UCRTT Deliberations

"Do the apparently positive results of this study suggest that the UCRTT will be recommending installation of more small wood structures?," was the immediate feedback the UCRTT received from WATs and project sponsors. While the study was short term, only one year, and only looked at a small sample size of structures in a particular habitat type (the Lower Entiat), the study was intensive and well designed. Similarly, the Biological Strategy objective of "increasing stream habitat complexity" suggests that treatments ought to be developed over a wide range of shapes and sizes. Smaller pools, for example, may have biological benefits unrealized by large pools, and a range of habitat sizes can increase "instream habitat diversity." However, concerns about siting, scaling, and structure longevity will likely be amplified for small-scale projects. For instance, it may be counter productive to recovery objectives if the installation process damages riparian habitat, particularly if a small-scale project may not survive the next flood or have other long-term benefits. Furthermore, smaller-scale treatments may be less likely to effect the geomorphic changes on the river (like "thalweg development" and "channel forming processes") that is the second half of the two-pronged approach in the lower Entiat. Therefore, small-scale structures may be a part of meetinghabitat restoration objectives and will continue to be considered for future implementation, particularly if these types of structures are used where existing habitat values won't be diminished or used to augment channel forming processes and floodplain function.

tion treatments might be necessary to detect impacts to fish populations. Short-term data such as these help identify temporal variation in the use of treated vs. untreated habitat and whether there is a measurable change in density dependent life history traits such as growth and movement. Restoration treatments show some measurable positive impact on the species of concern but further analysis and more data are required to establish these conclusions more firmly.

Effectiveness of Actions in Beaver Creek

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Background

Actions were taken to replace four diversion dams in lower Beaver Creek with rock vortex weirs in order to enhance fish passage while maintaining the ability to divert water to gravity-fed irrigation ditches. Some of these diversion dams had been in place for over 100 years, and have impaired or completely blocked upstream migration of fish. Three diversion dams were replaced in 2003 (Lower Stokes, Thurlow Transfer, and Upper Stokes), and the forth and most-downstream (Rkm 2) diversion dam was replaced in 2004 (Fort-Thurlow). Four vortex weirs were designed and installed under the supervision of U.S. Bureau of Reclamation engineers and completed in accordance to National Marine Fisheries Service and Washington Department of Fisheries and Wildlife fish passage criteria. An effectiveness monitoring effort was warranted since installing rock vortex weirs represents a relatively new methodology and little information was available for their effectiveness of passing fish species of the Pacific Northwest.

Objectives

The primary objectives of the study were to: 1) assess effectiveness of the modified irrigation diversion structures for passage of fish, and 2) to document subsequent changes in fish populations in Beaver Creek.

Methods

An extensive PIT-tagging program with four PIT-tag detection antennas and a fish sampling weir was used to monitor the success of upstream passage of fish and to assess growth and survival within Beaver Creek (Figure 1). Electrofishing was used to survey and collect fish to measure change in fish assemblage, smolt production, and diversity of life history expression above the modified structures. Three sites in Beaver Creek were chosen for isotope analysis to represent the range of change in use by anadromous fish as the diversions were replaced with vortex weirs (Figures 2 and 3). For example, the lowest site (Rkm 3) was above two water diversions and we expected a large increase in

Figure 1. Sites for locations of PIT-tag interrogators, fish trap, and 500-m population electrofishing surveys in Beaver Creek. A2 = Upper Beaver Creek small interrogator, B0 = R1 large interrogator, A4 = R1 small interrogator, and A6 = Lower Beaver Creek small interrogator.

UCRTT Deliberations

- The monitoring program in Beaver Creek provides a unique and in-depth evaluation of the effectiveness of fish passage efforts in a small sub-watershed.
- This study also provides life history, phenotypic, and ecological information that could provide valuable insight for future evaluations following the re-colonization of Beaver Creek.
- The barrier passage efforts in Beaver Creek appear to have alleviated the primary limiting factor for this major spawning area of the Methow population.

anadromous fish in this reach after the diversions were replaced with vortex weirs. The middle site (Rkm 13) was selected because we expected to see some limited anadromous fish use after the water diversions were replaced with vortex weirs. Samples for isotope analysis were collected from fish, algae, leaves (cottonwood, red alder), and insects in fall 2004, and spring and fall 2005 and 2006, and the spring 2007.

Three 500m index sites (location of these sites was based largely on geomorphology and access) were sampled using electrofishing to obtain population and growth estimates (which were also obtained from the recapture of tagged fish at the fish sampling weir). Surveys were conducted during the spring, summer, and fall to collect previously PIT-tagged fish. Recapture data were analyzed by season of year. Recapture events were used when a fish was captured within the next season from its tagging or last recapture event. Since no sampling occurred during winter, we assessed growth for fish tagged (or recaptured) in the fall and recaptured in the spring. Recaptured fish were used only if they were recaptured after 10 days of their tagging or last recapture date. We defined seasons as: spring (March-May), summer (June-August), fall (September-November), and winter (December-February).

Results

After the lowermost remaining water diversion in Beaver Creek was replaced with a vortex weir, we collected or detected mountain whitefish, coho, and juvenile and adult Chinook at the R1 index site or large interrogator (Figure 4). Based on changes in fish assemblage, connectivity has been reestablished for a number of members of the fish community. Our PIT tag interrogator data indicate a four-fold increase from 2005-06 to 2007-08 in the number of potentially spawning adult steelhead getting past Rkm 4, with some getting past Rkm 12 by 2007 (Figure 5). Success of natural recolonization appears to be progressing, but it will likely take more time to realize full potential. In 2005, 2006 and 2008 the majority of recolonizing adults were wild.

The vortex weirs were demonstrated to be very effective in passing fish, including successful upstream passage of juvenile salmonids at all flow levels, even at flow levels as low as 2.3 cfs (0.07 m3/s; Figure 6). However, the rate at which rainbow trout/juvenile steelhead (Oncorhynchus mykiss) swam past the vortex weirs was significantly slower than the passage rate at the control reach (X2 = 8.32, P = 0.004).

In Beaver Creek, O. mykiss juveniles off all ages were most prevalent at the lowermost (R1) index site. The biomass of age-1 and older juvenile O. mykiss at the R1 index site was almost double the biomass of at other index sites sampled in the Methow watershed.

We found similar results of age-1 or older fish densities from 2004 to 2005 (Figure 7). The population of age-0 O. mykiss decreased in the R1 and R2 index sites in 2005, while the R4 index site's population increased. The biomass of O. mykiss in R1 and R2 decreased from 2004 to 2005, while the biomass increased

Figures 2 and 3. Before and after photographs of Beaver Creek. Left: Diversion dam in Beaver Creek that impaired or completely blocked fish passage upstream. Right: Diversion dam replaced with instream vortex weir allowing fish passage and maintaining ability to divert water for irrigation.

	Before: Lower	Before: Reach 1	Before: Reach 2	Before: Reach 4	After: Lower	After: Reach 1	After: Reach 2	After: Reach 4
Brook trout	x	x	x	x	x	x	x	x
Smallmouth bass	x				x			
Bridgelip sucker	x				x			
Longnose dace	x				x			
Shorthead sculpin	x	x	x		x	x	x	
Mountain whitefish	x				x	[x]		
Bull trout	x			x	x		[x]	x
Cutthroat trout				x	x			x
Rainbow trout/steelhead	x	x	x	x	x	x	x	x
Chinook salmon	x				x	[x]		
Coho salmon	x				x	[x]		

Figure 4. The presence of fish species in selected sections of Beaver Creek before and after the reconstruction of the lowest remaining water diversion.

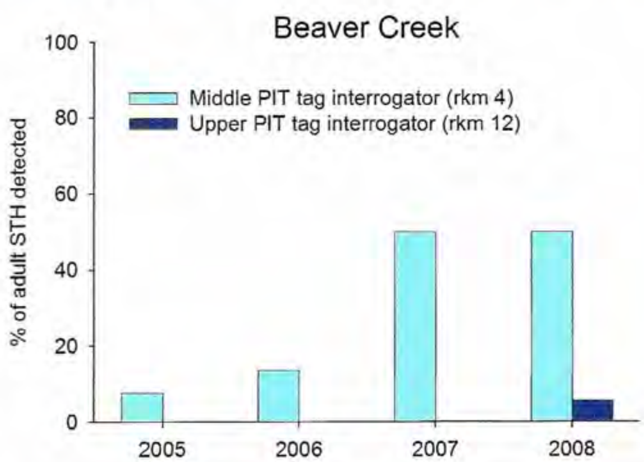

Figure 5. Percentage of adult steelhead caught at the weir and then detected upstream at the PIT tag detectors in Beaver Creek.

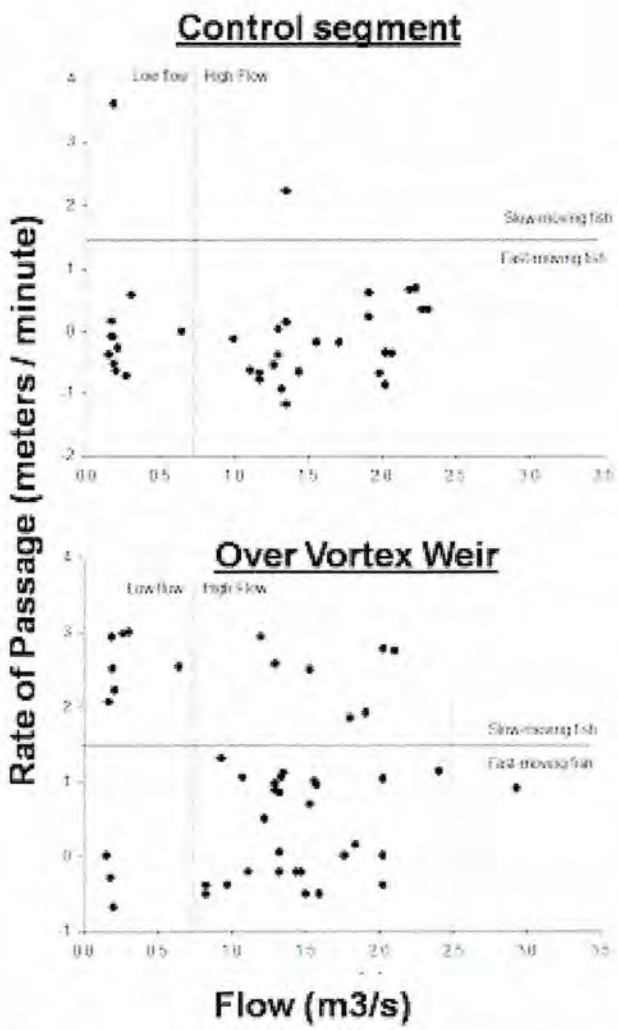

Figure 6. Rate of passage of juvenile steelhead across vortex weirs at various flows.

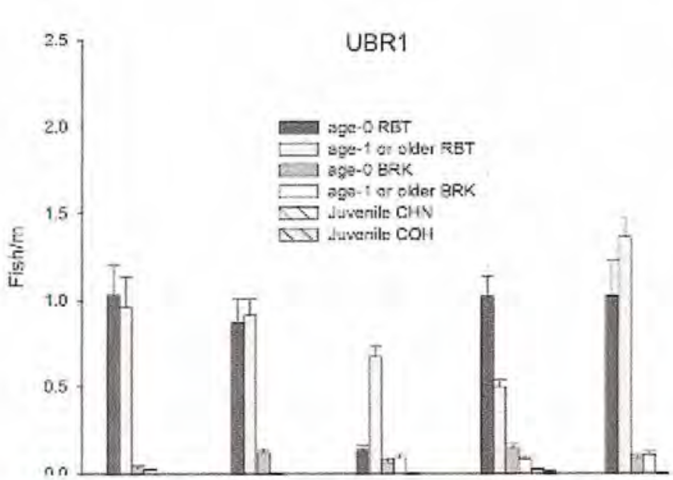

Figure 7. Salmonid abundance in upper Beaver Creek (Reach R1, Rkm 5) from 2004 to 2008.

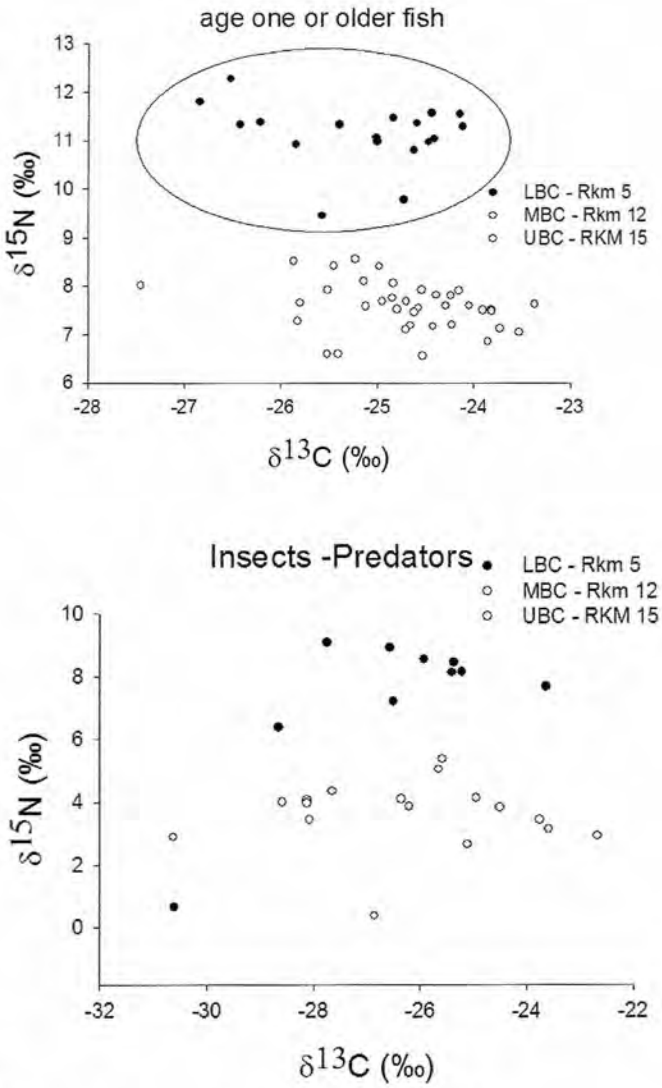

Figure 8. Isotope ratios (N, C) from 2004-2007.

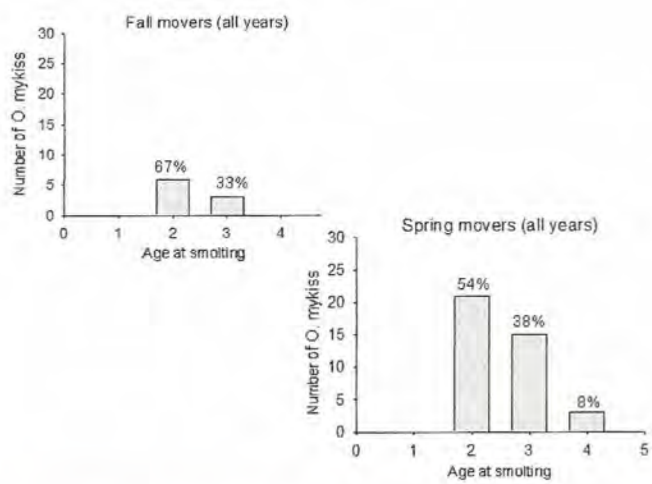

Figure 9. Lower Beaver Creek (R1) 2004-2007 age of smolts from two life history trajectorie, as detected in the Columbia River PIT tag interrogation network.

Year	Number PIT tagged	Number detected					
		2004	2005	2006	2007	2008	2009
2004	281	0	0	2	4	2	1
2005	169	--	0	0	1	3	1
2006	136	--	--	0	0	5	0
2007	113	--	--	--	0	1	1
2008	37	--	--	--	--	0	0

Table 1. Number of age 1 O. mykiss PIT tagged above Rkm 12, and then detected moving downstream past Rkm 4 (Stokes reader).

Year	Number PIT tagged	Number detected					
		2004	2005	2006	2007	2008	2009
2004	150	27	53	15	0	0	0
2005	140	--	31	30	1	0	0
2006	104	--	--	1	15	5	0
2007	50	--	--	--	13	8	1
2008	279	--	--	--	--	80	32

Table 2. Number of age 1 O. mykiss PIT tagged near Rkm 5, and then detected moving downstream past Rkm 4 (Stokes reader).

in R4. The population of age-0 and age-1 or older O. mykiss in Beaver Creek decreased at each upstream sampling site.

Because of the infancy of our analysis, we did not attempt a statistical analysis of the isotope data but present a brief qualitative analysis (Figure 8). The marine-derived isotopic signature indicates that anadromous fish currently use lower Beaver Creek (Rkm 5; solid circles in Figure 8) but also were present in lower Beaver Creek prior to the conversion of the Fort Thurlow and Lower Stokes water diversions to vortex weirs. Isotopic signatures suggest that the middle (rkm12) and upper (Rkm 15) reaches of Beaver Creek were not used by anadromous salmonids.

Juvenile O. mykiss that were tagged above Rkm 12 and that were subsequently detected moving downstream past the lower vortex weir at Rkm 4 were typically detected from 3 to 6 years after tagging and were detected at low levels (Table 1). Juvenile O. mykiss that were tagged above Rkm 5 and that were subsequently detected moving downstream past the lower vortex weir at Rkm 4 were typically detected from 1 to 3 years after tagging and were detected at higher levels (Table 2). A pattern of downstream movement was observed, with O. mykiss emigration prominent in April through June and in September through November.

We found differential smolting success of steelhead from the expressed life history strategies, where those juveniles that remain in the creek until smolting are contributing more to the smolt population than are fish which leave Beaver Creek in the fall at age-1 (Figure 9). Steelhead and other members of the fish community are actively recolonizing Beaver Creek but lower Beaver Creek is producing the majority of steelhead smolts.

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