Lower Columbia IMW Treatment Plan Update

Lower Columbia Fish Recovery Board
Longview, Washington
September 2016 Supplement

Preface

This document is structured as a supplement to the Abernathy and Germany Creeks Intensively Monitored Treatment Plan (HDR Inc. and Cramer Fish Sciences, 2009). This supplement was funded in order to incorporate new fish and habitat knowledge in the Lower Columbia IMW and project prioritization considerations following initial project implementation. Therefore, this document does not replace or supplant the original data analysis, reach descriptions, or project list (HDR Inc. and Cramer Fish Sciences, 2009), the Columbia IMW study plans (Ehinger et al. 2007; Zimmerman et al. 2012; Zimmerman et al. 2015), or the Lower Columbia Recovery Plan (LCFRB 2010). Instead, the supplement can be used by management and research agencies to prioritize future treatment implementation within the IMW complex, and measure progress since IMW monitoring and treatment implementation began.

Acknowledgements

This update would not have been possible without the hard work of project sponsors and partners. Many sponsors have successfully implemented treatment projects in the Lower Columbia IMW subbasins, an essential component of this study: Cowlitz County, Columbia Land Trust, Cowlitz Conservation District, the Lower Columbia Fish Enhancement Group, the Washington Department of Fish and Wildlife, and the Cowlitz Indian Tribe. These sponsors worked hand-in-hand with landowners as well, and projects would not have been possible without these partnerships. Multiple organizations funded these design and treatment projects, including Bonneville Power Administration, the Washington State Salmon Recovery Funding Board, and the Pacific States Marine Fisheries Commission. The Lower Columbia IMW Technical Oversight Group has also provided important resources and discussion throughout the IMW process, including valuable feedback on this treatment update.

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Introduction

Salmonid abundance and range have declined throughout the Pacific Northwest, resulting in U.S. Endangered Species Act (ESA) listings of many populations as well as the subsequent expenditure of millions of dollars on habitat rehabilitation (NRC 1996). However, rehabilitation often occurs at the project site-scale with no to short-term monitoring of fish populations and habitat (Roni et al. 2002, Katz et al. 2007). This limited spatial and temporal scope can make it difficult to evaluate the effectiveness of projects and management actions on restoring or enhancing fish populations and watershed processes, as well as discern project impacts from inter-annual variability. As recovery work continues with the goal of addressing ESA-listed salmon and steelhead populations, it is important to consider large spatial and temporal scale patterns through monitoring (Fausch et al. 2002). Monitoring goals should be to determine the effectiveness of treatment project implementation and management decisions on watershed conditions and fish responses (Bilby et al. 2004). This adaptive management framework will inform future project prioritization and monitoring methodologies, an essential strategy in this relatively new, and experimental, approach to salmon recovery (Bennett et al. 2016).

Washington State established four intensively monitored watersheds (IMWs) in 2004 to address limited long-term and watershed-scale understanding of habitat treatment on fish populations, including the Strait of Juan de Fuca Complex, Hood Canal Complex, Skagit River Estuary Complex, and the Lower Columbia Complex, with many additional complexes developed around the Pacific Northwest since then (Bennet et al. 2016). These watershed complexes were selected because of their small size and representative conditions, which meant that fish could complete their full life cycle within each study stream, results could be applied across the state of Washington, and that less treatment work may be required to detect fish population and watershed process responses (Bilby et al. 2004). Prior to any treatment project implementation, baseline population and habitat data were collected by the Washington Department of Fish and Wildlife (WDFW), Weyerhaeuser Company, and Washington Department of Ecology (ECY) to determine the degree of correlation among the IMW study streams, a statistical assumption for before-after/control-impact (BACI) experimental designs (Bilby et al. 2004). Because of this watershed-scale and BACI design methodology, IMW projects are considered the most efficient approach for measuring population-level responses to treatment action (Bennett et al. 2016).

The Lower Columbia IMW includes three stream basins of similar size and habitat conditions: Mill Creek, Abernathy Creek, and Germany Creek. Mill Creek was designated as the control stream, with no proposed habitat treatment. Abernathy and Germany Creek were designated as treatment streams, where treatment and fish responses would be assessed. Following baseline data collection and experimental design development, treatment projects were selected for funding and implementation based on a treatment plan (HDR Inc. and Cramer Fish Sciences, 2009). Projects were identified and prioritized based on how well they addressed ESA recovery plan goals, benefits to fish, cost benefits, and constraints and opportunities (HDR Inc. and Cramer Fish Sciences, 2009). A total of sixty projects were identified and ranked based on these prioritization methods in the IMW, divided into three phases of twenty projects each. Of these projects, thirty were proposed for each treatment stream. Main habitat limitations identified in the two treatment streams were channel stability, habitat diversity, key habitat quality, sediment load, water temperature, and flow regimes (HDR Inc. and Cramer Fish Sciences, 2009).

Treatment Plan update objectives

Since the treatment plan was completed in 2009, practitioners have completed a number of the proposed treatment projects within the IMW, and research agencies have conducted and published biological monitoring, habitat assessment, and nutrient treatment study results. To address these new results and compiled recovery goals, the Lower Columbia Fish Recovery Board (LCFRB) applied for and received Pacific States Marine Fisheries Commission (PSMFC) funding in 2015 for a Lower Columbia IMW treatment plan update (project grant 15-1444). Under this grant, the LCFRB worked with the IMW Technical Oversight Group (TOG) to review current accomplishments and recommend future work (PSMFC project grant 15-1444) during the summer of 2016. The TOG included monitoring and restoration representatives from the Cowlitz Indian Tribe, U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Natural Resources, who all provided valuable expertise and feedback regarding fish, habitat, and treatment considerations. Additionally, staff from Inter-Fluve and Environmental Science Associates attended meetings and provided feedback on specific projects, as consultants to the Cowlitz Indian Tribe.

Based on these meetings and discussion, treatment update components are synthesized in the 2016 treatment plan update (treatment plan update). This update addresses the following six tasks:

1. Compare 2009 IMW treatment plan (treatment plan) proposals to completed, in-progress, and proposed projects;
2. Summarize nutrient treatment and results in the two treatment streams;
3. Summarize habitat assessments and biological monitoring results;
4. Compile recommendations for future monitoring and treatment prioritization within IMW;
5. Revise reach descriptions to reflect recent projects or new knowledge on habitat or fish populations; and,
6. Review the literature cited section of the IMW treatment plan and incorporate more recent reports and scientific literature related to experimental design and treatment results.

The treatment plan update is structured to function as a supplement to the 2009 treatment plan rather than a standalone document. The six update components reference the treatment plan and other publications, but do not replace or supplant the original data analysis, reach descriptions, project list (HDR Inc. and Cramer Fish Sciences, 2009), the Columbia IMW study plans (Ehinger et al. 2007; Zimmerman et al. 2012; Zimmerman et al. 2015), or the Lower Columbia Recovery Plan (LCFRB 2010). Instead, the update can be used by management and research agencies to prioritize future treatment implementation within the IMW complex, and measure progress since IMW monitoring and treatment implementation began. The following summarizes each of the update components.

Update 1: Compare treatment plan proposals to completed, in-progress, and proposed projects.

The LCFRB and TOG compared the original sixty proposed projects to the completed, in-progress, and proposed treatment projects (actual projects). Original project descriptions from the 2009 treatment plan were matched to project proposals, designs, metrics, and reports in the LCFRB Six-Year Habitat Work Schedule (SalmonPORT database), the Washington State Recreation and Conservation Office (RCO) Project Information System (PRISM), and the Pacific Coastal Salmon Recovery Fund (PCSRF) Project and Performance Metrics Database. When a project was funded separately for design and implementation, only the implementation project portion was considered.

The LCFRB made project comparisons spatially and based on treatment actions (Figure 1). Proposed project stream lengths were estimated based on descriptions and delivered GIS layers and maps in the 2009 treatment plan (HDR Inc. and Cramer Fish Sciences, 2009). When a specific location was not identified for a project (i.e. riparian habitat should be enhanced throughout a stream reach, but treatment location depends on landowner outreach results), the project length was designated as the full EDT stream reach. Projects that occurred on a small spatial-scales were designated as points instead of lines. These included bank stabilization, fish passage barriers, and side-channel reconnection projects. Projects with unknown lengths were also depicted as points because of limited data. Projects funded prior to the 2009 treatment plan are displayed visually on watershed maps because they can still impact fish and habitat responses, although they are not compared to the proposed project list. Following data collection and preliminary results, the LCFRB reviewed and finalized project comparisons with the TOG. One actual project occasionally matched multiple proposed projects, but project completed numbers are based on the number of addressed proposed projects. This is because the study plan statistical analyses of detectable change (the power to detect increased fish production responses at the watershed-scale from habitat treatment) are based on completing the proposed projects (Zimmerman et al. 2012 and Zimmerman et al. 2015).

The IMW experimental approach is designed to measure fish and habitat responses to specific treatments from the watershed to project site-scale (Bilby et al. 2004). The Lower Columbia IMW Study Plans include hypothesized fish (abundance, distribution, life history strategy) and habitat (stream velocity, sediment transport, habitat quality and quantity) responses to specific treatment types (full descriptions in Zimmerman et al. 2012, summarized in Zimmerman et al. 2015). Treatment types from the study plans are summarized in this update for project comparison purposes, although they are categorized by their predicted functional habitat response to a specific treatment tool[1] (Table 1). Many projects utilized multiple treatment types to address limiting conditions (i.e. riparian planting and instream complexity to increase habitat quantity and diversity in the short and long-term). These treatment complexities are considered in the reach descriptions.

[1] A nutrient enhancement treatment project was also implemented in Germany and Abernathy Creek, but this project is considered separately in Update 2.

Table 1. Treatment types in the Lower Columbia IMW complex. Treatment types categorized by the treatment tools and functional habitat responses expected as a result of implementation. The spatial scale of expected responses are also included: project and watershed.

Treatment Type	Treatment Tool	Functional Response	Project -Scale	Watershed -Scale
Instream Habitat Complexity	Large wood material placement/ Engineered log jams	Increased complexity of main channel habitat through pool and shelter formation, and increased diversity in substrate and stream velocities.	X	X
Off-Channel/Side-Channel Reconnection	Channel aggradation/ excavation	Increased connectivity and fish access between side-channel/off-channel and main channel habitat.	X	
	Engineered log jams	Increased connectivity and fish access between side-channel/off-channel and main channel habitat.	X	
Floodplain Reconnection	Channel aggradation/ excavation	Increased connectivity and fish access between side-channel/off-channel and main channel habitat; increased diversity and complexity of habitat; improved sediment transport and stream flow processes.	X	X
	Engineered log jams			
Fish Passage	barrier removal/reduction	Increased fish access past full or partial barriers.	X	X
Riparian Planting/ Management	Riparian thinning	Increased recruitment of large-wood to stream habitat; improved sediment transport processes; increased nutrient inputs; improved flow and thermal regimes.	X	X
	Riparian planting			
	Invasive species removal			
Bank Stabilization	Large wood material placement	Decreased erosion of stream bank.	X	X
	Riparian planting			

The LCFRB calculated the number of completed projects per phase, although projects still in the proposal phase (projects initially proposed in 2016) and those funded prior to the 2009 treatment plan were excluded (Table 2). Total area of instream, off-channel, and riparian habitat treated was also calculated by summing reported metric values (Table 3).

Table 2. Summary of proposed projects completed per project phase and treatment stream, as of summer 2016. Projects are divided by the three treatment plan phases. One actual project occasionally matched multiple proposed projects. Projects proposed in 2016 are excluded. Full project data in Table 5 – Table 7.

	Number of proposed projects completed - funded		Phase Completion (%)		
Project Phase	**Abernathy**	**Germany**	**Abernathy**	**Germany**	**Total**
Phase 1	8 of 11	4 of 9	73%	44%	60%
Phase 2	2 of 9	0 of 11	22%	0%	10%
Phase 3	7 of 10	1 of 9	70%	10%	40%

Table 3. Total linear stream lengths and riparian areas treated once all projects currently in-progress (summer 2016) are completed. Phase 1 Germany Creek riparian area treated includes treated habitat beyond the initial proposed spatial project scope: Germany 2-C had a 5 acre riparian area treatment proposal (HDR Inc. and Cramer Fish Sciences, 2009), but the project that met these riparian treatment metrics occurred on a much larger spatial scale (Germany Creek Conservation and Restoration Phase 2, Project ID 09-1378). In-progress project metrics may change.

	Instream length treated (ft)		Off-Channel/Side-Channel length treated (ft)		Riparian area treated (acres)	
Project Phase	**Abernathy**	**Germany**	**Abernathy**	**Germany**	**Abernathy**	**Germany**
Phase 1	11,179	7,615	2,834	775	8.6	33.7
Phase 2	3,705	--	0	--	0.1	--
Phase 3	8,400	0	686	0	2.7	2.5

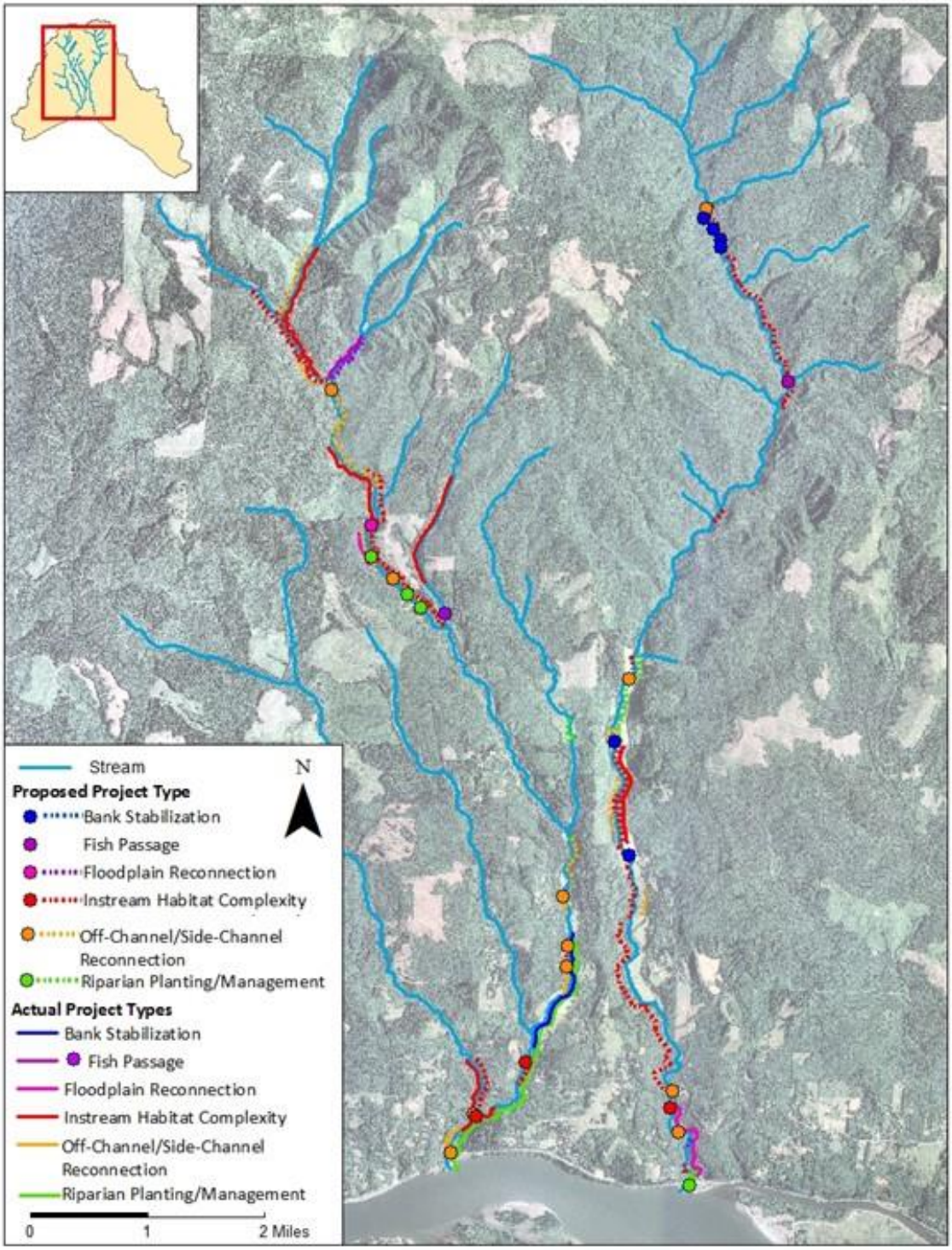

Figure 1. Proposed and actual project types in Abernathy and Germany Creeks (60 proposed sites and 22 funded and proposed actual projects). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management. Project locations are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary.

Since 2009, the majority of treatment projects have been implemented in Abernathy Creek (11 of 13 funded projects, matching 17 proposed projects). Five projects are completed or in-progress in the lower portions of the Abernathy Creek basin, matching eight of the twelve proposed projects (through Abernathy Reach 4 and Cameron Creek, Figure 2), no projects are funded of the three proposed projects in the middle portions (Abernathy Reach 5 – 8, Weist Creek, Figure 3), and six are implemented, one is proposed for implementation, and one is in the design stage in the headwater portion of the watershed, matching nine of the fifteen proposed projects (Abernathy Reach 9 – 11, Sarah Creek, Ordway Creek, Figure 4). Geographic distribution of projects has resulted in contiguous treatment that extends from Abernathy Reach 1 through Reach 3, as well as through Cameron Creek Reach 1 (Abernathy Creek Tidal Restoration and Abernathy Creek Cameron Site projects, Figure 2), and almost contiguous treatment from lower Abernathy Reach 11 and Ordway Creek Reach 1 through the mid-section of Abernathy Reach 9 (Figure 4).

These contiguous treatment reaches account for large proportions of main channel habitat, potentially increasing the ability to detect fish and habitat responses. Projects in lower Abernathy cover an estimated stream length of 11,775 linear feet, which encompasses about 34% of the total reach length where projects occurred. Projects in upper Abernathy cover an estimated 12,109 linear feet of habitat, which encompasses about 40% of the total reach length where projects occurred. If the proposed Sarah Creek project is funded for implementation, this contiguous treated length could increase to 14,694 linear feet, or 49% of the total upper watershed stream habitat. Primary treatment types implemented in the Abernathy basin address Instream Habitat Complexity (eleven implemented) and Off-Channel/Side-Channel Reconnection needs (five implemented) (Appendix A).

Only three projects have been implemented in Germany Creek since 2009, matching five proposed projects. These include one in lower Germany, matching three of the thirteen proposed projects (Figure 5), two in the middle portion of Germany matching two of the ten proposed projects (Figure 6), and no projects are funded of the seven proposed projects in the headwater portions of Germany Creek (Figure 7). Three implemented projects primarily treat Riparian Planting/Management needs (Germany Creek Conservation & Restoration Phase II) and two primary treat Instream Habitat Complexity needs (Germany Creek Andrews Site and Germany Creek Restoration Smith Site), covering a total of 7,615 linear stream length feet, or about 26%, of main channel habitat through lower and middle Germany Creek.

IMW funding for project implementation has been limited in the Lower Columbia IMW complex. In light of this, and to maximize measureable results, the majority of projects were completed in Abernathy Creek (Table 2). The LCFRB and the TOG support continuing this strategy in the short-term to maximize the potential to produce measurable fish and habitat responses. However, they also support considering Germany Creek for treatment actions in the long-term because of the potential to answer different treatment questions than in Abernathy Creek. For example, Germany Creek may require different treatment approaches than Abernathy Creek because of its higher stream gradient and confined channel (Zimmerman et al. 2016). The ability to detect steelhead smolt production responses is also lower in Germany Creek than Abernathy Creek (Zimmerman et al. 2015). Although work is currently limited, Germany Creek treatment implementation could increase the potential for lessons learned from the Lower Columbia IMW.

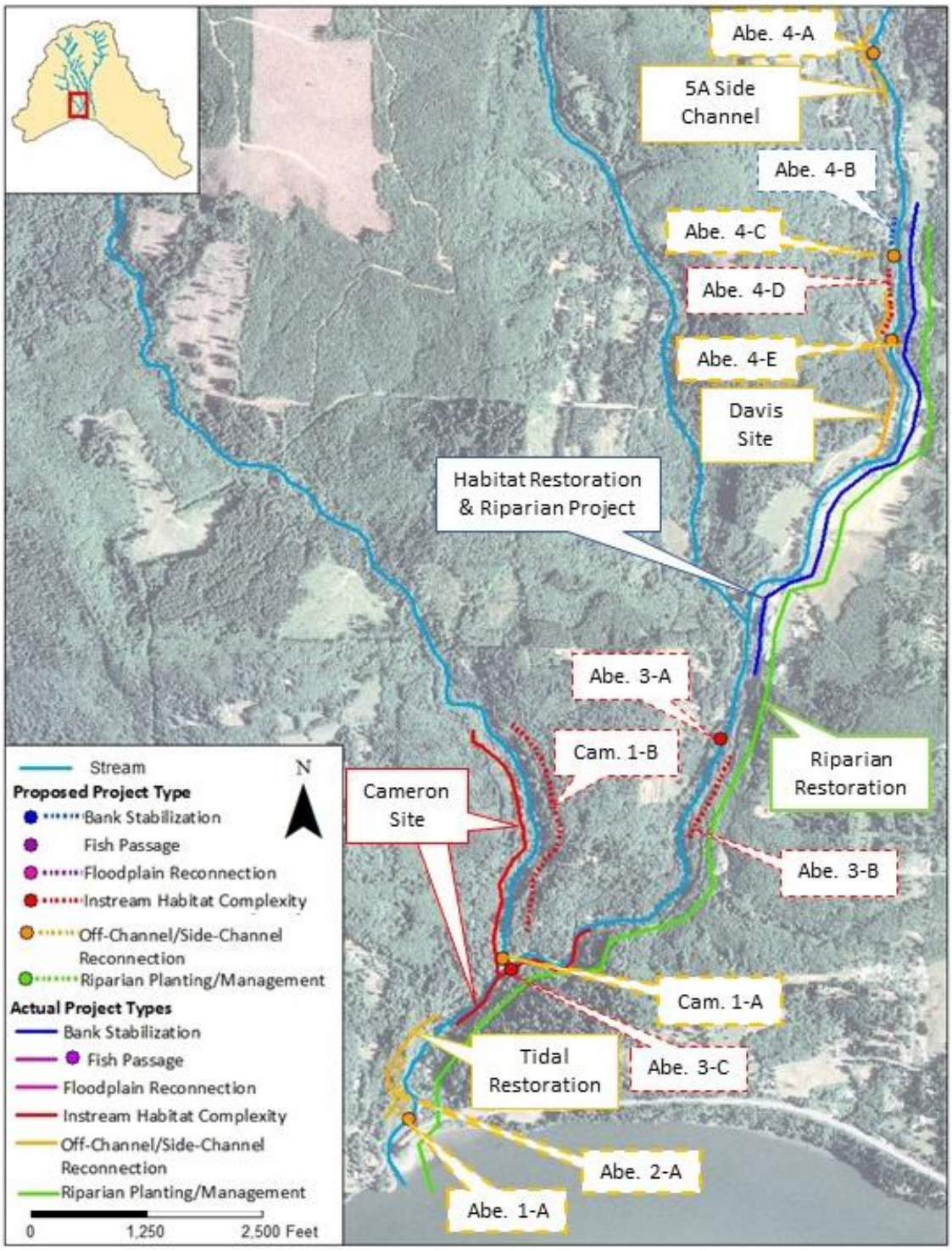

Figure 2. Proposed and actual project types in lower Abernathy Creek (EDT reach 1 through 4). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary. Riparian Restoration occurred prior to 2009 (funded in 2007).

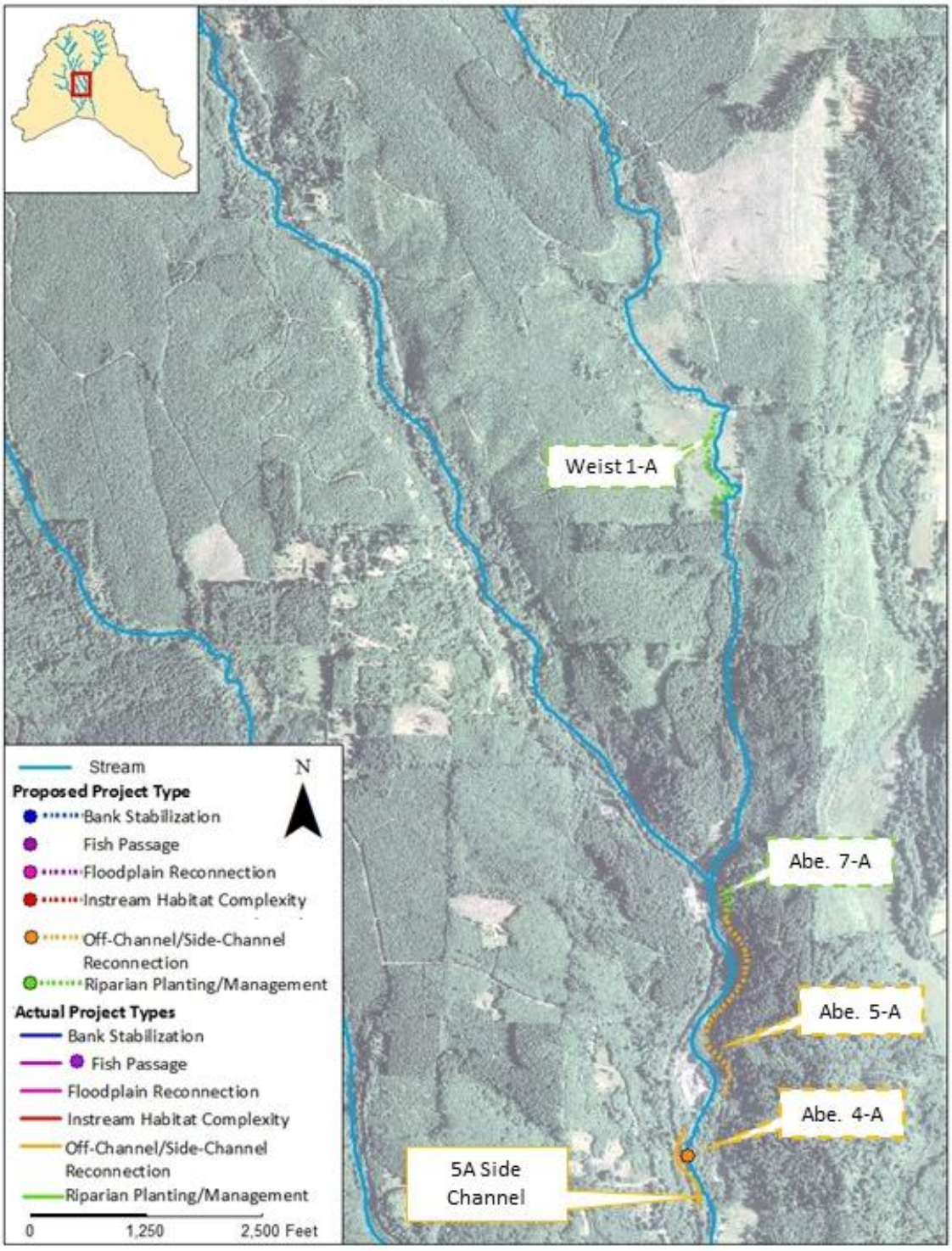

Figure 3. Proposed and actual project types in mid Abernathy Creek (EDT reach 4 through 8) and Weist Creek (EDT reach 1 -2). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary.

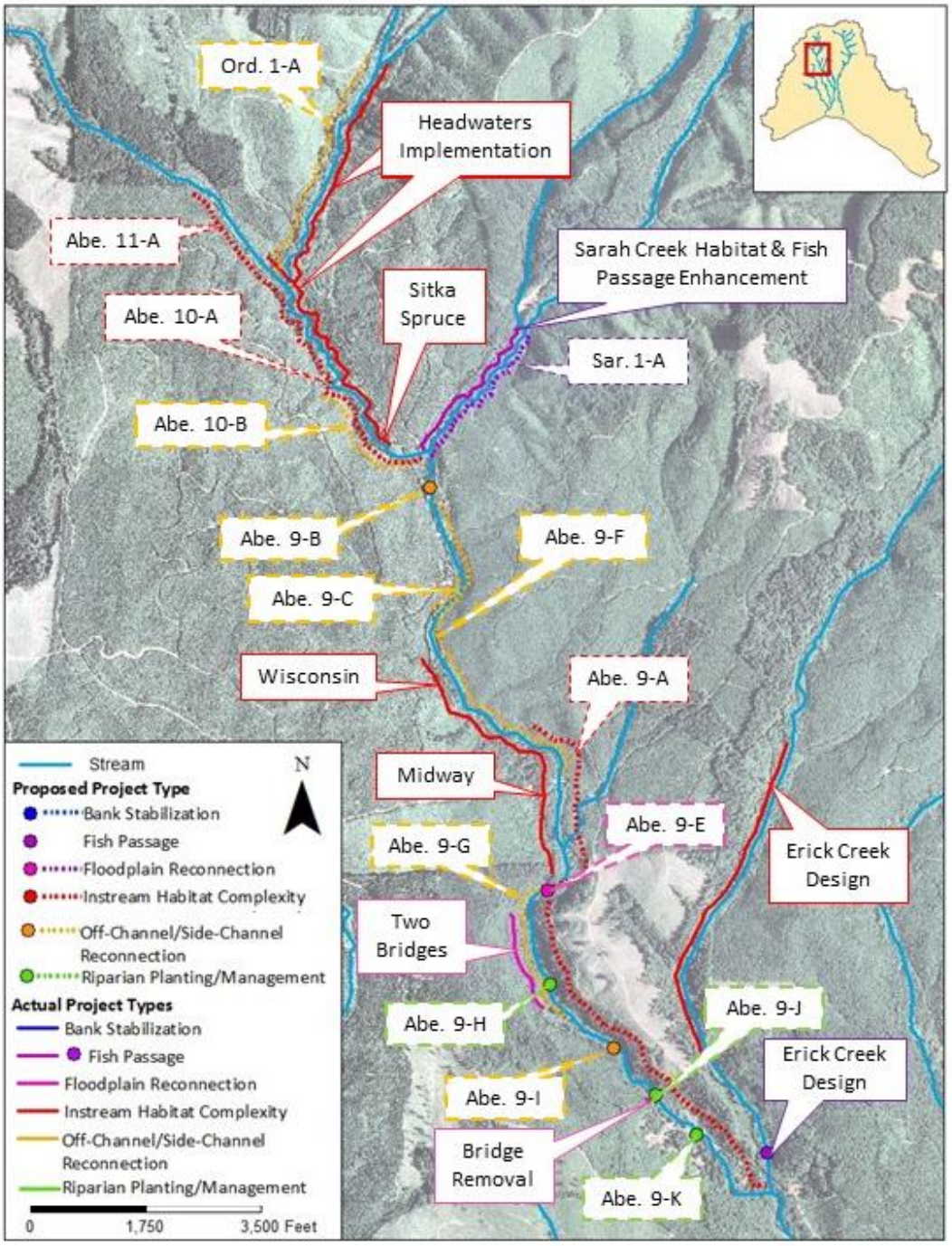

Figure 4. Proposed and actual project types in upper Abernathy Creek (EDT reach 9 through 12), Erick Creek, (EDT reach 1- 3), Sarah Creek (EDT reach 1), and Ordway Creek (EDT reach 1). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary. The Sarah Creek project is still in the proposal phase for implementation while Erick Creek Designs are not yet proposed for implementation (summer 2016). The Midway project is proposed for a downstream project extension of about five hundred linear feet, which is included in the project extension on this map.

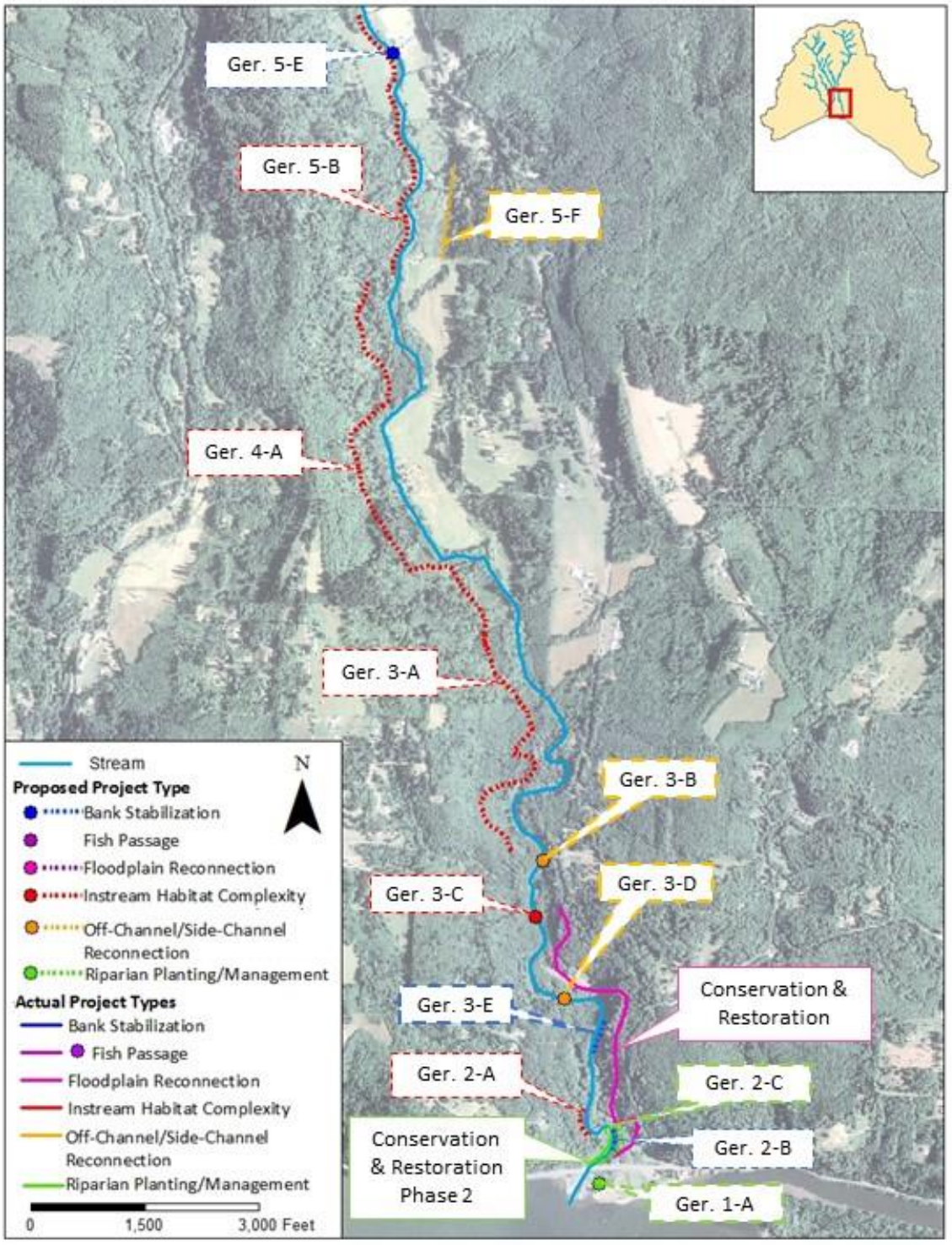

Figure 5. Proposed and actual project types in lower Germany Creek (EDT reach 1 through 5). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary. Conservation & Restoration occurred prior to 2009 (funded in 2004).

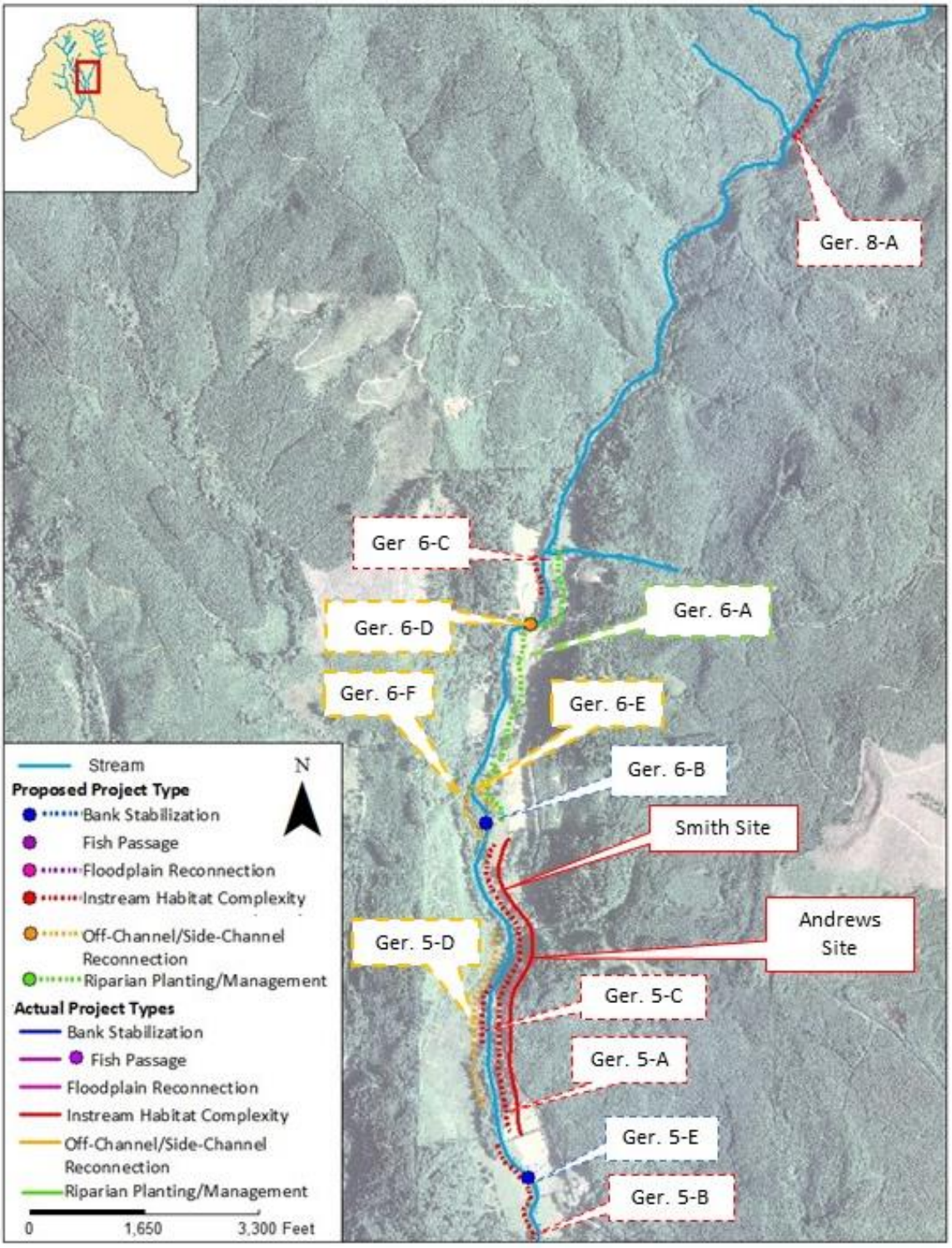

Figure 6. Proposed and actual project types in middle Germany Creek (EDT reach 5 through 8). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary.

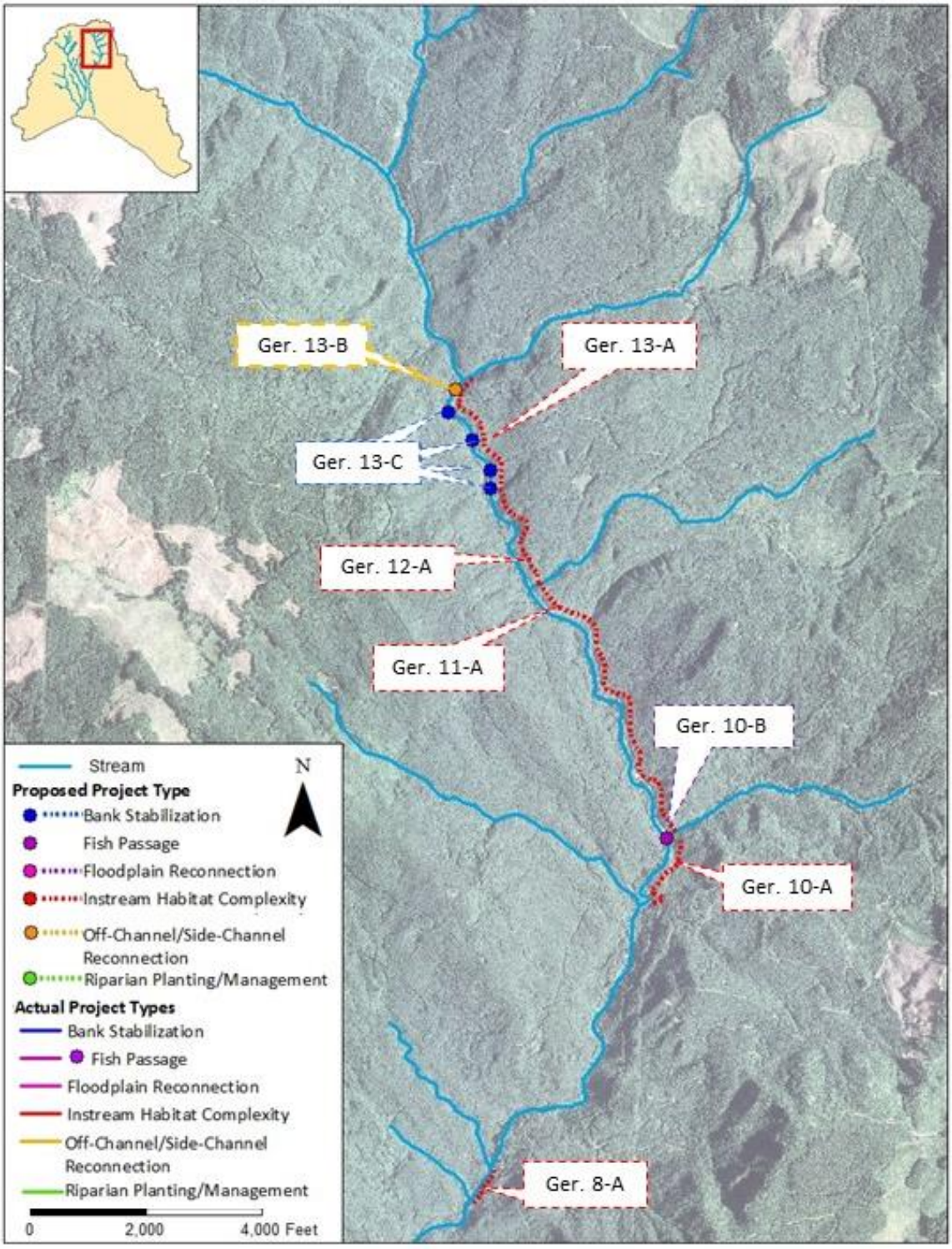

Figure 7. Proposed and actual project types in middle Germany Creek (EDT reach 8 through 13). Projects are coded by primary treatment type: bank stabilization, fish passage, floodplain reconnection, instream habitat complexity, off-channel/side-channel reconnection, or riparian planting/management with their abbreviated project name coded to match. Project lengths are off-set from the stream channel for readability. Inset includes Lower Columbia IMW stream habitat in relation to the Mill-Abernathy-Germany subbasin boundary.

Table 4. Comparison of IMW treatment plan Phase I proposals and any matching projects through September 2016. Original project descriptions from the 2009 treatment plan and matching project data and primary treatment types based on data in project proposals, designs, and reports from SalmonPORT, PRISM, and PCSRF databases. Status codes are C = completed; F = funded; P = proposed. Instream lengths are treated main channel linear feet, OC/SC lengths are treated Off-Channel/Side-Channel and Floodplain treated linear lengths. Lengths and area values are the credited amounts of each project used to calculate treated quantities per proposed project. When projects met multiple proposed projects, treated quantities were not duplicated, resulting in zeroes for some project comparisons. Non-completed project metrics may change.

Phase	Proposed Project Name	Proposed Primary Treatment	Project ID	Status	Project Name (Map Abbreviated Name)	Primary Treatment	Instream length (ft)	OC/SC length (ft)	Riparian area (acres)
Phase 1	Abernathy 9-G	Off-Channel/ Side-Channel Reconnection	11-1386	C	Abernathy Creek Two Bridges (Two Bridges)	Floodplain Reconnection	1584	528	1.5
	Abernathy 2-A	Off-Channel/ Side-Channel Reconnection	10-1300-01	C	Abernathy Creek Tidal Restoration (Tidal Restoration)	Off-Channel/ Side-Channel Reconnection	2375	875	7
	Abernathy 9-A	Instream Habitat Complexity	11-1386	C	Abernathy Creek Two Bridges (Two Bridges)	Floodplain Reconnection	0	0	0
	Abernathy 9-A	Instream Habitat Complexity	14-1310	F	Abernathy Creek Wisconsin Site (Midway)	Instream Habitat Complexity	0	0	0
	Abernathy 9-A	Instream Habitat Complexity	NOAA via PCSRF	F	Abernathy Creek Wisconsin Site (Wisconsin)	Instream Habitat Complexity	0	0	0
	Abernathy 10-B	Off-Channel/ Side-Channel Reconnection	13-1152	C	Abernathy Sitka Spruce (Sitka Spruce)	Instream Habitat Complexity	500	0	0.1
	Abernathy 3-C	Instream Habitat Complexity	14-1311	F	Abernathy Creek Cameron Site (Cameron Site)	Instream Habitat Complexity	1600	0	0
	Abernathy 5-A	Off-Channel/ Side-Channel Reconnection							
	Germany 2-A	Instream Habitat Complexity							
	Germany 5-D	Off-Channel/ Side-Channel Reconnection							
	Abernathy 3-A	Instream Habitat Complexity							
	Abernathy 3-B	Instream Habitat Complexity							
	Germany 5-A	Instream Habitat Complexity	15-1040	F	Germany Creek Andrews Site (Andrews Site)	Instream Habitat Complexity	4561	0	6.1
	Germany 2-C	Riparian Planting/ Management	09-1378	C	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	0	0	21.6
	Germany 2-B	Bank Stabilization	09-1378	C	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	270	0	5
	Germany 5-B	Instream Habitat Complexity							
	Abernathy 9-F	Off-Channel/ Side-Channel Reconnection	14-1310	F	Abernathy Creek Wisconsin Site (Midway)	Instream Habitat Complexity	1320	581	0

	Abernathy 9-F	Off-Channel/ Side-Channel Reconnection	NOAA via PCSRF	F	Abernathy Creek Wisconsin Site (Wisconsin)	Instream Habitat Complexity	1320	581	0
	Proposed Project Name	**Proposed Primary Treatment**	**Project ID**	**Status**	**Project Name (Map Abbreviated Name)**	**Primary Treatment**	**Instream length (ft)**	**OC/SC length (ft)**	**Riparian area (acres)**
	Abernathy 1-A	Off-Channel/ Side-Channel Reconnection	10-1300-01	C	Abernathy Creek Tidal Restoration (Tidal Restoration)	Off-Channel/ Side-Channel Reconnection	0	0	0
	Germany 5-C	Instream Habitat Complexity	15-1039	F	Germany Creek Restoration Smith Site (Smith Site)	Instream Habitat Complexity	2784	775	1
	Germany 5-F	Off-Channel/ Side-Channel Reconnection							
	Germany 6-F	Off-Channel/ Side-Channel Reconnection							
	Abernathy 10-A	Instream Habitat Complexity	15-1127	F	Abernathy Creek Headwaters Implementation (Headwaters Implementation)	Instream Habitat Complexity	2000	0	0

Table 5. Comparison of IMW treatment plan Phase I proposals and any matching projects through September 2016. Original project descriptions from the 2009 treatment plan and matching project data and primary treatment types based on data in project proposals, designs, and reports from SalmonPORT, PRISM, and PCSRF databases. Status codes are C = completed; F = funded; P = proposed. Instream lengths are treated main channel linear feet, OC/SC lengths are treated Off-Channel/Side-Channel and Floodplain treated linear lengths. Lengths and area values are the credited amounts of each project used to calculate treated quantities per proposed project. When projects met multiple proposed projects, treated quantities were not duplicated, resulting in zeroes for some project comparisons. Non-completed project metrics may change.

Phase	Proposed Project Name	Proposed Primary Treatment	Project ID	Status	Project Name (Map Abbreviated Name)	Primary Treatment	Instream length (ft)	OC/SC length (ft)	Riparian area (acres)
Phase 2	Abernathy 7-A	Riparian Planting/ Management							
	Germany 5-E	Bank Stabilization							
	Germany 8-A	Instream Habitat Complexity							
	Germany 6-E	Off-Channel/ Side-Channel Reconnection							
	Germany 6-D	Off-Channel/ Side-Channel Reconnection							
	Germany 10-A	Instream Habitat Complexity							
	Germany 10-B	Fish Passage							
	Germany 6-A	Riparian Planting/ Management							
	Abernathy 9-C	Off-Channel/ Side-Channel Reconnection							
	Germany 6-C	Instream Habitat Complexity							
	Abernathy 9-E	Floodplain Reconnection	11-1329	C	Abernathy Creek Bridge Removal Project (Bridge Removal)	Floodplain Reconnection	105	0	0.1
	Abernathy 9-B	Off-Channel/ Side-Channel Reconnection							
	Abernathy 9-I	Off-Channel/ Side-Channel Reconnection							
	Abernathy 9-H	Riparian Planting/ Management							
	Abernathy 9-J	Riparian Planting/ Management							
	Abernathy 9-K	Riparian Planting/ Management							
	Germany 6-B	Bank Stabilization							

Proposed Project Name	Proposed Primary Treatment	Project ID	Status	Project Name (Map Abbreviated Name)	Primary Treatment	Instream length (ft)	OC/SC length (ft)	Riparian area (acres)
Germany 3-A	Instream Habitat Complexity							
Cameron 1-B	Instream Habitat Complexity	14-1311	F	Abernathy Creek Cameron Site (Cameron Site)	Instream Habitat Complexity	3600	0	0
Germany 3-C	Instream Habitat Complexity							

Table 6. Comparison of IMW treatment plan Phase I proposals and any matching projects through September 2016. Original project descriptions from the 2009 treatment plan and matching project data and primary treatment types based on data in project proposals, designs, and reports from SalmonPORT, PRISM, and PCSRF databases. Status codes are C = completed; F = funded; P = proposed. Instream lengths are treated main channel linear feet, OC/SC lengths are treated Off-Channel/Side-Channel and Floodplain treated linear lengths. Lengths and area values are the credited amounts of each project used to calculate treated quantities per proposed project. When projects met multiple proposed projects, treated quantities were not duplicated, resulting in zeroes for some project comparisons. Instream length for Sarah Creek is proposed, and not included in current treated area calculations. Non-completed project metrics may change.

Phase	Proposed Project Name	Proposed Primary Treatment	Project ID	Status	Project Name (Map Abbreviated Name)	Primary Treatment	Instream length (ft)	OC/SC length (ft)	Riparian area (acres)
Phase 3	Germany 3-D	Off-Channel/ Side-Channel Reconnection							
	Germany 3-B	Off-Channel/ Side-Channel Reconnection							
	Germany 3-E	Bank Stabilization	09-1378	C	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	0	0	2.5
	Abernathy 4-C	Off-Channel/ Side-Channel Reconnection							
	Abernathy 4-A	Off-Channel/ Side-Channel Reconnection	12-1333	C	Abernathy 5A Side Channel Project (5A Side Channel)	Off-Channel/ Side-Channel Reconnection	600	0	1.7
	Abernathy 4-D	Instream Habitat Complexity	14-1296	F	Abernathy Creek Davis Site (Davis Site)	Off-Channel/ Side-Channel Reconnection	1800	686	1
	Germany 4-A	Instream Habitat Complexity							
	Abernathy 4-E	Off-Channel/ Side-Channel Reconnection	14-1296	F	Abernathy Creek Davis Site (Davis Site)	Off-Channel/ Side-Channel Reconnection	0	0	0
	Abernathy 4-B	Bank Stabilization							
	Germany 13-A	Instream Habitat Complexity							
	Cameron 1-A	Off-Channel/ Side-Channel Reconnection	14-1311	F	Abernathy Creek Cameron Site (Cameron Site)	Instream Habitat Complexity	1200	0	0
	Abernathy 11-A	Instream Habitat Complexity	15-1127	F	Abernathy Creek Headwaters Implementation (Headwaters Implementation)	Instream Habitat Complexity	800	0	0
	Germany 13-B	Off-Channel/ Side-Channel Reconnection							
	Germany 13-C	Bank Stabilization							
	Sarah 1-A	Fish Passage	16-1533	P	Sarah Creek Habitat & Passage Enhancement	Fish Passage	2600	0	0

Proposed Project Name	Proposed Primary Treatment	Project ID	Status	Project Name (Map Abbreviated Name)	Primary Treatment	Instream length (ft)	OC/SC length (ft)	Riparian area (acres)
Ordway 1-A	Off-Channel/ Side-Channel Reconnection	15-1127	F	Abernathy Creek Headwaters Implementation (Headwaters Implementation)	Instream Habitat Complexity	2585	0	0
Germany 1-A	Riparian Planting/ Management							
Weist 1-A	Riparian Planting/ Management							
Germany 11-A	Instream Habitat Complexity							
Germany 12-A	Instream Habitat Complexity							

Update 2: Summarize nutrient treatment and results in the two treatment streams.

The Lower Columbia Fish Enhancement Group (LCFEG) completed a nutrient treatment project in Germany and Abernathy Creeks with the goal of increasing juvenile fish growth and smolt size and survival. Nutrient treatments were completed in both Germany Creek (Fall 2010 – Fall 2013) and Abernathy Creek (Spring 2013 – Spring 2015). WDFW assessed nutrient benefits by measuring fish growth rates and analyzing stable isotope ratios to determine food web responses (Zimmerman et al. 2015) (Table 7). Preliminary results indicate that nutrient treatments resulted in limited benefits to fish, by increasing growth only in the short-term in Abernathy Creek, and not at all in Germany Creek (Table 7). No detectable differences are yet reported for outmigrating smolt size and abundance in response to nutrient treatment (Table 7). Ecosystem response results are being explored in more detail through a Western Washington University Master of Science thesis, which will tentatively be completed in December 2017 (Zimmerman et al. 2016). Stream metabolism results will be analyzed by Ecology.

Table 7. Nutrient treatment timeline and results for Germany and Abernathy Creek. Data from biological monitoring report (Zimmerman et al. 2015) and project ID 09-1373 final report. Nutrient inputs were salmon carcass analogs (SCA), and treatment quantity is summarized as pounds of SCA.

Creek	Treatment Dates	Treatment Season	SCA (lbs)	Length (ft)	Food Web Effect	Fish Growth Effect	Smolt Population Effect
Germany	Oct. 11 - 26, 2010	Fall 2010	21,230	39,550	Disintegrated	--	--
	Feb. 1 and Mar. 29, 2011	Spring 2011	13,200	40,000	Disintegrated	--	--
	Sept. 12-21 and Oct. 19 - 26, 2011	Fall 2011	25,500	61,500	observed in system 6-weeks post treatment; no food web response	no effect observed	no effect observed
	Oct. 8, 30-31 and Nov. 6 - 7, 2012	Fall 2012	22,500	61,500	potential primary consumer response	no effect observed	no effect observed
	Oct. 2013	Fall 2013	16,000	40,000	potential primary consumer response	no effect observed	no effect observed
Abernathy	May 14 - 16 and Jun. 11 -13, 2013	Spring 2013	11,300	30,624	positive periphyton and invertebrate response in July but not Aug., Dec., or Jan.	positive short-term length and weight response by juvenile coho salmon, but no long-term growth benefit	no smolt outmigration abundance or size response for Chinook, coho, or steelhead
	May and Jun. 2014	Spring 2014	14,400	37,624	not reported yet	not reported yet	no effect observed
	May and Jun. 2015	Spring 2015	40,000	73,810	not reported yet	not reported yet	no effect observed

Update 3: Summarize habitat assessments and biological monitoring results.

WDFW and Ecology have reported biological and habitat monitoring through 2015, with the goal of establishing baseline "fish-in" and "fish-out" abundances and habitat conditions (Zimmerman et al. 2016). Monitoring of specific treatment project sites is ongoing since many projects are only recently completed or are still in-progress. As practitioners receive funding for and complete more treatment actions, five-year post-project monitoring results will include any detected changes following treatment implementation (Zimmerman et al. 2016).

In addition to long-term habitat monitoring through IMW funding, two independent rapid habitat assessments were conducted in Abernathy Creek in 2014 by Cramer Fish Sciences and Fisher and Associates, LLC (Stevens et al. 2014 and Fisher and Associates, LLC 2014). Results quantified rearing and spawning habitat for target salmon species across stream reaches, and recommended future treatment to help meet population recovery goals. Population metrics were estimated as adult and juvenile abundances (Fisher and Associates, LLC 2014) and adult equivalent estimate (AEQ) (Stevens et al. 2014). Results and recommendations are summarized below for long-term IMW monitoring and the rapid habitat assessments.

Monitoring Results

1. Juvenile coho salmon survival is likely limited by summer and winter habitat conditions rather than spawning abundance. Patterns in apparent overwinter survival (survival plus emigration prior to pre-spring smolt trapping) of juvenile coho salmon were useful for explaining the number of smolts produced in each watershed, and exhibited inverse relationships to summer parr abundance for Mill and Germany Creeks (Zimmerman et al. 2015) (Figure 8). However, both summer and winter conditions may contribute to apparent overwinter survival. For example, juvenile coho that were larger at the end of the summer rearing period were more likely to emigrate as spring smolts than juvenile coho that were smaller at the end of the summer rearing period.
2. Two distinct migration timing patterns are present for juvenile coho from Abernathy Creek. Coho salmon parr were observed moving downstream into lower Abernathy Creek and the Columbia River during the fall (fall movers), while coho smolts were observed moving downstream in the spring (spring smolts) (Figure 9). Fall movers were not detected moving back upstream into the IMW complex, suggesting that these individuals either concentrated in the lower extent of Abernathy Creek during the winter months or that they leave Abernathy Creek in the fall and use the Columbia River or other estuarine-draining tributaries for additional rearing (Zimmerman et al. 2015).
3. Summer rearing habitat may influence outmigration timing of juvenile coho salmon from Abernathy Creek. Fall parr migrants were more likely to have been tagged the previous summer in stream reaches lower in the watershed than spring smolts, which were more likely have been tagged the previous summer in stream reaches higher in the watershed or in the tributary streams (Johnson et al. 2015). Downstream migration behavior was also related to summer parr length: juvenile coho that were larger by the end of the summer were more likely to be detected as emigrants (spring smolts) than smaller juveniles (Figure 10). Taken together, these patterns suggest that apparent survival to spring smolts was lower for smaller than larger juvenile coho at the end of the summer rearing period. This is considered 'apparent survival'

because the lower prevalence of movements detected for the smaller fish could be due to a) leaving the watershed prior to the overwinter rearing period (i.e., fall migration), or b) mortality during the over-winter period (Zimmerman et al. 2015). The roll of fall migration in explaining these results is currently under investigation (M. Zimmerman, WDFW, personal communication).

4. Fall nutrient treatment was not observed to significantly impact food web productivity for coho salmon parr growth, although there was some evidence for spring nutrient treatments to increase food web productivity and coho salmon parr growth in the month immediately following the treatment. However, spring nutrient treatment still did not ultimately impact smolt numbers or body size of the resulting smolts, suggesting that the response to the nutrient treatment was short-term (Zimmerman et al. 2015).
5. Pre-treatment monitoring suggests that large wood is extremely limited and plane-bed channel types are common in this subbasin (Zimmerman et al. 2016). These conditions reduce habitat diversity, channel stability, natural sediment loading, and hydrologic and thermal regime conditions, and may reflect historical forest management practices (Zimmerman et al. 2016). Changes to these land use practices over time (i.e., decreased road densities, culvert replacements, and enhanced riparian buffers) will likely increase the riparian-stream interaction over time, but stream responses may take decades to be fully realized.

Rapid habitat assessment results for Abernathy Creek

1. Lack of spawning habitat may limit ability to meet population recovery goals (Stevens et al. 2014 and Fisher and Associates, LLC 2014). The majority of spawning habitat is found in Abernathy EDT Reach 2, which has large parr production estimates for coho, Chinook, and steelhead, as well as AEQ production for chum salmon (Stevens et al. 2014).
2. Low numbers of Chinook spawners were observed at the USFWS Research Facility (EDT Reach 5) (Fisher and Associates, LLC 2014). However, WDFW observed Chinook salmon spawning above Abernathy falls almost every year since 2005, with distribution patterns related to fall stream flow conditions. Additionally, USFWS does not begin diverting fish into its facility until early October, after the majority of fall Chinook in Abernathy Creek have already passed the facility to spawn (M. Zimmerman, WDFW, personal communication).
3. Reaches with the greatest AEQ production (rearing and spawning habitat) are Abernathy EDT reaches 3, 4 and 9 for Chinook, coho, and steelhead (Stevens et al. 2014).
4. Most rearing habitat is located in upper reaches, with lack of large wood complexity limiting the extent of rearing across the basin (Stevens et al. 2014). Most rearing habitat consisted of main channel pools, with limited alcove, beaver pond, and backwater channel units. This lack of complexity may especially limit coho rearing because greater coho density is associated with alcoves, backwaters, and beaver ponds in comparison to main channel pools (Stevens et al. 2014 and Fisher and Associates, LLC 2014).

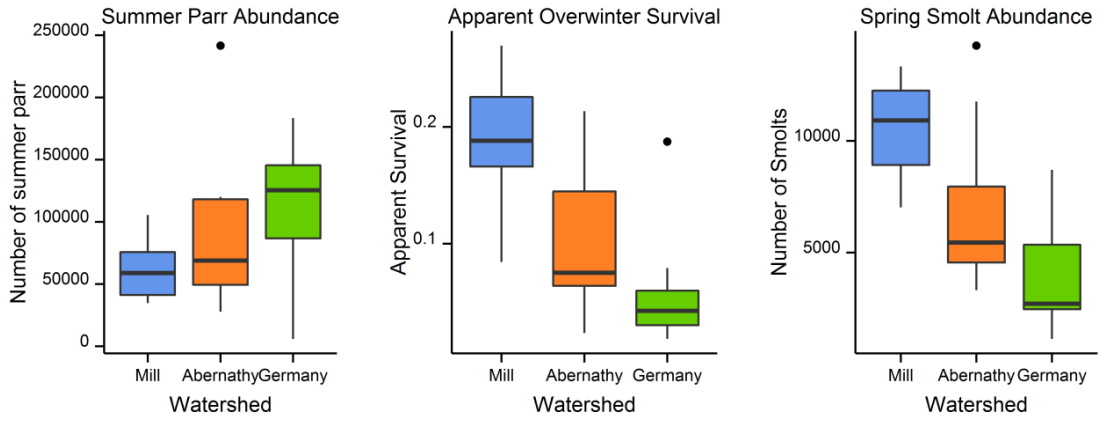

Figure 8. Seasonal abundance and survival comparisons among the three study streams, from Zimmerman et al. (2015).

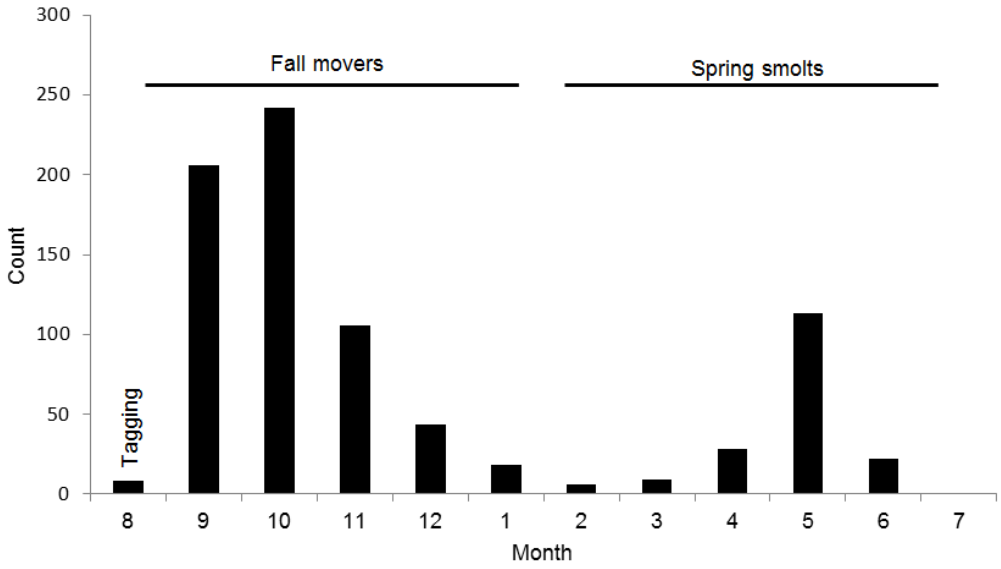

Figure 9. Monthly detection counts of PIT-tagged juvenile coho salmon at the Abernathy Creek PIT detection site (river kilometer 5) from 2005 – 2013, from Zimmerman et al. (2016).

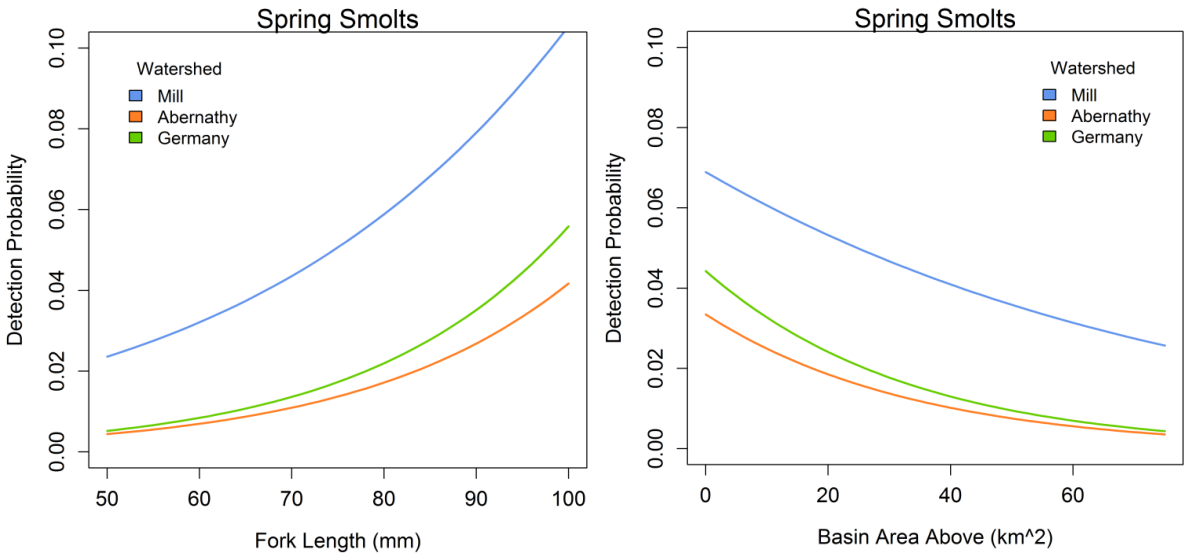

Figure 10. Probability of an individual coho salmon being detected as a spring smolt based on its summer length (fork length, mm) and rearing location (upslope basin area, km^2) for Mill, Abernathy, and Germany Creek basins, from Zimmerman et al. (2015).

Update 4: Compile recommendations for future monitoring and treatment prioritization within the IMW.

The LCFRB and TOG compiled a list of recommended treatment and monitoring priorities for the Lower Columbia IMW based on monitoring results, habitat assessment reports, and discussions. Watershed processes that form habitat for fish spawning and rearing in the Lower Columbia IMW complex are currently impaired, and site-specific and short-term treatment projects could support recovery efforts until watershed-scale and long-term processes are restored (LCFRB 2010). The TOG concluded that continued implementation of projects that increase instream large wood (Instream Habitat Complexity treatment), floodplain connectivity (Floodplain Reconnection treatment), and Fish Passage treatment will be important short-term actions contributing to salmon recovery in these subbasins.

For habitat treatments to result in "restoration", they must cause a measurable change in the habitat and resulting fish abundances. Both project effectiveness monitoring and post-treatment population monitoring can be used to evaluate the success of the treatments and provide feedback useful for adaptive management of future treatments. Project effectiveness monitoring of instream habitat could reveal the responses at site-specific and watershed scale to the implemented treatments. Post-treatment monitoring between five and ten years after the completion of all Phase 1 projects from the Treatment Plan will be required to detect a fish response from treatment project implementation (Zimmerman et al. 2015). As of summer 2016, eight of eleven (73%) Phase I proposed projects in Abernathy Creek and four of nine (44%) Phase I proposed projects in Germany are completed or are in-progress, as well as nine of 19 Phase II and Phase III proposed projects in Abernathy Creek and one of 20 Phase II and Phase III proposed projects in Germany Creek are completed or are in-progress. This results in a total of 22 of the original proposed 60 projects completed or in-progress (Table 2). The TOG anticipates that achieving treatment success may be an iterative process where treatments are implemented and the effectiveness monitoring of these treatments are used to adaptively manage future treatments.

In the long-term, land use management and policy changes are also likely to impact watershed processes and salmon and steelhead recovery efforts (Bilby et al. 2004). The Lower Columbia IMW has a high road density and commercial forestland use, both of which negatively influence watershed processes (LCFRB 2010). However, recent improvements to water resource planning, forestland, and road management activities are expected to improve watershed functions over the long-term. The TOG concluded that long-term impacts from these indirect sources should be considered through watershed-scale assessment, rather than at the project-site scale (Table 8).

To address long-term population recovery and watershed process treatment, the TOG recommended considering treatment success beyond project implementation sites and minimum detectable smolt production estimates. This can be accomplished by considering connectivity between the stream and upslope processes over time. To consider broad temporal-scale interactions, the LCFRB compared naturally produced spawner abundance goals from the Recovery Plan to current estimated abundances in the each study stream and for the total subbasin (Table 9). Current spawner estimates are about half of recovery goal abundances for steelhead and coho, while only one-sixth of the recovery goal abundance for Chinook (**Error! Reference source not found.**). Additionally, 90% of returning Chinook spawners are hatchery origin, meaning recovery of Chinook spawners is even less than for steelhead and coho (M. Zimmerman, WDFW, personal communication). Continued treatment action that increases

smolt production and subsequent spawner abundances could support continued recovery within the IMW and the Lower Columbia region.

Table 8. Potential impacts of habitat management and policies on fish populations and habitat in the Lower Columbia IMW.

Organization	Project	Timeline	Potential Impact
Washington State	Shoreline Management Master Programs	Shoreline Management Act of 1971.	Counties, towns, and cities must address environmental impacts on streams, rivers, lakes, and associated wetlands, as well as marine waters.
Washington State	Critical Areas Ordinances	Growth Management Act of 1990.	County and city-level to address growth and development impacts on environmental resources.
Washington State	The Watershed Planning Act	90.82 RCW was passed in 1998.	Long-term watershed planning and management occurs at the local scale (Water Resource Inventory Areas, WRIAs). Includes water quality and quantity and needs for people and fish.
Washington Department of Natural Resources	Road Maintenance and Abandonment Plan (RMAP)	Part of the Forest and Fish Rules (2001).	Addresses fish passage and road improvement projects on forest land roads to improve habitat connectivity and to reduce erosion. All RMAP improvement projects must be completed by 2021.
Washington Department of Natural Resources	Forest Practices Habitat Conservation Plan (HCP)	Plan was completed in 2006.	Improves forest land management to better address aquatic and riparian species needs through a Riparian Conservation and Upland Conservation Strategy.
Washington Department of Transportation	Fish Passage Barrier Removal Program	Court injunction requiring barrier removal from 2013 through 2030.	The State of Washington is required to increase its effort in removing state-owned culverts that block salmon and steelhead habitat.

Table 9. Status and recovery goals for salmon and steelhead spawner abundances in the Mill, Abernathy, and Germany Creek subbasin (MAG). Recovery priorities, historical, current, and recovery goal abundances are from the Recovery Plan (LCFRB 2010). Recovery priorities are primary (P) and contributing (C) populations. Median abundance values are from combined WDFW natural-origin and hatchery-origin spawner abundance estimates from 2005 – 2015 (fall Chinook and winter steelhead) and from 2010-2012 (coho). The median proportion hatchery-origin spawners (pHOS) for fall Chinook and coho are recorded in parentheses following median total spawner abundance estimates (natural-origin plus hatchery-origin). Coho spawner abundances estimates are preliminary, and updates are in-progress by WDFW. No recovery goals or spawner abundances are reported for chum at this time due to low return rates.

Lower Columbia Recovery Plan					WDFW Spawner Abundance Estimates			
Species	**Recovery Priority**	**Historical**	**Current**	**Recovery Goal**	**Mill Creek Median (pHOS)**	**Abernathy Creek Median (pHOS)**	**Germany Creek Median (pHOS)**	**MAG Median (pHOS)**
Fall Chinook	P	2500	50	**600**	77.5 (0.91)	56.5 (0.86)	96.5 (0.89)	230.5 (0.89)
Chum	P	7000	<100	**--**	--	--	--	--
Winter Steelhead	P	900	600	**600**	38	156	132	326
Coho	C	2800	<50	**1800**	180.5 (0.17)	125.5 (0.16)	46.5 (0.10)	352.5 (0.16)

Based on reviewed literature and discussions, the LCFRB and TOG have identified the following habitat treatment recommendations:

1. Completing the remaining Phase I projects in Abernathy Creek should result in detectable smolt production responses following five to ten years of post-treatment monitoring (Zimmerman et al. 2012). Three Phase I projects are not yet funded in Abernathy Creek: 3-A, 3-B, and 5-A (Table 4). These projects primarily address Instream Habitat Complexity treatment needs, although Abernathy 5-A would also treat Off-Channel/Side-Channel Reconnection needs (HDR Inc. and Cramer Fish Sciences, 2009). That said, the LCFRB and TOG believe that these projects have low likelihood of implementation success because of local site constraints. Abernathy 3-A and Abernathy 3-B are located in a confined and remote canyon, while Abernathy 5-A is adjacent to the USFWS Research Facility and just upstream of bridges (HDR Inc. and Cramer Fish Sciences, 2009). Therefore, it is recommended that projects in Phase II and Phase III are prioritized over completing Phase I work in Abernathy Creek.
2. Prioritized Phase II and Phase III projects in Abernathy Creek should add to already large, spatially contiguous treatment areas or provide treatment actions that support measuring coho salmon migration timing responses.
    a. A number of small spatial-scale Phase II projects are not yet implemented in Abernathy Reach 9, including Abernathy 9-B, 9-C, and 9-I (Off-Channel/Side-Channel Reconnection treatment projects) and 9-H, 9-J, and 9-K (Riparian Planting/Management treatment projects). Abernathy 9-B and 9-C occur on DNR forestland and between two large-scale treatment areas, potentially improving implementation efficiencies and the ability to detect treatment responses (Figure 4). These two projects include enhancement of winter refuge habitat for coho salmon, one of the main biological responses being

considered in Abernathy Creek. The other projects are located at the downstream end of the reach on privately-owned parcels. Implementation of these projects would require landowner outreach, although this would extend the spatial scale of upper watershed treatment to the mouth of Erick Creek, where two design project components could be brought forward for implementation in the near future (Erick Creek Designs).

b. One project was proposed in Weist Creek, a tributary to Abernathy Creek at the upstream end of Reach 7 (Figure 3). Implementation of this project would require partnering with a landowner on privately-owned land, which is not considered feasible in the near future. However, this project should still be considered in the long-term because of the high potential for treatment at this site to enhance coho salmon and steelhead rearing habitat (HDR Inc. and Cramer Fish Sciences, 2009).

3. Although no projects were initially proposed in Abernathy Reach 8, this reach has observed spawning activity for coho, steelhead, and Chinook as well as habitat enhancement needs. This reach has local and watershed-scale sediment processes rated as Moderately Impaired, based on Integrated Watershed Assessment results (LCFRB 2010). On a species-specific population recovery level, this reach is considered to have high need for habitat diversity and medium need for sediment transport treatment for coho population recovery, medium need for habitat diversity and sediment transport treatment for Chinook population recovery, and low need for habitat diversity and medium need for sediment transport treatment for steelhead population recovery (LCFRB 2010). Although this reach is considered to have a low priority for population recovery for all three species (tier 4), this Species Reach Potential (SRP) rating could likely be adjusted because of observed spawner abundances. For instance, an average of 14% of coho spawning and 13% Chinook spawning between 2005 and 2015 in Abernathy Creek has occurred in this reach (M. Zimmerman, WDFW, personal communication). Although the relative proportion of Chinook spawning has a high variability that is related to changes in the timing of fall stream flow events (15% standard deviation over ten years), the relative proportion of coho salmon spawning in this reach is fairly stable (6% standard deviation over ten years) (M. Zimmerman, WDFW, personal communication). The importance of this reach to salmon and steelhead recovery, especially coho salmon, may therefore elevate the importance of this reach to population recovery, increasing its SRP rating for treatment project scoring during the LCFRB SRFB project scoring. Furthermore, projects in this reach may help address impaired sediment processes concerns, a major habitat limitation in the Abernathy Creek basin identified through long-term IMW monitoring.

   a. In 2009, a treatment project was proposed by the Cowlitz Conservation District in Abernathy Reach 8 in partnership with a private landowner (Project ID 09-1405). This project was not funded, but if pursued again, would address Instream Habitat Complexity and Riparian Planting/Management treatment needs. Large woody material placement was proposed over about 600 feet of main channel habitat, potentially leading to increased habitat quantity and quality, and reduced fine sediment transport. Riparian planting of native pioneer and conifer species was also proposed for about 2.5 acres, potentially leading to long-term wood recruitment and reduced bank erosion. If the landowner is still interested in pursuing this project, this could add to lower Abernathy Creek treated area and sediment transport treatment needs. Based on TOG

discussions, there is also potential for side channel enhancement if landowner is interested.

4. Increasing stream sinuosity and floodplain function could reduce stream power and improve bedload transport processes in the IMW subbasin. Future projects should occur at sediment loading sites, but consider upstream and downstream processes as well.
    a. All Phase I Abernathy projects that primarily treat Floodplain Reconnection and Instream Habitat Complexity needs have already been funded or have low chances of implementation success. However, the projects suggested for implementation in prioritization Step 2a would all treat bedload transport processes needs: the Off-Channel/Side-Channel Reconnection projects would address this in the near future, and the Riparian Planting/Management treatment projects in the long-term through riparian vegetation community establishment.
5. Due to the high-number of ongoing and completed projects in Abernathy Creek, it is suggested by the LCFRB and the TOG that Germany Creek projects are reconsidered for implementation, although not at the detriment to measuring responses from Abernathy Creek treatment. Treatment in Germany Creek could lead to better understanding of treatment effectiveness in a confined, high-gradient stream.
    a. Five Phase I projects in Germany Creek are not currently proposed, four of which are located close to two ongoing projects sponsors by the Cowlitz Conservation District in Germany Reach 5 (15-1039 and 15-1040): Germany 5-B, 5-C, 5-F and Germany 6-F. Because of high private ownership in the Germany Creek watershed, the chances of project implementation relies on successful partnerships with local landowners. Working adjacent to ongoing projects may increase the chances of success, by having high visibility of similar, ongoing treatments. With this in mind, it is suggested that treatment prioritization in Germany Creek consider high priority projects in Germany Reach 5 and Reach 6 in order to take advantage of ongoing landowner outreach by the Cowlitz Conservation District.
    b. The headwater portion of Germany Creek is primarily forest land, and project implementation may be more feasible in these industrially-owned parcels. Following lower watershed treatment implementation, it is suggested that large-scale projects in Germany 10 through 13 be proposed for treatment. Because of their large spatial-scale and upper watershed location, Instream Habitat Complexity and Off-Channel/Side-Channel Reconnection treatment in these reaches may lead to both local and watershed-scale measurable responses. These projects include 10-A, 11-A, 12-A, 13-A, and 13-B.

Based on reviewed literature and discussions, the TOG identified the following biological monitoring recommendations:

1. Analyze habitat responses and fish population responses to the implemented projects, and use this information to provide feedback on the effectiveness of treatments. Adaptively manage how future projects are prioritized based on lessons learned from this monitoring (Zimmerman et al. 2015). Fish responses to treatment may be measurable in the near future in Abernathy Creek, because seventeen of the 30 proposed projects are in-progress or completed (Table 2).

2. Continue to analyze multiple population responses (abundance, diversity, and growth) to the habitat treatments at multiple life stages. Consideration of multiple potential responses could increase understanding of full life history benefits from treatment (Bennett et al. 2016).
3. Document the density-dependent and density-independent relationships between spawner abundance and smolt survival and growth for each species included in the fish monitoring (Zimmerman et al. 2015).
4. Increase biological monitoring in order to determine importance of fall versus spring coho migrants to returning adult spawners (Zimmerman et al. 2015 and Johnson et al. 2015), as well as relationships between fall migrants and available instream habitat (Zimmerman et al. 2015). Other studies have documented early emigrant contributions to returning spawner numbers (Bennett et al. 2015 and Jones et al. 2014). This could help prioritize juvenile coho salmon rearing projects in the IMW as well as across the Lower Columbia River basin.

Update 5: Revise reach descriptions to reflect recent projects or new knowledge on habitat or fish populations.

Reach descriptions for Germany and Abernathy Creeks were included in the 2009 treatment plan, detailing geomorphic and channel processes, potential causal factors to observed local conditions, and limiting conditions to salmon and steelhead recovery (HDR Inc. and Cramer Fish Sciences, 2009). Treatment projects were recommended based on these observations, including design elements and any potential constraints to implementation (HDR Inc. and Cramer Fish Sciences, 2009). Main fish recovery limitations identified lack of geomorphic diversity and complexity, limited large woody material, impacted and poorly sorted sediments, confined and vertically unstable stream channels, limited channel sinuosity, and lack of connected side channel and floodplain habitat (HDR Inc. and Cramer Fish Sciences, 2009).

Updated reach descriptions are grouped and ordered the same as in the 2009 treatment plan. New reach conditions and knowledge that may influence habitat and fish are incorporated, including monitoring and treatment results, and recommendations from publications and TOG discussions. The TOG determined that one important component of this update is more consideration of upslope and downslope interactions, and short and long-term temporal impacts on habitat and fish. Reach descriptions reflect these multi-scale interactions. Additionally, monitoring suggests that Abernathy Creek may be better suited for measuring treatment effects on coho salmon while Germany Creek is better suited for measuring treatment effects on steelhead. Treatment recommendations and project suggestions incorporate these fish-habitat differences. Updated reach descriptions can provide important information on future treatment project opportunities and should be considered when determining future prioritization of efforts.

A1. Abernathy 1 & 2

Original reach concerns in Abernathy Reach 1 and 2 were lack of habitat diversity, coverage for predator avoidance, riparian vegetation, and the use of rip-rap for erosion control, which all limit rearing and spawning habitat for Abernathy Creek Chinook, coho, steelhead, chum, and out-of-basin Columbia River migrants (HDR Inc. and Cramer Fish Sciences, 2009). Abernathy Creek Tidal Restoration project (Bonneville Power Administration grant 10-1300-01) was implemented with the goal of restoring 12 acres of stream habitat, including improved access to three tidally-influenced side channels and wetland enhancement. Complexity and scour concerns were addressed with floodplain roughness, and large wood structures, as well as side channel and wetland reconnection, which should all improve rearing habitat. Riparian areas were also enhanced with tree and shrub plantings across approximately seven acres.

Coho rearing capacity could be improved by increasing pool:riffle ratios and spawning habitat could be improved by reducing fine sediment deposition (Stevens et al. 2014). Sediment inputs could also be reduced by increased channel complexity at the mouth of Cameron Creek and in Abernathy Reach 3, and through large woody material placement in Cameron Creek as part of the Abernathy Creek Cameron Site (Project ID 14-1311). This project is designed to increase rearing habitat for winter steelhead, coho, and fall Chinook by improving floodplain inundation, increasing pool habitat, and improving channel complexity and spawning habitat for steelhead, coho, fall Chinook, and chum by increase gravel recruitment (Inter-Fluve 2013a). Large wood placement will promote habitat formation in the short-term, but also improve wood recruitment in the long-term from riparian zone contributions becoming

trapped in placed wood structures (Inter-Fluve 2013a). Chum spawning and egg incubation habitat needs should continue to be prioritized, due to recent spawning increases in the Lower Columbia region, including the IMW subbasin (Zimmerman et al. 2016).

A2. Abernathy 3

Original reach concerns in Abernathy Reach 3 were lack of habitat complexity and diversity, which limit coho, steelhead, and Chinook rearing habitat and chum spawning habitat (HDR Inc. and Cramer Fish Sciences, 2009). Abernathy Creek Cameron Site (Project ID 14-1311) is a funded project being implemented in summer of 2016 that proposes to enhance channel complexity and refuge by increasing access to side channel habitat and adding log jams and individual logs to increase channel complexity. This reach also has some of the highest estimated Chinook, coho and steelhead juvenile rearing in the stream basin, as well as estimated AEQ production (Stevens et al. 2014). Increasing large wood complexity in this reach may further increase rearing capacity for all three species (Stevens et al. 2014). Habitat enhancement objectives of the Abernathy Creek Cameron Site project are to improve rearing and spawning habitat for Chinook, coho, and steelhead, as well as spawning habitat for chum (Inter-Fluve 2013a). Coho are expected to primarily benefit from the rearing habitat enhancements, because of the expected increase in off-channel alcove and backwater habitat in an area where this habitat type is currently lacking (Inter-Fluve 2013a). Chum spawners were primarily observed from the mouth of Abernathy Creek upstream to the confluence with Cameron Creek (S. West, WDFW, personal communication). Therefore, improved sediment and flow processes in Cameron Creek and downstream may support chum returns as well.

A3. Abernathy 4

Original reach concerns in Abernathy Reach 4 included perched side channels and limited main channel habitat complexity, which limit coho and steelhead rearing and spawning habitat for Chinook and chum. The Abernathy 5A Side Channel Project (Project ID 12-1333) reconnected previously perched side channels just downstream of the Abernathy Fish Technology Center. Main channel and side channel large wood structures were used to increase access to the side channel, complex pool habitat, sort gravels, and improve channel stability, which should support both juvenile rearing and adult spawner holding. Primary species expected to benefit include coho salmon and steelhead (Inter-Fluve 2014). Riparian plantings as part of this project will improve long-term recruitment of wood, and potentially improve water temperature in lower reaches. A second project is funded in this reach, Abernathy Creek Davis Site (Project ID 14-1296), which will also address limited channel complexity and side channel connectivity via large wood placement and pool formation.

This reach has some of the highest juvenile rearing capacity for Chinook and steelhead in the stream basin, as well as AEQ production for steelhead (Stevens et al. 2014). Increasing large wood complexity would increase rearing production for coho, Chinook, and steelhead, although this analysis was completed prior to the 12-1333 and 14-1296 treatment projects being completed (Stevens et al. 2014). Chum spawning and egg incubation habitat needs should also be considered, due to recent spawning increases in the Lower Columbia region, including the IMW subbasin (Zimmerman et al. 2016).

A4. Abernathy 5

Original reach concerns in Abernathy Reach 5 were an upstream low flow fish passage barrier at a natural bedrock waterfall (Reach 6), lack of gravel substrate and instream habitat diversity, and limited riparian conifer trees, all of which may limit Chinook, coho, and steelhead rearing and chum spawning (HDR Inc. and Cramer Fish Sciences, 2009). No projects have been funded yet for this reach. Currently, there are low rearing production estimates in this reach for Chinook, coho, and winter steelhead, and negligible spawning habitat (Stevens et al. 2014). Additionally, increasing large wood complexity is estimated to have limited juvenile rearing benefits in comparison to other reaches in Abernathy (Stevens et al. 2014). Overall, prioritizing treatment in other Abernathy stream reaches may provide greater benefits to fish than treatment conducted in Abernathy Reach 5.

A5. Abernathy 7

Original reach limitations include lack of instream large woody material and limited riparian habitat on the right bank, which may limit spawning and rearing for Chinook, coho, and steelhead (HDR Inc. and Cramer Fish Sciences, 2009). No projects have been funded yet for this reach. However, increasing large wood complexity would provide limited juvenile production benefits for Chinook, coho, or steelhead in comparison to other Abernathy Creek reaches (Stevens et al. 2014), and limited implementation success because of physical constraints and landowner concerns (HDR Inc. and Cramer Fish Sciences, 2009). Instead, the single proposed project (7-A) addresses riparian rehabilitation rather than instream habitat conditions (HDR Inc. and Cramer Fish Sciences, 2009). This proposed riparian rehabilitation effort could improve watershed processes throughout lower Abernathy Creek in the long-term through providing wood recruitment, temperature moderation, and improved sediment loading.

A6. Abernathy 8

Abernathy Reach 8 was not included in the 2009 treatment plan, but may provide high quality tributary habitat for spawning coho, Chinook and steelhead. This reach has impaired sediment processes at the local and watershed-scale, and population recovery habitat needs include instream habitat diversity treatment (LCFRB 2010). Spawning data may also support increasing the SRP ranking of this reach, making treatment funding more feasible. WDFW has observed an average of 14% of coho spawning and 13% Chinook spawning between 2005 and 2015 in Abernathy Creek in this reach (M. Zimmerman, WDFW, personal communication). Although relative proportion of Chinook spawning has a high variability that is related to changes in the timing of fall stream flow events (15% standard deviation over ten years), the relative proportion of coho salmon spawning in this reach is fairly stable (6% standard deviation over ten years) (M. Zimmerman, WDFW, personal communication). Projects that address spawning needs and sediment transport processes may be beneficial within this reach, and improve habitat downstream as well.

The Cowlitz Conservation District proposed a project in 2009 that was not funded and may be worth reconsidering (Project ID 09-1405). The 2009 project proposed to increase large wood and enhance riparian habitat over about 600 linear feet of stream habitat and 2.5 acres of riparian area. This treatment is expected to lead to increased habitat quality and quantity as well as reduce fine sediment transport. Additionally, this project could add to the amount of lower Abernathy Creek treated area, increasing the potential to assess the relationship between summer rearing location and coho migration timing (fall movers versus spring smolts).

A7. Abernathy 9

Original concerns in Abernathy Reach 9 were limited large woody material, channel complexity, conifer trees in the riparian zone, and perched floodplain habitat, all of which may limit coho and steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). Two completed projects, Abernathy Creek Two Bridges (Project ID 11-1386) and Abernathy Creek Bridge Removal Project (Project ID 11-1329), address these limitations by increasing channel migration through bridge removal, reconnecting floodplain habitat, adding in-stream large woody material, and planting conifers. Primary treatment types for these two projects are improving floodplain function (Floodplain Reconnection), although wood recruitment is likely in the long-term. Expected project salmonid benefits were increased coho and steelhead spawning and rearing habitat. Preliminary results indicate that coho salmon redd abundance has increased in the project reach following project completion: the percentage of total Abernathy Creek coho salmon spawning in this project reach increased from 2.1% to 5.2% between 2013 and 2015 (Zimmerman et al. 2016). However, impacts of spawning distribution response on smolt production are still unknown.

Two additional projects are in-progress, Abernathy Creek Wisconsin Site Project (Midway, Project ID 14-1310) and Abernathy Creek Wisconsin Site Project (PCSRF funded). The primary treatment type for both of these projects is Instream Habitat Complexity, through large wood placement. Reach 9 was already considered to support some of the highest juvenile production for Chinook, coho, and steelhead, as well as AEQ production (Stevens et al. 2014). Instream habitat complexity responses to ongoing treatments are expected to further increase juvenile rearing production for all three species (Stevens et al. 2014). Additionally, these projects are spatially contiguous and their cumulative effect may further improve habitat formation in Abernathy Creek. These projects are also spatially connected to treatments in Abernathy Reach 11 and 10, Ordway Creek, and potentially Sarah Creek, where a 2016 proposed fish passage treatment project could be implemented.

Fine sediment accumulation in spawning habitat are also present in this reach (Stevens et al. 2014). Reducing sources and deposition could increase spawning capacity (Stevens et al. 2014). In-progress projects may also address some of the still identified concerns from the 2014 rapid habitat assessment survey through the addition of wood structures, which should increase channel complexity and floodplain inundation, reducing local stream power and increasing local gravel deposition (Inter-Fluve 2013b).

A8. Abernathy 10

Original reach concerns were lack of conifer trees in the riparian zone and instream large woody material, which may limit coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). One project is completed, Abernathy Sitka Spruce (Project ID 13-1152), and a second project is in-progress in the summer of 2016, Abernathy Creek Headwaters Implementation (Project ID 15-1127). The Abernathy Sitka Spruce project used large woody material to treat Instream Habitat Complexity and Floodplain Reconnection needs, and conifer understory plantings to address Riparian Planting/Management needs. In the near-term, large wood is expected to increase pool formation in the main channel and connectivity between the main channel and floodplain habitats. In the long-term, riparian plantings are expected to improve connectivity between the instream and riparian systems, including wood recruitment. The Abernathy Creek Headwaters Implementation project uses large wood placement to treat Instream Habitat Complexity needs (Inter-Fluve 2015a). Large wood includes channel spanning logs in the main channel and across the floodplain to increase floodplain roughness,

aggrade sediment, and enhance a beaver dam complex (Inter-Fluve 2015a). This project is spatially connected to treatments upstream in Ordway Creek and Abernathy Reach 11 and downstream in Abernathy Reach 9, as well as potentially with Sarah Creek, where a fish passage treatment project is proposed, for tentative implementation beginning in summer 2018.

Riparian conifer deficiencies identified in the 2009 treatment plan are likely not yet fully addressed in Abernathy Reach 10, and conifer plantings should be considered in future treatment efforts. Rapid habitat assessments also estimated that juvenile rearing habitat availability was very low for all species, although current projects may improve these numbers (Stevens et al. 2014). However, increasing large wood complexity is estimated to produce limited juvenile rearing benefits in comparison to other reaches in Abernathy (Stevens et al. 2014). Instead, treatments in Reach 10 may have downstream benefits in Abernathy Reach 9, which has high rearing and spawning habitat potential (Stevens et al. 2014).

A9. Abernathy 11

Original reach concerns are limited large wood complexity in the lower two-thirds of this reach and a lack of conifer species in the riparian zone, which may limit the formation of rearing habitat for coho and steelhead (HDR Inc. and Cramer Fish Sciences, 2009). The Abernathy Creek Headwaters Implementation project (Project ID 15-1127), which is in progress in summer of 2016, is intended to address instream habitat limitations in Abernathy Reach 11 through Instream Habitat Complexity treatment. This project uses large wood placement to substantially improve habitat in the lower portions of the reach. This project also is spatially connected to instream treatments in the tributary Ordway Creek and Abernathy Reach 9, and potentially with a proposed project in Sarah Creek, which is tentatively scheduled for implementation beginning in summer 2018.

The lack of riparian conifers throughout the reach are not yet addressed through treatment projects. Sediments in this reach are primarily fines, likely due to limited stream power in this reach and historical logging (Stevens et al. 2014). Additionally, increasing large wood complexity is estimated to have limited juvenile rearing benefits in comparison to other reaches in Abernathy (Stevens et al. 2014). Instead, future treatment projects should target long-term conifer enhancement in the riparian zone. Riparian rehabilitation in this reach could improve temperature, habitat, and stream flow conditions in downstream reaches, where rearing and spawning habitat potential is greater.

A10. Cameron 1

Original reach concerns were lack of instream large wood and exposed bedrock substrate low in the reach, which may limit coho and winter steelhead rearing as well as chum spawning (HDR Inc. and Cramer Fish Sciences, 2009). Treatment needs are being addressed by the Abernathy Creek Cameron Site (Project ID 14-1311), implemented in the summer of 2016. This project is designed to increase instream and off-channel habitat complexity throughout the lower half of Cameron Creek Reach 1, primarily through Instream Habitat Complexity and Floodplain Reconnection treatment. This project will also increase the length of habitat enhanced throughout lower Abernathy Creek: the Abernathy Creek Tidal Restoration project (BPA ID 10-1300-01) enhanced large wood density and floodplain function from the confluence of Cameron Creek downstream through Abernathy Reach 2. Smaller streams like Cameron Creek supported the spring smolt life history strategy of coho salmon. Increasing spawner access to these reaches may increase the number of juvenile coho salmon rearing in these habitats,

potentially leading to more spring smolts in the Abernathy Creek subbasin (Zimmerman et al. 2015 and Zimmerman et al. 2016).

A11. Weist 1

Reach concerns for Weist Creek were incision and bedrock exposure in the lower portions of this reach, where an adjacent road confines the channel, potentially limiting coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). The one proposed project has not yet been completed, and was designed to increase large wood complexity and side-channel habitat, and enhance the riparian corridor in the broad, meadow portion of this reach (HDR Inc. and Cramer Fish Sciences, 2009). Smaller streams supported the spring smolt life history strategy of coho salmon. Increasing spawner access to these habitats may increase the number of juveniles rearing in these habitats, potentially leading to more spring smolts in the Abernathy Creek subbasin (Zimmerman et al. 2015 and Zimmerman et al. 2016).

A12. Erick 1 – 3

Erick Creek was not included in the 2009 treatment plan, but may provide high quality tributary habitat for spawning and rearing coho and steelhead. Two projects are in the design phase for this tributary - a fish passage project at a culvert near the mouth of Erick Creek, and an upstream instream treatment project (Project ID 15-1444). It is important to complete both of these projects together in order to assess fish and habitat responses to treatment: improving access for coho and steelhead spawners past the culvert may result in additional area used for juvenile rearing (M. Zimmerman, WDFW, personal communication). Implementation of these two projects would also contribute the amount of treatment that has occurred in upstream reaches, including projects in Abernathy Reach 9, 10 and 11, Sarah Creek, and Ordway Creek. This length of treatment may increase the ability to determine whether upper watershed main channel and tributary habitat conditions are related to the spring smolt life history strategy of coho salmon (Zimmerman et al. 2015 and Zimmerman et al. 2016).

A13. Sarah 1

Original reach concerns included a potential waterfall passage barrier and bedrock-exposed substrates low in this reach, which may limit coho and steelhead passage to higher quality habitat upstream (HDR Inc. and Cramer Fish Sciences, 2009). A design has been completed and treatment is proposed to address this barrier by reducing waterfall jump height by creating step-pools, increasing complexity in the adjacent habitat, and planting conifers in the understory for future wood recruitment (Project ID 16-1533). Addressing fish passage and improving in-stream habitat needs by placing large wood could improve local habitat quality as well as access to upper Sarah Creek where habitat is low gradient and more complex, and includes large wood structures, pools, and split channel flow (Inter-Fluve 2015b). If funded, this project will address original project proposal concerns. Smaller streams supported the spring smolt life history strategy of coho salmon. Increasing spawner access to these habitats may increase the number of juveniles rearing in these habitats, potentially leading to more spring smolts in the Abernathy Creek subbasin (Zimmerman et al. 2015 and Zimmerman et al. 2016). Implementing this project would also increase the amount of spatially contiguous treatment in upper Abernathy Creek, including treatments in Abernathy Reach 11, 10, 9, Ordway Creek, and potential projects in Erick Creek.

A14. Ordway 1

Original reach concerns were limited in-stream large wood complexity and perched floodplain habitat upstream of the Abernathy Creek Road Bridge, which may limit coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). Only one project was originally proposed, and will be addressed at least in part by the in-progress Abernathy Creek Headwaters Implementation project (15-1127). The primary treatment type of this project is Instream Habitat Complexity, which should increase instream and floodplain complexity connectivity to support coho and winter steelhead rearing in lower Ordway Creek (Inter-Fluve 2015a). This project will also increase the amount of fairly contiguous treated habitat in upper Abernathy Creek, including work conducted in Abernathy Reach 11, Abernathy Reach 10, Abernathy Reach 9, as well as potential fish passage and large woody material enhancement projects in Sarah Creek and Erick Creek. Lack of conifers in the riparian zone may still need to be addressed. Tributary habitat in this reach may support an earlier outmigration life history strategy of coho salmon, and future work may influence juvenile coho salmon movement timing (fall movers versus spring smolts).

A15. Germany 1 and 2

Original reach concerns in lower Germany Creek were lack of native vegetation and large woody material, the presence of invasive vegetation species (reed canary grass and blackberry), and the use of static, channel stabilizing structures (rip-rap) along both banks downstream of the Highway 4 bridge (HDR Inc. and Cramer Fish Sciences, 2009). These habitat limitations may reduce rearing and spawning for Chinook, coho, winter steelhead, and chum (HDR Inc. and Cramer Fish Sciences, 2009). Habitat concerns in Reach 2 were addressed through the Germany Creek Conservation and Restoration Phase 2 project (09-1378), which increased instream habitat complexity and bank stability through wood and dolo structure additions. To enhance riparian conditions, native species plantings and invasive plant removal were also completed across 29 acres. Reach 1 channel complexity and floodplain connection downstream of the Highway 4 bridge have not yet been addressed (Proposed Project Germany 1-A). Chum spawning and egg incubation habitat needs should also be considered, due to recent spawning increases in the Lower Columbia region, including the IMW subbasin (Zimmerman et al. 2016).

A16. Germany 3

Lack of large wood and habitat diversity across the entire reach were concerns in the original treatment plan, which may limit spawning and rearing for Chinook, coho, winter steelhead, and chum (HDR Inc. and Cramer Fish Sciences, 2009). The upper extent of the Germany Creek Conservation and Restoration Phase 2 project (09-1378) addressed some habitat limitations in this reach, by increasing the riparian buffers and installing dolo and wood channel deflector structures against the bank along Germany Creek Road. However, floodplain connectivity, riparian plantings, and channel complexity concerns still need to be addressed in upper portions of Reach 3 where habitat is currently used by spawning and rearing salmon, but could be enhanced. Chum spawning and egg incubation habitat needs should also be considered, due to recent spawning increases in the Lower Columbia region, including the IMW subbasin (Zimmerman et al. 2016).

A17. Germany 4

Original concerns in this reach were lack of riparian buffer along the left bank and limited large wood in the channel. These conditions result in lack of habitat diversity, key habitat quantity, and temperature problems, which all may limit Chinook, coho, and winter steelhead rearing as well as Chinook (HDR Inc.

and Cramer Fish Sciences, 2009). The original instream habitat complexity project proposed in this reach has not yet been completed.

A18. Germany 5

Original treatment plan concerns in this reach were lack of large wood and pools, poor riparian and temperature conditions, and lack of floodplain and side channel connectivity, which all may limit rearing coho and winter steelhead as well as Chinook spawning (HDR Inc. and Cramer Fish Sciences, 2009). Two projects are in-progress to address these limiting factors - Germany Creek Restoration Smith Site (15-1039), and Germany Creek Andrews Site (15-1040). These projects are designed to improve pool formation and complexity in the mainstem by placing large woody material (Instream Habitat Complexity), and improving temperature and long-term wood recruitment by enhancing the riparian zone (Riparian Planting/Management treatment). The Smith Site project also addresses side channel access concerns by increasing connectivity and habitat complexity of four side channels (Off-Channel/Side-Channel Reconnection). Lack of large wood and in-stream habitat complexity, floodplain reconnection, and riparian planting outside these projects (proposed project Germany 5-B, 5-C, 5-E, and 5-F) have not yet been addressed.

A19. Germany 6

Original treatment plan concerns in Germany Reach 6 were limited gravel accumulation, lack of large wood and riparian habitat, and incised main channel habitat with limited habitat diversity and floodplain connectivity in the upper portion of this reach, all which may limit coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). The Germany Creek Stream Restoration Godinho (16-1521) project was proposed to address some of these habitat limitations, by increasing in-stream pool frequency, enhancing side channel habitat, and enhancing the riparian corridor. However, this project was not successfully proposed for funding in 2016 through the SRFB grant round. If funded in the future, this project along with other Reach 5 and Reach 6 projects could improve the ability to detect treatment responses in Germany Creek.

A20. Germany 8

Original treatment plan concerns in Germany Reach 8 were confined left bank conditions and lack of off-channel habitat connection, which may limit coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). Only one project was proposed (Germany 8-A) to address these limiting factors but has not yet been implemented.

A21. Germany 10

Original treatment plan concerns in this reach were lack of channel complexity, perched side channel habitat, lack of large wood, and degraded riparian habitat conditions (HDR Inc. and Cramer Fish Sciences, 2009). Proposed treatment strategies included placing large wood in the main channel to elevate and reconnect floodplain areas to increase winter steelhead and coho rearing habitat, and replacing a culvert to restore fish passage into a tier 4 tributary. No projects have been completed yet in this reach, but implementing the large-scale Instream Habitat Complexity project (Germany 10-A) along with similar Germany Reach 11, 12, and Reach 13 projects (Germany 11-A, 12-A, 13-A) could add a large, upper watershed treatment area to Germany Creek, potentially providing both local and downstream responses.

A22. Germany 11

Original treatment plan concerns in this reach were limited habitat complexity, floodplain connection, and in-stream large wood and riparian recruitment (HDR Inc. and Cramer Fish Sciences, 2009). Only one project was proposed to address lack of large wood, but to date it has not been funded. Implementing this project along with Germany Reach 10, 12, and Reach 13 projects (Germany 10-A, 12-A, 13-A) could add a large, upper watershed treatment area to Germany Creek, potentially providing both local and downstream responses.

A23. Germany 12

Original treatment plan concerns in this reach were limited floodplain connection, in-stream large wood and riparian recruitment (HDR Inc. and Cramer Fish Sciences, 2009). Only one project was proposed to address lack of large wood, but to date it has not been funded. Implementing this project along with Germany Reach 10, 11, and Reach 13 projects (Germany 10-A, 11-A, 13-A) could add a large, upper watershed treatment area to Germany Creek, potentially providing both local and downstream responses.

A24. Germany 13

Original treatment plan concerns in Germany Reach 13 were lack of side channel connectivity, limited large wood, and lack of bank stability from alder recruitment, all which may limit coho and winter steelhead rearing (HDR Inc. and Cramer Fish Sciences, 2009). Three projects were proposed to address lack of large wood, side channel connection, and bank stability concerns, but to date none have been funded. Implementing the large-scale Instream Habitat Complexity project (Germany 13-A) along with Germany Reach 10, 11, and Reach 12 projects (Germany 10-A, 11-A, 12-A) could add a large, upper watershed treatment area to Germany Creek, potentially providing both local and downstream responses.

Update 6: Review the literature cited section of the IMW treatment plan and incorporate more recent reports and scientific literature related to experimental design and treatment results.

The references below are suggested additions to the treatment plan update. References either: 1.) provide new biological or habitat knowledge within the Lower Columbia IMW, 2.) provide experimental design considerations in the Lower Columbia IMW or in similar systems, or 3.) recommend monitoring and treatment next steps in the Lower Columbia IMW or in similar study systems.

1. **Bennett, T. R., Roni, P., Denton, K., McHenry, M. and R. Moses. 2015. Nomads no more: early juvenile coho salmon migrants contribute to the adult return. Ecology of Freshwater Fish, 24: 264–275. doi: 10.1111/eff.12144.**

   This peer-reviewed journal publication tracked survival of 25,981 PIT-tagged individual smolts to spawning from 2004 through 2010. The authors observed that 32 of 86 observed returning adults were early coho outmigrants (fall/winter parr) while the remaining 54 were spring smolt outmigrants. All detected returning spawners were larger at tagging than those that did not return regardless of the juvenile life history. Juveniles that were 70 mm or longer at the time of late summer tagging were almost four times more likely to return to spawn than smaller individuals. Fall/winter migrants also returned to spawn about two weeks later than spring migrants, although the observed temporal difference was not statistically significant. This study provides support for the importance of early coho outmigrants to population abundance and greater variability in spawn timing, potentially increasing population resiliency. Additionally, it suggests that a juvenile size threshold (70 mm in this study) may partially explain the higher survival of spring smolts than fall/winter parr to the spawning life stage.

2. **Bennett, S., Pess, G., Bouwes, N., Roni, P., Bilby, R., Gallagher, S., Ruzycki, J., Buehrens, T., Krueger, K., Ehinger, W., Anderson, J., Jordan, C., Bowersox, B., and C. Greene. 2015. Progress and challenges of testing the effectiveness of stream restoration in the Pacific Northwest using intensively monitored watersheds. Fisheries, 41:2, 92-103, DOI: 10.1080/03632415.2015.1127805.**

   This peer-reviewed journal publication reviews the IMW program in the Pacific Northwest eleven years after initial program implementation. Seventeen different IMW projects have been implemented, with nine occurring in the Columbia River basin. The most common restoration actions considered are instream large wood placement, tributary and floodplain connectivity, and barrier removal. Riparian enhancements are another restoration action that commonly occurs in IMWs, but fish population and watershed condition responses are not yet directly assessed due to the longer timeline required for tree maturation. Habitat reconnection has already been shown to increase spawner distribution and increase juvenile life history diversity, while beaver dam analogs and large wood projects have resulted in increases in juvenile abundance.

   Main challenges identified across the IMW projects were lack of coordination among restoration and experimental design planning groups, non-standardized monitoring protocols, lack of annual reporting, project location selection based on logistical and political feasibility rather than efficiency of experimental design, and restoration approaches not considering watershed

processes. It is also suggested that multiple fish and habitat variables be considered at multiple spatial and temporal scales to increase the chance of a detectable response.

3. **Fisher and Associates, LLC. 2014. Rapid Assessment Method Demonstration Project Report for Salmon Habitat Quantification Survey of Mainstem Abernathy Creek Watershed. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

   This report summarizes salmon and steelhead rearing and spawning capacity in Abernathy Creek. Carrying capacities were calculated using the Fisher Protocol during stream surveys from July through September 2014. Carrying capacities were then compared to Abernathy Creek recovery goals in the Lower Columbia Recovery Plan (LCFRB 2010). Current habitat was estimated to not support full recovery goals, primarily due to a lack of Chinook spawning habitat, limited off-channel rearing habitat, and a lack of large wood throughout Abernathy Creek.

4. **HDR Inc, and Cramer Fish Sciences. 2009. Abernathy and Germany Creeks Intensively Monitored Treatment Plan. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

   The goal of this plan is to guide restoration project implementation in the Lower Columbia IMW system to meet experimental design goals for the IMW project as well as ESA recovery objectives. Ecosystem Diagnosis and Treatment (EDT) and Integrated Watershed Assessment (IWA) from the Lower Columbia Fish Recovery Board Fish and Wildlife Recovery Plan (2004), as well as fish and habitat field surveys, fish passage barrier, wetland, floodplain, road and stream networks, local expertise, and aerial photography were all used to assess watershed conditions, limiting factors to fish, and restoration project prioritization.

   Channel stability, habitat diversity, key habitat quality, sediment load, water temperature and flow are the primarily limiting habitat factors identified across the IMW system. These conditions were used to prioritize sixty restoration projects across three, two-year project phases. Conceptual designs were included for ten of these projects. Prioritization was based on meeting Recovery Plan goals and calculated benefits to fish, project cost benefits, and constraints and opportunities at the site.

5. **Inter-Fluve, Inc. 2013a. Abernathy Creek Restoration Design Cameron Project: 90% Design Report. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

   This report was submitted along with preliminary design drawings for the Cameron Creek Project (Project ID 14-1311). This report details field survey and hydraulic modeling results that informed the preliminary design drawing. Primary goals of the project are to a.) improve habitat conditions for ESA-listed salmonids in Abernathy Creek and b.) implement restoration actions so that fish and habitat responses can be measured as part of the Lower Columbia Intensively Monitored Watershed (IMW) program.

   Habitat enhancement objectives were determined based on the need to increase the quantity of winter spawning and rearing habitat for steelhead, Chinook, and coho and spawning habitat for chum. Primary habitat limitations identified for these species-life stages were determined to be lack of off-channel habitat complexity, low pool frequency, limited spawning gravels, and limited cover and hydraulic refuge. To meet these goals, large wood placement will be used to increase channel sinuosity and complexity, floodplain inundation, scour pools, and large wood density to meet NMFS Western Cascade stream standards.

6. **Inter-Fluve, Inc. 2013b. Abernathy Creek Restoration Design Wisconsin Project: 90% Design Report. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

This report was submitted along with preliminary design drawings for the Wisconsin Project (now entitled Abernathy Creek Wisconsin Site Project, Project ID 14-1310). The report details field survey and hydraulic modeling results that informed the preliminary project design. Primary goals of the project are to improve habitat conditions for ESA-listed salmonids in Abernathy Creek, and implement restoration actions so that fish and habitat responses can be measured as part of the Lower Columbia Intensively Monitored Watershed (IMW) program.

Habitat enhancement objectives were determined based on the need to increase the quantity of winter steelhead and coho rearing habitat as well as winter steelhead spawning habitat. Primary habitat limitations for these species-life stages were determined to be lack of off-channel habitat, low pool frequency, and limited cover and hydraulic refuge. To meet these goals, large wood placement will be used to increase sediment aggradation including gravels, improve lateral channel dynamics including floodplain inundation, and increase large wood density to meet NMFS Western Cascade stream standards.

7. **Inter-Fluve, Inc. 2014. Abernathy Creek Hatchery Project Design: Design Report. Prepared for the Cowlitz Indian Tribe, Longview, Washington.**

This report details field survey and hydraulic modeling results that informed the Abernathy 5A Side Channel Project design (Project ID 12-1333). Primary goals of the project are to improve habitat conditions for ESA-listed salmonids in Abernathy Creek, and implement restoration actions so that fish and habitat responses can be measured as part of the Lower Columbia Intensively Monitored Watershed (IMW) program.Habitat enhancement objectives were determined based on the need to increase the quantity of winter steelhead, Chinook, and coho rearing and spawning habitat. Primary habitat limitations at the site were lack of floodplain access and straightened main channel conditions with limited pool habitat. To improve these conditions within the constraints of the adjacent Abernathy Fish Technology Center, side channel habitat on one bank will be enhanced and large wood will be placed. Wood structures will be utilized to promote side channel inundation, increase local gravel deposition, and provide cover and high-flow refuge.

8. **Inter-Fluve, Inc. 2015a. Abernathy Creek Headwaters Habitat Restoration: Preliminary Design Report. Prepared for the Cowlitz Indian Tribe, Longview, Washington.**

This report details field survey and hydraulic modeling results that informed the Abernathy Creek Headwaters Design (Project ID 14-1459). This design includes habitat in Ordway Creek Reach 1, and Abernathy Creek reaches 10 and 11. Primary goals were to improve habitat conditions for ESA-listed salmonids in Abernathy Creek and Ordway Creek, and implement restoration actions so that fish and habitat responses can be measured as part of the Lower Columbia Intensively Monitored Watershed (IMW) program.

Habitat enhancement objectives were determined based on the need to improve both spawning and rearing habitat for coho and winter steelhead. Habitat limitations in the project area of limited habitat diversity and key habitat quality and quantity, sediment loading concerns, and lack of channel stability. To address these limiting conditions, large wood placement is promoted to increase channel aggradation and gravel deposition, improve later channel and

floodplain connectivity, and increase large wood density to meet NMFS Western Cascade stream standards.

9. **Inter-Fluve, Inc. 2015b. Sarah Creek Preliminary Design Report. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

This report details field survey and hydraulic modeling results that informed the Sarah Creek preliminary design. Topographic and bathymetric surveys in Sarah Creek Reach 1 were used to assess current conditions and to determine the best restoration design to meet both site habitat needs and regional salmon and steelhead recovery goals.

Analysis determined that the waterfall was a barrier for both juvenile and adult winter steelhead and coho salmon. Based on the observed habitat conditions and modeling results, the design had two goals, including improving fish passage over a 7-foot waterfall in Sarah Creek, and enhancing instream habitat in the 300 feet long, riffle downstream of the waterfall.

10. **Johnson, T., M. S. Zimmerman, M. Sturza, and P. Hanratty. 2015. Apparent over-winter survival of juvenile coho in three tributaries to the lower Columbia River. PSMFC PIT Tag Workshop, Stevenson, Washington, http://www.ptagis.org/docs/default-source/pit-tag-workshops/05-coho-overwinter-survival-2015.ppsx?sfvrsn=2.**

This workshop presentation discussed fish-habitat relationships for rearing juvenile coho salmon in the Lower Columbia IMW. Apparent overwinter survival and outmigration timing were determined using PIT and spring smolt trap data by the Washington Department of Fish and Wildlife. Models predicting coho apparent overwinter survival found that summer rearing watershed location and fish size were important, with greater overwinter survival found for coho rearing in tributaries and upper main channel reaches and for relatively large fish observed in the prior summer.

Two discrete downstream movement periods were also observed for juvenile coho salmon in Abernathy Creek using PIT antenna data: fall movers and spring smolts. These seasonal movements are highly correlated with summer rearing location and fish size metrics as well. Spring smolts were more likely to have reared the previous summer in tributary streams or upper Abernathy Creek main stem reaches than fall movers. This suggests that growth and location during summer rearing as well as winter rearing habitat may influence outmigration timing and abundance for coho salmon.

11. **Jones, K. K., Cornwell, T. J., Bottom, D. L., Campbell, L. A. and S. Stein. 2014. The contribution of estuary-resident life histories to the return of adult *Oncorhynchus kisutch*. Journal of Fish Biology, 85: 52–80. doi:10.1111/jfb.12380.**

This peer-reviewed study assessed how rearing location (estuary versus stream) compared to migration timing, fish size, and life history type contribution to spawning adult returns for wild coho salmon in the Salmon River basin, Oregon. From 2008-2011, PIT tag technology and electrofishing surveys, a lower basin rotary screw trap, and estuary beach seining were used to collect, tag, and measure individuals. Four life history types were observed: a) 1 year stream-rearing followed by spring ocean outmigration; b) spring or summer estuary emigration followed by next spring ocean outmigration; c) spring or summer estuary emigration, winter freshwater emigration, spring ocean outmigration; and d) winter estuary emigration, spring ocean outmigration. Type 1 was the dominant contributing strategy for both juvenile and adult fish in

this study.

No significant difference was detected in fish size between these fall/winter estuary emigrants and spring emigrants. However, winter growth rates and spring fish length for coho parr were significantly greater for estuary-rearing fish than freshwater-rearing fish, suggesting high growth potential for estuary-rearing fish in comparison to overwintering freshwater fish.

12. **Katz, S. L., Barnas, K., Hicks, R., Cowen, J., and Jenkinson, R. 2007. Freshwater habitat restoration actions in the Pacific Northwest: a decade's investment in habitat improvement. Restoration Ecology, 15:3, 494-505.**

    This peer-reviewed journal publication details the authors' effort to establish a Pacific Northwest freshwater restoration project database. Database objectives were to: a) centralize restoration information for all projects that directly or indirectly impact salmon habitat in Washington, Oregon, Idaho, and Montana; b) determine effectiveness of different project types; and c) recommend next steps in improving efficiency and effectiveness of freshwater restoration on a regional scale. A total of 23,123 past projects were collected from federal, state, tribal, and non-governmental agencies through 2004.

    The majority of projects collected addressed sediment reduction, riparian improvements, and upland management while water quality, nutrient enrichment, and diversion screens were the least common. Most projects occurred in western Oregon and Washington and in watersheds with anadromous fish populations. Additionally, there was a strong negative correlation between project costs and abundance, suggesting more expensive projects were less likely to be implemented. Less than 7% of all projects reported any monitoring as well, providing limited understanding of restoration impacts on ecological conditions

13. **Kinsel, C., Hanratty, P., Zimmerman, M., Glaser, B., Gray, S., Hillson, T., Rawding, D., and VanderPloeg, S. 2009. Intensively Monitored Watersheds: 2008 fish population studies in the Hood Canal and Lower Columbia Stream Complexes. Washington Department of Fish and Wildlife.**

    This report includes methods and results for salmonid abundance estimates in the Hood Canal and Lower Columbia IMW complexes for the 2008 field survey season. This data was collected and analyzed by the Washington Department of Fish and Wildlife, and is part of the baseline monitoring period for the Hood Canal and Lower Columbia IMW complexes. Baseline monitoring is an important component of the Before-After Control-Impact (BACI) experimental design, because populations and stream conditions must be comparable to determine effectiveness of restoration treatment projects. Coho abundance was estimated at the parr, smolt, and spawner life stages while smolt and adult abundances were estimated for steelhead and chum in the Hood Canal IMW and for Chinook and steelhead in the Lower Columbia IMW.

14. **LCFRB. 2010. The Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan - Volume II E Mill, Abernathy, and Germany Creeks. Lower Columbia Fish Recovery Board, Kelso, Washington, http://www.lcfrb.gen.wa.us/#!library/c1tqm.**

    This recovery plan was written with the goal of restoring Endangered Species Act listed fish species to healthy, harvestable levels as well as to protect and enhance other fish and wildlife species from human actions, including the Federal Columbia River Power System. It is both a recovery plan for the Washington lower Columbia salmon and steelhead populations and a

Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Plan for the lower Columbia subbasins. The Mill, Abernathy, and Germany Creek subbasin portion of this plan addresses goals specifically in the IMW complex study streams.

Salmon and steelhead in Mill, Abernathy, and Germany Creeks need to be restored to medium to high viability to meet Lower Columbia recovery goals. Key priorities identified for recovery were managing forest lands, restoring floodplain and riparian function as well as stream habitat diversity in middle to lower mainstem reaches and tributary streams, managing development in the watershed, and using short-term habitat fixes to address immediate population risks until long-term watershed process restoration can occur, align hatchery priorities with natural population conservation, manage fishery impacts on recovery, and reduce out-of-subbasin impacts so that in-subbasin actions can be accurately assessed.

15. **National Research Council. 1996. *Upstream: salmon and society in the Pacific Northwest*. Washington, DC: National Academy Press.**

This report was published as a result of multiple meetings from 1992 to 1994 of a committee that included natural and social science, policy, and management experts. The committee was convened to perform three tasks assigned by Congress: assess all life histories for the seven Pacific Northwest salmon species, determine reasons for large population declines, and present options for policy addressing future salmon declines.

This review determined that about 40% of the historical range of Pacific salmon across the Pacific Northwest have been lost over the 20th century. Interior and southern populations were found to be more heavily impacted than coastal and northern populations. Population losses and declines were found to be largely due to human impacts, including hatcheries, fisheries, dams, urbanization, agricultural, forestry, and industry. The report also recommends a two-prong approach to salmon recovery: technology (hatcheries, transport of fish, stream channel modification) in the short-term; and, natural process regeneration in the long-term (ecosystem restoration).

16. **Roni, P., Beechie, T. J., Bilby, R. E., Leonetti, F. E., Pollock, M. M., and Pess, G. R. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management 22.1: 1-20**.

This review summarizes the effectiveness of different freshwater restoration techniques in restoring salmonid populations in the Pacific Northwest and presents a hierarchical approach for prioritizing restoration projects at the site-scale to address watershed-scale processes. Freshwater restoration techniques were categorized into five groups: habitat reconnection, road improvement, riparian restoration, instream habitat restoration, and nutrient enrichment. Different techniques under each category are summarized in terms of years required to determine a salmonid response, the length of the project effectiveness, and ratings of the degree of variability in success among reported projects and the probability of success.

The hierarchical approach has three main components: assess a watershed to understand current processes and restoration needs, protect and reconnect existing high-quality habitat, use current knowledge of restoration effectiveness and probability of success to meet specific watershed and salmonid population needs. In general, it is recommended to focus on reconnecting high quality floodplain or instream habitats disconnected by artificial barriers.

Then, a focus on restoring watershed processes, followed by instream habitat enhancement work. Overall, more monitoring is required to more fully understand the impacts of different restoration techniques.

17. **Stevens, P., Cramer, S., Gaskill, P., and Carpenter, F. 2014. Rapid Habitat Assessment for Abernathy Creek: an Application of the Unit Characteristic Method. Prepared for the Lower Columbia Fish Recovery Board, Longview, Washington.**

    This report summarizes habitat conditions and recommends restoration strategies in Abernathy Creek. Data was collected during an August 2014 rapid habitat assessment across eleven Abernathy Creek reaches. Habitat data was used to calculate carrying capacity of spawning and rearing chum, Chinook, coho, and steelhead using the Unit Characteristic Method.

    Rearing habitat is more limited than spawning habitat across Abernathy Creek. This suggests that restoration projects should target rearing habitat enhancement. Specifically, projects that increase large woody material and increase the number of alcove and back channels, which are important to winter rearing coho salmon. Spawning habitat was primarily limited by gravel, which were covered by fine substrates in lower reaches.

18. **Zimmerman, M.S., Krueger, K., Ehinger, W., Bilby, R., Walters, J. and Quinn, T. 2015. Intensively Monitored Watersheds Program: Lower Columbia River Study Plan Update, 2015. Report to the Washington Salmon Recovery Funding Board Monitoring Panel.**

    This document updates the fish and habitat monitoring plan for Mill Creek, Abernathy Creek, and Germany Creek in the Lower Columbia IMW system. The monitoring plan utilizes both a Before-After Control-Impact (BACI) and a Before-After experimental design approach to measure fish responses to restoration actions and includes a power analysis, to determine the number of restoration actions required to result in detectable fish responses per study stream and species. Additionally, recommendations are included for the Lower Columbia IMW study, including the need for more habitat project implementation, continued assessment of fish-habitat relationship for baseline data, and further research on coho salmon summer rearing influence on spring smolt outmigration and fall migrant life history.

    Hypothesized fish responses to habitat restoration actions are included and will be tested once enough habitat restoration projects are fully implemented. Nutrient enhancement is the only fully implemented restoration action in which fish responses can be measured, and preliminary results suggest that spring nutrient treatment results in a stronger ecosystem response than fall nutrient treatment, but that the ecosystem responses was temporary, with no change in resulting smolt abundance or body size.

19. **Zimmerman, M.S., Johnson, T., Krueger, K., and W. Ehinger. 2016. Overview of Lower Columbia IMW. Presentation to Lower Columbia IMW Technical Oversight Group, Kelso, Washington.**

    This presentation was given to the Lower Columbia IMW Technical Oversight Group (TOG) with the goal of: a) reviewing Washington IMW goals, b) summarizing the experimental design AND monitoring approach in the Lower Columbia IMW c) presenting pre-restoration monitoring results, and d) framing discussion of restoration project prioritization and monitoring recommendations at the TOG meeting.

Pre-restoration monitoring results included spawning distribution of Chinook, coho, and steelhead, smolt production, and habitat metrics across the three study streams. Excessive bedload transport was the main habitat concern, and restoration projects may not be fully effective until this watershed process is addressed. Apparent overwinter survival of coho salmon was studied more in-depth, due to the two discrete outmigration time periods observed (fall movers and spring smolts) in Abernathy Creek. Survival was positively associated with larger summer fish size for all juvenile coho salmon. Fall movers were correlated with lower watershed mainstem summer rearing, while spring smolts were correlated with small tributary and upper watershed mainstem summer rearing. These relationships suggest that summer growth and winter rearing influence survival and movement timing of juvenile coho salmon, and that restoration projects should consider these spatial and temporal relationships.

20. **Zimmerman, M.S., Krueger, K., and W. Ehinger. 2016. Lower Columbia Intensively Monitored Watersheds Study: 2016 Annual Report. Washington Department of Fish and Wildlife. Olympia, Washington. Report to the SRFB Monitoring Panel.**

    This report summarizes tasks and results conducted and collected from October 2014 through September 2015 in Lower Columbia IMW complex. Tasks included life cycle monitoring for salmon and steelhead in Mill Creek, Abernathy Creek, and Germany Creek, restoration action progress, and reporting timelines for fish-habitat responses to restoration treatment.

Appendix A

Original proposed project names, scoring, and prioritization order for the sixty IMW treatment plan projects (HDR Inc. and Cramer Fish Sciences, 2009). Original proposed projects are matched with any completed, in-progress (funded), or proposed for likely implementation, as of summer 2016. Treatment types are added based on TOG and LCFRB discussions, with the goal of determining the expected functional habitat and fish responses to treatment project implementation.

Phase	Proposed Project Name	EDT Tier	PAR Score	Cost	Benefit /Cost	Opportunity /Constraints Score	Total Benefit Score	Proposed Treatment Type 1	Proposed Treatment Type 2	Proposed Treatment Type 3	Project ID	Project Status	Project Name	Actual Treatment Type 1	Actual Treatment Type 2	Actual Treatment Type 3
1	Abernathy 9-G	1	101	$ 500,485	9	high opportunity	141	Off-Channel/ Side-Channel Reconnection			11-1386	Completed	Abernathy Creek Two Bridges	Floodplain Reconnection	Instream Habitat Complexity	
1	Abernathy 2-A	1	35	$ 260,640	16	high opportunity	135	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	Riparian Planting/ Management	10-1300-01	Completed	Abernathy Creek Tidal Restoration	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	Floodplain Reconnection
1	Abernathy 9-A	1	77	$ 589,262	6	moderate	117	Instream Habitat Complexity	Riparian Planting/ Management		11-1386	Completed	Abernathy Creek Two Bridges	Floodplain Reconnection	Instream Habitat Complexity	
1	Abernathy 9-A	1	77	$ 589,262	6	moderate	117	Instream Habitat Complexity	Riparian Planting/ Management		14-1310	Funded	Abernathy Creek Wisconsin Site Project (downstream)	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection	
1	Abernathy 9-A	1	77	$ 589,262	6	moderate	117	Instream Habitat Complexity	Riparian Planting/ Management		NOAA via PCSRF: 0000	Funded	Abernathy Creek Wisconsin Site Project (upstream)	Instream Habitat Complexity		
1	Abernathy 10-B	1	62	$ 608,933	6	high opportunity	112	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		13-1152	Completed	Abernathy Sitka Spruce	Instream Habitat Complexity	Floodplain Reconnection	
1	Abernathy 3-C	1	21	$ 138,959	26	high opportunity	112	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection		14-1311	Funded	Abernathy Creek Cameron Site	Instream Habitat Complexity	Floodplain Reconnection	
1	Abernathy 5-A	1	20	$ 137,500	25	high opportunity	106	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity							
1	Germany 2-A	1	15	$ 282,360	12	high opportunity	106	Instream Habitat Complexity	Riparian Planting/ Management							
1	Germany 5-D	1	46	$ 897,149	4	Constraints	105	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity							
1	Abernathy 3-A	1	10	$ 125,000	26	moderate	101	Instream Habitat Complexity								
1	Abernathy 3-B	1	10	$ 130,320	25	high opportunity	101	Instream Habitat Complexity								

Phase	Proposed Project Name	EDT Tier	PAR Score	Cost	Benefit /Cost	Opportunity /Constraints Score	Total Benefit Score	Proposed Treatment Type 1	Proposed Treatment Type 2	Proposed Treatment Type 3	Project ID	Project Status	Project Name	Actual Treatment Type 1	Actual Treatment Type 2	Actual Treatment Type 3
1	Germany 5-A	1	39	$ 274,732	11	moderate	98	Instream Habitat Complexity	Riparian Planting/ Management		15-1040	Funded	Germany Creek Andrews Site	Instream Habitat Complexity	Riparian Planting/ Management	
1	Germany 2-C	1	6	$ 298,650	10	high opportunity	97	Riparian Planting/ Management			09-1378	Completed	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	Instream Habitat Complexity	
1	Germany 2-B	1	3	$ 47,325	63	high opportunity	94	Bank Stabilization	Instream Habitat Complexity	Riparian Planting/ Management	09-1378	Completed	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	Instream Habitat Complexity	
1	Germany 5-B	1	34	$ 569,343	5	Constraints	93	Instream Habitat Complexity	Riparian Planting/ Management							
1	Abernathy 9-F	1	50	$ 221,659	13	high opportunity	91	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		14-1310	Funded	Abernathy Creek Wisconsin Site Project (downstream)	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection	
1	Abernathy 9-F	1	50	$ 221,659	13	high opportunity	91	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		NOAA via PCSRF	Funded	Abernathy Creek Wisconsin Site Project (upstream)	Instream Habitat Complexity		
1	Abernathy 1-A	1	4	$ 80,000	36	high opportunity	91	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		10-1300-01	Completed	Abernathy Creek Tidal Restoration	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	Floodplain Reconnection
1	Germany 5-C	1	19	$ 189,096	13	Constraints	78	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection	Riparian Planting/ Management	15-1039	Funded	Germany Creek Restoration Smith Site	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection	Riparian Planting/ Management
1	Germany 5-F	1	13	$ 223,570	10	Constraints	72	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity							
1	Germany 6-F	1	26	$ 330,490	6	Constraints	67	Off-Channel/ Side-Channel Reconnection	Riparian Planting/ Management							
1	Abernathy 10-A	1	16	$ 120,357	17	high opportunity	66	Instream Habitat Complexity	Riparian Planting/ Management		15-1127	Funded	Abernathy Creek Headwaters Implementation	Instream Habitat Complexity		
2	Abernathy 7-A	1	1	$ 36,200	56	moderate	64	Riparian Planting/ Management								
2	Germany 5-E	1	2	$ 43,440	45	Constraints	61	Bank Stabilization	Instream Habitat Complexity							

Phase	Proposed Project Name	EDT Tier	PAR Score	Cost	Benefit /Cost	Opportunity /Constraints Score	Total Benefit Score	Proposed Treatment Type 1	Proposed Treatment Type 2	Proposed Treatment Type 3	Project ID	Project Status	Project Name	Actual Treatment Type 1	Actual Treatment Type 2	Actual Treatment Type 3
2	Germany 8-A	1	10	$ 187,000	9	high opportunity	55	Instream Habitat Complexity	Floodplain Reconnection							
2	Germany 6-E	1	12	$ 121,639	14	Constraints	53	Off-Channel/ Side-Channel Reconnection								
2	Germany 6-D	1	11	$ 72,160	23	Constraints	52	Off-Channel/ Side-Channel Reconnection	Riparian Planting/ Management							
2	Germany 10-A	1	9	$ 104,178	15	moderate	50	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection							
2	Germany 10-B	1	7	$ 55,000	28	high opportunity	48	Fish Passage								
2	Germany 6-A	1	6	$ 612,658	2	Constraints	47	Riparian Planting/ Management			16-1521	Not Funded	Germany Creek Stream Restoration Godinho			
2	Abernathy 9-C	1	6	$ 130,320	12	high opportunity	47	Off-Channel/ Side-Channel Reconnection								
2	Germany 6-C	1	4	$ 144,320	10	Constraints	45	Instream Habitat Complexity	Riparian Planting/ Management	Floodplain Reconnection	16-1521	Not Funded	Germany Creek Stream Restoration Godinho			
2	Abernathy 9-E	1	3	$ 100,000	14	high opportunity	44	Floodplain Reconnection			11-1329	Completed	Abernathy Creek Bridge Removal Project	Floodplain Reconnection	Riparian Planting/ Management	
2	Abernathy 9-B	1	3	$ 115,000	12	high opportunity	44	Off-Channel/ Side-Channel Reconnection								
2	Abernathy 9-I	1	2	$ 64,367	21	high opportunity	43	Off-Channel/ Side-Channel Reconnection								
2	Abernathy 9-H	1	1	$ 123,409	11	high opportunity	42	Riparian Planting/ Management								
2	Abernathy 9-J	1	0	$ 27,424	48	high opportunity	41	Riparian Planting/ Management								
2	Abernathy 9-K	1	0	$ 27,424	48	moderate	41	Riparian Planting/ Management								
2	Germany 6-B	1	0	$ 42,000	31	Constraints	41	Bank Stabilization								

Phase	Proposed Project Name	EDT Tier	PAR Score	Cost	Benefit /Cost	Opportunity /Constraints Score	Total Benefit Score	Proposed Treatment Type 1	Proposed Treatment Type 2	Proposed Treatment Type 3	Project ID	Project Status	Project Name	Actual Treatment Type 1	Actual Treatment Type 2	Actual Treatment Type 3
2	Germany 3-A	2	35	$ 243,905	17	high opportunity	130	Instream Habitat Complexity	Riparian Planting/ Management							
2	Cameron 1-B	2	55	$ 95,000	37	high opportunity	109	Instream Habitat Complexity			14-1311	Funded	Abernathy Creek Cameron Site	Instream Habitat Complexity	Floodplain Reconnection	
2	Germany 3-C	2	13	$ 60,209	52	high opportunity	99	Instream Habitat Complexity	Riparian Planting/ Management							
3	Germany 3-D	2	13	$ 72,250	44	high opportunity	99	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	Riparian Planting/ Management						
3	Germany 3-B	2	12	$ 244,567	13	high opportunity	98	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	Riparian Planting/ Management						
3	Germany 3-E	2	2	$ 40,565	69	high opportunity	89	Bank Stabilization	Instream Habitat Complexity	Riparian Planting/ Management	09-1378	Completed	Germany Creek Conservation and Restoration Phase 2	Riparian Planting/ Management	Instream Habitat Complexity	
3	Abernathy 4-C	2	11	$ 219,113	12	moderate	83	Off-Channel/ Side-Channel Reconnection								
3	Abernathy 4-A	2	7	$ 101,024	25	high opportunity	80	Off-Channel/ Side-Channel Reconnection	Riparian Planting/ Management		12-1333	Completed	Abernathy 5A Side Channel Project	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	
3	Abernathy 4-D	2	7	$ 252,771	10	moderate	80	Instream Habitat Complexity	Riparian Planting/ Management		14-1296	Funded	Abernathy Creek Davis Site	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	
3	Germany 4-A	2	6	$ 367,875	7	moderate	79	Instream Habitat Complexity	Riparian Planting/ Management							
3	Abernathy 4-E	2	5	$ 69,479	36	moderate	78	Off-Channel/ Side-Channel Reconnection			14-1296	Funded	Abernathy Creek Davis Site	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity	
3	Abernathy 4-B	2	4	$ 78,400	31	moderate	77	Bank Stabilization								
3	Germany 13-A	2	24	$ 60,000	37	high opportunity	69	Instream Habitat Complexity								
3	Cameron 1-A	2	3	$ 112,500	16	high opportunity	57	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		14-1311	Funded	Abernathy Creek Cameron Site	Instream Habitat Complexity	Floodplain Reconnection	

Phase	Proposed Project Name	EDT Tier	PAR Score	Cost	Benefit /Cost	Opportunity /Constraints Score	Total Benefit Score	Proposed Treatment Type 1	Proposed Treatment Type 2	Proposed Treatment Type 3	Project ID	Project Status	Project Name	Actual Treatment Type 1	Actual Treatment Type 2	Actual Treatment Type 3
3	Abernathy 11-A	2	12	$ 330,485	5	high opportunity	48	Instream Habitat Complexity	Riparian Planting/ Management		15-1127	Funded	Abernathy Creek Headwaters Implementation	Instream Habitat Complexity		
3	Germany 13-B	2	2	$ 112,500	13	high opportunity	47	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity							
3	Germany 13-C	2	1	$ 47,784	31	moderate	46	Bank Stabilization								
3	Sarah 1-A	2	9	$ 60,000	24	high opportunity	45	Fish Passage	Instream Habitat Complexity		16-1533	Proposed	Sarah Creek Habitat & Passage Enhancement	Fish Passage	Instream Habitat Complexity	
3	Ordway 1-A	2	0	$ 11,557	100	high opportunity	36	Off-Channel/ Side-Channel Reconnection	Instream Habitat Complexity		15-1127	Funded	Abernathy Creek Headwaters Implementation	Instream Habitat Complexity		
3	Germany 1-A	3	11	$ 260,640	10	moderate	79	Riparian Planting/ Management	Bank Stabilization	Floodplain Reconnection						
3	Weist 1-A	3	16	$ 446,006	2	moderate	34	Riparian Planting/ Management	Instream Habitat Complexity	Off-Channel/ Side-Channel Reconnection						
3	Germany 11-A	4	47	$ 100,000	25	high opportunity	79	Instream Habitat Complexity								
3	Germany 12-A	4	10	$ 100,000	13	high opportunity	42	Instream Habitat Complexity								