WF | 317 | | 294 | | |
| | WF | 362 | | 440 | | |
| | WF | 305 | | 300 | | |
| | WF | 331 | | 354 | | |
| | WF | 288 | | 258 | | |
| | WF | 275 | | 190 | | |
| | WF | 330 | | 369 | | |
| | WF | 325 | | 314 | | |
| | WF | 304 | | 257 | | |
| | WF | 334 | | 457 | | |
| | WF | 273 | | 199 | | |
| | WF | 251 | | 158 | | |
| | WF | 361 | | 493 | | |
| | WF | 256 | | 157 | | |
| | WF | 330 | | 364 | | |
| | WF | 257 | | 168 | | |
| | WF | 120 | | 18 | | |
| | WF | 112 | | 14 | | |
| * | RB | 302 | | 296 | | |
| * | RB | 293 | | 243 | | |
| * | BB | 302 | | 285 | | |
| | BB (wild) | 175 | | 48 | | |

* Hatchery fish

Torreys Hole



| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER | |
|---|---|---|---|---|---|---|---|
| | CS | 110 | | 13 | AA | 1 | |
| ✓ | CS | 89 | | 8 | | | mortality |
| | CS | 75 | | 3 | | | |
| | CS | 109 | | 12 | | | |
| | CS | 115 | | 14 | | | |
| ✓ | CS | 96 | | 6 | | | mortality |
| | CS | 95 | | 10 | | | |
| | CS | 93 | | 8 | | | |
| | RB (wild) | 194 | | 57 | | | |
| | WF | 128 | | 15 | | | |
| | WF | 108 | | 9 | | | |
| V | RB | 146 | | 30 | | | mortality |
| V | DS | 90 | | 10 | | | |
| V | DS | 100 | | 12 | | | |
| V | DS | 98 | | 12 | | | |
| V | WF | 101 | | 10 | | | |
| | SH | 25 | | <1 | | | |
| | SH | 23 | | <1 | | | |
| | SH | 25 | | <1 | | | |
| V | SH | 56 | | 3 | | | |
| V | SH | 61 | | 3 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 50 | | 2 | | | |
| | SH | 50 | | 3 | | | |
| | SH | 43 | | 2 | | | |
| | SH | 51 | | 2 | | | |
| | SH | 52 | | 2 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 50 | | 2 | | | |
| | SH | 50 | | 2 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 45 | | 2 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 44 | | 2 | | | |
| | SH | 45 | | 2 | | | |
| | SH | 45 | | 2 | | | |
| | SH | 50 | | 2 | | | |
| | SH | 47 | | 2 | | | |
| | SH | 49 | | 2 | | | |
| | SH | 46 | | 2 | | | |
| | SH | 41 | | 2 | | | |

V= voucher specimens

Salmon ...

Torrey's Hole



| | SPECIES | TOTAL LENGTH | STANDARD LENGTH | WEIGHT | ANOMALIES | NUMBER |
|---|---|---|---|---|---|---|
| V | SH | 73 | | 6 | AA | 1 |
| V | SH | 75 | | 6 | | |
| | SH | 72 | | 5 | | |
| | SH | 70 | | 5 | | |
| | SH | 66 | | 5 | | |
| | SH | 60 | | 3 | | |
| | SH | 85 | | 10 | | |
| | SH | 73 | | 6 | | |
| | SH | 74 | | 6 | | |
| | SH | 66 | | 4 | | |
| | SH | 75 | | 7 | | |
| | SH | 78 | | 7 | | |
| | SH | 71 | | 6 | | |
| | SH | 62 | | 4 | | |
| | SH | 69 | | 5 | | |
| | SH | 68 | | 5 | | |
| | SH | 70 | | 5 | | |
| | SH | 73 | | 6 | | |
| | SH | 72 | | 6 | | |
| | SH | 66 | | 4 | | |
| | ~~SH~~ | ~~66~~ | | 4 | | |
| | SH | 65 | | 4 | | |
| V | SH | 85 | | 9 | | |
| V | SH | 86 | | 10 | | |
| | SH | 96 | | 12 | | |
| | SH | 90 | | 12 | | |
| | SH | 91 | | 13 | | |
| | SH | 78 | | 6 | | |
| | SH | 88 | | 10 | | |
| | SH | 90 | | 10 | | |
| | SH | 84 | | 9 | | |
| | SH | 80 | | 8 | | |
| | SH | 80 | | 8 | | |
| | SH | 80 | | 8 | | |
| | SH | 81 | | 7 | | |
| | SH | 88 | | 10 | | |
| V | SH | 116 | | 29 | | |
| V | SH | 132 | | 46 | | |

V = voucher specimen

— Attributes of freshwater fish species known to occur in Idaho, Oregon, and Washington

| OK le | Family/Common Name | Species | Origin by state[1] | Tolerance[2] | Adult habitat guild | Temperature preference | Adult trophic guild |
|---|---|---|---|---|---|---|---|
| | Catostomidae | | | | | | |
| | Utah sucker | Catostomus ardens | ID | T | benthic | warm | omnivore |
| | longnose sucker | Catostomus catostomus | ID, WA | T | benthic | cold | invertivore |
| | bridgelip sucker | Catostomus columbianus | ID, OR, WA | T | benthic | cool | herbivore |
| | bluehead sucker | Catostomus discobolus | ID | I | benthic | cool | herbivore |
| | largescale sucker | Catostomus macrocheilus | ID, OR, WA | T | benthic | cool | omnivore |
| | mountain sucker | Catostomus platyrhynchus | ID, OR, WA | I | benthic | cool | herbivore |
| | Centrarchidae | | | | | | |
| | pumpkinseed | Lepomis gibbosus | A | T | water column | warm | invert/piscivore |
| | bluegill | Lepomis macrochirus | A | T | water column | warm | invert/piscivore |
| | smallmouth bass | Micropterus dolomieui | A | I | water column | cool | piscivore |
| | largemouth bass | Micropterus salmoides | A | T | water column | warm | piscivore |
| | white crappie | Pomoxis annularis | A | T | water column | warm | invert/piscivore |
| | black crappie | Pomoxis nigromaculatus | A | T | water column | warm | invert/piscivore |
| | Cobitidae | | | | | | |
| | oriental weatherfish | Misgurnus anquillicaudatus | A | T | benthic | warm | omnivore |
| | Cottidae | | | | | | |
| | mottled sculpin | Cottus bairdi | ID, OR, WA | I | benthic | cold | invertivore |
| | Paiute sculpin | Cottus beldingi | ID, OR, WA | I | benthic | cold | invertivore |
| | slimy sculpin | Cottus cognatus | ID, WA | I | benthic | cold | invertivore |
| | shorthead sculpin | Cottus confusus | ID, OR, WA | S | benthic | cold | invertivore |
| | Shoshone sculpin | Cottus greenei | ID | S | benthic | cold | invertivore |
| | Wood River sculpin | Cottus leiopomus | ID | S | benthic | cold | invertivore |
| | torrent sculpin | Cottus rhotheus | ID, OR, WA | S | benthic | cold | invertivore |
| | Cyprinidae | | | | | | |
| | chiselmouth | Acrocheilus alutaceus | ID, OR, WA | I | benthic | cool | herbivore |
| | goldfish | Carassius auratus | A | T | benthic | warm | omnivore |
| | common carp | Cyprinus carpio | A | T | benthic | warm | omnivore |
| | Utah chub | Gila atraria | ID | T | water column | warm | omnivore |
| | ui chub | Gila bicolor | ID, OR, WA | T | water column | warm | omnivore |
| | eatherside chub | Gila copei | ID | I | water column | cool | invertivore |
| | eamouth | Mylocheilus caurinus | ID, OR, WA | I | water column | cool | invertivore |
| | athead minnow | Pimephales promelas | A | T | water column | warm | omnivore |
| | orthern squawfish | Ptychocheilus oregonensis | ID, OR, WA | T | water column | cool | invert/piscivore |
| | ongnose dace | Rhinichthys cataractae | ID, OR, WA | I | benthic | cool | invertivore |
| | eopard dace | Rhinichthys falcatus | ID, OR, WA | I | benthic | cool | invertivore |
| | peckled dace | Rhinichthys osculus | ID, OR, WA | I | benthic | cool | invertivore |
| | edside shiner | Richardsonius balteatus | ID, OR, WA | I | water column | cool | invertivore |
| | ench | Tinca tinca | A | I | water column | warm | invertivore |

tilapia

| ode | Family/Common Name | Species | Origin by state[1] | Tolerance[2] | Adult habitat guild | Temperature preference | Adult trophic guild |
|---|---|---|---|---|---|---|---|
| | Embiotocidae | | | | | | |
| P | shiner perch | Cymatogaster aggregata | OR, WA | S | benthic | cold | invertivore |
| | Esocidae | | | | | | |
| P | northern pike | Esox lucius | A | I | water column | cool | piscivore |
| | Gadidae | | | | | | |
| UR | burbot | Lota lota | ID, OR, WA | I | benthic | cold | piscivore |
| | Ictaluridae | | | | | | |
| - | black bullhead | Ameiurus melas | A | T | hider | warm | invert/piscivore |
| 3 | yellow bullhead | Ameiurus natalis | A | T | hider | warm | invert/piscivore |
| 3 | brown bullhead | Ameiurus nebulosus | A | T | hider | warm | invert/piscivore |
| C | channel catfish | Ictalurus punctatus | A | T | benthic | warm | invert/piscivore |
| A | tadpole madtom | Noturus gyrinus | A | T | hider | warm | invert/piscivore |
| ; | flathead catfish | Pylodictis olivaris | A | T | benthic | warm | piscivore |
| | Percidae | | | | | | |
| ' | yellow perch | Perca flavescens | A | I | water column | cool | invert/piscivore |
| E | walleye | Stizostedion vitreum | A | I | water column | cool | piscivore |
| | Percopsidae | | | | | | |
| | sand roller | Percopsis transmontana | ID, OR, WA | I | hider | cool | invertivore |
| | Poeciliidae | | | | | | |
| ) | western mosquitofish | Gambusia affinis | A | T | water column | warm | invertivore |
| | shortfin molly | Poecilia mexicana | A | T | water column | warm | omnivore |
| | guppy | Poecilia reticulata | A | T | water column | warm | omnivore |
| | green swordtail | Xiphophorus helleri | A | T | water column | warm | omnivore |
| | Salmonidae | | | | | | |
| | lake whitefish | Coregonus clupeaformis | A | I | water column | cold | invert/piscivore |
| | golden trout | Oncorhynchus aquabonita | A | S | hider | cold | invert/piscivore[3] |
| | cutthroat trout | Oncorhynchus clarki | ID, OR, WA | S | hider | cold | invert/piscivore |
| | coho salmon | Oncorhynchus kisutch | ID, OR, WA | S | water column | cold | invertivore[3] |
| | rainbow trout | Oncorhynchus mykiss | ID, OR, WA | S | hider | cold | invert/piscivore |
| | sockeye salmon (kokanee) | Oncorhynchus nerka | ID, OR, WA | S | water column | cold | invertivore[3] |
| | chinook salmon | Oncorhynchus tshawytscha | ID, OR, WA | S | water column | cold | invertivore[3] |
| | pygmy whitefish | Prosopium coulteri | ID, WA | I | water column | cold | invertivore |
| | mountain whitefish | Prosopium williamsoni | ID, OR, WA | I | benthic | cold | invertivore |
| | brown trout | Salmo trutta | A | I | hider | cold | invert/piscivore |
| | bull trout | Salvelinus confluentus | ID, OR, WA | S | hider | cold | piscivore |
| | brook trout | Salvelinus fontinalis | A | I | hider | cold | invert/piscivore |
| | lake trout | Salvelinus namaycush | A | S | benthic | cold | piscivore |
| | Arctic grayling | Thymallus arcticus | A | S | water column | cold | invert/piscivore |

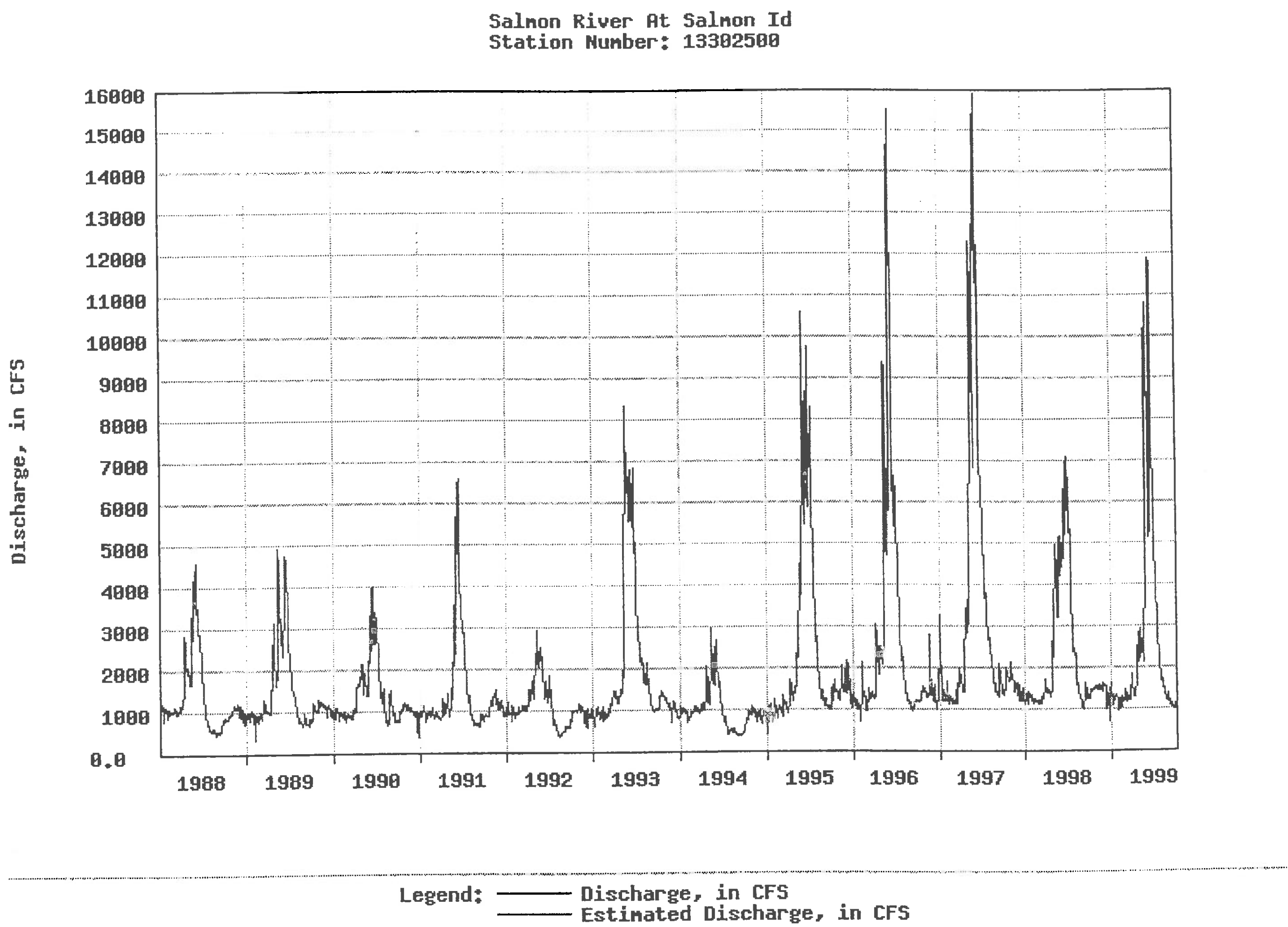
alien to all three states, ID = native to Idaho, OR = native to Oregon, WA = native to Washington

intermediate species, S = sensitive species, T = tolerant species

aracterizes most of freshwater life

/home1/lrmarel/fishlist1.xls (6/10/98)

# APPENDIX H
## Streamflow for Salmon River at Salmon, Idaho
## 1988 - 1999


Salmon River At Salmon Id
Station Number: 13302500
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0.0
Discharge, in CFS
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Legend:
Discharge, in CFS
Estimated Discharge, in CFS