Teanaway Community Forest Fish and Wildlife Habitat Baseline Report

Report submitted to Department of Ecology's Office of Columbia River by Washing
Department of Fish and Wildlife in partial fulfillment of Contract # C1400237

Figures

Tables

1.0 Introduction

1.1 Teanaway Community Forest

The Teanaway Community Forest (TCF) was acquired by the State of Washington in 2013 from American Forest Holdings (AFH). The acquisition consisted of 50,241 acres and was located in three watersheds; Teanaway River, First Creek and Cabin Creek (Figure 1). The TCF is owned by the Washington State Department of Natural Resources (WSDNR), and the Washington Department of Fish and Wildlife (WDFW) holds a Habitat Restoration and Working Lands Easement (conservation easement) for the forest. Collectively the two agencies are managing the forest together with input and guidance from the TCF advisory committee. The legislation authorizing the purchase of the TCF and consequently the TCF Management Plan gave clear directives that the forest should maintain working lands for forestry and grazing while protecting and conserving fish and wildlife habitat (WSDNR & WDFW, 2015). The law states that the management plan, "must ensure that the land is managed in a manner that is consistent with the Yakima Basin Integrated Plan principles for forest land acquisitions, including the following goals:

Goal 1: Water Supply and Watershed Protection
Goal 2: Working Lands (Grazing and Forestry)
Goal 3: Recreation
Goal 4: Fish and Wildlife Habitat
Goal 5: Community Partnerships

This report focuses on goals 1, 2, and 4 and provides some information on what kind of information should be collected to monitor anticipated recreation as it may impact Goals 1, 2, & 4. This report does not elaborate on community partnerships, Goal 5. Main chapters of this report will focus on data compiled, collected, or needed to address the first four goals. Many types of data that support these objectives are related to multiple goals, such as road-delivered sediment monitoring and riparian health, and are discussed in multiple locations or refer to prior discussion of those data as appropriate.

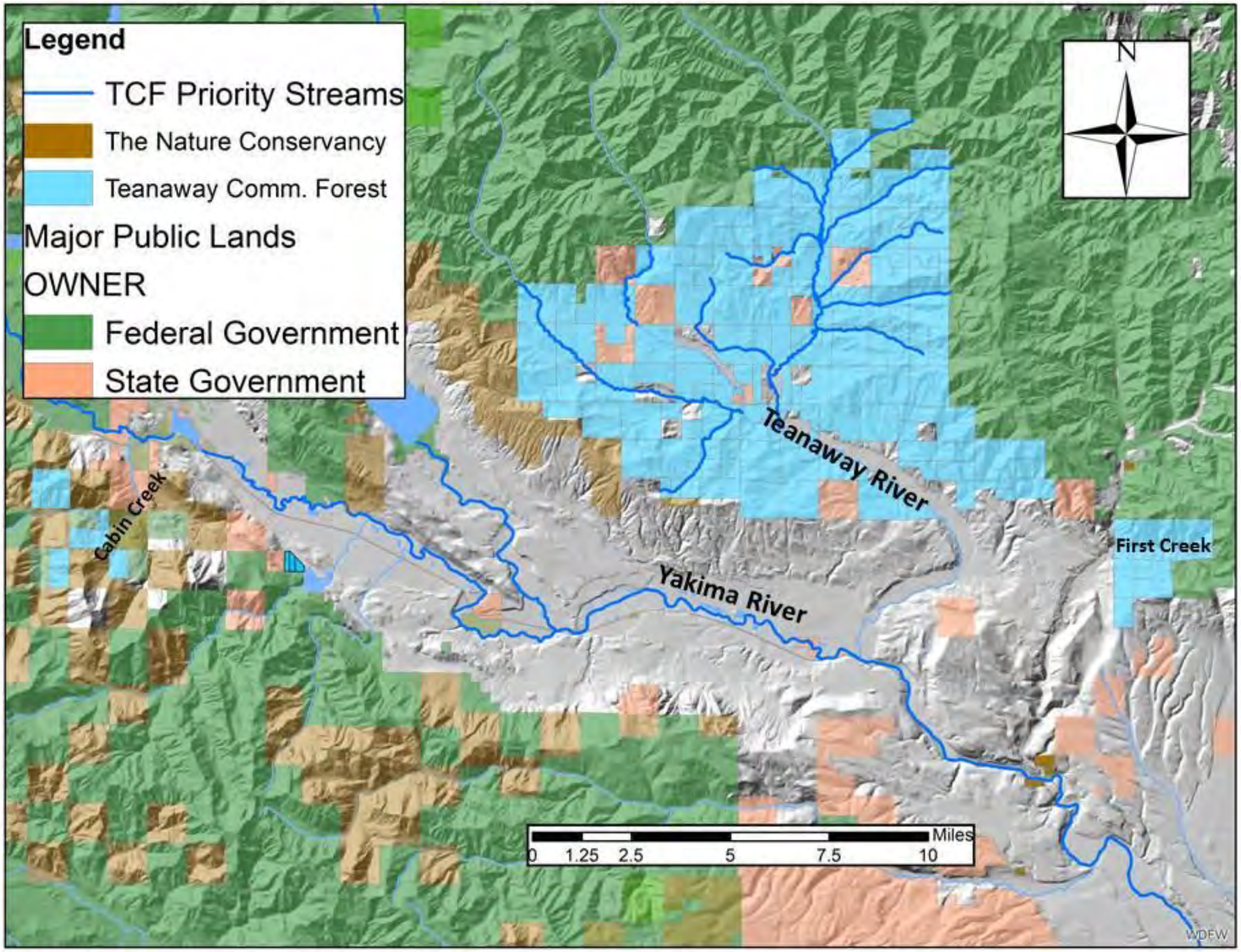
1.2 Description of what WDFW was tasked to provide to Washington State Department of Ecology

WDFW was contracted through Department of Ecology's Office of Columbia River (OCR) to collect baseline fish and wildlife habitat information for the Teanaway Community Forest. WDFW was tasked with identification of existing data and data gaps where data needs to be collected. Given the large task of filling all the potential data gaps with limited staff and monetary resources, some data gaps were filled by June 30, 2015, but other data gaps would not be filled until after June 30, 2015. Spatial information obtained for this report, both existing and new data collected by WDFW staff, are linked to ArcMap. ArcGIS documents are available for use by authorized personnel upon request.

1.3 Timeline of work, field and office

A team of biologists and scientific technicians were hired to perform tasks that were outlined in Section 1.2 above. The two lead biologists started in late July 2014 and the four scientific technicians started in late August and early September 2014. Focus during the fall was on other contractual tasks such as Keechelus to Kachess Conveyance Environmental Impact Statement (EIS) support, Kachess Drought Relief Pumping Plant EIS support, Cle Elum Pool Raise EIS Support, Wymer Reservoir habitat and species analysis, and Bumping Reservoir Expansion habitat and species impact analysis. Collection of existing data started during January 2015. Collection of field data started in April 2015 and continued until submission of

Figure 1. Overview of the Teanaway Community Forest and surrounding landscape.



this report. Field data collection was timed after the first draft of the TCF Management Plan to ensure a consistent approach with the plan and efficiency in collection. Collection of

some field data will continue through the summer and fall of 2015. Collection of field data from March 2015 through June 2015 focused on:

Goal 1: Water Supply and Protection:

Fine sediment delivery estimation using the Washington Road Sediment Evaluation Model (WARSEM)
Water quality monitoring (past & present)
Wetland mapping and identifying enhancement or creation opportunities
"Green" Lidar of floodplains, topo bathymetry to document baseline conditions and inform restoration.
Bedrock mapping along the three main forks
Identify data gaps

Goal 2: Working Lands (Grazing and Forestry)

Documenting livestock access points to streams (MIM)
Establishing long-term monitoring sites
"Red" Lidar obtained for uplands & forest assessments (Winter 2015/16)
Identify data gaps

Goal 4: Fish and Wildlife Habitat & Surveys

Mapping and assessing fish passage barriers
Digital elevation model developed through "Green & Red" LiDAR acquisition, useful for terrestrial and aquatic habitat assessments.
Conducting Northern spotted owl presence surveys
Identify data gaps

2.0 Water Supply and Watershed Protection

2.1 Wetland surveys

2.1.1 Introduction

The Teanaway Community Forest (TCF) legislation, Senate Bill 5367, and the Yakima Basin Integrated Plan (YBIP) both identify the need for restoring watershed health. One of the most fundamental elements of watershed health is the protection, enhancement and creation of wetlands. This wetland assessment addresses the water management and wildlife habitat goals and objective. Senate Bill 5367 authorized the purchase of the TCF and established a framework for its management. Sections 3 (2) (a) and (b) are as follows:

(a) Protection, mitigation, and enhancement of fish and wildlife through improved water management; improved instream flows; improved water quality; protection, creation, and enhancement of wetlands; improved fish passage, and by other appropriate means of habitat improvement, including the protection and enhancement of natural wetlands, floodplains, and groundwater storage systems;

(b) Improved water availability and reliability, and improved efficiency of water delivery and use, to enhance basin water supplies for agricultural irrigation, municipal, commercial, industrial, domestic, and environmental water uses;

Towards this end, the Teanaway Community Forest Management Plan (WSDNR & WDFW, 2015) established specific management goals pertaining to wetlands. These include: 1) improving the function of riparian areas, wetlands and meadows, 2) addressing the fragmentation of floodplains and wetlands by roads and trails and 3) improving fish habitat. The Teanaway Community Forest Management Plan has established *priority streams* within the boundary of the TCF. These include all or a portion of the West Fork of the Teanaway River, North Fork of the Teanaway River, Middle Fork of the Teanaway River, Carlson Creek, Dickey Creek, Indian Creek, Jack Creek, Jungle Creek, Lick Creek, Middle Creek, Stafford Creek and Rye Creek. Figure 1 showed the priority stream sections. Wetland inventory is called for in the TCF Management Plan (WSDNR & WDFW, 2015). In the TCF Management Plan, two specific dates regarding baseline wetland surveys are referenced:

- Survey conditions such as roads, trails and infrastructure that are impeding wetlands by February 2016
- Inventory wetlands in priority streams by December 2016.

This wetland assessment comprises a portion of the work described in the Proposal for Baseline Assessment of Wetland Resources and Potential for Wetland Functional Improvement in the Teanaway Community Forest (WDFW, 2015; unpublished). This document will be referred to as the 'Wetland Work Plan' in this report. This proposal was based on field and office work extending through December 2015; only a portion of the wetland work described in the Wetland Work Plan was accomplished during the spring of 2015 due to time constraints. Only the wetlands near the priority stream sections of the West, Middle and North Forks of the Teanaway River were analyzed since these wetlands are considered the most essential for water storage for the Teanaway River. The majority of NWI wetlands in the TCF are located along the three major forks which gave these areas a higher priority for wetland assessment. Wetlands directly associated with the priority stream sections of the North, Middle and West Forks of the Teanaway River are analyzed in this report.
A second wetland assessment was conducted within the TCF and is described in the report Teanaway Community Forest Major Tributary Area Wetland Report (WDFW, August 2015). This work described delineations and ratings of wetlands along seven major tributaries to the Teanaway River forks as well as opportunities for wetland restoration and enhancement in these areas. This wetland report was financed from the Great Northern Landscape Conservation Cooperative via the Cascadia Partner Forum (WDFW contract 15-03562) and facilitated by Conservation Northwest. This report can be made available through WDFW.

The Teanaway Community Forest has limited capacity to replenish the aquifer from its surface waters. It is part of the Roslyn Basin which is comprised of finer lacustrine deposits that do not transfer water to the aquifer as quickly as more coarse deposits in the Kittitas Basin (ESA, 2012). Additionally, bedrock underlies many of the rivers and this impedes conductivity between surface waters and the aquifer. Bedrock is exposed in the river channels in many places. The depth from the terrestrial surface to the bedrock has not been extensively studied; in the vicinity of lower Jack Creek it was found to be 8 to 10 feet deep (Anna Hoselton, Washington Department of Ecology, personal communication). Excess surface water is stored at the surface in wetlands and the soil and replenishes the streams during the summer months. This means that wetland creation, restoration and enhancement in areas near streams would be beneficial to the water management and wildlife habitat goals stated in Senate Bill 5367.

2.1.2 Methods

Methods consisted of GIS analysis and fieldwork. An NWI layer (USDFW, 2015), NAIP 2013 orthophoto layer (USDA, 2013) and topographic layer (ESRI, USGS & NGA, 2007) were studied using ArcMap 2010 (ESRI, Redlands, CA) to gain a sense of where documented wetlands were in the landscape and strategize field efforts.

The priority stream sections of the West, Middle and North Forks of the Teanaway River were surveyed on foot by Chris Holcomb, WDFW. Holcomb is a graduate of the University of Washington Extension's Wetland Science and Management Program and has 3 years of experience with wetland consulting. A Garmin GPS Map 62s was used to document any wetland or potential creation, restoration or enhancement area. Other wetlands not associated with priority streams were incidentally observed and documented while driving to stream reaches for targeted surveys. Each wetland was sketched, its size was estimated and notes were taken to aid in wetland rating. Many wetlands were photographed. Fieldwork took place on April 17, 23, 24, 30, May 1, 29 and June 5. Holcomb visited wetlands and possible wetland restoration and enhancement sites with Catherine Reed, of the Washington Department of Ecology on May 29 in order to get her thoughts on wetland determinations, rating and restoration strategies.

Wetlands were determined using the Regional Supplement to the US Army Corps of Engineers Wetland Delineation Manual; Western Mountains Valley's and Coasts Region (USACE 2010). This manual states that wetland determinations in western riparian areas pose challenges. Cottonwoods and willows may not necessarily reflect wetland hydrology and entisol soil types may not show wetland soil indicators. Therefore, riparian areas were determined to be wetlands or not based on the understory plant community in areas where soils did not show typical wetland soil indicators and that were under the river's ordinary high water mark.

NWI wetlands were rated using the Washington Department of Ecology Wetland Rating System for Eastern Washington (Hruby, 2014). NWI documents wetlands based on Cowardin classifications (Cowardin et al., 1979) but these areas were not individually rated; rather any contiguous NWI wetland unit was combined for rating. Additionally, NWI polygons did not always reflect the shape of wetlands so they were considered in conjunction with waypoints and field sketches for wetland rating. Rating analyzes the level of water quality, hydrologic and habitat functions that the wetland provides. In addition to determining how well wetlands provide functions based on their inherent features, the rating system considers the opportunity of the wetland to provide those functions and the value of that functioning. For example, a wetland may provide good water quality functions due to its vegetation and may have opportunity to provide those functions if pollutant sources are present in the landscape. These functions would have value if the downstream portion of the wetland has a watershed management plan that considers water quality a concern. The better the wetlands inherent characteristics coupled with opportunity and value, the higher the rating score. From the rating score, wetlands are assigned a category ranging from I to IV with Category I wetlands offering the highest functioning and Category IV wetlands offering the lowest.

During the course of fieldwork, areas that could be used for wetland creation, restoration or enhancement were located and evaluated. In addition, areas that would be appropriate for wetland buffer enhancement were located and evaluated. Wetland buffers are the upland areas immediately adjacent to wetlands that help shield the wetland from human impacts. Collectively these sites are referred to as wetland 'Improvement Opportunities' in this report. Selecting and evaluating wetland improvement opportunity sites was based on three criteria.

- Is the site in an area that a wetland was likely present before or in a place that could allow a created wetland to sustain itself?
- Is the site disturbed by human actions?
- Would replacing the disturbance with a wetland run counter to other Teanaway Community Forest goals such as recreation?

2.1.3 Results

The National Wetland Inventory (NWI) documents 30 wetlands and wetland complexes that are directly associated with the North, West and Middle Fork priority stream sections (USFWS, 2015). These wetlands were visited and rated. Twenty-nine new wetland areas that were not documented by NWI were also identified. Most of these wetlands are riverine wetlands that include seasonally-inundated side channels but some were depressional wetlands that receive most of their water from the surrounding upland landscape or a shallow water table. Generally, the wetlands offered high levels of functioning for water quality and habitat, and moderate levels of function for water storage.

Figure 2 shows the Teanaway block of the TCF and references subsequent figures that will show detailed locations of assessed wetlands. Table 1 lists wetlands along the West Fork Teanaway River that were delineated and rated. Figure 3 shows the legend to be used for Figures 4 through 10, which show all wetlands discussed in this analysis. Map figures for each fork follow tables that summarize the wetland characteristics on each fork. The figures also show wetland improvement opportunities in the area.

Figure 2. Overview of the wetland survey area with coverage of Figures 4 through 10. Priority streams are included.

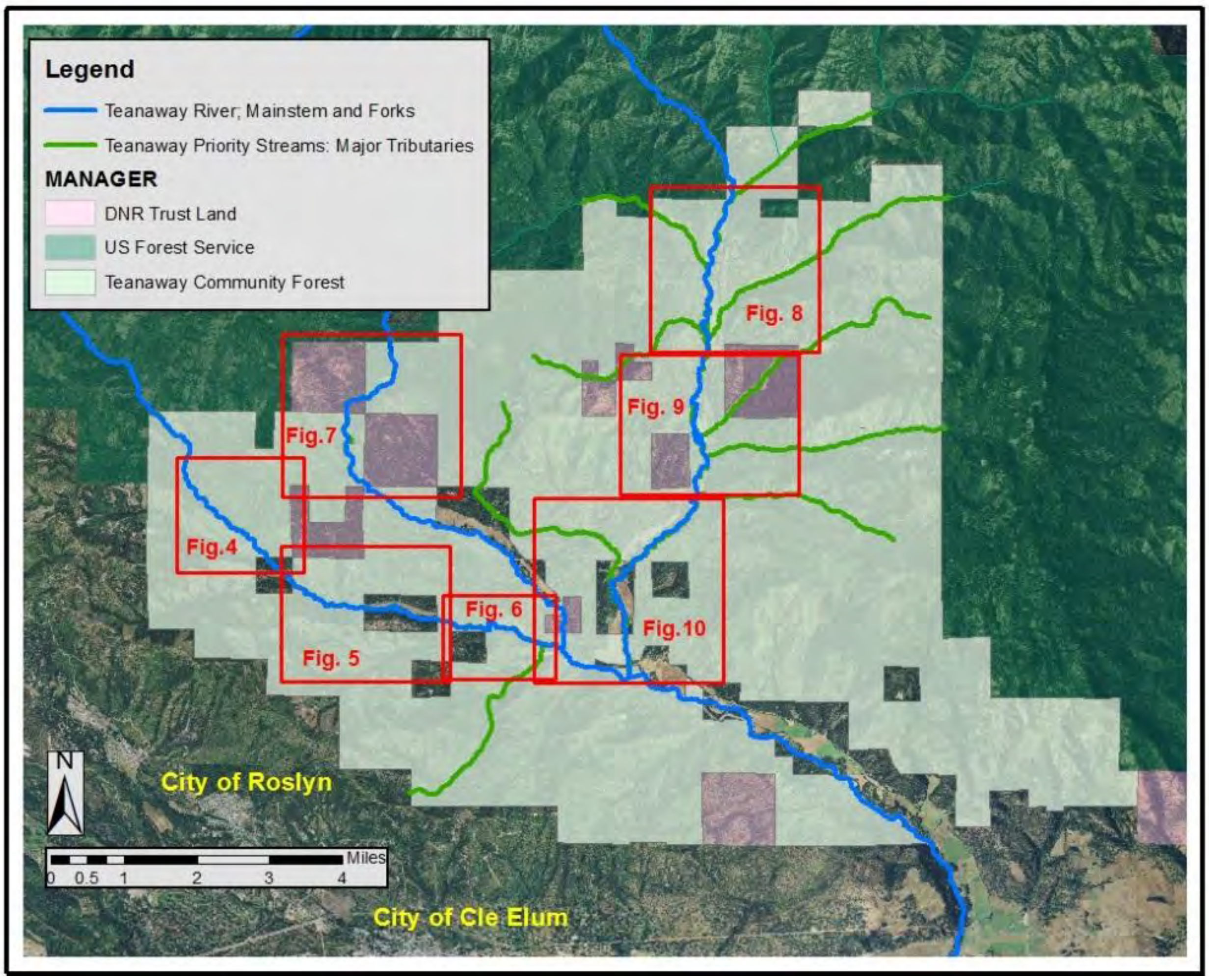


Table 1. Wetlands assessed on West Fork Teanaway River. 'WF' =West Fork. 'TW' = new wetlands that are not associated with the river but were discovered incidentally. Figures 4 through 6 show the location of these wetlands.

Wetland Name	NWI Status[1]	HGM Type[2]	Category[3]	Total Area (in acres) (Portion of extensions to NWI-documented wetlands given in parenthesis)
WF 1	Documented, area added[4]	R, D	I	8.2 (2.5)
WF 2	New	D	II	2.1
WF 3	Documented	R	I	1.3
WF 4	New	R	II	.2
WF 5	New	R	II	.2
WF 6	New	D	II	.1
WF 7	New	D	II	.2
WF 8	New	R	II	.3
WF 9	New	R	II	.2
WF 10	Documented	R	I	7.8
WF 11	New	R	II	.2
WF 12	Documented, area added	R	II	1.8 (.5)
WF 13	New	S	II	.3
WF 14	Documented, area added	R	II	1.1 (.4)
WF 15	Documented, area added	R	I	2.2 (1.2)
WF 16	New	R	II	.8
WF 17	Documented	R	II	.3
WF 18	New	R	II	.2
WF 19	New	R	II	.4
WF 20	Documented, area added	R	I	7.4 (.4)
TW 1	New	D	II	.5
WF 21	New	R	II	.2
WF 22	New	R	II	.2
WF 23	New	R	II	.7
TW 2	New	S	III	.2
WF 24	New	R	II	.4
WF 25	New	R	II	.3
WF 26	New	R	II	.2
WF 27	New	D	II	.8
WF 28	New	R	II	.3
WF 29	New	R	II	.2
WF 30	New	R	II	.8
WF 31	New	R	I	8.1
WF 32	New	R	II	1.0

[1] National Wetland Inventory. 'Documented' wetlands were on the NWI database; 'New' wetlands were found by this survey.
[2] Hydrogeomorphic Wetland Classification system; R= Riverine, D= Depressional, S= Slope
[3] The wetland category is determined from the wetland rating system (Hruby, 2014). Category I wetlands provide the highest levels of functions while category IV wetlands provide the lowest level of functions.
[4] 'Area Added' refers to extensions that were placed on documented NWI wetlands.

Figure 3. Legend for Figures 4-10.

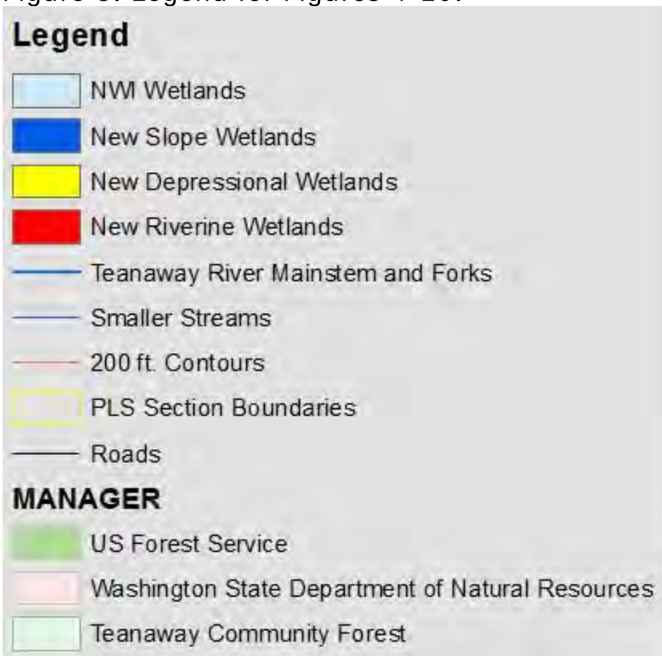


Figure 4. Wetlands and wetland improvement opportunities in the West Fork Teanaway River, Upper Section.

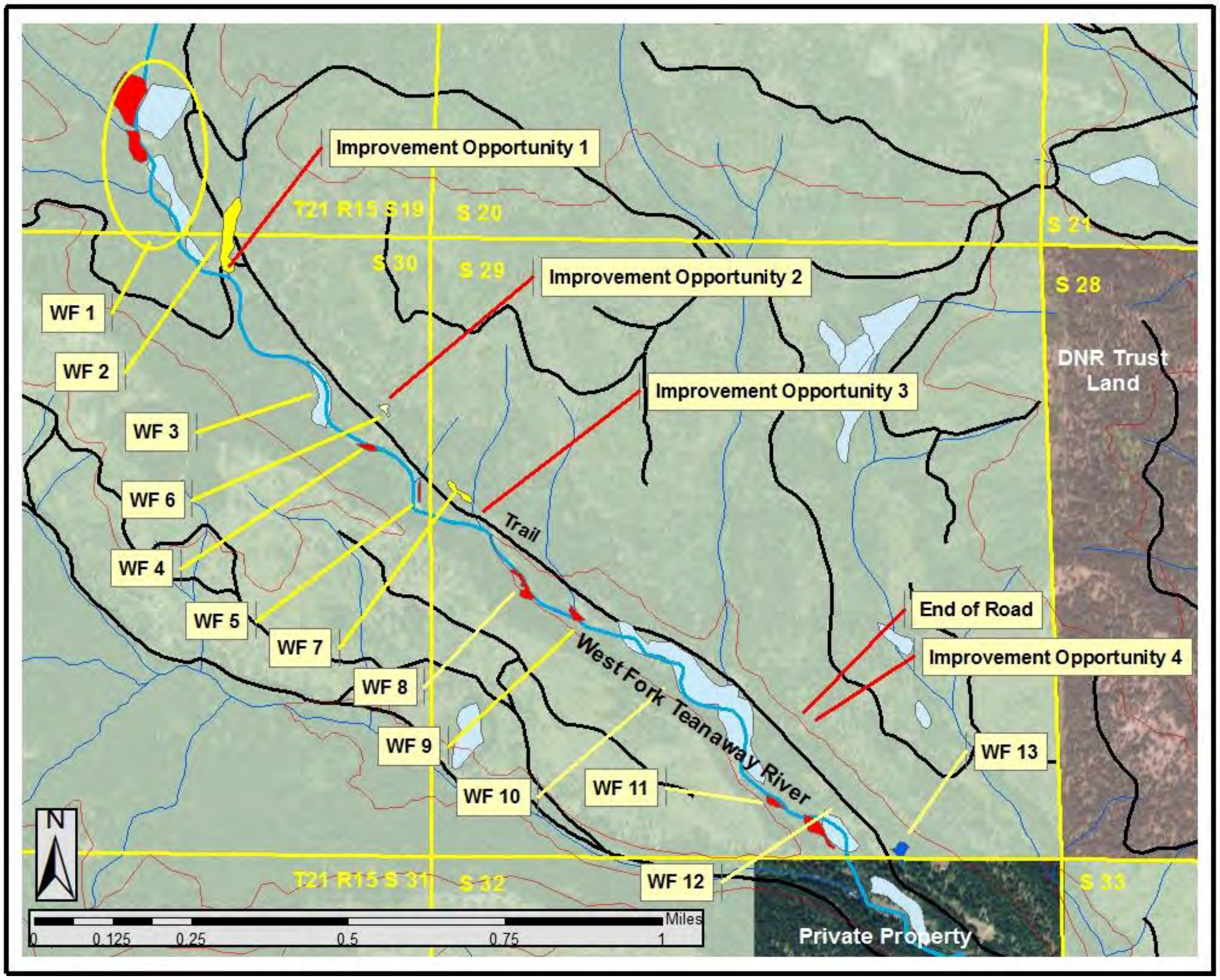


Figure 5. Wetlands and wetland improvement opportunities in the West Fork Teanaway River, Middle Section.

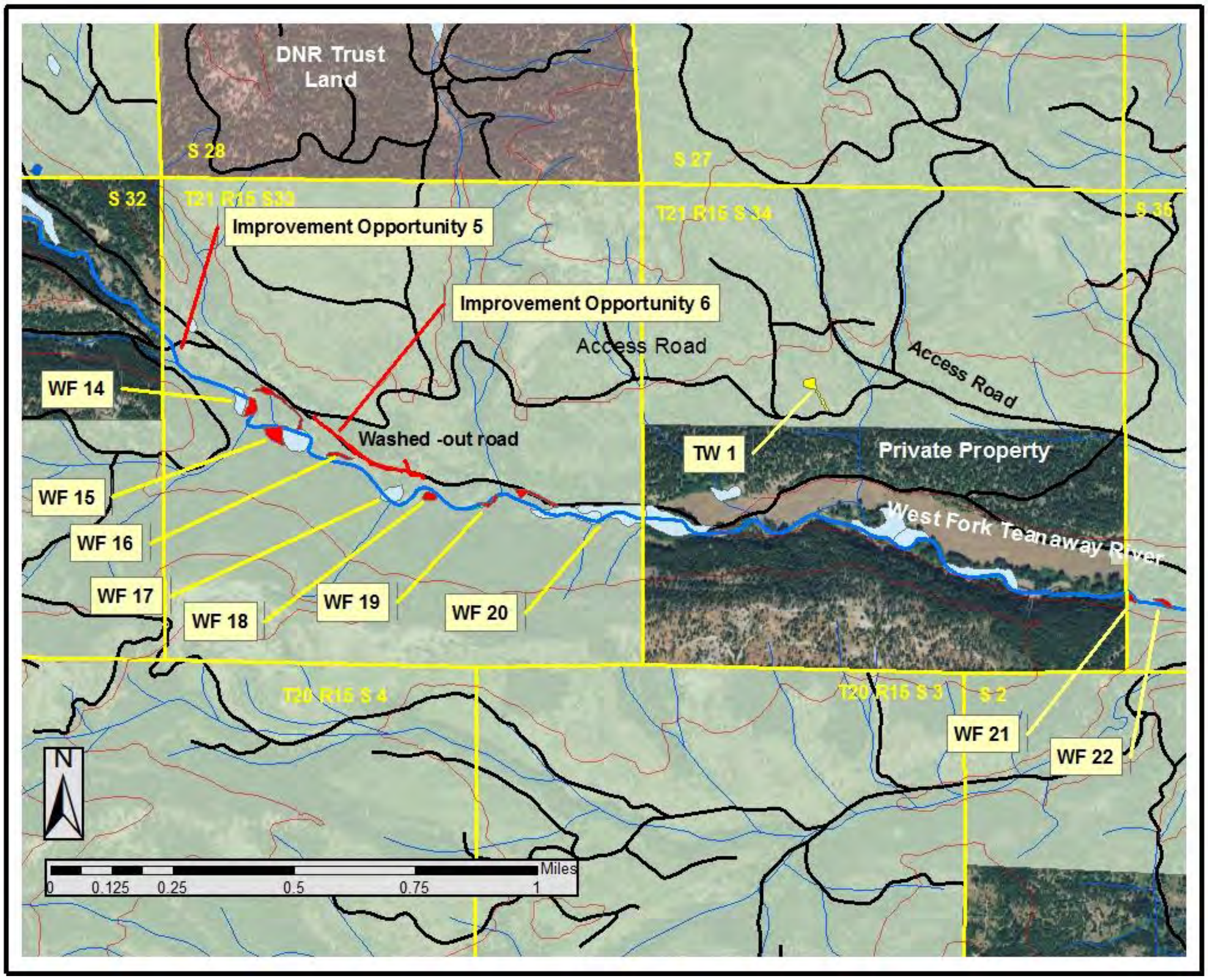


Figure 6. Wetlands and wetland improvement opportunities in the West Fork Teanaway River Wetlands, Lower Section.

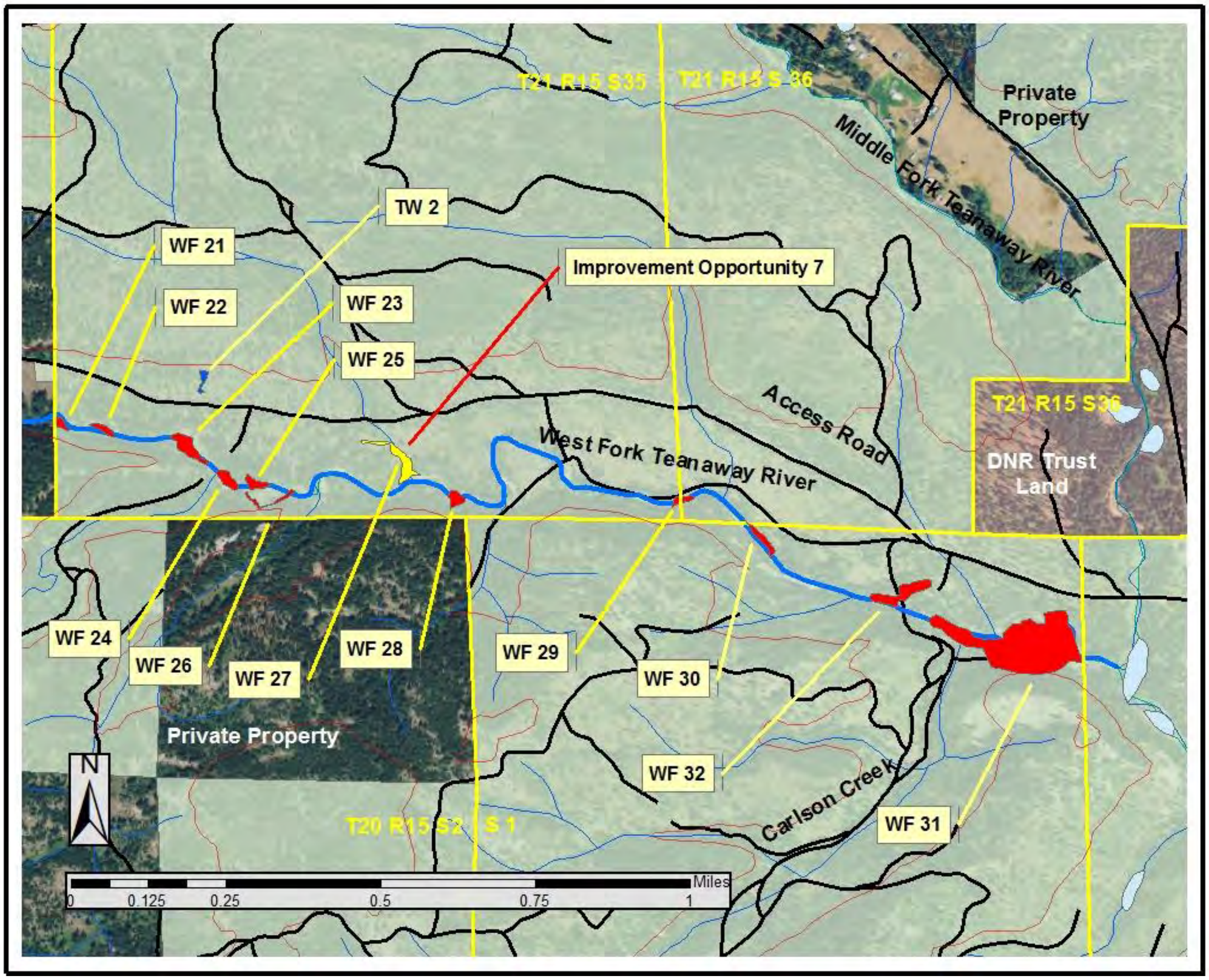


Table 2. Wetlands assessed along the priority stream section of the Middle Fork Teanaway River. 'MF' refers to 'Middle Fork'. Figure 7 shows the location of these wetlands.

Wetland Name	NWI Status[1]	HGM Type[2]	Category[3]	Area (in acres) (Portion of extensions to NWI-documented wetlands given in parenthesis)
MF 1	Documented	R	II	3.2
MF 2	Documented	R	II	.9
MF 3	Documented	R	II	3.7
MF 4	Documented	R	II	2.5
MF 5	Documented, area added[4]	R, D	I	11.2 (2.3)

[1] National Wetland Inventory. The wetlands on the Middle Fork were documented by NWI. No 'New' wetlands were discovered.
[2] Hydrogeomorphic Wetland Classification system; R= Riverine, D= Depressional, S= Slope
[3] The wetland category is determined rom the wetland rating system (Hruby, 2014).Category I wetlands offer the highest level of functions and Category IV offer the lowest level of functions.
[4] 'area added' refers to NWI-documented wetlands that were determined to be larger based on field observations.

Figure 7. Wetlands and wetland improvement opportunities in the Middle Fork Teanaway River.

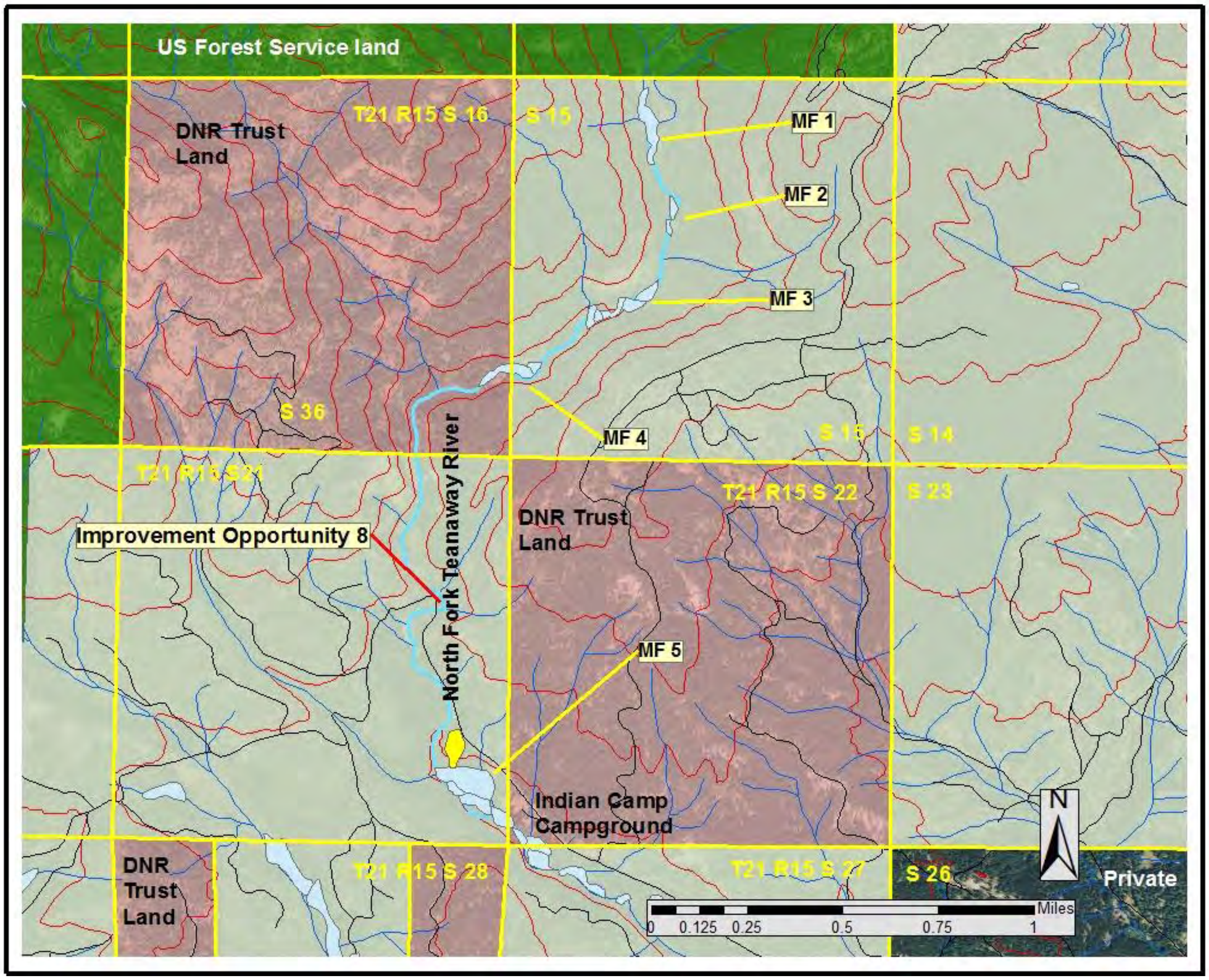


Table 3. Wetlands assessed along the North Fork Teanaway River. Figures 8 through 10 show the location of these wetlands. 'NF' = North Fork.

Name	NWI Status[1]	HGM Type[2]	Category[3]	Area (acres) (Portion of extensions to NWI-documented wetlands given in parenthesis)
NF 1	Documented	R	II	.3
NF 2	Documented	R	II	.4
NF 3	New	D	II	1.6
NF 4	Documented	R	II	1.4
NF 5	New	R	I	1.2
NF 6	Documented	R	I	9.9
NF 7	Documented	R	I	4.7
NF 8	Documented	R	II	4.5
NF 9	Documented	R	I	12.6
NF 10	Documented	R	II	10.5
NF 11	New	D	II	5.7
NF 12	Documented	R	I	2.6
NF 13	Documented	R	II	1.8
NF 14	Documented	R	I	4.8
NF 15	Documented, area added[4]	R, D	I	26.9 (11.2)
NF 16	Documented	R	II	1.2
NF 17	Documented	R	II	1.4
NF 18	Documented	R	II	2.5
NF 19	Documented	R, D	I	34.6

[1] National Wetland Inventory. 'Documented' wetlands were in NWI database; 'New' wetlands were found from this survey.
[2] Hydrogeomorphic Wetland Classification system; R= Riverine, D= Depressional, S= Slope
[3] The wetland category is determined rom the wetland rating system (Hruby, 2014). Category I wetlands provide the highest level of functions while Category IV wetlands provide the lowest level of functions.
[4] 'area added' refers to documented NWI wetlands that were determined to be larger based on field observations.

Figure 8. North Fork Teanaway River Wetlands, Upper Section.

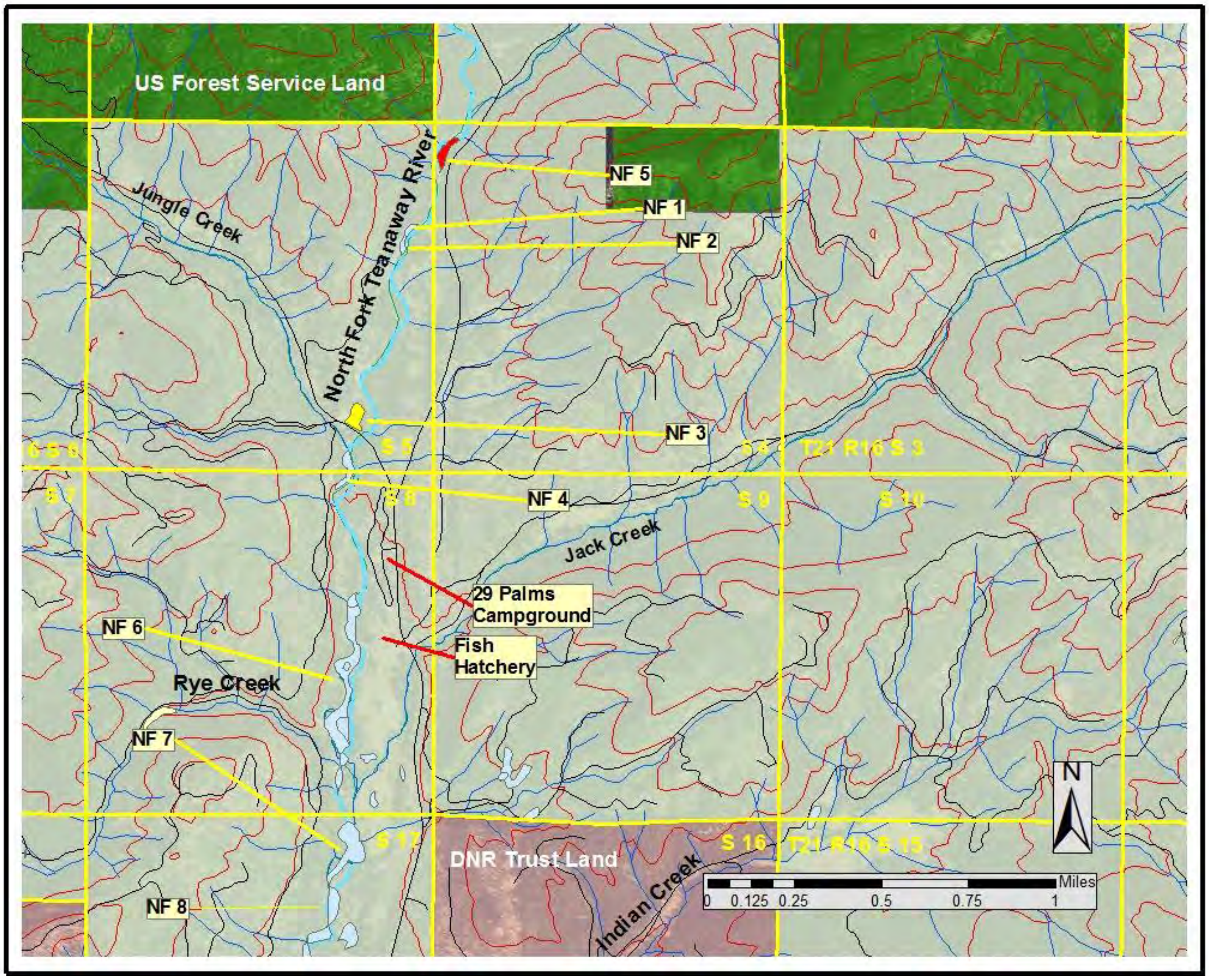


Figure 9. North Fork Teanaway River Wetlands, Middle Section.

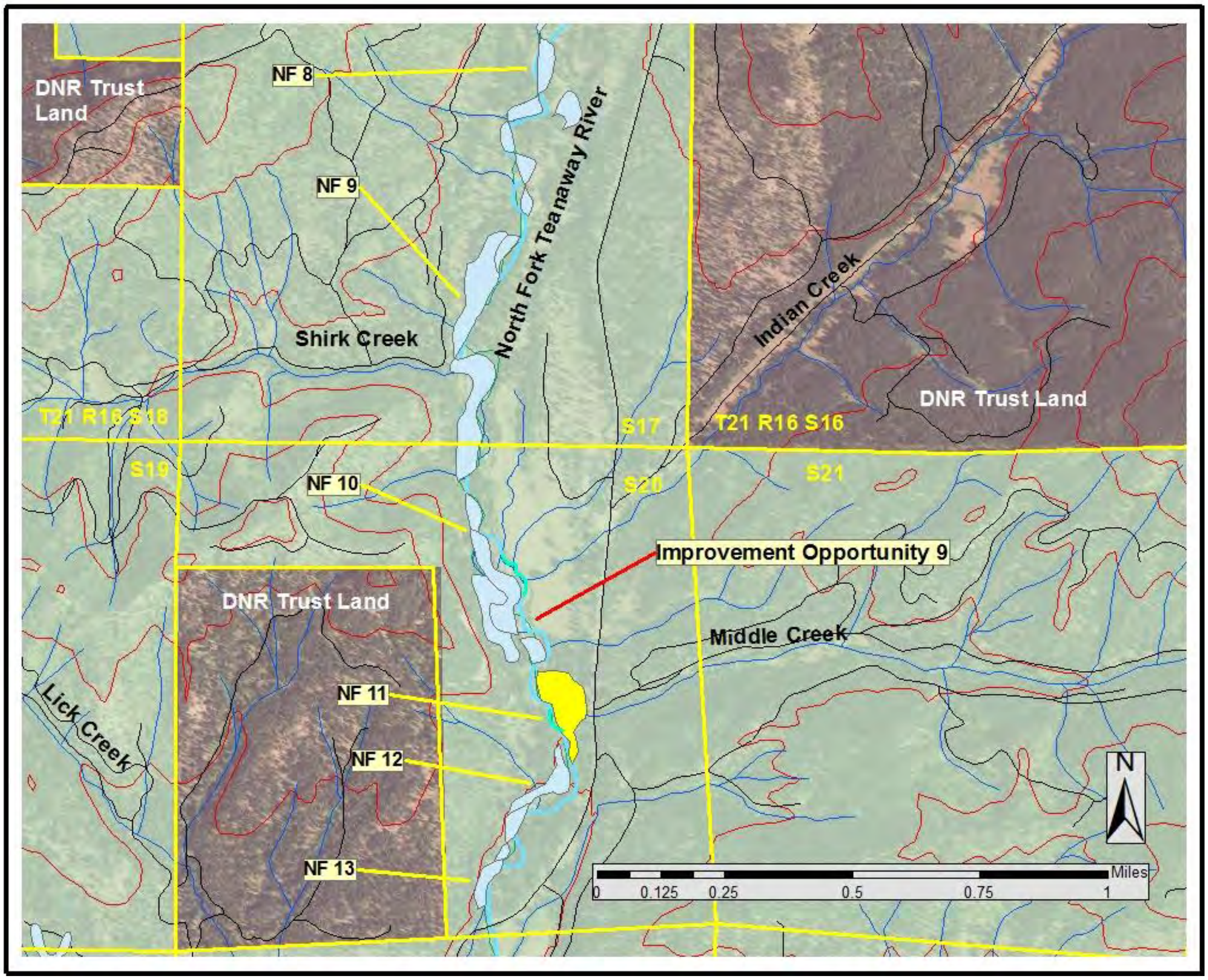
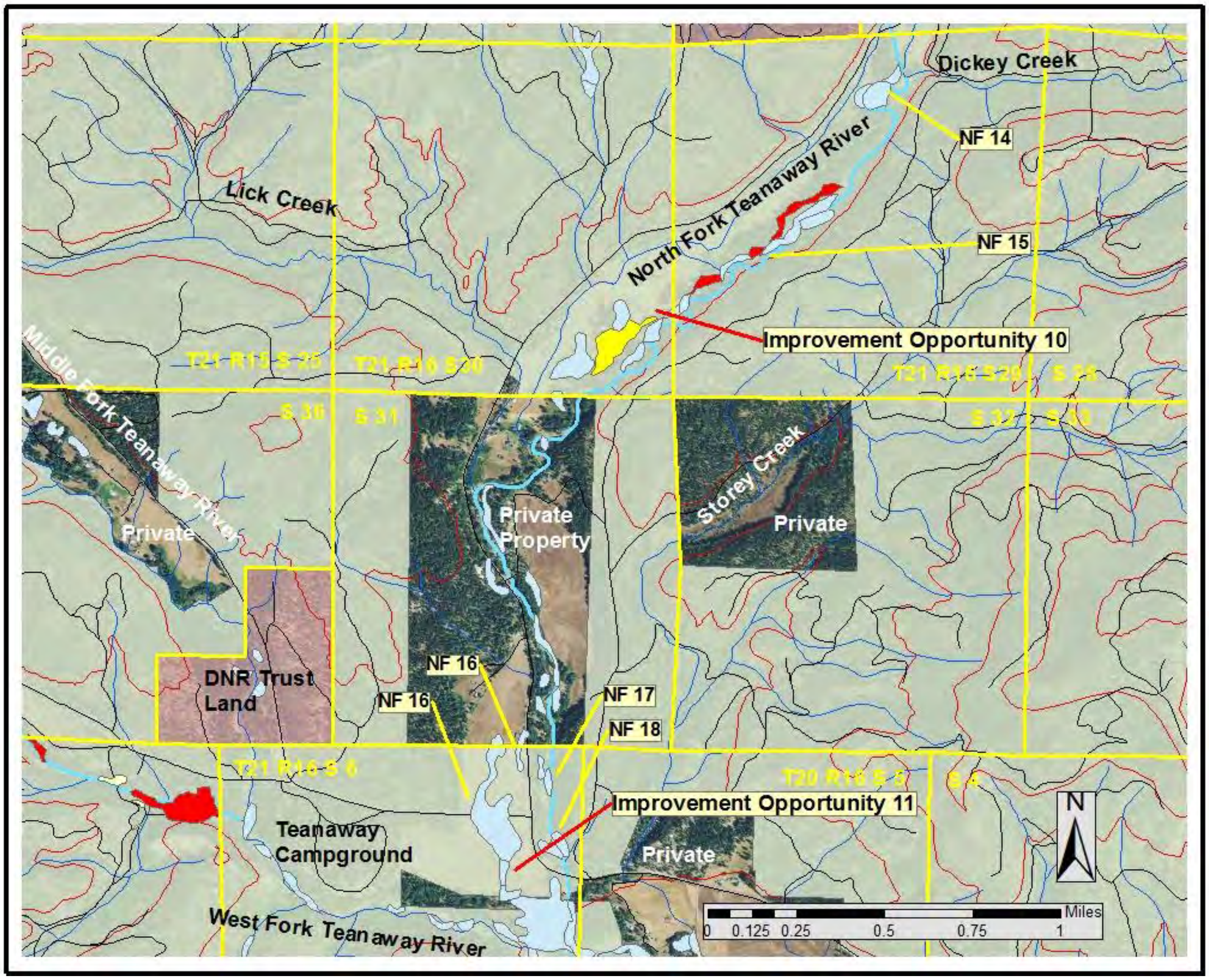


Figure 10. North Fork Teanaway River Wetlands, Lower Section.



2.1.4 Discussion

Wetland Characteristics

Most of the wetlands along the three forks are riverine wetlands that receive seasonal or occasional water from overbank flooding (Figures 11 & 12). There are some depressional wetlands that receive water from higher upland areas and some of these are contiguous with the more common riverine wetlands (Figure 13). Finally there are a few slope wetlands that receive water from seeps and in most cases this water eventually makes its way to one of the three forks.

Most of the wetlands had higher ratings (Category I and II). There are relatively few pollutant sources in the area so the *opportunity* for water quality improvement is moderate. Flooding problems occur on the mainstem and further downstream so the wetlands have high opportunity for hydrological functions even though many of them are not particularly wide relative to the river channel width. The Teanaway Community Forest Management Plan considers the forest integral for water quality and hydrology functions so this factor alone increases the value of both the water quality and hydrology functions that the wetlands provide.

Figure 11. Wetland NF 4, North Fork Teanaway River. This is representative of a typical riverine wetland.

Figure 12. Wetland WF 10, a large category 1 NWI wetland on the West Fork Teanaway River. It has a particularly large side channel.

Figure 13 Wetland NF 11. This is a depressional wetland at the junction of Middle Creek and the North Fork Teanaway River. It features amphibian breeding habitat.

<u>Wetland and Wetland Buffer Improvement Opportunities</u>

Wetland improvement opportunities are synonymous with wetland creation, restoration, enhancement as well as improvement of wetland buffers (areas that surround wetlands). Creating, restoring and enhancing wetlands adds or increases wetland function in a given area. Enhancing wetland buffers also expands the functionality of wetlands and helps shield them from human impacts.

Shapefile points were digitized to aid in finding them again. The points were stored in the folder "S:\Reg3\HP\Integrated Plan - Downes-Kline\Teanaway\GIS\Wetland Waypoints\Restoration Areas\Digitized restoration points". The points were named IO-#; 'IO 5 site' for example, refers to Improvement Opportunity 5 site. Some sites had multiple shapefile points to refer to different points within them.

Most of the wetland improvement sites are located in places adjacent to wetlands or streams or in topographical depressions. These places likely had wetlands in the past or will be able to sustain created wetlands in the future. Most of the sites were impacted by roads while a few were impacted by grazing and possible historic clearing. The road sections that are proposed for wetland creation or restoration are bound by tank traps and dead ends so it is assumed that they are not utilized for vehicle transportation.

Improvement Opportunity 1

<u>Location:</u> West fork Teanaway River, near WF 2,
3000 sq. ft. of wetland creation / restoration.

This road section is about 200 ft. long and lies between the river and a tank trap (Figure 14). A trail extends to the south and north from this road section and a road is present on the opposite side of the river. Part of the road could be retained to connect these two trail sections but the rest of the road could be excavated and converted to wetland. It is not known if a wetland was here previously but the area is in topographic depression near the river and wetland WF 2 is a short distance to the east so the area has potential to sustain a wetland. If the trails are retained, up to 4000 square feet of wetland could be restored or created. A challenge that this site poses is that it is relatively remote and the tank trap and drop-off area separating it from the main road is about 18 feet high which would impede access by heavy equipment. Additionally, the gains in wetland function from creation or restoration would be relatively low compared to the work involved.

Figure 14. Wetland Improvement Opportunity 1. The tank trap is out of view.

Improvement Opportunity 2

<u>Location:</u> Abandoned road adjacent to wetland WF 6.
500 sq. ft. of wetland creation

A broad trail abuts a small wetland in this area. Re-rout the trail to the south of the road's present location and replace about 70 ft of road with created depressional wetland adjacent to the existing wetland. This existing abandoned road could be used as a horse trail. Create a trail south of the road's present location in the vicinity of wetland WF 6 and replace 100 ft. of road with wetland.

Improvement Opportunity 3

<u>Location:</u> Abandoned road directly north of West Fork Teanaway River
12,000 sq. ft. of wetland / side channel creation

This is a 3000 foot-long section of road that is tank trapped from other roads to the north and unmaintained; it is littered with logs in some places (Figure 15). The southern end, in the vicinity of wetland WF 10, was washed out and has an exposed culvert. South of the culvert, this road connects with another road via a short trail and is tank-trapped. Part of the road could be retained as a narrow horse and foot trail. The rest could be converted to a narrow channel. Wetlands in long narrow side channels occur naturally in the area; one is present between wetlands WF 14 and 15. Given its length, this action could store substantial amounts of water from high flows. If this option is enacted, it may be necessary to excavate between it and the river in order to create hydrologic connectivity with the West Fork Teanaway River.

Figure 15. Wetland Improvement Opportunity 3. View of tank-trapped road and exposed culvert at its southern end.

Improvement Opportunity 4

<u>Location</u>: North shore of West Fork Teanaway River
Make 800 sq. ft. of road area available for river channel expansion

This area is part of the same road-trail system that is described in Improvement Opportunity 3, but is located further downstream along the river. The road comes very close the river and then dead-ends about 200 feet further, meaning that little benefit is gained from that extra 200 ft. of road (Figure 16). Retain part of the road as a trail and excavate the other half and armor it with large woody debris including large woody debris that extends perpendicular into the river. This would create more of river meander in this area. A disadvantage of this option is that the road is above the river's ordinary high water mark and vegetation grows between it and the river; carrying out this option may require destroying vegetation and excavating. If a trail is maintained in the area, the side of the trail nearest the water would have to be armored.

Figure 16. View of area for Improvement Opportunity 4. This road's dead end is visible in the background.

Improvement Opportunity 5

Location: North bank of West Fork Teanaway River near a bridge and just east of a private property block.
10,300 sq. ft. of wetland creation adjacent to river

This is a roughly 1000 sq. ft. grassy area adjacent to the river (Figure 17). It could be excavated to below the ordinary high water mark elevation and connected to the river or turned into a riverine wetland by excavating and possibly creating a more substantial connection with the river. The trees between the field and the river could be retained. This area is directly beside the road and therefore provides easy access for heavy equipment. Creating a wetland in this area could provide substantial water storage.

Figure 17. Wetland Improvement Opportunity 5. Excavate the grassy area to create more of a depression and connect it with the river.

Improvement Opportunity 6

<u>Location:</u> North of the West Fork Teanaway River.
Create 27,000 sq. ft of wetland

This abandoned road segment is about 1,300 ft. long and extends from a tank trap to the West Fork Teanaway River (Figure 18). The road is constructed on an embankment that is 3 ft. high in some places. The road used to extend alongside the river but got washed out. No trail extends through or along the river from where the road ends. This road extends through a cottonwood / fir forest that is very near the ordinary high water mark. This area has cobbly substrate and gradual hills suggesting that it was a river channel in the past. The road could be replaced with a depression and possibly connected via trench to the river near the tank trap. This would result in a large water storage area. The tank trap is adjacent to the main access road for this area, meaning that heavy equipment would have easy access to this site.

Figure 18. Wetland Improvement Opportunity 6. From this point, this tank-trapped road extends about 400 m to the river.

Wetland Improvement Option 7

Location: Field north of the West Fork Teanaway River around WF 27.
24,000 sq. ft. of wetland buffer enhancement and or wetland enhancement

Wetland WF 27 is partially surrounded by a grassy field that has probably been grazed and compacted by cattle. Portions of this field are emergent wetland and these areas could be enhanced. A trail goes right through wetland WF 27 (Figure 19). The grassy area around the wetland could be re-planted and fenced. This action would reduce pollutants entering wetland WF 27. Enhancing existing emergent wetlands would further improve water quality improvement functions in this area. There is no easy place to re-route the trail since wetland WF 27 extends to the road embankment. A bridge could be placed over the wetland in the location where the trail is in order to reduce impacts by horses and hikers. This area is adjacent to the main road which gives it good access.

Figure 19. Wetland improvement opportunity 7. Trail passing through wetland WF 27.

Wetland Improvement Option 8

Location: Unofficial Campsite on the Middle Fork Teanaway River near a bridge
Enhance existing riverine wetlands and creation of 14,000 sq. ft. of new wetland

The bridge in this area is in poor condition and may get replaced. Its abutments could be placed higher on the bank which would allow for wider flows downstream. This would improve streamside wetlands downstream from the bridge. About 80 ft. downstream from the bridge on the right bank is a dispersed campsite with a 'No camping sign' (Figure 20). 14,000 sq. ft. of wetland could be created in the campsite with a small channel connecting it with the river. This action would provide additional water storage for the Middle Fork

Teanaway River. The campsite is at an elevation about 3 ft. higher than the ordinary high water mark so wetland creation would require excavation. The depth of bedrock is unknown and shallow bedrock may impede sufficient excavation depth. Although the campsite is near the main road, it is about 15 feet below it which may impede access by heavy equipment.

Figure 20. Improvement Opportunity 8. Dispersed campsite on Middle Fork. The bridge can be seen in the background.

Improvement Opportunity 9

Location: Field at the junction of Indian Creek and the North Fork Teanaway River
Enhance emergent wetlands and enhance wetland buffers along 2000 ft. of North Fork Teanaway River shoreline; about 115,600 sq. ft. of wetland enhancement or buffer enhancement.

A large field exists where Indian Creek intersects the North Fork Teanaway River and field areas immediately to the south (Figure 21). This area is currently dominated by invasive emergent vegetation and is heavily grazed. The area has channels, indicating that water flows here during flooding events and that it could sustain created wetlands. This area has relatively easy access to a road. The north half of this field should not be included as a mitigation site as it will be part of an ongoing Multiple Indicator Monitoring analysis to assess cattle grazing impacts to streams.

Figure 21. View of a portion of Improvement Opportunity 9. The North Fork Teanaway River is on the right (not visible). Channels in the field and grassy areas can be enhanced by appropriate shrub species.

Improvement Opportunity 10

Location: Field along the North Fork Teanaway River
Restoration of seasonal channels and wetland buffer areas in a 20,000 sq. ft. area

This area exists near the left bank of the North Fork Teanaway River at the edge of a large field (Figure 22). Channels that receive water during high flows and that are surrounded by forests are common in the area between the Dickey Creek Bridge and the Tracy Family land. Improvement opportunity 10 exists in a grassy field with dry channels. Cattle have impacted this area by grazing and soil compaction. This area could be fenced off from cattle and forest and shrub vegetation could be planted. Channel areas could count as wetland enhancement and areas with higher topography could count as wetland buffer enhancement.

Figure 22. Improvement opportunity 10. View of a portion of the pasture near the North Fork Teanaway River. Channels in this area (not visible in photo) and adjacent upland areas could be fenced off from grazing and installed with appropriate plants.

Improvement Opportunity 11

Location: Fields around wetland NF 19, near the junction of the North Fork and the mainstem Teanaway River.
900,000 of wetland buffer enhancement

Wetland NF 19 is a large depressional and reverine wetland complex that is partially surrounded by fields that are grazed and have some invasive plants (Figure 23). This area could be enhanced by installing plants in the fields adjacent to NF 19. This would improve the area's capacity to clean water prior to it entering the Teanaway River. The wetland and the surrounding buffer would need to be fenced off from grazing. This area is easily accessed from the road.

Figure 23. Improvement Opportunity 11. Wetland NF 19 is partially surrounded by a field, a portion of which is in the foreground. This field can be replanted with plants to enhance the wetland buffer.

Recommendations for Future Study

Wetland Reconnaissance and Rating

In keeping with the Wetlands Work Plan, more time should be devoted to wetland assessment and determining priorities for wetland creation, restoration and enhancement in the TCF. With respect to assessing current wetland functions, non-NWI wetlands should be rated along the North, Middle and West Forks and wetlands that are not associated with the three forks or the nine tributaries should be identified and rated. Wetland creation, restoration and enhancement opportunities should be assessed first along the nine major tributaries to the forks and then in areas that are not associated with the three forks and nine major tributaries. The TCF has an extensive road network that impacts water flow across the landscape and impedes wetland function.

Wetland Function Improvement

Capturing spring snowmelt and retaining it to gradually replenish the water table is an important need in the TCF. More analysis should be conducted on ways that wetland creation and restoration can be incorporated toward these ends. The geology at wetland improvement sites should be analyzed in order to determine if standing surface water could contribute to the water table. This information could inform the prioritization of improvement opportunity sites and inform their design.

Wetland creation, restoration and enhancement opportunities need to be inventoried along with existing wetlands. The TCF has an extensive road network that impacts water flow across the landscape and impedes wetland function. After wetlands and wetland impacts are inventoried, a selection of wetland and wetland buffer improvement measures should be compiled based on resource management objectives, mitigation needs, and the financial resources available. Consultation with the Washington Department of Ecology and Kittitas County should be established early in the process so that permitting requirements can be anticipated. If wetland and wetland buffer improvement opportunities are more abundant in the TCF than mitigation requirements incurred from Integrated Plan actions, it is possible that improvement opportunities in the TCF could be made available to other agencies that need to mitigate for wetland impacts. A prime example of such an agency would be the Washington Department of Transportation.

Society has had mixed results with wetland and wetland buffer creation, restoration and enhancement and it is best to plan projects carefully based on what has been learned from past successes and failures. Once improvement opportunities have been identified, the hydrology of sites should be analyzed for at least a year so that soil work and plant selection can be tailored to improve chances of success. Pasture areas around the lower reaches of the North and West Forks have invasive species so strategies to minimize their presence at restoration and enhancement sites would need to be considered.

2.2 Fine Sediment – Large scale and site-specific measures. WARSEM (Washington Road Sediment Evaluation Model) and McNeil Core sampling.

2.2.1 Introduction

Fine sediment can be a significant indicator of aquatic habitat quality. In streams where salmonids are present, increased fine sediment levels can have detrimental effects on fish embryo survival and fitness (Koski, 1975). Fine sediment percentages of <12%, 12-20%, and >20% in east side streams of Washington indicate properly functioning habitat, functioning at risk, and improperly functioning habitat, respectively (NMFS, 1996). According to a 1982 National Fisheries Survey of fisheries managers (with more than 9 years of experience), excessive sedimentation ranked as the number one source adversely affecting fishery habitats and was a major concern in all streams (Judy et al. 1982). The impact of roads on sediment input has been well studied and reviewed in Appendix A of Dubé et al. 2004.

Sediment delivery from roads to streams is being assessed and modeled through the Washington Road Sediment Evaluation Model (WARSEM). This model provides an estimate of the annual delivery of sediment in a particular area, not specific point measurements at a particular time of year. The relative measure of sediment delivery across the landscape at a particular time is useful for determining which areas to focus road repairs and decommissioning.

The model is also useful to run scenarios where proposed best management practices are applied to certain road segments virtually to determine if the BMP has the desired result. Combined with future identical field assessment after BMPs are implemented, the model can show progress towards reducing sediment delivery on an annual basis.

A second measure considered for evaluating sediment at a particular location at a specific time of year is McNeil core sampling. To achieve the performance measure of reducing sediment levels in spawning reaches, sediment sampling should occur as a site-specific measure of suitable spawning habitat. The concept of measuring actual sediment loading and conditions in the spawning reaches. No in-situ sediment sampling has been completed and is discussed here as a recommendation for future implementation to determine suitability of spawning gravels in the TCF.

Both modeled sediment estimates and direct in-situ sediment sampling require long-term monitoring protocols. A study plan has been drafted for both WARSEM and in-situ sampling methods and are included in Appendices C and F, respectively.

2.2.2 Methods (WARSEM)

The overall goal of sediment monitoring is to characterize and manage fine sediment input from roads and trails throughout the TCF. This information will be used to identify specific road segments that are generating relatively high fine sediment levels. These roads will be prioritized for application of appropriate Best Management Practices (BMP's), redesigning, relocating, or decommissioning.

WARSEM was developed to quantify the amount of sediment produced by roads. The model can be easily calibrated to allow evaluation of sediment input from trails (Dubé, 2004). We will apply this model to the TCF to characterize the present status of sediment load in various sub-basins and help select locations for applicable types of habitat improvement projects.

The goal of quantifying sediment input into the streams of the TCF is achieved by visiting all road and trail segments within the TCF and determining if that particular segment potentially delivers sediment to a stream or wetland. If it does not likely deliver sediment, that segment is noted and the next road segment is visited. If the road segment does potentially deliver sediment to a stream or wetland, that data necessary as inputs to the WARSEM model are collected (See appendix C for a detailed list of required model inputs).

Prior to field data collection, roads and trails were prioritized based on their active or abandoned status, the relative contribution of that portion of the TCF on the overall landscape, and ease of access to the roads or trails. The field data will be entered into a Microsoft Excel spreadsheet and quality assured and controlled for accuracy. The spreadsheet will be formatted and organized for input to the model.

The model will be run to generate expected sediment inputs from the sampled road and trail segments, grouped by sub-basins of the TCF. An assumption being made here is that the model can accurately estimate sediment produced from these segments. This is an acceptable assumption because that is what the model was designed to do and the model has been validated to varying degrees in studies quantifying sediment load due to roads in Washington (Dubé et al. 2010), Montana (Montana Department of Environmental quality 2009), Oregon (Surfleet et al. 2011), and in Iran (Jaafari et al. 2014).

The WARSEM model will be run at a level four assessment, the most versatile and functional level. While the level three assessment allows estimates of sediment delivery from each road segment and can be used to determine reductions in sediment delivery resulting from application of potential road maintenance Best Management Practices (BMPs) to road segments (a.k.a. scenario playing), the level 4 assessment allows additional functionality with little extra data collection and effort. The only additional parameters required for the level 4 assessment are ditch condition and best management practice applications to individual segments.

A level 4 assessment provides:

- The ability to track changes in road segment attributes and modeled erosion/delivery resulting from road maintenance or BMPs through time
- Documents and monitors reduction in road surface erosion resulting from Road Maintenance and Abandonment Plans (RMAPs) through future model runs
- Computes Forest and Fish Rules (FFR) performance metrics
- Ability to complete watershed-scale evaluations

This level 4 assessment will be used to establish fine sediment baseline conditions and to help prioritize rehabilitation efforts according to their potential for fine sediment delivery to specific streams.

2.2.3 Methods (McNeil core sampling)

In-situ monitoring of sediment is necessary to assess specific stream locations for spawning habitat suitability. Specifics of McNeil core sampling are described in Appendix F. Sites sampled for fine sediment by Boise Cascade Corporation in 1995 would be sampled again to maintain the long-term monitoring value of those sites. Other high priority locations would include existing spawning habitat with documented use and potential spawning habitat in areas where restoration projects actively reduce fine sediment, introduce LWM, or influence spawning gravel quality in some way. Upon approval of the in-situ sediment sampling study plan (Appendix F), sites will be selected for monitoring and an sample collection schedule will be developed.

2.2.4 Results

The areas to be sampled for WARSEM model input data were prioritized as follows:

1. Active roads within the TCF

2. Active roads outside the TCF that could deliver sediment to the TCF via a stream or wetland, or to the mainstem Teanaway River downstream of the TCF. Two exceptions to this rule are: no roads outside of the TCF portions within the Cabin Creek watershed were assessed because of the relatively small area of the TCF within that watershed; roads high in the Teanaway watershed will be deferred to priority level 4 because of the effort to get to them and the expected small impact they would have on overall sediment levels by the time the streams they impact flow to the TCF itself.

3. Abandoned/decommissioned/orphaned roads within the TCF

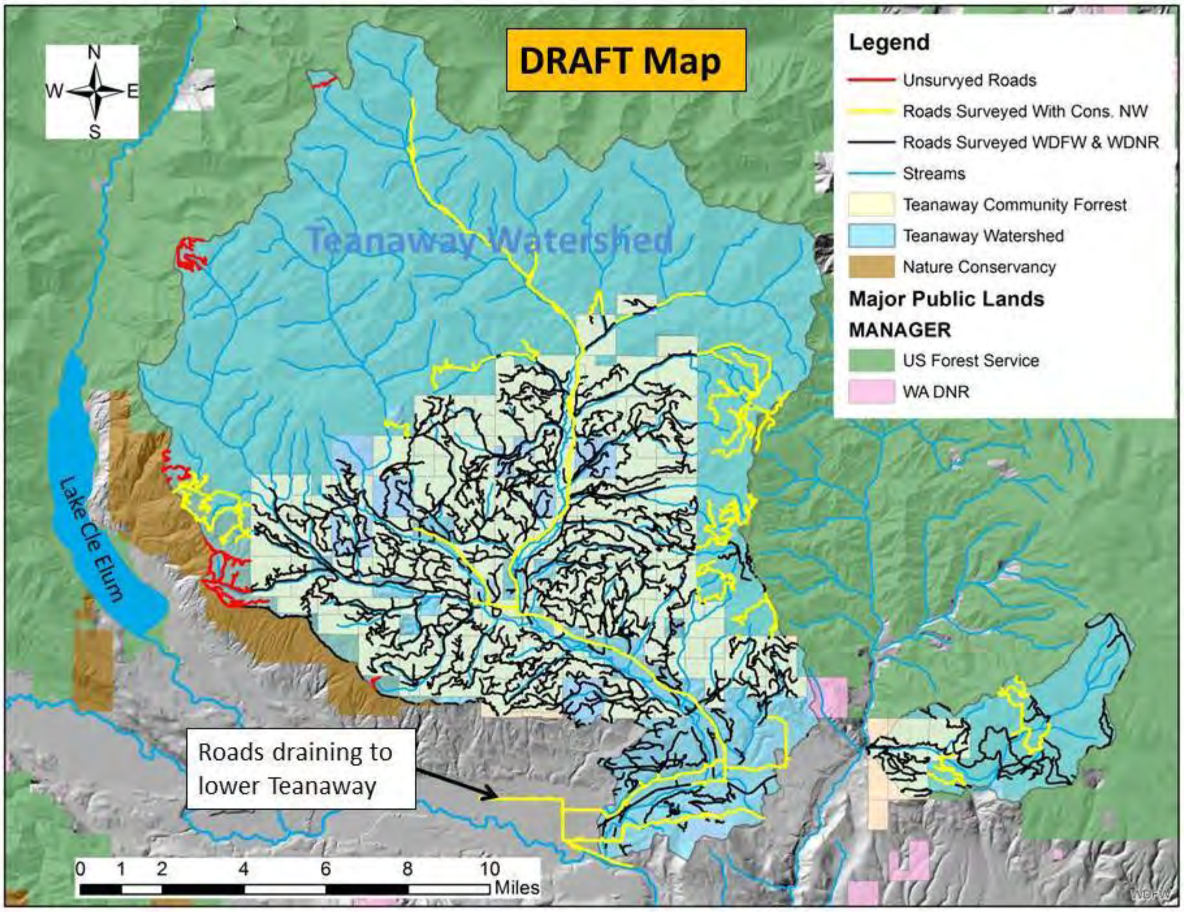
4. Recreational trails within the TCF, including hiking, horseback riding, mountain biking, snowmobile, and off-road vehicle trails.

At this time we are not proposing to assess abandoned roads or recreational trails outside of the TCF.

WDFW and DNR staff coordinated with each other to efficiently survey active roads and shared the resulting data. A limited number of remote, high elevation roads in the northwest portion of the Teanaway watershed outside of the TCF were not assessed due to the difficulty in reaching those locations combined with the lack of impact those roads were expected to have on sediment load in the TCF. No abandoned roads or recreational trails within the TCF were assessed.

The roads assessed are shown in Figure 24. The total number of road-miles assessed in all three blocks of the TCF was approximately 602.5 miles.

Figure 24. Roads assessed for WARSEM model data input. Cabin Creek roads within the TCF were assessed but not shown on this map.



A Microsoft Excel spreadsheet will be developed that shows the attributes of all road segments that deliver to a stream or wetland within, influenced by, or impacting the TCF. This spreadsheet will be used, after appropriate file formatting and organization, as the input file for the WARSEM model. This model will An input file for roads assessed within the TCF boundaries has already been developed by DNR and is now available as input to the WARSEM model. Those results can be used to start prioritization of work required to reduce sediment load into the streams of the TCF, but a full assessment should be delayed until data outside of the TCF boundaries is ready for input into the model.

2.2.4 Discussion

For a complete assessment of sediment delivery to streams in the TCF, completion of data collection in priority areas as described above is recommended. Following that, the WARSEM model could be run to produce the best estimates of annual sediment delivery from specific road segments. The data that has been collected to date could be used in a model run to provide less accurate estimates of sediment delivery. Using the WARSEM model is the only effective way to make use of the data collected to date.

Once the model is run, sediment delivery at the downstream locations of major sub-basins of the TCF will be documented. The usefulness of establishing spatially explicit baseline fine sediment information, and the ability to track changes over time at a landscape scale cannot be overstated. Furthermore, the ability to prioritize road work to achieve the greatest reduction in fine sediment via the model is invaluable. Now that the majority of the survey work is completed the model can be updated through time as Best Management Practices are applied, or roads are decommissioned or obliterated.

2.3 Topobathymetry of streams and modeling of floodplains (LiDAR)

2.3.1 Introduction

The Teanaway River and First Creek basins contain over 137 km (85 miles) of fish-bearing streams. The final Fish Passage Barrier Inventory report will determine the amount of existing stream habitat that is not currently accessible to fish. Collecting habitat data over such a large area is labor intensive and costly. LiDAR is a cost-effective remote-sensing method that collects highly accurate elevational data which can be used to quantify a variety of habitat metrics. Different wavelengths of LiDAR are used for terrestrial and aquatic assessments. "Red" LiDAR is typically used for terrestrial assessments, whereas "Green" LiDAR is used for aquatic assessments. The two can work together especially at the boundaries of terrestrial and aquatic features, and both types of LiDAR will be collected and processed for the TCF.

Specifically, LiDAR can be used to measure vegetation height and maturity, water depth, water's edge, pool frequency, and pool distribution, among many other things. It can be used to identify historic stream channels, existing and abandoned roads, railroad grades, recreational trails, dikes, berms, and remnant splash dams from early logging. It can be used to develop floodplain modeling at different flows (e.g. 2-yr, 10-yr, 25 yr, 100-yr flows), aid in wetlands delineation, and possibly assist with parts of wetland ratings. This list is not exhaustive and new uses of LiDAR are being developed continually.

2.3.2 Methods

For detailed methods of LiDAR acquisition and processing, see "Teanaway Community Forest Streams topo-bathymetric LiDAR proposal" (Quantum Spatial, 2015a) and "Teanaway Community Forest LiDAR Technical Data Report" (Quantum Spatial, Inc. 2015b). LiDAR data for both the "Green" aquatic and "Red" terrestrial projects were collected by Quantum Spatial, Inc. between April 3 and May 3, 2015. Data processing for the "Red" LiDAR is complete. "Green" LiDAR processing started in July 2015 because additional funding was not available until that time. Final LiDAR processing is underway and products for the green LiDAR will be available at the end of 2015. Figures 25 and 26 show the coverage area for Green LiDAR and Red LiDAR, respectively while Figure 27 contrasts Red LiDAR data with aerial imagery. Figure 28 shows an example of how LiDAR data can be used to provide a 3D picture of the landscape.

2.3.3 Results

Initial data analysis by Quantum Spatial showed that the data was of sufficient quality to provide the products that were intended. Those products are expected to be delivered to WDFW by the end of November 2015, or possibly sooner. These products will include:

Point Cloud returns in files that will include the following fields:

All returns
Point files X,Y,Z

Return Intensity
Return Number
Point Classification (ground, default, water)
Scan Angle
GPS Time

Surface models including:

Combined (topo-bathymetry) Surface Model (DEM), 1 m resolution, ESRI Grid format
Highest Hit Model (DEM), 1 m resolution, ESRI Grid format
Intensity Images, ½ m resolution, GeoTIFF format

Vectors including:

Survey Boundary, shapefile format
Tile delineation, shapefile format
Water's edge, shapefile format (polyline)
Submerged Topography Density

Once these products are delivered, these will be analyzed to determine pool frequency, distribution, and depth. They will also be analyzed to help determine where stream/floodplain connections can most easily made with modifications to existing obstacles, such as dikes and roads.

Figure 25. Map showing the "Green" LiDAR Project Area.

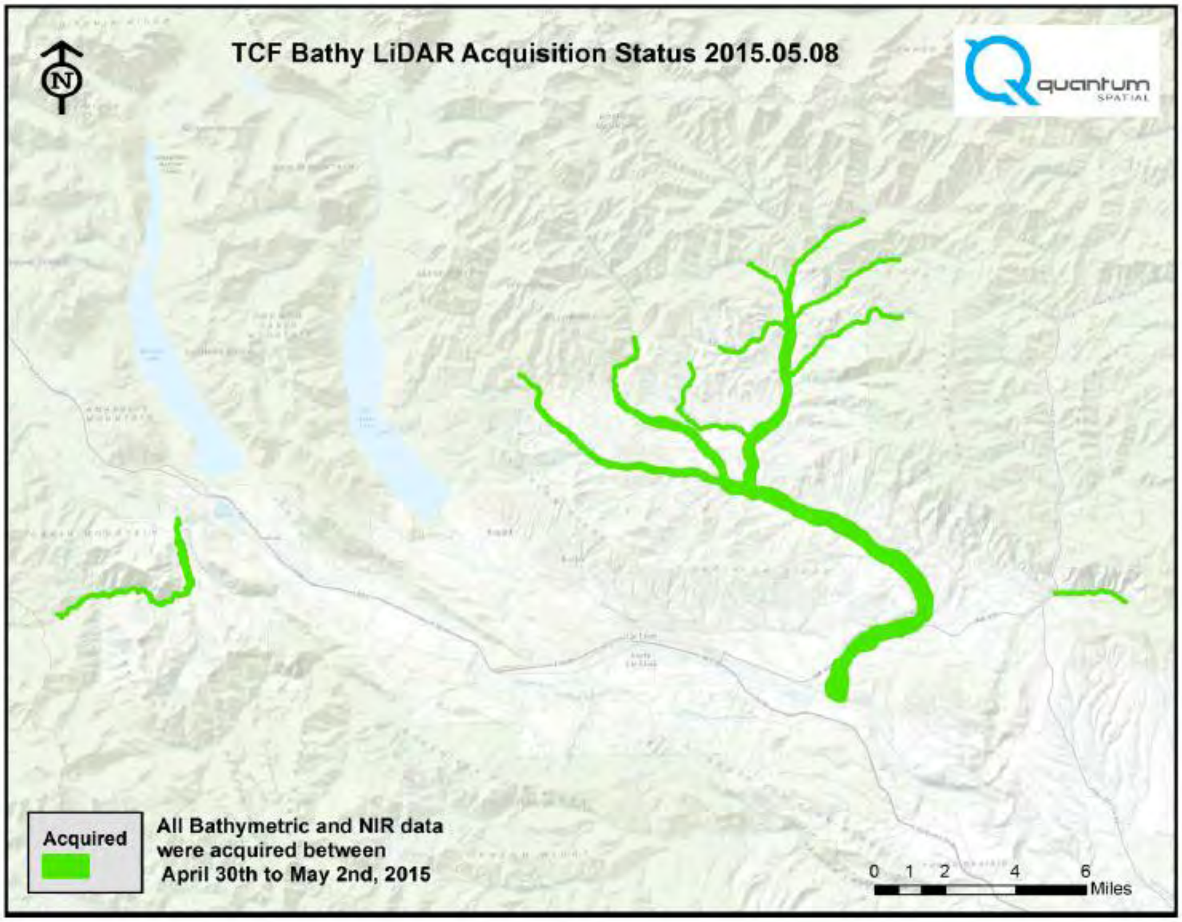


Figure 26. Map showing the "Red" LiDAR Project Area.

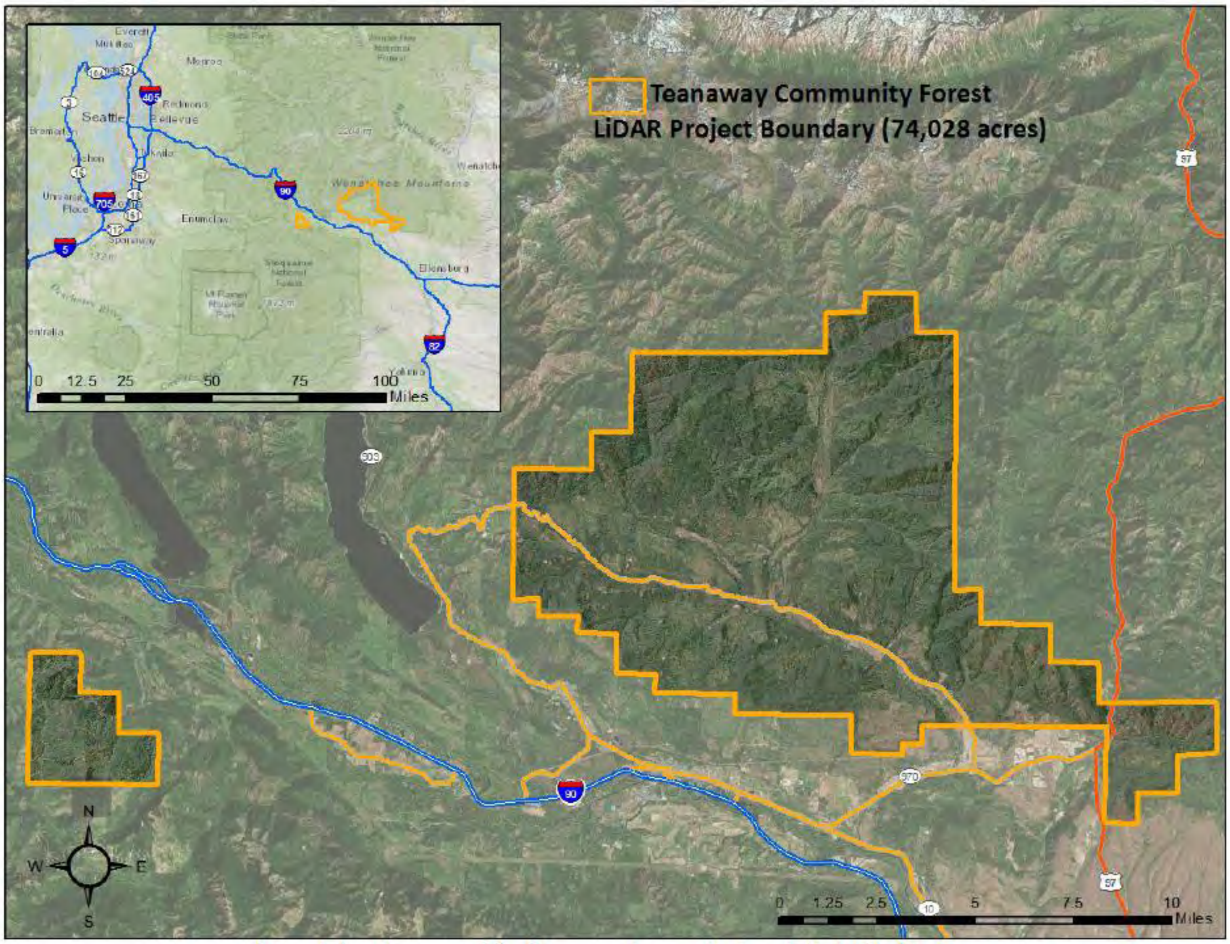


Figure 27. Air photo and example "Red" LiDAR image of the North Fork Teanaway confluence with Middle/West forks.

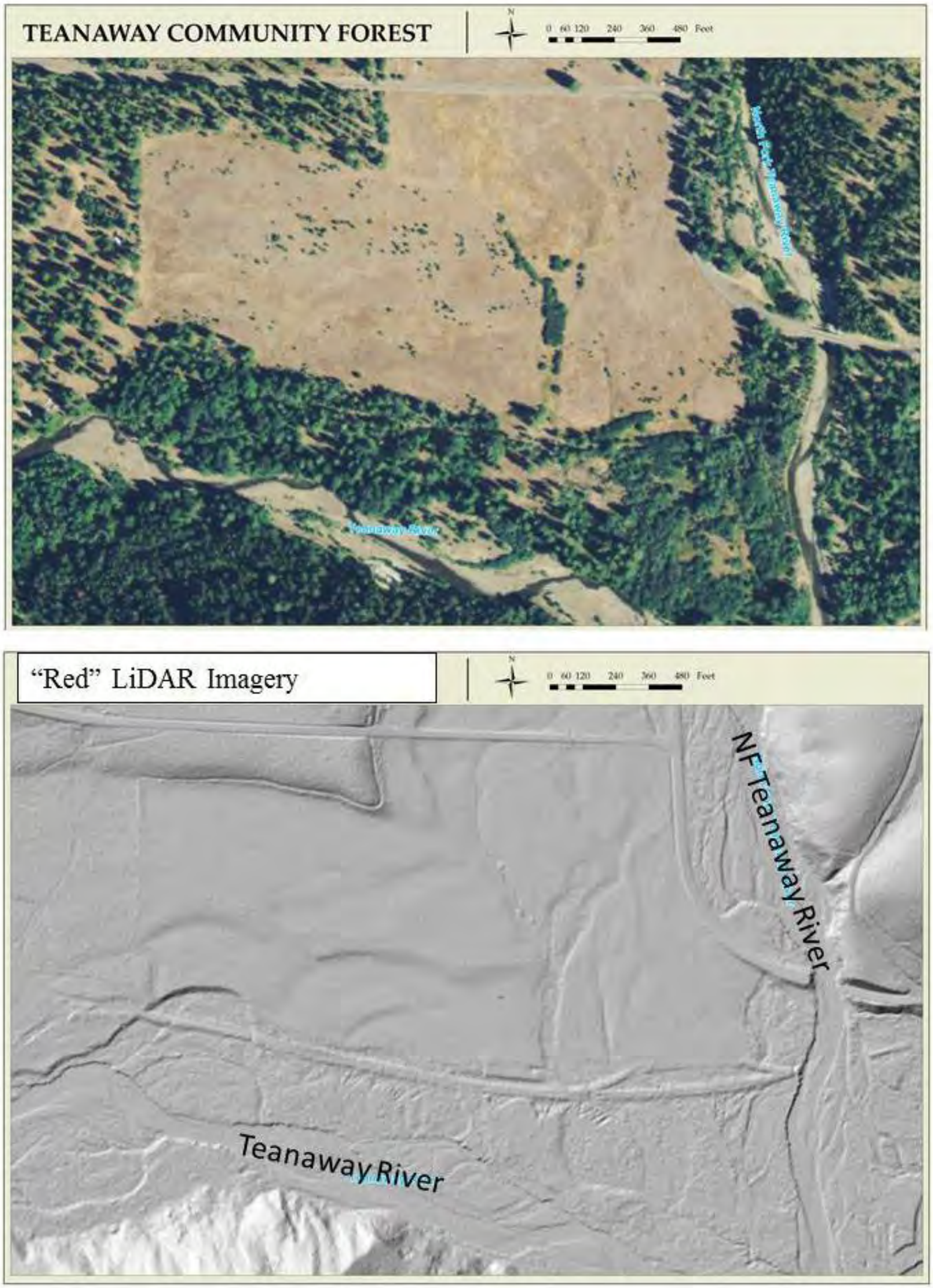
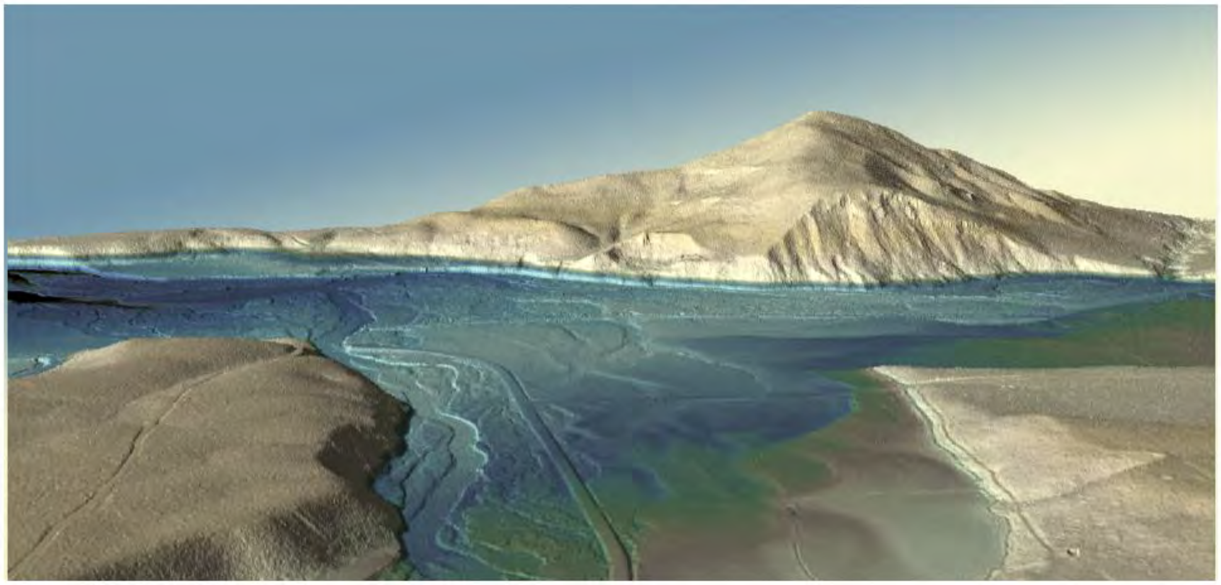


Figure 28. LiDAR image created from gridded LiDAR surface colored by elevation. View looking South at the Teanaway River just northeast of Teanaway Campground, QSI.



2.4 Water Temperature and Flow Data

2.4.1 Introduction

The Yakima Basin Integrated Plan calls for protecting and enhancing watershed function, and this is also a central goal of the Teanaway Community Forest Plan through improving instream flows and water quality. WDFW was tasked with collecting baseline environmental inventory data from the Teanaway Community Forest and watershed, including information about previous water quality monitoring efforts by a range of agencies. Prior to developing a water quality plan, it is important to understand where current monitoring is occurring and where past efforts have taken place. Furthermore, we sought to understand what type of water quality data had been collected, over what period, and who was responsible for the collection. In this way, we could best design a monitoring plan that would complement ongoing and past efforts.

Establishing baseline stream flow and temperature conditions is important to understanding effects on fish and wildlife and their habitat in the TCF. Two Federally listed fish species, Mid-Columbia steelhead, and bull trout both occur in the Teanaway watershed, in addition to anadromous Chinook Salmon, and several resident native species, including cutthroat trout, rainbow trout, mountain whitefish, and several species of sculpin and dace. Protecting water quality facilitates the propagation and protection of fish, shellfish, and wildlife.

Ecology funded WDFW to purchase water quality monitoring equipment for the Teanaway Community Forest in the 2013-15 biennium.

2.4.2 Methods

WDFW staff worked with Ecology's Water Quality specialist for the upper Yakima, Jane Creech, to develop a Draft Quality Assurance Project Plan (QAPP) for the Teanaway Community Forest (see Appendix A2). Further refinement and review of the QAPP is required during the 2015-17 biennium.

2.4.3 Water Temperature

Water temperature data collected by several agencies is shown in Figure 29. Table 4 describes this temperature data in more detail.

Figure 29. Water temperature data collection locations in the TCF.

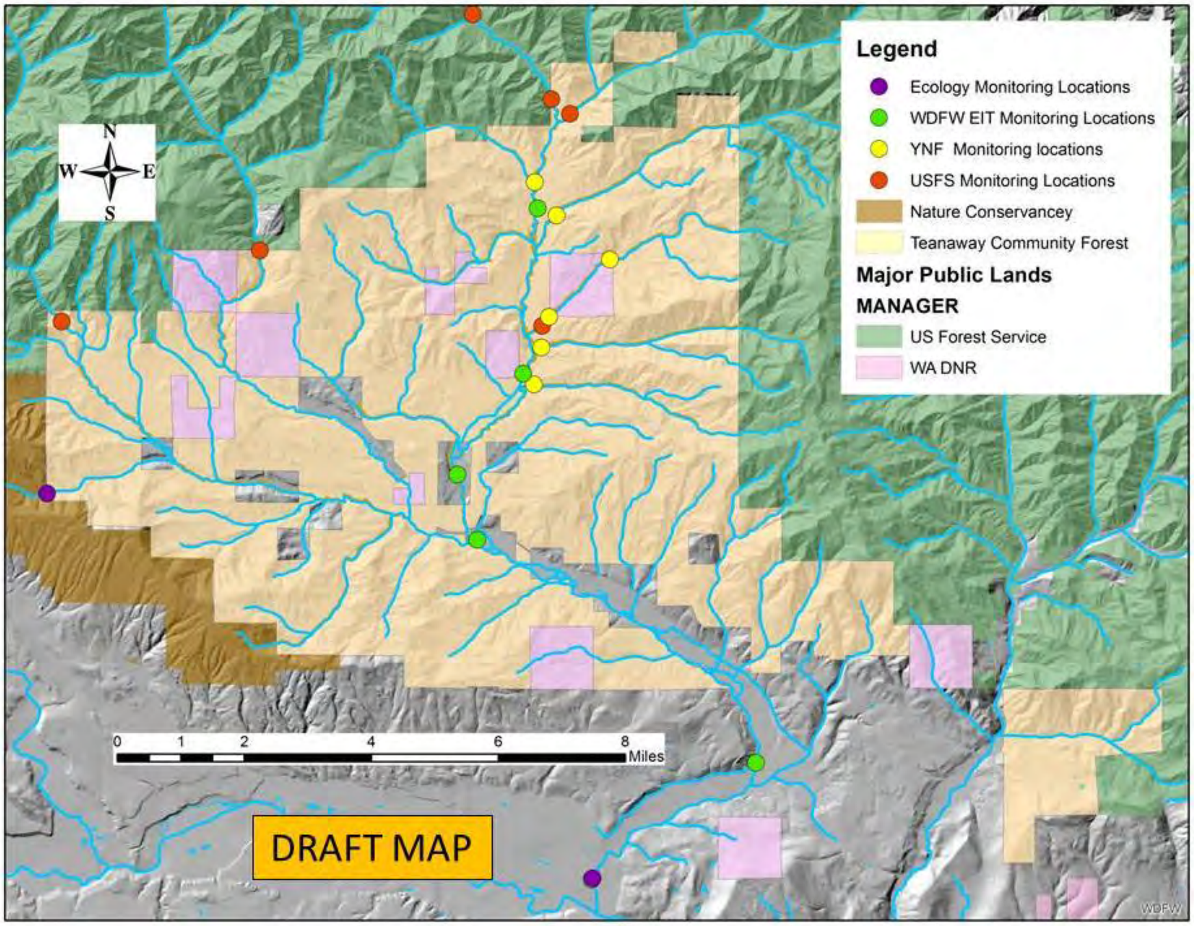


Table 4. Water temperature data collected in TCF.

Yakima Nation Fisheries (YNF)			
	Locations	**Data Range**	**Continuous Data**
	Mouth of Jungle Creek		2014-Ongoing
	Mouth of Jack Creek		2014-Ongoing
	Indian Creek 1 Bottom		2014-Ongoing
	Indian Creek 2 Top		2014-Ongoing
	Mouth of Middle Creek		2014-Ongoing
	Beverly Creek		2014-Ongoing
	DeRoux Creek	2004	
	Stafford Creek	2004	
	Miller Creek	2004	
	Standup Creek	2004	
	Johnson Creek	2004	
	Bear Creek	2001	
	M.F. Teanaway Above Bridge	2001	
	N.F. Teanaway Above Johnson Creek	2001	
	W.F. Teanaway Above Corral Creek	1995	
	W.F. Teanaway Above Carlson Canyon	1995	
	M.F. Teanaway Above Confluence	1995	
	Teanaway River (N. Fork Above Confluence)	1995	
	W.F. Teanaway	1994	
	W.F. Teanaway River above Carlson Canyon	1994	
	W.F. Teanaway River Above Tumble Creek	1993	
	W.F. Teanaway River Below Corral Creek	1993	

YNF (cont'd)	Locations	Data Range	Continuous Data
	West Fork Teanaway Above Carlson Canyon	1993	
	Middle Fork Teanaway Above Confluence	1992	
	North Fork Teanaway (Middle Creek above Confluence)	1992	
	North Fork Teanaway (W. Fork Above Carlson Canyon	1992	
Ecology			
	Locations	**Data Range**	**Continuous Data**
	Teanaway River at Mouth	1961, 1962, 1963, 1964, 1965, 1966, 1991, 1992, 1999	
	Teanaway River at Lambert Bridge	Summer 2011	
	North Fork Teanaway Near Confluence	Summer 1998, Summer 2011	
	North Fork Teanaway Near Dickey Creek Bridge	Summer 1998	
	North Fork Teanaway Above Stafford Creek	Summer 1998	
	North Fork Teanaway Below Eldorado Creek	Summer 1998	
	Stafford Creek Above Standup Creek	Summer 1998	
	West Fork at Mid-Point	2002	
	Middle Fork at Mid-Point	1993, 2000, 2002, 2003	
	Middle Fork Near Confluence	Summer 1998	
	Middle Fork Near National Forest	Summer 1998	
	Dingbat Creek	2007-2008	
	Indian Creek Above Culvert		July 2014-Present

United State Fish and Wildlife Service			
	Locations	**Data Range**	**Continuous Data**
	North Fork Teanaway River Below Deroux Creek	1998, 2000-2010	2000-2010
	North Fork Teanaway River One Mile North in Nat. Forest	2001-2004	
	Mouth of Stafford Creek	1994, 1996, 1997, 1998, 2000, 2001-2010	2001-2010
	North Fork Teanaway River at Nat. Forest	1994-1998, 2000-2010	2000-2010
	Indian Creek above Culvert	1994-1999, 2001, 2009	
	Middle Fork Teanaway River near Nat. Forest	1994-1998, 2000-2007, 2009	
	West Fork Teanaway River near Nat. Forest	1994-1997, 2000, 2001, 2003, 2004, 2006, 2007, 2009	
WDFW Environmental Interactions Team Program			
	Locations	**Data Range**	**Continuous Data**
	Lambert Bridge		2006-2014
	Mainstem Teanaway Near Confluences		2007-2010
	North Fork Teanaway at Ranch Rd. Bridge		2006-2013
	North Fork Teanaway at 29 Pines		2006-2014
	North Fork Teanaway at Bridge near Dickey Creek		2009-2013
	Second Data Set		
	West Fork Near Confluence	2007-2008	
	West Fork at Mid-Point	2006-2007	
	West Fork Near National Forest	2007-2008	
	Middle Fork Near Confluence	2006	
	Middle Fork at Mid-Point	2006, 2008	
	Middle Fork Above Upper Bridge	2006-2008	
	North Fork Teanaway Above Ranch Rd. Bridge	2006-2008	

WDFW	Locations	Data Range	Continuous Data
	North Fork Teanaway Below Rye Creek	2006-2008	
	North Fork Teanaway Below Eldorado Creek	2006-2008	
	Mainstem Teanaway Above Lambert Rd.	2006	
	Mainstem Teanaway at Mid-Point		
	Mainstem Teanaway Below N. Fork Confluence	2007, 2008	
National Oceanic and Atmospheric Association			
	Locations	**Data Range**	**Continuous Data**
	Lower Teanaway	2007-2012	2007-2012
	Upper Teanaway	2007-2012	2007-2012

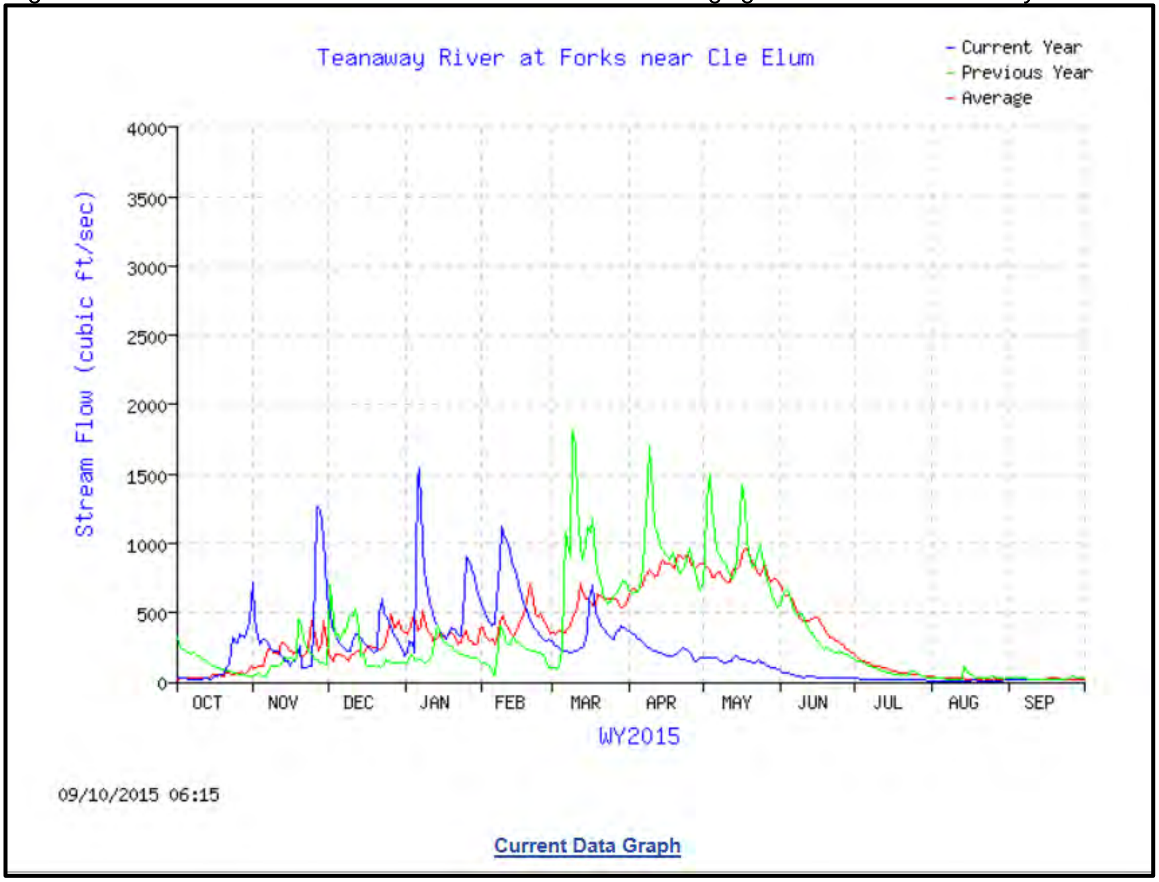
2.4.4 Flow

The Bureau of Reclamation has two active gages that measure streamflow as part of their Hydromet network. The first gage is located below Lambert Bridge on the mainstem Teanaway River (upstream of confluence with Yakima River). The second gage is on the mainstem Teanaway River, below the forks of the Teanaway. Both gages are near the town of Cle Elum. Data from WY2015, WY2014, and average flows at the site are shown in Figure 30.

Ecology also operates two additional flow gages on the Teanaway River. One is positioned at Red Bridge Road (downstream of TCF) and one is located on Indian Creek (near the confluence of the North Fork Teanaway River). The two Ecology stations are operated seasonally (May – September) and may not provide adequate data for peak flows.

WDFW purchased a Hach flowmeter in order to measure flow at ungagged sites throughout the Teanaway Community Forest.

Figure 30. Recent streamflow from the Reclamation gage near the Teanaway forks.



2.5 Bedrock Mapping

2.5.1 Introduction

The Teanaway River basin is currently known for long continuous stretches of exposed bedrock which can impact the landscape by reducing available spawning and rearing habitat for species of salmonids, increasing water temperature by more readily absorbing solar radiation, and limiting primary productivity that is provided by gravel and fine sediment. This bedrock exposure and the resulting lack of stream productivity increases stream water velocity which also limits habitat for fish and invertebrates. The higher water velocities, combined with limited opportunities for over-land flow, few large pools, and limited large woody material (LWM), limits the potential for water to infiltrate the ground resulting in reduced base flows in the summer and fall.

2.5.2 Methods

Exposed bedrock was mapped in an attempt to establish a baseline inventory of this metric and highlight areas where future restoration activities might allow development of sand and gravel bars in the Teanaway River. The West Fork of the Teanaway River was mapped on March 18, 25 and April 2, 2015. The Middle Fork of the Teanaway River was mapped on April 7 and 10, 2015. The North Fork of the Teanaway River was mapped on April 23, 24 and 27. The main stem of the Teanaway River was mapped on April 29, 30 and May 7. The main stem was mapped to where the TCF ends in the surrounding landscape, though much of the main stem in this area is not part of the TCF.

Using hand-held GPS units (Garmin 62 S and the Garmin eTrex 10), biologists took information on the location of each piece of exposed bedrock in the areas described above. For medium and large patches of exposed bedrock, GPS track data was used to make an outline around the individual pieces of bedrock. For small patches of bedrock, waypoints with appropriate measurements were taken. Measurements were taken using a 100-meter measuring tape and pre-measured walking sticks. Sketches of each bedrock patch were drawn to compare to the resulting polygon displayed in ArcGIS. On many occasions multiple smaller bedrock patches were adjacent to each other and separated by small areas and ribbons of gravel. To limit the amount of time defining individual small bedrock patches, GPS track information was used to encompass multiple bedrock patches in one large continuous patch and the area within that patch that was covered by gravel was quantified visually. Coverage was estimated as a percentage of the bedrock patch that was not exposed bedrock.

After bedrock patches had been field-measured, the information was then downloaded using DNR GPS software. The compiled data was then imported to ArcGIS where the track data was modified to make representative polygons. Bedrock patches represented by one waypoint were digitized into polygons by hand. Field measurements and sketches of each polygon were used to ensure they were sized correctly. Polygons were adjusted using ArcGIS to within two feet of their original field measurement. Within the attribute table in ArcGIS, information on the general size of the polygon, the composition of the stone, percent covered by non-bedrock, and a unique identification number were included. Also, the total length of stream assessed for bedrock was determined with ArcGIS.

2.5.3 Results

Bedrock was mapped in the three forks of the Teanaway and the main stem within the Teanaway Community Forest and in adjacent lands to the TCF. Data is summarized in Table 5 and spatially shown in Figures 31-33. Table 5 includes the number of bedrock patches mapped; approximate miles of river surveyed, total area of bedrock patches for that river section, the range of bedrock patch size, and the average percent of the patch that was covered by gravel. All of these factors are important to note when comparing river reaches as it is the combined data of number of patches, size of patches, location of patches relative to each other, and how much of the patch is presently covered by gravel, that show the true summary of data. Biologists started in the west fork, so some slight revision of methods occurred after the first couple of days of mapping that resulted in minor differences in mapping method. Biologists do not believe those minor differences affected the ability to compare river reaches to each other. Also of note is that the sizes of the river reaches are not equal. River mile distances were measured in GIS rather than field calculations of river miles. Spatial databases (GIS) were compiled for these efforts and will be made available on the shared Teanaway folder.

Table 5. Summary of bedrock mapping in the Teanaway River Basin.

Location	Number of Patches	Kilometers of River Measured (Miles)	Total Area of Bedrock Patch (m^2)	Patch Size Min-Max (m^2)	% of Patch Covered by Gravel	Coverage % Min-Max
Main stem	115	10.9 (6.75)	29,139	1-3,293	6.82%	0-60%
Middle Fork	111	10.9 (6.75)	18,540	0-8,661	4.50%	0-40%
North Fork	113	14.1 (8.75)	22,929	1-1,766	9.30%	0-45%
West Fork	219	12.9 (8.00)	27,553	0-2,189	8.89%	0-65%
Total	**558**	**30.25**	**98,161**	**0-8,661**	**7.58%**	**0-65%**

2.6 Photo-monitoring

Photo-monitoring is an excellent tool to track monitoring changes over a period of time. Areas that are proposed for restoration, monitoring, or active management such as tributaries, riparian areas, forests, and wetlands should have long-term photo-monitoring locations established according to a vetted photo-monitoring protocol. No protocol has been established for future work in the TCF, but various references for established protocols are listed in the bibliography and summarized below. The summaries include a brief abstract from each protocol and advantages of that protocol. Many of these protocols were passed to WDFW by Tip Hudson, a range specialist with Washington State University extension in Ellensburg. Staff such as Tip Hudson should be consulted as a technical resource when deciding on photo monitoring protocols. Copies of these manuals are currently stored in WDFW drives, but can be uploaded to the shared Teanaway drive if needed by other agencies.

With a proper protocol and clear instructions from biologists and managers, this could be a project appropriate for citizen science. The following summarize several different protocols to be considered when developing a standardized photomonitoring method for the TCF.

UC Davis Photomonitoring- Publication 8067

A good concise overview of what photo monitoring is good for- How to use it to detect change. Consistency in photos is stressed. One way to achieve this is through the use of one consistent camera with one lens, this is by far the most ideal way to achieve consistency, using different cameras or the same one with modifications to the lens produces a similar image but variations in the focal length effect how light is captured on film; Resulting in some variation in the image series. Finally, good record keeping is also key in conducting quality photo monitoring. These two before mentioned points are relatively basic, but they are integral for elevating a photo monitoring project to a professional level.

UC Davis Photomonitoring- Guidelines for monitoring the establishment of Riparian Grazing Systems -Publication 8094

This document is a more in depth look at how to effectively photo monitor riparian areas. It is recommended that a representative site is selected within the riparian area and broken down into a minimum of 6 transects with a length of 72 feet between each. The transect length is measured on one side of the creek with the transect line being perpendicular to where it intersects the stream channel. This perpendicular alignment can result in the

Figure 31. Bedrock locations in the Mainstem of the Teanaway River within and adjacent to the Teanaway Community Forest.

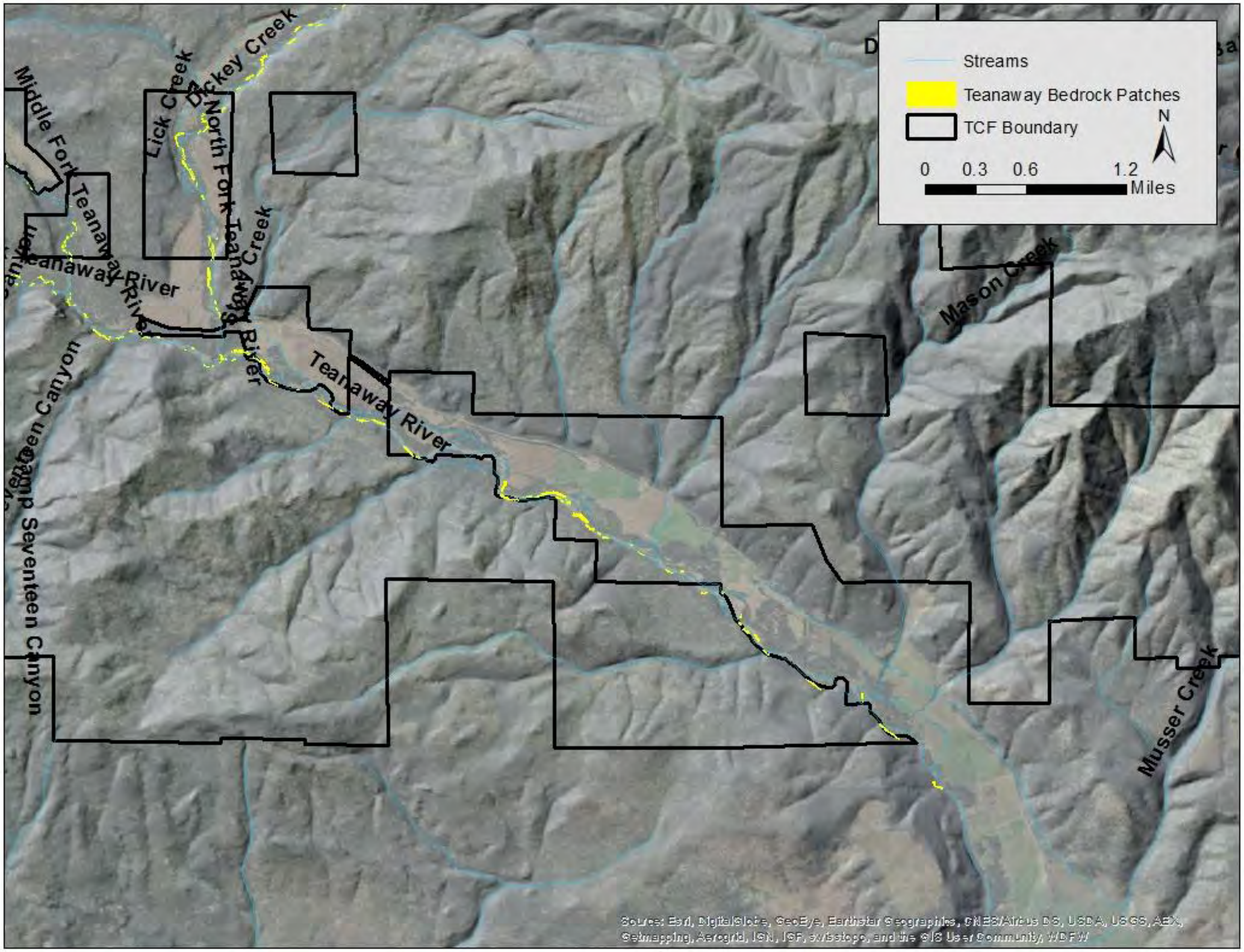


Figure 32. Bedrock locations in the Middle Fork and West Fork of the Teanaway River within and adjacent to the Teanaway Community Forest.

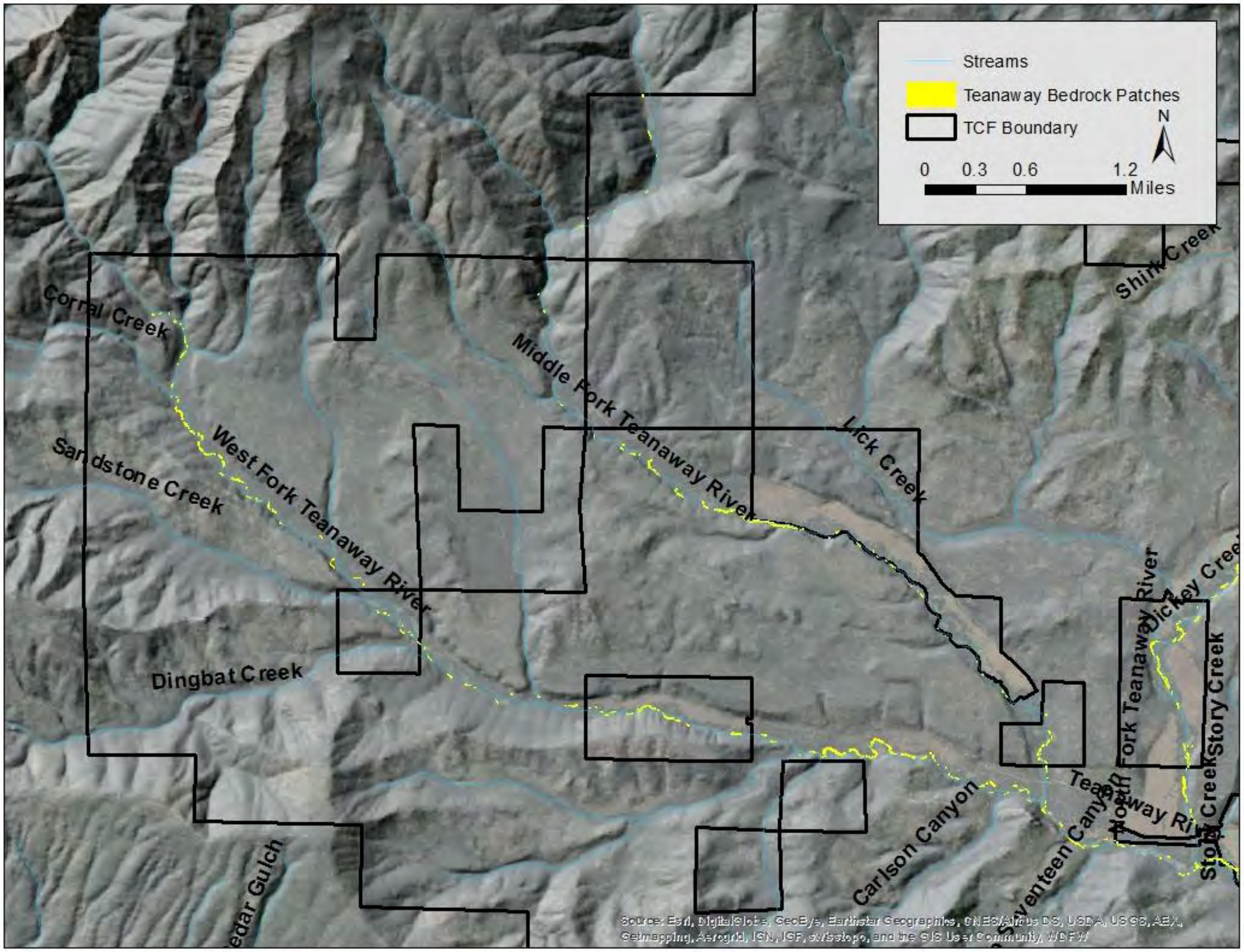
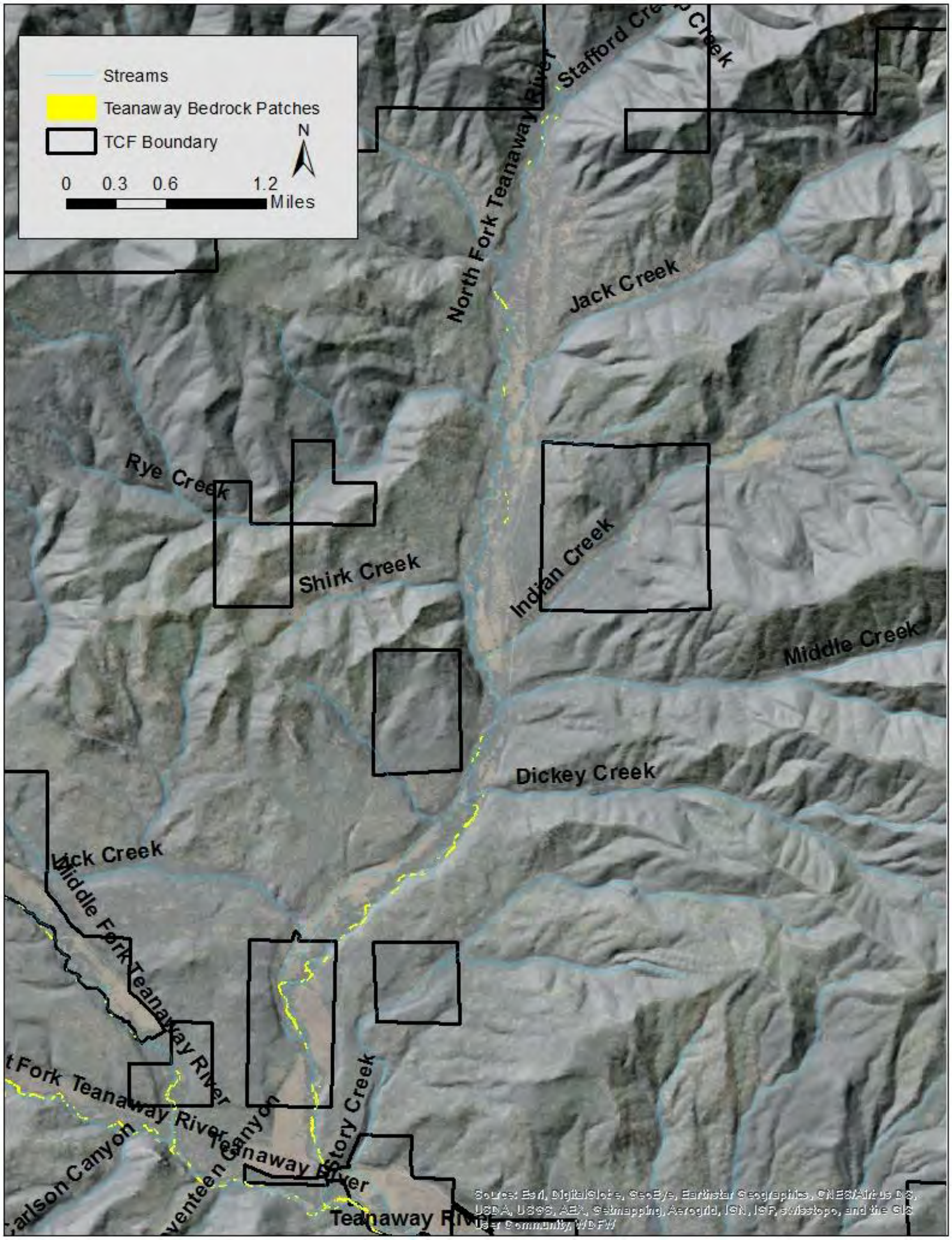


Figure 33. Bedrock locations in the North Fork of the Teanaway River within and adjacent to the Teanaway Community Forest.



Repeat Photography Monitoring Made Easy-

transects being longer than 72 feet on the opposing bank. The width of the transect should be appropriate to the width of the riparian area, with some inclusion of upland vegetation that borders the riparian area so that changes in the overall riparian width and succession in the margin can be asses in the photos. An example of varying widths are headwater streams with small flood plains should be relatively narrow while flat rivers of a high order should be wider. The document lists several protocols that help solidify this document as a robust holistic monitoring protocol instead of limiting itself to just photo points. See appendix A for list of suggested monitoring protocols. This is a basic overview of how to conduct photo monitoring.

Rangeland Monitoring: Selecting Key Areas-

This is a basic overview of what components to include in site selection.

Visual Assessment of Riparian Health-

A general overview on what sorts of visual cues one should be using to asses variables affecting riparian health.

Monitoring the Vegetation Resources in Riparian Areas-

This is more of a vegetation and green line monitoring protocol. There are some photos that are included as part of the protocol but photo-monitoring is not the focus.

USDA Photo Point Monitoring-

A basic overview of what equipment and what elements should be included in a photo monitoring protocol. The in-photo placard is featured in this protocol for marking each photo in the image.

USDA-Photopoint Monitoring Handbook-Part A Field Techniques

This document is the full detailed version of how to effectively execute a photo monitoring protocol. This first portion focuses on the needed materials and pre planning. This document and its second part highlight the importance of planning, maybe to the point of too much detail. Certainly a highly thought out document, but as mentioned before some of the details may be a bit excessive and not necessary for someone who is confident in collecting photos.

USDA-Photopoint Monitoring Handbook-Part B Concepts and Analysis

In the second part of this document, the focus is how to analyze and follow trends on the landscape, as well as some of the variations one may expect from using cameras with different focal lengths. Overall, these two documents explain photo monitoring to its fullest extent and offer some contrast to the shorter overview documents. Sometimes the detail is useful but other times it seems a little longwinded and unnecessary.

2.7 Water Supply and Watershed Protection Data Gaps

- Complete survey of wetlands associated with streams and all uplands areas.
- Analyze wetland and stream/floodplain data to determine opportunities for potential increases in summer base flows.
- Utilize LiDAR and other analysis techniques to generate a "topographic wetness index" for the TCF (Quantum Spatial Inc. discussion).
- Deploy water and air temperature probes purchased in June 2015.
- Establish and implement flow monitoring protocol.
- Work with Ecology staff to finalize the water quality Quality Assurance Project Plan (QAPP)
- Analyze green and red LiDAR data for wetlands impacted by man-made features, floodplain connectivity opportunities (analyze for different flows: 2 yr, 10 yr, 25 yr, 50 yr, 100 yr etc), pool location, frequency, depth, and distribution.
- Utilize LiDAR to accurately define stream and river channels in order to create a baseline hydro layer(s).
- Develop monitoring plan to detect future changes in bedrock exposure.
- Complete WARSEM inventory of un-surveyed roads in and outside of the TCF. Complete WARSEM inventory of trails and abandoned roads within and outside the TCF.
- Prepare input files for WARSEM model on TCF, whole sub-watersheds. Run model. Analyze results to determine problem roads and prioritize work on most heavily impacted sub-basins.
- Establish photopoint monitoring points of wetlands, bedrock, problem roads, and problem trails.
- Identify sub-watershed basins where tree age and density do not meet desired conditions to reduce the rate of runoff from rain-on-snow events.

3.0 Working Lands: Grazing and Forestry

3.1 Grazing

3.1.1 Introduction

The legislation that created the TCF intended the management of the TCF "to maintain working lands for forestry and grazing while protecting key watershed functions and aquatic habitat (State of Washington, 2013)." The Teanaway Community Forest Management Plan (DNR & WDFW, 2015) has identified livestock grazing as an activity that will be supported by the TCF as long as that activity is "held to a high standard to protect the watershed, riparian areas, water quality, and fish and wildlife habitat." A variety of general grazing management objectives are outlined in the TCF management plan to achieve this goal. The primary strategy supported by this document to achieve the TCF management goal is: "develop and implement a monitoring program that facilitates adaptive management (DNR & WDFW, 2015)." Progress on developing and implementing that monitoring plan is described below.

3.1.2 Methods

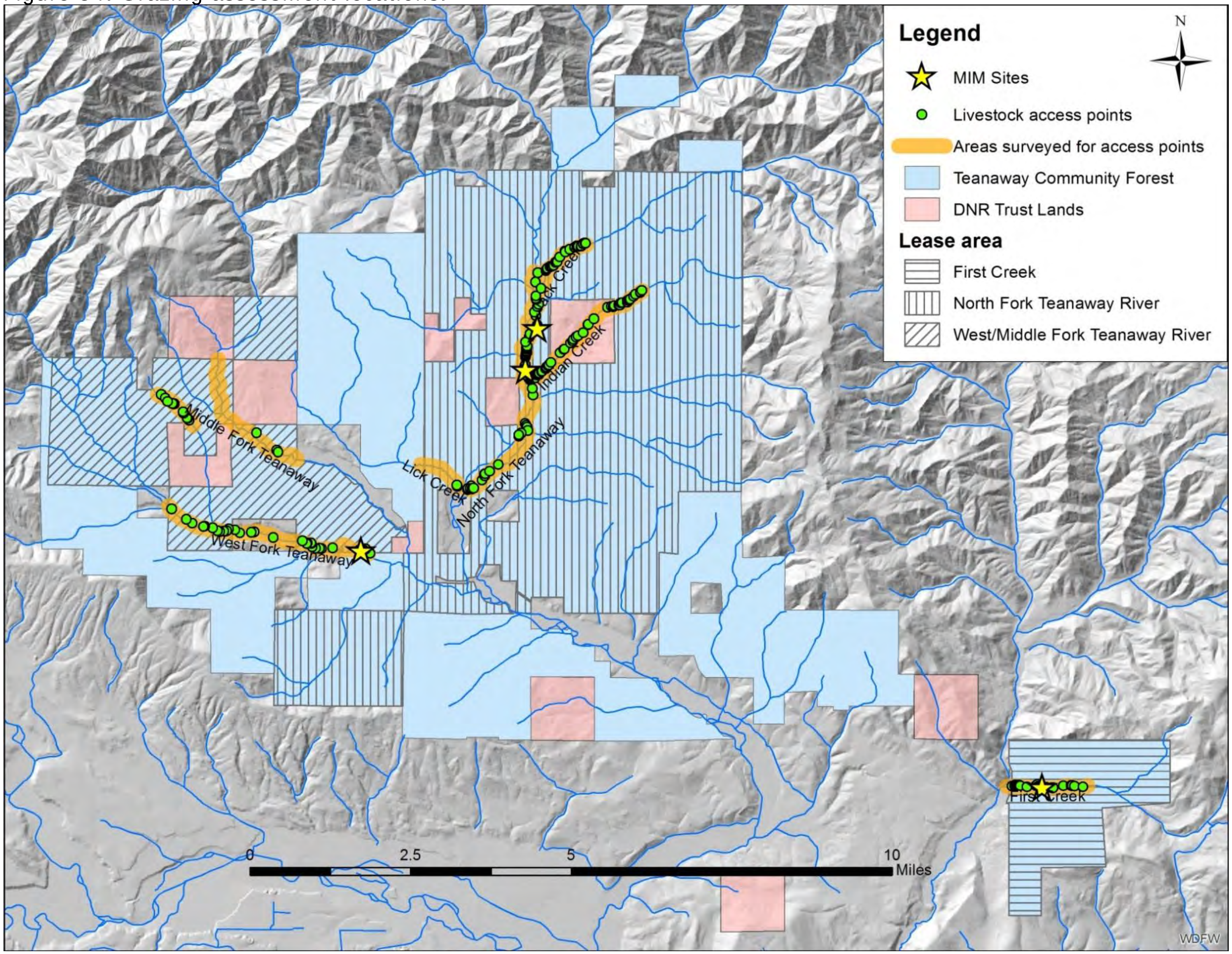
Habitat Monitoring

The primary method for habitat monitoring within grazing areas chosen for the TCF is the Multiple Indicator Monitoring (MIM) protocol developed by the Bureau of Land Management (BLM, 2011; BLM 2013). This method provides extensive information about livestock use and riparian impacts of relatively short reaches of stream. The draft study plan for grazing monitoring is shown in Appendix D1. Before those reaches could be selected a more general survey of the grazing leases needed to be completed to catalog all livestock water access points and use this database to help determine where long-term intensive monitoring would take place. These general surveys were called pre-MIM surveys.

WDFW and WDNR YBIP staff conducted pre-MIM surveys of livestock water access and crossing points during mid-June 2015 through late August 2015. These pre-MIM surveys were located in all three grazing allotments and conducted along priority streams within the TCF (Figure 34) with particular attention paid to whether the site was near a known salmonid spawning location. Presence of livestock use near spawning locations is a concern because of the potential for impacts to salmonid populations by, for example, trampling incubating embryos or degrading the habitat with excess fine sediment, reduced stream complexity, or increased water temperatures as a result of no shade. The data collected for these pre-MIM surveys is shown in Appendix D2, and included GPS location, photos, size of area impacted, potential for impact to salmonid spawning, bank stability, woody species utilization, among others, at each identified livestock crossing or access point.

After identifying areas heavily impacted by grazing along riparian areas and susceptible to management prescriptions with the pre-MIM surveys, more intensive riparian monitoring surveys using MIM were completed at four long-term MIM monitoring sites (Figure 34).

Figure 34. Grazing assessment locations.



Data collection at these sites was initiated in September 2015. Appendix D3 shows the data form used for the MIM assessment and includes greenline width and composition, woody species height/age class/use, streambank cover and stability, stubble height, substrate size, pool frequency, and pool depth. Documentation for this protocol was used to properly conduct the data collection (Burton et al. 2008; Burton et al. 2013).

Both the pre-MIM and MIM surveys were done under the guidance of Jeff Burnham, WDFW Range Ecologist, Eric Winford (WDNR), and Bill Oakes, Agricultural Stewardship, Monitoring and Compliance Specialist with WDNR.

Infrastructure Assessment

Grazing infrastructure (fences, watering locations, piping, and cattle guards) and stream crossings would be noted while conducting other biological monitoring within the TCF. During the spring of 2015, WDFW and WSDNR staff attempted to identify areas of grazing infrastructure. A principle source of this infrastructure was a meeting between WDFW staff (J. Burnham), WSDNR staff (B. Oakes and E. Barnett) and personnel associated with the Kayser and Fudacz leases (Sam Kayser, Bill Johnson (range rider), and Mr. Fudacz) during which known infrastructure and traditional stream crossing locations for these lease were identified. Biologists and Scientific Technicians with the Yakima Integrated Plan team also attempted to record grazing infrastructure when encountered during field surveys for bedrock, wetlands, northern spotted owl surveys, WARSEM road surveys, and habitat surveys at livestock water access points. Mid-Columbia Fisheries Enhancement Group (MCFEG) and United State Forest Service (USFS) are coordinating on mapping fence condition in areas of the North Fork Teanaway, including main stem areas and Jack and Dickey Creek. These surveys were to be conducted in the spring and summer of 2015. Aja Woodrow of the USFS and Melissa Babik of Mid-Columbia Fisheries are the contacts for this mapping effort.

3.1.3 Results

MIM Assessment

All cattle access points assessed with the Pre-MIM protocol and the long-term grazing assessment sites to which complete MIM protocol was applied are shown in Figure 34. The stream reaches surveyed are also shown. It was apparent during the surveys on the Middle Fork Teanaway and First Creek that areas upstream of the surveyed portions would not show significant evidence of grazing because of the steep terrain there. Areas downstream of the surveyed portions of Middle Fork Teanaway do not show significant evidence of grazing impacts, likely because of the private homes in that area. Remaining areas that should be surveyed within the grazing leases include Story Creek, Dickey Creek, Middle Creek, upstream portions of Indian and Jack Creeks, North Fork Teanaway River up to the Stafford Creek confluence, Jungle Creek, Rye Creek, Shirk Creek, Carlson Creek, Camp 17 Creek, downstream portions of the unnamed tributary to West Fork Teanaway that flows through the "U-betcha" section, and the upper potions of the West Fork Teanaway.

Data for the riparian MIM monitoring have not been analyzed, but a compilation of the data is available. WDFW anticipates that these data will help enable recommendations to be made for specific management actions regarding livestock water access.

Infrastructure Assessment
Cataloguing of grazing infrastructure is ongoing, and will be used by WDFW and WSDNR to populate a database. WDFW staff will follow up with Aja Woodrow (USFS) and Melissa Babik (Mid-Columbia Fisheries) to obtain data from their fence monitoring efforts along the North Fork Teanaway.

3.1.4 Discussion

MIM and Upland Grazing Surveys
While the study plan has been used to initiate grazing monitoring already, it needs to be finalized during the fall of 2015 so that the parameters that we are studying can be adopted for future assessments, additional sample sites can be included, and future timelines for monitoring can be established. Finalizing this study plan involves guidance from range ecologists with WDFW and WSDNR. Completed monitoring in 2015 will serve as baseline data and will help to direct prescriptive future management. The study plan also lays out recommended future monitoring schedules.

Upland meadows are important habitat for wildlife, especially for deer and elk. Assessment of these sites will allow managers to recommend grazing strategies for these areas that are in accordance with wildlife habitat goals for the TCF. Ongoing discussion is occurring regarding the approach for an upland meadow grazing monitoring assessment. Upon acceptance of the grazing study plan, upland grazing monitoring sites will be chosen during the fall of 2015.

Assessment of Grazing Infrastructure

As shown in results, some assessment of grazing infrastructure is occurring now, but the assessment is not complete. A database needs to be created to track this infrastructure and changes to the infrastructure such as fences repaired, removed, stream crossings changed etc. This database is needed to enable managers to track these performance measures and inform biologists of potential issues such as stream crossings, water access sites in riparian areas, and broken or unused fences that could endanger wildlife.

3.2 Forestry

As outlined in the TCF Management Plan, conduct the following analysis:

- Conduct a forest inventory to determine the current structure and condition of the forest.
- Identify potential distribution of future forest habitats
- Develop a long-term restoration schedule, including a landowner option plan specific to northern spotted owl habitat, to improve forest conditions by modifying the structure and composition of the forest.
- Identify sub-watershed basins where tree age and density do not meet desired conditions to reduce the rate of runoff from rain-on-snow events.

3.3 Working Lands Data Gaps

- Complete pre-MIM surveys on remaining stream and river segments within the grazing leases, and identify patterns of grazing utilization for meadows, uplands and riparian areas.
- Develop and implement plan for upland grazing monitoring.
- Complete grazing infrastructure inventory (upland watering sites, fence lines, cattle guards, salt lick sites, etc.).
- Establish photopoints of high priority grazing sites.

- Conduct a forest assessment and inventory to inform impacts and management in relation to species and their habitat, with emphasis on Northern spotted owls, large carnivores, deer and elk, and resident and anadromous fish species (Mid-Columbia steelhead, bull trout, Chinook salmon, resident trout species, etc).

4.0 Recreation

The recreation management plan for the TCF is scheduled to be developed by December 2016. The Teanaway Management Plan released in 2015 provides a comprehensive outline of the goals to be considered while developing the recreation management plan. WDFW strongly recommends that existing recreational use data be collected to enable sound decisions to be made with respect to the development of the recreational management plan. Use data includes vehicle traffic counters on the major public roads, recreationist surveys of people at trailheads, parking areas, and campgrounds, and vehicle/foot traffic counting to be done on major hiking, bicycling, motorcycling, and horseback riding trails.

These data will allow prioritization of management activities on the most used recreational sites and determine potential conflicts recreation might have on other TCF goals. For instance recreational impacts will need to be evaluated with regard to their impact on habitat and ecological processes, or on individual species. For example, usage of certain parts of campgrounds could detrimentally impact water quality goals, floodplain connectivity, or usage of certain trails could impact goals to reduce fine sediment in streams. Recreation can directly affect sensitive fish and wildlife such as wolf dens, spotted owl nests, or Chinook salmon redds. Identification of these conflicts will inform appropriate management activities, and ensure the intent of WDFW's conservation easement is met.

4.1 Recreation Data Gaps

- Complete recreationist user surveys
- Install traffic counters
- Document all types and locations of recreational use
- Identify potential areas of conflict between recreation and fish & wildlife or habitat
- Determine areas most impacted by recreationists
- Assist with recreation management plan development
- Establish photo monitoring points of impacted recreation sites

5.0 Fish and Wildlife Habitat

5.1 Fish Passage

5.1.1 Introduction

The Teanaway River and First Creek basins contain over 163 km (101 mi) of fish-bearing streams. About 75 km (47 mi) of that existing stream habitat is not accessible to migrating salmonids. For the habitat in the TCF to be useful for salmonids, the streams within the TCF must be free of fish passage barriers. This allows maximum production potential for species such as bull trout, steelhead, and spring chinook, and others. DNR has a database of culverts assessed via the Road Maintenance and Abandonment Plan (RMAP) process. This provided the initial baseline condition for fish passage in the TCF. However, comparison of these sites to those assessed by WDFW showed conflicting results regarding the passability status of some barriers. The reason for this discrepancy appeared to be caused by the methods of assessment between the two protocols. The protocol that DNR uses, while suitable for adherence to Forest Practices rules, did not provide the objective and science-based assessment that WDFW requires when assessing fish passage.

5.1.2 Methods

To obtain an objective and science-based assessment of fish passage within the TCF, WDFW's Fish Passage Inventory and Assessment Unit performed a fish passage assessment within the TCF. The protocol for this assessment is outlined in WDFW 2009. In summary, the methods involve walking all streams in the TCF and some streams upstream of the TCF that are impacted by fish passage barriers in the TCF to identify fish passage barriers. Data is collected at each barrier for a Level A assessment to determine if it is a barrier or not. Passability at certain fish passage structures cannot be determined with this data. In those cases, additional data is collected during a second level B assessment. Passability at most fish passage structures can be determined with a Level A assessment. In addition to a simple "passable" or "not passable" designation, culverts are assigned a "0%", "33%", or "67%" passable designation depending on slope of the culvert, water velocity through the culvert, water depth inside the culvert, and water surface drop at the outlet of the culvert. This passability suggests the percent of six-inch salmonid that can pass the feature throughout the year. In addition, the three categories represent a range of passability. The category "33%" represents fish passability between 16.5% and 50%. Non-culverts are assigned this percent passability designation based on the judgment of the assessors in the field.

In addition, an assessment of the potential fish habitat available above known RMAP barriers was completed. This was used to help determine where the most fish habitat could be accessed through directed fish passage removal efforts. This was accomplished by measuring the fish bearing streams up to the first fish barrier that a salmonid would reach as it swam upstream. Then the amount of fish habitat on those same fish bearing streams above the first fish barrier was measured to understand how much more habitat could be available if the barriers were corrected. This was done for each major and minor tributary. A second version of this assessment should be completed with the barriers assessed by WDFW.

5.1.3 Results

Figure 35 shows the DRAFT results of the Fish passage assessment completed by WDFW. Final results will be available within the final report produced by the Fish Passage and Inventory Assessment Unit.

5.1.4 Discussion

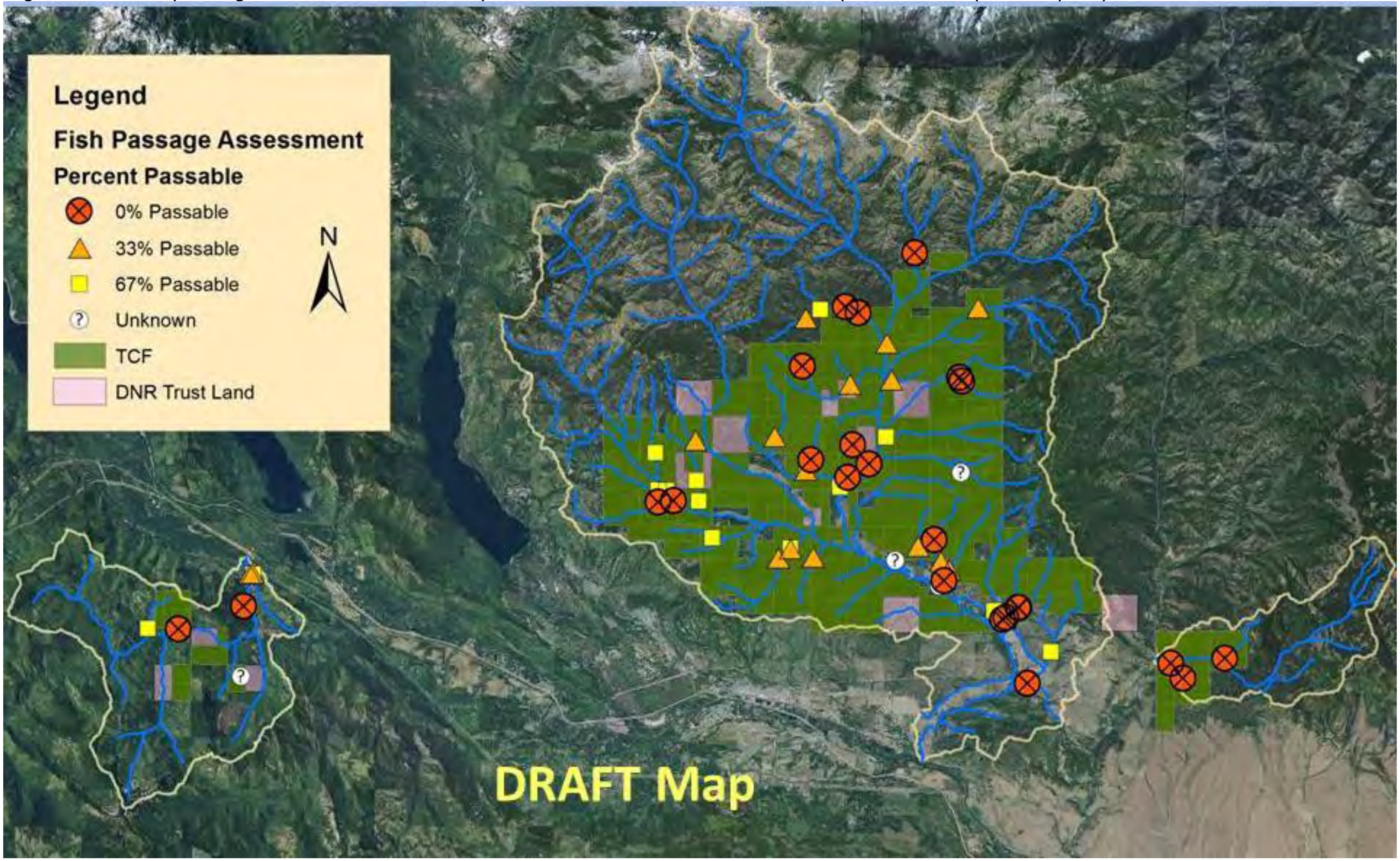
The results of WDFW's fish passage assessment need to be reviewed by DNR to help define DNR's scheduling of barrier resolution under the Fish and Forest Rules.

5.2 Fish Habitat

5.2.1 Introduction

Many different fish species use the rivers and streams within the Teanaway Community Forest for spawning and/or rearing. Bull trout and steelhead trout, both listed as threatened under the Endangered Species Act in 1998 and 1999, respectively, have been observed in the Teanaway River basin. Critical habitat for bull trout was designated in 2002 and included the Teanaway River. That designation was modified several times but its final iteration included the North and Middle forks of the Teanaway River, including several tributaries to the North Fork Teanaway including Stafford, Jungle, DeRoux, Jack, and Indian Creeks. Critical habitat for steelhead trout was designated in 2005 and included the Teanaway River, including all three major forks, most of the North Fork Teanaway tributaries, and Mason Creek. Chinook salmon, coho salmon, westslope cutthroat trout, rainbow trout, Paiute sculpin, and mountain sucker are Washington State PHS species that also exist in the Teanaway. This report will focus on bull trout, steelhead, and chinook

Figure 35. Fish passage barriers in the TCF (DRAFT Results, Refer to Final Report for complete report).



salmon because of their ESA or PHS status, documented presence within the TCF, and cultural importance to the area. However, knowledge of other species such as brook trout and western cutthroat slope trout is also important because of the potential for detrimental interactions with the former and similar habitat shared with the latter.

5.2.2 Habitat Surveys

Some data related to habitat has been compiled through the MIM effort to quantify grazing use of some areas. However, the area monitored with MIM is limited to areas within grazing leases and the metrics do not focus on several important fish habitat aspects, such as pool frequency, pool depth, gradient, pool/riffle/run/rapid definition, instream cover, scour-line width, etc. A more broad sampling area should be established along with fish-specific parameters. Established habitat assessment protocols needs to be reviewed to identify which fish-specific parameters should be collected and by what method. One potential protocol assessment that could be implemented is the habitat assessment portion from WDFW's fish passage and screening assessment manual (WDFW 2009).

In addition to a fish habitat assessment within the TCF, existing topobathymetry information that will be available near the end of 2015 could be used to assess certain fish habitat metrics. Topobathymetry and terrestrial topographic high-resolution elevational contours will be available within the TCF over the entire mainstem Teanaway, all three major Teanaway forks, select priority streams within the TCF (Stafford, Jack, Indian, Jungle, Rye, and Lick Creeks), and the mainstems of First and Cabin Creeks. This topobathymetry and terrestrial contours are not available outside of the TCF. Fish habitat metrics that could be determined from LiDAR data include pool depth, pool frequency, pool distribution, top of bank width, wetted bank width, canopy cover, instream cover, stream gradient, and possible scour-line width.

This LiDAR data can also be used to quantify existing and potential floodplain habitat and floodplain connectivity. LiDAR data and its other uses are discussed in more detail in Section 2.3, Water Supply and Watershed Protection.

5.2.3 LWD surveys

<u>Large Woody Debris</u>

Large woody debris sampling is targeted towards priority stream reaches that may have future restoration projects that place large woody debris in them. This baseline assessment will help guide restoration in streams which may be lacking in large woody debris. The U.S. Forest Service has completed a LWD assessment in the Teanaway watershed on USFS lands. They completed their assessment using methods defined in USFS 2014. In the interest of comparability to the upper watershed, we highly recommend that future LWD assessments follow this same methodology. All priority streams of the TCF should be assessed, giving higher priority to tributaries of the North Fork Teanaway and areas where known restoration projects that could influence LWD are occurring.

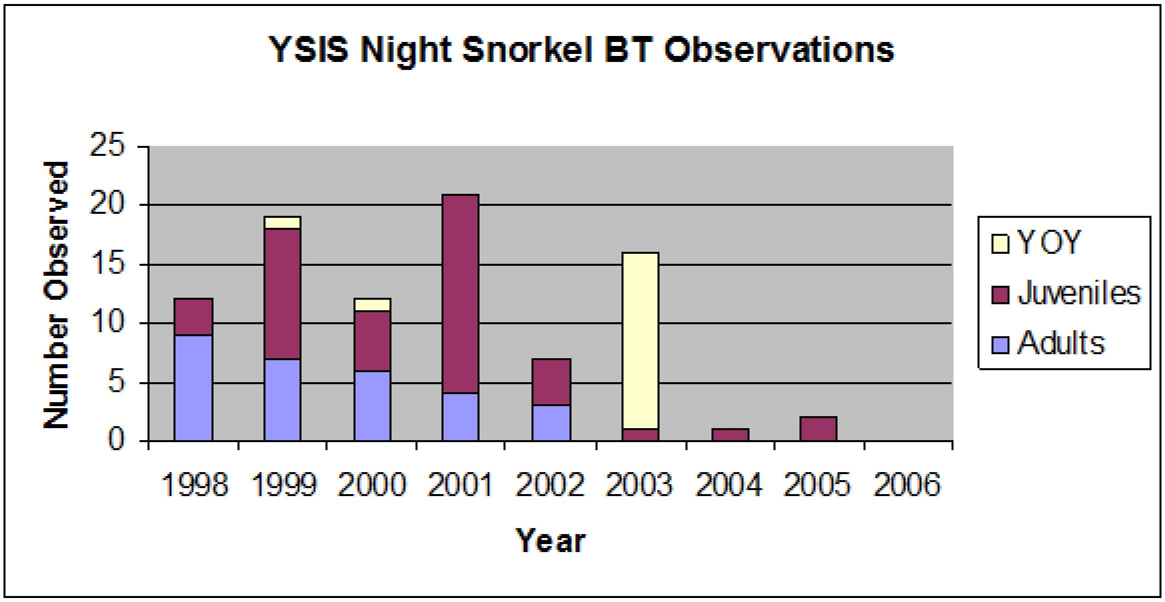
5.2.4 Fish Surveys

<u>Bull Trout</u>

Bull trout surveys conducted under the Yakima Species Interactions Study (funded by Bonneville Power Administration and implemented by WDFW) showed a steady decline in the number of adult and juvenile bull trout observed in the Teanaway between 1998 and 2006 (Figure 36). Some juvenile bull trout were observed by the U.S. Fish and Wildlife Service in 2006 in the upper NF Teanaway. Two bull trout redds were observed in DeRoux

Creek in 2006, one in 2009, and one in 2013, but no adult bull trout were observed. Electrofishing surveys in the Teanaway River basin by WDW's Ecological Interactions Team after 2006 did not observe any bull trout. Nearly annual night snorkel surveys headed by the USFS in DeRoux Creek up to the impassable barrier falls observed no bull trout after 2006 through 2014. Other opportunistic night snorkel surveys for bull trout in upper reaches of the North Fork Teanaway, Beverly Creek, Stafford Creek, and Bear Creek observed no bull trout after 2006 through 2014. All of these post-2005 night snorkel efforts have been the result of 1 to 3 two-person crews snorkeling for one or two evenings.

Figure 36. Bull trout observations during night snorkel efforts in the Teanaway River.



While this effort has lead to the general belief that bull trout are functionally extirpated from the Teanaway River Basin, the occasional night snorkeling for bull trout that has occurred did not cover significant areas of potential bull trout habitat and is not sufficient to determine absence with reasonable certainty. Complete bull trout surveys should be performed in the Teanaway River Basin using a peer-reviewed protocol, such as that established by the American Fisheries Society (AFS), to determine presence or absence probabilities of this threatened species with a definable measure of confidence.

Chinook Salmon

After the construction of a juvenile spring chinook acclimation facility on the left bank of the North Fork Teanaway River just above the Jack Creek confluence in 1997, the number of spring chinook spawning in the Teanaway River has increased dramatically since 2001. Redds are typically located in the Teanaway River mainstem and the North Fork Teanaway, and only occasionally observed in tributaries to the North Fork Teanaway, such as Indian Creek. The redd surveys used to monitor the Teanaway population of spring chinook are expected to continue through the foreseeable future.

Steelhead Trout

In a Bureau of Reclamation-funded study, 38.8% (137 of 353) of steelhead trout radio-tagged between 2002 and 2006 at Roza Dam spawned in the Teanaway River. Adults were tracked to the Mainstem Teanaway River, North, Middle, and West Forks of Teanaway River, as well as lower Stafford, Standup, and Jack Creeks. In a 2013 steelhead radio-tagging study conducted by WDFW, 15 steelhead adults were tracked to Jack Creek, Indian Creek, North Fork Teanaway, West Fork Teanaway, and Middle Fork Teanaway. These 2013 data are from an unpublished report and currently represent presence only, not absence from other locations or inference to population estimates. Continued steelhead redd surveys should be conducted in all reaches within the Teanaway River basin where steelhead have been known to spawn in the past (Dave Fast, 2015, personal email communication).

5.2.5 Water Temperature Data

Many fish species in the Teanaway River Basin are sensitive to water temperatures at various stages of their life history. Spawning is initiated at specific water temperatures. The length of time which eggs need to incubate and emerge, as well as fish growth and spatial preference, is dependent upon temperature. Thus, temperature can be a monitoring tool to understand actual and potential fish distributions in the Teanaway River Basin. See section 2.4 for further discussion of temperature data monitoring.

Temperature monitoring by several different agencies has occurred in the past and some still continues. The gages which the Department of Ecology operates both record temperature data every 15 minutes, though temperature data is available only seasonally, not year round. A Forward-Looking-Infrared (FLIR) data collection occurred via the USFS in 2001 and provided a snapshot of water temperature in the entire Teanaway mainstem and its three major forks (Figure 37). This data provides information regarding temperature refuges for fish, some of which may not be captured with the relatively few fixed water temperature probes that have been and will be installed.

Currently WDFW is in possession of 30 temperature probes and the equipment to install them to obtain both water and air temperature.

5.3 Wildlife

5.3.1 Introduction

Washington State Senate Bill 5367 authorized the purchase of the TCF for, among other things, the "protection, mitigation, and enhancement of fish and wildlife" through improved water and habitat management. Wildlife such as deer, elk, large predators, and spotted owls were specifically mentioned in the Bill. The TCF management plan recommends actions to enhance wildlife in the TCF, such as:

- Developing a schedule to manage the forest for spotted owl habitat
- Reduce fire risk
- Manage grazing to protect wildlife habitat
- Manage grazing to reduce wildlife-livestock conflict
- Manage the TCF to allow for wildlife connectivity and hunting of wildlife
- Protect dens, nests, and other wildlife concentration areas

5.3.2 Northern Spotted Owl

The Northern spotted owl was listed under the Endangered Species Act as threatened in 1990. The owl population in the Teanaway River Basin has declined significantly and documented through presence/absence surveys by multiple stakeholders. (Figure 38).

Figure 37. Map showing spatial temperature variation in the three main forks of the TCF.

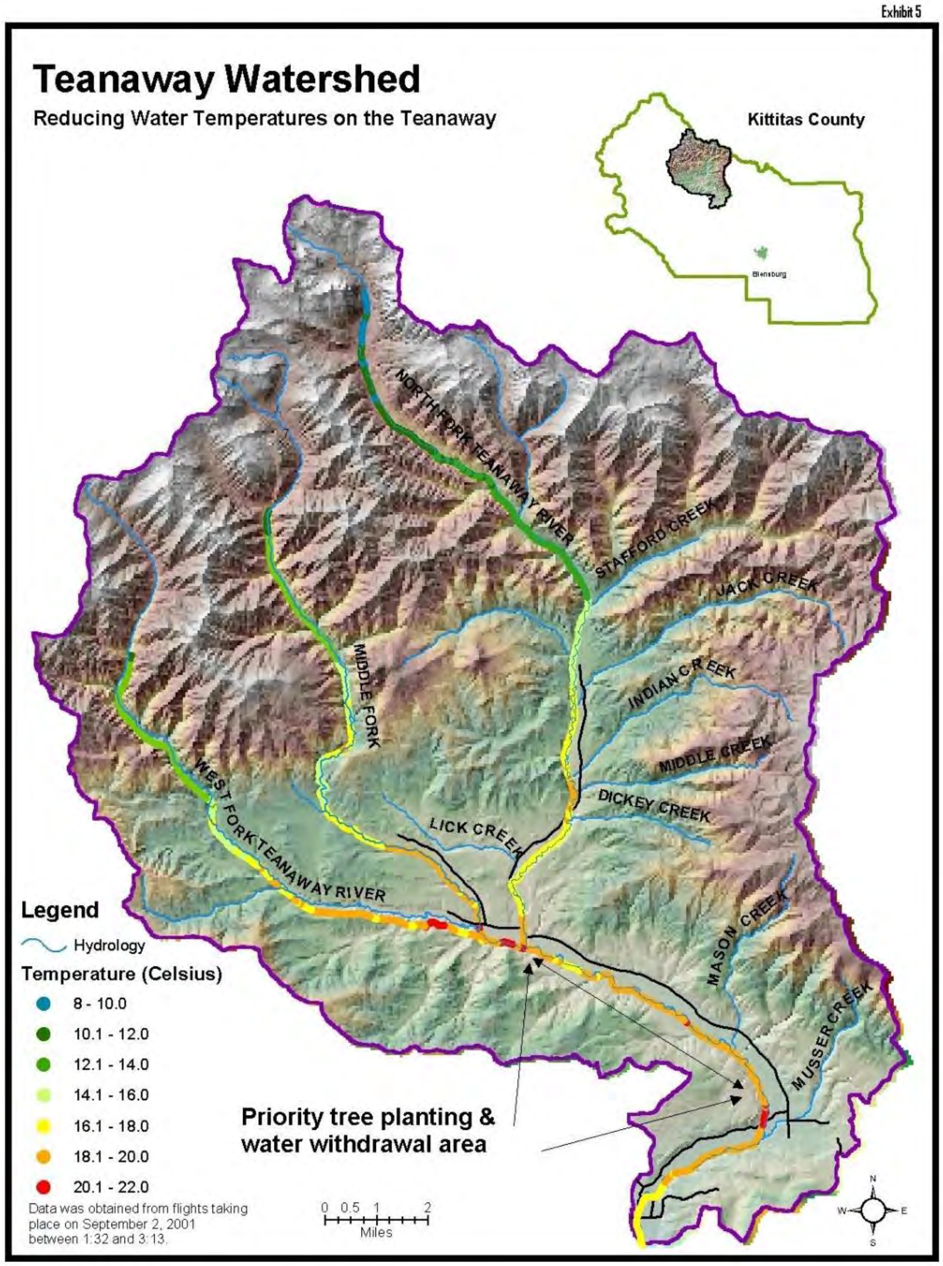
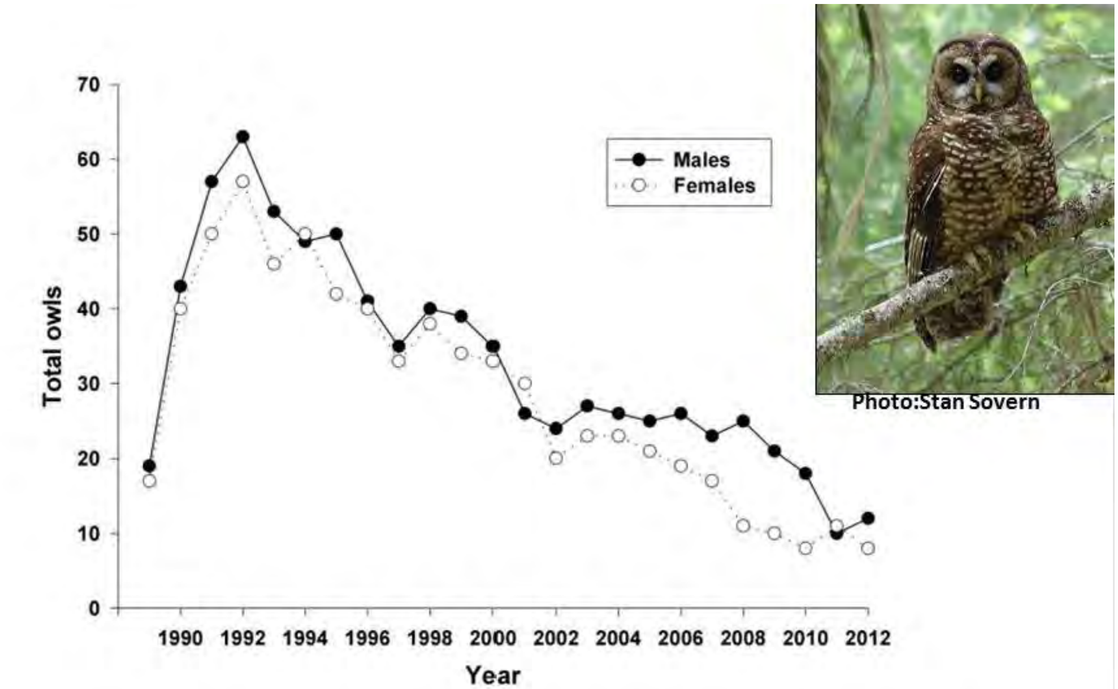


Figure 38. Number of male and female spotted owls in the USFS Cle Elum study area over time (USFS 2012).



Number of male and female Spotted Owls detected by year on the Cle Elum Study Area, Okanogan-Wenatchee National Forest, Washington, 1989-2012.

5.3.2.1 *Northern Spotted Owl Surveys*

Northern spotted owl surveys for several territories in the TCF were historically conducted by AFH biologists and later picked up by USFS biologists that are conducting a demographics study on the species in the area (S. Sovern pers. comm., 2015). WDFW agreed to conduct surveys of three of the territories during 2015 that were either entirely on TCF lands or the majority of the survey points were on TCF lands. These territories were Indian Creek, Shirk Creek and Yellow Hill. Surveys were conducted following protocol in Lint et al., 1999. Three surveys were conducted from May-June, 2015 at established calling stations for these sites. Indian Creek is a mix of diurnal and nocturnal survey locations. Shirk Creek is mostly nocturnal, except for one diurnal survey location. Yellow Hill is entirely diurnal.

Three surveys of Indian Creek, Shirk Creek and Yellow Hill were completed between May-June, 2015. No northern spotted owls were detected at any of the territories. Several other owl species were detected during these surveys. They are:

Indian Creek:
Western screech-owl; June 8, 2013 not on surveys but at gate to Indian Creek road.
Barred owl; May 13, June 8, 2015 and June 24, 2015
Northern pygmy owl; May 13, 2015

Shirk Creek:
Western screech-owl; May 9, 2015
Barred owl; May 9, 2015
Long-eared owl; May 9, 2015

Great horned owl; May 9, 2015 and June 23, 2015

Yellow Hill:
Barred owl; June 10, 2015
Northern saw-whet owl (juvenile); June 10, 2015

5.3.2.2 *Northern Spotted Owl Historical Activity*

Historical database information was obtained from USFS/OSU researchers for northern spotted owl territories entirely or partly within the TCF. This information shows activity levels in the past for these territories. There are 17 historical territories that at least part of the territory overlaps with the TCF. Of these 17, all overlap with at least part of the main block of the TCF. One territory overlaps with both the main block and the First Creek block. This data is linked to WDFW map documents currently. This data should be updated annually to obtain the latest information on these territories as the USFS/OSU continued spotted owl surveys in 2015. These territories should not be shown on publically available maps.

During a meeting on March 25th, 2015 between WDFW (William Meyer and Scott Downes) and USFS/OSU (Stan Sovern) it was determined that past telemetry data collected for demography in the watersheds surrounding the TCF could be used to direct northern spotted owl habitat management plans. Conclusion from this meeting was that the data would reside with the group that Stan Sovern represents for now and he would be contacted to perhaps model demographics against habitat management prescriptions that WDFW and WSDNR.

5.3.2.3 *Northern Spotted Owl Habitat*

In the TCF management plan, identification of both current forest condition and strategies for improvement of future habitat are identified. There are two sources of current habitat available now and a third that will be available later. Corporate data layers produced by WSDNR that mapped owl habitat on a state-wide scale are available, but most of these areas have not been ground-truthed. A second source is spotted owl habitat mapping data that was shared with WDFW and WSDNR staff by AFH, but so far that data has not been found. A third source of data is that WSDNR staff will be mapping northern spotted owl habitat from red LiDar flown in April and May 2015. Red LiDar is processed as of September 2015 but has not been used for mapping of owl habitat yet. That effort is expected either later in 2015 or in 2016. This mapping effort would also need some ground-truth component.

5.3.3 Large Carnivores (Wolves, Bears, Cougars)

5.3.3.1 *Gray Wolf-Teanaway Pack*

Updated Teanaway pack home range data for 2014 was obtained from WDFW staff (S. Becker) in March 2015. The data was obtained in the form of a shapefile. This data should continue to be updated for future years. This data is sensitive wildlife information and should not be displayed on public figures. Washington State has a recovery plan for this species.

5.3.3.2 *Black Bear and Cougars*

WDFW large carnivore specialist, Ben Maletzke was interviewed for information regarding non-listed large carnivores that occupy the TCF. These include cougar and black bear. Lynx are not believed to occur in the TCF and no suitable habitat exists for them. Grizzly bears are rare visitors if they occur in the TCF. Sighting believed to be valid was reported by WDFW staff in 1989. Data focused on cougar and black bear for this report.

Most of the TCF is believed to be suitable habitat for cougar and black bear occurrence. Generalized data showing cougar and black bear use of the area may be displayed on public reports. Individual locations of specific cougar and black bear from telemetry data should not be shown on public figures. Showing cougar and black bear sighting data as long as they are not symbolized to individuals is appropriate.

5.3.4 Deer and Elk

Deer and elk harvest data is available in WDFW Geolib databases. Priority habitats such as elk winter range are available in WDFW PHS Geolib databases.

5.3.5 PHS Wildlife Data

Occurrences of PHS data are linked to the Teanaway shared drive under the folder: GIS\WDFW. Data summarized for this report also uses USFS NRIS data. WDFW has obtained data files for Kittitas County encompassing the Teanaway Watershed through February 2015. Updated data files should continue to be obtained from USFS for up to date species information. Similar to WDFW PHS information, not all occurrences may be valid and all sightings should be treated with skepticism unless known to be verified through detailed notes or photos.

Existing Occurrences of PHS Species within the TCF

Amphibians:

Columbia spotted frog (State Candidate)
Western toad (State Candidate)

Birds:

Harlequin duck (PHS)
Northern goshawk (Federal Species of Concern, State Candidate)
Peregrine falcon (Federal Species of Concern, State Sensitive)
Sooty Grouse (PHS)
Northern spotted owl (Federal Threatened, State Endangered)
Flammulated owl (State Candidate)
Vaux's swift (State Candidate)
Black-backed woodpecker (State Candidate)
Pileated woodpecker (State Candidate)
White-headed woodpecker (State Candidate)

Mammals:

Gray wolf (Federal Endangered, State Endangered)
Grizzly bear (Federal Threatened; State Endangered)
Elk calving area and winter range

Documentation of PHS Occurrences for this report

TCF area is well traveled by biologists and recreational users, thus the databases for these areas were fairly complete. However, biologists for this report did document several new PHS occurrences during fish and wildlife habitat surveys for this report. These occurrences were sent to WDFW wildlife diversity staff in Olympia to be added to PHS databases. New PHS occurrences documented by the team of biologists associated with this report are:

- Western toad on April 27, 2015 in the North Fork Teanaway and June 26, 2015 on Indian Creek, a tributary to the North Fork Teanaway, and August 13 and 26 on the West Fork Teanaway.
- Columbia spotted frog on May 1, 2015 in the North Fork Teanaway
- Harlequin duck on April 10, 2015 in two locations on the Middle Fork Teanaway, April 24, 2015 on the West Fork Teanaway, April 28, 2015 on the North Fork Teanaway and June 26, 2015 on the North Fork of the Teanaway at the mouth of Dickey Creek
- Sooty grouse on May 15, 2015 in the Middle Fork Teanaway and May 18, 2015 in the North Fork Teanaway
- Pileated woodpecker on May 16, 2015 in the Middle Fork Teanaway
- White-headed woodpecker on September 28, 2015 on First Creek, part of the TCF but not within the Teanaway River Basin.

WDFW and USFS databases were acquired and searched for wildlife information in the Teanaway River Basin. That wildlife information includes both listed species and Priority Habitat and Species (PHS) observations. WDFW PHS databases and USFS NRIS databases are living databases that updated by biologists. In addition to being queried for this report, those databases should continue being accessed in the future to obtain relevant species information. WDFW databases are available on the shared Teanaway Drive.

All vertebrate species identified during field surveys were recorded and compiled for a comprehensive species list. When target species were encountered and the observation met PHS recording requirements, staff filled out a PHS wildlife observation form and submitted it to WDFW Wildlife Diversity Program. Staff used the PHS manual (WDFW, 2008) as guidance on what to record.

For birds, there are two citizen science projects within the Teanaway that are worth referencing for future data. The Cle Elum Christmas Bird Count encompasses most of the TCF and is run annually during the mid-December since 2006. Christmas Bird Counts are run through the National Audubon Society and represent a long-term data set. This count provides important trend data for common bird species using the Teanaway during the winter. The second citizen science project is eBird (eBird, 2015). This citizen science database is regularly used by birders and contains a wealth of data both for PHS and common bird species.

5.4 Road Density Assessment

A road density assessment was performed for Boise Cascade Inc. in their Teanaway Watershed Analysis (Boise Cascade Inc., 1996). They focused on tributaries of the North Fork Teanaway River. The average road density was 2.7 miles per square mile with a range of 1.9 to 3.3 mi/mi^2. Information regarding the influence of road density on the presence of bull trout should be used to help determine if areas where bull trout were most recently observed in the Teanaway contain road densities that are high enough to be detrimental to bull trout. These areas could be targeted for possible road abandonment or road removal to aid in bull trout habitat rehabilitation. Results of the WARSEM model run should be analyzed in concert with the road density assessment.

5.5 Fish and Wildlife Data Gaps

- Fish habitat assessment, including finalizing the fish habitat assessment study plan and beginning its implementation.
- Use LiDAR to accurately identify stream locations (correct the hydro layer in GIS).
- Develop a restoration work plan for priority streams.
- Large Woody Material assessment, including finalizing the LWD assessment study plan and beginning its implementation.

- Establish photomonitoring sites likely to experience habitat restoration.
- Bull trout surveys to AFS protocol to establish presence/absence in the NF Teanaway.
- Northern spotted owl surveys on the historic TCF owl circles to establish presence/absence (coordinate with USFS).
- Identify critical areas to maintain or restore habitat corridors for spotted owls.
- Conduct a beaver presence survey in the TCF in order to identify existing locations and densities, and in order to identify relocation sites.
- Finalize fine sediment sampling protocol for in-gravel conditions on spawning reaches and implement monitoring (e.g. McNeil sampling).
- Complete road and trail density analysis and integrate with other data layers, such as WARSEM model results. Determine roads and trails that may be relocated, decommissioned and restored, removed, to decrease negative road impacts to fish and wildlife or their habitat.
- Collaborate with DNR on water-typing modifications and fish habitat designations.
- Determine need for additional PHS species or State-listed or Federally-listed species surveys and implement where necessary.
- FLIR flight for all streams of the TCF, or similar spatially continuous water temperature monitoring method (to identify cold water refugia in summer or relatively warm groundwater refugia in winter).
- Discuss and refine WDFW's fish passage assessment of fish barriers in the TCF with DNR, County, USFS, Private landowners etc.
- Conduct a habitat connectivity analysis for terrestrial species in relation to the TCF and lands adjacent to the TCF and the region.

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7.0 Bibliography

7.1 Bibliography Data Gap:

- List all appropriate historic and ongoing literature, studies, and data related to the Teanaway Community Forest or surrounding landscapes or species.

8.0 Appendices

Appendix A1. Water Temperature Monitoring Draft Study Plan

Teanaway Community Forest Baseline Monitoring – (Steam Temperature monitoring)

Introduction and Problem Statement

Cold and clean water is essential for fostering salmonid populations. Not only are these variables essential for the physiology of the organisms, but they also have an effect on the food web on which these fish depend. Even within these variables the effect of sediment, a type of pollutant, can have a measurable effect on the temperature of the water (United States Environmental Protection Agency 2012). The interplay between cold and clean water can be quite complex, which is why measuring and trying to understand these variables are essential for managing a salmonid population and being good stewards of the water.

A mosaic of entities have collected stream temperature within the Teanaway watershed. From the Department of Ecology to the Yakama Nation, six different state, federal, and tribal entities have recorded stream temperature data in the Teanaway. Some data sets included one-time visits while others track continual changes in temperature for years. The efforts of these entities helped to identify elevated stream temperatures in the watershed that negatively affect salmonids. In 1998 the Department of Ecology confirmed the 303(d) listing, a formal designation that the watershed exhibits impaired temperatures, and found that middle and lower reaches of the Teanaway River exceeded 18°C for over 75% of the days monitored (Stohr, A. Leskie, S. 2000). With the recent presumed extirpation of bull trout within the watershed, an especially cold water dependent fish, the need to track changes in temperature has never been more important. Steam temperature monitoring over time will allow managers to track changes in stream temperatures and perceive trends.

Vital Background on Restoration

The Kittitas County Conservation District attempted to improve instream temperatures at two mainstem Teanaway River reaches through the planting of 2000 riparian trees and shrubs (Lael, A., Suzanne, W. 2002-2004). The intent of the restoration was to see a marked reduction in stream temperatures for the respective reaches, and make some connections to the efficacy of these types of restoration projects. The ambitious goal was not fully realized when funding was cut short following the post restoration monitoring.

Methods

The Washington Department of Fish and Wildlife would like to propose continuous stream temperature monitoring within the Teanaway Watershed throughout the summer when primary stream temperature elevation occurs. This study plan would place ~20 HOBOware thermographs within the main stem Teanaway River, each of its forks, and most of its tributaries within the community forest. Approximately 10 HOBOware thermographs would be deployed to record corresponding air temperatures within the TCF. This network of thermographs would function to quantify the temperature of the water and air hourly, day and night, from May until October. Successively collecting this data year to year will development a robust data set that over time will be less susceptible to yearly variations and will normalize and show trends statistically. Collecting one year of data explains very little about how temperatures are changing, it's only by having multiple years to compare can one make inferences about the character of the aquatic habitat. Based on this, it is strongly recommend that this proposal be considered for implementation for 10 years or longer. This is recommended to develop a meaningful data set that informs, rather than a short term snapshot that is susceptible to variation.

Study Goals and Objectives

The benefit of measuring water temperatures in this manner is that stream temperature is dynamic. From year to year and hour to hour the temperature of the water is constantly changing, by measuring temperature from a consistent location hourly, a high resolution graph of this dynamic change can be generated. This graph can then be used for analyzing trends and informing managers on potential actions. To effectively meet these desired out comes, a well thought out spatial sampling scheme is essential to aptly characterize the watershed and its aquatic environment.

Study Design

Generally, water tends to be colder in higher elevations while water in lower elevations tends to be warmer. Additionally, when water mixes at a confluence it tends to equalize temperature between the streams, with weighting toward the stream with more flow. Based on these concepts placing thermographs in lower reaches and above confluences reveal more information on stream temperatures and how individual drainages contribute to stream temperatures (Figure 1). There are a multitude of caveats to the above generalized statement. Most of those apply to localized natural processes, whereas the intent of this proposal is to understand and characterize broad scale stream temperatures. Considering all the water entering the Teanaway Community Forest to the water draining into Yakima River, there are approximately 460 miles of streams.

Focusing on broad scale characterization water temperatures will be collected on each of the river forks where it enters the community forest, in its middle section, and at its mouth. By collecting information as it enters the TCF the variables that maybe affecting the water on USFS land can be considered as well as determining the temperature as it enters the TCF. Next, by collecting information at mid points considerations can be made for temperatures as water progresses through the system. Lastly, information collected at the mouths of streams identifies the temperatures before they mix with their adjoining tributaries, which can be useful when identifying the contribution of some streams on others (Figure 2).

Study Units

At each monitoring location a HOBOware U-22 Thermograph will be installed inside a perforated PVC tube. Once placed inside the PVC tube, the tube will be sealed with end caps, and attached to a steel braided cable encased in vinyl. The steel braided cable is then looped through a sturdy object that is not likely to sour out, with the loop closed with a cable clamp. 16 of these complete units will be required for our initial proposal, while 8 units should be ordered as spares in case a unit is destroyed or stolen.

Site Selection

Sites have been selected based on their spatial context within the Teanaway watershed. As mentioned before, measuring temperatures at locations where they enter the TCF, mid reach locations, and mouths of streams are all informative. Additionally, collecting data in the priority streams of the TCF are also of a high importance since these streams have been designated as having a large benefit to the fish that use these reaches as well as these reaches also have the greatest potential for restoration.

Sampling Strategy

As part of the spatial design of this proposal there would be a thermograph no greater than 2.6 miles away at any location within the Teanaway River and its forks. This is helpful since there will always be a representative temperature monitoring site within 2.6 miles or less.

Sample Size

The sample size for this proposal is 16 temperature monitoring sites or 16 thermograph units in the Teanaway Watershed. Additionally, WDFW will be collaborating with other agencies such as Yakama Nation Fisheries and United States Forest Service within the watershed to help collect information on other tributaries. These other entities have already collected information within the region and will help to minimize expenses and labor. Collectively between the sites proposed in this study plan, the Yakama Nation sites, and the USFS sites the total temperature monitoring locations in the Teanaway Forest will be 23. This larger number will help to improve the overall characterization of stream temperatures, increase robustness of the data collected, help isolate variables affecting stream temperatures, and minimize cost for each vested entity.

Quality Assurance

Part of the quality assurance for this protocol, staff will have to periodically check the thermograph units to make sure that the units are in the water. Technicians will also have to make estimations on the placement of the thermographs as the water continues to drop as flows approach their base level.

Data Analysis

Once the season has concluded, the thermographs will be downloaded and removed from the stream. Back at the office with all the data collected from all the sites, the data can be clipped, edited, and reviewed for out of water errors. The use of an Excel macro can expedite analysis as well as generate graphs and other visuals for reporting findings. Over multiple years comparisons can be made which could lead to trends and predictions on how the watershed is changing.

Expected Results

It is expected that over time the Teanaway watershed will be increasing in temperature. The overall rate and how it will progress is hard to estimate. Installation of thermographs will allow quantification of the amount of change, identify where the changes are happening, and possibly attribute landscape variables to why certain reaches have increasing temperatures.

Appendix A2. Water Quality Assurance Project Plan (QAPP) Study Plan

This document was prepared by Ecology and is available as a separate document.

Appendix B. Wetland Draft Study Plan

Proposal for Baseline Assessment of Wetland Resources and Potential for Wetland Functional Improvement in the Teanaway Community Forest *March 18, 2015*

Objective: To assess current wetland functions in the Teanaway Community Forest (TCF) and to assess potential for expanding wetland functions to gain future benefits.

Justification: The TCF management plan includes wetlands in the performance measures of both water supply/watershed protection and fish and wildlife habitat. To assess changes to the number and quality of wetlands, a wetland inventory needs to be created in the TCF. A wetland inventory should include 1) an identification of wetlands within the TCF, 2) an assessment of level of functions that each wetland provides and 3) an inventory of opportunities for the expansion of wetland functions. Wetland functions for the surrounding landscape and communities include water quality, hydrology and habitat (Ecology, 2015). Opportunities for such wetland functional improvement would include enhancement of existing wetlands, restoration of former wetlands areas and creation of new wetlands.

Background and Study Elements

Documented Wetlands

The National Wetland Inventory (NWI) lists 153 wetland classification units as defined by Cowardin et al. (1979) within the TCF. Of this total, 145 are in the Main Block, 7 are within the First Creek Block and 1 is within the Cabin Creek Block (NWI, 2015). In many cases the Cowardin classification units comprising this total of 153 are contiguous with other classification units so the total of actual wetlands based on NWI data would be lower than 153. Other wetland databases such as Kittitas County critical areas GIS layer and any studies done by Boise Cascade will be studied.

Search for Undocumented Wetlands

NWI data is known to be incomplete (USFWS, 2015; Morrissey and Sweeney 2006) so more wetlands could be present and will need to be verified from fieldwork. This will be done by walking through the TCF and looking for willow or cottonwood trees from a distance and looking in depressions and drainages in the landscape for other wetland plant communities (i.e. dominated by dogwood, sedges, and rushes). The use of aerial imagery and topographic layers GIS could be utilized to streamline field efforts. Wetland reconnaissance fieldwork could be done in conjunction with general wildlife surveys or other fieldwork and could be carried out by technicians who are not trained in wetland science. Ultimately, Wetland determinations will be done by a technician who is trained in wetland science and in accordance with the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region* (USACE, 2010).

Delineation of Wetlands

Newly documented wetlands and areas designated for enhancement, restoration and creation in the restoration work plan will be delineated. Rough field sketches will be done in the field and waypoints will be taken to show both ends of a wetland. Areas will then be delineated using orthophoto and topography layers in GIS. If more precise methods are needed for restoration areas, they can be delineated by GPS tracks.

Rating of Wetlands

In order to determine the level of functions that wetlands provide wetlands in the TCF will be rated with the *Washington Department of Ecology's Wetland Rating System for Eastern Washington* (Hruby, 2014). Rating will be done in the field and in the office using online mapping sources or GIS. If necessary, information on typical hydrology or other relevant rating matters will be sought out from local people familiar with the area.

Assessing Wetland Function Expansion Opportunities

Opportunities for enhancement, restoration and creation of wetlands will be investigated during field visits. Other sources such as records of draining and filling and road building will be consulted. The landscape position, proximity to aquatic areas and observations of disturbance (i.e. roads and pastures) will factor into the evaluation of wetland function expansion areas. Once final enhancement, restoration and creation areas have been selected, their areas will be delineated using GPS and GIS. *Survey Areas*

The TCF wetlands and areas for potential wetland function expansion are grouped into three areas according to geographical regions. Two of these regions are derived from Priority Streams mentioned in the Teanaway Community Forest Management plan (WDFW, WDNR 2015).

Priority Stream Mainstems: This is limited to the Main Block. It includes the West Fork Teanaway River, North Fork of the Teanaway River, an upper section of the Middle fork Teanaway River.

Priority Stream Major Tributaries: This is limited to the Main Block. It includes; Carlson Creek, Lick Creek, Dickey Creek, Middle Creek, Indian Creek, Stafford Creek, Jungle Creek and Rye Creek.

Non-Priority TCF Landscape: This includes areas within all three blocks of the TCF. It includes non-priority streams and areas not adjacent to streams that contain or could contain wetlands.

Training

Ecology requires that people rating wetlands take a short course offered through their Coastal Training Program; 'Using the Revised Washington State Rating System for Eastern Washington' (2 days, $150/participant).

Timeline: While it is possible to observe wetland indicators year round, it is best to observe hydrology in the spring. A representative subset of wetlands will be observed in the spring so that hydrology observations can inform the bulk of baseline assessment work later in the year. Delineation of the selected enhancement, restoration and creation areas can take place in the late summer and early fall. TCF wetlands will be surveyed and rated and a general inventory of potential wetland function expansion opportunities will be completed by **December 2015**. A restoration work plan will be completed by **April 2016**.

Below are three proposal options for wetland inventory within the TCF. This proposal recommends Option B as the option that will collect the most relevant information to provide information for future management projects within the TCF. Within that option, this proposal recommends that all three components of Option B be conducted.

Option A: Assessment of the Entire TCF

Objective: *To provide data on all wetlands, former wetland areas and wetland function expansion opportunities in the entire TCF. This option would provide data on water quality and quantity functions in the TCF for the Yakima Basin. It would also provide thorough data on wetland habitat functions within the TCF.*

Locations and Justification:
Option A would include all areas of the TCF, including Priority Stream Mainstems, Priority Stream Major Tributaries and Non-Priority TCF Landscape. Roughly 4 days will be dedicated to the Cabin Creek and First Creek blocks and the remainder of the time will be dedicated to the Main Block. Based on NWI data, wetlands appear to be sparser away from Priority Stream mainstems and major tributaries but additional time will be required to drive and hike through the Non-Priority TCF Landscape.

Person Days Required:
Fieldwork: 62
Office: 32
Training: 2
Total: 96

Option B: Assessment of Priority Stream Mainstem and Major Tributaries within the Main Block (Part of this was completed for the June, 2015 work)

Objective: *To provide data on wetlands and wetland function expansion opportunities which are closely associated with Priority Stream Mainstems and Priority Stream Major Tributaries. This option would provide thorough data on wetland water quality and quantity functions to the Yakima Basin as well as some wildlife habitat functions to the Main Block.*

Locations and Justification:
Option B would include Priority Stream Mainstems and Priority Stream Major Tributaries. The table gives estimates of the time required for the three elements of Option B. Option B will address wetland functions and potential expansion of wetland functions on all Priority Stream areas. It will provide data on water quality and quantity functions in the TCF for the Yakima Basin and the habitat functions of over half of the wetlands in the TCF.

Person Days Required:

Option B Element	Field Days	Office Days	Total
B-1: Assess NWI documented wetlands	30	15	45
B-2: Assess undocumented wetlands	4	3	7
B-3: Assess wetland functional expansion opportunities	4	2	6
Training (would go with any 3 options)	2		2
Total	40	20	60

Option C: Assessment of Priority Stream Mainstems

Objective: *To provide data on all wetlands and wetland function expansion opportunities associated with Priority Stream Mainstems. Option C will provide adequate data on wetland water quality and quantity functions within the TCF for the Yakima Basin and some wildlife habitat functions to the TCF.*

Locations and Justification:
Option C would include an assessment of wetland functions and wetland function expansion potential on the Priority Steam Mainstems of the Main Block. Although wetland functions on the tributaries will not be assessed, Option C will provide data on the most crucial wetland functions for the Yakima Basin which, arguably, are the wetlands furthest downstream. Based on NWI data, roughly half of the wetlands in the TCF are along mainstems.

Person Days Required:
Fieldwork: 22
Office: 16
Training: 4
Total: 80

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Appendix C. WARSEM Draft Study Plan
DRAFT Study Plan

Title: **Teanaway Community Forest Baseline Monitoring – Road and Trail Sediment Delivery Prediction using the Washington Road Surface Erosion Model**

INTRODUCTION

The Teanaway Community Forest (TCF) was acquired by the State of Washington in 2013. There is a lot of public and agency support, as demonstrated by the Teanaway Community Forest Advisory Committee, to manage these 50,241 acres for multiple uses and actively measure specific habitat metrics to insure that its management is successful and can be modified as necessary to reach the goals of the TCF. Fine sediment input generated from roads and trails and delivered to aquatic systems is one of those habitat metrics proposed for monitoring. The Washington Road Surface Erosion Model (WARSEM) is proposed as the method for modeling fine sediment. The Teanaway Community Forest advisory committee has already suggested that WARSEM would be a good way to evaluate sediment in the TCF. WARSEM has been used as a measure of sediment delivery to streams in Washington State as documented in the State's Road Maintenance and Abandonment Program (RMAP) (Dubé 2010).

PROBLEM STATEMENT (reason for study)

Fine sediment can be a significant indicator of habitat quality. In streams where salmonids are present, increased fine sediment levels can have detrimental effects on fish embryo survival and fitness (Koski, 1975). Fine sediment percentages of <12%, 12-20%, and >20% in east side streams of Washington indicate properly functioning habitat, functioning at risk, and improperly functioning habitat, respectively (NMFS, 1996). The impact of roads on sediment input has been well studied and reviewed in Appendix A of Dubé et al. 2004. The Teanaway Watershed Analysis (Boise Cascade Corp. 1996) suggested that sediment delivery to streams occurs near roads in confined valleys next to upper elevation streams, specific road sites next to stream-bearing segments, and in areas with unrestricted recreational vehicle access, such as that adjacent to Dickey Creek. However, modeling results suggest that, overall, "road-related surface erosion is not significantly contributing fine sediment to basin streams" (Boise Cascade Corp. 1996). At that time there was less opportunity to deal with the fine sediment delivery to streams caused by roads in an area that was privately owned and had specific resource development goals. Now that the same land is owned by the State and there is a management plan to protect fish and wildlife resources, the opportunity and need to reduce fine sediment input into protected streams has increased.

Similarly, hiking and recreational vehicle trails are expected to have an effect on sediment load. Thus there is a need to reduce sediment input from roads and trails with the expectation that the reduced sediment load will improve stream conditions for incubating and rearing fish.

Reducing fine sediment has been identified as a specific goal for the TCF by the TCF Advisory Committee (AC), and a recovery objective in the Bull Trout Action Plan, Bull Trout Recovery Plan, and Steelhead Recovery Plan.

METHODS

STUDY GOALS AND OBJECTIVES

The overall goal of sediment monitoring is to characterize and manage fine sediment input from roads and trails throughout the TCF. It can also be used to aid the Washington State Department of Natural Resources (DNR) with their obligations to assess sediment delivery under the Forest and Fish Law. This information will be used to identify specific road segments that are generating relatively high fine sediment levels. These roads will be prioritized for application of appropriate Best Management Practices (BMP's), or redesigning, relocating, or decommissioning. This in turn will aid the overall strategy of fine sediment management over the TCF. WARSEM was developed to quantify the amount of sediment produced by roads. The model can be easily calibrated to allow evaluation of sediment input from trails (Dubé, 2004). We will apply this model to the TCF to characterize the present status of sediment load in various sub-basins and help select locations for applicable types of habitat improvement projects.

CONCEPTUAL MODEL LINKING GOALS WITH MONITORING APPROACH

The goal of quantifying sediment input into the streams of the TCF is achieved by visiting road segments and trail segments within the TCF, and collect data at those segments that are required as inputs to the WARSEM model. Prior to that effort, roads and trails will be selected based on their capacity to impact streams, opportunity for establishing habitat restoration programs in certain areas, their contribution to the TCF, the relative contribution of that portion of the TCF on the overall landscape, and ease of access to the roads. The field data will be processed into a format useable by the model. The model will be run to generate expected sediment inputs from the sampled road and trail segments. An assumption being made here is that the model can accurately estimate sediment produced from these segments useful for management purposes. This is an acceptable assumption because, by definition, that is what the model was designed to do. The model has been validated to a greater or lesser degree in studies to quantify sediment load due to roads in Washington (Dubé et al. 2009), Montana (Montana Department of Environmental quality 2009), Oregon (Surfleet et al 2011), and in Iran (Jaafari *et al.* 2014).

The WARSEM model can be run at four different levels of assessment. Currently the model is expected to be run at a level 3 assessment: Detailed Assessment and Scenario Playing. Level 3 assessment provides:

A detailed assessment of modeled erosion/delivery using field-verified data collected from each road segment.

The ability to determine reduction in sediment delivery resulting from applying potential road maintenance practices or Best Management Practices (BMPs) to road segments (a.k.a. scenario playing).

A level 4 assessment provides, in addition:

The ability to track changes in road segment attributes and modeled erosion/delivery resulting from road maintenance or BMPs through time

Documents and monitors reduction in road surface erosion resulting from Road Maintenance and Abandonment Plans (RMAPs) through future model runs

Computes Forest and Fish Rules (FFR) performance metrics

Used for watershed-scale evaluations.

A discussion must occur between Tim Quinn, DNR, and WDFW's policy team to get consensus on this level of assessment. The level 4 assessment requires two more metrics in the WARSEM model: ditch condition and implemented BMPs. A cost/benefit analysis will be completed and discussed to determine the value of the level 4 assessment relative to the increased effort to obtain these two extra parameters.

SAMPLING UNITS

Sampling units are all road segments in the TCF as well as all road segments that deliver to a stream or wetland that is connected to the TCF. Sediments are delivered from roads that have a direct hydraulic connection to a stream or that are located within 200 ft of a stream or wetland if no direct hydraulic connection is observed. All roads need to be visited to determine which road segments have the potential to deliver sediment to streams and wetlands. Trails need to be assessed in this same manner. Abandoned roads should be assessed as well to determine if they still have the potential to deliver sediment.

SITE SELECTION

The roads and trails within the TCF will be divided into segments and given a unique segment number, and their length estimated. Though another sediment modeling exercise has been completed by DNR for roads in the TCF, it has been determined that the road segments developed in that exercise are not adequate for the unique segment numbers for this exercise.

EQUIPMENT REQUIRED

The following is a list of equipment needed to complete the WARSEM data collection and analysis. Some items are already available within the Habitat Program.

100m tape (2)
measuring wheel (2)
GPS unit (2) 1 already available
laser range-finder (2) 1 already available
camera (2) 1 already available
clinometer (2) both already available
PC with Windows 98 or higher and 140 MB of free disk space (1) already available

A high precision distance measuring device has been recommended to be installed in a vehicle used by technicians collecting this WARSEM data. However, to maintain flexibility regarding which vehicle can be used for other concurrent data collection efforts, to maintain consistency of data collection among technicians, and because GPS units have been used by DNR for similar data collections, we are currently not planning to purchase and install this device.

SAMPLING STRATEGY

Roads, including abandoned roads, and trails will be sampled on a tiered priority scheme described below:

Active roads within the TCF

Active roads outside the TCF that could deliver sediment to the TCF via a stream or wetland. An exception to this rule is that no roads outside of the TCF portions within the Cabin Creek watershed will be assessed because of the relatively small area of the TCF within that watershed.

Abandoned/decommissioned/orphaned roads within the TCF

Recreational trails within the TCF, including hiking, horseback riding, mountain biking, snowmobile, and off-road vehicle trails.

Because of the large influence that the width of a road surface has on sediment delivery potential, trails are not likely to be significantly large sources of sediment delivery to streams and wetlands, so we do not plan on assessing trails outside of the TCF. Similarly, because many abandoned roads have regrown vegetation and have less potential to be a source of sediment, we do not plan on assessing abandoned roads outside of the TCF.

Ideally, sampling would occur at approximately 5 year intervals if activities to reduce sediment delivery from roads are ongoing. If those activities are not continuing on a regular basis, reassessing roads for sediment delivery should occur after significant road modifications are completed.

The thirteen parameters required for the WARSEM model at a level 3 assessment are shown below in Table 1. Those marked with an asterisk (*) are collected or verified in the field. Optional parameters are those additional parameters required for a level 4 assessment.

Table 1. Data required to run the WARSEM model. Numbered items are those required for level 3 assessment. Asterisked items require field verification. Optional items allow level 4 assessment.

1 Segment Number	9 Traffic Use (* if more precision necessary)
2 Segment Length*	10 Cutslope Cover Density*
3 Year Road Built	11 Cutslope Average Height*
4 Erosion Rating*	12 Ditch Width*
5 Road Slope (longitudinal)*	13 Ditch Delivery (connectivity to stream)*
6 Road Configuration (type of lateral slope)*	Optional: Ditch Condition*
7 Road Surfacing*	Optional: Existing Best Management Plan (BMP) applied*
8 Average Tread Width*	

SAMPLE SIZE

The preferred sample size is the entire population of roads and trails that deliver sediment to streams or wetlands.

QUALITY ASSURANCE

Quality assurance is achieved via the training process for collecting the data that will be the input for the WARSEM model. Training will include a component that requires evaluation of road segments by different individuals at separate times and discussing results of the data to calibrate the team so that data is consistent as possible among individuals. Some concern has been expressed by Tim Quinn, Mike Liquori, and Kathy Dubé, all experienced with the WARSEM model and data collection required for the model, regarding the precision and accuracy of the data collected by a team with little to no previous experience with collecting this data. Presently the intent is to hire a contractor who is experienced with the data collection and WARSEM model usage to train two scientific technicians of our crew and one biologist (to provide long-term consistency to collect the data). The decision to limit the number of technicians to two is based on a recommendation by Kathy Dubé suggesting that, due to the need for data reproducibility, consistency between locations, precision, and accuracy, two people collecting data would limit variability among individuals.

DNR will also provide one employee to attend the training to implement WARSEM and help coordinate each agencies goals and decide how this information can be used by both agencies.

DATA ANALYSIS

The actual model run will account for much of the data analysis. After running the model, data analysis will be performed by WDFW or a contractor. Possible data analyses that could be performed include, but are not limited to, the following exercises:

Compare high sediment input areas to their designation as a high, medium, or low priority stream.

Determine if roads in the TCF are meeting the Forest & Fish Report (FFR) hydrology performance target (in regard to miles of delivering road/miles of stream).

Determine if road characteristics that affect runoff and sediment delivery to streams are improving through time as Road Maintenance and Abandonment Plans (RMAP) are implemented between 2001 and 2016, or not. This would be accomplished with updates to the WARSEM model based on field assessments of the improvements.

Compare current predictions of sediment input into streams to sediment inputs predicted in previous sediment model runs.

Determine impact of potential future BMPs using the WARSEM model.

Compare high sediment input areas to road and trail density, predominant road surface, and proximity of the road or trail to the stream or wetland in the sub-basins of the TCF to help define habitat restoration projects.

EXPECTED RESULTS

Based on literature linking roads to higher sediment volumes in nearby streams (Anderson 1971, Brown and Krygier 1971, Frederickson 1970, Megahan and Kidd 1971), we expect areas with higher densities of roads, higher densities of unpaved roads, and roads close to streams to have higher sediment delivery potential than streams that have the inverse qualities. However, due to the many parameters that affect sediment delivery to streams we are expecting to identify some areas that have higher sediment delivery potential even if they do not have the characteristics described above. This is because there are other parameters, some of which WARSEM takes into account and many which are not taken into account, such as logging practices and grazing, that also influence sediment delivery.

UNCERTAINTY ANALYSIS

The WARSEM model results compute a long-term annual average sediment delivery rate produced from the subject roads with similar characteristics and climatic conditions to those used to calibrate the model. "The actual amount of sediment from any given road segment may be different than the predicted amount due to inter-annual variations in weather and traffic patterns and local changes in topography and soil characteristics that cannot be accounted for in the model." (Dubé 2004). As a result, model results should be used as a relative measure of sediment delivery to streams and wetlands only. The model does not provide actual sediment delivery amounts to any one location. We do not plan on validating the model as part of our TCF work.

RESOURCES REQUIRED

Table 2 Resources required for tasks associated with this WARSEM activity.

Task	Person days	$
Planning/Contract award	15	
Contract with trainer (for training 4 people)		8.8K
Contract with trainer (for training 5 people)		9.5K
Training in data collection	20	
Data collection	50	
Populating model database	10	
Data confirm/QA/QC	4	
Model run(s)	10	
Model output compilation	10	
Equipment	Range finder, measurement wheels (2), GPS (1), 100 m measuring tape (2), camera (1)	1.5K
Total	154	10.3-11K

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Appendix D1. Grazing Monitoring Draft Study Plan

Proposal for baseline monitoring for assessment of grazing impacts in the Teanaway Community Forest *April 17, 2015*

INTRODUCTION

The Teanaway Community Forest (TCF) was acquired by the State of Washington in 2013. The acquisition consisted of 50,241 acres and was located in three watersheds; Teanaway River, First Creek and Cabin Creek. The legislation authorizing the purchase of the TCF and consequently the TCF management plan (TCF 2015) gave clear directives that the forest should maintain working lands for forestry and grazing while protecting and conserving fish and wildlife habitat.

PROBLEM STATEMENT (reason for study)

The Teanaway Community Forest (TCF) Management Plan identifies grazing as a part of the working forest component of the TCF. The management plan further specifies that grazing needs to be conducted in a manner that will benefit fish and wildlife habitat. Improperly managed grazing can lead to reductions in fish and wildlife habitat. These habitat baseline monitoring studies are recommended as a way to assess current impacts to fish and wildlife habitat by grazing.

BACKGROUND

This baseline monitoring is to fulfill directives laid out in the Teanaway Community Forest Management Plan and to determine baseline conditions for future performance measures. Among the priority actions called for in Chapter 2 of the management plan under grazing is "use an interagency and interdisciplinary team to develop a rangeland and riparian management program that includes steps on monitoring for impacts and making changes to practices by March 2016." This baseline monitoring will help to inform decisions on management practices and assess current conditions within the grazing leases on the TCF.

METHODS

STUDY GOALS AND OBJECTIVES

The study goals and objectives of grazing monitoring within the TCF are to assess both short and long-term impacts to riparian and upland grazing areas and areas of grazing infrastructure (including stream crossings). This on-going monitoring will allow managers to develop grazing plans that benefit fish and wildlife habitat while still providing sustainable grazing opportunities for lessees. Grazing monitoring is identified within the TCF management plan under priority actions and performance measures for grazing, Chapter 2. Baseline monitoring is to be conducted in 2015 to assess current habitat conditions, both riparian and upland, and to identify grazing areas, stream crossings, and status of grazing infrastructure (including fences) as identified in the priority actions for grazing.

Monitoring of habitat for grazing assessment will be based on Multiple Indicator Monitoring (MIM) for assessment of riparian habitat (BLM 2011). Height-Weight method (BLM 1996) and species composition and stubble height will be tracked from an appropriate method to be determined in Herrick et al. 2009 for assessment of upland meadow habitat. In addition to these monitoring methods, other site specific data such as stream crossing locations, fence/cattle guard condition and off-stream watering areas/mineral blocks locations will be identified through baseline monitoring and assessed through long-term monitoring to determine their associated performance measures.

MIM is proposed to be used for monitoring short-term and long-term impacts to grazing within riparian habitats. Short-term indicator monitoring is to provide data on whether the current season grazing by livestock (or other herbivores) is meeting grazing use criteria. Long-term indicator monitoring is to provide data to assess the current condition and trend of streambanks, channels and riparian vegetation. Species composition and stubble height is proposed for upland meadow monitoring to provide data to assess the current condition and trend of upland meadows and their use by herbivores, both livestock and native ungulates.

The objective of inventory and assessment of stream crossings and grazing infrastructure is to determine the extent and locations of current conditions. This inventory would allow managers to determine if currently located stream crossings and infrastructure are in appropriate places for grazing while assessing impacts to fish and wildlife resources at grazing sites.

For stream crossings and grazing infrastructure, the objective is to evaluate current conditions (baseline) to allow assessment and planning for future grazing management plans within the TCF. These current conditions would be part of a baseline report on grazing habitat assessment within the TCF. The baseline report would also make recommendations on ways to improve these metrics to enhance fish and wildlife habitat in respect to managed grazing within the TCF. Baseline monitoring would mark locations and assess condition of the following locations/structures:
Condition and location of existing fencing and cattle guards
Condition and location of existing stream crossings
Condition and location of existing off-site watering locations and mineral block placement

STUDY DESIGN

CONCEPTUAL MODEL LINKING GOALS WITH MONITORING APPROACH
The TCF management plan specifies that a monitoring plan would be used to detect short term and long-term changes to riparian and upland habitats, stream bank stability and vegetation composition.

SAMPLING UNITS
Riparian monitoring using MIM

Short-term indicator metrics to be monitored:
Stubble height (adapted from BLM 1996) and Challis Resource Area (1999)
Streambank alteration (Cowley 2004)
Woody species use (adapted from BLM 1996)

Long-term indicator metrics to be monitored:
Greenline composition (adapted from Winward 2000 and BLM 1996a)
Woody species height class (Kershner et al. 2004), would not be collected for sites not expected to have woody species potential
Streambank Stability and Cover (adapted from Kershner et al. 2004)
Woody species age class (adapted from Winward 2000) ,would not be collected for sites not expected to have woody species potential
Greenline-to-greenline width (Burton et al. 2008)
Substrate (Bunte and Abt 2001)
Residual pool depth and pool frequency (Lisle 1987), in reaches where bathymetric LiDar is not expected to capture this information.

Upland Meadow Monitoring using Height-Weight Method and Species Composition
Species composition and stubble height will be tracked from an appropriate method to be determined as defined in Herrick et al. 2009.

SITE SELECTION
Riparian monitoring using MIM
Sites were selected to represent grazing impacts along streams for each grazing lease. Two sites were selected for the North Fork Teanaway area grazed by Kayser. An additional site may be selected in this lease along Indian Creek because of the imminent restoration activities planned for that location. One site was selected in the West-/Middle-Fork Teanaway area grazed by Fudacz.

One site was selected within the First Creek block of the TCF that is grazed by Burke. The list of proposed river forks and tributaries are listed below by grazing lessee. There are no grazing allotments for the Cabin Creek section of the TCF. The number of sites chosen for each grazing lease was greater in the North Fork Teanaway area because of the larger size of this area and high degree of grazing use. Sites were selected based un their importance to fish and wildlife habitat, accessibility, and whether they had the topography that would allow for application of the MIM protocol. Reaches selected were within the grazing allotments and within the TCF boundaries.

River Forks and Tributaries Proposed for Monitoring:
Kayser lease:
North Fork Teanaway River—floodplain meadows and areas important to fish and wildlife habitat.
Indian Creek – area where restoration is occurring in tandem with grazing lease

Fudacz lease:
West Fork Teanaway— area important to fish and wildlife habitat and where potential restoration opportunities exist.

Burke lease:
First Creek— *area important to fish and wildlife habitat and where potential restoration opportunities exist.*

Upland Meadow Monitoring using Height-Weight Method and Species Composition
Target areas have not been selected yet, but should include upland meadows within grazing leases that livestock are believed to use on a regular basis. This may also apply to upland meadows identified as areas that deer and elk use for concentration areas as their impact could be similar to livestock in these areas. Higher priority should be assigned to areas believed to have restoration potential/interest as long-term monitoring would track changes to management.

Inventory of grazing infrastructure and stream crossings
All infrastructure and stream crossings within the grazing leases on the TCF would be recorded. See below under sampling strategy for how they would be documented.

SAMPLING STRATEGY
Riparian monitoring using MIM
These reaches would be chosen through a combination of interagency and interdisciplinary input and a statistically valid sampling scheme such as Generalized Random Tessellation Stratified (GRTS) sampling method (Thomas et al. 2012).

Short-term monitoring timing and frequency: Preferred timing is early fall (late September-early October). Frequency is yearly; baseline to be conducted in 2015.

Long-term monitoring timing and frequency: Preferred timing of monitoring in late June through early July based on consultation with Jeff Burnham, WDFW Range Ecologist. Initial monitoring for baseline conditions will be completed in 2015, then three years after management changes. Following the three year assessment, sites would be monitored every five years to monitor ongoing management impacts. If no management changes are conducted, sites would still be monitored on a five year timeline to document trends.

Staff resources to conduct short-term monitoring: Following initial training of crews by Jeff Burnham, WDFW range ecologist, a crew of two people would be expected to conduct assessment on one to two sites per field day, depending on how many of the above metrics would be collected for a site. There are expected to be 18 sites once site selection is completed, so 18 to 36 person days would be required to complete field collection, depending on data collected. Data input and analysis would require additional time. Data input and analysis is estimated to be 1-4 hours per site, depending on whether data is input via a Personal Digital Assistant (PDA) or manually.

Staff resources to conduct long-term monitoring: Following initial training of crews by Jeff Burnham, WDFW range ecologist, a crew of two people would be expected to conduct assessment on three to four sites per field day. There are expected to be 18 sites once site selection is completed, so approximately 12 person days would be required to complete field collection. Data input and analysis would require additional time.

Upland Meadow Monitoring using Height-Weight Method and Species Composition
Samples would be chosen through a statistically valid sampling scheme that includes stratified random sampling along with interagency and interdisciplinary consultation.

Timing and frequency: Early fall (late September-early October).Yearly for height-weight, every five years for species composition. Species composition is a slower change and yearly assessments likely will not show change.

Staff resources to conduct Upland Meadow Monitoring: Following initial training of crews by Jeff Burnham, WDFW range ecologist, sites could be completed in approximately one hour/site, so several sites in a day depending on location of plots. Unknown at this time the number of plots, staff resources dependent on that number.

Inventory of grazing infrastructure and stream crossings
Grazing infrastructure (fences, watering locations, piping, and cattle guards) and stream crossings would be noted while conducting other biological monitoring within the TCF. When encountered, biologists would take a GPS waypoint of the location, take photos showing the condition and location of the stream crossing or infrastructure and record the appropriate notes.

Timing and frequency of infrastructure assessment: Baseline monitoring, April-October, 2015. Baseline monitoring would consist of crews reporting the location of this infrastructure while conducting other baseline monitoring within the TCF. Lessee would also be interviewed for their knowledge of these structures and their location. Frequency of reporting after baseline assessment is recommended at least every five years. More frequent incidental reporting is likely to occur by the lessee or biologists working in the area, the formal reporting would include summarizing incidental observations.

Staff resources to conduct inventory of grazing infrastructure and stream crossings: Minimal staff time is dedicated to searching for these locations. They would be recorded as described above when encountered while conducting other biological surveys. If a location is identified through interviewing agency staff or lessee, effort would be made to obtain GPS location, pictures and notes when in the area.

SAMPLE SIZE
Riparian monitoring using MIM
Within each selected stream, three sample reaches would be selected for monitoring sites. Thus, the total number of stream reaches would be 18 for completing all selected streams identified above.

Upland Meadow Monitoring using Height-Weight Method and Species Composition
Sample size would be determined once target areas have been identified. Sample size should be more than one sample per lease and enough sites to enable analysis to make statistically viable conclusions on change but less than all upland meadows within the TCF.

QUALITY ASSURANCE

Crews conducting the riparian and upland monitoring would be trained by Jeff Burnham, WDFW range ecologist on protocols selected for monitoring, including MIM. This training would include data calibration by crews collecting data at a site alongside Jeff to ensure that the data was being collected in a manner consistent with the protocol. In future years, any subsequent data collection would also be conducted by trained staff and calibrated with personnel trained in the protocol. Data entry would go through a QA/QC process where a subset of data would be checked for data entry errors prior to data analysis.

Recording of grazing infrastructure notes would be input into a database for tracking and their associated waypoints and photos would be put in associated files. Data would be shared between DNR and WDFW in accordance with the management directives laid out in the TCF.

DATA ANALYSIS

Riparian monitoring using MIM

Data analysis would follow procedures identified in the MIM protocol (USDI, BLM 2011). Once metrics from data analysis were calculated and reported, range ecologists from WDFW, DNR and possibly other partners such as WSU extension service would interpret the results and provide recommendations for incorporation into a grazing management plan.

Upland Meadow Monitoring using Height-Weight Method and Species Composition

Once a specific protocol for assessment of stubble height and species composition was chosen from Herrick et al. 2009, data analysis would follow procedures identified in that protocol. Once metrics from data analysis were calculated and reported, range ecologists from WDFW, DNR and possibly other partners such as WSU extension service would interpret the results and provide recommendations for incorporation into a grazing management plan.

Inventory of grazing infrastructure and stream crossings

Grazing infrastructure and stream crossings would be quantified in both a numerical and spatial manner and compared against goals set in the TCF grazing plan that identifies performance measures such as feet of fencing added or removed, number of infrastructure added, number of stream crossings removed, relocated or improved etc..

EXPECTED RESULTS

Baseline data collected from MIM, Upland Meadow monitoring and infrastructure inventory are expected to assess current conditions of grazing within the TCF in terms of upland and riparian fish and wildlife habitat. Assessment of current conditions should enable managers to make informed decisions regarding management of grazing on the three grazing leases within the TCF; Kayser, Burke and Fudacz.

UNCERTAINTY ANALYSIS

Site selection of sample stream reaches and upland meadows needs to be chosen carefully to ensure that changes in grazing can be detected through monitoring. This is best done through a combination of interagency consultation and statistically valid sampling schemes designed to detect such changes. If sampling schemes are not conducted to a rigorous standard, analysis may not be able to detect measurable change. There is uncertainty regarding the inventory of infrastructure. As the TCF is a large area and only targeted areas will be assessed by biologists during various baseline studies, the inventory will likely not be complete. The inventory will have to rely on reporting by the lessee or other parties and will still be only as complete as land has been visited.

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Appendix D2. Data worksheet for pre-MIM monitoring

Sand	< 2 mm
Fine gravel	2 - 24 mm
Coarse gravel	25 - 64 mm
Cobble	65 - 255 mm
Boulder	> 255 mm

Stream Crossing Survey Form
Teanaway Community Forest
Version of June 3rd, 2015

GENERAL

Name: Date:

Location (stream name and site #):

GPS Degrees coordinates::

Photos of site (label):

Crossing or access point?

Width of crossing or access point (parallel to the stream, area impacted by hooves):

Is the site less than 200' from a known spawning location? If yes, Explain reasoning:

Is there suitable spawning habitat within 50'?:

STREAM DESCRIPTION

Bend or straight run? Riffle or pool?

Describe the substrate within the stream(silt, gravel, cobble, or bedrock,):

Describe the substrate of the bank below the green line(silt, gravel, cobble, or bedrock,):

Woody Species Utilization:

Type of streambank (depositional or erosional)*:

Is the streambank covered (vegetation, gravel, or logs)? Or is it uncovered?*

Is there evidence of slumping or sloughing?*

*Note: Reference the BLM's Multiple Indicator Monitoring (MIM), Technical Reference 1737-23(2011) for help with this metric.

Appendix D3. Multiple Indicator Monitoring (MIM) data collection worksheet.

Multiple Indicator Monitoring Field Data Sheet—Part 1, Site Information

Allotment	Forest/District	Ranger District/ Field Office	Observers	Date

DMA ID	Stream Name	DMA Name and/or Description

Step Interval	Step Length (m)	Sample Interval	Stream Gradient	Substrate	Stubble Height Recorded in (I) inches or (C) centimeters	Plant Region	Subwatershed (6th Field HUC)

Downstream Marker		Upstream Marker		Reference Marker	
Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
Zone / UTM		UTM		UTM	

Woody Species			
1. Are woody plants supposed to be present at this site? (Y/N)		2. Are there any hydric woody plants present? (Y/N)	
3. Are all age classes of hydric woody plants present? (Y/N)		Comments:	

DMA Site Selection Criteria			
1. Was the riparian complex selected by an interdisciplinary team? (Y, N, or N/A)		2. Is the DMA in a riparian complex that represents management activity and is accessible to the activity? (Y, N, or N/A)	
3. Is the DMA in the riparian complex most sensitive to management? (Y, N, or N/A)		4. Is the DMA impervious to disturbance? (Y, N, or N/A)	
5. Will the DMA site respond to management? (Y, N, or N/A)		6. If the stream is over 4 percent, gradient, does it have a well-developed floodplain? (Y, N, or N/A)	
7. Is the DMA a livestock or activity concentration area? (Y, N, or N/A)		8. Is the DMA compounded by several management activities? (Y, N, or N/A)	
Is a critical DMA? (Y or N)		Is a Reference DMA? (Y or N)	

Narrative:

Photo Log	File Name			
	Lower Across	Lower Upstream	Upper Across	Upper Down Stream

MIM Field Data Sheet, Part 2

Page _____ of ______

DMA:	Allotment:	Pasture:	Stream:

Plot No.	Greenline Composition: Species/Rock/ Wood	Greenline Composition: Percent	Woody Species Height Class (1 to 6 or Blank)	Streambank: Alteration (0 to 5)	Streambank: Stability: Erosional/ Depositional (E/D)	Streambank: Stability: Covered/ Uncovered (C/U)	Streambank: Stability: *Stability (F, S, SL, E, A)	Stubble Height: Species	Stubble Height: Height (cm/in)	GGW (0.1 m)	Woody Species Age Class: Species	Woody Species Age Class: Seedling (no.)	Woody Species Age Class: Young (no.)	Woody Species Age Class: Mature (no.)	Species Use: Rhizome (1/blank)

*F-fracture, S-slump, SL-slough, E-eroding, or A-absent

Date:

Woody

Species																																			
Use (Midpoint)																																			

MIM Field Data Sheet—Part 3, Substrate

DMA:	**Allotment:**	**Pasture:**
Stream:	**Date:**	**Used Gravelometer (Y or N)?**

Plot No.	Pebble (mm)										Notes
	1	2	3	4	5	6	7	8	9	10	
2											
4											
6											
8											
10											
12											
14											
16											
18											
20											
22											
24											
26											
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46											
48											
50											
52											
54											
56											
58											
60											

MIM Field Data Sheet—Part 4, Residual Pool Depth and Pool Frequency

DMA:	Allotment:	Pasture:
Stream:		Date:

Distance between riffle crest and pool bottom	Depth of riffle crest or pool bottom	Riffle crest (R) or pool bottom (P)	Distance between riffle crest and pool bottom	Depth of riffle crest or pool bottom	Riffle crest (R) or pool bottom (P)
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P
		R			R
		P			P

MIM Field Data Sheet—Part 5, Comments

DMA:		Allotment:
Pasture:	Stream:	Date:

Plot No.	Narrative

Appendix E. Fish Passage Barrier Assessment

This document was prepared by Ecology and is available as a separate document.

Appendix F. Sediment Sampling Draft Study Plan

Teanaway Community Forest Baseline Monitoring – (In stream sediment composition)

INTRODUCTION

The Teanaway Community Forest (TCF) was acquired by the State of Washington in 2013. There is public and multi-agency support, as demonstrated by the Teanaway Community Forest Advisory Committee, to manage these 50,241 acres for multiple uses and actively measure specific habitat metrics to insure that its management is successful and can be modified as necessary to reach the goals of the TCF. Sediment monitoring is one of those habitat metrics proposed for monitoring.

PROBLEM STATEMENT (reason for study)

According to a 1982 National Fisheries Survey of fisheries managers (with more than 9 years' experience), excessive sedimentation ranked as the number one source adversely affecting fishery habitats and sedimentation as a major concern in all streams (Judy *et al.* 1982). Sediment monitoring in stream is a valuable tool for describing the current condition of the TCF. This monitoring can reliably identify changes or trends in stream characteristics and composition. Increased proportions of fine sediments can negatively impact the quality of the spawning substrates by decreasing egg survival to emergence (Reiser and White 1988) and increasing entrapment and suffocation of fry (Chapman and McCleod 1987). This study is designed for evaluating the composition of spawning gravel, estimating the percentage of fine sediments less than 0.85mm, comparing spawning gravel composition among stream segments, and monitoring the trends of spawning gravel composition through time

VITAL BACKGROUND ON RESTORATION OF AQUATIC HABITAT IN FORESTED ENVIRONMENTS

A multi-disciplinary team of individuals who are working together to make sure the goals of the Teanaway community forest are being met requested that we focus efforts on those stream reaches that support or sustain steelhead, spring chinook and bull trout, that will reduce stream temperatures most significantly, that provide for fish passage or improve fish habitat, and that help achieve other objectives. That team suggested that we refer to these as priority stream reaches (Teanaway Community Forest management plan draft 2015).

METHODS

STUDY GOALS AND OBJECTIVES

The goal of sediment monitoring as described in this study plan is to:

Quantify the quality of the spawning habitat within the Teanaway Community Forest.

Provide the baseline data that, coupled with future monitoring after restoration efforts to improve spawning habitat have occurred, allow measurement of the effectiveness of the TCF management plan to reach its goals, which includes the following from the draft Teanaway Community Forest Management Plan (DNR and WDFW 2015): "Restore and connect fish habitat to support thriving salmon, bull trout, and steelhead populations."

STUDY DESIGN

The primary study design for this project is based off the Timber Fish and Wildlife Monitoring (TFW) program outlined in Schuett-Hames et al. (1999). This study is designed to describe the substrate composition of known spawning areas within the TCF. This baseline data will be used to monitor the effectiveness of future restoration efforts and the Teanaway Community Forest Management Plan.

CONCEPTUAL MODEL LINKING GOALS WITH MONITORING APPROACH

SAMPLING UNITS

The McNeil Ahnell core sampler technique was published in 1960. This technique was designed to collect a standard volume of gravel to a depth of 23cm to characterize spawning substrate for salmonids. The core sampler is comprised of four basic parts a coring cylinder with serrated teeth to aid in reaching the proper depth, a collection cylinder to contain the sediment sample, a coring handle, and plunger cape to seal the sample into the collection cylinder after excavation. The sampler with the Koski plunger weighs 16 lb empty there are some researchers who have modified this instrument to make it more light weight and portable(McMahon 2005).

SITE SELECTION

Site selection for this project is based on observed spawning locations in previous years and where other projects focused on sediment sampling have already been done. Timing of surveys should be when the flows are at or near their base levels and during the same time frame that spawning takes place for salmonids while avoiding interruption of active spawning populations or incubating embryos. Quality samples will be taken during the same time as salmonids naturally spawn within the system so that the samples adequately describe the features of the spawning habitat salmonids encounter.

SAMPLING STRATEGY

TFW suggests two strategies for inventorying spawning habitat: the first is the riffle crest method and the second is the gravel patch method (Schuett-Hames et al. 1999). The riffle crest method is preferred because it allows the most consistent and reproducible sampling at a specific geomorphic feature. The crests are located at the transition between pools and riffles, a complex heavily used by salmonids. The gravel patch method is used in areas where there are not enough riffle crests to provide a minimum of 12 samples (Schuett-Hames et al. 1999). This method will only be used if the riffle crest options don't suffice. This technique divides patches along their length into equal sections where transect points establish the center of each section. Rather than using geomorphic features. Once samples are collected there are two different methods for measuring the collect core samples. The first being the volumetric or wet method using a water source and manual shaking method to sort the sample into their proper particle size class. The volume of sample particles are then measured using a water displacement technique. The volumetric method is quicker and requires less equipment but provides greater potential for inaccuracies. The gravimetric or dry method is similar while the main difference involves drying of samples and weighing of each class size. The sample is dried, baked, run through the same sieves as in the wet method but with the aid of a mechanical shaker rather than water and then weighed. This method requires more time and effort while also providing data that has less chance for human error and meets geology and engineering standards (Schuett-Hames *et al.* 1999). The volumetric method is not covered in this study plan but can be found from Schuett-Hames *et al.* 1999.

Before sampling can begin a stream inventory needs to be taken to determine where riffle crests are located within the stream. This is the preferred methodology. The gravel patch method should only be used if the stream doesn't provide enough riffle crest patches. Given the stream morphology of the Teanaway River system most sections will provide enough samples to where the gravel patch method will not be needed. There are five basic steps to the riffle crest inventory method.

1) Identify locations of reference points, landmarks and candidate riffle crests.

When a candidate riffle crest is found it's important to have geomorphic features along with GPS data to aid in returning to the site later.

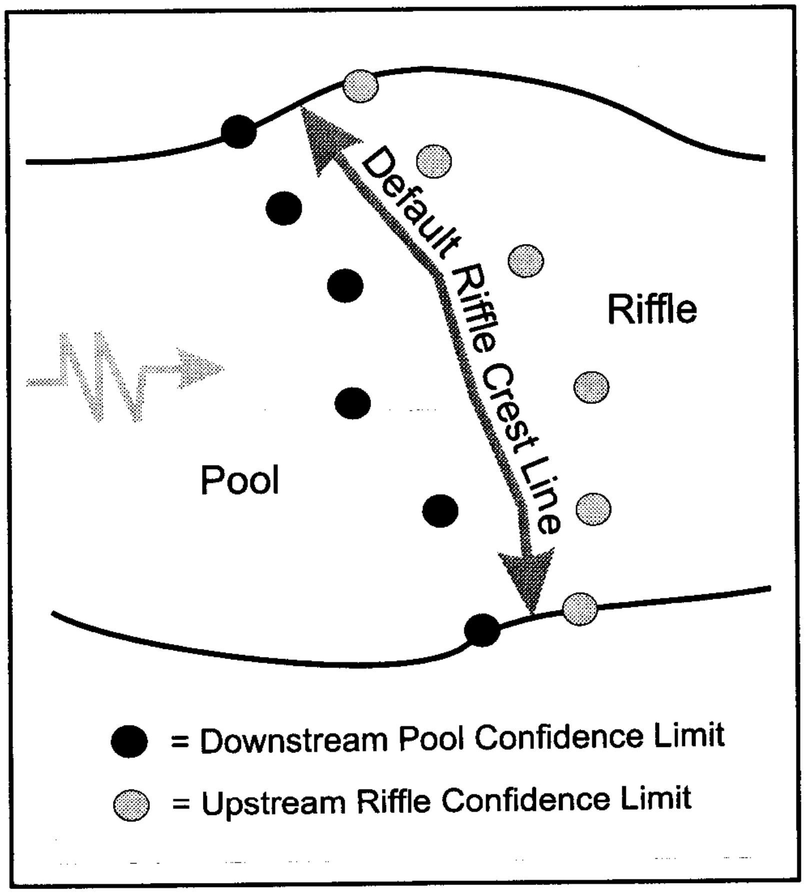
2) Determine suitability of the candidate riffle crests

According to the TFW protocol (Schuett-Hames et al. 1999) a riffle crest must meet all five of the following spawning gravel criteria:

- Dominated by spawning gravels between 8 and <100 mm;
- Minimum surface area of 1 square meter, minimum width of 0.5 meters, and minimum length of 2.0 meters;
- In the wetted channel under flowing water;
- Water depth less than 0.3 meters; and
- Obstructions do not affect criteria #2.

Knowledge of the differences between pools and riffles is critical for proper identification of the riffle crest at a site. Riffles are stream reaches with relatively shallower water depths, greater water speed and surface turbulence, steady upstream bed elevation increases, a flatter channel bed cross section shape and larger gravel sizes. Pools show generally the opposite of all that was just listed. These are increasing water depths, decreased water speeds, decrease in bed elevation until the pools deepest point, a curved or supped channel bed cross section shape and smaller sediment sizes. Once these two types have been identified at the site the riffle crest needs to be identified. This is done by setting up a weighted flag or having a person stand at the area where the crew is 100% sure they are still in pool habitat type. This will mark the upstream pool confidence limit. Now the crew needs to perform the same task but for the riffle, this is done by standing or placing a weighted flag in the area where they are 100% sure is riffle type. This marks the downstream confidence range. In areas where there is complex habitat types there may need to be multiple flags placed to mark the confidence range. Once the upper and lower confidence ranges have been set the riffle crest line can now take shape. This is the center line through the upstream and downstream confidence limits.

Figure 1. Riffle crest example (Schuett-Hames et al. 1999)



Once the riffle crest is identified the dominant spawning gravel type needs to be determined. Spawning gravel is defined as a range from 8mm to 100mm in width. While salmonids may spawn is substrate larger this is a function of equipment limitations. Water flow and depth are the next criteria to determine if a potential site is usable. The channel must be wetted at the time of sample being taken. If the water can flow over the core sampler (.3m tall) then samples cannot be taken. Obstructions are a limiting factor on the equipment being used to collect the data. These include woody debris, sediment greater than 100mm and bedrock.

3) Estimate number of potential samples.

Estimate the number of potential samples by measuring the width of the suitable spawning gravel across the riffle crest. Record a sample for each meter of width up to a maximum of three.

4) Record optional riffle crest information

The riffle crest can fall into three different categories a category "1" riffle crest spans more that 50 percent of the wetted channel width. A category "2" riffle crest spans less than 50 percent of the wetted channel width. These riffle crests are commonly found associated with small pools within larger riffles or in adjacent channels. Category "3" riffle crests are located in a side channel that is separated from the main channel by an island. Channel location such as RB(right bank), LB(left bank) or C(center) can also be useful. This information can be written onto the flagging used in step 5.

5) Place marked flagging adjacent to the sampling site.
   This aids the crew on future site visits.

Patch Inventory Method

The basic steps to the patch inventory method are similar to the riffle crest method. These are listed and explained below.

- Identify locations of reference points and candidate gravel patches.

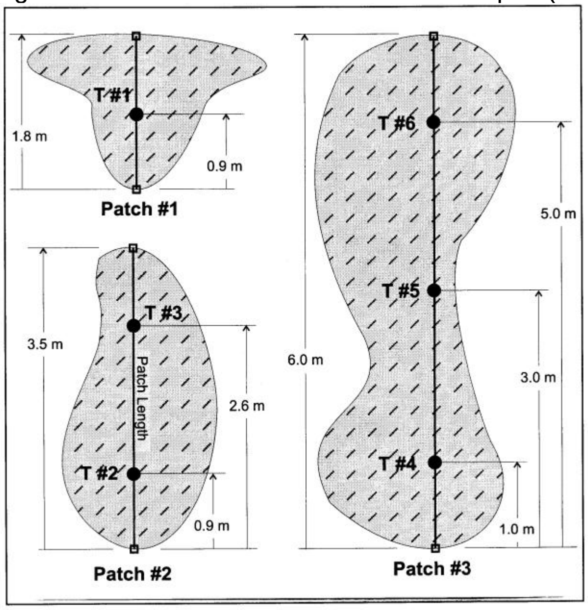
Similar to the riffle crest method, walk upstream recording candidate gravel patches. Take GPS point and mark land feature were needed to return to the site at a later time. Determine suitability of the candidate gravel patches.

"Gravel Patch" covers a broad range of potential spawning gravels. These are found in riffle and pool habitats alike. A patch is one contiguous formation of suitable spawning gravel as defined in the riffle crest section above. Patches are most often located on the downstream side of an obstruction such as a log or boulder, in the tailout of a pool, across a riffle crest, along a gravel bar in the submerged edge, and sometimes as a portion of a riffle unit. Patches may only meet minimum criteria and may be separated by non-sampling areas or obstructions.

- Determine the number and location of patch transects

Measure the length of the patch as it is oriented along the channel with measuring tape. Based on the patch length, determine the number and location of sampling transects and mark their positions in the channel with weighted flags. If the patch length is between 0-2m there is 1 transect, if between 2-4m 2 transects, 4-20m 3 transects and larger than 20m is 4 transects. Determine the number of transects within a patch based on its size, the location from the downstream patch boundary moving up stream of where the transect falls is the length of the patch. The following formulas divide the patch into evenly distributed patch lengths. If in the previous step it was determined there to be 1 transect then multiply the patch length by 0.5, if there is 2 than multiply the patch length by 0.25 and 0.75, when there is 3 transects the multiply the patch length by 0.17, 0.50, and 0.83; and finally when there is 4 transects are used multiply the patch length by 0.13, 0.38, 0.63, and 0.88. For example a patch length of 3.5 meters would have 2 transects located at 0.9m and 2.6m from the downstream edge of the patch.

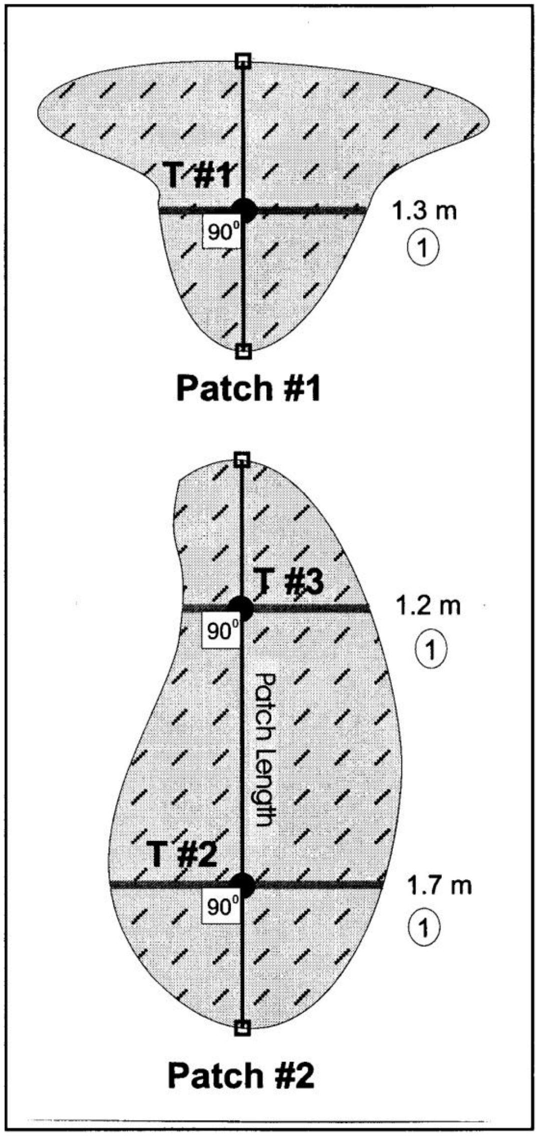
Figure 2. Gravel Patch Transect Example (Schuett-Hames et al. 1999)



- Estimate number of potential samples and flag transect locations.

This is done by measuring the width of the suitable spawning gravel at the first transects. Transects are oriented as a 90 degree angle to the centerline of the bankfull channel (Figure 3). This is the same for the riffle crest method, record one estimated sample for each meter of width to a maximum of 3.

Figure 3. Examples of measuring transect width (Schuett-Hames et al. 1999).



- Record patch and transect distance information.

This is very similar to the riffle crest procedure; record any information that may be helpful in the future when returning to the site. These can include channel category, channel location, spawning gravel size, whether presence of larger particles, and collection obstructions.

Sample Collection Method

The McNeil gravel sampler collects a standard volume of spawning gravel to a depth of 23 centimeters. It weighs around 25 pounds empty and up to 75 pounds with a full sample. There are five steps to the sample collection procedure.

- Locate and verify the selected sampling site

This can be done by using the notes previously taken and by aid of GPS locations.

- Establish sampling points

Stretch a measuring tape across the spawning gravel dominated section along the top of the riffle crest or gravel patch transect. For riffle crests, allow tape to follow the shape of the crest. The number of estimated samples per sampling site is based on the width of the sampling area across the channel (figure 4). When sampling width is equal to or greater than 1 and less than 2 meters multiply the actual width by 0.5 to identify the one sample point along the tape. Where the sampling width is greater than or equal to 2 m and less than 3 m, multiply the actual width by 0.25 and again by 0.75 to identify the two sampling points. When the sampling width is greater than 3 meters, multiply the actual width by 0.17, 0.50, and 0.83 to identify three sample points. Mark the sample points with weighted flags even if they fall within non-sample areas.

Figure 4. Sample point criteria (Schuett-Hames et al. 1999)

Sample Area Width	Number Samples	Multiply Width by
≥ 1.0 - 2.0	1	0.50
≥ 2.0 - 3.0	2	0.25 and 0.75
≥ 3.0 +	3	0.17, 0.50, and 0.83

If the point selected is on non-sample features such as a small dry bar, too close to a log or boulder, or in still water go to the nearest suitable location along the tape.

- Collect spawning gravel sample at sampling point.

The general procedure includes rinsing the gravel sampler, selecting the sample point, inserting the sampler, excavating the sample, and inserting the Koski plunger. More specifically the procedures are defined below:

Rinse the sampler without the plunger intact with stream water. Make a check with a bare hand to ensure no sediment is still within the sampler. Identify the sample point and approach the sample point from the downstream side.

Remove the flag and place the bottom of the coring cylinder where the flag was. The first sampling point should be the furthest point downstream to minimize disturbance to other potential sampling areas.

Insert the sampler by firmly grasping the handle on the top of the collection basin, on each side. Square the sampler to the streambed. Apply body weight directly over the coring handle.

Using downward force and rotational movements similar to a washing machine work the core down within the streambed. Avoid side to side and up and down agitation as it causes fine sediment particles to filter down and lost out of the bottom of the coring cylinder. The sampler is fully inserted when the bottom of the collection cylinder is just resting on top of the stream bed. This can be confirmed when fingers no longer fit between the bottom of the cylinder and the stream bed. Check points at the north, south, east, and west of the bottom of the cylinder with a finger and work the sampler down until fingers cannot be inserted at a minimum of three of those points. If an unseen obstruction, such as large substrate particles, wood, or bedrock prevent the sampler from being fully inserted, rinse it out and attempt at the nearest undisturbed location along the original sampling line or the next sample point. New sample points cannot be established within 1 meter of the rejected sample point or an established sample point. It may be the case that after several attempts the entire riffle crest may be unusable.

Excavate the sample gravel slowly, layer by layer, using a bare hand as a scoop. Place the material into the collection cylinder basin. Add clean water to the basin if needed to provide rinse water. Repeat the scoop and rinse technique until the stop ring at the bottom. During

the excavation process there is an important consideration to follow to prevent fine sediment loss from the sample. First, keep fingers tightly closed as each handful is removed from the cylinder. Second, scoop rather than pick out large particles. Third, always rinse the scooping hand in the collection basin water between each excavation. This prevents clinging particles from quickly washing off hands back into the coring cylinder. A wash bottle maybe used when taking a break to wash off hands, arms, or sleeves into the collection basin. Occasionally a large particle will partially protrude above the ring. In these cases, the particle is removed along with the material to provide an unbiased sample. In situations where the protruding particle also extends below the bottom of the coring cylinder (top of teeth), the sample must be rejected and a new sample selected.
After the sample is completely removed from the core cylinder and placed into the collection basin insert the clean plunger into the top of the coring cylinder and slowly push it down until it rests against the stop ring. The flapper valve should allow the suspended sediments to pass through and be trapped in the coring cylinder.

- Transfer the core sample into a storage bucket.

Place a clean 5 gallon bucket near the coring cylinder, grasp the coring cylinder and handle and lift the sampler out of the substrate and then carefully pour the gravel and water from the sampler into the clean bucket. Carefully rinse the inside of the sampler with a wash bottle into the bucket to removing any clinging sediment. Also make sure that no sediment from the outside of the sampler makes it into the bucket. The sediment that has stuck to the plunger will also need to be added to the bucket. This can be done by using the wash bottle to rinse the sediments into the storage bucket.

Secure the lid to the storage bucket and transfer the sample to the vehicle for processing later.

Sample Processing Method

The sample processing is performed gravimetrically and uses a dry sieve sorting procedure to divide the sample into different size classes. These classes include 63.0mm, 31.5mm, 16.0mm, 8.0mm, 4.0mm, 2.0mm, 1.0mm, 0.85mm, 0.50mm, 0.25mm, and 0.125mm. Once divided the samples are measured in grams. Equipment needed to perform gravimetric sieve processing is as follows:
drying oven
12" diameter sieves of the size classes shown above
mechanical shaker
various size brushes
electronic balance
drying pans (stainless steel, 52.5 x 32.2 x 10.1 cm)
weighing pans

Specific processing steps are as follows:

- Prior to processing the sediment sample allow 48 hours of resting time undisturbed to allow for particles to settle.
- Carefully open the lid to the 5 gallon bucket and inspect the sample. If there is excess clear water within the bucket siphon this water out to within 5 cm of the gravel layer.
- Place samples into trays to be placed into the oven. Be sure the bucket is clean of all sediment.
- Bake each sample for 12-24 hours between 50-105 degrees centigrade. Allow the sample to cool.
- Place the sieves in order within the shaker. Run the mechanical shaker for five minutes.

- Remove each size sieve and examine the sample. As sieve sizes decrease, the likelihood of the sieves becoming clogged with sediment increases. Each sieve will need to be thoroughly cleaned with a brush.
- Weigh the samples from each sieve size class and record the data.

SAMPLE SIZE

The number of samples within each monitored riffle depends on the width of the riffle within the stream. The number of monitored riffles depends on the amount of labor available for acquiring and processing the sediment samples. During development of the budget for this work, we defined the relationship between labor and work accomplished to be 6 person days for every 9 samples taken. 36 person days would allow about 54 samples to be taken. Assuming 2 to 3 samples per site, this allows 18 to 27 sites to be assessed.
The sediment samples from the McNiel core sampler are consistent with every sample. The weight of the sample will change depending on the sediment type. The weight of each complete sample will weigh between 20-50 pounds.

QUALITY ASSURANCE

All samples will be collected and analyzed using the same methods outlined in TFW monitoring program (Schuett-Hames et al. 1988).

DATA ANALYSIS

During this baseline data collection effort little data analysis will be required beyond generating average percent fines at riffles and measures of variability among samples at those sites. If detailed information on the previous sediment sampling study by Boise Cascade can be found, comparisons of our results to those would help show how sediment composition has or has not changed over time. This information would help prioritize areas for habitat restoration projects as well as meet the goals and objectives of this study. Additional data analysis similar to that will be required once a repeat of this study is completed to further define the trend in spawning habitat quality.

Appendix G. Large Woody Debris Draft Study Plan

Title: **Teanaway Community Forest Baseline Monitoring – Large Woody Material**

INTRODUCTION

The Teanaway Community Forest (TCF) was acquired by the State of Washington in 2013. There is a lot of public and agency support, as demonstrated by the Teanaway Community Forest Advisory Committee, to manage these 50,241 acres for multiple uses and actively measure specific habitat metrics to insure that its management is successful and can be modified as necessary to reach the goals of the TCF. Large woody material (LWM) is one of those habitat metrics proposed for monitoring.

PROBLEM STATEMENT (reason for study)

Large woody material (LWM) is an important component of the riparian ecosystem. Due to logging and grazing practices, road and rail alignments near streams, and general development within the riparian zone, the amount of LWM in the Teanaway River has significantly reduced compared to pre-development of the Teanaway basin. The present state of LWM must be assessed so that it can be compared to future LWM assessments performed to measure success of habitat restoration projects that are focused on LWM placement and recruitment. LWM is viewed as one of the easier metrics to monitor to show measurable positive change in the TCF.

Increasing LWM has been identified as a specific goal for the TCF by the TCF Advisory Committee (AC), and a recovery objective in the Bull Trout Action Plan, Bull Trout Recovery Plan, and Steelhead Recovery Plan.

VITAL BACKGROUND ON RESTORATION OF AQUATIC HABITAT IN FORESTED ENVIRONMENTS

LWM provides nutrients to terrestrial and aquatic species, cover for fish to escape predators (Harmon et al. 1986), and infrastructure for riparian vegetation development (Fetherston et al. 1995). LWM aids in sediment storage and dissipates energy (Swanson et al. 1982 a,b) to reduce the magnitude of stream-scouring events. In forest ecosystem streams, LWM provides nutrients and habitat for many organisms (Triska et al. 1982). LWM can also promote groundwater storage by encouraging more frequent overland flow of water, resulting in moderated flood peaks and higher summertime base flows (reference?).

METHODS

STUDY GOALS AND OBJECTIVES

The overall goal of this LWM monitoring is to characterize the present status of LWM throughout the TCF. This information will be used to help prioritize stream restoration projects designed to increase gravel and wood retention and aid the design of those stream restoration projects. Data collected at reference sites will provide the information necessary to identify goals of LWM size and frequency throughout streams with high priority for restoration.

STUDY DESIGN

CONCEPTUAL MODEL LINKING GOALS WITH MONITORING APPROACH

The goals of characterizing the present status of LWM, prioritizing restoration projects, and aiding their design can all be met through the proposed monitoring approach. By monitoring LWM in streams we can document its present status. By comparing LWM quantity between potential treatment streams and reference streams, and comparing existing LWM metrics to established LWM measures of habitat quality, restoration projects can be prioritized. For reaches where LWM enhancement projects are planned, knowledge of LWD amounts in reference reaches can help guide realistic LWM targets.

SAMPLING UNITS

Sampling units that will be considered for study will be all the sub-basins of the Teanaway River that have some portion of their drainage within the TCF. Additional sampling units will be needed to characterize LWM in areas without human influence that may not be within the TCF. There are some streams, particularly in the upper reaches of the west and middle forks of the Teanaway that should have areas that can represent the presence of LWM before human development due to the lack of road infrastructure there. This will be determined through GIS analysis.

SITE SELECTION

Stream reaches where LWM assessments will be performed will be determined using the Preliminary Reach Form as described in the Stream Inventory Handbook of the United States Forest Service (USFS 2014). These reaches will be the potential sites where LWM will be assessed. These reaches will be divided into categories based on gradient and valley width to allow comparison of LWM in different types of streams.

EQUIPMENT REQUIRED

The following is a list of equipment needed to complete the LWM assessments and analysis. Starred items define those that are already available within the Habitat Program.
20 m or longer measuring tape (2)*
10 m diameter at breast height tape (2)*

SAMPLING STRATEGY

Reaches will be sampled at low flows to avoid unsafe and turbid water so that as much of the existing LWM in the stream can be observed as possible. Sampling will be completed in teams of two, one measurer and one recorder.

SAMPLE SIZE

The preferred sample size is the entire population of fish-bearing stream reaches within all the sub-basins of the Teanaway River that have some portion of their drainage within the TCF, as described above. A subsample of stream reaches may be selected if the preferred sample size is not feasible.

QUALITY ASSURANCE

Quality assurance is achieved via the procedures outlined in the Stream Inventory Handbook (USFS 2014) as it applies to Large Woody Debris data.

DATA ANALYSIS

EXPECTED RESULTS

UNCERTAINTY ANALYSIS

No specific uncertainty analysis is expected to occur.

RESOURCES REQUIRED

The resources required for this task need to be developed.

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Appendix H. List of all fish and wildlife species found during field studies for the Teanaway Community Forest. Species are listed by their common name and in alphabetical order within their taxon.

Amphibians

Cascade Frog
Columbia Spotted Frog
Pacific Treefrog
Western Toad

Reptiles

Common Garter Snake
Western Fence lizard

Mammals

Black Bear
Coyote
Douglas Squirrel
Cascade Golden-mantled Ground Squirrel
Elk
Mule Deer
Striped Skunk
Yellow Pine Chipmunk

Birds

American Dipper
American Kestrel
Barred Owl
Brown Creeper
Canada Goose
Chipping Sparrow
Common Merganser
Common Nighthawk
Common Raven
Cedar Waxwing
Dark-eyed Junco
Downy Woodpecker
Evening Grosbeak
Gray Jay
Great Horned Owl

Birds Cont.

Harlequin Duck
Hermit Thrush
Hooded Merganser
Long-eared Owl
Mallard
MacGillivray's' Warbler
Merlin
Nashville Warbler
Northern Flicker
Pacific Wren
Peregrine Falcon
Pileated Woodpecker
Pygmy Nuthatch
Red-breasted Nuthatch
Red-tailed Hawk
Ruffed Grouse
Say's Phoebe
Sooty Grouse
Spotted Sandpiper
Steller's Jay
Townsend's Solitaire
Turkey Vulture
Western Tanager
Western Screech-owl
White-headed wood pecker
Wild Turkey
Williamson's Sapsucker
Yellow-rumped Warbler
Yellow Warbler

Fish

Long nosed Dace
Steelhead
Torrent Sculpin