RIVERSCAPE SURVEYS OF IN-STREAM FISH ASSEMBLAGES AND HABITAT IN THE CHEHALIS RIVER

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EXECUTIVE SUMMARY

Introduction

This report presents preliminary results of large scale, continuous fish distribution and habitat data for the Chehalis River basin. The work is part of the research undertaken to describe species utilization of the watershed, and informs of the Chehalis Basin Programmatic Environmental Impact Statement (PEIS) related to a potential dam in the upper watershed. The data will also be used to improve Ecosystem Diagnosis and Treatment (EDT) assumptions and support the watershed analysis for the Aquatic Species Restoration Plan (ASRP).

To date, three (3) riverscape surveys have been completed in the Upper Chehalis sub-basin and one survey each in the North Fork of the Newaukum River, the West Fork of the Satsop River and the East Fork of the Satsop River (Table 1). Additional work will be completed in 2016, with the work synthesized into a final report in June of 23017.

TABLE 1. Riverscape surveys completed in the upper Chehalis River, Newaukum, and Satsop rivers.

Sub-basin	Year	Distance (km)
Upper Chehalis River	2013	77
Upper Chehalis River	2014	35
Upper Chehalis River	2015	35
NF Newaukum River	2014	27
WF Satsop River	2015	49
EF Satsop River	2015	21

Methods

Surveys were completed between late July and early September in each sampling year, with fish, habitat, and temperature data from the main stem of each sub-basin collected concurrently. Data were collected in consecutive reaches approximately 200-m in length with breaks occurring between major habitat units (riffles or pools). Visual counts of fish were obtained by snorkeling in a downstream direction, with the fish identified by species and size category. Habitat measures were obtained simultaneously by surveyors on foot, with each reach assigned a channel type and where appropriate a predominant pool-forming structure. Surveyors also measured bankfull width, wetted

width, and thalweg depth at the top and middle of each reach and visually determined substrate type.

Results and Conclusions

Together, the Upper Chehalis, North Fork Newaukum, and West Fork Satsop shared a similar pattern of coarse substrate and cooler temperatures in the higher gradient headwaters transitioning to finer substrate and warmer temperatures in the lower elevations.

Composition of fish species was similar across all four of the sub-basins and included a suite of salmonid, cyprinid, catostomid, and centrarchid species.

- Juvenile coho and trout were the most frequently observed taxa in all of the sub-basins, with their abundance decreasing in a downstream direction, reflecting the importance of cooler headwater reaches to these species for summer rearing.
- Dace, redside shiner, and northern pikeminnow were observed in all sub-basins, with their relative abundance increasing in a downstream direction.
- Non-native smallmouth bass were observed in the lowest extent of the North Fork Newaukum surveys but not in other survey areas.
- The Upper Chehalis sub-basin had the highest fish counts per kilometer of any of the surveyed areas, indicating the importance of the area for both salmonids and non-salmonids.
- The East Fork Satsop was unique with respect to fish, habitat, and temperature. The basin was lowest in elevation among all survey areas, was the only sub-basin with spring-fed headwaters, and primarily supported salmonid-dominated fish assemblages over the full extent of surveyed reaches.

Next Steps

Additional work will be undertaken in 2016, with an additional draft report complied in the late-winter/spring of 2017. A final report synthesizing the 2015/16 results from multiple sub-basins will be completed by June 2017.

Additional analysis includes characteristic identification of the salmonid-cyprinid habitat-temperature continuum and an among-basin comparison of fish density to control for inter-annual differences in the survey years.

REPORT

Introduction

Riverscape surveys collect spatially continuous data on fish and habitat at relatively large spatial scales in order to understand fish distributions in a watershed (Fausch et al. 2002). In 2013 and 2014, this method was used to investigate the summer rearing distribution of fishes in the upper Chehalis River sub-basin (Zimmerman and Winkowski in prep). Summer rearing habitat is considered an important limiting factor for juvenile salmonids in rivers with rain-dominant hydrology such as the Chehalis River. From this study we learned that the majority of summer rearing for juvenile salmonids in the Chehalis River main stem occurs upstream of rkm 175, the proposed location for a flood reduction dam. Based on these results, salmon and steelhead may be far more vulnerable to the reduction in habitat caused by building a dam than if the entirety of the main stem was used as summer rearing habitat. We also learned that the distribution of fish species in the main stem was primarily explained by a spatial continuum of habitat and temperature characteristics. Single factors, such as temperature, had relatively little impact on overall fish composition although further investigation of thermal refugia is needed. These results suggested that location in the watershed will have a much greater impact on habitat suitability than manipulating environmental characteristics, such as temperature or pool frequencies, within a particular reach.

Summer rearing of salmonids characterized by the upper Chehalis River surveys is associated with the habitat and temperature characteristics of higher elevation headwaters. However, the Chehalis River watershed included multiple sub-basins that drain from the Willapa Hills, Cascade foothills, and Olympic Mountains. Diversity in habitat and temperature characteristics among sub-basins may influence fish assemblages and understanding these patterns should broaden our perspective on summer rearing habitat at a watershed scale. Therefore, the riverscape methodology developed in the upper Chehalis River was extended to the Newaukum and Satsop sub-basins in 2014 and 2015. Additional surveys in the Newaukum and Black rivers are planned for 2016. The objectives for each sub-basin are to identify the spatial organization of fishes within and among sub-basins and identify the associations between fish distributions and the habitat and temperature characteristics of each sub-basin. By setting up a comparative approach, we aim to understand the extent to which location and habitat diversity are influencing the summer rearing distributions of fish assemblages within the Chehalis River watershed. Results will improve understanding of how current habitat in the upper Chehalis River sub-basin contributes to the distribution and diversity of fishes in the Chehalis River watershed and will help to identify core areas for conservation and restoration actions.

Methods

Riverscape surveys were completed in the Upper Chehalis, Newaukum, and Satsop rivers between late July and early September (Table 1). Surveys included concurrent collection of fish, habitat, and temperature data from the main stem river in each sub-basin following the methodology of Zimmerman and Winkowski (in prep). The upper extent of surveys in each sub-basin was intended to occur at ~800 m above sea level and the lowest extent of surveys in each sub-basin was defined by the point where the size of the channel precluded the effectiveness of the riverscape methodology (bankfull width ~40 m, Figure 1). Surveys in the WF Satsop sub-basin began at a lower elevation (~600 m above sea level) due to safety concerns associated with access at higher elevation. The EF Satsop sub-basin is lower in elevation and a starting point of ~300 m above sea level was selected based on suitable stream size for the riverscape methodology.

Data were collected in consecutive reaches approximately 200-m in length with breaks occurring between major habitat units (riffles or pools). Visual counts of fish were obtained by snorkeling in a downstream direction. One to four divers were used depending on the width of the wetted channel. General taxa observed included salmon, trout, whitefish, cyprinids, suckers, stickleback, and centrarchids. Fish were identified to species and size category (Table 2). Habitat measures were obtained by surveyors on foot and were collected simultaneous with the snorkel counts (Table 3). Each 200-m reach was assigned a channel type (Montgomery and Buffington 1997) and a predominant pool-forming structure (channel sinuousity, wood, boulder, bedrock, bridge, other), if a pool was present. Bankfull width, wetted width, and thalweg depth were measured at the top and middle of each reach. Maximum depth was measured in the deepest area of each reach. Dominant and subdominant substrates were determined visually using substrate criteria developed by Cummins (1962). Pool counts included enumeration of all depressions in the main stem channel that would remain filled with water at least 0.5 m deep if no flowing water moved through the channel. Stream temperature data were collected using digital thermographs (Onset Hobo Pendant 64K, Onset Computer Corporation, Bourne, Massachusetts, accuracy± 0.5°C) spaced between 1 and 5 km apart throughout the study areas. Stream temperatures were recorded at 30 minute intervals. The accuracy of each logger was compared to a "reference" logger prior to deployment and an NIST reference thermometer upon retrieval in order to ensure that temperature deviations did not exceed 0.5°C.

Results

Three riverscape surveys have been completed in the Upper Chehalis sub-basin and one survey each in the NF Newaukum River, WF Satsop River and EF Satsop River (Table 1). A detailed analysis of the Upper Chehalis surveys is provided in Zimmerman and Winkowski (in prep). A preliminary summary of results from the other sub-basins

are included in this document. Additional work will be completed in 2016 and an analysis that synthesizes results from multiple sub-basins will be completed by June 2017.

TABLE 1. Riverscape surveys completed in the upper Chehalis River, Newaukum, and Satsop rivers.

Sub-basin	Year	Distance (km)
Upper Chehalis River	2013	77
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Habitat characteristics shared commonalities and unique features among sub-basins (Table 2). Together, the Upper Chehalis, NF Newaukum, and WF Satsop shared a similar pattern of coarse substrate and cooler temperatures in the higher gradient headwaters transitioning to finer substrate and warmer temperatures in the lower elevation extent of the survey area. The EF Satsop had fine substrate (primarily gravel) and cool temperatures without a noticeable upstream-downstream continuum in these characteristics. At a given elevation, the temperature profiles were warmest for the Upper Chehalis, similar for the NF Newaukum and WF Satsop and coolest in the EF Satsop (Figure 2). Individual habitat metrics varied among sub-basins (Table 2). Channel widths (wetted and bankfull) were narrower in the NF Newaukum sub-basin than the Upper Chehalis, WF Satsop, and EF Satsop. Thalweg depth was greater in the WF Satsop and EF Satsop rivers. Pool frequency and water inflows were greatest in the Upper Chehalis sub-basin. Large wood counts were highest in the EF Satsop and lowest in the Upper Chehalis sub-basin. Substrate was coarsest in the Upper Chehalis and smallest in the EF Satsop sub-basin. Temperature characteristics.

Composition of fish species was similar across all four of the sub-basins and included a suite of salmonid, cyprinid, catostomid, and centrarchid species. Juvenile coho and trout were the most frequently observed taxa in all of the sub-basins (Table 3). In the upper Chehalis River, NF Newaukum, and WF Satsop sub-basins, their relative abundance decreased in a downstream direction (Figure 3). In the EF Satsop sub-basin, juvenile salmonids were the dominant taxa throughout all surveyed reaches. EF Satsop was the only sub-basin with hatchery production and was also the only sub-basin where residualized hatchery fish (noted by the absence of an adipose fin) were observed. Adult Chinook were observed in all sub-basins except the WF Satsop and were most frequently observed in the NF Newaukum. Adult steelhead were observed in all sub-

basins except the NF Newaukum. A portion of the adult steelhead observed in the EF Satsop were of hatchery origin.

Dace, redside shiner, and northern pikeminnow were observed in all sub-basins (Table 3). In the upper Chehalis River, NF Newaukum, and WF Satsop rivers, their relative abundance increased in a downstream direction (Figure 3). In the EF Satsop, the presence of redside shiner and northern pikeminnow was limited with respect to occupancy and relative abundance. Of note, both longnose dace and speckled dace are both present in the watershed but these species could not be distinguished by the divers.

Other species did not follow an upstream-downstream pattern to their distribution. Mountain whitefish and largescale suckers were commonly found together and were observed in approximately half of the reaches in all sub-basins except the EF Satsop where there were few observations of largescale suckers. Threespine stickleback were rare in the NF Newaukum and not observed in the Upper Chehalis but were present in more than two thirds of the reaches surveyed in both forks of the Satsop River.

Smallmouth bass, which are not native to the Chehalis River watershed, were observed in the lowest extent of the NF Newaukum surveys but were not observed in other survey areas. This species was previously observed in the main stem Chehalis River between the SF Chehalis and Newaukum confluence (Zimmerman and Winkowski in prep).

Conclusions

In summary, fish assemblages followed comparable patterns in three of the four sub-basins with salmonid-dominated assemblage at the upper extent and cyprinid-dominated assemblage at the lower extent. These results indicate consistent patterns in summer fish distributions in the upper Chehalis, Newaukum, and Satsop sub-basins and demonstrate that higher elevation, headwater habitats are important summer rearing areas for juvenile and adult salmonids. Future analyses are needed to identify characteristics of the habitat-temperature continuum that describe the salmonid-cyprinid transition in fish assemblages. The Upper Chehalis sub-basin had the highest counts per kilometer of any of the surveyed areas. Among-basin comparison of fish density will require additional analyses to control for inter-annual differences in the survey years. The EF Satsop was unique with respect to fish, habitat, and temperature. The EF Satsop was lowest in elevation among all survey areas, was the only sub-basin with spring-fed headwaters, and primarily supported salmonid-dominated fish assemblages over the full extent of surveyed reaches.

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TABLE 2. Habitat metrics in surveyed areas of four sub-basins in the Chehalis River watershed. Data are summarized for the upper Chehalis (2014), North Fork Newaukum (2014), West Fork Satsop (2015), and East Fork Satsop rivers (2015). Data are mean (one standard deviation) of measured values at the 1-km reach scale. Substrate measures increase in value with increased coarseness from 1 (silt) to 6 (bedrock).

Metric	Description	Upper Chehalis	NF Newaukum	West Fork Satsop	East Fork Satsop
Wetted width (m)	Average measure	19.44 (5.61)	9.36 (1.39)	19.41 (3.99)	19.67 (4.99)
Bankfull width (m)	Average measure	38.96 (7.69)	19.46 (4.71)	40.90 (10.11)	44.41 (20.21)
Thalweg depth (m)	Average measure	0.50 (0.18)	0.46 (0.15)	0.71 (0.18)	0.71 (0.15)
Maximum depth (m)	Maximum	2.28 (0.79)	1.75 (0.42)	2.68 (0.67)	2.17 (0.72)
Pool frequency	Pools/Reach Length/BFW	0.32 (0.15)	0.24 (0.14)	0.22 (0.11)	0.19 (0.17)
Large wood counts	Total count	12.09 (14.70)	43.39 (30.26)	44.84 (25.64)	85.41 (47.09)
Water inflows	Total count	2.91 (2.96)	1.32 (1.93)	1.26 (1.94)	0.23 (0.43)
Dominant substrate (1-6)	Average of ordinal values	3.46 (0.80)	2.98 (1.05)	3.12 (0.44)	2.86 (0.72)
Subdominant substrate (1-6)	Average of ordinal values	4.06 (0.69)	2.91 (1.05)	3.46 (0.70)	3.19 (0.81)

TABLE 3. Occupancy and density of fish species-life stages during summer low flows in four sub-basins of the Chehalis River. Data are summarized at 1-km reach scale for the upper Chehalis (2014), North Fork Newaukum (2014), West Fork Satsop (2015), and East Fork Satsop rivers (2015). Occupancy is the proportion of reaches where the species is present. Density is the median count per km in reaches where the species was present. Snorkel counts are indices of abundance and should not be considered absolute values. Salmon and trout in the EF Satsop River include hatchery fish identified by a missing adipose fin.

	Upper Chehalis		NF Newaukum		West Fork Satsop		East Fork Satsop	
Species-Life Stage	**Occupancy**	**Density**	**Occupancy**	**Density**	**Occupancy**	**Density**	**Occupancy**	**Density**
Coho 0+	0.97	77	1.00	747	1.00	106	1.00	284
Chinook 0+	0.51	6	0.04	1	0.14	1	0.00	NA
Chinook adult	0.03	1	0.25	1	0.00	NA	0.14	2
Trout 0+	1.00	1229	1.00	124	1.00	137	1.00	60
Trout 1+	1.00	132	1.00	46	0.92	13	1.00	32
Trout Large	0.77	8	0.71	3	0.60	2	1.00	9
Steelhead adult	0.14	1	0.00	NA	0.06	1	0.50	2
Mountain whitefish (adult)	0.51	9	0.57	8	0.78	15	0.32	6
Mountain whitefish (juv)	0.00	NA	0.00	NA	0.24	1	0.41	1
Largescale sucker (adult)	0.51	40	0.43	3	0.14	15	0.09	25
Largescale sucker (juv)	0.51	1021	0.57	125	0.68	84	0.00	NA
Dace (adult)	0.83	250	0.75	503	0.98	189	0.64	9
Dace (fry)	0.54	810	0.46	255	0.84	322	0.18	29
Redside shiner (adult)	0.51	176	0.50	312	0.66	294	0.18	51
Redside shiner (fry)	0.37	1160	0.36	443	0.58	1134	0.00	NA
Northern pikeminnow (adult)	0.40	17	0.57	29	0.48	11	0.09	11
Northern pikeminnow (juv)	0.00	NA	0.00	NA	0.34	43	0.09	19
Smallmouth bass	0.00	NA	0.04	1	0.00	NA	0.00	NA
Threespine stickleback	0.00	NA	0.04	30	0.70	234	0.73	10

FIGURE 1. Elevation profile for riverscape surveys conducted in sub-basins of the Chehalis River in 2014 and 2015.

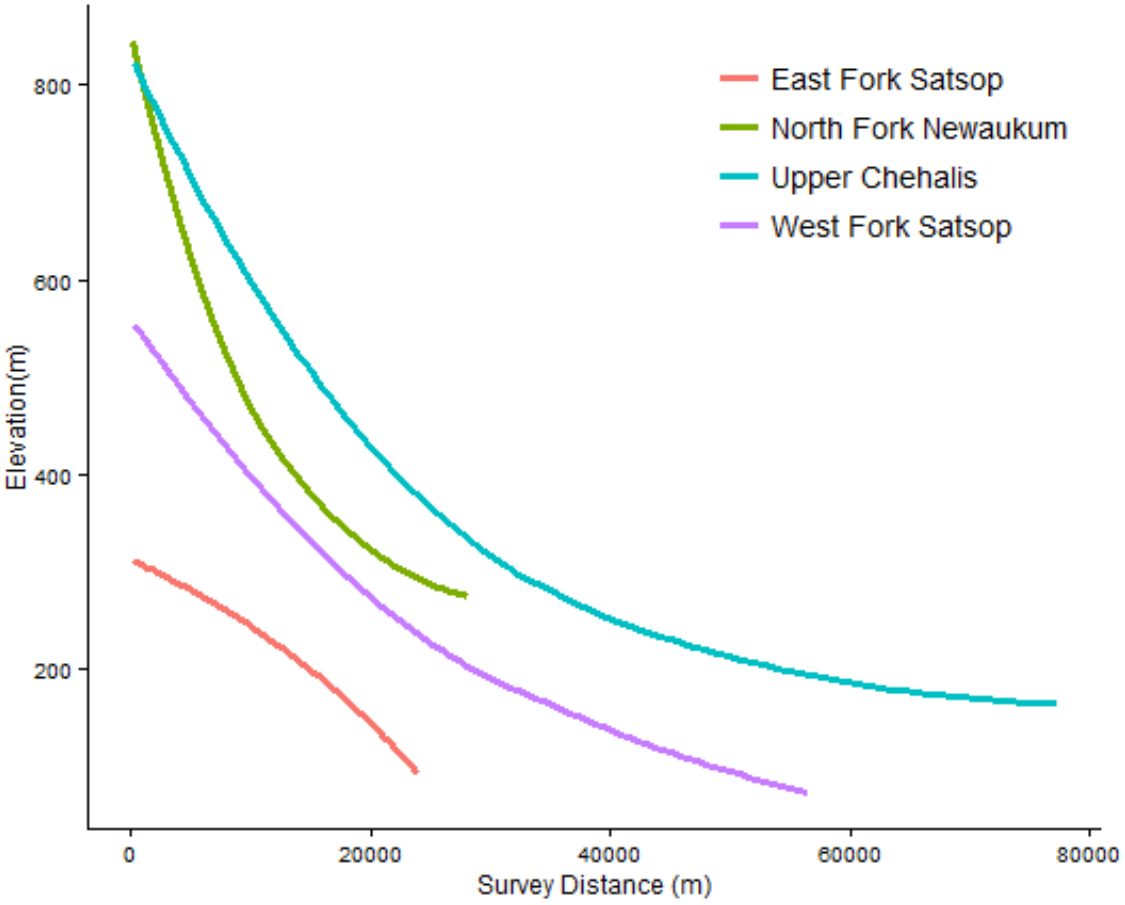

FIGURE 2. Summer temperatures by elevation in sub-basins of the Chehalis River. Plots show mean daily maximum temperature by elevation between July 15 and August 31 in Upper Chehalis (2014), NF Newaukum (2014), WF Satsop (2015), EF Satsop (2015).

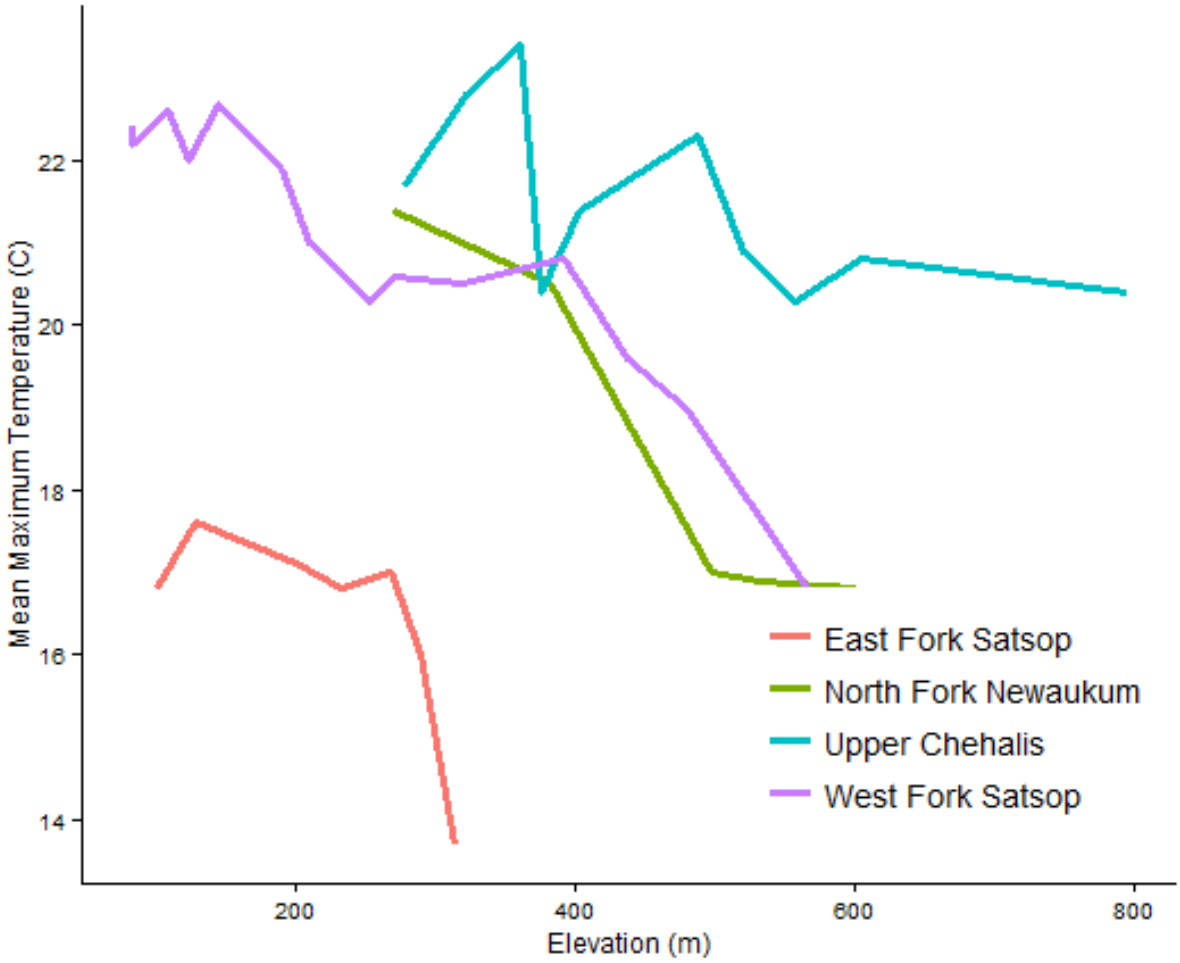

FIGURE 3. Proportion of juvenile salmonids observed during continuous snorkel surveys conducted during the month of August in the upper Chehalis River (2013), North Fork Newaukum River (2014), West Fork Satsop River (2015), and East Fork Satsop River (2015).