RECLAMATION
Managing Water in the West

Pole Flat Area Baseline Condition Assessment Yankee Fork of the Salmon River, Upper Salmon Subbasin

Custer County, Idaho

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Pacific Northwest Regional Office, Boise, Idaho

October 2012

U.S. DEPARTMENT OF THE INTERIOR

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

MISSION OF THE BUREAU OF RECLAMATION

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Cover Photo: View to the north looking upstream along the Yankee Fork near confluence of Ramey Creek – Bureau of Reclamation

Date: September 2, 2010 Photo by: David Walsh

RECLAMATION
Managing Water in the West

Pole Flat Area Baseline Condition Assessment Yankee Fork of the Salmon River, Upper Salmon Subbasin

Custer County, Idaho

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Pacific Northwest Regional Office, Boise, Idaho

October 2012

This page intentionally left blank

Acronyms and Abbreviations

BiOp	Biological Opinion
cfs	cubic feet per second
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
GIS	geographic information system
HUC	hydrologic unit code
IDEQ	Idaho Department of Environmental Quality
LiDAR	light detection and ranging
mi^2	square miles
mi/mi^2	miles per square mile
NOAA Fisheries	NOAA's National Marine Fisheries Service
Reclamation	Bureau of Reclamation
REI	reach-scale ecosystem indicators
RM	river mile
RPA	Reasonable and Prudent Alternative
TMDL	total maximum daily load
Tribes	Shoshone-Bannock Tribes
Tributary Assessment	Yankee Fork of the Salmon River Tributary Assessment
TWA	total wetted area
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
West Fork	West Fork of the Yankee Fork Salmon River
Yankee Fork	Yankee Fork of the Salmon River

This page intentionally left blank

Table of Contents

List of Figures

List of Tables

ACKNOWLEDGEMENTS

We would like to thank members of the Yankee Fork Interdisciplinary Team for their input in the development of this Pole Flat Area Baseline Condition Assessment and acknowledge them for their comments and suggestions on the draft report.

We would also like to acknowledge U.S. Bureau of Reclamation personnel, Terril Stevenson, L.G., Team Leader for the Geomorphology Section of the River Systems Analysis Group whom was the peer reviewer and provided comments that helped further refine and clarify concepts presented in this report. Also, we would like to acknowledge Kristin Swoboda for her assistance in developing the geographic information system (GIS) database in support of this assessment. Finally, thanks to Kelly Vick, Natural Resources Technical Writer, for her thorough editorial work.

This page intentionally left blank

EXECUTIVE SUMMARY

The Yankee Fork of the Salmon River (Yankee Fork) is located in Custer County, Idaho, and is one of the major tributaries to the Salmon River. The Yankee Fork drainage area covers about 122,000 acres and the river flows south about 28 miles from its headwaters in the Salmon-Challis National Forest to the Salmon River near river mile (RM) 368 near Sunbeam, Idaho.

The purpose for this Pole Flat Area Baseline Condition Assessment (Baseline Assessment) is to (1) complete a geomorphic analysis of the mainstem Yankee Fork, (2) document physical features associated with created off main channel habitats, and (3) identify potential ways and locations to improve habitat-forming processes along the mainstem Yankee Fork.

The assessment area consists of a portion of the Yankee Fork from its confluence with the West Fork of the Yankee Fork (West Fork) (RM 6.8) to above its confluence with Polecamp Creek (RM 3.0). The two principal species of concern are (1) spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) that are part of the Snake River Evolutionary Significant Units and (2) summer steelhead (*Oncorhynchus mykiss*) that are part of the Snake River Basin Distinct Population Segment. Other fish species of interest are the Columbia River bull trout (*Salvelinus confluentus*) and Westslope cutthroat trout (*Oncorhynchus clarki lewisi*).

The primary limiting and causal factors for the listed species in the Yankee Fork within the assessment area are (1) habitat fragmentation and connectivity due to dredge tailings artificially constraining the channel and disconnecting historic floodplains, and (2) habitat quantity and quality due to mining activities that have confined the channel, removed the vegetation, and disconnected off-channel habitat.

Historically, the Yankee Fork flowed through an alluvial valley with a valley gradient of about 1.1 percent and depth to bedrock was relatively shallow throughout the valley segment. The Yankee Fork was moderately confined by glacial outwash, alluvial fans, bedrock, and colluvial deposits. The channel had a straight planform with a plane-bed and a low rate of lateral channel migration. Under existing conditions, the channel remains moderately confined with a similar planform and bedform. The primary difference between the historic and existing conditions is related to disconnected tributaries and channel/floodplain interactions as follows:

1. Cearly Creek, Silver Creek, and Jerrys Creek, as well as other small, unnamed tributaries are disconnected from the mainstem Yankee Fork by dredge tailings.
2. Channel confinement has increased by about 25 percent resulting in a similar loss in available floodplain area and associated increases in instream velocities and shear stresses during high-water events.

3. Dredge tailing mounds encroach on the channel causing flow constrictions in some locations.
4. Dredge tailing mounds block access to available floodplain patches and form topographic highs that fragment floodplain patches in some locations.

Additional off-channel habitat was created in the late 1980s to early 1990s through connecting four series of isolated dredge ponds within the assessment area to the Yankee Fork, referred to as Pond Series 1 through 4. When rehabilitation efforts were completed, the four pond series provided about 9,850 linear feet or 7.4 acres of additional off-channel habitat, though the majority of this additional area was still-water pond habitat. Information on existing baseline conditions was collected in 2011 and has been included in this report. The purpose of documenting the four pond series was to develop a baseline for monitoring purposes prior to sponsors adaptively managing these pond series to provide more beneficial habitat types.

Habitat fragmentation and connectivity are the two most significant impacts related to loss of physical and ecological processes. First, tributaries are disconnected by dredge tailings resulting in isolation of tributary habitats, and the loss of sediment (including wood) and nutrient inputs to the Yankee Fork that help drive habitat-forming processes. Secondly, the loss of available floodplain areas, albeit relatively a small percentage, does affect channel/floodplain interactions resulting in a reduction in the accessibility and connectivity of off-channel habitats, and an increase in flow velocities within the channel during high flows.

The objectives along the mainstem Yankee Fork are to improve habitat-forming processes, and the potential modifications needed to achieve those conditions include, but are not limited to the following:

- Reconnecting tributaries directly to the Yankee Fork, where possible, will increase sediment inputs and nutrients, and availability of additional habitats. Further analysis will be necessary to evaluate potential alternatives, objectives, and their limitations.
- Increasing dynamic channel/floodplain interactions by increasing the average floodplain patch size and connectivity, which will reduce and add variability to flow velocities, and improve nutrient cycling and sediment retention.
- Improving riparian vegetation conditions will increase channel boundary and floodplain roughness, provide shading and cover, and improve nutrient cycling.

Potential habitat actions to meet the objectives include the following:

- Removing and/or re-contouring dredge tailings on the valley floor to reconnect tributaries
- Removing and/or re-contouring sections of dredge tailings and embankments to an elevation accessible to the stream during less than 2- to 5-year flood events.

- Connecting existing small (less than 0.5 acres), fragmented active floodplain patches to create larger (0.8 to 1 acre), more continuous active floodplains.
- Planting appropriate vegetation in constructed floodplain and other cleared areas.

The expected channel response will primarily benefit juvenile salmonids through improving rearing habitats and high-water refugia by (1) increasing availability of high-flow refuge, (2) improving variability in flow velocities, and (3) improving channel/floodplain interactions during flood events.

The findings in this Baseline Assessment are intended to be used as only one of many tools to guide rehabilitation and habitat improvements on the Yankee Fork River. The habitat actions outlined in this report represent appropriate actions based on physical and ecological processes for these riverine systems, but are not an exhaustive assessment of all possible actions that can be used to achieve habitat benefits.

This page intentionally left blank

INTRODUCTION

The Bureau of Reclamation (Reclamation) and Bonneville Power Administration contribute to the implementation of salmonid habitat improvement projects in the Upper Salmon subbasin to help meet commitments contained in the *2010 Supplemental Federal Columbia River Power System* (FCRPS) *Biological Opinion* (BiOp) (NOAA Fisheries 2010). This Biological Opinion includes a Reasonable and Prudent Alternative (RPA), or a suite of actions, to protect salmon and steelhead listed under the Endangered Species Act (ESA) across their life cycle. Habitat improvement projects in various Columbia River tributaries are one aspect of this RPA. Reclamation's contributions to habitat improvement are all meant to be within the framework of the FCRPS RPA or related commitments. The assessment described in this document provides scientific information on geomorphology and physical processes that can be used to establish a baseline condition and help identify, prioritize, and implement sustainable fish habitat improvement projects and to help focus those projects on addressing key limiting factors to protect and improve survival of salmon and steelhead listed under the ESA.

Tributary and reach assessments are generally the first steps in a process aimed at focusing habitat improvement efforts toward the most beneficial actions in the most appropriate locations (Figure 1). This Pole Flat Area Baseline Condition Assessment (from here on referred to as the Baseline Assessment in this report) is a composite of a reach assessment along the mainstem of the Yankee Fork and a baseline condition document for the four pond series within the assessment area.

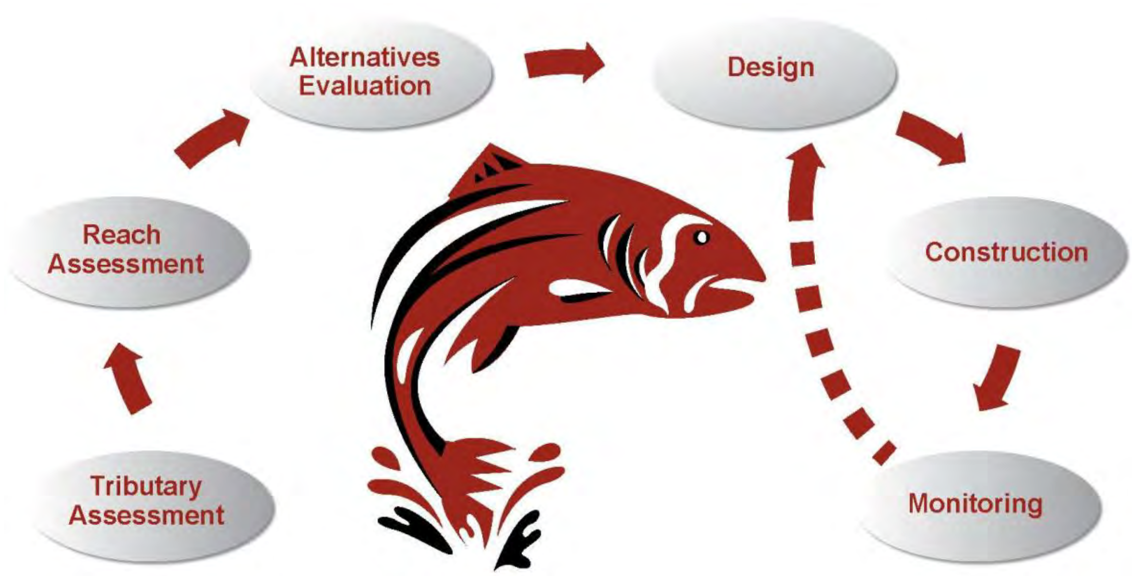


Figure 1. Flow chart illustrating typical steps in the approach to habitat improvement.

Along the mainstem Yankee Fork of the Salmon River (Yankee Fork), several project areas may be selected based on the assessment and feedback from local project partners and stakeholders. Each project area may undergo an Alternatives Development and Evaluation process to conceptually identify the project that best improves habitat while addressing local stakeholder needs. The preferred conceptual alternative is typically advanced through the design process. The final design incorporates feedback from several technical reviews provided by local and regional review teams and permitting agencies. With landowner approval and permits in place, the final design is advanced for construction. Following construction, Reclamation and other groups monitor the physical and biological performance of the project. Performance deficiencies may be remedied through adaptive management.

Purpose of this Baseline Assessment

This Baseline Assessment is a compilation report providing scientific information relevant to habitat rehabilitation actions along the mainstem Yankee Fork and coarse enough to support continuity between those actions. Additionally, this assessment documents baseline conditions along four pond series that had been modified to provide off-channel habitat for juvenile salmonids in the late 1980s, and are planned to be adaptively managed to improve and/or maintain the habitat in the coming years (2012 to 2016).

The purpose of the mainstem Yankee Fork type reach assessment approach is to assess and document reach-scale characteristics and how they have changed over time for the purpose of identifying suitable habitat rehabilitation actions that address the limiting and causal factors (discussed separately in the Limiting and Causal Factors section of this report). The completed assessment can be used to guide future habitat rehabilitation actions, ensuring that specific projects are developed and advanced in a manner suitable to the geomorphic character and trends prevalent throughout the reach. In this way, a reach-scale approach to sustainable habitat improvement can be facilitated.

Assessment Philosophy

This Baseline Assessment represents a reach-scale refinement of data and analyses presented in existing watershed-scale reports such as the *Yankee Fork of the Salmon River Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho* (Tributary Assessment) (Reclamation 2012). Information in the Baseline Assessment is not intended to duplicate previous efforts, rather it is intended to provide a summary of pertinent larger-scale background information and expand upon that information at the reach scale. The assessment area was delineated from the Tributary Assessment in which the Yankee Fork was divided into subwatersheds, and then into unique valley segments and channel reaches based on changes in geomorphic character along the length of the channel and its floodplain.

The Yankee Fork is a 5th field Hydrologic Unit Code (HUC) watershed (HUC 1706020105) and covers about 190.2 square miles (mi^2) (USFS 2006). Principal tributaries to the Yankee Fork are the West Fork of the Yankee Fork Salmon River (West Fork), Jordan Creek, Eightmile Creek, and McKay Creek. Smaller tributaries include Fourth of July Creek, Adair Creek, Slaughterhouse Creek, Fivemile Creek, and Ramey Creek.

Figure 2 shows the locations of the Yankee Fork subwatersheds that include:

- Upper Yankee Fork [6th field HUC 170602010501] that covers about 42.8 mi^2
- Middle Yankee Fork [6th field HUC 170602010502] that covers about 44.5 mi^2
- Jordan Creek [6th field HUC170602010503] that covers about 16.6 mi^2
- West Fork [6th field HUC 170602010504] that covers about 57.8 mi^2
- Lower Yankee Fork [6th field HUC 170602010505] area that covers about 28.5 mi^2

Within the Lower Yankee Fork subwatershed, the Tributary Assessment delineated three separate geomorphic reaches (YF-3 through YF-1 from upstream to downstream) along the Yankee Fork based on reach-scale changes in valley characteristics, channel slopes, and channel types. This Baseline Assessment focuses on Geomorphic Reach YF-2 which includes the portion of the Yankee Fork from the West Fork (river mile [RM] 6.8) to above Polecamp Creek (RM 3.0). This assessment area was identified in the Tributary Assessment as a priority area for habitat improvement and included a recommendation to collect and establish baseline conditions for monitoring purposes.

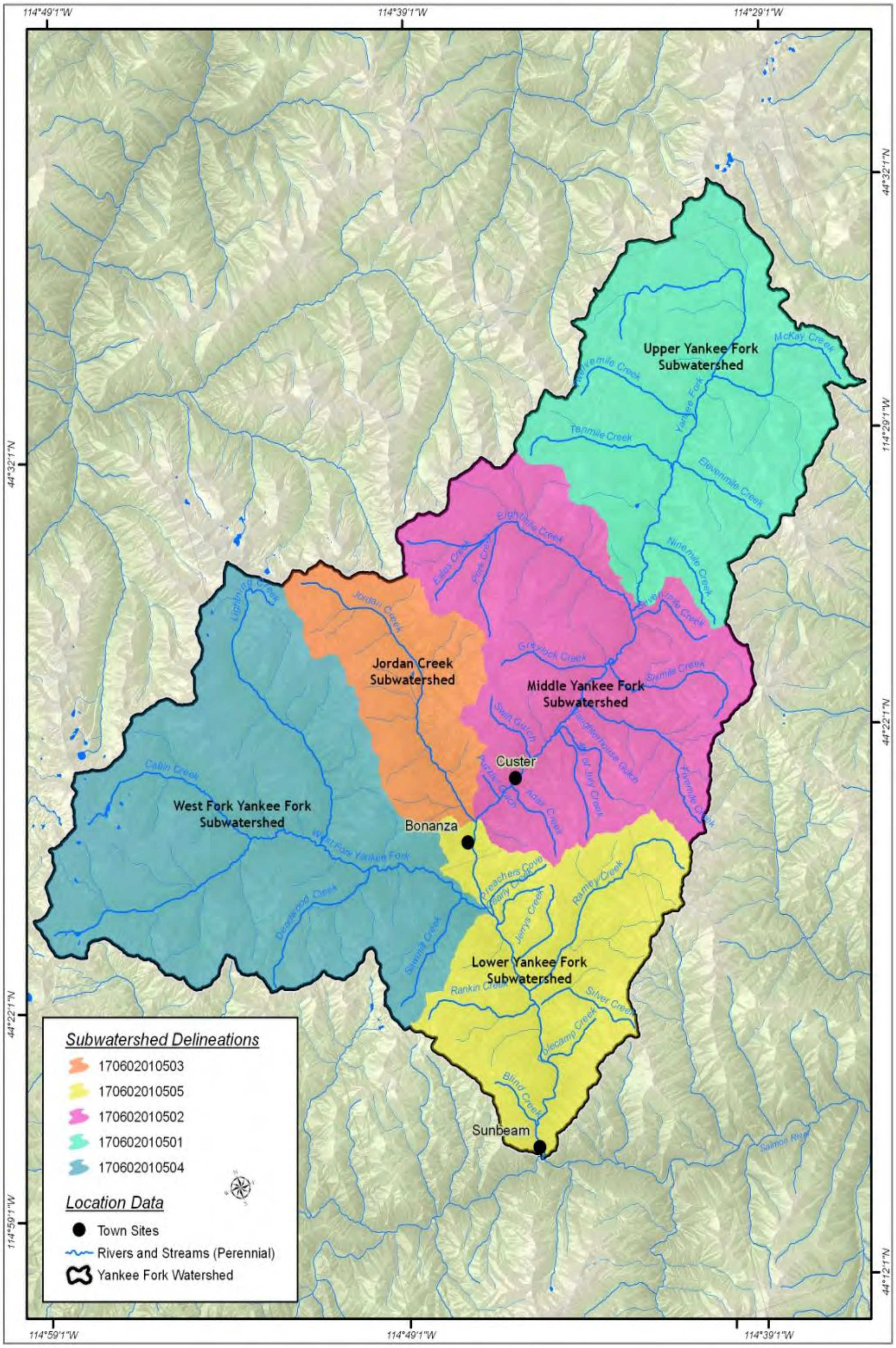


Figure 2. Yankee Fork subwatershed locations.

Assessment Goals

There are three primary goals for this Baseline Assessment:

1. Document past, existing (baseline), and potential target physical conditions along the mainstem Yankee Fork within the assessment area.
2. Document past and baseline conditions along the four pond series that will be adaptively managed in the future.
3. Identify objectives and potential rehabilitation actions along the mainstem Yankee Fork that should improve reach-scale habitat-forming processes, and increase the abundance and productivity potential for salmonids in this geomorphic reach.

Using this Document

This report is intended for the use of interdisciplinary scientists, engineers, and planners focusing on fish habitat improvement and rehabilitation. Conclusions from this Baseline Assessment are intended to guide future project development along the mainstem Yankee Fork and contribute to monitoring efforts of the four pond series.

The reach assessment approach used along the mainstem Yankee Fork should be a guide to habitat improvement actions directed toward options that are most geomorphically appropriate for the given channel reach, while providing a means to begin prioritizing a variety of actions based on potential benefit to habitat. This document should not be used exclusively as the basis for habitat design. Detailed, site-specific analyses should be conducted to identify the most appropriate suite of actions, refine conceptual plans, and develop detailed designs for implementation.

This Baseline Assessment was prepared by physical and biological scientists and engineers at Reclamation, with assistance and feedback from an interdisciplinary team of local and regional scientists familiar with the Yankee Fork. This document was prepared following a review of available background information, significant remote analysis using a Geographic Information System (GIS), and multiple site visits during high- and low-flow conditions. Focus was placed on reach-scale data since larger-scale data was already documented in the Tributary Assessment. Finer-scale project area specific data will likely be necessary for each implemented project to monitor the physical and biological responses.

Information documented in this report is focused around habitat-forming processes and physical changes occurring along the Yankee Fork and physical features occurring along the four pond series. Efforts to reestablish natural and appropriate physical and ecological conditions represent an improvement to habitat for these species.

Assessment Methods

At the reach scale, habitat-forming processes (or physical and ecological habitat dynamics) for surface water dominated systems are predominantly controlled by sediment, water, and wood inputs, which drive channel/floodplain interactions, riparian processes, and formation of habitat features (Beechie et al. 2010). To understand how the riverine ecosystem dynamics are functioning, riparian processes and channel/floodplain interactions were analyzed using a matrix of reach-scale ecosystem indicators (REI) and other physical and ecological parameters. At the reach-scale, the thresholds in the REI were derived primarily from the Matrix of Pathways and Indicators (NOAA Fisheries 1996) and Matrix of Diagnostics/Pathways and Indicators (USFWS 1998). The criteria and thresholds are for a "Desired Future Condition" for low-gradient, unconstrained valley floor reaches and are not absolute, and should be adjusted to each unique subbasin as data becomes available (USFS 1994). When the criteria or thresholds are not applicable based on the geomorphology of the stream, a justification for the condition status is given in a narrative section.

The Pole Flat Area Baseline Assessment REI is provided in Appendix A of this report. The objectives of the REI analysis were to help identify root causes of degradation and the driving habitat-forming processes that create and maintain physical and ecological conditions. Several of the condition rating thresholds are not applicable to this Yankee Fork channel reach because they were developed for an unconfined, meandering channel system, and not for a moderately confined, straight channel system. However, the listed indicators and pathways are useful in evaluating habitat-forming processes. For example, vegetation composition and structure on the floodplain influences the delivery of wood to the channel, bank reinforcement, nutrient cycling, and thermal regimes. In addition, an appropriately functioning floodplain influences water quality, hyporheic interactions, and terrestrial connectivity.

The Baseline Assessment analysis is provided in Appendix B of this report. It generally includes hierarchically nested subdivisions of the watershed, valley segments, channel reaches, and bedforms, falling in size between landscapes and watersheds, and individual point measurements made along the stream network (Frissell et al. 1986). Within the hierarchy of spatial scales, these subdivisions represent the largest physical parameters that can be directly altered by human activities (Bisson, Buffington, and Montgomery 2006). In addition, photographic documentation (Appendix C), and available GIS data used in the analysis are provided in Appendix D.

Background Information

The Yankee Fork is located in Custer County, Idaho, and is one of the major tributaries to the Salmon River. The Yankee Fork drainage area covers about 122,000 acres and the river flows south about 28 miles from its headwaters in the Salmon-Challis National Forest to the Salmon River near RM 368 near Sunbeam, Idaho.

The assessment area consists of a portion of the Yankee Fork from its confluence with the West Fork (RM 6.8) to just above the confluence with Polecamp Creek (RM 3) (Figure 3). The two principal species of concern are (1) spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) that are part of the Snake River Evolutionary Significant Units, and (2) summer steelhead (*Oncorhynchus mykiss*) that are part of the Snake River Basin Distinct Population Segment. Other fish species of interest are the Columbia River bull trout (*Salvelinus confluentus*) and Westslope cutthroat trout (*Oncorhynchus clarki lewisi*).

Physical and ecological processes have been negatively impacted by gold dredging operations along the Yankee Fork in the assessment area. The channel is naturally (geologically) constrained within a moderately confined valley segment, but most of the channel has been anthropogenically constrained further by dredge tailings.

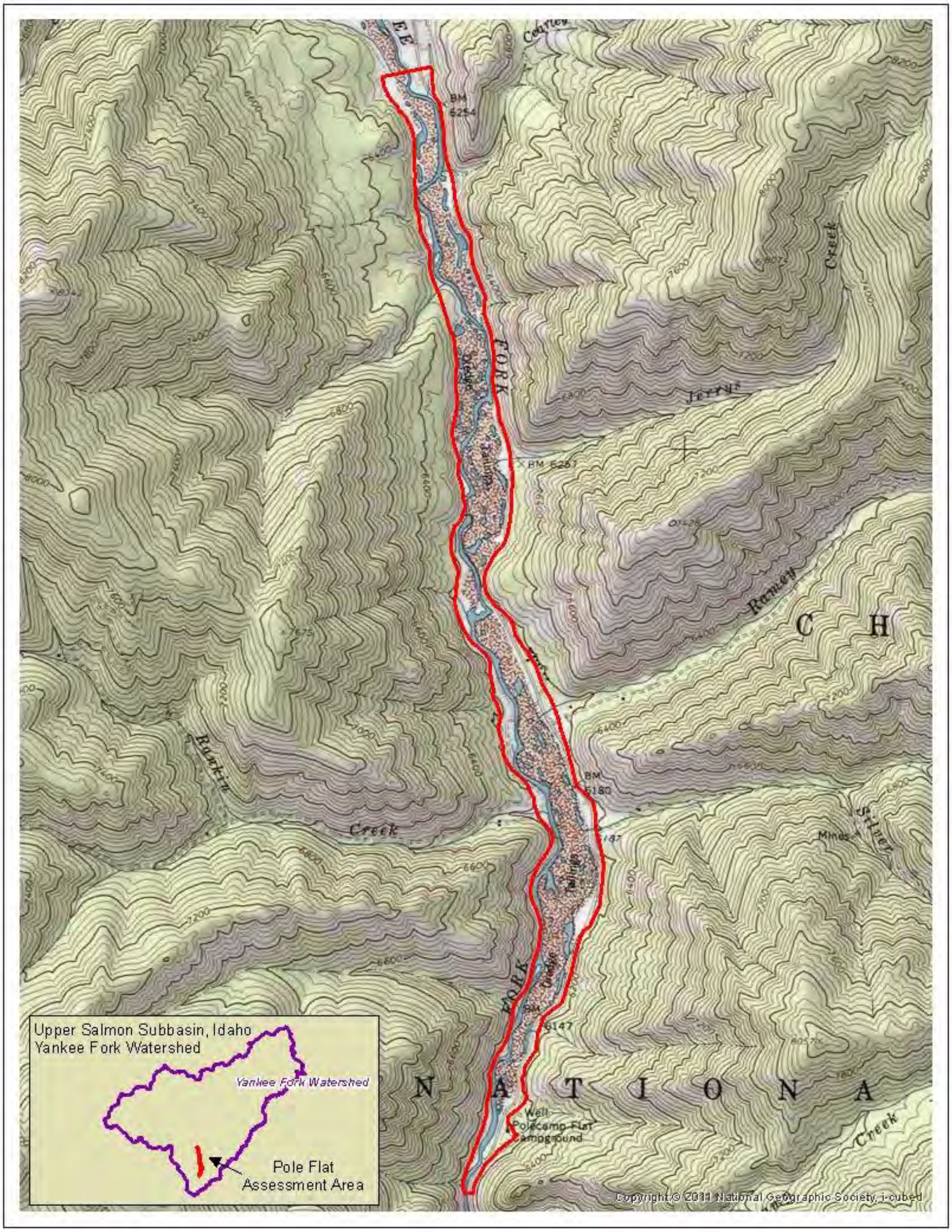


Figure 3. Pole Flat Area Baseline Assessment location.

Limiting and Causal Factors

Limiting factors are defined as those conditions or circumstances which limit the successful growth, reproduction, and/or survival of select species of concern. This report focuses primarily on physical conditions for spring/summer Chinook salmon and summer steelhead. Reach-scale limiting and causal factors identified in the Tributary Assessment are summarized in Table 1 in the order of most limiting to least limiting factors.

Existing water quality does not negatively impact the fish species of concern (IDEQ 2011; SBT 2011; Reclamation 2012), but past and ongoing mining activities have impacted the system a great deal. These impacts have been most prominent in habitat disturbance and connectivity. Sediment surveys have shown that while there are areas of concern, generally there is a low risk associated from chemical contamination.

Table 1. Summary table of reach-scale limiting and casual factors.

Limiting Factors	Causal Factors
Habitat fragmentation and connectivity	Relocated channels through the dredge tailings have resulted in a simplified channel configuration that confines flows within the channel and between dredge tailings with little or no channel/floodplain interactions. Historic floodplain areas along the Yankee Fork have been disconnected by dredge tailings. While these floodplain areas were relatively small in area and not continuous, they provided important high-water refugia and rearing habitat for juveniles during biologically significant flows. Additionally, dredge tailings have disconnected (isolated) Cearly Creek, Silver Creek, and Jerrys Creek as well as other small, unnamed tributaries from the Yankee Fork.
Habitat quantity and quality	Placer mining (i.e., dredging) has altered the fluvial processes that create and maintain complex habitat units. The mining activities have resulted in the removal of riparian vegetation and relocation of the channel through dredge tailings. Significant impact areas are the dredge tailings from the West Fork to Pole Flat Campground along the Yankee Fork.

Summary of Existing Reports

Sections of the Lower Yankee Fork subwatershed have been the subject of many reports and analyses that suggested the river has been severely impacted by anthropogenic alterations, resulting in the degradation of fish habitat. This Baseline Assessment will show that humans have impacted geomorphic processes in the Lower Yankee Fork subwatershed. Particularly, the impact from past gold dredging along the Yankee Fork between the West Fork and Pole Flat that resulted in channel alterations and the loss of floodplains.

Pertinent reach-scale information has been extracted from past work and used in this Baseline Assessment. Specific broad-scale background information from existing reports and analyses has been summarized to help develop a better perspective regarding the reach-scale information to follow.

Regional Setting

The Yankee Fork watershed is within the Northern Rocky Mountains physiographic province which is characterized by a rugged, mountainous landscape that has been dissected by fluvial and glacial erosion (Fenneman 1931). Many of the taller peaks and higher elevation drainages were glaciated during the Pleistocene Epoch (Borgert, Lundeen, and Thackray 1999; Evenson, Cotter, and Cinch 1982).

Ecoregion classifications are (1) the Challis Volcanic section of the Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province (Bailey's classification), and (2) the Idaho batholith (Omernik's classification). Vegetation compositions are generally Grand fir and Douglas-fir, and at higher elevations Engelmann spruce and subalpine fir occurs. Lodgepole pine, Ponderosa pine, shrubs, and grasses grow in deep canyons (www.nationalatlas.gov).

Climate is influenced by orographic uplift that occurs when air is forced to rise and cool due to mountainous terrain. The average annual precipitation locally exceeds 60 inches in the upper areas but decreases to 15 inches in "rain shadow" canyon bottoms. Snowfall is the dominant form of precipitation during the winter months (Reclamation 2012). Climate projections are that average mean-annual temperature will increase and that the mean-annual precipitation will not change significantly through the 21^{st} Century. It is notable that the northern and higher elevations may experience net increases in snowpack, reflecting a general trend toward increasing total precipitation with the projected warming (Reclamation 2011).

Bedrock geology consists primarily of Tertiary volcanic and plutonic rocks, Cretaceous intrusive rocks, and Paleozoic and Precambrian sedimentary and metamorphic rocks (USGS 1995; Link and Janecke 1999). Many, if not all, of these rocks have been displaced by the northeast trending Trans-Challis fault system that cuts across Central Idaho and has had a controlling effect on the location of volcanic vents, dikes, faults, and zones of mineralization (McIntyre, Ekren, Hardyman 1982; Kiilsgaard, Fisher, and Bennett 1986; Janecke 1992). Known active faults are associated with north-northwest to northwest trending Basin-and-Range type normal faults that have been grouped together as the Central Idaho Seismic Zone. Some earthquakes have produced strong ground motions (or shaking) that have triggered landslides and debris flows in the past (IBHS 2009).

Yankee Fork Watershed Physical Characteristics and Condition

The Yankee Fork watershed has a dendritic drainage pattern, draining about 190 mi^2, and has a drainage density of about 2.71 miles per square mile (mi/mi^2) which is a measure of the amount of stream network necessary to drain the basin. There is an estimated 223.6 miles of perennial streams and 291.3 miles of ephemeral streams within the basin (USFS 2006). Basin relief is about 4,407 feet with a maximum elevation of about 10,329 feet at The General peak and a minimum elevation of about 5,922 feet at the confluence with the Salmon River.

Hydrology is influenced by the accumulation and subsequent melting of snow in the upper watershed. Average annual air temperature generally ranges from -50^{o} F to 95^{o} F and freezing temperatures can occur throughout the year. Most precipitation comes in the form of snow in late fall to early spring, resulting in a hydrologic regime dominated by late spring and early summer snowmelt. Peak discharge is dominated by surface runoff, especially during rain-on-snow events. High intensity thunderstorms can occur during the spring and summer months. There are no large dams in the watershed that can influence the flow and sediment regimes.

Watershed conditions were analyzed in the Tributary Assessment using NOAA Fisheries' (1996) matrix of pathways and indicators which describes the functional condition pertaining to watershed-scale components. The matrix provides guidance on thresholds that should be considered, and refined for the individual watersheds, to assess the condition ratings as properly functioning, at risk, or not properly functioning. Watershed conditions are applicable for most, if not all, riverine systems and are used to evaluate cause and effects of disturbances throughout the drainage area. The most significant impacts in the Yankee Fork watershed that affect physical and ecological processes were found to be from mining activities, particularly in the Lower Yankee Fork and Jordan Creek subwatersheds (Table 2).

Table 2. Watershed condition summary.

Watershed Pathway or Indicator	Condition Rating	Comments
Road density and location	At risk	The watershed appears to have a low road density (less than 2 mi/mi^2); but these calculations do not include mining access roads or all-terrain vehicle trails. There are several roads located on the valley bottoms and adjacent to waterways that encroach on channels and floodplains, redirect or impound overland flows, and provide fine sediment inputs through dust drift along the channel network.
Anthropogenic disturbance history	At risk	Mining activities primarily in the Lower Yankee Fork and Jordan Creek subwatersheds have negatively impacted riverine processes through ground disturbances (i.e., dredging, hydraulic mining, and open-pit mines) that redirect drainage networks, through surface and groundwater contamination (i.e., cyanide and mercury), and through past timber harvests to fuel the mills (i.e., loss of mature trees).
Riparian reserves	At risk	Riparian reserves are at or near natural levels throughout most of the watershed. The exceptions are in the dredged reaches in the Lower Yankee Fork and Jordan Creek subwatersheds
Water quality and quantity	Water quality – at risk Water quantity – properly functioning	There remains a threat to water quality and aquatic species due to potential chemical contaminants (i.e., cyanide, mercury, and selenium) associated with past and present mining activities
Main Channel Physical Barriers (mainstem Yankee Fork)	Properly functioning	There are no man-made fish passage barriers along the mainstem Yankee Fork preventing fish migration into the watershed.

Yankee Fork Salmon and Steelhead Usage

Spring/summer Chinook salmon adults enter and ascend the Columbia River between March and July and reach the Upper Salmon River (about 850 miles upriver) in late July and August. Adult fish hold in deep pools within the main Salmon River and then move into tributary streams including the Yankee Fork in late July and August to begin spawning (USFS 2006). Spawning occurs in August and September, and the eggs remain in the gravel with winter and early spring water temperatures determining the actual time of emergence which typically occurs by mid-March to late April (USFS 2006). Young salmon emerge from redds in the spring and will rear in a variety of environments. Within the first month of emergence (or release, if planted) the fish generally remain within a localized area from the point of emergence (or release) to roughly 0.5 to 1.0 mile downstream (Richards and Cernera 1989). Juveniles will migrate from the Yankee Fork watershed to the Salmon River during fall and throughout the winter (Reiser and Ramey 1987), but the highest migration may be as young-of-the-year (age 0) and is done before spring (Gregory 2012). Juveniles spend about one year in freshwater before smolting and migrating to the Pacific Ocean between April and June (Reiser and Ramey 1987). The Yankee Fork salmon typically spend 1 to 3 years in the ocean before returning based on Shoshone-Bannock Tribes (Tribes) counts of returning fish (Gregory and Wood 2012).

Steelhead adult migration requirements are generally similar to those described for Chinook salmon. Steelhead enter and ascend the Columbia River in June and July, arriving near their spawning grounds several months prior to spawning (USFS 2006). However, adult holding takes place over a much longer period (from fall arrival in the Snake River drainage until spring spawning). Most adult steelhead have moved into tributary streams like the Yankee Fork by November. However, some adults hold in the Salmon River until February or March before moving into natal streams to spawn. Unlike Chinook salmon that return from the ocean to spawn and subsequently die, steelhead have the ability to migrate back to the ocean after spawning (kelting) and to return and spawn again. Juvenile rearing lasts up to about 3 years prior to ocean emigration (Rowe et al. 1989; NOAA Fisheries 2011).

Supplementation and habitat programs have been implemented in the Yankee Fork watershed by the Tribes in response to declining populations of Chinook salmon and steelhead. Their interest is to increase the viability and production of these species, increase harvest potential for members of the Tribes, increase knowledge of fishery management techniques, and facilitate adaptive management.

Chinook Salmon Fish Density

Summer densities of juvenile spring Chinook salmon were estimated by snorkeling riffle-pool sites between 1984 and 2008 (Tsosie, Bacon, and Wadsworth 2009). Mean density (number of fish/100 square meters) by sampling stratum was estimated by averaging the density of fish at each of the six sites per stratum. This information was then summarized on a subwatershed basis. Based on the average fish density per 100 square meters shown in Figure 4, the Yankee Fork stock of naturally-producing spring Chinook salmon is severely depressed and well below the estimated carrying capacity of 425,000 smolts (Reclamation 2012).

Figure 4 also shows that the Middle Yankee Fork subwatershed had the highest fish densities for juvenile Chinook salmon followed by the West Fork and Lower Yankee Fork subwatersheds. The Lower Yankee Fork subwatershed had nearly three times lower fish densities than the Middle Yankee Fork subwatershed. Based on the geomorphological conditions of the Lower Yankee Fork watershed, it is expected that densities would be lower there; however, the numbers appear to be much lower and likely are at least partially due to the anthropogenic impacts described in this report.

Annual spawning ground surveys (and recent low number of redds) conducted by the Idaho Department of Fish and Game and the Tribes for spring Chinook salmon in the Yankee Fork drainage reflect depressed juvenile Chinook salmon numbers. The Middle Yankee Fork subwatershed had the highest redd counts in the watershed followed by the West Fork. Survey data indicate that the Yankee Fork redd counts have ranged from 615 redds in 1968 to zero redds in 1995 (Figure 5), and that similar continuing declines of redds throughout the rest of the Salmon River drainage have been documented from 1968 through 2007.

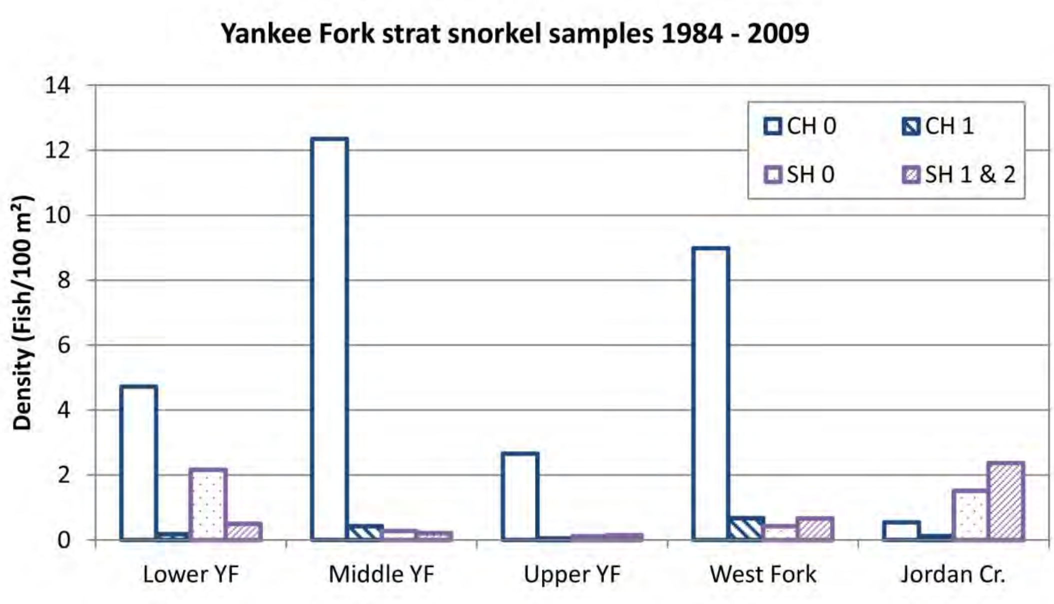


Figure 4. Yankee Fork stratified ("strat") snorkel survey samples from 1984 to 2009 by subwatershed based on data collected by the Tribes. *Chinook age classes: CH 0 = young of the year and CH 1 = one year old. Steelhead age classes: SH 0 = young of the year and SH 1 & 2 = one to two years old.*

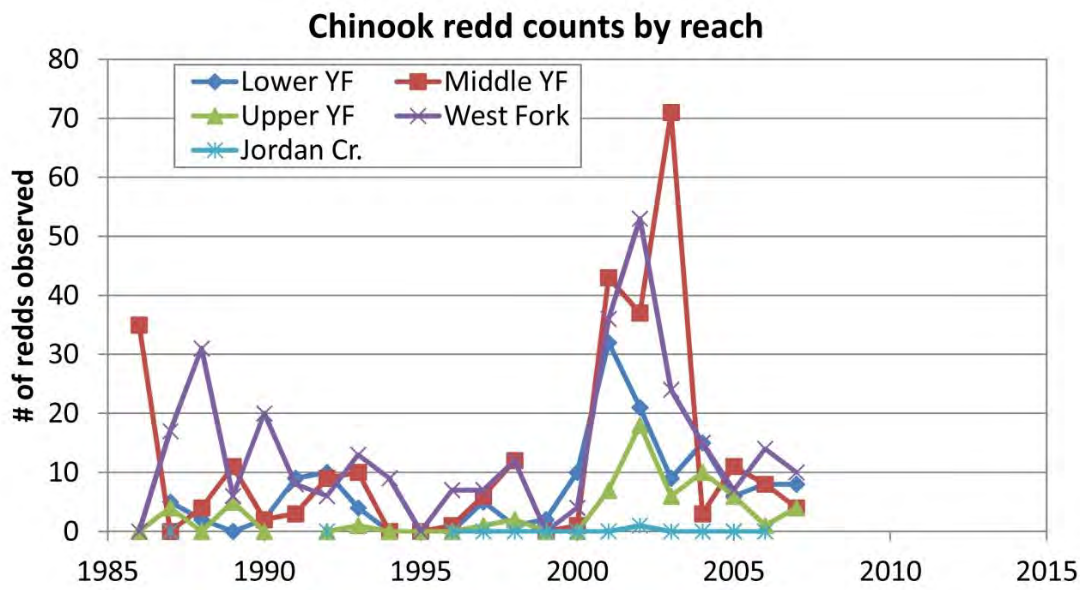


Figure 5. Yankee Fork redd counts by subwatershed based on data collected by the Tribes.

Lower Yankee Fork Subwatershed

The Lower Yankee Fork drainage area is about 29 mi^2 and the drainage density is about 1.45 mi/mi^2. Bedrock geology consists predominantly of the Challis Volcanics with the following exceptions: (1) Precambrian to Paleozoic metamorphic rocks from about the West Fork downstream to about Silver Creek along the east valley wall, (2) Cretaceous Idaho batholith igneous rocks from about Cearly Creek to downstream to about Silver Creek along the west valley wall, and (3) Idaho batholith rocks that crop out along both valley walls from downstream of Silver Creek to the Yankee Fork and Salmon River confluence. The Yankee Fork valley segment generally has a north-south orientation except for the lower 3-mile section where it trends north-northeast.

Anthropogenic disturbances that have significantly impaired riverine processes are primarily from mining activities. Prior to 1952, the mining practice of dredging left about 7.2 miles of unconsolidated and unvegetated dredge tailings along the Yankee Fork and Jordan Creek valley floors. These tailings are located along the Yankee Fork valley bottom for about 5.8 miles and along the Jordan Creek valley bottom for about 1.4 miles. Dredge tailing mounds have disconnected tributaries and floodplains, and have altered channel processes and channel form. Impacts to habitat include the isolation of perennial drainages, loss of rearing habitat and high water refugia, altered instream velocities, and loss of instream habitat diversity.

Efforts by the Tribes, funded by the Bonneville Power Administration, have replaced a portion of the lost rearing habitat by interconnecting four series of off-channel dredge/settling ponds and then connecting them to the Yankee Fork. This work also included riparian vegetation plantings along the perimeter of these projects. The projects were completed between 1987 and 1989, and provided effective rearing habitat to hatchery out-planted and naturally produced juvenile Chinook salmon and steelhead (USFS 2006). The design life of 20 years for these projects has been exceeded, and each of these projects should be re-evaluated through an adaptive management process. As part of the adaptive management process, consideration should be given to increasing the available channel-type habitats and improving fish cover that were found to be the preferred habitat for juvenile fish utilizing these pond series (Richards et al. 1992). More details of the Lower Yankee Fork subwatershed area are available in the Tributary Assessment (Reclamation 2012).

HISTORICAL TIMELINE

Prior to Euro-American entry and settlement in the Yankee Fork watershed in the 1800s, the Shoshone and Bannock peoples resided in the Salmon River area and specifically hunted for fish, wildlife, and plants for subsistence. One historical reference identified that the Bannock people utilized a camp near the mouth of Ramey Creek, a tributary to the Yankee Fork near RM 4.6. After Euro-American settlement of the area, recorded historical events and activities occurring in the Yankee Fork watershed impacted physical and ecological processes. Some significant historical events are summarized in Table 3. A more detailed historical timeline of the area is available in Appendices D and E of the Tributary Assessment (Reclamation 2012).

Table 3. Significant historical events impacting the Lower Yankee Fork subwatershed.

Year or Period	Significant Historical Event
1870s – early 1900s	Placer gold deposits found along Jordan Creek down to the Yankee Fork confluence which were mined using drag-line dredges and hydraulic monitors (cannons).
1875	First significant gold bearing quartz vein was found in Jordan Creek drainage which began the development of hard-rock mines in the area.
1877	Bonanza townsite built along the Yankee Fork upstream of West Fork/Yankee Fork confluence to serve the Charles Dickens Mine in the Jordan Creek drainage and other mines operating in the district.

Year or Period	Significant Historical Event
1879 - 1892	Custer townsite built (1879) to serve the General Custer Mine and Mill located along the Yankee Fork upstream of Jordan Creek/Yankee Fork confluence. The mill operated from 1881 to 1892, and gold recovery was by amalgamation and chlorination processing (USGS 2009). Waste from the milling process appears to have had a significant impact on salmonids based on a report from the Yankee Fork Herald (February 19, 1881), "the water in the Yankee Fork is of a deep red since the starting up of the Custer mill. No more fish need be looked for in that stream. Lovers of salmon will be compelled to go without their luxury or have them shipped in future". Custer Mill operated from 1881 to 1892, and required over 300 cords of wood logged from the surrounding watershed per month to fuel the steam engines (LOYF Historical Association 2005).
Late 1800s to Early 1900s	Hydraulic mining techniques were used in several tributary drainages to the Yankee Fork including Adair Creek, Jordan Creek, and mouth of the West Fork.
1906 -1911	Golden Sunbeam Mining Company developed the Golden Sunbeam Group mining claims about four miles up Jordan Creek. Sunbeam Hydroelectric Dam was constructed on the Salmon River above its confluence with the Yankee Fork to provide power to the Golden Sunbeam Mining Company. Entire Sunbeam enterprise including mine, mill, and dam abandoned in 1911.
By 1916	Most of the lumber used in building Custer and Bonanza was cut in Lavalle Creek (now Sawmill Creek), which enters West Fork near Bonanza. The 1916 Intensive land Classification for the Challis National Forest says that along the Yankee Fork, "most of the good timber was taken out years ago for mining use and for cordwood" (USFS 2006).
1933 or 1934	Sunbeam Dam was breached by the Idaho State Game Department, presumably to improve upstream fish passage on the Salmon River.
1940 - 1952	Yankee Fork Gold Dredge operated along the valley bottom of the Yankee Fork from about Pole Flat Campground to Jordan Creek confluence (Figure 6).
1980 - 2004	U.S. Antimony Corporation's subsidiary Yankee Fork Silver and Gold Company began processing dump material from Charles Dickens mine and mines on Estes Mountain using a vat leach cyanide mill at Preachers Cove in 1980 (Figure 7). There were some environmental problems at the mill site associated with soil and groundwater contamination from cyanide spills and heavy metals leaching from tailing ponds. Presumably, by the end of 1993, over 90 percent of the chemicals had been neutralized (Mitchell 1997). In 1995, the U.S. Forest Service (USFS) discovered a cyanide leak at the processing facility. Approximately 20,000 gallons of cyanide solution from the tailing ponds leached into the ground about 650 feet from the Yankee Fork (High Country News, August 21, 1995). No documented fish kill was associated with this release.

Year or Period	Significant Historical Event
1993 - 2012	The following is a summary of activities associated with the Grouse Creek Mine based on the *Removal Action Memorandum, Grouse Creek Mine Tailings Impoundment Closure*, initiated by the USFS in 1998. Construction of the Grouse Creek Mine in the Jordan Creek drainage by Hecla Mining Company (Hecla) began in 1993, and actual mining operations were from 1994 to 1997. The mine was a 536 acre open-pit mine and gold recovery used a carbon-in-pulp cyanide vat leach process which included a 105 acre tailings impoundment (Figure 8). In 1997, Hecla suspended mining operations due to unfavorable economic conditions. Beginning in 1997, water monitoring sites detected weak acid dissociable (WAD) cyanide off-site, instream and downstream of the mine. In 1999, a USFS Technical Team concluded that cyanide was from the tailings impoundment. In October of 2000, Hecla entered into an Administrative Order on Consent (AOC), under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), for a Time-Critical Removal Action with the USFS and the Environmental Protection Agency (EPA). In 2003, Hecla under an Action Memorandum was allowed to discharge treated and untreated tailings impoundment water to the Yankee Fork via a pipe to Outfall 003 (Lat. 44° 23' 01": Long. 114° 43' 22"; downstream of the Yankee Fork/Jordan Creek confluence). No impacts to aquatic life in Jordan Creek were noted in the *Removal Action Memorandum*. Presently, Hecla has reclaimed about 80 percent and the final reclamation of the site with completion of the tailings impoundment closure is planned to be completed in 2012 **(http://www.hecla-mining.com/resposibility/resposibility_stewardship_reclamation.php)**.

Figure 6. Yankee Fork Gold Dredge working between Jerrys Creek and Rankin Creek in 1945.

Figure 7. U.S. Antimony Corporation's vat leach cyanide mill at Preachers Cove in 1991.

Figure 8. Grouse Creek Mine that was operated by Hecla Mining along Jordan Creek in 2009.

HISTORIC AND EXISTING CONDITIONS COMPARISON

In mountain drainage basins, valley segments define portions of the drainage network exhibiting similar valley-scale morphologies and governing geomorphic processes (Montgomery and Buffington 1998). Valley form and channel form are closely related, and together can provide clues about how the system historically functioned, such as stream gradient, expected habitat unit types and characteristics, and the relationship of the stream to the riparian zone (ODFW 2010).

For this report, the historical conditions are defined as the relatively unaltered or natural conditions representative of the assessment area prior to large-scale anthropogenic influences (i.e., Euro-American settlement). The existing conditions are the resultant processes following anthropogenic disturbances that currently shape the assessment area. Although it is not necessarily the goal of habitat improvement to restore historical conditions, it is those historical conditions in which the species of concern have evolved and will likely thrive in the future. As such, the historical conditions and the physical and ecological processes that created them can be used as a guide for developing the target conditions that can improve habitat-forming processes for the reach.

Valley segments, channel reaches, and bedforms are hierarchically nested subdivisions of the drainage network (similar to those proposed by Frissell et al. 1986) used in this report to document physical and ecological changes, and interpret how habitat-forming processes have changed through time. A conscious effort was made to use published methodologies in the analysis. However, some methodologies, particularly geomorphic measurements, were modified in order to capture temporal changes to the habitat-forming processes. Significant modifications to how geomorphic measurements were conducted are as follows:

1. Typically valley bottom width measurements are conducted between side slopes of the surrounding hills or mountains (USFS 2010) or between constraining terraces (ODFW 2010). In this report, the valley bottom width measurements are conducted between geologic constraints (i.e. alluvial fans, bedrock, etc.) or geomorphic constraints (i.e. dredge tailing mounds, levees, etc.) that physically restrict the stream's ability to migrate laterally across the valley bottom, and are referred to as the constrained valley bottom width.

2. Valley length measurements are typically conducted along the midpoints between the geologic valley constraints, and are used to calculate valley gradient and channel sinuosity. This report uses a similar method, but also includes the geomorphic constraints in order to improve valley gradient and channel sinuosity estimates, and are referred to as the constrained valley length.

3. Bankfull width or active channel width are measured in the field based on the width of active channel scour (USFS 2010; ODFW 2010). Historic field measurements of this type are rare and unattainable from aerial photography. Unvegetated channel width is used in this report as a surrogate because it should represent that portion of the channel that is inundated and frequently disturbed at times of high discharge when sediment transport or scour is initiated (Montgomery and MacDonald 2002; Rapp and Abbe 2003). The unvegetated channel width can be identified and measured from aerial photographs for analysis.

4. Channel confinement in this report is the ratio between the average constrained valley bottom width and the average unvegetated channel width. The degree of channel confinement adapted from Bisson and Montgomery (1996) is classified in this report as confined (less than 2:1), moderately confined (2:1 to 4:1), and unconfined (greater than 4:1).

5. Side channels can be categorized as secondary channels that are typically activated during channel forming flows and tertiary channels that generally take discharges higher than a channel forming flow to activate (Rapp and Abbe 2003). Secondary channels can be further described as (1) split-flow channels where the character of the mainstem and side channel are essentially the same, or (2) floodplain side channels where a relatively small side channel has formed in the low-lying active floodplain. Tertiary channels can be further described as overflow channels which are also important because some are groundwater fed and provide cooler water to the stream.

Historical Conditions

The Yankee Fork valley segment described in the following sections was shaped by alpine glaciers that carved a U-shaped trough during the Pleistocene Epoch between roughly 2.5 million and 10,000 years ago. At least two valley glaciers have occupied these valley segments based on the older, higher glacial terraces and the younger, inset glacial outwash plain. When these valley glaciers retreated they released large volumes of sediment and high discharges that combined to fill the valley with coarse- to fine-grained alluvial deposits. Along the valley margins, alluvial fans have been built-up through accumulated debris flows that overlay the glacial outwash deposits in many places.

Following the Pleistocene Epoch punctuated by multiple glacial periods, the climate in the Yankee Fork valley became warmer and drier during the Holocene Epoch (about 10,000 years ago to present). The glaciers essentially disappeared in the Yankee Fork watershed, and both discharge and sediment yield significantly decreased. The Yankee Fork became an “underfit” alluvial stream, defined as a relatively small stream flowing through a valley formed by and over sediment deposited from a much larger river.

The Yankee Fork flowed through an alluvial valley with a valley gradient of about 1.1 percent and the depth to bedrock was relatively shallow, on the order of tens of feet, throughout the valley segment. The valley and channel metrics provided in Table 4 are based on analysis of the 1945 aerial photographs that covered the assessment area from near the present-day West Fork confluence (2010 – RM 7) to about the Jerrys Creek confluence (2010 – RM 5.3). From about Jerrys Creek to Polecamp Creek (2010 – RM 3), the valley bottom had already been dredged by the time the 1945 aerial photographs were taken. Therefore, the valley and channel were qualitatively analyzed based on the 1934 Bureau of Fisheries stream survey (USFB 1934) and surficial geology. This area contained one distinct channel reach, a moderately confined channel between the West Fork and Pole Flat Campground.

Table 4. Valley and channel metrics.

Location	Year	Average Valley Length	Average Valley Width	Average Unvegetated Channel Width	Average Channel Confinement
West Fork to Pole Flat Campground	1945	7,550 feet	250 feet	75 feet	Moderately Confined (3.3)

The valley bottom was geologically constrained by glacial outwash, alluvial fans, bedrock, and colluvial deposits. These geologic deposits physically restricted the stream's ability to migrate laterally, resulting in a moderately confined channel (constrained valley bottom width ranged between 2 to 4 unvegetated channel widths). Channel planform observed in the 1908 survey photograph (Figure 9) shows a straight (defined as sinuosity less than 1.5), free-formed alluvial channel near Silver Creek, which indicates there was a relatively low rate of lateral channel migration and channel/floodplain dynamics occurring (Beechie et al. 2006). Bedform patterns indicate a predominantly plane-bed channel with little bedform diversity. This observation was further supported by the 1934 Bureau of Fisheries stream survey (USFB 1934), which documented that 90 percent of the bedforms were riffles with gravel to boulder substrate. Few pools would be expected along the plane-bed channel because of uniform velocity and depth, and higher sediment transport capacity that can develop an armor layer. The armor layer can preclude pool development (scour) when flows cannot mobilize the armoring particles, or in the absence of significant flow convergence (Montgomery and Buffington 1997).

Figure 9. View to the north looking upstream along the Yankee Fork near Silver Creek (Mineral Survey No. 2405 – Iowa Group – Yankee Fork Placer Co., Limited 1908).

The vegetation composition within the watershed varied primarily by elevation and aspect. Lower elevation, south-facing slopes supported patches of big sagebrush and forested habitats of the Douglas-fir series (USFS 1995). Vegetation most likely consisted of forested hillslopes, of the Douglas-fir series, with diverse shrub and grass riparian vegetation along stream channels and floodplains (Overton, Radko, and Woolrab 1999).

Historically, there would have been more floodplain connectivity relative to the existing conditions with an average patch size of about 1 acre, based on an analysis of the 1945 aerial photographs from near the Yankee Fork and West Fork confluence (2010 – RM 7) to about Jerrys Creek (2010 – RM 5.3). Between Jerrys Creek and Pole Flat Campground (2010 – RM 3.3), the valley bottom had already been dredged by the time the 1945 aerial photographs were taken.

Off-channel habitats were comprised of secondary floodplain and split-flow type side channels, and tertiary (or overflow) channels that would have been available during floods, though this channel type would not support a large amount of off-channel habitat. The lower channel segments of some tributaries provided off main channel rearing habitat as they flowed across the valley bottom. The lower quarter mile of Silver Creek was identified in the 1934 stream survey (USFB 1934) as slow and shallow with many fingerlings. Ramey Creek and Jerrys Creek may have provided similar rearing habitat conditions.

Woody debris would have accumulated infrequently during and as a result of high-water events, with most wood lodging along the banks upstream or downstream of constriction points and at the upstream end of vegetated bars. Woody debris would have been highly transient and accumulations likely did not build over time, rather they washed downstream during high-water events. Wood inputs were likely from upstream sources, debris flows entering the channel, and lateral recruitment through blow-down and mortality.

Existing Conditions

The existing conditions along the Yankee Fork were assessed for the time period 2010 through 2011, giving a "snapshot" in time of the assessment area. Data collected to assess existing conditions included detailed light detection and ranging (LiDAR) topography, aerial photographs, and field observations.

Channel Reach Characteristics

Channel reach types are identified in terms of channel morphology and observed processes. Transition zones between adjacent reaches may be gradual or sudden, and exact upstream and downstream reach boundaries may be a matter of some judgment (Bisson, Buffington, and Montgomery 2006). Alluvial valleys typically exhibit varieties of alluvial channel reach types that are related to the supply and size of sediment, and the streams ability to mobilize the streambed (Montgomery and Buffington 1998).

Under existing conditions in the assessment area, the Yankee Fork is moderately confined along its length by mine tailings, bedrock, and alluvial and colluvial deposits. The channel metrics (Table 5) and location maps (Figure 10 and Figure 11) are provided. The channel planform is a straight, free-formed alluvial channel with a sinuosity of about 1.1 and a channel gradient of about 1 percent which indicates a low rate of lateral channel migration and channel/floodplain dynamics (Beechie et al. 2006). Depth to bedrock remains relatively shallow (tens of feet).

Table 5. Valley and Channel Metrics.

Metrics	RM 7 to 3
Average Constrained Valley Width	150 feet
Average Constrained Valley Length	19,520 feet
Average Channel Length	20,790 feet
Average Unvegetated Channel Width	65 feet
Channel Confinement	Moderately Confined (2.3)
Channel Gradient	~1 percent
Sinuosity	1.1
Dominant Substrate	Cobble (2.5-10.1 inches; 64-256 mm)*
Substrate Gradiation (Approx.)	Cobble (43%); Gravel (30%); Sand (16%); Boulder (7%); Bedrock (4%)*
Bank Composition	Predominantly Cobble With Boulder, Gravel and Sand*

* 2010 USFS stream inventory survey (USFS 2010).

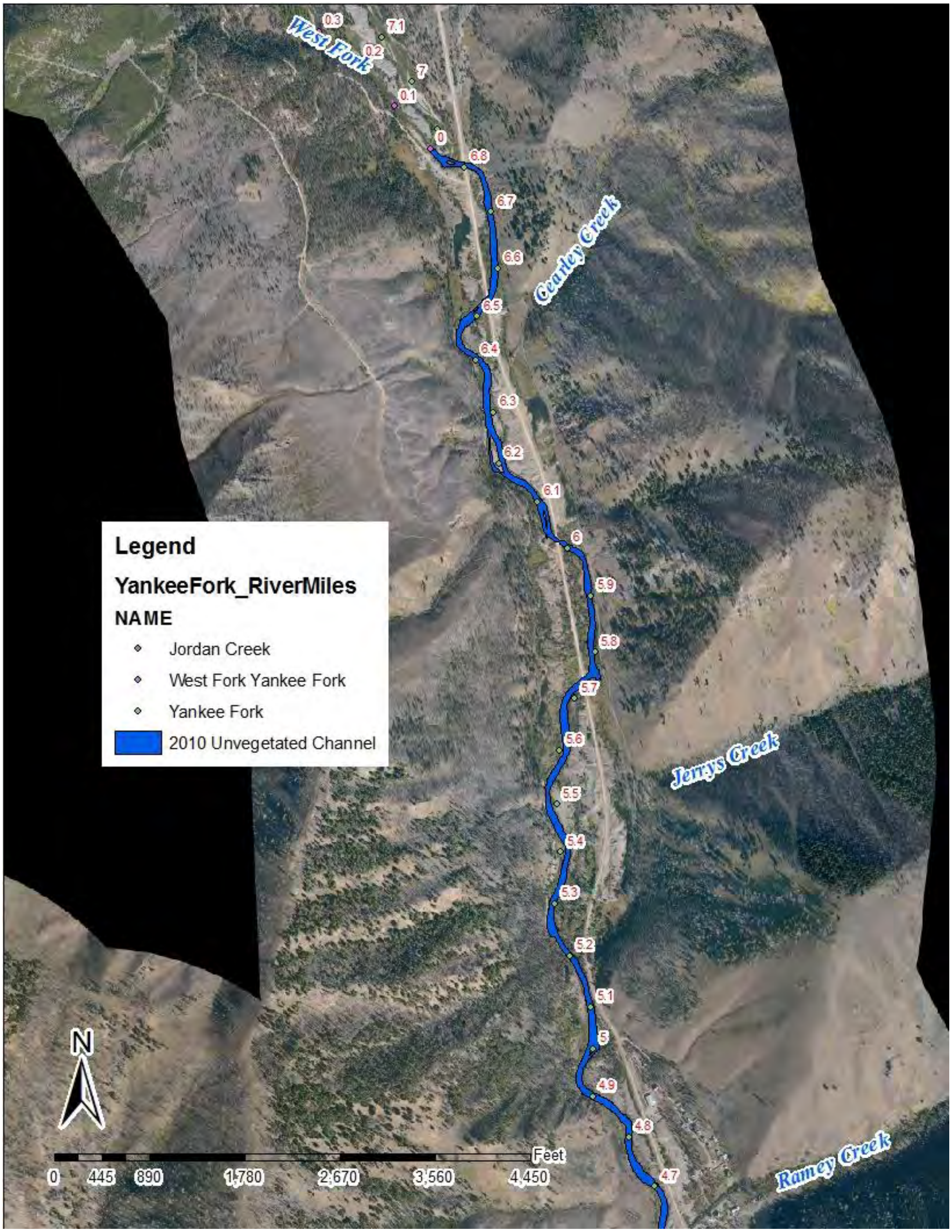


Figure 10. Yankee Fork 2010 unvegetated channel between RM 6.8 and 4.7.

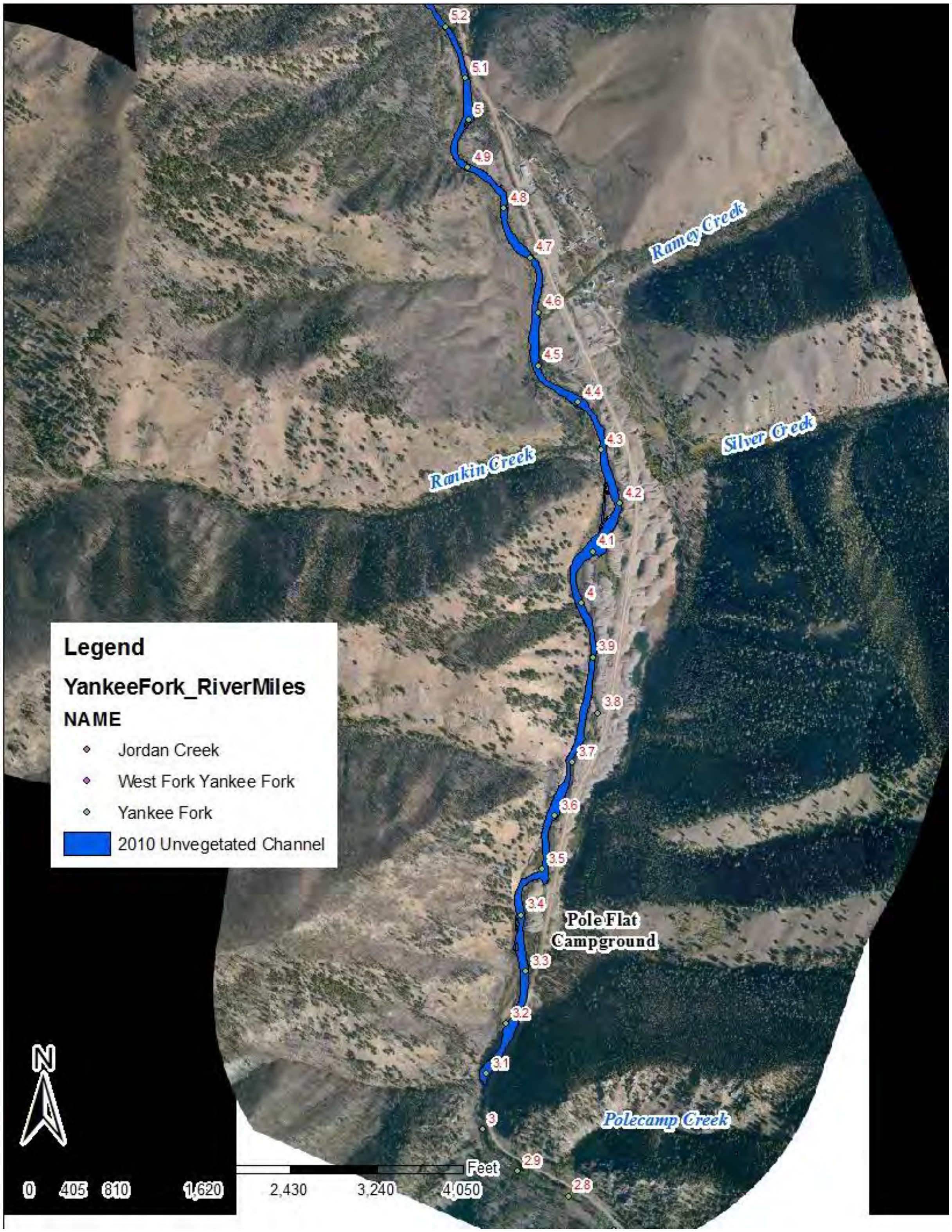


Figure 11. Yankee Fork 2010 unvegetated channel between RM 5.2 and 3.1.

While the channel historically had a similar channel planform with a plane-bed, the existing channel confinement has been increased by about 25 percent due to the tailings mounds that restrict lateral channel migration and floodplain development (Figure 12). The changes to the geometry of the channel/floodplain cross-sectional area results in faster and deeper water during high flow events that translates into higher sediment transport capacity and increased shear stress within the channel.

In this reach of the Yankee Fork, the outcome has been a more armored, uniform plane-bed channel with larger sediment sizes (i.e. cobbles and boulders), and a wider channel that can accommodate higher flows (i.e., spring run-off and intense thunderstorms). In addition, the armored bed inhibits the development of diverse bedforms (i.e. pool and riffles) because flows are not sufficient to mobilize the armoring particles (i.e. scour) in the absence of constrictions or structures that cause flow convergence.

Figure 12. View to the south looking downstream along a confined channel segment constrained by mine tailings, colluvial deposits, and bedrock along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Hydraulic modeling showed that for the 2-year recurrence discharge in the mainstem, the average flow velocity was about 5.1 feet per second and the average shear stress was about 1.3 pounds per square foot, which indicates the river is capable of transporting gravel and small cobbles up to 3.4 inches (86 mm) in diameter (Reclamation 2012). The dominant substrate size found in surface bed material, or armor layer, is cobble (2.5-10.1 inches; 64-256 mm). Wolman pebble counts showed that the gradation of the surface bed material included about 43 percent cobble with 30 percent gravel (0.1-2.5 inches; 2-64 mm), 16 percent sand (less than 0.1 inches or 2 mm), 7 percent boulder (10.1-161.3 inches; 256-4096 mm), and 4 percent bedrock (greater than 161.3 inches or 4096 mm) (USFS 2010). The hydraulic model results are supported by the armor layer's coarseness and increased channel confinement. The indication was that stream power is no longer being dissipated at its historical rate resulting in a higher energy stream with more sediment transport capacity.

Along the mine tailings and alluvial deposits, the bank materials have a similar gradation as the streambed materials based on field observations. The stream has been rerouted and confined between the mine tailings and alluvial deposits and, to a lesser degree, bedrock and colluvial deposits that have a higher percentage of boulders. Many of the banks do not have woody root reinforcement, primarily due to the lack of riparian vegetation and unconsolidated nature of the material, but still over 80 percent of the banks were found to be stable (USFS 2010). The bank stability along the mine tailings and alluvial deposits was because of the following: (1) banks tend to be "self-armoring" in that finer materials (i.e., fines to gravels) were eroded and coarser materials (i.e., cobbles to boulders) were deposited along the toe of the slope, thus protecting it from erosion, and (2) the size and volume of the material in these deposits inhibits the stream's ability to erode and transport the sediment load. The coarse alluvial and colluvial materials and the bedrock sections indicate that this reach is naturally armored and laterally stable; however the dredge tailings have increased the confinement and stability to some degree.

Bedforms and Floodplain Characteristics

In this plane-bed, free-formed alluvial channel, there is little bedform diversity, except where local forcing agents are present that create flow convergence sufficient to mobilize the streambed. This channel reach is dominated by riffles (75 percent of total wetted area [TWA]) and lacks pools (6 percent TWA) because there are only a few forcing agents that provide sufficient flow convergence to scour the streambed. The observed pool scour forcing agents included: (1) flow convergence at the Yankee Fork and West Fork confluence, (2) flow constriction at bridge locations with protected abutments (Figure 13), and (3) lateral scour forced by bedrock, boulders, or mine tailing mounds along the outside of meanders (Figure 14). Instream wood does not have a significant role in forcing flow convergence that would be sufficient to scour pools because the high energy flow moves the available wood through this channel reach, and very large wood that could be retained is essentially not available from the local or upstream sources.

Figure 13. View to the northeast looking upstream at mid channel pool forced by flow constriction at a Custer Motorway Bridge. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Figure 14. View to the south looking downstream at mid channel pool most likely created during dredging operations and then maintained by flow convergence. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Off-channel habitats are comprised predominantly of side channels and connected dredge ponds. There are about 2,650 linear feet of secondary channels comprised of two split-flow and six floodplain-type side channels. Tertiary or overflow channels make available about 5,300 linear feet of additional off-channel habitat during large floods (5 to 10 year recurrence interval). In this reach, wood was generally transient and was predominantly in the small- to medium-size class. Most of the observed wood that interacted with flood flows occurred where debris flows had made it available to the channel downstream of Rankin Creek. Two locations were observed where small wood had accumulated at the head of vegetated bars, and may contribute to the development of floodplain-type side channels.

Additional off-channel habitat has been created by connecting four series of dredge ponds (pond series) to the Yankee Fork in this channel reach. These pond series provide about 9,850 linear feet or 7.4 acres of potential juvenile rearing habitat and high water refugia. The four pond series within the assessment area are further described and discussed in the Pond Series section of this report.

Vegetation Condition

Vegetation along the channel and in floodplains both influences and is influenced by channel processes. The vegetation condition within, along, and near channels can influence changes in channel geometry or sediment storage and transport. Root strength of vegetation growing along channel banks enhances bank stability, especially in uncohesive alluvial deposits (Montgomery and Buffington 1993). Vegetation also shades the channel, provides a source of wood that can be recruited by the channel, and enhances ecological processes.

The vegetation successional stages in the connected floodplain areas was qualitatively assessed and ranged from grasslands and forbs to small trees. Roughly 60 percent of vegetation was in a shrub/seedling-to-sapling/pole condition. Riparian vegetation along the mine tailings adjacent to the channel was predominantly a narrow strip of sapling sized alders and willows, except for the few and minor areas where the mine tailings are actively eroding or have recently been eroded through lateral channel migration (Figure 15). The alder and willow roots somewhat enhance bank stability along the unconsolidated mine tailings and provide some channel boundary roughness.

Figure 15. Yankee Fork channel actively eroding mine tailings along river left.
Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation
Photograph by E. Lyon, October 26, 2011.

Active (connected) floodplain areas are generally comprised of smaller patches (less than a half acre) that either have no vegetation, or vegetation consisting of grassland/forbs, shrub/seedlings, and/or sapling poles, depending on the degree of disturbance (i.e. ground disturbing flows or mining activities). Alders, willows, grasses, and forbs were dominant in the lower areas of the active floodplain (Figure 16) and along the pond series (Figure 17) where floods commonly disturb the surface and the soils tend to be wetter. Grasses with dispersed lodgepole pines were dominant in the higher areas where floods less frequently disturb the surface and the soils tend to be drier. Most of the mine tailings adjacent to the stream are unvegetated, and the vegetation along the channel shades less than 35 percent of the stream (USFS 2010).

Figure 16. Yankee Fork riparian vegetation showing varying vegetation successional stages associated with floodplain elevations and disturbance histories. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Figure 17. Pond Series Three (PS3) riparian vegetation showing the varying vegetation composition associated with elevations and soil moisture content. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Floodplain Connectivity

Historically, the Yankee Fork was moderately confined by glacial outwash, alluvial fans, bedrock, and colluvial deposits. Under existing conditions, the channel remains moderately confined except that dredge tailings have further confined the channel by about 25 percent based on average unconstrained valley bottom width measurements, which implies that about 25 percent of available floodplain has been lost. Under existing conditions, there were about 31 acres of active floodplains (excluding the four pond series) along the mainstem Yankee Fork with an average patch size of about 0.5 acres. Many of these floodplain patches have been fragmented due to (1) dredge tailing mounds encroaching on the channel and blocking access to available floodplain patches, and (2) by dredge tailing mounds bisecting and separating floodplain patches. The existing loss of channel/floodplain interactions increases flow velocities and shear stress within the channel during high water events.

In the late 1980s, four pond series were connected to the mainstem Yankee Fork as a habitat rehabilitation project. The primary objective was to create juvenile rearing habitat for salmon and steelhead. Connecting the pond series to the mainstem resulted in about 9 additional acres of floodplain available to the Yankee Fork (Table 6). These four pond series are further discussed in the following Pond Series section.

Table 6. Pond series metrics based on 2010 aerial photographs and GIS analysis.

Pond Series	Total Additional Floodplain Area*
PS4	1.8 acres
PS3	2.8 acres
PS 2	2 acres
PS 1	2.6 acres
Totals	**9.2 acres**

* Total additional floodplain area equals the wetted area plus active floodplain area along the pond series.

POND SERIES

Gold dredging along the valley bottom of the Yankee Fork occurred from the 1930s to the 1950s. The dredging activity left behind mounds of tailing piles where spoils were discarded, and depressions where excavations were made along the margins and between many of the tailings mounds. Numerous depressions extend below the water table and have created ponds (e.g., dredge ponds). These isolated dredge ponds occur throughout the assessment area.

A study conducted along the Yankee Fork dredged area indicated that spring Chinook salmon populations had a limited quantity of rearing habitats. Rehabilitation efforts at the time (1980s to 1990s) were focused on increasing juvenile rearing habitats (Richards et al. 1992). At the request of the Tribes, a feasibility plan was developed by Bechtel National, Inc.

(Bechtel 1987) to enhance the availability of juvenile rearing habitats by interconnecting the dredge ponds and then connecting them to the Yankee Fork. Four series of ponds were identified and conceptual designs were developed (Bechtel 1987).

Development of off-channel habitats utilizing the four pond series are discussed in Richards et al. (1992). In brief, each pond series included (1) constructing channels to interconnect individual ponds which were connected to the Yankee Fork, (2) intake structures which were constructed on three of the four pond series to control inflows from the Yankee Fork into the ponds, (3) adjustable check structures which were strategically placed to control water levels and flows through the ponds, and (4) boulders that were placed in the constructed channels to improve rearing habitat and minimize migration barriers between the ponds. Completion of the pond series projects created additional off-channel habitats (about 4 acres of pond habitat and 2,000 feet of channel habitats) accessible to juvenile salmonids for rearing and refugia.

Richards et al. (1992) also completed a study on juvenile Chinook salmon usage and distribution within the developed pond series. Their study showed that juvenile fish used all available habitats; however, the fish showed a strong preference for channel-type habitats with cover. They concluded that the channel-type habitats provided the physical conditions of low water velocities and moderate depths similar to natural small backwater channels, and recommended that addition or construction of channel-type habitats would provide the most effective means of adding habitat.

The following sections provide brief descriptions and observations on each of the four pond series from upstream to downstream.

Pond Series Four (PS4)

Pond Series Four has three ponds (Figure 18), an upper pond (Pond 3), middle pond (Pond 2), and lower pond (Pond 1). Bechtel’s (1987) conceptual design originally recommended connecting only two ponds (Pond 2 and Pond 1). They recommended an intake facility (infiltration gallery) for water supply to the two ponds because to connect Pond 3 would take relocating the intake structure upstream to provide the additional required head. In addition, their concept included egg incubator facilities, supplemental feeding, connecting channel, and check structures.

The original design (Bechtel 1987) was modified to provide a surface water withdrawal from the Yankee Fork that connected Pond 3 (infiltration gallery was deleted). This new concept allowed migrating salmonids to enter the pond series through an inlet, as well as an outlet. The final design connected the three ponds, one of which was about 0.6 acres, to the Yankee Fork with an inlet into Pond 3 and outlet from Pond 1. Channels were constructed with check structures to connect the ponds and control water levels. The total length of the project was about 1,000 feet (Richards et al. 1992).

Field observations in 2011 showed (1) the pond series was seasonally (high-flows) connected to the Yankee Fork and flows into Pond 3 were regulated by a culvert placed through a dirt road embankment (Figure 19), (2) a small channel from the culvert through an area had filled with sediment to a rock cascade in the upper pond, (3) all three ponds were interconnected (Figure 20), and (4) channels and check structures had been constructed to connect the ponds and control pond levels (Figure 21). At low flows, the inlet and the check structures between the ponds had dewatered with the result that only Pond 1 is connected to the mainstem Yankee Fork via the outlet channel.

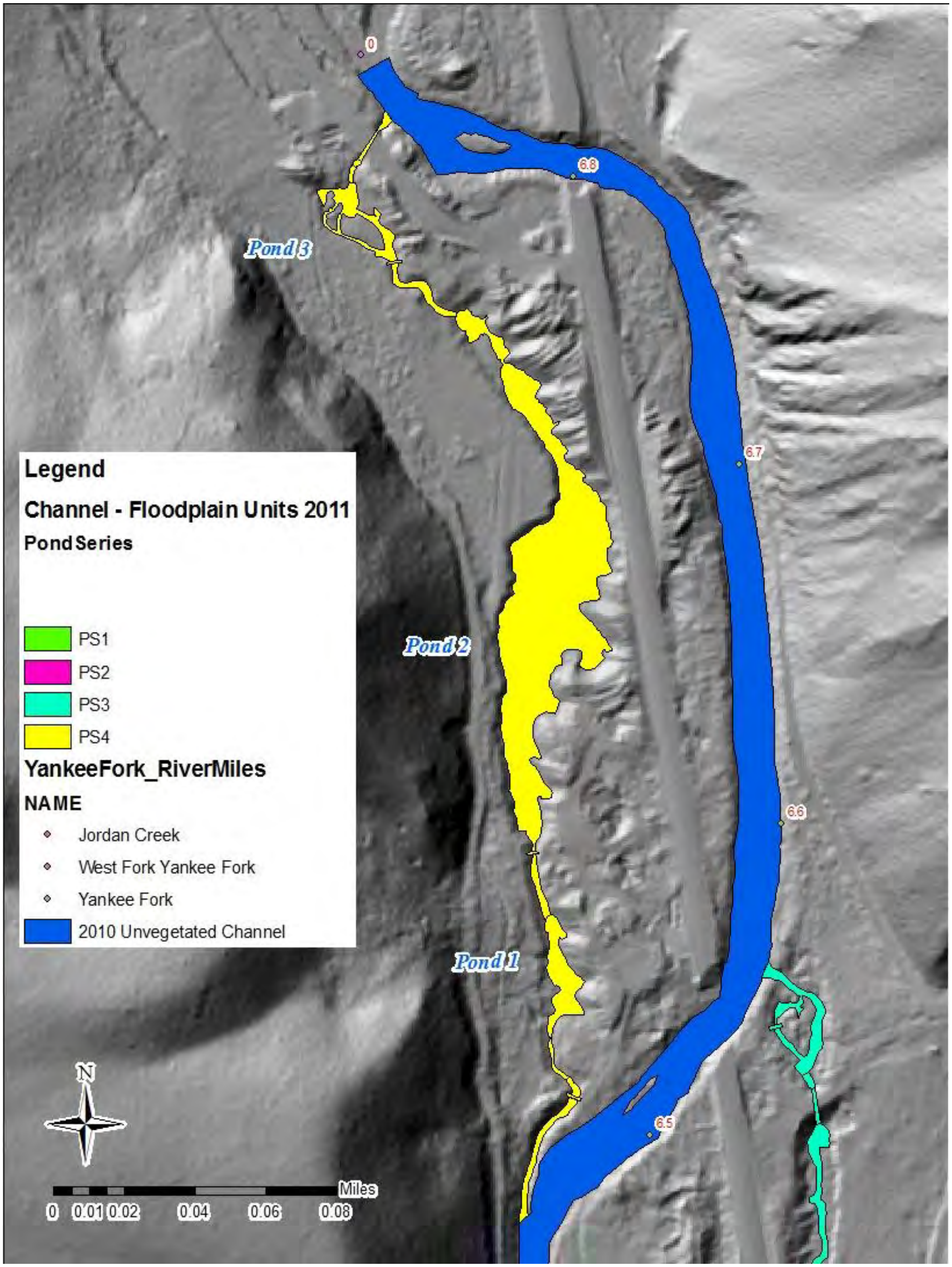


Figure 18. Pond Series Four (PS4) location. *Yankee Fork 2010 unvegetated channel is the dark blue color.*

Figure 19. View to the southwest looking downstream at a culvert placed through a dirt road embankment that provides a high-water connection between the Yankee Fork and Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Figure 20. View to the south looking downstream at Pond 2 bordered by mine tailings (left) and undisturbed ground (right) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Figure 21. View to the north looking upstream at connecting channel and check structure along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Pond Series Three (PS3)

Pond Series Three has three ponds (Figure 22), plus an upstream swampy area partially connected to the Yankee Fork. Bechtel's (1987) conceptual design recommended that this pond series would be the most appropriate for opening the inlet directly to the Yankee Fork based on its physical layout relative to the river. The swampy area directly adjacent to the Yankee Fork at the inlet of the pond series is separated from the river by a riprap berm placed during bridge construction along the Custer Motorway. The conceptual design included (1) the removal of the riprap berm, (2) rock placements to divert flow from the Yankee Fork into the pond series, and (3) regulating the flow using a culvert installed beneath an existing road and a check dam structure upstream. In addition, channels would be constructed to connect the ponds and five check structures would be placed to control flow through the ponds. Total length of the pond series was about 1,790 feet (Richards et al. 1992).

The original design (Bechtel 1987) does not appear to have been significantly modified. One of their assumptions was that the pond series would have ingress and egress for juvenile salmonids to the Yankee Fork and would be naturally populated by salmonids. Field observations in 2011 showed (1) the pond series was connected to the Yankee Fork with rock placements to divert flows (Figure 23), (2) a culvert was placed though a road embankment (Figure 24), (3) channels were constructed to interconnect the ponds (Figure 25), (4) check structures had been installed to control pond levels and flows (Figure 26), and (5) beaver activity was altering the performance of many of the features, most significantly the inlet and culvert. At low flows, the inlet area exhibits little, if any, inflow to the pond series with most of the water that is moving into the ponds provided by a small tributary (Cearly Creek) upstream of the culvert, and the check structures between the ponds appear to be dewatered such that only Pond 1 is connected to the mainstem Yankee Fork via the outlet channel at these lower flows.

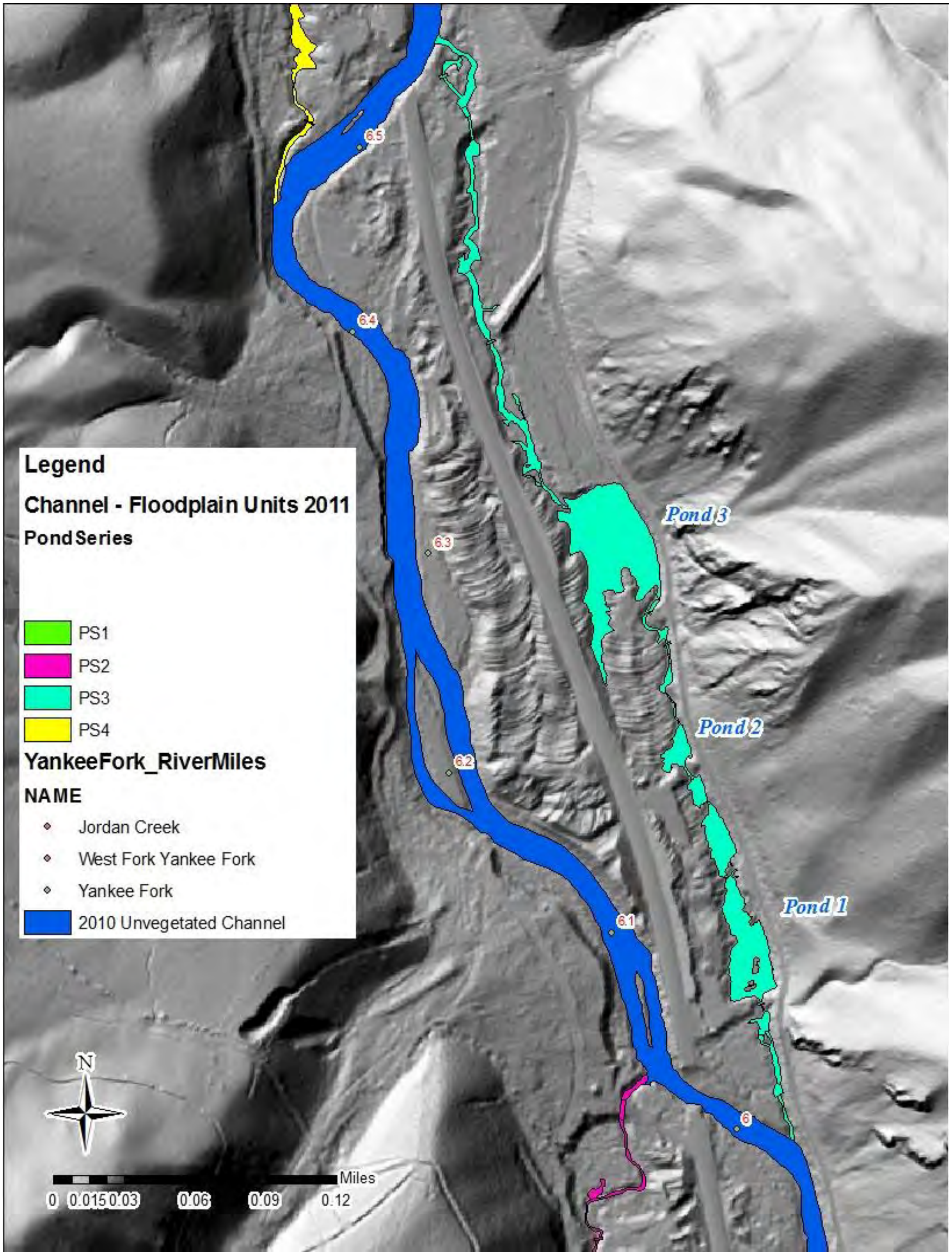


Figure 22. Pond Series Three (PS3) location. *Yankee Fork 2010 unvegetated channel is the dark blue color.*

Figure 23. View to the southeast looking across the Yankee Fork at breach through the riprap berm and placement of boulders to divert flows from the Yankee Fork into Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Figure 24. View to the south looking downstream at culvert placed through an existing road to help regulate flows into Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Figure 25. View to the south looking downstream from dirt road embankment at constructed channel along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Figure 26. View to the north looking upstream at check structure placed between embankment constrictions at the outlet of Pond 1. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Pond Series Two (PS2)

Pond Series Two has a total of six ponds (Figure 27). Bechtel's (1987) conceptual design originally recommended connecting the six ponds by constructing channels with check structures, and using a 300 feet long, 24-inch-diameter pipe to connect Pond 6 to the Yankee Fork and increase flows through the pond because the pond was perched about 2 feet above the river. An unnamed creek had been diverted into Pond 6, and water rights on the tributary are claimed for up to 0.8 cubic feet per second (cfs) which is greater than the amount of water available during low flows. The tributary was assumed to contribute most of the water to these ponds during low flow season. In addition, their concept included egg incubator facilities, and they also indicated that hatchery outplants could be used for supplementation. Juveniles could also ingress into the pond series from the outlet.

The original design (Bechtel 1987) was modified to provide a surface water withdrawal from the Yankee Fork that connected Pond 6 (intake pipe was deleted), and the pond was dredged to retain about the same water depth as the channel. This new concept allowed migrating salmonids to enter the pond series through an inlet as well as an outlet. The final design connected the six ponds to the Yankee Fork with an inlet into Pond 6 and outlet from Pond 1. Channels were constructed to interconnect the ponds and check structures were added to control water levels. Total length of the project was about 485 feet (Richards et al. 1992). Field observations in 2011 showed (1) the pond series was connected to the Yankee Fork year-round at the outlet and during high flows at the inlet (Figure 28) and flows were regulated by a culvert placed through a road embankment (Figure 29), (2) all six ponds were interconnected by constructed channels (Figure 30) with check structures to control pond levels (Figure 31), and (3) there were signs of beaver activity (i.e. chewed branches), particularly downstream of Pond 1 (Figure 32). At low flows the inlet and the check structures between the ponds appear to be dewatered such that only Pond 1 is connected to the mainstem Yankee Fork via the outlet channel at these lower flows.

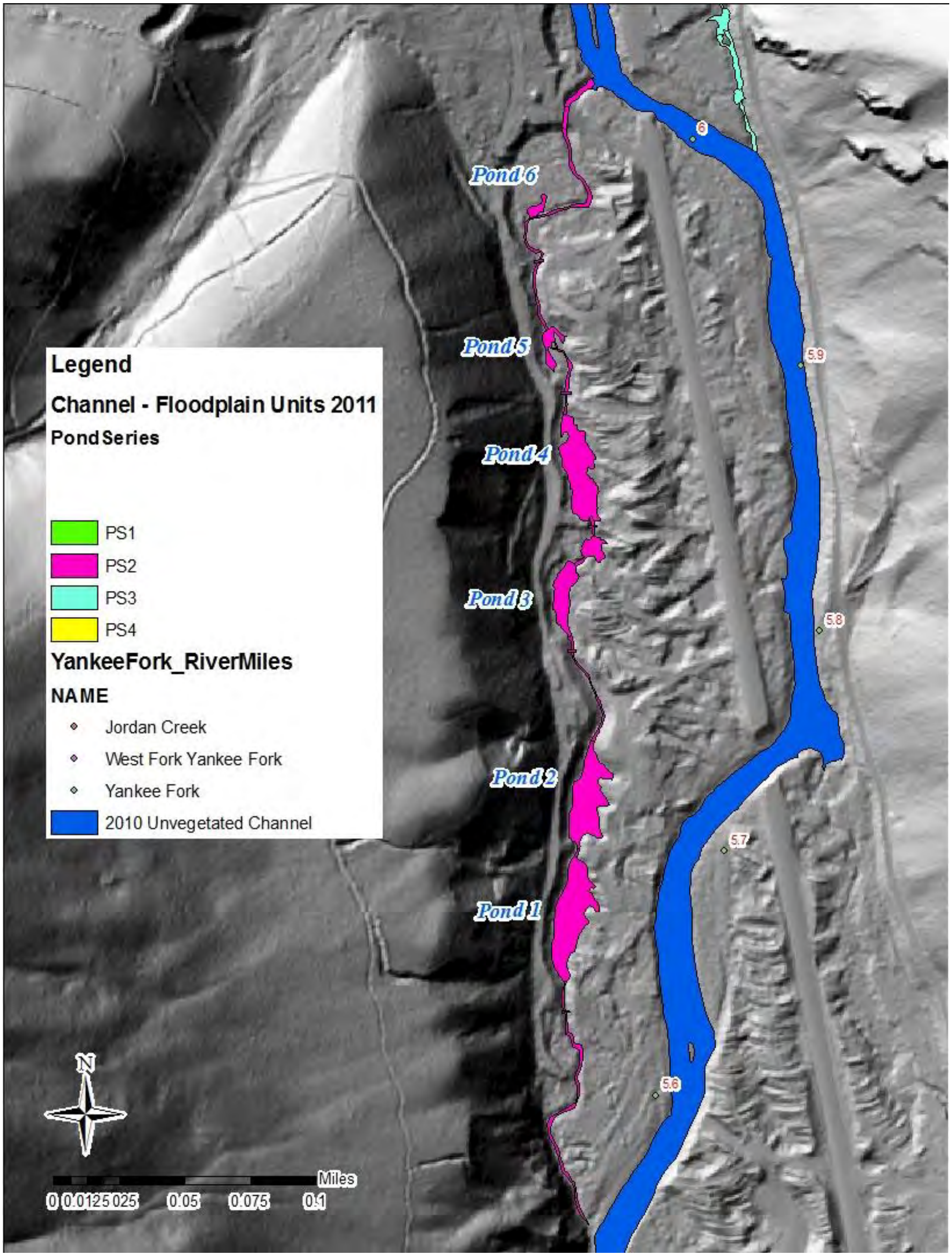


Figure 27. Pond Series Two (PS2) location. *Yankee Fork 2010 unvegetated channel is the dark blue color.*

Figure 28. View to the southeast looking downstream along the Yankee Fork at the inlet to Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Figure 29. View to the southwest looking downstream at culvert placed through road embankment that controls flow into Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Figure 30. View to the southeast looking downstream along constructed channel with boulder placements along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Figure 31. View to the south looking downstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Figure 32. View to the south looking downstream near outlet where there were signs of beaver activity along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Pond Series One (PS1)

Pond Series One (Figure 33) is located along river left between RM 3.5 (upstream of Pole Flat Campground) and RM 4.3 (upstream of Silver Creek). The pond series included eight separate ponds that are bordered by dredge tailings on the right and primarily alluvial fan deposits on the left. A perched road culvert connected the outlet of the pond series to the Yankee Fork. Several of the ponds were managed as put-and-take rainbow trout fisheries. Silver Creek, a historic tributary to the Yankee Fork, flows directly into Pond 8 and does not have a surface outlet (Bechtel 1987).

Bechtel's (1987) conceptual design originally recommended (1) a diversion structure on Silver Creek designed to divert about 5 cfs into Pond 7 with overflows and sediment being delivered directly to Pond 8, (2) excavation of connecting channels to interconnect seven of the eight ponds, (3) installation of check structures to regulate flow, (4) replacement of the existing perched culvert, (5) installing incubator and feeding facilities, (6) and installation of an adult holding and trapping facility.

The actual development of Pond Series One included connecting the lower four ponds shown in the Bechtel (1987) drawings by constructing channels with check structures, and replacing the culvert through the Custer Motorway to provide ingress and egress to the ponds. Total length of the project was about 1,230 feet (Richards et al. 1992). Field observations in 2011 showed (1) a significant amount of groundwater inflow (likely from the Yankee Fork since water level elevation in the ponds are the same as water level elevation in the river) maintains the ponds, (2) all four ponds (Figure 34) were interconnected by constructed channels with check structures to control pond levels (Figure 35), (3) the lower channel upstream of the culvert had not been modified with boulder placements (Figure 36), and (4) the culvert had been replaced and was no longer perched above the Yankee Fork (Figure 37). At low flows, the check structures between the ponds appear to be dewatered. And in fact, the outlet of Pond 1 was dewatered during low flows which disconnected the pond series from the mainstem Yankee Fork.

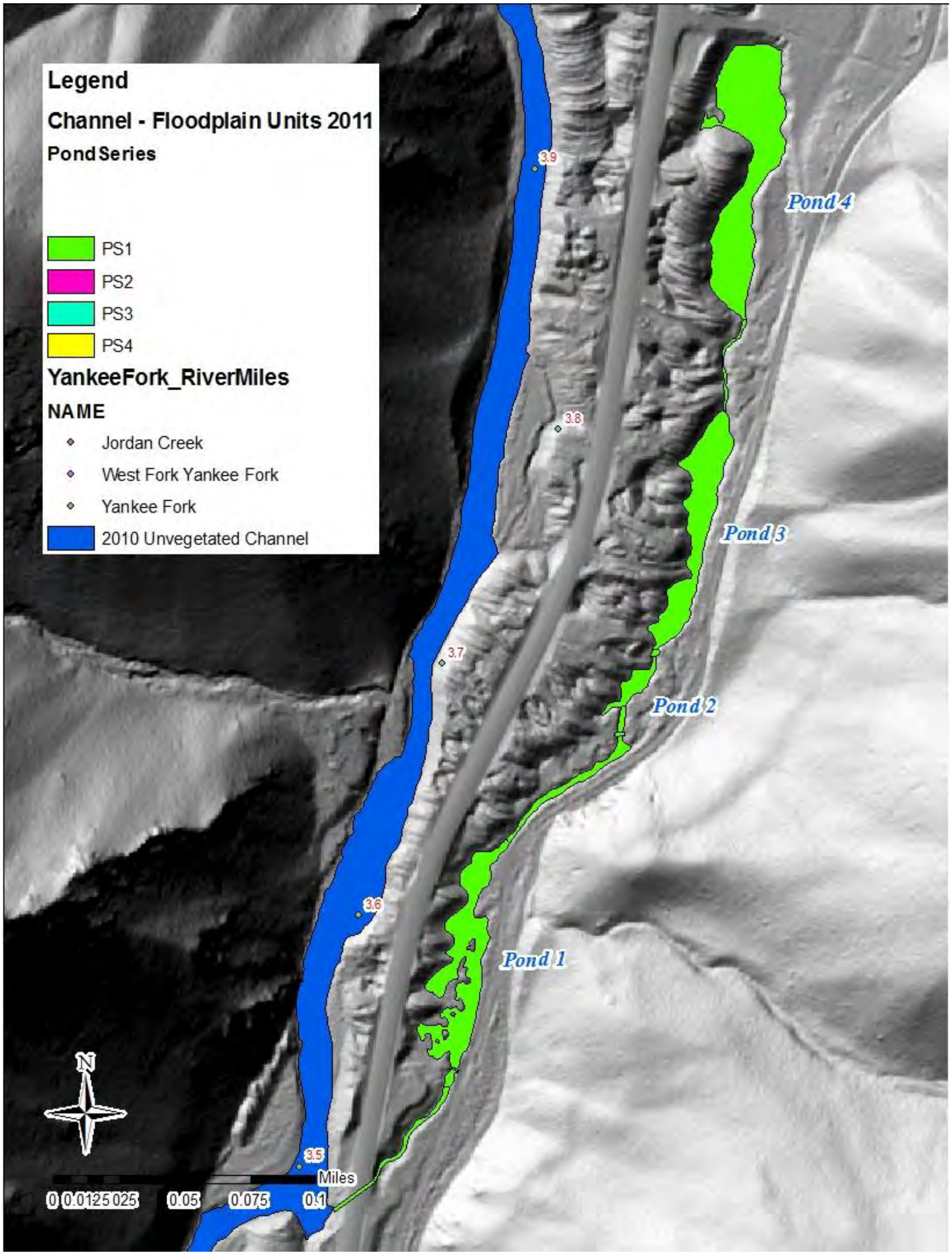


Figure 33. Pond Series One (PS1) location. *Yankee Fork 2010 unvegetated channel is the dark blue color.*

Figure 34. View to the north looking upstream at Pond 4, the largest pond, that is maintained as a put-and-take rainbow trout fishery along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Figure 35. View to the southwest looking downstream at check structure in a constructed channel along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Figure 36. View to the northeast looking upstream at boulder placement along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Figure 37. View to the northeast looking upstream at outlet to the Yankee Fork from Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 1, 2011.

Pond Series Habitat Analysis

During the fall of 2011, field observations and photographic documentation were made along the four pond series. The objective was to document baseline conditions so that modifications to the pond series could be monitored. Channel units were identified and mapped on 2010 aerial photographs in the field, and then input into GIS for analysis (Appendix D). For simplicity, the habitats were grouped as channel type (flowing water) and pond type (still water) and acreage for each habitat type was computed in GIS. Table 7 summarizes the results of the GIS analysis.

Table 7. Pond series metrics based on 2010 aerial photographs and GIS analysis.

Pond Series	Total Habitat	Channel Type Habitat	Pond Type Habitat
PS4	1.6 acres	0.2 acres (12%)	1.4 acres (88%)
PS3	2.2 acres	0.1 acres (5%)	2.1 acres (95%)
PS 2	1.1 acres	0.2 acres (18%)	0.9 acres (82%)
PS 1	2.5 acres	0.2 acres (8%)	2.3 acres (92%)
Totals	**7.4 acres**	**0.7 acres (9%)**	**6.7 acres (91%)**

* Total additional floodplain area equals the wetted area plus active floodplain area.

MAINSTEM YANKEE FORK DEGREE OF IMPAIRMENT

Historically, the Yankee Fork flowed through an alluvial valley with a valley gradient of about 1.1 percent and depth to bedrock was relatively shallow throughout the valley segment. The Yankee Fork was moderately confined by glacial outwash, alluvial fans, bedrock, and colluvial deposits. The channel had a straight planform with a plane-bed and a low rate of lateral channel migration. Under existing conditions, the channel remains moderately confined with a similar planform and bedform. The primary difference between the historic and existing conditions is related to disconnected tributaries and channel/floodplain interactions as follows:

(1) Cearly Creek, Silver Creek, and Jerrys Creek, as well as other small, unnamed tributaries are disconnected from the mainstem Yankee Fork by dredge tailings.

(2) Channel confinement has increased by about 25 percent resulting in a similar loss in available floodplain area.

(3) Dredge tailing mounds encroach on the channel causing flow constrictions in some locations.

(4) Dredge tailing mounds block access to available floodplain patches and form topographic highs that fragment floodplain patches in some locations.

The primary limiting and causal factors for the Yankee Fork in the assessment area are (1) habitat fragmentation and connectivity due to mine tailings artificially constraining the stream and disconnecting historic floodplains, and (2) habitat quantity and quality due to mining activities that have confined the channel, removed the vegetation, and disconnected off-channel habitat.

As discussed throughout this report, and further emphasized here, the Yankee Fork has been and remains moderately confined with a straight channel and plane-bed bedform. This channel type has a low rate of lateral channel migration and low channel/floodplain dynamics as compared to an unconfined, meandering channel with a pool-riffle bedform (Beechie et al 2006). Habitat quantity and quality equates to instream habitat units (or channel units) which have not significantly changed through time (historical versus existing conditions).

Habitat fragmentation and connectivity primarily pertains to habitat accessibility and diversity at varying spatial and temporal scales. In the assessment area, the two most significant impacts related to these limiting factors are reach-scale impairments to the habitat-forming processes. First, tributaries are disconnected by dredge tailings resulting in isolation of tributary habitats, and the loss of sediment (including wood) and nutrient inputs to the Yankee Fork that help drive both physical and ecological processes. Secondly, the loss of available floodplain areas, albeit relatively a small percentage, does affect channel/floodplain interactions resulting in a reduction in the accessibility and connectivity of off-channel habitats, and an increase in flow velocities within the channel during high flows (Table 8).

Left alone, the mainstem Yankee Fork will continue to function in a similar manner as it has since the channel was relocated after dredging operations ceased in the late 1940s. Physical and ecological processes that create and maintain diverse habitat patches for anadromous fish, and other aquatic and terrestrial species, can be improved along this channel reach with the appropriate interventions that are discussed in the Mainstem Yankee Fork Potential Habitat Actions section of this report.

Table 8. Relative comparison of the Yankee Fork's historical and existing conditions, and impaired processes.

Metrics	Historical Condition	Existing Condition	Processes Impaired Resulting in the Change	Degree of Impairment Based on Limiting Factors (High, Medium, Low, None)
Average Constrained valley width	Moderately confined (3.3)[1]	Moderately confined (2.3)[1]	Change in the channel/floodplain cross-sectional geometry has increased sediment transport capacity due to increased flow velocities and shear stresses within the channel.	Medium
Channel pattern	Straight, free-formed alluvial channel	Straight, free-formed alluvial channel	Increased channel confinement resulted in very slight changes to the channel planform.	Low
Channel bedform	Plane-bed	Plane-bed	Small increase in sediment transport capacity may have resulted in coarsening of the bed and simplification of the bedform.	Low
Floodplain connectivity	Channel connected to a patchy floodplain; generally the active floodplain patch size was about 1 acre and located on the inside of meanders.	Connected floodplain is fragmented due to dredge tailings and embankments; average floodplain patch size is about 0.5 acres.	About 50 percent reduction in floodplain patch size resulting in a moderate increase in flow velocities within the channel during floods (2-5 year recurrence interval) because of the loss in effective floodplain roughness.	Medium
Vegetation condition	Patches of mixed shrub/seedling and small-to-large trees	Patches of mixed shrub/seedling and small trees; slight reduction in riparian buffer zone width due to mine tailings.	Reduction in vegetated cover, in conjunction with a reduction in available floodplain patches, has decreased effective channel boundary and floodplain roughness resulting in increased flow velocities and sediment transport capacity.	Medium

Metrics	Historical Condition	Existing Condition	Processes Impaired Resulting in the Change	Degree of Impairment Based on Limiting Factors (High, Medium, Low, None)
Off-channel habitat	Off-channel habitat was comprised of secondary floodplain and split-flow type side channels, and tertiary (or overflow) channels would have been available during floods based on 1908 plat maps and photographs; some tributaries provided off-channel rearing habitat as they flowed across the valley bottom based on 1934 stream survey (USFB 1934).	About 2,650 linear feet of secondary side channels; additional 9,850 linear feet created by connecting pond series; some tributaries disconnected by mine tailings.	Channel relocated in some locations and constructed through or adjacent to mine tailings that constrain lateral channel migration and the stream's ability to create and maintain diverse off-channel habitat patches; mine tailings disconnect Jerrys Creek and Silver Creek and other tributaries from the Yankee Fork, preventing fish access to the drainages and disconnecting physical and ecological processes.	Medium (for tributary reconnections) Low (for creating additional off-channel habitats)
Pools	Variable for plane-bed channels depending on the availability of forcing agents.	Variable pool frequency with the primary forcing agents being bridge constrictions, mine tailing mounds, and bedrock that create sufficient flow convergence.	Pool frequencies is variable in plane-bed channels and are contigent on the number of constrictions and structures that force flow convergence sufficient enough to mobilize the armor layer.	Low
Dominant roughness elements	Bedrock, boulders and cobbles, and vegetated banks for plane-bed channels	Primarily from bedrock, boulders and cobbles, and to a lesser degree, vegetated banks due to unvegetated mine tailings.	Similar channel roughness processes are occurring, except that the channel is somewhat more confined and vegetation has less of an effect on channel boundary roughnes, resulting in more sediment transport capacity.	Low

[1]Ratio between the constrained valley bottom width and the unvegetated channel width, defined as confined for less than 2 channel widths, moderately confined for 2-4 channel widths, and unconfined for greater than 4 channel widths.

Mainstem Yankee Fork Target Conditions

The approach used in this Baseline Assessment describes reach-scale habitat-forming processes and identifies locations where these processes are impaired due to anthropogenic disturbance, and identifies specific rehabilitation actions that should be considered to re-create and maintain such processes. Target conditions represent the most appropriate physical and ecological characteristics for a given channel reach based on the habitat-forming processes that should be occurring. The difference between target conditions and historical conditions is that target conditions take into consideration existing conditions, constraints, and future trends. Critical to the development of target conditions is an understanding of the linkage between the physical and ecological processes that create and maintain habitat. By better understanding this relationship, targeted conditions can be identified that will provide the appropriate habitat-forming processes for that particular riverine system.

Target conditions were determined by comparing historical and existing channel and floodplain metrics, where possible. Little consideration was given to socioeconomic constraints when determining the appropriate target conditions to rehabilitate habitat-forming processes. However, these socioeconomic constraints are considered in the potential habitat actions and will need to be evaluated and mitigated accordingly, at the project level.

The target conditions for the Yankee Fork are summarized and compared with existing conditions, and the potential degree of improvement to habitat-forming processes in Table 9.

Table 9. Comparison of existing conditions, target conditions, and degree of improvement to processes.

Metrics	Existing Condition	Target Condition	Degree of Improvement to Habitat-forming Processes (High, Medium, Low, None)
Constrained valley width	Moderately confined channel (2.3); average constrained valley bottom width is about 150 feet	Moderately confined channel (2.7); average constrained valley bottom width of about 175 feet	Medium
Channel pattern	Straight, free-formed alluvial channel	Same	None
Channel bedform	Plane-bed	Same	None
Floodplain connectivity	The total acres of active floodplain is unknown due to the extent of dredging that had occurred prior to the 1945 aerial photograph, but the average patch size was about 1.0 acre based on anlaysis of the 1945 aerial photographs showing pre-dredging conditions from about 0.3 miles downstream of Jerrys Creek to the West Fork.	About 40 to 45 acres of active floodplain with an average patch size of about 0.8 to 1 acre	Medium
Vegetation condition	Mixed vegetation (e.g., shrubs and seedlings with patches of small trees); fragmented riparian buffer zone due to unvegetated mine tailings.	Mixed vegetation (e.g., grasslands, shrubs, and seedlings with patches of small to large trees); generally a continuous riparian buffer zone 30-feet wide or greater, and vegetated floodplain patches, where appropriate.	Medium

Metrics	Existing Condition	Target Condition	Degree of Improvement to Habitat-forming Processes (High, Medium, Low, None)
Off-channel habitat	About 2,650 linear feet of secondary side channels; additional 9,850 linear feet created by connecting pond series; disconnected tributaries.	Maintain or increase the total linear feet of secondary side channels along the mainstem; reconnect Silver Creek and Jerrys Creek, and other unnamed tributaries to the mainstem Yankee Fork, where feasibile, and improve access conditions into Ramey Creek.	Medium (for tributary reconnections) Low (for creating additional off-channel habitats)
Pools	Variable for plane-bed channels	Similar conditions will probably remain. However, there may be a potential to create a deep pool near RM 4.2 on river left by excavating tailing piles and placing wood, similar to "maternity hole."	Low
Dominant roughness elements	Primarily bedrock, boulders, and cobbles; vegetated banks are fragmented by unvegetated mine tailings which has reduced channel boundary roughness.	Vegetated banks and mine tailing modifications (see pools) to dissipate stream power.	Low

The expected degree of improvement to habitat-forming processes from the existing conditions to the target conditions can be used to interpret the potential improvements to habitats required during varying salmonid life stages. Anticipated changes in the quantity and quality of habitat elements, such as channel confinement, floodplain connectivity, riparian vegetation, and flow velocities are qualitatively considered based on the expected channel response.

As an example, Richards and Cernera's (1989) study showed that hatchery-reared and naturally spawned juvenile Chinook salmon generally disperse and rear within a mile, primarily in the downstream direction, of their release or emergence site for up to one month following emergence. Under existing conditions, the moderately confined channel along the dredged reaches has small discontinuous floodplain patches, and flood flows are primarily confined to within the channel. The increased channel confinement and loss of channel/floodplain interactions has resulted in an increase in flow velocities, shear stresses and sediment transport capacity within the channel, and an overall reduction in the availability of off-channel habitats that are suitable for juvenile rearing and high water refuge associated with dynamics floodplains. These plane-bed channel types have predominantly uniform flow that can be altered by increasing channel roughness and channel/floodplain interactions. The expected channel responses would be (a) more instream flow variability which improves migratory and holding habitats, (b) an increase in channel/floodplain interactions which increases and improves the availability of off-channel habitats, and (c) a reduction in sediment transport capacity which potentially increases the number of available spawning patches.

In general, when the quantity and diversity of habitat patches increases, and the quality of the habitat patches improves, there should be a cumulative, beneficial effect for salmonids at varying life stages. Table 10 summarizes the expected overall improvements to salmonid habitats.

Table 10. Mainstem Yankee Fork stream metrics and their potential to improve varying salmonid habitats based on tributary reconnects and target conditions (X – large improvements; ♦ – small improvements).

Habitat Improvements	Channel Confinement	Channel Pattern	Channel Bedforms	Floodplain Connectivity	Vegetation Condition	Off-channel Habitat	Pool Frequency	Roughness Elements
Migration Habitat	♦			♦		♦	♦	
Spawning Habitat	♦			♦	♦		♦	♦
Egg Incubation to Emergence Habitat	♦							
Adult Holding Habitat	♦				♦		♦	♦
Juvenile Rearing Habitat	♦			♦	♦	♦		♦

MAINSTEM YANKEE FORK POTENTIAL HABITAT ACTIONS

The target condition is to improve habitat-forming processes by (1) reconnecting tributaries to the Yankee Fork, (2) reducing channel confinement by increasing the average constrained valley bottom width to about 175 feet, (3) increasing floodplain patch size to about 0.8 to 1 acre, (4) improving floodplain connectivity, and (5) improving the riparian buffer zone.

The objectives are to reconnect tributary inputs and to dissipate mainstem stream energy during flood flows across a wider, more continuous floodplain. Expected results include the following:

- Increase in sediment supply and nutrients that help drive physical and ecological processes in the mainstem.
- Decrease in flow velocity and shear stress by changing the channel/floodplain cross-sectional geometry to allow flows to access larger, more continuous floodplain patches.
- Increase in channel boundary and floodplain roughness to dissipate stream energy during flood flows.
- Improve the stream's ability to migrate laterally and rework the valley bottom.

Potential habitat actions to meet the objectives include (1) removing and re-contouring dredge tailings on the valley floor to reconnect tributaries, (2) removing and/or re-contouring sections of dredge tailings and embankments to an elevation accessible to the stream during less than 2- to 5-year flood events, (3) connecting existing small (less than 0.5 acres), fragmented active floodplain patches to create larger (0.8 to 1 acre), more continuous active floodplains, and (4) planting appropriate vegetation in constructed floodplain and other cleared areas. Potential locations to implement these types of actions are shown in Figure 38.

Constraints to implementation of potential habitat actions are primarily (1) the need to maintain relatively “pristine” mine tailings as a historical property and attraction, (2) active mining claims within the channel reach, (3) landowner and stakeholder cooperation and willingness, and (4) availability of funding.

The expected channel response will benefit adult and juvenile salmonid habitats through (1) improved accessibility to tributary habitats, (2) increased spawning patches associated with improved sediment inputs from reconnected tributaries, (3) increased availability of high-flow refuge, (4) instream variability of flow velocities, and (5) decreased stream power and sediment transport capacity through increased floodplain connectivity and roughness during flood events.

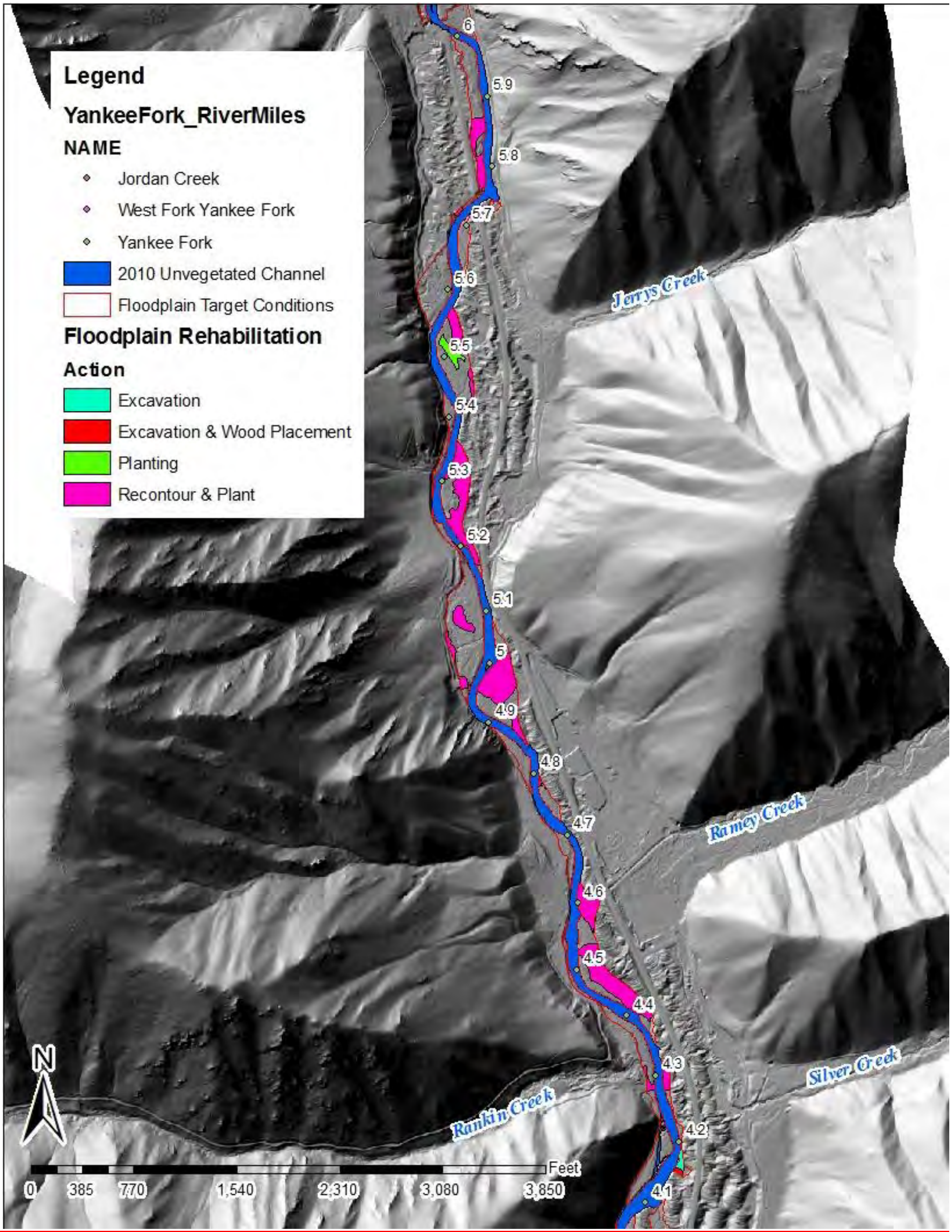


Figure 38. Examples of potential mainstem areas to implement appropriate habitat actions between RM 6.0 and 4.1. *Jerrys Creek and Silver Creek are disconnected from the mainstem Yankee Fork.*

SUMMARY

In the assessment area, limiting and causal factors for the mainstem Yankee Fork are (1) habitat fragmentation and connectivity due to dredge tailings artificially constraining the channel and disconnecting historic floodplains, and (2) habitat quantity and quality due to mining activities that have confined the channel, removed the vegetation and disconnected off-channel habitat.

Historically, the Yankee Fork channel had a straight planform with a plane-bed and a low rate of lateral channel migration. Under existing conditions, the channel remains moderately confined with a similar planform and bedform. The primary difference between the historic and existing conditions is related to disconnected tributaries and channel/floodplain interactions. Beechie et al. (2006) found that straight, plane-bed channels similar to the Yankee Fork have a low rate of lateral channel migration and low channel/floodplain dynamics as compared to unconfined, meandering pool-riffle channels. The habitat quantity and quality have not significantly changed from historical conditions, and would not be expected to change without enhancing or creating habitat units.

Additional off-channel habitat was created in the late 1980s to early 1990s through connecting four series of isolated dredge ponds within the assessment area to the Yankee Fork, referred to as Pond Series 1 through 4. Individual ponds within each pond series were also interconnected with constructed channels. In 2011, information on existing baseline conditions was collected and has been included in this report. The purpose of documenting the four pond series was to develop a baseline for monitoring purposes prior to adaptively managing them to provide more beneficial habitat types because the existing pond series projects are functioning as intended.

The objectives along the mainstem Yankee Fork are to improve habitat-forming processes, and the potential actions to achieve those conditions include, but are not limited to the following:

For the mainstem Yankee Fork, the objectives are to improve habitat-forming processes by reconnecting tributaries, increasing dynamic channel/floodplain interactions, and improving riparian vegetation conditions. The goals are to reconnect tributary inputs to the Yankee Fork and to dissipate mainstem stream energy across more continuous floodplain patches. The expected channel responses would primarily benefit juvenile salmonids through rearing habitats and high-water refugia habitats by (1) increasing availability of high-flow refuge, (2) improving variability in flow velocities, and (3) improving channel/floodplain interactions during flood events.

NEXT STEPS

This Baseline Assessment is intended to be used as only one of many tools to help monitor physical and ecological changes, and to help guide rehabilitation and habitat improvement actions on the mainstem Yankee Fork. Neither the baseline conditions nor the potential habitat actions outlined in this report are an exhaustive assessment of all possible monitoring metrics or habitat actions.

The overarching reach-scale goals are to improve and monitor habitat-forming processes. Potential monitoring strategies are not identified in this report, and are up to the discretion of entities interested in documenting the physical interventions (i.e. habitat actions) and their biological effects on target species populations at varying spatial scales.

Potential habitat actions outlined and delineated along the mainstem Yankee Fork in this report can be grouped in any number of ways or places to form projects. In some instances only one course of action may be appropriate, whereby project development is relatively simple. In other instances, multiple groupings may be appropriate requiring prioritization based on collaboration amongst project stakeholders. In either case, evaluating the proposed action(s) based on the goals and objectives of the project stakeholders will ensure the most appropriate suite of actions is developed. Throughout the entire project development, design, and implementation process, this Baseline Assessment can be used as a reference to verify whether or not project components are appropriate for the geomorphic character and trends prevalent in the assessment area of the Yankee Fork. Completed projects can be monitored and evaluated to determine the extent to which they helped achieve the identified objectives to improve or re-establish habitat-forming processes. Shortcomings can be addressed through adaptive management of the project and in future project designs.

LIST OF PREPARERS

Name	Organization	Contribution
Edward W. Lyon, Jr., L.G.	Bureau of Reclamation Pacific Northwest Regional Office Boise, Idaho	Principal Author River Systems Analysis Group Geomorphologist
Rick Rieber	Bureau of Reclamation Pacific Northwest Regional Office Boise, Idaho	Reviewer/Contributor Ecosystems Analysis Group
Terril Stevenson, L.G.	Bureau of Reclamation Pacific Northwest Regional Office Boise, Idaho	Peer Reviewer River Systems Analysis Geomorphology Group Manager
Kristin Swoboda	Bureau of Reclamation Pacific Northwest Regional Office Boise, Idaho	GIS Peer Reviewer Geographic Information System Geodatabase
Kelly Vick	Bureau of Reclamation Pacific Northwest Regional Office Boise, Idaho	Natural Resources Writer Liaison & Coordination Group

This page intentionally left blank

LITERATURE CITED

Parenthetical Reference	Bibliographic Citation
Bechtel 1987	Bechtel National, Inc. 1987. Feasibility plan for the enhancement of the Yankee Fork of the Salmon River, Idaho, prepared for The Shoshone-Bannock Tribes Fisheries Department, Fort Hall, Idaho: Bechtel National, Inc., San Francisco, California.
Beechie et al. 2006	Beechie, T., Liermann, M., Pollock, M., Baker, S., and Davies, J. 2006. Channel pattern and river-floodplain dynamics in forested mountain river systems: Geomorphology 78 (2006) p. 124-141.
Beechie et al. 2010	Beechie, T., Sear, D., Olden, J., Pess, G., Buffington, J., Moir, H., Roni, P., and Pollock, M. 2010. Process-based principles for restoring river ecosystems: BioScience 60 (2010) p. 209-222.
Bisson, Buffington, and Montgomery 2006	Bisson, P., Buffington, J., and Montgomery, D. 2006. *Valley segments, stream reaches, and channel units: in Methods in Stream Ecology*. Elsevier, p. 23-49.
Bisson and Montgomery 1996	Bisson, P., and Montgomery, D. 1996. Valley segments, stream reaches, and channel units: *in* R. Hauer and G. Lamberti, editors, Methods in stream ecology. Academic Press, New York, New York, p. 23-52.
Borgert, Lundeen, and Thackray 1999	Borgert, J., Lundeen, K., and Thackray, G. 1999. "Glacial geology of the southeastern Sawtooth Mountains" in hughes, S., and Thackray, C., eds., *Guidebook to the geology of Eastern Idaho*. Idaho Museum of Natural History, Pocatello, Idaho, p. 205-217.
Evenson, Cotter, and Cinch 1982	Evenson, E.B., Cotter, J.F.P., and Clinch, J.M. 1982. "Glaciation of the Pioneer Mountains, a proposed model for Idaho" in Bonnichsen B., and Breckenridge, R.M., eds., *Cenozoic Geology of Southern Idaho*. Idaho Bureau of Mines and Geology Bulletin, v. 26, p.653-665.
Fenneman 1931	Fenneman, N. 1931. *Physiography of the Western United States*. McGraw-Hill, New York, 534 p.
Frissell et al. 1986	Frissell, C., Liss, W., Warren, C., and Hurley, M. 1986. A hierarchial framework fir stream habitat classification: Viewing streams in a watershed context: Environmental Management 10 (1986) p. 199-214.
Gregory 2012	Gregory, J. 2012. Lost River Fish Ecology INC. Personal Communication. July 19, 2012.

Parenthetical Reference	Bibliographic Citation
Gregory and Wood 2012	Gregory, J., and Wood, C. 2012. Evaluation of juvenile anadromous fish populations in Pond Series 2 and Pond Series 3 and adjacent areas in the Yankee Fork drainage. Prepared for Bureau of Reclamation.
IBHS 2009	Idaho Bureau of Homeland Security. 2009. *Putting down roots in earthquake country, your handbook for earthquakes in Idaho*. Idaho Bureau of Homeland Security, Boise, Idaho. 38 p.
IDEQ 2011	Idaho Department of Environmental Quality. 2011. *Idaho's 2010 Integrated Report*: Idaho Department of Environmental Quality, Boise, Idaho, 46 p. + Appendices
Janecke 1992	Janecke, S. 1992. "Kinematics and timing of three superposed extensional systems, east central Idaho: Evidence for an Eocene tectonic transition." *Tectonics*, v. 11, p. 1121-1138.
Kiilsgaard, Fisher, and Bennett 1986	Kiilsgaard, T., Fisher, F., and Bennett, E. 1986. "The Trans-Challis fault system and associated precious metal deposits, Idaho." *Economic Geology*, v. 81, p. 721-724.
Link and Janecke 1999	Link, P., and Janecke, S. 1999. "Geology of East-Central Idaho: Geologic roadlogs for the Big and Little Lost River, Lemhi, and Salmon River valleys." Pages 295-334 in Hughes, S., and Thackray, G., eds., *Guidebook to the Geology of Eastern Idaho*: Idaho Museum of Natural History, Pocatello, Idaho
LOYF Historical Association 2005	Land of the Yankee Fork Historical Association. 2005 *Land of the Yankee Fork Historic Area in Words and Pictures.* Produced and Published by the Land of the Yankee Fork Interpretive Center and the Idaho Department of Parks and Recreation. 51 p.
McIntyre, Ekren, and Hardyman 1982	McIntyre, E., Ekren, E., and Hardyman, R. 1982. "Stratigraphic and structural framework of the Challis volcanics in the eastern half of the Challis 1º x 2º quadrangle, Idaho," in Bonnichsen, B., and Breckenridge, R., eds., Cenozoic geology of Idaho. Idaho Bureau of Mines and Geology Bulletin 26, p. 3-22.
Mitchell 1997	Mitchell, V. 1997. "History of the Sunbeam Mine, Custer County, Idaho." Idaho geological Survey Staff Report 97-18, 19 p.
Montgomery and Bolton 2003	Montgomery, D., and Bolton, S. 2003. "Hydrogeomorphic variability and river restoration" in R. C. Wissmar and P.A. Bisson, editors. Strategies for restoring river ecosystems: sources of variability and uncertainty in natural and managed system: American Fisheries Society, Bethesda, Maryland, 39-79 pp.

Parenthetical Reference	**Bibliographic Citation**
Montgomery and Buffington 1993	Montgomery, D., and Buffington, J. 1993. "Channel classification, prediction of channel response, and assessment of channel condition." *Washington State Timber, Fish & Wild-life*: p.84 + figures
Montgomery and Buffington 1997	Montgomery, D., and Buffington, J. 1997. Channel reach morphology in mountain drainage basins: Geological Society of America Bulletin 109 (1997) p. 596-611.
Montgomery and Buffington 1998	Montgomery, D., and Buffington, J. 1998. *Channel processes, classification, and response: in River Ecology and Management*. Robert Naiman & Robert Bilby [editors]: Springer-Verlag New York, Inc., p. 13-39.
Montgomery and MacDonald 2002	Montgomery, D., and MacDonald, L. 2002. "Diagnostic approach to stream channel assessment and monitoring." *Journal of the American Water Resources Association 38: 1-16.*
NOAA Fisheries 1996	NOAA's National Marine Fisheries Service. 1996. *Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale* [Matrix of Pathways and Indicators]: NOAA's National Marine Fisheries Service, Northwest Region, Portland, Oregon.
NOAA Fisheries 2010	NOAA's National Marine Fisheries Service. 2010. *Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program*. May 20, 2010, F/NWR/2010/0209.
NOAA Fisheries 2011	NOAA's National Marine Fisheries Service. 2011. *Draft recovery plan for the Idaho Snake River spring/summer Chinook and steelhead populations in the Snake River spring/summer Chinook salmon evolutionary significant unit and Snake River steelhead distinct population segment.* National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Boise, Idaho.
ODFW 2010	Oregon Department of Fish and Wildlife. 2010. *Aquatic inventories project methods for stream habitat surveys*. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Conservation and Recovery Program, Corvallis, Oregon 70 p.
Overton, Radko, and Woolrab 1999	Overton, C., Radko, M., and Wollrab, S. 1999. *Watershed analysis approaches for Chinook salmon, Yankee Fork of the Salmon River, Idaho*. An example [draft]: U.S.D.A. Forest Service, Rocky Mountain Research Station, Boise, Idaho 47 p.

Parenthetical Reference	**Bibliographic Citation**
Rapp and Abbe 2003	Rapp, C., and Abbe, T. 2003. "A framework for delineating channel migration zones." Washington State Department of Ecology, *Ecology Publication #03-06027*. 66 p.
Reclamation 2011	U.S. Department of the Interior, Bureau of Reclamation. 2011. *SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water 2011*. Prepared for: United States Congress. 226 p.
Reclamation 2012	Bureau of Reclamation. 2012. Yankee Fork Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho: Department of Interior, Bureau of Reclamation, Pacific Northwest Region, Boise, Idaho, 153 p.
Reiser and Ramey 1987	Reiser, D.W., and M.P. Ramey. 1987. *Feasibility Plan For The Enhancement Of The Yankee Fork Of The Salmon River, Idaho*. Prepared for the Shoshone-Bannock Tribes Fisheries Department. Fort Hall, Idaho. BPA contract No. 83-359.
Richards and Cernera 1989	Richards, C., and Cernera, P. 1989. Dispersal and abundance of hatchery-reared and naturally spawned juvenile Chinook salmon in an Idaho stream: North American Journal of Fisheries Management, 9:345-351 p.
Richards et al. 1992	Richards, C., Cernera, P., Ramey, M., and Reiser, D. 1992. Development of off-channel habitats for use by juvenile Chinook salmon: North American Journal of Fisheries Management, 12: 721-727 p.
Rowe et al. 1989	Rowe, M., S. Spaulding, J., Gunderman, and K. Bacon. 1989. *Salmon River habitat enhancement annual report 1989, subproject II: Yankee Fork Salmon River*. Prepared for the U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Project 83-359, Portland, Oregon.
SBT 2011	Shoshone Bannock Tribes. 2011. *Crystal Springs Fish Hatchery and programs for Snake River Chinook Salmon and Yellowstone Cutthroat Trout, Master Plan*. Shoshone Bannock Tribes, Fort Hall, Idaho, 198 p.
Tsosie, Bacon, and Wadsworth 2009	Tsosie, T., Bacon, K., and Wadsworth, P. 2009. Salmon River Habitat Enhancement: Shoshone-Bannock Tribes, Fort Hall, Idaho.
USFB 1934	Bureau of Fisheries. 1934. West Fork of the Yankee Fork stream survey: U.S. Department of Commerce, Bureau of Fisheries.
USFS 1994	U.S. Department of Agriculture, Forest Service. 1994. Section 7 fish habitat monitoring protocol for the Upper Columbia River Basin: U.S. Department of Agriculture, Forest Service, Pacific Northwest, Intermountain, and Northern Regions 59 p.

Parenthetical Reference	Bibliographic Citation
USFS 1995	U.S. Department of Agriculture, Forest Service. 1995. Biological assessment for Chinook salmon in the Yankee Fork Section 7 watershed: Challis National Forest, 264 p.
USFS 2006	U.S. Department of Agriculture, Forest Service. 2006. *Biological assessment for the potential effects of managing the Salmon-Challis National Forest in the Yankee Fork Section 7 Watershed on Snake River Basin Spring/Summer Chinook Salmon, Snake River Steelhead, and Columbia River Bull Trout [Draft]*. U.S. Department of Agriculture, Salmon-Challis National Forest, Yankee Fork Ranger District, Clayton, Idaho. 126 p.
USFS 2010	U.S. Department of Agriculture, Forest Service. 2010. *Stream Inventory Handbook, Level I & II, Version 2.10*. Pacific Northwest Region, Region 6, Portland, Oregon.
USFWS 1998	U.S. Fish and Wildlife Service. 1998. A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the Bull Trout subpopulation watershed scale: U.S. Fish and Wildlife Service, 49 p.
USGS 1995	U.S. Geological Survey. 1995. "Geology and Mineral Resource Assessment of the Challis 1º X 2º Quadrangle." *Professional Paper 1525*. U.S. Geological Survey, U.S. Government Printing Office, Washington, 204 p. + maps.
USGS 2009	U.S. Geological Survey. 2009. "Stream-sediment geochemistry in mining-impacted drainages of the Yankee Fork of the Salmon River, Custer County, Idaho." *U.S. Geological Survey Scientific Investigation Report 2009-5115*. 49 p.

This page intentionally left blank

GLOSSARY

Some terms in the glossary appear in this Reach Assessment.

TERM	DEFINITION
action	Proposed protection and/or rehabilitation strategy to improve selected physical and ecological processes that may be limiting the productivity, abundance, spatial structure or diversity of the focal species. Examples include removing or modifying passage barriers to reconnect isolated habitat (i.e., tributaries), planting appropriate vegetation to reestablish or improve the riparian corridor along a stream that reconnects channel/floodplain processes, placement of large wood to improve habitat complexity, cover and increase biomass that reconnects isolated habitat units.
alluvial fan	An outspread, gently sloping mass of alluvium deposited by a stream, esp. in an arid or semiarid region where a stream issues from a narrow canyon onto a plain or valley floor. Viewed from above, it has the shape of an open fan, the apex being at the canyon mouth.
alluvium	A general term for detrital deposits made by streams on river beds, floodplains, and alluvial fans; esp. a deposit of silt or silty caly laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas and lakes.
anadromous fish	A fish, such as the Pacific salmon, that spawns and spends its early life in freshwater but moves into the ocean where it attains sexual maturity and spends most of its life span.
anthropogenic	Caused by human activities.
bank	The margins of a channel. Banks are called right or left as viewed facing in the direction of the flow.
baseflow	That part of the streamflow that is not attributable to direct runoff from precipitation or melting snow; it is usually sustained by groundwater discharge.
basin	The drainage area of a river and its tributaries.
bedrock	The solid rock that underlies gravel, soil or other superficial material and is generally resistant to fluvial erosion over a span of several decades, but may erode over longer time periods.
cfs	Cubic feet per second; a measure of water flows

TERM	DEFINITION
channel forming flow	Sometimes referred to as the effective flow or ordinary high water flow and often as the bankfull flow or discharge. For most streams, the channel forming flow is the flow that has a recurrence internal of approximately 1.5 years in the annual flood series. Most channel forming discharges range between 1.0 and 1.8. In some areas it could be lower or higher than this range. It is the flow that transports the most sediment for the least amount of energy, mobilizes and redistributes the annually transient bedload, and maintains long-term channel form.
channel morphology	The physical dimension, shape, form, pattern, profile and structure of a stream channel.
channel planform	The two-dimensional longitudinal pattern of a river channel as viewed on the ground surface, aerial photograph or map.
channelization	The straightening and/or deepening of a stream channel, typically to permit the water to move faster, to reduce flooding, or to drain marshy acreage.
colluvial	A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.
control	A natural or human feature that restrains a streams ability to move laterally and/or vertically.
degradation	Transition from a higher to lower level or quality. A general lowering of the earth's surface by erosion or transportation in running waters. Also refers to the quality (or loss) of functional elements within an ecosystem.
discharge	The volume per unit of time of streamflow at a given instant or for a given area. Discharge is often used interchangeably with streamflow.
diversity	Genetic and phenotypic (life history traits, behavior, and morphology) variation within a population. Also refers variations in physical conditions or habitat.
dredging	The various processes by which material is mined from a water body, often by large floating machines, or dredges, scoop up earth material at the bottom of a body of water, raise it to the surface, and discharge it back to the water body after removal of ore minerals.
ecosystem	An ecologic system, composed of organisms and their environment. It is the result of interaction between biological, geochemical, and geophysical systems.
erosion	Wearing away of the lands by running water, glaciers, winds, and waves.
fine sediment	Sand, silt and organic material that have a grain size of 6.4 mm or less.
floodplain	That portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stages.
fluvial	Produced by the action of a river or stream. Also used to refer to something relating to or inhabiting a river or stream. Fish that migrate between rivers and streams are labeled "fluvial."

TERM	DEFINITION
fluvial process	A process related to the movement of flowing water that shape the surface of the earth through the erosion, transport, and deposition of sediment, soil particles, and organic debris.
geomorphic reach	An area containing the active channel and its floodplain bounded by vertical and/or lateral geologic controls, such as alluvial fans or bedrock outcrops, and frequently separated from other reaches by abrupt changes in channel slope and valley confinement. Within a geomorphic reach, similar fluvial processes govern channel planform and geometry resulting from streamflow and sediment transport.
geomorphology	The science that focuses on the general configuraion of the earth's surface; specif. the study of the classification, description, nature, origin and development of landforms and their relationships to underlying structures, and the history of geologic changes as recorded by these surface features.
GIS	Geographical information system. An organized collection of computer hardware, software, and geographic data designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.
gradient	Degree of inclination of a part of the earth's surface; steepness of slope. It may be expressed as a ratio (of vertical to horizontal), fraction, percentage, or angle.
groundwater	That part of the subsurface water that is in the saturated zone.
habitat connectivity	Aquatic and/or terrestrial conditions that are linked together and needed to provide the physical and ecological processes necessary for the transfer of energy (i.e., food web) to maintain all life stages of species that are dependent on the riverine ecosystem.
habitat unit	A segment of a stream which has a distinct set of characteristics.
headwaters	Streams at the source of a river.
hydraulics	The branch of fluid mechanics dealing with the flow of water in conduits and open channels.
hydrograph	A graph relating stage, flow, velocity, or other characteristics of water with respect to time.
hydrology	The applied science concerned with the waters of the earth, their occurrences, distribution, and circulation through the unending hydrologic cycle of: precipitation, consequent runoff, infiltration, and storage; eventual evaporation; and so forth. It is concerned with the physical and chemical reaction of water with the rest of the earth, and its relation to the life of the earth.
indicator	A variable used to forecast the value or change in the value of another variable; for example, using temperature, turbidity, and chemical contaminents or nutrients to measure water quality.

TERM	DEFINITION
limiting factor	Any factor in the environment that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.
mainstem	The reach of a river/stream formed by the tributaries that flow into it.
peak flow	Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.
perennial stream	A stream that flows all year round. Compare intermittent stream.
reach	A section between two specific points outlining a portion of the stream, or river.
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
recurrence interval	The average amount of time between events of a given magnitude. For example, there is a 1 percent chance that a 100-year flood will occur in any given year.
redd	A nest built in gravel or small substrate materials by salmonids where eggs are deposited; the nest is excavated by the adult fish and the eggs are covered by the female after spawning.
riparian area	An area adjacent to a stream, wetland, or other body of water that is transitional between terrestrial and aquatic ecosystems. Riparian areas usually have distinctive soils and vegetation community/composition resulting from interaction with the water body and adjacent soils.
riprap	Materials (typically large angular rocks) that are placed along a river bank to prevent or slow erosion.
river mile (RM)	Miles measured in the upstream direction beginning from the mouth of a river or its confluence with the next downstream river.
runoff	That part of precipitation that flows toward the streams on the surface of the ground or within the ground. Runoff is composed of baseflow and surface runoff.
shear stress	The combination of depth and velocity of water. It is a measure of the erosive energy associated with flowing water.
side channel	A distinct channel with its own defined banks that is not part of the main channel, but appears to convey water perennially or seasonally/ephemerally. May also be referred to as a secondary channel.
sinuosity	Ratio of the length of the channel or thalweg to the down-valley distance. Channels with sinuosities of 1.5 or more are called "meandering."
smolt	A subadult salmonid that is migrating from freshwater to seawater; the physiological adaptation of a salmonid from living in freshwater to living in seawater.

TERM	DEFINITION
spawning and rearing habitat	Stream reaches and the associated watershed areas that provide all habitat components necessary for adult spawning and juvenile rearing for a local salmonid population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident and migratory fish, and may also support subadults and adults from local populations.
subbasin	A subbasin represents the drainage area upslope of any point along a channel network (Montgomery and Bolton 2003). Downstream boundaries of subbasins are typically defined in this assessment at the location of a confluence between a tributary and mainstem channel.
terrace	A relatively level bench or steplike surface breaking the continuity of a slope. The term is applied to both the lower or front slope (the riser) and the flat surface (the tread).
Total Maximum Daily Load (TMDL)	TMDLs are written plans and analyses established to ensure that the waterbody will attain and maintain water quality standards. The OAR definition is "The sum of the individual wasteload allocations (WLAs) for point sources and LAs for nonpoint sources and background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any nonpoint sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. If Best Management Practices (BMPs) or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TDML prcess provides for nonpoint source control tradeoffs."
tributary	Any stream that contributes water to another stream.
valley segment	An area of river within a watershed sometimes referred to as a subwatershed that is comprised of smaller geomorphic reaches. Within a valley segment, multiple floodplain types exist and may range between wide, highly complex floodplains with frequently accessed side channels to narrow and minimally complex floodplains with no side channels. Typical scales of a valley segment are on the order of a few to tens of miles in longitudinal length.
viable salmonid population	An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity (ICBTRT 2007).
watershed	The area of land from which rainfall and/or snow melt drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins. Ridges of higher ground form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

This page intentionally left blank

APPENDICES

This page intentionally left blank

APPENDIX A

Reach-based Ecosystem Indicators

This page intentionally left blank

Appendix A

Reach-based Ecosystem Indicators (REI)

The reach-based ecosystem indicators table has been compiled from literature review, data contained in the *Yankee Fork Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho* (Reclamation 2012), and from new data collected for this assessment. The metrics used in this REI are for existing conditions (2011) based on anthropogenic constraints (i.e., mine tailings). At the reach-scale, the thresholds in the REI were derived primarily from the Matrix of Pathways and Indicators (NOAA Fisheries 1996) and Matrix of Diagnostics/Pathways and Indicators (USFWS 1998). The criteria and thresholds are for a "Desired Future Condition" for low-gradient, unconstrained valley bottom reaches and are not absolute, and should be adjusted to each unique subbasin as data become available (USFS 1994: Endangered Species Act Section 7 Consultation).

General Regional Characteristics

At the regional spatial scale, characteristics are described by ecoregion, drainage basin, valley segments, and channel segments. This information informs planners and evaluators on the regional setting where the assessment occurred.

Watershed Characteristics

At the watershed/subwatershed spatial scales, several reach-based ecosystem indicators are evaluated as general indicators to inform planners and evaluators on how the geomorphic and ecologic processes are functioning. At this scale, an overall condition is evaluated to determine if deficiencies at the reach-scale are symptomatic of a larger (watershed scale) problem that should be addressed to reduce impact to the sustainability and effectiveness of planned habitat actions.

Reach Characteristics

At the reach spatial scale, individual reach-based ecosystem indicators are evaluated to inform planners and evaluators on the condition status of indicators that are responsive to reach scale impacts. The condition status, based on the geomorphology of the stream (i.e., valley confinement, channel type, gradient), is assigned as **adequate** for those that meet or exceed criteria and **at risk** or **unacceptable** for those that could use improvement. When the criteria are not applicable, based on geomorphology of the stream, a justification for the condition status is given in the narrative.

GENERAL REGIONAL CHARACTERISTICS

REGIONAL SETTING

Ecoregion	
Bailey's Classification	Challis Volcanic Section of the Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province (www.nationalatlas.gov)
Omernik Classification	Idaho Batholith (www.nationalatlas.gov)
Physiography	Northern Rocky Mountains physiographic province which is characterized by a rugged, mountainous landscape that has been dissected by fluvial and glacial erosion (Fenneman 1931)
Geology	Quaternary alluvium, Tertiary volcanic and plutonic rocks, Cretaceous intrusive rocks, and Paleozoic and Precambrian sedimentary and metamorphic rocks (USGS 1995)

DRAINAGE BASIN CHARACTERISTICS

Geomorphic Features	Yankee Fork Basin Area	Basin Relief	Drainage Density	Hydrologic Unit Code (5th Field)	Strahler Stream Order	Land Ownership
	122,000 acres	4,407 feet (10,329-5,922 feet elevation)	2.71 mi/mi^2	1706020105	6	>99% public <1% private

VALLEY SEGMENT CHARACTERISTICS

Valley Characteristics	Valley Type	Valley Bottom Type	Average Valley Bottom Gradient	Average Constrained Valley Bottom Width[2]	Average Unvegetated Channel Width	Channel Confinement[3]
Yankee Fork (West Fork Confluence, RM 6.8[1], to downstream of Pole Flat Campground, RM 3.1)	Alluvial	Glaciated U-shaped valley	1.1%	150 feet	65 feet	Moderately Confined (2.3)

[1] 2011 Yankee Fork and West Fork river miles (RM)
[2] Average constrained valley bottom widths are based on geologic and/or geomorphic features that constrain the channel and floodplain, modified from the Oregon Department of Fish and Wildlife (2010) to include anthropogenic constraints (i.e., mine tailings and levees).
[3] Degree of channel confinement is classified as confined (average constrained valley bottom width less than 2 average unvegetated channel widths), moderately confined (average constrained valley bottom width is equal to 2-4 average unvegetated channel widths, or unconfined (average constrained valley bottom width is greater than 4 average unvegetated channel widths; adapted from Bisson and Montgomery 1996 to recognize changes due to geomorphic channel constraints in highly disturbed systems.

CHANNEL REACH CHARACTERISTICS

Location	Channel Reach Type[1]	Bedform Type[1]	Channel Gradient	Sinuosity
Yankee Fork (RM 6.8-3.1)	Free-formed alluvial channel	Plane-bed	0.6 %	1.1

[1]Montgomery and Buffington (1998)

WATERSHED CHARACTERISTICS

GENERAL INDICATOR: EFFECTIVE DRAINAGE NETWORK AND WATERSHED ROAD DENSITY

Criteria: The following criteria were developed by USFWS (1998).

General Characteristics	General Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Condition	Effective Drainage Network and Watershed Road Density	Zero or minimum increases in active channel length correlated with human caused disturbance. And Road density <1 miles/miles^2.	Low to moderate increase in active channel length correlated with human caused disturbances. And Road density 1-2.4 miles/miles^2.	Greater than moderate increase in active channel length correlated with human caused disturbances. And Road density >2.4 miles/miles^2.

Narrative:

Road densities (0.85 mi/mi^2 excluding mining access roads and all-terrain vehicle trails) are low within the Yankee Fork watershed, there are several roads that are valley bottom roads and adjacent to waterways. The thresholds contained in the matrix of pathways and indicators for properly functioning are: (1) less than 2 mi/mi^2 of road, and (2) no valley bottom roads. For **at risk**, the thresholds are: (1) 2 to 3 mi/mi^2 of road, and (2) some valley bottom roads. Presently, this road density indicator is **at risk** based on roads being located on the valley bottoms and adjacent to fish-bearing streams. An analysis of all roads, including mining access roads and all-terrain vehicle trails, is needed to provide further clarification on the actual effects roads may have on waterways, erosion potential, and habitat quality (Reclamation 2012).

GENERAL INDICATOR: DISTURBANCE REGIME (NATURAL/HUMAN)

Criteria: The following criteria were modified from USFWS (1998).

General Characteristics	General Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Condition	Disturbance Regime	Environmental disturbance is short lived; predictable hydrograph, high quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Scour events, debris torrents, or catastrophic fires are localized events that occur in several minor parts of the watershed. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major part of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.

Narrative:

Mining activities have resulted in the most significant anthropogenic disturbances in the watershed. The dredged area along the Yankee Fork valley bottom between Jordan Creek and Pole Flat Campground, and the lower 1.4-mile section of lower Jordan Creek are the most negatively affected areas based on physical and ecological processes. Valley bottoms were cleared of vegetation and are now predominantly barren mounds of dredge tailings with isolated patches of vegetation resulting in fragmentation of terrestrial and aquatic ecological interactions. The construction of the Yankee Fork channel and channelization of tributaries through the dredge tailings has further confined these channels and reduced channel/floodplain interactions, disconnected tributaries, and increased flow velocity and shear stress within the channel. Impacts to aquatic habitat include: (1) loss of juvenile rearing habitat and high water refugia; (2) reduction in spawning habitat; (3) isolation of tributaries that historically provided juvenile rearing habitat; and (4) increased flow velocities and shear stress in several channels.

Past livestock grazing and timber harvest practices impacted (1) channel form and function; (2) streambank stability; (3) sediment supply and delivery; (4) thermal regimes; and (5) ecological connectivity. Current USFS management practices preclude livestock grazing and timber harvest activities on their administered lands. The indication is that vegetation density and coverage along stream corridors and valley walls have been improving, except in areas where dredge tailings persist. The improving riparian and upland vegetation conditions have positively impacted sediment supply and delivery processes to the channel network by reducing erosion and providing streambank stability. In addition, as vegetation grows and progresses from small tree to mature tree successional stages, larger wood sizes will become increasingly more available to the channel networks.

The condition rating for anthropogenic disturbance history is **at risk** due to negative impacts from past and present mining activities (Reclamation 2012).

GENERAL INDICATOR: FLOW/HYDROLOGY

Criteria: The following criteria were developed by USFWS (1998).

General Characteristics	General Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Condition	Flow/hydrology	Magnitude, timing, duration and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology and geography.	Some evidence of altered magnitude, timing duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology and geography.

Narrative:

The Yankee Fork is a snowmelt dominated system that is characterized by a spring snowmelt runoff with low summer and winter flows, except for occasional rain-on-snow events that typically occur in late fall (November and December) and late winter (January and February). The annual hydrograph (Figure 1) illustrates that annual peak flows occur during spring runoff from May through June and base flows of approximately 30 cfs can extend from September through March. Based on the flow exceedance curve, a flow rate of 200 cfs is equaled or exceeded 20 percent of the time and a flow rate of 500 cfs is equaled or exceeded 10 percent of the time. Peak flow statistics determined by the USGS are summarized in Table 1 (Reclamation 2012).

The flow/hydrology regime have been affected in the lower Yankee Fork subwatershed due to dredge tailings and the Custer Motorway that disconnect tributary surface water flows from reaching the mainstem Yankee Fork; thereby reducing the magnitude and timing of peak flows in the mainstem Yankee Fork. The disconnected tributaries do provide groundwater to the mainstem Yankee Fork through hyporheic flow, but the transmissivity of the sand to boulder size dredge materials increases the amount of time that it takes for such flows to reach the mainstem Yankee Fork which attenuates the amplitude of the hydrograph. Therefore, the flow/hydrology general indicator is **at risk**.

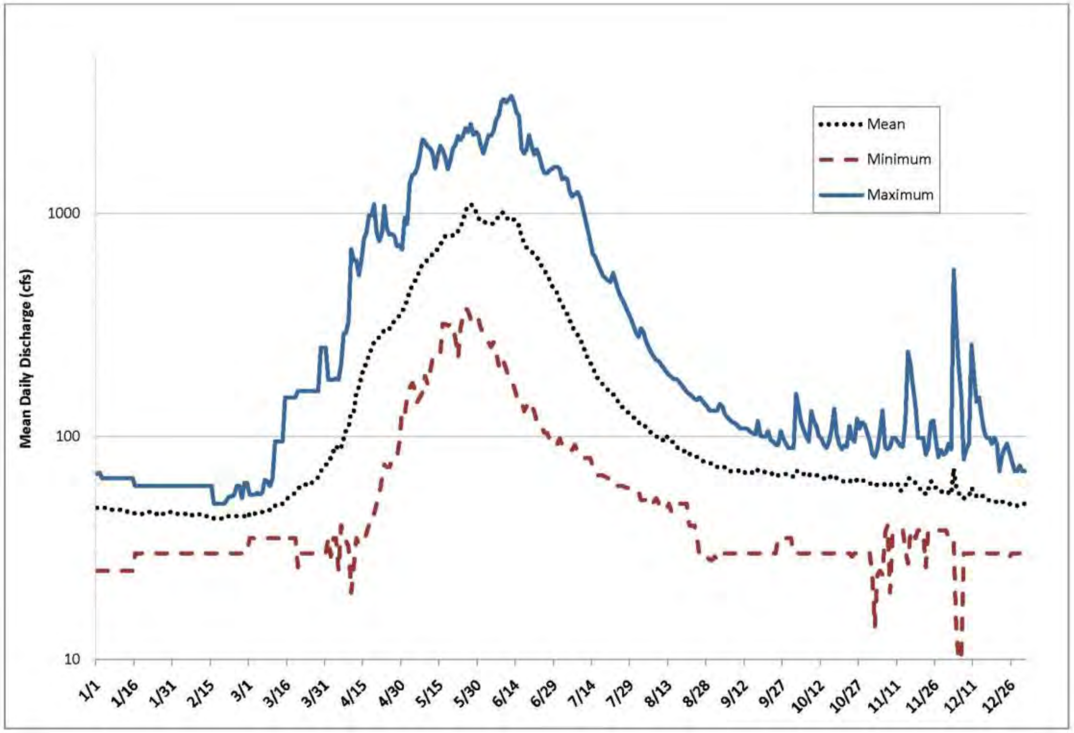


Figure 1. USGS 13296000 Gage Annual Hydrograph (Period of Record 1922-1949).

Table 1. USGS 13296000 Peak Flow Statistics Estimated by Berenbrock (2002) (Period of Record 1921-1949, 1974).

High Flow Statistic		Discharge, cfs
Recurrence Interval, years	Probability of Occurrence, %	
2	50	1,470
5	20	2,240
10	10	2,780
25	4	3,490
50	2	4,030
100	1	4,590
200	0.5	5,160
500	0.2	5,940

GENERAL INDICATOR: WATER QUANTITY AND QUALITY

Criteria: The following criteria were adapted and modified from the USFWS (1998).

General Characteristics	General Indicators	Adequate Condition	At Risk Condition	Unacceptable Condition
Water Quality and Quantity	Quantity/Temperature/Chemical Contamination/ Nutrients	Adequate instream flows for habitat, low levels of water quality impairments from landuse sources, no excessive nutrients, no CWA 303d designated reaches.	Inadequate instream flows for habitat, moderate levels of water quality impairments from landuse sources, some excess nutrients, CWA 303d designated reaches.	Inadequate instream flows for habitat, high levels of water quality impairments from landuse sources, high levels of excess nutrients, CWA 303d designated reaches.

Narrative:

Water quality presently meets IDEQ standards. Conditions were all found to be currently functioning properly although there was some variability for the fine sediment and surface water temperature indicators. Although the chemical contamination indicator is currently within the properly functioning threshold, there are some chemical contaminant sources related to past and present mining activities that may become available to the channel network through natural and anthropogenic disturbances; thereby, posing a threat to aquatic species. The ongoing mining activities and presence of elemental mercury from past mining in the watershed justifies a condition rating of **at risk** for chemical contamination (Reclamation 2012).

Instream flows (water quantity) are currently sufficient to maintain year-round access through the Yankee Fork mainstem to other fish-bearing tributaries (i.e., West Fork, Jordan Creek, Eightmile Creek, etc.). There are no dams regulating flows and there is no evidence showing a change in the hydrograph timing, peak flow, or base flow for the period of record. Therefore, based on current information, the water quantity indicator is **adequate** (Reclamation 2012).

GENERAL INDICATOR: MAIN CHANNEL PHYSICAL BARRIERS (NATURAL/HUMAN)

Criteria: The following criteria have been modified from USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Access	Main Channel Physical Barriers	Barriers (Natural/Human)	No manmade barriers present in the mainstem that limit upstream or downstream migration at any flow.	Manmade barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant.	Manmade barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.

Narrative:

There are no man-made physical barriers present on the mainstem of the Yankee Fork that prevent fish passage (Reclamation 2012). Therefore, the habitat access general indication is **adequate**.

REACH CHARACTERISTICS

GENERAL INDICATOR: WATER TEMPERATURE

Criteria: The following criteria were developed by Hillman and Giorgi (2002) and USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Water Quality	Water Temperature	MWMT/ MDMT/ 7-DADMax	Bull Trout: Incubation: 2-5°C Rearing: 4-10°C Spawning: 1-9°C Salmon and Steelhead: Spawning: June-Sept 15°C Sept-May 12°C Rearing: 15°C Migration: 15°C Adult holding: 15°C	MWMT in reach during the following life history stages: Incubation: <2°C or 6°C Rearing: <4°C or 13-15°C Spawning: <4°C or 10°C Temperatures in areas used by adults during the local spawning migration sometimes exceed 15°C.	MWMT in reach during the following life history stages: Incubation: <1°C or >6°C Rearing: >15°C Spawning: <4°C or >10°C Temperatures in areas used by adults during the local spawning migration regularly exceed 15°C.

Narrative:

Table 2 and Table 3 summarize the water temperature thresholds used by the Salmon-Challis National Forest and IDEQ. Water temperature monitoring by the Salmon-Challis National Forest indicate that the maximum weekly (7-day average) maximum temperature at most water temperature monitoring stations along the mainstem Yankee Fork exceeded the temperature limits set by the USFS. The 2001 Yankee Fork Watershed Analysis explains that water temperatures are generally less than 57º F within most reaches (USFS 2006). Water temperatures are warmer during the late summer period in the Yankee Fork below Jordan Creek and fish seek refugia in cooler tributary streams (i.e., West Fork where water temperatures are generally 37 to 41º F). Water temperature is not considered limiting in most surface waters, with the exception of the dredged area on the Yankee Fork below Jordan Creek (USFS 2006).

Table 2. USFS water temperature standards for salmonids (USFS 2006).

Use Metric	Salmonid Incubation	Salmonid Juvenile Rearing	Salmonid Spawning
MWMT[1]	36-41º F (2-5º C)	39-54º F (4-12º C)	39-48º F (4-9º C)

[1]MWMT = Maximum Weekly (7-day average) Maximum Temperature

Table 3. IDEQ water temperature standards for cold water use (http://www.deq.idaho.gov/water-quality/surface-water/temperature.aspx).

Use Metric	Cold Water	Salmonid Spawning	Bull Trout
MDMT[1]	72º F (22º C)	55º F (13º C)	N/A
MWMT[2]	N/A	N/A	55º F (13º C)
MDAT[3]	66º F (19º C)	48º F (9º C)	N/A

[1]MDMT = Maximum Daily Maximum Temperature
[2]MWMT = Maximum Weekly (7-day average) Maximum Temperature
[3]MDAT = Maximum Daily Average Temperature

Detailed thermal imaging was conducted in 2010 along the Yankee Fork between RM 16.4 and 3.4, Jordan Creek between RM 4 and 0, West Fork, and Rankin Creek in August 2010 (Watershed Sciences 2010). Complete analysis of the data and trends are included in Appendix J of the *Tributary Assessment* (Reclamation 2012).

Along the Yankee Fork mainstem between about RM 16.4 and 3.4, water temperatures generally ranged from 48 to 56º F. Eightmile Creek (RM 16.4) and Jordan Creek (RM 9.1) were noted to contribute warmer waters to the mainstem. The West Fork had an insignificant influence on water temperature in the Yankee Fork. Ramey Creek and Rankin Creek provide cooler water to the mainstem near RM 4.6 and 4.3, respectively. Some tailing pond outlets contributed warmer waters, but most contributed cooler waters. Several springs also contributed cooler waters and their locations were noted in the analysis.

In Jordan Creek between about RM 4 to the Yankee Fork confluence, water temperatures generally ranged from 49 to 60º F. Along the lower ½-mile of the creek, water temperatures exceeded 59º F. A mine discharge outlet near RM 4 contributed significantly warmer waters to Jordan Creek. Inflows from smaller tributaries contributed predominantly cooler waters with only a few exceptions.

In general, warm water contributions to the Yankee Fork come from Jordan Creek and some tailing pond outlets. There are also several smaller tributaries, springs, and tailing ponds that contribute cooler waters to the Yankee Fork. Warm water temperatures and their effects on habitat quality are a concern primarily in the Yankee Fork downstream of Jordan Creek (Reaches YF-2 and YF-3) where unvegetated mine tailings covers the valley bottom. The Salmon-Challis National Forest considers the Yankee Fork watershed to be **at risk** for the water temperature indicator (Status of baseline conditions for Yankee Fork watershed, Salmon-Challis National Forest, updated December 12, 2011).

GENERAL INDICATOR: CHANNEL SUBSTRATE

Criteria: Performance standards for these criteria are from Hillman and Giorgi (2002).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Substrate	Dominant Substrate/ Fine Sediment	Gravels or small cobbles make-up >50% of the bed materials in spawning areas. Reach embeddedness in rearing areas <20%. <12% fines (<0.85mm) in spawning gravel or ≤12% surface fines of ≤6mm.	Gravels or small cobbles make-up 30-50% of the bed materials in spawning areas. Reach embeddedness in rearing areas 20-30%. 12-17% fines (<0.85mm) in spawning gravel or 12-20% surface fines of ≤6mm.	Gravels or small cobbles make-up <30% of the bed materials in spawning areas. Reach embeddedness in rearing areas >30%. >17% fines (<0.85mm) in spawning gravel or >20% surface fines of ≤6mm.

Narrative:

Channel confinement influences the stream's sediment transport capacity differently in each of the channel segments observed in this assessment. The Yankee Fork is artificially confined between RM 6.8 and 3.4 by mine tailings. Dominant substrate, or armor layer, is comprised of cobble with gravel (USFS 2010) due to the high energy, high transport capacity within this channel reach. . However, there are quite a few spawning patches that due have adequate substrate. Historically, the channel was moderately confined from the Yankee Fork and West Fork confluence to Pole Flat Campground, but the dredging along the valley bottom reduced the average constrained valley bottom with by about 40 percent (about 250 feet to 150 feet). The thresholds listed for substrate do not apply to moderately confined, plane-bed channels, but due to the increase in channel confinement and change to the geometry of the channel/floodplain cross sectional area, the mainstem is functioning in an **at risk** condition for substrate. Table 4 summarizes the substrate and condition rating by channel segment.

Table 4. Dominant substrate and approximate gradation

Channel Segment	Dominant Substrate	Approximate Substrate Gradation	Condition Rating
Yankee Fork (RM 6.8-3.1)	Cobble (64-256 mm)	Cobble (45%); Gravel (30%); Sand (15%); Boulder (5%); Bedrock (5%)	At Risk

GENERAL INDICATOR: CHEMICAL CONTAMINATION/NUTRIENTS

Criteria: The following criteria were developed by USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Condition
Water Quality	Chemical Contamination/ Nutrients	Metals/ Pollutants, pH, DO, Nitrogen, Phosphorous	Low levels of chemical contamination from land use sources, no excessive nutrients, no CWA 303d designated reaches.	Moderate levels of chemical contamination from land use sources, some excess nutrients, one CWA 303d designated reach.	High levels of chemical contamination from land use sources, high levels of excess nutrients, more than one CWA 303d designated reach.

Narrative:

There remains a potential risk of chemical contamination from past and present mining activities (i.e., selenium, mercury, cyanide, etc.). Past mining activities are known to have had negative water quality impacts. For example, Rodeheffer (1935) reported “that creek (Jordan Creek) is so badly polluted by several small mines along its course that no fish or fish foods are found.” Pollution control efforts have been implemented at the Grouse Creek Mine which is being reclaimed to control discharge of cyanide from leaking tailings ponds into Jordan Creek which flows into the Yankee Fork near RM 9.1, and the Preachers Cove ore processing site on the Yankee Fork near RM 7.3 has been reclaimed (IDEQ 2003). Presently, there are no chemical contaminants that are not within IDEQ standards, so the chemical contamination/nutrients indicator condition is **adequate**. However, some chemical contaminant sources related to past and present mining activities pose a risk that contaminants may become available to the channel network (Reclamation 2012).

GENERAL INDICATOR: HABITAT ACCESS

Criteria: The following criteria have been modified from USFWS (1998).

General Characteristics	General Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Access	Physical Barriers	No manmade barriers present that inhibit salmonid access to tributaries and/or off-channel habitats.	Few manmade barriers present that prevent or inhibit salmonid access to tributaries and/or off-channel habitats.	Many manmade barriers present that prevent or inhibit salmonid access to tributaries and/or off-channel habitats.

Narrative:

Dredge tailings prevent access to off-channel habitats (i.e., connected floodplain patches) that were historically accessible to salmonids. These floodplains and associated floodplain-type side channels historically provided juvenile rearing and high water refugia habitats. Silver Creek and Jerrys Creek drainages are disconnected from the Yankee Fork mainstem by dredge tailings and the Custer Motorway. Therefore, habitat access is **unacceptable** due to physical barriers (i.e., dredge tailings) disconnecting floodplain patches and isolating tributary drainages.

GENERAL INDICATOR: INSTREAM WOOD

Criteria: The following criteria were developed by USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Instream Wood	Pieces Per Mile at Bankfull	>20 pieces/mile >12" diameter >35 ft length; and adequate sources of woody debris available for both long- and short-term recruitment.	Currently levels are being maintained at minimum levels desired for "adequate", but potential sources for long-term woody debris recruitment is lacking to maintain these minimum values.	Current levels are not at those desired values for "adequate", and potential sources of woody debris for short- and/or long-term recruitment are lacking.

Narrative:

Channel confinement influences the stream's sediment transport capacity and its ability to transport wood. The Yankee Fork is artificially confined between RM 6.8 and 3.4 by mine tailings. A stream inventory survey conducted by the Forest Service in this channel reach in 2010 determined the wood frequency was less than 3 pieces per mile in the main channel (USFS 2010). Wood would not be expected to be retained in this high energy channel. The threshold for wood frequency should not be expected to be met in a plane-bed channel due to the inherent higher energy and higher transport capacity as compared with a pool-riffle channel. The listed thresholds do not apply to this moderately confined plane-bed channel reach. Therefore, the Yankee Fork is now functioning in an **at risk** condition because there is an insufficient supply of wood available for recruitment by the stream.

GENERAL INDICATOR: POOLS

Criteria: The following criteria were adapted from USFWS (1998) and Montgomery and Buffington (1993).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Pools	Pool Frequency and Quality Large Pools (in adult holding, juvenile rearing, and over-wintering reaches where streams are >3 m in wetted width at base flow)	Pool frequency: Channel width — No. pools/mile 0.5 ft — 39 5-10 ft — 60 10-15 ft — 48 15-20 ft — 39 20-30 ft — 23 30-35 ft — 18 35-40 ft — 10 40-65 ft — 9 65-100 ft — 4 For channel widths greater than 100 feet, pool spacing for an alluvial valley type that are moderately confined to unconfined with a channel slope <2% is generally a pool for every 5-7 channel widths (Montgomery and Buffington (1993). Pools have good cover and cool water and only minor reduction of pool volume by fine sediment. Each reach has many large pools >1 m deep with good fish cover.	Pool frequency is similar to values in “functioning adequately”, but pools have inadequate cover/temperature, and/or there has been a moderate reduction of pool volume by fine sediment. Reaches have few large pools (>1 m) present with good fish cover.	Pool frequency is considerably lower than values for “functioning adequately”, also cover/temperature is inadequate, and there has been a major reduction of pool volume by fine sediment. Reaches have no deep pools (>1 m) with good fish cover.

Narrative:

From RM 6.8 to 3.1 the Yankee Fork has a moderately confined, plane-bed channel. In this type of channel flow velocities and shear stresses tend to armor the bed which inhibits pool development when flows are not sufficient to mobilize the armoring particles. This channel reach is dominated by riffles (75 percent of total wetted area [TWA]) and lacks pools (6 percent TWA) because there are only a few forcing agents that provide sufficient flow convergence to scour the streambed. The listed threshold for pool frequency is not necessarily applicable to this straight, plane-bed channel because pool creation is (a) variable for these channel types and (b) controlled by the availability of forcing agents that provide sufficient flow convergence to scour the bed. The Yankee Fork is currently functioning in an **at risk** condition because (1) the channel is artificially constricted and no longer has the ability to migrate laterally, (2) there is low wood recruitment potential due to the unvegetated dredge tailings, and (3) wood is almost nonexistent in the unvegetated channel where it can contribute to flow convergence and bed scour.

GENERAL INDICATOR: OFF-CHANNEL HABITAT

Criteria: The following criteria have been modified from USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Off-channel Habitat	Connectivity with Main Channel	Reach has many ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are low energy areas. No manmade barriers present along the mainstem that prevent access to off-channel areas.	Reach has some ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are generally high energy areas. Manmade barriers present that prevent access to off-channel habitat at some flows that are biologically significant.	Reach has few or no ponds, oxbows, backwaters, and other off-channel areas. Manmade barriers present that prevent access to off-channel habitat at multiple or all flows.

Narrative:

The Yankee Fork between RM 6.8 and 3.1 has a moderately confined, plane-bed channel and, in general, the listed thresholds are not applicable to this channel type. Off-channel habitats in this channel reach are comprised predominantly of side channels and connected dredge ponds. There are about 2,650 linear feet of secondary channels comprised of two split-flow and six floodplain type side channels. Tertiary, or overflow channels, can provide about 5,300 linear feet of additional off-channel habitat during large floods. Additional off-channel habitat has been created by connecting four pond series to the Yankee Fork. Theses pond series provide about 9,850 linear feet or 7.4 acres of juvenile rearing habitat and high water refugia.

Off-channel habitat that has been created through lateral channel migration and through habitat actions provides more off-channel rearing habitat and refugia than was present in this channel reach prior to dredging based on the 1908 Iowa Group mining claim, 1934 stream survey, and 1945 aerial photographs. Therefore, the off-channel habitat in this channel reach is **adequate**.

SPECIFIC INDICATOR: FLOODPLAIN CONNECTIVITY

Criteria: The following criteria have been modified from USFWS (1998).

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel Condition	Channel Dynamics	Floodplain Connectivity	Floodplain areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly.

Narrative:

Much of the historic channel paths and floodplains along this channel reach had been almost completely obliterated by dredging activities based on the 1945 and 2010 aerial photographs. The channel had been rerouted around and through the mine tailings by the 1966 aerial photographs, and most of the historic channel and floodplains were buried by mounds of mine tailings. Presently, there are about 31 acres of active floodplains (excluding the four pond series) along the Yankee Fork mainstem that are generally fragmented by mine tailings with an average patch size of about 0.5 acres.

In the late 1980s four pond series were connected to the Yankee Fork mainstem that resulted in 9 additional acres of active floodplain available to the Yankee Fork (Table 5).

Table 5. Pond series metrics based on 2010 aerial photographs and GIS analysis

Pond Series	Total Additional Floodplain Area*
PS4	1.8 acres
PS3	2.8 acres
PS 2	2 acres
PS 1	2.6 acres
Totals	**9.2 acres**

*Total additional floodplain area equals the wetted area plus active floodplain area along the pond series

There has been a reduction in floodplain connectivity due to dredge tailing mounds that artificially constrain the channel. Overbank flows that historically would have accessed larger, more continuous floodplain patches during large floods are now limited to smaller, fragmented floodplain patches. Changes from historic conditions to existing conditions are significant, but are not severe with respect to habitat-forming processes. Therefore, floodplain connectivity is considered **at risk**.

SPECIFIC INDICATOR: BANK STABILITY/CHANNEL MIGRATION

Criteria: The criteria for bank stability/channel migration are a relative condition of the specific indicator developed by Reclamation.

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel Condition	Channel Dynamics	Bank Stability/ Channel Migration	Channel is migrating at or near natural rates.	Limited amount of channel migration is occurring at a faster/slower rate relative to natural rates, but significant change in channel width or planform is not detectable.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.

Narrative:

The Yankee Fork between RM 6.8 and 3.4 is constrained by mine tailings. The stream has been rerouted and confined between the mine tailings and alluvial deposits, and to a lesser degree bedrock and colluvial deposits which have a higher percentage of boulders. Many of the banks do not have woody root reinforcement, primarily due to the lack of riparian vegetation and unconsolidated nature of the mine tailings, but remain stable (over 80 percent of the banks are stable). This bank stability along the mine tailings and alluvial deposits is because (1) they tend to be "self-armoring" in that finer materials (i.e., fines, sands, and gravels) are eroded and coarser materials (i.e., cobbles and boulders) are deposited along the toe of the slope, thus protecting it from erosion, and (2) the sheer size and volume of the material in these deposits inhibit the stream's ability to erode and transport the sediment. There has been some lateral channel migration occurring along this channel reach as evidenced by active bank erosion, but is generally restricted by mine tailings and embankments. Thus, the Yankee Fork is now functioning **at risk** because lateral channel migration is restricted and most likely occurring at a relatively slow rate.

SPECIFIC INDICATOR: VERTICAL CHANNEL STABILITY

Criteria: The criteria for vertical channel stability are a relative condition of the specific indicator developed by Reclamation.

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel Condition	Channel Dynamics	Vertical Channel Stability	No measurable or observable trend of aggradation or incision and no visible change in channel planform.	Measurable or observable trend of aggradation or incision that has the potential to, but not yet caused, disconnect the floodplain or a visible change in channel planform (e.g. single thread to braided).	Enough incision that the floodplain and off-channel habitat areas have been disconnected; or, enough aggradation that a visible change in channel planform has occurred (e.g. single thread to braided).

Narrative:

Bedrock is shallow (tens of feet) along the Yankee Fork, and crops out along and in the channel in some locations. These bedrock outcrops provide grade controls along the channel channels, limiting the depth to which the channel can incise. There is no observable trend of incision or aggradation, so the vertical channel stability is **adequate**.

SPECIFIC INDICATOR: VEGETATION CONDITION – DISTURBANCE

Criteria: The criteria for riparian vegetation disturbance are a "relative" indication to the functionality of the specific indicator.

General Characteristics	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Riparian/Upland Vegetation	Vegetation Condition	Vegetation Disturbance (Natural/Human)	>80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; <20% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); <2 mi/mi^2 road density in the floodplain.	50-80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; 20-50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); 2-3 mi/mi^2 road density in the floodplain.	<50% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; >50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); >3 mi/mi^2 road density in the floodplain.

Narrative:

The vegetation along the Yankee Fork qualitatively ranged from grasslands and forbs to small trees with roughly 60 percent of the vegetation ranging from shrubs and seedlings to saplings and poles. Riparian vegetation along the mine tailings adjacent to the channel was predominantly a narrow strip of sapling sized alders and willows, except where the mine tailings are actively eroding or have recently eroded through lateral channel migration.

In general, the mine tailings adjacent to the Yankee Fork lack woody vegetation and limit the size of area suitable for riparian vegetation to a narrow strip along the channel. Most of the valley floor has been disturbed due to gold dredging, although much of this disturbance was in older glacial outwash terraces. Based on this qualitative analysis, the vegetation disturbance history associated with dredging the valley bottom has removed mature trees thereby changing the vegetation structure and reducing the riparian buffer width leaving the vegetation in an **unacceptable** condition.

REFERENCES

Parenthetical Reference	Bibliographic Citation
Berenbrock 2002	Berenbrock, C. 2002. "Estimating the magnitude of peak flows at selected recurrence intervals for streams in Idaho." U.S. Geological Survey Water-Resources Investigation Report 02-4170, 59 p.
Bisson and Montgomery 1996	Bisson, P., and Montgomery, D. 1996. Valley segments, stream reaches, and channel units: in Hauer, F.R. and Lamberti, G.A., eds. Methods in stream ecology. San Diego, CA: Academic Press: p. 23-52.
Fenneman 1931	Fenneman, N. 1931. *Physiography of the Western United States*. McGraw-Hill, New York, 534 p.
Hillman and Giorgi 2002	Hillman, T., and Giorgi, A. 2002. *Monitoring protocols: effectiveness monitoring of physical/environmental indicators in tributary habitats*, prepared for the Bonneville Power Administration: BioAnalysts, Inc., Boise, Idaho. 104 pp.
IDEQ 2003	Idaho Department of Environmental Quality. 2003. *Upper Salmon River subbasin assessment and TMDL*: Idaho Department of Environmental Quality, Boise, Idaho, 217 p.
Montgomery and Buffington 1993	Montgomery, D., and Buffington, J. 1993. "Channel classification, prediction of channel response, and assessment of channel condition." *Washington State Timber, Fish & Wild-life*: p.84 + figures
Montgomery and Buffington 1998	Montgomery, D., and Buffington, J. 1998. *Channel processes, classification, and response: in River Ecology and Management*. Robert Naiman & Robert Bilby [editors]: Springer-Verlag New York, Inc., p. 13-39.
NOAA Fisheries 1996	NOAA's National Marine Fisheries Service. 1996. *Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale* [Matrix of Pathways and Indicators]: NOAA's National Marine Fisheries Service, Northwest Region, Portland, Oregon.
ODFW 2010	Oregon Department of Fish and Wildlife. 2010. *Aquatic inventories project methods for stream habitat surveys*. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Conservation and Recovery Program, Corvallis, Oregon 70 p.
Reclamation 2012	U.S. Department of the Interior, Bureau of Reclamation. 2012. *Yankee Fork Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho.* Pacific Northwest Region, Boise, Idaho. 153 p.

Parenthetical Reference	Bibliographic Citation
Rodeheffer 1935	Rodeheffer, I.A. 1935. *A Survey of the Waters of the Challis National Forest, Idaho*. Department of Commerce, Bureau of Fisheries. Washington.
USFS 1994	U.S. Department of Agriculture, Forest Service. 1994. Section 7 fish habitat monitoring protocol for the Upper Columbia River Basin. Pacific Northwest, Intermountain, and Northern Regions. 59 p.
USFS 2006	U.S. Department of Agriculture, Forest Service. 2006. *Biological assessment for the potential effects of managing the Salmon-Challis National Forest in the Yankee Fork Section 7 Watershed on Snake River Basin Spring/Summer Chinook Salmon, Snake River Steelhead, and Columbia River Bull Trout [Draft]*. U.S. Department of Agriculture, Salmon-Challis National Forest, Yankee Fork Ranger District, Clayton, Idaho. 126 p.
USFS 2010	U.S. Department of Agriculture, Forest Service. 2010. *Yankee Fork of the Salmon River, 2010 Stream Survey Report.* Salmon-Challis National Forest, Yankee Fork Ranger District. Prepared by La Grande Ranger District, Wallowa-Whitman National Forest, La Grande, Oregon. 37 p.
USFWS 1998	U.S. Fish and Wildlife Service. 1998. *A framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the Bull Trout subpopulation watershed scale.* 49 p.
USGS 1995	U. S. Geological Survey. 1995. "Geology and Mineral Resource Assessment of the Challis 1º X 2º Quadrangle." *Professional Paper 1525*. U.S. Geological Survey, U.S. Government Printing Office, Washington, 204 p. + maps.
Watershed Sciences 2010	Watershed Sciences. 2010. *Airborne Thermal Infrared Remote Sensing, Yankee Fork River Basin, Idaho*. September 27, 2010.

APPENDIX B

Geomorphic Analysis

Appendix B

Overview

In this analysis and report, valley segments, channel reaches and channel units are described using the following methodology:

1. Valley shape is described based on Naiman et al. (1992) classification of valley bottom types.
2. Valley confinement, defined as the degree that geologic or geomorphic features constrain the lateral migration of the stream, are described as confined (valley floor width less than 2 channel widths), moderately confined (valley floor width equal to 2-4 channel widths, or unconfined (valley floor width greater than 4 channel widths).
3. Valley types are classified as colluvial, alluvial, or bedrock as described in Montgomery and Buffington (1997).
4. Channel reaches are classified based on specific types of channel units and specific ranges of channel characteristics as described in Montgomery and Buffington (1998) and Bisson, Buffington, and Montgomery (2006).
5. Channel patterns are classified as (1) straight, (2) meandering, (3) island braided, and (4) braided channels, and can be used to interpret river-floodplain dynamics (Beechie et al. 2006).
6. Channel units, sometimes referred to as habitat units, are relatively homogeneous localized areas of the channel that differ in depth, velocity, and strata characteristics from adjoining areas (Bisson, Buffington and Montgomery 2006).
7. The floodplain, for this assessment, is divided into the (1) active floodplains defined as those areas that have evidence of relatively recent disturbance (on the order of 5 to 10 years) by the stream such as vegetated bars and overbank deposits, (2) available floodplains defined as those low lying areas that would likely be inundated during the 100 year flood event and provide room for lateral channel migration, and (3) disconnected floodplains that are historic floodplains that are hydraulically disconnected from the channel due to anthropogenic disturbances such as mine tailing or embankments.
8. The channel is divided into the (1) active channels that are unvegetated due to frequent flow disturbances that inhibit vegetation growth and approximates the area where channel forming flows occur, and (2) disconnected channels that are historic channels that are hydraulically disconnected from the channel due to anthropogenic disturbances.

9. Vegetation analysis included a predominantly qualitative analysis of vegetation successional stages based on relative height classification (USFS 2010) interpreted from 2010 aerial photographs and ground photographs.

Geology

The dominant bedrock types in the Yankee Fork watershed are the Eocene-age Challis volcanic and Cretaceous-age Idaho batholith (Fisher and Johnson 1995). Surface exposure of the Idaho batholith terrane is confined predominantly to the southern portion of the watershed; and in the western and southern portion the Idaho batholiths terrane underlies parts of the Challis volcanic terrane. Geologic structures are related to the Challis volcanics, Idaho batholith, and Trans-Challis fault zone (Fisher and Johnson 1995).

Alpine glaciers have sculpted the Yankee Fork drainage leaving behind erosional aand constructional landforms. At least three major alpine glacial advances recorded in Idaho (Williams 1961; Colman and Pierce 1986; Evenson, Cotter, and Clinch 1982) and there are two known Pleistocene alpine glaciations that occurred in the Yankee Fork drainage (Mackin and Schmidt 1956; Williams 1961). Glacial terraces are present along the valley walls and valley floor. Most placer gold has been produced from the constructional glacial landforms, and little gold has been found in Holocene alluvium (active channel and floodplain areas). Many of the gold deposits are believed to be close to their ore deposits (Kiilsgaard, Fisher, and Bennett 1986), and may have been exhumed by alpine glaciers and fluvial erosion.

In the Lower Fork subwatershed, there are high glacial benches along the east and west valley walls that are ice marginal or glacial outwash terraces. The high glacial benches can be tracked downvalley to about Polecamp Flat Campground suggesting that a Copper Basin-age alpine glacier flowed downvalley to this location. The younger Potholes glaciations were not as extensive as the Copper Basin glaciations and drainage from the glaciers reworked the older glacial deposits left on the valley floor creating an outwash plain. The Yankee Fork valley has eroded to a U-shape valley form due to glacial erosion and the Yankee Fork is “underfit” for the valley under current climate conditions.

Figure 1 through Figure 3 show the delineated surficial geology of the assessment area. The surficial geology was revised from mapping that was completed in the Tributary Assessment (Reclamation 2012). One of the “key” features to note is that the placer mining (i.e., dredging) focused on the glacial terrace and outwash deposits that filled the valley floor and have since been reworked by the underfit Yankee Fork. In several locations large, Pleistocene to Holocene age alluvial fans were dredged to reach the underlying, or interbedded, gold bearing glacial deposits. One interpretation is that the dredging waste piles represent the extent of the area once occupied by glacial deposits within this underfit fluvial system.

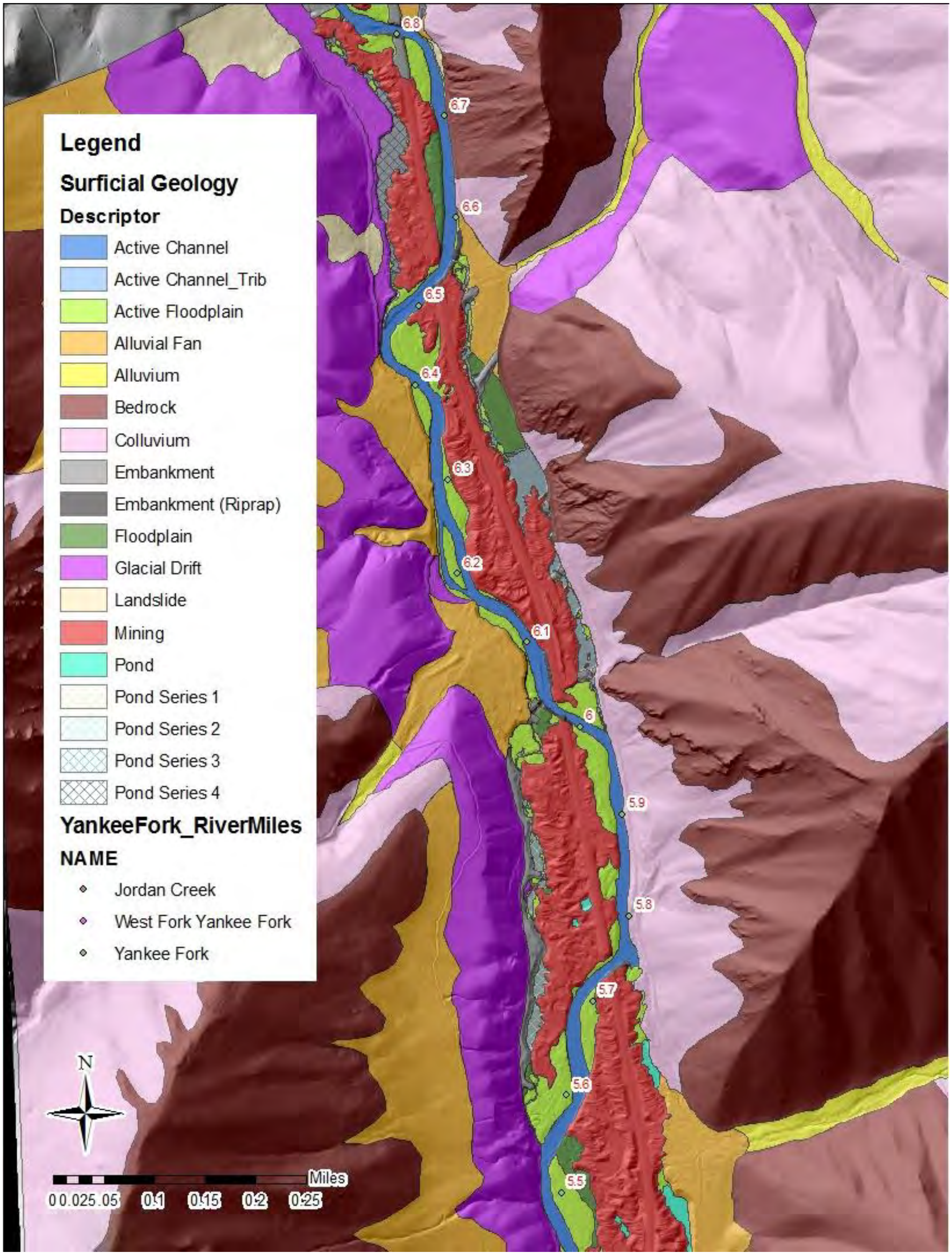


Figure 1. Surficial geology between RM 6.8 and 5.5.

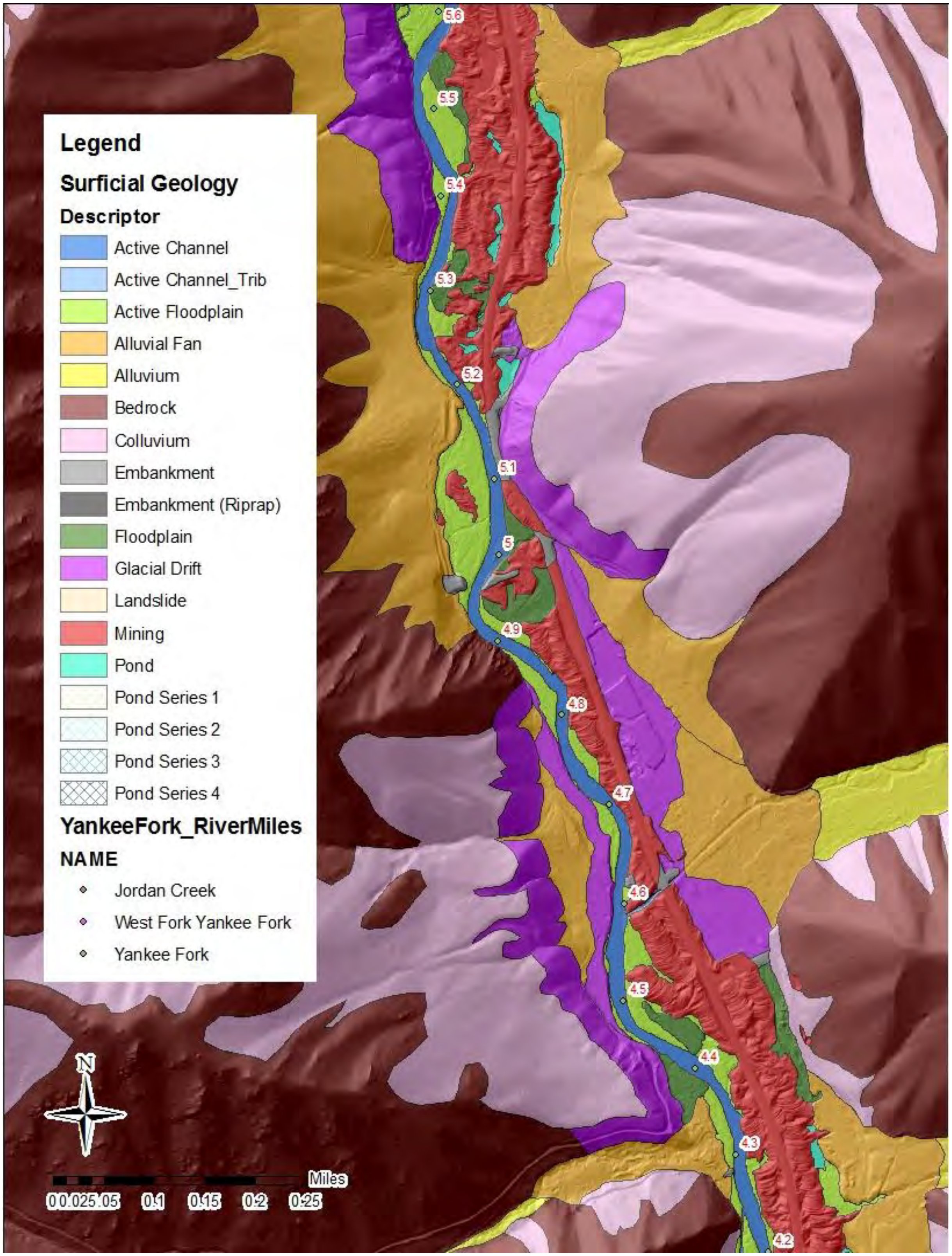


Figure 2. Surficial geology between RM 5.6 and 4.2.

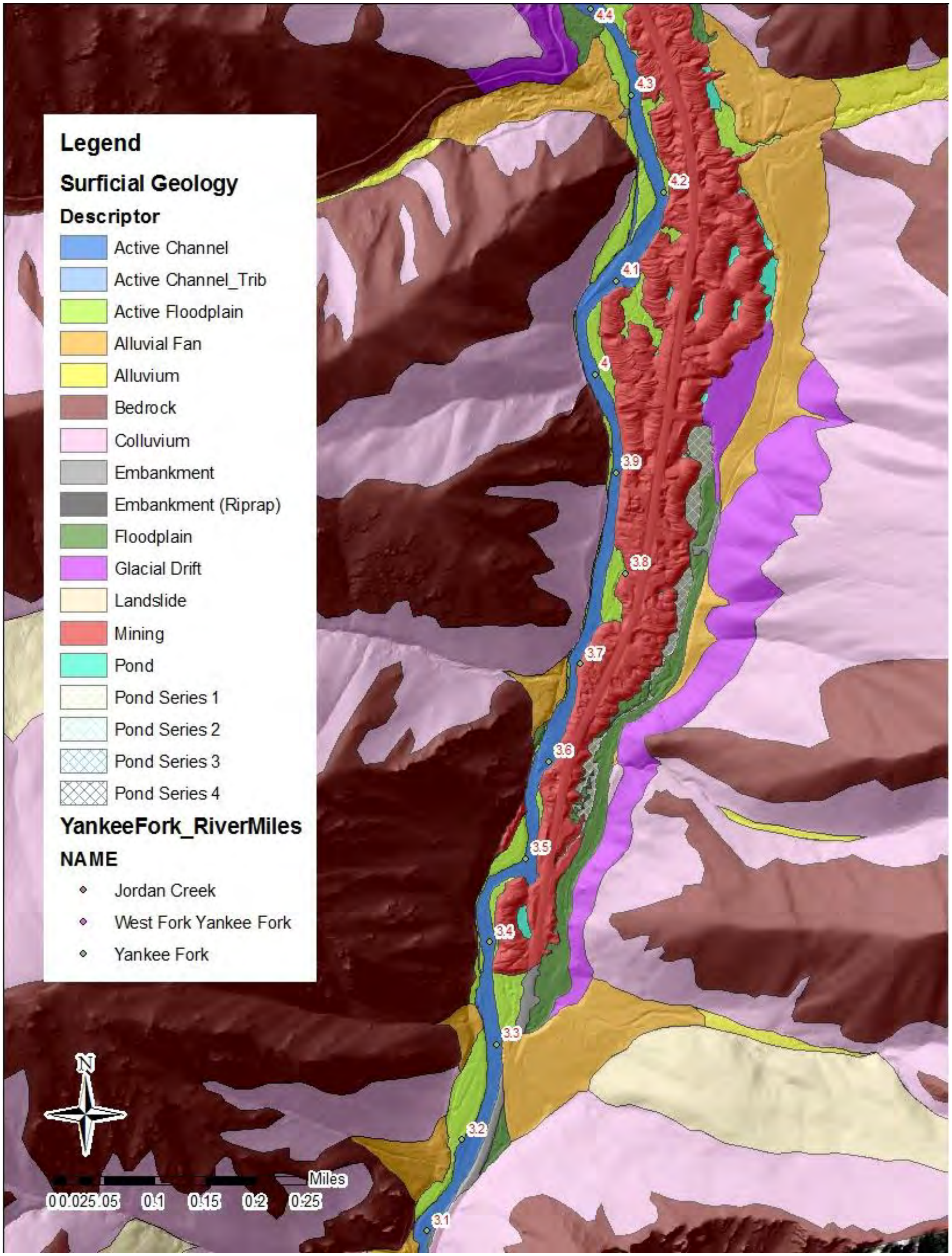


Figure 3. Surficial geology between RM 4.4 and 3.1.

Valley Segments and Channel Confinement

The Yankee Fork valley segment (Geomorphic Reach YF-2 in the Tributary Assessment) was shaped by alpine glaciers that carved a U-shaped trough during the Pleistocene Epoch between roughly 2.5 million and 10,000 years ago. The valley and channel metrics for the pre-dredging characteristics is based on analysis of the 1945 aerial photographs that covered from near the post-dredging West Fork confluence (2010 – RM 7) to about the Jerrys Creek confluence (2010 – RM 5.3). From about Jerrys Creek to Polecamp Creek (2010 – RM 3) the valley and channel were qualitatively analyzed based on the 1934 Bureau of Fisheries stream survey and surficial geology due to the valley bottom had being dredged by when the 1945 aerial photographs were taken. Post-dredging characteristics are based on 2010 aerial photographs and field observations. Table 1 and Table 2 summarize the pre-dredging and post-dredging valley and channel metrics for the assessment area.

Table 1. Yankee Fork pre-dredging and post-dredging valley metrics for channel reach.

Channel Reach	Average Constrained Valley Width	Channel Confinement
West Fork to Polecamp Flat Campground (Pre-dredging)	258 feet	Moderately Confined (3.3)
West Fork to Polecamp Flat Campground (Post-dredging)	147 feet	Moderately Confined (2.3)

Table 2. Yankee Fork (2010) valley and channel metrics.

Metrics	**RM 7 to 3**
Average Channel Length	20,790 feet
Average. Unvegetated Channel Width	65 feet
Channel Confinement	Moderately Confined
Channel Gradient	0.6 percent
Sinuosity	1.1
Dominant Substrate	Cobble (2.5-10.1 inches; 64-256 mm)*
Substrate Gradiation (Approx.)	Cobble (43%); Gravel (30%); Sand (16%); Boulder (7%); Bedrock (4%)*
Bank Composition	Predominantly Cobble With Boulder, Gravel and Sand*

Channel and Floodplain Units, and Miscellaneous Features

Yankee Fork Mainstem

The channel units used in this report are based on the classification system proposed by Hawkins et al. (1993) and are typically identified during low flow discharge which often makes them indistinguishable from each other during higher discharges due to a change in the hydraulic properties (Bisson, Buffington and Montgomery 2006).

Additional channel and floodplain units, and other miscellaneous features were added to the analysis based on Washington State Department of Ecology Publication #03-06-027: A Framework for Delineating Channel Migration Zones (WSDOE 2003).

Table 3summarizes the channel and bar units, Table 4 summarizes the active floodplain units, and Table 5 summarizes the miscellaneous features delineated along the Yankee Fork between West Fork and Polecamp Flat Campground based on field observations and 2010 aerial photographs. Figure 4 through Figure 8 show the delineated units and features.

Table 3. Yankee Fork summary of channel and bar units.

Type	Count[1]	Area[2]	Average Size
Pool	15	1.45 acres	0.10 acres
Riffle	43	18.05 acres	0.42 acres
Run	29	3.95 acres	0.14 acres
Rapid	7	0.82 acres	0.12 acres
Secondary Channel	8	1.12 acres	0.14 acres
Tertiary Channel	18	1.33 acres	0.07 acres
Unvegetated Bar	75	4.06 acres	0.05 acres
Vegetated Bar	7	0.24 acres	0.03 acres

[1]Must be 0.005 acres or more to be counted
[2]Rounded to the nearest tenth of an acre

Table 4. Yankee Fork summary of active floodplain units.

Type	Count[1]	Area[2]	Average Size
Vegetated Floodplain	98	31.11 acres	0.32 acres
Unvegetated Floodplain	2	0.27 acres	0.14 acres
Ponded Floodplain	1	0.08 acres	0.08 acres

[1]Must be 0.005 acres or over to be counted
[2]Rounded to the nearest tenth of an acre

Table 5. Yankee Fork summary of miscellaneous features.

Type	Count[1]	Area[2]	Average Size
Bank Erosion	30	1.29 acres	0.04 acres
Riprap	13	0.42 acres	0.03 acres

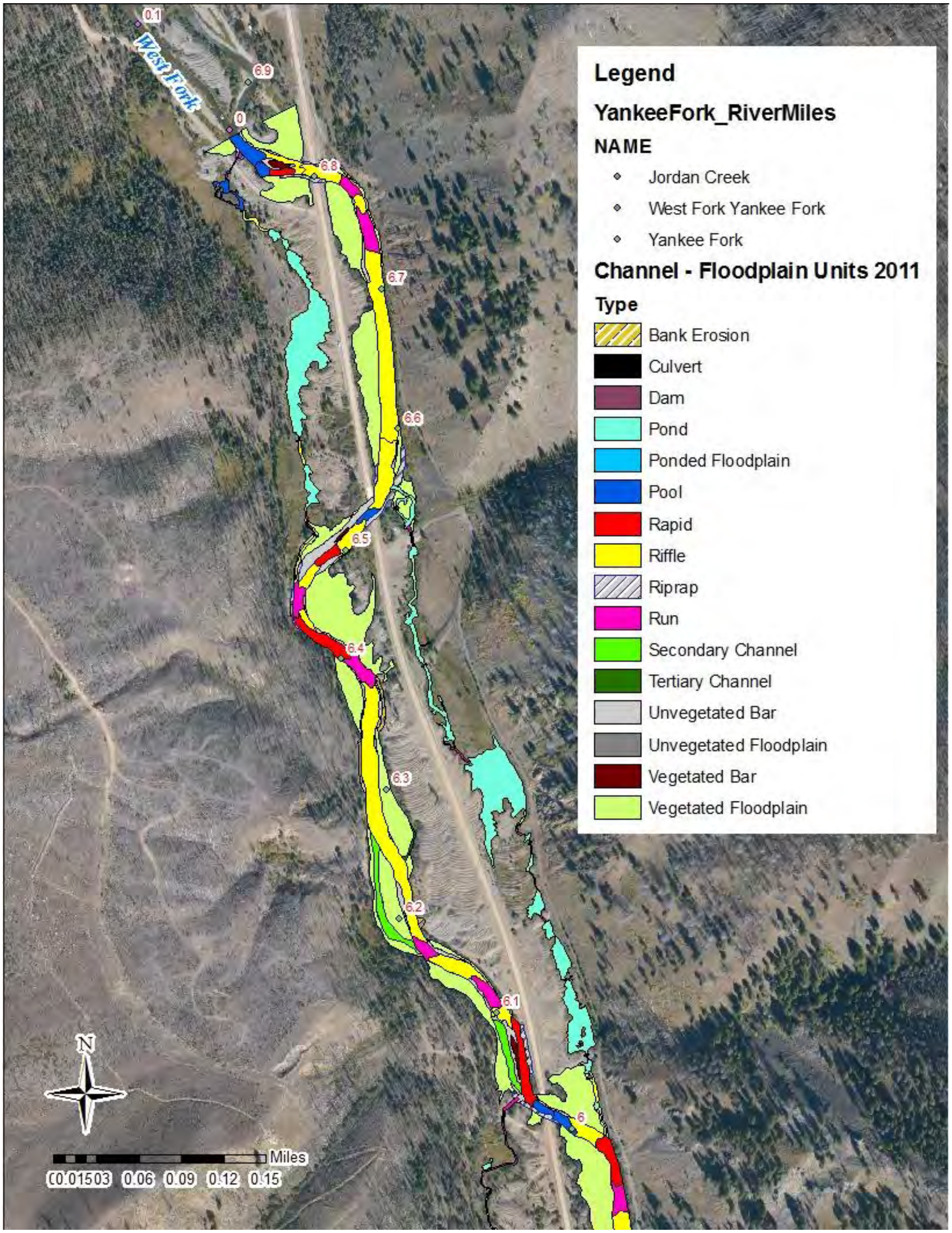


Figure 4. Delineated units and features between RM 6.8 and 6.0.

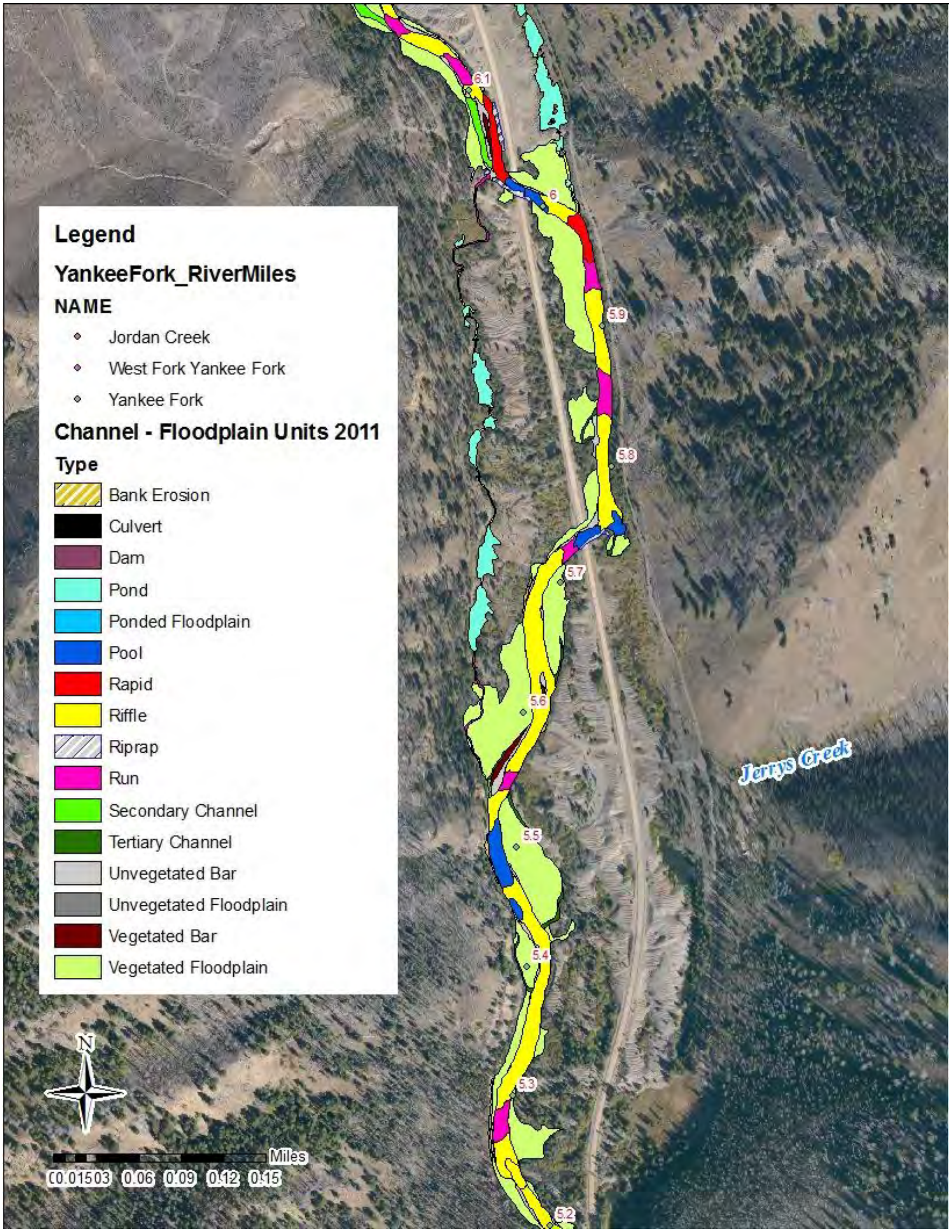


Figure 5. Delineated units and features between RM 6.1 and 5.3.

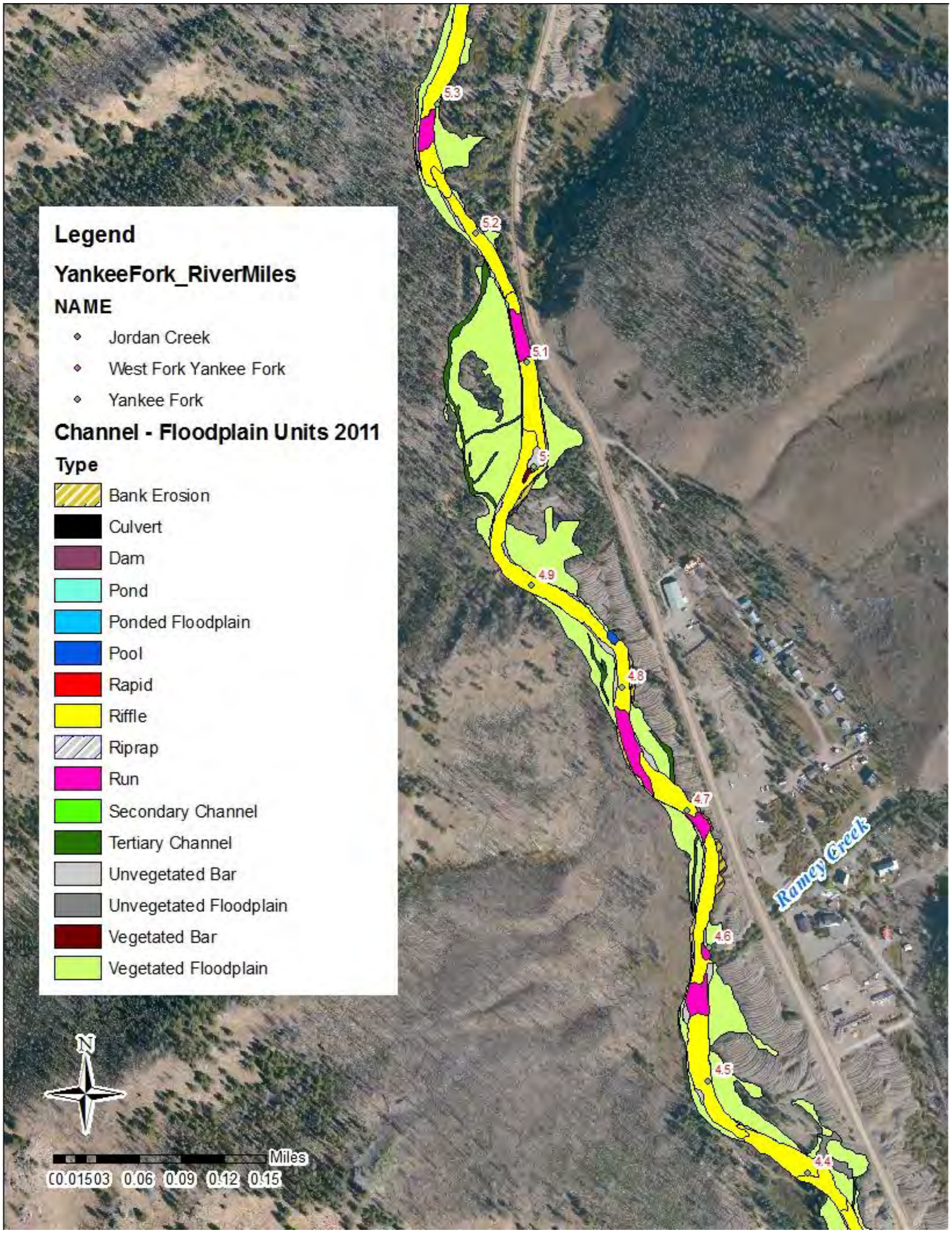


Figure 6. Delineated units and features between RM 5.3 and 4.4.

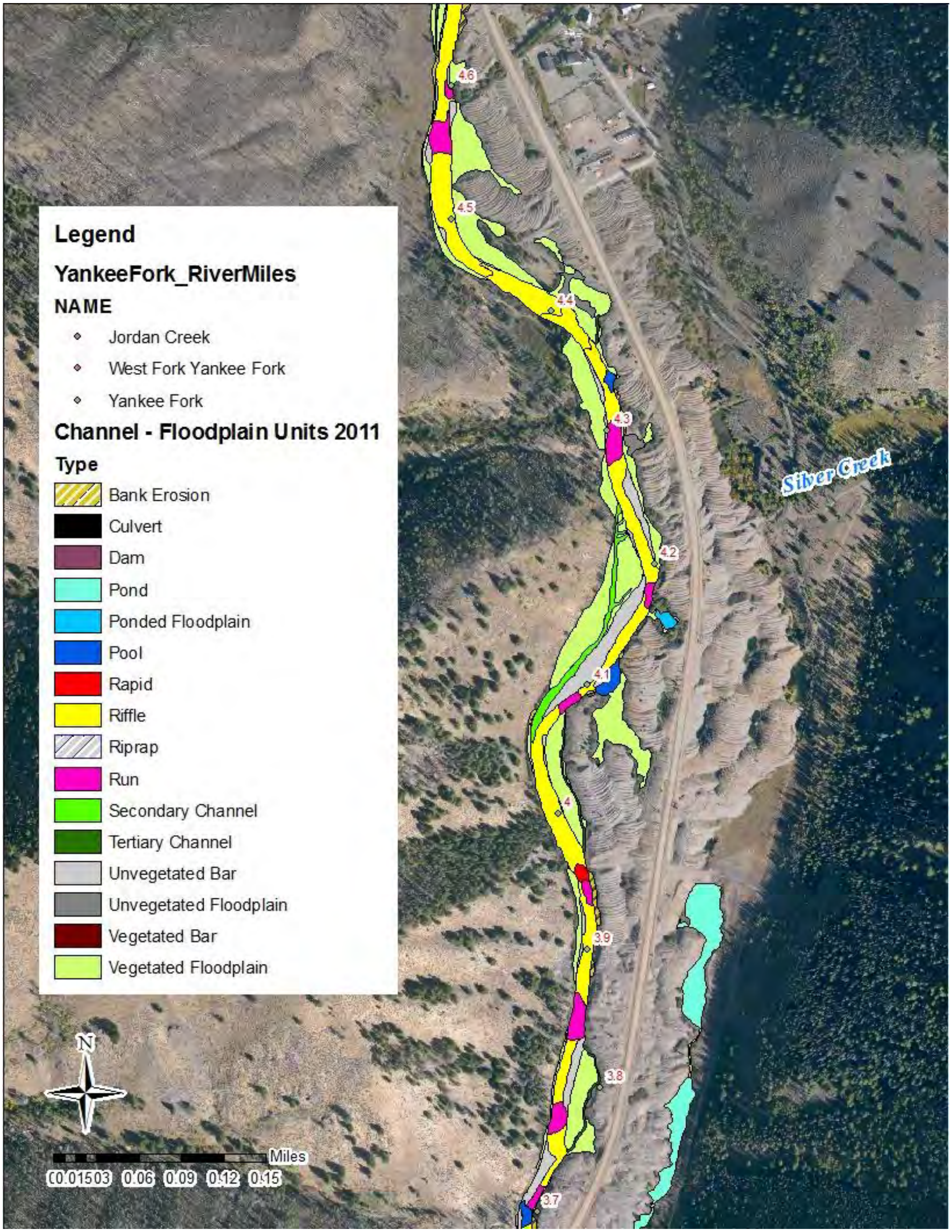


Figure 7. Delineated units and features between RM 4.6 and 3.7.

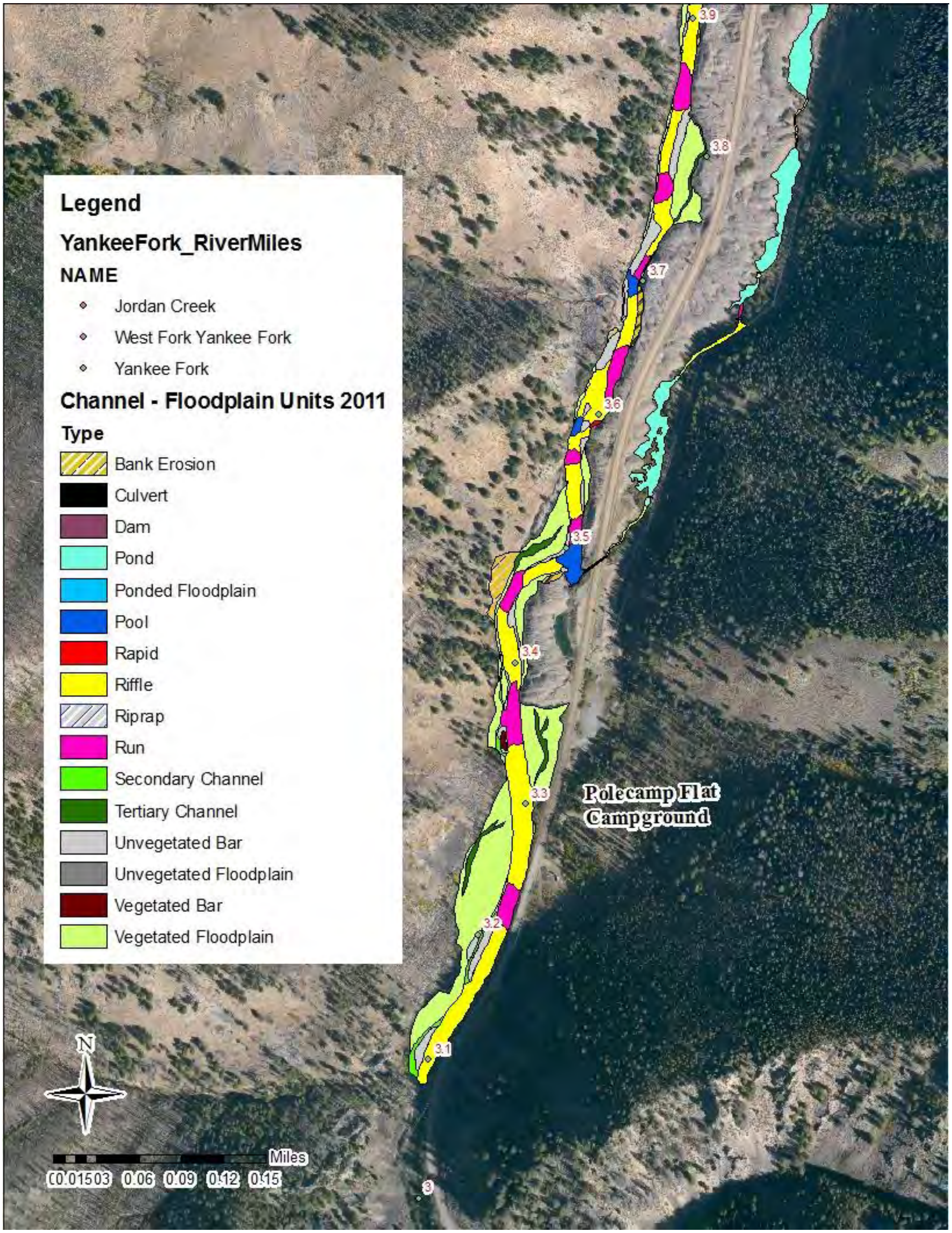


Figure 8. Delineated units and features between RM 3.9 and 3.1.

Pond Series

Development of off-channel habitats utilizing four pond series are discussed in Richards et al. (1992). In brief, each pond series included (1) constructing channels to interconnect individual ponds and connect each pond series to the Yankee Fork, (2) intake structures were constructed on three of the four pond series to control inflows from the Yankee Fork into the ponds, (3) adjustable check structures were strategically placed to control water levels and inflows through the ponds, and (4) boulders were placed in the constructed channels to improve rearing habitat and minimize migration barriers between the ponds. Completion of the pond series projects created additional off-channel habitats (about 4 acres of pond habitat and 2,000 feet of channel habitats) accessible to juvenile salmonids for rearing and refugia.

Pond Series #4

Final design connected the three ponds, one of which was about 0.6 acres, to the Yankee Fork with an inlet into Pond 3 and outlet from Pond 1. Channels were constructed with check structures to connect the ponds and control water levels and flows. The total length of the constructed project was about 1,000 feet (Richards et al. 1992). Field observations in 2011 showed (1) the pond series was connected to the Yankee Fork and flows into Pond 3 was regulated by a culvert placed through a dirt road embankment, (2) all three ponds were interconnected, and (3) channels and check structures were constructed to connect the ponds and control pond levels. Channel-type and pond-type habitats are summarized in Table 6 and shown on Figure 9.

Table 6. Summary of habitat types for Pond Series 4

Channel Type Habitat	Count[1]	Area[2]
Riffle[3]	5	0.11 acres
Run	2	0.02 acres
Pool	1	0.09 acres
	Total Area 0.22 acres	
Pond Type Habitat	**Total Area 1.35 acres**	

[1]Must be 0.005 acres or over to be counted
[2]Rounded to the nearest tenth of an acre
[3]Culvert area included in riffle channel unit

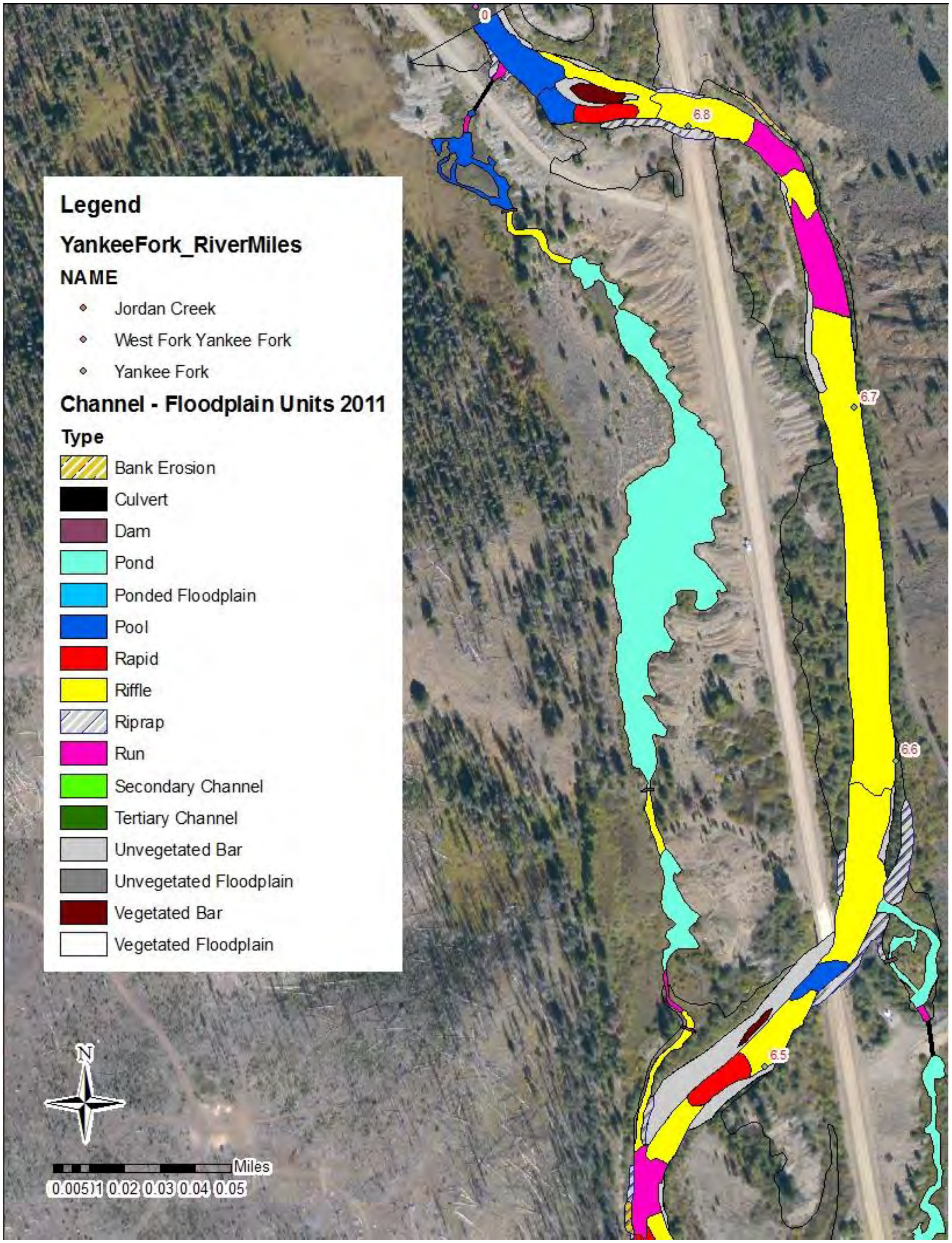


Figure 9. Delineated units for Pond Series 4.

Pond Series #3

Original design (Bechtel 1987) does not appear to have been modified. One of their assumptions was that the pond series would have ingress and egress for juvenile salmonids to the Yankee Fork and would be naturally seeded. Field observations in 2011 showed (1) the pond series was connected to the Yankee Fork with rock placements to divert flows, (2) a culvert was placed though a dirt road embankment, (3) channels were constructed to interconnect the ponds, and (4) check structures had been installed to control pond levels and flows. Channel-type and pond-type habitats are summarized in Table 7 and shown on Figure 10.

Table 7. Summary of habitat types for Pond Series 3

Channel Type Habitat	Count[1]	Area[2]
Riffle[3]	5	0.08 acres
Run	3	0.04 acres
Pool	0	0 acres
	Total Area 0.12 acres	
Pond Type Habitat	**Total Area 2.14 acres**	

[1]Must be 0.005 acres or over to be counted
[2]Rounded to the nearest tenth of an acre
[3]Culvert area included in riffle channel unit

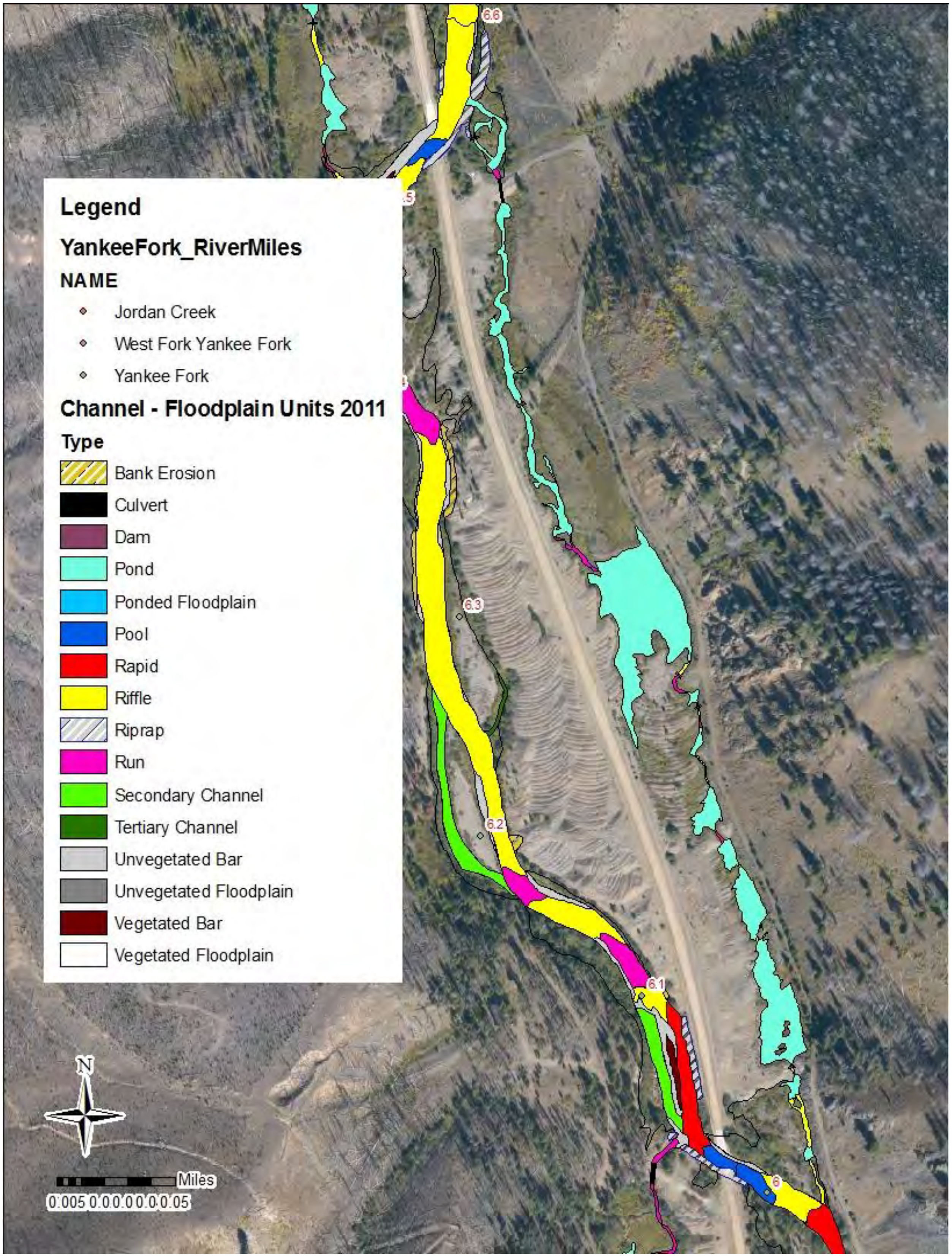


Figure 10. Delineated units for Pond Series 3.

Pond Series #2

The original design (Bechtel 1987) was modified to provide a surface water withdrawal from the Yankee Fork that connected Pond 6 (intake pipe was deleted), and the pond was dredged to retain about the same water depth. This new concept allowed migrating salmonids to enter the pond series through an inlet as well as an outlet. The final design connected the six ponds to the Yankee Fork with an inlet into Pond 6 and outlet from Pond 1. Channels were constructed with check structures to interconnect the ponds and control water levels. Total length of the project was about 485 feet (Richards et al. 1992). Field observations in 2011 showed (1) the pond series was connected to the Yankee Fork and flows were regulated by a culvert placed through a dirt road embankment, (2) all six ponds were interconnected by constructed channels with check structures to control pond and flow levels, and (3) there were signs of beaver activity (i.e. chewed branches), particularly downstream of Pond 1. Channel-type and pond-type habitats are summarized in Table 8 and shown on Figure 11.

Table 8. Summary of habitat types for Pond Series 2.

Channel Type Habitat	Count[1]	Area[2]
Riffle[3]	4	0.06 acres
Run	4	0.13 acres
Pool	0	0 acres
	Total Area 0.19 acres	
Pond Type Habitat	**Total Area 0.90 acres**	

[1]Must be 0.005 acres or over to be counted
[2]Rounded to the nearest tenth of an acre
[3]Culvert area included in riffle channel unit

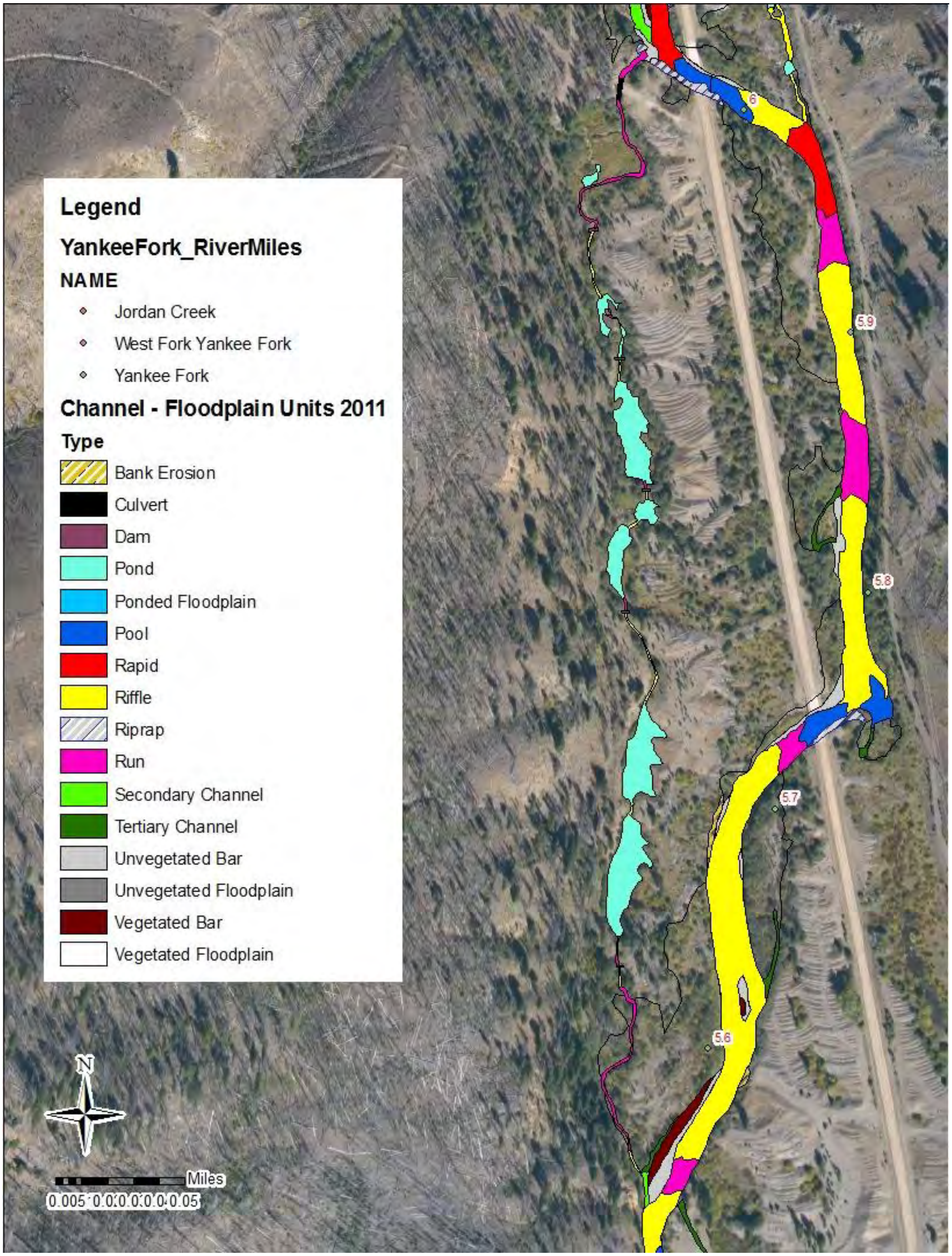


Figure 11. Delineated units for Pond Series 2.

Pond Series #1

Actual development of Pond Series One included connecting the lower four ponds shown in the Bechtel (1987) drawings by constructing channels with check structures, and replacing the culvert through the Custer Motorway to provide ingress and egress to the ponds. Total length of the project was about 1,230 feet (Richards et al. 1992). Field observations in 2011 showed (1) all four ponds were interconnected by constructed channels with check structures to control pond levels, (2) the lower channel upstream of the culvert had been modified with boulder placements, and (3) the culvert was no longer perched above the Yankee Fork. Channel-type and pond-type habitats are summarized in Table 9 and shown on Figure 12.

Table 9. Summary of habitat types for Pond Series 1.

Channel Type Habitat	Count[1]	Area[2]
Riffle[3]	5	0.20 acres
Run	1	0.01 acres
Pool	0	0 acres
	Total Area 0.21 acres	
Pond Type Habitat	**Total Area 2.26 acres**	

[1]Must be 0.005 acres or over to be counted
[2]Rounded to the nearest tenth of an acre
[3]Culvert area included in riffle channel unit

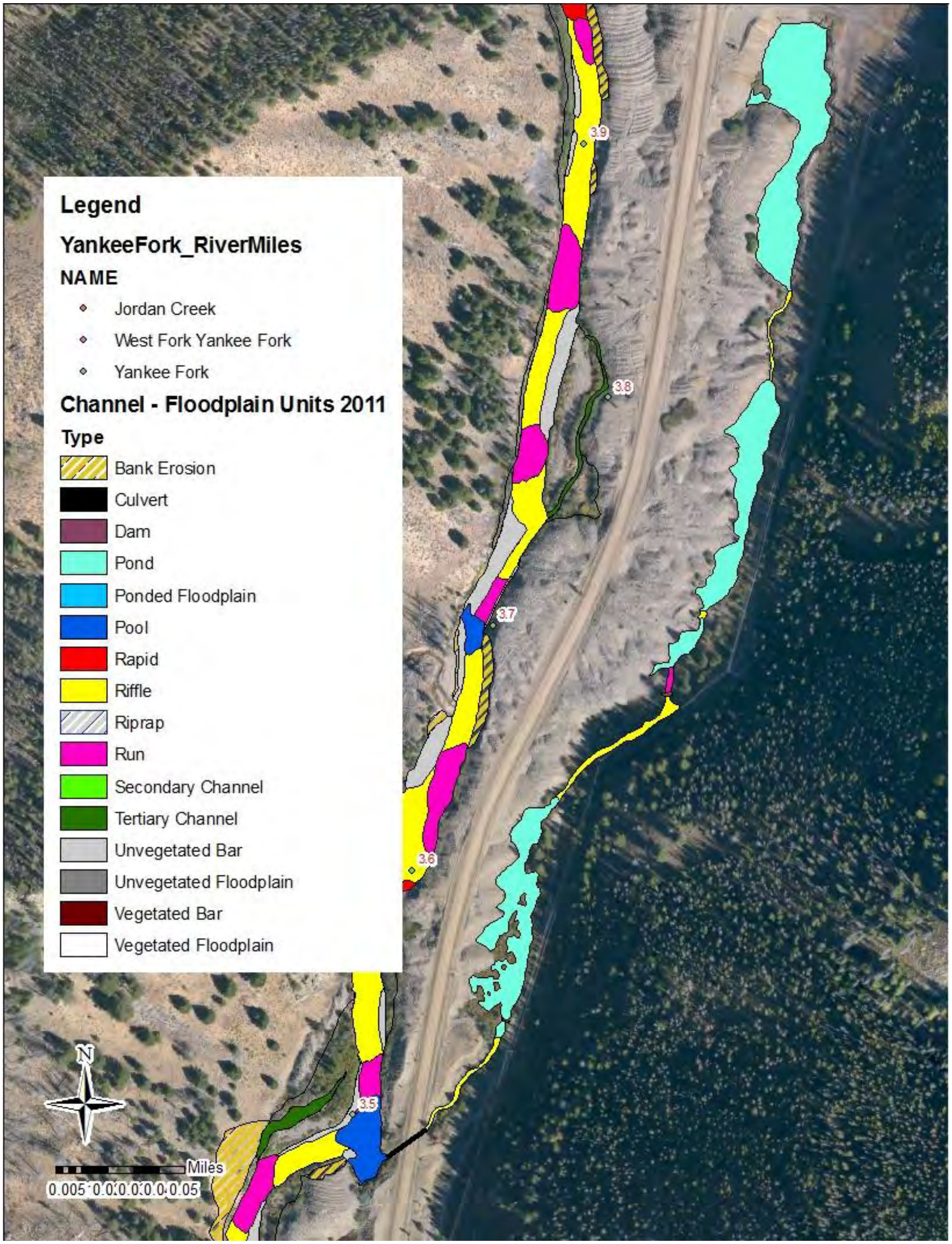


Figure 12. Delineated units for Pond Series 1.

Off-channel Habitat

Lengths of secondary side channels and tertiary side channels were added to the analysis based on Washington State Department of Ecology Publication #03-06-027: A Framework for Delineating Channel Migration Zones (WSDOE 2003).

Table 10 summarizes the side channel types, number of side channels and lengths (in feet) of side channels, the primarily off-channel habitat in this channel segment.

Table 10. Yankee Fork summary of side channels based on 2010 aerial photographs and 2011 observations.

Side Channel Type	Activation	Count	Length	Average Length
Split-Flow	Secondary	4	1,089 feet	272 feet
Floodplain	Secondary	10	2,717 feet	272 feet
Overflow	Tertiary	4	854 feet	214 feet

REFERENCES

Parenthetical Reference	Bibliographic Citation
Bechtel 1987	Bechtel National, Inc. 1987. Feasibility plan for the enhancement of the Yankee Fork of the Salmon River, Idaho, prepared for The Shoshone-Bannock Tribes Fisheries Department, Fort Hall, Idaho: Bechtel National, Inc., San Francisco, California
Beechie et al. 2006	Beechie, T., Liermann, M., Pollock, M., Baker, S., and Davies, J., 2006. Channel pattern and river-floodplain dynamics in forested mountain river systems: Geomorphology 78 (2006) p. 124-141.
Bisson, Buffington, and Montgomery 2006	Bisson, P., Buffington, J., and Montgomery, D. 2006. *Valley segments, stream reaches, and channel units: in Methods in Stream Ecology*. Elsevier, p. 23-49.
Colman and Pierce 1986	Colman, S., and Pierce, K. 1986. Glacial sequence near McCall, Idaho: Weathering rinds, soil development, morphology, and other relative-age criteria: Quaternary Research v. 25, p. 25-42.
Evenson, Cotter, and Clinch 1982	Evenson, E.B., Cotter, J.F.P., and Clinch, J.M. 1982. "Glaciation of the Pioneer Mountains, a proposed model for Idaho" in Bonnichsen B., and Breckenridge, R.M., eds., *Cenozoic Geology of Southern Idaho*. Idaho Bureau of Mines and Geology Bulletin, v. 26, p.653-665.
Fisher and Johnson 1995	Fisher, F., and Johnson, K. 1995. Geology and Mineral Resource Assessment of the Challis 1º X 2º Quadrangle, U.S. Geological Survey Professional Paper 1525: U.S. Geological Survey, U.S. Government Printing Office, Washington, 204 p. + maps.
Hawkins et al. 1993	Hawkins, C., Kershner, J., Bisson, P., Bryant, M., Decker, L., Gregory, S., McCullough, D., Overton, C., Reeves, G., Steedman, R., and Young, M. 1993. A hierarchical approach to classifying stream habitat features: Fisheries 18: 3-12.
Kiilsgaard, Fisher, and Bennett 1986	Kiilsgaard, T., Fisher, F., and Bennett, E. 1986. "the Trans-Challis fault system and associated precious metal deposits, Idaho." *Economic Geology*, v. 81, p. 721-724.

Parenthetical Reference	Bibliographic Citation
Mackin and Schmidt 1956	Mackin, J., and Schmidt, D. 1956. "Uranium and thorium-bearing minerals in placer deposits in Idaho" in Page, L., Stocking, H., and Smith, H., compilers, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, 1955: U.S. Geological Survey Professional Paper 300, p. 375-380.
Montgomery and Buffington 1997	Buffington, J.M. and D.R. Montgomery. 1997. "A Systematic Analysis of Eight Decades of Incipient Motion Studies, With Special Reference to Gravel-Bedded Rivers." *Water Resources Research, Vol. 33, No. 8*, Pages 1993-2029.
Montgomery and Buffington 1998	Montgomery, D., and Buffington, J. 1998. *Channel processes, classification, and response: in River Ecology and Management*. Robert Naiman & Robert Bilby [editors]: Springer-Verlag New York, Inc., p. 13-39.
Naiman et al. 1992	Naiman, R.J., Lonzarich, D.G., Beechie, T.J., and Ralph, S.C. 1992. "General principles of classification and the assessment of conservation potential in rivers." Pages 93-123 in: P.J. Boon, P. Calow, and G.E. Petts, editors. River conservation and management. John Wiley and Sons, New York, NY.
Reclamation 2012	U.S. Department of the Interior, Bureau of Reclamation. 2012. *Yankee Fork Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho.* Pacific Northwest Region, Boise, Idaho. 153 p.
Richards et al. 1992	Richards, C., Cernera, P., Ramey, M., and Reiser, D., 1992. Development of off-channel habitats for use by juvenile Chinook salmon: North American Journal of Fisheries Management, 12: 721-727 p.
USFS 2010	U.S. Department of Agriculture, Forest Service. 2010. *Yankee Fork of the Salmon River, 2010 Stream Survey Report.* Salmon-Challis National Forest, Yankee Fork Ranger District. Prepared by La Grande Ranger District, Wallowa-Whitman National Forest, La Grande, Oregon. 37 p.
Williams 1961	Williams, P.L. 1961. "Glacial geology of the Stanley Basin." Idaho Bureau of Mines and Geology Pamphlet, no. 123, 29 p.
WSDOE 2003	Washington State Department of Ecology. 2003. A framework for delineating channel migration zones; Ecology Publication #03-06-027: Washington State Department of Ecology, Olympia, Washington 66 p.

APPENDIX C

Photographic Documentation

This page intentionally left blank

Appendix C

Polecamp Flat Area Photographic Log

Photographic documentation of the Polecamp Flat area channel reach was completed during the fall 2011 in support of the document, *Polecamp Flat Area Baseline Assessment, Yankee Fork of the Salmon River, Custer County, Idaho*. Photographs were taken in the field and their location and direction were noted on aerial photographs. The photopoints were then mapped using GIS and are provided as Figures 1 through 8. Each photograph was captioned with the direction of the photograph, subject matter, and date, and provided as Photographs No. 1 through 193 in this appendix.

PHOTOGRAPH LOCATION DOCUMENTATION

Aerial photographs showing photograph locations for the Yankee Fork and West Fork are provided in Figure 1 through 8.

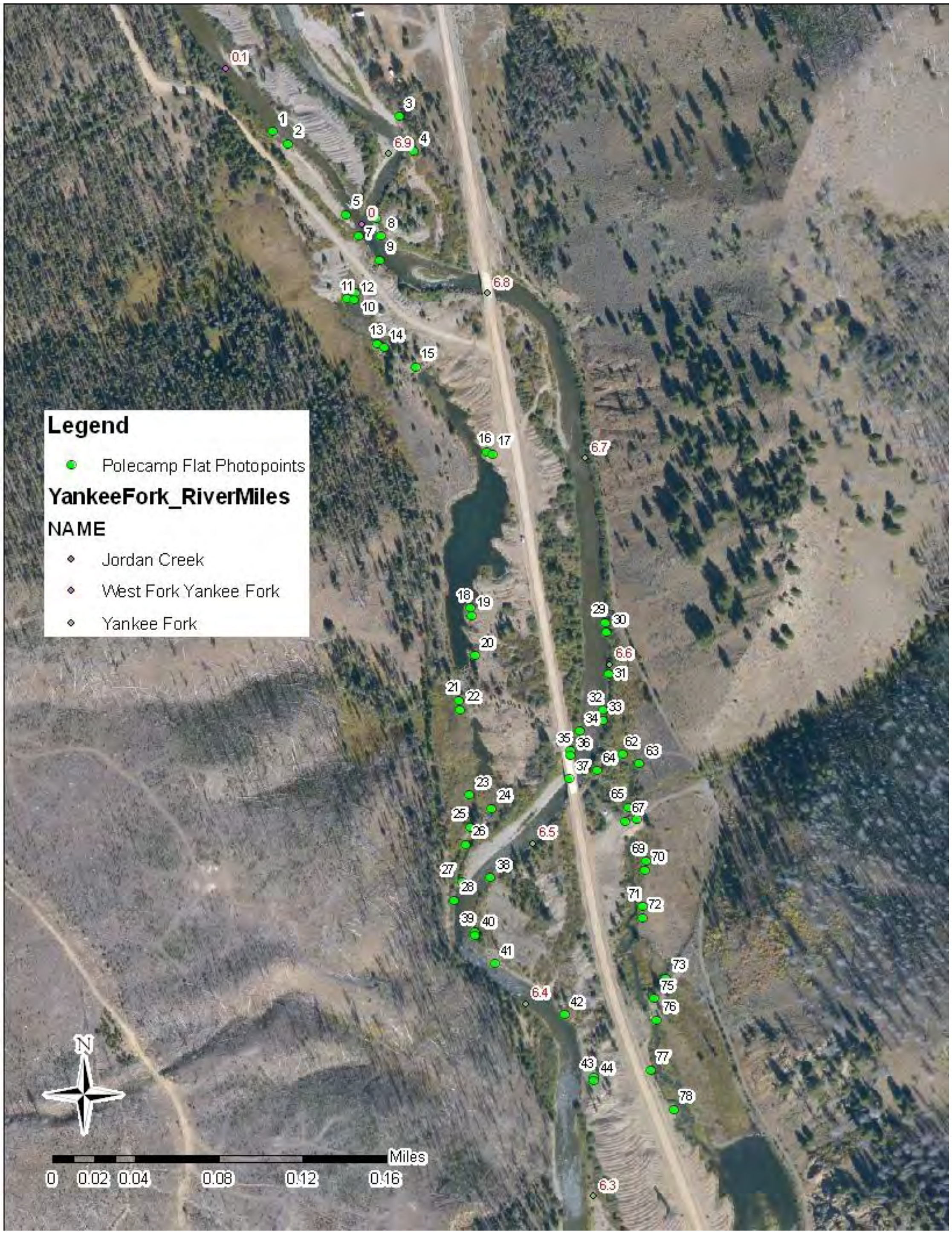


Figure 1. Photographic locations along the Yankee Fork between RM 6.9 and 6.3.

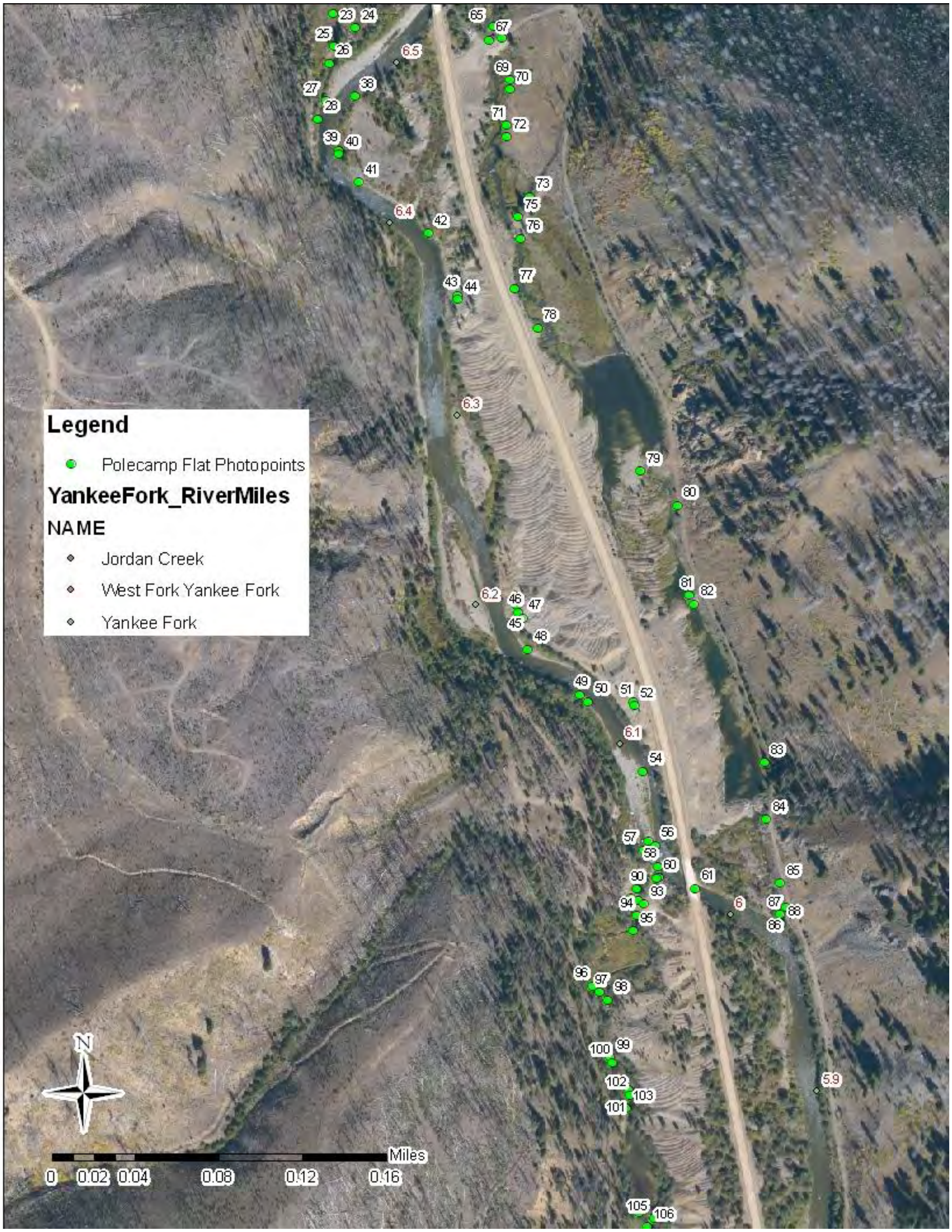


Figure 2. Photographic locations along the Yankee Fork between RM 6.5 and 5.9.

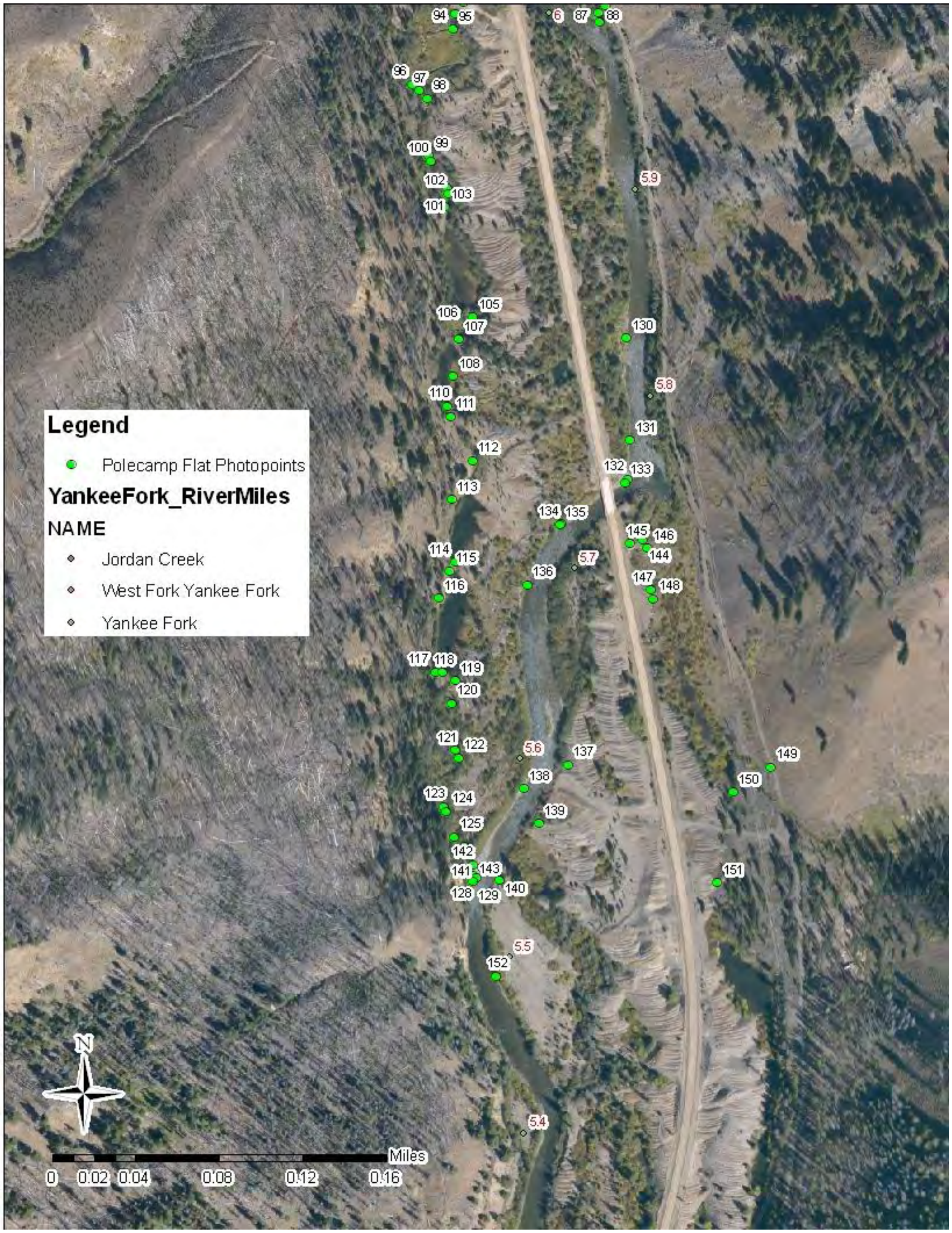


Figure 3. Photographic locations along the Yankee Fork between RM 6.0 and 5.4.

Figure 4. Photographic locations along the Yankee Fork between RM 5.4 and 4.8.

Figure 5. Photographic locations along the Yankee Fork between RM 4.9 and 4.3.

Figure 6. Photographic locations along the Yankee Fork between RM 4.5 and 3.9.

Figure 7. Photographic locations along the Yankee Fork between RM 3.9 and 3.4.

Figure 8. Photographic locations along the Yankee Fork between RM 3.5 and 2.9.

PHOTOGRAPHIC DOCUMENTATION

Captioned photographs that correlate to the location maps in the previous section are provided as Photograph No. 1 through Photograph No. 193.

Photograph No. 1. View to the southeast looking downstream along the West Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 2. View to the northwest looking upstream along the West Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 3. View to the south looking downstream at a lateral scour pool forced by boulders along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 4. View to the north looking upstream at a lateral scour pool along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 5. View to the southeast looking downstream along the West Fork at the Yankee Fork/West Fork confluence. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 6. View to the north looking upstream along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 7. View to the north looking upstream at middle channel scour pool forced by flow convergence at the West Fork/Yankee Fork confluence. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 8. View to the northwest looking upstream at West Fork/Yankee Fork confluence. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 13, 2011.

Photograph No. 9. View to the southwest looking downstream at a culvert at the entrance of Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 10. View to the northeast looking upstream at the culvert at the entrance of Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 11. View to the south looking downstream at beaver activity and sedimentation along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 12. View to the south looking downstream at sedimentation along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 13. View to the southeast looking downstream at channel that connects two of the ponds along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 14. View to the northwest looking upstream at check structure along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 15. View to the southeast looking downstream at head of a pond where groundwater daylights along the mine tailings (left) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 16. View to the northwest looking upstream at pond bordered by mine tailings (right) and undisturbed ground (left) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 17. View to the south looking downstream at pond bordered by mine tailings (left) and undisturbed ground (right) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 18. View to the south looking downstream at wood accumulation at check structure near the mouth of the pond along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 19. View to the north looking upstream at pond bordered by mine tailings (right) and undisturbed ground (left) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 20. View to the south looking downstream at wood accumulation at check structure near the mouth of a pond along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 21. View to the north looking upstream at check structure along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 22. View to the south looking downstream at pond bordered by mine tailings (left) and undisturbed ground (right) along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 23. View to the south looking downstream along outlet of Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 24. View to the southwest looking downstream at check structure along outlet of Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 25. View to the south looking downstream along outlet of Pond Series Four.
Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 26. View to the northeast looking upstream along outlet of Pond Series Four.
Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 27. View to the south looking at where the outlet enters the Yankee Fork along Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 28. View to the north looking upstream at outlet of Pond Series Four. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 25, 2011.

Photograph No. 29. View to the north looking upstream at the plane-bed channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 30. View to the south looking downstream at the plane-bed channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 31. View to the southwest looking downstream at Custer Motorway bridge crossing along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 32. View to the north looking upstream at the plane-bed channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 33. View to the southwest looking downstream at Custer Motorway bridge crossing near the head of Pond Series Three along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 34. View to the southeast looking across the Yankee Fork at the inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 35. View to the southeast looking across the Yankee Fork at the inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 36. View to the east looking across the Yankee Fork at beaver dam at the inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 25, 2011.

Photograph No. 37. View to the southwest looking downstream from Custer Motorway bridge along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 38. View to the northeast looking upstream at Custer Motorway bridge along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 39. View to the north looking upstream along the Yankee Fork at Pond Series Four outlet. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 40. View to the west looking across the Yankee Fork at riprap placed along historic roadway. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 41. View to the southeast looking downstream at actively eroding bank (mine tailings) on the outside meander along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 42. View to the northwest looking upstream along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 43. View to the northwest looking upstream from eroding bank (mine tailings) along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 25, 2011.

Photograph No. 44. View to the southwest looking downstream from eroding bank (mine tailings) at eroding bank (alluvial fan) on river right along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 25, 2011.

Photograph No. 45. View to the northwest looking upstream from eroding bank (mine tailings) at vegetated bar with floodplain type side channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 46. View to the south looking downstream at outlet of floodplain type side channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 47. View to the southeast looking downstream from mine tailings along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 48. View to the northwest looking upstream at vegetated bar with floodplain type side channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 25, 2011.

Photograph No. 49. View to the northwest looking upstream along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 50. View to the southeast looking downstream at run along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 51. View to the south looking downstream at split-flow type side channel and riprap in the distance at the head of Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 52. View to the south looking downstream at split-flow type side channel and riprap in the distance at the head of Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 25, 2011.

Photograph No. 53. View to the south looking downstream at riprap along river left and in the distance on river right at the head of Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 54. View to the northwest looking upstream from middle channel bar along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 55. View to the southeast looking downstream from middle channel bar at large boulders (5 feet plus) placed in the channel near the head of Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 56. View to the north looking upstream on middle channel bar along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 57. View to the southeast looking downstream at Pond Series Two inlet and riprap along river right along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 58. View to the southwest looking downstream at the inlet to Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 59. View to the north looking upstream at middle channel bar from riprap placed near the inlet to Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 60. View to the north looking upstream at middle channel bar from riprap placed near the inlet to Pond Series Two along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 61. View to the southeast looking downstream from Custer Motorway bridge at lateral scour pool forced by riprap along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 12, 2011.

Photograph No. 62. View to the northwest looking upstream at inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 63. View to the northwest looking upstream at inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 64. View to the southeast looking downstream at side inlet to Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 65. View to the south looking downstream at culvert along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 66. View to the south looking downstream from road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 67. View to the north looking upstream from road embankment at beaver dam along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 68. View to the north looking upstream at culvert through road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 69. View to the north looking upstream at culvert through road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 70. View to the south looking downstream along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 71. View to the north looking upstream along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 72. View to the southwest looking downstream along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 73. View to the northwest looking upstream from road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 74. View to the south looking downstream from road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 75. View to the southwest looking at check structure placed between cut in road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 76. View to the northwest looking upstream at check structure placed between cut in road embankment along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 77. View to the southeast looking downstream at beaver dam along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 78. View to the south looking downstream at beaver dam along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 79. View to the northeast looking upstream at check structure along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 80. View to the north looking upstream along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 81. View to the north looking upstream from road embankment constriction along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 82. View to the south looking downstream from road embankment constriction along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 83. View to the south looking downstream at check structure placed between embankment constrictions along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 84. View to the north looking upstream at check structure placed between embankment constrictions along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 85. View to the northwest looking upstream at beaver dam near the outlet along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 86. View to the southwest looking downstream at outlet to Yankee Fork along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 87. View to the south looking downstream at outlet to Yankee Fork along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 88. View to the north looking upstream from outlet to Yankee Fork along Pond Series Three. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 89. View to the southwest looking downstream at culvert placed through road embankment near inlet along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 90. View to the southwest looking downstream at culvert near the inlet along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 91. View to the northeast looking upstream from road embankment at inlet along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 92. View to the south looking downstream from road embankment along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 93. View to the west looking along road embankment with culvert along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 94. View to the northwest looking at the road embankment with culvert along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 14, 2011.

Photograph No. 95. View to the southeast looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 96. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 97. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 98. View to the south looking downstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 99. View to the southeast looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 100. View to the southeast looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 101. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 102. View to the south looking downstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 103. View to the south looking downstream from check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 104. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 105. View to the northwest looking upstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 106. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 107. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 108. View to the south looking downstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 109. View to the east looking across seepage area along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 110. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 111. View to the southeast looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 112. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 113. View to the northeast looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 114. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 115. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 116. View to the south looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 117. View to the southeast looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 118. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 119. View to the southwest looking downstream at check structure along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 120. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

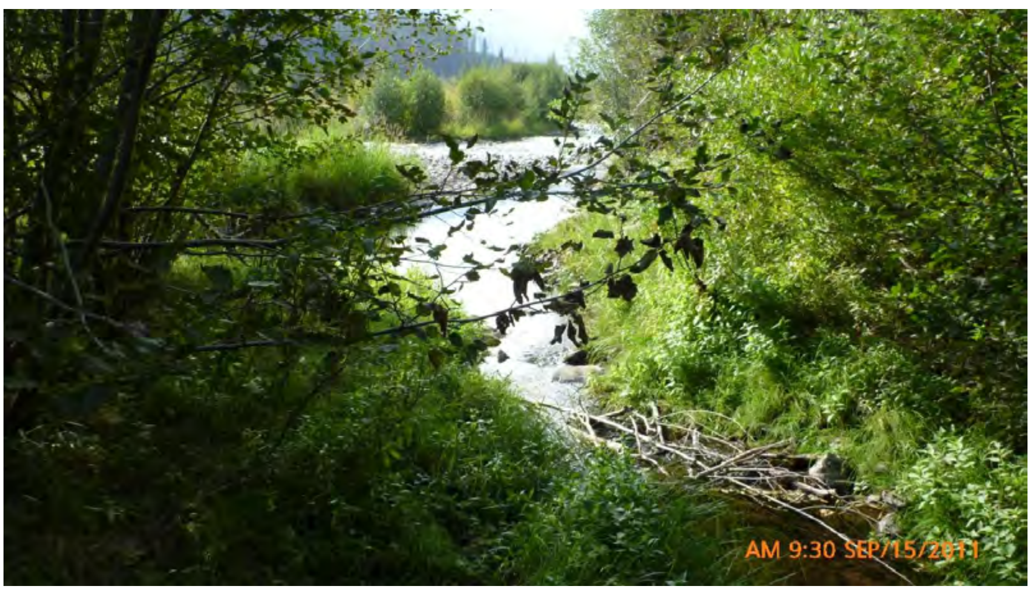
Photograph No. 121. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 122. View to the southwest looking downstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 123. View to the north looking upstream along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 124. View to the south looking downstream near outlet along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 125. View to the southeast looking downstream near outlet along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.



Photograph No. 126. View to the south looking downstream at outlet to the Yankee Fork along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 127. View to the north looking upstream from outlet to Yankee Fork along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 128. View to the north looking upstream from outlet to Yankee Fork along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 129. View to the south looking downstream at the outlet to Yankee Fork along Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, September 15, 2011.

Photograph No. 130. View to the south looking downstream at a riffle along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 131. View to the south looking downstream at inlet to Pond Series One on river left along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 132. View to the east looking across the Yankee Fork at inlet to Pond Series One on river left. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 133. View to the west looking downstream at Custer Motorway bridge crossing along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 134. View to the northeast looking upstream at Custer Motorway bridge along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 135. View to the southwest looking downstream at riffle along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 136. View to the south looking downstream at eroding left bank (mine tailings) along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 137. View to the southwest looking downstream along eroding left bank (mine tailings) toward bedrock restriction along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 138. View to the southwest looking downstream toward bedrock restriction along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, September 15, 2011.

Photograph No. 139. View to the northeast looking upstream along eroding toward bedrock restriction along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 140. View to the northeast looking upstream at eroding bank along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 141. View to the south looking downstream at floodplain on river left along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 142. View to the south looking downstream at outlet from Pond Series Two entering the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 143. View to the south looking downstream from outlet of Pond Series Two at bedrock restriction along river right along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 144. View to the northeast looking downstream at outlet of Jerrys Creek flowing toward the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 145. View to the northeast looking downstream at outlet of Jerrys Creek flowing toward the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 146. View to the southeast looking upstream at channel along Jerrys Creek flowing toward the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 147. View to the north looking at lowland area adjacent to Jerrys Creek from mine tailing mound. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 148. View to the south looking upstream along Jerrys Creek and ponds. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 149. View to the northwest looking at lowland area adjacent to Jerrys Creek. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 150. View to the north looking at lowland area with pond that Jerrys Creek flows into. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 151. View to the south looking downstream at ponds and mine tailings along toe of Jerrys Creek alluvial fan. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 152. View to the north looking upstream at lateral scour pool forced by bedrock on river right along the Yankee Fork and outlet of Pond Series Two. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 153. View to the south looking downstream at riffle along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 154. View to the south looking downstream at eroding banks along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 155. View to the south looking at Ramey Creek entering the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 156. View to the north looking upstream at floodplain patch along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 157. View to the southeast looking downstream along the Yankee Fork at ford crossing that connects to the Rankin Creek unimproved road. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 158. View to the south looking downstream at lateral scour pool along river left that is forced by a mine tailings mound along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 159. View to the south looking across at the head of a floodplain type side channel on river right along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 160. View to the east looking at piece of large wood deposited high on a gravel bar along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 161. View to the southwest looking downstream at floodplain on river right along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 162. View to the south looking downstream at lateral scour pool forced by mine tailings mound along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 163. View to the south looking downstream along a confined channel segment constrained by mine tailings, colluvial deposits and bedrock along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 164. View to the north looking upstream at confined, plane-bed channel along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 165. View to the south looking downstream at floodplain patch on river left where a split-flow type channel activates during channel forming flows along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 166. View to the south looking a floodplain type side channel in the forefront and a split-flow type side channel in the center along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 167. View to the south looking downstream at eroding banks caused by debris flows from an unnamed tributary near RM 3.7 forcing the channel to adjust laterally toward the left bank along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 168. View to the south looking downstream at middle channel pool caused by mine tailing mounds that forces the river to flow around the mounds along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 169. View to the north looking upstream where the channel becomes naturally confined by bedrock and colluvial deposits near RM 3 along the Yankee Fork. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by E. Lyon, October 26, 2011.

Photograph No. 170. View to the north where Silver Creek flows into ponds adjacent to mine tailings. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 171. View to the south where Silver Creek could potentially be diverted into Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 172. View to the north looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 173. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 174. View to the southwest looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 175. View to the south looking across a meadow where a constructed channel is being considered to connect the upper ponds and Silver Creek along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 176. View to the north looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 177. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 178. View to the south looking downstream accumulated (or placed) wood along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 179. View to the north looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 180. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 181. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 182. View to the north looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 183. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 184. View to the southwest looking downstream at check structure along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 185. View to the northeast looking upstream at check structure along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 186. View to the northeast looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 187. View to the southwest looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 188. View to the southwest looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 189. View to the northeast looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 190. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 191. View to the north looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 192. View to the south looking downstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

Photograph No. 193. View to the northeast looking upstream along Pond Series One. Yankee Fork of the Salmon River, Yankee Fork Subbasin, Idaho – Bureau of Reclamation Photograph by P. Drury, October 26, 2011.

APPENDIX D

GIS Databases

This page intentionally left blank

Appendix D – Polecamp Flat Area Baseline Condition Assessment Geodatabase

Introduction

Geodatabase was produced in support of the document, *Polecamp Flat Area Baseline Condition Assessment, Yankee Fork of the Salmon River, Upper Salmon Subbasin, Custer County, Idaho*. More file geodatabases at the tributary spatial scale are contained in the *Yankee Fork Tributary Assessment,Upper Salmon Subbasin, Custer County, Idaho(Reclamation 2012).*

Metadata for GIS-based mapping are provided in the related GIS files available for the *Baseline Assessment* report. For more information or to request a copy of the *Polecamp Flat Area Baseline Condition Assessment* geodatabase and other pertinent geographic information system data on DVD, contact Geographic Information System (GIS) Group at the Reclamation's Pacific Northwest Regional Office, 1150 North Curtis Road Suite 100, Boise, Idaho 83706.

GIS DATA SOURCES AND CITATIONS

Polecamp Flat Assessment Area – U.S. Bureau of Reclamation; displays the area of focus for the *Baseline Assessment*

Surficial Geology – U.S. Bureau of Reclamation; displays the surficial geology and geomorphic features analyzed from 1 meter LiDAR surface models.

Valley Lengths – U.S. Bureau of Reclamation; displays the locations of where the valley length was determined based on geomorphic and geologic constraints.

Valley Widths – U.S. Bureau of Reclamation; displays the locations of where the valley widths were determined based on geomorphic and geologic constraints.

Channel Lengths – U.S. Bureau of Reclamation; displays the 1945 and 2010 channel alignment delineations for the Yankee Fork.

Channel Widths – U.S. Bureau of Reclamation; displays the locations where the 1945 and 2010 unvegetated channel widths were determined.

Polecamp Flat Photopoints – U.S. Bureau of Reclamation; displays the locations where photographs were taken to document 2011 baseline conditions (Appendix C of this report).

Unvegetated Channel 2010 – U.S. Bureau of Reclamation; displays the Yankee Fork unvegetated channel delineated from the 2010 aerial photographs.

Channel – Floodplain Units 2011 – U.S. Bureau of Reclamation; displays geomorphic channel and floodplain units, and miscellaneous features that influence the channel based on USFS (2010) stream inventory survey handbook and WSDOE (2003) framework for delineating channel migration zones.

Channel – Floodplain Units_1945 – U.S. Bureau of Reclamation; displays geomorphic channel and floodplain units, and miscellaneous features that influence the channel based on USFS (2010) stream inventory survey handbook and WSDOE (2003) framework for delineating channel migration zones.

1945 Side Channels – U.S. Bureau of Reclamation; displays location of side channels and includes type and lengths in attribute table.

2010 Side Channels – U.S. Bureau of Reclamation; displays location of side channels and includes type and lengths in attribute table.

Floodplain Target Conditions – U.S. Bureau of Reclamation; displays the floodplain target conditions to create connected floodplain patches to improve habitat-forming processes for the appropriate channel type.

Target VB Widths – U.S. Bureau of Reclamation; displays the locations of where the desired valley widths were determined based on geomorphic and geologic constraints.

Floodplain Rehabilitation – U.S. Bureau of Reclamation; displays the locations where mine tailings, embankments or levee could potentially be removed and/or recontoured to obtain the desired floodplain and valley widths to reach target conditions.

REFERENCES

Parenthetical Reference	Bibliographic Citation
Reclamation 2012	U.S. Department of the Interior, Bureau of Reclamation. 2012. *Yankee Fork Tributary Assessment, Upper Salmon Subbasin, Custer County, Idaho.* Pacific Northwest Region, Boise, Idaho. 153 p.
USFS 2010	U.S. Department of Agriculture, Forest Service. 2010. *Yankee Fork of the Salmon River, 2010 Stream Survey Report.* Salmon-Challis National Forest, Yankee Fork Ranger District. Prepared by La Grande Ranger District, Wallowa-Whitman National Forest, La Grande, Oregon. 37 p.
WSDOE 2003	Washington State Department of Ecology. 2003. "A framework for delineating channel migration zones." *Ecology Publication #03-06027.* 66 p.