Watershed Overview & History
North Fork Coeur d'Alene River Subbasin

Little North Fork - Road 209 Stream Restoration Project

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to Section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section.
BMP	Best Management Practice
BURP	IDEQ Beneficial Use Reconnaissance Program
CdA	Coeur d'Alene
CWA	Federal Clean Water Act
CWE	IDL Cumulative Watershed Effects protocol
IDEQ	Idaho Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
FPA	Idaho Forest Practice Act
HUC	Hydrologic Unit Code(s) assigned by the USGS
IDFG	Idaho Department of Fish & Game
IDL	Idaho Department of Lands
IDWR	Idaho Department of Water Resources
m	meter
mm	millimeter
mg/L	milligrams per liter
North Fork	mainstem North Fork Coeur d'Alene River
North Fork Subbasin	(or subbasin) references the 4th field drainage area.
Coeur d'Alene River Basin	(or basin) references the drainage area comprised of three, 4th field HUCs: the North Fork, the South Fork Coeur d'Alene River (HUC = 17010302), and the Coeur d'Alene River proper plus Coeur d'Alene Lake (HUC = 17010303).
NRCS	National Resource Conservation Service
TMDL	Total Maximum Daily Load
µg/L	micrograms per liter
U of I	University of Idaho
USFS	U.S. Forest Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
WPN	Watershed Professionals Network
WY	Water Year

Acknowledgements

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1.0 INTRODUCTION

This document provides an overview of the North Fork Coeur d'Alene River (North Fork) Watershed Analysis which was completed to support the development of a sediment TMDL Implementation Plan for the North Fork. In order to provide sufficient information to develop an effective Implementation Plan, the IDEQ requested assistance in compiling information on sediment sources, recent watershed improvements, and aquatic habitat conditions in the listed subbasins of the North Fork watershed. Funding for this effort was provided by a grant from EPA. This work was completed in two Phases.

Phase I involved compilation and synthesis of existing watershed data and completion of a Watershed History. This information was presented in the following document:

- Summary of Existing Information and Knowledge within the North Fork Coeur d'Alene River Subbasin (January 2006)

An initial analysis of the existing information was then completed to identify data gaps and potential field assessment needs. This 'Draft Initial Analysis' included preliminary aerial photo review results and detailed summaries of the existing stream channel data that was obtained from the Forest Service. This initial analysis provided recommendation for field investigations and futher analysis recommendations for Sediment Sources, Channel Geomorphic response and Hydrologic Modeling. This information and preliminary analysis is in the following document and was used to develop a scope of work for Phase II of the assessment:

- INITIAL DRAFT - North Fork Coeur d'Alene Phase II Report North Fork Coeur d'Alene River Subbasin (July 2006)

The actual Phase II Watershed Assessment focused on identifying and quantifying sediment sources and impacts related to the condition of §303(d) listed impaired streams within the North Fork subbasin This analysis was based on in-depth aerial photo analysis, field surveys in targeted subbasins and detailed hydrologic modeling of targeted subbasins.

The hydrologic and sediment source modeling for roads and tributary streams was focused on two sub-basins, the upper Little North Fork CDA River and Big Elk Creek (tributary of Tepee Creek) (Figure 1) which represented the range of the past management actions in the watershed. These subbasins were selected because stream segments in both of these basins were listed in the TMDL for sediment and there are several currently-operating stream gages which were critical to the hydrologic modeling.

The next, broader, analysis level was addressing channel response to sediment inputs through time for response reaches of the mainstem North Fork CDA, Tepee and Independence Creeks, plus selected downstream parts of other major tributaries. The Tepee Creek subbasin provided data for burned watersheds with relatively little timber harvest or road-building. The Middle North Fork and some headwater areas of Tepee Creek provided data for harvested and roaded conditions.

These analysis results are presented in four reports. The detailed technical analyses for Sediment Sources, Stream Channel Analysis and Hydrology Analysis are in individual reports.
In addition to the technical reports the analysis team created a database of road and stream restoration activities and a database of the data and reports located and reviewed during the course of this analysis. The files are included as appendices to the Final Report.

This Overview Report presents a summary of watershed conditions and summarizes the key analysis goals and findings to assist the non-technical Watershed Advisory Group (WAG). The following reports are all part of the final work product:

- North Fork Coeur d'Alene Watershed Overview & History (this document)
  - Appendix A – Technical Appendix: Summary of Existing Information
  - Appendix B - Hydrology Analysis North Fork Coeur d'Alene Subbasin
  - Appendix C - Sediment Source Analysis North Fork Coeur d'Alene Subbasin
  - Appendix D - Stream Channel Analysis North Fork Coeur d'Alene Subbasin
  - Appendix E- Reviewed Reports and Data Sources
  - Appendix F – Stream and Road Project Database

Figure 1: North Fork Coeur d'Alene subbasin location and 5th code HUC boundaries.

2.0 WATERSHED DESCRIPTION

The North Fork Coeur d'Alene River (North Fork) and its tributaries drain a mountainous area approximately 900 square miles in size (Map 1) just east of Coeur d'Alene Lake. The North Fork converges with the South Fork Coeur d'Alene River near Enaville. From the confluence the Coeur d'Alene River proper flows west into Lake Coeur d'Alene. Elevations in the North Fork drainage range from approximately 2,200 feet at the confluence with the South Fork to approximately 6,800 feet on Granite Peak in the Prichard Creek drainage.

2.1 WATERSHED BOUNDARIES AND TERMINNOLGY USED IN THIS REPORT

The entire North Fork drainage basin is classified as a 4th field hydrologic unit (or cataloging unit) by the US Geological Survey (USGS). This drainage basin is assigned the 8 digit Hydrologic Unit Code (HUC)[1] 17010301. The Technical Appendix (Appendix A) provides an overview of the numbering and delineation of the HUCs. It is important to note IDEQ used somewhat different boundaries and divisions for their seven, 5th field HUCs used in the *North Fork Subbasin Assessment and TMDL* document (IDEQ, 2001) then the boundaries used by the Forest Service. Unless explicitly specified, this report uses the HUC divisions delineated by the USFS (Figure 1, Table 1).

2.2 LAND COVER

The National Land Cover Dataset provides a seamless map of land cover for the United States based on Landsat Thematic Mapper satellite data. This data was downloaded and analyzed to provide insight on vegetation patterns in the subbasin. Land cover in the North Fork Subbasin is predominantly evergreen forest (87% of total area; USGS 1999). Areas classified as "transitional", consist primarily of regenerating harvest areas or areas recovering from wildfire, and make up an additional 6% of the total area. Other significant cover types include shrubland (3%), mixed forest types (2%) and grasslands (1%). All remaining types combined make up less then 1% of the total area.

2.3 TOPOGRAPHY

The North Fork Subbasin is mountainous, with deeply dissected drainages (Figure 2). For the most part, tributary stream valleys are narrow and confined. There are a few broader, flat valleys in the Lower North Fork HUC and in lower areas of the Teepee Creek HUC. Elevations in the subbasin range from 2,100 feet at the mouth of the river to 5,000-6,000 feet at the peaks along the Bitterroot Divide.

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[1] The USGS had divided the United States into successively smaller hydrologic units. The entire NFCDA River is a fourth-field "Subbasin", which is identified by a unique eight-digit hydrologic unit code (HUC); 17010301. Nested within this level of classification are fifth-field "watersheds" (10-digit code), and sixth-field "sub-watersheds" (12-digit code).

Table 1. The names, HUC designations and areas of watersheds and subwatershed within the North Fork Subbasin.

5th-field HUC watersheds (names used in this report)[a]	Area (mi^2)	6th-field HUC subwatersheds delineated by USFS	Area (mi^2)
1701030101: NF Coeur d'Alene River above Tepee Cr (Upper North Fork HUC)	102	170103010101: NF Coeur d'Alene River abv Marten Cr	36.5
		170103010102: NF abv Tepee & blw Marten Cr	65.3
1701030102: Tepee Cr (Tepee Creek HUC)	144	170103010201: Tepee Cr abv Trail Cr	34.7
		170103010202: Trail Cr	29.8
		170103010203: Tepee Cr blw Trail Cr	19.4
		170103010204: Independence Cr	59.8
1701030103: Middle NF Coeur d'Alene River above Prichard Cr (Middle North Fork HUC)	123	170103010301: NF abv Yellowdog Cr & blw Tepee Cr	50.8
		170103010302: NF abv Prichard Cr & blw Yellowdog Cr	48.5
		170103010303: Lost Cr	24.2
1701030104: Shoshone Cr (Shoshone Creek HUC)	69	170103010401: Shoshone Cr abv Falls Cr	41.7
		170103010402: Shoshone Cr blw Falls Cr	13.6
		170103010403: Falls Cr	13.9
1701030105: Prichard Cr (Prichard Creek HUC)	98	170103010501: Prichard Cr abv Eagle Cr	49.6
		170103010502: Eagle Cr	45.1
		170103010503: Lower Prichard Cr	3.5
1701030106: Lower NF Coeur d'Alene River below Prichard Cr (Lower North Fork HUC)	189	170103010601: Lower NF Coeur d'Alene River blw Prichard Cr	85.6
		170103010602: Beaver Cr	42.3
		170103010603: Steamboat Cr	41.8
		170103010604: Cougar Gulch	19.3
1701030107: Little NF Coeur d'Alene River (Little North Fork HUC)	170	170103010701: Little NF Coeur d'Alene River abv Cabin Cr	76.4
		170103010702: Little NF Coeur d'Alene River blw Cabin Cr	93.8
Entire North Fork Subbasin			**895**

a: 5th field HUC boundaries established by the USFS differ from the 5th field boundaries and divisions used by IDEQ in their North Fork Subbasin Assessment and TMDL (IDEQ, 2001). These differences are:

1. Upper North Fork HUC: IDEQ includes Independence Creek, USFS does not
2. Tepee Creek HUC: IDEQ does not include Independence Creek, USFS does
3. Middle North Fork HUC: IDEQ boundary for North Fork River is Yellowdog Creek to Tepee Creek, and does not include Lost Creek where USFS does.
4. Shoshone Creek HUC: IDEQ includes Lost Creek, USFS does not
5. Prichard Creek HUC: IDEQ includes Beaver Creek, USFS does not.
6. Lower North Fork HUC: IDEQ reach for North Fork River is from mouth to Yellowdog Creek. IDEQ does not include Beaver Creek, USFS does.
7. Little North Fork HUC: IDEQ and USFS are the same.

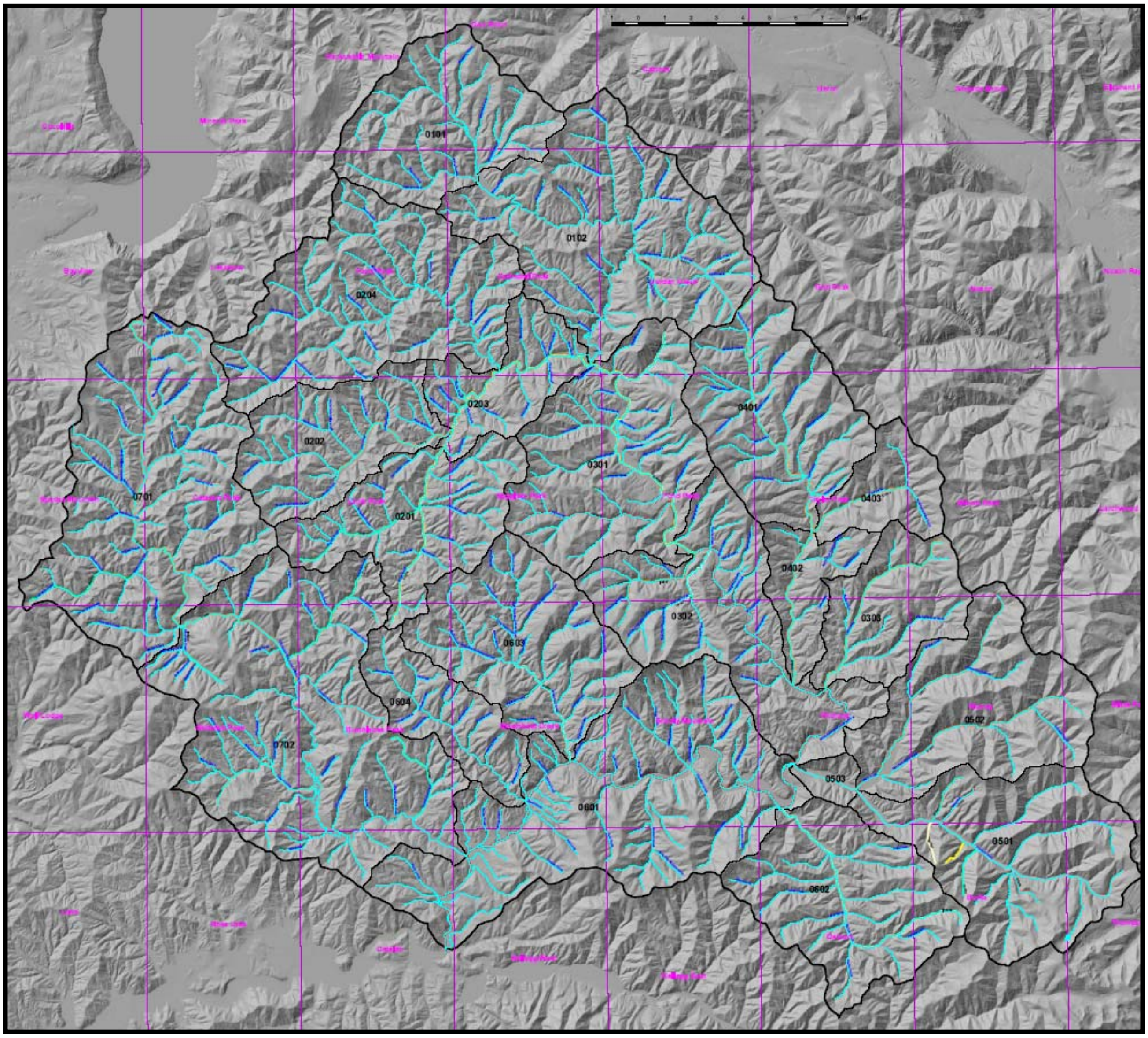


Figure 2 : North Fork Coeur d'Alene shaded relief topography.

3.0 WATERSHED HISTORY

3.1 NATIVE AMERICAN PRESENCE

The Coeur d'Alene Indians occupied the Coeur d'Alene River Basin for thousands of years prior to European-American settlers moving into the area. The Tribe's settlements were located on the forest edges in the lower part of the basin and the camas grounds south of Lake Coeur d'Alene (USFS, 1998). The Coeur d'Alene tribes used fire to improve hunting, built fish weirs, and occasionally engaged in communal hunting drives (USFS, 1998). There was no information found on any specific tribal activities or encampments in the North Fork subbasin.

3.2 HISTORICAL SETTLEMENT, LAND USE, AND RESOURCE MANAGEMENT PATTERNS AND TRENDS

The Coeur d'Alene River Basin is an area rich in natural resources, with a relatively mild climate and excellent transportation routes with large lakes and rivers. The North Fork subbasin was heavily harvested, mined, and burned, strongly influencing the watershed conditions we see today. Table 2 is a timeline of historic events and activities that have influenced the current subbasin conditions. Below is a brief narrative of the development patterns in the area.

European settlers (trappers, traders, missionaries, etc) began visiting the basin prior to the 1850's. Construction of the Mullan Road, in 1859, opened the area to larger scale development and resource extraction by Euro-Americans. The Mullan Road was the first overland road between the navigable waters of the Missouri and the Columbia Rivers and it was the only connecting link from east to west until the 1880's (Strong and Webb, 1970). Completion of the Northern Pacific Railroad in 1881 connected the west coast with eastern and midwestern timber markets. Then in the 1890's the Great Northern Railroad came into the area.

When Europeans first visited the subbasin there were vast stands of high quality old-growth white pine, as well as western red cedar and Douglas fir. The supply of old growth white pine in the eastern states was almost exhausted and agents were actively seeking new supplies (Strong and Webb, 1970). The region's white pine timber resources had a strong market in the east and the railroads provided the means to transport them east or west (Strong and Webb, 1970).

Once the Coeur d'Alene area could be accessed by the Mullan Road, and the railroads, population growth began to explode. With passage of the Homestead Act of 1862 homesteaders moved in quickly to set up houses and began cultivation on land in the lower parts of the basin and prospectors began searching for potential miming claims.

3.2.1 Mining History & Impacts

Gold was discovered in the Prichard Creek area of the North Fork Subbasin in 1880. By 1884 the towns of Eagle and Murray were established and 4 sawmills were operating to supply the mining operations with timber (Strong & Webb, 1970). Between 1917 and 1926 floating dredges worked the mainstem of Prichard Creek (USGS, 2004). In the 1920's to about 1960 various underground mines operated in the headwaters of Eagle, Prichard and Beaver Creeks. The largest of these was the Jack Waite Mine, which released fine milled tailings directly into

Table 2. Timeline of Historical Activities in the North Fork River Subbasin.

YEAR	Activity	Reference
	No information on Native Settlement & Use	
Pre-1849	Major forest stand replacing events every 203 years 1542, 1580, 1654, 1764, 1772, 1790, 1814, 1830, 1859, 1878, and 1889.	USFS 1998, 2001
1859	Mullan Road connects navigable waters of the Missouri & Columbia Rivers	Strong & Webb 1970
1862	Homestead Act of 1862 –Settlement of lands in the public domain	Strong & Webb 1970
1880 - 1885	Discovery of Placer gold in Prichard , lower Eagle, and Trail Creeks. Eagle & Murray establ. 1883. 1st sawmill 1883, 4 more saw mills by 1884	USGS 04 Strong & Webb 1970
1881	Northern Pacific Railroad connected to eastern & midwest timber markets.	Strong & Webb 1970
1890's	Great Northern railroad increased transport of lumber and forest products	Strong & Webb 1970
1898	**Flood – houses flooded along NF**	Russell 1984
1900 -1925	Timber Development Period: big sawmills were constructed & railroads	Strong & Webb 1970
1910	Largest fire of 20th century. Burned Tepee, Upper Cd'A, Independence & Shoshone	USFS 1998
1915	Chutes described along NF: Falls Creek, Steamboat Creek, Peplo Creek,	Russell 1984
1917	**Flood partially washed out Railroad**	Russell 1984
1917 -1926	Large Floating dredge in 8km reach of Prichard near Murray	USGS 04
1919	Forest Fire between Steamboat and Scott Creek burned Upper North Fork	Russell 1984
	Over 35 flume projects identified with total mileage exceeding 150 miles.	Strong & Webb 1970
1922, 26&31	More Big Forest Fires	Strong & Webb 1970
1923	Brunt Cabin Railroad completed. ~ 250 **billion** bf harvested 1923 to 1944 (Burnt Cabin Creek Area)	Strong & Webb 1970
1920-1960	Underground zinc, lead & silver mines: headwaters of EF Eagle, Prichard & Beaver Creeks. Mills left tailings with varying metal concentrations.	USGS 04
1930	Jack Waite Mine released fine tailings into Tributary Creek until 1930 when downstream communities complained	USGS 04
1930's	7 Splash Dams on Little NF. 1+ splash dam Steamboat Creek Road Development Begins	Russell 1984 Ruebke 2003
1932,33	Boxcars of Elk planted in Steamboat Creek	Russell 1984
12/15/33	High flow (48,200) at NF Coeur d'Alene River gage USGS 12413000 – Destroyed Railroad near Enaville	Russell 1984
4/15/38	High flow (40,400) at NF Coeur d'Alene River gage USGS 12413000	
1940	Log Transportation changes to roads – no more working flumes or chutes after 1940 Administrative closure of headwater and small tributary streams restrict fishing ~ 25% of drainage is open to the public. Dolly Varden (Bull Trout) noted as occurring from mouth to Yellow Dog Creek.	Strong and Webb 1970 Tentative Fish Management Plan. 1940
12/23/64	High flow (34,800) at NF Coeur d'Alene River gage USGS 12413000	
~1970	Upgrade road from Interstate 90 to Trail Creek – double lane paved from Senator Creek down. No harvest for 40-60 years??? Most of Little NF cut – Yellowdog, Grizzly & tributaries heavily logged last 10 -15 years	Rabe
1/16/74	*Very high flow (61,000) at NF Coeur d'Alene River gage USGS 12413000*	
12/27/80	*High flow (34,800) at NF Coeur d'Alene River gage USGS 12413000*	
2/21/82	*High flow (38,800) at NF Coeur d'Alene River gage USGS 12413000*	
winter of 1995-1996	Fill failures from riparian roads delivered ~ 11,500 cubic yards of material in 18 streams and considerably altered the condition and trend for fish habitat.	District ERFO reports, 1996
2/9/96	*High flow (56,600) at NF Coeur d'Alene River gage USGS 12413000*	
1992,1995, 1996,2002	Removal of 3 miles streamside road, over 70 miles of hillslope road and over 120 road-channel crossings – Steamboat Creek	Ruebke 2003
4/15/03	***High flow (32,700) at NF Coeur d'Alene River gage USGS 12413000***	

Tributary Creek. The release of tailings was stopped about 1930 because of complaints from downstream property owners and towns (USGS, 2004).

Placer gold mining operations, most notably on Prichard Creek, have altered the entire floodplain and valley floor as well as the channel. USFS reports that "as vegetation has been removed, the critical topsoils have been displaced or eroded, and the streams have been channeled or left in an unstable position, unable to function or adjust in a way that fully supports beneficial uses" (USFS, 1998). Tailings from mines have added contaminated sediments to Eagle and Prichard Creeks, primarily fine sediment.

3.2.2 Timber Harvest History, Methods & Impacts

Timber harvest in the North Fork Subbasin began in the lower elevation valleys in the late 1800's. Cutting and bucking trees on the hillslopes occurred over wide areas. Transporting the trees from the hillside to the mill included flumes, splash dams, and log drives down rivers. Since running water from stream channels or the channels themselves were the basis for these transportation methods, the stream channel and surrounding riparian areas of the mainstem and tributaries were severely impacted and there is evidence of widespread erosion. Some of this is illustrated in photographs of logging practices of the era (Figure 3).

Between 1900 and 1940 big sawmills and railroad operations were constructed increasing the ability to harvest and process timber. Much of the timber was moved out of the subbasin using a system of log chutes, flumes and splash dams. Figure 4 illustrates the extent of early timber harvest systems. According to the Forest Service's Watershed Characterization (USFS, 1998c), early logging, splash dams, flumes, chutes, and drives occurred extensively in the Little North Fork, Shoshone Creek, lower Teepee Creek, Eagle Creek, Cougar Gulch, Steamboat Creek, and in the lower and middle North Fork. Construction and operation of these systems required riparian clearing, including removal of any timber that might catch transported logs and channel straightening. In addition, the splash dam operations which involved blocking the channel to back up enough water to move logs downstream, altered the functions and processes of the streams and riparian areas to an extent that it is difficult to see any significant recovery even today. There were 7 documented splash dams on the Little North Fork River and additional splash dams noted in Steamboat Creek (Russell, 1984 and USFS, 1998). Figure 5 shows splash dam locations on the Little North Fork.

Each mile of log chute or flume built required over a quarter-million board feet of timber. There were hundreds of miles of chutes built in the Coeur d'Alene Basin. In the North Fork, 35 flume projects were built with a total mileage probably exceeding 150 miles (Strong and Webb, 1970). With the completion of the Brunt Cabin railroad in 1923, heavy harvest began in the Burnt Cabin Creek area of the Little North Fork HUC. Over 250 billion board feet were harvested between 1923 and 1944. The peak of this logging activity occurred in 1929, and the last log drive occurred in 1943 (Strong & Webb, 1970).

White pine blister rust began to impact the forest health in the 1930's. White pine blister rust was introduced to North Idaho in the 1890's and the fungus utilizes currants and gooseberries (*Ribes* spp.) as an alternate host. Management options to increase white pine success is complex; most common methods include *Ribes* control, maintaining a partial overstory canopy, and

Figure 3. Logs ready for log drive. Note lack of riparian buffer, and bare soil on hillside where logs were slid into river (University of Idaho).

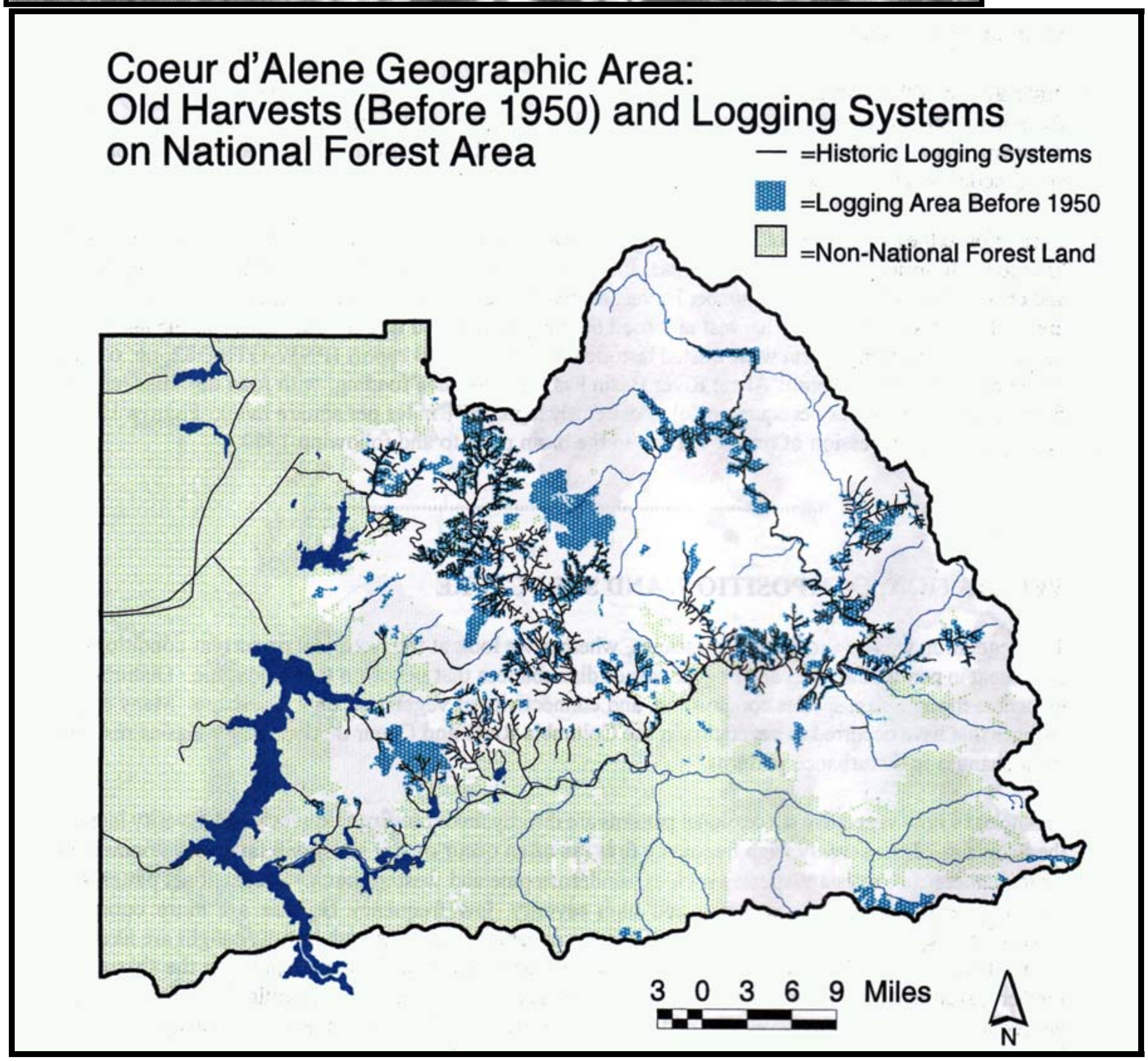


Figure 4. Map of Historic logging systems and harvest within National Forest lands of the Coeur d'Alene River Basin (USFS 1998).

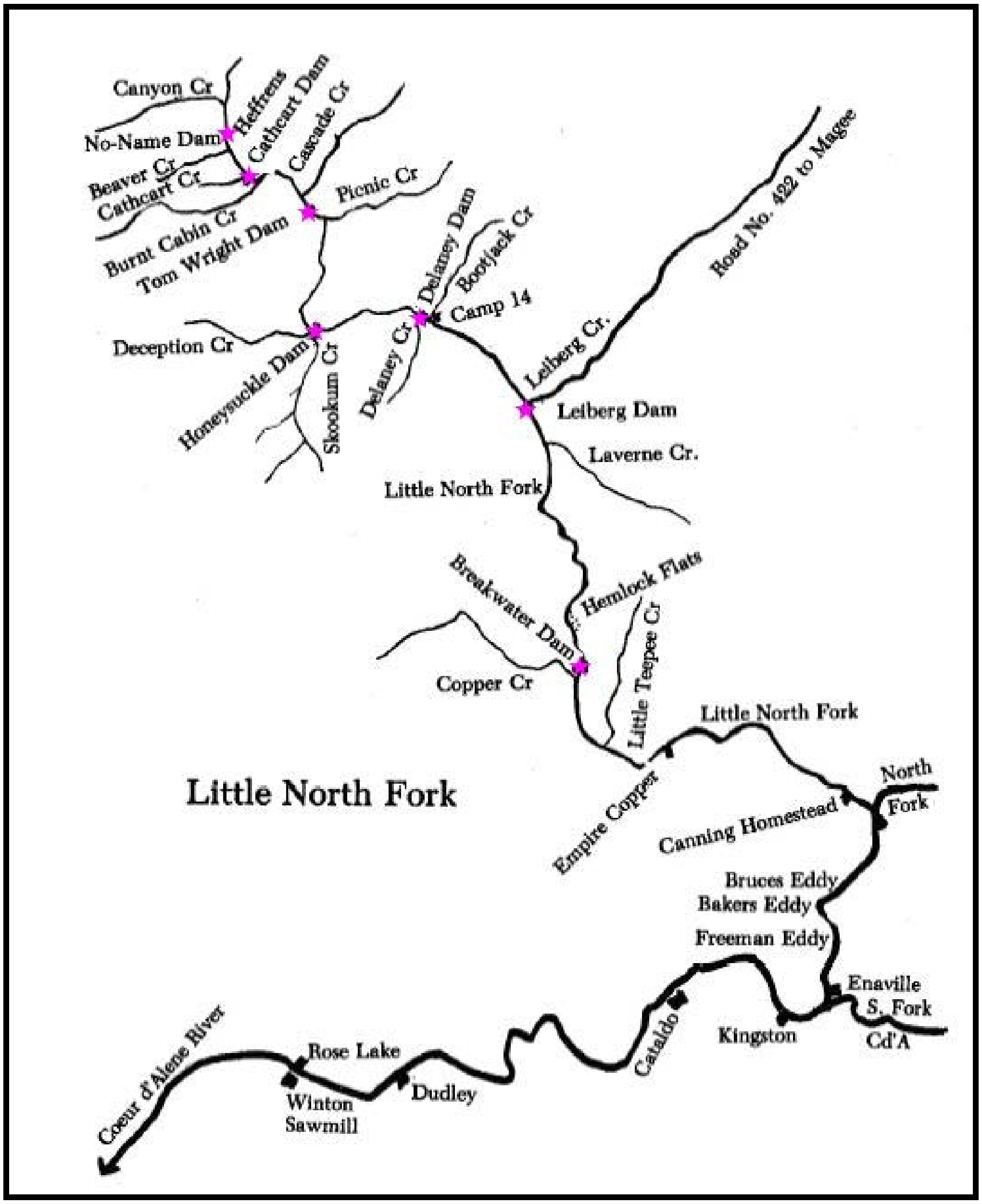


Figure 5. Locations of splash dams on the Little North Fork Coeur d'Alene River (Russell 1984).

manual pruning of lower branches of young sapling trees. As a control measure, Trail and Tepee Creek bottoms were bulldozed in the 1930s to remove *Ribes* in an attempt to control white pine blister rust, and bulldozers pulled out large wood from Independence Creek in the 1950s to improve fish passage (USFS, 1997), and this practice occurred in additional streams in the North Fork CDA watershed through the 1980s (Ed Lider, USFS, personal comm. Sept. 2005).

3.3 DISTURBANCE PATTERNS

Natural and human disturbances are important processes that shape the development and forest structure and composition of the basin. Flooding on the rivers and lakes happened frequently, and in the early years of development, damaged railroads, mills, roads, and homes was a common event. Large high flow events were documented in the winters of 1898, 1917, 1933, 1938. A portion of the Mullan Road on the lower Coeur d'Alene River flooded annually and eventually was relocated north (Strong and Webb, 1970).

Natural disturbances include fire, insects and diseases, winds, snowfall, and ice storms. At landscape scales, these natural disturbances have historically occurred at regular intervals with varying degrees of intensity. At local scales, disturbance maintains and promotes species and structural diversity in a patchwork mosaic (hundreds of acres in size), often following topographic features.

Major human-caused disturbances in the analysis area include timber harvest, mining, railways, and roads. As was also the case elsewhere in the interior mountain west, human settlement (mostly of Euro-American descent) often altered the historic fire regime to an increased frequency of fires in areas that often did not regularly burn. Miners and railroads used fire to clear vegetation and make it easier to locate mines and right-of-ways; fire ignitions increased along narrow-gauge rail lines due to spark throw (USFS, 1998). Fire suppression success began to increase following the World War II, and since that time, few fires (from natural or human-caused sources) have been allowed to burn in or around the basin. Through successful fire suppression, a different type of disturbance has recently affected the landscape, called *fire exclusion* (Keane *et al*., 2002).

3.3.1 Fire History

Historic fire patterns in the Coeur d'Alene Basin typically involved a pattern of widespread, *low severity* (low mortality) and high frequency fire activity prior to Euro-American settlement (Agee, 1994 and Smith and Fisher, 1993). At longer fire return intervals, the *low severity* fire types would sometimes result in small patches (few acres in size) of complete stand replacement (*mixed severity* fires). In certain forest types, where fires are supported in extremely dry weather conditions, complete stand replacement occurs at larger scales (*high severity* fires); very large-scale stand replacement fire events occur rarely in the basin, on an interval that averages 203 years (USFS, 1998). There are indications that the area had massive fires in 1542, 1580, 1654, 1764, 1772, 1790, 1814, 1830, 1859, 1878, and 1889 (USFS, 1998).

The frequency and distribution of fire scars in North Idaho ecosystems have shown that historic fire patterns (~1650's – 1880's) have averaged 200 – 500 acres in size, at a frequency of 15 – 20 years in warm-dry sites and 20 – 40 years in cool-moist sites (Smith and Fisher, 1993 and Shellhass *et al*., 2000). Clearly, individual sites might not have burned for hundreds of years (e.g. riparian zones, moist seeps), but on the landscape scale, every portion of the basin was affected in some way by fire. The signature pattern of this *low*- and *moderate-severity* fire activity is best described as a "patchwork mosaic" of stands of even-age that are distributed unevenly across the landscape; this signature contributes to the broad compositional and structural diversity in the basin.

Fire activity increased in frequency and severity following the establishment of logging camps, mining claims, and railroads in the basin (ca. 1870's), where human-caused ignitions increased fire activity outside of the historic range. Between 1870 and 1931, several large stand-replacing fire events occurred in most of Upper North Fork HUC, Tepee Creek HUC, Lost Creek, upper Prichard Creek, Beaver Creek, and the forested corridor along the Lower North Fork HUC. In 1910, the largest *high-severity*, stand replacement fire known in the basin occurred as a result of a combination of human- and lightning-caused fires with very strong winds (Figure 6). These stand replacement fires included riparian zone forests, and as such few riparian forests are found to be older than ~70 - 90 years. Burnt timber was salvaged from Independence Creek after the 1910 fire and transported down the channel in a "log drive" (Russell, 1984).

4.0 FISHERY RESOURCES

The North Fork subbasin is famous for it's cutthroat trout fishing. With an extensive network of roads in the subbasin, there is easy access to the river for fishing. The available information on fish populations and migration, and habitat conditions were compiled and reviewed. There have been several Master's and PhD thesis research projects, and focused Forest Service studies. These are listed and described in Appendix A. All of these studies typically focused on a small watershed. Many of these studies had differing goals and addressed questions at differing scales, thus, not all data is comparable. In addition, over time Idaho Fish and Game (IDFG) has altered Fishing Harvest regulations making it difficult to determine trends over time in the entire North Fork subbasin.

There have been two key IDFG sampling efforts that sampled large areas of the subbasin. First, in an effort to understand the population trends in the North Fork, IDFG set up snorkel survey transects in 1973 that have been snorkeled on a regular basis ever since (Bowler, 1974 and DuPont *et al*., 2003). In addition, IDFG conducted a radio tagging study on large cutthroat trout from May 2003 to June 2004 to evaluate the movement, mortality, and habitat use of westslope cutthroat trout throughout the Coeur d'Alene River basin.

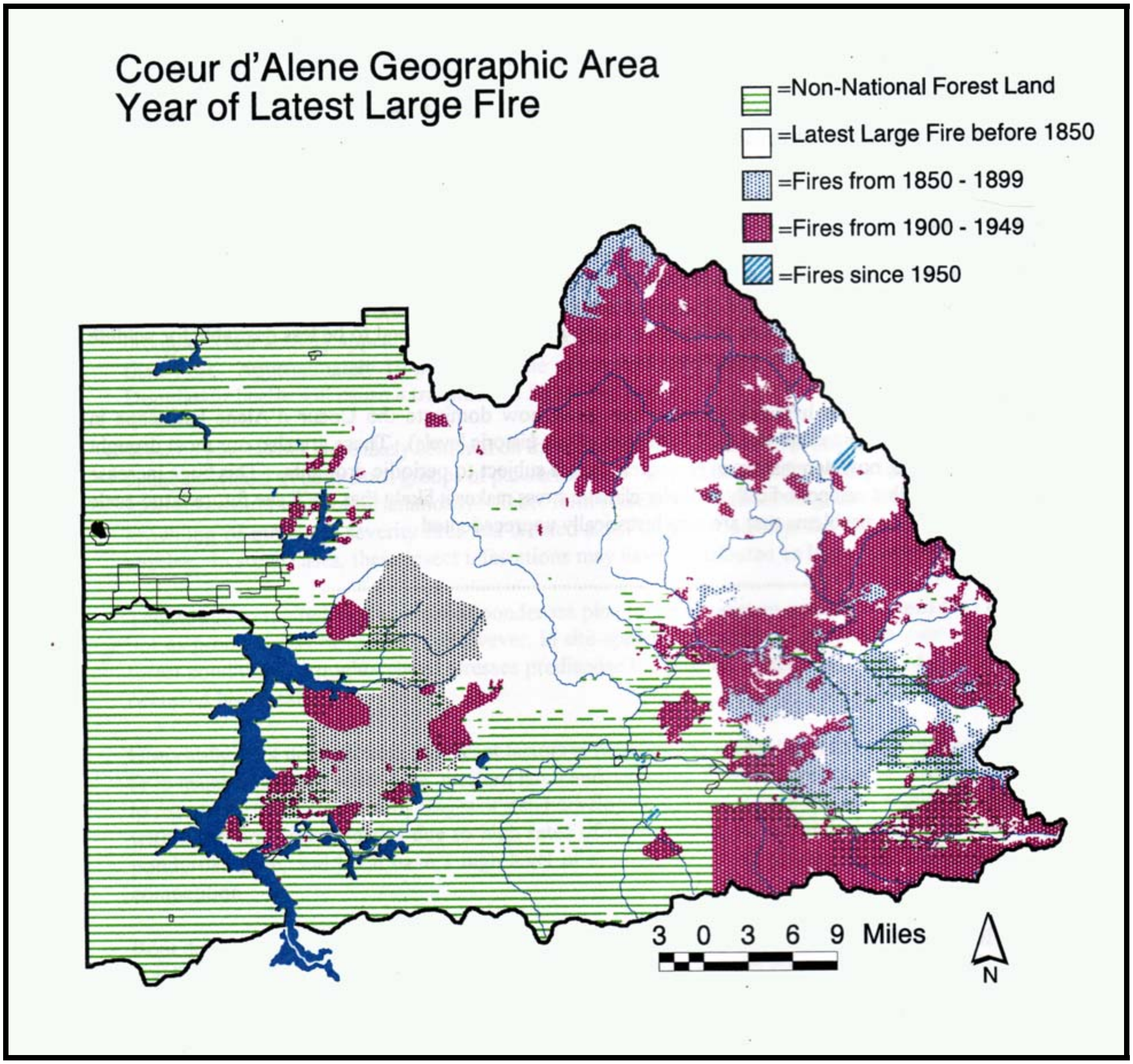


Figure 6. Locations of historic fires within National Forest lands of the Coeur d'Alene River Basin.

4.1 FISH SPECIES IN THE NORTH FORK SUBBASIN

Fish species that historically or currently inhabit streams in the North Fork subbasin are listed in Table 3 (Simpson and Wallace, 1978). Fisheries studies that have been completed have almost exclusively focused on cutthroat trout populations and habitat utilization, thus information on other species is limited.

Table 3. Selected fish species in the North Fork Subbasin.

Native Species
Westslope Cutthroat (*Oncorhynchus clarki*) Bull Trout (*Salvelinus confluentus*) Mountain Whitefish (*Prosopium williamsoni*) Northern Pike Minnow (*Ptychocheilus oregonensis*) (formerly squawfish) Large-Scale Sucker (*Catostomus macrocheilus*) Torrent Sculpin (*Cottus rhotheus*) Shorthead Sculpin (*Cottus confusus*) Longnose Dace (*Rhinichthys cataractae*) Redside Shiner (*Richardsonius balteatus*)
Introduced Species
Rainbow Trout (*Oncorhynchus mykiss*) Brook Trout (*Salvelinus fontinalis*)

4.2 BULL TROUT PRESENCE & DISTRIBUTION

The U.S. Fish and Wildlife Service lists bull trout as a "Threatened Species" with respect to section 7(c) of the 1973 Endangered Species Act (USDI Fish and Wildlife Service, July 23, 2001 letter, FWS 1-9-01-SP-613). Bull trout are native to watersheds draining into Lake Coeur d'Alene including the North Fork subbasin. Currently, only occasional migrants are found within the Coeur d'Alene River basin. They have been noted in the Coeur d'Alene River proper, and the Little North Fork Coeur d'Alene River (Horton, 1984), and are known to occur within Lake Coeur d'Alene (J. Davis, Idaho Department of Fish and Game, personal communication).

A 1940 Forest Service Fisheries Management Plan notes bull trout (called dolly varden in the plan) were documented occurring at all locations sampled, including the North Fork mainstem between Grizzly and Yellowdog Creeks, a number of tributaries, and West Fork Eagle Creek (McClay, 1940). The same report notes extensive habitat degradation from mining and log drives. These impacts coupled with heavy fishing pressure had resulted in complete closure of fishing so that only 25% of the entire drainage was open to fishing in an effort to restore the remaining fish populations (McClay, 1940).

In general, bull trout have more specific habitat requirements than other salmonids (Rieman and McIntyre, 1993), they are more sensitive to temperature and fine sediment impacts in their habitats, and can also be displaced by non native eastern brook trout. Given the long history of watershed-wide sediment inputs and historic stocking of eastern brook trout, it is likely the bull trout population is reduced to a few individuals.

4.3 WESTSLOPE CUTTHROAT TROUT DISTRIBUTION

Westslope cutthroat trout are listed as "Sensitive" by Region 1 of the Forest Service and listed as a "Species of Special Concern" by the State of Idaho. In addition, the U.S. Fish and Wildlife Service list westslope cutthroat trout as a "Species of Concern" with respect to section 7(c) of the 1973 Endangered Species Act (USDI Fish and Wildlife Service, March 2, 1998 letter, FWS 1-9-99-SP-158). Westslope cutthroat trout are native to the North Fork subbasin.

There have been numerous studies on cutthroat in various parts of the subbasin. But the only effort to understand the population trends has been the ongoing snorkeling survey effort conducted by IDFG (since 1973). Fish counts at these snorkel transects showed that a strong increasing trend in the density of cutthroat occurred from 1973 until 1997. A series of floods in 1996 and 1997 were believed to cause a decline in counts in 1998 and 2000. An overall increase in abundance since 1973 was believed to be a combination of more restrictive fishing regulations, improvements in water quality in the South Fork Coeur d'Alene River, and significant efforts to improve habitat conditions throughout the watershed (DuPont *et al*., 2003).

Despite the increase in the overall density of cutthroat trout, when only those cutthroat trout ≥ 300 mm were evaluated from this data set (1973-2002), no apparent increase in density had occurred over time. In addition, the observed density of these larger fish were considered low (0.06 fish/100 m^2) for rivers in northern Idaho. IDFG conducted a radio tagging study on 75 cutthroat trout from May 2003 to June 2004 (DuPont *et al*., 2006). The primary goal of this study was to determine why densities of cutthroat trout ≥ 300 mm in length had not increased in the North Fork subbasin based on the snorkel survey data. Dupont *et al*. identified the following factors as having some role in the suppression of cutthroat trout ≥ 300 mm in length;

- Non-compliance with fishing regulations.
- Degraded or loss of cold water refugia.
- Degraded or loss of over-winter habitat.
- Degraded summer rearing habitat.

Dupont *et al*. feel efforts to correct these problems should lead to improvements in this fishery. Appendix A provides a more complete discussion of these factors and their influence on the cutthroat trout populations.

4.4 FISHING REGULATIONS

The cutthroat trout telemetry study provided a better understanding of the movement patterns of cutthroat trout both within the Coeur d'Alene River proper and North Fork subbasin. DuPont *et al*. (2006) recommend improvements to the fishing regulations that would increase opportunities for anglers as well as protect areas that appear important to survival of cutthroat trout. Currently, harvest is allowed in areas where the largest congregations of fish were observed during the open fishing season, such as in some side channels in the lower North Fork subbasin, and at the mouths of Prichard Creek and in lower Shoshone Creek. These fish moved into these congregations during stressful times (warm water temperatures) which makes them more vulnerable to anglers at a time when they need the most protection.

Catch-and-release areas for cutthroat trout have been located in upstream reaches of the subbasin, and allowable harvest areas (with limitations) are in the downstream reaches. These types of regulations make sense in watersheds where cutthroat trout have more extensive migration patterns. However, in the North Fork subbasin the catch-and-release areas are in the most upstream, difficult to access areas and appear to receive the least amount of fishing pressure (e.g. upper North Fork subbasin, and Little North Fork upstream of Lavern Creek). Within the Little North Fork, it appears that after spawning, most large fish migrate downstream into the area of allowable harvest. This is not surprising as this stretch of river has the most pools, deepest waters, and wide floodplain. As a result, the catch-and-release area in the upper portion of Little North Fork does not provide much protection to this cutthroat trout fishery. Thus, changing the lower reaches of river to catch-and-release would provide an area with easy access where people would have a better chance of catching larger, long lived cutthroat trout. Dupont *et al.* (2006) did not believe the current fishing regulations allow cutthroat to reach their potential in these areas especially with the non-compliance that was observed.

4.5 SUMMER & WINTER KEY HABITAT

4.5.1 Summer Temperature Refugia

Dupont *et al*. (2006) found radio tagged fish utilized four different strategies to cope with high water temperatures. This included: 1) moving short distances (< 5 km) to areas where cold water refugia occurred (4-9 °C cooler than what occurred in the main river channel), 2) moving to the mouths of tributaries, 3) moving into tributaries and, 4) moving into side channels with cold water upwellings. Side channels appear to be the most important form of cold water refugia in the lower North Fork subbasin as 50% of all radio tagged fish that utilized this subbasin during late July/early August, were located in side channels. Unfortunately, side channel habitats are limited in number in the lower subbasin.

Based on stream temperature work (Dupont *et al*. 2006 and Lider and Davis 2004), water temperature appeared to increase as it flowed through confined reaches (little floodplain existed), and decreased when it flowed through unconfined areas with wide floodplains. This pattern was observed in the mainstem North Fork downstream of Prichard Creek as the river enters a wide floodplain and temperatures continually decline to the point where they never reached 22 °C in much of the free flowing reach of the river. In the Little North Fork, temperatures decreased where a wide floodplain occurred.

Without this cooling effect, Dupont *et al*. (2006) believe much of the lower river would frequently reach water temperatures that would not support salmonids. For this reason, they recommend that future activities that may occur within floodplains need to be carefully planed to insure the floodplains maintain their fully functioning benefits.

4.5.2 Winter Habitat

The habitat use data showed that radio tagged cutthroat trout tended to move to areas with wider floodplains during winter. In fact, all the radio tagged fish that utilized river reaches where confined valley types occurred (e.g. upper North Fork subbasin) migrated from these areas at the onset of winter (November) to where the river valley spread out and wide floodplains occurred. It appears the presence of a floodplain can be a key factor in winter habitat selection for many cutthroat trout populations in larger river systems. The presence of floodplains may provide several benefits. Winter rain-on-snow events which are common in northern Idaho can cause increases in energy expenditure of fish during a critical period of survival. With adjacent floodplains, cutthroat trout can move out of the main flow where they can conserve energy.

4.6 TORRENT AND SHORTHHEAD SCULPIN AS IMPAIRMENT INDICATOR SPECIES

Several recent studies have suggested the utility of using sculpins as impairment indicator species (Maret and MacCoy, 2002 and MeBane, 2001). Sculpins are apparently less mobile than salmonids, they are not stocked and are seldom harvested (MeBane, 2001) which are all confounding factors in relating the abundance of salmon or trout to the ambient habitat conditions. Because sculpins live on and near the stream bottom, and feed predominantly on benthic invertebrates, they are more likely to come in contact with contaminated bed sediment than the more mobile salmonids. Maret and MacCoy (2002) found that streams located downstream from areas of intensive hard rock mining in the Coeur d'Alene River basin did not support sculpins, suggesting they are more severely affected by elevated metals than salmonids. However, while these studies suggest sculpin presence or absence may be indicative of habitat contamination of fine sediment levels, they do not provide any specific metrics. The Technical Appendix contains a brief discussion of the life history and habitat requirements of the sculpin species occurring in the North Fork subbasin.

5.0 CLIMATE

The North Fork subbasin is located in the northern Rocky Mountains, on the west flank of the Bitterroot Mountain Range (IDEQ, 2001). The climate of the area is influenced by both moist maritime air masses moving east from the Pacific Ocean, and cold continental air masses moving south from Canada. Moist air masses moving east from the Pacific Ocean cool as they are forced up and over the mountains in the area, resulting in increased precipitation with increasing elevation. Highest monthly precipitation occurs during the winter months. Summers are generally warm and dry with the exception of convective storms. The majority of the subbasin is located with the rain-on-snow (ROS)[2] zone, which locally occurs in the 3,300-4,500 foot elevation range (IDEQ, 2001). Snow pack is transitory below the ROS zone, while in higher elevations snowpack is generally resistant to significant melting during winter storm events.

Mean annual precipitation ranges from 23 to 67 inches, and averages 46 inches overall for the subbasin and varies primarily with elevation. The lowest area of precipitation is within the river corridor of the Lower North Fork HUC, the area of highest precipitation occurs in the upper elevations of the Upper North Fork HUC. A snowpack is generally in place from October to July in the higher elevation areas of the subbasin, reaching its maximum depth during the months of March and April. Snowpack is generally proportional to elevation, however, snowpack decreases from west to east across the subbasin and is probably proportional to annual precipitation.

Monthly air temperatures vary with season and elevation. Minimum air temperatures occur in the months of December and January, and maximum temperatures occur in the months of July and August.

The Technical Appendix (Appendix A) provides detailed information on the climate within the North Fork subbasin, describes how climatic conditions vary among the 5th and 6th field HUCs that comprise the subbasin, and describes what climatic data is available.

[2] Rain-on-snow is the common term used to describe wintertime conditions when relatively warm wind and rain combine to produce rapid snow melt

6.0 HYDROLOGY

The US Geological Survey (USGS) identifies six stream gages within the North Fork subbasin. In addition, the US Forest Service (USFS) has operated 5 gages within the subbasin, with an additional two gages (Maries Creek and Upper Wolf Lodge Creek) located immediately west of the subbasin divide. Of the five USGS gages, only two are currently active (#12411000, NF Coeur d'Alene River above Shoshone Ck; #12413000, NF Coeur d'Alene River at Enaville). The remaining three USGS gages all have a very short period of record. Six of the seven USFS stream gages are currently active; the exception being the Shoshone Creek gage which was discontinued in 1996 following a large storm event which damaged the gage. The Technical Appendix provides the analysis of this data which are summarized below.

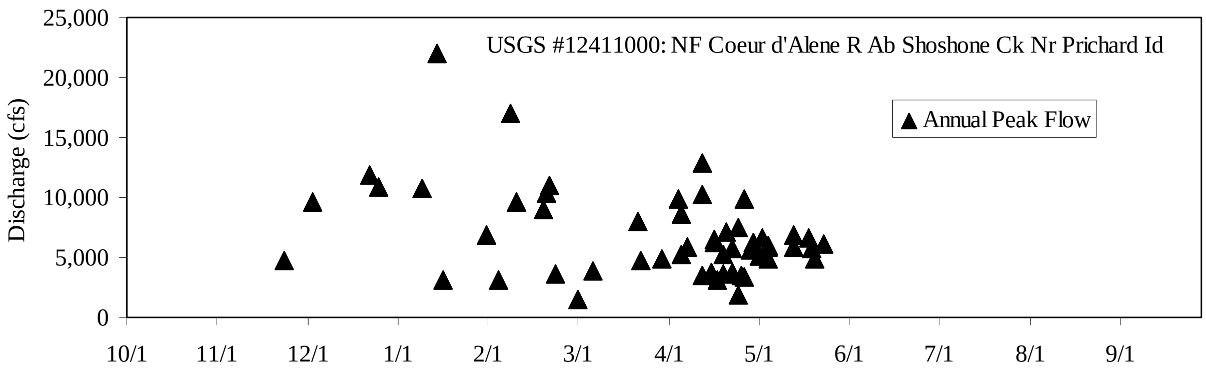
6.1 HYDROLOGIC REGIME

The mean daily flow record at the USGS gage site, North Fork Coeur d'Alene River above Shoshone Creek (Figure 7; bottom graph), illustrates overall hydrologic conditions within the North Fork subbasin. Mean daily flows fluctuate early in the winter in response to ROS events, however, the highest mean daily flows occur during the spring snowmelt season (April-June). Flows steadily decline with diminishing snowpack during the late spring and early summer, reaching their lowest levels prior to the beginning of fall rains. An examination of annual peak flows at the gage (Figure 7; top graph) indicates that approximately half of the annual peaks occur during the spring snowmelt season, and the remainder during the winter ROS season. The two largest events at the gage (1/15/1974 and 2/9/1996) were regionally significant ROS events. The pattern appears to be similar in the tributary streams.

6.2 FLOOD HISTORY

A time series of annual flood peaks was assembled for the two long-term USGS gages within the North Fork subbasin. The long-term annual peak flow history provides context to recent channel disturbances (or lack thereof) observed throughout the area. For purposes of comparison, the data are presented as a time series showing the recurrence interval of the annual flow event (Figure 8). This approach allows for a comparison of events from a wide variety of watershed sizes. Recurrence intervals were calculated for the period of record at each gage station using techniques described by the Interagency Advisory Committee on Water Data (1982). Peak flow magnitude was next plotted against probability (i.e., 1/recurrence interval) on log-probability paper. Recurrence interval was then interpolated for each event from the plotted values.

The two gages presented in Figure 8 both present a similar peak flow response. This is not surprising given that both are located on the mainstem of the North Fork River. Based on the record presented in Figure 8, it appears that the later half of the record (from the early 1970s to present) saw many larger peak flow events than the earlier half of the record. Note that this period of greater peak flow activity coincides with the cool/wet PDO cycle that began in the North Fork area in ~1973 and continues to present.



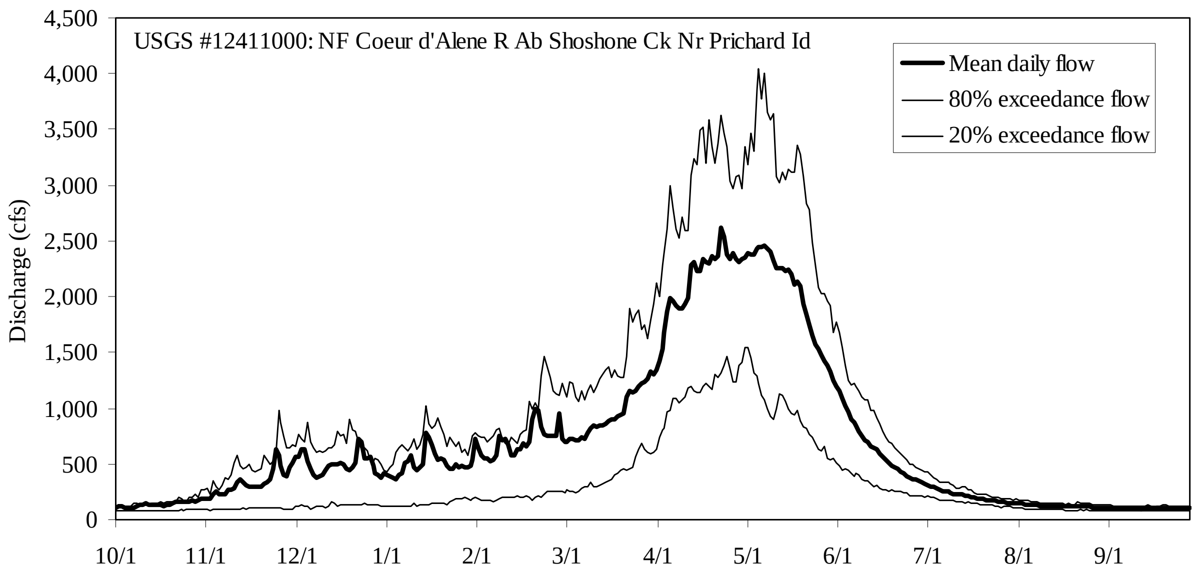


Figure 7. Mean daily flow (bottom) and annual peak flows (top) at USGS gage # 12411000, North Fork Coeur d'Alene River above Shoshone Creek near Prichard Idaho (mean daily flows are averaged over the period December 1950 to September 2006). 20% and 80% exceedance flow are mean daily flows that have been exceeded 20% and 80% of the time for the designated period.

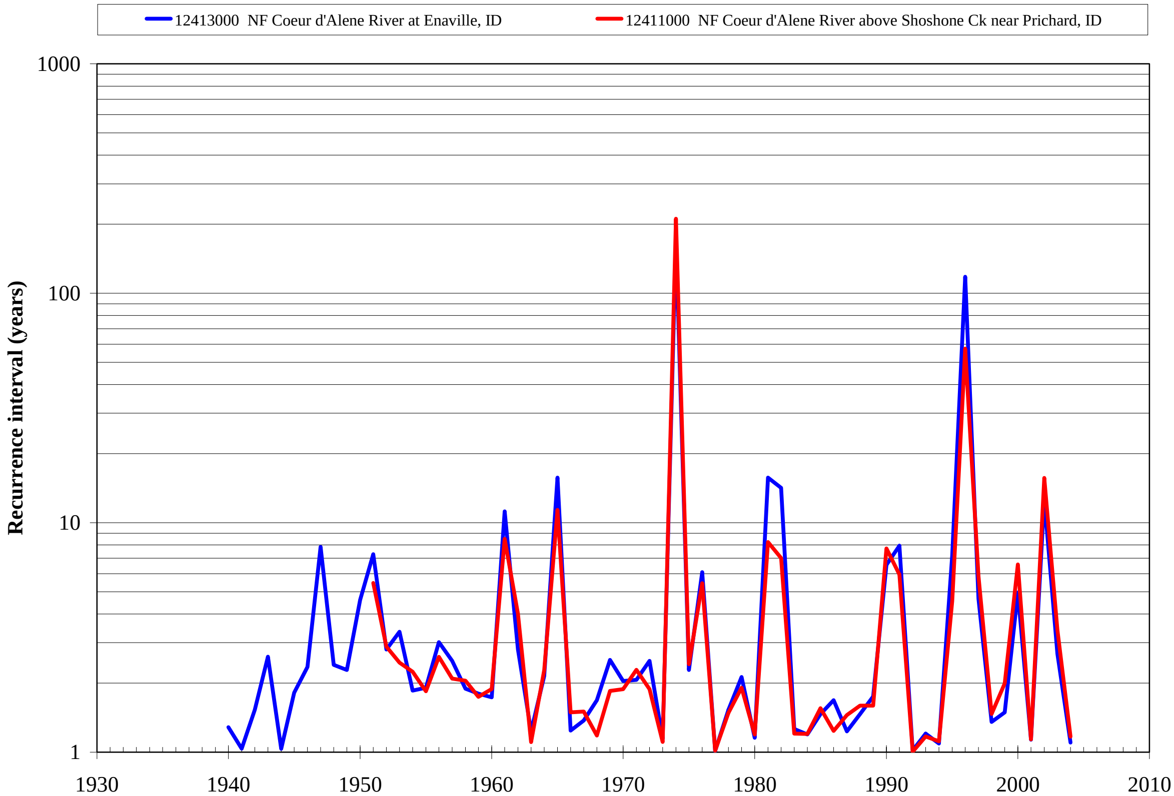


Figure 8. Recurrence interval associated with annual peak flow events at two stream gages in the North Fork Subbasin (USGS, 2005).

6.3 HYDROLOGIC CHANGE ANALYSIS

The North Fork Coeur d'Alene River TMDL (IDEQ, 2001) addressed water-quality limited stream segments in the subbasin (Figure 9). Several streams segments were listed as water quality limited due to "flow alteration", specifically, adverse changes in the magnitude of flood flows.

Section 2.3.2.1.1 of the North Fork TMDL attempted to address the concerns of increased peak flow magnitudes in the North Fork subbasin by comparing the magnitude of the largest regionally significant peak flow on record, the peak flow of January 1974, with the second largest peak flow on record, the flood of February 1996. Because the 1996 flood was of a smaller magnitude then the 1974 event the authors concluded that peak flow events have not been significantly affected by land use practices in the North Fork subbasin. Given that peak flow magnitude is driven by climate conditions during and immediately preceding the storm event, and given the complete lack of any analysis as to what these conditions were, the analysis presented in no way supported this claim. These results were cited in subsequent sections of the document to support the claim of no management-related impacts on peak streamflow. This conclusion could not be made based on the analysis presented.

Further study was needed given the legitimate concerns that hydrologic change issues were not adequately addressed in the North Fork TMDL. An understanding of to what extent stream flows may have changed due to management-related activities (harvest and roads) was needed to assess the significance of hydrologic change on sediment production (primarily through bank erosion) and in-channel sediment dynamics. We used the DHSVM model to assess management-related impacts on stream flows from forest harvest and roads in two subwatersheds within the subbasin.

The Distributed Hydrology Soil Vegetation Model[3] (DHSVM) is a distributed hydrologic model originally developed to evaluate the effects of topography and vegetation on water movement through a watershed (Wigmosta *et al*., 1994). Spatially distributed models such as DHSVM provide a dynamic representation of the spatial distribution of soil moisture, snow cover, evapotranspiration, and runoff production, at the scale of digital elevation model (DEM) pixels. DHSVM has been used to assess changes in flood peaks due to enhanced rain-on-snow and spring radiation melt response (e.g., Thyer *et al*., 2004), effects of forest roads and road drainage (e.g., Lamarche and Lettenmaier, 2001), and the prediction of sediment erosion and transport (Doten and Lettenmaier, 2004).

The two subwatersheds selected for analysis were the upper Little North Fork Coeur d'Alene River, upstream of the confluence with Burnt Cabin Creek (hereafter referred to as the ULNF), and Big Elk Creek (Figure 1). These subwatersheds had continuous stream flow data (for model calibration purposes), and had experienced moderate to high levels of forest harvest and road construction. The ULNF has a drainage area of 44 mi^2, and the period of record for the stream gage at the subwatershed outlet is from 2001 to present. Big Elk Creek is a tributary to Teepee Creek, draining an area 11.6 mi^2 in size, and the gage period of record is from1988 to present.

For each subwatershed the model was first constructed for the current condition (i.e., current vegetation, and current road network). We then evaluated management-related impacts on stream flows by selectively removing each management impact (i.e., replacing areas currently occupied by roads and harvest units with the potential land cover appropriate for the area), and rerunning the model. Results from these allowed us to compare peak flow magnitudes for selected storm events under three scenarios:

- Current conditions (i.e., existing vegetation and road conditions)
- Current vegetation conditions with road effects removed
- Potential vegetation conditions (no management) and no roads

One additional model run was also conducted in the ULNF subwatershed to evaluate the effects of timber harvests planned as part of the Iron-Honey EIS.

[3] An overview of the DHSVM model, source code, and details of the model application, can be found at http://www.hydro.washington.edu/SurfaceWaterGroup/Models/DHSVM/index.shtml

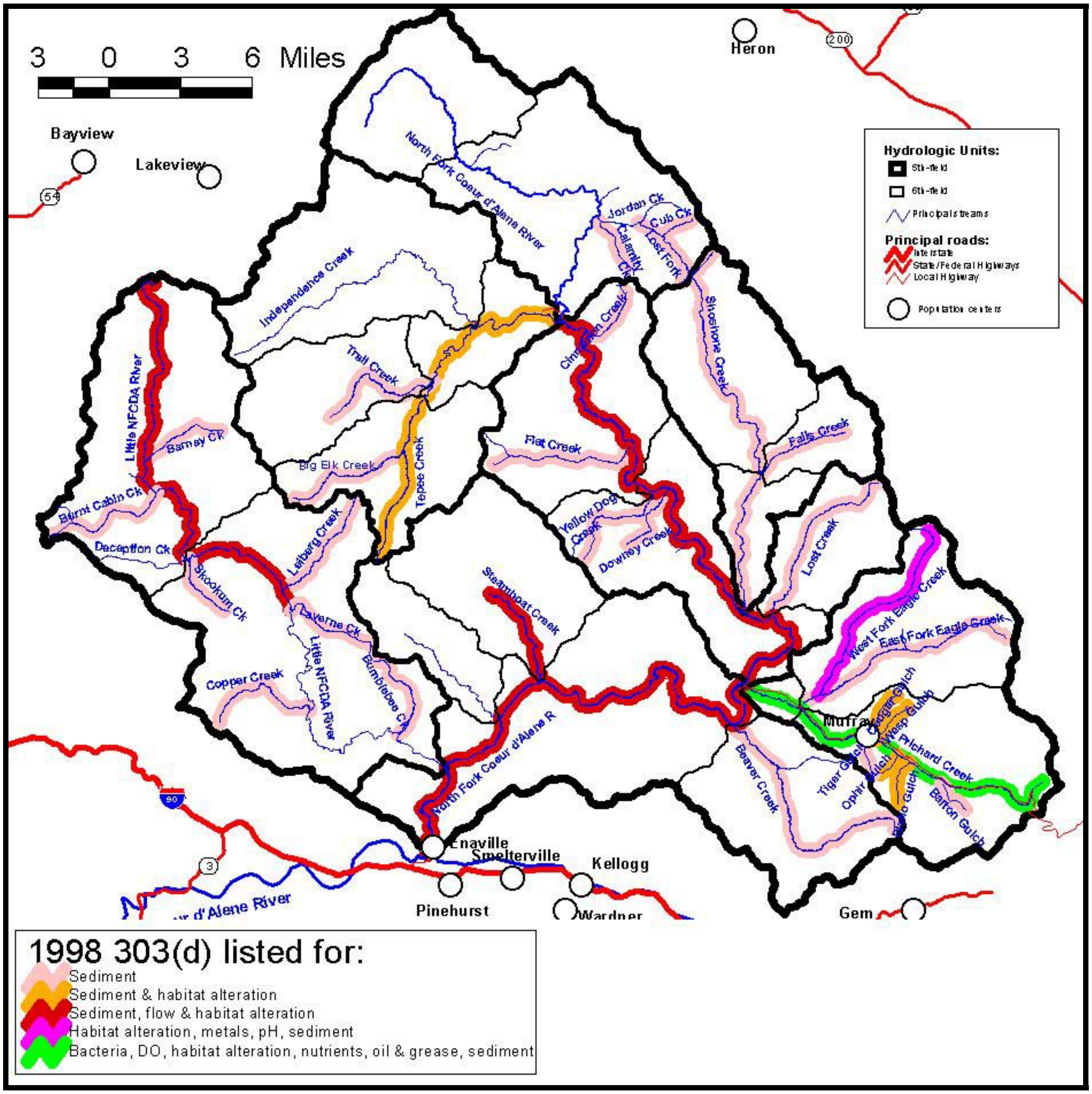


Figure 9. Water quality limited streams in the NFCDA Subbasin.

The model was first run using historic vegetation and no roads. The resultant values were used as the baseline against which all other model runs were compared. The five largest peak flow events (all with an estimated recurrence interval of 5 years or less) in each of five water years were used to evaluate management impacts.

Model results suggest that peak flow conditions due to current vegetation conditions are not significantly different then under the baseline condition. Roads and road drainage however appear to result in an increase of approximately 5-10% over the baseline condition. No correlation was seen in the results between percent change in peak flow value and flood size.

Model results also suggest that road decommissioning performed to date has resulted in a ~2 to ~3% decrease in peak flow magnitudes, as compared to the most impacted past condition.

A proposed suite of timber harvests (primarily shelterwood removal with some clearcut and thinning units) in the ULNF was also evaluated using the DHSVM model. Model results suggest that average post-harvest peak flow magnitude would not be significantly different from current conditions. However, storm-to-storm variability among the 25 peak flows increased.

Uncertainty remains as to the continuing impacts of non-decommissioned, non-maintained roads in the watersheds. It is not known to what extent passive restoration of hydrologic function has occurred in these roads. The USFS has indicated (Lider *et al*., 2007) that they believe our model over represents the actual amount of roads in the study area. Further investigation is needed to map the condition of all roads. The model results presented here probably represent a "worst case" scenario in terms of hydrologic impact from roads.

Model results indicate that hydrologic response is not constant across all storm events (i.e., percent change varied widely by individual storm). Hydrologic response probably varies in response to antecedent conditions, within-storm weather patterns, and position of roads and harvest units within the landscape. For example, road location may affect the volume of water intercepted by road ditches, and the extent to which peak flow timing may be changed. La Marche and Lettenmaier (1998) theorize that although ridgetop roads may have the greatest potential to change the timing of flows (flow that would have traveled a relatively long distance as slower subsurface flow would now travel as quicker surface flow) the volume of flow intercepted is relatively small because of the small upslope contributing area. Conversely, valley bottom roads have the ability to capture large volumes of flow, but the timing change is small because of the close proximity of these roads to streams. Midslope roads may have the biggest effect on peak streamflows because they capture moderately large volumes of water and the timing change may be significant.

7.0 GEOLOGY/ SEDIMENT SOURCES

7.1 GEOLOGY AND SOILS

The North Fork subbasin is underlain by rocks of the Belt Supergroup which includes very old metamorphic rocks. These rocks were formed as sedimentary rocks were buried, subjecting them to heat and pressure of metamorphosis, and changing them into argillite, siltite, and quartzite. Following metamorphosis, the rocks were uplifted and faulted to form the present Bitterroot and Coeur d'Alene mountain ranges. Rivers and streams have cut deep valleys into the mountain range, and deposited thick layers of cobble and gravel alluvium in the wider mainstem valleys.

Soils developed on the metamorphic rocks are generally thin and silty with rock fragments. When these soils are eroded, they provide fine sediment and cobble/gravel material to streams. Soils in valley bottoms are thicker, and formed from colluvium (material that has moved down the hillsides and accumulated in the valleys) and alluvium (stream-worked material). These soils are generally silty to sandy, with occasional pockets of organic material in wetlands and old side channels.

7.2 SEDIMENT SOURCES

An estimate of sediment sources was prepared for the North Fork subbasin as part of the 2001 TMDL efforts (IDEQ, 2001). As a result of that work, several water bodies within the subbasin were listed under section 303(d) of the Clean Water Act for sediment excesses (Figure 9). In the TMDL, sediment sources were estimated based primarily on GIS and map data. As part of TMDL implementation planning, IDEQ requested a more detailed analysis of sediment sources in the subbasin to aid in identifying the best methods to reduce sediment inputs to listed water bodies in the North Fork subbasin. The sediment source study completed as part of this Watershed Analysis was based on field inventories, checking of current sediment sources, and an aerial photograph study to look at past and current sediment sources. The sediment source study provides information on the legacy (historic) sediment inputs as well as current rates of the following sediment sources:

- Agricultural Land
- Mining
- Timber Harvest
- Wildfire
- Landslides (Mass Wasting)
- Road Erosion (forest roads and paved roads)
    - Gully/culvert washouts
    - Surface erosion
    - Road encroachment on stream channels
- Streambank erosion
- Channel filling/entrenchment

Table 4. Summary of sediment methods used in present (historic and 2006 conditions) sediment source study.

Sediment Source	Method	Total Acres or Miles
Background (natural) erosion	Sediment production coefficient: 0.023 t/ac/yr applied to entire watershed	**559,360 acres**
Wildfire burn area	Historic: no quantitative estimate, but assumed large Current: Aerial photograph inventory shows these areas have revegetated; no increased erosion included	**none**
Agricultural land	RUSLE; 0.03 t/ac/yr; 25% delivery	**576 acres**
Mining	Historic inputs: USGS report Current inputs: included in streambank erosion estimate (below) based on aerial photographs and site visits	**Placer/hydraulic mining, 9 major mine tailings, 5 miles of flotation dredging**
Non-stocked forest (timber harvest units)	Historic: no quantitative estimate, but assumed large Current: Increased sediment production coefficient (0.027/ac/yr) applied to all harvest areas	**Average harvest over past five years: 1,610 acres/year**
Mass wasting (landslides)	Aerial photograph analysis of slide area/delivery	**6 slides inventoried (1933-2003)**
Road surface erosion (Highway and Forest roads)	Field inventory of road conditions/lengths/delivery on all active roads in Big Elk and Upper Little North Fork. Erosion/delivery estimates from SEDMODL and WEPP; extrapolation to rest of watershed. Historic: estimate based on all roads in database. Current: estimate based on all active (open system) roads in database	**Historic: 3,838 crossings** **Current: 933 crossings**
Road/culvert washouts and gullying	Field inventory of washouts and gullying on active roads in Big Elk and Upper Little North Fork; some USFS data on washouts; extrapolation to rest of watershed. Historic: based on all roads in database Current: based on all roads in database except decommissioned roads and culverts upgraded to 100-year flood volumes	**Historic: 3,838 crossings** **Current: 3,1016 crossings**
Road encroachment	Field inventory to identify actual road segments susceptible to road encroachment (length, height, width); estimated recurrence intervals ranging from 10-30 years	**20 miles of road susceptible to encroachment**
Streambank erosion	Measurements of streambank erosion along North Fork between Prichard Creek and confluence with South Fork	**Extrapolated to all streams in subbasin**
Channel entrenchment	Measurements of entrenchment along North Fork between Prichard Creek and confluence with South Fork	**Extrapolated to all streams in subbasin**

The methods to estimate sediment input in the 2007 Sediment Source Analysis report were based on field measurements and historic aerial photograph analysis to help identify site-specific locations of past and current sediment sources and to provide information on erosion rates and delivery to water bodies. Estimates of sediment sources under 2006 watershed conditions were made, as well as quantitative and/or qualitative estimates of sediment sources under historic (1900-1960s) conditions. The analysis team felt it was important to understand the historic sediment inputs because these legacy sources of sediment, particularly course sediment (gravel/cobble), can continue to have an influence on stream conditions for decades or centuries as they are processed by the stream. The current sediment source methods are summarized in Table 4 for comparison with the 2001 TMDL methods. Detailed information on the methods is provided in the "*Sediment Source Analysis North Fork Coeur d'Alene River Subbasin*" technical report.

Due to the large size of the subbasin, it was not possible to conduct an intensive field analysis of the entire area. Instead, two subwatersheds were chosen for more intensive study, and the results of the intensive study were extrapolated to provide an estimate of sediment inputs in other portions of the subbasin, as appropriate. The two subwatersheds chosen were the Upper Little North Fork (upstream of Burnt Cabin Creek) and Big Elk Creek (upstream of the confluence with Teepee Creek). These areas were chosen because: 1) there was a stream gage available with a long enough record to provide data for hydrologic modeling, 2) they had a varied intensity of past land use that was representative of most of the rest of the subbasin, and 3) they were placed on the 303(d) list for exceedances in sediment load in the 2001 analysis.

Sediment-related work in these two subwatersheds included aerial photo analysis of the entire available aerial photograph record and field inventory of the entire open road system to check for hydrologic connectivity, road gullying/washouts, sediment sources, and road/streambank encroachment. In addition, several recent timber harvest units were visited. Detailed description of the field work and findings are included in the *Sediment Source Analysis* Technical Report.

7.2.1 Observations from Aerial Photographs

In general for the entire subbasin, there were few current sources of sediment observed in the 1996 aerial photographs (note that river response and channel migration are discussed in a separate section). Much of the subbasin was well vegetated, with few areas of bare soil or landslides. It was obvious that there was extensive road building and timber harvest in the past that likely were a large source of sediment, but many of these areas have revegetated and stabilized. The current most disturbed areas are the spoil piles and mining areas in Beaver, Prichard, and Eagle creeks. Other potential sediment sources noted on the photos included areas that had previously burned, and roads.

<u>Previously burned areas</u> – Much of the northern portion of the subbasin that was burned in the fires of the early 1900s has revegetated, even in the 1937 photos. However, there are also many sparsely vegetated areas, primarily on southern-facing slopes in areas underlain by what is mapped as the Wallace Formation (Munts, 2000). These areas are prevalent in Independence Creek, upper North Fork areas (Callis, Hamilton, and Owl Creeks), as well as along the high ridges on the eastern side of the watershed, areas of Lost Creek, and in the upper Beaver and Prichard Creek drainages.

<u>Roads</u> – There is evidence of four types of road-related erosion that were observed on the aerial photographs: road washouts at stream crossings, cutbank or fillslope erosion on steep slopes, fillslope erosion on stream-parallel roads, and surface erosion from hydrologically connected road segments (roads that drain to stream channels).

There were a few road washouts observed on the aerial photographs, but no very large washouts. It is likely that there were small washouts that were not visible on the air photos.

Landslides in the watershed are rare; a few cutbank/fillslope slides were noted. Cutslope failures can be sources of sediment to streams if they occur near stream crossings or on roads that run parallel to streams.

Fillslope erosion on roads that run parallel to streams was noted in several locations. Stream-parallel roads were built in the early part of the 1900s since stream valleys provide the easiest access routes. As a result, most of the streams in the lower subbasin have stream-parallel roads.

Many of the intensively harvested areas in the past had a very dense road network. When this road network was first constructed, it undoubtedly was a large source of sediment to streams until the roads stabilized. It is likely that areas with very high road densities had large sediment inputs in the 1950s and 1960s, including the Little North Fork, Steamboat Creek, Shoshone/Falls Creek, Flat Creek, Yellowdog Creek, Downey Creek, Eagle Creek, and Beaver Creek. As mentioned previously, many of these roads have revegetated and stabilized and are not a very large source of sediment at present.

7.2.2 Background (natural) Erosion

Sediment input to streams is a natural occurrence, and provides streams with coarse and fine substrate that create diverse aquatic habitat. Natural sediment input is often used to judge the relative amount of management-related sediment loading that a watershed can handle.

In the North Fork subbasin, natural sources of sediment include mass wasting and streambank erosion fed by soil creep, natural channel migration, and erosion following natural fires. Since all areas of the subbasin have been disturbed in some manner, it is not possible to measure or directly determine an appropriate background sediment input. The North Fork TMDL estimated background sediment based on an average sediment yield of 14.6 tons/square mile/year (0.023 t/ac/yr) for forested Belt series geology (IDEQ, 2001). Background erosion was estimated using the same methods as the 2001 assessment.

There were several areas noted on the aerial photographs, primarily in some areas burned in the 1910 fires and in the upper elevations on the west side of the subbasin, that were sparsely vegetated and appeared to have many areas of talus (loose, cobbly to bouldery rocks covering the hillside). It is not known if this is a natural condition or if the areas did not revegetate following the 1910 fire, but these are likely areas with the potential for large natural inputs of cobbly material to streams (Figure 10). These types of talus slopes were observed on aerial photographs and along the road leading to the Grove of the Patriarchs. These features could be one of the causes of high coarse sediment input to the streams in the unmanaged West Fork Eagle Creek watershed upstream of the Grove, and likely in other unmanaged portions of the watershed.

7.2.3 Fire

Two watershed areas were nearly completely burned by the 1910 fires: Tepee Creek and the Upper North Fork above Tepee Creek. Sediment loads to the creeks were probably elevated for a least a few years following the 1910 fires as a result of the removal of ground cover. Rill and gully erosion likely occurred in some locations of intense fire from rainfall on bare slopes. Fire can be a naturally occurring phenomenon that is considered part of background sediment inputs.

Figure 10. Talus slopes in the West Fork Eagle drainage and similar angular sediment choking the stream

No quantitative assessment of erosion from the 1910 fire was made as part of this analysis. WEPP modeling of high severity fire indicates that high surface erosion rates (up to 12 tons/acre/year) could have occurred immediately following the fire in areas of intense burns. Fires normally do not burn entire watershed at an intense level, but contain a mosaic of intensely burned, less intensely burn, and lightly burned areas. It is likely that most areas revegetated fairly quickly (hence the grazing on new grasslands reported following the fire) and erosion rates dropped after a few years.

The majority of the burned areas are now stocked with forests and/or meadows so current erosion rates are low. A few locations on exposed southern slopes were noted with relatively low vegetation levels. These were correlated with outcrops of Belt Group rocks. Similar areas were seen in other parts of the North Fork subbasin. Field visits to some of these areas showed that they contain unconsolidated gravel and cobble sized rock that are not well vegetated, but appear as talus or scree slopes. Most of these are not close to streams, but in locations where they are undercut by streams they provide a continuing source of course sediment.

7.2.4 Agricultural Lands

The few acres currently devoted to agricultural uses in the subbasin are located in the lower areas and are primarily in pasture and hay production. In the past, farming in the lower subbasin was more extensive, and grazing occurred in the upper watershed.

Heavy grazing by sheep occurred within at least parts of the burned areas in both the Tepee and upper North Fork HUCs from the 1910s through the 1930s. There were lower levels of cattle, sheep, and horse grazing within Tepee and Trail Creeks in the 40s through 50s, and on Independence Creek in the 1940s through 1960s. The Forest Service has had no grazing allotments in any of these basins since then (Sherri Lionberger, USFS, phone call 5/18/07). Sheep herds may have worsened erosion in the burned areas or caused it to persist for longer than would have occurred without grazing pressure.

An assessment of erosion and delivery from agricultural lands within the North Fork subbasin was prepared in 2005 as part of the agricultural TMDL implementation plan (ISCC, 2005). This analysis determined that an estimated 17 tons/year of sediment was produced from 576 acres of agricultural lands in the lower North Fork subbasin. An estimated 4 tons/year of sediment was delivered to streams from agricultural uses.

7.2.5 Mining

Mining activities in the subbasin are concentrated in the Prichard, Eagle, and Beaver Creek watersheds. Historic mining activity began in the North Fork subbasin in the early 1880s with placer gold operations on Prichard Creek, lower Eagle Creek, and Trail Creek (Box *et al*., 2004). Hydraulic mining of gravel deposits began around 1900 in the hills north of Prichard Creek. Between 1917 and 1926, a floating dredge worked 5 miles of Prichard Creek and left large cobble dredge spoil piles in the valley that are still visible today. Each of these activities likely introduced large quantities of sediment into the streams.

Beginning in the early 1900s and continuing through the 1920s, ore-concentration mills operated as gravity (jig) mills, produced piles of mine tailings and trains of tailings down streams in Prichard, Eagle, and Beaver Creeks. Ore concentration methods changed in the 1920s to flotation methods, which produced large quantities of tailings contained to some extent in tailings ponds at most locations. Box *et al*. (2004) reported the amount and locations of mining tailings. These data were used to estimate sediment inputs from historic mining activities, with delivery to streams based on descriptions of extent of tailing pile erosion.

While the majority of sediment from historic mining operations is no longer directly delivered to streams, the large quantities of sediment delivered to the channels are still being processed and eroded by Prichard, Eagle, and Beaver Creeks and their tributaries. An estimate of this on-going processing is included in the current sediment input calculations as part of bank erosion and channel entrenchment. In addition, mining operations continue at a much smaller scale in these watersheds. A detailed assessment of the extent of current mining activities was not included in this report since it will be addressed in a separate metals TMDL. However, casual field observations of some recent mining activity suggest that tailings and/or mining-related sediments are still being delivered to streams in some locations.

7.2.6 Timber Harvest

Current timber harvest practices include stream buffers and yarding methods that result in minimal sediment inputs to streams. However, it is evident from the air photos that past harvesting resulted in more sediment inputs to streams.

Timber harvest in the North Fork subbasin began in the early part of the 1900s in the lower, easily accessible portions of the watershed. Timber was moved to mill by a system of flumes and splash dams that likely caused localized large inputs of sediment and erosion of streambanks. In some areas, timber was salvaged after the 1910 fires and transported down some creeks in log drives. This occurred in 1910-1912 in the lower 4 miles of Independence Creek, Tepee Creek "down from Magee", and the North Fork River from above Cathedral Rocks (Russell, 1984).

Intensive harvest in the middle parts of the subbasin occurred in the 1950s and 1960s. Timber was moved to mills on trucks utilizing a dense network of roads to accommodate jammer harvest methods. This was also a period of high harvest-related sediment inputs since there were few or no stream buffers, skid trails and/or fire roads were constructed up small stream channels, and many miles of new roads were constructed using methods that do not meet today's standards (Figure 11). Most of these areas have revegetated and are no longer sediment sources (Figure 11).

Current timber harvest practices greatly reduce the potential for sediment inputs to streams. Best Management Practices (BMPs) include measures such as stream buffers, yarding away from streams, keeping skid trails away from streams, installing water bars on roads, and utilizing a much lower density of roads. Several recent harvest units on USFS land in the Upper Little North Fork Coeur d'Alene were visited during the 2006 field inventory. No evidence of delivery of sediment from the harvest units was seen.

An estimate of erosion from recent timber harvest units was developed based on the average acres of harvest (all types) over the past 5 years (2002-2006).

7.2.7 Mass Wasting

Mass wasting (landslides) can be a large source of sediment in steep, unstable watersheds. Landslides typically occur during large storm events and are an episodic source of sediment. Mass wasting was inventoried over the entire watershed on the 1996 aerial photographs, and USFS personnel provided information on slides they were familiar with in the subbasin (Ed Lider USFS, personal communication 11/9/05). Two slides that were related to road construction were visited in the Steamboat Creek watershed during the field inventory.

A total of six landslides were inventoried in the entire subbasin:

- Large slide in the Sob Creek drainage, visible on all air photos. Does not appear to deliver sediment to stream or be related to management activities.
- Three small slides in the Hamilton Creek drainage, visible on the 1996 aerial photographs. One slide may deliver a small amount of sediment. Do not appear to be related to management activities
- A slide complex in the West Fork Steamboat Creek drainage along the 965 road includes several active shallow translational slides and several re-vegetating (inactive) slides and was visited during the field inventory. These slides are not currently delivering sediment to the stream, but reportedly have delivered small amounts in the past.

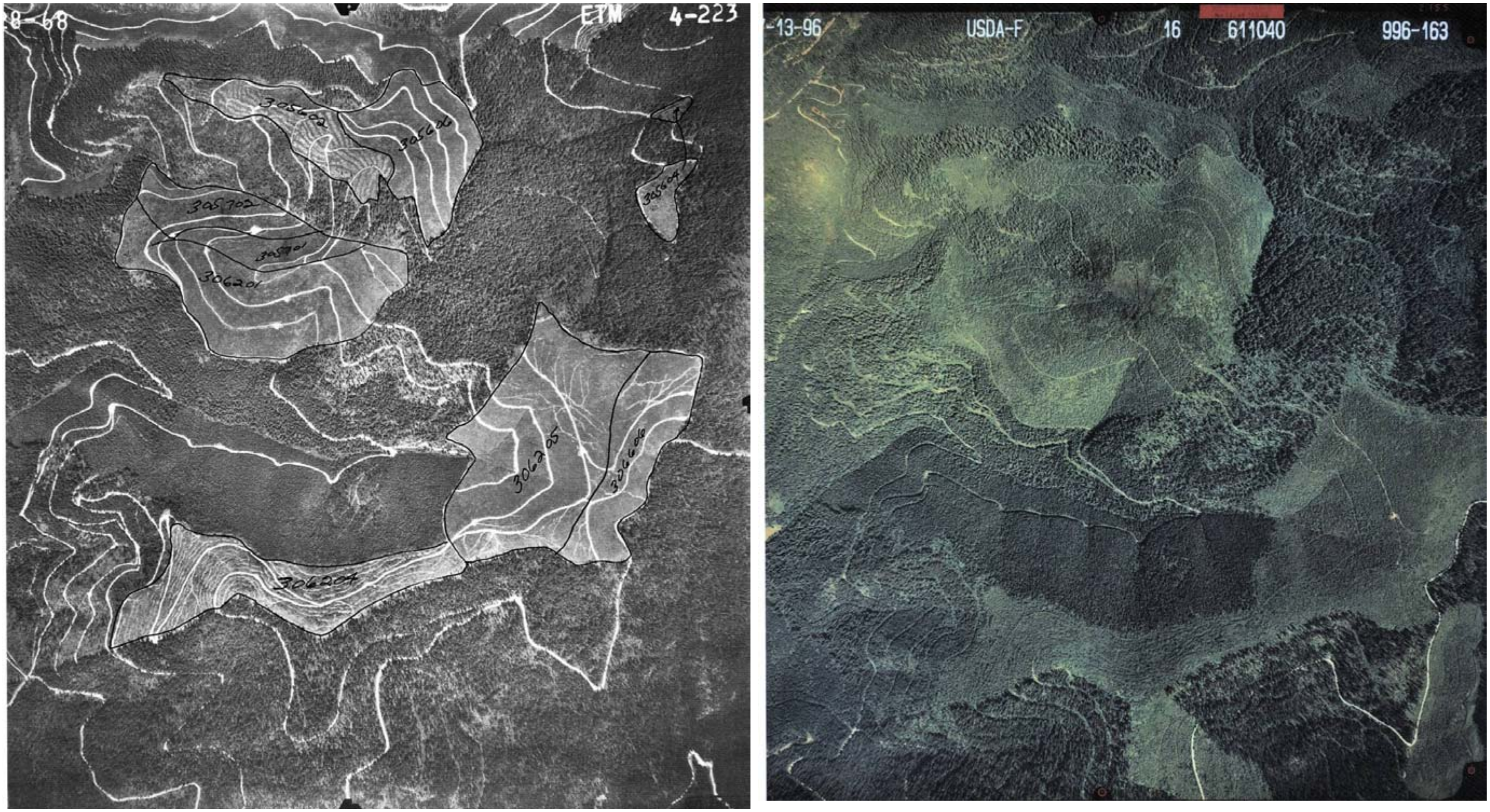


Figure 11. Aerial Photographs of Barney Creek. Left photo showing timber harvest and road building practices in 1968. Right photo, showing revegetation on past harvest units and non-system (inactive/closed) roads taken in 1996.

Additional small areas of sliding or raveling road cutbanks are likely present throughout the subbasin, but none were inventoried that appeared to deliver large amounts of sediment to a stream. Due to the small number and size of the slides, a quantitative estimate of sediment production from mass wasting was not made.

7.2.8 Road Network

Roads can be a large source of ongoing management-related erosion in forested watersheds. The majority of roads in the North Fork Coeur d'Alene watershed were constructed to access timber as harvest technology shifted from splash damming to railroad logging to truck transport. The advent of railroads and then roads to transport logs reduced direct impacts to streams that were associated with flumes and log drives, but many railroad and road systems were constructed within the flat floodplains or directly adjacent to streams. The railroads and roads often resulted in fill at stream crossings or parallel to streams that constricted channels. Roads constructed in the 1950s and 1960s were engineered to serve jammer operations which required a network of roads spaced 300 feet apart across a hillside. As a result, areas harvested during the mid 1900s have a legacy of closely-spaced "spaghetti" roads along the hillsides (Figures 11 & 12). These are particularly evident in the middle of the subbasin, where early harvest had not taken place. The lack of roads in the northern subbasin is the result of the large 1910 fires that burned that area; there were no trees to harvest, so few roads were constructed.

The total of 5,011 miles of road and 3,838 road/stream crossings were included in the current sediment source analysis. Roads were classified into three main groupings for analysis: currently open roads, currently closed roads, and decommissioned roads. Currently closed roads include both system roads (those roads that are still considered part of the USFS transportation network) and non-system roads (old roads that have been abandoned for many years and are still on the landscape but are not in the USFS transportation network).

Open roads receive maintenance and traffic. Open roads have fewer culvert washouts (they are occasionally cleaned and some have been replaced with larger pipes) but more surface erosion due to use by traffic. Closed roads are not regularly maintained and do not receive traffic. They are often vegetated and/or overgrown, so surface erosion is minimal. However, they are probably more susceptible to culvert washouts because culverts are not cleaned and often are older wood or undersized pipes that are nearing the end of their expected life. Decommissioned roads have had culverts removed, and in some cases, road fill pulled back and are no longer considered to be a source of sediment.

7.2.9 Surface Erosion

Road surface erosion can occur on all unvegetated roads. Surface erosion is generally higher on native surfaced roads, steeper roads, and on roads that receive high traffic use. Good gravel surfacing, gentler slopes, less traffic, and more frequent cross drains can all reduce surface erosion. Sediment produced from road surface erosion generally does not travel farther than 200 feet from the outlet of a culvert on an insloped road, and only about 10-15 feet from the edge of a road on outsloped roads (Haupt 1959, Megahan and Ketcheson 1996). Open roads in the Upper Little North Fork and Big Elk Creek drainages were inventoried to determine delivery from

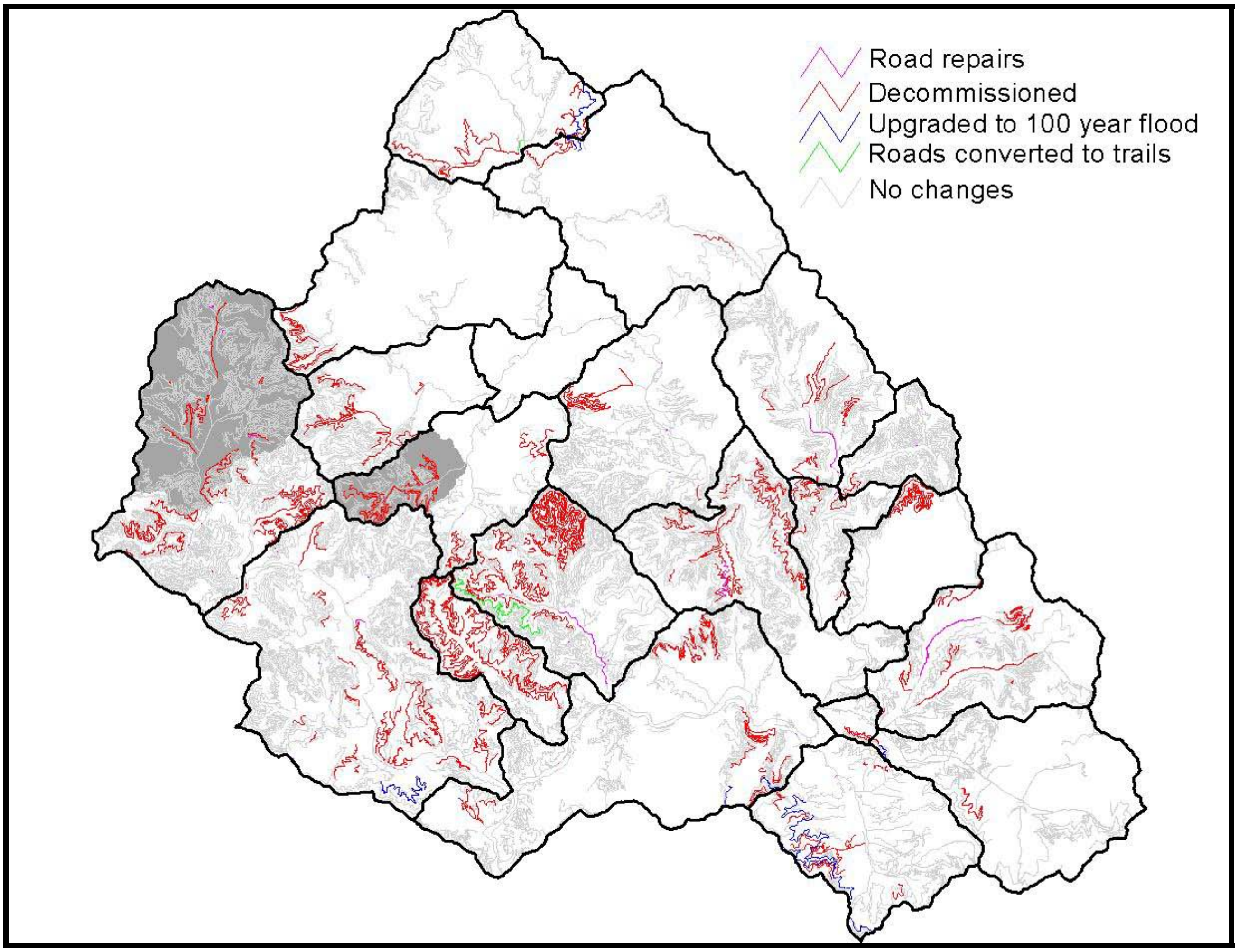


Figure 12. Location and Status of Roads used in Analysis (note intensive study basins shaded in gray).

hydrologically connected segments as well as road attributes that control surface erosion (road width, length delivering, surfacing, gradient, tread drainage configuration, and cutslope height and cover.) The inventory results were used to model road surface erosion and to extrapolate results to roads in the rest of the subbasin that were not inventoried.

The majority of open major forest roads in the North Fork subbasin are gravel surfaced with a 15-20 foot wide tread, and receive primarily administrative and recreational traffic. Open secondary roads are narrower, with a 10-15 foot wide tread and receive light recreational use. Secondary roads often have some vegetation growth on the tread. Closed roads are generally revegetated after 1-2 years of closure.

Figure 13. Examples of main roads, secondary open roads, and closed/overgrown non-system roads

Estimates of surface erosion were made using two road surface erosion models: WEPP:Road and SEDMODL. WEPP:Road generally estimates less surface erosion than SEDMODL, but does not provide the ability to model as many different traffic scenarios. The estimates are based on the currently open road system (1,171 miles, 933 stream crossings) since closed roads were vegetated and are assumed to have little to no surface erosion. Historic estimates were based on the entire road system (system and non-system roads) since most roads were open during times of peak logging operations and would have had much higher traffic levels.

7.2.10 Road Washouts and Gullying

Road stream crossings can be locations where the interaction of the road prism and the stream channel result in sediment input to the stream. In order to keep a relatively flat road running surface, fill is usually placed across the stream channel at the crossing. Under current construction practices and BMPs, a large corrugated metal (or plastic) pipe is laid in the stream channel prior to fill placement, the stream is directed through the pipe (often pumped or diverted around the construction area), and the fill is surfaced with large rocks or rip rap to reduce the potential for erosion. Pipes are sized to handle the estimated 100-year flow and, in high sediment or debris load streams, a trash rack is sometimes placed at the upstream end to reduce the chance of plugging. Downspouts can be constructed at the downstream end if a large or erodible fill is being traversed. Historic construction practices often did not take these measures, and resulted in a much higher probability of the culvert plugging or failing. Historically smaller metal culverts, wood culverts, or Humboldt crossings (logs placed in the stream parallel to the flow) were used at stream crossings, and fill was placed on top of these crossings. The majority of the road system was constructed prior to the 1960s, so some of these pipes are reaching the end of their life cycle and either rusting or rotting.

Culverts that are deteriorated or too small to handle high flows or high sediment or debris loads can plug, resulting in water ponding upstream of the fill and either flowing over the road and into the stream or down the road tread to the next crossing. Either way, gullies generally form under these circumstances and deliver sediment to streams. If the road fill saturates, the fill can fail, washing out the road prism and delivering the sediment to the stream.

Culvert washout and gully erosion was estimated based on past inventories of erosion at culverts conducted by the USFS on open and closed (system and non-system) roads and a smaller scale on open roads during the current study. The USFS inventory showed that an average of 22% of the culverts had failed to some extent on system and non-system roads at the time of the inventories (1988 or 1996). An average of 470 tons of fill had been delivered to streams at these failures (range: 2 - 1,100 tons). This number was converted to an average rate of 2.1 tons/ culvert/ year and applied to the number of potential culverts on the historic and current road system.

The USFS has been working on reducing the risk of culvert failure by decommissioning roads (pulling culverts and re-shaping the road fill in the vicinity of the stream channel) as well as upgrading culverts on roads that will remain in the system to be able to handle the 100-year peak flow. These continued efforts will continue to decrease the potential volume of sediment delivered to streams from culvert washouts and gullying.

7.2.11 Road Encroachment on Stream Channels

Early road construction in the North Fork subbasin commonly followed the easiest routes – right up river and stream valleys. The majority of these roads are still in use today; many forming the primary access routes in the subbasin. While these routes are the easiest from a road construction standpoint, the road prism in many locations encroaches upon the stream channel and/or floodplain. The effects on stream morphology (constricting the channel and/or flood plain, armoring banks, loss of riparian vegetation) are discussed in the Stream Channel report. Encroaching roads have additional sediment source effects during flood events if the stream power is sufficient to erode the road fill, washing out sections of road and delivering the eroded sediments to the stream. Erosion from road encroachment was estimated to be the largest sediment source during the 2001 TMDL study. The 2001 estimate was made using ¼ inch of erosion/year from all lengths of road within 50 feet of a stream based on the GIS coverages available at the time of the analysis. Since the result was such a relatively large sediment source, additional aerial photograph and field assessments of this source were made for the current analysis.

All areas with potential stream encroachment concerns were identified on the 1996 aerial photographs of the subbasin. Areas were identified where a stream impinged upon the road fill. Many of these areas were field checked for evidence of past stream encroachment erosion in August 2006, and road fill lengths, widths, and heights subject to erosion were estimated in the field. In addition, each site was rated as having a High, Medium, or Low susceptibility to road encroachment erosion based on the location of the road relative to the stream and the angle that the stream impinged upon the road fill (e.g., generally roads at the outside of meanders were rated as having a High potential; roads that paralleled the streamflow at straight sections were rated as Moderate).

Sections of roads identified as having potential road encroachment concerns on the aerial photographs, with some of the roads field checked, are listed in the *Sediment Source Analysis* Technical Report (page 36). Figure 14 maps the locations of encroaching roads.

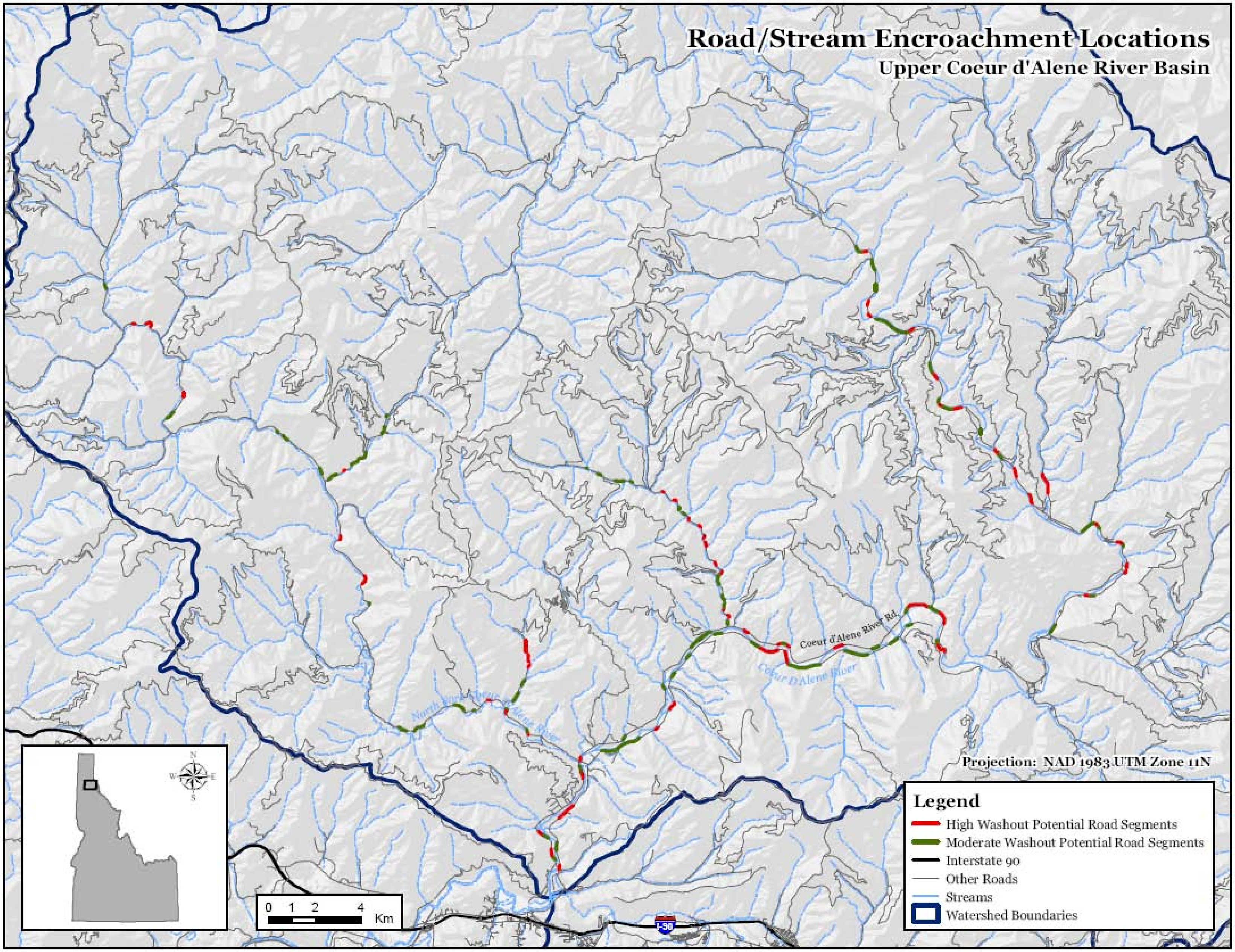


Figure 14: North Fork Coeur d'Alene Road Encroachment locations.

7.2.12 USFS Road Repair Data

The USFS provided data on road decommissioning, restoration, and repairs that have been completed since 1988. These data are not complete, but they do provide a sense of the type and frequency of repairs needed, which is likely linked to sediment sources from road washouts/gullies and stream channel encroachment. The database was sorted to look at road repairs only (not decommissioning) and data were summarized by reason for repair and year.

The length of roads that were repaired was used as a comparison metric (most records did not have information on volume of material needed to repair the road, although that would have been a good indicator of sediment lost to erosion). The miles of road by year, and reason for repair are listed in Table 5. The frequency (number) of road repairs by reason and year is also shown in Figure 15.

Road repairs to provide access, or general road repair were the most frequently listed road issues. These include culvert failures, washouts, and general repairs. The next most frequent repair was to remove fish barriers, followed by bank stabilization, or moving roads away from streams. These data may not be complete or totally representative of road erosion processes occurring in the North Fork area, but they are consistent with observations from the aerial photographs, and suggest that small culvert/road washouts and stream-parallel roads are the primary road erosion issues.

Table 5. Miles of Road Repaired by Year (from USFS Data, 1991-1997). Data were tabulated only for the 3 years shown, and may or may not represent the intervening years.

Reason for Repair	1991	1995	1997	Total Miles
Access	12.47	0	0.47	12.93
Bridge repair	0	0	0.18	0.18
Move road, bank stabilization	0	1.18	0.35	1.53
Remove fish barrier, reduce erosion	0	0.84	4.08	4.92
Replace culverts, repair road	0.22	0	0	0.22
Road repair	0	2.90	6.55	9.45
Stabilize bank	0	0	2.72	2.72
Total Miles	12.68	4.92	14.34	31.95

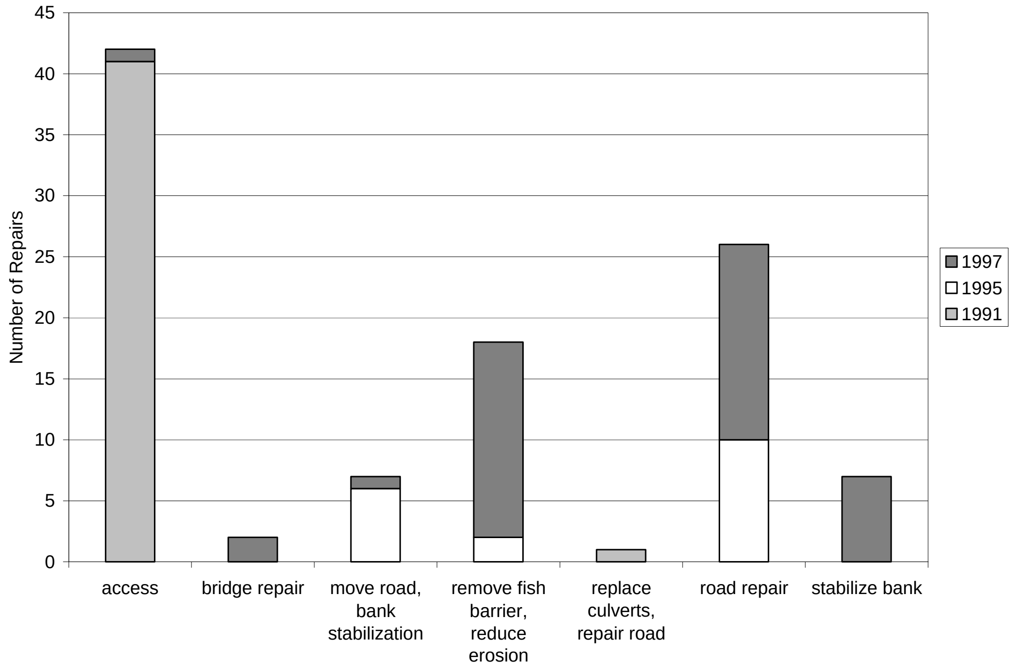


Figure 15. Number of road repairs by year and reason for repair.

7.2.13 Streambank Erosion and Stream Entrenchment

Channel erosion rates from the upper Little North Fork CdA River and Big Elk Creek were extrapolated to the rest of the North Fork subbasin using the methods described in the *Stream Channel Analysis* Technical Report. These rates are more speculative than the rates for the two watersheds that were studied in detail. The extrapolation was done for the purpose of identifying the relative magnitudes of erosion types and source areas.

The peak rate of channel entrenchment may have been as high as 400,000 tons per year if all channel entrenchment occurred within a 30 year period. If the same volume of erosion occurred in two separate 30 year periods, such as the early 20th century logging using water-based transport followed by the later logging with extensive road building, the rates would be approximately halved. The extent and magnitude of channel entrenchment in the northern watersheds that were burned and then heavily grazed is unknown; however, these were likely sources of substantial quantities of sediment.

Current channel entrenchment appears to be limited to just a few watersheds, most notably in the mining district. The current entrenchment erosion rate is estimated at 3,000 to 30,000 tons per year, which is one to two orders of magnitude lower than historic peak rates.

The estimated bank erosion rate for the total subbasin is about 7,000 tons per year. This is equivalent to about 7 tons per square mile per year and is in addition to the background erosion rate of 14.7 tons per square mile per year. Total current channel erosion from bank erosion plus entrenchment is estimated as between 10,000 and 37,000 tons per year.

7.3 SEDIMENT INPUT BUDGET

Estimated sediment inputs from all sources were compiled for two time periods: historic and current.

7.4 HISTORIC SEDIMENT INPUTS

The analysis team felt that an understanding of the magnitude of historic sediment inputs (1900-2000) was important because there were such large inputs of coarse sediment (cobble, gravel) in the past that it was quite likely that the river channel was still being affected by the routing of these sediments. The historic inputs were quantified to the extent possible (Table 6). Where quantification was not possible, an estimate of the relative magnitude (high, low) was noted. The sediment inputs from historic activities were annualized; however, the peak of some sediment inputs occurred for several decades (e.g. mining, timber harvest) and were not as high during other decades in the 1900s. Table 6 summarizes major sediment inputs that occurred during the 1900s but does not differentiate inputs by decade.

The largest historic sediment input was from channel entrenchment and bank erosion. These sources are related to the channel responding to loss of structure, log drives, riparian vegetation removal, and inputs of course sediment from other sources. The channel destabilized, widened and downcut, and mobilized large amounts of stored alluvium in response to these changes. Channel entrenchment is an episodic source of primarily course-grained material (alluvium).

Sediment inputs from erosion of encroaching road fill is estimated to be another historically large source of sediment. The easiest place to construct roads and railroad grades is in flat stream valleys, but these roads are generally within the floodplain of the river and vulnerable to erosion by the stream during peak flow events. Road encroachment is an episodic source of course and fine sediment (road fill). Sediment input from culvert washouts/gullies was a moderate, episodic source associated with roads. Sediment input from road surface erosion was a smaller, chronic source of primarily fine-grained material (sand, silt, clay).

Sediment inputs from mining activities was a major source of sediment in the Prichard, Eagle, and Beaver Creek drainages. Early mining practices resulted in large quantities of spoils being supplied to the streams, as well as disruption and sediment inputs from the stream channels themselves from dredging along many miles of stream. Sediment input from mining activities occurred relatively continuously over several decades and included fine and coarse sediment (mining spoil and alluvium).

Timber harvest practices in the early and middle parts of the 1900s likely resulted in large sediment inputs to streams as well as the destabilization of the streams themselves by log drives down the channels. These sources were likely relatively large and a chronic input.

The 1910 fires undoubtedly resulted in increased fine-grained sediment inputs from burned land as surface erosion occurred for several years following the fires. Heavy sheep grazing on the burned areas as grass began to grow likely also resulted in some erosion. These sources were not quantified.

Table 6. Summary Sediment Input Budget, Historic Time Period. All inputs in average tons/year

				Management Related								
6th-field HUC	Area (sq mi)	Back-ground	Fire	Bank Ero-sion	Channel Entrench-ment	Road/Stream Encroach-ment	Road Surface Erosion	Road Culvert Washout/ Gullies	Agri-cul-ture	Mining	Timber Harvest	Land-slides
170103010101 NF Coeur d'Alene River above Marten Cr	37	540	Large after 1910 fires	Included in channel entrenchment	1,500	0	70	150	Possible moderate from sheep grazing after fire	0	Small	Unknown but small
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	65	960			0	80 -160	40	110		0		
170103010201 Tepee Cr above Trail Cr	35	520			3,000	360 -430	140	230		0		
170103010202 Trail Cr	30	440			2,700	150 -150	120	230		0		
170103010203 Tepee Cr below Trail Cr	19	290			0	590 -990	20	40		0		
170103010204 Independence Cr	59	870			1,700	0	60	140		0		
170103010301 NF Coeur d'Alene River above Yellowdog Cr	51	750			11,200	7,400 -9,760	170	420		0		
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	49	710	Unknown but likely small		10,700	3,610 -5,500	200	520	0	0	Likely large from 1900 through 1970's	
170103010303 Lost Cr	24	360			8,000	0	40	120	0	0		
170103010401 Shoshone Cr above Falls Cr	42	610			13,800	0	120	320	0	0		
170103010402 Shoshone Cr below Falls Cr	14	200			4,500	210 -260	60	180	0	0		
170103010403 Falls Cr	14	200			4,600	0	110	230	0	0		
170103010501 Prichard Cr above Eagle Cr	50	740			81,800	0	100	390	0	14,100		
170103010502 Eagle Cr	45	660			74,300	0	140	390	0	3,700		
170103010503 Lower Prichard Cr	3	50			5,800	0	10	50	0			
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	86	1,260			18,800	35,240 - 52,540	150	730	17	0		
170103010602 Beaver Cr	42	620			69,800	0	160	470	0	1,200		
170103010603 Steamboat Cr	42	620			9,200	570 -850	310	750	0	0		
170103010604 Cougar Gulch	19	280			4,300	0	100	270	0	0		
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	76	1,120			25,200	100 -100	570	1,120	0	0		
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	94	1,380			30,900	960 -960	490	1,050	0	0		
TOTAL Entire NF CDA Subbasin	**896**	13,180	**1910 large**		**381,800**	**49,270-71,720**	**3,180**	**7,910**	**17**	**19,000**	**1900's-1970's large**	**Small**

Table 7. Summary Sediment Input Budget, Current Time Period. All inputs in average tons/year

				Legacy Sources		*Current Management Sources*						
6th-field HUC	**Area (sq mi)**	**Back-ground**	**Fire**	**Bank Ero-sion**	**Channel Entrench-ment**	**Road/Stream Encroach-ment**	**Road Surface Erosion**	**Road Culvert Washout/ Gullies**	**Agri-cul-ture**	**Mining**	**Timber Harvest**	**Land-slides**
170103010101 NF Coeur d'Alene River above Marten Cr	37	540	0	10	0	0	10	80	0	0	2	0
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	65	960	0	0	0	0 -60	10	90	0	0	2	0
170103010201 Tepee Cr above Trail Cr	35	520	0	10	0	0 -140	10	160	0	0	3	0
170103010202 Trail Cr	30	440	0	60	600-6,000	0 -150	15	150	0	0	0	0
170103010203 Tepee Cr below Trail Cr	19	290	0	0	0	90 -480	10	40	0	0	0	0
170103010204 Independence Cr	59	870	0	10	0	0	10	100	0	0	1	0
170103010301 NF Coeur d'Alene River above Yellowdog Cr	51	750	0	50	0	2,520 -6,810	25	370	0	0	1	0
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	49	710	0	50	0	850 -3130	40	400	0	0	0	0
170103010303 Lost Cr	24	360	0	190	0	0	5	80	0	0	3	0
170103010401 Shoshone Cr above Falls Cr	42	610	0	330	0	0*	10	300	0	0	0	0
170103010402 Shoshone Cr below Falls Cr	14	200	0	110	0	80 -200	15	160	0	0	4	0
170103010403 Falls Cr	14	200	0	110	0	0*	20	220	0	0	1	0
170103010501 Prichard Cr above Eagle Cr	50	740	0	1,800	1,600-16,000	0	5	380	0	in bank eros.	1	0
170103010502 Eagle Cr	45	660	0	1,080		0*	20	320	0		0	0
170103010503 Lower Prichard Cr	3	50	0	80		0	0	30	0		0	0
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	86	1260	0	90	0	10,500 - 11,540	20	650	4	0	6	0
170103010602 Beaver Cr	42	620	0	1,020	700-7,000	0	10	380	0	in bank	1	0
170103010603 Steamboat Cr	42	620	0	40	0	0 -410	40	560	0	0	6	0
170103010604 Cougar Gulch	19	280	0	150	0	0	10	130	0	0	2	0
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	76	1120	0	610	0	0 -40	85	970	0	0	0	0
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	94	1380	0	750	0	190 -600	60	860	0	0	10	0
TOTAL Entire NF CDA Subbasin	**896**	**13,180**	**0**	**6,550**	**3,000-30,000**	**14,230-23,560**	**430**	**6,430**	**4**	**--**	**43**	**0**

7.5 CURRENT SEDIMENT INPUTS

Current sediment inputs (those occurring under 2006 road and land management practices) were compiled to help the TMDL implementation team understand on-going sediment sources and how current management practices could be altered to reduce sediment inputs (Table 7). Total estimated sediment inputs under current conditions are 43,900 to 80,200 tons/year (50-90 tons/sq mi/yr).

Background sediment input was computed by applying the same set sediment production rate as the 2001 analysis. The TMDL used this background sediment input to help determine which drainages were sediment impaired, and to set sediment reduction goals that could be attained through the implementation planning efforts.

Two sediment sources were classified as legacy sources: bank erosion and channel entrenchment. These on-going sediment inputs are primarily related to land management practices that occurred in the 1900s (large-scale mining, historic timber harvest practices) and are no longer taking place in the manner that caused the stream instability. These both continue to be fairly large sources of course-grained sediment that are provided episodically (during peak flow events).

Sediment sources related to current management practices include road-related sources: road encroachment on stream channels, surface erosion, and culvert washouts/gullies. These are the largest sources of current management sediment in the subbasin. There is an extensive system of roads, particularly in the middle portion of the watershed (Figure 12) as a result of intensive timber harvest in the mid 1900s. The majority of roads are on USFS land and are included in either system roads or non-system road categories by the USFS. System roads (open and closed roads that are part of the USFS transportation system) receive some level of regular maintenance (approx. 1,200 miles), or are closed to current use and receive no maintenance (approx. 1,800 miles). Non-system roads are closed/abandoned roads that likely still have some drainage structures in place but receive no use or maintenance (approx. 1,200 miles). These non-system roads could be considered a legacy source of sediment, but were included in the current management practices category for this assessment. Erosion of roads encroaching on stream channel was estimated to be a large source of sediment, followed by culvert washouts, with road surface erosion a much smaller input.

There is currently little timber harvest on USFS lands. Current timber harvest practices include procedures that limit erosion and delivery of sediment to streams (i.e., stream buffers, yarding away from streams). If extensive timber harvest takes place in the future, this could become a larger source of sediment, but it is relatively small under current conditions.

Agriculture is a very minor sediment source under current conditions. A separate agriculture implementation plan has been developed for the subbasin.

7.6 RECENT SEDIMENT TRANSPORT RATES NEAR THE MOUTH OF THE NORTH FORK COEUR D'ALENE RIVER

As a check on the estimated current sediment input budget listed in Table 7, comparison with total computed sediment input was made with recent measurements in the river. In 1999 and 2000, the USGS measured bedload and suspended sediment load at the *North Fork CDA River at Enaville* gage and seven other gauging stations in the Coeur d'Alene River basin (Clark and Woods, 2000). Rating curves were developed by the USGS to predict sediment discharge for a given water discharge. Bedload and suspended sediment transport rates on the South Fork Coeur d'Alene River were an order of magnitude higher than on the North Fork. The rating curves had high correlation coefficients indicating a tight fit of the data to the curves.

The total sediment yield based on analysis of USGS gage records is estimated to be 85 to 93 tons per square mile per year depending upon the discharge record used. This does not correspond directly to erosion rate, since some sediment is deposited on the valley floors of upstream tributaries. In addition, bedload moves very slowly downstream so gravel at the Enaville gage was likely eroded decades earlier. For comparison, the 2001 TMDL study calculated 34 tons of erosion per square mile per year. The regional background sediment rate is about 14.7 tons per square mile per year (IDEQ 2001). The current sediment input rate estimated in this study is about 50 to 90 tons per square mile per year.

7.7 COMPARISON OF CURRENT SEDIMENT SOURCES TO BACKGROUND INPUT

One measure used in the TMDL process to set sediment loads compares management-related sediment inputs to background sediment inputs. The ratio of management:background sediment is often used as a metric to set sediment loading in a drainage. A ratio below 1.5 (e.g., management related sediment input is less than 1.5 times background) is considered acceptable; a ratio over 1.5 is not considered acceptable.

Two ratios of management to background inputs were calculated for each drainage in the North Fork subbasin (Table 7):

1) the sum of legacy and current management inputs relative to background inputs, and
2) current management inputs (without the continuing legacy contributions) relative to background inputs.

The ratios incorporating both legacy and current management inputs were greater than 1.5 in 52% of the drainages. Only 4 drainages (19% of the 21 drainages evaluated) had ratios greater than 1.5 when only current management inputs were considered. These drainages are: 1) the North Fork above Yellowdog Creek, 2) the North Fork downstream of Yellowdog Creek and upstream of Prichard Creek, 3) the lower North Fork downstream of Prichard Creek, and 4) Shoshone Creek downstream of Falls Creek (Table 8).

Table 8. Current Management-related Sediment Inputs and Ratio over Background Input. Drainages with ratios over 1.5 have shaded cells.

6th-field HUC	Management-related Inputs (average tons/yr)		Ratio over Background Sediment	
	Legacy & Current	Current Only	Legacy & Current Management	Current Management Only
170103010101 NF Coeur d'Alene River above Marten Cr	100	90	0.2	0.2
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	130	130	0.1	0.1
170103010201 Tepee Cr above Trail Cr	250	240	0.5	0.5
170103010202 Trail Cr	900	240	2.0	0.5
170103010203 Tepee Cr below Trail Cr	350	350	1.2	1.2
170103010204 Independence Cr	120	110	0.1	0.1
170103010301 NF Coeur d'Alene River above Yellowdog Cr	5,110	5,060	6.8	6.7
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	2,480	2,430	3.5	3.4
170103010303 Lost Cr	280	90	0.8	0.2
170103010401 Shoshone Cr above Falls Cr	640	310	1.0	0.5
170103010402 Shoshone Cr below Falls Cr	430	320	2.1	1.6
170103010403 Falls Cr	350	240	1.8	1.2
170103010501 Prichard Cr above Eagle Cr	3,190	390	4.3	0.5
170103010502 Eagle Cr	3,020	340	4.6	0.5
170103010503 Lower Prichard Cr	110	30	2.2	0.6
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	11,790	11,700	9.4	9.3
170103010602 Beaver Cr	2,110	390	3.4	0.6
170103010603 Steamboat Cr	850	810	1.4	1.3
170103010604 Cougar Gulch	290	140	1.0	0.5
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	1,690	1,080	1.5	1.0
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	2,080	1,330	1.5	1.0
TOTAL Entire NF CDA Watershed	36,270	25,820	2.8	0.2

8.0 STREAM CHANNEL CONDITION & ANALYSIS

Channel responses to disturbances can be complex and occur over long time periods. In particular, gravel and cobble sediment moves slowly as bedload and may take decades for sediment to travel through a watershed. The stream channel analysis gathered evidence to evaluate how the lower Little North Fork Coeur d'Alene River and the North Fork Coeur d'Alene River were processing the coarse sediment loads that are currently in the channels.

Rivers respond to changes in sediment load and water discharge by adjusting their morphology. The current channel morphology provides many clues as to where and how sediment is being processed through the system. Comparing past and present morphology using historic maps, aerial photographs, and cross-section surveys was done to evaluate the extent and patterns of sediment movement in channels to the extent that historic data was available.

This section starts with an overview of the channel geomorphology and then provides a summary of the channel analysis findings. Due to the large size of the subbasin the analysis focused on the Big Elk Creek subwatershed and the Little North Fork Coeur d'Alene River subwatershed above Burnt Cabin Creek (highlighted in Figure 1). The channel analysis also examined the remainder of the North Fork subbasin, although in less detail. The full analysis and results are in the *Stream Channel Analysis Technical Report*, in addition, extensive information on the stream channel processes was identified and summarized in the Appendix A- Technical Report.

8.1 STREAM CHANNEL GRADIENTS & PROFILE

The gradient of a stream channel reflects the ability of that channel to transport water and sediment. Channels with gradients below 1% and moderately-confined to unconfined valleys are the most likely to respond to excess coarse sediment supply by depositing sediment, becoming wider, and sometimes braiding. Channels in the 1 to 2% range are also sensitive to coarse sediment but the impacts are less likely to be visible on air photos. As an initial indicator of likely channel response, GIS-generated maps showing channel gradient class were generated. Figure 16 shows gradients of stream segments in the study area (USFS GIS). The channel gradient maps were used to select locations for historic air photo analysis, and to select channel segments in a variety of gradient classes for field work.

The North Fork gradually steepens upstream with a concave profile. The river gradient is less than 0.5% on the mainstem of major rivers and gradients increase in the upper headwaters. The major tributaries are steeper than the North Fork with the exception of Tepee Creek, which occupies a flatter valley that is a continuation of the middle North Fork valley. The Little North Fork River and Tepee Creek have average gradients of less than 0.5%. Beaver, Prichard, and Shoshone Creeks have average gradients above 0.7% but below 1.0% where they join the North Fork, but steepen upstream to above 1%. Short segments of all these larger channels are greater than 1% according to the gradient map (Figure 16). Slightly smaller tributaries (such as Lost Creek and Prichard Creek above Eagle Creek) are steeper than 1% except in the Tepee Creek valley.

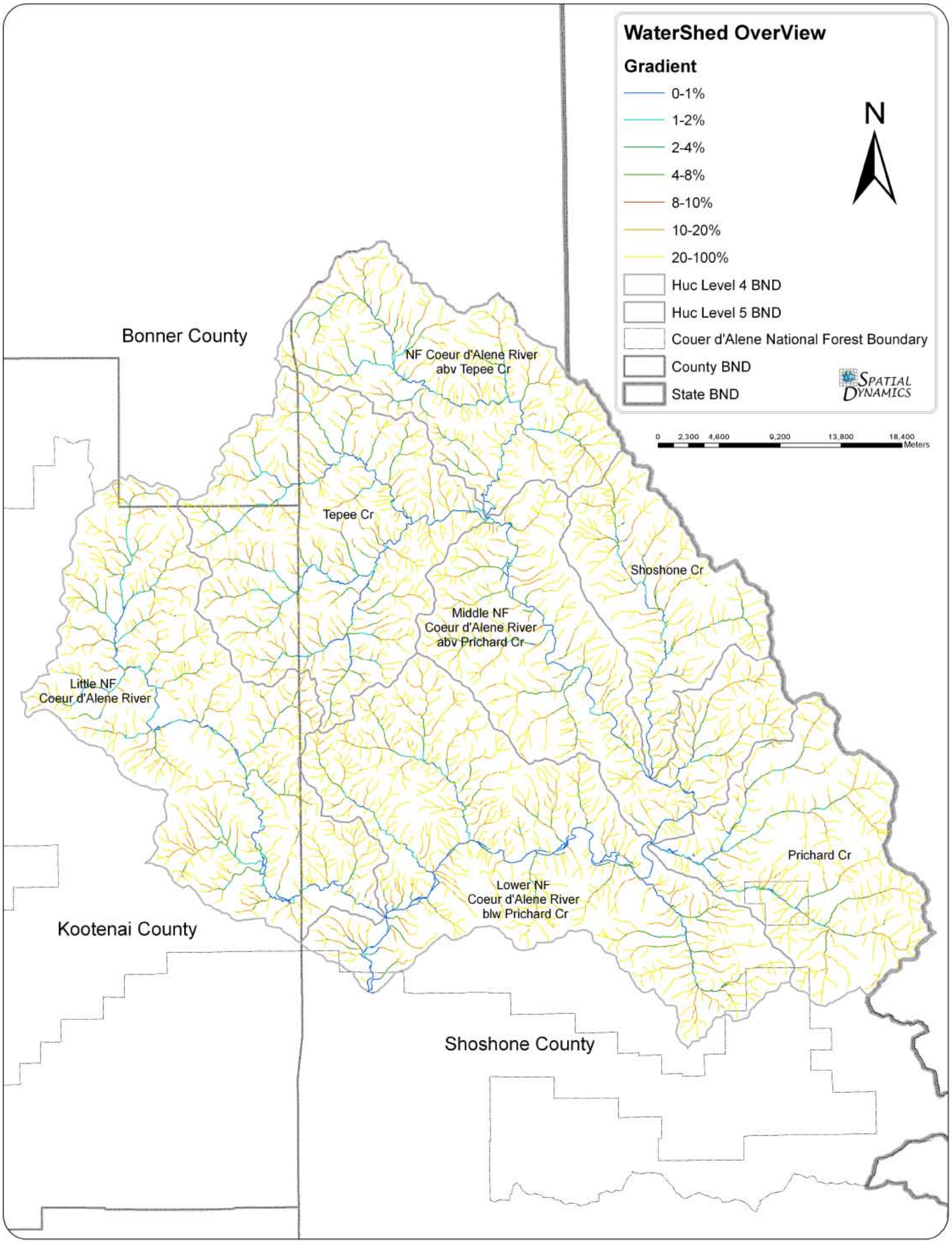


Figure 16. North Fork Coeur d'Alene stream channel gradients.

8.2 RIVER CHANNEL PATTERN, CONFINEMENT AND MIGRATION

The river channel patterns and valley confinement infulence the stream's capacity to move sediment and provide a variety of fish habitat. Generally flatter unconfined rivers and streams have wide floodplains with a variety of side channels and heterogeneous habitat. These types of reaches also are susceptible to sediment deposition and because of the low gradient they are lower energy so sediment tends to accumulate. The steeper or more confined a reach is the more energy generated by water moving through the reach and the high capacity for sediment transport. Modification to the river floodplain also alters the sediment transport capacity.

A time series of historical air photographs and the oldest survey maps were used to track changes in channel width and pattern. The earliest Government Land Office (GLO) survey maps and survey notes were obtained. The maps were compared with modern USGS topographic maps to determine locations where the North Fork had changed position since approximately 1905. Due to the small scale of the early maps, they were only usable for the lower North Fork reach and part of the middle North Fork.

Historic photo analysis was completed for response reaches, which are the flatter, unconfined to moderately confined reaches where sediment is deposited in gravel bars. The analysis included response reaches of the North Fork, the Little North Fork, Prichard, Beaver, Eagle, Tepee, Independence, and Trail Creeks, and Shoshone Creek at its mouth. In addition, photo analysis of smaller streams was completed using a stereoscope with magnification in the two detailed study areas, Big Elk Creek and the Little North Fork above Burnt Cabin Creek. Following is a summary of these findings.

In general the river pattern in the early 1900s was similar to today in most of the Lower and Middle North Fork HUCs, based upon comparison of recent USGS topographic maps with the original Government Land Office (GLO) survey. Some mappable changes in channel position have occurred in wide reaches near the Little North Fork confluence, and between Grizzly and Beaver Creeks. There are also some sloughs and side channels in the downstream one-third of the lower North Fork that have been disconnected from the river by roads. In the middle North Fork, there are 1 or 2 roads along the edge of the river valley throughout this reach, as well as bridge crossings. In the upper North Fork a road goes up the narrow valley, with some bridge crossings.

Channel patterns and river location in the North Fork are impacted by roads and bridges which constrain the river's migration and reduce floodplain width. Roads are typically located at the edges of the valley, but in some locations (primarily in the Lower North Fork HUC), they cut off larger portions of the floodplain including meander bends and former side channels. There is also a gas pipeline that constricts the river downstream from the Little North Fork.

8.3 CHANNEL CHANGES VISIBLE ON HISTORIC AERIAL PHOTOGRAPHS

Low-gradient, unconfined channels (response reaches) typically respond to excess coarse-sediment load by widening, depositing bars, straightening, and sometimes forming multiple channels (braiding). Large floods also can cause channel widening. Following passage of a sediment wave or large flood, the active channel gradually narrows and vegetation grows on the former gravel bars. When sediment load has decreased, the river will become more sinuous, bars will become smaller, and farther apart, and mid-channel grade bars will disappear. These changes can be readily observed on aerial photographs for all but the smallest streams.

The channel response analysis focused on major low-gradient, unconfined valley segments throughout the North Fork subbasin, as well as smaller tributaries in the two detailed study areas of Big Elk Creek and the Little North Fork above Burnt Cabin Creek. The North Fork above Tepee Creek sub-basin was not analyzed except near the Tepee Creek confluence. Likely response reaches were viewed on a series of historic aerial photos (Table 9) to determine relative changes in channel width and pattern, and to identify direct disturbances to the channels. Very few response reaches had 1975 air photos, and many were missing 1968 and/or 1983/84 photographs. Bar charts depicting the relative changes in channel width were developed for the 39 reaches analyzed (*Stream Channel Analysis* Technical Report).

Extreme width increases, avulsion channels, and continuous, wide gravel bars occurred in the Little North Fork, Shoshone Creek, Trail Creek (tributary of Tepee Creek), the North Fork above Tepee Creek, North Fork below the Little North Fork, Prichard Creek, and Eagle Creek (Table 9). Growth of bars where no bars previously existed was noted in some locations on the North Fork just downstream of Prichard Creek (Table 9). Less extreme, but significant, width increases occurred in Tepee, Independence, Big Elk, Beaver, Iron and Burnt Cabin Creeks, the middle North Fork in the vicinity of Miners -Brett-Wilson Creeks, and three reaches of the lower North Fork (Table 9).

Width increases occurred by 1937 or by 1968 in most response reaches. In many locations, avulsions were observed on the 1983/84 photos that presumably occurred during the 1974 or 1982 floods. An avulsion is a sudden switch to a new channel, often leaving a forested island between the old and new channels. Despite the avulsions, in many cases the 1983/84 active channel width stayed the same or decreased relative to 1968. Most response zones had narrowed by 1996 and stayed narrow since then. A few stream reaches either widened again or remained wide in the 1996 or 2004 photos.

The mined watersheds -- Prichard, Eagle, and Beaver -- had the most severe, widespread, and persistent channel response to coarse-sediment load with relatively little recovery. Logged areas, such as Big Elk Creek and the Little North Fork, had fewer widened reaches than the mined watersheds and quicker recovery with the exception of the reaches furthest downstream. Some streams with early 20th-century burns, which had little to no logging and road building, had channel widening of a similar magnitude and timing as the densely-roaded, logged subbasins.

Table 9. Locations and dates of extreme increases in active channel width (values of 13 or 12 on bar charts included in *Stream Channel Analysis* Technical Report - Appendix 2).*

Subbasin	Reaches with extreme width increases (value of 13 on bar charts in Stream Channel Technical Report - Appendix 2)	Date of Photo with Maximum Width
MANAGEMENT TYPE: LOGGED, DENSE ROAD NETWORK		
Little North Fork above Burnt Cabin	Little North Fork between Burnt Cabin and Hudlow Creeks	1968
	Little North Fork Coeur d'Alene River near Deception Creek	1968
	Little North Fork Coeur d'Alene River near Bootjack Creek	1983/84
	Little North Fork Coeur d'Alene River near Little Tepee Creek	1937
Lower North Fork (below Prichard)	North Fork Coeur d'Alene River just below Prichard Creek	1975
	North Fork Coeur d'Alene River below Little North Fork	1937
Prichard	Prichard Creek below Eagle	1937
	Prichard Creek above Eagle	1996
	Eagle Creek	1996
Shoshone (viewed only near mouth)	Shoshone Creek near mouth	1937
MANAGEMENT TYPE: BURNED, EARLY GRAZING, FEW OR NO ROADS		
Upper North Fork above Tepee (photos viewed only near Tepee Cr)	North Fork Coeur d'Alene River -- first few miles above Tepee	1937
Tepee	Trail Creek below Hamilton Creek	1983/84
Sub-basin	**Reaches with extreme width increases (value of 12 on bar charts in Stream Channel Technical Report - Appendix 2 2)**	**Date of Photo with Maximum Width**
MANAGEMENT TYPE:LOGGED, DENSE ROAD NETWORK		
Little North Fork above Burnt Cabin	Little North Fork Coeur d'Alene River -- scattered areas between Tom Lavin and Solitaire Creeks	1996 or earlier
	Iron Creek	1968, 1983/84
	Burnt Cabin Creek	1937, 1968
	Little North Fork Coeur d'Alene River near Copper Creek	1937
	Little North Fork Coeur d'Alene River near Bumblebee Creek	1937, 1968
Lower North Fork (Below Prichard)	Beaver Creek below Trail Creek	1968, 1975
	North Fork Coeur d'Alene River near mouth	1937
	North Fork Coeur d'Alene River above Little North Fork	1968
	North Fork Coeur d'Alene River east of Grizzly Creek	1937
Middle North Fork (Above Prichard)	North Fork Coeur d'Alene River near Brett, Miners, and Wilson Creeks	1996 or earlier
MANAGEMENT TYPE: MOSTLY BURNED, EARLY GRAZING, FEW OR NO ROADS (SOME LOGGING IN HEADWATERS)		
Tepee	Tepee Creek near mouth	1996
	Tepee Creek downstream of Magee	1968
	Upper Independence Creek response zones	1937, 1968, 1983/84
	Independence Creek between Owl and Griffith creeks	1968, 1983/84, 2004
	Trail Creek near mouth	1968
	Trail Creek above Hamilton Creek	1983/84

* Note the historic channel analysis did not include most of the upper North Fork Coeur d'Alene River above Tepee Creek, nor smaller tributaries except Big Elk Creek and the upper Little North Fork Coeur d'Alene River watershed above Burnt Cabin Creek.

8.4 CHANNEL ANALYSIS SUMMARY

Many low-gradient channels in the North Fork subbasin show response to large inputs of coarse sediment (as well as loss of riparian trees) by depositing large gravel bars, becoming wider, and braiding or changing course. Inspection of historical air photographs dating from the 1930s through 2004 found that most channel-widening responses occurred in the 1930s through 1980s. The width of most channels was reduced by 1996 and the length of disturbed channels had decreased greatly. Previously-widened channels became even narrower between 1996 and 2004. The historical increase in channel width was extensive in both the logged and roaded part of the watershed and the portions that were burned but not logged or roaded.

Prichard, Eagle, and Beaver Creeks in the Coeur d'Alene Mining District had the most severe and persistent channel response to high sediment load. Many stream reaches remain over-widened and braided, and have long reaches with eroding banks. Parts of Prichard Creek have been pushed next to the valley wall by dredge spoils, resulting in occasional valley-wall landslides as well as erosion of the spoils piles. Portions of Prichard and Eagle Creeks go dry in the summer due to the large volume of coarse sediment that has filled in their channels.

Channel conditions in the logged portions of the subbasin where no mining has occurred were investigated in Big Elk Creek and the upper Little North Fork, with limited field reconnaissance elsewhere. Most tributary channels currently have mostly-stable banks and low to moderate sediment load. Most streams are connected to their floodplain, which reduces erosion rates, and most of the steeper streams now have large woody debris that stabilizes the channel. Many channels steeper than two percent showed evidence of previous entrenchment. Deepening and widening of entrenched channels was formerly a large sediment source.

The Tepee Creek and upper North Fork watersheds burned in the early 20th century so they had little logging or road-building. Many low-gradient channels in these basins widened in the 1930s or later, with a similar scale of response as the logged watersheds. Although most of the affected reaches have narrowed, some still remained excessively wide and have switched channels in the 1990s or later. These basins were far from pristine. In addition to removal of vegetation by fires, parts were heavily grazed with sheep up until the 1930s, and log drives occurred in some of the larger streams to remove burnt timber. The current sediment load at the lower ends of most Tepee Creek tributaries appeared to be low; however, some Trail Creek tributaries have high erosion rates and are undergoing channel entrenchment.

The local geology appears to supply a relatively high volume of cobbles and gravel to the streams. Coarse sediment enters the streams from streamside cliffs that are undermined at the toe by the stream. The old-growth cedar forest in Settlers Grove on West Fork Eagle Creek has large gravel bars in the creek, and coarse gravel and cobbles are visible on the floodplain surface between the cedar trees.

Although many of the smaller stream channels have recovered well from past disturbances, some reaches of rivers and larger creeks still remain overloaded with sediment. Large woody debris is rare in the larger channels. In many cases, the low abundance of instream wood is having a greater effect on the low number of pools than is the excess supply of coarse sediment. Coarse sediment moves downstream fairly slowly, taking the better part of a century to travel from upper reaches of the watershed to the river mouth. The remaining river reaches that still have an excess coarse sediment supply are for the most part responding to sediment generated far upstream many decades earlier.

9.0 RECOMMENDATIONS

9.1 FISH POPULATION & HABITAT

1. Summer Habitat: Protect cold water refugia areas especially side channels and wider floodplains.
    - 50% of tagged fish used side channels during warm water temperatures (in lower North Fork)
    - Summer river water temperatures cooled moving downstream coinciding with increases in floodplain width.
2. Winter Habitat: Protect wide floodplain areas
    - The habitat use data showed that radio tagged cutthroat trout tended to move to areas with wider floodplains during winter. Maintaining these habitats will increase survival.
3. Adjust fishing regulations to protect areas where large fish congregate
    - Changing the lower reaches of river where larger trout congregate to catch-and-release would provide an area with easy access where people would have a better chance of catching larger, long lived cutthroat trout.

9.2 HYDROLOGY

Further investigation is needed to map the condition of all roads. The model results probably represent a "worst case" scenario in terms of hydrologic impact from roads, however, uncertainty remains as to the continuing impacts of non-decommissioned, non-maintained roads in the watersheds. It is not known to what extent passive restoration of hydrologic function has occurred in these roads.

9.3 SEDIMENT SOURCE RECOMMENDATIONS

The largest continuing sediment sources in the North Fork subbasin are estimated to be erosion from roads encroaching on stream channels and erosion from culvert failures and washouts. Continued efforts by the USFS to reduce road encroachment by relocating or removing stream adjacent roads or armoring the fill in areas where roads cannot be moved will help to reduce road encroachment erosion. Areas most susceptible to road encroachment erosion have been identified. Continued work to upgrade culverts on system roads and pull culverts on closed roads will help to reduce future erosion from culvert failures and gullying.

It is possible that some of the drainages listed in the 2001 TMDL document no longer need to be listed for sediment under current conditions based on a more detailed analysis. This possibility can be evaluated based on findings in this report along with stream and aquatic indicators.

Table 10. Ongoing sediment sources identified during 2006 channel analysis. Other sediment sources likely exist in areas that were not field-surveyed.

Location of known current sediment sources	Description
Prichard Creek	Miles of creek are pinned between dredge spoils and valley wall, erodes both (valley wall landslides)
Beaver tributaries, perhaps elsewhere in mining district	Placer mining by bulldozer or hydraulic methods, next to streams
Prichard-Eagle-Beaver tributaries	Roads up narrow gulches, creek erodes fill or gullies the road surface
Prichard-Eagle-Beaver watersheds	Mine tailings piles eroded by creeks (remediation underway by BLM, other agencies)
North Fork Coeur d'Alene River along Old River Road	Road fill erosion due to 1) road bed is several feet below flood level, and 2) undersized riprap
Trail Creek upper tributaries (Tepee Creek watershed)	Former road washouts and slides on Potter and Stewart Creek during large floods including 1996; current status unknown
Trail Creek lower tributaries (Tepee Creek watershed)	Channel incision and bank erosion
Cougar Gulch -- extent unknown	Bank erosion and possible channel incision
Iron Creek near airfield	ATV traffic across creek erodes fine and coarse sediment from streambed and banks

9.4 Stream Channel Recommendations

Current channel sources of coarse sediment are concentrated in specific watersheds (Table 10). Sediment source reduction efforts will be most effective if they are concentrated in these locations. Culvert replacements or other remedial road work on tributaries will have maximum benefits if the work is focused on streams that deliver coarse sediment directly to larger channels (see examples in Big Elk Creek and upper Little North Fork in the *Stream Channel Technical Report*). Although work on streams that deposit their coarse sediment on valley margins would produce local erosion-control benefits, it would not reduce the coarse sediment load of downstream waters.

9.4.1 Larger Rivers and Streams

The following recommendations apply primarily to the larger rivers and streams. They address the legacy effects of past coarse sediment inputs, riparian harvest, and early log transport down waterways. These recommendations are primarily intended to mitigate negative effects on beneficial use by aquatic species. If widely implemented, they would also eventually reduce bank erosion and promote sediment storage in floodplains.

Excessive coarse sediment has been shown to reduce pool volumes, therefore reducing the quantity and quality of fish habitat. Coarse sediment load will likely remain high along the mainstem Little North Fork and North Fork Coeur d'Alene Rivers for at least several more decades due to the slow downstream movement of coarse sediment. Large Woody Debris (LWD) of sufficient size to form jams increases the depth and number of pools in pool-riffle channels with gradients less than 1%.

Although coarse sediment loads have declined in most streams, long reaches of the larger tributaries have smooth, featureless channels that lack pools and LWD (e.g., Steamboat and Shoshone Creeks). Streams with gradients in the 1 to 3% range tend to have plane-bed morphology (long, featureless riffles) in the absence of LWD, but will form pools if LWD is added.

Add Large Woody Debris (LWD). LWD placement should include trees with rootwads that are large enough to function as stable single logs or key members in jams. These key members will then rack up smaller LWD that floats in from upstream, in time forming new jams. LWD that piles up on bridge piers during floods could be redistributed in stream channels that lack functional wood. We noted that many Forest Service restoration projects in the watershed used small logs about the diameter of a telephone pole, without rootwads. In most cases these logs were too small to produce any beneficial effect on channel morphology. Log diameter and length should be selected based on bankfull channel dimensions and be large enough to remain in the channel reach being treated. LWD placement will be most feasible in smaller streams with good road access, or in conjunction with other sediment source control projects such as road removal.

Encourage the development of major riparian forests in areas upslope of the normal flood level that are currently vegetated with willows or grass. A system-wide increase in channel LWD levels will only occur once mature riparian forests have been reestablished. This has already occurred along many tributary creeks and upper reaches of the Little North Fork, but many lower reaches have grass or willow flats next to the stream. Channels vegetated with large trees are better able to resist bank erosion and have lower width:depth ratios, which improves shading and lowers water temperature. Care should be taken to ensure that planting areas are not within the annual or frequent flood zone, where trees may be torn out in high flows or be drowned.

Discourage clearing or bank armoring near channels by enforcing adequate riparian buffer zones. Bank armoring prevents channel migration and prevents establishment of forest on the banks. Channel migration stores sediment in the floodplain and recruits LWD into the channel. Prior to extensive road building and bank armoring, the lower North Fork had channel migration zones that recruited large cottonwoods and cedar trees. Narrow buffer zones increase the likelihood of riparian clearing and bank armoring to protect developed property.

9.4.2 Coeur d'Alene River tributaries in the Mining District

The following recommendations apply to the streams affected by mining. Note, the mining district effects are also addressed in a separate TMDL for metals. These recommendations are not intended to supersede any recommendations addressing metals which were developed in that TMDL.

- Pull back spoils piles along Prichard Creek enough to reestablish a floodplain, ideally at least 200 feet wide. Establishing a floodplain will reduce stream power and sediment transport rates. Relocate the creek away from the valley wall and the base of the spoils piles using barbs and revegetation.

- Move other creeks away from mining debris where possible. Armor banks where moving the creeks is not feasible.

- Shut down and remediate placer mining operations that cannot be isolated from tributary creeks.

- Plant riparian vegetation (and minimize livestock effect on riparian vegetation if applicable) along eroding reaches of lower Beaver Creek.

- Construct new channels through seasonally dry reaches of the mainstem creeks (Prichard, Eagle, and Beaver) that have completely filled in with coarse sediment. This should be undertaken only after the upstream sediment supply has been significantly reduced. An approach using riparian vegetation, LWD, and limited armoring to train the channel (for instance barbs directing the channel away from high, erodible banks) may prove both useful and cost-effective (Matthews and Kondolf, 1996).

- Remove road fill and repair road-related erosion in narrow tributary gulches.

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