Lower Columbia River Channel Improvement: Assessment of Salmonid Populations and Habitat on Tenasillahe and Welch Islands

2007 Project Report

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Introduction

Multiple factors have contributed to the decline of anadromous salmonids throughout the Columbia River basin. The lower Columbia River and estuary are of particular importance because all stocks of anadromous salmonids within the basin use the area to varying extents, especially as rearing habitat for juveniles. Lower Columbia River habitats have been substantially altered by such factors as flow manipulation and reduced connectivity among the river, tidal wetlands, and the floodplain. For instance, the construction of dikes and filling of tidal wetlands has resulted in a 65% reduction of tidal marshes and swamps compared to that historically present (Bottom et al. 2005).

Restoring tidally-influenced wetlands to improve conditions for juvenile anadromous salmonids has been included in recovery and management plans and regulatory requirements, such and the Subbasin Plan for the Columbia Mainstem and Estuary (Lower Columbia Fish Recovery Board (LCFRB) 2004) and NOAA Fisheries' FCRPS Biological Opinions (NOAA 2004). Although restoring tidal wetlands and improving fish access to them are major components of recovery strategies for anadromous salmonids, considerable uncertainty exists concerning appropriate restoration actions. Information on specific habitat requirements and restoration needs of juvenile salmonids in these areas is lacking (Bottom et al. 2005). An approach to assist in alleviating uncertainties and evaluating restoration strategies is to conduct before-after-control impact monitoring (BACI; e.g., described in Diefenderfer et al. 2005), which includes comparisons of variables of interest among reference and treatment sites both

before and after implementation of restoration actions at treatment sites. In the case of the lower Columbia River, the intent of such evaluations is to improve our understanding of the habitat relations of juvenile salmonids and assist in developing and implementing additional restoration actions.

Both Tenasillahe and Welch islands (Figure 1) are part of the National Wildlife Refuge system, which is managed by the U.S. Fish and Wildlife Service. The islands are adjacent to each other and located at about river kilometer 56 in the lower Columbia River. Much of the tidal marsh habitat historically occurring at Tenasillahe Island was altered due to the construction of dikes around the island during the course of the last century. Aquatic habitat on the island now consists primarily of a network of interior sloughs connected to the Columbia River via two tide gates. Tenasillahe Island is currently managed, primarily, to provide habitat for Columbian White-tailed deer. The tidal marsh habitat on Welch Island is relatively pristine. It does not appear that Welch Island was ever settled by humans, roads do not currently exist on the island, and none of the sloughs on the island have been diked. Thus, these two islands provide an opportunity to compare diked sloughs to un-impacted sloughs, under a BACI-type framework.

The U.S. Army Corps of Engineers (USACOE) has proposed and has begun a phased restoration project at Tenasillahe Island intended to benefit juvenile salmonids while balancing the needs of white-tailed deer. The interim phase includes modifications to tide gates to improve water movement and juvenile salmonid ingress and egress between the sloughs and river. Activities of

the final phase may include breaching dikes on the island to restore natural tidal circulation. Proposed long-term restoration actions are contingent upon delisting of the Columbian white-tailed deer and a finding that the activities are compatible with the purposes and goals of the refuge. This project offers an opportunity to conduct pre- and post-construction monitoring that will assist in evaluating the overall effectiveness of the restoration project and will likely contribute to other potential restoration efforts in the Columbia River estuary.

The U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office (CRFPO) has begun to monitor biological and physical attributes of sloughs on Tenasillahe Island using a BACI-type approach. The overall approach is to describe fish presence in, distribution through, and habitat use of sloughs, as well as habitat conditions. The project focuses on the time when juvenile salmonids are in the areas, likely March-July. Comparisons were conducted among sloughs on Tenasillahe Island (treatment site), before construction associated with the USACOE restoration project, and sloughs on Welch Island (reference site), which is not influenced by dikes and tide gates. These comparisons will assist in evaluating the effects of the restoration project and likely contribute to other potential restoration efforts in the Columbia River estuary. Overall, this project uses a BACI-type approach, which will involve multiple years and specifically compare pre- and post-construction restoration periods. This proposal focuses on work that would be conducted during 2007. Pilot work conducted during June-August 2005 yielded preliminary information concerning fish and habitats in the sloughs, and insights into logistical constraints

such as access to sample sites and fish sampling methods amenable to conditions within the sloughs. Work conducted in March through June 2006 provided information on fish habitat and salmonid distribution during spring emigration. Sampling activities conducted during March through May 2007 focused on assessing fish movements into and out of Large Tenasillahe Slough (LTS).

Specific objectives addressed in 2007 were 1. Determine whether juvenile salmon enter or leave Large Tenasillahe Slough, 2. Determine capture efficiency of tide gate traps for juvenile salmon, 3. Describe juvenile salmon residence time in Large Tenasillahe Slough. This work concludes pre-construction assessment of fish community and habitat conditions.

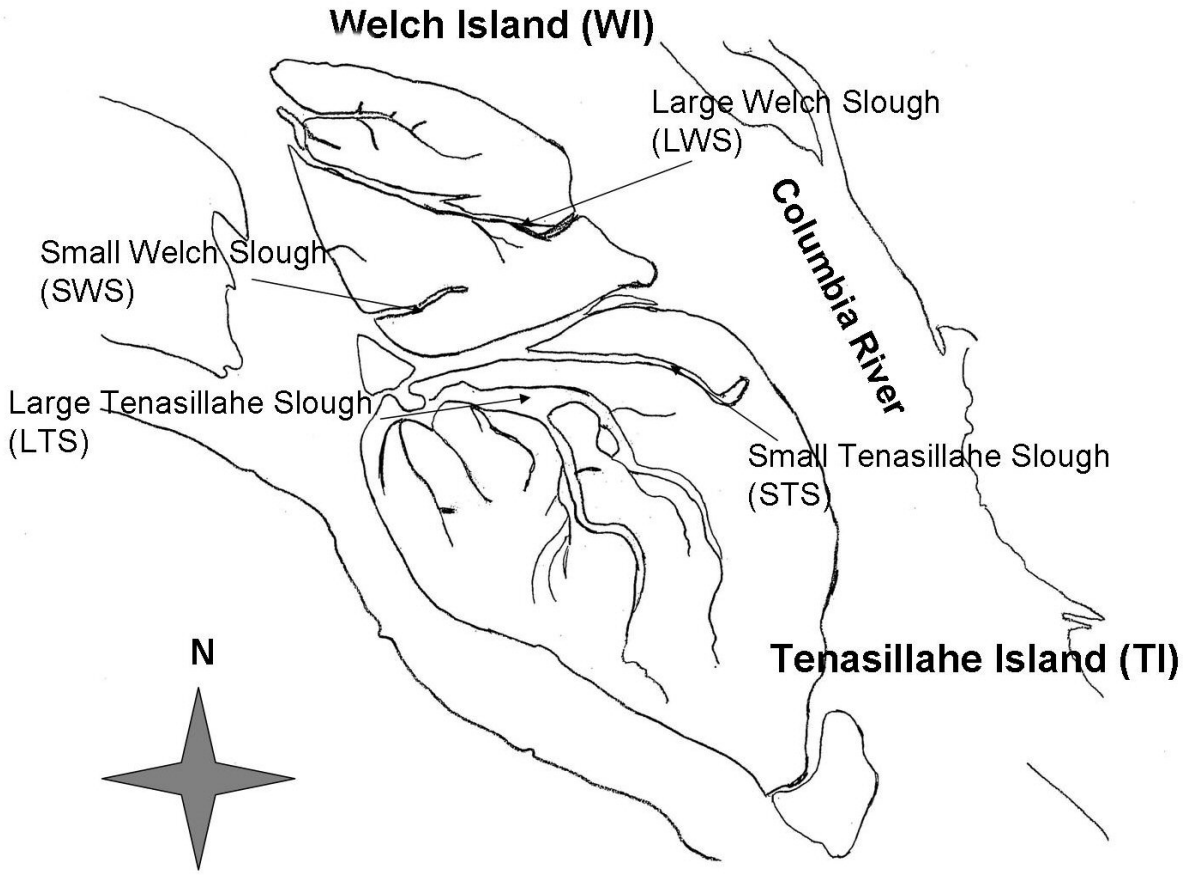

Figure 1. Area map of Tenasillahe Island and Welch Island showing locations of sloughs.

Methods

LTS tide gate passage

A primary goal of this study is to learn whether juvenile salmonids enter and use large Tenasillahe Slough (LTS). The design of the LTS tide gates and culverts allow capture of fish entering or leaving LTS. Three 2.1 m diameter culverts pass water from LTS toward three separate tide gates. Water flowing by each tide gate enters a separate caisson that in turn drains toward the Columbia River through one of three culverts (Figure 2). Two fish traps were installed on

two slough side culverts to capture fish entering the slough through the tide gates. These traps were installed on March 15 and were removed May 14. On April 17 a fish trap was installed on the river side of the remaining culvert to capture fish exiting the slough. This trap was removed May 16. Traps were removed when construction began on LTS tide gates. All three traps were checked daily for fish. All captured fish were identified, enumerated and length was documented for all captured salmonids.

Capture Efficiency

In an attempt to determine culvert-trapping efficiency of juvenile salmonids, a known number of PIT tagged fish were released in LTS and were available for recapture during culvert trap operation. On April17, 896 PIT tagged Tule Fall Chinook were transported from Little White Salmon National Fish Hatchery to Cathlamet, Washington. All fish were scanned for Pit tag identification, weighed and measured for length. Groups of PIT tagged fall chinook (220-226) were released into reach 1, 2, 4 and 8 (Figure 3). Fish were acclimated to LTS water following methods used during 2006 (Johnson *et. al*. 2007). To test delayed mortality, ten PIT tagged fish were held inside a pair of holding traps (five fish per trap) at each release location for 24 hours. Holding traps consisted of a pair of minnow traps with the opening pinched closed. Each set of holding traps was suspended approximately 0.5 meter below the surface of the water. Holding traps were checked after 24 hours. All delayed mortality fish were released into the respective reach.

Field crews installed PIT antenna arrays inside each tide gate bay on March 18, to detect movement of PIT tagged fish exiting LTS. The number of fish detected and the number of these fish subsequently captured in culvert traps were used to determine efficiency of the traps.

LTS residence time

Release and detection dates of PIT tagged hatchery fall chinook were used as surrogate of juvenile salmonid survival and residence times in LTS. Pit tagged fish were released April 17 and detected as described above. In addition, wild juvenile salmonids captured entering LTS were PIT tagged. These fish were then available from detection at the tide gate PIT antenna array. Tag and detection dates were then used to estimate residence time.

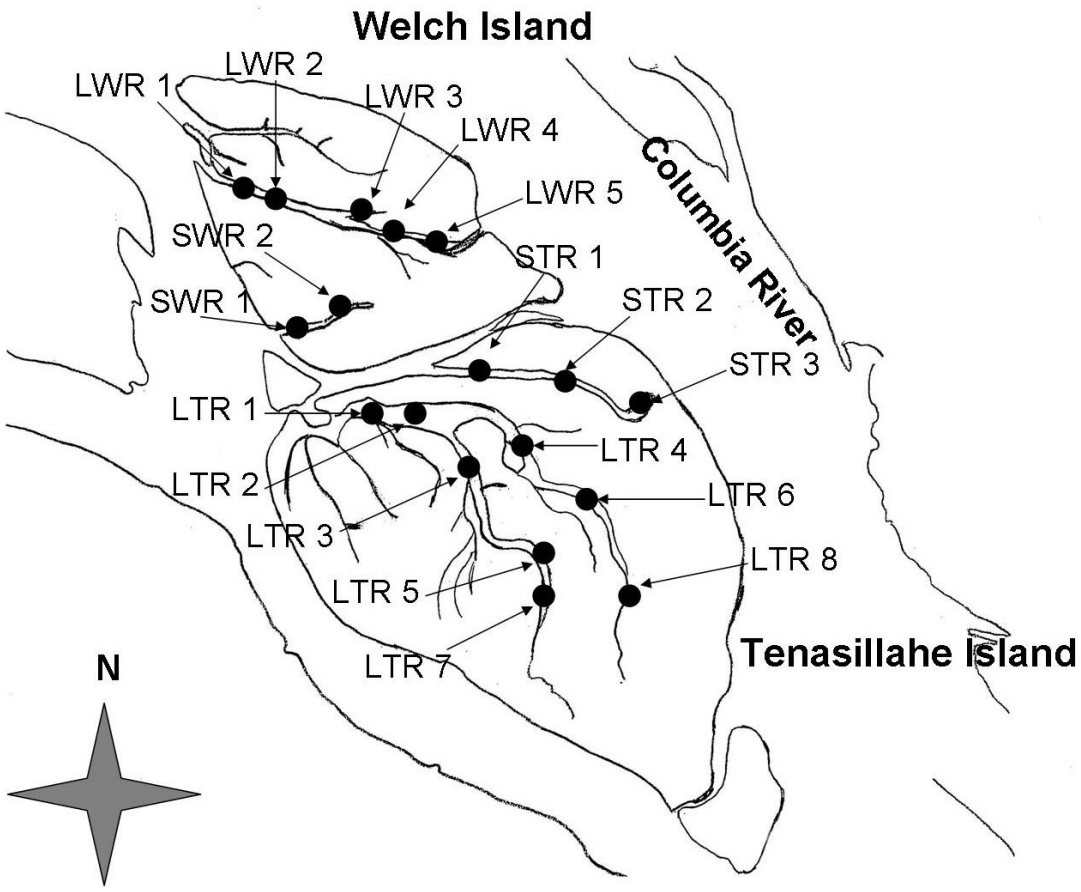

Figure 3. Tenasillahe Island and Welch Island sample reaches, 2007.

Results

LTS tide gate passage

Three juvenile Chinook salmon and two juvenile Coho salmon were captured entering through LTS tide gates between March 15 and May 14. A total of 814 additional fish were captured during the operation of these traps (Table 1). Of these, Peamouth, Largescale Sucker and Three-spine Stickleback were most prevalent in both traps. These species accounted for approximately 95% of all individuals entering LTS.

Table 1: Total fish captured and percentage of total trap catch in Large Tenasillahe Island slough tide gate traps, 2007.

Fish Species	# of individuals	% of Total
	Immigration trap #1	
Peamouth	184	65.48%
Largescale Sucker	62	22.06%
3-spine Stickleback	23	8.19%
Common Carp	4	1.42%
N. Pike Minnow	4	1.42%
Chinook Salmon	2	0.71%
Coho Salmon	1	0.36%
Sculpin	1	0.36%
Total	281	
	Immigration trap #2	
Peamouth	468	86.99%
3-spine Stickleback	54	10.04%
Largescale Sucker	8	1.49%
N. Pike Minnow	2	0.37%
Sculpin	2	0.37%
Bluegill	1	0.19%
Chinook Salmon	1	0.19%
Coho Salmon	1	0.19%
Common Carp	1	0.19%
Total	538	
	Emigration trap	
3-spine Stickleback	28314	94.76%
Peamouth	1116	3.73%
Chinook Salmon	203	0.68%
E. Banded Killifish	80	0.27%
Largescale Sucker	52	0.17%
Pumpkinseed	25	0.08%
Unknown Sunfish	21	0.07%
Yellow Perch	16	0.05%
Bluegill	14	0.05%
Sculpin	10	0.03%
Coho Salmon	8	0.03%
Common Carp	7	0.02%
N. Pike Minnow	7	0.02%
Crayfish	3	0.01%
Yellow Bullhead	3	0.01%
Cutthroat Trout	2	0.01%
Total	29881	

Approximately 30,000 individual fish were captured exiting through LTS tide gates. Three-spine Stickleback, Peamouth and Chinook salmon were most prevalent. Three-spine Stickleback accounted for 95% of all individuals. Two hundred three Chinook salmon were captured exiting LTS. Chinook can be separated into three groups by type of mark; PIT tagged, adipose clip and unmarked (Table 2). Median fork length and weights were significantly different among these three groups (Kruskal-Wallis one way ANOVA on Ranks followed by Dunn's multiple comparison procedure). Eight Coho and 2 coastal cutthroat trout were captured exiting LTS. Three of these Coho were adipose clipped and ranged from 132 mm to 139 mm fork length. The remaining five Coho were not marked and ranged from 40 to 113 mm fork length (mean=74.8 mm)

Table 2: Number, median fork length and median weight of Chinook salmon captured exiting Large Tenasillahe Island Slough. Measurements sharing superscript letters are significantly different.

	number	Median Fork length(mm)	Median weight
PIT tagged	76	79.5 ^{x}	4.9 ^{y}
Ad marked	99	143.5 ^{x}	29.8 ^{y}
unmarked	28	187 ^{x}	70.5 ^{y}

Capture Efficiency

Twenty-five PIT tagged fish detected while tide gate traps were in operation. Nineteen of these individuals were captured in one of the tide gate traps. This results in a tide gate trap efficiency of 76 percent. Due to PIT antenna array

equipment failure, the array was not operating for 36 hours after PIT tagged fish were released in LTS. During this time, 57 PIT tagged fish were captured in the tide gate traps. Applying the calculated trap efficiency to the number of captured individuals results in an estimate of 75 PIT tagged fish leaving LTS during this first 36 hours. The number of juvenile salmonids entering LTS, corrected for trap efficiency is four Chinook and three Coho during the time period March 15 and May 14.

LTS residence time

PIT tagged hatchery Chinook salmon that exited LTS took from one to 73 days to travel from release site and exit the tide gate (Table 3). The median number of days to exit was 38 - 41 for groups. Distance between release sites to the tide gate antenna array was between 330 and 2800 meters. Percent of fish detected leaving the slough ranged from 50 to 84 percent for different release groups. No PIT tagged fish other than study fish were detected at the array.

Table 3. Percent and number of PIT tagged and released hatchery chinook salmon detected at tide gate antenna array and the median days and range of time between release and detection.

	one	two	three	four
Number released	226	225	225	220
Distance (m)	2800	1500	595	330
%detected	50	81	83	84
Median(Range)	41 (1-68)	39 (1-70)	38 (1-73)	38 (1-69)

Discussion

Juvenile salmonids were able to enter Large Tenasillahe Slough through the tide gates March through May 2007 but at low numbers. Chinook and coho salmon juveniles were captured along with non-salmonid species entering LTS. These fish can only enter LTS when tide gates are open. Gates are open only when LTS water elevation is higher than Columbia River elevation thus fish must swim against water flow to enter LTS. Thought this behavior has been documented for juvenile salmonids (Haskell *et. al.* 2004), it is likely less common than active or passive flow with the current since they are in the process of smolting (seaward).

More juvenile salmonids were captured exiting LTS than entering. Of the 203 juvenile chinook captured exiting LTS, 76 were PIT tagged hatchery chinook that were released for capture efficiency calculation. The remaining likely entered LTS through the tide gates. It remains uncertain when these fish entered LTS. Given that these fish were significantly larger than the released PIT tagged fish, it is possible that they are older fish that over wintered in the lower Columbia River and LTS more specifically. They are unlikely to have entered LTS prior to the previous fall because LTS summer temperatures are detrimental to juvenile salmonids (Johnson *et. al.* 2007). We captured no chinook entering the slough that approached the size of this group, giving more evidence that individuals enter prior to spring outmigration.

Tide gate trap efficiency was 76% based on the emigration trap. Expanding the juvenile chinook captures with this efficiency equates to 167

juvenile Chinook salmon exiting LTS between 15 March and 15 May. Efficiency of tide gate traps was sufficient to estimate total number of juvenile salmonids exiting and entering Large Tenasillahe Slough while the traps were operational (March 15 through May 14, 2007).

Juvenile salmonids can inhabit and persist in and exit Large Tenasillahe Island slough. Depending on release location, 50 to 84% of Pit tagged hatchery chinook survived and exited LTS. Some exited up to 73 days after release, giving evidence that juvenile salmonids can survive Tenasillahe Island sloughs if given access. The pattern of survival and residence time is similar to that found with released fish in 2006 (Johnson *et. al.* 2007). Fish released furthest from the tide gates showed lower survival than those released closer in both years. The survival difference was greater in 2007. The mechanism for this difference is unknown and this study was not designed to investigate possible mechanisms.

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Appendix 1: Total fish captured and percentage of total trap catch in Tenasillahe Island and Welch Island sloughs, 2007.

Fish Species	# of individuals captured	Percentage of Total
	Large Tenasillahe (LTS)	
Yellow Bullhead	22	31.43%
Unknown Sunfish	14	20.00%
3-spine Stickleback	8	11.43%
Sculpin	7	10.00%
Pumpkinseed	7	10.00%
Peamouth	6	8.57%
Bluegill	3	4.29%
Brown Bullhead	2	2.86%
White Crappie	1	1.43%
Total	70	
	Large Welch (LWS)	
3-spine Stickleback	4995	96.50%
Chinook Salmon	68	1.31%
Sculpin	49	0.95%
Peamouth	25	0.48%
E. Banded Killifish	22	0.43%
Chum Salmon	6	0.12%
Largescale Sucker	4	0.08%
N. Pike Minnow	2	0.04%
Pacific Lamprey	2	0.04%
Starry Flounder	1	0.02%
W. Brook Lamprey	1	0.02%
Yellow Bullhead	1	0.02%
Total	5176	
	Small Welch (SWS)	
3-spine Stickleback	1316	95.57%
Sculpin	34	2.47%
Chinook Salmon	11	0.80%
Peamouth	10	0.73%
Crayfish	2	0.15%
E. Banded Killifish	2	0.15%
Common Carp	1	0.07%
N. Pike Minnow	1	0.07%
Total	1377	

Appendix 2: Total fish captured and percentage of total seine catch in Tenasillahe Island and Welch Island sloughs, 2007.

Fish Species	# of individuals captured	Percentage of Total
	Large Tenasillahe (LTS)	
3-spine Stickleback	6	75.00%
Sculpin	1	12.50%
Unknown Sunfish	1	12.50%
Total	8	
	Large Welch (LWS)	
3-spine Stickleback	3176	94.72%
Chinook Salmon	159	4.74%
Chum Salmon	11	0.33%
E. Banded Killifish	3	0.09%
Largescale Sucker	2	0.06%
Sculpin	1	0.03%
Starry Flounder	1	0.03%
Total	3353	
	Small Welch (SWS)	
3-spine Stickleback	87	87.88%
Chinook Salmon	12	12.12%
Total	99	