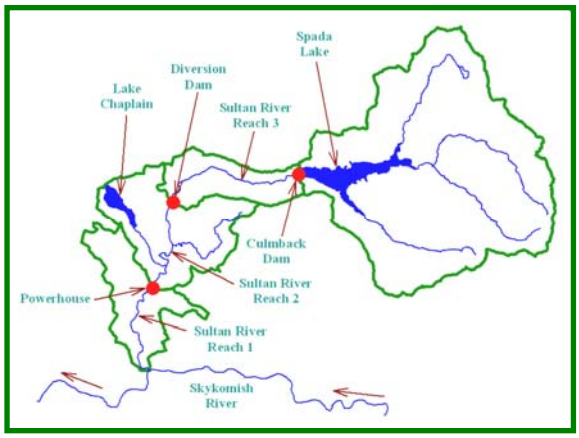
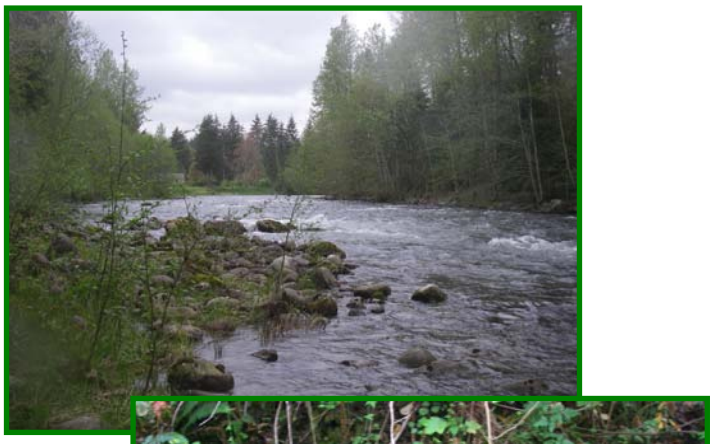
Juvenile Fish Abundance, Life History and Distribution Within the Sultan River, Washington – RSP 5



Prepared for:

Public Utility District No. 1
of Snohomish County
City of Everett



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April 30, 2009

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Prepared for:

Public Utility District No. 1
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and
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EXECUTIVE SUMMARY

This report presents the results of the Sultan River Juvenile Fish Abundance, Life History and Distribution Study completed by R2 Resource Consultants (R2). The study was completed in accordance with Revised Study Plan 5 (RSP 5) (dated September 12, 2006 and approved by the Federal Energy Regulatory Commission (FERC) on October 12, 2006)[1] as further modified based on recommendations proffered during a December 7, 2007 stakeholder meeting. Those modifications were ultimately approved by the FERC in a letter dated February 5, 2008[2].

The overall objective of the study was to determine the relative distributions and abundance of juvenile salmonids in the Sultan River by life history stages, stream location, and habitat type, using snorkel, electrofishing, and minnow trap surveys. For this, nine juvenile salmonid index sites (Mainstem 1-6 and Side Channel 1-3) were established in the Sultan River; two index sites (Mainstem 5-6) within Reach 2 (from Diversion Dam downstream to Powerhouse), while seven (Mainstem 1-4, Side Channel 1-3) were located in Reach 1 (reach extending below the Powerhouse). These sites were selected based on the current extent of anadromous salmonids, the distribution of spawning salmonids, distribution of suspected rearing habitats that included three currently active side channels, site accessibility, and overall habitat representation. The majority (four of six sites) of the mainstem index sites were comprised of combinations of glide and riffle habitat types. For the other two sites, one (Index Site 5) was dominated by pool habitat, and the other (Index Site 6) by Rapids. Side channel index sites were comprised primarily of glide and pool habitats.

Snorkel surveys were conducted quarterly (spring, summer, fall) during 2007 and 2008. These surveys were conducted primarily during daylight hours. Evening/night surveys were conducted the first season at sites that provided safe access, however results were similar to the day time surveys and were discontinued. Each of the nine sites was surveyed three to four times in each survey quarter as stream conditions (i.e., turbidity) allowed. Elevated streamflow and turbidity present during the winter quarter 2008 precluded snorkel surveys at that time. Overall, each site was surveyed a total of eighteen times during the study period. The snorkel surveys were completed by a team of five surveyors (4 divers, 1 observer) working in an upstream direction.

[1] See Public Utility District No. 1 of Snohomish County and City of Everett. 2006. Revised Study Plans and Studies Not Proposed. Henry M. Jackson Hydroelectric Project, FERC 2157. In accordance with 18 CFR §5.13

[2] See letter dated February 5, 2008 to: Mr. Kim Moore of Public Utility District No. 1 of Snohomish County, from J. Mark Robinson, Federal Energy Regulatory Commission. Subject: Determination on Requests for Modifications to the Henry M. Jackson Hydroelectric Project Study Plan

Backpack electrofishing was utilized as a juvenile salmonid survey technique when the following conditions as specified in the National Marine Fisheries Service collection permit occurred: a) water temperature was less than 21ºC; b) turbidity levels prevented underwater observations ≥1.0 meter; and 3) discharge conditions caused safety concerns for underwater observers. Water temperatures during electrofishing surveys did not exceed 8.0ºC.

Minnow traps were used to provide supplemental distribution information when visibility and/or streamflow precluded snorkel surveys (winter survey periods). A total of 25 Gee type wire minnow traps were installed on 18-19 February 2008 in the Sultan River. Traps were checked twice, once on 21 February and again on 27 February, with all traps removed on 27 February. Traps were baited with a commercial scented egg mixture.

The surveys were completed over a 16-month time period extending from June 2007 through October 2008. During this period, over 134,000 juvenile salmonids were enumerated, with the majority observed during the snorkel surveys. A total of only 1,431 juvenile salmonids were captured during electrofishing surveys and only 162 juveniles in the minnow traps. The results of the study indicated that juvenile anadromous salmonid utilization of habitat varies both spatially and temporally within the two lower reaches of the Sultan River. Highest densities of juvenile salmonids were consistently found in side channel locations that contained numerous woody debris-formed pools and abundant habitat structure. The two side channels present in Index Sites 1 and 2 supported the highest densities of juvenile fish and both contained abundant cover, wood, and habitat complexity. The highest density of fish (juvenile coho) in the mainstem index sites was found at Index Site 5, which was comprised predominately of pool habitat. In terms of timing, juvenile salmonid abundance peaked during the spring and summer survey periods at a time when newly-emerged salmonid fry (age-0) are present in the river and before overyearling (age-1+) salmon smolts have moved downstream to the Skykomish River. This pattern was best exhibited with coho salmon, but also existed with steelhead and to a lesser extent Chinook salmon.

The overall results of the study demonstrated the biological importance of side-channel habitats in the Sultan River basin, and as well the types of habitat areas being used in mainstem portions of the river. Both the availability and quantity of side channel habitats and the quantity of juvenile habitat within the main river are influenced by mainstem flows. Thus, the information provided from this study will be useful for understanding potential effects of both current and future Project operations on juvenile anadromous salmonid production.

1. INTRODUCTION AND BACKGROUND

This report presents the results of the Sultan River Juvenile Fish Abundance, Life History and Distribution Study completed by R2 Resource Consultants (R2) in accordance with Revised Study Plan 5 (RSP 5) (dated September 12, 2006 and approved by the Federal Energy Regulatory Commission (FERC) on October 12, 2006)[3] as further modified based on recommendations proffered during a December 7, 2007 stakeholder meeting. Those modifications (described in more detail in Section 3: Methods) were ultimately approved by the FERC in a letter dated February 5, 2008[4]. The basis for the refinements was related to the "take" limitations on Chinook salmon associated with R2's Endangered Species Act section 10(a)(1)(A) scientific collection permit which only allowed the capture, handling and release of 75 fish.

The original need for the study was identified during stakeholder consultations as part of the FERC Integrated Licensing Process (ILP) for the Henry M. Jackson Hydroelectric Project (Project) (FERC # 2157). The study was specifically requested by the Tulalip Tribes to determine the "rearing locations and densities of steelhead (*Oncorhynchus mykiss*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*) in the lower river (below the Diversion Dam) throughout the year." The study is one of 21 others that were proposed by the Public Utility District No. 1 of Snohomish County (District) and the City of Everett, Washington (City).

1.1 STUDY OBJECTIVES

Studies have shown that the success of early life history stages of salmonids is strongly size dependent; small differences in growth and mortality often drive adult recruitment (Quinn and Peterson 1996; Schindler 1999). The overall objective of the Juvenile Fish Abundance, Life History and Distribution Study was to determine the relative distributions and abundance of juvenile salmonids in the Sultan River by life history stages, stream location, and habitat type. Specifically, the life history strategies of juvenile Chinook salmon (i.e., residency period) are of particular importance to the Tulalip Tribe because of the uncertainty about dominant (ocean-type) and sub-dominant (stream-type) rearing strategies of naturally-produced populations in the Snohomish River Basin.

The information collected from RSP 5 will supplement existing life history information on these species in the Sultan River and will be useful for evaluating relationships between mainstem and

[3] See Public Utility District No. 1 of Snohomish County and City of Everett. 2006. Revised Study Plans and Studies Not Proposed. Henry M. Jackson Hydroelectric Project, FERC 2157. In accordance with 18 CFR §5.13

[4] See letter dated February 5, 2008 to: Mr. Kim Moore of Public Utility District No. 1 of Snohomish County, from J. Mark Robinson, Federal Energy Regulatory Commission. Subject: Determination on Requests for Modifications to the Henry M. Jackson Hydroelectric Project Study Plan

side-channel habitat use and stream flows in the river. Combining the results of RSP 5 with information from other studies (e.g., instream flow [Revised Study Plan (RSP) 3] (R2 Resource Consultants 2008), habitat composition (RSP18) (Stillwater Sciences and Meridian Environmental 2008a), and geomorphic processes (RSP22) (Stillwater Sciences and Meridian Environmental 2008b) will be useful for identifying and evaluating potential protection, mitigation and enhancement measures focused on juvenile salmonid habitats.

The study was designed to assist in addressing the following technical questions that are important in evaluating operational and flow regulatory effects of the Project on juvenile fish abundance and distribution in the Sultan River:

- What is the spatial and temporal distribution of different species of juvenile anadromous salmonids in the Sultan River below the Diversion Dam?
- How does the relative abundance of different species of juvenile anadromous salmonids change spatially and temporally in the Sultan River below the Diversion Dam?
- What types of habitats do juvenile salmonids occupy in the Sultan River below the Diversion Dam?
- What types of habitats are most frequently used by juvenile salmonids in the Sultan River below the Diversion Dam?
- Are the habitats that are used by juvenile salmonids in the Sultan River below the Diversion Dam vulnerable to project related flow regulation?
- Which sampling/survey methods are most effective for providing indices of juvenile salmonid relative abundance?

Although the study was limited to the reach of the river below the Diversion Dam that currently supports anadromous salmonid populations, the information on spatial and temporal trends in juvenile habitat use can be applied in evaluating tradeoffs relative to providing fish passage above the dam.

2. BACKGROUND INFORMATION

In 1960, the Co-licenses filed a joint application with the Federal Power Commission (now Federal Energy Regulatory Commission [FERC]) to develop what was then known as the Sultan River Project (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From the beginning, the Project was envisioned to serve two purposes; generating power for the District from the waters of the Sultan River, and increasing the City's water supply system to meet growing demands. A license authorizing construction of the Project in two phases was issued on 6 June 1961.

The Stage I development was completed in 1965 and involved the construction of Culmback Dam and the creation of Spada Lake, which greatly increased the City's water supply available from the Sultan River Basin (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Originally, Stage II, the addition of the hydropower generation facilities, was to commence in 1967. Economic studies undertaken at that time indicated the cost of power from the Bonneville Power Administration (BPA) was still low enough to call into question the financial feasibility of moving ahead with Stage II. FERC granted a series of time extensions so the District and the City could investigate alternative plans.

In 1976, BPA, the source of almost all of the District's power at that time, announced it would not be able to meet the District's power needs after mid-1983. BPA offered to purchase the early years of power from new non-thermal resources, which motivated the District to develop the generating potential of the Sultan River (Public Utility District No. 1 of Snohomish County and City of Everett 2005).

On 6 July 1979, the District and the City filed an application with FERC to amend the original license with a revised hydroelectric scenario better suited to the regional economic and load demand projections, and to reduce the environmental impacts of the original design (Public Utility District No. 1 of Snohomish County and City of Everett 2005). FERC granted this amendment on 16 October 1981, and construction of generating facilities and raising of Culmback Dam commenced in 1982. One of the earliest Settlement Agreements with several state and federal agencies and the Tulalip Tribes (the Joint Agencies) was filed with the FERC and accepted in 1982. The Project was renamed after the late Senator Henry M. Jackson in 1984 when operation began. The current operating license for the Project will expire on 31 May 2011.

2.1 SULTAN RIVER BASIN DESCRIPTION

The Project is located on the Sultan River, approximately 24 miles east of Everett, Washington, in south central Snohomish County (Public Utility District No. 1 of Snohomish County and City

of Everett 2005). From its headwaters near Vesper Peak on the western slope of the Cascade Mountains, the Sultan River flows west for approximately 19 miles, then south-southwest for 11 miles to its confluence with the Skykomish River at the City of Sultan (Skykomish River Mile [RM] 34.4). The Skykomish River drains the northern 835 square miles of the Snohomish River Basin, the second largest river basin draining into Puget Sound (Haring 2002).

The Sultan River has a watershed area of approximately 105 square miles (Figure 1). The Sultan River watershed can be divided into four subbasins: upstream from Culmback Dam (68.2 square miles): between Culmback Dam and the Diversion Dam (8.9 square miles); between the Diversion Dam and the Powerhouse (17.1 square miles); and between the Powerhouse and the confluence with the Skykomish River (10.7 square miles).

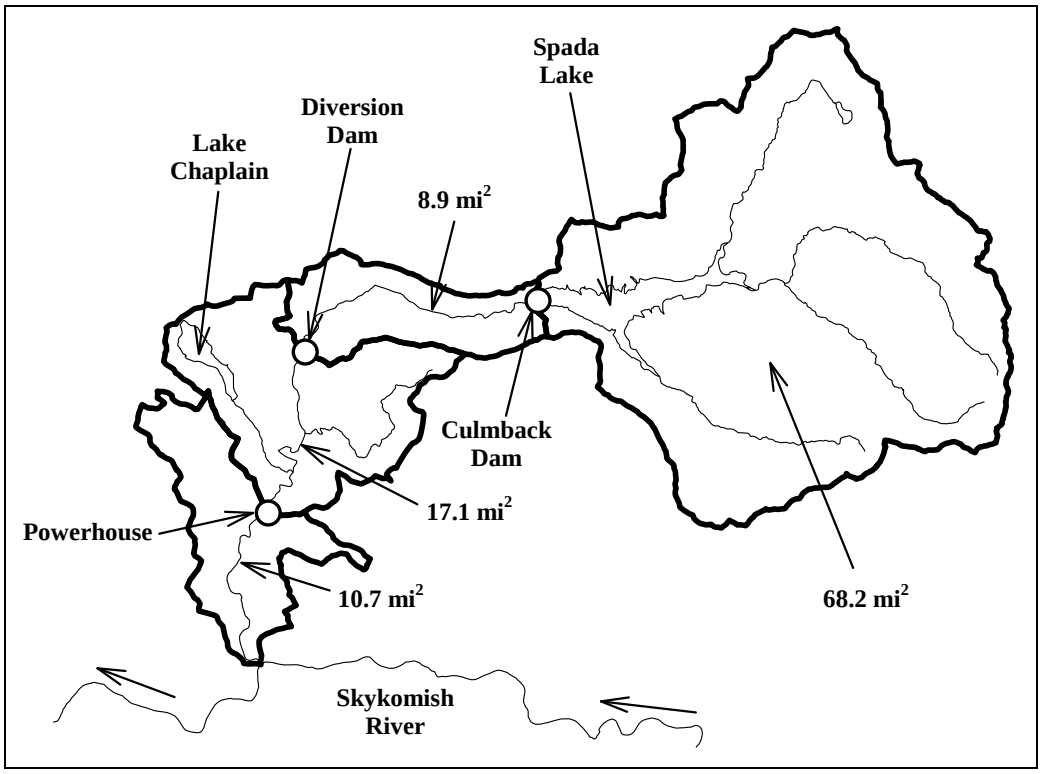

Figure 1. Four subbasins of the Sultan River watershed, Snohomish County, Washington.

The basin is bounded on the east by the Cascade Mountains, on the north and south by lateral ridges extending westward from the Cascade crest, and on the west by the Puget Sound lowlands (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Elevations in the basin range from the 6,617-foot summit of Del Campo Peak to 130 feet at the confluence of the Sultan and Skykomish rivers. Major tributaries to the Sultan River above Culmback Dam include the South Fork Sultan River, North Fork Sultan River, Elk Creek, and Williamson Creek. Downstream of Culmback Dam, major tributaries include Marsh Creek, Chaplain Creek, Woods Creek (drains Woods Lake), Ames Creek, and Winters Creek.

Downstream of Culmback Dam (RM 16.5), the Sultan River flows through a deep gorge for nearly 14 miles (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The steep side slopes above the channel are densely forested with conifer and mixed deciduous growth. The river channel in this reach is relatively high gradient and confined, containing numerous cascades and rapids separated by short pool-riffle, stretches. Much of the streambank is sheer rock face or large rock cuts (Williams et al. 1975). The City's Diversion Dam at RM 9.7 historically directed a portion of the river's flow to its water supply reservoir, Lake Chaplain. While that method of diversion remains in place and is used when Project maintenance or other reasons require, water now is normally supplied to Lake Chaplain through the Lake Chaplain pipeline after passing through the Project Powerhouse. The Sultan River emerges from the canyon reach onto a broad, relatively flat valley floor containing intermittent stands or strips of deciduous trees, underbrush, and some mixed conifers near RM 3. The river channel in this reach has a moderate gradient with several split channel sections forming braided island reaches. For purposes of this study and for consistency with RSP 3 (R2 2008), the river was divided into three Operational Reaches since the flows within each are all influenced by the Project. These include Reach 3 which extends from Culmback Dam at River Mile (RM) 16.5 to the Diversion Dam at RM 9.7, Reach 2 extending from the Diversion Dam to the Powerhouse (RM 4.3), and Reach 1 from the Powerhouse to the confluence with the Skykomish River. Since anadromous fish are currently limited to the sections of the river below the Diversion Dam, this study (RSP 5) focused only on Reaches 1 and 2.

The Sultan River watershed supports seven salmonid species, each with slightly different life history strategies. Reproducing populations of Chinook, coho, pink (*O. gorbuscha*), and chum (*O. keta*) salmon; steelhead and coastal cutthroat trout (*O. clarki*) are present downstream from the Diversion Dam (i.e., Operational Reaches 2 and 1) in varying numbers. Transitory bull trout (*Salvelinus confluentus*) have also been observed downstream from the Diversion Dam, but are not thought to spawn in the Sultan River (citation – i.e., who observed the bull trout?). While occurring upstream to the Diversion Dam, anadromous salmonid spawning habitat is primarily

located in the lower reaches of the Sultan River (Haring 2002). Anadromous fish access upstream from RM 9.7 is currently prevented by the Diversion Dam. Resident rainbow, cutthroat, and rainbow/cutthroat hybrids reside in Spada Lake, upstream from Culmback Dam which is located at RM 16.5.

2.2 PROJECT OPERATIONS

In 1930, the City of Everett constructed the Current Diversion Dam at RM 9.7 (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This dam was used to divert water from the Sultan River through a pipeline and tunnel, west to Lake Chaplain for municipal water supply storage. In 1965, Stage I of Culmback Dam was built at RM 16.5 for additional storage of municipal water supply, but the traditional operation of the Diversion Dam and tunnel to Lake Chaplain remained essentially unchanged. With completion of the Stage II hydroelectric project facilities in 1984 (which included a raised Culmback Dam, a power tunnel and pipeline, a powerhouse, and a Lake Chaplain pipeline from the Powerhouse to Lake Chaplain), the function of the Diversion Dam changed considerably. Prior to the completion of Stage II, water flowed west from the Diversion Dam through the tunnel to Lake Chaplain. Currently, water flows east through the tunnel between Lake Chaplain and the Diversion Dam. Some of the water diverted from Spada Lake at Culmback Dam is now returned to the Sultan River at the Diversion Dam to provide minimum instream flows below that point for fishery protection and enhancement.

Under current operations, 20 cfs of water is released from Culmback Dam into the river reach between Culmback Dam and the City's Diversion Dam at all times (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This 20 cfs, plus natural inflow from streams above the Diversion Dam, provides a constant flow for the fisheries in this reach. The rest of the water diverted from Spada Lake travels through the power tunnel and power pipeline to the Powerhouse. Most of the water delivered to the Powerhouse in this manner passes through the Pelton turbines for electrical generation and is returned to the river at the Powerhouse. However, an amount of water necessary for municipal supply and maintenance of minimum instream flows in the reach below the Diversion Dam is routed through two Francis turbines in the Powerhouse, and then through the Lake Chaplain pipeline to the "Portal 2" facilities on the shores of Lake Chaplain.

At Lake Chaplain, a portion of the water in the Lake Chaplain pipeline is diverted by means of the "Portal 2" facilities to the lake for municipal water supply (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The remainder is transported east via the original water diversion tunnel back to the Sultan River at the Diversion Dam to provide minimum instream flows in the reach between the Diversion Dam and the Powerhouse. In this manner,

regulated fish flows are maintained for the full length of the Sultan River below Culmback Dam, with larger flows provided below the Diversion Dam and Powerhouse where river conditions offer more suitable fish habitat than exists in the reach above the Diversion Dam. Occasionally, when storm events cause natural inflows within the reach between Culmback Dam and the City's Diversion Dam to exceed the combined total flows needed to meet both the City's water supply requirements and established minimum instream flows below the Diversion Dam, the Diversion Dam will be made to operate in its original manner (Public Utility District No. 1 of Snohomish County and City of Everett 2005). At these times, water for municipal supply is diverted from the Sultan River by the Diversion Dam and routed westerly through the tunnel to Lake Chaplain. Remaining flows in the river are allowed to pass over the Diversion Dam to provide required instream flows. The Powerhouse then routes water diverted from Spada Lake through only the larger Pelton units for more efficient power generation, and then immediately returns the water to the river.

3. METHODS

The original study plan developed for RSP 5 utilized the Hankin-Reeves visual abundance estimation technique that requires that underwater visual counts be adjusted by comparing them with electrofishing abundance estimates. In order to electrofish in the Sultan River, R2 submitted a collection permit application to the National Marine Fisheries Service (NMFS) in March 2007. The permit application included requests for steelhead which were recently listed under ESA. The NMFS issued Federal Register notice soliciting comments and no comments were received on this permit application. A Section 10 Permit issued for take (handling) of 75 Chinook salmon (mortality limit of 3 fish) was issued to R2 on 6 September 2007. At this level of take, electrofishing was severely limited in its application because of a high probability of encountering numerous Chinook salmon. As a result, seasonal snorkel observations were selected as the primary survey technique to determine the relative abundance, life history, and distribution of juvenile salmonids in the lower Sultan River.

Following the initial round of snorkel observations conducted in summer and fall of 2007, the Co-licensees held a meeting on December 4, 2007 to update the Stakeholders on and discuss potential modifications to RSP 5. As a result, RSP 5 was amended to: remove mark/recapture surveys; to de-emphasize electrofishing; to increase the snorkel survey effort within the remaining survey periods from three (original) to four surveys; and to use limited minnow trapping. These modifications were designed to achieve the study objectives of documenting the presence/absence and relative abundance of juvenile fish in the mainstem Sultan River and to determine which types of off-channel habitat are the most heavily used by overwintering salmonids. In addition, the modified RSP 5 specified that juvenile salmonid snorkel surveys would be conducted according to the following schedule: one winter snorkel survey (December-February 2007/2008 timeframe); one spring snorkel survey (April-May 2008 timeframe); one summer snorkel survey (July-August 2008 timeframe); and one fall snorkel survey (September-November 2008 timeframe). Four surveys would be conducted during each seasonal survey period to seek to identify the presence/absence and relative abundance of subyearling and yearling juvenile salmonids and their distribution within selected mainstem and off-channel habitats of the Sultan River. Each snorkel survey was to entail systematic observation and enumeration of fish (species and size/age class) by snorkelers within habitat units stratified by location within the basin (reach) and by habitat unit type (pool/riffle/glide/side channel). Electrofishing and minnow traps would be used as additional sampling techniques during the times of expected low juvenile Chinook salmon abundance (e.g., winter survey periods).

On 5 February 2008, FERC, pursuant to 18 CFR § 5.13(c), approved the study plan as proposed because the "increased sampling effort proposed by Snohomish PUD would adequately meet the

study objectives and, coupled with information being gathered from other studies, would be adequate for staff's environmental analysis."

Snorkel observations were selected, in part, due to their repeatability over different seasons, habitat strata, and reaches of the river. Snorkel surveys were conducted primarily during daylight hours. Evening/night surveys were conducted the first season at sites that provided safe access, however results were found to be similar to the day time surveys and were discontinued. Backpack electrofishing and minnow traps were used in concert with snorkel observations during winter periods when juvenile salmonids typically exhibit daytime concealment behavior (Roni and Fayram 2000) and periods when the Sultan River exhibits elevated turbidity levels, precluding accurate snorkel observations (Thurow 1994). Backpack electrofishing and minnow traps also provided additional information in locations that contained areas of dense woody debris and during periods of decreased juvenile Chinook salmon abundance.

Underwater observation has long been established as a valuable tool for study of fish behavior and habitat use particularly in regard to riverine juvenile salmonid species (O'Neal 2007). Snorkel observations are a quick, inexpensive, and non-invasive technique, that when properly structured, can provide accurate quantitative information concerning the abundance, size structure, distribution and habitat use of salmonids (Schill and Griffith 1984; Thurow 1994; O'Neal 2007). Salmonids exhibit territorial behavior and inhabit areas with high water clarity making snorkel surveys particularly effective in determining presence/absence of salmonid species (Slaney and Martin 1987; Zubik and Fraley 1988; Hillman et al. 1992; Rodgers et al. 1992). Snorkel surveys have been proven to provide reliable and accurate survey information. Specifically, Schill and Griffith (1984) utilized snorkel observations to create population estimates for cutthroat trout in the Yellowstone River. Zubik and Fraley (1988) determined that in large clear streams, snorkel counts that were multiplied by a determined expansion factor provided a reliable density estimate in comparison to other survey methods. Slaney and Martin (1987) found similar results in a large stream in British Columbia, as did Mullner et al. (1998) in streams in Wyoming. Rodger et al. (1992) concluded that snorkeling was an appropriate method for sampling the population size of juvenile coho over large sections of stream in coastal Oregon. Roni and Fayram (2000) reported that night snorkeling allowed for quick and relatively reliable enumeration of juvenile salmonids during the winter in Pacific Northwest streams.

Snorkel surveys also provide for direct observation of fish habitat utilization (Thurow 1994; O'Neal 2007). Fish observations specific to the habitat being utilized provide information for management decisions affecting those specific habitats (Northcote and Wilkie 1963). For example, differences in utilization of mainstem and off-channel habitats can be determined by observation of these habitats at different times of the year (Bustard and Narver 1975).

Furthermore, by comparing areas of observed fish use with areas of similar habitat (as identified in R2 2008) enables the development of estimates of fish use over a greater area.

3.1 INDEX SITE SELECTION

Nine juvenile salmonid index sites (Mainstem 1-6 and Side Channel 1-3) were selected in the Sultan River (Figure 2). Two index sites (Mainstem 5-6) were located within Reach 2, while seven (Mainstem 1-4, Side Channel 1-3) were located in Reach 1. These selections were based on the following parameters: current extent of anadromous salmonids, distribution of spawning salmonids, distribution of suspected rearing habitats, site accessibility, available lineal area, and overall habitat representation. The majority of index sites (Mainstem 1-5, Side Channel 1-3) were selected within or downstream from where the preponderance of salmonid spawning activity occurs (Williams et al. 1975). Three juvenile salmon index sites (Side Channel 1-3) were chosen within Operational Reach 1 which contains the majority of the side-channel habitat in the Sultan River. Index Site 4 - Mainstem was likewise within Operational Reach 1 and was located just downstream of the powerhouse; this site did not contain any off-channel habitats. Index Sites 5 and 6 - Mainstem were located within Operational Reach 2, with Index Site 5 located near the old USGS gaging station, and Index Site 6 located within one of few readily accessible areas in the gorge section of the river and locally known as the "Steelheaders" access point.

Juvenile salmonid Mainstem and Side Channel index sites 1 are the downstream-most index site, located near RM 1.5 on the Sultan River, and were comprised of approximately 24,350 m^2 of mainstem and 7,050 m^2 of side-channel wetted area as computed at a discharge of 400 cfs measured at the Powerhouse (Figure 3; Table 1). Habitat area was estimated using aerial coverage in ArcView and calibrated with field measurements from a handheld range finding unit. Index Site 2 is located near RM 1.6 in the lower Sultan River and is bounded by Index Site 1 on the downstream end and Index Site 3 on the upstream portion. Mainstem and Side Channel index sites 2 were comprised of approximately 27,500 m^2 of mainstem and 2,560 m^2 of side-channel wetted area estimated at a discharge of 400 cfs at the Powerhouse (Figure 4; Table 1). Index sites 1 and 2 overlap each other for a small segment. For purposes of this study, this segment area was counted as part of both sites 1 and 2. Index Site 3, which is located near RM 1.8 in the lower Sultan River, was comprised of approximately 20,730 m^2 of mainstem and 7,480 m^2 of side-channel wetted area at a discharge of 400 cfs at the Powerhouse (Figure 5; Table 1).

Juvenile salmonid Index Site 4 - Mainstem is located near RM 4.6 in the Sultan River and was comprised of approximately 6,020 m^2 of mainstem wetted area at a discharge of 400 cfs as measured at the Powerhouse (Figure 6; Table 1). Mainstem Index Site 5 is located near RM 5.2

in the lower Sultan River, near the discontinued Sultan River downstream of Chaplain Creek gage, and was comprised of approximately 7,380 m^2 of mainstem wetted area as measured at a discharge of 100 cfs at the Diversion Dam (Figure 7; Table 1). Index Site 6 - Mainstem is located near RM 9.0 in the lower Sultan River and was comprised of approximately 1,790 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 8; Table 1).

Table 1. Wetted area (m^2) of juvenile salmonid index sites as estimated from aerial coverage and field measurements, Sultan River, Snohomish County, Washington.

	Wetted Area (m^2)	
Index Site	**Mainstem**	**Side-Channel**
Site 1	24,360	7,050
Site 2	27,510	2,560
Site 3	20,730	7,480
Site 4	6,020	-
Site 5	7,380	-
Site 6	1,790	-

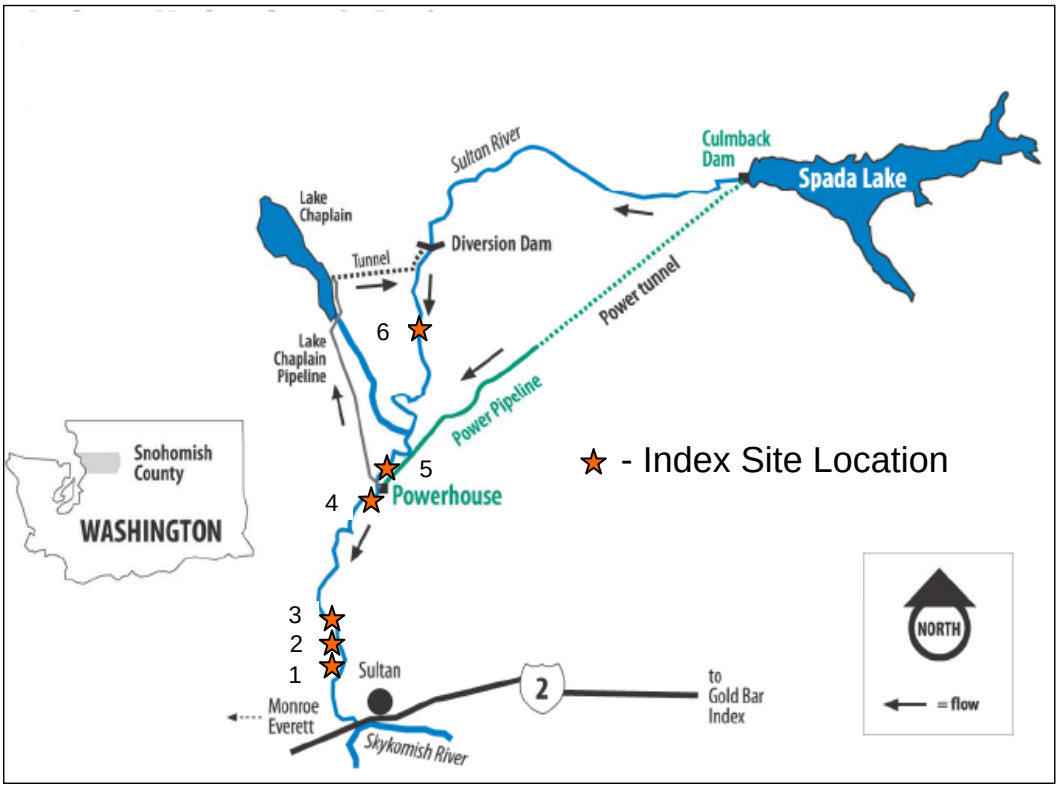

Figure 2. Location of Juvenile salmonid Index Sites 1 through 6 located on the Sultan River, Snohomish County, Washington. The lower three sites (1 through 3) included both mainstem and side channel survey areas.

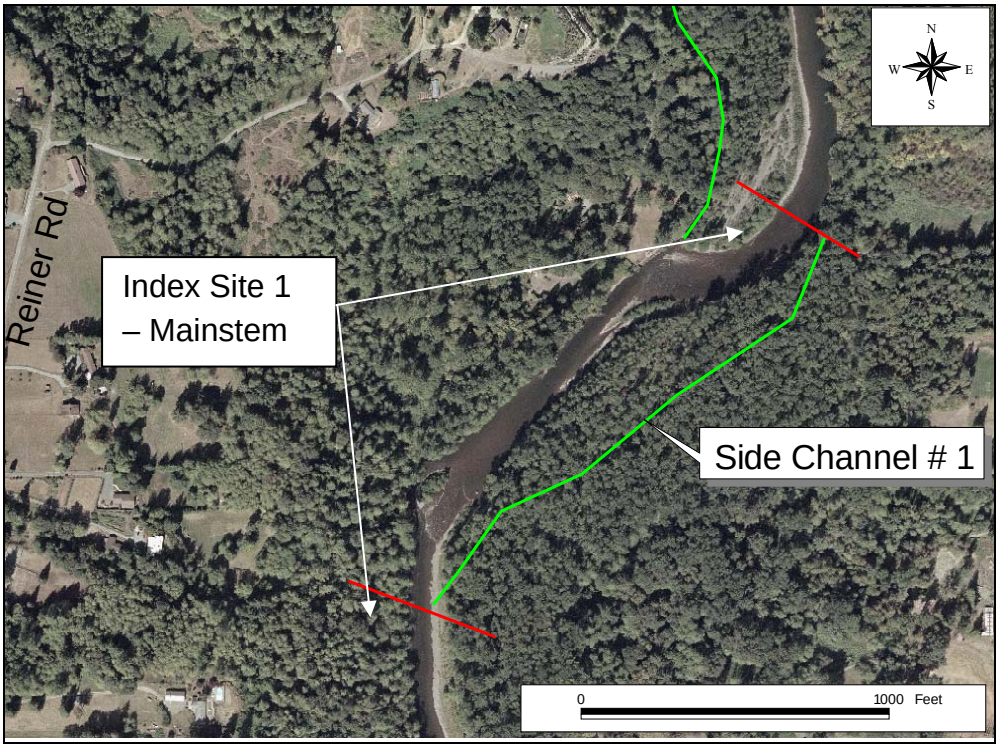

Figure 3. Location of juvenile salmonid Mainstem and Side Channel Index Sites 1 on the Sultan River, Snohomish County, Washington.

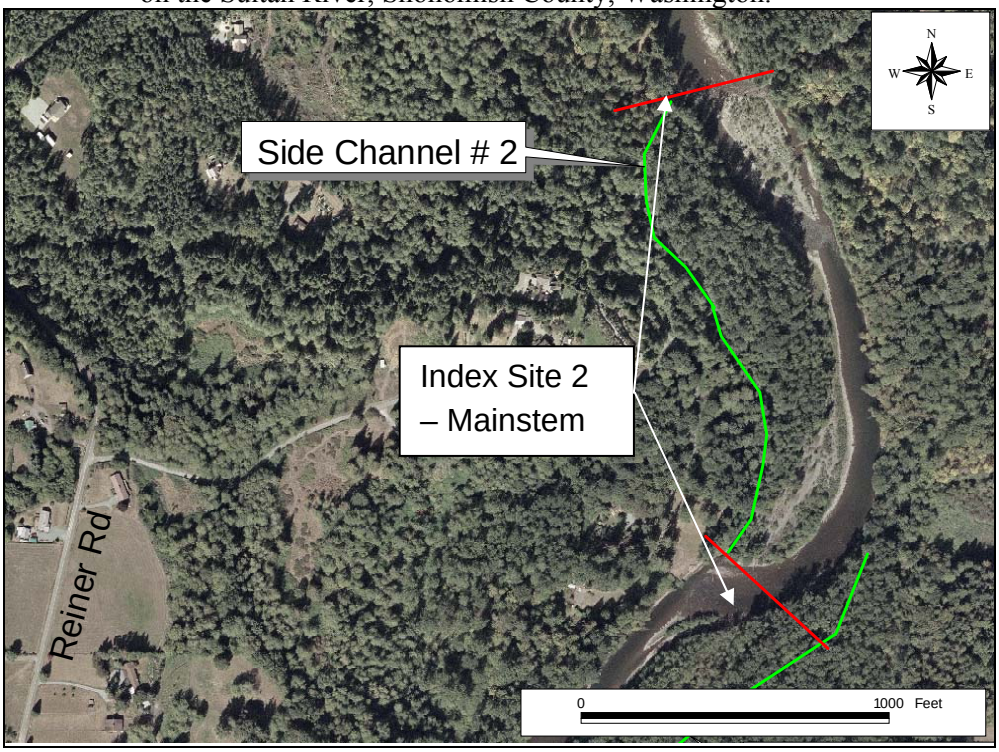

Figure 4. Location of juvenile salmonid Mainstem and Side Channel Index Site 2 on the Sultan River, Snohomish County, Washington.

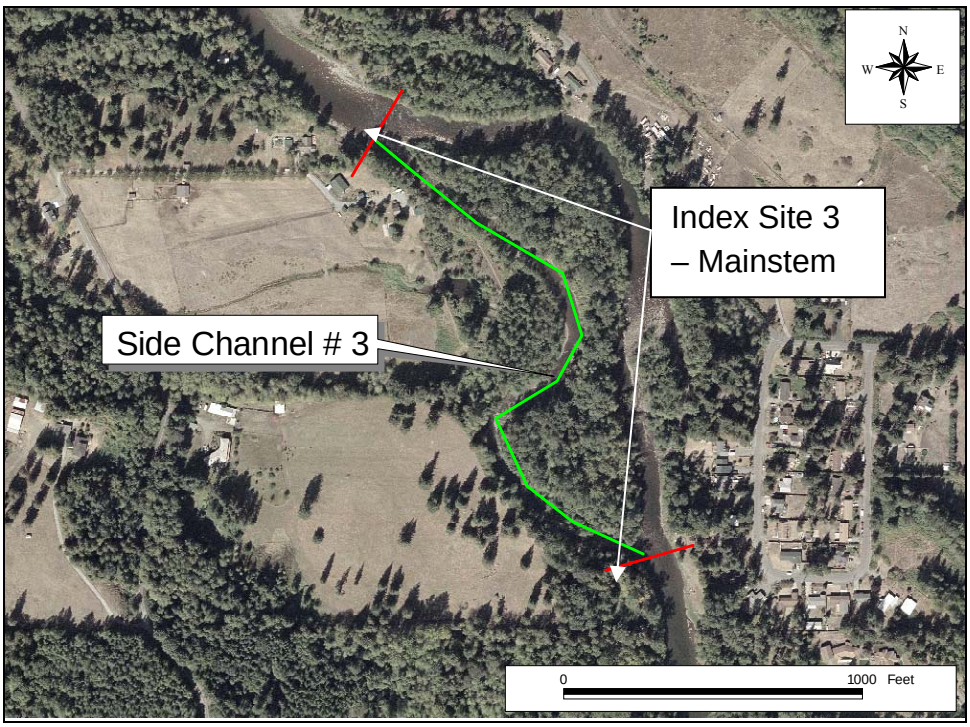

Figure 5. Location of juvenile salmonid Mainstem and Side Channel Index Site 3 on the Sultan River, Snohomish County, Washington.

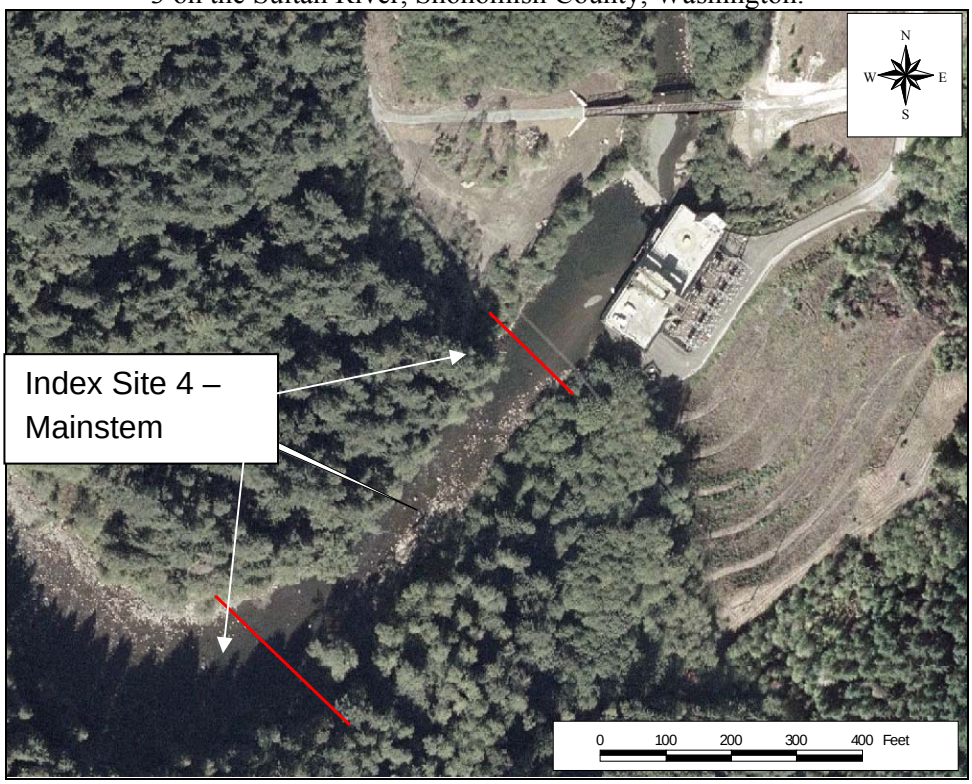

Figure 6. Location of juvenile salmonid Mainstem Index Site 4 on the Sultan River Snohomish County, Washington.

Figure 7. Location of juvenile salmonid Mainstem Index Site 5 on the Sultan River, Snohomish County, Washington.

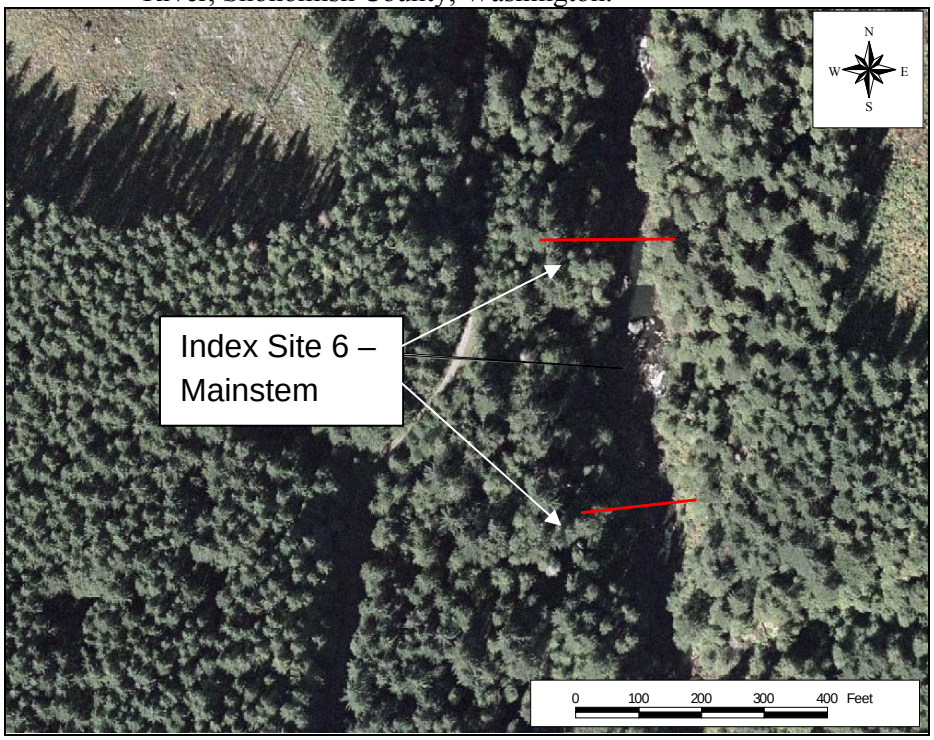

Figure 8. Location of juvenile salmonid mainstem Index Site 6 on the Sultan River, Snohomish County, Washington.

3.2 SNORKEL SURVEYS

Snorkel surveys were conducted quarterly (spring, summer, fall) during 2007 and 2008 (Table 2). Each site was surveyed three to four times in each survey quarter as stream conditions (i.e., turbidity) allowed. Elevated streamflow and turbidity present during the winter quarter 2008 precluded snorkel surveys at that time (Figure 9). Water temperatures varied from lows of around 2-3^{o}C during the February surveys to highs of about 11-12^{o}C in September (Figure 9). Spot measurements of water temperatures measured in side channels were at times 1-2^{o}C warmer than in the mainstem during the summer and fall survey periods. All juvenile salmonid index sites were surveyed a total of eighteen times during the study period.

The snorkel surveys were completed by a team of five surveyors (4 divers, 1 observer); surveys began at the downstream boundary of the index site and proceeded upstream along each margin of the index site (Figure 10). One or two of the surveyors surveyed the side channels at the same time or immediately following the mainstem survey depending on the amount of area available to survey. Upon completion of the margins, all the divers entered the upstream boundary of the mainstem index site and completed the center portion of the index site in a downstream direction. The observer served as a recorder and as a safety measure in case one of the snorkelers encountered any problems. Night surveys were performed in 2007, but were not repeated in 2008 in part due to access and safety concerns in the mainstem index sites.

Divers were positioned so that all of the wetted area was surveyed, but observations did not overlap. Fish were enumerated by species and placed in size class (mm FL) ranges as the snorkeler passed them, so duplicate counts were avoided (Figure 11). The distance between the divers was less than the maximum distance the divers could identify fish to species and size class. This distance was determined prior to the snorkel observations by underwater observations downstream from the index site boundary. Divers periodically coordinated with adjacent divers in order to maintain comprehensive single coverage. Underwater observations were recorded individually by each observer on DuraRite® notebooks carried "on person" in a small pack attached to the waist. Water temperatures were recorded at the time of survey. Water temperatures were generally less than 15ºC in most survey reaches. During two low flow snorkel surveys conducted in July 2007, isolated pool water temperatures in the Side Channel 1 index site reached 18ºC.

Table 2. Summary of snorkel survey trips made to the Sultan River, Snohomish County, Washington.

Quarter	Trip	Date	Index Sites[1]	Time of Survey	Flow (cfs)[2]
Summer	1	26-Jun-07	1-3	Day	549
Summer	1	27-Jun-07	4, 5-6	Day	563, 99
Summer	2	2-Jul-07	1-3	Day	310
Summer	2	3-Jul-07	4, 5-6	Day	354, 98
Summer	3	9-Jul-07	1-2	Night	321
Summer	3	10-Jul-07	3	Night	319
Summer	3	11-Jul-07	4, 5-6	Night	322, 99
Fall	4	25-Sep-07	1-3	Day	325
Fall	4	26-Sep-07	4, 5-6	Day	305, 165
Fall	5	27-Sep-07	1-3	Day	305
Fall	5	28-Sep-07	4, 5-6	Day	312
Fall	6	7-Nov-07	4, 5-6	Night	386
Fall	6	8-Nov-07	1-3	Night	387
Spring	7	28-Apr-08	1-3	Day	473
Spring	7	29-Apr-08	4	Day	499
Spring	8	5-May-08	4, 5-6	Day	728, 179
Spring	8	6-May-08	1-3	Day	808
Spring	9	12-May-08	1-3	Day	448
Spring	9	14-May-08	4	Day	560
Spring	10	14-Jul-08	4, 5-6	Day	810, 98
Spring	10	15-Jul-08	1-3	Day	750-500
Summer	11	2-Sep-08	5-6	Day	102
Summer	11	8-Sep-08	1-3 ms	Day	400
Summer	11	9-Sep-08	1s-3s	Day	400-700
Summer	12	15-Sep-08	4, 5-6	Day	370, 153
Summer	12	16-Sep-08	1-3	Day	370
Summer	13	17-Sep-08	4, 5-6	Day	375, 153
Summer	13	18-Sep-08	1-3	Day	375

Table 2. Summary of snorkel survey trips made to the Sultan River, Snohomish County, Washington.

Quarter	Trip	Date	Index Sites[1]	Time of Survey	Flow (cfs)[2]
Summer	11	19-Sep-08	4	Day	375
Summer	14	26-Sep-08	4, 5-6	Day	400, 162
Summer	14	29-Sep-08	1-3	Day	388
Fall	15	1-Oct-08	4, 5-6	Day	388, 162
Fall	15	2-Oct-08	1-3	Day	384
Fall	16	6-Oct-08	4, 5-6	Day	388, 162
Fall	16	7-Oct-08	1-3	Day	400
Fall	17	13-Oct-08	1-3	Day	376
Fall	17	14-Oct-08	4, 5-6	Day	392, 162
Fall	18	20-Oct-08	4, 5-6	Day	380, 163
Fall	18	21-Oct-08	1-3	Day	400

1- Index Sites include both side channel and mainstem units

2- As measured at USGS gage 21318160, Sultan River below the Powerplant (sites 1-4), and USGS gage 12137800 Sultan River below diversion dam (sites 5-6).

Relative abundance indices were calculated by dividing snorkel observations per wetted unit area and multiplying by 100 (no $100m^{-2}$) for each species (coho, Chinook, chum, and pink salmon, and rainbow and cutthroat trout). Juvenile rainbow and cutthroat trout were combined because they generally could not be differentiated at the sizes encountered (<100 mm). Intra-site data comparisons were conducted to determine relative abundance over the study periods and channel type (i.e., mainstem and side-channel), while inter-site relative abundance data were used to determine relative utilization between index sites throughout the study area and period.

Habitat composition (area) of each index site was identified using data collected from relicensing studies conducted by Stillwater and Meridian (2000a) and R2 (2008). Habitat units identified in the index sites included rapid, riffle, glide and pool. Cascade habitat types were not present at juvenile salmonid index sites. All data were entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes.

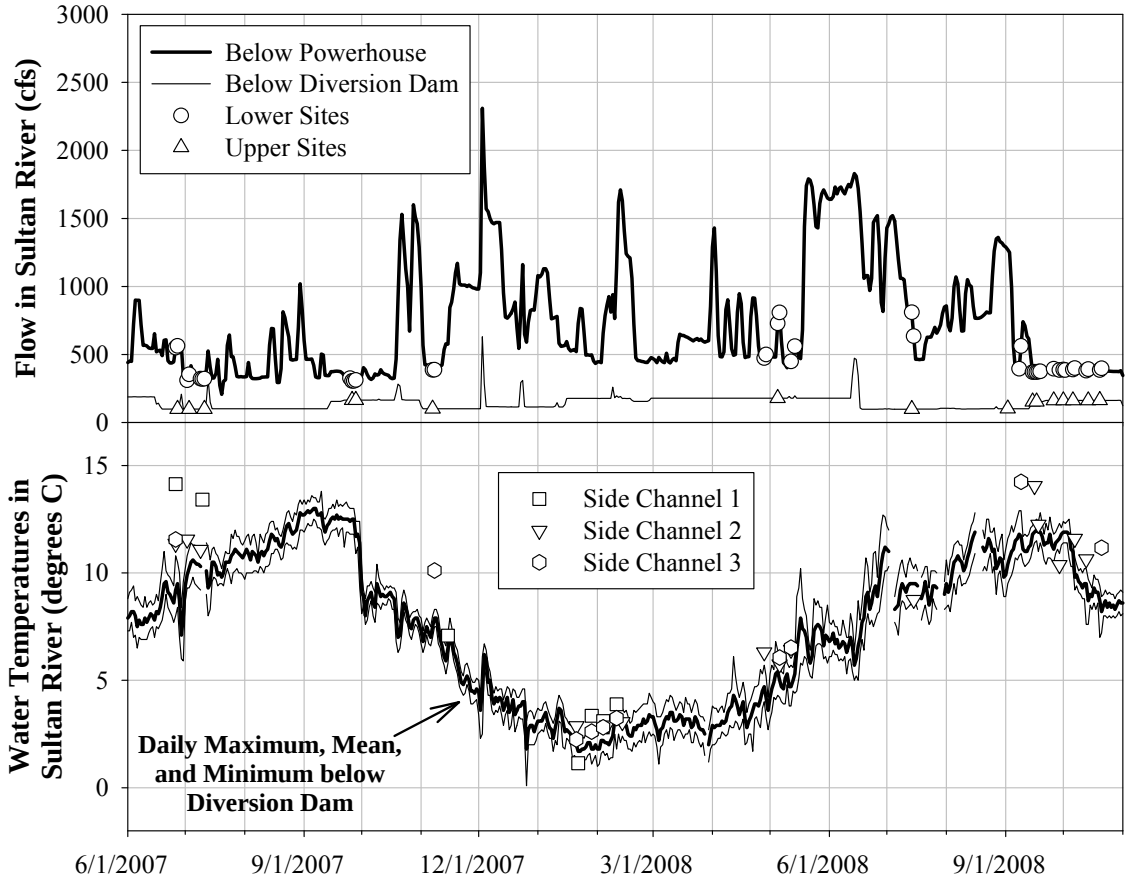

Figure 9. Discharge (cfs) (upper figure) and water temperature (lower figure) at time of snorkel surveys (upper sites = Sites 5-6; lower sites = Sites 1-4) in the Sultan River, Snohomish County, Washington.

Figure 10. Juvenile salmonid snorkel observation on mainstem margin of the Sultan River, Snohomish County, Washington.

Figure 11. Juvenile salmonids (coho) observed at mainstem index site on the Sultan River, Snohomish County, Washington.

3.3 BACKPACK ELECTROFISHING SURVEYS

Backpack electrofishing was utilized as a juvenile salmonid survey technique when the following conditions as specified in the NMFS collection permit occurred: a) water temperature was less than 21ºC; b) turbidity levels prevented underwater observations ≥1.0 meter; and 3) discharge conditions caused safety concerns for underwater observers. Water temperatures during electrofishing surveys did not exceeded 8.0ºC. The NMFS collection permit further specified that no more than 75 natural origin Chinook salmon could be captured/handled over the entire duration of the survey period. Sites selected for electrofishing were areas representative of the habitat present in the snorkel survey sites and included the shoreline margins and mid-channel portions of the juvenile salmonid index site (Figure 12). Electrofishing survey site selection was limited to areas that were shallow enough to provide effective backpack shocking (<3.5 ft deep). Backpack electrofishing sites included all habitat types in the side channel index sites, mainstem margin, and mainstem habitat surrounding island complexes. Areas known to contain redds were specifically avoided.

Figure 12. Electrofishing on the Sultan River, Snohomish County, Washington, February 2007.

Backpack electrofishing surveys were conducted between 15 November 2007 and 14 February 2008 (Table 3). A total of five electrofishing trips were conducted, each trip consisted of 2-3 days of electrofishing effort (Table 3). No electrofishing surveys were conducted during hours of darkness for safety reasons.

All electrofishing surveys were completed using a SmithRoot, Inc. Model 15-C programmable wave output backpack electrofishing unit, using "straight DC" current. A block net was installed at the upstream end of selected sites when feasible and necessary. Electrofishing began at the lower site boundary and continued upstream to the block net or a natural barrier such as a shallow riffle or inlet. One transect (i.e., pass) was electrofished at each survey site; guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act (NMFS 1998) were strictly adhered to during the electrofishing surveys. This methodology was not intended to provide population estimates, but instead provided an additional index of abundance, while minimizing potential injury to the fish. It also provided the opportunity to obtain empirical length measurements of captured fish.

During the electrofishing surveys, fish were captured with a dip net (3-mm nylon mesh) and placed into a darkened recovery bucket where they were anesthetized with 75 mg L^{-1} tricaine methanesulfonate (MS 222). Each fish was identified to species, measured to the nearest mm total length, allowed to recover in fresh water for a minimum of 30 minutes, and then released within the survey site that they were captured. The survey time (seconds) of each backpack electrofishing survey was recorded along with individual fish data (species, length, comments), photographs, and water temperatures (°C) on field data sheets. Catch per unit effort was computed by dividing the number of each species captured by the survey time. All data were entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes. Catch per unit effort (CPUE) estimates were computed for each pass based on numbers of fish captured per unit time (seconds).

Table 3. Summary of electrofishing survey trips made to the Sultan River, Snohomish County, Washington.

Date	Sites	Type	Cfs[1]
15-Nov-07	1	Electrofish	576
16-Nov-07	3-4, 5	Electrofish	846, 102
21-Jan-08	2-3	Electrofish	521
22-Jan-08	1	Electrofish	727
23-Jan-08	4, 5-6	Electrofish	839, 177
29-Jan-08	1-3	Electrofish	497
30-Jan-08	4, 5	Electrofish	452, 177
31-Jan-08	2, 6	Electrofish	433, 177
4-Feb-08	1-3	Electrofish	656
5-Feb-08	4, 5	Electrofish	786, 177
6-Feb-08	2, 6	Electrofish	863, 177
11-Feb-08	1, 3	Electrofish	1140
12-Feb-08	4, 5	Electrofish	1620, 185
14-Feb-08	2, 6	Electrofish	1630, 176

1- As measured at USGS gage 21318160, Sultan River below the Powerplant (sites 1-4), and USGS gage 12137800 Sultan River below diversion dam (sites 5-6). Data are preliminary.

3.4 MINNOW TRAP SURVEYS

Minnow traps were used in addition to snorkel and backpack electrofishing surveys to provide supplemental distribution information when visibility and/or streamflow precluded snorkel surveys (winter survey periods). Gee type wire minnow traps were installed on 18-19 February 2008 in the Sultan River (Figure 13). As with electrofishing, minnow trapping sites were selected from within the snorkel survey sites. Trapping sites were selected that provided lower stream velocities and instream cover that would most likely maximize fish capture. A total of 25 traps were installed (Table 4). Traps were checked twice, once on 21 February and again on 27 February, with all traps removed on 27 February. Traps were baited with a commercial scented egg mixture.

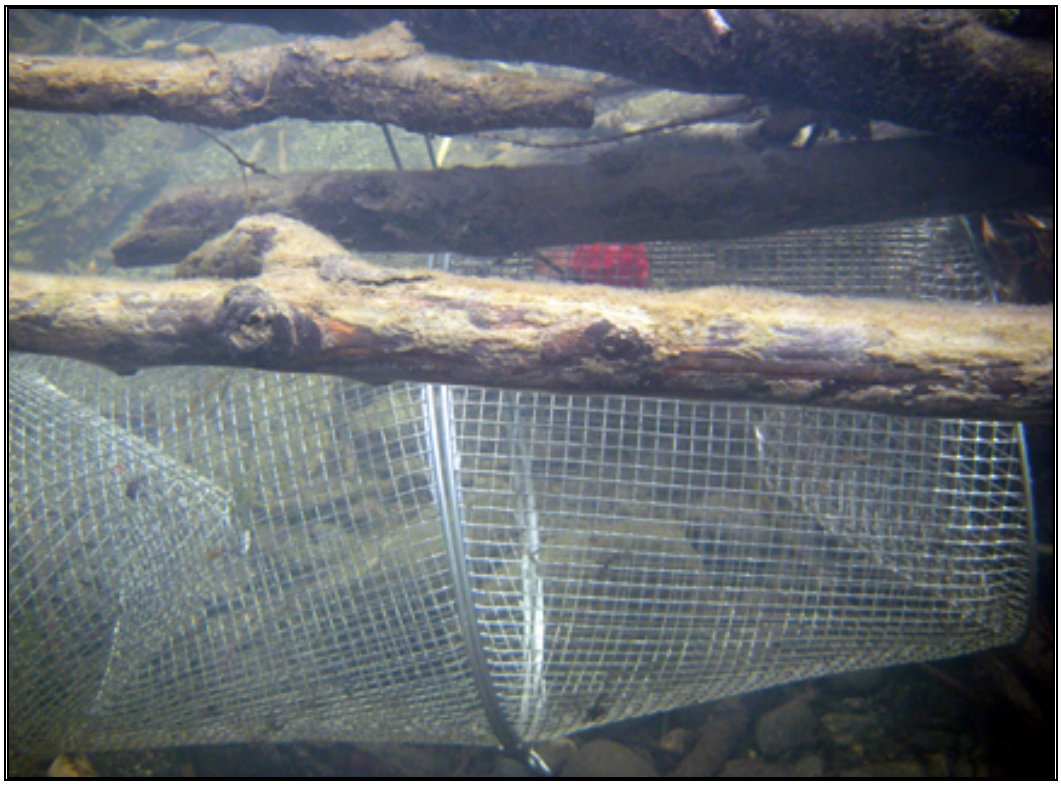

Figure 13. Minnow trap installed in the Sultan River, Snohomish County, Washington, 2008.

Minnow trap surveys followed the same NMFS specified collection permit requirements as for electrofishing. Captured fish were placed into a darkened recovery bucket where they were anesthetized with 75 mg L^{-1} tricaine methanesulfonate (MS 222). Each fish was identified to species, measured to the nearest mm fork length, allowed to recover in fresh water for a minimum of 30 minutes, and then released within the survey site from which they were captured. No immediate injuries or mortalities were incurred during minnow trapping activities. Catch per unit effort indices were computed by dividing the number of fish captured by the number of traps and the number of days (24 hr period) that each trap was fished.

Table 4. Location of minnow traps placed on the Sultan River, Snohomish County, Washington, 2008.

Trap #	Index Site	Date Deployed	Checked	Removed	GPS Location	Description
1	Side channel 1	18 Feb	21 Feb	27 Feb	47.8691° -121.829°	just above lowest bridge
2	Side channel 1	18 Feb	21 Feb	27 Feb	47.8693° -121.829°	25 yards above trap 1
3	Side channel 1	18 Feb	21 Feb	27 Feb	47.8694° -121.828°	20 ft upstream trap 2
4	Mainstem 1	18 Feb	21 Feb	27 Feb	47.8696° -121.829°	left bank across island from lowest bridge
5	Mainstem 1	18 Feb	21 Feb	27 Feb	47.8684° -121.830°	left bank below outlet to side channel 1
6	Mainstem 2	18 Feb	21 Feb	27 Feb	47.8715° -121.827°	just below outlet to side channel 2
7	Side channel 2	18 Feb	21 Feb	27 Feb	47.8719° -121.826°	first log jam up from mouth
8	Side channel 2	18 Feb	21 Feb	27 Feb	47.8724° -121.826°	above road crossing
9	Side channel 2	18 Feb	21 Feb	27 Feb	47.8727° -121.826°	200 ft above trap 8

Table 4. Location of minnow traps placed on the Sultan River, Snohomish County, Washington, 2008.

Trap #	Index Site	Date Deployed	Checked	Removed	GPS Location	Description
10	Mainstem 2	18 Feb	21 Feb	27 Feb	47.8722° -121.825°	just above road crossing
11	Mainstem 3	18 Feb	21 Feb	27 Feb	47.8826° -121.833°	right bank just above inlet to side channel 3
12	Mainstem 3	18 Feb	21 Feb	27 Feb	47.8827° -121.833°	100 yards above trap 11
13	Mainstem 3	18 Feb	21 Feb	27 Feb	47.8828° -121.833°	20 yards above trap 12
14	Side channel 3	18 Feb	21 Feb	27 Feb	47.8821° -121.832°	upper end of side channel
15	Side channel 3	18 Feb	21 Feb	27 Feb	47.882° -121.831°	upper end of side channel
16	Side channel 3	18 Feb	21 Feb	27 Feb	47.8818° -121.830°	upper end of side channel
17	Mainstem 4	18 Feb	21 Feb	27 Feb	47.9081° -121.815°	just below Powerhouse, left bank
18	Mainstem 4	18 Feb	21 Feb	27 Feb	47.9079° -121.815°	150 yards below Powerhouse, left bank

Table 4. Location of minnow traps placed on the Sultan River, Snohomish County, Washington, 2008.

Trap #	Index Site	Date Deployed	Checked	Removed	GPS Location	Description
19	Mainstem 4	18 Feb	21 Feb	27 Feb	47.9078° -121.815°	left bank in jam at end of snorkel site
20	Mainstem 5	19 Feb	21 Feb	27 Feb	47.9138° -121.811°	left bank, just upstream from trail access
21	Mainstem 5	19 Feb	21 Feb	27 Feb	47.9133° -121.812°	right bank just below trail access
22	Mainstem 5	19 Feb	21 Feb	27 Feb	47.9129° -121.812°	left bank below cascade
23	Mainstem 6	19 Feb	21 Feb	27 Feb	47.9408° -121.801°	right bank, 50' downstream of trail access
24	Mainstem 6	19 Feb	21 Feb	27 Feb	47.9415° -121.801°	right bank 100 yd. above access trail
25	Mainstem 6	19 Feb	21 Feb	27 Feb	47.9422° -121.801°	right bank, 60' downstream house rock

4. RESULTS

The juvenile fish abundance surveys conducted as part of RSP 5 were completed over a 16-month time period extending from June 2007 through October 2008. During this period, over 134,000 juvenile salmonids were enumerated, with the majority observed during snorkel surveys. This section presents the overall results of each of the three types of surveys, including the snorkel surveys, backpack electrofishing surveys, and minnow trap surveys. Comparisons are made within each of the index sites as well as longitudinally and laterally between index sites.

4.1 SNORKEL SURVEYS

Index Site 1

Mainstem

A total of 12,211 juvenile salmonids were observed during snorkel surveys conducted at Index Site 1 - Mainstem located at RM 1.5 (Table 5; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance of juvenile salmonids as determined from snorkel surveys was 2.6 salmonids 100 m^{-2} (Table 6; Figure 14). Total juvenile salmonid relative abundance was greatest (6.4 salmonids 100 m^{-2}) during the summer 2008 survey period and lowest (0.8 salmonids 100 m^{-2}) during the fall 2007 survey period (Table 6; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; $P > 0.05$). Juvenile coho salmon were the dominant species present during the survey period (Tables 5 and 6).

Side Channel

A total of 34,017 juvenile salmonids were observed during snorkel surveys conducted at Index Site 1 - Side Channel located at RM 1.5 (Table 5; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance of juvenile salmonids was 25.3 salmonids 100 m^{-2} (Table 6; Figure 14). Juvenile salmonid relative abundance was greatest (42.5 salmonids 100 m^{-2}) during the summer 2008 survey period and lowest (3.5 salmonids 100 m^{-2}) during the fall 2007 survey period (Table 6; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; $P > 0.05$). Juvenile coho salmon were the dominant species present during the survey period (Tables 5 and 6). Total juvenile salmonid abundance was significantly greater

in the Side Channel site when compared to the Mainstem (Mann-Whitney Rank Sum Test; P <0.01).

Table 5. Number of juvenile salmonids) observed during snorkel surveys conducted at Index Site 1 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.5	**Segment Site 1**	**No. Fish Observed**					
		Summer	**Fall**	**Spring**	**Summer**	**Fall**	
Habitat	**Species**	**07**	**07**	**08**	**08**	**08**	**Total**
Mainstem	Chinook	180	0	1,326	41	0	**1,547**
	Chum	0	0	1	0	0	**1**
	Coho	467	354	4,919	3,144	871	**9,755**
	Pink	0	0	10	0	0	**10**
	Trout <100mm	169	239	3	293	88	**792**
	RB Trout >100mm	7	0	15	65	19	**106**
	Total	***823***	***593***	***6,274***	***3,543***	***978***	**12,211**
Side Channel	Chinook	2	0	855	7	10	**874**
	Chum	0	0	16	0	0	**16**
	Coho	4,191	652	7,405	11,555	8,541	**32,344**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	140	86	12	408	113	**759**
	RB Trout >100mm	7	0	3	12	2	**24**
	Total	***4,340***	***738***	***8,291***	***11,982***	***8,666***	***34,017***

Table 6. Juvenile salmonid abundance (no 100m-2) observed during snorkel surveys conducted at Index Site 1 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.5	Segment Site 1	No. Fish Observed $100m^{-2}$					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Mean
Mainstem	Chinook	0.2	0.0	1.4	0.0	0.0	**0.330**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	0.6	0.5	5.0	3.2	0.9	**2.058**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.002**
	Trout <100mm	0.2	0.3	0.0	0.3	0.1	**0.190**
	RB Trout >100mm	0.0	0.0	0.0	0.1	0.0	**0.022**
	Total	***1.1***	***0.8***	***6.4***	***3.6***	***1.0***	***2.603***
Side Channel	Chinook	0.0	0.0	3.0	0.0	0.0	**0.620**
	Chum	0.0	0.0	0.1	0.0	0.0	**0.011**
	Coho	19.8	3.1	26.3	41.0	30.3	**24.084**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	0.7	0.4	0.0	1.4	0.4	**0.592**
	RB Trout >100mm	0.0	0.0	0.0	0.0	0.0	**0.019**
	Total	***20.5***	***3.5***	***29.4***	***42.5***	***30.7***	***25.326***

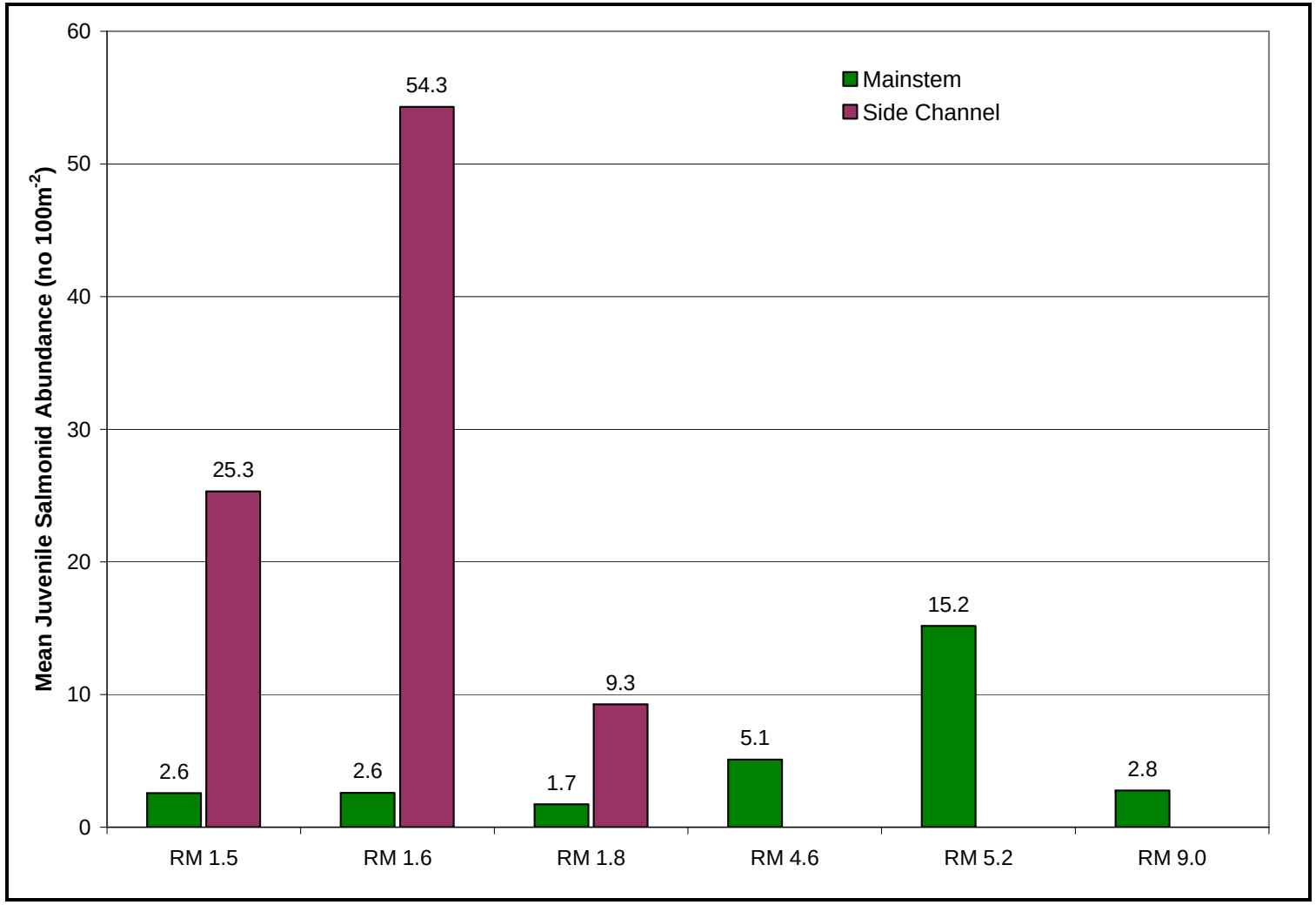

Figure 14. Mean juvenile salmonid relative abundance (no $100m^{-2}$) snorkel indices at nine locations in the Sultan River, Snohomish County, Washington 2007-2008.

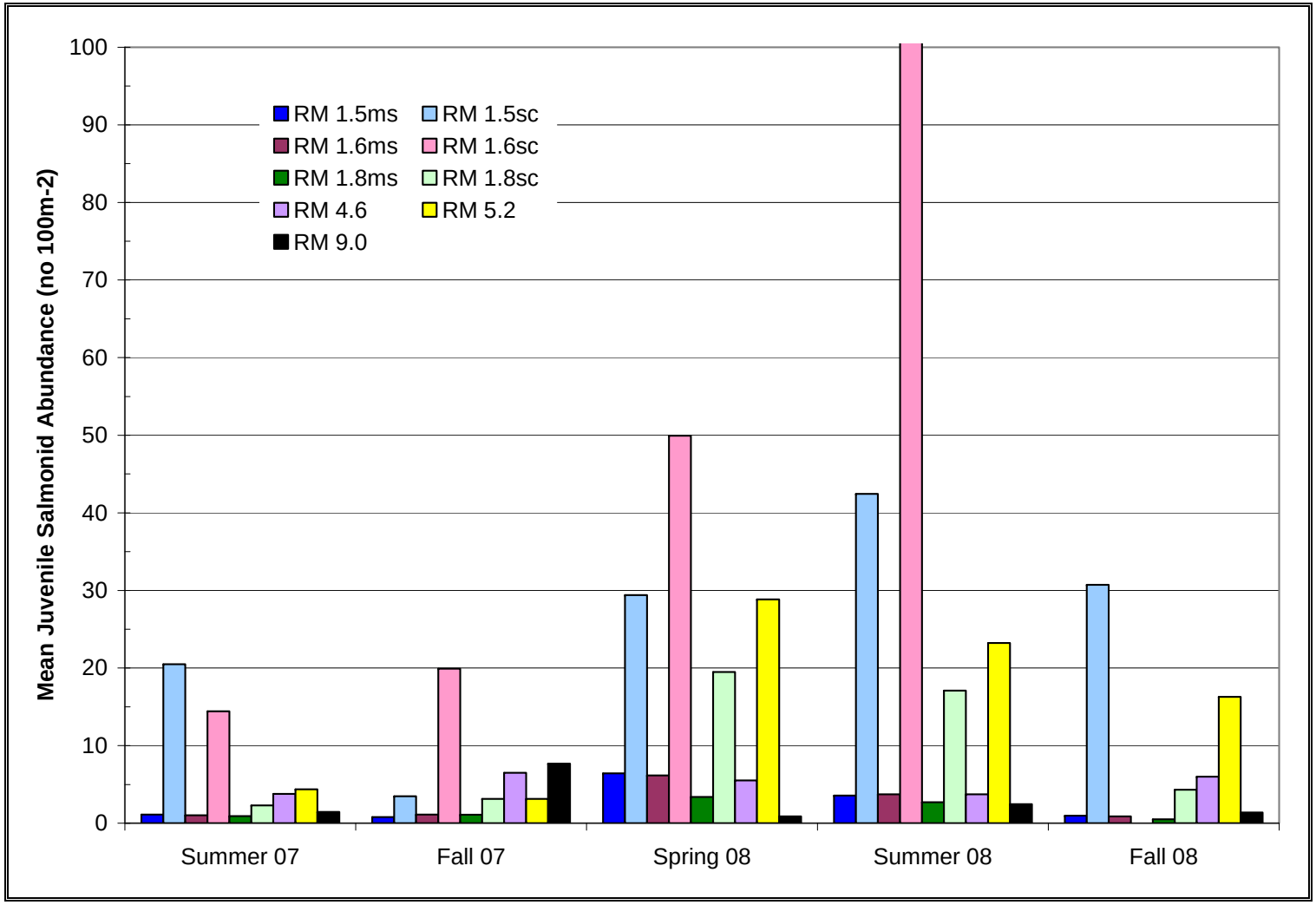

Figure 15. Mean seasonal juvenile salmonid relative abundance (no $100m^{-2}$) as determined from snorkel surveys at nine locations (ms=mainstem; sc=side channel) in the Sultan River, Snohomish County, Washington 2007-2008.

Index Site 2

Mainstem

A total of 13,791 juvenile salmonids were observed during snorkel surveys conducted at Index Site 2 -Mainstem located at RM 1.6 (Table 7; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance determined from snorkel surveys was 2.6 salmonids 100 m^{-2} (Table 8; Figure 14). Total juvenile salmonid relative abundance was greatest (6.2 salmonids 100 m^{-2}) during the spring 2008 survey period and lowest (0.9 salmonids 100 m^{-2}) during the fall 2007 survey period (Table 8; Figure 15); however, there was not a significant difference amongst the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; $P > 0.05$). Juvenile coho salmon were the dominant species present throughout the survey period (Tables 7 and 8).

Side Channel

A total of 26,945 juvenile salmonids were observed during snorkel surveys conducted at Index Site 2 - Side Channel 2 located at RM 1.6 (Table 7; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance was 54.3 salmonids 100 m^{-2} (Table 8; Figure 14). Juvenile salmonid relative abundance was greatest (108.7 salmonids 100 m^{-2}) during the summer 2008 survey period and lowest (14.5 salmonids 100 m^{-2}) during the summer 2007 survey period (Table 8; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; $P > 0.05$). Juvenile coho salmon was the dominant species present throughout the survey period (Tables 7 and 8). Total juvenile salmonid abundance was significantly greater in the Side Channel of Index Site 2 compared to the Mainstem site (Mann-Whitney Rank Sum Test; $P < 0.01$).

Table 7. Number of juvenile salmonids observed during snorkel surveys conducted at Index Site 2 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.6	Segment Site 2	No. Fish Observed					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	119	0	1,534	36	1	**1,690**
	Chum	0	0	3	0	0	**3**
	Coho	627	564	5,245	3,551	861	**10,848**
	Pink	0	0	13	0	0	**13**
	Trout <100mm	107	371	3	518	120	**1,119**
	RB Trout >100mm	9	0	12	75	22	**118**
	Total	***862***	***935***	***6,810***	***4,180***	***1,004***	**13,791**
Side Channel	Chinook	34	0	95	8	8	**145**
	Chum	0	0	0	0	0	**0**
	Coho	1,013	1,075	5,016	10,802	7,948	**25,854**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	61	454	4	314	88	**921**
	RB Trout >100mm	5	0	6	8	6	**25**
	Total	***1,113***	***1,529***	***5,121***	***11,132***	***8,050***	**26,945**

Table 8. Juvenile salmonid abundance (no 100m^{-2}) observed during snorkel surveys conducted at Index Site 2on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.6	Segment Site 2	No. Fish Observed 100m^{-2}					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Mean
Mainstem	Chinook	0.1	0.0	1.4	0.0	0.0	**0.314**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.001**
	Coho	0.8	0.7	4.8	3.2	0.8	**2.044**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.002**
	Trout <100mm	0.1	0.4	0.0	0.5	0.1	**0.232**
	RB Trout >100mm	0.0	0.0	0.0	0.1	0.0	**0.022**
	Total	***1.0***	***1.1***	***6.2***	***3.8***	***0.9***	**2.615**
Side Channel	Chinook	0.4	0.0	0.9	0.1	0.1	**0.305**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	13.2	14.0	49.0	105.5	77.6	**51.855**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	0.8	5.9	0.0	3.1	0.9	**2.134**
	RB Trout >100mm	0.1	0.0	0.1	0.1	0.1	**0.052**
	Total	***14.5***	***19.9***	***50.0***	***108.7***	***78.6***	**54.347**

Index Site 3

Mainstem

A total of 7,006 juvenile salmonids were observed during snorkel surveys conducted at Index Site 3 - Mainstem 3 located at RM 1.8 (Table 9; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance of juvenile salmonids determined from snorkel surveys was 1.7 juvenile salmonids 100 m^{-2} (Table 9; Figure 14). Total juvenile salmonid relative abundance was greatest (3.5 salmonids 100 m^{-2}) during the spring 2008 survey period and lowest (0.6 salmonids 100 m^{-2}) during the fall 2008 survey period (Table 10; Figure 15); however, there was no significant difference among the

survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile coho salmon was the dominant species present throughout the survey period (Tables 9 and 10).

Side Channel

A total of 13,553 juvenile salmonids were observed during snorkel surveys conducted in Index Site 3 - Side Channel located at RM 1.8 (Table 9; Appendices A-C for entire data set). All six species of juvenile salmonids were observed during the study period, including Chinook, coho, chum and pink salmon and trout (rainbow and cutthroat). Overall, mean relative abundance was 9.3 salmonids 100 m^{-2} (Table 10; Figure 14). Juvenile salmonid relative abundance was highest (19.5 salmonids 100 m^{-2}) during the spring 2008 survey period and lowest (2.4 salmonids 100 m^{-2}) during the summer 2007 survey period (Table 10; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile coho salmon was the dominant species present throughout the survey period (Tables 9 and 10). Total juvenile salmonid abundance was significantly greater in the Side Channel site compared to the Mainstem site (Mann-Whitney Rank Sum Test; P=0.05).

Table 9. Number of juvenile salmonids observed during snorkel surveys conducted at Index Site 3 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.8	**Segment Site 3**	**No. Fish Observed**					
Habitat	**Species**	**Summer 07**	**Fall 07**	**Spring 08**	**Summer 08**	**Fall 08**	**Total**
Mainstem	Chinook	55	0	697	12	1	**765**
	Chum	0	0	3	0	0	**3**
	Coho	382	320	2,111	1,983	340	**5,136**
	Pink	0	0	2	0	0	**2**
	Trout <100mm	127	355	13	265	85	**845**
	RB Trout >100mm	23	4	45	144	39	**255**
	Total	***587***	***679***	***2,871***	***2,404***	***465***	**7,006**
Side Channel	Chinook	122	0	413	14	0	**549**
	Chum	0	0	0	0	0	**0**
	Coho	371	500	5,402	4,876	1,242	**12,391**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	26	201	14	222	46	**509**
	RB Trout >100mm	15	10	16	46	17	**104**
	Total	***534***	***711***	***5,845***	***5,158***	***1,305***	**13,553**

Table 10. Juvenile salmonid abundance (no 100m-2) observed during snorkel surveys conducted at Index Site 3on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 1.8	Segment Site 3	No. Fish Observed 100m^{-2}					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	0.1	0.0	0.8	0.0	0.0	**0.189**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.001**
	Coho	0.6	0.5	2.5	2.4	0.4	**1.295**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	0.2	0.6	0.0	0.3	0.1	**0.243**
	RB Trout >100mm	0.0	0.0	0.1	0.2	0.0	**0.064**
	Total	***0.9***	***1.1***	***3.5***	***2.9***	***0.6***	**1.792**
Side Channel	Chinook	0.5	0.0	1.4	0.0	0.0	**0.394**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	1.7	2.2	18.1	16.3	4.2	**8.477**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	0.1	0.9	0.0	0.7	0.2	**0.391**
	RB Trout >100mm	0.1	0.0	0.1	0.2	0.1	**0.075**
	Total	***2.4***	***3.2***	***19.5***	***17.2***	***4.4***	**9.337**

Index Site 4

A total of 5,520 juvenile salmonids were observed during snorkel surveys conducted at Index Site 4 -Mainstem located at RM 4.6 (Table 11; Appendices A-C for entire data set). Four species of juvenile salmonids were observed during the study period, including Chinook and coho and rainbow and cutthroat trout. Overall, mean relative abundance was 5.1 juvenile salmonids 100 m^{-2} (Table 12; Figure 14). Total juvenile salmonid relative abundance was greatest (6.5 salmonids 100 m^{-2}) during the fall 2007 survey period and lowest (3.7 salmonids 100 m^{-2}) during the summer 2008 survey period (Table 12; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile coho salmon was the dominant species present in 60% of the survey period, while rainbow trout dominated the assemblage during the remaining 40% of the survey period (Tables 11 and 12).

Table 11. Number of juvenile salmonids observed during snorkel surveys conducted at Index Site 4 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 4.6	Segment Site 4	No. Fish Observed					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	4	0	268	5	0	**277**
	Chum	0	0	0	0	0	**0**
	Coho	199	462	1,063	810	1,363	**3,897**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	480	709	0	78	79	**1,346**
	RB Trout >100mm	2	0	5	16	20	**43**
	Total	***683***	***1,171***	***1,331***	***893***	***1,442***	***5,520***

Table 12. Juvenile salmonid abundance (no 100m-2) observed during snorkel surveys conducted at Index Site 4 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 4.6	**Segment Site 4**	**No. Fish Observed 100m^{-2}**					
		Summer	**Fall**	**Spring**	**Summer**	**Fall**	
Habitat	**Species**	**07**	**07**	**08**	**08**	**08**	**Total**
Mainstem	Chinook	0.0	0.0	1.1	0.0	0.0	**0.231**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	1.1	2.6	4.4	3.4	5.7	**3.420**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	2.7	3.9	0.0	0.3	0.3	**1.447**
	RB Trout >100mm	0.0	0.0	0.0	0.1	0.1	**0.036**
	Total	***3.8***	***6.5***	***5.5***	***3.7***	***6.0***	**5.098**

Index Site 5

A total of 21,920 juvenile salmonids were observed during snorkel surveys conducted at Index Site 5 -Mainstem located at RM 5.2 (Table 13; Appendices A-C for entire data set). Four species of juvenile salmonids were observed during the study period, including Chinook and coho salmon and rainbow and cutthroat trout. Overall, mean relative abundance was 5.1 juvenile salmonids 100 m^{-2} (Table 13; Figure 14). Total juvenile salmonid relative abundance was greatest (28.9 salmonids 100 m^{-2}) during the spring 2008 survey period and lowest (3.7 salmonids 100 m^{-2}) during the summer 2008 survey period (Table 14; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; P >0.05). Juvenile coho salmon was the dominant species throughout the survey period (Tables 13 and 14).

Table 13. Number of juvenile salmonids observed during snorkel surveys conducted at Index Site 5 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 5.2	Segment Site 5	No. Fish Observed					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	10	0	1,291	171	19	**1,491**
	Chum	0	0	0	0	0	**0**
	Coho	510	145	7,156	6,142	4,427	**18,380**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	448	546	67	545	367	**1,973**
	RB Trout >100mm	11	20	15	32	48	**126**
	Total	***979***	***711***	***8,529***	***6,890***	***4,861***	***21,970***

Table 14. Juvenile salmonid abundance (no $100m^{-2}$) observed during snorkel surveys conducted at Index Site 5 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 5.2	Segment Site 5	No. Fish Observed $100m^{-2}$					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	0.0	0.0	4.4	0.6	0.1	**1.012**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	2.3	0.7	24.2	20.8	15.0	**12.600**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	2.0	2.5	0.2	1.8	1.2	**1.561**
	RB Trout >100mm	0.0	0.1	0.1	0.1	0.2	**0.092**
	Total	***4.4***	***3.2***	***28.9***	***23.3***	***16.5***	**15.266**

Index Site 6

A total of 1,121 juvenile salmonids were observed during snorkel surveys conducted at Index Site 6 - Mainstem located at RM 9.0 (Table 15; Appendices A-C for entire data set). Four species of juvenile salmonids were observed during the study period, including Chinook and coho salmon and rainbow and cutthroat trout. Overall, mean relative abundance as determined

from the snorkel surveys was 3.6 juvenile salmonids 100 m^{-2} (Table 16; Figure 14). Total juvenile salmonid relative abundance was greatest (8.5 salmonids 100 m^{-2}) during the fall 2007 survey period and lowest (1.4 salmonids 100 m^{-2}) during the spring 2008 survey period (Table 16; Figure 15); however, there was no significant difference among the survey periods (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile rainbow and cutthroat trout were the dominant species present in throughout the survey period (Tables 15 and 16).

Table 15. Number of juvenile salmonids observed during snorkel surveys conducted at Index Site 6 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 9.0	**Segment Site 6**	**No. Fish Observed**					
		Summer	**Fall**	**Spring**	**Summer**	**Fall**	
Habitat	**Species**	**07**	**07**	**08**	**08**	**08**	**Total**
Mainstem	Chinook	0	0	11	0	0	**11**
	Chum	0	0	0	0	0	**0**
	Coho	3	0	43	24	5	**75**
	Pink	0	0	0	0	0	**0**
	Trout <100mm	74	412	10	151	94	**741**
	RB Trout >100mm	59	46	38	82	69	**294**
	Total	***136***	***458***	***102***	***257***	***168***	**1,121**

Table 16. Juvenile salmonid abundance (no 100m-2) observed during snorkel surveys conducted at Index Site 6 on the Sultan River, Snohomish County, Washington, 2007-2008 (rb=rainbow).

River Mile 9.0	Segment Site 6	No. Fish Observed 100m^{-2}					
		Summer	Fall	Spring	Summer	Fall	
Habitat	Species	07	07	08	08	08	Total
Mainstem	Chinook	0.0	0.0	0.2	0.0	0.0	**0.031**
	Chum	0.0	0.0	0.0	0.0	0.0	**0.000**
	Coho	0.1	0.0	0.6	0.3	0.1	**0.212**
	Pink	0.0	0.0	0.0	0.0	0.0	**0.000**
	Trout <100mm	1.4	7.7	0.1	2.1	1.3	**2.522**
	RB Trout >100mm	1.1	0.9	0.5	1.1	1.0	**0.919**
	Total	***2.5***	***8.5***	***1.4***	***3.6***	***2.3***	***3.684***

Combined Comparisons

Overall, juvenile salmonid abundance was significantly higher at Index Site 2 - Side Channel (median=50.00 salmonids 100 m^{-2}) compared to the other index sites (Kruskal-Wallis One Way Analysis of Variance on Ranks; P<0.05). The second highest juvenile salmonid relative abundance (median=29.4 salmonids 100 m^{-2}) occurred at Index Site 1-Side Channel, which was significantly greater than the remaining seven juvenile salmonid index sites (Kruskal-Wallis One Way Analysis of Variance on Ranks; P<0.05). Index Site 5 -Mainstem relative abundance (median=16.50 salmonids 100 m^{-2}) was significantly greater than all remaining index sites (Kruskal-Wallis One Way Analysis of Variance on Ranks; P<0.05) except for Index Site 3 - Side Channel 3 (median =5.50 salmonids 100 m^{-2}) (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile salmonid abundance at Index Site 3 - Side Channel was greater than Index Site 4 - Mainstem, however the difference was not significant (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05). Juvenile salmonid abundance at Index Site 4 - Mainstem (4.40 salmonids 100 m^{-2}) was greater than the remaining four index sites (Mainstem 6, median=2.50; Mainstem 1, median=1.10; Mainstem 2, median=1.10; and Mainstem 3, median=1.10), but differences were not significant (Kruskal-Wallis One Way Analysis of Variance on Ranks; P>0.05).

4.2 BACKPACK ELECTROFISHING SURVEYS

A total of 1,431 juvenile salmonids were captured during electrofishing surveys conducted in the Sultan River (Table 17; see Appendix D for entire data set). A total of nine different fish species were captured, including Chinook, coho, and pink salmon and rainbow and cutthroat trout. Other species captured during backpack electrofishing surveys included: lamprey spp., threespine stickleback, sucker spp., sculpin spp. Juvenile salmonids accounted for 85.2% (n=1,431) of the total catch (Table 17). Cutthroat trout were generally the largest species captured (mean FL=170.9 mm) while pink salmon were the smallest (mean FL=170.9 mm) (Table 17). Catch per unit effort was greatest at Index Site 1 - Side Channel (0.066 fish second^{-1}) and lowest at Index Site 2 - Mainstem (0.005 fish second^{-1}) (Table 18; Figure 16). Backpack electrofishing indices were generally greater in side-channel habitats when compared to mainstem habitats (Table 12; Figure 16).

Table 17. Backpack electrofishing total number captured, minimum, mean and maximum fork lengths (nearest 1.0 mm) of juvenile salmonids on the Sultan River, Snohomish County, Washington, 2008.

Species	No. Captured	Min	Mean	Max
Chinook	22	27	35.1	43
Coho	659	32	76.3	118
Cutthroat trout	10	28	170.9	310
Pink	35	21	27.4	33
Rainbow trout	705	31	68.0	237

Table 18. Backpack electrofishing catch per unit effort (fish second^{-1}) indices for salmonids at nine locations on the Sultan River, Snohomish County, Washington, 2007-2008

River Mile	Index Site	Chinook	Coho	Cutthroat trout	Pink	Rainbow trout	Total
RM 1.5	Mainstem 1	0.0006	0.0051	0.0000	0.0006	0.0046	0.0109
	Side Channel 1	0.0001	0.0578	0.0006	0.0000	0.0075	0.0661
RM 1.6	Mainstem 2	0.0006	0.0001	0.0000	0.0009	0.0035	0.0051
	Side Channel 2	0.0003	0.0070	0.0006	0.0001	0.0100	0.0311
RM 1.8	Mainstem Site 3	0.0005	0.0049	0.0001	0.0009	0.0082	0.0147
	Side Channel 3	0.0001	0.0013	0.0000	0.0010	0.0086	0.0110
RM 4.6	Mainstem 4	0.0003	0.0023	0.0000	0.0002	0.0135	0.0164
RM 5.2	Mainstem 5	0.0002	0.0096	0.0000	0.0006	0.0175	0.0185
RM 9.0	Mainstem 6	0.0000	0.0006	0.0002	0.0000	0.0150	0.0157

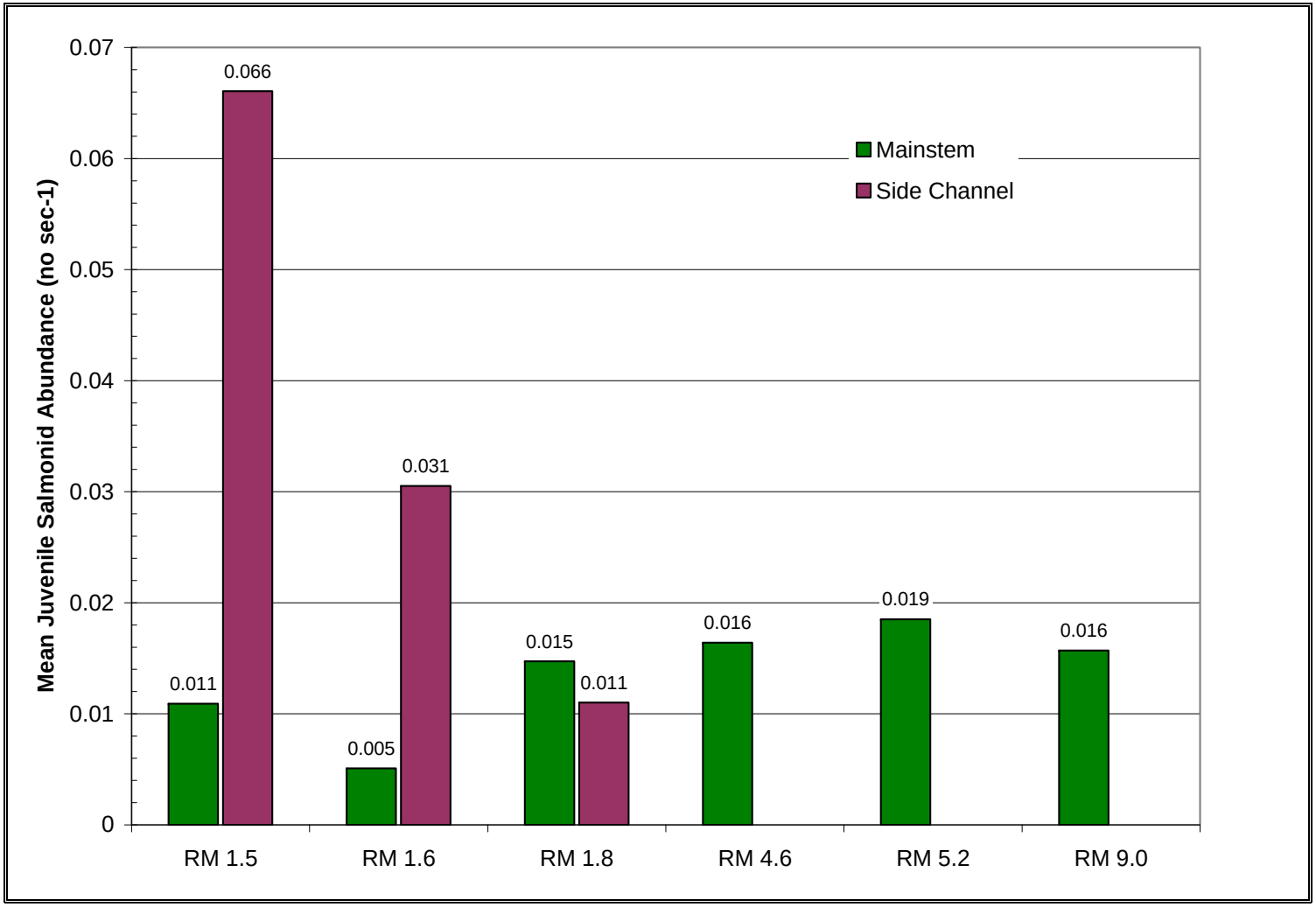

Figure 16. Mean juvenile salmonid relative abundance (no sec^{-1}) backpack electrofishing indices at nine locations in the Sultan River, Snohomish County, Washington 2007-2008.

4.3 MINNOW TRAP SURVEYS

A total of 162 fish were captured during the trapping surveys (see Appendix D for entire data set).). Juvenile salmonids accounted for 143 or 88.3% of the total fish captured. Average fork length of the Chinook captured was 41 mm (range of 37-45 mm), while average fork length of coho was 48.7mm (range = 57-103 mm FL). Minnow trap catch per unit effort was greatest at Index Site 1 - Side Channel (1.7 fish trap day^{-1}) and lowest at Index Site 5 (0 fish trap day^{-1}) (Table 19; Figure 17). Minnow trap juvenile salmonid abundance indices were consistently greater in side-channel habitats when compared to mainstem habitats (Table 19; Figure 17).

Table 19. Minnow trap catch per unit effort (fish trap-1) indices at nine locations on the Sultan River, Snohomish County, Washington, 2008.

River Mile	Index Site	Catch Per Unit Effort
RM 1.5	Mainstem 1	0.67
	Side Channel 1	1.70
RM 1.6	Mainstem 2	0.22
	Side Channel 2	1.48
RM 1.8	Mainstem 3	0.30
	Side Channel 3	0.63
RM 4.6	Site 4	0.50
RM 5.2	Site 5	0.00
RM 9.0	Site 6	0.08

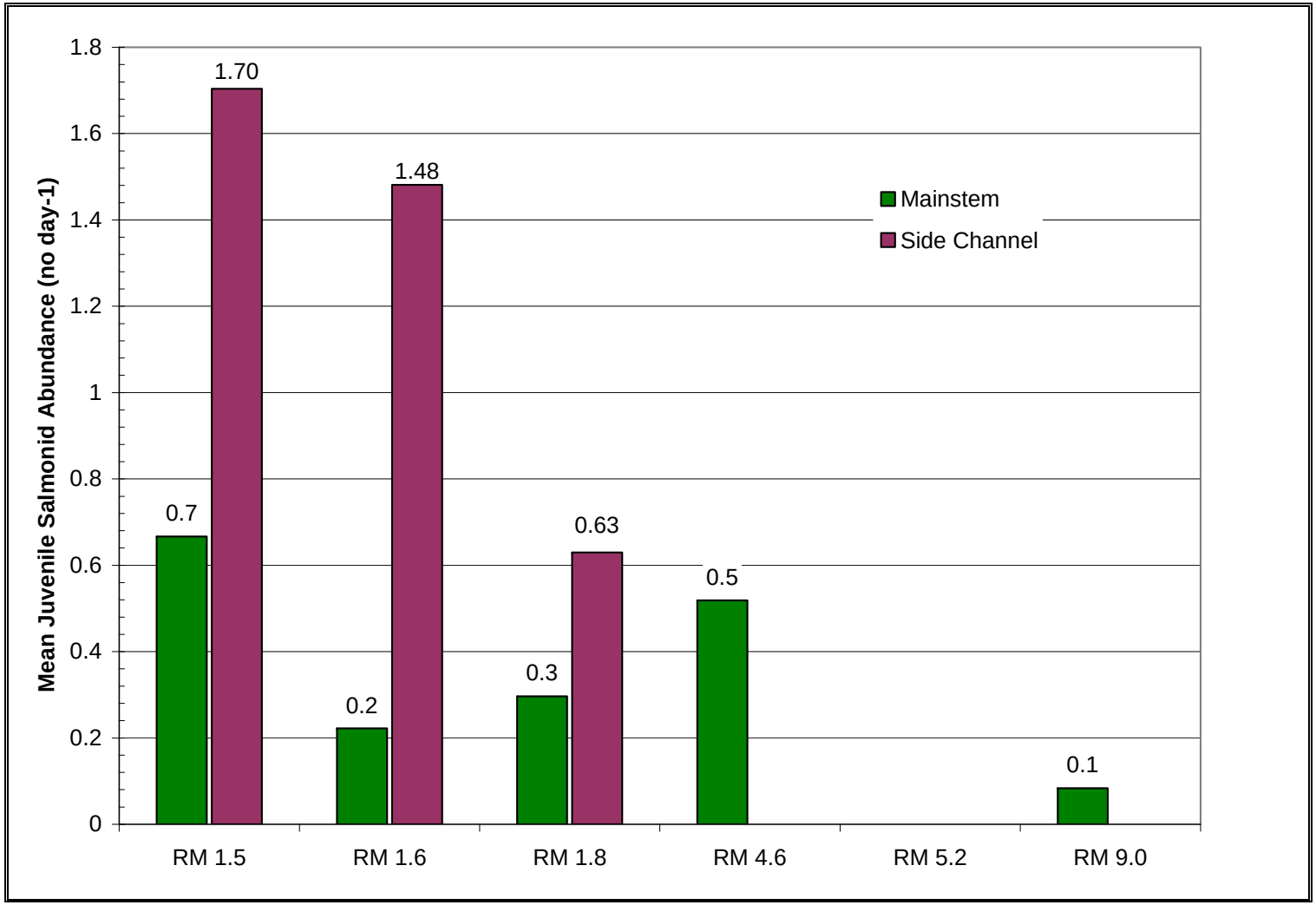

Figure 17. Mean juvenile salmonid relative abundance minnow trapping indices at nine locations in the Sultan River, Snohomish County, Washington 2008.

4.4 HABITAT SURVEY DATA

Habitat composition within each of the Index Sites is presented in Table 20. Overall, the index sites were comprised of glide (32.3%), riffle (31.6%) pool (24.7%), and rapid (11.4%) habitat types (Table 20, Figure 19). Side channel index sites were comprised primarily of glide (36.8%) and pool (34.1%) habitats, while mainstem index sites were dominated by riffle (32.8%) and glide (30.0%) habitat types (Table 20).

Table 20. Estimated habitat composition area of nine index sites on the Sultan River, Snohomish County, Washington, 2008. (Data from Stillwater Sciences and Meridian Environmental 2008a)

River Mile	Index Site	Rapid	Riffle	Glide	Pool
RM 1.5	Mainstem 1	0.0%	48.5%	51.5%	0.0%
	Side Channel 1	0.0%	10.0%	10.0%	80.0%
RM 1.6	Mainstem 2	0.0%	46.3%	53.7%	0.0%
	Side Channel 2	0.0%	40.3%	39.2%	20.5%
RM 1.8	Mainstem Site 3	20.2%	36.0%	43.8%	0.0%
	Side Channel 3	0.0%	37.2%	61.2%	1.7%
RM 4.6	Mainstem 4	0.0%	51.1%	31.2%	17.8%
RM 5.2	Mainstem 5	0.0%	15.1%	0.0%	84.9%
RM 9.0	Mainstem 6	82.7%	0.0%	0.0%	17.3%
	Mainstem mean	17.2%	32.8%	30.0%	20.0%
	Side Channel mean	0.0%	29.1%	36.8%	34.1%
	Overall mean	11.4%	31.6%	32.3%	24.7%

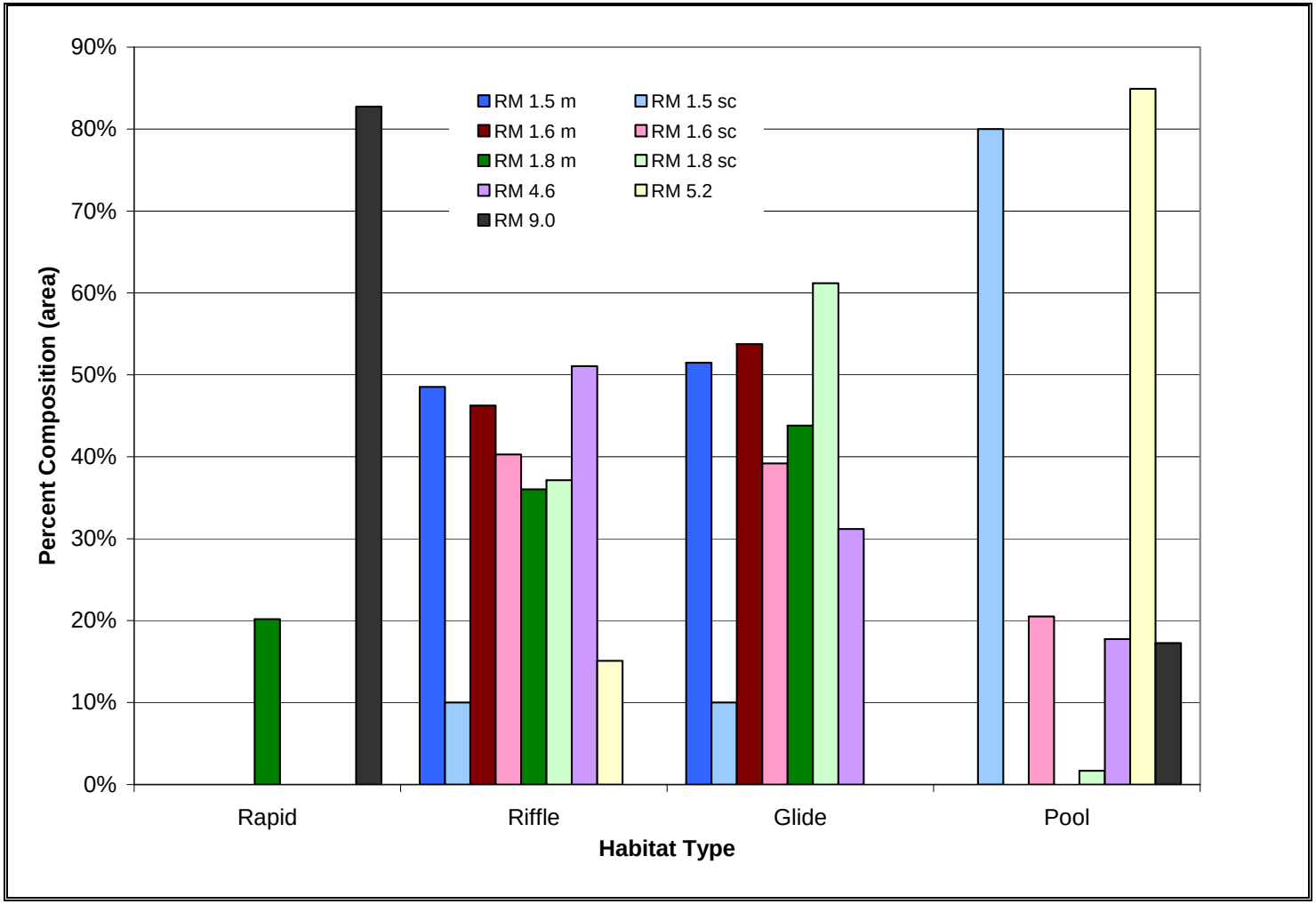

Figure 18. Estimated habitat composition at nine locations (ms=mainstem; sc=side channel) in the Sultan River, Snohomish County, Washington 2008. (Data from Stillwater Sciences and Meridian Environmental 2008a)

5. SUMMARY

This study provided information useful for addressing the technical questions raised on page 2 of this report. The results indicate that juvenile anadromous salmonid utilization of habitat varies both spatially and temporally within the two lower reaches of the Sultan River. Overall, the highest densities of juvenile salmonids were consistently found in side channel locations that contained numerous woody debris-formed pools and abundant habitat structure. The highest density of fish (juvenile coho) in the mainstem index sites was found at Index Site 5, which was comprised predominately of pool habitat (Tables 21-22). These results support the findings of other researchers who have noted the importance of off-channel habitats as rearing areas for juvenile salmonids (Bustard and Narver 1975; Quinn 2005) and the importance of pools within mainstem rivers for supporting coho salmon (Sharma and Hilborn 2001). Side channel areas often provide shelter from high flows, abundant cover for predator avoidance, and habitat complexity and structure that forms feeding stations.

Both of the two side channels present in Index Sites 1 and 2 that supported the highest densities of juvenile fish contained abundant cover, wood, and habitat complexity. In contrast, the habitat composition of the side channel in Index Site 3 was comprised primarily of riffle (37.2%) and glide habitat (61.2%) with relatively little pool habitat (1.7%, primarily found in the lower 500 lineal feet of the channel), and correspondingly contained significantly lower densities of juvenile salmonids compared to the other two side channel sites (Figure 18). A comparison of densities of juvenile fish in the two lower side channels suggests it is not simply the presence of pool habitat, but rather having a mix of habitat types that favors greater abundance. In this case, although the lower side channel (Index Site 1) had about four times the amount of pool habitat compared to the side channel in Index Site 2 (80% compared to 20.5%), its density was approximately half of what was found in the Index Site 2 side channel (25.31 fish 100 m^{-2} compared to 54.3 fish 100 m^{-2}), which in addition to pool habitat also contained a mix of riffle (40.3%) and glide (39.2%) habitats. Interestingly, Index Site 5 on mainstem contained the largest proportion of pool habitat of the six mainstem index sites, and supported higher densities of juvenile salmonids compared to the Side Channel 3 index site (Tables 20 and 21).

Table 21. Snorkel, backpack electrofishing, and minnow trap catch per unit effort indices at six locations on the Sultan River, Snohomish County, Washington, 2008.

River Mile	Index Site	Snorkel (fish $100m^{-2}$)	Backpack Electrofishing (fish sec^{-1})	Minnow Trap (fish $trap^{-1}$)
RM 1.5	Mainstem 1	2.58	0.0109	0.67
	Side Channel 1	25.31	0.0661	1.70
RM 1.6	Mainstem 1	2.59	0.0051	0.22
	Side Channel 2	54.30	0.0311	1.48
RM 1.8	Mainstem 3	1.73	0.0147	0.30
	Side Channel 3	9.26	0.0110	0.63
RM 4.6	Site 4	5.10	0.0164	0.50
RM 5.2	Site 5	15.17	0.0185	0.00
RM 9.0	Site 6	2.77	0.0157	0.08

In terms of timing, juvenile salmonid abundance in the lower Sultan River peaked during the spring and summer survey periods at a time when newly-emerged salmonid fry (age-0) are present in the river and before overyearling (age-1+) salmon smolts have moved downstream to the Skykomish River (Figure 15). This pattern was best exhibited with coho salmon, but also existed with steelhead and to a lesser extent Chinook salmon in the Sultan River. Juvenile coho salmon abundance was dominated by recently emerged fry in the early spring and summer periods and smolt-sized coho in the late fall and winter periods (Figure 19). Small (35-45 mm FL), relatively recently-emerged coho comprised the majority of coho in the Sultan River in the spring and summer, and smolt-sized (60+ mm FL) coho were in the minority as they had started to outmigrate. However by late fall the fry had grown considerably and were likely entering overwinter habitats where they reside until smolt migration the following spring (Figure 19).

Juvenile steelhead followed a similar pattern of temporal distribution, with the main difference with coho salmon appearing to be related to their overwinter habitat selection. Overwintering juvenile coho appeared to select for side channel areas with abundant pool and overhead cover in the form of woody debris (e.g., Index Sites 1-2 - Side Channel), while steelhead preferred to occupy the deeper mainstem areas that are comprised of rapid habitat types containing instream boulders and generally higher water velocities (e.g., Index Site 6 - Mainstem).

Juvenile Chinook salmon were infrequently encountered during fall and early winter surveys in the Sultan River even though "Chinook from the Snohomish basin comprise roughly 25 percent stream-type fish and 75 percent ocean-type fish" (Tulalip Tribe's comment cited in Public Utility District Number 1 of Snohomish County and City of Everett 2006). In total, over 136,000 juvenile salmonid observations were collected on the lower Sultan River, of which only two were from juvenile Chinook salmon during the fall survey periods. The Chinook found in the fall were observed in one side channel (Index Site RM 1.5 Side Channel) in pool habitats. The fish were observed as solitary individuals along with schools of coho and steelhead pre-smolts. Many steelhead pre-smolts were observed in similar habitat types without the occurrence of Chinook. The same habitat types were electrofished during winter periods and resulted in the same findings as the snorkel surveys; i.e., no Chinook were captured, even though other species/lifestages were found. This suggests that the majority of juvenile Chinook freshwater overwintering behavior takes place downstream in the Skykomish or mainstem Snohomish River.

Juvenile chum and pink salmon fry (35-45 mm; age-0) were observed in the spring and summer periods but only for an abbreviated period (spring periods) when compared to the other species lifestages (Figure 20). Both species occupied similar habitat, preferring the margins of the mainstem sites. Congregations of both pink and chum were observed behind woody debris accumulations and generally not associated with other species. Chum and pink fry were not present in the Sultan River during summer snorkel surveys (Figure 20).

Of the techniques employed, snorkel surveys proved to be the most effective and reliable for evaluating the distribution and relative abundance of juvenile anadromous salmonids in the Sultan River. Moreover, snorkeling is a non-injurious technique that does not require any handling or direct contact with the fish, an important consideration when working with ESA listed species. However, its' application in the Sultan River was and will continue to be limited to those times when both flow conditions and visibility are suitable for conducting these types of surveys. Snorkel observations were supplemented with backpack electrofishing and minnow trap surveys during the winter periods (water temperature < 8.0C) when Chinook salmon would not be negatively impacted (because they are generally absent) by these survey techniques.

The overall results of this survey have demonstrated the biological importance of side-channel habitats in the Sultan River basin, and as well the types of habitat areas being used in mainstem portions of the river. As noted in R2 (2008), both the availability and quantity of side channel habitats are influenced by mainstem flow. Likewise, the quantity of juvenile habitat within the main river is related to mainstem flows. Thus, the information provided in this study will be useful for understanding potential effects of both current and future Project operations on juvenile anadromous salmonid production.

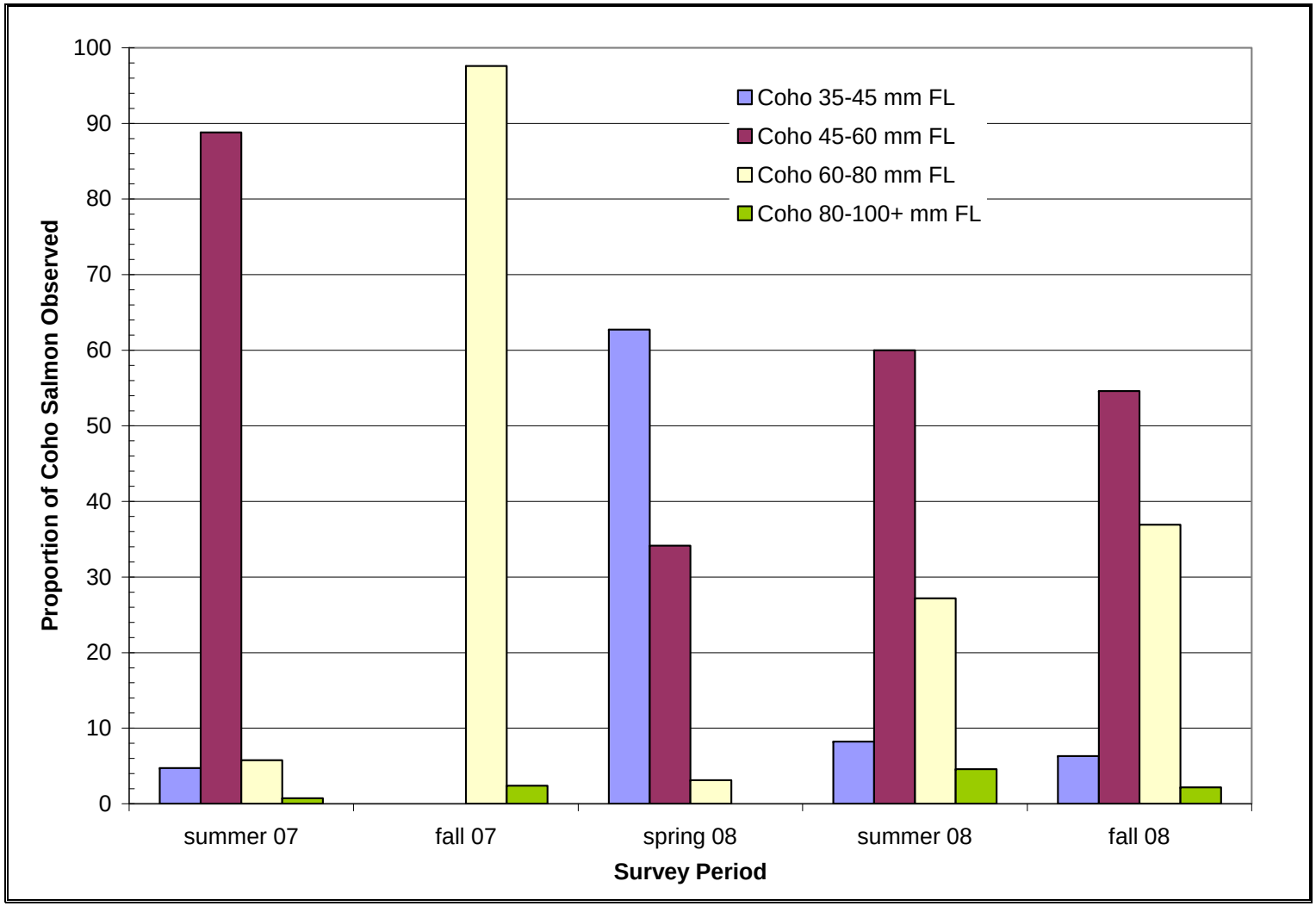

Figure 19. Juvenile coho salmon size composition from snorkel observations conducted in the Sultan River, Snohomish County, Washington 2007-2008.

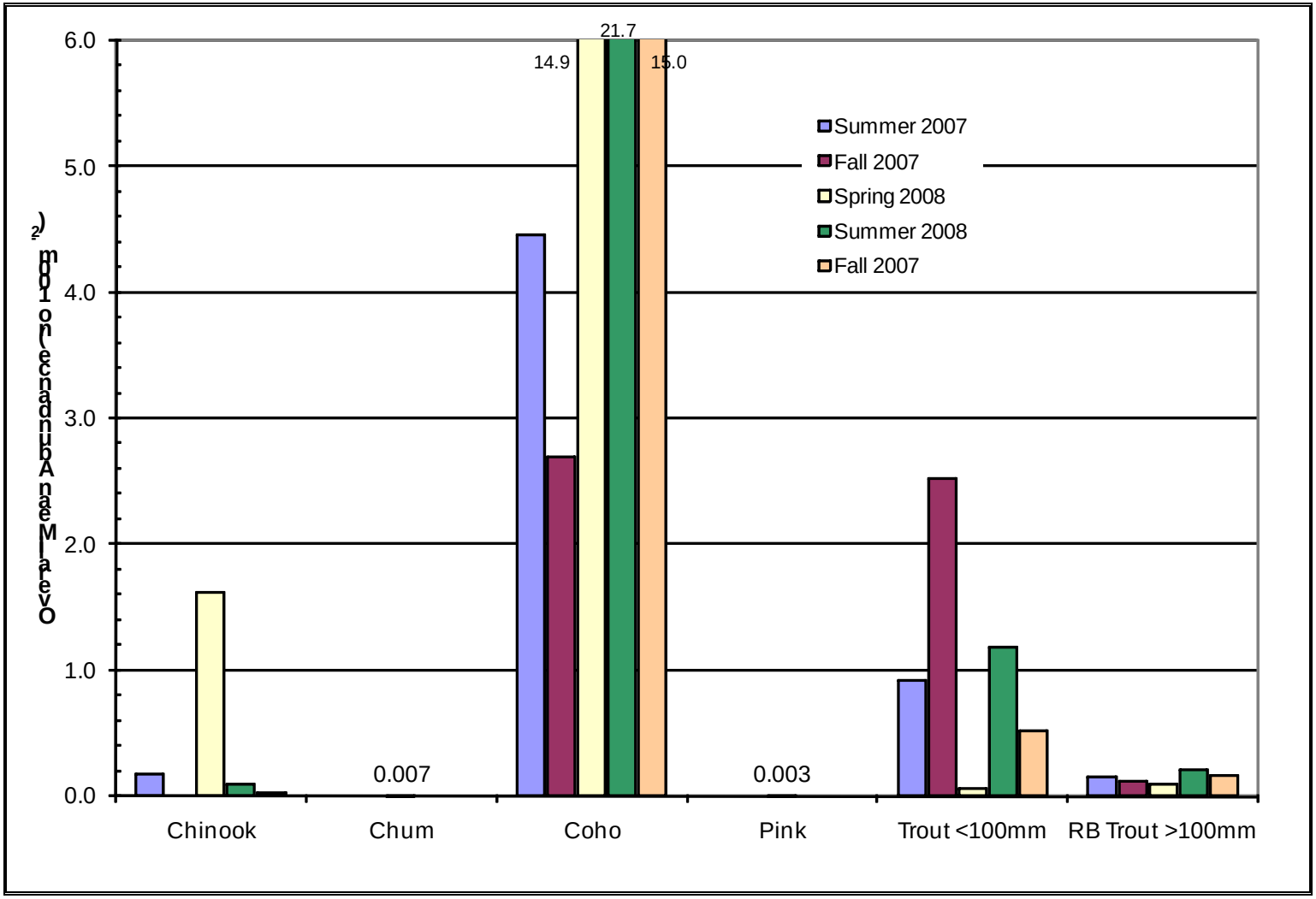

Figure 20. Overall mean abundance of juvenile salmonids from snorkel observations conducted in the Sultan River, Snohomish County, Washington 2007-2008.

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APPENDIX A

RSP 5 Progress Report Dated December 2007 (Spring, Summer and Fall 2007 data)

DRAFT

HENRY M. JACKSON HYDROELECTRIC PROJECT

FERC No. 2157

Study Plan 5

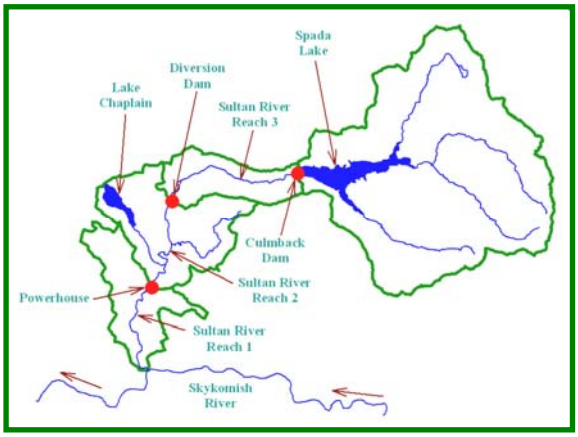
Juvenile Fish Abundance, Life History and Distribution
Progress Report

Prepared for:

Public Utility District No. 1
of Snohomish County
City of Everett

Prepared by:

R2 Resource Consultants, Inc.



5 December 2007

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1.0 STUDY OBJECTIVES AND DESCRIPTION

Population dynamics of aquatic species are often driven by the success of early life history cohorts (Quinn 2005). Understanding the respective life history characteristics of juvenile salmonids will ultimately play an invaluable role to assist water managers in developing strategies that minimize the effects of flow changes on multiple species and life stages on the Sultan River. Water management strategies such as planned short-term, high flow releases (i.e., freshets) may facilitate downstream migration for one species, but displace newly emerged fry from another species to less favorable habitats, exposing them to increased predation. As with other fish species, the success of early life history is strongly size dependent; small differences in growth and mortality often drive adult recruitment (Quinn and Peterson 1996; Schindler 1999). Therefore, studies that identify specific habitat and behavioral characteristics used by juvenile salmonids will be integral to developing water management strategies that address anthropocentric needs of the Puget Sound, while protecting and enhancing salmonid populations inhabiting the Sultan River.

As part of relicensing activities for the Henry M. Jackson Hydroelectric Project (Project) FERC No. 2157, the Tulalip Tribes requested a study to determine the "rearing locations and densities of steelhead (*Oncorhynchus mykiss*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*) in the lower river (below the Diversion Dam) throughout the year." The information collected from this study will supplement life history information on these species in the Sultan River and will be useful for evaluating relationships between habitats used by these species and stream flows in the Sultan River. The information will also be useful for identifying and evaluating potential protection, mitigation and enhancement measures focused on juvenile salmonid habitats. The Tulalip study request entailed two components; a year-round study of juvenile occurrence, and a study to quantify smolt abundance and migration characteristics.

In response to the study request, the Snohomish County Public Utility District No. 1 (District) and the City of Everett (City), as Co-Licensees of the Project, proposed to conduct a study to determine the relative occurrence of juvenile salmonids during the spring and fall as well as a similar study to be conducted in off-channel habitats during the winter residency period. The overall objective of the Juvenile Fish Occurrence, Life History and Distribution Study is to determine the relative distributions of juvenile salmonids in the Sultan River by life history stages, stream location, and habitat type. Specifically, the life history strategies of juvenile Chinook salmon (i.e., residency period) are of particular importance to the Tulalip Tribe because of the uncertainty about dominant (ocean-type) and sub-dominant (stream-type) rearing strategies of naturally-produced populations in the Snohomish River Basin. The specific information collected from this study, when combined with other study elements (e.g., instream flow [Revised Study Plan (RSP) 3]), habitat composition (RSP18), and geomorphic processes (RSP22)) will provide a solid foundation of information that can be used to make informed decisions regarding the protection and enhancement of fish populations in the Sultan River.

2.0 BACKGROUND INFORMATION

The Co-licenses filed a joint application with the Federal Power Commission (now Federal Energy Regulatory Commission [FERC]) in 1960 to develop what was then known as the Sultan River Project (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From the beginning, the Project was envisioned to serve two purposes; generating power for the District from the waters of the Sultan River and increasing the City's water supply system to meet growing demands. A license authorizing construction of the Project in two phases was issued on 6 June 1961.

The Stage I development was completed in 1965 and involved the construction of Culmback Dam and the creation of Spada Lake, which greatly increased the City's water supply available from the Sultan River Basin (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Originally, Stage II, the addition of the hydropower generation facilities, was to commence in 1967. Economic studies undertaken at that time indicated the cost of power from the Bonneville Power Administration (BPA) was still low enough to call into question the financial feasibility of moving ahead with Stage II. FERC granted a series of time extensions so the District and the City could investigate alternative plans.

In 1976, BPA, the source of almost all of the District's power at that time, announced it would not be able to meet the District's power needs after mid-1983. BPA offered to purchase the early years of power from new non-thermal resources, which motivated the District to develop the generating potential of the Sultan River (Public Utility District No. 1 of Snohomish County and City of Everett 2005).

On 6 July 1979, the District and the City filed an application with FERC to amend the original license with a revised hydroelectric scenario better suited to the regional economic and load demand projections, and to reduce the environmental impacts of the original design (Public Utility District No. 1 of Snohomish County and City of Everett 2005). FERC granted this amendment on 16 October 1981, and construction of generating facilities and raising of Culmback Dam commenced in 1982. One of the earliest Settlement Agreements with several state and federal agencies and the Tulalip Tribes (the Joint Agencies) was filed with the FERC and accepted in 1982. The Project was renamed after the late Senator Henry M. Jackson in 1984 when operation began. The current operating license for the Project will expire on 31 May 2011.

2.1 Sultan River Basin Description

The Project is located on the Sultan River, approximately 24 miles east of Everett, Washington, in south central Snohomish County (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From its headwaters near Vesper Peak on the western slope of the Cascade Mountains, the Sultan River flows west for approximately 19 miles, then south-southwest for 11 miles to its confluence with the Skykomish River at the City of Sultan (river mile [RM] 34.4). The Skykomish River

drains the northern 835 square miles of the Snohomish River Basin, the second largest river basin draining into Puget Sound (Haring 2002).

The Sultan River has a watershed area of approximately 105 square miles (Figure 1). The Sultan River watershed can be divided into four sub-basins: upstream from Culmback Dam (68.2 square miles): between Culmback Dam and the Diversion Dam (8.9 square miles); between the Diversion Dam and the Powerhouse (17.1 square miles); and between the Powerhouse and the confluence with the Skykomish River (10.7 square miles).

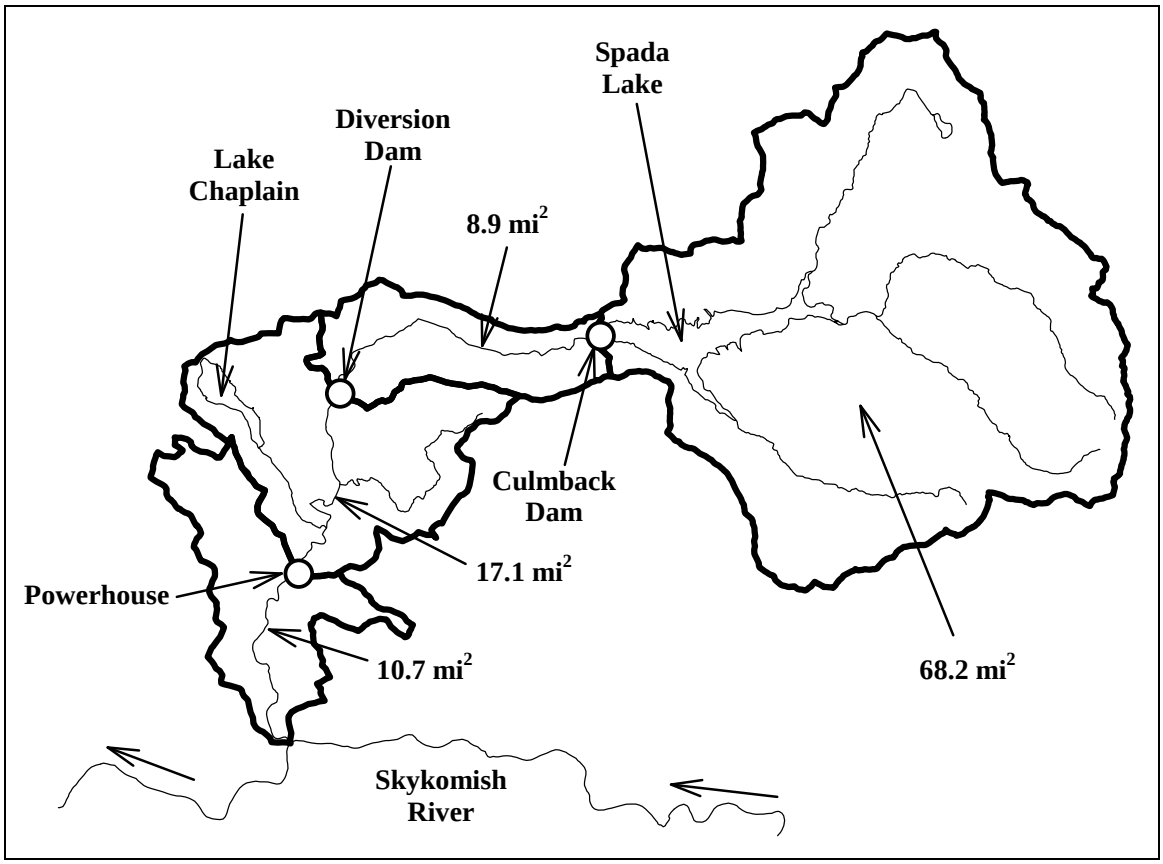

Figure 1. Four sub-basins of the Sultan River watershed, Snohomish County, Washington.

The basin is bounded on the east by the Cascade Mountains, on the north and south by lateral ridges extending westward from the Cascade crest, and on the west by the Puget Sound lowlands (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Elevations in the basin range from the 6,617-foot summit of Del Campo Peak to 130 feet at the confluence of the Sultan and Skykomish rivers. Major tributaries to the Sultan River above Culmback Dam include the South Fork Sultan River, North Fork Sultan River, Elk Creek, and Williamson Creek. Downstream of Culmback Dam, major

tributaries include Marsh Creek, Chaplain Creek, Woods Creek (drains Woods Lake), Ames Creek, and Winters Creek.

Downstream of Culmback Dam (RM 16.5), the Sultan River flows through a deep gorge for nearly 14 miles (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The steep side slopes above the channel are densely forested with conifer and mixed deciduous growth. The river channel in this reach is relatively high gradient and confined, containing numerous cascades and rapids separated by short pool-riffle, stretches. Much of the streambank is sheer rock face or large rock cuts (Williams et al. 1975). The City's Diversion Dam at RM 9.7 historically directed a portion of the river's flow to its water supply reservoir, Lake Chaplain. While that method of diversion remains in place and is used when Project maintenance or other reasons require, water now is normally supplied to Lake Chaplain through the Lake Chaplain pipeline after passing through the Project powerhouse. The Sultan River emerges from the canyon reach onto a broad, relatively flat valley floor containing intermittent stands or strips of deciduous trees, underbrush, and some mixed conifers near RM 3. The river channel in this reach has a moderate gradient with several split channel sections.

The Sultan watershed supports a wide array of salmonid species, each with slightly different life history strategies. Reproducing populations of Chinook, coho, pink (*O. gorbuscha*), and chum (*O. keta*) salmon; steelhead and coastal cutthroat trout (*O. clarki*) are present downstream from the Diversion Dam in varying numbers. Transitory bull trout (*Salvelinus confluentus*) have also been observed downstream from the Diversion Dam, but are not thought to spawn in the Sultan River. While occurring upstream to the Diversion Dam, anadromous salmonid spawning habitat is primarily located in the lower reaches of the Sultan River (Haring 2002). Access upstream from RM 9.7 is prevented by the Diversion Dam. Resident rainbow, cutthroat, and rainbow/cutthroat hybrids reside in Spada Lake, upstream from Culmback Dam which is located at RM 16.5.

2.2 Project Operations

In 1930, the City of Everett constructed the Diversion Dam at RM 9.7 (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This dam was used to divert water from the Sultan River through a pipeline and tunnel, west to Lake Chaplain for municipal water supply storage. In 1965, Stage I of Culmback Dam was built at RM 16.5 for additional storage of municipal water supply, but the traditional operation of the Diversion Dam and tunnel to Lake Chaplain remained essentially unchanged. With completion of the Stage II hydroelectric project facilities in 1984 (which included a raised Culmback Dam, a power tunnel and pipeline, a powerhouse, and a Lake Chaplain pipeline from the powerhouse to Lake Chaplain), the function of the Diversion Dam changed considerably. Prior to the completion of Stage II, water flowed west from the Diversion Dam through the tunnel to Lake Chaplain. Currently, water flows east through the tunnel between Lake Chaplain and the Diversion Dam. Some of the water diverted from Spada Lake at Culmback Dam is now returned to the Sultan River at the Diversion Dam to provide minimum instream flows below that point for fishery protection and enhancement.

Under current operations, 20 cfs of water is released from Culmback Dam into the river reach between Culmback Dam and the City's Diversion Dam at all times (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This 20 cfs, plus natural inflow from streams above the Diversion Dam, provides a constant flow for the fisheries in this reach. The rest of the water diverted from Spada Lake travels through the power tunnel and power pipeline to the Powerhouse. Most of the water delivered to the powerhouse in this manner passes through the Pelton turbines for electrical generation and is returned to the river at the powerhouse. However, an amount of water necessary for municipal supply and maintenance of minimum instream flows in the reach below the Diversion Dam is routed through two Francis turbines in the powerhouse, and then through the Lake Chaplain pipeline to the "Portal 2" facilities on the shores of Lake Chaplain.

At Lake Chaplain, a portion of the water in the Lake Chaplain pipeline is diverted by means of the "Portal 2" facilities to the lake for municipal water supply (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The remainder is transported east via the original water diversion tunnel back to the Sultan River at the Diversion Dam to provide minimum instream flows in the reach between the Diversion Dam and the powerhouse. In this manner, regulated fish flows are maintained for the full length of the Sultan River below Culmback Dam, with larger flows provided below the Diversion Dam and powerhouse where river conditions offer more suitable fish habitat than exists in the reach above the Diversion Dam. Occasionally, when storm events cause natural inflows within the reach between Culmback Dam and the City's Diversion Dam to exceed the combined total flows needed to meet both the City's water supply requirements and established minimum instream flows below the Diversion Dam, the Diversion Dam will be made to operate in its original manner (Public Utility District No. 1 of Snohomish County and City of Everett 2005). At these times, water for municipal supply is diverted from the Sultan River by the Diversion Dam and routed westerly through the tunnel to Lake Chaplain. Remaining flows in the river are allowed to pass over the Diversion Dam to provide required instream flows. The Powerhouse then routes water diverted from Spada Lake through only the larger Pelton units for more efficient power generation, and then immediately returns the water to the river.

3.0 METHODS

Seasonal snorkel observations were selected as the primary survey technique to determine the relative occurrence, life history, and distribution of juvenile salmonids in the lower Sultan River. Snorkel observations were selected, in part, based on their repeatability over different seasons, habitat strata, and reaches of the river. Backpack electrofishing will also be used in concert with snorkel observations during winter periods when juvenile salmonids typically exhibit daytime concealment behavior (Roni and Fayram 2000) and periods when the Sultan River exhibits elevated turbidity levels, precluding accurate snorkel observations (Thurow 1994).

Underwater observation has been long established as a valuable tool for study of fish behavior and habitat use particularly in regard to riverine juvenile salmonid species (O'Neal 2007). Snorkel observations are a quick, inexpensive, and non-invasive technique, that when properly structured, can provide accurate quantitative information concerning the abundance, size structure, distribution and habitat use of salmonids (Schill and Griffith 1984, Thurow 1994; O'Neal 2007).

Salmonids exhibit territorial behavior and inhabit areas with high water clarity making snorkel surveys particularly effective in determining presence/absence of salmonid species (Slaney and Martin 1987; Zubik and Fraley 1988; Hillman et al. 1992; Rodgers et al. 1992). Snorkel surveys have been proven to provide reliable and accurate survey information. Specifically, Schill and Griffith (1984) utilized snorkel observations to create population estimates for cutthroat trout in the Yellowstone River. Zubik and Fraley (1988) determined that in large clear streams, snorkel counts that were multiplied by a determined expansion factor provided a reliable density estimate in comparison to other survey methods. Slaney and Martin (1987) found similar results in a large stream in British Columbia, as did Mullner et al. (1998) in streams in Wyoming. Rodger et al. (1992) concluded that snorkeling was an appropriate method for sampling the population size of juvenile coho over large sections of stream in coastal Oregon. Roni and Fayram (2000) reported that night snorkeling allowed for quick and relatively reliable enumeration of juvenile salmonids during the winter in Pacific Northwest streams.

Snorkel surveys also provide for direct observation of fish habitat utilization (Thurow 1994; O'Neal 2007). Fish observations specific to the habitat being utilized provide information for management decisions affecting those specific habitats (Northcote and Wilkie 1963). For example, differences in utilization of mainstem and off-channel habitats can be determined by observation of these habitats at different times of the year (Bustard and Narver 1975). Furthermore, by comparing areas of observed fish use with areas of similar habitat enables the development of estimates of fish use.

The timing and the specific methodology employed in snorkel surveys are important determinants in the overall success of the snorkel surveys. The methodology of the surveys should reflect the objectives of the study at hand. For example, the use of night surveys during colder winter conditions are generally considered to have greater effectiveness than day surveys (Roni and Fayram 2000). Overall, snorkel observations

are a cost-effective technique and can encompass more diverse habitat than other sampling techniques (Dolloff et al. 1996).

3.1 Index Site Selection

Six juvenile salmonid index sites were selected in the Sultan River (Figure 2). Based on the following parameters: distribution of spawning salmonids, distribution of rearing habitats, site accessibility, lineal or reach representation, and overall habitat representation. The majority of index sites (5) were selected within or downstream from where the preponderance of salmonid spawning activity occurs. Three index sites were chosen from within the reach that contains the majority of the off-channel habitat in the Sultan River, while the final index site was chosen to represent an accessible location within the gorge section of Reach 2.

Index Site 1, is located near RM 1.5 in the lower Sultan River. Index Site 1 is the downstream-most index site located on the Sultan River and is comprised of approximately 24,350 m^2 of mainstem and 7,050 m^2 of off-channel wetted area as computed at a discharge of 400 cfs measured at the Powerhouse (Figure 3; Table 1). Index Site 2 is located near RM 1.6 in the lower Sultan River. Index Site 2 is bounded by Index Site 1 on the downstream end and Index Site 3 on the upstream portion. Index Site 2 is comprised of approximately 27,500 m^2 of mainstem and 2,560 m^2 of off-channel wetted area estimated at a discharge of 400 cfs at the Powerhouse (Figure 4; Table 1). Index Site 3 is located near RM 1.8 in the lower Sultan River. Index Site 3 is comprised of approximately 20,730 m^2 of mainstem and 7,480 m^2 of off-channel wetted area at a discharge of 400 cfs at the Powerhouse (Figure 5; Table 1).

Juvenile salmonid Index Site 4 is located near RM 4.6 in the lower Sultan River and is comprised of approximately 6,020 m^2 of mainstem wetted area at a discharge of 400 cfs as measured at the Powerhouse (Figure 6; Table 1). Index Site 5 is located near RM 5.2 in the lower Sultan River. The site, located near the discontinued Sultan River downstream of Chaplain Creek gage, is comprised of approximately 7,380 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 7; Table 1). Index Site 6 is located near RM 9.0 in the lower Sultan River and is comprised of approximately 1,790 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 8; Table 1).

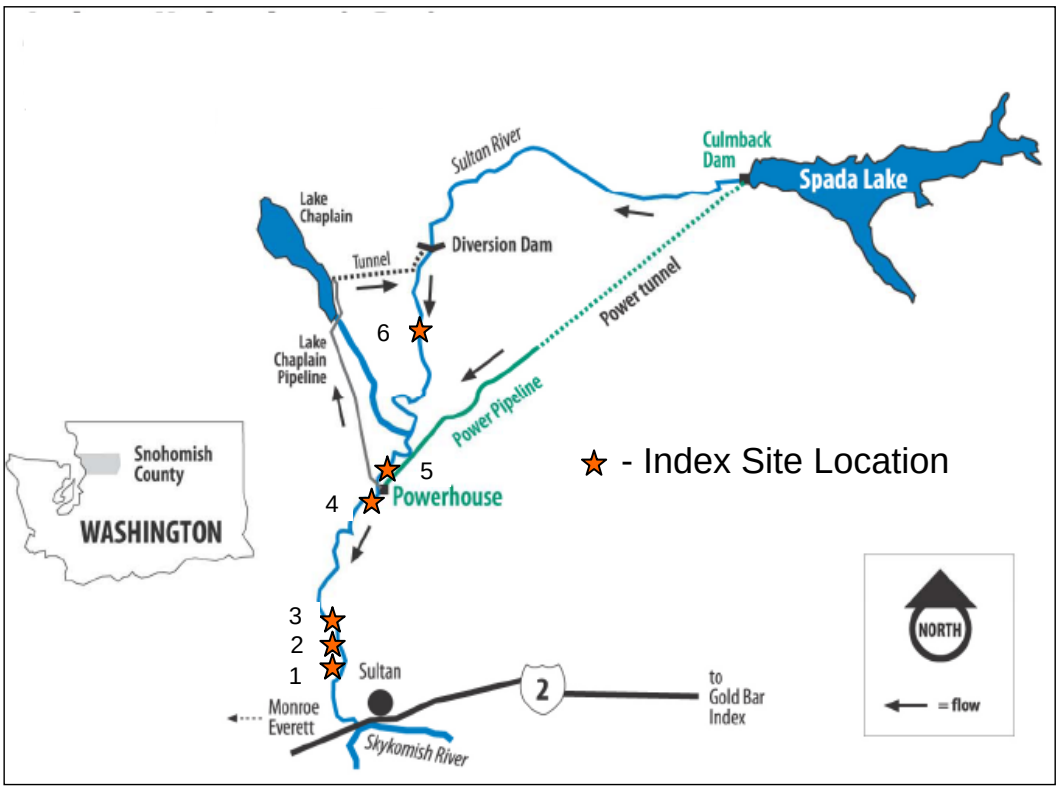

Figure 2. **Juvenile salmonid index sites, Sultan River, Snohomish County, Washington.**

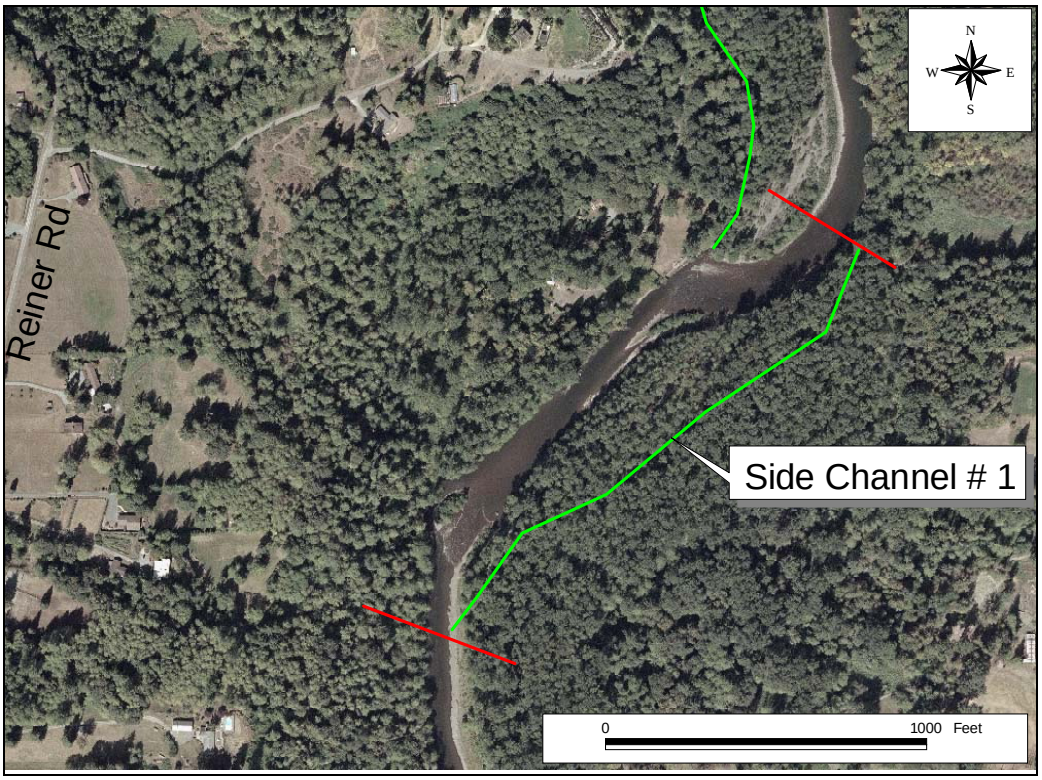

Figure 3. **Juvenile salmonid Index Site 1 (Side Channel 1), Sultan River, Snohomish County, Washington.**

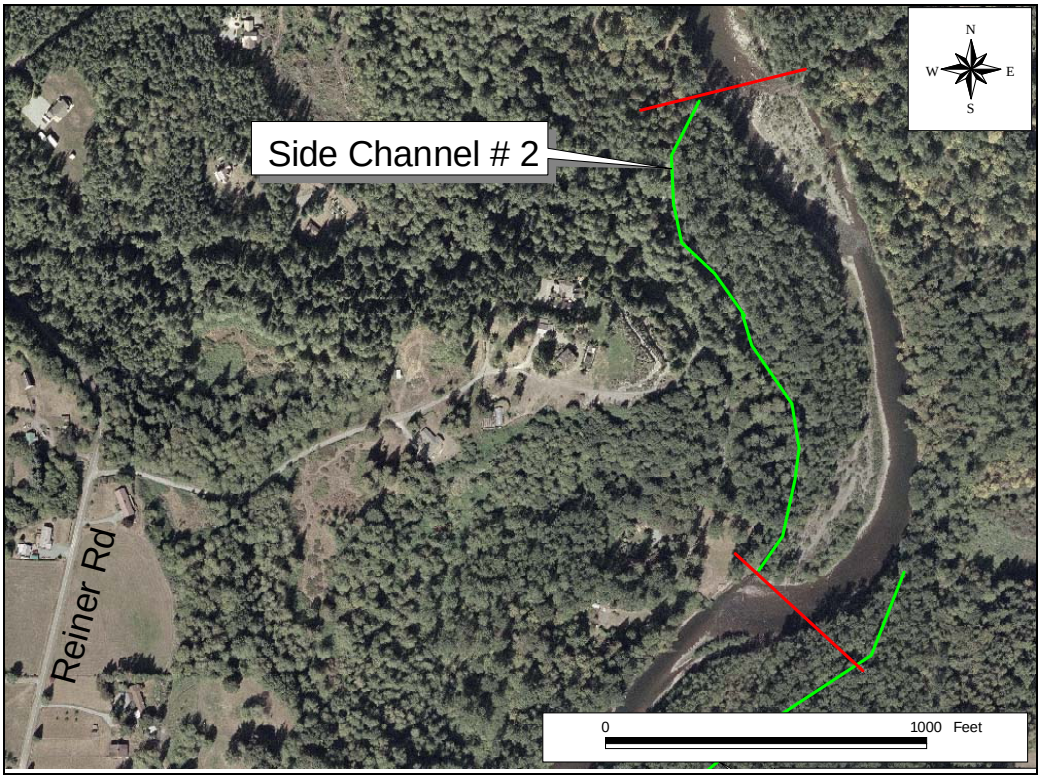

Figure 4. **Juvenile salmonid Index Site 2, Sultan River, Snohomish County, Washington.**

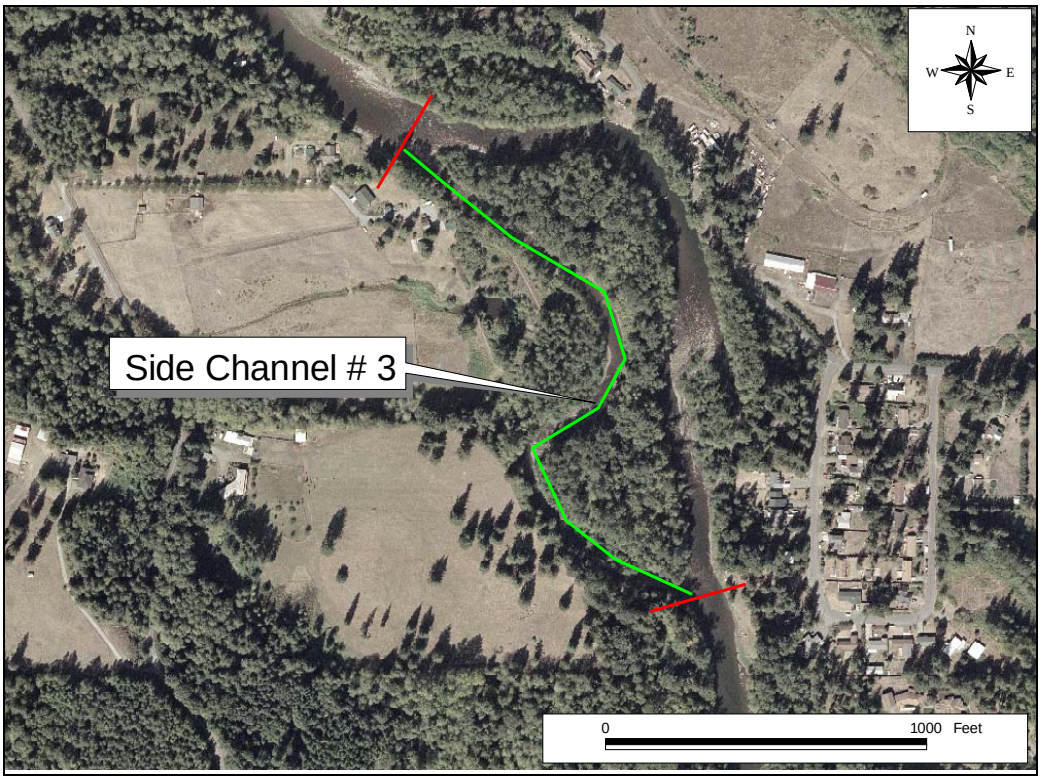

Figure 5. **Juvenile salmonid Index Site 3, Sultan River, Snohomish County, Washington.**

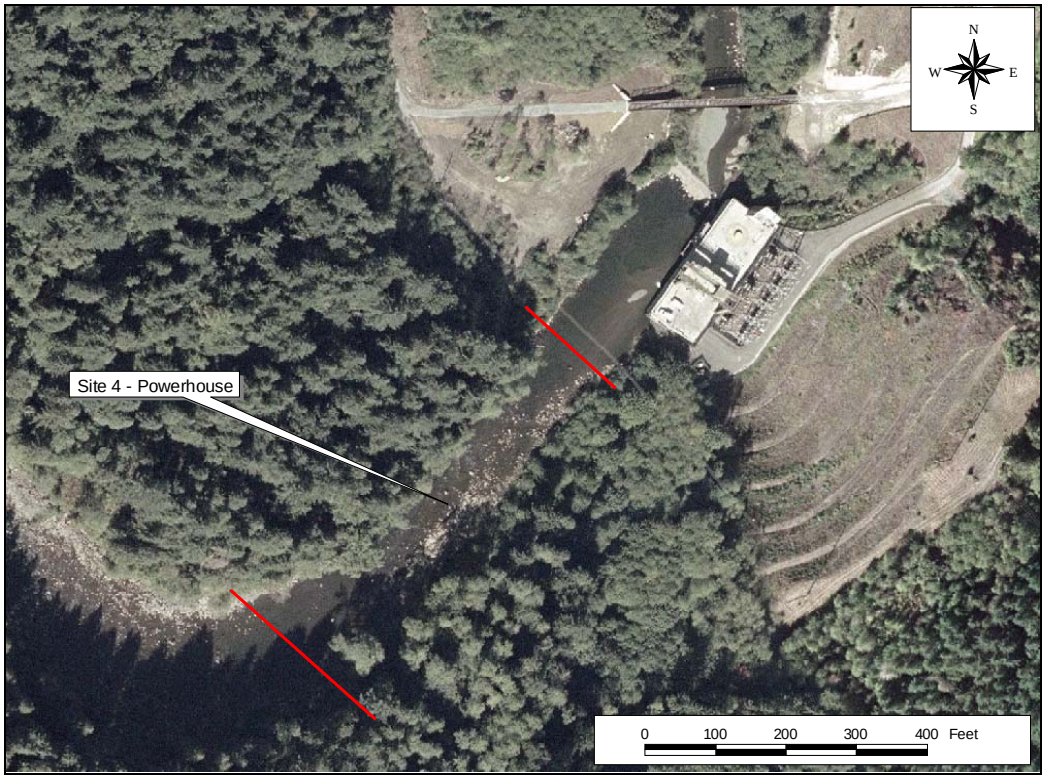

Figure 6. **Juvenile salmonid Index Site 4, Sultan River, Snohomish County, Washington.**

Figure 7. Juvenile salmonid Index Site 5, Sultan River, Snohomish County, Washington.

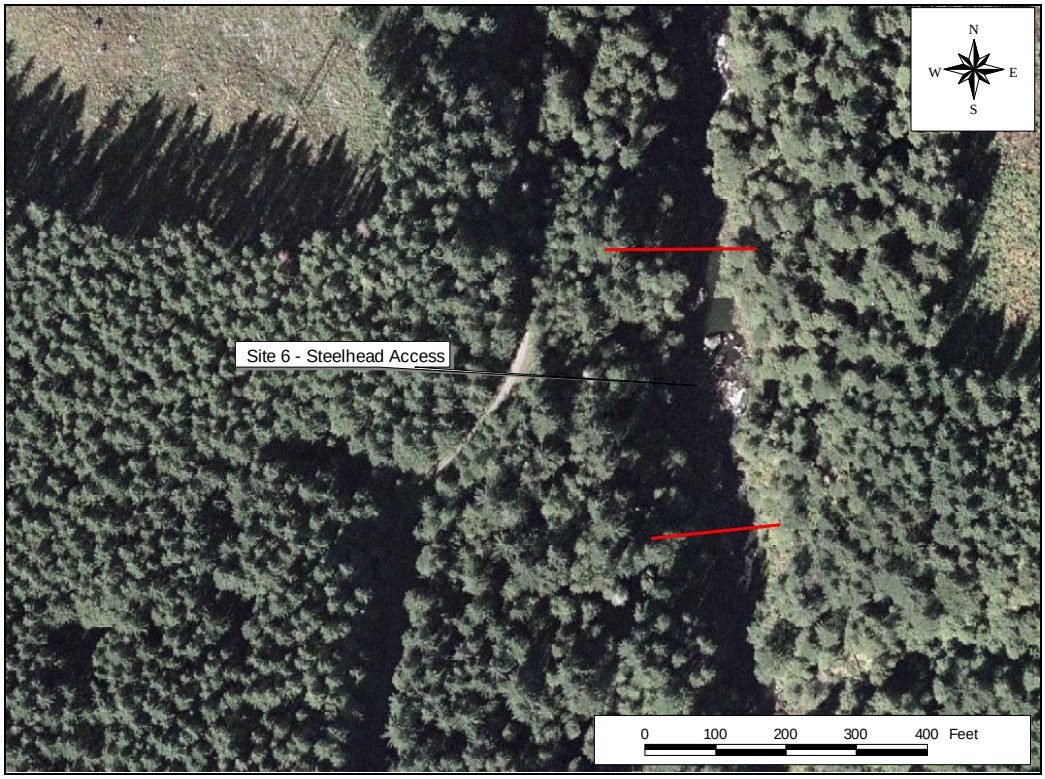

Figure 8. Juvenile salmonid Index Site 6, Sultan River, Snohomish County, Washington.

Table 1. Wetted area (m^2) of juvenile salmonid index sites, Sultan River, Snohomish County, Washington.

Index Site	Wetted Area (m^2)	
	Mainstem	Off-Channel
Site 1	24,360	7,050
Site 2	27,510	2,560
Site 3	20,730	7,480
Site 4	6,020	-
Site 5	7,380	-
Site 6	1,790	-

3.2 Snorkel Surveys

Juvenile salmonid surveys were conducted during the summer (June-July) and fall (September-November) residency periods. Originally, snorkel observations were scheduled for the spring residency period; however, an extended period of elevated turbidity in the Sultan River prevented spring surveys in 2007. Each index site was surveyed on three occasions on each period, two day surveys, and one evening survey, for a total of six surveys at each index site to date. The snorkel surveys were completed by a team of five surveyors (4 divers, 1 observer); surveys began at the downstream boundary of the index site and proceeded upstream along each margin of the index site. Upon completion of the margins, the divers entered the upstream boundary of the index site and completed the center portion of the index site in a downstream direction. The observer served as a recorder and as a safety measure in case one of the snorkelers encountered any problems.

Divers were positioned so that all of the wetted area was surveyed, but observations did not overlap. Fish were enumerated by species and size class (mm FL) as the snorkeler passed them, so duplicate counts were avoided. The distance between the divers was less than the maximum distance the divers could identify fish to species and size class. This distance was determined before the snorkel observations began by underwater observations downstream from the index site boundary. Underwater observations were recorded individually by each observer on DuraRite® notebooks carried on the person in a small pack attached to the waist. To date, snorkel observations have been conducted under similar flow regimes (i.e., similar wetted areas), when underwater visibility has been greater than 1.0 meter, and water temperatures were greater than 10ºC.

Relative occurrence indices were calculated by dividing snorkel observations per wetted unit area and multiplying by 100 (no $100m^{-2}$)) for each species (coho and Chinook salmon, and rainbow and cutthroat trout) and life stage (fry, pre-smolts, and overyearling). Intra-site data comparisons were conducted to determine relative

occurrence over the study periods and channel type (i.e., mainstem and off-channel), while inter-site relative occurrence data were used to determine relative utilization between index sites throughout the length of the study area. All data were entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes.

3.3 Electrofishing Surveys

Backpack electrofishing was selected as a juvenile salmonid survey technique that will be used when all of the following criterion occur: water temperature is less than 10ºC, turbidity levels prevent underwater observations from 1.0 meter, discharge conditions cause safety concerns for underwater observers. Backpack electrofishing shall not occur unless the above physical conditions are present in the Sultan River to stay within the requirements of the collection permit obtained from National Marine Fisheries Service.

A SmithRoot, Inc. Model 15-C programmable wave output backpack electrofishing unit, using "straight DC" current will be utilized to conduct electrofishing surveys. A block net will be installed at the upstream end of selected sites when feasible. Electrofishing shall begin at the lower site boundary and continue upstream to the block net. One transect (i.e., pass) will be electrofished at each survey site; guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act (NMFS 1998) will be strictly adhered to during the electrofishing surveys. This methodology will not provide population estimates but will result in an index of occurrence, while minimizing potential injury to the fish.

Fish will be captured with a dip net (3-mm nylon mesh) and placed into a darkened recovery unit where they will be anesthetized with 75 mg L^{-1} tricaine methanesulfonate (MS 222). Each fish will be identified to species, measured to the nearest mm total length, allowed to recover in fresh water for a minimum of 30 minutes, and then released within the survey site that they were captured. Survey time of electrofishing transects (sec) will be recorded along with fish data, photographs, and water temperatures (°C) on field data sheets.

Relative occurrence indices will be calculated by dividing electrofishing counts per wetted unit area and multiplying by 100 (no $100m^{-2}$) for each species (coho and Chinook salmon, and rainbow and cutthroat trout)) and life stage (fry, pre-smolts, and overyearling). Intra-site data comparisons will be conducted to determine relative occurrence over the study periods and channel type (i.e., mainstem and off-channel), while inter-site relative occurrence data was used to determine relative utilization between index sites throughout the length of the study area. All data shall be entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes.

4.0 RESULTS

4.1 Index Site 1 – Side Channel 1

A total of 5,515 juvenile salmonids were observed during the summer snorkel period resulting in an average of relative occurrence of 21.3 (std. dev. = 3.4) juvenile salmonids at Index Site 1 (Table 2). Mean relative occurrence was greatest in the side channel (20.5; std. dev. = 3.8) when compared to the mainstem portion (0.8; std. dev. = 0.3) of Index Site 1 during the summer residency period. Species and life stages present included trout and coho fry, Chinook and coho pre-smolts, and overyearling coho.

Table 2. Summer juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 1	Chinook	45-60	0.6610	0.0534	0.0246	0.25
Mainstem	Coho	45-60	0.3859	0.4393	0.7760	0.53
		60-80	0	0	0	0
		80-100+	0.1560	0	0.0082	0.05
	Coho Total		0.5420	0.4393	0.7842	0.59
	Trout	35-45	0	0	0	0
		45-60	0.0041	0.0246	0	0.01
	Trout Total		0.0041	0.0246	0	0.01
Sub Total			*1.2*	*0.5*	*0.8*	*0.84*
Site 1	Chinook	45-60	0	0.0284	0	0.01
Side-Channel	Coho	45-60	16.9266	22.5688	18.0323	19.18
		60-80	0.3119	1.5027	0.0709	0.63
	Coho Total		17.2384	24.0714	18.1032	19.80
	Trout	35-45	0.0425	0.5529	1.3751	0.66
Sub Total			*17.3*	*24.7*	*19.5*	*20.47*
Grand Total			**18.5**	**25.2**	**20.3**	**21.32**

A total of 1,331 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 4.3 (std. dev. = 2.7) juvenile salmonids at Index Site 1 (Table 3). Mean relative occurrence was greatest in the side channel (3.5; std. dev. = 1.9) when compared to the mainstem portion (0.8; std. dev. = 0.4) of Index Site 1 during the fall residency period. Species and life stages present included trout and coho fry and coho pre-smolts. Overall, mean Index Site 1 fall relative occurrence was approximately 25% of that observed during the summer residency period.

Table 3. Fall juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 1	Coho	60-80	0.7965	0.6487	0.0082	0.48
Mainstem	Trout	45-60	0.1889	0.6487	0.0082	0.28
		60-100+	0.0164	0.1191	0	0.05
	Trout Total		0.2053	0.7678	0.0082	0.33
Sub Total			*1.0*	*1.4*	*0.02*	*0.81*
Site 1	Coho	60-80	4.3947	3.7567	0	2.72
Side-Channel		80-100+	0	0	1.0916	0.36
	Coho Total		4.3947	3.7567	1.0916	3.08
	Trout	45-60	0.3969	0.6946	0.1276	0.41
Sub Total			*4.8*	*4.5*	*1.2*	*3.49*
Grand Total			**5.8**	**5.9**	**1.2**	**4.30**

4.2 Index Site 2 – Side Channel 2

A total of 1,926 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 15.5 (std. dev. = 3.9) juvenile salmonids at Index Site 2 (Table 4). Mean relative occurrence was greatest in the side-channel (14.5; std. dev. = 3.9) when compared to the mainstem portion (1.0; std. dev. = 0.2) of Index Site 2 during the summer residency period. Species and life stages present included Chinook, trout, and coho fry, coho and Chinook pre-smolts, and overyearling coho.

A total of 2,324 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 20.9 (std. dev. = 18.3) juvenile salmonids at Index Site 2 (Table 5). Mean relative occurrence was greatest in the side-channel (19.9; std. dev. = 17.4) when compared to the mainstem portion (1.0; std. dev. = 0.8) of Index Site 2 during the fall residency period. Species and life stages present included trout and coho fry, coho pre-smolts, and overyearling trout. Overall, mean Index Site 2 fall relative occurrence was approximately 134% of that during the summer residency period.

Table 4. Summer juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 2	Chinook	45-60	0.3671	0.0400	0.0254	0.14
Mainstem	Coho	45-60	0.3598	1.1376	0.4798	0.66
		60-80	0	0.0509	0.0763	0.04
		80-100+	0.1308	0	0.0073	0.05
	Coho Total		0.5	1.2	0.6	0.75
	Trout	35-45	0	0	0.2253	0.08
		45-60	0	0.0436	0.0109	0.02
	Trout Total		0.0	0.0	0.2	0.09
Sub Total			*0.9*	*1.3*	*0.8*	*0.98*
Site 2	Chinook	45-60	0	0.8194	0	0.27
Side-Channel		60-80	0.4682	0.0390	0	0.17
	Chinook Total		0.4682	0.8584	0.0000	0.44
	Coho	45-60	9.2470	14.3972	12.6805	12.11
		60-80	0	0.2341	2.7312	0.99
		80-100+	0.2341	0	0	0.08
	Coho Total		9.4811	14.6313	15.4116	13.17
	Trout	35-45	0	0.1171	2.0679	0.73
		45-60	0.1951	0.0390	0.1561	0.13
	Trout Total		0.1951	0.1561	2.2240	0.86
Sub Total			*10.1*	*15.6*	*17.6*	*14.48*
Grand Total			**11.0**	**16.9**	**18.5**	**15.46**

Table 5. Fall juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 2	Coho	60-80	0.9377	1.1049	0.0073	0.68
Mainstem	Trout	45-60	0.2871	0.3562	0.0109	0.22
		60-100	0.0981	0.0872	0	0.06
	Trout Total		0.3853	0.4434	0.0109	0.28
Sub Total			*1.3*	*1.5*	*0.02*	*0.96*
Site 2	Coho	60-80	18.9231	23.0199	0	13.98
Side-Channel	Trout	45-60	7.9984	9.6762	0	5.89
		80-100+	0	0	0.0390	0.01
	Trout Total		7.9984	9.6762	0.0390	5.90
Sub Total			*26.9*	*32.7*	*0.06*	*19.89*
Grand Total			**28.2**	**34.2**	**0.1**	**20.85**

4.3 Index Site 3 – Side Channel 3

A total of 984 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 3.1 (std. dev. = 1.4) juvenile salmonids at Index Site 3 (Table 6). Mean relative occurrence was greatest in the side-channel (2.4; std. dev. = 1.6) when compared to the mainstem portion (0.7; std. dev. = 0.2) of Index Site 3 during the summer residency period. Species and life stages present included Chinook, trout, and coho fry, coho and Chinook pre-smolts, and overyearling coho.

Table 6. Summer juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 3	Chinook	45-60	0.2653	0	0	0.09
Mainstem	Coho	45-60	0.5981	0.3907	0.6849	0.56
		60-80	0	0.0579	0.0531	0.04
		80-100+	0.0096	0	0	0.00
	Coho Total		0.6077	0.4485	0.7379	0.60
	Trout	45-60	0.0145	0.0434	0.0531	0.04
Sub Total			*0.9*	*0.5*	*0.8*	*0.72*
Site 3	Chinook	45-60	1.0294	0.4278	0	0.49
Side-Channel		60-80	0	0.1070	0	0.04
		80-100	0.0401	0.0267	0	0.02
	Chinook Total		1.0695	0.5615	0	0.54
	Coho	45-60	0.3476	2.9144	0.8155	1.36
		60-80	0.0000	0.4011	0.4813	0.29
	Coho Total		0.3476	3.3155	1.2968	1.65
	Trout	35-45	0	0.0668	0	0.02
		45-60	0.0802	0.2406	0.1604	0.16
	Trout Total		0.0802	0.3075	0.1604	0.18
Sub Total			*1.5*	*4.2*	*1.5*	*2.38*
Grand Total			**2.4**	**4.7**	**2.2**	**3.10**

A total of 1,379 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 4.2 (std. dev. = 3.7) juvenile salmonids at Index Site 3 (Table 7). Mean relative occurrence was greatest in the side-channel (3.1; std. dev. = 2.7) when compared to the mainstem portion (1.1; std. dev. = 1.0) of Index Site 3 during the fall residency period. Species and life stages present included trout and coho fry and coho and trout pre-smolts. Overall, mean Index Site 2 fall relative occurrence was approximately 135% of that during the summer residency period.

Table 7. Fall juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 3	Coho	60-80	0.6704	0.8730	0	0.51
Mainstem	Trout	45-60	0.6800	0.9598	0	0.55
		60-80	0.0289	0.0434	0.0096	0.03
	Trout Total		0.7090	1.0032	0.0096	0.57
Sub Total			*1.4*	*1.9*	*0.01*	*1.09*
Site 3	Coho	60-80	3.4893	3.1952	0	2.23
Side-Channel	Trout	45-60	0.4412	1.7781	0	0.74
		60-80	0.4278	0.0401	0.0134	0.16
	Trout Total		0.8690	1.8182	0.0134	0.90
Total			*4.4*	*5.0*	*0.01*	*3.13*
Grand Total			**5.7**	**6.9**	**0.02**	**4.22**

4.4 Index Site 4 – Powerhouse

A total of 685 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 3.8 (std. dev. = 5.2) juvenile salmonids at Index Site 4 (Table 8). Species and life stages present included Chinook, trout, and coho fry, and coho pre-smolts.

Table 8. Summer juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 4	Chinook	45-60	0	0.0664	0	0.02
Mainstem	Coho	35-45	0	0.3987	0.7143	0.37
		45-60	0.0664	0.4817	1.6279	0.73
		60-80	0	0.0166	0	0.01
	Coho Total		0.0664	0.8970	2.3422	1.10
	Trout	35-45	0.0166	0.4651	7.4086	2.63
		45-60	0.0332	0.0332	0.0498	0.04
	Trout Total		0.0498	0.4983	7.4585	2.67
Grand total			**0.1**	**1.5**	**9.8**	**3.79**

A total of 1,195 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 6.6 (std. dev. = 6.2) juvenile salmonids at Index Site 4 (Table 9). Species and life stages present included trout and coho fry, and coho pre-smolts, and coho overyearlings.

Table 9. Fall juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 4	Coho	60-80	5.2824	2.2924	0.0997	2.56
Mainstem	Trout	45-60	6.5282	4.5183	0.0831	3.71
		60-80	0.4153	0.1495	0.0166	0.19
		80-100+	0.4153	0.0498	0.0000	0.16
	Trout Total		7.3588	4.7176	0.0997	4.06
Grand Total			**12.6**	**7.0**	**0.2**	**6.62**

4.5 Index Site 5 – Old USGS

A total of 979 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 4.4 (std. dev. = 7.1) juvenile salmonids at Index Site 5 (Table 10). Species and life stages present included Chinook, trout, and coho fry, coho pre-smolts, and overyearling coho.

Table 10. Summer juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 5	Chinook	45-60	0.1355	0	0	0.05
Mainstem	Coho	35-45	0.1084	0	0.3795	0.16
		45-60	0.0407	0.1084	5.0820	1.74
		60-80	0	0	1.1248	0.37
		80-100+	0	0	0.0678	0.02
	Coho Total		0.1491	0.1084	6.6540	2.30
	Trout	35-45	0.0136	0.1626	5.8545	2.01
		45-60	0.0000	0.0271	0.1626	0.06
	Trout Total		0.0136	0.1897	6.0171	2.07
Grand Total			**0.3**	**0.3**	**12.7**	**4.42**

A total of 701 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 3.2 (std. dev. = 2.0) juvenile salmonids at Index Site 5 (Table 11). Species and life stages present included trout and coho fry, and trout and coho pre-smolts.

Table 11. Fall juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 5	Coho	60-80	0.8809	0.8944	0	0.59
Mainstem		80-100+	0	0	0.1897	0.06
	Coho Total		0.8809	0.8944	0.1897	0.66
	Trout	45-60	3.5506	3.3880	0.0678	2.34
		80-100+	0.2846	0.1355	0.1084	0.18
	Trout Total		3.8352	3.5235	0.1762	2.51
Grand Total			**4.7**	**4.4**	**0.4**	**3.17**

4.6 Index Site 6 – Steelheader

A total of 136 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 2.5 (std. dev. = 1.7) juvenile salmonids at Index Site 6 (Table 12). Species and life stages present included trout and coho fry.

Table 12. Summer juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 6	Coho	45-60	0	0.1115	0.0558	0.06
Mainstem	Trout	35-45	0.7808	0.0000	3.2906	1.36
		45-60	1.2270	1.0039	1.1154	1.12
	Trout Total		2.0078	1.0039	4.4060	2.47
Grand Total			**2.0**	**1.1**	**4.5**	**2.53**

A total of 457 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 8.5 (std. dev. = 3.7) juvenile salmonids at Index Site 6 (Table 13). Species and life stages present included trout fry, pre-smolts, overyearlings.

Table 13. Fall juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 6 Mainstem	Trout	45-60	10.8756	7.8639	2.0636	6.93
		60-80	0.5020	0.5577	0.0000	0.35
		80-100	0.0000	0.7250	1.8405	0.86
		100-150+	0.2231	0.3904	0.4462	0.35
Grand Total			**11.6**	**9.5**	**4.4**	**8.50**

Overall, Index Site 2 displayed the greatest relative occurrence of juvenile salmonids during the summer/fall sampling period followed by Index Sites 1, 6, 4, 5, and 3 in decreasing order (Table 14; Figure 9). The fall sampling period generally (the exception being Index Sites1 and 5) had greater juvenile salmonid indices than during summer periods (Table 14; Figure 10). Finally, juvenile salmonid indices were greater in side channel habitats when compared to mainstem habitat types (Table 14; Figure 11).

Table 14. Mean summer and fall juvenile salmonid indices at Index Sites established in the Sultan River, Snohomish County, Washington.

River Mile	Segment	Habitat	Relative Occurrence (No 100m^{-2} wetted area)	
			Summer	Fall
RM 1.5	Index Site 1	Mainstem	0.84	0.81
		Side Channel	20.47	3.49
RM 1.6	Index Site 2	Mainstem	0.98	0.96
		Side Channel	14.48	19.89
RM 1.8	Index Site 3	Mainstem	0.72	1.09
		Side Channel	2.38	3.13
RM 4.6	Index Site 4	Mainstem	3.79	6.62
RM 5.2	Index Site 5	Mainstem	4.42	3.17
RM 9.0	Index Site 6	Mainstem	2.53	8.50

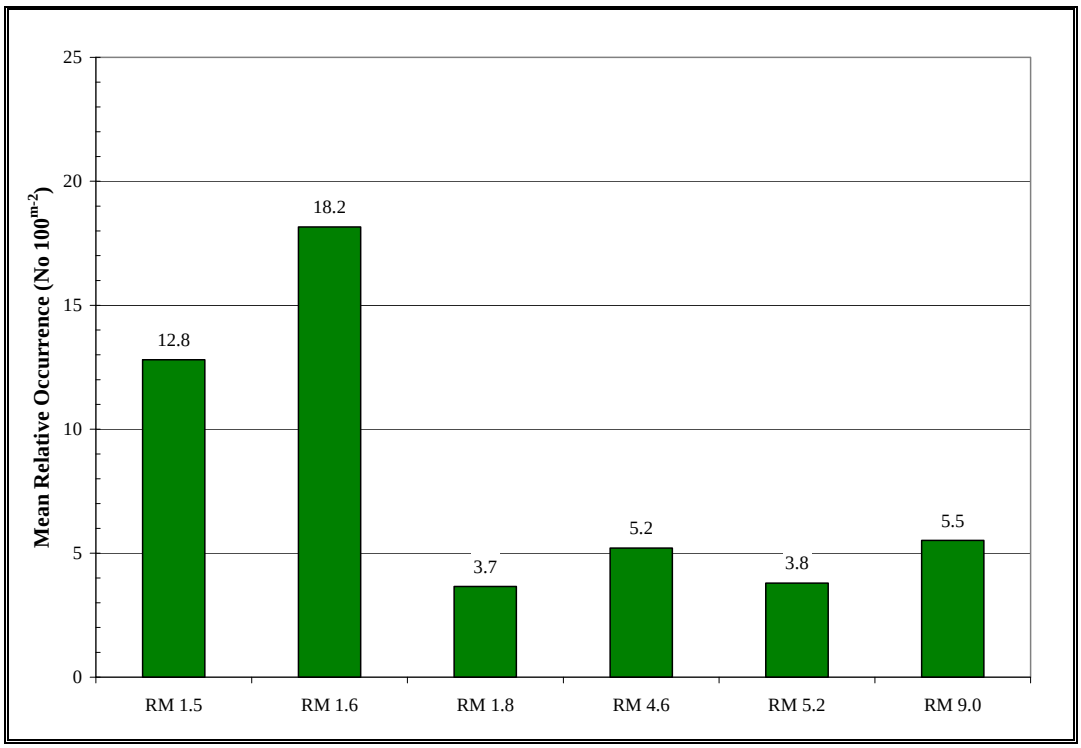

Figure 9. **Mean juvenile salmonid indices at six locations, Sultan River, Snohomish County, Washington.**

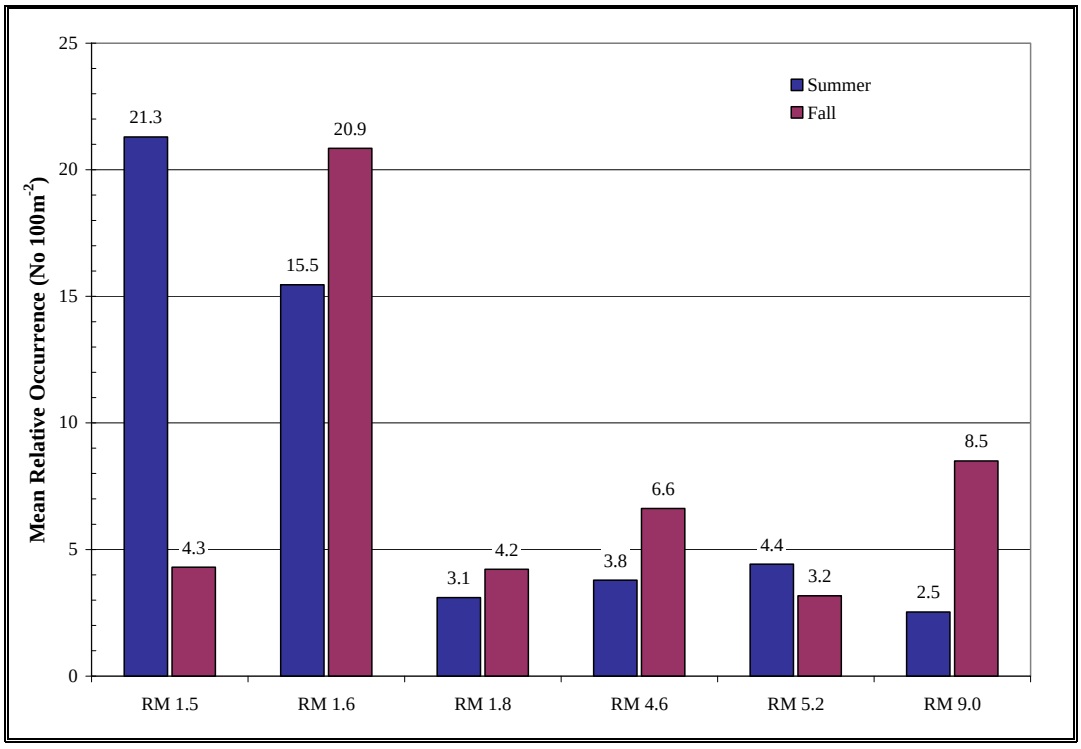

Figure 10. **Mean juvenile salmonid indices during summer and fall sample periods, Sultan River, Snohomish County, Washington.**

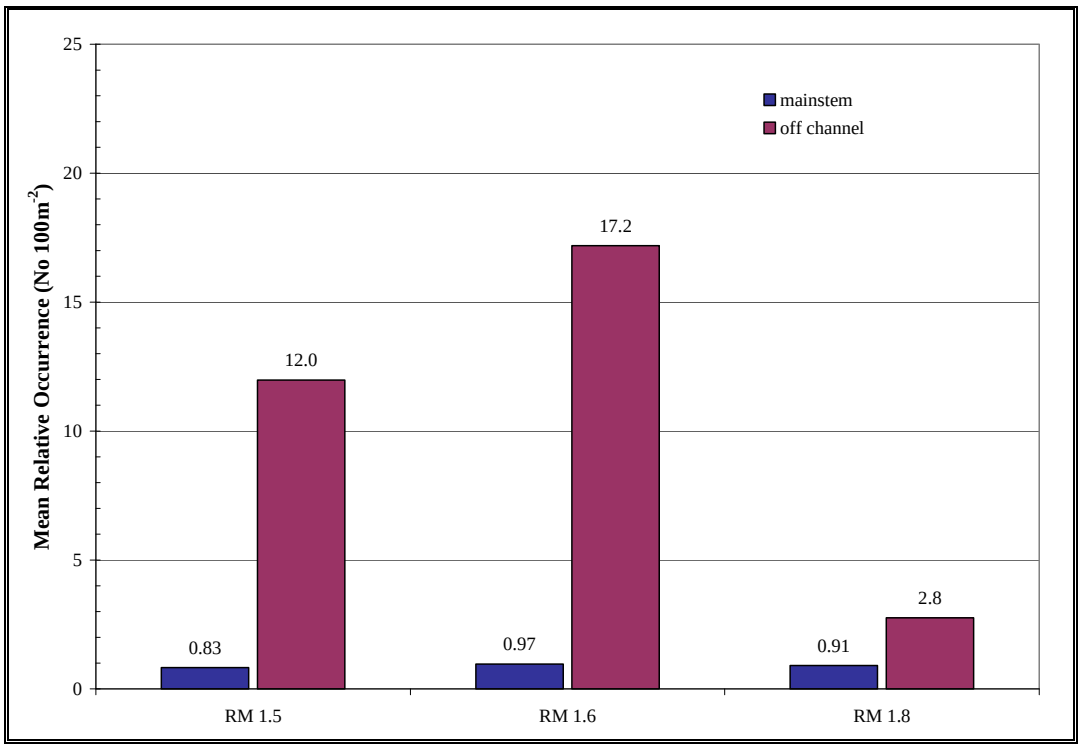

Figure 11. Mean juvenile salmonid indices at mainstem and off channel habitats, Sultan River, Snohomish County, Washington.

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APPENDIX B

RSP 5 Progress Report Dated September 2008 (Spring and Early Summer 2008 data)

DRAFT

HENRY M. JACKSON HYDROELECTRIC PROJECT

FERC No. 2157

Study Plan 5

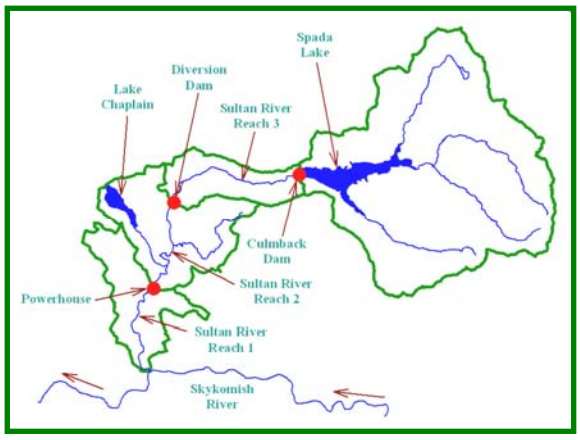
Juvenile Fish Abundance, Life History and Distribution
Progress Report
2007 and 2008 data

Prepared for:

Public Utility District No. 1
of Snohomish County
City of Everett

Prepared by:

R2 Resource Consultants, Inc.



September 2008

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1.0 STUDY OBJECTIVES AND DESCRIPTION

Population dynamics of aquatic species are often driven by the success of early life history cohorts (Quinn 2005). Understanding the respective life history characteristics of juvenile salmonids will ultimately play an invaluable role to assist water managers in developing strategies that minimize the effects of flow changes on multiple species and life stages on the Sultan River. Water management strategies such as planned short-term, high flow releases (i.e., freshets) may facilitate downstream migration for one species, but displace newly emerged fry from another species to less favorable habitats, exposing them to increased predation. As with other fish species, the success of early life history is strongly size dependent; small differences in growth and mortality often drive adult recruitment (Quinn and Peterson 1996; Schindler 1999). Therefore, studies that identify specific habitat and behavioral characteristics used by juvenile salmonids will be integral to developing water management strategies that address anthropocentric needs of the Puget Sound, while protecting and enhancing salmonid populations inhabiting the Sultan River.

As part of relicensing activities for the Henry M. Jackson Hydroelectric Project (Project) FERC No. 2157, the Tulalip Tribes requested a study to determine the "rearing locations and densities of steelhead (*Oncorhynchus mykiss*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*) in the lower river (below the Diversion Dam) throughout the year." The information collected from this study will supplement life history information on these species in the Sultan River and will be useful for evaluating relationships between habitats used by these species and stream flows in the Sultan River. The information will also be useful for identifying and evaluating potential protection, mitigation and enhancement measures focused on juvenile salmonid habitats. The Tulalip study request entailed two components; a year-round study of juvenile occurrence, and a study to quantify smolt abundance and migration characteristics.

In response to the study request, the Snohomish County Public Utility District No. 1 (District) and the City of Everett (City), as Co-Licensees of the Project, proposed to conduct a study to determine the relative occurrence of juvenile salmonids during the spring and fall as well as a similar study to be conducted in off-channel habitats during the winter residency period. The overall objective of the Juvenile Fish Occurrence, Life History and Distribution Study is to determine the relative distributions of juvenile salmonids in the Sultan River by life history stages, stream location, and habitat type. Specifically, the life history strategies of juvenile Chinook salmon (i.e., residency period) are of particular importance to the Tulalip Tribe because of the uncertainty about dominant (ocean-type) and sub-dominant (stream-type) rearing strategies of naturally-produced populations in the Snohomish River Basin. The specific information collected from this study, when combined with other study elements (e.g., instream flow [Revised Study Plan (RSP) 3]), habitat composition (RSP18), and geomorphic processes (RSP22)) will provide a solid foundation of information that can be used to make informed decisions regarding the protection and enhancement of fish populations in the Sultan River.

2.0 BACKGROUND INFORMATION

The Co-licenses filed a joint application with the Federal Power Commission (now Federal Energy Regulatory Commission [FERC]) in 1960 to develop what was then known as the Sultan River Project (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From the beginning, the Project was envisioned to serve two purposes; generating power for the District from the waters of the Sultan River and increasing the City's water supply system to meet growing demands. A license authorizing construction of the Project in two phases was issued on 6 June 1961.

The Stage I development was completed in 1965 and involved the construction of Culmback Dam and the creation of Spada Lake, which greatly increased the City's water supply available from the Sultan River Basin (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Originally, Stage II, the addition of the hydropower generation facilities, was to commence in 1967. Economic studies undertaken at that time indicated the cost of power from the Bonneville Power Administration (BPA) was still low enough to call into question the financial feasibility of moving ahead with Stage II. FERC granted a series of time extensions so the District and the City could investigate alternative plans.

In 1976, BPA, the source of almost all of the District's power at that time, announced it would not be able to meet the District's power needs after mid-1983. BPA offered to purchase the early years of power from new non-thermal resources, which motivated the District to develop the generating potential of the Sultan River (Public Utility District No. 1 of Snohomish County and City of Everett 2005).

On 6 July 1979, the District and the City filed an application with FERC to amend the original license with a revised hydroelectric scenario better suited to the regional economic and load demand projections, and to reduce the environmental impacts of the original design (Public Utility District No. 1 of Snohomish County and City of Everett 2005). FERC granted this amendment on 16 October 1981, and construction of generating facilities and raising of Culmback Dam commenced in 1982. One of the earliest Settlement Agreements with several state and federal agencies and the Tulalip Tribes (the Joint Agencies) was filed with the FERC and accepted in 1982. The Project was renamed after the late Senator Henry M. Jackson in 1984 when operation began. The current operating license for the Project will expire on 31 May 2011.

2.1 Sultan River Basin Description

The Project is located on the Sultan River, approximately 24 miles east of Everett, Washington, in south central Snohomish County (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From its headwaters near Vesper Peak on the western slope of the Cascade Mountains, the Sultan River flows west for approximately 19 miles, then south-southwest for 11 miles to its confluence with the Skykomish River at the City of Sultan (river mile [RM] 34.4). The Skykomish River

drains the northern 835 square miles of the Snohomish River Basin, the second largest river basin draining into Puget Sound (Haring 2002).

The Sultan River has a watershed area of approximately 105 square miles (Figure 1). The Sultan River watershed can be divided into four sub-basins: upstream from Culmback Dam (68.2 square miles): between Culmback Dam and the Diversion Dam (8.9 square miles); between the Diversion Dam and the Powerhouse (17.1 square miles); and between the Powerhouse and the confluence with the Skykomish River (10.7 square miles).

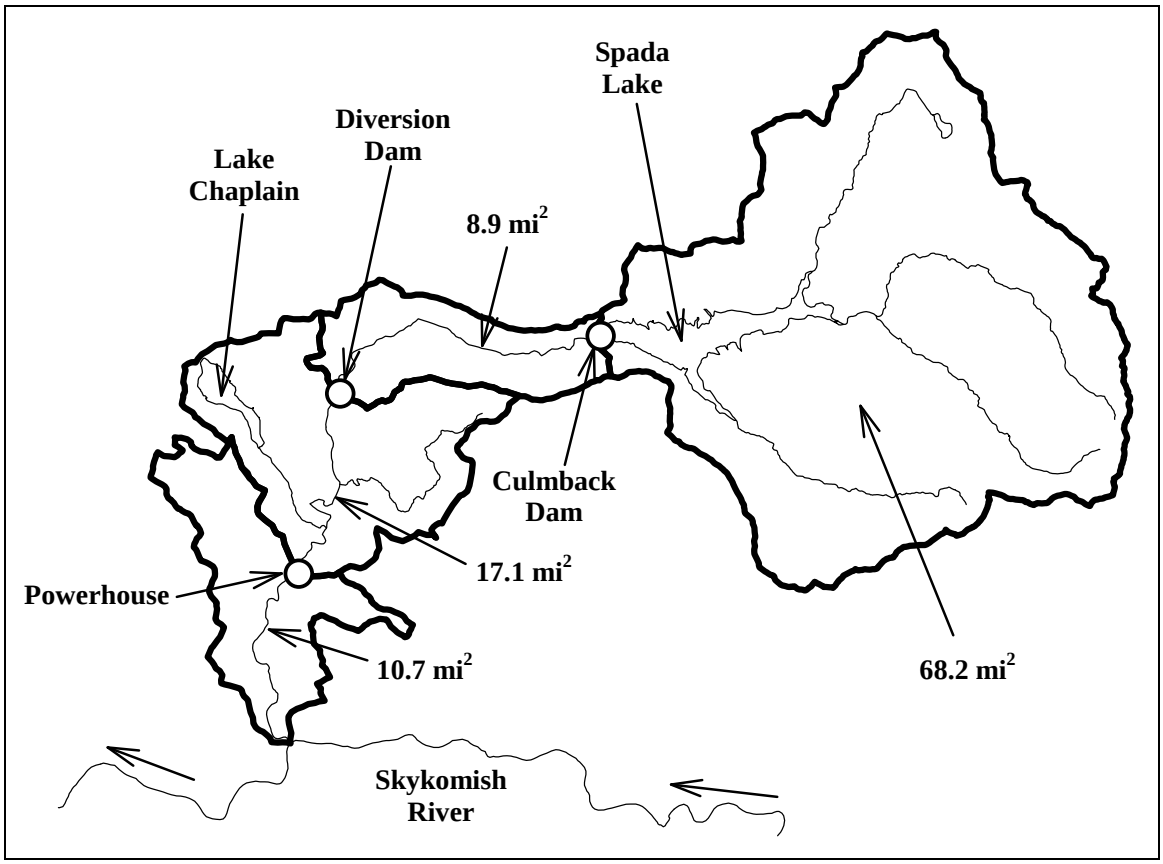

Figure 1. Four sub-basins of the Sultan River watershed, Snohomish County, Washington.

The basin is bounded on the east by the Cascade Mountains, on the north and south by lateral ridges extending westward from the Cascade crest, and on the west by the Puget Sound lowlands (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Elevations in the basin range from the 6,617-foot summit of Del Campo Peak to 130 feet at the confluence of the Sultan and Skykomish rivers. Major tributaries to the Sultan River above Culmback Dam include the South Fork Sultan River, North Fork Sultan River, Elk Creek, and Williamson Creek. Downstream of Culmback Dam, major

tributaries include Marsh Creek, Chaplain Creek, Woods Creek (drains Woods Lake), Ames Creek, and Winters Creek.

Downstream of Culmback Dam (RM 16.5), the Sultan River flows through a deep gorge for nearly 14 miles (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The steep side slopes above the channel are densely forested with conifer and mixed deciduous growth. The river channel in this reach is relatively high gradient and confined, containing numerous cascades and rapids separated by short pool-riffle, stretches. Much of the streambank is sheer rock face or large rock cuts (Williams et al. 1975). The City's Diversion Dam at RM 9.7 historically directed a portion of the river's flow to its water supply reservoir, Lake Chaplain. While that method of diversion remains in place and is used when Project maintenance or other reasons require, water now is normally supplied to Lake Chaplain through the Lake Chaplain pipeline after passing through the Project powerhouse. The Sultan River emerges from the canyon reach onto a broad, relatively flat valley floor containing intermittent stands or strips of deciduous trees, underbrush, and some mixed conifers near RM 3. The river channel in this reach has a moderate gradient with several split channel sections.

The Sultan watershed supports a wide array of salmonid species, each with slightly different life history strategies. Reproducing populations of Chinook, coho, pink (*O. gorbuscha*), and chum (*O. keta*) salmon; steelhead and coastal cutthroat trout (*O. clarki*) are present downstream from the Diversion Dam in varying numbers. Transitory bull trout (*Salvelinus confluentus*) have also been observed downstream from the Diversion Dam, but are not thought to spawn in the Sultan River. While occurring upstream to the Diversion Dam, anadromous salmonid spawning habitat is primarily located in the lower reaches of the Sultan River (Haring 2002). Access upstream from RM 9.7 is prevented by the Diversion Dam. Resident rainbow, cutthroat, and rainbow/cutthroat hybrids reside in Spada Lake, upstream from Culmback Dam which is located at RM 16.5.

2.2 Project Operations

In 1930, the City of Everett constructed the Diversion Dam at RM 9.7 (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This dam was used to divert water from the Sultan River through a pipeline and tunnel, west to Lake Chaplain for municipal water supply storage. In 1965, Stage I of Culmback Dam was built at RM 16.5 for additional storage of municipal water supply, but the traditional operation of the Diversion Dam and tunnel to Lake Chaplain remained essentially unchanged. With completion of the Stage II hydroelectric project facilities in 1984 (which included a raised Culmback Dam, a power tunnel and pipeline, a powerhouse, and a Lake Chaplain pipeline from the powerhouse to Lake Chaplain), the function of the Diversion Dam changed considerably. Prior to the completion of Stage II, water flowed west from the Diversion Dam through the tunnel to Lake Chaplain. Currently, water flows east through the tunnel between Lake Chaplain and the Diversion Dam. Some of the water diverted from Spada Lake at Culmback Dam is now returned to the Sultan River at the Diversion Dam to provide minimum instream flows below that point for fishery protection and enhancement.

Under current operations, 20 cfs of water is released from Culmback Dam into the river reach between Culmback Dam and the City's Diversion Dam at all times (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This 20 cfs, plus natural inflow from streams above the Diversion Dam, provides a constant flow for the fisheries in this reach. The rest of the water diverted from Spada Lake travels through the power tunnel and power pipeline to the Powerhouse. Most of the water delivered to the powerhouse in this manner passes through the Pelton turbines for electrical generation and is returned to the river at the powerhouse. However, an amount of water necessary for municipal supply and maintenance of minimum instream flows in the reach below the Diversion Dam is routed through two Francis turbines in the powerhouse, and then through the Lake Chaplain pipeline to the "Portal 2" facilities on the shores of Lake Chaplain.

At Lake Chaplain, a portion of the water in the Lake Chaplain pipeline is diverted by means of the "Portal 2" facilities to the lake for municipal water supply (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The remainder is transported east via the original water diversion tunnel back to the Sultan River at the Diversion Dam to provide minimum instream flows in the reach between the Diversion Dam and the powerhouse. In this manner, regulated fish flows are maintained for the full length of the Sultan River below Culmback Dam, with larger flows provided below the Diversion Dam and powerhouse where river conditions offer more suitable fish habitat than exists in the reach above the Diversion Dam. Occasionally, when storm events cause natural inflows within the reach between Culmback Dam and the City's Diversion Dam to exceed the combined total flows needed to meet both the City's water supply requirements and established minimum instream flows below the Diversion Dam, the Diversion Dam will be made to operate in its original manner (Public Utility District No. 1 of Snohomish County and City of Everett 2005). At these times, water for municipal supply is diverted from the Sultan River by the Diversion Dam and routed westerly through the tunnel to Lake Chaplain. Remaining flows in the river are allowed to pass over the Diversion Dam to provide required instream flows. The Powerhouse then routes water diverted from Spada Lake through only the larger Pelton units for more efficient power generation, and then immediately returns the water to the river.

3.0 METHODS

Seasonal snorkel observations were selected as the primary survey technique to determine the relative occurrence, life history, and distribution of juvenile salmonids in the lower Sultan River. Snorkel observations were selected, in part, based on their repeatability over different seasons, habitat strata, and reaches of the river. Backpack electrofishing will also be used in concert with snorkel observations during winter periods when juvenile salmonids typically exhibit daytime concealment behavior (Roni and Fayram 2000) and periods when the Sultan River exhibits elevated turbidity levels, precluding accurate snorkel observations (Thurow 1994).

Underwater observation has been long established as a valuable tool for study of fish behavior and habitat use particularly in regard to riverine juvenile salmonid species (O'Neal 2007). Snorkel observations are a quick, inexpensive, and non-invasive technique, that when properly structured, can provide accurate quantitative information concerning the abundance, size structure, distribution and habitat use of salmonids (Schill and Griffith 1984, Thurow 1994; O'Neal 2007).

Salmonids exhibit territorial behavior and inhabit areas with high water clarity making snorkel surveys particularly effective in determining presence/absence of salmonid species (Slaney and Martin 1987; Zubik and Fraley 1988; Hillman et al. 1992; Rodgers et al. 1992). Snorkel surveys have been proven to provide reliable and accurate survey information. Specifically, Schill and Griffith (1984) utilized snorkel observations to create population estimates for cutthroat trout in the Yellowstone River. Zubik and Fraley (1988) determined that in large clear streams, snorkel counts that were multiplied by a determined expansion factor provided a reliable density estimate in comparison to other survey methods. Slaney and Martin (1987) found similar results in a large stream in British Columbia, as did Mullner et al. (1998) in streams in Wyoming. Rodger et al. (1992) concluded that snorkeling was an appropriate method for sampling the population size of juvenile coho over large sections of stream in coastal Oregon. Roni and Fayram (2000) reported that night snorkeling allowed for quick and relatively reliable enumeration of juvenile salmonids during the winter in Pacific Northwest streams.

Snorkel surveys also provide for direct observation of fish habitat utilization (Thurow 1994; O'Neal 2007). Fish observations specific to the habitat being utilized provide information for management decisions affecting those specific habitats (Northcote and Wilkie 1963). For example, differences in utilization of mainstem and off-channel habitats can be determined by observation of these habitats at different times of the year (Bustard and Narver 1975). Furthermore, by comparing areas of observed fish use with areas of similar habitat enables the development of estimates of fish use.

The timing and the specific methodology employed in snorkel surveys are important determinants in the overall success of the snorkel surveys. The methodology of the surveys should reflect the objectives of the study at hand. For example, the use of night surveys during colder winter conditions are generally considered to have greater effectiveness than day surveys (Roni and Fayram 2000). Overall, snorkel observations

are a cost-effective technique and can encompass more diverse habitat than other sampling techniques (Dolloff et al. 1996).

3.1 Index Site Selection

Six juvenile salmonid index sites were selected in the Sultan River (Figure 2). Based on the following parameters: distribution of spawning salmonids, distribution of rearing habitats, site accessibility, lineal or reach representation, and overall habitat representation. The majority of index sites (5) were selected within or downstream from where the preponderance of salmonid spawning activity occurs. Three index sites were chosen from within the reach that contains the majority of the off-channel habitat in the Sultan River, while the final index site was chosen to represent an accessible location within the gorge section of Reach 2.

Index Site 1, is located near RM 1.5 in the lower Sultan River. Index Site 1 is the downstream-most index site located on the Sultan River and is comprised of approximately 24,350 m^2 of mainstem and 7,050 m^2 of off-channel wetted area as computed at a discharge of 400 cfs measured at the Powerhouse (Figure 3; Table 1). Index Site 2 is located near RM 1.6 in the lower Sultan River. Index Site 2 is bounded by Index Site 1 on the downstream end and Index Site 3 on the upstream portion. Index Site 2 is comprised of approximately 27,500 m^2 of mainstem and 2,560 m^2 of off-channel wetted area estimated at a discharge of 400 cfs at the Powerhouse (Figure 4; Table 1). Index Site 3 is located near RM 1.8 in the lower Sultan River. Index Site 3 is comprised of approximately 20,730 m^2 of mainstem and 7,480 m^2 of off-channel wetted area at a discharge of 400 cfs at the Powerhouse (Figure 5; Table 1).

Juvenile salmonid Index Site 4 is located near RM 4.6 in the lower Sultan River and is comprised of approximately 6,020 m^2 of mainstem wetted area at a discharge of 400 cfs as measured at the Powerhouse (Figure 6; Table 1). Index Site 5 is located near RM 5.2 in the lower Sultan River. The site, located near the discontinued Sultan River downstream of Chaplain Creek gage, is comprised of approximately 7,380 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 7; Table 1). Index Site 6 is located near RM 9.0 in the lower Sultan River and is comprised of approximately 1,790 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 8; Table 1).

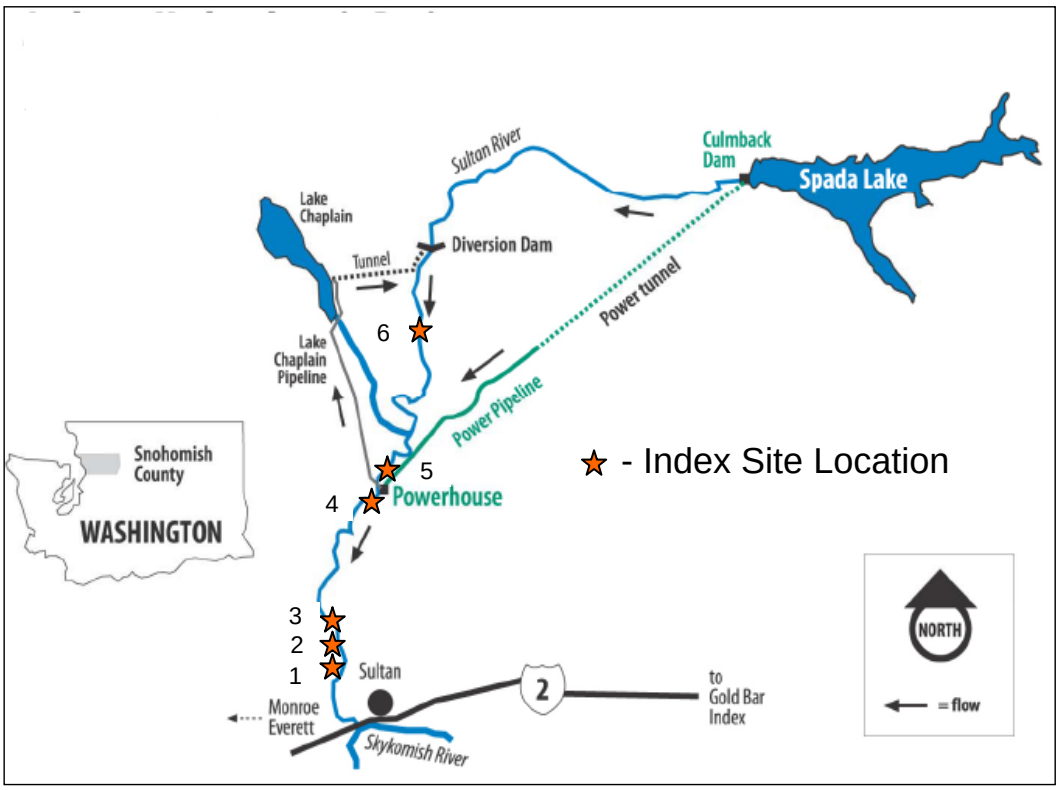

Figure 2. Juvenile salmonid index sites, Sultan River, Snohomish County, Washington.

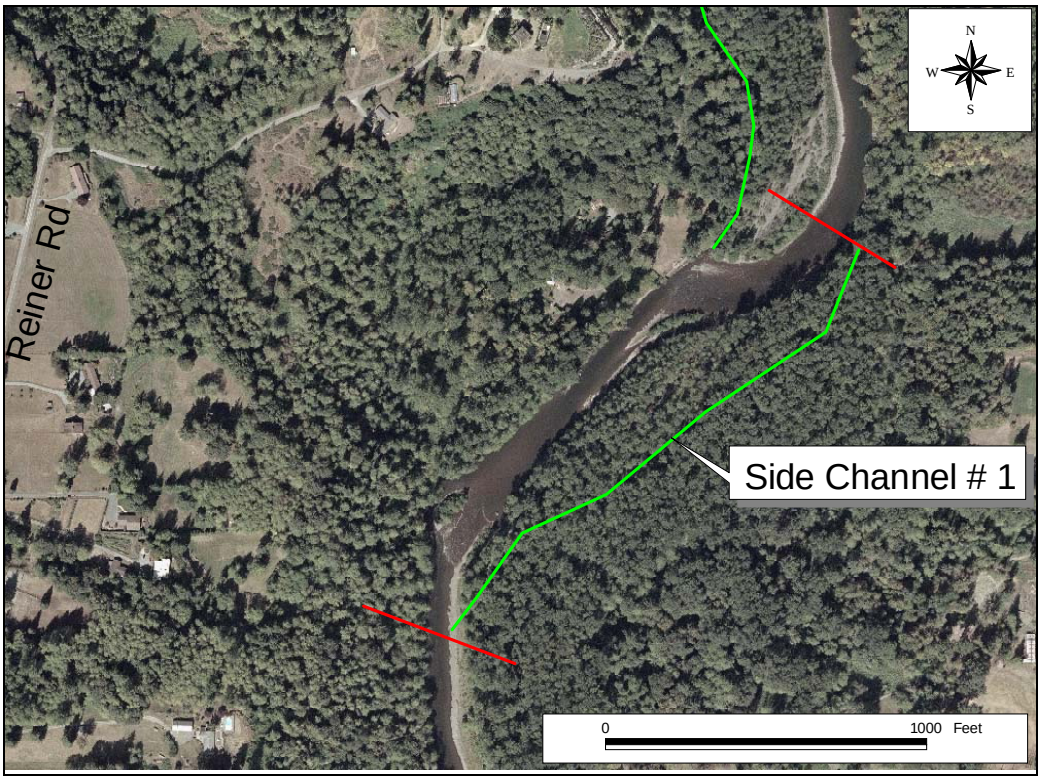

Figure 3. **Juvenile salmonid Index Site 1 (Side Channel 1), Sultan River, Snohomish County, Washington.**

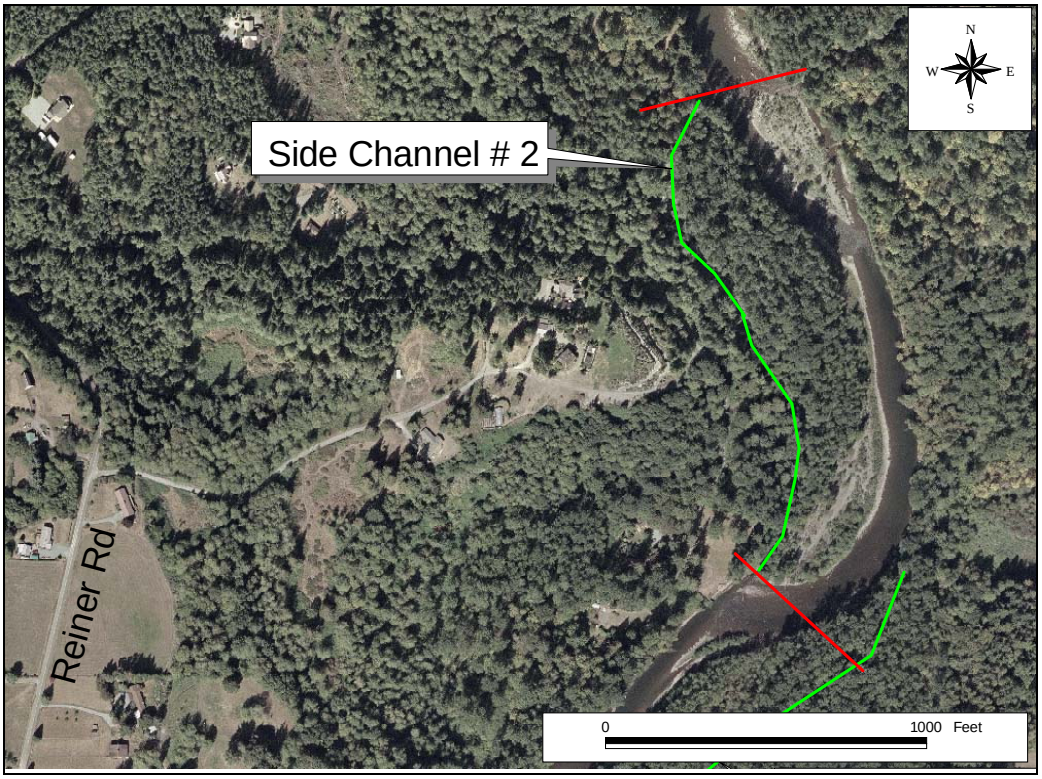

Figure 4. **Juvenile salmonid Index Site 2, Sultan River, Snohomish County, Washington.**

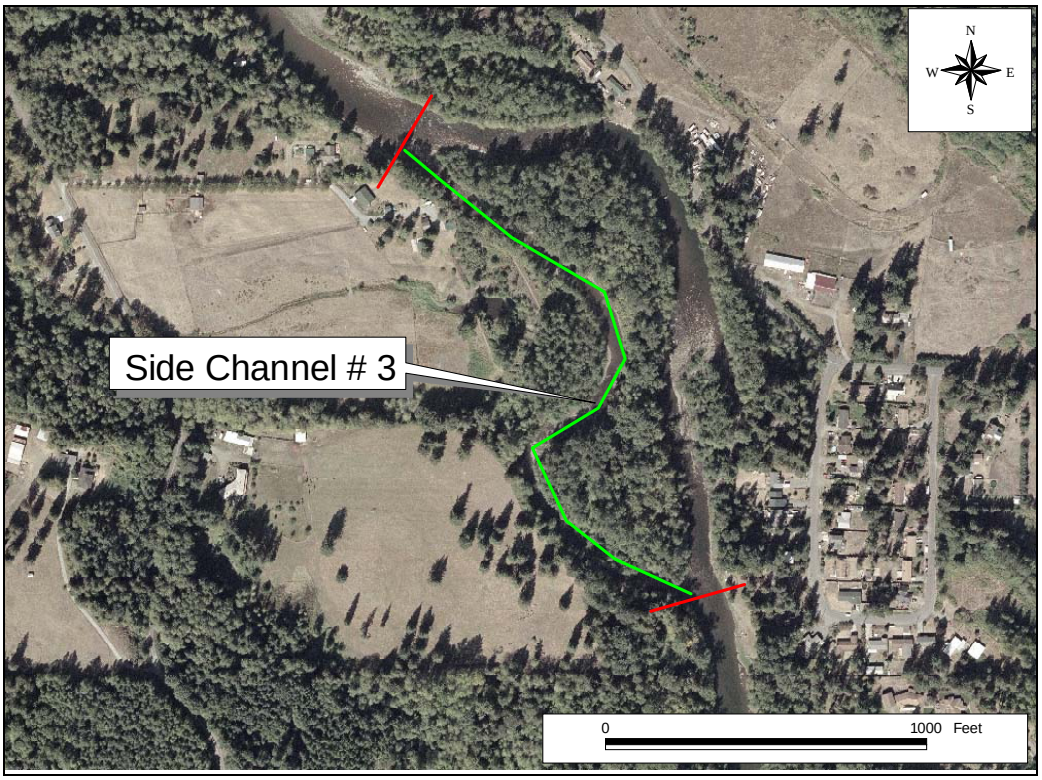

Figure 5. **Juvenile salmonid Index Site 3, Sultan River, Snohomish County, Washington.**

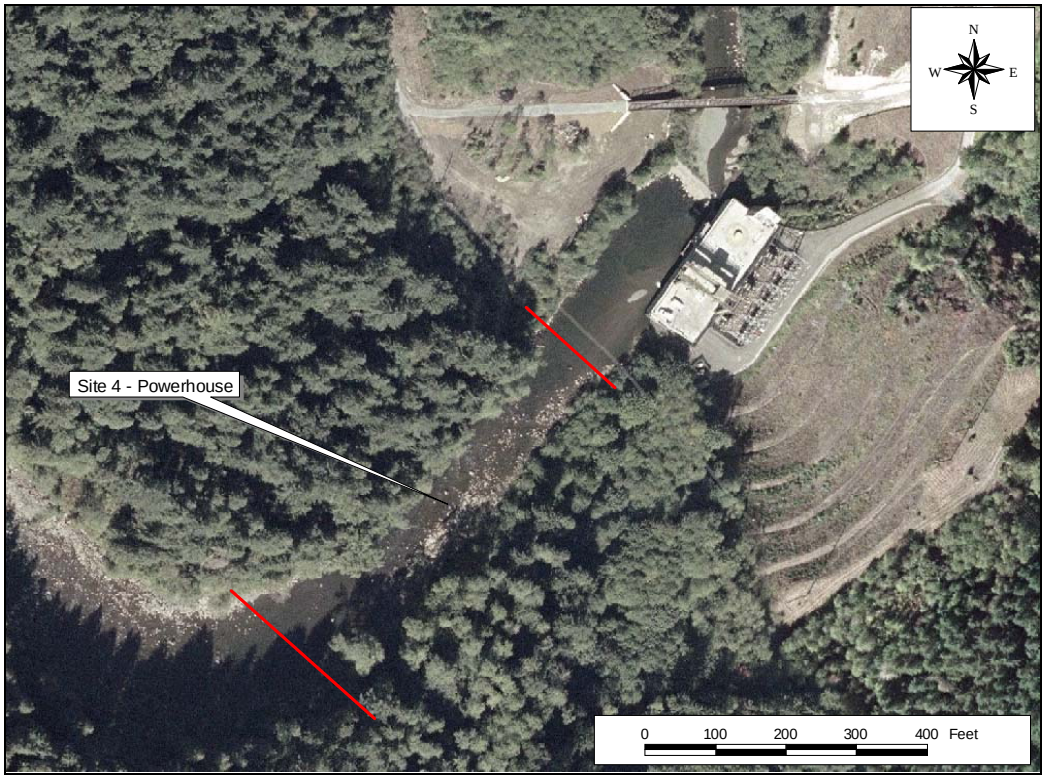

Figure 6. **Juvenile salmonid Index Site 4, Sultan River, Snohomish County, Washington.**

Figure 7. Juvenile salmonid Index Site 5, Sultan River, Snohomish County, Washington.

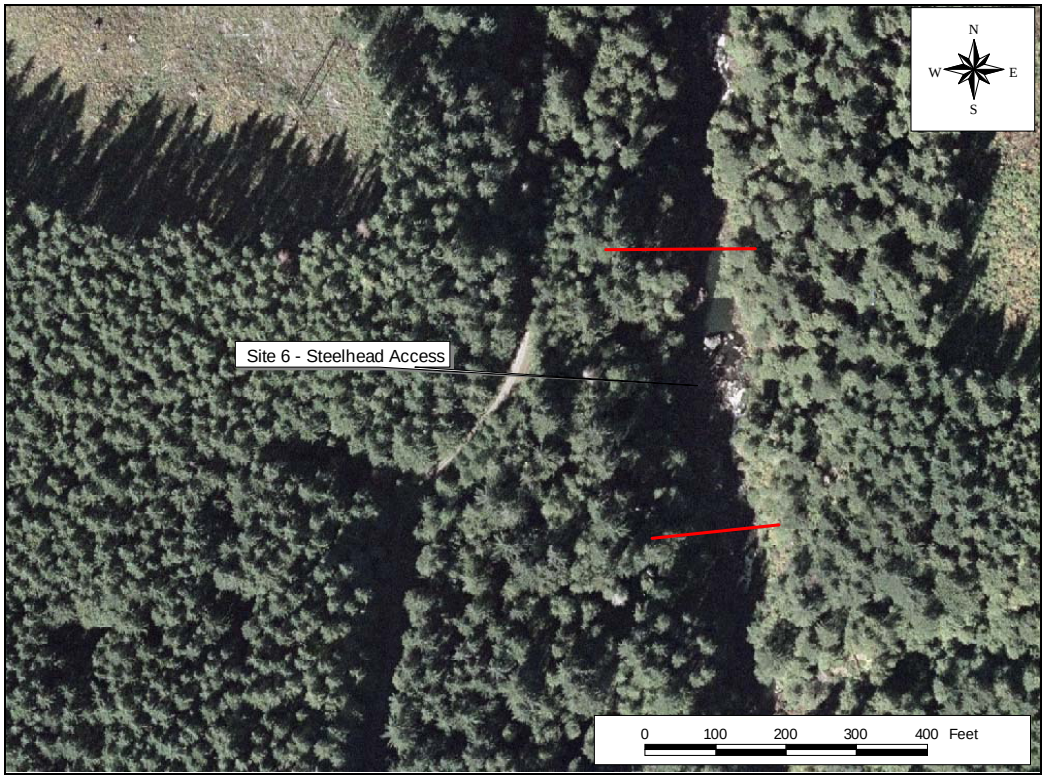

Figure 8. Juvenile salmonid Index Site 6, Sultan River, Snohomish County, Washington.

Table 1. Wetted area (m^2) of juvenile salmonid index sites, Sultan River, Snohomish County, Washington.

Index Site	Wetted Area (m^2)	
	Mainstem	Off-Channel
Site 1	24,360	7,050
Site 2	27,510	2,560
Site 3	20,730	7,480
Site 4	6,020	-
Site 5	7,380	-
Site 6	1,790	-

3.2 Snorkel Surveys

2008

Snorkel surveys were conducted during the spring (April –July) and summer (September-in progress) of 2008. Fall (October-November) surveys will also be completed as stream conditions allow in 2008. Each site was surveyed four times on each survey period. Late spring surveys were affected by turbidity and were scheduled and completed as feasible.

The snorkel surveys were completed by a team of five surveyors (4 divers, 1 observer); surveys began at the downstream boundary of the index site and proceeded upstream along each margin of the index site. Upon completion of the margins, the divers entered the upstream boundary of the index site and completed the center portion of the index site in a downstream direction. The observer served as a recorder and as a safety measure in case one of the snorkelers encountered any problems.

Divers were positioned so that all of the wetted area was surveyed, but observations did not overlap. Fish were enumerated by species and size class (mm FL) as the snorkeler passed them, so duplicate counts were avoided. The distance between the divers was less than the maximum distance the divers could identify fish to species and size class. This distance was determined before the snorkel observations began by underwater observations downstream from the index site boundary. Underwater observations were recorded individually by each observer on DuraRite® notebooks carried on the person in a small pack attached to the waist.

Relative occurrence indices were calculated by dividing snorkel observations per wetted unit area and multiplying by 100 (no $100m^{-2}$)) for each species (coho and Chinook salmon, and rainbow and cutthroat trout) and life stage (fry, pre-smolts, and overyearling). Intra-site data comparisons were conducted to determine relative occurrence over the study periods and channel type (i.e., mainstem and off-channel), while inter-site relative occurrence data were used to determine relative utilization

between index sites throughout the length of the study area. All data were entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes.

2007

In 2007, juvenile salmonid surveys were conducted during the summer (June-July) and fall (September-November) residency periods. Originally, snorkel observations were scheduled for the spring residency period; however, an extended period of elevated turbidity in the Sultan River prevented spring surveys in 2007. Each index site was surveyed on three occasions on each period, two day surveys, and one evening survey, for a total of six surveys at each index site to date. Protocol was similar that described previously for 2008.

4.0 RESULTS

4.1 Index Site 1 – Side Channel 1 and Adjacent Mainstem

2008

A total of 14,565 juvenile salmonids were observed in Site 1 during the spring snorkel survey. This was an average abundance of 35.9 juvenile salmonids (Table 2). The side channel portion of the survey had a greater abundance than the mainstem (29.4 vs. 6.4). Species present included juvenile Chinook, coho, chum and pink salmon and trout.

Table 2. Spring juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			28-Apr	6-May	12-May	15-Jul	Mean
Site 1 Mainstem	Chinook	35-45	0.2053	1.3875	2.1100	0.0000	0.93
		45-60	0.0000	0.5665	0.1437	0.3900	0.28
		60-80	0.0000	0.0000	0.0000	0.6404	0.16
	Chinook Total		0.2053	1.9540	2.2537	1.0304	1.36
	Chum	35-45	0.0000	0.0041	0.0000	0.0000	0.00
	Coho	35-45	0.0164	0.5131	0.7882	4.2323	1.39
		45-60	0.0041	0.0000	0.0205	13.9573	3.50
		60-80	0.0000	0.0041	0.0000	0.6568	0.17
	Coho Total		0.0205	0.5172	0.8087	18.8465	5.05
	Pink	35-45	0.0164	0.0123	0.0123	0.0000	0.01
	Trout	80-100	0.0000	0.0000	0.0000	0.0123	0.00
		100+	0.0000	0.0000	0.0082	0.0534	0.02
	Trout Total		0.0000	0.0000	0.0082	0.0657	0.02
Sub Total			*0.2*	*2.5*	*3.1*	*19.9*	*6.44*
Site 1 Side-Channel	Chinook	35-45	3.6879	6.0993	0.5674	0.0000	2.59
		45-60	0.0000	0.8227	0.0709	0.8794	0.44
	Chinook Total		3.6879	6.9220	0.6383	0.8794	3.03
	Chum	35-45	0.2270	0.0000	0.0000	0.0000	0.06
	Coho	35-45	3.5461	14.6241	17.0355	55.5319	22.68
		45-60	0.0000	0.4965	4.6950	4.6667	2.47
		60-80	0.4965	3.1631	0.7801	0.0000	1.10
	Coho Total		4.0426	18.2837	22.5106	60.1986	26.26
	Trout	35-45	0.0000	0.0000	0.0000	0.0142	0.00
		80-100	0.0000	0.0000	0.0000	0.1560	0.04
		100+	0.0000	0.0000	0.0426	0.0000	0.01
	Trout Total		0.0000	0.0000	0.0426	0.1702	0.05
Sub Total			*8.0*	*25.2*	*23.2*	*61.2*	*29.41*
Grand Total			**8.3**	**27.7**	**26.3**	**81.2**	**35.85**

A total of 12,530 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 35.9 (Table 3). The mainstem portion of Site 1 had a mean relative occurrence of 4.3, while the side channel was 44.6. Species present included juvenile Chinook, coho and trout.

Table 3. Summer juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			8-Sep	16-Sep	18-Sep	Mean
Site 1	Chinook	40-60	0.0000	0.0000	0.0369	0.01
Mainstem		60-80	0.0000	0.0287	0.0862	0.04
		80-100	0.0041	0.0000	0.0000	0.00
	Chinook Total		0.0041	0.0287	0.1232	0.05
	Coho	35-45	0.0000	0.0082	0.0616	0.02
		45-60	2.5164	2.1100	3.1773	2.60
		60-80	0.7800	2.2085	0.5008	1.16
		80-100	0.0000	0.0287	0.0493	0.03
	Coho Total		3.2964	4.3555	3.7890	3.81
	Trout	35-45	0.3161	0.2874	0.1888	0.26
		45-60	0.0123	0.0862	0.0411	0.05
		60-80	0.0000	0.0000	0.0041	0.00
		80-100	0.0000	0.0000	0.0123	0.00
		100+	0.0205	0.0575	0.1642	0.08
	Trout Total		0.3489	0.4310	0.4105	0.40
Sub Total			*3.7*	*4.8*	*4.3*	*4.26*
Site 1	Chinook	80-90	0	0.028369	0.028369	0.019
Side-Channel	Coho	35-45	1.134752	14.39716	15.92908	10.49
		45-60	48.36879	11.7305	13.65957	24.59
		60-80	0.368794	11.82979	13.65957	8.62
		80-100	0	0.666667	0.453901	0.37
	Coho Total		49.87234	38.62411	43.70213	44.07
	Trout	35-45	0.468085	0.836879	0.255319	0.52
		80-100	0.014184	0	0	0.01
		100+	0	0.028369	0.070922	0.03
	Trout Total		0.48227	0.865248	0.326241	0.56
Sub Total			*50.4*	*39.5*	*44.1*	*44.64*
Grand Total			**53.7**	**44.3**	**48.4**	**48.90**

2007

A total of 5,515 juvenile salmonids were observed during the summer snorkel period resulting in an average of relative occurrence of 21.3 (std. dev. = 3.4) juvenile salmonids at Index Site 1 (Table 4). Mean relative occurrence was greatest in the side channel (20.5; std. dev. = 3.8) when compared to the mainstem portion (0.8; std. dev. = 0.3) of Index Site 1 during the summer residency period. Species and life stages present included trout and coho fry, Chinook and coho pre-smolts, and overyearling coho.

Table 4. Summer juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 1	Chinook	45-60	0.6610	0.0534	0.0246	0.25
Mainstem	Coho	45-60	0.3859	0.4393	0.7760	0.53
		60-80	0	0	0	0
		80-100+	0.1560	0	0.0082	0.05
	Coho Total		0.5420	0.4393	0.7842	0.59
	Trout	35-45	0	0	0	0
		45-60	0.0041	0.0246	0	0.01
	Trout Total		0.0041	0.0246	0	0.01
Sub Total			*1.2*	*0.5*	*0.8*	*0.84*
Site 1	Chinook	45-60	0	0.0284	0	0.01
Side-Channel	Coho	45-60	16.9266	22.5688	18.0323	19.18
		60-80	0.3119	1.5027	0.0709	0.63
	Coho Total		17.2384	24.0714	18.1032	19.80
	Trout	35-45	0.0425	0.5529	1.3751	0.66
Sub Total			*17.3*	*24.7*	*19.5*	*20.47*
Grand Total			**18.5**	**25.2**	**20.3**	**21.32**

A total of 1,331 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 4.3 (std. dev. = 2.7) juvenile salmonids at Index Site 1 (Table 5). Mean relative occurrence was greatest in the side channel (3.5; std. dev. = 1.9) when compared to the mainstem portion (0.8; std. dev. = 0.4) of Index Site 1 during the fall residency period. Species and life stages present included trout and coho fry and coho pre-smolts. Overall, mean Index Site 1 fall relative occurrence was approximately 25% of that observed during the summer residency period.

Table 5. Fall juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 1	Coho	60-80	0.7965	0.6487	0.0082	0.48
Mainstem	Trout	45-60	0.1889	0.6487	0.0082	0.28
		60-100+	0.0164	0.1191	0	0.05
	Trout Total		0.2053	0.7678	0.0082	0.33
Sub Total			*1.0*	*1.4*	*0.02*	*0.81*
Site 1	Coho	60-80	4.3947	3.7567	0	2.72
Side-Channel		80-100+	0	0	1.0916	0.36
	Coho Total		4.3947	3.7567	1.0916	3.08
	Trout	45-60	0.3969	0.6946	0.1276	0.41
Sub Total			*4.8*	*4.5*	*1.2*	*3.49*
Grand Total			**5.8**	**5.9**	**1.2**	**4.30**

4.2 Index Site 2 – Side Channel 2 and Adjacent Mainstem

2008

A total of 7,459 juvenile fish were observed in Site 2 during the spring survey period. Average juvenile salmonid relative occurrence for Site 2 was 56.2 (Table 6). Similar to Site 1, mean relative occurrence for Site 2 was higher in the side channel than the mainstem (50.0 vs. 6.2). Species present in Site 2 included juvenile Chinook, coho, chum and pink salmon and trout.

Table 6. Spring juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			28-Apr	6-May	12-May	15-Jul	Mean
Site 2 Mainstem	Chinook	35-45	0.2545	1.5776	2.1156	0.0000	0.99
		45-60	0.0000	0.3308	0.2036	0.5671	0.28
		60-80	0.0000	0.0000	0.0000	0.5271	0.13
	Chinook Total		0.2545	1.9084	2.3192	1.0941	1.39
	Chum	35-45	0.0000	0.0109	0.0000	0.0000	0.00
	Coho	35-45	0.0145	0.4798	0.7888	3.9622	1.31
		45-60	0.0036	0.0000	0.0182	12.7590	3.20
		60-80	0.0000	0.0036	0.0000	1.0360	0.26
	Coho Total		0.0182	0.4835	0.8070	17.7572	4.77
	Pink	35-45	0.0218	0.0109	0.0145	0.0000	0.01
	Trout	80-100	0.0000	0.0000	0.0000	0.0109	0.00
		100+	0.0000	0.0000	0.0036	0.0400	0.01
	Total Trout		0.0000	0.0000	0.0036	0.0509	0.013
Sub Total			*0.3*	*2.4*	*3.1*	*18.9*	*6.19*
Site 2 Side-Channel	Chinook	35-45	1.9141	0.0000	1.4063	0.0000	0.83
		60-80	0.0000	0.0000	0.0000	0.3906	0.10
	Chinook Total		1.9141	0.0000	1.4063	0.3906	0.93
	Coho	35-45	0.0000	19.5313	34.5703	111.7188	41.46
		45-60	0.0000	0.5859	1.3672	27.3438	7.32
		60-80	0.0000	0.0391	0.0391	0.7422	0.21
	Coho Total		0.0000	20.1563	35.9766	139.8047	48.98
	Trout	80-100	0.0000	0.0000	0.0000	0.1563	0.04
		100+	0.0000	0.0000	0.0000	0.2344	0.06
	Trout Total		0.0000	0.0000	0.0000	0.3906	0.10
Sub Total			*1.9*	*20.2*	*37.5*	*140.6*	*50.01*
Grand Total			**2.2**	**22.6**	**40.6**	**159.5**	**56.2**

A total of 12,280 juvenile salmon were observed in Site 2 during the summer snorkel surveys, with a mean relative abundance of 115.5 (Table 7). The side channel again had the highest relative abundance with 110.9 versus 4.6 in the mainstem of Site 2. Juvenile Chinook, coho and trout were the species present.

Table 7. Summer juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			8-Sep	16-Sep	18-Sep	Mean
Site 2	Chinook	40-60	0	0	0	0
Mainstem		60-80	0	0.032715	0.079971	0.038
		80-100	0	0	0	0
	Chinook Total		0	0.032715	0.079971	0.04
	Coho	35-45	0.03635	0.218103	0.134497	0.13
		45-60	2.061069	3.06434	3.213377	2.78
		60-80	0.890585	1.374046	0.752454	1.01
		80-100	0	0.025445	0.043621	0.02
	Coho Total		2.988004	4.681934	4.143948	3.94
	Trout	35-45	0.512541	0.334424	0.41076	0.42
		45-60	0.101781	0.181752	0.101781	0.13
		60-80	0.003635	0.00727	0.003635	0.01
		80-100	0	0	0	0
		100+	0.02908	0.061796	0.098146	0.06
	Trout Total		0.647037	0.585242	0.614322	0.62
Sub Total			*3.6*	*5.3*	*4.8*	*4.59*
Site 2	Chinook	60-80	0	0.117188	0	0.04
Side-Channel		80-100	0.117188	0	0.078125	0.07
	Chinook Total		0.117188	0.117188	0.078125	0.10
	Coho	35-45	1.757813	0	13.98438	5.25
		45-60	89.21875	70.50781	41.44531	67.06
		60-80	1.757813	54.88281	41.52344	32.72
		80-100	0	3.984375	5.390625	3.13
	Coho Total		92.73438	129.375	102.3438	108.15
	Trout	35-45	0.390625	0.390625	2.851563	1.21
		45-60	0	3.203125	0	1.07
		60-80	0.117188	0	0.039063	0.05
		80-100	0.429688	0	0.234375	0.22
		100+	0.195313	0.039063	0.078125	0.10
	Trout Total		1.132813	3.632813	3.203125	2.66
Sub Total			*94.0*	*133.1*	*105.6*	*110.91*
Grand Total			**97.6**	**138.4**	**110.4**	**115.5**

2007

A total of 1,926 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 15.5 (std. dev. = 3.9) juvenile salmonids at

Index Site 2 (Table 8). Mean relative occurrence was greatest in the side-channel (14.5; std. dev. = 3.9) when compared to the mainstem portion (1.0; std. dev. = 0.2) of Index Site 2 during the summer residency period. Species and life stages present included Chinook, trout, and coho fry, coho and Chinook pre-smolts, and overyearling coho.

Table 8. Summer juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 2 Mainstem	Chinook	45-60	0.3671	0.0400	0.0254	0.14
	Coho	45-60	0.3598	1.1376	0.4798	0.66
		60-80	0	0.0509	0.0763	0.04
		80-100+	0.1308	0	0.0073	0.05
	Coho Total		0.5	1.2	0.6	0.75
	Trout	35-45	0	0	0.2253	0.08
		45-60	0	0.0436	0.0109	0.02
	Trout Total		0.0	0.0	0.2	0.09
Sub Total			*0.9*	*1.3*	*0.8*	*0.98*
Site 2 Side-Channel	Chinook	45-60	0	0.8194	0	0.27
		60-80	0.4682	0.0390	0	0.17
	Chinook Total		0.4682	0.8584	0.0000	0.44
	Coho	45-60	9.2470	14.3972	12.6805	12.11
		60-80	0	0.2341	2.7312	0.99
		80-100+	0.2341	0	0	0.08
	Coho Total		9.4811	14.6313	15.4116	13.17
	Trout	35-45	0	0.1171	2.0679	0.73
		45-60	0.1951	0.0390	0.1561	0.13
	Trout Total		0.1951	0.1561	2.2240	0.86
Sub Total			*10.1*	*15.6*	*17.6*	*14.48*
Grand Total			**11.0**	**16.9**	**18.5**	**15.46**

A total of 2,324 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 20.9 (std. dev. = 18.3) juvenile salmonids at Index Site 2 (Table 9). Mean relative occurrence was greatest in the side-channel (19.9; std. dev. = 17.4) when compared to the mainstem portion (1.0; std. dev. = 0.8) of Index Site 2 during the fall residency period. Species and life stages present included trout and coho fry, coho pre-smolts, and overyearling trout. Overall, mean Index Site 2 fall relative occurrence was approximately 134% of that during the summer residency period.

Table 9. Fall juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 2	Coho	60-80	0.9377	1.1049	0.0073	0.68
Mainstem	Trout	45-60	0.2871	0.3562	0.0109	0.22
		60-100	0.0981	0.0872	0	0.06
	Trout Total		0.3853	0.4434	0.0109	0.28
Sub Total			*1.3*	*1.5*	*0.02*	*0.96*
Site 2	Coho	60-80	18.9231	23.0199	0	13.98
Side-Channel	Trout	45-60	7.9984	9.6762	0	5.89
		80-100+	0	0	0.0390	0.01
	Trout Total		7.9984	9.6762	0.0390	5.90
Sub Total			*26.9*	*32.7*	*0.06*	*19.89*
Grand Total			**28.2**	**34.2**	**0.1**	**20.85**

4.3 Index Site 3 – Side Channel 3 and Adjacent Mainstem

2008

A total of 8,905 juvenile salmonids were observed during the spring snorkel surveys with mean relative abundance measuring 23.0 (Table 10). Mean relative occurrence was greatest in the side channel (19.5) when compared to the mainstem portion (3.5) of Site 3 during the spring surveys. Juvenile Chinook, coho, chum and pink salmon were observed in Site 3.

Table 10. Spring juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			28-Apr	6-May	12-May	15-Jul	Mean
Site 3	Chinook	35-45	0.0145	1.1963	1.3169	0.0000	0.63
Mainstem		45-60	0.0000	0.1447	0.0772	0.2412	0.12
		60-80	0.0000	0.0000	0.0000	0.3714	0.09
	Chinook Total		0.0145	1.3411	1.3941	0.6126	0.84
	Chum	35-45	0.0096	0.0048	0.0000	0.0000	0.00
	Coho	35-45	0.0096	0.8201	3.4443	1.4472	1.43
		45-60	0.0000	0.0000	0.0000	3.7385	0.94
		60-80	0.0000	0.0000	0.0000	0.7236	0.18
	Coho Total		0.0096	0.8201	3.4443	5.9093	2.55
	Pink	35-45	0.0000	0.0000	0.0096	0.0000	0.00
	Trout	80-100	0.0000	0.0000	0.0000	0.0627	0.02
		100-125	0.0000	0.0000	0.0000	0.0145	0.00
		100+	0.0000	0.0000	0.0000	0.2026	0.05
	Trout Total		0.0000	0.0000	0.0096	0.2798	0.07
Sub Total			*0.0*	*2.2*	*4.8*	*6.8*	*3.47*
Site 3	Chinook	35-45	0.8957	2.4064	0.1337	0.0000	0.86
Side-Channel		60-80	0.0000	0.0000	0.0000	2.0856	0.52
	Chinook Total		0.8957	2.4064	0.1337	2.0856	1.38
	Coho	35-45	0.0000	0.9358	5.2139	56.4171	15.64
		45-60	0.0000	0.0000	0.0000	7.9545	1.99
		60-80	0.0000	0.0000	0.0000	1.6979	0.43
	Coho Total		0.0000	0.9358	5.2139	66.0695	18.06
	Trout	80-100	0.0000	0.0000	0.0000	0.1872	0.05
		100+	0.0000	0.0134	0.0000	0.2005	0.05
	Trout Total		0.0000	0.0134	0.0000	0.3877	0.10
Sub Total			*0.9*	*3.4*	*5.4*	*68.5*	*19.54*
Grand Total			**0.9**	**5.6**	**10.2**	**75.3**	**23.01**

A total of 6,892 juvenile salmon were observed in Site 3 during summer snorkel surveys with a mean relative abundance of 24.7 (Table 11). Similar to spring surveys, the summer surveys had a greater mean relative occurrence in the side channel (21.4) in comparison to the mainstem areas (3.3) of Site 3.

Table 11. Summer juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			8-Sep	16-Sep	18-Sep	Mean
Site 3	Chinook	60-80	0.0000	0.0000	0.0579	0.02
Mainstem	Coho	45-60	2.0502	1.8862	2.6146	2.18
		60-80	0.1833	1.0323	0.4534	0.56
	Coho Total		2.2335	2.9185	3.0680	2.74
	Trout	35-45	0.4679	0.2171	0.1158	0.27
		45-60	0.0868	0.1302	0.0820	0.10
		100+	0.2074	0.1833	0.2508	0.21
	Trout Total		0.7622	0.5306	0.4486	0.58
Sub Total			*3.0*	*3.5*	*3.6*	*3.34*
Site 3	Chinook	60-80	0.0401	0.0134	0.0000	0.02
Side-Channel		80-100	0.0802	0.0000	0.0535	0.05
	Chinook Total		0.1203	0.0134	0.0535	0.06
	Coho	35-45	0.4813	0.0000	0.0000	0.16
		45-60	15.7353	6.5508	2.8877	8.39
		60-80	1.0027	15.5080	14.9198	10.48
		80-100	0.0000	0.5749	3.2219	1.27
	Coho Total		17.2193	22.6337	21.0294	20.29
	Trout	35-45	0.1872	0.3877	0.6417	0.41
		45-60	0.0267	0.0000	0.1337	0.05
		60-80	0.4947	0.0000	0.1203	0.21
		80-100	0.2674	0.0000	0.2540	0.17
		100+	0.2005	0.4011	0.1604	0.25
	Trout Total		1.1765	0.7888	1.3102	1.09
Sub Total			*18.5*	*23.4*	*22.4*	*21.4*
Grand Total			**21.5**	**26.9**	**26.0**	**24.74**

2007

A total of 984 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 3.1 (std. dev. = 1.4) juvenile salmonids at Index Site 3 (Table 12). Mean relative occurrence was greatest in the side-channel (2.4; std. dev. = 1.6) when compared to the mainstem portion (0.7; std. dev. = 0.2) of Index Site 3 during the summer residency period. Species and life stages present included Chinook, trout, and coho fry, coho and Chinook pre-smolts, and overyearling coho.

Table 12. Summer juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 3	Chinook	45-60	0.2653	0	0	0.09
Mainstem	Coho	45-60	0.5981	0.3907	0.6849	0.56
		60-80	0	0.0579	0.0531	0.04
		80-100+	0.0096	0	0	0.00
	Coho Total		0.6077	0.4485	0.7379	0.60
	Trout	45-60	0.0145	0.0434	0.0531	0.04
Sub Total			*0.9*	*0.5*	*0.8*	*0.72*
Site 3	Chinook	45-60	1.0294	0.4278	0	0.49
Side-Channel		60-80	0	0.1070	0	0.04
		80-100	0.0401	0.0267	0	0.02
	Chinook Total		1.0695	0.5615	0	0.54
	Coho	45-60	0.3476	2.9144	0.8155	1.36
		60-80	0.0000	0.4011	0.4813	0.29
	Coho Total		0.3476	3.3155	1.2968	1.65
	Trout	35-45	0	0.0668	0	0.02
		45-60	0.0802	0.2406	0.1604	0.16
	Trout Total		0.0802	0.3075	0.1604	0.18
Sub Total			*1.5*	*4.2*	*1.5*	*2.38*
Grand Total			**2.4**	**4.7**	**2.2**	**3.10**

Table 13. Fall juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 3	Coho	60-80	0.6704	0.8730	0	0.51
Mainstem	Trout	45-60	0.6800	0.9598	0	0.55
		60-80	0.0289	0.0434	0.0096	0.03
	Trout Total		0.7090	1.0032	0.0096	0.57
Sub Total			*1.4*	*1.9*	*0.01*	*1.09*
Site 3	Coho	60-80	3.4893	3.1952	0	2.23
Side-Channel	Trout	45-60	0.4412	1.7781	0	0.74
		60-80	0.4278	0.0401	0.0134	0.16
	Trout Total		0.8690	1.8182	0.0134	0.90
Total			*4.4*	*5.0*	*0.01*	*3.13*
Grand Total			**5.7**	**6.9**	**0.02**	**4.22**

A total of 1,379 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 4.2 (std. dev. = 3.7) juvenile salmonids at Index Site 3 (Table 13). Mean relative occurrence was greatest in the side-channel (3.1; std. dev. =

2.7) when compared to the mainstem portion (1.1; std. dev. = 1.0) of Index Site 3 during the fall residency period. Species and life stages present included trout and coho fry and coho and trout pre-smolts. Overall, mean Index Site 2 fall relative occurrence was approximately 135% of that during the summer residency period.

4.4 Index Site 4 – Powerhouse

2008

A total of 1,316 juvenile salmon were observed at Site 4 during the spring surveys with a mean relative abundance of 5.6 (Table 14). Juvenile Chinook, coho and trout were the species observed in Site 4.

Table 14. Spring juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			29-Apr	5-May	14-May	14-Jul	Mean
Site 4 Mainstem	Chinook	35-45	0.2159	3.372	0.7309	0.0000	1.08
		45-60	0.0000	0.0000	0.0000	0.1329	0.03
	Chinook Total		0.2159	3.372	0.7309	0.1329	1.11
	Coho	35-45	0.0000	0.8140	4.535	0.1661	1.38
		45-60	0.0000	0.0000	0.0000	11.81	2.95
		60-80	0.0000	0.0000	0.0000	0.3322	0.08
	Coho Total		0.0000	0.8140	4.535	12.31	4.41
	Trout	100+	0.0000	0.0000	0.0000	0.0831	0.02
Grand Total				**0.3**	**4.2**	**5.3**	**5.55**

Table 15. Summer juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			8-Sep	16-Sep	18-Sep	Mean
Site 4 Mainstem	Coho	35-45	0.0000	0.3322	0.3156	0.22
		45-60	0.2658	0.0831	1.2791	0.54
		60-80	0.0997	4.6013	0.0332	1.58
		80-100	0.0000	0.6312	0.0000	0.21
	Coho Total		0.3654	5.6478	1.6279	2.55
	Trout	35-45	0.1163	0.0997	0.1993	0.14
		45-60	0.0332	0.5150	0.1495	0.23
		60-80	0.0000	0.0332	0.0166	0.02
		80-100	0.0166	0.0166	0.0166	0.02
		100+	0.0664	0.0664	0.1329	0.09
	Trout Total		0.2326	0.7309	0.5150	0.49
Grand Total			**0.6**	**6.4**	**2.1**	**3.04**

A total of 552 juvenile salmonids were observed during the summer surveys of Site 4 with a mean relative abundance of 3.0 (Table 15). Juvenile coho and trout were the only juvenile species observed.

2007

A total of 685 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 3.8 (std. dev. = 5.2) juvenile salmonids at Index Site 4 (Table 16). Species and life stages present included Chinook, trout, and coho fry, and coho pre-smolts.

Table 16. Summer juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 4 Mainstem	Chinook	45-60	0	0.0664	0	0.02
	Coho	35-45	0	0.3987	0.7143	0.37
		45-60	0.0664	0.4817	1.6279	0.73
		60-80	0	0.0166	0	0.01
	Coho Total		0.0664	0.8970	2.3422	1.10
	Trout	35-45	0.0166	0.4651	7.4086	2.63
		45-60	0.0332	0.0332	0.0498	0.04
	Trout Total		0.0498	0.4983	7.4585	2.67
Grand Total			**0.1**	**1.5**	**9.8**	**3.79**

A total of 1,195 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 6.6 (std. dev. = 6.2) juvenile salmonids at Index Site 4 (Table 17). Species and life stages present included trout and coho fry, and coho pre-smolts, and coho overyearlings.

Table 17. Fall juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 4 Mainstem	Coho	60-80	5.2824	2.2924	0.0997	2.56
	Trout	45-60	6.5282	4.5183	0.0831	3.71
		60-80	0.4153	0.1495	0.0166	0.19
		80-100+	0.4153	0.0498	0.0000	0.16
	Trout Total		7.3588	4.7176	0.0997	4.06
Grand Total			**12.6**	**7.0**	**0.2**	**6.62**

4.5 Index Site 5 – Old USGS

2008

A total of 8,533 juvenile salmonids were observed in Site 5, including juvenile Chinook, coho and trout. Relative mean abundance for Site 5 was 38.5 (Table 18). The majority of the observed fish were coho fry counted in July.

Table 18. Spring juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			5-May	14-May	14-Jul	Mean
Site 5	Chinook	35-45	3.1978	1.3821	3.3875	2.66
Mainstem		45-60	0.0000	0.0542	8.7940	2.95
		60-80	0.0000	0.0000	0.6775	0.23
	Chinook Total		3.1978	1.4363	12.8591	5.83
	Coho	35-45	0.5691	2.5610	38.6179	13.92
		45-60	0.0000	0.0000	53.1843	17.73
		60-80	0.0000	0.0000	2.0325	0.68
	Coho Total		0.5691	2.5610	93.8347	32.32
	Trout	35-45	0.0000	0.0000	0.6911	0.23
		60-80	0.0000	0.0000	0.0271	0.01
		80-100	0.0000	0.0000	0.1897	0.06
		100+	0.0136	0.0000	0.1897	0.07
	Trout Total		0.0136	0.0000	1.0976	0.37
Grand Total			**3.8**	**4.0**	**107.8**	**38.52**

A total of 5,217 juvenile salmonids were observed during summer surveys at Site 5. The mean relative abundance was 23.6 (Table 19).

Table 19. Summer juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			2-Sep	15-Sep	17-Sep	Mean
Site 5	Chinook	45-60	0.7453	0.0000	0.0000	0.25
Mainstem		60-80	0.9892	0.0542	0.1626	0.40
		80-100	0.0000	0.0407	0.0949	0.05
	Chinook Total		1.7344	0.0949	0.2575	0.70
	Coho	35-45	0.0000	0.4065	3.4959	1.30
		45-60	18.8347	13.1436	14.7967	15.59
		60-80	0.9350	8.3875	1.2466	3.52
		80-100	0.0000	0.2439	0.0000	0.08
	Coho Total		19.7696	22.1816	19.5393	20.50
	Trout	35-45	0.5014	2.1003	1.2195	1.27
		45-60	0.0000	2.0325	0.5149	0.851
		60-80	0.0000	0.1355	0.0407	0.06
		80-100	0.0000	0.0542	0.1084	0.05
		100+	0.0271	0.2168	0.1084	0.12
	Trout Total		0.5285	4.5393	1.9919	2.35
Grand Total			**22.0**	**26.8**	**21.8**	**23.55**

2007

A total of 979 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 4.4 (std. dev. = 7.1) juvenile salmonids at Index Site 5 (Table 20). Species and life stages present included Chinook, trout, and coho fry, coho pre-smolts, and overyearling coho.

Table 20. Summer juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 5	Chinook	45-60	0.1355	0	0	0.05
Mainstem	Coho	35-45	0.1084	0	0.3795	0.16
		45-60	0.0407	0.1084	5.0820	1.74
		60-80	0	0	1.1248	0.37
		80-100+	0	0	0.0678	0.02
	Coho Total		0.1491	0.1084	6.6540	2.30
	Trout	35-45	0.0136	0.1626	5.8545	2.01
		45-60	0.0000	0.0271	0.1626	0.06
	Trout Total		0.0136	0.1897	6.0171	2.07
Grand Total			**0.3**	**0.3**	**12.7**	**4.42**

A total of 701 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 3.2 (std. dev. = 2.0) juvenile salmonids at Index Site 5 (Table 21). Species and life stages present included trout and coho fry, and trout and coho pre-smolts.

Table 21. Fall juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 5	Coho	60-80	0.8809	0.8944	0	0.59
Mainstem		80-100+	0	0	0.1897	0.06
	Coho Total		0.8809	0.8944	0.1897	0.66
	Trout	45-60	3.5506	3.3880	0.0678	2.34
		80-100+	0.2846	0.1355	0.1084	0.18
	Trout Total		3.8352	3.5235	0.1762	2.51
Grand Total			**4.7**	**4.4**	**0.4**	**3.17**

4.6 Index Site 6 – Steelheader

2008

A total of 102 juvenile salmon were observed during spring surveys at Site 6. Mean relative abundance was 2.9 (Table 22).

Table 22. Spring juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)		
			5-May	14-May	Mean
Site 6	Chinook	35-45	0.0559	0.0000	0.03
Mainstem		45-60	0.0000	0.2793	0.14
		60-80	0.0000	0.2793	0.134
	Chinook Total		0.0559	0.5587	0.33
	Coho	35-45	0.7821	1.6201	1.20
	Trout	35-45	0.0000	0.0559	0.03
		80-100	0.0559	0.4469	0.25
		100+	0.1117	2.0112	1.06
	Trout Total		0.1676	2.5140	1.34
Grand Total			**1.0**	**4.7**	**2.85**

A total of 187 juvenile salmonids were observed during summer surveys of Site 6, with a mean relative abundance of 3.3 (Table 23).

Table 23. Summer juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			2-Sep	15-Sep	17-Sep	Mean
Site 6	Coho	45-60	0.2793	0.2235	0.5587	0.35
Mainstem		60-80	0.0000	0.2235	0.0000	0.08
	Coho Total		0.2793	0.4469	0.5587	0.43
	Trout	35-45	0.0000	0.3911	0.0000	0.13
		45-60	0.2235	1.0615	0.4469	0.58
		60-80	0.0000	0.8939	1.5084	0.80
		80-100	0.0000	0.0559	0.7263	0.26
		100+	0.2793	0.5028	2.6257	1.14
	Trout Total		0.5028	2.9050	5.3073	2.91
Grand Total			**0.8**	**3.4**	**5.9**	**3.33**

2007

A total of 136 juvenile salmonids were observed during the summer survey period resulting in an average relative occurrence of 2.5 (std. dev. = 1.7) juvenile salmonids at Index Site 6 (Table 24). Species and life stages present included trout and coho fry.

Table 24. Summer juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			26-Jun	2-Jul	10-Jul	Mean
Site 6	Coho	45-60	0	0.1115	0.0558	0.06
Mainstem	Trout	35-45	0.7808	0.0000	3.2906	1.36
		45-60	1.2270	1.0039	1.1154	1.12
	Trout Total		2.0078	1.0039	4.4060	2.47
Grand Total			**2.0**	**1.1**	**4.5**	**2.53**

A total of 457 juvenile salmonids were observed during the fall survey period resulting in an average relative occurrence of 8.5 (std. dev. = 3.7) juvenile salmonids at Index Site 6 (Table 25). Species and life stages present included trout fry, pre-smolts, overyearlings.

Table 25. Fall juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)			
			25-Sept	28-Sept	7-Nov	Mean
Site 6 Mainstem	Trout	45-60	10.8756	7.8639	2.0636	6.93
		60-80	0.5020	0.5577	0.0000	0.35
		80-100	0.0000	0.7250	1.8405	0.86
		100-150+	0.2231	0.3904	0.4462	0.35
Grand Total			**11.6**	**9.5**	**4.4**	**8.50**

2008 Summary

Overall, Index Site 2 had the greatest relative occurrence of juvenile salmonids during the spring and summer sampling period followed by Index Sites 1, 5, 3, 4, 6 in decreasing order (Figure 9; Table 26). The summer sampling period had greater total mean relative abundance than the spring sample period (219.0 vs. 162.1). Surveys in 2008 indicate a greater number of young of the year coho than in 2007. In July and September in particular, all three side channels had relatively high mean abundances of coho. Mainstem Sites 1, 2 and 5 also had high mean coho abundance in July in comparison to 2007. Another noticeable difference from 2007 was the addition of a few pink and chum fry in the lower three sites.

Table 26. Mean summer and fall juvenile salmonid indices at Index Sites established in the Sultan River, Snohomish County, Washington.

River Mile	Segment	Habitat	Relative Occurrence (No 100m^{-2} wetted area)			
			Spring 08	Summer 08	Summer 07	Fall 07
RM 1.5	Index Site 1	Mainstem	6.5	4.3	0.84	0.81
		Side Channel	29.4	44.6	20.47	3.49
RM 1.6	Index Site 2	Mainstem	6.2	4.6	0.98	0.96
		Side Channel	50.0	110.9	14.48	19.89
RM 1.8	Index Site 3	Mainstem	3.5	3.3	0.72	1.09
		Side Channel	19.5	21.4	2.38	3.13
RM 4.6	Index Site 4	Mainstem	5.6	3.0	3.79	6.62
RM 5.2	Index Site 5	Mainstem	38.5	23.6	4.42	3.17
RM 9.0	Index Site 6	Mainstem	2.9	3.3	2.53	8.50

2007 Summary

Overall, Index Site 2 displayed the greatest relative occurrence of juvenile salmonids during the summer/fall sampling period followed by Index Sites 1, 6, 4, 5, and 3 in decreasing order (Figure 9). The fall sampling period generally (the exception being Index Sites1 and 5) had greater juvenile salmonid indices than during summer periods (Table 26; Figure 10). Finally, juvenile salmonid indices were greater in side channel habitats when compared to mainstem habitat types (Table 26; Figure 10).

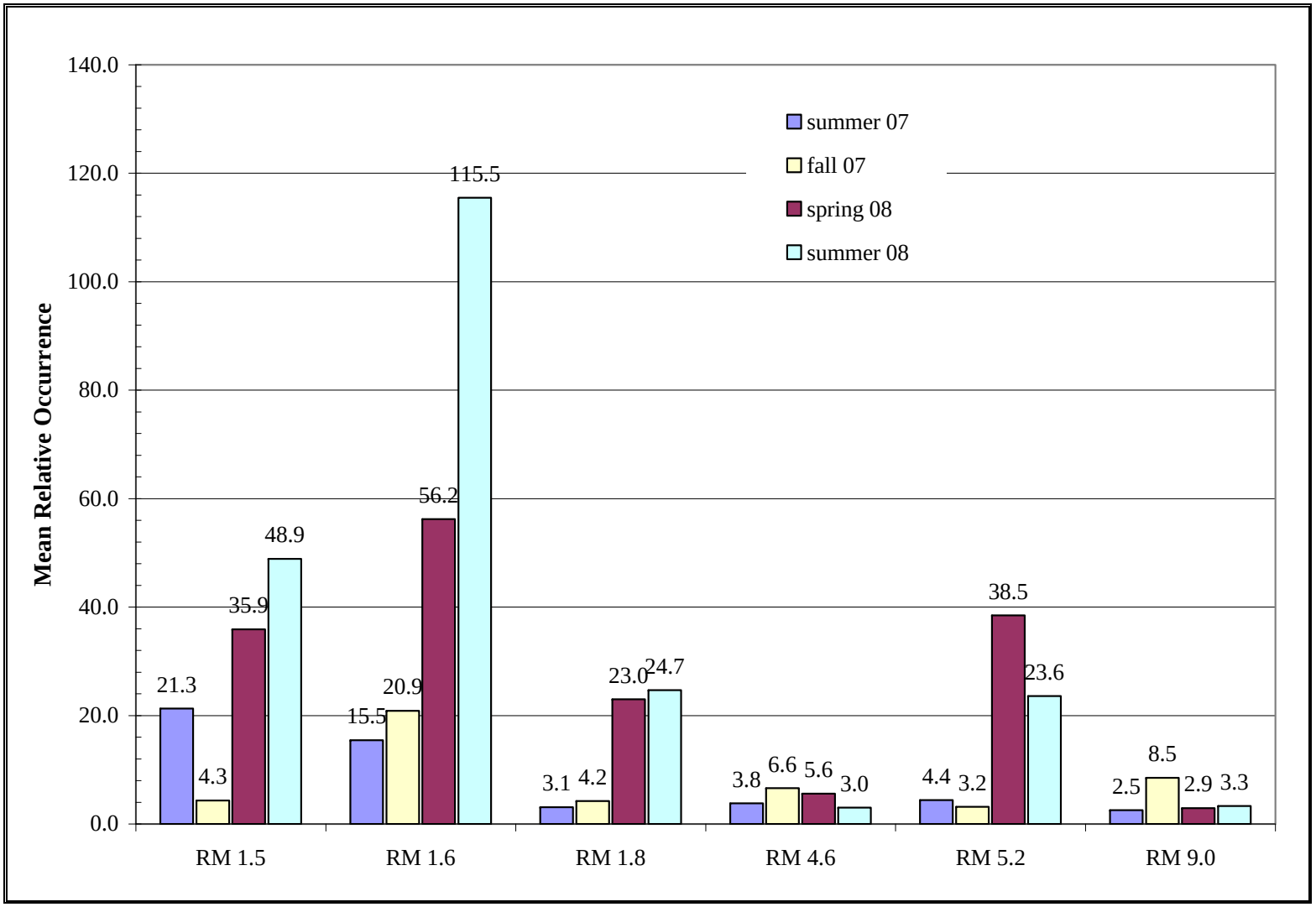

Figure 9. Mean juvenile salmonid indices at six locations, 2008, Sultan River, Snohomish County, Washington.

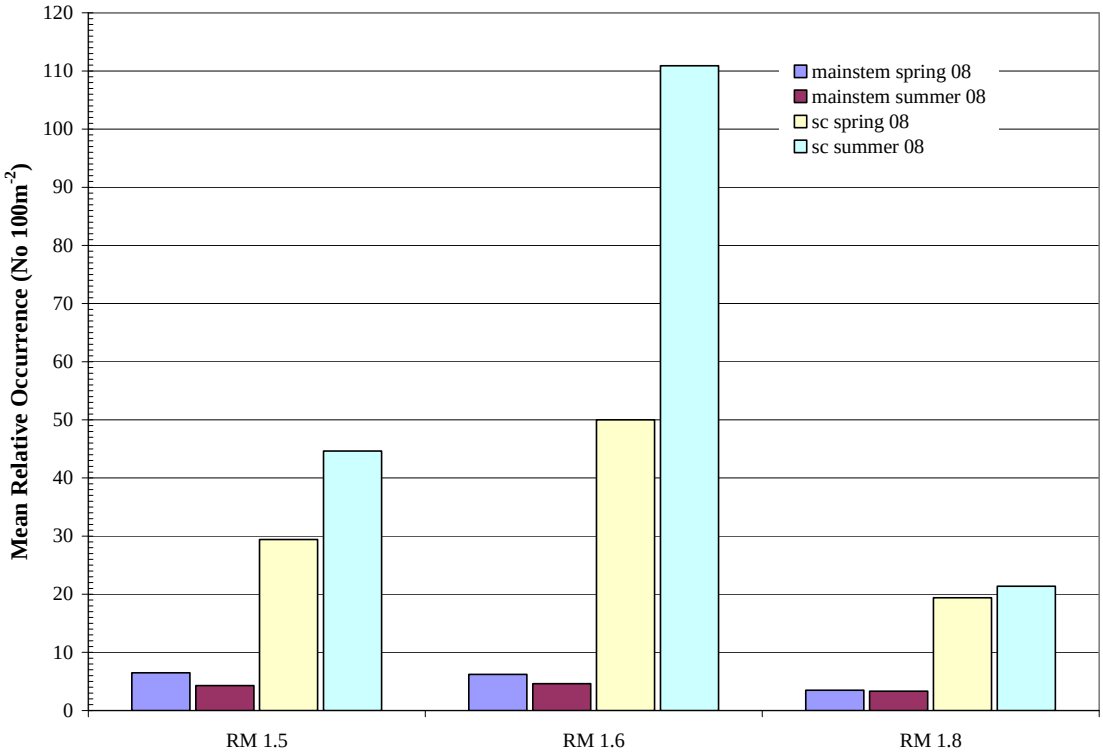

Figure 10. Mean juvenile salmonid indices at mainstem and off channel habitats, 2008, Sultan River, Snohomish County, Washington.

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APPENDIX C

RSP 5 Progress Report Dated November 2008 (late Summer and Fall 2008 data)

DRAFT

HENRY M. JACKSON HYDROELECTRIC PROJECT

FERC No. 2157

Study Plan 5

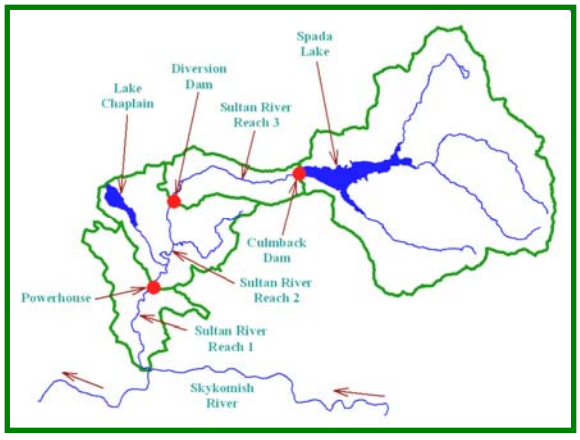
Juvenile Fish Abundance, Life History and Distribution
Progress Report
2008 Summer and Fall Data

Prepared for:

Public Utility District No. 1
of Snohomish County
City of Everett

Prepared by:

R2 Resource Consultants, Inc.



November 2008

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1.0 STUDY OBJECTIVES AND DESCRIPTION

Population dynamics of aquatic species are often driven by the success of early life history cohorts (Quinn 2005). Understanding the respective life history characteristics of juvenile salmonids will ultimately play an invaluable role to assist water managers in developing strategies that minimize the effects of flow changes on multiple species and life stages on the Sultan River. Water management strategies such as planned short-term, high flow releases (i.e., freshets) may facilitate downstream migration for one species, but displace newly emerged fry from another species to less favorable habitats, exposing them to increased predation. As with other fish species, the success of early life history is strongly size dependent; small differences in growth and mortality often drive adult recruitment (Quinn and Peterson 1996; Schindler 1999). Therefore, studies that identify specific habitat and behavioral characteristics used by juvenile salmonids will be integral to developing water management strategies that address anthropocentric needs of the Puget Sound, while protecting and enhancing salmonid populations inhabiting the Sultan River.

As part of relicensing activities for the Henry M. Jackson Hydroelectric Project (Project) FERC No. 2157, the Tulalip Tribes requested a study to determine the "rearing locations and densities of steelhead (*Oncorhynchus mykiss*), coho (*O. kisutch*) and Chinook (*O. tshawytscha*) in the lower river (below the Diversion Dam) throughout the year." The information collected from this study will supplement life history information on these species in the Sultan River and will be useful for evaluating relationships between habitats used by these species and stream flows in the Sultan River. The information will also be useful for identifying and evaluating potential protection, mitigation and enhancement measures focused on juvenile salmonid habitats. The Tulalip study request entailed two components; a year-round study of juvenile occurrence, and a study to quantify smolt abundance and migration characteristics.

In response to the study request, the Snohomish County Public Utility District No. 1 (District) and the City of Everett (City), as Co-Licensees of the Project, proposed to conduct a study to determine the relative occurrence of juvenile salmonids during the spring and fall as well as a similar study to be conducted in off-channel habitats during the winter residency period. The overall objective of the Juvenile Fish Occurrence, Life History and Distribution Study is to determine the relative distributions of juvenile salmonids in the Sultan River by life history stages, stream location, and habitat type. Specifically, the life history strategies of juvenile Chinook salmon (i.e., residency period) are of particular importance to the Tulalip Tribe because of the uncertainty about dominant (ocean-type) and sub-dominant (stream-type) rearing strategies of naturally-produced populations in the Snohomish River Basin. The specific information collected from this study, when combined with other study elements (e.g., instream flow [Revised Study Plan (RSP) 3]), habitat composition (RSP18), and geomorphic processes (RSP22) will provide a solid foundation of information that can be used to make informed decisions regarding the protection and enhancement of fish populations in the Sultan River.

2.0 BACKGROUND INFORMATION

The Co-licenses filed a joint application with the Federal Power Commission (now Federal Energy Regulatory Commission [FERC]) in 1960 to develop what was then known as the Sultan River Project (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From the beginning, the Project was envisioned to serve two purposes; generating power for the District from the waters of the Sultan River and increasing the City's water supply system to meet growing demands. A license authorizing construction of the Project in two phases was issued on 6 June 1961.

The Stage I development was completed in 1965 and involved the construction of Culmback Dam and the creation of Spada Lake, which greatly increased the City's water supply available from the Sultan River Basin (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Originally, Stage II, the addition of the hydropower generation facilities, was to commence in 1967. Economic studies undertaken at that time indicated the cost of power from the Bonneville Power Administration (BPA) was still low enough to call into question the financial feasibility of moving ahead with Stage II. FERC granted a series of time extensions so the District and the City could investigate alternative plans.

In 1976, BPA, the source of almost all of the District's power at that time, announced it would not be able to meet the District's power needs after mid-1983. BPA offered to purchase the early years of power from new non-thermal resources, which motivated the District to develop the generating potential of the Sultan River (Public Utility District No. 1 of Snohomish County and City of Everett 2005).

On 6 July 1979, the District and the City filed an application with FERC to amend the original license with a revised hydroelectric scenario better suited to the regional economic and load demand projections, and to reduce the environmental impacts of the original design (Public Utility District No. 1 of Snohomish County and City of Everett 2005). FERC granted this amendment on 16 October 1981, and construction of generating facilities and raising of Culmback Dam commenced in 1982. One of the earliest Settlement Agreements with several state and federal agencies and the Tulalip Tribes (the Joint Agencies) was filed with the FERC and accepted in 1982. The Project was renamed after the late Senator Henry M. Jackson in 1984 when operation began. The current operating license for the Project will expire on 31 May 2011.

2.1 Sultan River Basin Description

The Project is located on the Sultan River, approximately 24 miles east of Everett, Washington, in south central Snohomish County (Public Utility District No. 1 of Snohomish County and City of Everett 2005). From its headwaters near Vesper Peak on the western slope of the Cascade Mountains, the Sultan River flows west for approximately 19 miles, then south-southwest for 11 miles to its confluence with the Skykomish River at the City of Sultan (river mile [RM] 34.4). The Skykomish River

drains the northern 835 square miles of the Snohomish River Basin, the second largest river basin draining into Puget Sound (Haring 2002).

The Sultan River has a watershed area of approximately 105 square miles (Figure 1). The Sultan River watershed can be divided into four sub-basins: upstream from Culmback Dam (68.2 square miles): between Culmback Dam and the Diversion Dam (8.9 square miles); between the Diversion Dam and the Powerhouse (17.1 square miles); and between the Powerhouse and the confluence with the Skykomish River (10.7 square miles).

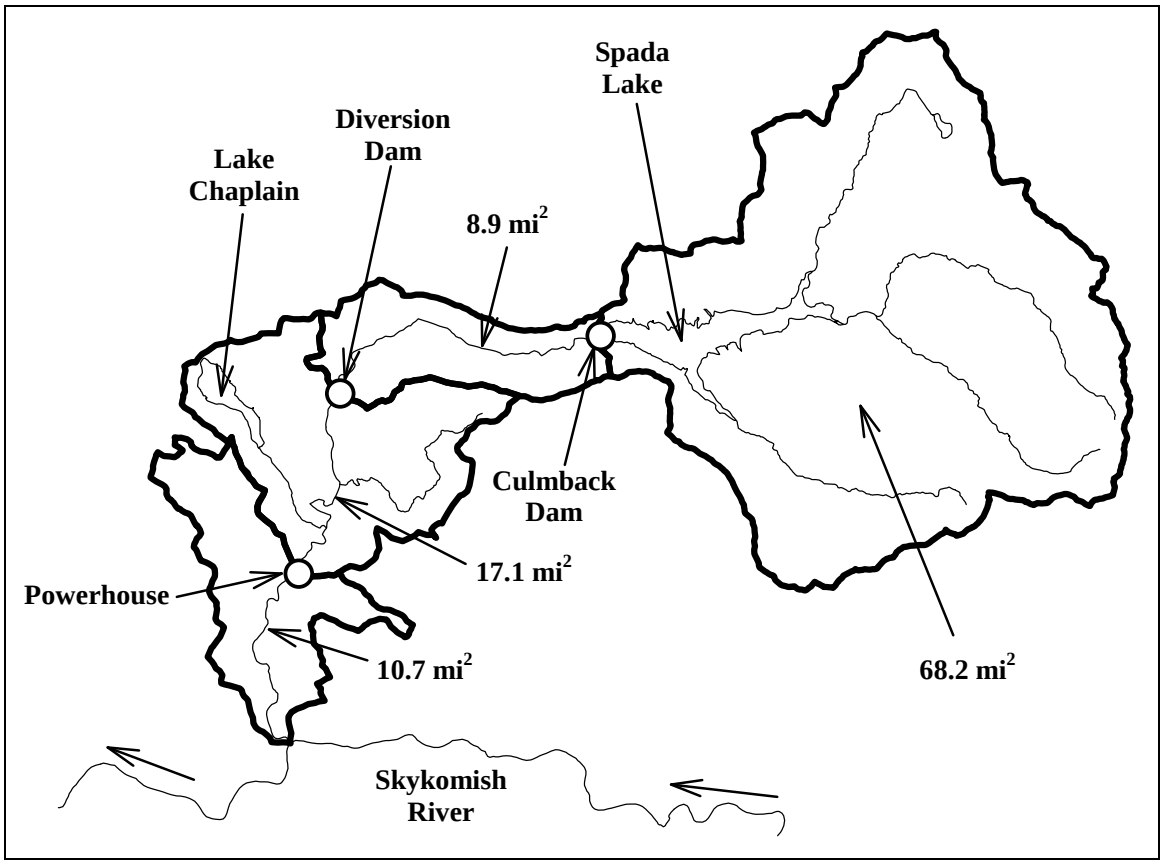

Figure 1. Four sub-basins of the Sultan River watershed, Snohomish County, Washington.

The basin is bounded on the east by the Cascade Mountains, on the north and south by lateral ridges extending westward from the Cascade crest, and on the west by the Puget Sound lowlands (Public Utility District No. 1 of Snohomish County and City of Everett 2005). Elevations in the basin range from the 6,617-foot summit of Del Campo Peak to 130 feet at the confluence of the Sultan and Skykomish rivers. Major tributaries to the Sultan River above Culmback Dam include the South Fork Sultan River, North Fork Sultan River, Elk Creek, and Williamson Creek. Downstream of Culmback Dam, major

tributaries include Marsh Creek, Chaplain Creek, Woods Creek (drains Woods Lake), Ames Creek, and Winters Creek.

Downstream of Culmback Dam (RM 16.5), the Sultan River flows through a deep gorge for nearly 14 miles (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The steep side slopes above the channel are densely forested with conifer and mixed deciduous growth. The river channel in this reach is relatively high gradient and confined, containing numerous cascades and rapids separated by short pool-riffle, stretches. Much of the streambank is sheer rock face or large rock cuts (Williams et al. 1975). The City's Diversion Dam at RM 9.7 historically directed a portion of the river's flow to its water supply reservoir, Lake Chaplain. While that method of diversion remains in place and is used when Project maintenance or other reasons require, water now is normally supplied to Lake Chaplain through the Lake Chaplain pipeline after passing through the Project powerhouse. The Sultan River emerges from the canyon reach onto a broad, relatively flat valley floor containing intermittent stands or strips of deciduous trees, underbrush, and some mixed conifers near RM 3. The river channel in this reach has a moderate gradient with several split channel sections.

The Sultan watershed supports a wide array of salmonid species, each with slightly different life history strategies. Reproducing populations of Chinook, coho, pink (*O. gorbuscha*), and chum (*O. keta*) salmon; steelhead and coastal cutthroat trout (*O. clarki*) are present downstream from the Diversion Dam in varying numbers. Transitory bull trout (*Salvelinus confluentus*) have also been observed downstream from the Diversion Dam, but are not thought to spawn in the Sultan River. While occurring upstream to the Diversion Dam, anadromous salmonid spawning habitat is primarily located in the lower reaches of the Sultan River (Haring 2002). Access upstream from RM 9.7 is prevented by the Diversion Dam. Resident rainbow, cutthroat, and rainbow/cutthroat hybrids reside in Spada Lake, upstream from Culmback Dam which is located at RM 16.5.

2.2 Project Operations

In 1930, the City of Everett constructed the Diversion Dam at RM 9.7 (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This dam was used to divert water from the Sultan River through a pipeline and tunnel, west to Lake Chaplain for municipal water supply storage. In 1965, Stage I of Culmback Dam was built at RM 16.5 for additional storage of municipal water supply, but the traditional operation of the Diversion Dam and tunnel to Lake Chaplain remained essentially unchanged. With completion of the Stage II hydroelectric project facilities in 1984 (which included a raised Culmback Dam, a power tunnel and pipeline, a powerhouse, and a Lake Chaplain pipeline from the powerhouse to Lake Chaplain), the function of the Diversion Dam changed considerably. Prior to the completion of Stage II, water flowed west from the Diversion Dam through the tunnel to Lake Chaplain. Currently, water flows east through the tunnel between Lake Chaplain and the Diversion Dam. Some of the water diverted from Spada Lake at Culmback Dam is now returned to the Sultan River at the Diversion Dam to provide minimum instream flows below that point for fishery protection and enhancement.

Under current operations, 20 cfs of water is released from Culmback Dam into the river reach between Culmback Dam and the City's Diversion Dam at all times (Public Utility District No. 1 of Snohomish County and City of Everett 2005). This 20 cfs, plus natural inflow from streams above the Diversion Dam, provides a constant flow for the fisheries in this reach. The rest of the water diverted from Spada Lake travels through the power tunnel and power pipeline to the Powerhouse. Most of the water delivered to the powerhouse in this manner passes through the Pelton turbines for electrical generation and is returned to the river at the powerhouse. However, an amount of water necessary for municipal supply and maintenance of minimum instream flows in the reach below the Diversion Dam is routed through two Francis turbines in the powerhouse, and then through the Lake Chaplain pipeline to the "Portal 2" facilities on the shores of Lake Chaplain.

At Lake Chaplain, a portion of the water in the Lake Chaplain pipeline is diverted by means of the "Portal 2" facilities to the lake for municipal water supply (Public Utility District No. 1 of Snohomish County and City of Everett 2005). The remainder is transported east via the original water diversion tunnel back to the Sultan River at the Diversion Dam to provide minimum instream flows in the reach between the Diversion Dam and the powerhouse. In this manner, regulated fish flows are maintained for the full length of the Sultan River below Culmback Dam, with larger flows provided below the Diversion Dam and powerhouse where river conditions offer more suitable fish habitat than exists in the reach above the Diversion Dam. Occasionally, when storm events cause natural inflows within the reach between Culmback Dam and the City's Diversion Dam to exceed the combined total flows needed to meet both the City's water supply requirements and established minimum instream flows below the Diversion Dam, the Diversion Dam will be made to operate in its original manner (Public Utility District No. 1 of Snohomish County and City of Everett 2005). At these times, water for municipal supply is diverted from the Sultan River by the Diversion Dam and routed westerly through the tunnel to Lake Chaplain. Remaining flows in the river are allowed to pass over the Diversion Dam to provide required instream flows. The Powerhouse then routes water diverted from Spada Lake through only the larger Pelton units for more efficient power generation, and then immediately returns the water to the river.

3.0 METHODS

Seasonal snorkel observations were selected as the primary survey technique to determine the relative occurrence, life history, and distribution of juvenile salmonids in the lower Sultan River. Snorkel observations were selected, in part, based on their repeatability over different seasons, habitat strata, and reaches of the river. Backpack electrofishing will also be used in concert with snorkel observations during winter periods when juvenile salmonids typically exhibit daytime concealment behavior (Roni and Fayram 2000) and periods when the Sultan River exhibits elevated turbidity levels, precluding accurate snorkel observations (Thurow 1994).

Underwater observation has been long established as a valuable tool for study of fish behavior and habitat use particularly in regard to riverine juvenile salmonid species (O'Neal 2007). Snorkel observations are a quick, inexpensive, and non-invasive technique, that when properly structured, can provide accurate quantitative information concerning the abundance, size structure, distribution and habitat use of salmonids (Schill and Griffith 1984, Thurow 1994; O'Neal 2007).

Salmonids exhibit territorial behavior and inhabit areas with high water clarity making snorkel surveys particularly effective in determining presence/absence of salmonid species (Slaney and Martin 1987; Zubik and Fraley 1988; Hillman et al. 1992; Rodgers et al. 1992). Snorkel surveys have been proven to provide reliable and accurate survey information. Specifically, Schill and Griffith (1984) utilized snorkel observations to create population estimates for cutthroat trout in the Yellowstone River. Zubik and Fraley (1988) determined that in large clear streams, snorkel counts that were multiplied by a determined expansion factor provided a reliable density estimate in comparison to other survey methods. Slaney and Martin (1987) found similar results in a large stream in British Columbia, as did Mullner et al. (1998) in streams in Wyoming. Rodger et al. (1992) concluded that snorkeling was an appropriate method for sampling the population size of juvenile coho over large sections of stream in coastal Oregon. Roni and Fayram (2000) reported that night snorkeling allowed for quick and relatively reliable enumeration of juvenile salmonids during the winter in Pacific Northwest streams.

Snorkel surveys also provide for direct observation of fish habitat utilization (Thurow 1994; O'Neal 2007). Fish observations specific to the habitat being utilized provide information for management decisions affecting those specific habitats (Northcote and Wilkie 1963). For example, differences in utilization of mainstem and off-channel habitats can be determined by observation of these habitats at different times of the year (Bustard and Narver 1975). Furthermore, by comparing areas of observed fish use with areas of similar habitat enables the development of estimates of fish use.

The timing and the specific methodology employed in snorkel surveys are important determinants in the overall success of the snorkel surveys. The methodology of the surveys should reflect the objectives of the study at hand. For example, the use of night surveys during colder winter conditions are generally considered to have greater effectiveness than day surveys (Roni and Fayram 2000). Overall, snorkel observations

are a cost-effective technique and can encompass more diverse habitat than other sampling techniques (Dolloff et al. 1996).

3.1 Index Site Selection

Six juvenile salmonid index sites were selected in the Sultan River (Figure 2). Based on the following parameters: distribution of spawning salmonids, distribution of rearing habitats, site accessibility, lineal or reach representation, and overall habitat representation. The majority of index sites (5) were selected within or downstream from where the preponderance of salmonid spawning activity occurs. Three index sites were chosen from within the reach that contains the majority of the off-channel habitat in the Sultan River, while the final index site was chosen to represent an accessible location within the gorge section of Reach 2.

Index Site 1 is located near RM 1.5 in the lower Sultan River. Index Site 1 is the downstream-most index site located on the Sultan River and is comprised of approximately 24,350 m^2 of mainstem and 7,050 m^2 of off-channel wetted area as computed at a discharge of 400 cfs measured at the Powerhouse (Figure 3; Table 1). Index Site 2 is located near RM 1.6 in the lower Sultan River. Index Site 2 is bounded by Index Site 1 on the downstream end and Index Site 3 on the upstream portion. Index Site 2 is comprised of approximately 27,500 m^2 of mainstem and 2,560 m^2 of off-channel wetted area estimated at a discharge of 400 cfs at the Powerhouse (Figure 4; Table 1). Index Site 3 is located near RM 1.8 in the lower Sultan River. Index Site 3 is comprised of approximately 20,730 m^2 of mainstem and 7,480 m^2 of off-channel wetted area at a discharge of 400 cfs at the Powerhouse (Figure 5; Table 1).

Juvenile salmonid Index Site 4 is located near RM 4.6 in the lower Sultan River and is comprised of approximately 6,020 m^2 of mainstem wetted area at a discharge of 400 cfs as measured at the Powerhouse (Figure 6; Table 1). Index Site 5 is located near RM 5.2 in the lower Sultan River. The site, located near the discontinued Sultan River downstream of Chaplain Creek gage, is comprised of approximately 7,380 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 7; Table 1). Index Site 6 is located near RM 9.0 in the lower Sultan River and is comprised of approximately 1,790 m^2 of mainstem wetted area at a discharge of 100 cfs as measured at the Diversion Dam (Figure 8; Table 1).

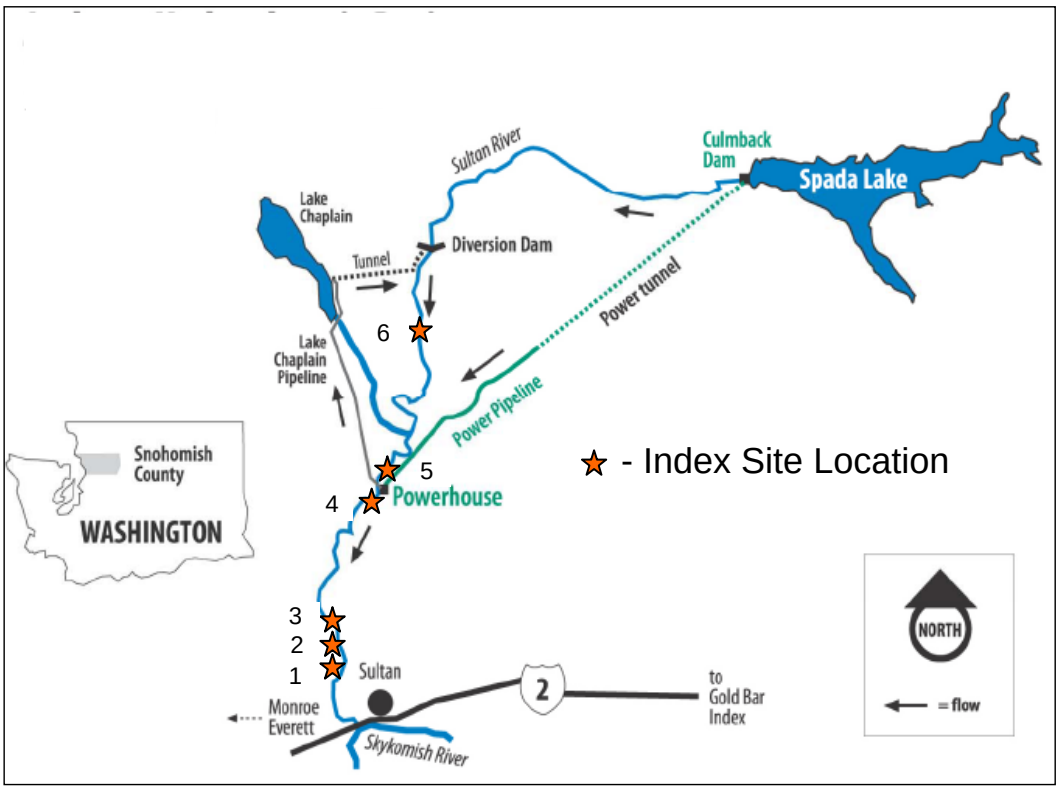

Figure 2. Juvenile salmonid index sites, Sultan River, Snohomish County, Washington.

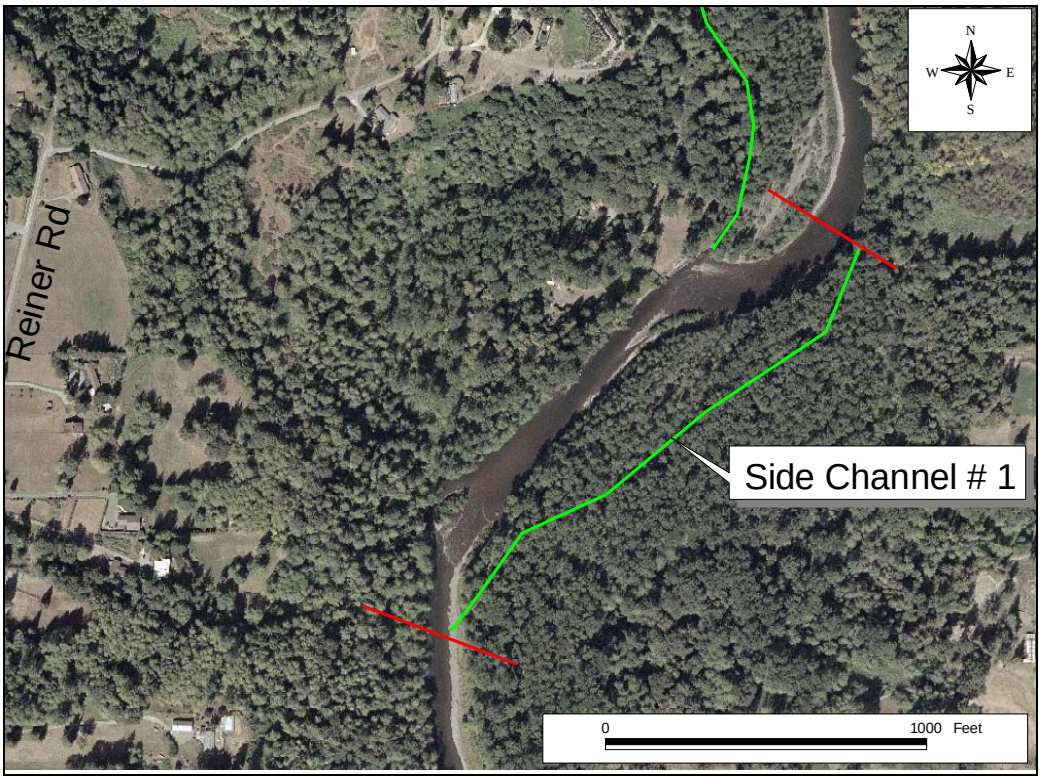

Figure 3. Juvenile salmonid Index Site 1 (Side Channel 1), Sultan River, Snohomish County, Washington.

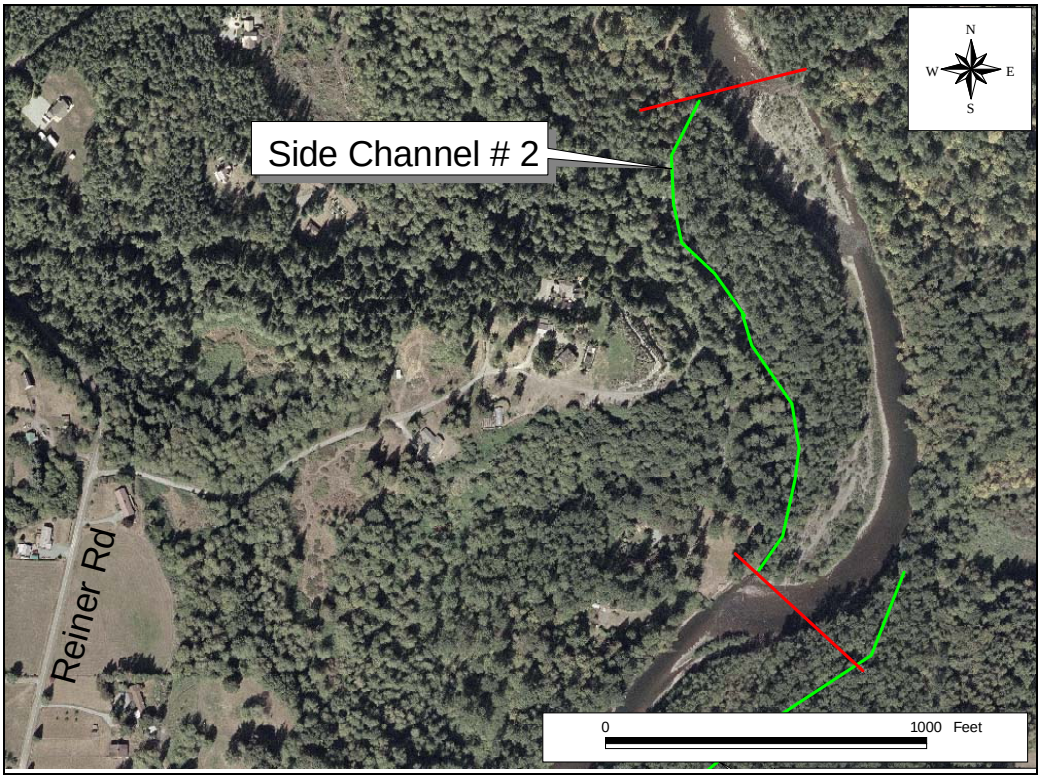

Figure 4. Juvenile salmonid Index Site 2, Sultan River, Snohomish County, Washington.

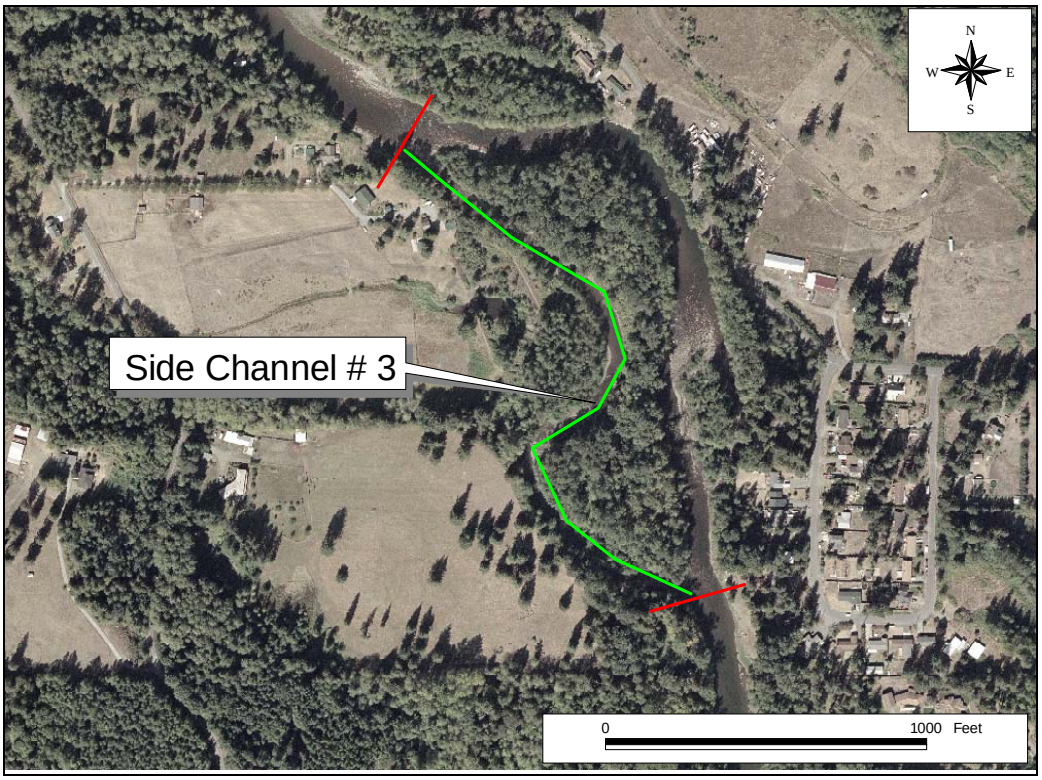

Figure 5. **Juvenile salmonid Index Site 3, Sultan River, Snohomish County, Washington.**

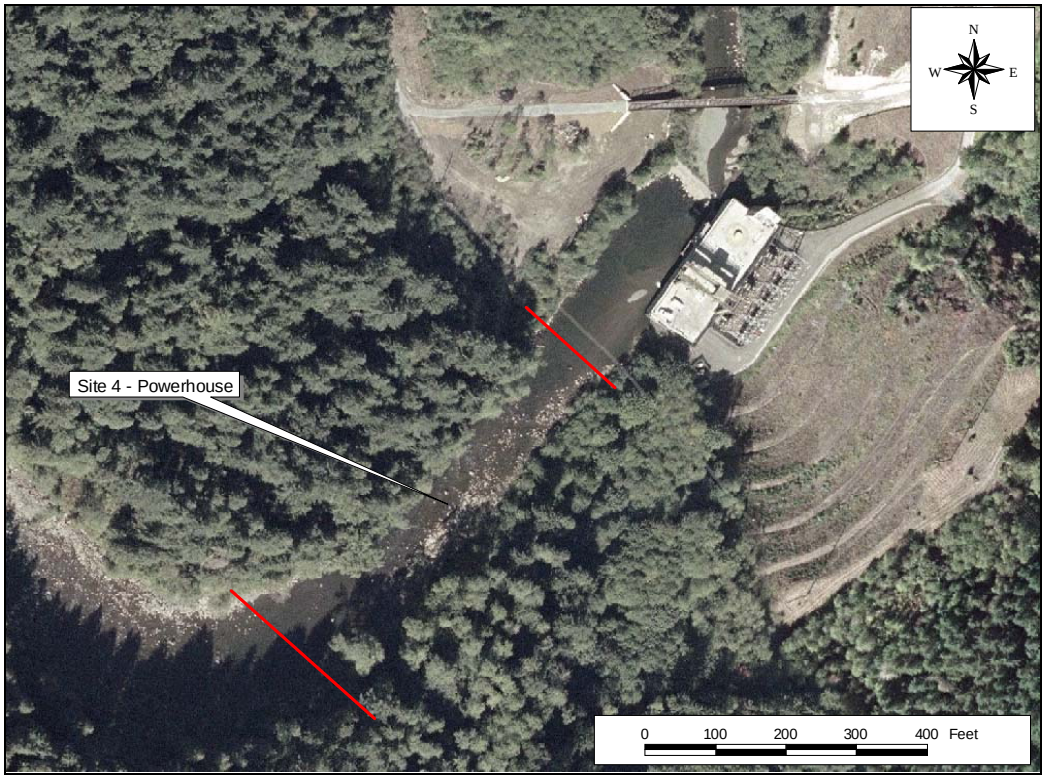

Figure 6. **Juvenile salmonid Index Site 4, Sultan River, Snohomish County, Washington.**

Figure 7. Juvenile salmonid Index Site 5, Sultan River, Snohomish County, Washington.

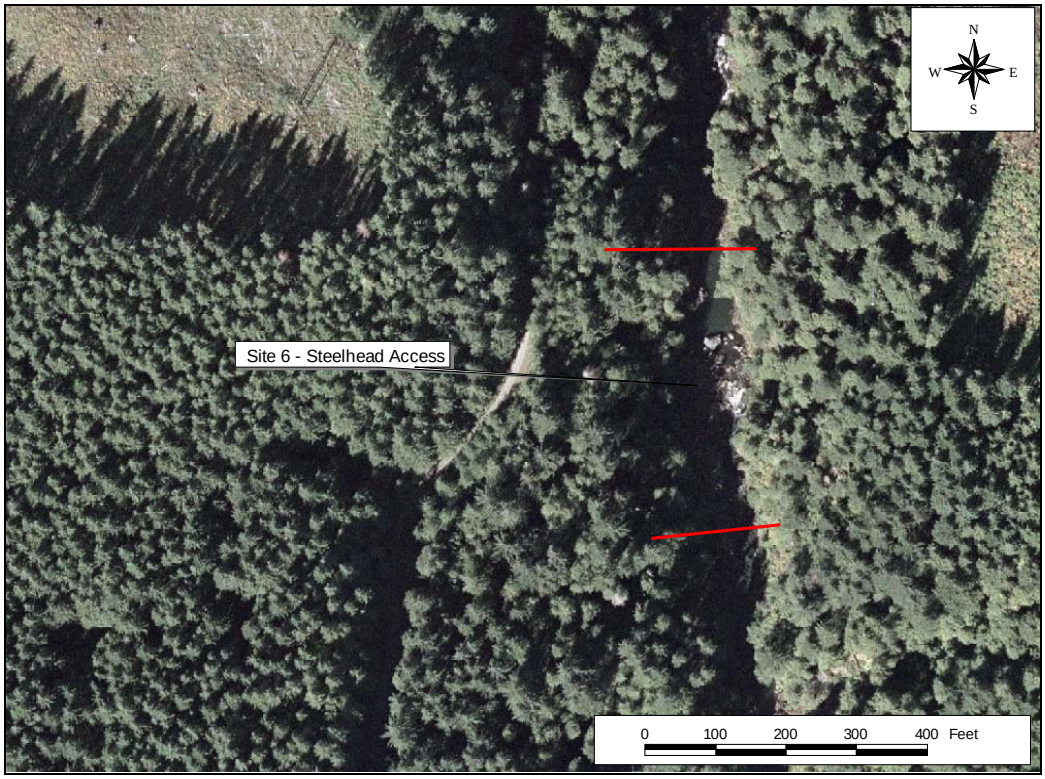

Figure 8. Juvenile salmonid Index Site 6, Sultan River, Snohomish County, Washington.

Table 1. Wetted area (m^2) of juvenile salmonid index sites, Sultan River, Snohomish County, Washington.

Index Site	Wetted Area (m^2)	
	Mainstem	Off-Channel
Site 1	24,360	7,050
Site 2	27,510	2,560
Site 3	20,730	7,480
Site 4	6,020	-
Site 5	7,380	-
Site 6	1,790	-

3.2 Snorkel Surveys

This memo is the third in the series of progress reports, providing the snorkel survey results for the summer (September) quarter and fall (October) quarter of the 2008 surveys. Each of the six Index Sites were surveyed four times during each quarter.

The snorkel surveys were completed by a team of five surveyors (4 divers, 1 observer); surveys began at the downstream boundary of the index site and proceeded upstream along each margin of the index site. Upon completion of the margins, the divers entered the upstream boundary of the index site and completed the center portion of the index site in a downstream direction. The observer served as a recorder and as a safety measure in case one of the snorkelers encountered any problems.

Divers were positioned so that all of the wetted area was surveyed, but observations did not overlap. Fish were enumerated by species and size class (mm FL) as the snorkeler passed them, so duplicate counts were avoided. The distance between the divers was less than the maximum distance the divers could identify fish to species and size class. This distance was determined before the snorkel observations began by underwater observations downstream from the index site boundary. Underwater observations were recorded individually by each observer on DuraRite® notebooks carried on the person in a small pack attached to the waist.

Relative occurrence indices were calculated by dividing snorkel observations per wetted unit area and multiplying by 100 (no $100m^{-2}$) for each species (coho and Chinook salmon, and rainbow and cutthroat trout). Intra-site data comparisons were conducted to determine relative occurrence over the study periods and channel type (i.e., mainstem and off-channel), while inter-site relative occurrence data were used to determine relative utilization between index sites throughout the length of the study area. All data were entered electronically using MS Excel and cross-referenced with original field data forms for QA/QC purposes.

4.0 RESULTS

4.1 Index Site 1 – Side Channel 1 and Adjacent Mainstem

A total of 3,513 juvenile salmonids were observed in the mainstem area of Site 1 during the summer snorkel period. A total of 11,982 juvenile salmonids were observed in the side channel portion of Site 1. Mean relative abundance was approximately ten times higher in the side channel than the mainstem reach (42.5 versus 3.6; Table 2). Species present at both locations included juvenile Chinook and coho salmon, and trout.

Table 2. Summer juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			8-Sep	16-Sep	18-Sep	29-Sep	Mean
Site 1	Chinook	40-60	0.0000	0.0000	0.0369	0.0000	0.01
Mainstem		60-80	0.0000	0.0287	0.0862	0.0082	0.04
		80-100	0.0041	0.0000	0.0000	0.0041	0.00
	Chinook Total		0.0041	0.0287	0.1232	0.0123	0.04
	Coho	35-45	0.0000	0.0082	0.0616	0.0411	0.02
		45-60	2.5164	2.1100	3.1773	0.9113	2.60
		60-80	0.7800	2.2085	0.5008	0.5090	1.16
		80-100	0.0000	0.0287	0.0493	0.0041	0.03
	Coho Total		3.2964	4.3555	3.7890	1.4655	3.23
	Trout	35-45	0.3161	0.2874	0.1888	0.0164	0.26
		45-60	0.0123	0.0862	0.0411	0.1273	0.05
		60-80	0.0000	0.0000	0.0041	0.1067	0.00
		80-100	0.0000	0.0000	0.0123	0.0000	0.00
		100+	0.0205	0.0575	0.1642	0.0287	0.08
	Trout Total		0.3489	0.4310	0.4105	0.2791	0.37
Sub Total			*3.6*	*4.8*	*4.3*	*1.8*	*3.6*
Site 1	Chinook	80-100	0.0000	0.0284	0.0284	0.0426	0.02
Side-Channel	Coho	35-45	1.1348	14.3972	15.9291	1.4894	8.24
		45-60	48.3688	11.7305	13.6596	8.7376	20.62
		60-80	0.3688	11.8298	13.6596	13.1206	9.74
		80-100	0.0000	0.6667	0.4539	8.3546	2.37
	Coho Total		49.8723	38.6241	43.7021	31.7021	40.98
	Trout	35-45	0.4681	0.8369	0.2553	2.0284	0.90
		45-60	0.0000	0.0000	0.0000	0.8511	0.21
		60-80	0.0000	0.0000	0.0000	1.2624	0.32
		80-100	0.0142	0.0000	0.0000	0.0709	0.02
		100+	0.0000	0.0284	0.0709	0.0709	0.04
	Trout Total		0.4823	0.8652	0.3262	4.2837	1.49
Sub Total			*50.4*	*39.5*	*44.1*	*36.0*	*42.5*
Grand Total			**53.7**	**44.3**	**48.4**	**37.8**	**46.1**

A total of 978 juvenile salmonids were observed in the mainstem portion of Site 1 during the fall surveys, while 8,666 juvenile salmonids were observed in the adjacent side channel. Similar to the summer surveys, mean relative abundance was much higher in the side channel (30.7) than in the mainstem reach (1.0) (Table 3).

Table 3. Fall juvenile salmonid indices at Index Site 1, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			2-Oct	7-Oct	13-Oct	21-Oct	Mean
Site 1	Chinook	45-60	0.0000	0.0000	0.0000	0.0000	0.00
Mainstem	Coho	45-60	0.6486	0.4844	0.3243	0.1437	0.40
		60-80	0.7389	0.5213	0.5172	0.0205	0.45
		80-100	0.0862	0.0369	0.0493	0.0041	0.04
	Coho Total		1.4737	1.0427	0.8908	0.1683	0.89
	Trout	35-45	0.0903	0.0000	0.0000	0.0000	0.02
		45-60	0.1314	0.0205	0.0246	0.0082	0.05
		60-80	0.0205	0.0000	0.0000	0.0164	0.01
		80-100	0.0411	0.0082	0.0000	0.0000	0.01
		100+	0.0328	0.0328	0.0082	0.0041	0.02
	Trout Total		0.3161	0.0616	0.0328	0.0287	0.11
Sub Total			*1.8*	*1.1*	*0.9*	*0.2*	*1.0*
Site 1	Chinook	60-80	0.0284	0.0000	0.0142	0.0000	0.01
Side-Channel		80-100	0.0000	0.0567	0.0284	0.0142	0.02
	Chinook Total		0.0284	0.0567	0.0426	0.0142	0.04
	Coho	35-45	1.0922	2.7660	3.2908	2.6809	2.46
		45-60	17.2340	18.6241	18.1560	14.8511	17.22
		60-80	16.5248	10.1418	7.5603	6.1986	10.11
		80-100	0.5674	0.7943	0.5816	0.0851	0.51
	Coho Total		35.4184	32.3262	29.5887	23.8156	30.29
	Trout	35-45	0.0000	0.3121	0.3121	0.2128	0.21
		45-60	0.2411	0.1844	0.0993	0.0709	0.15
		60-80	0.0000	0.0426	0.0709	0.0000	0.03
		80-100	0.0000	0.0000	0.0567	0.0000	0.01
		100+	0.0000	0.0142	0.0142	0.0000	0.01
	Trout Total		0.2411	0.5532	0.5532	0.2837	0.41
Sub Total			*35.7*	*32.9*	*30.2*	*24.1*	*30.7*
Grand Total			**37.5**	**34.0**	**31.1**	**24.3**	**31.7**

4.2 Index Site 2 – Side Channel 2 and Adjacent Mainstem

A total of 4,150 juvenile salmonid were observed in the mainstem portion of Site 2 during the summer surveys. A total of 11,132 juvenile salmonids were observed in the adjacent Side Channel 2. Mean relative abundance in the mainstem measured 3.8 juvenile salmonids versus 108.7 in the side channel (Table 4).

Table 4. Summer juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			8-Sep	16-Sep	18-Sep	29-Sep	Mean
Site 2	Chinook	40-60	0.0000	0.0000	0.0000	0.0000	0.00
Mainstem		60-80	0.0000	0.0327	0.0800	0.0073	0.04
		80-100	0.0000	0.0000	0.0000	0.0109	0.00
	Chinook Total		0.0000	0.0327	0.0800	0.0182	0.03
	Coho	35-45	0.0364	0.2181	0.1345	0.0364	0.13
		45-60	2.0611	3.0643	3.2134	0.9197	2.78
		60-80	0.8906	1.3740	0.7525	0.1345	1.01
		80-100	0.0000	0.0254	0.0436	0.0036	0.02
	Coho Total		2.9880	4.6819	4.1439	1.0941	3.23
	Trout	35-45	0.5125	0.3344	0.4108	0.0182	0.42
		45-60	0.1018	0.1818	0.1018	0.1236	0.13
		60-80	0.0036	0.0073	0.0036	0.0727	0.00
		80-100	0.0000	0.0000	0.0000	0.0036	0.00
		100+	0.0291	0.0618	0.0981	0.0909	0.06
	Trout Total		0.6470	0.5852	0.6143	0.3090	0.54
Sub Total			*3.6*	*5.3*	*4.8*	*1.4*	*3.80*
Site 2	Chinook	60-80	0.0000	0.1172	0.0000	0.0000	0.04
Side-Channel		80-100	0.1172	0.0000	0.0781	0.0000	0.07
	Chinook Total		0.1172	0.1172	0.0781	0.0000	0.08
	Coho	35-45	1.7578	0.0000	13.9844	0.0000	5.25
		45-60	89.2188	70.5078	41.4453	78.3594	67.06
		60-80	1.7578	54.8828	41.5234	0.0000	32.72
		80-100	0.0000	3.9844	5.3906	19.1406	3.13
	Coho Total		92.7344	129.3750	102.3438	97.5000	105.49
	Trout	35-45	0.3906	0.3906	2.8516	0.0000	1.21
		45-60	0.0000	3.2031	0.0000	2.6172	1.07
		60-80	0.1172	0.0000	0.0391	1.6016	0.05
		80-100	0.4297	0.0000	0.2344	0.3906	0.22
		100+	0.1953	0.0391	0.0781	0.0000	0.10
	Trout Total		1.1328	3.6328	3.2031	4.6094	3.14
Sub Total			*94.0*	*133.1*	*105.6*	*102.1*	*108.71*
Grand Total			**97.6**	**138.4**	**110.4**	**103.5**	**112.5**

A total of 1,004 juvenile salmonids were observed in the mainstem reach of Site 2 during the fall surveys. A total of 8,050 juvenile salmonids were observed in the adjacent side channel. Mean relative abundance was 2.3 juvenile salmonids in the mainstem versus 78.6 in the side channel (Table 5). Chinook and coho salmon and trout were the juvenile salmonid species observed.

Table 5. Fall juvenile salmonid indices at Index Site 2, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			2-Oct	7-Oct	13-Oct	21-Oct	Mean
Site 2	Chinook	60-80	0.0036	0.0000	0.0000	0.0000	0.00
Mainstem	Coho	45-60	1.2214	0.1890	0.2726	0.0000	0.42
		60-80	0.5416	0.2617	0.4253	0.0254	0.31
		80-100	0.1127	0.0327	0.0436	0.0036	0.05
	Coho Total		1.8793	0.4835	0.7415	0.0291	0.78
	Trout	35-45	0.0872	0.0000	0.0109	0.0000	0.02
		45-60	0.2435	0.0218	0.0291	0.0073	0.08
		60-80	0.0073	0.0000	0.0036	0.0145	0.01
		80-100	0.0109	0.0000	0.0000	0.0000	0.00
		100+	0.0473	0.0254	0.0073	0.0000	0.02
	Trout Total		0.3962	0.0473	0.0509	0.0218	0.13
Sub Total			*2.3*	*0.5*	*0.8*	*0.1*	*2.3*
Site 2	Chinook	60-80	0.0781	0.0000	0.0000	0.0000	0.02
Side Channel		80-100	0.1563	0.0000	0.0781	0.0000	0.06
	Chinook Total		0.2344	0.0000	0.0781	0.0000	0.08
	Coho	35-45	1.5625	1.4844	10.7422	3.5547	4.34
		45-60	69.9219	19.1406	52.1484	36.6406	44.46
		60-80	21.8750	35.6250	45.8203	9.5313	28.21
		80-100	0.0781	0.8984	1.4453	0.0000	0.61
	Coho Total		93.4375	57.1484	110.1563	49.7266	77.62
	Trout	35-45	0.3516	0.3516	0.8984	0.0000	0.40
		45-60	0.5859	0.8984	0.1953	0.0000	0.42
		60-80	0.0781	0.0000	0.0000	0.0000	0.02
		80-100	0.0781	0.0000	0.0000	0.0000	0.02
		100+	0.1172	0.0781	0.0391	0.0000	0.06
	Trout Total		1.2109	1.3281	1.1328	0.0000	0.92
Sub Total			*94.9*	*58.5*	*111.4*	*49.7*	*78.6*
Grand Total			**97.2**	**59.0**	**112.2**	**49.8**	**79.5**

4.3 Index Site 3 – Side Channel 3 and Adjacent Mainstem

A total of 2,406 juvenile salmon were observed in the mainstem portion of Site 3 during summer surveys. A total of 5,158 juvenile salmonids were observed in the adjacent side channel area (Table 6). Mean relative abundance measured 2.9 juvenile salmonids in the mainstem and 17.2 in the side channel.

Table 6. Summer juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			8-Sep	16-Sep	18-Sep	29-Sep	Mean
Site 3	Chinook	60-80	0.0000	0.0000	0.0579	0.0000	0.01
Mainstem	Coho	45-60	2.0502	1.8862	2.6146	0.5837	1.78
		60-80	0.1833	1.0323	0.4534	0.7429	0.60
		80-100	0.0000	0.0000	0.0000	0.0193	0.00
	Coho Total		2.2335	2.9185	3.0680	1.3266	2.39
	Trout	35-45	0.4679	0.2171	0.1158	0.0000	0.20
		45-60	0.0868	0.1302	0.0820	0.1061	0.10
		60-80	0.0000	0.0000	0.0000	0.0241	0.01
		80-100	0.0000	0.0000	0.0000	0.0145	0.00
		100+	0.2074	0.1833	0.2508	0.0868	0.18
	Trout Total		0.7622	0.5306	0.4486	0.2315	0.49
Sub Total			*3.0*	*3.4*	*3.6*	*1.6*	*2.9*
Site 3	Chinook	60-80	0.0401	0.0134	0.0000	0.0000	0.01
Side Channel		80-100	0.0802	0.0000	0.0535	0.0000	0.03
	Chinook Total		0.1203	0.0134	0.0535	0.0000	0.05
	Coho	35-45	0.4813	0.0000	0.0000	0.0000	0.12
		45-60	15.7353	6.5508	2.8877	0.2005	6.34
		60-80	1.0027	15.5080	14.9198	2.7406	8.54
		80-100	0.0000	0.5749	3.2219	1.3636	1.29
	Coho Total		17.2193	22.6337	21.0294	4.3048	16.30
	Trout	35-45	0.1872	0.3877	0.6417	0.0000	0.30
		45-60	0.0267	0.0000	0.1337	0.1203	0.07
		60-80	0.4947	0.0000	0.1203	0.1872	0.20
		80-100	0.2674	0.0000	0.2540	0.0000	0.13
		100+	0.2005	0.4011	0.1604	0.0000	0.19
	Trout Total		1.1765	0.7888	1.3102	0.3075	0.90
Sub Total			*18.5*	*23.4*	*22.4*	*4.6*	*17.2*
Grand Total			**21.5**	**27.8**	**26.0**	**6.2**	**20.1**

A total 465 juvenile salmonids were observed in the mainstem portion of Site 3 during fall surveys. A total of 1,305 fish were observed in side channel (Table 7). Mean relative abundance was 0.6 juvenile salmonids in the mainstem and 4.4 in the side channel habitat.

Table 7. Fall juvenile salmonid indices at Index Site 3, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			2-Oct	7-Oct	13-Oct	21-Oct	Mean
Site 3	Chinook	60-80	0.0048	0.0000	0.0000	0.0000	0.00
Mainstem	Coho	45-60	0.4197	0.0000	0.0579	0.0048	0.12
		60-80	0.6850	0.0772	0.3280	0.0000	0.27
		80-100	0.0386	0.0000	0.0289	0.0000	0.02
	Coho Total		1.1481	0.0772	0.4149	0.0048	0.41
	Trout	35-45	0.1206	0.0000	0.0000	0.0000	0.03
		45-60	0.1833	0.0338	0.0096	0.0000	0.06
		60-80	0.0048	0.0048	0.0000	0.0000	0.00
		80-100	0.0434	0.0096	0.0000	0.0000	0.01
		100+	0.1399	0.0386	0.0096	0.0000	0.05
	Trout total		0.4920	0.0868	0.0193	0.0000	0.15
Sub Total			*1.6*	*0.2*	*0.4*	*0.0*	*0.6*
Site 3	Coho	35-45	0.1604	0.2139	0.0000	0.1337	0.13
Side-Channel		45-60	3.2219	2.2861	1.3369	0.1471	1.75
		60-80	3.7701	2.7139	2.1390	0.0936	2.18
		80-100	0.3209	0.0535	0.0000	0.0134	0.10
	Coho Total		7.4733	5.2674	3.4759	0.3877	4.15
	Trout	35-45	0.0668	0.0668	0.0267	0.0000	0.04
		45-60	0.1203	0.0802	0.1337	0.0000	0.08
		60-80	0.0000	0.0134	0.0267	0.0000	0.01
		80-100	0.0401	0.0134	0.0134	0.0134	0.02
		100+	0.1471	0.0535	0.0267	0.0000	0.06
	Trout total		0.3743	0.2273	0.2273	0.0134	0.21
Sub Total			*7.8*	*5.5*	*3.7*	*0.4*	*4.4*
Grand Total			**9.4**	**5.7**	**4.1**	**0.4**	**5.0**

4.4 Index Site 4 – Powerhouse

A total of 909 juvenile salmonids were observed in Site 4 during the summer surveys. This was a mean relative abundance of 3.8 juvenile salmonids (Table 8). Juvenile salmonids observed include Chinook and coho salmon and trout.

Table 8. Summer juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			15-Sep	17-Sep	19-Sep	26-Sep	Mean
Site 4 Mainstem	Chinook	60-80	0.0000	0.0000	0.0000	0.0831	0.02
	Coho	35-45	0.0000	0.3322	0.3156	0.0166	0.17
		45-60	0.2658	0.0831	1.2791	1.4950	0.78
		60-80	0.0997	4.6013	0.0332	4.3023	2.26
		80-100	0.0000	0.6312	0.0000	0.0000	0.16
	Coho Total		0.3654	5.6478	1.6279	5.8140	3.36
	Trout	35-45	0.1163	0.0997	0.1993	0.0166	0.11
		45-60	0.0332	0.5150	0.1495	0.0498	0.19
		60-80	0.0000	0.0332	0.0166	0.0166	0.02
		80-100	0.0166	0.0166	0.0166	0.0000	0.01
		100+	0.0664	0.0664	0.1329	0.0000	0.07
	Trout Total		0.2326	0.7309	0.5150	0.0831	0.39
Grand Total			**0.6**	**6.4**	**2.1**	**6.0**	**3.8**

A total of 1,462 juvenile salmonids were observed in Site 4 during the fall surveys. The mean relative abundance measured 6.1 juvenile salmonids (Table 9).

Table 9. Fall juvenile salmonid indices at Index Site 4, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			1-Oct	6-Oct	14-Oct	20-Oct	Mean
Site 4 Mainstem	Coho	45-60	2.0930	0.4983	0.3322	1.9269	1.21
		60-80	5.7807	3.4385	1.6279	3.6711	3.63
		80-100	1.4120	0.0000	0.0000	1.8605	0.82
	Coho Total		9.2857	3.9369	1.9601	7.4585	5.66
	Trout	35-45	0.0664	0.0000	0.0166	0.0000	0.02
		45-60	0.5316	0.2159	0.0000	0.2492	0.25
		60-80	0.1329	0.0166	0.0166	0.0332	0.05
		80-100	0.0000	0.0166	0.0000	0.0166	0.01
		100+	0.1163	0.0664	0.0332	0.1163	0.08
	Trout Total		0.8472	0.3156	0.0664	0.4153	0.41
Grand Total			**10.1**	**4.3**	**2.0**	**7.9**	**6.1**

4.5 Index Site 5 – Old USGS

A total of 6,829 juvenile salmonids were observed in Site 5 during the summer surveys. Mean relative abundance for this site measured 23.3 juvenile salmonids (Table 10).

Table 10. Summer juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			2-Sep	15-Sep	17-Sep	26-Sep	Mean
Site 5 Mainstem	Chinook	45-60	0.7453	0.0000	0.0000	0.0000	0.19
		60-80	0.9892	0.0542	0.1626	0.1491	0.34
		80-100	0.0000	0.0407	0.0949	0.0813	0.05
	Chinook Total		1.7344	0.0949	0.2575	0.2304	0.58
	Coho	35-45	0.0000	0.4065	3.4959	1.7886	1.42
		45-60	18.8347	13.1436	14.7967	17.8726	16.16
		60-80	0.9350	8.3875	1.2466	2.0732	3.16
		80-100	0.0000	0.2439	0.0000	0.0000	0.06
	Coho Total		19.7696	22.1816	19.5393	21.7344	20.81
	Trout	35-45	0.5014	2.1003	1.2195	0.2168	1.01
		45-60	0.0000	2.0325	0.5149	0.3388	0.72
		60-80	0.0000	0.1355	0.0407	0.0949	0.07
		80-100	0.0000	0.0542	0.1084	0.0000	0.04
		100+	0.0271	0.2168	0.1084	0.1084	0.12
	Trout Total		0.5285	4.5393	1.9919	0.7588	1.95
Grand Total			**22.0**	**26.8**	**21.8**	**22.7**	**23.3**

A total of 4,861 juvenile salmonids were observed at Site 5 in the fall. Mean relative abundance was 16.5 juvenile salmonids (Table 11).

Table 11. Fall juvenile salmonid indices at Index Site 5, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			1-Oct	6-Oct	14-Oct	20-Oct	Mean
Site 5 Mainstem	Chinook	45-60	0.0000	0.0000	0.0000	0.0407	0.04
		60-80	0.0271	0.1626	0.0000	0.0000	0.19
		80-100	0.0271	0.0000	0.0000	0.0000	0.03
	Chinook Total		0.0542	0.1626	0.0000	0.0407	0.06
	Coho	35-45	0.2304	1.9106	1.6531	1.6667	5.46
		45-60	10.9756	9.9051	7.3848	8.8753	37.14
		60-80	7.1274	5.5014	1.5176	2.6287	16.78
		80-100	0.5149	0.0271	0.0136	0.0542	0.61
	Coho Total		18.8482	17.3442	10.5691	13.2249	15.00
	Trout	35-45	0.2168	0.0000	0.1626	0.0271	0.41
		45-60	1.6938	1.0569	0.1491	0.5014	3.40
		60-80	0.4201	0.4336	0.0000	0.2304	1.08
		80-100	0.0000	0.0542	0.0000	0.0271	0.08
		100+	0.2981	0.2846	0.0136	0.0542	0.65
	Trout Total		2.6287	1.8293	0.3252	0.8401	1.41
Grand Total			**21.5**	**19.3**	**10.9**	**14.1**	**16.5**

4.6 Index Site 6 – Steelheader

A total of 295 juvenile salmonids were observed during summer surveys at Site 6. Species observed included juvenile coho and trout. Mean relative abundance measured 3.3 juvenile salmonids (Table 12).

Table 12. Summer juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			2-Sep	15-Sep	17-Sep	26-Sep	Mean
Site 6 Mainstem	Coho	45-60	0.2793	0.2235	0.5587	0.0000	0.27
		60-80	0.0000	0.2235	0.0000	0.0559	0.07
	Coho Total		0.2793	0.4469	0.5587	0.0559	0.34
	Trout	35-45	0.0000	0.3911	0.0000	0.0000	0.10
		45-60	0.2235	1.0615	0.4469	1.4525	0.80
		60-80	0.0000	0.8939	1.5084	0.5028	0.73
		80-100	0.0000	0.0559	0.7263	0.5587	0.34
		100+	0.2793	0.5028	2.6257	1.3408	1.19
	Trout Total		0.5028	2.9050	5.3073	3.8547	2.91
Grand Total			**0.8**	**3.4**	**5.9**	**3.9**	**3.3**

A total of 168 juvenile salmonids (coho and trout) were observed at Site 6 during the fall surveys. Mean relative abundance was 2.3 juvenile salmonids (Table 13). Similar to summer surveys, juvenile coho and trout were the only species observed.

Table 13. Fall juvenile salmonid indices at Index Site 6, Sultan River, Snohomish County, Washington.

Segment	Species	Length (mm FL)	Relative Occurrence (No 100m^{-2} wetted area)				
			1-Oct	6-Oct	14-Oct	20-Oct	Mean
Site 6 Mainstem	Coho	45-60	0.0559	0.0000	0.0000	0.0559	0.03
		60-80	0.1676	0.0000	0.0000	0.0000	0.04
	Coho Total		0.2235	0.0000	0.0000	0.0559	0.07
	Trout	35-45	0.0000	0.0000	0.0559	0.0000	0.01
		45-60	0.5587	0.5028	0.5587	0.3911	0.50
		60-80	1.2849	0.0559	0.0559	0.2793	0.42
		80-100	1.1732	0.0559	0.2235	0.0559	0.38
		100+	1.3408	1.0615	0.6145	0.8380	0.96
	Trout Total		4.3575	1.6760	1.5084	1.5642	2.28
Grand Total			**4.6**	**1.7**	**1.5**	**1.6**	**2.3**

Side Channel 2 has the greatest relative occurrence of juvenile salmonids during both the summer and fall survey periods in 2008 (108.7 and 78.6 respectively) (Table 14). A relatively large number of rearing young of the year coho in Side Channel 2 contributed to this high relative occurrence. All three of the side channels had higher relative juvenile salmonid occurrence than their associated mainstem during all survey periods. Site 5, the old USGS gage site, also had a relatively high number of rearing young of the year coho that contributed to the highest relative juvenile salmonid occurrence for the mainstem sites during both the summer and fall survey periods.

Table 14. Total mean relative occurrence, (No 100m-2 wetted area), of juvenile salmonids in the Sultan River, Snohomish County, Washington.

River Mile	Segment	Habitat	Relative Occurrence (No 100m^{-2} wetted area)	
			Summer	Fall
RM 1.5	Index Site 1	Mainstem	3.6	1.0
		Side Channel	42.5	30.7
RM 1.6	Index Site 2	Mainstem	3.8	2.3
		Side Channel	108.7	78.6
RM 1.8	Index Site 3	Mainstem	2.9	0.6
		Side Channel	17.2	4.4
RM 4.6	Index Site 4	Mainstem	3.8	6.1
RM 5.2	Index Site 5	Mainstem	23.3	16.5
RM 9.0	Index Site 6	Mainstem	3.3	2.3

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APPENDIX D

RSP 5 - Electrofishing and Minnow Trapping Data Summary, March 2008 (Winter 2007-2008 data)

Sultan River Electrofishing and Minnow Trapping Data Summary
Winter 2007-2008

Backpack electrofishing and minnow trapping were performed by R2 Resource Consultants on the Sultan River between 15 November 2007 and 27 February 2008. A total of five sets of electrofishing trips were conducted. Each set consisted of two to three days of electrofishing effort:
Set 1: 15-16 November 2007;
Set 2: 21-23 January 2008;
Set 3: 29-31 January 2008;
Set 4: 4-6 February 2008;
Set 5: 11, 12, 14 February 2008.

Areas that were selected for electrofishing were areas representative of the habitat present in the snorkel survey sites. Site choice was further limited to areas that were shallow enough to provide effective backpack shocking methodology. This included the majority of the habitat in side channels 1 through 3, and much of the mainstem margins of the Sultan River, particularly riffle areas around island complexes. Areas known to contain redds were avoided. Complete results of the electrofishing surveys are provided in the tables at the end of this summary.

Gee type wire minnow traps were installed on 18-19 February in the Sultan River. Minnow trapping sites were also selected within the snorkel survey sites. Trapping sites were areas that provided lower stream velocities and instream cover. A total of 25 traps were installed. Traps were checked twice, once on 21 and again on 27 February, with all traps removed on 27 February. Complete minnow trapping results are provided in the tables at the end of this summary.

Figure 1. Electrofishing on the Sultan River, Washington, 2008.

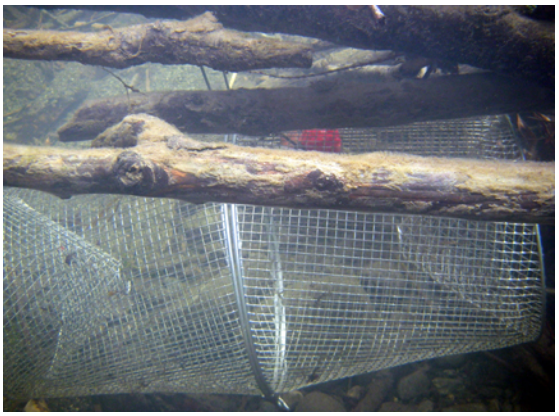

Figure 2. Minnow trap on the Sultan River, Washington, 2008.

TABLES

Table 1. Electrofishing results by site for the Sultan River, Washington, 2007-2008.

		SITE								
		1 ms	**1 sc**	**2 ms**	**2 sc**	**3 ms**	**3 sc**	**4 ms**	**5 ms**	**6 ms**
15 Nov	b. bullhead	1		n/a	n/a		n/a			n/a
	coho	11	257	n/a	n/a	1	n/a	2	24	n/a
	cutthroat		3	n/a	n/a		n/a			n/a
	lamprey spp.	3		n/a	n/a		n/a			n/a
	sculpin spp.	14		n/a	n/a	7	n/a	4	4	n/a
	stickleback		7	n/a	n/a		n/a			n/a
	trout	16	15	n/a	n/a	29	n/a	26	24	n/a
21 Jan	Chinook	1		2		2		1	1	
	coho		15		6	15	2		14	
	cutthroat		1		4					
	lamprey	1							1	
	pink					2	2			
	sculpin spp.	5		4	1	9	5	3	3	1
	trout	5	4	4	26	10	13	18	34	40
29 Jan	Chinook	1				1		1		
	coho	1	66	1	26	19	1	12	9	
	cutthroat					1				
	lamprey spp.	2		1			1	2	3	
	pink	1								
	sculpin spp.	7		9	1	10	7	4	5	
	stickleback		3							
	trout	6	15	9	23	20	17	27	15	20
	sucker spp.		1							
4 Feb	Chinook	1		1		1				
	coho		39		10	3	3		39	
	lamprey spp.		1	1	1					
	pink	2				2	1	2	1	
	sculpin spp.	1	1	17	3	1	10	4	6	
	trout	2	10	8	9	10	29	27	45	20
	threespine		5							
11 Feb	Chinook	1	1	1	2	1	1	1	1	
	coho	21	29		8	7	4	7	3	4
	cutthroat									1
	lamprey spp.			2	1				26	
	pink	1		6	1	4	5		5	
	sculpin spp.		1	3		5	12		9	
	trout	1	9	3	14	6	9	24	44	19
	sucker spp.	1								
	threespine	4	4							
	Total	*110*	*487*	*72*	*136*	*166*	*122*	*165*	*316*	*106*

Note: n/a indicates site wasn't sampled

Table 2. Location of minnow traps in the Sultan River, Washington 2007-2008.

Trap #	Site	Location
1	Side channel 1	just above lowest bridge
2	Side channel 1	just above lowest bridge
3	Side channel 1	just above lowest bridge
4	Mainstem 1	across island from lowest bridge
5	Mainstem 1	below outlet to s. channel 1
6	Mainstem 2	just below outlet to s. channel 2
7	Side channel 2	first jam up from mouth
8	Side channel 2	above road crossing
9	Side channel 2	above road crossing
10	Mainstem 2	just above road crossing
11	Mainstem 3	just above inlet to s. channel 3
12	Mainstem 3	just above inlet to s. channel 3
13	Mainstem 3	just above inlet to s. channel 3
14	Side channel 3	upper end of s. channel
15	Side channel 3	upper end of s. channel
16	Side channel 3	upper end of s. channel
17	Powerhouse	just below powerhouse, left bank
18	Powerhouse	150 yrd. below powerhouse, left bank
19	Powerhouse	left bank in jam at end of snorkel site
20	USGS	left bank, just upstream from trail access
21	USGS	right bank just below trail access
22	USGS	left bank below cascade
23	Steelheader	right bank, 50' downstream trail access
24	Steelheader	right bank 100 yd. above access trail
25	Steelheader	right bank, 60' downstream house rock

Table 3. Summary of minnow trapping results on the mainstem Sultan River, Washington, 2008.

		Mainstem 1		Mainstem 2		Mainstem 3			Powerhouse			USGS			Steelheader		
	Trap	**4**	**5**	**6**	**10**	**11**	**12**	**13**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
21-Feb	Chinook		1					1									
	coho		10			3											
	sculpin spp.					1											
	threespine		4														
	trout			1		2	1		4	1	1				1		
	Total	*0*	*15*	*1*	*0*	*6*	*1*	*1*	*4*	*1*	*1*	*0*	*0*	*0*	*1*	*0*	*0*
27-Feb	coho			1					1								
	sculpin spp.		1	2													
	threespine																
	trout		1	1	1	1			3	3	1					1	
	Total	*0*	*2*	*4*	*1*	*1*	*0*	*0*	*4*	*3*	*1*	*0*	*0*	*0*	*0*	*1*	*0*

Table 4. Summary of minnow trapping results on side channels on the Sultan River, Washington, 2008.

		S. Channel 1			S. Channel 2			S. Channel 3		
	Trap	**1**	**2**	**3**	**7**	**8**	**9**	**14**	**15**	**16**
21-Feb	Chinook									
	coho	8		9			19		2	5
	sculpin spp.									
	threespine			4						
	trout						5	2	3	
	Total	*8*	*0*	*13*	*0*	*0*	*24*	*2*	*5*	*5*
27-Feb	coho	17	5	4			14		1	
	sculpin spp.									1
	threespine	1	2	3						
	trout	2	1				2	2	2	
	Total	*20*	*8*	*7*	*0*	*0*	*16*	*2*	*3*	*1*