# Middle Salmon River-Chamberlain Creek Subbasin Assessment And Crooked Creek Total Maximum Daily Load

Final

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## EXECUTIVE SUMMARY

The middle Salmon River – Chamberlain Creek subbsain is located in central Idaho and includes the main Salmon River from the Middle Fork Salmon River to French Creek. This is primarily wilderness country. Major portions of the subbsain are in either the Frank Church River of No Return Wilderness or the Gospel Hump Wilderness. There are eight stream segments that are listed on the 1998 303d list for Idaho. The listed stream segments are located in portions of the subbasin primarily outside of wilderness areas.

Six north-side tributaries of the Salmon River are listed for sediment. These are Big Creek, Crooked Creek, Jersey Creek, Big Mallard Creek, Little Mallard Creek, and Rhett Creek. Additionally, Warren Creek, a south-side tributary to the Salmon River, is listed for habitat alteration from its headwaters to the wilderness boundary. The Salmon River is 303d listed from Corn Creek to Cherry Creek for unknown pollutants.

All listed streams were assessed by Idaho DEQ and determined to be fully supporting their aquatic life uses, with the exception of Crooked Creek. Additionally, north-side streams and the Salmon River were assessed by the Nez Perce National Forest using NEZSED modeling, BOISED modeling information provided by the Payette National Forest, and USGS sediment and streamflow data. The Nez Perce National Forest assessment provides a coarse estimation of sediment yields based on land use coefficients and natural erosion potential. Simulations from this modeling suggest these streams may not produce abundant activity-related sediment, at least not in excess of the model's inherent variability.

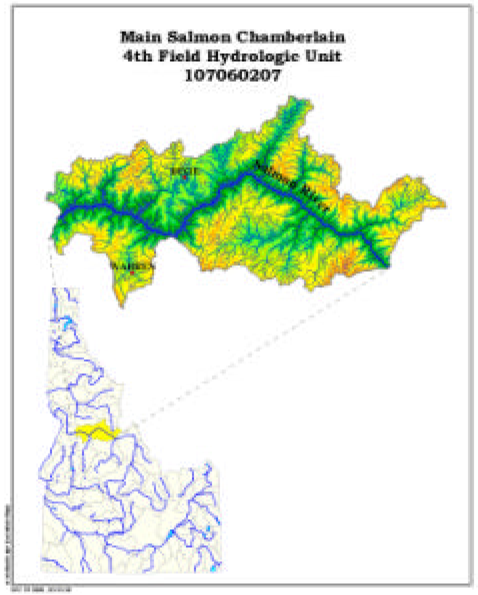
Because all streams are supporting their aquatic life uses and human activity related sediment yields appear to be low, it was determined that none of the streams 303d listed for sediment, including the Salmon River, were sufficiently impacted to require total maximum daily loads for sediment. Warren Creek, is obviously altered by past dredge mining, and is correctly listed for habitat alteration. No total maximum daily load is required for a stream listed for habitat alteration.

During the subbasin assessment, water temperature data indicated the upper portion of Crooked Creek has elevated water temperatures, which may impact salmonid spawning throughout the creek. A total maximum daily load (TMDL) for temperature in Crooked Creek was calculated based on effective shade modeling. This TMDL suggests water temperatures need to decrease and effective shade needs to increase in upper Crooked Creek to achieve a natural water temperature regime. Effective shade modeling suggests Crooked Creek should have thermal loads that vary from 60 to 300 Langleys/day and effective shade from 50 to 90%. Existing canopy coverage was used to identify problem areas that may lack effective shade and have increased solar loading in upper Crooked Creek.

# Mid-Salmon/Chamberlain Subbasin at a Glance

IDEQ 1998 303(d) List
Mid-Salmon/Chamberlain Subbasin Hydrological Unit Code # 17060207

| WQLS | Assessment Units of ID17060207 | Waterbody | Boundaries | Year of TMDL | Pollutants | | **Stream Miles** |
|---|---|---|---|---|---|---|---|
| 3346 | SL001_07, SL008_07, SL018_07, SL037_07 | Salmon River | Corn Creek to Cherry Creek | 2000 | | Unknown | 76.9 |
| 3349 | SL067_05, SL068_02, SL068_03, SL068_04 | Crooked Creek | Headwaters to Salmon River | 2000 | | Sediment | 21.25 |
| 3351 | SL069_02, SL069_03 | Big Creek | Headwaters to Crooked Creek | 2000 | | Sediment | 12.25 |
| 3352 | SL007_02, SL007_03, SL007_03a | Warren Creek | Headwaters to Wilderness boundary | 2000 | Habitat Alteration | | 16.15 |
| 5018 | SL061_02, SL061_02a | Big Mallard Creek | Headwaters to Salmon River | 2000 | | Sediment | 18.77 |
| 5099 | SL065_02 | Jersey Creek | Headwaters to Salmon River | 2000 | | Sediment | 7.65 |
| 5109 | SL062_02 | Little Mallard Creek | Headwaters to Salmon River | 2000 | | Sediment | 8.78 |
| 5156 | SL063_03 | Rhett Creek | Headwaters to Salmon River | 2000 | | Sediment | 8.39 |




Changes for 303(d) List
Based on Mid-Salmon/Chamberlain subbasin assessment
(Changes in bolded italics)

| Waterbody | Boundaries | Year of TMDL | Pollutant | | | **Stream Miles** |
|---|---|---|---|---|---|---|
| Salmon River | Corn Creek to Cherry Creek | 2000 | | | ***De-list Unknown*** | 76.9 |
| Crooked Creek | Headwaters to Salmon River | 2000 | | ***De-list Sediment*** | ***Add Temperature*** | 21.25 |
| Big Creek | Headwaters to Crooked Creek | 2000 | | ***De-list Sediment*** | | 12.25 |
| Warren Creek | Headwaters to Wilderness boundary | 2000 | Habitat Alteration | | | 16.15 |
| Big Mallard Creek | Headwaters to Salmon River | 2000 | | ***De-list Sediment*** | | 18.77 |
| Jersey Creek | Headwaters to Salmon River | 2000 | | ***De-list Sediment*** | | 7.65 |
| Little Mallard Creek | Headwaters to Salmon River | 2000 | | ***De-list Sediment*** | | 8.78 |
| Rhett Creek | Headwaters to Salmon River | 2000 | | ***De-list Sediment*** | | 8.39 |

| | |
|---|---|
| *Hydrologic Unit Code* | 17060207 |
| *Primary drainage* | Main Salmon River |
| *Listed stream miles* | 170.14 |
| *Beneficial Uses Affected* | Cold water biota<br>Salmonid spawning |
| *Species of Concern* | Chinook Salmon, Steelhead Trout, Bull Trout, Westslope Cutthroat Trout |
| *Population* | Less than 100 |
| *Major land uses* | Forestry, rangeland and recreation |
| *Public participation* | 1/17/2001 – 2/19/2001<br>Two agencies and one tribe responded |

## Crooked Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 21.25 |
| *Geomorphic characteristics* | Third order stream<br>Rosgen B Channel |
| *Salmonid spawning* | Multiple age classes above and below migration barrier; bull trout observed below barrier |
| *Cold water biota* | Macroinvertebrate index scores = 4.92(lower), 4.46(upper) |
| *Impacts to riparian area* | Placer and dredge mining in upper watershed |

## Listing History

- Crooked Creek was placed on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

## Waterbody Assessments

- BURP
  - 1997SLEWC011 MBI 4.92, fines 30%, w/d ratio 36.7
  - 1997SLEWC016 MBI 4.46, fines 18%, w/d ratio 21.6
- NPNF
  - Sediment yield 4.4% over base for CEW, 0.7% lower Crooked Cr., 24% upper Crooked Cr.
  - Temperature exceed criteria for salmonid spawning and bull trout.

## Recommendations and Conclusions

- Crooked Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment. Temperature criteria violations led to TMDL for temperature. An increase in canopy coverage is needed in upper Crooked Creek watershed to correct water temperature problems.

## Big Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 12.25 |
| *Geomorphic characteristics* | Third order stream<br>Rosgen B channel |
| *Salmonid spawning* | Rainbow trout and hybrid trout spawning and early rearing |
| *Cold water biota* | Macroinvertebrate index score = 5.07(lower), 4.61(upper) |
| *Impacts to riparian area* | Some minor grazing |

## Listing History

- Big Creek was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

## Waterbody Assessments

- BURP
  - 1997SLEWA014 MBI 5.07, fines 19%, w/d ratio 17.3
  - 1997SLEWA015 MBI 4.61, fines 15%, w/d ratio 10.8
- NPNF
  - Sediment yield 0.7% to 2% over base.

## Recommendations and Conclusions

- Big Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment.

## Big Mallard Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 18.77 |
| *Geomorphic characteristics* | Third order stream<br>Rosgen C Channel |
| *Salmonid spawning* | Multiple size classes of brook trout |
| *Cold water biota* | Macroinvertebrate index scores = 5.06(lower), 5.31(upper) |
| *Impacts to riparian area* | Some minor grazing and timber harvesting |

### Listing History

- Big Mallard Creek was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

### Waterbody Assessments

- BURP
  - 1997SLEWC012 MBI 5.31, fines 20%, w/d ratio 10.9
  - 1997SLEWC015 MBI 5.06, fines 19%, w/d ratio 21.8
- NPNF
  - Sediment yield 3.5% over base for CEW.
  - Temperature exceed criteria for bull trout at mouth.

### Recommendations and Conclusions

- Big Mallard Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment. Temperature criteria violations at mouth are probably not in spawning areas.

## Little Mallard Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 8.78 |
| *Geomorphic characteristics* | Second order stream<br>Rosgen A channel |
| *Salmonid spawning* | No fish observed; migration barrier at mouth |
| *Cold water biota* | Macroinvertebrate index score = 4.25 |
| *Impacts to riparian area* | Some minor mining, grazing, timber harvesting |

### Listing History

- Little Mallard Creek was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

### Waterbody Assessments

- BURP
  - 1997SLEWA017 MBI 4.25, fines 18%, w/d ratio 30.1
- NPNF
  - Sediment yield 2% over base.

### Recommendations and Conclusions

- Little Mallard Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment.

## Jersey Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 7.65 |
| *Geomorphic characteristics* | Second order stream<br>Rosgen A Channel |
| *Salmonid spawning* | Rainbow trout, cutthroat trout, steelhead rearing |
| *Cold water biota* | Macroinvertebrate index scores = 4.93 |
| *Impacts to riparian area* | Some minor mining and timber harvesting |

# Listing History

- Jersey Creek was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

# Waterbody Assessments

- BURP
  - 1997SLEWC014 MBI 4.93, fines 4%, w/d ratio 23.1
- NPNF
  - Sediment yield 3.8% over base.

# Recommendations and Conclusions

- Jersey Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment.

## Rhett Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 8.39 |
| *Geomorphic characteristics* | Second order stream<br>Rosgen B channel |
| *Salmonid spawning* | Multiple age classes above and below migration barrier |
| *Cold water biota* | Macroinvertebrate index score = 5.13 |
| *Impacts to riparian area* | Some minor mining, grazing, timber harvesting |

# Listing History

- Rhett Creek was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information.

# Waterbody Assessments

- BURP
  - 1997SLEWA013 MBI 5.13, fines 23%, w/d ratio 39.4
- NPNF
  - Sediment yield 0.7% over base for CEW.

# Recommendations and Conclusions

- Rhett Creek was listed for sediment. However, good macroinvertebrate scores and low sediment yield overall indicated that the stream should be de-listed for sediment.

## Salmon River at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 76.90 |
| *Geomorphic characteristics* | Major River |
| *Salmonid spawning* | Anadromous and resident salmonid migration |
| *Cold water biota* | Macroinvertebrate index scores = NA |
| *Impacts to riparian area* | Some minor homesteading and recreation |

# Listing History

- Salmon River was place on the State of Idaho 303(d) list in 1996 by EPA, it was retained on the 1998 list due to a lack of information. Listed pollutants are unknown.

# Waterbody Assessments

- BURP
  - NA
- NPNF
  - Sediment yield - minimal contributions from subbasin activties.

# Recommendations and Conclusions

- Salmon River was listed for unknown pollutants. However, low sediment yield overall and the lack of other documented problems within the subbasin indicated that the river should be de-listed.

## Warren Creek at a Glance

| | |
|---|---|
| *1998 303(d) listed stream miles* | 16.15 |
| *Geomorphic characteristics* | Third order stream<br>Rosgen A-C channel |
| *Salmonid spawning* | Several salmonid species observed below migration barrier |
| *Cold water biota* | Macroinvertebrate index score = 4.99(upper), 4.93(lower) |
| *Impacts to riparian area* | Some major mining, timber harvesting |

# Listing History

- Warren Creek was place on the State of Idaho 303(d) list in 1996 by EPA for habitat alteration, it was retained on the 1998 list due to a lack of information.

# Waterbody Assessments

- BURP
  - 1997SLEWA022 MBI 4.99, fines 5%, w/d ratio 42.3
  - 1997SLEWA023 MBI 4.93, fines 8%, w/d ratio 55.7
- PNF
  - Sediment surface fines 15% or less.

# Recommendations and Conclusions

- Warren Creek was listed for habitat alteration. Good macroinvertebrate scores and low surface fine sediment indicated that the stream does not have a sediment problem. However, the stream should remain listed for habitat alteration due to extensive dredge mining.

# MIDDLE SALMON RIVER-CHAMBERLAIN CREEK SUBBASIN ASSESSMENT

The middle Salmon River-Chamberlain Creek subbasin (Hydrologic Unit Code #17060207) (from here on referred to as the Salmon-Chamberlain subbasin or, on maps, Main Salmon - Chamberlain) is in north-central Idaho (Map 1–Subbasin Location). The mainstem Salmon River originates in the Sawtooth and Lemhi Valleys of central and eastern Idaho. The area under consideration includes the middle segment of the main Salmon River and its tributaries from its confluence with the Middle Fork Salmon River to, but not including, French Creek. Floating downstream and entering the subbasin from the east, the first few sub-watersheds encountered include Corn, Bear Basin, and Kitchen Creeks, and the last few watersheds before leaving the subbasin on the western edge are Wind River, Carey and Fall Creeks (Map 2–Surface Water Hydrology). The Salmon River flows through a vast wilderness (Frank Church River of No Return Wilderness and Gospel Hump Wilderness) in the Salmon River Gorge, second deepest gorge in the lower 48-contiguous states, more than one mile deep.

## PHYSICAL AND BIOLOGICAL CHARACTERISTICS

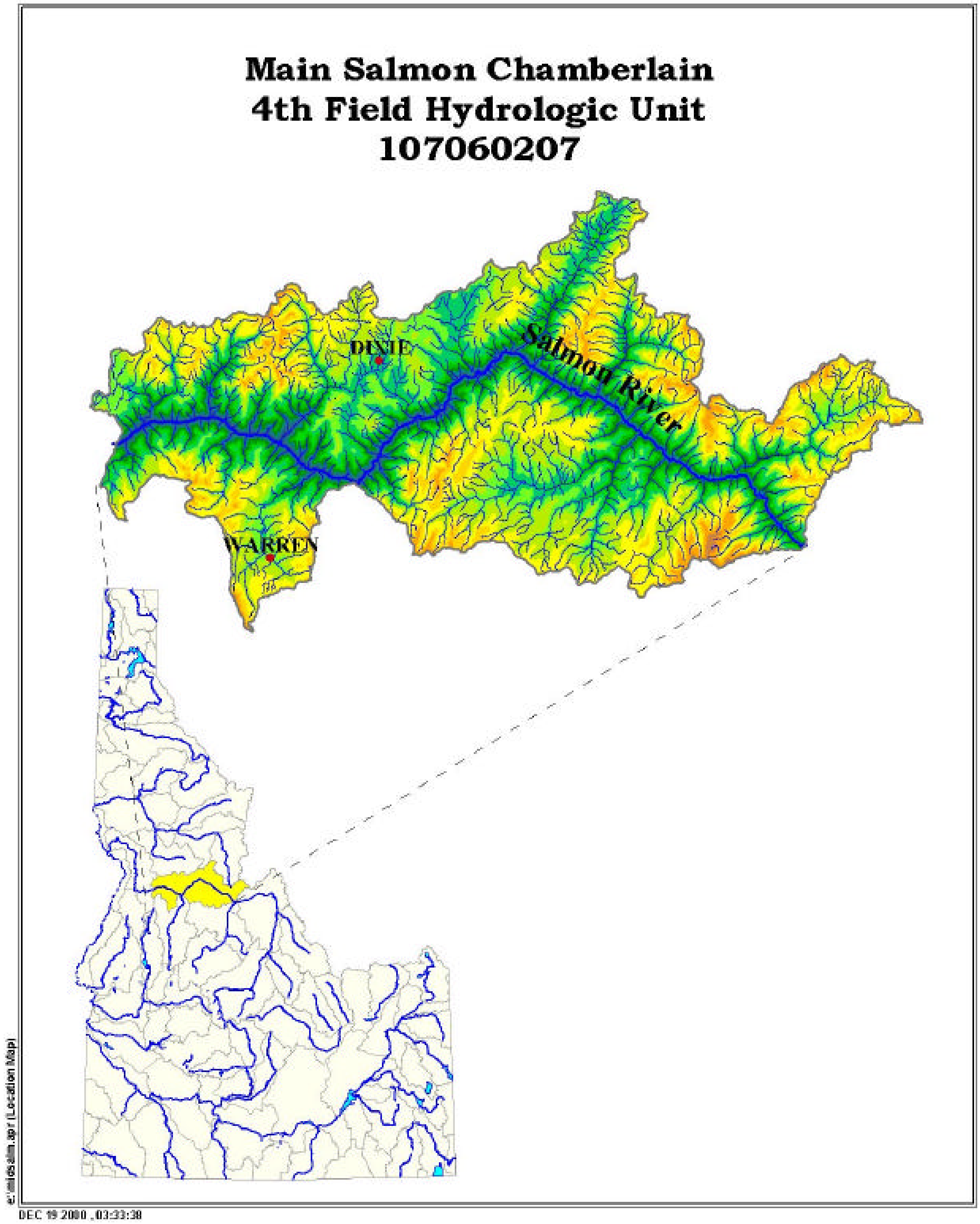
### CLIMATE

Northern Idaho climate is dominated by Pacific maritime air masses and prevailing westerly winds. Precipitation at Dixie is nearly 30 inches annually, but at higher elevations can be as high as 50 to 60 inches annually (NPNF, 1999a). Mid- to high-elevation precipitation is generally high enough to support forested ecosystems. Annual precipitation at lower elevations is in the range of 15 to 25 inches (NPNF, 1999a) The subbasin is typical of many central Idaho drainages: relatively high mountains with large snowpack giving way to warmer, drier canyons at lower elevations. Temperature and precipitation normals for three climatological stations in or near the subbasin are presented in Table 1.

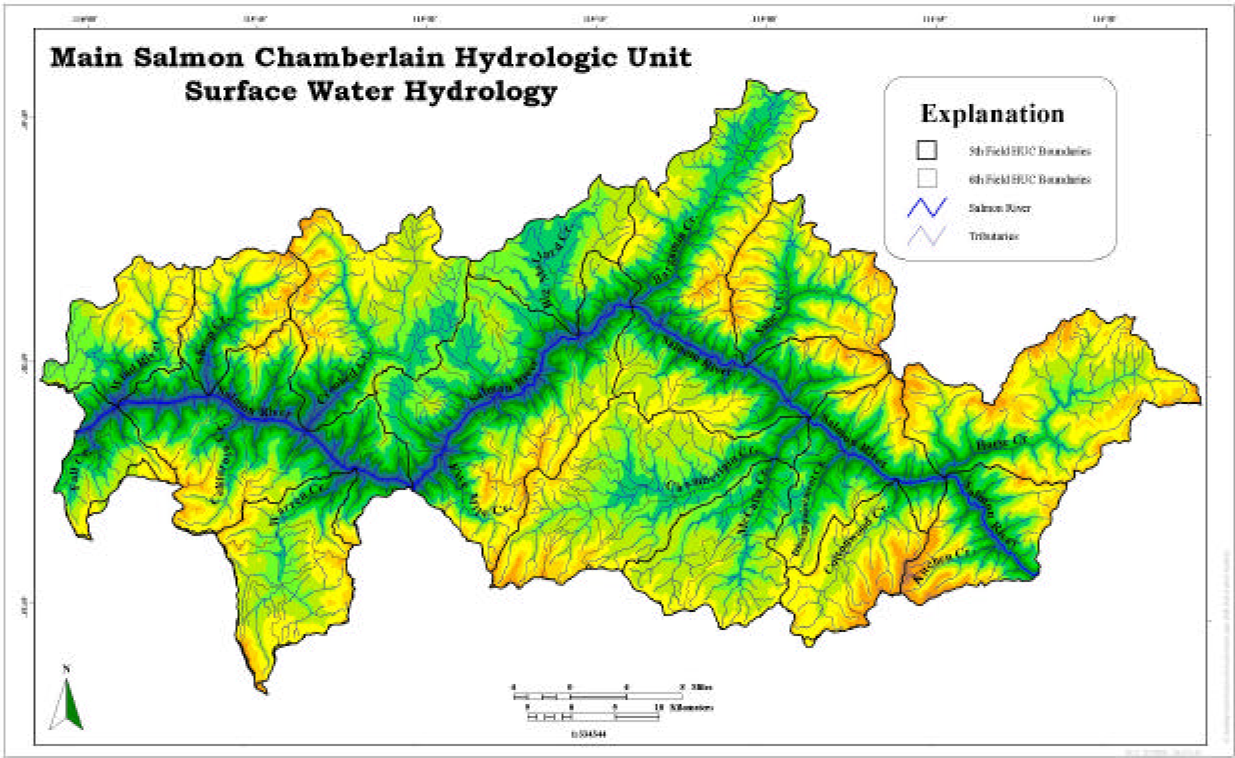
Table 1. Normals for precipitation and temperatures 1961-1990 (From: Abramovich et al., 1998).

| Station Name | ID No. | Elev. (feet) | Lat. | Long. | Mean Annual Precipt. (inch.) | Total Ave. Snowfall (inch.) | Mean Annual Temp. ($^{O}$F) | Ave. Annual Daily Max. $^{O}$F | Ave. Annual Daily Min. $^{O}$F |
|---|---|---|---|---|---|---|---|---|---|
| Dixie | 2575 | 5620 | 45:33 | 115:28 | 29.60 | 206.8 | 35.8 | 50.7 | 20.9 |
| Riggins | 7706 | 1800 | 45:25 | 116:19 | 17.45 | 7.9 | 54.0 | 65.8 | 42.1 |
| Warren | 9560 | 5910 | 45:16 | 115:40 | 27.10 | 177.3 | 37.5 | 53.5 | 21.4 |

**Map 1. Location Map**



**Map 2. Surface Water Hydrology**




Elevations within the subbasin range from around 1900 feet at the mouth to over 9000 feet in the mountains at the east end of the subbasin. Climate stations at Dixie and Warren represent the mid-range in elevation. Higher elevations in the subbasin would be expected to be cooler with higher annual precipitation. The Riggins station is at a lower elevation than the subbasin; however, it reflects the drier, warmer conditions present in the canyon near the mouth of the subbasin.

## HYDROLOGY

The U.S. Geological Survey (USGS) gage station for White Bird (Table 2) (Map 3XUSGS Gaging Stations) which is downstream from the subbasin and other USGS station data from tributaries in and around the subbasin (Table 3) give some indication of the flows experienced within this subbasin. The drainage area above White Bird is 13,550 square miles ($mi^2$) and includes most of the Salmon River basin from Stanley to White Bird. This gaging station records the accumulative flow of the Salmon River originating near Galena Summit and includes the North Fork, Middle Fork, South Fork, the Little Salmon River, Lemhi River, Pahsimeroi River and the many tributaries. With an average annual mean flow over 11,000 cubic feet per second (cfs) at White Bird, more than half this flow (6400 cfs) is added by the Salmon River basin above the Salmon-Chamberlain subbasin, the Middle Fork, and the South Fork. The remaining 5000 cfs comes from the subbasin and Panther Creek, Little Salmon River, and all the tributaries between the subbasin and White Bird. Five and ten year peak flows approximate 80,000 to 96,000 cfs (Table 4).

Table 2. Downstream Flow and Basin Runoff - Salmon River at White Bird, ID, USGS Station # 13317000. Ac-Ft = Acre-feet; CFSM = cubic feet per square mile.

| Years | Average Annual Mean (cfs) | Highest Annual Mean (cfs) | Lowest Annual Mean (cfs) | Annual Runoff (Ac-Ft) | Annual Runoff (CFSM) | Annual Runoff (Inches) |
|---|---|---|---|---|---|---|
| 1910-1998 | 11210 | 17870 (1997) | 5812 (1931) | 8124000 | 0.83 | 11.25 |

**Map 3. USGS Gaging Stations**

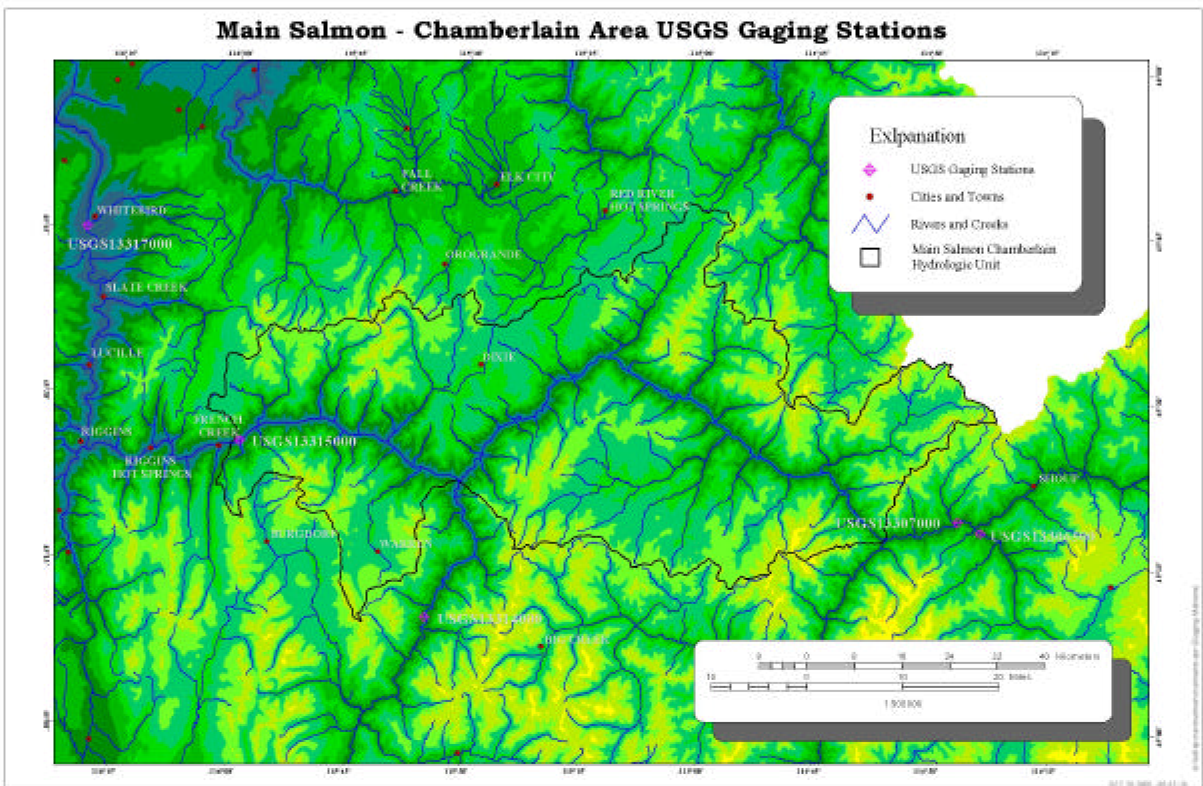


Table 3. Contributing Flows in and Around the Subbasin.

| Station Name | Station # | Data Years | Average Annual (cfs) | Highest annual flow in cfs (year of occurrence) | Lowest annual flow in cfs (year of occurrence) |
|---|---|---|---|---|---|
| Salmon R. near Shoup | 13307000 | 1944-1981 | 3037 | 4513 (1965) | 1813 (1977) |
| MF Salmon R. at mouth | 13310199 | 1993-1996 | 1753 | 2151 (1995) | 1355 (1994) |
| SF Salmon near Warren | 13314300 | 1993-1996 | 1645 | 2327 (1995) | 963 (1994) |
| Warren Cr. Near Warren | 13314500 | 1943-1949 | 48 | 71 (1948) | 30 (1944) |

Table 4. 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 |
| SF Salmon near Warren | 13314000 | 1932-1948 | 11,600 | 15,100 | 17,300 | 19,900 | 21,700 |
| Salmon R. near French | 13315000 | 1945-1956 | 61,300 | 75,000 | 82,800 | 91,500 | 97,300 |
| Salmon R. at White Bird | 13317000 | 1894, 1911-1917, 1920-1997 | 61,300 | 82,900 | 96,000 | 111,000 | 122,000 |

The Salmon River canyon is steep and rocky, with an average gradient of approximately 0.23%, and the channel alternates between large pools and boulder-dominated rapids (Clearwater Basin Bull Trout Technical Advisory Team, 1998). The hydrology of tributaries tends to be dominated by snowmelt runoff from the Sawtooth and Salmon River Mountains in the south and the Clearwater and Bitterroot Mountains in the north. Snowmelt runoff generally produces high-gradient, high-energy stream systems. Gradients average 7.7% for first and second order streams.

## GEOLOGY AND GEOMORPHOLOGY

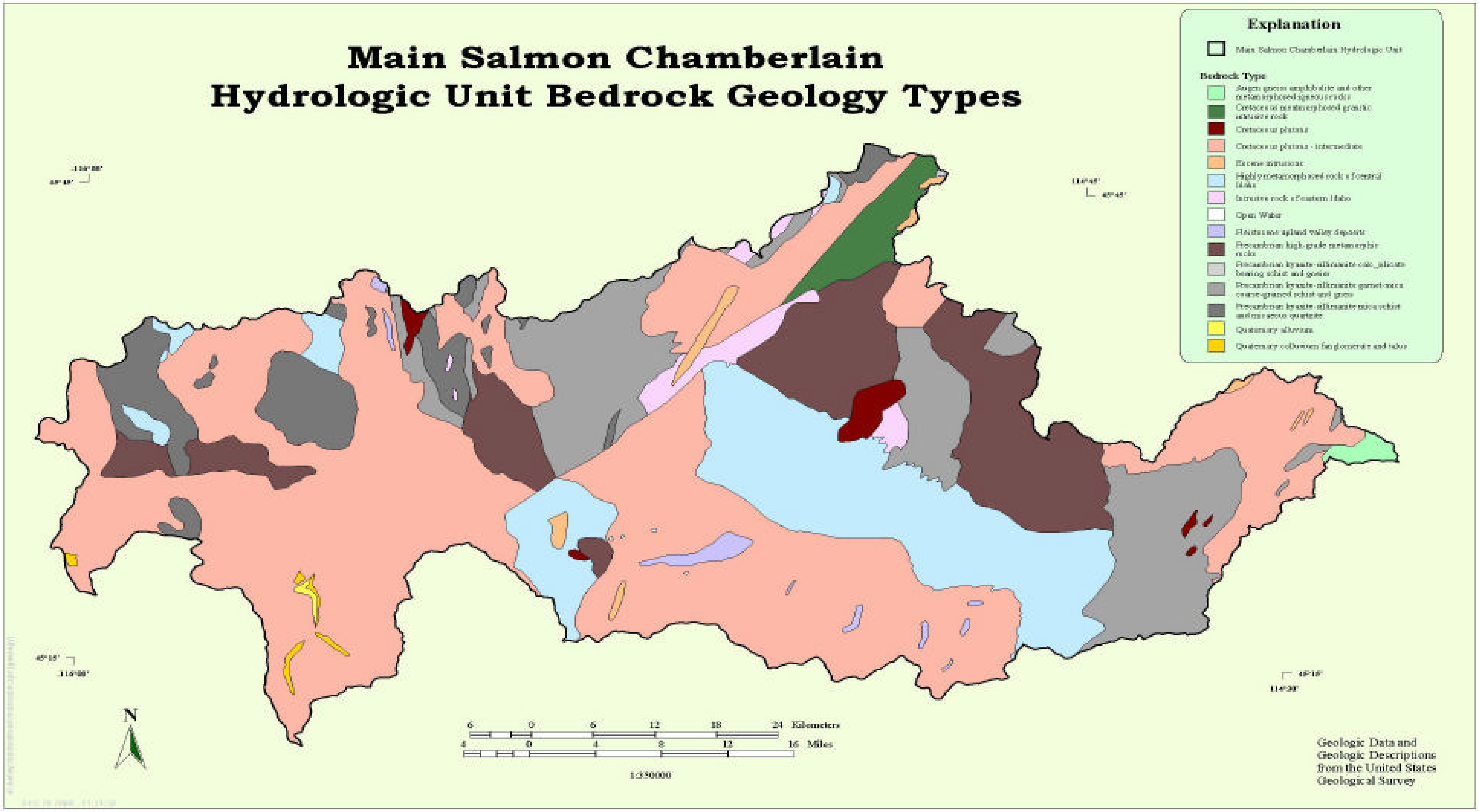
The geology of the subbasin is a combination of Idaho batholith (mostly Cretaceous aged rock; green, blue, and salmon colors on Map 4) and metamorphic Precambrian basement rocks (shades of gray and maroon colors on Map 4) that intergrade with each other throughout the area (Map 4–Bedrock Geology). The Salmon River flows through an area referred to as the Salmon River Arch, an expanse of Precambrian basement rock considered to be old continental crust that separates the northern and southern parts of the Idaho batholith (Alt and Hyndman, 1989). The Precambrian basement complex is mostly comprised of 1,500 million-year-old gneiss and schists, metamorphosed from much older rock under intense heat and pressure.

The Idaho batholith is a pale greyish granite approximately 75 million years old (Alt and Hyndman, 1989). It is made up primarily of feldspar crystals intergrown with quartz. Throughout the rock are scattered black-colored crystals, either flakes of biotite mica or needles of hornblende. Several thousand feet thick, the Idaho batholith=s sheets of granite resulted from an intrusion of magma rising up from below. As the magma encountered native rock of similar density, it spread out horizontally in the subsurface underlying large expanses of central Idaho. The Salmon River Arch is thought to be a broad anticline that warped the granite sheet upward, thus allowing it to erode and expose the underlying, older metamorphic basement rock. A few miles west of French Creek, the canyon cuts through the suture zone between the former western coastline of the continent and an old chain of volcanic islands which became the Seven Devils complex. These volcanic islands accreted onto the side of the continent at a subduction zone between colliding crustal plates. Presumably, the subduction of oceanic crust under the continent led to the melting and rising of magma to form the batholith which appeared soon after the joining of the Seven Devils complex (Hyndman, 1989). Down the Salmon River canyon towards French Creek, the pale grey granite of the batholith gives way to darker mylonite, sheared granite caused by the collision and subduction.

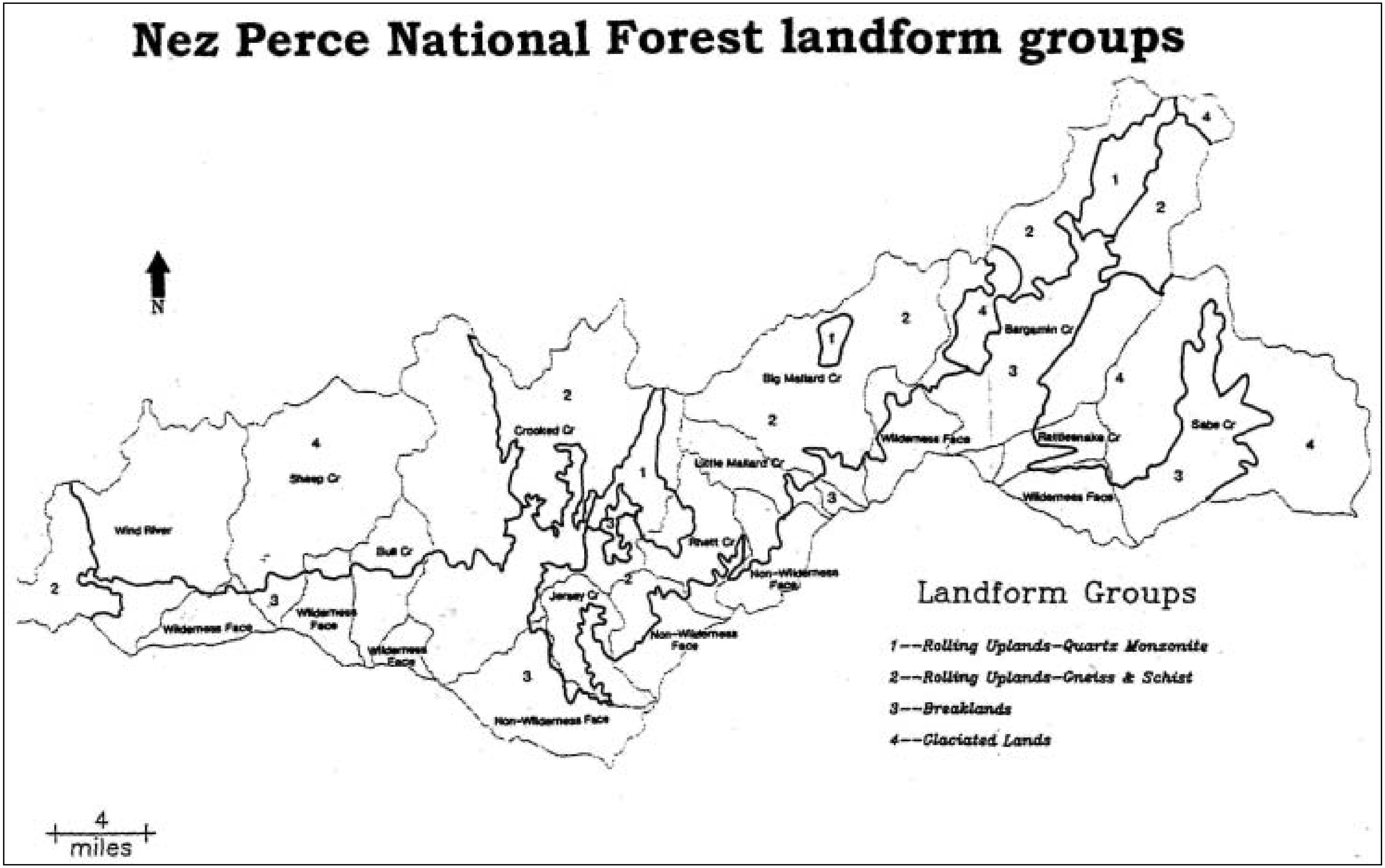
The moderately well-weathered crystalline rock is highly erodible, generating sand and gravel-sized sediment throughout most of the northern upland areas of the subbasin. Natural sediment sources in the rolling upland channel reaches are channel erosion and, to a lesser extent, surface erosion. Surface erosion is generally inhibited by a volcanic-rich soil layer that acts as a buffer in undisturbed areas. Sediment transport occurs primarily during the spring runoff and often as a result of summer precipitation events. Mass wasting is generally considered a relatively insignificant source.

On the north side of the subbasin, the Nez Perce National Forest has identified four natural stratifications within the scope of this Subbasin Assessment, which are represented by Landform Groups (Map 5–Nez Perce National Forest Landform Groups). A landform group is based upon geomorphology, geology, stream morphology, vegetation, disturbance regimes (including fire), and climate. A full description and discussion of the four landform groups including composition, structure, function, and the range of natural variability of each ecological system is provided in Biological Assessment Main Salmon River Tributaries (Northeast) Watershed Analysis Area (NPNF, 1994).

**Map 4. Bedrock Geology**



**Map 5. Nez Perce National Forest Landform Groups**



Landform Group One (LFG-1) is characterized by rolling upland hills derived from moderately well weathered granite, which is highly erodible. Under natural conditions, surface erosion occurs as a response to wildfire. Generally, the ability of riparian vegetation to recover after disturbance is limited due to low soil productivity. LFG-1 occurs in three primary areas of the subbasin: upper Crooked Creek valley bottom, including the lower reaches of Crooked Creek's numerous tributaries, a small portion of Big Mallard Creek near Jack Creek, and upper Rhett Creek. The hydrology of LFG-1 is dominated by snowmelt. The elevation ranges from 5,000 to 6,500 feet above sea level.

Landform Group Two (LFG-2) is characterized by rolling upland hills with low to moderate relief, with slopes between 20 and 50% and dendritic drainage patterns at the 1st and 2nd order. Parent materials are moderately-to well-weathered granite, gneiss, schist, and quartzite, which are highly fractured. The soils are generally capped by a volcanic ash and buffered against surface erosion unless disturbed. The hydrology is dominated by a slow and sustained snowmelt. LFG-2 occurs in the upper half of several drainages: Big Creek and Crooked Creek, Little Mallard, Big Mallard, and Jersey. The elevation ranges from 5,000 to 7,600 feet above sea level. Landform Group Three (LFG-3) is characterized by steep to very steep stream breaklands and mountain slopes along the mainstem Salmon River. Parent materials are moderately well- weathered granite, gneiss, schist, and quartzite. These surfaces are highly erodible, especially along the steepest south aspects, generating mostly sand and cobble-sized materials. Where soil occurs, they are shallow to moderately deep over the bedrock. Slopes range from 40 to 80% with parallel drainage channels. LFG-3 occurs along the mainstem Salmon River, the lower two miles of its tributaries, as well at the lower half of large drainages such as Crooked, Sabe, and Bargamin. Much of this landform is contained within the Gospel-Hump and Frank Church wilderness areas. The elevation ranges from 2,000 to 6,800 feet above sea level.

Landform Group Four (LFG-4) includes alpine glaciated lands from 6,800 to 8,900 feet in elevation. This group includes the upper reaches of the Wind River, Sheep Creek, Crooked Creek, and Sabe Creek drainages. The area is characterized by steep ice-scoured cirques and troughs and gently sloping ice scoured ridges, valley bottoms, and moraine deposits. Parent materials are poorly- to well-weathered hard crystalline rock, including granite, gneiss, schist, and quartzite, highly erodible except with enough rock to buffer movement. Soils are shallow with some deeper pockets and volcanic ash tends to be intermixed rather than layered.

## TOPOGRAPHY

The hills surrounding the Salmon River canyon are softly rounded haystacks in appearance and composed of a thick mantle of soil and weathered rock. The thick soil along with sufficient precipitation allows for the near complete forested canopy. The western and southern portions of the subbasin are underlain by batholith, which erodes to granular sugar, giving the hills their soft, rounded appearance. The older metamorphic basement rock found in the lower canyon and on the north side above Sabe Creek give the river's edge its distinctly rugged appearance.

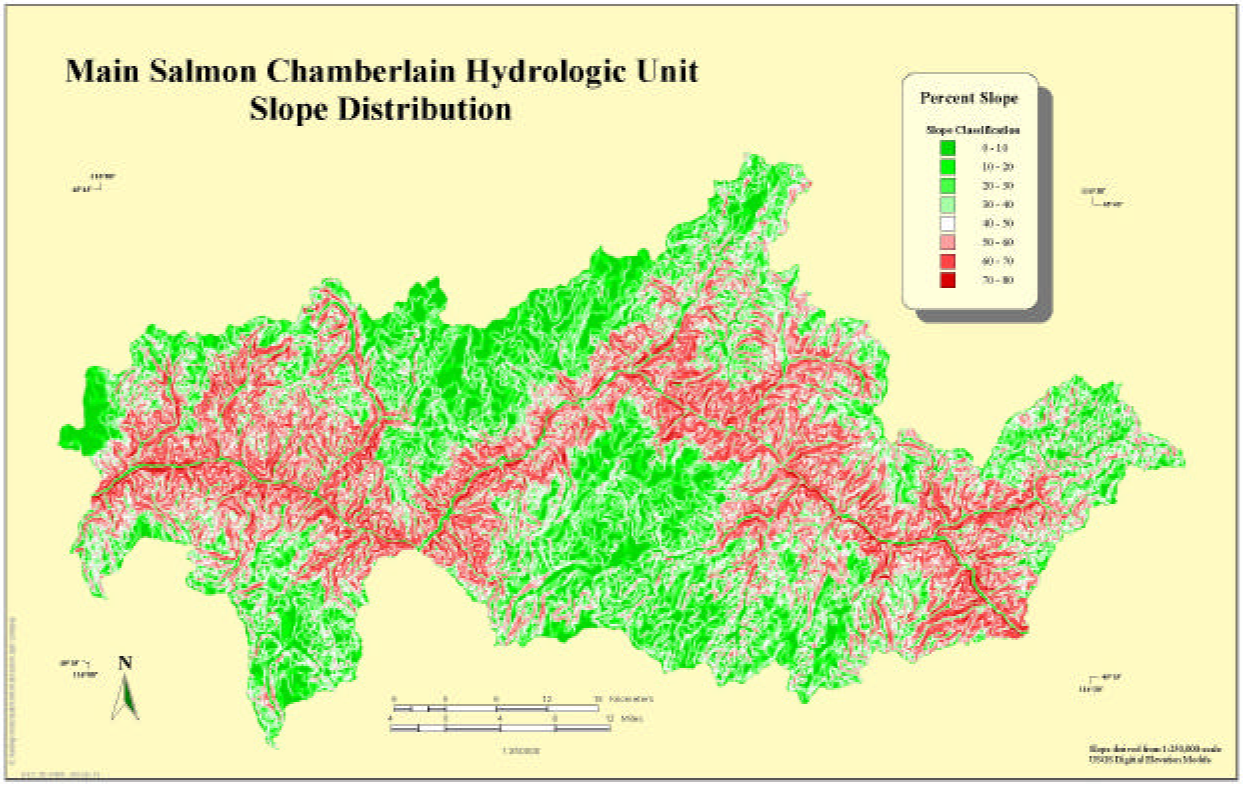
The rolling uplands vary in elevation from greater than 9000 feet at Cottonwood Butte in the southeast to 6700 feet at Black Butte on the western edge of the subbasin. Elevations in the canyon at the river=s edge vary from near 3000 feet at the eastern end of the subbasin to approximately 1900 feet at the western end. Typically, face drainages and the lower portions of major drainages are higher gradient as water runs off the rolling highlands and then plunges into the deeper canyon to join the Salmon River (Map 6–Slope Distribution). Drainages run basically north-south in the subbasin with those on the north side of the canyon draining south and the south side of the canyon draining north. North-south drainages create more east- and west-facing slopes. In general, north-facing slopes are the coolest and south-facing slopes the warmest, since they receive more direct sunlight. East- and west-facing slopes are more intermediate with west-facing slopes slightly warmer as late afternoon sun tends to cause warmer air temperatures.

**VEGETATION**

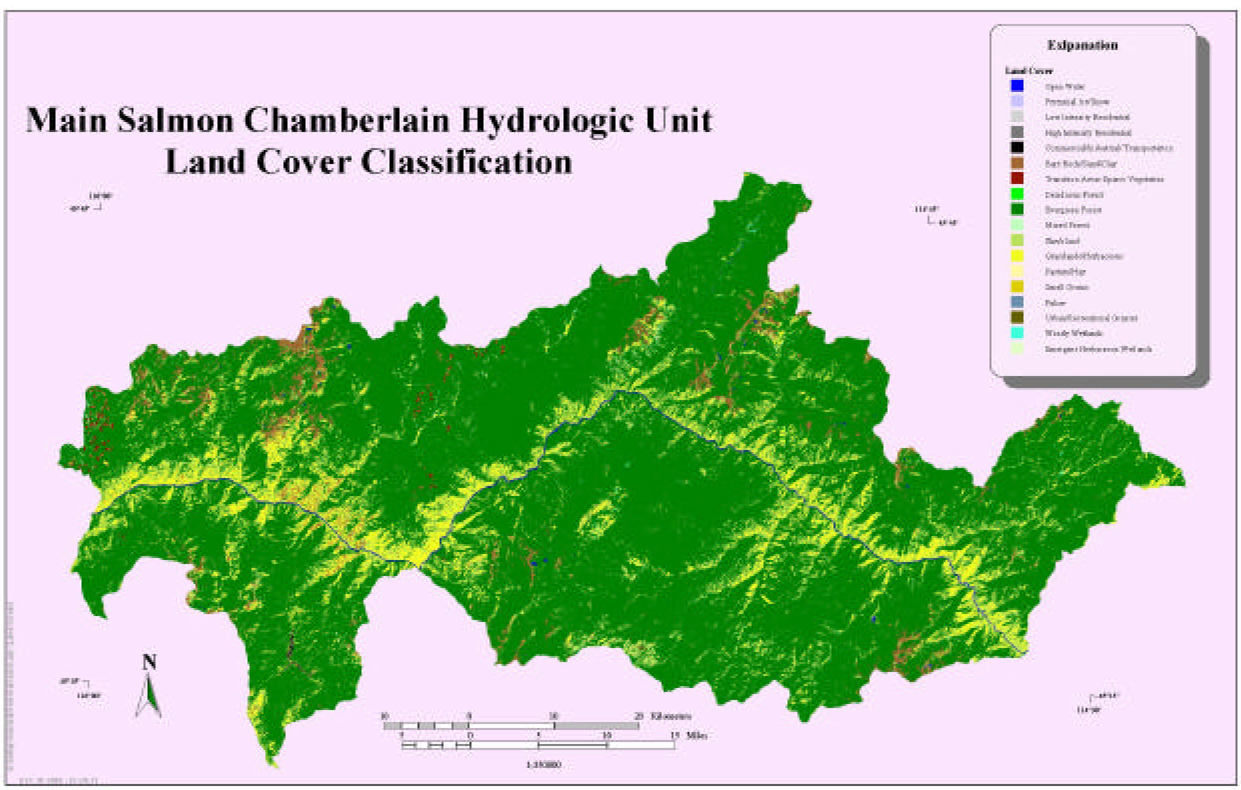
The subbasin is substantially forested, but the lower elevation canyon walls, along the Salmon River especially, are often in shrublands, sagebrush (*Artemisia sp.*) and/or mountain mahogany (*Cercocarpus sp.*) (Map 7–Land Cover Classification). The principle forest types are ponderosa pine (*Pinus ponderosa*) within drier elevations at 2,000 to 6,500 feet, especially on the south side of the Salmon River; Douglas fir (*Psuedotsuga menziesii*) on more mesic sites; mixed conifers with a predominance of grand fir (*Abies grandis*) at mid-elevations between 4,500 to 6,500 feet; and subalpine fir (*Abies lasiocarpa*) at higher elevations above 6,500 feet (Steele et al., 1981; NPNF, 1999a). In addition, a number of other conifers may be present in mixed communities or locally dominant, including western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), whitebark pine (*Pinus albicaulis*), western white pine (*Pinus monticola*), and Engelmann spruce (*Picea engelmannii*).

Fire cycles vary considerably between lower elevation canyon shrublands and higher elevation forests. Breaklands may have experienced short interval (10 to 20 years) cool surface fires on southern aspects before fire suppression (NPNF, 1994). Many of these smaller fires may have been started by indigenous peoples. Upland stand-replacing natural fires occur every 117 to 150 years, and 174 years or more for valley bottoms (NPNF, 1994). Forested communities at higher elevation glaciated lands experience fire every 100 to 150 years in lodgepole, 200+ years in riparian areas (NPNF, 1994). The open whitebark pine/subalpine fir communities at ridge-tops experience small infrequent fires because of discontinuous fuel distribution and cooler temperatures. Stand-replacing fires were infrequent in these ridge-top areas, with fire-free intervals ranging from 63 to 300 years (NPNF, 1994). Shrublands dominated by sagebrush/bunchgrass may experience fires every 40 to 100 years. Because of fire-suppression efforts, the number of acres burned in the last 125 years is four times less than for similar periods in pre-settlement times. The fire cycle today is considered to be a four-fold reduction in acres burned or 125 years, compared to that for pre-settlement times.

**Map 6. Slope Distribution**




**Map 7. Land Cover Classification**



The year 2000 fire season has proved to be one of the largest in recorded history. Portions of this subbasin have been burned in 2000 primarily in the Payette National Forest. The Burgdorf Junction fire burned over 64,000 acres between July 15, 2000 and September 4, 2000 (Payette National Forest, 2001). The majority of the burned area includes most of the California Creek watershed, the northern half of the Carey Creek watershed, and a portion of lower Warren Creek watershed. Tha majority of the fire area in this subbasin has been categorized as low intensity burn (unburned to <50% scorched canopy) (BAER Team, 2000). Smaller areas of moderate intensity burn exist in portions of California Creek watershed, especially near the headwaters. Effects of wildfires on listed watersheds is relatively minor due to low intensity burns in a small portion (11%) of Warren Creek drainage (Zuniga, 2001). Moderate intensity burns occurred on 2% of the Warren Creek watershed. Planned restoration activities in the Warren Creek drainage include several miles of trail relocation and probably some road maintenance (Zuniga, 2001). Little fire rehabilitation is necessary in Warren Creek because the area burned is primarily roadless and the fire intensity was low (Zuniga, 2001).

Because the subbasin is predominantly in designated wilderness (61% of total area), very little timber harvesting has occurred. The Nez Perce National Forest reports some 3,000 acres (<1% of total area, 2% of non-wilderness national forest area) have been harvested, primarily by clear-cut logging from the area on the north side of the Salmon River between Wind River and Sabe Creek (NPNF, 1994). Between 1970 and 1998, 14,000 acres per year (less than 1 percent) were burned on average, mostly in wilderness (USFS, 1999).

**FISH**

The free-flowing nature of the main Salmon River and the abundance of wilderness area means this subbasin is likely to contain some of the better conditions for native fisheries in the state. Many streams provide habitat for spawning and early rearing for anadromous fish. Native fish reported to inhabit the subbasin include: sockeye salmon (*Oncorhynchus nerka*), northern pikeminnow (*Ptychocheilus oregonensis*), mottled sculpin (*Cottus bairdi*), shorthead sculpin (*C. confusus*), torrent sculpin (*C. rhotheus*), speckled dace (*Rhinichthys osculus*), longnose dace (*R. cataractae*), leopard dace (*R. falcatus*), Pacific lamprey (*Entosphenus tridentatus*), mountain whitefish (*Prosopium williamsoni*), westslope cutthroat trout (*O. clarki lewisi*), redband trout and steelhead (*O. mykiss*), fall, spring-summer chinook salmon (*O. tshawytscha*), bull trout (*Salvelinus confluentus*), redside shiner (*Richardsonius balteatus*), bridgelip sucker (*Catostomus columbianus*), largescale sucker (*C. macrocheilus*), mountain sucker (*C. platyrhynchus*), and white sturgeon (*Acipenser transmontanus*) (Lee et al., 1980; Simpson and Wallace, 1980; Clearwater Basin Bull Trout Technical Advisory Team, 1998).

Non-native and hatchery fish have been introduced into various areas within the subbasin. Most alpine lakes originally did not contain native fish. Introduced species include brook trout (*S. fontinalis*), Yellowstone cutthroat trout (*O. clarki bouvieri*), and rainbow trout (*O. mykiss*) (Payette National Forest, 1999).

The Main Salmon River Bull Trout Problem Assessment (Clearwater Basin Bull Trout Technical Advisory Team, 1998) has identified seventeen bull trout sub-watersheds in this subbasin. Most were described as subadult and adult rearing areas, although five watersheds (Bargamin, Sabe, Chamberlain, Warren, and Fall Creeks) were identified as spawning and early adult rearing areas. Native fisheries in the Bargamin and Sabe watersheds appear to be the most productive. Bull trout spawning is suspected in the lower reaches of Crooked Creek (Clearwater Basin Bull Trout Technical Advisory Team, 1998). Bull trout spawning is suspected in Sheep Creek and Wind River. Carey Creek apparently has no bull trout, and a possible migration barrier to other species at mile 5.5. No information is available for Harrington Creek. The main Salmon provides subadult and adult rearing habitat for bull trout as well as connectivity for the movement of fish throughout the subbasin.

Designated critical habitat for chinook salmon extends from the mouth of the Salmon River through this subbasin, and includes many streams accessible to salmon (Clearwater Basin Bull Trout Technical Advisory Team, 1998). According to the Bull Trout Problem Assessment, chinook salmon spawning or juvenile rearing have been detected in Bargamin, lower Crooked, Sheep, Rhett, Little Mallard and Big Mallard Creeks, and lower Wind River watersheds. Steelhead have been found in Sabe, Bargamin, Big Mallard, lower Sheep, and lower Wind watersheds. Additionally, Chamberlain Creek and West Fork Chamberlain Creek have significant spawning and rearing for chinook salmon and steelhead (A. VanVooren, pers. comm., 2000). Cutthroat trout are documented in Sabe and Big Mallard watersheds (Clearwater Basin Bull Trout Technical Advisory Team, 1998). Fall chinook salmon have been reported in the Salmon River just downstream of Mackey Bar. Redds were observed that were probably made by fall chinook salmon (A. Van Vooren, pers. comm., 2000).

Crooked Creek has a possible migration barrier 3/4 miles below Big Creek, with steelhead and bull trout below the barrier and resident and hatchery rainbows, cutthroats and possibly some rainbow/cutthroat hybrids above the barrier (NPNF, 1999a). The 10,000 acre Jersey Creek drainage has steelhead/rainbow juveniles and no barriers, but no bull or cutthroat trout were observed (NPNF, 1999a). Crooked Creek is considered important in terms of fish production due to both its size and accessibility to the mainstem Salmon River (USFS, 1999). The sub-watershed supports spring/summer chinock salmon, rainbow/steelhead trout, westslope cutthroat trout, and bull trout.

Rhett Creek supports juvenile spring/summer chinook rearing at the mouth (NPNF, 1994). Rhett Creek has a barrier at 0.7 mile from the mouth. Steelhead spawning occurred in the lower half-mile and cutthroat and bull trout were present when sampled by the Forest Service; no chinook were observed however (NPNF, 1999a). Additionally, bull trout sub-adult and adult rearing may occur.

Little Mallard Creek has a barrier ½ mile from the mouth according to the Forest Service. Steelhead/rainbow and bull trout have been observed, but not chinook or cutthroat trout (NPNF, 1999a). However, the creek supports juvenile spring/summer chinook rearing at the mouth. Subadult and adult bull trout are located below the falls in the lower reach near the confluence (Clearwater Basin Bull Trout Technical Advisory Team, 1998). A fish population does not exist above the falls. It is not clear why, but perhaps fish were not able to migrate into the stream prior to the formation of the barrier, nor have there been any introductions or those successfully reproducing. Various salmonids are also found in the Wind River and Meadow Creek.

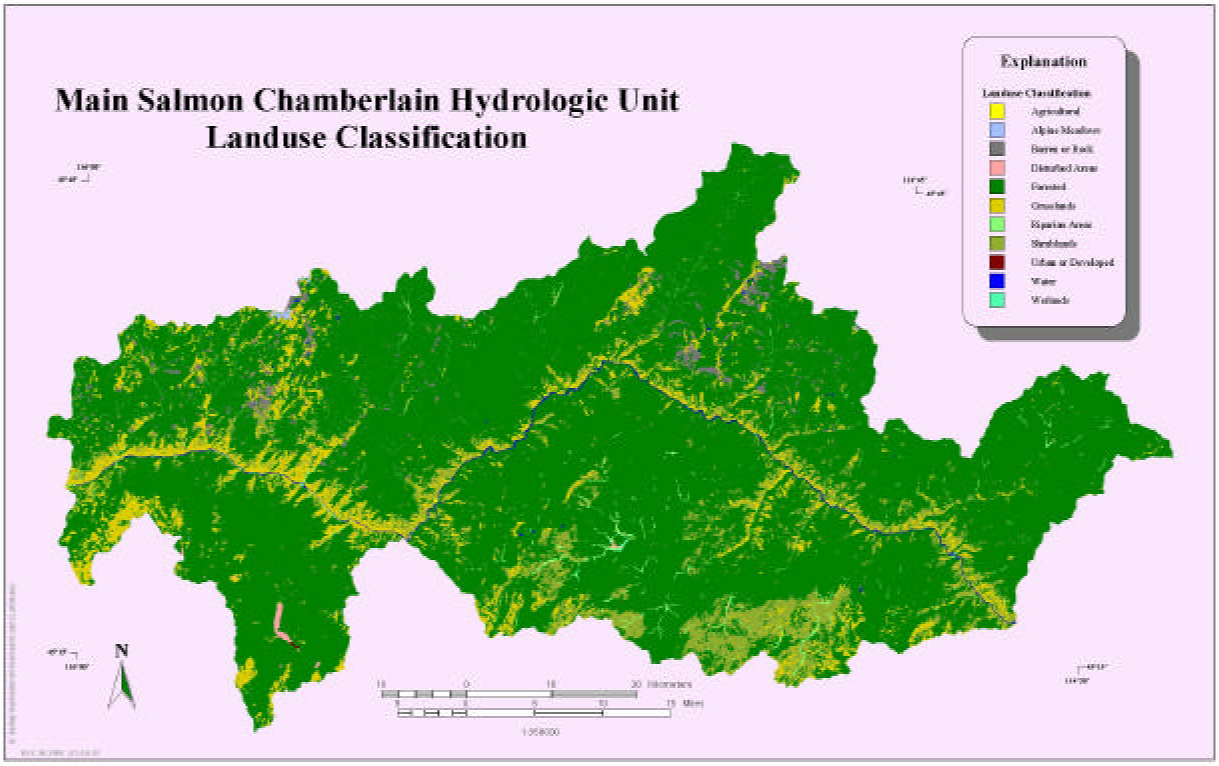
## LAND OWNERSHIP AND LAND USE

The subbasin is considered almost entirely forested land use (Map 8–Landuse Classification). Many watersheds experienced mining in the past, with some mining activities still in existence today. In particular, larger mining areas include the Marshall Mountain area, Warren Creek, and the vicinity of Dixie. Commercial logging is not planned for the foreseeable future in the Nez Perce National Forest between the two wilderness areas in the vicinity of Dixie (Cove-Mallard) (Bernhardt, 2001). Timber harvest has occurred in recent times (1990's) on about 3,000 acres of the Cove-Mallard area (NPNF, 1994). Historically, much of this subbasin has been used for grazing. There is a 5,000 acre area in the upper Chamberlain fifth field HUC identified as rangeland on the land use map. This is probably a large meadow referred to as the Meadow of Doubt. This meadow is within the Frank ChurchXRiver of No Return Wilderness.

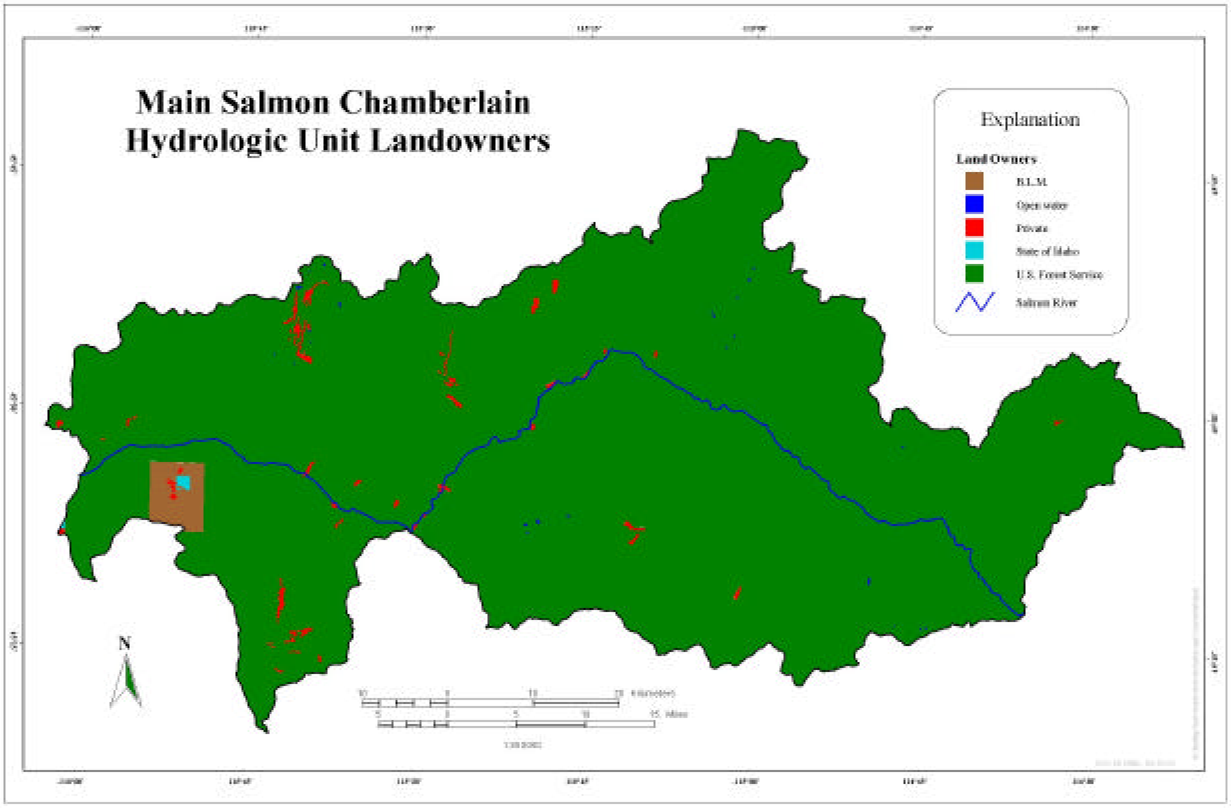
A large portion of these Forests are managed as wilderness. The Frank ChurchXRiver of No Return Wilderness flanks both sides of the Salmon River from Corn Creek to the vicinity of Mackay Bar (Map 9–Landownership). At Crooked Creek, the Gospel Hump Wilderness begins on the north side of the river; the south side continues to be the Frank Church Wilderness (Map 10–Wilderness Protection Areas). Of the 2.3 million acres in the Frank Church Wilderness, 105,000 acres are in the Nez Perce National Forest, all in this subbasin. Gospel Hump Wilderness is 200,464 acres in size and mostly in this subbasin. Wilderness boundaries end where the Wind River enters the Salmon River. The remaining stretch of the Salmon River from the Wind River to the mouth of the subbasin near French Creek is primarily National Forest outside of wilderness boundaries. The Warren Creek and Carey Creek drainages on the southwest end of the subbasin are primarily outside of wilderness, as is Corn Creek, Bear Basin Creek and the top end of Horse Creek on the east end of the subbasin.

The subbasin is almost entirely federal land (98%), mostly in the Nez Perce and Payette National Forests. The north side of the Salmon River is in the Nez Perce and Bitterroot National Forests and the south side in the Payette and Salmon-Challis National Forests. Forest boundaries split the northern half of the subbasin at Sabe Creek with the west side in the Nez Perce and the east side in the Bitterroot National Forest. The Payette and Salmon National Forests' common boundary occurs at the eastern edge of the Cottonwood Creek drainage near the eastern end of the subbasin. There are a number of small private holdings within the subbasin, most less than 500 acres in size. Many of these holdings have, and continue to be, used for mining activities. The Bureau of Land Management (BLM) has an 11,000 acre area that contains the Marshall Mountain mining area. The State of Idaho also owns a section within this BLM area.

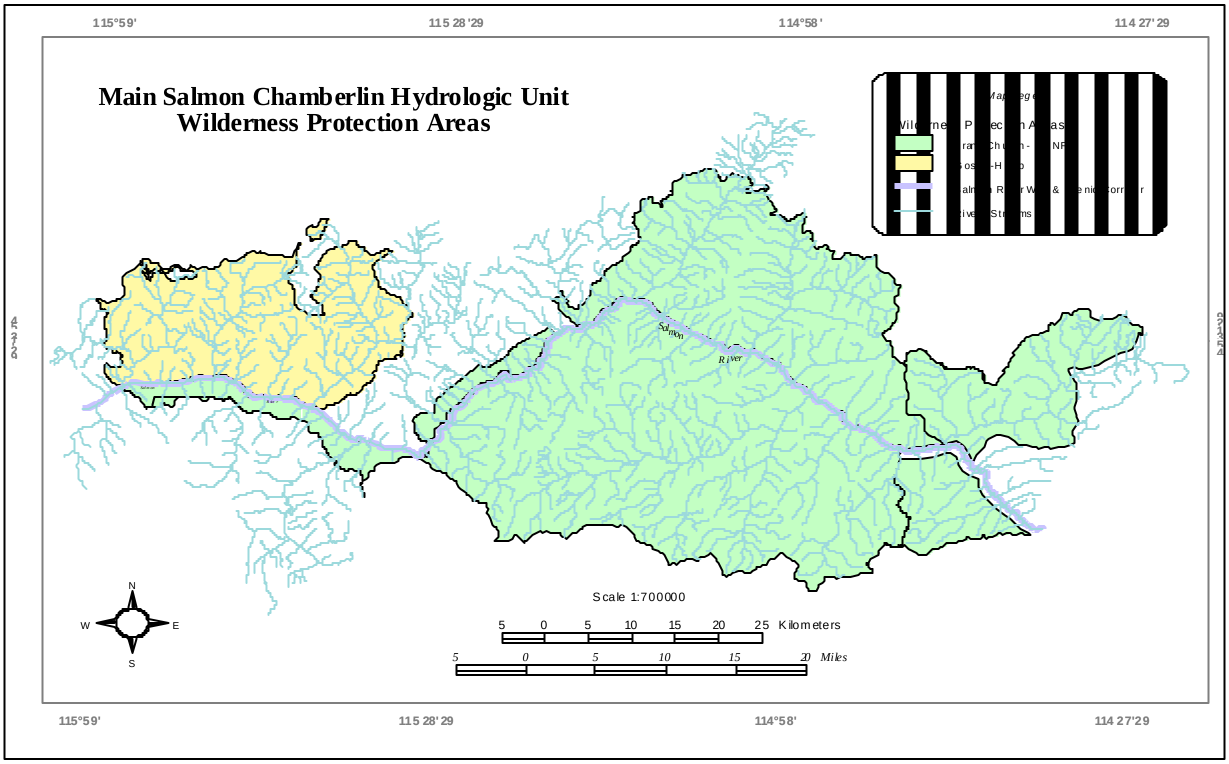
## Map 8. Land Use Classification




## Map 9. Land Ownership



**Map 10.  Wilderness Protection Area**




Most of the subbasin is within Idaho County, county seat Grangeville.  Population of the county is currently around 15,000, 77% of which is rural (Idaho Dept. of Commerce, 1999).  A small portion of the east end of the subbasin, the Horse Creek sub-watershed and half of Kitchen Creek sub-watershed, is in Lemhi County.  The extreme southern tip of the Warren Creek sub-watershed extends into Valley County.  There are no incorporated cities within the subbasin.  Riggins and Whitebird are the closest incorporated cities outside of the subbasin.  Place names in the vicinity which may have permanent inhabitants include Warren, Burgdorf, Dixie, and Orogrande.  The 1990 Census indicated that Dixie had 10 residents, and Warren had 35.  Elk City and Orogrande, north of Dixie and outside of the subbasin, had populations of 450 and 10, respectively, in 1990.  Most jobs are related to timber, mining, livestock grazing, recreation, or government agencies.

The Salmon River is a major recreational destination.  The Salmon River has a 66-mile corridor designated as a Wild and Scenic River including most of the section flowing through the subbasin. Wild and Scenic River status includes a quarter-mile corridor on either side of the river from the western edge of the subbasin to Cherry Creek.  This free flowing river provides extraordinary whitewater rafting opportunities.  Thousands of people float the river annually (National Park Service, 1999). Additionally, many people enjoy the canyon for hiking, horse packing, and jet boating.  Forest service permits administered by the Nez Perce and Salmon-Challis National Forests are required during the period from June 20 to September 7, for both float boats and jet boats on the wild section of the river through the subbasin.  All wastes, including human excrement, must be carried out by floaters.

## SUB-WATERSHED DESCRIPTIONS

Many of the descriptions of activities, disturbances, and associated water quality effects found in this section are informational or anecdotal descriptions, and should not be interpreted as verified water quality standards violations or beneficial use impairments.

The subbasin can be divided into 18 sub-watersheds or 5th field hydrologic units (Map 2). On the north side of the Salmon River are the Wind River (includes Meadow Creek), Sheep Creek, Crooked Creek (includes Big Creek), Big Mallard Creek, face drainages (includes Jersey, Rhett, Little Mallard) Bargamin Creek, Sabe Creek, and [1]Horse Creek sub-watersheds. A summary of most north-side watersheds is provided in Table 5. On the south side of the river are Carey Creek (includes Fall Creek), Warren Creek, [1]Upper Chamberlain Creek, [1]Lower Chamberlain Creek, and [1]Cottonwood Creek sub-watersheds. Straddling both sides of the Salmon River are Bull Creek (includes California Creek), Rabbit Creek, face drainages (includes Fivemile, Lemhi, Trout, and Richardson Creeks), [1]Dillinger Creek (includes Harrington Creek), [1]Disappointment Creek, and [1]Kitchen Creek (includes Corn Creek) sub-watersheds.

These sub-watersheds vary in size from 84,483 acres (Crooked Creek) to approximately 6,000 acres for some of the face drainages (NPNF, 1994, see Table 5). Many of the sub-watersheds have low road densities (<1 mi/mi$^2$), low disturbances (<5% of area), and very little private land. Natural sediment yields, as predicted by NEZSED, vary from 44.6 tons/square mile/yr for Bull Creek, one of the smaller sub-watersheds, to 10.4 tons/square mile/yr for the Big Mallard sub-watershed (Paradiso, 2000). Natural sediment yield is generally around 40 to 60 pounds per acre per year. Smaller face drainages may produce up to 140 pounds per acre per year. The assumptions used in NEZSED modeling are many and great, and there is a great deal of uncertainty associated with the figures. Interpretation should be cautious and the results treated as crude estimations at best (NPNF, 1994).

Tributaries to the Salmon River tend to be mountainous, high gradient, high energy streams dominated by snowmelt runoff. These streams tend to be in V-shaped valleys, of stream type Rosgen (1994) A2 - A3 or B2 - B4 (NPNF, 1999a), and with low sinuosity (Table 6). Gradients in Table 6 vary from as high as 12% in first order streams to as low as 1 to 2% at third order streams.

The steep breakland channel reaches are separated from the rest of the watershed by a series of steep cascading falls which serve as barriers to anadromous and fluvial fish migration up-gradient. The steep A-type channels in the breaklands are high energy and capable of transporting large sediment loads.

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[1]Note: No information was obtained on these sub-watersheds east of Sabe and Dillinger Creeks. Most of these drainages are entirely in wilderness and have not received the attention the western half of the subbasin has received.

They are confined in V-shaped or narrow canyon bottoms. Due to the high energy nature of the channels, bank stability of these channel reaches rely on substrate size of bed and bank material and riparian vegetation.  Intense storm events will scour bed and bank materials, transporting them downstream to the Salmon River.

Table 5.  North-side Watershed Characteristics (NPNF, 1994; NPNF, 1999a; Paradiso, 2000).

| Sub-watershed Name | Acres (sq.mi.) | Acres Disturbed (% of total) | Natural Sediment Yield (tons/sq.mi./yr) | Sediment Yield per Acre (tons/acre/yr) | Road Density ($mi/mi^2$) | Wilderness (%) | Private (%) |
|---|---|---|---|---|---|---|---|
| Wind River | 41,347 (64.6) | 1,825 (4%) | 17.9 | 0.03 | 0.75 | 68 | 1 |
| Sheep Creek | 32,974 (51.5) | 7 (<1%) | 35.5 | 0.05 | 0.07 | 93 | 1.7 |
| Crooked Cr. | 84,483 (132) | 1,282 (2%) | 19.6 | 0.03 | 0.77 | 54 | 2 |
| Big Mallard | 36,530 (57) | 1,416 (4%) | 10.4 | 0.02 | 0.27 | 4 | 1 |
| Little Mallard | 8,215 (12.8) | No data | 14.4 | 0.02 | 1.0 | 0 | 1.5 |
| Jersey Creek | 10,001 (15.6) | No data | 21.7 | 0.03 | 1.14 | 12 | <1 |
| Rhett Creek | 12,348 (19.3) | No data | 13.5 | 0.02 | 1.5 | 7 | 3 |
| Bargamin Cr. | 69,989 (109.3) | 45 (<1%) | 15.1 | 0.02 | 0.18 | 72 | 0 |
| Sabe Creek | 53,218 (83.1) | 7 (<1%) | 21.8 | 0.03 | 0.15 | 99 | 0 |
| Bull Creek | 9,774 (15.3) | No data | 44.6 | 0.07 | 0 | 100 | 0 |
| Rattlesnake | 6,013 (9.4) | No data | 31.4 | 0.05 | 0 | 100 | 0 |
| Face (non-wilderness) | 39,493 (61.7) | No data | No data | No data | 0.32 | 18 | <1 |
| Face (wilderness) | 30,452 (47.6) | No data | No data | No data | 0 | 100 | 0 |
| Other Tributaries* | NA | No data | No data | No data | No data | No data | <1 |

* on the northwest side of the subbasin, includes Face drainages.

Table 6. Stream Types from Beneficial Use Reconnaissance Project Sites in Subbasin.

| Creeks | Stream Order | Gradient (%) | Rosgen Type | Valley Type | Sinuosity |
|---|---|---|---|---|---|
| Rhett | 2 | 4 | B | V-shaped | low |
| Big (lower) | 3 | 3 | B | V-shaped | low |
| Big (upper) | 2 | 4 | B | Flat Bottom | moderate |
| Eutopia | 2 | 6 | A | V-shaped | low |
| Little Mallard | 2 | 8 | A | V-shaped | low |
| McGuire | 2 | 4 | B | V-shaped | low |
| Warren (U) | 4 | 2.5 | B | V-shaped | low |
| Warren (L) | 4 | 2 | C | V-shaped | low |
| Crooked (U) | 3 | 4.5 | B | Flat Bottom | moderate |
| Crooked (L) | 3 | 3 | B | V-shaped | moderate |
| Big Mallard (U) | 3 | 2 | C | Flat Bottom | high |
| Big Mallard (L) | 3 | 1.5 | C | V-shaped | moderate |
| Noble | 2 | 8 | A | V-shaped | moderate |
| Jersey | 2 | 8 | A | V-shaped | low |
| Corn | 2 | 11 | A | V-shaped | moderate |
| Bear Basin | 2 | 12.5 | A | V-shaped | moderate |
| Cramer | 1 | 12 | A | V-shaped | moderate |

The channel morphology of low gradient channel reaches of Big Creek, Crooked Creek, and Big Mallard Creek is characterized by slow, incremental changes. Much of the eroded sediment is stored in the lower gradient meadow and shrub-dominated reaches. The first and second order stream reaches in forested portions of the watershed are Rosgen (1994) channel types A5 and B5, and E4 in meadow and shrub complexes. Third through fifth order streams are channel types B3 and B4 in forested portions and C3, C4, and E4 in meadow complexes. The headwater stream segments tend to transport sediment through the steeper reaches where erosion is common.

Riparian areas are typically narrow, constrained by the presence of steep mountainous terrain in the vicinity of the canyon. Farther up-gradient where hills become more rolling, riparian areas can be more broad. Some meadow-like areas exist periodically at low-gradient, mid-elevation locations. Riparian vegetation is typically dominated by spruce, fir, alder, mountain maple, thimbleberry, and a number of herbaceous plants. At lower elevations along the Salmon River, and in alpine and subalpine meadows, willow and/or herbaceous plants may dominate.

The following sections of this subbasin assessment are descriptions in alphabetical order of fourteen watersheds with some percentage of non-wilderness designation. Much of the material is summarized from the 1994 Biological Assessment: Main Salmon River Tributaries (Northeast), by the Nez Perce National Forest (NPNF, 1994), or as otherwise cited. Mean annual and mean monthly flows reported in these sections are estimates based on regional equations and reference stream gages.

**BARGAMIN CREEK**

Seventy-two percent (72%) of the Bargamin sub-watershed is in wilderness. The upper one third of the drainage is outside of wilderness, but managed by the Forest Service. There is no private land in the sub-watershed. Bargamin Creek originates near Three Prong Mountain at an elevation of 8,000 feet and is about 22.5 miles long. The estimated average annual discharge is 142 cfs with an estimated mean monthly flow ranging from 37 cfs to 526 cfs. The sub-watershed has almost equal proportions in all four Landform Groups. Since 1960, about 26% of the sub-watershed has been burned, only a small percentage of which received high intensity, stand-replacing fire. The sub-watershed has experienced very little development. No timber harvests or mining activity are known to have occurred. There are two vacant grazing allotments. The lower end of the drainage was heavily grazed between 1900 and 1940 before there was any management of such activities. The same areas were grazed as part of the Salmon River Breaks Allotment from 1950 to 1970. In 1971, the number of animals was reduced. General statements concerning vegetation indicated overutilization at that time. There are approximately 21 miles of road in the upper third of the drainage used for recreational purposes (NPNF, 1994).

**BIG CREEK (1998 303(d) Listed for Sediment)**

In lower gradient sections of Big Creek the dominant substrate is small cobbles. As gradient increases the substrate changes to large cobbles and boulders. There are localized impacts from grazing, especially in the Big Creek meadows, including bank sloughing, loss of cover, sedimentation, and soil compaction. These impacts are considered minor with little contribution to the overall Crooked Creek watershed condition (NPNF, 1994).

**BIG MALLARD CREEK (1998 303(d) Listed for Sediment)**

Big Mallard Creek originates near Boston Mountain at 7,600 feet elevation, and is about 15 miles long. Estimated mean annual discharge is 74 cfs with estimated mean monthly flows ranging from 14.5 cfs in September to 300 cfs in May. The majority (91%) of the sub-watershed is in LFG-2. The bottom 4% of the sub-watershed is in wilderness. Most of the sub-watershed is undeveloped; however, it has past and present timber harvesting, and past grazing impacts, including non-native vegetation introductions (Clearwater Basin Bull Trout Technical Advisory Team, 1998). There are 507 acres (1%) of private land used primarily for grazing and subsistence farming in the past. Some of it is presently subdivided and developed as recreational homes.

Timber harvest occurred within the lower Big Mallard watershed from 1965 to 1994. According to the USFS (1999), 132 acres were clearcut during 1965-67, 468 acres were harvested in 1985-88. The Grouse and Noble timber sales have been completed. The Grouse timber sale removed timber from 234 acres from 1992 to 1994. The Noble timber sale included 513 acres and was awarded in 1991. The roads for the Jack timber sales are completed and considered ongoing with planned harvest of 381 acres. There are 33 miles of road in the sub-watershed with an overall road density of 0.58 miles per square mile used for accessing timber harvests and for recreation. Two-thirds of these roads have been constructed or reconstructed since 1992.

According to the USFS (1999), the subwatershed has sustained a variety of impacts, including road construction on the watershed's naturally high erosive geology, resulting in high levels of deposited sediment.

There are two active grazing allotments, which have been in use since the 1940s. Some damage to streambanks has been documented. There is one vacant allotment in the Salmon River breaks area. There is very little evidence of mining in the sub-watershed (NPNF, 1994).

The lower three miles of Big Mallard Creek are separated from the rest of the watershed by Mallard Falls, a 1/4 mile series of very steep cascades, which prevent fish migration (NPNF, 1994). This lower section consists of steep A-type channel whereas the remaining portions of the creek are B- and C-type channels. Big Mallard Creek below the falls is a steep, high energy stream, highly entrenched, and with gradients exceeding 8% and as high as 30-40%. The dominant substrate here is boulders and large rubble. Habitat types include plunge pools, cascade riffles, and pocket water, and very few depositional areas. Above the falls, Big Mallard Creek and its tributaries are generally less than 4% gradient. These channels are sinuous and highly depositional with the dominant substrate being sand and gravels. Percent fines are generally greater than the natural levels found in Bargamin Creek (Table 7). Rooted aquatic macrophytes are common, especially in Noble, Jack, middle Big Mallard, and upper Big Mallard Creeks. Habitat types include shallow runs, riffles, and lateral scour pools. Cobble embeddedness above the falls ranges from 40 to 80%, and pebble counts indicate the average substrate size to be medium to large gravels. Jack Creek has been identified as a source of suspended sediment from grazing, timber, and road activities (Table 7).

**BULL CREEK & CALIFORNIA CREEK**

Bull Creek is a third order, high energy stream that enters the Salmon River from the north, and is entirely within the Gospel Hump Wilderness. Estimated mean annual discharge is 21.5 cfs and estimated mean monthly flows range from 5.6 cfs in January to 79.5 cfs in June. The entire drainage has been burned at least once since 1960, and reburns have occurred in some areas including in 2000. The drainage is largely shrub and herbaceous species dominated, especially since heavy grass reseeding occurred after a 1973 fire. No timber or mining activity has been recorded for the sub-watershed, and grazing has ceased since 1987 (NPNF, 1994).

California Creek is a 12 mile long high energy system on the south side of the Salmon River. The lower two miles of the stream are in wilderness. California Creek originates near War Eagle Lookout at an elevation of about 8,000 feet. This drainage (15,209 acres) is rugged, mountainous terrain and is somewhat remote. Road densities are less than one mile per square mile and primarily associated with mining claims. One mine site in particular has un-vegetated disturbed areas and a small perennial stream in need of some rehabilitation to prevent sediment movement during storm events. Little other human disturbance has taken place in the watershed. A tributary to California Creek extends into BLM and State land in the vicinity of the Marshall Mountain mining area. No information was obtained on any effects to the stream from these activities (PNF, 1999).

Table 7. Percent Fines (<6mm) for All Reaches of Fixed Transects (NPNF, 1999b).

| Site # | Site Name | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|
| 1 | Little Mallard Cr. (below Noble timber sale) | 34 | 35 | 17 | 22 |
| 2 | Grouse Cr. | 41 | 49 | 40 | 32 |
| 3 | Jack Cr. | 80 | 74 | 75 | 77 |
| 4a | Big Mallard Cr. (below Grouse Cr.) | 20 | 19 | 19 | 21 |
| 4b | Big Mallard Cr. (above Jack Cr.) | Reach #1<br>Reach #2 | 26<br>34 | 26<br>36 | 25<br>27 |
| 5 | Big Mallard Cr. (above Slide Cr.) | 48 | 35 | 38 | 37 |
| 6 | SF Big Mallard Cr. | 43 | 41 | 24 | 46 |
| 7 | Bargamin Cr. | 26 | 20 | 17 | 21 |

**CAREY CREEK**

The Carey Creek sub-watershed is located on the south side of the Salmon River at the very western edge of the subbasin. The sub-watershed includes Carey Creek and Fall Creek. Fall Creek appears to have the potential to be affected by the Marshall Mountain mining area; however, no information has been obtained for this sub-watershed.

**CROOKED CREEK (1998 303(d) Listed for Sediment)**

Fifty-four percent of the Crooked Creek watershed is in the Gospel-Hump Wilderness, while 2% is in private ownership. Estimated mean annual discharge is about 167 cfs with estimated mean monthly flows ranging from 44 cfs in January to 619 cfs in June. Upper reaches outside of the wilderness are low gradient (<4%) and lower wilderness reaches are higher gradient (5-15%). Watershed impacts are associated with the 1992 Porcupine Fire in the wilderness portion of the sub-watersheds. The fire resulted in 20 percent of the watershed being burned at moderate to high intensity (USFS, 1999). Post-fire monitoring has estimated low to moderate rates of surface erosion into Crooked Creek from the burned areas. Since this time, numerous debris torrents and other mass movement events have been documented.

High sediment delivery and deposition exists in the upper reaches, but not in the lower reaches. This has generally been attributed to the fact that the periphery of Crooked Creek has been developed in the upper watershed and minimally developed in the lower watershed (Clearwater Basin Bull Trout Technical Advisory Team, 1998). The town of Dixie and private recreational residences border the creek. The creek was dredge mined in the past. Past mining activities and homesite development, corrals, and crossings continue to affect the stream. Since 1960, 19% of the sub-watershed has been affected by fire. There are 101 miles of road in the sub-watershed, some of which are surfaced. The entire length of Crooked Creek outside of the wilderness is paralleled by road. Timber harvesting has occurred on 782 acres in two separate events in 1976 and 1988. There are four vacant grazing allotments established as early as 1921.

Localized bank damage has been documented along Big Creek and its upper tributaries. Three allotments have been closed in the 1960s and 1970s, and one allotment is still active in the lower part of the sub-watershed associated with the Shepp Ranch (20 horses and mules). The upper watershed has been most affected by mining. There have been three separate gold booms in Dixie in 1864, the 1890s, and the 1930s. There are 23 inactive underground lode mines and one inactive open pit mine. The presence or extent of any toxic chemicals or acid mine drainage is unknown. Most of these mine disturbances have revegetated although there is still some sediment delivery from them as well as possibly from roads and associated millsites. There are nine inactive placer mines and 4.6 miles of dredged streams. Unvegetated tailings are still prominent. There are 13 underground lode mines in the Buffalo Hump area west of Big Creek, including the War Eagle Mine on Fitz Creek active in the 1930s. Unvegetated areas still exist in the Buffalo Hump area. Mining has slowed considerably since the 1930s although a resurgence in gold prices created increased mining activity in the sub-watershed in the 1980s (NPNF, 1994).

The upper ten miles of Crooked Creek to its headwaters is predominantly low gradient (<4%) with moderate to low entrenchment and a substrate of sands and small gravels. A survey conducted in 1987-88 revealed high existing sediment deposition (cobble embeddedness ranging from 53 to 67%), low pool to riffle ratios, and a lack of woody debris in the upper portions of Crooked Creek (NPNF, 1999a). Common stream habitat types include riffles, runs, dammed pools, and lateral scour pools. The stream channel of upper Crooked Creek is in poor condition with large amounts of sediment moving through the system (NPNF, 1999a). Near Big Creek, sediment deposition tops banks. Between the wilderness boundary (near Big Creek) and Lake Creek, Crooked Creek has apparent cobble embeddedness and sediment deposition in low gradient reaches, but much less than observed upstream. Within the wilderness area, stream gradients range from 5 to 15%, entrenchment is high and the substrate consists of large rubble and boulders, with little sediment deposition. Numerous plunge pools exist with steep cascades and pocket water.

**JERSEY CREEK (1998 303(d) Listed for Sediment)**

Jersey Creek is a high energy, third order tributary that is approximately nine miles long. Estimated mean annual discharge is 21 cfs, with the highest mean monthly discharge of 85 cfs occurring in May and a minimum mean monthly discharge of 5.3 cfs in October. Only a small portion of the lower drainage is in wilderness (12% of total), and the remaining drainage is strongly influenced by fire and fire suppression. Since 1960, 35% of the watershed has been affected by fire. Vegetation is considered moving towards unnatural, fire-suppressed condition. Ninety-six (96) acres were clear-cut in 1985 and there is evidence of past mining activity in the watershed. Roads total 18 miles used to access mining claims and for recreation. Light grazing has occurred throughout the watershed; heavy grazing is unlikely due to topography (NPNF, 1994).

The lower reaches of Jersey Creek are very steep with slopes averaging 15%. The channel is 100% A-type with a boulder and large rubble substrate. Cobble embeddedness is very low in the lower reaches, but very high in the upper part of the watershed. Given the amount of sediment in the upper watershed, suspended sediment may be high during spring and thunderstorm runoff events.

**LITTLE MALLARD CREEK (1998 303(d) Listed for Sediment)**

Little Mallard Creek watershed is entirely outside of wilderness boundaries. The creek is a third order stream approximately eight miles long just downstream of the Big Mallard confluence with the mainstem Salmon. Estimated mean annual discharge is 18 cfs, with a maximum mean monthly discharge of 73 cfs in May and a minimum mean monthly discharge of 3.5 cfs in September. Since 1960, only 16 acres have been burned, again suggesting that fire suppression has played a major role in vegetation development in the watershed.

Little Mallard Creek watershed is predominantly composed of National Forest lands and mostly roadless. There are 120 acres of private land in the watershed, three acres of which are used for residences and subsistence agriculture, and the remaining 117 acres are in scenic easement. Water diversion from Little Mallard Creek is used for long-term hydropower. Significant human activities on National Forests lands include: exploratory mining, domestic livestock grazing, and limited timber harvest in or near the headwaters (USFS, 1999). There are 13 miles of road in the watershed, the majority of which have been built since 1991 to access the Noble Timber Sale. Approximately five acres of the headwaters of Little Mallard Creek were placer mined in the 1980s. As a consequence, 400 yards of stream channel were impacted and remain unvegetated. Since 1984, light grazing by 22 horses and mules has occurred within 8,215 acres of the watershed. This level of grazing has occurred here since 1946, although there may have been some damage from overgrazing in the 1970s (NPNF, 1994).

The lower 3/4 mile of Little Mallard Creek is a highly confined A-type channel, with cascades, plunge pools, and riffles. The substrate is predominantly bedrock, boulders, and large cobbles. Cobble embeddedness is less than 25%. A hydropower facility reconstructed in 1993 on private property was contributing sediment to the lower reach in 1994. The upper portion of Little Mallard Creek by contrast is a low gradient sediment storage area. Due to the undeveloped nature of the watershed, the upper reaches are considered to be in near natural condition (see Table 7 for percent fines).

**RABBIT CREEK**

Rabbit Creek is a small sub-watershed located between California Creek to the west and Warren Creek to the east. The lower portion (approximately one mile) of Rabbit Creek is within wilderness boundaries. The sub-watershed includes Indian Creek on the north side of the Salmon River. Indian Creek is located between Crooked Creek to the west and Jersey Creek to the east. Indian Creek is almost entirely outside of wilderness boundaries. Very little information was available on this sub-watershed.

**RHETT CREEK (1998 303(d) Listed for Sediment)**

Rhett Creek is a third order stream approximately 10 miles in length. Estimated mean annual flow is 26 cfs, maximum mean monthly discharge is 110 cfs in May and minimum mean monthly discharge is 5 cfs in September. There are 861 acres of wilderness and 349 acres of private land in the watershed. All private land resulted from mining patents. These areas were mined primarily during the 1890 to 1930s. The Black Diamond Mine is active in the drainage and contributes an unknown amount of sediment to a tributary of Rhett Creek (Clearwater Basin Bull Trout Technical Advisory Team, 1998). Timber harvests have occurred and are planned for these private lands, and recreational homes are located there as well. Additional mining activity within the drainage include seven inactive underground lode mines and limited placer mining. Approximately 1,280 acres in the headwaters are grazed as part of the Little Mallard Allotment. Since 1960, no fires have burned in the drainage, and fire suppression may lead to vegetation replacement and possible high intensity, stand-replacing fires. Road density for non-wilderness land is 1.6 miles per square mile (NPNF, 1994).

The lower mile of Rhett Creek is an A-type channel with a small boulder and large and small cobble substrate. Cobble embeddedness is 20-30% in this lower stretch, but much higher in the upper watershed due to mining activities. Cobble embeddedness may be increasing in the upper reaches. Development of Robinson Dike Mine in the late 1980s resulted in a substantial increase in sediment input to Comstock Creek, a tributary to Rhett Creek (NPNF, 1994). In 1994, the site continued to be a source of sediment. Since Rhett Creek does not have a natural sediment storage area, it could be anticipated that sediment will move through the system to lower reaches.

**SABE CREEK**

Sabe Creek originates near Sabe Mountain at an elevation of 6,600 feet. The large, high energy stream is about 17 miles long, and has an estimated mean annual discharge of 120 cfs. The estimated mean monthly flows are estimated to range from 31 cfs in January to 444 cfs in June. Ninety-nine percent (99%) of the sub-watershed is in wilderness; only a road corridor at the very top of the drainage is outside wilderness boundaries. The lower third of the drainage is in LFG-3 and the upper two-thirds is in LFG-4. Since 1960, 38% of the sub-watershed has been affected by fire. There have been no recorded timber harvests and there is no private land within the sub-watershed. There is no recorded mining activity within the drainage although it is likely that exploratory activity took place at the mouth of Sabe Creek. The single road at the top of the drainage traverses 11 miles of its border and is used for recreational purposes. Historic grazing has likely been a predominant activity in the sub-watershed. Grazing has been authorized rather continuously in the Bear Point region (upper breaklands) since 1960 (NPNF, 1994).

**SHEEP CREEK**

Sheep Creek is a large, high energy system almost entirely within the Gospel Hump Wilderness. Sheep Creek originates near Buffalo Hump at approximately 8,000 ft. elevation and is about 17 miles long. Estimated mean annual discharge is 69.5 cfs with estimated mean monthly flows as low as 25 cfs in January and as high as 246 cfs in June. There are a few miles of road associated with turn-of-the-century mining. There were 19 mining claims on 556 acres of private land, none of which are active today. Grazing has occurred in the sub-watershed since 1910. Although heavy at times, recent grazing management activity has allowed a general upward trend in vegetation condition. No grazing has occurred since 1987. Fire has affected 27% of the sub-watershed since 1960, some which has been locally intense. The majority of the sub-watershed is in alpine glaciated lands (Landform Group 4) (NPNF, 1994).

**WARREN CREEK (1998 303(d) Listed for Sediment)**

Warren Creek sub-watershed is a large drainage (57,500 acres) on the south side of the Salmon River. The creek itself is 21 miles long and predominantly high gradient and energy, although there is a pronounced lower gradient meadow area that has been extensively dredge mined. Warren Creek originates near Warren Summit at about 7,000 feet elevation. Summer discharge is estimated to be around 23 cfs. The lowest three miles of Warren Creek are within wilderness boundaries. Approximately 8.5% of the sub-watershed is private land including much of the dredged stream areas near Warren. There have been small amounts of timber harvesting, grazing and fire suppression.

A long history of mining activities has affected the upper part of the sub-watershed. Mining began in the late 1800s, and continued through the 1930s when substantial impacts occurred from placer and lode mining. Historic and active mining in the Warren Creek drainage has resulted in many ore and/or tailings piles bordering streams in the mined portions of the watershed. Natural vegetation recovery has been poor because of the lack of topsoil. Some sections of Warren Creek have been dredge mined in the past. The tailings and the dredge deposits are presumably the reason for listing this stream for habitat alteration. There are four active lode mines in the sub-watershed, three of which show current activities taking place. Other activities occur in the Warren Creek watershed, including timber harvesting, outfitter and guide use, recreation, road and trail use. There are about 70 miles of road in the watershed (density = 1 to 2 miles/square mile), some of which are old (50 years) roads built to access mines. There is apparently some sediment contribution to the stream from these roads. (Clearwater Basin Bull Trout Technical Advisory Team, 1998; PNF, 1999) Many of the tributaries to Warren Creek have excessive fine sediment (PNF, 1995).

The lower one to two miles of Warren Creek are A-type channels with gradients averaging 6.1% and as high as 12%. The substrate is primarily boulders and cobbles. Streambanks are more than 98% stable and the width to depth ratio is 21.6. Above 2.4 miles the gradient becomes steeper (9.4%) and the channel is characterized by boulders and high gradient riffles. At mile ten the gradient becomes 6.9%. Moving upstream to the mouth of Schissler Creek, Warren Creek becomes a C-type channel with non-turbulent units and lateral scour pools. For the remainder of Warren Creek to its headwaters, dredge piles confine the stream to A- and B-type channels. At the Warren meadows area, gradients are low (0.4-0.5%). The dredged areas lack pools, winter habitat, overhead vegetation, and woody debris. Fine sediment reaches 15% in this low gradient area.

**WIND RIVER**

Wind River is a fairly large drainage (41,348 acres) on the north side of the Salmon River. Sixty-eight percent of this watershed is in the Gospel Hump Wilderness. The Meadow Creek section of Wind River watershed is 60% outside of wilderness and has experienced a number of human activities. Average annual discharge from Wind River is estimated to be 88.6 cfs with mean monthly flow ranging from an average of 23 cfs in January to 328 cfs in June. The drainage averages B-type channels, 30 feet wide and 3 feet deep, which vary from 4 to 30% gradient (NPNF, 1999a). Since 1950, 22% of the sub-watershed has been affected by fire. Wind River has been affected by mining in the Meadow Creek drainage and grazing in the upland and headwater meadows.

There are approximately 49 miles of road used to access past mining and timber harvesting areas. Timber harvesting has occurred on 1812 acres mostly in the 1980s. Historic grazing dates back to 1861. There are two grazing allotments that have been vacant since 1987 and 1992. One allotment continues with active grazing in the Wind River Meadows area. There has been some damage to the vegetation in some areas of this sub-watershed. Past mining in the Florence Basin (Meadow Creek) has been extensive. Placer mining began in 1860 and lode mining began in the 1890s after placer mining slowed down. Placer mining activity increased again in the 1930s. After this time, activity slowed but has been continuous ever since. Miles of trenches have been dug to supply water to placer operations. One small open pit mine was started in the 1950s and has been worked off and on ever since. Mercury was used to extract gold from ore, and a spill was reported in 1983. Contaminated material was moved to an impermeable liner in 1986 (NPNF, 1994). Water sampling to detect mercury was done in 1995 to 1996 by Forest Service and DEQ personnel. Mercury was not detected in monitoring wells or any surface waters. However, sludge from the pond bottom had mercury levels of 6.86 ppm, 0.98 ppm, and 3.96 ppm in three samples taken by DEQ.

## WATER QUALITY CONCERNS AND STATUS

### WATER QUALITY-LIMITED WATERS

There are eight stream segments listed as water quality-limited on the 1996 303(d) list for this subbasin (Table 8). Six streams are listed for sediment pollution, all of which are in the vicinity of Dixie between the two wilderness areas (Map 11–303(d) Listed Stream Segments). Warren Creek on the south side of the Salmon River is listed for habitat alteration. The Salmon River itself is listed from Corn Creek to Cherry Creek for unknown pollutants.

The 1996 303(d) listing, exacted by EPA as a result of a lawsuit, included the Salmon River from Corn Creek to Cherry Creek reportedly because this section of the river was identified in Appendix D of Idaho's 1992 305(b) report. EPA indicated that it was also a Stream Segment of Concern (SSOC), although it was not found in SSOC reports (State of Idaho, 1989, 1992).

Appendix D of the 1992 305(b) report (DEQ, 1992), however, indicated that the Idaho Department of Fish and Game (IDFG) requested listing this section of the Salmon River as only partially supporting cold water biota and salmonid spawning due to moderate impacts from agricultural, timber harvesting, construction (including roads), and mining activities. However, we are not aware of data to substantiate this claim. Information included in Appendix D of the 1992 305(b) report was sometimes based on conjecture and was to be used only for guiding further assessment needs.

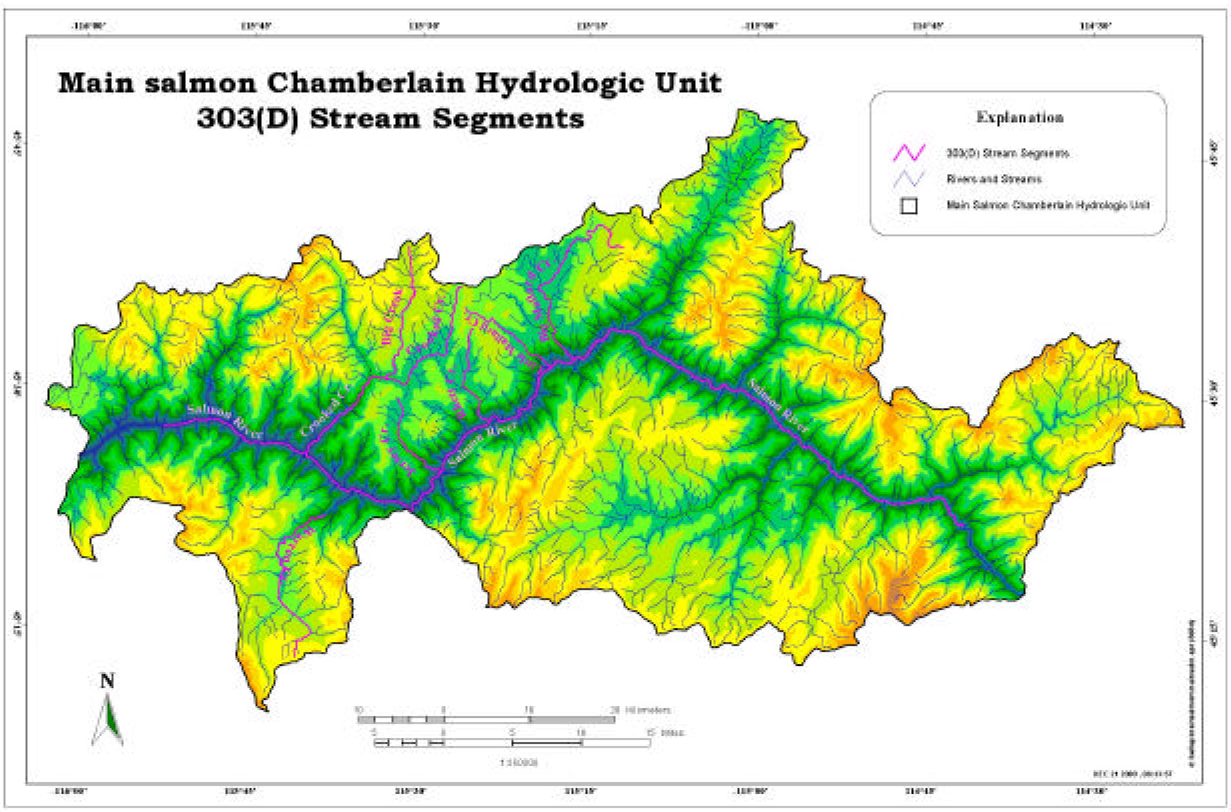
Table 8. Water Quality-limited Waters in Subbasin.

| Water Body Name | Boundaries | Pollutants |
|---|---|---|
| Big Creek | Headwaters to Crooked Creek | sediment |
| Big Mallard Creek | Headwaters to Salmon River | sediment |
| Crooked Creek | Headwaters to Salmon River | sediment |
| Jersey Creek | Headwaters to Salmon River | sediment |
| Little Mallard Creek | Headwaters to Salmon River | sediment |
| Rhett Creek | Headwaters to Salmon River | sediment |
| Warren Creek | Headwaters to Wilderness Boundary | habitat alteration |
| Salmon River | Corn Creek to Cherry Creek | unknown |

IDFG=s concerns with sediment in the Salmon River stem from up-river contributions of sediment from primarily the South Fork Salmon River (Anderson, 1999), an area previously identified as having impacts from sediment. A sediment TMDL was completed for the South Fork Salmon River. According to IDFG, these upstream impacts may affect beneficial uses within the Salmon River itself through sediment deposition reducing over-wintering habitat and affecting chinook and steelhead spawning areas. However, no data could be found to substantiate these claims.

The NPNF (1994) indicates that a combination of erodible soils, fire history, and periodic intense climatic events result in substantial natural erosion and delivery of sediment to the Salmon River. They indicate that suspended sediment concentrations and turbidity in the Salmon River during spring months are often high enough to preclude visibility. These conditions most often associated with early spring rains at low elevations, and later during higher flows from snowmelt runoff. Such conditions can last for several weeks. They can also occur in the summer as a result of rainstorms and last for over a week.

**Map 11. 303(d) Listed Stream Segments**




The NPNF (1994) reported that data are very sparse, but there was some suspended sediment data from USGS collected 6 to 12 times a year from 1971 to 1991. During most years suspended sediment concentrations ranged from 2 mg/l to 65 mg/l, except during May when concentrations ranged from 6 mg/l to 503 mg/l. Most of the time the Salmon River is below 25 mg/l suspended sediment. However, spring runoff, rain-on-snow events, and intense summer rainstorms can cause suspended sediment concentration to significantly exceed 25 mg/l (NPNF, 1994). The NPNF (1994) indicated from the literature that the effects of these suspended sediment concentrations on salmonid fishes was variable and unclear, and they recommended overall that suspended sediment was of moderate importance to fish due to their evolved ability to tolerate or avoid such periodic high concentrations.

The NPNF (1994) indicated that bedload and deposited sediment conditions were even less well documented than suspended sediment conditions. The coarse material is generally deposited in alluvial fans which are gradually eroded by the river during high flows over a period of years. Also, the NPNF (1994) indicated that some reduction in pool volume, by filling with gravel and small cobbles, in this portion of the Salmon River, may have occurred as a result of upstream activities. The river apparently has tremendous capability to transport sediment ranging in size from sand to large cobble as evidenced by casual observations of sediment deposition. There has not been a serious amount of deposition along most of the riverbed from Sabe Creek to its confluence with the Snake River. Observations suggest that beach erosion occurs during low water years and beaches are replenished during high water years (NPNF, 1994).

Anecdotal observations of accelerated sediment yields to the Salmon River from Nez Perce National Forest activities suggest that these impacts have not significantly degraded river habitat (NPNF, 1994). According to the NPNF (1994), this appears to be largely due to the high transport capacity and relatively low additional sediment input beyond that from other sources, both natural and human induced. The primary evidence for this is the apparent lack of fines deposition below major tributaries, such as Crooked Creek. Where significant alluvial fans do exist at the mouths of Nez Perce National Forest tributaries, it is believed that they formed largely in response to natural events.

IDFG also suggested temperature as a possible problem to cold water biota beneficial use as the Salmon River does warm up above 22$^{o}$C in the canyon during the summer (Anderson, 1999). The Nez Perce National Forest, in their biological assessments for endangered salmonids, identified temperature as a concern as well (NPNF, 1994). If forest activities along the tributaries have reduced vegetation cover, thus warming the streams, they could affect mixing zone refugia and incrementally increase temperatures in the Main Salmon, affecting migrating anadromous salmonids (NPNF, 1994).

Temperature data for the Salmon River in this subbasin are sparse. Temperature data collected by USGS for the Salmon River near Whitebird periodically from 1976 to 1991 showed July temperatures between 28.0$^{o}$C and 16.5$^{o}$C (NPNF, 1994). These temperatures may not be indicative of temperatures in the Salmon River in this subbasin as a number of tributaries enter after this subbasin and the river is progressively exposed to more solar radiation as it flows downstream. Reingold in August 1969 sampled Salmon River water temperatures within the vicinity of this subbasin (NPNF, 1994). The six samples showed temperatures between 18$^{o}$ and 20$^{o}$C. The Nez Perce National Forest measured Salmon River water temperatures at several locations within this subbasin from July to October during 1994 to 1998 (NPNF, 1999b). The 7-day moving average of maximum daily temperatures exceeded 22$^{o}$C for a short period of time in July, 1994; but were below this temperature in all other years. From these data it is likely that the cold water biota maximum temperature criterion (22$^{o}$C) was exceeded during July 1994, however not necessarily during the other months of 1994 nor during the other years (1995-1998). These data show fall water temperatures reached 13$^{o}$C (7-day moving average of maximum daily temperatures) about early October in the Salmon River. The USGS data at Whitebird showed Salmon River temperatures in May to be 9$^{o}$ to 13.5$^{o}$C (NPNF, 1994).

Water temperatures in the Salmon River near Whitebird clearly exceed state water quality standards for cold water biota during the summer. But there is insufficient information to determine whether water temperatures in the Salmon River in the Salmon-Chamberlain subbasin exceed state water quality standards any more than during the occassional very hot year. Even though water temperatures are warm in the Salmon River during the summer, it would be difficult to separate the difference between temperatures (or heat loads) that are a natural phenomenon and those that are caused by human activities.

The tributaries were 303d listed for reasons similar to the Salmon River. In addition to the Salmon River, the 1992 305(b) report, Appendix D also included Crooked Creek and Warren Creek (IDEQ, 1992). The report indicated that Crooked Creek from the headwaters (mines) to Big Creek was partially supporting salmonid spawning and cold water biota was supported but threatened. Again, IDFG suggested the causes as low impacts from construction and moderate impacts from mining. Warren Creek, headwaters to the wilderness boundary, was identified by the USFS as partially supporting cold water biota due to low impacts from road construction and recreation, and high impacts from placer and dredge mining. IDFG identified Warren Creek as partially supporting cold water biota and salmonid spawning due to low impacts from agriculture and timber harvesting, moderate impacts from construction, and high impacts from mining. Again, information included in Appendix D of the 1992 305(b) report was based on conjecture and was to be used only for guiding further assessment needs.

Another source of information used by EPA to create the court ordered 303(d) list was the Nez Perce National Forest Watershed Condition Analysis (Gloss and Gerhardt, 1992). Meeting Forest Plan objectives may have wrongly influenced EPA's analysis for 303(d) listing. This analysis, designed to provide regional foresters with broad scale information on the condition of major (5th field) watersheds in 1992, used a rating scheme that was based on analyses of watershed sensitivity (rated low, moderate, or high), the district's determinations on the significance or insignificance of activities (grazing, mining, timber harvesting, other) in the watershed, the road density (low, moderate, or high), the percent of watershed disturbed (low, moderate, or high), and the watershed's proximity to meeting Forest Plan objectives (low, moderate, or high). It should be noted that the watershed analysis gave Crooked Creek a low concern rating, which is in contrast to the 1996 303(d) listing.

Although the Forest Plan objective rating scheme was based on water quality habitat parameters, there were no comparisons made to the state's water quality standards or assessment processes. For example, a determination of existing condition relative to Forest Plan objectives included parameters such as cobble embeddedness, large woody debris, and bank stability that do not have directly comparable surrogates in the state's water quality standards. The fact that watersheds were not meeting forest plan objectives does not necessarily indicate that they were not, or are not now, meeting water quality standards. In fact, it is quite possible that a stream may meet water quality standards, but the Forest Plan had desired future conditions unrelated to these standards that the stream did not meet in 1992.

## WATER QUALITY STANDARDS

Designated beneficial uses (as per IDAPA 58.01.02.130.09) for waters in the Salmon-Chamberlain subbasin are listed in Table 9. All tributaries to the Salmon River are undesignated waters at the time of this writing. Undesignated waters are presumed to support cold water biota and primary or secondary contact recreation, and will be protected for these uses until such time as the waters are officially designated for beneficial uses (see IDAPA 58.01.02.101).

Water quality criteria used to protect these beneficial uses include narrative free form criteria applicable to all waters (IDAPA 58.01.02.200), and numerical criteria which vary according to beneficial uses (IDAPA 58.01.02.210, 250, 251, 252). Typical numeric criteria include bacteriological criteria for recreation uses, physical and chemical criteria for aquatic life (e.g. pH, temperature, DO, ammonia, toxics, etc), and toxics and turbidity criteria for water supplies.

Of particular importance regarding listed water bodies in this subbasin is the narrative criterion for sediment (IDAPA 58.01.02.200.08) as follows:

> "Sediment shall not exceed quantities specified in Section 250 and 252, 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."

Table 9. Designated Beneficial Uses.

| Map Code | Water Body | Designated Uses |
|---|---|---|
| S-1 | Salmon River - South Fork Salmon River to river mile 106 | Domestic Water Supply, Agricultural Water Supply<br>Cold Water Biota<br>Primary Contact Recreation, Secondary Contact Recreation<br>Special Resource Water |
| S-8 | Salmon River - Chamberlain Creek to South Fork Salmon R. | Domestic Water Supply, Agricultural Water Supply<br>Cold Water Biota, Salmonid Spawning<br>Primary Contact Recreation, Secondary Contact Recreation<br>Special Resource Water |
| S-18 | Salmon River - Horse Creek to Chamberlain Creek | Domestic Water Supply, Agricultural Water Supply<br>Cold Water Biota, Salmonid Spawning<br>Primary Contact Recreation, Secondary Contact Recreation<br>Special Resource Water |
| S-37 | Salmon River - Middle Fork Salmon River to Horse Creek | Domestic Water Supply, Agricultural Water Supply<br>Cold Water Biota, Salmonid Spawning<br>Primary Contact Recreation, Secondary Contact Recreation<br>Special Resource Water |

Quantities specified in Section 250 refer to turbidity criteria identified for cold water biota use and small public domestic water supplies. 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 egg incubation. Turbidity must be measured upstream and downstream from a sediment input in order to determine violation of the criteria. Intergravel dissolved oxygen measures require the placement of special apparatus in spawning gravels. Both measures are rarely conducted as a 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.

Theoretically, any stream with sediment pollution exceeding water quality standards will require a total maximum daily load (TMDL). In practice, the relationship between sediment and its effects on beneficial uses is not clearly understood. Although there are some criteria that are indicators of specific sediment-related problems (like turbidity and intergravel dissolved oxygen), the level of sediment necessary to cause an effect and actually violate water quality standards is not defined. Nor is it likely to be the same in all locations due to differences in geology and hydrology.

As indicated in the state's water quality standards (IDAPA 58.01.02.350), nonpoint source pollution is addressed through a feedback loop approach where best management practices (BMP) to control sediment are put into place, and evaluations are made to see if the practices are working. If they are not working, or if beneficial uses do not recover, then the BMPs are modified, and re-evaluated until successful. It is likely that an *adaptive management approach* will need to be taken to determine the level of sediment control necessary for a sediment TMDL. Adaptive management allows for initial sediment reduction targets to be set and the feedback loop used to monitor and assess the progress of sediment reductions towards improving the beneficial uses. When it is unknown how much sediment affects a beneficial use, only through the repetitive process of control and monitoring will appropriate results be achieved.

## WATER BODY ASSESSMENTS

### Beneficial Use Reconnaissance Project

Fourteen streams in this subbasin have been monitored using the DEQ Beneficail Use Reconnaissance Project (BURP) including all 303(d) listed streams. DEQ attempts to monitor streams in at least two locations, the upper part of the watershed and as close to the mouth as possible. Of the seven 303(d) listed streams in the subbasin, four were sampled in two locations and three were monitored in only one location. All streams except Rhett Creek were sampled close to the wilderness boundary within several miles of the mouth. It is expected that most BURP sites represent integrating reaches and will reflect the cumulative effects of disturbances in these watersheds. Rhett Creek was sampled once in the middle of the watershed.

Streams in this subbasin assessed through the DEQ Beneficial Use Reconnaissance Project (BURP) and the 1996 Water Body Assessment Guidance or "WBAG 1" as it is called (IDEQ, 1996) plus any additional information are listed in Table 10. For all of these streams, macroinvertebrate index scores (MBI) were calculate using the new 2000 calculator and habitat index scores were calculated using the 1996 process. Salmonid spawning beneficial use was assessed from BURP electrofishing data and/or from Forest Service information (Mays, 2000). A final assessment determination was made by comparing MBI and HI scores, fish age class data and other available data regarding criteria exceedances to pre-determined acceptable levels. From this analysis, streams were determined to be "full support," "needs verification," or "not full support" for cold water biota and salmonid spawning.

All streams except Cramer Creek would receive a "Full support" status for cold water biota based on the data in Table 10. MBI and HI scores were generally high reflecting the near pristine quality of these streams. The streams that had fish data would likewise receive a "full support" rating for salmonid spawning use. All streams with fish data had at least two age classes of salmonids and habitat scores greater than 73, which is needed for a full support rating on salmonid spawning (see Appendix 4). In fact, many of these streams had at least three age classes of salmonids and HI scores greater than 90.

Table 10. Water Bodies Assessed Through BURP.

| Water Body | Fish Data | MBI* | HI | Support Status# |
|---|---|---|---|---|
| Noble Creek | Cutthroats multiple size classes (BURP) | 5.57 | 111 | Full Support CWB and SS |
| Eutopia Creek | No data | 4.77 | 102 | Full Support CWB |
| McGuire Creek | No data | 4.68 | 111 | Full Support CWB |
| Big Creek (303d listed) | Rainbows and hybrids spawning and early rearing (Mays, 2000). | 5.07(L) 4.61(U) | 105 115 | Full Support CWB and SS |
| Jersey Creek (303d listed) | Cutthroat spawning and rearing, steelhead rearing (Mays, 2000). Rainbows 3 size classes (BURP). | 4.93 | 127 | Full Support CWB and SS |
| Rhett Creek (303d listed) | Salmonids - multiple age classes above and below barrier (Mays, 2000). Cutthroat 3 size classes (BURP). | 5.13 | 92 | Full Support CWB and SS |
| Warren Creek (303d listed) | No data | 4.99(U) 4.93(L) | 94 90 | Full Support CWB |
| Crooked Creek (303d listed) | Salmonids - multiple age classes above and below barrier (Mays, 2000) | 4.92(L) 4.46(U) | 94 99 | Full Support CWB and SS |
| Big Mallard Creek (303d listed) | Brook trout multiple size classes (BURP). | 5.06(L) 5.31(U) | 103 108 | Full Support CWB and SS |
| Little Mallard Creek (303d listed) | Barrier near mouth, no fish | 4.25 | 118 | Full Support CWB |
| Corn Creek | No data | 5.07 | 111 | Full Support CWB |
| Bear Basin Creek | No data | 4.02 | 99 | Full Support CWB |
| Cramer Creek | No data | 3.17 | 75 | Needs Verification |

* Macroinvertebrate Biotic Index (MBI) scores were calculated using the 2000 version calculator representing the latest inclusion of macroinvertebrate species.
# CWB = cold water biota; SS = salmonid spawning.

Macroinvertebrate and habitat scores were marginal for Cramer Creek (3.17 and 75, respectively). The low habitat score and the general condition of Cramer Creek were probably affected by its low flow (0.6 cfs) at the time of assessment. Such low flow conditions in general tend to preclude cold water biota as a result of a lack of water, increased temperatures, reduced dissolved oxygen, and the lack of substrate. The Cramer Creek macroinvertebrate sample had low species diversity (15 species) and percent dominance was high at 69%. However, the sample was dominated by one Plecoptera taxon indicative of better quality cold water streams. In fact, 75% of the taxa were stoneflies. Most of the other taxa in the sample were relatively tolerant species. This suggests that the stream exists in a state of flux between a good quality cold water stream and one that is compromised by low flow conditions. Cramer Creek should be re-assessed to determine if it should be classified as an intermittent water.

Early in 2002, the second edition of DEQ's Water Body Assessment Guidance was released. This WBAG II protocol modified considerably the process by which streams are assessed for support of beneficial uses. Specifically, multimetric indices were changed as more data were added since WBAG 1 was published. A process was put in place where macroinvertebrate, habitat, and fish indices are scored and then averaged to produce a single score from 0 to 3 where streams must score a 2 or higher to be considered fully supporting their aquatic life uses. Data from BURP sites in this subbasin were re-evaluated using this new WBAG II system. Those resulting indices and scores are presented in Appendix 8. As was demonstrated with the earlier WBAG 1 process, all streams except Cramer Creek showed cold water aquatic life use fully supported.

Water temperature was measured at several locations in Crooked Creek from 1994 to 1998 (NPNF, 1999b) (see Appendix 4). Temperatures exceeded 22$^{o}$C only slightly in 1994, but not in following years. Water temperatures exceeded 13$^{o}$C from late June to mid to late September in every year. BURP crews measured an instantaneous value of 15$^{o}$C in upper Crooked Creek on July 14, 1997. These measurements exceed the salmonid spawning maximum temperature of 13$^{o}$C. However, it is questionable whether this time period is reflective of natural spawning timing for rainbow and cutthroat trout found in this stream. Bull trout spawning and rearing temperature criteria would be exceeded by these data. The Bull Trout Problem Assessment (Clearwater Basin Bull Trout Technical Advisory Team, 1998) determined that past activities have affected the temperature of upper Crooked Creek to preclude bull trout spawning. However, the Forest Service (NPNF, 1999a) suggests that a possible migration barrier at approximately 3/4 mile downstream of the Big Creek confluence may have precluded bull trout from the upper watershed anyway.

Bull trout spawning temperature exceedances in lower Big Mallard Creek and lower Little Mallard Creek were detected in temperature data obtained from NPNF (1999b) (see Appendix 4). Water temperatures need to be below an instantaneous maximum of 13$^{o}$C and a daily average of 9$^{o}$C on and after September 1st for bull trout spawning. During the summer, bull trout rearing habitat needs to be below an average daily water temperature of 12$^{o}$C. It is not clear from the data (NPNF, 1999b) if water temperatures in the mouths of these two creeks exceed the daily average; however, they do exceed 13$^{o}$C during September. However, the mouths of these two creeks may not be salmonid spawning areas. Therefore, the applicability of salmonid spawning temperature criteria during September at these two locations is questionable. More information is needed on the temperature regime of the entire stream before potential impacts to salmonid spawning could be determined.

Additionally, macroinvertebrate samples from BURP efforts within the subbasin were further analyzed to assess relative impacts from fine sediment (Clark, 2000); see Appendix 1). This report concluded that, on a relative scale, Big Creek, Big Mallard Creek, and Rhett Creek appear to be in better condition than Crooked Creek, Jersey Creek, Warren Creek, and Little Mallard Creek. These conditions were based on macroinvertebrate assemblage characteristics such as taxa richness, numbers of Plecoptera taxa, and numbers of cold water indicator species. Both Crooked Creek and Warren Creek have been affected by past dredge mining activities and these legacy issues remain.

<u>Nez Perce National Forest Assessments</u>

The Main Salmon River Subbasin Biological Assessment (NPNF, 1999a) examined an area from the Little Salmon River to Sabe Creek, which includes only part of the Salmon-Chamberlain subbasin. This document described the most impacted areas to generally be the area west of Wind River (including the Meadow Creek area of the Wind River drainage), the Marshall Mountain mining area, and the upper Crooked Creek drainage. There are areas within the subbasin that have been altered by past mining activities, road construction, and grazing. Logging accounts for a small percentage of the human activities in the subbasin, generally less than 1% of the subbasin or 2% of the non-wilderness/non-roaded area. A summary of areas of concern for sensitive salmonids indicated that Warren and upper Crooked Creeks were targets for rehabilitation (NPNF, 1999a). The Nez Perce National Forest has recommended that it will work with local land owners in Dixie and the Idaho Department of Fish and Game to build a long-term aquatic restoration strategy for upper Crooked Creek (NPNF, 1999a). Currently, no restoration activities are planned in the area because of other high priority needs in the Forest. Table 11 presents the overall assessment of baseline conditions described on pages 36-39 of the Biological Assessment (NPNF, 1999a).

The U.S. Geological Survey has maintained a gaging station on the Salmon River at the mouth of White Bird Creek since 1910. As part of the response for *Term and Condition Number Four* of the AMain Salmon River Tributaries Northeast Biological Opinion≅ (NPNF, 1999b), the Nez Perce Forest Service addressed several components affecting listed aquatic species. One particular component was to establish baseline conditions related to sediment yield and concentration for the Salmon River from Sabe Creek to the Little Salmon River confluence based on available scientific information. The combination of collected sediment samples at the gaging station and further, modeling using NEZSED, BOISED, and unit area estimations were used to estimate the total annual sediment yield for the entire drainage. Sediment yields are predicted from natural sources, as well as from timber harvests and roads. The assumptions used in these modeling exercises are many and great, and there is a great deal of uncertainty associated with the figures. Interpretation should be cautious and the results treated as crude estimations at best (NPNF, 1994). At the White Bird gaging station, the total annual sediment yield was estimated at 530,000 tons/year. In using an Aarea-based proportion,≅ the sediment yield was estimated to be 490,000 tons/year, above Riggins (Table 12) (Gerhardt and Thompson, 1997).

Table 11. Overall Assessment for Middle Salmon-Chamberlain Subbasin (NPNF, 1999a)*.

| Characteristic | Subbasin Overall | Specific Waters |
|---|---|---|
| Road density | <1mi/mi$^2$ | Carey, Fall = 1 - 2.2 mi/mi$^2$<br>Jersey = 1 - 2.9 mi/mi$^2$<br>Meadow (Wind) = 3.4 mi/mi$^2$ |
| Riparian Vegetation | high condition | Meadow(Wind) = moderate |
| Width/Depth Ratio | moderate condition | Big Mallard, Crooked, Carey = moderate<br>southside watersheds = low |
| Streambank Stability | good condition | northside (except Wind Meadow) = 95-100% stable,<br>southside (except Lake) high condition |
| Temperature (for Steelhead rearing) | natural conditions | northside (except Crooked, Bargamin, face streams) = 14$^o$C,<br>lower elevation low to mid reaches = 16.8 - 18.5$^o$C |
| Cobble Embeddedness | highly variable | northside = high to moderate,<br>upper Crooked = high, lower Crooked = low to moderate,<br>Bargamin, Wind, face streams = <20%,<br>Big Mallard, Partridge, Elkhorn, French, face(uplands) = 20-35%,<br>Fall = >35% |
| Large Woody Debris | natural levels | Warren = below natural levels |
| Pool Frequency | low in 9 of 12 watersheds | California Cr. only one not meeting minimum standards for salmonids. Placer dredge mined creeks (Warren, Crooked) probably lack pools as well. |
| Fish Passage Barriers | no human made | except for several culverts on Road 1614. |
| Off Channel Habitat | high condition | low condition in Allison and face drainages from Wind to Berg. |
| Habitat Refugia | generally abundant | Big Mallard lacks refugia because of barrier and channel type. |
| Chemical Contamination | very little | Warren has potential, Warren may have sources of metals in soil and ground water. |

*Environmental baseline information provided by NPNF, 1999a includes condition ratings of "high, moderate, and low" which we interpret to mean good condition, moderate condition and poor condition, respectively. However, caution should be used in interpreting this information. We recommend the reader consult NPNF, 1999a for interpretations and assumptions used in these environmental conditions.

Table 12. Main Salmon River sediment yield summary (Gerhardt and Thompson, 1997)**.

| Analysis Point | Drainage Area (sq. mi) | Accrued natural (t/yr) | Accrued activity (t/yr) | Total (t/yr) | Rate* |
|---|---|---|---|---|---|
| below White Bird | 13,550 | N/A | N/A | 530,000 | 39.1 |
| Above Little Salmon | 12,518 | 104,000 | 12,800 | 490,000 | 39.1 |
| below Crooked Creek | 12,011 | 87,500 | 12,200 | 473,000 | 39.4 |
| below Big Mallard Creek | 10,268 | 9,500 | 61 | 383,000 | 37.3 |
| Above Sabe Creek | 9,909 | N/A | N/A | 373,000 | 37.7 |

* The units for Rate = tons/square mile/year.
** The assumptions used in NEZSED modeling are many and great, and there is a great deal of uncertainty associated with the figures. Interpretation should be cautious and the results treated as crude estimations at best (NPNF, 1994).

Sediment production from lands managed by the Nez Perce National Forest was estimated using the NEZSED model. The natural sediment yield for the north side of the Salmon River from the Little Salmon River to Sabe Creek was estimated at 19,200 tons/year. Activity-related sediment yield was estimated at 260 tons/year or about 0.05 percent (260/530,000) of the annual sediment yield of the river above Riggins. The total contribution from activity-caused sediment from actions within the Nez Perce National Forest to the mainstem Salmon was concluded to be minimal (NPNF, 1994, 1999a, Gerhardt and Thompson, 1997). Based on these calculations, it was estimated that 117,000 tons/year entered from all sources and tributaries the area between Sabe Creek and Little Salmon River (490,000 - 373,000 = 117,000) (Gerhardt and Thompson, 1997). Of this total, 104,000 tons/year is estimated to be natural and 12,800 tons/year are due to activities. Of the accrued sediment yield (117,000 tons/year), about 65% or 76,050 tons/year was estimated to be from the South Fork Salmon River. The South Fork is also the source of an estimated 92% of the accrued activity sediment yield (92% of 12,800 tons/year = 11,776 tons/year), assumed to be mostly from roads. (Gerhardt and Thompson, 1997). That means only 1,024 tons/year (12,800 – 11,776 = 1,024) of sediment accrue from activities in the main Salmon River watershed from Sabe Creek to the Little Salmon River.

A summary of NEZSED model runs for the Nez Perce portion of the subbasin (Paradiso, 2000) is contained in Appendix 2. The tables in the appendix present natural sediment yield and activity yield as predicted by the model. Percent over base for the 303d listed watersheds vary from 0.7% to 4.4%. Percent over base is defined as activity yield/natural yield times 100 (see Appendix 2 for further definitions). Some watersheds are broken down into smaller component watersheds on subsequent tables in the appendix. For example, upper Crooked Creek produced an output of 24% over base, whereas the entire Crooked Creek drainage was estimated at 4.4% over base. A yield of 24% is considered well within the range of variability of the analysis. Thus, such a yield may not represent a significant departure from natural levels. Again, interpretation of these data should be viewed with caution because of uncertainty with assumptions and estimations.

The Nez Perce National Forest has had an active sediment monitoring program in the subbasin since 1995 in the rolling uplands of Big and Little Mallard Creeks (NPNF, 1999b). The sediment monitoring consists of three parts: A) monitoring deposited sediment levels near project areas in the upper watersheds of Big and Little Mallard Creeks; B) monitoring of the Sinker minerals projects; and C) monitoring deposited sediment levels in the lower stream reaches that contain chinook habitat. Sampling has focused predominantly on the area between the given timber-related activities and the spring/summer chinook habitat in Big and Little Mallard Creeks.

The project area activities chosen to monitor include the Grouse, Noble, and Jack timber sales. Timber sale roads and harvest have been completed for these activities. The Grouse and Jack timber sales are located entirely within Grouse Creek and Jack Creek watersheds, both of which are tributaries of Big Mallard Creek. The Noble timber sale is located within the Little Mallard Creek watershed. Within each case, all road construction and timber harvesting were completed between 1992 and 1998.

Pebble count data for fixed transects, averaged for all water types, and collected in conjunction with these timber sales are summarized in Table 13. Percent fines (<6mm) are variable, but generally less than 40% for most sites. Stream monitoring indicated an overall decrease in the percentage of pebble count samples composed of substrate less than 6 mm at all of the monitoring sites from 1995 to 1998 (NPNF, 1999b). The report concludes, however, that four years of data is insufficient to test for trends. At a minimum, several years of additional data would be necessary to draw on presence/absence trends for deposited fine sediment in the streams monitored within Big and Little Mallard Creeks (NPNF, 1999b). Further, the current sampling site design, considered cumulative effects monitoring sites, is recognized as being inadequate to ever conclude whether a sediment trend at the sites could be tied to a number of activities related to roads, grazing, timber harvest, etc (Table 14). In the future, it is recommended by NPNF (1999b) that sampling focus on these activities through road and harvest reviews or other upslope monitoring methods to establish the need for implementing forest practices source control measures and other immediate mitigation measures (e.g., Forest Practices Cumulative Watershed Effect Process).

Table 14 summarizes all road miles, road density ($mi/mi^2$), and harvested acres, for the specified prescription watersheds (represented by a single watershed number and name). Generally, the equivalent clear-cut acres are less than 2 percent of Harvest %. The data contained within the table is as of February 1998.

Water samples for turbidity were collected in Crooked Creek near the Dixie Work Center (NPNF, 1990a). Turbidity ranged in values from 0.5 to 10 Jackson units, which are too low to be considered violations of state water quality standards for turbidity. These measurements were considered Aspot≅ and not taken from a representative context for monitoring critical conditions. Cobble embeddedness surveys in 1989 did conclude that upper Crooked Creek has relatively high cobble embeddedness (Table 15), although baseline natural embeddedness was considered lower than most other streams (NPNF, 1990a). Owing to disturbances being relatively light, the Nez Perce Forest speculated that the high cobble embeddedness in these creeks was due to natural geologic conditions, past fire history, low gradient channel reaches, and low sediment flushing rates (NPNF, 1990a). A high percentage of natural and existing cobble embeddedness was also reported for prescription watersheds within the Big

Mallard Creek drainage (i.e., Jack and Noble Creeks), as well as the Little Mallard Creek drainage.
Table 13. Summary of pebble count data (as % <6mm) for fixed transect locations averaged over all water types (slow to fast) (NPNF, 1999b).

| Stream Name | Range of percent (%) fines (<6mm) |
|---|---|
| Little Mallard Creek below Noble timber sale | 17 to 35 |
| Little Mallard Creek below Sinker Mine | 64 to 78 |
| Little Mallard Creek site #9 | 2 to 12 |
| Big Mallard Creek below Grouse Creek | 19 to 21 |
| Big Mallard Creek above Jack Creek | 25 to 36 |
| Big Mallard Creek above Slide Creek | 35 to 48 |
| SF Big Mallard Creek | 24 to 46 |
| Big Mallard Creek site #10a near mouth | 1 to 11 |
| Big Mallard Creek site #10b near mouth | 6 (1998 only) |
| Grouse Creek | 32 to 49 |
| Jack Creek | 74 to 80 |
| Bargamin Creek | 17 to 26 |

Table 14. Cumulative watershed accounting of management activities within Big and Little Mallard Creeks (NPNF, 1999b).

| Watershed Name | Acres | Road miles | Road density | Harvest acres | Harvest % |
|---|---|---|---|---|---|
| Noble Cr. | 7,283 | 10.7 | 0.94 | 271 | 4 |
| Grouse Cr. | 1,230 | 2.0 | 1.04 | 148 | 12 |
| Jack Cr. | 4,265 | 11.9 | 1.78 | 109 | 3 |
| Middle Big Mallard Cr. | 5,057 | 8.9 | 1.13 | 11 | 0 |
| Upper Big Mallard Cr. | 4,444 | 3.3 | 0.47 | 164 | 4 |
| SF Big Mallard | 4,622 | 0 | 0 | 0 | 0 |
| Big Mallard above Jack Cr. | 14,123 | 12.2 | 0.55 | 175 | 1 |
| Big Mallard below Grouse Cr. | 19,618 | 26.1 | 0.85 | 432 | 2.2 |
| Bat Creek | 2,957 | 0.2 | 0.05 | 0 | 0 |
| Lower Big Mallard Cr. | 6,672 | 4.9 | 0.47 | 0 | 0 |
| Big Mallard near mouth | 37,070 | 41.9 | 0.72 | 703 | 1.9 |
| Little Mallard Cr. | 8,215 | 13.3 | 1.04 | 76 | 1 |

Table 15. Estimated natural and existing cobble embeddedness (%) for streams in the Cove Mallard-Timber Sales areas (NPNF, 1990a).

| Stream | Channel Type | Natural | Existing |
|---|---|---|---|
| SF Big Mallard Creek | B | 59 | 59 |
| | C | 64 | 64 |
| Upper Big Mallard Creek | A | 48 | 48 |
| | B | 67 | 68 |
| | C | 63 | 63 |
| Middle Big Mallard Creek | B | 53 | 53 |
| | C | 62 | 62 |
| Noble Creek | A | 47 | 47 |
| | B | 67 | 73 |
| | C | 77 | 83 |
| Lower Big Mallard Creek | B | 58 | 58 |
| | C | 70 | 70 |
| Little Mallard Creek | A | 39 | 39 |
| | B | 65 | 65 |
| | C | 72 | 82 |
| Jersey Creek | A | 64 | 66 |
| | B | 67 | 74 |
| Upper Crooked Creek | A | 20 | 53 |
| | B | 25 | 62 |
| | C | 25 | 67 |
| Upper Rhett Creek | A | 48 | 48 |
| | B | 67 | 81 |
| | C | 76 | 88 |
| Jack Creek | B | 67 | 85 |
| | C | 77 | 85 |
| Grouse Creek | B | 67 | 72 |
| Bat Creek | A | 64 | 72 |

| Stream | Channel Type | Natural | Existing |
|---|---|---|---|
| | B | 67 | 74 |
| | C | 77 | 88 |
| Big Blowout Creek | A | 60 | 60 |
| | B | 67 | 88 |
| Comstock Creek | A | 64 | 80 |
| | B | 67 | 76 |

Warren Creek Watershed Habitat Assessments - Payette National Forest

The Warren Creek drainage was assessed by Payette National Forest in 1993 to 1995 (PNF, 1995). A synopsis of that assessment for Warren Creek proper is listed in Table 16. A number of tributaries to Warren Creek were also assessed. Most were identified as having excessive fines (greater than 15% as defined by the Payette National Forest) and a lack of pool and deep pool habitats. Warren Creek itself does not appear to have excessive fine sediments, although some reaches are marginal (near 15%), but Warren Creek has significant habitat degradation due to past dredge mining. Warren Creek above Schissler Creek has been extensively dredge mined in the 1920s and 1930s resulting in large, unvegetated cobble/rubble piles throughout the valley. Reach #1 apparently had a temperature measurement greater than the 22$^{o}$C maximum for cold water biota. Reach #1 is at the confluence with the Salmon River and temperatures may reflect mixing with the Salmon River or the higher air temperatures experienced at lower elevations. These data are considered minor criteria exceedances and insufficient to place the entire creek in violation of temperature standards.

Table 16. Warren Creek Habitat Assessment (PNF, 1995).

| Reach | Beginning Confluence | Channel radient | Dominant substrate | Flow (cfs) | Temp. (C) | Salmonids | Comments |
|---|---|---|---|---|---|---|---|
| 1 | mouth/ Salmon R. | A - 6% | boulder/ cobble | 23 | 18-24 | juv. steelhead & chinook, brook | whitefish, sculpin, sucker at mouth |
| 2 | Richardson | A - 9% | boulder/ cobble | 14.5 | 18-21 | rainbow/steelhead, brook | fines=5.9%, boulders, high gradient riffles, low pool and gravel |
| 3 | unnamed | A - 8% | boulder/ cobble | 16 | 9-21 | rainbow, steelhead, brook | fines=14.9%, lack of deep pools |
| 4 | Schissler | C -0.4% | gravel/ rubble | 14 | 10-14 | rainbow, steelhead, brook | fines=8.2%, slight pool shortage |
| 5 | unnamed sidechanne l | C -0.5% | gravel/ rubble | 11 | 8-20 | juv.steelhead, brook, bull | fines=9.9%, dredge ponds, rubble/cobble pilings, lack cover/ large woody debris |
| | | | | | | | |

| Reach | Beginning Confluence | Channel radient | Dominant substrate | Flow (cfs) | Temp. (C) | Salmonids | Comments |
|---|---|---|---|---|---|---|---|
| 6 | Steamboat | C - 1% | gravel/ rubble | 7.4 | 8-15 | steelhead, brook | fines=8.9%, deeply entrenched in dredge piles, lack cover/large woody debris |
| 7 | Slaughter | B -2.3% | gravel/ rubble | 1.6 | 15 | steelhead, brook | fines=15%, deeply entrenched in dredge piles, lack ponds/ cover/ large woody debris |
| 8 | Mayflower | A - 9% | cobble/ rubble/ boulders | 1.9 | 10-19 | brook | fines=12.4%, rock wall banks, lack pools, migration barrier |
| 9 | Webfoot | A - 5% | gravel/ rubble | 0.6 | 9-14 | no fish above barrier | fines=14.9%, small pilings, large pools askew from stream |

### ASSESSMENT DATA GAPS

More information on water temperature and bull trout spawning and rearing are needed for the mouths of Big and Little Mallard Creeks and Warren Creek to determine if there is indeed a water temperature problem here. No information on conditions has been obtained for Carey Creek and Rabbit Creek sub-watersheds, or from any sub-watershed east of Sabe Creek (with the exception of the three streams, Corn, Cramer, and Bear Basin Creeks, assessed through BURP). Most streams east of Sabe Creek (e.g. Chamberlain Creek drainage) are in wilderness area.

## POLLUTANT SOURCE INVENTORY

Pollutant sources may occur as point sources, those for which effluent limitations may be required under sections 301(b)(1)(A) and 301(b)(1)(B), or nonpoint sources of pollutants that are not subject to effluent limitations. There are no NPDES permitted point sources within the Salmon-Chamberlain subbasin according to EPA databases.

Nonpoint pollution sources that can affect sediment discharges in the Salmon-Chamberlain subbasin include forest management and forest road and harvest activities, recreational activities, roads, construction, pastures and paddocks associated with human occupied areas, mining, livestock grazing, and natural and induced mass wasting processes.

The Nez Perce National Forest and Payette National Forest conduct forest management activities including road building, timber thinning and harvesting, and fire suppression that may result in increased erosion and sedimentation. According to data from the Nez Perce National Forest (NPNF, 1994), there are about 288 miles of road in the area from Little Salmon River to Sabe Creek (north side of Salmon River). These roads range in type from high standard, aggregate- surfaced travelway to narrow, native-surfaced jeep trails with extreme grades.

Watershed road density in general across the subbasin is less than 1.0 mile/square mile. The exceptions are in the watersheds of Allison, Carey, Fall Creek, and several smaller drainages in the Salmon River north face 5th field HUC combined watershed. For example, the Jersey Creek watershed has a road density around 1.0 mile/square mile. Overall, the road density throughout the subbasin is considered low. Road density may be of concern in the western Wind River drainage, where there are no listed stream segments. The amount of effect (i.e., hydrograph changes, sediment yield changes, etc.) from road density within the subbasin is potentially minimal since most of the area is roadless or under wilderness designation.

There were two on-going activities in the Big Mallard Creek watershed that had the potential to significantly increase sediment: the hauling of harvested timber and improvements on Forest Road 421. These activities, now completed, were not considered to pose significant threat to steelhead habitat (NPNF, 1999a). Jack Creek has been identified as a source of suspended sediment, presumably originating from sloughed banks and overwidened areas caused by overgrazing, roads, and harvest activity (NPNF, 1994).

Dixie has the potential to produce a small, localized increase in storm water discharge to upper Crooked Creek because of the buildings and recreational development activities. Dixie has been extensively subdivided, with 80 private residences ranging from small lots to 40-acre parcels, and several businesses. The town site is located on the 154-acre Crooked Creek Placer patented mine claim, which runs adjacent to 32 miles of Crooked Creek. This reach of the Creek has been dredge mined and both the riparian and instream habitat has been moderately to severely altered. Common activities associated with the town site include: channelization, bridge construction, ford crossings, removal of riparian vegetation, landfills, stock holding corrals, and homesite development.

Recreational activities in the subbasin may contribute to erosion and sedimentation. They include off-road vehicle use, hunting, hiking, camping, horseback riding, bicycling, fishing, scenery and wildlife viewing, and cross-country skiing.

Placer and dredge mining for precious metals is conducted at several locations. Dredged areas near Warren and Dixie are primarily on private ground. Very few mining claims are still active on the north side of the river, either on private land or Forest Service land. There are no known recent impacts to streams from private claims on the north side of the river, but effects from past mining still influence the Crooked Creek watershed (NPNF, 1999a). The Robinson Dike Mine and private real estate development are probable sediment sources contributing to Rhett Creek.

Mining activity in the Dixie mining district has been extensive since 1861. In particular, three mining and exploration projects in upper Crooked Creek could be potential sources of sediment. Of the three projects, two are inactive, and the third, Million Dollar Placer 1 and 2, is not expected to significantly affect sediment yield (NPNF, 1999a). The Million Dollar Placer Project does occur in the floodplain and riparian zone, approximately 33 feet or more from the stream channel. According to the Nez Perce National Forest (NPNF, 1999a), the mine has exposed and not reclaimed a large area of bare soil in the floodplain of upper Crooked Creek. In the event of high water during flooding, the active part of the project within the floodplain may contribute fine sediment, gravel, and cobble materials.

Grazing activities that may contribute to riparian vegetation loss and increased sediment load are relatively few. They include short-term, site-specific grazing of pack and saddle stock and minor domestic livestock grazing that occurs mostly on private land holdings throughout the subbasin. Past grazing still impacts areas within the Big Creek drainage. Lower Big Mallard supports three grazing allottments, two active and one inactive. Grazing has occurred at various levsls since 1946. Within the Big Mallard Creek watershed, there is a 28,830 acre grazing allottment. Riparian function and channel characteristics have been altered at several ranch and residential locations along Jack, Meyers, and Big Mallard Creeks (USFS, 1999).

Mass wasting processes are important sedimentary processes to account for in the subbasin. The combination of easily weathered granitic rocks that yield non-cohesive soils on steep slopes, and warm Pacific air masses flowing through the area that cause rain-on-snow events, can result in significant events. Landslides and debris torrents are naturally-occurring processes. However, forest management activities have been shown to increase their occurrence. Many times, these mass wasting events are triggered by thunderstorms, the freeze-thaw cycle, wildland fires, or more commonly from rain-on-snow events. The effects from prescribed burning are considered to be less than those of uncontrolled wildland fires (USFS, 1999).

## POLLUTANT SOURCE DATA GAP

Information on sediment sources in listed streams is limited in extent. The recent NEZSED modeling performed by the Nez Perce National Forest would serve as a starting point for any further more in-depth characterization work necessary for the subbasin. The Nez Perce NEZSED model predicts natural and activity yield for stream segments along the north side of the Salmon River. Other than this preliminary modeling and that performed on the main Salmon River (see Table 12), there is limited sediment-related monitoring or sampling results available.

## SUMMARY OF POLLUTION CONTROL EFFORTS

This section describes some past and present pollution control efforts in surface waters in the subbasin. The scope is limited to those efforts that could control sediment, the primary parameter of concern identified in the 1996 э303(d) list.

### Past Pollution Control Efforts

A summary of restoration efforts completed within the subbasin by the Nez Perce National Forest between 1993 and 1997 is contained in Appendix 3. Most pertain to roadway improvements and streambank restoration.

The Idaho Forest Practices Act was codified during the mid-1970's to comply with э208 of the Clean Water Act. The Forest Practices Water Quality Management Plan identifies the Rules and Regulations Pertaining to the Idaho Forest Practices Act as best management practices (BMPs) to be used during forest practices (e.g., logging) to protect surface water quality.

### Present Pollution Control Efforts

Presently, there are not many control efforts being conducted or immediately planned in the mining areas of Warren Creek and Crooked Creek. The Payette National Forest plans to do some trail work and possibly some road maintenance in the Warren Creek drainage in the vicinity of the Burgdorf Junction fire (Zuniga, 2001). Rehabiliation work in the Crooked Creek drainage is of low priority compared to other projects elsewhere in the Nez Perce National Forest (Gerhardt, 2001).

In general, the USFS has an ongoing program to control pollution associated with forest practices. Fire prevention, suppression, and management activities are conducted by the forest service in ways developed to minimize water pollution. Additionally, the Forest Service has entered into a memorandum of understanding with the state and other federal agencies to address non-point source pollution to waterways. The following are excerted from the Idaho Department of Environmental Quality Non-point Source Management Plan (DEQ, 1999):

"The Forest Service, under the Organic Act Of 1897 (16 U.S.C. 551), the Multiple Use Sustained Yield Act of 1960 (16 U.S.C. 528), as amended, and the National Forest Management Act of 1976 (16 U.S.C. 1600), is directed to regulate the occupancy and use of National Forest System Lands. The Clean Water Act, as amended, (33 U.S.C. 1323) directs the Forest Service to meet state, interstate and local substantive as well as procedural requirements respecting control and abatement of pollution in the same manner, and to the same extent as any non-governmental entity.

"Executive Order 12372 (September 17, 1983) directs the Forest Service to make efforts to accommodate and foster intergovernmental partnership by relying on state processes, to the extent feasible for state coordination and review of proposed federal financial assistance and direct federal development.

"The U.S. Forest Service is responsible for the management of over 20.4 million acres of National Forest Service lands in Idaho. These are public lands that form the headwaters of many of Idaho's important river systems. The Forest Service has the statutory authority to regulate, permit and enforce land-use activities on the National Forest System lands that affect water quality.

“As the designated management agency, the Forest Service is responsible for implementing 1) nonpoint source (NPS) pollution control; and 2) the Idaho State Water Quality Standards on National Forest System lands. The basis of the Forest Services's nonpoint source pollution control policy stems from the: National Nonpoint Source Policy (December 12, 1984); Forest Service Nonpoint Strategy (January 29, 1985); and the USDA Nonpoint Source Water Quality Policy (December 5, 1986). The Forest Service's water quality policy is to: 1) promote the improvement, protection, restoration and the maintenance of water quality to support beneficial uses on all national forest service waters; 2) promote and apply approved best management practices to all management activities as the method for control of NPS pollution; 3) comply with established state or national water quality goals; and 4) design monitoring programs for specific activities and practices that may affect or have the potential to affect in-stream beneficial uses on National Forest System lands.

“The Forest Service also coordinates all water quality programs, on National Forest System lands within its jurisdiction, with the local, state and federal agencies, affected public lands users, adjoining land owners, and other affected interests.” (DEQ, 1999; Appendix A-1, pp.5-6)

“ *THE FEDERAL LAND MANAGEMENT AGENCIES AGREE*
1 . That federal agencies will be subject to, and comply with, state requirements in the same manner and to the same extent as any other party to this agreement, or other nongovernmental entity.
2 . To annually, by May 1, develop or update water quality monitoring plans to meet the intent of the Antidegradation Policy and the NPS Water Quality Management Program, and provide to IDHW monitoring results information relative to the feedback loop.
3. To annually provide, to the designated IDHW and IDL offices, by May 1, a general schedule of proposed land-disturbing activities during the forthcoming year. Projects and programs for which the federal agencies specifically request assistance will be identified.
4. To involve the IDWR, IDHW and IDL at the appropriate time in the NEPA process for projects having significant potential to impact beneficial water uses.
5. To incorporate the ten items for Federal Consistency Review Criteria (pages 26-28 of the Idaho Nonpoint Source Management Program) into NEPA documents.
6. To insure that all new and renewed plans, leases, contracts, special use authorizations, easements, right-of-way documents and other agreements involving permitted activity on federal lands, contain provisions for compliance with all water pollution control statutes and regulations (federal and state) under the authority of the Clean Water Act.
7 . To provide in-house training to federal Personnel to increase employee awareness of, and sensitivity to, the importance of maintaining water quality, potential impacts to water quality, applicable state and federal law, and state-of-the-art techniques used to prevent water quality problems.” (DEQ, 1999, Appendix A-1, p.9)

“The Federal Agencies Agree:
1.To comply with the water quality protection provisions of the IFPA Rules and Regulations.
2.To conduct interim internal reviews of best management practices (BMPs) by annually examining a representative sample (target 10%) of timber related projects on lands they administer and prepare written BMP evaluation reports. Summaries of these reports will be provided to IDL and IDHW, for inclusion in the annual Forest Practices Water Quality Management Plan Report.

3.To participate in the statewide Forest Practices Audit Team, provide necessary information for selection of timber sales and provide technical expertise in audit procedure.
4.To develop and implement a variance policy that assures that when a specialized BMP is used, instead of a specific IFPA rule or regulation, that the practice selected protects beneficial uses.
5.To provide technical support to IDL and participate on the forest practice cumulative effects tasks force.
6.To notify IDHW of any suspected occurrences of beneficial use impairment that occur on National Forest System lands and public lands administered by the BLM.
7.To notify IDL of all suspected non-compliance with water quality protection provisions of the IFPA rules and regulations on federally administered lands.
8.To provide technical support, to IDL, in the administration and implementation of the water quality protection provisions of the rules and regulations pertaining to the IFPA on federally administered lands." (DEQ, 1999; Appendix A-2, pp.3-4)

## DISCUSSION

The Salmon-Chamberlain subbasin is predominantly federal land, the majority of which is wilderness designation. With very little privately held land, low road densities, and few areas of disturbance, it is safe to characterize the overall subbasin as one of the more pristine in the lower 48 contiguous states. Notwithstanding, seven tributaries and the main stem of the Salmon River have been listed on the 303(d) list. This listing has apparently been done through an administrative process without actual documented violations of the Idaho Water Quality Standards for the designated pollutants of concern. The assessment of 1997 BURP samples and additional data for the listed stream segments in the subbasin indicates that the 303(d) listed streams are all fully supporting their aquatic life uses.

There are two areas of past and present activities, which are of concern. Warren Creek was extensively dredge mined in the past and a large area remains with sparse natural riparian vegetation. Crooked Creek in the vicinity of Dixie was dredged in the past and currently receives some level of perturbation from local residences and roads. An analysis of macroinvertebrate assemblages indicated that Crooked Creek has experienced some impacts from fine sediments (Clark, 2000). Both streams, however, are fully supporting their aquatic life uses. Although these areas are of concern and should receive some oversight to prevent further degradation or to restore habitat if possible, it is not clear that a TMDL is warranted or justified based on aquatic life assessments.

Throughout the subbasin, there are apparent legacy issues related to several areas that have been altered by mining, road construction, and grazing. Logging accounts for a small percentage of the subbasin, about 2% of the non-wilderness/non-roadless area. It is anticipated that the Forest Service, the principle land owner, will continue to monitor and take corrective actions where necessary to maintain water quality within these areas.

## RECOMMENDATIONS AND CONCLUSION

According to the Clean Water Act, any stream with sediment pollution exceeding water quality standards is required to have a TMDL prepared. The subbasin assessment is step one of two, where the second step is preparing the load characterization and allocation for waters truely impaired by pollutants.

Available data indicate a minimally impacted subbasin and aquatic life uses are fully supported. **We conclude that state water quality standards for sediment are not being exceeded in the listed water bodies in this subbasin. Therefore, Big Mallard Creek, Little Mallard Creek, Rhett Creek, Crooked Creek, Big Creek, and Jersey Creek, are to be delisted from the next 303(d) list. Warren Creek shall remain on the 303(d) list for habitat alteration.**

The lower portions of Big Mallard Creek, Little Mallard Creek and Warren Creek need to be further investigated for possible spawning and rearing temperature problems. If the mouths of these creeks are not used for salmonid spawning, then this is perhaps a moot point. **Crooked Creek violates temperature criteria for bull trout spawning and rearing. The Crooked Creek TMDL for temperature follows in the next sections of this document.**

**The IDEQ will also delist the Salmon River, from Cherry Creek to Corn Creek.** There are no pollutants identified for its 303(d) listing. This suggests it may have been listed based on concern that the Salmon River's water quality be preserved for fisheries and recreation, not concern that its water quality has been compromised. There is no evidence establishing that the river violates any state water quality standard. Since no pollution has been documented, and in fact all signs indicate it is one of the more pristine rivers in the country outside Alaska, a TMDL for the Middle Salmon River within the subbasin is not necessary at this time. Since it is important for threatened and endangered salmonids, the river will continue to be monitored and protected by land management agencies into the foreseeable future in accordance with their responsibilities and the Endangered Species Act.

Warren Creek, though impacted by past dredge mining, is still supporting its beneficial uses. Had beneficial uses not been fully supported, it is not possible to perform a load-oriented TMDL for habitat alteration. A recovery plan should be pursued by the Payette National Forest to address the long-term stability of dredged areas. Since impacts from roadways may be the greatest source of current human-caused sedimentation, a water quality management plan directed at road problems should be investigated by the Forest Service. Additionally, the sub-watershed will require substantial stream restoration work to return riparian areas to the natural state. We believe this restoration is important to further protect the aquatic life uses in this creek.

Load Allocation
For
Total Maximum Daily Load (TMDL)

Crooked Creek
Middle Salmon River – Chamberlain Creek Subbasin
17060207

Revised: December 2002

**<u>WQ CONCERNS AT A GLANCE:</u>**

| | |
|---|---|
| **Water Body of Concern:** | **Crooked Creek** |
| **Assessment Units:** | **(ID17060207SL067_05, ID17060207SL068_02, ID17060207SL068_03, ID17060207SL068_04)** |
| **Subbasin:** | **Middle Salmon River-Chamberlain Creek** |
| **Watershed Identifier:** | **17060207** |
| **Parameter of Concern:** | **Temperature** |
| **Key Resources:** | **Chinook Salmon**<br>**Steelhead Trout**<br>**Bull Trout**<br>**Westslope Cutthroat Trout**<br>**Resident Rainbow Trout** |
| **Uses Affected:** | **Salmonid Spawning, Cold Water Biota** |
| **Sources Considered:** | **Legacy Effects from Historic Mining,**<br>**Altered Riparian Condition** |

## WATERSHED DESCRIPTION

Crooked Creek is a tributary to the main Salmon River in central Idaho. Crooked Creek originates near the divide with the South Fork Red River (South Fork Clearwater River subbasin) below Elk City. The creek flows southwest for about 11 miles, then bends west for several miles, then flows southwest again for another eight miles before entering the Salmon River. Fifty-four percent of the Crooked Creek watershed is in the Gospel-Hump Wilderness (the lower half of the stream), while 2% is in private ownership. The remaining lands are in the Nez Perce National Forest. There are two large tributaries, Big Creek and Lake Creek, entering the middle reaches of Crooked Creek as well as numerous smaller tributaries throughout the watershed. The upper half of Crooked Creek is in mixed conifer forest communities. Below Big Creek, Crooked Creek enters an area of decreasing tree density. By the time Crooked Creek reaches the Salmon River, the landscape is predominantly grass/shrub communities with few trees (see aerial photographs in Appendix 6 for examples).

## WATER QUALITY CONCERNS

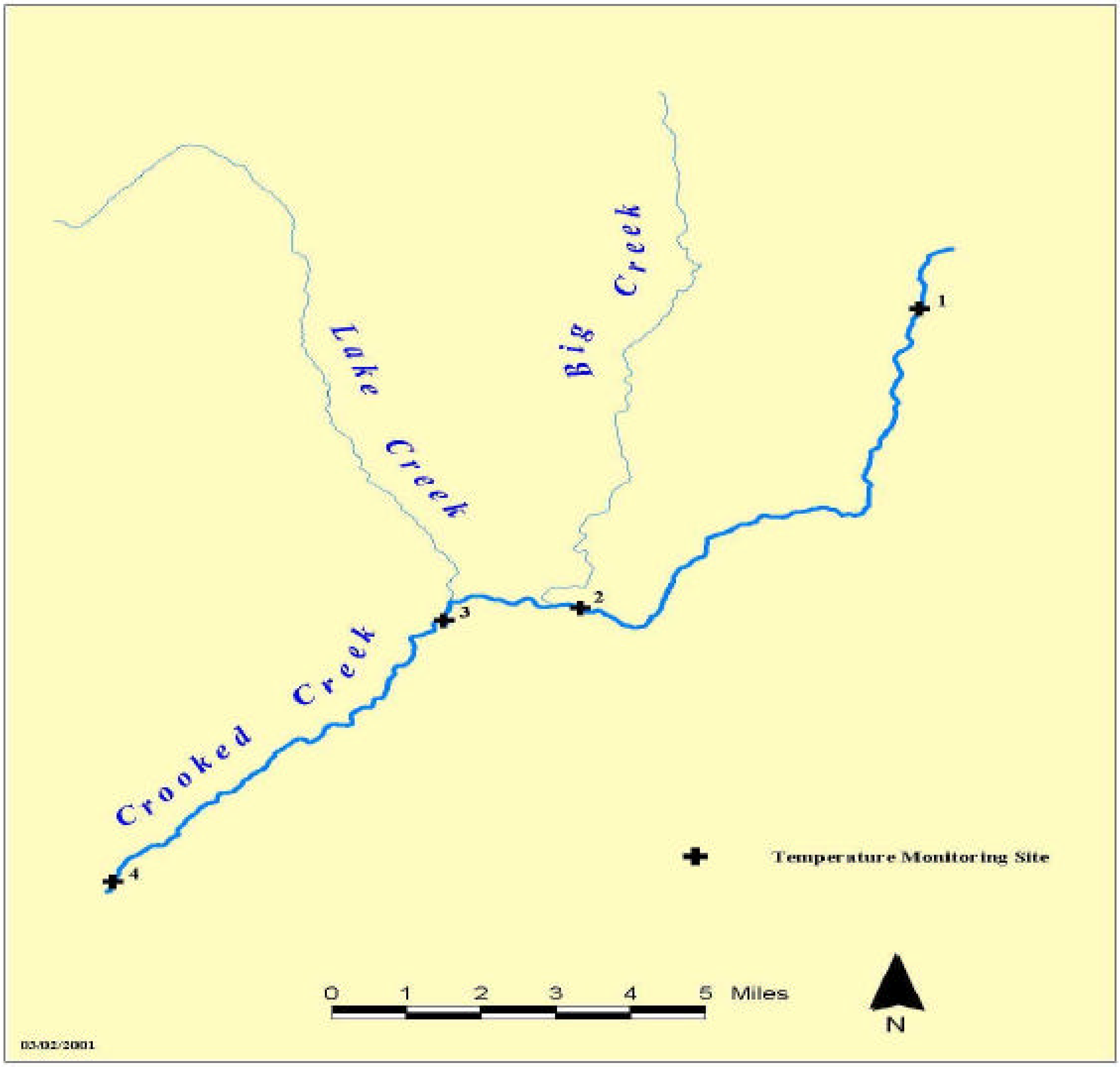
The problem assessment process determined that, although moderately high, sediment was not impairing aquatic life in this stream. However, it was determined that temperature measurements were high enough that salmonid spawning in upper Crooked Creek and bull trout spawning and rearing, if they occur in Crooked Creek, may be affected.

Temperature loggers have been placed in Crooked Creek at four locations every year from 1994 to 1999 (Map 12). These four locations include: 1) a headwaters site (Site 1), 2) a location below the town of Dixie and the Forest Service Dixie Work Center, but above the tributaries of Big Creek and Lake Creek (Site 2), 3) a location directly below Lake and Big Creeks (Site 3), and 4) a fourth location near the mouth of Crooked Creek (Site 4). The monitoring data show that the headwaters are relatively cool, but the water temperature increases rapidly through the impacted areas around Dixie. Water temperatures are cooled by entering the wilderness area and from the flow from Big Creek and Lake Creek. The water heats up again as it travels the remaining distance through the wilderness area to the mouth.

Elevations range from near 6000 feet in the headwaters to near 2000 feet at the mouth. We presumed that heating of the water as it passes through the wilderness area is a natural phenomenon, a result of atmospheric influences (air temperature and direct solar radiation). Aerial photos reveal that much of the wilderness area is open woodlands and grasslands (see Appendix 6).

Air temperature data for the Dixie area are presented in Appendix 5. From 1960 to 1990, Dixie reached an average maximum air temperature of about 78°F (25.5°C) in the summer time. With a standard lapse rate of 3.6°F (2°C) increase for every drop in 1000 feet of elevation (Aherns 1991), the mouth of Crooked Creek 3000 feet down may normally experience average maximum air temperatures near 89°F (31.7°C).

## Map 12. Temperature monitoring sites on Crooked Creek.




A description of the location of the four sites follows:

- Site 1, approximately 5860 feet elevation, is located in the headwaters above Horse Flat Creek, which is 1.5 miles downstream from the origin of Crooked Creek at Dixie Summit.
- Site 2, approximately 5020 feet elevation, is 1.5 miles upstream of Big Creek and above the wilderness boundary. It is below the town of Dixie and a large open meadow with airstrip.
- Site 3, approximately 4240 feet elevation, is approximately 300 feet below Lake Creek tributary.
- Site 4, approximately 2100 feet elevation, is 0.25 miles upstream from the mouth of Crooked Creek.

## Temperature Data Analysis

Surface water temperature data collected by the Nez Perce National Forest from Crooked Creek during 1994 to 1999 were used in this assessment. The data were collected from the four localities using temperature data loggers set to record hourly values. Raw data files were edited by deleting spurious air temperature values, days with less than 24 readings, and negative values. Mean and maximum statistics were calculated from the edited raw data and are presented in Table 17.

Table 17. Overall mean, peak maximum weekly maximum temperature (MWMT), and peak maximum weekly average temperature (MWAT) statistics calculated for the recording period (late June to early October) for each site and year.

| Overall Mean Temperature °C | | | | |
|---|---|---|---|---|
| Year | Site 1 | Site 2 | Site 3 | Site 4 |
| 1994 | 8.7 | 11.3 | 11.1 | 14.3* |
| 1995 | 7.4 | 10.1 | 9.0 | 12.3 |
| 1996 | 8.5 | 11.2 | 10.3 | 12.4 |
| 1997 | 7.6 | 8.9# | 8.8 | 13.5 |
| 1998 | 10.0* | 12.4* | 12.1* | 12.1 |
| 1999 | 5.6# | 9.4 | 7.9# | 10.3# |
| Average | 8.0 | 10.6 | 9.7 | 12.5 |
| Highest Maximum Weekly Maximum Temperature °C (MWMT) | | | | |
| 1994 | 14.1 | 21.5* | 18.2* | 22.4* |
| 1995 | 12.7# | 18.6# | 15.3# | 18.9 |
| 1996 | 13.5 | 19.5 | 15.6 | 18.8# |
| 1997 | 12.9 | 17.2 | 15.6 | 19.1 |
| 1998 | 14.4* | 20.2 | 17.0 | 20.9 |
| 1999 | 12.7# | 18.7 | 15.4 | 19.6 |
| Average | 13.4 | 19.3 | 16.2 | 20.0 |
| Highest Maximum Weekly Average Temperature °C (MWAT) | | | | |
| 1994 | 13.0* | 16.7* | 16.0* | 19.5* |
| 1995 | 10.7# | 13.8# | 13.2# | 16.3# |
| 1996 | 12.0 | 14.9 | 13.7 | 16.7 |
| 1997 | 11.5 | 14.1 | 13.9 | 16.9 |
| 1998 | 12.3 | 15.5 | 14.9 | 18.2 |
| 1999 | 11.6 | 14.3 | 13.7 | 17.0 |
| Average | 11.9 | 14.9 | 14.2 | 17.4 |

* Highest temperature for each statistic recorded at that site.
# Lowest temperature for each statistic recorded at that site.

Peak MWAT demonstrate consistently that 1994 was one of the warmest years and 1995 was one of the coolest in this data set. The other two statistics show this relationship less consistently. Overall means vary only a few degrees from upstream (Site 1) to downstream (Site 4). However, the average overall mean demonstrates an increase in temperature at Site 2 followed by a decrease in temperature at Site 3. This decrease in temperature at Site 3 is consistent throughout the data set. These data suggest that even the headwaters of Crooked Creek (Site 1) are fairly warm in the summer with peak MWMT averaging at 13.4°C.

**Temperature criteria evaluation**

Edited data sets were compared to Idaho temperature criteria for cold water aquatic life (22°C instantaneous and 19°C daily average throughout the monitoring periods), bull trout spawning (13°C instantaneous and 9°C daily average September through October at elevations over 4593 feet), bull trout juvenile rearing (12°C daily average June through August), and salmonid spawning (13°C instantaneous and 9°C daily average January 15 through July 15 and September through October). The edited data sets were also compared to the federal bull trout temperature criterion (10°C MWMT June through September). The number of days exceeding these criteria are summarized in Table 18 for each site and each year.

Table 18. Number of days exceeding temperature criteria at four sites on Crooked Creek.

| Number of days in 1994 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C**[1] | **19C**[2] | **13C**[3] | **12C**[4] | **10C**[5] | **9C-SS**[6] | **9C-BT**[7] |
| Site 1 Horse Flat Creek | 0 | 0 | 0 | 15 | 65 | 15 | 1 |
| Site 2 Halfway House | 4 | 0 | 28 | 49 | 89 | 31 | 14 |
| Site 3 Lake Creek | 0 | 0 | 15 | 0 | 77 | 30 | 0 |
| Site 4 Mouth | 7 | 11 | 36 | 0 | 81 | 44 | 0 |
| **TOTAL # of Days** | 11 | 11 | 79 | 64 | 312 | 120 | 15 |

| Number of days in 1995 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 1 | 0 | 62 | 18 | 6 |
| Site 2 Halfway House | 0 | 0 | 31 | 33 | 87 | 39 | 20 |
| Site 3 Lake Creek | 0 | 0 | 9 | 0 | 81 | 33 | 0 |
| Site 4 Mouth | 0 | 0 | 25 | 0 | 76 | 34 | 0 |
| **TOTAL # of Days** | 0 | 0 | 66 | 33 | 306 | 124 | 26 |

| Number of days in 1996 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 0 | 3 | 46 | 3 | 2 |
| Site 2 Halfway House | 0 | 0 | 22 | 46 | 72 | 26 | 13 |
| Site 3 Lake Creek | 0 | 0 | 7 | 0 | 71 | 22 | 0 |
| Site 4 Mouth | 0 | 0 | 17 | 0 | 69 | 40 | 0 |
| **TOTAL # of Days** | 0 | 0 | 46 | 49 | 258 | 91 | 15 |

1 22C=cold water aquatic life maximum year round.
2 19C=cold water aquatic life daily average year round.
3 13C=salmonid spawning maximum to 7/15 and 9/15-11/15.
4 12C=bull trout daily average 6/1-8/31.
5 10C=bull trout maximum weekly maximum 6/1-9/30.
6 9C-SS=salmonid spawning daily average to 7/15 and 9/15-11/15.
7 9C-BT=bull trout spawning 9/1-10/31.

Table 18. Continued.

| Number of days in 1997 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 0 | 1 | 45 | 11 | 11 |
| Site 2 Halfway House | 0 | 0 | 11 | 32 | 60 | 16 | 16 |
| Site 3 Lake Creek | 0 | 0 | 6 | 0 | 49 | 17 | 0 |
| Site 4 Mouth | 0 | 0 | 27 | 0 | 75 | 38 | 0 |
| **TOTAL # of Days** | 0 | 0 | 44 | 33 | 229 | 82 | 27 |

| Number of days in 1998 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 2 | 16 | 62 | 20 | 18 |
| Site 2 Halfway House | 0 | 0 | 19 | 48 | 73 | 22 | 20 |
| Site 3 Lake Creek | 0 | 0 | 15 | 0 | 66 | 21 | 0 |
| Site 4 Mouth | 0 | 0 | 47 | 0 | 118 | 71 | 0 |
| **TOTAL # of Days** | 0 | 0 | 83 | 64 | 319 | 134 | 38 |

| Number of days in 1999 that Crooked Creek temperatures violated criteria. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 2 | 1 | 62 | 8 | 0 |
| Site 2 Halfway House | 0 | 0 | 11 | 45 | 75 | 18 | 10 |
| Site 3 Lake Creek | 0 | 0 | 4 | 0 | 60 | 12 | 0 |
| Site 4 Mouth | 0 | 0 | 34 | 0 | 108 | 60 | 0 |
| **TOTAL # of Days** | 0 | 0 | 51 | 46 | 305 | 98 | 10 |

| Average annual number of days that Crooked Creek temperatures violated criteria at each site. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SITE** | **22C** | **19C** | **13C** | **12C** | **10C** | **9C-SS** | **9C-BT** |
| Site 1 Horse Flat Creek | 0 | 0 | 0.83 | 6 | 57 | 12.5 | 6.33 |
| Site 2 Halfway House | 0.67 | 0 | 20.33 | 42.17 | 76 | 25.33 | 15.5 |
| Site 3 Lake Creek | 0 | 0 | 9.33 | 0 | 67.33 | 22.5 | 0 |
| Site 4 Mouth | 1.17 | 1.83 | 31 | 0 | 87.83 | 47.83 | 0 |
| **TOTAL # of Days** | 1.84 | 1.83 | 61.49 | 48.17 | 288.16 | 108.16 | 21.83 |

Cold water aquatic life criteria (22C and 19C) were exceeded in only one (1994) of the six years of data. All other criteria were exceeded every year. The daily maximum salmonid spawning criterion (13C) included both spring spawning and fall spawning time periods. This criterion at Site 1 was exceeded only occasionally. At the other sites it was exceeded up to a month or more. The 12C and 9C-BT are state criteria for bull trout rearing and spawning, respectively. These criteria are applied to waters above 4593 ft. (1400 m) elevation. Thus, no violations are recorded for Sites 3 and 4 for these criteria. The 12C criterion is exceeded from zero to 16 days, with an average of six days at Site 1. At Site 2 this criterion is exceeded an average of 42 days. The 9C-SS and 9C-BT criteria reflect the differences between just the fall spawning period (9C-BT) and both spring and fall spawning periods (9C-SS). At Sites 1 and 2 the number of days exceeding criteria can double when both spring and fall spawning periods are considered. The 9C-SS criterion shows how spring and fall spawning temperatures faired at Sites 3 and 4, generally a month or more of violations. The 10C criterion is the federal bull trout criterion that applies to the entire creek during the summer months (June through September). It is the lowest temperature of all the criteria represented here that applies during the warmest time period of the year. Therefore, the 10C criterion reflects the maximum number of days in violation, averaging from 57 days at Site 1 to 88 days at Site 4.

The elevation change between Site 1 and Site 4 is about 3,731 feet. Over half (56%) of that change occurs between Sites 3 and 4 (Table 19). Surface waters tend to warm to a greater extent at lower elevations because air temperature is usually greater. However, the rate of change in water temperature should be proportional to the change in elevation, regardless of actual elevation provided that the water is flowing at the same rate and exposure is the same. Crooked Creek, however, has two large tributaries (Big Creek and Lake Creek) between Sites 2 and 3 that potentially contribute cooling water to Crooked Creek. And the gradient in the upper section is much lower than below Site 2.

Table 19. Amount of change between sites for numbers of days exceeding certain criteria (averages for period of record: 1994 to 1999).

| Site | Elevation (feet) | Distance from Source (miles) | No. Days Exceeding $9^oC$* | No. Days Exceeding $10^oC$@ |
|---|---|---|---|---|
| #1 – Horse Flat Creek | 5860 | 1.5 | 13 | 57 |
| #2 – Halfway House CG | 5049 | 10.7 | 25 | 76 |
| Change from #1 to #2 | -811(22%) | +9.2(47%) | +12(34%) | +19(61%) |
| #3 – Lake Creek | 4209 | 12.8 | 23 | 67 |
| Change from #2 to #3 | -840(22%) | +2.1(11%) | -2(-6%) | -9(-29%) |
| #4 – Mouth | 2129 | 21 | 48 | 88 |
| Change from #3 to #4 | -2080(56%) | +8.2(42%) | +25(71%) | +21(68%) |

*$9^oC$ as a daily average first day of monitoring through 7/15 and 9/1 through 10/31.
@ $10^oC$ as a 7-day moving average of daily maximums during June 1 to September 30.

Table 19 shows rates of change for various parameters between sites. For example, the elevation change between Sites 1 and 2 is 811 feet or 22% of the total elevation change for the creek. The largest elevation change occurs between Sites 3 and 4 (56%). The distance traveled between sites is greatest between Sites 1 and 2 (9.2 miles). We have used two criteria in Table 19 to analyze rates of change in number of days exceeding criteria. We used number of days exceeding criteria as an indication of water temperature; in other words, cooler temperatures produce few numbers of days exceeding criteria, warmer temperatures produce more days exceeding criteria. The number of days exceeding a daily average of $9^oC$ is based on the salmonid spawning criteria that would normally apply to Crooked Creek in the spring to July 15 for rainbow and cutthroat trout and from September 1 to October 31 for bull trout. Table 19 shows the number of days exceeding $9^oC$ as a daily average during those time periods. The other criterion is the federal bull trout criterion of $10^oC$ as a 7-day moving average of the daily maximums. This criterion applies June 1 through September 30.

The $10^oC$ criterion shows that there was about an equal amount of change in number of exceeding days between Sites 1 and 2 (19 days) as compared to Sites 3 and 4 (21 days) despite a two-fold difference in elevation change under the same comparison (811 ft. versus 2080 ft.). This suggests that the creek between Sites 1 and 2 is warming more than it should based on elevation change alone. The 9°C criterion does not show this relationship. However, this criterion was not applied during the warmest part of the summer between July 15 and September 1. In this case, the change in number of days exceeding 9°C daily average between Sites 3 and 4 is about twice the rate of change between Sites 1 and 2, consistent with elevation differences. In avoiding the warmest part of summer, this criterion does not reflect exceedances during warmer air temperatures and perhaps direct solar inputs from the sun high in the sky.

**Rates of Temperature Increase**

Rates of warming were estimated from raw temperature data as well. The differences in overall recording period mean temperature, maximum weekly maximum, and maximum weekly average, each averaged for all years of data, were calculated for the stream reaches between monitoring Sites 1 and 2, 2 and 3, and 3 and 4. For example, an overall mean is calculated for the June to October recording period for each site for each year. The overall means for each year are then averaged to form a single overall mean for that site. To determine rates of change between two sites, the overall mean for the upper site is subtracted from the overall mean for the lower site. These differences were divided by the amount of change in elevation and reach length to obtain two rates of temperature change. These rates are temperature change per stream mile and temperature change per 1000 feet of elevation (Table 20).

Table 20. Temperature change as a function of stream miles and elevation.

| | | |
|---|---|---|
| **Site 1 to Site 2:** 9.2 stream miles, 811 feet drop in elevation, gradient = 88.3ft/mi. | | |
| | Rate of change per stream mile | Rate of change per 1000 feet elevation |
| Change in overall mean | 0.28°C | 3.2°C |
| Change in highest MWMT* | 0.64°C | 7.3°C |
| Change in highest MWAT | 0.33°C | 3.7°C |
| **Site 2 to Site 3:** 2.1 stream miles, 840 feet drop in elevation, gradient = 394.4 ft/mi. | | |
| | Rate of change per stream mile | Rate of change per 1000 feet elevation |
| Change in overall mean | -0.41°C | -1.0°C |
| Change in highest MWMT | -1.46°C | -3.7°C |
| Change in highest MWAT | -0.31°C | -0.8°C |
| **Site 3 to Site 4:** 8.2 stream miles, 2080 feet drop in elevation, gradient = 252.4 ft/mi. | | |
| | Rate of change per stream mile | Rate of change per 1000 feet elevation |
| Change in overall mean | 0.34°C | 1.3°C |
| Change in highest MWMT | 0.46°C | 1.8°C |
| Change in highest MWAT | 0.39°C | 1.5°C |

*MWMT = maximum weekly average of daily maximum water temperatures.
# MWAT = maximum weekly average of daily average water temperatures.

Crooked Creek cools between Sites 2 and 3 because Big Creek and Lake Creek add flow, the stream turns westward and may receive more shading from the mountain ridge to its south, and there is an increase of riparian cover in the wilderness area. Thus rates of change are negative values. Between Sites 1 and 2 the gradient is the lowest (88.3 ft/mi or 1.7%) although this stretch is the longest distance (9.2 miles). Residence time is greatest between Sites 1 and 2. Between Sites 3 and 4 the distance (8.2 miles) is similar to Sites 1 and 2, however, the gradient is substantially greater (252.4 ft/mi or 4.8%). The rates of change per stream mile are similar between the lower reaches and the upper reaches. The rates of change per 1000 ft. elevation between Sites 1 and 2 are at least twice the rates of change between Sites 3 and 4.

The stream reach between monitoring Sites 1 and 2 had the highest rate of temperature increase on an elevational basis. This reach also has the lowest gradient, slower residence time, and contains the most human disturbance, particularly the Dixie mining district, the town of Dixie, the airstrip near Dixie Work Center, and associated roads. The stream reach between monitoring Sites 3 and 4 is contained primarily in the Gospel Hump Wilderness. An area that was affected by some legacy human disturbance from grazing (and possibly mining) at one time, and presumably some disturbance from wildfire and current recreational activities. However, the rate of temperature increase between Sites 1 and 2 needs to be reduced to be comparable to the stream reaches between Sites 3 and 4.

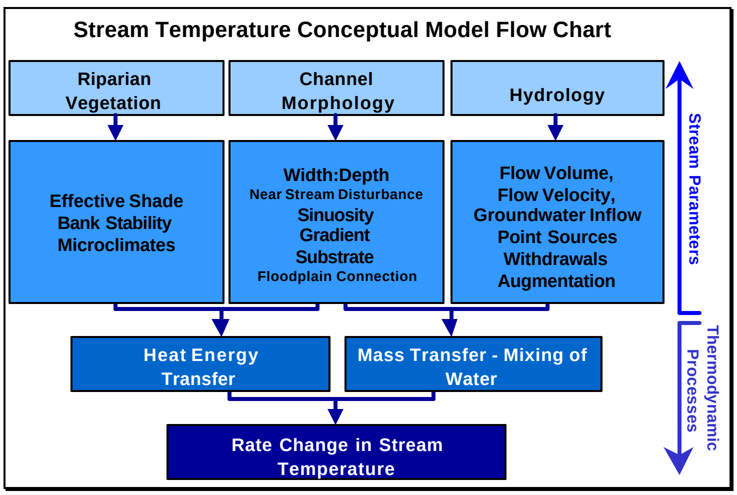
**Temperature Summary**

Temperature data suggest (see Table 18) that Crooked Creek may have slightly elevated temperatures naturally. The mouth of Crooked Creek on average has slight exceedances of cold water aquatic life criteria, consistent probably with the Salmon River itself in this canyon. Even in the headwaters of Crooked Creek stream temperatures are slightly greater than criteria on average creating a few days where salmonid spawning criteria are exceeded. Because salmonid spawning criteria are applied to a default time period for spring and fall spawning species, individual streams may have warmer temperatures near the end of the spring spawning period (mid-July) or at the beginning of the fall spawning period (September 1st) without seriously harming the actual spawning in the stream (i.e. fish spawn when the temperature is right and there is sufficient time to do so). Additionally, because we often consider average condition, there will be hot years when criteria are exceeded more often, and there will be cold years when criteria may not be exceed at all. In order to avoid confusion about criteria exceedances, the goal of this TMDL is to achieve the natural temperature regime in the stream by returning the effective shade to its natural condition. We anticipate that the natural temperature regime is cooler than the present condition, however, the natural temperature regime may not necessarily exclude temperature criteria exceedances.

# Temperature TMDL – Effective Shade/Thermal Load Modeling

### Effective Shade Overview - Description of Shading Processes
### (Provided by Peter Leinenbach, USEPA)

At any particular instant of time, a defined stream reach is capable of sustaining a particular water column temperature. Stream temperature change that results within a defined reach is explained rather simply. The temperature of a parcel of water traversing a stream/river reach enters the reach with a given temperature. If that temperature is greater than the energy balance is capable of supporting, the temperature will decrease. If that temperature is less than energy balance is capable of supporting, the temperature will increase. Stream temperature change within a defined reach, is induced by the energy balance between the parcel of water and the surrounding environment and transport of the parcel through the reach. The general relationships between stream parameters, thermodynamic processes (heat and mass transfer) and stream temperature change are outlined in the flow chart below.




### Cumulative Effects

It takes time for the water parcel to traverse the longitudinal distance of the defined reach, during which the energy processes drive stream temperature change. At any particular instant of time, water that enters the upstream portion of the reach is never exactly the temperature that is supported by the defined reach. And, as the water is transferred downstream, heat energy and hydraulic processes that are variable with time and space interact with the water parcel and induce water temperature change. Further, heat energy is stored within this parcel of water and its temperature is the result of the heat energy processes upstream. This is commonly referred to as a cumulative temperature effect, where conditions at a site contribute to heating of an already heated parcel of stream water. The described scenario is a simplification; however, understanding the basic processes in which stream temperature change occurs over the course of a defined reach and period of time is essential.

## Thermal Role of Riparian Vegetation

The role of near stream land cover in maintaining a healthy stream condition and water quality is well documented and accepted in scientific literature (Beschta et al. 1987). Riparian vegetation plays an important role in controlling stream temperature change. The important impacts that near stream land cover has upon the stream and the surrounding environment warrant listing.

- Near stream vegetation height, width and density combine to produce shadows that when cast across the stream reduce solar radiant loading.
- Near stream land cover creates a thermal microclimate that generally maintains cooler air temperatures, higher relative humidity and lower wind speeds along stream corridors.
- Bank stability is largely a function of near stream vegetation. Specifically, channel morphology is often highly influenced by land cover type and condition by affecting floodplain and instream roughness, contributing coarse woody debris and influencing sedimentation, stream substrate composition and stream bank stability.

The warming of water temperature as a stream travels and drops in elevation (longitudinal heating) is a natural process. However, rates of heating can be dramatically reduced when high levels of shade exist and solar radiation loading is minimized. The overriding justification for a reduction in solar radiation loading is to minimize longitudinal heating. A limiting factor in reducing longitudinal stream heating is that there is a natural maximum level of shade that a given stream is capable of attaining.

## Stream Surface Shade - Defined

Stream surface shade is an important parameter that controls the stream heating derived from solar radiation. Solar radiation has the potential to be the largest heat transfer mechanism in a stream system. Human activities can degrade near stream land cover and/or channel morphology, and in turn, decrease shade. It follows that human caused reductions in stream surface shade have the potential to cause significant increases in heat delivery to a stream system. Stream shade levels can also serve as an indicator of near stream land cover and channel morphology condition. For these reasons, stream shade is a focus of this analytical effort.

Shade is the amount of solar energy that is obscured or reflected by vegetation or topography above a stream. Shade is expressed in units of energy per unit area per unit time, or as a percent of total possible energy. In contrast, canopy cover is the percent of the sky covered by vegetation or topography. Shade producing features will cast a shadow on the water while canopy cover may not. In order to assess the ability of riparian land cover to shield a stream from solar radiation, two basic characteristics of shade must be addressed: *shade duration* and *shade quality.* The length of time that a stream receives shade can be referred to as *shade duration*. The density of shade that affects the amount of radiation blocked by the shade producing features is referred to as *shade quality.* Effective shade (**Figure 1**) is amount of potential solar radiation not reaching the stream surface and is a function of *shade duration* and *shade quality.*

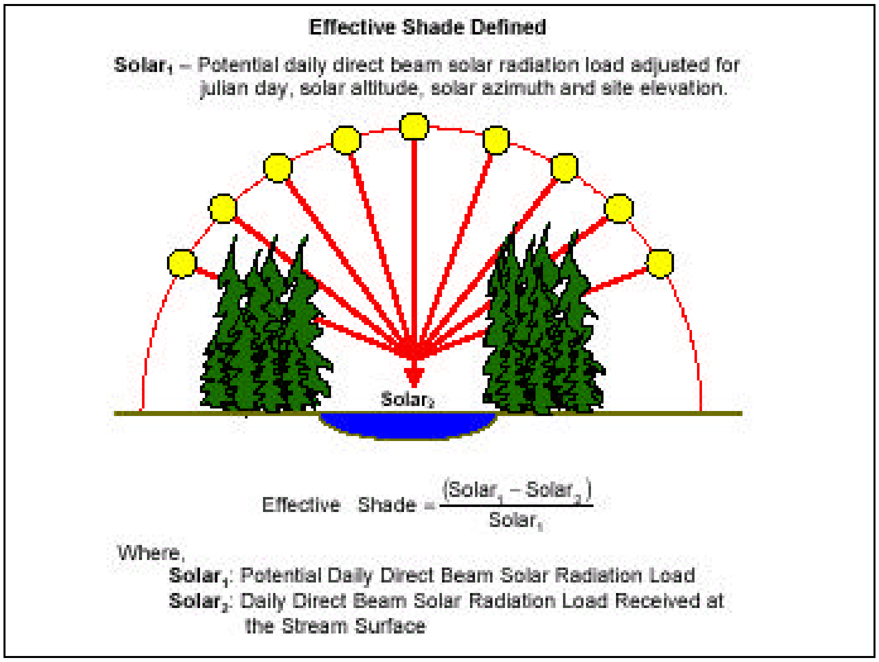



**Figure 1. Definition of Effective Shade**

In the Northern Hemisphere, the earth tilts on its axis toward the sun during summertime months allowing longer day length and higher solar altitude, both of which are functions of solar declination (i.e., a measure of the earth's tilt toward the sun) (**Figure 2**). Geographic position (i.e., latitude and longitude) fixes the stream to a position on the globe, while aspect provides the stream/riparian orientation. Near stream land cover height, width and density describe the physical barriers between the stream and sun that can attenuate and scatter incoming solar radiation (i.e., produce shade) (**Table 21**). The solar position has a vertical component (i.e., solar altitude) and a horizontal component (i.e., solar azimuth) that are both functions of time/date (i.e., solar declination) and the earth's rotation (i.e., hour angle measured as $15^{o}$ per hour). While the interaction of these shade variables may seem complex, the mathematics that describes them is relatively straightforward geometry. Using solar tables or mathematical simulations, the potential daily solar load can be quantified. The measured solar load at the stream surface can easily be measured with a Solar Pathfinder© or estimated using mathematical shade simulation computer programs (Boyd, 1996 and Park, 1993).

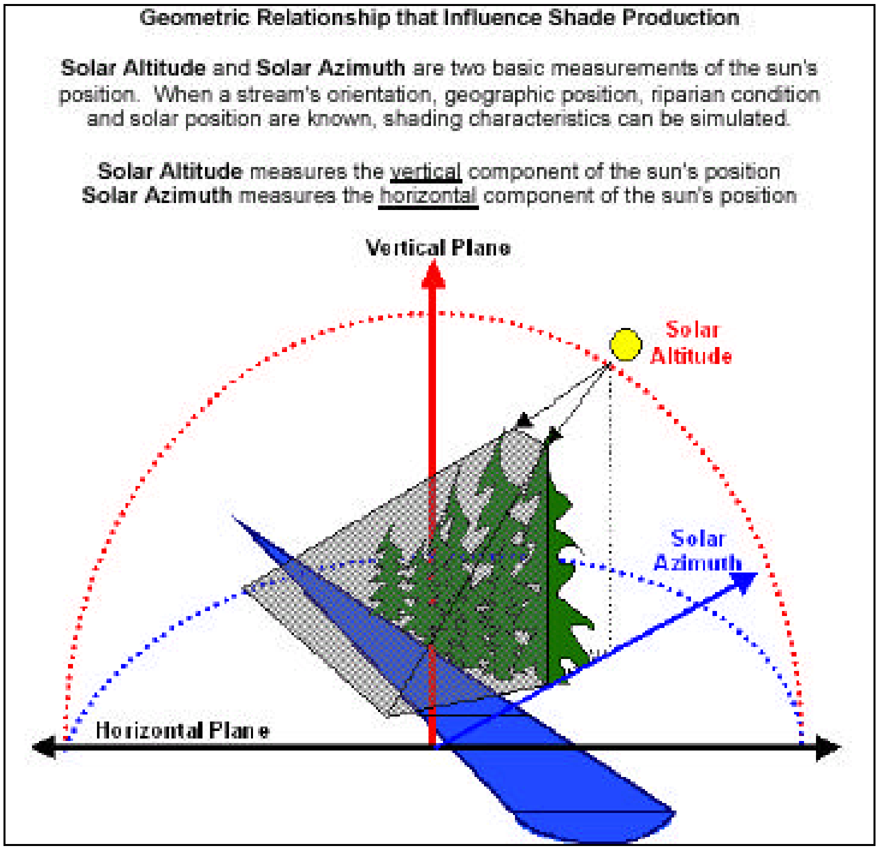



**Figure 2. Parameters that Affect Shade and Geometric Relationships**

**Table 21. Factors that influence stream shade.**

| Description | Parameter |
|---|---|
| Season/Time | Date/Time |
| Stream Characteristics | Aspect, **Channel Width** |
| Geographic Position | Latitude, Longitude |
| **Vegetative Characteristics** | **Near Stream Land Cover Height, Width, and Density** |
| Solar Position | Solar Altitude, Solar Azimuth |

**bold type** indicates factors that are influenced by human activities

**System Potential Effective Shade - Defined**

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

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

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

**System Potential Land Cover**

As listed above, "System potential land cover" is necessary to achieve "system potential effective shade," and is defined for purposes of the TMDL as "the potential near stream land cover condition that can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology and hydrologic processes." System potential does not consider management or land use as limiting factors. In essence, system potential is the design condition used for TMDL analysis that meets the temperature standard by minimizing human related warming.

System potential is an estimate of the condition where anthropogenic activities that cause stream warming are minimized.

System potential is not an estimate of pre-settlement conditions. Although it is helpful to consider historic land cover patterns, channel conditions and hydrology, many areas have been altered to the point that the historic condition is no longer attainable given drastic changes in stream location and hydrology (channel armoring, wetland draining, urbanization, etc.).

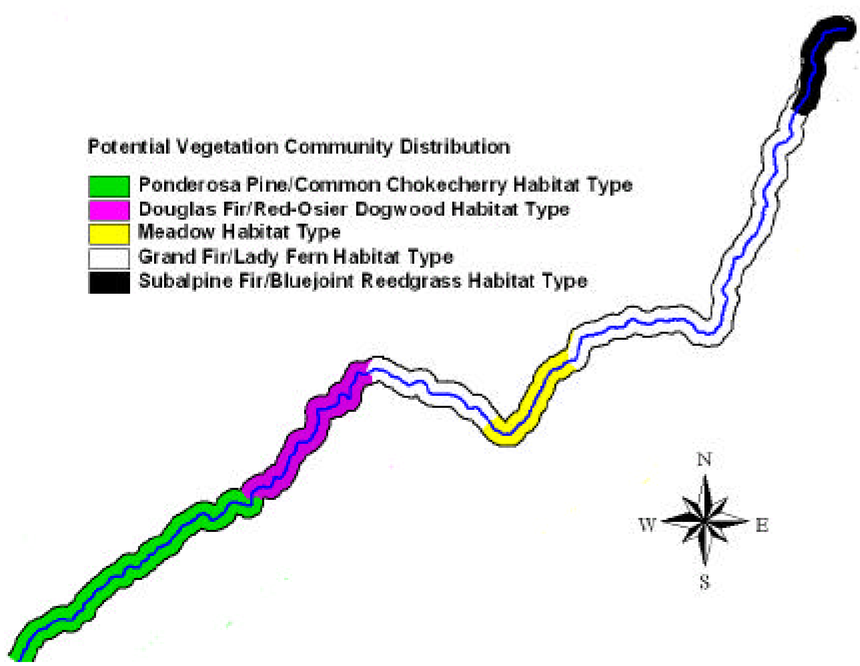
### Potential Natural Vegetation

#### *Spatial Distribution of Potential Natural Vegetation*

Potential natural vegetation cover was estimated from habitat type descriptions provided by Hansen et al. (1995). We determined the riparian habitat types from Hansen et al. (1995) most likely to apply to Crooked Creek. Estimated habitat type conditions were intended to provide general representations of expected natural vegetation conditions throughout Crooked Creek. Estimated habitat types are not necessarily representative of ***current*** conditions around Crooked Creek.

The upper reaches (from Horse Flat Creek to Lake Creek, but not including the large meadow) were included in the grand fir/lady fern (*Abies grandis/Athyrium filix-femina*) habitat type. The very headwaters (above Horse Flat Creek) may be in more of a subalpine fir habitat type. Hansen et al. (1995) included a subalpine fir/bluejoint reedgrass (*Abies lasiocarpus/ Calamagrostis canadensis*) habitat type that may be representative. The large, grassy meadow near Dixie Work Center and airstrip was included in the Coyote willow (*Salix exigua var. exigua*) or tufted hairgrass (*Deschampsia cespitosa*) habitat type depending on whether or not the meadow was once willow dominated or grass dominated. The lower reaches (below Lake Creek) are either in the Douglas fir/red-osier dogwood (*Psuedotsuga menziesii/Cornus stolonifera*) habitat type or the ponderosa pine/common chokecherry (*Pinus ponderosa/ Prunus virginiana*) habitat type. **Figure 3** illustrates the spatial distribution of these vegetation communities along Crooked Creek.

**Figure 3.** Distribution of Potential Natural Vegetation Communities along Crooked Creek



### *Canopy Cover of Potential Natural Vegetation*

For each habitat type, Hansen et al. (1995) provided average canopy cover, the range of canopy covers, and the constancy (% of sampling sites that contained the species) for species recorded in sampling plots. A weighted average canopy cover was calculated for each of the habitat types by summing the product of the average canopy cover and constancy for each tree species within each habitat type group. These calculations are presented in **Table 22**. It is important to note that these calculated cover values represent expected conditions based on the Habitat Type conditions presented above. These calculated canopy cover values should be viewed as a general representation of expected conditions within these habitat type groups. It must also be noted that, the Crooked Creek riparian area may contain other species not represented in this Table.

**Table 22.** A summary of species, canopy cover, and constancy for Habitat Types along Crooked Creek (from Hansen et al. (1995))

| | |
|---|---|
| **Grand Fir/Lady Fern Habitat Type** | |
| Grand fir (*Abies grandis*) | 30% average cover (100% constancy) = 30 |
| Subalpine fir (*Abies lasiocarpus*) | 3% average cover (20% constancy) = 0.6 |
| Paper Birch (*Betula Papyrifera*) | 3% average cover (20% constancy) = 0.6 |
| Western Larch (*Larix Occidentalis*) | 12% average cover (40% constancy) = 5 |
| Spruce (*Picea spp.*) | 20% average cover (60% constancy) = 12 |
| Black Cottonwood (*Popuus trichocarpa*) | 2% average cover (40% constancy) = 0.8 |
| Douglas fir (*Psuedotsuga menziesii*) | 9% average cover (60% constancy) = 5 |
| Rocky mountain maple (*Acer glabrum*) | 13% average cover (100% constancy) = 13 |
| Mountain Alder (*Alnus incana*) | 22% average cover (40% constancy) = 9 |
| | Total weighted average cover = 76% |
| **Subalpine Fir/Bluejoint Reedgrass Habitat Type** | |
| Subalpine fir (*Abies lasiocarpus*) | 32% average cover (100% constancy) = 32 |
| Spruce (*Picea spp.*) | 38% average cover (100% constancy) = 38 |
| Whitebark Pine (*Pinus albicaulis*) | 1% average cover (20% constancy) = 0.2 |
| Lodgepole Pine (*Pinus contorta*) | 17% average cover (50% constancy) = 9 |
| Mountain Alder (*Alnus incana*) | 2% average cover (20% constancy) = 0.4 |
| | Total weighted average cover = 80% |
| **Meadow Habitat Type** | |
| Current | |
| Tufted hairgrass (*Deschampsia cespitosa*) | 42% average cover (100% constancy) |
| Potential | |
| Coyote Willow (*Salix exigua* var. *exigua*) | 82% average cover |
| **Douglas Fir/Red-Osier Dogwood Habitat Type** | |
| Narrowleaf Cottonwood (*Populus angustifolia*) | 50% average cover (9% constancy) = 5 |
| Quaking Aspen (*Populus tremuloides*) | 21% average cover (30% constancy) = 6 |
| Black Cottonwood (*Populus trichocarpa*) | 44% average cover (43% constancy) = 19 |
| Douglas fir (*Psuedotsuga menziesii*) | 25% average cover (100% constancy) = 25 |
| Red-osier dogwood (*Cornus stolonifera*) | 11% average cover (43% constancy) = 5 |
| Common chokecherry (*Prunus virginiana*) | 10% average cover (43% constancy) = 4 |
| | Total weighted average cover = 64% |
| **Ponderosa Pine/Common Chokecherry Habitat Type** | |
| Ponderosa pine (*Pinus ponderosa*) | 27% average cover (100% constancy) = 27 |
| Green Ash (*Fraxinus pennssylvanica*) | 4% average cover (19% constancy) = 0.8 |
| Common chokecherry (*Prunus virginiana*) | 30% average cover (100% constancy) = 30 |
| | Total weighted average cover = 58% |

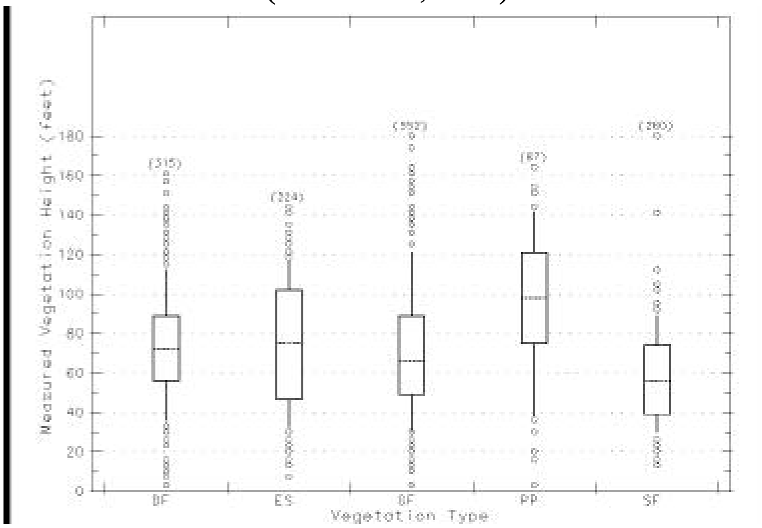
### *Height of Potential Natural Vegetation*

Nationally recognized (Forest Service Fire Effects Information System) mature vegetation heights for each of these species are presented in **Table 23**. To provide a "reality check," tree heights presented in Table 23 were compared to tree height values measured within the Nez Perce National Forest (NPNF) (**Figure 4**), and they are reasonably comparable (i.e. the mature heights fall within the range of measured heights on the Forest). It is important to note that current conditions illustrated in **Figure 4** were developed from data that included all age classes (i.e., young to mature), and included "disturbed" vegetation, not just mature trees. Mature tree heights were chosen for the remainder of the analysis to provide an addition to the margin of safety.

**Table 23. Mature Vegetation Height Condition**
(from the USDA Forest Service Fire Effects Information System (www . fs.fed.us/database/feis))

| Vegetation Type | Height Range (ft) | Suggested Value |
|---|---|---|
| Grand Fir (*Abies grandis*) | 131 to 164 | 148 |
| Engelmann Spruce (*Picea engelmannii*) | 45 to 130 | 88 |
| Douglas Fir (*Psuedotsuga menziesii*) | 100 to 120 (var. glauca, R. Mnt. Interior). | 110 |
| Subalpine Fir (*Abies lasiocarpa*) | 60 to 100 | 80 |
| Ponderosa Pine (*Pinus ponderosa*) | 90 to 130 (var. ponderosa, Pacific Ponderosa Pine). | 110 |
| Rocky Mountain Maple (*Acer glabrum*) | 20 to 30 | 25 |
| Red-osier Dogwood (*Cornus stolonifera* or *C. sericea*) | 3 to 19 | 11 |
| Chokecherry (*Prunus virginiana*) | 3 to 19.5 | 12 |
| Serviceberry (*Amelanchier alnifolia*) | 3 to 26 | 15 |
| Paper Birch (*Betula Papyrifera*) | 70 to 80 | 75 |
| Western Larch (*Larix Occidentalis*) | 164 ("Typical") | 164 |
| Black Cottonwood (*Popuus trichocarpa*) | 100 ("Common") | 100 |
| Mountain Alder (*Alnus incana*) | 6 to 15 | 11 |
| Whitebark Pine (*Pinus albicaulis*) | 50 to 70 | 60 |
| Lodgepole pine (*Pinus contorta*) | 50 – 100 (var. latifolia) | 75 |
| Narrowleaf Cottonwood (*Populus angustifolia*) | 60 | 60 |
| Quaking Aspen (*Populus tremuloides*) | < 48 | 40 |
| Green Ash (*Fraxinus pennssylvanica*) | 66 | 66 |
| Coyote Willow (*Salix exigua* var. *exigua*) | 6 to 12 | 8 |

**Figure 4.** Measured Tree Heights in the Nez Perce National Forest (1989 – 1993)
(USFS Data, 2002)




### *Estimated Community Composition of Potential Natural Vegetation*

Community composition dimensions for each of the Habitat Groups are presented in Table 24. This table shows the process by which dimensions for a composite shade producing vegetation are attained for each habitat type. The weighted average canopy cover from Table 22 is shown in the first column of numbers. These cover values for each species in the habitat type are converted to a relative proportion of the total cover in the second column of numbers. Vegetation heights from Table 23 are shown in the third column of numbers, and those heights are weighted based on relative cover to form the fourth column of numbers. Estimated overhang for the entire habitat type is then calculated as 10% of the total weighted height of trees (33% for shrubs). Thus, for example, the Grand fir type has a weighted average cover of 76%, a weighted height of 98 feet, and an estimated overhang of 9.8 feet. These values are used in the effective shade curve analysis to represent the composite shading potential of the all the species in the habitat type.

The average tree height condition within mature tree height range was included in subsequent effective shade analysis. Height values for several "Shrub" species were estimated in the upper range of expected values, except for the Meadow Habitat Group (i.e., Coyote Willow), which was allocated at the average value within the mature range of heights.

**Table 24.** Potential Natural Overstory Vegetation Composition along Crooked Creek

| PNOV Habitat Type | Overstory species | Weighted Ave. Canopy Cover (%) | Relative Proportion of Total (%) | Vegetation Height (ft) | Weighted Height (ft) (Proportions * Height) | Estimated Overhang (ft) |
|---|---|---|---|---|---|---|
| Grand Fir/Lady Fern | Grand Fir | 30 | 39 | 148 | 58 | |
| | Spruce | 12 | 16 | 88 | 14 | |
| | Douglas Fir | 5 | 7 | 110 | 7 | |
| | Rocky Mountain Maple | 13 | 17 | 25 | 4 | |
| | Subalpine Fir | 0.6 | 1 | 80 | 1 | |
| | Paper Birch | 0.6 | 1 | 75 | 1 | |
| | Western Larch | 5 | 7 | 164 | 11 | |
| | Black Cottonwood | 0.8 | 1 | 100 | 1 | |
| | Mountain Alder | 9 | 12 | 11 | 1 | |
| | **Composite** | **76** | | | **98** | **9.8** |
| Subalpine Fir/Bluejoint Reedgrass | Subalpine Fir | 32 | 40 | 80 | 32 | |
| | Spruce | 38 | 48 | 88 | 42 | |
| | Lodgepole Pine | 9 | 11 | 75 | 8 | |
| | Whitebark Pine | 0.2 | 0 | 60 | 0.2 | |
| | Mountain Alder | 0.4 | 1 | 11 | 0.1 | |
| | **Composite** | **80** | | | **83** | **8.3** |
| Meadow | Coyote Willow | 82 | 100 | 8 | 8 | 2.6 |
| | Tufted Hairgrass | 42 | 100 | 2 | 2 | 0.8 |
| Douglas Fir/Red-Osier Dogwood | Douglas fir | 25 | 39 | 110 | 43 | |
| | Red-Osier Dogwood | 5 | 8 | 11 | 1 | |
| | Common Chokecherry | 4 | 6 | 12 | 1 | |
| | Narrowleaf Cottonwood | 5 | 8 | 60 | 5 | |
| | Quaking Aspen | 6 | 9 | 40 | 4 | |
| | Black Cottonwood | 19 | 30 | 100 | 30 | |
| | **Composite** | **64** | | | **83** | **8.3** |
| Ponderosa Pine/Common Chockcherry | Ponderosa Pine | 27 | 47 | 110 | 51 | |
| | Green Ash | 0.8 | 1 | 66 | 1 | |
| | Common Chokecherry | 30 | 52 | 12 | 6 | |
| | **Composite** | **58** | | | **59** | **5.9** |

**Shade Curves - Surrogate Measure**

As presented earlier in this document, stream surface shade production is a function of geometric relationships between the sun's position and topography, near stream land cover and channel features. Stream surface shade at estimated potential natural vegetation community composition conditions (see Table 24 above) was simulated using computer software developed by Oregon Department of Environmental Quality[8].

Over the years, the term shade has been used in several contexts, including its components such as shade angle or shade density. For purposes of the shade curves, shade is defined as the percent reduction of potential direct beam solar radiation load delivered to the water surface. Thus, the role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the solar loading.

The non-point source assessment demonstrates that stream temperatures warm as a result of increased solar radiation loads, due to anthropogenic disturbance to near stream vegetation and channel morphology. A loading capacity for radiant heat energy (i.e., incoming solar radiation) can be used to define a reduction target that forms the basis for identifying a surrogate. The specific surrogate used is percent effective shade (expressed as the percent reduction in potential solar radiation load delivered to the water surface). The solar radiation loading capacity is translated directly (linearly) by effective solar loading. The definition of effective shade allows direct measurement of the solar radiation loading capacity.

As noted in Table 21, channel width is an important component of shade production. That is, it becomes progressively more difficult to shade a river with a particular vegetation conditions, as the channel width increases. Channel width is best described as the "Near-Stream Disturbance Zone" (NSDZ), which is defined for purposes of the shade curve as the width between shade-producing near-stream vegetation. Where near-stream vegetation was absent, the near-stream boundary was used, as defined as armored stream banks or where the near-stream zone is unsuitable for vegetation growth due to external factors (i.e., roads, railways, buildings, etc.). It is important to note that bankfull width and NSDZ are often similar.


Factors that affect water temperature are interrelated. The surrogate measures (percent effective shade and channel width) rely on restoring/protecting riparian vegetation to increase stream surface shade levels and reducing the NSDZ width (by reducing stream bank erosion and stabilizing channels), which will reduce the surface area of the stream exposed to radiant energy. Shade is more effective on narrow streams than on wider streams given the same flow of water at a given point because shadows cast by trees cover a greater percentage of the stream surface. Effective shade screens the water's surface from direct rays of the sun. Highly shaded streams often experience cooler stream temperatures due to reduced input of solar energy.

8 This shade calculator has been used by Oregon Department of Environmental Quality and Washington Department of Ecology during the development of temperature TMDLs during the past several years.

Effective shade curves were developed using vegetation conditions for Crooked Creek, as described in Table 24 (Figures 5 through 10). These curves are independent of location on the stream within a particular habitat type. Because effective shade is a measure of energy, a load in terms of Langleys per day can be directly calculated from this value. Given a measured or estimated channel width (e.g., NSDZ) and the directional aspect of a stream, the percent effective shade or the solar radiation loading can be estimated from the following graphs. It is best to have site-specific measurements of channel width and stream aspect (and vegetation for that matter) to produce an effective shade estimate at a specific location. In the case of Crooked Creek, because the site-specific information is based on interpretations of relatively coarse GIS-based information, the effective shade estimates are not precise for a particular location. To improve the estimates, actual channel width and aspect data would have to be collected in the field at some interval. The more frequent the interval, the more accurate the estimate.

As an example of how the effective shade curve works, let's say you have a location on a stream in a Grand fir habitat type where the aspect is NE ($45^o$), and the channel width (NSDZ) is five meters. Figure 5 shows that the squares line representing $45^o$ from North intersects the 5-m NSDZ grid where solar loading is about 58 Langleys/day and the potential effective shade is approximately 90%. In a similar stream in the same vegetation type, but with a 15-m wide channel, the potential effective shade is less than 75% (~156 ly/day solar loading). Actual effective shade may be less that these values at these stream sites due to disturbance. A solar pathfinder set up at the site could measure actual effective shade. Comparisons between actual and potential effective shade demonstrate how far from the target is the existing stream condition.

For the meadow habitat types (Figures 7 and 8), the shape of the curve is much different than forest based curves. Due to much lower vegetation height, a stream with a particular aspect will show rapid and substantial decreases in potential effective shade as the channel width increases. This is due to the fact that lower meadow vegetation cannot shade wide streams as well as trees can.

**Figure 5.** Effective Shade Curve – Application in Grand Fir/Lady Fern Habitat Type

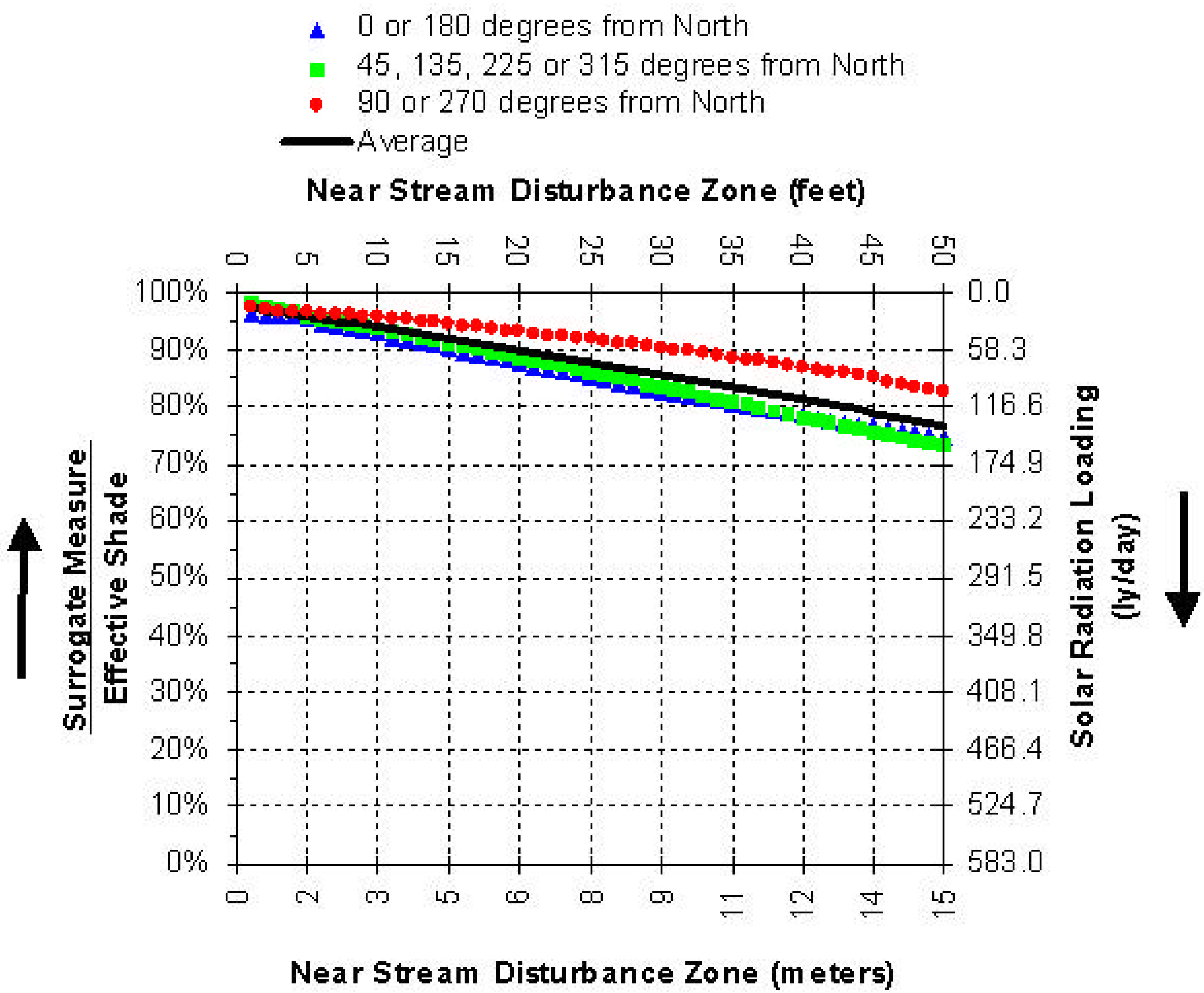


**Figure 6.** Effective Shade Curve – Application in Subalpine Fir/Bluejoint Reedgrass Habitat Type

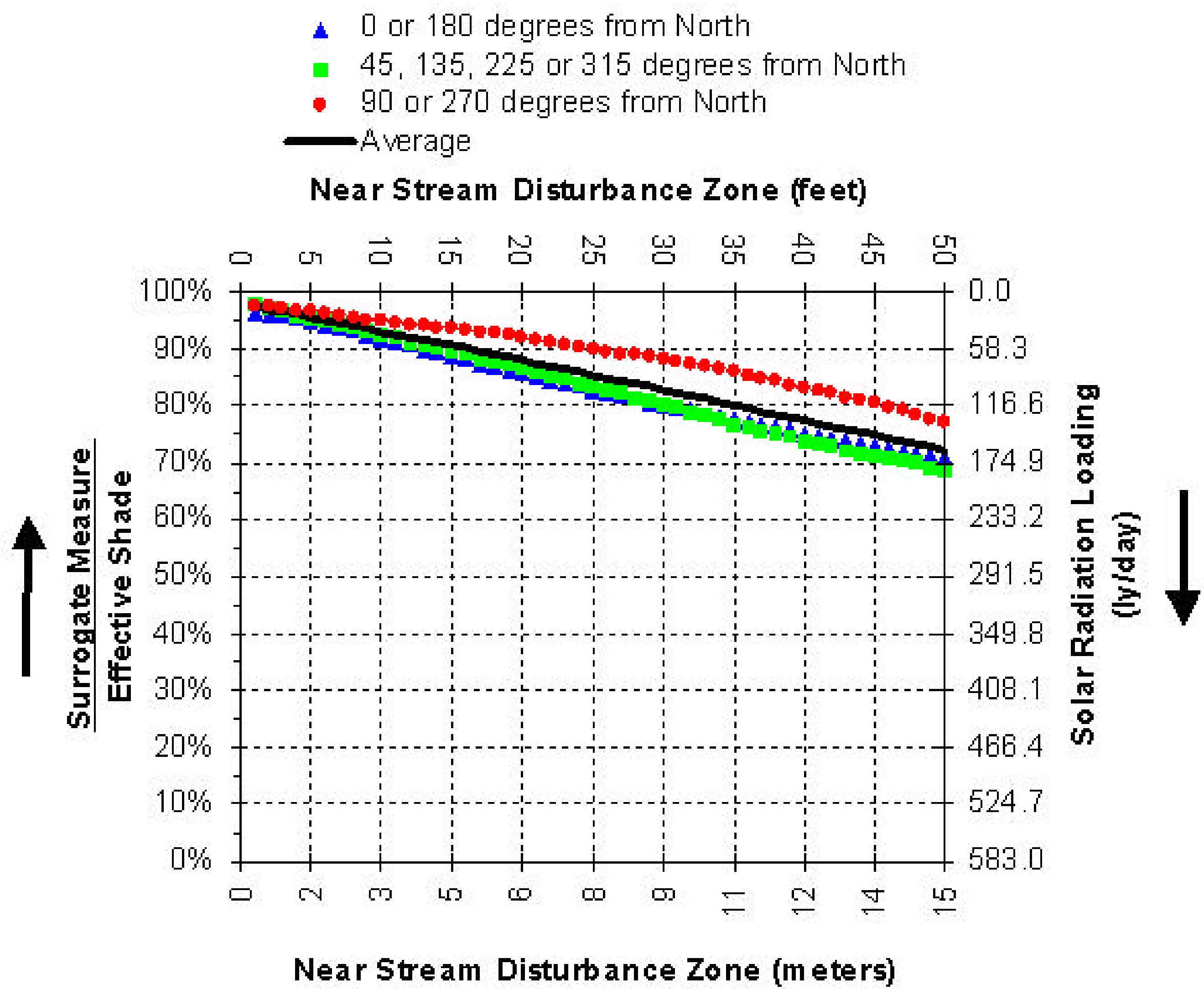


**Figure 7.** Effective Shade Curve – Application in Meadow Habitat Type - Coyote Willow

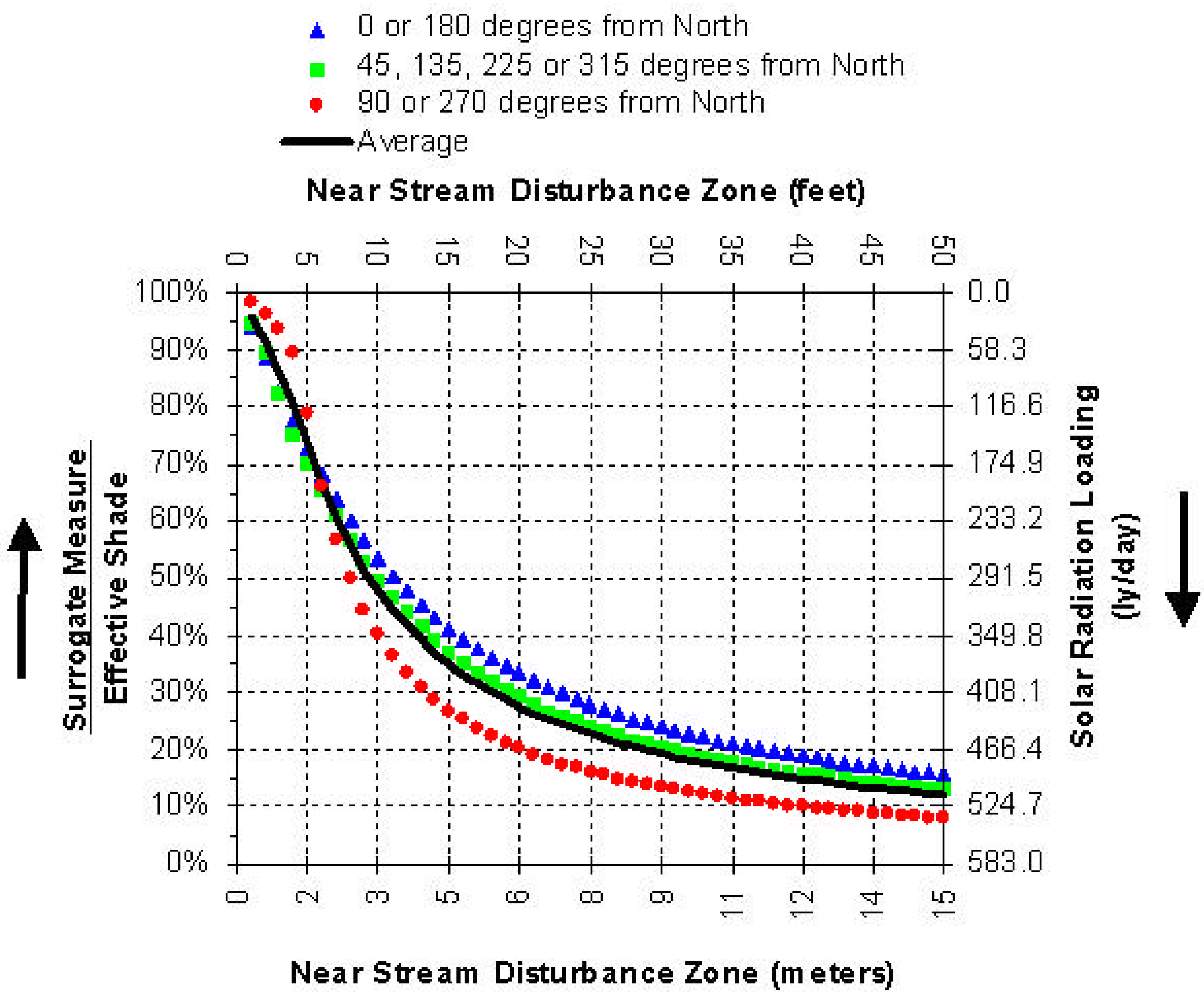


**Figure 8.** Effective Shade Curve – Application in Meadow Habitat Type – Tufted Hairgrass

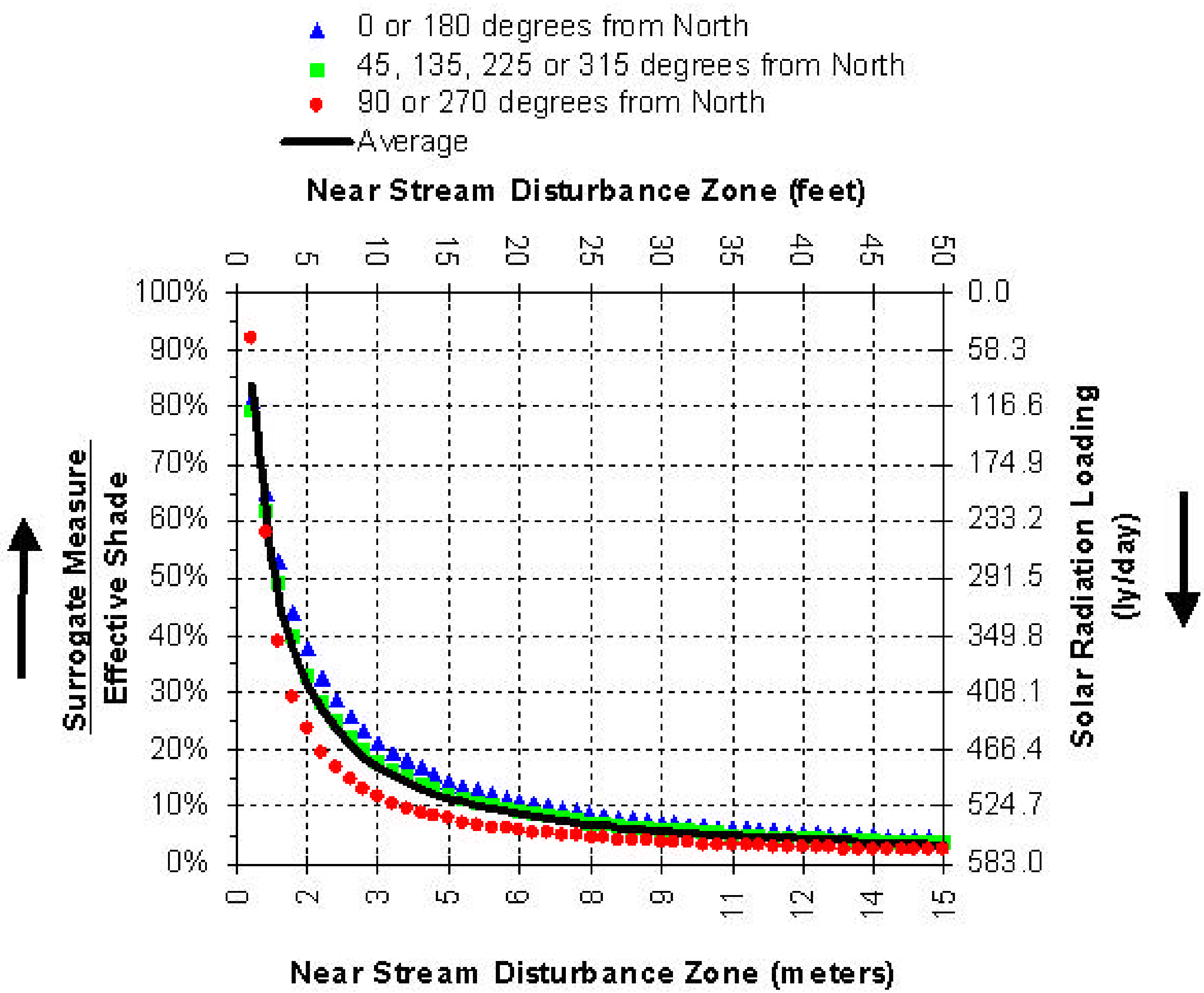


**Figure 9.** Effective Shade Curve – Application in Douglas Fir / Red-osier Dogwood Habitat Type

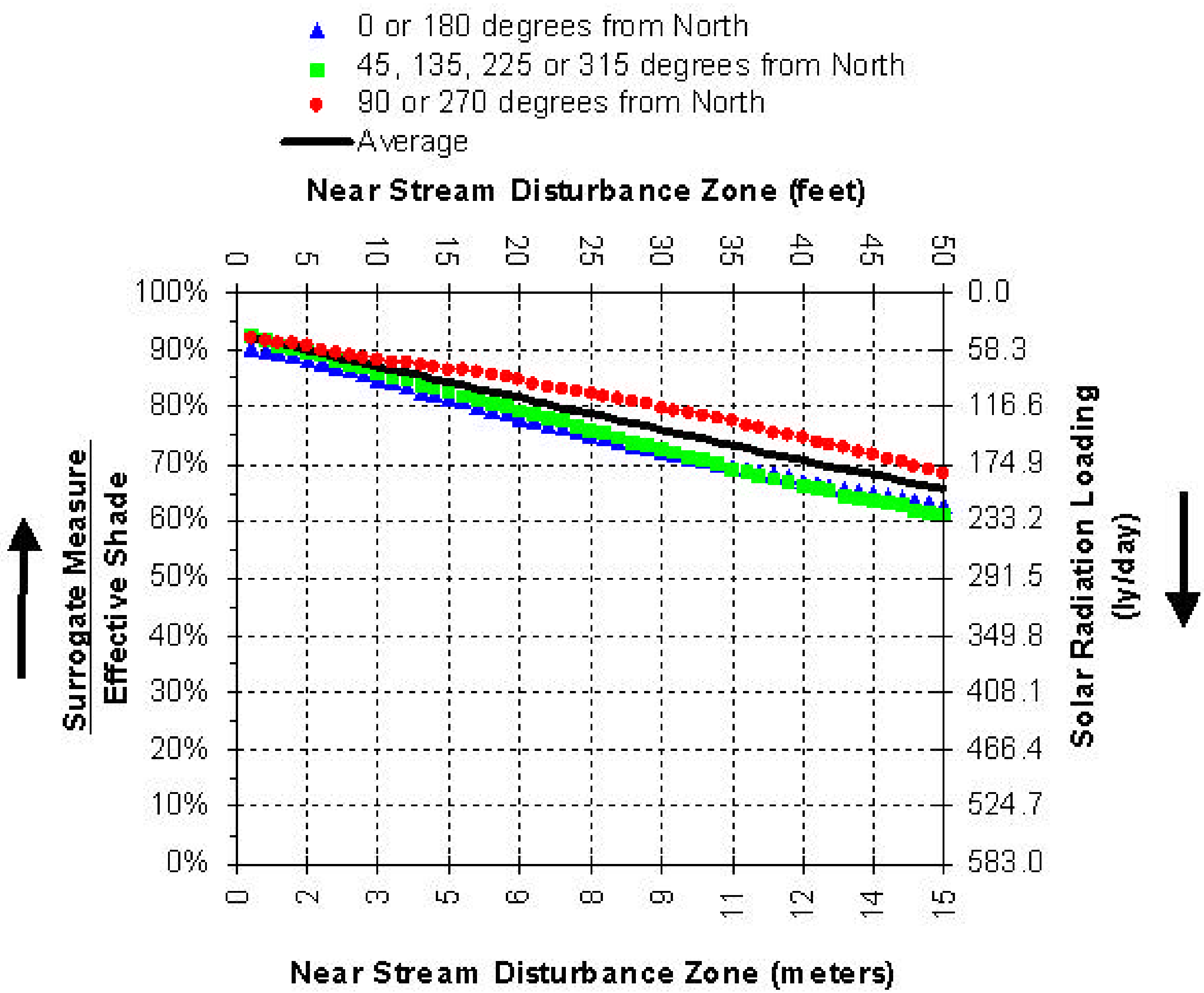
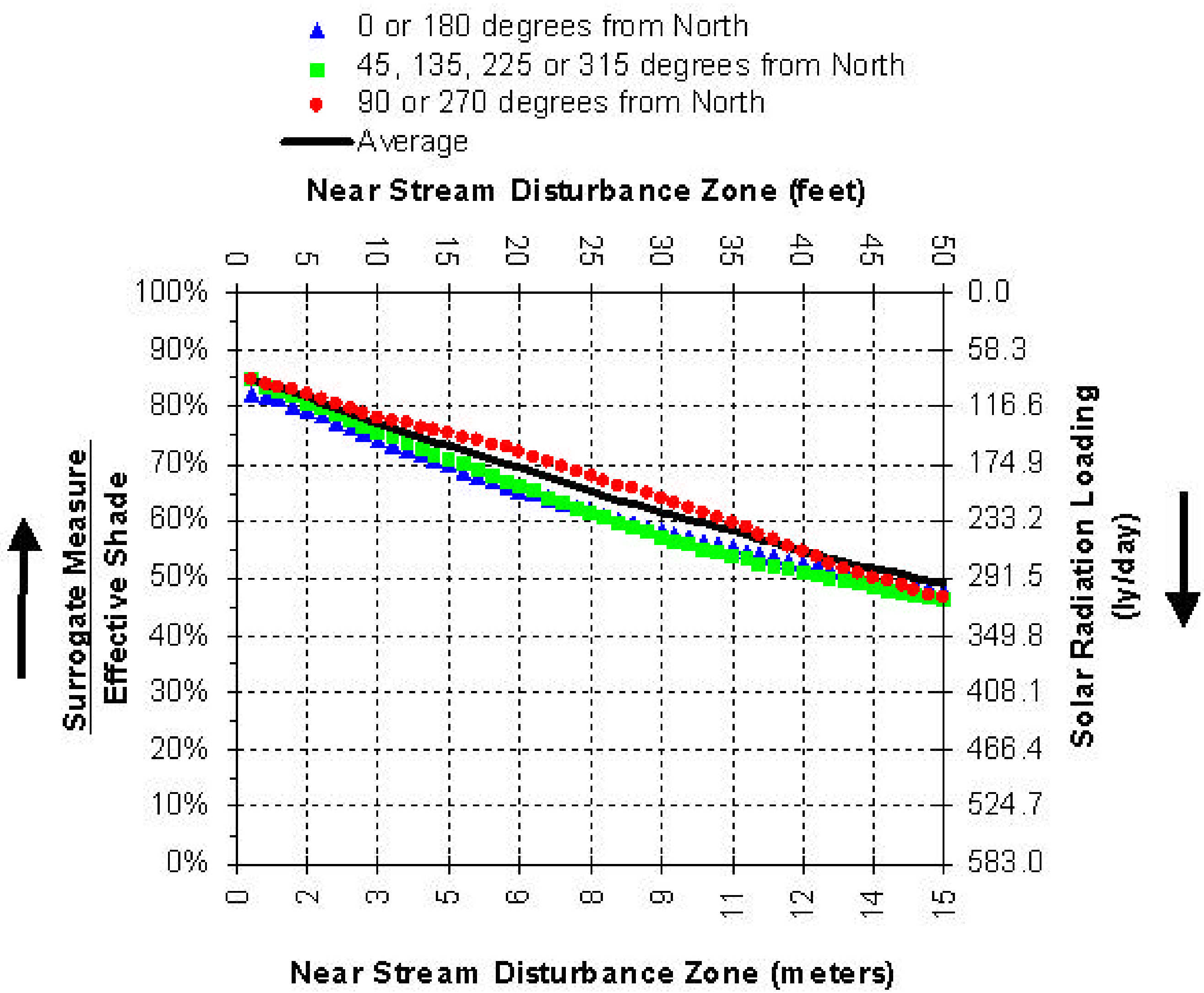


**Figure 10.** Effective Shade Curve – Application in Ponderosa Pine/Common Chokecherry Habitat Type



## Effective Shade and Temperature - Role of Local Condition

The local features affect the potential effective shade conditions along a stream. Along with the channel and vegetation features (illustrated above), local geographic features affect the potential stream shade conditions. For example, stream elevation is used for calculating solar radiation loading and solar position. In addition, stream aspect and topographic shade partly determine the effectiveness of vegetation in providing shade to the stream surface. For these reasons, stream elevation, aspect and topographic shade angle were sampled for Crooked Creek from a 30-meter digital elevation models (DEMs) (see image to right) at 100 foot intervals. Sampling was accomplished using GIS tools developed for this specific application (www deq.state.or.us/wq /TMDLs/ WQAnalTools.htm). Sampling landscape features at a high resolution, from available data sets, enables a detailed evaluation of additional landscape conditions that, in addition to near stream vegetation conditions, may be influencing effective shade conditions along Crooked Creek, and ultimately affecting the temperature of the river. Both sampled elevation and gradient data are plotted for Crooked Creek in Figure 11. Topographic Shade Angles calculated from the DEM are presented in Figure 12. Stream Aspect is presented in Figure 13. Finally, stream valley bottom widths, defined as a maximum one meter elevation increase from the stream bottom (defined as a 1:24K stream layer), are presented in Figure 14.

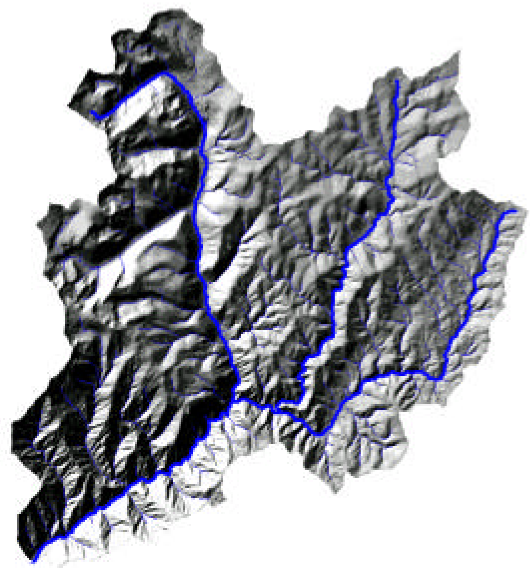


**Figure 11.** Stream Elevation and Stream Gradient along Crooked Creek.

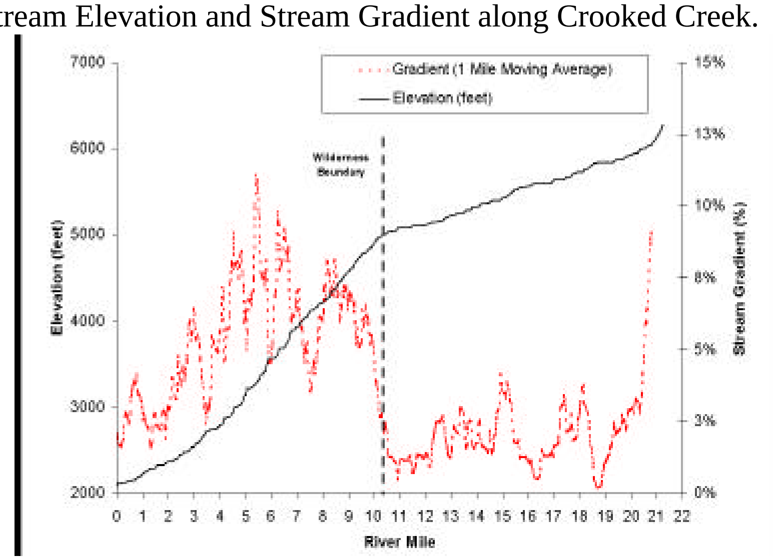


**Figure 12.** Topographic Shade Angle along Crooked Creek.

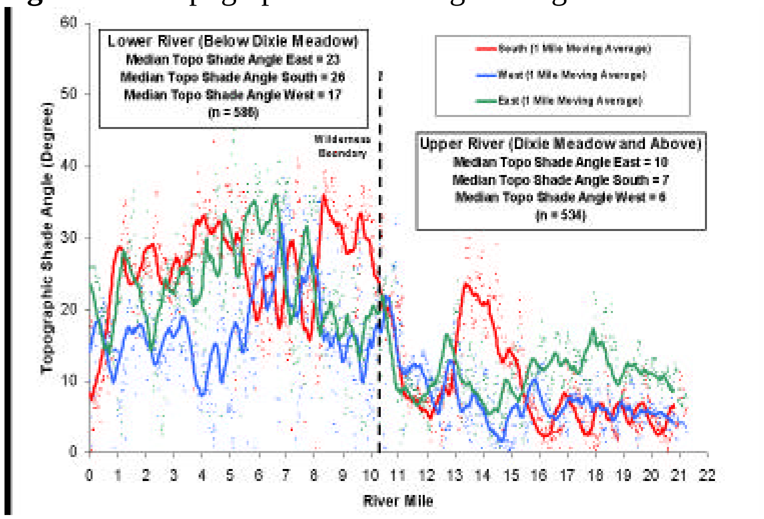



**Figure 13.** Stream Aspect along Crooked Creek.

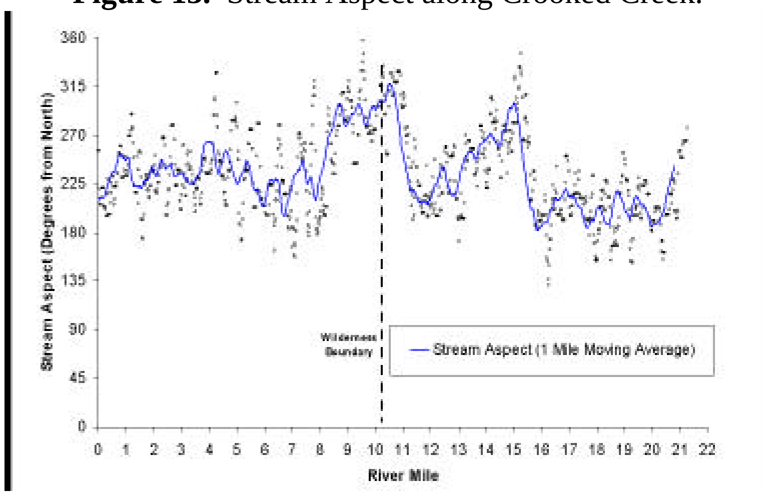
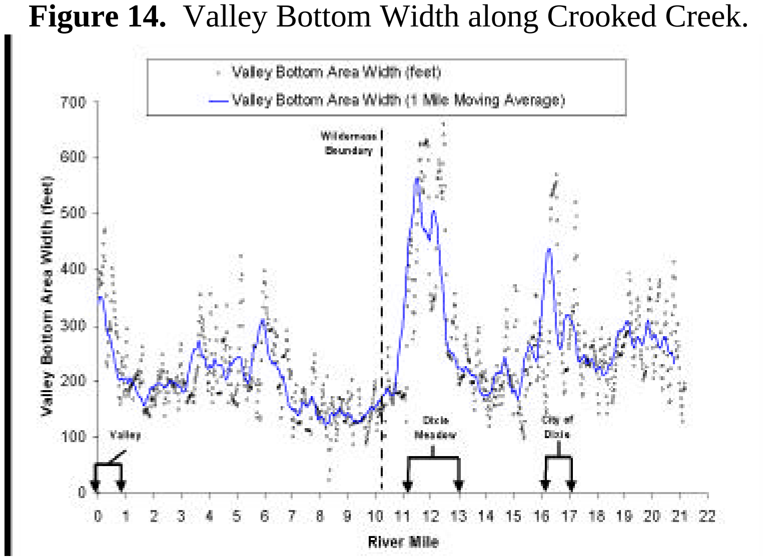



**Figure 14.** Valley Bottom Width along Crooked Creek.



These figures illustrate that Crooked Creek travels through several distinct areas, from upper reaches that experience relatively low gradients and topographic angles, downstream to an area with very high gradients and topographic angles. In addition, the upper reaches of the river travel through areas that are much less confined than in the lower reaches of the river (as defined by the rough estimates of valley bottom width illustrated in Figure14). This is especially evident within Dixie Meadow. All of these factors will affect the ability of the near stream vegetation to provide shade to the river, as well as determine the particular water temperature response from the energy balance affecting the river.

## Estimate of Effective Shade Along Crooked Creek

An estimation of effective shade conditions for Crooked Creek was developed using physical information illustrated above, along with detailed vegetation conditions presented in Table 24. It is important to note that the resulting effective shade profile developed from this effort utilize the same algorithms used to create the shade curves (Figures 5 though 10), however this effort will contain a spatial component.

### *Estimate of Bankfull Channel Width*

The only factor **not** developed from the work presented above is channel width (i.e., NSDZ or Bankfull Width). Accordingly, this parameter must be estimated from available information. Leopold et. al (1964) proposed that channel width tends to increase linearly with increases in drainage area. Rosgen (1996) reported that bankfull width can be estimated as a function of width to depth ratio and cross-sectional area.

$$BFW = \sqrt{W:D \cdot A_{bf}}$$

Where: $A_{bf}$ is the Bankfull Cross-Sectional Area ($ft^2$)
W:D is the width to depth ratio

Figure 15 illustrates the regional curve for bankfull cross-sectional area ($A_{bf}$) and drainage area (DA) in the Upper Salmon River Basin (USGS Professional Paper 870-A). As noted above, Crooked Creek was segmented by vegetation habitat types (see Table 2). GIS was used to calculate the upstream contributing area (DA) at the lower end of each of these unique habitat types (Figure 16). Upstream contributing areas between these locations were estimated through interpolation. Bankfull Cross-Sectional Area was then estimated using the relationship presented in Figure 15. Width to depth ratio values were assigned values derived from published ranges for level I stream types (Rosgen 1996).

| Level I Stream Type | Width to Depth (W:D) |
|---|---|
| A | 8 |
| B | 19 |
| C | 30 |
| D | N/A |
| E | 7 |
| F | 28 |
| G | 8 |

Target Bankfull Width values for each of these Rosgen Level I Stream Types were estimated using the equation listed above (Figure 17). Target values developed during this exercise were used to develop channel width conditions used in Effective Shade Calculations.

**Figure 15.** Bankfull Cross-Sectional Area as a function of Drainage Area in the Upper Salmon River Basin, Idaho (Emmett, 1975)

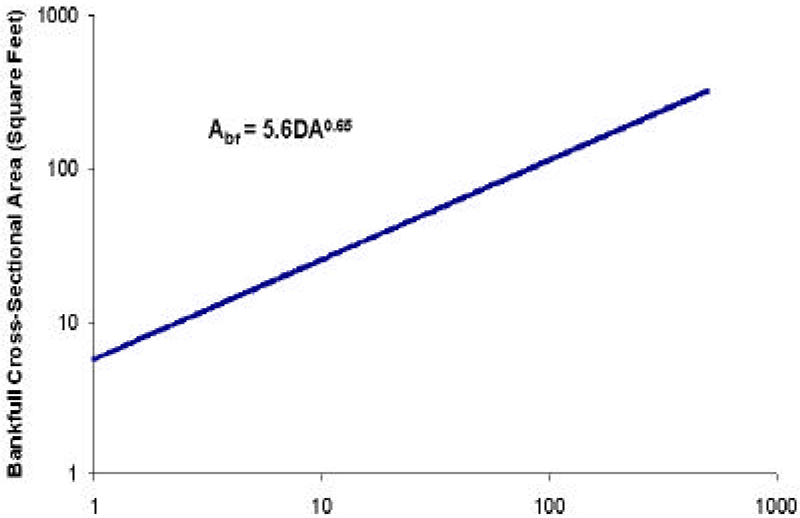



**Figure 16.** Upstream Contributing Areas within Crooked Creek

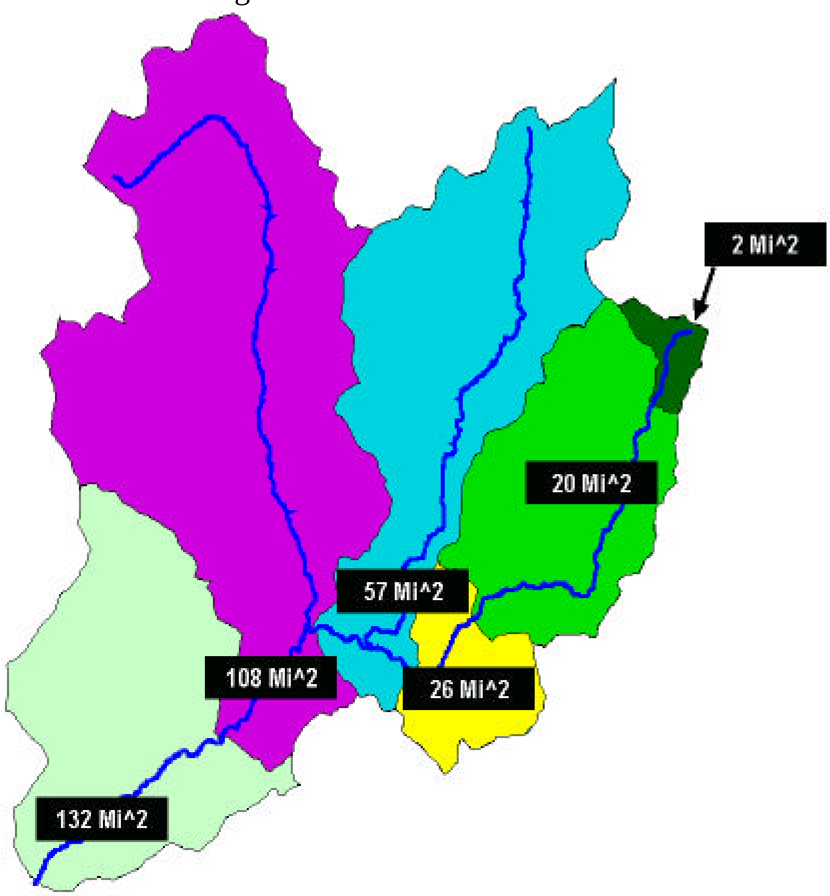
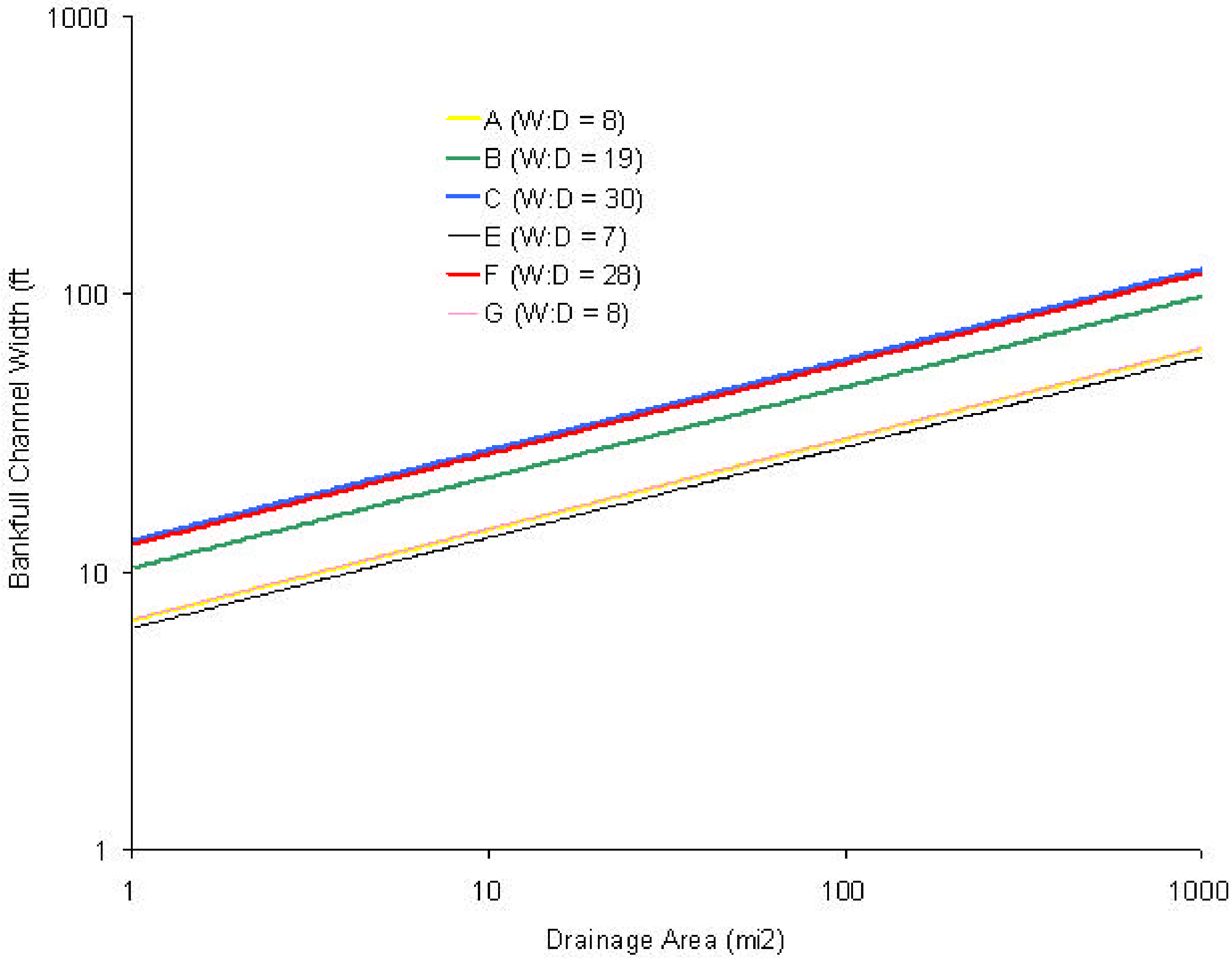


**Figure 17.** Bankfull Width as a Function of Width to Depth Ratio and Drainage Area



Accordingly, Rosgen level I classification can be used to estimate approximate bankfull width conditions through applying the equation listed above. Rough estimates of Rosgen level I classification for Crooked Creek were estimated from gradient information (Figure 11), and local knowledge. Figure 18 illustrates the approximate bankfull width conditions that would be expected as a potential condition along Crooked Creek. This information was used, along with aspect (Figure 13), topographic shade angle (Figure 14), and elevation (Figure 12) to calculate expected potential shade when applying vegetation communities along Crooked Creek (Table 24) (Figure 19).

**Figure 18.** Estimated Bankfull Widths in Crooked Creek

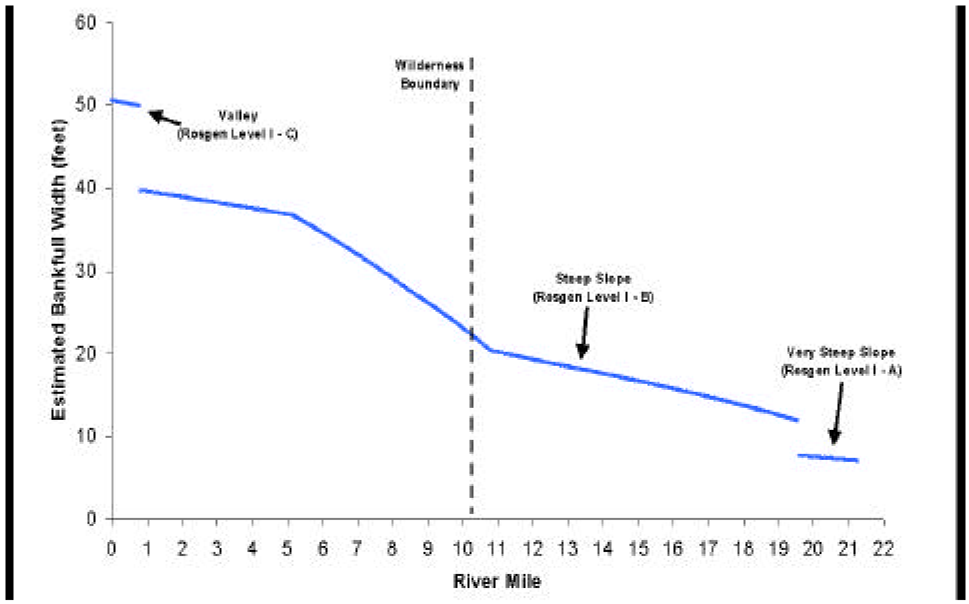
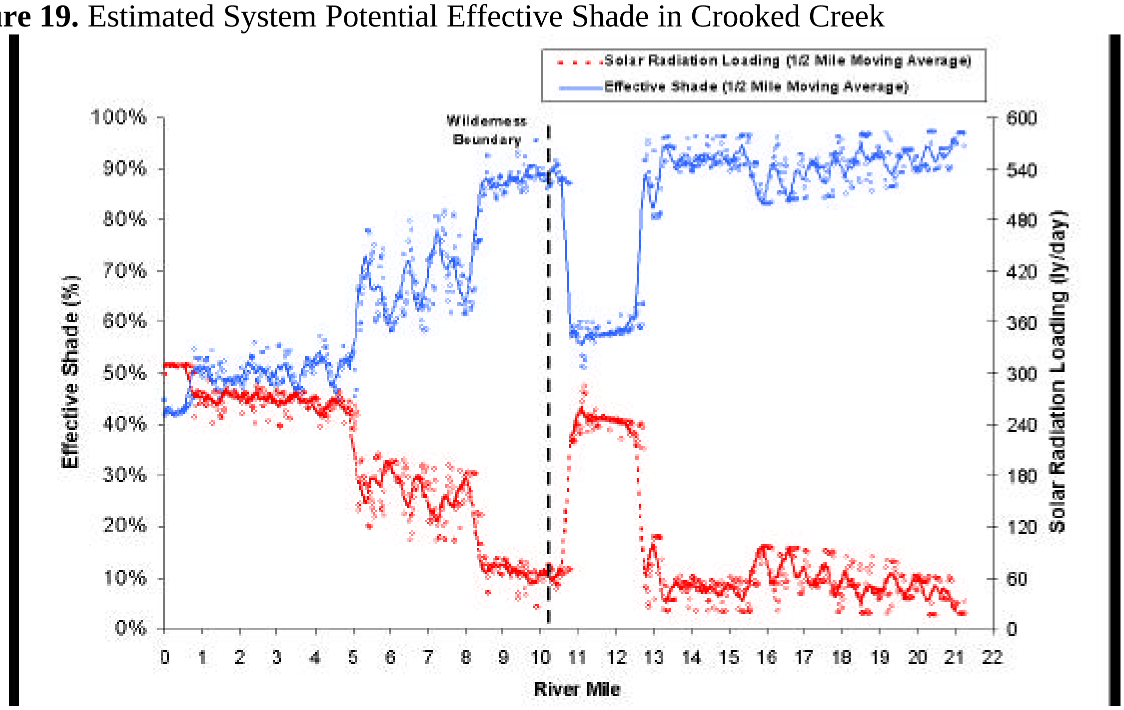



**Figure 19.** Estimated System Potential Effective Shade in Crooked Creek



## LOADING CAPACITIES

Crooked Creek, as it advances down a steep canyon towards the Salmon River, becomes increasingly exposed to hotter, drier conditions and a change in vegetation communities from cold forests to dry forests, and eventually to shrub or grass dominated communities. Using the shade curves in combination with GIS-based local condition information, we have estimated the effective shade under potential natural vegetation to vary from approximately 95% in the headwaters to 40% at the mouth of the stream (Figure 19). The potential effective shade of 85 to 95% in the upper reaches coincides with communities dominated by cold forest conifers (subalpine fir and grand fir). In the lower half of the stream, forest community types are more typical of dry forests dominated by ponderosa pine and Douglas fir. Potential natural vegetation in the lower reaches has slightly lower effective shade from 50% to 80%. Additionally, the large meadow complex near the Dixie Work Center and airstrip would have an effective shade under potential natural vegetation (coyote willow meadow) of approximately 58%.

Figure 19 also presents the thermal loading to the stream under these effective shade scenarios. Thus, the loading capacity of the stream is represented by the red line in Figure 19, and varies from less than 60 Langleys/day in the headwaters to as much as 300 Langleys/day at the mouth of Crooked Creek in the Salmon River canyon. The meadow area near the airstrip and Dixie Work Center has a loading capacity of about 240 Langleys/day. As Crooked Creek turns southwest and begins its decent into the Salmon River canyon, the loading capacity decreases to 120 to 180 Langleys/day for several miles, then increases to 240 –300 Langleys/day.

## WASTELOAD ALLOCATION

There are no permitted point sources within the Crooked Creek drainage, therefore there is no wasteload allocation for thermal loading to Crooked Creek.

## LOAD ALLOCATION

Because the goal of this TMDL is to achieve a natural temperature regime to reduce stream temperatures as far as they will go, there is essentially no load allocation. The entire loading capacity of the stream is dedicated to achieving a natural condition as much as possible. Thus, the loading capacity presented in Figure 19 is equal to the natural background load. There is no thermal load that is dedicated to a nonpoint source activity.

## TARGETS

To determine existing condition in the absence of solar pathfinder data, actual canopy coverage for Crooked Creek was visually estimated from 1996 aerial photographs at more or less 200-feet elevation intervals from the mouth to the headwaters. Table 25 shows these canopy estimates compared to those effective shade targets determined by the model. Unfortunately, stream segment intervals in Table 25 are not the same as river mile segments used in the effective shade modeling above. Rough comparisons to river mile are provided for some elevational intervals in Table 25.

Table 25. Canopy coverage estimates for 25 stream segments on Crooked Creek. The dashed line indicates the location of the Gospel Hump Wilderness boundary. (RM = river mile.)

| Stream Segment Number | Approximate River Mile | Segment Lowest Elevation (feet) | Aerial Photo Existing Cover (%) | Potential Effective Shade (%) | Difference Between Existing and Target Cover (%) |
|---|---|---|---|---|---|
| 1(Mouth) | RM 0 | 2080 | 50 | 50 | 0 |
| 2 | RM 1.1 | 2200 | 40 | 50 | 10 |
| 3 | RM 2.5 | 2400 | 40 | 50 | 10 |
| 4 | RM 3.4 | 2600 | 40 | 50 | 10 |
| 5 | RM 4 | 2800 | 20 | 50 | 30 |
| 6 | RM 4.8 | 3000 | 20 | 50 | 30 |
| 7 | RM 5.2 | 3200 | 40 | 60-75 | 20-35 |
| 8 | RM 5.7 | 3400 | 30 | 60-75 | 30-45 |
| 9 | RM 6.2 | 3600 | 30 | 60-75 | 30-45 |
| 10 | RM 6.6 | 3800 | 30 | 60-75 | 30-45 |
| 11 | RM 7 | 4000 | 50 | 60-75 | 10-25 |
| 12 | RM 7.8 | 4200 | 50 | 60-75 | 10-25 |
| 13 | RM 8.2 | 4400 | 50 | 60-75 | 10-25 |
| 14 | RM 8.8 | 4600 | 50 | 80-90 | 30-40 |
| 15 ( Wilderness ) | RM 9.4 | 4800 | 60 | 80-90 | 20-30 |
| 16 | RM10 | 5000 | 60 | 85-90 | 25-30 |
| 17 | RM 10.6 | 5060 | 20 | 60 | 40* |
| 18 | RM 12.6 | 5200 | 40 | 60 | 20 |
| 19 | RM 14.5 | 5400 | 50 | 90-95 | 40-45* |
| 20 | RM 15.7 | 5560 | 0 | 85-90 | 85-90* |
| 21 | RM 16.4 | 5600 | 20 | 85-90 | 65-70* |
| 22 | RM 18.2 | 5800 | 20 | 90-95 | 70-75* |
| 23 | RM 18.7 | 5840 | 60 | 90-95 | 30-35 |
| 24 | RM 19.3 | 5880 | 70 | 90-95 | 20-25 |
| 25 (Headwaters) | RM 20 | 6000 | 70 | 90-95 | 20-25 |

*Problem Areas – those segments in need of the most rehabilitation.

To identify problem areas, the difference between the target effective shade and the existing stream canopy cover were examined. Although existing canopy cover estimated from aerial photos is not the same as effective shade, the difference between the two estimates serves as a screening tool for highlighting problem areas along the creek.

The areas in need of the most restoration of vegetation are based on the difference between these two percentages. The larger the difference, the greater the need for restoration. Increases in riparian and valley canopy cover should have a concomitant increase in effective shade and a decrease in solar radiation loading consistent with the model, and thus, a decrease in water temperature. This is a crude estimate of problem areas. In order to be more accurate, current effective shade should be measured in the field. Headwaters of Crooked Creek (above Dixie) shows a difference in values from 20 to 35. Further down stream, the difference between target effective shade values and existing cover in the upper segments (Dixie to the meadow), those most impacted by legacy mining and current development, are from 40 to 90. In the meadow itself, the difference is 40 assuming coyote willow returned to its full potential. Wilderness area segments (middle and lower) show a 10 to 45 range in value differences.

In addition to areas with reduced canopy coverage, Crooked Creek likely has an increased width-to-depth ratio as a result of dredge mining rearranging the stream, increased hydraulic loading, and posibbly other riparian activities that have lead to downcutting and widening of the channel. Figure 18 suggests that for this size of stream, bankfull width should vary from less than 10 feet wide in the headwaters (Rosgen Level 1-A) to approximately 20 feet wide before the wilderness boundary (Rosgen Level 1-B. DEQ has measured bankfull width of Crooked Creek at two locations within this upper half of the stream. The first site near RM 14 had an average bankfull width of 21 feet (based on three transects). This value is near the normal bankfull width of 18 feet predicted by Figure 18. However, the second site near RM 11 had an average bankfull width of 32 feet, a third greater than the predicted 20 feet wide in Figure 18. Bankfull width data collected by the Forest Service showed widths averaging less than 5 feet above the town of Dixie, 18 feet below Dixie, and 62 feet near the mouth. Of these three, the latter two (18 and 62 feet) are slightly elevated. These data, although limited, suggest that perhaps the stream widens a little too much through the large meadow near the airstrip. Maintaining or reducing bankfull widths to be consistent with Figure 18 may also prove usefull in reducing heat loads to the stream..

Canopy cover and bankfull width data suggest that the area in need of the most improvement in effective shade and channel dimensions is that area from the bottom of Dixie Meadow (RM 11) to about Nugget Gulch (RM 17), where differences between potential effective shade and existing canopy cover are greater than a value of 40.

## MARGIN OF SAFETY

The margin of safety in this TMDL is implicit in the development of the potential effective shade. Effective shade is based on the hypothesis that the stream will experience a complete potential natural vegetal community along its borders all of the time. In reality, plant communities vary considerably with time as a result of natural disturbance (fire) and differential growth rates of species. To a certain extent, that is evident in the comparison of existing canopy coverage and the effective shade target for the wilderness section of Crooked Creek. Portions of this section have been exposed to wildfire in the recent past, probably resulting in less cover than is possible under potential natural vegetation. Nevertheless, there may be no greater margin of safety than achieving natural conditions.

## SEASONAL VARIATION AND CRITICAL TIME PERIODS

Temperature criteria are applied to different time periods due to differences in life histories of target species and different regulatory conventions. The target species in this analysis has been spawning and rearing salmonids, especially bull trout. The spring salmonid spawning period ends July 15$^{th}$, and the fall spawning period begins September 1$^{st}$. These spawning periods often provide more than adequate time for spawning to actually occur. The federal bull trout criterion

(10°C MWMT) applies during the summer months from June 1st to September 30th. Therefore, one of the lowest criteria is applied to the creek during the hottest time of the year. Considering the fact that potential natural vegetation estimations include deciduous species as well as conifers, the effective shade calculation targets the summer time period when the canopy should be at its greatest extent.

Climatic conditions vary from year to year. This variation is evidenced in the stream temperature data described above (Table 17 and 18). For example, 1994 seemed to have the highest temperature statistics and 1995 had the lowest. In Table 18, the number of days exceeding the federal bull trout criterion varies from a low of 229 days in 1997 to a high of 319 days in 1998, almost a 30% difference. The target effective shade should be consistent from year to year despite changes in climate from year to year. The majority of plant species considered are either long lived or receive their watering needs from the stream itself. The meadow is one area that may have its canopy cover more affected by drought conditions than other habitat types.

## Future Implementation

The increase in stream shading specified herein will improve (reduce) water temperatures. The analysis conducted provides our best estimate, with given information and resources, of the extent to which stream temperatures can be improved through increased shading. There remains uncertainty as to whether current temperature criteria can be met throughout the length of this stream. Upon implementation of shading improvements, including possible ancillary improvements in channel dimensions and floodplain connectivity as a result of actions taken to increase shade, an evaluation will be needed of other possible actions to meet the true thermal potential of this stream.

It is important that a long-term goal of achieving potential effective shade be realized through resource management objectives. Differences between the potential effective shade and the existing cover vary from 0% to 90%, although for the majority of the stream the difference is less than 40%. All but one stream segment had less existing vegetative cover than effective shade based on potential natural vegetation (Table 25). Differences found within the wilderness area are probably the result of wildfire and to a lesser extent legacy activities. In the upper reaches of Crooked Creek, major differences (70 - 95%) occur between existing cover and potential effective shade, an area roughly corresponding to the reaches between Horse Flat Creek and the cemetery below Blane Creek.

Given the nature of the environment around upper Crooked Creek after a century of placer, dredge and lode mining, it is very unlikely that canopy coverage can be increased to such high levels without a tremendous amount of expense and time. The stream system for at least four miles would need to be rehabilitated including the creation of proper channel dynamics (including width-to-depth ratio), the addition of topsoil, and the planting of vegetation.

We recommend the land owners (Forest Service and private) attempt any reasonable effort to affect temperature in Crooked Creek including decreasing width-to-depth ratio in the stream where possible, revegetation where possible, and the control of activities likely to affect vegetative cover and channel characteristics. We also encourage the Forest Service to continue to monitor stream temperatures to see what temperature reductions are achieved, to measure existing effective shade through the use of solar pathfinders, and to take additional channel width measurements (especially where shade is measured).

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# APPENDICES

# Appendix 1

# BIOTIC INTEGRITY REPORT

# Main Salmon River-Chamberlain (HUC 17060207)

# Idaho County, Idaho

# Subbasin Assessment

# Biotic Integrity (Macroinvertebrates)

**Idaho Division of Environmental Quality**

State Technical Services Office

2000

**Printed on recycled paper**

**Main Salmon River-Chamberlain (HUC 17060207)**
**Idaho County, Idaho**

**Subbasin Assessment**

**Biotic Integrity (Macroinvertebrates)**

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*27 July 2000*

## Abstract

The macroinvertebrates of several streams in the Main Salmon River-Chamberlain area were sampled as part of the Beneficial Use Reconnaissance Project (BURP) by the Idaho Division of Environmental Quality (DEQ) during July 1996 and July 1997. The streams were compared with each other and the literature for taxa richness and tolerance to fine sediment and temperature. Crooked Creek appears to be impacted by fine sediment the most of the streams examined in this study. Big Creek, Big Mallard Creek, Rhett Creek, which were listed on the 1998 303(d) list do not appear to be impaired by fine sediment. Crooked Creek, Jersey Creek, Little Mallard Creek, and Warren Creek were also included on the 1998 303(d) list but are more difficult to place in an impairment category. Additional study is suggested for these four streams. Of the streams studied which were not listed on the 1998 303(d) list, Bear Basin Creek, Corn Creek, Eutopia Creek, McGuire Creek**,** and Noble Creek do not seem to be impacted by fine sediment. The information on Cramer Creek gives a mixed signal and additional study is suggested for it in order to properly place it into the proper impairment category.

## Introduction

The macroinvertebrates of several streams in the Main Salmon River-Chamberlain area were sampled as part of the Beneficial Use Reconnaissance Project (BURP) by the Idaho Division of Environmental Quality (DEQ), Idaho Falls Regional Office during July 1996 and the Lewiston Regional Office during July 1997. The State Office of the DEQ are using these data, in part, to prepare a subbasin assessment of the Main Salmon River-Chamberlain. A total of 11 of the 17 stream segments were listed in the 1998 303(d) list (Idaho Division of Environmental Quality 1999). Six of the streams (nine sites/segments) were listed for sediment and one stream (two sites/segments) for habitat alteration, a result, in part, of past mining activity in the area. The present report is an analysis of the macroinvertebrate data available from the BURP sampling efforts.

## Materials and Methods

### Study Area

The study area is in Hydrologic Unit Code (HUC) 17060207 in the Main Salmon River-Chamberlain area, Idaho County, Idaho. The Majority of the area lies within the Nez Perce and Payette National Forests and some of the sites are located in the Frank Church River of No Return Wilderness. Seventeen stream sites were sampled on 13 streams for macroinvertebrates for this project (Table 1). The Beneficial Use Reconnaissance Project site identification number is included for reference

### 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 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.

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 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 Aneeds 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.

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.

<u>Richness</u> (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 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, 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 macroinvertebrate taxon is assigned a tolerance value relating to the response to organic and toxic pollutants. A value of 0-10 may be assigned to each taxon, with 0 being the least tolerant to pollution (inverse relationship). A score of 11 indicates the tolerance value is unknown. 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).

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).

## Results and Discussion

A total of 17 stream sites (13 streams) were sampled during July 1996 and July 1997 for macroinvertebrates (Table 1). Hafele and Hinton (1996), Relyea (1999), Oregon Watershed Enhancement Board (1999), and Wisseman (1996) were especially helpful in determining tolerance of the invertebrates collected to fine sediment. For this discussion I am assuming that the higher the taxa richness, Plecoptera (stonefly) richness, number and percentage of cold water indicator taxa, and percent EPT taxa found at a site relates to those that are less impacted by clean bedload sediment. Macroinvertebrate biotic index scores are listed in Tables 2 and 3. Cold water indicators (Table 4) are compared with a draft list prepared for Idaho (Clark 1997). EPT (Ephemeroptera, Plecoptera, and Trichoptera) will also be examined for water quality significance. Tables 5 and 6 list a variety of metrics examined for this study. For a regional comparison of the above data, Platts and Rountree (1974) was consulted.

Following is a list of sampled streams and a summary of their macroinvertebrate data as they relate to sediment impacts, water temperature tolerance, and the Idaho 303(d) list. The streams have been separated in the following discussion depending on their inclusion (or not) on the 1998 303(d) list (Idaho Division of Environmental Quality 1999):

### STREAMS INCLUDED ON THE 303(d) LIST:

### Big Creek

Two sites on Big Creek were sampled, one in the upper part of the stream and one in the lower section. The upper site had an MBI score of 4.61 and the lower site had an MBI score of 5.07, both qualifying the stream as not impaired. The two sites are similar in composition with 38 and 37 taxa, respectively, and each with six Plecoptera taxa (Tables 3, 4). The upper site has twice the number of individuals as compared to the lower site and has a higher percentage of Plecoptera (29 compared to 17). From these data the upper site appears less impacted by fine sediment as compared to the lower site. Yet both sites have both sediment tolerant (Diptera and Oligochaeta, for example) and intolerant (Peltoperlidae and *Drunella* spp. for example) taxa present. The stream, as a whole, appears to be not impacted by fine sediment.

### Big Mallard Creek

Two sites on Big Mallard Creek were sampled, one in the upper part of the stream and one in the lower section. The upper site had an MBI of 5.31 and the lower site had an MBI of 5.06, both near the top scores for this study (Tables 2, 3) Like Big Creek, the upper site on Big Mallard Creek appears to be in better condition as compared to the lower site. Taxa richness is 43 in the upper as compared to 30 in the lower site. Plectoptera richness is eight at the upper site and six at the lower site. Big Mallard Creek had few cold water indicators (four taxa at the upper site and only one taxon at the lower site for 2.3% and 1.2%, respectively, of the total). Both sites did have *Drunella doddsi* present, indicating cold water (Clark 1997) and low sediment (Oregon

Watershed Enhancement Board 1999). From these preliminary data, Big Mallard Creek can be considered to be not impacted by fine sediment.

**Crooked Creek**

Two sites on Crooked Creek were sampled, one in the upper part of the stream and one in the lower section. The upper site had an MBI score of 4.46 and the lower site had an MBI score of 4.92, indicating that the stream is not impaired. Crooked Creek appears to be more impacted by fine sediment than Big Creek and Big Mallard Creek. Taxa richness is 29 and 34, respectively, and both sites have only four Plecoptera taxa present (low for this study) (Tables 5, 6). Crooked Creek had totals of one and zero, respectively, cold water indicator taxa which made up 0.7% and zero%, respectively, of the total fauna at the site. Crooked Creek appears to be heavily impacted by fine sediment. Crooked Creek seems to be an enigma in our data analysis system. The stream has high MBI scores yet very low cold water indicator numbers. I would suggest additional sampling might help explain the conflicting results presented here.

**Jersey Creek**

Jersey Creek had an MBI score of 4.93 indicating that it is not impaired by fine sediment. Jersey Creek had a high taxa richness (40) and number of Plecoptera taxa present (nine). It had the highest total percent EPT found in this study. Many of the EPT taxa found are tolerant of fine sediment. The percent of the total organisms collected that are Plecoptera (7.6%) seems low as compared to the other sites. Jersey Creek had a total of three cold water indicator taxa which made up 4.3% of the total fauna at the site. From these preliminary data it appears that Jersey Creek is similar to Crooked Creek as far as our ability to relate it to fine sediment impacts.

**Little Mallard Creek**

Little Mallard Creek had a low MBI score for this study (4.25) yet a value high enough to place it in the not impaired category. Little Mallard Creek had good Plecoptera richness (9 taxa) yet low total richness (28 taxa) for this area (Tables 5, 6). Total abundance (284) was near the lower end (minimum = 249) for this survey (Table 2). The stream has a waterfall which precludes fish passage. The invertebrate samples were taken above the waterfall in the portion of the stream that has no fish (Daniel Stewart, Personal Communication, 29 November 1999). Little Mallard Creek had a total of four cold water indicator taxa which made up 25% of the total fauna at the site.

Little Mallard Creek seems to have some impacts from fine sediment, since this stream had low total richness and low total abundance of macroinvertebrates and yet apparently no predation by fish. I conclude that Little Mallard Creek is impacted by fine sediment but enough habitat exists to yield good MBI scores. Additional sampling for macroinvertebrates might give additional information to solve this apparent inconsistency in the data.

### Rhett Creek

Rhett Creek had a high MBI value of 5.13 (second high for this study, Tables 2, 3). Rhett Creek had a very high total taxa richness (45) and a high total abundance (528) when compared with the other streams listed on the 303(d) list from this area. It had a lower number of Plecoptera taxa present (7) as compared with those streams not on the 303(d) list (see below). But, Rhett Creek had a total of six cold water indicator taxa which made up 18% of the total fauna at the site. Rhett Creek does not appear to be impacted by fine sediment.

### Warren Creek

Two sites on Warren Creek were sampled, one in the upper part of the stream and one in the lower section. The upper site had an MBI score of 4.99 and the lower site a nearly identical score of 4.93 (Tables 2, 3). This stream gave mixed signals concerning its biotic condition: The lower site had better taxa richness as compared with the upper site (43 and 29 respectively) and had a higher percent EPT (59.4 as compared to 48.6 respectively). These differences may indicate that the impacts to the stream did not occur at the same time. On the other hand, the upper site had more Plecoptera taxa (6) as compared to the lower site (5) and double the total abundance. Warren Creek had a total of seven and two cold water indicator taxa, respectively, which made up 4.2% and 3.2%, respectively, of the total fauna at the site which is low for a stream in this area in good condition. Additional sampling for macroinvertebrates might give additional information to solve this apparent inconsistency in the data.

## STREAMS NOT INCLUDED ON THE 303(d) LIST:

### Bear Basin Creek

Bear Basin Creek had the next to lowest MBI score, 4.02 (Tables 2, 3). The site has a good group of intolerant macroinvertebrate taxa present (EPT - 51%) including three stonefly taxa (which is a low for this study) (Table 6). Bear Basin Creek has a good number of cold water indicator taxa (6) but a lower percent of the total (15%) than most of the other sites (Table 4). Hence, this stream does not seem to be impacted by fine sediment.

### Corn Creek

Corn Creek had a high MBI score, 5.07 (Tables 2, 3). The site had a much higher proportion of intolerant taxa (EPT - 83%) (including *Drunella doddsi*) as compared to tolerant taxa (Table 6). The site also has a good number of cold water indicator taxa (7) but a lower percent of the total (14%) (Table 4). Hence, this stream does not seem to be impacted by fine sediment.

## Cramer Creek

Cramer Creek had the lowest MBI score for this study (3.17) (Tables 2, 3). The MBI score places the stream into the needs verification category. I would suggest that additional samples be taken on Cramer Creek at several sites to allow us to place the stream in either the impaired or not impaired category. The site presents a very mixed signal from the samples taken so far in that it has some very pollution tolerant taxa (Diptera, Trichoptera, Coleoptera, and Oligochaeta). The one mayfly present, *Baetis tricaudatus*, is a tolerant taxon. Yet, the site has good Plecoptera diversity (five taxa and 75% of the total). More study is needed to be able to properly determine the condition of this stream.

## Eutopia Creek

Eutopia Creek had an MBI score of 4.77 which places it into the not impaired class. Eutopia Creek has the highest number of Plecoptera taxa (12), tied with Noble Creek (Table 6). Eutopia Creek had a relatively high total taxa richness (35) and a good percent Plecoptera (33.3) (Table 4). Eutopia Creek had a total of nine cold water indicator taxa which made up 46% of the total fauna at the site. Eutopia Creek seems to be similar in minimal impact by fine sediment as McGuire and Noble Creeks, and appears to be in much better condition than the streams on the 303(d) list. I conclude that Eutopia Creek is not impacted by fine sediment.

## McGuire Creek

McGuire Creek had the next highest number of Plecoptera taxa (11) as compared to the 14 stream sites examined. McGuire Creek had a total of six cold water indicator taxa which made up 29% of the total fauna at the site. McGuire Creek seems to be similar in minimal impact by fine sediment as Eutopia and Noble Creeks, and appears to be in much better condition than the streams on the 303(d) list. I conclude that McGuire Creek is not impacted by fine sediment.

## Noble Creek

Noble Creek had an MBI score of 5.57, the highest for this study (Tables 2, 3). Noble Creek was tied with Eutopia Creek for the highest number of Plecoptera taxa (12) (Table 6). It had a percent Plecoptera of 31 (Table 6). Noble Creek had the highest taxa richness (50) of any of the stream sites examined during this study (Table 5). Noble Creek had a total of eight cold water indicator taxa present which made up 22% of the fauna at the site (Table 4). I conclude that Noble Creek is not impacted by fine sediment.

## Conclusions and Recommendations

1. All stream sites examined, except for Cramer Creek, had macroinvertebrate biotic index scores in the not impaired (score of 3.5 and above) category.

2. Of the seven streams listed on the 1998 303(d) list, Big Creek, Big Mallard Creek, and Rhett Creek do not appear to be impacted by fine sediment and should be considered not impaired.

3. The remaining streams listed on the 1998 303(d) list, Crooked Creek, Jersey Creek, Little Mallard Creek, and Warren Creek are difficult to assign to an impairment category because the samples were a mix of both tolerant and intolerant taxa. Additional study is suggested to resolve these assessments.

4. For streams not listed on the 1998 303(d) list, Bear Basin Creek, Corn Creek, Eutopia Creek, McGuire Creek and Noble Creek, do not seem to be impacted by fine sediment and are considered not impaired.

5. Cramer Creek was likewise not listed on the 1998 303(d) list but gives a mixed signal and additional study is recommended to help determine the stream's status.

## Acknowledgments

EcoAnalysts, Inc. (Gary Lester) provided the macroinvertebrate identifications of the 1996 specimens and Wease Bollman provided the identifications of the 1997 samples presented here. The Grangeville DEQ Regional Office BURP crew took the field samples. Daniel Stewart and Steve Robinson coordinated the field work. Barry Burnell, Mark Shumar, Todd Maguire, and Daniel Stewart assisted with data summary. Steve Osborne assisted with editorial help.

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Table 1. 1999 Macroinvertebrate collections for the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207).

| STREAM | SITE | SITE ID | 303(d) Listed Pollutant |
|---|---|---|---|
| Bear Basin Creek | Above Road Crossing | 1996SIDFZ099 | n/a |
| Big Creek | Lower-upper | 1997SLEWA014 | Sediment |
| Big Creek | Upper-upper | 1997SLEWA015 | Sediment |
| Big Mallard Creek | Lower | 1997SLEWC015 | Sediment |
| Big Mallard Creek | Upper | 1997SLEWC012 | Sediment |
| Corn Creek | Above Road Crossing | 1996SIDFZ098 | n/a |
| Cramer Creek | Above Road Crossing | 1996SIDFZ100 | n/a |
| Crooked Creek | Lower | 1997SLEWC011 | Sediment |
| Crooked Creek | Upper | 1997SLEWC016 | Sediment |
| Eutopia Creek | Above USFS Road 311 | 1997SLEWA016 | n/a |
| Jersey Creek | Near Mouth | 1997SLEWC014 | Sediment |
| Little Mallard Creek | USFS Road 9505 | 1997SLEWA017 | Sediment |
| McGuire Creek | Above Big Creek | 1997SLEWA018 | n/a |
| Noble Creek | USFS Road 421 | 1997SLEWC013 | n/a |
| Rhett Creek | USFS Trail 231 | 1997SLEWA013 | Sediment |
| Warren Creek | Lower | 1997SLEWA023 | Habitat Alteration |
| Warren Creek | Upper | 1997SLEWA022 | Habitat Alteration |

Table 2. 1999 Macroinvertebrate Biotic Index scores for streams in the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207), arranged in alphabetical order by stream name.

| STREAM | MBI |
|---|---|
| Bear Basin Creek | 4.02 |
| Big Creek (lower-upper) | 5.07 |
| Big Creek (upper-upper) | 4.61 |
| Big Mallard Creek (lower) | 5.06 |
| Big Mallard Creek (upper) | 5.31 |
| Corn Creek | 5.07 |
| Cramer Creek | 3.17 |
| Crooked Creek (lower) | 4.92 |
| Crooked Creek (upper) | 4.46 |
| Eutopia Creek | 4.77 |
| Jersey Creek | 4.93 |
| Little Mallard Creek | 4.25 |
| McGuire Creek | 4.68 |
| Noble Creek | 5.57 |
| Rhett Creek | 5.13 |
| Warren Creek (lower) | 4.93 |
| Warren Creek (upper) | 4.99 |

Table 3. 1999 Macroinvertebrate Biotic Index scores for streams in the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207), arranged from the highest MBI score to the lowest.

| STREAM | MBI |
|---|---|
| Noble Creek | 5.57 |
| Big Mallard Creek (upper) | 5.31 |
| Rhett Creek | 5.13 |
| Big Creek (lower-upper) | 5.07 |
| Corn Creek | 5.07 |
| Big Mallard Creek (lower) | 5.06 |
| Warren Creek (upper) | 4.99 |
| Jersey Creek | 4.93 |
| Warren Creek (lower) | 4.93 |
| Crooked Creek (lower) | 4.92 |
| Eutopia Creek | 4.77 |
| McGuire Creek | 4.68 |
| Big Creek (upper-upper) | 4.61 |
| Crooked Creek (upper) | 4.46 |
| Little Mallard Creek | 4.25 |
| Bear Basin Creek | 4.02 |
| Cramer Creek | 3.17 |

Table 4. 1999 Macroinvertebrate cold water indicators for the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207).

| STREAM | # COLD WATER TAXA | % COLD WATER TAXA |
|---|---|---|
| Bear Basin Creek | 6 | 15.22 |
| Big Creek (lower-upper) | 9 | 17.76 |
| Big Creek (upper-upper) | 8 | 21.95 |
| Big Mallard Creek (lower) | 1 | 1.16 |
| Big Mallard Creek (upper) | 4 | 2.33 |
| Corn Creek | 7 | 14.35 |
| Cramer Creek | 3 | 74.18 |
| Crooked Creek (lower) | 0 | 0.0 |
| Crooked Creek (upper) | 2 | 0.99 |
| Eutopia Creek | 9 | 46.02 |
| Jersey Creek | 3 | 1.56 |
| Little Mallard Creek | 7 | 33.45 |
| McGuire Creek | 8 | 31.62 |
| Noble Creek | 13 | 34.35 |
| Rhett Creek | 10 | 24.43 |
| Warren Creek (lower) | 2 | 2.01 |
| Warren Creek (upper) | 9 | 3.81 |

Table 5. 1999 Macroinvertebrate data (taxa richness, total abundance, HBI, H', percent scrappers) for the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207).

| Water Body | Taxa Richness | Total Abundance | HBI | H= | Percent Scrappers |
|---|---|---|---|---|---|
| <u>303(d) listed</u> | | | | | |
| Big Creek (lower-upper) | 37 | | 1.69 | 1.18 | 45.39 |
| Big Creek (upper-upper) | 38 | 304 | 1.54 | 1.11 | 22.72 |
| Big Mallard Creek(lower) | 30 | 647 | 2.18 | 1.24 | 47.42 |
| Big Mallard Creek (upper) | 43 | 310 | 2.54 | 1.36 | 34.67 |
| Crooked Creek (lower) | 34 | 300 | 2.95 | 1.11 | 66.08 |
| Crooked Creek (upper) | 29 | 454 | 2.19 | 1.09 | 41.06 |
| Jersey Creek | 40 | 302 | 4.35 | 1.00 | 53.13 |
| Little Mallard Creek | 28 | 512 | 0.95 | 1.04 | 16.2 |
| Rhett Creek | 45 | 284 | 2.28 | 1.31 | 23.48 |
| Warren Creek (lower) | 29 | 528 | 1.96 | 1.21 | 45.78 |
| Warren Creek (upper) | 43 | 249 | 1.88 | 1.20 | 30.85 |
| | | 551 | | | |
| <u>Not 303(d) listed</u> | | | | | |
| Bear Basin Creek | 23 | | 4.34 | 0.98 | 42.55 |
| Corn Creek | 28 | 322 | 1.36 | 1.11 | 46.19 |
| Cramer Creek | 15 | 223 | 1.9 | 0.56 | 8.32 |
| Eutopia Creek | 35 | 457 | 1.43 | 1.13 | 18.91 |
| McGuire Creek | 31 | 402 | 1.07 | 1.13 | 29.04 |
| Noble Creek | 50 | 272 | 1.99 | 1.35 | 17.89 |
| | | 559 | | | |

Table 6. 1999 Macroinvertebrate data (percent EPT, Sum EPT taxa, percent Ephemeroptera, percent Plecoptera, percent Trichoptera, number of Ephemeroptera taxa, number of Plectoptera taxa) for the Main Salmon River-Chamberlain area, Idaho, July 1996 and July 1997 (HUC 17060207).

| Water Body | Percent EPT | SumEPTtaxa | %Ephem | %Plec | %Trich | #Plec Taxa |
|---|---|---|---|---|---|---|
| <u>303(d) listed</u> | | | | | | |
| Big Creek (lower-upper) | 60.53 | 21 | 39.80 | 17.11 | 3.62 | 6 |
| Big Creek (upper-upper) | 53.17 | 20 | 19.78 | 28.75 | 4.64 | 6 |
| Big Mallard Creek(lower) | 70.65 | 19 | 48.71 | 20.00 | 1.94 | 6 |
| Big Mallard Creek (upper) | 62.00 | 26 | 39.33 | 17.67 | 5.00 | 8 |
| Crooked Creek (lower) | 47.80 | 20 | 39.21 | 7.27 | 1.32 | 4 |
| Crooked Creek (upper) | 41.06 | 18 | 19.87 | 17.22 | 3.97 | 4 |
| Jersey Creek | 83.79 | 25 | 74.22 | 7.62 | 1.95 | 9 |
| Little Mallard Creek | 52.46 | 18 | 15.49 | 35.21 | 1.76 | 9 |
| Rhett Creek | 54.55 | 26 | 21.59 | 25.57 | 7.39 | 7 |
| Warren Creek (lower) | 59.44 | 19 | 46.59 | 10.84 | 2.01 | 5 |
| Warren Creek (upper) | 48.64 | 26 | 35.39 | 8.89 | 4.36 | 6 |
| <u>Not 303(d) listed</u> | | | | | | |
| Bear Basin Creek | 51.24 | 15 | 36.96 | 7.14 | 7.14 | 3 |
| Corn Creek | 82.96 | 22 | 59.64 | 12.11 | 11.21 | 6 |
| Cramer Creek | 87.31 | 9 | 5.47 | 74.84 | 7.0 | 9 |
| Eutopia Creek | 55.47 | 26 | 19.15 | 33.33 | 2.99 | 12 |
| McGuire Creek | 57.72 | 20 | 28.68 | 25.74 | 3.31 | 11 |
| Noble Creek | 59.21 | 35 | 20.21 | 31.13 | 7.87 | 12 |

# APPENDIX 2

## NEZSED MODELS FOR SUB-WATERSHEDS

**Main Salmon Basin (17060207) NEZSED Data Discussion**
**Nez Perce National Forest - 3/7/00**
**Summary by Jim Paradiso**

Sediment projections were based on data in the Nez Perce Watershed Database in April of 1999. Attached spreadsheets include:

Sheet 'Middle Salmon': Each line is a summary of each tributary that discharges into the Main Salmon on the north side of the river. These tributaries are numbered using the Nez Perce National Forest Plan numbering system, and each subwatershed is called a prescription watershed. On this sheet, tributaries composed of more than one prescription watershed are grouped in Cumulative Effects Watersheds (CEW).

Sheet 'Upper CEWS':This sheet lists the CEW's on the upper portion of the sub-basin. The total lines for each CEW are carried over to Sheet 'Middle Salmon'.

Sheet 'Wind CEW': This sheet is of one CEW, Wind River. The totals are carried onto Sheet 'Middle Salmon'.

<u>Data Completeness</u>

The NEZSED model was run based upon the data contained in the Watershed Database in April of 1999. The analysis was also modeled for the year 1999. A review of the present contents of the database indicates that the timber harvest activities for the Jack and Noble Timber sales since 1996 are not in the database. Activities in the database does include all road construction work for these sales.

<u>Column Definitions:</u>

NPNF Area: Acres in the subwatershed that are within the Nez Perce National Forest (NPNF).

Natural Yield: Sediment produced naturally on the landscape, without the influence of man's activities.

Activity yield: The sediment produced that is attributable to mans activities. This includes timber harvest, roads, and planned fires.

Unrouted Yield: Unrouted yield is the amount of sediment mobilized. It may move only a short distance until it is again stored in the watershed, while some of it may travel to the mouth of the watershed, at which time it is said to be 'routed' sediment.

Routed Yield: The sediment that moves out of the drainage.

Total Yield: The sum of the Natural and Activity Yields.

Routing Coefficient: calculated based upon the area in the drainage.

Percent Over Base: equals activity yield/natural yield X 100

| Summary of Salmon River 4th HUC | | | | Existing Unrouted and Routed Sediment. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Watershed # | Name | NPNF Area Acres[1] | NPNF Area Sq Mi | Unrouted Natural[2] $t/mi^2/yr$ | Unrouted Natural Yield (t/yr) | 1999 Unrouted Activity Yield (t/yr) | Routing Coefficient | Routed Natural[2] $t/mi^2/yr$ | Routed Natural Yield (t/yr) | 1999 Routed[3] Activity Yield (t/yr) | 1999 Routed Total Yield (t/yr) | Percent Over Base |
| 17060207-75 | **Sabe Creek CEW** | 53,218 | 83.15 | 106.7 | 3,209.7 | 0.4 | 0.45 | 48.1 | 1,448.4 | 0.2 | 1,448.6 | 0.0% |
| 17060207-04-14 | Nixion Creek | 1,284 | 2.01 | 68.9 | 138.1 | 0.0 | 0.88 | 60.7 | 121.9 | 0.0 | 121.9 | 0.0% |
| 17060207-04-15 | Bear Creek | 2,278 | 3.56 | 60.0 | 213.4 | 0.0 | 0.80 | 47.7 | 169.8 | 0.0 | 169.8 | 0.0% |
| 17060207-04-16 | Deer Park Creek | 1,056 | 1.65 | 73.0 | 120.4 | 0.0 | 0.91 | 66.7 | 110.0 | 0.0 | 110.0 | 0.0% |
| 17060207-04-17 | Rattlesnake Creek | 6,013 | 9.40 | 47.0 | 441.2 | 0.0 | 0.67 | 31.4 | 294.8 | 0.0 | 294.8 | 0.0% |
| 17060207-04 | **Bargamin Creek CEW** | 69,959 | 109.31 | 35.3 | 3,864.1 | 9.2 | 0.43 | 15.2 | 1,659.9 | 4.0 | 1,663.9 | 0.2% |
| 17060207-04-19 | Bailey Creek | 2,243 | 3.50 | 68.5 | 240.1 | 0.0 | 0.80 | 54.7 | 191.6 | 0.0 | 191.6 | 0.0% |
| 17060207-04-20 | Myers Creek | 3,204 | 5.01 | 36.8 | 184.0 | 0.0 | 0.75 | 27.5 | 137.7 | 0.0 | 137.7 | 0.0% |
| 17060207-04-99 | Salmon River Face 0207-04 | 8,272 | 12.93 | 63.6 | 821.9 | 0.0 | 1.00 | 63.6 | 821.9 | 0.0 | 821.9 | 0.0% |
| 17060207-03-08 | Five Mile Creek | 1,427 | 2.23 | 59.0 | 131.5 | 0.0 | 0.87 | 51.0 | 113.8 | 0.0 | 113.8 | 0.0% |
| 17060207-03 | **Big Mallard Creek CEW** | 36,530 | 57.08 | 21.6 | 1,230.9 | 42.9 | 0.48 | 10.4 | 594.4 | 20.7 | 615.1 | 3.5% |
| 17060207-03-10 | **Little Mallard Creek** | 8,215 | 12.84 | 22.7 | 291.9 | 5.7 | 0.63 | 14.4 | 184.4 | 3.6 | 188.0 | 2.0% |
| 17060207-03-11 | Elkhorn Creek | 2,743 | 4.29 | 25.2 | 108.0 | 0.0 | 0.77 | 19.4 | 83.1 | 0.0 | 83.1 | 0.0% |
| 17060207-03-12 | Slide Creek | 557 | 0.87 | 38.1 | 33.1 | 0.0 | 1.00 | 38.1 | 33.1 | 0.0 | 33.1 | 0.0% |
| 17060207-03-13 | Groundhog Creek | 248 | 0.39 | 16.6 | 6.4 | 0.0 | 1.00 | 16.6 | 6.4 | 0.0 | 6.4 | 0.0% |
| 17060207-03 | **Rhett CEW** | 12348 | 19.29 | 23.0 | 444.1 | 3.3 | 0.59 | 13.5 | 260.7 | 1.9 | 262.6 | 0.7% |
| 17060207-03-17 | Blowout Creek | 4,741 | 7.41 | 36.1 | 267.6 | 0.1 | 0.70 | 25.2 | 186.6 | 0.1 | 186.7 | 0.0% |
| 17060207-03-18 | Paine Creek | 715 | 1.12 | 67.2 | 75.0 | 0.0 | 0.98 | 65.8 | 73.5 | 0.0 | 73.5 | 0.0% |
| 17060207-03-19 | Boise Creek | 826 | 1.29 | 55.0 | 71.0 | 0.0 | 0.96 | 52.5 | 67.8 | 0.0 | 67.8 | 0.0% |
| 17060207-03-20 | No Man's Creek | 606 | 0.95 | 69.4 | 65.7 | 0.0 | 1.00 | 69.4 | 65.7 | 0.0 | 65.7 | 0.0% |
| 17060207-03-21 | TePee Creek | 1,906 | 2.98 | 48.1 | 143.1 | 1.5 | 0.82 | 39.5 | 117.6 | 1.2 | 118.8 | 1.0% |
| 17060207-03-22 | **Jersey Creek** | 10,001 | 15.63 | 33.6 | 524.4 | 20.0 | 0.61 | 20.5 | 319.7 | 12.2 | 331.9 | 3.8% |
| 17060207-03-23 | Cove Creek | 2,581 | 4.03 | 47.6 | 192.1 | 2.3 | 0.78 | 37.1 | 149.5 | 1.8 | 151.3 | 1.2% |
| 17060207-03-99 | Salmon River Face 0207-03 | 10,598 | 16.56 | 62.0 | 1,026.4 | 4.3 | 1.00 | 62.0 | 1,026.4 | 4.3 | 1,030.7 | 0.4% |
| 17060207-02-10 | Unname No. 10 | 856 | 1.34 | 73.0 | 97.6 | 0.0 | 0.95 | 69.3 | 92.6 | 0.0 | 92.6 | 0.0% |
| 17060207-02-11 | Unname No. 11 | 876 | 1.37 | 72.2 | 98.8 | 0.0 | 0.95 | 68.2 | 93.4 | 0.0 | 93.4 | 0.0% |
| 17060207-03-16 | **Indian CEW** | 5,407 | 8.45 | 68.6 | 579.4 | 0.1 | 0.68 | 46.7 | 394.6 | 0.1 | 394.7 | 0.0% |
| 17060207-02-13 | Cougar Creek | 2,341 | 3.66 | 73.2 | 267.8 | 0.0 | 0.79 | 58.0 | 212.0 | 0.0 | 212.0 | 0.0% |
| 17060207-02-14 | Rattlesnake Creek | 499 | 0.78 | 72.8 | 56.8 | 0.0 | 1.00 | 72.8 | 56.8 | 0.0 | 56.8 | 0.0% |
| 17060207-02 | **Crooked Creek CEW** | 79,487 | 124.20 | 29.8 | 3,705.4 | 162.0 | 0.42 | 12.5 | 1,555.6 | 68.0 | 1,623.6 | 4.4% |
| 17060207-02-16 | Basin Creek | 1,449 | 2.26 | 85.0 | 192.4 | 0.0 | 0.86 | 73.4 | 166.1 | 0.0 | 166.1 | 0.0% |
| 17060207-02-17 | Whiskey Bob Creek | 717 | 1.12 | 85.0 | 95.2 | 0.0 | 0.98 | 83.3 | 93.3 | 0.0 | 93.3 | 0.0% |
| 17060207-02-99 | Salmon River Face 0207-02 | 3,367 | 5.26 | 61.1 | 321.6 | 0.0 | 1.00 | 61.1 | 321.6 | 0.0 | 321.6 | 0.0% |
| 17060207-02 | **Bull Creek CEW** | 9,774 | 15.27 | 73.0 | 1,114.1 | 0.0 | 0.61 | 44.7 | 682.1 | 0.0 | 682.1 | 0.0% |
| 17060207-01-11 | T-Bone Creek | 421 | 0.66 | 85.0 | 55.9 | 0.0 | 1.00 | 85.0 | 55.9 | 0.0 | 55.9 | 0.0% |
| 17060207-01-10 | Unnamed No. 10 | 822 | 1.28 | 85.0 | 109.2 | 0.0 | 0.96 | 81.3 | 104.4 | 0.0 | 104.4 | 0.0% |
| 17060207-01-09 | Elk Creek | 3,913 | 6.11 | 85.0 | 519.7 | 0.0 | 0.72 | 61.4 | 375.2 | 0.0 | 375.2 | 0.0% |
| 17060207-01 | **Sheep Creek CEW** | 32,974 | 51.52 | 72.2 | 3,720.8 | 0.5 | 0.49 | 35.5 | 1,830.1 | 0.2 | 1,830.4 | 0.0% |
| 17060207-01-14 | Johnson Creek | 1,593 | 2.49 | 82.0 | 204.2 | 0.0 | 0.85 | 69.6 | 173.3 | 0.0 | 173.3 | 0.0% |
| 17060207-01-15 | Wisdom Creek | 460 | 0.72 | 85.0 | 61.1 | 0.0 | 1.00 | 85.0 | 61.1 | 0.0 | 61.1 | 0.0% |
| 17060207-01-16 | Cherry Creek | 624 | 0.98 | 85.0 | 82.9 | 0.0 | 1.00 | 85.0 | 82.9 | 0.0 | 82.9 | 0.0% |
| 17060207-01-17 | Chittam Creek | 1,228 | 1.92 | 85.0 | 163.1 | 0.0 | 0.89 | 75.6 | 145.0 | 0.0 | 145.0 | 0.0% |
| 17060207-01-18 | Vinegar Creek | 583 | 0.91 | 85.0 | 77.4 | 0.0 | 1.00 | 85.0 | 77.4 | 0.0 | 77.4 | 0.0% |
| | **Wind River CEW** | 41,347 | 64.60 | 37.9 | 2,445.3 | 47.4 | 0.47 | 17.9 | 1,154.7 | 22.4 | 1,177.1 | 1.9% |
| 17060207-01-20 | Bullion Creek | 1,011 | 1.58 | 50.6 | 80.0 | 2.0 | 0.92 | 46.6 | 73.6 | 1.8 | 75.5 | 2.5% |
| 17060207-01-21 | Witscher Creek | 1,311 | 2.05 | 54.2 | 111.1 | 5.5 | 0.88 | 47.7 | 97.6 | 4.8 | 102.5 | 5.0% |
| 17060207-01-22 | Scott Creek | 996 | 1.56 | 53.6 | 83.5 | 5.3 | 0.92 | 49.5 | 77.1 | 4.9 | 82.0 | 6.3% |
| 17060207-01-99 | Salmon River Face 0207-01* | 4,329 | 6.76 | 66.4 | 449.2 | 0.3 | 1.00 | 66.4 | 449.2 | 0.3 | 449.5 | 0.1% |
| | **Main Salmon Total** | 437,954 | 684.30 | 41.7 | 28,536 | 312.8 | | 24.4 | 16,664.2 | 152.5 | 16,816.8 | |

| CEW Prescription Watersheds for Main Salmon | (Partial list) | Existing Unrouted and Routed Sediment. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Watershed # | Name | Area Acres[1] | Area Sq Mi | Unrouted Natural[1] t/mi²/yr | Unrouted Natural Yield (t/yr) | 1999 Unrouted Activity Yield (t/yr) | Routing Coefficient | Routed Natural[1] t/mi²/yr | Routed Natural Yield (t/yr) | 1999 Routed[2] Activity Yield (t/yr) | 1999 Routed Total Yield (t/yr) | Percent Over Base |
| **Sheep Creek CEW** | | | | | | | | | | | | |
| 17060207-01-05 | Butcher Creek | 7620 | 11.91 | 61.95 | 737.6 | 0.5 | 0.64 | 39.7 | 472.3 | 0.3 | 472.6 | 0.1% |
| 17060207-01-04 | Peterson Creek | 5183 | 8.10 | 31.24 | 253.0 | 0.0 | 0.69 | 21.4 | 173.6 | 0.0 | 173.6 | 0.0% |
| 17060207-01-12 | Unname No. 12 | 567 | 0.89 | 85.00 | 75.3 | 0.0 | 1.02 | 86.9 | 77.0 | 0.0 | 77.0 | 0.0% |
| 17060207-01-07 | East Fork Sheep Creek | 4038 | 6.31 | 82.36 | 519.6 | 0.0 | 0.72 | 59.1 | 373.0 | 0.0 | 373.0 | 0.0% |
| 17060207-01-08 | Green Saddle | 1361 | 2.13 | 85.00 | 180.8 | 0.0 | 0.87 | 74.2 | 157.8 | 0.0 | 157.8 | 0.0% |
| 17060207-01-06 | Slaughter Creek | 2505 | 3.91 | 100.00 | 391.4 | 0.0 | 0.78 | 78.2 | 306.2 | 0.0 | 306.2 | 0.0% |
| 17060207-01-03 | Long Meadow Creek | 4661 | 7.28 | 73.87 | 538.0 | 0.0 | 0.70 | 51.7 | 376.3 | 0.0 | 376.3 | 0.0% |
| 17060207-01-13 | Sheep Creek | 2688 | 4.20 | 85.00 | 357.0 | 0.0 | 0.77 | 65.6 | 275.7 | 0.0 | 275.7 | 0.0% |
| 17060207-01-32 | Plummer Creek | 1704 | 2.66 | 100.00 | 266.3 | 0.0 | 0.84 | 83.8 | 223.2 | 0.0 | 223.2 | 0.0% |
| 17060207-01-30 | Porcupine Creek | 1850 | 2.89 | 98.50 | 284.7 | 0.0 | 0.83 | 81.4 | 235.2 | 0.0 | 235.2 | 0.0% |
| 17060207-01-31 | Unnamed No. 31 | 797 | 1.25 | 94.10 | 117.2 | 0.0 | 0.96 | 90.5 | 112.6 | 0.0 | 112.6 | 0.0% |
| | **CEW Total** | **32974** | **51.52** | **72.22** | **3,720.8** | **0.5** | **0.49** | **35.5** | **1,830.1** | **0.2** | **1,830.4** | 0.0% |
| **Bull Creek CEW** | | | | | | | | | | | | |
| 17060207-02-18 | Lower Bull Creek | 3211 | 5.02 | 85.00 | 426.5 | 0.0 | 0.75 | 63.6 | 319.0 | 0.0 | 319.0 | 0.0% |
| 17060207-02-19 | Unnamed No. 19 | 914 | 1.43 | 85.00 | 121.4 | 0.0 | 0.94 | 79.7 | 113.8 | 0.0 | 113.8 | 0.0% |
| 17060207-02-20 | Hurst Creek | 961 | 1.50 | 85.00 | 127.6 | 0.0 | 0.93 | 79.0 | 118.6 | 0.0 | 118.6 | 0.0% |
| 17060207-02-21 | Upper Bull Creek | 1738 | 2.72 | 88.02 | 239.0 | 0.0 | 0.84 | 73.5 | 199.7 | 0.0 | 199.7 | 0.0% |
| 17060207-02-23 | Unnamed No. 23 | 814 | 1.27 | 21.44 | 27.3 | 0.0 | 0.96 | 20.5 | 26.1 | 0.0 | 26.1 | 0.0% |
| 17060207-02-24 | Brandon Creek | 2136 | 3.34 | 51.63 | 172.3 | 0.0 | 0.80 | 41.6 | 138.7 | 0.0 | 138.7 | 0.0% |
| | **CEW Total** | **9774** | **15.27** | **72.95** | **1,114.1** | **0.0** | **0.61** | **44.7** | **682.1** | **0.0** | **682.1** | 0.0% |
| **Crooked Creek CEW** | | | | | | | | | | | | |
| 17060207-02-01 | Upper Big Creek | 9626 | 15.04 | 21.00 | 315.9 | 6.2 | 0.61 | 12.9 | 193.9 | 3.8 | 197.7 | 2.0% |
| 17060207-02-02 | Upper Crooked Creek | 17474 | 27.30 | 21.08 | 575.5 | 138.0 | 0.55 | 11.6 | 317.4 | 76.1 | 393.5 | 24.0% |
| 17060207-02-03 | Lower Big Creek | 5307 | 8.29 | 26.62 | 220.7 | 1.6 | 0.68 | 18.2 | 150.8 | 1.1 | 151.9 | 0.7% |
| 17060207-02-04 | Jim Sandy Creek | 1922 | 3.00 | 25.93 | 77.9 | 0.0 | 0.82 | 21.3 | 63.9 | 0.0 | 63.9 | 0.0% |
| 17060207-02-05 | Power Creek | 807 | 1.26 | 20.54 | 25.9 | 0.0 | 0.96 | 19.7 | 24.8 | 0.0 | 24.8 | 0.0% |
| 17060207-02-06 | Fritz Creek | 2466 | 3.85 | 25.83 | 99.5 | 0.0 | 0.78 | 20.3 | 78.1 | 0.0 | 78.1 | 0.0% |
| 17060207-02-07 | Lower Crooked Creek | 9476 | 14.81 | 37.33 | 552.7 | 3.7 | 0.62 | 23.0 | 340.3 | 2.3 | 342.5 | 0.7% |
| 17060207-02-15 | Arlington Creek | 2402 | 3.75 | 39.00 | 146.4 | 0.0 | 0.79 | 30.7 | 115.4 | 0.0 | 115.4 | 0.0% |
| 17060207-02-22 | West Fork Creek | 48.55 | 0.08 | 39.61 | 3.0 | 0.0 | 1.59 | 63.0 | 4.8 | 0.0 | 4.8 | 0.0% |
| 17060207-02-25 | Jumbo Canyon | 6060 | 9.47 | 43.72 | 414.0 | 1.8 | 0.67 | 29.2 | 276.2 | 1.2 | 277.4 | 0.4% |
| 17060207-02-26 | Lake Creek | 11130 | 17.39 | 32.54 | 565.9 | 0.0 | 0.60 | 19.5 | 338.4 | 0.0 | 338.4 | 0.0% |
| 17060207-02-27 | Whistling Pig Creek | 1704 | 2.66 | 39.65 | 105.6 | 0.0 | 0.84 | 33.2 | 88.5 | 0.0 | 88.5 | 0.0% |
| 17060207-02-28 | Upper Kelly Creek | 3703 | 5.79 | 52.19 | 302.0 | 5.6 | 0.73 | 38.1 | 220.2 | 4.1 | 224.2 | 1.9% |
| 17060207-02-29 | Wildhorse Creek | 1102 | 1.72 | 27.92 | 48.1 | 4.0 | 0.91 | 25.3 | 43.6 | 3.6 | 47.2 | 8.3% |
| 17060207-02-30 | Lower Kelly Creek | 2051 | 3.20 | 40.40 | 129.5 | 1.1 | 0.81 | 32.8 | 105.0 | 0.9 | 105.9 | 0.8% |
| 17060207-02-31 | Pete Creek | 1202 | 1.88 | 19.55 | 36.7 | 0.0 | 0.89 | 17.5 | 32.8 | 0.0 | 32.8 | 0.0% |
| 17060207-02-32 | McGuire Creek | 3006 | 4.70 | 18.35 | 86.2 | 0.0 | 0.76 | 13.9 | 65.2 | 0.0 | 65.2 | 0.0% |
| | **CEW Total** | **79,487** | **124.20** | **29.83** | **3,705.4** | **162.0** | **0.42** | **12.5** | **1,555.6** | **68.0** | **1,623.6** | 4.4% |
| **Indian CEW** | | | | | | | | | | | | |
| 17060207-02-08 | Upper Indian Creek | 2,720 | 4.25 | 66.7 | 283.5 | 0.1 | 0.77 | 51.4 | 218.5 | 0.1 | 218.6 | 0.0% |
| 17060207-02-09 | Moccasin Creek | 1,575 | 2.46 | 67.1 | 165.2 | 0.0 | 0.85 | 57.1 | 140.5 | 0.0 | 140.5 | 0.0% |
| 17060207-02-12 | Lower Indian Creek | 1,112 | 1.74 | 75.2 | 130.7 | 0.0 | 0.91 | 68.1 | 118.3 | 0.0 | 118.3 | 0.0% |
| | **CEW Total** | **5,407** | **8.45** | **68.58** | **579.4** | **0.1** | **0.68** | **46.7** | **394.6** | **0.1** | 394.7 | 0.0% |
| **Rhett CEW** | | | | | | | | | | | | |
| 17060207-03-14 | Rabbit Creek | 2,804 | 4.38 | 17.6 | 77.1 | 1.1 | 0.77 | 13.5 | 59.1 | 0.8 | 59.9 | 1.4% |
| 17060207-03-15 | Upper Rhett Creek | 8,247 | 12.89 | 18.6 | 239.4 | 1.1 | 0.63 | 11.7 | 151.1 | 0.7 | 151.8 | 0.5% |
| 17060207-03-16 | Lower Rhett Creek | 1,297 | 2.03 | 63.0 | 127.6 | 1.1 | 0.88 | 55.4 | 112.3 | 1.0 | 113.3 | 0.9% |
| | **CEW Total** | **12,348** | **19.29** | **23.02** | **444.1** | **3.3** | **0.59** | **13.5** | **260.7** | **1.9** | **262.6** | 0.7% |

Wind River Ck CEW — Present sediment.

| Watershed # | Name | Area Acres[1] | Area Sq Mi | Unrouted Natural[1] t/mi²/yr | Unrouted Natural Yield (t/yr) | Existing 1998 Unrouted[3] Activity Yield (t/yr) | 1999 Unrouted[3] Activity Yield (t/yr) | 2000 Unrouted[3] Activity Yield (t/yr) | 2001 Unrouted[3] Activity Yield (t/yr) | 2002 Unrouted[3] Activity Yield (t/yr) | 2003 Unrouted[3] Activity Yield (t/yr) | 2004 Unrouted[3] Activity Yield (t/yr) | 2005 Unrouted[3] Activity Yield (t/yr) | 2006 Unrouted[3] Activity Yield (t/yr) | 2007 Unrouted[3] Activity Yield (t/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17060207-01-01 | Upper Wind River | 5356 | 8.37 | 17.7 | 148.1 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 |
| 17060207-01-02 | Anchor Ck | 4832 | 7.55 | 43.8 | 330.7 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 17060207-01-19 | Lower Wind River | 3085 | 4.82 | 70.6 | 340.3 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 17060207-01-23 | Sand Creek | 3084 | 4.82 | 35.7 | 172.0 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 17060207-01-24 | Meadow Creek | 5313 | 8.30 | 38.4 | 318.8 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 |
| 17060207-01-25 | WF Meadow Ck | 1592 | 2.49 | 39.2 | 97.5 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 |
| 17060207-01-26 | EF Meadow Ck | 1908 | 2.98 | 31.7 | 94.5 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 |
| 17060207-01-27 | Hanover Creek | 3472 | 5.43 | 20 | 108.5 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 17060207-01-28 | Rock Creek | 2523 | 3.94 | 22.5 | 88.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17060207-01-29 | Mid. Wind River | 10182 | 15.91 | 46.9 | 746.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | CEW Totals = | 41347.0 | 64.6 | 37.85 | 2445.3 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 | 47.4 |
| | CEW Routing Coefficient[2] = | 0.47 | | | | | | | | | | | | | |
| | Routed Sediment Yield (t/yr) = | | | | 1154.7 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 | 22.4 |
| | Percent Over Base = | | | | | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% | 1.9% |

Footnotes:
[1]from NEZSED out_list dated 04/09/97
[2]as described in "Guide for Predicting Sediment Yield"
[3]from NEZSED 'out_totals'

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jersey Creek CEW | | only 1 watershed in this CEW; see mid_salmon | | | | | | | | | | |
| Little Mallard Creek CEW | | only 1 watershed in this CEW; see mid_salmon | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Big Mallard Creek CEW** | | | | | | | | | | | | |
| 17060207-03-01 | Noble Creek | 7283 | 11.38 | 18.74 | 213.3 | 5.2 | 0.65 | 12.1 | 137.7 | 3.4 | 141.0 | 2.4% |
| 17060207-03-02 | Grouce Creek | 1230 | 1.92 | 17.56 | 33.7 | 1.7 | 0.89 | 15.6 | 30.0 | 1.5 | 31.5 | 5.0% |
| 17060207-03-03 | Jack Creek | 4265 | 6.66 | 17.97 | 119.8 | 15.9 | 0.71 | 12.8 | 85.1 | 11.3 | 96.4 | 13.3% |
| 17060207-03-04 | Middle Big Mallard Creek | 5057 | 7.90 | 20.59 | 162.7 | 10.0 | 0.69 | 14.2 | 112.1 | 6.9 | 119.0 | 6.1% |
| 17060207-03-05 | Upper Big Mallard | 4444 | 6.94 | 23.19 | 161.0 | 0.9 | 0.71 | 16.4 | 113.6 | 0.6 | 114.2 | 0.6% |
| 17060207-03-06 | South Fork Big Mallard | 4622 | 7.22 | 20.16 | 145.6 | 0.0 | 0.70 | 14.1 | 102.0 | 0.0 | 102.0 | 0.0% |
| 17060207-03-07 | Bat Creek | 2957 | 4.62 | 18.06 | 83.4 | 0.5 | 0.76 | 13.7 | 63.4 | 0.4 | 63.7 | 0.6% |
| 17060207-03-09 | Lower Big Mallard Creek | 6672 | 10.43 | 29.87 | 311.4 | 8.7 | 0.66 | 19.6 | 204.2 | 5.7 | 209.9 | 2.8% |
| | **CEW Total** | **36530** | **57.08** | **21.57** | **1,230.9** | **42.9** | **0.48** | **10.4** | **594.4** | **20.7** | **615.1** | **3.5%** |
| | | | | | | | | | | | | |
| **Bargamin Creek CEW** | | | | | | | | | | | | |
| 17060207-04-01 | Green Mountain Creek | 1676 | 2.62 | 21.35 | 55.9 | 0.6 | 0.84 | 18.0 | 47.0 | 0.5 | 47.5 | 1.1% |
| 17060207-04-02 | Upper Bargamin Creek | 11730 | 18.33 | 24.18 | 443.2 | 0.0 | 0.59 | 14.3 | 262.6 | 0.0 | 262.6 | 0.0% |
| 17060207-04-03 | Hot Springs Creek | 3246 | 5.07 | 22.88 | 116.0 | 0.1 | 0.75 | 17.1 | 86.6 | 0.1 | 86.7 | 0.1% |
| 17060207-04-04 | Poet Creek | 2127 | 3.32 | 21.57 | 71.7 | 0.2 | 0.81 | 17.4 | 57.7 | 0.2 | 57.9 | 0.3% |
| 17060207-04-06 | Middle Bargamin Creek | 10547 | 16.48 | 37.69 | 621.1 | 0.0 | 0.60 | 22.8 | 375.1 | 0.0 | 375.1 | 0.0% |
| 17060207-04-18 | Lower Bargamin Creek | 8692 | 13.58 | 58.85 | 799.3 | 0.0 | 0.63 | 36.8 | 499.8 | 0.0 | 499.8 | 0.0% |
| 17060207-04-21 | Rainey Creek | 3704 | 5.79 | 60.48 | 350.0 | 0.0 | 0.73 | 44.1 | 255.2 | 0.0 | 255.2 | 0.0% |
| 17060207-04-22 | Salt Creek | 3241 | 5.06 | 40.19 | 203.5 | 0.0 | 0.75 | 30.0 | 152.0 | 0.0 | 152.0 | 0.0% |
| 17060207-04-23 | Cache Creek | 5879 | 9.19 | 32.85 | 301.8 | 0.2 | 0.67 | 22.0 | 202.4 | 0.1 | 202.6 | 0.1% |
| 17060207-04-24 | Lake Creek | 2685 | 4.20 | 48.96 | 205.4 | 0.0 | 0.77 | 37.8 | 158.7 | 0.0 | 158.7 | 0.0% |
| 17060207-04-25 | Unnamed NO. 25 Creek | 1643 | 2.57 | 42.02 | 107.9 | 0.0 | 0.84 | 35.5 | 91.0 | 0.0 | 91.0 | 0.0% |
| 17060207-04-26 | Prospector Creek | 2137 | 3.34 | 28.56 | 95.4 | 0.0 | 0.80 | 23.0 | 76.8 | 0.0 | 76.8 | 0.0% |
| 17060207-04-27 | Porcupine Creek | 4842 | 7.57 | 23.04 | 174.3 | 2.4 | 0.69 | 16.0 | 121.1 | 1.7 | 122.8 | 1.4% |
| 17060207-04-28 | Unnamed 28 | 1174 | 1.83 | 21.66 | 39.7 | 0.3 | 0.90 | 19.4 | 35.6 | 0.3 | 35.9 | 0.8% |
| 17060207-04-29 | Unnamed 29 | 3410 | 5.33 | 27.29 | 145.4 | 0.1 | 0.74 | 20.2 | 107.6 | 0.1 | 107.7 | 0.1% |
| 17060207-04-30 | Up-Middle Bargamin Creek | 3226 | 5.04 | 26.48 | 133.5 | 5.3 | 0.75 | 19.8 | 99.8 | 4.0 | 103.7 | 4.0% |
| | **CEW Total** | **69959** | **109.31** | **35.35** | **3,864.1** | **9.2** | **0.43** | **15.2** | **1,659.9** | **4.0** | **1,663.9** | **0.2%** |
| | | | | | | | | | | | | |
| **Sabe Creek CEW** | | | | | | | | | | | | |
| 17060207-75-05 | Camp Creek | 1176 | 1.84 | 46.75 | 77.0 | 0.0 | 0.90 | 41.9 | 69.0 | 0.0 | 69.0 | 0.0% |
| 17060207-75-07 | Goodman Creek | 1263 | 1.97 | 45.76 | 79.9 | 0.0 | 0.88 | 40.5 | 70.7 | 0.0 | 70.7 | 0.0% |
| 17060207-75-08 | Saddle Creek | 2481 | 3.88 | 44.98 | 136.6 | 0.0 | 0.78 | 35.2 | 107.0 | 0.0 | 107.0 | 0.0% |
| 17060207-75-09 | Ring Creek | 3590 | 5.61 | 48.65 | 200.1 | 0.0 | 0.73 | 35.7 | 146.7 | 0.0 | 146.7 | 0.0% |
| 17060207-75-10 | Brown Creek | 1853 | 2.90 | 40.38 | 96.6 | 0.0 | 0.83 | 33.3 | 79.8 | 0.0 | 79.8 | 0.0% |
| 17060207-75-11 | Center Creek | 2122 | 3.32 | 51.82 | 138.5 | 0.0 | 0.81 | 41.8 | 111.6 | 0.0 | 111.6 | 0.0% |
| 17060207-75-12 | Steep Creek | 1513 | 2.36 | 59.46 | 120.4 | 0.0 | 0.86 | 50.9 | 103.1 | 0.0 | 103.1 | 0.0% |
| 17060207-75-13 | Canyon Creek | 1093 | 1.71 | 67.14 | 104.1 | 0.0 | 0.91 | 61.0 | 94.5 | 0.0 | 94.5 | 0.0% |
| 17060207-75-31 | Sabe Creek | 4163 | 6.50 | 43.56 | 202.3 | 0.4 | 0.71 | 31.1 | 144.4 | 0.3 | 144.7 | 0.2% |
| | NPNF Portion Total | 19,254 | 30.08 * | 38.41 | 1,155.5 | 0.4 * | 0.54 * | 20.8 | 626.1 | 0.2 | 626.4 | 0.0% |
| | Bitterroot NF Portion | 33964 | 53.07 | 68.3 | 2,054.2 | | 0.49 | 33.4 | 1,005.0 | 0.0 | 1,005.0 | 0.0% |
| | **CEW Total** | **53218** | **83.15** | **106.7** | **3,209.7** | **0.4** | **0.45** | **48.1** | **1,448.4** | **0.2** | **1,448.6** | **0.0%** |
| | | | | | | | | | | | | |
| | *Includes acreage on Red River Ranger District | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Footnotes: | | | | | | | | | | | | |
| | [1]from NEZSED out_list dated 04/09/97 | | | | | | | | | | | |
| | [2]as described in "Guide for Predicting Sediment Yield" | | | | | | | | | | | |
| | [3]from NEZSED 'out_totals' | | | | | | | | | | | |

# Appendix 3

# Summary of Restoration Efforts

**Mid Salmon River Subbasin (17060207) Restoration Efforts**
**Red River Ranger District - 1992-1997**
**Summary by Bob Vermey - 3/6/00**

| PROJECT NAME & DESCRIPTION | SUBWATERSHED | YR COMPLETED |
|---|---|---|
| Road 311F Eutopia Creek Improvements<br>- french drain installed<br>- 1 ford hardening<br>- 30 waterbars installed<br>- seeding and fertilizing of disturbed areas | 170602070201 | completed 1995 |
| Drainage Improvements on Roads 9527, 9527B, 9527D, 222C, 222C1, 22C3<br>- 14 miles road obliteration, waterbars, french drains, sediment traps, seeding and fertilizing | 170602070202 | completed 1993 |
| 222C2 Watershed Improve. Planting of Mining Area<br>- 3 acres planted with trees | 170602070202 | completed 1994 |
| Crooked Creek Bank Stabilization<br>- 5 acrea planted along creek | 170602070202 | completed 1994 |
| Road 1188 Burpee Cutbank Planting<br>- 11 acres cutbank tree planting<br>- 11 acres straw mulching | 170602070202 | completed 1994 |
| Boulder Creek Road Improvements<br>- 10 waterbars constructed/reconstructed<br>- road seeded (~1.25 miles) | 170602070202 | completed 1995 |
| Road 1188 Burpee Road Slump Removal<br>- slump removal | 170602070202 | completed 1995 |
| Road 9537 Long Tom Spur Reconstruction<br>- .25 miles road reconstructed<br>- .25 miles waterbars installed<br>- creek rediverted into original channel<br>- .25 miles shrubs and sedges transplanted<br>- .25 miles seeding road | 170602070202 | completed 1995 |
| Wakefield Mine Ditch Diversion<br>- rediverted creek in 2 spots | 170602070202 | completed 1995 |
| Robinson Dyke road 9537, 9537A and 9538 Drainage<br>- 2640 feet minor road reconstruction<br>- 2640 feet waterbars installed | 170602070202 | completed 1996 |

| PROJECT NAME & DESCRIPTION | SUBWATERSHED | YR COMPLETED |
|---|---|---|
| Robinson Dyke Road Obliteration<br>- 8962 feet road recontoure & wood/debris placement<br>- 3 culverts removed<br>- 8962 feet seeded and fertilized | 170602070202<br>170602070315 | completed 1996 |
| Swastika Road 222D Drainage Improvements<br>- waterbarred entire road (5 ac.) | 170602070202 | completed 1996 |
| Road 222 Stabilization<br>- 2 miles slash filter windrow construction<br>- 2 miles aggregate placement<br>- 6 culverts installed<br>- 5 acres seeding and fertilization | 170602070202 | completed 1997 |
| Road 311 Drainage Improvements<br>- 12 miles road blading<br>- 80 waterbars installed<br>- 30cubic yards aggregate placement | 170602070202<br>17060207 0203<br>17060207 0204 | completed 1997 |
| Road 9527/9528 Ford Hardening<br>- 5 units ford hardening<br>- 10 waterbars repaired | 170602070202 | completed 1997 |
| Road 421 Planting and Sediment Traps<br>- straw bale sediment traps and windrows<br>- cutbank and fill shrub and forb planting (54 acres) | 170602070301<br>170602070303<br>170602070309 | completed 1993 |
| 1190B, B3 Hydroseeding<br>- 6.3 acres cutbank and fillslope hydroseeding | 170602070301 | completed 1994 |
| Road 421 Cutbank Planting<br>- .5 acres shrub planting | 170602070301<br>170602070303<br>170602070309 | completed 1994 |
| 1190D/1190D1 Culvert Removal / Road Oblit.<br>- .25 miles wood/debris on road<br>- 1.25 miles culverts pulled<br>- 2 barricades installed<br>- 1 acre mulching and netting | 170602070301<br>170602070302<br>170602070303 | completed 1995 |
| Bagley/Noble Road 1190B1 Drainage<br>- .7 miles waterbars installed<br>- aggregate placement at creek crossing | 170602070301 | completed 1996 |

| PROJECT NAME & DESCRIPTION | SUBWATERSHED | YR COMPLETED |
|---|---|---|
| Grouse T. S. Area Cutbank Planting<br>- 5 acres shrub planting | 170602070301 | completed 1996 |
| Jeep Trail Obliteration, 1190B Parallel<br>- .35 miles road obliterated with wood/debris placement<br>- .35 miles waterbars installed | 170602070301 | completed 1996 |
| Grouse Creek Culvert sediment Reduction Implem.<br>- 2 acres straw bale sediment traps and log weirs in creek | 170602070302 | completed 1992 |
| 1190E Hydroseeding<br>- 8 acres cutbank and fillslope hydroseeding | 170602070302<br>170602070303 | completed 1994 |
| 1190E Improvements<br>- 1 acre shrub and tree planting | 170602070302<br>170602070303 | completed 1996 |
| Road 468 Montana Road Hydroseeding<br>- 1.6 acres cutbank and fillslope hydroseeding | 170602070305 | completed 1993 |
| Road 468M Montana Rd Spur Cul Rem and Scarif.<br>- wood culvert removal and area seeding<br>- wood /debris placed on road<br>- seed and fertilize road (1 acre)<br>- tank trap construction<br>- 1 acre tree and shrub planting | 170602070305 | completed 1995 |
| Little Mallard Meadows<br>- built fence to prvent vehicle access into wet meadow | 170602070310 | completed 1992 |
| 9505 and Spurs A,B,C,E Straw Mulching<br>- 33 acres machine cutbank and fillslope straw mulching with tackifier | 170602070310 | completed 1994 |
| Black Sands Watershed Improvements<br>- 4.5 acres planted in mining disturbance | 170602070310 | completed 1994 |
| 222N Access Restrictions and Improvements<br>- entire road waterbarred (? miles)<br>- gated<br>- seeded road (? miles) | 170602070310 | completed 1995 |
| Robinson Dyke Planting and Channel stabilization<br>- 12 acres tree planting<br>- 12 acres seeding and fretilizing<br>- log weir placement (several) | 170602070315 | completed 1994 |

- reshape 1 headcut

| PROJECT NAME & DESCRIPTION | SUBWATERSHED | YR COMPLETED |
|---|---|---|
| 222D1 Comstock to Swastika Mine Drainage<br>- aggregate placement at creek crossing<br>- 2 miles waterbars installed<br>- bridge removal | 170602070315 | completed 1995 |
| Road 222D Lower 1/4 Mile<br>- .25 miles waterbars installed<br>- 1000 feet road seeded and fertilized | 170602070315 | completed 1995 |
| 222D Comstock to Rhett Creek Improvements<br>- .5 miles seeding<br>- .5 miles waterbars installed | 170602070315 | completed 1996 |
| 222P Buckhorn Meadows Improvements<br>- 7920 feet waterbar installation<br>- 7920 feet seeding and fertilization | 170602070322 | completed 1995 |
| Jersey Ridge Trail #214 Drainage<br>- 1 mile waterbars installed | 170602070322 | completed 1996 |
| Crofoot Jeep Trail<br>- 60 rock and wood waterbars installed (1 mile) | 170602070417<br>170602070499 | completed 1995 |
| Burntknob<br>- 3 miles road blading | 170602070428<br>170602070429<br>170602070430 | completed 1997 |
| 1190B Road Obliteration<br>- rip and till 2640 feet<br>- waterbar, seed and drainage removal 2640 feet | 17060207???? | completed 1996 |
| 222D Road Coppernoll/North Star<br>- 1 mile drainage installation | 17060207???? | completed 1994 |
| Moccasin Mountain Jeep Trail Obliteration<br>- 2 miles recontour road<br>- 2 miles seeding and fertilizing road<br>- 2 miles waterbars installed | 17060207???? | completed 1993 |

# Appendix 4

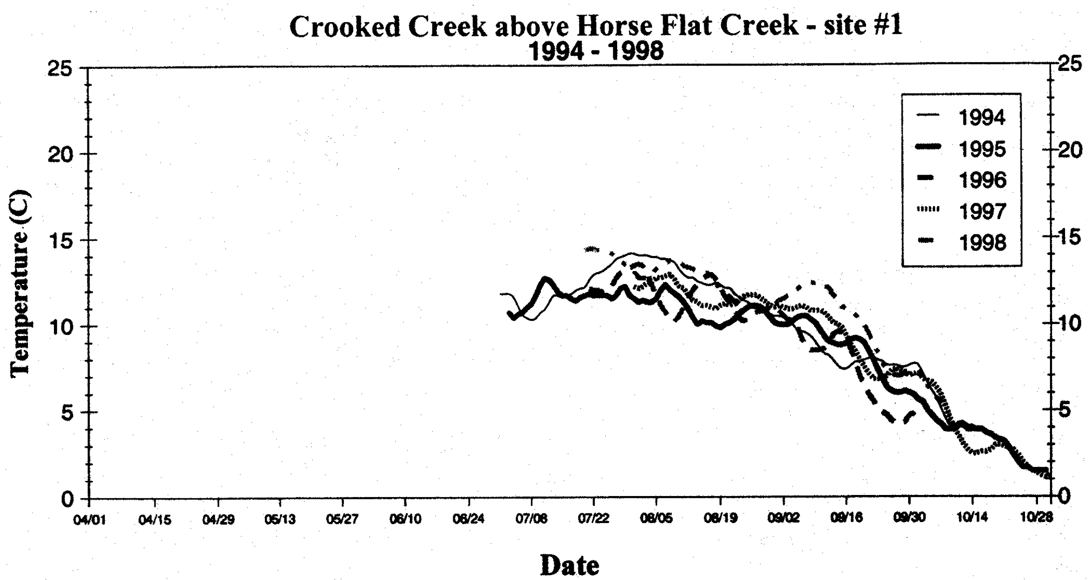
# Beneficial Use Assessments

# Crooked Creek

## Crooked Creek

The first site is located in the headwaters of the watershed above the tributary of Horse Flat Creek (site 1). The monitoring site is located approximately 1.5 miles downstream from the origin of Crooked Creek at Dixie Summit. The next downstream temperature monitoring site is located approximately .5 miles above Big Creek and the wilderness boundary (site 2). This site is below the town of Dixie and a large meadow. The third site is located within wilderness and approximately 100 meters below a major wilderness tributary of Lake Creek ( site 3). The fourth site is located .25 miles upstream from the mouth (site 4).

Graph 11



*7-day moving average of maximum daily temperature*

**Table 17 Crooked Creek above Horse Flat Creek (Site 1)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Maximum Temp. (C) |
|---|---|---|---|---|
| 1994 | 6/25-10/17 | 20 | 0 | 14.5 |
| 1995 | 6/27-10/30 | 2 | 0 | 13.1 |
| 1996 | 7/15-10/30 | 11 | 0 | 13.9 |
| 1997 | 7/25-11/2 | 4 | 0 | 13.6 |
| 1998 | 7/14-10/07 | 24 | 0 | 14.8 |

**Graph 12**

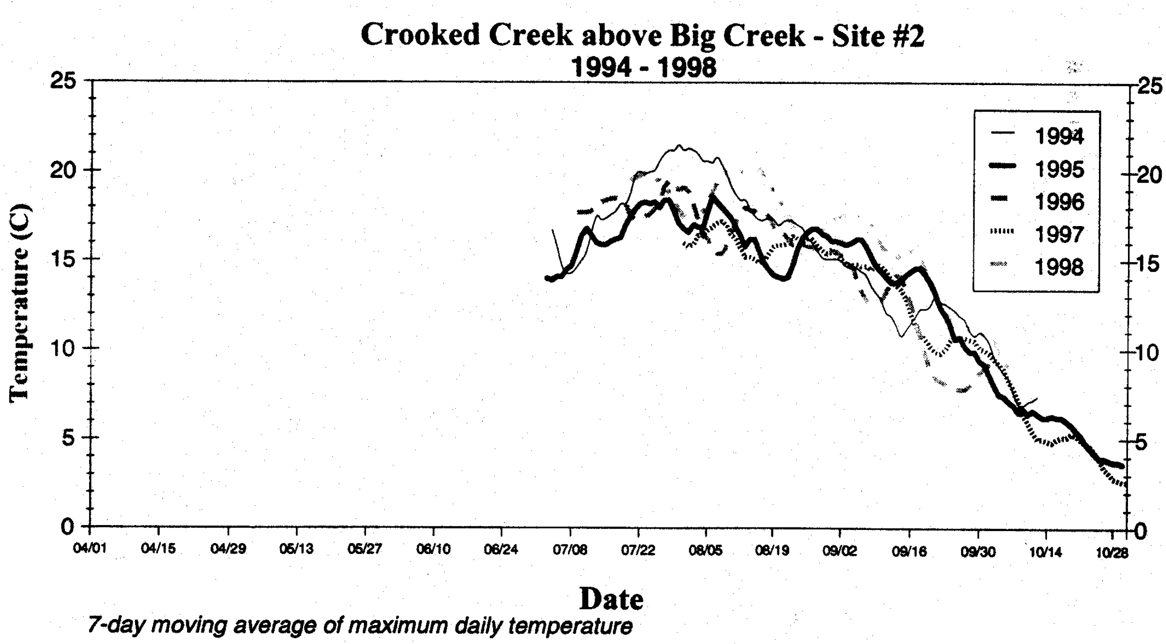



**Table 18 Crooked Creek above Big Creek (Site 2)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Days > 20 C | Maximum Temp. (C) |
|---|---|---|---|---|---|
| 1994 | 6/28-10/12 | 74 | 50 | 16 | 22.9 |
| 1995 | 6/27-10/30 | 76 | 47 | 0 | 19.9 |
| 1996 | 7/3-10/30 | 70 | 46 | 1 | 20.2 |
| 1997 | 7/25-11/2 | 48 | 20 | 0 | 18.3 |
| 1998 | 7/14-10/07 | 66 | 56 | 12 | 20.6 |

Graph 13

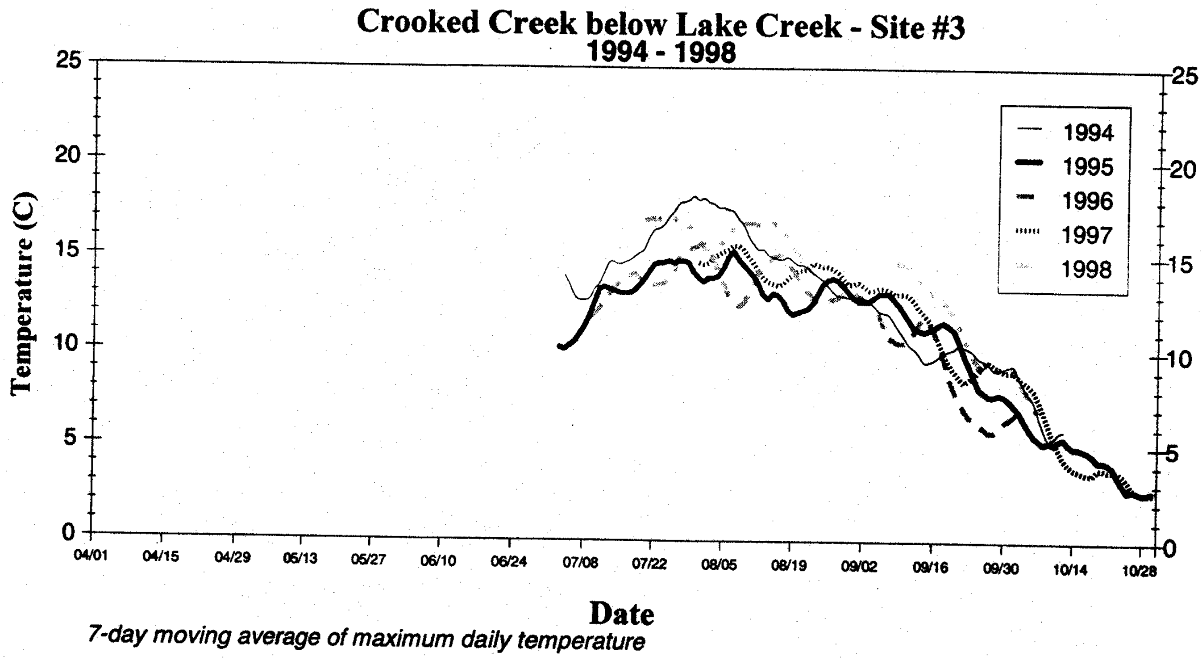
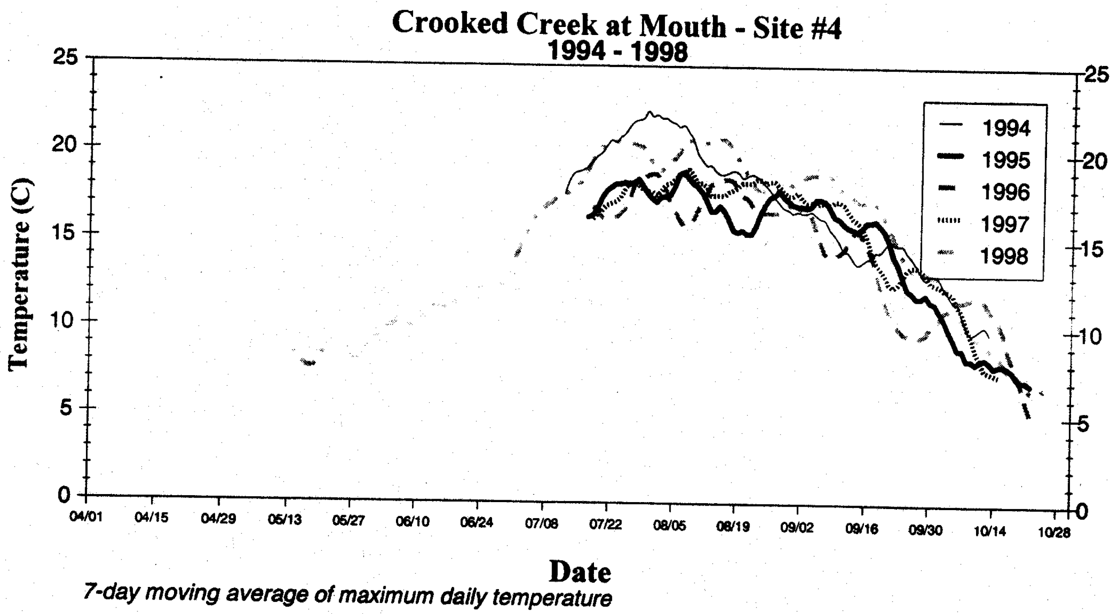



**Table 19 Crooked Creek below Lake Creek (Site 3)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Maximum Temp. (C) |
|---|---|---|---|---|
| 1994 | 6/28-10/12 | 60 | 21 | 18.6 |
| 1995 | 6/27-10/30 | 38 | 3 | 16.1 |
| 1996 | 7/3-10/30 | 40 | 1 | 16.1 |
| 1997 | 7/25-11/2 | 47 | 3 | 16.2 |
| 1998 | 7/14-10/07 | 61 | 27 | 17.7 |

**Graph 14**




*7-day moving average of maximum daily temperature*

**Table 20 Crooked Creek at the mouth (site 4)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Days > 20 C | Maximum Temp. (C) |
|---|---|---|---|---|---|
| 1994 | 7/6-10/13 | 84 | 59 | 24 | 22.9 |
| 1995 | 7/11-10/22 | 70 | 55 | 2 | 20.2 |
| 1996 | 7/12-10/22 | 65 | 46 | 0 | 19.6 |
| 1997 | 7/12-10/15 | 72 | 59 | 0 | 19.9 |
| 1998 | 4/29-10/25 | 94 | 77 | 25 | 21.7 |

5-2-2000

Personal communications: J.P. Mays, USFS, Nez Perce NF
Elk City/Red River Ranger District fish biologist

**Crooked Creek**: info within the last 5 years

Anadramous barrier 800 meters below mouth of Big Creek

| | |
|---|---|
| Above barrier: | rbt with fish and game stocking maybe within 2 years ago<br>Lots of rbt's<br>Spawning and rearing of rbt in this area |
| below barrier | steel head, bulltrout, chinook, cutthroat<br>All spawning and rearing |
| Lake Creek | steel head, bulltrout, cutthroat<br>All spawning and rearing |

**Big Creek** data is from 1990 and 1992 thru 1998

Rbt and rbt x cutt crosses (hybrids)
spawning and early rearing

**Rhett Creek** data from within the last 5 years

steel head, bull trout, cutthroat, juvenile chinook

spawning and rearing of steel head and cutthroat
rearing bulltrout and chinook

**Jersey Creek** info within last 5 years

cutthroat and steel head juveniles

spawning and rearing of cutthroat
rearing of steel head

**Little Mallard:** total fish migration barrier just above mouth. Above barrier the stream is fish less.

Below barrier, rearing steel head and incidental other salmonids

# Big Creek

5-2-2000

Personal communications: J.P. Mays, USFS, Nez Perce NF
Elk City/Red River Ranger District fish biologist

**Crooked Creek**: info within the last 5 years

Anadramous barrier 800 meters below mouth of Big Creek

| | |
|---|---|
| Above barrier: | rbt with fish and game stocking maybe within 2 years ago<br>Lots of rbt's<br>Spawning and rearing of rbt in this area |
| below barrier | steel head, bulltrout, chinook, cutthroat<br>All spawning and rearing |
| Lake Creek | steel head, bulltrout, cutthroat<br>All spawning and rearing |

**Big Creek** data is from 1990 and 1992 thru 1998

Rbt and rbt x cutt crosses (hybrids)
spawning and early rearing

**Rhett Creek** data from within the last 5 years

steel head, bull trout, cutthroat, juvenile chinook

spawning and rearing of steel head and cutthroat
rearing bulltrout and chinook

**Jersey Creek** info within last 5 years

cutthroat and steel head juveniles

spawning and rearing of cutthroat
rearing of steel head

**Little Mallard:** total fish migration barrier just above mouth. Above barrier the stream is fish less.

Below barrier, rearing steel head and incidental other salmonids

# Rhett Creek

**Upper Rhett Creek**
**Electrofishing Results 1993**

#17060207-03-15

| Reach Data | | | | | | | | Habitat Data | | | | | | | Pebble Counts | | | Electrofishing Results | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | Location Description | Legal Location | Date | Time | Rch Grad. (%) | Water Temp. (°C) | Channel Type | Habitat Unit no. | Habitat Sub-Type | Length (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Dominant Substrate (ocular) | Pebble Counts in Habitat Units | D-50 | Dominant Substrate | Species | Length (mm) | Weight (g) | Species | Length (mm) | Weight (g) | Reach Specific |
| 1 | 2 miles upstream from wilderness boundary | T25N R8E SEC14 NE SE | 7/28/93 | 1030 | 4 | 9 | B3 | G-1 | P | 4 | 3 | 25 | 50 | CG | G | f.gravel | s.cobble | cutthroat | 120 | | cutthroat | 117 | | scale malfunction, no weights for fish. |
| | | | | | | | | G-2 | R | 11 | 2.8 | 20 | 35 | CG | G | f.gravel | m.gravel | cutthroat | 123 | | cutthroat | 109 | | |
| | | | | | | | | G-3 | P | 32.2 | 2.8 | 25 | 50 | SC | R-1 | s.cobble | l.cobble | cutthroat | 110 | | cutthroat | 114 | | |
| | | | | | | | | R-1 | R | 61 | 2.9 | 20 | 35 | SC | | | | cutthroat | 158 | | cutthroat | 91 | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 129 | | cutthroat | 125 | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 126 | | cutthroat | 78 | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 173 | | cutthroat | 108 | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 128 | | cutthroat | 109 | | |
| 2 | 2 miles upstream from wilderness boundary | T25N R8E SEC11 SE SE | 7/28/93 | 1330 | 5 | 9 | B4/5 | P-1 | P | 4.9 | 3.5 | 45 | 55 | SA | P | m.gravel | s.sand | cutthroat | 110 | 18 | cutthroat | 197 | 88 | |
| | | | | | | | | R-1 | R | 31.5 | 3.4 | 20 | 35 | R | R | s.cobble | l.cobble | cutthroat | 188 | 50 | cutthroat | 118 | 19 | |
| | | | | | | | | P-2 | P | 4.7 | 4.8 | 45 | 65 | SA | | | | cutthroat | 136 | 30 | cutthroat | 129 | 18 | |
| | | | | | | | | R-2 | R | 35 | 3.2 | 25 | 40 | R | | | | cutthroat | 117 | 18 | | | | |
| | | | | | | | | R-3 | CA | 30 | 4.1 | 25 | 45 | R | | | | | | | | | | |
| 3 | East of Dillinger Mine | T25N R8E SEC02 NW SE | 7/28/93 | 1500 | 4.0 | 9.5 | B3/4 | G-1 | R | 25 | 0.7 | 20 | 37 | SA | NONE | | | cutthroat | 110 | 19 | | | | ocular estimate for reach: 70% cobble, 20% |
| | | | | | | | | G-2 | P | 14 | 0.8 | 16 | 27 | SA | | | | cutthroat | 118 | 19 | | | | gravel, and 10% sand |
| | | | | | | | | P-1 | D | 3 | 1.25 | 17 | 25 | SA | | | | | | | | | | |
| | | | | | | | | G-3 | R | 29 | 0.9 | 18 | 30 | | | | | | | | | | | |
| 4 | Comstock Cr., .75 mi. upstream from Rhett Cr. | T25N R8E SEC14 NW SE | 7/29/93 | | 4 | 9.5 | A4 | R-1 | | 22.9 | 2.0 | 15 | 25 | G | P | c.gravel | vc.gravel | cutthroat | 178 | 70 | | | | |
| | | | | | | | | P-1 | | 18.8 | 3 | 15 | 40 | G | R | c.gravel | vc.gravel | cutthroat | 171 | 48 | | | | |
| | | | | | | | | R-2 | R | 54.1 | 1.8 | 15 | 40 | G | | | | | | | | | | |
| 5 | Comstock Cr., 1.5 mi. upstream from Rhett Cr. | T25N R8E SEC15 NE NE | 7/29/93 | 1400 | 4.5 | 12 | A4 | R-1 | R | 22.7 | 1.3 | 10 | 25 | CG | P-1 | m.gravel | vc.gravel | cutthroat | 84 | 7 | cutthroat | 82 | 6 | |
| | | | | | | | | R-2 | CA | 20.2 | 1.5 | 15 | 30 | SG | R | c.gravel | s.gravel | cutthroat | 79 | 5 | cutthroat | 77 | 5 | |
| | | | | | | | | R-3 | R | 8.4 | 1.7 | 10 | 20 | CG | | | | cutthroat | 92 | 10 | cutthroat | 78 | 4 | |
| | | | | | | | | P-1 | P | 3.3 | 2.3 | 25 | 40 | SG | | | | cutthroat | 77 | 5 | | | | |
| | | | | | | | | R-4 | R | 29.4 | 1.7 | 15 | 35 | SG | | | | | | | | | | |
| | | | | | | | | P-2 | S | 8.6 | 2 | 20 | 30 | SG | | | | | | | | | | |
| | | | | | | | | R-5 | | 31 | 1.3 | 15 | 30 | SG | | | | | | | | | | |

Lots of CTT
plus <100 mm
= juvenile

**Fish Collection Data Form (Reconnaissance)**

reach length: total for all 486.5M | water temp(°C): ____________

conductivity (µS/cm): ____________ | water clarity: turbid, clear, stained

method: ☐ visual (viewbox), ☒ snorkel, ☒ electrofish (☐AC ☐DC)

| species code* | species | est. length (cm) | voucher (y/n) | total count | identification conf.** | anomalies *** | # of juveniles |
|---|---|---|---|---|---|---|---|
| | Trout | <7.5 | N | 4 | | | |
| | Rb/ stlhd | 7.5-12.7 | N | 20 | | | |
| | Rb/ stlhd | 12.7-20.0 | N | 8 | | | |
| | Cutthroat | 7.5-30.5 | N | 44 | | | |
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Fish Collection Data Form Adapted from DEQ Protocol #6.

* see 1995 training manual for updated codes

** Fish confidence Codes: A (99.9%) - Must have fisheries taxonomist on collection crew or entire sample preserved and taxa work done by fisheries taxonomist (no visual estimate), B (99%) - Must have an experienced fisheries biologist on collection crew, or only part of sample preserved, C (90%) - Crew made up of individuals familiar with species, D (<90%) - No confidence or confidence unknown. *** Anomalies include parasites, deformities, frayed fins, etc.

1997 Beneficial Use Reconnaissance Project Field Forms, Idaho Division of Environmental Quality

# Division of Environmental Quality Fish Voucher Data Sheet

Lab Name: **EcoAnalysts, Inc.** Date into Lab: **8/25/97** Taxonomist: **Dr. Richard Wallace** RLW

Stream name: **Rhett Cr** Site ID No: **97NCIROA13** Date: **12July1997**

| species code | species | total length (mm) | total count | ID confid | anomalies | # of juveniles |
|---|---|---|---|---|---|---|
| 11 | Oncorhynchus clarki | 104, 114, 150 | 3 | A | — | 0 |
| | | 2 size classes | | | | |
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IDHW - Division of Environmental Quality
FISH DATA SHEET

Field Information - Shaded areas must be completed before submittal of sample

| | | | | |
|---|---|---|---|---|
| DEQ Project Code | | | | |
| Name of Water Body RHeTT Creek | | | Site ID No. | |
| Location Description (Permanent Landmarks) | | | | |
| Station and/or Subsample No. | County Idaho | Township 24N | Range R8E | Section | Quarter |
| Elevation (ft or m) | Collector(s) First (or initial) & Last Name(s) USFS | | Sample Method Electro + Snorkel | |
| Collection Date (YY/MM/DD) 93/7/28 + 93/8/03 | | | | |

Receiving Lab Information

| Lab Name | Date into Lab | Sent Out | Sorted | Lab's Sample Number |
|---|---|---|---|---|
| | | | | |

Identifying Lab Information

| Lab Name | Date into Lab | Date Reported | IDHW Central Lab Log No. |
|---|---|---|---|
| Taxonomist (First Initial & Last Name) | | Remarks: | |

5 Reachs were sampled this is a compilation of the DATA.
Reach #1: 2 miles up stream from Wilderness Boundary T25N R8E SEC14 NESE
Reach #2: 3 mi upstream from Wilderness Boun. T25N R8E Sec 11 SESE
Reach #3: East of Dillinger Mine T25N R8E Sec 02 SWSE
Upper Rhett Cr. (above)
Lower Rhett Cr.
T25N R9E Sec 30 SWSW
Reach #1: 1/3 mile from Salmon River T25N R8E Sec 24 NWNE
Reach #2: 1 mile upstream from Wilderness Boundary

**1997 Beneficial Use Reconnaissance Project Field Form Idaho Division of Environmental Quality**

| DEQ Fish Collection Record (Pass 1 of 1, effort 710 seconds) | | | | | | |
|---|---|---|---|---|---|---|
| | Taxa Code/ID Confidence | | | | | |
| Total Length (mm) | | | | | | |
| 10-19 | Cutthroat | | | | | |
| 20-29 | | | | | | |
| 30-39 | | | | | | |
| 40-49 | | | | | | |
| 50-59 | | | | | | |
| 60-69 | | | | | | |
| 70-79 | | | | | | |
| 80-89 | | | | | | |
| 90-99 | | | | | | |
| 100-109 Vouchered | / | | | | | |
| 110-119 | | | | | | |
| 120-129 Vouchered | / | | | | | |
| 130-139 | | | | | | |
| 140-149 | | | | | | |
| 150-159 Vouchered | / | | | | | |
| 160-169 | | | | | | |
| 170-179 | | | | | | |
| 180-189 | | | | | | |
| 190-199 | | | | | | |
| 200-209 | | | | | | |
| 210-219 | | | | | | |
| 220-229 | | | | | | |
| 230-239 | | | | | | |
| 240-249 | | | | | | |
| 250-259 | | | | | | |
| 260-269 | | | | | | |
| 270-279 | | | | | | |
| 280-289 | | | | | | |
| 290-299 | | | | | | |
| ≥300 mm | | | | | | |

Stream Name: RHETT Creek Site ID Nº: 97NCIROA13 Date: 96/07/12

**Lower Rhett Creek**
Electrofishing Results 1993

#17060207-03-15

| Reach | Location Description | Legal Location | Date | Time | Rch Grad. (%) | Water Temp. (°C) | Channel Type | Habitat Unit no. | Habitat Type | Length (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Dominant Substrate (ocular) | Habitat Units with Pebble Counts | D-50 | Dominant Substrate | Species | Length (mm) | Weight (g) | Age (yrs) | Species and Size (mm) | Unit 1 # | Unit 1 # | Unit 1 # | Unit 1 # | Total # | Comments: Reach Specific |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | third of a mile from Salmon R. | T25N R6E SEC 30 SW SW | 8/3/93 | 900 | 15 | 9 | | R-1 | CA | 14.7 | 4.5 | 35 | 65 | R | P-1 | s.cobble | s.cobble | | | | 0+ | trout<75 | | | | | 3 | |
| | | | | | | | | R-2 | RI | 9.4 | 3 | 50 | 70 | R | R | l.cobble | l.cobble | | | | 1+ | Rb/Sthd 75-127 | | | | | 20 | |
| | | | | | | | | R-3 | CA | 61 | 4 | 40 | 60 | R | | | | | | | 2+ | Rb/Sthd 127-200 | | | | | 8 | |
| | | | | | | | | S-1 | R | 13.3 | 2.3 | 15 | 35 | R | | | | | | | Res | Rainbow >200 | | | | | | |
| | | | | | | | | P-1 | P/D | 7.9 | 8.5 | 50 | 65 | R | | | | | | | 0+ | Chinook <127 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | 1+ | Chinook >127 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | Cutthroat 75-305 | | | | | 7 | |
| | | | | | | | | | | | | | | | | | | | | | | Cutthroat >305 | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | Bulltrout (all sizes) | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | Brooktrout " | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | Whitefish " | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | other | | | | | | |
| | 1 mile upstrm. from wilderness boundary | T25N R8E SEC 24 NW NE | 7/27/93 | | 4 | 11 | | R-1 | RI | 17.2 | 3.4 | 25 | 40 | LR | P | s.cobble | l.cobble | cutthroat | 86 | 5 | | | | | | | | |
| | | | | | | | | P-1 | P | 6.5 | 8 | 40 | 60 | LR | R | s.cobble | l.cobble | cutthroat | 73 | 3 | | | | | | | | |
| | | | | | | | | R-2 | RI | 15.9 | 3.4 | 25 | 50 | LR | | | | cutthroat | 78 | 4 | | | | | | | | |
| | | | | | | | | R-3 | RA | 4.6 | 3.3 | 20 | 35 | BO | | | | cutthroat | 185 | 41 | | | | | | | | |
| | | | | | | | | B-1 | G | 13.9 | | 25 | 50 | SR | | | | cutthroat | 158 | 39 | | | | | | | | |
| | | | | | | | | S-2 | R | 12.8 | 3.3 | 15 | 30 | LR | | | | cutthroat | 129 | 18 | | | | | | | | |
| | | | | | | | | G-2 | P | 14.7 | 4.7 | 35 | 70 | SB | | | | cutthroat | 187 | 46 | | | | | | | | |
| | | | | | | | | P-2 | D | 3 | 3 | 40 | 80 | LR | | | | cutthroat | 156 | 33 | | | | | | | | |
| | | | | | | | | P-3 | P | 9.3 | 3.8 | 40 | 70 | BO | | | | cutthroat | 138 | 18 | | | | | | | | |
| | | | | | | | | R-5 | RI | 7.9 | 2.4 | 15 | 45 | LR | | | | cutthroat | 196 | 72 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 190 | 61 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | cutthroat | 128 | 16 | | | | | | | | |

CTT from
86 mm → 128 mm
1993

5-2-2000

Personal communications: J.P. Mays, USFS, Nez Perce NF
Elk City/Red River Ranger District fish biologist

**Crooked Creek**: info within the last 5 years

Anadramous barrier 800 meters below mouth of Big Creek

| | |
|---|---|
| Above barrier: | rbt with fish and game stocking maybe within 2 years ago<br>Lots of rbt's<br>Spawning and rearing of rbt in this area |
| below barrier | steel head, bulltrout, chinook, cutthroat<br>All spawning and rearing |
| Lake Creek | steel head, bulltrout, cutthroat<br>All spawning and rearing |

**Big Creek** data is from 1990 and 1992 thru 1998

Rbt and rbt x cutt crosses (hybrids)
spawning and early rearing

**Rhett Creek** data from within the last 5 years

steel head, bull trout, cutthroat, juvenile chinook

spawning and rearing of steel head and cutthroat
rearing bulltrout and chinook

**Jersey Creek** info within last 5 years

cutthroat and steel head juveniles

spawning and rearing of cutthroat
rearing of steel head

**Little Mallard:** total fish migration barrier just above mouth. Above barrier the stream is fish less.

Below barrier, rearing steel head and incidental other salmonids

# Big Mallard Creek

## Big Mallard Creek

Three temperature monitoring sites were located in Big Mallard Creek in 1998. Two thermographs were located upstream of accessible habitat. One was located in the uppermost part of the watershed above Slide Creek, this site was not monitored in 1994 (site 7). The second site was located upstream from the confluence with Jack Creek (site 8). The third site is located approximately 400 meters from the mouth within critical habitat (site 9). The lower 1,100 meters upstream from the mouth are accessible for spawning and rearing chinook.

Graph 17

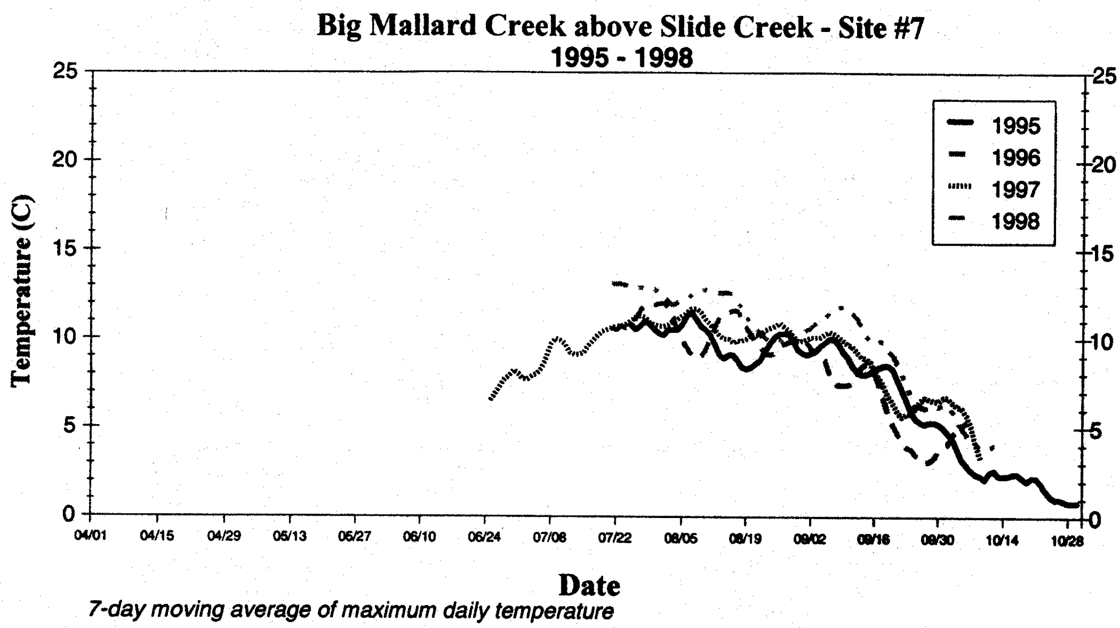



**Table 23 Big Mallard Creek above Slide Creek (Site 7)**

| Year | Deployment Dates | Days > 13 C | Maximum Temp. (C) |
|---|---|---|---|
| 1995 | 7/19-10/30 | 0 | 12.5 |
| 1996 | 7/15-10/6 | 0 | 12.9 |
| 1997 | 6/19-10/9 | 0 | 12.3 |
| 1998 | 7/18-10/14 | 7 | 13.7 |

**Graph 18**

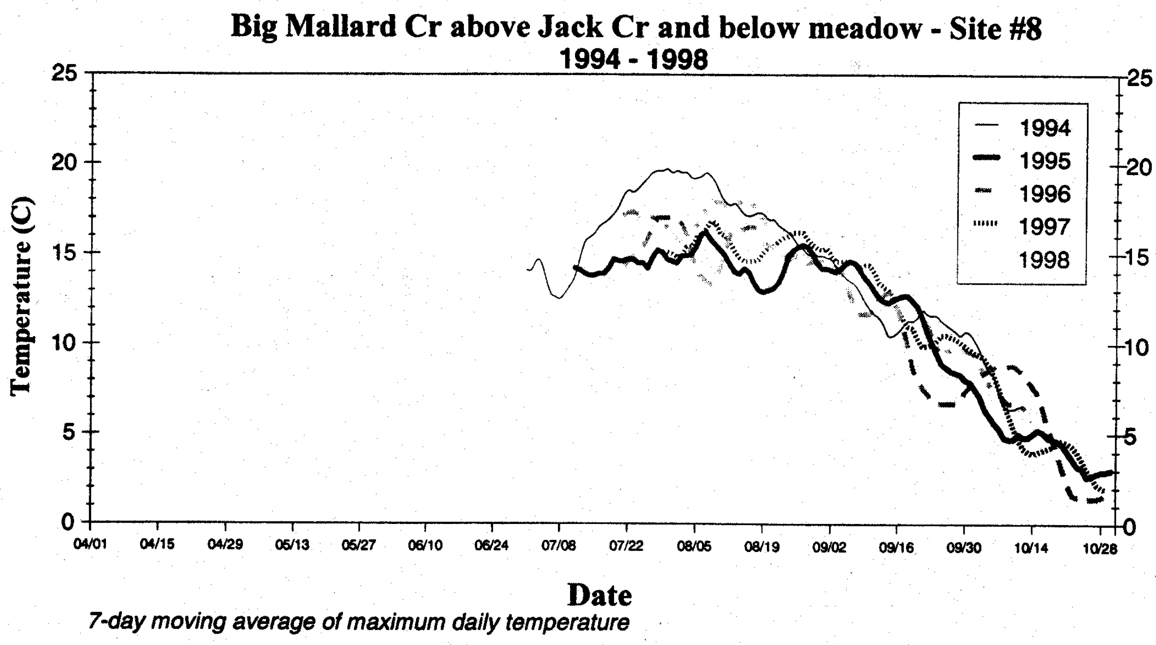
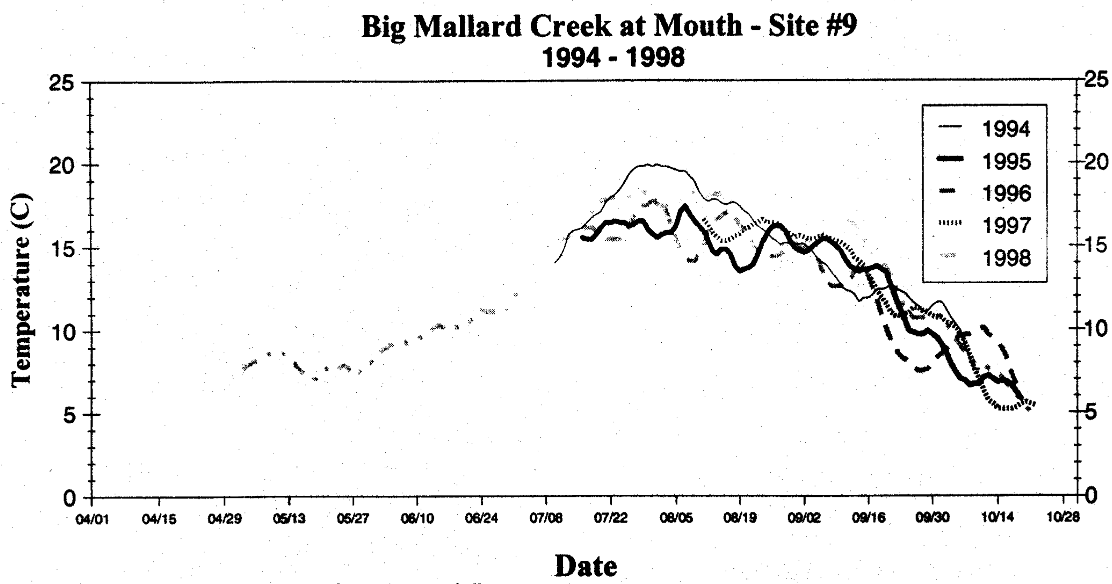



**Table 24 Big Mallard Creek above Jack Creek (Site 8)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Maximum Temp. (C) |
|---|---|---|---|---|
| 1994 | 6/25-10/12 | 67 | 39 | 20.6 |
| 1995 | 7/5-10/30 | 52 | 12 | 17.3 |
| 1996 | 7/15-11/15 | 49 | 19 | 18.3 |
| 1997 | 7/24-10/29 | 50 | 19 | 18.0 |
| 1998 | 7/15-10/14 | 65 | 35 | 18.8 |

**Graph 19**




*7-day moving average of maximum daily temperature*

**Table 25 Big Mallard Creek at the Mouth (Site 9)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Days > 20 C | Maximum Temp. (C) |
|---|---|---|---|---|---|
| 1994 | 7/4-10/10 | 65 | 40 | 7 | 20.4 |
| 1995 | 7/10-10/19 | 68 | 25 | 0 | 18.6 |
| 1996 | 7/10-10/19 | 59 | 25 | 0 | 18.3 |
| 1997* | 8/5-10/22 | 40 | 17 | 0 | 18.5 |
| 1998 | 4/27-10/21 | 81 | 42 | 0 | 18.8 |

*The original deployment date in 1997 for this site was on July 9th, but the thermograph subsequently released from site and was later put back into the creek in August.

## Jersey Creek

## IDHW - Division of Environmental Quality
## FISH DATA SHEET

**Field Information - Shaded areas must be completed before submittal of sample**

**DEQ Project Code** | | — | | — | | —

| | |
|---|---|
| Name of Water Body: Jersey Creek | Site ID No. |
| Location Description (Permanent Landmarks): First major fork in Jersey Cr. | |

| Station and/or Subsample No. | County: Idaho | Township: 24N | Range: 8E | Section | Quarter |
|---|---|---|---|---|---|
| Elevation (ft or m) | Collector(s) First (or initial) & Last Name(s): USFS | | | Sample Method: Electro | |

Collection Date (YY/MM/DD): 93/07/27

**Receiving Lab Information**

| Lab Name | Date into Lab | Sent Out | Sorted | Lab's Sample Number |
|---|---|---|---|---|
| | | | | |

**Identifying Lab Information**

| Lab Name | Date into Lab | Date Reported | IDHW Central Lab Log No. |
|---|---|---|---|
| | | | |

| Taxonomist (First Initial & Last Name) | Remarks: |
|---|---|
| | |

The fish Data compiled from USFS survey containing 9 reaches at various locations + Dates

Reach #1 @ mouth of Jersey Cr. at Salmon R.
T24N R8E SEC 15 NWSW 7/29/93.

Reach #2: 1 mile from mouth at Salmon R. T24N R8E SEC 16 NESW 7/28/93

Reach #3: first major fork in Jersey Cr. T24N R8E Sec 07 NWNE 7/27

Reach #3a: ~400m downstream from fork T24N R8E Sec 07 NWNE 7/27

Reach #4: Below fork of Jersey Cr. T25N R8E Sec 30 SESW 8/3/93

Reach #5: North fork of Jersey Cr. T25N R8E Sec 30 SESW 8/3/93

" #6: Below 3rd Trib T25N R8E Sec 30 NWSW 8/4/93

" #7: Tributary below bridge T25N R7E Sec 25 NENE 8/4/93

#8: Cross Hwy at secondary trib T25N R7E sec NENE 8/4/93

#9: first cross " Hwy T25N R8E Sec 19 SESW

**ersey Creek**

lectrofishing Results 1993

#17060207-02-22

| Reach | Location Description | Legal Location | Date | Time | Rch Grad. (%) | Water Temp. (°C) | Channel Type | Habitat Unit no. | Habitat Sub-Type | Length (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Dominant Substrate (ocular) | Habitat Units with Pebble Counts | D-50 | Dominant Substrate | Species | Length (mm) | Weight (g) | Species | Length (mm) | Weight (g) | Comments Reach Specific |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | first major fork in Jersey Cr. | T24N R8E SEC07 NWNE | 7/27/93 | | 15 | | A2/3 | G-1 | R | 7.9 | 2.7 | 25 | 50 | BO | R | s.boulder | s.boulder | rainbow | 145 | 41 | rainbow | 148 | 33 | tributary on left bank enters unit R-2 |
| | | | | | | | | R-1 | RA | 30.8 | 2.6 | 25 | 45 | BO | G-2 | s.cobble | s.cobble | rainbow | 132 | 24 | rainbow | 126 | 21 | |
| | | | | | | | | PW-1 | | 8.3 | 5.2 | 25 | 25 | BO | | | | rainbow | 138 | 28 | rainbow | 100 | 11 | |
| | | | | | | | | R-2 | RA | 42.4 | 6.1 | 25 | 45 | LR | | | | rainbow | 75 | 4 | rainbow | 107 | 12 | |
| | | | | | | | | R-3 | CA | 28.2 | 4.54 | 25 | 80 | BO | | | | rainbow | 101 | 11 | rainbow | 120 | 17 | |
| | | | | | | | | G-2 | P | 6.3 | 3.9 | 25 | 35 | SR | | | | rainbow | 102 | 10 | rainbow | 136 | 28 | |
| | | | | | | | | | | | | | | | | | | rainbow | 146 | 30 | rainbow | 91 | 7 | |
| | | | | | | | | | | | | | | | | | | rainbow | 164 | 43 | rainbow | 64 | 2 | |
| | | | | | | | | | | | | | | | | | | rainbow | 76 | 3 | | | | |
| 3a | ~400 m dwnstrm. from fork | T24N R8E SEC07 NWNE | 7/27/93 | | 13 | | | | | | | | | | | | | rainbow | 117 | 18 | rainbow | 74 | 4 | test shocking reach to see what species |
| | | | | | | | | | | | | | | | | | | rainbow | 131 | 27 | rainbow | 165 | 36 | are present, no habitat typing done |
| | | | | | | | | | | | | | | | | | | rainbow | 126 | 20 | rainbow | 127 | 14 | |
| | | | | | | | | | | | | | | | | | | rainbow | 151 | 39 | rainbow | 72 | 4 | |
| | | | | | | | | | | | | | | | | | | rainbow | 102 | 11 | rainbow | 72 | 4 | |
| | | | | | | | | | | | | | | | | | | rainbow | 145 | 29 | rainbow | 58 | 2 | |
| | | | | | | | | | | | | | | | | | | rainbow | 117 | 17 | rainbow | 66 | 3.5 | |
| | | | | | | | | | | | | | | | | | | rainbow | 137 | 26 | rainbow | 73 | 5 | |
| | | | | | | | | | | | | | | | | | | rainbow | 66 | 3 | rainbow | 60 | 4 | |
| | | | | | | | | | | | | | | | | | | rainbow | 68 | 3 | rainbow | 71 | 4 | |
| 6 | below third tributary | T25N R8E SEC30 NWSW | 8/4/93 | | 3.7 | | | G-1 | | 66 | 1.1 | 15 | 40 | CG/SR | G-1 | c.gravel | c.gravel | rainbow | 113 | 16 | rainbow | 88 | 8 | |
| | | | | | | | | | | | | | | | | | | rainbow | 78 | 5 | rainbow | 86 | 7.5 | |
| | | | | | | | | | | | | | | | | | | rainbow | 104 | 11 | rainbow | 62 | 3 | |
| | | | | | | | | | | | | | | | | | | rainbow | 140 | 32 | rainbow | 91 | 6.5 | |
| | | | | | | | | | | | | | | | | | | rainbow | 57 | 3 | rainbow | 60 | 2 | |
| | | | | | | | | | | | | | | | | | | rainbow | 57 | 3 | rainbow | 80 | 2.5 | |
| | | | | | | | | | | | | | | | | | | rainbow | 44 | 2 | rainbow | 58 | 2 | |
| | | | | | | | | | | | | | | | | | | rainbow | 141 | 32 | rainbow | 40 | 1 | |
| 7 | tributary below bridge | T25N R7E SEC25 NENE | 8/4/93 | | 4.2 | | B4 | | | ~100 | 1.1 | 10 | 25 | | R | m.gravel | c.gravel | rainbow | 120 | | | | | habitat types not broken out, avg. width |
| | | | | | | | | | | | | | | | | | | | | | | | | and depths were taken for the ~100 m |
| | | | | | | | | | | | | | | | | | | | | | | | | stretch that was shocked, only the one |
| | | | | | | | | | | | | | | | | | | | | | | | | rainbow was found |
| 8 | cross 4x4 at second tributary | T25N R7E SEC25 NENE | 8/4/93 | | 3.8 | | | | | ~150 | 0.75 | 10 | 35 | | G | m.gravel | m.gravel | rainbow | 96 | 11.5 | | | | stream was too small to break into |
| | | | | | | | | | | | | | | | | | | rainbow | 119 | 18 | | | | habitat types, avg. width and depth are |
| | | | | | | | | | | | | | | | | | | | | | | | | given for the ~150 m that was shocked |
| 9 | first cross of 4x4 | T26N R8E SEC10 SESW | 8/4/93 | | | | | | | ~80 | 1.1 | 6 | 15 | | G | c.gravel | vc.gravel | no fish | | | | | | 80 m shocked, no fish, no habitat typing |

RBT - 3 age class
including YOY

1997 Beneficial Use Reconnaissance Project Field Forms, Idaho Division of Environmental Quality

# Division of Environmental Quality Fish Voucher Data Sheet

Lab Name: **EcoAnalysts, Inc.** Date into Lab: **8/25/97** Taxonomist: **Dr. Richard Wallace**

Stream name: **Jersey Cr** Site ID No: **97NCIROC14** Date: **13July1997**

| species code | species | total length (mm) | total count | ID confid. | anomalies | # of juveniles |
|---|---|---|---|---|---|---|
| 10 | Oncorhynchus mykiss | 84, 101, 143 | 3 | A | – | 0 |
| | | | | | | |
| | | | | | | |
| | | 2 Age classes | | | | |
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## Fish Collection Data Form (Reconnaissance)

reach length: total of all 887 m

water temp(°C):

conductivity (μS/cm):

water clarity: turbid, clear, stained

method: ☐ visual (viewbox), ☒ snorkel, ☒ electrofish (☐AC ☐DC)

| species code* | species | est. length (cm) | voucher (y/n) | total count | identification conf.** | anomalies *** | # of juveniles |
|---|---|---|---|---|---|---|---|
| | Trout <75 mm | <75 | N | 36 | | | |
| | RB/stlhd | 7.5-12.7 | N | 53 | | | |
| | RB/stlhd | 12.7-20.0 | N | 65 | | | |
| | RB/stelhead | >20.0 | N | 1 | | | |
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| | | | | | | | |

Fish Collection Data Form Adapted from DEQ Protocol #6. * see 1995 training manual for updated codes

** Fish confidence Codes: A (99.9%) - Must have fisheries taxonomist on collection crew or entire sample preserved and taxa work done by fisheries taxonomist (no visual estimate), B (99%) - Must have an experienced fisheries biologist on collection crew, or only part of sample preserved, C (90%) - Crew made up of individuals familiar with species, D (<90%) - No confidence or confidence unknown. *** Anomalies include parasites, deformities, frayed fins, etc.

Stream Name: Jersey Creek Site ID Nº: Date: / / page 5

**Jersey Creek** #17060207-02-22

Electrofishing/Snorkeling Results 1993

| Reach Data | | | | | | | | Habitat Data | | | | | | | Pebble Counts | | | Snorkel/Electrofishing Data | | | | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | Location Description | Legal Location | Date | Time | Rch Grad. (%) | Water Temp. (°C) | Channel Type | Habitat Unit no. | Habitat Type | Length (m) | Width (m) | Mean Depth (cm) | Max. Depth (cm) | Dominant Substrate (ocular) | Habitat Units with Pebble Counts | D-50 | Dominant Substrate | Age (yrs) | Species and Size (mm) | Unit # | Unit # | Unit # | Unit # | Unit # | Unit # | Total # | Reach Specific |
| 1 | mouth of Jersey Cr. at Salmon R. | T24N R8E SEC15 NWSW | 7/29/93 | | 16.1 | | A2 | R-1 | CA | 17.9 | 8.1 | 20 | 35 | LR | NONE | | | | | N/A | R-1 | R-2 | R-3 | R-4 | R-5 | | first snorkel unit # N/A, is the small area |
| | | | | | | | | R-2 | CA | 19.5 | 3.2 | 20 | 30 | BO | | | | 0+ | trout<75 | 2 | | | 1 | | | 3 | where Jersey Cr. empties into Salmon R. |
| | | | | | | | | R-3 | RA | 23.1 | 3.8 | 25 | 65 | BO | | | | 1+ | Rb/Stlhd 75-127 | 4 | 1 | 2 | 5 | 1 | | 13 | |
| | | | | | | | | R-4 | CA | 8 | 8.3 | 15 | 40 | BO | | | | 2+ | Rb/Stlhd 127-200 | 3 | 1 | | 7 | | 3 | 14 | |
| | | | | | | | | R-5 | RA | 27.6 | 3.5 | 20 | 50 | BO | | | | Res | Rainbow >200 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 0+ | Chinook <127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 1+ | Chinook >127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat 75-305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat >305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Bulltrout (all sizes) | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Brooktrout " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Whitefish " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | other | | | | | | | | |
| 2 | 1 mile from mouth at Salmon R. | T24N R8E SEC16 NESE | 7/28/93 | | 14.7 | | A2 | R-1 | CA | 30.5 | 5.4 | 25 | 38 | LR | NONE | | | | | R-1 | R-2 | P-1 | R-3 | | | | |
| | | | | | | | | R-2 | RA | 34.7 | 4.2 | 25 | 45 | LR | | | | 0+ | trout<75 | | | | | | | | |
| | | | | | | | | P-1 | P | 10 | 3 | 30 | 50 | LR | | | | 1+ | Rb/Stlhd 75-127 | | | 2 | | | | 2 | |
| | | | | | | | | R-3 | CA | 21.3 | 4.6 | 25 | 50 | LR | | | | 2+ | Rb/Stlhd 127-200 | 3 | 10 | 8 | 2 | | | 23 | |
| | | | | | | | | | | | | | | | | | | Res | Rainbow >200 | 1 | | | | | | 1 | |
| | | | | | | | | | | | | | | | | | | 0+ | Chinook <127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 1+ | Chinook >127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat 75-305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat >305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Bulltrout (all sizes) | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Brooktrout " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Whitefish " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | other | | | | | | | | |
| 4 | below fork of Jersey Cr. | T25N R8E SEC30 SESW | 8/3/93 | | 4.5 | | | R-1 | RI | 36 | 2.3 | 20 | 30 | SR | R-1 | s.cobble | s.cobble | | | | | | | | | | net was forgotten, fish were shocked and counted |
| | | | | | | | | P-1 | P | 4.3 | 2.3 | 35 | 50 | SR | | | | 0+ | trout<75 | | | | | | | 5 | with sizes estimated, based on snorkeling size classes. |
| | | | | | | | | G-1 | R | 42.5 | 2.8 | 25 | 35 | SR | | | | 1+ | Rb/Stlhd 75-127 | | | | | | | 8 | approximately half of the fish were taken from the water |
| | | | | | | | | | | | | | | | | | | 2+ | Rb/Stlhd 127-200 | | | | | | | 8 | for positive species identification |
| | | | | | | | | | | | | | | | | | | Res | Rainbow >200 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 0+ | Chinook <127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 1+ | Chinook >127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat 75-305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat >305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Bulltrout (all sizes) | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Brooktrout " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Whitefish " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | other | | | | | | | | |
| 5 | North Fork of Jersey Cr. | T25N R8E SEC30 SESW | 8/3/93 | | 7.4 | | | G-1 | P | 94.3 | 1.8 | 10 | 30 | SR | G-1 | vc.gravel | c.gravel | | | | | | | | | | stream was too small to break habitat units out, the |
| | | | | | | | | P-1 | P | 4.5 | 2.1 | 25 | 45 | SR | | | | 0+ | trout<75 | | | | | | | 9 | reach was all glide or glide pool with the one plunge |
| | | | | | | | | | | | | | | | | | | 1+ | Rb/Stlhd 75-127 | | | | | | | 9 | pool at the end |
| | | | | | | | | | | | | | | | | | | 2+ | Rb/Stlhd 127-200 | | | | | | | 6 | |
| | | | | | | | | | | | | | | | | | | Res | Rainbow >200 | | | | | | | | fish sizes were estimated the same way as reach 4 |
| | | | | | | | | | | | | | | | | | | 0+ | Chinook <127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | 1+ | Chinook >127 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat 75-305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Cutthroat >305 | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Bulltrout (all sizes) | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Brooktrout " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | Whitefish " | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | other | | | | | | | | |

3 age classes including YOY

5-2-2000

Personal communications: J.P. Mays, USFS, Nez Perce NF
Elk City/Red River Ranger District fish biologist

**Crooked Creek**: info within the last 5 years

Anadramous barrier 800 meters below mouth of Big Creek

| | |
|---|---|
| Above barrier: | rbt with fish and game stocking maybe within 2 years ago<br>Lots of rbt's<br>Spawning and rearing of rbt in this area |
| below barrier | steel head, bulltrout, chinook, cutthroat<br>All spawning and rearing |
| Lake Creek | steel head, bulltrout, cutthroat<br>All spawning and rearing |

**Big Creek** data is from 1990 and 1992 thru 1998

Rbt and rbt x cutt crosses (hybrids)
spawning and early rearing

**Rhett Creek** data from within the last 5 years

steel head, bull trout, cutthroat, juvenile chinook

spawning and rearing of steel head and cutthroat
rearing bulltrout and chinook

**Jersey Creek** info within last 5 years

cutthroat and steel head juveniles

spawning and rearing of cutthroat
rearing of steel head

**Little Mallard:** total fish migration barrier just above mouth. Above barrier the stream is fish less.

Below barrier, rearing steel head and incidental other salmonids

# Little Mallard Creek

**1997 Beneficial Use Reconnaissance Project Field Forms, Idaho Division of Environmental Quality**

## Division of Environmental Quality Fish Data Sheet

Field Information - Shaded areas must be completed before submittal of sample

| | | | | | |
|---|---|---|---|---|---|
| DEQ Project Code | 82-91004P00-BRP-4010 | | | | |
| Name of Water Body | Little Mallard Creek | | | Site ID Nº: | 97NCIROA17 |
| Location Description: permanent Landmarks | Approx. 5 miles down F.S. Road 9505 | | | | |
| Station or subsample Nº: | County: | Township | Range: | Section: | Quarter: |
| All habitats | Idaho | 26N | 9E | 29 | SE, NW, NE |
| Elevation: | Collector(s) First (or initial) & Last Names(s): | | | | Sample Method: |
| 1700m | R. Weldeet, S. Patrau, E. Myers | | | | Electroshock |
| Collection date (YY/MM/DD) | Reach Length: | | Avg. Reach Width: | | |
| 97/07/17 | 132m | | 5m | | |
| Field Taxonomist: | Temperature: | | Conductivity: | | |
| R. Weldeet | 9.5°C | | 19uS | | |
| Identifying Lab Information: | | | | | |
| Lab Name: | Date Into Lab: | | Date Reported: | | |
| Taxonomist (First Initial & Last Name): | | | Remarks: | | |

Taxa Vouchered: No fish found

Anomalies Noted:

Equipment Settings:

Species Stocked in last 5 years (note year)

Field Comments:

Stream Name: Little Mallard Creek Site ID Nº: 97NCIROA17 Date: 97/07/14

**IDHW - Division of Environmental Quality**
**FISH DATA SHEET**

**Field Information - Shaded areas must be completed before submittal of sample**

**DEQ Project Code** __ __ – __ __ __ __ __ __ __ __ – __ __ __ – __ __ __ __

| | |
|---|---|
| Name of Water Body: Little Mallard Creek | Site ID No. |
| Location Description (Permanent Landmarks): 10 m Above Rd at Whitewater | |

| Station and/or Subsample No. | County | Township | Range | Section | Quarter |
|---|---|---|---|---|---|
| 1 | Idaho | 25N | 9E | 12 | NW NW |

| Elevation (ft or m) | Collector(s) First (or initial) & Last Name(s) | Sample Method |
|---|---|---|
| | USFS | |

Collection Date (YY/MM/DD): 93/07/22

**Receiving Lab Information**

| Lab Name | Date into Lab | Sent Out | Sorted | Lab's Sample Number |
|---|---|---|---|---|
| | | | | |

**Identifying Lab Information**

| Lab Name | Date into Lab | Date Reported | IDHW Central Lab Log No. |
|---|---|---|---|
| | | | |

| Taxonomist (First Initial & Last Name) | Remarks: |
|---|---|
| | |

4 other Reaches were also shocked which resulted in No Fish due to a fish passage barrier located .5 mi upstream from the mouth. No fish were located above this barrier.

## Little Mallard Creek

Two sites were monitored in Little Mallard Creek from 1994 - 1998. The most upstream site is located below the headwater meadows area (site 5). The second site is located 80 meters from the mouth (site 6). A fish barrier is present at approximately 1,100 meters from the mouth. Little Mallard Creek at most summer flows is not accessible to juvenile chinook for rearing, due to the 31% gradient of the alluvial fan. It does provide rearing at the mixing zone confluence with the Salmon River.

Graph 15

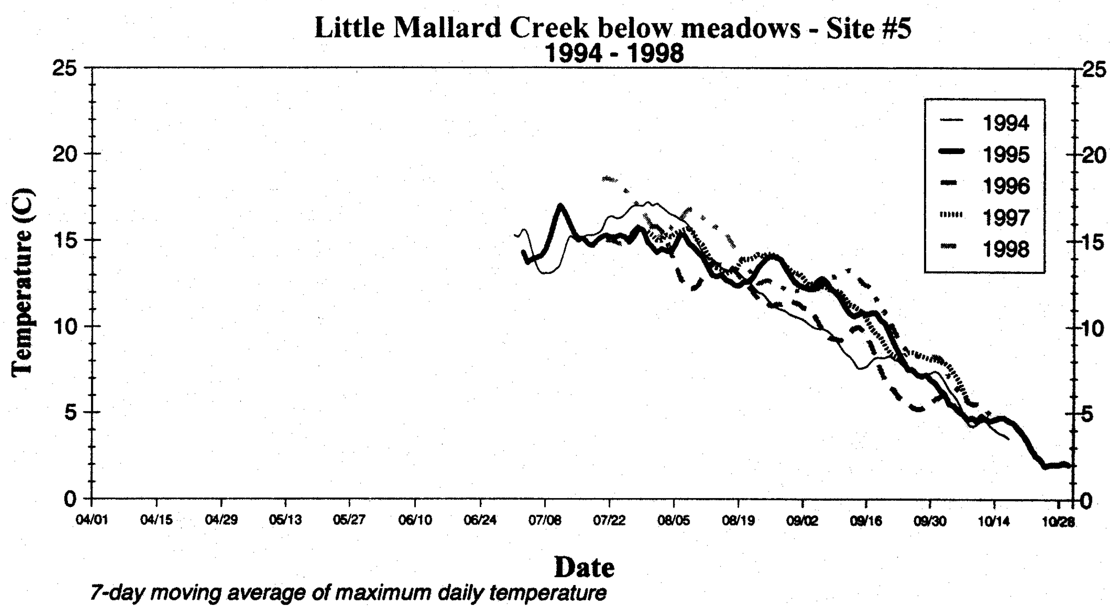



**Table 21 Little Mallard Creek below Meadows (Site 5)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Maximum Temp. (C) |
|---|---|---|---|---|
| 1994 | 6/25-10/17 | 48 | 19 | 18.0 |
| 1995 | 6/27-10/30 | 49 | 19 | 16.9 |
| 1996 | 7/15-10/3 | 28 | 6 | 16.7 |
| 1997 | 7/24-10/8 | 32 | 7 | 17.0 |
| 1998 | 7/14-10/14 | 39 | 20 | 19.3 |

**Graph 16**

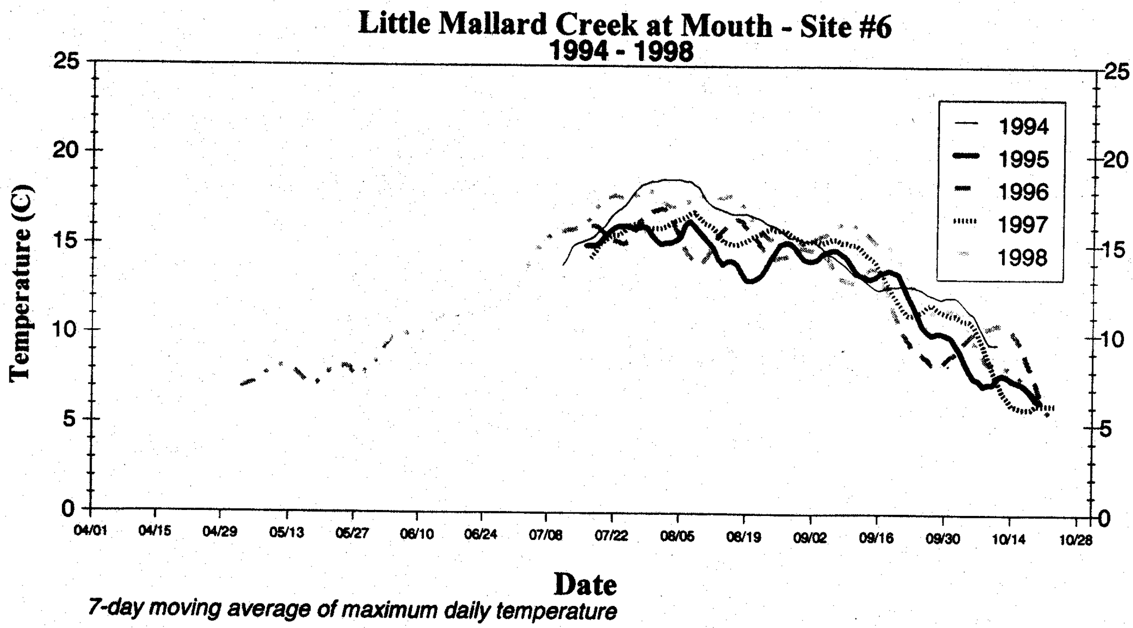



**Table 22 Little Mallard Creek at the Mouth (Site 6)**

| Year | Deployment Dates | Days > 13 C | Days > 16 C | Maximum Temp. (C) |
|---|---|---|---|---|
| 1994 | 7/5-10/11 | 65 | 36 | 19.1 |
| 1995 | 7/10-10/20 | 63 | 15 | 17.3 |
| 1996 | 7/11-10/20 | 60 | 20 | 17.3 |
| 1997 | 7/11-10/23 | 65 | 18 | 17.8 |
| 1998 | 4/27-10/22 | 83 | 39 | 18.5 |

5-2-2000

Personal communications: J.P. Mays, USFS, Nez Perce NF
Elk City/Red River Ranger District fish biologist

**Crooked Creek**: info within the last 5 years

Anadramous barrier 800 meters below mouth of Big Creek

| | |
|---|---|
| Above barrier: | rbt with fish and game stocking maybe within 2 years ago<br>Lots of rbt's<br>Spawning and rearing of rbt in this area |
| below barrier | steel head, bulltrout, chinook, cutthroat<br>All spawning and rearing |
| Lake Creek | steel head, bulltrout, cutthroat<br>All spawning and rearing |

**Big Creek** data is from 1990 and 1992 thru 1998

Rbt and rbt x cutt crosses (hybrids)
spawning and early rearing

**Rhett Creek** data from within the last 5 years

steel head, bull trout, cutthroat, juvenile chinook

spawning and rearing of steel head and cutthroat
rearing bulltrout and chinook

**Jersey Creek** info within last 5 years

cutthroat and steel head juveniles

spawning and rearing of cutthroat
rearing of steel head

**Little Mallard:** total fish migration barrier just above mouth. Above barrier the stream is fish less.

Below barrier, rearing steel head and incidental other salmonids

## Noble Creek

1997SLEWC013

DEQ FISH DATA ENTRY FORM

Site ID: | Water body: Noble Creek | Date: 97/07/12

DEQ Fish Collection Record (pass 1 of 1, effort 402 seconds)

| T. Lngth (mm) | Taxa code/ID confidence 11/A | 11/C | 78/A | | | | |
|---|---|---|---|---|---|---|---|
| 10-19 | | | | | | | |
| 20-29 | | | | | | | |
| 30-39 | | | | | | | |
| 40-49 | | | | | | | |
| 50-59 | | | [redacted] | | | | |
| 60-69 | | ① | | | | | |
| 70-79 | | | | | | | |
| 80-89 | | | | | | | |
| 90-99 | | ① | | | | | |
| 100-109 | | | | | | | |
| 110-119 | | ② | | | | | |
| 120-129 | ① √ 122 | ① | | | | | |
| 130-139 | | ③ | | | | | |
| 140-149 | | | | | | | |
| 150-[redacted] | [redacted] | | | | | | |
| 160-169 | | | | | | | |
| 170-179 | | | | | | | |
| 180-189 | | | | | | | |
| 190-199 | | | | | | | |
| 200-209 | | | | | | | |
| 210-219 | | | | | | | |
| 220-229 | | | | | | | |
| 230-239 | | | | | | | |
| 240-249 | | | | | | | |
| 250-259 | | | | | | | |
| 260-269 | | | | | | | |
| 270-279 | | | | | | | |
| 280-289 | | | | | | | |
| 290-299 | | | | | | | |
| 300-309 | | | | | | | |
| 310-319 | | | | | | | |
| 320-329 | | | | | | | |
| 330-339 | | | | | | | |
| 340-349 | | | | | | | |
| 350-359 | | | | | | | |
| 360-369 | | | | | | | |
| 370-379 | | | | | | | |
| 380-389 | | | | | | | |
| 390-399 | | | | | | | |
| 400-409 | | | | | | | |
| 410-419 | | | | | | | |
| 420-429 | | | | | | | |
| 430-439 | | | | | | | |
| 440-449 | | | | | | | |
| Total | ② | ⑧ | ① | | | | |

**Corn Creek**
**Bear Basin Creek**
**Cramer Creek**

# Appendix F: The Idaho Division of Environmental Quality Water Body Assessment Form

| Water Body Initialization | | | | |
|---|---|---|---|---|
| Water Body Name **Bear Basin Creek** | | | | |
| Upstream Limit **Headwater** | | Downstream Limit **Mouth** | | |
| WQ Standard | | PNRS | | |
| EPA River Reach # | | HUC **17060207** | | |
| **Beneficial Uses** | | | | |
| | Designated Use | Existing Use | Attainable Use | Support Status (circle correct) |
| XCold/□Warm Water Biota | | **X** | | **FS** |
| Salmonid Spawning | | | | FS, NFS, NA |
| Primary Contact Recreation | | | | FS, NFS, NA |
| Secondary Contact Recreation | **X** | | | **FS** |
| Domestic Water Supply | | | | FS, NFS, NA |
| Agricultural Water Supply | | | | FS, NFS, NA |
| Industrial Water Supply | X | | | FS |
| Wildlife Habitat | X | | | FS |
| Aesthetics | X | | | FS |
| Criteria Exceedances (See cover letter for explanation of abbreviations) | | | | |
| **No data** | | | | |
| Assessment Caveats (See cover letter for explanation of abbreviations) | | | | |
| **96EIROZ099: NR ecoregion; MBI 3.59; HI 99; 2.1 cfs.** | | | | |
| Assessor Information | | | | |
| Name: **Chris Mebane** | | | Signature: C Mebane 4/23/97 | |
| Affiliation: **Division of Environmental Quality, Idaho Falls Regional Office, 900 N. Skyline, Suite B, Idaho Falls, ID 83402** | | | | |

# Appendix F: The Idaho Division of Environmental Quality Water Body Assessment Form

| Water Body Initialization | | | | |
|---|---|---|---|---|
| Water Body Name **Corn Creek** | | | | |
| Upstream Limit **Headwaters** | | Downstream Limit **Mouth** | | |
| WQ Standard | | PNRS | | |
| EPA River Reach # | | HUC **17060207** | | |
| **Beneficial Uses** | | | | |
| | Designated Use | Existing Use | Attainable Use | Support Status (circle correct) |
| XCold/□Warm Water Biota | | **X** | | **FS** |
| Salmonid Spawning | | | | FS, NFS, NA |
| Primary Contact Recreation | **X** | | | **FS** |
| Secondary Contact Recreation | | | | FS, NFS, NA |
| Domestic Water Supply | | | | FS, NFS, NA |
| Agricultural Water Supply | | | | FS, NFS, NA |
| Industrial Water Supply | X | | | FS |
| Wildlife Habitat | X | | | FS |
| Aesthetics | X | | | FS |
| **Criteria Exceedances (See cover letter for explanation of abbreviations)** | | | | |
| **No data** | | | | |
| **Assessment Caveats (See cover letter for explanation of abbreviations)** | | | | |
| **96EIROZ098: NR ecoregion; HI 111; MBI 4.98; 5.8 cfs.** | | | | |
| **Assessor Information** | | | | |
| Name: **Chris Mebane** | | | C Mebane 4/23/97 Signature | |
| Affiliation: **Division of Environmental Quality Idaho Falls Regional Office 900 N. Skyline, Suite B Idaho Falls, ID 83402** | | | | |

# Appendix F: The Idaho Division of Environmental Quality Water Body Assessment Form

| Water Body Initialization | |
|---|---|
| Water Body Name **Cramer Creek** | |
| Upstream Limit **Headwater** | Downstream Limit **Mouth** |
| WQ Standard | PNRS |
| EPA River Reach # | HUC **17060207** |

**Beneficial Uses**

| | Designated Use | Existing Use | Attainable Use | Support Status (circle correct) |
|---|---|---|---|---|
| XCold/□Warm Water Biota | | **X** | | **NV** |
| Salmonid Spawning | | | | FS, NFS, NA |
| Primary Contact Recreation | | | | FS, NFS, NA |
| Secondary Contact Recreation | **X** | | | **NA** |
| Domestic Water Supply | | | | FS, NFS, NA |
| Agricultural Water Supply | | | | FS, NFS, NA |
| Industrial Water Supply | X | | | FS |
| Wildlife Habitat | X | | | FS |
| Aesthetics | X | | | FS |

**Criteria Exceedances (See cover letter for explanation of abbreviations)**

**No data**

**Assessment Caveats (See cover letter for explanation of abbreviations)**

**96EIROZ100: NR ecoregion; MBI 3.00; HI 75; 0.6 cfs. No macroinvertebrate cold water indicators collected.**

**Assessor Information**

| | |
|---|---|
| Name: **Chris Mebane** | Signature: C Mebane 4/14/97 |
| Affiliation: **Division of Environmental Quality**<br>**Idaho Falls Regional Office**<br>**900 N. Skyline, Suite B**<br>**Idaho Falls, ID 83402** | |

# Appendix 5

# Air Temperature Data

**30 Year Averages (1961 – 1990) of Daily Air Temperatures at Dixie, Idaho (Station #102575) for the Time Period Between July 1st and September 30th.**
**NOAA Western Regional Climate Center *www.wrcc.dri.edu***

| Julian Day | Ave. Max. Air Temp. (°F) | Ave. Min. Air Temp. (°F) | Julian Day | Ave. Max. Air Temp. (°F) | Ave. Min. Air Temp. (°F) |
|---|---|---|---|---|---|
| 183 (July 1) | 71.1 | 36.4 | 229 | 75.9 | 35.4 |
| 184 | 71.4 | 36.5 | 230 | 75.5 | 35.3 |
| 185 | 71.7 | 36.5 | 231 | 75.2 | 35.1 |
| 186 | 71.9 | 36.5 | 232 | 74.9 | 34.9 |
| 187 | 72.2 | 36.6 | 233 | 74.5 | 34.7 |
| 188 | 72.5 | 36.6 | 234 | 74.2 | 34.4 |
| 189 | 72.8 | 36.7 | 235 | 73.9 | 34.3 |
| 190 | 73.1 | 36.7 | 236 | 73.7 | 34.2 |
| 191 | 73.4 | 36.7 | 237 | 73.4 | 34.0 |
| 192 | 73.7 | 36.7 | 238 | 73.1 | 33.8 |
| 193 | 74.0 | 36.7 | 239 | 72.7 | 33.5 |
| 194 | 74.2 | 36.7 | 240 | 72.4 | 33.3 |
| 195 | 74.6 | 36.8 | 241 | 72.0 | 33.1 |
| 196 | 74.9 | 36.9 | 242 | 71.6 | 32.8 |
| 197 | 75.3 | 37.0 | 243 | 71.2 | 32.5 |
| 198 | 75.5 | 37.1 | 244 | 70.8 | 32.2 |
| 199 | 75.8 | 37.1 | 245 (Sep 1) | 70.4 | 32.0 |
| 200 | 76.0 | 37.2 | 246 | 70.0 | 31.8 |
| 201 | 76.3 | 37.2 | 247 | 69.7 | 31.5 |
| 202 | 76.4 | 37.2 | 248 | 69.4 | 31.2 |
| 203 | 76.6 | 37.1 | 249 | 69.1 | 31.0 |
| 204 | 76.8 | 37.2 | 250 | 68.6 | 30.8 |
| 205 | 77.0 | 37.1 | 251 | 68.1 | 30.6 |
| 206 | 77.1 | 37.0 | 252 | 67.7 | 30.3 |
| 207 | 77.3 | 36.9 | 253 | 67.4 | 30.1 |
| 208 | 77.5 | 36.9 | 254 | 67.1 | 29.9 |
| 209 | 77.7 | 36.9 | 255 | 66.8 | 29.7 |
| 210 | 78.0 | 36.9 | 256 | 66.5 | 29.5 |
| 211 | 78.1 | 36.9 | 257 | 66.2 | 29.4 |
| 212 | 78.2 | 36.9 | 258 | 65.8 | 29.2 |
| 213 | 78.2 | 37.0 | 259 | 65.5 | 29.0 |
| 214 (Aug 1) | 78.3 | 36.9 | 260 | 65.4 | 28.8 |
| 215 | 78.4 | 36.9 | 261 | 65.1 | 28.6 |
| 216 | 78.3 | 36.8 | 262 | 64.8 | 28.5 |
| 217 | 78.2 | 36.7 | 263 | 64.4 | 28.3 |
| 218 | 78.1 | 36.6 | 264 | 63.9 | 28.1 |
| 219 | 77.9 | 36.6 | 265 | 63.4 | 27.8 |
| 220 | 77.7 | 36.5 | 266 | 63.0 | 27.5 |
| 221 | 77.5 | 36.4 | 267 | 62.6 | 27.2 |
| 222 | 77.4 | 36.4 | 268 | 62.1 | 27.0 |
| 223 | 77.2 | 36.3 | 269 | 61.7 | 26.8 |
| 224 | 77.0 | 36.2 | 270 | 61.2 | 26.6 |
| 225 | 76.7 | 36.0 | 271 | 60.9 | 26.4 |
| 226 | 76.5 | 35.8 | 272 | 60.6 | 26.3 |
| 227 | 76.2 | 35.7 | 273 | 60.3 | 26.2 |
| 228 | 76.0 | 35.5 | 274 (Sep 30) | 59.9 | 26.0 |

**Monthly Average Air Temperatures at Dixie, Idaho (Station #102575) for the Period of Record: 6/18/1952 to 7/31/2000.**

**NOAA Western Regional Climate Center *www.wrcc.dri.edu***

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ave Max Air Temperature ($^o$F) | 30.6 | 35.6 | 39.9 | 46.7 | 56.6 | 65.9 | 75.9 | 75.8 | 66.7 | 54.0 | 38.3 | 31.2 | 51.4 |
| Ave Min Air Temperature ($^o$F) | 4.5 | 7.3 | 12.6 | 21.0 | 28.6 | 34.8 | 36.8 | 35.1 | 28.9 | 22.7 | 14.3 | 5.6 | 21.0 |
| Ave Total Precipitation (in) | 3.62 | 2.63 | 2.67 | 2.24 | 2.44 | 2.55 | 1.12 | 1.32 | 1.38 | 1.86 | 3.20 | 3.55 | 28.57 |
| Ave Total Snowfall (in) | 42.9 | 28.5 | 27.1 | 15.7 | 5.2 | 0.5 | 0.0 | 0.0 | 0.9 | 5.3 | 28.2 | 40.8 | 195.2 |
| Ave Snow Depth (in) | 36 | 42 | 39 | 24 | 4 | 0 | 0 | 0 | 0 | 0 | 6 | 21 | 14 |

# Appendix 6

# Idaho Department of Lands
# Cumulative Watershed Effects (CWE) Temperature models

## Southern Idaho Temperature Model

Southern Idaho Regression Statistics (with Drought Index)

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.842473 |
| R Square | 0.709761 |
| Adjusted R Square | 0.685574 |
| Standard Error | 1.986893 |
| Observations | 40 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 347.5423 | 115.8474 | 29.34522 | 8.89E-10 |
| Residual | 36 | 142.1188 | 3.947745 | | |
| Total | 39 | 489.6611 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 33.29682 | 2.326537 | 14.31176 | 1.98E-16 | 28.5784 | 38.01525 | 28.5784 | 38.01525 |
| Elevation | -0.00236 | 0.000446 | -5.28525 | 6.27E-06 | -0.00326 | -0.00145 | -0.00326 | -0.00145 |
| Canopy | -0.09012 | 0.013476 | -6.68786 | 8.46E-08 | -0.11745 | -0.06279 | -0.11745 | -0.06279 |
| DI Score | -0.27811 | 0.158584 | -1.7537 | 0.087993 | -0.59973 | 0.043513 | -0.59973 | 0.043513 |

Temperature = 33.29682 - (Elevation x 0.00236) - (Canopy x 0.09012) - (DI x 0.27811)

Southern Idaho Regression Statistics (without Drought Index)

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.827627 |
| R Square | 0.684966 |
| Adjusted R Square | 0.667937 |
| Standard Error | 2.041859 |
| Observations | 40 |

ANOVA

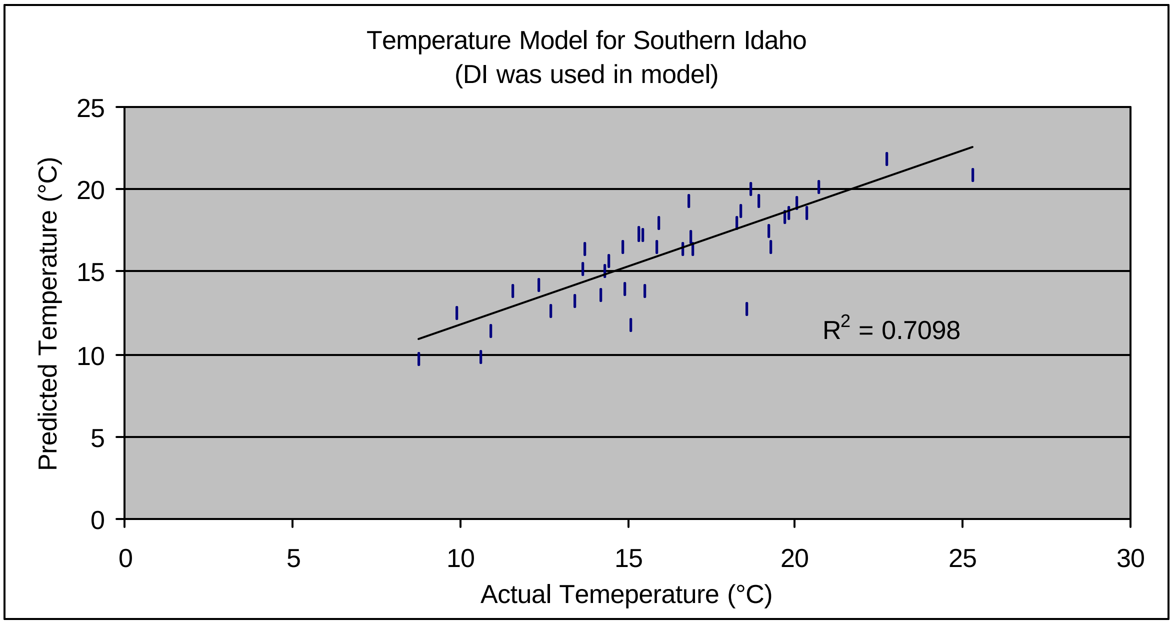
| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 335.4011 | 167.7005 | 40.22377 | 5.24E-10 |
| Residual | 37 | 154.26 | 4.169189 | | |
| Total | 39 | 489.6611 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 31.01952 | 1.983817 | 15.63629 | 6.92E-18 | 26.99993 | 35.03911 | 26.99993 | 35.03911 |
| Elevation | -0.00201 | 0.000412 | -4.88904 | 1.99E-05 | -0.00285 | -0.00118 | -0.00285 | -0.00118 |
| Canopy | -0.0896 | 0.013845 | -6.47158 | 1.45E-07 | -0.11765 | -0.06155 | -0.11765 | -0.06155 |

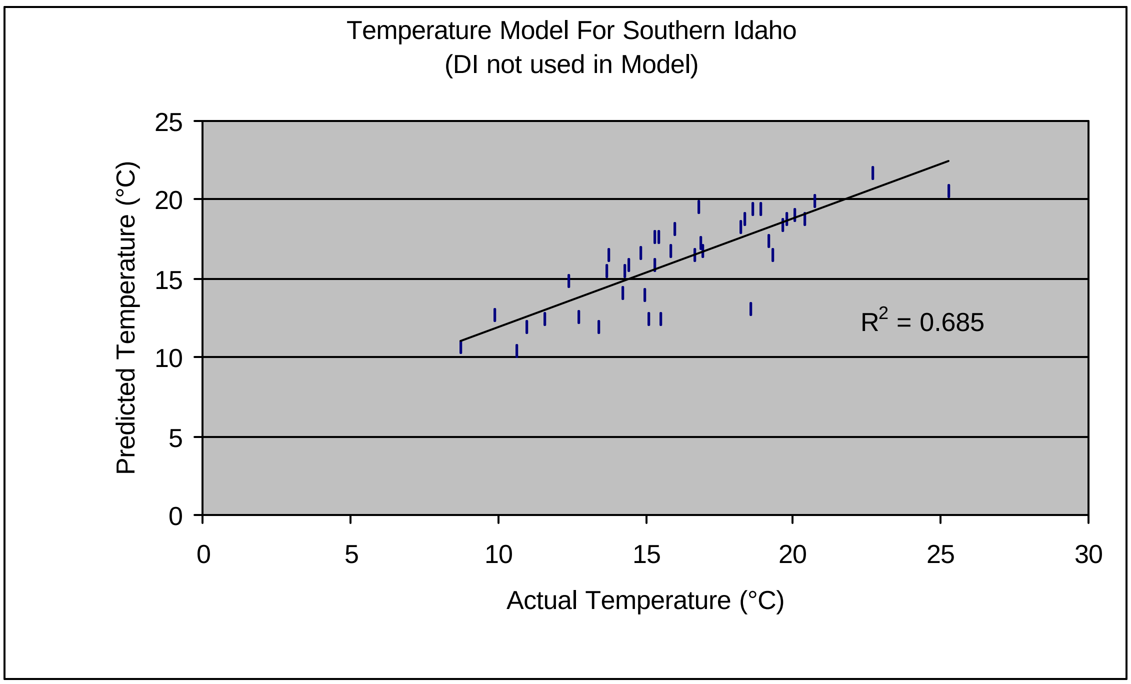
Temperature = 31.01952 -(0.00201 x Elevation) - (0.0896 x Canopy)

| Site Number | Name | Tributary To | Year | DI | Elevation | Canopy | DI Score | Actual MWMT | DI scores used Predicted MWMT | no DI Scores Predicted MWMT | 3-day Max (C) | Instanteous Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1 | Grimes Cr | Mores Creek | 1995 | 4 | 3700 | 34.32 | 2.17 | 25.28 | 20.8684029 | 20.507448 | 26.41 | 26.52 |
| Site 2 | Grimes Cr. | Mores Creek | 1995 | 4 | 4300 | 7.77 | 2.17 | 22.71 | 21.8450889 | 21.680328 | 23.74 | 24.09 |
| Site 3 | Grimes Cr. | Mores Creek | 1995 | 4 | 6540 | 60.41 | 2.17 | 15.1 | 11.8147721 | 12.461384 | 15.85 | 16.22 |
| Site 4 | Anderson Cr. | MF Payette | 1995 | 4 | 3190 | 57.47 | 2.17 | 18.65 | 19.9857249 | 19.458308 | 19.59 | 19.76 |
| Site 5 | Murray Cr. | NF Payette | 1995 | 4 | 4710 | 100 | 2.17 | 12.72 | 12.5657213 | 12.59242 | 13.35 | 13.56 |
| Site 6 | Bogus Cr. | NF Payette | 1995 | 4 | 4530 | 89.01 | 2.17 | 14.94 | 13.9809401 | 13.938924 | 15.54 | 15.75 |
| Site 7 | Tripod Cr. | NF Payette | 1995 | 4 | 4530 | 60.61 | 2.17 | 19.27 | 16.5403481 | 16.483564 | 20.08 | 20.24 |
| Site 8 | Clear Cr. | NF Payette | 1995 | 4 | 4940 | 19.11 | 2.17 | 18.9 | 19.3127281 | 19.377864 | 19.75 | 20.24 |
| Site 9 | Clear Cr. | NF Payette | 1995 | 4 | 5340 | 41.8 | 2.17 | 13.74 | 16.3239053 | 16.54084 | 14.54 | 14.96 |
| Site 10 | Big Cr. | NF Payette | 1995 | 4 | 5190 | 27.44 | 2.17 | 15.95 | 17.9720285 | 18.128996 | 16.44 | 17.34 |
| Site 11 | Flat Cr. | Gold Fork R | 1995 | 4 | 5340 | 80.91 | 2.17 | 18.54 | 12.7993121 | 13.036584 | 19.65 | 19.76 |
| Site 12 | Gold Fork R. | NF Payette | 1995 | 4 | 4870 | 27.46 | 2.17 | 18.35 | 18.7254261 | 18.770404 | 19.65 | 19.92 |
| Site 13 | Gold Fork R. | NF Payette | 1995 | 4 | 5060 | 47.37 | 2.17 | 14.83 | 16.4827369 | 16.604568 | 15.85 | 16.38 |
| Site 15 | Kennally Cr. | Gold Fork R | 1995 | 4 | 5075 | 48.23 | 2.17 | 16.66 | 16.3698337 | 16.497362 | 17.5 | 17.82 |
| Site 16 | Fish Cr. | Upper Little Salmon | 1995 | 4 | 4680 | 46.93 | 2.17 | 19.18 | 17.4191897 | 17.407792 | 19.92 | 20.08 |
| Site 17 | Big Cr. | NF Payette | 1995 | 4 | 5100 | 26.23 | 2.17 | 19.67 | 18.2934737 | 18.418312 | 20.57 | 20.73 |
| Site 20 (92) | Foolhen Cr | NF Gold Fork | 1992 | 4 | 5400 | 86.35 | -3.615 | 11.6 | 13.77632565 | 12.42856 | 11.87 | 12.4 |
| Site 20 (94) | Foolhen Cr | NF Gold fork | 1994 | 4 | 5400 | 86.35 | -3.65 | 15.49 | 13.7860595 | 12.42856 | 15.7 | 19 |
| Site 21 | Trib 4 NFGF | NF Gold Fork | 1995 | 4 | 6360 | 87.6 | 2.17 | 10.63 | 9.7892093 | 10.38696 | 11.07 | 11.23 |
| Site 22 (93) | Lodgepole Cr | NF Gold Fork | 1993 | 4 | 5480 | 90.57 | 2.67 | 10.94 | 11.4592979 | 11.889648 | 11.1 | 11.4 |
| Site 22 (94) | Lodgepole Cr | NF Gold Fork | 1994 | 4 | 5480 | 90.57 | -3.65 | 13.43 | 13.2169531 | 11.889648 | 13.7 | 13.9 |
| Site 24 (92) | Gold Fork R | Gold Fork R | 1992 | 4 | 4995 | 56.75 | -3.615 | 15.33 | 17.39967765 | 15.89477 | 16.33 | 16.9 |
| Site 24 (93) | Gold Fork R | Gold Fork R | 1993 | 4 | 4995 | 56.75 | 2.67 | 14.41 | 15.6517563 | 15.89477 | 14.53 | 15 |
| Site 26 (93) | Kennally Cr. | Gold Fork R | 1993 | 4 | 5405 | 52.42 | 2.67 | 14.3 | 15.0743759 | 15.458638 | 14.37 | 15 |
| Site 26 (95) | Kennally Cr. | Gold Fork R | 1995 | 4 | 5405 | 52.42 | 2.17 | 13.67 | 15.2134309 | 15.458638 | 14.83 | 15.1 |
| Site 28 | Big Cr. | Little Salmon | 1995 | 4 | 4280 | 37.86 | 2.17 | 20.03 | 19.1805781 | 19.024464 | 20.93 | 21.5 |
| Site 29 | Little Salmo | Salmon R | 1995 | 4 | 4190 | 29.62 | 2.17 | 20.7 | 20.1355669 | 19.943668 | 21.37 | 21.5 |
| Site 30 | Little Salmo | Salmon R | 1995 | 4 | 4920 | 94.7 | 2.17 | 9.91 | 12.5477573 | 12.6452 | 10.5 | 11.1 |
| Site 31 | Fall Cr. | MF Weiser | 1995 | 5 | 4140 | 95.95 | 4.475 | 14.2 | 13.63486375 | 14.101 | 14.93 | 15.3 |
| Site 32 (93) | M.F. Weiser | Weiser R | 1993 | 5 | 3650 | 46.06 | 4.35 | 16.79 | 19.3221143 | 19.556044 | 16.9 | 17.4 |
| Site 36 | Unnamed Cr | Weiser R | 1995 | 5 | 5760 | 97.49 | 4.475 | 8.74 | 9.67287895 | 10.706816 | 9.17 | 9.4 |
| Site 37 | Cottonwood C | Weiser R | 1995 | 5 | 3590 | 62.08 | 4.475 | 18.24 | 17.98522815 | 18.241252 | 19.5 | 19.6 |
| Site 38 | Mill Cr. | Weiser R | 1995 | 5 | 3480 | 75.12 | 4.475 | 16.87 | 17.06966335 | 17.293968 | 17.67 | 17.8 |
| Site 39 | E.F. Weiser | Weiser R | 1995 | 5 | 4820 | 71.83 | 4.475 | 12.37 | 14.20375815 | 14.895352 | 12.73 | 13.4 |
| Site 40 | E.F. Weiser | Weiser R | 1995 | 5 | 3750 | 75 | 4.475 | 16.96 | 16.44327775 | 16.76202 | 18.2 | 18.4 |
| Site 41 | W Br. Weiser | Weiser R | 1995 | 5 | 4175 | 55.07 | 4.475 | 15.31 | 17.23636935 | 17.693498 | 16.23 | 16.3 |
| Site 42 | Weiser R | Weiser R | 1995 | 5 | 3520 | 57.81 | 4.475 | 20.36 | 18.53524055 | 18.764544 | 21.5 | 21.8 |
| Site 40 (93) | E.F. Weiser | Weiser R | 1993 | 5 | 3750 | 75 | 4.35 | 15.87 | 16.4780415 | 16.76202 | 16.17 | 16.4 |
| Site 41 (93) | W. Br. Weise | Weiser R | 1993 | 5 | 4175 | 55.07 | 4.35 | 15.43 | 17.2711331 | 17.693498 | 15.7 | 15.9 |
| Site 42 (93) | Weiser R. | Weiser R | 1993 | 5 | 3520 | 57.81 | 4.35 | 19.8 | 18.5700043 | 18.764544 | 20.07 | 20.5 |

Temperature (°C) = 33.29682 - (Elevation x .00236) - (Canopy x 0.09012) - (DI x .27811)
Canopy Cover = (33.29682/0.09012) - (Elevation x 0.00236/0.09012) - (Temperature/0.09012) - (DI x 0.27811)




Temperature (°C) = 31.01952 -(0.00201 x Elevation) - (0.0896 x Canopy)




Canopy Cover = (31.01952/0.0896) - (0.00201 x Elevation/0.0896) - (Temperature/0.0896)

**Northern Idaho Temperature Model**

Northern Idaho Regression Statistics (with Drought Index)

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.759005 |
| R Square | 0.576089 |
| Adjusted R Square | 0.569793 |
| Standard Error | 2.207239 |
| Observations | 206 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 1337.409 | 445.8029 | 91.5049 | 1.96E-37 |
| Residual | 202 | 984.1242 | 4.871902 | | |
| Total | 205 | 2321.533 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 29.09861 | 0.907499 | 32.06461 | 3.49E-81 | 27.30923 | 30.888 | 27.30923 | 30.888 |
| Elev (ft) | -0.00262 | 0.000239 | -10.9357 | 3.65E-22 | -0.00309 | -0.00214 | -0.00309 | -0.00214 |
| Canopy (%) | -0.08492 | 0.007113 | -11.9389 | 3.29E-25 | -0.09894 | -0.07089 | -0.09894 | -0.07089 |
| DI jul-aug | -0.29433 | 0.062792 | -4.68741 | 5.08E-06 | -0.41815 | -0.17052 | -0.41815 | -0.17052 |

Temperature = 29.09861 - (Elev x 0.00262) - (Canopy x 0.08492) - (DI x .29433)

Canopy = (29.09861/.08492) - (Elev x 0.00262/0.08492) - (Temp/0.08492) - (DI x 0.29433/0.08492)

| Plum Creek, Potlatch and Idaho Department of Lands Idaho Data Set Through 1998<br>Stream/Site | River Basin | Cooperator | Year | DI division | Elev (ft) | Canopy (%) | DI jul-aug | Actual<br>MWMT (C) | Calculated<br>MWMT (C) |
|---|---|---|---|---|---|---|---|---|---|
| Adair | Little NF Clearwater | Plum Creek | 1997 | 4 | 3760 | 24.09 | 2.175 | 13.50 | 16.561519 |
| Alpine1 | St. Joe | Plum Creek | 1995 | 4 | 3820 | 49.35 | 2.17 | 12.23 | 14.260712 |
| Alpine2 | St. Joe | Plum Creek | 1995 | 4 | 4520 | 59.72 | 2.17 | 12.02 | 11.546092 |
| Bear Creek 1 | Cda River | Idaho Dept of Lands | 1998 | 4 | 2375 | 90.5 | 2.01 | 16.61429 | 14.599247 |
| Bear Creek 2 | Cda River | Idaho Dept of Lands | 1998 | 4 | 2800 | 97 | 2.01 | 13.71857 | 12.933767 |
| Beaver Cr. | St. Joe | Plum Creek | 1995 | 4 | 3620 | 32.18 | 2.17 | 18.73 | 16.242788 |
| Boulder1 | Potlatch | Potlatch | 1997 | 3 | 2440 | 63 | 4.98 | 19.3 | 15.890087 |
| Boulder1 | Potlatch | Potlatch | 1995 | 3 | 2440 | 63 | 3.915 | 18.9 | 16.203548 |
| Boulder1 | Potlatch | Potlatch | 1996 | 3 | 2440 | 63 | 3.375 | 18.9 | 16.362486 |
| Boulder2 | Potlatch | Potlatch | 1997 | 3 | 2800 | 66 | 4.98 | 18.7 | 14.692127 |
| Boulder2 | Potlatch | Potlatch | 1996 | 3 | 2800 | 66 | 3.375 | 17.6 | 15.164526 |
| Boulder2 | Potlatch | Potlatch | 1995 | 3 | 2800 | 66 | 3.915 | 16.4 | 15.005588 |
| Browns1 | Lolo Creek | Potlatch | 1994 | 3 | 3130 | 23 | -2.29 | 25.5 | 19.618866 |
| Browns1 | Lolo Creek | Potlatch | 1996 | 3 | 3130 | 23 | 3.375 | 23.4 | 17.951486 |
| Browns1 | Lolo Creek | Potlatch | 1997 | 3 | 3130 | 23 | 4.98 | 22.4 | 17.479087 |
| Browns1 | Lolo Creek | Potlatch | 1995 | 3 | 3130 | 23 | 3.915 | 21.8 | 17.792548 |
| Browns11 | Lolo Creek | Potlatch | 1997 | 3 | 3300 | 64 | 4.98 | 15.1 | 13.551967 |
| Browns11 | Lolo Creek | Potlatch | 1995 | 3 | 3300 | 64 | 3.915 | 14.3 | 13.865428 |
| Browns11 | Lolo Creek | Potlatch | 1996 | 3 | 3300 | 64 | 3.375 | 14.4 | 14.024366 |
| Browns11 | Lolo Creek | Potlatch | 1994 | 3 | 3300 | 64 | -2.29 | 15.9 | 15.691746 |
| Browns12 | Lolo Creek | Potlatch | 1994 | 3 | 3420 | 91 | -2.29 | 13.5 | 13.084506 |
| Browns2 | Lolo Creek | Potlatch | 1994 | 3 | 3150 | 71 | -2.29 | 16 | 15.490306 |
| Browns3 | Lolo Creek | Potlatch | 1994 | 3 | 3150 | 10 | -2.29 | 25 | 20.670426 |
| Browns3 | Lolo Creek | Potlatch | 1995 | 3 | 3150 | 10 | 3.915 | 22 | 18.844108 |
| Browns3 | Lolo Creek | Potlatch | 1996 | 3 | 3150 | 10 | 3.375 | 22.6 | 19.003046 |
| Browns4 | Lolo Creek | Potlatch | 1995 | 3 | 3170 | 38 | 3.915 | 18 | 16.413948 |
| Browns4 | Lolo Creek | Potlatch | 1997 | 3 | 3170 | 38 | 4.98 | 17.7 | 16.100487 |
| Browns4 | Lolo Creek | Potlatch | 1996 | 3 | 3170 | 38 | 3.375 | 18.5 | 16.572886 |
| Browns4 | Lolo Creek | Potlatch | 1994 | 3 | 3170 | 38 | -2.29 | 18.8 | 18.240266 |
| Browns5 | Lolo Creek | Potlatch | 1997 | 3 | 3180 | 65 | 4.98 | 15.4 | 13.781447 |
| Browns5 | Lolo Creek | Potlatch | 1995 | 3 | 3180 | 65 | 3.915 | 15.2 | 14.094908 |
| Browns5 | Lolo Creek | Potlatch | 1996 | 3 | 3180 | 65 | 3.375 | 15.1 | 14.253846 |
| Browns5 | Lolo Creek | Potlatch | 1994 | 3 | 3180 | 65 | -2.29 | 16.6 | 15.921226 |
| Browns6 | Lolo Creek | Potlatch | 1994 | 3 | 3155 | 9 | -2.29 | 23.8 | 20.742246 |
| Browns6 | Lolo Creek | Potlatch | 1996 | 3 | 3155 | 9 | 3.375 | 21.7 | 19.074866 |
| Browns6 | Lolo Creek | Potlatch | 1997 | 3 | 3155 | 9 | 4.98 | 20.8 | 18.602467 |
| Browns6 | Lolo Creek | Potlatch | 1995 | 3 | 3155 | 9 | 3.915 | 20.3 | 18.915928 |
| Browns7 | Lolo Creek | Potlatch | 1995 | 3 | 3190 | 72 | 3.915 | 16 | 13.474268 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Browns7 | Lolo Creek | Potlatch | 1997 | 3 | 3190 | 72 | 4.98 | 15.7 | 13.160807 |
| Browns7 | Lolo Creek | Potlatch | 1994 | 3 | 3190 | 72 | -2.29 | 17.9 | 15.300586 |
| Browns7 | Lolo Creek | Potlatch | 1996 | 3 | 3190 | 72 | 3.375 | 15.4 | 13.633206 |
| Browns8 | Lolo Creek | Potlatch | 1994 | 3 | 3230 | 39 | -2.29 | 19.3 | 17.998146 |
| Browns9 | Lolo Creek | Potlatch | 1995 | 3 | 3240 | 24 | 3.915 | 18.8 | 17.419428 |
| Browns9 | Lolo Creek | Potlatch | 1994 | 3 | 3240 | 24 | -2.29 | 21.2 | 19.245746 |
| Browns9 | Lolo Creek | Potlatch | 1997 | 3 | 3240 | 24 | 4.98 | 18.5 | 17.105967 |
| Browns9 | Lolo Creek | Potlatch | 1996 | 3 | 3240 | 24 | 3.375 | 18.9 | 17.578366 |
| Carpenter1 | St. Maries | Potlatch | 1995 | 4 | 2740 | 45 | 2.17 | 18.7 | 17.459714 |
| Carpenter1 | St. Maries | Potlatch | 1997 | 4 | 2740 | 45 | 2.175 | 18.2 | 17.458242 |
| Carpenter1 | St. Maries | Potlatch | 1996 | 4 | 2740 | 45 | 0.05 | 18.4 | 18.083694 |
| Carpenter2 | St. Maries | Potlatch | 1994 | 4 | 2750 | 55 | -3.65 | 22.1 | 18.297315 |
| Carpenter2 | St. Maries | Potlatch | 1995 | 4 | 2750 | 55 | 2.17 | 18.1 | 16.584314 |
| Carpenter3 | St. Maries | Potlatch | 1994 | 4 | 2930 | 75 | -3.65 | 18.5 | 16.127315 |
| Carpenter3 | St. Maries | Potlatch | 1995 | 4 | 2930 | 75 | 2.17 | 15 | 14.414314 |
| Carpenter4 | St. Maries | Potlatch | 1995 | 4 | 3170 | 59 | 2.17 | 13.3 | 15.144234 |
| Carpenter4 | St. Maries | Potlatch | 1997 | 4 | 3170 | 59 | 2.175 | 12.9 | 15.142762 |
| Carpenter4 | St. Maries | Potlatch | 1996 | 4 | 3170 | 59 | 0.05 | 13.2 | 15.768214 |
| Carpenter5 | St. Maries | Potlatch | 1995 | 4 | 3600 | 53 | 2.17 | 12.6 | 14.527154 |
| Carpenter6 | St. Maries | Potlatch | 1995 | 4 | 4000 | 23 | 2.17 | 15.1 | 16.026754 |
| E.FK Potlatch1 | Potlatch | Potlatch | 1995 | 1 | 3110 | 22 | 2.28 | 18.9 | 18.411098 |
| E.FK Potlatch1 | Potlatch | Potlatch | 1994 | 1 | 3110 | 22 | -1.955 | 21 | 19.657585 |
| E.FK Potlatch1 | Potlatch | Potlatch | 1997 | 1 | 3110 | 22 | 5.335 | 18.4 | 17.511919 |
| E.FK Potlatch1 | Potlatch | Potlatch | 1996 | 1 | 3110 | 22 | 3.675 | 18.9 | 18.000507 |
| E.FK Potlatch2 | Potlatch | Potlatch | 1995 | 1 | 3380 | 18 | 2.28 | 15.3 | 18.043378 |
| E.FK Potlatch2 | Potlatch | Potlatch | 1997 | 1 | 3380 | 18 | 5.335 | 14.7 | 17.144199 |
| E.FK Potlatch2 | Potlatch | Potlatch | 1996 | 1 | 3380 | 18 | 3.675 | 13.7 | 17.632787 |
| E.FK Potlatch3 | Potlatch | Potlatch | 1995 | 1 | 3600 | 30 | 2.28 | 14.3 | 16.447938 |
| E.FK Potlatch3 | Potlatch | Potlatch | 1997 | 1 | 3600 | 30 | 5.335 | 13.5 | 15.548759 |
| E.FK Potlatch3 | Potlatch | Potlatch | 1996 | 1 | 3600 | 30 | 3.675 | 13.7 | 16.037347 |
| E.FK Potlatch4 | Potlatch | Potlatch | 1997 | 1 | 3960 | 30 | 5.335 | 16.8 | 14.605559 |
| E.FK Potlatch4 | Potlatch | Potlatch | 1996 | 1 | 3960 | 30 | 3.675 | 16.8 | 15.094147 |
| E.FK Potlatch4 | Potlatch | Potlatch | 1995 | 1 | 3960 | 30 | 2.28 | 14.4 | 15.504738 |
| E.FK Potlatch5 | Potlatch | Potlatch | 1994 | 1 | 2920 | 21 | -1.955 | 24.7 | 20.240305 |
| East Bluff1 | St. Joe | Plum Creek | 1994 | 4 | 3840 | 23 | -3.65 | 15.05 | 18.158955 |
| East Bluff2 | St. Joe | Plum Creek | 1995 | 4 | 4520 | 66.3 | 2.17 | 8.62 | 10.987318 |
| East Bluff1 | St. Joe | Plum Creek | 1995 | 4 | 3840 | 23 | 2.17 | 12.87 | 16.445954 |
| East Bluff2 | St. Joe | Plum Creek | 1994 | 4 | 4520 | 66 | -3.65 | 10.26 | 12.725795 |
| Fish Creek 1 | Twin Lakes | Idaho Dept of Lands | 1997 | 4 | 2360 | 97.5 | 2.175 | 14.62571 | 13.995542 |
| Fish Creek 2 | Twin Lakes | Idaho Dept of Lands | 1997 | 4 | 2400 | 71.8 | 2.175 | 15.14571 | 16.073186 |

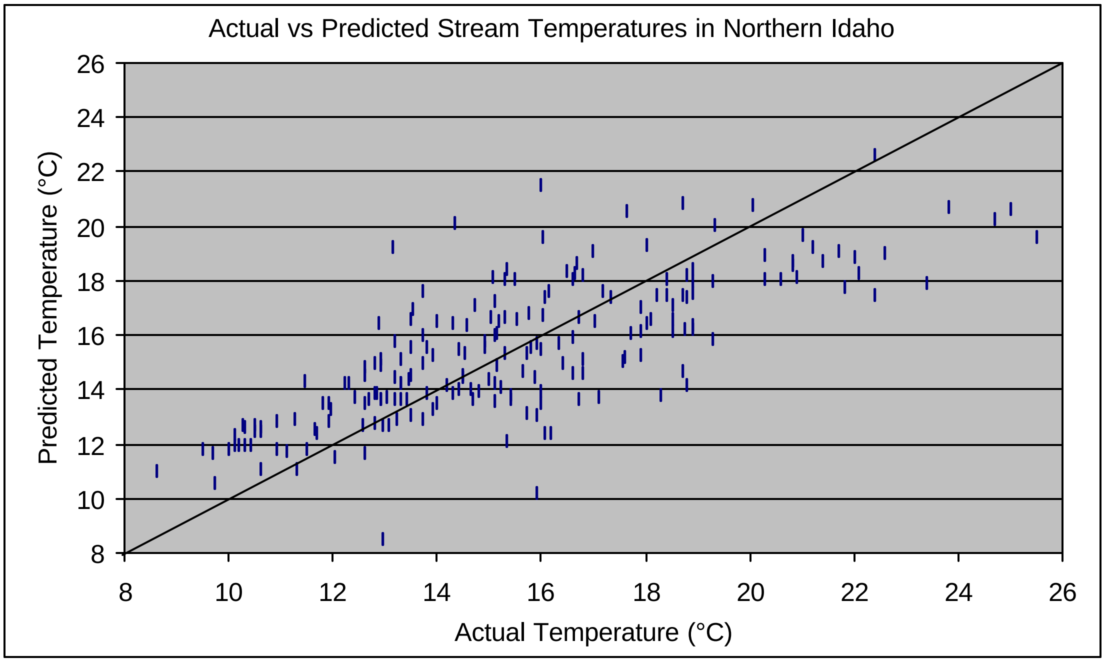
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Fish Creek 3 | Twin Lakes | Idaho Dept of Lands | 1997 | 4 | 2560 | 80.3 | 2.175 | 15.13571 | 14.932166 |
| Fishhook1 | St. Joe | Plum Creek | 1994 | 4 | 2600 | 9.1 | -3.65 | 22.39 | 22.588143 |
| Fishhook1 | St. Joe | Plum Creek | 1995 | 4 | 2600 | 9 | 2.17 | 18.70 | 20.883634 |
| Fishhook2 | St. Joe | Plum Creek | 1994 | 4 | 3250 | 40.4 | -3.65 | 16.77 | 18.227147 |
| Fishhook2 | St. Joe | Plum Creek | 1995 | 4 | 3250 | 40 | 2.17 | 14.00 | 16.548114 |
| Flemming Cr. | St. Joe | Plum Creek | 1995 | 4 | 2480 | 66 | 2.17 | 14.58 | 16.357594 |
| Floodwood 1 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 1700 | 75 | 2.175 | 17.16 | 17.635442 |
| Floodwood 2 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2170 | 15 | 2.175 | 15.99429 | 21.499242 |
| Floodwood 3 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2190 | 70 | 2.175 | 16.00429 | 16.776242 |
| Floodwood 4 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2480 | 55 | 2.175 | 15.10143 | 17.290242 |
| Floodwood 5 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2520 | 15 | 2.175 | 17.61714 | 20.582242 |
| Floodwood 6 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2570 | 75 | 2.175 | 14.50714 | 15.356042 |
| Fly Cr. | St. Joe | Plum Creek | 1995 | 4 | 3580 | 51.95 | 2.17 | 15.65 | 14.66872 |
| Heller Cr. | St. Joe | Plum Creek | 1995 | 4 | 4700 | 25.77 | 2.17 | 15.97 | 13.957526 |
| Hugus1 | St. Joe | Plum Creek | 1994 | 4 | 2300 | 39.3 | -3.65 | 20.06 | 20.809559 |
| Hugus1 | St. Joe | Plum Creek | 1995 | 4 | 2300 | 39 | 2.17 | 16.99 | 19.122034 |
| Hugus2 | St. Joe | Plum Creek | 1994 | 4 | 2400 | 45.3 | -3.65 | 19.34 | 20.038039 |
| Hugus2 | St. Joe | Plum Creek | 1995 | 4 | 2400 | 45 | 2.17 | 16.49 | 18.350514 |
| Indian Creek 1 | Hangman Creek | Idaho Dept of Lands | 1998 | 1 | 2740 | 90.5 | 1.64 | 17.11286 | 13.751849 |
| Indian Creek 2 | Hangman Creek | Idaho Dept of Lands | 1998 | 1 | 2760 | 89 | 1.64 | 18.28857 | 13.826829 |
| Indian Creek 3 | Hangman Creek | Idaho Dept of Lands | 1998 | 1 | 2800 | 90 | 1.64 | 16.69571 | 13.637109 |
| Indian Creek 4 | Hangman Creek | Idaho Dept of Lands | 1998 | 1 | 3080 | 99.5 | 1.64 | 15.31714 | 12.096769 |
| Jungle_ID | Little NF Clearwater | Plum Creek | 1997 | 4 | 3790 | 61.64 | 2.175 | 11.97 | 13.294173 |
| Keokee Cr 1 | Priest River | Idaho Dept of Lands | 1998 | 1 | 3660 | 54 | 1.64 | 14.48 | 14.441029 |
| Lion Creek 1 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2470 | 36.3 | 3.675 | 15.34 | 18.462951 |
| Lion Creek 2 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2520 | 58 | 3.675 | 15.16 | 16.489187 |
| Lion Creek 3 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2760 | 24.7 | 3.675 | 16.66 | 18.688223 |
| Lion Creek 4 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2790 | 59 | 3.675 | 16.34 | 15.696867 |
| Lion Creek 5 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2870 | 45 | 3.675 | 15.01 | 16.676147 |
| Lion Creek 7 | Priest River | Idaho Dept of Lands | 1996 | 1 | 3910 | 60 | 3.675 | 13.06 | 12.677547 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lost Lake | Little NF Clearwater | Plum Creek | 1997 | 4 | 4840 | 37.64 | 2.175 | 11.65 | 12.581253 |
| Lower Bluff | St. Joe | Plum Creek | 1995 | 4 | 3280 | 21.54 | 2.17 | 15.50 | 18.037137 |
| Medecine Cr. | St. Joe | Plum Creek | 1995 | 4 | 5040 | 27.64 | 2.17 | 11.26 | 12.907925 |
| MF East River 1 | Priest River | Idaho Dept of Lands | 1998 | 1 | 2380 | 50.5 | 1.64 | 16.60429 | 18.091849 |
| MF East River 2 | Priest River | Idaho Dept of Lands | 1998 | 1 | 3240 | 75 | 1.64 | 13.03286 | 13.758109 |
| MF East River 3 | Priest River | Idaho Dept of Lands | 1998 | 1 | 3880 | 93 | 1.64 | 9.727143 | 10.552749 |
| Mica1 | St. Joe | Potlatch | 1992 | 4 | 3960 | 72 | -3.615 | 12.9 | 13.673173 |
| Mica1 | St. Joe | Potlatch | 1995 | 4 | 3960 | 72 | 2.17 | 10.3 | 11.970474 |
| Mica1 | St. Joe | Potlatch | 1993 | 4 | 3960 | 72 | 2.67 | 10 | 11.823309 |
| Mica1 | St. Joe | Potlatch | 1997 | 4 | 3960 | 72 | 2.175 | 10.2 | 11.969002 |
| Mica1 | St. Joe | Potlatch | 1994 | 4 | 3960 | 72 | -3.65 | 12.7 | 13.683475 |
| Mica1 | St. Joe | Potlatch | 1991 | 4 | 3960 | 72 | 0.455 | 10.6 | 12.47525 |
| Mica1 | St. Joe | Potlatch | 1996 | 4 | 3960 | 72 | 0.05 | 10.3 | 12.594454 |
| Mica2 | St. Joe | Potlatch | 1994 | 4 | 3960 | 72 | -3.65 | 13.3 | 13.683475 |
| Mica2 | St. Joe | Potlatch | 1997 | 4 | 3960 | 72 | 2.175 | 10.4 | 11.969002 |
| Mica2 | St. Joe | Potlatch | 1992 | 4 | 3960 | 72 | -3.615 | 12.9 | 13.673173 |
| Mica2 | St. Joe | Potlatch | 1995 | 4 | 3960 | 72 | 2.17 | 10.1 | 11.970474 |
| Mica2 | St. Joe | Potlatch | 1991 | 4 | 3960 | 72 | 0.455 | 10.5 | 12.47525 |
| Mica2 | St. Joe | Potlatch | 1993 | 4 | 3960 | 72 | 2.67 | 9.5 | 11.823309 |
| Mica2 | St. Joe | Potlatch | 1996 | 4 | 3960 | 72 | 0.05 | 10.6 | 12.594454 |
| Mica3 | St. Joe | Potlatch | 1995 | 4 | 3920 | 75 | 2.17 | 11.5 | 11.820514 |
| Mica3 | St. Joe | Potlatch | 1994 | 4 | 3920 | 75 | -3.65 | 14 | 13.533515 |
| Mica3 | St. Joe | Potlatch | 1997 | 4 | 3920 | 75 | 2.175 | 10.9 | 11.819042 |
| Mica3 | St. Joe | Potlatch | 1996 | 4 | 3920 | 75 | 0.05 | 11.7 | 12.444494 |
| Mica3 | St. Joe | Potlatch | 1992 | 4 | 3920 | 75 | -3.615 | 12.6 | 13.523213 |
| Mica3 | St. Joe | Potlatch | 1993 | 4 | 3920 | 75 | 2.67 | 9.7 | 11.673349 |
| Mica3 | St. Joe | Potlatch | 1991 | 4 | 3920 | 75 | 0.455 | 10.1 | 12.32529 |
| Mica4 | St. Joe | Potlatch | 1994 | 4 | 3850 | 65 | -3.65 | 14.5 | 14.566115 |
| Mica4 | St. Joe | Potlatch | 1995 | 4 | 3850 | 65 | 2.17 | 11.9 | 12.853114 |
| Mica4 | St. Joe | Potlatch | 1992 | 4 | 3850 | 65 | -3.615 | 13.5 | 14.555813 |
| Mica4 | St. Joe | Potlatch | 1996 | 4 | 3850 | 65 | 0.05 | 11.8 | 13.477094 |
| Mica4 | St. Joe | Potlatch | 1997 | 4 | 3850 | 65 | 2.175 | 10.9 | 12.851642 |
| Mica4 | St. Joe | Potlatch | 1993 | 4 | 3850 | 65 | 2.67 | 10.5 | 12.705949 |
| Mica5 | St. Joe | Potlatch | 1995 | 4 | 3480 | 67 | 2.17 | 13.4 | 13.652674 |
| Mica5 | St. Joe | Potlatch | 1997 | 4 | 3480 | 67 | 2.175 | 13.2 | 13.651202 |
| Mica5 | St. Joe | Potlatch | 1994 | 4 | 3480 | 67 | -3.65 | 15.7 | 15.365675 |
| Mica5 | St. Joe | Potlatch | 1992 | 4 | 3480 | 67 | -3.615 | 15.3 | 15.355373 |
| Mica5 | St. Joe | Potlatch | 1996 | 4 | 3480 | 67 | 0.05 | 13.3 | 14.276654 |
| Mica5 | St. Joe | Potlatch | 1993 | 4 | 3480 | 67 | 2.67 | 11.9 | 13.505509 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mica6 | St. Joe | Potlatch | 1994 | 4 | 3340 | 56 | -3.65 | 16.7 | 16.666595 |
| Mica6 | St. Joe | Potlatch | 1995 | 4 | 3340 | 56 | 2.17 | 13.7 | 14.953594 |
| Mica6 | St. Joe | Potlatch | 1996 | 4 | 3340 | 56 | 0.05 | 13.8 | 15.577574 |
| Mica6 | St. Joe | Potlatch | 1993 | 4 | 3340 | 56 | 2.67 | 12.6 | 14.806429 |
| Mica6 | St. Joe | Potlatch | 1997 | 4 | 3340 | 56 | 2.175 | 12.8 | 14.952122 |
| Mica6 | St. Joe | Potlatch | 1992 | 4 | 3340 | 56 | -3.615 | 15.3 | 16.656293 |
| Mica7 | St. Joe | Potlatch | 1995 | 4 | 3340 | 69 | 2.17 | 13.8 | 13.849634 |
| Mica7 | St. Joe | Potlatch | 1994 | 4 | 3340 | 69 | -3.65 | 15.8 | 15.562635 |
| Mica7 | St. Joe | Potlatch | 1997 | 4 | 3340 | 69 | 2.175 | 12.8 | 13.848162 |
| Mica7 | St. Joe | Potlatch | 1993 | 4 | 3340 | 69 | 2.67 | 12.4 | 13.702469 |
| Mica7 | St. Joe | Potlatch | 1992 | 4 | 3340 | 69 | -3.615 | 14.9 | 15.552333 |
| Mica7 | St. Joe | Potlatch | 1996 | 4 | 3340 | 69 | 0.05 | 13.2 | 14.473614 |
| Montana | Little NF Clearwater | Plum Creek | 1997 | 4 | 4200 | 54.91 | 2.175 | 12.81 | 12.791485 |
| Moose1 | North Fork Clearwater | Potlatch | 1995 | 4 | 3800 | 50 | 2.17 | 13.3 | 14.257914 |
| Moose1 | North Fork Clearwater | Potlatch | 1997 | 4 | 3800 | 50 | 2.175 | 12.3 | 14.256442 |
| Moose1 | North Fork Clearwater | Potlatch | 1996 | 4 | 3800 | 50 | 0.05 | 12.9 | 14.881894 |
| Moose2 | North Fork Clearwater | Potlatch | 1997 | 4 | 4100 | 78 | 2.175 | 11.3 | 11.092682 |
| Moose2 | North Fork Clearwater | Potlatch | 1995 | 4 | 4100 | 78 | 2.17 | 10.6 | 11.094154 |
| Moose2 | North Fork Clearwater | Potlatch | 1996 | 4 | 4100 | 78 | 0.05 | 11.1 | 11.718134 |
| Mosquito Cr. | St. Joe | Plum Creek | 1995 | 4 | 3320 | 55.77 | 2.17 | 17.55 | 15.025526 |
| Nugget Cr. | St. Joe | Plum Creek | 1995 | 4 | 2920 | 64.9 | 2.17 | 13.91 | 15.298206 |
| Olson 1 | St Maries | Idaho Dept of Lands | 1997 | 4 | 2700 | 15 | 2.175 | 14.33429 | 20.110642 |
| Olson 2 | St Maries | Idaho Dept of Lands | 1997 | 4 | 2760 | 50 | 2.175 | 13.52714 | 16.981242 |
| Pack Creek | Lochsa | Plum Creek | 1995 | 4 | 4180 | 60 | 2.17 | 16.19 | 12.413114 |
| Pack Creek | Lochsa | Plum Creek | 1996 | 4 | 4180 | 60 | 0.05 | 15.89 | 13.037094 |
| Papoose | Lochsa | Plum Creek | 1995 | 4 | 3300 | 26 | 2.17 | 16.13 | 17.605994 |
| Papoose | Lochsa | Plum Creek | 1994 | 4 | 3300 | 26 | -3.65 | 18.01 | 19.318995 |
| Parachute | Lochsa | Plum Creek | 1995 | 4 | 3460 | 79 | 2.17 | 12.56 | 12.686034 |
| Parachute | Lochsa | Plum Creek | 1994 | 4 | 3460 | 79.2 | -3.65 | 13.45 | 14.382051 |
| Prospector Cr. | St. Joe | Plum Creek | 1995 | 4 | 2800 | 21.95 | 2.17 | 13.14 | 19.25992 |
| Red Ives Cr. | St. Joe | Plum Creek | 1995 | 4 | 3880 | 29.86 | 2.17 | 14.90 | 15.758603 |
| Rock | Lochsa | Plum Creek | 1997 | 4 | 4390 | 50 | 2.175 | 12.94 | 12.710642 |
| Rutledge | Little NF Clearwater | Plum Creek | 1997 | 4 | 3700 | 52 | 2.175 | 11.44 | 14.348602 |
| Shotgun | Lochsa | Plum Creek | 1997 | 4 | 4380 | 32.91 | 2.175 | 14.19 | 14.188125 |
| Simmons Cr. | St. Joe | Plum Creek | 1995 | 4 | 3400 | 29.32 | 2.17 | 17.89 | 17.06206 |
| Spruce1 | Lochsa | Plum Creek | 1994 | 4 | 5670 | 60 | -3.65 | 15.91 | 10.222315 |
| Spruce1 | Lochsa | Plum Creek | 1995 | 4 | 5670 | 60 | 2.17 | 12.96 | 8.5093139 |
| Spruce2 | Lochsa | Plum Creek | 1994 | 4 | 4920 | 37 | -3.65 | 18.79 | 14.140475 |
| Spruce2 | Lochsa | Plum Creek | 1995 | 4 | 4920 | 37 | 2.17 | 16.07 | 12.427474 |
| Stony 1 | Little N.F. Clearwater | Idaho Dept of | 1997 | 4 | 2760 | 45 | 2.175 | 17.31857 | 17.405842 |

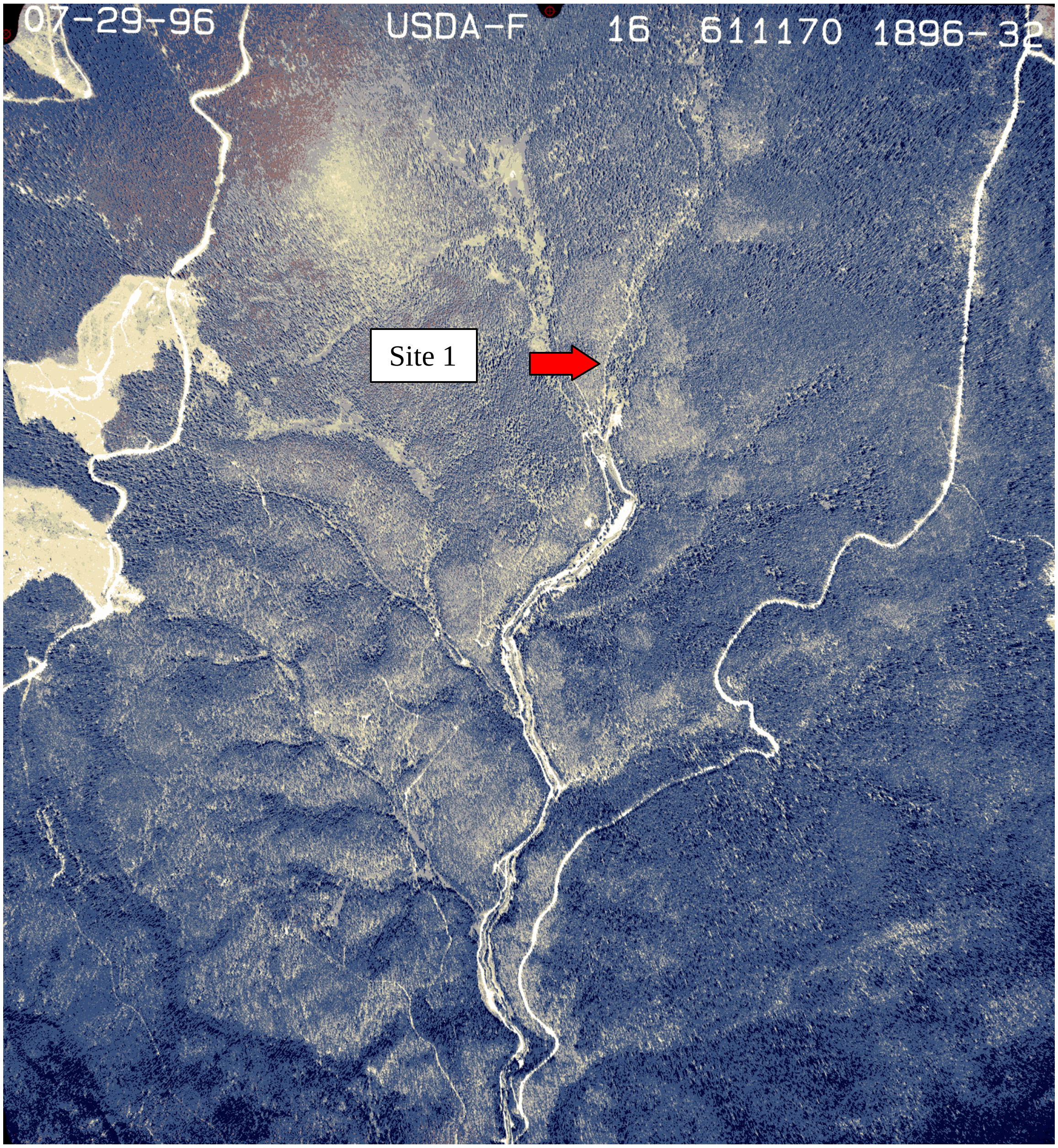
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Lands | | | | | | | |
| Stony 2 | Little N.F. Clearwater | Idaho Dept of Lands | 1997 | 4 | 2920 | 30 | 2.175 | 16.63714 | 18.260442 |
| Trapper Cr 1 | Priest River | Idaho Dept of Lands | 1998 | 1 | 2450 | 71.3 | 1.64 | 17.90429 | 16.142113 |
| Trapper Cr 2 | Priest River | Idaho Dept of Lands | 1998 | 1 | 2620 | 61.2 | 1.64 | 17 | 16.554405 |
| Trapper Cr 3 | Priest River | Idaho Dept of Lands | 1998 | 1 | 2680 | 49.2 | 1.64 | 16.05286 | 17.416245 |
| Twin Creek | Lochsa | Plum Creek | 1995 | 1 | 4520 | 58.2 | 2.28 | 12.62 | 11.642794 |
| Two Mouth 1 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2475 | 22.5 | 3.675 | 16.03143 | 19.621747 |
| Two Mouth 2 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2505 | 54.7 | 3.675 | 15.75571 | 16.808723 |
| Two Mouth 3 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2550 | 80.8 | 3.675 | 15.85571 | 14.474411 |
| Two Mouth 4 | Priest River | Idaho Dept of Lands | 1996 | 1 | 2800 | 48.5 | 3.675 | 15.53714 | 16.562327 |
| Two Mouth 5 | Priest River | Idaho Dept of Lands | 1996 | 1 | 3340 | 62.8 | 3.675 | 14.79714 | 13.933171 |
| Two Mouth 6 | Priest River | Idaho Dept of Lands | 1996 | 1 | 3760 | 57 | 3.675 | 13.89571 | 13.325307 |
| Two Mouth 7 | Priest River | Idaho Dept of Lands | 1996 | 1 | 4030 | 53.2 | 3.675 | 13.22286 | 12.940603 |
| Upper St. Jo | St. Joe | Plum Creek | 1995 | 4 | 5000 | 19.63 | 2.17 | 14.68 | 13.692934 |
| W.FK St.Maries1 | St Maries | Potlatch | 1997 | 4 | 2825 | 35 | 2.175 | 20.6 | 18.084742 |
| W.FK St.Maries1 | St Maries | Potlatch | 1995 | 4 | 2825 | 35 | 2.17 | 20.3 | 18.086214 |
| W.FK St.Maries1 | St Maries | Potlatch | 1996 | 4 | 2825 | 35 | 0.05 | 20.8 | 18.710194 |
| W.FK St.Maries2 | St Maries | Potlatch | 1995 | 4 | 2810 | 35 | 2.17 | 20.9 | 18.125514 |
| W.FK St.Maries2 | St Maries | Potlatch | 1996 | 4 | 2810 | 35 | 0.05 | 21.4 | 18.749494 |
| Walton | Lochsa | Plum Creek | 1997 | 4 | 3590 | 61.09 | 2.175 | 12.85 | 13.864879 |

Temperature = 29.09861 - (Elev x 0.00262) - (Canopy x 0.08492) - (DI x .29433)

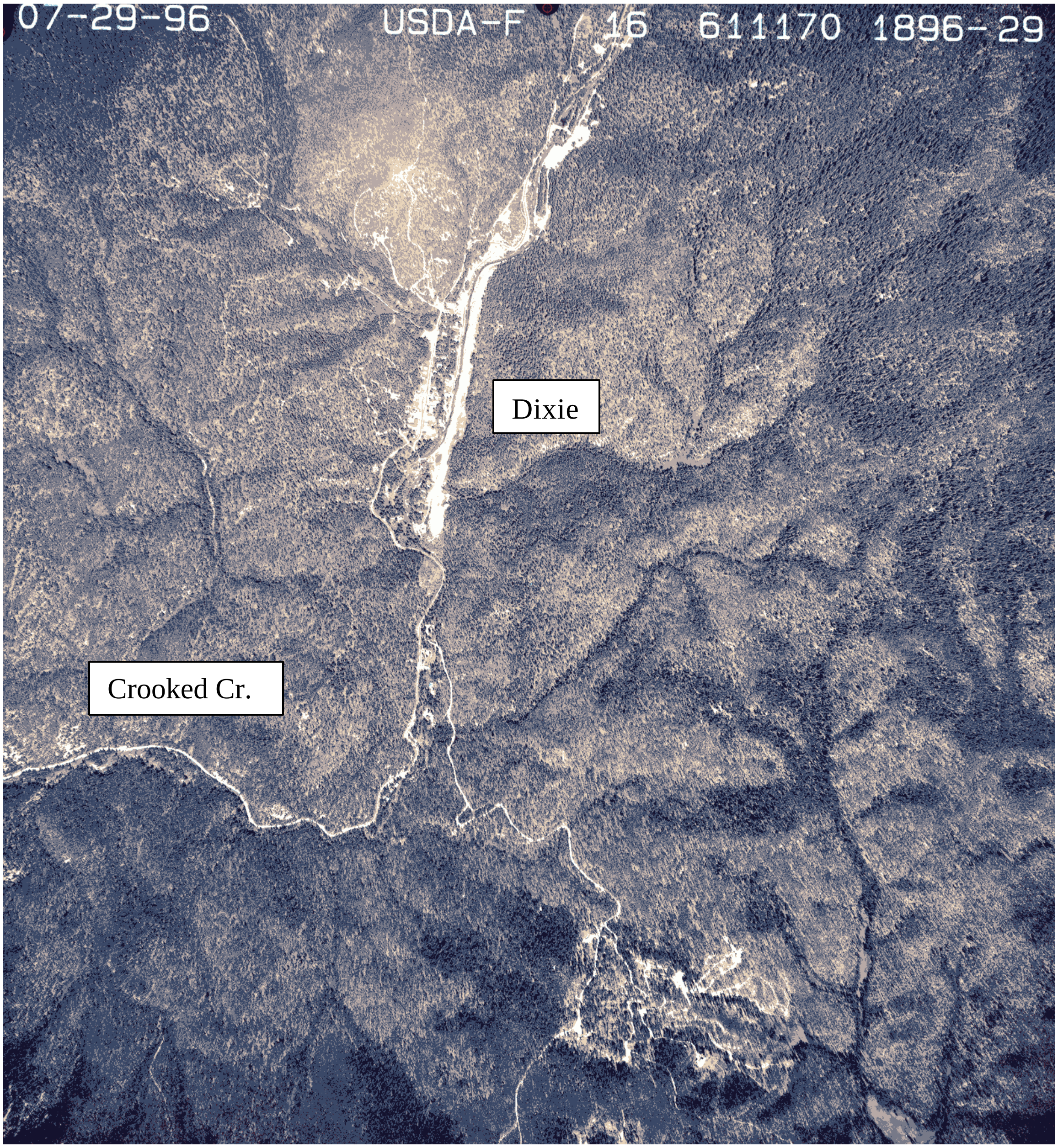



| **R/R²** |
|---|
| 0.7590048 |
| 0.5760883 |

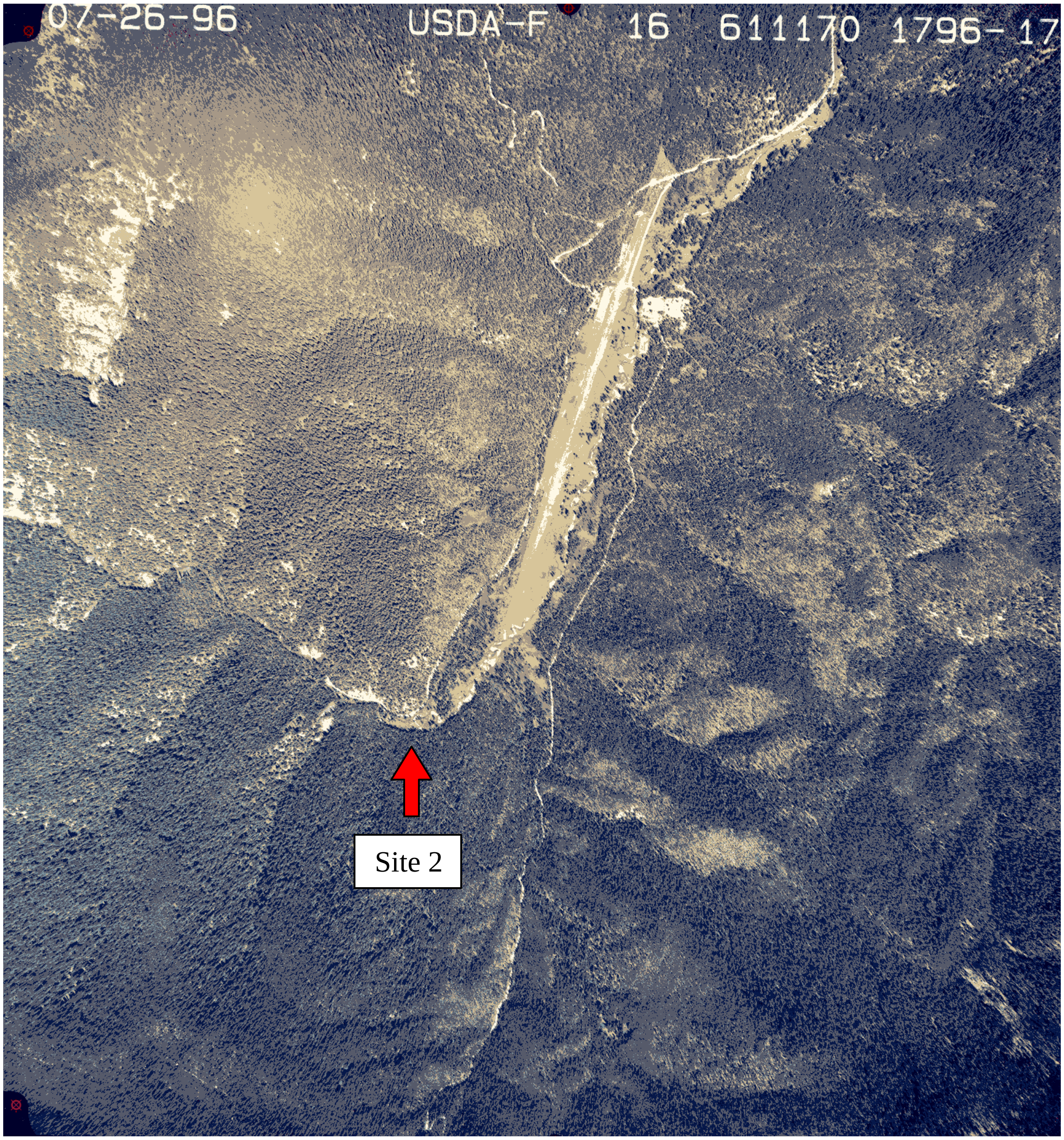
Approximate location of temperature logger Site 1 above Horse Flat Creek and dredge mining area. This site is upstream from the town of Dixie.



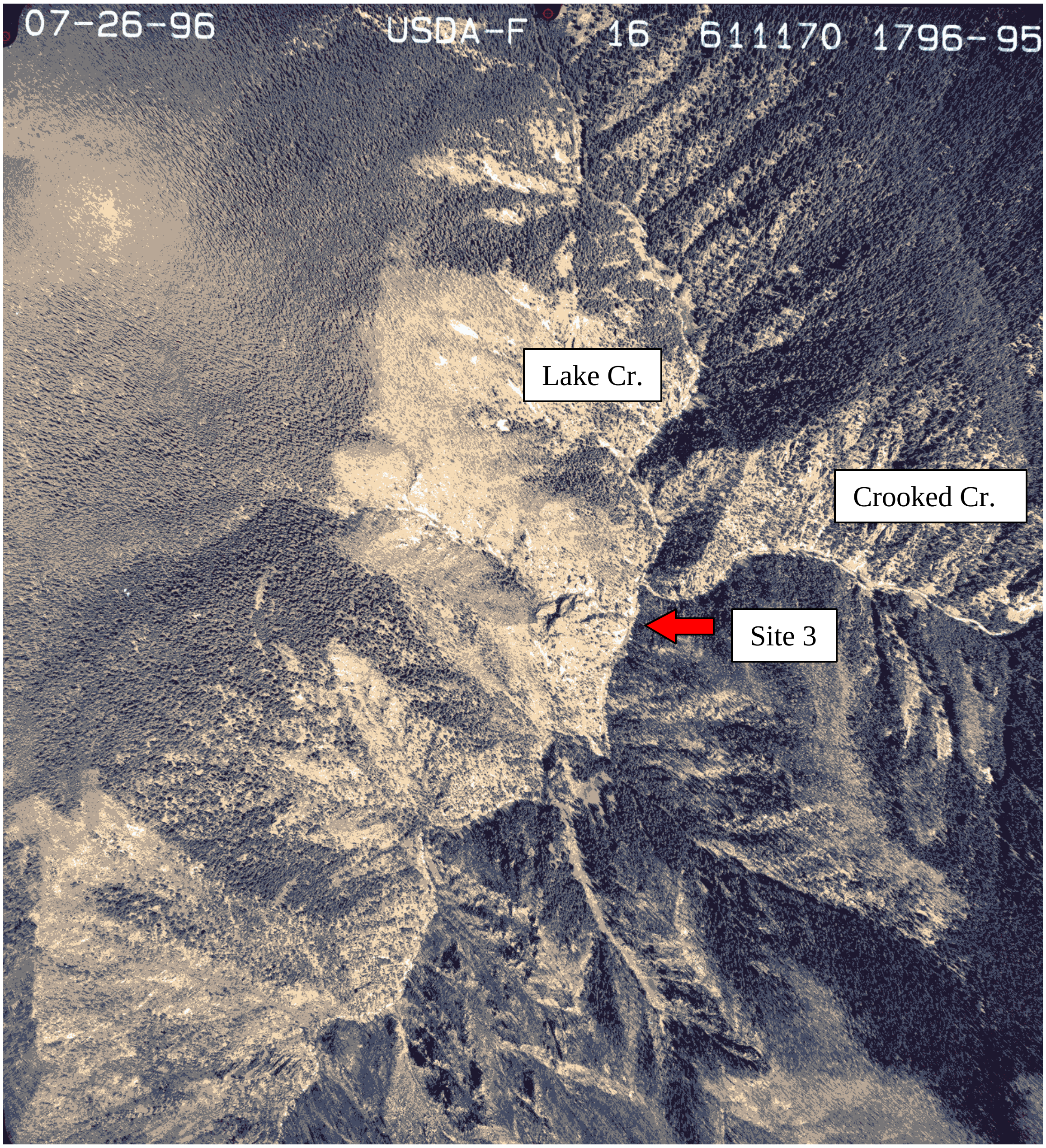
Aerial photograph of Dixie town site on Crooked Creek.



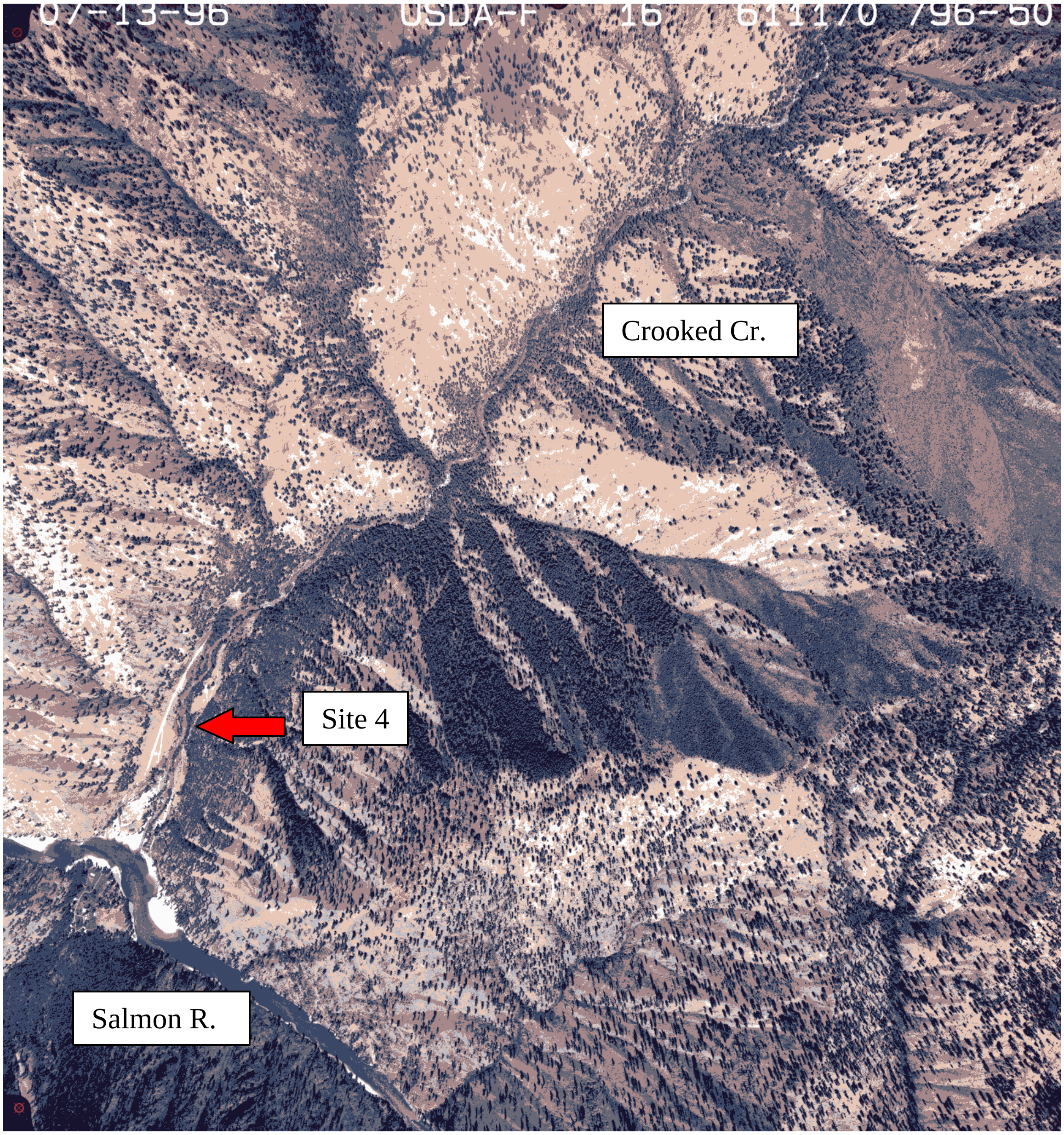
Approximate location of temperature logger Site 2 near Halfway House Campground.



Approximate location of temperature logger Site 3, 300 feet below the confluence with Lake Creek.



Approximate location of temperature logger Site 4, ¼ mile upstream from mouth of Crooked Creek.



# Appendix 7

# Response to Comments

## RESPONSE TO COMMENTS.

Three comment letters were received regarding the Mid-Salmon/Chamberlain Subbasin Assessment and Crooked Creek TMDL during its public comment period (January 17, 2001 to February 19, 2001). We have listed the substantive comments below (in italics) followed by IDEQ's reponse. Those comments that are typographical in nature are not listed, however, appropriate changes have been made to the document.

Nez Perce National Forest

> *We concur with most of the findings in the subbasin assessment. The TMDL is properly focused on upper Crooked Creek, which is the most highly impacted subwatershed within the Nez Perce National Forest portion of the subbasin. Whether this segment should have been delisted for sediment is arguable. However, implementing the water temperature TMDL would logically result in a watershed restoration plan that addresses sediment and channel morphology concerns, as well as riparian shade and water temperature.*

DEQ Response: Because sediment criteria in Idaho's water quality standards rely heavily upon narrative "free from" statements, it is often difficult to ascertain violations of standards for sediment pollution. Based on our analysis of BURP biomonitoring data, we were not able to detect serious beneficial use effects from sediment pollution. We are not saying there has been no affect due to elevated sediment loading. Rather we are saying the effects are not so severe as to violate water quality standards.

To produce accurate total maximum daily loads for sediment would require substantially more information than is available on either suspended or bedload sediment, or both to produce loadings based on mass/time or concentration, or on appropriate target surrogates. In order to commit to such work in the limited time frame established by the court-ordered TMDL schedule, serious beneficial use impairment should be realized.

We agree that addressing temperature should result in actions that improve sediment loads as well. Temperature data are easier to compare to numerical standards to determine violations. However, even with temperature there are substantial problems with application of standards in inappropriate areas. Often their application is based on legal requirements rather than actual biological necessities.

> *Executive Summary – The referenced Nez Perce NF sediment analysis of the main stem Salmon River incorporated additional information beyond NEZSED modeling. It included other data such as USGS sediment and streamflow data and BOISED modeling results provided by the Payette NF.*

*Executive Summary - The summary should state that the main stem Salmon River is recommended for removal from the 303(d) list.*

DEQ Response: We have made the requested changes to the executive summary.

*Page 13 – The contention that water temperature in upper Crooked Creek is too high due to timber harvesting is suspect. To our knowledge, there is no conclusive evidence to support this and we could not find that particular statement in the referenced Bull Trout Problem Assessment. We acknowledge that there is a high level of development in upper Crooked Creek, including riparian encroaching roads, stream channelization, residential development, mining, and timber harvest. These impacts, combined with natural factors, are likely working together to produce the observed water temperature conditions.*

DEQ Response: It was not our intent to implicate timber harvesting as an industry or activity, but it was to suggest that removal of vegetation from the valley of upper Crooked Creek as a result of a whole variety of activities led to the subsequent water temperature problem. However, the commentor is correct in that we did not accurately reflect the nature of the problem. We have made necessary changes to the document.

*Pages 13-14 – We do not suggest connecting a lack of documented bull trout spawning to high temperatures originating in the upper watershed. Temperatures in lower and middle Crooked Cr are probably more affected by aspect shading and the temperature and flow of Lake Cr. There is very little bull trout survey information for the Crooked Cr watershed. The only documented bull trout in the watershed were some reported in lower Crooked in IDFG's parr monitoring work. Bull trout have never been reported in upper Crooked Cr, but could be present as a small resident population in some obscure second-order tributary. If we find a "real" population of bull trout in Crooked Cr watershed, we suspect they'll be in one of the Big Cr or lower Lake Cr tributaries.*

DEQ Response: In both EPA's promulgated rule regarding Idaho's water quality standards and in Idaho's standards themselves, bull trout criteria are applied to the whole Crooked Creek watershed regardless of actual presence of the species. We attempted to make rational connections in the subbasin assessment where possible to correct or concur with this broad sweeping approach to water quality standards setting. Ideally, it would have been beneficial to know if in fact bull trout spawn anywhere in Crooked Creek and to apply the temperature criteria only to those portions where they actually spawn. We were unable to do that. Therefore, we assume bull trout spawning (or salmonid spawning in the case of other species) occurs in the locations where these species are observed. Because bull trout are suspected to be present in lower Crooked Creek, spawning is likewise suspected, at least in the context of applying spawning temperature criteria in water quality standards.

Because other salmonids are suspected to be present in upper Crooked Creek, salmonid spawning temperatures apply there as well.

The question of whether or not higher stream temperatures in the upper watershed affect bull trout spawning in the lower watershed is unanswerable at this point without further study of the temperature balance in the stream. The commentor may indeed be correct that lower watershed stream temperatures are more affected by aspect shading and the temperature and flow of Lake Creek than by stream temperatures in the upper watershed. However, improvements in water temperature at the upper watershed will benefit salmonid spawning in that area.

> *Page 14 – DEQ might want to contact Rob Leary (note the misspelling "Leery" in the document) of the Payette NF regarding the redband population in Fivemile Creek. Dave Mays' interpretation of this paper is that there are some differences in the Fivemile Creek population, but not to the extent portrayed in the Assessment.*

DEQ Response: Because Fivemile Creek is not a 303(d) listed stream in this subbasin, and the contribution of this information is relatively inconsequential regarding water quality and total maximum daily loads, the questioned information has been removed from the subbasin assessment.

> *Page 14 – Juvenile steelhead are also found in lower Sheep Creek. Also, critical habitat for spring/summer chinook and steelhead is mentioned for Chamberlain Creek and West Fork Chamberlain Creek, but also exists in other streams in the subbasin.*

> *Page 15 - Commercial logging is not planned in the foreseeable future in the area between the GH and Frank Church Wildernesses.*

> *Page 17 – For consistency, the segment of the Salmon River coded on Map 10 as "Wild River" only could be split in mid-river to show the "Wild River/FCRONR Wilderness" on the south side. A simpler option would be show the entire classified river reach as "Wild River" since the adjacent designations are already depicted. Although the Wild and Scenic River and Wilderness designations overlay each other on the ground, Forest Service management of the river corridor is premised on the senior designation, which is Wild and Scenic River in this case.*

> *Page 18 – Not all of the NPNF subwatersheds have road densities < 1 mi/mi$^2$.*

> *Page 21 – The mean annual and mean monthly flows referenced from NPNF, 1994 are estimates based on regional equations and reference stream gages. They should be portrayed as "estimated". This comment also applies to other pages where the same data are referenced. This was an oversight in the NPNF source document.*

*Page 22 - The way the first paragraph is written, it appears grazing and other management is solely responsible for high fine sediment levels.  Road construction probably has had the greatest contribution to fine sediment of any management action. The watershed is also composed of highly erosive geology, which may account for most of the sediment levels.*

*Page 24 – The War Eagle Mine is located southwest of Big Creek, but does not drain into Big Creek.  It is located along Fitz Creek, which drains into lower Crooked Creek.*

*Pages 22- 27 – California and Warren Creeks, as well as smaller watersheds on the south side of the Salmon River, were affected by the Burgdorf Fire in 2000.  A summary of changed conditions from this fire should be provided.  Information can be obtained from the Payette NF.*

*Page 31 – It is incorrect to say that the 1992 Watershed Condition Analysis criteria have not been used since that time.  The results of this analysis have been used for many purposes.  However, it is correct to say that the analysis has not been updated since 1992 using the identical set of criteria.*

*Page 45 – The reference for the six defined objectives should be given.*

*Page 49 – A map of the Crooked Creek watershed, showing sites 1-4 and the major tributaries would be helpful.*

*Page 49 – A reference should be provided for the CWE procedure.*

DEQ Response:  We have made the necessary changes to the document for all of these comments.

*Page 51 – The assumptions and limitations of the CWE regression equation should be summarized.  It would be interesting to know how different the results might be if the north Idaho temperature model were applied, since Crooked Creek is in a transition zone.*

DEQ Response:  The CWE model was abandoned in favor of EPA's effective shade modeling.

*Page 58 – Should there be some discussion of the approach and timing to be used to develop an implementation plan for the TMDL?*

DEQ Response: While it can be beneficial to address the approach and timing of implementation in the TMDL, such is not a requirement for approval under current regulations. There is also a largely practical consideration of completing an aggressive eight-year schedule on time. So, as a matter of policy DEQ has not been including implementation plans with TMDLs sent to EPA for approval. This is not to say implementation plans are not essential, but recognizes they often take considerable more time to negotiate than is allowed under the TMDL submittal schedule. Furthermore, how load reductions are to be achieved is more the province of land management agencies, individual stakeholders and point sources, than it is of DEQ. Thus it is DEQ's intent that implementation plans follow an EPA approved TMDL within 18 months, lead by designated management agencies for non-point sources and any point sources in the drainage. In the Crooked Fork this lead logically lies with the Forest Service in cooperation with the Idaho Department of Lands, the designated management agency in Idaho for forestry and mining related pollution.

Nez Perce Tribe

***Waterbody Assessment Guidance***

*Of major concern to the Tribe is the continued reliance this subbasin assessment places on the 1996 Waterbody Assessment Guidance (WBAG). The assessment utilizes this WBAG to make significant determinations, including the decision to delist for sediment the waterbodies in the subbasin that were on the approved 1998 303(d) list.*

*As you know, the Environmental Protection Agency (EPA) has expressed strong concern with the WBAG. In fact, IDEQ is currently completing the development of a new assessment process. Allowing continued use of the 1996 WBAG prevents the meaningful achievement of the Clean Water Act's goals of restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters.*

*Given the development of a new WBAG, the Tribe would recommend that IDEQ postpone finalization of this document pending approval of the new assessment guidance. While the Tribe recognizes that IDEQ is under a court approved schedule for completing Total Maximum Daily Load (TMDL) analyses for which the subbasin assessments are the basis, there is a process for seeking an extension of the deadline. Further, given the ongoing lawsuit over the TMDL schedule, there may be an opportunity to seek an extension through settlement discussions with the EPA and the plaintiffs. Compromising the scientific and legal defensibility of a decision not to pursue TMDLs for sediment in order to meet the TMDL schedule is not consistent with the goals of the Clean Water Act and with IDEQ's legal obligations to produce TMDLs that will lead to achievement of water quality standards.*

DEQ Response: Assessing the BURP data collected for this subbasin with the new Water Body Assessment Guidance (WBAG II) is warrented. We have included the information in the subbasin assessment and Appendix 8, the conclusions drawn from our WBAG II assessment is the same. In fact, these listed streams, including Crooked Creek, had some of the highest scores attainable under the WBAG II process. The fact remains that Crooked Creek would assess as not supporting salmonid spawning because of temperature criteria violations.

> *Insufficient data*
>
> *In several instances the document states that there is insufficient data available for the tributary in question. When there is insufficient data, the scientifically correct conclusion is not that water quality standards are met because there is no data to show that they are not, but rather that further investigation is needed. Also, output from the NEZSED model, the results of which the document states have a great deal of uncertainty, ought not to be used without field verification. Similarly, the document states that there is speculation that some exceedances of water quality standards are due to natural conditions. In the absence of data clearly supporting such claims, they are as stated simply speculation.*

DEQ Response: We agree that further investigation would provide a clearer picture. In order to more accurately perform these assessments and analyses, more data and further investigation would be helpful. However, we often do not have that luxury and must make due with the level of information that is available at the time. In this particular case, we relied heavily upon our own biomonitoring results, the Forest Service sediment yield modeling, and the fact that substantial portions of the subbasin is in wilderness status. None of these processes is perfect or infallible, however, together they provide sufficient evidence that these streams, relative to other streams in the state, are in reasonably good shape.

> *Sediment criteria*
>
> *Since the sediment criteria are mainly narrative, it can be difficult to clearly define what conditions constitute a violation of that standard. In addition, as stated in the document, turbidity and intergravel dissolved oxygen, two quantitative measures used in assessing sediment, are rarely used in the backcountry that comprises most of this subbasin.*
>
> *To address this problem, the Cottonwood Creek TMDL document used surrogate sediment measures for their coarse sediment TMDL. Those measures included bankfull channel width to depth ratio, pool frequency, residual pool volume, and depth fines. Such data could well apply in this subbasin. These surrogate measures are a more quantitative determination of support of beneficial uses than the macroinvertebrate index (MBI) and*

*habitat index (HI) used in the assessment. MBI does not accurately reflect local conditions, and HI is very subjective.*

DEQ Response: The Cottonwood Creek TMDL may have used such surrogate measures in determining coarse estimations of load, however, Cottonwood Creek was originally assessed as not supporting uses by the same 1996 WBAG process used here. Only after it was demonstrated through assessment of BURP data that Cottonwood Creek is indeed impacting uses and in need of a TMDL were surrogate measures used to produce the actual TMDL. This is usually out of necessity for the lack of other kinds of data. The surrogate measures themselves cannot provide enough information on the impacts to beneficial uses.

***Big Creek:*** *The document states that there are localized impacts from grazing, including bank sloughing, loss of cover, sedimentation, and soil compaction in this basin, but that the impacts are considered minor with little impact on overall Crooked Creek watershed condition. Is there quantitative data to support this conclusion?*

***Big Mallard Creek:*** *This creek is of concern due to the presence of chinook juvenile rearing or spawning and steelhead. According to the document, there are high levels of deposited sediment in the sub-watershed, and some evidence of damage to streambanks. The past and present timber harvest and grazing in this sub-watershed likely contribute to that sediment. Measures of habitat quality as determined in the National Marine Fisheries Service's "Matrix of Pathways and Indicators of Watershed Condition" (Matrix) as adapted by the Cottonwood BLM, Clearwater National Forest, and Nez Perce National Forest provide a means to further assess Big Mallard Creek. In that sub-watershed, cobble embeddedness above the falls is 40 to 80%. According to NMFS's Matrix, cobble embeddedness greater than 30% is an indicator of low habitat quality. That same document lists percent fines greater than 25% as an indicator of low habitat quality. According to data in Table 7, several reaches of Big Mallard Creek have percent fines above that value. These data call into question the conclusion that beneficial uses are being supported.*

***Little Mallard Creek:*** *The extent of the presence of chinook juvenile rearing or spawning is not clear from the document. There are seemingly contradictory statements regarding their presence. The impact of the hydropower plant is also not clear. The stated cobble embeddedness of less than 25% falls within the NMFS Matrix range for moderate habitat quality. The range of percent fines, 17 to 35, covers all NMFS Matrix habitat quality groups. Although those numbers are decreasing, we agree that there is too little data to say there is a trend. Data in Table 13, however, seem to indicate there are parts of Little Mallard Creek with very high percent fines. Here again, more data seem to be needed.*

***Rhett Creek:*** *This is another sub-watershed with spring/summer chinook rearing that has significant habitat degradation, mostly due to mining impacts. As stated in the document, the Black Diamond Mine is active and contributing sediment to a tributary of Rhett Creek. The Robinson Creek Mine in the upper watershed was still a source of sediment in 1994, and it is likely that the sediment will move through the system to lower reaches. There is also sediment from placer mines, timber harvest, and roads. Additional timber harvests are planned. In upstream reaches where mining activities are taking place, we question the conclusion that beneficial uses are being supported.*

***Jersey Creek:*** *The document states that parts of this sub-watershed were clear cut, there was past mining activity, and light grazing is occurring. The extent of these activities, however, is not given. Since there are anadromous fish several miles above mouth, the possible sediment impacts from these activities is of concern. It seems that more data is needed to determine whether sediment is a water quality problem.*

DEQ Response: The document states that clear cutting amounted to 96 acres or less than one percent of the Jersey Creek watershed, which is a relatively small area. Observations and descriptive language found in agency documents cannot be substantiated or concluded as violations of water quality standards. Often an agency document will report that a stream has been "affected" or "impacted" by some activity, or that sediment is high in areas, however the degree may be highly variable. Water quality standards act as threshold values for pollutants the violation of which can be identified by impaired uses. We relied upon assessment of BURP data and Forest Service sediment yield modeling to guide us on whether or not sediment loads to a creek were adversely affecting beneficial uses and violating water quality standards.

***Crooked Creek:*** *This is another sub-watershed of particular concern due to the presence of chinook juvenile rearing or spawning, and its importance in terms of fish production. The area has several known significant habitat impacts. As the document states, the biggest impact is from dredge mining. The history of mining along with the presence of unvegetated tailings indicate a likelihood of water quality degradation from acid mine drainage and toxic metal or chemical contamination. The Nez Perce Tribe would like to encourage data collection to ascertain whether or not these pollutants exist in waters adjacent to and downstream from mining areas.*

*Mining along with other habitat disturbances in the sub-watershed are likely contribute to sedimentation. Since the 1992 Porcupine Creek fire in the wilderness portion of the sub-watershed, numerous debris torrents and other mass movement events have been documented. The document also states that there is high sediment delivery and deposition in upper reaches. Past timber harvesting and grazing, which are often sources of* *sediment to streams, have occurred in the area. In addition, the entire length of Crooked Creek outside of the wilderness is paralleled by roads, another major source of sediment.*

*The existing data for the sub-watershed indicate that sedimentation is a water quality problem. The document states that in 1987-88 there was high existing sediment deposition. Cobble embeddedness as given in the document is 53 to 67%, which is above the 30% given in NMFS's Matrix as indicating of low habitat quality. In addition, the document states that in upper Crooked Creek there are low pool to riffle ratios, a lack of woody debris, and poor stream channel conditions with large amounts of sediment running through the system. Even the macroinvertebrate assemblages indicated that Crooked Creek is experiencing some impact from sediment. This does not sound like a sub-watershed where sediment is not a water quality problem. At the very least, habitat indicators clearly reflect that beneficial uses are not being supported.*

DEQ Response: Crooked Creek is indeed affected by sediment pollution, especially in the upper watershed where development and a century of placer and dredge mining has taken place. This type of mining usually does not result in, and we are not aware of, acid mine drainage or an excess of heavy metal pollution in this watershed. The degree to which the sediment in the system created by these activities is impacting beneficial uses is not a forgone conclusion as a consequence of presence of the activities. Yes, sedimentation has been increased, and likely was even greater during the era of extensive mining, and is now improving. Assessment of BURP data indicates that these streams are supporting their uses. The surrogate measures mentioned do suggest that there is still sediment moving through these systems as a result of activities and from naturally erosive geology. However, these measures have not been reliable in directly translating into beneficial use impacts. High cobble embeddedness, for example, does not necessarily mean uses are not supported.

***Warren Creek:*** *According to the document, this area has major habitat impacts associated with a long history of both placer and lode mining activities. It has been extensively dredge mined with dredge piles in the upper basin confining the stream. Dredged areas also lack vegetation, increasing the likelihood of sediment being washed into the stream and the leaching of toxic materials, especially since many ore and/or tailings piles border streams. In addition, as the document states, the dredged areas lack pools, winter habitat, overhead vegetation, and woody debris. The four active lode mines as well as past lode mining sites are additional likely sources of acid mine drainage and toxic metal contamination. Roads to mines and timber harvest also add sediment and pollutants to the stream.*

*The document acknowledges the habitat degradation in Warren Creek, but based on MBI and HI values alone considers this sub-watershed as fully supporting its aquatic life uses. Habitat factors, though, point to poor habitat quality in the mined areas of the sub-watershed. The Nez Perce Tribe suggests that sediment surrogates be used to further evaluate sedimentation, and that acid mine drainage and toxic metal contamination be investigated.*

DEQ Response: Warren Creek is listed on the 1998 303(d) list as impaired due to habitat alteration. The stream was not listed for sediment. Assessments of BURP data and Forest Service inventory of percent fines (15%) suggested to us that the stream did not have a serious sediment problem requiring us to address this unlisted pollutant. However, we do agree that the affects a mining activities have demonstrably altered the habitat around Warren Creek. We believe Warren Creek should stay on the 303(d) list for habitat alteration. This was incorrectly addressed in the document. We have modified the document to state that Warren Creek should remain on the 303(d) list for habitat alteration. However, there is no load reduction a TMDL can specify for Warren Creek that will lead to improved habitat conditions. This will require active restoration efforts beyond the scope of a TMDL.

*Crooked Creek TMDL*

*It is not clear that a model developed for southern Idaho is truly applicable to the Crooked Creek sub-watershed. Regardless, it is important to field check model results. It must be kept in mind that model output numbers are always estimates. The Nez Perce Tribe suggests that other methods to decrease stream temperatures in addition to increasing canopy cover be considered. Decreasing stream width to depth ratios is mentioned in the "Load Allocation" section, but is it not clear if that approach will be investigated.*

DEQ Response: The CWE model has been replaced by effective shade modeling.

We agree that decreasing width-to-depth ratios may be an important mechanism for improving stream temperatures. The document inadvertently described it as "increasing" width-to-depth ratios. This has been corrected. In this case, the degree to which changes in width-to-depth ratio will be employed as a means of correcting the problem is a matter for the implementation plan to address.

Environmental Protection Agency

**General Comments on the Subbasin Assessment**

*Given the documented problems described for many of the tributaries, the fact that they are judged to be fully supporting their beneficial uses needs some additional explanation.*

*It is not enough to say that disturbance is relatively low compared to other parts of the state or that much of the sub-basin is designated wilderness. There are multiple lines of evidence that point toward environmental effects of fine sediment in some locations. It would help to describe how the locations where the beneficial uses were evaluated are spatially related to the disturbances described in the text.*

*If the disturbances are relatively localized in relation to the scale of the watersheds, is there any way to quantify that to provide a better perspective on watershed condition? Some assurance that the locations selected for beneficial use evaluation are representative of the overall condition of the stream segment would strengthen this position. For three of the streams, there were evaluations of both upper and lower parts of the segment, so it looks like some efforts were made to address this issue.*

DEQ Response: DEQ BURP monitoring procedures attempt to sample streams in at least two locations, an upper watershed site and a lower watershed site, whenever possible. However, access problems tend to limit when that occurs. In these particular streams, access is limited by roadless areas. Crooked Creek, for example, has two BURP sites, one near the wilderness boundary at the end of the access road, and the other 4-5 miles upstream closer to the town of Dixie. However, both sites are below the major points of impact for that stream. Two sample locations were obtained for other streams in the subbasin including Big Creek, Warren Creek, and Big Mallard Creek. However, only one sample location was obtained from each of Jersey Creek, Rhett Creek, and Little Mallard Creek. Most streams were sampled near their mouth with the exception of Rhett Creek, which was sampled in the middle of the watershed.

We have used the sub-watershed description section as a way to communicate what land management agencies have said about past and present activities and conditions in the watershed. We expect this information to be anecdotal and treat it as such. There is no way to interpret what others may describe in terms of water quality standards violations or beneficial use impairment. In order to assess whether or not the stream is meeting standards or protecting beneficial uses, we rely on our water body assessment process and actual data provided by management agencies that demonstrates a problem. In this particular case, we did not see sediment problems sufficient to require a TMDL for sediment. The descriptions of disturbances in watersheds may be localized, historic, or otherwise not affecting the biology of the streams as measured by our assessment process.

Our choices at this point are to go through the document and eliminate this anecdotal information or to describe it as anecdotal and let it remain in the document. We have chosen the later.

**Specific comments / suggestions**

*P 1. "Warren Creek... cannot receive a load allocation for habitat alteration. No TMDL is provided." I suggest adding text explaining that no TMDL is required for a stream listed only for habitat alteration.*

*P 7. The text refers to the Idaho batholith, but the batholith is not specifically denoted on the geologic map. It would help to clarify by adding text to be specific. (Not all readers will know that the batholith is of Cretaceous age, which is how it is labeled in the map legend.) Alternatively, the map legend could be changed, but it seems easier to clarify in the text. Also, since the batholith is known to develop into erosive soils, it would be useful to know what proportion of the sub-basin is underlain by batholithic rocks.*

*P 13. The document states that "there may be other portions of the sub-basin burned this year before the fire season is complete." This reference was to the 2000 season, so it seems likely it could be updated by now.*

*P 18. The reference to the natural sediment yield needs a citation and a brief description of how the estimate was derived (NEZSED?) and what parameters it is based on.*

DEQ Response: We have modified the text to present things more clearly and to address these comments.

*P 36. According to the Nez Perce NF, Warren and upper Crooked creeks are "targets for rehabilitation." Is there any additional information that could be provided here regarding the type and scale of the rehabilitation?*

DEQ Response: This particular question led us to discover that most of the dredged areas in Warren Creek are in private holdings and are not targeted for any kind of restoration. The Payette National Forest is doing some trail relocation and road maintenance work in the Warren Creek drainage, but not directly associated with the dredge mining areas. Portions of the dredged area in Crooked Creek are also in private ownership associated with the town of Dixie. The Nez Perce Forest does not have any immediate plans to do any stream restoration work in the Crooked Creek drainage as there are other higher priority places on their radar screen. The short answer is that we were incorrect, and these areas are not target for rehabilitation anytime soon.

*Table 11, p 37*
*The table would be easier to comprehend if it were more clear what "high" and "low" refer to in some places. For example, is "high" under embeddedness referring to the degree of embeddedness or the quality of the condition as indicated by embeddedness? It seems to be the former. (With other indicators, it is more clear where the word "condition" is in the previous column, such as for width-depth ratio, where "low" means poor condition, not low ratio)*

*P 37-38*
*Model estimates indicate that the "activity-related" sediment is a very small part of the total sediment yield of the subbasin (0.05% from the north side, so even as an order of magnitude estimate, it is very small). Estimates of "accrued" sediment showed 12% as coming from human activities. A much greater proportion of the human-caused sediment is not leaving the subbasin, though the percentage is still relatively low. Why is there such a large difference? Is this primarily because so much of the "accrued" activity-related sediment has its source in the South Fork? It might be worth emphasizing this, if that is the case, since activities within the Main-Salmon-Chamberlain subbasin cannot have any effect on sediment sources elsewhere.*

*P 38. The dose of reality presented by the caveats in the second footnote below the sediment modeling yields is appropriate and appreciated. There has already been a lot of discussion in the document that relies on these modeling results, however, so it would be better to point out model limitations sooner in the sub-basin assessment**B**at least to introduce the idea that these estimates are best used in a relative, rather than an absolute sense.*

DEQ Response: We have modified the text to present things more clearly and to address these comments.

**Load Allocation for Temperature TMDL, Crooked Creek**

*Temperature TMDLs by nature have to be somewhat creative with regard to deriving targets and describing loading capacity and load allocations. This TMDL uses some creative approaches that are potentially useful, but it needs to provide more information in several areas.*

*The CWE (Cumulative Watershed Effects) temperature model needs more explanation, for example, since so much of the analysis depends upon it. How much validation has it had and where was it validated? Given that the citation in the TMDL is a personal communication from Idaho Department of Lands, additional information is needed.*

*Although no real citation or model documentation is provided here, EPA is currently reviewing some work that DEQ is doing comparing CWE results to SSTemp and HeatSource models and other comments on the use of the CWE model in general may be forthcoming from EPA.*

*As with the use of any model, one of the first steps should be to demonstrate that the model is appropriate for this particular application in this particular place. How was the model adapted for use in southern Idaho? Has the model been validated? If so, where and under what conditions was it validated and how similar is that location to the one in question?*

*Another step is to discuss the inherent uncertainties associated with the model, as well as to point out which input parameters it is most sensitive to. It would also help to explain the significance of the modified Palmer Drought Severity Index to the model, since that seems to be a fundamental input parameter. As I understand it, the Palmer Index is not designed for use in mountainous terrain and assumes all precipitation to be rainfall. How would this assumption be expected to affect the model results in this mountainous subbasin, where snowpack is clearly an important aspect of the basin hydrology? Would it affect model results conservatively, non-conservatively, or unpredictably? The model does not have to be discussed exhaustively, but some fundamental pieces of information are needed to strengthen the analysis.*

*Looking at Table 17, I see that the modeled canopy cover percentages at a given location are quite variable. For example, site 1 ranges from 51-75%, site 2 from 0-34%, site 3 from 53-88%, and site 4 from 61-97%. I assume that there were no activities or natural events that caused actual canopy cover changes of this magnitude. If that is the case, what does this variability mean in terms of the estimating capability of this model in this watershed? Do those ranges represent the inherent uncertainty in the technique, or is there something that can be done to narrow them? Would it help to compare the modeled canopy cover to some measurements of canopy cover?*

*On the other hand, the model results, when averaged, do show the relative differences among the sites in a consistent way that makes sense with regard to what is known about the measurement locations. What does the variability described above tell us about the absolute value of the numbers shown on Table 18? Shouldn't those also be considered to represent one point within a relatively wide range? (The table shows ranges of canopy cover of 24 to 36 percentage points for a given location.)*

*Even with the inherent uncertainties discussed above, the model does seem useful as a way to make a link between canopy cover and temperature standards. Using it to predict existing canopy cover based on temperature data seems a little odd, however, since canopy cover information is not too difficult to obtain either through direct measurements or estimates from aerial photography. It seems there are only two actual measurements of canopy cover reported for the watershed. Since canopy cover is the link with the targets, the analysis would be strengthened by having less uncertainty regarding the existing conditions that correspond with the temperature measurements presented.*

DEQ Response: We have revised the TMDL considerably based on these comments. EPA has provided effective shade modeling to replace the CWE model. We obtained aerial photos for Crooked Creek and analyzed them for canopy cover for comparison to model predictions, and in deed found some unique results that we had not anticipated before. Finally, throughout the document we have provided better descriptions and have attempted to clarify all of the above concerns.

We have not changed the outcome of the TMDL. We believe that an increase in canopy coverage and improved channel characteristics in the affected area is all that is necessary to improve temperature.

*The section on TMDL targets is difficult to understand.*

*Some specific suggestions:*

*P 51 "Sites 3 and 4 are within the wilderness area and canopy coverage estimates are considered natural." It seems that it would be useful to know what these natural canopy coverage amounts are rather than having to rely on modeled coverage percentages.*

*P 51 It would be helpful if you pointed out what segments the IDEQ canopy measurements were made in. The landmarks used are different for those used to describe the temperature monitoring sites.*

DEQ Response: We have addressed these concern with our aerial photo analysis.

*P 51 The CWE model predicts that >100% canopy cover would be required to meet the bull trout criterion at any elevation less than 6000 feet, "suggesting this criterion is unattainable in Crooked Creek." Might it not be suggesting that the model results are not very precise due to necessary simplifications and that canopy cover should be <u>maximized</u>?*

*Table 20 is confusing. Perhaps some additional text walking through one of the examples would make it more clear. I think the confusion is due to the combination of discussing rate of change of temperature, the number of days of exceedances, and then the "rates of change in number of days exceeding criteria." (A graph showing the temperature increase expected downstream due to elevation alone compared with the measured downstream increases would help to illustrate the rate changes as well as the differences between current conditions and conditions that would meet the temperature criteria.)*

*P 56 The last sentence in the first paragraph summarizes what I'm finding most confusing about this section. "The average rate of change in number of days exceeding 10EC (7 day moving average of maximum daily water temperatures) needs to decrease from 19 days to about 9 or 10 days." I would suggest how to change it if I understood what it meant. I don't actually know what it is that is changing from 19 days to 9 or 10 days. The difference in the number of "exceedance days" between two locations? Or the absolute value of the number of days exceeding the standard? It is not unreasonable to expect that the standard might be exceeded from time to time. What is important is to be clear about just how often you'd expect the standard to be exceeded. It could be expressed as a number of days per year or based on a specific statistic describing air temperature during anomalously hot summers.*

DEQ Response: We have made changes to the text to provide better explanations to confusing areas.

# Appendix 8

# Results of the new Water Body Assessment Guidance (WBAG II)

| BURPID | STREAM | ECOREGION | MBI | SMI | SMI score | SHI | SHI score | SFI | SFI score | average score |
|---|---|---|---|---|---|---|---|---|---|---|
| 1996SIDFZ098 | CORN CREEK | NORTHERN ROCKIES | 4.69 | 69.97 | 3 | 70 | 3 | | | 3 |
| 1996SIDFZ099 | BEAR BASIN CREEK | NORTHERN ROCKIES | 3.87 | 53.72 | 2 | 62 | 2 | | | 2 |
| 1996SIDFZ100 | CRAMER CREEK | NORTHERN ROCKIES | 3.05 | 45.32 | 1 | 55 | 1 | | | 1 |
| 1997SLEWA013 | RHETT CREEK | NORTHERN ROCKIES | 4.78 | 87.06 | 3 | 65 | 2 | 76.23 | 2 | 2.33 |
| 1997SLEWA014 | BIG CREEK(LOWER-UPPER) | NORTHERN ROCKIES | 4.55 | 71.4 | 3 | 74 | 3 | | | 3 |
| 1997SLEWA015 | BIG CREEK(UPPER-UPPER) | NORTHERN ROCKIES | 4.2 | 76.77 | 3 | 71 | 3 | | | 3 |
| 1997SLEWA016 | EUTOPIA CREEK | NORTHERN ROCKIES | 4.37 | 77.33 | 3 | 71 | 3 | | | 3 |
| 1997SLEWA017 | LITTLE MALLARD CREEK | NORTHERN ROCKIES | 3.79 | 65.48 | 3 | 87 | 3 | | | 3 |
| 1997SLEWA018 | MCGUIRE CREEK | NORTHERN ROCKIES | 4.25 | 68.84 | 3 | 69 | 3 | | | 3 |
| 1997SLEWA022 | WARREN CREEK(UPPER) | NORTHERN ROCKIES | 4.42 | 75.2 | 3 | 53 | 1 | | | 2 |
| 1997SLEWA023 | WARREN CREEK(LOWER) | NORTHERN ROCKIES | 4.5 | 69.1 | 3 | 57 | 1 | | | 2 |
| 1997SLEWC011 | CROOKED CREEK(LOWER) | NORTHERN ROCKIES | 4.48 | 64.53 | 3 | 63 | 2 | | | 2.5 |
| 1997SLEWC012 | BIG MALLARD CREEK(UPPER) | NORTHERN ROCKIES | 4.82 | 81.97 | 3 | 71 | 3 | 38.5 | 1 | 2.33 |
| 1997SLEWC013 | NOBLE CREEK | NORTHERN ROCKIES | 5.03 | 90.98 | 3 | 83 | 3 | 98.81 | 3 | 3 |
| 1997SLEWC014 | JERSEY CREEK | NORTHERN ROCKIES | 4.49 | 69.78 | 3 | 86 | 3 | 99.07 | 3 | 3 |
| 1997SLEWC015 | BIG MALLARD(LOWER) | NORTHERN ROCKIES | 4.55 | 71.63 | 3 | 72 | 3 | 28.65 | 0 | 2 |
| 1997SLEWC016 | CROOKED CREEK(UPPER) | NORTHERN ROCKIES | 4.03 | 66.23 | 3 | 69 | 3 | | | 3 |
| 1999SLEWA005 | BARGAMIN CREEK | NORTHERN ROCKIES | 4.82 | 83.3 | 3 | 86 | 3 | | | 3 |
| 1999SLEWA006 | BIG MALLARD (UPPER) | NORTHERN ROCKIES | 4.67 | 83.61 | 3 | 78 | 3 | 58.8 | 1 | 2.33 |
| 1999SLEWA027 | WIND RIVER | NORTHERN ROCKIES | 5.25 | 86.58 | 3 | 89 | 3 | 99.5 | 3 | 3 |