North Fork Nooksack
Wildcat Reach Phase 1 Restoration Project
Final Implementation Report
EPA/PSP Agreement No. 10EPA PSP414

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1
Abstract

The Nooksack Indian Tribe (NIT) constructed 33 log jams in the North Fork Nooksack Wildcat Reach, River Mile (RM), 53 - 55 during summer 2011. EPA/PSP funds were used to provide partial match for the project in addition to matching funds that were provided from Pacific Coast Salmon Recovery Funds. The majority of the project was funded by the Salmon Recovery Funding Board (SRFB). The log jams were designed to address factors most limiting Nooksack early Chinook and other salmonid populations in the reach and will ultimately lead to restored habitat conditions and habitat-forming processes in the project reach, with associated improvement in abundance and productivity of Nooksack early Chinook. These populations are essential for ESU delisting and recovery to sustainable harvest levels and is the highest natural resources priority for the Nooksack Tribe.

Introduction

The North Fork Nooksack River system supports eight salmonid species: chinook (both fall and spring populations), chum, coho, sockeye, and pink salmon, and steelhead, cutthroat, and bulltrout. The Nooksack stocks of chinook, steelhead, and bulltrout all comprise components of Evolutionary Significant Units (ESU) or Distinct Population Segments (DPS) listed as “Threatened” under the Endangered Species Act, and the Nooksack North Fork chinook stocks are considered essential to the recovery of the Puget Sound ESU (Puget Sound Technical Review Team 2002). The North Fork Nooksack provides extensive mainstem spawning and rearing habitat which includes significant length added from side channels and braids (Hyatt 2007).

Productivity and abundance of natural-origin North Fork/Middle Fork Nooksack early Chinook is critically low. Without the stock rebuilding program at Kendall Hatchery, the population would be at or near extinction. North Fork/Middle Fork Nooksack early Chinook comprise an independent population in the Puget Sound ESU, and its recovery is essential to recovery of the broader ESU. This population is a unique population in the ESU, as it is a spring Chinook population with early river entry timing and lengthy adult holding, and is a very early spawning population relative to most others (beginning in mid to late July). It also has a comparatively high component of stream type life history strategy (average 29% of natural origin fish outmigrated as yearlings) and is genetically more unique than many Puget Sound populations (WRIA 1 SRB 2005).

The WRIA I Salmonid Recovery Plan (WRIA I SRB 2005) prioritized geographic areas and limiting factors for early Chinook using the Ecosystem Diagnosis and Treatment Model (EDT) in combination with qualitative and quantitative analyses based on scientific literature and local knowledge of land use, watershed processes, and salmonid populations. The Lower North Fork (from South Fork to Glacier Creek) is along the highest priority geographic areas for restoration for the NF/MF Nooksack early Chinook. The Recovery Plan cites channel instability and resulting redd scour in the lower North Fork as the principal factor limiting early Chinook in the reach. Hyatt and Rabang (2003) found that redd failure rates in mainstems were nearly twice as high as in protected off-channel habitats, suggesting that restoration of stable side channels could substantially increase Chinook incubation and rearing survival.

Limiting habitat conditions, restoration strategies, and preliminary project concepts were presented in the Lower North Fork Nooksack Reach Assessment: Ecological Findings and Restoration Recommendations (Hyatt 2007). The report has documented the loss of channel islands in the North Fork which has led to a decrease in side channels and other floodplain habitats associated with these islands. There is a lack of large stable log jams in the North Fork due to historic riparian harvest and active wood removal from the channel coupled with higher flood intensities in the past two decades. Without mature riparian stands to
contribute new wood to the channel and lack of existing stable log jams, the process of channel island and floodplain creation has been disturbed (Montgomery and Abbe 2006). As a result there has been a shift from an island-braided channel pattern to a frequently shifting, and thereby less stable, braided pattern.

The Reach Assessment demonstrated a link between declining spring Chinook populations and the disappearance of high quality off-channel spawning and rearing habitat. Building engineered log jams are a recommendation from the report as a way to create and increase the longevity of channel islands and the side channels associated with them. Logjams take advantage of natural processes to encourage vegetation establishment and growth, resulting in protected side channel habitats where formerly there were only actively-shifting braids. The North Fork Nooksack Wildcat Reach (RM 53-55) was identified as a priority for habitat restoration in the Reach Assessment. The Wildcat Reach is identified #12 among the reaches analyzed in the lower 21 miles of the North Fork Nooksack (Figure 1).

![Map of the North Fork Nooksack River](Image)

Figure 1. The North Fork Nooksack River showing the 14 analysis reaches delineated by Hyatt (2007).

**Background**

**Project location**

The Wildcat Reach is 1.5 miles long, extending from the Mt. Baker Highway (SR 542) crossing Warnick Bridge at RM 54.8 to the confluence with McDonald Creek at RM 53.3 (Figure 2). The Canyon Creek alluvial fan confines most of the right bank side of the reach. However, the channel has carved into lower
portions of the fan leaving tall (~60 feet) unconsolidated bluffs along the right bank of the river. Channel migration into the high bluff has forced the relocation of the highway twice, and the Washington Department of Transportation (WDOT) have installed bank roughening structures at the toe of the slope to encourage sediment deposition. The left bank floodplain is owned by Whatcom Land Trust and the right bank is a mixture of small private landowners and Whatcom Land Trust as well.

Figure 2. The North Fork Nooksack Wildcat Project Reach.

Project Development

This project is the first of three phases to be constructed by the Nooksack Indian Tribe for the Wildcat Reach. As part of the development process (Table 1), the Wildcat Reach project design and feasibility analysis was completed prior to construction of Phase I under funding from FY 09 SRFB and also the Pacific Coastal Salmon Recovery Fund (PCSRF). The project design included conceptual design for the entire reach and final design for Phase I of the project reach (see 100% plans in Appendix). The North Fork Nooksack Wildcat Reach Feasibility Analysis (Maudlin 2011) reviewed historical and current habitat data in the 1.5-mile reach. Considerable differences were found between mainstem channel and secondary channel habitat diversity. Only one mainstem pool was located in the reach and 40 secondary pools. A limited supply of large wood pieces and natural, stable log jams were found in the reach (Lummi Natural Resources 2007, NNR 2010 data). In addition to low channel habitat diversity, the Feasibility Analysis found a considerable decrease in the area of forested islands in the reach through aerial photo records. Along with the change in forested islands through time in the Wildcat Project Reach, GeoEngineers (2011) also characterized the active channel changes in the Wildcat Reach. The active channel (wetted channel and gravel bars) in the Wildcat Reach has ranged between 330 and 630 feet in average width through the historic period, compared with the current width of 510 feet. The
historic ratio of main channel (excluding braids) to side channels of 0.97 is comparable to the range found among relatively undisturbed island-braid reaches throughout western Washington (GeoEngineers 2011; Beechie et al. 2006).

Current conditions in the Wildcat reach are characterized by loss of key habitat, reduced habitat diversity and increased channel instability associated with the rapid channel location changes, loss of mature floodplain vegetation and wood accumulations (Figure 3). Addressing the causal mechanisms for these limiting factors has led to identifying two main restoration goals:

1. Slow lateral migration to allow transient river bars to stabilize and immature floodplain vegetation to reach a size where it can produce functional wood to the channel; and
2. Increase stable spawning habitat in the reach, especially in side channel areas, by restoring low-flow connectivity of existing and encouraging formation of new perennial side channels. Both of these goals would result from restoring the forested island channel pattern in the reach.

Based on these restoration goals, specific project measurable objectives for the Wildcat Reach were developed and include:

1. Reduce the mean active channel width to the 1933-1986 mean (from 510 to 430 feet).
2. Increase the perennial side-channel (channel separated from the main channel by persistent woody vegetation) length to 30% of the main channel length, to reflect the mean of non-zero years (1955-1994).
3. Increase the forested island area to the recent historic mean 1955-1994 (from 0-17.5 acres) and increase the persistence to 50 years to allow for mature conifer stands.
4. Increase mainstem key habitat quantity (primary and backwater pools, complex edges and pool tail-outs) form 1 pool to pools (6 pools per mile based on the 2005 maximum value per mile dominated by complex woody cover.)
Additional benefits of the project are 80% survival of conifer seedlings in areas disturbed during construction and monitoring data collected to evaluate project effectiveness. Restoring side channel habitat will improve survival and productivity of chinook and other salmonids by providing stable spawning habitat; redd failure in side channels is significantly lower than in mainstem and braid habitats in the North Fork. Protecting and encouraging growth of forested channel islands will ultimately increase spawning to incubation success by restoring the island braided planform historically evident in the North Fork. Ultimately the forest islands will provide large wood in the channel after they have reached maturity.

**Methods**

**Construction**

Access to the Wildcat Phase 1 Project Area was accomplished by improving an existing road that is accessible from Hwy 542. The road accessed the right bank gravel bar just below the Warnick Bridge on Hwy 542 (Figure 4a). Structures 1-16 were all accessible from the gravel bar with minimal disturbance to existing vegetation. In order to reach structures 17-25 NNR installed a bridge across the North Fork of the Nooksack River at approximately RM 54.35 (Figure 4b, 4c). The bridge consisted of 2, 40-foot rail car bridges with attached 1’x 1’ footers. A 300 John Deere excavator was used to pick the bridges up and place them side-by-side on the right bank of the river. Multiple one-inch 8” x 20” steel plates were placed on top of the bridges to provide a safe and stable platform for vehicles to drive on. The excavator could then drive onto the first set of bridges and place the second set of 40-foot bridges on the left bank side of the river. The bridges were secured by cabling the rail cars together.
The majority of phase I structures were built during summer 2011 with additional structures built during summer 2012 concurrently with Wildcat Phase II construction. During both construction seasons, high flows at the beginning of the permitted fish window limited access across the river. This was more of an issue during 2012 when all construction was on the left bank of the river requiring a bridge crossing. There were five types of ELJ’s constructed for the Wildcat Phase 1 Restoration Project in summer 2011 (Table 1). Structure design for Type 1, 2, and 3a and 3b included six elements: (1) vertical logs or uprights placed in excavated hole; (2) V- shaped frame comprised of several layers of logs, most with rootwads and some placed perpendicular to flow; (3) placement of large ballast rocks over layer logs with cable to reduce buoyancy and increase stability (4) cabling of log frame to increase stability; (5) spaces filled with racking logs and slash; and (6) structures backfilled with alluvium.

Table 1. ELJ structure type, placement and intended function of structure type, and quantity constructed.

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Placement and Function</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELJ Type 1</td>
<td>Placed at the upstream ends of emerging forested islands to encourage low flow connectivity and protect maturing forest. Also, placed within active channel as individual installations to encourage side channel formation and reduce active channel un-vegetated width.</td>
<td>7</td>
</tr>
<tr>
<td>ELJ Type 2</td>
<td>Placed at the edge of floodplain forest to protect maturing vegetation and encourage flow into floodplain channels. Also, placed within active channel as individual installations to encourage side channel formation and reduce active channel un-vegetated width.</td>
<td>5</td>
</tr>
<tr>
<td>ELJ Type 3A</td>
<td>Placed along the edges of forest islands and floodplain to encourage sediment deposition and increase bank resistance.</td>
<td>9</td>
</tr>
<tr>
<td>ELJ Type 3B</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Enhancement</td>
<td>Placed at accumulations in side channel to enhance existing wood.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>
Type 1 structures were the largest structures designed for the project consisting of 11 uprights, six layers including 20 layer logs of various sizes, and 25 2-ton ballast rocks. Type 2 structures are medium-size structures with six uprights, seven layers including 17 layer logs, and 16 2-ton ballast rocks. Type 2 ELJ’s were constructed primarily at the edge of floodplain forest to protect maturing vegetation and encourage flow into floodplain channels. Two types of Type 3 ELJ’s were designed for this project, Type 3A and Type B, which were placed along the edges of forest islands and floodplain to encourage sediment deposition and increase bank resistance. The Type 3A structures consisted of five uprights, six layers with seven layer logs, nine 2-ton ballast rocks and are “v-shaped”. The Type 3B structures have four uprights, six layers with nine layer logs, 11 2-ton ballast rocks and are diamond-shape. Figures 5-8 display the “skeleton” and the finished product for each structure type built during the Wildcat Phase 1 project. Figure 9 shows ELJ 23 and 24 after construction. The fifth type of ELJ constructed in this project was enhancement of two existing log jams in the Wildcat side channel. This consisted of layering logs with rootwads on top of the existing jams perpendicular to flow. For full project plans see Appendix.
Figure 7. Type 3A Structure

Figure 8. Type 3B Structure

Figure 9. Enhancement ELJ’s in Wildcat Side Channel. ELJ 23 downstream end (left); ELJ 24 upstream end (right).
The project was constructed with two large excavators and one mini-excavator, in addition to a log loader to move logs to ELJ locations. The first step in the construction process was to identify the upright locations which were staked out in advance by the contracted engineer, Herrera Environmental Consultants. Once the upright locations were identified excavators could begin digging the 10-15’ deep hole where uprights could be placed. Uprights were installed one at a time and were held in place by the excavator bucket as a second excavator would backfill alluvium around the log until it could stand without assistance. Once the uprights were installed, construction of the log layering could begin, typically with one excavator/operator following the detailed Layering Plan for the specific structure type outlined in the 100% Design Plans (Appendix). The log layering consisted of rootwad and non-rootwad logs of various lengths placed. Figure 10 shows the construction of ELJ 3A-1 on the left bank. Figure 11 shows technicians prepping the wire cable, then securing it by hand and finally tightening the junction with assistance from the excavator. Multiple segments of cable could be prepped ahead of time which increased the efficiency of construction.

Figure 10. Construction photos from ELJ 3A-1.
Revegetation

We salvaged approximately 70% of the conifers on site prior to disturbance using the mini excavator and the larger John Deere 200 excavator. An off channel nursery was created in a cool area with shallow stream flow to stage the plants until planting in October. The conifers ranged from one to three feet in height. All cottonwood and willow stakes were also salvaged from on-site. They were staged with the conifers in the protected area. During replanting we amended the conifer planting holes with top soil.
Monitoring
Preconstruction and post construction monitoring was conducted under different funding from PCSRF and will be reported on with a final effectiveness and implementation report to be submitted in the future.

Results
All structures withstood a harsh winter (2012/2012) with high precipitation and river flows. Immediately after finishing construction on the left bank, there was a high flow event of 3,000 cubic feet per second (cfs) on 9/27/2011 that can be seen in Figure 13. A comparable flow of 3,500 cfs, during the spring occurred on 6/18/12 (Figure 13). Approximately, 50% of the plantings survived year 1 and we replanted failed locations in December 2012. Project effectiveness is currently being monitored under a different funding source.

Figure 12. From top left to bottom right: conifer salvage pre-construction; willow and cottonwood stake salvaging and storage pre-construction; planting ELJ cluster 3 post construction; conifer plantings immediately after construction (10/6/2011).

Figure 13. From left to right: looking towards top of side channel from HWY 542 on 9/27/11, flow 3000 cfs; looking down the top of the side channel on 6/18/12, flow 3,500 cfs. Red arrow points to ELJ 20 in each photo.
Discussion

The completed project enhanced a perennial side channel that provides conditions suitable for spawning habitat for spring Chinook. The log structures also provided protection for vegetated islands developing in the reach. The design and construction took into account the need for the structures to withstand 100 year flood events while maintaining their integrity over time. The structures are designed to be stable, self-sustaining, and consistent with habitat forming processes. They will provide immediate habitat benefits such as cover from the complexity of the logs and provide long term benefits over time. As the vegetation develops on top and around the large structures it will provide the stability missing from the natural log jams in North Fork system. Including subsequent phases of construction at the Wildcat Reach, there will be properly functioning habitat-forming processes restored on 4.1 miles of the North Fork Nooksack River. Riparian conditions (density, species composition, and age structure) will be equivalent to or better than pre-project conditions. Implementing the first phase of three phases was an important effort at the Wildcat Reach Project because valuable construction lessons were learned and the constructability of the design was tested. For example all five structure types were new designs that the restoration project managers, engineers, construction operators and technicians learned valuable on the ground building techniques from during construction. This was valuable during this past summer during construction of Phase II. It improved construction efficiency which is critical during shorter work windows and also decreased the cost of the structures.

The removal of large trees from the watershed and especially along the banks has produced a need to accelerate instream wood placement. Currently, engineered log jam projects are one of the most effective tools to regain habitat lost in the Nooksack River. The Nooksack Tribe along with the other stakeholders in the Water Resource Inventory Area 1(WRIA1) are using the Wildcat project and other log jam projects as one tool for habitat restoration. The Wildcat project is phase I of a larger project designed to: 1) increase the low-flow connectivity and habitat diversity of the Wildcat Side Channel and other floodplain channels; and 2) to increase channel stability and protect and encourage growth of maturing forested islands in the main channel. Protecting and encouraging growth of forested channel islands will ultimately increase spawning to incubation success by restoring the island braided planform historically evident in the North Fork Nooksack River.
Table 2. Project timeline. Note includes additional work in the reach conducted with different funding.

<table>
<thead>
<tr>
<th>Task</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<th>2013</th>
<th>2014</th>
<th>Beyond</th>
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<td>Jan</td>
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<td>Feasibility study</td>
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<td>Acquire necessary materials</td>
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<td>Replant disturbed areas</td>
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<td>Project Monitoring</td>
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Legend:
- SRFB FY09; PCSR
- EPA/PSP FY10; SRFB FY10
- PCSR; SRFB FY10;SRFB FY11;SRFB FY12;EPA/PSP FY11; WA DOE NEP
References


Nooksack Natural Resources. 2010. North Fork Nooksack River Large Woody Debris Mapping. Unpublished data. Nooksack Indian Tribe, Natural Resources Department, Deming, WA.


Appendix

- Wildcat Phase I 100% Design Plans