Restoring Channel Anabranching and Floodplain Connectivity Downstream of Dams: Example Assessment of the Tieton River in Yakima County

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Introduction

Aquatic and riparian habitat within the Lower Tieton River in Yakima County, Washington have been severely impacted by the Tieton Dam, built in 1925, which has altered the flow, sediment and wood regime of the Tieton River. One of the most significant impacts has been disconnection of the river's mainstem channel from secondary channels and the floodplain. Simplification of the river, flow confinement to the mainstem channel, bed armoring and the artificial "flip-flop" flow regime have created conditions that have nearly eliminated steelhead spawning and rearing habitat from portions of the river once rich in this habitat. In addition to the dam, the river has been impacted by historic clearing of riparian forests and construction of State Route (SR) 12, confining major segments of the river. **As a result of these flow regime and landscape changes, most of the river within the project reach has become simplified, incised, and disconnected from adjacent off-channel and floodplain areas.**

Based on the critical status of steelhead, WDFW and Yakama/Klickitat Fisheries Project (YKFP) wanted to improve both juvenile rearing and adult spawning habitat. Natural Systems Design (NSD) was contracted by YKFP to assess in-stream habitat and present possible restoration actions. A preliminary geomorphic and hydraulic assessment was completed in 2016 that substantiated concerns regarding the severe degradation of in-stream habitat. **While the assessment found there was clearly a need to improve mainstem in-stream habitat, the most dramatic revelation was the large quantity of floodplain restoration opportunities that met desired project goals and objectives, as well as basin-wide habitat recovery goals.**

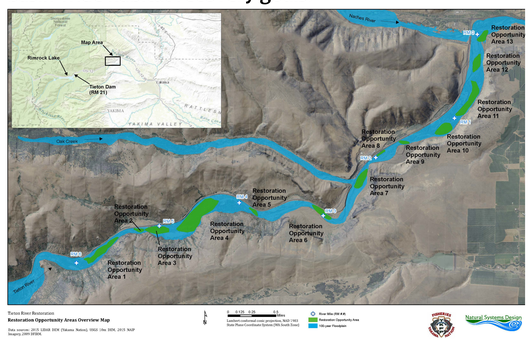

Figure 1: Tieton River, Washington (NSD 2015)

Species of concern

Tieton River steelhead (*Oncorhynchus mykiss*) are listed as threatened under the Endangered Species Act. It has been widely assumed that the changes listed above severely limited the use of the lower Tieton River for spawning and rearing. Recent studies conducted by Yakama Nation Fisheries beginning in 2012 indicate that, despite simplification, confinement and other landscape changes, steelhead are using the lower Tieton River for spawning and rearing.

Figure 2: Reservoir operations and channel degradation are two factors that limit steelhead *Oncorhynchus mykiss*, populations on the Tieton River (photo credit: Aquarium of the Pacific).

Restoration goals and objectives

Restore spawning and rearing habitat for ESA listed steelhead in the lower 6 miles of the Tieton River by:

1. Increase overall **channel length accessible to steelhead** by reconnecting side channels and floodplain areas.
2. Increase/retain **spawning sized gravels** in the mainstem and off-channel areas.
3. Increase/retain the supply of function **large wood** in the mainstem and off-channel areas.
4. Accommodate/reduce risk to **recreational users** within the project reach and create recreational boating features where practical and feasible.
5. Incorporate **rock** features where appropriate to fit in with existing landscape features.
6. Restore/enhance **riparian and floodplain vegetation**.

Flow regimes

Gage Discharge (cfs)	Flow Significance for Steelhead
200	Average year - Median flow for spawning (mid-March to mid-May)
500	Wet year - 75th percentile exceedance flow for spawning (mid-March to mid-May)
1500	Approximate 1.01-year peak discharge and median September flow encountered by rearing steelhead

Table 1. Modeled flows of significance for steelhead spawning and rearing in the lower Tieton River.

Hydraulic Modeling and HSI Analysis Results

Two-dimensional hydraulic modeling and Habitat Suitability Index (HSI) analysis and were conducted for seven project opportunity areas to evaluate habitat restoration potential in the lower Tieton River. The results show that restoration efforts could reconnect over 2.5 miles of perennial side channel habitat, which would significantly increase spawning and rearing habitat– **essentially creating a new, more complex river beside the existing mainstem channel**. Compared with existing conditions, the inundated area would increase by 27% to 44% depending on flow and the total wetted perimeter of the inundation would be about double for all flows (Table 2). Restoration actions would also improve conditions in the existing mainstem channel by reducing flows and allowing finer sediments to accumulate and more diverse habitat to form. Gravels sequestered in the floodplain will become available again for spawning in the lower Tieton River where spawning sized gravels are limited due to dam operations (Figure 5). Large wood or rock structures in the mainstem would locally increase water elevations and deflect flow into the side channels where the flows would capture and sort existing alluvium stored in the floodplain. **Restored fluvial processes would create new spawning areas, scour pools, recruit wood from existing riparian vegetation, raise the water table, and accelerate recovery of mature riparian forests. Restoration of riparian and floodplain vegetation will provide shade, wood recruitment, and restoration of natural geomorphic function of the lower river.**

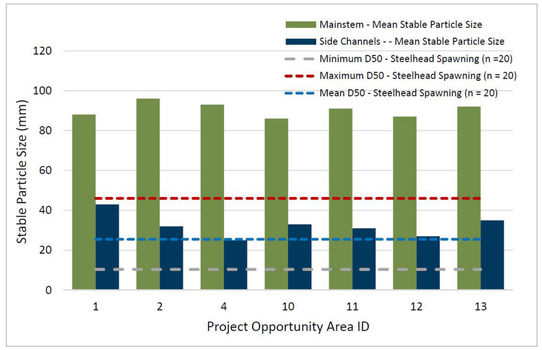

Figure 4: Comparison of mean stable particle size for mainstem and side channel areas. Median or D50 values for steelhead spawning are derived from Kondolf and Wolman (1993, n=20).

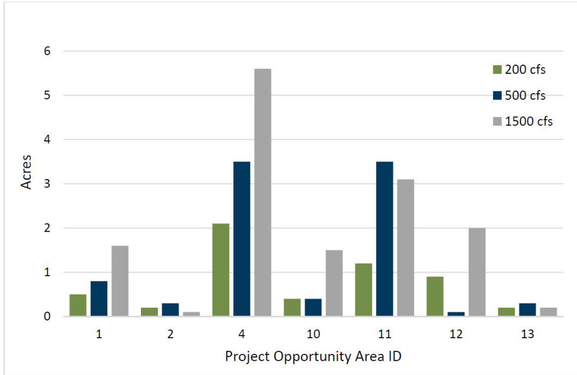

Figure 5: Net change in inundated acreage for Restoration Project Opportunity Areas under various modeled flows.

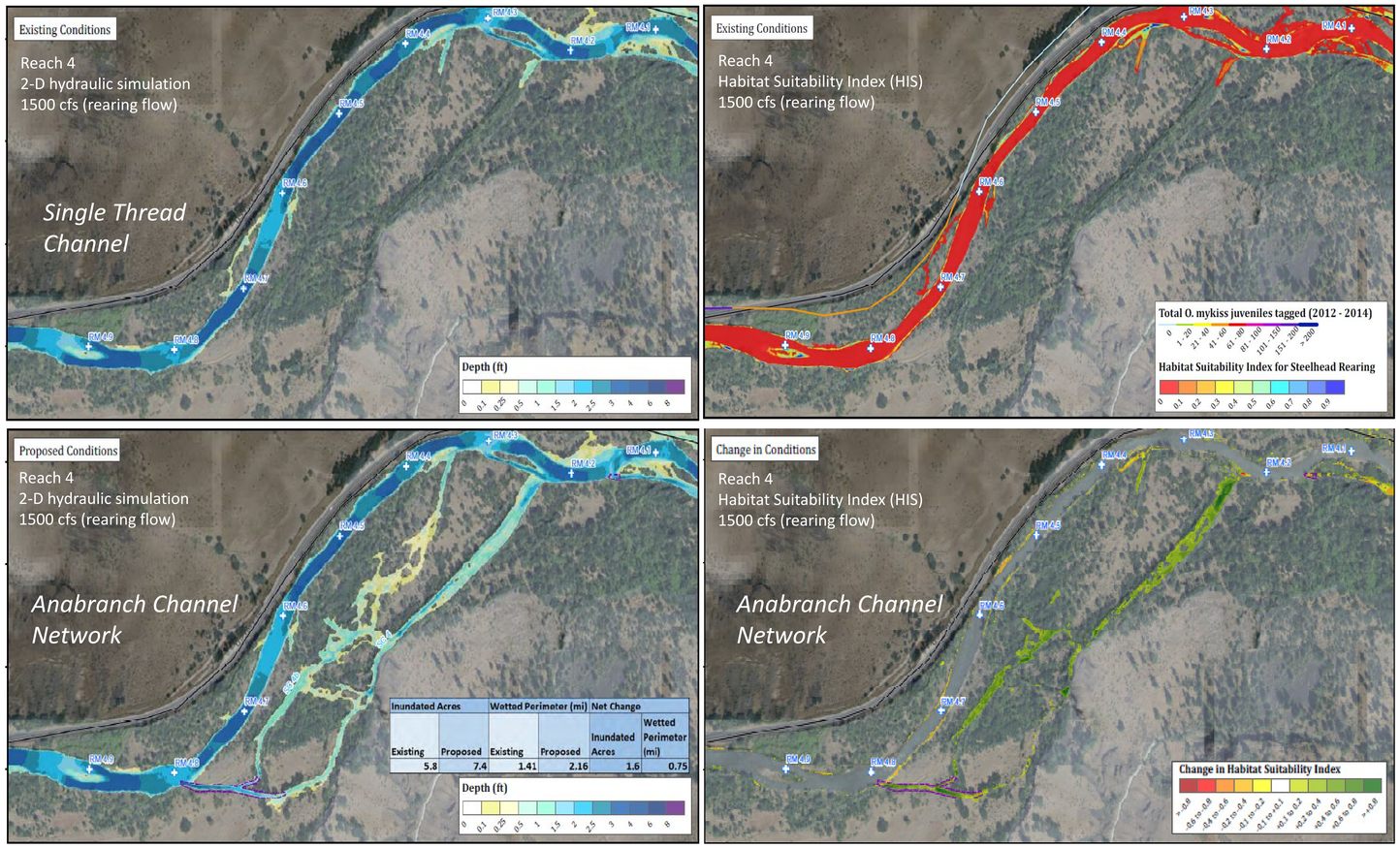

Figure 3 Restoration Project Opportunity Area 4 two-dimensional hydraulic modeling results at the steelhead rearing flow rate (1500 cfs) for depth (2 left panels) and Habitat Suitability Index analysis (2 right panels) for existing, and proposed (or changed) conditions. Results indicate that side channel reconnection will increase perennial channel length about 3-fold, increasing suitable rearing habitat from nearly zero (no suitable rearing habitat) to 1.6 acres. Restoration will not only create a new channel network within finer floodplain alluvium, but will also reduce bed scour within in mainstem during peak flows, thus improving mainstem conditions. Modeling demonstrates that perennial side channels are sustained over the full range of flows.

Restoration in the Lower Tieton

The site assessment identified 13 potential restoration project opportunity areas that include a combination of the following restoration actions: (1) reconnecting side channels and floodplain areas; (2) increasing functional large wood in the mainstem and off-channel areas; and (3) restoration and enhancement of riparian and floodplain vegetation. Conceptual designs were developed for each of these opportunity areas. New LiDAR flown in October 2016, suggested that 7 of the 13 opportunity areas are priority candidates for off-channel reconnection and steelhead habitat uplift.

Flow	Total Inundation Area for 7 Priority Restoration Sites (acres)		Total Wetted Perimeter for 7 Priority Restoration Sites (mi)		Total New Area Created (acres)	Total New Wetted Perimeter Created (mi)
	Existing Conditions	Proposed Conditions	Existing Conditions	Proposed Conditions		
200	20.2	25.7	5.9	11.7	**5.5**	**5.8**
500	23.1	32.0	6.0	12.1	**8.9**	**6.1**
1500	32.1	46.2	7.8	15.0	**14.1**	**7.1**

Table 2. Summary of total potential new inundation area and wetted perimeter for the 7 priority restoration opportunity areas in the lower Tieton River.

Selected References

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Natural Systems Design

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