SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT NO. 1
Your Northwest renewables utility

May 19, 2015

VIA ELECTRONIC FILING

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Fisheries and Habitat Monitoring Plan – 2014 Annual Report
License Article 410

Dear Secretary Bose:

Enclosed is Public Utility District No. 1 of Snohomish County's Fisheries and Habitat Monitoring Plan Annual Report for 2014 pursuant to License Article 410 for the Jackson Hydroelectric Project. The draft report was provided to the Aquatic Resource Committee for a 30-day review and comment period. Consultation documentation, along with a response to the comment received, is included in the report's appendices.

If you have any questions on the Fisheries and Habitat Monitoring Plan Annual Report for 2014, please contact Keith Binkley, Natural Resources Manager, at (425) 783-1769 or KMBinkley@snopud.com.

Sincerely,

Craig W. Collar, P.E.
Assistant General Manager of Generation
CWCollar@snopud.com
(425) 783-1825

Enclosed: FHMP Annual Report 2014

Henry M. Jackson Hydroelectric Project
(FERC No. 2157)

License Article 410:
Fisheries and Habitat Monitoring Plan – 2014 Annual Report

Snohomish County PUD Public Utility District No. 1

Everett, WA

May 2015

Final – This document has been prepared for the District. It has been peer-reviewed by the District for accuracy and formatting based on information known at the time of its preparation and with that understanding is considered complete by the District. The document may be cited as:

District. 2015. License Article 410: Fisheries and Habitat Monitoring Plan 2014 Annual Report, Henry M. Jackson Hydroelectric Project, FERC No. 2157. May 2015.

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1. INTRODUCTION

Public Utility District No. 1 of Snohomish County (the District) received a license on September 2, 2011 (License) from the Federal Energy Regulatory Commission (FERC) for the Henry M. Jackson Hydroelectric Project (Project) (FERC 2011). License Article 410 approved the Fisheries and Habitat Monitoring Plan (FHM Plan) filed with the FERC on September 2, 2010, with modification. Per Section 4.1 of the FHM Plan, the District is to prepare a report by June 30 of each year detailing the monitoring efforts of the previous calendar year.

This FHM Plan Annual Report covers activities conducted in calendar year 2014. Appendix A contains the Sultan River Riverine Habitat Monitoring Report prepared by Stillwater Sciences. Appendices B, C, and D contain water temperature data. Appendix B contains mean daily temperature in graphical format and Appendix C contains the same data in tabular format. Appendix D contains seven-day average of the daily maximum water temperature (7-DAD Max) in tabular format. Appendix E is the Smolt Screw Trap Report for 2014. Appendix F contains data tables from the 2013 and 2014 supplemental assessments of fish distribution and utilization in the side channels. This Annual Report was provided to the Aquatic Resources Committee (ARC) [consisting of the City of Everett, City of Sultan, Snohomish County, Washington Department of Ecology, Washington Department of Fish and Wildlife (WDFW), Tulalip Tribes, U.S. Forest Service, National Marine Fisheries Service, U.S. Fish and Wildlife Service and American Whitewater] for a 30-day review and comment period. Consultation documentation on the draft report is included in Appendix G, with a response to the one comment received included in Appendix H.

2. MONITORING OF FISH HABITAT IN THE SULTAN RIVER

2.1. Riverine Habitat Monitoring

As articulated in the FHM Plan and as prescribed in the Process Flow Plan, Marsh Creek Slide Modification Plan, Side Channel Enhancement/Large Woody Debris Plan, and the Side Channel Ramping Rate Evaluation Report, the District is required to conduct a habitat survey after a high flow event or other major event causing changes in habitat conditions. The flow event of March 16, 2014, warranted this survey and the District contracted for subsequent data collection during summer 2014. Detailed quantitative monitoring of physical habitat was conducted to document high flow induced changes in the lower, alluvial portion of the Sultan River as well as habitat changes attributable to the large scale side channel enhancement project and placement of engineered log jams. This work was conducted by Stillwater Sciences and built upon their prior “baseline” surveys conducted prior to license issuance. The results of this monitoring of aquatic habitat conditions in the lower Sultan River are presented in Appendix A. In addition, an aerial survey of the entire Sultan River downstream of Culmback Dam was also conducted during 2014.

2.2. Water Temperature Monitoring

Water temperature was continuously monitored at 13 locations with the Project area during 2013 (Figure 1). Monitoring at 10 of these locations was conducted by the District. The remaining monitoring was conducted by the U.S. Geological Survey (USGS) through a cooperative agreement. These locations, in order from upstream to downstream, include:

- South Fork Sultan River, upstream of Culmback Dam, near river mile (RM) 18.2 (USGS Gage No. 12137290);
- Sultan River, within the bypass reach immediately downstream of Culmback Dam, at RM 15.8;
- Sultan River, within the bypass reach, near RM 14.3;
- Sultan River, within the bypass reach, near RM 12.8;
- Sultan River, within the bypass reach, near RM 11.3;
- Big Four Creek, tributary to Sultan River, near RM 11.3;
- Sultan River, within the bypass reach immediately upstream of the Diversion Dam, near RM 9.8;
- Sultan River, immediately downstream of the Diversion Dam, near RM 9.6 (USGS Gage No. 12137800);
- Sultan River, upstream of the Powerhouse, near RM 4.9;
- Sultan River, downstream of the Powerhouse, near RM 4.4,
- Sultan River, near the confluence with the Skykomish River, at RM 0.2;
- Skykomish River, upstream of the confluence with the Sultan River, at RM 14.1; and
- Skykomish River, downstream of the confluence with the Sultan River, at RM 13.2.

Water temperature monitoring at Sultan River RM 14.3, 12.8 and 11.3, are part of the Water Temperature Conditioning Plan monitoring sites; the others are requirements under the FHM Plan.

In general, water temperatures observed during 2014 were consistent with those collected during 2008 and 2009 by CH2M Hill and presented in the Water Quality Final Technical Report (CH2M 2009). Figures depicting mean daily water temperature during 2014 are presented in Appendix B. A tabulation of all mean daily temperature data for 2014 is presented in Appendix C. The seven-day average of the daily maximum temperature (7-DAD Max) is presented in Appendix D. Data gaps are attributed to malfunctioning equipment or equipment lost due to vandalism.

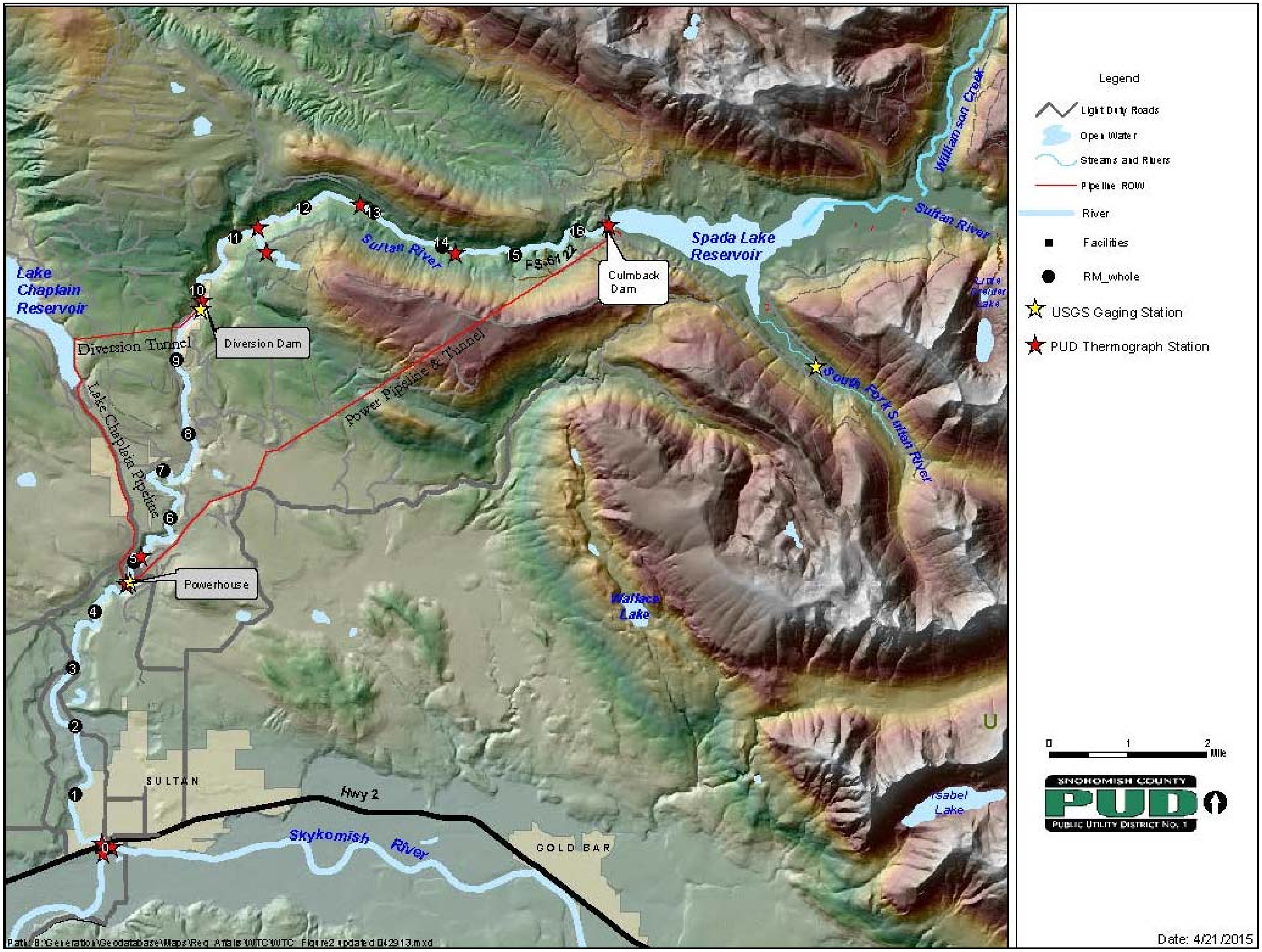

Figure 1. **Locations of water temperature monitoring.**

3. MONITORING OF FISH POPULATIONS IN THE SULTAN RIVER

3.1. Spawner Abundance, Distribution, and Timing in the Sultan River

In the Sultan River, steelhead and salmon escapement surveys are conducted during the spring and fall, respectively. These surveys are conducted, as conditions allow, within four index areas located downstream of the Diversion Dam (RM 9.7) (Figure 2). During 2014, water visibility and flow conditions were generally favorable during both the spring and fall surveys. Spring surveys were used to develop an escapement estimate of 86 steelhead based on the direct observation of 49 redds and expanded count of 53 redds. Six steelhead redds were observed in the Diversion Dam Index Area (DDIA).

Fall surveys occurred between September and November 2014. These surveys were used to generate an escapement estimate of 365 Chinook based on field observations and extrapolation to a total 146 redds. Of the 146 redds observed in index areas, 5 (3.4%) were observed in the Diversion Dam Index Area. Both the steelhead estimate and Chinook estimate were developed cooperatively with WDFW.

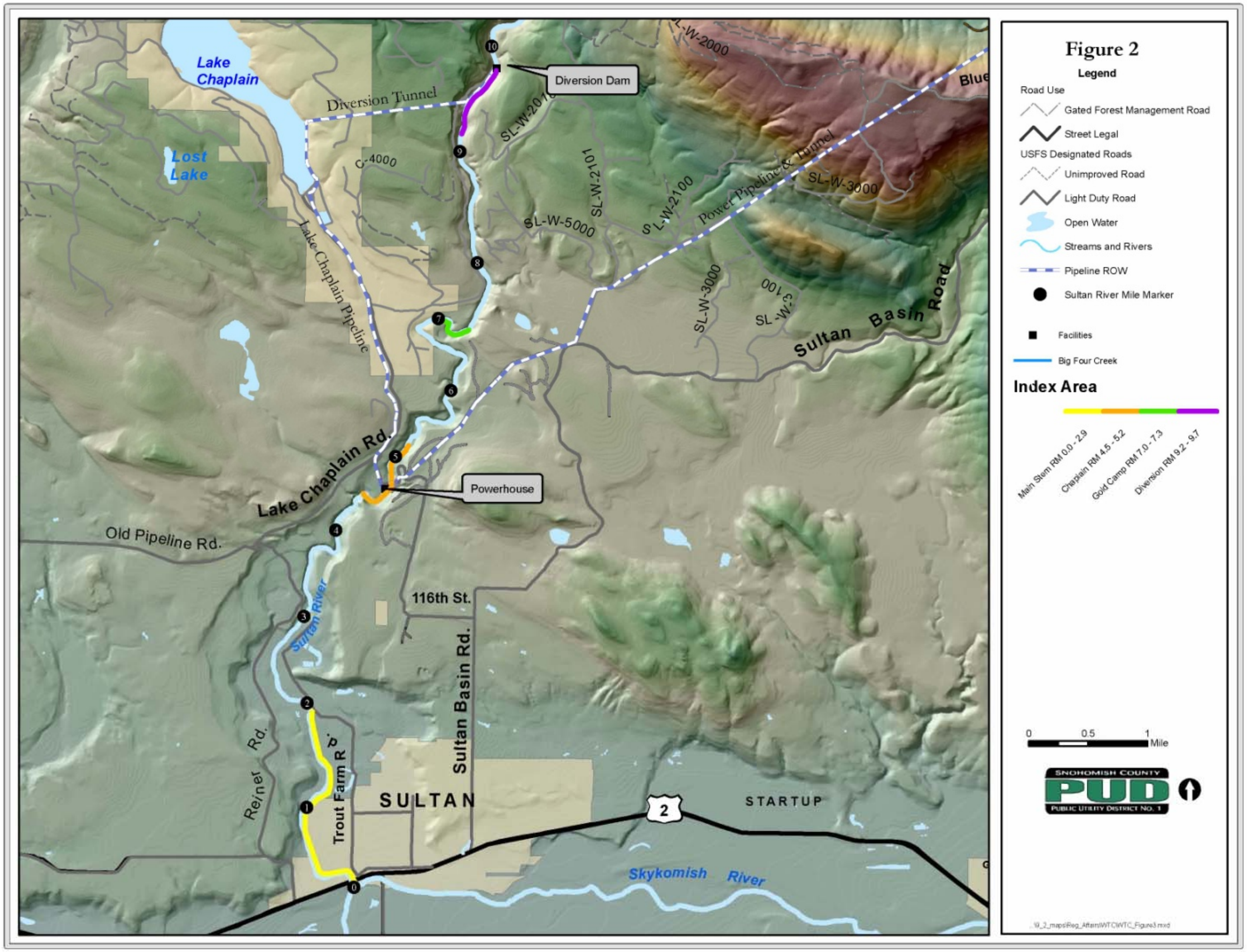

Figure 2. **Locations of steelhead and salmon escapement surveys.**

3.2. Flow Ceiling, Implemented for Chinook Salmon

A flow ceiling of 550 cfs is implemented annually between September 15 and October 15 in the reach of the Sultan River downstream of the Powerhouse (RM 4.7). This ceiling ensures that areas used by spawning Chinook salmon remain wetted through incubation and emergence should flows from the Project approach the minimum instream flow of 300 cfs. Mean daily discharge downstream of the Powerhouse averaged 371 cfs during the period. However, there was a flow increase as high as 785 cfs (October 14) during this period (Figure 3). This initial excursion above the salmon ceiling on October 14 was directly attributed to four consecutive days of rain totaling 5.1 inches. The subsequent excursion on October 15 was also directly attributed to 1.8 inches of rain on that date.

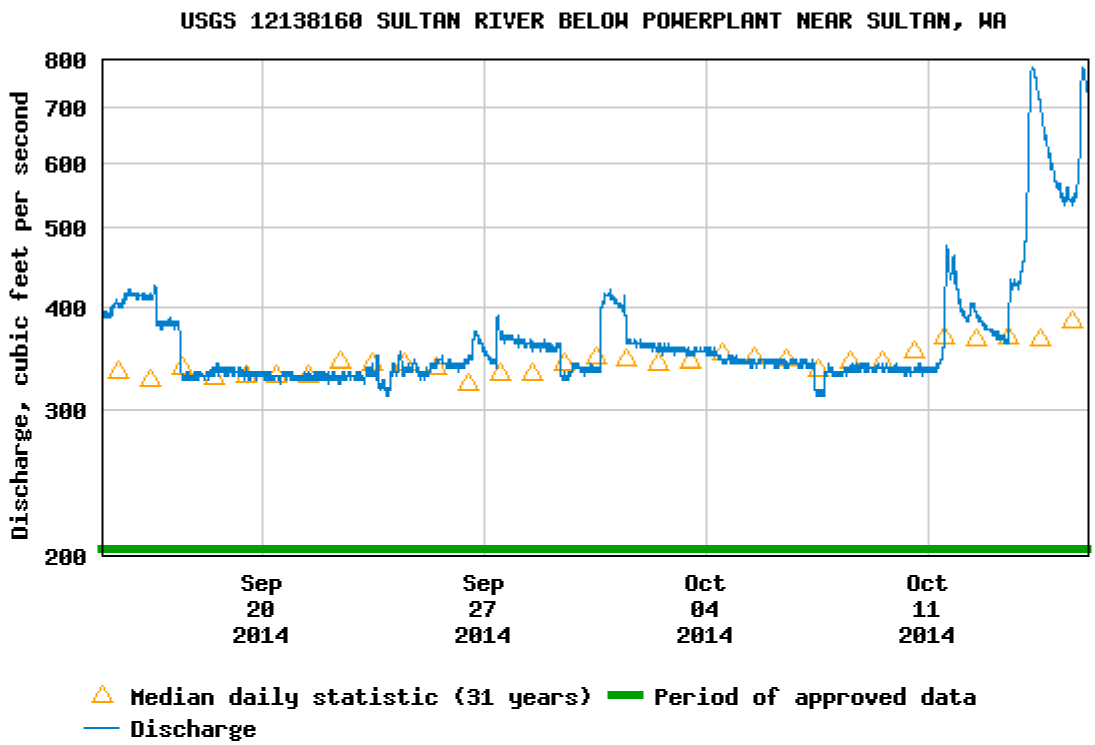

Figure 3. Mean Daily Discharge in the Sultan River downstream of the Powerhouse.

3.3. Juvenile Production in the Sultan River

The third year of smolt trapping efforts to estimate the outmigration of juvenile salmonids and production within the Sultan River was initiated on January 26, 2014. A five-foot diameter rotary screw trap operation was established in the Sultan River near RM 0.2, just upstream of the confluence with the Skykomish River. Sampling continued until June 30. A report presenting the results of the 2014 sampling season is presented in Appendix E.

4. SIDE CHANNEL MAINTENANCE AND MONITORING

On October 31, 2013, the District filed with the FERC a comprehensive Side Channel Enhancement Ramping Rate Evaluation Report pursuant to the License Article 405 and the FERC-approved Ramping Rate Evaluation Plan. During 2013, the District conducted detailed quantitative and qualitative surveys of side channels in the lower Sultan River to assess flow behavior and distribution and to determine whether additional ramping rate restrictions were necessary to prevent juvenile fish stranding within existing and newly constructed side channel habitats. The surveys included measurements of: 1) topography at side channel inlets, 2) water surface and channel elevation at point of hydraulic control near inlet, 3) flow routing and distribution into and within side channels under conditions of low to moderate mainstem discharge, 4) wetted width and depth at systematic intervals along each channel, and 5) photo documentation of low flow habitat conditions along the length of each side channel. Additional quantitative surveys of physical habitat, related specifically to the adequacy of existing ramping rates, are anticipated during summer 2015, after approval by FERC of the RREP Supplemental Plan.

Qualitative monitoring to assess the performance of both newly constructed and modified side channels, as well as the engineered log jams, was initiated after construction was completed. No maintenance, beyond the removal human placed obstructions to flow, has been required to date.

Qualitative fish populations surveys (snorkel and minnow traps) were conducted during summer 2013 and 2014, to document species presence, size, relative abundance, and habitat utilization of the newly constructed side channels as identified in Section 3.2.1 of the FHM Plan. Data results for these supplemental assessments are included in Appendix F.

5. FUTURE MONITORING

The 2014 calendar year marks the third calendar year under the new license. Monitoring methodologies employed in 2014 were consistent with those identified in the FHM Plan. Monitoring of physical habitat and water quality conditions will continue through 2015 and 2016. Spawner abundance, distribution and timing monitoring and juvenile production (smolt trap) monitoring will take place per the FHM Plan.

6. REFERENCES

CH2M Hill. 2009. Water Quality Final Technical Report. Henry M. Jackson Hydroelectric Project, FERC No. 2157. Water Quality Parameter Study (RSP 1). Prepared for Public Utility District No. 1 of Snohomish County. August 2009. Available at: http://www.snopud.com/Site/Content/Documents/relicensing/Study%20Reports/Jackson2157_SP1WQ_FTR_Aug2009.pdf

FERC. 2011. Order Issuing New License, Project No. 2157-188. 136 FERC ¶ 62,188. September 2, 2011. Available at: http://www.snopud.com/Site/Content/Documents/relicensing/License/20110902LICENSE.pdf

Stillwater Sciences. 2008. Study Plan 18: Riverine, Riparian, and Wetland Habitat Assessment Technical Report. Prepared for Public Utility District No. 1 of Snohomish County. March 2008. Available at: http://www.snopud.com/Site/Content/Documents/relicensing/Study%20Reports/Jackson2157_SP18_FINAL_compiled.pdf

APPENDIX A

Sultan River – Riverine Habitat Monitoring (Stillwater Sciences, 2014)

FINAL REPORT ◦ FEBRUARY 2015

Sultan River
Riverine Habitat Monitoring




PREPARED FOR

Snohomish County
Public Utility District No.1
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Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2015. Sultan River riverine habitat monitoring. Prepared by Stillwater Sciences, Portland, Oregon for Snohomish County Public Utility District No.1., Portland, Oregon.

Cover photos: Clockwise from top left: Installed large wood in Side Channel 1; Stillwater staff surveying the main channel of the Sultan River; bridge on Side Channel 4; upper end of Side Channel 4.

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EXECUTIVE SUMMARY

Stillwater Sciences conducted a field habitat survey of the lower 2.7 miles of the Sultan River in March 2014, including four side channels (of which three had been previously surveyed). The study was undertaken to determine if any habitat changes have occurred since the initial baseline survey in 2007 that included the mainstem river and Side Channel 3 (SC-3), and the subsequent 2010 survey of Side Channels 1 (SC-1) and 2 (SC-2). The surveys were conducted as part of the relicensing of the Henry M. Jackson Hydroelectric Project. Table 1 lists each reach and the year it was surveyed.

Riverine habitat attributes recorded for this study include in-stream unit subtype (e.g., pools, riffles, glides, islands), measurements of wetted unit surface area dimensions (length and width), unit margin features (lengths of undercut banks and bar edges), and the distribution and characterization of large woody debris (LWD). Subsequent to the 2007 and 2010 surveys, engineered LWD jams have been installed along the margins of the mainstem, the side channels have been enhanced with engineered LWD, and other channel enhancements were made in all four side channels.

Table 1. Reaches surveyed and the year the survey was conducted. LWD installations were constructed in 2012, between the last two surveys.

Reach	Surveyed in 2007	Surveyed in 2010	2012	Surveyed in 2014
Mainstem	Yes	No	LWD installations	Yes
Side Channel 1	No	Yes (partially)		Yes
Side Channel 2	No	Yes		Yes
Side Channel 3	Yes	No		Yes
Side Channel 4	No	No		Yes

The results of the study indicate that natural processes of wood recruitment and channel evolution have thus far resulted in only modest limited changes to habitat attributes in the mainstem of the Sultan River since the initial surveys were conducted in 2007 and 2010. The side channels are primarily glide habitat, with smaller amounts of low-gradient riffles and a few pools. The presence of engineered log jams and LWD in the mainstem river and along the side channels represent, by far, the greatest improvement in habitat along the lower Sultan River since 2007 and 2010. They have successfully stabilized the inlet to side channels, such that all had flowing water at the 320 cfs mainstem discharge during which the 2014 survey was made. Although the installations have not initiated widespread changes in habitat features to date beyond their simple presence and the local cover that they provide, their persistence and continued interaction with future high flows may result in greater habitat complexity in the future.

1 STUDY OBJECTIVES AND DESCRIPTION

The objective of this habitat survey was to delineate in-river habitat units and to conduct an in-river large woody debris inventory in the Sultan River's lower 2.7 miles, including four previously identified side channels (Figure 1). The mainstem and SC-3 were surveyed as part of project relicensing in 2007 and this effort was reported in *Revised Study Plan 18: Riverine, Riparian, and Wetland Habitat Assessment* (hereafter referenced as "RSP 18"). In 2010, habitat was surveyed in SC-1 and SC-2 and a geomorphic assessment was conducted to inform wood placement and channel enhancement feasibility. Construction occurred in 2012, with inlet and outlet enhancement and boulder placement associated with the four side channels SC-1, SC-2, SC-3, and SC-4. Enhancements included multiple log structures and individual logs in the side channels and seven large engineered log jams in the mainstem.

The 2014 survey was a follow-up habitat survey required by the Comprehensive Settlement Agreement for the continued operation of the Jackson Hydroelectric Project, operated by the Snohomish Public Utility District (the District) in accordance with FERC licensing requirements. Habitat re-surveys are triggered by high "process" flow events, of which one occurred in March 2014 (with a peak discharge of 4,940 cfs at USGS mainstem gage 12138160, corresponding to a 3- to 4-yr flood).

The primary purpose for resurveying is to identify any significant changes that have occurred since 2007 and 2010 that could affect fish habitat in the lower Sultan River. This study thus evaluates habitat changes that have occurred as a result of the constructed habitat enhancements and their interaction with a single high-flow event. This study also provides baseline information for comparison with future habitat surveys in the mainstem and side channels of this reach of the Sultan River.

2 BACKGROUND INFORMATION

As part of the formal relicensing process for Culmback Dam in 2007, RSP 18 was completed to address Federal Energy Regulation Commission (FERC) requirements for a detailed description of aquatic and terrestrial resources of the Project-related environment between Culmback Dam and the mouth of the Sultan River. Study objectives were designed to provide the District with the information required to make management decisions pursuant to FERC guidelines as well as other federal, state, and local requirements.

The Sultan River below Culmback Dam is a highly confined, steep channel over 13 of its 16-mile length to its confluence with the Skykomish River. The canyon that confines the river creates a high-energy environment that significantly affects the nature of instream habitats found within it. At approximately river mile (RM) 3.3, however, the river transforms into a less confined, alluvial valley where the channel widens and gravels from upstream sources deposit and accumulate. This survey was conducted on the lowermost low- gradient alluvial portion of the watershed (Figure 1) below the power line crossing at RM 2.7.

The Sultan River below Culmback Dam currently provides spawning and rearing habitat for numerous species of resident and anadromous salmonids. The reach between the Culmback Dam and the Diversion Dam (RM 9.7) supports self-sustaining stocks of resident rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki*), and mountain whitefish (*Prosopium williamsoni*). Anadromous species, including Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), coastal cutthroat trout *(O. clarki)* and steelhead trout (*O. mykiss*), are utilizing spawning and rearing habitats within the river downstream of the Diversion Dam, which at present is a barrier to upstream passage. Bull trout (*Salvelinus confluentus*) have not been observed spawning in the Sultan River but are known to use the lower river as rearing/foraging habitat during odd years when pink salmon eggs are prevalent. Each of these fish species depend on aquatic habitats that are affected by Project operations, and it is thus important to collect information on habitats within the affected reach on an ongoing basis.

Figure 1. Overview map of Study Area, spanning the lowermost 2.7 miles of the Sultan River upstream of its confluence with the Skykomish River (bottom right portion of the image). The four side channels covered by this survey are highlighted.

3 METHODS

3.1 Study Area Description and River Reach Delineation

RSP 18 broke the river into three "operational reaches" and four "survey reaches," each of which contained multiple habitat units identified by Natural Sequence Order (NSO) or "unit" numbers. The present Study Area for the 2014 survey covers the lower mainstem Sultan River from the power lines at RM 2.7, including four side channels within the reach, to its confluence with the Skykomish River. The 2014 survey took place wholly within Operational and Survey Reach 1. Habitat unit numbers assigned to the mainstem and SC-3 in 2007 have not been altered except in the case where habitat has changed. Habitat boundaries assigned in 2010 for SC-1 and SC-2 were sufficiently different in 2014 that the habitat unit numbers for these side channels were redefined during the present survey. Maps illustrating 2010 habitat units are included in Appendix D.

3.2 Riverine Habitat Mapping and Large Woody Debris Survey

Methods used to quantify in-river habitat units and associated LWD for the 2014 survey were identical to those utilized in 2007 and were selected to provide repeatable identification of habitat types, dimensions, and locations, as well as documentation of associated LWD. In 2010, only a qualitative LWD evaluation was conducted in the two side channels covered by that survey. General notes were made on significant LWD, but specific data such as size and decay class were not recorded.

The classification schemes used to identify specific habitat unit types, substrate sizes, and LWD attributes are given in Tables 2 and 3.

Table 2. Riverine (instream) habitat types.

Habitat types	Pool
	Riffle
	Cascade
	Rapid
	Glide
	Island
	Side Channel
	Undercut Banks
	Backwater Areas
	Bar Edges

Table 3. Large woody debris (LWD) attributes.

LWD jam	Number of Pieces
	Dimension (length, width, height)
	Channel Position (bank, mid-channel, bar)
	Percent of Channel Width
	Largest Piece Size
LWD piece	Length
	Diameter
	Decay Class
	Species Class (conifer, deciduous)
	Rootwad (yes, no)
	Anchoring (bed bank)
	Channel Position (bank, mid-channel, bar)

3.2.1 Delineation of in-river habitat units

The in-river habitat unit classification system and field methods from RSP 18 were used for this survey. The classification system and field methods were adapted from those commonly used in Washington State (Pleus et al. 1999; Schuett-Hames et al. 1999). They provide consistency for unit type identification and for recording unit dimensions. Habitat attributes recorded include unit type (e.g., pools, riffles), measurements of wetted unit surface area dimensions (length and width), unit margin features (lengths of undercut banks and bar edges), and LWD characteristics. Example habitat unit field data collection forms and respective criteria for identification are provided in Appendix A.

The habitat and LWD assessments were conducted in July and August 2014 within the Study Area. The assessment involved a field survey (or census) by a two-person crew and was conducted moving upstream from the mouth of the Sultan River to RM 2.7. Flows during the survey (313 to 320 cfs) were maintained by dam releases to match the discharge experienced during the initial surveys in 2007 (319 cfs). Prior to enhancements, SC-1 and SC-2 were only activated at higher flows; therefore the 2010 survey of these two side channels was conducted at a higher discharge (Table 4).

Table 4. Discharge at time of each survey as measured by USGS gage 12138160, "Sultan River below powerplant near Sultan, WA."

Year of survey	Flow (cfs)
2007	319
2010	561 to 802
2014	313 to 320

Habitat unit delineation and measurement of habitat features is best conducted at similar flows in order to make direct comparisons. At different flows, bank edges can be inundated or revealed (changing the measurement of bar edges and undercut banks), and wetted widths and depths are obviously altered. The different discharges between 2010 and 2014 resulted in 0.45 ft stage difference in the Sultan River mainstem gage. Differences in depth in each of the side channels were recognized, but unquantified. As one example, Figures 2 and 3 show photographs taken in 2010 and 2014 within approximately 25 ft of each other of the same habitat unit (SC1-6 [SC1-15 in 2010]). From these and the remainder of the field photos, there was clearly more water present in 2010 than in 2014, rendering some of the direct comparisons of habitat changes between years less precise.

Figure 2. Photo of SC-1 in 2010.

Figure 3. Photo of SC-1 in 2014.

The field crew surveyed each unit semi-sequentially to identify habitat unit boundaries and associated attributes. For the mainstem, data were collected in a hierarchical manner to first identify or confirm previous habitat unit boundaries, to verify or assign a habitat subtype, and to define the unit's position within the lateral channel. These first-order, reach-scale data were recorded using the same alphanumeric coding system as in RSP 18 that assigned: (1) a unique numeric data identifier (Natural Sequence Order or NSO unit number); (2) a primary unit type (pool, riffle, or other); (3) a subtype (riffle, pool, subsurface flow, obscured, or other [Pleus et al. 1999]); and (4) a ranking that defined the degree to which the unit occupied the wetted channel. The latter included primary main channel units (Category 1), secondary main channel habitat units (i.e., units that did not span the entire river channel) (Category 2), and side channel habitat units separated from the main channel by an island (Category 3). Islands (Category 3) were identified according to Schuett-Hames et al. (1999), who defined the minimum length of an island unit being at least two times the bankfull channel width with the terrestrial area vegetated by perennial plants two meters or greater in height.

Subsequent data, including unit subtype and dimension measurements, were recorded for each habitat unit. Length, average depth (except in pool habitat units), and three wetted width measurements were either verified from the previous study or recorded for each habitat unit that were either newly delineated (as in the side channels) or re-delineated where habitat units had changed since the last survey. Habitat unit subtypes were designated for the "pool" and "riffle" primary units according to the criteria given in Table 5. Additional information was recorded for pools, including maximum depth, residual pool depth, and the dominant factor forming the pool according to the criteria given in Table 6 (Pleus et al. 1999).

Table 5. Criteria used to identify primary and subtypes and associated field code acronyms. (Subtype designations and definitions are adapted from Flosi et al. 1998 and Edelen 2005.)

Primary habitat unit type	Habitat sub-type	Criteria definition
Riffle (R)	Low Gradient Riffle (LGR)	Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient <4% is usually cobble-dominated.
	High Gradient Riffle (HGR)*	Relatively higher gradient than low gradient riffles and dominant bed material is cobble instead of gravel.
	Rapid (RPD)	Steep sections of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is >4%, and substrate is boulder dominated. In Flosi et al. (1998), these are termed "high gradient riffles."
	Glide (GLD)	Wide uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel, and sand.
	Cascade (CAS)	The steepest riffle habitat, consisting of alternating small waterfalls and small shallow pools. Substrate is usually bedrock and boulders.
Pool (P)	Main Channel Pool (MCP)	Large pools formed by mid-channel scour. Water velocity is slow, and the substrate is highly variable.
	Lateral Scour Pool (SCP)	Formed by flow impinging against a partial channel-bank obstruction.
Other (OT)	Island (ISL)	Bars or land segments within the stream channel that are relatively stable, usually vegetated, and normally surrounded by water.
	Subsurface flow (SUB)	That portion (part or all) of the water that infiltrates the stream bed and moves horizontally through and below it. It may or may not return to the stream channel at some point downstream.

* This habitat sub-type was only used in the 2010 survey.

Table 6. List of pool-forming factors and associated field codes (Pleus et al. 1999). Definitions for individual large woody debris (LWD) pieces versus debris jams are according to Schuett-Hames et al. (1999).

Field code	Pool-forming factor
1	LWD log(s)
2	LWD rootwad(s)
3	LWD jam
4	Roots of standing tree(s) or stump(s)
5	Boulder(s)
6	Bedrock
7	Channel bedform
8	Resistant bank
9	Artificial bank
10	Beaver dam
11	Other/Unknown

3.2.2 In-river LWD inventory

Survey methods to characterize and enumerate LWD within the Study Area followed methods refined for the Timber Fish and Wildlife Monitoring Program (Schuett-Hames et al. 1999). Deviations from survey methods included consolidating LWD into size categories and characterizing LWD in debris jams by tallying individual pieces and rootwads, as was done in 2007. In 2010, only qualitative notes were taken on the existing LWD. Example field data collection forms and criteria are provided in Appendix A.

For the field survey, LWD was defined as dead logs, limbs, or rootwads partially or entirely located within the bankfull channel. LWD was enumerated according to a minimum size and length criteria. Individual downed logs and rootwads tallied had a minimum length of two meters and a mid-point diameter of twenty centimeters or greater. Total length for each piece was recorded, and a diameter class was assigned. Diameter classes were defined as (1) ≥20 cm to <40 cm, (2) ≥40 cm to <60 cm, or (3) ≥60 cm. The location of LWD, either primarily (greater than 50 percent) within the wetted channel (zone 1) or within the bankfull channel width (zone 2), was also recorded based on the wetted channel conditions present. Additional LWD data attributes recorded were:

- anchor feature (root system, boulder, pinned, or unstable [Schuett-Hames et al. 1999]);
- species class (conifer, deciduous, or unknown);
- decay class (1-5, [Robison and Beschta 1990 cited in Schuett-Hames et al.1999]); and
- the presence or absence of an intact rootwad.

In addition to individual pieces of LWD, debris jams were recorded on base maps and their dimensions estimated. The criteria for identifying debris jams was the accumulation of ten or more pieces of interlocked LWD (including rootwads) where at least ten pieces were ≥20 cm in diameter and >1.82 m (6 ft) in length, and the majority of the debris jam was located within the bankfull channel (Schuett-Hames et al. 1999). Attribute data recorded for debris jams included a tally of all pieces and rootwads meeting the criteria described above, and approximate length, width, and height dimensions. Specific diameter and length measurements were recorded for the most prominent individual piece within each jam. All LWD locations were identified by recording the associated habitat unit NSO in addition to other data described above. The location and characteristics of engineered log jams, log structures, single placed logs, were noted separately from the naturally occurring LWD.

3.2.3 Characterization of river channel substrate

Wolman pebble counts (Wolman, 1954) were conducted using the standard methodology in the same habitat unit as in 2007 (habitat unit 89) on the mainstem, and one count was conducted in each of the side channels not previously surveyed. No pebble counts were conducted in 2010. Pebble count results are typically summarized by the intermediate diameter of the median particle size, D_{50} (Wolman 1954). D_{50} values ranging from 20 to 60 mm, with less than 10% of particles smaller than 0.85 mm in diameter, are considered suitable substrate size for spawning anadromous fish (Kondolf and Wolman, 1993; Kondolf 2000). In addition to the value of D_{50}, we also report D_{16} (the particle size that 16 percent of all particles are smaller than) and D_{84} (the particle size that 84 percent of all particles are smaller than).

3.3 Deviations from RSP 18/Monitoring Plan

There were no significant deviations from the RSP 18 measurement methods, although some enhancements were employed to facilitate current and future uses. These include a Google Earth .kmz file, with all habitat units delineated and field photographs from the 2010 and 2014 surveys embedded, neither of which were provided with the 2007 or 2010 data. In addition, GPS coordinates for the wetted width measurements of the side channels are provided with the GIS data to ensure repeatability with future efforts.

4 RESULTS

4.1 Survey Results: Riverine Habitat and Large Woody Debris

4.1.1 Habitat unit composition

A total of 111 in-river habitat units were surveyed within the Study Area. The spatial distribution of these habitats is best viewed using the maps and interactive .kmz file provided with this report. Maps illustrating 2014 habitat units are included in Appendix B.

Low-gradient riffles, glides, and islands are the most abundant habitat unit subtypes, in order of prevalence; in total, they account for 88% of all habitat units surveyed. Table 7 provides summary statistics for habitat unit types by reach. In terms of combined average percent surface area per subtype, glides account for 55%, low gradient riffles for 25%, and islands for 16% (Figure 4, Table 8).

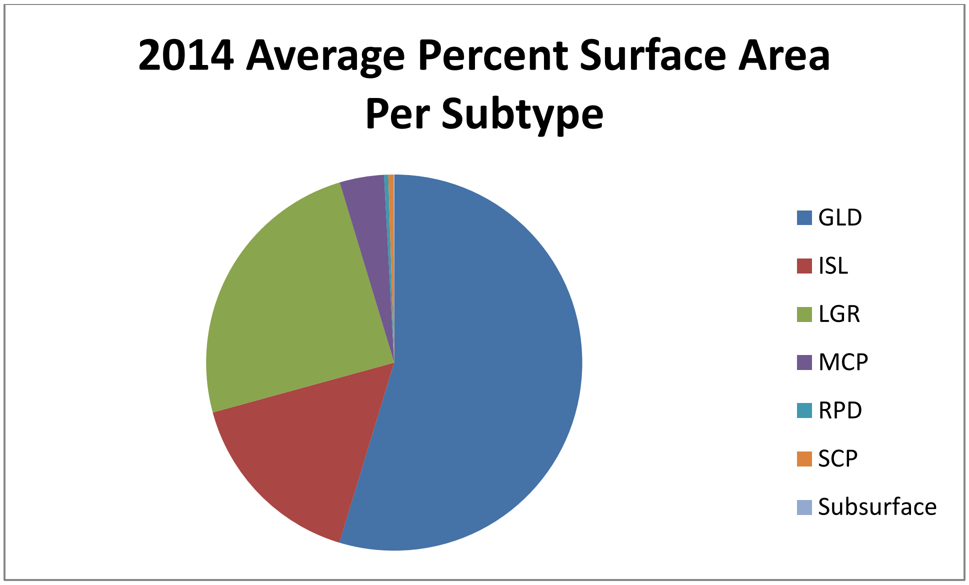


Figure 4. 2014 Combined average percent surface area per subtype. Habitat subtypes are as listed in Table 5: glide (GLD), island (ISL), low gradient riffle (LGR), main channel pool (MCP), rapid (RPD), lateral scour pool (SCP), and subsurface.

Table 7. Composition of surveyed riverine habitat units by river reach and side channels of the lowermost 2.7 miles of the Sultan River.

Habitat		Process reach ID and side channel						Total number of habitat units
Primary unit type	**Sub-type**	**Mainstem (unit cat 1*)**	**Mainstem (unit cat 2 & 3)***	**SC-1**	**SC-2**	**SC-3**	**SC-4**	
Pool	Main channel pool			3	2	2	1	**8**
	Lateral scour pool	1	1		1			**3**
	Backwater pool							**0**
Riffle	Low gradient rifle	14	13	4	5	8	1	**45**
	High gradient riffle							
	Rapid	1						**1**
	Glide	13	6	7	7	6	1	**40**
	Cascade							**0**
Other	Island		9	3		1		**13**
	Subsurface			1				**1**
Total habitat units		**29**	**29**	**18**	**15**	**17**	**3**	**111**

* Mainstem (unit category 1) includes primary main channel units. Mainstem (unit categories 2 and 3) includes secondary main channel habitat units (i.e., units that did not span the entire river channel) and side channel habitat units separated from the main channel by an island.

The average wetted widths for the primary unit type of pool in the mainstem ranged from 20.0 to 28.0 ft. The average wetted width for pools in the side channels ranged from 11.2 to 31.9 ft. For riffles and glides in the mainstem and the four side channels, the average wetted width ranged from 10.1 ft for low-gradient riffles in SC-1 to 92.0 ft for glides in the main channel (Table 9). Habitat unit lengths within the total Study Area range between 25 ft and 1,276 ft, with rapid and glide habitat units being the longest and backwater pools the shortest (Table 10). In SC-2, average unit lengths are generally smaller than the other reaches contributing to the side channel's complexity in terms of variability of habitat. Even at the low flows maintained for the surveys, the Sultan River is large, deep and fast, and crews were unable to wade across most of the units. Previous wetted width data for units surveyed in 2007 were visually compared to current conditions; no evidence of changes in the values (which would indicate active bank erosion or sediment accretion) or active erosional or depositional features themselves were noted.

Glides were longest in the main channel and in SC-4 (a homogenous reach composed 90% of one continuous glide with a length of 1,276 ft), with an average overall length of 485 ft across all reaches. The sole rapid in the Study Area within the mainstem was (coincidentally) also 485 ft long. Islands had the next highest average unit length of 355 ft.

Table 8. Percent total surface area by riverine habitat unit, by river reach and side channels in the Study Area.

Habitat		Process reach ID and side channel						Combined average % surface area
Primary unit type	**Sub-type**	**Mainstem (unit cat 1*)**	**Mainstem (unit cat 2 & 3*)**	**SC-1**	**SC-2**	**SC-3**	**SC-4**	
Pool	Main channel	0	0	7.0	5.8	6.9	3.0	3.8
	Lateral scour	0.05	0.1	0	2.6	0	0	0.5
	Backwater	0	0	0	0	0	0	0
Riffle	Low gradient	31.51	9.4	19.4	38.3	42.3	6.8	24.6
	High gradient	0	0	0	0	0	0	0
	Rapid	0	0	0	0	0	0	0
	Glide	66.2	6.1	70.8	53.3	41.6	90.2	54.7
	Rapid(was cascade)	2.23	0	0	0	0	0	0.4
Other	Subsurface	0	0	0.2	0	0	0	0.04
	Island	0	84.4	2.5	0	9.2	0	16.0

* Mainstem (unit category 1) includes primary main channel units. Mainstem (unit category 2 and 3) includes secondary main channel habitat units (units that did not span the entire river channel) and side channel habitat units separated from the main channel by an island.

Table 9. Average wetted width (ft) by surveyed riverine habitat unit within the Study Area.

Primary unit type	Subtype	Mainstem (unit cat 1)	Mainstem (unit cat 2 & 3)	SC-1	SC-2	SC-3	SC-4
Pool	Main channel pool	-	-	17.4	21.6	15.5	11.2
	Lateral scour pool*	20.0	28.0	-	31.9	-	-
Riffle	Low gradient riffle	90.9	29.2	10.1	24.6	46.0	25.2
	High gradient riffle	-	-	-	-	-	-
	Glide	92.0	29.1	15.1	29.3	52.3	22.2

* Width of lateral scour pools is an estimate of the pool within the wider channel.

Table 10. Average unit length (ft) by surveyed subtype within the Study Area. Italicized entries indicate measurement of a single unit (i.e., not an average value).

Habitat		Process reach ID and side channel						
Primary unit type	**Subtype**	**Mainstem (unit cat 1*)**	**Mainstem (unit cat 2 & 3*)**	**SC-1**	**SC-2**	**SC-3**	**SC-4**	**Total average unit length (ft)**
Pool	Main channel	-	-	61	49	92	*84*	**69**
	Lateral scour	*35*	*25*	-	*62*	-	-	**41**
	Backwater	-	-	-	-	-	-	
Riffle	Low gradient	373	178	178	129	184	*84*	**230**
	High gradient	-	-	-	-	-	-	
	Rapid	*485*	-	-	-	-	-	***485***
	Glide	788	288	326	115	220	*1,276*	**439**
	Cascade	-	-	-	-	-	-	
Other	Island	-	454	76	-	*192*	-	**355**
	Subsurface	-	-	*12*	-	-	-	***12***
Total average unit length (ft)		**551**	**281**	**196**	**107**	**185**	**482**	**306**

* Mainstem (unit category 1) includes primary main channel units. Mainstem (unit categories 2 and 3) includes secondary main channel habitat units (units that did not span the entire river channel) and side channel habitat units separated from the main channel by an island.

4.1.1.1 Additional pool habitat unit attributes

Where possible, the apparent primary factor responsible for each pool's formation was recorded during field survey efforts, as specified in the study plan. Within the Study Area, 45% of the pools either formed or were constructed adjacent to engineered wood (Table 11). Two of the seven large engineered log jams had pools formed or created in front of them. For the remaining pools, channel bedform (18%), resistant bank (18%), and LWD (l8%) were primary factors in their formation.

Table 11. Primary pool-forming factors for habitat units surveyed in the Study Area.

Pool-forming factor	Reach ID and side channel						Total # of pools
	Mainstem (unit category 1*)	**Mainstem (unit category 2 & 3*)**	**SC-1**	**SC-2**	**SC-3**	**SC-4**	
Roots of standing trees or stumps (Field code 4)							**0**
Boulder(s) (Field code 5)							**0**
Bedrock (Field code 6)							**0**
Channel Bedform (Field code 7)					2		**2**
Resistant Bank (Field code 8)				2			**2**
Artificial Bank (Field code 9)							**0**
LWD (logs) (Field Code 1)			1				**2**
Engineered Log Jam Associated	1	1	3				**5**
Total	**1**	**1**	**4**	**2**	**2**	**1**	**11**

* Mainstem (unit cat 1) includes primary main channel units. Mainstem (unit cat 2, 3) includes secondary main channel habitat units (units that did not span the entire river channel) and side channel habitat units separated from the main channel by an island.

Residual pool depth measurements for a given stream provide the number and spatial distribution of deep pool habitats that can support aquatic life even through annual low-flow periods. Residual pool depth is the maximum wetted depth minus the wetted pool crest depth (Lisle 1987). Median residual pool depths were comparable between reaches, ranging from 1.4 ft (SC-1) to 3.9 ft (mainstem). Residual depths were most variable in SC-3 (Figure 5).

In all cases, residual pool depth on average was 2.3 ft with the first quartile measuring about 1.8 ft. However, survey measurements likely underestimated actual residual pool depths. Low visibility made it difficult to locate maximum depth accurately, and one pool in SC-3 that did not exist in 2007 was too deep to safely measure.

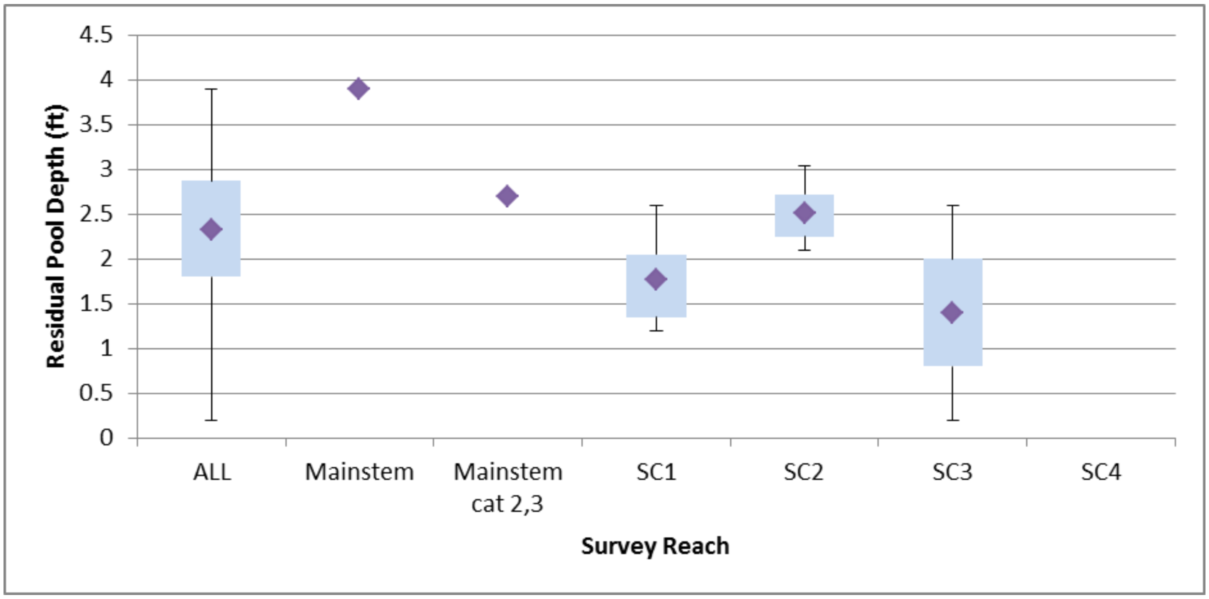


Figure 5. Box-and-whisker plots of surveyed residual pool depth by survey reach. The boundary of a box closest to zero indicates the 25th percentile, diamond within a box marks the median and the boundary of a box farthest from zero indicates the 75th percentile. Box whiskers indicate the minimum and maximum values.

4.1.1.2 Bar edge and undercut habitat attributes

Bar edge habitat is used by emergent juvenile salmon during spring and early summer rearing periods because of their conditions of low velocity and shallow depth. Bar edge and undercut bank habitat were recorded as the percent of the unit length on either the right or left edges of each habitat unit. Results are presented as cumulative averages for both sides of the stream (i.e., left and right combined).

Bar edge habitat is described as gravel bars along stream margins, either wetted or immediately adjacent to the wetted fringe. In this regard, it was primarily present in low-gradient riffle and glide habitats (Figure 6).

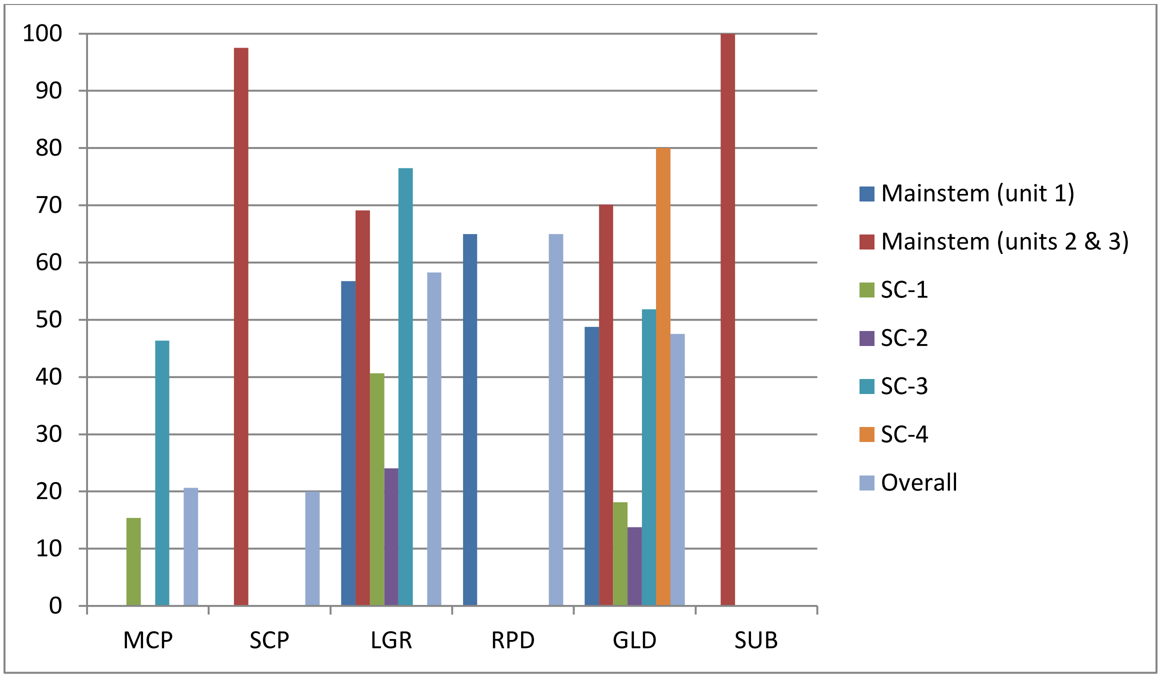


Figure 6. Average length (expressed as a percent) of bar edge per subtype by reach in the lowermost 2.7 miles of the Sultan River, including side channels.

Within the total surveyed Study Area, bar edge habitat constitutes approximately 44% of stream length. Bar edge habitat is more abundant in mainstem of the Sultan River (24%) (Table 12).

Table 12. Average combined lengths of left and right bar edges for each reach per subtype (ft).

Subtype	Mainstem (unit cat1)	Mainstem (unit cat 2 & 3)	SC-1	SC-2	SC-3	SC-4	Overall
Main Channel Pool (MCP)	0	0	28	0	85	0	113
Lateral Scour Pool (SCP)	0	24	0	0	0	0	24
Low Gradient Riffle (LGR)	2,965	1,604	290	187	1127	0	6,171
Rapid (RPD)	315	0	0	0	0	0	315
Glide (GLD)	4,995	1,210	414	127	570	1,021	8,337
Subsurface (SUB)	0	12	0	0	0	0	0
% total average combined length per reach	41%	70%	22%	17%	58%	71%	

Undercut banks associated with habitat units provide refuge–cover and habitat complexity for fish and other aquatic organisms. Throughout the total surveyed Study Area, only 11 habitat units had undercut banks. Undercut banks were present on the mainstem, SC-1, and SC-2 and are restricted to main channel pools, glides, and riffles. The majority of undercut bank habitat observed is present in the mainstem and SC-2. When comparing the average combined length (right and left bank) of undercut habitat within each reach to the reach's total length, it accounts for approximately 12% of the total cumulative perimeter length in SC-2, 4.1% in SC-1, and 1.2% in the mainstem. Across all reaches, undercut bank features were essentially absent (1.8% of total stream length) and predominantly found alongside main channel pools (9% of total main channel pool stream length in the study area).

4.1.2 Results: large woody debris survey

A field census of abundance and key attributes of LWD was included with the riverine habitat survey of the Study Area.

4.1.2.1 LWD—individual pieces

The density of LWD can be presented using a variety of denominators. For this report, density of LWD is presented as pieces per mile of stream channel. Only naturally occurring LWD was tallied (see Section 4.1.2.3 below for a discussion of engineered wood structures). In some locations it was unclear whether the wood occurred naturally or had been placed as part of stream enhancement. In such cases where the origin of the wood was ambiguous, it was included in the "natural" LWD tally. Maps indicating the distribution of LWD by habitat unit are included as Appendix C.

Table 13. LWD density per mile in the Study Area.

Survey reach	Length (mi)	LWD density per mile including only individual pieces	LWD density per mile including individual pieces and debris jam pieces
Mainstem	2.7	36	53
SC-1	0.6	83	83
SC-2	0.4	68	68
SC-3	0.4	55	55
SC-4	0.3	17	17

Data collected for individual LWD pieces included categories of piece diameter, length estimates, species type, and decay class. For purposes of the survey, individual LWD pieces were tallied separate from pieces occurring within debris jams. Fifty six percent of all individual LWD pieces were downed trees of a small diameter class (20 to 40 cm), 34% were of medium diameter (>40–60 cm), and 10% were of large diameter (>60 cm). Eleven of the 216 tallied wood pieces were rootwads and are not included in the calculations in Table 13.

The position of LWD within the bankfull channel was also recorded. Wood was classified on whether it was primarily (greater than 50%) in Zone 1 (wetted width) or 2 (bankfull width). LWD pieces in the wetted channel were also further differentiated if any part of the LWD extended to mid channel. The position of LWD within the channel is relevant to understanding how LWD contributes to habitat complexity by affecting channel hydraulics at different river discharges (Ralph et al 1994; Montgomery et al. 1995). Within the Study Area, 50 % of the individual LWD pieces were primarily in Zone 2. The remaining 50% of individual LWD pieces occur within the wetted river channel (Zone 1), with 33% of those extending into mid-channel.

Tree species type and decay class were identified for all individual LWD pieces. Throughout the total surveyed Study Area, LWD by species was composed of 80% unknown species (classified as such due to a lack of bark or otherwise identifying features), 11% coniferous species, and 9% deciduous species. Using a decay class scale of 1 to 5, where 1 indicates the lowest state of decay and 5 indicates the highest state of decay, the majority (75%) of individual LWD pieces were within decay classes 1 to 3, indicating that they are of fairly recent (i.e., the last few decades) origin.

4.1.2.2 LWD—jams

Within the Study Area there were 2 natural debris jams within the wetted portion of the river channel at the time of the survey. This includes a jam in habitat unit 36 (unchanged from the 2007 survey) and a jam in habitat unit 93 at the mouth of SC-4. This jam had accumulated against an engineered log jam within the last two years.

4.1.2.3 LWD—engineered wood

Since the last survey, significant habitat enhancement has been conducted in the form of engineered log jams in the main stem, log structures in the side channels and helicopter placed LWD. The log jams were installed to stabilize the entrances of the side channels, and to direct flow into the side channels. Seven large engineered log jams, approximately 30 ft wide across the face, 12 to 15 ft high, and extending approximately 10 ft into the wetted channel have been installed. This compares to just two naturally occurring jams noted during this survey. The naturally occurring jams extend farther into the channel (much of the engineered jams are buried in the banks, but may become exposed over time), but the engineered log jams represent twice the number of jams in the study reach over 2007. Small pools have either former or were constructed at the base of two of these jams. Only the log jam at the mouth of SC-4 has accumulated any significant wood in addition to what was initially installed.

According to plans provided by Snohomish County PUD, habitat enhancement included placement of 370 logs, most with rootwads attached. The logs were primarily 16-24 inches in diameter, with some greater than 24 inches. The logs ranged from 20 to 50 ft long. The wood habitat enhancements include seven large engineered log jams, 30 to 35 ft wide across the face, 12 to 15 ft high and extending approximately 10 ft into the wetted channel. Small pools have either former or were constructed at the base of two of these jams (Habitat units 79a and 93a, refer to the habitat unit maps in Appendix B). In addition to the log jams, there is one log revetment along a residential lawn in habitat unit 80. While the number and location of log structures observed was not identical to what was depicted on the plans provided by the District, the volume and nature of LWD placement was consistent with the plans.

The following is a description of engineered LWD structures and logs placed in the side channels since the previous habitat survey. Photographs were taken of many of these structures and can be viewed on the provided .kmz file.

SC-1

Investigators classified LWD structures in SC-1 into four categories:

- Structures: Structures were three-log structures, two logs pinned into the bank, and one parallel to the bank, generally with an attached rootwad.
- 2-log pins: same as three-log structures, but with just one log pinned into the bank, and one log parallel to the bank.

- Single Logs: Single logs pinned to the bank
- Mid-channel: Mid channel structures consisted of three logs buried in a bundle in the middle of the channel, two had cut-ends emerging from the substrate while the third had a root-wad emerging from the substrate. They extended out of the substrate six to eight ft.

Table 14 includes the tally for the habitat units for these structure types. If any part of the structure was within the wetted channel at the time of the survey, it was considered to be in Zone 1. Structures that were completely above the water surface were in Zone 2.

Table 14. Tally of structure type per habitat unit.

Habitat unit	Zone	Structures		Mid-Channel	2-log		Single logs	
		Left bank	Right bank		Left bank	Right bank	Left bank	Right bank
SC1-1	1							
	2	1						
SC1-2	1	2	2	4	7	5		
	2	6	4		3	3		
SC1-3	1		2				1	1
	2							
SC1-11	1		1				4	3
	2							

Unit SC1-6 (all habitat units are depicted on maps in Appendix B) had numerous helicopter-placed logs that were difficult to differentiate in some cases from natural LWD. Sixteen logs ranging in length from 10 to 35 ft were assumed to be helicopter-placed and were not included in the natural LWD tally.

Unit SC1-14 has two very old and rotted cabled log structures. One consisted of three small logs 10 ft long, and the other consisted of one rootwad and one log eight ft long.

SC-2

Unit SC2-4 contained one structure composed of 4 logs, three with rootwads, extending six to eight ft into the channel, and one channel spanning log. The logs extended from both the right and left banks. One apparently natural log was pinned against one of the rootwads.

Unit SC2-13 contained a structure with two rootwads extending six to eight ft into the wetted channel, with a crossbar log with rootwad pinning them to the bank and extending along 35 ft of channel. A 40-ft channel-spanning log was present just upstream, along with a possibly natural (or helicopter placed) 50-ft log extending from the top of bank into the channel.

Unit SC2-15 had six logs with rootwads pinned with boulders extending approximately 20 ft into the wetted channel. The second-most downstream log had a small beaverdam built against it. Aside from this, there was no natural wood accumulation on any of the engineered structures.

SC-3

SC-3 had two large woody debris structures on the left bank from the border of unit 1-47 and 1-46 extending into unit 1-47. Each consisted of 3 logs with rootwads extending approximately 6 ft into the channel, and tied to the bank with one cross log with rootwad. Each extended along 35 ft of bank.

SC-4

SC-4 has nine, possibly ten, engineered wood structures and single logs (with one additional single logs that may have been naturally occurring, or may have been placed), all in habitat unit SC4-1. No natural accumulation of large woody debris was noted against any of the structures. LWD structures 1–8 are located on the right bank, with 9 and 10 on the left bank. Descriptions of the structures follow.

1. Twelve logs buried in the bank, jutting into the channel, with two visible crossbeam logs perpendicular to the
2. Single log buried in the bank extending approximately three ft into the wetted channel
3. Two logs extending parallel along the channel, with a third log extending approximately six ft into the channel above the water surface.
4. One log structure along 35 ft of bank consisting of four logs (one with rootwad) and three rootwads. The logs extend 8 to 15 ft into the channel, and the rootwads are attached to logs buried in the bank, anchoring the other logs.
5. May be a natural or placed log anchored to the bank extending 22 ft into the channel
6. Structure made up of 3 logs; two with rootwads extending five and 11 ft into the channel, respectively. The third log is buried in the bank perpendicular to the channel, anchoring the first two logs.
7. Two logs extending out into the channel approximately five ft along 12 ft of bank. One log atop the other and perched above the water surface
8. One rootwad extending into the channel, tied to the channel with one crossbeam log with attached rootwad. Both run along approximately ten ft of shore, and extend out from the bank approximately five ft into the wetted channel.
9. Two logs buried into the bank, extending approximately 7.5 ft into the wetted channel.
10. One log extending approximately seven ft into the channel, anchored by a second log buried in the bank, with only its rootwad extending into the channel.

4.1.3 Characterization of river channel substrate

Pebble count results are typically reported in “D” values, with the number following the “D” representing the percentage of particles smaller than that size, (for instance D_{50} is the 50th percentile, or median substrate size) (Wolman 1954). Results from Wolman pebble counts are presented in Table 15.

Table 15. Approximate size distribution (in mm) of river substrate material from sample sites throughout the Study Area.

Reach	Unit number containing sample	Stream substrate particle size (mm)		
		D_{16}	D_{50}	D_{84}
OR 1	89	22	51	84
SC-1	11	3	23	50
SC-2	16	25	62	129
SC-4	1	5	23	49

The pebble counts indicated that the gravel patches assessed were all suitable for spawning, although the median size in SC-2 was slightly higher than considered to be the ideal range (62 mm vs 60 mm).

5 DISCUSSION

5.1 Riverine Habitat Characteristics

The primary objective of this 2014 study is to identify any significant changes that have occurred since 2007 in the lower 2.7 miles of the Sultan River and side channels that could affect fish habitat.

When comparing the 2014 to 2007 and 2010 data, the following general observations were made:

- The percent of total surface area of each subtype in the Study Area was not significantly different than what existed in in 2007. Glides accounted for 66%, low gradient riffle for 29%, and islands for 6% (Figure 7) in 2007. In 2014, glides account for 55%, low gradient riffles for 25%, and islands for 16 %.
- Compared to 2007 and 2010, results in 2014 show an additional 4,834 ft of stream length was created due to both naturally created channels and the enhancement of SC-1, -2, and -4 (Table 16). SC-3, surveyed last in 2007, has increased in complexity by the creation of one additional island and one pool.
- Compared to 2007, there was an overall net gain for the study area combined of 1,706 ft in left bank bar edge and 933 ft of right bank bar edge habitat. Thirty percent of the increase in left bank bar edge and 23% of the increase in right bank bar edge occurred in SC-3. The remaining increase in bar edge occurred in the mainstem. Higher flow and high water levels in 2010 prohibit the ability to make valid comparisons to bank bar edge in SC-1 and SC-2 and are therefore not included in this analysis.
- Lastly, unit 37 (mainstem) and 50 (SC-3) no longer exhibit undercut bank features. Overall, compared to 2007, there was a net increase in the length of left bank undercut of 911 ft and a net increase length of 201 ft of right undercut bank. No other changes in undercut lengths were observed. Higher flow and high water levels in 2010 prohibit the ability to make valid comparisons to undercut features for SC-1 and SC-2 and are therefore not included in this analysis.

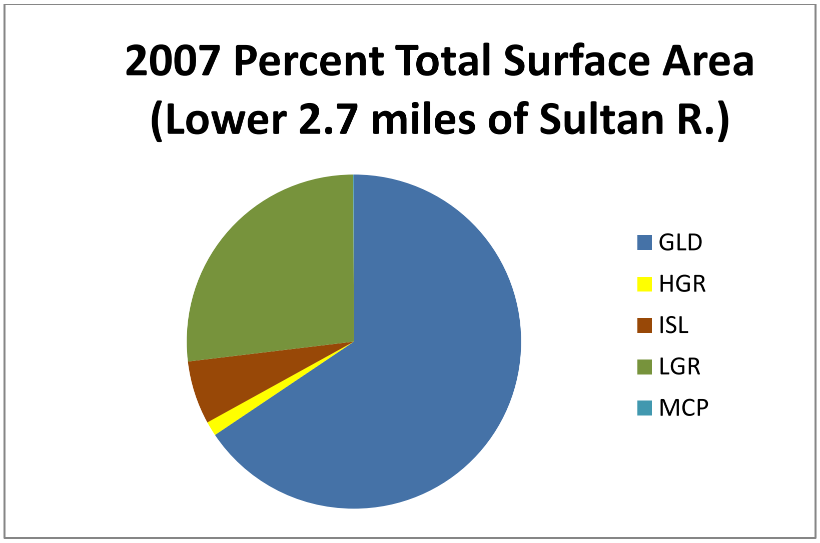


Figure 7. 2007 percent surface area per subtype for the lower 2.7 miles of the Sultan River. Habitat subtypes as described in Table 3: glide (GLD), HGR (high gradient riffle), island (ISL), low gradient riffle (LGR), and main channel pool (MCP).

5.1.1 Main channel

Mainstem habitat unit changes constituted ~10% of total bank length, along with localized changes in the vicinity of the engineered log jams. Specifically, the following changes were noted:

- three small side channels not previously mapped were observed at units 1-60 and 1-35 adding 747 ft of stream length and increasing wetted surface area by 16,004 ft^2;
- some bar edge lengths changed, resulting in net gains of 1,024 ft of left bar edge and 714 ft of right bar edge;
- undercut banks were no longer observed in 1-37;
- undercut lengths increased by 238 ft on the left bank and by 168 ft on the right bank due to the formation of undercuts at 1-35A and 1-92;
- seven large engineered log jams were installed to stabilize the entrances of the side channels and direct flow;
- small pools have either former or were constructed at the base of two of the installed jams; and
- the log jam at the mouth of SC-4 has accumulated additional wood beyond what was initially installed. The accumulation included 19 pieces and extends across the entrance to SC-4.

The engineered log jams have stabilized the entrances to the side channels and appear to be functioning to direct flow into the side channels, as all side channels contained flowing water with 320 cfs mainstem flows. The engineered debris jams have accumulated (and will likely continue to accumulate) additional large woody debris and contribute to habitat complexity over time.

5.1.2 Side channels

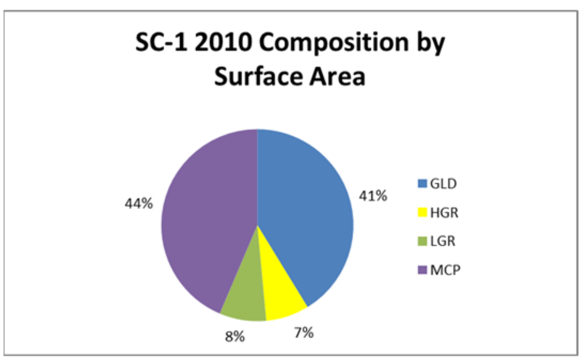
The four side channels vary in their complexity, with SC-2 and SC-3 being the most diverse with generally smaller and less uniform habitat units. SC-1 and SC-4 are homogenous, especially SC-4 which is 90% composed of one large, continuous glide. The enhancement of the side channels has led to increased habitats, even during low flows, as outlined in the results section. There has been a gain of 4,834 ft in low-flow stream channel length since 2007 (Table 16), adding habitat complexity and refugia. This gain comes through the reconnection (at lower flows) of the side channel extending south from habitat unit SC1-5, and containing SC1-1 and SC1-2. While this unit is currently primarily a largely homogenous run, it has abundant engineered LWD that provides cover, and over time should result in additional habitat complexity. Photos provided with the .kmz file will be useful in determining future changes to the side channels over time.

Table 16. Side channel length comparisons from 2010 and 2014 data.

Side channel	2007 and 2010 lengths (ft)	2014 digitized lengths (ft)	Difference
SC-1	2,512	5,744	3,232
SC-2	1,735	1,722	-13
SC-3	2,202	2,350	148
SC-4	No Data	1,467	1,467
Total gain or loss in side channels			**4,834**

SC-1

SC-1 was previously surveyed for habitat in 2010 before enhancements were made to the channel. This survey did not include the southerly extension (units SC1-1 and SC1-2 of the 2014 survey). In 2014, SC-1 was largely uniform, consisting mostly of glides with smaller amounts of pools and riffles (Figure 8). The pools mostly appear to have been constructed or have formed at installed large woody debris. There are some deeper areas beginning to form at large wood structures within the glides, and it is reasonable to expect that habitat complexity will increase with additional high-flow events.



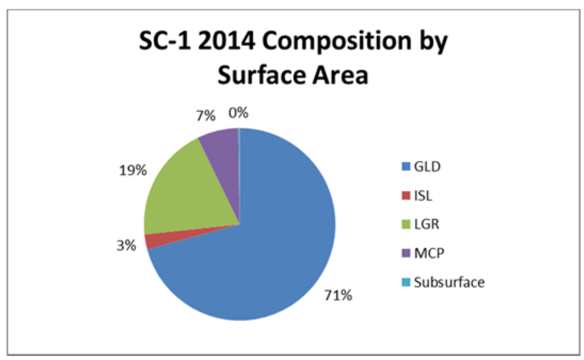


Figure 8. Comparison of SC-1 composition by surface area in 2010 and 2014.

In 2010, investigators mapped long contiguous areas of SC-1 as main channel pools, notably six contiguous pool units SC1-10 through SC1-15. In 2014, field observations indicated that this entire stretch should be mapped as a single glide unit (SC1-6), reflecting its homogeneous nature and the absence of any habitat enhancements between 2010 and 2014. There are many possible reasons for the characterization as pools in 2010 and glides in 2014: actual changes to the morphology of the side channels, higher water in 2010, and the inherent subjectivity of habitat typing, especially among slower-water habitat types (Poole et al. 1997). Therefore, we do not believe that these results necessarily indicate that there has been a significant loss of pool habitat in the side channels, and in any case juvenile salmonids are likely to use pools and slow glides in much the same way (especially if the habitats have a similar degree of cover). Thus, although the raw data show a loss of pool area, any actual effect on fish would be premature.

Likewise, in 2010, investigators quantified some riffles as high gradient. They chose to differentiate high- and low-gradient riffles to characterize variations in grade and substrate type. However, the 2010 "high-gradient" riffles did not approach the 4% grade threshold from Flosi et al. (1998) required to meet this definition; the same was true in 2014, and so this category was not mapped in the recent survey. Thus, the results do not indicate a loss of high gradient riffles between 2010 and 2014, only a change in classification criteria that is recommended to be maintained in all future surveys.

SC-2

SC-2 is more structurally complex than SC-1, with generally smaller and less uniform habitat units. Although not yet occurring, the new LWD structures are likely to accumulate additional large wood and may retain spawning gravels and initiate pool formation over time.

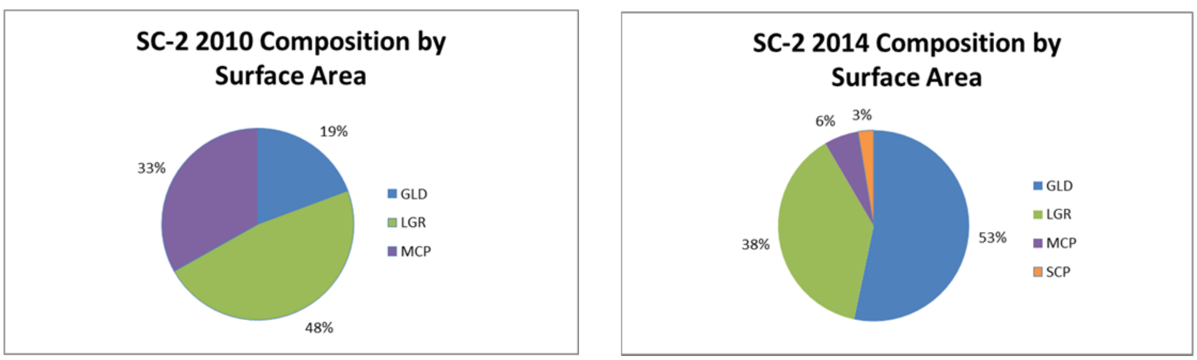


Figure 9. Comparison of SC-2 composition by surface area in 2010 and 2014.

In the 2014 habitat typing, individual units were generally smaller than in 2010, and adjacent units of the same types were not subdivided into separate units unless there was an intervening unit of sufficient extent to be mapped (for instance, two glides were not mapped as separate units unless there was an intervening pool or riffle). When comparing 2010 and 2014 by surface area, results show a loss of pool habitat and an increase in glide habitat, although this distinction is highly flow-dependent and could primarily reflect the higher flows during the 2010 survey rather than an actual loss of pool habitat (Figure 9).

Since 2010, there have been abundant wood structures (helicopter-placed logs) placed in many of these areas (i.e., mapped as pools in 2010 and as glide in 2014) at the north end of SC-2. Figures 10 and 11 illustrate two such areas near each other (SC2-5 in 2010 and SC2-15 in 2014).

Figure 10. Glide (SC2-15) with helicopter placed logs (2014).

Figure 11. Pool unit (SC2-5, 2010).

Given the large amount of wood placed throughout SC-2 and visual comparisons such as these, the greater degree of habitat complexity and more, smaller habitat units in 2014 is likely an accurate indication of actual habitat changes between the two survey years, rather than simply an artifact of different mapping techniques between crews, or differences in flow.

SC-3

In the Stillwater 2007 report, data for SC-3 were included in the OR1 mainstem reach. For this report, the side channel habitat unit data are reported as a separate reach (SC-3).

Since the last survey, SC-3 has had an engineered large wood structure installed. The composition in terms of surface area per subtypes is unchanged between 2010 and 2014 (Figure 12). However, a secondary channel, not previously mapped, was surveyed adjacent to unit 1-54; it measured 317 ft in length with a surface area of 2,821 ft^2. In addition, units 1-52 and 1-53 (previously mapped as a low-gradient riffle and a glide) could not be differentiated and were combined into a single low-gradient riffle. Additionally, the upstream 134 ft of unit 1-51 (previously mapped as a glide) was identified as a pool.

Additional changes in SC-3 since 2007 include:

- bar edge lengths increased for a net gain of 489 ft on the left bank and 219 ft on the right bank;
- undercut banks were no longer observed in unit 50;
- an island was formed at unit 1-54B;
- the length of the island at 1-55 was reduced by 83 ft ; and
- the length of the pool at 1-57 was reduced by 9 ft and its residual depth decreased by 4 ft.

The effects of these minor changes on habitat and fish carrying capacity are both positive and negative, and likely not large in aggregate.

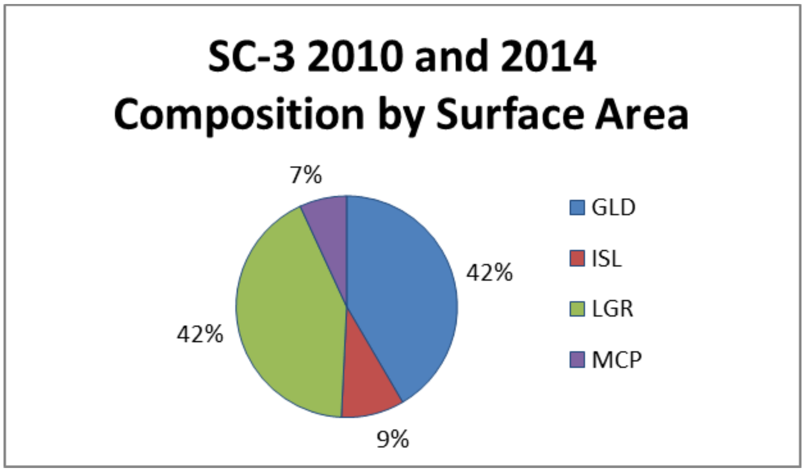


Figure 12. SC-3 composition by surface area in 2007 and 2014.

SC-4

SC-4 was not previously surveyed. SC-4 habitat conditions are homogeneous with one glide unit, one riffle unit, and a pool at its mouth.

5.2 Large Woody Debris Characteristics

There were some shifts in LWD distribution than can be best compared on the distribution maps and GIS layers from 2007 and 2014. In terms of number of pieces per mile, the amount of naturally occurring LWD in the mainstem of the Sultan River and SC-3 was little changed from 2007, with 35 pieces per mile in 2007 vs. 36 pieces per mile in 2014. The number of pieces tallied was very similar, with 120 pieces in 2014 and 107 in 2007. Most of the wood is individual pieces, with only two jams. One natural jam has formed at the mouth of SC-4 against an engineered log jam, and the other is unchanged from 2007. A jam recorded in 2007 on habitat unit 55 (an island), was not found by field staff in 2014. There were similar percentages of LWD present (primarily in Zone 2) in both survey years, with 56 % in 2014 and 55 % in 2007. The wood present was more decayed in 2014 than 2007, with 43% of the LWD classified in decay classes 4 or 5 in 2014, vs 22% in 2007. The amount of naturally occurring LWD in the lower 2.7 miles of the Sultan River and side channels is low and located on the stream margins. As such, it does little to contribute to fish habitat.

The engineered log jams and LWD placed since 2007 were designed to provide habitat complexity, divert water into the side channels, retain gravel, provide bank habitat at varying flows, and roughen the flood plain. The engineered jams represent a significant increase in LWD in the mainstem over levels observed in 2007 and have begun to contribute to habitat complexity through the formation of pools and the accumulation and retention of natural LWD, which has limited availability (due to the upstream dam) and/or may be flushed downstream and lost from the system.

In 2010, investigators noted only one debris jam (shown in photos as perched on the bank, and not extending into the wetted channel), two individual pieces of LWD, and “several locations of placed wood” in SC-1, and only seven pieces of LWD in SC-2. The habitat enhancements conducted since that time have contributed a very significant amount of LWD to the side channels.

The structures and logs in the side channels are providing cover for fish over a range of flows. Although most of the structures have not yet accumulated any additional large wood or led to the formation of pools, they are well-positioned to serve as a catalyst for habitat change (e.g. accumulation of addition wood, retention of gravel, and increasing habitat complexity in the side channels) in the future.

5.3 Sediment Characteristics

Only one pebble count was conducted in 2007 in the Study Reach, and its location was revisited for 2014 (Table 17).

Table 17. Comparison of approximate size distribution (in mm) of river substrate in the Study Reach for 2007 and 2014.

Year	Unit number	Stream substrate particle size (mm)		
		D_{16}	D_{50}	D_{84}
2007*	89	23	39	63
2014	89	22	51	84

* The size distributions for this site were erroneously reported in RSP 22; values reported here were recalculated from the raw field data.

As can be seen, the median and 84th percentile particle sizes were smaller in 2007 than were present in 2014. This could be due to actual change in the particle size, the pebble counts could have been conducted in a different portion of Unit 89, or the variability could be due to the imprecise nature of pebble count data. Olsen et al. (2005) found that it is difficult to reduce differences in pebble count metrics among observers below 10 to 15 percent, with additional variability introduced by substrate heterogeneity at a site, timing, and differences in substrate sample locations. Thus, it cannot be conclusively determined from only one paired measurement that the observed differences between 2007 and 2014 are due to an actual, systematic shift in substrate size.

6 REFERENCES

Edelen, W.J. 2005. A Technical glossary of stream & river stabilization, restoration, and bioengineering terms. www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/wapmctn6333.pdf.

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R. and Collins, B. California salmonid stream habitat restoration manual. 1998. 3rd ed. California Department of Fish and Game.

Kondolf, G. M. 2000. Assessing salmonid spawning gravels. Transactions of the American Fisheries Society 129: 262–281.

Kondolf, G. M., and M. G. Wolman. 1993. The sizes of salmonid spawning gravels. Water Resources Research 29: 2,275–2,285.

Lisle, T. E. 1987. Using “residual depths” to monitor pool depths independently of discharge. Research Note PSW-394. USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

Mongtomery, D. R., J. M. Buffington, R. D. Smith, K. M. Schmidt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research 4: 1,097–1,105.

Olsen, D. S., B. B. Roper, J. L. Kershner, R. Henderson, and E. Archer. 2005. Sources of variability in conducting pebble counts: their potential influence on the results of stream monitoring programs. Journal of the American Water Resources Association 41:1,225–1,236

Pleus, A. E., D. Schuett-Hames, and L. Bullchild. 1999. TFW monitoring program method manual for the habitat unit survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish and Wildlife Agreement. TFW-AM9-99-003; DNR#105.

Poole, G. C., Frissell, C. A., Ralph, S. C. 1997. In-stream habitat unit classification: inadequacies for monitoring and some consequences for management. Journal of the American Water Resources Association 33: 879-896.

Ralph, S. C., G. C. Poole, L. L. Conquest, and R. J. Naiman. 1994. Stream channel morphology and woody debris in logged and unlogged basins of Western Washington. Canadian Journal of Fisheries and Aquatic Sciences 51: 37–51.

Robison, E. G., and R. L. Beschta. 1990. Characteristics of coarse woody debris for several coastal streams of southeast Alaska, USA. Canadian Journal of Fisheries and Aquatic Sciences 47: 1,684–1,693.

Schuett-Hames, D., A. E. Pleus, J. Ward, M. Fox, and J. Light. 1999. TFW monitoring program method manual for the large woody debris survey. Prepared for the Washington State Deptartment of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-0004. DNR#106.

Wolman, G. M. 1954. A method of sampling coarse river-bed material. Transactions, American Geophysical Union 35, Number 6.

Appendix A

Field Data Sheets

Sultan River In-River Habitat Survey

Reach ______________________

NSO (cont) ______________________

BFW Criteria ______________________

Date ______________________

Form # ________ of ________

Crew ______________________

Recorder ______________________

QC

Date ______________________

QC'er ______________________

				Dimensions					Pool Data				Bar Edges		Undercut bank				
nso	**core** unit type	**sub** unit type	unit **category**	length (ft)	avg. depth(ft)	wet width1	wet width2	wet width3	Pool Out Depth	Pool Form Fact	Pool Max Depth	Dive (Y/N)	bar % left bank	bar % right bank	uc % left bank	uc width (ft)	uc % right bank	uc width (ft)	comments

Reaches

Operational Reaches

A	RM 0.0 - 2.7	Confluence with Skykomish River upstream to BPA transmission line crossing
B	RM 2.7 - 4.3	BPA transmission line crossing upstream to Jackson Powerhouse

Process Reaches

C	RM 4.3 - 9.7	Jackson Powerhouse upstream to City of Everett Diversion Dam
D	RM 9.7 - 16.5	City of Everett Diversion Dam upstream to Culmback Dam

Habitat Unit Codes

Core Unit Types

Riffle	R
Pool	P
Sub-surface flow	SSF
Wetland	W
Obscured	OB
Other	OT

Sub - unit types (Calif. salmonid stream restoration manual)

Pool	MCP	main channel pool	(e.g. trench pool, mid-channel pool, channel conf. pool, step pool)
	SCP	scour pool	(e.g. corner pool, scour enhanced by root wad - log - boulder)
	BKW	backwater pool	
Riffle	LGR	Low gradient riffle	
	HGR	High gradient riffle	
	GLD	Glide	
	CAS	Cascade	

Pool forming features (TFW pg 24)

1	LWD log(s)	7	channel bedform
2	LWD rootwad(s)	8	resistant bank
3	LWD jam	9	artificial bank
4	roots of standing trees or stump(s)	10	beaver dam
5	Boulder(s)	11	other / unknown
6	Bedrock		

Unit Category

1 primary units: dominant units in the mainchannel
2 secondary units: sub-dominant units within the main channel that span less than 50% of the wetted channel width along less than half their channel length
3 side channel units: units in smaller clearly defined channels that are separated from main low flow channel (say by an island for example)

LWD Single Pieces

Date ____________________

Reach ____________________

NSO (cont) ____________________

BFW ____________________

Form # ______ of ______

Crew ____________________

Recorder ____________________

	Diameter												KEY PIECES	
NSO	Rtwd diam ≥ 20cm	Small >20 to <40cm	Med ≥40 to <60cm	Large >60cm	Length (ft)	Zone 1 or 2	Mid-chan (Y/N)	Rtwd (Y/N)	Anchor R / P / B / U	Species Conf / Dec / Unk	Decay Class (1 - 5)		Key Piece #	Piece Diam (cm)

QC'D BY ____________________ **DATE:** ____________________

Sultan River LWD SURVEY
Debris Jams

Reach ____________________ Date ____________________ QC

NSO (cont) ____________________ Form # ________ of ________ OC'er ____________________

BFW Criteria ____________________ Recorder ____________________ Date ____________________

LWD DEBRIS JAMS

						DJ Largest Piece			DJ Dimensions		
NSO	Jam #	Lowest Zone (1or2)	Mid-Chan (Y/N)	Tally Rtwd diam ≥ 20cm	Tally Pieces Approx ≥20 cm	Key Piece#	Diam (cm)	Length (ft)	DJ Length (ft)	DJ Width (ft)	DJ Height (ft)

LWD Hab Survey Codes
Descriptions

ZONE 1 defined as the portion of the bankfull channel that is wetted at the time of the survey, regardless of whether the water is flowing or stagnant

ZONE 2 defined as the area between the bankfull channel edge on both banks, below an imaginary line that connects those points, above the wetted gravel bars channel surface, and includes areas such as dry

ZONE 3 the area vertically above Zone 2, the bankfull channel

ZONE 4 area outside of the bankfull channel and Zone 3

LWD Log Criteria
1 dead
2 the root system (if present) no longer supports the weight of the stem / bole
3 minimum diameter of 0.1 meters along 2 meters of its length, AND
4 minimum 0.1 meter of length extending into the bankfull channel

LWD Rootwad Criteria
1 dead
2 root system detached from original position
3 minimum diameter of 0.2 meters with a total length <2 meters; AND,
4 minimum 0.1 meter of length extending into the bankfull channel

LWD Jam Identification
1 minimum 10 qualifying pieces of LWD either physically touching at one or more points, or associated with jam structure
2 minimum 0.1 meter of one LWD piece's length extending into the bankfull channel

KEY PIECE CRITERIA
See pg 17 and Appendix C of TFW Large Woody Debris Survey Manual

Sultan River Habitat Survey Wolmann Pebble Count

Date ______________
Reach ______________
NSO ______________ BFW (m) __________
FeatureID ______________

	size (mm)	Count	Total #
Mud Silt	<2		
Fine Sand	<2		
Sand	2 - 4		
G	4 - 6		
R	6 - 8		
A	8 - 12		
V	12 - 16		
E	16 - 22		
L	22 - 32		
S	32 - 45		
	45 - 64		
C	64 - 90		
O	90 - 128		
B	128 - 180		
B	180 - 256		
B	256 - 362		
L	362 - 512		
D	512 - 1024		
R	1024 - 2048		
S	2048 - 4096		
Bdrck	Bedrock		

Total =

Comments:

Date ______________
Reach ______________
NSO ______________ BFW (m) __________
Feature# ______________

	size (mm)	Count	Total #
Mud Silt	<2		
Fine Sand	<2		
Sand	2 - 4		
G	4 - 6		
R	6 - 8		
A	8 - 12		
V	12 - 16		
E	16 - 22		
L	22 - 32		
S	32 - 45		
	45 - 64		
C	64 - 90		
O	90 - 128		
B	128 - 180		
B	180 - 256		
B	256 - 362		
L	362 - 512		
D	512 - 1024		
R	1024 - 2048		
S	2048 - 4096		
Bdrck	Bedrock		

Total =

Comments:

Sultan River Hab Survey
Aerial Photo Mapping: Landmark / Photo / Comments Log

Date: ____

River Reach: ____

Form _____of _____

Comments	**NSO**	**ID / Item#**	**Photo#**	**GPS ID Info**

Appendix B

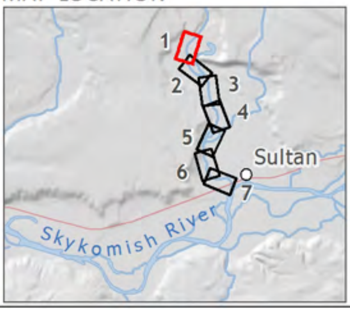
Maps Illustrating 2014 Habitat Units

SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- Low-gradient riffle
- Rapid
- Island
- Main channel pool
- Subsurface flow

MAP LOCATION



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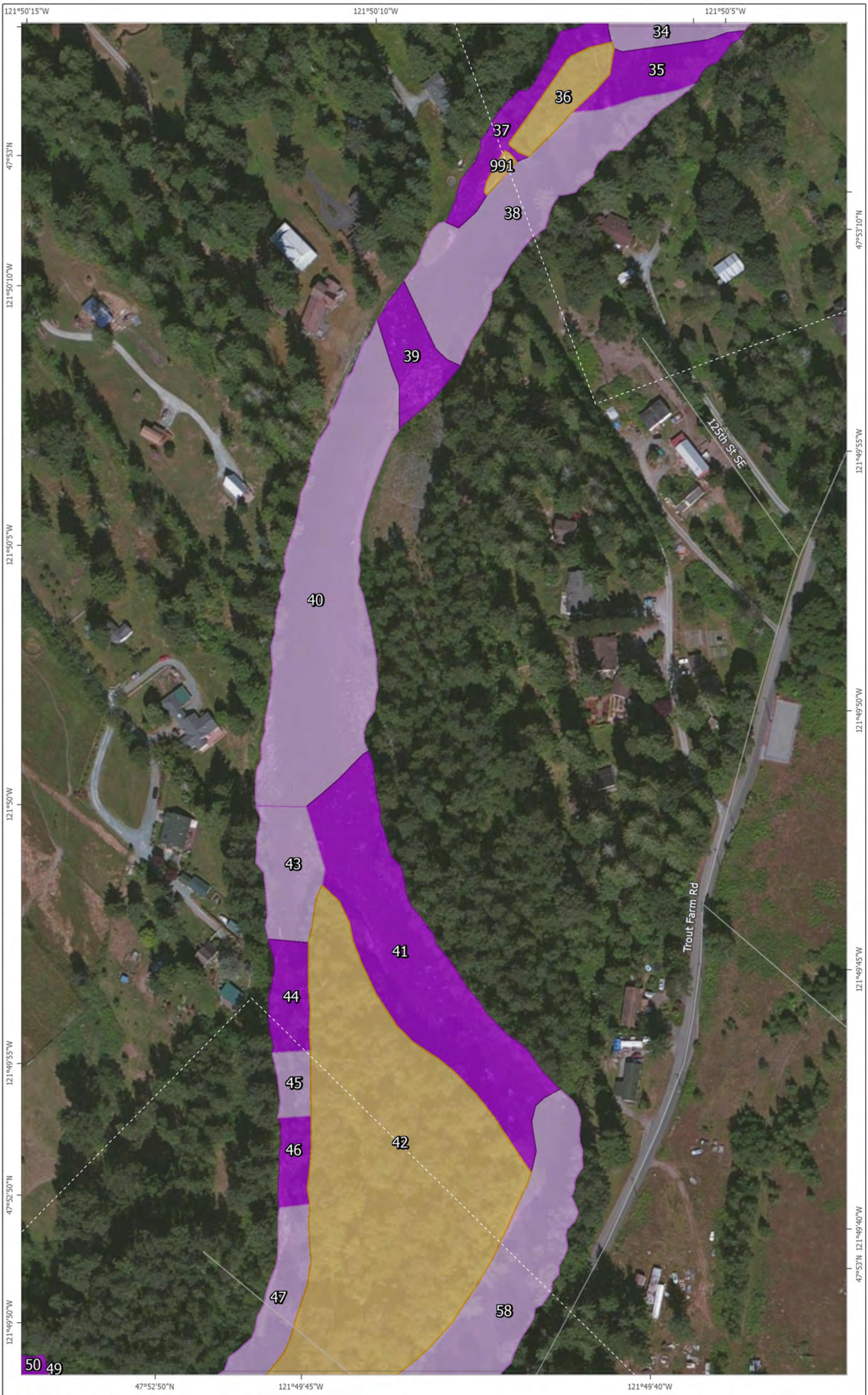
0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
www.stillwatersci.com

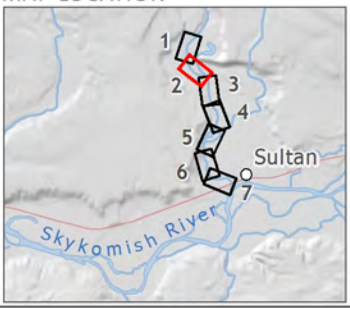


SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

Glide | Low-gradient riffle | Rapid
Island | Main channel pool | Subsurface flow

MAP LOCATION



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1:2,100 1 in = 175 feet

DATA SOURCES
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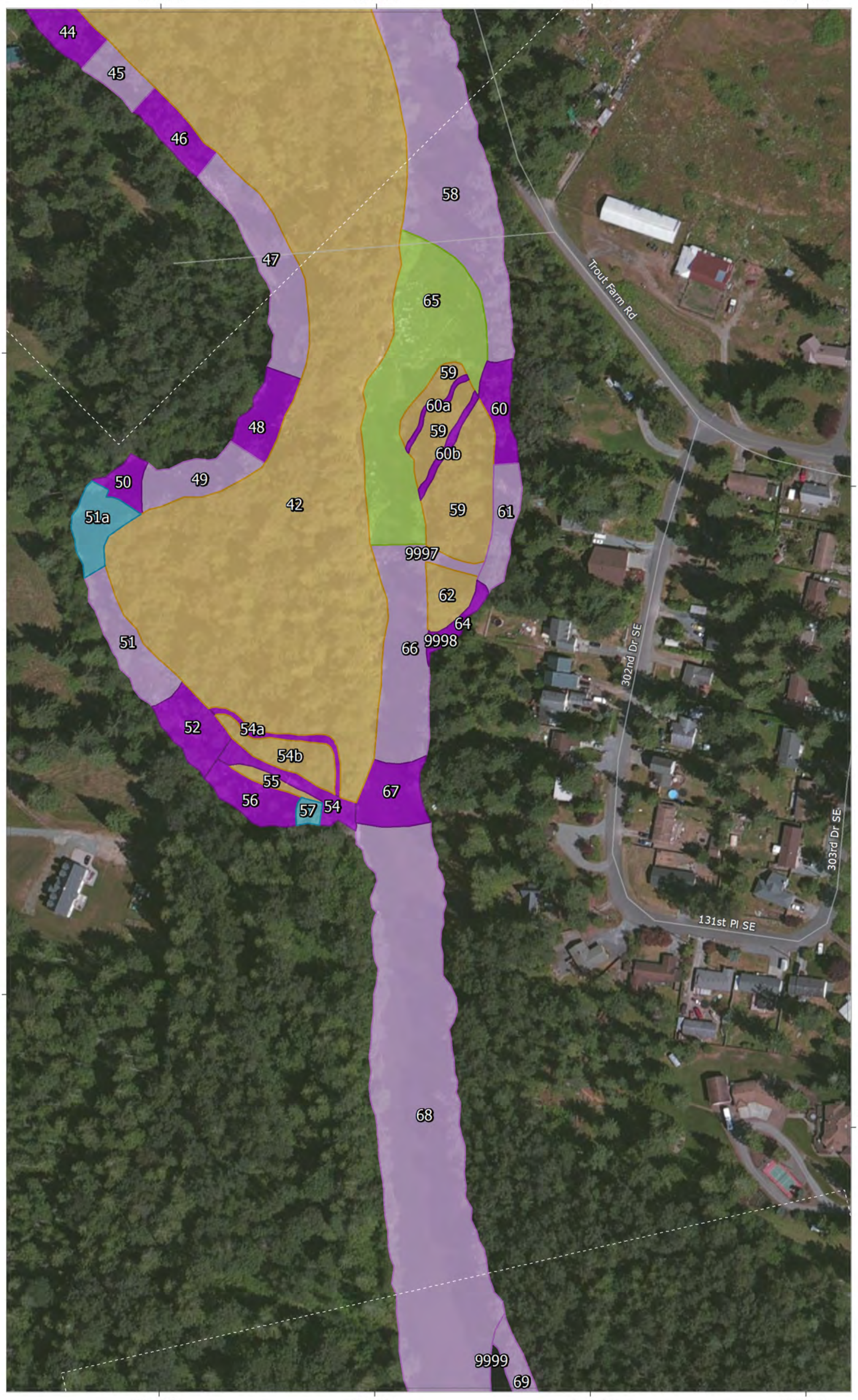
Roads: ESRI 2014

Stillwater Sciences
www.stillwatersci.com

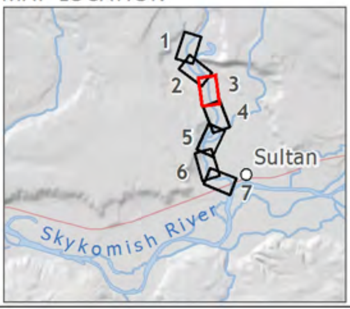


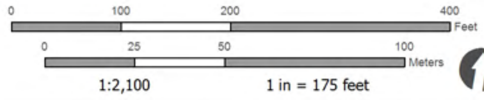
SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

Glide · Low-gradient riffle · Rapid · Island · Main channel pool · Subsurface flow

MAP LOCATION





1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

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SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

Glide | Low-gradient riffle | Rapid

Island | Main channel pool | Subsurface flow

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- Low-gradient riffle
- Rapid
- Island
- Main channel pool
- Subsurface flow

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,130 1 in = 178 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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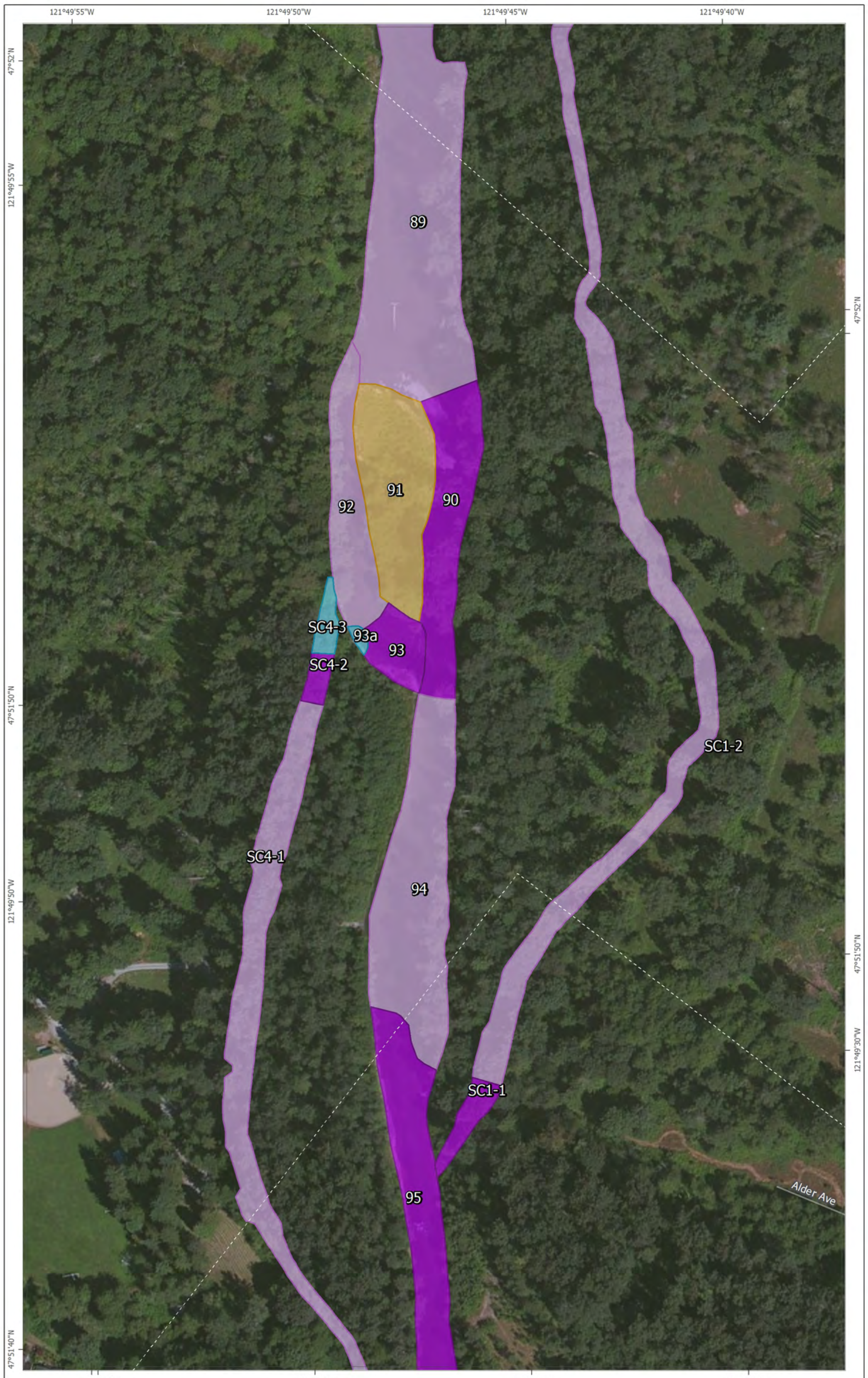

SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- Low-gradient riffle
- Rapid
- Island
- Main channel pool
- Subsurface flow

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

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SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- Low-gradient riffle
- Rapid
- Island
- Main channel pool
- Subsurface flow

MAP LOCATION

0 100 200 400 Feet
0 25 50 100 Meters
1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

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Appendix C

Maps Illustrating Large Woody Debris

SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

LWD count by Habitat Unit

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 10
- 11 - 20
- 20 - 25

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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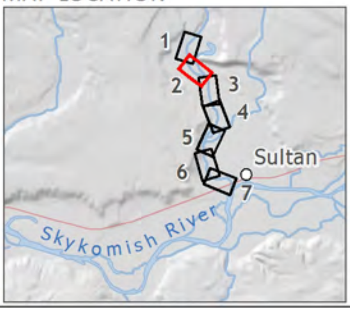
SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

MAP LOCATION



LWD count by Habitat Unit

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 10
- 11 - 20
- 20 - 25

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

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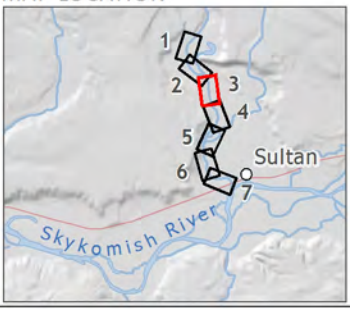
SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

LWD count by Habitat Unit

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 10
- 11 - 20
- 20 - 25

MAP LOCATION



0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

LWD count by Habitat Unit

0 | 4 - 7 | 20 - 25
1 | 8 - 10
2 - 3 | 11 - 20

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

MAP LOCATION

LWD count by Habitat Unit

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 10
- 11 - 20
- 20 - 25

0 100 200 400 Feet

0 25 50 100 Meters

1:2,130 1 in = 178 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

LWD count by Habitat Unit

- 0
- 1
- 2 - 3
- 4 - 7
- 8 - 10
- 11 - 20
- 20 - 25

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
www.stillwatersci.com

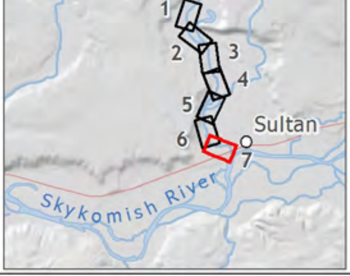
SULTAN RIVER LARGE WOODY DEBRIS

Large Woody Debris (LWD)

LWD count by Habitat Unit

0 | 1 | 2 - 3 | 4 - 7 | 8 - 10 | 11 - 20 | 20 - 25

MAP LOCATION



0 100 200 400 Feet

0 25 50 100 Meters

1:2,100 1 in = 175 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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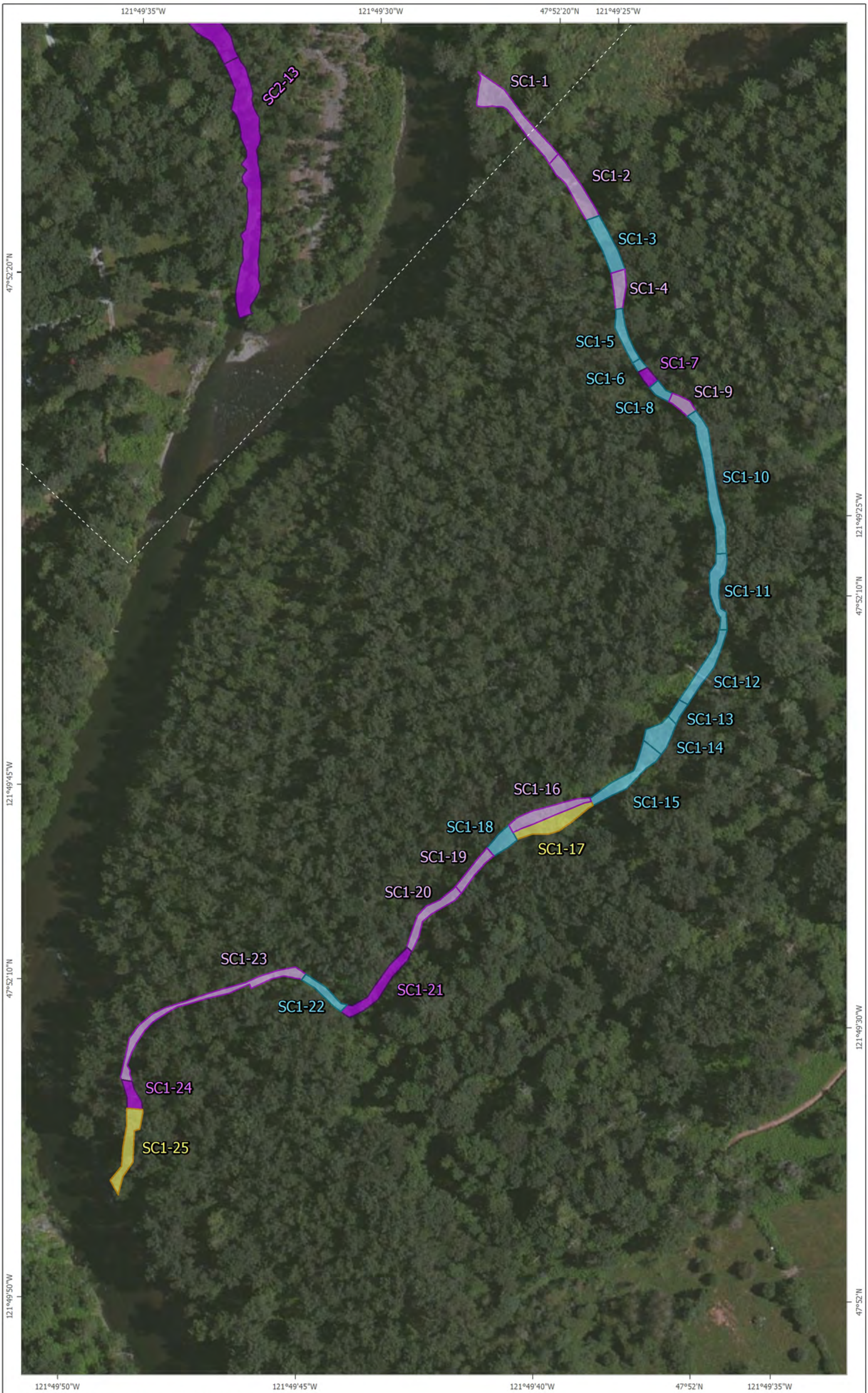
Appendix D

Maps Illustrating 2010 Habitat Units



SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- High-gradient riffle
- Low-gradient riffle
- Main channel pool

MAP LOCATION

0 100 200 400 Feet

0 25 50 100 Meters

1:2,030 1 in = 169 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

Stillwater Sciences
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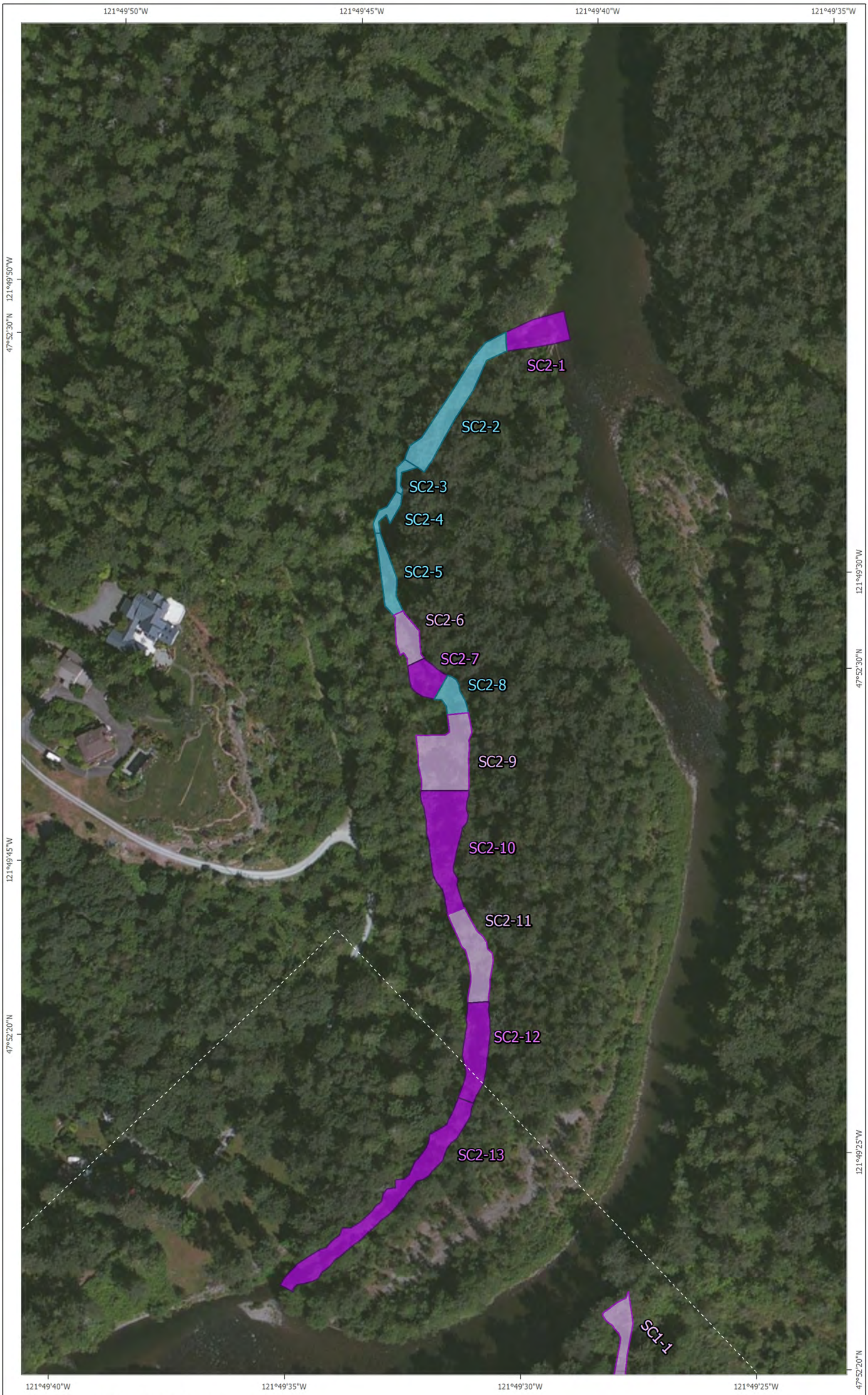

SULTAN RIVER LARGE WOODY DEBRIS

Habitat Types

- Glide
- High-gradient riffle
- Low-gradient riffle
- Main channel pool

MAP LOCATION

0 100 200 400 Feet
0 25 50 100 Meters
1:2,000 1 in = 167 feet

DATA SOURCES
Imagery: ESRI World Mapping Service
Roads: ESRI 2014

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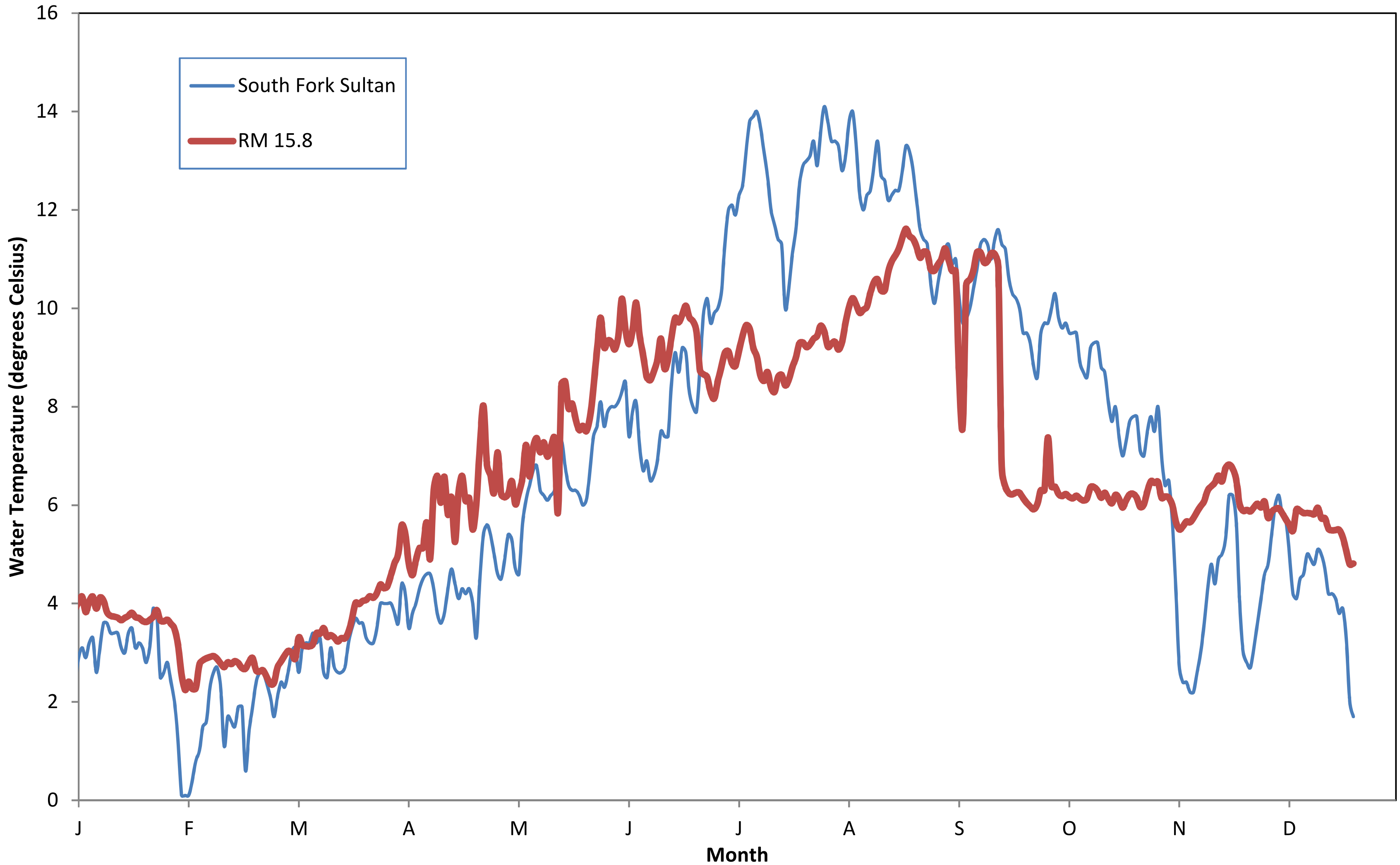
APPENDIX B

2014 Water Temperature Figures

Figure B-1. Mean Daily Water Temperature in the South Fork Sultan River, upstream of Culmback Dam (RM 18.2), and in the mainstem Sultan River immediately downstream of Culmback Dam (RM 15.8) during 2014



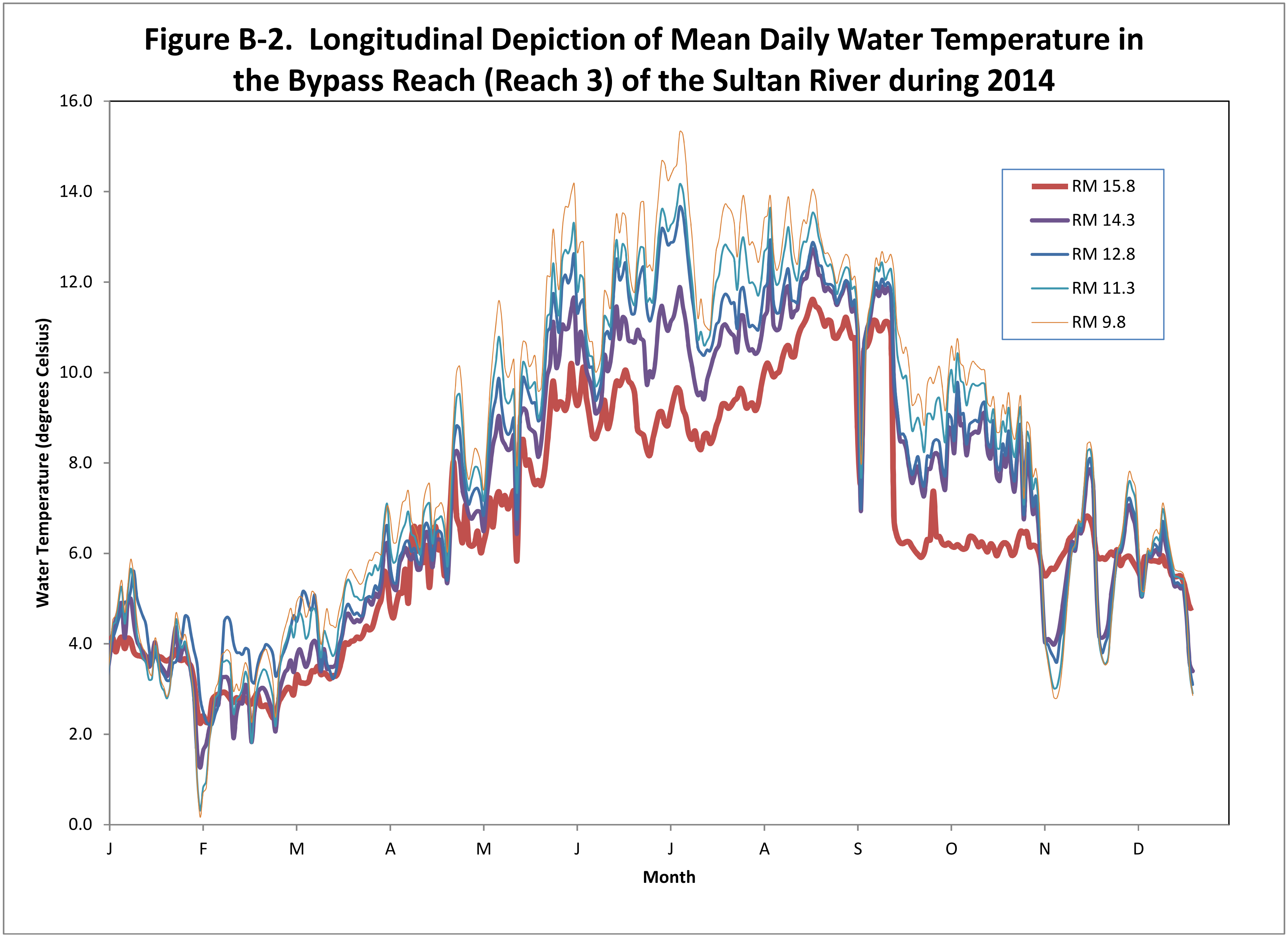
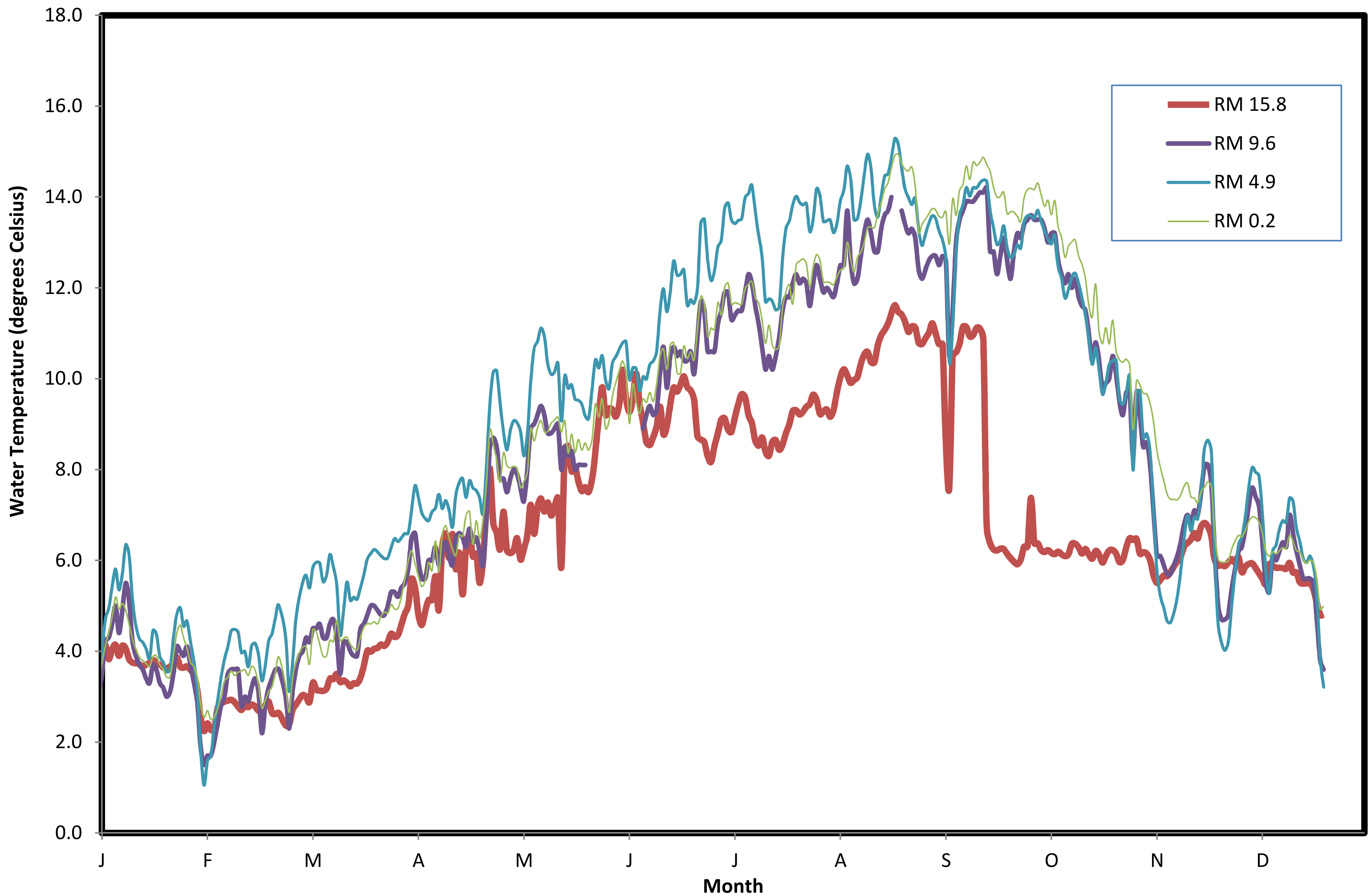


Figure B-2. Longitudinal Depiction of Mean Daily Water Temperature in the Bypass Reach (Reach 3) of the Sultan River during 2014
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Water Temperature (degrees Celsius)
J
F
M
A
M
J
J
A
S
O
N
D
Month
RM 15.8
RM 14.3
RM 12.8
RM 11.3
RM 9.8

Figure B-3. Longitudinal Depiction of Mean Daily Water Temperature, Sultan River downstream of Culmback Dam, 2014



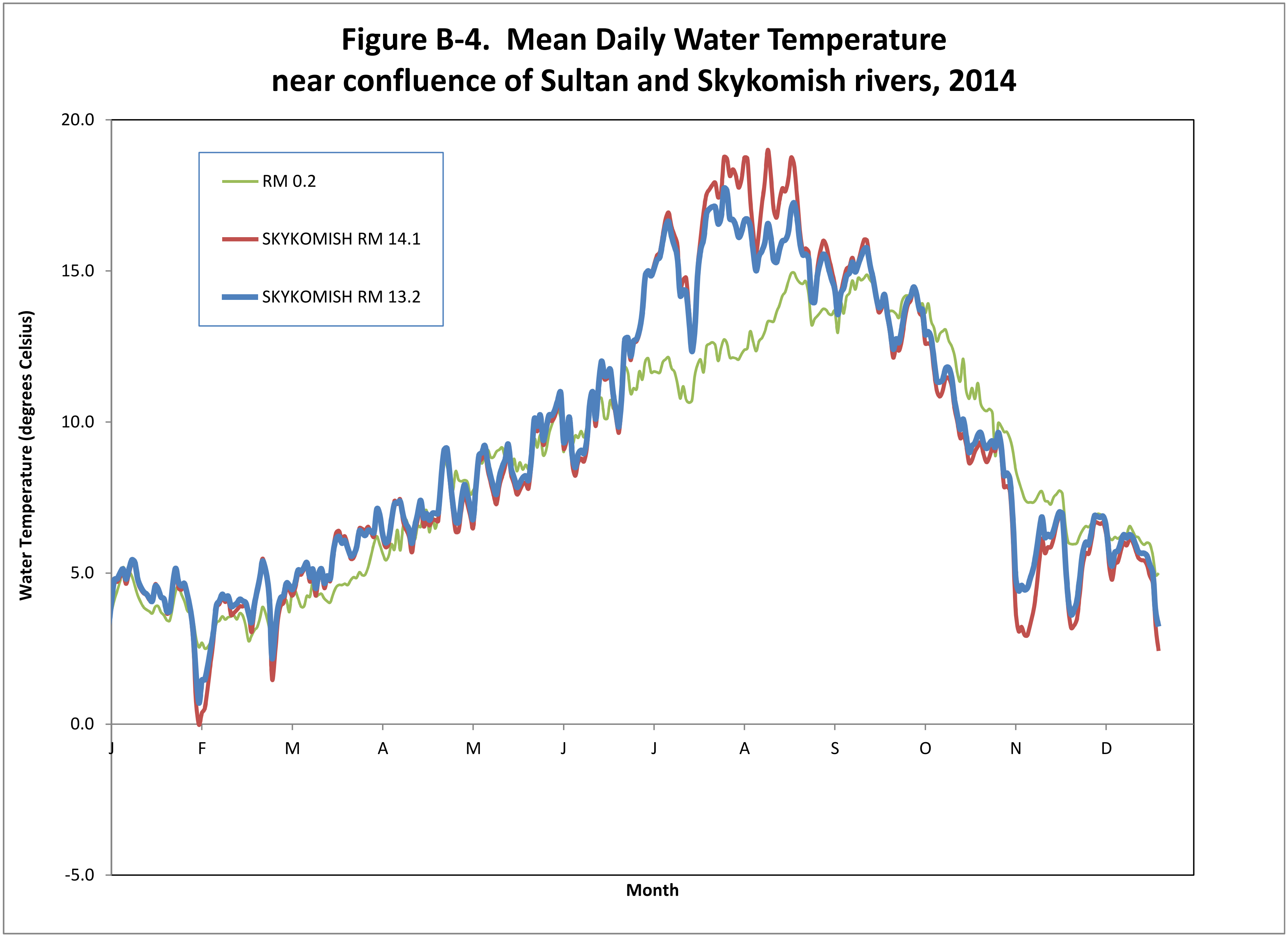


Figure B-4. Mean Daily Water Temperature
near confluence of Sultan and Skykomish rivers, 2014
RM 0.2
SKYKOMISH RM 14.1
SKYKOMISH RM 13.2
Water Temperature (degrees Celsius)
20.0
15.0
10.0
5.0
0.0
-5.0
J
F
M
A
M
J
J
A
S
O
N
D
Month

APPENDIX C

2014 Mean Daily Water Temperature Data in Tabular Format

	Sultan River											Skykomish River	
DATE	RM 18.2 (SFK)	RM 15.8	RM 14.3	RM 12.8	RM 11.3	RM 9.8	RM 9.6	RM 4.9	RM 4.4	RM 0.2	Big Four Creek	RM 14.1	RM 13.2
1/1	3.2	4.1	4.3	4.4	4.3	4.6	4.1	4.8	4.4	4.4	4.5	4.8	4.9
1/2	3.5	4.2	4.5	4.3	4.6	4.7	4.2	5.0	4.5	4.5	5.0	4.9	5.0
1/3	3.0	3.8	4.3	4.6	4.5	4.7	4.2	5.0	4.7	4.6	4.6	4.9	5.0
1/4	2.3	3.7	3.4	4.7	3.5	4.1	3.6	4.1	4.0	4.0	3.9	4.0	4.1
1/5	2.0	3.8	3.0	4.3	2.9	3.3	3.1	3.3	3.4	3.4	3.5	3.0	3.2
1/6	2.4	3.9	3.3	4.0	3.0	3.2	3.1	3.3	3.4	3.4	3.7	3.1	3.3
1/7	2.9	4.0	3.7	4.0	3.7	3.7	3.5	4.0	3.7	3.7	4.3	4.0	4.1
1/8	3.1	4.1	4.2	4.1	4.4	4.5	4.2	4.7	4.3	4.1	4.8	4.7	4.8
1/9	2.9	3.8	4.5	4.3	4.5	4.6	4.3	4.9	4.7	4.4	4.7	4.7	4.8
1/10	3.2	4.0	4.7	4.5	4.9	5.1	4.6	5.4	5.0	4.7	5.0	4.9	5.0
1/11	3.3	4.1	4.9	4.8	5.3	5.4	5.0	5.8	5.6	5.2	5.2	5.0	5.1
1/12	2.6	3.9	4.1	4.9	4.4	4.7	4.4	5.4	5.1	4.9	4.7	4.6	4.8
1/13	3.1	4.1	4.9	4.9	5.1	5.3	4.9	5.7	5.3	5.1	5.3	5.0	5.1
1/14	3.6	4.1	5.0	5.2	5.7	5.9	5.5	6.3	5.0	4.9	5.6	5.3	5.4
1/15	3.6	3.8	4.5	5.6	5.2	5.5	5.1	6.1	4.6	4.6	5.3	5.3	5.4
1/16	3.4	3.7	4.1	5.0	4.2	4.5	4.2	5.1	4.2	4.3	5.0	4.7	4.8
1/17	3.4	3.7	3.9	4.8	3.9	4.1	3.9	4.6	3.9	4.0	4.9	4.5	4.5
1/18	3.4	3.7	3.8	4.6	3.7	3.9	3.7	4.3	3.7	3.9	4.8	4.3	4.4
1/19	3.1	3.7	3.7	4.4	3.6	3.8	3.6	4.2	3.7	3.8	4.4	4.3	4.3
1/20	3.0	3.7	3.5	3.9	3.2	3.4	3.4	4.0	3.6	3.7	4.0	4.1	4.2
1/21	3.4	3.7	3.7	3.5	3.2	3.3	3.3	3.8	3.6	3.7	4.3	4.1	4.1
1/22	3.5	3.8	4.0	3.7	4.0	4.1	3.7	4.5	3.7	3.9	4.7	4.6	4.6
1/23	3.1	3.7	3.7	3.8	3.6	3.8	3.6	4.4	3.8	3.9	4.3	4.4	4.5
1/24	3.2	3.7	3.5	3.4	3.1	3.2	3.3	3.9	3.7	3.7	4.5	4.2	4.2
1/25	3.1	3.6	3.4	3.3	3.0	3.0	3.2	3.8	3.6	3.6	4.5	4.2	4.1
1/26	2.8	3.6	3.3	3.2	2.8	2.8	3.0	3.5	3.4	3.4	4.2	3.7	3.7
1/27	3.1	3.7	3.5	3.2	3.1	3.0	3.1	3.6	3.4	3.4	4.2	3.7	3.7
1/28	3.9	3.7	4.0	3.6	3.9	4.0	3.5	4.3	3.8	3.9	4.7	4.6	4.6
1/29	3.8	3.9	4.4	3.6	4.5	4.7	4.1	4.8	4.3	4.4	5.2	5.1	5.2
1/30	2.5	3.7	3.7	3.9	4.1	4.4	4.0	5.0	4.5	4.6	4.9	4.5	4.7
1/31	2.6	3.6	3.8	4.2	3.9	4.1	3.9	4.6	4.2	4.3	4.6	4.4	4.6

	Sultan River											Skykomish River	
DATE	RM 18.2 (SFK)	RM 15.8	RM 14.3	RM 12.8	RM 11.3	RM 9.8	RM 9.6	RM 4.9	RM 4.4	RM 0.2	Big Four Creek	RM 14.1	RM 13.2
2/1	2.8	3.7	4.0	4.6	4.1	4.2	4.1	4.7	4.1	4.1	4.4	4.7	4.7
2/2	2.4	3.6	3.7	4.6	3.7	3.9	3.7	4.2	3.7	3.8	3.9	4.3	4.3
2/3	2.0	3.5	3.4	4.2	3.3	3.4	3.3	3.8	3.6	3.7	3.2	3.7	3.8
2/4	1.2	3.2	2.8	3.8	2.6	2.7	2.9	3.1	3.4	3.4	2.4	2.8	3.1
2/5	0.1	2.6	1.6	3.5	1.0	1.0	1.9	1.8	3.0	2.8	0.8	0.7	1.6
2/6	0.1	2.2	1.3	2.8	0.3	0.2	1.5	1.1	2.6	2.5	0.4	0.0	0.7
2/7	0.1	2.4	1.6	2.5	0.8	0.7	1.7	1.6	2.6	2.7	0.6	0.4	1.5
2/8	0.4	2.3	1.8	2.3	1.0	0.8	1.7	1.7	2.4	2.5	0.8	0.5	1.5
2/9	0.8	2.3	2.1	2.2	1.8	1.8	2.0	2.4	2.4	2.6	1.2	1.2	1.9
2/10	1.0	2.8	2.4	2.2	2.3	2.4	2.4	2.9	2.5	2.7	1.7	2.0	2.5
2/11	1.5	2.8	2.8	2.4	2.8	3.0	2.8	3.4	2.8	3.0	2.3	2.8	3.1
2/12	1.6	2.9	2.6	2.7	2.9	3.2	3.0	3.8	3.3	3.3	2.9	3.9	3.9
2/13	2.3	2.9	3.2	3.4	3.6	3.7	3.5	4.1	3.4	3.4	3.4	4.0	4.1
2/14	2.6	2.9	3.3	4.5	3.6	3.8	3.6	4.4	3.6	3.6	3.6	4.2	4.3
2/15	2.7	2.9	3.3	4.6	3.6	3.9	3.6	4.5	3.6	3.5	3.7	4.0	4.1
2/16	2.3	2.8	3.0	4.5	3.5	3.8	3.6	4.4	3.8	3.5	3.5	4.1	4.2
2/17	1.1	2.7	1.9	4.0	2.5	3.0	2.8	4.0	3.6	3.6	3.4	3.6	3.9
2/18	1.7	2.8	2.4	3.8	2.8	3.1	3.0	4.0	3.7	3.6	3.4	3.7	3.9
2/19	1.6	2.8	2.7	3.8	2.8	3.0	2.9	3.7	3.4	3.5	3.1	3.8	4.0
2/20	1.5	2.8	2.7	3.8	3.0	3.3	3.2	4.1	3.7	3.7	3.2	3.9	4.1
2/21	1.9	2.8	3.1	3.9	3.4	3.6	3.4	4.2	3.7	3.6	3.3	3.9	4.1
2/22	1.9	2.7	2.8	3.9	3.1	3.4	3.1	3.9	3.4	3.3	3.0	4.0	4.0
2/23	0.6	2.7	1.8	3.2	1.8	2.3	2.2	3.4	2.7	2.8	2.3	3.7	3.7
2/24	1.4	2.8	2.5	3.1	2.6	2.9	2.8	3.7	2.9	2.9	3.0	3.0	3.4
2/25	1.9	2.9	2.9	3.5	3.1	3.4	3.2	4.2	3.2	3.1	3.3	3.8	3.9
2/26	2.4	2.6	3.0	3.8	3.3	3.6	3.4	4.4	3.5	3.2	3.6	4.5	4.4
2/27	2.6	2.6	3.0	3.9	3.4	3.8	3.6	4.7	3.9	3.5	3.7	5.0	4.9
2/28	2.6	2.6	2.9	4.0	3.4	3.9	3.6	5.0	4.2	3.9	4.0	5.5	5.4

	Sultan River											Skykomish River	
DATE	RM 18.2 (SFK)	RM 15.8	RM 14.3	RM 12.8	RM 11.3	RM 9.8	RM 9.6	RM 4.9	RM 4.4	RM 0.2	Big Four Creek	RM 14.1	RM 13.2
3/1	2.1	2.4	2.5	3.8	2.8	3.2	3.0	4.3	3.6	3.2	3.4	4.3	4.3
3/2	1.7	2.4	2.1	3.3	2.2	2.4	2.3	3.1	2.7	2.7	2.9	1.5	2.2
3/3	2.1	2.7	2.8	3.4	3.2	3.4	3.1	3.7	3.5	3.4	3.8	2.2	2.9
3/4	2.4	2.8	3.1	3.7	3.7	4.0	3.6	4.7	3.9	3.7	4.2	3.4	3.8
3/5	2.3	2.9	3.4	3.9	4.0	4.3	3.9	5.2	4.1	4.0	4.7	3.9	4.2
3/6	2.6	3.0	3.4	4.1	4.2	4.6	4.0	5.5	4.2	4.1	4.9	4.0	4.3
3/7	3.0	3.0	3.6	4.4	4.4	4.8	4.3	5.7	4.1	4.1	5.0	4.5	4.7
3/8	3.1	2.9	3.4	4.6	4.1	4.5	4.2	5.4	3.6	3.7	5.0	4.4	4.6
3/9	2.6	3.3	3.7	4.5	4.5	4.9	4.5	5.8	4.9	4.5	5.4	4.3	4.5
3/10	3.1	3.2	3.9	4.8	4.7	5.0	4.5	6.0	4.4	4.4	5.2	4.5	4.7
3/11	3.2	3.1	3.7	5.2	4.5	5.0	4.6	5.9	4.0	4.2	5.0	5.0	5.1
3/12	3.2	3.1	3.5	5.1	4.1	4.6	4.3	5.5	3.7	3.9	4.9	4.9	5.1
3/13	3.4	3.2	3.6	4.8	4.2	4.7	4.3	5.7	3.7	3.9	5.0	5.1	5.2
3/14	3.2	3.4	4.0	4.7	4.8	5.2	4.6	6.1	4.2	4.2	5.5	5.2	5.3
3/15	3.3	3.4	4.1	5.1	4.8	5.1	4.7	5.9	4.1	4.2	5.4	4.7	4.9
3/16	2.6	3.5	3.9	4.3	4.4	4.7	4.3	5.5	4.8	4.7	5.3	5.0	5.1
3/17	2.5	3.3	3.4	3.4	3.7	4.0	3.5	4.4	4.1	4.2	4.4	4.3	4.5
3/18	3.1	3.4	3.9	3.8	4.3	4.3	4.2	4.9	4.1	4.3	4.7	4.8	5.0
3/19	2.7	3.3	3.5	3.6	4.1	4.8	4.2	5.5	4.2	4.3	4.6	5.0	5.1
3/20	2.6	3.2	3.5	3.4	3.9	4.4	4.0	5.1	4.0	4.2	4.2	4.5	4.7
3/21	2.6	3.3	3.5	3.2	3.7	4.4	3.9	5.2	3.9	4.1	4.0	4.8	4.9
3/22	2.7	3.3	3.6	3.4	3.9	4.4	3.9	5.1	3.8	4.0	4.1	4.7	4.8
3/23	3.2	3.4	3.9	3.9	4.4	4.7	4.5	5.4	4.0	4.3	4.4	5.8	5.7
3/24	3.5	3.7	4.2	4.2	4.7	5.0	4.6	5.7	4.2	4.5	4.9	6.3	6.1
3/25	3.7	4.0	4.6	4.7	5.2	5.4	4.8	6.0	4.4	4.6	5.6	6.4	6.2
3/26	3.6	4.0	4.7	4.9	5.4	5.6	5.0	6.1	4.4	4.6	5.4	6.1	6.0
3/27	3.6	4.1	4.6	4.8	5.3	5.6	5.0	6.2	4.4	4.6	5.3	6.2	6.1
3/28	3.3	4.1	4.5	4.6	5.1	5.5	4.9	6.2	4.4	4.6	5.4	5.9	5.8
3/29	3.2	4.1	4.5	4.7	5.0	5.4	4.8	6.1	4.6	4.8	5.3	5.5	5.6
3/30	3.2	4.1	4.5	4.6	5.0	5.3	4.8	6.0	4.7	4.9	5.2	5.5	5.6
3/31	3.5	4.2	4.6	4.6	5.0	5.4	5.0	6.1	4.6	4.8	5.1	5.8	5.8

	Sultan River											Skykomish River	
DATE	RM 18.2 (SFK)	RM 15.8	RM 14.3	RM 12.8	RM 11.3	RM 9.8	RM 9.6	RM 4.9	RM 4.4	RM 0.2	Big Four Creek	RM 14.1	RM 13.2
4/1	4.0	4.4	5.0	5.0	5.4	5.6	5.3	6.3	4.7	5.0	5.5	6.5	6.4
4/2	4.0	4.3	4.9	5.0	5.6	5.8	5.3	6.5	4.7	4.9	5.5	6.5	6.3
4/3	4.0	4.4	4.9	5.0	5.5	5.8	5.2	6.4	4.7	4.9	5.5	6.4	6.2
4/4	4.0	4.6	5.1	5.3	5.7	6.0	5.4	6.5	5.0	5.2	5.7	6.5	6.4
4/5	3.8	4.8	5.0	5.2	5.6	6.0	5.5	6.6	5.4	5.6	5.7	6.3	6.4
4/6	3.6	5.0	5.3	5.5	5.9	6.0	5.8	6.6	5.8	6.0	5.9	6.2	6.3
4/7	4.4	5.6	6.1	6.4	6.7	6.5	6.5	7.1	5.9	6.2	6.6	7.0	7.1
4/8	4.2	5.4	6.2	6.6	7.1	7.0	6.6	7.6	5.7	5.9	7.0	6.8	6.9
4/9	3.5	4.8	5.6	5.7	6.2	6.8	6.0	7.4	5.5	5.6	6.1	6.2	6.3
4/10	3.8	4.6	5.3	5.4	5.8	6.2	5.6	7.0	5.2	5.4	5.7	5.9	6.0
4/11	4.0	4.9	5.2	5.3	5.9	6.2	5.6	6.9	5.4	5.6	5.9	5.9	6.1
4/12	4.3	5.1	5.8	5.9	6.3	6.7	6.0	6.9	5.7	6.0	5.9	6.7	6.7
4/13	4.5	5.1	5.9	6.0	6.5	7.1	6.0	7.1	5.5	5.8	6.0	7.4	7.3
4/14	4.6	5.6	6.1	6.2	6.7	7.2	6.3	7.2	6.1	6.4	6.4	7.3	7.3
4/15	4.6	4.9	5.9	6.3	6.9	7.4	5.9	7.5	5.6	5.7	6.3	7.4	7.4
4/16	4.3	6.3	5.9	6.0	6.4	6.7	6.2	7.1	6.6	6.6	6.4	6.7	6.9
4/17	3.8	6.6	6.0	6.1	6.4	6.6	6.4	7.3	6.8	6.8	6.4	6.4	6.6
4/18	3.6	6.1	5.6	5.8	6.2	6.4	6.1	7.1	6.6	6.5	6.0	6.2	6.4
4/19	3.8	6.6	5.7	5.8	6.0	6.2	5.9	6.7	6.2	6.3	6.0	5.7	6.0
4/20	4.3	5.8	6.2	6.5	6.8	7.1	6.5	7.4	6.0	6.1	6.3	6.4	6.5
4/21	4.7	6.2	6.5	6.7	7.1	7.4	6.6	7.7	6.6	6.6	6.5	6.8	7.0
4/22	4.4	5.3	6.2	6.5	7.1	7.5	6.5	7.8	6.6	6.5	6.2	7.2	7.4
4/23	4.1	6.3	5.7	5.8	6.2	6.6	6.3	7.4	6.9	7.0	6.1	6.6	6.8
4/24	4.3	6.6	6.3	6.4	6.7	7.0	6.7	7.8	7.1	7.1	6.4	6.7	7.0
4/25	4.2	6.1	6.3	6.5	6.8	7.0	6.4	7.6	6.5	6.4	6.3	6.6	6.8
4/26	4.3	6.1	6.3	6.4	6.8	7.1	6.5	7.5	6.8	6.9	6.1	6.7	7.0
4/27	4.0	5.5	5.8	5.9	6.5	6.8	6.2	7.4	6.5	6.5	5.9	6.8	7.0
4/28	3.3	6.0	5.4	5.4	5.7	6.0	5.9	7.0	6.7	6.9	5.7	6.7	7.0
4/29	4.5	7.2	6.7	6.9	7.2	7.6	7.0	8.1	7.5	7.7	6.7	7.9	8.1
4/30	5.4	8.0	8.1	8.4	8.6	9.0	8.5	9.4	8.4	8.9	7.7	8.8	9.1

APPENDIX D

2014 Seven-Day Average of the Daily Maximum (7-DAD Max) Water Temperature in Tabular Format

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
1/1	3.4	4.1	4.5	4.5	4.7	4.8	4.3	5.1	4.6	4.6	4.8	5.0	5.1
1/2	3.2	4.1	4.3	4.5	4.8	4.6	4.2	4.9	4.5	4.5	4.7	4.8	4.9
1/3	3.1	4.0	4.1	4.5	4.7	4.4	4.0	4.7	4.3	4.4	4.5	4.6	4.7
1/4	3.0	4.0	4.0	4.5	4.0	4.3	3.9	4.6	4.3	4.2	4.5	4.5	4.6
1/5	3.0	4.0	4.0	4.4	3.0	4.3	4.0	4.6	4.3	4.2	4.5	4.4	4.6
1/6	2.9	4.0	4.1	4.4	3.3	4.3	4.0	4.5	4.3	4.2	4.5	4.4	4.5
1/7	3.0	4.0	4.2	4.4	4.0	4.4	4.0	4.6	4.4	4.2	4.5	4.4	4.5
1/8	3.1	4.1	4.3	4.4	4.8	4.6	4.2	4.8	4.6	4.3	4.7	4.5	4.6
1/9	3.2	4.1	4.6	4.5	4.8	4.8	4.4	5.1	4.8	4.6	4.9	4.7	4.8
1/10	3.3	4.2	4.9	4.6	5.1	5.1	4.7	5.4	5.1	4.8	5.1	4.9	5.0
1/11	3.5	4.2	5.0	4.8	5.6	5.4	5.0	5.8	5.3	5.0	5.3	5.1	5.2
1/12	3.6	4.1	5.1	5.0	5.1	5.5	5.1	5.9	5.3	5.0	5.3	5.2	5.3
1/13	3.6	4.1	4.9	5.2	5.5	5.6	5.2	6.0	5.2	5.0	5.4	5.2	5.3
1/14	3.7	4.1	4.8	5.2	5.8	5.4	5.1	5.9	5.0	4.9	5.4	5.1	5.3
1/15	3.6	4.0	4.6	5.2	5.6	5.2	4.9	5.7	4.8	4.7	5.3	5.0	5.1
1/16	3.6	4.0	4.5	5.1	4.7	5.0	4.7	5.5	4.5	4.5	5.2	5.0	5.1
1/17	3.6	3.9	4.3	5.0	4.1	4.8	4.5	5.3	4.3	4.3	5.1	4.9	5.0
1/18	3.6	3.9	4.1	4.7	3.8	4.4	4.2	4.9	4.1	4.1	4.9	4.7	4.8
1/19	3.5	3.9	4.0	4.5	3.7	4.3	3.9	4.7	3.9	4.0	4.8	4.7	4.7
1/20	3.5	3.9	4.0	4.3	3.6	4.2	3.8	4.6	3.8	4.0	4.8	4.6	4.6
1/21	3.5	3.9	3.9	4.1	3.6	4.0	3.7	4.5	3.8	4.0	4.7	4.6	4.6
1/22	3.5	3.8	3.8	3.9	4.3	3.9	3.7	4.4	3.8	4.0	4.7	4.7	4.6
1/23	3.5	3.8	3.8	3.7	4.2	3.8	3.6	4.3	3.8	4.0	4.6	4.6	4.6
1/24	3.5	3.8	3.8	3.6	3.2	3.8	3.6	4.3	3.7	3.9	4.7	4.6	4.5
1/25	3.5	3.8	3.8	3.6	3.1	3.9	3.6	4.3	3.8	4.0	4.7	4.7	4.6
1/26	3.6	3.9	3.9	3.6	2.9	3.9	3.7	4.3	3.9	4.1	4.8	4.7	4.7
1/27	3.5	3.8	4.0	3.6	3.5	4.0	3.7	4.4	4.0	4.1	4.8	4.7	4.7
1/28	3.5	3.8	4.0	3.7	4.3	4.1	3.8	4.5	4.1	4.2	4.8	4.6	4.7
1/29	3.4	3.8	4.1	3.9	4.9	4.3	4.0	4.6	4.2	4.2	4.8	4.7	4.7
1/30	3.4	3.8	4.2	4.1	4.9	4.4	4.1	4.7	4.2	4.3	4.8	4.8	4.8
1/31	3.0	3.8	4.2	4.3	4.2	4.5	4.1	4.8	4.3	4.3	4.7	4.8	4.8

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
2/1	2.9	3.7	4.0	4.3	4.4	4.3	4.0	4.6	4.2	4.2	4.4	4.5	4.6
2/2	2.4	3.5	3.7	4.3	3.9	3.8	3.7	4.3	4.0	4.0	3.8	4.0	4.2
2/3	1.9	3.3	3.3	4.2	3.6	3.2	3.3	3.8	3.7	3.7	3.2	3.4	3.6
2/4	1.4	3.2	2.9	4.0	3.1	2.7	3.0	3.3	3.5	3.5	2.6	2.8	3.3
2/5	1.2	3.0	2.6	3.6	2.0	2.3	2.7	3.0	3.2	3.3	2.1	2.3	2.8
2/6	0.9	2.8	2.4	3.3	0.7	2.0	2.4	2.7	3.0	3.1	1.7	1.9	2.5
2/7	0.8	2.7	2.3	3.0	1.1	1.8	2.3	2.5	2.9	3.0	1.5	1.6	2.3
2/8	1.0	2.7	2.3	2.8	1.5	1.9	2.3	2.6	2.8	2.9	1.4	1.6	2.3
2/9	1.0	2.7	2.4	2.6	2.2	2.1	2.4	2.7	2.8	3.0	1.7	2.0	2.6
2/10	1.4	2.8	2.7	2.8	2.5	2.6	2.7	3.2	2.9	3.1	2.1	2.7	3.1
2/11	1.8	2.9	2.9	3.1	3.1	3.1	3.0	3.6	3.1	3.3	2.5	3.2	3.5
2/12	2.2	2.9	3.1	3.4	3.2	3.5	3.2	3.9	3.2	3.4	2.9	3.6	3.8
2/13	2.3	3.0	3.2	3.8	3.9	3.7	3.5	4.2	3.4	3.6	3.3	4.0	4.2
2/14	2.4	3.0	3.2	4.0	3.9	3.8	3.6	4.4	3.6	3.7	3.5	4.3	4.4
2/15	2.4	3.0	3.1	4.2	3.8	3.8	3.6	4.5	3.8	3.8	3.7	4.4	4.5
2/16	2.3	2.9	3.2	4.4	3.8	3.9	3.7	4.5	3.8	3.8	3.7	4.3	4.5
2/17	2.2	2.9	3.1	4.3	3.0	3.8	3.6	4.5	3.9	3.8	3.7	4.3	4.4
2/18	2.2	2.9	3.1	4.2	3.2	3.8	3.6	4.4	3.9	3.8	3.6	4.2	4.3
2/19	2.1	2.9	3.1	4.1	3.5	3.7	3.5	4.4	3.9	3.7	3.5	4.2	4.3
2/20	1.9	2.8	2.9	4.0	3.4	3.6	3.4	4.3	3.8	3.6	3.3	4.1	4.3
2/21	1.9	2.9	2.9	3.8	3.7	3.5	3.3	4.2	3.7	3.5	3.3	4.0	4.2
2/22	1.9	2.9	3.0	3.8	3.4	3.6	3.4	4.3	3.6	3.5	3.2	4.1	4.2
2/23	2.1	2.9	3.0	3.8	2.4	3.7	3.5	4.4	3.7	3.5	3.3	4.3	4.4
2/24	2.4	2.8	3.1	3.8	2.9	3.8	3.5	4.5	3.7	3.5	3.4	4.6	4.5
2/25	2.4	2.8	3.0	3.8	3.4	3.8	3.6	4.6	3.8	3.7	3.5	4.9	4.8
2/26	2.4	2.8	3.0	3.8	3.8	3.8	3.6	4.8	3.9	3.7	3.6	5.0	5.0
2/27	2.5	2.8	3.1	3.9	3.9	4.0	3.6	4.7	3.8	3.7	3.7	4.8	4.8
2/28	2.6	2.8	3.1	3.9	3.7	3.9	3.7	4.8	4.0	3.8	3.9	4.8	4.9

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
3/1	2.7	2.8	3.1	3.8	3.2	3.9	3.6	4.8	4.1	3.8	4.0	4.6	4.8
3/2	2.7	2.8	3.1	3.8	2.6	3.9	3.7	4.9	4.1	3.9	4.2	4.5	4.6
3/3	2.6	2.8	3.2	3.8	3.8	4.0	3.7	4.9	4.2	3.9	4.3	4.2	4.5
3/4	2.8	2.9	3.3	3.9	3.9	4.2	3.8	5.1	4.2	3.9	4.4	4.0	4.3
3/5	2.8	3.0	3.4	4.0	4.3	4.4	4.0	5.2	4.1	3.9	4.7	4.0	4.3
3/6	3.0	3.1	3.6	4.2	4.4	4.7	4.3	5.5	4.5	4.2	5.0	4.3	4.6
3/7	3.1	3.2	3.8	4.4	4.9	4.9	4.5	5.8	4.6	4.3	5.2	4.6	4.8
3/8	3.3	3.2	3.9	4.6	4.5	5.1	4.7	6.0	4.6	4.4	5.3	4.9	5.1
3/9	3.4	3.3	4.0	4.8	4.9	5.2	4.8	6.1	4.5	4.4	5.4	5.1	5.3
3/10	3.5	3.3	4.1	5.0	5.1	5.3	4.9	6.2	4.3	4.4	5.5	5.3	5.5
3/11	3.6	3.4	4.1	5.0	4.8	5.3	4.9	6.2	4.4	4.5	5.5	5.4	5.5
3/12	3.6	3.4	4.2	5.1	4.6	5.4	5.0	6.3	4.4	4.5	5.6	5.5	5.6
3/13	3.7	3.5	4.3	5.2	4.9	5.5	5.0	6.3	4.5	4.6	5.6	5.5	5.6
3/14	3.7	3.5	4.2	5.0	4.9	5.3	4.9	6.1	4.4	4.6	5.5	5.5	5.6
3/15	3.7	3.5	4.3	4.8	5.4	5.2	4.9	5.9	4.5	4.6	5.4	5.5	5.6
3/16	3.5	3.5	4.2	4.6	5.4	5.1	4.9	5.9	4.5	4.6	5.4	5.4	5.5
3/17	3.4	3.5	4.2	4.4	3.9	5.0	4.8	5.7	4.6	4.6	5.2	5.3	5.5
3/18	3.3	3.5	4.1	4.3	4.9	4.9	4.8	5.6	4.5	4.6	5.1	5.3	5.5
3/19	3.2	3.5	4.1	4.1	4.8	4.7	4.7	5.4	4.5	4.6	4.9	5.3	5.4
3/20	3.4	3.4	4.1	4.0	4.5	4.7	4.6	5.3	4.2	4.6	4.7	5.5	5.6
3/21	3.5	3.5	4.4	4.2	4.3	4.8	4.8	5.5	4.2	4.6	4.8	5.9	5.9
3/22	3.5	3.6	4.4	4.4	4.5	4.9	4.8	5.6	4.3	4.7	4.9	6.1	6.0
3/23	3.7	3.7	4.6	4.5	5.1	5.1	4.9	5.7	4.3	4.8	5.0	6.3	6.2
3/24	3.8	3.9	4.7	4.7	5.4	5.2	5.0	5.9	4.3	4.8	5.1	6.5	6.3
3/25	3.9	4.0	4.8	4.9	5.6	5.4	5.1	6.0	4.4	4.8	5.3	6.5	6.4
3/26	3.9	4.1	4.9	5.0	5.8	5.5	5.2	6.1	4.5	4.9	5.4	6.6	6.5
3/27	3.9	4.2	4.9	5.1	5.6	5.6	5.2	6.2	4.6	5.0	5.5	6.5	6.4
3/28	4.0	4.2	5.0	5.1	5.3	5.6	5.3	6.2	4.6	5.0	5.5	6.4	6.3
3/29	4.0	4.4	5.1	5.2	5.1	5.7	5.4	6.3	4.7	5.1	5.6	6.6	6.5
3/30	4.1	4.4	5.2	5.3	5.4	5.7	5.5	6.3	4.7	5.2	5.6	6.6	6.5
3/31	4.2	4.5	5.3	5.3	5.8	5.8	5.6	6.4	4.8	5.3	5.6	6.7	6.6

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
4/1	4.3	4.6	5.4	5.5	6.3	5.9	5.7	6.4	4.9	5.4	5.7	6.8	6.7
4/2	4.4	4.7	5.5	5.6	6.2	6.0	5.8	6.5	5.0	5.5	5.7	6.9	6.8
4/3	4.5	4.9	5.6	5.7	6.0	6.1	6.0	6.6	5.2	5.7	5.9	7.0	6.9
4/4	4.6	5.1	5.9	6.0	6.1	6.3	6.2	6.8	5.4	5.9	6.1	7.2	7.1
4/5	4.6	5.2	5.9	6.1	5.9	6.5	6.3	6.9	5.6	6.0	6.3	7.2	7.2
4/6	4.6	5.3	6.0	6.2	6.8	6.7	6.4	7.1	5.8	6.1	6.4	7.2	7.2
4/7	4.6	5.3	6.1	6.3	7.8	6.8	6.5	7.2	5.9	6.2	6.4	7.1	7.2
4/8	4.6	5.4	6.2	6.4	7.4	6.9	6.6	7.3	5.9	6.3	6.5	7.0	7.1
4/9	4.9	5.5	6.4	6.6	6.8	7.3	6.7	7.3	6.0	6.5	6.6	7.3	7.4
4/10	5.0	5.5	6.7	6.7	6.5	7.6	6.8	7.4	5.9	6.6	6.6	7.5	7.6
4/11	5.0	5.5	6.7	6.7	6.6	7.8	6.7	7.4	6.0	6.7	6.6	7.5	7.6
4/12	5.0	5.5	6.7	6.7	7.6	8.0	6.7	7.4	6.0	6.7	6.5	7.6	7.6
4/13	4.9	5.7	6.7	6.7	7.9	7.9	6.7	7.3	6.1	6.8	6.5	7.6	7.6
4/14	4.9	6.0	6.7	6.7	7.8	7.9	6.7	7.3	6.3	6.9	6.5	7.6	7.6
4/15	4.9	6.2	6.7	6.8	7.3	7.9	6.8	7.4	6.5	7.0	6.5	7.7	7.7
4/16	4.8	6.3	6.6	6.7	6.8	7.7	6.7	7.4	6.6	6.9	6.5	7.4	7.5
4/17	4.8	6.4	6.5	6.7	6.6	7.5	6.8	7.5	6.7	6.9	6.5	7.2	7.3
4/18	4.7	6.5	6.5	6.7	6.8	7.6	6.8	7.7	6.8	6.8	6.6	7.1	7.3
4/19	4.7	6.5	6.5	6.8	6.5	7.6	6.9	7.8	6.9	7.0	6.6	7.0	7.2
4/20	4.8	6.6	6.6	6.8	7.6	7.6	6.9	7.8	7.0	7.1	6.6	7.0	7.2
4/21	4.8	6.6	6.6	6.8	8.1	7.7	7.0	7.9	7.0	7.2	6.6	7.1	7.3
4/22	4.9	6.6	6.8	7.0	7.9	7.8	7.0	8.0	7.0	7.2	6.6	7.2	7.4
4/23	5.0	6.5	6.9	7.1	6.7	8.0	7.2	8.1	7.1	7.4	6.6	7.4	7.6
4/24	4.9	6.4	6.9	7.0	7.2	7.9	7.1	8.1	7.2	7.6	6.6	7.5	7.7
4/25	4.9	6.5	6.7	6.9	7.3	7.7	7.0	8.1	7.2	7.7	6.5	7.5	7.7
4/26	4.9	6.9	7.0	7.1	7.6	7.9	7.2	8.2	7.4	7.9	6.6	7.7	8.0
4/27	5.2	7.1	7.5	7.6	7.1	8.4	7.6	8.7	7.7	8.1	6.9	8.2	8.4
4/28	5.5	7.1	7.9	8.0	6.8	9.1	8.0	9.0	7.9	8.4	7.2	8.6	8.8
4/29	5.7	7.2	8.2	8.4	9.1	9.5	8.2	9.4	8.1	8.6	7.6	8.7	8.9
4/30	5.8	7.3	8.3	8.6	10.7	9.8	8.4	9.7	8.4	8.6	8.0	8.8	9.0

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
5/1	5.9	7.5	8.4	8.7	11.3	10.0	8.6	9.9	8.6	8.8	8.2	8.8	9.0
5/2	5.9	7.5	8.5	8.8	10.6	10.1	8.8	10.0	8.7	8.9	8.4	8.6	8.8
5/3	6.0	7.2	8.4	8.8	9.7	10.0	8.8	10.0	8.6	8.8	8.5	8.4	8.7
5/4	5.9	7.0	8.1	8.6	8.1	9.9	8.7	9.9	8.6	8.8	8.4	8.3	8.5
5/5	5.7	7.0	7.7	8.2	7.7	9.4	8.6	9.7	8.5	8.7	8.2	8.2	8.4
5/6	5.6	6.9	7.5	8.0	8.6	9.0	8.4	9.5	8.4	8.6	8.1	7.9	8.1
5/7	5.7	6.8	7.3	7.8	9.4	8.7	8.3	9.2	8.3	8.5	7.8	7.7	8.0
5/8	5.8	6.8	7.6	8.0	8.2	9.0	8.5	9.4	8.2	8.6	7.9	8.1	8.3
5/9	6.2	7.0	7.9	8.4	8.0	9.5	8.9	9.7	8.4	8.9	8.0	8.5	8.7
5/10	6.5	7.1	8.2	8.7	7.6	10.0	9.1	10.0	8.4	9.1	8.2	8.8	8.9
5/11	6.9	7.2	8.6	9.1	9.9	10.4	9.2	10.3	8.5	9.2	8.5	8.9	9.1
5/12	7.1	7.3	9.1	9.5	11.0	11.1	9.5	10.7	8.6	9.4	8.9	9.0	9.2
5/13	7.3	7.5	9.3	9.9	11.9	11.6	9.8	11.0	8.7	9.7	9.3	9.3	9.4
5/14	7.5	7.6	9.6	10.1	12.3	12.0	10.0	11.3	8.8	9.9	9.6	9.5	9.7
5/15	7.4	7.7	9.7	10.1	12.1	12.0	9.9	11.5	9.0	9.9	9.8	9.3	9.5
5/16	7.3	7.5	9.7	10.1	11.0	11.9	9.8	11.5	8.9	9.9	9.9	9.1	9.3
5/17	7.2	7.6	9.7	10.0	9.9	11.9	9.8	11.5	9.0	9.9	9.9	9.1	9.3
5/18	7.2	7.6	9.4	9.7	9.8	11.5	9.5	11.3	9.1	9.9	9.8	9.0	9.2
5/19	7.3	7.9	9.5	9.7	10.3	11.4	9.5	11.3	9.1	10.1	9.7	9.1	9.3
5/20	7.4	8.1	9.6	9.8	10.7	11.3	9.4	11.1	9.1	10.0	9.6	9.2	9.4
5/21	7.4	8.2	9.7	9.9	9.8	11.5	9.4	11.1	9.1	10.1	9.7	9.2	9.4
5/22	7.4	8.4	9.7	10.0	11.7	11.4	9.3	10.9	9.0	10.0	9.7	9.4	9.5
5/23	7.4	8.4	9.7	10.1	10.7	11.5	9.1	10.8	8.9	10.0	9.8	9.3	9.5
5/24	7.5	8.4	9.8	10.1	10.7	11.4	8.9	10.6	8.8	9.9	9.8	9.3	9.4
5/25	7.2	8.5	9.8	10.1	9.9	11.4	8.9	10.5	8.6	9.9	9.7	9.1	9.2
5/26	6.8	8.3	9.5	9.9	10.5	11.1	8.7	10.2	8.4	9.5	9.6	8.8	9.0
5/27	7.2	8.2	9.7	10.0	11.4	11.4	8.6	10.2	8.4	9.6	9.4	8.9	9.1
5/28	7.2	8.4	10.0	10.3	9.7	11.8	8.5	10.5	8.5	9.8	9.4	9.2	9.4
5/29	7.6	8.6	10.5	10.6	9.8	12.3	8.5	10.7	8.5	10.1	9.4	9.5	9.7
5/30	8.0	9.0	11.1	11.1	12.8	13.0	8.5	10.9	8.6	10.3	9.5	10.0	10.1
5/31	8.4	9.3	11.3	11.5	13.6	13.3	8.6	11.0	8.8	10.3	9.6	10.2	10.4

Appendix D: 7-Day Average of the Daily Maximum Temperature Tables

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
6/1	8.7	9.6	11.7	11.9	13.1	13.8		11.1	8.8	10.4	9.7	10.5	10.7
6/2	9.1	10.0	12.4	12.5	15.0	14.5		11.6	9.0	10.8	9.9	11.0	11.1
6/3	9.2	10.1	12.6	12.8	12.4	14.9		11.7	9.3	11.0	10.0	11.1	11.2
6/4	9.3	10.3	12.8	12.9	12.7	15.1		11.8	9.4	11.1	10.1	11.1	11.3
6/5	9.3	10.3	13.0	13.1	15.0	15.5		12.0	9.7	11.3	10.2	11.3	11.4
6/6	9.3	10.2	13.0	13.1	14.8	15.5		12.0	9.8	11.3	10.2	11.4	11.5
6/7	9.2	10.1	12.9	13.1	14.7	15.5		12.0	9.8	11.3	10.2	11.4	11.5
6/8	9.2	10.3	13.1	13.3	14.4	15.9		12.2	9.9	11.6	10.2	11.4	11.6
6/9	9.1	10.4	12.8	13.2	15.0	15.6		12.0	10.0	11.4	10.2	11.4	11.5
6/10	8.9	10.3	12.4	12.9	12.5	15.0		11.7	9.8	11.1	10.2	11.1	11.3
6/11	8.5	10.2	11.9	12.5	14.7	14.4	9.1	11.4	9.7	10.8	10.1	10.7	10.9
6/12	8.1	10.0	11.5	12.1	12.6	13.6	9.6	11.1	9.6	10.6	10.0	10.3	10.5
6/13	7.9	9.8	10.9	11.6	11.3	12.8	9.7	10.9	9.5	10.4	9.8	10.0	10.2
6/14	7.7	9.7	10.7	11.2	10.8	12.3	9.7	10.8	9.5	10.5	9.7	9.7	10.0
6/15	7.4	9.5	10.2	10.8	10.9	11.6	9.7	10.7	9.5	10.3	9.7	9.6	9.9
6/16	7.5	9.4	10.3	10.6	10.6	11.6	10.0	11.0	9.5	10.7	9.7	9.8	10.0
6/17	7.5	9.4	10.4	10.7	10.2	11.7	10.1	11.4	9.7	11.1	9.8	10.1	10.3
6/18	7.7	9.4	10.7	10.9	11.0	12.0	10.4	11.7	9.8	11.3	9.8	10.4	10.7
6/19	8.2	9.6	11.1	11.3	13.4	12.6	10.7	12.1	9.9	11.8	10.0	10.9	11.2
6/20	8.8	9.8	11.5	11.8	12.0	13.3	11.0	12.4	10.0	12.0	10.3	11.4	11.6
6/21	9.0	9.9	11.8	12.2	13.4	13.8	11.2	12.7	10.1	12.2	10.5	11.8	12.0
6/22	9.5	10.1	12.3	12.6	14.5	14.5	11.5	13.1	10.2	12.3	10.8	12.2	12.3
6/23	9.7	10.1	12.3	12.8	14.4	14.5	11.4	13.1	10.4	12.1	11.0	12.3	12.4
6/24	9.7	10.2	12.4	12.9	13.1	14.6	11.3	13.0	10.3	12.0	11.1	12.3	12.4
6/25	9.8	10.4	12.2	12.8	15.4	14.4	11.4	13.0	10.4	11.9	11.3	12.2	12.3
6/26	9.5	10.3	11.9	12.6	13.1	14.1	11.2	12.8	10.4	11.6	11.4	11.8	11.9
6/27	9.5	10.2	11.9	12.6	12.6	14.1	11.4	12.9	10.5	11.8	11.4	11.8	12.0
6/28	10.1	10.1	12.1	12.7	12.0	14.4	11.7	13.2	10.6	12.1	11.7	12.1	12.2
6/29	10.0	9.9	12.0	12.6	12.2	14.3	11.8	13.3	10.7	12.5	11.9	12.2	12.3
6/30	10.0	9.6	11.8	12.6	15.2	14.1	11.8	13.3	10.7	12.4	12.0	12.2	12.4

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
7/1	10.3	9.3	11.8	12.5	15.4	14.3	11.9	13.5	10.8	12.7	12.1	12.5	12.7
7/2	10.8	9.1	11.8	12.5	14.7	14.4	11.9	13.6	10.9	12.8	12.2	12.9	13.1
7/3	11.2	9.0	11.9	12.7	12.7	14.8	12.1	13.9	11.0	13.1	12.4	13.5	13.6
7/4	11.6	8.9	12.0	12.8	13.5	14.9	12.1	14.0	11.0	13.0	12.7	13.8	13.9
7/5	11.9	8.9	12.1	12.9	12.5	15.0	12.1	14.0	11.0	13.0	12.7	14.2	14.2
7/6	12.4	9.0	12.2	13.0	14.5	15.2	12.1	14.2	11.1	13.0	12.8	14.5	14.6
7/7	12.7	9.1	12.7	13.2	15.9	15.6	12.2	14.5	11.2	13.3	12.8	15.0	15.1
7/8	13.1	9.2	12.9	13.5	16.3	16.0	12.4	14.7	11.2	13.5	13.0	15.5	15.5
7/9	13.5	9.4	13.2	13.8	15.9	16.5	12.5	15.0	11.2	13.6	13.2	16.0	15.9
7/10	14.2	9.5	13.4	14.0	15.7	16.6	12.6	14.9	11.2	13.6	13.4	16.3	16.2
7/11	14.3	9.6	13.5	14.1	15.9	16.7	12.6	15.2	11.2	13.8	13.6	16.6	16.5
7/12	14.6	9.7	13.4	14.2	15.4	16.8	12.8	15.2	11.2	13.8	13.8	16.9	16.8
7/13	14.9	9.7	13.4	14.2	15.3	16.8	12.9	15.3	11.3	13.8	13.9	17.2	17.0
7/14	15.1	9.7	13.2	14.1	16.6	16.6	12.9	15.2	11.3	13.8	14.1	17.3	17.2
7/15	15.2	9.6	13.0	13.9	16.3	16.3	12.9	15.1	11.4	13.8	14.2	17.4	17.2
7/16	15.1	9.5	12.6	13.6	16.0	15.8	12.7	14.9	11.4	13.5	14.1	17.4	17.1
7/17	14.7	9.3	12.0	13.1	14.5	15.2	12.4	14.5	11.3	13.2	14.0	17.2	16.9
7/18	14.1	9.1	11.6	12.6	13.6	14.6	12.2	14.2	11.2	13.1	13.8	17.0	16.7
7/19	13.9	9.0	11.1	12.1	12.3	13.8	11.7	13.6	11.0	12.7	13.5	16.6	16.2
7/20	13.2	8.9	10.7	11.6	11.1	13.0	11.4	13.0	10.9	12.2	13.2	16.0	15.6
7/21	12.6	8.9	10.5	11.2	12.6	12.5	11.2	12.6	10.8	11.8	13.0	15.4	15.0
7/22	12.2	8.9	10.5	11.2	11.2	12.3	11.3	12.5	10.7	11.8	12.8	15.1	14.8
7/23	12.1	8.9	10.8	11.3	11.2	12.6	11.6	12.8	10.7	12.1	12.7	15.2	14.9
7/24	12.2	9.0	11.3	11.6	11.3	13.1	12.0	13.2	10.9	12.5	12.7	15.6	15.3
7/25	12.4	9.2	11.6	11.9	13.1	13.4	12.3	13.5	11.1	12.4	12.8	15.9	15.5
7/26	13.0	9.3	12.1	12.3	14.4	14.0	12.7	14.0	11.4	12.9	13.0	16.5	16.1
7/27	13.2	9.3	12.4	12.7	14.5	14.6	13.1	14.5	11.6	13.5	13.1	17.2	16.8
7/28	13.8	9.5	12.8	13.0	15.0	15.2	13.4	15.0	11.8	14.0	13.3	18.2	17.7
7/29	14.2	9.6	12.9	13.1	15.1	15.4	13.4	15.2	12.0	14.1	13.6	18.8	18.1
7/30	14.5	9.7	12.7	13.0	15.0	15.2	13.2	15.0	12.1	14.0	13.8	19.0	18.2
7/31	14.6	9.8	12.7	13.0	15.0	15.2	13.2	15.1	12.2	14.0	14.0	19.2	18.4

Appendix D: 7-Day Average of the Daily Maximum Temperature Tables

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
8/1	14.9	9.8	12.7	13.0	14.0	15.3	13.3	15.1	12.3	14.4	14.1	19.5	18.8
8/2	15.0	9.8	12.6	13.0	12.7	15.2	13.2	15.1	12.2	14.3	14.2	19.7	18.8
8/3	14.9	9.8	12.4	12.8	14.9	15.0	13.2	15.0	12.2	14.1	14.3	19.7	18.7
8/4	14.9	9.8	12.3	12.7	15.2	14.9	13.1	14.9	12.2	13.9	14.2	19.8	18.5
8/5	14.9	9.8	12.2	12.7	14.4	14.9	13.1	14.9	12.1	13.8	14.2	19.9	18.4
8/6	15.0	9.8	12.3	12.8	13.7	15.0	13.2	15.0	12.1	13.8	14.0	20.1	18.4
8/7	14.9	9.8	12.3	12.8	14.0	14.9	13.1	15.0	12.1	13.7	13.8	20.1	18.3
8/8	14.8	9.9	12.2	12.7	14.0	14.8	13.1	14.9	12.1	13.5	13.7	20.1	18.0
8/9	14.7	10.1	12.3	12.7	13.8	14.7	13.0	14.9	12.1	13.4	13.7	20.0	17.7
8/10	14.6	10.2	12.5	13.0	14.2	14.7	13.3	15.1	12.3	13.5	13.8	19.8	17.6
8/11	14.1	10.3	12.5	12.9	14.4	14.5	13.3	15.1	12.5	13.4	13.9	19.3	17.3
8/12	14.0	10.4	12.4	12.8	13.7	14.2	13.2	14.9	12.5	13.3	14.0	18.8	17.0
8/13	13.8	10.4	12.3	12.7	14.3	14.1	13.2	14.9	12.6	13.4	14.1	18.4	16.8
8/14	13.6	10.4	12.3	12.7	13.0	14.0	13.3	14.9	12.7	13.4	14.3	18.2	16.7
8/15	13.6	10.5	12.4	12.7	12.3	14.0	13.4	15.0	12.9	13.4	14.3	18.1	16.6
8/16	13.5	10.5	12.4	12.8	12.8	14.1	13.7	15.1	13.0	13.5	14.4	18.3	16.7
8/17	13.3	10.6	12.2	12.5	13.8	14.0	13.5	15.0	13.0	13.6	14.3	18.4	16.7
8/18	13.5	10.6	12.4	12.6	14.6	14.0	13.5	14.9	13.1	13.7	14.3	18.6	16.7
8/19	13.6	10.8	12.6	12.7	14.6	14.2	13.7	15.0	13.4	14.0	14.2	18.9	16.8
8/20	13.7	11.0	12.9	12.9	13.4	14.4	13.9	15.2	13.6	14.2	14.0	19.2	16.9
8/21	13.8	11.1	13.0	13.0	13.4	14.6	14.1	15.3	13.9	14.4	13.9	19.3	17.0
8/22	13.7	11.2	13.0	12.9	12.9	14.5	14.1	15.2	14.1	14.5	13.7	19.3	17.0
8/23	13.7	11.3	13.1	13.0	14.2	14.5	14.1	15.3	14.2	14.7	13.5	19.1	16.9
8/24	13.8	11.5	13.4	13.2	14.4	14.7	14.2	15.4	14.4	15.0	13.5	19.4	17.2
8/25	13.9	11.7	13.6	13.4	14.2	14.9	14.4	15.7	14.6	15.3	13.5	19.6	17.5
8/26	13.9	11.7	13.6	13.4	14.7	14.9	14.4	15.7	14.7	15.3	13.5	19.7	17.7
8/27	13.5	11.7	13.4	13.3	15.0	14.7	14.3	15.6	14.7	15.4	13.6	19.3	17.6
8/28	13.5	11.7	13.2	13.2	14.4	14.4	14.1	15.5	14.7	15.5	13.6	18.9	17.5
8/29	13.3	11.7	13.2	13.1	13.6	14.3	14.1	15.4	14.7	15.6	13.5	18.6	17.5
8/30	13.0	11.6	12.9	12.9	13.1	14.0	13.8	15.1	14.6	15.6	13.4	18.0	17.3
8/31	12.3	11.4	12.6	12.7	12.8	13.6	13.7	14.7	14.4	15.3	13.2	17.2	16.7

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
9/1	12.1	11.3	12.5	12.5	13.6	13.3	13.6	14.4	14.2	15.1	13.0	16.6	16.3
9/2	11.8	11.3	12.5	12.5	12.8	13.3	13.5	14.3	14.0	15.1	12.9	16.4	16.2
9/3	11.8	11.3	12.6	12.5	12.5	13.4	13.5	14.2	13.8	15.1	12.9	16.5	16.3
9/4	11.8	11.3	12.7	12.6	12.8	13.6	13.5	14.3	13.7	15.1	12.9	16.6	16.4
9/5	11.7	11.3	12.7	12.6	13.1	13.5	13.4	14.1	13.6	15.0	13.0	16.7	16.4
9/6	11.7	11.2	12.7	12.5	13.3	13.4	13.3	14.1	13.4	14.9	13.0	16.7	16.3
9/7	11.8	11.2	12.7	12.6	13.5	13.5	13.4	14.1	13.5	14.9	12.9	16.9	16.5
9/8	11.6	11.1	12.6	12.5	13.1	13.4	13.4	14.1	13.6	15.0	12.8	16.9	16.5
9/9	11.6	11.0	12.0	12.0	12.5	13.0	13.2	13.9	13.6	14.8	12.5	16.7	16.2
9/10	11.4	11.0	11.8	11.8	13.0	12.7	13.1	13.6	13.7	14.8	12.2	16.5	16.0
9/11	11.3	10.9	11.6	11.7	12.0	12.4	13.1	13.5	13.8	14.7	12.0	16.3	15.9
9/12	11.2	10.9	11.6	11.7	10.9	12.3	13.2	13.6	13.9	14.8	11.8	16.2	15.8
9/13	11.1	10.9	11.6	11.7	11.4	12.4	13.4	13.7	13.9	15.0	11.7	16.2	15.8
9/14	11.1	11.0	11.6	11.8	12.0	12.4	13.5	13.8	14.7	15.1	11.8	16.2	15.8
9/15	11.2	11.1	11.6	11.8	12.3	12.4	13.6	13.9	15.4	15.0	11.9	16.2	15.8
9/16	11.5	11.1	12.2	12.3	12.5	12.9	13.9	14.2	15.5	15.4	12.2	16.3	16.1
9/17	11.6	11.2	12.3	12.4	13.0	13.1	14.1	14.5	15.7	15.5	12.4	16.4	16.2
9/18	11.7	11.3	12.4	12.5	12.6	13.3	14.3	14.7	15.8	15.6	12.7	16.6	16.4
9/19	11.9	11.3	12.4	12.5	13.2	13.3	14.3	14.8	15.9	15.7	12.9	16.6	16.4
9/20	11.8	11.2	12.2	12.4	12.7	13.3	14.4	14.8	15.9	15.6	13.0	16.6	16.4
9/21	11.8	10.5	11.8	12.0	12.9	13.0	14.3	14.7	15.2	15.5	13.2	16.4	16.2
9/22	11.7	9.8	11.4	11.5	12.7	12.8	14.2	14.6	14.6	15.6	13.2	16.3	16.1
9/23	11.5	9.1	10.9	11.0	12.2	12.3	13.9	14.4	14.4	15.4	13.1	16.0	15.8
9/24	11.3	8.4	10.3	10.5	10.8	12.0	13.8	14.2	14.3	15.2	13.0	15.7	15.6
9/25	11.1	7.7	9.7	9.9	10.4	11.6	13.6	14.1	14.2	15.1	12.9	15.3	15.3
9/26	10.8	7.0	9.1	9.3	10.2	11.1	13.4	13.8	14.0	14.8	12.7	15.0	15.0
9/27	10.5	6.4	8.6	8.8	10.2	10.7	13.1	13.6	13.8	14.7	12.5	14.6	14.6
9/28	10.1	6.3	8.5	8.7	9.7	10.5	13.1	13.5	13.7	14.6	12.2	14.3	14.4
9/29	10.0	6.3	8.3	8.5	9.1	10.3	13.1	13.4	13.6	14.5	12.0	14.1	14.2
9/30	9.8	6.3	8.2	8.4	9.1	10.2	13.2	13.5	13.6	14.5	11.8	14.0	14.1

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
10/1	9.8	6.3	8.1	8.4	9.5	10.1	13.3	13.5	13.7	14.5	11.8	13.8	14.0
10/2	9.8	6.3	8.1	8.4	9.1	10.1	13.4	13.5	13.7	14.5	11.7	13.7	13.9
10/3	9.8	7.2	8.4	8.7	8.8	10.3	13.5	13.7	13.8	14.7	11.8	13.9	14.1
10/4	9.9	7.3	8.7	9.0	9.7	10.5	13.7	13.8	13.8	14.8	11.9	14.1	14.3
10/5	10.1	7.3	8.7	9.1	9.4	10.6	13.7	13.8	13.9	14.9	12.0	14.4	14.6
10/6	10.3	7.4	8.7	9.1	9.4	10.6	13.8	13.9	14.0	14.9	12.2	14.6	14.7
10/7	10.4	7.4	8.7	9.1	9.7	10.6	13.8	13.9	14.0	14.9	12.3	14.7	14.8
10/8	10.4	7.4	9.0	9.3	9.8	10.6	13.8	13.9	14.0	14.9	12.3	14.7	14.9
10/9	10.3	7.3	9.1	9.4	9.4	10.7	13.8	13.8	13.9	14.7	12.2	14.5	14.6
10/10	10.2	6.4	8.9	9.2	8.8	10.7	13.7	13.7	13.9	14.7	12.1	14.2	14.4
10/11	10.2	6.4	8.9	9.2	10.5	10.7	13.6	13.7	13.9	14.5	12.0	14.0	14.2
10/12	9.9	6.4	9.0	9.3	10.3	10.7	13.5	13.5	13.7	14.3	11.9	13.6	13.8
10/13	9.7	6.3	9.2	9.5	9.9	10.7	13.3	13.2	13.5	14.1	11.7	13.1	13.4
10/14	9.5	6.3	9.3	9.6	10.8	10.7	13.2	13.0	13.4	13.9	11.6	12.6	13.0
10/15	9.5	6.3	9.2	9.4	10.2	10.7	13.0	12.9	13.3	13.8	11.6	12.3	12.6
10/16	9.5	6.4	9.1	9.4	10.0	10.6	12.9	12.8	13.2	13.7	11.6	12.1	12.5
10/17	9.4	6.4	9.1	9.4	9.5	10.5	12.6	12.6	12.9	13.4	11.5	11.8	12.2
10/18	9.2	6.3	9.0	9.3	9.9	10.4	12.4	12.4	12.7	13.2	11.5	11.6	12.0
10/19	9.2	6.4	9.0	9.3	10.1	10.4	12.2	12.3	12.5	13.1	11.4	11.5	11.8
10/20	9.2	6.4	9.1	9.3	10.0	10.4	12.1	12.1	12.4	12.9	11.4	11.3	11.6
10/21	9.1	6.4	9.1	9.4	9.8	10.3	11.8	11.9	12.2	12.7	11.3	11.1	11.4
10/22	8.7	6.3	9.1	9.3	10.2	10.2	11.6	11.7	12.0	12.6	11.2	10.9	11.2
10/23	8.6	6.4	9.1	9.4	10.2	10.1	11.4	11.4	11.8	12.3	10.9	10.5	10.9
10/24	8.2	6.3	9.0	9.2	9.2	9.9	11.1	11.0	11.5	12.0	10.6	10.1	10.5
10/25	8.0	6.3	8.8	9.1	9.4	9.7	10.9	10.8	11.4	11.8	10.5	9.8	10.1
10/26	7.9	6.3	8.7	8.9	9.5	9.6	10.7	10.7	11.2	11.6	10.3	9.6	9.9
10/27	7.8	6.3	8.5	8.7	8.6	9.4	10.6	10.6	11.2	11.6	10.3	9.4	9.8
10/28	7.8	6.3	8.5	8.7	8.6	9.4	10.6	10.6	11.1	11.5	10.3	9.4	9.8
10/29	7.7	6.3	8.4	8.7	9.3	9.4	10.4	10.5	10.8	11.2	10.1	9.3	9.7
10/30	7.7	6.2	8.2	8.4	9.1	9.3	10.2	10.3	10.7	11.1	10.0	9.2	9.6
10/31	7.8	6.3	8.3	8.6	9.4	9.4	10.2	10.3	10.7	11.0	10.1	9.2	9.6

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
11/1	7.8	6.4	8.6	8.7	9.1	9.2	10.2	10.3	10.6	10.9	10.1	9.2	9.6
11/2	7.8	6.4	8.3	8.8	9.2	9.0	10.1	10.0	10.3	10.6	10.1	9.2	9.5
11/3	7.8	6.4	8.4	8.6	8.9	8.9	9.9	9.9	10.1	10.5	10.1	9.2	9.5
11/4	7.8	6.4	8.4	8.6	8.9	8.6	9.8	9.8	10.0	10.3	10.0	9.2	9.5
11/5	7.7	6.5	8.2	8.4	8.9	8.1	9.6	9.7	9.9	10.2	9.9	9.1	9.4
11/6	7.6	6.5	8.2	8.3	8.7	7.7	9.5	9.6	9.8	10.1	9.8	9.0	9.3
11/7	7.1	6.4	7.9	8.1	8.6	6.9	9.3	9.4	9.6	10.0	9.6	8.8	9.1
11/8	7.0	6.3	7.4	7.7	8.4	6.0	8.9	9.1	9.5	9.8	9.2	8.5	8.9
11/9	6.3	6.2	7.0	7.3	7.9	5.3	8.5	8.8	9.5	9.7	8.5	7.9	8.3
11/10	5.5	6.0	6.4	7.1	7.5	4.6	8.0	8.1	9.3	9.4	7.7	7.0	7.6
11/11	4.5	5.9	5.8	6.2	6.7	4.0	7.5	7.4	9.0	9.1	6.9	6.2	6.9
11/12	4.1	5.9	5.3	5.5	5.9	3.7	7.1	6.8	8.7	8.8	6.1	5.5	6.4
11/13	3.5	5.8	4.9	5.0	5.3	3.8	6.8	6.3	8.4	8.5	5.4	4.9	5.9
11/14	3.0	5.8	4.5	4.6	4.6	4.0	6.4	5.7	8.1	8.2	4.7	4.3	5.5
11/15	2.9	5.8	4.5	4.3	4.0	4.4	6.2	5.4	7.8	7.9	4.2	3.9	5.2
11/16	2.9	5.9	4.7	4.2	3.8	4.9	6.3	5.4	7.6	7.8	4.2	4.0	5.3
11/17	3.2	6.0	4.9	4.6	3.8	5.5	6.4	5.5	7.5	7.7	4.3	4.3	5.6
11/18	3.5	6.1	5.3	4.9	4.1	6.0	6.5	5.8	7.4	7.7	4.6	4.7	5.8
11/19	4.0	6.2	5.6	5.2	4.5	6.5	6.6	6.1	7.4	7.7	5.0	5.0	6.1
11/20	4.2	6.4	5.9	5.2	5.0	7.0	6.8	6.4	7.4	7.7	5.5	5.4	6.3
11/21	4.6	6.4	6.2	6.0	5.5	7.4	7.0	6.7	7.4	7.6	5.9	5.7	6.5
11/22	5.0	6.6	6.5	6.4	6.0	7.8	7.2	7.1	7.4	7.6	6.5	6.0	6.6
11/23	5.4	6.7	6.8	6.7	6.5	7.8	7.4	7.4	7.4	7.6	7.0	6.3	6.7
11/24	5.6	6.7	7.1	7.0	7.0	7.4	7.5	7.7	7.5	7.6	7.4	6.5	6.8
11/25	5.8	6.8	7.3	7.3	7.3	7.0	7.7	8.0	7.5	7.7	7.7	6.5	6.8
11/26	5.8	6.7	7.3	7.4	7.7	6.4	7.7	8.0	7.5	7.6	7.7	6.5	6.7
11/27	5.2	6.6	7.0	7.4	7.7	5.7	7.4	7.7	7.3	7.4	7.4	6.3	6.5
11/28	5.2	6.5	6.7	6.9	7.3	5.2	7.1	7.3	7.1	7.2	7.0	5.9	6.1
11/29	4.7	6.4	6.2	6.4	6.9	4.7	6.7	6.8	6.9	7.0	6.5	5.5	5.8
11/30	4.3	6.3	5.7	6.1	6.3	4.7	6.2	6.2	6.7	6.8	5.9	5.1	5.4

DATE	RM 18.2 (SFK) 7 Day Avg Max	RM 15.8 7 Day Avg Max	RM 14.3 7 Day Avg Max	RM 12.8 7 Day Avg Max	RM 11.3 7 Day Avg Max	RM 9.8 7 Day Avg Max	RM 9.6 7 Day Avg Max	RM 4.9 7 Day Avg Max	RM 4.4 7 Day Avg Max	RM 0.2 7 Day Avg Max	Big Four 7 Day Avg Max	Skykomish Above 7 Day Avg Max	Skykomish Below 7 Day Avg Max
12/1	4.0	6.1	5.4	5.3	5.2	5.0	5.9	5.7	6.5	6.6	5.3	4.8	5.1
12/2	3.6	6.0	5.0	5.1	5.1	5.4	5.5	5.3	6.2	6.4	4.9	4.6	5.0
12/3	3.6	6.1	5.0	4.8	4.7	6.0	5.5	5.2	6.1	6.3	4.9	4.5	4.9
12/4	3.9	6.1	5.3	5.1	4.7	6.6	5.6	5.5	6.2	6.4	5.1	4.7	5.1
12/5	4.6	6.1	5.6	5.4	4.9	7.0	5.9	5.9	6.3	6.5	5.5	5.1	5.5
12/6	4.8	6.1	6.0	5.7	5.4	7.3	6.3	6.4	6.4	6.6	6.1	5.6	6.0
12/7	5.2	6.1	6.4	6.2	5.9	7.4	6.7	6.9	6.5	6.7	6.7	6.0	6.3
12/8	5.5	6.1	6.6	6.6	6.5	7.3	7.0	7.3	6.6	6.8	7.1	6.3	6.6
12/9	5.7	6.1	6.8	6.8	6.9	7.1	7.2	7.6	6.7	6.9	7.3	6.5	6.7
12/10	5.8	6.0	6.8	6.9	7.1	6.9	7.3	7.7	6.7	6.9	7.4	6.6	6.8
12/11	5.7	6.0	6.7	6.8	7.2	6.7	7.2	7.7	6.7	6.9	7.3	6.6	6.8
12/12	5.5	5.9	6.6	6.7	7.1	6.5	7.0	7.5	6.6	6.8	7.2	6.4	6.7
12/13	5.2	5.9	6.4	6.6	6.9	6.4	6.9	7.3	6.5	6.7	6.9	6.2	6.5
12/14	5.1	5.9	6.2	6.4	6.8	6.3	6.7	7.0	6.4	6.6	6.7	6.0	6.3
12/15	4.9	5.9	6.1	6.2	6.5	6.5	6.5	6.8	6.3	6.5	6.5	5.9	6.2
12/16	4.8	5.9	6.0	6.1	6.3	6.7	6.4	6.7	6.2	6.4	6.4	5.8	6.2
12/17	4.9	5.9	6.0	6.1	6.2	6.7	6.3	6.6	6.2	6.3	6.4	5.8	6.1
12/18	5.0	6.0	6.2	6.2	6.2	6.8	6.5	6.8	6.2	6.4	6.5	5.9	6.2
12/19	5.1	6.0	6.3	6.3	6.4	6.7	6.7	7.0	6.3	6.5	6.7	6.0	6.3
12/20	5.2	6.0	6.3	6.4	6.6	6.5	6.7	7.1	6.4	6.5	6.8	6.1	6.3
12/21	5.0	5.9	6.3	6.5	6.6	6.4	6.7	7.1	6.4	6.5	6.8	6.1	6.3
12/22	5.0	5.9	6.2	6.5	6.6	6.2	6.6	7.0	6.4	6.4	6.7	6.1	6.3
12/23	4.9	5.8	6.1	6.2	6.5	5.9	6.5	6.9	6.4	6.4	6.6	6.0	6.2
12/24	4.7	5.8	6.0	6.1	6.4	5.6	6.4	6.8	6.3	6.3	6.4	5.9	6.1
12/25	4.5	5.7	5.8	5.9	6.2	5.1	6.2	6.6	6.2	6.2	6.2	5.7	5.9
12/26	4.3	5.6	5.6	5.7	6.0	4.7	5.9	6.3	6.0	6.1	5.9	5.5	5.7
12/27	4.0	5.4	5.3	5.4	5.8	4.4	5.6	6.0	5.9	6.0	5.5	5.2	5.5
12/28	3.6	5.3	4.9	5.2	5.4	4.2	5.2	5.5	5.7	5.8	5.1	4.8	5.1
12/29	3.3	5.2	4.6	4.8	5.0	3.4	4.9	5.1	5.5	5.7	4.7	4.4	4.8
12/30	3.1	5.1	4.5	4.5	4.6	2.6	4.7	4.8	5.4	5.5	4.4	4.1	4.6
12/31	3.0	5.1	4.4	4.3	4.3	2.0	4.6	4.6	5.3	5.4	4.1	4.0	4.5

APPENDIX E

Smolt Outmigration Report, Sultan River

Smolt Outmigration Report
Sultan River

Annual Monitoring Report 2014

Jackson Hydroelectric Project,
FERC No. 2157

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LIST OF ACRONYMS AND ABBREVIATIONS

District	Public Utility District No. 1 of Snohomish County
FERC	Federal Energy Regulatory Commission
FHMP	Fisheries and Habitat Monitoring Plan
Project	Jackson Hydroelectric Project, FERC No. 2157
s.d.	standard deviation

1. INTRODUCTION

In 2012, Public Utility District No. 1 of Snohomish County (the District) began monitoring the outmigration of juvenile salmonids (smolts) as a measure (index) of reproductive success in the Sultan River near Sultan, Washington. This monitoring is one component of the Fisheries and Habitat Monitoring Plan (FHMP), as outlined in Article 410 of the License issued by the Federal Energy Regulatory Commission (FERC) on September 2, 2011, for the continued operation of the Jackson Hydroelectric Project, FERC No. 2157 (Project). This report presents the results of the third year (Year 3) of operation of the rotary screw trap (smolt trap) located on the lower Sultan River. Year 3 is the third of six consecutive years of initial operation, as outlined in the FHMP. Beginning in 2018 and extending to the end of the 45-year License term, the District will continue to operate the smolt trap for 2 of every 6 years.

The FHMP also stipulates that, subject to the results of monitoring, the District will commence operation of the smolt trap on February 1 and continue operations through June 30 of each sampling year. The District will operate the trap between 30 and 40 percent of the hours in any given week during the sampling year, except during severe flow events; and scheduled to fish for four day and four night periods per week, with each fishing period lasting a minimum of six hours. During periods when few fish are emigrating, trapping frequency can be reduced to fewer days per week. The FHMP also stipulates that the trap will be located in the lower mile of the Sultan River and that the District will collect, compile, analyze and report the following trap data by species and life stage: number captured, size distribution, timing (diel and seasonal), fish population estimates and trap efficiency.

2. METHODS

2.1. Trap Description, Location, and Operation

The Sultan River smolt trap, manufactured by E.G. Solutions, is 5 feet in diameter and designed to sample out-migrating fish over a range of flow conditions (discharge, depth, and velocity). The trap is seasonally positioned in the Sultan River at a location approximately 0.2 miles upstream of the confluence with the Skykomish River (Figure 1).

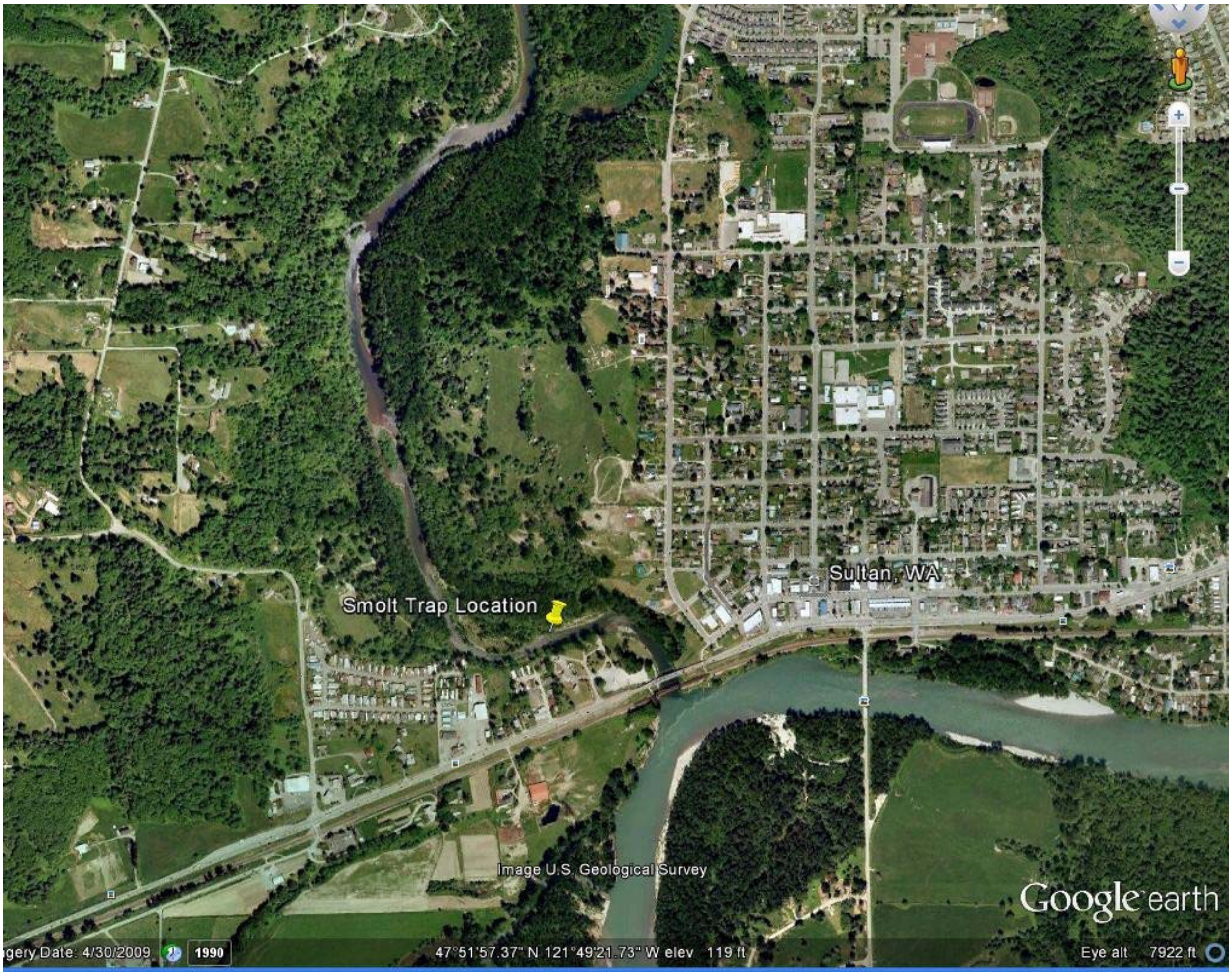


Figure 1. Aerial photograph depicting the location of the Sultan River smolt trap at River Mile 0.2 on the Sultan River.

During 2014, the trap was operated from January 26 to June 27, fishing 57.5 percent of the hours during that time period (61.0% of the day hours and 54.0% of the night hours). Table 1 summarizes total hours and percentage of time fished by week.

Table 1. Number and percentage of hours operated by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Sample Block Start Date	Hours Operated	Percent Hours Operated
1	26-Jan	117	70
2	2-Feb	72	43
3	9-Feb	125	74
4	16-Feb	102	61
5	23-Feb	55	32
6	2-Mar	51	30
7	9-Mar	89	53
8	16-Mar	66	39
9	23-Mar	72	43
10	30-Mar	106	63
11	6-Apr	120	71
12	13-Apr	120	71
13	20-Apr	120	71
14	27-Apr	79	47
15	4-May	145	86
16	11-May	99	59
17	18-May	102	61
18	25-May	121	72
19	1-Jun	122	72
20	8-Jun	72	43
21	15-Jun	79	47
22	22-Jun	94	56

During operation, the trap was under constant observation via video surveillance. Site visits occurred at a minimum of once per day and frequently more than once per day depending on operating conditions. The number of revolutions of the trap cone per minute was recorded at the beginning and end of each trapping period (set). Discharge information from upstream of the trapping site was obtained from the U.S. Geological Survey Gaging Station No. 12138160 (Sultan River below Power Plant; River Mile 4.5).

At the end of each set, captured fish were enumerated and sorted by species and life history stage. Throughout the sampling season, on a weekly basis, a subsample of fish were measured (fork length, mm). Prior to measurement, fish were anesthetized with tricaine methanesulfonate (MS-222).

Trap Efficiency

In order to estimate total outmigration, the capture efficiency (percentage of out-migrating fish that were captured) of the trap was determined. Capture efficiency tests were performed by releasing marked groups of Chinook (wild and hatchery), pink, and chum salmon. Wild Chinook and chum were captured at the trap, anesthetized with MS-222, and marked with Alcian blue colored dye applied with a jet inoculator to produce a small mark near the lateral line. Pink salmon were also captured at the trap and marked with Bismarck Brown dye. Hatchery Chinook were used to increase our sample size and confidence in test results. A total of four thousand five hundred (4,500) hatchery Chinook, obtained from the Wallace River Hatchery, were released in batches of 750 fish on six separate nights during weeks 9, 12, 13, 15, 19, and 22. These fish were approximately 70 mm in length, slightly larger than wild Chinook (Table 15). Hatchery Chinook were marked with Calcein (SE-MARK).

The District conducted efficiency trials at various discharges in order to determine efficiency under varied conditions. All efficiency releases were made at Reese Park, approximately 0.3 miles upstream of the trap. This distance was great enough to allow for mixing of fish across the stream channel and within the water column, but short enough to reduce the likelihood of predation that would result in the loss of fish before they have an opportunity to arrive at the trap. To further reduce predation, all releases occurred approximately 1 hour after sunset. In order to be assured that marked fish and unmarked fish have the same probability of capture, the trap fished continuously for a minimum of 72 hours after each release to allow all marked fish to migrate past the trap.

2.2. *Estimating Total Migration*

A modified Peterson mark-recapture approach was used to estimate total migration for the season (Volkhardt 2007).

The following 5 assumptions must be met in order to achieve an estimate:

1) The population is closed;
2) All fish (marked and unmarked) have an equal opportunity of capture;
3) Marking does not affect catchability;
4) Marked fish mix at random with unmarked fish; and
5) All marks are detected and reported.

Peterson's equation is slightly biased. Therefore, we used Seber's adjustment (Seber 1982) to Peterson's equation because it assumes that the second sampling is done without replacement. Because we did not sample all hours during the season, we've modified Seber's equation to adjust for our sampling effort. Our modified Seber's estimator is as follows:

$$U_{2014} = \left(\frac{u_{2014}+1}{p_{2014}}\right)\left(\frac{M_{2014}+1}{m_{2014}+1}\right)$$

Where

U_{2014} = Estimated number of fish migrating past the trap including hours not fished
u_{2014} = Number of fish captured at the trap
p_{2014} = Percent of hours fished
M_{2014} = Number of fish marked and released during efficiency trials
m_{2014} = Number of marked fish captured during efficiency trials

An approximate variance estimate of U_{2014} is as follows:

$$\widehat{Var}(U_{2014}) = \frac{(u_{2014}+1)(M_{2014}+1)(u_{2014}-m_{2014})(M_{2014}-m_{2014})}{{p_{2014}}^2(m_{2014}+1)^2(m_{2014}+2)}$$

and an approximate 95% confidence interval is

$$U_{2014} \pm 1.96\sqrt{\widehat{Var}(U_{2014})}$$

2.3. Chinook Egg-to-Migrant survival

Once total Chinook migration was estimated, egg-to-migrant survival was estimated by:

$$S_{2014} = \left(\frac{E_{2013}}{U_{2014}}\right)$$

Where

S_{2014} = Chinook egg-to-migrant survival in 2014

U_{2014} = Estimate of 2014 Chinook migration
E_{2013} = Number of Chinook eggs deposited in gravel in 2013
The number of Chinook eggs deposited in gravel in 2013 figure is calculated using Chinook spawner data from 2013 surveys and average Chinook fecundity from Wallace River Hatchery data.

3. RESULTS AND DISCUSSION

3.1. Catch

A total of 80,450 fish and 4 salamanders were captured during the 2014 sampling year (Table 2). Although scales were not collected, all Chinook were age 0+ based on size and identification keys. This is confirmed by scale sample data from adult Chinook that indicate that virtually all Sultan River Chinook migrate as sub-yearlings (0+).

Table 2. Total fish captured by species and lifestage, Sultan River smolt trap, 2014.

Species	Total
Pink	75,068
Chinook	3,326
Chum	859
Coho (1+)	671
Coho (0+)	179
Dace	127
Lamprey	101
Rainbow Trout	80
Sculpin	27
Cutthroat Trout	8
Northwest Salamander	4
Three spine Stickleback	3
Brown Bullhead	1

3.3. Trap Efficiency

In order to estimate total migration, groups of wild Chinook, pink, and chum, as well as 4,500 hatchery Chinook were used to assess capture efficiency throughout the season. The number of yearling coho captured was not sufficient to conduct efficiency trials using these fish.
Flows from January 26 to May 23 (time period 1) were quite high, generally 1,400-1,600 cubic feet per second (cfs) and rarely less than 1,200 cfs. Flows from May 24 to June 27 (time period 2) were much lower, and did not exceed 600 cfs. Efficiency trials were conducted during both periods and efficiency was considerably higher during time period 2. Therefore, we used two different efficiency estimates for these time periods. Tables 3 and 4 summarize results of efficiency trials by species and time periods.

Table 3. Summary of mark-recapture tests of trap capture efficiency of wild Chinook, hatchery Chinook, chum, and pink salmon, Sultan River smolt trap, January 26 to May 23, 2014 (time period 1).

Fish Used	Total Marked and Released	Total Recaptured	% Trap Efficiency
Wild Chinook	447	12	2.7
Hatchery Chinook	3,000	143	4.8
Wild and Hatchery Chinook Combined	3,447	155	4.5
Chum	131	4	3.1
Pink	9,645	222	2.3
All Species Combined	13,223	381	2.9

Table 4. Summary of mark-recapture tests of trap capture efficiency of wild and hatchery Chinook salmon, Sultan River smolt trap, May 24 to June 27, 2014 (time period 2).

Fish Used	Total Marked and Released	Total Recaptured	% Trap Efficiency
Wild Chinook	98	4	4.1
Hatchery Chinook	1,500	102	6.8
Wild and Hatchery Chinook Combined	1,598	106	6.6

3.4. Estimating Total Migration

A modified Peterson mark-recapture approach was used to estimate total migration of Chinook, yearling coho, pink, and chum salmon. This method accounts for hours not fished during the season. Mark and recapture rates were stratified into two discrete time periods for estimating total migration of Chinook and yearling coho. Very few pink and chum were captured during time period 2, therefore only time period 1 efficiency was used for these species. Table 5 presents total migration by species using wild Chinook only, wild and hatchery Chinook combined, pink only, chum only, or all species combined efficiency rates for time period 1. Table 6 presents total migration of Chinook and yearling coho during time period 2 using wild Chinook only and wild and hatchery Chinook combined efficiency rates.

Table 5. Total migration of Chinook and yearling coho from January 26 to May 23, 2014 (time period 1) and total migration of pink and chum from January 26 to June 27, 2014 (time period 1 and 2) using wild Chinook only, wild and hatchery Chinook combined, pink only, chum only, or all species combined efficiency rates, Sultan River smolt trap.

Fish used for efficiency test	Chinook Migration	Yearling Coho	Pink Migration	Chum Migration
Wild Chinook (2.7%)	183,565	28,962	na	na
Wild and Hatchery Chinook (4.5%)	117,733	18,575	na	na
Pink (2.3%)	na	na	5,661,706	na
Chum (3.1 %)	na	na	na	39,586
All Species Combined (2.9%)	na	na	na	51,909

Table 6. Total migration of Chinook and yearling coho salmon using wild Chinook only and wild and hatchery Chinook combined efficiency rates, Sultan River smolt trap, May 24 to June 27, 2014 (time Period 2).

Fish used for efficiency test	Chinook Migration	Yearling coho Migration
Wild Chinook (4.1%)	9,323	6,523
Wild and Hatchery Chinook (6.6%)	7,037	4,923

Tables 7 through 12 summarize migration, 95% confidence levels, and variance estimates for Chinook, yearling coho, pink, and chum using various efficiencies. Chinook and yearling coho are separated into time period 1 (January 26 to May 23) and time period 2 (May 24 to June 27).

Table 7. Chinook migration estimate, 95% confidence level, and migration variance using wild Chinook only efficiency and wild and hatchery Chinook combined efficiency, Sultan River smolt trap, January 26 to May 23, 2014 (time period 1).

Fish Used for Efficiency Test	Chinook Migration Estimate	95 % Confidence Level		Migration Variance
		High	Low	
Wild Chinook (2.7%)	183,565	278,115	89,015	2.33E+09
Wild and Hatchery Chinook (4.5%)	117,733	135,262	100,204	8.00E+07

Table 8. Chinook migration estimate, 95% confidence level, and migration variance using wild Chinook only efficiency and wild and hatchery Chinook combined efficiency, Sultan River smolt trap, May 24 to June 27, 2014 (time period 2).

Fish Used for Efficiency Test	Chinook Migration Estimate	95 % Confidence Level		Migration Variance
		High	Low	
Wild Chinook (4.1%)	9,323	16,526	2,121	1.35E+07
Wild and Hatchery Chinook (6.6%)	7,037	8,037	6,037	2.60E+05

Using Wild Chinook only efficiency, the total migration estimate of Chinook for the season (time periods 1 and 2 combined) is 192,888. Using Wild and hatchery Chinook combined efficiency, the total migration estimate of Chinook for the season is 124,770.

Table 9. Yearling coho salmon migration estimate, 95% confidence level, and migration variance using wild and hatchery combined efficiency, Sultan River smolt trap, January 26 to May 23, 2014 (time period 1).

Fish Used for Efficiency Test	Yearling Coho Migration	95 % Confidence Level High	Low	Migration Variance
Wild and Hatchery Chinook (4.5%)	18,575	20,910	16,240	1.42E+06

Table 10. Yearling coho salmon migration estimate, 95% confidence level, and migration variance using wild and hatchery combined efficiency, Sultan River smolt trap, May 24 to June 27, 2014 (time period 2).

Fish Used for Efficiency Test	Yearling Coho Migration Estimate	95 % Confidence Level High	Low	Migration Variance
Wild and Hatchery Chinook (6.6%)	4,923	5,518	4,328	9.21E+04

Using Wild and hatchery Chinook combined efficiency, the total migration estimate of yearling coho for the season is 23,498.

Table 11. Pink salmon migration estimate, 95% confidence level, and migration variance using pink salmon (2.3%) efficiency only, Sultan River smolt trap, 2014.

Fish Used for Efficiency Test	Pink Migration Estimate	95 % Confidence Level High	Low	Migration Variance
Pink (2.3%)	5,661,706	6,393,442	4,929,970	1.39E+11

Table 12. Chum salmon migration estimate, 95% confidence level, and migration variance using chum salmon only (3.1%) all fish combined (2.9%) efficiency, Sultan River smolt trap, 2014.

Fish Used for Efficiency Test	Chum Migration Estimate	95 % Confidence Level High	Low	Migration Variance
Chum (3.1%)	39,586	70,566	8,607	2.50E+08
All Species Combined (2.9%)	51,909	55,728	48,090	3.80E+06

The Peterson mark-recapture approach is based on 5 assumptions which must be met, or accommodated, in order to ensure an unbiased abundance estimate. We determined that we satisfied all 5 assumptions.

1. The population is closed with no immigration or emigration.

We satisfied this assumption because all fish that passed the trap were migrating from only the Sultan River. Because we were far enough upstream (0.2 miles) from the mouth, we do not believe any fish that passed the trap were emigrating from the Skykomish River.

2. All fish (marked and unmarked) have an equal opportunity of capture.
In order to be assured that marked fish and unmarked fish have the same probability of capture, we fished continuously for a minimum of 72 hours after each release. All efficiency releases were at a site 0.3 miles upstream of the trap. This distance was great enough to allow for mixing

of fish across the stream channel and within the water column, but short enough to reduce the likelihood of predation that would result in the loss of fish before they have an opportunity to arrive at the trap. Also, in order to avoid predation, all releases occurred approximately 1 hour after sunset.

3. Marking does not affect catchability.
After marking, fish were held in aerated totes for a minimum of one hour prior to release. The fish showed no unusual behavior or stress as a result of marking.

4. The fish do not lose their marks.
Marking techniques satisfied this assumption.

5. All recovered marks are detected and reported.
Marks were easily detected. All recovered marked fish were recorded immediately.

3.5. Migration Timing

Table 13 and Figure 2 summarize migration of all salmon and trout by week.

Table 13. Chinook, coho (1+), coho (0+), pink, and chum salmon and rainbow and cutthroat trout caught by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Sample Block Start Date	Chinook	Coho (1+)	Coho (0+)	Pink	Chum	Rainbow	Cutthroat
1	26-Jan	39	9		99	3	1	
2	2-Feb	20	3		65	1		
3	9-Feb	132	5	3	176	4		2
4	16-Feb	162	4	1	511			
5	23-Feb	52	2		204			1
6	2-Mar	270	3		1,317	5		
7	9-Mar	188	3	2	1,885	33	2	
8	16-Mar	183	9	15	1,484	36		
9	23-Mar	238	3	13	1,411	109	4	
10	30-Mar	270	6	15	3,773	165		
11	6-Apr	354	7	12	9,104	215	4	
12	13-Apr	519	15	37	17,846	119	7	
13	20-Apr	185	38	18	22,090	127	4	2
14	27-Apr	300	170	14	14,935	34	9	
15	4-May	66	127	2	141	6	12	1
16	11-May	26	35		19		5	1
17	18-May	50	42	3	5		10	1
18	25-May	98	85	8		1	7	
19	1-Jun	134	75	21		1	11	

20	8-Jun	25	25	7			4	
21	15-Jun	6	4	4	2			
22	22-Jun	9	1	4	1			
Season Total		3,326	671	179	75,068	859	80	8

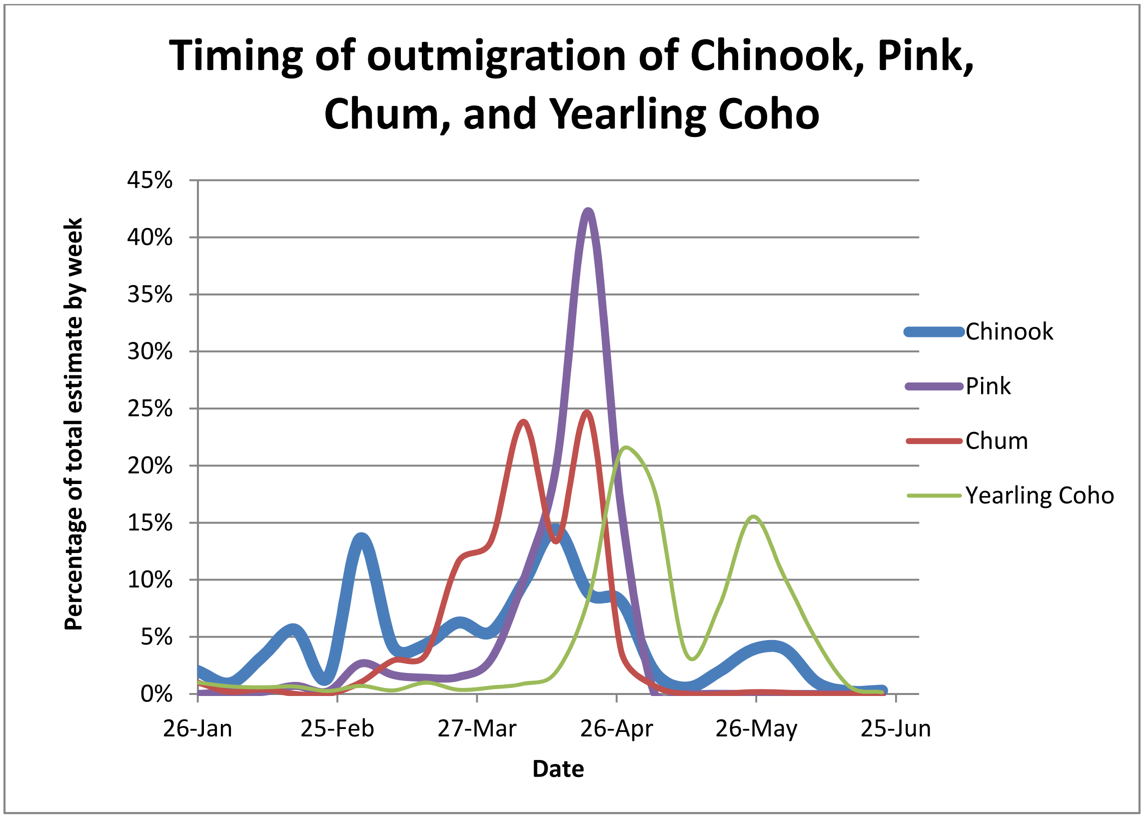


Figure 2. Timing of outmigration for Chinook, pink, chum, and yearling coho (1+) salmon, Sultan River smolt trap, 2014.

3.6. Chinook Egg-to-Migrant Survival

During the fall of 2013, a total of 184 Chinook redds were estimated during spawner surveys. Assuming a Chinook outmigrant estimate of 124,770 (hatchery and wild Chinook combined efficiency) we calculated 15.0% egg-to-migrant survival for brood year 2013 (Table 14). Egg-to migrant survival was estimated at 19.2% and 25.2 % for brood years 2011 and 2012, respectively.

Table 14. Number of Chinook eggs deposited in 2013 to migrant survival in 2014, Sultan River smolt trap, 2014. The number of Chinook eggs is calculated using Wallace River Hatchery data of 4,510 eggs/female.

Chinook redds in 2013	Number of Chinook Eggs in 2013	Chinook Migration in 2014	Egg-to-migrant Survival Rate
184	829,840	124,770	15.0%

3.7. *Fish Size*

Chinook

Chinook lengths averaged 45 mm or less through Week 16 of the season. Beginning in Week 17, and continuing through the end of the season, Chinook lengths increased, averaging 54.7mm during the last 5 weeks of the season (Table 15, Figure 3).

Table 415. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, and percent sampled of Chinook salmon by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
1	41.1	1.51	38	43	12	39	31
2	42.1	0.90	41	43	7	20	35
3	39.9	1.11	37	43	71	132	54
4	40.0	0.97	38	42	18	162	11
5	39.8	0.94	38	42	29	52	56
6	40.4	1.16	38	43	61	270	23
7	40.7	1.35	38	45	41	188	22
8	40.7	1.39	38	44	43	183	23
9	41.0	1.38	38	44	42	238	18
10	41.1	1.85	38	47	55	270	20
11	41.0	1.84	38	48	44	354	12
12	41.1	1.16	39	44	29	519	6
13	42.6	3.29	39	54	41	185	22
14	41.6	1.64	37	48	134	300	45
15	42.8	1.80	40	46	26	66	39
16	44.7	3.30	40	51	13	26	50
17	49.3	6.31	41	58	23	50	46
18	50.1	5.78	41	60	17	98	17
19	52.8	9.18	38	71	21	134	16
20	58.1	7.34	46	70	17	25	68
21	60.8	7.78	47	68	6	6	100
22	66.9	4.48	58	71	9	9	100
Season Summary	42.8	5.81	37	71	759	3,326	23

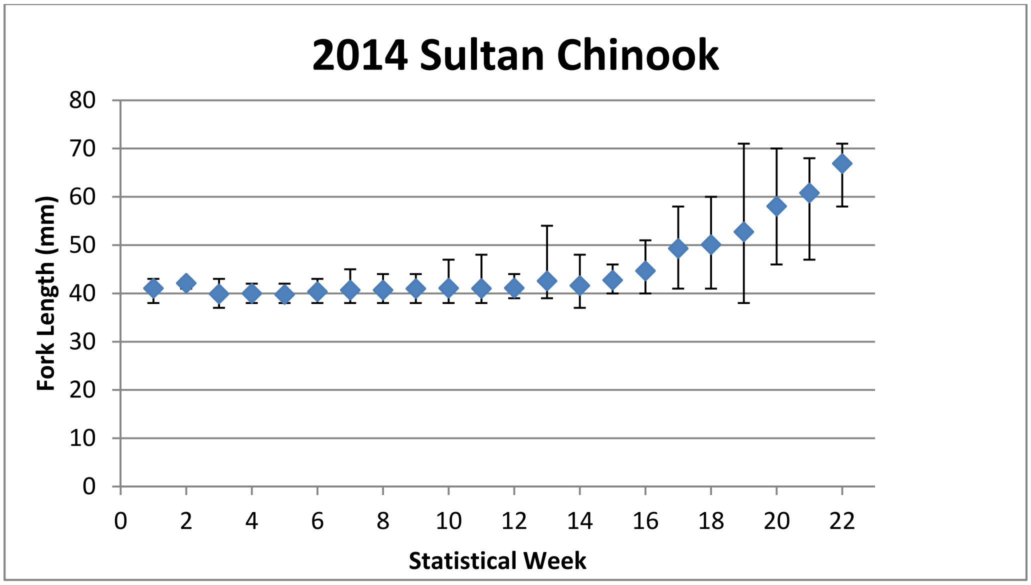


Figure 3. Range (mean, minimum, and maximum) of Chinook salmon fork lengths (mm), by statistical week, Sultan River smolt trap, 2014.

Yearling coho (1+)

Yearling coho averaged 98.2 mm for the season. During weeks 1-12 they averaged 86.9 mm. Beginning in Week 12, lengths increased, averaging 102.2 mm in Week 13 through the end of the season (Table 16, Figure 4).

Table 516. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, and percent sampled of yearling coho (1+) salmon by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
1	82.3	8.22	69	96	9	9	100
2	87.7	9.07	78	96	3	3	100
3	95.6	13.83	78	111	5	5	100
4	79.5	10.66	70	93	4	4	100
5	92.5	16.26	81	104	2	2	100
6	76.0	1.41	75	77	2	3	67
7	74.3	6.11	69	81	3	3	100
8	82.0	7.11	78	100	9	9	100
9	84.7	6.66	79	92	3	3	100
10	85.8	5.17	83	95	5	6	83
11	92.1	15.12	72	108	7	7	100
12	92.1	19.15	70	135	15	15	100
13	99.9	13.31	72	124	28	38	74
14	104.1	9.55	76	127	67	170	39
15	98.2	7.77	78	114	24	127	19
16	101.5	11.18	79	126	27	35	77
17	108.3	9.11	95	124	7	42	17
18	98.4	10.85	74	113	13	85	15
19	100.9	9.13	80	122	25	75	33
20	107.9	4.36	101	115	16	25	64
21	99.5	2.38	97	102	4	4	100
22	103.0		103	103	1	1	100
Season Summary	98.4	12.77	69	135	279	671	42

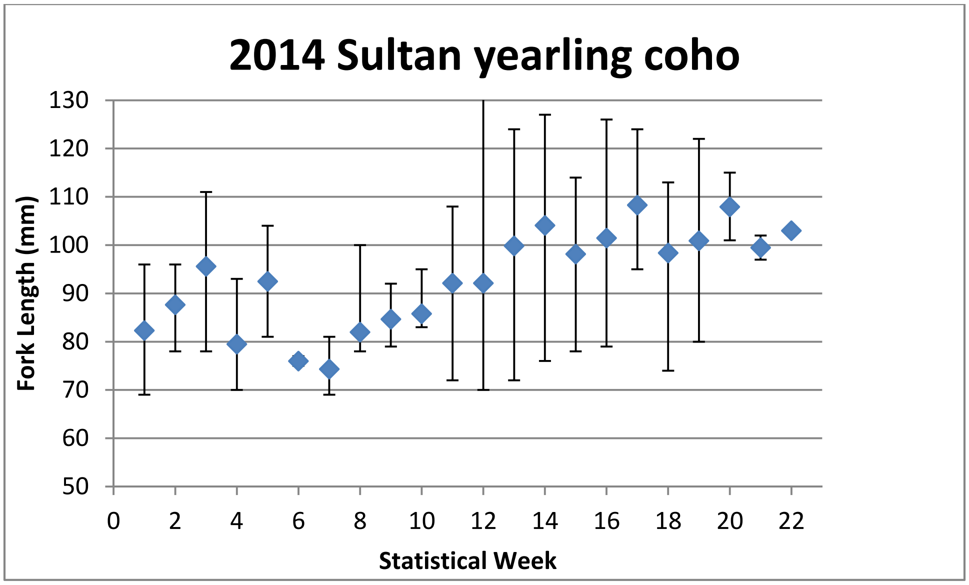


Figure 4. Range (mean, minimum, and maximum) of yearling (1+) coho salmon fork lengths (mm) by statistical week, Sultan River smolt trap, 2014.

Sub-yearling (0+) coho

Sub-yearling coho showed little variation in length. The average length for the season was 36.4 mm and standard deviation was 2.99 (Table 17, Figure 5).

Table 17. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, and percent sampled of sub-yearling (0+) coho salmon by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
1						0	
2						0	
3	36.5	0.71	36	37	2	3	67
4	35.0		35	35	1	1	100
5						0	
6						0	
7	35.0		35	35	1	2	50
8	36.0	2.65	34	41	9	15	60
9	36.3	1.28	35	39	8	13	62
10	36.2	2.32	34	41	11	15	73
11	36.7	2.11	35	42	8	12	67
12	38.2	2.48	35	42	15	37	41
13	37.6	2.41	34	42	10	18	56
14	37.3	1.74	35	40	11	14	79
15	37.6	2.07	36	41	2	2	100
16						0	
17	38.3	2.52	36	41	3	3	100
18	39.2	3.11	36	43	5	8	63
19	40.0	3.39	35	47	16	21	76
20	41.8	4.09	37	46	5	7	71
22	42.5	3.54	40	45	2	4	50
Season Summary	37.9	2.99	34	47	109	179	61

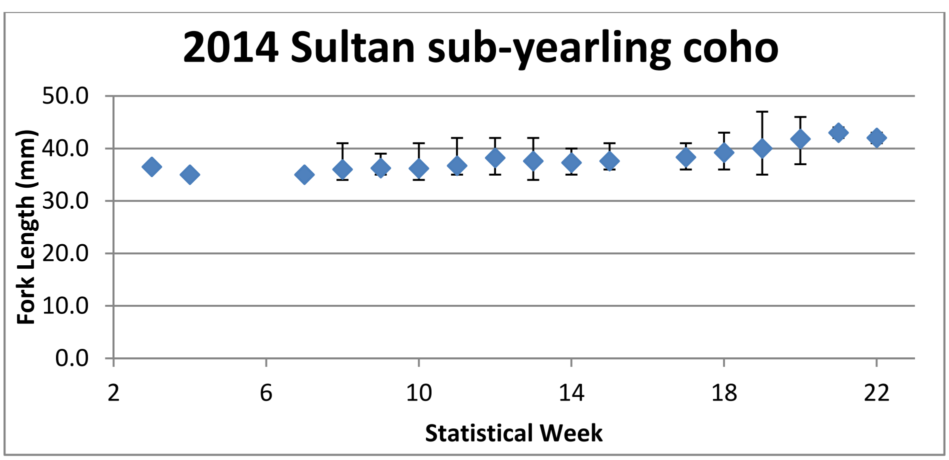


Figure 5. Range (mean, minimum, and maximum) of sub-yearling (0+) coho salmon fork lengths (mm) by statistical week, Sultan River smolt trap, 2014.

Chum

Chum salmon showed little variation in length. The average length for the season was 39.2 mm and standard deviation was 1.18 (Table 18, Figure 6).

Table ~~6~~18. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, and percent sampled of chum salmon by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
1	37.7	0.58	37	38	3	3	100
2	38.0		38	38	1	1	100
3	37.3	1.26	36	39	4	4	100
4						0	
5						0	
6	39.0	1.00	38	40	5	5	100
7	38.0	1.41	37	39	2	33	6
8	38.5	0.93	37	40	8	36	22
9	39.6	0.84	38	41	10	109	9
10	39.2	0.80	38	41	13	165	8
11	39.8	1.04	38	41	8	215	4
12	39.4	0.84	38	40	10	119	8
13	39.3	1.11	38	42	28	127	22
14	39.7	1.49	38	43	16	34	
15	39.3	1.50	38	41	4	6	67
16						0	
17						0	
18	39.0		39	39	1	1	100
19	40.0		40	40	1	1	100
Season Summary	39.2	1.18	36	43	114	859	13

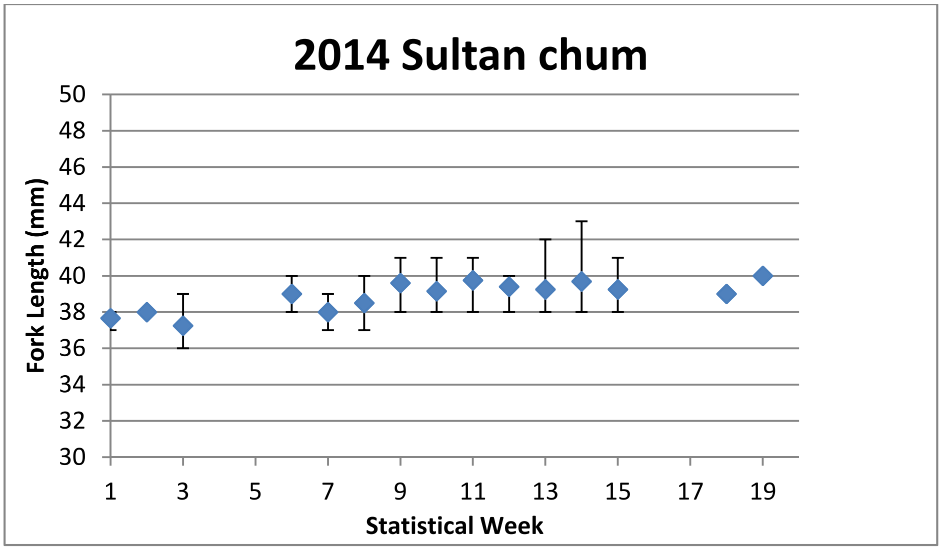


Figure 6. Range (mean, minimum, and maximum) of chum salmon fork lengths (mm) by statistical week, Sultan River smolt trap, 2014.

Rainbow Trout

Table 19 and Figure 7 summarize lengths of rainbow trout throughout the season.

Table 19. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, percent sampled and number smolts of rainbow trout by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
1	252.0		252	252	1	1	100
2						0	
3						0	
4						0	
5						0	
6						0	
7	101.0	39.60	73	129	2	2	100
8						0	
9	81.75	11.32	78	96	4	4	100
10						0	
11	138.3	30.64	100	175	4	4	100
12	115.6	35.08	78	170	7	7	100
13	120.5	32.92	80	160	4	4	100
14	122.8	82.56	59	270	6	9	67
15	137.5	44.00	72	207	12	12	100
16	192.0	75.58	105	287	4	5	80
17	132.3	42.73	93	202	10	10	100
18	138.4	53.17	78	204	7	7	100
19	108.2	33.15	78	202	11	11	100
20	116.3	31.88	98	164	4	4	100
Season Summary	128.0	49.79	59	287	76	80	95

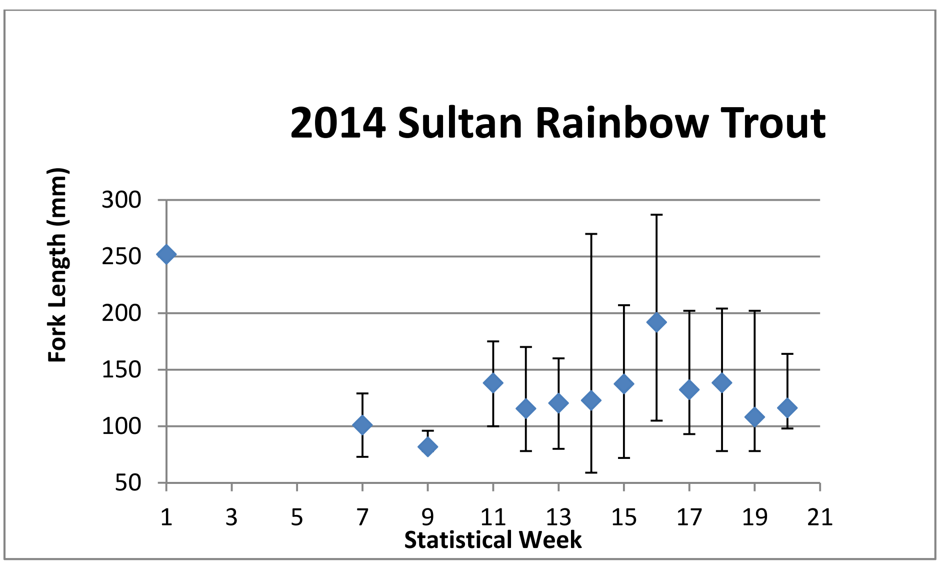


Figure 7. Range (mean, minimum, and maximum) of rainbow trout fork lengths (mm) by statistical week, Sultan River smolt trap, 2014.

Cutthroat Trout

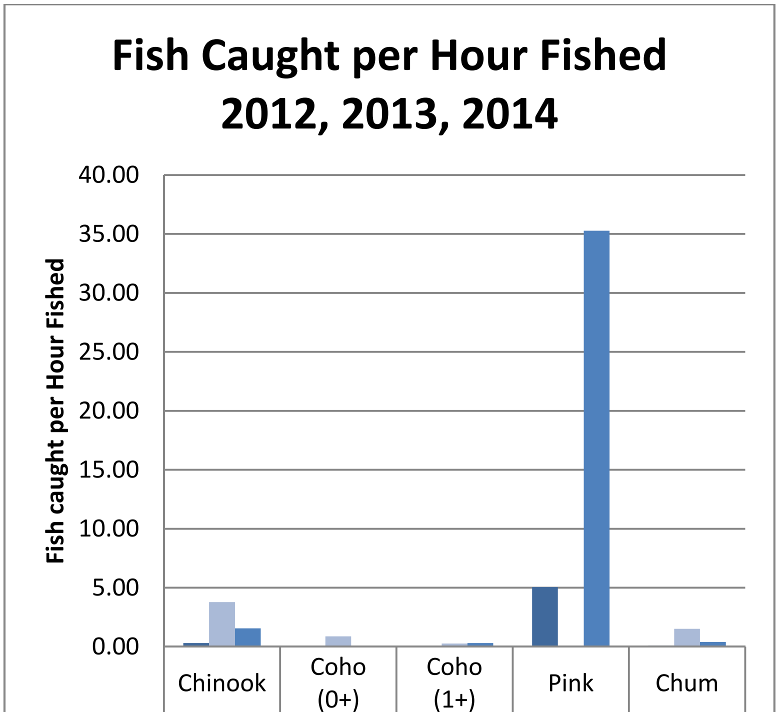
Table 20 summarizes cutthroat trout fork lengths.

Table 20. Mean fork length (mm), standard deviation (s.d.), minimum and maximum length, number sampled, number captured, and percent sampled of cutthroat trout by statistical week, Sultan River smolt trap, 2014.

Statistical Week	Mean	s.d.	Minimum	Maximum	Number Sampled	Number Captured	Percent Sampled
3	260.0	110.31	182	338	2	2	100
4	78.0		78	78	1	1	100
7	82.0		82	82	1	1	100
11	188.0	76.37			2	2	100
12	160		160	160	1	1	100
14	148.0		148	148	1	1	100
Season Summary	170.5	85.89	78	338	8	8	100

3.8. Catch Per Unit Effort for 2012, 2013, and 2014

The smolt trap has been in the same location during the first three years of operation and will continue to be operated in the same location in future years. Figure 8 summarizes catch per unit effort (CPUE in hours fished) for Chinook, sub-yearling coho (0+), yearling coho (1+), pink, and chum salmon for 2012-2014.



	Chinook	Coho (0+)	Coho (1+)	Pink	Chum
2012	0.31	0.05	0.10	5.06	0.11
2013	3.78	0.88	0.27	0.00	1.52
2014	1.56	0.08	0.32	35.28	0.40

Figure 8. Chinook, sub-yearling coho (0+), yearling coho (1+), pink, and chum salmon captured per hour fished during 2012-2014, Sultan River smolt trap.

4. SUMMARY

This report presents the results of the third year of operation of the rotary screw trap located on the Sultan River. In 2014, the trap was operated from January 26 to June 27 and fished 57.5% of the hours during that time period. Chinook, pink, yearling coho, and chum salmon production estimates were made using a modified Peterson mark-recapture approach. An estimated 124,770 Chinook, 23,498 yearling coho, 5,661,706 pink and 51,909 chum salmon migrated during the trapping period. Chinook egg-to-migrant survival was estimated at 15.0%. This value was calculated using Chinook spawner data from 2013 (184 redds) and the juvenile production estimate of 124,770 in 2014. No flooding occurred in 2013 that would have resulted in scouring of Chinook redds.

5. REFERENCES

Cordone, A.J. and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. Calif. Fish and Game 47(2):189-228.

Seber, G.A. F.1982. The estimation of animal abundance and related parameters, 2nd edition. Charles Griffin and Company. London.

Volkhardt, G.C., S.L. Johnson, B. Miller, T.E. Nickelson, and D. E. Seiler. 2007. Rotary screw traps and inclined plane traps. Pages 235-266 in D.H. Johnson, B.M. Shrier, J.S. O'Neal, J.A.

Knutzen, X. Augerot, T.A. O'Neil, and T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

APPENDIX F

Side Channel Supplemental Assessments

Jackson - Sultan River, Results of 2013 Minnowing Trapping Efforts

Trap #	Site	Date Deployed	Date checked and removed	Description	Number Fish Captured					
					coho	rainbow	cutthroat	sculpin	dace	stickleback
Trap 1	Side channel #1 (historic)	25-Jul	29-Jul	20' below inlet	0			5		
Trap 2	Side channel #1 (redundent)	25-Jul	29-Jul	15' below inlet	4			3		
Trap 3	Side channel #1 (historic)	25-Jul	29-Jul	50' above middle bridge	6					
Trap 4	Side channel #1 (historic)	25-Jul	29-Jul	30' below middle bridge	4			3		1
Trap 5	Side channel #1 (extension)	25-Jul	29-Jul	250' above outlet	5			1		
TOTAL					**19**			**12**		**1**
Trap 6	Side channel #2	25-Jul	29-Jul	80' below inlet	0		1	3		
Trap 7	Side channel #2	25-Jul	29-Jul	150' below inlet	4			2	1	
Trap 8	Side channel #2	25-Jul	29-Jul	300' below inlet	0		1	1		
Trap 9	Side channel #2	25-Jul	29-Jul	200' above outlet	12	5		4		
Trap 10	Side channel #2	25-Jul	29-Jul	100' above outlet	1	3		3		
TOTAL					**17**	**8**	**2**	**13**	**1**	
Trap 11	Side channel #3	25-Jul	29-Jul	150' below inlet	19	1		7		
Trap 12	Side channel #3	25-Jul	29-Jul	250' below inlet	7			6		
Trap 13	Side channel #3	25-Jul	29-Jul	300' above outlet	6	1		1		
Trap 14	Side channel #3	25-Jul	29-Jul	200' above outlet	9			1		
Trap 15	Side channel #3	25-Jul	29-Jul	40' above outlet	1		1	3		
TOTAL					**42**	**2**	**1**	**18**	**1**	**2**
all rainbow and cutthroat > 100 mm				**Total All Side Channels**	78	10	3	43	2	3

Jackson - Sultan River, Results of Snorkel Survey Summer 2013 - 3 sections per side channel, each 100' feet long

Site			Date	Discharge (cfs)		Coho	Avg Size	Trout	Size
				Mainstem	Side Channel	Number		Number	
Side Channel #1 (historic)	Just upstream of confluence with redundant	Snorkel	25-Jul	317	6	109	75	9	
Side Channel #1 (historic)	u/s of middle bridge	Snorkel	25-Jul	317	10.2	66	75	3	
Side Channel #1 (historic)	below middle bridge, start u/s of jam	Snorkel	25-Jul	317	10.2	61	75	17	
Side Channel #1 (redundant)	entire channel	VISUAL SURFACE (too shallow)	25-Jul		4.2	122	75		
Side Channel #2	u/s of fjord	Snorkel	25-Jul	317	8	141	75	6	
Side Channel #2	further upstream	Snorkel	25-Jul	317	8	58	75	21	
Side Channel #2	further but before RB inflow	Snorkel	25-Jul	317	8	75	75	9	
Side Channel #3	d/s of "s" near lower boulder placement	Snorkel	25-Jul	317	22.5	17	90-120		
Side Channel #3	u/s of "s"	Snorkel	25-Jul	317	22.5	1	80		
Side Channel #3	near LWD on LB	Snorkel	25-Jul	317	22.5	26	70		
Side Channel #4		Drift Snorkel (too swift)	25-Jul	317	61.3	81	80-90		

Jackson - Sultan River, Results of 2014 Minnowing Trapping Efforts

Trap #	Site	Date Deployed	Date Checked and Removed	Description	Number Fish Captured				
					coho	rainbow	cutthroat	sculpin	dace
Trap 1	Side channel #1 (historic)	8-Aug	11-Aug	20' downstream inlet	4			13	
Trap 2	Side channel #1 (redundent)	8-Aug	11-Aug	15' downstream inlet	1	2	1	6	
Trap 3	Side channel #1 (historic)	8-Aug	11-Aug	50' upstream middle bridge	1	1			
Trap 4	Side channel #1 (historic)	8-Aug	11-Aug	30' downstream middle bridge	2	2		5	
Trap 5	Side channel #1 (extension)	8-Aug	11-Aug	250' upstream outlet	9				
TOTAL					**17**	**5**	**1**	**24**	**0**
Trap 6	Side channel #2	11-Aug	14-Aug	80' downstream inlet	2				
Trap 7	Side channel #2	11-Aug	14-Aug	150' downstream inlet	1	2	1	3	
Trap 8	Side channel #2	8-Aug	11-Aug	300' downstream inlet	2				1
Trap 9	Side channel #2	8-Aug	11-Aug	200' upstream outlet	3	1		4	
Trap 10	Side channel #2	8-Aug	11-Aug	100' upstream outlet	1			1	
TOTAL					**9**	**3**	**1**	**8**	**1**
Trap 11	Side channel #3	11-Aug	14-Aug	150' downstream inlet	20			1	
Trap 12	Side channel #3	11-Aug	14-Aug	250' downstream inlet	1			2	
Trap 13	Side channel #3	11-Aug	14-Aug	300' upstream outlet		1			
Trap 14	Side channel #3	11-Aug	14-Aug	200' upstream outlet	3				
Trap 15	Side channel #3	11-Aug	14-Aug	40' upstream outlet		2		4	
TOTAL					**24**	**3**	**0**	**7**	**0**
coho ~ 75 mm									
all rainbow and cutthroat > 100 mm				**Total All Side Channels**	**50**	**11**	**2**	**39**	**1**

Jackson - Sultan River, Results of Snorkel Survey Summer 2014

Site			Date	Discharge (cfs)		Coho	Avg Size	Trout	Avg Size
				Mainstem	Side Channel	Number		Number	
Side Channel #1 (historic)	Just upstream of confluence with redundant	Snorkel	7-Aug	365	≈ 5	90	75	6	120
Side Channel #1 (historic)	u/s of middle bridge	Snorkel	7-Aug	365	≈ 5	39	75	2	120
Side Channel #1 (historic)	below middle bridge, start u/s of jam	Snorkel	7-Aug	365	≈ 5	56	75	10	115
Side Channel #1 (redundant)	entire channel	VISUAL SURFACE (too shallow)	7-Aug	365	≈ 5	78	75	7	120
Side Channel #2	u/s of fjord	Snorkel	7-Aug	365	≈ 20	88	75	2	115
Side Channel #2	further upstream	Snorkel	7-Aug	365	≈ 20	69	75	11	115
Side Channel #2	further but before RB inflow	Snorkel	7-Aug	365	≈ 20	32	75	3	115
Side Channel #3	d/s of "s" near lower boulder placement	Snorkel	7-Aug	652	≈ 45	19	75	1	
Side Channel #3	u/s of "s"	Snorkel	7-Aug	652	≈ 45	4	75	0	
Side Channel #3	near LWD on LB	Snorkel	7-Aug	652	≈ 45	18	75	3	45 (YOY)
Side Channel #4		Drift Snorkel (too swift)	7-Aug	380	≈ 60	45	75	0	

APPENDIX G

Consultation Documentation Regarding Draft Report

Presler, Dawn

From:	Presler, Dawn
Sent:	Tuesday, April 14, 2015 3:11 PM
To:	'Steven Fransen' (steven.m.fransen@noaa.gov); 'Tim_Romanski@fws.gov' (Tim_Romanski@fws.gov); Anne Savery; 'Loren Everest - USFS' (leverest@fs.fed.us); 'Leonetti, Frank' (frank.leonetti@snoco.org); 'James (ECY) Pacheco' (JPAC461 @ECY.WA.GOV); 'brock.applegate@dfw.wa.gov' (brock.applegate@dfw.wa.gov); 'Jim Miller' (JMiller@ci.everett.wa.us); Mick Matheson; Tom O'Keefe
Cc:	Binkley, Keith
Subject:	JHP (FERC No. 2157) - draft Fishery and Habitat Monitoring Plan for your 30-day review
Attachments:	Sultan Riverine Habitat Monitoring Final_Feb 2015.pdf; 2014 FHMP Annual DRAFT Report.pdf; Appendix_E_Sultan_River_Smolt_Trap_Report_2014.pdf

Dear ARC,
Attached is the draft FHMP Annual Report for your 30-day review and comment. Please email comments, if any, on the report to me (with cc: to Keith) by May 14, 2015. Failure to respond will be deemed approval of the report as written. Also, attached are the related reports - 2014 Smolt Trap Report by the District and the Riverine Habitat Monitoring Report conducted by Stillwater.

If you have any questions on the reports, please contact Keith; otherwise we can discuss at the ARC Meeting on April 21 if needed.

Have a great day!

Dawn Presler
Sr. Environmental Coordinator
Generation Resources
(425) 783-1709
****
Public Utility District No. 1 of Snohomish County
PO Box 1107
Everett, WA 98206-1107

Presler, Dawn

From:	Presler, Dawn
Sent:	Tuesday, April 14, 2015 3:52 PM
To:	''Steven Fransen' (steven.m.fransen@noaa.gov)'; ''Tim_Romanski@fws.gov' (Tim_Romanski@fws.gov)'; 'Anne Savery'; ''Loren Everest - USFS' (leverest@fs.fed.us)'; ''Leonetti, Frank' (frank.leonetti@snoco.org)'; ''James (ECY) Pacheco' (JPAC461 @ECY.WA.GOV)'; ''brock.applegate@dfw.wa.gov' (brock.applegate@dfw.wa.gov)'; ''Jim Miller' (JMiller@ci.everett.wa.us)'; 'Mick Matheson'; 'Tom O'Keefe'
Cc:	Binkley, Keith
Subject:	RE: JHP (FERC No. 2157) - draft Fishery and Habitat Monitoring Plan for your 30-day review
Attachments:	2014 Temperature Data (Appendices B through D).xlsx

And here are the corresponding 2014 temperature data appendices

Dawn

From: Presler, Dawn
Sent: Tuesday, April 14, 2015 3:11 PM
To: 'Steven Fransen' (steven.m.fransen@noaa.gov); 'Tim_Romanski@fws.gov' (Tim_Romanski@fws.gov); Anne Savery; 'Loren Everest - USFS' (leverest@fs.fed.us); 'Leonetti, Frank' (frank.leonetti@snoco.org); 'James (ECY) Pacheco' (JPAC461@ECY.WA.GOV); 'brock.applegate@dfw.wa.gov' (brock.applegate@dfw.wa.gov); 'Jim Miller' (JMiller@ci.everett.wa.us); Mick Matheson; Tom O'Keefe
Cc: Binkley, Keith
Subject: JHP (FERC No. 2157) - draft Fishery and Habitat Monitoring Plan for your 30-day review

Dear ARC,
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Dawn Presler
Sr. Environmental Coordinator
Generation Resources
(425) 783-1709
****
Public Utility District No. 1 of Snohomish County
PO Box 1107
Everett, WA 98206-1107

Presler, Dawn

From:	Applegate, Brock A (DFW) <Brock.Applegate@dfw.wa.gov>
Sent:	Thursday, May 14, 2015 4:57 PM
To:	Presler, Dawn; 'Steven Fransen' (steven.m.fransen@noaa.gov); 'Tim_Romanski@fws.gov' (Tim_Romanski@fws.gov); Anne Savery; 'Loren Everest - USFS' (leverest@fs.fed.us); 'Leonetti, Frank' (frank.leonetti@snoco.org); Pacheco, James (ECY); 'Jim Miller' (JMiller@ci.everett.wa.us); Mick Matheson; Tom O'Keefe
Cc:	Binkley, Keith
Subject:	RE: Jackson Hydro -- Question for the draft Fishery and Habitat Monitoring Plan for your 30-day review

Hi Dawn, I have reviewed the Fish Habitat Monitoring Plan and the attached appendices. I have one question:

I did not have time to go through the Fishery Habitat Monitoring Plan, but did go through License Article 410 and A-LA 17.

When and under what conditions trigger this type of fry surveys?

"Under circumstances defined in the monitoring plan, the Licensee shall conduct supplemental assessments using snorkeling and/or backpack electrofishing surveys, subject to obtaining appropriate permits, to evaluate such things as rearing, fish distributions, relative abundance, habitat utilization, size, and life stage survival."

Thanks ahead of time for your answer.

Sincerely, Brock

Brock Applegate
Renewable Energy/Major Projects Mitigation Biologist
Washington Department of Fish and Wildlife
P.O. Box 1100
111 Sherman St. (physical address)
La Conner, WA 98257-9612

(360) 466-4345 x244 (office)
(360) 789-0578 (cell)
(360) 466-0515 (fax)

From: Presler, Dawn [mailto:DJPresler@SNOPUD.com]
Sent: Tuesday, April 14, 2015 3:11 PM
To: 'Steven Fransen' (steven.m.fransen@noaa.gov); 'Tim_Romanski@fws.gov' (Tim_Romanski@fws.gov); Anne Savery; 'Loren Everest - USFS' (leverest@fs.fed.us); 'Leonetti, Frank' (frank.leonetti@snoco.org); Pacheco, James (ECY); Applegate, Brock A (DFW); 'Jim Miller' (JMiller@ci.everett.wa.us); Mick Matheson; Tom O'Keefe
Cc: Binkley, Keith
Subject: JHP (FERC No. 2157) - draft Fishery and Habitat Monitoring Plan for your 30-day review

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If you have any questions on the reports, please contact Keith; otherwise we can discuss at the ARC Meeting on April 21 if needed.

Have a great day!

Dawn Presler
Sr. Environmental Coordinator
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****
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Everett, WA 98206-1107

APPENDIX H

Response to Comments Regarding Draft Report

Comment	District's Response
B. Applegate, WDFW, Email Dated 5/14/2015	
I have one question: I did not have time to go through the Fishery Habitat Monitoring Plan, but did go through License Article 410 and A-LA 17. When and under what conditions trigger this type of fry surveys? "Under circumstances defined in the monitoring plan, the Licensee shall conduct supplemental assessments using snorkeling and/or backpack electrofishing surveys, subject to obtaining appropriate permits, to evaluate such things as rearing, fish distributions, relative abundance, habitat utilization, size, and life stage survival."	The FHM Plan Section 3.2.1 ties the conduct of these surveys to the monitoring outlined in the Side Channel Enhancement and Woody Debris Placement Plan. The District has conducted snorkel surveys and minnow traps in the side channels during 2013 and 2014; these data have been included as Appendix F. The District will continue these surveys per the Side Channel Enhancement and Large Woody Debris Placement Plan's Section 5.3.