

TECHNICAL MEMORANDUM



To: Mitch Long, David Gerth, Kittitas Conservation Trust

From: David French, Tim Abbe, Mike Ericsson, Shawn Higgins

Date: May 31, 2013

Re: Gold Creek Habitat Assessment & Conceptual Design Task 1: Data Inventory & Data Gap Analysis

PROJECT BACKGROUND

The Kittitas Conservation Trust (KCT) has identified the lower 6.8 miles of Gold Creek above Keechelus Lake near Snoqualmie Pass as a candidate location for habitat restoration (Figure 1). The primary objective of the Gold Creek Project (Project) is to restore instream habitat for threatened Gold Creek Bull Trout (*Salvelinus confluentus*). The Project reach has been impacted by historic development and currently experiences significant dewatering during the summer months.

The purpose of the Project is to :

- Identify and describe the causal mechanisms contributing to seasonal dewatering of the channel
- Produce detailed conceptual design drawings to enhance habitat conditions for Gold Creek Bull Trout
- Provide scientific basis for how the concept design will achieve the Project goal

SITE LOCATION

Gold Creek is a tributary to Keechelus Lake, a reservoir adjacent to Interstate 90 near Snoqualmie Pass in Kittitas County, Washington.

EXISTING DATA

Information relevant to the Project was compiled by Natural Systems Design (NSD), KCT, and members of the Technical Working Group (TWG), in order to guide the assessments and conceptual design development. A data inventory compiled from state, federal, private, and non-profit agencies, as well as information provided by local stakeholders, was developed to determine the extent of existing knowledge related to the Project. Information gaps were noted and will direct the objectives of the proposed hydrologic, geomorphic, and habitat assessments. The current state of understanding of the causal mechanisms contributing to dewatering in Gold Creek is presented here, followed by a brief summary of additional information needed to complete the project goals.

Data Sources

All pertinent, available data from state, federal, private, and non-profit agencies as well as information provided by local landowners and stakeholders was compiled into a project database. A total of 150 references related to Gold Creek and the surrounding area make up this database (Appendix A), which encompasses historical communication documents, aerial imagery, relevant scientific studies, land use history, climate, regional geology, and channel morphology. In addition to references provided by KCT and TWG, NSD retrieved data from:

- WA Department of Natural Resources
- WA Department of Ecology
- WA Department of Transportation
- WA Department of Fish & Wildlife
- US Forest Service
- US Geological Survey
- US Bureau of Reclamation
- US Fish & Wildlife
- University of Washington
- Central Washington University
- Geo REF Database
- Science Direct Database
- Personal correspondence records (KCT, WDFW, UW, CWU, BoR, Menconi, Trotter, others)

Gold Creek Watershed

Gold Creek drains a 14.3 square mile (9,122 acre) watershed in the Cascade Mountain range, flowing for approximately 8 miles before entering Keechelus Lake near Interstate 90 (Figure 2) (Craig 1997, Wissmar & Craig 2004, USFS 1998). The drainage basin ranges from 2,507 to 6,933 feet (ft) above sea level (total relief of 4,426 ft.) (Wissmar & Craig 2004) with an average annual precipitation of 87.6 inches and mean temperatures ranging from 33 – 52 degrees Fahrenheit (Western Regional Climate Center 2013). The lower reach of Gold Creek (river mile (RM) 0 – 1.85) is a low-gradient (1%), braided channel flowing through a broad, alluvial valley of highly-permeable sand and gravel (USFS 1998, Collins 1997). The average bankfull width in this reach is 160 ft and the valley is 500 ft wide in some areas, greatly reducing tributary inputs of sediment and large woody debris (LWD) (Collins 1997). The middle reach (RM 1.85 – 3.1) is more confined, with average bankfull and valley widths of 50 and 100 ft, respectively (Collins 1997). This reach averages a 3% gradient, and is composed of pool-riffle segments dominated by cobble and boulders (USFS 1998, Collins 1997). The upper reach (RM 3.1-7.1) is a high-gradient (5%) channel of step-pool segments underlain by boulders and bedrock (Collins 1997). The upper reach is moderately confined, with an average bankfull width of 40 ft and a mean valley width of 100 ft. Fish passage is impeded by a bedrock cascade segment and a waterfall at RM 5.3 and 7.1, respectively (Craig 1997, Collins 1997). Stream discharge measurements in lower Gold Creek range from 12.3 cfs in mid-August to 19.9 cfs in late September and a peak flow of 331 cfs was measured in mid-June (Thomas 2001). In recent years, channel dewatering in the lower and middle reaches has been observed between mid-July and late September (Craig 1997, Mayo 2003).

Land Use History & Associated Impacts

Placer mining, timber harvest, residential development, Keechelus Lake reservoir impoundment, natural geomorphic processes (landslides, channel migration, etc), and the construction of I-90 have all contributed to a changing landscape in lower Gold Creek. Timber removal likely began during construction of a mining tramway into the valley in the late 1800s (USFS 1993) and continued into the 1990s until

formation of the Alpine Lakes Wilderness. Construction of the dam impounding Lake Keechelus was completed in 1917, raising the high water level nearly 61 feet and inundating Gold Creek 2.5 miles upstream from its historic mouth (Deichl, et al. 2011). Gold Creek Pond now occupies a gravel borrow pit, which was excavated to a depth of 60 feet (Craig 1997) throughout construction of I-90 in the 1970s and 1980s before being reclaimed as a visitor's area in the early 1990s. The pond is fed by cold groundwater seeps (Craig 1997) and its depth reportedly exceeds that of the water table (Ehlert 1997). In 1992, the Washington Department of Transportation and the U.S. Forest Service converted the drainage outlet of the pond to a spawning channel for resident and adfluvial fish and began replanting the surrounding area with additions of topsoil, seed, and fertilizer (Mayo 2003). This spawning channel rejoins Gold Creek approximately 1800 ft downstream from the pond outlet (USFS 2012). A second, smaller pond further to the Northeast (RM 1.9) was constructed some time in the late-1990s in what appears to be a historic alignment of Gold Creek (Anderson 2000).

Estimates from Plum Creek Timber Company suggest that the width of Gold Creek's active channel has nearly tripled since 1941, and that channel bars have grown in size in response to timber harvest (Collins 1997, Meyer 2002). Historical aerial images clearly show a reduction in forest canopy throughout the watershed and Ehlert (1997) estimates a 90% reduction in shaded area over the course of 50 years (Figure 3) (Deichl, et al. 2011; Meyer 2012). The presence or absence of LWD can influence the formation of deep pools in the creek, which serve as refugia for fish during periods of low-flow or higher water temperatures (Meyer 2002). LWD is viewed as a key component to the recovery of Gold Creek's lower reaches (Plum Creek Timber Company 1997, Unknown 2012). An avalanche in 2008 near RM 4 delivered a significant volume of LWD to the channel, which appears to be accumulating sediment at the upstream end of the debris deposits. The discharge in this reach is insufficient for downstream transport of the woody material. Several landslide hazard areas within the watershed have been identified by Washington Department of Natural Resources, but there is no evidence of recent mass wasting events near the channel (Figure 2). Potential contributors to Gold Creek dewatering also include a domestic sewer line adjacent to the Ski Tur development, and a water resource well located northeast of Gold Creek Pond, which feeds a 30,000 gallon reservoir for domestic use (WA Dept. of Ecology 1983).

Hydrologic Changes

Segments of Gold Creek have gone dry in recent years during the summer months. Dewatering typically occurs between RM 0.6 and 1, but extends as far as RM 2.5 in some years (Trotter 2012). Dewatering has been reported to occur as early as July 16 (Thomas 2001). A 2001 study conducted by the Bureau of Reclamation showed no correlation between Keechelus reservoir drawdown and the water level in Gold Creek Pond, but reported that dewatering of the channel may occur when the surface level of the pond is below that of the channel (Didricksen). Because the water surface at the upstream end of the pond is at a lower elevation than the adjacent creek channel, hyporheic flow into the pond is likely to occur (Meyer 2012). Craig (1997) reported that dewatering of Gold Creek occurs when stream discharge is less than the base flow (4.6 cfs) in the spawning channel draining Gold Creek Pond. The temperature of the pond outlet (at the inlet to the spawning channel) is 7° Fahrenheit warmer than water seeping into the northern end of the pond, presumably due to cold groundwater seeps and hyporheic flow from the creek, and solar warming of the ponded water (Plum Creek Timber Company 1997, Craig & Wissmar 1994). Coarse sediment inputs due to management-induced reductions in bank stability have resulted in channel widening and increased infiltration rates (Cupp 1997). During full pool of the Keechelus reservoir (Spring), Gold Creek experiences a backwater effect to RM 0.5 during the same time when Spring freshet events capable of transporting sediment occur. This has resulted in sediment deposition and bar formation at the extent of backwater effects (Bakke 2012). Low-gradient streams with highly permeable substrate are prone to subsurface flow where they encounter an alluvial fan (Winter, et al. 1999), which is an analog for conditions at this location.

Although it is beyond the scope of the Project budget to assess, climate change may be a contributing factor to channel dewatering. Glacial recession has been observed in the North Cascades for the past decade (Fountain, et al. 2009) and more precipitation in the form of rainfall is projected in the Northwest due to a higher frequency of atmospheric rivers or ‘pineapple expresses’, which will likely result in reductions to snowpack and summer base flows (Neiman, et al. 2011). An estimated 1.6 inches of rainfall per month is needed to maintain surface flow in Gold Creek, and below normal precipitation is likely to result in further channel dewatering (Wissmar & Craig 1997). A study conducted in Western Washington estimated the drainage area required for perennial streamflow to be 2.4 acres (ac) in areas with basaltic substrate and 0.5 ac in watersheds underlain by Astoria sandstone (Jaeger, et al. 2007). Thus, the basaltic Gold Creek watershed (9122 ac) should be of sufficient size to maintain perennial flow under normal meteorological conditions.

Spatial Data

The U.S. Forest Service conducted stream surveys on portions of Gold Creek in 1993, 1998, and 2012. These reports contain surface information, water temperature, channel cross sections, and a thalweg profile for select reaches. LiDAR data for the watershed was collected by Watershed Sciences, Inc. in 2011. Landslide hazard areas for the region were identified by the Washington Department of Natural Resources and the GIS dataset was completed in June 2010. Aerial imagery of the watershed exists for select years from 1944 through 2011 from various sources (Appendix B). Tax parcels and land ownership data from 2012 was downloaded from the Washington Department of Natural Resources. Well log information for 48 geotechnical borings in the vicinity of the I-90 bridge crossing and for 2 water resource wells within the Gold Creek valley were obtained from the Department of Ecology.

DATA GAPS

The existing data inventory revealed several missing components that are considered critical to completion of the project goals:

- Temporal and spatial variability of surface and groundwater elevations
- Stream discharge/hydrograph
- Channel substrate size and distribution
- Precipitation gage data
- Spatial distribution of erosional/depositional areas
- Spatial distribution of LWD and associated geomorphological features
- Hydraulic modeling
- Spatial arrangement of pools and other habitat features

Attachments:

Figure 1 – Gold Creek Project Site Map

Figure 2 – Gold Creek Watershed Map

Figure 3 – Historic Aerial Imagery 1942 – 1975

Appendix A- Reference List for Gold Creek

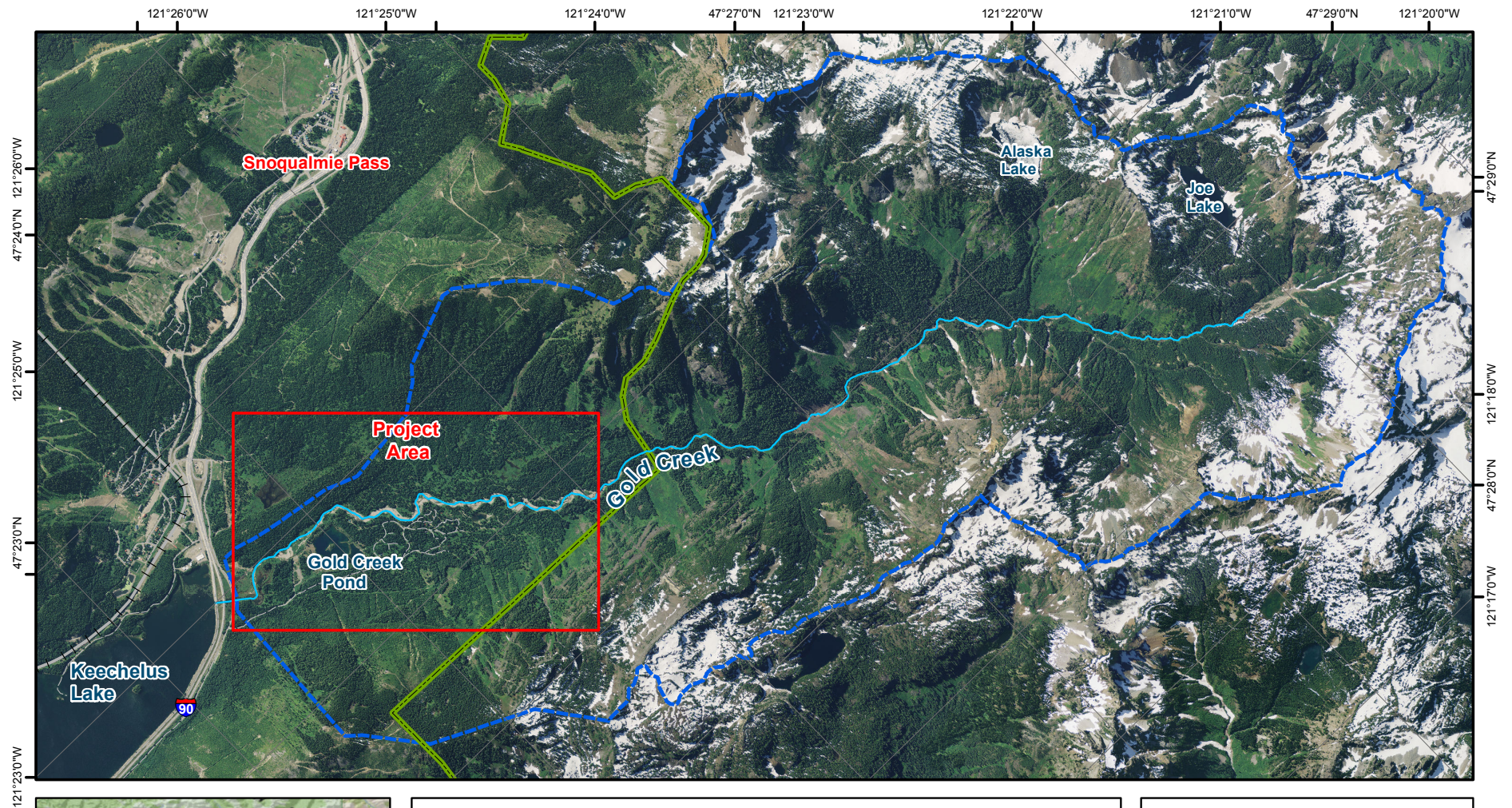
Appendix B- Gold Creek Aerial Imagery Inventory

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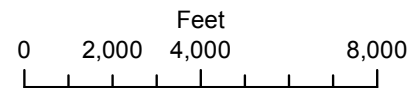
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Legend

- Main Channel
- Roads
- ++++ Railroad
- Wilderness Boundary
- Watershed Boundary



Data sources:
USDA National Agriculture Imagery Program
USGS National Hydrography Dataset



**Gold Creek
Project Site Area**

**Northeast of Snoqualmie Pass
Kittitas County, Washington**

FIGURE I – Gold Creek Project Site Map

Gold Creek Habitat Assessment & Conceptual Design



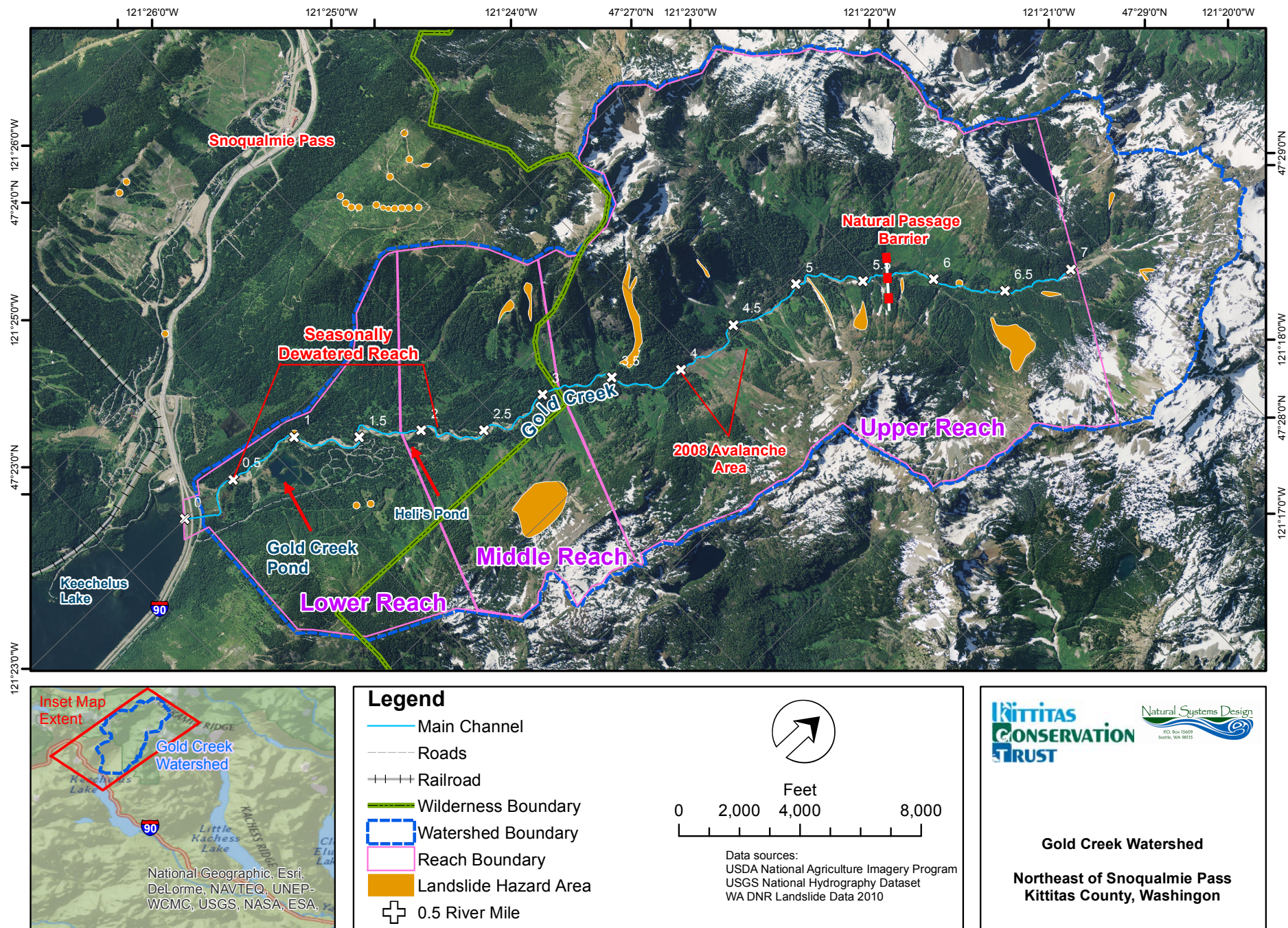


FIGURE 2 – Gold Creek Watershed Map

Gold Creek Habitat Assessment & Conceptual Design



Source: Meyer, W., 2012. Habitat Assessment & Conceptual Design Powerpoint Presentation, Yakima Basin Fish & Wildlife Recovery Board.

FIGURE 3 – Historic Aerial Imagery 1942 - 1975

Gold Creek Habitat Assessment & Conceptual Design

APPENDIX A

Reference List for Gold Creek Habitat Restoration & Conceptual Design

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APPENDIX B

Gold Creek Aerial Imagery Inventory

Compiled by S. Higgins 05/06/2013, Updated by D. French 05/13/2013

Imagery downloaded from USGS Earth Explorer database

Date	Scale*	Hz Rez	Georef	Type
9/10/1957	47200		N	BW
9/4/1958	40000		N	BW
6/22/1977	63666		N	CIR
8/9/1979	80000		N	BW
9/23/1985	24000	1 m	N	CLR
9/27/1994	12000	1 m	Y	BW
7/25/1998	12000	1 m	Y	BW
4/1/2006	12000	0.5 m	Y	CLR
8/26/2011	12000	1 m	Y	CLR

Imagery available from UW map library (not yet obtained)

Date	Scale*	Hz Rez	Georef	Type	Source
1944	20000		N	BW	USACE
1962	12000		N	BW	USFS
1965	60000		N	BW	Pacific Aerial Surveys
1970	15840		N	BW	USFS
1974	24000		N	BW	WA DNR
1975	15840		N	BW	USFS
1991	12000		N	BW	WA DNR

Imagery available from WSDOT (not yet obtained)

Date	Scale*	Hz Rez	Georef	Type	Source
1957				BW	WSDOT
1963				BW	WSDOT
1977				BW	WSDOT

Imagery downloaded from CWU

Date	Scale*	Hz Rez	Georef	Type	Source
9/24/1954	20000		N	BW	USDA
9/24/1954	20000		N	BW	USDA

Imagery from Carl Menconi

Date	Scale*	Hz Rez	Georef	Type	Source
6/12/2004			N	CLR	Menconi
12/27/2004			N	CLR	Menconi
7/28/2005			N	CLR	Menconi
10/13/2007			N	CLR	Menconi