Pend Oreille Lake and River Tributaries

TMDL Five-Year Review

Final

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TMDL Five-Year Review

August 2017

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Table of Contents

List of Tables

List of Figures

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Executive Summary

This total maximum daily load (TMDL) 5-year review evaluates water bodies with US Environmental Protection Agency (EPA)-approved TMDLs found in two TMDL documents:

1. *Clark Fork/Pend Oreille Sub-Basin Assessment and Total Maximum Daily Loads* (DEQ 2001, hereafter referred to as the Clark Fork/Pend Oreille TMDL)
2. *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007), an addendum to the Clark Fork/Pend Oreille TMDL

The TMDLs address a large number of water bodies—too many to cover in one 5-year review. Therefore, only water bodies in the Pack River, Sand Creek, and Pend Oreille River watersheds are evaluated under this review. Water bodies in the Clark Fork watershed and water bodies that are tributaries to the eastern shoreline of Lake Pend Oreille will be deferred to another 5-year review process. Temperature and nutrient addendums approved by the EPA in 2008 will also be addressed in a separate TMDL review. This 5-year review evaluates TMDLs for 42 assessment unit-pollutant combinations for sediment and one assessment unit-pollutant combination for dissolved oxygen (Figure A).

This 5-year review has been developed to comply with Idaho Code §39-3611(7). The review describes the existing TMDL(s), beneficial use support status, pollutant sources, current water quality data, and recent pollution control actions in the Pend Oreille subbasin, located in northern Idaho. The results of this evaluation are summarized below.

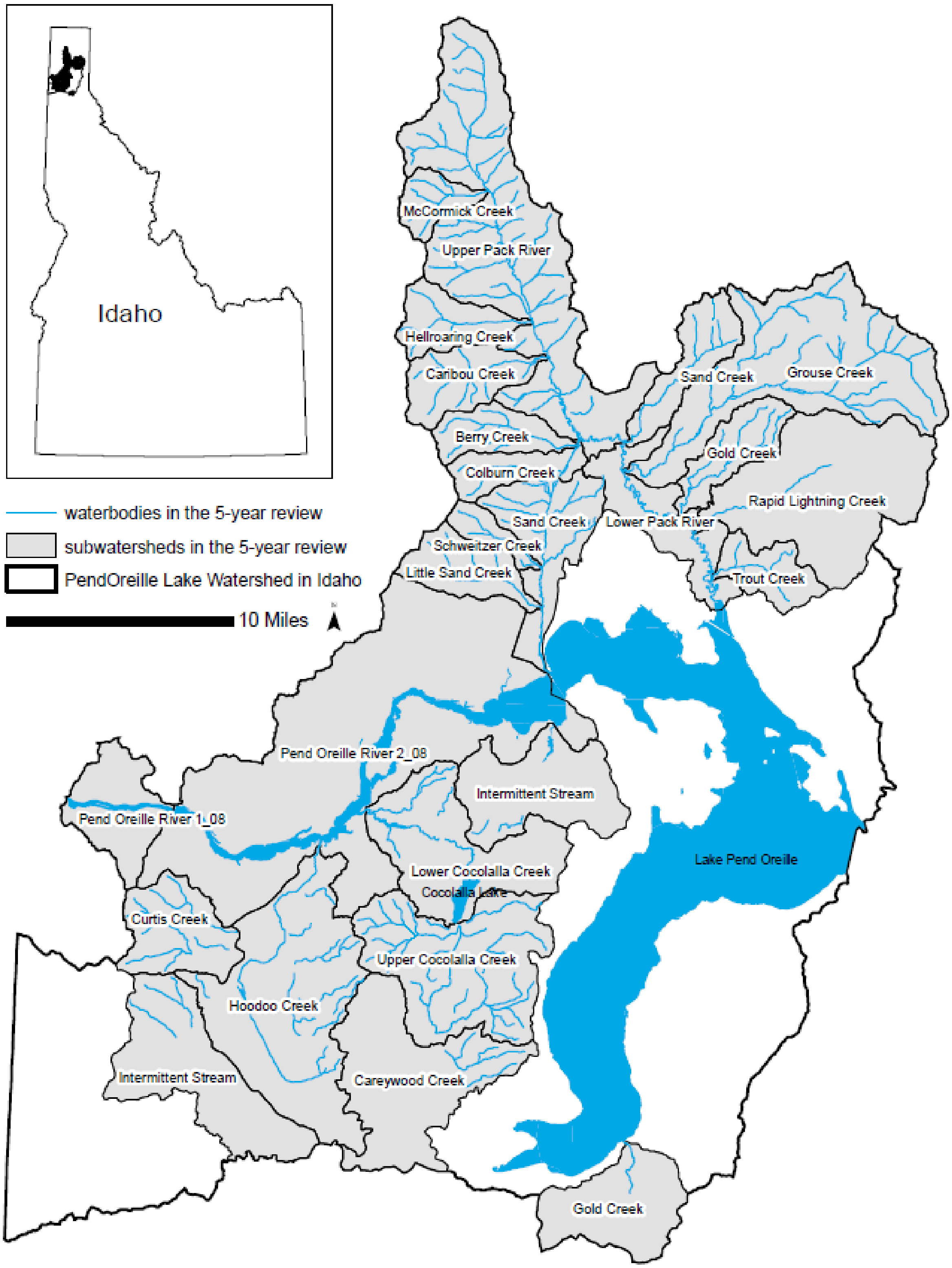


Figure A. Water bodies addressed in this total maximum daily load 5-year review.

Berry Creek (ID17010214PN046_02)

Beneficial Use Support Status: Berry Creek (ID17010214PN046_02) is a 3rd-order tributary to Colburn Creek in the Pack River system. It flows into Colburn Creek approximately 0.25 miles upstream of the confluence of Colburn Creek and the Pack River. Berry Creek Listed in Idaho's 2012 Integrated Report as not supporting the cold water aquatic life use due to sediment impairment. According to the Clark Fork/Pend Oreille TMDL and the Pend Oreille tributaries sediment TMDL, the watershed is the third-highest sediment loading watershed per acre.

TMDL Implementation Projects Completed: Road maintenance, road resurfacing, road closures, bridge replacement, and improved road crossings.

Evidence of Beneficial Use Support: This creek has never been evaluated using the Idaho Department of Environmental Quality's (DEQ's) Beneficial Use Reconnaissance Program (BURP). Idaho Department of Fish and Game (IDFG) data suggest a good population of Westslope Cutthroat Trout.

TMDL 5-Year Review Recommendations: Habitat conditions are poor due to excessive bedload. TMDL sediment load reductions have not been met, and the creek is still impaired. This assessment unit (AU) will remain under the constraints and guidelines of the *Clark Fork/Pend Oreille TMDL* (DEQ 2001).

Caribou Creek (ID17010214PN045_02)

Beneficial Use Support Status: Caribou Creek (ID17010214PN045_02) is a 3rd-order tributary to the Pack River. It is listed in Idaho's 2012 Integrated Report as not supporting its cold water aquatic life use due to sediment impairment. Salmonid Spawning is currently incorrectly listed as full support. This use should have been listed as impaired with sediment as a cause.

TMDL Implementation Projects Completed: Road maintenance, road resurfacing, road closures, culvert and bridge replacements, and improved road crossings.

Evidence of Beneficial Use Support: BURP data indicate excellent habitat, fish, and macroinvertebrate conditions. IDFG data suggest a good population of Westslope Cutthroat Trout and Bull Trout. Data collected under this 5-year review indicate the stream is in excellent condition

TMDL 5-Year Review Recommendations: Re-evaluate for beneficial use support using the BURP protocol before the year 2018. If data indicate the stream is fully supporting beneficial uses, remove the AU from Category 4a in Idaho's Integrated Report and move to Category 2 showing full support of beneficial uses..

Colburn Creek (ID17010214PN047_02)

Beneficial Use Support Status: Colburn Creek (ID17010214PN046_03 and ID17010214PN047_02 and ID17010214PN046_03) is a 2nd-order tributary to the Pack River. It is listed in Idaho's 2012 Integrated Report as not supporting the cold water aquatic life use due to sediment and phosphorus impairments.

TMDL Implementation Projects Completed: None known.

Evidence of Beneficial Use Support: No BURP data exist and a representative reach was not evaluated during this 5-year review due to a lack of access. Beneficial use support and TMDL loading cannot be evaluated at this time.

TMDL 5-Year Review Recommendations: This AU will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL (DEQ 2001).

Gold Creek (ID17010214PN034_02)

Beneficial Use Support Status: Gold Creek (ID17010214PN034_02) is a 3rd-order tributary to the Pack River. Its confluence with the Pack River is approximately 4 miles upstream of the State Highway 200 crossing. In Idaho's 2012 Integrated Report, Gold Creek was listed as not supporting the aquatic life beneficial use due to sediment and temperature. Gold Creek also does not support the salmonid spawning beneficial use due to temperature.

TMDL Implementation Projects Completed: None known.

Evidence of Beneficial Use Support: No BURP data exists, and a representative reach was not evaluated during this 5-year review due to lack of access. Beneficial use support and TMDL loading cannot be evaluated at this time.

TMDL 5-Year Review Recommendations: This AU will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL.

Grouse Creek headwaters with 1st- and 2nd-order tributaries, Chute, Flume, Plank, South Fork Grouse, Taffy and Wylie Creeks (ID17010214PN036_02)

Beneficial Use Support Status: Grouse Creek headwaters, 1st- and 2nd-order tributaries, and Chute, Flume, Plank, South Fork Grouse, Taffy, and Wylie Creeks (ID17010214PN036_02) are also not supporting cold water aquatic life due to sediment and temperature impairments, and they are not supporting salmonid spawning due to temperature.

TMDL Implementation Projects Completed: River Design Group prioritized this reach for two restoration projects with the goals of increasing sediment transport competency and capacity, reducing instream and bank erosion sources of sediment, converting braided morphology to a primary channel, and improving aquatic habitat conditions. These projects have not been implemented and should be a priority.

Evidence of Beneficial Use Support: BURP data in 2003 indicate the stream had excellent macroinvertebrate and stream habitat conditions. In 2011–2012, IDFG determined Grouse Creek had a good bull trout and Westslope Cutthroat Trout population, which is further evidence the stream may be fully supportive of beneficial uses.

In 2009, stream data collected by River Design Group (2009) noted the AU had a high mass failure potential and active mass failures were present. They also determined that between Plank

Creek and Flume Creek, mid-channel depositional features, channel braiding, and streambank erosion were substantial. South Fork Grouse Creek had loss of habitat complexity due to lack of large wood, excess bedload, and lack of sediment transport capacity. In addition, residential development in the floodplain and terrace has resulted in lack of bank-stabilizing vegetation, bank erosion, channel widening, and low wood recruitment potential.

TMDL 5-Year Review Recommendations: Although 2003 BURP data and IDFG data suggested full support of beneficial use, there is no recommendation to survey the reach again until the restoration projects recommended by River Design Group are implemented. After implementation, two BURP surveys should be completed before considering whether this AU is fully supporting beneficial uses. In the meantime, this AU will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL (DEQ 2001).

Main stem Grouse Creek from Flume Creek to North Fork Grouse Creek (ID17010214PN036_03)

Beneficial Use Support Status: Main stem Grouse Creek (ID17010214PN036_03) is not supporting cold water aquatic life due to sediment and temperature impairments. It is also not supporting salmonid spawning due to temperature.

TMDL Implementation Projects Completed: River Design Group prioritized reach 5 for two restoration actions due to the high degree of channel instability and the presence of residential buildings. Channel restoration and bank stabilization were prioritized to stabilize the creek and stop further bank erosion. These projects have not been implemented.

In 2015, The US Forest Service and the US Fish and Wildlife Service implemented restoration actions in Grouse Creek Reach 5; 77 pieces of large wood (trees) were added to the stream to create deep pools, sort and retain streambed gravel, and maximize habitat complexity. An early December rain-on-snow event resulted in 40% of the wood being transported to Reach 6 to form new log jams. The trees that remained in place recruited a substantial amount of fine sediment and/or large woody material.

Evidence of Beneficial Use Support: In 2006, DEQ evaluated the AU upstream of the confluence with North Fork Grouse Creek using the BURP monitoring method. The stream had excellent macroinvertebrate and stream habitat conditions. No fish data were collected. IDFG and AVISTA data collected between 2002 and 2011 concluded the main stem Grouse Creek has good bull trout and Westslope Cutthroat Trout populations. The combined data suggests this AU may be supporting its beneficial uses.

In 2009, stream data collected by River Design Group showed a number of subreaches in this AU that had reference reach conditions due to the abundance of large wood and well-developed pool-riffle sequences. Habitat complexity lacked in some subreaches due to excessive sediment and the diminished transport capacity in those reaches. In addition, residential impacts and a major channel avulsion and incision have destabilized the channel in reach 5, resulting in severe bank erosion, land loss, and degraded habitat conditions.

TMDL 5-Year Review Recommendations: It is reasonable to conclude from the data that this AU is trending toward full support of beneficial uses. Reference reach conditions exist in much of the AU. The good population of Bull Trout and Westslope Cutthroat Trout supports this conclusion. However, Grouse Creek continues to be effected by an oversupply of course sediment, and additional projects at the watershed scale would be required to reduce sediment inputs.

In December 2015, a rain-on-snow storm event caused channel-forming flow where a significant amount of lateral erosion occurred, recruiting a substantial amount of large trees with rootwads. This large wood created debris jams that backed up water, dropping bedload that caused further lateral erosion and bank failure. Some debris jams failed causing even more channel and bank scour. Many of these trees mobilized to Reaches 6 and 7. It is important to let some time pass following this event to determine whether the stream continues to trend toward full-support of beneficial uses. In the meantime, this AU will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL (DEQ 2001).

Main stem Grouse Creek from NF Grouse Creek to the Mouth (ID17010214PN035_03)

Beneficial Use Support Status: Main stem Grouse Creek (ID17010214PN035_03) is not supporting cold water aquatic life due to sediment and temperature impairments. It is also not supporting salmonid spawning due to temperature.

Implementation Projects Completed: River Design Group recommendations for Reaches 8 and 9 were to install large woody debris aggregates, channel spanning trees, and single trees into the stream channel. These structures would increase pool habitat frequency, the distribution of spawning substrate, pool habitat diversity, channel roughness, and large woody debris retention. In 2015, 74 pieces of large wood (trees) were placed into the creek as single trees and as groups of multiple trees clumped together. Trees were also placed on point bars in Reach 8 using an excavator.

Three site-specific restoration actions were recommended by River Design Group. The goal of these actions was to stabilize the streambank and minimize streambank erosion using vegetated soil lifts and incorporate large wood and revegetation to improve aquatic habitat conditions. The first action was located in the middle of Reach 10 on an outside meander bend. This project was completed in 2012 by the US Fish and Wildlife Service and Natural Resources Conservation Service. The second site-specific restoration project was located on the outside of a tortuous meander bend with severely eroding banks in Reach 10. The immediate riparian area had been completely taken over by reed canarygrass and weeds. This project was completed in 2013 by the US Fish and Wildlife Service and Natural Resources Conservation Service. The third site-specific restoration project was located on the outside of a severely eroding meander sequence in the lower portion of Reach 10. This project was completed in 2013 by the US Fish and Wildlife Service and Natural Resources Conservation Service.

Evidence of Beneficial Use Support: In 2003, 2006, 2007, and 2008, DEQ evaluated the main stem Grouse Creek from North Fork Grouse Creek to the mouth (AU ID17010214PN035_03) at various locations on the creek. Often, this reach had good to excellent macroinvertebrate scores, but most of the time it had poor fish and habitat scores, indicating the stream was not fully supporting aquatic life and salmonid spawning beneficial uses. In 2009, stream data collected by

River Design Group (2009) noted some of this AU (Reaches 8 and 9) exhibited reference conditions for channel conditions, pool morphology, and riffle-pool-run-glide characteristics. The habitat complexity was excellent due to the abundance of large wood and well-developed pool-riffle sequences. The wood also functioned to disperse flow energy and provide channel and streambank stability. However, reaches 10 and 11 exhibited simplified habitat conditions, bedload deposition, and bank erosion. Bank erosion and unstable point bars made this reach one of the biggest sediment contributors to the Pack River.

TMDL 5-Year Review Recommendations: Due to the poor BURP scores, this reach will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL (DEQ 2001).

North Fork Grouse Creek (ID17010214PN037_02)

Beneficial Use Support: North Fork Grouse Creek and its tributaries BRC Creek and Dyree Creek (ID17010214PN037_02) are not supporting cold water aquatic life due to sediment and temperature impairments, and they are not supporting salmonid spawning due to temperature.

TMDL Implementation Projects Completed: The River Design Group recommended road and crossing improvements in the North Fork Grouse Creek watershed to improve moderate to high erosion/sediment delivery areas to the creek. A high-priority project was completed in 2010 to replace a culvert with a free-span bridge at the main crossing of US Forest Service Road 280 and North Fork Grouse Creek. Other improvements to road and crossings in the North Fork Grouse Creek watershed still need to be done.

Evidence of Beneficial Use Support: 2006 BURP data indicated the stream had excellent macroinvertebrate and stream habitat conditions. A fish survey was not performed. Fisheries data collected between 2009 and 2011 by IDFG and AVISTA suggest a good population of Westslope Cutthroat Trout in the North Fork Grouse Creek stream network. Stream data collected by River Design Group (2009) noted most of North Fork Grouse Creek to be reference reach conditions. The stream may be fully supportive of the aquatic life and salmonid spawning beneficial uses.

TMDL 5-Year Review Recommendations: It is presumed that North Fork Grouse Creek is supporting beneficial uses and sediment is no longer a pollutant of concern in this AU. Therefore, North Fork Grouse Creek should be evaluated for beneficial use support for two consecutive years using the BURP method.

Hellroaring Creek (ID17010214PN044_02)

Beneficial Use Support: Hellroaring Creek (AU ID17010214PN044_02) is a 2nd-order tributary to the Pack River. It is not supporting cold water aquatic life due to sediment and temperature impairments. The salmonid spawning beneficial use is not supported due to temperature impairment.

TMDL Implementation Projects Completed: Many restoration projects have been completed in the Hellroaring Creek watershed. Most of the projects were completed by Hancock Forest Management, the primary landowner in the watershed, and included road resurfacing, road abandonment, and culvert and bridge replacements.

Evidence of Beneficial Use Support: This creek has never been evaluated using BURP methods. Recent IDFG data show a presence of Bull Trout, Rainbow Trout, and Westslope Cutthroat × Rainbow Trout hybrids. Data collected under this 5-year review indicate stream conditions in Hellroaring Creek deviated only slightly from reference conditions, despite the erosive characteristics of the watershed. Habitat was diverse, even at extreme low-flow conditions. Streambank stability was excellent and the riparian buffer was well-vegetated with a diverse assemblage of shrubs/trees.

TMDL 5-Year Review Recommendations: Given the good habitat and sediment transport conditions in Hellroaring Creek, and the presence of Bull Trout, the creek may be supporting beneficial uses. The creek should be evaluated twice within a 5-year time period for beneficial use support using BURP monitoring. In the meantime, this AU will remain under the constraints and guidelines of the *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007).

Little Sand Creek (ID17010214PN053_02)

TMDL Implementation Projects Completed: This watershed provides the City of Sandpoint with drinking water; the city owns 59% of the watershed, which will remain undeveloped. The highway district has decreased the amount of traction sand application to Schweitzer Mountain Road by 69% and has implemented erosion control methods in the line ditches near the road.

Evidence of Beneficial Use Support: BURP scores in 2014 indicate the stream may be supporting both the aquatic life and salmonid spawning beneficial uses. Data collected in 2015 suggest Little Sand Creek upstream of the Sandpoint water treatment plant and upstream of any influence of Schweitzer Mountain Road is at reference conditions.

TMDL 5-Year Review Recommendations: Recent BURP data and data collected under this TMDL review suggest beneficial use support in Little Sand Creek and that the sediment load reductions necessary to meet beneficial use support have been met. The TMDL states the stream should be evaluated twice in a 5-year period using BURP methods to determine support status for a water body. The first evaluation in 2014 suggests beneficial use support. Therefore, Little Sand Creek should be re-evaluated using the BURP protocol before 2018. Should the data indicate the stream is fully supporting beneficial uses, the stream can be removed from Category 4a in Idaho’s Integrated Report and moved to Category 2.

McCormick Creek (ID17010214PN042_02)

TMDL Implementation Projects Completed: Road decommissioning and road crossing obliteration.

Evidence of Beneficial Use Support: 2014 BURP data indicated excellent stream habitat and macroinvertebrate conditions. Electrofishing efforts were unreliable. Recent IDFG data show a population of Westslope Cutthroat Trout but no Bull Trout in McCormick Creek.

TMDL 5-Year Review Recommendations: McCormick Creek is affected by an oversupply of course sediment that impairs channel stability and habitat complexity. Mass wasting and bare, vertical banks continue to be a significant source of fine sediment to the Pack River. Therefore, McCormick Creek will remain under the constraints and guidelines of the *Clark Fork/Pend Oreille TMDL* (DEQ 2001)

Rapid Lightning Creek (ID17010214PN033_02, ID17010214PN033_03)

TMDL Implementation Projects Completed: Road reconstruction and pavement, agriculture and forestry best management practices, and other.

Evidence of Beneficial Use Support: Rapid Lightning Creek has not been evaluated for beneficial use support since 1997.

TMDL 5-Year Review Recommendations: Data collected under this 5-year review indicate habitat conditions are poor due to excessive bedload, and suboptimal riparian conditions are causing excessive streambank erosion and sedimentation. Therefore, Rapid Lightning Creek will remain under the constraints and guidelines of the *Clark Fork/Pend Oreille TMDL* (DEQ 2001)

Sand Creek—Tributary to Lake Pend Oreille (ID17010214PN049_02, ID17010214PN049_03, ID17010214PN048_03, ID17010214PN048_03a)

TMDL Implementation Projects Completed: Agriculture and forestry best management practices.

Evidence of Beneficial Use Support: Sand Creek has not been evaluated for beneficial use support since the late 1990s.

TMDL 5-Year Review Recommendations: With the lack of recent BURP data, beneficial use support cannot be adequately evaluated. However, results from monitoring under this TMDL review indicated stream habitat conditions were fair on lower Sand Creek, and the overall physical habitat condition rating for upper Sand Creek was good. Given the suboptimal ratings from data collection under this TMDL review, it is appropriate to conclude that the stream remains impaired due to excessive sediment, and more sediment reduction projects in the watershed need to be done. In addition, restoration projects that introduce large wood into the creek would add to habitat complexity, provide cover, and increase pool depth and frequency. As such Sand Creek remains under the constraints of the *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007).

Sand Creek — Tributary to Pack River (ID17010214PN038_02)

TMDL Implementation Projects Completed: None known.

Evidence of Beneficial Use Support: Sand Creek has not been evaluated for beneficial use support since the late 1990s.

TMDL 5-Year Review Recommendations: Because a representative reach was not evaluated during this 5-year review, and due to a lack of recent BURP data, an effective discussion on beneficial use support and TMDL loading cannot be performed at this time. Therefore, the TMDL load reduction requirements remain in effect until a proper evaluation of Sand Creek can be performed.

Schweitzer Creek (ID17010214PN052_02)

TMDL Implementation Projects Completed: None known.

Evidence of Beneficial Use Support: Although data suggest Schweitzer Creek may be supporting beneficial uses, BURP data are 10 years old.
TMDL 5-Year Review Recommendations: Data collected in 2015 under this TMDL review suggest Schweitzer Creek below the Schweitzer Mountain complex was at a minor departure from reference conditions. It is is a transporting stream and is transporting stormwater with sediment from the Schweitzer Mountain Resort complex to Sand Creek. Impervious surfaces and unvegetated surfaces within the Schweitzer Mountain Resort complex should be addressed with implementation of stormwater BMPs. In addition, future expansion should be done carefully with adequate BMPs to avoid additional sediment sources to Schweitzer Creek.

Upper Pack River (17010214PN041_02, 17010214PN041_03, 17010214PN039_03)

Upper Pack River from the headwaters to Colburn Creek includes three AUs: upper Pack River tributaries (17010214PN041_02), Pack River headwaters to Hellroaring Creek (17010214PN041_03), and Hellroaring Creek to Colburn Creek (17010214PN039_03).

TMDL Implementation Projects Completed: A diversity of projects have been implemented in the Pack River watershed.

Evidence of Beneficial Use Support: Recent data suggest the upper Pack River is trending toward full support of beneficial uses. Reference reach conditions exist in much of the AU.

TMDL 5-Year Review Recommendations: The upper Pack River is trending toward full support of beneficial uses. However, the addition of large woody debris would enhance pool diversity, sediment storage, and channel stability. Projects should be implemented that introduce large wood to this AU. Due to the unreliability of fish data collected under BURP, fish data should be collected again under a more efficient and reliable electrofishing effort before an assessment is made on beneficial use support.

Lower Pack River (ID17010214PN039_04, ID17010214PN031_04)

The lower Pack River from Colburn Creek to the mouth includes two AUs: Colburn Creek to Sand Creek (ID17010214PN039_04) and Sand Creek to the mouth (ID17010214PN031_04).

TMDL Implementation Projects Completed: A diversity of projects have been implemented in the Pack River watershed.

Evidence of Beneficial Use Support: Given the abundance of excessively eroding banks and the lack of pool habitat and refuge for migrating fish, the aquatic life beneficial use in the lower Pack River is still impaired.

TMDL 5-Year Review Recommendations: Projects that introduce large wood and stabilize streambanks will improve factors that contribute to beneficial use impairment on the lower Pack River.

Pend Oreille River (ID17010214PN002_08), (ID17010214PN001_08)

Idaho has taken an aggressive approach towards eradicating Eurasian watermilfoil since 2006. As a result, there has been a significant decrease in the species in the river. Eurasian watermilfoil was present throughout the river; however, researchers concluded there is still excellent diversity and abundance of native plants in the Pend Oreille River ecosystem—adequate to sustain the structure and function of an aquatic littoral ecosystem.

In Idaho's 2010 Integrated Report, total phosphorus was delisted as a cause of impairment to the Pend Oreille River based on a thorough analysis of all existing and readily available data collected on the Pend Oreille River. Results of the analysis determined the following:

- Lentic targets of 0.009 mg/L (average) and 0.012 mg/L (instantaneous) of the *Total Maximum Daily Load (TMDL) for Nutrients for the Nearshore Waters of the Pend Oreille Lake, Idaho* are not appropriate in evaluating beneficial use status of the Pend Oreille River.
- Total phosphorus concentrations are decreasing in the river over time.
- The Pend Oreille River system phosphorus load appears to be at equilibrium with plant and algae uptake at current load rates.
- While concern exists for localized areas of non-native plants, the native aquatic plant community is highly diverse in the river.
- Beneficial uses as related to total phosphorus in the river are fully supported.

Routine water quality monitoring on the Pend Oreille River began during the 2009 field season. Since 2009, DEQ has collected water quality samples at five stations from the railroad bridge to the Idaho/Washington state. An analysis of total phosphorus was limited primarily to a comparison between 2009 and 2015. At all stations, total phosphorus concentrations were below 10 µg/L. A comparison of the 2 years shows no significant difference between the years. However, total phosphorus concentrations were significantly higher in August 2015 than in August 2009 at all the stations except the Albeni Falls Forebay station.

Cocolalla Lake (ID17010214PN013L_0L) and its tributaries

The Cocolalla Lake watershed includes the lake and the following tributaries: Cocolalla Creek headwaters with 1st and 2nd-order tributaries (ID17010214PN014_02); Cocolalla Creek (ID17010214PN012_02), (ID17010214PN014_03) and (ID17010214PN013L_0L), Fish Creek (ID17010214PN015_02), (ID17010214PN015_03), Butler Creek (ID17010214PN014_02), Johnson Creek (ID17010214PN013_02), and Westmond Creek (ID17010214PN013_2a, and

Cocolalla Lake (ID17010214PN013L_0L). Intermittent streams include lower Butler, Westmond, lower Fish Creek, and Johnson Creek.

TMDL Implementation Projects Completed: Implementation Activities on Cocolalla Creek above the highway 95 crossing between 2007 and 2015 include agricultural pasture management with offsite watering; over two miles of fence constructed to partition pasture and protect riparian areas, vegetation enhancement, 761 acres of forest stand improvement, and development of a Forest Management Plan. §319 grants have been implemented for improved drainage and management for Fish Creek Road and there is a nutrient management habitat enhancement project on the IDFG Wildlife Management Area that captures nutrients from Fish Creek and improves channel condition and habitat for fish passage and spawning habitat. Numerous outreach and education projects are focused on the watershed including the Pend Oreille Water Festival Environmental Education Program, Idaho State Forestry Contest, Stormwater Erosion Education Program, Lake*A*Syst (lakeshore resident assistance) and ongoing outreach and education provided by the Cocolalla Lake Association with monthly and annual meetings for interested residents.

Evidence of Beneficial Use Support: Trophic conditions in Cocolalla Lake are improving, and many nutrient sources have reduced and stabilized. Hypolimnetic anoxia is less common in frequency and duration. Nutrient Targets are not yet being met in Lake Cocolalla which is the sentinel target for tributary implementation of nutrient and sediment reductions.

TMDL 5-Year Review Recommendations: Revegetation of historic timber harvests and succession of plant species has reduced the aerial loading rate of nutrients to tributaries and the Lake. Road management continues to be very important and a number of maintenance deficiencies exist on residential roads near the lake that are privately maintained as well as collector roads managed by the County. Road culvert drainage and stream crossings are particularly important to implement maintenance and prevent erosion and culvert failure. Education programs should be maintained for residents to provide guidance and assistance with management of lakeshore and near-lake residences. Ultimately a centralized sewer system around the lake would reduce nutrient loading over time as would septic and drain field maintenance and management. While there has been a good effort at nutrient reduction implementation projects, additional nutrient and sediment efforts are needed.

Hoodoo Creek (ID17010214PN003_02, ID17010214PN003_02a):

TMDL Implementation Projects Completed: Implementation projects are very low priority in this watershed as a result of stream channel alteration.

Evidence of Beneficial Use Support: Hoodoo Creek remains impaired due to channel alteration from dredging to drain wetlands and wholesale removal of habitat.

TMDL 5-Year Review Recommendations: Nutrient and sediment controls in the Hoodoo Creek watershed would be directed at the Pend Oreille River though deposition in the perturbed system may likely reduce inputs to the river through channel storage and processing in Hoodoo Creek's drainage network.

1 Introduction

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

Idaho Code §39-3611(7) requires a 5-year cyclic review process for Idaho TMDLs:

> The director shall review and reevaluate each TMDL, supporting sub-basin assessment, implementation plan(s) and all available data periodically at intervals of no greater than five (5) years. Such reviews shall include the assessments required by section 39-3607, Idaho Code, and an evaluation of the water quality criteria, instream targets, pollutant allocations, assumptions and analyses upon which the TMDL and sub-basin assessment were based. If the members of the watershed advisory group, with the concurrence of the basin advisory group, advise the director that the water quality standards, the sub-basin assessment, or the implementation plan(s) are not attainable or are inappropriate based upon supporting data, the director shall initiate the process or processes to determine whether to make recommended modifications. The director shall report to the legislature annually the results of such reviews.

This report is intended to meet the intent and purpose of Idaho Code §39-3611(7). This report documents the review of approved Idaho TMDLs and implementation plans and considers the most current and applicable information in conformance with Idaho Code §39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, evaluates the implementation plans, and includes consultation with the watershed advisory group (WAG). Final decisions for TMDL modifications are decided by the Idaho Department of Environmental Quality (DEQ) director. Approval of TMDL modifications is decided by the US Environmental Protection Agency (EPA), with consultation by DEQ.

1.1 About Assessment Units

Prior to 2002, impaired waters were defined as stream segments with geographical descriptive boundaries. In 2002, DEQ modified the structure and format of Idaho's §303(d) list by combining it with the §305(b) report, required by the CWA to inform Congress of the state of Idaho's waters. This modification included identifying stream segments by assessment units (AUs) instead of non-uniform stream segments, and defining the use support of stream AUs by five categories in the Integrated Report. AUs now define all the waters of the state of Idaho. These units and the methods used to describe them can be found in the *Water Body Assessment Guidance* (DEQ 2016).

AUs are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—even if ownership and land use change significantly, an AU usually remains the same. Because AUs are an extension of water body identification numbers, they tie directly to the water quality standards so that beneficial uses defined in the standards are clearly tied to streams on the landscape.

To facilitate comparisons between the 1998 §303(d) list and the 2002 "impaired waters" list in the Integrated Report, a crosswalk was developed and is available at *www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report*. All AUs contained wholly or partially in any listed segment were carried forward to the 2002 §303(d) listings in Category 5 of the Integrated Report (DEQ 2005). This approach was necessary to maintain the integrity of the 1998 §303(d) list and continuity with the TMDL program. When assessing new data that indicate full support, only the AU that the monitoring data represent will be removed (delisted) from the §303(d) list (Category 5 of the Integrated Report).

1.2 TMDL 5-Year Review Approach

In 2000 and 2001, EPA approved TMDLs for sediment addressed in the *Clark Fork/Pend Oreille Sub-Basin Assessment and Total Maximum Daily Load* (DEQ 2001), hereafter referred to as the Clark Fork/Pend Oreille TMDL. The TMDLs are located in both the Lake Pend Oreille and Pend Oreille River watersheds. The TMDL for dissolved oxygen and total phosphorus for Cocolalla Lake was also approved in this TMDL.

In 2008, EPA approved the *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007), an addendum to the *Clark Fork/Pend Oreille Subbasin Total Maximum Daily Load* (DEQ 2001). The TMDLs are located in both the Lake Pend Oreille and Pend Oreille River watersheds.

As required in Idaho Code §39-3611, DEQ shall review and reevaluate each TMDL, supporting subbasin assessment, implementation plan(s), and all available data periodically at intervals of no greater than 5 years. This 5-year review will only address AUs within the Lake Pend Oreille and Pend Oreille River watersheds (hydrologic unit code [HUC] (17010214). Water bodies in the Clark Fork watershed and water bodies that are tributaries to the eastern shoreline of Lake Pend Oreille will be deferred to another 5-year review process. Temperature and nutrient addendums approved by the EPA in 2008 will also be addressed in a separate TMDL review.

1.2.1 Streams

Due to the large number of streams to be evaluated in this review, a qualitative approach was used to evaluate the current state of sediment and/or nutrient impairment in individual streams. During meetings prior to this effort, stakeholders agreed on the following steps for the review:

1. Review the Clark Fork/Pend Oreille TMDL and Pend Oreille tributaries sediment TMDL. Rank subwatersheds by pollutant loading severity based on documented allocations from the TMDL loading analysis.
2. Review recent (since the TMDL) data and evaluate against TMDL conclusions. Data sources include, but are not limited to, the following:
    a. Idaho Beneficial Use Reconnaissance Program (BURP) data and assessments

   b. Idaho Department of Lands (IDL) Cumulative Watershed Effects (CWE) reports for the following creeks: Berry, Caribou, Curtis, Fish, Hellroaring, Hoodoo, Little Sand, Upper Rapid Lightning, and Spring
   c. US Forest Service data
   d. *Grouse Creek Watershed Assessment and Restoration Prioritization Plan Final Report* (RDI 2009)
   e. *Pack River Stream Channel Assessment Final Report* (Golder and Associates 2003)
   f. Stressor identification reports

3. Identify streams that are fully supporting beneficial uses and are candidates for delisting.
4. For each subwatershed, review aerial photographs, topography, and land use maps to accomplish the following:
   a. Evaluate changes in land use since TMDL was written.
   b. Determine location of active roads and roadless areas.

5. Prioritize subwatersheds for further evaluation based on information obtained in 1–4 above.
6. Identify points of access to medium- and high-priority streams.
7. On high- and medium-priority streams with sediment TMDLs, identify two, 100-meter representative stream reaches. Evaluate representative reaches using Rosgen's *Watershed Assessment of River Stability and Sediment Supply* (2008), the Vermont Agency of Natural Resources Reach Habitat Assessment and Rapid Geomorphic Assessment (VANR 2008), and Wolman (1954) and the survey forms therein.
8. Conduct a randomized survey of road crossings in all high- and medium-priority subwatersheds. Digitize road crossings into a GIS layer. Randomly select three to five road crossings from medium- and high-priority subwatersheds for evaluation using the method described by the Center for Aquatic Technology Transfer (USFS 2011).

1.2.2 Pend Oreille River

DEQ conducts routine water quality monitoring on the Pend Oreille River at a minimum of three monitoring locations from a list of five thalweg locations. At each of the monitoring locations, DEQ collects monthly water quality data from June through September.

1.2.3 Cocolalla Lake

Water Quality Data

Data are collected from Cocolalla Lake by the Citizen Volunteer Monitoring Program (CVMP). CVMP data consist of temperature and oxygen profiles and total phosphorus, which is collected at the Secchi depth and 1 meter above the bottom. A chlorophyll-a sample and total nitrogen (collected during the 2015 field season for this review) were also collected at the Secchi depth.

Periphyton Productivity

The periphyton productivity data for Cocolalla Lake was collected weekly from August through early October. This data was used to investigate periphyton growth rates and community structure/density on artificial substrates at three nearshore locations in Cocolalla Lake.

2 TMDL Review and Status

This 5-year review evaluates TMDLs for 42 AU-pollutant combinations for sediment, 1 AU-pollutant combination for total phosphorus and 1 AU-pollutant combination for dissolved oxygen (Figure 1; Table 1). The TMDL review includes an evaluation of the Pend Oreille river for sediment impairment. The following assessment units were not evaluated due to their low priority ranking in the above process and are not covered in this review: Trout, Schertz, French, and Tavern Creek (ID17010214PN032_02), Jeru Creek (ID17010214PN043_02), Jack Creek (ID17010214PN050_02), Swede Creek (ID17010214PN051_02).

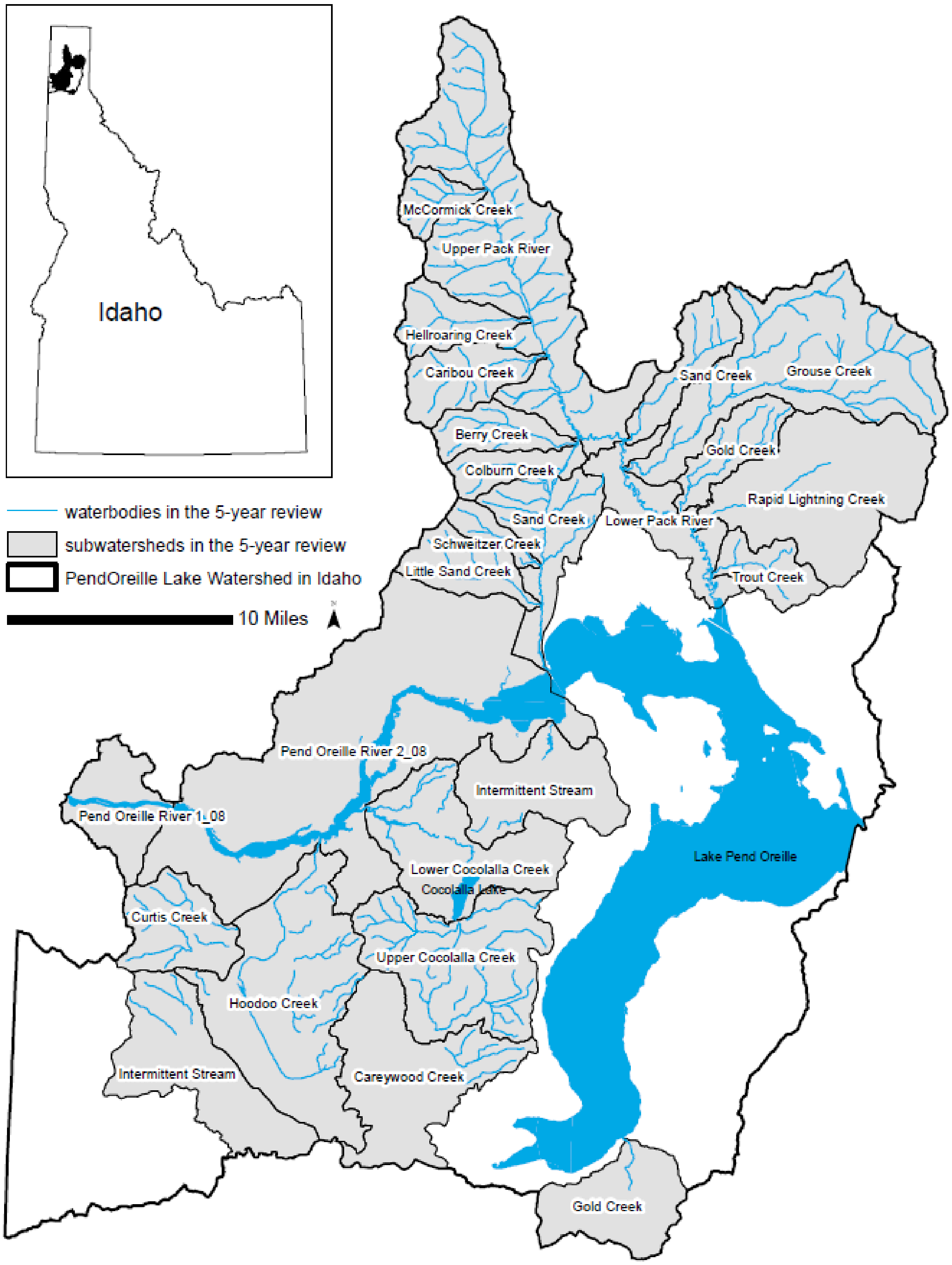


Figure 1. Assessment units addressed by this 5-year review.

Table 1. Assessment units and pollutants addressed by this 5-year review.

Water Body	Assessment Unit Number	Pollutant	TMDL and Approval Date
Pend Oreille River	ID17010214PN001_08 ID17010214PN002_08	Sediment (not on 303(d) list)	No sediment TMDL , this review is for informational purposes only.
Hoodoo Creek and tributaries Hoodoo Creek Unnamed creek	ID17010214PN003_02 ID17010214PN003_02a	Sediment	Clark Fork/Pend Oreille TMDL; September 2000
Lower Cocolalla Creek	ID17010214PN012_02	Sediment	Clark Fork/Pend Oreille TMDL; September 2000
Cocolalla Lake	ID17010214PN013_0L	Dissolved Oxygen Total Phosphorus	Clark Fork/Pend Oreille TMDL; September 2000
Upper Cocolalla Creek and tribs: Beaver Creek Butler Creek Careywood Creek Upper Cocolalla Creek Kreiger Creek Micro Creek Three Sisters Creek Unnamed creek	ID17010214PN014_02 ID17010214PN014_03 ID17010214PN014_04	Sediment	Clark Fork/Pend Oreille TMDL; September 2000
Fish Creek	ID17010214PN015_02 ID17010214PN015_03	Sediment	Clark Fork/Pend Oreille TMDL; September 2000
Lower Pack River	ID17010214PN031_04	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Trout Creek Shertz Creek	ID17010214PN032_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Rapid Lightning Creek	ID17010214PN033_02 ID17010214PN033_03	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Gold Creek	ID17010214PN034_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001

Water Body	Assessment Unit Number	Pollutant	TMDL and Approval Date
Grouse Creek and tributaries Chute Creek Flume Creek Grouse Creek Jones Creek Plank Creek South Fork Grouse Creek Taffy Creek Unnamed tributary Wylie Creek	ID17010214PN035_02 ID17010214PN035_03 ID17010214PN036_02 ID17010214PN036_03	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
North Fork Grouse Creek & tribs BRC Creek Dyree Creek North Fork Grouse Creek Unnamed tributary	ID17010214PN037_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Sand Creek and unnamed tributary	ID17010214PN038_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Pack River	ID17010214PN039_03 ID17010214PN039_04	Sediment	Clark Fork/Pend Oreille TMDL; September 2000
Upper Pack River & tributaries Beehive Creek Blane Creek Chimney Creek Homestead Creek Lindsey Creek Martin Creek Pack River Pearson Creek Slide Creek Thor Creek Torrent Creek Unnamed tributaries West Branch Pack River Youngs Creek Zee Creek Zuni Creek	ID17010214PN041_02 ID17010214PN041_03	Sediment	Clark Fork/Pend Oreille TMDL September 2000 Pend Oreille tributaries sediment TMDL, 2008
McCormick Creek Unnamed tributary	ID17010214PN042_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Jeru Creek Unnamed tributary	ID17010214PN043_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001

Water Body	Assessment Unit Number	Pollutant	TMDL and Approval Date
Hellroaring Creek	ID17010214PN044_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001 Pend Oreille tributaries sediment TMDL; January 2008
Caribou Creek Unnamed tributary	ID17010214PN045_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Berry Creek Unnamed tributary	ID17010214PN046_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Colburn Creek	ID17010214PN046_03 ID17010214PN047_02	Sediment	Clark Fork/Pend Oreille TMDL; April 2001
Sand Creek	ID17010214PN049_02 ID17010214PN049_03 ID17010214PN048_03 ID17010214PN048_03a	Sediment	Pend Oreille tributaries sediment TMDL; January 2008
Jack Creek Swede Creek Schweitzer Creek Little Sand Creek	ID17010214PN050_02 ID17010214PN051_02 ID17010214PN052_02 ID17010214PN053_02		

2.1 Clark Fork/Pend Oreille Sub-Basin Assessment and Total Maximum Daily Load

The *Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Load* (DEQ 2001) examined 43 streams, 1 major river, and 1 lake in the Pend Oreille Lake and River portion of the subbasin assessment. Of the 11 streams, 9 were water quality impaired and required load allocations, primarily for sediment. These streams were upper and lower Cocolalla Creeks, Hoodoo Creek, Fish Creek, North Fork Grouse Creek, Grouse Creek, Caribou Creek, and the Pack River. Cocolalla Lake was also found to be impaired due to low dissolved oxygen levels, resulting in load allocations for phosphorus for the lake and its tributaries.

2.1.1 Sediment TMDLs

To determine sediment impairment of individual water bodies, the Clark Fork/Pend Oreille TMDL used a sediment modeling exercise to determine existing and target sediment loads. Target sediment loads were set to natural background. Sediment load reductions were then calculated by subtracting the target sediment load (natural background) from the existing load.

The sediment model attempted to identify the primary sources of stream sedimentation in the watershed by looking at five land uses: pasture, forest land, unstocked forest, highway, and double fires. Pasture land included hay fields, grazing pastures, and any low-elevation treeless land. Unstocked forest included natural openings and 90–100% logged forest. Double fires were land areas burned by two large wildfires. Existing sediment load estimates were based primarily on sources of sediment from land-use types and road characteristics. Details of existing sediment load estimates can be reviewed in the Clark Fork/Pend Oreille TMDL (DEQ 2001). Sediment loads were estimated separately for each land use type using the following equation:

Total acreage for each land use type × Sediment yield coefficient = Sediment load from land use

Appropriate sediment yield coefficients were selected based on local characteristics within the watershed. The sediment yield coefficient for pasture land was estimated by the Idaho Soil and Water Conservation Commission using the Revised Universal Soil Loss Equation (RUSLE) (Mark Hogen, personal communication, 1998). The sediment yield coefficient for forested land was based on sediment production rates used in the US Forest Service (USFS) WATSED model. All sediment load estimates were assumed to have 100% delivery to the stream channel. The land use sediment load estimates were conservative in the TMDL.

Sediment loading from potential road crossing failure on forested land was estimated using the Idaho Department of Lands (IDL cumulative watershed effects (CWE database on road fill failure in the watershed. The sediment load estimates from fill failure and road encroachment were conservative in the TMDL.

County and private road surface erosion was estimated with the RUSLE model. Road fill failure and encroachment of county and private roads were evaluated differently than forest roads by taking a weighted-average of the forest road. The sediment delivery estimates from roads were conservative in the TMDL.

Streambank erosion was estimated using a coefficient for bank erosion taken from a study in the Cocolalla Lake area (DEQ 2001).

The TMDL did not consider sediment routing, nor did it attempt to estimate erosion to streambeds and banks resulting from localized sediment deposition in the streambed. It also did not attempt to measure the effects of additional water capture at road crossings.

2.1.1.1 TMDL Targets

The TMDL calculated a target load to individual subwatersheds based on the assumption of land use historically present in the watershed; however, there are uncertainties in how this number was determined. Acreage of historical land use was multiplied by a coefficient for natural background to calculate the target load for the subwatershed. The target load was then subtracted from the existing load to determine the sediment load reduction necessary for the subwatershed. The target load is an estimate of the amount of pollutant that can exist in a water body while still supporting all of its beneficial uses.

The TMDL states there is much uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. This TMDL was very conservative; the sediment target was limited to natural background amounts. It acknowledges that beneficial uses may be fully supported at some point before the target is achieved, and a measure of sediment reduction cannot be used exclusively to determine a return to full support.

2.1.1.2 TMDL Allocations

TMDL sediment load allocations (existing loads, target loads, and necessary load reductions) for the Pack River watershed and Cocolalla watershed are presented in Table 2 and Table 3. The *Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Load* calculated the total sediment export for individual tributaries to the Pack River. However, it assigned one target load to the entire watershed. Therefore, load reductions for individual waterbodies could not be calculated.

Table 2. Pack River watershed assessment unit sediment existing loads, target loads, and load reductions in *Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Load* (DEQ 2001).

Water Body Name	TMDL Approval Year	Assessment Unit	Watershed Acres	Existing Load (tons/yr)	Target Load (tons/yr)	Load Reduction (tons/yr)
Trout Creek Shertz Creek	2001	ID17010214PN032_02	14,349	1,084.2	Assigned to Pack River watershed	Cannot calculate
Rapid Lightning Creek	2001	ID17010214PN033_02 ID17010214PN033_03	67,443	7,929.2	Assigned to Pack River watershed	Cannot calculate
Gold Creek	2001	ID17010214PN034_02	7,316	707.8	Assigned to Pack River watershed	Cannot calculate
Grouse Creek Jones Creek Chute Creek Flume Creek Plank Creek SF Grouse Creek Taffy Creek Wylie Creek	2001	ID17010214PN035_02 ID17010214PN035_03 ID17010214PN036_03 ID17010214PN036_02	42,674	3,315	Assigned to Pack River watershed	Cannot calculate
Grouse Creek main stem	2001	ID17010214PN035_03 ID17010214PN036_03	25,387	2,490.9	935	1,555.9
NF Grouse Creek BRC Creek Dyree Creek	2001	ID17010214PN037_02	10,805	2,371.8	Assigned to Pack River watershed	Cannot calculate
NF Grouse Creek	2001	ID17010214PN037_02	10,805	2,371.8	684.4	1,687.4
Sand Creek (tributary to the Pack River)	2001	ID17010214PN038_02	8,298	832.7	Assigned to Pack River watershed	Cannot calculate
McCormick Creek	2001	ID17010214PN042_02	6,709	1,721.7	Assigned to Pack River watershed	Cannot calculate
Jeru Creek	2001	ID17010214PN043_02	5,539	226	Assigned to Pack River watershed	Cannot calculate
Hellroaring Creek	2001	ID17010214PN044_02	9,198	4,110.3	Assigned to Pack River watershed	Cannot calculate
Caribou Creek	2001	ID17010214PN045_02	9,173	2,850.1	663.4	2,186.8
Caribou Creek (as part of the upper Pack River watershed)	2000	ID17010214PN045_02	10,254	2,606.1	Assigned to Pack River watershed	Cannot calculate
Berry Creek	2001	ID17010214PN046_02	8,210	2,828.9	Assigned to Pack River watershed	Cannot calculate
Colburn Creek	2001	ID17010214PN046_03 ID17010214PN047_02	6,485	1,546.3	Assigned to Pack River watershed	Cannot calculate
Minor lower-Pack Tributaries	2001	Not defined but likely ID17010214PN031_04	54,557	22,490.8	Assigned to Pack River watershed	Cannot calculate
Minor mid-Pack Tributaries	2000	Not defined but likely ID17010214PN039_02 ID17010214PN039_03 ID17010214PN039_04	61,836	6,309	Assigned to Pack River watershed	Cannot calculate
Pack headwaters	2000	Not defined but likely ID17010214PN041_02 ID17010214PN041_03	20,562	2,118.5	Assigned to Pack River watershed	Cannot calculate
Homestead Creek	2000	Part of ID17010214PN041_02	5,022	124.5	Assigned to Pack River watershed	Cannot calculate
Lindsey Creek	2000	Part of ID17010214PN041_02	2,806	456.3	Assigned to Pack River watershed	Cannot calculate

Water Body Name	TMDL Approval Year	Assessment Unit	Watershed Acres	Existing Load (tons/yr)	Target Load (tons/yr)	Load Reduction (tons/yr)
Martin Creek	2000	Part of ID17010214PN041_02	4,987	187	Assigned to Pack River watershed	Cannot calculate

Table 3. Cocolalla Lake watershed assessment unit sediment existing loads, target loads, and load reductions in *Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Load* (DEQ 2001).

Water Body Name	TMDL Approval Year	Assessment Unit	Watershed Acres	Existing Load (tons/yr)	Target Load (tons/yr)	Load Reduction (tons/yr)
Hoodoo Creek Curtis Creek	2000	ID17010214PN003_02 ID17010214PN003_02a	30,342	6,150.9	1,012.7	5,138.2
Lower Cocolalla	2000	ID17010214PN012_02 ID17010214PN012_04	34,553	4,885.7	1,202.5	3,483.2
Upper Cocolalla Beaver Creek Butler Creek Careywood Creek Kreiger Creek Micro Creek Three Sisters Creek	2000	ID17010214PN014_02 ID17010214PN014_03 ID17010214PN014_04	18,913	5,745.9	673.5	5,072.4
Fish Creek	2000	ID17010214PN015_02 ID17010214PN015_03	7,281	806.4	278	528.4

2.1.1.3 Control and Monitoring Points

DEQ uses BURP data to indicate if a stream is impaired. The TMDL dictates that this survey be repeated twice after implementation to determine if there is improvement toward full support status.

2.1.1.4 Margin of Safety

The Clark Fork/Pend Oreille TMDL has an inherent margin of safety. All assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis.

2.1.2 Cocolalla Lake TMDL

Idaho's water quality standard states dissolved oxygen must exceed 6 milligrams per liter (mg/L) at all times. In lakes, this standard does not apply to (1) the bottom 20% of water depth, where lakes are 35 meters or less; (2) the bottom 7 meters of water depth in lakes greater than 35 meters; and (3) those waters of the hypolimnion in stratified lakes.

2.1.2.1 TMDL Targets

Modeling done in the early 1990s demonstrated that a phosphorus reduction of 39% would result in an epilimnetic phosphorus concentration of 16 µg/L, a chlorophyll-a value around 8.5 micrograms per liter (µg/L), and a Secchi depth of 10 feet. These conditions were determined to support beneficial uses. Data showed that meeting the phosphorus reductions necessary to meet the 16 µg/L target would not achieve dissolved oxygen conditions that meet Idaho's water quality standard of 6 mg/L. In addition, the 16 µg/L would only move the lake trophic level to a borderline mesotrophic-eutrophic lake. A reduction to 10 µg/L would, in theory, move the trophic level of the lake to a state where there is no internal nutrient cycling, and dissolved oxygen concentrations above the water quality standard would be met. A target of 10 µg/L total phosphorus would require a load reduction of 2,244 kilograms per year (kg/yr), or a 69% load reduction from existing conditions. When a 20% margin of safety is included, the necessary load reduction becomes 2,693 kg/yr (89%), which would translate to an 8 µg/L total phosphorus concentration in the lake (DEQ 2001). The 8 µg/L total phosphorus concentration ultimately was chosen for the TMDL target.

2.1.2.2 TMDL Load Allocations

The TMDL accounted for total phosphorus loading from tributaries to Cocolalla Lake as 55% of the total load to the lake. Septic systems contributed 3.6%, atmospheric load was 7.5%, and internal loading accounted for 34% of the total load. Allocations for each of these sources is found in Table 4.

Table 4. TMDL load allocations for total phosphorus sources to Cocolalla Lake in *Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Load* (DEQ 2001).

Source	Necessary Load Reduction (kg/yr)
Fish Creek	269
Johnson Creek	81
Westmond Creek	296
Butler Creek	108
Cocolalla Creek	727
Septic systems	108
Atmosphere	188
Internal loading	916
Total load reduction	**2,693**

2.1.2.3 Control and Monitoring Points

The Citizen Volunteer Monitoring Program collects dissolved oxygen data on Cocolalla Lake monthly from May to September. The most critical time to measure dissolved oxygen would be in late August and September when oxygen levels would be at their lowest concentration. The DEQ beneficial use reconnaissance surveys are to be conducted once every five years. Due to the variable nature of nutrient loading to the lake, two concurrent surveys showing full support status should be obtained before de-listing is considered.

2.1.2.4 Margin of Safety

A 20 % margin of error was added to the total phosphorus target, reducing it from 10 µg/L to 8 µg/L.

2.2 Pend Oreille Tributaries Sediment Total Maximum Daily Loads

To determine sediment impairment of individual water bodies, the *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007), an addendum to the Clark Fork/Pend Oreille TMDL, used a sediment modeling exercise specific to the Pend Oreille subbasin to determine existing and target sediment loads. The method was developed to quantify the State of Idaho's narrative sediment water quality standard. Six different types of modeling techniques were used to quantify the sediment load to the streams in the Pend Oreille subbasin, depending on the source of eroded sediment:

- Sediment yield coefficients, derived from the literature and previous studies, were used to estimate the sediment load from forestland, harvested forestland, and burned forestland.
- RUSLE Version 2 estimated erosion from agricultural land and permanent pastureland.
- WEPP Roads calculated erosion from paved and unpaved roads at stream crossings.
- The McGreer Relationship approximated erosion from roads, other than at stream crossings (McGreer et al. 1997).
- The CWE reports provided data to estimate the sediment load due to mass wasting (landslide) events.
- Application of best professional judgment was used to estimate stream erosion due to narrowing of the stream channel near roadways (road encroachment).

Results of these models were synthesized for each watershed, and the existing sediment load from each source of sediment was estimated.

2.2.1 TMDL Targets

While streams have the ability to process sediment levels above natural background, it is not well understood to what level this is possible before impairment occurs. The natural background sediment load was estimated using sediment yield coefficients derived from literature for a coniferous forestland. To determine the target sediment load above natural background, a reference condition stream was chosen. Trestle Creek, a tributary to Lake Pend Oreille, was selected as a watershed supportive of beneficial uses due to its robust Bull Trout and Cutthroat Trout populations. The stream was selected using local knowledge and input from a local Pend Oreille Tributary Working Group. The target sediment load was derived from the current condition of Trestle Creek by modeling the watershed using the same method and input variables as those used for each impaired water body. Sediment yield coefficients were applied to each appropriate land use/land cover category in Trestle Creek and multiplied by the watershed acreage. The sediment load from Trestle Creek was 42% above natural background. The TMDL assigned sediment load reduction allocations to land owners and managers based on modeled land use types located within areas of ownership. The load reduction required for each land owner/manager was based on the difference between the existing sediment load and the target sediment load capacity at 42% above natural background conditions.

Although the same sediment models were used in the Clark Fork/Pend Oreille TMDL and the Pend Oreille tributaries TMDL, the output from these models are not comparable due to the difference in input variables and coefficients. For more information on details of the models, see each TMDL document (DEQ 2001, 2007).

2.2.2 TMDL Load Allocations

The pollutant load allocation is the load capacity minus a margin of safety and natural background. Since there are no sediment contributions from National Pollutant Discharge Elimination System (NPDES)-permitted point sources, the sediment load allocations were for nonpoint sources only. Sediment load allocations and reductions were modeled for each watershed and are summarized in Table 5. The allocations and percent reduction goals are based on the specific load reduction necessary to maintain loads at or below the load capacity, which was set at 42% above natural background conditions. Load allocations and percent reduction goals were also calculated for each type of landowner and are summarized in the Pend Oreille tributaries sediment TMDL (DEQ and EPA 2007).

Table 5. Pack River watershed assessment unit sediment existing loads, target loads, and necessary load reductions in *Pend Oreille Tributaries Sediment Total Maximum Daily Loads* (DEQ and EPA 2007).

Waterbody Name	TMDL Year	Assessment unit	Watershed Acres	Existing Load (tons/yr)	Target Load (tons/yr)	Load Reduction (tons/yr)
Gold Creek	2008	ID17010214PN034_02	7,747	390	257	133
Upper Pack River headwaters to Hellroaring Creek and Hellroaring Creek	2008	ID17010214PN041_02 ID17010214PN041_03 ID17010214PN044_02	48,467	2,309	1,377	932
Sand Creek Jack Creek Swede Creek Schweitzer Creek Little Sand Creek	2008	ID17010214PN048_03 ID17010214PN048_03a ID17010214PN049_02 ID17010214PN049_03 ID17010214PN050_02 ID17010214PN051_02 ID17010214PN052_02 ID17010214PN053_02	24,209	2,039	798	1,241

2.2.3 Control and Monitoring Points

The DEQ BURP method was prescribed in the TMDL for long-term evaluation of compliance for watersheds exceeding the sediment target load. While specific targets are set as guidelines, beneficial use support status will be determined using the BURP method and any other available information. While specific reaches of each water body are impaired by sediment, sediment load reductions will be required from the entire watershed to ultimately achieve full support status.

2.2.4 Margin of Safety

The margin of safety is a conservative measure incorporated into the TMDL that accounts for the uncertainty associated with calculating the allowable sediment load to ensure beneficial uses are attained. EPA guidance allows for use of implicit or explicit expressions of the margin of safety, or both. When conservative assumptions are used in developing the TMDL, or conservative factors are used in the calculations, the margin of safety is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the margin of safety is considered explicit. Because the measure of sediment entering a stream throughout an entire watershed is a difficult and inexact science, assigning an arbitrary explicit margin of safety would add more error to the analysis. Therefore, the margin of safety for these sediment TMDLs is implicit. The margin of safety is derived from conservative assumptions and estimates made in the model construction and application, which result in conservatively high estimates of sediment loading to surface water.

3 Changes to Subbasin Characteristics

The Pack River and Cocolalla Creek watersheds lie entirely within Bonner County, Idaho. The 2000 census population of Bonner County was 36,835, compared to 40,877 in 2010, a 10.9% increase. The City of Sandpoint has experienced much of the growth. The 2000 census population of Sandpoint was 6,835, compared to 7,366 in 2010.

Bonner County continues to be a popular location for growth and development. Nearly half the county's residents, and 40% of the county's land parcels, are located within the Sandpoint Urban Cluster and within one-half mile of the Lake Pend Oreille shoreline (Claire Marley, personal communication, Bonner County). The EPA conducted a search of their ICIS records, and 11 NPDES permits were issued after 2000 (Table 6). There were also additional industrial and construction projects: *IDR1000G3*- Wastewater facility expansion Sagle, *IDR1000EY* – US-95 Cocolalla Cr. Bridge, *IDR1000EP* – ITD-District #1 US-95 Cocolalla Cr. Bridge, and *IDR1000DK* & *IDR100059* – US-95 Council Alt Routes.

Table 6. NPDES-permitted facilities issued since 2000.

Facility Name	NPDES ID	Permit Date
Black Diamond Engineering – Cedars at Sandcreek	IDR10B621	7/1/2003
City of Sandpoint, Sand Creek Water Treatment Plant	ID0024350 & IDG380005	9/27/2006
City of Dover, Dover Waste Water Treatment Plant	ID0027693	11/30/2001
Interstate Concrete and Asphalt Sandpoint	IDR053211	12/22/2016
Kootenai-Ponderay STP	ID0021229	11/30/2001
Laclede Water District – Laclede Water Treatment Plant	ID0027944	9/27/2006
Laclede Water District – Laclede Water Treatment Plant	IDG380006	11/1/2016
McFarland Cascade Pole and Lumber	IDR053032	11/15/2015
Pacific Steel and Recycling Inc.	IDR053092	12/6/2015
Priest River Waste Water Treatment Plant	ID0020800	11/16/2011
Riley Creek Lumber Co.	IDR053134	12/10/2015
City of Sandpoint	IDL020842	1/1/2016
Stimson Lumber Company Priest River	IDR053126	10/31/2016
Waste Management of Idaho, Sandpoint	IDR053087	12/6/2015

Since 2000, there has been no significant change in major landownership in the subwatersheds addressed in either TMDL document (DEQ 2001, 2007). However, the loss of forest cover is measureable and may have effected sediment loading to the subwatersheds. In the Pack River watershed, the largest loss in forest cover occurred in the Hellroaring Creek, Rapid Lightning Creek, and Berry Creek subwatersheds between 2001 and 2014 (Figure 2). The loss of forest cover was due to commercial timber harvest in Hellroaring and Berry Creek subwatersheds and development in Rapid Lightning Creek. In the Cocolalla region, the largest decrease in forest cover occurred in the Curtis Creek and Careywood Creek subwatershed, where a 14–17% loss occurred. An 11–13% loss in forest cover occurred in the Trout Creek subwatershed (Pack River watershed) and the Upper Cocolalla Creek subwatershed, Hoodoo Creek subwatershed, and an intermittent stream subwatershed due to development.

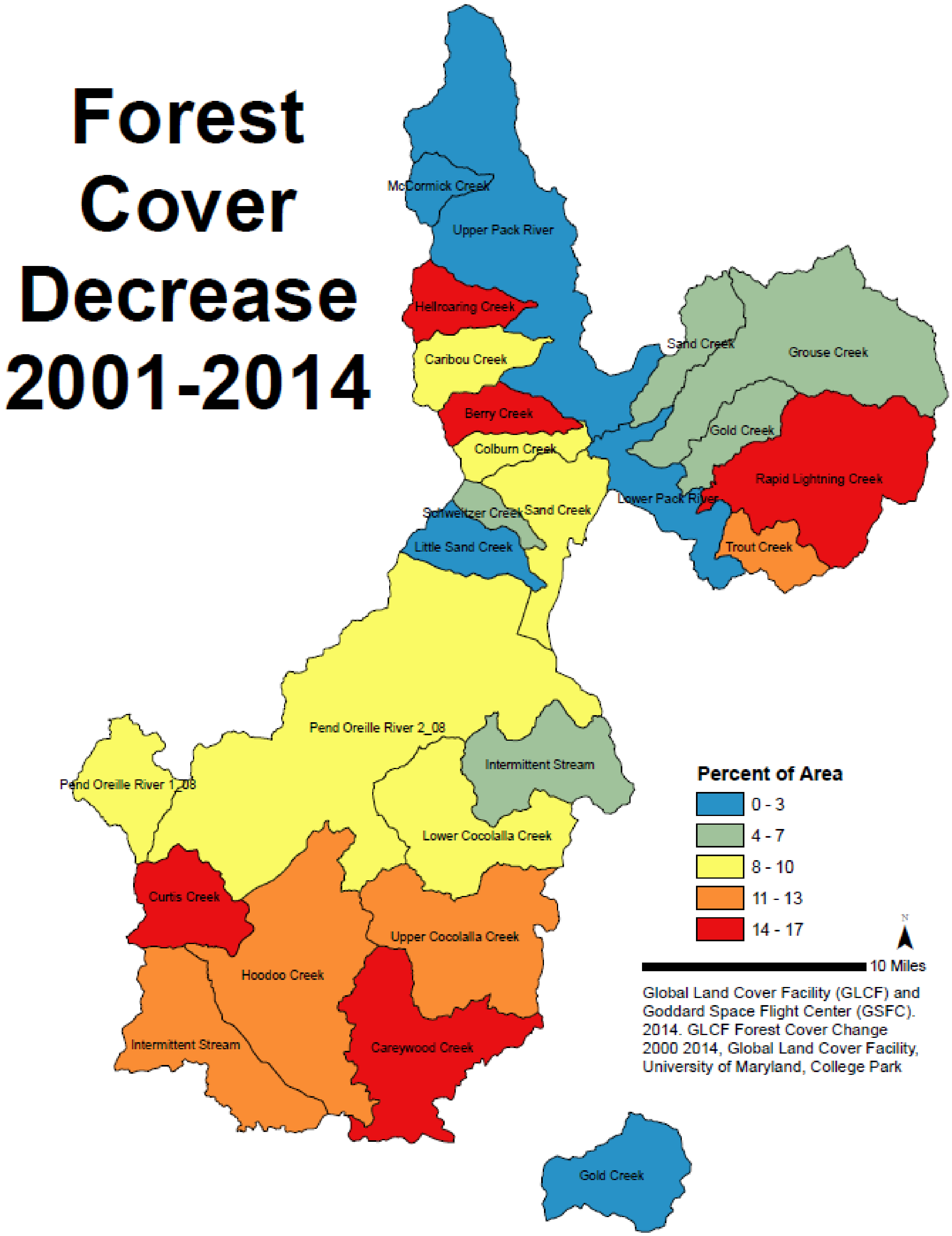


Figure 2. Change in forest cover in the Pend Oreille Lake and River tributaries watershed.

4 Beneficial Use Status

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses. The *Water Body Assessment Guidance* (DEQ 2016) gives a detailed description of beneficial use identification for use assessment purposes.

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." Designated uses are specifically listed for water bodies in Idaho in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109–160 in addition to citations for existing and presumed uses). Water bodies addressed in this TMDL with designated uses are listed in Table 7.

Use designation can only be assigned by Idaho legislation. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water aquatic life criteria and primary or secondary contact recreation criteria to undesignated waters.

Table 7. Designated beneficial uses in the subbasin.

Waterbody	Assessment Unit	Aquatic Life	Recreation	Other
Pend Oreille River	ID17010214PN001_08 ID17010214PN002_08	COLD	PCR	DWS
Cocolalla Creek – Cocolalla Lake to mouth	ID17010214PN014_02 ID17010214PN014_03 ID17010214PN014_04	COLD	PCR	DWS
Cocolalla Lake	ID17010214PN013_0L	COLD	PCR	DWS
Lower Pack River – Sand Creek to mouth	ID17010214PN031_04	COLD, SS	PCR	DWS
Upper Pack River – source to Sand Creek	ID17010214PN039_03 ID17010214PN039_04 ID17010214PN041_02 ID17010214PN041_03	COLD, SS	PCR	DWS

Note: cold water aquatic life (COLD), salmonid spawning (SS), primary contact recreation (PCR), drinking water supply (DWS)

4.1 Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250). For more information about the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation, see the *Water Body Assessment Guidance* (DEQ 2016).

4.2 Pollutant-Beneficial Use Support Status Relationship

The beneficial uses addressed in this 5-year review are cold water aquatic life, salmonid spawning, and recreation. The critical habitat requirements for aquatic life and salmonid spawning are cover, foraging, and reproductive habitat. Cover provides habitat for refuge from predators and hydrologic and thermal stress. Cover is associated with pools, bank cover, bed substrates, and woody debris (VANR 2008). Organics either transported from upstream or produced in the water column or on bed substrate provide food for aquatic life. Channel bed form and hydrology play a critical role in the transport and retention of organics. Critical habitat for salmonid spawning provides for juvenile migration, egg incubation, spawning, and rearing (VANR 2008). Ecological attributes supporting these critical habitat requirements—as summarized in the Vermont Natural Resources Rapid Habitat Assessment—are as follows (VANR 2008):

- Stream, riparian, and floodplain connectivity: the movement without obstruction of water, sediment, organic material, and organisms both longitudinally and laterally between the stream channel and the riparian zone
- Sediment regime: the size, quantity, sorting, and distribution of sediment
- Hydrologic regime: the timing, volume, velocity, and duration of flow events
- Temperature regime: the daily and seasonal instream water temperature
- Large wood and organic regimes: the diversity, quantity, and physical retention of wood and organic material

AUs addressed in this 5-year review have aquatic life or aquatic life/salmonid spawning beneficial use impairment by sediment and/or nutrient pollutants. A discussion on the pollutant-beneficial use support status relationship follows.

4.2.1 Sediment

Sediment impairment of aquatic life or salmonid spawning beneficial uses is most often associated with excessive fine sediment. However, such impairments can be from excessive sediment of any particle size. Both suspended (floating in the water column) and lake- or streambed sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time—such as during natural spring runoff—but longer exposures are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (e.g., difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases lead to death.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For Rainbow Trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50–100 mg/L when maintained for 14–60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment. Organic suspended materials can also settle to the bottom and, due to their high carbon content, diminish DO through decomposition.

Below are physical and ecological attributes that affect sediment transport and ultimately the quality of stream aquatic habitat. These attributes are described in the Vermont Reach Habitat Assessment document through an extensive summary of peer-reviewed literature. Indicators used to evaluate these features are discussed in the remainder of this section. The discussion highlights important concepts that were summarized in the literature review provided by Milone & MacBroom (2008).

Large Woody Debris

Large woody debris (LWD) is an important feature in a stream channel, providing refuge during high flows, cover from predation, bed roughness for habitat complexity, and retention of organic material. It also provides substrate for macroinvertebrate colonization. Some research has shown a correlation between LWD abundance and increased fish diversity. In addition to its biological benefits, the size and distribution of LWD can have a profound effect on stream hydrology, streambank stability, and sediment transport.

LWD is recruited into the channel by shear stress on undercut banks with overhanging vegetation that eventually falls into the channel. The abundance, distribution, and recruitment of LWD are dependent on the presence of large woody riparian vegetation, riparian and floodplain connectivity, stream hydrology, and stream and valley morphology.

Debris jams are accumulations of LWD that span, or nearly span, the width of the channel. They have similar physical and biological benefits as LWD; however, they provide more habitat heterogeneity for fish and macroinvertebrate cover, foraging, and reproduction. Debris jams also play a much larger role in stream hydrology and sediment retention and stability.

Factors that inhibit the recruitment and distribution of large wood and organic matter are removal of riparian vegetation, channel incision, lack of floodplain connectivity, dams, impoundments, undersized stream crossings, stream channelization, berming, roads, or other infrastructure encroachment in the floodplain.

Effective stream restoration practices often include introducing LWD and debris jams to influence stream hydrology, channel morphology, habitat complexity, and sediment transport.

Bed Substrate

The Wolman pebble count is a method to determine particle-size distribution and median substrate size (d50). Particle size and its product with sediment load are proportional to the product of channel slope and flow. A stream in equilibrium has a balance between these variables resulting in optimal sediment transport capacity and channel stability. Longitudinal distribution and lateral sorting of bed substrate has a direct relationship between the quality and quantity of aquatic habitat features and the distribution and diversity of biological communities.

When a stream is not in equilibrium, it is due to an alteration in slope, flow, and/or sediment load in the stream channel. Therefore, the channel must adjust its sediment transport regime to re-establish equilibrium. This stream may be sediment-starved or have excessive sediment. Both conditions may result in stream channel instability and habitat degradation that is detrimental to macroinvertebrates and fish. Indicators of a sediment-starved stream are excessive bed and bank erosion, channel incision, loss of lateral connectivity with the floodplain, lack of substrate heterogeneity, and homogenization of the stream bed. Indicators of a stream with excessive sediment are embeddedness, lack of substrate sorting, excessive bedload transport, aggradation, and frequent disturbance of habitat features. Instream aggradational features can also cause lateral channel migration and streambank erosion.

Some aquatic lifecycle requirements for salmonids and macroinvertebrates are dependent on clean interstitial spaces and bed stability. Embeddedness occurs when excessive fine sediment exceeds the stream's ability to transport during low flow, and the fines clog the interstitial space of course particles. Embeddedness impairs the use of interstitial space for spawning grounds, embryonic and juvenile life stages of salmonids, and macroinvertebrates.

Land use practices that don't follow best management practice (BMP) guidelines may lead to a change in a stream's sediment regime. Examples are vegetation removal resulting in exposed soil either through silviculture, agriculture, construction or sand sand/gravel mining. Road encroachments and developments, dams, diversions, and undersized stream crossings will also disrupt natural sediment regimes.

Scour and Depositional Features

In stable channels, scour and deposition result in diverse habitat features required for many aquatic lifecycles. Plunging flow and riffles provide turbulent cover and well-oxygenated areas for macroinvertebrates and fish. Pools offer refuge from high flows and predation. They also provide thermal refuge during hot summer months and ice-free winter habitat. At their downstream end, pools have gravel for salmonid spawning.

Pool spacing and depth is an important habitat aspect in streams. Abundant pools provide more refuge for fish during stressed times. Residual pool depth of 20–60 cm is ideal for trout habitat in low flows. Residual pool depth removes the influence of discharge when evaluating pool quality. Pool quality is a direct result of the balance between erosion and deposition. During low flow, deposition occurs in the pools. Flushing flows are important to maintain the pools.

A step-pool system is characterized by longitudinal steps with plunging flows over large wood or large substrate. Retention and stability of large wood and substrate is critical for step-pool stability. During high flow, steps are fortified, moved, or eliminated based on large wood and large substrate transport. The plunging flow over large wood or substrate dissipates energy in high-gradient streams and creates plunge pools. In a stable system, step-pool spacing is between 1 and 4 channel widths.

A riffle-pool system is in moderate to low-gradient, moderately sinuous channels with a well-established floodplain. The channel has a repeating sequence of riffles, runs, pools, and point bars. This pattern provides a diversity of velocity-depth features important for hydraulic refuge for fish and macroinvertebrates. The riffle-pool scour and deposition pattern are influenced by sediment supply and location within the channel network, channel form roughness, and peak flows. Riffle-pool form and distribution indicates whether the channel is stable or not. The presence of vegetated point bars and pool spacing every 5–7 channel widths are indicators of a stable riffle-pool system.

While some substrate movement is necessary for habitat diversity, excessive erosion/sedimentation can create unstable step-pool and riffle-pool channels with reduced diversity of aquatic habitat. The resultant change in habitat impairs biological communities. Channel widening or incision causes loss of pool and riffle habitat as bed features merge toward a uniform plane bed. Excess fine sediment and/or loss of flow will create shallower pools, embeddedness, and loss of habitat. Excessive aggradation of coarse sediment leads to bed instability and homogenization.

The use of LWD structures in low-gradient streams is an effective restoration tool to increase pool area. LWD may not be effective in higher-gradient streams where large boulders and bedrock are the primary hydraulic controls in these systems. If the source of excess sediment is not addressed, the restored pool habitat may be short-lived due to smothering from fine particles or large-scale deposition of coarse sediment. Revegetation of uplands and the riparian area are common practices for decreasing fine sediment input to a stream. Large wood structures that foster fine sediment deposition and revegetation of point bars are effective tools in immobilizing coarse sediment.

Channel Morphology

Streams are dynamic systems with ever changing morphology and flow patterns. Channel morphology is the stream channel's width, depth, meander wavelength, and gradient. Geomorphically stable channels have a balance between flow, slope, and sediment. They have periodic episodes of flooding important for loss of stream power during high flow, inundation of riparian soils, filtering of sediment, and recharge to ground water. Geomorphically stable channels are closely linked to habitat quality and heterogeneity and biological community diversity and distribution.

Bankfull flow is most effective at maintaining channel morphology because it transports the most amount of sediment/debris over time. It is also referred to as the "channel forming flow." Bankfull flow has an average recurrence interval of 1.5 years. Bankfull stage is an important geomorphic variable measured in the field. Bankfull stage is the point in the stream channel when flow just begins to enter the active floodplain. Determining bankfull stage is done by identifying physical features associated with erosion and deposition processes during bankfull flow.

Two geomorphic variables important to habitat quality are width/depth ratio and entrenchment ratio. Width/depth ratio is calculated by dividing mean bankfull depth into bankfull width taken at a channel cross section. The geomorphic type of a stream will have an expected width/depth ratio. Departure from the expected width/depth ratio is a result of a change in channel morphology. Entrenchment ratio equals the flood-prone width (width at twice maximum bankfull depth) divided by the bankfull width.

Channels with high width/depth ratios tend to be shallow and wide. Over-widened channels have a homogenous streambed with less diversity in habitat and flow. Channel widening occurs with a significant decrease in flow, increase in sediment transport, or decrease in channel slope. In some instances, channel widening follows channel aggradation. Channel aggradation is the raising of channel-bed elevation in streams incapable of transporting sediment load. The excess sediment deposition on the streambed and mid-channel bar formation concentrates stream flow onto both banks, causing streambank erosion and channel widening. In some instances, channel widening follows channel incision, when containment of higher flows causes excessive erosion of streambanks. Channel alteration—such as removal of riparian vegetation, bank trampling, and diversion of flow—can result in over-widened channels.

Channels with low width/depth ratios tend to be narrow and deep as a result of channel incision. Channel incision, also called bed degradation, entrenchment, or downcutting, occurs by the process of erosion or scour of bed material resulting in a lowering of channel-bed elevation. Channel incision occurs with a significant increase in flow, decrease in sediment transport, or increase in channel slope. Often channel incision follows headcut movement. A headcut is a nick point in a stream that migrates upstream with downcutting of the stream channel. Incised channels have faster and more turbulent flow, reduced habitat complexity, and diminished riparian/floodplain connectivity with the channel. Channel alteration such as dredging, straightening, and bar scalping/gravel mining will result in a change in channel incision.

Hydrologic Characteristics

Flow is directly related to habitat suitability for macroinvertebrates and fish. Variables closely linked to the hydrology of a stream are adjacent water features (such as spring/seeps and wetlands) and the frequency and duration of precipitation events, snow melt, and rain-on-snow events (common in north Idaho). Other variables closely linked to the hydrology of a stream are land use, flow alteration, and change in channel morphology.

When evaluating stream hydrology, it is important to determine wetted useable habitat and access to quality habitat when conditions are not favorable. Connectivity to less-stressful conditions is important for fish and macroinvertebrate survival in both high- and low-flow regimes.

Alteration of the natural flow regime disrupts the balance between flow, sediment, and slope that is so vital to the stability of a stream channel and habitat quality. Alterations can be as simple as diversion of water from a stream channel or impoundment of water, or as complex as alteration due to changes in land use within the watershed. Land use changes affect the path, timing, and volume of runoff, which ultimately affect stream hydrology. Development, roads, agriculture, silviculture, and fire immediately adjacent to the stream channel can profoundly affect the hydrology of a stream channel. Urbanization can permanently alter runoff characteristics, stream hydrology, and habitat quality.

Connectivity

The unobstructed movement of water, sediment, and biota along a stream corridor is important for the formation of critical habitat for refuge and foraging, recruitment of LWD, access to spawning habitat, and dispersal of aquatic species and vegetation. This connectivity includes the interconnectedness between a stream and its floodplain, which is vital for water quality, a healthy riparian area, stream channel stability, and ground water recharge. Periodic flooding allows for dissipation of stream energy and attenuation of sediment during high flow. The recession of flood water and infiltration into ground water leaves slower water habitat for juveniles and fish rearing. Examples of obstructions to stream connectivity are dams, impoundments, undersized stream crossings, diversions, berms, and encroachment of roads and other developments.

Dams, impoundments, and undersized stream crossings alter both upstream and downstream channel morphology due to changes in stream hydrology and disruption of the sediment/debris transport regime. This alteration results in upstream aggradation and downstream scour/degradation, coarsening of bed material, and a reduction in riffle, pool, and glide features. Dams and perched culverts disrupt the dispersal of aquatic species and vegetation, which may result in genetic isolation and impairment of the biological communities.

Diversions result in decreased flow downstream, dissipating the energy available for sediment transport, and resulting bed aggradation, channel over-widening, streambed homogenization, and less diversity in habitat and flow. Berms, encroachment of roads, and other developments diminish riparian/floodplain connectivity and flooding. This containment of higher flows causes an increase in available energy for sediment transport resulting in channel incision, bed homogenization, and reduced habitat complexity. The resultant change in habitat impairs biological communities.

Streambanks

Stable streambanks are essential to habitat quality in streams. Streambank erosion is a natural process resulting in deep, cool undercut banks and overhanging cover that provide shade, thermal refuge, refuge from predation, and hydraulic shelter. Undercut banks have also shown to be important refuge for some macroinvertebrates. Bank erosion is important for recruitment of large wood into the stream channel. Excessive erosion reduces habitat quality through loss of riparian vegetation, slumping banks, increasing width:depth ratio, excessive sedimentation, and destabilization of habitat features in the stream channel.

Bank erosion is caused by general hydraulic scour, lateral instability, and/or large-scale degradation (such as landslides). During the winter, ice jams may be a cause of scouring action on a streambank. Streambank height relative to bankfull flow, bank angle, root density, and soil matrix are factors that determine bank erodibility. The type of riparian vegetation and its density will dictate root density. Herbaceous shrubs, grasses, sedges, and rushes have a higher root density and provide better bank stability than trees. Land use practices that remove bank vegetation, elicit bank trampling, and/or increase runoff will result in increased bank erosion. Massive landslides or extensive bank slumping can introduce large amounts of sediment into a stream channel causing large-scale channel adjustment and plant, macroinvertebrate, and fish habitat degradation.

Riparian Vegetation

A healthy riparian buffer is important for aquatic life habitat and for stream morphology and transport of sediment and organic debris. A healthy riparian buffer with diverse plant species promotes shade and thermal refuge, root density, streambank stability, lateral connectivity, and longitudinal continuity in a stream corridor. These are measures of habitat quality that influence fish, macroinvertebrates, and other biota.

Riparian canopy cover provides shade, regulates stream temperature, and provides cover from predation. It is also important for recruitment of LWD for habitat diversity in the stream channel and is a source of organic debris for the food web.

A healthy riparian buffer plays a vital role in the connection between surface water and ground water by providing roughness to slow runoff and over-bank flooding so water can saturate soils and recharge ground water. During runoff or a flood event, a healthy riparian buffer protects stream water quality by filtering sediment, nutrients, and other pollutants. This capture of sediment and nutrients fosters pioneer species and diverse plant structure.

Removing the riparian buffer destabilizes a stream channel through excessive streambank erosion, sedimentation, and channel aggradation, which can lead to a decrease in habitat complexity and higher frequency/longer duration flood events. An effective stream restoration practice is revegetation of the riparian buffer through exclusionary fencing or planting.

4.2.2 Sediment–Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus adsorbs (i.e., adheres) to soil through precipitation as calcium carbonate in calcareous soils or through phosphorus sorption by aluminum and iron-oxide minerals. HDR (2007) prepared a thorough literature review of fate and transport of phosphorus in soils, soil sorption isotherms, and fate and transport of phosphorus in ground water. Soil sorption modeling has proven soils have a finite capacity for sorption of phosphorus, with tremendous variability depending on soil type. Soils with a low percentage of calcium carbonate and/or clay particles have a lower affinity to adsorb phosphorus (HDR 2007). Regardless of the soil type, the primary form of phosphorus in soil and runoff is total phosphorus (TP), not dissolved phosphorus, because it is bound to soil.

Because phosphorus is primarily bound to particulate matter in aquatic systems, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most substratum attached macrophytes. The US Department of Agriculture (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling macrophyte growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, when conditions become anoxic, sediment releases phosphorous into the water column. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is primarily a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This results in a loss of nitrogen oxides to the atmosphere.

Sediment can play an integral role in reducing the frequency and duration of algae blooms in lakes and rivers. In many cases, phytoplankton biomass responds immediately when external sediment sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

4.2.3 Nutrients

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

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

TP is the measurement of all forms of phosphorus in a water sample, including inorganic and organic particulate and soluble forms. In freshwater systems, typically greater than 90% of the TP occurs in organic forms as cellular constituents in the biota or adsorbed to particulate materials (Wetzel 1983). The remaining phosphorus is mainly soluble orthophosphate, a more biologically available form of phosphorus than TP. In impaired systems, a larger percentage of the TP is orthophosphate. The relative amount of each form can provide information on the potential for algal growth within the system.

Nitrogen may be a limiting factor at times when a substantial depletion of nitrogen in sediments occurs due to uptake by rooted macrophyte beds. In systems dominated by blue-green algae, nitrogen is not a limiting nutrient since algae can fix nitrogen at the water/air interface. When water nitrogen concentrations are low, this ability gives them a competitive advantage over phytoplankton that cannot fix nitrogen.

Total nitrogen (TN) to TP ratios greater than 7 are indicative of a phosphorus-limited system, while ratios less than 7 are indicative of a nitrogen-limited system. Only biologically available forms of the nutrients are used in the ratios because these are the forms used by the immediate aquatic community.

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

4.2.4 Dissolved Oxygen (Lakes)

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

DO levels of 6 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6 mg/L, organisms are stressed; if levels fall below 3 mg/L for a prolonged period, these organisms may die. Oxygen levels that remain below 1–2 mg/L for a few hours can result in large fish kills. DO levels below 1 mg/L are often referred to as hypoxic, while anoxic refers to conditions with no measurable DO. Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water).

DO reflects the health and balance of the aquatic ecosystem. Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water through plant photosynthesis and directly from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering water is called aeration.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. An oxygen sag will typically occur once photosynthesis stops at night and plant respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with daylight.

Temperature, flow, nutrient loading, and channel alteration all impact DO. Colder waters hold more DO than warmer waters. Oxygen is necessary to help decompose organic matter in the water and on the lakebed. Nutrient-enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand can result in lower lake DO levels.

4.2.5 Floating, Suspended, or Submerged Matter (Nuisance Algae)

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

Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The extent of the effect is dependent on both the type of algae present and the size, extent, and timing of the bloom. Nuisance algae blooms appear as extensive layers or algal mats on the surface of the water; they often create objectionable odors and coloration. In extreme cases, algal blooms can impair recreational and drinking water uses due to toxicity.

Blue-green algae blooms appear in summer and fall and can be considered a nuisance in high concentrations. The physical appearance of blue-green algae blooms can be unsightly, often causing thick green mats along shorelines. In addition, some species can produce toxins (cyanotoxins) that may cause illness and death to animals or humans. The primary target organs for cyanotoxins are the liver and nervous system, but other health effects do occur.

In lakes, algae die and sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the lake bottom. Low DO in these areas can lead to decreased fish habitat since fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Low DO levels caused by decomposing organic matter can also lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations on excess algal growth within the water column, combined with the direct effect of the algal lifecycle on DO and pH within aquatic systems. Therefore, reducing TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface water systems dominated by blue-green algae. Phosphorus management within these systems can potentially result in improvements in nutrient (phosphorus), nuisance algae, DO, and pH levels.

5 Summary and Analysis of Current Water Quality Data and Review of Implementation Activities

5.1 Data Evaluated Under this 5-Year Review

Water quality data evaluated during this 5-year review includes data collected by DEQ, nondirect measurements, and data from external sources.

5.1.1 Data Collected by DEQ

DEQ collected data to support this 5-year review effort during 2015. The types of data collected are discussed below.

During the 2015 field season, extreme dry conditions persisted throughout much of the summer. At the Sandpoint Experiment Station, maximum temperatures were in the upper 90s–100s in late June through early July. Temperatures remained in the 90s through much of August. Essentially no precipitation fell from June 3 through August 30. The dry conditions produced extreme fire danger for the entire region. Relief from extremely dry conditions came between August 31 and September 3 when over 1.5 inches of rain fell and temperatures dropped.

Stream Reach Habitat Assessment – Pack River and Sand Creek Watersheds

Data were collected on high- and medium-priority streams under the scope of this project. Detailed surveys were performed when provided access, in the Pack River and Sand Creek watersheds on two 100 meter representative stream reaches were selected then evaluated using modified stream classification methods described in Rosgen (2008). We also used methods described by Milone & MacBroom, Inc. (2008) and Wolman (1954). The VANR method was chosen based on a thorough literature review justifying each of the parameters selected for the assessment. This method is also similar to DEQ’s habitat assessment using the BURP method; therefore, some uniformity in the evaluations can be achieved by running recent BURP data through the assessment protocol for an overall physical habitat condition score. Physical habitat assessment is a good indication of existing sediment sources in the stream channel and the stream’s ability to transport sediment. Data collection sites are illustrated in Figure 3. Below are the physical and ecological attributes addressed in the VANR method and assessed in this 5-year review, with some background scientific basis as summarized thoroughly in the literature review provided in Milone & MacBroom, Inc. (2008):

Woody Debris Cover (large woody debris, debris jam, coarse particulate organic matter)

Variables evaluated in the field were:

- LWD: count of pieces that have length > 6 feet, D_{wide}>1 foot, $D_{6'out}$>0.5 feet
- Jams: count of jams that have more than 1 LWD and span or nearly span the channel

Bed Substrate Cover (embeddedness, cobbles+boulders, sand+gravels, and sediment mobility)

Variables evaluated in the field were:

- Embeddedness: qualitative assessment in head or middle of riffle/run with cobbles
- Pebble count: as described in Wolman (1954)
- Sediment stability: qualitative assessment during pebble count

Scour and Depositional Features (pool frequency, pool depth, turbulent cover, step/riffle structure, step/riffle spacing, deposition)

Variables evaluated in the field were:

- Step-pool/riffle-pools: visual qualitative estimate of frequency
- Pool depth: abundance of pools with depth greater than 20 centimeter (cm)
- Turbulent cover: proportion of water surface with turbulent cover
- Step-pool or riffle-pool structure: qualitative assessment of form and completeness
- Step-pool or riffle-pool spacing: estimate spacing per channel width

- Channel deposition: description of deposition locations

Channel Morphology

Variables evaluated in the field were:

- Width/depth ratio: bankfull width divided by mean bankfull depth obtained during cross section and channel measurements
- Entrenchment and incision ratios: entrenchment ratio equals flood-prone width divided by the bankfull width; incision ratio equals low bank height by maximum bankfull depth
- Channel alteration: identification of dredging, straightening, bar scalping/gravel mining, and other direct alterations to the channel

Hydrologic Characteristics

Variables evaluated in the field were:

- Wetted width/bankfull width: current wetted channel width divided by bankfull width from cross section and channel measurements
- Substrate exposure: estimate of amount of substrate not under water
- Adjacent water features: nearby springs, seeps, or wetlands
- Flow alteration: known changes to flow (withdrawals, land use, extreme morphology

Connectivity

Variables evaluated in the field were:

- Reach blockage
- Aquatic species
- Sediment
- Organic matter

River Banks

Variables evaluated in the field were:

- Percentage of bank erosion: length and average height of active erosion between toe and top of slope
- Abundance of mass failures
- Bank texture: size of dominant particles on the lower third and upper two-thirds of bank
- Undercut banks: presence of overhanging bank and water depth and stability
- Roots and bank vegetation abundance
- Bank canopy: percentage of canopy closure over channel and over channel margin
- Bank composition: type of vegetation on bank based on estimation of dominant and subdominant types based on area of coverage

Riparian Area

Variables evaluated in the field were:

- Channel canopy: percentage of canopy closure over channel and over channel margin
- Buffer width

- Buffer composition: type of vegetation on bank and in buffer based on estimation of dominant and subdominant types and area of coverage

Stream Surveys and Geomorphic Risk Assessment – Cocolalla Watershed

Visual stream surveys were conducted, when access was provided, on Hoodoo Creek, upper Cocolalla Creek, lower Cocolalla Creek and Fish Creek to determine the condition of the streams specifically as it relates to sediment impairment. A geomorphic risk assessment for the watershed was developed using GIS software to identify drainage density, subwatershed soil types, stream slope, and relative length of source, transport, and response reaches of streams in watersheds for Cocolalla, Fish, Butler, Johnson, and Westmond Creeks (Figure 3). The geomorphic Risk Assessment identifies watershed characteristics that result in higher erosion, increased transport and deposition due to valley and hillside slope and soil type.

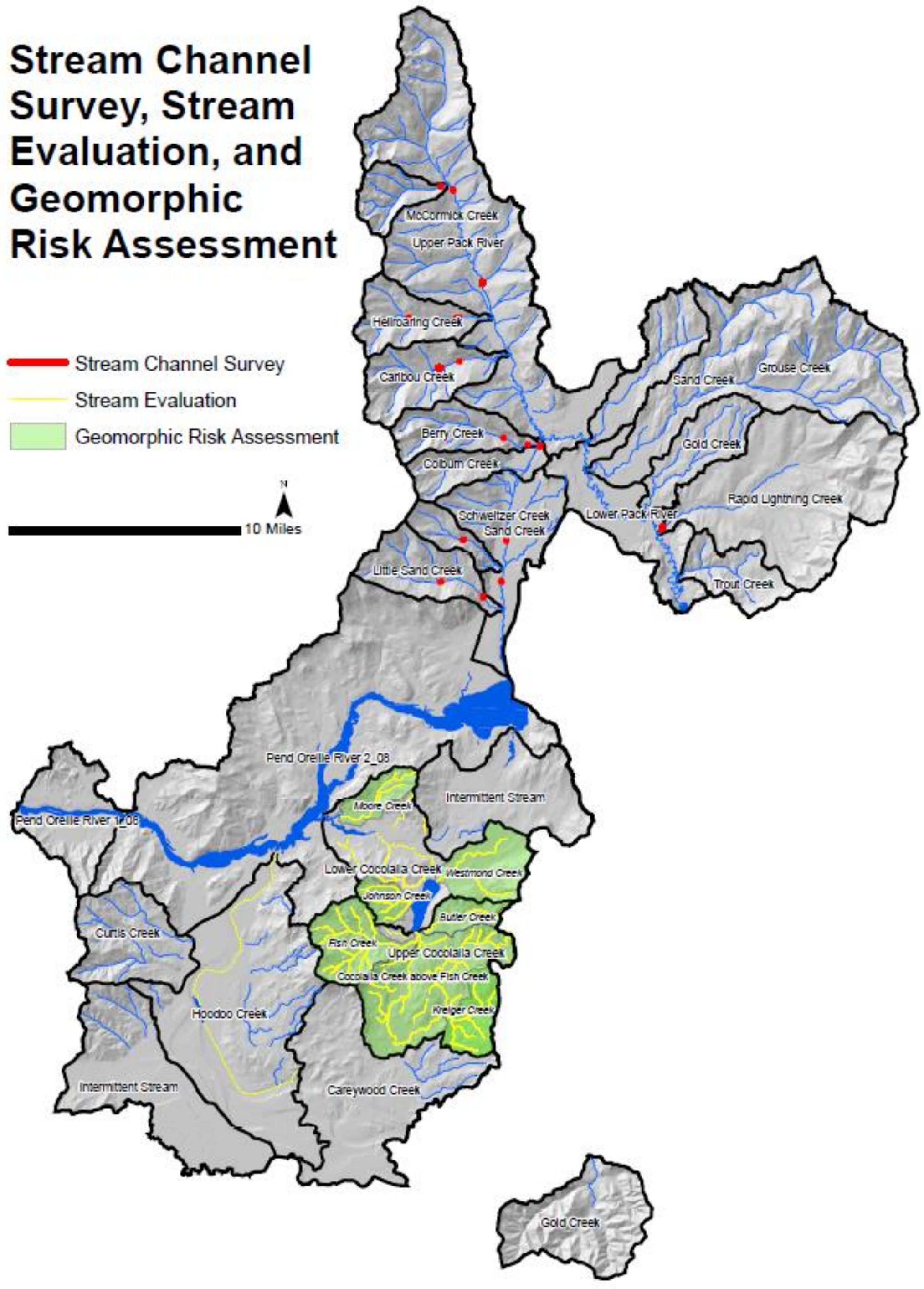


Figure 3. TMDL 5-year review stream habitat data collection sites.

Road Survey

In addition to stream reach habitat assessment, a road crossing survey was done on randomized road crossings in all high- and medium-priority subwatersheds. Roads surveyed are in Figure 4.

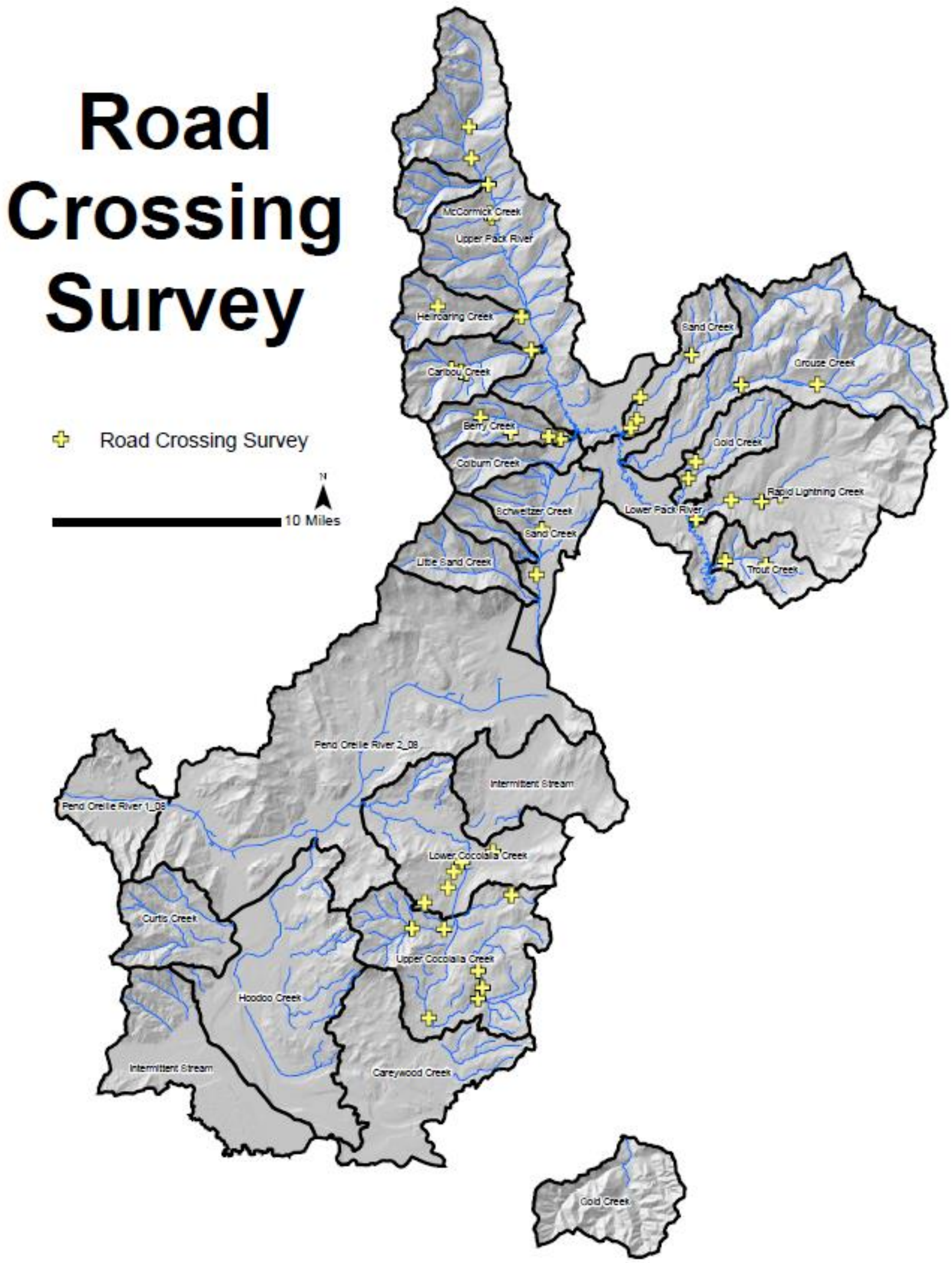


Figure 4. Road crossings surveyed under the TMDL 5-year review.

Cocolalla Lake Monitoring

Water Quality Data

Data collected from Cocolalla Lake is done by the Citizen Volunteer Monitoring Program (CVMP) under the guidance of DEQ. CVMP data consists of temperature and oxygen profiles collected at 1 meter (m) intervals from 0.1 m to 1 m off the bottom. Depth varies with lake level but is generally at 11 m at the sampling location, which is in the deepest area of the lake, identified by Z_{max}. TP is collected at two depths: the Secchi depth and 1 m above the bottom. A chlorophyll-a sample and TN (collected during the 2015 field season for this review) are also collected at the Secchi depth. The combined samples from the Secchi depth are collected using a Van Dorn or Kemmerer bottle. Sample water is alternately placed from both depths in a mixing churn and samples are drawn from the spigot. TP and TN samples are preserved and chilled for transport to the lab.

Periphyton Productivity

Artificial substrates were deployed by boat during the week of August 9, 2015, at an intended depth of approximately 3 m below surface. The substrate consisted of an expanded polystyrene block mounted to plywood (Figure 5). The plywood is bolted to a piece of concrete flagstone to provide added support and ballast. The expanded polystyrene substrates were large enough (1 square foot) for weekly sampling for 6 consecutive weeks. The artificial substrates were deployed without a line connecting them to a surface object in order to avoid entanglement and to reduce potential vandalism. Two artificial substrates were placed at each station: one as a primary and the other as a back-up.

For each consecutive week, the substrates were retrieved and sampled while the substrate remained at a depth just below the water surface (approximately 0.1 m). Care was taken to ensure the substrate was not dewatered at any time during the sampling effort.

The artificial substrates were deployed in areas less susceptible to vandalism. Intentional or unintentional vandalism may have affected results, especially if the artificial substrate was dewatered. The substrate was visually inspected for vandalism during each retrieval event.

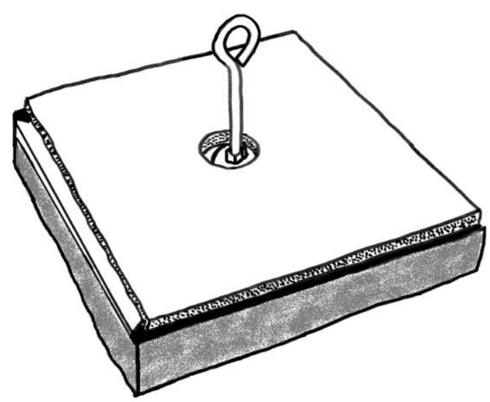


Figure 5. Illustration of artificial substrate.

Chlorophyll-a sampling was conducted during weeks 1–6 from the expanded polystyrene. Two 241-square-millimeter samples were hole-punched from the polystyrene and placed into a 20-milliliter (mL) plastic scintillation vial. The caps and labels were placed on the vials, and the vials were each wrapped in foil and placed on dry ice in a darkened cooler. The samples were placed in a freezer within 10 hours of collection until delivered to the lab. One sample was used by the lab for analysis of chlorophyll-a concentrations. The other sample was for a back-up, if necessary.

During retrieval (week 6), two additional samples were collected from each of the expanded polystyrene substrate—again with a hole punch and placed in a 20-mL plastic scintillation vial—for periphyton taxonomy and enumeration. The sample was preserved by adding analyte-free water to the vials along with 2 drops of Lugol's solution. The caps and labels were placed on the vials. These vials were not placed in a cooler but were kept out of direct light.

Expanded polystyrene foam (EPS) is a low-weight, rigid, tough, closed-cell foam. Many of the sample bottles that are commonly used for water quality monitoring are made of polystyrene. EPS is inert, nonbiodegradable, and 90% air. For this project, 0.5-inch thick Insulfoam Molded Expanded Polystyrene Foam R-Tech was selected. This EPS is safe, noncorrosive, and nontoxic and contains no hydrochlorofluorocarbons (HCFCs) or formaldehyde. The EPS components selected include <2% pentane and <1% bromine flame retardant. Pentane is rapidly metabolized and is not a bioaccumulator; it degrades readily and rapidly in the presence of oxygen. Pentane is not toxic to aquatic organisms (LC50 shows no mortality in fish [*Oncorynchus kisutch*] at 100 mg/L in 96 hours). The bromine flame retardant is in the form hexabromocyclododecane (HBCD). HBCD is pervasive in the environment, slightly soluble, and is bioaccumulative. HBCD may be at extremely low concentrations on the surface of the EPS, and HBCD has the potential of being toxic to algae.

Periphyton chlorophyll-a concentration analysis, periphyton taxonomy, and enumeration was conducted by Advanced Eco-Solutions Inc., a subcontractor for SVL Analytical. Results are presented in section 5.4.

Pend Oreille River Monitoring

DEQ conducts routine water quality monitoring on the Pend Oreille River from a minimum of three monitoring locations from a list of five thalweg locations. At each of the monitoring locations, DEQ collects the following data monthly from June through September:

- Profiles are collected through the water column of chemical and physical parameters including water temperature, pH, dissolved oxygen, electrical conductivity, turbidity, and chlorophyll-a fluorescence.
- Secchi depth is measured.
- Composite water samples are taken according to the depth of the photic zone and level of stratification and analyzed for nutrients, chlorophyll-a, and total alkalinity.
- If the station is stratified, a grab sample is taken from the hypolimnion and analyzed for nutrients.
- If there are hypoxic conditions (less than 3% oxygen saturation), a sample is collected from the zone of hypoxia and analyzed for nutrients and total alkalinity.

Batches of samples for each month (with 10% duplicate and blanks) are submitted to the laboratory for analysis.

5.1.2 Nondirect Measurements and External Data

Nondirect measurements and external data refer to data obtained for use by this project from existing data sources, not directly measured or generated in the scope of this project. This type of data is often referred to as "existing data." Examples of this type of data include data obtained from existing sources or databases (either from within or outside DEQ) and data obtained by others and offered or presented to DEQ for use. Criteria for acceptance of existing data are outlined in the *Water Body Assessment Guidance* (DEQ 2016).

The following data are recent (since the TMDL), have met the criteria for data acceptance, and will be evaluated against TMDL conclusions. Data are from BURP, IDL CWE, and Idaho Department of Fish and Game salmonid abundance monitoring. Information on these programs is provided in the sections below. Other data sources included the following:

1. US Forest Service data
2. Grouse Creek Watershed Assessment and Restoration Prioritization Plan Final Report (RDI 2009)
3. Pack River Stream Channel Assessment Final Report (Golder Associates 2003)
4. Idaho Fish and Game electrofishing and redd count data
5. TerraGraphics Environmental Engineering Stressor Identification reports

Idaho Beneficial Use Reconnaissance Program (BURP)

DEQ's Beneficial Use Reconnaissance Program (BURP) combines biological monitoring and habitat assessment data to determine the quality of Idaho's waters using three potential indices. BURP is used in determining the existing uses and beneficial use support status of Idaho's water bodies. The program was implemented statewide in 1994. Each summer, the DEQ Coeur d'Alene Regional Office completes 30–60 BURP surveys in northern Idaho using temporary summer staff.

The first index is the Stream Macroinvertebrate Index (SMI). By recording the abundance of macroinvertebrates known to live only in specific water quality conditions, the index is used as a direct biological measure of cold water aquatic life (DEQ 2016). A detailed description of this index can be found in Jessup and Gerritsen (2000). A score of 3 indicates a healthy assemblage of species close to reference streams in the state.

The second index is the Stream Fish Index (SFI). This index is also considered a direct biological measure of cold water aquatic life and is used to determine how close the stream is to achieving the Clean Water Act "fishable" goal. The details of the development of this index can be found in Mebane (2002). Mebane developed this index based on least impacted and stressed sites. Fish counts are taken in each watershed, and the index relates data found to known reference sites.

The last index considered when determining beneficial use support is the Stream Habitat Index (SHI). Details of this index can be found in Fore and Bollman (2000). The habitat index considers ten habitat metrics, including instream cover, substrate composition, bank and canopy cover, and zone of influence. SHI is not considered a direct biological measure; therefore, it is recommended that it always be used in conjunction with at least one other index due to significant variability in physical habitat measures (DEQ 2016). Table 8 lists the index scoring criteria for BURP.

Table 8. Index scoring criteria, Idaho Beneficial Use Reconnaissance Program.

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above 25th percentile of reference condition	≥65	≥81	≥66	3
10th to 25th percentile of reference condition	57–64	67–80	58–65	2
Minimum to 10th percentile of reference condition	39–56	34–66	<58	1
Below minimum of reference condition	<39	<34	No minimum	Minimum threshold

Note: Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI)

Idaho Department of Lands (IDL) Cumulative Watershed Effects (CWE)

IDL CWE data are collected under the program's quality assurance procedures. The CWE process evaluates the extent to which forest practices affect sediment delivery to the stream and recommends management actions based on the evaluation. If the stream is not supporting its beneficial uses, additional analysis is completed. The CWE process consists of seven specific assessments:

- Erosion and mass failure hazards
- Channel stability
- Hydrologic risks
- Sediment delivery
- Nutrients
- Beneficial uses/fine sediment

The data from these assessments are then analyzed using the methodology described in the *Forest Practices Cumulative Watershed Effects Process for Idaho* (IDL 2000).

Surface erosion and mass failure hazard ratings are based on soil characteristics, geologic material type, and percent slope. The Channel Stability Index is based on two assessments of the stream: (1) the streambank assessment and (2) the channel bottom assessment. The streambank assessment evaluates the amount of bank sloughing, the percent of vegetative cover, percent of bank rock content, and the prevalence of bank cutting. The channel bottom assessment evaluates the quantity of LWD, channel bottom movement, channel bottom rock shape, and brightness. Scores that are low are considered stable, moderate are moderately unstable, and high scores indicate unstable. When the Forest Canopy Removal Index is graphed against the Channel Stability Index, a Hydrologic Risk Assessment can be determined. The Hydrologic Risk Assessment determines the risk of adverse impacts to stream channel stability from the potential increase in magnitude and frequency of peak flow events in response to forest canopy removal. The total sediment delivery rating is the sum of the sediment delivery scores for roads, skid trails, and mass failures for the watershed.

For more information on the CWE process, see individual CWE reports. CWE scores are summarized under each individual subwatershed in the sections that follow. CWE reports written since the TMDLs are available for the following creeks: Berry, Caribou, Curtis, Fish, Grouse, Hellroaring, Hoodoo, Little Sand, Upper Rapid Lightning, and Spring.

TerraGraphics Environmental Engineering Stressor Identification Reports

Stressor identification data is collected under EPA's stressor identification guidance (EPA 2000). A stressor identification was completed using existing biological data, water chemistry data, aerial photos, field notes from previous investigations, BURP data, and the Clark Fork/Pend Oreille TMDL (DEQ 2001). Stressor identification reports written since the TMDLs are available for the following streams: Upper Pack River, McCormick Creek, Hellroaring Creek, Gold Creek, Rapid Lightning Creek, and Sand Creek.

Idaho Department of Fish and Game Salmonid Abundance Monitoring

Research and monitoring by the Idaho Department of Fish and Game (IDFG) has occurred on a 5-year rotational basis on 25 tributaries to Lake Pend Oreille. Monitoring is largely focused on abundance and distribution of salmonids through electrofishing surveys and Bull Trout *(Salvelinus confluentus)* redd counts. Both efforts were funded by the Idaho Tributary Habitat Acquisition and Fishery Enhancement Program and the Dissolved Gas Supersaturation Control, Mitigation, and Monitoring Program of the Clark Fork Settlement Agreement that supports ongoing research and monitoring in Idaho tributaries.

Electrofishing survey reaches were established on systematic intervals from the mouth through upper reaches. Typically, 100 meters were surveyed for every kilometer of stream, except on longer streams where every-other kilometer was surveyed. Sample reaches were closed using block nets at the downstream end of the electrofishing survey reach. Fish were collected, identified, measured, and weighed. Abundance estimates included fish ≥75 millimeters (mm) in total length.

Age of fish was estimated by collection of otoliths of each *Oncorhynchus* species. Age distribution of fish was used to determine the presence or absence of migratory fish. A strong presence of fish 4 years or older was assumed to indicate resident fish. Details of the electrofishing methods can be found in Ryan and Jakubowski (2012) and Bouwens and Jakubowski (2015).

Forest Cover Change

Forest cover change in watersheds was determined from a GIS exercise using the global forest change between 2001–2014. GIS data was downloaded from: *http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.2.html*. Forest loss during 2001-2014 was defined as a stand-replacement disturbance, or a change from a forest to nonforest state. Forest gain during 2001–2014 was defined as the inverse of loss, or a nonforest to forest change entirely within the study period.

Data came from Landsat imagery (earth observed satellite data) at a 30-m spatial resolution (900 m^2). The original raster data was converted to vector (polygon) data. The minimum area size was set at 5 acres; anything smaller was removed. The output represents a gain or loss of forest cover greater than 5 acres during the period from 2001 to 2014. The loss or decrease of forest cover was classified into three time periods: 2001–2004, 2005–2009, and 2010–2014. These periods established a time lapse within the 13-year period. The gain or increase of forest cover is for the entire period.

The forest cover decrease was totaled for each watershed, divided by the area of the watershed, and multiplied by 100 for a percent of forest cover decrease within a watershed area.

The fire disturbance layer was created by the Idaho Panhandle National Forests to describe the spatial location and characteristics of wildfires. The source layer is titled “Fire_Hist_Polygons” and was downloaded from *www.fs.usda.gov/main/ipnf/landmanagement/gis#roads*.

5.2 Pack River Watershed

The Pack River is the second largest tributary to Lake Pend Oreille, draining a watershed of approximately 101,207 acres. The USFS manages about 55% of the watershed, primarily in the headwaters and upper reaches of the Pack River. Approximately 36% of the watershed is privately owned and concentrated in the lower two-thirds of the watershed. Most of these lower reaches are zoned agricultural, with a parcel-size limit no smaller than 10 acres. Just north of Highway 200 is the Hidden Lakes Golf Course and housing development (PRTAC 2004).

The highest elevation in the watershed is at Mount Roothan (7,326 feet), and the lowest is the valley bottom (2,055 feet). The average maximum temperature during August in the higher elevations is 70 ºF and in the lower elevations is 85 ºF. During the winter, average maximum temperatures at higher elevations are 20 ºF, while lower elevations are 30 ºF (PRTAC 2004).

At elevations between 3,000 feet and 4,500 feet, the Pack River watershed experiences rain-on-snow events. These elevations cover approximately 38% of the watershed (PRTAC 2004). Rain-on-snow events can cause some of the highest peak flows, which can significantly influence the channel morphology and sediment transport regime.

High-intensity fires have been another disturbance regime that has influenced the stream channel morphology and sediment transport regime of the Pack River and its tributaries. The most recent large fire, the Sundance Fire, occurred in 1967 when approximately 50,000 acres burned. The Sundance Fire and other high-intensity fires caused a change in water yield and a change in the timing and distribution of runoff within the Pack River watershed. Runoff following such fires has been characterized by higher peak flows and higher minimum flows. In addition, the fire caused a loss of riparian vegetation and LWD within stream channels (PRTAC 2004).

Temporary patterns of sediment transport, sediment storage, and channel structure are a result of natural disturbances such as fire, rain-on-snow events, large-scale rainstorms, and associated flooding. These events cause random sediment pulses into stream channels. The upper drainages in the Pack River watershed effectively respond to these disturbance regimes and sediment inputs and sustain their long-term functions, processes, and conditions (PRTAC 2004).

Land use activities in the Pack River watershed have been responsible for hydrologic changes contributing to increased seasonal runoff volumes, increased peak discharges, and increased soil moisture levels. These activities have included the conversion of forestland to agriculture, surface drainage systems for agriculture and roads, channel modifications for log transport, and timber harvesting. Cumulative effects of these practices have increased discharges in the Pack River watershed that have accelerated downcutting of the Pack River and its tributaries. The downcutting may still be working its way up the tributary streams. Since passage of the Idaho Forest Practices Act in 1974 and the National Forest Management Act, streams and riparian areas are better protected and impacts on fish and aquatic habitat have been significantly reduced (PRTAC 2004).

The Pack River provides important spawning and rearing habitat for Bull Trout and Westslope Cutthroat Trout. Bull Trout are listed as threatened under the Endangered Species Act. Bull Trout migrate to spawn in tributaries as early as May, with peak spawning in September. Limiting factors to Bull Trout production in the Pack River watershed are fine sediment, lack of LWD, lack of pool habitat and cover, and elevated temperatures (PRTAC 2004).

Westslope Cutthroat Trout are recognized by the State of Idaho as a species of special concern. Adfluvial Westslope Cutthroat Trout migrate and spawn from March through July. Details of fisheries studies conducted by IDFG and AVISTA Utilities are provided below with individual subwatershed information. For more details on the Pack River watershed, consult the *Pack River Watershed Management Plan* (PRTAC 2004).

5.2.1 Berry Creek

Berry Creek (ID17010214PN046_02) is a 3rd-order tributary to Colburn Creek in the Pack River system. It flows into Colburn Creek approximately 0.25 miles upstream of the confluence of Colburn Creek and the Pack River (Figure 6). According to the TMDL, the Berry Creek watershed is 8,210 acres in size. Land use in the watershed is primarily timber production and agriculture on private property. The US Bureau of Land Management (BLM) and USFS manage small areas of land in the watershed. State land is located near the mouth of Berry Creek. Berry Creek also supplies domestic water for the city of Colburn, Idaho, which is 8 miles north of Sandpoint (DEQ 2001).

The geology of the Berry Creek watershed consists of granitics of the Kaniksu Batholith overlain by highly weathered glacial drift and till along the main stem flood plain and lower tributary flood plains, and to a lesser extent, metasediments and alluvium low in the watershed (IDL 2003a, 2005).

Berry Creek is not supporting the cold water aquatic life use due to sediment impairment. According to the Clark Fork/Pend Oreille TMDL and the Pend Oreille tributaries sediment TMDL, the watershed is the third-highest sediment loading watershed per acre.

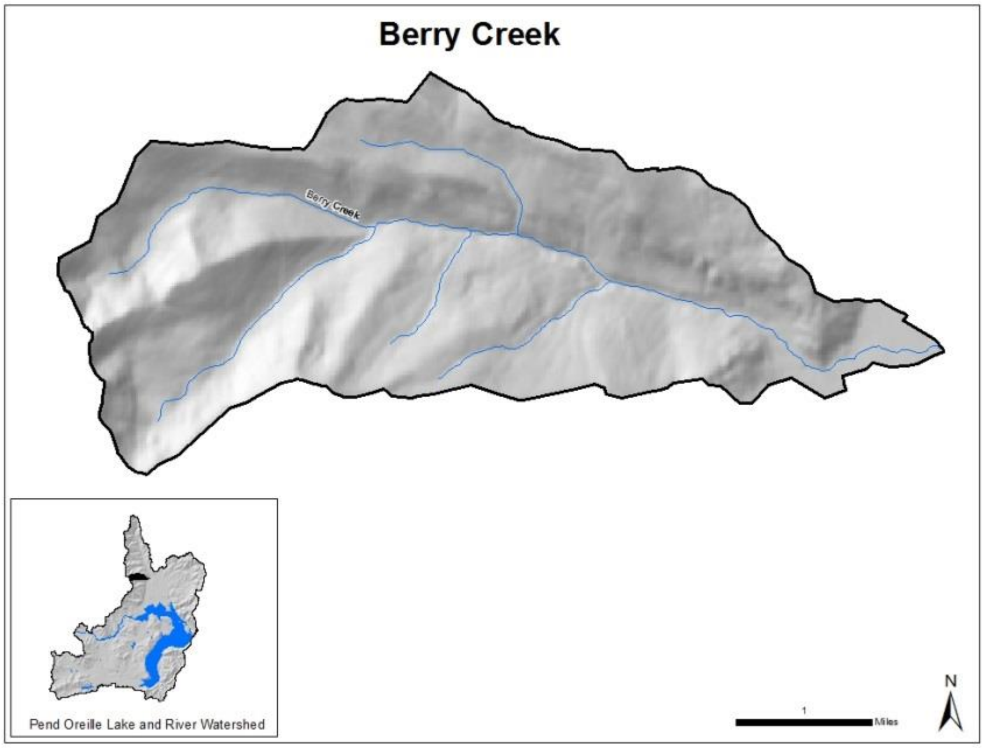


Figure 6. Berry Creek subwatershed.

Idaho Beneficial Use Reconnaissance Program (BURP)

No BURP data have been collected on Berry Creek.

IDL Cumulative Watershed Effects (CWE)

IDL last conducted the CWE evaluation of Berry Creek in 2003, 2005, and 2008 (IDL 2003a, 2005b; IDL 2009). Results of these evaluations are as follows and they are listed in Table 9.

Surface erosion and mass failure hazard ratings are based on soil characteristics, geologic material type, and percent slope. In 2003, the ratings were derived from land-type association maps. Because a large portion of the watershed below 3,500 feet has a thick layer of glacial till and debris, the surface erosion hazard was determined to be high. The mass failure hazard in the watershed was determined to be low (IDL 2003a). In 2005 and 2008, IDL determined the surface erosion and mass failure hazard ratings using a geographic information system (GIS) tool to calculate the soil characteristics and geologic material types against the percent slope. In both years, the surface erosion hazard was determined to be high, and the mass wasting hazard was moderate (IDL 2005b, IDL 2009).

Forest canopy removal may influence the magnitude and timing of surface runoff. Increased peak flows can cause erosion of streambanks and bed. CWE calculates a Canopy Removal Index for a watershed by dividing the equivalent acres of canopy removed through timber harvest, road construction, and forest fire by the total forested watershed acres for that particular watershed

(IDL 2000). IDL's hydrologic risk rating compares the level of canopy removal (Canopy Removal Index) with the stability of the stream channel (Channel Stability Index). Therefore, the hydrologic risk rating reflects the risk that the stream channel may be impacted by forest canopy removal.

In 2003, forestry was practiced on 99% of the Berry Creek watershed. Approximately 1,071 acres of canopy was removed through timber harvest, approximately 20% of the watershed, for a CWE Canopy Removal Index of 0.14. The 2005 and 2008 CWE report did not report what percentage of the forest canopy was removed through timber harvest.

The 2003 CWE process evaluated channel stability data from 1998 taken from four similar stream reaches. Due to the abundance of sand and the scoured condition of bedload material, Berry Creek scored a moderate Channel Stability Index (IDL 2003a). In August 2005 and June 2008, two 1,000-foot stream reaches were evaluated for channel stability. In 2005, an overall low channel stability rating was attributed to very little bank sloughing and cutting, moderate vegetative bank protection, excellent bank rock content, and a moderate amount of large organic debris (IDL 2005b).

In 2008, the Channel Stability Index rating was moderate, which was attributed to the stability and composition of the banks that exhibited frequent and high cutting and limited instances of sloughing. The banks were well vegetated with good stability from the root system of diversified riparian species. Large organic debris was sparse and smaller in size (IDL 2009). The overall hydrologic risk assessment in 2003 and 2005 was low. The overall hydrologic risk assessment in 2008 was moderate.

The CWE process evaluates sediment delivery to streams from roads, skid trails, and mass wasting of the road prism. In 2003, 16 roads were evaluated out of the 40 existing roads in the watershed because they had the potential to impact water quality and were primarily used for forestry practices. The sediment delivery rating for roads was moderate due to roads that paralleled the main stem and roads in the lower end of the drainage that were built on glacial debris (IDL 2003a). The sediment delivery rating from skid trails and mass wasting from roads in Berry Creek were both high due to historic skid trails using ground-based tractor skidding, sometimes in stream protection zones. These skid trails were not recovering well and delivering sediment directly to streams. In addition, 15 instances of mass wasting from the road prism were observed in the Berry Creek watershed. Other sediment pollution concerns observed in the Berry Creek watershed were six washouts and a ditch with gully erosion. In 2003, the overall sediment delivery rating to Berry Creek was high.

In 2005, the CWE process evaluated sediment delivery to streams from roads, skid trails, and mass wasting using data collected using GPS technology then entered into GIS. This analysis concluded the Berry Creek Watershed had 38.5 miles of roads, 99.0% of those being within forest land use. The CWE road assessment identified 26.0 miles of forest roads near streams or roads with potential to impact water quality. The CWE road sediment delivery rating from roads was low, indicating little sediment was being generated and delivered to a stream channel (IDL 2005b).

In 2008, the CWE process evaluated sediment delivery to streams from roads, skid trails, and mass wasting using data collected using GPS technology then entered into GIS. The Berry Creek watershed had 44.7 miles of roads. The CWE road assessment identified 21.3 miles of forest roads, or 48% of the total roads near streams or roads with potential to impact water quality. The CWE road sediment delivery rating was low, indicating little sediment was being generated and delivered to a stream channel (IDL 2005b).

In 2005, old skid trails that were in stream protection zones were observed to have substantial vegetative recovery. In 2005 and 2008, new skid trails were observed, but the Forest Practices Act dictates they must be outside stream protection zones. Therefore, these skid trails had a low CWE sediment delivery rating due to their very low potential for sediment delivery to a stream channel.

In 2005, nine mass failures were observed on the north side of Berry Creek where road construction was across the steep slopes on glacial drift and till. Two failures were directly into Berry Creek. Therefore, the sediment delivery rating for mass failures associated with roads was high. In 2008, three mass failures identified in the first (1998) CWE assessment still existed, and one new mass failure was identified. Therefore, the sediment delivery rating for mass failures associated with roads was low.

In 2005 and 2008, the overall sediment delivery rating from roads, skid trails, and mass wasting of the road prism for Berry Creek was low, a significant improvement from 2003.

Table 9. Idaho Department of Lands Cumulative Watershed Effects data.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydro-logic Risk	Roads	Skid Trails	Mass Failure	Total Sediment Delivery
2003	High	Low	Mod	0.14	Low	Mod	High	High	High
2005	High	Mod	Low	0.16	Low	Low	Low	High	Low
2008	High	Mod	Mod	0.36	Mod	Low	Low	Low	Low

Changes in Subbasin Characteristics

Berry Creek is a primarily forested watershed, with large tracts of land managed for timber production. Therefore the changes in subbasin characteristics since 2000 are primarily in forest cover and in road density.

Forest Cover Change

Between 2001 and 2014, 1,098 acres (13%) of forest cover were lost in the Berry Creek subwatershed (Figure 7):

- 2001–2004: 131 acre decrease
- 2005–2009: 610 acre decrease
- 2010–2014: 357 acre decrease

Aerial photos show that the loss was due to commercial timber harvest (Figure 8, Figure 9).

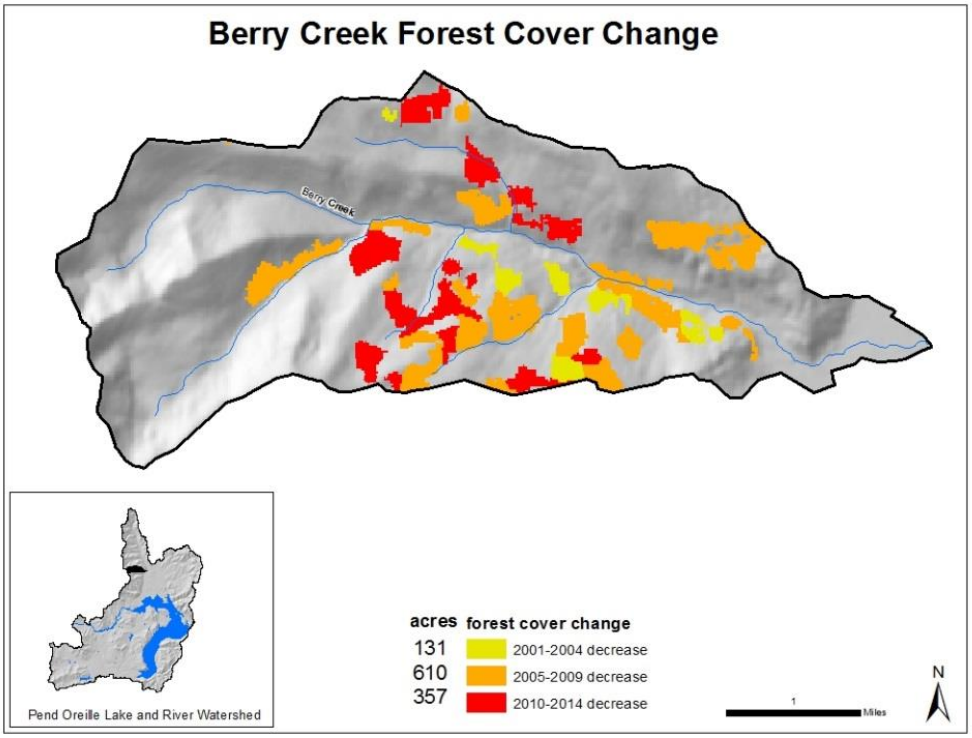


Figure 7. Percent forest cover change in the Berry Creek subwatershed, 2001–2014.

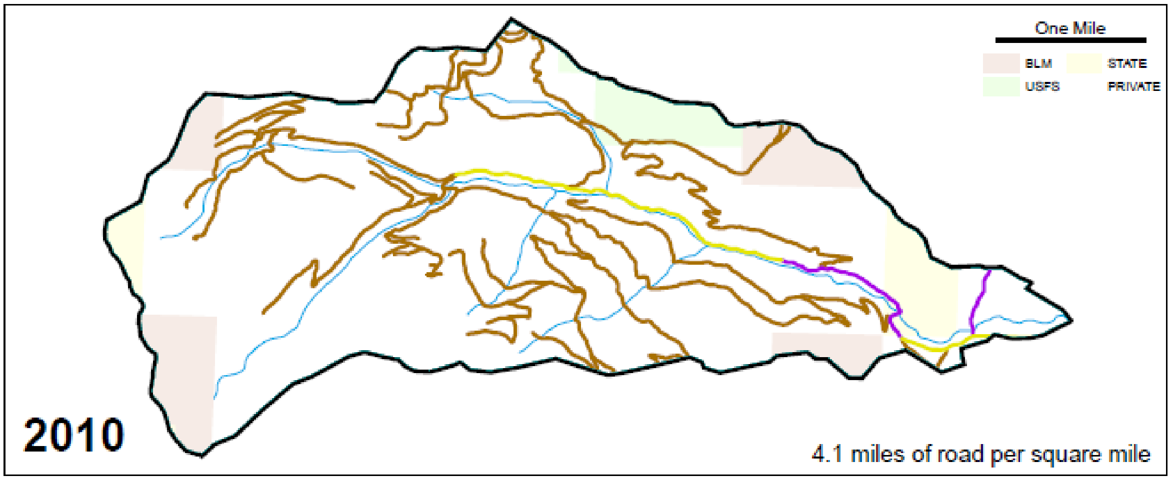
Figure 8. Berry Creek watershed imagery, 8/10/1998.

Figure 9. Berry Creek watershed imagery, 7/11/2014.

Roads

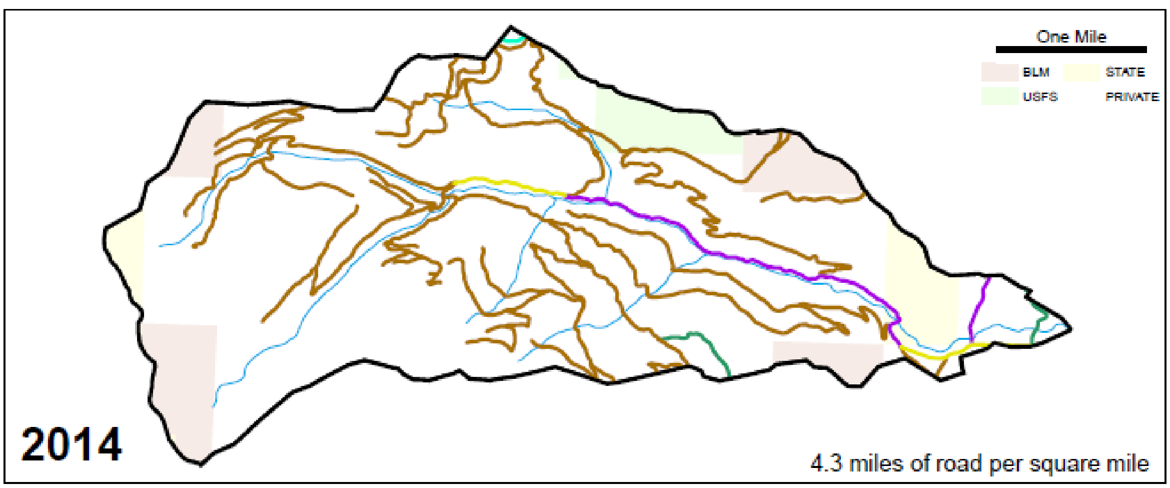
Road density in the Berry Creek watershed did not change significantly between 2010 and 2014 (Figure 10, **Error! Reference source not found.**). The density went up from 4.1 to 4.3 miles of road per square mile. Much of the roads in the network in the Berry Creek watershed are unimproved dirt roads.

Berry Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Berry Creek	Unimproved dirt	36.12	88	41
Berry Creek	Improved partial	3.24	7.9	41
Berry Creek	Waterbarred dirt	1.69	4.1	41

Surface: Improved gravel, Improved partial, Primary highway, Secondary highway, Unknown, Abandoned, Improved native, Improved paved, Primative, Unimproved dirt, Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Berry Creek	Unimproved dirt	37.15	85.6	43.4
Berry Creek	Waterbarred dirt	3.32	7.6	43.4
Berry Creek	Improved partial	1.63	3.8	43.4
Berry Creek	Unknown	1.11	2.6	43.4
Berry Creek	Abandoned	0.18	0.4	43.4

Figure 10. Comparison of road networks in the Berry Creek watershed, 2010 and 2014.

Fishery Data

In 2013, IDFG conducted monitoring on Berry Creek. The dominant species observed was Westslope Cutthroat Trout at a mean estimated density of 11 fish/100 m^2. Other species observed at very low abundance were Brook Trout (0.2 fish/100 m^2), Rainbow Trout (0.5 fish/100 m^2), and Rainbow x Westslope Cutthroat Trout hybrids (0.8 fish/100 m^2) (Bouwens and Jakubowski. 2015).

2015 DEQ Stream Evaluation

In 2015, DEQ evaluated two 100-meter stream reaches using a modified method described in Rosgen (2008), Vermont Agency of Natural Resources Reach Habitat Assessment (VANR 2008), and Wolman (1954). The stream reach described as "Upper Berry Creek" is located in steep, timbered terrain with little development. This reach is more representative of the AU as a whole. The stream reach described as "Lower Berry Creek" was near the mouth of the creek on agricultural property. Both study reaches are illustrated in Figure 3 (Section 5.1.1)

Upper Berry Creek

Upper Berry Creek was evaluated using Rosgen (2008). Data were collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 10. Upper Berry Creek is an entrenched, over-widened "A" channel with channel substrate ranging from small cobble to small boulder (64–1,024 mm).

Table 10. Reach characteristics for upper Berry Creek.

Measurement	Cross Section			Avg
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	16.6	16.7	13.5	15.6
Bankfull Depth (D_{bkf}), ft	0.37	0.60	0.39	0.45
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	44.86	27.83	34.62	35.77
Maximum Depth (D_{mbkf}), ft	0.7	1.0	0.9	0.9
Width of Flood-Prone Area (W_{fpa}), ft	18.0	22.5	19.0	19.8
Wetted Width, ft	12.4	14.8	8.6	11.9
Entrenchment Ratio (ER), ft/ft	1.08	1.35	1.41	1.28
Channel Materials (Particle Size Index) D_{50}, mm	large cobble (128–256 mm)	small cobble (64–128 mm)	small boulder (256–512 mm)	—
Water Surface Slope, %	4.5	5.0	5.0	4.8
Rosgen Stream Type	A			

The following reach habitat assessment of upper Berry Creek was completed on September 25, 2015, according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

At the upstream boundary of the study reach was the city of Colburn dam, used for storage of domestic water for the city (Figure 11). The dam spans the entire width of Berry Creek obstructing movement of aquatic life and causing downstream flow alteration. A man-made ditch running from the storage structure provides some water to the creek downstream of the structure. On September 25, flow in the creek upstream of the dam was 1.0 cubic feet per second (cfs). The flow below the dam was 0.03 cfs. A qualitative evaluation of stream conditions upstream of the dam is also provided below. Extremely low base-flow conditions existed on the creek on the date of evaluation due to low spring runoff, lack of spring moisture, and high (greater than 100 °F) summer temperatures.

Figure 11. Dam for the City of Colburn's public drinking water system.

Woody Debris Cover

While log jams were not abundant in upper Berry Creek, an abundance of LWD existed both above and below the Colburn Dam, which is a minor departure from reference conditions. There were no channel-spanning log jams in upper Berry Creek. Recruitment potential of large wood was high both above and below the dam due to the presence of a healthy cedar-hemlock riparian area (Figure 12).

Figure 12. Large woody debris is abundantly available to Berry Creek.

Bed Substrate Cover

Upper Berry Creek is a step-pool stream type dominated by large alluvial substrate both above and below the Colburn Dam (D_{50} = large cobble to small boulder or 128–512 mm). Pool and pool-margin embeddedness showed a minor departure from reference conditions due to the upstream dam entrapment of fine sediment and scour downstream of the dam from the lack of sediment. In the channel below the Colburn Dam, excessive large cobble and suboptimal sediment transport capacity was evident with mobility and lack of sorting of the large-cobble substrate (Figure 13). Excessive cobble substrate is also above the dam with evidence of substrate mobility and lack of sorting (Figure 14).

Figure 13. Excess large cobble in upper Berry Creek (below Colburn Dam).

Figure 14. Excess cobble in upper Berry Creek (above Colburn Dam).

Scour and Depositional Features

Below the dam, scour and depositional features were in good condition with some departure from reference conditions due to excessive and somewhat mobile cobble. Steps were moderately well formed, somewhat complete, and stable; however, step spacing showed a minor departure from reference condition (spacing less than 3–5 bankfull widths). Some mid-channel accumulation was evident. Below the dam there were two depth-velocity combinations (slow-shallow, slow-deep). Some pools provided good cover and thermal refuge for fish, which was noteworthy due to the extreme low-flow conditions and the dewatering of the creek from the dam. Also noteworthy was the presence of Cutthroat Trout and other unidentified fish in various age classes (including young-of-the-year) that were abundant in the pools. One amphibian was observed. Also observed were abundant caddisfly casings throughout the stream.

Above the dam, scour and deposition features were near reference conditions. Steps were distinctly formed, complete and stable (Figure 15). Step spacing was between 5–7 bankfull channel widths. Pool size and abundance were greater than those observed below the dam, providing excellent cover and thermal refuge for fish. An abundance of multiple age classes of Cutthroat Trout and an abundance of caddisfly casings were observed above the dam. Above the dam, more than two depth-velocity combinations were present.

Figure 15. Abundant pools in Berry Creek.

Channel Morphology

Both above and below the dam, Berry Creek channel morphology showed a major departure from reference conditions. The channel was over-widened (width/depth ratio greater than 25) and entrenched (entrenchment ratio greater than 1.2) (Figure 16). This is likely because of a historic road that paralleled Berry Creek at this location.

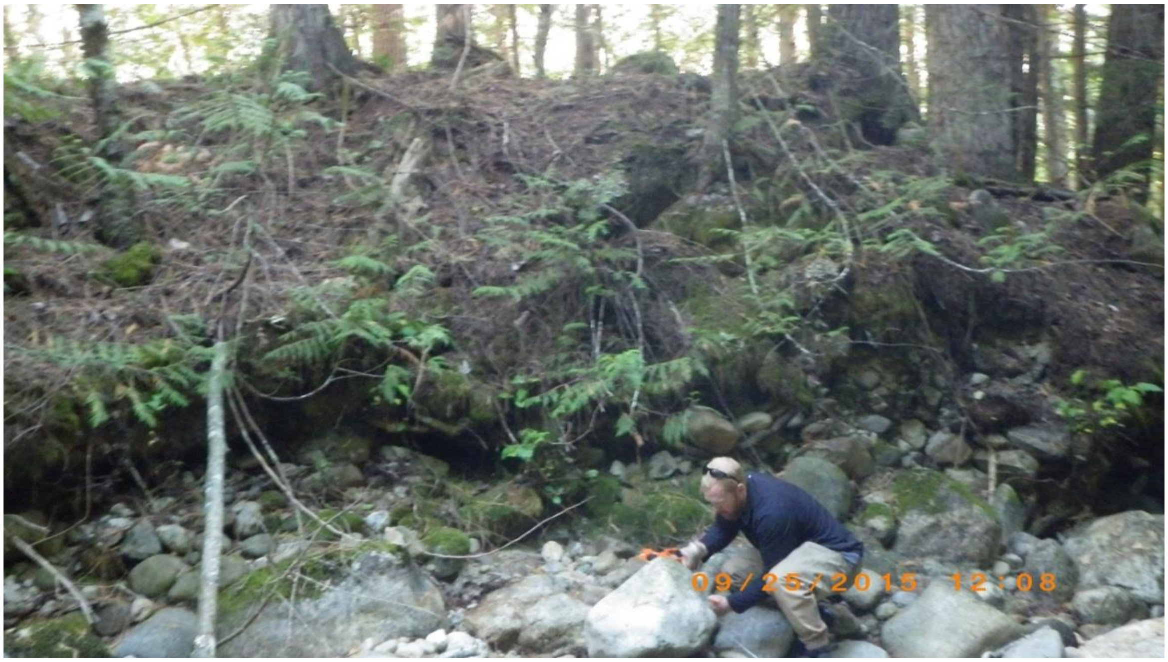


Figure 16. Upper Berry Creek (below Colburn Dam) channel entrenchment.

Hydrologic Characteristics

Upper Berry Creek had major flow alteration due to the dam. On the date of the survey, the gates were completely shut, and the only flow downstream of the dam was from the ditch running from the water storage structure. As such, the wetted width below the dam was less than 50% of the channel bankfull width. Exposed substrate was greater than 50% below the dam and between 30 and 50% above the dam. The altered hydrologic conditions both above and below the dam were exacerbated by the low-runoff year, prolonged lack of precipitation, and high summer temperatures.

Connectivity

Due to the Colburn Dam, longitudinal connectivity is completely obstructed. In addition, upper Berry Creek both above and below the dam was over-widened and entrenched, providing limited floodplain access.

Streambanks

Aside from being entrenched, the streambanks were at or near reference conditions above and below the dam. Therefore, disturbance causing widening and entrenchment was historical. Streambanks in upper Berry Creek were densely vegetated with diverse plant assemblages that created good cover with roots that stabilized the bank (Figure 17). Undercut banks were abundant, providing excellent cover for fish. The undercut banks had some unstable boundaries, indicating some bank erosion, but bank erosion was overall quite low. No mass failures were observed on the streambanks within the study reach.

Figure 17. Stream bank, Berry Creek.

Riparian Area

The riparian area of upper Berry Creek consisted of a cedar-hemlock overstory with mountain maple, devils club, and alder at or near potential natural vegetation (Figure 18). The riparian area buffer width was greater than 200 feet. Since obliteration of the road adjacent to Berry Creek, development and infrastructure was absent, except for the dam and water storage structure.

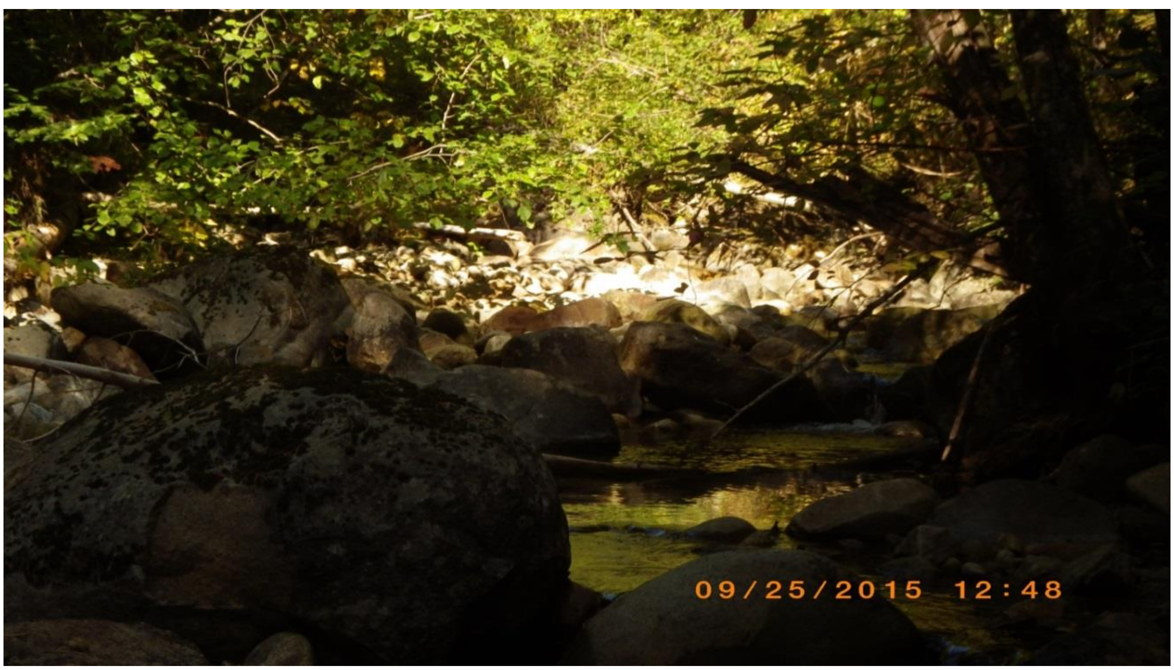


Figure 18. Canopy cover, Berry Creek.

Lower Berry Creek

One 100-meter reach of lower Berry Creek was evaluated using Rosgen (2008). Data were collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 11. Lower Berry Creek was an entrenched, over-widened "F" channel. The channel was dry on the day of evaluation, with frequent isolated pools perhaps filled by ground water. The landowner explained the stream goes dry on an annual basis.

Table 11. Reach characteristics for lower Berry Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	20.8	46.6	52.1	39.8
Bankfull Depth (D_{bkf}), ft	1.3	0.4	0.5	0.7
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	15.4	108.3	98.3	74.0
Maximum Depth (D_{mbkf}), ft	1.9	0.9	1.7	1.5
Width of Flood-Prone Area (W_{fpa}), ft	24.9	49.1	65.0	46.3
Wetted Width, ft	Dry	Dry	Dry	—
Entrenchment Ratio (ER), ft/ft	1.2	1.1	0.4	0.9
Channel Materials (Particle Size Index) D_{50}, mm	Small cobble (64–128 mm)	Very coarse pebble (31–64 mm)	No Wolman count	—
Water Surface Slope, %	0.5	0.5	0.5	0.5
Rosgen Stream Type	F			

The following reach habitat assessment of lower Berry Creek was completed according to the Milone & MacBroom, Inc. (2008) step-pool stream type. Although the stream was dry, the evaluation was still completed. Therefore, these data will not be used for assessment of beneficial use support purposes. The overall physical habitat condition rating for lower Berry Creek using this method was fair. Extremely low base-flow (dry) conditions existed on the creek on the date of evaluation due to low spring runoff, lack of spring moisture, and high (greater than 100 °F) summer temperatures.

Woody Debris Cover

The study reach in lower Berry Creek was in an agricultural pasture with no riparian exclusion fencing and limited riparian vegetation at the upstream end of the study reach. The lack of riparian vegetation coupled with poor streambank stability and active channel widening limited the recruitment and distribution of LWD. However, LWD and debris jams did exist in low abundance in lower Berry Creek, providing some fish habitat. The LWD jams were not channel-spanning jams. Riparian vegetation increased going downstream in the study reach, resulting in more recruitment and distribution of large wood (Figure 19).

Figure 19. Abundance of large woody debris increased downstream in the study reach.

Bed Substrate

Lower Berry Creek is a plane bed stream type dominated by very course pebble to large-cobble substrate (D_{50} = 31.1-128 mm). Pool and pool margin embeddedness was moderate, and there was major evidence of sediment mobility and lack of sorting (Figure 20).

Scour and Depositional Features

Scour and depositional features were in fair-good condition due to the excessive bedload limiting the stream's transport capacity. Due to bedload mobility, unstable point bar and mid-channel bar features were common, and a meandering thalweg was only moderately identifiable (Figure 21). Although the stream historically was straightened, the stream had good sinuosity. Pool formation on lower Berry Creek was evident, with pool size substantial in many cases. Some pools had water providing some refuge for fish (Figure 22). Cutthroat Trout and Brook Trout in various age classes (including young-of-the-year) were alive in these pools. Also observed were abundant caddisfly casings throughout the stream. Riffle formation appeared to be limited.

Figure 20. Lack of sediment sorting in lower Berry Creek.

Figure 21. A meandering thalweg in lower Berry Creek.

Figure 22. Salmonids in an isolated pool in lower Berry Creek.

Channel Morphology and Hydrologic Characteristics

Lower Berry Creek was severely over-widened and entrenched, providing limited floodplain access (Figure 23), due to the lack of riparian vegetation and historic channelization. As such, the stream channel lacked habitat complexity that would result in refuge during high and low flow regimes. A major obstruction upstream was a very large pond that was built on the stream, which could limit longitudinal movement of aquatic species.

Streambanks and Riparian Area

Streambank erosion was significant in the upper 50 meters of the study reach due to sparse riparian vegetation and livestock trampling (Figure 24). Undercut banks were evident; however, some undercuts lacked stability due to the loss of riparian vegetation. The undercuts nevertheless would be important habitat for fish in this creek. Bank sloughing was common within the study reach of Berry Creek (Figure 25).

Because much of lower Berry Creek is within a pasture, the riparian buffer was limited to primarily alder in the upper 50 meters of the study reach. Riparian vegetation became increasingly abundant going downstream, particularly beyond the study reach (Figure 26).

Figure 23. Channel incision and eroding banks, lower Berry Creek.

Figure 24. Trampled banks, lower Berry Creek.

Figure 25. Lack of riparian vegetation leading to bank instability, lower Berry Creek.

Figure 26. Riparian vegetation more abundant downstream in the study reach.

2015 Road Crossing Survey

DEQ conducted a road crossing survey in the Berry Creek watershed (Table 12). A number of roads have been decommissioned or put in storage, including obliterating the road that was immediately adjacent to the creek. The roads that provided access were well-maintained with good drainage to the forest floor (Figure 27, Figure 28). While numerous relief culverts and road crossings were looked at, four road crossings were evaluated. Their crossing type and location are listed in Table 12 and illustrated in Figure 3 (section 5.1.1). In general, the condition and placement of culverts and relief culverts were good, and erosion potential was low (Figure 29). One road crossing that was evaluated was a fish barrier (Figure 30). Another road crossing had a recent clear-cut that drained directly into the creek (Figure 31, Figure 32). IDL was notified of this problem, and the landowner installed a water bar upstream of the crossing. Water-bar maintenance will be critical to minimizing sediment discharge to the creek at this location.

Table 12. Road crossing characteristics, Berry Creek.

Waterbody	Type	GPS Coordinates	Erosion Severity	Overall Condition	Fish Barrier?
Tributary to Berry Creek	Round, steel-corrugated culvert	N 48.416324 W -116.577865	None	Good	Yes
Lower Berry Creek	Bridge, railroad tie decking, steel footings	N 48.415518 W -116.534415	Low	Good	No
Tributary to Berry Creek	Bridge, steel with timber decking	N 48.427586 W -116.612019	Medium	Good	No
Upper Berry Creek	Bridge, steel with timber decking	N. 48.416859 W -116.545541	Low	Excellent	No

Figure 27. Road, Berry Creek watershed.

Figure 28. Road, Berry Creek watershed.

Figure 29. Bridge with minimal erosion potential, upper Berry Creek.

Figure 30. Fish barrier on tributary to Berry Creek.

Figure 31. Clear cut with potential to drain to Berry Creek.

Figure 32. Clear cut upslope of Berry Creek stream crossing.

Review of Implementation Plan and Activities

Implementation activities on Berry Creek have included road maintenance, road resurfacing, road closure, bridge replacement, and improved road crossings (IDL, personal communication).

TMDL Discussion

Berry Creek is not supporting the cold water aquatic life use due to sediment impairment. Salmonid spawning beneficial use is not supported due to temperature impairment. This listing is a result of analysis of the Lower Pack River tributaries under efforts for the Clark Fork/Pend Oreille TMDL. This analysis based much of its conclusions on a 1998 IDL CWE analysis. The TMDL concludes the sources of pollution impairing beneficial uses in the main stem Pack River are occurring in places other than the Pack River headwaters, such as tributary streams and land uses along the lower reaches of the Pack River. According to the TMDL, the watershed is the 3rd-highest sediment loading watershed per acre in the Pack River watershed. According to the TMDL, a 74% load reduction in sediment is required for the lower Pack River watershed. No load reduction requirement was calculated for individual subwatersheds such as Berry Creek.

The most recent (2008) IDL CWE survey of Berry Creek indicated a low potential for sediment delivery to the creek. However, there was a moderate Channel Stability Index rating, which was attributed to the stability and composition of banks that exhibited frequent and high cutting and limited instances of sloughing. The banks were well vegetated with good stability from the root system of diversified riparian species.

IDFG and AVISTA electrofishing surveys indicate a good population of Westslope Cutthroat Trout in Berry Creek. The 2015 stream survey of upper Berry Creek confirmed this data with the presence of Cutthroat Trout and other unidentified fish in various age classes (including young-of-the-year) that were abundant in the pools. One amphibian was observed. Also observed were abundant caddisfly casings throughout the stream, which was remarkable given the low-flow conditions of the stream.

With the lack of data, beneficial use support cannot be adequately evaluated. Surveys conducted under this review concluded that while fish and macroinvertebrate presence were good in Berry Creek, beneficial use support in Berry Creek was questionable. Habitat was limited with an excessive amount of cobble substrate, large cobble mobility, and lack of sorting. Much of this cobble was entrained above the Colburn Dam. Below the dam there was channel scour and over-widening with excessive large cobble and suboptimal sediment transport capacity. There was no longitudinal connectivity and limited floodplain connectivity due to the presence of the dam and entrenched channel conditions, which limited the bedload transport and large wood recruitment capability of the stream.

Downstream near the mouth was a major departure from reference conditions. This reach was in an agricultural pasture with no riparian exclusion fencing and limited riparian vegetation. The lack of riparian vegetation coupled with poor streambank stability and channel widening limited habitat in this reach. Excessive bedload and aggradation may have caused Berry Creek to go subsurface in the summer months. Given the impaired habitat conditions due to excessive bedload, it is reasonable to conclude the TMDL load reductions still need to be met in Berry Creek.

5.2.2 Caribou Creek

Caribou Creek (ID17010214PN045_02) is a 3rd-order tributary to the Pack River (Figure 33). According to the TMDL, the Caribou Creek watershed is 9,173 acres (DEQ 2001).

The geology of the watershed consists of the Kaniksu Batholith in the headwaters and Pleistocene glacial debris and till in the lower elevations (IDL 2003b, 2010a). Land use in the Caribou Creek watershed is mainly timber production with one primary landowner.

Caribou Creek is listed in Idaho's 2012 Integrated Report as not supporting its cold water aquatic life use due to sediment impairment. The salmonid spawning beneficial use is incorrectly listed as fully supported. According to the Clark Fork/Pend Oreille TMDL, the watershed is the fourth-highest sediment loading watershed per acre (DEQ 2001).

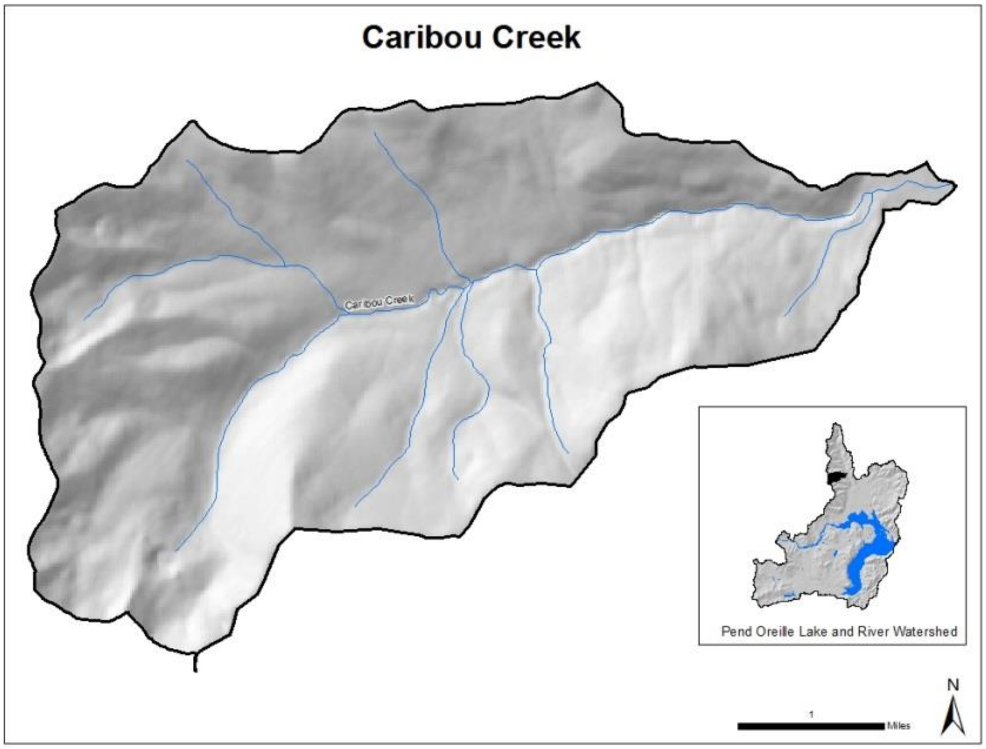


Figure 33. Caribou Creek subwatershed.

Idaho Beneficial Use Reconnaissance Program (BURP)

Since 2000, DEQ has monitored Caribou Creek twice using the BURP monitoring method (Table 13). In 2006, the stream had excellent macroinvertebrate and stream habitat scores, indicating the stream is fully supportive of the aquatic life and salmonid spawning beneficial uses. Streamflow was 1.8 cfs. No fish data were collected. DEQ found abundant pools with moderate cover. Streambanks were stable from an abundance of roots with stable undercut banks. There was 8.3% fines with little embeddedness.

In 2014, Caribou Creek was evaluated again using the BURP protocol, but for unknown reasons the data weren't scored. An evaluation of the 2014 BURP data indicates Caribou Creek was in good condition. Large wood was abundant, including the presence of log jams, and woody debris recruitment potential was moderate. Pool embeddedness was limited with the sediment apparently stable and sorted. There was a moderate abundance of large pools. Steps were moderately well formed, complete, and stable. The width/depth ratio was trending toward a reference condition, with evidence of only minor historic channel alteration. The channel banks were stable, with low density of bank erosion. Undercut banks were mostly stable, with abundant overhanging vegetation. The riparian area was healthy with little corridor development. Bull Trout were present.

Table 13. Beneficial Use Reconnaissance Program data for Caribou Creek.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA054	77.16	3.0	—	—	70.0	3.0	3.0
2014SCDAA097	—	—	Bull Trout present	—	—	—	—

IDL Cumulative Watershed Effects (CWE)

IDL last conducted the CWE evaluation of Caribou Creek in 2002 and 2009 (IDL 2003b, TerraGraphics 2010). Results are listed in Table 14.

Due to the granitic geology of the watershed, Caribou Creek rated high for surface erosion hazard in 2002 and 2009. The risk of mass failure was rated moderate in 2002 and 2009. In 2002, approximately 24% of the effective canopy had been removed in the watershed either through harvest or forest fires. An estimated 10% of the watershed was naturally devoid of tree cover. With a moderate Channel Stability Index, the overall hydrologic risk that the channel would be impacted from forest canopy removal was low.

In 2009, two 1,000-foot stream reaches were evaluated for channel stability; the overall rating was moderate. This score was attributed to a fairly stable channel with moderately vegetated and stable banks. In 2009, approximately 3,485 acres (38% of the watershed) had been removed from fire or timber harvest, giving an overall hydrologic risk rating of moderate.

Sediment from roads, skid trails, and mass wasting was evaluated. Roads were given a sediment delivery score for a number of segments, then given a weighted average over the total road mileage evaluated. Mass failures were recorded as they were observed, and a mass failure delivery score was calculated based on frequency, size, and delivery. In 2002, approximately 46 miles of road existed in the Caribou Creek watershed, and 22 miles of roads close to streams were evaluated. The rating for sediment delivery to streams from roads was moderate. The rating from skid trails was low. Due to the presence of nine significant mass failures, the rating for mass failures was high. In 2002, the overall sediment delivery rating to streams was moderate. During this evaluation, a number of management problems were identified such as culvert problems, washout of roads, and mass failures.

In 2009, approximately 43.1 miles of roads were in the Caribou Creek watershed. The CWE assessment evaluated 27.9 miles, or 65% of the total roads. The sediment delivery rating from roads was low. In 2009, 31 skid trails were identified; however, their risk of sediment delivery to a stream was low. The overall mass failure rating for sediment delivery to a stream was low. In 2009, six new management problems were identified as prolonged, major sources of sediment to the stream. These problems were all associated with roads and culverts.

Table 14. Idaho Department of Lands Cumulative Watershed Effects data, Caribou Creek.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydro-logic Risk	Roads	Skid Trails	Mass Failure	Total Sediment Delivery
2002	High	Mod	Mod	0.24	Low	Mod	Low	High	Mod
2009	High	Mod	Mod	0.38	Mod	Low	Low	Low	Low

Changes in Subbasin

Forest Cover Change

Between 2001 and 2014, a 930 acre (10%) loss in forest cover occurred in the Caribou Creek subwatershed (Figure 34).

- 2001–2004: 87 acre decrease in forest cover
- 2005–2009: 433 acre decrease in forest cover
- 2010–2014: 410 acre decrease in forest cover

An evaluation of aerial photos concluded that most of the loss was due to commercial timber harvest (Figure 35, Figure 36).

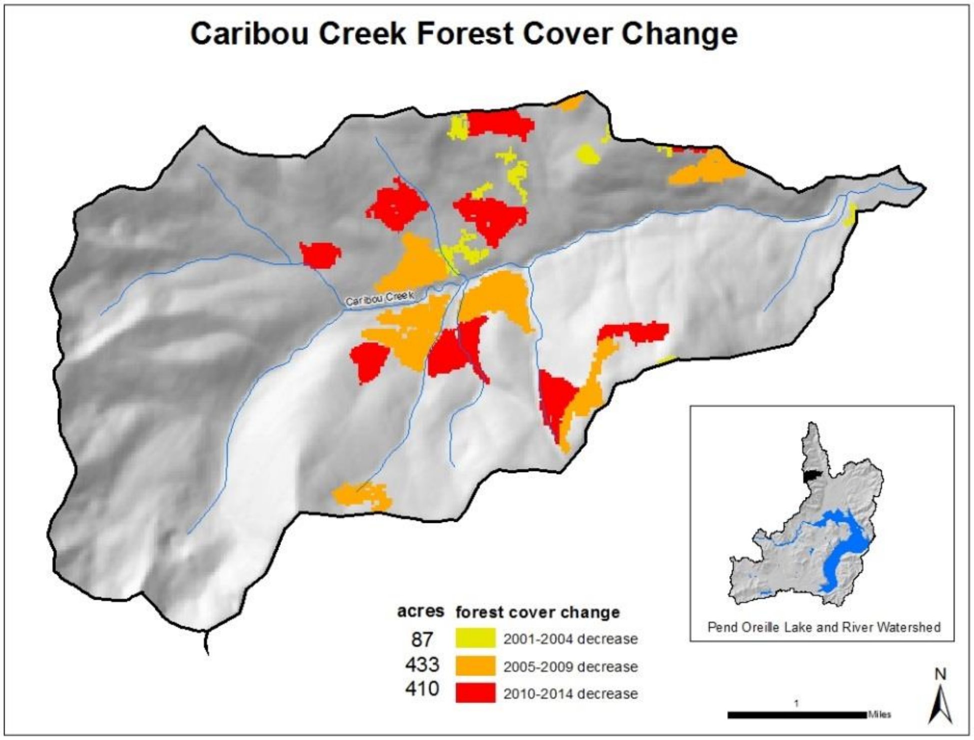


Figure 34. Forest cover change in Caribou Creek subwatershed, 2001–2014.

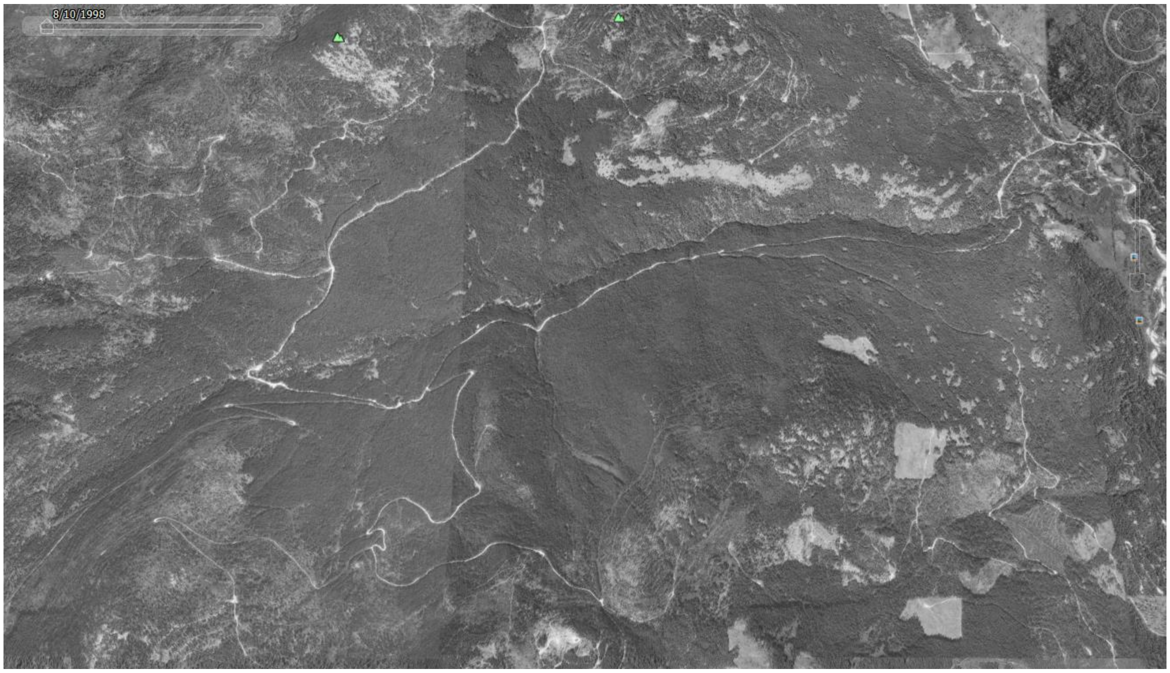


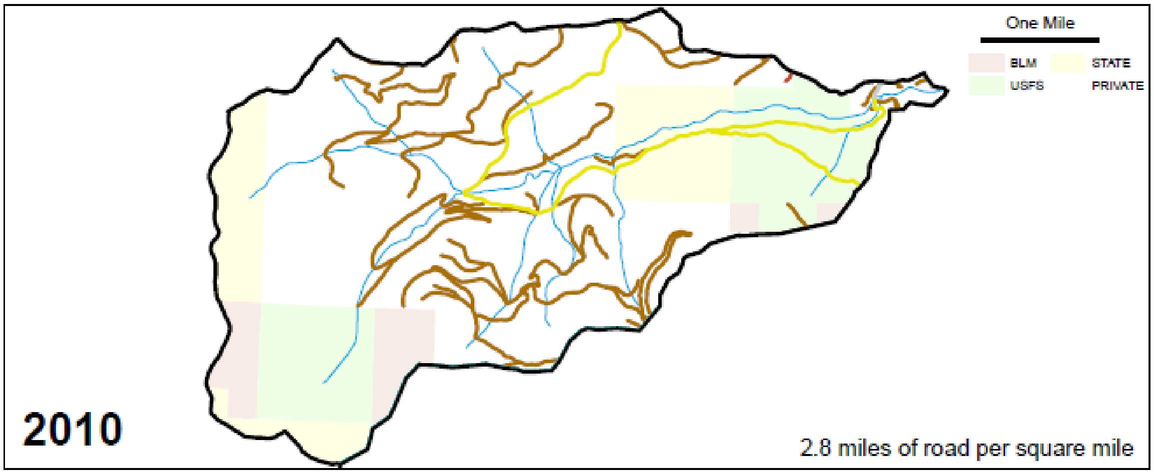
Figure 35. Caribou Creek watershed, August 1998.

Figure 36. Caribou Creek watershed, February 2014.

Roads

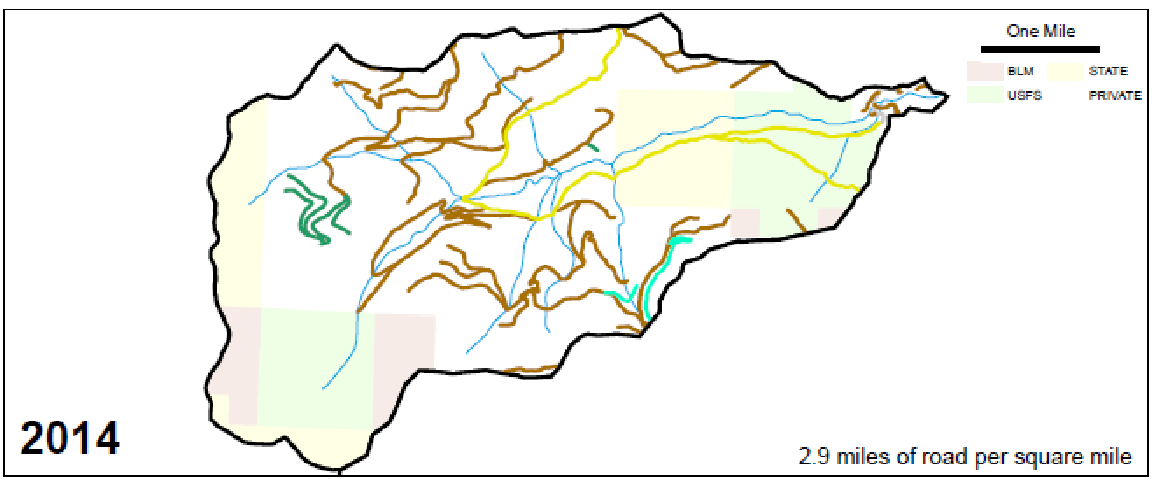
Between 2010 and 2014, road density in the Caribou Creek watershed did not change significantly (Figure 37), increasing from 2.8 to 2.9 miles of road per square mile. Approximately 1.48 miles of road were abandoned, and almost 0.5 miles of road was improved with gravel. Much of the roads in the Caribou Creek watershed were unimproved dirt roads.

Caribou Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Caribou Creek	Unimproved dirt	30.48	78.7	38.7
Caribou Creek	Improved partial	7.88	20.4	38.7
Caribou Creek	Improved gravel	0.24	0.6	38.7
Caribou Creek	Improved native	0.11	0.3	38.7

Surface — Improved gravel; Improved partial; Primary highway; Secondary highway; Unknown; Abandoned; Improved native; Improved paved; Primative; Unimproved dirt; Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Caribou Creek	Unimproved dirt	27.46	68.8	39.9
Caribou Creek	Improved partial	7.64	19.1	39.9
Caribou Creek	Unknown	2.85	7.1	39.9
Caribou Creek	Abandoned	1.48	3.7	39.9
Caribou Creek	Improved gravel	0.49	1.2	39.9

Figure 37. Comparison of road networks in the Caribou Creek watershed, 2010 and 2014.

Fisheries Data

The IDFG electrofishing survey efforts in Caribou Creek took place in 2011. Survey reaches were established on systematic intervals from the mouth through upper reaches. Five 100-meter sections over 9 km of stream were surveyed. Age distributions of fish sampled were used to determine the presence of resident and/or migratory fish. A strong presence of fish 4 years or older was assumed to indicate resident fish. Bull Trout and Westslope Cutthroat Trout were observed in abundance and distribution in Caribou Creek. According to IDFG, this is the first known documentation of Bull Trout in Caribou Creek. Bull Trout were observed in almost all the study reaches, with densities ranging from 0 to 7 fish/100 m^2. Westslope Cutthroat Trout were the most abundant species found in Caribou Creek, averaging 6 fish/100 m^2 and ranging from <1 to 12 fish/100 m^2. Rainbow Trout, Brook Trout, and Rainbow × Westslope Cutthroat Trout hybrids were found in low abundance.

2015 DEQ Stream Evaluation

In 2015, DEQ evaluated one 100-meter stream reach using a modified method described in Rosgen (2006), Milone & MacBroom, Inc. (2008), and Wolman (1954). The stream reach is located in steep, timbered terrain with little development and is representative of the AU as a whole. The study reach is illustrated in Figure 3 (section 5.1.1). Streamflow was 0.6 cfs at 8.7 ºC. The stream pH was 7.09, and conductivity was 32 µS/cm.

A 100-meter stream reach of upper Caribou Creek was evaluated using Rosgen (2006) on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 15. Caribou Creek was an entrenched, over-widened "B" channel, with large cobble channel substrate (128–256 mm).

Table 15. Reach characteristics for Caribou Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	18.1	21.3	24.4	21.3
Bankfull Depth (D_{bkf}), ft	0.78	0.61	0.44	0.61
Width/Depth Ratio (W_{bkf}/D_{bkf}). ft/ft	23.21	34.92	55.45	37.9
Maximum Depth (D_{mbkf}), ft	1.2	1.2	0.9	1.1
Width of Flood-Prone Area (W_{fpa}), ft	24.8	25.0	36.3	28.7
Wetted Width, ft	15.7	17.1	14.7	15.8
Entrenchment Ratio (ER), ft/ft	1.37	1.17	1.49	1.34
Channel Materials (Particle Size Index) $D_{50,}$ mm	Large cobble (128–256 mm)	Large cobble (128–256 mm)	Large cobble (128–256 mm)	
Water Surface Slope, %	2.5	2.0	1.5	2.0
Rosgen Stream Type	B			

The following reach habitat assessment of Caribou Creek was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

While log jams were not abundant in upper Caribou Creek, there existed an abundance of LWD 1 foot or greater in diameter. Recruitment potential of large wood was moderate due to the presence of a healthy cedar-hemlock riparian area (Figure 38). Based on this evaluation, woody debris cover exhibited a minor departure from reference conditions.

Figure 38. Large woody debris in Caribou Creek.

Bed Substrate Cover

Caribou Creek was a riffle-pool stream type dominated by large alluvial substrate (D_{50} = large cobble or 128–256 mm). Riffle embeddedness was 20–40%, and riffle margin embeddedness was 40–60%—both a minor departure from reference conditions. Due to the excessive amount of cobble substrate, there was some evidence of large cobble mobility and lack of sorting (Figure 39). The substrate was free of dense algae growth.

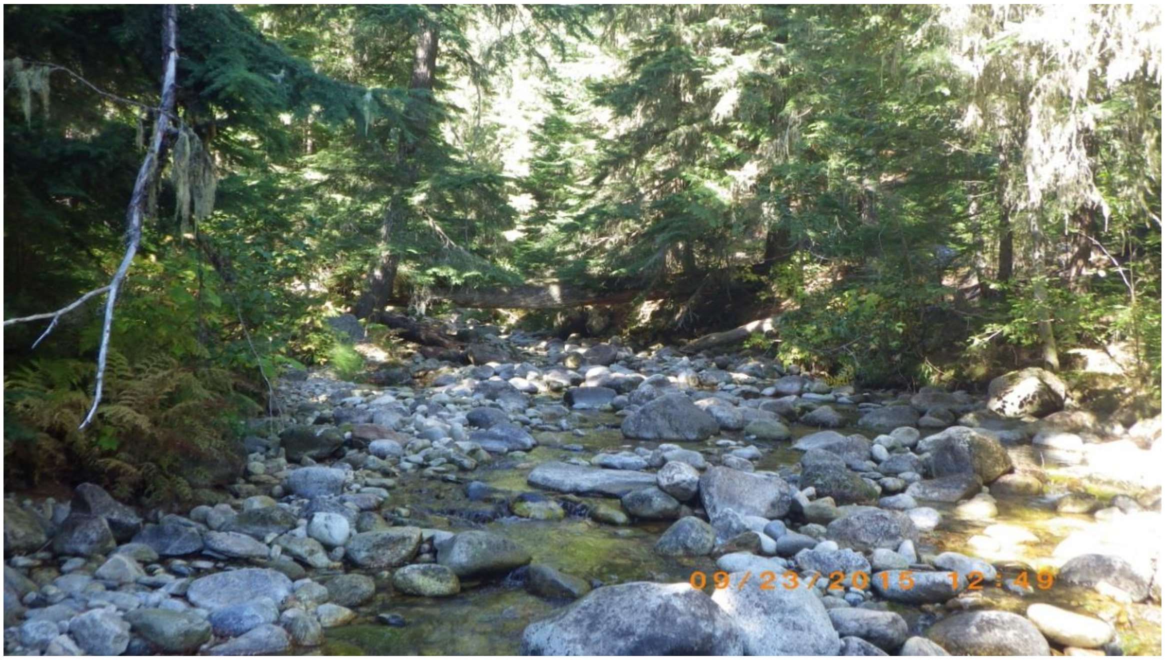


Figure 39. Excessive cobble substrate in Caribou Creek.

Scour and Depositional Features

Caribou Creek had an abundance of pools at a depth of 2 feet or greater, which was remarkable given the extreme low-flow conditions. Pool size and abundance provided excellent cover and thermal refuge for fish. An abundance of multiple age classes of Cutthroat Trout and an abundance of caddisfly casings were observed. A Bull Trout was also observed in one pool. Riffle stability was moderate due to the moderately defined riffle-pool-glide pattern. The excessive cobble created the instability of riffles. Two depth-velocity combinations were present (fast shallow, slow deep).

Channel Morphology

Caribou Creek in the study reach was over-widened and entrenched. Due to minimal bank erosion, excessive substrate was not the cause of over-widening. There was no evidence of channel alteration that would suggest active incision or channel widening. Therefore, the over-widened, entrenched condition was due to historical logging activity and excessive erosion in the riparian zone (Figure 40).

Figure 40. Evidence of historical timber harvest in the riparian zone in Caribou Creek.

Hydrologic Characteristics

Caribou Creek has no known flow alteration or obstructions that block longitudinal movement of aquatic species. However, the over-widened and entrenched condition of the stream somewhat limits access to the floodplain (Figure 41). The floodplain was narrow due to steep side-slopes. Due to the extreme low-flow conditions during evaluation, the stream reach had a reduced wetted width and an uncharacteristic abundance of exposed substrate.

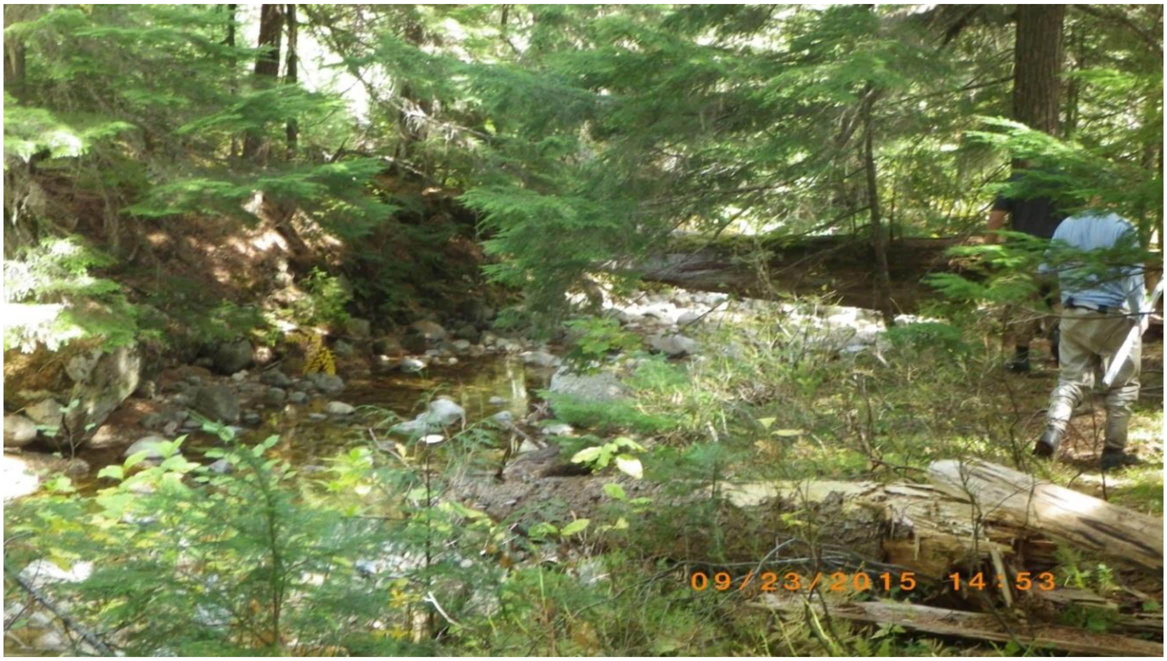


Figure 41. Moderately entrenched reach in Caribou Creek.

Streambanks

Aside from being entrenched, the streambanks showed only a minor departure from reference conditions in Caribou Creek. Streambank erosion was less than 10%, with little bank revetments. Undercut banks were fairly abundant with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency. Bank canopy was between 80 and 90%, with diverse plant assemblages that created good cover with roots that stabilized the bank. No mass failures were observed on the streambanks within the study reach.

Riparian Area

The riparian area was in good condition with near maximum channel canopy and a diversity of vegetation species (Figure 42). No invasive species were present. The riparian buffer width was between 150 and 250 feet, providing excellent shade and thermal refuge, root density, and streambank stability. The buffer appeared to promote moderate lateral connectivity and excellent longitudinal continuity in the stream corridor.

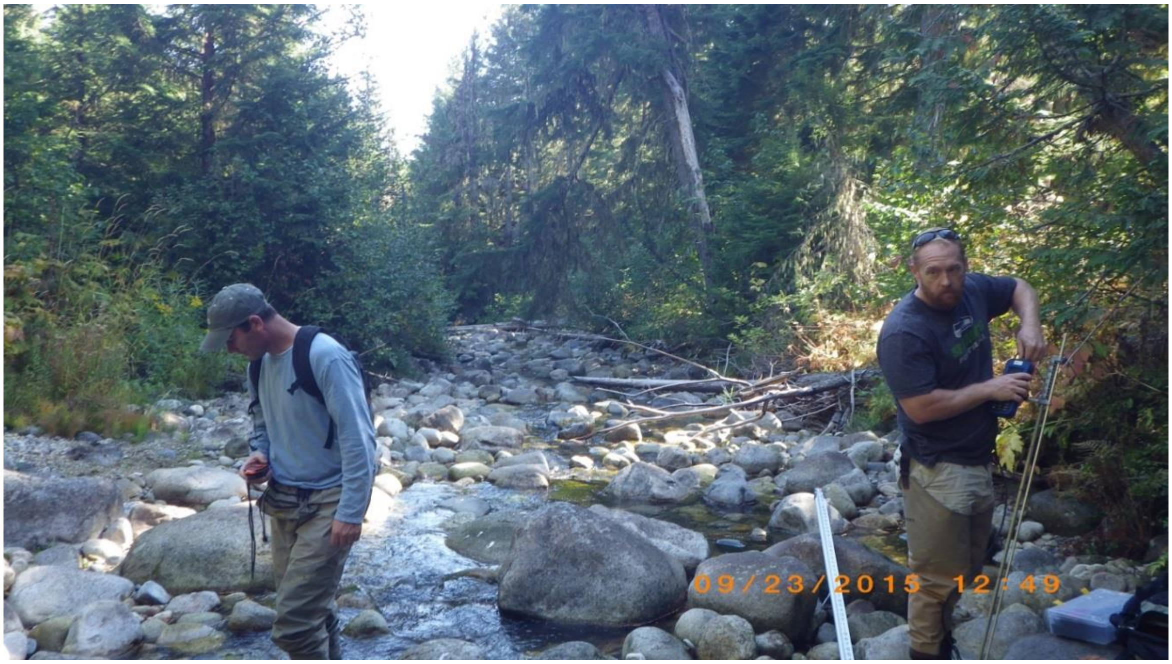


Figure 42. Riparian area in Caribou Creek.

2015 Road Crossing Survey

In 2015, DEQ conducted a survey of road crossing conditions in the Caribou Creek watershed (Table 16). Because there is primarily one landowner in the Caribou Creek watershed, the road into the watershed was gated. The landowner provided access for the survey.

In general, the road surfaces were well maintained, with well-vegetated ditches. Many relief and stream crossing culverts had been replaced, and a major bridge was replaced (Figure 43, Figure 44). No erosion issues were noted on the survey. Crossings evaluated using the randomized road evaluation protocol are listed in Table 16.

Table 16. Stream crossing condition, Caribou Creek watershed.

Type of Crossing	Road	Water Body	Lat	Long	Erosion severity
Bridge—steel with wood decking	Caribou Creek Road	Caribou Creek	N48.457697	W116.641027	None
Culvert—steel corrugated	Caribou Creek Road	Trib to Caribou Creek	N48.456224	W116.631930	Low–none
Culvert—steel corrugated	Caribou Creek Road	Trib to Caribou Creek	N48.455397	W116.627140	None
Bridge—concrete with timber decking	Caribou Creek Road	Caribou Creek	N48.471505	W116.564965	Low

Figure 43. Road surface, Caribou Creek Road.

Figure 44. Recent bridge replacement on upper Caribou Creek.

Review of Implementation Plan and Activities

Much implementation has been completed in the Caribou Creek watershed. Most of the projects were by Hancock Forest Management, the primary landowner in the watershed. Projects completed include road resurfacing, road abandonment, and culvert and bridge replacements. Table 17 lists projects completed on a total of 28 miles of road within the Caribou Creek watershed.

Table 17. Restoration projects completed in the Caribou Creek watershed.

Project	Township, Range, Section			Project Description
Culvert replacement	59N	2W	14	Replaced culvert on USFS road at mouth of Caribou Creek
Bridge replacement	59N	2W	14	Cost-share project to replace bridge at mile 4 on Caribou Creek in conjunction with IDL timber sale
Culvert upgrades/installations	59N	2W	17	Cost-share with IDL on road system through Caribou section 17
Road abandonment	59N	2W	10	Postharvest road abandonment of 0.5 miles of road between Hellroaring and Caribou Creeks
Culvert installation and road reshaping/contouring	59N	2W	21	Improving road surface in preparation for long hauling in section 21
Road reshaping/contouring	59N	2W	17, 20	Improving road surface at stream crossings on first 2.5 miles of Caribou Creek Road

TMDL Discussion

Caribou Creek was placed on Idaho's 1996 §303(d) list of water quality impaired streams due excess sediment. This determination was based on 1995 BURP data. Additional data from a 1998

IDL CWE analysis verified the impairment, finding poor road conditions, numerous mass failures, streambank instability, and a lack of riparian vegetation. The Clark Fork/Pend Oreille TMDL assigned a 74% reduction to meet natural background for sediment loading in the watershed.

BURP data from 2006 and 2014 may indicate Caribou Creek is fully supporting beneficial uses. In 2006, the stream had excellent macroinvertebrate and stream habitat scores. No fish data were collected. In 2014, the stream had excellent stream habitat scores. Macroinvertebrates weren't scored, but Bull Trout were present. In 2011, IDFG and AVISTA conducted electrofishing and Bull Trout redd surveys. They concluded Bull Trout and Westslope Cutthroat Trout were observed in abundance and distribution in Caribou Creek. These data are further indication Caribou Creek is fully supporting beneficial uses.

Hancock Forest Management, the primary landowner in the Caribou Creek watershed, has done numerous improvements to the road infrastructure including road resurfacing and culvert and bridge replacements. The road survey conducted in 2015 showed the roads in excellent condition with numerous new culverts and a major bridge replacement. There were no outstanding issues noted on the road system.

The Clark Fork/Pend Oreille TMDL is explicit that load reductions be tracked to determine if load reduction requirements have been met. Once load reductions are met, the TMDL directs an evaluation of beneficial use support with BURP. The TMDL was not explicit enough in how the sediment loads were calculated; therefore, an evaluation of sediment load reductions cannot be made. Therefore, evidence of TMDL implementation projects, BURP and other data will be used to determine whether beneficial use support exists in Caribou Creek and the sediment load reductions necessary to meet beneficial use support have been met.

Extensive restoration projects done in the Caribou Creek watershed; therefore, a significant reduction in sediment load has been made. The TMDL states the stream should be evaluated twice in a 5-year period using BURP to determine support status for a water body. The first evaluation in 2014 suggests beneficial use support. Therefore, it is recommended that Caribou Creek be re-evaluated for beneficial use using the BURP protocol before the year 2018. Should the data indicate the stream is fully supporting beneficial uses, the stream can be removed from Category 4a in Idaho's Integrated Report with a delisting of sediment as a cause of impairment.

5.2.3 Colburn Creek

Colburn Creek (ID17010214PN047_02 and ID17010214PN046_03) is a 2nd-order tributary to the Pack River (Figure 45). It drains a 6,485-acre watershed. It is not supporting the cold water aquatic life use due to sediment and phosphorus impairments. According to the Clark Fork/Pend Oreille TMDL and the Pend Oreille tributaries sediment TMDL, Colburn Creek was grouped together and assigned a single sediment load reduction under the lower Pack River watershed.

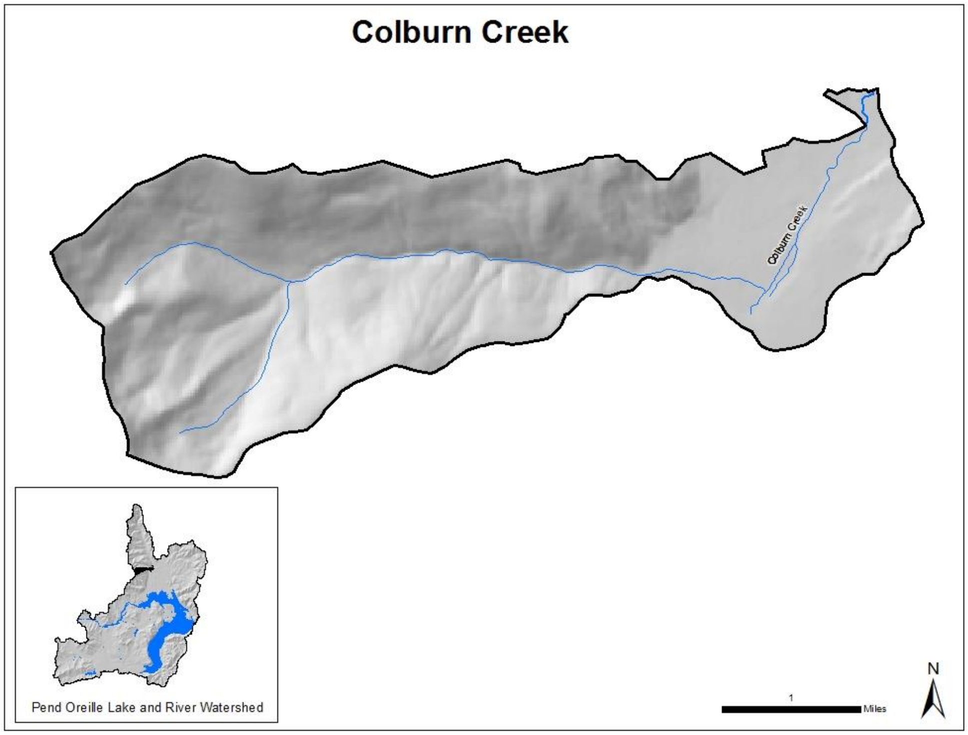


Figure 45. Colburn Creek watershed.

Idaho Beneficial Use Reconnaissance (BURP)

No BURP data have been collected on Colburn Creek since 1998.

IDL Cumulative Watershed Effects (CWE)

No CWE evaluation was done on Colburn Creek.

Changes in Subbasin

Forest Cover Change

Between 2001 and 2014, a 484 acre (7%) loss in forest cover occurred in the Colburn Creek subwatershed (Figure 46).

- 2001–2004: 93 acre decrease in forest cover
- 2005–2009: 338 acre decrease in forest cover
- 2010–2014: 53 acre decrease in forest cover

Aerial photos show that the loss was due to commercial timber harvest (Figure 47, Figure 48).

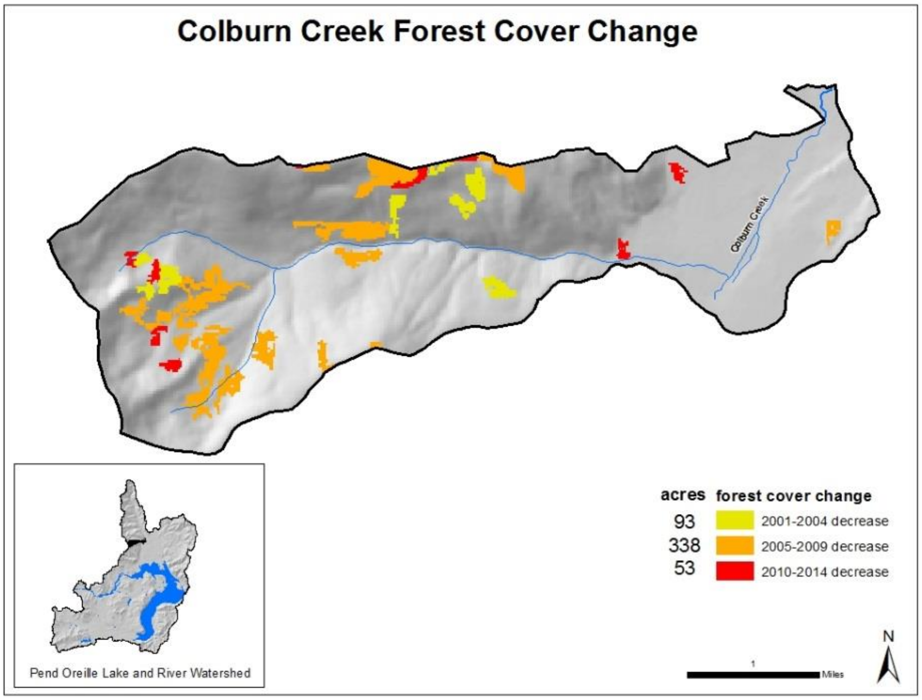


Figure 46. Forest cover change in the Colburn Creek subwatershed, 2001–2014.

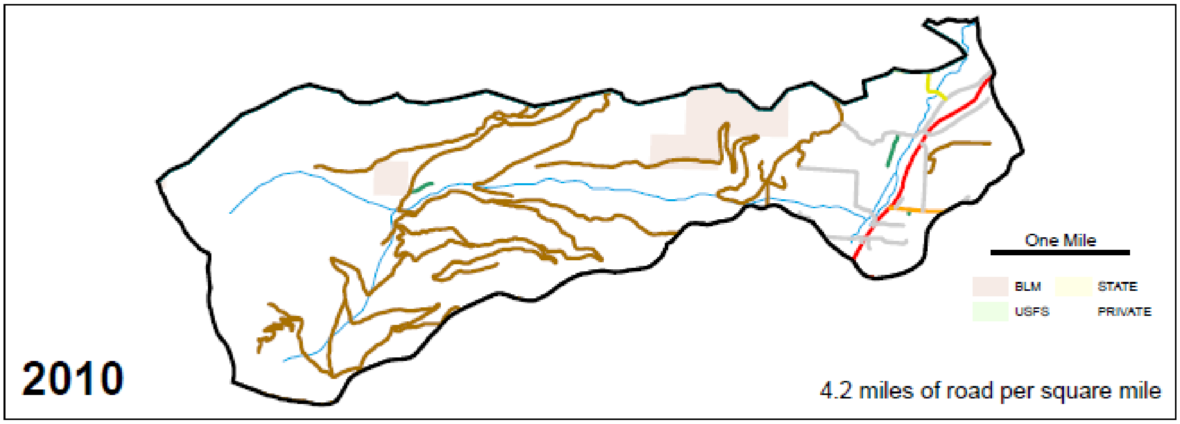
Figure 47. Colburn Creek watershed, 2004.

Figure 48. Colburn Creek watershed, 2014.

Roads

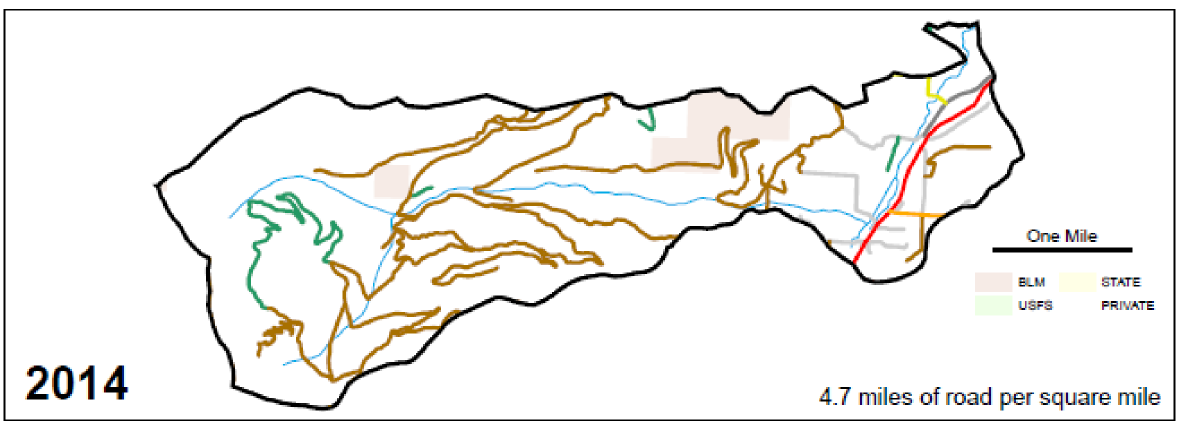
Road density in the Colburn Creek watershed changed slightly between 2010 and 2014 (Figure 49), increasing from 4.2 to 4.7 miles of road per square mile. Approximately 3.5 miles road was constructed in the headwaters of the watershed.

Colburn Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Colburn Creek	Unimproved dirt	25.76	77.3	33.3
Colburn Creek	Improved gravel	4.6	13.8	33.3
Colburn Creek	Primary highway	1.74	5.2	33.3
Colburn Creek	Unknown	0.46	1.4	33.3
Colburn Creek	Secondary highwa	0.41	1.2	33.3
Colburn Creek	Improved partial	0.36	1.1	33.3
Colburn Creek	Improved native	0.01	0	33.3

Surface: Improved gravel, Improved partial, Primary highway, Secondary highway, Unknown, Abandoned, Improved native, Improved paved, Primative, Unimproved dirt, Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Colburn Creek	Unimproved dirt	26.51	70.5	37.6
Colburn Creek	Unknown	3.98	10.6	37.6
Colburn Creek	Improved gravel	3.9	10.4	37.6
Colburn Creek	Primary highway	1.74	4.6	37.6
Colburn Creek	Improved paved	0.7	1.9	37.6
Colburn Creek	Secondary highw	0.41	1.1	37.6
Colburn Creek	Improved partial	0.36	1	37.6
Colburn Creek	Improved native	0.01	0	37.6

Figure 49. Comparison of road networks in the Colburn Creek watershed, 2010 and 2014.

Fisheries Data

No fisheries data have been collected on Colburn Creek since 1998.

2015 DEQ Stream Evaluation

In 2015, DEQ evaluated one 100-meter stream reach using a modified method described in Rosgen (2006), Milone & MacBroom, Inc. (2008) and Wolman (1954). The stream reach was located near the mouth of the creek in a valley bottom and was not representative of the AU as a whole. Due to access issues, a representative reach was not evaluated. The stream reach is illustrated in Figure 3 (section 5.1.1). Streamflow was 0.68 cfs at 10.7 ºC. The stream pH was 7.28, and conductivity was 211 µS/cm.

The 100-meter stream reach of Colburn Creek evaluated using Rosgen (2008) had data collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 18. Colburn Creek was an entrenched gully or “G” channel with a sandy channel substrate.

Table 18. Reach characteristics for Colburn Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	18.8	12.1	808	13.2
Bankfull Depth (D_{bkf}), ft	1.65	1.09	1.2	1.31
Width/depth Ratio (W_{bkf}/D_{bkf}), ft/ft	11.39	11.10	7.33	9.94
Maximum Depth (D_{mbkf}), ft	2.3	1.6	1.5	1.8
Width of Flood-Prone Area (W_{fpa}), ft	28.4	16.2	10.2	18.3
Wetted Width, ft	11.8	10.5	8.2	10.2
Entrenchment Ratio (ER), ft/ft	1.51	1.34	1.16	1.33
Channel Materials (Particle Size Index) D_{50}, mm	Sand	Sand	Sand	Sand
Water Surface Slope, %	0	0	0	0
Rosgen Stream Type		G		

The following reach habitat assessment of Colburn Creek was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

Log jams were abundant in Colburn Creek, with greater than 5 log jams per mile. An abundance of LWD 1 foot or greater in diameter was also observed. Recruitment potential of large wood was moderate due to the presence of a healthy alder/willow riparian area (Figure 50). Based on this evaluation, woody debris showed a minor departure from reference conditions.

Figure 50. Large wood in Colburn Creek.

Bed Substrate Cover

Colburn Creek is a plane bed stream type dominated by a sandy substrate. The substrate was free of dense algae growth.

Scour and Depositional Features

Colburn Creek had a relative abundance of pools at a depth of 2 feet or greater. Pool size and abundance provided good cover and thermal refuge for fish. Some unidentifiable fish were observed, which was exceptional for such a low water year. Riffle formation was limited, with only two depth-velocity combinations present (slow shallow, slow deep). The thalweg was moderately identifiable with some evidence of bar formation (Figure 51).

Figure 51. Point bar in Colburn Creek.

Channel Morphology

Colburn Creek in the study reach was narrow and entrenched. There was no evidence of channel alteration that would suggest active incision or channel widening. This reach appeared to be near reference conditions for a valley-bottom stream.

Hydrologic Characteristics

Colburn Creek had no known flow alteration or obstructions that block longitudinal movement of aquatic species. However, the somewhat entrenched condition of the stream limited access to the floodplain.

Streambanks

Aside from being entrenched, the streambanks showed a minor departure from reference conditions in Colburn Creek. Streambank erosion was minimal. Undercut banks were fairly abundant with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency. Bank canopy was between 80 and 90%. The abundance of sedge, willow, and alder provided good cover with roots that stabilize the bank (Figure 52). No mass failures were observed on the streambanks within the study reach.

Figure 52. Stable overhanging banks in Colburn Creek.

Riparian Area

The riparian area within the study reach was in good condition with near maximum channel canopy and a diversity of vegetation species. No invasive species were present. The riparian buffer width was between 150 and 250 feet, providing excellent shade and thermal refuge, root density, and streambank stability. The buffer appeared to promote moderate lateral connectivity and excellent longitudinal continuity in the stream corridor. The condition of the stream and riparian zone were exceptional given that the land use in this reach was cattle grazing. This reach is a great example of good management practices for cattle grazing near a riparian area.

2015 Road Crossing Survey

No road crossings were evaluated in the Colburn Creek watershed.

TMDL Discussion

Because no BURP data exist and a representative reach was not evaluated during this 5-year review, an effective discussion on beneficial use support and TMDL loading cannot be performed until access is granted. However, a 2015 evaluation of the conditions at the mouth of Colburn Creek indicate that sediment loading to the Pack River is low.

5.2.4 Gold Creek

Gold Creek (ID17010214PN034_02) is a 3rd-order tributary to the Pack River (Figure 53). Its confluence with the Pack River is approximately 4 miles upstream of the State Highway 200 crossing. In Idaho's 2008 Integrated Report, Gold Creek was listed as not supporting the aquatic life beneficial use due to sediment and temperature. Gold Creek also does not support the salmonid spawning beneficial use due to temperature.

Gold Creek drains a 7,747-acre watershed. The drainage is oriented primarily in a westerly direction with an average slope of 18%. The drainage has slopes greater than 30% (DEQ and EPA 2007). The higher elevations of the Gold Creek watershed are underlain by Cretaceous granitics of the Kaniksu Batholith. The lower and mid elevations are Pleistocene glacial outwash, fanglomerates, and flood and terrace gravels intermixed with unconsolidated alluvium. At the confluence with the Pack River are lacustrine sediments associated with Lake Pend Oreille and the Pack River floodplain.

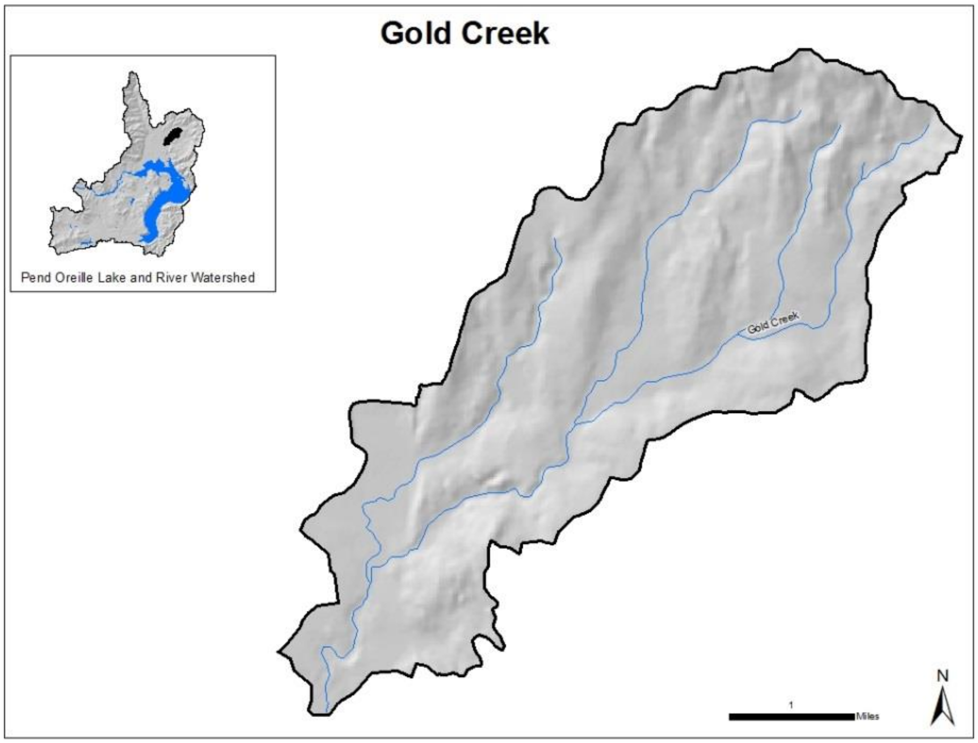


Figure 53. Gold Creek watershed.

Idaho Beneficial Use Reconnaissance (BURP)

Gold Creek has not been evaluated for beneficial use support using BURP since the late 1990s.

IDL Cumulative Watershed Effects (CWE)

Since 2000, Gold Creek has not been evaluated using the IDL CWE program.

Stressor Identification

Gold Creek was listed on Idaho's 2002 Integrated Report as not supporting beneficial uses due to an unknown pollutant. To determine the unknown pollutant, a stressor identification analysis was completed for Gold Creek in 2006 (TerraGraphics 2006a). Based on an analysis of 1998 BURP data, upper Gold Creek had excessive fine sediment within the stream channel, which was likely impairing aquatic life. Therefore, a TMDL for sediment was recommended for upper Gold

Creek. Lower Gold Creek also had a significant percentage of fines; however, it was determined not to impair the aquatic community.

Changes in Subbasin Characteristics

Forest Cover Change

Between 2001 and 2014, a 549 acre (7%) loss in forest cover occurred in the Gold Creek subwatershed (Figure 54).

- 2001–2004: 103 acre decrease
- 2005–2009: 173 acre decrease
- 2010–2014: 270 acre decrease

An evaluation of aerial photos shows that the loss was likely due to development (Figure 55, Figure 56).

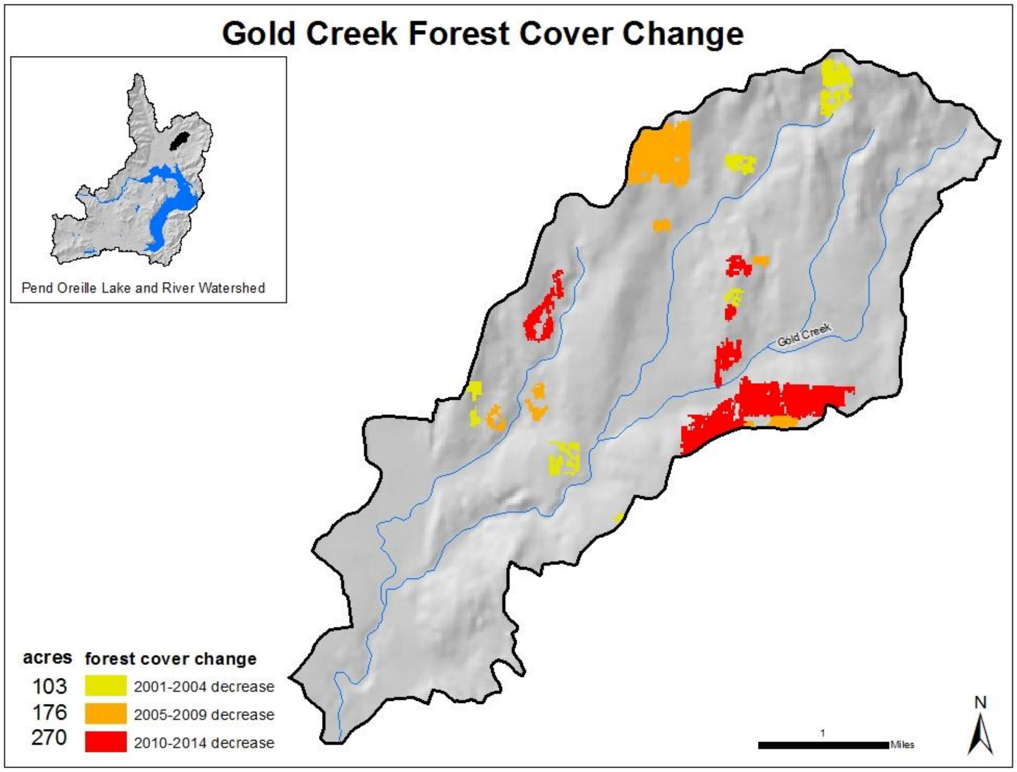


Figure 54. Forest cover change in the Gold Creek watershed, 2001–2014.

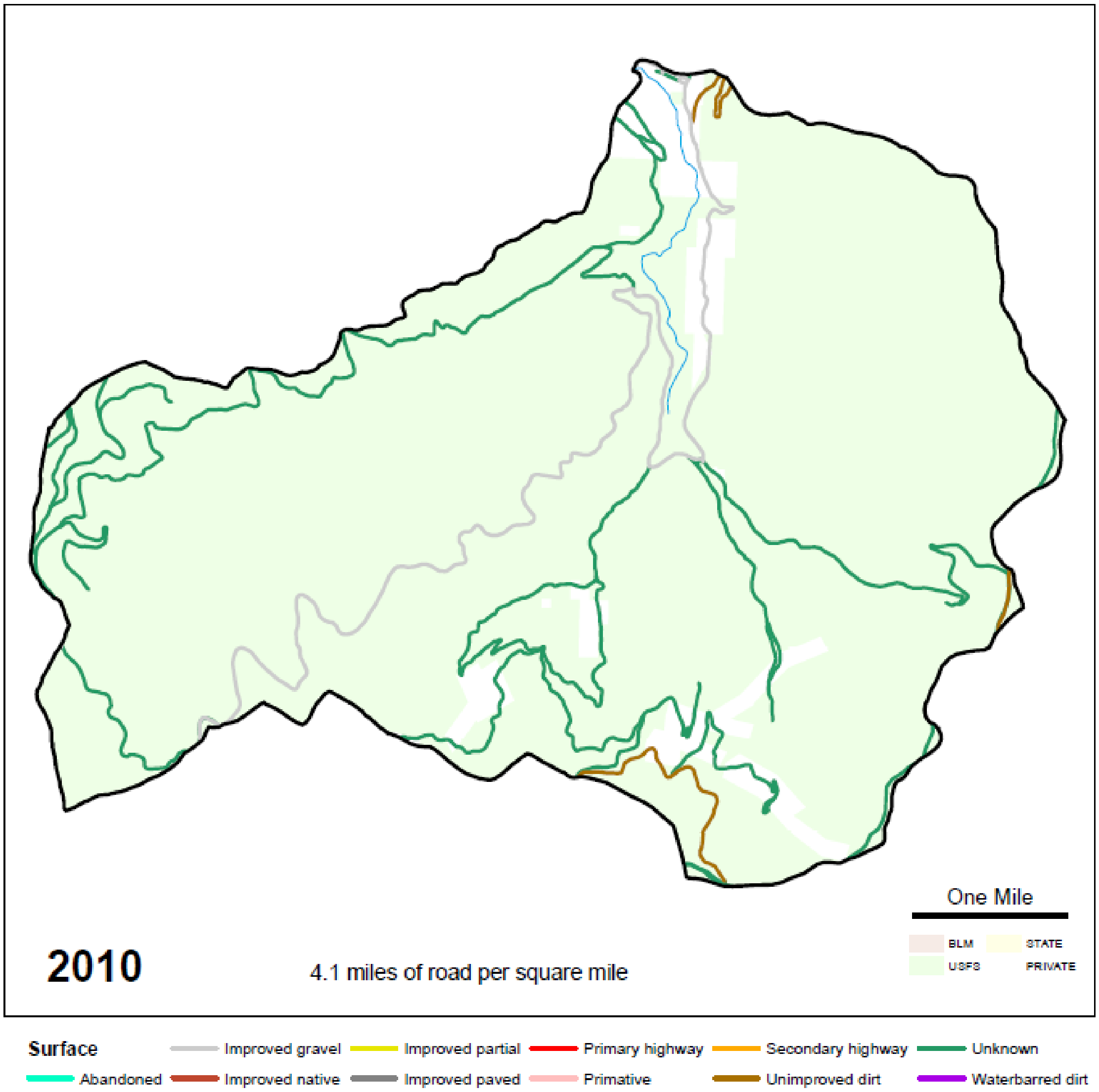
Figure 55. Aerial photograph of the Gold Creek watershed, September 2004.

Figure 56. Aerial photograph of the Gold Creek watershed, July 2014.

Roads

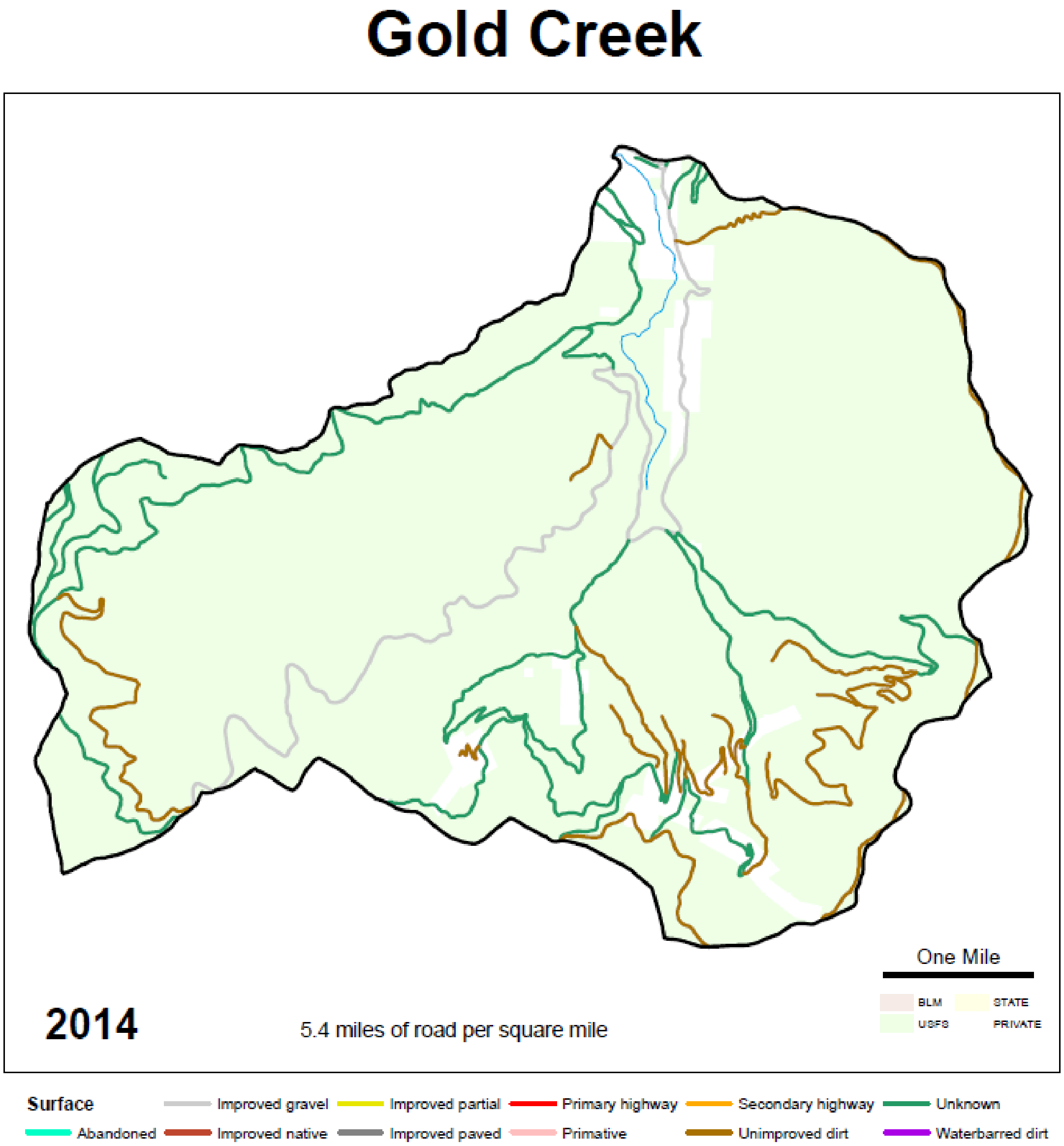
Between 2010 and 2014, road density in the Gold Creek watershed increased from 4.1 to 5.4 miles of road per square mile of watershed (Figure 57, Figure 58). This increase was primarily due to 18.3 miles of unimproved dirt roads constructed within the watershed.

Gold Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Gold Creek	Unknown	34.65	70.1	49.4
Gold Creek	Improved gravel	11.58	23.4	49.4
Gold Creek	Unimproved dirt	3.21	6.5	49.4

Figure 57. Road network in the Gold Creek watershed, 2010.



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Gold Creek	Unknown	31.35	48.7	64.4
Gold Creek	Unimproved dirt	21.5	33.4	64.4
Gold Creek	Improved gravel	11.54	17.9	64.4
Gold Creek	Improved gravel	0.01	0	64.4
Gold Creek	Unknown	0.01	0	64.4

Figure 58. Road network in the Gold Creek watershed, 2014.

2015 DEQ Stream Evaluation

DEQ was unable to gain access from property owners to conduct a stream habitat survey on Gold Creek.

2015 Road Crossing Survey

In October 2015, DEQ conducted a survey of road crossing conditions in the Gold Creek watershed. Two road crossings were selected for evaluation. Road crossing characteristics are represented in Table 19. Both crossings were culverts maintained by the county. Both culverts were in good-to-excellent condition with a low erosion potential (Figure 59, Figure 60). However, the fill material on the round, corrugated steel culverts had gully erosion formation near the culvert (Figure 61). Both culverts seemed to be barriers to fish passage.

Table 19. Road crossing characteristics, Gold Creek.

Water Body	Type	GPS Coordinates	Erosion Severity	Overall Condition	Fish Barrier?
Gold Creek	Round, corrugated metal pipe	N 48.403706 W -116.403912	Low	Good	Yes
Gold Creek	Round, corrugated steel	N 48.393040 W -116.410432	Low	Excellent	Yes

Figure 59. Culvert 1 on Gold Creek.

Figure 60. New culvert on Gold Creek.

Figure 61. Gully erosion on new culvert on Gold Creek.

TMDL Discussion

Because a representative reach was not evaluated during this 5-year review, an effective discussion on beneficial use support and TMDL loading cannot be performed until access is granted. Therefore, the TMDL load reduction requirements remain in effect until a proper evaluation of Gold Creek can be performed.

5.2.5 Grouse Creek

Grouse Creek is a primary tributary to the Pack River (Figure 62). It flows into the Pack River about 2 miles east of Colburn, Idaho. The Grouse Creek watershed is 15.4 square miles and has a number of AUs.

Timber harvesting in the Grouse Creek drainage in the 1920s and 1930s intensified following construction of a logging railroad along Grouse Creek with associated spur lines, loading areas, camps, logging chutes, flumes, and a pole road. By 1934, roughly 70% of the main Grouse Creek drainage had been cleared and/or burned. Logging was concentrated in the stream bottoms and proximal side slopes. As a result, large amounts of bedload were introduced into the stream network, which caused accelerated lateral erosion, braided channels, and bank erosion. A 1993 environmental assessment of Grouse Creek concluded that the main stem Grouse Creek could take a couple hundred years to regain equilibrium from its current state due to excess bedload (USDA USFS 1993). As such, Grouse Creek and North Fork Grouse Creek were placed on Idaho's 1998 §303(d) list of impaired waters (DEQ 2001).

Main stem Grouse Creek (ID17010214PN035_03 and ID17010214PN036_03) is not supporting cold water aquatic life due to sediment and temperature impairments. It is also not supporting salmonid spawning due to temperature. The headwaters, 1st- and 2nd-order tributaries, and Chute, Flume, Plank, South Fork Grouse, Taffy, and Wylie Creeks (ID17010214PN036_02) are also not supporting cold water aquatic life due to sediment and temperature impairments, and they are not supporting salmonid spawning due to temperature. Jones Creek and a small unnamed tributary to Grouse Creek (ID17010214PN035_02) are not supporting cold water aquatic life due to sediment impairments. North Fork Grouse Creek and its tributaries BRC Creek and Dyree Creek (ID17010214PN037_02) are not supporting cold water aquatic life due to sediment and temperature impairments, and they are not supporting salmonid spawning due to temperature.

Belt Series and the Kaniksu Batholith are the major underlying bedrock types in the Grouse Creek watershed. The Belt Series are metamorphic sedimentary deposits from the Bitterroot and Cabinet Mountains. The Kaniksu Batholith is a granitic formation that makes up part of the Cabinet Mountains and the Selkirk Mountains. Over 38% of the total watershed area is comprised of Pleistocene till, moraines, and unsorted glacial debris (RDI 2009). For more information on geology or soils in the Grouse Creek watershed, refer to River Design Group (2009).

Landownership in the Grouse Creek watershed is primarily within the Kaniksu National Forest (83%). The remaining 17% is private land mostly in lower Grouse Creek.

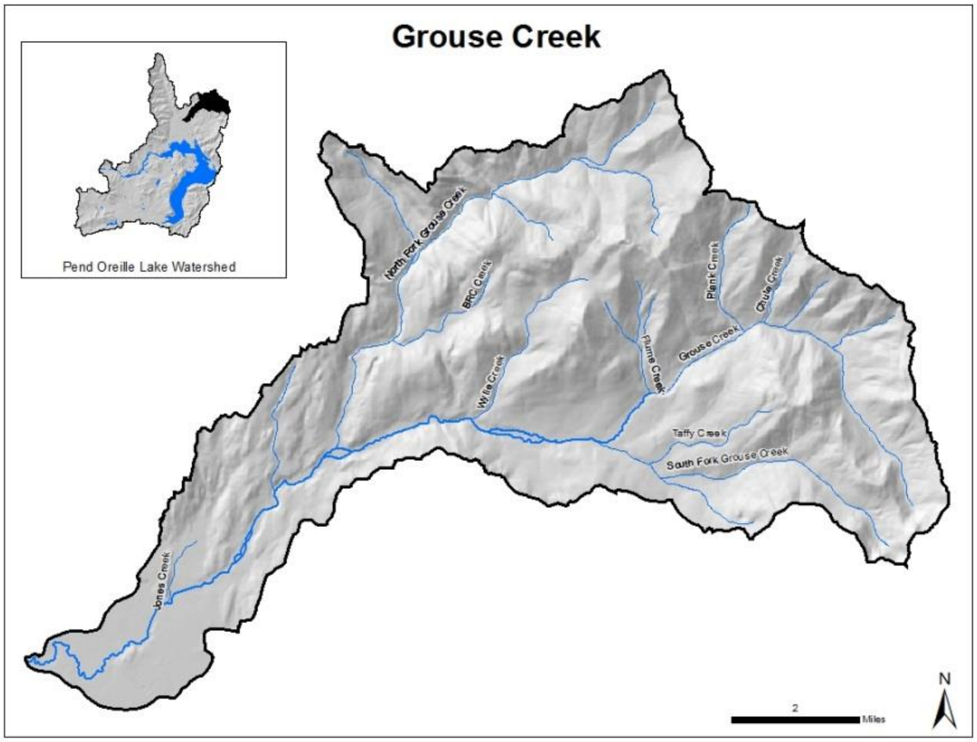


Figure 62. Grouse Creek subwatershed.

Idaho Beneficial Use Reconnaissance Program (BURP)

Grouse Creek Headwaters with 1st- and 2nd-order Tributaries, Chute, Flume, Plank, South Fork Grouse, Taffy, and Wylie Creeks (ID17010214PN036_02)

In 2003, DEQ sampled ID17010214PN036_02 using the BURP monitoring method. BURP scores are summarized in Table 20. The stream had excellent macroinvertebrate and stream habitat scores, indicating the stream was fully supporting aquatic life and salmonid spawning beneficial uses. Streamflow was 3.6 cfs. There were abundant pools with moderate cover. Streambanks were stable from an abundance of roots with stable undercut banks. Substrate consisted of 3.7% fines with minimal embeddedness. Fish were in abundance with the presence of Bull Trout in sizes ranging from 40 mm to 175 mm. Rainbow Trout were present in sizes ranging from 57 to 171 mm. Other native salmonids were present, but their species were not identified. BURP sampling in 2013 found a dry stream.

Table 20. Grouse Creek (ID17010214PN036_02) BURP results.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2003SCDAA017	80.45	3	78.94	2	76.00	3	2.67
2013SDEQA106							Stream dry

Main Stem Grouse Creek from Flume Creek Downstream to North Fork Grouse Creek (ID17010214PN036_03)

In 2006, DEQ evaluated 540 meters of ID17010214PN036_03 using the BURP monitoring method. BURP scores are summarized in Table 21. The stream was a Rosgen "C" channel in this reach with moderate sinuosity and good width/depth ratio. The stream had excellent macroinvertebrate and stream habitat scores, indicating the stream was fully supporting aquatic life and salmonid spawning beneficial uses. No fish data were collected. Streamflow was 6.26 cfs. Stream temperature was 19.1 ºC. There were abundant pools of diverse types with excellent cover. Pools were associated with undercut banks, LWD, and substrate. LWD was abundant, providing habitat complexity and sediment stability. Streambanks were 100% stable with an abundance of roots and stable undercut banks. There were 3.7% fines with minimal embeddedness. Sampling in 2013 found a dry stream.

Table 21. Grouse Creek (ID17010214PN036_03) BURP results.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA055	66.22	3	-	-	79.00	3	3.0
2013SCDAA106							Stream dry

Main Stem Grouse Creek from North Fork Grouse Creek to the Mouth (ID17010214PN035_03)

In 2003, DEQ evaluated 240 meters of AU ID17010214PN035_03 using the BURP monitoring method. The study reach was near the mouth of the creek. BURP scores are summarized in Table 22. The stream was a Rosgen "G" channel, indicating moderate sinuosity and significant entrenchment. This reach had excellent macroinvertebrate scores but poor fish and habitat scores, indicating the stream was not fully supporting aquatic life and salmonid spawning beneficial uses. Streamflow was 15.0 cfs. Stream temperature was 19.3 ºC. While there was some LWD, pool abundance was low and riffles were absent. While some vegetation provided streambank stability and cover, 50–60% of streambanks were eroding and unstable with sparse vegetation. While a number of nongame fish were observed (longnose dase, redside shiner, slimey sculpin, northern pikeminnow), salmonids were virtually absent. Stoneflies (*Plecoptera* sp.) were the only water quality indicator macroinvertebrate species present.

In 2006, DEQ evaluated 551 meters of stream in AU ID17010214PN035_03 using the BURP monitoring method. The study reach was in the lower third of the AU above the Jones Creek confluence. BURP scores are summarized in Table 22. The stream was an overwidened Rosgen "C" channel with moderate sinuosity and minimal entrenchment. This reach had good habitat and macroinvertebrate scores but poor fish scores, indicating the stream was not fully supportive of the aquatic life and salmonid spawning beneficial uses. Streamflow was 17.9 cfs. Stream temperature was 19.2 ºC. While there was some LWD, pool abundance was low and riffles were absent. These conditions, along with the overwidened stream channel, indicated poor habitat variability. Streambanks were well-vegetated and stable. Nongame fish were observed (longnose dase, slimey sculpin), and Rainbow Trout were fairly abundant. However, other native salmonids were in low abundance.

In 2007, DEQ evaluated 390 meters of AU ID17010214PN035_03 using the BURP monitoring method. The study reach was in the upper third of the AU downstream of the North Fork Grouse Creek confluence. BURP scores are summarized in Table 22. The stream was an overwidened Rosgen "B" channel with moderate sinuosity and minimal entrenchment. This reach had good habitat and macroinvertebrate scores, and fish were not sampled. These scores may have indicated the stream was fully supporting aquatic life and salmonid spawning beneficial uses. Streamflow was 10.8 cfs. Stream temperature was 19.6 ºC. While there was minimal LWD, there was an abundance of pools with good cover and diversity. Riffles were absent. Percent fines were less than 2%, and embeddedness was minimal. Streambanks were well-vegetated and stable.

In 2008, DEQ evaluated 300 meters of stream AU ID17010214PN035_03 using the BURP monitoring method. The study reach was near the mouth of the creek. BURP scores are summarized in Table 22. The stream was an overwidened Rosgen "F" channel with moderate sinuosity and significant entrenchment. This reach had poor macroinvertebrate scores and poor habitat scores, indicating the stream was not fully supporting aquatic life and salmonid spawning beneficial uses. No fish data were collected. Streamflow was 20.4 cfs. Stream temperature was 21.0 ºC. There was abundant LWD and pool abundance was high, but with moderate cover. Over 75% of streambanks were eroding, unstable, and with sparse vegetation. Percent fines were greater than 75% and embeddedness was significant.

Table 22. Grouse Creek from North Fork Grouse Creek downstream to mouth (ID17010214PN035_03) BURP results.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2003SCDAA016	66.51	3	14.64	0	42.00	1	0.00
2006SCDAA013	57.64	2	41.25	1	64.00	2	1.67
2007SCDAA046	62.75	2	-	-	62.00	2	2.00
2008SCDAA040	31.21	0	-	-	22.00	1	0.00

North Fork Grouse Creek and Tributaries (ID17010214PN037_02)

In 2006, DEQ evaluated 192 meters of AU ID17010214PN037_02 using the BURP monitoring method. BURP scores are summarized in Table 23. The study reach was a moderately overwidened Rosgen "C" channel. The stream had excellent macroinvertebrate and stream habitat scores, indicating the stream was fully supporting aquatic life and salmonid spawning beneficial uses. A fish survey was not performed. Streamflow was 2.3 cfs. Stream temperature was 11.1 ºC. While there was some LWD, pool abundance and diversity was limited. Streambanks were stable from an abundance of roots with stable undercut banks. Percent fines were 16% with minimal embeddedness.

Table 23. North Fork Grouse Creek and tributaries BURP results.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA061	72.12	3	-	-	69.00	3	3.00

IDL Cumulative Watershed Effects (CWE)

In 2002, IDL evaluated the headwaters of Grouse Creek downstream to the confluence with Wylie Creek (IDL 2003d), a 6,609-acre forested area primarily located within the Kaniksu National Forest. With the majority of land in this watershed underlain by Belt Supergroup geology, surface erosion and mass failure hazard were both rated as low. In 2002, approximately 10.7% of the watershed, or 1,798 acres of the effective canopy, had been removed in the watershed either through harvest or forest fires. An estimated 6% of the watershed was naturally devoid of tree cover. With a moderate Channel Stability Index, the overall hydrologic risk that the channel would be impacted from forest canopy removal was low. Five stream reaches in the forested portion of Grouse Creek were evaluated for channel stability, and the overall rating was moderate.

Sediment from roads, skid trails, and mass wasting was evaluated under IDL's CWE program (Table 24). Roads were given a sediment delivery score for a number of segments then given a weighted average over the total road mileage evaluated. Mass failures were recorded as they were observed, and a mass failure delivery score was calculated based on frequency, size, and delivery. In 2002, approximately 46 miles of road existed in the Grouse Creek watershed; 16 miles of these roads that were close to streams were evaluated. The rating for sediment delivery to streams from roads was low. The rating from skid trails was low. Although there were seven mass failures, the rating for mass failures was low. In 2002, the overall sediment delivery rating to streams was low. During this evaluation, only three management problems were identified (one culvert and two fords).

Table 24. Cumulative Watershed Effects scores for Grouse Creek.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydrologic Risk	Roads	Mass Wasting	Skid Trails	Total Sediment Delivery
2002	Low	Low	Mod	0.1	Low	Low	Low	Low	Low

Changes in Subbasin

Forest Cover Change

Between 2001 and 2014, a 1,694 acre (17%) loss in forest cover occurred in the Grouse Creek subwatershed (Figure 63).

- 2001–2004: 669 acre decrease
- 2005–2009: 403 acre decrease
- 2010–2014: 622 acre decrease

Aerial photos show that most of the loss was due to timber harvest on private property and development in the lower watershed (Figure 65Figure 64, Figure 65).

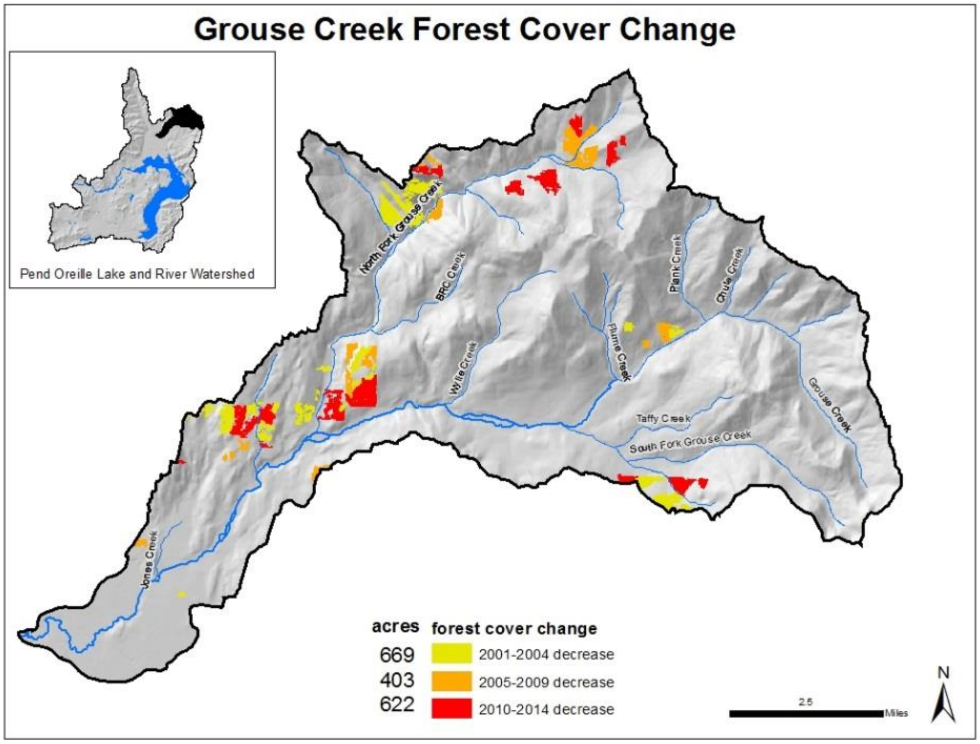


Figure 63. Forest cover change in the Grouse Creek subwatershed, 2001–2014.

Figure 64 Arial photograph of Grouse Creek subwatershed, June 2004.

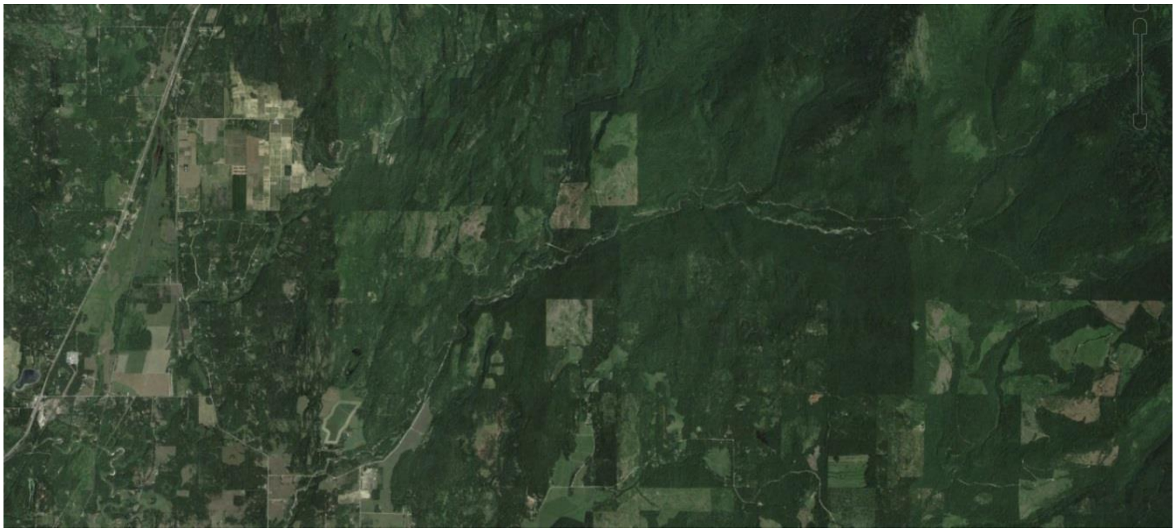
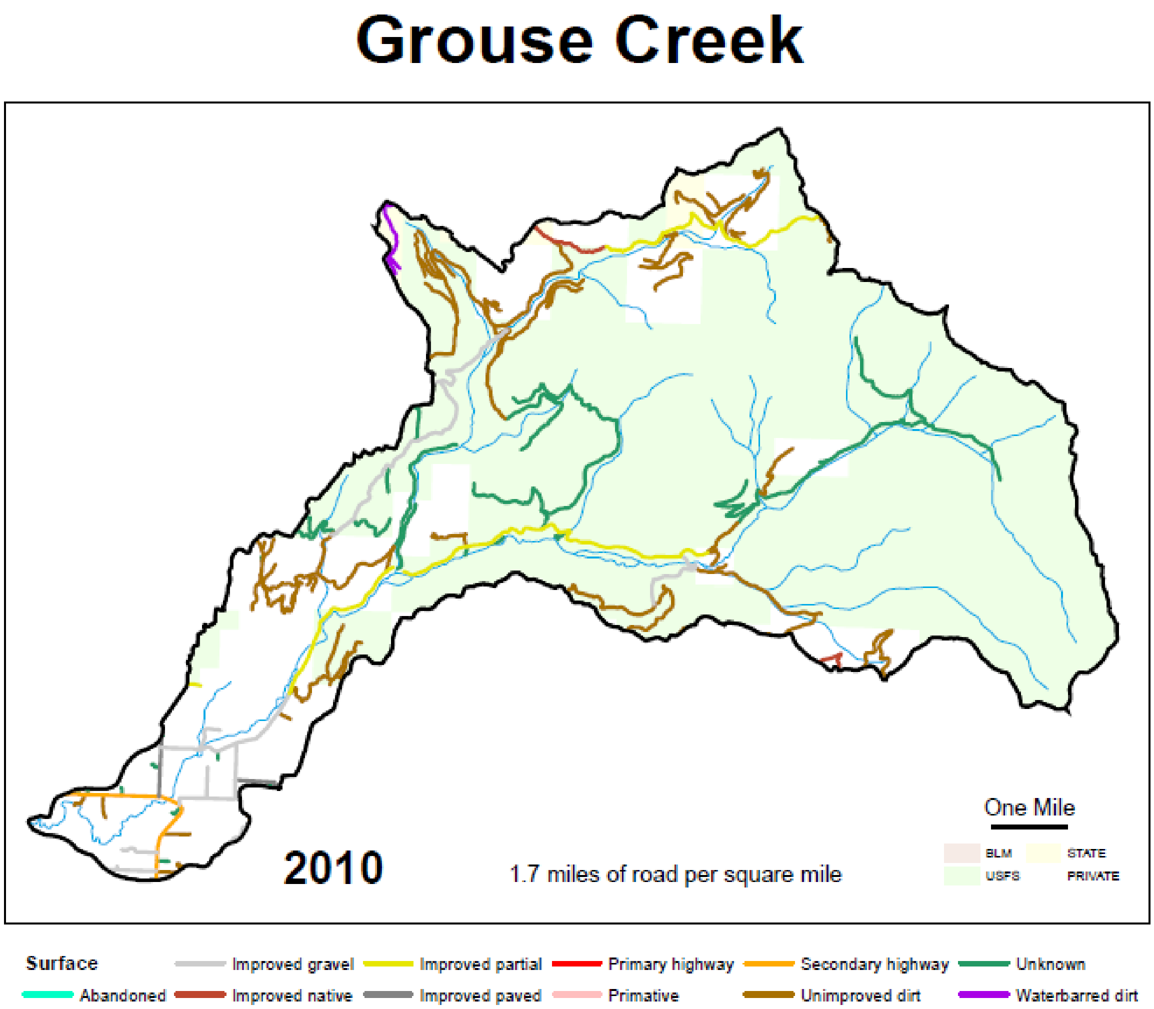


Figure 65. Arial photograph of Grouse Creek subwatershed, July 2014.

Roads

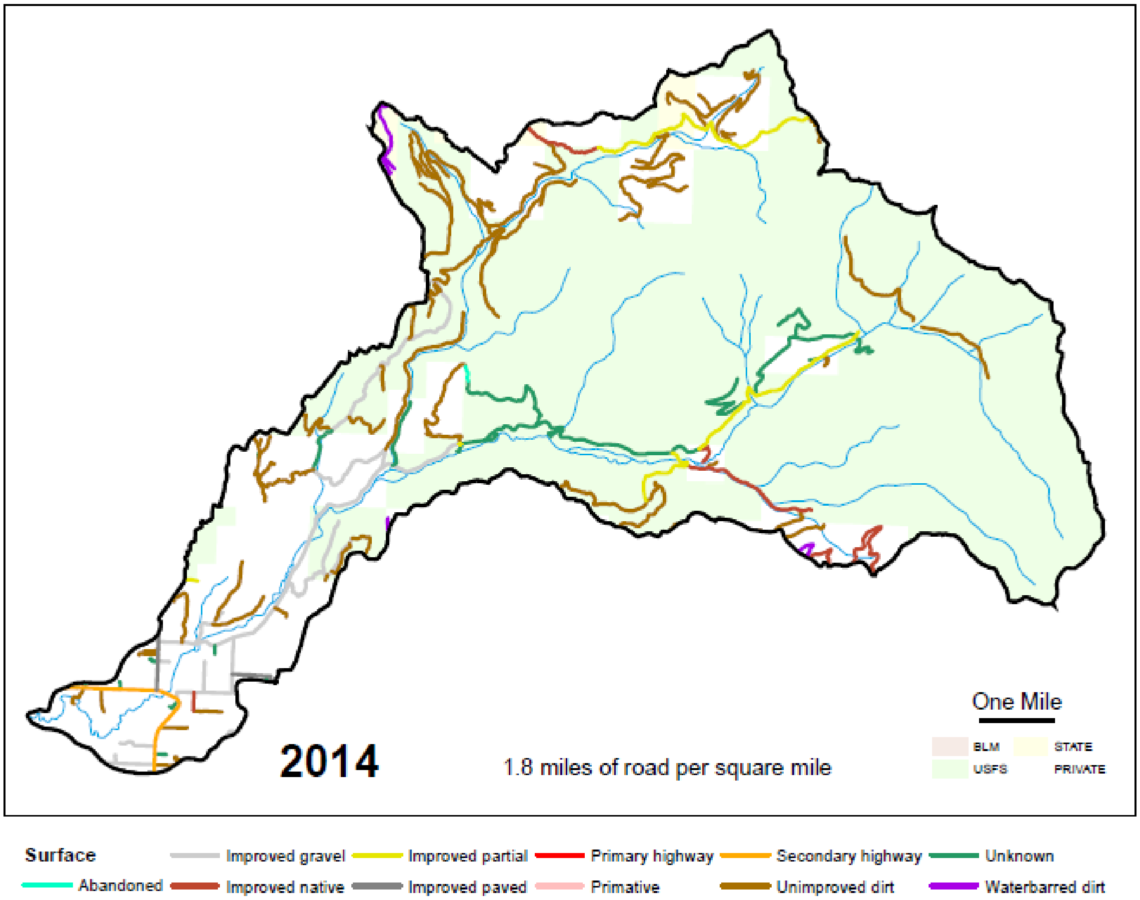
Density in road miles did not change significantly from 2010 to 2014 in the Grouse Creek watershed (Figure 66, Figure 67). However, road improvements did occur, particularly on Grouse Creek Road. On US Forest Service property, many roads off the main Grouse Creek Road or the North Fork Grouse Creek Road have been put into storage, barriered, or gated (Figure 68).



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Grouse Creek	Unimproved dirt	41.93	43.8	95.7
Grouse Creek	Unknown	23.51	24.6	95.7
Grouse Creek	Improved gravel	12	12.5	95.7
Grouse Creek	Improved partial	10.9	11.4	95.7
Grouse Creek	Secondary highway	2.65	2.8	95.7
Grouse Creek	Improved native	1.67	1.8	95.7
Grouse Creek	Waterbarred dirt	1.59	1.7	95.7
Grouse Creek	Improved paved	1.4	1.5	95.7

Figure 66. Road network in the Grouse Creek watershed, 2010.

Grouse Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Grouse Creek	Unimproved dirt	48.31	48.4	99.9
Grouse Creek	Improved gravel	16.88	16.9	99.9
Grouse Creek	Unknown	14.08	14.1	99.9
Grouse Creek	Improved partial	8.16	8.2	99.9
Grouse Creek	Improved native	5.83	5.8	99.9
Grouse Creek	Secondary highway	2.64	2.6	99.9
Grouse Creek	Waterbarred dirt	2.17	2.2	99.9
Grouse Creek	Improved paved	1.39	1.4	99.9
Grouse Creek	Abandoned	0.22	0.2	99.9
Grouse Creek	Improved gravel	0.07	0.1	99.9
Grouse Creek	Unknown	0.07	0.1	99.9
Grouse Creek	Primative	0.02	0	99.9
Grouse Creek	Unknown	0.01	0	99.9
Grouse Creek	Improved partial	0.01	0	99.9

Figure 67. Road network in the Grouse Creek watershed, 2014.

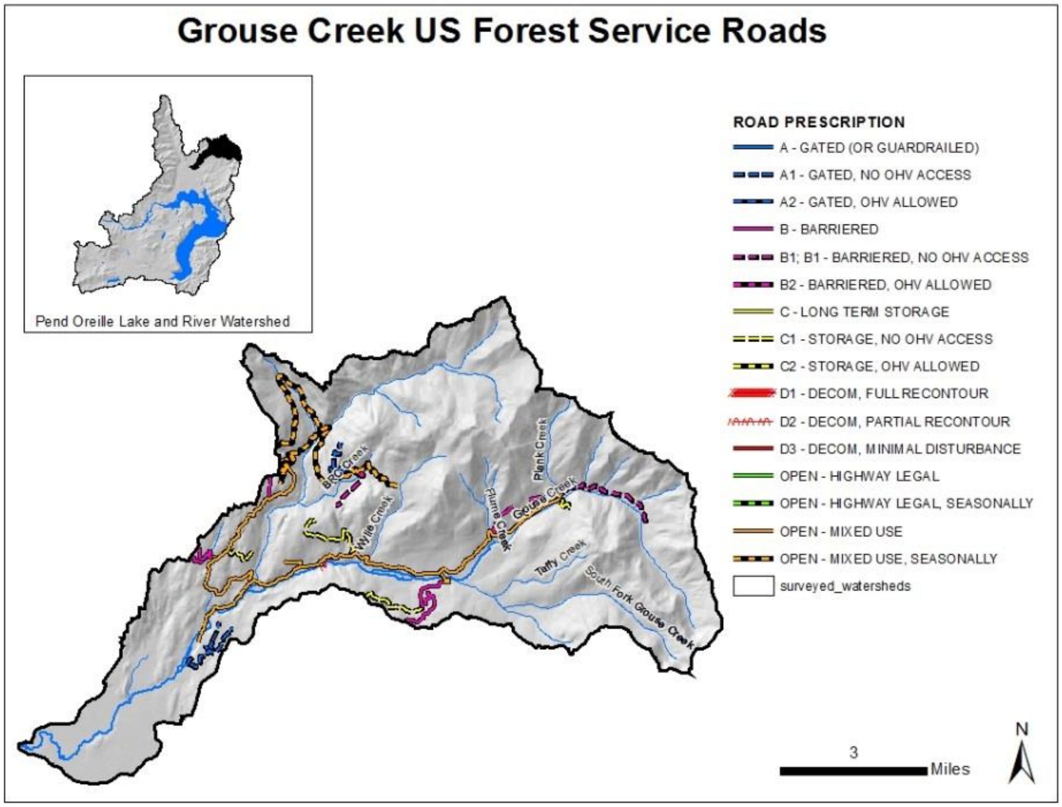


Figure 68. US Forest Service road network with road prescription classifications.

Fisheries Data

Between 2001 and 2011, distribution of fish in Grouse Creek was largely nonnative fish throughout the stream and native fish in the upper-most reaches. The mean estimated densities of salmonids (≥75 mm) in Grouse Creek and North Fork Grouse Creek between 2009 and 2011 are listed in Table 25. Rainbow Trout were most abundant in Grouse Creek, followed by Bull Trout and Westslope Cutthroat Trout. Westslope Cutthroat Trout were in highest abundance in North Fork Grouse Creek, followed by Rainbow Trout and Brook Trout.

Age of fish was estimated by collecting otoliths of each *Oncorhynchus* species. Estimated mean length and age for Westslope Cutthroat Trout and Rainbow Trout are listed in Table 26. In both Grouse Creek and North Fork Grouse Creek, resident fish were present in abundance. Due to the strong presence of age 1 and 2 Westslope Cutthroat Trout, it was not believed there were migratory fish in Grouse Creek or North Fork Grouse Creek. However, Rainbow Trout in Grouse Creek are believed to be migratory.

Between 2002 and 2014, IDFG, AVISTA, and US Forest Service staff conducted Bull Trout redd counts in Grouse Creek from Flume Creek to the end of US Forest Service Road 280. Counts were done by visual observation. Overall, Bull Trout redd counts varied, but were strongest in 2011 with 116 (Table 27). When comparing to the average between 1983 and 2001, the average went up from 37 to 50. Redd counts were lowest in 2013, with 12 redds.

Table 25. Mean estimated density of salmonids between 2009 and 2011 (estimates only for fish ≥75 mm).

Stream	Species (average fish/100 m²)					
	Bull Trout	Brook Trout	Mountain Whitefish	Rainbow Trout	Westslope Cutthroat Trout	Westslope × Rainbow Hybrid
Grouse Creek	3.5	0.4	0.6	8.2	3.6	0.3
NF Grouse Creek	0.0	4.1	0.0	5.0	5.9	0.3

Table 26. Estimated mean length and number sampled for salmonids between 2009 and 2011.

Stream	Species	Length in Millimeters (Number Sampled)							
		Age							
		1	2	3	4	5	6	7	8
Grouse Creek	Westslope Cutthroat	86(7)	114(10)	153(4)	165(1)	198(3)	222(2)	226(1)	
Grouse Creek	Rainbow Trout	108(12)	138(8)	177(6)	196(2)				
NF Grouse Creek	Westslope Cutthroat	81(6)	105(20)	143(7)	139(8)	168(3)	176(1)	182(3)	192(1)

Table 27. Bull Trout redd counts in Grouse Creek between 2002 and 2014.

Year and Number of Redds													
Avg (1983–2001)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
37	42	45	28	77	55	38	31	51	27	116	69	12	54

2009 Grouse Creek Watershed Assessment

AVISTA Corporation provided funding to conduct an assessment of the Grouse Creek watershed, which included an inventory of the stream corridor, stream crossings, sediment sources, and riparian conditions. The assessment was conducted by River Design Group, Inc. (RDI 2009). Grouse Creek and its major tributaries were delineated into 21 reaches based on changes in stream type, valley morphology, and tributary confluences. Reaches were classified according to Rosgen using channel sinuosity, slope, entrenchment ratio, width/depth ratio, and dominant sediment particle size (Rosgen 1994). Rosgen Level III geomorphic surveys were completed to determine reference and impaired conditions (Rosgen 2006). Data were collected to characterize floodplain, terrace, bankfull, water surface, cross-section dimensions, and thalweg features. Channel plan form was evaluated from aerial photographs and/or from the field survey. Wolman pebble counts were collected to characterize channel substrate.

Instream sediment sources were evaluated in Grouse Creek and North Fork and South Fork Grouse Creek. The survey identified, mapped, and characterized major sources of sediment loading to the stream channel. Rosgen Bank Erosion Hazard Index (BEHI) was used to evaluate bank erosion hazard of the streambank (Rosgen 2008). A basin-wide evaluation of all major stream crossing and drainage structures was conducted with a sediment survey on major stream and road intersections and road segments within 300 feet of a perennial stream.

Main Stem Grouse Creek

Grouse Creek in the upper watershed is a steep, confined Rosgen B3a stream with coarse cobble and boulder substrate and localized inclusions of higher gradient, bedrock-controlled chutes.

Near the confluence with North Fork Grouse Creek, the channel has a lower-gradient Rosgen C channel morphology. At the mouth, the gradient decreases to a flat valley bottom channel with fine-gravel substrate. Main stem Grouse Creek was divided into 11 study reaches due to changes in stream type, valley morphology, and tributary confluences. A map of the study reaches is provided in Appendix A.

The headwaters of Grouse Creek downstream to Plank Creek (Grouse Creek Reach 1) are moderately entrenched and over-widened with little embeddedness. LWD was abundant, creating diverse aquatic habitat and an abundance of pools. Large wood recruitment was high from the riparian area, which was comprised of dense hemlock and cedar-dominated riparian zone with alder, rocky mountain maple, and redosier dogwood. This reach rated as high mass failure potential, particularly in areas where the channel interacted with the toe of adjacent hillslopes. Active mass wasting was observed as a significant sediment source in this reach.

Downstream of Plank Creek to the Flume Creek confluence, main stem Grouse Creek (Grouse Creek Reaches 2 and 3) is a lower-gradient, moderately entrenched, cobble-dominated riffle-pool channel with a braided, depositional channel regime. Point bars and mid-channel depositional features were substantial, indicating low sediment-transport competence. LWD was less abundant than the upstream reach. A dilapidated railroad car bridge across the active belt width was causing extensive bedload deposition upstream and downstream of the crossing, resulting in braided channel morphology. On private property in this reach, much of the riparian vegetation was harvested. Mass wasting and surface erosion in this reach was low. However, streambank erosion hazard was high to very high, and actual sediment load from streambank erosion was found to be significant in some areas.

The main stem Grouse Creek 0.8 miles from the Flume Creek confluence downstream to within 0.25 miles of the South Fork Grouse Creek confluence (Grouse Creek Reach 4) is a high-energy B3 single-thread channel confined by adjacent hillslopes with a minimal floodplain. It was characterized as a steep, step-pool channel with cobble and boulder-dominated substrate. While shrubs were minimal in this reach, a multi-age class cedar-dominated overstory existed. The dense nature of this overstory provided excellent bank stability with deep root masses. Due to this bank stability, bank erosion in this reach was low. Large wood was less abundant due to the high transport nature of this reach. Overall, Grouse Creek Reach 4 was determined to have reference conditions; however, it lacked habitat complexity due to the loss of pool-forming structure such as large wood.

Extending 1.2 miles downstream of the South Fork Grouse Creek confluence is Grouse Creek Reach 5. This reach flows primarily through private property and transitions to a C3 stream type with some F and D stream type inclusions. The sediment-transport capacity was improved from the upstream reaches. While lateral terraces and hillslopes limited the floodplain, it was more prominent than in the upstream reach. Within this reach, residential development resulted in removal of the riparian area, causing diminishing large wood recruitment and pool development and increased streambank erosion and hillslope failure (sometimes severe). Just upstream of the development was a channel avulsion created during a 2006 flood. The avulsion resulted in severe channel downcutting and vertical bank erosion. Bank erosion in this reach was significant and threatened to undermine two homes in this reach.

Extending from 2.0 miles downstream of Grouse Creek 5 to 0.5 miles downstream of the Wylie Creek confluence is Grouse Creek Reach 6. This reach has a decreased channel slope and becomes depositional in nature. This reach was observed to be a C3/C4 riffle-pool stream type that is slightly entrenched with a broad floodplain. It had gravel and cobble substrate that was in excess of the stream's transport capacity resulting in braided inclusions. The excess bedload was a result of episodic fluxes in sediment and water throughout the 20th century in response to logging, wildfire, and flooding. Pool habitat was a diversion from reference conditions, likely due to excess gravel/cobble deposition in the pools. This reach had areas with an active floodplain with diverse riparian vegetation. Beaver were present in the numerous side channels resulting in wetland development. Floodplain stability was enhanced in some areas by the presence of wood accumulations associated with large wood "K-jacks" installed by the USFS between 1997 and 2002. Some areas of floodplain were unstable, with loose alluvium that was sparsely vegetated with spotted knapweed. Bank erosion was high in these areas, amounting to a significant sediment load due to bank heights ranging from 4 to 8 feet in some instances. Overall, Grouse Creek Reach 6 was determined to be an impaired stream reach due to the oscillation between braided and single-thread channel regimes. However, there were channel segments within this reach that exhibited reference channel conditions.

Extending 0.5 miles from Wiley Creek to 1.0 miles upstream of North Fork Grouse Creek is Grouse Creek Reach 7. It is a high-transport reach with Grouse Creek Falls, which is a bedrock-controlled slot canyon. Below the canyon is a B3/B4 stream channel with a riffle-pool morphology. Several structures in this reach were installed in the mid-1990s by the USFS; many of them were not functioning properly. Two banks 100–125 feet long were identified as significant sediment sources that should be stabilized.

Grouse Creek Reach 8 extends 1 mile from reach 7 to the North Fork Grouse Creek confluence. It has a broad floodplain surface with a primary bankfull channel and multiple secondary flood channels, which provides diverse habitat for fish of all life-stages. Abundant LWD throughout the reach provided bank stability, affecting channel scour, and providing fish habitat. Sections of this reach were densely vegetated with a cottonwood overstory and sandbar and Drummond willow, alder, and rocky mountain maple understory. This vegetation provided excellent streambank stability. Other reaches dominated by riparian shrub vegetation types, reed canarygrass, and weeds had significant bank erosion producing a large amount of sediment. All of these sites were on outside meander bends with low abundance of LWD, shallow rooting depth, and high near-bank stress.

Upstream of the North Fork Grouse Creek confluence, Grouse Creek Reach 8 is adjacent to USFS Road 280. While the fill-slope of the road was riprapped, the road was still a source of fine sediment to the creek. Reach 8 bank erosion was estimated to produce 330 tons of sediment annually. Aerial photographs of Grouse Creek Reach 8 suggested increasing channel stability with time and better ability of the channel to route sediment. Grouse Creek Reach 8 exhibited reference channel conditions such as floodplain width, bankfull width, width/depth ratio, and entrenchment ratio. In addition, reference pool morphology was exhibited in some subreaches of Grouse Creek Reach 8. The longitudinal profile evaluation determined reach 8 was at reference conditions for riffle-pool-run-glide and other characteristics. This reach, along with the lower portion of reach 9, had the best habitat complexity of all measured C stream reaches due to the abundance of large wood and well-developed pool-riffle sequences. The wood also dispersed flow energy and provided channel and streambank stability. Floodplain-channel connectivity resulted in numerous side channels, adding to habitat complexity and dispersion of flow energy during bankfull flows.

Grouse Creek Reach 9 extends from the confluence of North Fork Grouse Creek downstream to approximately 0.5 miles upstream from the Jones Creek confluence. The upper portion of reach 9 was high energy, with coarse bed material, low sinuosity, minimal wood, and limited pool habitat. Large wood was more abundant downstream as the valley bottom widened, the gradient decreased, and channel sinuosity increased. The floodplain also broadened downstream. The reach was moderately entrenched with access to the floodplain. Floodplain processes were observed to occur in this reach, but the low abundance of large wood precluded the ability to recruit stabilizing vegetation. As observed in reach 8, areas of sparse riparian vegetation translated to bank instability and erosion. The sediment loading to Grouse Creek from bank erosion was somewhat more than that observed in reach 8. Based on reach-averaged conditions, bank erosion produced an estimated 782 tons of sediment annually.

Overall, Grouse Creek Reach 9 exhibited reference channel conditions. These conditions were exhibited in floodplain width, bankfull width, width/depth ratio, entrenchment ratio, and pool morphology. The longitudinal profile evaluation also determined reach 9 was at reference conditions for riffle-pool-run-glide and other characteristics. The lower portion of Grouse Creek Reach 9, along with reach 8, had the best habitat complexity of all measured C stream reaches due to the abundance of large wood and well-developed pool-riffle sequences. The wood also dispersed flow energy and provided channel and streambank stability. Floodplain-channel connectivity resulted in numerous side channels, adding to habitat complexity and dispersion of flow energy during bankfull flows.

Reach 10 extends 3.3 miles downstream from the Jones Creek confluence to 1.7 miles from the confluence with the Pack River. This is a C4 stream type with increasing width/depth ratios, bedload deposition, and bank erosion. Land use in this reach is primarily private residential and agricultural production. Large wood was considered to be the limiting factor in this reach. While pools were abundant, they were shallow and void of complexity, including cover and shade. While much of the floodplain had a well-vegetated riparian buffer with mature alder, the understory had dense areas of reed canarygrass. Point bars often lacked structural complexity to recruit large wood allowing for shrub regeneration. The degraded riparian areas and entrenched condition of some subreaches resulted in this reach being one of the biggest sediment loaders to Grouse Creek and the Pack River. Eroding streambanks were typically on outside meander bends where near-bank stress was high, shrub regeneration was low, and reed canarygrass invasion was prominent. Streambank erosion was estimated to produce 724 tons of sediment per year to Grouse Creek.

From the downstream extent of reach 10 to the confluence with the Pack River is Grouse Creek Reach 11. This reach is a deeply entrenched, sinuous E channel in a sandy substrate. Channel morphology through this reach included run and pool features and simplified habitat conditions. Vegetation was limited to a narrow band of rose, snowberry, tansy, and reed canarygrass. These conditions resulted in prominent bank erosion and high sediment loading in this reach, which was one of the biggest sediment loading reaches on the main stem Grouse Creek. This reach was estimated to produce 1,958 tons of sediment annually from bank erosion. Large wood was prominent in this reach due to rotational failure and slumping of streambanks. Pool habitat was shallow, even near large wood aggregates, due to the excess sandy substrate filling in the pools.

North Fork Grouse Creek

North Fork Grouse Creek is a 3rd-order tributary to Grouse Creek located primarily within USFS property with some private land used for forestry practice. North Fork Grouse Creek was divided into four study reaches based on degree of valley confinement and slope.

North Fork Grouse Creek Reach 1 is a B4a stream type with coarse bed material and steep hillslopes of glacial outwash deposits on metasedimentary bedrock. Channel morphology was characterized by steep riffles with moderately deep pools formed by large wood and bedrock inclusions. The riparian zone had a dense canopy of old-growth western red cedar. Overall, North Fork Grouse Creek Reach 1 was determined to be a reference reach. This reach was determined not to be a source of sediment load to Grouse Creek.

North Fork Grouse Creek Reach 2 is a B3a stream type that was lower gradient with a wider floodplain. LWD recruitment was excellent with a dense riparian buffer. Upstream of Dyree Creek was private property with a fairly recent clear cut located on steep slopes near the main channel. Although the buffer between the stream and the clear cut was narrow, this site was not observed to be a source of sediment to North Fork Grouse Creek. This reach had bedrock chutes and rapids within it. The riparian zone had a dense canopy of old-growth western red cedar. Overall, North Fork Grouse Creek Reach 2 was determined to be a stable stream reach with reference reach conditions. It was determined that this reach was not a concern for sediment loading to Grouse Creek.

North Fork Grouse Creek Reach 3 is a B4c stream type with a gravel channel and a distinct floodplain with a riparian area of willow, alder, and Rocky Mountain maple. LWD was abundant, providing habitat complexity and channel stability. However, excessive bedload conditions existed with depositional point bars and aggraded conditions near historic habitat improvement structures. Streambank erosion was moderate with an estimated 503 tons of sediment annually.

North Fork Grouse Creek Reach 4 is within an unconfined valley with a broad floodplain and fine substrate. Riparian vegetation was primarily willow, alder, and Rocky Mountain maple. Large wood was less abundant in this reach. Two large beaver dams were present in this reach resulting in backwater conditions. The crossing at USFS Road 280 had a skewed alignment and was identified as a potential sediment load to the creek. Bank erosion was determined to be high in North Fork Grouse Creek Reach 4 due to less than optimal riparian conditions. Overall, Reach 4 was determined to be an impaired stream reach in dimension, pattern, and profile; however, there were channel segments within this reach that exhibited reference condition channel morphology.

South Fork Grouse Creek

South Fork Grouse Creek was divided into two reaches delineated by stream type. Reach 1 is a moderately entrenched, steep, high-gradient stream with a B3 type and a step-pool morphology. Streambank erosion was moderate, producing an estimated 572 tons of sediment annually. While stream channel conditions were significantly less complex than North Fork Grouse Creek, South Fork Reach 1 was still considered to be a reference reach.

South Fork Reach 2 is downstream of reach 1. It is a low-gradient reach in an unconfined channel with a broad floodplain and gravel bed. Reach 2 is a depositional reach receiving sediment from current sediment sources and sediment sources from historical logging. As such, there were over-widened sections with moderately eroding streambanks. Poor pool habitat in this reach was shallow and void of complexity including cover and shade. This condition was due to a lack of large wood, high sediment loading, and lack of sediment transport capacity. An estimated 274 tons of sediment were produced annually from streambank erosion. This reach was classified as an impaired reach.

Chute Creek

Chute Creek is a steep, 2nd-order tributary to Grouse Creek. Due to the geology of unconsolidated glacial till over steep bedrock, there is a high potential for mass wasting in the watershed. As such, fluxes of coarse sediment are common in this watershed due to the mass wasting. Near the confluence with Grouse Creek the channel was depositional, and abundant gravel bedload had caused a recent channel avulsion.

Flume Creek

Flume Creek is a steep, 3rd-order tributary to Grouse Creek. Like Chute Creek, it had unconsolidated glacial till geology over steep bedrock. Therefore, mass failure potential with sediment delivery to the creek was high. Sediment delivery from bank erosion was low due to the presence of bank-stabilizing riparian vegetation.

Plank Creek

Plank Creek is a moderately steep and confined 2nd-order tributary to Grouse Creek. Colluvial channels, debris avalanches, and intermittent face drainages contributed abundant wood and course sediment to Plank Creek. In addition, the unconsolidated glacial till geology over steep bedrock was a significant source of sediment from mass wasting.

Wylie Creek

Wylie Creek is a moderately steep tributary to Grouse Creek. Like Plank Creek, Wylie Creek had colluvial channels, debris avalanches, and intermittent face drainages contributing abundant wood and course sediment to the creek. Streambanks in Wylie Creek were stable and it was estimated that 377 tons of sediment were produced annually from bank erosion to Wylie Creek.

Jones Creek

Jones Creek is an intermittent tributary to lower Grouse Creek. It is a lower-gradient creek that flowed through ponds and wetlands then through agricultural property at the mouth where it was straightened along the margin of a meadow.

2009 Stream Crossing and Road Evaluation

In 2009, approximately 112.3 miles of road and trail existed within the Grouse Creek watershed. Road segments and stream crossings were evaluated in the field and through remote sensing. Data collected included crossing characteristics, channel dimensions, road conditions, and upslope condition that could affect stream and crossing stability. Due to restoration actions completed under the 1999 Grouse Creek Enhancement Project, stream crossing and road segments in the upper Grouse Creek watershed were in good conditions with no risk for sediment delivery to the stream. No significant issues were observed in the middle Grouse Creek watershed either. One culvert was identified in the lower Grouse Creek watershed as undersized, at risk for failure, and needing replacement.

In the North Fork Grouse Creek watershed, most stream culverts were stable and functioning, but some could be improved. Site-specific recommendations for improving these culverts are provided in River Design Group (2009) and listed in the section below reviewing implementation plan activities.

2015 Road Crossing Survey

In October 2015, DEQ conducted a survey of road crossing conditions in the Grouse Creek watershed. Two road crossings were selected for evaluation. Road crossing characteristics are presented in Table 28. The bridge over Grouse Creek on Grouse Creek Road was a fairly new bridge in good condition with a low erosion potential (Figure 69). The bridge appeared to be sized correctly for bankfull flow.

A culvert on an unnamed tributary to Grouse Creek was inspected. The stream was low-gradient and depositional in character. Approximately 75 feet from the culvert was a beaver dam. The culvert was under-sized with damage to the inlet (Figure 70). However, water still passed through. Erosion potential at this culvert was medium.

Table 28. Road crossing characteristics, Gold Creek.

Water Body	Type	GPS Coordinates	Erosion Severity	Overall Condition	Fish Barrier?
Grouse Creek	Timber-framed, timber decked bridge	N 48.455371 W -116.289359	Low	Good	No
Unnamed tributary to Grouse Creek	Round, corrugated steel culvert	N 48.453833 W -116.362901	Medium	Fair	No

Figure 69. Newly constructed bridge on Grouse Creek.

Figure 70. Undersized culvert on unnamed tributary to Grouse Creek.

Review of Implementation Plan and Activities

The focus of restoration efforts in Grouse Creek began in the 1990s when the USFS installed numerous structures to increase habitat complexity, decrease erosion, and stabilize the stream channel. The Pack River Watershed Management Plan (PRTAC 2004) identified the following threats to the Grouse Creek drainage: timber harvest, urbanization, roads and railroads, agriculture livestock grazing, exotic species such as Brook Trout, illegal harvest of Bull Trout, and unscreened diversions. The plan provided approaches to address threats and limiting factors.

In 2009, River Design Group recommended restoration actions in the Grouse Creek watershed. Agencies have been working toward implementing those recommendations. Details are provided below.

Grouse Creek Headwaters with 1st- and 2nd-order Tributaries, Chute, Flume, Plank, South Fork Grouse, Taffy, and Wylie Creeks (ID17010214PN036_02)

This AU includes Grouse Creek Reaches 1, 2, and 3 and South Fork Grouse Creek Reaches 1 and 2. Some work has been done in this AU following the recommendations of the River Design Group. Table 29 lists the status of activities recommended by River Design Group. River Design Group prioritized this reach for several restoration projects that have not been implemented, including two restoration projects with the goals of increasing sediment transport competency and capacity, reducing instream and bank erosion sources of sediment, converting braided morphology to a primary channel, and improving aquatic habitat conditions. These projects will be implemented as funds allow. However, two bridges were replaced on Wylie Creek and Chute Creek.

Table 29. Recommended restoration projects for Grouse Creek headwaters and tributaries.

Project Code	Project Location	Description	Priority Rank	Project Complete	Agencies
SFGC 2-1	N48º26’49.9” W116º14’41.5”	Reconstruct instream water control structure used for hydroelectric. Structure spans bankfull width of channel.	2	No	
UGC 2-1	N48º28’37.7” W116º14’39.2”	Increase sediment transport capacity. Reconstruct channel, add large wood, revegetate floodplain.	8	No	
UGC 2-1	N48º28’28.2” W116º15’06.3”	Increase sediment transport capacity. Convert braided morphology, add large wood, remove bridge abutments.	9	No	
CC1	Chute Creek	Stop streambank erosion using coir logs on 50 feet of streambank and plant toe of slope.	Low	2011	USFS
FC1	Flume Creek	Bridge replacement.	Low	2012	USFS
GCT1-4 & 10	Unnamed Tribs to Grouse Creek	Stop streambank erosion using coir logs on 30 feet of streambank and plant toe of slope.			
WC1	Wylie Creek	Replace bridge.	Low	2014	USFS
GC2B	Intermittent stream crossing	Upgrade existing pipe and reset to match channel alignment. Armor fill slope and catch basin.	Low–Mod	No	
GC2C	Unnamed Tribs	Crown road, armor ditch, improve catch basin.	Low	No	
GC2A	Grouse Creek	Crown road, armor ditch, improve catch basin.	Low	No	County maintained
SF2	SF Grouse Creek	Remove old bridge located under current bridge.	Mod–High	No	
SFT1	Unnamed Trib to SF Grouse	Replace existing pipe for fish passage and channel stability.	Low	No	
TFC1	Taffy Creek	Replace existing pipe for fish passage and channel stability.	Mod	No	

Main Stem Grouse Creek from Flume Creek to North Fork Grouse Creek (ID17010214PN036_03)

This AU includes Grouse Creek Reaches 3–7 and part of reach 8. Some restoration actions have been done in this AU following the recommendations of the River Design Group. Table 30 lists the status of activities recommended. The recommendations were limited to reach 5. Of biggest concern to River Design Group was eroding banks that were threatening houses. To date, these banks have not been stabilized.

In 2015, the USFS and US Fish and Wildlife Service implemented restoration actions in the main stem Grouse Creek downstream of the confluence with the South Fork Grouse Creek (Grouse Creek Reach 5) and in main stem Grouse Creek; 77 pieces of large wood (trees) were added to the stream to create deep pools, sort and retain streambed gravel, and maximize habitat complexity. Trees (both singles and clumps) were placed into the creek. No cables, ropes, or other hardware was used to hold trees in place; rather, wood structures were designed for limited movement during high flows. In early December 2015, 6.9 inches of rain fell with an accompanying loss of 1 inch of snow water equivalent (measured at the Bear Mountain Snotel site), amounting to 7.9 inches of water contributing to flow in the Grouse Creek watershed. About 40% of the logs moved downstream and were transported to a point bar in lower reach 5, while others traveled further into reach 6 where they were deposited over numerous bar features. About 60% of the trees in reach 5 remained in place on nearside gravel bars or were swept parallel with the flow.

Table 30. Recommended restoration projects on main stem Grouse Creek.

Project Code	Project Location	Description	Priority Rank	Project Complete	Agencies
MGC 5-2	N48º27'21.2" W116º16'47.9	Channel restoration or bank stabilization to protect adjacent residence from river migration.	3	N	
MGC 5-1	N48º27'25.5" W116º16'41.9	Channel restoration or bank stabilization to protect adjacent residence from river migration.	7	N	
GC5	Grouse Creek	Deepen road ditch and in-slope road.		USFS: no problem with this site	

Main Stem Grouse Creek from North Fork Grouse Creek to the Mouth (ID17010214PN035_03)

This AU includes part of Grouse Creek Reach 8 and all of reaches 9–11. Some restoration actions have been done in this AU following the recommendations of the River Design Group. Table 31 lists the activities recommended and the date completed. River Design Group prioritized reach 8 and 9 for watershed and reach-scale restoration actions. Their recommendations for reach 8 and 9 were to install LWD aggregates, channel spanning trees, and single trees into the stream channel. These structures would increase pool habitat frequency, the distribution of spawning substrate, pool habitat diversity, channel roughness, and LWD retention. In 2015, 74 pieces of large wood (trees) were placed into the creek as single trees and as clumps. No cables, ropes, or other hardware was used to hold trees in place; rather, wood structures were designed for limited movement during high flows. Trees were also placed on point bars in reach 8 using an excavator. The accumulations of wood in reach 8 created a more sinuous channel that will stabilize existing sediment deposits while continuing to accumulate additional sediment during "normal" high flow events. Over time, this sediment will be colonized and stabilized by riparian vegetation, creating a deeper, narrower channel supporting cooler summer water temperatures and more complex in-channel habitat.

In reach 10, River Design Group recommended revegetation strategies to improve channel-floodplain connectivity and implement revegetation treatments by creating exaggerated swale features within floodplain surfaces and adding coarse woody debris and large wood to the floodplain. They also emphasized reed canarygrass suppression in the riparian area of reach 10.

Three site-specific restoration actions were recommended by River Design Group. The first was located in the middle of reach 10 on an outside meander bend, the second was located on the outside of a tortuous meander bend with severely eroding banks in reach 10, and the third was located on the outside of a severely eroding meander sequence in the lower portion of reach 10. The goal of all three actions was to stabilize the streambank and minimize streambank erosion using vegetated soil lifts and incorporate large wood and revegetation to improve aquatic habitat conditions. These projects were completed in 2012 and 2013 by the US Fish and Wildlife Service and Natural Resources Conservation Service.

Table 31. Recommended restoration projects in the lower Grouse Creek watershed.

Project Code	Project Location	Description	Priority Rank	Project Complete	Agencies
LGC10-1	N48º24’25.5 W116 º26’29.2	Bank stabilization and fish habitat improvement	5	2012	NRCS, USFWS
LGC10-2	N48º24’04.4” W116 º27’04.1	Bank stabilization and fish habitat improvement	4	2013	NRCS, USFWS
LGC 10-3	N48º23’52.8” W116 º27’11.3	Bank stabilization and fish habitat improvement	6	2013	NRCS, USFWS

Note: Natural Resources Conservation Service (NRCS), US Fish and Wildlife Service (USFWS)

North Fork Grouse Creek (ID17010214PN037_02)

In 2009, River Design Group provided a list of restoration activities recommended for the North Fork Grouse Creek watershed (Table 32). Two bridge replacements have been completed as a result of these recommendations.

Table 32. Recommended restoration projects in the North Fork Grouse Creek watershed (ID17010214PN037_02).

Project Code	Project Location	Description	Priority Rank	Project Complete	Agencies
NFGC 4-1	Reach 4	Large woody debris, habitat enhancement	5	No	
NF- 3	Reach 3	Culvert replacement with bridge and channel reconstruction	1	2010	USFS
NFT1	Unnamed tributary to North Fork Grouse Creek	Replace culvert and recontour	Mod	No	
NFT2	Unnamed tributary to North Fork Grouse Creek	Replace culvert and recontour	Mod	No	
NF1	North Fork Grouse Creek	Remove bridge and upstream ford	High	No	
NFT12	Unnamed tributary to North Fork Grouse Creek	Armor outlet and remove debris, replace undersized culvert	Mod	No	
DC1	Dyree Creek	Replace undersized culvert	Low	No	
NFT10	Unnamed tributary to North Fork Grouse Creek	Replace undersized culvert	Low	No	
NF3	North Fork Grouse Creek	Replace culvert with bridge or build downstream weir for fish passage	Low	2010	USFS
BRC1	BRC Creek	Build downstream weir for fish passage	Low	No	
BRC2	BRC Creek	Remove debris and build downstream weir for fish passage	Low	No	

TMDL Discussion

Timber harvesting in the Grouse Creek watershed in the 1920s and 1930s introduced large amounts of bedload into the stream network, which caused accelerated lateral erosion, braided channels, and bank erosion. A 1993 environmental assessment of Grouse Creek concluded that the main stem Grouse Creek could take a couple hundred years to regain equilibrium from its current state due to excess bedload. As such, Grouse Creek and North Fork Grouse Creek were placed on Idaho's 1996 §303(d) list of impaired waters (DEQ 2001). According to the Clark Fork/Pend Oreille TMDL, bedload continues to be transported to the main stem from the North Fork subwatershed (DEQ 2001). The TMDL suggests that the forested portions of the main stem (above Wylie Creek) maintained their beneficial uses, but the lower-gradient, depositional reaches of the creek were impaired. Therefore, a TMDL was necessary.

The TMDL assigned main stem Grouse Creek a 62% load reduction requirement and North Fork Grouse Creek a 71% load reduction requirement. The TMDL is explicit that load reductions be tracked to determine if load reduction requirements have been met. Once load reductions are met, the TMDL calls for an evaluation of beneficial use support using BURP protocols. The beneficial use evaluation must be repeated to ensure beneficial use support is met. Because load reductions were not assigned to individual AUs, it was impossible to parse out load reduction requirements for AUs in the main stem and South Fork Grouse Creek watershed. Therefore, the approach was to look at existing data for each AU to determine whether the AU is still impaired due to sediment and load reductions are still necessary, or whether individual AUs may be supporting beneficial uses.

Grouse Creek Headwaters with 1st- and 2nd-order Tributaries, Chute, Flume, Plank, South Fork Grouse, Taffy and Wylie Creeks (ID17010214PN036_02)

AU ID17010214PN036_02 is not supporting cold water aquatic life due to sediment and temperature impairments and is not supporting salmonid spawning due to temperature.

In 2002, IDL evaluated the headwaters of Grouse Creek downstream to the confluence with Wylie Creek. While a few areas had active mass wasting, the overall rating for sediment delivery to Grouse Creek was low. In 2003, DEQ collected habitat, fish, and macroinvertebrate data on main stem Grouse Creek above the confluence with Flume Creek. The stream had excellent macroinvertebrate and habitat scores, and Bull Trout were present, indicating the stream was fully supporting its beneficial uses. In 2009–2011, IDFG and AVISTA conducted electrofishing, and between 2002 and 2011 they collected Bull Trout redd data. They determined Grouse Creek had a good bull trout and Westslope Cutthroat Trout population, which is further evidence the stream may be fully supporting beneficial uses.

In 2009, stream data collected by River Design Group (2009) noted the following in this AU:

- The headwaters to Plank Creek had high mass failure potential and active mass failures.
- Flume Creek and Plank Creek contributed abundant wood and course sediment to Grouse Creek.
- Between Plank Creek and Flume Creek, mid-channel depositional features, channel braiding, and streambank erosion were substantial.
- South Fork Grouse Creek had loss of habitat complexity due to lack of large wood, excess bedload, and lack of sediment transport capacity.

Due to the highly erosive nature of the upper Grouse Creek watershed, this AU is at risk of episodic fluxes of sediment loading into the channel resulting in lack of sediment transport capacity. This risk could be exacerbated with land use practices that destabilize hillslopes or riparian areas. In addition, residential development in the floodplain and terrace has resulted in lack of bank-stabilizing vegetation, bank erosion, channel widening, and low wood recruitment potential. River Design Group prioritized this reach for two restoration projects with the goals of increasing sediment transport competency and capacity, reducing instream and bank erosion sources of sediment, converting braided morphology to a primary channel, and improving aquatic habitat conditions. These projects have not been implemented and should be a priority to better stabilize the channel and improve sediment routing conditions in this AU. Other projects recommended by River Design Group still need to be completed as well.

Although 2003 BURP data and IDFG data suggested full support of beneficial use, there is no recommendation to survey the reach again until the restoration projects recommended by River Design Group are implemented. Once the projects have been implemented, the TMDL directs that two BURP surveys be completed before deciding whether this AU fully supports beneficial uses.

Main Stem Grouse Creek from Flume Creek to North Fork Grouse Creek (ID17010214PN036_03)

This AU is not supporting cold water aquatic life due to sediment and temperature impairments and is not supporting salmonid spawning due to temperature. In 2006, DEQ evaluated the AU upstream of the confluence with North Fork Grouse Creek using BURP methods. The stream had excellent macroinvertebrate and stream habitat scores, indicating the stream may have been fully supporting the aquatic life and salmonid spawning beneficial uses. No fish data were collected. In 2009–2011, IDFG and AVISTA conducted electrofishing, and between 2002 and 2011 they collected Bull Trout redd data. Main stem Grouse Creek had good bull trout and Westslope Cutthroat Trout populations. These data suggest this AU may be supporting its beneficial uses.

In 2009, stream data collected by River Design Group (2009) noted the following in this AU:

- Overall, a number of subreaches in this AU had reference reach conditions.
- Habitat complexity lacked in some subreaches due to excessive sediment and the diminished transport capacity in those reaches.
- Near the confluence of North Fork Grouse Creek (reach 8) were reference reach conditions with excellent habitat complexity due to the abundance of large wood and well-developed pool-riffle sequences. The wood also functioned to disperse flow energy and provide channel and streambank stability.
- Residential impacts and a major channel avulsion and incision have destabilized the channel in reach 5, resulting in severe bank erosion, land loss, and degraded habitat conditions.

River Design Group prioritized reach 5 for two restoration actions due to the high degree of channel instability and due to the presence of residential buildings. Channel restoration and bank stabilization were prioritized to stabilize the creek and stop further bank erosion. These projects have not been implemented.

In 2015, the USFS and US Fish and Wildlife Service implemented restoration actions in reach 5 of main stem Grouse Creek downstream of the confluence with South Fork Grouse Creek; 77 pieces of large wood (trees) were added to the stream to create deep pools, sort and retain streambed gravel, and maximize habitat complexity. An early December rain-on-snow event resulted in 40% of the wood felled into reach 5 transporting to reach 6 to form new log jams. The trees that remained in place recruited a substantial amount of fine sediment and/or large woody material.

In reaches 5, 6, and 7, a significant amount of lateral erosion occurred during the flood event, recruiting a substantial amount of large trees with rootwads. This large wood created debris jams that backed up water and dropped bedload that caused further lateral erosion and bank failure. Some debris jams failed, causing even more channel and bank scour. Many of these trees mobilized to reaches 6 and 7 (USFS 2016; recent DEQ field observations).

The amount of natural recruitment of LWD, though liberated by unusual conditions, far exceeded the amount of wood placed in the project areas of reaches 5, 6, and 7. This large input of wood managed to sort out and incorporate into the channel. At some locations, bank erosion was likely increased but it wouldn't have been the result of project trees alone. In many locations, streambanks were armored by trees that distributed well along the channel.

Overall, natural or placed trees that moved during December's high-flow event did not pose an imminent threat to any of the bridges in the study reaches. However, care must be taken when working in proximity to infrastructure.

Bank conditions and channel types adjacent to private properties have a range of classifications and erosion vulnerabilities. These conditions should be considered in projects placing wood that could increase erosion of more vulnerable banks if a jam were to occur that would deflect flow toward incised and very erodible channel banks.

Overall, the bank erosion was significantly elevated compared to preproject conditions, but the erosion was not considered to be in excess of prescribed levels in the TMDL. In many cases, fine sediments were trapped on more course depositional features where habitat diversity and complexity increased.

It seems reasonable to conclude from the data summarized above that this AU is trending toward full support of beneficial uses. Reference reach conditions in much of the AU and the presence of a good population of Bull Trout and Westslope Cutthroat Trout would support this conclusion. However, Grouse Creek continues to be effected by an oversupply of course sediment, and additional projects on the watershed scale would be required to reduce inputs and reduce supply. Significant coarse material is stored in the channel, and transport effectiveness is important to maintain to continue moving materials down gradient.

Main Stem Grouse Creek from North Fork Grouse Creek to the Mouth (ID17010214PN035_03)

In 2003, 2006, 2007, and 2008, DEQ evaluated this AU at various locations. Often, this reach had good to excellent macroinvertebrate scores but poor fish scores and poor to good habitat scores, indicating the stream was not fully supporting aquatic life and salmonid spawning beneficial uses. In 2009, stream data collected by River Design Group (2009) noted the following in this AU:

- Some of this AU (reaches 8 and 9) exhibited reference conditions for channel conditions, pool morphology, and riffle-pool-run-glide characteristics. The habitat complexity was excellent due to the abundance of large wood and well-developed pool-riffle sequences. The wood also functioned to disperse flow energy and provide channel and streambank stability.

- Floodplain-channel connectivity resulted in numerous side channels, adding to habitat complexity and dispersion of flow energy during bankfull flows.
- 3.3 miles from the Jones Creek confluence to the mouth (reaches 10 and 11) exhibited simplified habitat conditions, bedload deposition, and bank erosion. Bank erosion and unstable point bars made this reach one of the biggest sediment loaders to the Pack River.
- Reach 10 had constraints limiting establishment of riparian and floodplain habitat plant communities including current land management, lack of complex floodplain surfaces, reed canarygrass infestation, and channel entrenchment.

In 2015, large wood was installed on point bars in reach 8 using an excavator. In 2017, the USFS implemented a LWD habitat enhancement project in reach 9.

Three site-specific restoration actions were recommended for reach 10 by River Design Group. All three were on severely eroding streambanks on meander bends with reed canarygrass infestations and poor riparian health. The goal of the restoration action was to stabilize the streambank and minimize streambank erosion using vegetated soil lifts and incorporate large wood and revegetation to improve aquatic habitat conditions. These projects were completed in 2012 and 2013 by the US Fish and Wildlife Service and Natural Resources Conservation Service.

Due to the poor BURP scores, this reach will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL (DEQ 2001).

North Fork Grouse Creek (ID17010214PN037_02)

North Fork Grouse Creek is not supporting the cold water aquatic life beneficial use due to temperature and sediment. It does not support salmonid spawning due to temperature. In 2006, DEQ evaluated the AU representing North Fork Grouse Creek and its tributaries using BURP methods. The stream had excellent macroinvertebrate and stream habitat scores indicating it was fully supporting the aquatic life and salmonid spawning beneficial uses. A fish survey was not performed. Fisheries data collected between 2009 and 2011 by IDFG and AVISTA suggest a good population of Westslope Cutthroat Trout in the North Fork Grouse Creek stream network. These data suggest North Fork Grouse Creek may be fully supporting beneficial uses.

In 2009, stream data collected by River Design Group (2009) noted most of North Fork Grouse Creek to have reference conditions. The River Design Group recommended road and crossing improvements in the North Fork Grouse Creek watershed, some of them addressing moderate to high erosion/sediment delivery to the creek. A high-priority project was completed in 2010 to replace a culvert with a free-span bridge at the main crossing of USFS Road 280 and North Fork Grouse Creek. While improvements to roads and crossings in the North Fork Grouse Creek watershed need to be done, BURP and AVISTA data indicate North Fork Grouse Creek is supporting beneficial uses and sediment is no longer a pollutant of concern in this AU. Therefore, it is recommended that North Fork Grouse Creek be evaluated for beneficial use support for two consecutive years using the BURP method.

5.2.6 Hellroaring Creek

Hellroaring Creek (AU ID17010214PN044_02) is a 2nd-order tributary to the Pack River and drains a watershed 14.4 square-miles in size (Figure 71). It flows in an easterly direction until it meets the Pack River approximately 6.5 miles upstream from Colburn, Idaho. It is not supporting cold water aquatic life due to sediment and temperature impairments. The salmonid spawning beneficial use is not supported due to temperature impairment. According to the Clark Fork/Pend Oreille TMDL, the watershed is the highest sediment loading watershed to the Pack River (DEQ 2001).

Hellroaring Creek is underlain by Cretaceous granitics of the Kaniksu Batholith making it a naturally erosive watershed. At the mouth of the creek are deposits of Pleistocene unconsolidated glacial debris and coarse alluvial materials.

Landownership in Hellroaring Creek includes USFS, state, and private land. Timber harvest has not been practiced on USFS-managed land since the 1990s. On private property, which is primarily one landowner, and state-owned property the land is managed primarily for timber harvest.

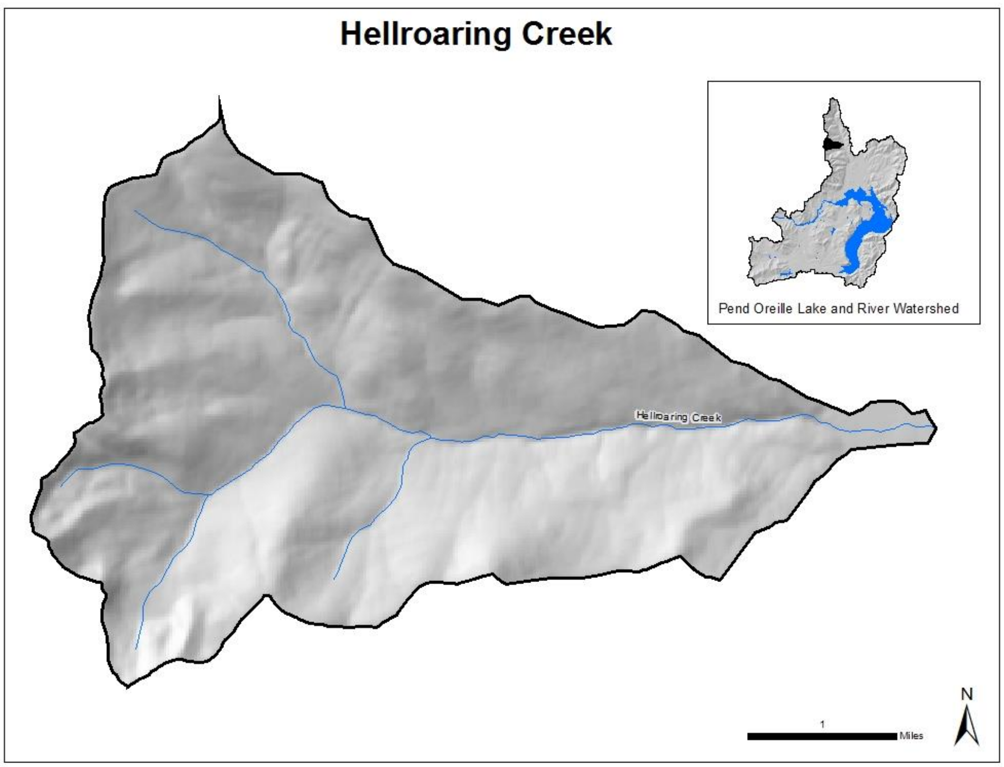


Figure 71. Hellroaring Creek watershed.

Idaho Beneficial Use Reconnaissance Program

No BURP data have been collected on Hellroaring Creek since 1998.

IDL Cumulative Watershed Effects (CWE)

IDL last conducted the CWE evaluation of Hellroaring Creek in 2003 and 2009 (IDL 2003c, TerraGraphics 2010b) (Table 33). During both evaluations, the surface erosion hazard rating was high due to the highly erosive soils on granitic geologic material and the steep, mountainous terrain. In both 2003 and 2009, the Channel Stability Index ratings were moderate, which is attributed to stable, yet poorly vegetated banks.

Forest canopy removal may influence the timing and magnitude of surface water runoff. IDL's hydrologic risk rating compares the level of canopy removal (Canopy Removal Index) with the stability of the stream channel (Channel Stability Index). Therefore, the hydrologic risk rating rates the risk that the stream channel may be impacted by forest canopy removal. The hydrologic risk rating was moderate in both 2003 and 2009.

In 2003, the CWE assessment identified numerous roads in the watershed needing management attention; thus, the sediment delivery rating from roads was categorized as high. At that time, 41 miles of roads and trails existed, and 16 miles of road were close to streams. In 2009, IDL estimated the Hellroaring Creek watershed contained 58.3 miles of road, 13.9 of which were close to streams or had a high potential to impact water quality. However, the sediment delivery rating from roads was categorized as low due to improvements to the road system.

In 2003, the CWE assessment identified 200 skid trails in the Hellroaring Creek watershed that were eroding and delivering sediment to a stream; therefore, the sediment delivery rating from skid trails was categorized as high. During 2009, no skid trails were identified; therefore, the overall CWE skid trail score was low, indicating little risk of sediment delivery to a stream.

In 2003, while no mass failures were recorded in the watershed, the CWE mass failure score for roads was high due to 10 different sites identified as problem areas. In 2009, the CWE assessment identified no new mass failures; therefore, the overall CWE mass failure score for roads was low.

Table 33. CWE scores for Hellroaring Creek.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydrologic Risk	Roads	Mass Wasting	Skid Trails	Total Sediment Delivery
2003	High	High	Moderate	0.38	Moderate	High	Low	High	High
2009	High	Moderate	Moderate	0.36	Moderate	Low	Low	Low	Low

Stressor Identification

In 2006, TerraGraphics conducted a stressor identification assessment to determine the nature of the "unknown" cause of beneficial use impairment on Hellroaring Creek (TerraGraphics 2006b). The analysis was based on 1998 BURP scores and a 2003 IDL CWE evaluation of the creek. Results indicated there was a significant portion of fine sediment within the bankfull zone (30%). Furthermore, the granitic and glacial debris geology of the watershed made it high risk for mass failures and high sediment delivery. Therefore, sediment delivery to Hellroaring Creek was the likely impairment to the aquatic life beneficial use support.

Changes in Subbasin Characteristics

Forest Cover Change

Between 2001 and 2014, a 1,032 acre (11%) loss in forest cover occurred in the Hellroaring Creek subwatershed (Figure 72).

- 2001–2004: 380 acre decrease in forest cover
- 2005–2009: 295-acre decrease in forest cover
- 2010–2014: 357 acre decrease in forest cover

Aerial photos show that most of the loss was due to commercial timber harvest on private property (Figure 73, Figure 74). No timber activity has occurred on USFS property since 1998.

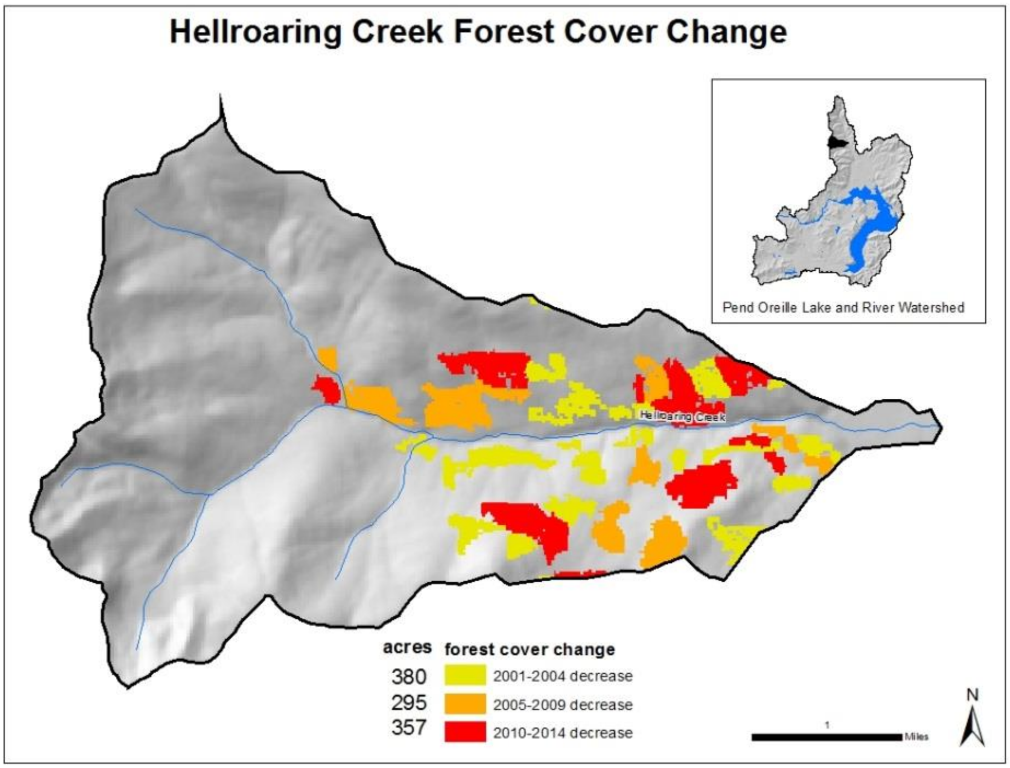


Figure 72. Forest cover change in the Hellroaring Creek subwatershed, 2001–2014.

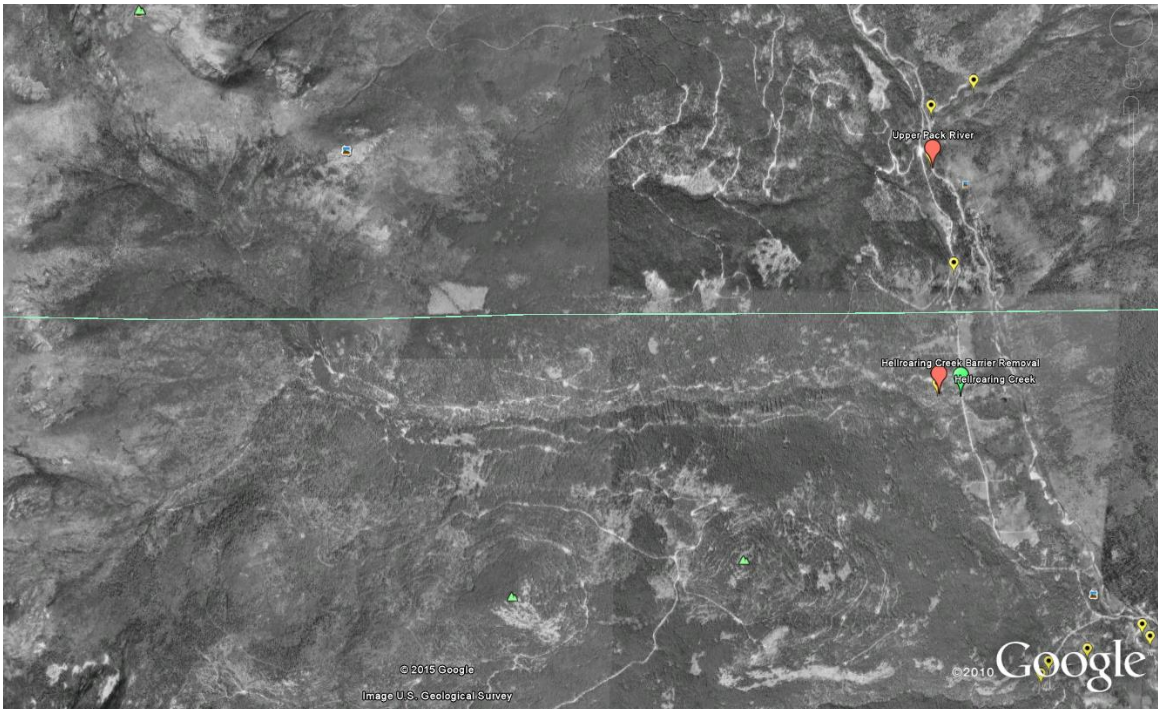


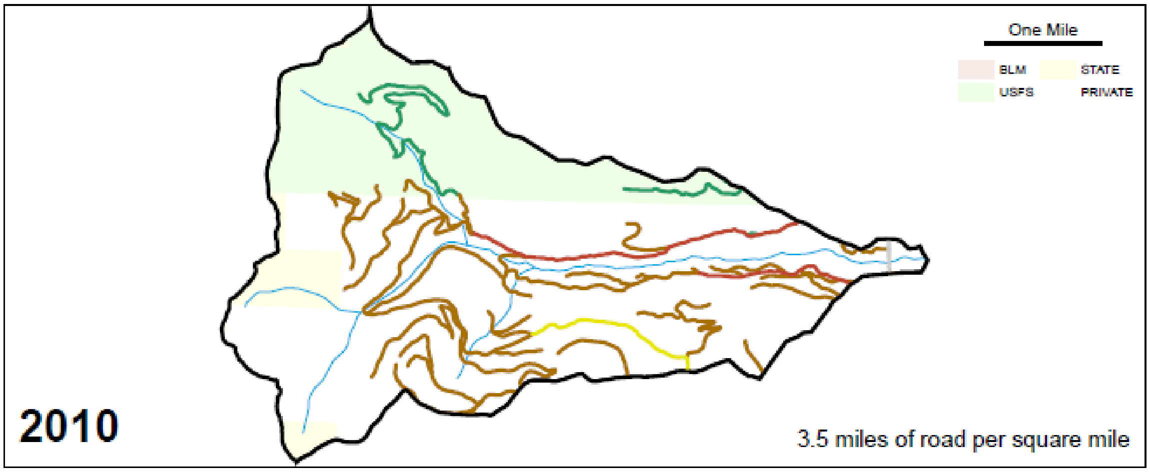
Figure 73. Picture of Hellroaring Creek watershed in 1998.

Figure 74. Picture of Hellroaring Creek watershed in 2014.

Roads

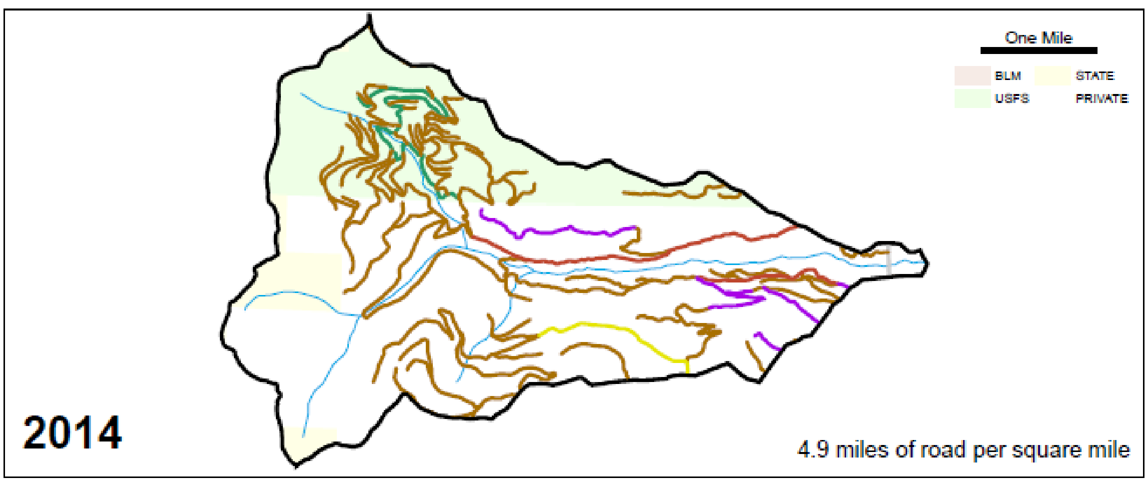
Road density in the Hellroaring Creek watershed increased from 3.5 to 4.9 miles of road per square mile between 2010 and 2014 (Figure 75). Approximately 13.4 miles of road was constructed on USFS-managed property in the watershed, although information obtained from the USFS shows USFS property to be roadless (Figure 76)

Hellroaring Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Hellroaring Creek	Unimproved dirt	27.19	70.8	38.4
Hellroaring Creek	Unknown	4.93	12.8	38.4
Hellroaring Creek	Improved native	4.37	11.4	38.4
Hellroaring Creek	Improved partial	1.59	4.2	38.4
Hellroaring Creek	Improved gravel	0.3	0.8	38.4

Surface: Improved gravel, Improved partial, Primary highway, Secondary highway, Unknown, Abandoned, Improved native, Improved paved, Primative, Unimproved dirt, Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Hellroaring Creek	Unimproved dirt	40.61	74.9	54.2
Hellroaring Creek	Improved native	4.27	7.9	54.2
Hellroaring Creek	Waterbarred dirt	3.88	7.2	54.2
Hellroaring Creek	Unknown	3.63	6.7	54.2
Hellroaring Creek	Improved partial	1.53	2.8	54.2
Hellroaring Creek	Improved gravel	0.3	0.6	54.2

Figure 75. Comparison of road networks in the Hellroaring Creek watershed, 2010 and 2014.

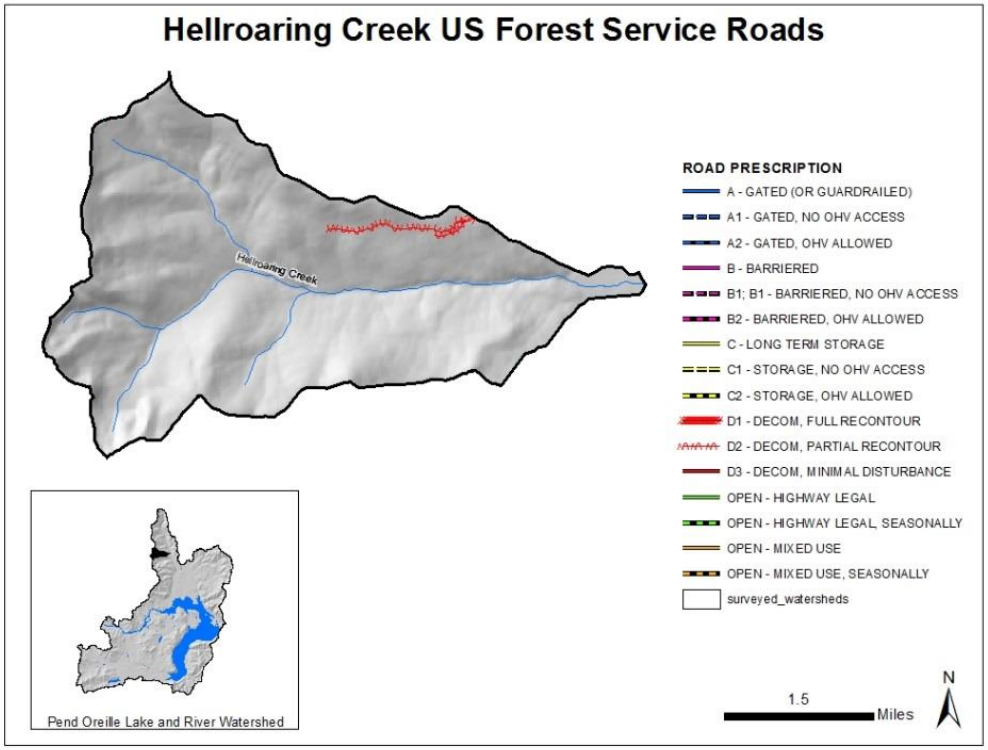


Figure 76. US Forest Service road network in the Hellroaring Creek watershed.

Fisheries

In 2014, IDFG and AVISTA collected fishery data on Hellroaring Creek. Bull Trout were present in a mean density of 0.2 fish/100 m^2. Rainbow Trout were present in a mean density of 4 fish/100 m^2. Westslope Cutthroat Trout were not present; however, Westslope Cutthroat × Rainbow Trout hybrids were present in a mean density of 0.2 fish/100 m^2. In 2012, IDFG and AVISTA collected Bull Trout redd count data on Hellroaring Creek from the mouth to the falls (2.4 km). Three Bull Trout redds were counted. In no other years were Bull Trout redds surveyed in Hellroaring Creek.

2015 DEQ Stream Evaluation

Two 100-meter stream reaches of Hellroaring Creek were evaluated using Rosgen's method (Rosgen 2006). Data were collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 34.

Table 34. Reach characteristics for Hellroaring Creek.

Name	Date	Type	Length (meters)	Latitude	Longitude
Upper Hellroaring Creek	9/22/2015	Step-Pool	100	N48.494094	W116.601346
Lower Hellroaring Creek	9/22/2015	Step-Pool	130	N48.493971	W116.601689

Lower Hellroaring Creek

Stream classification for lower Hellroaring Creek was done according to Rosgen (2009). Characteristics are listed in Table 35. Lower Hellroaring Creek is an over-widened, moderately entrenched Rosgen "B" channel. The channel substrate is primarily bedrock.

Table 35. Reach characteristics for lower Hellroaring Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	16.2	8.8	27.0	17.3
Bankfull Depth (D_{bkf}), ft	Not recorded	Not recorded	Not recorded	0.61
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	-	-	-	28.4
Maximum Depth (D_{mbkf}), ft	1.5	1.8	0.8	1.4
Width of Flood-Prone Area (W_{fpa}), ft	21.9	26.8	42.3	30.3
Wetted Width, ft/ft	15.4	4.7	21.5	13.9
Entrenchment Ratio (ER), ft/ft	1.35	3.04	1.57	1.9
Channel Materials (Particle Size Index) D_{50}, mm	Bedrock controlled			
Water Surface Slope, %	3.0	6.5	6.5	5.3
Rosgen Stream Type	B			

The following reach habitat assessment of lower Hellroaring Creek was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

The presence of LWD and woody debris jams in Hellroaring Creek exhibited a minor deviation from reference conditions. LWD greater than 2 feet in diameter was not in relative abundance, but smaller diameter wood was. Log jams were also abundant—some of them channel spanning log jams (Figure 77). Recruitment of LWD was moderate.

Figure 77. Abundant large woody debris in lower Hellroaring Creek provides cover for aquatic life.

Bed Substrate Cover

Bed substrate in lower Hellroaring Creek was bedrock in much of the study reach (Figure 78). However, large boulders dominated in the upper third of the study reach and were stable with some evidence of mobility and sorting.

Figure 78. Bedrock-dominated substrate in lower Hellroaring Creek.

Scour and Depositional Features

Abundant pools with excellent cover were observed in lower Hellroaring Creek, providing refuge during all flow regimes (Figure 79). These would be considered near reference conditions. The size and depth of the pools were remarkable given the extreme low-flow conditions. The pools were formed from abundant wood and the step-pool morphology, which was well-formed and stable.

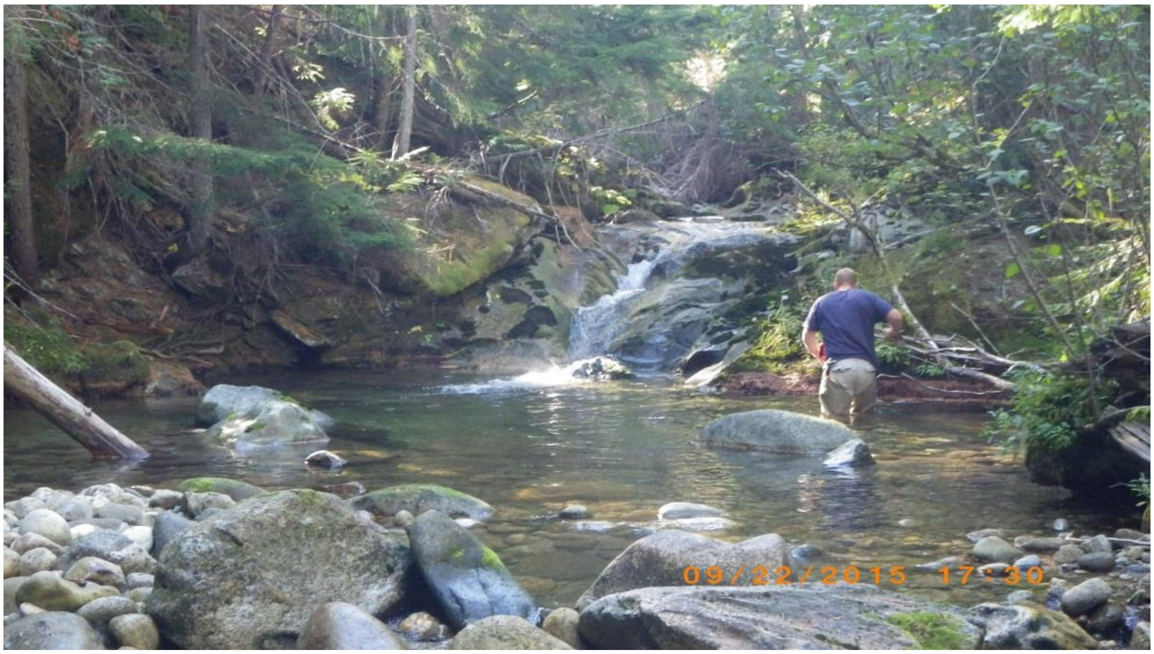


Figure 79. Pools in lower Hellroaring Creek provide abundant refuge even in low flow years.

Channel Morphology

Lower Hellroaring Creek had no evidence of channel alteration, but the channel was over-widened and slightly entrenched. This condition was likely due to the effects of historical logging and fire in the watershed.

Hydrologic Characteristics and Connectivity

Given it was an extreme low-flow year, the wetted width of lower Hellroaring Creek was good, with an abundance of refuge during high and low flow. No flow alteration existed on lower Hellroaring Creek. However, a waterfall did obstruct longitudinal connectivity at the lower end of the study reach (Figure 80). Due to minor entrenchment, there was little obstruction to floodplain connectivity. However, the floodplain was narrow due to the steep mountain side-slopes.

Figure 80. Waterfall on lower Hellroaring Creek.

Streambanks

Streambank erosion and bank stability was at or near reference conditions on lower Hellroaring Creek. Bank erosion was less than 10%, typical of natural conditions. Bank vegetation was diverse, creating good cover and excellent streambank stability. Undercut banks were abundant with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency.

Riparian Area

The riparian area was composed of cedar and hemlock overstory with fern and devil's club understory (Figure 81). The buffer width was greater than 200 feet with maximum channel canopy. The riparian area was at reference conditions.

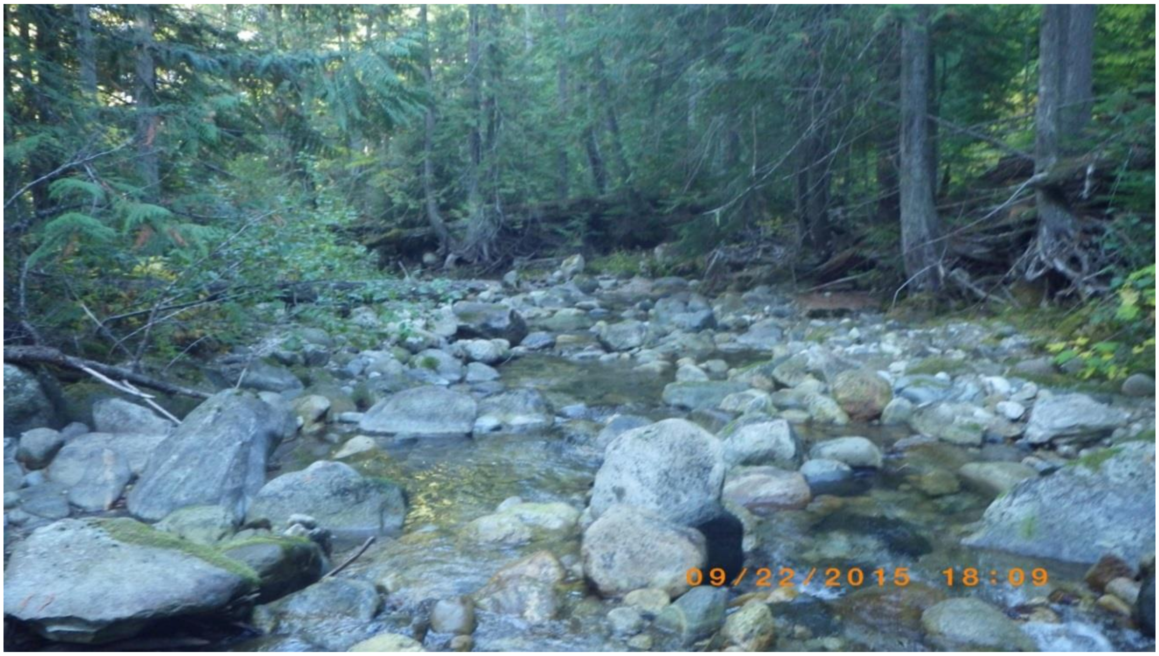


Figure 81. Dense riparian buffer at lower Hellroaring Creek.

Upper Hellroaring Creek

A 130-meter stream reach of upper Hellroaring Creek evaluated using Rosgen's method (2006). The study reach was larger than the typical 100 meter study reach because of a log jam at the upper boundary of the 100-meter reach. Data were collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 36. Upper Hellroaring Creek is a moderately sloped, Rosgen "A-B" channel that was over-widened and slightly entrenched. The median substrate was boulders.

Table 36. Reach characteristics for upper Hellroaring Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	14.5	25.8	37.2	25.8
Bankfull Depth (D_{bkf}), ft	1.40	0.77	0.88	1.02
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	10.4	33.5	42.3	28.7
Maximum Depth (D_{mbkf}), ft	2.20	1.25	1.60	1.68
Width of Flood-Prone Area (W_{fpa}), ft	24.5	36.8	41.5	34.3
Wetted Width, ft	12.1	13.5	34.6	24.1
Entrenchment Ratio (ER), ft	1.7	1.4	1.1	1.33
Channel Materials (Particle Size index) D_{50}, mm	Boulder			256–512
Water Surface Slope, %	4.6	3.5		4.1
Rosgen Stream Type	A-B			

The following reach habitat assessment of upper Hellroaring Creek was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

The presence of LWD and woody debris jams in upper Hellroaring Creek showed a minor deviation from reference conditions. LWD greater than 2 feet in diameter was less abundant, but wood of smaller diameter was abundant. Log jams were also abundant—some of them spanning the channel. Recruitment of LWD was moderate.

Bed Substrate Cover

Upper Hellroaring Creek had a boulder-dominated substrate with some evidence of sediment mobility and lack of sorting (Figure 82). The excess bedload somewhat limited the stream's transport capacity. Pool and margin embeddedness was not a concern. Small substrate patches were covered in dense algae growth suggesting some nutrient enrichment (Figure 83). The source of nutrients was likely natural due to the lack of development and infrastructure in the watershed.

Figure 82. Boulder substrate, upper Hellroaring Creek.

Figure 83. Algae growth on substrate, upper Hellroaring Creek.

Scour and Depositional Features

Upper Hellroaring Creek had a step-pool morphology with steps moderately well-formed, complete, and stable. Due to the excessive bedload, pool size and cover varied. Overall pool abundance was good, providing good habitat in the extreme low-flow conditions of 2015 (Figure 84).

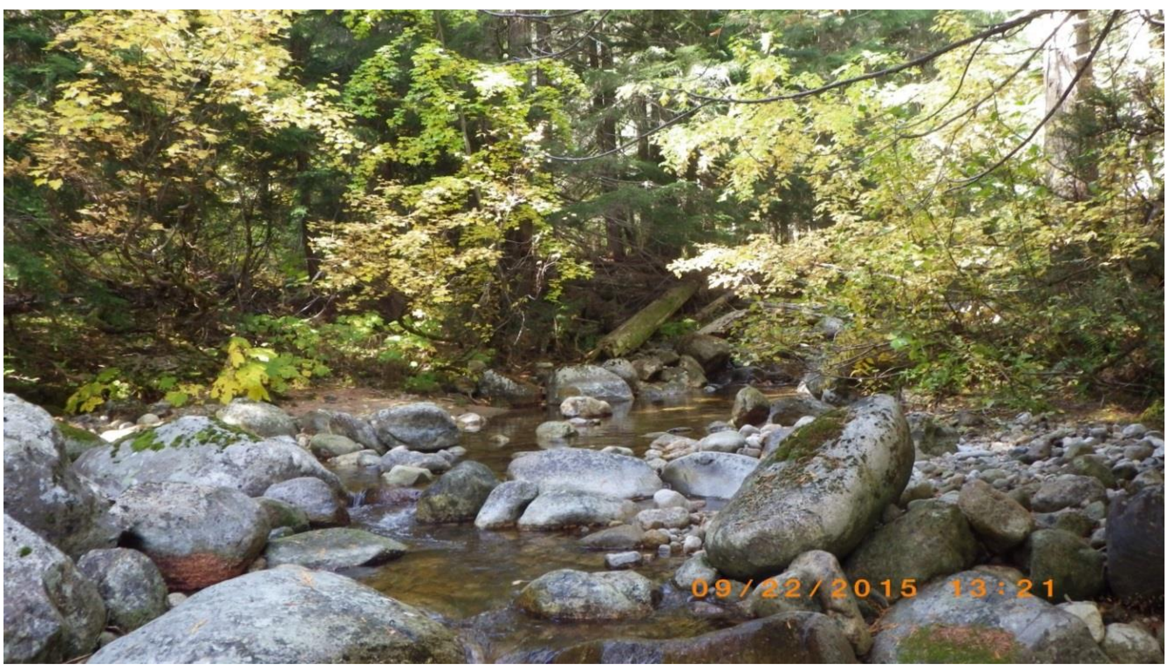


Figure 84. Pools in upper Hellroaring Creek.

Channel Morphology and Connectivity

Channel morphology was over-widened and somewhat entrenched. There was no evidence of channel alteration suggesting active widening or channel incision. The widening and entrenchment was likely a result of historic logging and fire in the riparian area. A channel-spanning log jam was observed that may have obstructed movement of aquatic species. Channel incision was low enough that there was still good connectivity to the floodplain; however, the floodplain was narrow due to the steep mountainous terrain.

Streambanks

Streambank erosion was less than 10% in the study reach, which was at reference conditions. Streambank vegetation was between 75% and 90% of reference conditions with a diverse plant assemblage. Plants created good cover and roots provided bank stability. Streambank canopy was between 80% and 90%, a minor deviation from reference conditions. Undercut banks were abundant, providing excellent cover and refuge. Undercut banks had stable boundaries, abundant overhanging vegetation, and consistent water adjacency. Due to the erosive nature of the soils in this watershed, mass wasting was evident (Figure 85).

Figure 85. Mass wasting in upper Hellroaring Creek watershed.

Riparian Area

The riparian area was composed of a cedar and hemlock overstory with a fern and devil's club understory (Figure 86). The riparian buffer width varied from less than 100 feet to 200 feet, with the narrower buffer on the north side of the creek. The canopy was 75% to 90% maximum channel capacity. Land use was strictly timber production in this watershed, so river corridor development and infrastructure was absent.

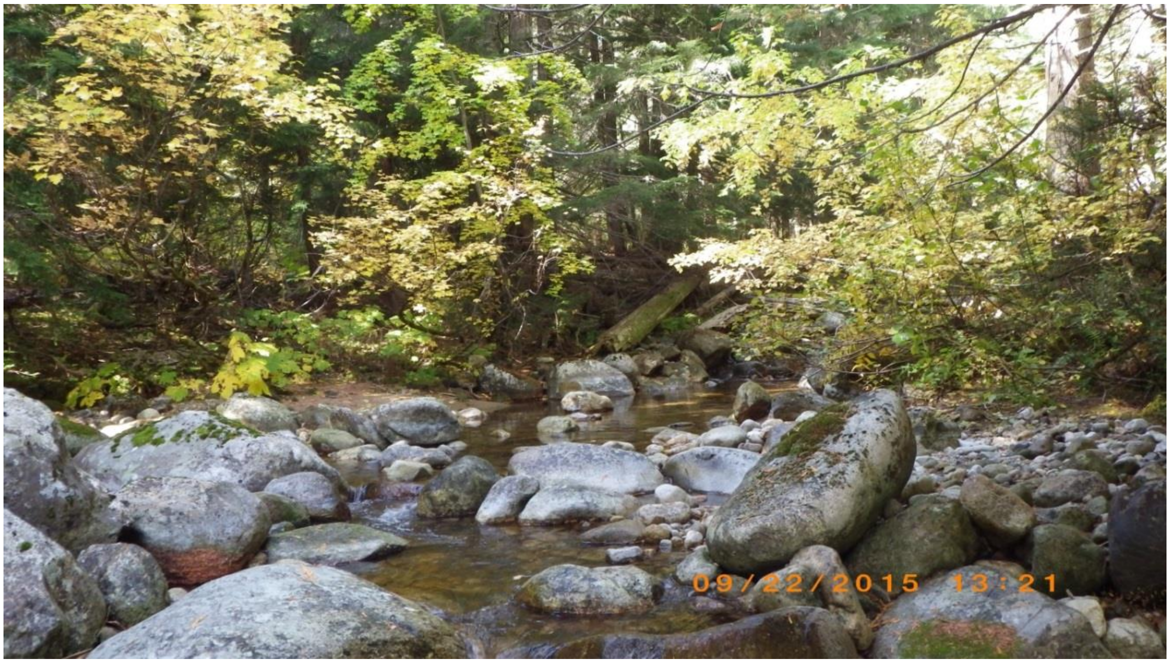


Figure 86. Riparian overstory, upper Hellroaring Creek.

2015 Road Crossing Survey

In 2015, DEQ conducted a survey of road conditions in the Hellroaring Creek watershed. Private property ownership was to the south of Hellroaring Creek, with ownership by one landowner. USFS-managed property was to the north of Hellroaring Creek. The main Hellroaring Creek road was just to the north of Hellroaring Creek, and it was entirely on private property owned primarily by one landowner. The road was well up-slope of the creek until it crossed a tributary to upper Hellroaring Creek. Public access into private property was not allowed, and the road was gated off. However, the landowner allowed access for the road survey.

In general, the road surfaces were highly erosive with a fine-sandy-textured soil road base (Figure 87). Despite the erodibility, the surfaces were well maintained, with mostly-vegetated ditches. No relief culverts were observed on Hellroaring Creek Road; rather, there were frequent water bars (spacing every 50 to 100 feet). The cutslopes of the road were also highly erosive with frequent unvegetated sections.

Due to the long distance between the road and Hellroaring Creek, there was a very low risk of sediment delivery to Hellroaring Creek from the road, except at the single crossing on North Fork Hellroaring Creek. However, proper maintenance of the road and water bars and limited access on this road is critical to limit the risk of rill and gully erosion on the road surface. At the North Fork Hellroaring Creek crossing, the culvert had been replaced and was well armored upstream and at the outlet (Figure 88). However, it appeared that water could flow underneath the culvert. Limited access and proper maintenance of the road surface and water bars near the road crossing is critical to protecting habitat and water quality in Hellroaring Creek.

Figure 87. Road surface, water bar, and cutslope erosion on Hellroaring Creek Road.

Figure 88. New culvert on North Fork Hellroaring Creek Road.

Review of Implementation Plan and Activities

Many restoration projects have been completed in the Hellroaring Creek watershed. Most of the projects were completed by Hancock Forest Management, the primary landowner in the watershed, and included road resurfacing, road abandonment, and culvert and bridge replacements (Table 37).

Table 37. Restoration projects completed in the Hellroaring Creek watershed.

Project	T	R	S	Project Description
Road rocking	59N	2W	6	Road surface rocking on upper road
Road reshaping contouring	59N	2W	4	Reshaping/contouring lower road on north side of Hellroaring Creek to reduce potential road erosion
Culvert replacement	59N	2W	6	Installing culvert on North Fork Hellroaring Creek
Road abandonment	59N	2W	10	Abandoning 0.5-mile road between Hellroaring and Caribou Creeks
Road reconstruction	59N	2W	6	Improving road surface in Hellroaring Creek watershed

TMDL Discussion

Hellroaring Creek is not supporting the cold water aquatic life use due to sediment and temperature impairment or salmonid spawning due to temperature impairment. These listings were a result of analyses under efforts for the Clark Fork/Pend Oreille TMDL (DEQ 2001).

The analysis performed in the 2001 TMDL is part of the Lower Pack River TMDL analysis, which bases much of its conclusions on a 1998 IDL CWE analysis. The Lower Pack River TMDL concludes the sources of pollution impairing beneficial uses in the main stem Pack River occur in places other than the Pack River headwaters such as tributary streams and land uses along the lower reaches of the Pack River. The TMDL requires a 74% load reduction in sediment in the lower Pack River watershed; however, there was no load reduction requirement calculated for individual subwatersheds such as Hellroaring Creek. According to the TMDL, the watershed is the highest sediment-loading watershed per acre in the Pack River watershed.

Hellroaring Creek is also addressed in the 2007 Pend Oreille tributaries sediment TMDL (DEQ and EPA 2007). Since the TMDLs are established based on land use categories and land management responsibilities, the sediment TMDL required for Hellroaring Creek was incorporated within the TMDL calculations for the upper Pack River since the entire upper Pack River watershed was modeled as one watershed.

Hellroaring Creek is in steep, mountainous terrain on highly erosive soils on granitic geologic material. As such, Hellroaring Creek is at high risk of sediment loading from surface erosion and mass failures. The road network is relatively far from the creek, so the risk of sediment delivery from roads is minimal, except at the North Fork Hellroaring Creek crossing. Limited road access in this watershed is critical. The roads are highly erosive, and water routing off the road is with the use of water bars only. Road maintenance has been a priority for the primary private landowner in the Hellroaring Creek watershed. Road resurfacing, rocking, and culvert replacement have all taken place. The effect of this work on stream water quality was minimal, given the distance of the road from the creek. Nonetheless, highly erosive roads could pose a risk at a large enough scale.

Because of the highly erosive soils in the watershed, forest canopy removal may influence the timing and magnitude of surface water runoff and ultimately sediment transport to the stream. IDL’s CWE hydrologic risk rating compares the level of canopy removal with the stability of the stream channel. Therefore, the hydrologic risk rating indicates the risk that the stream channel may be impacted by forest canopy removal. The hydrologic risk rating was moderate in both 2003 and 2009. Much caution should be taken with land use (e.g. timber) practices in the

Hellroaring Creek watershed. A 200-foot buffer is recommended at all times. More caution should be practiced near the stream crossing on North Fork Hellroaring Creek. Sediment delivery at this crossing could be costly to water quality.

Despite the erosive characteristics of the watershed, stream conditions in the two study reaches showed only a minor deviation from reference conditions. Large wood was abundant and, in addition to the step-pool morphology of the creek, provided diverse habitat even at extreme low-flow conditions. Streambank stability was excellent and the riparian buffer was well-vegetated with a diverse assemblage of shrubs/trees.

Given the good habitat and sediment transport condition in Hellroaring Creek, the creek may be supporting beneficial uses. Therefore, it is recommended the creek be evaluated twice within a 5-year time period for beneficial use support using DEQ’s BURP monitoring.

5.2.7 Little Sand Creek

Little Sand Creek (ID17010214PN053_02) is a 2nd-order tributary to Sand Creek (Figure 89). The predominantly forested watershed is 8,081 acres in size. The higher elevations of the watershed are underlain by granitics while the lower elevation and valley bottom are underlain by glacial drift/till.

The City of Sandpoint owns approximately 4,800 acres (59%) within the watershed area—all of which is kept as undeveloped forest land because the stream is a secondary source of private and industrial water for Sandpoint (serving 9,500 people).

Little Sand Creek was placed on Idaho’s 2008 Integrated Report for impairment to cold water aquatic life due to sediment. The Pend Oreille tributaries sediment TMDL modeling indicated that the amount of sediment in Sand Creek exceeded the load capacity for full support streams in the area. Therefore, Sand Creek and its tributaries were assigned sediment load reductions that would bring Sand Creek into compliance with Idaho’s water quality standards.

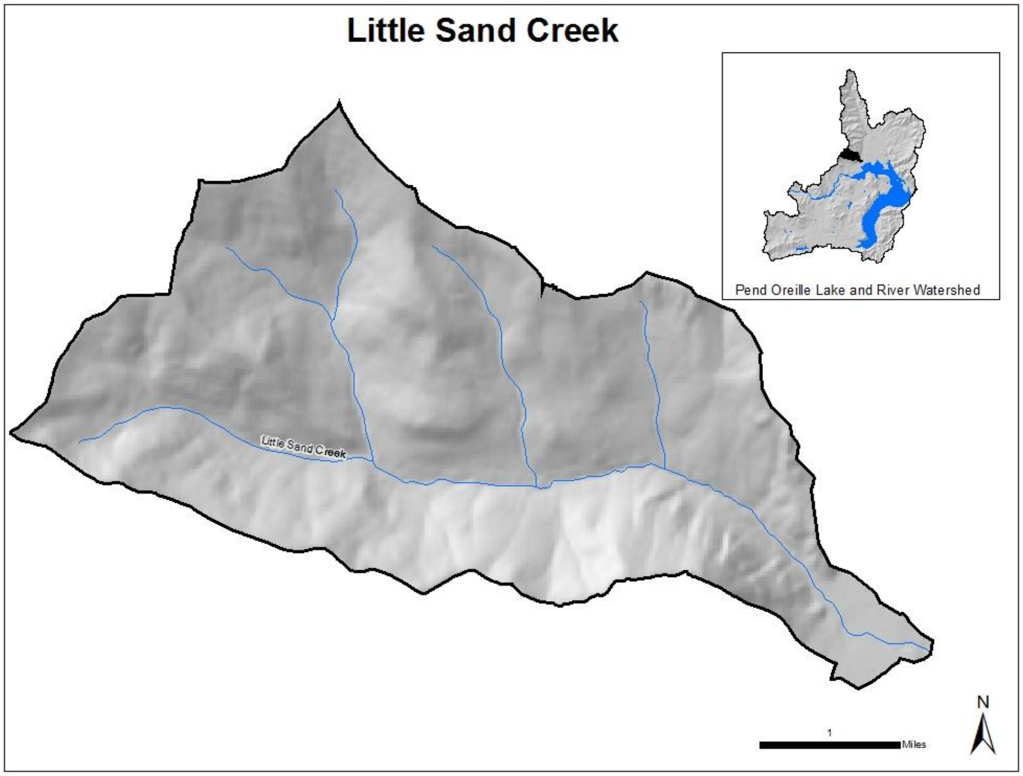


Figure 89. Little Sand Creek watershed.

Idaho Beneficial Use Reconnaissance Program

Little Sand Creek was evaluated for beneficial use support using BURP monitoring in 2006 and 2014 (Table 38). In 2006, the macroinvertebrate scores were low, habitat scores were excellent, and no fish data were collected. BURP data were collected in September 2014 on Little Sand Creek above the Sandpoint drinking water facility and upstream of the Schweitzer Mountain Road switchback leading away from the creek. The data produced an average score of 3.0, indicating macroinvertebrate, fish, and habitat in Little Sand Creek were supporting the aquatic life beneficial uses. The stream temperature was 9.1 ºC. The pH was 6.63, and conductivity was 24 µS/cm. Stream flow was 3.42 cfs. At this location, the stream was an overwidened Rosgen "B" channel. The channel had abundant large wood and pools for good habitat complexity and good cover. Streambanks were well-vegetated providing excellent streambank protection. Minimal erosion was observed on the streambanks. The channel substrate was not embedded. Cutthroat Trout were present in the size range between 70 and 170 mm.

Table 38. Beneficial Use Reconnaissance Program data (2006 and 2014).

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA028	52.95	1.0	—-	—	85.00	3.0	2.0
2014SCDAA088	87.18	3.0	91.44	3.0	83.00	3.0	3.0

IDL Cumulative Watershed Effects

IDL last conducted the CWE evaluation of the Little Sand Creek watershed in 2003 and 2009 (IDL 2003e and TerraGraphics 2010c) (Table 39). During both evaluations, the surface erosion hazard rating was high due to the highly erosive soils on granitic geologic material and the steep, mountainous terrain. Stream channel stability was assessed in 2009, and the Channel Stability Index ratings were moderate, which was attributed to stable, moderately vegetated banks.

Forest canopy removal may influence the timing and magnitude of surface water runoff. IDL's hydrologic risk rating compares the level of canopy removal (Canopy Removal Index) with the stability of the stream channel (Channel Stability Index). Therefore, the hydrologic risk rating rates the risk that the stream channel may be impacted by forest canopy removal. The hydrologic risk rating was low in both 2003 and 2009.

In 2003, the CWE assessment identified no roads in the watershed needing management attention; however, the observation was made that sediment and asphalt from previous washout events on the access road to Schweitzer Mountain Resort were in the stream channel. Nonetheless, the sediment delivery rating from roads was categorized as low in 2003. At that time, 39 miles of roads and trails existed, and 14 miles of road were close to streams. In 2009, IDL estimated the Little Sand Creek watershed contained 38.2 miles of road, 13.1 of which were close to streams having high potential to impact water quality. However, the sediment delivery rating from roads was categorized as low.

In 2003, the CWE assessment assigned a sediment delivery rating from skid trails as moderate. During 2009, no skid trails were identified; therefore, the overall CWE skid trail score was low, indicating little risk of sediment delivery to a stream.

In 2003, one mass failure was recorded in the watershed, and the CWE mass failure score for roads was low. In 2009, the CWE assessment identified no new mass failures; therefore, the overall CWE mass failure score for roads was low.

Table 39. Idaho Department of Lands cumulative watershed effects data.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydrologic Risk	Roads	Mass Wasting	Skid Trails	Total Sediment Delivery
2003	High	Moderate	—	0.04	Low	Low		Moderate	Low
2009	High	Moderate	Moderate	0.26	Low	Low		Low	Low

Changes in Subbasin Characteristics

Forest Cover

Between 2001 and 2014, a 69-acre (less than 1%) loss in forest cover occurred in the Little Sand Creek subwatershed (Figure 90).

- 2001–2004: 38 acre decrease
- 2005–2009: 6 acre decrease
- 2010–2014: 25 acre decrease

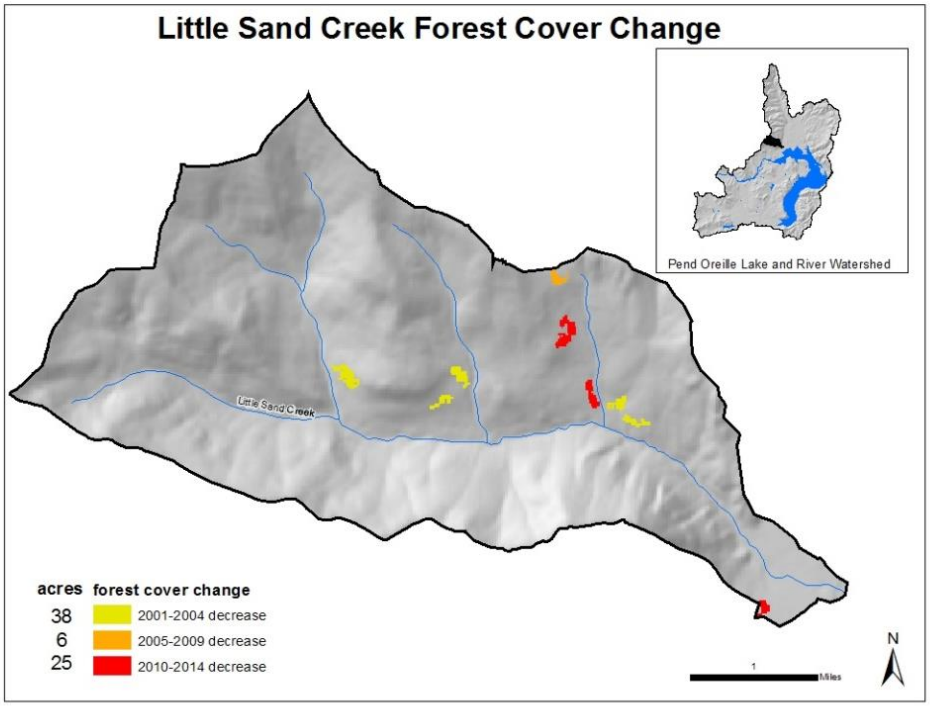
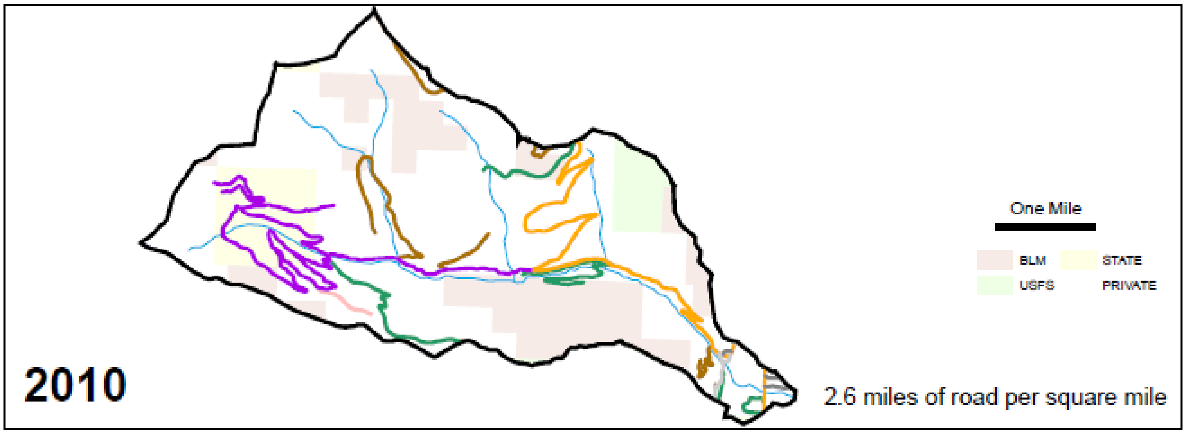


Figure 90. Forest cover change in the Little Sand Creek subwatershed, 2001–2014.

Roads

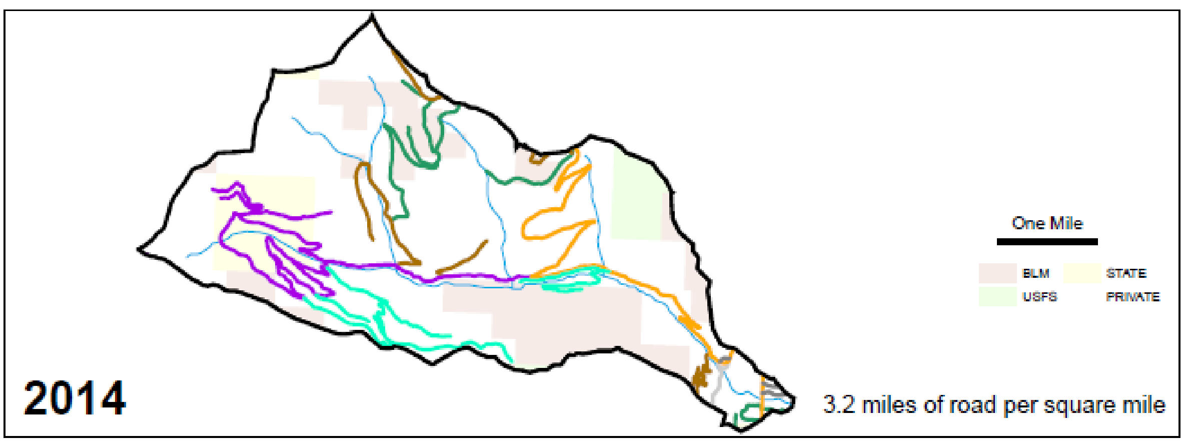
Road density in the Little Sand Creek watershed increased from 2.6 to 3.2 miles of road per square mile between 2010 and 2014 (Figure 91). The density; however, 7.7 miles of road was abandoned.

Little Sand Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Little Sand Creek	Waterbarred dirt	10.52	34.1	30.9
Little Sand Creek	Secondary highway	7.19	23.3	30.9
Little Sand Creek	Unknown	6.23	20.2	30.9
Little Sand Creek	Unimproved dirt	5.11	16.5	30.9
Little Sand Creek	Improved gravel	0.67	2.2	30.9
Little Sand Creek	Primative	0.62	2	30.9
Little Sand Creek	Improved paved	0.55	1.8	30.9

Surface Improved gravel, Improved partial, Primary highway, Secondary highway, Unknown, Abandoned, Improved native, Improved paved, Primative, Unimproved dirt, Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Little Sand Creek	Waterbarred dirt	10.52	27.5	38.3
Little Sand Creek	Abandoned	7.71	20.2	38.3
Little Sand Creek	Secondary highway	7.19	18.8	38.3
Little Sand Creek	Unknown	6.09	15.9	38.3
Little Sand Creek	Unimproved dirt	5.52	14.4	38.3
Little Sand Creek	Improved gravel	0.66	1.7	38.3
Little Sand Creek	Improved paved	0.56	1.5	38.3

Figure 91. Comparison of road networks in the Little Sand Creek watershed, 2010 and 2014.

2015 DEQ Stream Evaluation

Due to the presence of the Sandpoint drinking water treatment plant, two stream reaches were evaluated: one reach above the plant and one below. Reach characteristics are described in Table 40 and Table 41.

Table 40. Reach location for Little Sand Creek.

Name	Date	Type	Length (feet)	Latitude	Longitude
Upper Little Sand Creek	8/27/2015	Step-Pool	330	None recorded	None recorded
Lower Little Sand Creek	8/27/2015	Step-Pool	330	48º 19’.09.56”	116º 34’ 07.34”

Upper Little Sand Creek

Stream classification for upper Little Sand Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 41. Upper Little Sand Creek was a slightly entrenched, overwidened “B” channel. Flow on August 27, 2015, was 1.2 cfs. The pH was 7.49. Conductivity was 29 µS/mL, and temperature was 12.3 ºC.

Table 41. Reach characteristics for upper Little Sand Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	25.1	23.0	18.0	22.0
Bankfull Depth (D_{bkf}), ft	0.29	0.80	0.64	0.58
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	86.6	28.8	28.1	47.8
Maximum Depth (D_{mbkf}), ft	1.75	1.4	1.5	1.6
Width of Flood-Prone Area (W_{fpa}), ft	25.5	29.8	26.4	27.2
Wetted Width, ft	16.7	19.3	10.1	15.4
Entrenchment Ratio (ER), ft/ft	1.0	1.3	1.5	1.3
Channel Materials (Particle Size index) D_{50}, mm	Datafile lost	Datafile lost	Datafile lost	—
Water Surface Slope, %		4		
Rosgen Stream Type		B		

The following reach habitat assessment was completed for upper Little Sand Creek according to the Milone & MacBroom, Inc. (2008). The overall physical habitat conditioning score using this methodology was reference condition.

Woody Debris Cover

Upper Little Sand Creek had abundant woody debris cover, with large wood greater than 1 foot in diameter. Log jams were abundant (Figure 92). The stream also had high woody debris recruitment potential.

Figure 92. Log jam in upper Little Sand Creek.

Bed Substrate Cover

Upper Little Sand Creek bed substrate cover was near reference conditions. Pool embeddedness was less than 25% in pools and less than 40% in pool margins. Sediment was stable and well sorted; substrate was free of algae growth.

Scour and Depositional Features

Upper Little Sand Creek was at reference conditions for scour and depositional features with an abundance of pools and excellent pool cover. Pools greater than 3 feet deep made up about 50% of the total pools, which was important given the extreme low-flow conditions. Steps were well-formed, complete, and stable with more than two depth-velocity combinations present (Figure 93).

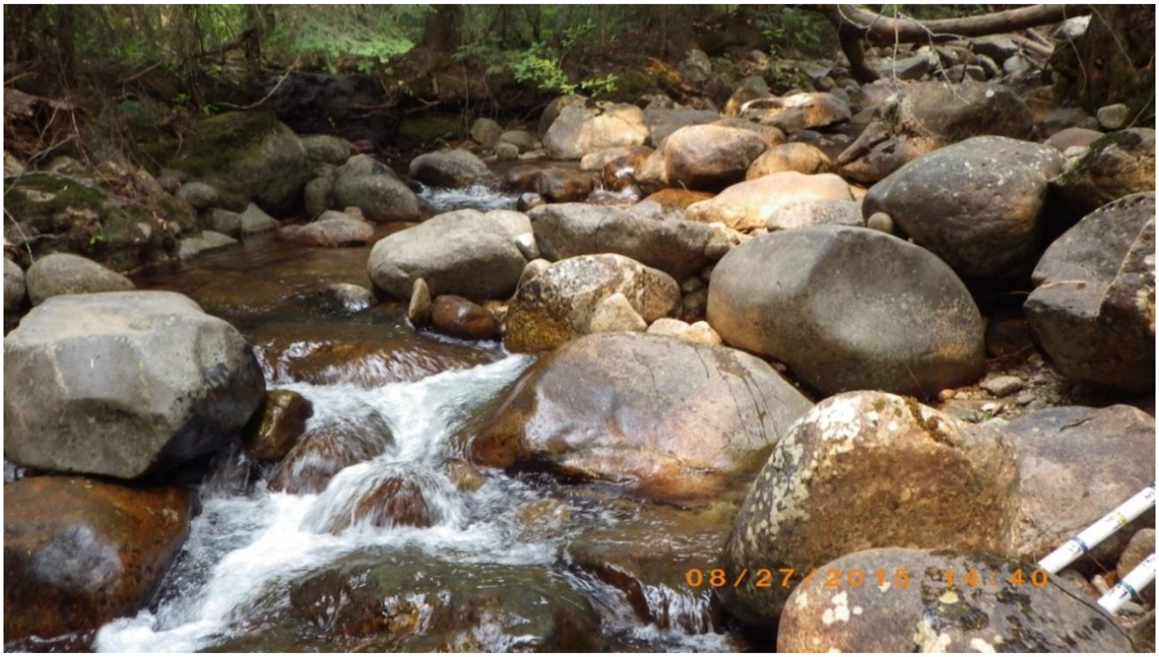


Figure 93. Pools provide abundant refuge for aquatic life in upper Little Sand Creek.

Channel Morphology

Although 2015 was a low-flow year, upper Little Sand Creek was in good condition with no flow alteration or channel obstructions. The channel was somewhat entrenched, with limited connectivity with the channel floodplain; however, this reach of the creek had a narrow floodplain due to the steeper terrain.

Streambanks

Streambanks in upper Little Sand Creek were at reference condition with bank erosion in less than 10% of the banks. Bank vegetation was abundant with a diversity of species. Bank vegetation roots provided excellent streambank stabilization. Bank undercuts were present but mostly stable. Bank canopy was well developed providing good shade to the creek.

Riparian Area

The riparian area was composed of cedar and hemlock, with fern overstory and devil’s club understory. The area was at or near its maximum canopy over the creek (Figure 94). The riparian buffer width was between 150 and 200 feet.

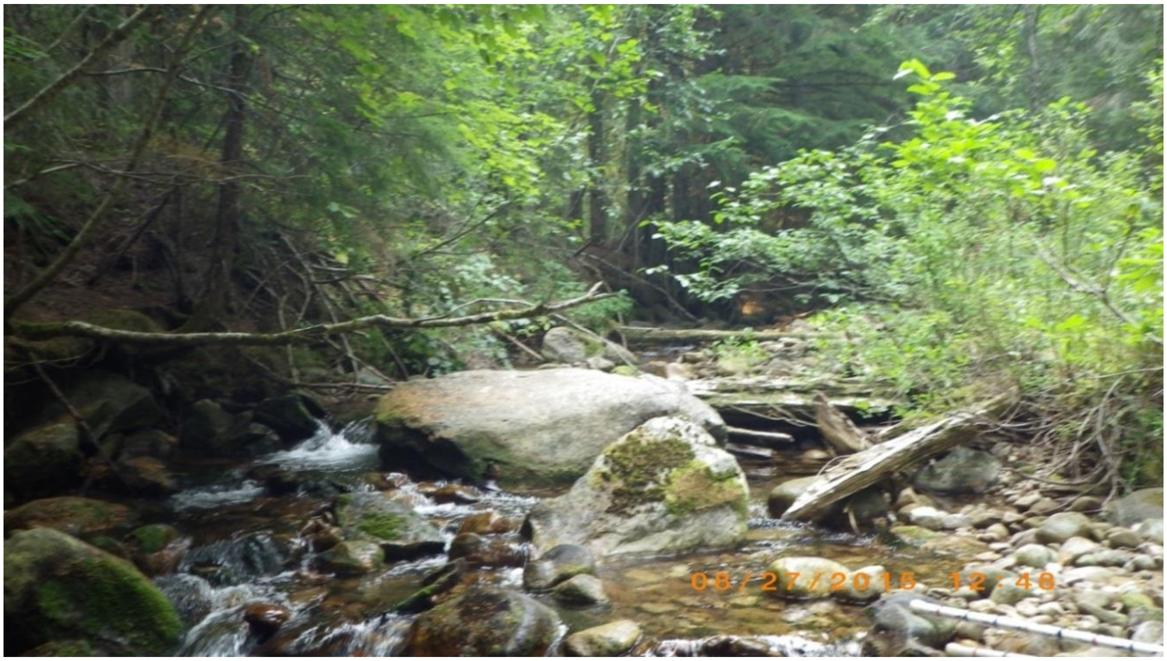


Figure 94. Dense riparian area in upper Little Sand Creek.

Lower Little Sand Creek

Stream classification for lower Little Sand Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 42. Lower Little Sand Creek is an overwidened, slightly entrenched Rosgen "B" channel.

Table 42. Reach characteristics for lower Little Sand Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	16.5	27.5	24.0	22.7
Bankfull Depth (D_{bkf}), ft	1.56	1.21	0.95	1.24
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	10.6	22.7	25.3	19.5
Maximum Depth (D_{mbkf}), ft	2.3	2.1	2.5	2.3
Width of Flood-Prone Area (W_{fpa}), ft	33.5	43.4	35.6	37.5
Entrenchment Ratio (ER), ft/ft	2.0	1.6	1.5	1.7
Channel Materials (Particle Size index) D_{50}, mm	Large cobble (128–256 mm)			
Water Surface Slope, %	4			
Rosgen Stream Type	B			

The following reach habitat assessment of lower Little Sand Creek was completed according to the Milone & MacBroom, Inc. (2008) step-pool stream type. The overall physical habitat conditioning score using this methodology was fair-good.

Woody Debris Cover

Lower Little Sand Creek had some woody debris cover, with less abundant large wood greater than 1 foot in diameter (Figure 95). No log jams were observed in the study reach. Woody debris recruitment potential was moderate.

Bed Substrate Cover

Lower Little Sand Creek bed substrate cover scored "fair" under the Vermont Habitat Reach Assessment (VNR 2009) due to the low abundance of LWD and log jams in the study reach. Pool embeddedness was 40% in pools and 50% in the pool margins. Some evidence showed sediment mobility and sorting with small patches of substrate covered by dense algae growth.

Figure 95. Large woody debris provided abundant cover for aquatic life.

Scour and Depositional Features

Lower Little Sand Creek had an abundance of pools and good pool cover (Figure 96). Many of the pools were greater than 3 feet deep. Steps were moderately well formed, complete, and stable.

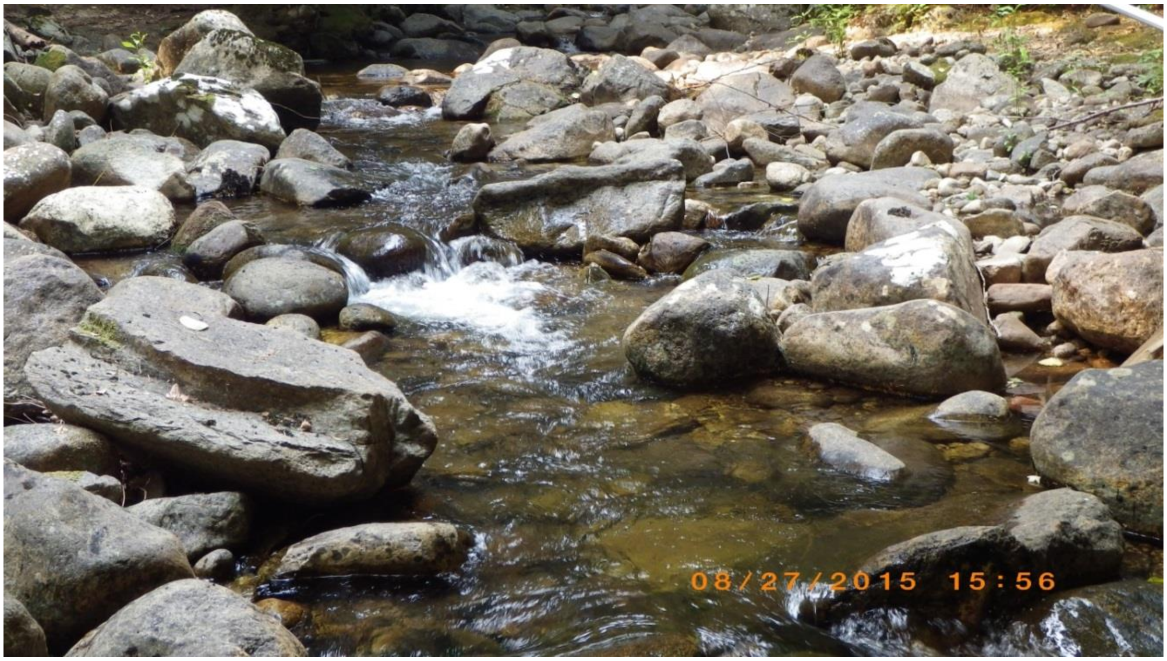


Figure 96. Pools in lower Little Sand Creek.

Channel Morphology

Lower Little Sand Creek was somewhat overwidened and entrenched, which likely resulted from hydrologic modifications of an upstream dam for Sandpoint's drinking water treatment plant. Approximately 2.5 miles of the road is immediately adjacent to Little Sand Creek, so the channel was straightened on this reach.

Streambanks

Streambanks in lower Little Sand Creek were in good condition with less than 20% bank erosion. Bank vegetation was abundant with a diversity of species. Bank vegetation roots provided good streambank stabilization. Bank undercuts were present but mostly stable. Bank canopy was well developed providing good shade to the creek.

Riparian Area

The riparian area was composed of cedar and hemlock, with fern overstory and devil's club understory. The buffer width was 150–200 feet wide with 75%–90% maximum channel canopy (Figure 97). Minimal invasive plants were present.

Figure 97. Riparian area on lower Little Sand Creek.

2015 Road Crossing Survey

No road crossing survey was completed on Little Sand Creek.

Review of Implementation Plan and Activities

The City of Sandpoint has one of its surface water intakes on Little Sand Creek for the drinking water system that produces water for domestic and industrial uses. Currently, this intake is a secondary source, and Lake Pend Oreille is the primary water source. Sandpoint owns approximately 4,800 acres within the watershed area.

In 2000, DEQ conducted a source water assessment and determined that the Little Sand Creek intake had a low susceptibility to contamination because the Little Sand Creek drainage is mostly forested. Under Sandpoint's management plan, the property is maintained under forest cover with proper forest management for optimal forest health. Sandpoint's source water protection plan identifies the main source of contamination to be the Schweitzer Mountain Road.

Approximately 2.5 miles of the road going to Schweitzer Mountain Resort is immediately adjacent to Little Sand Creek. This road is managed by the Independent Highway District. During the winter season, November to April 2010–2011, over 86,500 vehicles traveled up the road adjacent to Little Sand Creek to the Schweitzer Mountain Resort. This road winds through steep terrain with an elevation gain of almost 3,400 feet. To improve vehicle traction, Independent Highway District applied approximately 2,800 cubic yards (4,600 tons) of traction air quality sand (pea washed gravel) to the road during this same winter season.

In 2011, some agency partners raised concern that most of the sand was being washed off the roads into Little Sand Creek, impairing the cold water aquatic life beneficial use in the stream and contributing to turbidity in Sandpoint's primary drinking water source. The concern was that phosphorus-bound sediment would eventually be transported to Lake Pend Oreille and the Pend Oreille River.

To minimize the use of traction sand during the winter months along 9 miles of the road to Schweitzer Mountain Resort, in 2012 the Independent Highway District converted from applying gravel/sand to road deicing, primarily applying wet sodium chloride salt and sodium chloride. During the last winter season (between November to April 2015), 861 cubic yards (1,120 tons) of air quality grade sand (washed 3/8-inch pea-gravel) was applied to Schweitzer Mountain road, a 69% decrease in the amount of traction sand applied to the road compared to the 2010–2011 winter driving season.

To minimize the amount of erosion from the ditch line on the road, Independent Highway District cleaned and rock lined approximately 1.7 miles of ditch line from Woodland (mile post 0.3) to Switch Back 3 (mile post 3.4) (Figure 98). Switch Back 3 is where the road turns and heads away from Little Sand Creek. The highway district will continue rock the ditch line in the future to limit erosion.

Figure 98. Rock-lined ditch best management practice on Schweitzer Mountain Road.

TMDL Discussion

Little Sand Creek was listed as not supporting the cold water aquatic life use due to sediment impairment. However, BURP scores in 2014 indicate the stream may be supporting both the aquatic life and salmonid spawning beneficial uses. Data collected in 2015 under this TMDL review suggests Little Sand Creek upstream of the Sandpoint water treatment plant and upstream of any influence of Schweitzer Mountain road is at reference conditions. Downstream of the treatment plant, the stream is in fair-good condition according to the Vermont Habitat Reach

Assessment (VNR 2009). This stream reach was somewhat straightened due to Schweitzer Mountain Road. This reach had less abundant LWD and habitat complexity, and the channel substrate was embedded. The embeddedness was likely due to gravel from traction sand applications on Schweitzer Mountain Road.

The Little Sand Creek watershed is a predominantly forested watershed. Approximately 59% of the Little Sand Creek watershed is owned by the City of Sandpoint. Because Little Sand Creek is a secondary drinking water source for Sandpoint, the city maintains the property under forest cover.

The Pend Oreille tributaries sediment TMDL (DEQ and EPA 2007) assigned a 61% sediment load reduction requirement to the Sand Creek watershed, including Sand, Swede, Jack, Schweitzer, and Little Sand Creeks. No load reductions were assigned to individual subwatersheds. With current landownership under the City of Sandpoint, the goal was to keep the forested condition of the Little Sand Creek watershed and ensure that no new sources of sediment on a large scale would be introduced into the watershed. Reducing sand application to Schweitzer Mountain Road resulted in a significant load reduction of sediment to the creek. It is assumed sediment load reductions may be at their maximum on Little Sand Creek.

The recent BURP data and data collected under this TMDL review suggest it is reasonable to believe beneficial use support exists in Little Sand Creek, and the sediment load reductions from Little Sand Creek to Sand Creek have been met. The TMDL states the stream should be evaluated twice in a 5-year period using the BURP to determine support status for a water body. The first evaluation in 2014 suggests beneficial use support; therefore, DEQ recommends that Little Sand Creek be re-evaluated for beneficial use using the BURP protocol before 2018. If the data indicate the stream is fully supporting beneficial uses, the stream can be removed from Category 4a in Idaho's Integrated Report, and delisted for sediment impairment.

5.2.8 McCormick Creek

McCormick Creek (ID17010214PN042_02) is a 2nd- order tributary to the Pack River (Figure 99). The McCormick Creek drainage is approximately 4,355 acres. Landownership is primarily the US Forest Service. The creek is currently listed on Idaho's 2012 Integrated Report as not supporting cold water aquatic life due to temperature. Sediment impairment is not listed for McCormick Creek, but the Clark Fork/Pend Oreille TMDL grouped McCormick Creek with other tributaries to the Pack River and assigned a single sediment load reduction under the lower Pack River watershed.

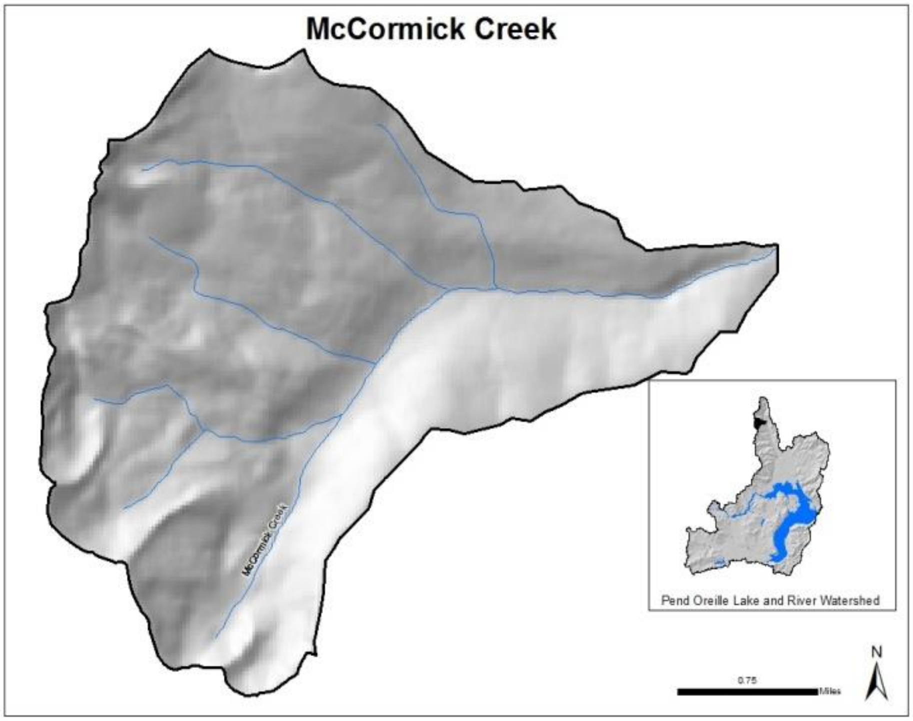


Figure 99. McCormick Creek watershed.

Idaho Beneficial Use Reconnaissance Program

In 2014, McCormick Creek was evaluated for beneficial use support using the BURP methodology (Table 43). The study reach was located 40 meters upstream of the confluence with the Pack River. Stream temperature was 15 ºC, conductivity was 8 µS/cm, and pH was 6.96. Pools were abundant, providing good cover and variability. Streambank conditions were covered and stable with little bank erosion. The stream substrate had less than 5% fines with minimal embeddedness. The macroinvertebrate community showed abundance and diversity. Only one Rainbow Trout was caught electrofishing, which resulted in a failing BURP score for beneficial use support. The low specific conductance may have made electrofishing inefficient for stunning fish, and they may have escaped the field. Therefore, it is reasonable to believe the fish data were unreliable.

Table 43. Beneficial Use Reconnaissance Program data for McCormick Creek.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2014SCDAA029	76.91	3.00	24.86	0.00	71.00	3.00	0.00

IDL Cumulative Watershed Effects

No CWE evaluation was done on McCormick Creek.

Stressor Identification

In 2006, a stressor identification was performed on McCormick Creek to determine the reason for impairment of beneficial uses (TerraGraphics 2006c). Impairment was determined based on 1998 BURP scores. Much of the evaluation was based on analysis of the 1998 BURP data, which showed poor macroinvertebrate and fish data. The evaluation results concluded sediment was not a pollutant of concern in McCormick Creek due to the low percent fines and the large cobble substrate. However, CWE scores indicated the watershed is susceptible to mass failure.

The evaluation concluded that the stream did not have a well-developed riparian community, primarily because of the steep channel gradient, large cobble substrate, and abundance of large boulders. Due to the narrow floodplain, hyporheic water for plants would be minimal. Given these conditions, it was concluded that temperature was the pollutant of concern for McCormick Creek.

Changes in Subbasin

Forest Cover

The McCormick Creek subwatershed is entirely within the US Forest Service boundaries. Between 2001 and 2014, only 8 acres of timber harvest occurred in the McCormick Creek subwatershed (Figure 100).

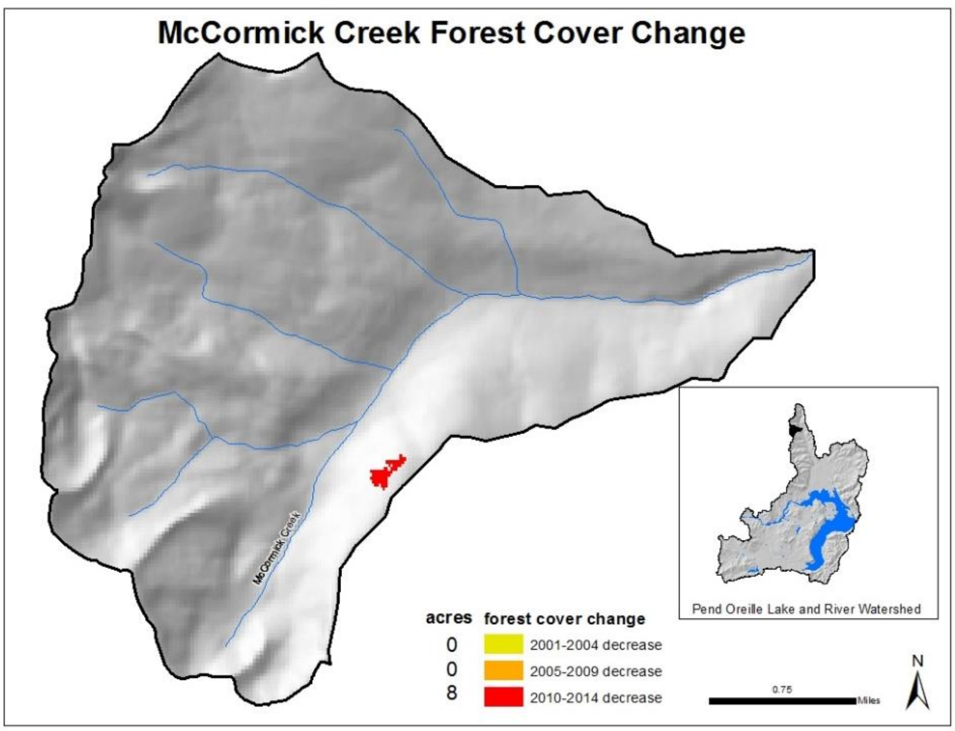


Figure 100. Forest cover change in the McCormick Creek subwatershed, 2001–2014.

Roads

The McCormick Creek subwatershed remained roadless (Figure 101).

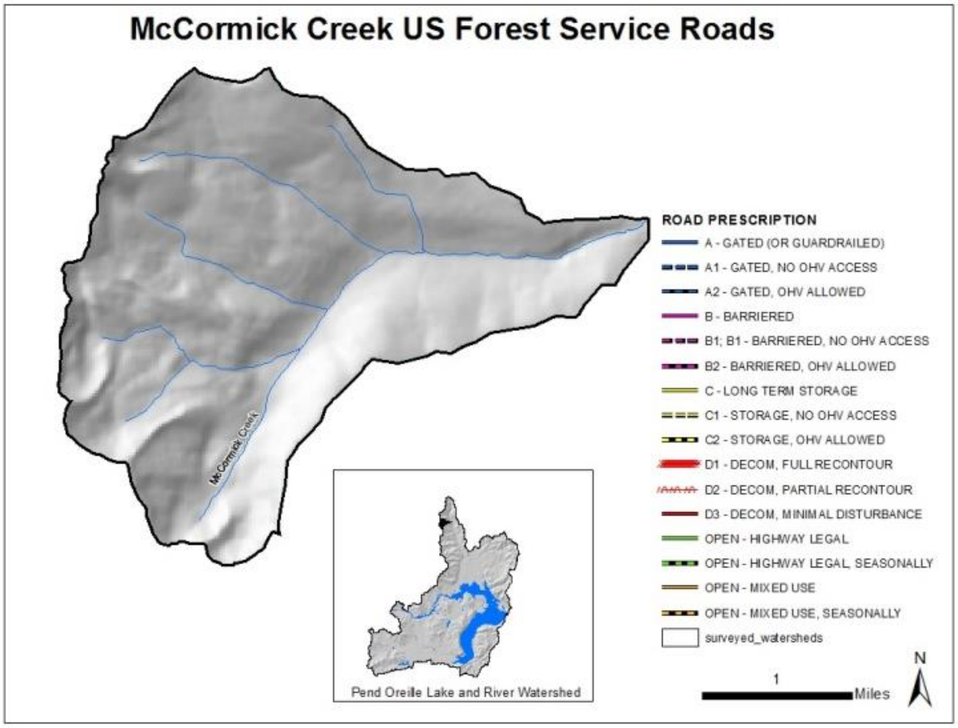


Figure 101. US Forest Service road network in the McCormick Creek watershed.

Fisheries Data

In 2014, the IDFG and AVISTA collected fishery data on McCormick Creek. Bull Trout were not present. Rainbow Trout were present in a mean density of 0.5 fish/100 m^2. Westslope Cutthroat Trout were present in a mean density of 1.7 fish/100 m^2. Westslope Cutthroat Trout × Rainbow Trout hybrids were present in a mean density of 0.3 fish/100 m^2.

2015 DEQ Stream Evaluation

In 2015, DEQ evaluated one 100-meter stream reach using a modified method described in Rosgen (2008), the Vermont Agency of Natural Resources Reach Habitat Assessment (2008), and Wolman (1954). The stream reach was located upstream of the Pack River confluence. This reach was considered representative of the AU as a whole. Streamflow was 0.68 cfs at 10.7 ºC. The stream pH was 7.28, and conductivity was 211 µS/cm.

On the 100-meter stream reach, data were collected on three cross sections: (1) downstream boundary of the reach, (2) middle (50 meter) of the reach, and (3) uppermost boundary of the reach. Reach characteristics are listed in Table 44. McCormick Creek was a Rosgen "B3" channel with a large cobble channel substrate.

Table 44. Reach characteristics for McCormick Creek.

Measurement	Cross Section			Average
	1	2	3	
Bankfull Width (W_{bkf}), ft	12.5	7.1	23.4	14.3
Bankfull Depth (D_{bkf}). ft	0.64	0.63	0.88	0.72
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	19.5	11.3	26.6	19.1
Maximum Depth (D_{mbkf}). ft	1.2	1.2	1.8	1.4
Width of Flood-Prone Area (W_{fpa}), ft	17.8	14.0	34.4	22.1
Wetted Width, ft	8.1	5.8	19.3	11.1
Entrenchment Ratio (ER), ft/ft	1.4	2.0	1.5	1.6
Channel Materials (Particle Size index) D_{50}, mm	3–64 mm very coarse pebble	128–256 large cobble	64–128 small cobble	
Water Surface Slope, %	5.0	5.0	7.0	5.7
Rosgen Stream Type	B3			

The following reach habitat assessment of McCormick Creek was completed according to the Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was fair.

Woody Debris Cover

LWD 1 foot or greater in diameter were present in McCormick Creek; however, log jams were few. This departure from the reference condition is due to a low recruitment potential of large wood.

Bed Substrate Cover

McCormick Creek was a cobble-dominated stream with large boulders throughout. Cobbles were slightly embedded in pools and pool margins. The cobble substrate showed evidence of sediment mobility and lack of sorting. This excessive mobility resulted in a reduced diversity of aquatic habitat. Small patches of substrate were covered by dense algae growth (Figure 102).

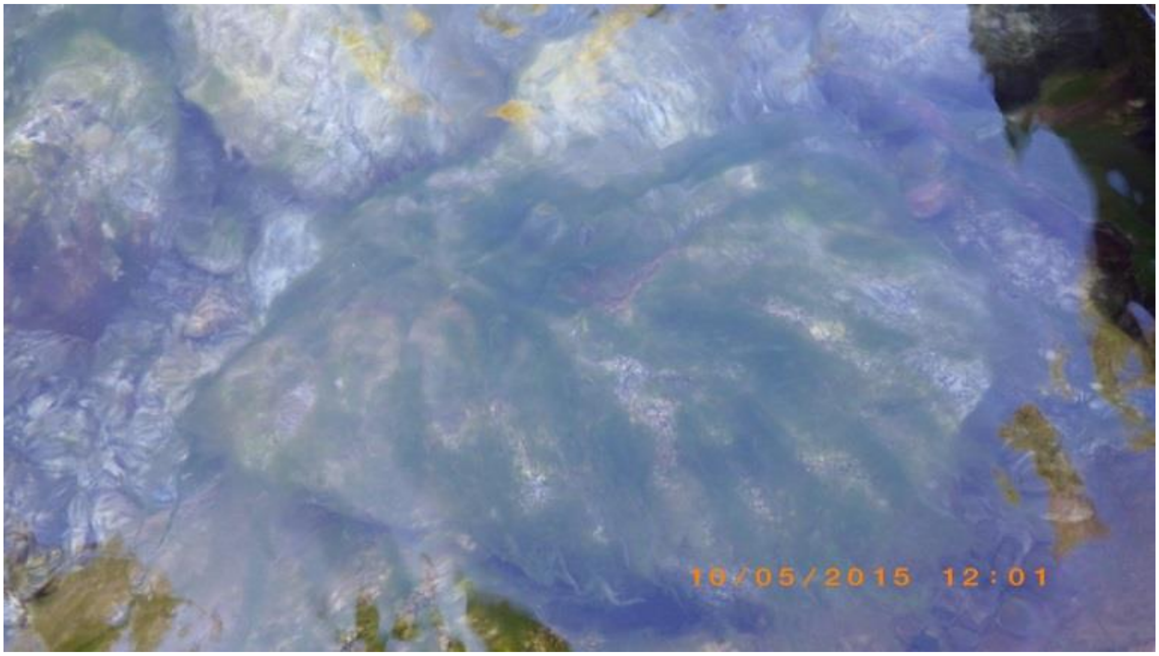


Figure 102. Dense algae patch in McCormick Creek.

Scour and Depositional Features

McCormick Creek had a relative abundance of pools at a depth of 2 feet or greater. Pool size and abundance provided good cover and thermal refuge for fish. These conditions were excellent given the very low flow in fall 2015. Some fish were observed; however, the species could not be identified. Steps were moderately well-formed, complete, and stable with step spacing between 3 and 5 bankfull widths. Despite substrate mobility, large boulders provided stability for the pools (Figure 103). Only two depth-velocity combinations were present (fast shallow and slow deep).

Figure 103. Pools in McCormick Creek.

Channel Morphology

In the study reach, McCormick Creek was overwidened and entrenched. In 2006, a culvert blew out below this site resulting in channel widening and entrenchment. The channel widening decreased moving upstream in the study reach

Hydrologic Characteristics

McCormick Creek had no known flow alteration or obstructions that block longitudinal movement of aquatic species. However, the somewhat entrenched and steep sideslope condition of the stream limited access to the narrow floodplain. Abundant refuge for both high and low-flow conditions existed.

Streambanks

Due to the presence of vertical, unvegetated streambanks on McCormick Creek, riparian vegetation was limited (<50%) (Figure 104). The bank canopy was less than 60%. The substrate comprised of large cobble and boulders suggested limited substrate in which the vegetation could grow. Many mass failures were observed on the streambanks within the study reach (Figure 105).

Figure 104. Vertical streambanks in McCormick Creek.

Figure 105. Mass failure near McCormick Creek.

Riparian Area

The channel gradient and large cobble substrate precludes a well-developed riparian community. However, the riparian area within the study reach was in fairly good condition with a diversity of vegetation species and minimal invasive species (Figure 106). The riparian buffer width was greater than 200 feet, providing some shade and thermal refuge.

Figure 106. Riparian buffer adjacent to McCormick Creek.

2015 Road Crossing Survey

The McCormick Creek watershed was essentially roadless in 2015; therefore, no road crossings were evaluated under this TMDL review.

TMDL Implementation

The US Forest Service has completed road decommissioning and road crossing obliteration in the McCormick Creek watershed..

TMDL Discussion

McCormick Creek is currently listed on Idaho's 2012 Integrated Report as not supporting the cold water aquatic life use due to temperature. According to the Clark Fork/Pend Oreille TMDL, McCormick Creek was grouped with other tributaries to the Pack River and assigned a single sediment load reduction under the lower Pack River watershed (DEQ 2001).

In 2014, DEQ evaluated McCormick Creek using the BURP methodology. Results indicated excellent stream habitat and macroinvertebrate scores. However, only one Rainbow Trout was collected during electrofishing. The low specific conductance of the creek may have made electrofishing inefficient for stunning fish, and they may have escaped the field. Therefore, it is reasonable to believe the fish data were unreliable. The 2006 stressor identification evaluation of McCormick Creek concluded sediment was not a pollutant of concern; rather, temperature was the cause for not supporting beneficial uses.

The 2015 stream habitat assessment observed bare, vertical streambanks and mass failures throughout the study reach. However, little substrate embeddedness was exhibited. Given the steep gradient of the stream, this is a transporting reach, and a significant amount of fine sediment is delivered downstream to the Pack River. Due to the vertical banks, riparian vegetation was lacking on this stream. However, the lack of riparian vegetation was also due to the high gradient of the stream and the large cobble and boulder substrate.

In 2006, a culvert failed downstream of the study reach, and since then, this stream crossing has been removed. The steep, vertical banks resulted from this event. The large cobble substrate throughout the study reach showed mobility and lack of sorting, which was exacerbated at the site where the culvert failed. It will take some time for the excessive cobble and the cobble liberated from the event to work through the system and restabilize.

Because the McCormick Creek watershed is roadless and the BURP scores were excellent in 2014, McCormick Creek may be supporting beneficial uses. However, this stream is affected by an oversupply of course sediment that impairs channel stability and habitat complexity. Mass wasting and bare, vertical banks continue to be a significant source of fine sediment to the Pack River. Therefore, McCormick Creek will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL.

5.2.9 Rapid Lightning Creek

Rapid Lightning Creek (ID17010214PN033_02 and ID17010214PN033_03) is a 3rd-order tributary to the Pack River that drains a 30,985 acre watershed (Figure 107). Drainage is predominantly oriented in a westerly direction. The watershed is steep, with an average slope of 24%, and over 47% of the watershed has slopes greater than 30%.

The main stem Rapid Lightning Creek (ID17010214PN033_03) is listed in Idaho’s 2012 Integrated Report as not supporting the cold water aquatic life and salmonid spawning beneficial use due to temperature. This listing is due to 1997 failing BURP data. The tributaries to Rapid Lightning Creek (ID17010214PN033_02) are listed in Idaho’s 2012 Integrated Report as fully supporting beneficial uses.

The 2007 Pend Oreille tributaries sediment TMDL determined sediment was not likely a cause for beneficial use impairment; however, the 2001 Clark Fork/Pend Oreille TMDL prescribed a sediment load reduction requirement for Rapid Lightning Creek as part of the Lower Pack River TMDL.

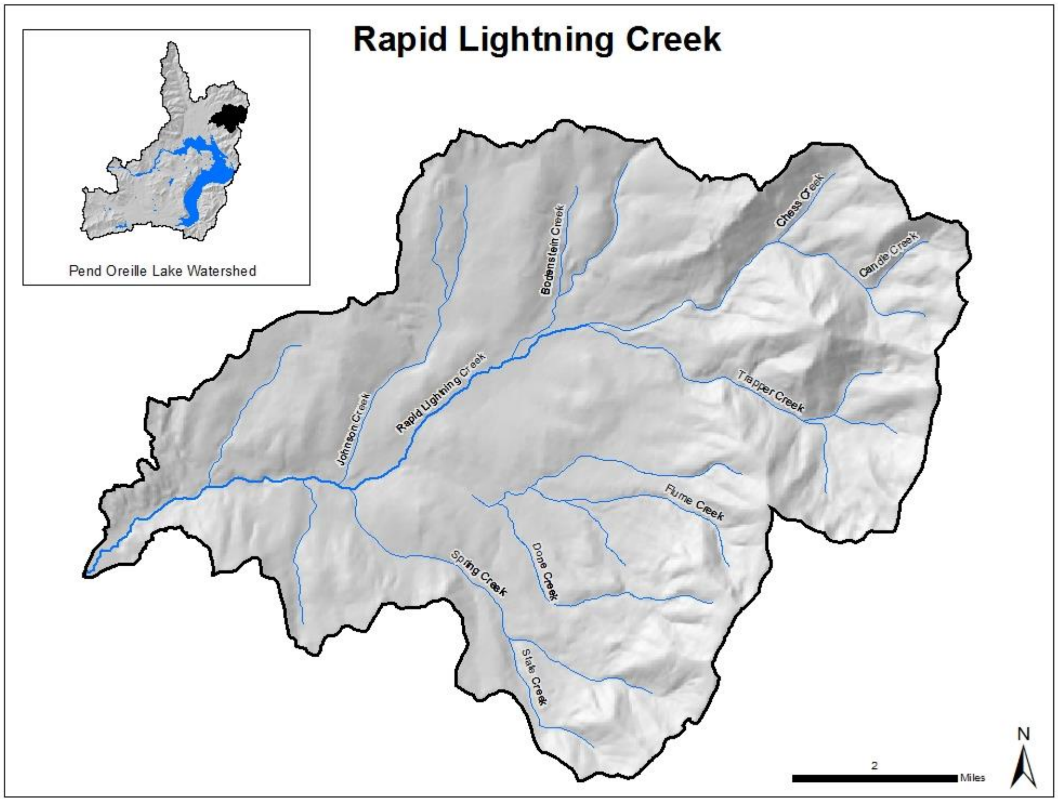


Figure 107. Rapid Lightning Creek subwatershed.

Idaho Beneficial Use Reconnaissance Program

The main stem Rapid Lightning Creek has not been evaluated for beneficial use support using the BURP methodology since 1997. Spring Creek, a tributary to Rapid Lightning Creek, was more recently evaluated for beneficial use support using the BURP methodology. Data suggested Spring Creek is fully supporting its beneficial uses (Table 45). Because Spring Creek is one of six tributaries to Rapid Lightning Creek, these data are not representative of the AU as a whole.

Table 45. Beneficial Use Reconnaissance Program data for Spring Creek—tributary to Rapid Lightning Creek.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA062	66.85	3.00	-	-	75.00	3.00	3.00

IDL Cumulative Watershed Effects (CWE)

IDL last conducted a CWE evaluation of the upper Rapid Lightning Creek watershed in 2005 and 2009 (IDL 2005a; TerraGraphics 2010d) (Table 46). The upper Rapid Lightning Creek watershed is 13,006 acres in size.

Due to the steep terrain and the weathered geology of the watershed, upper Rapid Lightning Creek had a moderate surface erosion hazard in 2005 and 2009. The mass failure hazard was rated high in 2005 and moderate in 2009.

Changes in streamflow and the susceptibility of the stream channel to impairment will determine the hydrologic condition. The risk of stream channel impacts is done under the CWE analysis by assessing the amount of forest cover removal and its impact on stream channel stability. In 2005, a Canopy Removal Index of 0.41 was calculated for upper Rapid Lightning Creek. A moderate Channel Stability Index was determined due to little bank rock content and loosely packed streambed material. When the Canopy Removal Index is graphed against the Channel Stability Index, the overall hydrologic risk can be determined. The overall hydrologic risk that the channel would be impacted from forest canopy removal was moderate. In 2009, two 1,000-foot stream reaches were evaluated for channel stability, and the overall rating was moderate. This score was attributed to a fairly stable channel with well-vegetated and stable banks. There was moderate bank rock content, and LWD was essentially absent. In 2009, a Canopy Removal Index of 0.32 was calculated for upper Rapid Lightning Creek, giving an overall hydrologic risk rating of moderate.

Sediment from roads, skid trails, and mass wasting was evaluated. Roads were given a sediment delivery score for a number of segments then given a weighted average over the total road mileage evaluated. Mass failures were recorded as they were observed, and a mass failure delivery score was calculated based on frequency, size, and delivery. In 2005, there were approximately 67.6 miles of road in the upper Rapid Lightning Creek watershed; 15.7 miles of these roads that were close to streams were evaluated. The rating for sediment delivery to streams from roads was low. The rating from skid trails was low; all new skid trails were observed outside the stream protection zone. No mass failures were observed; therefore, the rating for mass failures was low. In 2005, the overall sediment delivery rating to streams was low. During this evaluation, no management problems were identified.

In 2009, approximately 68.8 miles of roads were in the upper Rapid Lightning Creek watershed. Approximately 28.3 miles of roads were evaluated in the CWE assessment, or 41% of the total roads. There was a low overall rating for sediment delivery to the stream from roads, skid trails, and mass failures. In 2009, one new management problem was identified as a prolonged, major sources of sediment to the stream.

Table 46. Idaho Department of Lands Cumulative Watershed Effects data, upper Rapid Lightning Creek.

Year	Surface Erosion Hazard	Mass Failure Hazard	Channel Stability Index	Canopy Removal Index	Hydro-logic Risk	Roads	Skid Trails	Mass Failure	Total Sediment Delivery
2005	Mod	High	Mod	0.41	Mod	Low	Low	Low	Low
2009	Mod	Mod	Mod	0.32	Mod	Low	Low	Low	Low

Stressor Identification

In 2002, main stem Rapid Lightning Creek (ID17010214PN033_03) was listed on Idaho’s 2002 Integrated Report as not supporting the aquatic life beneficial use due to temperature and an unknown pollutant. In 2006, TerraGraphics conducted a stressor identification analysis to determine the unknown pollutant on the main stem (TerraGraphics 2006d). The analysis found excessive fine sediment within the stream channel. In addition, a significant lack of pools within the stream channel existed, likely as a result of excessive coarse-grained sediment (small to large cobble) to the system. These results conflicted somewhat from the IDL CWE analysis of the upper Rapid Lightning Creek watershed, which had low erosion potential, low mass failure risk, and low total sediment delivery. Therefore, the analysis was inconclusive as to whether sediment was a significant stressor to the aquatic system, and TerraGraphics recommended the watershed be modeled to determine whether excessive sediment loading was occurring in the Rapid Lightning Creek watershed.

Changes in Subbasin Characteristics

Forest Cover Change

Between 2001 and 2014, a 4,667 acre (15%) loss in forest cover occurred in the Rapid Lightning Creek subwatershed (Figure 108).

- 2001–2004: 1,060-acre decrease in forest cover
- 2005–2009: 1,432-acre decrease in forest cover
- 2010–2014: 2,175-acre decrease in forest cover

Aerial photos show that the loss was due to commercial timber harvest and development (Figure 109, Figure 110).

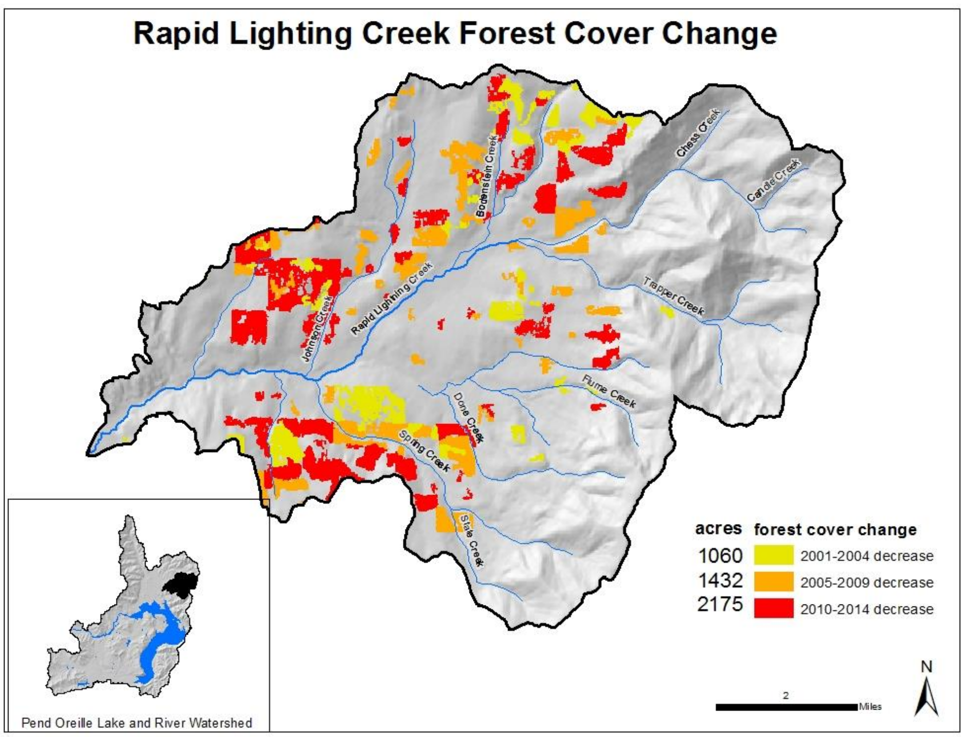


Figure 108. Forest cover change in the Rapid Lightning Creek watershed, 2001–2014.

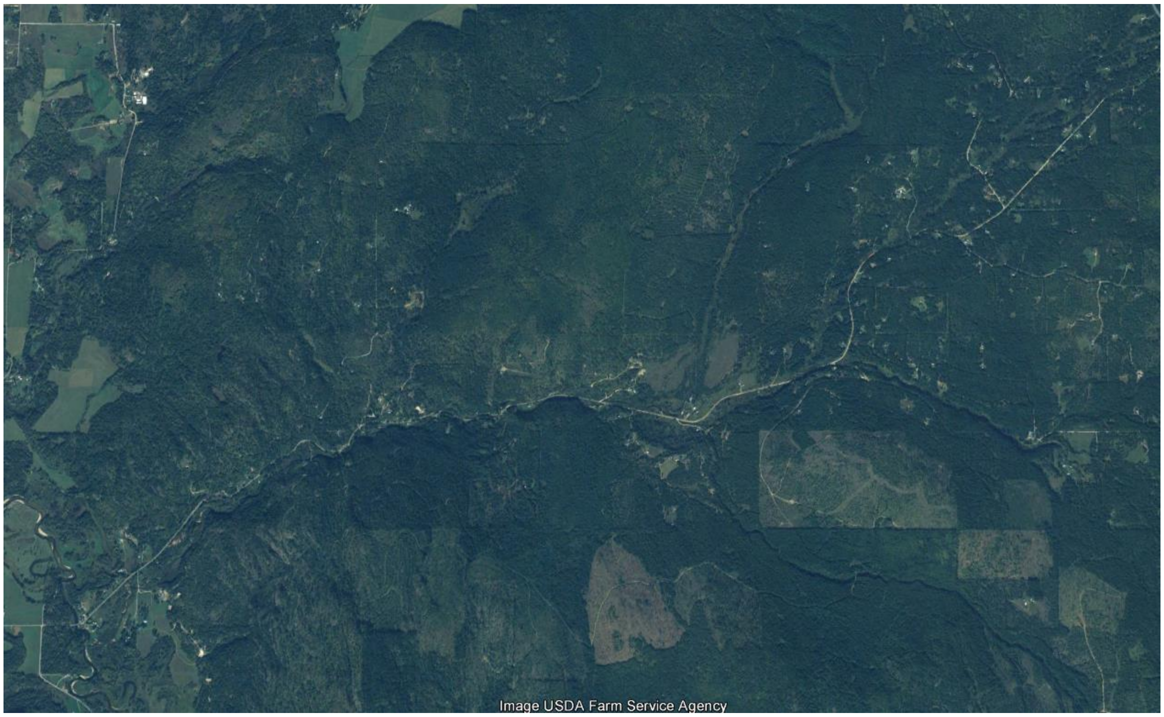
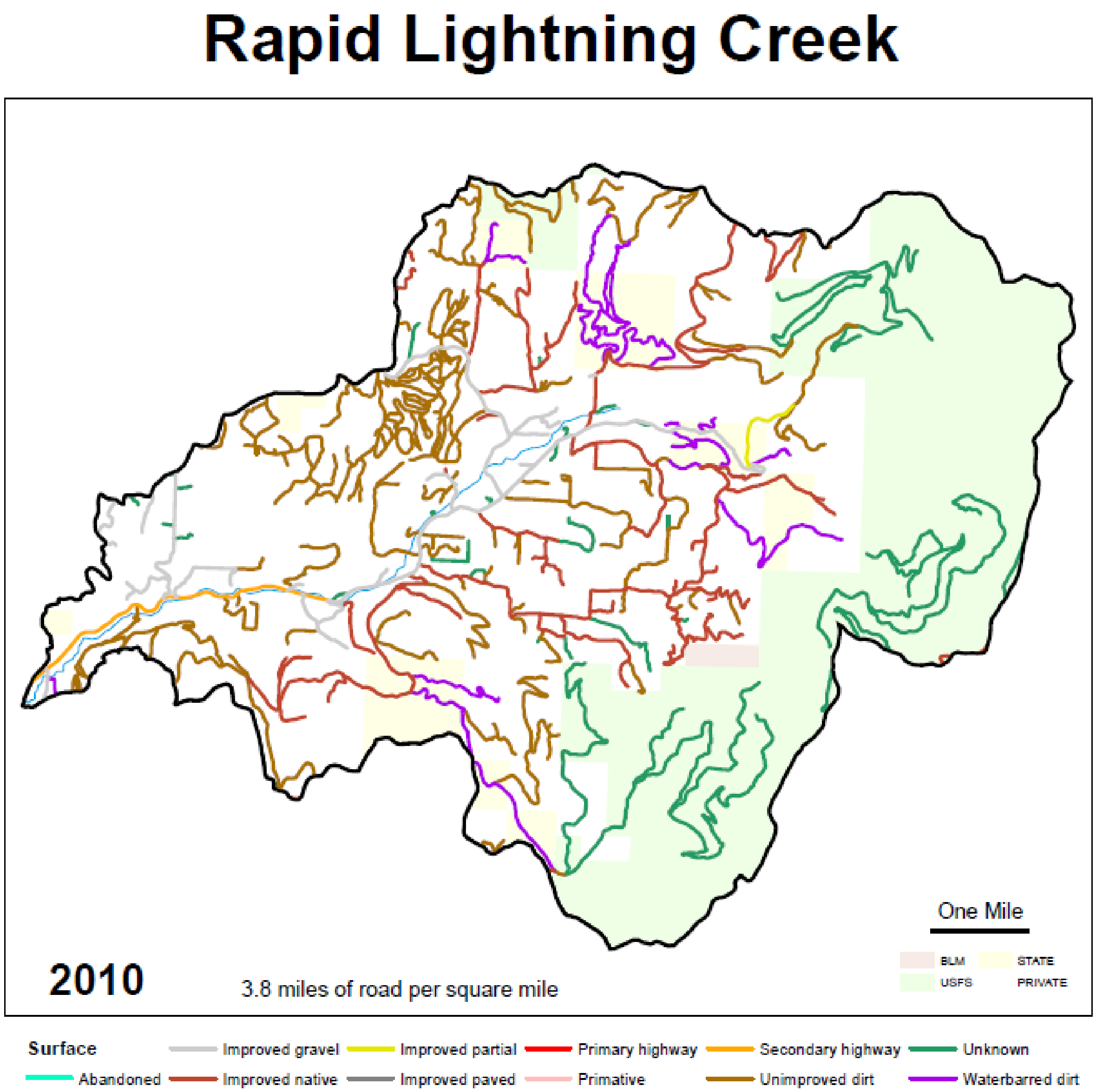


Figure 109. Aerial photograph of the Rapid Lightning Creek watershed, June 2004.

Figure 110. Aerial photograph of the Rapid Lightning Creek watershed, July 2014.

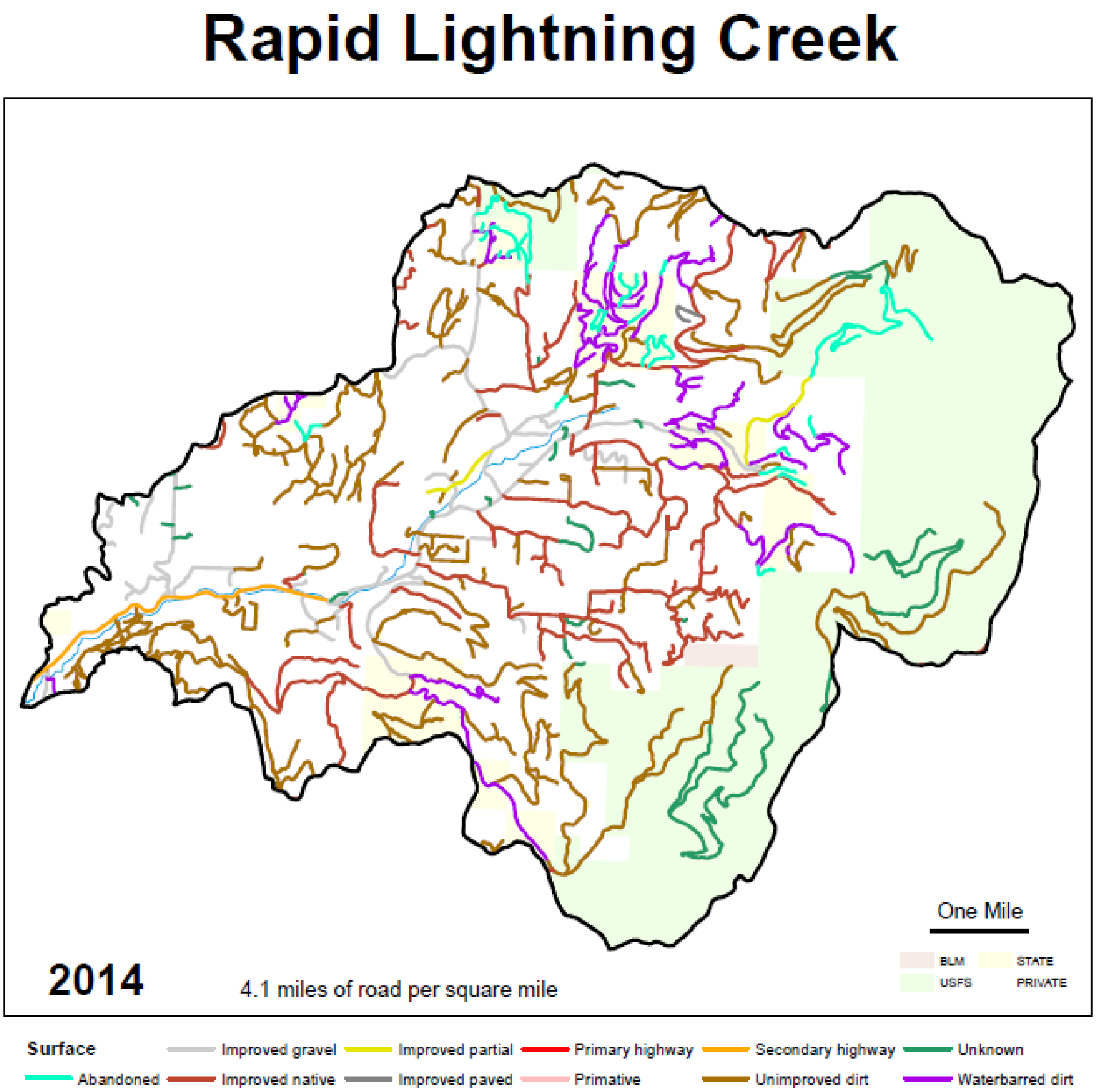
Roads

Road density has increased in the Rapid Lightning Creek watershed from 3.8 miles of road per square mile to 4.1 miles of road per square mile (Figure 111, Figure 112). This increase was seen in roads categorized as waterbarred dirt and improved gravel. The increase in road network was due to the increase in development in the watershed. Since 2010, 11.1 miles of road were abandoned primarily in the upper watershed.



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Rapid Lightning Creek	Unimproved dirt	72.37	38.6	187.6
Rapid Lightning Creek	Unknown	39.15	20.9	187.6
Rapid Lightning Creek	Improved native	37.35	19.9	187.6
Rapid Lightning Creek	Improved gravel	17.2	9.2	187.6
Rapid Lightning Creek	Waterbarred dirt	17.08	9.1	187.6
Rapid Lightning Creek	Secondary highway	3.49	1.9	187.6
Rapid Lightning Creek	Improved partial	0.97	0.5	187.6

Figure 111. Road network in the Rapid Lightning Creek watershed, 2010.



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Rapid Lightning Creek	Unimproved dirt	79.23	39.3	201.6
Rapid Lightning Creek	Improved native	42.52	21.1	201.6
Rapid Lightning Creek	Waterbarred dirt	24.16	12	201.6
Rapid Lightning Creek	Improved gravel	22.16	11	201.6
Rapid Lightning Creek	Unknown	16.31	8.1	201.6
Rapid Lightning Creek	Abandoned	11.12	5.5	201.6
Rapid Lightning Creek	Secondary highway	3.49	1.7	201.6
Rapid Lightning Creek	Improved partial	2.16	1.1	201.6
Rapid Lightning Creek	Improved paved	0.48	0.2	201.6

Figure 112. Road network in the Rapid Lightning Creek watershed, 2014.

2015 DEQ Stream Evaluation

One 100-meter reach of lower Rapid Lightning Creek was evaluated using Rosgen's (2006) method with data collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 47. No access was granted on Rapid Lightning Creek further upstream in the watershed.

Table 47. Reach location characteristics for Rapid Lightning Creek.

Name	Date	Type	Length (meters)	Latitude	Longitude
Lower Rapid Lightning Creek	9/30/2015	Riffle-Pool	100	N48.367153	W116.402888

Stream classification for lower Rapid Lightning Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 48. Lower Rapid Lightning Creek was an over-widened, moderately entrenched Rosgen “B” channel. The channel substrate was primarily very coarse pebble (31–64 mm).

Table 48. Stream characteristics of lower Rapid Lightning Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	12.1	28.5	14.7	55.3
Bankfull Depth (D_{bkf}), ft	1.07	0.37	0.78	0.74
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	11.3	77.0	18.8	35.7
Maximum Depth (D_{mbkf}), ft	1.35	0.85	1.1	3.3
Width of Flood-Prone Area (W_{fpa}), ft	31.6	60	21.4	37.2
Wetted Width, ft	9.8	22.3	10.2	14.1
Entrenchment Ratio (ER), ft/ft	2.6	2.1	1.7	6.4
Channel Materials (Particle Size index) $D_{50,}$ mm	Very coarse pebble (31–64 mm)			
Water Surface Slope, %	0.5	0.5	1.0	0.7
Rosgen Stream Type	B			

Woody Debris Cover

Within the study reach, Rapid Lightning Creek had low woody debris recruitment potential, with few LWD and no log jams.

Bed Substrate Cover

There was some evidence of sediment mobility and lack of sorting; however, some willow recruitment on point bars was observed (Figure 113).

Substrate embeddedness was measured within a riffle and the margin of the riffle. In both cases, the substrate was considerably embedded. Except in riffles, periphyton covered the substrate in a fine layer, and algae was excessive on much of the rock, indicating there may be a nutrient impairment in Rapid Lightning Creek (Figure 114, Figure 115).

Figure 113. Recruitment of willows on point bars.

Figure 114. Excessive periphyton growth on rocks.

Figure 115. Algae on rocks, Rapid Lightning Creek.

Scour and Depositional Features

Pool abundance in the study reach was good, especially for a very low-flow year. While no fish were observed in the study reach, the landowner said salmonids were present. Caddisfly casings were abundant in the riffle sections only, perhaps due to the excess of periphyton in the runs and pools of the channel. The riffle-run-pool-glide pattern was well-defined. Riffle coverage was good in the reach area, and riffles were moderately well-formed and complete.

Channel Morphology

In the study reach, Rapid Lightning Creek had a moderately stable meander pattern, with a wide floodplain. The channel was somewhat widened with some entrenchment; however, the stream still had access to its floodplain. The large parcel size on the creek provides low density of structures on the stream, allowing lateral movement within the floodplain.

Streambanks

Streambank erosion was variable in the study reach, ranging from 10–30% to greater than 60% (Figure 116). Streambank stability was directly related to the presence of bank-stabilizing vegetation. Undercut banks were abundant and were the primary cover for fish; however, a number of the undercut banks were unstable and at risk of slumping into the stream.

Figure 116. Bank erosion on Rapid Lightning Creek.

Riparian Area

The riparian area on Rapid Lightning Creek provided a 50–100 foot buffer width in the study area (Figure 117). However, it provided a reduced canopy and was estimated to be less than 50% of its potential natural condition. Invasive species such are reed canary grass and tansy were present throughout the study reach.

Figure 117. Riparian area on Rapid Lightning Creek.

2015 Road Crossing Survey

In September 2015, DEQ conducted a survey of road crossing conditions in the Rapid Lightning Creek watershed. Four road crossings were selected for evaluation. Road crossing characteristics are presented in Table 49. Three of the crossings were bridges maintained by the county. Three bridges were in good-excellent condition with a low erosion potential (Figure 118–Figure 120). However, one bridge was poorly aligned with the stream and may be an erosion hazard at higher flows. The culvert was new and in excellent condition. However, fill material near the culvert had fine material that will erode into the creek with precipitation and snowmelt. The culvert was not a barrier to fish passage (Figure 121).

The Rapid Lightning Creek Road was newly upgraded to pavement. It was in excellent condition. However, a section of road near Rapid Lightning Creek had fill material containing fines (Figure 122). This material will erode into the creek with runoff from precipitation and snowmelt.

Table 49. Road crossing characteristics, Rapid Lightning Creek.

Water Body	Type	GPS Coordinates	Erosion Severity	Overall Condition	Fish Barrier?
Rapid Lightning Creek	Steel/timber with asphalt decking bridge	N 48.580039 W -116.368841	Low	Good	No
Rapid Lightning Creek	Steel with gravel decking bridge	N 48.367009 W -116.401769	Low	Excellent	No
Unnamed tributary to Rapid Lightning Creek	Aluminum corrugated culvert	N 48.383910 W -116.321930	Medium	Good	No
Rapid Lightning Creek	Steel/timber with gravel decking bridge	N 48.379569 W -116.339752	Low	Fair	No

Figure 118. Bridge crossing over Rapid Lightning Creek.

Figure 119. Bridge crossing over Rapid Lightning Creek.

Figure 120. Bridge crossing over Rapid Lightning Creek.

Figure 121. Culvert on tributary to Rapid Lightning Creek.

Figure 122. Newly constructed Rapid Lightning Creek Road.

Review of Implementation Plan and Activities

The Natural Resources Conservation Service (NRCS) and agency partners have conducted the following projects in the Rapid Lightning Creek watershed between 2007 and 2015:

- Forest stand improvement 46.8 acres
- Forest slash treatment 34.5 acres
- Pest management 20.3 acres
- Stream crossing 1
- Tree/shrub establishment 30 acres
- Critical area planting 0.5 acres

TMDL Discussion

Rapid Lightning Creek is not supporting the cold water aquatic life beneficial use. The sediment impairment on Rapid Lightning Creek is currently not reflected in the Idaho's 2014 Integrated Report although the Clark Fork/Pend Oreille TMDL assigned a sediment load reduction to Rapid Lightning Creek. The TMDL requires a 74% load reduction in sediment in the lower Pack River watershed; however, there was no load reduction requirement calculated for individual subwatersheds such as Rapid Lightning Creek. Modeling under the Pend Oreille tributaries sediment TMDL suggested Rapid Lightning Creek was not impaired by sediment; however, the TMDL concluded the load reduction requirements prescribed under the Clark Fork/Pend Oreille TMDL were still in effect.

The main stem Rapid Lightning Creek has not been evaluated for beneficial use support since 1997. The data at that time suggested Rapid Lightning Creek was not supporting its beneficial uses. BURP data were collected more recently on Spring Creek, one of six tributaries to Rapid

Lightning Creek; however, these data are not representative of the AU as a whole. Therefore, Rapid Lightning Creek should be re-evaluated for beneficial use support using BURP.

The steep terrain and the weathered geology make the Rapid Lightning Creek watershed highly erosive and susceptible to mass failure. In 2005 and 2009, IDL CWE data determined that the overall hydrologic risk that the channel is impacted from forest canopy removal was moderate. Therefore, caution should be taken during timber harvest in this watershed.

Data were collected in 2015 under this TMDL review on lower Rapid Lightning Creek. No access was provided higher in the watershed. The data suggest Rapid Lightning Creek is over-widened, moderately entrenched, and with moderate embeddedness due to riparian area quality that was compromised by development and invasive weeds. The patchy riparian area provided suboptimal streambank stability resulting in streambank erosion and sedimentation. The poor-quality riparian area also provided low LWD recruitment. The stream has excess bedload forming unstable point bars and poor habitat complexity. Restoration projects that introduce large wood into the creek would add to habitat complexity, provide cover, and increase pool depth and frequency. In addition, restoration projects that foster re-establishment of willow on the point bars would help stabilize the bedload and trap sediment to favor more riparian vegetation.

In summary, Rapid Lightning Creek is affected by an oversupply of course sediment that impairs channel stability and habitat complexity. The riparian area condition lends itself to eroding banks and sedimentation. Therefore, Rapid Lightning Creek will remain under the constraints and guidelines of the Clark Fork/Pend Oreille TMDL

5.2.10 Sand Creek—Tributary to Lake Pend Oreille

Sand Creek is a tributary to Lake Pend Oreille. The Sand Creek watershed covers 38 square miles or 24,209 acres (Figure 123). Sand Creek generally flows north to south and discharges into Lake Pend Oreille within the city limits of Sandpoint. The watershed is underlain mostly by Pleistocene outwash fenglomverate flood and terrace gravel and Cretaceous metamorphosed granitic intrusive rock (DEQ and EPA 2007). The average gradient of Sand Creek is 1%. The land use/land cover is forestry, agriculture grasslands, permanent grasslands, urban or developed land, and small areas of shrubland and barren land. Landownership in the watershed is primarily private, with the remainder of the watershed held by the City of Sandpoint, BLM, state, and USFS (DEQ and EPA 2007).

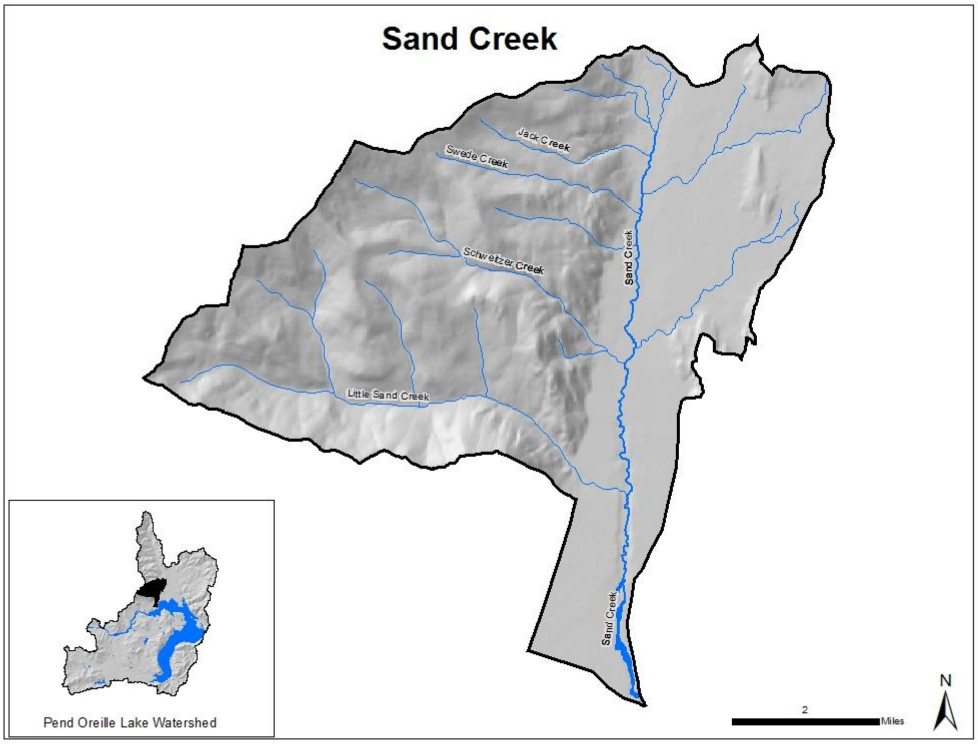


Figure 123. Sand Creek sub-watershed.

Sand Creek is made up of four AUs:

1. Headwaters and minor tributaries (ID17010214PN049_02)
2. Main stem, headwaters to confluence with Schweitzer Creek (ID17010214PN049_03)
3. Main stem, confluence with Schweitzer Creek to Lake Pend Oreille inundated reach (ID17010214PN048_03)
4. Lake Pend Oreille inundated reach (ID17010214PN048_03a)

All of the above AUs are listed on Idaho's 2012 Integrated Report as not supporting the cold water aquatic life beneficial use due to temperature and sediment. The salmonid spawning beneficial use is not supported due to temperature. The Pend Oreille tributaries sediment TMDL modeling indicated that the amount of sediment in Sand Creek exceeds load capacity for full support streams in the area (DEQ and EPA 2007). Therefore, Sand Creek and its tributaries were assigned sediment load reductions to bring Sand Creek into compliance with Idaho water quality standards.

Idaho Beneficial Use Reconnaissance Program

Sand Creek has not been evaluated for beneficial use support using BURP since the late 1990s.

Stressor Identification

In 2002, Sand Creek (AUs ID17010214PN049_02 and ID17010214PN049_03) was listed on Idaho's 2002 Integrated Report as not supporting the aquatic life beneficial use due to temperature and an unknown pollutant. In 2006, TerraGraphics conducted a stressor identification analysis to determine the unknown pollutant on the main stem (TerraGraphics 2006e). The analysis determined the majority of substrate in Sand Creek was sand, which may have been the reason for low macroinvertebrate and habitat BURP scores. However, the soil types in the stream corridor are sandy, which would suggest it is a natural stream channel condition. Therefore, it was recommended that the watershed be modeled to determine if excessive sediment is the cause of beneficial use impairment in Sand Creek.

IDL Cumulative Watershed Effects

Since 2000, Sand Creek has not been evaluated using the IDL CWE program.

Changes in Subbasin Characteristics

Changes since the 2007 TMDL along the main stem Sand Creek have been minimal. The primary land use continues to be agriculture/rural (Figure 124, Figure 125). Rural development has not increased along Sand Creek.

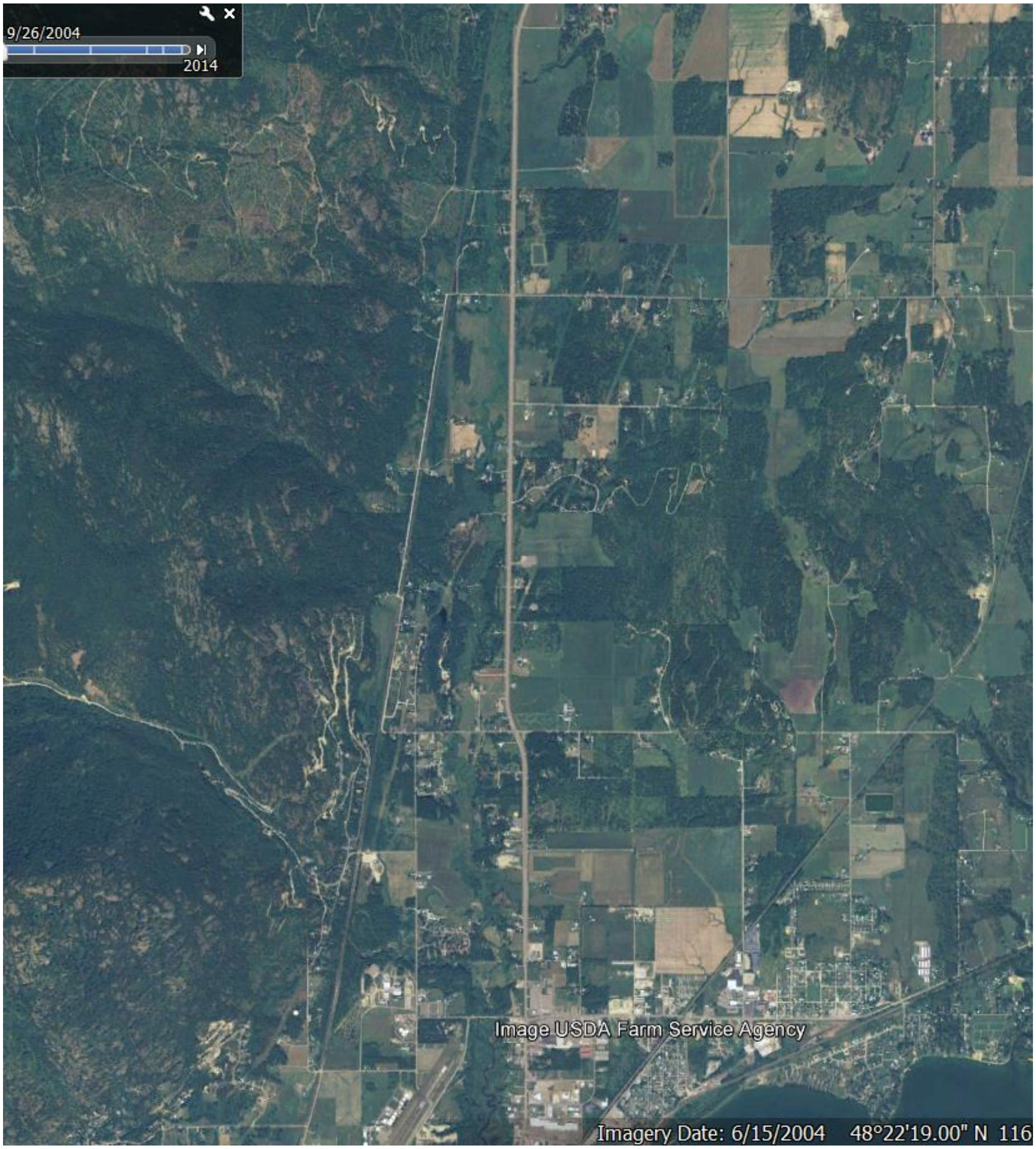


Figure 124. Aerial photograph of Sand Creek corridor, June 2004.

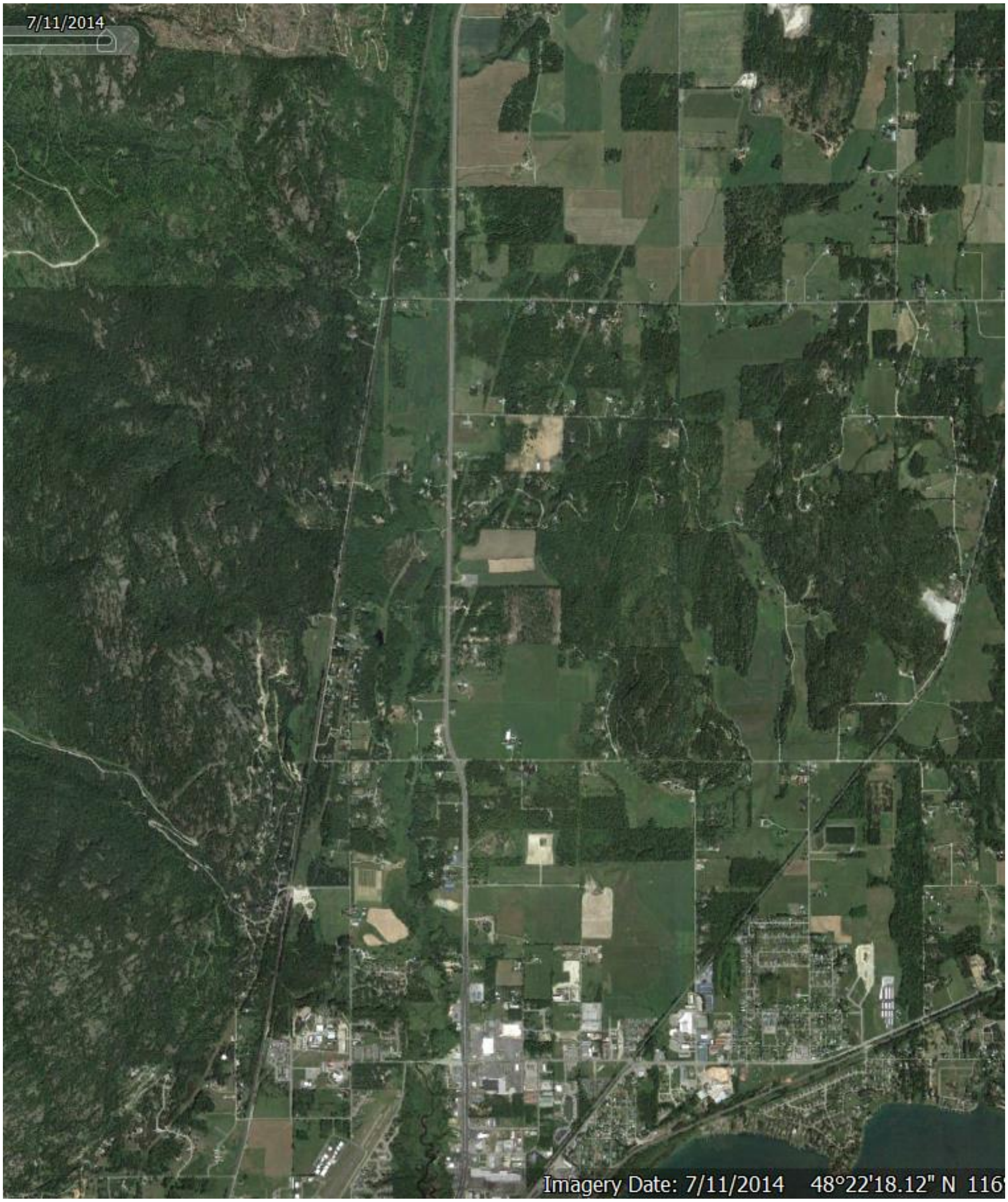


Figure 125. Aerial photograph of Sand Creek corridor, July 2014.

2015 DEQ Stream Evaluation

Lower Sand Creek

One 100-meter reach of lower Sand Creek was evaluated using Rosgen's method (2006), with data collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 50.

Table 50. Reach location characteristics for Sand Creek.

Name	Date	Type	Length (meters)	Latitude	Longitude
Upper Sand Creek	10/2/2015	Plane bed	100	N48.35637	W116.549109
Lower Sand Creek	10/2/2015	Plane bed	100	N48.329027	W116.552769

Stream classification for lower Sand Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 51. Lower Sand Creek was an over-widened, moderately entrenched Rosgen "F" channel. The channel substrate was primarily sand.

Table 51. Stream characteristics of lower Sand Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	19.3	29.3	27.0	25.2
Bankfull Depth (D_{bkf}), ft	1.89	0.75	0.82	1.15
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	10.2	39.1	32.9	27.4
Maximum Depth (D_{mbkf}), ft	1.1	1.1	1.2	1.1
Width of Flood-Prone Area (W_{fpa}), ft	24.2	29.5	27.4	27.0
Wetted Width, ft	18.0	18.5	27.0	21.2
Entrenchment Ratio (ER), ft/ft	1.3	1.0	1.0	1.1
Channel Materials (Particle Size index) D_{50}, mm	Sand	Sand	Very fine pebble	
Water Surface Slope, %	0.5	0.5	0.5	0.5
Rosgen Stream Type		F		

The following reach habitat assessment of lower Sand Creek was completed according to Milone & MacBroom, Inc. (2008). The overall physical habitat condition rating for lower Sand Creek using this method was fair. Extremely low base-flow conditions existed on the creek during the evaluation.

Woody Debris Cover

Within the study reach, lower Sand Creek was an agriculture pasture with no riparian exclusion fencing and decreasing riparian vegetation moving downstream in the study reach (Figure 126). The lack of large woody shrubs resulted in low woody debris recruitment potential and a low number of LWD. There were no log jams in the study reach.

Figure 126. Lower Sand Creek, downstream end of the study reach.

Bed Substrate Cover

The channel substrate was primarily sand and very fine pebbles, typical of a valley meadow stream. The substrate was covered in about 1/8-inch of periphyton, perhaps indicating nutrient impairment (Figure 127).

Figure 127. Excessive periphyton on substrate in Sand Creek.

Scour and Depositional Features

Pool abundance in the study reach was limited, and the channel bottom was fairly uniform. As such, thermal refuge and cover was limited to undercut banks. The channel bed lacked complexity and the meandering thalweg was barely identifiable in the cross section. Bar formation and riffle formation were limited, with only two depth-velocity combinations present (slow shallow, slow deep). Fish were observed in the study reach ranging from young-of-the-year to 250 mm.

Channel Morphology

Lower Sand Creek had a stable meander pattern with a wide floodplain (Figure 128). However, it was evident that the channel had been historically channelized. The channel was somewhat widened and entrenched, but the stream still had access to its floodplain. The large parcel size on the creek provided low density of structures on the stream, allowing it lateral movement within the floodplain.

Figure 128. Sand Creek at the upstream end of the study reach.

Hydrologic Characteristics

The wetted width of the stream channel spanned the entire width. The stream was over-widened with an average width-to-depth ratio greater than 25; however, the stream was only slightly entrenched with an entrenchment ratio was less than 1.2. There was no known flow alteration on Sand Creek. High- and low-flow refuge was limited. There were no obstructions in the reach that blocked longitudinal movement of aquatic species.

Streambanks

Streambank erosion was evident in the study reach, ranging from 30–60%. Most of the streambank erosion was in the downstream end of the study reach where riparian vegetation was less. Bank canopy decreased moving downstream in the study reach where it was less than 50%. Undercut banks were abundant and were the primary cover for fish; however, a number of the undercut banks were unstable and at risk of slumping into the stream. The streambanks, however, appeared to be recovering, perhaps due to a lack of livestock pressure on the banks (Figure 129).

Figure 129. Vertical banks on the mend in Sand Creek.

Riparian Area

The riparian area of lower Sand Creek consisted primarily of willow, alder, grasses, and sedges (Figure 130, Figure 131). The riparian buffer width was less than 50 feet in the entire study reach due to the pasture. The canopy was in better condition in the upstream end of the study reach, but it was severely reduced in the downstream end. Near one of the streambanks, a neighbor had brought in fill material for a parking space. The material was less than 50 feet from the stream channel (Figure 132), presenting a risk of erosion with runoff from this material and sedimentation into the stream channel.

Figure 130. Riparian area in lower Sand Creek.

Figure 131. Riparian area in lower Sand Creek at the upper end of the study reach.

Figure 132. Earth-moving activity on lower Sand Creek.

Upper Sand Creek

One 100-meter stream reach of upper Sand Creek was evaluated using Rosgen's method (2006) with data collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 50.

Stream classification for upper Sand Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 52. Upper Sand Creek was an over-widened, moderately entrenched Rosgen "F" channel. The channel substrate was primarily very fine pebble and sand.

Table 52. Stream characteristics of upper Sand Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	7.5	9.6	4.4	7.2
Bankfull Depth (D_{bkf}), ft	0.61	0.64	0.72	0.18
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	12.3	15.0	6.1	11.1
Maximum Depth (D_{mbkf}), ft	0.9	1.0	1.3	1.1
Width of Flood-Prone Area (W_{fpa}), ft	8.3	9.6	8.5	8.8
Wetted Width, ft	6.6	8.7	4.9	6.7
Entrenchment Ratio (ER), ft/ft	1.1	1.0	1.9	1.3
Channel Materials (Particle Size index) D_{50}, mm	Very fine pebble (2.5–6.0 mm)		Sand (1.1–2.5 mm)	
Water Surface Slope, %	0.5	0.5	0.5	
Rosgen Stream Type	F			

The following reach habitat assessment of upper Sand Creek was completed according to Milone & MacBroom, Inc. (2008). The overall physical habitat condition rating for upper Sand Creek using this method was good. Extremely low base-flow conditions existed on the creek during the evaluation.

Woody Debris Cover

Within the study reach, upper Sand Creek was an agriculture pasture with no riparian exclusion fencing (Figure 133). LWD was present in the study reach with a low number of log jams (less than 3 per mile). The lack of large woody shrubs resulted in low woody debris recruitment potential.

Figure 133. Upper Sand Creek, upstream end of the study reach.

Bed Substrate Cover

The channel substrate was primarily sand and very fine pebbles, typical of a valley meadow stream. The substrate was somewhat embedded, with some evidence of sediment mobility and lack of sorting. The substrate was free of dense algae growth.

Scour and Depositional Features

Pool abundance in the study reach was excellent, providing thermal refuge and cover. Two depth-velocity combinations were present (slow shallow, slow deep). A meandering thalweg was moderately identifiable in the cross section, with some evidence of bar formation. There was some sign of mid-channel accumulation. Fish were observed in the study reach ranging from young-of-the-year to 250 mm.

Channel Morphology

In the study reach, upper Sand Creek had a stable meander pattern with a wide floodplain (Figure 134). However, it was evident that the channel had been historically channelized. The channel had a good width-to-depth ratio, but it was entrenched (Figure 135). The stream had marginal access to its floodplain. The large parcel size on the creek provided low density of structures on the stream, allowing potential lateral movement within the floodplain.

Figure 134. Meandering channel morphology in upper Sand Creek.

Figure 135. Entrenched nature of upper Sand Creek.

Hydrologic Characteristics

The wetted width of the stream channel spanned approximately three-quarters of the stream channel. Given the extreme low-flow condition of the creek, there was limited exposure of channel substrate. High- and low-flow refuge was excellent. There was no known flow alteration on upper Sand Creek. There were no obstructions in the reach that blocked longitudinal movement of aquatic species. However, the entrenched condition of the creek limited floodplain access at high flow.

Streambanks

Streambank erosion was near reference condition in the study reach, with less than 10% eroding banks. Due to excellent pasture management, livestock pressure on the streambanks was minimal. Due to the presence of reed canary grass, the bank canopy was limited in diversity and cover (Figure 136). Undercut banks were abundant, proving cover for fish. Undercut banks had mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency. There were no slumping or bare-vertical banks.

Figure 136. Reed canarygrass in upper Sand Creek.

Riparian Area

The riparian area of upper Sand Creek consisted primarily of willow, alder, spirea, and reed canarygrass. The riparian buffer width was less than 50 feet in the entire study reach due to the pasture. The riparian vegetation diversity was compromised due to the presence of reed canary grass.

2015 Road Crossing Evaluation

In 2015, DEQ evaluated two stream crossings on Sand Creek. Both crossings were bridges, the first on Selle Road (Figure 137). The bridge was a county bridge made of pre-stressed concrete with a gravel surface. The crossing was in good condition with a low erosion severity. The other bridge was a county bridge on lower Sand Creek (Figure 138). The bridge was a concrete bridge with asphalt decking. It was in excellent condition with a low severity of erosion.

Water Body	Type	GPS Coordinates	Erosion Severity	Overall Condition	Fish Barrier?
Upper Sand Creek	Concrete with asphalt decking	N 48.357182 W -116.549197	Low	Good	No
Lower Sand Creek	Concrete with asphalt decking	N 48.328181 W -116.552867	Low	Excellent	No

Figure 137. Road crossing on upper Sand Creek.

Figure 138. Road crossing on lower Sand Creek.

Review of Implementation Plan and Activities

The NRCS and agency partners have conducted the following projects in the Sand Creek watershed between 2007 and 2015:

- Forest stand improvement 921.3 acres
- Forest slash treatment 16.5 acres
- Forest pruning 335 acres

- Forest site prep 4.3 acres
- Tree/shrub establishment 10.7 acres
- Prescribed grazing 443.6 acres
- Pasture/hayland/biomass 525.7 acres
- Critical area planting 1 acre
- Access road 430 feet
- Diversion 1,509 feet
- Fencing 4,184 feet
- Heavy-use area protection 0.5 acre
- Stream crossing 1

TMDL Discussion

Sand Creek is not supporting the cold water aquatic life beneficial use due to sediment and temperature impairment. It is not supporting salmonid spawning due to temperature. In Idaho's 2002 Integrated Report, the cause of the impairment was not yet determined. A stressor identification evaluation done in 2006 found a high percent of fines in Sand Creek; therefore, the sediment impairment was assigned to Sand Creek. The lack of riparian vegetation and the over-widened stream channel warranted the temperature listing.

The Pend Oreille tributaries sediment TMDL (DEQ and EPA 2007) modeling indicated that the amount of sediment in Sand Creek exceeds load capacity for full support streams in the area. Therefore, Sand Creek and its tributaries were assigned sediment load reductions to bring Sand Creek into compliance with Idaho water quality standards. The TMDL requires a 61% load reduction requirement for Sand Creek and its tributaries.

With the lack of recent BURP data, beneficial use support cannot be adequately evaluated. However, results of monitoring conducted under this TMDL review indicated stream habitat conditions were fair on lower Sand Creek. This site was within an agricultural pasture, which appeared to no longer have livestock pressure to the streambanks. However, the stream continued to have a uniform streambed with a low abundance of riparian vegetation and poor streambank stability. Restoration projects that introduce large wood into the creek would add to habitat complexity, provide cover, and increase pool depth and frequency. Monitoring conducted under this TMDL review indicated a good overall physical habitat condition rating for upper Sand Creek. Although cattle management was excellent on this parcel, reed canary grass limited the riparian vegetation diversity. Given the suboptimal ratings from data collection under this TMDL review, it is appropriate to conclude that the stream remains impaired due to excessive sediment, and more sediment reduction projects in the watershed are needed.

5.2.11 Sand Creek—Tributary to Pack River

Sand Creek (ID17010214PN038_02) is a 3rd-order tributary to the Pack River (Figure 139). In Idaho's 2008 Integrated Report, Sand Creek was listed as not supporting the aquatic life beneficial use due to sediment.

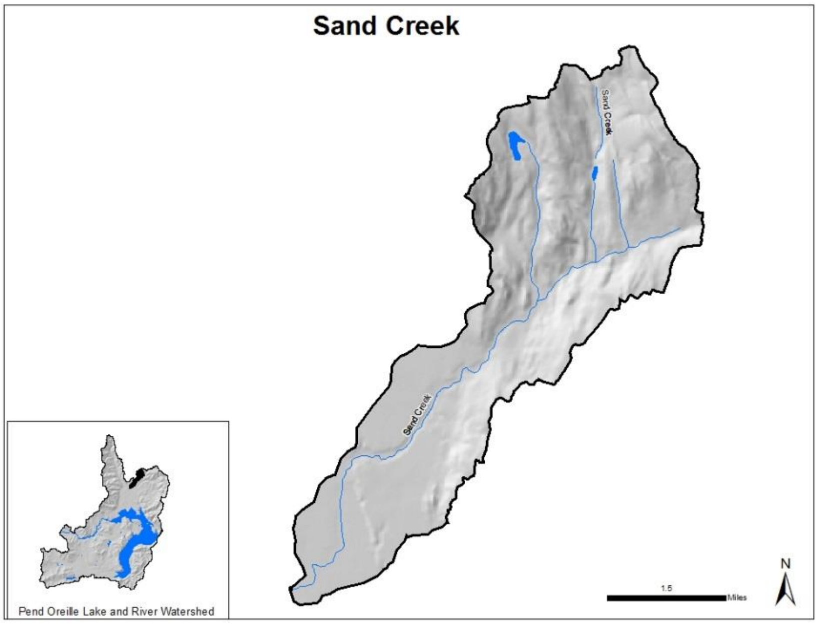


Figure 139. Sand Creek watershed, tributary to the Pack River.

Idaho Beneficial Use Reconnaissance Program

No recent BURP data have been collected on Sand Creek.

IDL Cumulative Watershed Effects

Since 2000, Sand Creek has not been evaluated using the IDL CWE program.

Changes in Subbasin Characteristics

Forest Cover Change

Between 2001 and 2014, a 464-acre loss in forest cover occurred in the Sand Creek subwatershed (Figure 140).

- 2001–2004: 154-acre decrease in forest cover
- 2005–2009: 124-acre decrease in forest cover
- 2010–2014: 186-acre decrease in forest cover

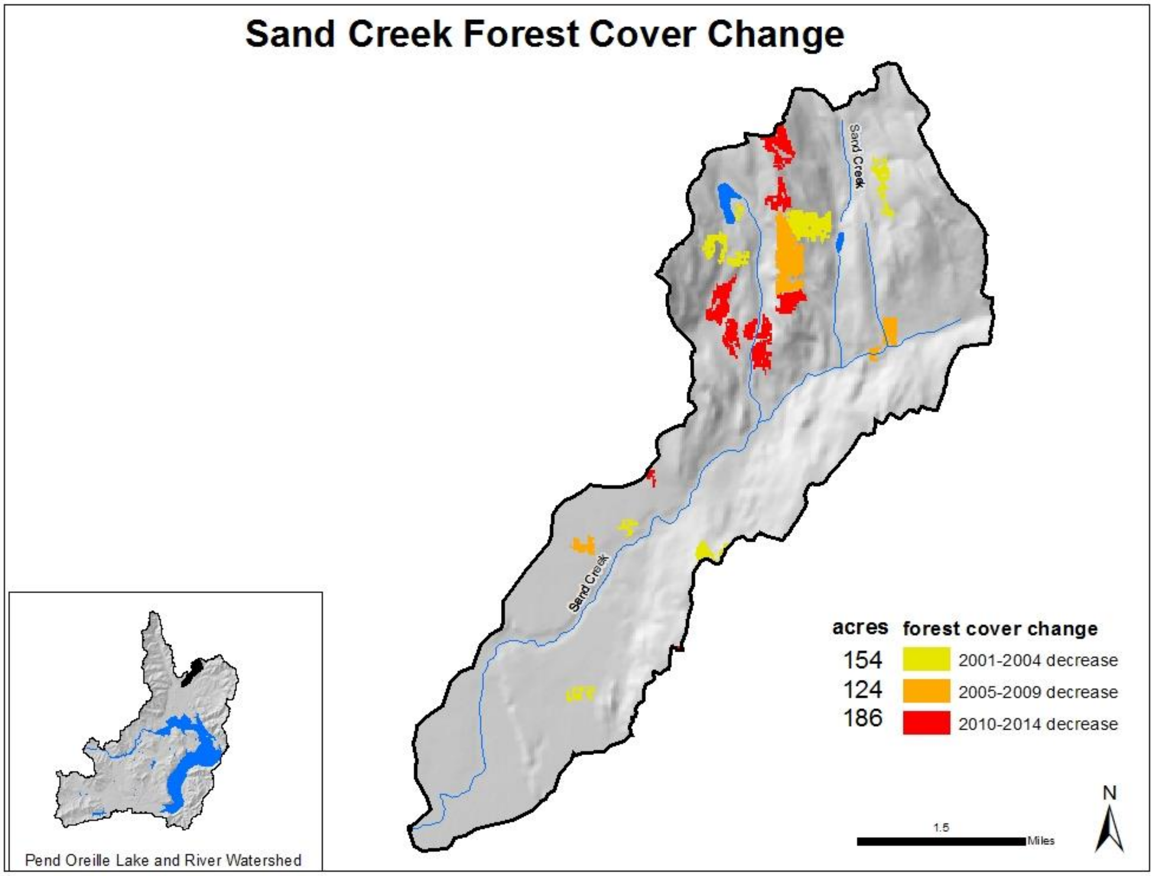
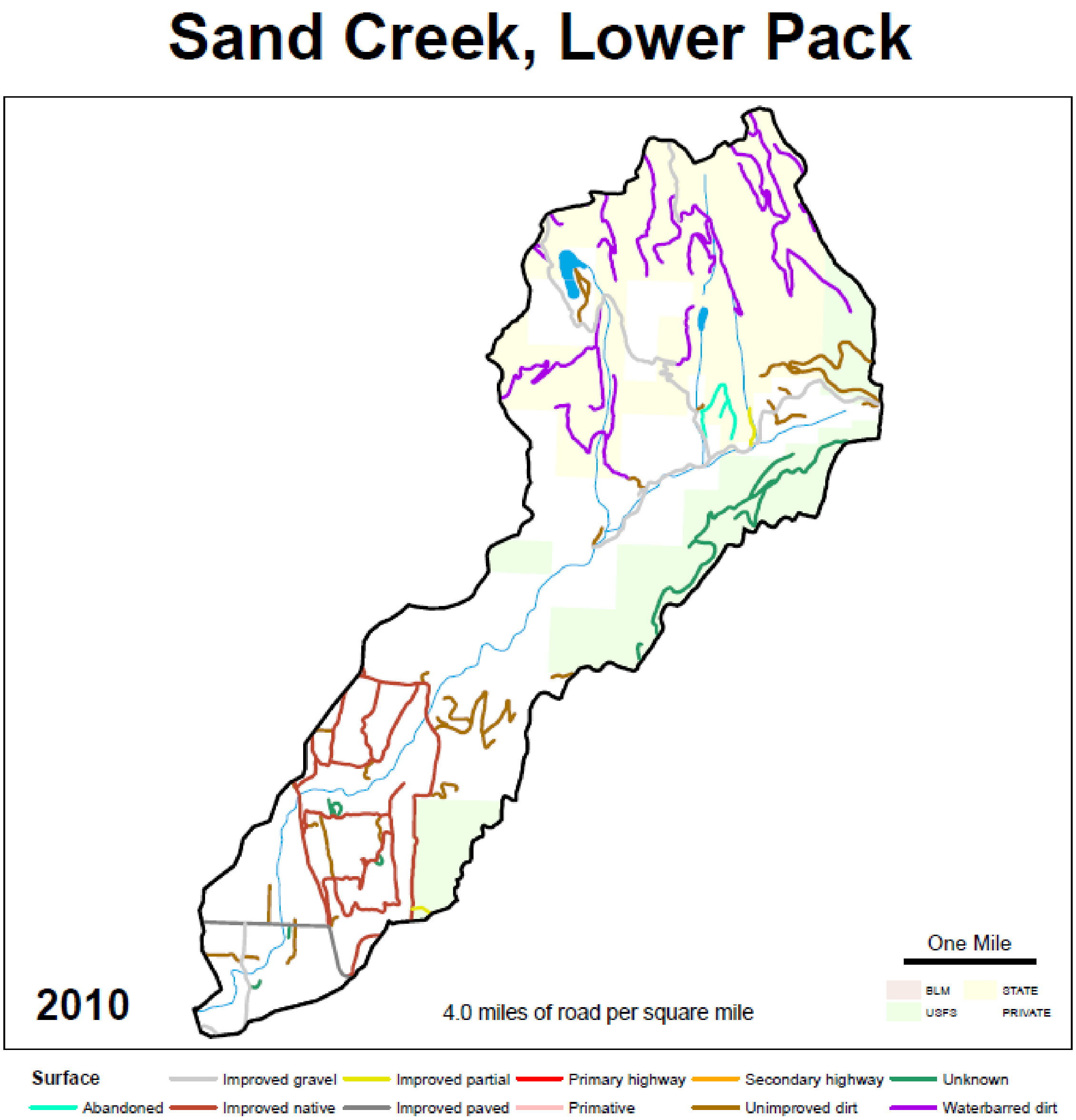


Figure 140. Forest cover change on Sand Creek, tributary to the Pack River.

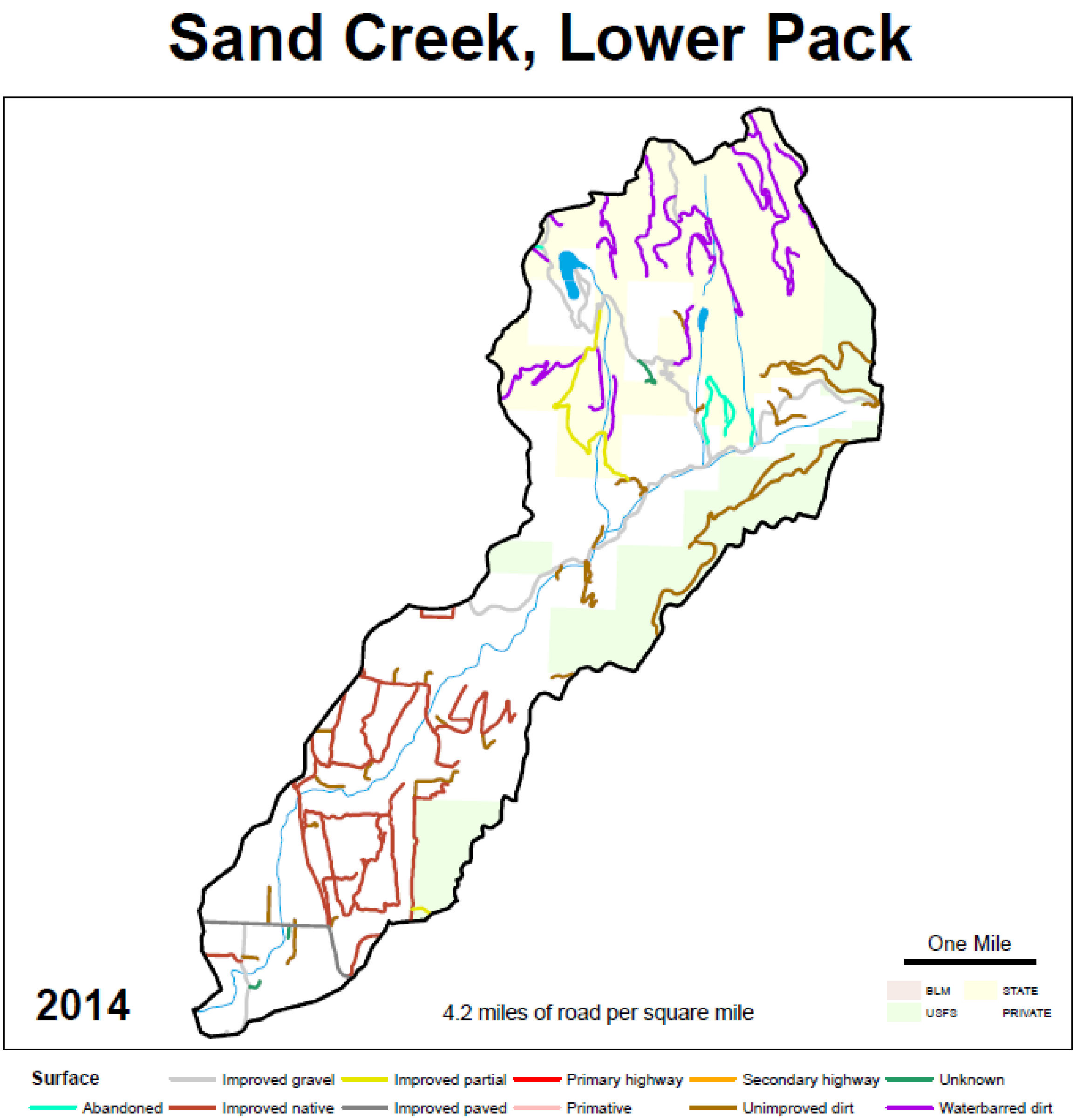
Roads

Road density in the Sand Creek watershed increased from 4.0 to 4.2 miles per square mile in the watershed (Figure 141, Figure 142).



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Sand Creek	Waterbarred dirt	14.74	28.7	51.4
Sand Creek	Improved native	11.24	21.9	51.4
Sand Creek	Unimproved dirt	9.26	18	51.4
Sand Creek	Improved gravel	8.23	16	51.4
Sand Creek	Unknown	4.87	9.5	51.4
Sand Creek	Improved paved	1.42	2.8	51.4
Sand Creek	Abandoned	1.14	2.2	51.4
Sand Creek	Improved partial	0.46	0.9	51.4

Figure 141. Road network in Sand Creek watershed (tributary to Pack River), 2010.



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Sand Creek	Improved native	14.91	27.4	54.4
Sand Creek	Waterbarred dirt	12.64	23.2	54.4
Sand Creek	Unimproved dirt	10.7	19.7	54.4
Sand Creek	Improved gravel	10.27	18.9	54.4
Sand Creek	Improved partial	2.31	4.2	54.4
Sand Creek	Abandoned	1.62	3	54.4
Sand Creek	Improved paved	1.43	2.6	54.4
Sand Creek	Unknown	0.51	0.9	54.4

Figure 142. Road network in Sand Creek watershed (tributary to Pack River), 2014.

2015 DEQ Stream Evaluation

DEQ was not given access in the Sand Creek watershed. Therefore, no stream evaluation was completed under this TMDL review.

2015 Road Crossing Survey

In 2015, DEQ conducted a survey of four road crossings in the Sand Creek watershed (Table 53). All of the crossings were on Sand Creek. Three of the four road crossings were in fair condition, primarily because of excessive erosion at the inlet and/or outlet of the crossing (Figure 143–Figure 145). One culvert (culvert 2) had road gravel eroding into the creek at the crossing (Figure 146).

Table 53. Stream crossing condition, Sand Creek watershed.

Type of Crossing	Latitude	Longitude	Erosion Severity	Overall Condition	Fish Barrier?
Culvert 1: corrugated aluminum	N 48.429232	W 116.461511	Low	Good	No
Culvert 2: corrugated steel	N 48.424000	W 116.467010	Medium	Fair	No
Culvert 3: corrugated steel	N 48.443705	W 116.459046	Low	Fair	No
Bridge	N 48.471836	W 116.411386	Low	Fair	No

Figure 143. Eroding outlet of culvert 1 on Sand Creek, tributary to Pack River.

Figure 144. Eroding outlet of culvert 3 on Sand Creek, tributary to Pack River.

Figure 145. Eroding inlet of bridge on Sand Creek, tributary to Pack River.

Figure 146. Culvert inlet on Sand Creek.

TMDL Discussion

Because a representative reach was not evaluated during this 5-year review, and due to a lack of recent BURP or CWE data, an effective discussion on beneficial use support and TMDL loading cannot be performed at this time. Therefore, the TMDL load reduction requirements remain in effect until a proper evaluation of Sand Creek can be performed.

5.2.12 Schweitzer Creek

Schweitzer Creek (ID17010214PN052_02) is a 2nd-order tributary to Sand Creek (Figure 147). The watershed is 3,196 acres and predominantly forested. Schweitzer Creek was placed on Idaho's 2008 Integrated Report for impairment to cold water aquatic life due to sediment. The Pend Oreille tributaries sediment TMDL modeling indicated that the amount of sediment in Schweitzer Creek exceeds load capacity for full support streams in the area (DEQ and EPA 2007). Therefore, Schweitzer Creek and its tributaries were assigned sediment load reductions that would bring Schweitzer Creek into compliance with Idaho water quality standards.

Most of the Schweitzer Creek watershed is undeveloped forest land, which includes USFS-managed property. However, the headwaters of the watershed is occupied by Schweitzer Mountain Resort, a 2,900-acre ski resort with a village at the base of the mountain.

The higher elevations of the watershed are underlain by granitics while the lower elevation and valley bottom are underlain by glacial drift/till.

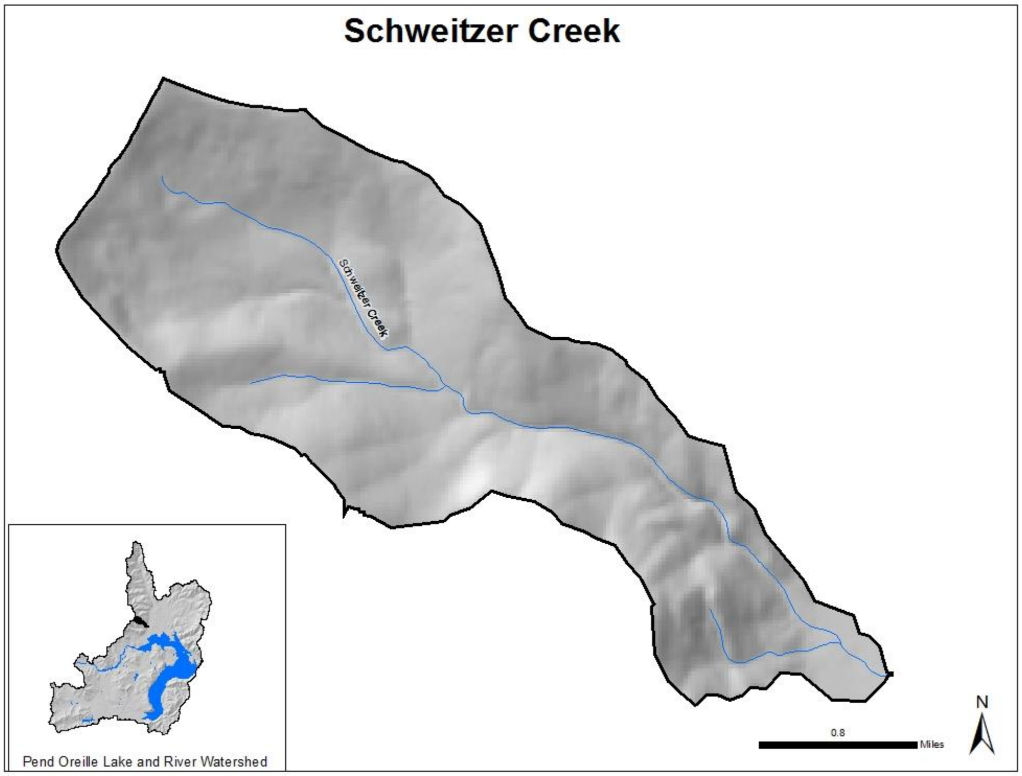


Figure 147. Schweitzer Creek subwatershed.

Idaho Beneficial Use Reconnaissance Program

In August 2006, Schweitzer Creek was evaluated at three different locations using Idaho's BURP method (Table 54). All of the data suggest Schweitzer Creek may be fully supporting its beneficial uses.

Near the mouth of the creek, flow was 0.65 cfs. The channel was a Rosgen "A" channel with a good width-to-depth ratio. Pool abundance was good, but pools lacked in diversity, probably because of the lack of LWD. The channel substrate was somewhat embedded, with 20% fines. Streambank conditions were excellent with bank-stabilizing vegetation. No fish data were collected at this site.

In the headwaters of the creek, flow was 0.79 cfs. The channel was a Rosgen "A" channel with a good width-to-depth ratio. It had a diversity of pools, with relatively good pool cover and an abundance of LWD. The channel substrate was not embedded and had a low percentage of fines. Streambank conditions were excellent with bank-stabilizing vegetation. No fish data were collected at this site.

A tributary to Schweitzer Creek was evaluated just downstream of the Schweitzer Mountain Resort complex. Flow was 0.45 cfs. The channel was a Rosgen "A" channel with a good width-to-depth ratio. Habitat quality was good, although it had a low abundance and diversity of pools, with poor pool cover. LWD was present, but not in abundance. The channel substrate was minimally embedded but the substrate had 35% fines. Streambank conditions were excellent with bank-stabilizing vegetation. No fish data were collected at this site.

Table 54. Beneficial Use Reconnaissance Program data for Schweitzer Creek.

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2014SCDAA054	Stream was dry/inaccessible						
2006SCDAA049	71.48	3.0	-	-	79.00	3.0	3.0
2006SCDAA050	51.34	1.0	-	-	73.00	3.0	2.0
2006SCDAA051	69.97	3.0	-	-	69.00	3.0	3.0

IDL Cumulative Watershed Effects

Since 2000, Schweitzer Creek has not been evaluated using the IDL CWE program.

Changes in Subbasin Characteristics

Forest Cover Change

Between 2001 and 2014, a 155-acre loss in forest cover occurred in the Schweitzer Creek subwatershed (Figure 148).

- 2001–2004: 21-acre decrease in forest cover
- 2005–2009: 116-acre decrease in forest cover
- 2010–2014: 17-acre decrease in forest cover

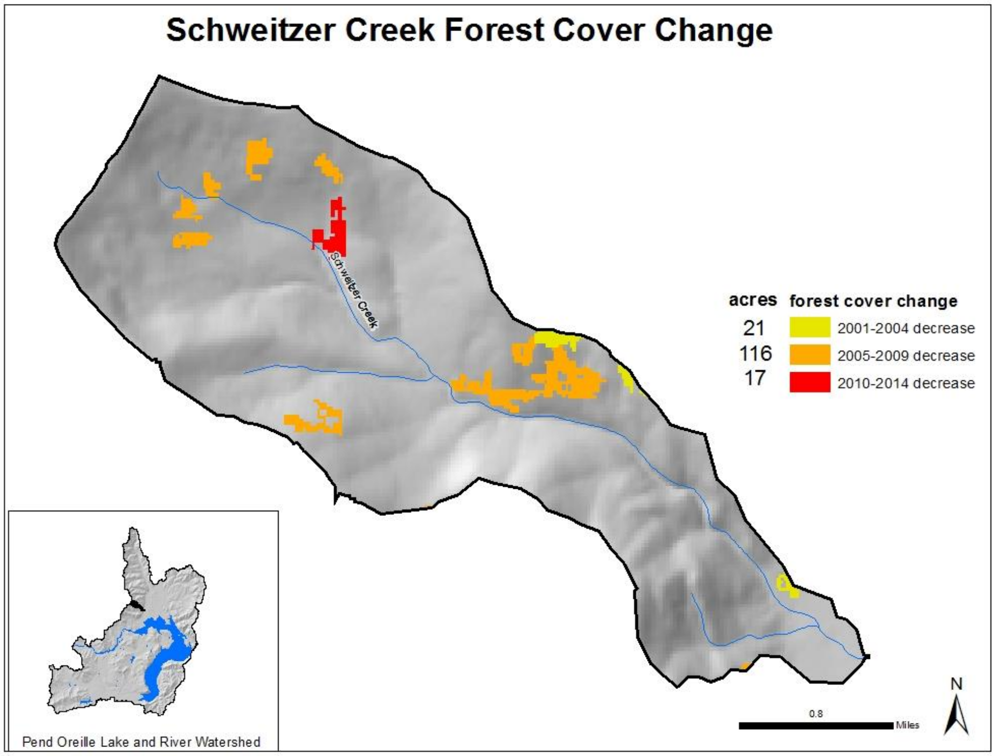
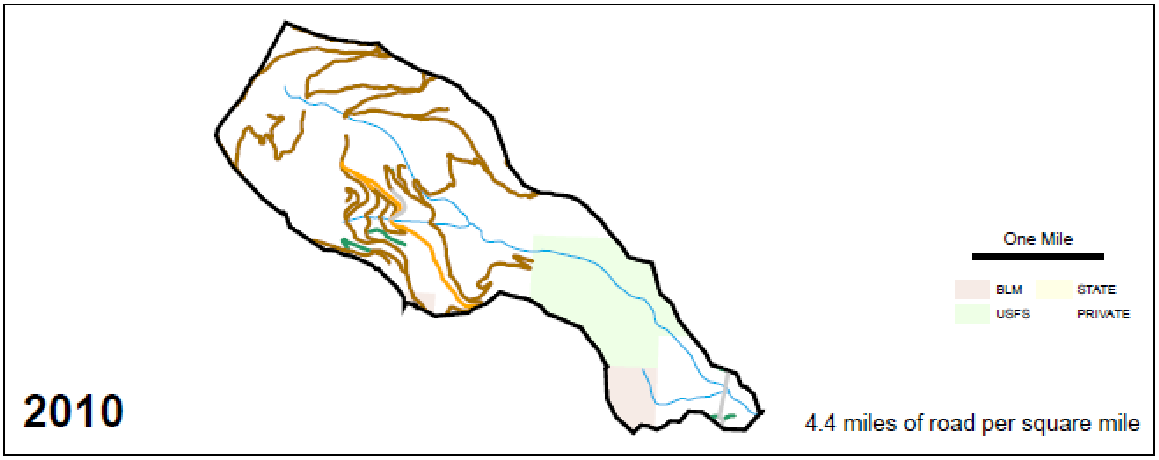


Figure 148. Forest cover change in the Schweitzer Creek subwatershed, 2001–2014.

Roads

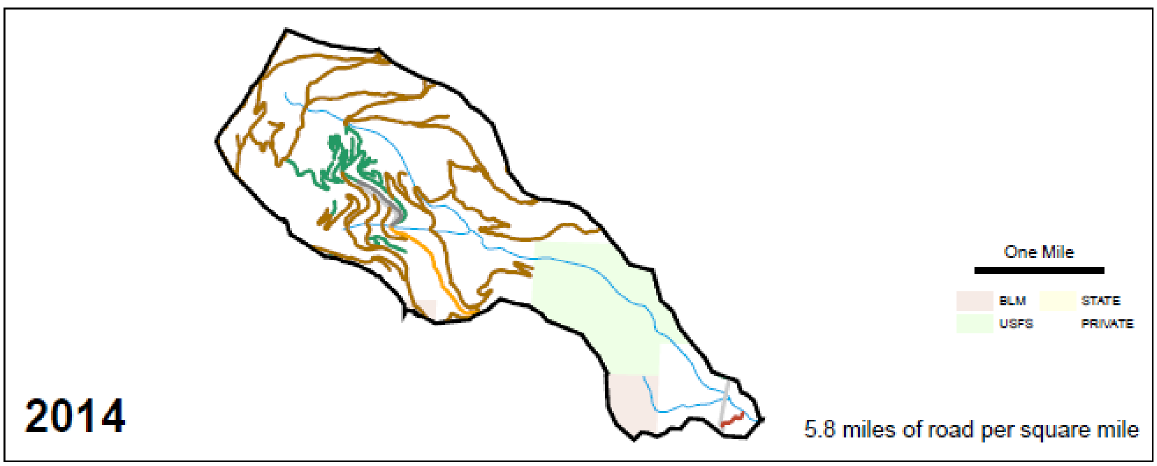
Road density increased in the Schweitzer Creek watershed from 4.4 to 5.8 miles of road per square mile, primarily in the category of unimproved dirt roads within the Schweitzer Resort area (Figure 149). In the lower watershed, the USFS-managed property is roadless.

Schweitzer Creek



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Schweitzer Creek	Unimproved dirt	18.42	83.5	22.1
Schweitzer Creek	Secondary highway	1.93	8.7	22.1
Schweitzer Creek	Unknown	0.95	4.3	22.1
Schweitzer Creek	Improved gravel	0.76	3.5	22.1

Surface — Improved gravel; Improved partial; Primary highway; Secondary highway; Unknown; Abandoned; Improved native; Improved paved; Primative; Unimproved dirt; Waterbarred dirt



Watershed_Name	Surface	length_miles	percent_type_per_watershed	length_miles_watershed_total
Schweitzer Creek	Unimproved dirt	21.06	72.9	28.9
Schweitzer Creek	Unknown	5.09	17.6	28.9
Schweitzer Creek	Secondary highway	1.04	3.6	28.9
Schweitzer Creek	Improved gravel	0.95	3.3	28.9
Schweitzer Creek	Improved paved	0.54	1.9	28.9
Schweitzer Creek	Improved native	0.22	0.8	28.9

Figure 149. Comparison of road networks in the Schweitzer Creek watershed, 2010 to 2014.

2015 DEQ Stream Evaluation

One 100-meter reach of Schweitzer Creek was evaluated using Rosgen's method (2006) with data collected on three cross sections: one at the downstream boundary of the reach, one at the middle (50-meter) of the reach, and one at the uppermost boundary of the reach. Reach characteristics are listed in Table 55.

Table 55. Reach location characteristics for Schweitzer Creek.

Name	Date	Type	Length (meters)	Latitude	Longitude
Schweitzer Creek	8/28/2015	Step-Pool	100	N48.355824	W116.601346

Stream classification for Schweitzer Creek was done according to Rosgen (2009). Characteristics for classification are listed in Table 56. Schweitzer Creek was a Rosgen “A” channel with a good width-to-depth ratio.

Table 56. Reach characteristics for Schweitzer Creek.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	16.1	14.5	24.2	18.3
Bankfull Depth (D_{bkf}), ft	0.85	1.00	0.59	2.05
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	18.9	14.5	41.0	20.0
Maximum Depth (D_{mbkf}), ft	2.0	1.7	1.35	1.68
Width of Flood-Prone Area (W_{fpa}), ft	24.9	36.0	34.8	31.9
Wetted Width, ft	12.3	11.2	9.6	11.0
Entrenchment Ratio (ER), ft/ft	1.55	2.48	1.44	1.82
Channel Materials (Particle Size index) D_{50}, mm	Data set was lost			
Water Surface Slope, %	7			
Rosgen Stream Type	A			

The following reach habitat assessment of Schweitzer Creek was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

The presence of LWD and woody debris jams in Schweitzer Creek were at reference conditions. LWD greater than 2 feet in diameter was abundant. Log jams were also abundant—some of them channel-spanning log jams (Figure 150). Recruitment potential of LWD was excellent.

Figure 150. Abundant large woody debris in Schweitzer Creek provides cover for aquatic life.

Bed Substrate Cover

Bed substrate in Schweitzer Creek was cobble-boulders in much of the study reach (Figure 151). The sediment was stable with some evidence of mobility and sorting. Substrate embeddedness was slight. The substrate was free of dense algae growth.

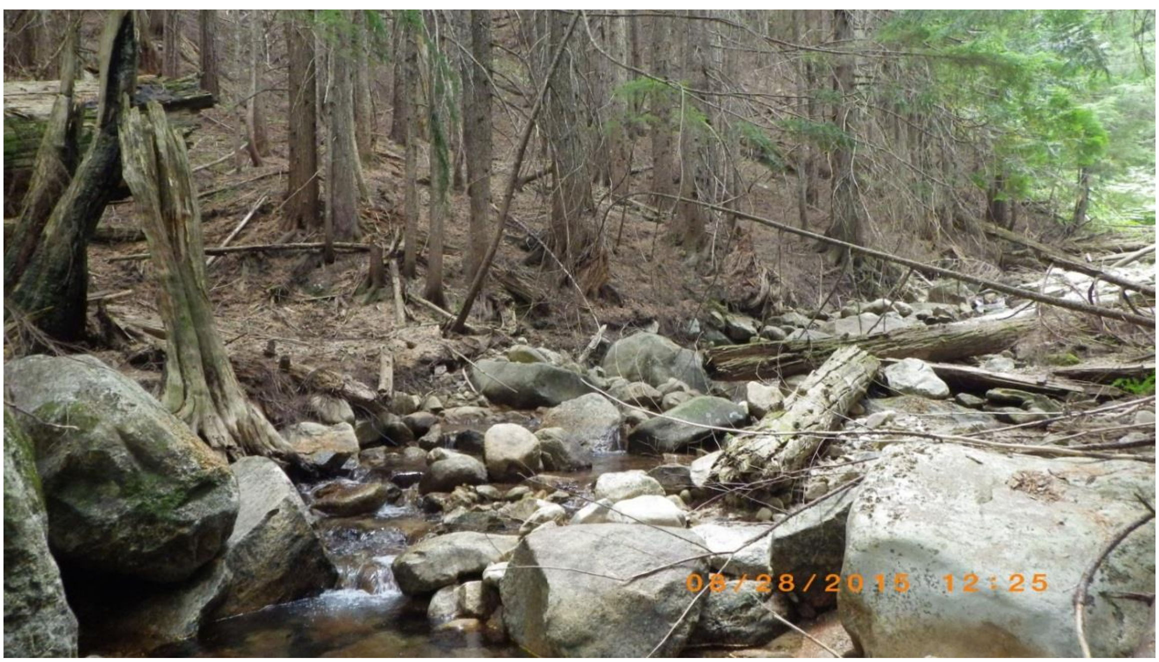


Figure 151. Cobble-dominated substrate in Schweitzer Creek.

Scour and Depositional Features

Pools are relatively abundant with good cover, providing refuge during all flow regimes (Figure 152). The pools were formed from abundant wood and the step-pool morphology, which was moderately well-formed and stable.

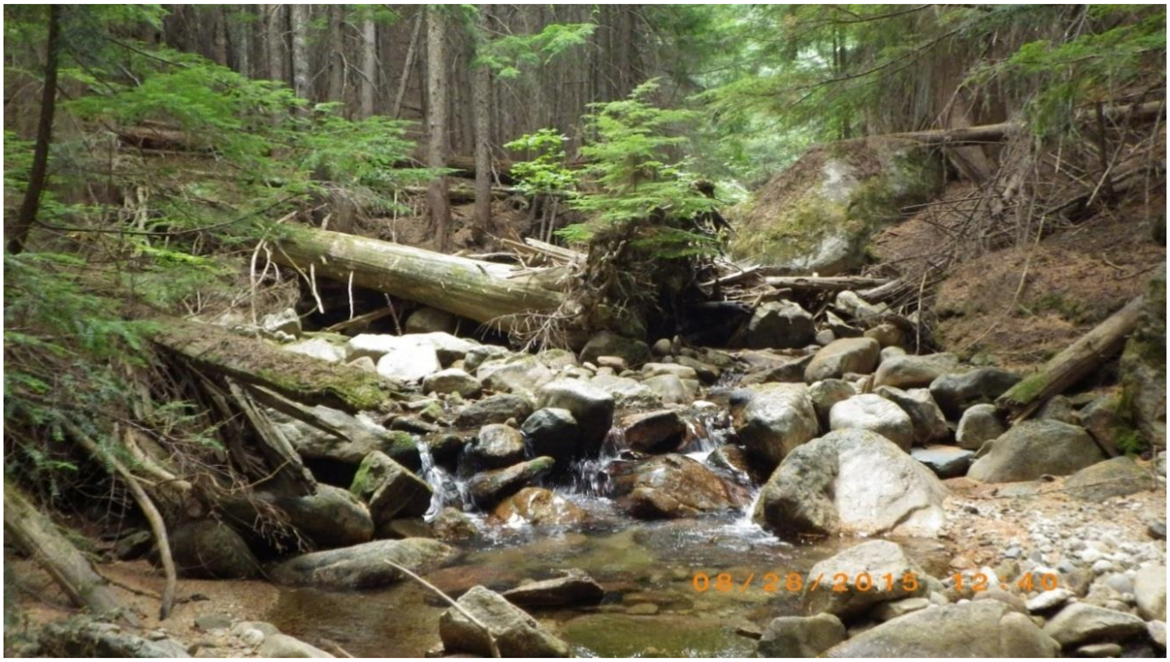


Figure 152. Pools in Schweitzer Creek provide relatively good refuge even in low flow years.

Channel Morphology

Schweitzer Creek had no evidence of channel alteration. The channel was somewhat over-widened and slightly entrenched, possibly due to the increased flow moving into the creek from development of Schweitzer Mountain Resort in the upper watershed.

Hydrologic Characteristics and Connectivity

Given it was an extreme low-flow year, the wetted width of Schweitzer Creek was good, with evidence of good refuge during high and low flow. No flow alteration existed on Schweitzer Creek. Due to minor entrenchment, there was little obstruction to floodplain connectivity. However, the floodplain was narrow due to the steep mountain side-slopes.

Streambanks

Streambank erosion and bank stability was good on Schweitzer Creek. Bank erosion was between 10 and 20%, a minor departure from reference conditions. Bank vegetation was somewhat diverse, creating good cover and streambank stability. Undercut banks were abundant with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency.

Riparian Area

The riparian area was composed of cedar and hemlock overstory with ferns and devil's club understory (Figure 153). The buffer width was between 150 and 200 feet with maximum channel canopy.

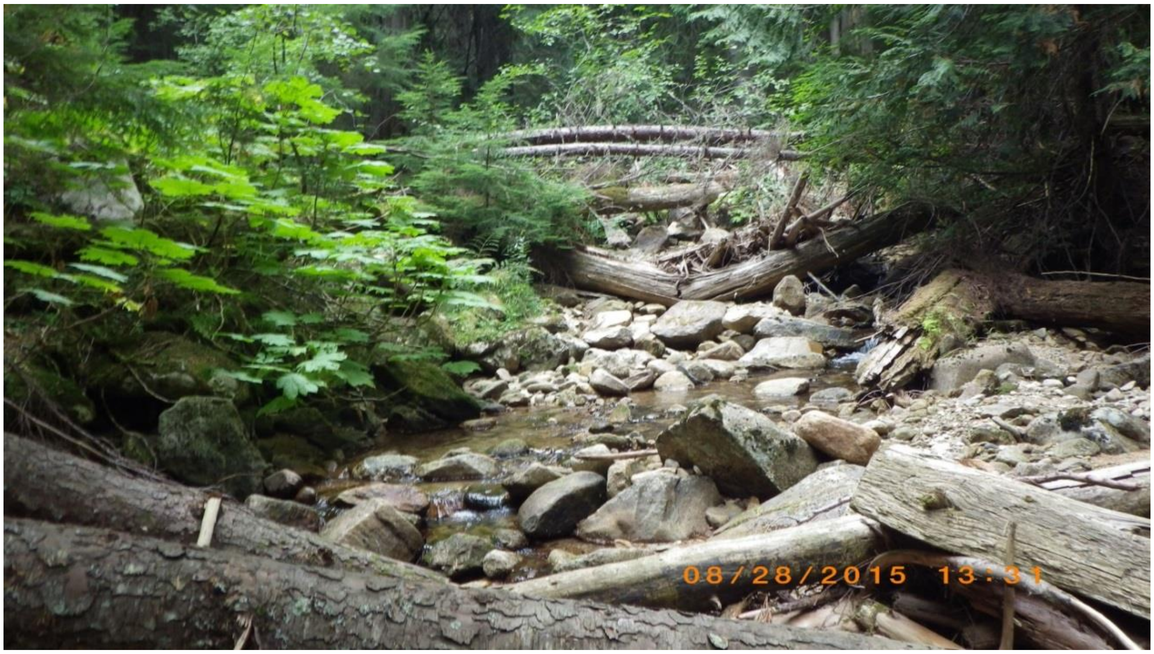


Figure 153. Dense riparian buffer at Schweitzer Creek.

Review of Implementation Plan and Activities

There are no known projects in the Schweitzer Creek watershed.

2015 Road Crossing Survey

In 2015, no road crossing survey was conducted within the Schweitzer Creek watershed.

TMDL Discussion

Schweitzer Creek is listed as not supporting the cold water aquatic life use due to sediment impairment. The listing is due to poor 1995 BURP scores. BURP scores in 2006 indicate the stream may be supporting both the aquatic life and salmonid spawning beneficial uses. Data collected in 2015 under this TMDL review suggest Schweitzer Creek below the Schweitzer Mountain complex was at a minor departure from reference conditions. Large wood was abundant and, in addition to the step-pool morphology of the creek, provided good habitat and refuge even at the extreme low-flow conditions. Streambank stability was excellent and the riparian buffer was well-vegetated with a fairly diverse assemblage of shrubs/trees. The Schweitzer Creek watershed in the headwaters is heavily developed by the Schweitzer Mountain Resort. The ski slopes are well-vegetated and likely contribute a minor load to Schweitzer Creek. The village at the base of Schweitzer Mountain has impervious surfaces and unvegetated surfaces that likely contribute stormwater/sediment to Schweitzer Creek. Schweitzer Creek is in steep terrain, making it a transporting reach through much of the creek. Therefore, any sediment from the headwaters is likely transported to Sand Creek.

The Pend Oreille tributaries sediment TMDL (DEQ and EPA 2007) assigned a 61% sediment load reduction requirement to the Sand Creek watershed. This includes Sand Creek, Swede Creek, Jack Creek, Schweitzer Creek, and Little Sand Creek. No load reductions were assigned to individual subwatersheds. Although recent data suggest Schweitzer Creek may be supporting beneficial uses, it is a transporting stream and is transporting stormwater with sediment from the Schweitzer Mountain Resort complex to Sand Creek. Revisiting Schweitzer Creek for evaluation using the BURP method should not be done until impervious surfaces and unvegetated surfaces are implemented with stormwater BMPs within the Schweitzer Mountain Resort complex. In addition, future expansion should be done carefully with adequate BMPs to avoid additional sediment sources to Schweitzer Creek.

5.2.13 Upper Pack River

The upper Pack River from the headwaters to Colburn Creek includes three AUs: Upper Pack River tributaries (ID17010214PN041_02), Pack River, Zuni Creek to Hellroaring Creek (ID17010214PN041_03), and Pack River Hellroaring Creek to Colburn Creek (ID17010214PN039_03). All three AUs are listed on Idaho's 2012 Integrated Report as not supporting the aquatic life beneficial use due to phosphorus, sediment, and temperature. The salmonid spawning beneficial use is impaired due to temperature.

Idaho Beneficial Use Reconnaissance Program

Pack River, Zuni Creek to Hellroaring Creek (ID17010214PN041_03)

On August 22, 206, DEQ evaluated the upper Pack River downstream of Martin Creek using the BURP method (Table 56). Streamflow was 21.56 cfs. Water temperature was 20 ºC and conductivity was 23.2 µS/cm. The upper Pack River in the study reach was an over-widened 3rd-order Rosgen "C" channel. The study reach had a low abundance of pools, with a lack of pool variability. Instream cover was good. Percent fines were less than 6%, and the channel substrate was slightly embedded. The macroinvertebrate scores under this were excellent. No fish data were collected.

On July 29, 2008, DEQ evaluated the upper Pack River downstream of Martin Creek using the BURP method (Table 57). Streamflow was 31.75 cfs. Water temperature was 12.2 ºC and conductivity was 18.5 µS/cm. The channel had good pool habitat; however, pool variability was compromised due to the lack of LWD. Instream cover was excellent. Percent fines in the study reach were less than 5%, and the channel substrate was slightly embedded. Streambank conditions were excellent, with good vegetation and minimal streambank erosion. The macroinvertebrate scores under this effort are not reliable due to insufficient number of macroinvertebrates sampled. The electrofishing data may also be unreliable under this effort due to the large cobble substrate.

On July 22, 2014, DEQ evaluated the upper Pack River downstream of Martin Creek using the BURP method. Streamflow was 37.34 cfs. Water temperature was 13.1 ºC; pH was 7.28; and conductivity was 13 µS/cm. Stream conditions remained the same as described above for the 2008 effort. Macroinvertebrate and fish sampling were again unreliable.

Table 57. Beneficial Use Reconnaissance Program data for upper Pack River, Zuni Creek to Hellroaring Creek (ID17010214PN041_03).

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2014SCDAA027	68.43	3.00	25.80	0.00	72.00	3.00	0.00
2008SCDAA041	49.35	1.00	50.98	1.00	64.00	2.00	1.33
2006SCDAA052	66.53	3.00	—	—	67.00	3.00	3.00

Pack River, Hellroaring Creek to Colburn Creek (ID17010214PN039_03)

On August 23, 2006, DEQ evaluated the upper Pack River near the mouth of Caribou Creek using the BURP method (Table 58). Streamflow was 17.5 cfs. Water temperature was 12.7 ºC and conductivity was 23 µS/cm. The upper Pack River in the study reach was an over-widened 3rd-order Rosgen "C" channel. The channel had good pool habitat; however, pool variability and cover was compromised primarily due to the lack of LWD. Instream cover was good. Percent fines in the study reach were less than 5%, and the channel substrate was slightly embedded. Streambank conditions were excellent, with good vegetation and minimal streambank erosion. The macroinvertebrate data under this effort was determined to be reliable, and the scores indicate poor macroinvertebrate scores. Fish were not collected under this effort.

Table 58. Beneficial Use Reconnaissance Program data for Pack River, Hellroaring Creek to Colburn Creek (ID17010214PN039_03).

BURP ID	SMI		SFI		SHI		Average Score
	Rating	Score	Rating	Score	Rating	Score	
2006SCDAA053	55.09	1.00	—	—	63.00	2.00	1.5
2004SCDAA070	Unwadeable reach						

Stressor Identification

In 2006, TerraGraphics conducted a stressor identification analysis to determine the nature of the "unknown" pollutant cause to beneficial use impairment on upper Pack River (TerraGraphics 2006f). The analysis was based on 1998 BURP scores on two tributaries (Youngs Creek and Martin Creek) and 2003 BURP data for the upper Pack River. The analysis concluded the upper Pack River had relatively few fines within the stream channel. However, fine sediment was greater than 25% in both Youngs and Martin Creeks. The Youngs Creek aquatic community did not exhibit impairment; however, there was excessive sediment due to the percent fine sediment in the streambed. Based on this analysis, it was concluded that a TMDL for sediment was appropriate for the lower portion of AU ID17010214PN41_02, which included Martin, Youngs, Lindsey, Person, and Homestead watersheds. The upper Pack River was determined to not require additional sediment reduction, so a TMDL was not recommended.

Changes in Subbasin Characteristics

Forest Cover Change

Since 2000, forest cover change in the upper Pack River watershed was primarily in the Hellroaring Creek and Lindsey Creek watersheds, where approximately 1,100 acres were harvested (Figure 154). In this part of the watershed, the forest is regenerating from the impact of the 1967 Sundance Fire.

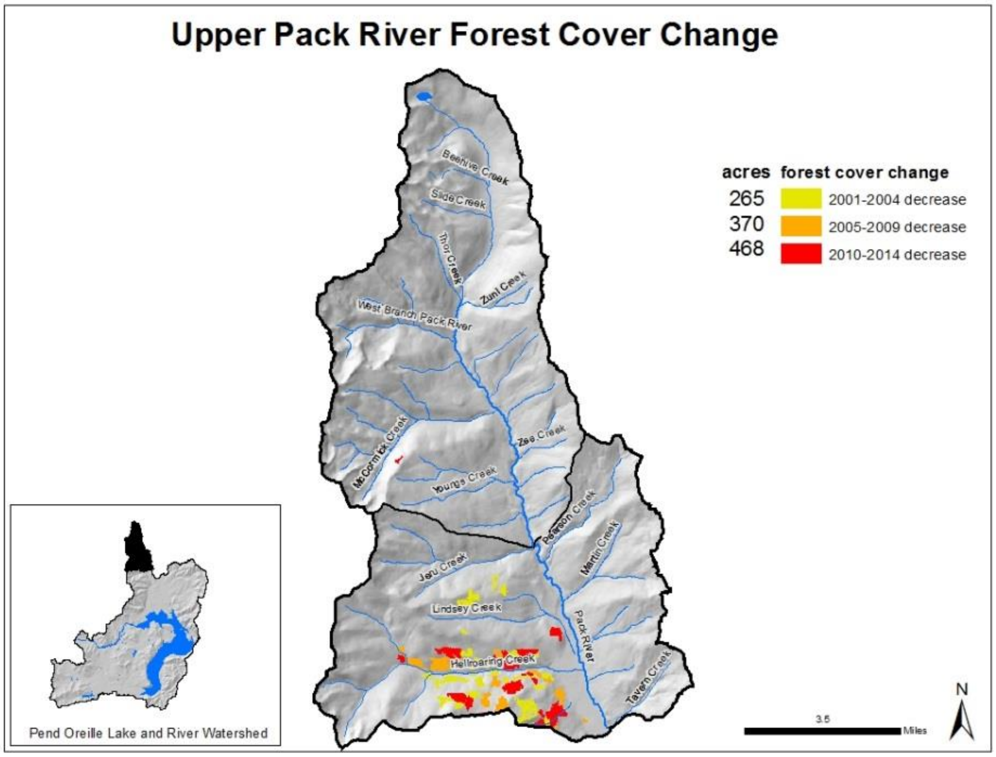


Figure 154. Forest canopy change in the upper Pack River watershed, 2001 to 2014.

Roads

Because the upper Pack River is managed primarily by the USFS, DEQ evaluated USFS GIS coverage for roads (Figure 155). Except for the Pack River Road, most of the upper Pack River watershed is roadless.

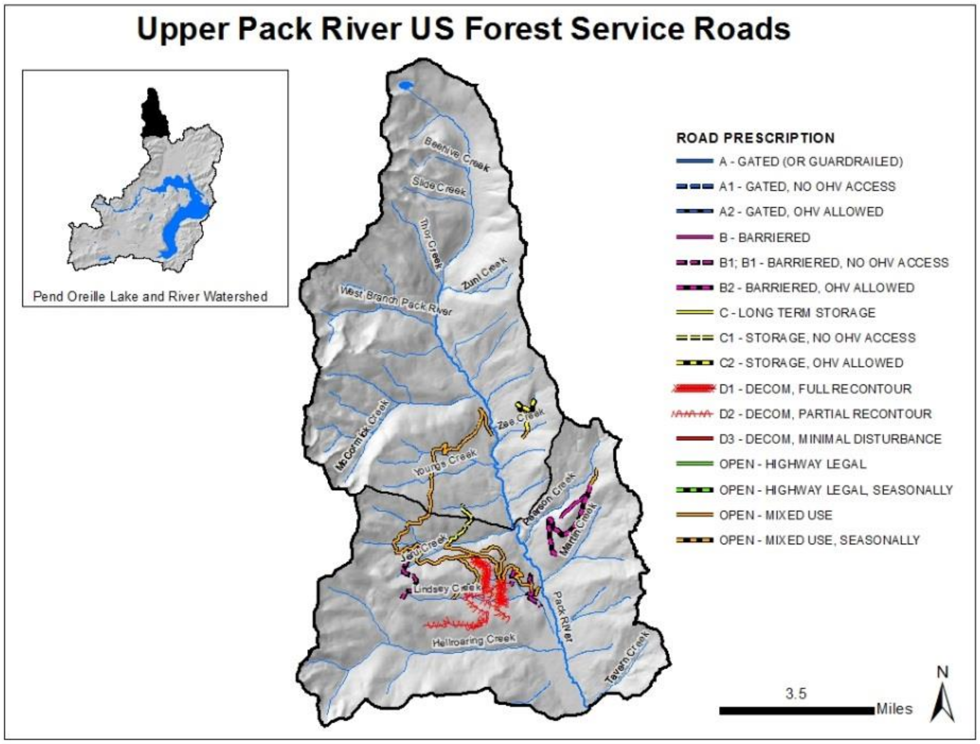


Figure 155. US Forest Service roads, upper Pack River watershed.

Pack River Stream Channel Assessment

In September 2002, AVISTA Utilities provided funding to the Pack River Watershed Council Technical Advisory Committee to conduct an inventory of geomorphic and habitat conditions in the Pack River. The information was later used in the Pack River Watershed Management Plan (PRTAC 2004) and the TMDL implementation plan (Bonner Soil and Water Conservation District, et. al 2006). The inventory was conducted by Golder and Associates (2003). The assessment included 40 continuous miles of the Pack River from the Zuni Creek confluence to the confluence with Lake Pend Oreille. Important geomorphic features were characterized using the Rosgen stream classification method (Rosgen 1994). Vegetation communities were evaluated using the “greenline” method described in Winward (2000). Fish habitat was evaluated using the R1R4 Fish and Fish Habitat Survey (Overton et al. 1997).

The river was broken into 54 continuous subreaches based on river gradient changes and gradation in substrate size. The subreaches were grouped into larger reach segments. The reach segments in the upper Pack River watershed were as follows:

- Reach A: Zuni Creek confluence to McCormick Creek confluence (ID17010214PN041_03)
- Reach B: McCormick Creek confluence to Hellroaring Creek confluence (ID17010214PN041_03)
- Reach C: Hellroaring Creek confluence to 2 miles downstream of Caribou Creek (ID17010214PN039_03)

- Reach D: 2 miles downstream of Caribou Creek confluence to US 95 bridge (ID17010214PN039_03 and ID17010214PN039_04)
- Reach E extends from the US 95 bridge to US 200 bridge (AU ID17010214PN039_04)

Reach A

Reach A is the upper reach of AU ID17010214PN041_03 and a Rosgen B-type channel. After the Sundance Fire, the loss of slope and streambank stabilizing vegetation had a profound influence on sediment transport in the system. As such, bedload transport increased considerably in this reach. Since the fire, bedload has moved through the headwater reaches of the Pack River, vegetation has recovered, and geomorphic stability increased.

Results of the Pack River stream channel assessment indicate Reach A was in a stable geomorphic condition. Furthermore, of the 8 subreaches evaluated under this study, only 3 deviated from the reference conditions due to width-depth, entrenchment, and slope. Vegetation conditions in Reach A indicated reference conditions for a western red cedar vegetation type with subdominant alder or willow. Only 2 subreaches deviated from the reference condition. Pool habitat in Reach A was abundant and diverse, with pools formed from boulder scour and LWD. However, LWD was below reference condition in 5 of the subreaches.

Reach B

Reach B is in the lower reach of AU ID17010214PN041_03 and is a Rosgen B-type channel with low-to-moderate gradient, gentle side-slopes, and cobble/boulder-gravel substrate. Over half of the subreaches were in a stable geomorphic condition. Other subreaches were functioning slightly at risk or diverged from the reference condition, primarily due to width/depth ratios higher than reference condition. This subreach had well-vegetated banks with good stability; however, the vegetation lacked late-seral habitat. Pool habitat was a considerable divergence from reference condition due to the lack of LWD and the lack of large boulders.

Reach C

Reach C is in AU ID17010214PN039_03. A change in gradient and substrate size occurs at Reach C, which is an unstable Rosgen C- and F-type channel. The subreaches in this reach diverge significantly from reference conditions. Vegetation is of the early-seral type, dominated by willow. Pool habitat was significantly reduced due to lack of boulders and LWD.

Reach D

Reach D is in AU ID17010214PN039_03 and ID17010214PN039_04. Like Reach C, it was primarily unstable, entrenched Rosgen C and F channel types. All but two of the subreaches diverged significantly from the reference condition. Unlike Reach C, vegetation in Reach D included late-seral species but in significantly less density than reference condition. The entrenched condition of the stream precluded a natural riparian vegetation community. LWD was more abundant in Reach D than Reach C, providing more diverse habitat for migrating fish; however, large wood abundance was far less than the reference condition. Pool habitat from boulder scour was more abundant in Reach D than in Reach C.

Reach E

Reach E extends from the US 95 bridge to US 200 bridge and is in AU ID17010214PN039_04. It is a low-gradient, over-widened, and entrenched Rosgen C channel with a dominant substrate of fine gravel and sand. Vegetation was of the early-seral type, dominated by willow. Invasive species such as common tansy and Canada thistle were found throughout this reach. Slow, deep habitat important for salmonid migration was lacking, and pool habitat was significantly reduced due to lack of LWD.

Fisheries Data

IDFG and AVISTA Utilities have been conducting Bull Trout redd surveys on the Pack River near the USFS Road 231 bridge near McCormick Creek, 0.4 km downstream of W. Branch Pack River within AU ID17010214PN041_03. Redds have declined since 2005 (Figure 156). IDFG and AVISTA qualify redd count data due to variability in survey conditions, spawning timing, and surveyors.

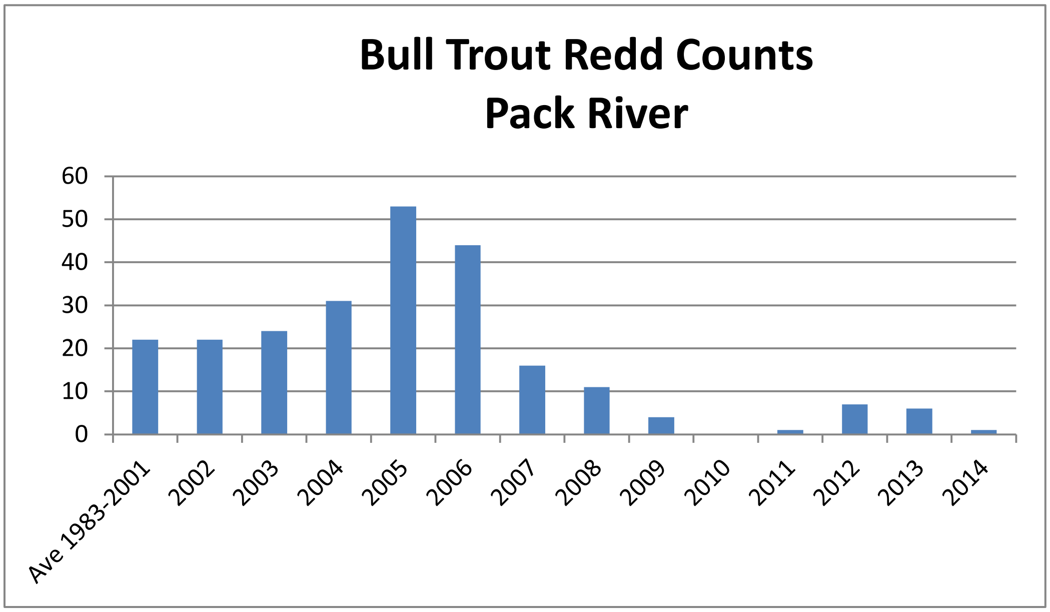


Figure 156. Bull Trout redd counts in the Pack River near McCormick Creek confluence.

2015 DEQ Stream Evaluation

In 2015, DEQ evaluated two 100-meter stream reaches in the upper Pack River (AU ID17010214PN041_03) using a modified method described in Rosgen (2006), the Vermont Agency of Natural Resources Reach Habitat Assessment (VANR 2008), and Wolman (1954). The stream reach described as "upper Pack River 1" was located just downstream of McCormick Creek. The stream reach described as "upper Pack River 2" was downstream of Martin Creek (Table 59). Both study reaches are illustrated in Figure 3 (in Section 5.5.1).

Table 59. Reach location for upper Pack River.

Name	Date	Type	Length (meters)	Latitude	Longitude
Upper Pack River 1	10/5/2016	Riffle-pool	100	N48.573900	W116.610885
Upper Pack River 2	10/8/2016	Riffle-pool	100	N48.516506	W116.580696

Upper Pack River 1

Upper Pack River 1 is located just downstream of the McCormick Creek confluence. Reach characteristics for Upper Pack River 1 are listed in Table 60.

Table 60. Reach characteristics for upper Pack River 1.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	26.4	23.5	20.5	23.5
Bankfull Depth (D_{bkf}), ft	1.10	0.59	0.66	0.78
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	22.2	39.8	31.1	31.0
Maximum Depth (D_{mbkf}), ft	1.9	1.6	1.7	1.7
Width of Flood-Prone Area (W_{fpa}), ft	35.0	30.8	29.6	31.8
Wetted Width, ft	21.6	16.5	15.2	17.8
Entrenchment Ratio (ER), ft/ft	1.3	1.3	1.4	1.3
Channel Materials (Particle Size index) D_{50}, mm	Small cobble (64–128 mm)	Large cobble (128–256 mm)		
Water Surface Slope, %	2.5	4.0	3.5	3.3
Rosgen Stream Type	B			

The following reach habitat assessment of upper Pack River 1 was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology is good.

Woody Debris Cover

Upper Pack River 1 had a very low abundance of LWD, a major–severe departure from reference conditions. Recruitment of LWD was low.

Bed Substrate Cover

Bed substrate in upper Pack River 1 was small cobble to large cobble (Figure 157). The substrate had some evidence of sediment mobility and lack of sorting. In this reach, the substrate was 40–75% embedded in the riffles and 60–80% embedded in the pools. The substrate had patches of dense algae growth (Figure 158).

Figure 157. Large cobble-boulder substrate on upper Pack River 1.

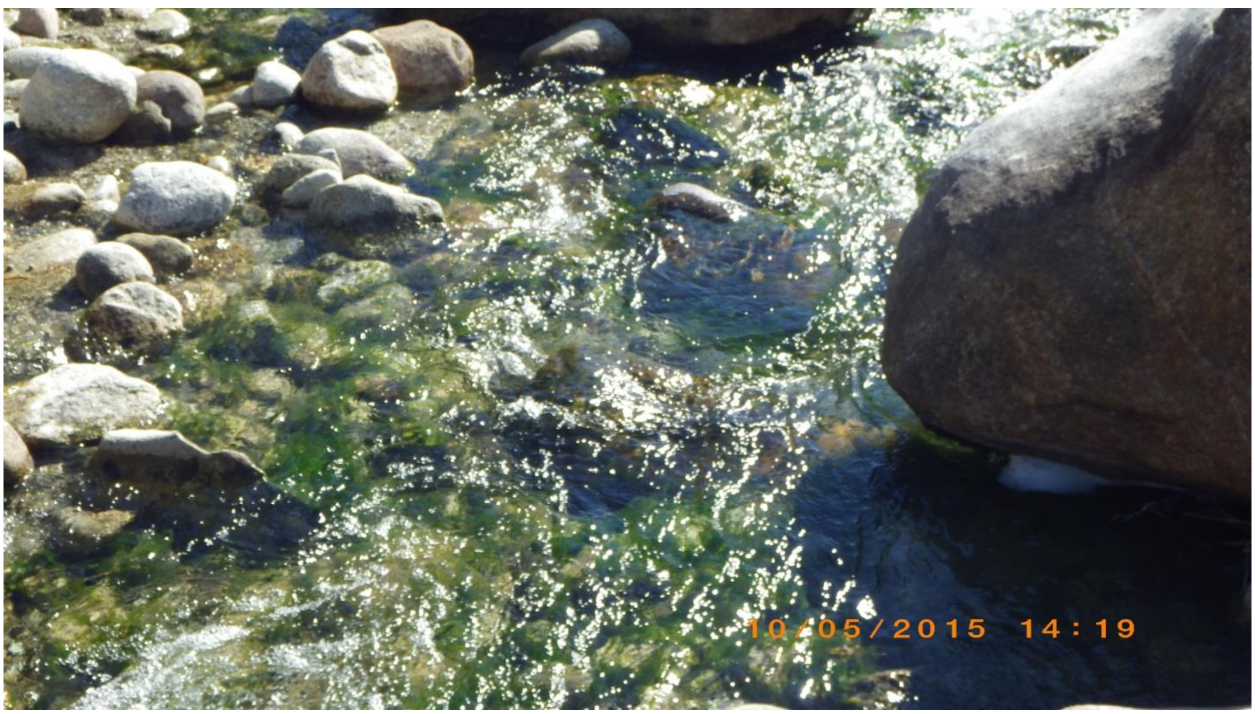


Figure 158. Algae growth on substrate in upper Pack River 1.

Scour and Depositional Features

Upper Pack River 1 had an abundance of pools with good cover providing refuge during all flow regimes (Figure 159), showing a minor departure from reference conditions. The pools were formed from boulders. Pool morphology diversity was low due to a lack of LWD. The study reach had good riffle spacing between 7 and 12 bankfull widths. Abundant mayflies were observed in this reach.

Figure 159. Abundant pools in the upper Pack River.

Channel Morphology

Upper Pack River 1 was considerably over-widened and entrenched, with steep, erosive banks. Major evidence of channel alteration from fire, most likely the Sundance Fire, was seen throughout the reach (Figure 160).

Figure 160. Steep, eroding bank on upper Pack River 1.

Hydrologic Characteristics and Connectivity

Given it was an extreme low-flow year, the wetted width of upper Pack River 1 was good, with an abundance of refuge during high and low flow. No flow alteration existed on upper Pack River 1. Due to channel entrenchment and the presence of the road near the river, there was minimal floodplain connectivity.

Streambanks

Streambank erosion was evident on entrenched, unvegetated banks. Plants provided no cover and roots did not stabilize banks. The lack of vegetation could also have been attributed to the presence of very large boulders occupying the streambank. No undercut banks were observed in the study reach.

Riparian Area

The riparian area vegetation was sparse with a buffer width of less than 50 feet due to the presence of Pack River Road. On the other streambank, the riparian buffer was between 40 and 100 feet wide. Within the study reach, riparian plant diversity was low.

Upper Pack River 2

Upper Pack River 2 is located just downstream of the Martin Creek confluence. Reach characteristics for Upper Pack River 2 are listed in Table 61.

Table 61. Reach characteristics for Upper Pack River 2.

Measurement	Cross Section			Average
	#1	#2	#3	
Bankfull Width (W_{bkf}), ft	56.9	57.0	47.3	53.7
Bankfull Depth (D_{bkf}), ft	0.76	0.69	0.87	0.77
Width/Depth Ratio (W_{bkf}/D_{bkf}), ft/ft	74.9	82.6	54.4	70.6
Maximum Depth (D_{mbkf}), ft	1.5	1.5	1.6	1.5
Width of Flood-Prone Area (W_{fpa}), ft	66.5	67.8	62.7	65.6
Wetted Width, ft	50.6	47.8	43.2	47.2
Entrenchment Ratio (ER), ft/ft	1.2	1.2	1.3	1.2
Channel Materials (Particle Size index) D_{50}, mm	Large cobble (256–512 mm)			
Water Surface Slope, %	1	1	1	
Rosgen Stream Type	F			

The following reach habitat assessment of upper Pack River 2 was completed according to Milone & MacBroom, Inc. (2008) for a step-pool stream type. The overall physical habitat conditioning score using this methodology was good.

Woody Debris Cover

Upper Pack River 2 had a very low abundance of LWD, a major–severe departure from reference conditions and despite the moderate recruitment potential of LWD.

Bed Substrate Cover

Bed substrate in upper Pack River 2 was large cobble. The substrate had some evidence of sediment mobility and lack of sorting. In this reach, the substrate was somewhat (20–40%) embedded in the riffles and somewhat (40–60%) embedded in the pools. The substrate had patches of dense algae growth (Figure 161).

Figure 161. Algae growth on substrate—Pack River.

Scour and Depositional Features

Upper Pack River 2 had an abundance of pools with good cover providing refuge during all flow regimes, a minor departure from reference conditions. Due to the lack of LWD, the pools were primarily formed from boulders. The study reach had good riffle spacing between 7 and 10 bankfull widths.

Channel Morphology

Upper Pack River 2 was considerably over-widened and entrenched, with steep, erosive banks (Figure 162). Major evidence of channel alteration from fire, most likely the Sundance Fire, was found throughout the reach.

Figure 162. Channel entrenchment, upper Pack River 2.

Hydrologic Characteristics and Connectivity

Given the extreme low-flow year, the wetted width of upper Pack River 2 was good, with an abundance of refuge during high and low flow (Figure 163). No flow alteration existed on upper Pack River 2.

Figure 163. Low flow in upper Pack River 2.

Streambanks

Streambank erosion was evident on entrenched, unvegetated banks. Non-entrenched banks were well vegetated with a diverse assemblage of plants creating good cover and bank stabilization (Figure 164). The bank canopy was good, providing cover near the banks. Undercut banks in the study reach were in abundance, with some unstable boundaries or reduced overhanging vegetation. Mass failures were also observed in the study reach.

Figure 164. Riparian area in upper Pack River 2.

Riparian Area

The riparian buffer was greater than 150 feet. However, the river was near the Pack River Road at the upper end of the reach, and the riparian buffer was less than 50 feet. The riparian vegetation was in good condition with maximum channel canopy and minimal invasive plants.

2015 Road Crossing Survey

In 2015, DEQ conducted a survey of six road crossings along the Pack River Road (Table 62). Four of the six road crossings were in good condition, three with no/low erosion severity. Culvert 3 was in good condition; however, erosion severity was classified as medium due to the gully erosion from the road ditch to culvert 3 into the stream channel (Figure 165) and gully erosion near the outlet of the culvert 3 (Figure 166). Bridge 2 was in new condition; however, a mass failure of the hillslope occurred just upstream of the bridge (Figure 167). One bridge was in excellent condition. There was abundant sediment in the Pack River (Figure 168). In general, the Pack River Road was well-maintained with adequate relief of drainage off the road prism.

Table 62. Stream crossing condition, Pack River Road.

Type of Crossing	Latitude	Longitude	Erosion Severity	Overall Condition	Fish Barrier?
Culvert 1 & 2: round corrugated steel, ellipse corrugated steel	N 48.492948	W 116.575712	Low	Good	No
Culvert 3: round corrugated steel	N 48.555194	W 116.607667	None	Good	Yes
Culvert 4: round corrugated steel	N 48.558106	W 116.609489	Medium	Good	No
Bridge 1: steel	N 48.576494	W 116.612055	Low	Excellent	No
Culvert 5: round corrugated aluminum	N 48.592878	W 116.629114	None	Good	No
Bridge 2: steel and timber	N 48.612772	W 116.632530	High	Fair	No

Figure 165. Gully erosion in road ditch draining into culvert 3, Pack River Road.

Figure 166. Gully erosion near outlet of culvert 3, Pack River Road.

Figure 167. Mass failure upstream of upper Pack River.

Figure 168. Excessive sediment from mass failure in upper Pack River.

Review of Implementation Plan and Activities

Pack River Management Plan

In 2000, about 40 landowners living in the Pack River watershed joined to create the Pack River Watershed Council (PRWC). The PRWC formed a collaborative partnership between the following agencies: the Tri-State Water Quality Council, the Bonner Soil and Water Conservation District, and the NRCS. This partnership recruited a technical advisory committee (TAC), a group of professionals of various expertise with interest in the Pack River watershed.

In 2001, the TAC convened and developed the comprehensive watershed management plan that would protect the natural resources of the Pack River and its tributaries (PRTAC 2004). This plan serves as an implementation plan for the Clark Fork/Pend Oreille TMDL (DEQ 2001). The plan addresses diverse land uses along with natural resource and habitat issues and provides strategies for education, on-the-ground improvements, program coordination, and monitoring to protect natural resources in the Pack River watershed. The goals of the plan include to return the river to full support of beneficial uses; use consistent standards when planning and implementing restoration projects; ensure floodplain accessibility; maintain wetlands; reduce pollution from logging, agriculture, and development; improve habitat and river conditions for migration and spawning of Bull Trout; enact zoning regulations; and enforce existing regulations. The plan identifies partners and resource agencies responsible for implementing the goals.

Pack River Watershed Council

The mission of the PRWC is "to improve water quality and riparian habitat in the Pack River watershed for people, fish, and wildlife through education, collaboration, and cooperative projects." The council has been active in the Pack River watershed, implementing a program to improve water quality by doing the following:

- Developing a water quality monitoring program with students from local high schools
- Informing and educating stakeholders on water quality issues and empowering them to take appropriate action with technical assistance
- Developing a cohesive strategy for long-term monitoring and protection
- Coordinating restoration projects and funding with private landowners and agencies

Natural Resources Conservation Service and Local Conservation District

The NRCS and agency partners have conducted the following projects in the Pack River watershed between 2007 and 2015:

- Streambank/shoreline protection 1,946 feet
- Tree/shrub establishment 9 acres
- Fencing 10,092 feet
- Seasonal high tunnel 2,152 feet
- Waste management system 1
- Forest harvest trails/landing 1 acre
- Nutrient management 14.4 acres
- Prescribed grazing 170.2 acres
- Pasture/hay/biomass 87.5 acres
- Forest stand improvement 36.5 acres
- Conservation cover 6.9 acres
- Pipeline 1,771 feet
- Brush management 4.5 acres
- Pest management 52.8 acres
- Forest slash treatment 22 acres
- Watering facility 1

TMDL Discussion

In 1998, the Pack River was listed on Idaho's §303(d) list for nutrients, sediment, dissolved oxygen, habitat alterations, pathogens, and pesticide pollution. The conclusion of the Clark Fork/Pend Oreille TMDL was that the Pack River was water quality limited due to excess sediment and nutrients. A pollutant source inventory indicated five primary nonpoint sources of pollution: urbanization, roads, wildfire, agriculture/livestock grazing, and timber harvest. No point sources of pollutants were identified.

The analysis of the Pack River watershed based much of its conclusions on a 1998 IDL CWE analysis that found the following:

- Sediment delivery from forest practices to the upper watershed was low.
- There were no hydrologic adverse conditions in the Pack River headwaters.
- Forest management practices as specified by the Idaho Forest Practices Act are adequate to protect water quality and beneficial uses for the forested portions of the Pack River headwaters watershed.

It concludes that sources of pollution impairing beneficial uses in the main stem Pack River were occurring in places other than the Pack River headwaters, such as tributary streams and lower reaches of the Pack River.

The sediment modeling exercise under the TMDL was run on the “lower Pack River” watershed, which included the following tributaries to the Pack River (although many of them would not be classified as being in the “lower Pack River watershed” and have been categorized as upper Pack River tributaries in this report): Pack headwaters, McCormick Creek, minor mid-Pack, minor lower-Pack, North Fork Grouse, Grouse, Lower Grouse, Gold Creek, Rapid Lightning Creek, Trout Creek, Lindsey Creek, Hellroaring Creek, Caribou Creek, Berry Creek, Sand Creek, and Colburn Creek.

The TMDL assigned a target load to the “lower” Pack River watershed based on the assumption of land use historically present in the watershed. However, there are uncertainties in how this number was calculated: (1) estimates of historical land use type and percentages of those land use types were not documented and (2) the total acreage used to calculate target loads in the lower Pack River analysis is significantly lower than the sum of the individual subwatershed acreages listed in the tables provided in the TMDL. The TMDL calculated a 74% sediment load reduction requirement for the lower Pack River watershed. It did not assign load reductions to individual subwatersheds. The load reductions were established to meet the target load for the lower Pack River watershed. The target load was calculated for a portion of acreage in the lower Pack River watershed using “historical” acreage of forested and unforested land. However, the TMDL did not explain how that acreage was determined. The existing loads for all subwatersheds were added up and the load reduction was calculated for the upper Pack River.

Results of BURP monitoring indicate the upper Pack River may be supporting beneficial uses. Stream habitat and streambank stability was excellent with abundant pools. However, the upper Pack River does lack large wood. Fish data collected under BURP in 2008 and 2014 were not reliable. IDFG Bull Trout redd surveys show a steady decline since 2003 in Bull Trout redds in the upper Pack River.

Results of the Pack River stream channel assessment indicated the upper Pack River from the headwaters to the Hellroaring Creek confluence was in a stable geomorphic condition, with stability decreasing downstream. Vegetation conditions above Hellroaring Creek indicated reference conditions for a western red cedar vegetation type with subdominant alder or willow. Pool habitat in this reach was abundant and diverse, with pools formed from boulder scour and LWD. However, LWD abundance decreased moving downstream in this reach. In areas where LWD and pool habitat is lacking, projects to introduce wood and habitat complexity are recommended. In addition, riparian area enhancement through planting in areas that lack abundant vegetation will help with streambank stability and decrease erosion.

Results of DEQ’s stream habitat assessment indicate similar results as the BURP assessment and the Pack River stream channel assessment. The only problem noted was isolated highly erosive streambanks and the lack of large wood.

The upper Pack River is trending toward full support of beneficial uses. Reference reach conditions exist in much of the AU. Increased LWD would enhance pool diversity, sediment storage, and channel stability. Projects should be implemented that introduce large wood to this

AU. Due to the unreliability of fish data collected under BURP, fish data should be collected again under more efficient and reliable electrofishing efforts.

5.2.14 Lower Pack River

The lower Pack River from Colburn Creek to the mouth includes two AUs: Colburn Creek to Sand Creek (ID17010214PN039_04) and Sand Creek to the mouth (ID17010214PN031_04). Both AUs are listed on Idaho's 2012 Integrated Report as not supporting the aquatic life beneficial use due to phosphorus, sediment, and temperature. The salmonid spawning beneficial use is impaired due to temperature.

The Pack River is a migratory corridor for mature adfluvial Bull Trout. It is likely also a migratory corridor for Westslope Cutthroat Trout. Bull Trout migrate into spawning tributaries between May and October, with peak spawning in September. Adfluvial Westslope Cutthroat Trout spawn between March and July (PRTAC 2004).

Idaho Beneficial Use Reconnaissance (BURP)

This reach is too large for evaluation using Idaho's BURP method, which is only suitable for wadeable streams.

Pack River Stream Channel Assessment

In September 2002, AVISTA Utilities provided funding to the PRWC TAC to inventory geomorphic and habitat conditions in the Pack River. The information was later used in the Pack River Watershed Management Plan (PRTAC 2004) and the TMDL implementation plan (Bonner Soil and Water Conservation District 2006). The inventory was conducted by Golder and Associates (2003). The assessment included 40 continuous miles of the Pack River from the Zuni Creek confluence to the confluence with Lake Pend Oreille. Important geomorphic features were characterized using the Rosgen stream classification method (Rosgen 1994). Vegetation communities were evaluated using the "greenline" method described in Winward (2000). Fish habitat was evaluated using the R1R4 Fish and Fish Habitat Survey (Overton et al. 1997).

The river was broken into 54 continuous subreaches based on river gradient changes and gradation in substrate size. The subreaches in the lower Pack River are as follows:

- Reach E: US 95 bridge to near Highway 200 bridge (ID17010214PN039_04 and ID17010214PN031_04)
- Reach F: near Highway 200 bridge to confluence with Lake Pend Oreille (ID17010214PN031_04)

Reach E

Reach E is a low-gradient, over-widened, and entrenched Rosgen C channel with a dominant substrate of fine gravel and sand. Vegetation was of the early-seral type, dominated by willow. Invasive species such as reed canarygrass, common tansy, and Canada thistle were found throughout this reach. Slow, deep habitat important for salmonid migration was lacking, and pool habitat was significantly reduced due to lack of LWD.

Reach F

Reach F is inundated much of the year by Lake Pend Oreille, so the reach has more lentic, wetland characteristics. Hydrophytic vegetation such as bulrush and cattails predominated in this reach.

Fisheries Data

No fisheries data have been collected on the lower Pack River.

2015 DEQ River Evaluation

In May 2015, personnel from DEQ and the NRCS evaluated the lower Pack River by floating approximately 4.9 miles from the Colburn Bridge to the north of the intersection of Colburn Culver Rd. and Selle Rd. Overall, the channel was entrenched with excessively eroding banks and banks that were poorly vegetated with a lack of bank stability (Figure 169, Figure 170). The erosive process was through lateral migration of the channel and mass bank failure (Figure 171, Figure 172). The channel itself lacked the complexity in pool habitat and cover provided by large wood. Given this reach serves as a migratory passage habitat for salmonids, large wood projects to enhance pool habitat and refuge are needed.

Figure 169. Eroding riverbank on the lower Pack River.

Figure 170. Poorly stabilized riverbank on the lower Pack River.

Figure 171. Slumping riverbank on lower Pack River.

Figure 172. Eroding riverbanks on the Pack River.

Review of Implementation Plan and Activities

Pack River Management Plan

For information about the Pack River management plan, PRWC, and a list of BMPs implemented in the entire Pack River watershed, see the "Review of Implementation Plan and Activities" section for the upper Pack River (page 207).

Pack River TMDL Implementation Plan for Agriculture

In 2007, the Idaho Association of Soil Conservation Districts—in cooperation with Bonner Soil and Water Conservation District, Idaho Soil Conservation Commission, and the NRCS—developed the Pack River TMDL Implementation Plan for Agriculture (Bonner Soil and Water Conservation District (2006). In the lower portion of the Pack River watershed, the river valley widens and the slope decreases, providing more suitable land for agriculture. Sand Creek, Grouse Creek, Gold Creek, and the main stem lower Pack River are high priority for agriculture in the form of hay production and livestock grazing. A list of BMPs implemented in the entire Pack River watershed is listed under the review of implementation activities for the upper Pack River (page 207).

TMDL Discussion

In 1998, the Pack River was listed on Idaho's §303(d) list for nutrients, sediment, dissolved oxygen, habitat alterations, pathogens, and pesticide pollution. Grouse Creek was the only tributary to the Pack River that was listed on this §303(d) list, and it was only listed for temperature. The conclusion of the problem assessment under the Clark Fork/Pend Oreille TMDL was that the Pack River was water quality limited due to excess sediment and nutrients. It concluded that sources of pollution impairing beneficial uses in the main stem Pack River were occurring in places other than the Pack River headwaters, such as tributary streams and lower reaches of the Pack River. The loading analysis in the TMDL concludes the "minor lower-Pack tributaries" and the "minor mid-Pack tributaries" were the largest and the third-largest sediment loading sources to the Pack River, respectively. The TMDL does not specify which tributaries are included in this classification, and all tributaries represented on the National Hydrography Dataset have individual AUs, so it is unknown what "minor tributaries" the TMDL is referring to. Nonetheless, the TMDL calculated a 74% sediment load reduction requirement for the lower Pack River watershed. It did not assign load reductions to individual subwatersheds. The load reductions were established to meet the target load for the lower Pack River watershed.

Given the abundance of excessively eroding banks and the lack of pool habitat and refuge for migrating fish, the aquatic life beneficial use in the lower Pack River is still impaired. Projects that introduce large wood and stabilize streambanks will improve factors that contribute to beneficial use impairment on the lower Pack River.

5.3 Pend Oreille River

The Pend Oreille River begins at the outlet of Lake Pend Oreille and drains 24,200 square miles (62,678 km^2). Flows range from 11,200 to 73,000 cfs. It is listed on Idaho's 2012 Integrated report as not supporting of cold water aquatic life due to total dissolved gas and temperature impairments. Albeni Falls Dam was built on the Pend Oreille River in 1952, about 26 miles downstream from the outlet of Lake Pend Oreille. The dam significantly influences water levels in the lake and Pend Oreille River. During the summer months, the dam holds the lake level artificially high, and the Pend Oreille River downstream of its mouth essentially becomes a shallow outlet arm of the lake. During the fall, the gates are opened at Albeni Falls and water level is drawn down for flood control storage (Corsi et al. 1998). The dam altered the river substrate, which historically was deep holes and runs with cobble and gravel. This historical bottom substrate provided spawning habitat for salmonids, and before the dam, the river provided good Cutthroat and Rainbow Trout, Bull Trout, and Mountain Whitefish sport fishing (DuPont 1994). When the dam was constructed, riparian vegetation was cleared to prevent excessive debris from entering the water during flow changes. This removal increased erosion and deposition of silt in gravel bars (DEQ 2001).

The Pend Oreille River has an average depth of 23.3 feet (7.1 m), a maximum depth of 159 feet (48.5 m), and an average width of 2,300 feet (700 m). Much of the Pend Oreille River watershed is privately owned with a concentration of homes along the river frontage (DEQ 2001).

The Pend Oreille River has four permitted facilities that discharge directly into the river. The City of Sandpoint Wastewater Treatment Plant discharges treated wastewater to the Pend Oreille River near Memorial Park just west of the Highway 95 long bridge. The Cities of Dover and Priest River discharge treated wastewater to the Pend Oreille River. Albeni Falls Dam has a small wastewater treatment system that serves facilities for its employees and also discharges into the Pend Oreille River (DEQ 2001).

Due to a high population growth rate in Bonner County, the shoreline along the Pend Oreille River is developed with year-around residents. The development along with the water level and fluctuations of the Albeni Falls dam have compromised the establishment of native riparian vegetation along the shoreline. The riparian vegetation often is now replaced with lawns and rock rip-rap for bank stabilization.

5.3.1 Aquatic Plant Distribution and Abundance Study

Understanding the correlation between total phosphorus concentration and beneficial use impairment starts with Idaho's water quality standard. Idaho, along with most other state water quality standards, includes a narrative statement for protecting waters from excess nutrients: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses" (IDAPA 58.01.02.200.06). In 2009, DEQ evaluated whether nuisance aquatic growth occurred in the Pend Oreille River. These findings were published in *Idaho's 2010 Integrated Report*, Appendix Q, Attachment A (DEQ 2011). The document states Idaho has taken an aggressive approach towards eradicating Eurasian watermilfoil since 2006. As a result, there has been a significant decrease in the species in the river. Eurasian watermilfoil was present throughout the river (Figure 173); however, researchers concluded there is still excellent diversity and abundance of native plants in the Pend Oreille River ecosystem—adequate to sustain the structure and function of an aquatic littoral ecosystem.

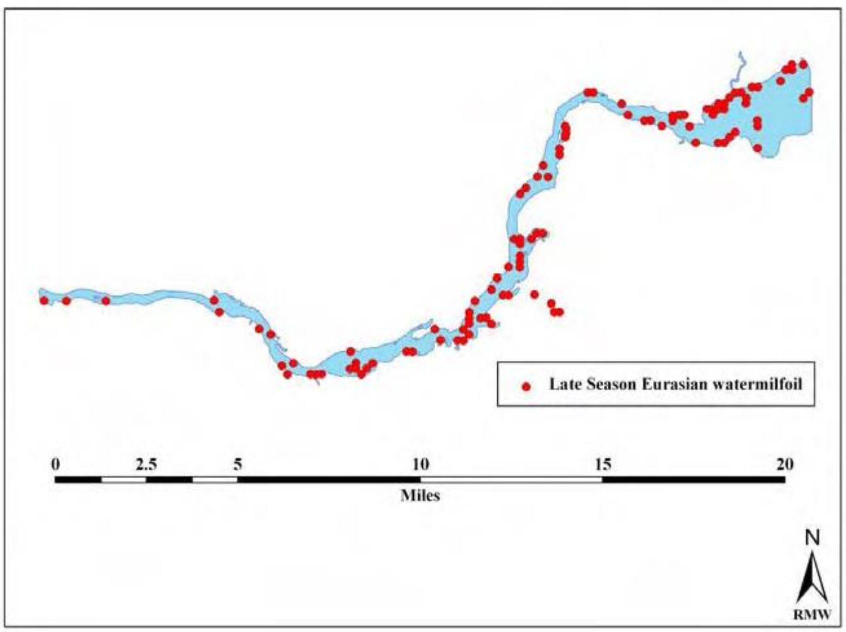
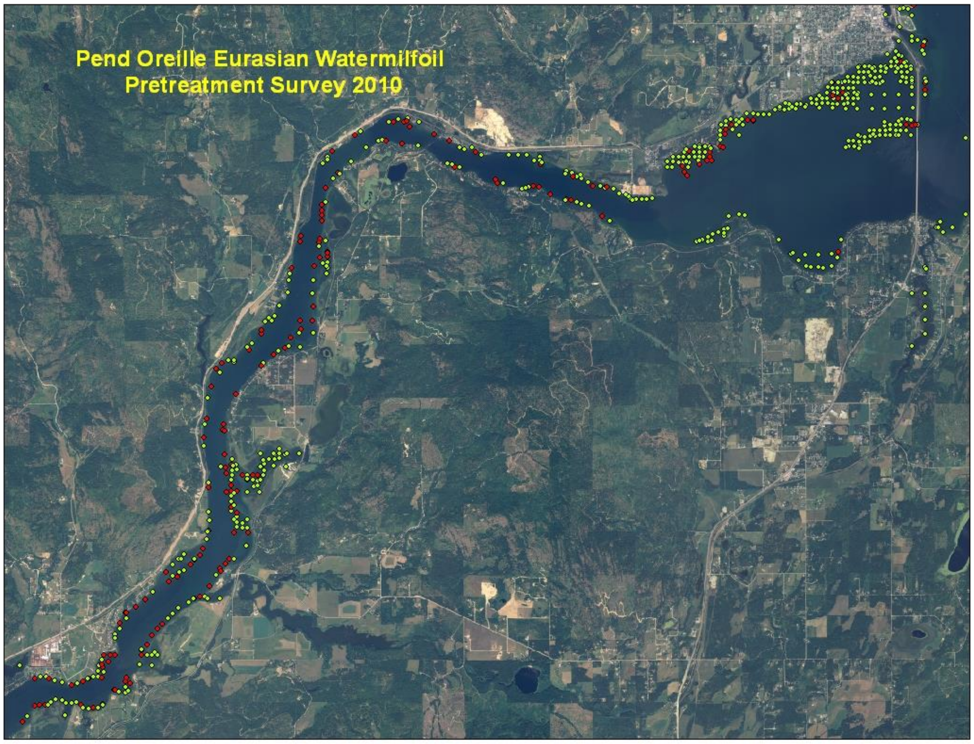


Figure 173. The locations of Eurasian watermilfoil during the late season littoral zone survey of the Pend Oreille River, Idaho (Madsen and Wersal 2008)

In 2008, the same survey was repeated by Mississippi State University to understand temporal changes in the aquatic plant community within the river. They concluded that there continued to be a stable, diverse native aquatic plant community within the Pend Oreille River, and the presence of Eurasian watermilfoil had decreased from 2007 to 2008 in response to herbicide treatment conducted in 2007 (Madsen and Wersal 2009).

In 2010, an increase in watermilfoil was observed throughout the river (Figure 174), and there are localized areas within the river where a monoculture of milfoil is present. The increase is believed to have three causes: 1) a re-invasion of areas previously treated with herbicide, 2) limited drawdown of Pend Oreille Lake in winter 2009, and 3) the growth of milfoil in areas on the Pend Oreille River where flow rates preclude successful treatment of the plant (personal communication, Tom Woolf, ISDA, 2011). Nevertheless, there is still good diversity in native plant species throughout the river system, and public use is not inhibited on the river due to the presence of watermilfoil (personal communication, Tom Woolf, ISDA, 2011). This important information helped in making the conclusion that beneficial uses were supported in the river.

Currently, the localized areas of monoculture milfoil still exist, especially near the boat docks at drawdown. However, there remains good diversity of native plant species throughout the river system (personal communication, Tom Woolf, ISDA, 2016).



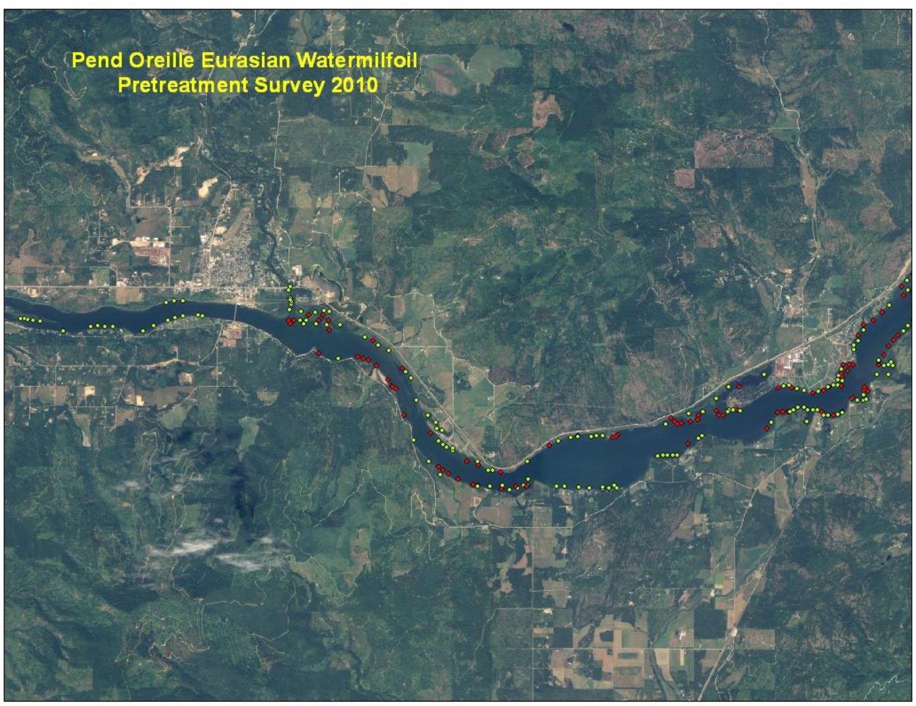


Figure 174. Two images showing locations of Eurasian watermilfoil detected in the Pend Oreille River, Idaho, in 2010. Red dots are detection points (Personal communication, Tom Woolf, ISDA, 2011).

5.3.2 Nutrient Delisting

In Idaho's 2002 Integrated Report, the Pend Oreille River was listed as impaired for cold water aquatic life due to sedimentation/siltation and "other flow regime alterations." In 2008, "other flow regime alterations" and "sedimentation/siltation" were delisted with "flaws in original listing" as the basis. Total phosphorus was added to the 2008 Integrated Report because DEQ received water quality data collected in 2003–2004 along with a request from an outside party to nominate total phosphorus as a cause of impairment to the Pend Oreille River (DEQ 2009). The 2004 DEQ evaluation of this seemingly reliable data indicated nutrients may be impairing beneficial uses. The submitted data reported to show an increasing trend of total phosphorus concentrations. Therefore, total phosphorus was added as a "cause" to the 2008 Integrated Report. This assessment did not include a link to beneficial use impairment in the river to the total phosphorus concentrations.

In Idaho's 2010 Integrated Report, total phosphorus was delisted as a cause of impairment to the Pend Oreille River based on a thorough analysis of all existing and readily available data collected on the Pend Oreille River. This analysis compared all existing Tier I total phosphorus data with numeric interpretations of the narrative standard, detection and quantification of visible periphytic and epiphytic algae growth, an evaluation of rooted aquatic plants, an evaluation of dissolved oxygen profiles, and modeling (see DEQ 2016 for an explanation of Tier I data). Results of this evaluation determined the following (DEQ 2011):

- Lentic targets of 0.009 mg/L (average) and 0.012 mg/L (instantaneous) of the *Total Maximum Daily Load (TMDL) for Nutrients for the Nearshore Waters of the Pend Oreille Lake, Idaho* (DEQ 2002, hereafter referred to as the Pend Oreille Lake nearshore nutrient TMDL) are not appropriate in evaluating beneficial use status of the Pend Oreille River.
- Total phosphorus concentrations are decreasing in the river over time.
- The Pend Oreille River system phosphorus load appears to be at equilibrium with plant and algae uptake at current load rates.
- While concern exists for localized areas of non-native plants, the native aquatic plant community is highly diverse in the river.
- Beneficial uses as related to total phosphorus in the river are fully supported.

Upon analysis of the data, DEQ concluded that the 2003–2004 data are informative but not of sufficient quantity or quality to be the basis for assessment; therefore, the original basis for the listing was appropriate at the time, but it was incorrect. For details on the analysis that was the basis of this delisting, consult *Idaho's 2012 Integrated Report* (DEQ 2014).

5.3.3 Water Quality Monitoring

Routine water quality monitoring on the Pend Oreille River began during the 2009 field season. Since 2009, DEQ has collected water quality samples at five stations from the railroad bridge to the Idaho/Washington state line following strict quality assurance/quality control procedures as documented in the project QAPP (DEQ 2015). Table 63 lists the location of the five stations. The monitoring stations were based on a water quality monitoring design that would be representative of the three Pend Oreille River AUs. These AUs include waters between Pend Oreille Lake and the Idaho/Washington state line. AU ID17010214PN002_08, which begins at the Pend Oreille Lake outlet and extends to the confluence with Priest River, flows for 32.56 miles, is up to 2 miles wide, and is, on average, 25 to 30 feet deep during full pool. This AU has a base flow between 8,000 and 13,000 cfs (DEQ 2011).

Due to limited resources, collecting a complete set of water quality data at all the representative stations was not feasible between 2010 and 2014 when some data were collected at downstream Springy Point and LaClede locations. In 2015, funding was secured from AVISTA to collect water quality data at all five stations representative of the Pend Oreille River.

Table 63. Water quality monitoring stations in the Pend Oreille River.

Station Name	Symbol	Type	Latitude (WGS 1984)	Longitude (WGS 1984)
Albeni Falls Forebay	AFF	Thalweg	N 116° 59' 20"	W 48° 10' 32"
Downstream Springy Point	DSP	Thalweg	N 116° 36' 8"	W 48° 14' 23"
Laclede	LL	Thalweg	N 116° 44' 27"	W 48° 9' 50"
Railroad Bridge	RRB	Thalweg	N 116° 31' 40"	W 48° 15' 29"
Upstream Priest River	UPR	Thalweg	N 116° 53' 12"	W 48° 10' 17"

Total Phosphorus

An analysis of total phosphorus was limited primarily to a comparison between 2009 and 2015 (Table 64). Total phosphorus concentrations were below 10 µg/L, except in July at Albeni Falls Forebay during 2009 when total phosphorus concentrations were 10.1 µg/L and in August, 2015 at Upstream Priest River where total phosphorus concentrations were 10.5 µg/L. The June 2009 sampling event did not meet field precision data quality objectives because the duplicate (0.0034 mg/L) and original sample (0.0117 mg/L) were significantly different and likely the result of a total phosphorus-sorbed particle making it into one sample but not the other; therefore, this sampling event should not be considered. June sampling will always be a challenge for the Pend Oreille River because the normal, natural suspended particle concentrations are higher because of runoff within the watershed. Relatively high total phosphorus results in June should always be given less weight in determining representative Pend Oreille River total phosphorus concentrations.

A Mann-Whitney statistical comparison of the 2 years shows no significant difference between the years. However, total phosphorus concentrations were significantly higher in August 2015 than in August 2009 at all the stations except the Albeni Falls Forebay station (Figure 175 through Figure 181). At the LaClede station, the August 2015 total phosphorus concentration was also significantly higher than total phosphorus in August 2012–2014 (Figure 179). At downstream Springy Point, August 2015 total phosphorus concentrations were greater than total phosphorus in 2012 (Figure 176). Total phosphorus data were not collected in August and September in 2013 and 2014 at that station.

Table 64. Total phosphorus concentration in the Pend Oreille River, comparison of 2009 and 2015.

Month	Total Phosphorus (milligrams/liter)									
	Railroad Bridge		Downstream Springy Point		Laclede		Upstream Priest River		Albeni Falls Forebay	
	2009	2015	2009	2015	2009	2015	2009	2015	2009	2015
June[a]	—	7.3	—	8.8	—	8.9	—	9.7	—	9.9
July	—	6.9	7.6	7.4	7.9	7.5	7.9	6.8	10.1	6.8
Aug	5.6	9.1	4.3	9.3	4.1	7.7	6.0	10.5	8.8	9.4
Sept	4.1	5.8	4.3	6.1	5.5	4.6	5.8	5.5	5.9	5.3

[a] June 2009 concentrations did not meet precision data quality objectives.

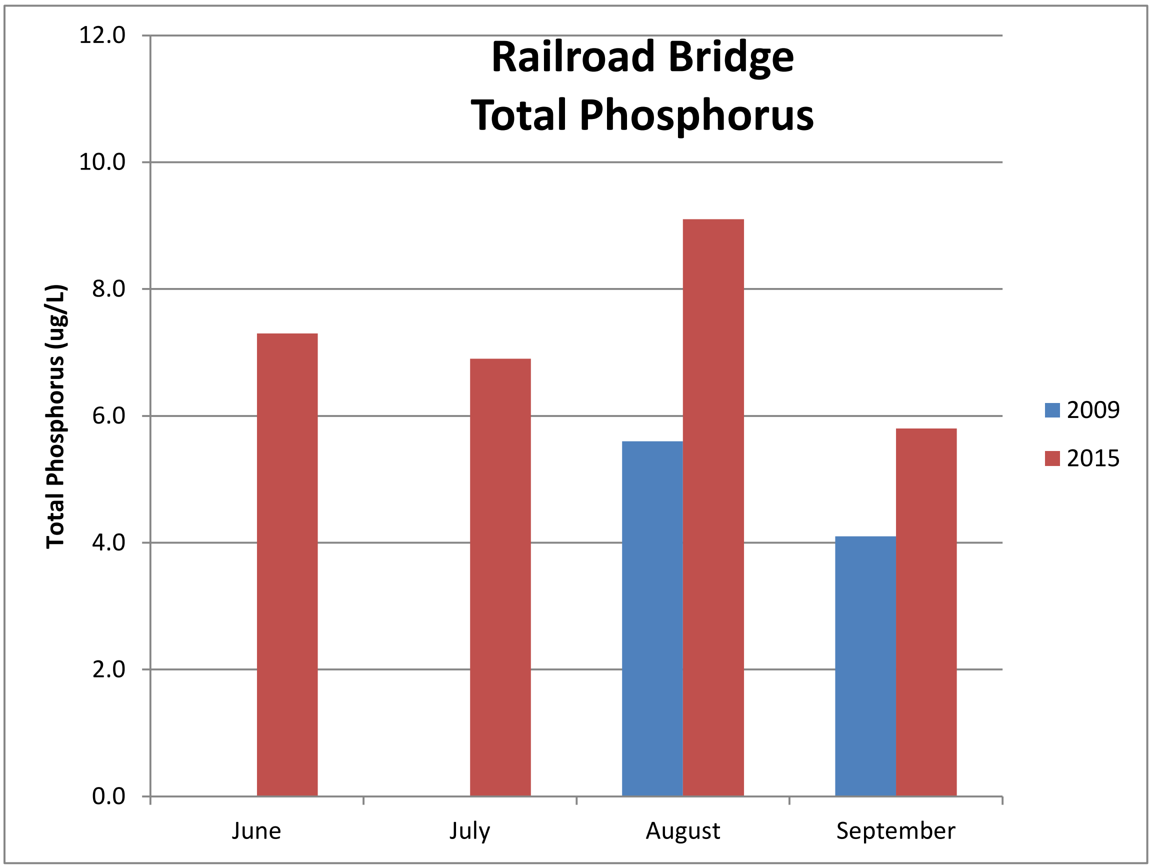


Figure 175. Total phosphorus concentrations at Railroad Bridge, 2009 and 2015.

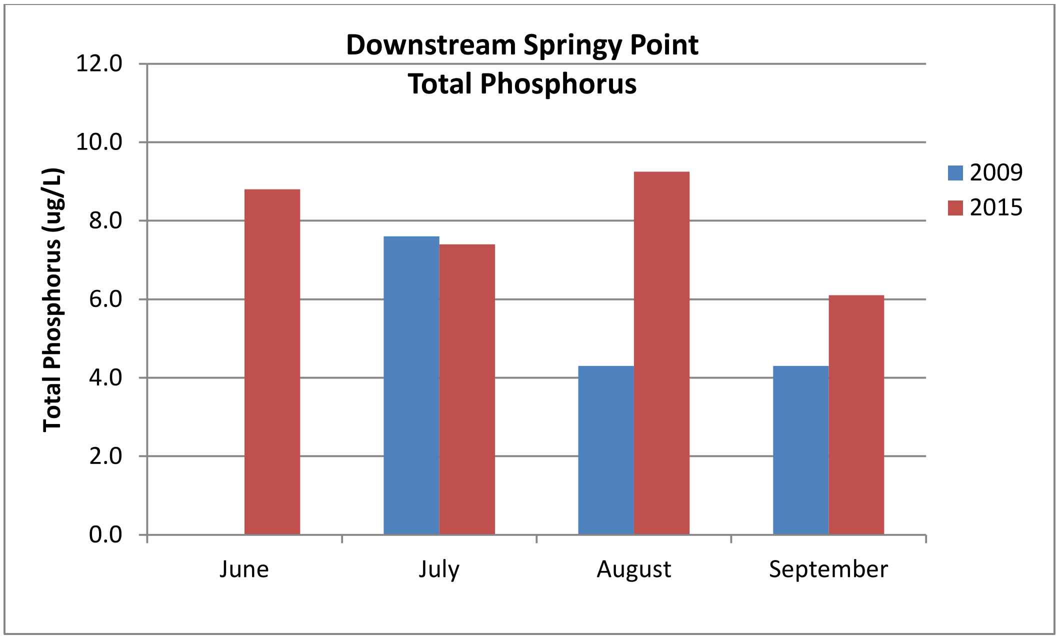


Figure 176. Total phosphorus concentrations at downstream Springy Point, 2009 and 2015.

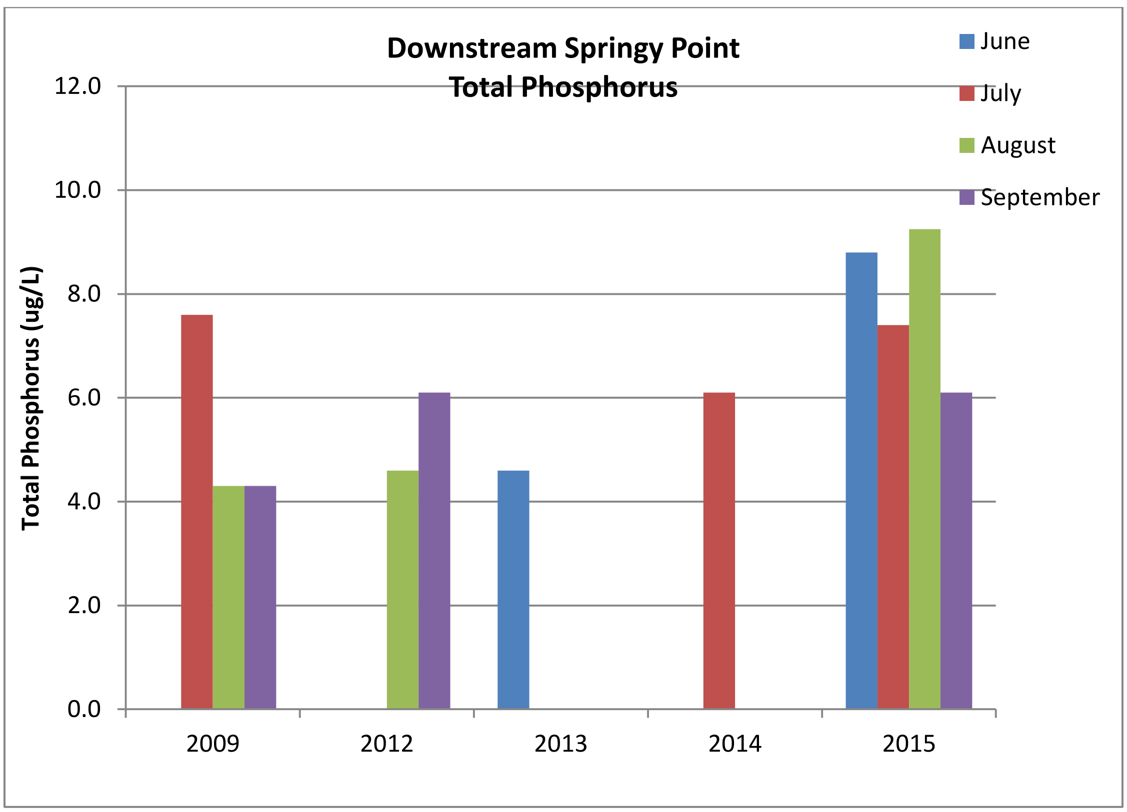


Figure 177. Total phosphorus concentrations at downstream Springy Point, 2009–2015.

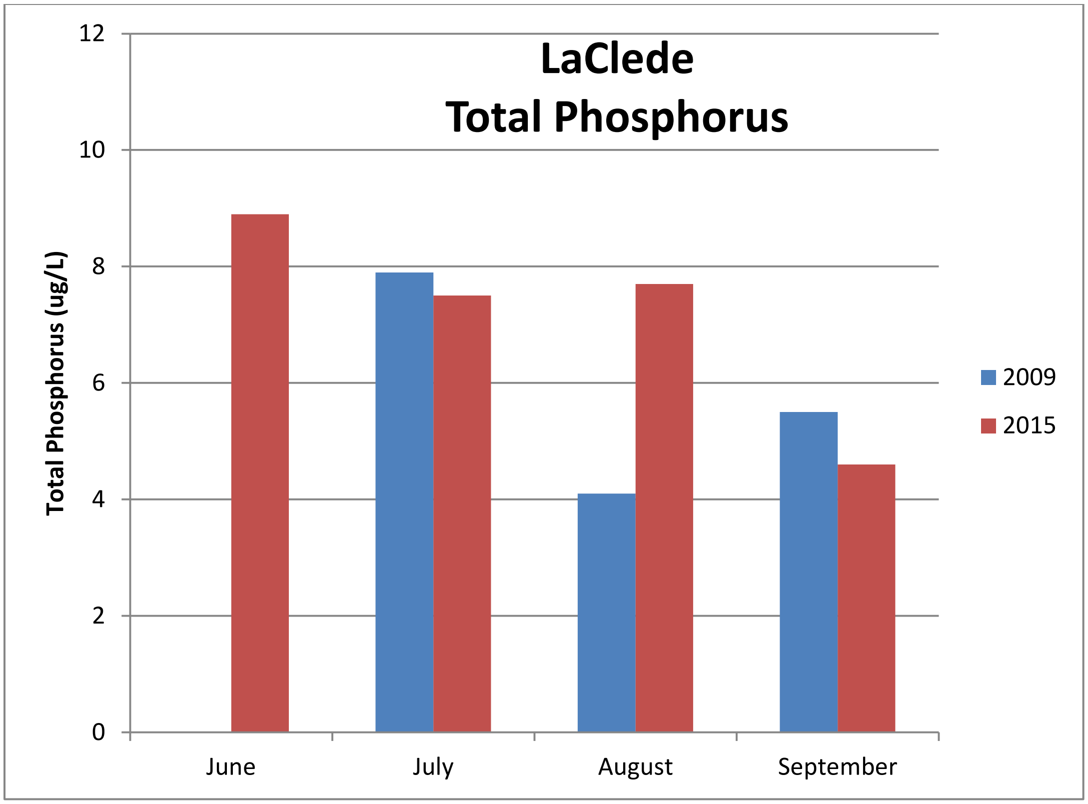


Figure 178. Total phosphorus concentrations at LaClede, 2009 and 2015.

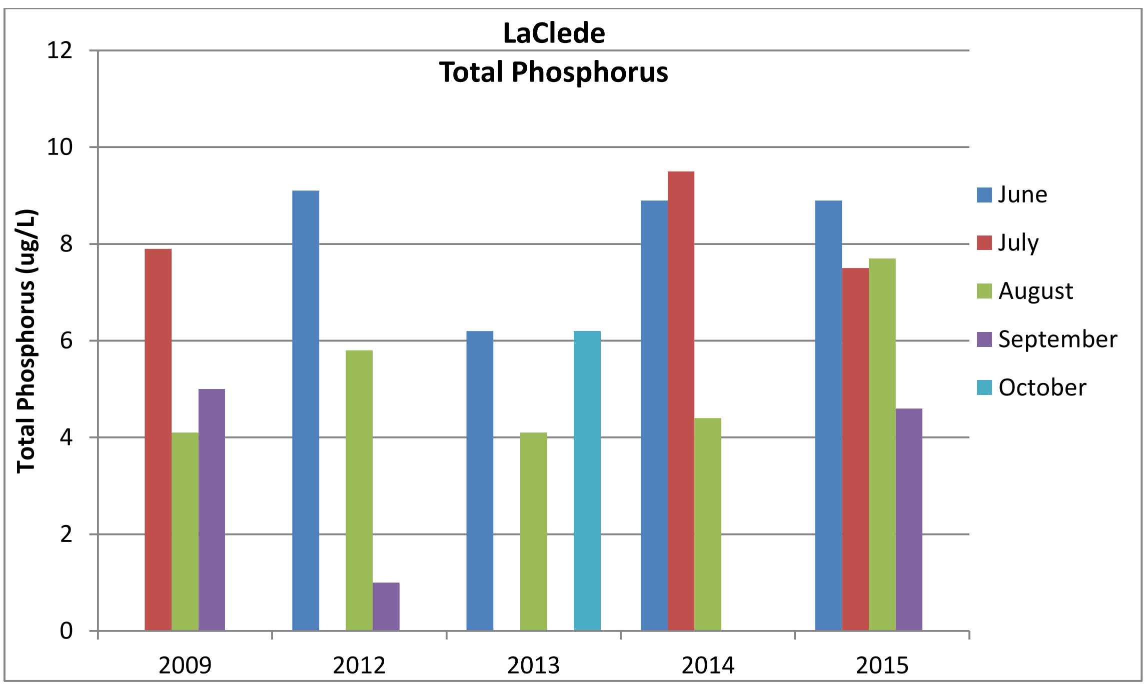


Figure 179. Total phosphorus concentration at LaClede, 2009–2015.

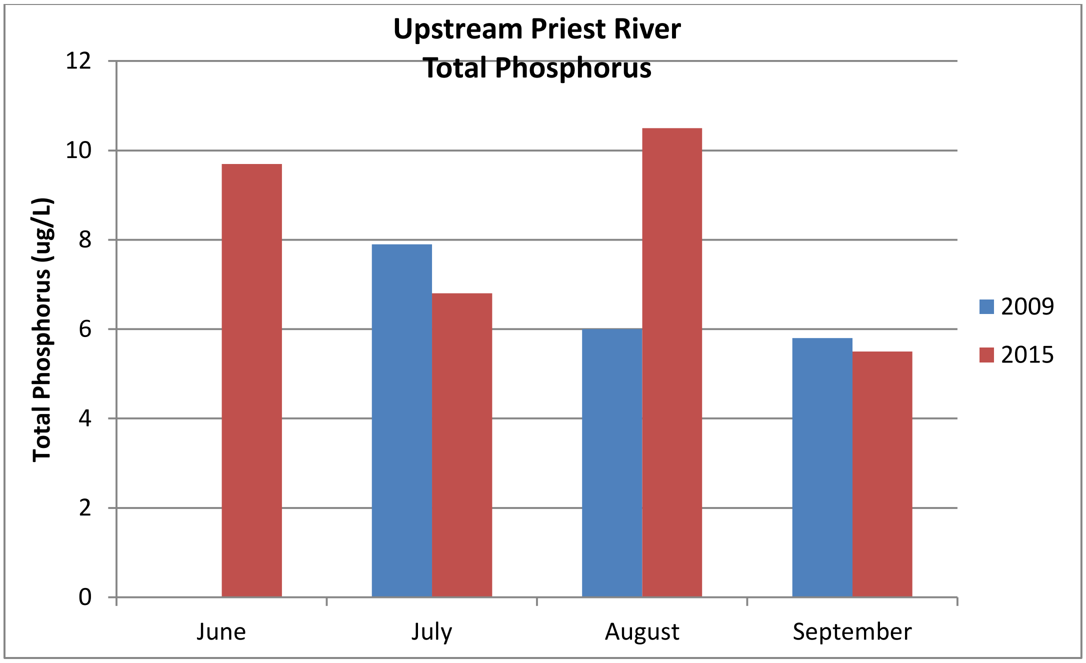


Figure 180. Total phosphorus concentration at upstream Priest River.

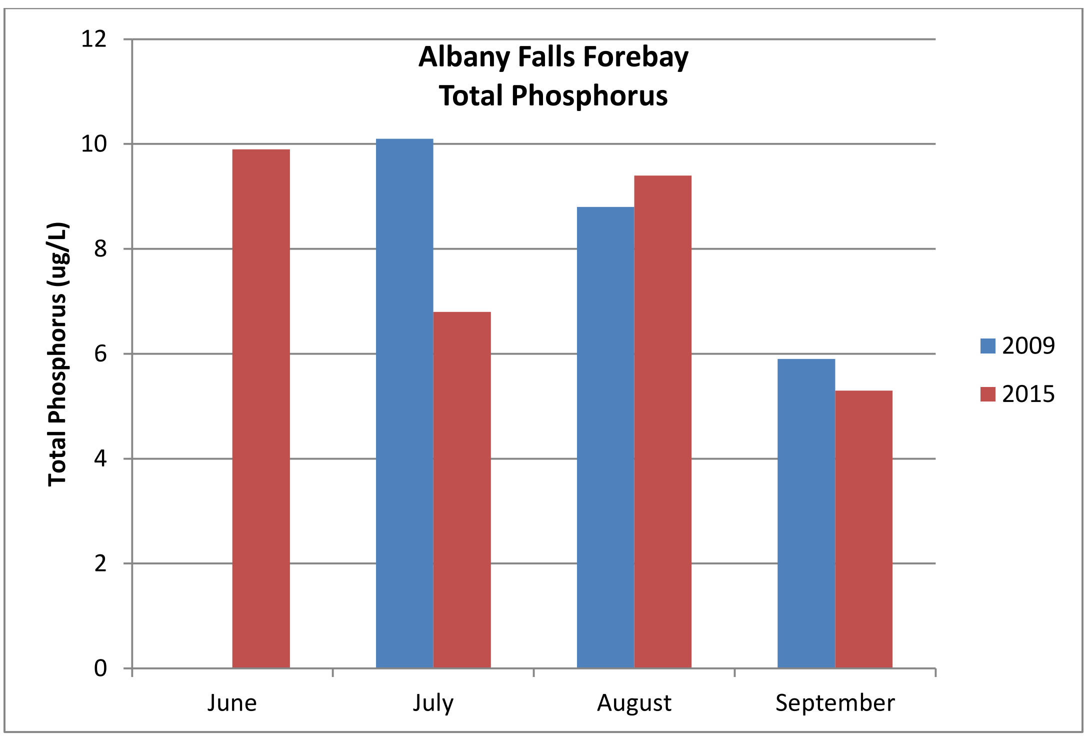


Figure 181. Total phosphorus concentrations at Albany Falls Forebay.

Total Nitrogen

A comparison of total nitrogen between 2009 and 2015 was limited. Total nitrogen values in 2009 were calculated with the sum of nitrate + nitrogen as N and total Kjeldahl nitrogen, and the values were all below detection (Table 65). Total Kjeldahl nitrogen method detection limits in 2009 were too high (0.220 mg/L) for nitrogen conditions in the Pend Oreille River.

Table 65. Total nitrogen concentration on the Pend Oreille River, 2009 and 2015.

Month	Total Nitrogen (milligrams/liter)									
	Railroad Bridge		Downstream Springy Point		Laclede		Upstream Priest River		Albeni Falls Forebay	
	2009	2015	2009	2015	2009	2015	2009	2015	2009	2015
June	bdl[a]	0.107	bdl	0.114	bdl	0.117	bdl	0.127	bdl	0.116
July	bdl	0.112	bdl	0.131	bdl	0.115	bdl	0.113	bdl	0.075
Aug	bdl	0.114	bdl	0.128	bdl	0.100	bdl	0.105	bdl	0.113
Sept	bdl	0.106	bdl	0.121	bdl	0.106	bdl	0.125	bdl	0.123

[a] below detection limit

Algae

Understanding the correlation between total phosphorus concentration and beneficial use impairment goes beyond evaluating total phosphorus concentrations, which is why state water quality standards typically do not include a numeric total phosphorus criterion. Idaho, along with most other state water quality standards, includes a narrative statement for protecting waters from excess nutrients: “Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses” (IDAPA 58.01.02.200.06).

Detecting and quantifying visible slime and nuisance aquatic growth is critical in evaluating whether designated beneficial uses are impaired and whether the “exceedances” of the nearshore target were applicable to the Pend Oreille River. In 2009, DEQ attempted to quantify epiphytic algae within the Pend Oreille River using tile pieces placed at the shoreline stations, but not enough material was available to conduct an actual assay. Therefore, DEQ conducted a qualitative analysis of epiphytic algae growth. Results indicated a range within the low levels of detection. Almost all stations had “very low” levels of epiphytic algae growth and “none” to “low” levels of periphytic algae growth, even at the shoreline sites on the river in July where the “exceedances” were expected. This important information helped in concluding that beneficial uses were supported, and the Pend Oreille Lake nearshore nutrient TMDL targets were inappropriate for evaluating the Pend Oreille River—even in the shoreline stations portion of the river (DEQ 2011).

Dissolved Oxygen

Between 2009 and 2015, dissolved oxygen (DO) profiles were collected at all stations during most events. Stations were generally iso-saturated, and only a few showed very weak DO and temperature stratification during certain events. This finding means that DO concentrations at the stations were all very similar throughout each station’s depth and at equilibrium with the air at the air/water interface. All open channel DO measurements were greater than Idaho’s water quality criterion of a minimum of 6.0 mg/L.

5.3.4 Bank Erosion Inventory

The bank erosion inventory showed localized erosion problems with evidence of increased turbidity following boat wake action. The localized turbidity problem is not representative of the AU (Figure 182).

Figure 182. Turbidity effects of boat wakes on Pend Oreille River.

5.4 Cocolalla Lake

5.4.1 Background

In northern Idaho, Cocolalla Lake (ID17010214PN013L_0L) is an important resource for recreation, fisheries, wildlife, residential and economic development, and agriculture and serves as a transportation corridor. Historically, the lake was an important source of ice for shipping and storage by rail and local residents, and much of the watershed is managed for timber harvest on private land. Development has increased around the lake and the lakeshore is developed on the western and northern shores. The south shore is under IDFG management as a Wildlife Management Area that provides limited mitigation for loss of habitat due to the impoundment of Pend Oreille River and Lake Pend Oreille from Albeni Falls Dam operations. Water quality impacts from Albeni Falls Dam operations have never been mitigated. The eastern shore of Lake Cocolalla is bordered by the Burlington Northern–Santa Fe rail line. While this shore is essentially undeveloped, the shore is altered by hydrologic modifications resulting from the proximity of the rail line and State Highway 95. The lake is popular for day use by recreational boaters, campers, and fishers. Currently, no developed campgrounds are in use around the lake. A public access boat ramp on the north shore accommodates small boats. Larger boats lose the ability to launch by midsummer as lake levels drop from reduced inflow. A private unregulated boat ramp is located south of Johnson Creek on the western middle part of the lake. Major tributaries in order of discharge are Cocolalla, Fish, Westmond, Johnson, and Butler Creeks.

Cocolalla Lake was listed as impaired due to unspecified “pollutants,” nutrients, and DO on Idaho’s 1996 §303(d) list. The lake is listed in Idaho’s 2012 Integrated Report as impaired due to DO and total phosphorus.

5.4.2 Changes to Subbasin Characteristics

Pollutant loads have not significantly increased since the 2001 TMDL. Improved land management continues as historic timber harvests have demonstrated ground cover regrowth, and replacement stands of timber have developed. Population growth has generally occurred in areas with existing infrastructure, rather than extensive new projects in undeveloped areas, which has reduced nonpoint source nutrient loading. Agriculture remains oriented toward the broader valley along approximately 5.5 miles of southern Blacktail Road adjacent to the lower gradient reach of Cocolalla Creek from the southern Blacktail Road culvert to the Highway 95 bridge. Residences are interspersed within the agricultural areas along Cocolalla Creek with properties of varying sizes from a few acres to 10–15 acres, often referred to as ranchettes. Riparian buffers exist and continue to grow, increasing shade and nutrient buffers and reducing streambank erosion.

Within the watershed, no centralized sewer system exists, and there are no point source discharges requiring EPA permits. Two large soil absorption systems (LSAS) are in use upland of the northwest area of the lake and most residences have individual drain fields.

Road density has not significantly increased, although road maintenance practices have been variable. Road erosion continues to be a maintenance challenge because many of the roads in the watershed were initially built facilitate timber harvest specifications. After significant harvests within the watershed were completed, many private parcels were developed for residences along these roads. County maintenance has been counterproductive in reducing roadbed erosion at times due to inadequate maintenance practices. A practice employed for snow management called “daylighting” is intended to increase melting of plowed snow over a wider right-of-way. This practice involves physical destruction of shrubs and recruiting trees along ditches but leaves organic debris in place to clog ditches and culverts, which in turn fills ditches and forces water carrying sediment and nutrients to flow down roadways, increasing delivery to surface waters. Sediment deposition, observed accumulating along Loop Road and residential roads closer to the water, is transported into creeks and seeps to the lake. During high flow events there have been numerous undersize culverts block with debris, resulting in water impoundment and then catastrophic failure releasing road bed, twisted culvert, and even old car bodies used as fill material. This happened in 2012 on the south Loop Road. In 2017 a blowout occurred on Irish Road over lower Cocolalla Creek. The road crossings on lower Blacktail Road is significant source of sediment and road material from snow removal and dumping gravel to fill continual erosion around the culvert. On the Creek above this crossing there are numerous residential road crossings facilitated by culverts that are placed shallow and poorly maintained that could isolate numerous residents after a failure.

Highway 95 is the primary transportation corridor along the eastern side of the lake with the Burlington Northern- Santa Fe Railroad between the highway and lake. The railbed material directly interfaces with the lake over several hundred yards along the northeastern region of the lake. Metal retaining walls are flimsy and failing in several spots resulting in cobble-sized materials along the edge of the lake. Roadbed material erodes along rail line service roads adjacent to the rail line and is transported by Butler Creek to Cocolalla Creek in significant amounts and ultimately has to be dredged to not erode the footings of the rail trestle where Cocolalla Creek makes its southern crossing to carry the eroded fine sediment to the lake.

Highway is undergoing an extensive widening to accommodate increased traffic. Along Cocolalla Lake this project is slated to continue and will likely impinge on perched wetlands along this route from Southern Blacktail Road to beyond the Westmond Creek crossing. It will be very important, in combination with the expansion of rail lines in this area to provide mitigation, protection, and enhancement of wetlands to protect lake water quality. Stormwater management will also be extremely important here.

Transport of hazardous materials and nutrient-rich materials is increasing along Highway 95 and the rail line including crude oil, coal, ammonium nitrate, acids, industrial chemicals, and raw materials. For example, in 2014 a tandem trailer transporting explosive-grade ammonium nitrate overturned just above Cocolalla Lake along Cocolalla Creek. Twelve hundred gallons of liquid fertilizer used in Canadian mines for its explosive properties spilled into roadside ditches and entered drainage ditches leading to Cocolalla Creek. Containment involved plugging ditches and pumping surface water and contaminant, but nutrients seeped into the creek and subsequently the lake. Most of the product was contained, although significant amounts penetrated soil, entered wetlands, and overtime, released to the lake. Nitrogen levels were not noted to increase in surface waters, and lake monitoring did not identify increased nitrogen in the lake. The risk, however, was made clear in the confusion that occurred between emergency services, contracted removal efforts, and company personnel in relation to stopping the leak, quantifying the spill, and monitoring the dispersal.

5.4.3 Physical and Biological Characteristics

The Cocolalla Lake watershed has the following physical and biological characteristics:

- Drainage area: 66.3 mi^2
- Percentage covered by forest: 71%
- Average basin elevation: 2,820 feet
- Mean annual precipitation: 27.3 inches
- Mean basin slope (from 10 meter DEM): 18%
- Area with slopes greater than 30%: 18%
- Agricultural land as a percentage of drainage area: 6.1%
- Developed land as a percentage of drainage area: 2.1%
- Percentage of lakes and ponds as a percentage of drainage area: 2.2%
- Percentage of drainage area as surficial volcanic rocks: 33.2%
- Percentage of drainage area as impervious: 0.5%

5.4.4 Hydrology

Flow in Cocolalla Creek is snowmelt-dominated with base flow influenced by springs and seeps. No USGS streamflow gages exist in the watershed. During extreme drought conditions in 2015, many of the tributaries were dry at the confluence with the lake or Cocolalla Creek including Fish, Johnson, Westmond, and Butler Creeks. Base flow in Cocolalla Creek was less than average, though flow was continuous from the headwaters reach supplied by springs and seeps to the confluence with Cocolalla Lake. Cocolalla Creek flows out of Cocolalla Lake on the northwest corner of the lake and flows into Round Lake 2.8 miles below the outlet of Cocolalla Lake. Cocolalla Creek flows out of Round Lake at a fish barrier weir that was installed in the 1950s. Cocolalla Creek enters slack water in the unnamed slough (referred to locally as Cocolalla Slough) formed by the impoundment created by Albeni Falls Dam on the Pend Oreille River and the historic course of Cocolalla Creek. There is significant sediment deposition in Cocolalla Slough from widely fluctuating water levels in the backwaters formed by impoundment of the Pend Oreille River. Significant erosion along the Pend Oreille River creates a large deltaic deposition at the confluence of Cocolalla Creek with the Pend Oreille River. This creates a favorable environment for colonization by nuisance and aquatic invasive species that have been proliferating along the Pend Oreille River. Water quality has never been mitigated for the impacts of Albini Falls Dam, only lost wildlife habitat has been mitigated through IDFG.

The StreamStats USGS Watershed Model shows the following flow parameters at the inlet to the lake:

- Mean estimated annual flow of Cocolalla Creek: 49.1 cfs
- Estimated peak flow, April 20: 153 cfs
- Estimated peak flow, May 20: 137 cfs

Peak flows observed during rain-on-snow events can easily exceed the estimated peak flows for April and May. These events often occur in February and March such as in 2008 and 2017 resulting in extensive lake flooding, creek flooding, culvert blowout, landslides, and damage to homes and drain fields

5.4.5 Lake Characteristics

Cocolalla Lake has a surface area of approximately 840 acres (3.3 km^2) and a mean depth of 25.9 feet with the maximum depth of 44.6 feet. It is a glacial scour lake that lies in the Purcell Trench, a land feature created by successive glacial activity oriented north to south, beginning in Canada and extending to the Rathdrum Prairie. Successive glacial pulses have alternately scoured the lake and created the terminal moraine at the southern end of the lake where Cocolalla Creek enters the lake after receiving flow from Fish and Butler Creeks. The bathymetry of Cocolalla Lake is shown in Figure 183. Bottom structure is uniformly flat with moderately sloped sides. Bottom composition varies from fractured boulders and glacial rubble to cobble and gravel. A significant portion of the lake is composed of organic sediment and soft materials that contribute to internal nutrient load. The southern end of the lake becomes shallow over the lower one fifth of the lake to where Cocolalla Creek enters.

Cocolalla Creek is the northwestern outlet of the lake between Westmond and Johnson Creeks that flows to Round Lake. Cocolalla Creek is the outlet of Round Lake that is impounded above a fish barrier weir and then flows to Mortenson Slough, which discharges to the Pend Oreille River.

The 2001 TMDL estimated internal loading to be the most significant source of nutrients to the lake followed by sediment delivered to the lake from bank and road erosion. Sediment is fairly well distributed through the deeper areas of the lake with the southern portion of the lake having a more organic substrate due to extensive aquatic macrophyte growth that accumulates seasonally and combines with deposition from Cocolalla Creek. Invasive aquatic plants have been established in the southern area of the lake for years as Eurasian water milfoil and curly leaf pondweed stands have increased in area and distribution. Stands of high-stem density invasive species increase organic deposition and nutrification in shallow areas where sunlight penetrates to the substrate. Internal loading occurs primarily under ice cover when anoxia at the sediment-water interface releases nutrients stored in the sediment. Softer substrate indicates potential areas of increased nutrient release to the water column. Relative bottom hardness is shown in Figure 184.

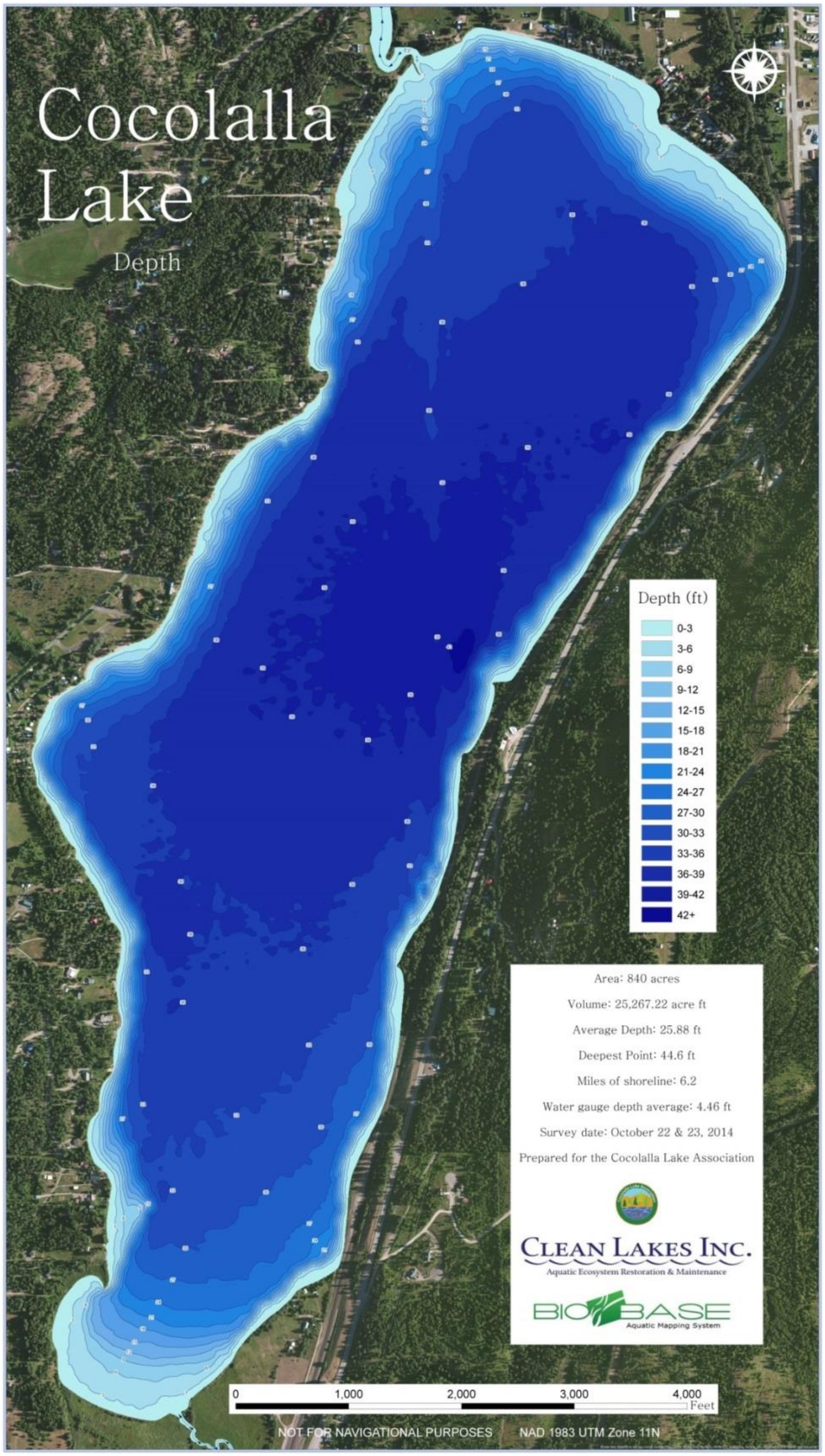


Figure 183. Cocolalla Lake bathymetry map.

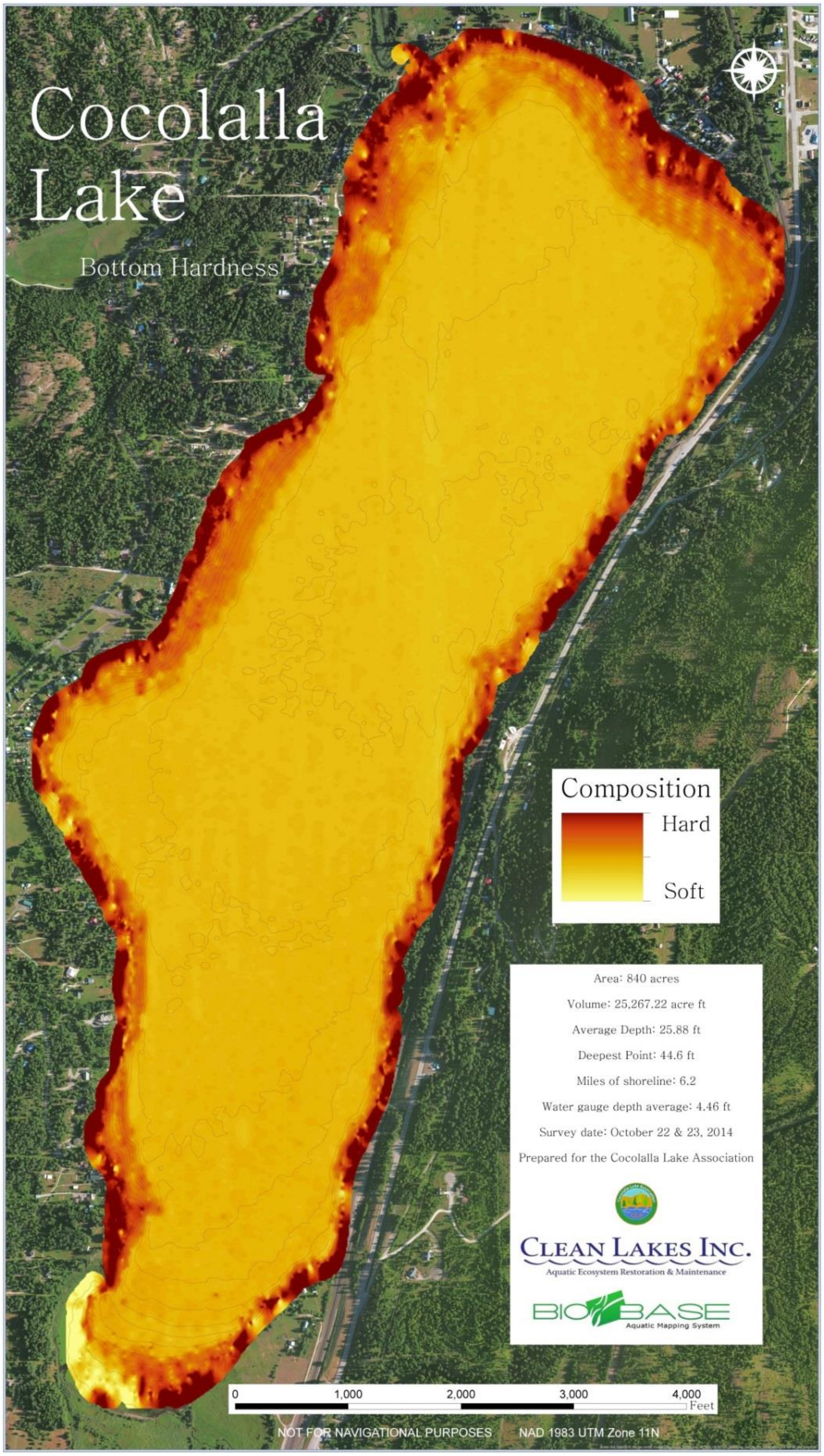


Figure 184. Cocolalla Lake hardness map.

5.4.6 Fisheries

Cocolalla Lake is a multifaceted warm- and cool-water fishery. Natural production of Westslope cutthroat trout, brook trout, and brown trout inhabit perennial tributaries including Cocolalla, Fish, and Butler Creeks. Rainbow trout are stocked into Cocolalla Creek. Butler Creek is isolated by a dry channel that consistently forms during base-flow periods due to infiltration into valley fill material just above Highway 95. This isolation may protect this population from hybridization, though brook trout are present in this watershed.

Cocolalla Creek has a self-sustaining population of brown trout that tolerate the warmer waters and impacted habitat in the valley reach of Cocolalla Creek along Highway 95. Headwaters of Cocolalla Creek and upper tributaries have remnant populations of Westslope cutthroat trout, but are largely composed of brook trout. Higher gradient reaches of Cocolalla Creek and its tributaries are perennial and may have a greater component of Westslope cutthroat trout. It is possible that Fish Creek tributaries that are isolated by fish barrier culverts may have Westslope cutthroat trout present in upper reaches. These reaches should be surveyed.

Cocolalla Lake has been characterized as having a high density of channel catfish that can grow to over 60 cm. Brown bullheads are also present. Self-sustaining populations of largemouth bass, smallmouth bass, perch, and bluegill are popular with anglers. Round Lake receives inflow from Cocolalla Creek and has an outlet that is impounded by a fish weir that was installed in the 1950s to protect native Westslope Cutthroat Trout. Unlawful introductions of fish and incidental stocking introductions likely account for today’s population diversity. The fish population seems stable and productive. No indications exist of winter or summer kill impacting fish abundance or diversity. The fishery in Cocolalla Lake is important to the local economy and anglers come from neighboring states and Canada to fish.

5.4.7 Geomorphic Risk Assessment

A geomorphic risk assessment for the watershed was developed using GIS software to identify drainage density, subwatershed soil types, stream slope, and relative length of source, transport, and response reaches of streams in watersheds for Cocolalla, Fish, Butler, Johnson, and Westmond Creeks. The geomorphic Risk Assessment identifies watershed characteristics that result in higher erosion, increased transport and deposition due to valley and hillside slope and soil type. Vulnerable areas exhibit steep slopes, highly erodible soils, high road density, and extensive response reaches that can accumulate sediment that results in bank erosion or steep channel reaches that contribute sediment and adsorbed nutrients to the lake. Areas of concern that are identified in the evaluation include Butler, Cocolalla, Fish, and Johnson Creeks. The Fish Creek subwatershed has high stream density (a significant number of contributing smaller streams), high gradient, moderate road density, and historic high sediment loads. Cocolalla Creek exhibits a large watershed area with areas of steep gradient channel and high road density. Butler Creek flows adjacent to forest roads and has a steep canyon section and steep channel slope over much of its course. The Johnson Creek watershed has a high drainage density and road density. The combination of high stream gradient, high road density, and numerous road crossings increase sediment load and transport capability. Road maintenance practices have featured poor drainage, improperly sized culverts, and hanging culverts that cause headcuts and downcuts and create fish barriers.

5.4.8 Summary and Analysis of Current Water Quality Data

Water quality data have been collected fairly consistently since 1987 (Falter and Good 1987). At that time, concern over water quality had mounted regarding increasing frequency and severity of blue-green algal blooms thought to be related to increased developmental pressure and historic nonpoint source pollution sources including lakeside-improvised septic systems, road erosion, and land management practices in the watershed. These concerns ultimately led to listing the lake for nutrients and developing a TMDL that captured existing data up to 2001 (DEQ 2001).

Citizen's Volunteer Monitoring Program

Since 1987, water quality data have been collected by the CVMP except from 2009 through 2011, when the recession limited DEQ funding for monitoring. CVMP data consist of temperature and oxygen profiles and samples for total phosphorus, total nitrogen (a recent addition to the sample plan) and chlorophyll-a analysis. Temperature and oxygen profiles are collected at 1 meter intervals from 0.1 meter to 1 meter off the bottom. Depth varies with lake level but is generally 11 meters at the sampling location, which is in the deepest area of the lake. Total phosphorus is collected at two depths, the Secchi depth and 1 meter above the bottom. A chlorophyll-a sample and a total nitrogen sample are also collected at the Secchi depth. The combined samples from the Secchi depth are collected using a Van Dorn or Kemmerer bottle. Sample water is alternately placed from both depths in a mixing churn and samples are drawn from the spigot. Total phosphorus and total nitrogen samples are preserved and chilled for transport to the lab.

Total Phosphorus

Total phosphorus can be partitioned between the epilimnion and hypolimnion in stratified lakes. During the summer months, Cocolalla Lake regularly stratifies by depth and temperature with warmer waters above cooler water; however, it often mixes after sustained wind events and restratifies. The lower boundary layer of the hypolimnion, the sediment/water interface, produces phosphorus that diffuses from anaerobic activity in the sediment to the water column above the sediment to the confining layer of the thermocline or metalimnion. Phosphorus can diffuse through the hypolimnion and then, when the thermal resistance to mixing is eliminated in a wind event, the phosphorus mixes throughout the water column. When the water restratifies, within days, the epilimnetic phosphorus concentration can increase and the hypolimnetic phosphorus concentration can decrease in relation to premixing conditions. Epilimnetic total phosphorus generally ranges between less than 10 µg/L and 60 µg/L. Hypolimnetic total phosphorus can range between 20 µg/L to over 200 µg/L. Epilimnion values from 60 to 100 µg/L may indicate wind mixing events that pulse phosphorus from sediments (also referred to as internal loading).

Dissolved Oxygen

DO content in Cocolalla Lake is determined by water temperature at depth, wind mixing and aeration, and the sum of oxygen demand from respiration and decomposition. DO in the epilimnion decreases as waters warm above the thermocline and can range from 5 mg/L during the warm season of the year to 12 mg/L. Generally, epilimnetic DO stays above 6 mg/L throughout the summer months and is not stressful to fish. Thermocline DO decreases through the warm season of the year from near saturation values in May to around 2 mg/L in the warm season between July and September. Historically, DO levels in the hypolimnion also follow this pattern between saturation at around 12 mg/L in the early season and less than 1 mg/L during the warm season.

An evaluation of DO trend data in Cocolalla Lake shows that in recent years, incidents of hypolimnetic anoxia and hypoxia are less frequent and shorter than in previous years. Anoxic hypolimnion conditions in Cocolalla Lake seem to manifest during periods of warm weather, bright sunlight, and reduced wind for mixing and circulation. These conditions often precede conditions that facilitate blue-green algae blooms. The lake oxygenates during occasional wind events that mix waters over all but the deepest areas of the lake. DO is plotted from 1989 to present with time trend data showing improvement in hypolimnetic DO. Data represented are based on seasonal data and associated residuals to show overall improving trends (Figure 185).

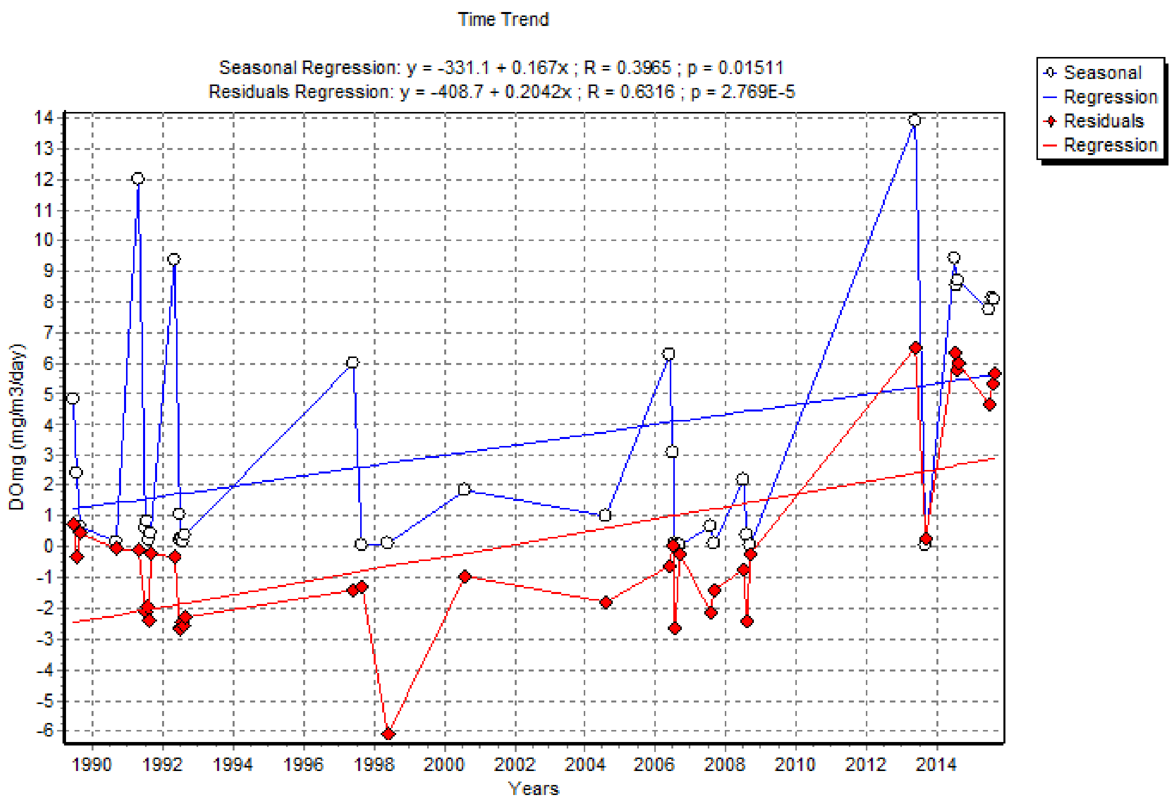


Figure 185. Hypolimnion dissolved oxygen regressions for data from 1989 through the 2015 field season.

Trophic State Analysis

Trophic Level Index values and trends are a good indicator of improved water quality based on reduced nutrient inputs and improved land and residence management. Water quality data from the period of record was evaluated for trophic conditions in the lake using a limnological assessment software called LakeWatch. Trends include trophic indices calculated independently for total phosphorus, Secchi depth, chlorophyll-a, and total nitrogen. The software generates both Carlson and Burns Trophic Level Index values, index scores, and trends analysis based on nutrient concentrations and water clarity. LakeWatch reports generated from the accumulated data show improving trophic state trends in Cocolalla Lake. Both reports summarize trophic values and base index scores to identify the trophic level as eutrophic and the trend as "improvement probable."

Data throughout the evaluation period show slight improvement of epilimnion total phosphorus, although wind mixing can periodically break down stratification and increase variability of total phosphorus concentrations. Regression of seasonal and associated residuals shows phosphorus concentrations may be decreasing slightly though the trend indicator for calculation with residuals is more static though lower values. Epilimnion total phosphorus over time is shown in Figure 186.

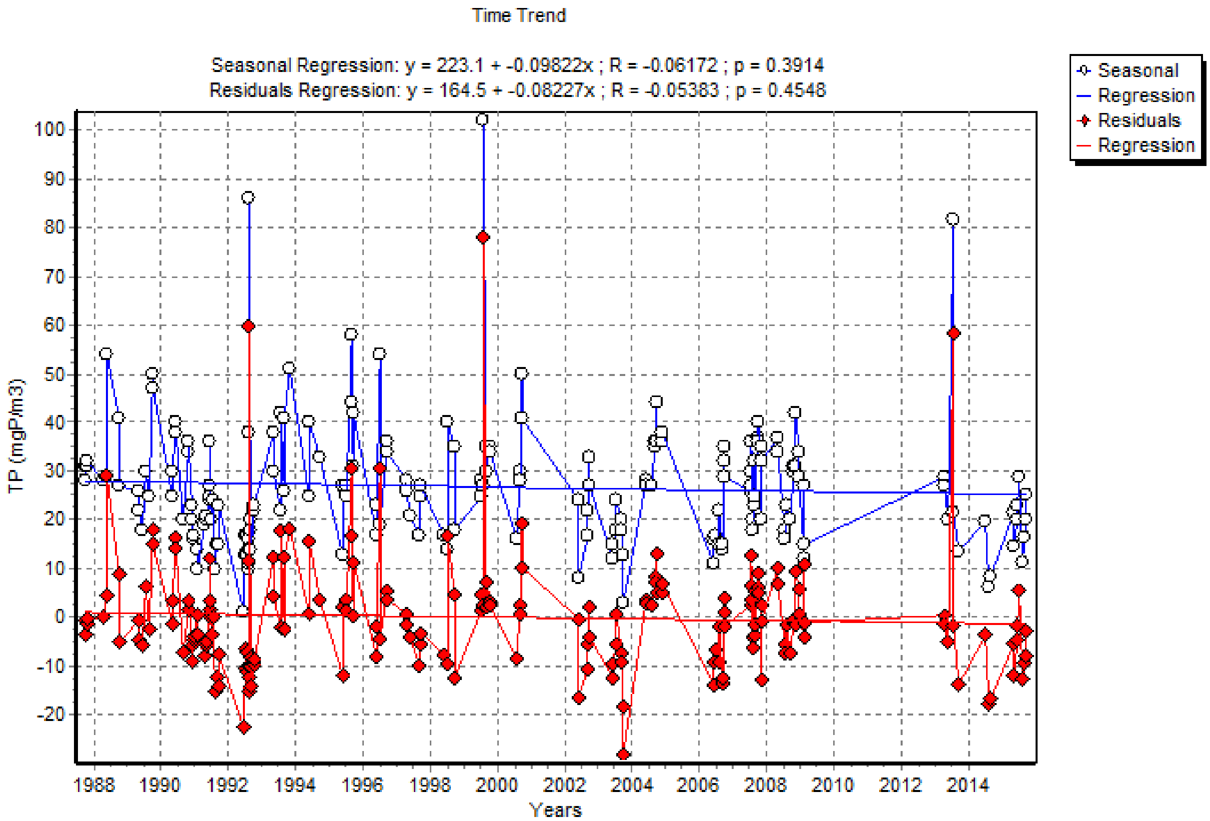


Figure 186. Epilimnion total phosphorus regressions for data from 1988 through the 2015 field season.

Trophic State Index calculations are based on Secchi disk depth as well as nutrient and chlorophyll-a data. While the long-term trend analysis does not show a significant decrease in chlorophyll-a since 1987, chlorophyll-a concentrations do seem to be lower in the last 3 years (Figure 187). The long-term trend data show increasing water clarity as evidenced by increasing Secchi depth readings (Figure 188).

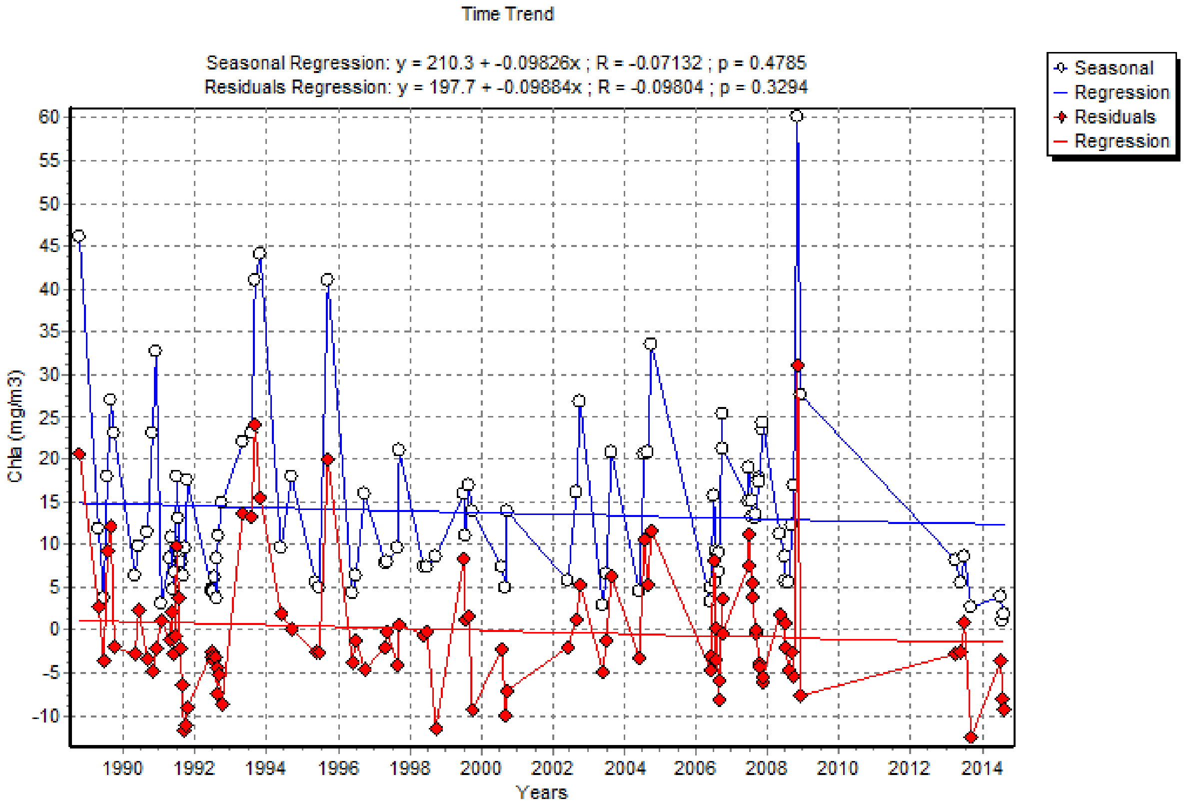


Figure 187. Chlorophyll-a regressions for data from 1988 through the 2015 field season.

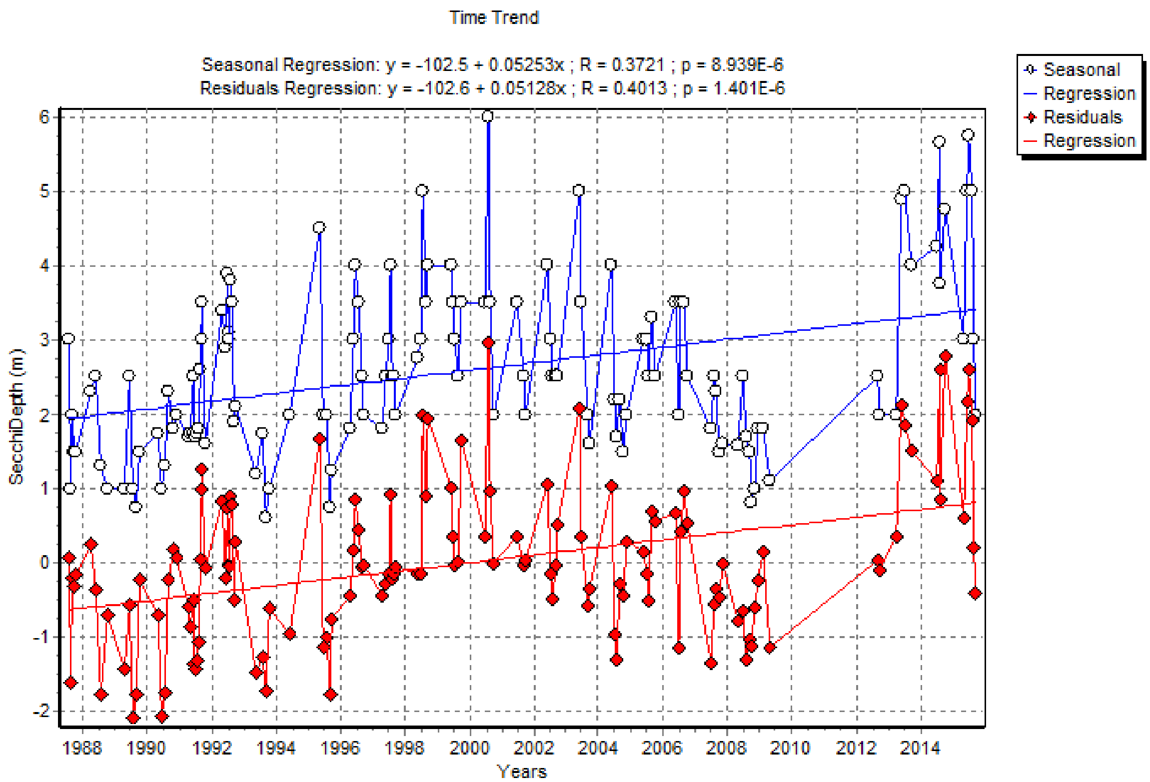


Figure 188. Secchi depth regressions for data from 1988 through the 2015 field season.

Blue-Green Algae

An anecdotal indicator of trophic condition includes trends for noxious algal blooms. Over the previous 3 years; 2014 through 2016, there have been significant blue-green algae blooms though the only blooms to trigger a health district advisory were fall of 2009 and 2016. The 2009 bloom was primarily *Gloetrichia* sp. A bloom during September and October 2009 occurred that required an advisory warning against contact, or consumption of waters visibly affected by an algal bloom. During August, September, and October 2015, a lower intensity bloom of *Aphanizomenon flos-aquae*. and *Anabaena* sp. occurred but did not warrant an advisory. The 2016 bloom began in mid-July as evidenced by decreasing Secchi depth measurements and microscopic examination by staff. The advisory was placed in effect on November 21st and remained in effect through ice formation on December 15th 2016 when the advisory was lifted. Throughout the lake, algal densities were below toxin-producing concentrations described by World Health Organization standards. Concentrations that triggered advisories were primarily along shorelines from wind-blown algae accumulations. Blooms were nearly annual at the time that the TMDL was developed and the frequency of blue-green algal blooms has reduced but bloom severity seems to remain significant.

Summary and Analysis of Periphyton Productivity

Chlorophyll-a concentrations, periphyton cell identification and enumeration (counts), relative temperature, and relative light measures were collected from artificial substrates to characterize productivity measures to accompany routine trophic monitoring. Artificial substrates are styrene 1 ft^2 squares glued to inert pavers to provide a substrate that measures increases in periphyton at weekly intervals to plot a growth rate dependent on bioavailable phosphorus and nitrogen.

Productivity monitoring was focused on the organisms living on the surfaces (periphyton) of the bottom (benthos) of the lake in the nearshore zone. Periphyton is representative of lake productivity because it remains in place (relatively nonmotile), is relatively easily sampled, and integrates a number of biotic and abiotic factors.

Artificial substrates were deployed at three nearshore locations during the week of August 9, 2015, and were visited weekly for the following 6 weeks (Table 66, Figure 189). The substrates were retrieved the first week of October. Periphyton samples were collected and analyzed for chlorophyll-a concentrations each week. Analysis of chlorophyll-a in the periphyton was used to determine a growth rate and a relative measure of productivity. During the retrieval, an additional periphyton sample was taken for periphyton taxa identification and enumeration.

Table 66. Productivity monitoring stations on Cocolalla Lake.

Station Name	Latitude[a]	Longitude[a]
Southwest	W 116° 37.5495”	N 48° 06.8879”
North	W 116° 37.0785”	N 48° 07.9414”
Southeast	W 116° 37.0906”	N 48°06.7003”

[a] Datum WGS84

Figure 189. Location of 2015 periphyton sampling sites on Cocolalla Lake.

Chlorophyll Growth Rate

Figure 190 through Figure 192 illustrate chlorophyll growth rates at the three sites. All graphs show good regressions for biologic measures. The study should have run longer to capture a leveling off of the growth rate, where the periphyton is fully stocked and additional growth is limited by space. The average chlorophyll-a growth rate for both the northern and southeastern sites were above 600 µg/m^2/day. The southwestern site had a lower growth rate of 346 µg/m^2/day. The southeastern site had a growth rate of 625 µg/m^2/day. The chlorophyll-a data suggest that water column nutrients in the northern portion of the lake support higher periphyton productivity than do the nutrients in the southern portion of the lake. This higher productivity may be partially due to prevailing winds from the southwest and potential accumulation of nutrients from lakeshore residences. It can also be due to in-lake productivity of localized substrate and accumulation of internal nutrient loading from biological processes.

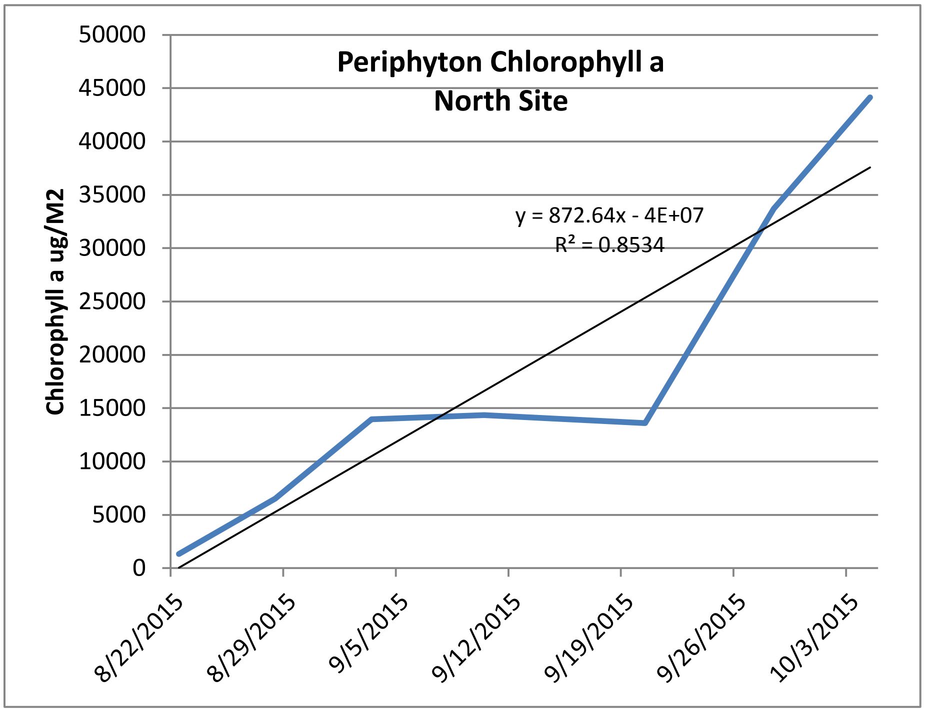


Figure 190. Periphyton chlorophyll-a growth rate, north site.

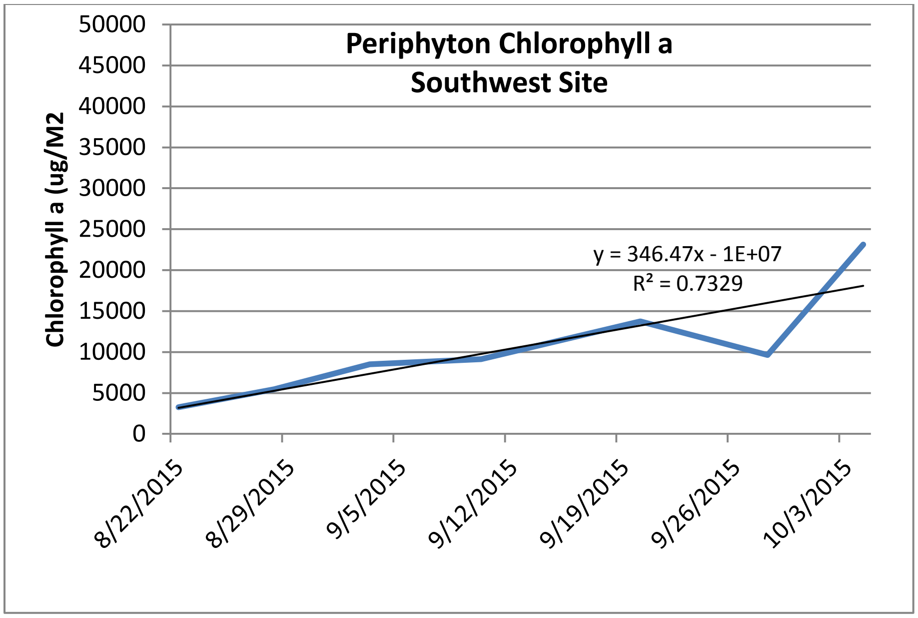


Figure 191. Periphyton chlorophyll-a growth rate, southwest site.

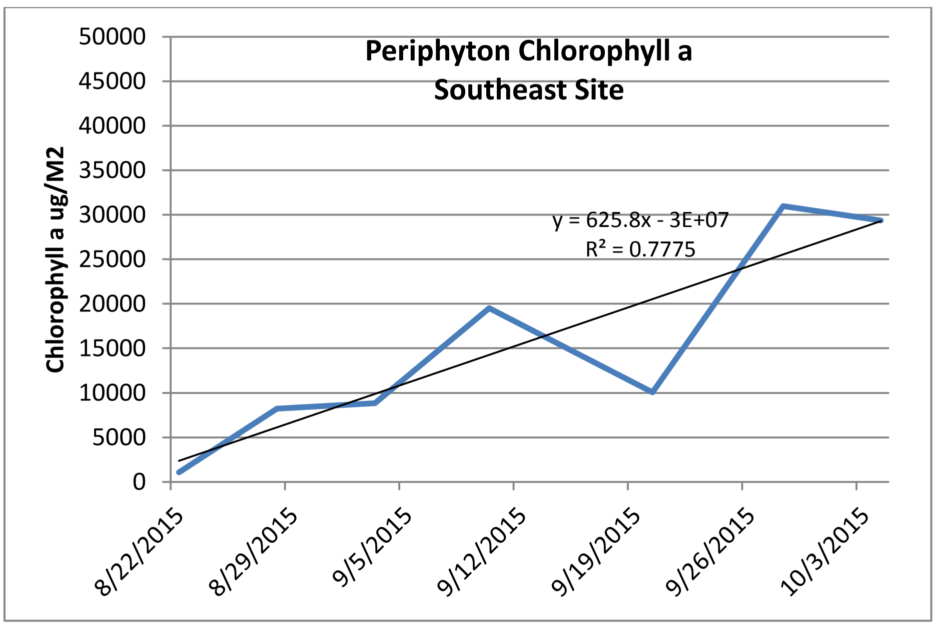


Figure 192. Periphyton chlorophyll-a growth rate, southeast site.

Comparison of Chlorophyll Growth Rates with Nearshore Sites on Lake Pend Oreille

Chlorophyll growth was compared to oligotrophic bays in Lake Pend Oreille in 2014. Artificial substrates were deployed in 14 stations in nearshore waters of Lake Pend Oreille. It was determined in the study that water column nutrients in the northern portion of Lake Pend Oreille support higher periphyton productivity than do the nutrients in the mid/southern portion of the lake. Two bays in the higher-production northern portion of the lake (Ellisport and Kootenai Bays) and one bay in the low-production southern portion of the lake (Idelwilde Bay) were chosen for this comparison. Chlorophyll growth rate in Ellisport and Kootenai Bays were approximately 535 µg/m^2/day (Figure 193 and Figure 194). The chlorophyll growth rate in

Idelwilde Bay was 134 µg/m^2/day (Figure 195). Both the northern and southeastern locations on Cocolalla Lake exceeded the rates in the northern bays of Lake Pend Oreille. A comparison of water column concentrations of total phosphorus in Cocolalla Lake and Lake Pend Oreille suggest periphyton productivity in Cocolalla Lake is a result of the higher nutrient concentrations. As stated earlier, epilimnetic total phosphorus in Cocolalla Lake generally ranges between less than 10 µg/L and 60µg/L. However, higher epilimnion values from 60 to 100 60µg/L are observed, likely a result of wind mixing events with the higher-concentration hypolimnion. During 2006–2015, mean total phosphorus concentrations in Ellisport, Kootenai, and Idelwilde Bays were all below 8 µg/L.

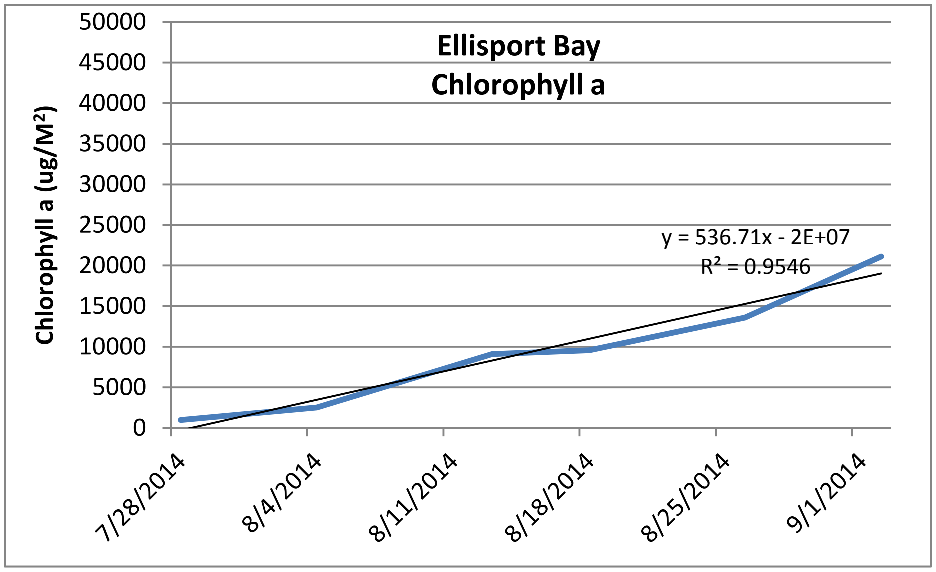


Figure 193. Periphyton chlorophyll-a growth rate, Ellisport Bay, Lake Pend Oreille.

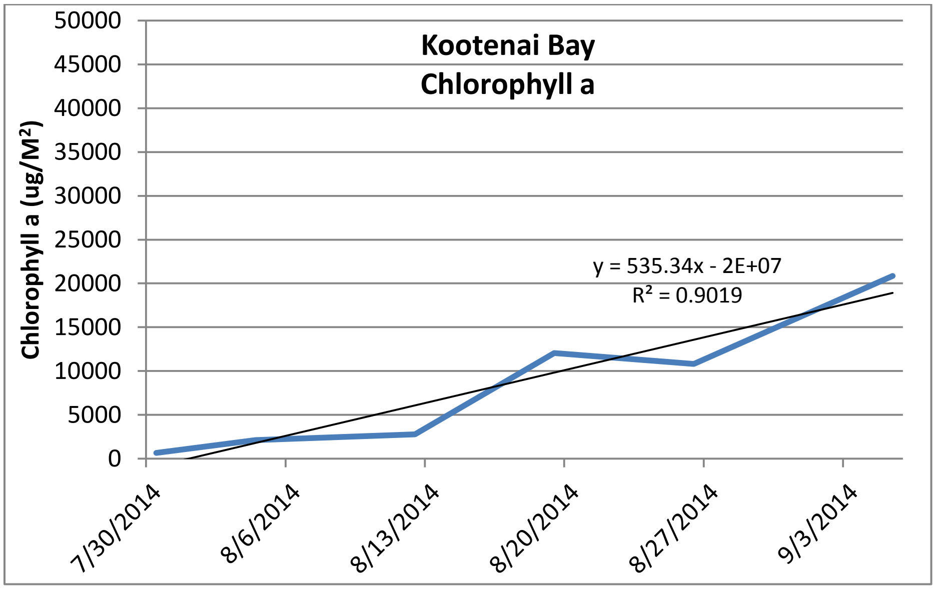


Figure 194. Periphyton chlorophyll-a growth rate, Kootenai Bay, Lake Pend Oreille.

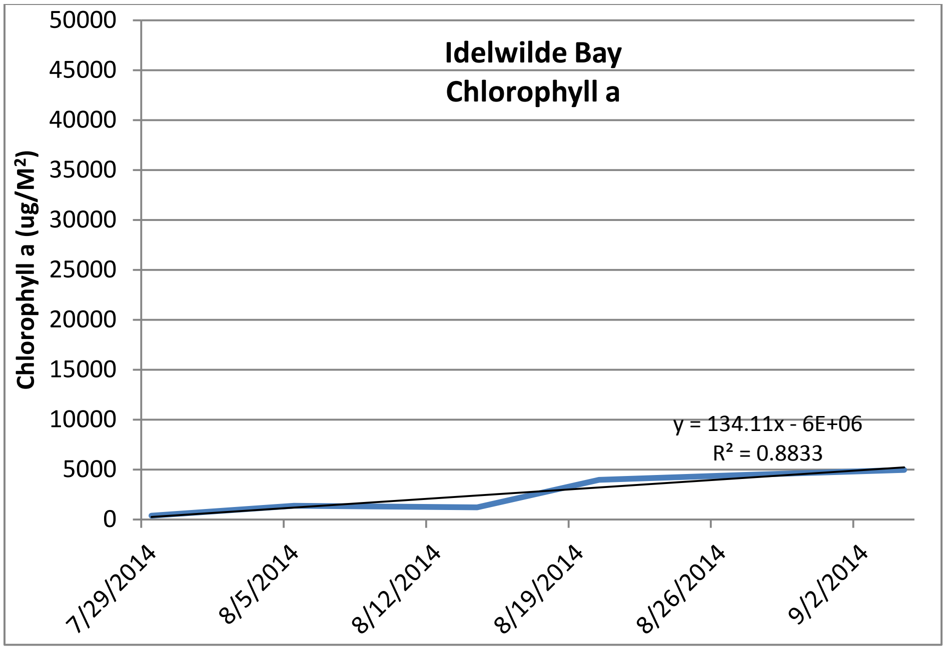


Figure 195. Periphyton chlorophyll-a growth rate, Idelwilde Bay, Lake Pend Oreille.

Periphyton Communities

Periphyton community structure and abundance provide an additional line of evidence that the stations in the northern portion of the lake support higher periphyton productivity than do the stations in the mid/southern portion of the lake. Appendix B includes the identification (taxa) and enumeration (cell counts) of the organisms from samples taken during the last week (week 6). The results indicate 17 individual taxa were identified from three separate classes:

- *Bacillariophyte*, commonly known as diatoms
- *Chlorophyceae* (coccoid greens and desmids), commonly known as green algae
- *Cyanophyceae* (colonial and filamentous blue-greens), commonly known as cyanobacteria

While many of the taxa were benthic organisms and attached to the substrate, some were free floating or swimming planktonic organisms and part of the periphyton community. Appendix B includes a relative taxa frequency for each taxa present.

An additional line of evidence that the northern region of the lake has higher productivity than other regions of the lake is the dominate periphyton taxa, which were *Ulothrix*, a green algae, (4.6 billion cells/m^2) and *Aulacoseira*, a diatom (2.6 billion cells/m^2). Other chlorophyll-a-producing taxa at the northern location were *Anabaena*, a cyanobacteria, (182 million cells/m^2) and *Mougeotia*, a green algae (182 million cells/m^2). The sum of these taxa is four times the abundance in the southern sites.

Dominate periphyton taxa collected in the southeastern region of the lake were *Aulacoseira*, a diatom, (2.0 billion cells/m^2) and *Anabaena*, a cyanobacteria (1.2 billion cells/m^2). Other chlorophyll-a-producing taxa in the southwestern location were *Staurastrum*, a green algae (48 million cells/m^2).

Dominate periphyton taxa collected in the southwestern region of the lake were *Mougeotia*, a green algae, (975 million cells/m^2) and *Aulacoseira*, a diatom (853 million cells/m^2). Other chlorophyll-a-producing taxa in the southwestern location were *Anabaena*, a cyanobacteria, (365 million cells/m^2).

5.4.9 2015 Road Crossing Inventory

In 2015, DEQ conducted a survey of 12 stream crossing conditions within the Cocolalla Lake watershed (Table 67). Eight of the crossings had erosion issues. One crossing over Westmond Creek had severe erosion at the outlet of the culvert, which was exacerbated by cattle grazing (Figure 196). Three crossings had road fill erosion into the creek at the crossing (Figure 197 and Figure 198). A bridge at the outlet of Cocolalla Lake was undersized with two overflow culverts that were rusted out (Figure 199 and Figure 200).

Table 67. Stream crossing condition, Cocolalla Lake watershed.

Type of Crossing	Location	Lat/Long	Erosion Severity	Overall Condition	Fish Barrier?
Culvert: round corrugated steel	Westmond Creek crossing	N 48.150546 W 116.	Medium: water backs up at inlet	Good	No
Culvert: round corrugated steel	Upper Cocolalla Lake tributary	N 48.074093 W 116.596290	High: cattle grazing	Fair	No
Culvert: arched corrugated steel	Upper Cocolalla Lake	N 48.047913 W 116.628502	Medium: road fill eroding	Good	No
Culvert: squashed corrugated steel	Upper Cocolalla Lake	N 48.049862 W 116.588013	Medium: road fill eroding	New	No
Culvert: squashed corrugated steel	Fish Creek at Loop Road	N 48.099870 W 116.672729	Low	Excellent	No (fish ladder)
Two culverts: round corrugated steel	Fish Creek	N 48.099897 W 116.660655	Medium: road fill eroding	Good	No
Culvert	Cocolalla Lake unnamed tributary	N 48.114409 W 116.633380	Low	Good	No
Culvert: round corrugated steel	Cocolalla Lake unnamed tributary	N 48.137128 W 116.622473	Low	Good	No
Culvert: round corrugated steel	Cocolalla Lake unnamed tributary	N 48.138929 W 116.612795	Medium at outlet	Good	No
Bridge: timber	Cocolalla Creek at outlet of lake	N 48.143247 W 116.615173	Low/medium bridge undersized	Fair	No
Culvert: round corrugated steel	Butler Creek	N 48.138905 W 116.615173	Low/poor alignment	Good	No
Culvert: round corrugated steel	Butler Creek	Unknown	Low	Good	No

Figure 196. Erosion at outlet of upper Cocolalla Creek crossing.

Figure 197. Road fill erosion into upper Cocolalla Creek.

Figure 198. Road fill erosion into Fish Creek.

Figure 199. Undersized bridge at outlet of Cocolalla Lake.

Figure 200. Rusted-out, overflow culvert at outlet of Cocolalla Lake.

5.4.10 Review of Implementation Plan and Activities

Upon approval of the TMDL for Cocolalla Lake (DEQ 2001), an implementation plan was developed for Cocolalla Lake and its tributaries by the Bonner Soil and Water Conservation District and HDR Engineering for DEQ (HDR 2004). Implementation projects are considered voluntary and cooperative on private lands and include mitigation for the impacts of Albeni Falls Dam, §319 implementation grant projects, application of Idaho Forest Practices Act standards, outreach and education projects, and individual residence practices guided by Lake*A*Syst and county ordinances that protect lakeshore zones with setbacks and disturbance ordinances. Implementation projects recommended in the implementation plans are summarized below:

1. Work with the Idaho Transportation Department for mitigation land at the southern end of Cocolalla Lake and determine a restoration plan for wetlands.
2. Increase water quality monitoring to include winter months and research use of more precise instrumentation.
3. Obtain lake-level monitoring equipment that will not be damaged by ice and current.
4. Work with the Idaho Association of Soil Conservation Districts to assist in implementing its agriculture plan for the Cocolalla Lake watershed.
5. Encourage formation of sewer district around Cocolalla Lake.
6. Reduce sediment in Fish Creek through road improvements and bank stabilization.
7. Encourage county to be consistent with watershed goals to reduce pollution to Cocolalla Lake on the Westmond area county-owned property of more than 400 acres.
8. Clean up beach at railroad access sites—provide trash receptacles.
9. Fund additional inventories of plants, sediment nutrient levels, habitat, and BURP monitoring.

The implementation projects provided below have been completed by agency partners since the TMDL was approved.

Agency Partner Implementation Projects

The NRCS and agency partners have conducted the following projects in the Cocolalla Lake watershed dated between 2007 and 2015:

- Fencing 10,881 feet
- Pest management 56.2 acres
- Watering facilities 2
- Critical area planting 1 acre
- Pipeline 802 feet
- Pasture/hay/biomass 109.1 acres
- Use exclusion 23 acres
- Stream crossing 2
- Tree/shrub establishment 30.7 acres
- Technical assistance 1
- Forest stand improvement 761.3 acres
- Prescribed burn 3 acres
- Slash treatment 79.4 acres
- Prescribed grazing 76.2 acres
- Conservation cover 2.1 acres
- Forest management plan 1
- Tree pruning 8 acres
- Herbaceous weed control 3.6 acres
- Seasonal high tunnel 1,337.5 feet
- Irrigation system 1 acre
- Tree/shrub site prep 20 acres
- Range planting 20 acres

Education Projects

Education and outreach projects include educating youth about land management and watershed management to improve water quality. The Pend Oreille Water Festival, an annual comprehensive environmental education program for all fifth graders in the area, includes stations that children progress through that identify sources of pollutants, BMPs to reduce pollutants, and management strategies for streams, lake shorelines, wetlands, and riparian areas to reduce nutrient and sediment inputs. The Idaho State Forestry Contest is held in the Cocolalla watershed to educate high school students about good forestry practices to reduce erosion and nutrient inputs from timber harvest, roads, and regrowth strategies to improve water quality.

A Stormwater Erosion Education Program helps local developers and landscapers improve their knowledge and implementation of BMPs to reduce sediment and nutrients from entering surface waters.

The Lake*A*Syst program is directed toward lake residents to improve shoreline management, property erosion, nutrient management, and littoral zone vegetation to enhance water quality and fish habitat and reduce pollutant inputs to surface water. These projects have increased awareness among citizens and developers to provide water quality improvements over time. These programs are available to citizens, lake residents, and the development sector year-round and have greatly improved construction and residence management to reduce pollutants.

Another important outreach and education forum is the monthly meetings of the Cocolalla Lake Association. Various speakers with IDFG, DEQ, Bonner Road and Bridge, Emergency Management, BNSF Rail, the soil and water conservation district, and nationally recognized invasive species experts make presentations at association meetings to educate residents and answer questions to improve land management in the watershed.

Citizen Monitoring

Citizen monitoring is an important facet of awareness and implementation in the watershed. It is primarily an outreach and education function, although voluntary monitoring data can facilitate DEQ awareness and planning. The Cocolalla Lake Association provides volunteers to collect water quality data from May through September on the lake and as needed in the winter through the ice. The sampling protocol is identified in the Citizen's Volunteer Monitoring Manual (DEQ 1991) to ensure good technique and quality control of monthly monitoring for dissolved oxygen and temperature profiles, Secchi depth, chlorophyll-a, and total phosphorus from the photic depth and 1 meter above the bottom. Data are submitted to a local credible laboratory and managed through LakeWatch, which is a software product geared to data management and reporting for lake monitoring.

The University of Idaho also provides a framework for stream monitoring through the Master Water Stewards Program to monitor fine sediment, turbidity, total nutrients, discharge, basic insect presence, and *E. coli* levels. Monitoring has been conducted on Westmond Creek, an ephemeral creek on the northern part of the lake, and Johnson's Creek, an ephemeral stream entering the lake on the eastern shore.

Invasive Species

Invasive aquatic plants have been a concern in Lake Cocolalla since the June 2009 discovery of Eurasian water milfoil (EWM) on the south end of the lake. Initially the Cocolalla Lake Association gained approval to fund treatment of EWM by private consultants. The Idaho State Department of Agriculture began oversight of aquatic invasive species in 2011. Hybrid strains of EWM are increasingly resistant to conventional treatment and have proliferated to several new areas along the western shore of the lake. Fragmentation from boat propellers and ambient wind direction are consistent forces that move species from the southern end of the lake where Cocolalla Creek enters the lake. There may be a reservoir of EWM in some slack reaches of the creek that will effect recolonization of the lake after apparent eradication.

Cocolalla Lake is moderately productive and this equates to a vigorous fishery featuring quick growth and good survival. Infestation by zebra or quagga mussels would certainly impact the lake, which has suitable habitat with light penetration to bottom layers over much of the lake. Invasive mussels drastically change the cycling of nutrients and impact the aquatic food chain to greatly reduce the number of fish with life stages dependent on phytoplankton and zooplankton and the forage fish that depend on primary and secondary producers. Such a change would increase water clarity but would also facilitate the spread of invasive species to deeper habitats.

Vigilance over invasive species continues with the implementation of a boat washing station funded by the Cocolalla Lake Association and the Idaho State Department of Agriculture to remove invasive species on boats and trailers before they get into Cocolalla Lake. Facilities are provided through cooperative efforts at the IDFG boat ramp on the north end of the lake. Annual surveys for aquatic invasive species are now conducted by the Idaho State Department of Agriculture Invasive Species Program. The lake generally requires annual treatment due to proliferation of EWM hybrid plants that resist control by aquatic herbicides. Curley leaf pondweed is also increasing its distribution and density and requires increasing treatment. The Cocolalla Lake Association continues to be the prime force in oversight of lake management, invasive species vigilance, water quality data collection, and outreach and education.

Fish Creek Road Sediment Reduction Project

The Cocolalla Lake Association sponsored a §319 grant valued at $180,000 in 2009 to provide improvements to Fish Creek Road, a major sediment and nutrient source to the lake. The project improved 15 culverts and installed 9 new culverts. The project also graded roads, improved ditches, identified erosion reduction measures, and improved road drainage. Private driveways were evaluated for improvements (culverts, ditch work, etc.). Hydroseeding revegetation was also done. An agreement was made through the Cocolalla Lake Association memorandum of understanding that the association would inspect and cleanout as necessary (twice each spring and once each fall) 20 culverts in this program. The project required some application refinement and was ultimately awarded to Bonner Road and Bridge through the Bonner Soil and Water Conservation District.

Idaho Department of Fish and Game Wetland Restoration Project

In 2014, the IDFG—in collaboration with the Bonneville Power Administration, DEQ, the NRCS, Ducks Unlimited, and the Cocolalla Lake Association—completed a wetland enhancement project on the south end of the lake adjacent to Fish Creek. The project restored wetland function across 90 acres of property and restored more than 700 feet of Fish Creek with diversion into historic sinuous channels. This project will significantly reduce the sediment, nutrient, and temperature load coming from Fish Creek into the lake, and it has improved habitat to enhance fish passage, spawning, and bank stability.

Cocolalla Lake Association

The Cocolalla Lake Association continues to hold monthly meetings that are informational with guest speakers and agency updates. The Cocolalla Lake Association is instrumental in facilitating coordination and communication between agencies, rail industry representatives, Bonner County Emergency Services, and the interested public. Meeting discussions range from aquatic invasive species survey results, treatment reports, and distribution changes to emergency response for transportation corridor spills that may affect water quality. Members provide updates on lake level, fishing reports, and volunteer water quality monitoring updates. The association has been a long-term advocate of wetlands enhancement and mitigation as well as promoting BMPs to improve and protect water quality. The association is often called on to express preference for water quality related issues and wetland mitigation from Idaho Transportation Department and BNSF rail activities. Recreation management, boat inspections, boating safety issues, and invasive species issue updates are regular topics of discussion.

Outreach and education has been facilitated by the Cocolalla Lake Association, which gives presentations on BMPs for reducing nutrient loading to the lake and describing Lake*A*Syst techniques for reducing nutrient loading by eliminating lawn fertilization, improving riparian buffer strips, controlling erosion in disturbed areas, and maintaining septic tanks.

The Cocolalla Lake Association formed an Algae Reduction Committee in 2009 to evaluate ways of limiting internal cycling of nutrients from sediments to curb harmful algal blooms. External loading of sediment and nutrients has been reduced but remains to the extent that layering phosphorus absorbing materials on the substrate of the lake would be nullified by loading from tributaries. Disturbance of substrate by bottom dwelling fish would also likely reduce the efficacy of an alum or Phoslock (brand) treatment, rendering the cost estimate of $1.2 million for a single Phoslock treatment that would only last a few years as not cost effective.

The Cocolalla Lake Association organizes a lake clean-up annually and members provide boats and individuals to pick up garbage and debris around the lake and in areas along railroad tracks and the wildlife management area on the southern shore of the lake.

5.4.11 TMDL Discussion

Modeling done in the early 1990s demonstrated that a phosphorus reduction of 39% would result in an epilimnetic phosphorus concentration of 16 µg/L, a chlorophyll-a concentration of 8.5 µg/L, and a Secchi depth of 10 feet. These conditions were determined to support beneficial uses. Data showed that meeting the phosphorus reductions necessary to meet the 16 µg/L target would not achieve dissolved oxygen conditions that meet Idaho’s water quality standard of 6 mg/L. During the 2001 TMDL development process, it was thought that a reduction to 10 µg/L would move the trophic level of the lake to a state where there is no internal nutrient cycling, and the dissolved oxygen standard would be met. However, the TMDL added at 20% margin of safety, which translated to a TMDL target of 8 µg/L total phosphorus in the lake and a load reduction requirement of 89% (DEQ 2001). The target identified in the TMDL was determined to be adequate to show that reduced nutrient loading was required to improve conditions in the lake and to restore full support of beneficial uses.

Water quality and trophic state is improving in Cocolalla Lake. Water quality data shows slight improvement of water clarity and improvement of epilimnetic total phosphorus concentrations. More recent epilimnetic total phosphorus concentrations have generally been observed in a range of <10 µg/L to 30 µg/L. However, wind mixing can periodically break down stratification and increase the variability of total phosphorus concentrations. Nevertheless, total phosphorus concentrations are still above the TMDL target, and nutrient loads to Cocolalla Lake still need to be reduced.

DO data in Cocolalla Lake show that epilimnetic DO generally stays above 6 mg/L throughout the summer months and is not stressful to fish. In recent years, incidents of hypolimnetic anoxia and hypoxia are less frequent and shorter duration than in previous years. Aggressive aquatic nuisance species management by the Cocolalla Lake Association has reduced DO demand by reducing biomass and plant decay.

Many TMDL projects have been implemented to reduce nutrients and sediment-bound nutrients into Cocolalla Lake. Agency partners and willing landowners have installed a number of projects on private property. Education and outreach efforts have targeted audiences from lakeshore owners, to contractors, to school-aged children. The Cocolalla Lake Association has been active in monitoring and facilitating coordination and communication between agencies, rail industry representatives, Bonner County Emergency Services, and the interested public. It is also active in recreation management, boat inspections, invasive species management, and in finding innovative ways to reduce internal cycling. Road improvements have been made along Fish Creek and other roads. A project on IDFG property on the southern end of the lake restored wetland function across over 90 acres of property and restored more than 700 feet of Fish Creek, which will significantly reduce the sediment, nutrient, and temperature load into the lake.

In summary, trophic conditions are improving, and many nutrient sources have reduced and stabilized. Hypolimnetic anoxia is less common in frequency and duration. Since the 1980s, numerous implementation projects have been completed, land management practices have improved, development pressure has subsided, and regrowth of over-harvested timber lands has occurred. A large condominium development was cancelled that was planned on the eastern part of the lake known as Sandy Shores, where Johnson Creek makes its confluence with the lake. This project would have been the first commercial residential development that would have had a soil absorption system that would likely have negatively impacted water quality in an area with a high water table.

While nutrient reduction projects have been successful, there continues to be a need for nutrient and sediment reduction where opportunities exist. A geomorphic risk assessment for the watershed identified areas of concern in the Butler, Cocolalla, Fish, and Johnson Creek watersheds. In addition to the steep gradient of these watersheds, high road density and numerous road crossings were a concern for increased sediment load and transport capability. Continued improvement of road drainage, erosion control, and culverts needs to occur. In addition, continued assistance to lakeshore residents using the Lake*A*Syst program is needed for improved lakeshore habitat and reduced nutrient and sediment introduction from runoff to the lake.

5.5 Cocolalla Lake Watershed

5.5.1 Hoodoo Creek

Hoodoo Creek (ID17010214PN003_02, ID17010214PN003_02a) remains impaired due to channel alteration from dredging to drain wetlands and wholesale removal of habitat. The stream channel has extremely diminished transport capability due to oversized channels with no access to floodplains. This creates a depositional environment for the buildup of organic material from adjacent drained wetlands. This increases oxygen demand during warm periods that results in occasional summer fish kills. Removal of riparian vegetation and dredging are perpetuated by a drainage district that has a taxing district and is not likely to change toward improvement. Implementation projects are very low priority in this watershed as a result of stream channel alteration. Nutrient and sediment controls in the Hoodoo Creek watershed would be directed at the Pend Oreille River though deposition in the perturbed system may likely reduce inputs to the river through channel storage and processing in Hoodoo Creek's drainage network.

5.5.2 Lower Cocolalla Creek

Lower Cocolalla Creek (ID17010214PN012_02**)** has good bank stability, reduced cobble embeddedness and a good riparian overstory. It benefits from groundwater recharge which can actually cool the flow from the fish barrier weir below Round Lake, which is the source of water to the lower Creek. Lake outlets exhibit elevated temperatures during the warm season, and as such, this lake outlet should not be expected to ever meet temperature criteria due to the epilimnion source of the flow out of Round Lake.

5.5.3 Upper Cocolalla Creek and tributaries

Upper Cocolalla Creek (ID17010214PN014_02, ID17010214PN014_03, ID17010214PN014_04) includes the creek itself with the following tributaries: Beaver Creek, Butler Creek, Careywood Creek, Kreiger Creek, Micro Creek, and Three Sisters Creek. Butler Creek is a tributary to Cocolalla Creek just above the inlet to Lake Cocolalla. Butler Creek caries a heavy sediment load from the BNSF rail line service road that is very unstable. It creates so much of a sediment load that it must be dredged from the Cocolalla Creek channel at its outfall between the Highway 95 bridge and the BNSF trestle because it is a threat to infrastructure. The remaining creeks are headwater creeks that have excessive channel storage of sediment from historic land management practices and road inputs. These streams continue to be impaired by sediment as evidenced by high cobble embeddedness, midstream depositional features, and over widened channels. Because many of these streams have spring sources they lack transport capacity over their lower gradient reaches and become aggraded. Headland reaches are cooler and more stable as they are above the influence of roads and eroding reaches. Since the assessment units are combined the upper tributaries will remain on the §303(d) list as impaired by sediment.

5.5.4 Fish Creek

Fish Creek (ID17010214PN015_02, ID17010214PN015_03) has benefitted from a §319 grant to improve drainage and culverts along Fish Creek Road to where the Creek departs the right of way and is joined by an unimproved road to its headwaters. Conditions have improved in Fish Creek to exhibit multiple year classes of salmonids including young of the year. There is reduced sediment input from road erosion and there is less cobble embeddedness and increased stability in the channel over the 2.4 miles of Fish Creek Road from the intersection with the Cocolalla Loop Road. There was an additional §319 grant awarded to an IDFG project below the Cocolalla Loop Road that incorporated channel improvements on the Wildlife Management Area on the south end of the Lake. Off channel wetlands were incorporated into the project to accept water from the channel above bankful stage to settle sediment and cycle nutrients before they reach the lake. This project was also aimed at improving waterfowl rearing and upland diversity for game and non-game species.

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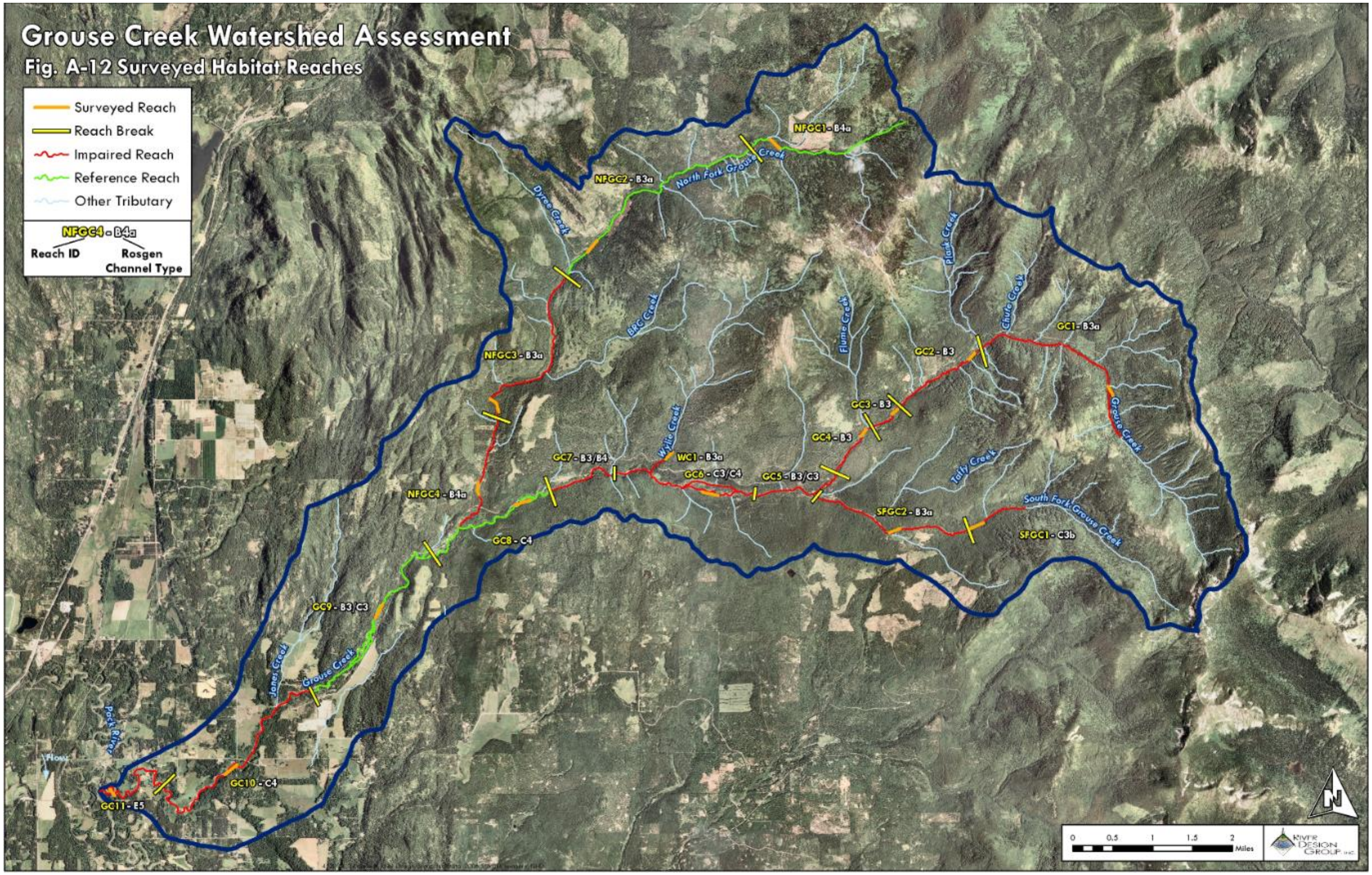
Appendix A. Map of Study Reaches in the *Grouse Creek Watershed Assessment and Restoration Prioritization Plan* (River Design Group 2009)


Grouse Creek Watershed Assessment
Fig. A-12 Surveyed Habitat Reaches
Surveyed Reach
Reach Break
Impaired Reach
Reference Reach
Other Tributary
NFGC4 - B4a
Reach ID
Rosgen Channel Type
NFGC1 - B4a
NFGC2 - B3a
North Fork Grouse Creek
Dyree Creek
Plank Creek
Chute Creek
BRC Creek
Flume Creek
GC1 - B3a
GC2 - B3
NFGC3 - B3a
GC3 - B3
GC4 - B3
Wylie Creek
WC1 - B3a
GC7 - B3/B4
GC6 - C3/C4
GC5 - B3/C3
Grouse Creek
Taffy Creek
South Fork Grouse Creek
SFGC2 - B3a
SFGC1 - C3b
NFGC4 - B4a
GC8 - C4
GC9 - B3/C3
Jones Creek
Pack River
Flow
GC10 - C4
GC11 - E5
0 0.5 1 1.5 2 Miles
River Design Group

Appendix B. Periphyton Community Structure and Abundance—Cocolalla Lake

Location	Sample Date	Group	Taxa	Cells/m^2
Southeast	10/4/2015	Diatoms	Aulacoseira sp.	2,000,602,000
Southeast	10/4/2015	Blue Greens	Anabaena sp. (CELLS)	1,219,880,000
Southeast	10/4/2015	Diatoms	Fragilaria sp.	878,313,000
Southeast	10/4/2015	Diatoms	Cyclotella sp.	113,855,000
Southeast	10/4/2015	Diatoms	Achnanthes	65,060,000
Southeast	10/4/2015	Diatoms	Cymbella (SM)	48,795,000
Southeast	10/4/2015	Diatoms	Pinnularia sp.(SM)	48,795,000
Southeast	10/4/2015	Greens	Staurastrum sp. (SMALL)	48,795,000
Southeast	10/4/2015	Diatoms	Caloneis sp.	16,265,000
Southeast	10/4/2015	Diatoms	Gomphonema sp.(LG)	16,265,000
Southeast	10/4/2015	Diatoms	Rhopalodia gibba	16,265,000
Southeast	10/4/2015	Diatoms	Synedra sp.:	16,265,000
North	10/4/2015	Greens	Ulothrix (CELLS)	4,574,754,000
North	10/4/2015	Diatoms	Aulacoseira sp.	2,622,859,000
North	10/4/2015	Diatoms	Cyclotella sp.	579,469,000
North	10/4/2015	Diatoms	Fragilaria sp.	396,479,000
North	10/4/2015	Diatoms	Frustulia sp.(SM)	243,987,000
North	10/4/2015	Blue Greens	Anabaena sp. (CELLS)	182,990,000
North	10/4/2015	Greens	Mougeotia (MEDIUM-CELLS)	182,990,000
North	10/4/2015	Diatoms	Epithemia sp.	121,993,000
North	10/4/2015	Diatoms	Cymbella (LG)	30,498,000
North	10/4/2015	Diatoms	Cymbella (SM)	30,498,000
North	10/4/2015	Diatoms	Tabellaria fenestrate	30,498,000
Southwest	10/4/2015	Greens	Mougeotia (MEDIUM-CELLS)	975,904,000
Southwest	10/4/2015	Diatoms	Aulacoseira sp.	853,916,000
Southwest	10/4/2015	Diatoms	Cyclotella sp.	414,841,000
Southwest	10/4/2015	Blue Greens	Anabaena sp. (CELLS)	365,964,000
Southwest	10/4/2015	Diatoms	Fragilaria sp.	365,964,000
Southwest	10/4/2015	Diatoms	Achnanthes	170,865,000
Southwest	10/4/2015	Diatoms	Epithemia sp.	48,467,000
Southwest	10/4/2015	Diatoms	Frustulia sp.(SM)	48,467,000
Southwest	10/4/2015	Diatoms	Cymbella (SM)	24,233,000
Southwest	10/4/2015	Diatoms	Navicula sp.(SM)	24,233,000
Southwest	10/4/2015	Diatoms	Pinnularia sp.(SM)	24,233,000
Southwest	10/4/2015	Diatoms	Synedra sp.	24,233,000

Appendix C. Geomorphic Risk Assessment – Cocolalla Lake Watershed

Butler Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	4640	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0.09
minimum watershed elevation (ft)= E_{mn}	2215			
basin length (ft) = L_B	26144			
total stream length (mi)= L_S	4.28	**Drainage Density**	**(L_S/A_W)**	1.11
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	25	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	25			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**0**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.165**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**1.27**			
drainage area (mi^2)= A_W	3.84			
Potential Sediment Transport Coefficient= P_S	**0.625**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = 0.625

Cocolalla Creek, above Fish Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	4467	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0.03
minimum watershed elevation (ft)= E_{mn}	2215			
basin length (ft) = L_B	72684			
total stream length (mi)= L_S	44.51	**Drainage Density**	**(L_S/A_W)**	1.59
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	93	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	93			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**14.2**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.591**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**4.67**			
drainage area (mi^2)= A_W	27.97			
Potential Sediment Transport Coefficient= P_S	**0.083**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = 0.083

Fish Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	4558	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0.08
minimum watershed elevation (ft)= E_{mn}	2215			
basin length (ft) = L_B	28822			
total stream length (mi)= L_S	18.97	**Drainage Density**	**(L_S/A_W)**	1.93
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	63	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	63			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**0.81**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.145**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**1.23**			
drainage area (mi^2)= A_W	9.84			
Potential Sediment Transport Coefficient= P_S	**1.082**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = **1.082**

Johnson Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	3765	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0.10
minimum watershed elevation (ft)= E_{mn}	2203			
basin length (ft) = L_B	14977			
total stream length (mi)= L_S	7.26	**Drainage Density**	**(L_S/A_W)**	2.15
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	17	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	17			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**0**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.114**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**0.77**			
drainage area (mi²)= A_W	3.38			
Potential Sediment Transport Coefficient= P_S	**1.967**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = 1.967

Kreiger Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	4240	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0. 09
minimum watershed elevation (ft)= E_{mn}	2380			
9basin length (ft) = L_B	20311			
total stream length (mi)= L_S	11.07	**Drainage Density**	**(L_S/A_W)**	1.76
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	34	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	34			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**1.61**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.421**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**2.07**			
drainage area (mi^2)= A_W	6.28			
Potential Sediment Transport Coefficient= P_S	**0.383**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = **0.383**

Westmond Creek

maximum watershed elevation at initial Drainage Point (ft)= E_{mx}	4893	**Relief Ratio**	**$(E_{MX}-E_{MN})/L_B$**	0.12
minimum watershed elevation (ft)= E_{mn}	2203			
basin length (ft) = L_B	22788			
total stream length (mi)= L_S	8.93	**Drainage Density**	**(L_S/A_W)**	0.91
estimated bankfull discharge for a given unit (cfs)= Q_{unit}	38	**Bankful Discharge Ratio**	**(Q_{unit}/Q_{AA})**	1
estimated bankfull discharge for analysis area (cfs)= Q_{AA}	38			
total response reach length (<1.5% slope) (mi)= L_{RSP}	**4.44**	**Depositional Stream Density**	**$(L_{RSP}+(0.5*L_{TSP})/A_W)$**	**0.465**
total transport reach length (1.5 to 3% slope) (mi)= L_{TSP}	**0.28**			
drainage area (mi^2)= A_W	9.86			
Potential Sediment Transport Coefficient= P_S	**0.230**			

$P_S=((E_{MX}-E_{MN})/L_B*(L_S/A_W)*(Q_{unit}/Q_{AA}))/(L_{RSP}+(0.5*L_{TSP})/A_W)$=dimensionless Sediment Transport Coefficient=

P_S = 0.230