Final Report
Packwood Lake Hydroelectric Project (FERC No. P-2244)
Tailrace Slough Use by Anadromous Salmonids

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1.0 INTRODUCTION

Energy Northwest's Packwood Lake Hydroelectric Project, FERC No. 2244, received its initial license in 1960. The majority of the Project is located in the Gifford Pinchot National Forest. The Project consists of an intake canal, a concrete drop structure (dam) and intake building on Lake Creek located about 424 feet downstream from the outlet of Packwood Lake, a 21,691-foot system of concrete pipe and tunnels, a 5,621-foot penstock, a surge tank, and powerhouse with a 26,125 kW turbine generator.

The source of water for the Project, Packwood Lake, is situated at an elevation of approximately 2,857 feet above mean sea level (MSL), about 1,800 feet above the powerhouse. Water discharged from the Project is released to the Cowlitz River via a tailrace channel. Power from the Project is delivered over an 8,009-foot 69 kV transmission line to the Packwood substation.

Anadromous salmonids are known to spawn in the tailrace slough where it adjoins the Cowlitz River. Spawner surveys in these two areas were conducted for a two year period, starting in 2004 (EES Consulting 2007).

1.1 Goals and Objectives

The goal of this study was to identify the anadromous salmonids that use the tailrace slough by life stage, timing, and type of use. The objectives of the study are to identify:

- Habitat use of the tailrace slough by juvenile salmonids;
- Habitat use of the tailrace slough by migrating adult salmonids

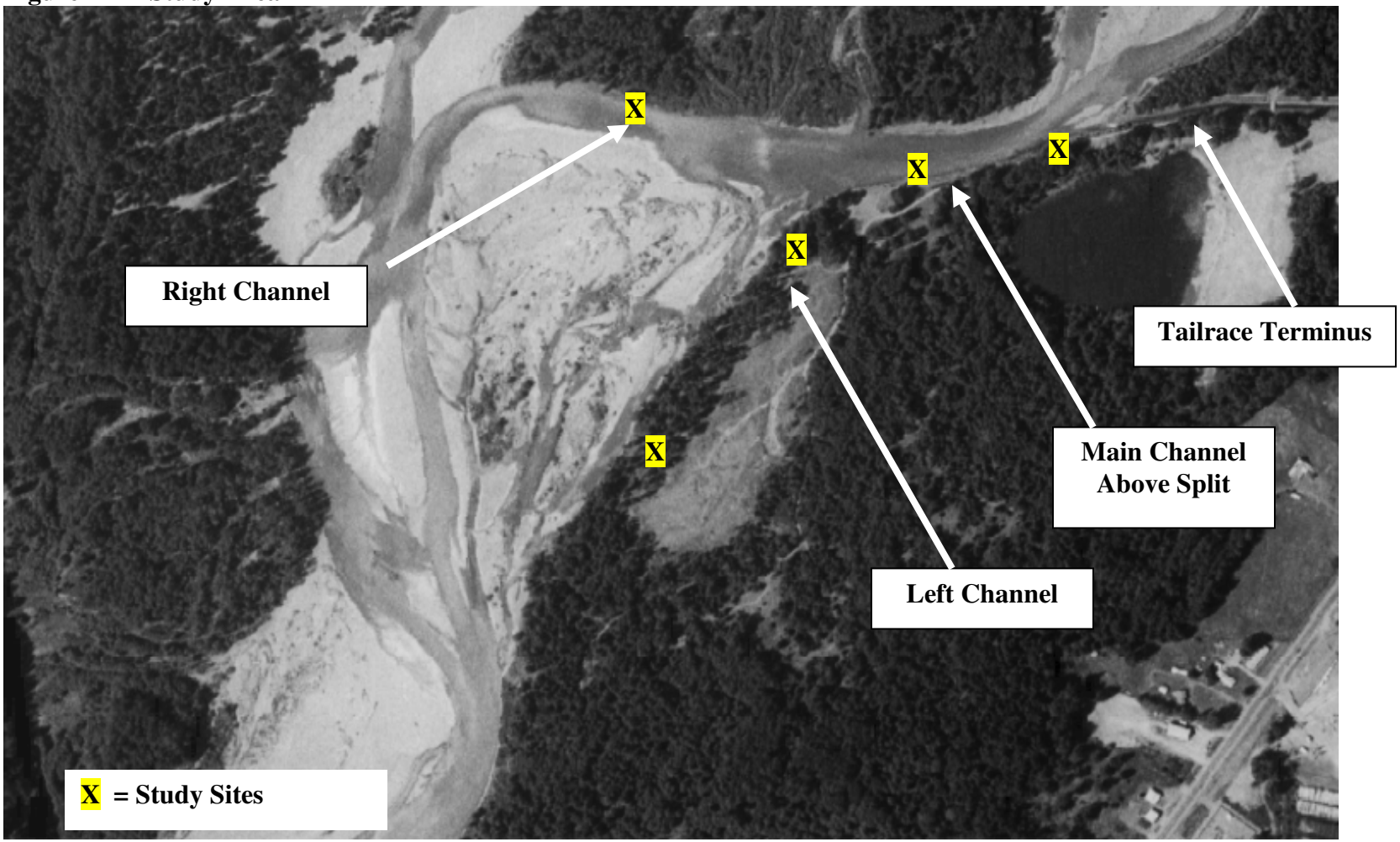
Data related to anadromous spawning in the tailrace slough are contained in the Packwood Anadromous Salmonid Habitat and Spawner Survey Report (EES Consulting 2007).

2.0 STUDY AREA AND METHODS

2.1 Study Area

The tailrace slough study area is comprised of three channel segments of the Cowlitz River located within a zone that extends approximately 2,500 feet downstream of the Project tailrace terminus (Figure 2-1). The configuration of the tailrace slough changes often. The study area was made up of the waters within the bankfull channel for the tailrace slough at the time of the study.

Figure 2-1 – Study Area



2.2 Methods

Habitat use information was gathered by a combination of visual, electrofishing, and snorkeling surveys. Various factors were examined to determine the proper method to use. Electrofishing surveys had the greatest potential restrictions due to possible injury of listed salmonids. Thus, electrofishing was used as little as possible. Snorkeling surveys were initially deemed to be the most efficient method, given their likelihood for up close, non-harmful identification of species.

Per protocol established in the Revised Tailrace Slough Use by Anadromous Study Plan (EES Consulting 2005), 30 meters of every 160 meters was snorkeled in the tailrace slough, including both the right and left side channels and the main channel to assess:

- Fish species presence
- Life stage and approximate length
- Water depths (measured at ¼, ½, and ¾ channel)
- Velocities (measured at ¼, ½, and ¾ channel)
- Substrate composition
- Riverine habitat types

The left side channel and main channel above the split had enough length per the study protocol to have two 30 m study sites. The shorter right channel only had one 30 m study site (Figure 2-1).

The study took place over a one year period, investigating the same 30-m study sites during each survey. Although the study was to begin with a spring 2006 investigation, high water and lack of water clarity precluded biologists from conducting an accurate assessment. Therefore, the study began with a summer investigation in July 2006 and concluded with a spring survey in June 2007. Surveys were to be conducted during all four seasons. The fall survey was scheduled to take place in December 2006; however, the large flood in early November and the subsequent high water and lack of water clarity prevented the biologists from conducting a survey until January, 2007. The remaining two surveys were conducted in April and June of 2007. Comprehensive anadromous fish presence data during the fall time period are discussed in the Packwood Anadromous Salmonid Habitat and Spawner Survey Report (EES Consulting 2007).

2.2.1 Visual Observations

Spawner Surveys were conducted on the tailrace slough from June 2004 through June 2006. Please see the Anadromous Salmonid Habitat and Spawning Survey Study Report (EES Consulting 2007) for further specifics. Spawner surveys were conducted twice monthly to note visibility and evaluate redd life in Lake Creek as well as the tailrace slough.

2.2.2 Underwater Observations

Where habitat conditions permitted, underwater observation (snorkeling) was conducted. Certain flows in the tailrace slough allowed efficient snorkeling practices. Techniques followed the methodology outlined by Dolloff et al. (1996).

In general, three snorkelers entered the water downstream of the study site and each focused on one third of the channel width working in an upstream direction. Information collected included: species observed; approximate length; habitat variables (depth, velocity, substrate and cover), and approximate location on the stream by river mile. The sample effort generally followed the approach described by Bonar et al. (1997).

2.2.3 Electrofishing

Electrofishing proved to be a useful technique during low flows, given the shallow nature of portions of the slough. Techniques followed the methodology outlined by Cowx and Lamarque (1990) and NOAA-Fisheries protocol (http://www.nwr.noaa.gov/1salmon/salmesa/4ddocs/final4d/electro2000.pdf)).

All electrofishing was conducted by trained biologists using backpack electrofishing units. Five study sites were selected that were representative of the entire reach. In general, one person operated the electrofishing unit while two others used long fiberglass dip nets to capture fish. Two passes were made working in an upstream direction. Block nets were placed at the upstream and downstream ends of the study site to prevent fish from entering or exiting the study sites. Captured fish were released either up or downstream of the block nets so as to not reintroduce them into the study site, which could result in counting fish multiple times. Data collected included: species; fish length; habitat variables (substrate and cover), and approximate location in the stream.

2.3 Principal Investigators

- **John Blum, EES Consulting, Inc. Fisheries Biologist and Instream Flow Scientist (Project Manager)**

  John Blum has a Master of Science in Fisheries, a Bachelor of Science in Environmental Biology and a Bachelor of Science in Business, specializing in Business Management. Mr. Blum has over 25 years experience as a fisheries biologist and consultant in instream flow analysis, habitat assessment, Endangered Species Act studies, fisheries research, enhancement, management, water resources and endangered species assessment, FERC regulatory licensing and relicensing studies, and expert witness testimony. In his role as a senior fisheries biologist and consultant, Mr. Blum has successfully managed over 50 fisheries and aquatic resources impact assessments in the Pacific and Inland Northwest, including many on the mid Columbia River.

  Mr. Blum has conducted numerous fisheries and instream flow studies throughout the Pacific Northwest, including the Columbia River System in Washington, Oregon, Idaho

and Montana. He is extensively trained and certified in the Instream Flow Incremental Methodology (IFIM) and has been recently certified in 2-dimensional instream flow modeling. He is Principal Scientist for the Box Canyon Dam Relicensing, and was principal scientist for the Box Canyon License Amendment and Sullivan Creek License Amendment for Pend Oreille Public Utility District in Pend Oreille County, WA. He was also Project Manager for relicensing studies for Chelan County Public Utility District on the Lake Chelan and Rocky Reach Hydroelectric Projects. He has been principal investigator on fisheries inventory and instream flow studies throughout the Northwest, including in British Columbia and Alaska, and has co-authored the Historic and Current Resources of the Clark Fork River, and for fisheries investigations on the Bear River relicensing projects for PacifiCorp. He recently completed, as Aquatic Lead and Principal Scientist, fisheries investigations for PG&E's Haas Kings Hydroelectric Project in California. He is also currently working with PGE on its Clackamas River Relicensing Project, and was Principal Scientist for the aquatics portion of the Cedar Creek relicensing and Biological Assessment.

Mr. Blum is currently Project Manager and Principal Scientist for the Packwood Lake Hydroelectric Project, and is Principal Scientist for the Anyox and Kitsault rivers hydroelectric projects in British Columbia.

- **Cory Warnock, EES Consulting, Inc. Fisheries Biologist and Instream Flow Scientist (Assistant Project Manager)**

Mr. Warnock has more than six years of experience as a fisheries biologist leading and participating in numerous fisheries studies including fish population monitoring, instream flow analysis, habitat analysis and assessment, genetic sampling, entrainment studies and habitat restoration. His duties have included project implementation, logistical and technical planning, field investigations and report writing. He has managed projects and lead crews in all aspects of various fisheries studies and instream flow investigations. Clients have ranged from owners of hydroelectric facilities and timber companies to state and federal agencies.

He is adept in many aspects of field collection and analysis as related to various types of fisheries monitoring, sampling, IFIM and habitat restoration. Mr. Warnock is currently involved with the relicensing efforts by EES Consulting at Box Canyon Dam for Pend Oreille PUD and the Packwood Lake Hydroelectric Project for Energy Northwest. Both projects require extensive monitoring of the anadromous and resident species present as well as determining the quality of their habitat. Other work has included habitat mapping, fish passage and connectivity issues, anadromous barrier analysis, spawning surveys, juvenile and adult snorkeling work, genetic sampling and entrainment studies for various salmonid species at all life stages. He has played an integral role in many IFIM studies from analyzing various reaches for quality habitat and identifying potential transects to carrying out flow measurements, substrate analysis and surveying. He has participated and led all facets of these studies from the logistics and preparation phases to the data analysis, report writing and submittal.

- **Nic Truscott, EES Consulting Inc. Field Biologist**

Mr. Truscott has two years of experience as a field biologist for EES Consulting. He has participated in field aspects of instream flow studies on many drainages, including the Spokane and Skagit River systems. Mr. Truscott has played an integral role in many of the fisheries and water quality investigations for Energy Northwest's relicensing efforts. Studies have included anadromous and resident salmonid spawning surveys, fish population assessments, habitat and barrier analysis and lake and stream water quality investigations. He has participated in a variety of studies in Washington and Oregon dealing with fisheries and water quality issues as they pertain to anadromous and resident salmonids. Currently, Mr. Truscott is working on a 5 year analysis of spawning Chinook salmon population in the Methow and Okanogan river basins.

- **Brian Johnson, EES Consulting, Inc. Field Biologist**

Mr. Brian Johnson, biologist, has a strong background in spawner surveys, snorkel and SCUBA surveys, radio-telemetry, instream flow assessment, habitat surveys, adult passage and water quality assessment. Mr. Johnson has been the field lead for spawner surveys for Energy Northwest's Packwood Lake Hydroelectric Project re-licensing. He managed and conducted the field logistics of survey crews covering the Cowlitz River and Hall, Snyder, and Lake creeks. He is skilled at species and redd identification, and biological sample collection.

Mr. Johnson has extensive fisheries field experience in north-central Washington. He took part in aquatic habitat, plants, creel, recreation, sturgeon, mollusks, salmon spawning and snorkel surveys related to operations of the Rocky Reach Dam. He conducted salmonid snorkel surveys, creel surveys, spawner surveys and redd mapping in the Stehekin River, the major tributary to Lake Chelan. He served as part of the field crew conducting instream flow and habitat suitability analyses in the Wenatchee River watershed. His experience included collection of physical habitat and hydrologic information, habitat surveys, and habitat suitability data. The work took place in the mainstem Wenatchee River, Peshastin Creek, and the Chiwawa River and tributaries including Phelps and Rock Creek.

He has additional fisheries field work experience throughout Washington State, Oregon, and California over the past 15 years

3.0 RESULTS

Four surveys were conducted on the five study sites during the following time periods:

- July 2006
- January 2007
- April 2007
- June 2007

Appendix A displays the data collected during the surveys.

3.1 July 2006

The summer investigation took place on July 27 and August 2, 2006. Site set-up took place during this part of the study. Five 30 m study sites were established and snorkeled. During the surveys, the Cowlitz River flow in the Packwood area (as measured at Skate Creek) was approximately 925 cfs and the Project contributed 94 cfs to the tailrace slough via the tailrace.

At the time of this investigation, the habitat of the left side channel study sites was made up primarily of glides (74%) with much smaller percentages of runs (17%) and riffles represented (10%). Depths and velocities ranged from 0.35 ft to 1.35 ft and 0.09 fps to 1.39 fps, respectively. Substrate was primarily a combination of cobble and gravel. A total of 606 coho juveniles were observed in the left side channel with approximately 75% of those fish located in glide habitat. Four Chinook juveniles measuring approximately 75 mm were observed in a small run. Seven whitefish and one long nosed dace were also observed in the left side channel.

The 30-m study site in the right channel consisted entirely of glide habitat. Depths and velocities across the channel ranged from 0.85 ft to 1.4 ft and 0.3 fps to 1.01 fps, respectively. Substrate composition was made up entirely of sand. Two root wads were present along the margin. Eighty one coho juveniles were documented in the right side channel, all in glide habitat associated with the root wads.

Two 30 m study sites were examined in the main side channel upstream of the split. Habitat composition of the two study sites during the summer investigation consisted entirely of glide habitat. Depths and velocities ranged from 1.2 ft to 3.75 ft and 0.1 fps to 1.27 fps, respectively. Substrate composition at the study site further downstream primarily consisted of sand while the upstream site consisted of a combination of gravel and cobble. Four hundred and seventy two coho juveniles were identified in the main channel upstream of the split. Rainbow trout, mountain whitefish and sculpin were also observed. Table 3-1 displays pertinent habitat variables and fish observation information. No anadromous salmonid adults were observed during the July 2006 investigation.

Table 3-1 July, 2006 – Habitat and Fish Observation Information									
	Habitat Percentages					Depth Range (ft)	Velocity Range (Fps)	Number of Coho Juveniles Observed	Number of Chinook Juveniles Observed
	Riffle	Run	Glide	Pool	Substrate				
Left Side Channel	10	16	74	0	Cobble/ Gravel	0.35/1/35	0.09/1.39	606	4
Right Side Channel	0	0	100	0	Sand	0.85/1.4	0.3/1.01	81	0
Main Channel Above Split	0	0	100	0	Sand/ Gravel	1.2/3.75	0.1/1.27	472	0

3.2 January 2007

Anadromous fish use during the fall time period is discussed in the Packwood Anadromous Salmonid Habitat and Spawner Survey Report (EES Consulting 2007). The fall 2006 survey was scheduled for the week of December 10, 2006 since the summer survey was done in August and Project preparation and shutdown began in September and extended into October. Due to the floods in early November, the subsequent damage and water clarity issues, biologists weren't able to conduct a survey until January 15, 2007. The November flood dramatically changed the riverine habitat types at the study sites and the corresponding substrate composition. Habitat typing and substrates were re-assessed per the initial study plan. Due to the low flow conditions during this survey, electrofishing was deemed the most efficient method for identification purposes. During the surveys, the Cowlitz flow in the Packwood area was approximately 1,370 cfs and the Project was contributing 58 cfs to the tailrace slough via the tailrace. No anadromous species were observed during this survey.

After the flooding, glides comprised 67% of the habitat at the two study sites in the left side channel with the remainder being made up of pools. Substrate compositions consisted primarily of a combination of sand and cobble. Depths and velocities ranged from 0.9 ft to 1.8 ft and 0.01 fps to 0.65 fps, respectively. Rainbow trout, mountain whitefish and sculpin were documented at the study sites.

The right side channel study site had been transformed into 50% runs and 50% glides. Substrates consisted of a mixture of gravel, cobble and small boulders. Depths and velocities ranged from 0.85 ft to 1.65 ft and 1.18 fps to 2.57 fps, respectively. Rainbow trout, mountain whitefish and sculpin were the only species observed at the study site.

The main channel above the split had been turned into a long glide due to the flooding in November, 2006. Substrate composition was made up primarily of sand with small amounts of cobble intermixed at both study sites. Depths and velocities ranged from 0.65 ft to 3.0 ft and 0.97 fps to 1.73 fps, respectively. Rainbow trout, mountain whitefish and sculpin were documented at the study sites. Table 3-2 displays pertinent habitat variables and fish observation information. No anadromous salmonid adults were observed during this survey.

Table 3-2 January, 2007 – Habitat and Fish Observation Information								
	Habitat Percentages							
	Riffle	Run	Glide	Pool	Substrate	Depth Range (ft)	Velocity Range (Fps)	Number of Coho Juveniles Observed
Left Side Channel	0	0	67	33	Sand/ Cobble	0.9/1.8	0.01/0.65	0
Right Side Channel	0	50	50	0	Gravel/ Cobble	0.85/1.65	1.18/2.57	0
Main Channel Above Split	0	0	100	0	Sand/ Cobble	0.65/3.0	0.97/1.73	0

3.3 April 2007

The third survey was conducted on April 26, 2007. An on-site decision was made to evaluate habitat and substrate characteristics at the established study sites again due to high water conditions due to high water events in March which again altered the habitat, and to maintain consistency with the previous two surveys. It was further determined that habitat and substrate analysis would take place during the final survey in June. Due to the low flow conditions during this survey, electrofishing was deemed the most efficient method for identification purposes. During the surveys, the Cowlitz flow in the Packwood area was approximately 1430 cfs and the Project was contributing 44 cfs to the tailrace slough via the tailrace.

The left side channel study sites were made up of approximately 88% glide with the remainder consisting of riffles. The primary substrates were a combination of gravel and cobble intermixed with a small amount of sand. Depths and velocities ranged from 0.2 ft to 1.0 ft and 0.0 fps to 2.33 fps, respectively. Approximately 300 coho fry measuring roughly 20 mm were observed at the upstream study site on the left side channel. A single coho measuring approximately the same length was observed at the downstream site. Rainbow trout and sculpin were also observed at both study sites.

During the April investigation the habitat composition of the right channel consisted entirely of a single run. Depths and velocities ranged from 0.6 ft to 1.4 ft and 2.17 fps to 3.32 fps, respectively. The substrate at the study site was primarily a mixture of small and large gravel. One Chinook juvenile measuring approximately 40 mm was identified at the site. Rainbow trout and sculpin were also present.

The two study sites in the main side channel above the split were entirely made up of glide habitat. Substrates consisted primarily of sand and small gravel. Depths and velocities ranged from 0.3 ft to 3.6 ft and 0.12 fps to 1.6 fps, respectively. Approximately 200 coho fry measuring around 20 mm were documented at the downstream study site in the main side channel prior to the split. No anadromous species were observed at the upper site of the main channel. Rainbow trout, mountain whitefish and sculpin were also observed. Table 3-3 displays habitat variables and fish observation information. No anadromous salmonid adults were observed during the April, 2007 investigation.

Table 3-3 April, 2007 – Habitat and Fish Observation Information									
	Habitat Percentages					Depth Range (ft)	Velocity Range (Fps)	Number of Coho Juveniles Observed	Number of Chinook Juveniles Observed
	Riffle	Run	Glide	Pool	Substrate				
Left Side Channel	12	0	88	0	Gravel/ Cobble	0.2/1.0	0.0/2.33	301	0
Right Side Channel	0	100	0	0	Gravel	0.6/1.4	2.17/3.32	0	1
Main Channel Above Split	0	0	100	0	Sand/ Gravel	0.3/3.6	0.12/1.6	200	0

3.4 June 2007

The final survey was conducted on June 19, 2007. Water clarity and flow conditions allowed the biologists to snorkel the sites. During the surveys, the Cowlitz flow in the Packwood area was approximately 2,030 cfs with the tailrace was contributing 110 cfs to the tailrace slough.

Glides made up a majority of the left channel habitat (83%), with a long run making up the remaining 17%. Sand and cobble were the primary substrates in the left side channel. Depths and velocities ranged from 0.5 ft to 1.6 ft and 0.09 fps to 1.42 fps, respectively. Approximately 1200 coho juveniles measuring around 75 mm were observed in the lower study site in the left side channel. The coho were all associated with a downed tree on the right margin which provided cover and a velocity break that was advantageous for feeding and resting purposes. Approximately 200 coho juveniles measuring 75 mm were observed in the run at the upstream end of the upper study site on the left side channel. These fish were also associated with large woody debris on the margin. Two small rainbow trout measuring approximately 100 mm were also observed.

A long run made up the entirety of the 30 m study site in the right side channel. Substrate composition consisted of medium and large gravel. Depth and velocities ranged from 1.0 ft to 1.3 ft and 2.11 fps to 3.10 fps, respectively. The channel was uniform from margin to margin with a relatively high flow and no cover. No fish were observed in this study site.

All 60 m of the main channel study sites were made up of a single long glide. Substrate composition of the study site further downstream was made up almost entirely of sand while the upstream study site consisted of cobble and boulders. Depth and velocities ranged from 0.8 ft to 3.8 ft and 0.34 fps to 2.63 fps, respectively. Twenty five coho juveniles measuring approximately 70 mm were observed in the lower study site. All were associated with slow moving pocket water along the margins. Approximately 30 whitefish and 100 bridgelip suckers were observed at the upper study site. Table 3-4 displays pertinent habitat variables and fish observation information. No anadromous adults were observed during the June 2007 investigation.

Table 3-4 June, 2007 – Habitat and Fish Observation Information								
	Habitat Percentages							
	Riffle	Run	Glide	Pool	Substrate	Depth Range (ft)	Velocity Range (Fps)	Number of Coho Juveniles Observed
Left Side Channel	0	17	83	0	Sand/ Cobble	0.5/1.6	0.09/1.42	1400
Right Side Channel	0	100	0	0	Gravel	1.0/1.3	2.11/3.10	0
Main Channel Above Split	0	0	100	0	Sand/ Cobble	0.8/3.8	0.34/2.63	25

4.0 DISCUSSION

The upper Cowlitz River Basin periodicity chart (Figure 4-1) documents fish spawning, incubation and rearing timing for the anadromous species in the Tailrace Slough vicinity. Approximately 2,200 coho juveniles and 5 Chinook juveniles were observed during the four surveys. All of the data collected during this study and the Packwood Anadromous Salmonid Habitat and Spawner Survey (EES Consulting 2007) are consistent with the timing put forth in Figure 4-1.

Aside from five Chinook juveniles observed during the study, the only other anadromous species and life stage observed were coho juveniles. Coho spawn in the tailrace slough area of the Cowlitz River from early October through February (Figure 4-1). Spawner survey data from the two year Anadromous Salmonid Habitat and Spawning Survey Report are displayed in Appendix B. During spawning surveys conducted in the tailrace slough from 2004 through 2006, 34 coho adults and 57 redds were observed primarily in the left side channel. All but one of the coho and all 57 redds were observed during the 2004/2005 season (October-January). All spawners and redds in the tailrace slough were observed in the left side channel. Since high water and turbidity precluded surveys in the fall/winter period, the Anadromous Salmonid Habitat and Spawner Survey Report describes presence of anadromous species in the tailrace slough during this time.

The largest number of coho juveniles were observed in June in the left side channel (n=1400). The June, 2007 observation is consistent with the expected rearing period for coho juveniles in the tailrace slough (Figure 4-2). Over 500 coho were observed in both the July 2006 and April 2007 surveys. The fish observed in July, 2006 coincided with the beginning of the annual low flow period in the upper Cowlitz basin. These juveniles were likely the remaining young from 2006 and will soon to move out of the tailrace slough as flows continue to decrease. The juveniles observed in April, 2007 were newly emerged and likely the beginning of the 2007 class of coho in the tailrace slough.

No coho were observed during the January survey. It should be noted that four Chinook juveniles were observed during the July survey in the left side channel and one in the right channel in April.

Emergence typically occurs in April and May (Figure 4-1) with most coho out-migrating as year 1+ (over wintering) juveniles. Low flows in the late summer months likely push a majority of the juvenile coho into the mainstem Cowlitz River or other perennial side channels downstream for further rearing. This movement of juveniles during the late summer combined with the November, 2006 flood likely explains the lack of coho observations during the January survey. Concurrently, coho are at the peak of their spawning activity for the year and new fry will emerge in April.

The other factor influencing juvenile coho presence in the tailrace slough involves habitat quality for rearing fish. Coho juveniles prefer slow-moving, marginal pocket water with cover including large wood and overhanging banks. The area most representative of these qualities throughout the study was the left side channel. Figure 4-2 displays coho presence in the left, right and main channels during all four surveys. A majority of the resident species observed during the study were seen in the main channel above the split. Most of the habitat in these areas was made up of fast moving water with large substrate generally preferred by rainbow trout and whitefish.

The tailrace slough is a dynamic segment of the Cowlitz River. Habitat characteristics in the slough can change on an annual basis depending on high flows and the relative contribution of the river and tailrace. The large flood in November, 2006 and a subsequent high water event in March, 2007 changed the habitat in the tailrace slough. These changes were more associated with the movement of large wood within habitat units than the proportional changes of the habitat units themselves. While there were some changes in the relative percentages of habitat present at the study sites (Figures 4-3 through 4-5), marginal wood and glide habitat remained critical for coho juvenile presence throughout. By far, the largest numbers of juvenile coho were observed in the left side channel. It is important to note that all gravel and wood that is routed into the area is a product of transport down the Cowlitz River. No wood or gravel is sent down the tailrace into the tailrace slough area.

Channel configuration and associated habitat types were altered somewhat during the flood events in the left side channel. However, spawning substrate and the subsequent rearing components (wood on the margins, low velocities), necessary for high numbers of juvenile coho remained in the left side channel throughout the study period.

The main channel above the split had adequate slow-moving water and associated large wood during the July 2006 and April 2007 surveys. The November, 2006 flood moved most suitable juvenile coho rearing habitat out of the area. The following March another high water event brought new large wood into the area which is likely why coho juveniles were observed during the April, 2007 survey.

Figure 4-1 Periodicity Table for Fish Species in the Upper Cowlitz Basin

Species	Lifestage	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Spring Chinook	Spawning												
	Incubation												
	Rearing												
Coho	Spawning												
	Incubation												
	Rearing												
Steelhead	Spawning												
	Incubation												
	Rearing												
Cutthroat Trout	Spawning												
	Incubation												
	Rearing												
Rainbow Trout	Spawning												
	Incubation												
	Rearing												

Based on:

John Serl, WDFW Fish Biologist, Cowlitz Falls (May 10, 2007)

Key:

Black indicates periods of heaviest use

Grey indicates periods of moderate use

Blank areas indicate periods of little or no use

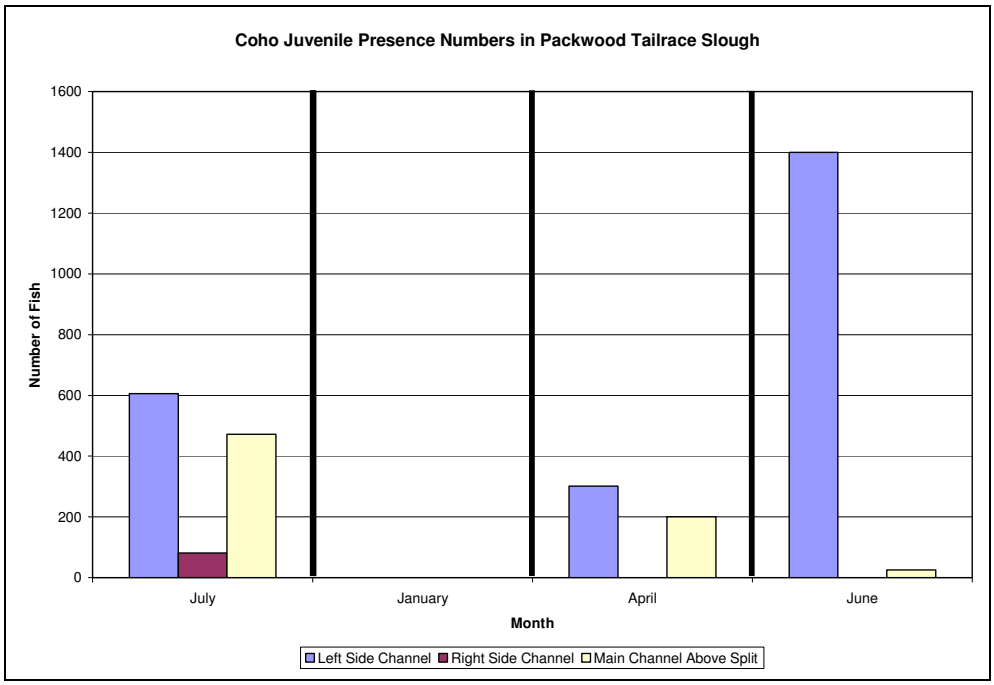


Figure 4-2 – Juvenile Coho Observations During the Four Survey Periods

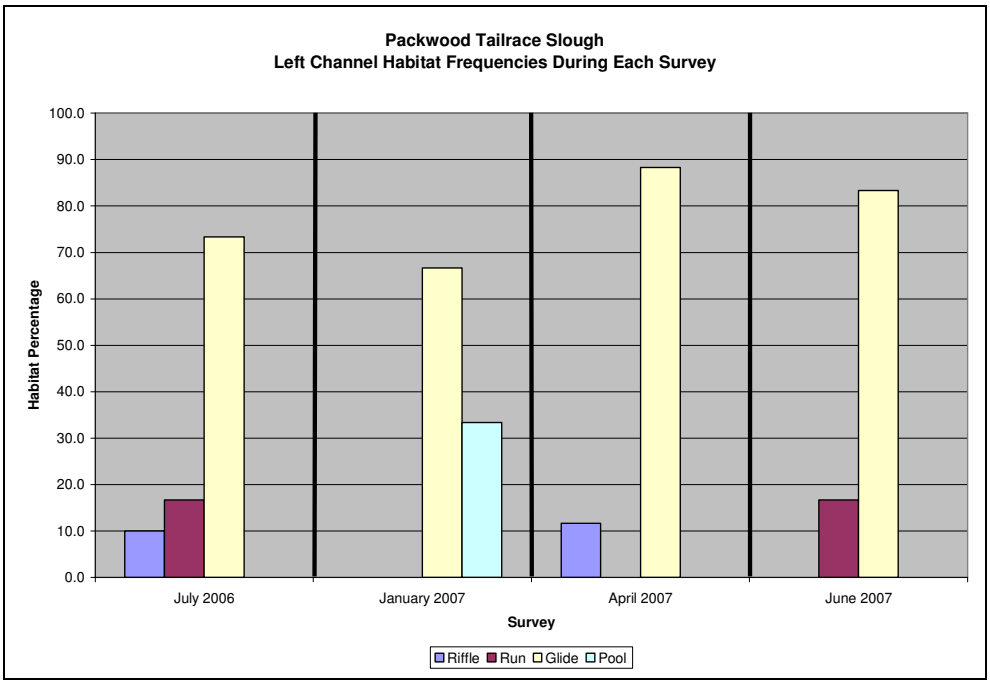


Figure 4-3 – Left Channel Habitat Frequency Changes throughout the Study Period

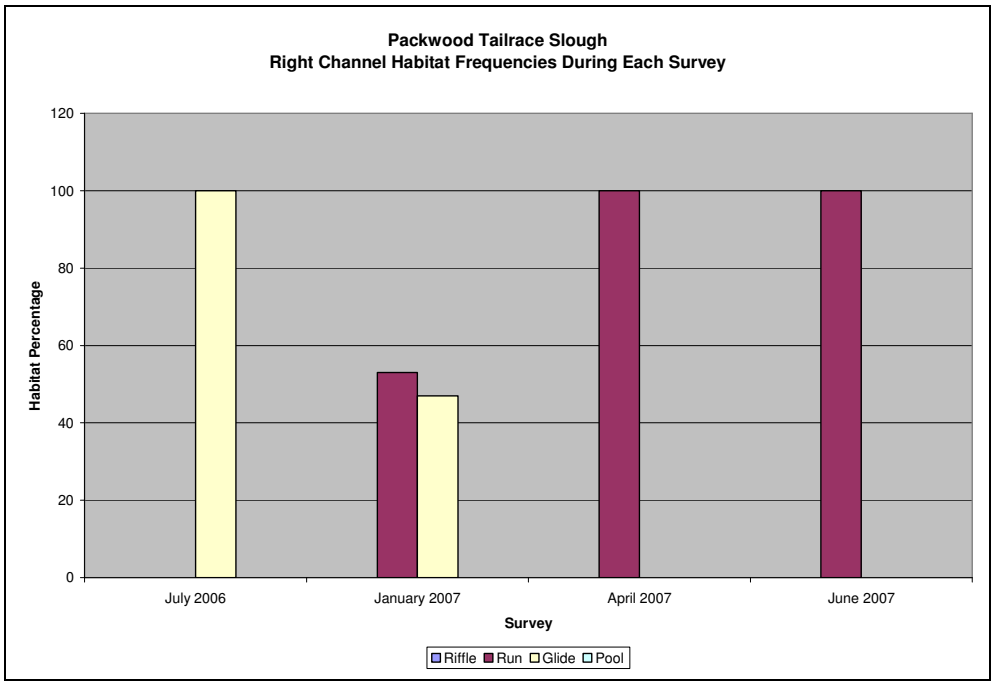


Figure 4-4 – Right Channel Habitat Frequency Changes throughout the Study Period

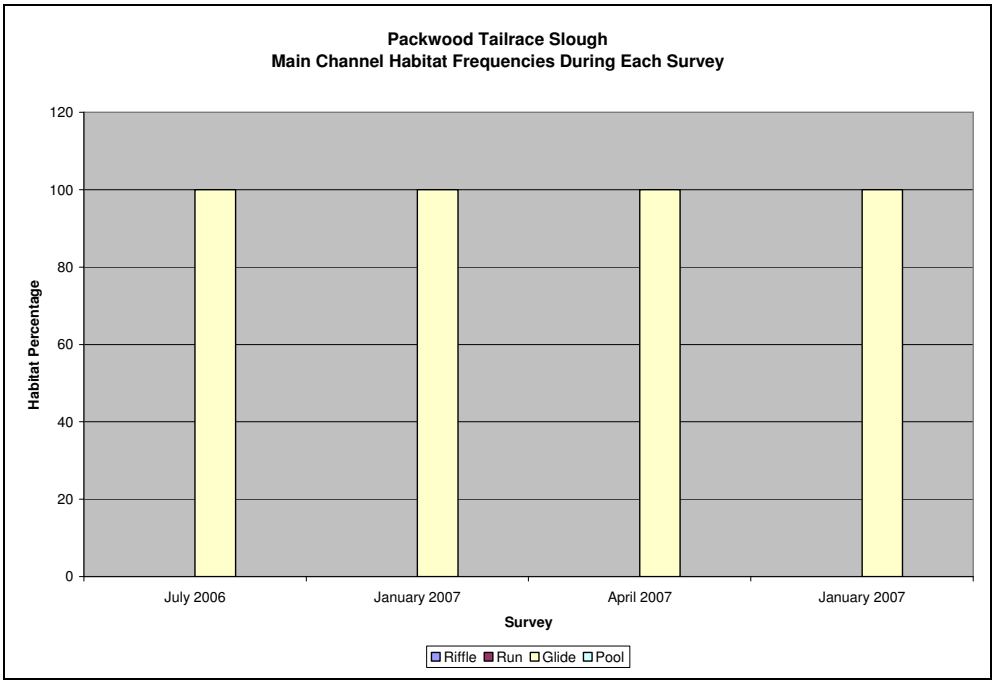


Figure 4-5 – Main Channel Habitat Frequency Changes throughout the Study Period

5.0 GOALS AND OBJECTIVES

5.1 Goals

1. *Identify the anadromous salmonids that use the tailrace slough by life stage, timing, and type of use.*

- Four surveys were conducted which documented anadromous use of the tailrace slough by all species and life stages present. A periodicity chart for the upper Cowlitz River basin was utilized to confirm presence information on an annual basis. A description of anadromous species presence in the tailrace slough during the fall period can be found in the Anadromous Salmonid Habitat and Spawner Survey Report. Appendix A contains the data collected during the tailrace slough investigations and Appendix B contains all anadromous spawning surveys in the tailrace slough data.

5.2 Objectives

1. *Identify habitat use of the tailrace slough by anadromous salmonids.*

- Habitat units and the associated pertinent variables (substrate type, depths and velocities) were collected during every survey at the study sites to show alteration related to flow and seasonality. Secondary habitat units in the left side channel, (the primary location of anadromous species), were changed during the study as a result of high flows in the Cowlitz River. Appendix A displays all habitat data collected during the surveys.

2. *Habitat use of the tailrace slough by migrating adult salmonids*

- Adult anadromous use of the tailrace slough occurs between the months of August and March. Previous spawner survey data indicated that the tailrace slough could be used by coho salmon adults during this period with some potential for coho, Chinook and steelhead juveniles. A description of anadromous species presence and habitat use in the tailrace slough during the fall period can be found in the Anadromous Salmonid Habitat and Spawner Survey Report. Appendix B contains all data pertaining to the anadromous spawning surveys in the tailrace slough.

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Appendix A

Raw Data Collected During Tailrace Slough Use by Anadromous Salmonids

Main Channel

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	15:45
Date:	8/2/2006	**Study Site:**	Upper Main Channel	**TF:**	16:20
People:	CW, NT, BJ, JM			**Type:**	Snorkel

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
0-30	30	Glide	3.0	0.91	3.0	1.27	3.75	0.31	57.6

Species Information

Number	Species	Length (mm)	Habitat Unit
142	Coho	40-59	Glide
130	Coho	60-79	Glide
6	Coho	80-99	Glide
9	Coho	100-119	Glide
2	Rainbow	40-59	Glide
2	Rainbow	60-79	Glide
3	Sculpin	40-59	Glide
1	Sculpin	80-99	Glide
8	Whitefish	60-79	Glide

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	14:30
Date:	8/2/2006	**Study Site:**	Lower Main Channel	**TF:**	15:10
People:	CW, NT, BJ, JM			**Type:**	Snorkel

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	1.5	0.01	1.2	0.26	2.3	0.31	23.9

Species Information

Number	Species	Length (mm)	Habitat Unit
200	Coho	60-79	Glide
9	Whitefish	30-39	Glide

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	15:05
Date:	1/15/2007	**Study Site:**	Upper Main Channel	**TF:**	15:35
People:	NT, BJ			**Type:**	Shockig

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	0.5	0.31	2.2	1.73	3	1.59	27.6

Species Information

Number	Species	Length (mm)	Habitat Unit
1	Rainbow	80-99	Glide
2	Sculpin	20-39	Glide
1	Sculpin	60-79	Glide

Pass 1:	352 s
Pass 2:	277 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	12:50
Date:	1/15/2007	**Study Site:**	Lower Main Channel	**TF:**	13:35
People:	NT, BJ			**Type:**	Shocking

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	0.65	0.97	1	1.46	1.1	1.38	27.9

Species Information

Number	Species	Length (mm)	Habitat Unit
5	Rainbow	80-99	Glide
2	Rainbow	100-119	Glide
1	Rainbow	120-139	Glide
30+	Sculpin	10-19	Glide
6	Sculpin	60-79	Glide
1	Whitefish	80-99	Glide
2	Whitefish	100-119	Glide
1	Whitefish	120-139	Glide

Pass 1:	630 s
Pass 2:	705 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	13:30
Date:	4/26/2007	**Study Site:**	Upper Main Channel	**TF:**	14:00
People:	NT, BJ			**Type:**	Shockig

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
0-30	30	Glide	1.3	1.04	2.1	1.34	3.6	1.6	25.7

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
4	Sculpin	25-65	Glide	1
2	Whitefish	15-25	Glide	1
2	Sculpin	30-45	Glide	2

Pass 1: 220 s
Pass 2: 264 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	12:45
Date:	4/26/2007	**Study Site:**	Lower Main Channel	**TF:**	13:15
People:	NT, BJ			**Type:**	Shockig

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
0-30	30	Glide	0.3	0.12	0.8	1.12	1.2	1.5	34.6

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
21	Sculpin	15-70	Glide	1
4	Whitefish	15-25	Glide	1
1	Rainbow	75	Glide	1
100+	Coho Fry*		Glide	1
12	Sculpin	20-85	Glide	2
2	Whitefish	15-25	Glide	2
100+	Coho Fry*		Glide	2

Pass 1: 315 s
Pass 2: 331 s

* Not Shocked (Just observed)

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	11:15
Date:	6/19/2007	**Study Site:**	Upper Main Channel	**TF:**	11:45
People:	CW, NT, JB			**Type:**	Snorkeling

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
30	30	Glide	1.9	1.73	2.7	2.63	3.8	2.03	68.7

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
30	Whitefish	300	Glide	
40	Bridgelip Sucker	400	Glide	

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	10:45
Date:	6/19/2007	**Study Site:**	Lower Main Channel	**TF:**	11:15
People:	CW, NT, JB			**Type:**	Snorkeling

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
30	30	Glide	0.8	0.34	1.0	1.52	2.45	1.79	23.9

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
25	Coho	70	Glide	

Left Side Channel

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	12:45
Date:	8/2/2006	**Study Site:**	Upper Left	**TF:**	13:35
People:	CW, NT, BJ, JM		Side Channel	**Type:**	Snorkel

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-22	22	Glide	0.7	0.09	0.85	0.18	0.65	0.61	52.7
22-27	5	Run	1.35	0.19	0.35	0.82	0.55	0.15	56.8
27-30	3	Riffle	0.45	0.32	0.45	1.13	0.5	1.39	56.7

Species Information

Number	Species	Length (mm)	Habitat Unit
3	Coho	60-79	Glide
8	Coho	60-79	Run
125	Coho	80-99	Glide
8	Coho	80-99	Riffle
50	Coho	80-99	Run
5	Coho	100-119	Glide
3	Coho	140-159	Glide
1	Rainbow	20-39	Run
8	Rainbow	20-39	Glide
1	Rainbow	40-59	Glide
3	Rainbow	60-79	Glide
1	Rainbow	60-79	Run
1	Rainbow	80-99	Glide
1	Rainbow	80-99	Run
1	Rainbow	240-259	Run
4	Chinook	75-90	Run
4	Whitefish	40-59	Glide
3	Whitefish	60-79	Glide
1	Long-nosed Dace	40-59	Glide
2	Suckers	20-39	Run

Approx. 400 additional coho per Blum

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	9:15
Date:	1/15/2007	**Study Site:**	Upper Left	**TF:**	9:45
People:	NT, BJ		Side Channel	**Type:**	Shocking

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	1.8	0.31	1.3	0.05	1.4	0.43	26.7

Species Information

Number	Species	Length (mm)	Habitat Unit
4	Rainbow	60-79	Glide
5	Rainbow	80-99	Glide
1	Sculpin	20-39	
2	Sculpin	40-59	
1	Sculpin	60-79	
1	Sculpin	80-99	
1	Sculpin	100-119	
2	Whitefish	100-119	

Pass 1:	423 s
Pass 2:	328 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	10:00
Date:	1/15/2007	**Study Site:**	Lower Left	**TF:**	10:45
People:	NT, BJ		Side Channel	**Type:**	Shocking

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
0-20	20	Pool	0.9	0.01	1.5	0.23	1.9	0.01	27.8
20-30	10	Glide	0.7	0.39	0.9	0.27	0.65	0.13	25.7

Species Information

Number	Species	Length (mm)	Habitat Unit
1	Rainbow	40-59	Pool
1	Sculpin	60-79	Glide
1	Whitefish	140-159	Pool

Pass 1:	287 s
Pass 2:	282 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	11:30
Date:	4/26/2007	**Study Site:**	Upper Left	**TF:**	12:00
People:	NT, BJ		Side Channel	**Type:**	Shocking

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-7	7	Riffle	0.3	2.33	0.4	2.13	0.2	0.62	65.7
7-30	23	Glide	1.0	0.26	0.9	0.06	1.0	0.00	52.7

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
12	Sculpin	20-80	Glide	1
2	Rainbow	100-120	Glide	1
300+	Coho Fry*		Glide	1
24	Sculpin	25-80	Riffle	1
1	Coho	25	Riffle	1
7	Sculpin	30-75	Glide	2
1	Rainbow	65	Glide	2
2	Rainbow	75-80	Riffle	2
18	Sculpin	25-100	Riffle	2

Pass 1:	222 s
Pass 2:	200 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	9:15
Date:	1/15/2007	**Study Site:**	Upper Left	**TF:**	9:45
People:	NT, BJ		Side Channel	**Type:**	Shocking

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	1.8	0.31	1.3	0.05	1.4	0.43	26.7

Species Information

Number	Species	Length (mm)	Habitat Unit
4	Rainbow	60-79	Glide
5	Rainbow	80-99	Glide
1	Sculpin	20-39	
2	Sculpin	40-59	
1	Sculpin	60-79	
1	Sculpin	80-99	
1	Sculpin	100-119	
2	Whitefish	100-119	

Pass 1:	423 s
Pass 2:	328 s

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	9:45
Date:	6/19/2007	**Study Site:**	Upper Left	**TF:**	
People:	CW, NT, JB		Side Channel	**Type:**	Snorkeling

Habitat Information

			Dep/Vel						
			1/4		1/2		3/4		
Distance (m)	Unit Distance (m)	Habitat							Substrate
0-20	20	Glide	1.2	0.75	1.4	1.14	1.6	0.21	26.6
20-30	10	Run	0.8	1.36	1.2	1.42	0.6	0.09	63.6

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
200	Coho	75	Run	
3	Rainbow	100	Run	

Location:	Tailrace Slough	**Dist:**	30m/160m	**TS:**	9:00
Date:	6/19/2007	**Study Site:**	Lower Left	**TF:**	
People:	CW, NT, JB		Side Channel	**Type:**	Snorkeling

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0	30	Glide	0.5	0.32	0.7	0.58	0.5	0.15	25.6

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
1200	Coho	75	Glide	

Right Side Channel

Location:	Tailrace Slough		**Dist:**	30m/160m		**TS:**	13:00			
Date:	8/2/2006		**Study Site:**	Rt. Side Channel		**TF:**	13:45			
People:	CW, NT, BJ, JM					**Type:**	Snorkel			

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Glide	0.85	0.3	1.1	1.01	1.4	0.91	22.9

Species Information

Number	Species	Length (mm)	Habitat Unit
81	Coho	60-79	Glide

Location:	Tailrace Slough		**Dist:**	30m/160m		**TS:**	11:00			
Date:	1/15/2007		**Study Site:**	Rt. Side Channel		**TF:**	11:30			
People:	NT, BJ					**Type:**	Shocking			

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-16	16	Run	0.85	2.21	1.4	2.57	1.1	2.05	35.8
16-30	14	Glide	1.2	2.20	1.65	2.56	1.4	1.18	27.7

Species Information

Number	Species	Length (mm)	Habitat Unit						
1	Rainbow	60-79	Glide			Pass 1:	324 s		
1	Sculpin	40-59	Glide			Pass 2:	304 s		
1	Sculpin	60-79	Glide						
1	Whitefish	460-479	Run						

Location:	Tailrace Slough		**Dist:**	30m/160m		**TS:**	12:10			
Date:	4/26/2007		**Study Site:**	Rt. Side Channel		**TF:**	12:35			
People:	NT, BJ					**Type:**	Shocking			

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Run	0.6	2.17	1.4	3.32	1	3.11	35.6

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass					
16	Sculpin	30-100	Run	1		Pass 1:	322 s		
1	Rainbow	85	Run	1		Pass 2:	321 s		
8	Sculpin	30-80	Run	2					
1	Chinook	40	Run	2					

Location:	Tailrace Slough		**Dist:**	30m/160m		**TS:**	10:00			
Date:	6/19/2007		**Study Site:**	Rt. Side Channel		**TF:**				
People:	CW, NT, JB					**Type:**	Snorkeling			

Habitat Information

			Dep/Vel						
Distance (m)	Unit Distance (m)	Habitat	1/4		1/2		3/4		Substrate
0-30	30	Run	1	2.43	1.3	3.1	1.1	2.11	34.8

Species Information

Number	Species	Length (mm)	Habitat Unit	Pass
0	-	-	-	-

Appendix B

Tailrace Slough Spawners Survey Data (2004-2006)

Tailrace Slough			
Date	**Spawners Observed**	**Species**	**Redds Observed**
7/26/04	0		0
8/25/04	0		0
9/16/04	0		0
9/28/04	0		0
10/28/04	0		0
11/11/04	3	Coho	3
11/23/04	14	Coho	9
12/9/04	14	Coho	45
12/21/04	2	Coho	0
1/4/05	0		0
1/25/05	0		0
2/8/05	0		0
2/22/05	0		0
3/10/05	0		0
3/24/05	0		0
4/12/05	0		0
5/10/05	0		0
5/25/05	0		0
6/7/05	0		0
8/11/05	0		0
9/8/05	0		0
9/22/05	0		0
10/7/05	0		0
10/19/05	0		0
11/2/05	0		0
11/18/05	0		0
12/1/05	0		0
12/15/05	1	Coho	0
2/9/06	0		0
2/23/06	0		0
3/9/06	0		0
4/6/06	0		0
4/20/06	0		0
5/4/06	0		0
6/1/06	0		0
6/28/06	0		0
7/26/06	0		0
Total	**34**	**Total**	**57**