Chum Salmon Spawning Habitat Report for the Youngs Bay and Big Creek Populations

Oregon Department of Fish and Wildlife

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November 2017

Table of Contents

Introduction

Historically, Chum Salmon represented a significant portion of the annual returns of salmon and steelhead to the lower Columbia River. It is thought that 10–15 million salmon and steelhead returned annually (Gresh et al. 2000), of which Chum Salmon may have comprised 7–10% of the return (NPPC 1986). The earliest estimate of abundance of Chum Salmon comes from commercial catch data; in 1928, over 700,000 Chum Salmon were captured (Smith 1979), which may have represented a population of over a million Chum Salmon (NPPC 1986). Beginning in the early 1800s, settlement along the lower Columbia River (LCR) and tributaries resulted in changes to land use and harvest of Chum Salmon that ultimately led to the extirpation of 90% of Chum Salmon populations in the LCR. By the 1950s, returns to the lower Columbia River numbered in the thousands.

In response to these dramatic declines, all populations of Columbia River Chum Salmon were listed as "threatened" under the Endangered Species Act in 1999 (USFWS 1999) as a single evolutionary significant unit (ESU). At the time of listing, 17 historic populations were recognized (Myers et al. 2003, USFWS 1999) and all but two of them (the Grays River and lower gorge populations) were considered extirpated (Kostow 1995). Following listing, Oregon developed the Chum Recovery Strategy (ODFW 2010), which outlined the overall approach towards restoring Chum Salmon populations. In preparing that recovery strategy, it was determined that very little historical data existed on Chum Salmon distribution and abundance within the lower Columbia River. Moreover, it was unclear which specific limiting factors existed within each historical population and whether those limiting factors had been addressed. To address these critical uncertainties, Oregon created a Chum Salmon Reintroduction Project in 2012.

The goals of the Chum Salmon Reintroduction Project are to identify and address factors that limit the abundance of Chum Salmon, restore habitat to promote natural recolonization, and reintroduce Chum Salmon into locations where they do not currently exist. As such, baseline habitat surveys were completed in all populations within the coastal stratum (Youngs Bay, Big Creek, Clatskanie River, and Scappoose Creek). This report summarizes data collected during these surveys.

Methods

In designing the Chum-centric surveys, spatial extent was determined based on high intrinsic potential habitat (Hale et al. 1985). Primarily, this relates to stream gradient (targeting contiguous locations with a gradient < 1%), proximity to tidal extent (beginning as close to tidal extent as feasible), and is limited by the maximum gradient in corridors between spawning habitat (gradient < 5%). Specific survey parameters were selected to capture habitat attributes relevant to Chum Salmon spawning, including quantity and quality of appropriate substrate size (0.7–7.6 cm, Duker 1977; 2–3 cm but sometimes larger, Scott and Crossman 1973; Morrow 1980), low percent fines (< 20%; Rukhlov 1969), presence of cold water patches during summer surveys, which might imply upwelling groundwater (Tautz and Groot 1975), and lack of barriers.

For all surveyed streams, previous habitat data were collected by the Aquatic Inventories Project (AQI). AQI surveys provide detailed information about channel morphology, valley form, land use, riparian zones, large woody debris, and substrate. AQI surveys also include data on potential barriers and habitat conditions upstream and downstream of the reaches surveyed for the Chum Reintroduction Project. Both AQI and Chum survey data were collected in a spatially explicit manner such that they could be aggregated into a single, complete database.

For the purposes of these surveys, suitable spawning gravel is defined as: patches (1) with an area ≥ 1 m^2, (2) comprised of substrate size from small gravel to small cobble (4–128 mm, diameter), and (3) with < 20% fine sediment interspersed in the patch. The following substrate size classes were derived from the literature and were used to describe chum spawning habitat:

Fines/Sand	< 4 mm
Small Gravel	4–11 mm
Large Gravel	12–45 mm
Small Cobble	46–128 mm
Large Cobble	129–300 mm
Boulder	> 300 mm

Cold water patches were defined as a patch of any size with a temperature difference from the surrounding area of at least 1^o C. These patches could be produced by upwelling groundwater or by seeps or springs entering the active channel. Microhabitat data (substrate, channel unit type) were recorded at each patch site in order to differentiate between cold water that could indicate upwelling groundwater and cold water resulting from stream shading or deep pools.

Defining Chum Salmon barriers is difficult because there is no accepted standard of what vertical height or gradient can be ascended by adults. We designed our barrier criteria to be highly conservative by encompassing conditions that are likely not barriers. This will allow further refinement of our barrier data based on improved definitions of what Chum Salmon can surmount. We recorded potential barriers using the following criteria:

A potential barrier was defined as any natural or man-made structure at least 1 meter high and extending across the width of the watered channel. Culverts were recorded as potential barriers even if there was no drop to the stream (because they could be velocity barriers).

CC = Circular Culvert
SC = Semicircular Culvert
DL = Dam with fish Ladder
D = Dam without fish ladder
ID = Irrigation Ditch
W = Waterfall (> 1 m drop height)
G = Gradient/ Rapids (> 5 %)
LWD = Large Woody Debris blocking channel
TG = Tide Gate
DK = Dike
O = Other

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Youngs Bay Population

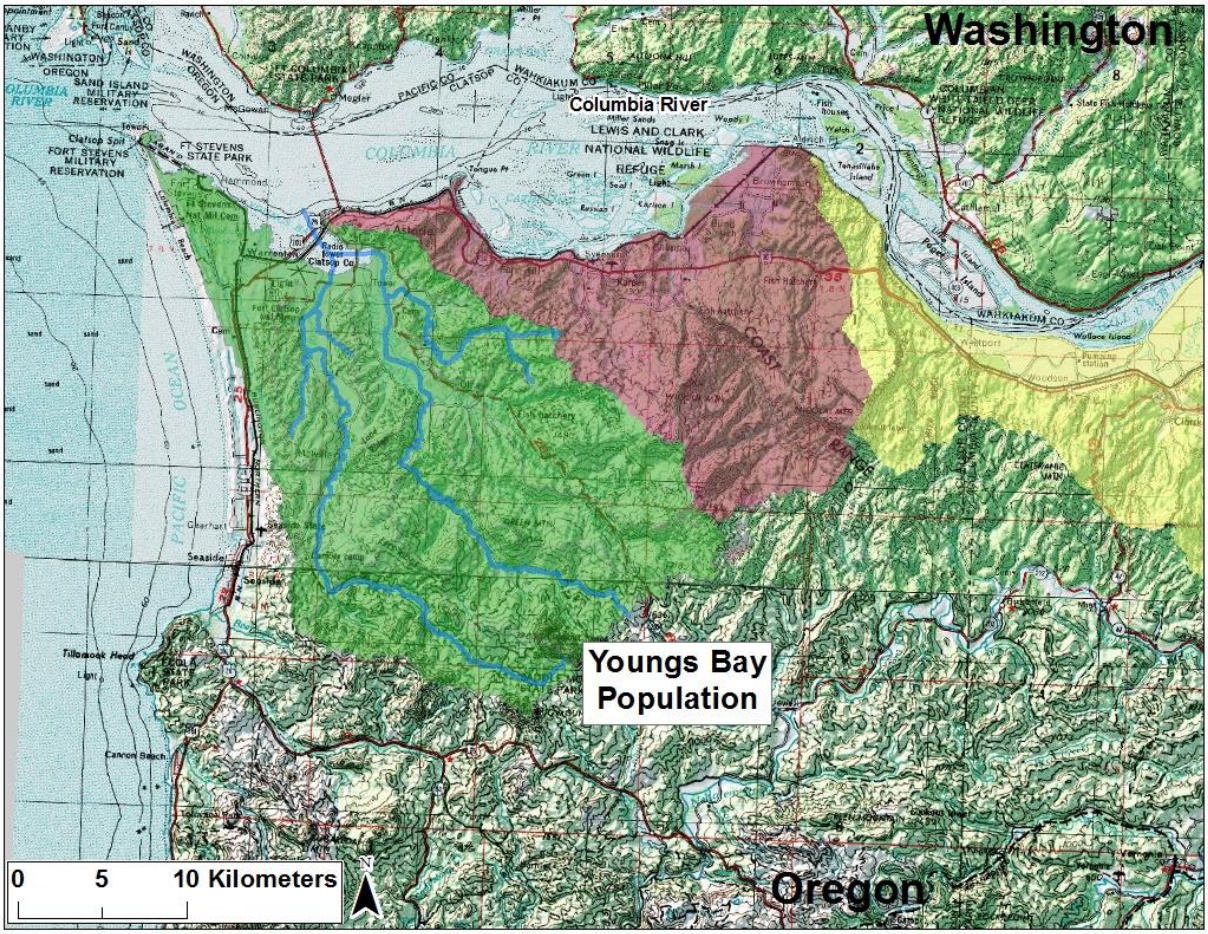

Figure 1. Map of Youngs Bay Chum Salmon *Oncorhynchus keta* population (green).

Barrett Creek

SURVEY DATE: July 23, 2014

SURVEY CREW: Brian Alfonse and Nick Baisley

GENERAL DESCRIPTION:

The Barrett Creek habitat survey (Township: 7N Range: 9W Section: 6B) started at the culvert under the Lewis and Clark Road bridge (Lat: 46.123845, Long: -123.855746), and continued upstream to the culvert beneath Conifer Lane bridge (Lat: 46.121831, Long: -123.851475; Figure 2). The survey consisted of one reach, with a mainstem thalweg length of 512 m. Within the reach there were no side channels, and few meanders. The riparian zone was densely vegetated with shrubs and alders (Figure 3, panel A). The land use in this reach was light grazing and agriculture, and an active irrigation pipe with a pump was observed on the stream bank. Substantial quantities of woody debris were observed throughout the reach (Figure 3, panel B). Low gradient habitat existed upstream of the Conifer Lane bridge culvert; however, the stream could not be surveyed because of dense vegetation, excess silt, lack of a defined channel, and landowner denials.

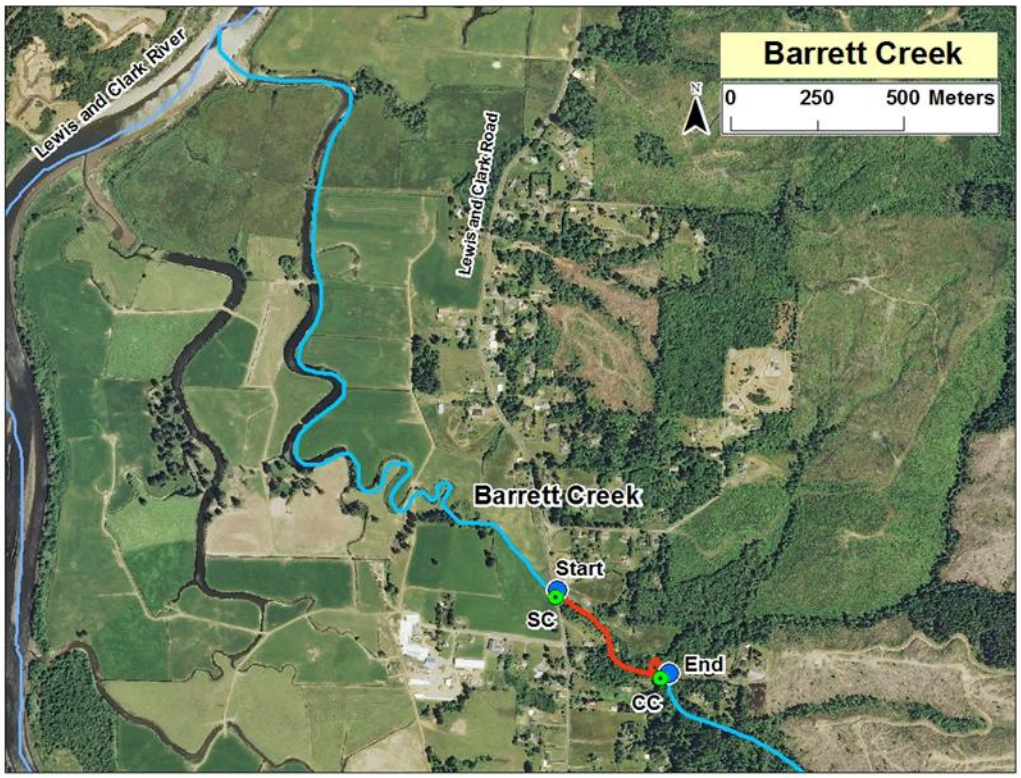

Figure 2. Map of reach (red line) surveyed on Barrett Creek, located south of Astoria, OR, including start and end points (blue dots), a semicircular culvert (SC), and a circular culvert (CC).

Figure 3. Survey pictures on Barrett Creek show a riparian zone dominated by alder and shrub (panel A), substantial quantities of woody debris within the stream channel (panel B), a semicircular culvert under Lewis and Clark Road located at the downstream end of the reach (panel C), and a circular culvert under Conifer Lane located at the upstream end of the reach (panel D).

RESULTS:

The streambed in Barrett Creek consisted entirely of silt and mud, with no gravel or cobble substrate. There were no suitable gravel patches. One 4.2 m^2 cold-water patch was recorded; the temperature in this patch was 15.2° C and temperature adjacent to this patch was 16.2° C. The dominant substrate type within this cold-water patch was fine sediment (< 4 mm diameter). There were two potential barriers to Chum Salmon *Oncorhynchus keta* migration within the reach (Figure 2; Table 1). The first barrier was a semicircular culvert located under Lewis and Clark Road at the downstream end of the reach (Table 1; Figure 3, panel C). The second barrier was a circular culvert located under Conifer Lane at the upstream end of the reach (Table 1; Figure 3, panel D).

Table 1. List of barriers, types, barrier heights, barrier widths (across stream), barrier lengths (upstream and downstream), and max pool depths downstream of the barrier in Barrett Creek, south of Astoria, OR, in July 2014.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Semicircular culvert	0	2.5	11	0.5
2	Circular culvert	0.2	0.9	17	0.2

Colewort Creek

SURVEY DATE: July 23, 2014

SURVEY CREW: Brian Alfonse and Nick Baisley

GENERAL DESCRIPTION:

The Colewort Creek habitat survey (Township: 7N Range: 10W Section: 2A) started at a small footbridge (Lat: 46.125018, Long: -123.883854) and continued upstream to a confluence of forks with equal flow (Lat: 46.123569, Long: -123.886117; Figure 4). The survey consisted of one reach with a mainstem thalweg length of 239 m, with no side channels and few meanders. Colewort Creek is a small tributary of the Lewis and Clark River, located on the southern end of Fort Clatsop National Park. Between 2005 and 2012, the Columbia River Estuary Study Taskforce (CREST) and Lewis and Clark National Historical Park did substantial restoration work on the tidal area of Colewort Creek to restore connectivity. The riparian vegetation in this reach was dominated by alders and shrubs (Figure 5, panel A). In the south fork, crews observed a complete barrier to Chum Salmon migration; however, this barrier was located upstream of the top of the survey (Figure 5, panel B).

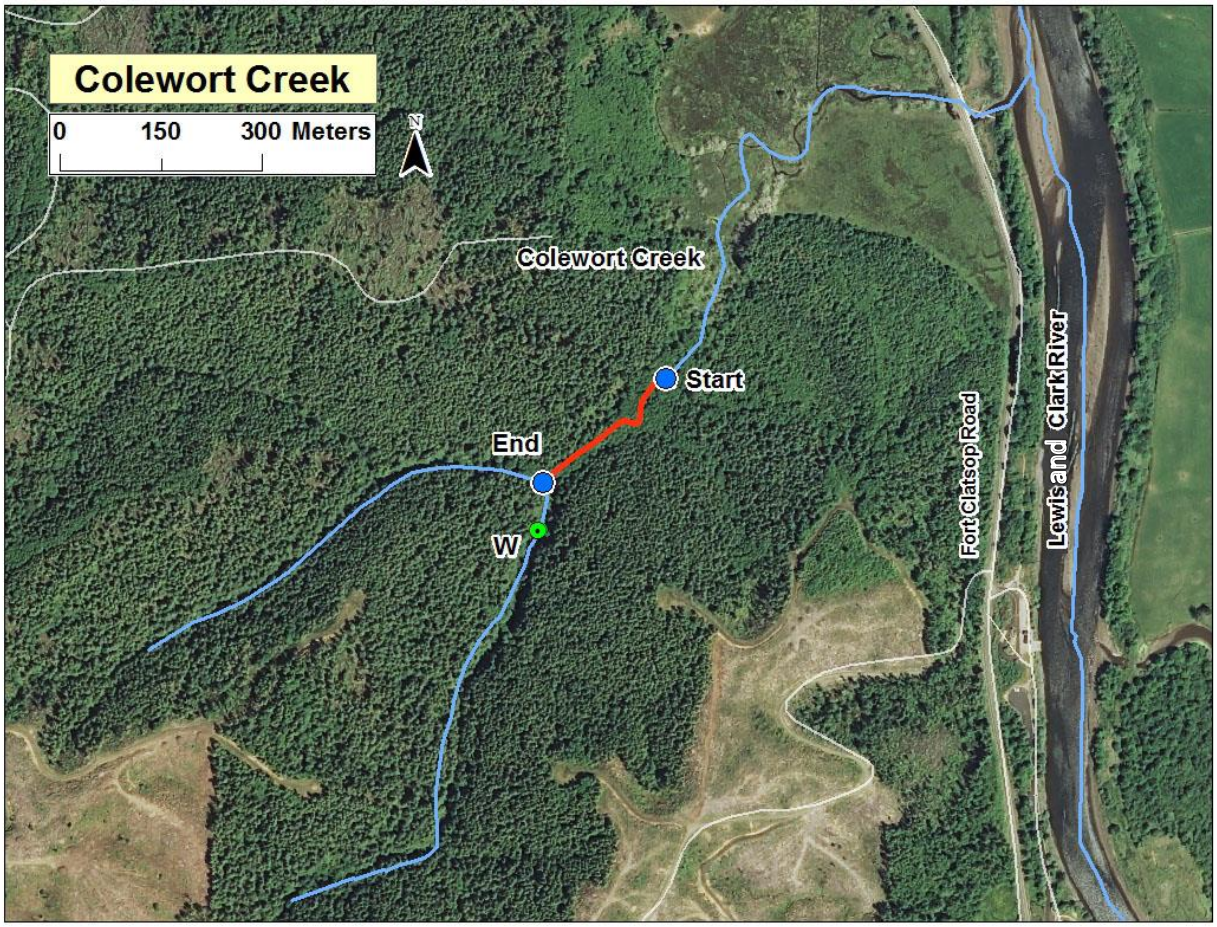

Figure 4. Map of reach (red line) surveyed on Colewort Creek, located south of Astoria, OR, including start and end points (blue dots) and a waterfall (W) located upstream from the end of the reach.

Figure 5. Survey pictures on Colewort Creek showing an alder and shrub dominated riparian zone (panel A), a waterfall located upstream from the end of the reach (panel B), and tidal channel downstream of the reach (panel C).

RESULTS:

Substrate in Colewort Creek consisted of small gravel (4–11 mm, diameter); however, because fine sediment levels were > 20%, no suitable spawning habitat that met the minimum criteria established was identified. No cold-water patches were detected. There were no potential barriers to Chum Salmon migration in this reach; however, there was one waterfall barrier located 100 m upstream from the top of the reach (Table 2, Figure 5, panel B).

Table 2. Barrier type, barrier height, barrier width (across stream), barrier length (upstream and downstream), and max pool depth downstream of the barrier in Colewort Creek, south of Astoria, OR, in July 2014. Note: * barrier was found to be outside the designated reach boundaries.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
*1	Waterfall	1.6	1.2	0.4	0.35

Johnson Creek and Abercrombie Creek

SURVEY DATE: July 16, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, John Cox, Regina Southworth, and Nick Baisley

GENERAL DESCRIPTION:

The Johnson Creek and Abercrombie Creek habitat surveys (Township: 7N Range: 10W Section: 12A) started at the confluence of these two creeks, with one reach surveyed upstream from this point for each creek (Figure 6). Survey length for each reach was constrained by the tidal area below the reaches, while dense timber blow down and heavy brush limited access upstream of the reaches. The section on Johnson Creek from Loukas Lane to the downstream end of reach 2 was designated as reach 1; however, it fell entirely within tidal influence and was not surveyed.

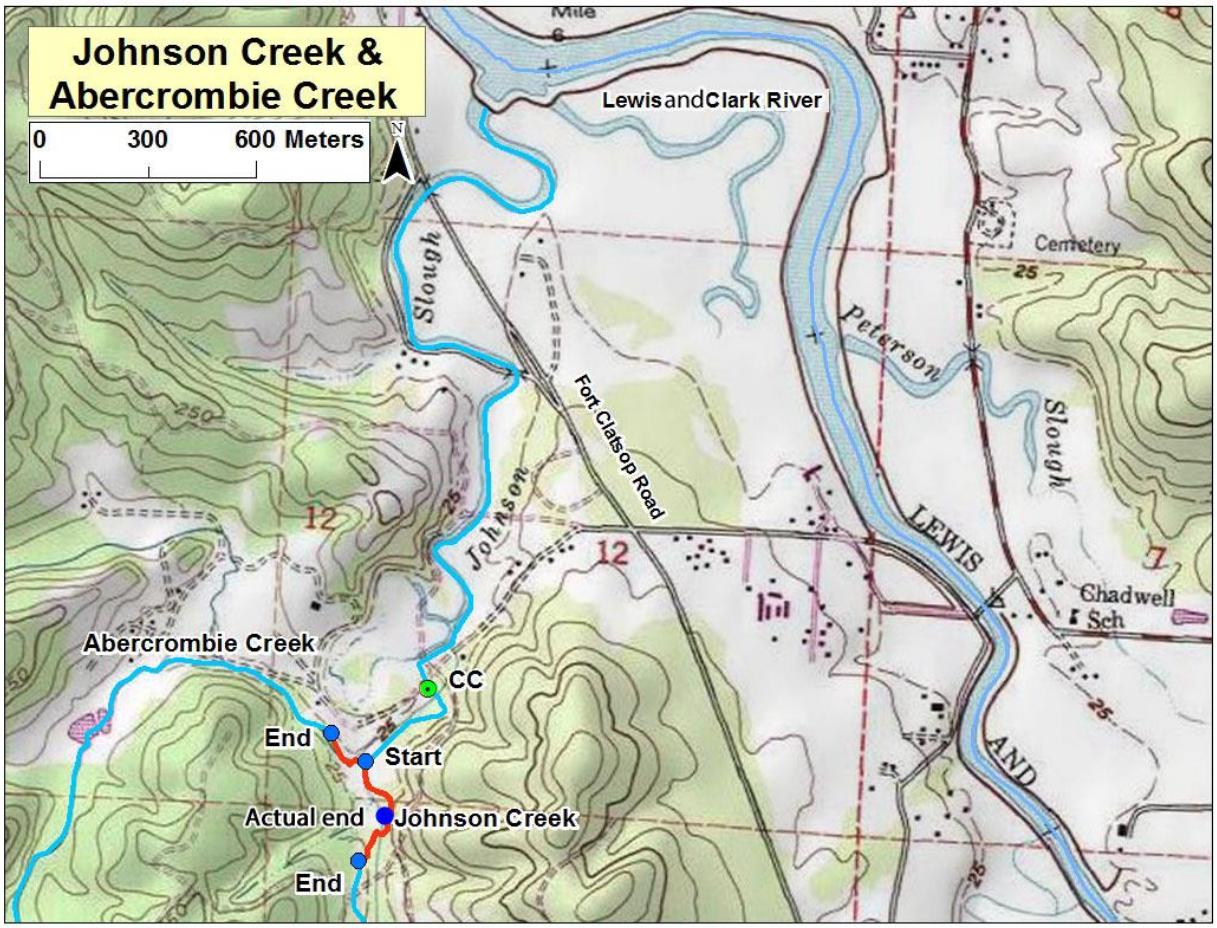

Figure 6. Map of reaches (red line) surveyed on Johnson and Abercrombie creeks, located south of Astoria, OR, including start point, end point (blue dots), new end point (dark blue dot) and a circular culvert (CC) located downstream of both reaches.

Johnson Creek- REACH 2

REACH DESCRIPTION:

The Johnson Creek reach started at the confluence of Abercrombie Creek (Lat: 46.098888, Long: -123.875878) and continued upstream to a culvert under a logging road (Lat: 46.096396, Long: -123.875979). The mainstem thalweg length of this reach was 375 m, with meanders but no side channels. Within this reach, the riparian zone was split between two distinct vegetation types. In the downstream portion, the stream bordered a field used for grazing sheep. Upstream from this field, riparian vegetation was very dense and consisted of young alders, blackberries, reeds canary grass, and salal (Figure 7, panels B and C). The land use for this reach was light grazing and rural residential. Dense blow down of woody debris was observed throughout the reach. This limited access to the stream and the survey was ended before the first logging road bridge (Figure 7, panel E).

Figure 7. Survey pictures on Johnson Creek showing a circular culvert downstream of the reach start under Loukas Lane (panel A), a slough channel downstream from reach 2 (panel B), dense brush and grass along the stream channel in reach 2 (panel C), a streambed consisting of silt and mud (panel D), and dense woody debris within the stream channel (panel E).

RESULTS:

The streambed in Johnson Creek consisted of mud and fine sediment (<4 mm diameter) with limited substrate in larger size classes (Figure 7, panel D). There were no gravel patches observed that met minimum the criteria established. There were also no cold-water patches that were ≥ 0.5° C colder than the main channel water temperature. There were no potential barriers to Chum Salmon migration in this reach; however, there was one potential barrier observed downstream of the reach start, a circular culvert (Table 3; Figure 7, panel A).

Table 3. Barrier type, barrier height, barrier width (across stream), barrier length (upstream and downstream), and max pool depth downstream of the potential barrier in Johnson Cr, south of Astoria, OR, in July 2014. Note: * barrier was found outside the designated reach boundaries. ** data not collected

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
*1	Circular culvert	0	**	**	**

Abercrombie Creek- REACH 1

REACH DESCRIPTION:

The Abercrombie Creek reach started at the confluence of Johnson Creek (Lat: 46.098817, Long: -123.87602) and continued upstream 50 m beyond a small farm bridge (Lat: 46.099575, Long: -123.877186). The mainstem thalweg length of this reach was 150 m, with no side channels and few meanders. The riparian zone consisted of a grass field used for livestock grazing on the river-left bank, while the river-right bank was dominated by alder and shrub brush (Figure 8, panel A). Land use for this reach was light grazing. A farming road bridge located in the middle of the reach was not considered a potential barrier to Chum Salmon migration. The upstream end of the reach was characterized by impassable, dense brush and woody debris within the stream channel (Figure 8, panels B and C).

Figure 8. Survey pictures on Abercrombie Creek showing the streambed dominated by fine sediments and a grass-covered bank (panel A) and dense woody debris within the stream channel (panels B and C).

RESULTS:

Substrate in Abercrombie Creek consisted of small and large gravel (4–45 mm, diameter); however, fine sediment levels were > 20%, so no suitable spawning habitat that met the minimum criteria were observed. No cold-water patches were found. There were no potential barriers to Chum Salmon migration in this reach.

Lewis and Clark River

SURVEY DATES: July 7, July 10, July 16, July 17, July 22, July 23, July 24, July 28, July 29, July 31, and August 11, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, John Cox, Regina Southworth, and Nick Baisley

GENERAL DESCRIPTION:

The Lewis and Clark River habitat survey (Township: 7N Range: 9W Section: 30C) started at the upstream end of tidal influence, 4.5 km upstream from the Login Road bridge and ended 24.9

km upstream.. Surveys were delineated into 14 reaches based on physical features, landowner access, and overall distance (Figure 9). One section within reach 2, (mainstem thalweg length = 600 m), was not surveyed due to a landowner denial.

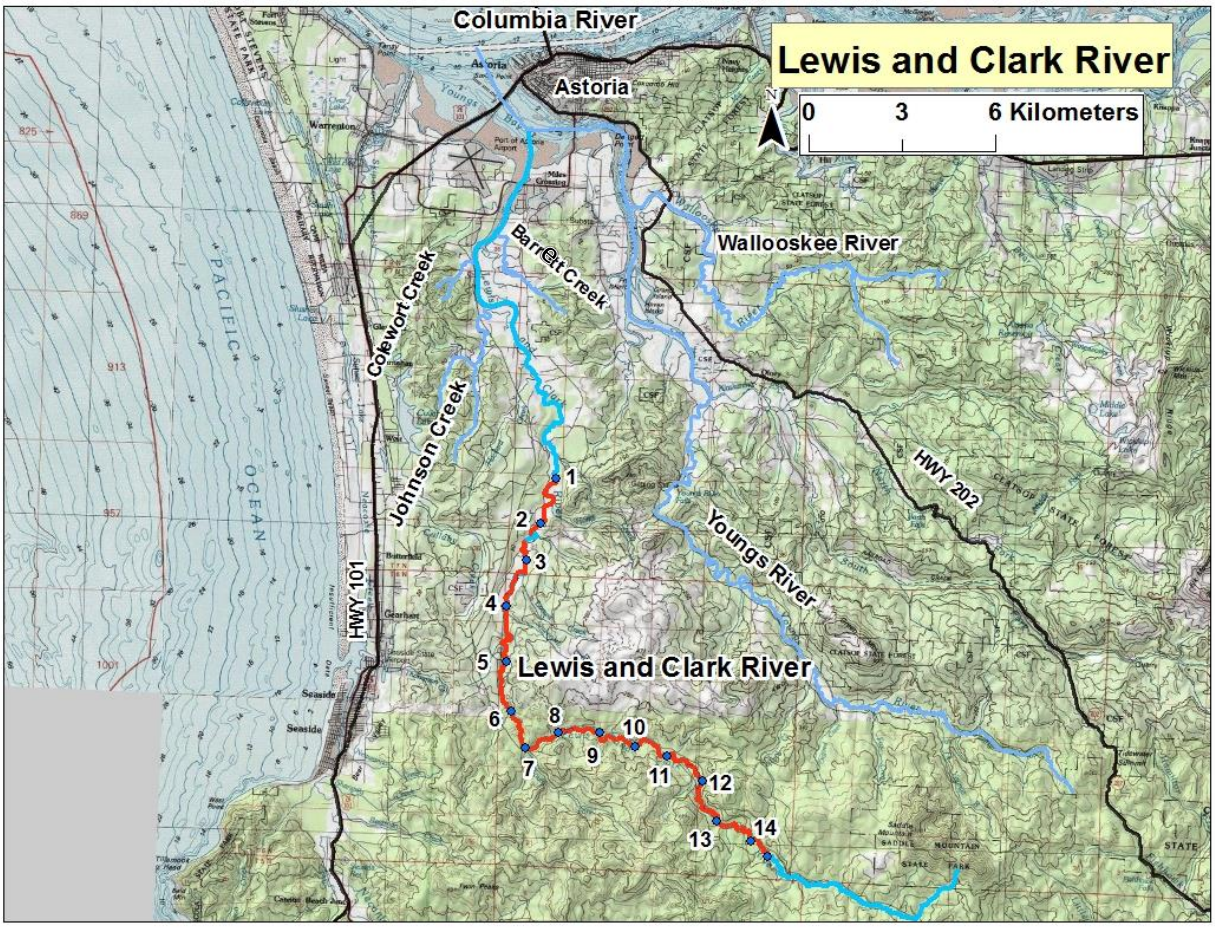

Figure 9. Map of reaches (red line) surveyed on the Lewis and Clark River, located south of Astoria, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started at Lat: 46.067118, Long: -123.839622, and continued upstream to a point 750 m downstream from the Klickitat Creek confluence (Lat: 46.053938, Long: -123.845576; Figure 10). The mainstem thalweg length of this reach was 2,254 m. The channel form was unconfined with meanders, and there was one side channel with a thalweg length of 52 m. The riparian vegetation was dominated by grasses, with sparsely distributed alders (Figure 11, panel A). Land use was defined by light grazing, as livestock activity was observed within the stream

channel in this reach (Figure 11, panel C). There is a confluence with one named tributary, on the river-right bank in the middle of this reach.

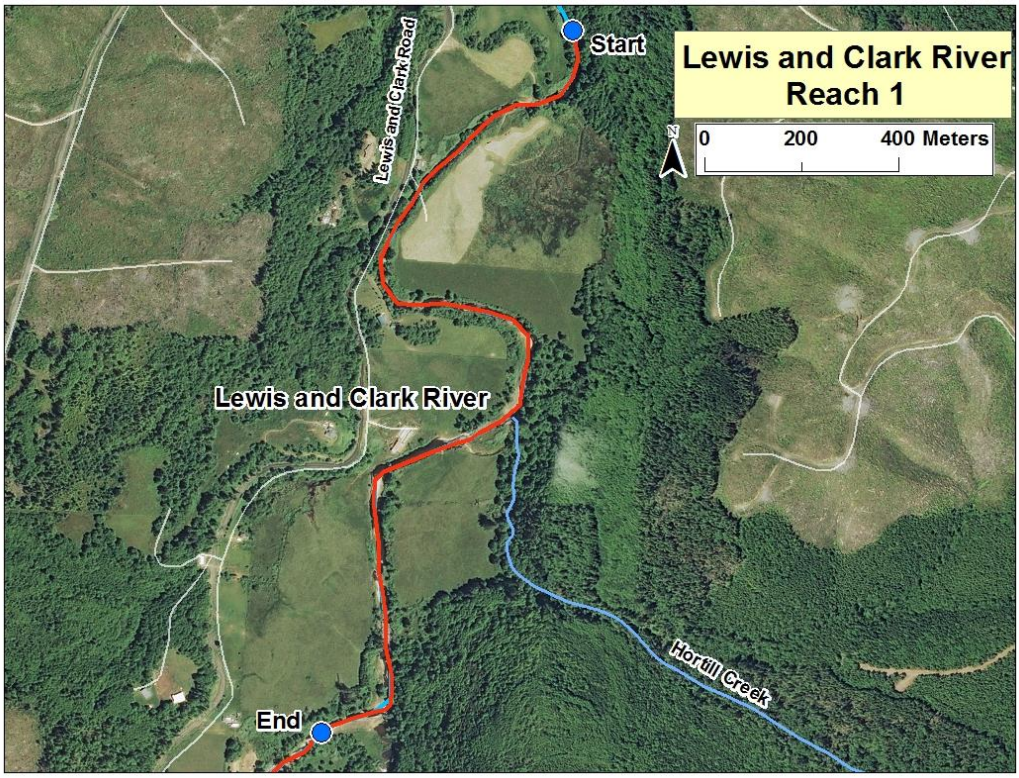

Figure 10. Map of reach 1 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 11. Survey pictures on reach 1 of the Lewis and Clark River showing a long pool section of stream with grass and alder dominated riparian vegetation (panel A), a farm road bridge along the streambed (panel B), hoof depressions from cattle in the stream channel (panel C), and an isolated cold-water patch in a side channel (panel D).

RESULTS: Forty-five patches of suitable spawning substrate were found in reach 1 of the Lewis and Clark River (Table 4; Figure 12), measuring a total of 3,681 m². None of these patches were categorized as "high" quality, 12 patches were of "moderate" quality, and 33 patches were of "low" quality (Table 4; Figure 12). Several of these substrate patches were observed in the creek near an instream road crossing (Figure 11, panel B). Twenty-two cold-water patches measuring a total of 242.8 m² were observed (Figure 12). Average temperature in these patches was 17.4° C, while average temperature adjacent to these patches was 19.5° C. Several of these cold-water patches were found in isolated pools located in predominantly dry side channels, however GPS data location was not collected (Figure 11, panel D).The dominant substrate types within these cold-water patches were fine sediment (n = 4), large gravel (n = 17), and small cobble (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 4. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 1 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

substrate quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	2	50
moderate	0-10	0	50	50	1	1
low	0-10	0	25	75	3	472
low	0-10	0	0	100	1	15
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	1	12
moderate	11-20	25	75	0	6	340
moderate	11-20	0	100	0	2	26
low	11-20	0	75	25	7	238
low	11-20	0	50	50	17	2383
low	11-20	0	25	75	1	24
low	11-20	0	0	100	4	120

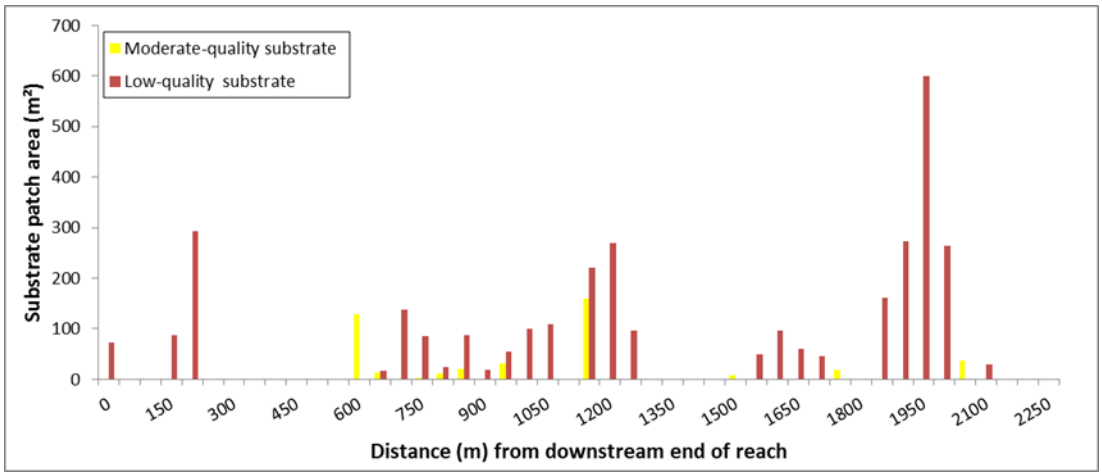

Figure 12. Location of substrate patches measured as distance from downstream end of survey in reach 1 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For each category of substrate quality, patch area was summed and binned into 50 m units. No location data was collected for cold-water patches in this reach due to a GPS device malfunction.

REACH 2

REACH DESCRIPTION:

Reach 2 started 750 m downstream from the Klickitat Creek confluence (Lat: 46.053938, Long: -123.845576) and continued upstream to a point 550 m downstream from the confluence with Loowit Creek (Lat: 46.043028, Long: -123.8509; Figure 13). The mainstem thalweg length of this reach was 1,476 m. There were five side channels in this reach, with a combined thalweg length of 206 m. The channel form of this reach was unconfined with multiple channels and meanders. In the middle of the reach there was a 600 m portion of the stream not surveyed due to a landowner denial. The riparian zone was dominated by grass; however, sparse alders, blackberries, and several clusters of invasive knotweed were also observed (Figure 14, panels A and B). Land use in this reach was young trees and light grazing. Two named tributaries entered the reach, both from the river-right bank. Algal growth was observed within the active channel throughout the reach (Figure 14, panel C), as was artificially placed pieces of large woody debris were observed along the banks of the river (Figure 14, panel D).

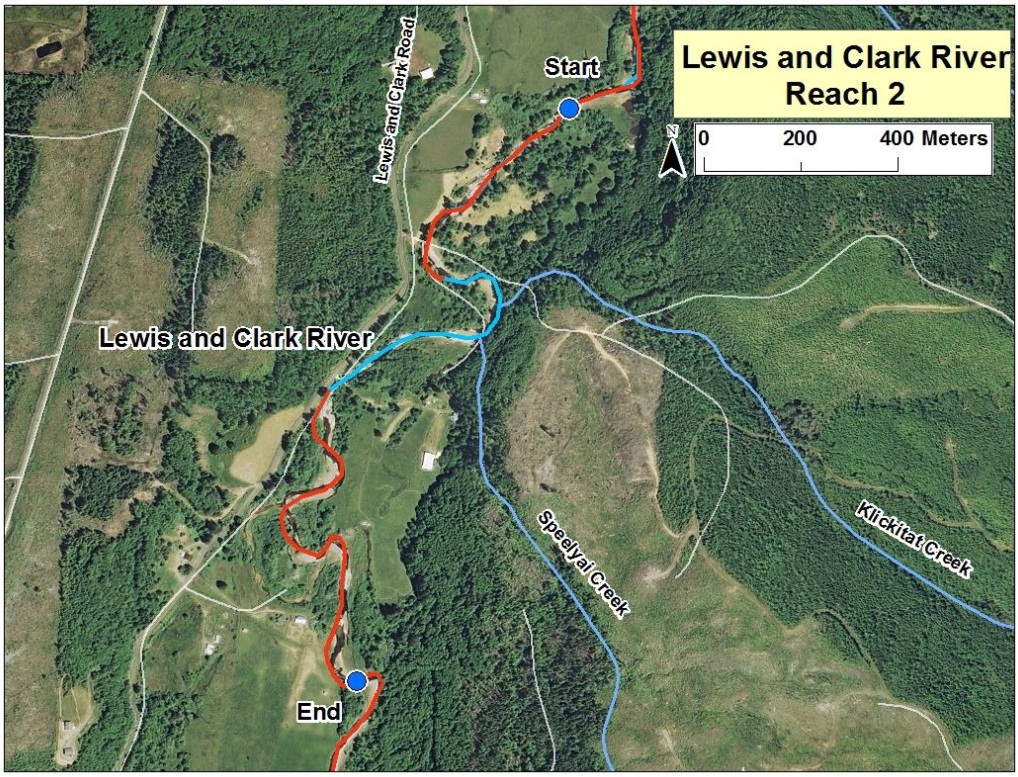

Figure 13. Map of reach 2 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 14. Survey pictures on reach 2 of the Lewis and Clark River showing a riparian zone dominated by grass, blackberry, and alder (panels A and B), algal growth within the active stream channel (panel C), and several pieces of artifically placed large woody debris (panel D).

RESULTS:

Seventy patches of suitable spawning substrate were found in reach 2 of the Lewis and Clark River (Table 5; Figure 15), measuring a total of 2,658 m². One of these patches was categorized as "high" quality, 30 patches were of "moderate" quality, and 39 patches were of "low" quality (Table 5; Figure 15). Nine cold-water patches measuring a total of 59.0 m² were observed (Figure 15). Average temperature in these patches was 15.5° C and average temperature adjacent to these patches was 17.3° C. The dominant substrate types within these cold-water patches were fine sediment (n = 6), small gravel (n = 1), and small cobble (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 5. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 2 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	1	24
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	3	89
low	0-10	0	25	75	4	46
low	0-10	0	0	100	1	4
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	5	44
moderate	11-20	25	75	0	8	169
moderate	11-20	0	100	0	14	641
low	11-20	0	75	25	8	517
low	11-20	0	50	50	11	639
low	11-20	0	25	75	11	329
low	11-20	0	0	100	4	156

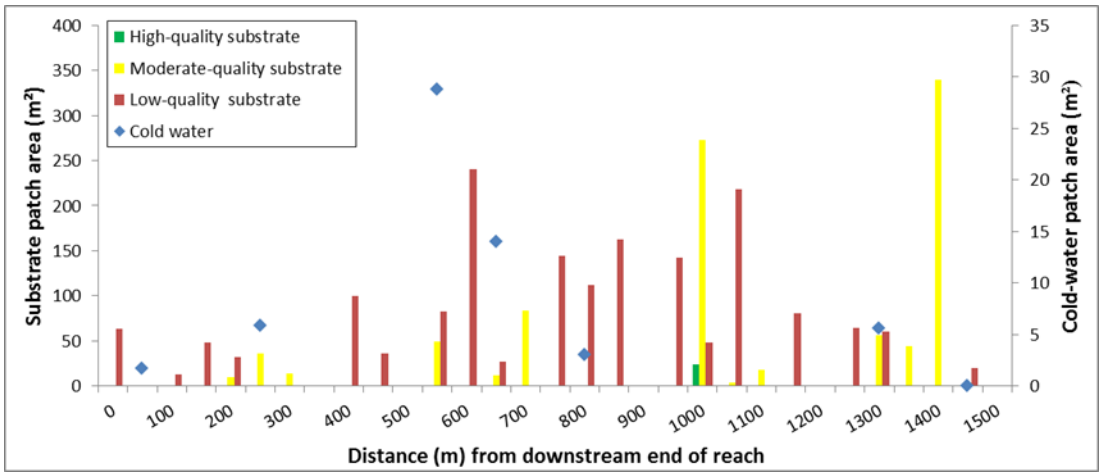

Figure 15. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 2 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 3

REACH DESCRIPTION:

Reach 3 started 550 m downstream from the confluence with Loowit Creek (Lat: 46.043028, Long: -123.8509) and continued upstream to the confluence with Shweeash Creek (Lat: 46.029692, Long: -123.858427; Figure 16). The mainstem thalweg length of this reach was 2,050 m. There were five side channels, with a combined thalweg length of 509 m. Channel form of this reach was unconfined with multiple channels and meanders. The riparian zone was dominated by grasses, particularly in areas where clear cutting occurred (Figure 17, panel A). The land use was timber harvest, light grazing, and young timber. Large woody debris was common through the reach, with several channel-spanning log jams (Figure 17, panel B). Loowit Creek and Shweeash Creek were the two named tributaries entering the Lewis and Clark River in this reach from river right. A small residential road bridge, located in the upstream half of the reach, was not a potential barrier to Chum Salmon migration (Figure 17, panel D).

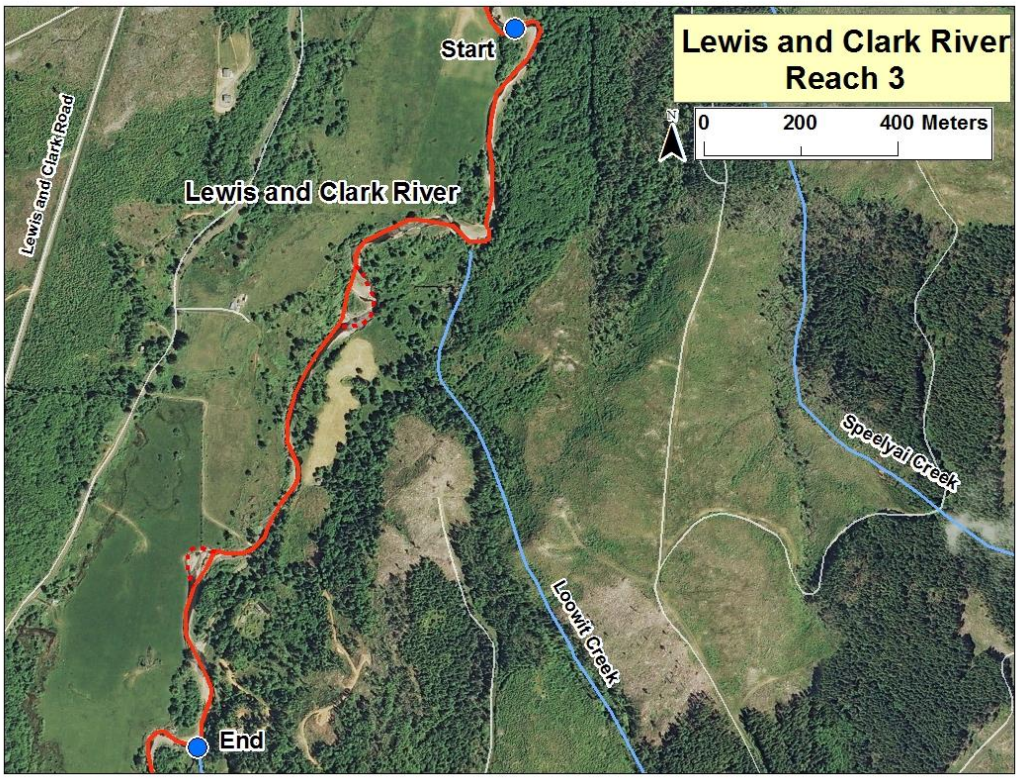

Figure 16. Map of reach 3 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 17. Survey pictures on reach 3 of the Lewis and Clark River showing a riparian zone with sparse trees and grass fields (panel A), a channel-spanning log jam (panel B), large cobble substrate within the channel (panel C), and a residential bridge (panel D).

RESULTS:

Seventy-nine patches of suitable spawning substrate were found in reach 3 of the Lewis and Clark River (Table 6; Figure 18), measuring a total of 2,476 m². Four of these patches were categorized as "high" quality, 26 patches were of "moderate" quality, and 49 patches were of "low" quality (Table 6; Figure 18). There were also several areas with large cobble substrate observed (129–256 mm, diameter; Figure 17, panel C). Sixteen cold-water patches measuring a total of 185.1 m² were observed (Figure 18). Average temperature in these patches was 16.3° C, and average temperature adjacent to these patches was 18.6° C. The dominant substrate types within these cold-water patches were fine sediment (n = 5), large gravel (n = 3), small cobble (n = 1), and bedrock (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 6. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 3 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

substrate quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	3	36
high	0-10	0	100	0	1	8
moderate	0-10	0	75	25	1	8
moderate	0-10	0	50	50	3	20
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	4	77
moderate	11-20	25	75	0	11	310
moderate	11-20	0	100	0	7	76
low	11-20	0	75	25	14	705
low	11-20	0	50	50	19	633
low	11-20	0	25	75	12	381
low	11-20	0	0	100	4	222

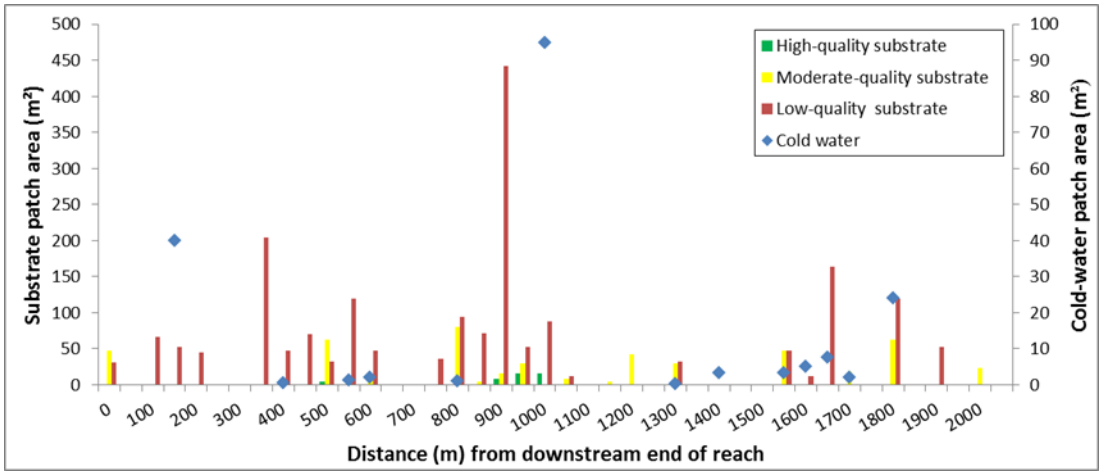

Figure 18. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 3 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 4

REACH DESCRIPTION:

Reach 4 started at the confluence with Shweeash Creek (Lat: 46.029692, Long: -123.858427), and continued upstream to the 400 Line logging road bridge (Lat: 46.013271, Long: -123.857388; Figure 19). The mainstem thalweg length of this reach was 2,490 m, and there were no side channels. The channel form for this reach was unconfined with meanders in the downstream portion, followed by a transition into a confined channel. In the downstream quarter of the reach, the riparian vegetation consisted of grass and sparse trees, with several areas of active erosion along the banks (Figure 20, panel A). Throughout the remainder of the reach, riparian vegetation was dense and consisted of alders, firs, and cedars (Figure 20, panel B). The land use was a mix of second growth and large timber. In the upstream half of the reach, the stream flowed through several small canyons. The bridge at the upstream end of the reach was not a potential barrier to Chum Salmon migration (Figure 20, panel D).

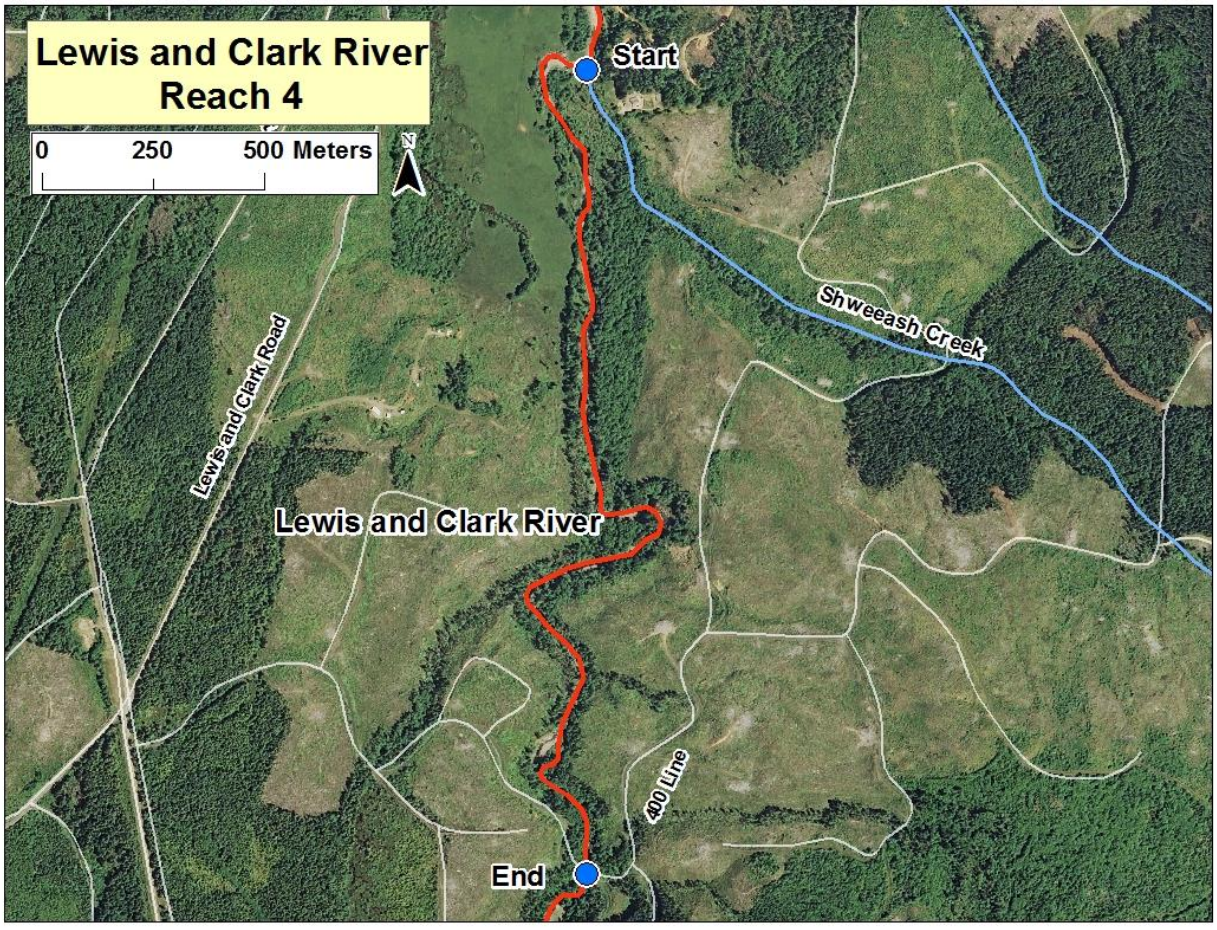

Figure 19. Map of reach 4 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 20. Survey pictures on reach 4 of the Lewis and Clark River show active erosion of the river bank near the downstream end of the reach (panel A), dense riparian vegetation (panel B), an area of large cobble and boulder substrate (panel C), and the 400 Line bridge located at the upstream end of the reach (panel D).

RESULTS:

Twenty-six patches of suitable spawning substrate were found in reach 4 of the Lewis and Clark River (Table 7; Figure 21), measuring a total of 432 m^2. None of these patches were categorized as "high" quality, three patches were of "moderate" quality, and 23 patches were of "low" quality (Table 7; Figure 21). The remainder of substrate was dominated by large cobble and boulders (Figure 20, panel C). Twenty-eight cold-water patches measuring a total of 501.3 m^2 were observed (Figure 21). Average temperature in these patches was 15.0° C and average temperature adjacent to these patches was 17.0° C. The dominant substrate types within these cold-water patches were fine sediment (n = 5), large gravel (n = 7), small cobble (n = 8), large cobble (n = 7), and boulder (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 7. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 4 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

substrate quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	1	14
moderate	11-20	25	75	0	2	28
moderate	11-20	0	100	0	0	0
low	11-20	0	75	25	3	7
low	11-20	0	50	50	7	43
low	11-20	0	25	75	7	208
low	11-20	0	0	100	6	132

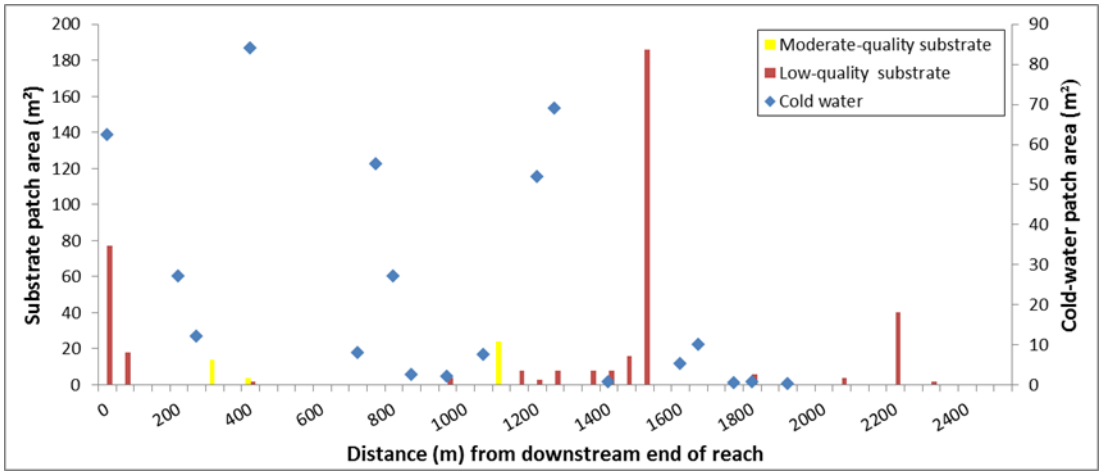

Figure 21. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 4 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel. No location data were recorded for cold-water patches from 1,950 m to 2,550 m due to a GPS device malfunction.

REACH 5

REACH DESCRIPTION:

Reach 5 started at the 400 Line logging road bridge (Lat: 46.013271, Long: -123.857388) and continued upstream to the confluence of a large unnamed tributary entering from the river-left bank (Lat: 45.999051, Long: -123.854523; Figure 22). The mainstem thalweg length of this reach was 1,903 m. There was also one side channel with a thalweg length of 66 m. The downstream half of the river valley was unconfined and the stream was low gradient with meanders (Figure 23, panel A). The upstream half of the river was constrained by a narrow canyon and the gradient increased (Figure 23, panel B). Riparian vegetation throughout the reach was dense and consisted of alders, firs, maples, and cedars; however, in the canyon portion of this reach some sections of the riparian zone on the top of the canyon walls were quite narrow. Land use was mature timber.

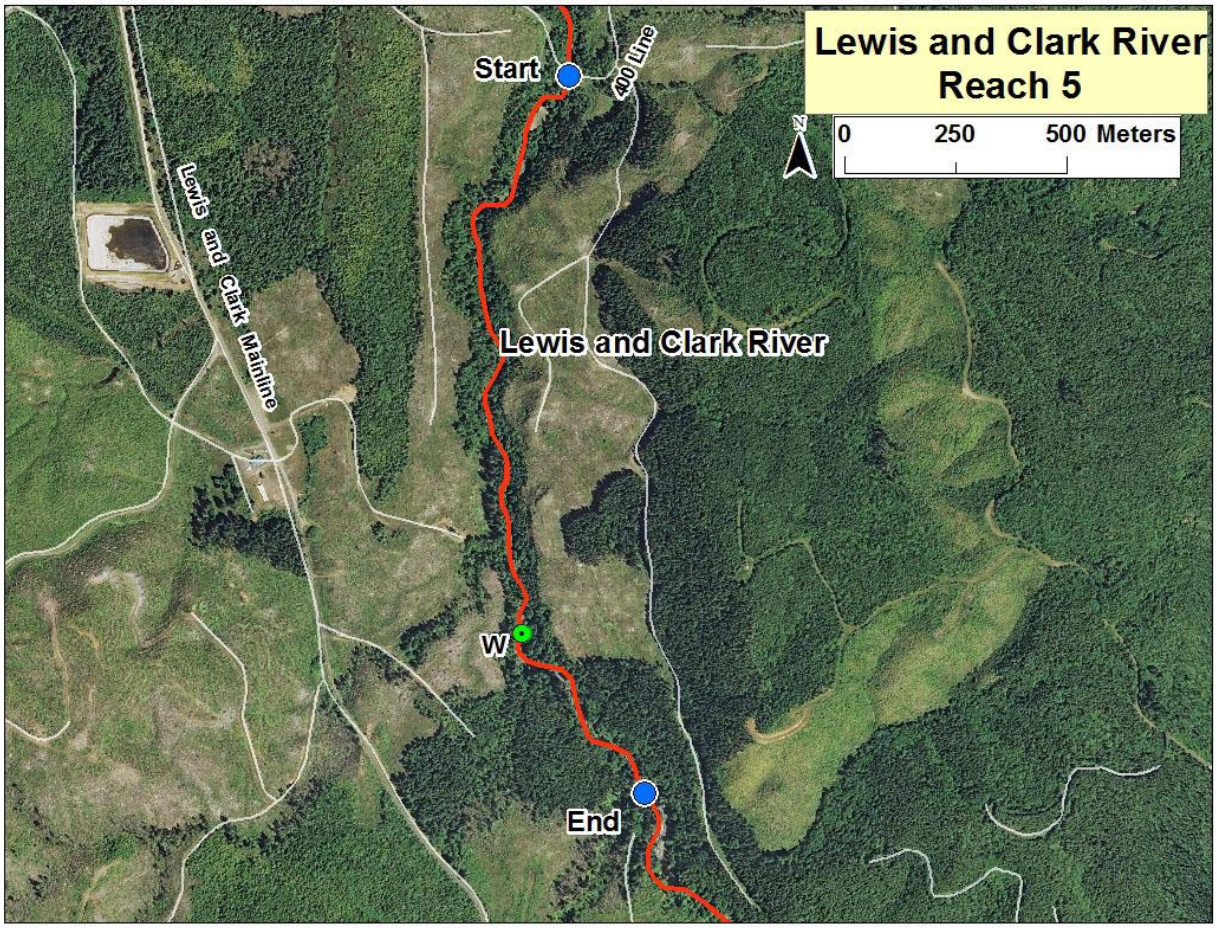

Figure 22. Map of reach 5 (red line) on the Lewis and Clark River, including start and end points (blue dots) and a waterfall (W).

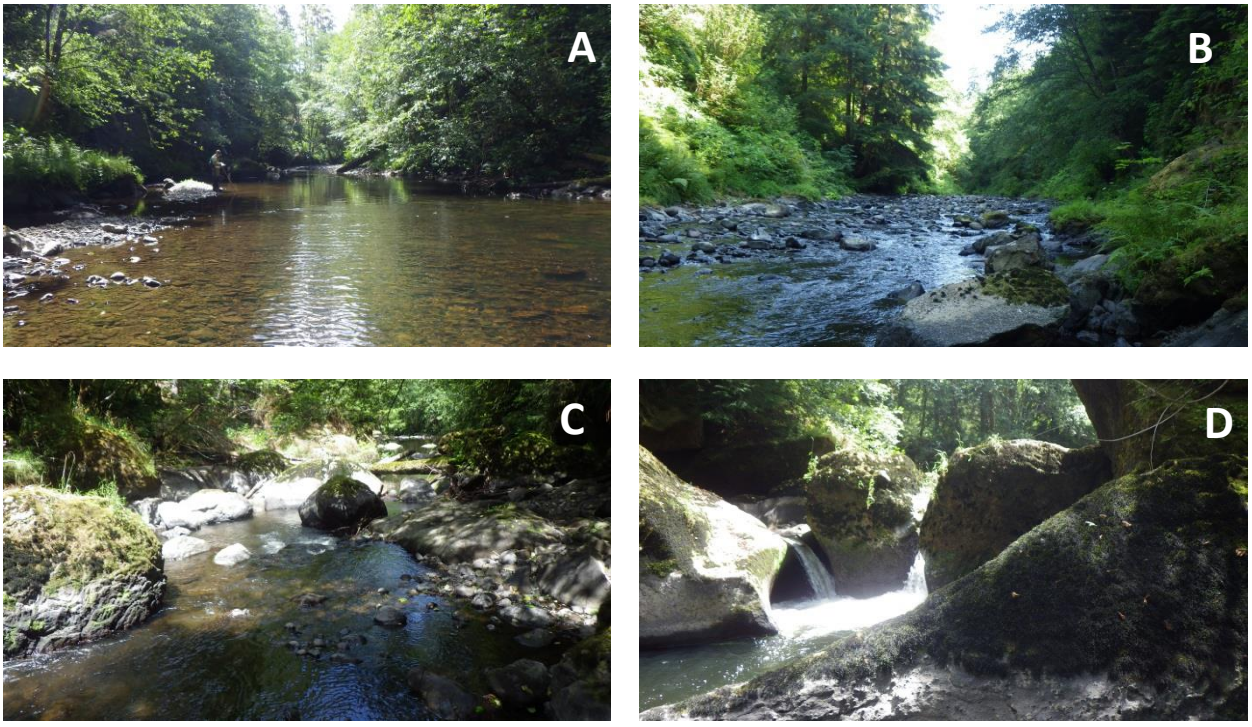

Figure 23. Survey pictures on reach 5 of the Lewis and Clark River showing a low gradient glide near the downstream end of the reach (panel A), a high gradient riffle in the upstream half of the reach (panel B), increased stream gradient in the upstream half of the reach (panel C), and a waterfall (panel D).

RESULTS:

Sixty-two patches of suitable spawning substrate were found in reach 5 of the Lewis and Clark River (Table 8; Figure 24), measuring a total of 595 m^2. Fifteen of these patches were categorized as "high" quality, 29 patches were of "moderate" quality, and 18 patches were of "low" quality (Table 8). Large boulders (>2 m diameter) were also common in this reach, and several substrate patches were observed immediately downstream of these boulders. Twenty-six cold-water patches measuring a total of 205.9 m^2 were observed (Figure 24). Average temperature in these patches was 14.8° C, and average temperature adjacent to these patches was 16.6° C. The dominant substrate types within these cold-water patches were fine sediment (n = 1), large gravel (n = 4), small cobble (n = 9), large cobble (n = 6), boulder (n = 1), and bedrock (n = 5). There was one potential barrier to Chum Salmon migration in this reach, a small waterfall between boulders (Figure 22; Figure 23, panel D; Table 9).

Table 8. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) %) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 5 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	1	2
high	0-10	75	25	0	1	4
high	0-10	50	50	0	3	8
high	0-10	25	75	0	5	33
high	0-10	0	100	0	5	31
moderate	0-10	0	75	25	9	83
moderate	0-10	0	50	50	4	23
low	0-10	0	25	75	2	20
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	1	4
moderate	11-20	50	50	0	1	8
moderate	11-20	25	75	0	5	50
moderate	11-20	0	100	0	9	61
low	11-20	0	75	25	7	154
low	11-20	0	50	50	7	105
low	11-20	0	25	75	1	1
low	11-20	0	0	100	1	8

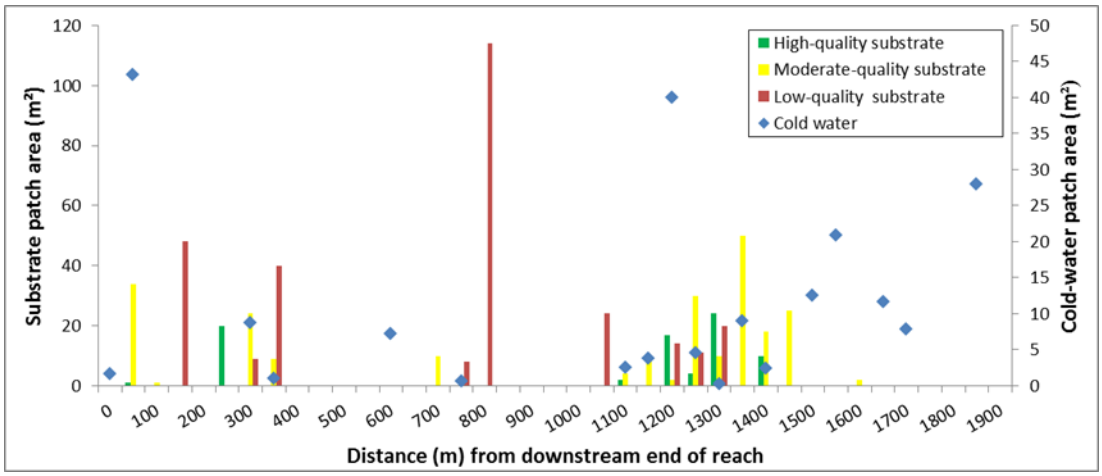

Figure 24. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 5 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 9. List of barrier, type, barrier height, barrier width (across stream), barrier length (upstream and downstream), barrier gradient (% slope), and max pool depth downstream of the barriers in reach 5 of the Lewis and Clark River, south of Astoria, OR, in July 2014

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Waterfall	1.3	3	1	22

REACHES 6 and 7

REACH DESCRIPTIONS:

Reaches 6 and 7 occurred in a high gradient, confined canyon that was thought to be a barrier to chum salmon migration. As such no habitat data (substrate or temperature) were collected, but data on potential barriers (specifically gradient) were recorded for consecutive 50 m units. Reach 6 started at the confluence of a large unnamed tributary entering from the river-left bank (Lat: 45.999051, Long: -123.854523) and continued upstream to the confluence with the South Fork of the Lewis and Clark River (Lat: 45.988268, Long: -123.847785; Figure 25). Reach 7 started at the confluence with the South Fork of the Lewis and Clark River and ended at a large dam with a fish ladder (Lat: 45.993225, Long: -123.83428; Figure 25). The mainstem thalweg lengths for these reaches were 1,478 m and 1,338 m for reaches 6 and 7, respectively. GPS waypoints were recorded at ~50 m unit intervals and slope (%) was measured for each of these units (Table 10). In the first 850 m of reach 6, the slope was consistently low (mean = 0.52%; Figure 26, panel A). Upstream of this point, the river was constrained by a canyon and the slope was higher (mean = 1.96%) throughout the remainder of reaches 6 and 7 (Table 10). The riparian zone along the canyon walls consisted of a thin row of trees at the top edge. (Figure 26, panel B). The confined channel with its limited meanders still formed pools (Figure 26, panel D) and in one of these pools there was an incidental observation of a school of about 20 adult Chinook Salmon and several other unidentifiable salmonids (Figure 26, panel E). The confluence that marked the break between reaches 6 and 7 was defined by especially steep and narrow canyon walls (Figure 26, panel F). There were several areas with large boulders and narrow channels that were potentially barriers to Chum Salmon migration (Figure 27, panels B, C, and D). A dam with a fish ladder was located at the upstream end of reach 7 (Table 11; Figure 27, panel F).

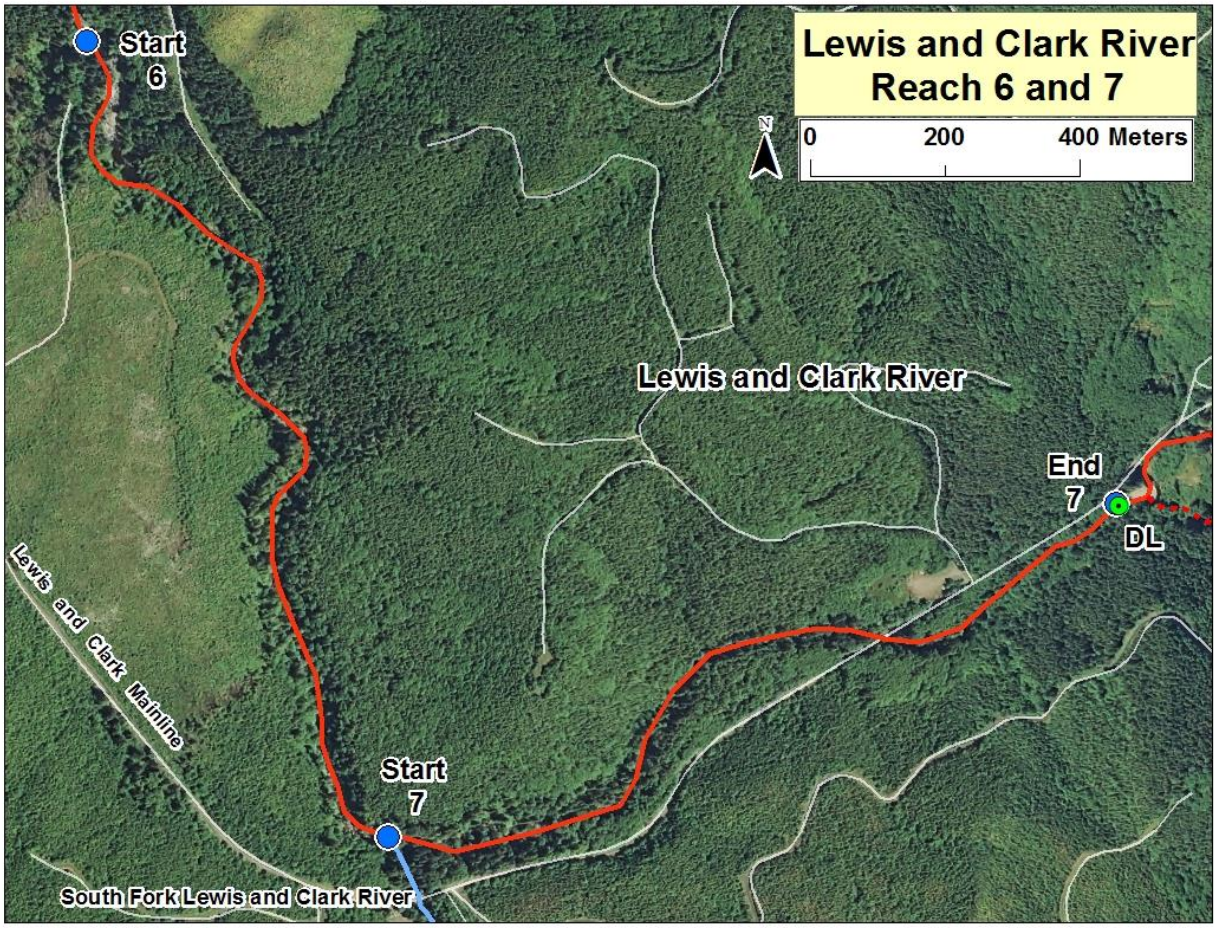

Figure 25. Map of reaches 6 and 7 (red line) on the Lewis and Clark River, including start and end points (blue dots) and a dam with a fish ladder (DL).

Figure 26. Survey pictures on reach 6 of the Lewis and Clark River showing dense riparian vegetation in a lower section of the reach (panel A), a narrow riparian zone resulting from adjacent timber harvest (panel B), large cobble substrate (panel C), a trench pool in a narrow canyon (panel D), an adult salmonid of unknown species swimming in a deep pool (panel E), and the confluence with the North Fork of the Lewis and Clark River (right) at the upstream end of the reach (panel F).

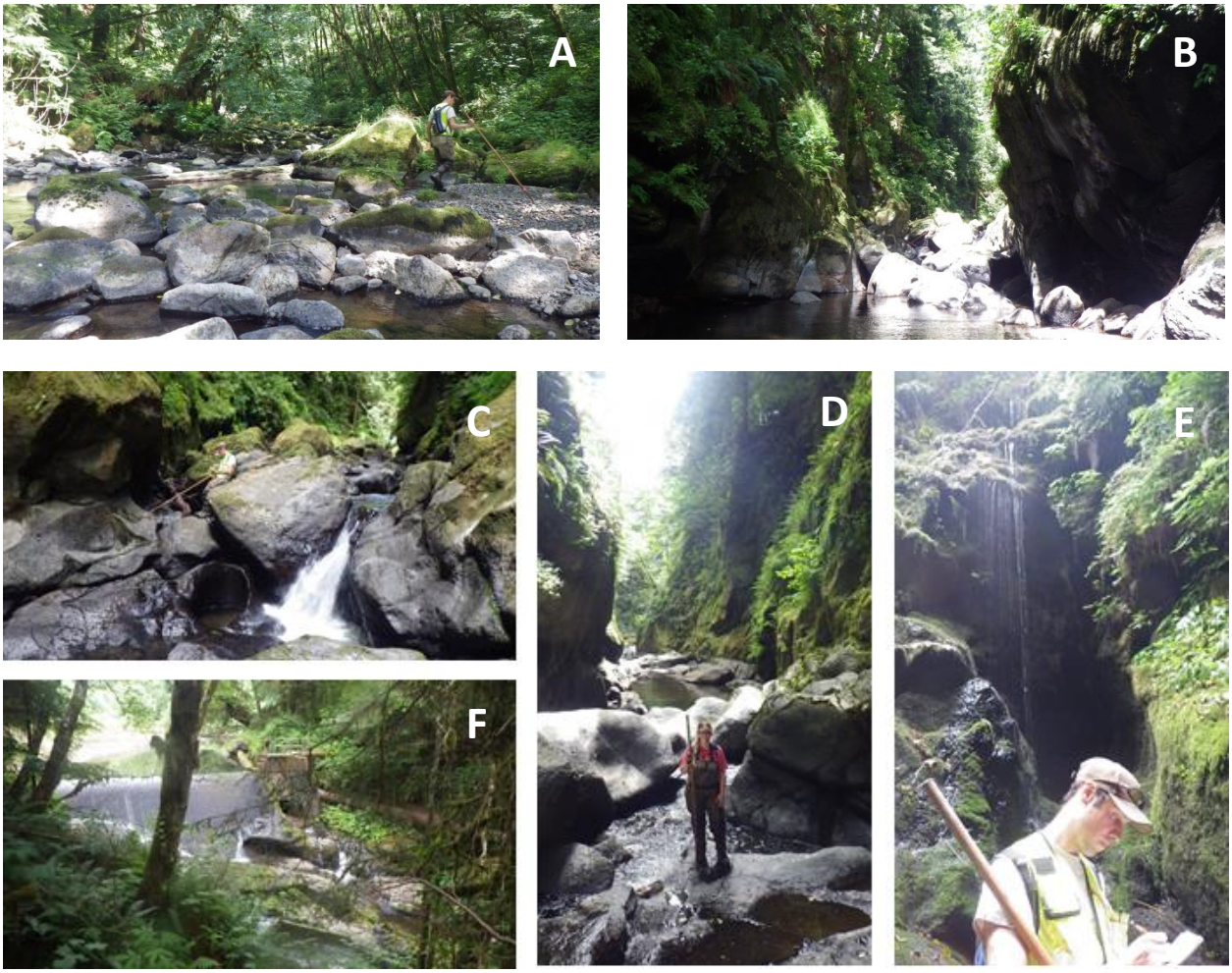

Figure 27. Survey pictures on reach 7 of the Lewis and Clark River showing a patch of small gravel downstream from a large boulder (panel A), a section of stream with steep canyon walls and boulders (panel B), a cascade over bedrock and boulders (panel C), narrow canyon, characteristic of this reach (panel D), water seeping out of canyon walls (panel E), and a dam with a fish ladder marking the upstream end of the reach (panel F).

RESULTS:

The substrate in reaches 6 and 7 of the Lewis and Clark River was predominantly large cobble, boulders (several > 2 m in diameter), and bedrock, with very limited substrate that met the established criteria for Chum Salmon spawning (4–128 mm, diameter; Figure 26, panel C; Figure 27, panel A). Throughout both reaches there were areas where water was seeping from the top and sides of the canyon walls (Figure 27, panel E). Due to the high gradient stream features found in this reach, this entire section of the Lewis and Clark River is potentially a barrier to Chum Salmon migration. Additionally, the dam with the fish ladder is a potential barrier to Chum Salmon migration (Table 11).

Table 10. Distance from downstream end of reach (m), unit length (m), and slope (%) for each unit measured in reaches 6 and 7 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Reach 6			Reach 7		
Distance from start of reach (m)	Unit length (m)	Slope (%)	Distance from start of reach (m)	Unit length (m)	Slope (%)
50	50	1	50	50	3
100	50	0.5	100	50	3.5
150	50	1	150	50	2
200	50	0	200	50	1.5
250	50	0	250	50	2.5
300	50	1	300	50	3
350	50	0	350	50	5
400	50	0	400	50	0
450	50	1	449	49	5.5
500	50	1.5	469	20	9
550	50	0	499	30	5
600	50	1	523	24	0
650	50	1.5	549	26	7
700	50	0.5	599	50	3
750	50	0	649	50	0.5
800	50	0	695	46	6
850	50	0	699	4	0
900	50	2	749	50	1.5
950	50	1.5	792	43	3
1000	50	1	814	22	0
1050	50	0.5	842	28	2.5
1100	50	1	892	50	1
1150	50	0	942	50	2
1200	50	0.5	992	50	10
1250	50	0	1042	50	2
1300	50	0	1092	50	3
1333	33	0	1142	50	2
1383	50	2.5	1192	50	0.5
1433	50	3	1242	50	1
1478	45	2.5	1338	96	N/A

Table 11. List of barrier, type, barrier height, barrier width (across stream), barrier length (upstream and downstream), barrier gradient (% slope), and max pool depth downstream of the barriers in reach 7 of the Lewis and Clark River, south of Astoria, OR, in July 2014

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Dam w/fish ladder	*	*	*	*

REACH 8

REACH DESCRIPTION:

Reach 8 started at a dam with a fish ladder (Lat: 45.993225, Long: -123.83428) and continued upstream to Lat: 45.993714, Long: -123.817336 (Figure 28). The mainstem thalweg length of this reach was 1,681 m. There were five side channel sections with a combined thalweg length of 780 m. The river was not constrained by canyons walls in this reach, which resulted in a channel form best described as unconfined with substantial meanders and side channels. This included the formation of two long side channel sections located near the downstream end of the reach (Figure 29, panel B). Large log jams were common in this reach as well (Figure 29,

panel C). The riparian zone was densely vegetated with large alders, firs, spruces, maples, and cedars (Figure 29, panel A). The land use for this reach was mature timber.

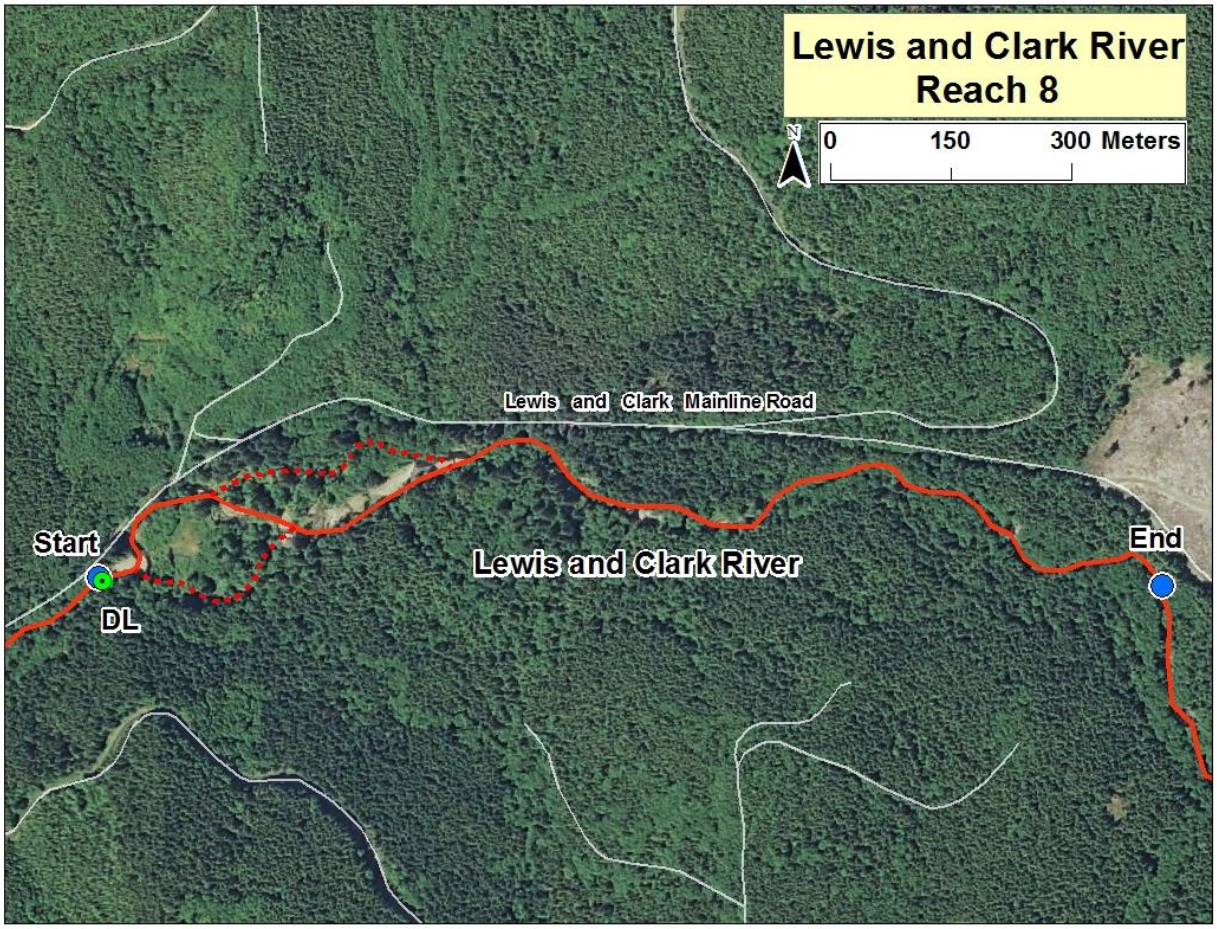

Figure 28. Map of reach 8 (red line) on the Lewis and Clark River, including start and end points (blue dots) and a dam with a fish ladder (DL)

Figure 29. Survey pictures on reach 8 of the Lewis and Clark River showing a densely-vegetated riparian zone (panel A), a long side channel near the downstream end of the reach (panel B), a large log jam (panel C), and an extensive substrate patch (panel D).

RESULTS:

Sixty-eight patches of suitable spawning substrate that met established criteria were found in reach 8 of the Lewis and Clark River (Table 12; Figure 30), measuring a total of 2,692 m². In a section of stream in the upper half of the reach, extensive patches of suitable spawning substrate were discovered, with some patches > 100 m in length (Figure 29, panel D). Four of these patches were categorized as "high" quality, 21 patches were of "moderate" quality, and 43 patches were of "low" quality (Table 12; Figure 30). Twenty-one cold-water patches (measuring a total of 565.0 m²) were observed (Figure 30). Average temperature in these patches was 13.2° C, and average temperature adjacent to these patches was 15.4° C. The dominant substrate types within these cold-water patches were fine sediment (n = 12), large gravel (n = 7), small cobble (n = 1), and large cobble (n = 1). There was one potential barrier to Chum Salmon migration in this reach, the dam with fish ladder at the downstream start of the reach (Table 13).

Table 12. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 8 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

substrate quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	1	6
high	0-10	0	100	0	3	47
moderate	0-10	0	75	25	4	18
moderate	0-10	0	50	50	4	175
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	20	0	0	0
moderate	11-20	50	50	0	2	13
moderate	11-20	25	75	0	4	19
moderate	11-20	0	100	0	7	138
low	11-20	0	75	25	19	747
low	11-20	0	50	50	15	1237
low	11-20	0	25	75	5	215
low	11-20	0	0	100	4	77

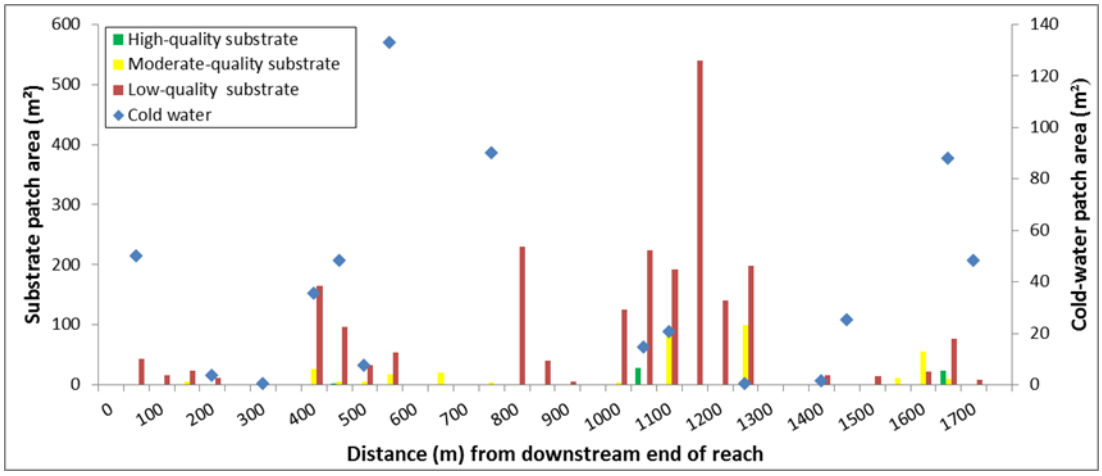

Figure 30. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 8 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 13. List of barrier, type, barrier height, barrier width (across stream), barrier length (upstream and downstream), barrier gradient (% slope), and max pool depth downstream of the barriers in reach 8 of the Lewis and Clark River, south of Astoria, OR, in July 2014

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Dam w/fish ladder	*	*	*	*

REACH 9

REACH DESCRIPTION:

Reach 9 started at Lat: 45.993714, Long: -123.817336, and continued upstream to a bridge where Lewis and Clark Mainline logging road crosses the river (Lat: 45.990108, Long: -123.802261; Figure 31; Figure 32, panel A). The mainstem thalweg length of this reach was 1,715 m. There were 11 side channels with a combined thalweg length of 455 m. The channel form for this reach was unconfined, with multiple channels and meanders. The riparian zone was densely vegetated with mature alders, firs, maples and cedars (Figure 32, panel B). Land use consisted primarily of mature timber and large woody debris was abundant throughout the reach, including many log jams (Figure 32, panel C).

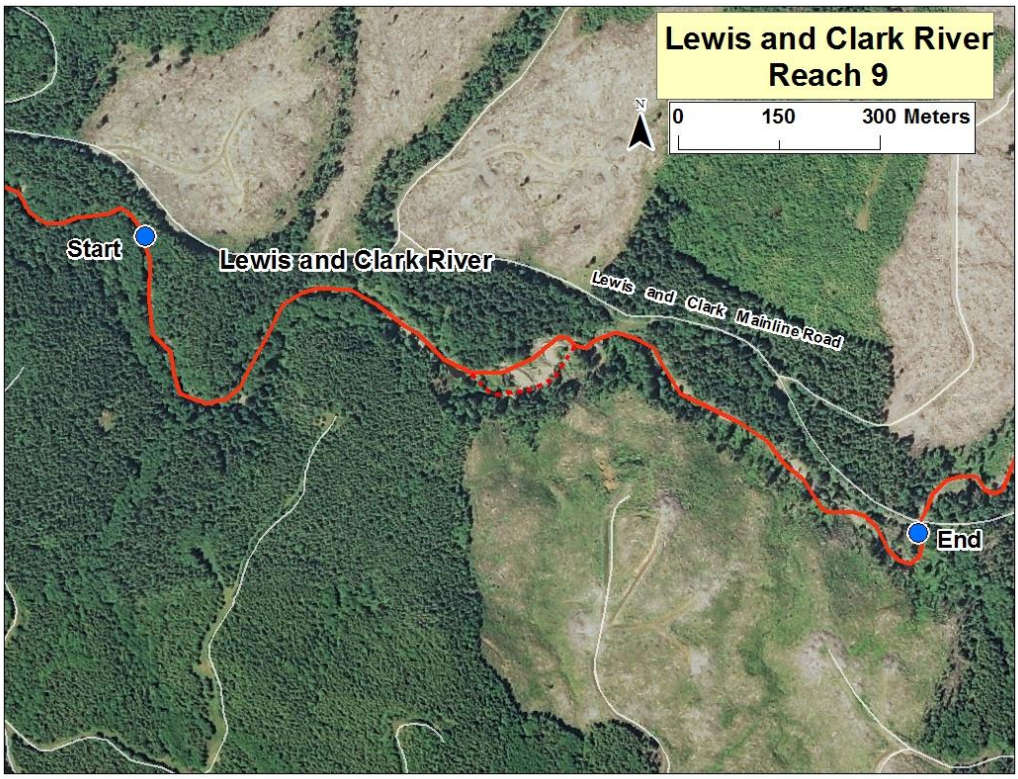

Figure 31. Map of reach 9 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 32. Survey pictures on reach 9 of the Lewis and Clark River showing the mainline bridge marking that upstream end of the reach (panel A), dense riparian vegetation (panel B), a channel-spanning log jam (panel C), and a gravel bar located downstream of a log jam (panel D).

RESULTS:

Thirty-one patches of suitable spawning substrate were found in reach 9 of the Lewis and Clark River (Table 14; Figure 33), measuring a total of 410 m². Substrate suitable for Chum Salmon spawning was common, with several patches observed downstream of log jams (Figure 32, panel D). In a section of stream in the upper half of the reach extensive patches of suitable spawning substrate, with some patches > 100 m in length (Figure 32, panel D) were discovered. One of these patches was categorized as "high" quality, 7 patches were of "moderate" quality, and 23 patches were of "low" quality (Table 14; Figure 33). Eighteen cold-water patches were detected, measuring a total of 264.8 m² (Figure 33). Average temperature in these patches was 14.1° C and average temperature adjacent to these patches was 15.9° C. The dominant substrate types within these cold-water patches were fine sediment (n = 10), large gravel (n = 2), small cobble (n = 5), and bedrock (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 14. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 9 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	1	2
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	1	12
low	0-10	0	25	75	3	15
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	4	42
moderate	11-20	0	100	0	2	52
low	11-20	0	75	25	4	26
low	11-20	0	50	50	7	109
low	11-20	0	25	75	8	144
low	11-20	0	0	100	1	8

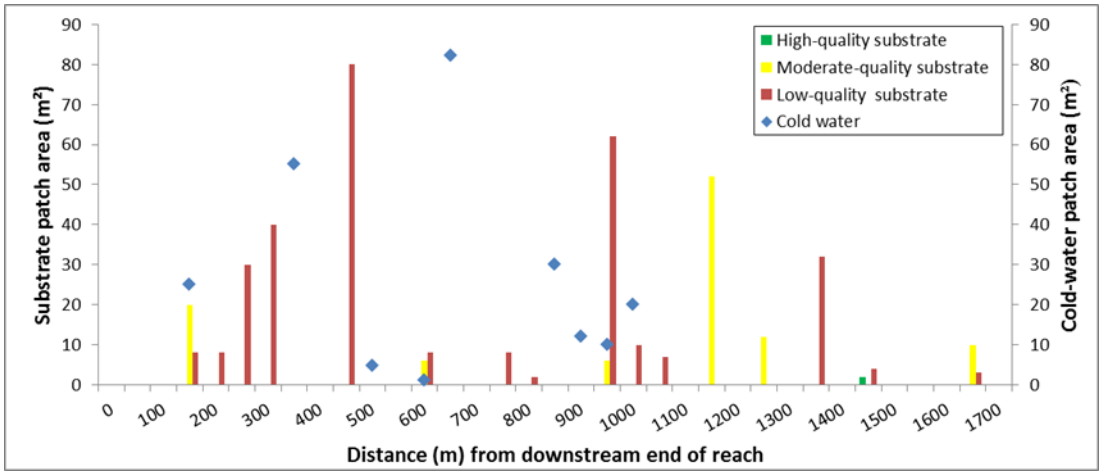

Figure 33. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 9 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel. No location data were recorded for cold-water patches from 1,450 m to 1,700 m due to a GPS device malfunction.

REACH 10

REACH DESCRIPTION:

Reach 10 started at the Lewis and Clark mainline logging road bridge (Lat: 45.990108, Long: -123.802261) and continued upstream to a small ephemeral side channel that entered from the river-left bank (Lat: 45.987717, Long: -123.789013; Figure 34). The mainstem thalweg length of this reach was 1,450 m. Channel form was unconfined with meanders, including one side channel with a thalweg length of 69 m. The riparian vegetation was limited in this reach due to the proximity of the road to the channel and a thin riparian buffer with blown down trees (Figure 35, panel A). Land use was a mix of mature timber and timber harvest.

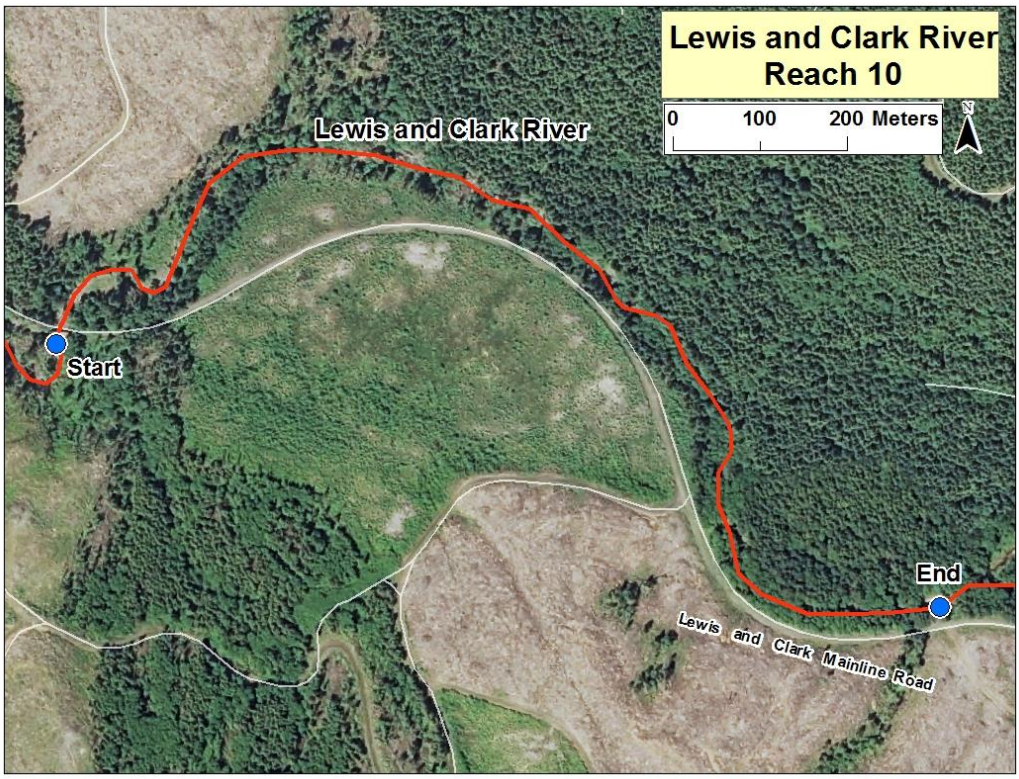

Figure 34. Map of reach 10 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 35. Survey pictures on reach 10 of the Lewis and Clark River showing a section of riparian vegetation with sparse trees (panel A), bedrock (panel B) and hardpan (panel C) banks, and large cobble substrate (panel D).

RESULTS:

The substrate was predominantly large cobble (129–256 mm, diameter; Figure 35, panel D), however 30 patches of suitable spawning substrate that met established criteria were found in reach 10 of the Lewis and Clark River measuring a total of 217 m^2 (Table 15; Figure 36). None of these patches were categorized as "high" quality, but 16 patches were of "moderate" quality, and 14 patches were of "low" quality (Table 15; Figure 36). Bedrock and hardpan clay were also observed throughout the reach (Figure 35, panel B and C). Twenty-seven of these patches contained ≥ 50% large gravel (12–45 mm, diameter; Table 15). Six cold-water patches were detected, measuring a total of 25.7 m^2 (Figure 36). Average temperature in these patches was 12.8° C and average temperature adjacent to these patches was 14.1° C. The dominant substrate types within these cold-water patches were large gravel (n = 1), small cobble (n = 1), large cobble (n = 2), and bedrock (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 15. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 10 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	1	2
moderate	11-20	25	75	0	4	13
moderate	11-20	0	100	0	11	104
low	11-20	0	75	25	7	39
low	11-20	0	50	50	4	52
low	11-20	0	25	75	2	6
low	11-20	0	0	100	1	1

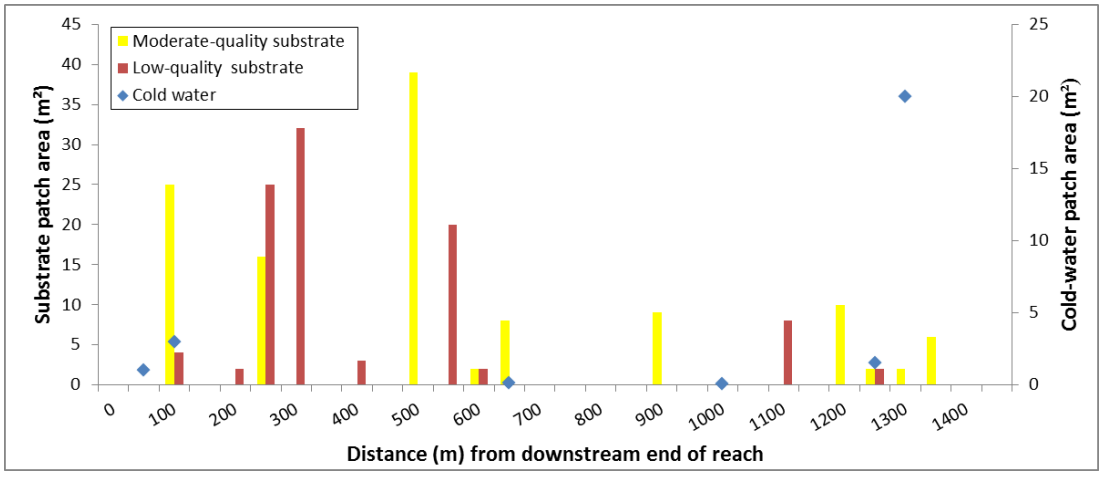

Figure 36. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 10 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 11

REACH DESCRIPTION:

Reach 11 started at a small ephemeral side channel on the river-left bank (Lat: 45.987717, Long: -123.789013) and continued upstream to Lat: 45.980747, Long: -123.773535 (Figure 37). The mainstem thalweg length of this reach was 1,919 m. There were 18 side channels with a combined thalweg length of 1,646 m. The channel form in this reach was complex and unconfined, with numerous meanders and several long (>100 m) side channels that were interconnected with tertiary channels (Figure 38, panel A–C). Some side channels had flow, others had isolated pools, and some were completely dry. Riparian vegetation was dense, consisting predominantly of alders and spruces (Figure 38, panel D). There were signs of logging, indicating an overall land use of mature timber mixed with timber harvest. Large wood was abundant throughout the reach and many log jams were associated with side-channel complexes.

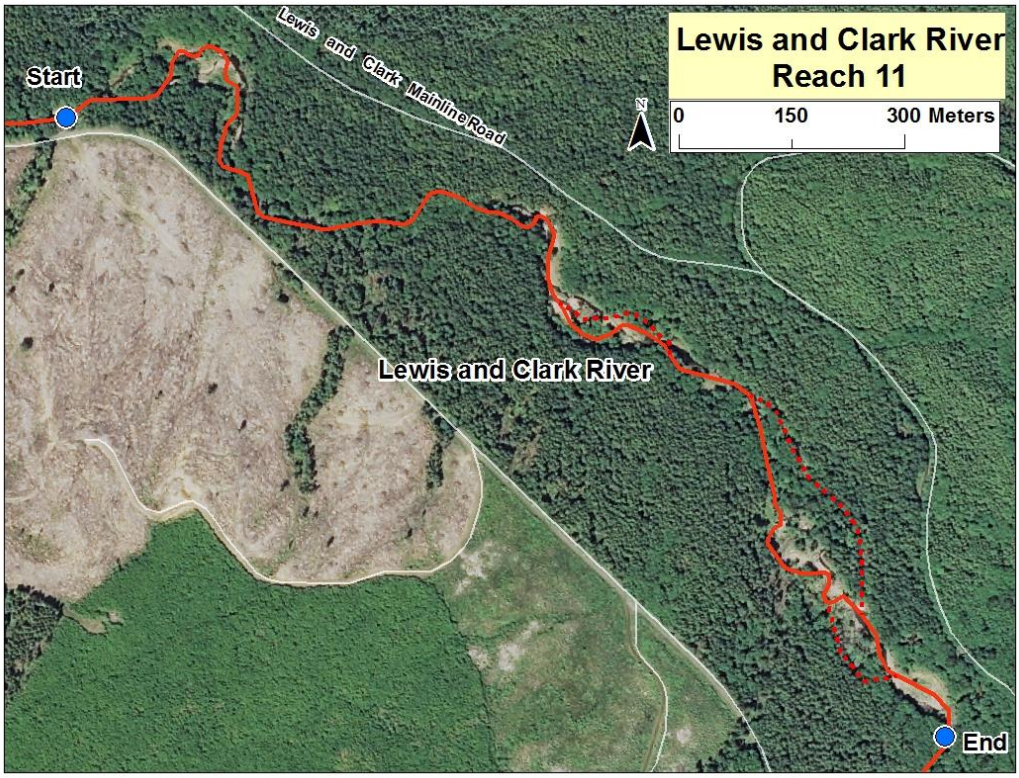

Figure 37. Map of reach 11 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 38. Survey pictures on reach 11 of the Lewis and Clark River showing three different large side channels (panels A–C), a riparian zone dominated by alder and spruce along a side channel (panel D), a hardpan shelf along the river-right bank (panel E), and an accumulation of gravel downstream of a log jam in a dry side channel (panel F).

RESULTS:

Forty-seven patches of suitable spawning substrate were found in reach 11 of the Lewis and Clark River (Table 16; Figure 39), measuring a total of 657 m². Substrate in size classes suitable for Chum Salmon spawning was abundant in side channels and downstream of log jams (Figure 38, panel F). Five of these patches were categorized as "high" quality, 25 patches were of "moderate" quality, and 17 patches were of "low" quality (Table 16; Figure 39). All but three of these patches contained ≥ 50% large gravel (12–45 mm, diameter; Table 16). Bedrock and hardpan clay was also common along the banks and in the stream channel (Figure 38, panel E). Twenty-nine cold-water patches were detected, measuring a total of 361.0 m² (Figure 39). Average temperature in these patches was 13.7° C and average temperature adjacent to these

patches was 15.7° C. Several of the isolated pools found were classified as cold-water patches. The dominant substrate types within these cold-water patches were fine sediment (n = 13), large gravel (n = 11), small cobble (n = 4), and large cobble (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 16. Total number and area (m^2) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 11 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	3	5
high	0-10	0	100	0	2	20
moderate	0-10	0	75	25	4	288
moderate	0-10	0	50	50	1	6
low	0-10	0	25	75	1	8
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	5	7
moderate	11-20	25	75	0	10	78
moderate	11-20	0	100	0	5	138
low	11-20	0	75	25	8	48
low	11-20	0	50	50	6	47
low	11-20	0	25	75	1	4
low	11-20	0	0	100	1	8

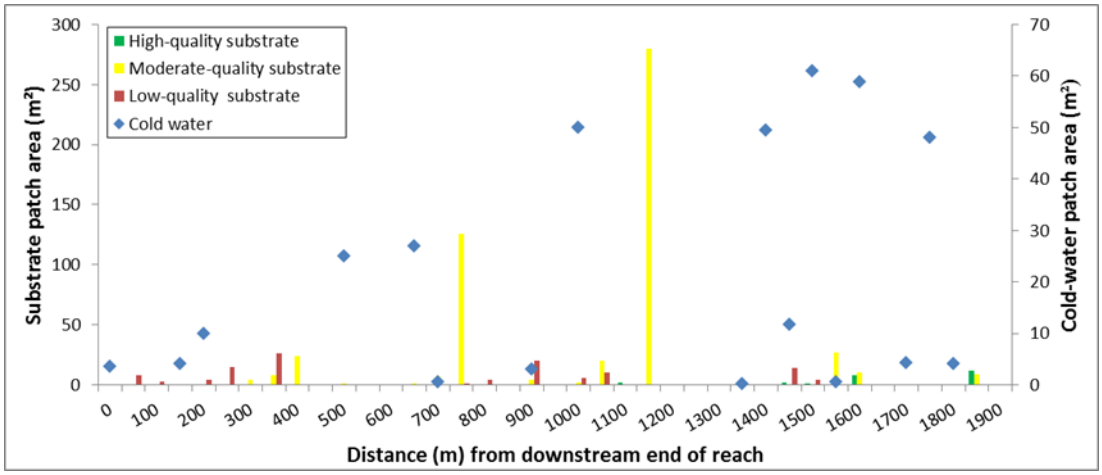

Figure 39. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 11 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 12

REACH DESCRIPTION:

Reach 12 started at Lat: 45.980747, Long: -123.773535, and continued upstream to a small unnamed tributary 1.7 km downstream from the Bridge Road bridge (Lat: 45.96933, Long: -123.766865; Figure 40). The mainstem thalweg length of this reach was 1,823 m. There were 9 side channel sections with a combined thalweg length of 716 m. The channel form in this reach was complex and unconfined, with numerous meanders and side channels. There were two long (>100 m) side-channel complexes in this reach (Figure 40, dashed red line). One of these side-channel complexes, located near the downstream end of the reach, had a large log jam at the upstream end and there was a substantial amount of gravel associated with it (Figure 41, panels A and B). Some of these side channels were dry and others contained active flow (Figure 41, panel C). Throughout the reach most of the riparian vegetation was dense and consisted of alders and firs. Some of the riparian zone also consisted of cleared areas with limited vegetation, thus land use was deemed a mix of mature timber and timber harvest. One extensive landslide section, located in the upstream quarter of the reach, deposited large quantities of sandstone into the stream channel (Figure 41, panel E).

Figure 40. Map of reach 12 (red line) on the Lewis and Clark River, including start and end points (blue dots).

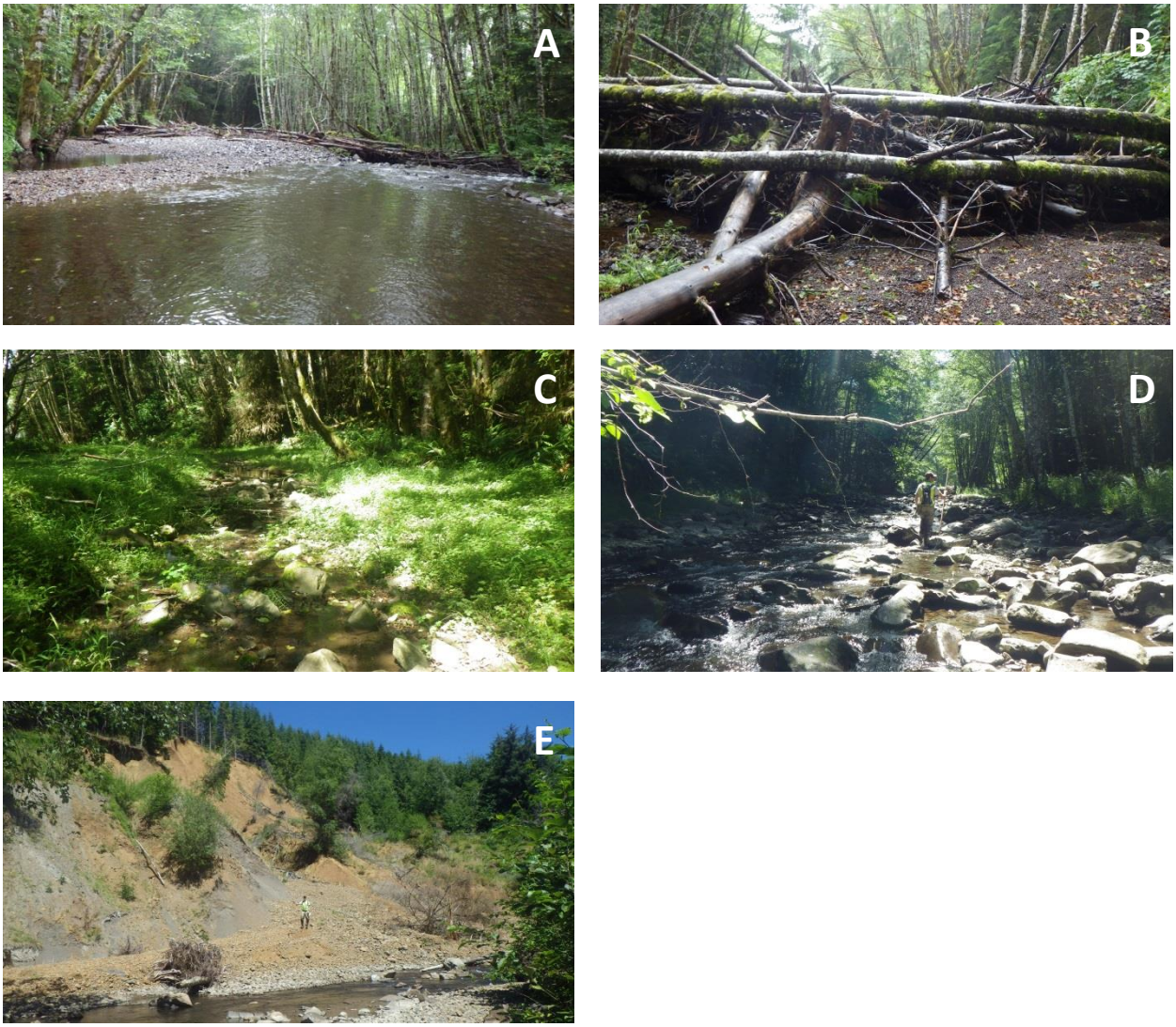

Figure 41. Survey pictures on reach 12 of the Lewis and Clark River showing a gravel accumulation upstream from a large log jam near the downstream end of the reach (panel A), a dry side channel downstream from a log jam (panel B), a long side channel (panel C), large cobble and boulder substrate (panel D), and a landslide near the upstream end of the reach (panel E).

RESULTS:

Thirty-eight patches of suitable spawning substrate were found in reach 12 of the Lewis and Clark River (Table 17; Figure 42), measuring a total of 600 m². Substrate outside of side-channel complexes consisted predominantly of large cobble (129–256 mm, diameter) and boulders (Figure 41, panel D). Five of these patches were categorized as "high" quality, 17 patches were of "moderate" quality, and 16 patches were of "low" quality (Table 17; Figure 42). Thirty-three of these patches contained ≥ 50% large gravel (12–45 mm, diameter; Table 17). Thirty-nine cold-water patches were detected, measuring a total of 1,151.5 m² (Figure 42). Average temperature in these patches was 13.3° C and average temperature adjacent to these patches was 15.8° C. The dominant substrate types within these cold-water patches were fine sediment

(n = 12), small gravel (n = 7), large gravel (n = 2), small cobble (n = 9), large cobble (n = 4), and bedrock (n = 5). There were no potential barriers to Chum Salmon migration in this reach.

Table 17. Total number and area (m^2) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 12 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	1	14
high	0-10	25	75	0	0	0
high	0-10	0	100	0	4	14
moderate	0-10	0	75	25	4	141
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	1	16
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	1	2
moderate	11-20	25	75	0	7	50
moderate	11-20	0	100	0	5	46
low	11-20	0	75	25	4	51
low	11-20	0	50	50	7	138
low	11-20	0	25	75	2	60
low	11-20	0	0	100	2	68

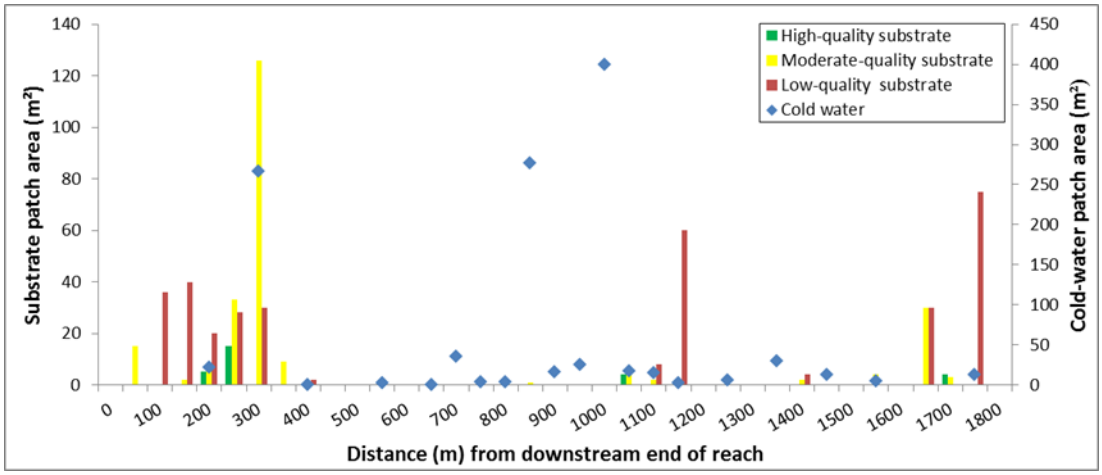

Figure 42. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 12 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 13

REACH DESCRIPTION:

Reach 13 started at a small, unnamed tributary 1.7 km downstream from the Bridge Road bridge (Lat: 45.96933, Long: -123.766865) and continued upstream to another small tributary 200 m upstream from the Bridge Road bridge (Lat: 45.964135, Long: -123.752255; Figure 43). The mainstem thalweg length of this reach was 1,878 m. There were four side channel sections with a combined thalweg length of 251 m. Channel form was unconfined with multiple side channels and meanders. The riparian vegetation was dense and included spruce, fir, alder, maple, and cedar trees (Figure 44, panel A). Land use was a mix of mature timber and timber harvest. Large woody debris and log jams (Figure 44, panel B) were numerous throughout the reach (Figure 44, panel C). Bridge Road crossed the creek 200 m downstream from the end of the reach. This bridge was not considered a barrier to Chum Salmon migration.

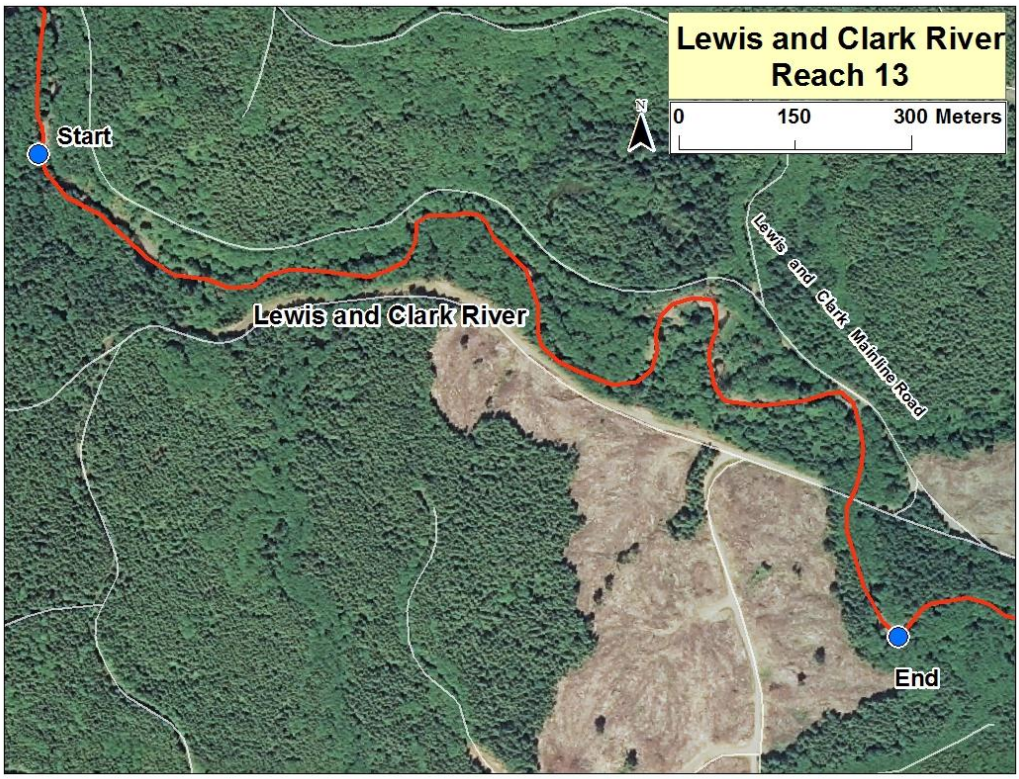

Figure 43. Map of reach 13 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 44. Survey pictures on reach 13 of the Lewis and Clark River showing a riparian zone with a variety of tree species (panel A), a channel-spanning log jam (panel B), a large Douglas fir log (panel C), and a log jam in a dry side channel (panel D).

RESULTS:

Eighty-five patches of suitable spawning substrate were found in reach 13 of the Lewis and Clark River (Table 18; Figure 45), measuring a total of 3,090 m². Five of these patches were categorized as "high" quality, 38 patches as "moderate" quality, and 42 patches as "low" quality (Table 18; Figure 45). Seventy-three of these patches contained ≥ 50% large gravel (12–45 mm, diameter; Table 18). Several suitable substrate patches were identified in dry side channels (Figure 44, panel C). Forty-two cold-water patches were detected, measuring a total of 489.7 m² (Figure 45). Average temperature in these patches was 12.8° C and average temperature adjacent to these patches was 14.7° C. The dominant substrate types within these cold-water patches were fine sediment (n = 16), small gravel (n = 10), large gravel (n = 8), small cobble (n = 4), large cobble (n = 1), and bedrock (n = 3). There were no potential barriers to Chum Salmon migration in this reach.

Table 18. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 13 of the Lewis and Clark River, south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	2	5
high	0-10	25	75	0	0	0
high	0-10	0	100	0	3	47
moderate	0-10	0	75	25	3	46
moderate	0-10	0	50	50	1	20
low	0-10	0	25	75	1	4
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	1	6
moderate	11-20	50	50	0	3	26
moderate	11-20	25	75	0	12	188
moderate	11-20	0	100	0	18	520
low	11-20	0	75	25	18	744
low	11-20	0	50	50	13	821
low	11-20	0	25	75	8	303
low	11-20	0	0	100	2	360

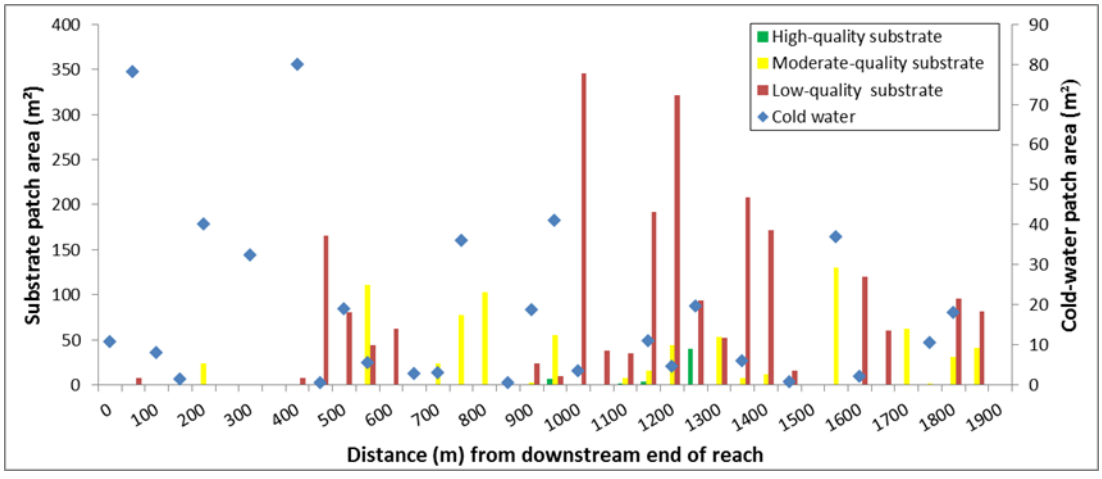

Figure 45. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 13 of the Lewis and Clark River, south of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 14

REACH DESCRIPTION:

Reach 14 started at a small tributary 200 m upstream form the Bridge Road bridge (Lat: 45.964135, Long: -123.752255) and continued upstream to Lat: 45.959734, Long: -123.745148 (Figure 46). The mainstem thalweg length of this reach was 954 m. There were five side channel sections with a combined thalweg length of 178 m. Channel form was unconfined with multiple side channels and meanders. Riparian vegetation in this reach was dense, consisting of alders, firs, and cedars (Figure 47, panel A). Land use was a mix of mature timber and timber harvest. Log jams were common throughout the reach (Figure 47, panel B). Several unnamed tributaries entered the river from the river-left bank, with most having colder water than the main channel (Figure 47, panel C).

Figure 46. Map of reach 14 (red line) on the Lewis and Clark River, including start and end points (blue dots).

Figure 47. Survey pictures on reach 14 of the Lewis and Clark River showing dense riparian vegetation (panel A), a log jam (panel B), an unnamed tributary entering from river-left (panel C), and a large substrate patch (panel D).

RESULTS:

Sixty-two patches of suitable spawning substrate were found in reach 14 of the Lewis and Clark River (Table 19; Figure 48), measuring a total of 2,789 m². Seven of these patches were categorized as "high" quality, 25 patches were of "moderate" quality, and 30 patches were of "low" quality (Table 19; Figure 48). Fifty-three of these patches were comprised of ≥ 50% large gravel (12–45 mm, diameter; Table 19). Substantial quantities of gravel in the size range suitable for Chum Salmon spawning were found (4–128 mm, diameter), distributed in large patches (Figure 47, panel D). Twenty-one cold-water patches were detected, with a combined surface area of 400.5 m² (Figure 48). Average temperature in these patches was 14.5° C and average temperature adjacent to these patches was 16.6° C. The dominant substrate types within these cold-water patches were fine sediment (n = 5), small gravel (n = 1), large gravel (n = 8), small cobble (n = 6), and large cobble (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 19. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 14 of the Lewis and Clark River, south of Astoria, OR, in August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	1	24
high	0-10	25	75	0	1	10
high	0-10	0	100	0	5	62
moderate	0-10	0	75	25	2	28
moderate	0-10	0	50	50	5	147
low	0-10	0	25	75	2	402
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	2	13
moderate	11-20	25	75	0	4	174
moderate	11-20	0	100	0	12	205
low	11-20	0	75	25	14	505
low	11-20	0	50	50	7	976
low	11-20	0	25	75	4	144
low	11-20	0	0	100	3	99

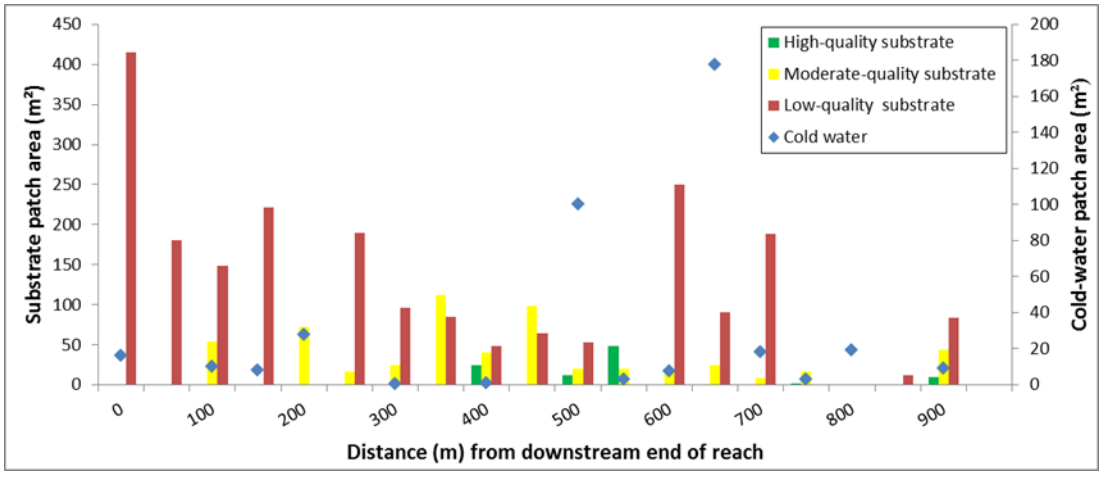

Figure 48. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 14 of the Lewis and Clark River, south of Astoria, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Wallooskee River

SURVEY DATES: July 14–15, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, John Cox, Regina Southworth, and Nick Baisley

GENERAL DESCRIPTION:

The Wallooskee River habitat survey (Township: 7N Range: 9W Section: 2A) started at the confluence with an unnamed tributary on river left, and continued 3.8 km upstream to the Labiske Road bridge. Surveys on the Wallooskee River were delineated into two reaches based on physical features, landowner access, and overall distance (Figure 49). The Wallooskee River, downstream from reach 1 to where the river enters Youngs Bay, is a tidal slough. The Little Wallooskee River is the only named tributary of the Wallooskee River and entered the main channel from the river-right bank in tidewater. The non-tidal portion of the Little Wallooskee was not surveyed due to heavy brush in the channel.

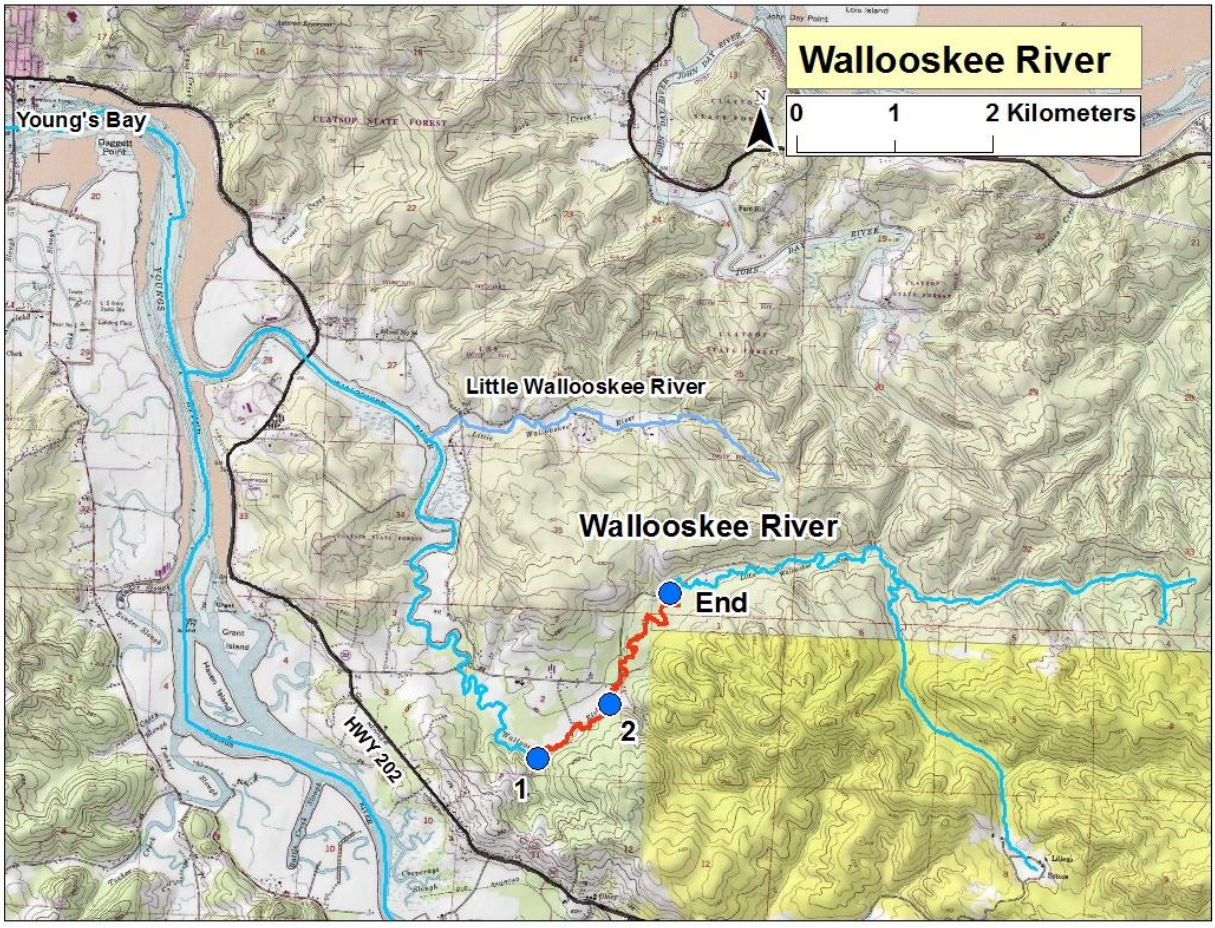

Figure 49. Map of reaches (red line) surveyed on the Wallooskee River, located southeast of Astoria, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started at the confluence with an unnamed tributary entering from the river-left bank (Lat: 46.112571, Long: -123.765502) and continued upstream to the confluence with a second unnamed tributary 500 m downstream from Palmer Road (Lat: 46.117881, Long: -123.756185; Figure 50). The mainstem thalweg length of this reach was 1,287 m. There was one side channel with a thalweg length of 180 m. Riparian vegetation was sparse and dominated by alders (Figure 51, panel A). Land use was agriculture and timber harvest. The stream channel form was confined by deeply entrenched, hardpan clay banks (Figure 51, panel B), with one side channel and limited meanders. Large woody debris was abundant throughout the reach (Figure 51, panel C). In the upstream end of the reach, one long side channel had several isolated pools (Figure 51, panel D).

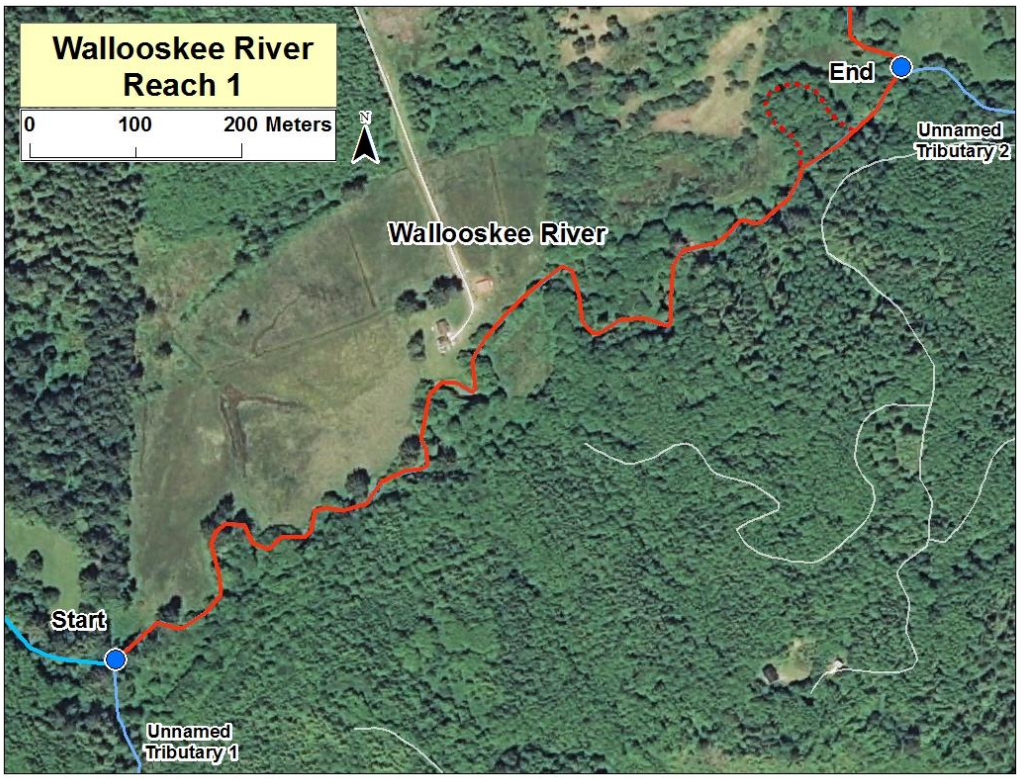

Figure 50. Map of reach 1 (red line) on the Wallooskee River, including start and end points (blue dots).

Figure 51. Survey pictures on reach 1 of the Wallooskee River showing an alder-dominated riparian zone (panel A), a deeply entrenched channel (panel B), several pieces of large woody debris in the stream channel (panel C), and an isolated pool in a predominantly dry side channel (panel D).

RESULTS:

Substrate in reach 1 of the Wallooskee River consisted entirely of mud and silt (< 4 mm diameter), and there were no suitable gravel patches. Two cold-water patches were recorded, totaling 106.8 m^2 (Figure 52). Average temperature in these patches was 14.7° C and average temperature adjacent to these patches was 15.6° C. The dominant substrate type within these cold-water patches was fine sediment (< 4 mm diameter). Both cold-water patches were in isolated pools in a side channel within 200 m of the upstream end of the reach. There were no potential barriers to Chum Salmon migration in this reach.

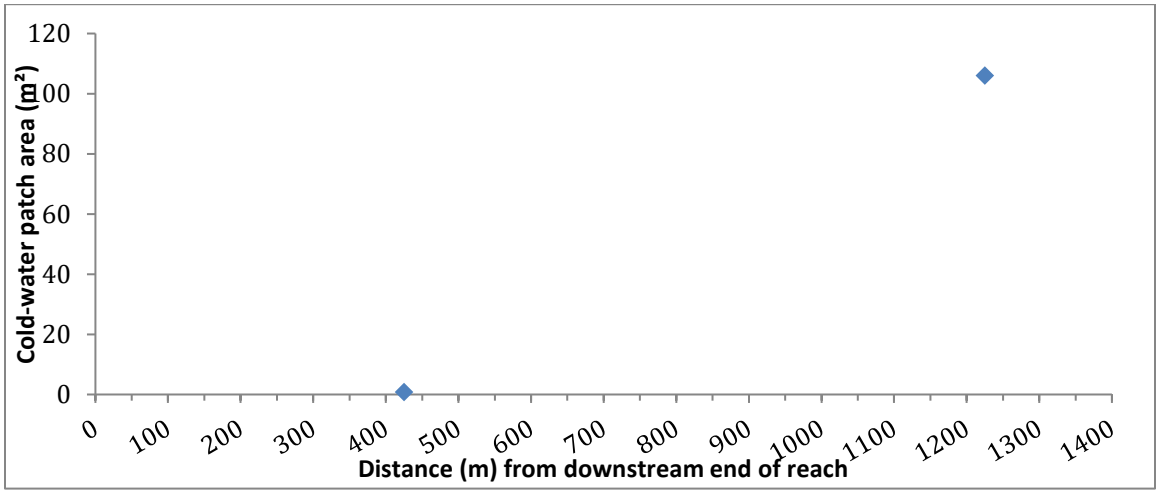

Figure 52. Location of cold-water patches measured as distance from downstream end of survey in reach 1 of the Wallooskee River, south of Astoria, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 2

REACH DESCRIPTION:

Reach 2 started at the confluence with the second unnamed tributary 500 m downstream from Palmer Road (Lat: 46.117881, Long: -123.756185; Figure 54, panel A) and continued upstream to the Labiske Road bridge (Lat: 46.128326, Long: -123.74887; Figure 53). The mainstem thalweg length of this reach was 2,489 m, including two side channels with a combined thalweg length of 36 m. Riparian vegetation consisted of alders, firs, cedars, ferns, and shrubs (Figure 54, panel B). Land use was agriculture and timber harvest. The stream channel form was confined with multiple channels and extensive meanders. Beaver activity, including several small dams, was observed throughout the reach (Figure 54, panel C).

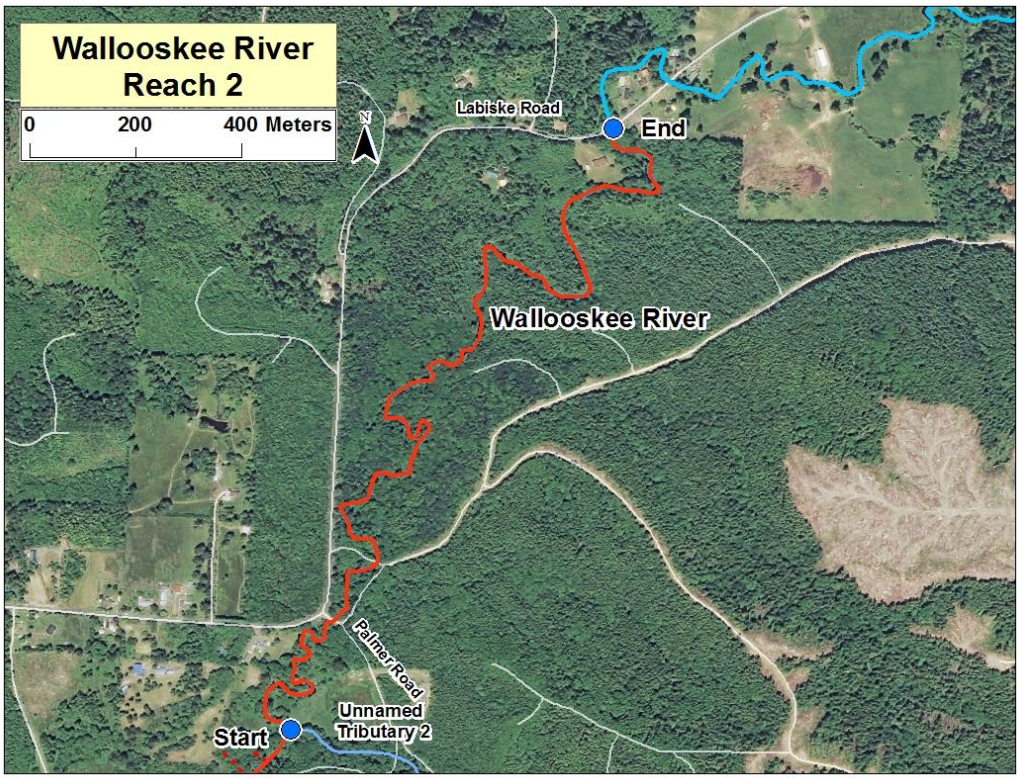

Figure 53. Map of reach 2 (red line) on the Wallooskee River, including start and end points (blue dots).

Figure 54. Survey pictures on reach 2 of the Wallooskee River showing the confluence with an unamed tributary marking the downstream end of the reach (panel A), riparian vegetation consisting of firs, alders, ferns, and shrubs (panel B), a small beaver dam (panel C), and gravel and small cobble substrate (panel D).

RESULTS:

Thirteen patches of suitable spawning substrate were found in the Wallooskee River reach 2 (Table 20; Figure 55), measuring a total of 76 m². None of these patches were categorized as "high" quality, two patches were of "moderate" quality, and 11 patches were of "low" quality (Table 20; Figure 55). Substrate size gradually increased from the downstream to the upstream end of the reach (Figure 54, panel D). Ten cold-water patches were recorded, with a combined surface area of 26.4 m² (Figure 55). Average temperature in these patches was 14.9° C and average temperature adjacent to these patches was 17.0° C. The dominant substrate types within these cold-water patches were fine sediment (n = 7), small gravel (n = 1), and bedrock (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 20. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 2 of the Wallooskee River, southeast of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	2	5
low	11-20	0	75	25	0	0
low	11-20	0	50	50	5	38
low	11-20	0	25	75	6	33
low	11-20	0	0	100	0	0

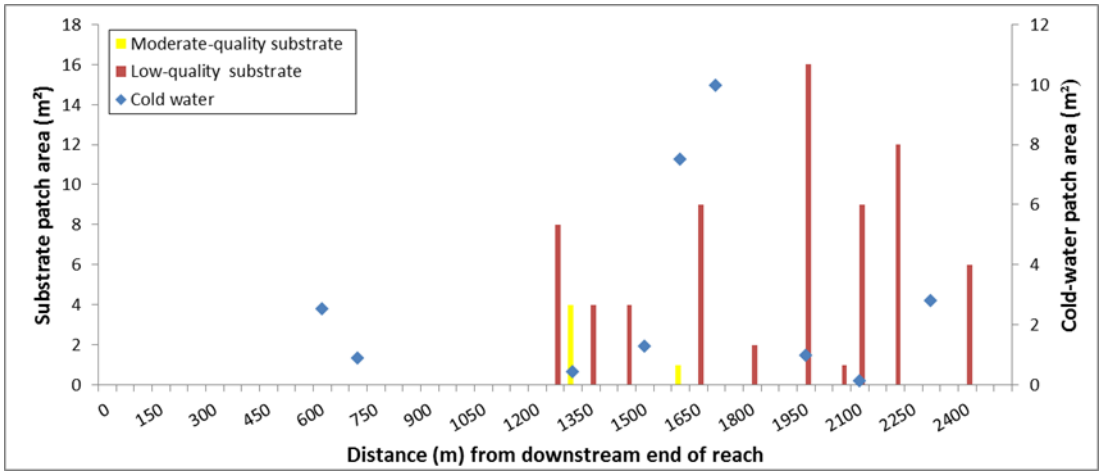

Figure 55. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 2 of the Wallooskee River, southeast of Astoria, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Youngs River

SURVEY DATE: July 2, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, and John Cox

GENERAL DESCRIPTION:

The Youngs River habitat survey (Township: 7N Range: 9W Section: 27D) started at a point in the river 500 m upstream from where the Youngs River Road crosses the river (Lat: 46.067255, Long: -123.785527), and continued upstream to the Youngs River Falls (Lat: 46.067397, Long: -123.789334; Figure 56, and Figure 57, panel C). The survey consisted of one reach with a mainstem thalweg length of 350 m. There were two side channels with a combined thalweg length of 109 m. This stream channel form was wide (>20 m) and braided, with multiple channels. Riparian vegetation consisted of a variety of species including firs, alders, cedars, hemlock, and shrubs (Figure 57, panel B). Land use was a mix of young and mature timber, with some timber harvest influence.

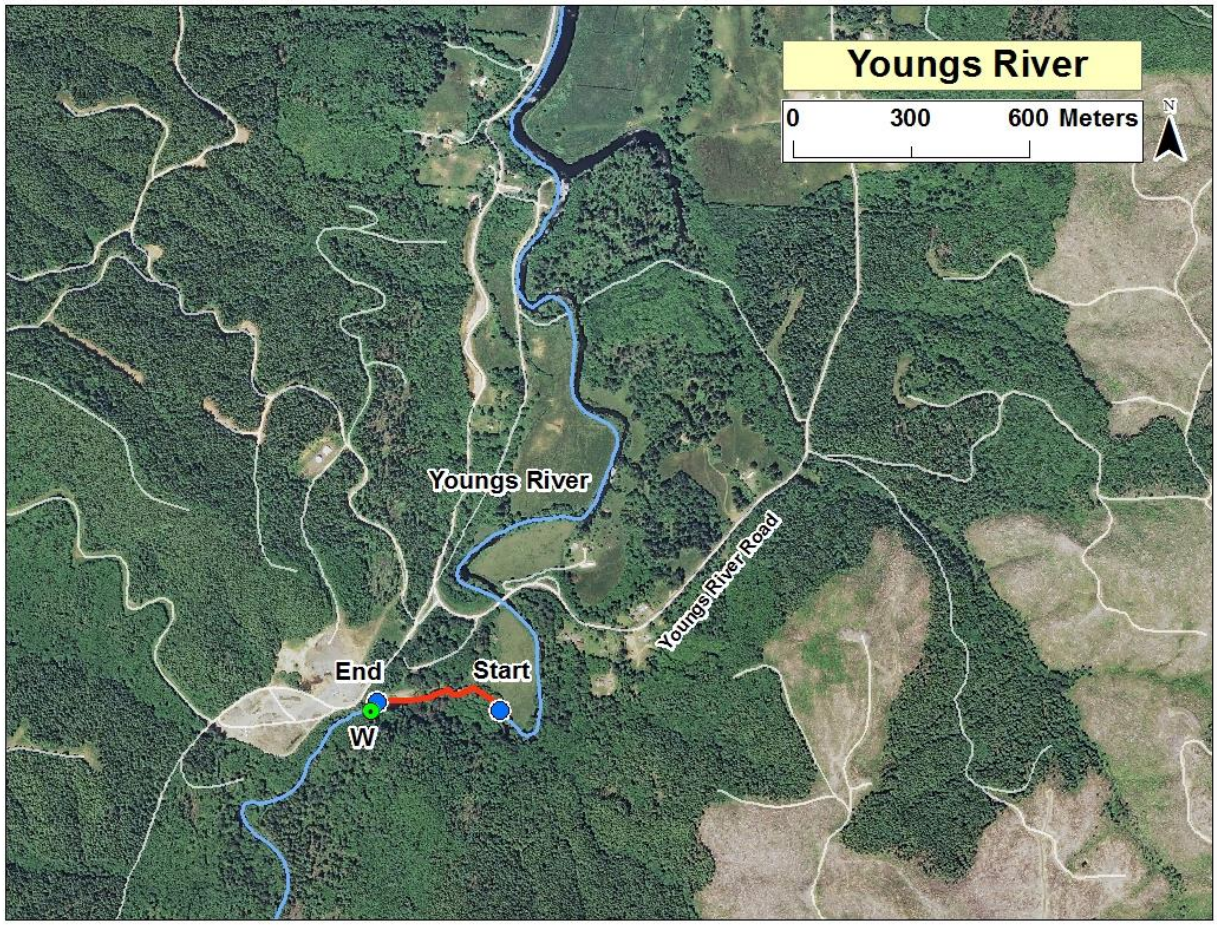

Figure 56. Map of reach (red line) surveyed on the Youngs River, located south of Astoria, OR, including start and end points (blue dots) and a waterfall (W).

Figure 57. Survey pictures on the Youngs River showing riparian vegetation consisting of a wide variety of species (panel A), a substrate patch located in a dry side channel (panel B), and the Youngs River Falls marking the upstream end of the reach (panel C).

RESULTS:

Suitable spawning substrate for Chum Salmon (4–128 mm, diameter), was observed throughout the Youngs River reach (Figure 57, panel B). Thirteen patches of suitable spawning substrate were found (Table 21; Figure 58), measuring a total of 328 m^2. Six of these patches were categorized as "high" quality, four patches were of "moderate" quality, and three patches were of "low" quality (Table 21; Figure 58). Ten of these patches consisted of ≥ 75% large gravel (12–45 mm diameter; Table 21). No cold-water patches were detected. The reach ended at Youngs River Falls, (height = 16.5 m; width = 13.7 m), which is a permanent barrier to Chum Salmon migration (Figure 56; Figure 57, panel C; Table 22).

Table 21. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in the Youngs River, located south of Astoria, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	1	12
high	0-10	25	75	0	0	0
high	0-10	0	100	0	5	30
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	1	6
moderate	11-20	0	100	0	3	178
low	11-20	0	75	25	1	32
low	11-20	0	50	50	2	70
low	11-20	0	25	75	0	0
low	11-20	0	0	100	0	0

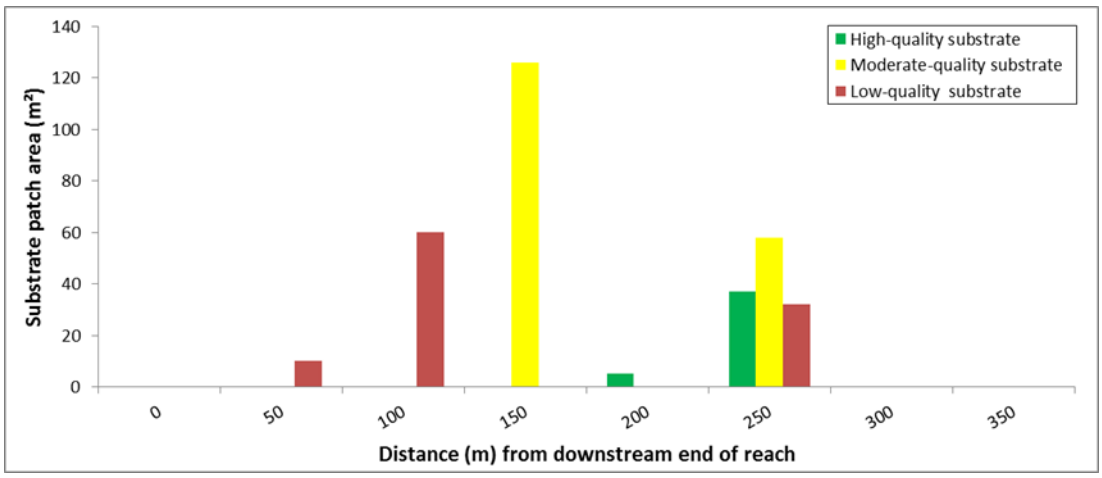

Figure 58. Location of substrate patches measured as distance from downstream end of survey in the Youngs River, south of Astoria, OR, in July 2014. For each category of substrate quality, patch area was summed and binned into 50 m units.

Table 22. List of barrier, type, barrier height, barrier width (across stream), barrier length (upstream and downstream), barrier gradient (% slope), and max pool depth downstream of the barriers in the Youngs River reach, south of Astoria, OR, in July 2014. ** indicates data not collected

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Waterfall	16	14	**	**

Big Creek Population

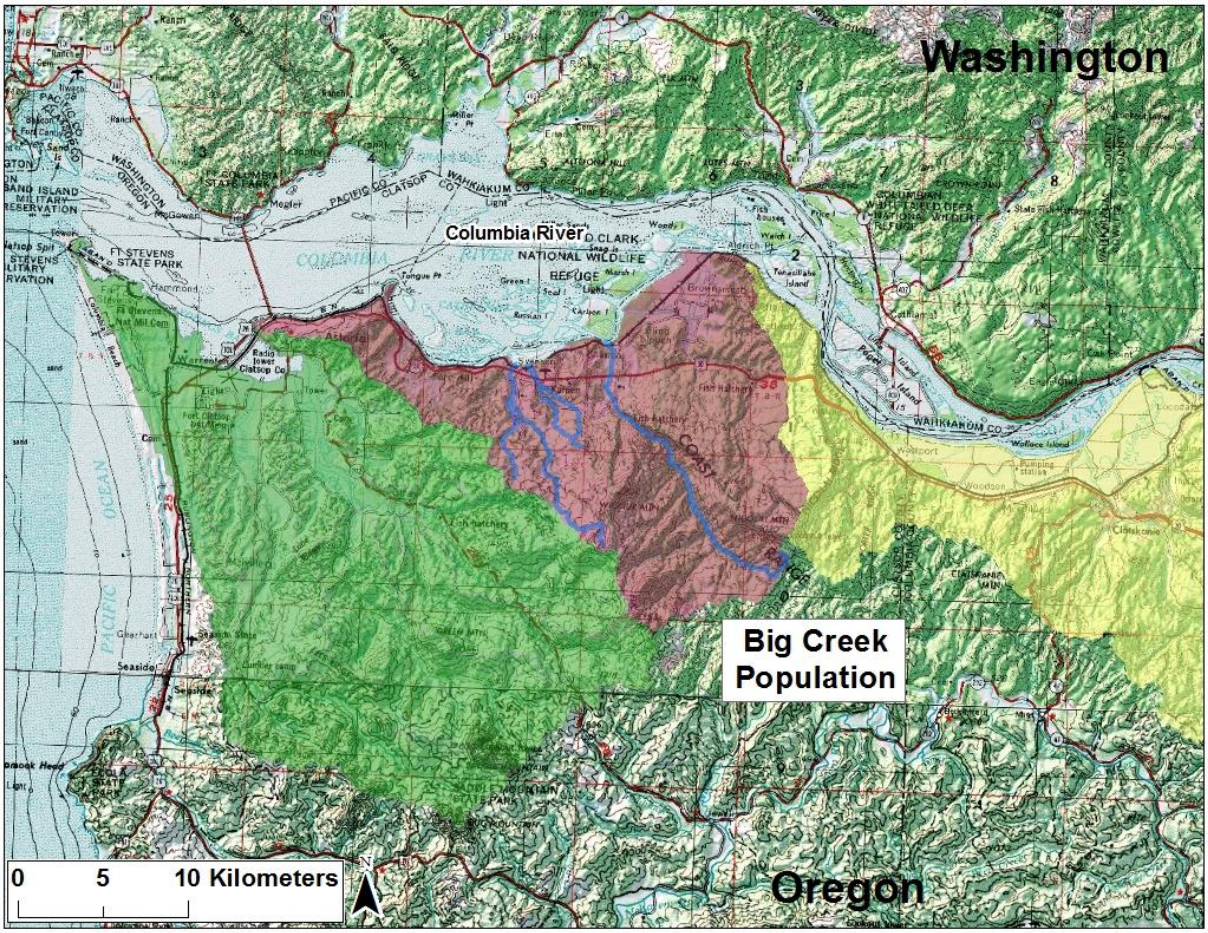

Figure 59. Map of Big Creek Chum Salmon population (magenta).

Bear Creek

SURVEY DATES: July 21 and August 7, 2014

SURVEY CREW: Brian Alfonse, John Cox, and Lorana McCalester

GENERAL DESCRIPTION:

The Bear Creek habitat survey (Township: 8N Range: 8W Section: 22D) started in tidewater 200 m downstream from Old Highway 30 and continued upstream 2.6 km upstream to the Svensen Market Road bridge. Two reaches were surveyed on Bear Creek and one reach was surveyed on Little Bear Creek, a small tributary to Bear Creek that enters Bear Creek from river left. (Figure 60).

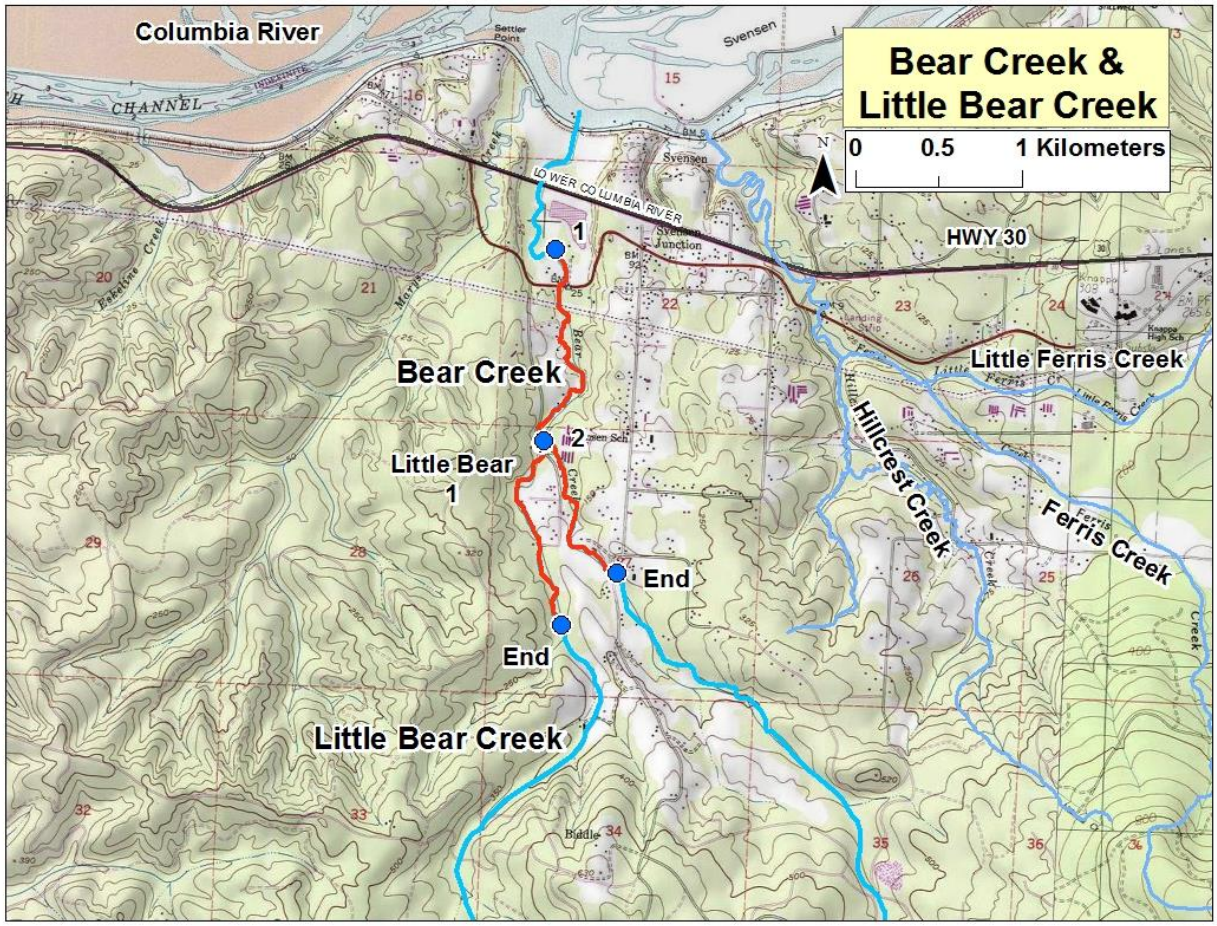

Figure 60. Map of reaches (red line) surveyed on Bear and Little Bear Creeks, located west of Svensen, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started 200 m downstream from Old Highway 30 (Lat: 46.164858, Long: -123.666908) and continued upstream to the confluence with Little Bear Creek (Lat: 46.154507, Long: -123.66721; Figure 61). The mainstem thalweg length of this reach was 1,516 m. There were six side channels with a combined thalweg length of 189 m, and the channel form included meanders. The riparian zone was sparsely vegetated with alders, and blackberry bushes (Figure 62, panel A). There is a large area of invasive knotweed spanning the river-left bank located in the downstream half of the reach (Figure 62, panel B). Land use in the surveyed portion of these creeks was rural residential. Numerous pieces of channel-spanning LWD were located throughout the reach (Figure 62, panel C). Directly upstream from Old Highway 30, large boulders were placed along the river-left bank to stabilize the stream bank (Figure 62, panel D).

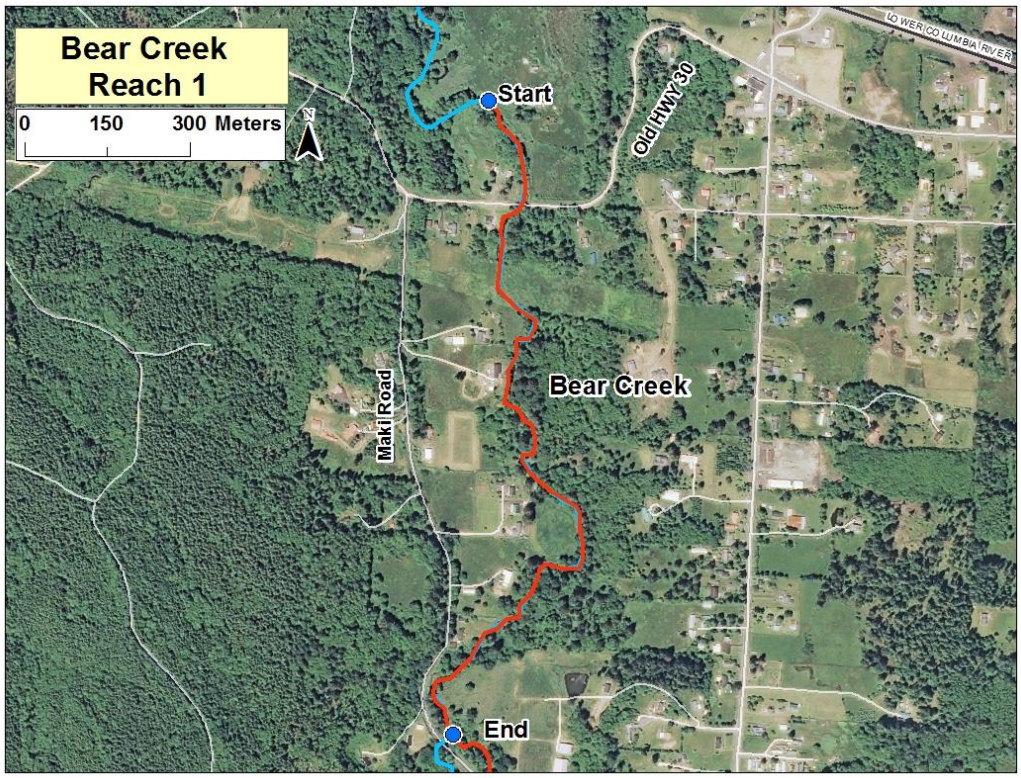

Figure 61. Map of reach 1 (red line) on Bear Creek, including start and end points (blue dots).

Figure 62. Survey pictures on reach 1 of Bear Creek showing a sparsely-vegetated riparian zone with alders and shrubs (panel A), a dense area of knotweed along the stream bank (panel B), a channel-spanning log jam (panel C), and large boulder rip rap (panel D).

RESULTS:

Five patches of suitable spawning substrate were found in Bear Creek reach 1 (Table 23; Figure 63), measuring a total of 16 m^2. None of these patches were categorized as "high" quality, one patch was of "moderate" quality, and four patches were of "low" quality (Table 23; Figure 63). These patches consisted of 11–20% fine sediment interspersed within the substrate (Table 23). There were 15 cold-water patches in this reach, totaling 189.3 m^2 (Figure 63). Average temperature in these patches was 15.6° C and average temperature adjacent to these patches was 16.6° C. The dominant substrate types within these cold-water patches were fine sediment (n = 5), large gravel (n = 1), and small cobble (n = 9). There were no potential barriers to Chum Salmon migration found in this reach.

Table 23. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 1 of Bear Creek, located west of Svensen, OR, in July 2014

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	1	4
low	11-20	0	75	25	0	0
low	11-20	0	50	50	1	4
low	11-20	0	25	75	1	4
low	11-20	0	0	100	2	4

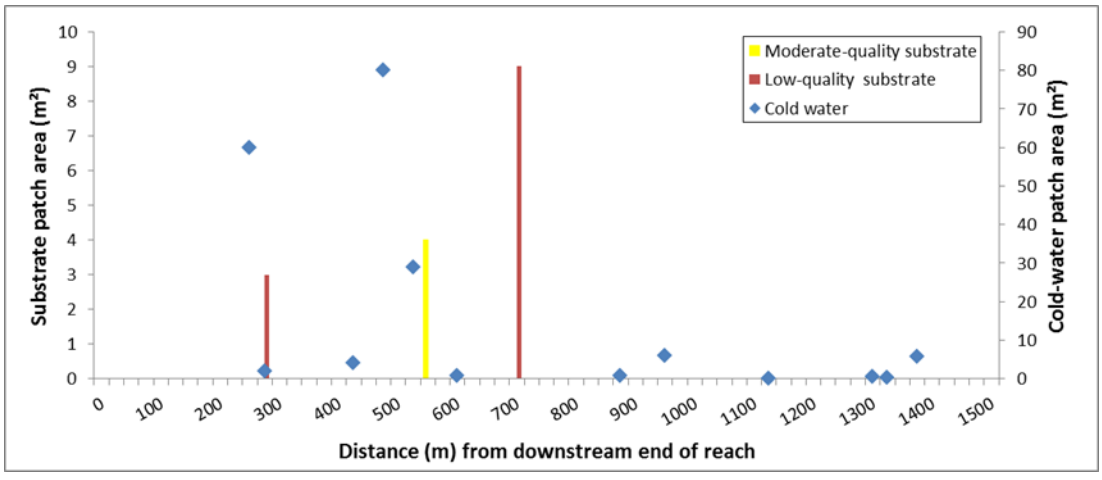

Figure 63. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 1 of Bear Creek, located west of Svensen, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 25 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 2

REACH DESCRIPTION:

Reach 2 started at the confluence with Little Bear Creek (Lat: 46.154507, Long: -123.66721; Figure 64; Figure 65, panel A) and continued upstream to the Svensen Market Road bridge (Lat: 46.147545, Long: -123.661214; Figure 64). The mainstem thalweg length of this reach was 1,112 m. There were four side channels with a combined thalweg length of 133 m. Channel form was unconfined, with multiple channels and meanders. The riparian vegetation varied throughout the reach with some areas of dense trees and other areas dominated by grass (Figure 65, panel B). A large patch of invasive knotweed was located on the river-right bank in the upstream half of the reach. Land use in the surveyed portion of these creeks was rural residential.

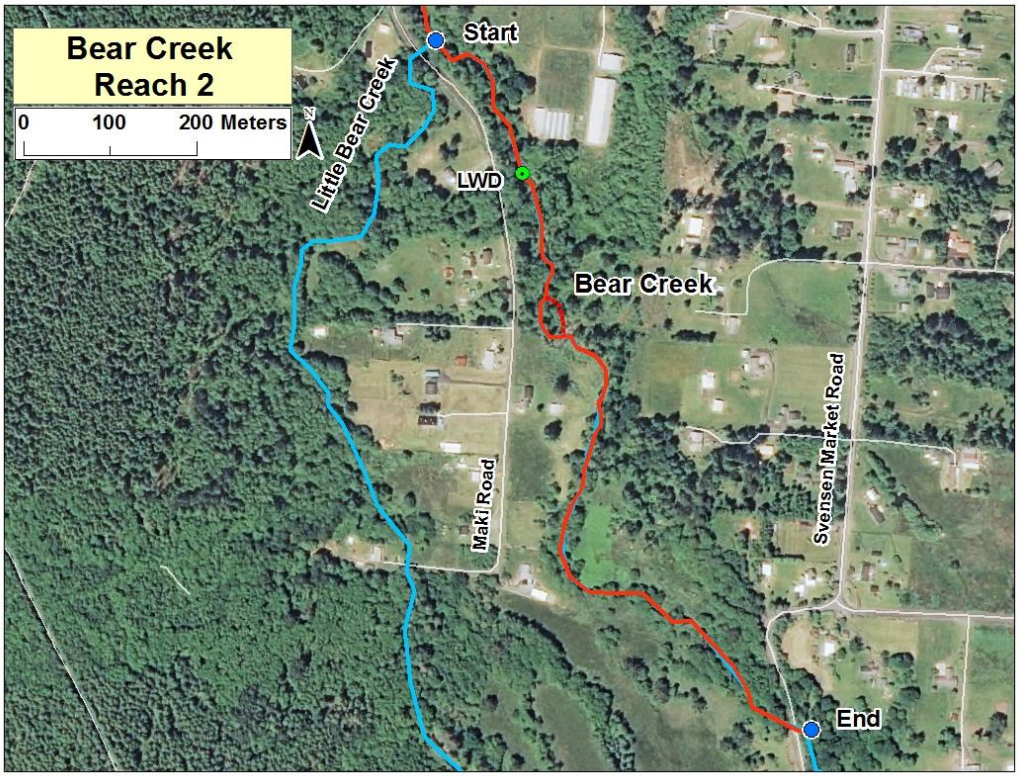

Figure 64. Map of reach 2 (red line) on Bear Creek, including start and end points (blue dots) and a log jam barrier (LWD).

Figure 65. Survey pictures on reach 2 of Bear Creek showing the confluence with Little Bear Creek at the downstream end of the reach (panel A), a riparian zone dominated by grass and including some trees (panel B), large cobble substrate (panel C), and a log jam (panel D).

RESULTS:

Thirteen patches of suitable spawning substrate were found in Bear Creek reach 2 (Table 24; Figure 66), measuring a total of 40 m². None of these patches were categorized as "high" quality, three patches were of "moderate" quality, and ten patches were of "low" quality (Table 24; Figure 66). Eleven of these patches contained ≥ 50% small cobble (46–128 mm, diameter; Table 24). The substrate in this reach was predominantly small and large cobble (45–256 mm, diameter; Figure 65, panel C). Six cold-water patches were detected, measuring a total of 17.5 m² (Figure 66). Average temperature in these patches was 14.2° C and average temperature adjacent to these patches was 16.3° C. The dominant substrate types within these cold-water patches were fine sediment (n = 2), small cobble (n = 1), large cobble (n = 2), and bedrock (n = 1). There was one potential barrier to Chum Salmon migration in this reach, classified as a channel-spanning log jam located in the downstream half of the reach (Figure 64; Table 25; Figure 65, panel D).

Table 24. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 2 of Bear Creek, west of Svensen, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	2	5
low	0-10	0	25	75	0	0
low	0-10	0	0	100	2	4
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	1	1
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	0	0
low	11-20	0	75	25	1	2
low	11-20	0	50	50	3	11
low	11-20	0	25	75	2	12
low	11-20	0	0	100	2	5

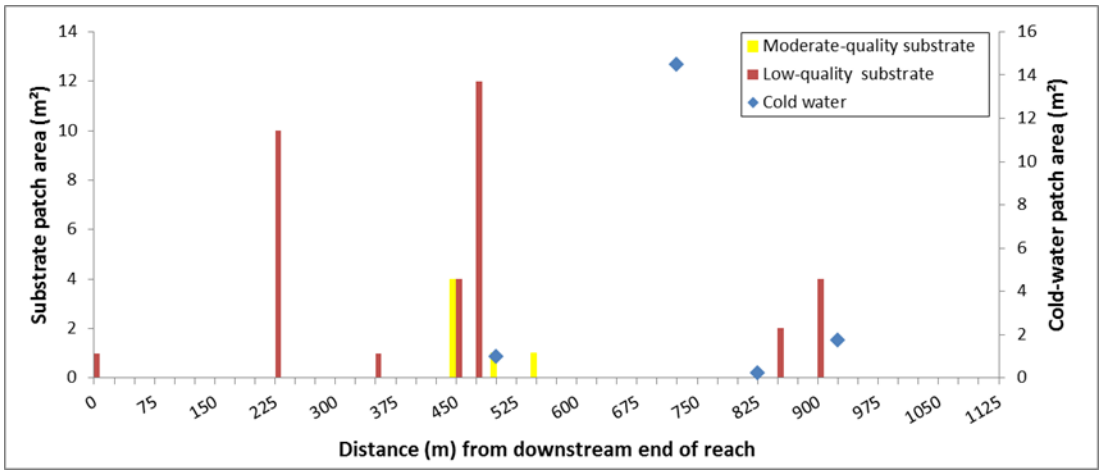

Figure 66. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 2 of Bear Creek, west of Svensen, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 25 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 25. Barrier type, barrier height, barrier width (across stream), barrier length (upstream and downstream), and max pool depth downstream of the barrier in reach 2 of Bear Creek, west of Svensen, OR, in July 2014.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Large woody debris	1.7	10	2	0.5

Little Bear Creek

SURVEY DATE: July 21, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, and John Cox

GENERAL DESCRIPTION:

The Little Bear Creek habitat survey (Township: 8N Range: 8W Section: 27D) started at the confluence with Bear Creek (Lat: 46.1544, Long: -123.66732; Figure 68, panel A), and continued upstream to a point in the middle of county tax lot 8N8W27C 1001 (Lat: 46.144471, Long: -123.665579); Figure 67). The mainstem thalweg length of this reach was 1,434 m. There were seven side channels with a combined thalweg length of 158 m. Channel form was unconfined, with multiple side channels and meanders. The riparian zone in the downstream half of the reach consisted of dense trees on the river-left bank and grassy vegetation on the river-right bank (Figure 68, panels B and C). In the upstream half of the reach, the riparian vegetation consisted of alders, shrubs, ferns, and firs (Figure 68, panel D). Land use in the surveyed portion of these creeks was rural residential. Large woody debris was abundant throughout the reach, but more so in the upstream half.

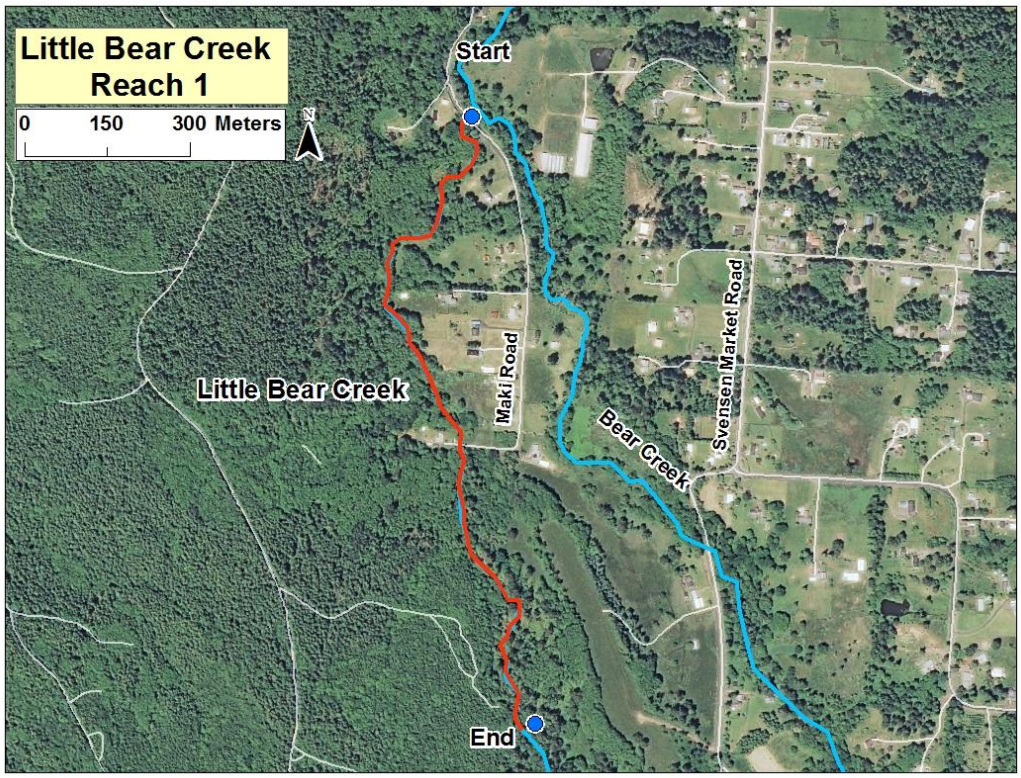

Figure 67. Map of reach 1 (red line) on Little Bear Creek, including start and end points (blue dots).

Figure 68. Survey pictures on reach 1 of Little Bear Creek showing the Maki Road bridge viewed from the downstream end of the survey (panel A), a field located in the downstream half of the reach (panel B), a grass-dominated riparian zone located adjacent to the residential road bridge (panel C), and a densely-vegetated riparian zone consisting of alders, shrubs, and ferns located in the upstream half of the reach (panel D).

RESULTS:

No suitable gravel patches were found in reach 1 of Little Bear Creek. Fourteen cold-water patches were detected, measuring a total of 16.1 m^2. Average temperature in these patches was 14.2° C and average temperature adjacent to these patches was 15.4° C. Due to a GPS unit malfunction, no location data is available for cold-water patches in this reach. The dominant substrate types within these cold-water patches were fine sediment (n = 4), large gravel (n = 3), small cobble (n = 6), and large cobble (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Big Creek

SURVEY DATES: July 8, July 9, July 15, July 30, 2014; August 4, August 6, August 12, August 20 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, John Cox, Regina Southworth, and Nick Baisley

GENERAL DESCRIPTION:

The Big Creek habitat survey (Township: 8N Range: 7W Section: 18B) started at tidewater 1.2 km upstream from the confluence with Knappa Slough. It continued upstream for 13.6 km to a spur road off Big Creek Mainline Road between Mud Creek and Coon Creek. Surveys were delineated into 8 reaches (Figure 69) based on physical features, landowner access, and overall distance. There were five named tributaries, all entering Big Creek from river left. Big Creek hatchery is located within reach 4 and operates two dams within this reach.

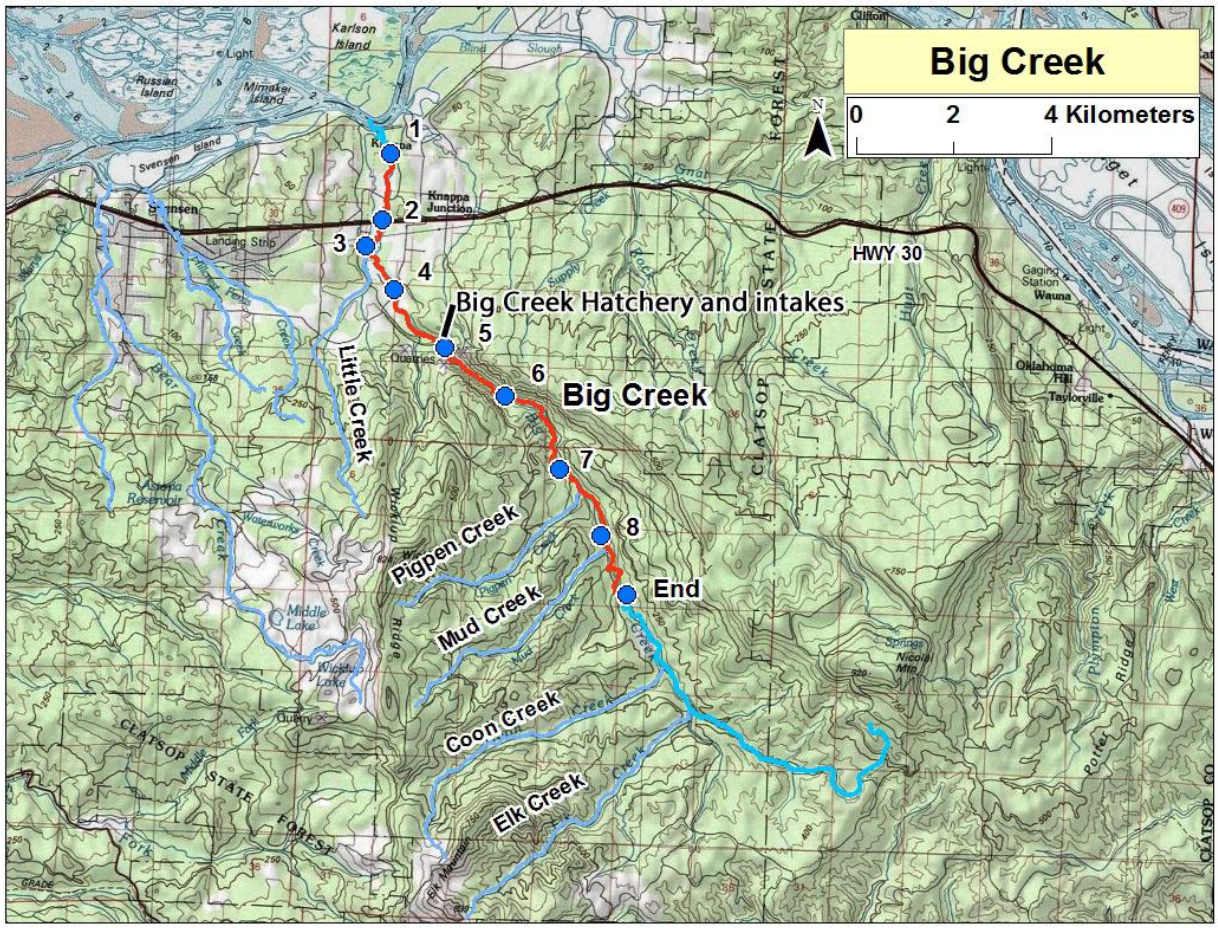

Figure 69. Map of reaches (red line) surveyed on Big Creek, located south of Knappa, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started at tidewater 1.2 km upstream from the confluence with Knappa Slough (Lat: 46.179847, Long: -123.590885) and continued upstream to the Old Highway 30 Road bridge (Lat: 46.167321, Long: -123.592351; Figure 70). The mainstem thalweg length of this reach was 1,555 m. There were three side channels with a combined thalweg length of 285 m. Channel form was unconfined with multiple channels and meanders. Riparian vegetation was sparse with almost the entire length of the river-left bank consisting of a single row of young alders (Figure 71, panel A). Land use was a mix of rural residential and agriculture. A long side channel with isolated pools was observed in the section upstream from Old Highway 30 (Figure 71, panel C).

Figure 70. Map of reach 1 (red line) on Big Creek, including start and end points (blue dots).

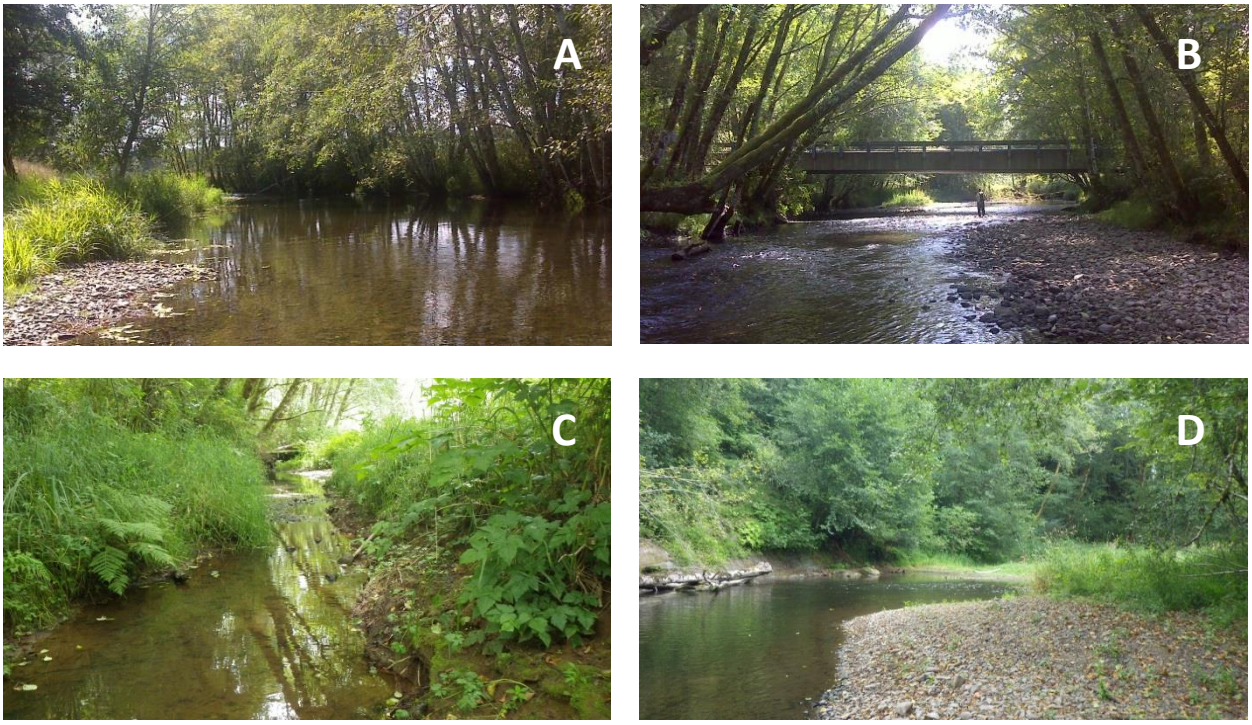

Figure 71. Survey pictures on reach 1 of Big Creek showing a thin strip of alders along the river-left bank (panel A), the Old Highway 30 bridge (panel B), a side channel with isolated pools located upstream of the Old Highway 30 bridge (panel C), and a sharp bend in the stream with a deep pool (panel D).

RESULTS:

Seven patches of suitable spawning substrate were found in Big Creek reach 1 (Table 26; Figure 72), measuring a total of 136 m². None of these patches were categorized as "high" quality, one patch was of "moderate" quality, and six patches were of "low" quality (Table 26; Figure 72). All patches consisted of 11–20% fine sediment interspersed within the substrate (Table 26). Downstream of Old Highway 30 (Figure 71, panel B), there were large amounts of substrate in the size range suitable for Chum Salmon spawning (4–128 mm, diameter); however, because fine sediment levels were > 20% little suitable spawning habitat was identified in this section. Upstream of Old Highway 30, fine sediment was less common, substrate was larger, and fewer suitable patches were identified. Six cold-water patches were detected, totaling 182.3 m² (Figure 72). Average temperature in these patches was 13.9° C and average temperature adjacent to the patch was 15.6° C. The dominant substrate types within these cold-water patches were fine sediment (n = 3), large gravel (n = 1), and small cobble (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 26. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 1 of Big Creek, south of Knappa, OR, in August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	1	12
low	11-20	0	75	25	0	0
low	11-20	0	50	50	2	39
low	11-20	0	25	75	2	57
low	11-20	0	0	100	2	28

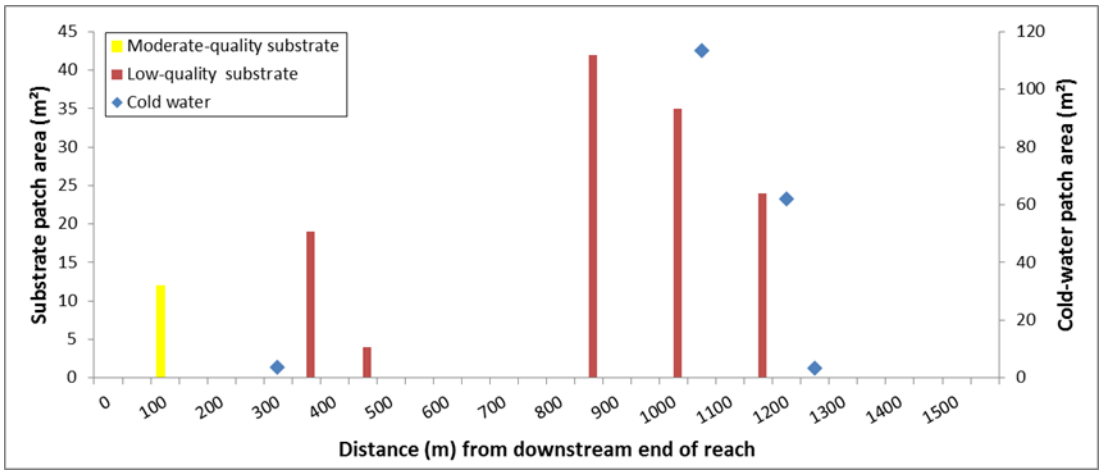

Figure 72. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 1 of Big Creek, south of Knappa, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches

REACH 2

REACH DESCRIPTION:

Reach 2 started at the Old Highway 30 bridge (Lat: 46.167321, Long: -123.592351) and ended at the confluence with Little Creek (Lat: 46.16267, Long: -123.596573; Figure 73; Figure 74, panel A). The mainstem thalweg length of this reach was 759 m. There were six side channels with a combined thalweg length of 277 m. Channel form was unconfined with multiple channels and meanders. In one very long side channel, crews surveyed 130 m before encountering heavy brush, which prevent any further surveying. Riparian vegetation was limited in the downstream half of the reach especially on the river-left bank (Figure 74, panel B); however, in the upstream half the riparian zone consisted of more alders and maples. Land use was a mix of rural residential and agriculture. The creek flowed through a county park near the middle of this reach. Power lines crossed the creek at this park and there was limited vegetation under the lines. Adjacent to the side channel, there was a large log jam with a deep pool on the downstream end and substantial gravel accumulation on the upstream end (Figure 74, panel C).

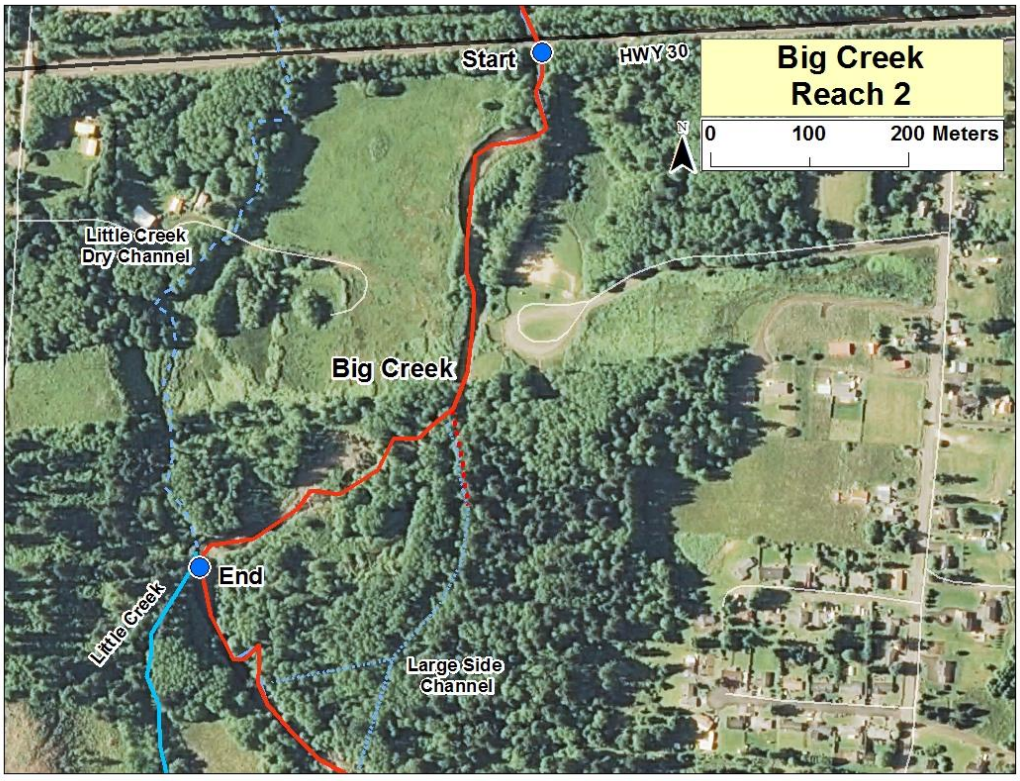

Figure 73. Map of reach 2 (red line) on Big Creek, including start and end points (blue dots).

Figure 74. Survey pictures on reach 2 of Big Creek showing the confluence with Little Creek (panel A), an eroded stream bank with with no trees in the riparian zone (panel B), and a log jam located in the upstream half of the reach (panel C).

RESULTS:

Three patches of suitable spawning substrate were found in Big Creek reach 2 (Table 27; Figure 75), measuring a total of 90 m². None of these patches were categorized as "high" quality, two patches were of "moderate" quality, and one patch was of "low" quality (Table 27; Figure 75). These patches consisted of ≥ 75% large gravel (12–45 mm diameter; Table 27). Four cold-water patches were detected, totaling 11.3 m² (Figure 75). Average temperature in these patches was 14.6° C and average temperature adjacent to these patches was 15.7° C. The dominant substrate type within these cold-water patches was fine sediment (< 4 mm diameter). There were no potential barriers to Chum Salmon migration in this reach.

Table 27. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 2 of Big Creek, south of Knappa, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	2	84
low	11-20	0	75	25	1	6
low	11-20	0	50	50	0	0
low	11-20	0	25	75	0	0
low	11-20	0	0	100	0	0

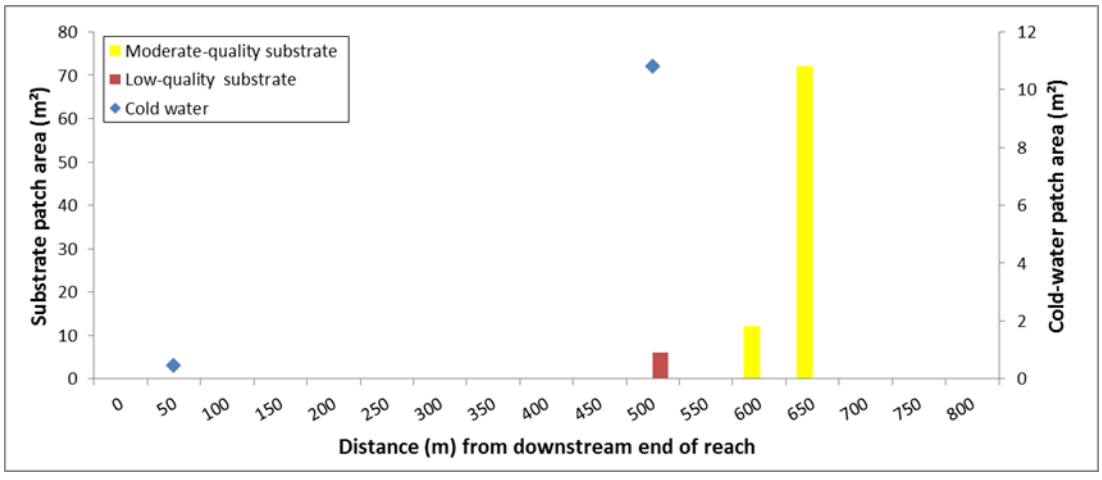

Figure 75. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 2 of Big Creek, south of Knappa, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 3

REACH DESCRIPTION:

Reach 3 started at the confluence with Little Creek (Lat: 46.16267, Long: -123.596573) and continued upstream to the Hillcrest Loop Road bridge (Lat: 46.154726, Long: -123.588493; Figure 76). The mainstem thalweg length of this reach was 1,200 m. There were four side channels with a combined thalweg length of 195 m. Channel form was unconfined with multiple channels and meanders. The riparian zone was more densely vegetated on the river-right bank than on the river-left and this vegetation was dominated by alders (Figure 77, panel A). Land use was a mix of rural residential and agriculture.

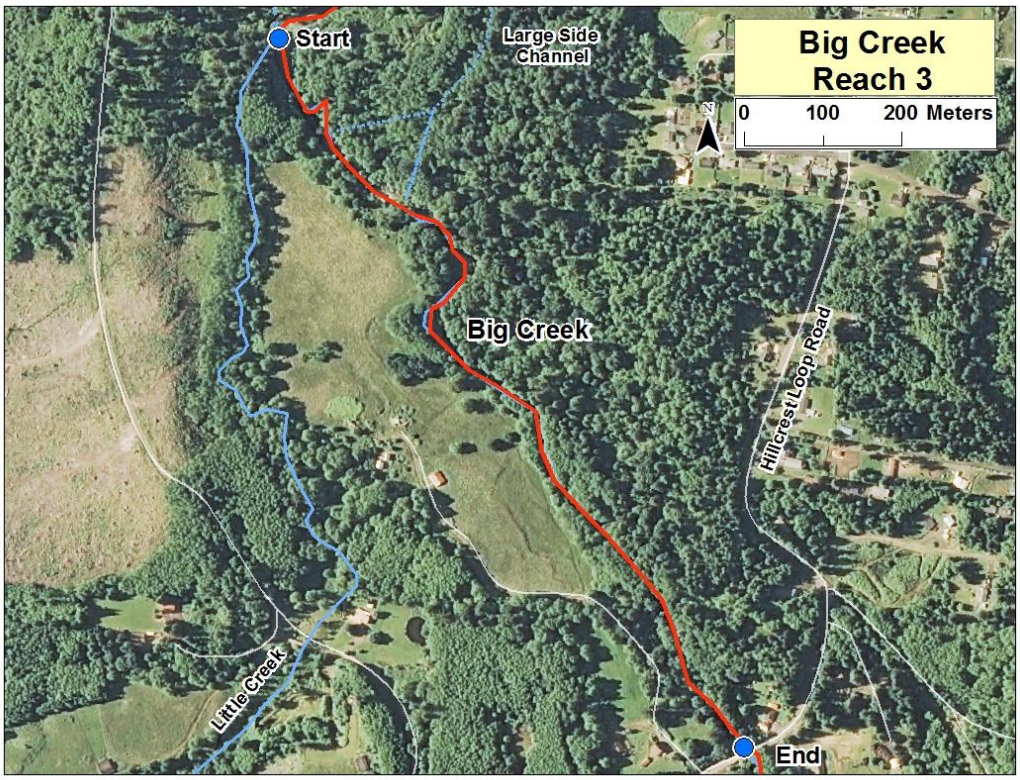

Figure 76. Map of reach 3 (red line) on Big Creek, including start and end points (blue dots).

Figure 77. Survey pictures on reach 3 of Big Creek showing an alder-dominated riparian zone (panel A), and small and large cobble substrate throughout the stream channel (panel B).

RESULTS:

Substrate in this reach was predominantly small and large cobble (46–256 mm, diameter; Figure 77, panel B). Sixteen patches of suitable spawning substrate were found in Big Creek reach 3 (Table 28; Figure 78), measuring a total of 76 m². None of these patches were categorized as "high" quality, four patches were of "moderate" quality, and 12 patches were of "low" quality (Table 28; Figure 78). Four cold-water patches were detected, totaling 17.3 m² (Figure 78). Average temperature in these patches was 14.5° C and average temperature adjacent to these patches was 15.6° C. The dominant substrate types within these cold-water patches were small cobble (n = 2), large cobble (n = 1), and bedrock (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

Table 28. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 3 of Big Creek, south of Knappa, OR, in August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	1	3
moderate	11-20	0	100	0	3	10
low	11-20	0	75	25	4	26
low	11-20	0	50	50	3	15
low	11-20	0	25	75	3	12
low	11-20	0	0	100	2	10

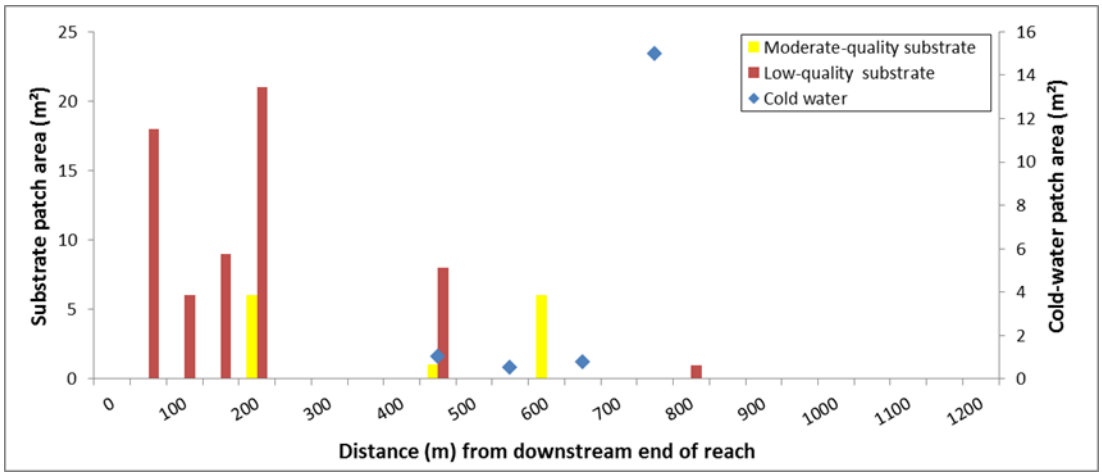

Figure 78. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 3 of Big Creek, south of Knappa, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 4

REACH DESCRIPTION:

Reach 4 started at the Hillcrest Loop Road bridge (Lat: 46.154726, Long: -123.588493) and continued upstream to the Big Creek Hatchery intake dam (Lat: 46.144431, Long: -123.574323; Figure 79, Figure 80, panel D). The mainstem thalweg length of this reach was 1,830 m. There were four side channels with a combined thalweg length of 189 m. Channel form was unconfined with multiple channels and meanders. Riparian vegetation was dense and dominated by alders (Figure 80, panel A). Land use was a mix of rural residential and agriculture.

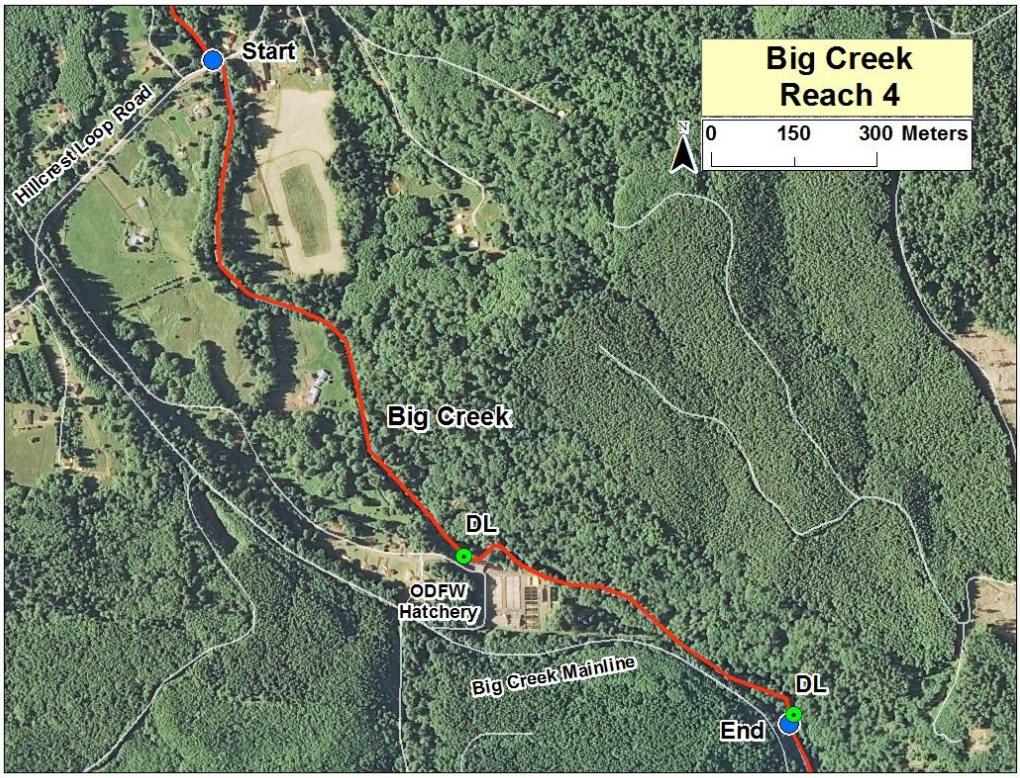

Figure 79. Map of reach 4 (red line) on Big Creek, including start and end points (blue dots) and two dams with fish ladders (DL).

Figure 80. Survey pictures on reach 4 of Big Creek showing an alder-dominated riparian zone (panel A), large cobble and boulder-sized substrate (panel B), the dam at Big Creek Hatchery (panel C), and the dam at the intake for Big Creek Hatchery (panel D).

RESULTS:

Substrate in this reach consisted of large cobbles (129–256 mm, diameter) and boulders, with few substrate patches suitable for Chum Salmon spawning (Figure 80, panel B). Two patches of suitable spawning substrate were found in Big Creek reach 4 (Table 29; Figure 81), measuring a total of 4 m^2. One patch was of "moderate" quality, and one patch was of "low" quality (Table 29; Figure 81 Figure). Four cold-water patches were detected, totaling 132.0 m^2 (Figure 81). Average water temperature in these patches was 12.1° C and average temperature adjacent to these patches was 14.3° C. The dominant substrate types within these cold-water patches were large gravel (n = 1), small cobble (n = 1), and large cobble (n = 2). There were two potential barriers to Chum Salmon migration in this reach (Figure 79; Table 30). The first barrier encountered was a dam with a fish ladder located at Big Creek Hatchery (Table 30; Figure 80, panel C). The second barrier was another dam with a fish ladder located at the Big Creek Hatchery water intake (Table 30, Figure 80, panel D).

Table 29. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 4 of Big Creek, south of Knappa, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	1	1
low	11-20	0	75	25	1	3
low	11-20	0	50	50	0	0
low	11-20	0	25	75	0	0
low	11-20	0	0	100	0	0

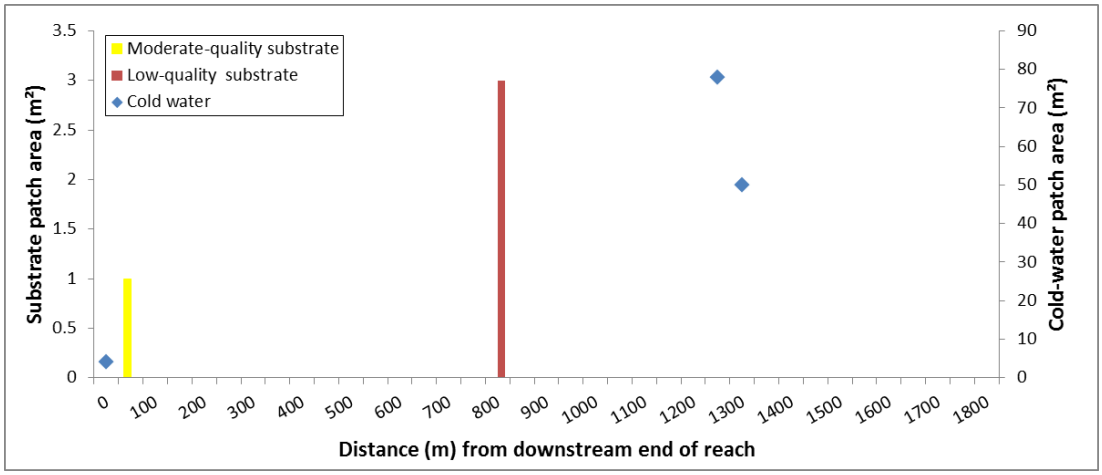

Figure 81. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 4 of Big Creek, south of Knappa, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 30. List of barriers, types, barrier heights, barrier widths (across stream), barrier lengths (upstream and downstream), and max pool depths downstream of the barrier in reach 4 of Big Creek, south of Knappa, OR, in July 2014.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Dam with ladder	1.2	38	3	3
2	Dam with ladder	2	27	2	1

REACH 5

REACH DESCRIPTION:

Reach 5 started at the Big Creek Hatchery intake dam (Lat: 46.144431, Long: -123.574323) and continued upstream to the first Big Creek Mainline Road bridge (Lat: 46.135739, Long: -123.558077; Figure 82). The mainstem thalweg length of this reach was 1,729 m. There were three side channels with a combined thalweg length of 111 m. Riparian vegetation was dense along both banks, consisting of alder and fir trees (Figure 83, panel A). Land use was primarily influenced by timber harvest. Throughout most of this reach the stream flowed through a confined canyon with limited meanders (Figure 83, panel B).

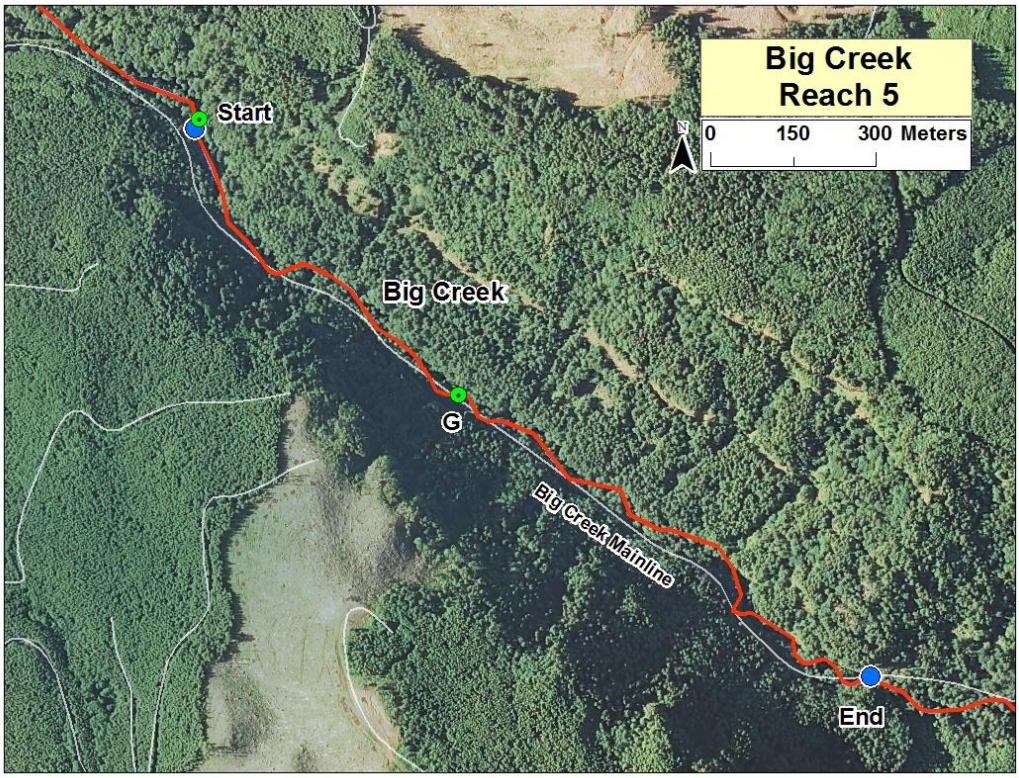

Figure 82. Map of reach 5 (red line) on Big Creek, including start and end points (blue dots) and one high gradient barrier (G).

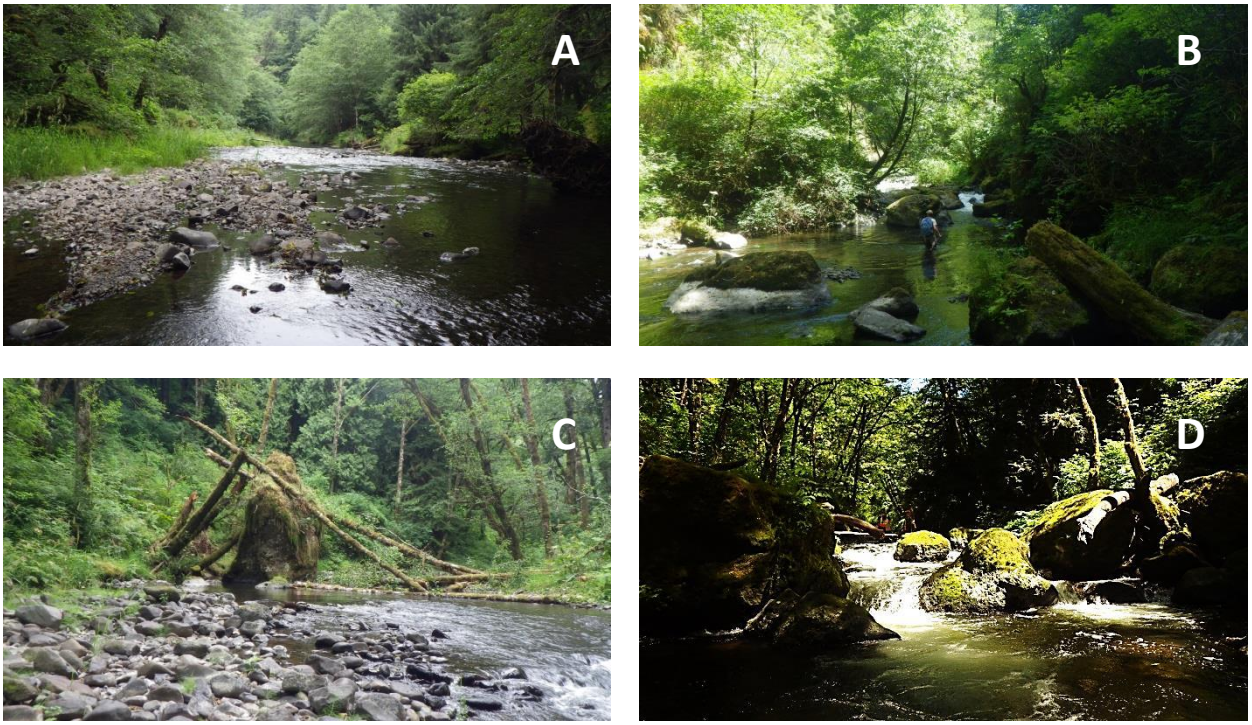

Figure 83. Survey pictures on reach 5 of Big Creek showing dense riparian vegetation consisting of alders, fir, maple, and cedars (panel A), the creek flowing through a canyon section (panel B), large cobble substrate (foreground) and a large boulder (background; panel C) and increased gradient where the stream cascades over large boulders (panel D).

RESULTS:

The substrate in this reach was primarily large cobble (129–256 mm, diameter) and boulders (Figure 83, panel C). Thirty-six patches of suitable spawning substrate that met established criteria were found in Big Creek reach 5 (Table 31; Figure 84), measuring a total of 195 m². Suitable Chum Salmon spawning substrate patches were commonly associated with large boulders (>2 m diameter). None of these patches were categorized as "high" quality, 16 patches were of "moderate" quality, and 20 patches were of "low" quality (Table 31; Figure 84). Thirty-one cold-water patches totaling 265.8 m² were observed (Figure 84). Average water temperature in these patches was 10.9° C and average temperature adjacent to these patches was 14.3° C. Several of the observed cold-water patches were seeps cascading down from the top of canyons walls. The dominant substrate types within these cold-water patches were fine sediment (n = 7), large gravel (n = 4), small cobble (n = 5), large cobble (n = 1), and boulder (n = 14). There was one potential barrier to Chum Salmon migration, classified as a gradient barrier with a calculated % slope of 20% (Figure 82; Table 32; Figure 83, panel D).

Table 31. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 5 of Big Creek, south of Knappa, OR, in July and August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	2	16
moderate	0-10	0	50	50	3	10
low	0-10	0	25	75	0	0
low	0-10	0	0	100	1	2
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	4	14
moderate	11-20	0	100	0	7	38
low	11-20	0	75	25	5	41
low	11-20	0	50	50	7	27
low	11-20	0	25	75	3	22
low	11-20	0	0	100	4	25

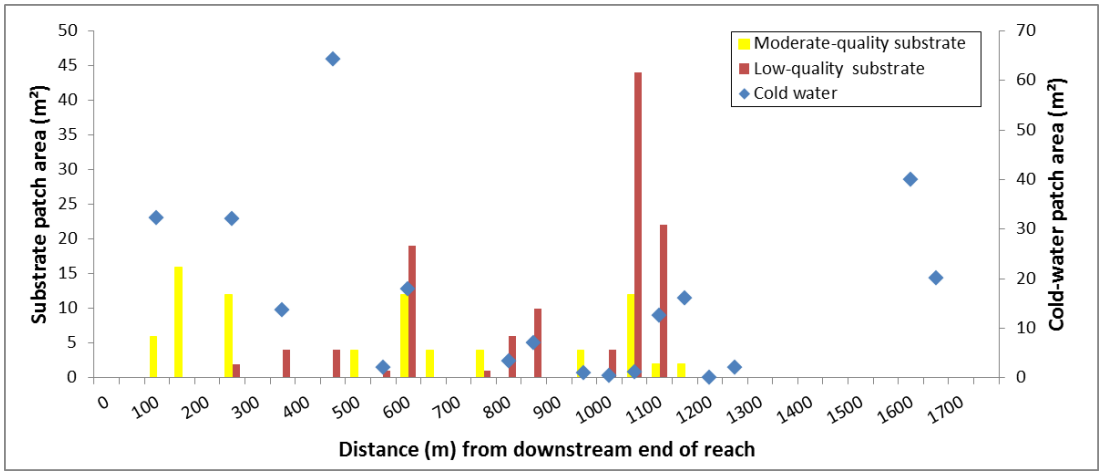

Figure 84. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 5 of Big Creek, south of Knappa, OR, in July and August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 32. Barrier types, heights, widths (across stream), lengths (upstream and downstream), gradient (% slope), and max pool depths downstream of the barrier in reach 5 of Big Creek, south of Knappa, OR, in July and August 2014. Calculated % slope for gradient barrier was 20%

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Dam with ladder	2	27	2	1
2	Gradient	3	15	15	1.5

REACH 6

REACH DESCRIPTION:

Reach 6 started at the first Big Creek Mainline Road bridge (Lat: 46.135739, Long: -123.558077) and continued upstream to the second Big Creek Mainline Road bridge (Lat: 46.122441, Long: -123.542942; Figure 85). The mainstem thalweg length of this reach was 2,478 m. There were two side channels with a combined thalweg length of 195 m. Channel form varied within the survey between confined and unconfined with meanders throughout. The riparian zone was densely vegetated with alders and firs (Figure 86, panel A). Land use was primarily influenced by timber harvest. The lower end of this reach was in a canyon with large boulders along the stream channel (Figure 86, panel B); however, upstream from this canyon the river flowed through an open valley (Figure 86, panel C).

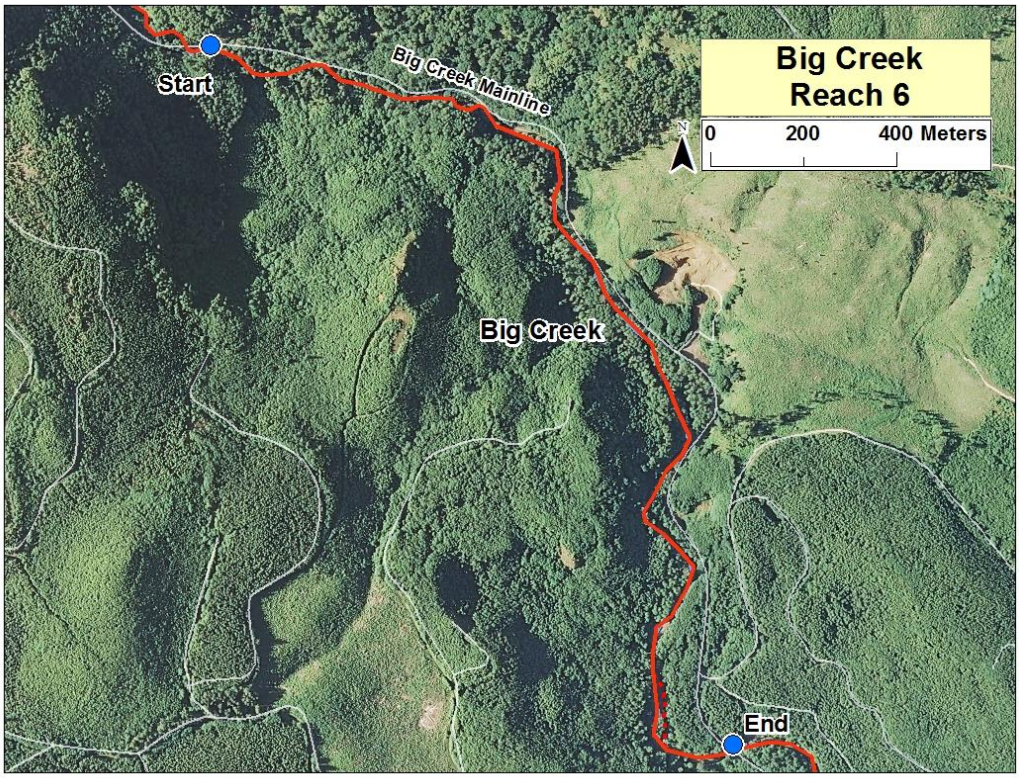

Figure 85. Map of reach 6 (red line) on Big Creek, including start and end points (blue dots).

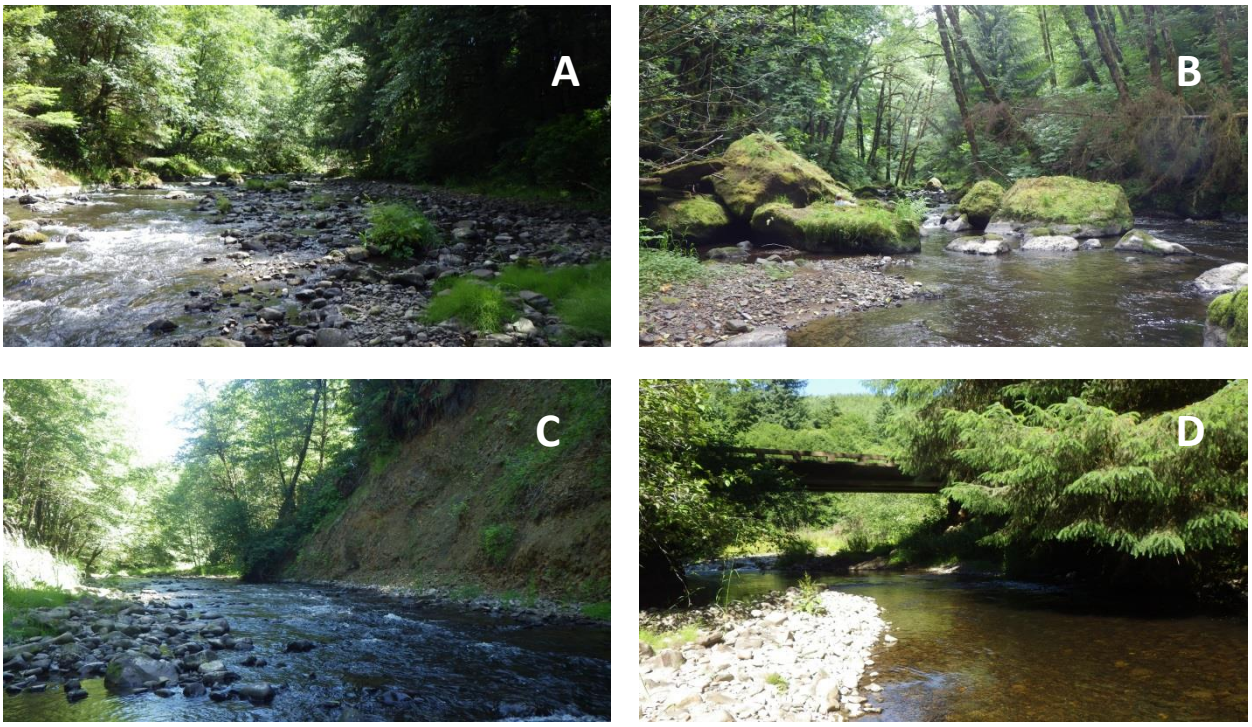

Figure 86. Survey pictures on reach 6 of Big Creek showing dense riparian vegetation consisting of alders and firs (panel A), large boulders (> 2 m) in a canyon section in the downstream quarter of the reach (panel B), tapered canyon walls leading to an open valley upstream (panel C), and the second Big Creek Mainline bridge marking the upstream end of the reach (panel D).

RESULTS:

Substrate in size classes suitable for Chum Salmon (4–128 mm, diameter) was more common in the upper section than in the lower canyon section; however, levels of fine sediment were elevated and few patches of suitable spawning substrate were identified. Three patches of suitable spawning substrate that met established criteria were found in Big Creek reach 6 (Table 33; Figure 87), measuring a total of 7 m². These patches were categorized "low" quality (Table 33; Figure 87). Nineteen cold-water patches were detected, totaling 429.7 m² (Figure 87). Average temperature in these patches was 12.0° C and average temperature adjacent to these patches was 15.1° C. The dominant substrate types within these cold-water patches were fine sediment (n = 1), large gravel (n = 2), small cobble (n = 6), large cobble (n = 5), and bedrock (n = 5). There were no potential barriers to Chum Salmon migration in this reach.

Table 33. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 6 of Big Creek, south of Knappa, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	0	0
low	11-20	0	75	25	0	0
low	11-20	0	50	50	0	0
low	11-20	0	25	75	2	3
low	11-20	0	0	100	1	4

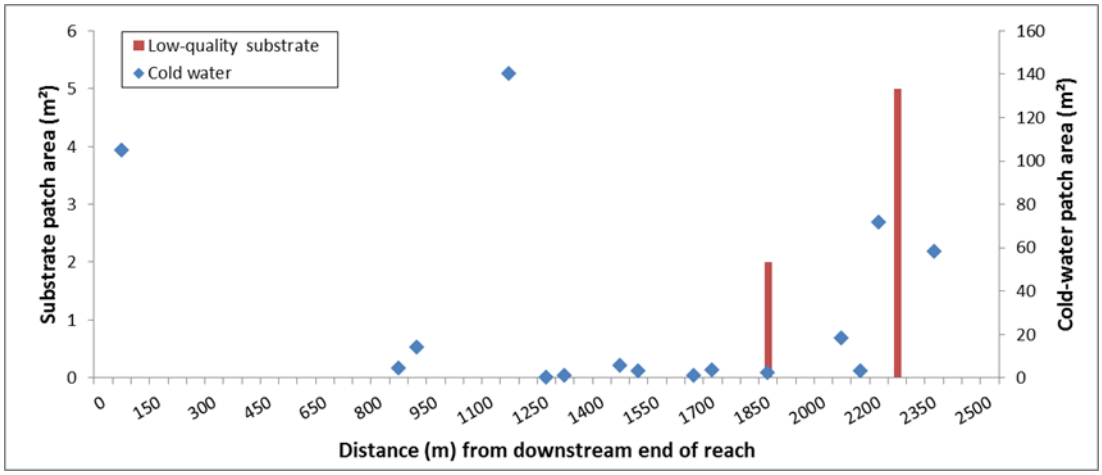

Figure 87. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 6 of Big Creek, south of Knappa, OR, in July 2014. For cold water and for low-quality substrate, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 7

REACH DESCRIPTION:

Reach 7 started at the second Big Creek Mainline Road bridge (Lat: 46.122441, Long: -123.542942) and continued upstream to a point 500 m downstream from the Mud Creek confluence (Lat: 46.110636, Long: -123.531063; Figure 88). The mainstem thalweg length of this reach was 1,950 m. There were five side channels with a combined thalweg length of 371 m. The riparian zone was densely vegetated with alders and firs (Figure 89, panel A). Land use was primarily influenced by timber harvest and mature timber. The channel was constrained throughout the entire extent of the reach by a steep hillside on the river-right bank, however meanders were observed (Figure 89, panel B). The confluence of a small side channel and the main stem occurred near the downstream end of the reach, and a spring flowed into this side channel (Figure 89, panel C). Pigpen Creek flowed into this reach from river left.

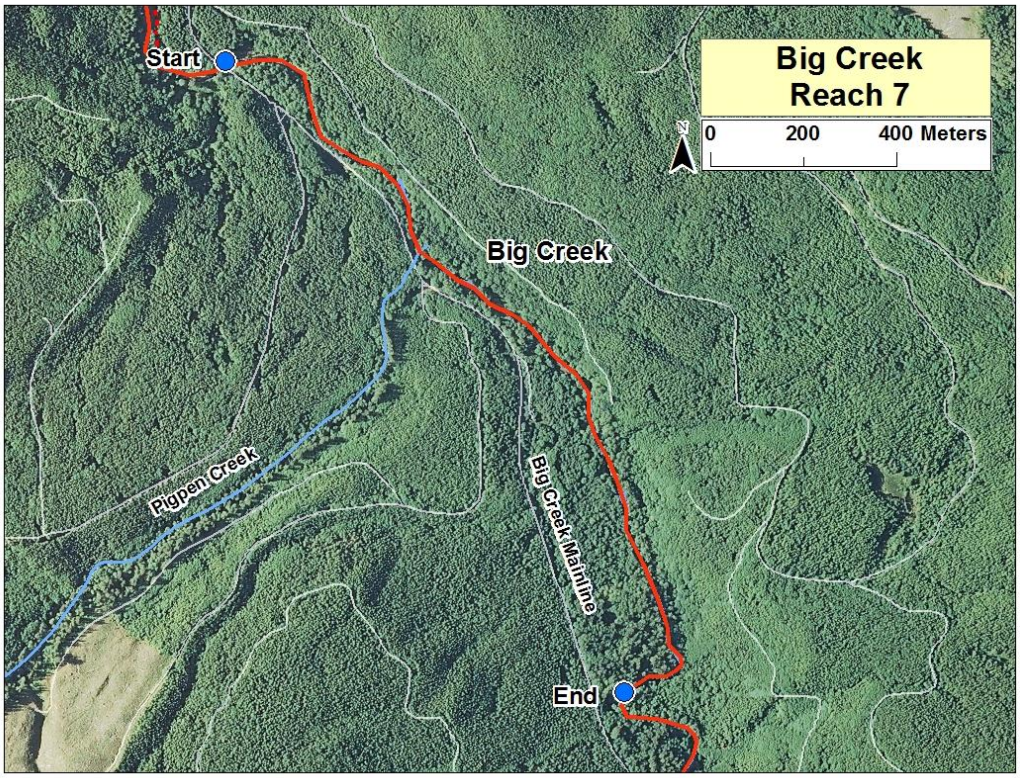

Figure 88. Map of reach 7 (red line) on Big Creek, including start and end points (blue dots).

Figure 89. Survey pictures on reach 7 of Big Creek showing a dense riparian zone consisting of alders and firs (panel A), a hill slope constraining the stream on the river-right bank (panel B), and a side channel (panel C).

RESULTS:

Eight patches of suitable spawning substrate were found in Big Creek reach 7 (Table 34; Figure 90), measuring a total of 89 m². None of these patches were categorized as "high" quality, three patches were of "moderate" quality, and five patches were of "low" quality (Table 34; Figure 90). Ten cold-water patches were detected, totaling 132.8 m² (Figure 90). Average temperature in these patches was 12.8° C and average temperature adjacent to these patches was 15.0° C. The dominant substrate types within these cold-water patches were fine sediment (n = 3), large gravel (n = 1), small cobble (n = 2), large cobble (n = 2), and bedrock (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 34. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 7 of Big Creek, south of Knappa, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	0	0
low	0-10	0	25	75	0	0
low	0-10	0	0	100	1	3
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	1	2
moderate	11-20	0	100	0	2	26
low	11-20	0	75	25	0	0
low	11-20	0	50	50	0	0
low	11-20	0	25	75	1	3
low	11-20	0	0	100	3	55

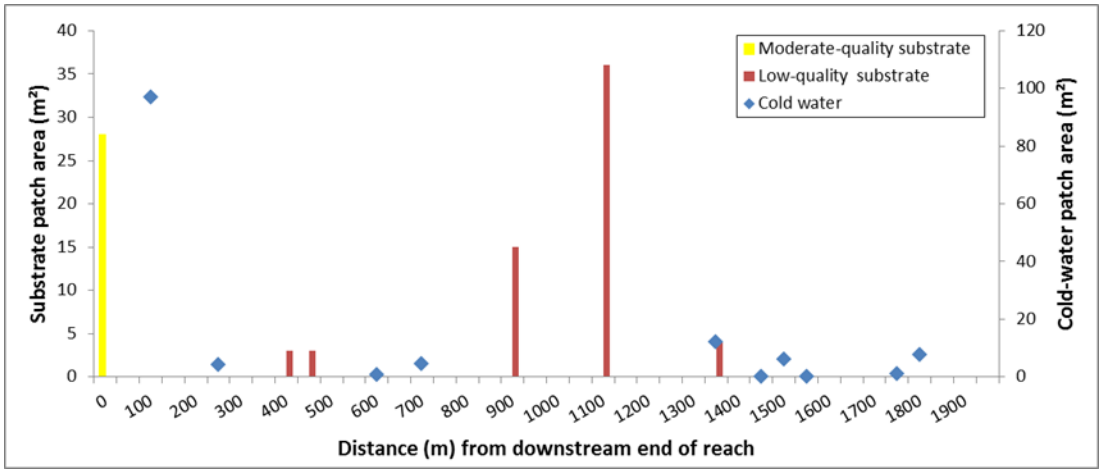

Figure 90. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 7 of Big Creek, south of Knappa, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 8

REACH DESCRIPTION:

Reach 8 started at a point in the stream 500 m downstream from the Mud Creek confluence (Lat: 46.110636, Long: -123.531063) and continued to a spur road off Big Creek Mainline Rd between Mud Creek and Coon Creek (Lat: 46.09979, Long: -123.52355; Figure 91). The mainstem thalweg length of this reach was 2,061 m. There were five side channels with a combined thalweg length of 202 m. Channel form was confined, but with multiple channels and meanders. The riparian zone was densely vegetated with alders, firs, cedars, and hemlocks (Figure 92, panel A), with several small areas of invasive knotweed were also present. Land use was primarily influenced by timber harvest. The stream channel meandered between steep bedrock cliffs that extended into the stream channel (Figure 92, panel B). Many of the side channels in this reach were short (< 100 m) with log jams at the upstream end of them (Figure 92, panel C). Several suitable substrate patches in this reach were on dry gravel bars within the active channel margin (Figure 92, panel D).

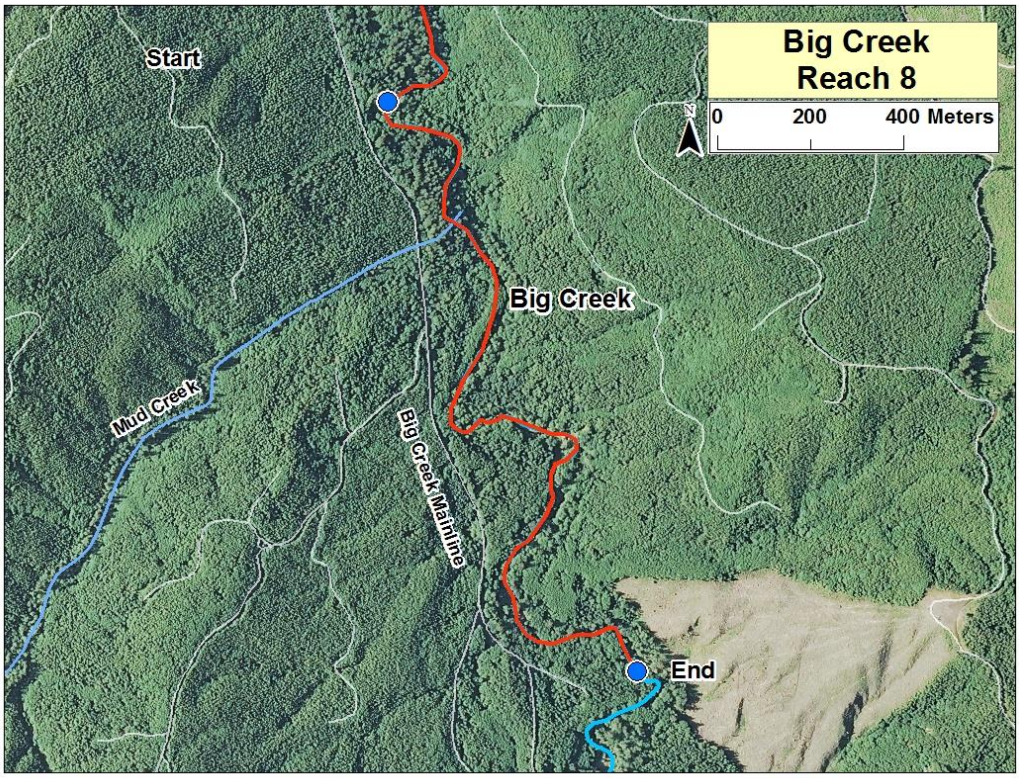

Figure 91. Map of reach 8 (red line) on Big Creek, including start and end points (blue dots).

Figure 92. Survey pictures on reach 8 of Big Creek showing a densely-vegetated riparian zone comprised of alder, fir, cedar, hemlock, and spruce (panel A), a bedrock shelf at a bend in the creek (panel B), a side channel (< 100 m) with large woody debris (panel C), and a substrate patch on a gravel bar (panel D).

RESULTS:

Forty-two patches of suitable spawning substrate were found in Big Creek reach 8 (Table 35; Figure 93), measuring a total of 483 m². None were categorized as "high" quality, seven patches were of "moderate" quality, and 35 patches were of "low" quality (Table 35; Figure 93). Thirty-three of these patches contained ≥ 50% small cobble (46–128 mm, diameter; Table 35). Eighteen cold-water patches were detected, totaling 217.4 m² (Figure 93). Average temperature in these patches was 13.5° C and average temperature adjacent to these patches was 15.2° C. The dominant substrate types within these cold-water patches were fine sediment (n = 1), small gravel (n = 1), large gravel (n = 2), small cobble (n = 3), large cobble (n = 5), and boulder (n = 6). There were no potential barriers to Chum Salmon migration in this reach.

Table 35. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 8 of Big Creek, south of Knappa, OR, in July 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	0	0
moderate	0-10	0	50	50	3	21
low	0-10	0	25	75	3	65
low	0-10	0	0	100	4	39
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	4	10
low	11-20	0	75	25	5	38
low	11-20	0	50	50	14	189
low	11-20	0	25	75	8	113
low	11-20	0	0	100	1	8

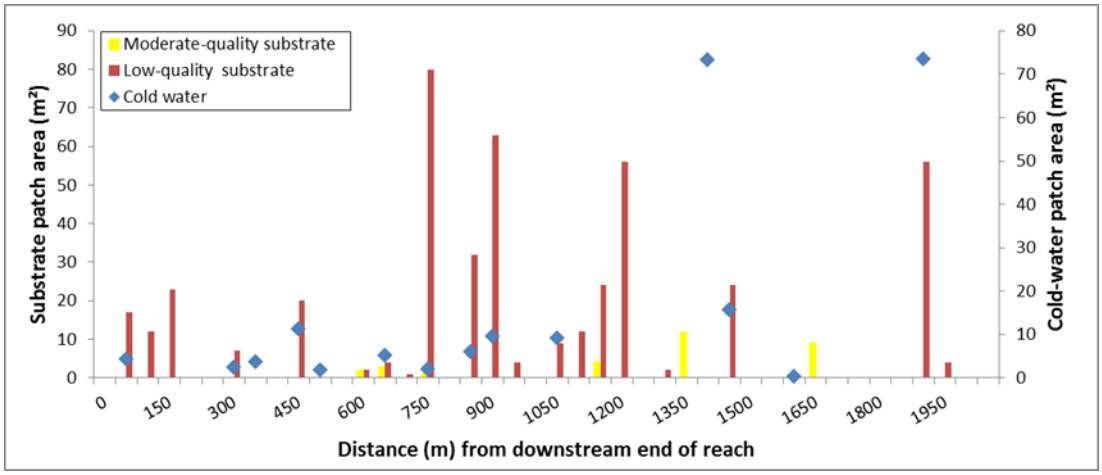

Figure 93. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 8 of Big Creek, south of Knappa, OR, in July 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Ferris Creek

SURVEY DATES: August 7 and August 12, 2014

SURVEY CREW: Brian Alfonse, Lorana McCalester, and John Cox

GENERAL DESCRIPTION:

The Ferris Creek habitat survey (Township: 8N Range: 8W Section: 23D; Figure 94) started at the confluence of Ferris Creek and Hillcrest Creek and continued upstream to a small beaver dam parallel to the end of Schoolhouse Road. One reach was surveyed in Ferris Creek and one was surveyed in Little Ferris Creek. Between these surveys, 1 km of stream could not be surveyed because of a landowner denial. Land use surrounding surveyed reaches was agricultural and residential.

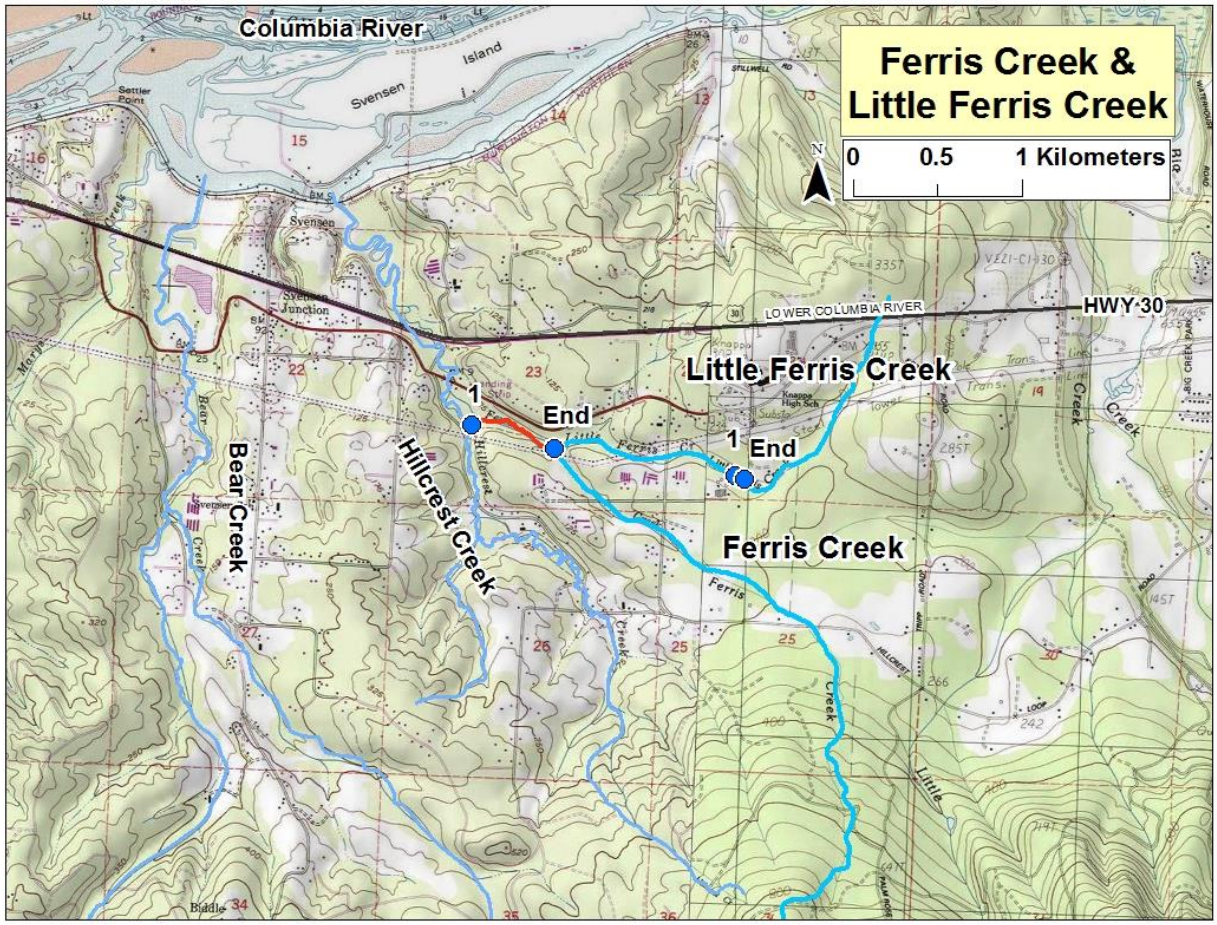

Figure 94. Map of reaches (red line) surveyed on Ferris and Little Ferris Creeks, located southeast of Svensen, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started at the confluence with Hillcrest Creek (Lat: 46.159605, Long: -123.644241) and continued upstream to the confluence with Little Ferris Creek (Lat: 46.158483, Long: -123.637848; Figure 95). The mainstem thalweg length of this reach was 550 m, including one side channel with a thalweg length of 16 m and multiple meanders. The riparian zone throughout the reach was densely vegetated with alders, shrubs, and ferns (Figure 96, panel A). Land use was a mix of light grazing and rural residential. In the upstream portion of the reach, a power line crossed the creek and vegetation in this section consisted of grass and blackberry bushes (Figure 96, panel B). Stream temperature increased several degrees between the lower, shaded section and the upper section underneath the power lines. There was one side channel in the middle of the reach and it was adjacent to a small log jam (Figure 96, panel C).

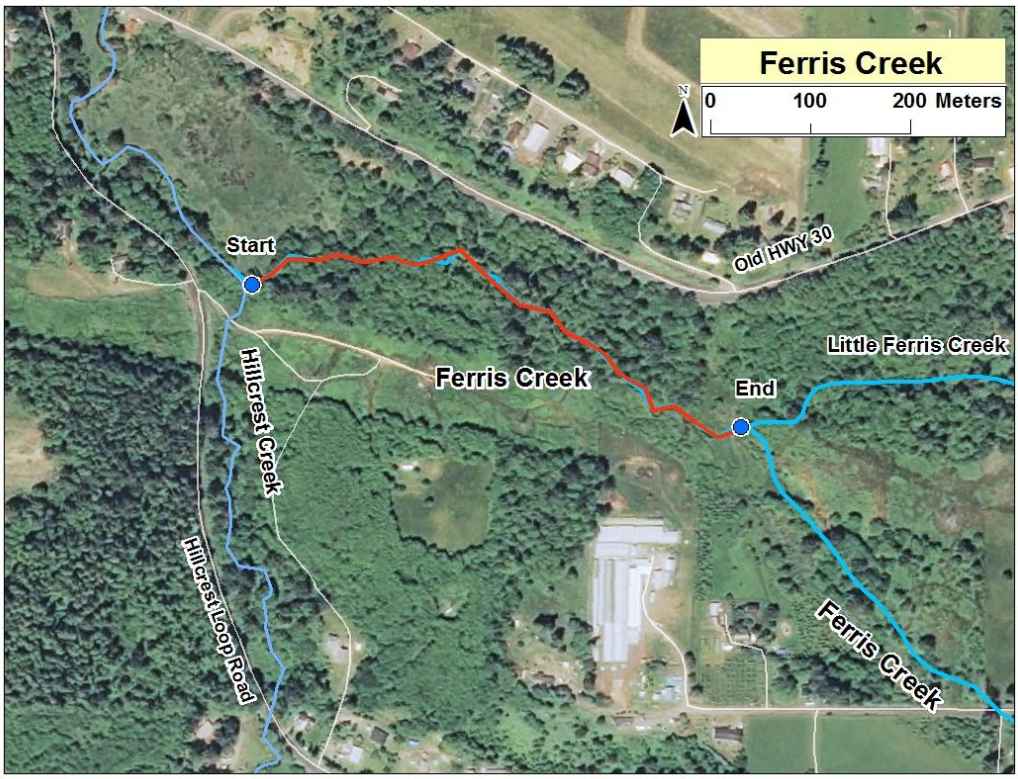

Figure 95. Map of reach 1 (red line) on Ferris Creek, including start and end points (blue dots).

Figure 96. Survey pictures on reach 1 of Ferris Creek showing dense riparian vegetation consisting of alders, shrubs, and ferns (panel A), a section of stream at the upstream end of the reach where power lines cross the creek and the riparian vegetation is dominated by grass (panel B), and a short side channel next to a log jam (panel C).

RESULTS:

Substrate consisted of small cobble (46–128 mm, diameter) and fine sediment (< 4 mm diameter), with fine sediment being the more dominant. Two patches of suitable spawning substrate that met established criteria were found in reach 1 of Ferris Creek (Figure 97), measuring a total of 7 m² in surface area. Both patches were categorized as "low" quality and consisted of 50% large gravel (12–45 mm, diameter) and 50% small cobble (46–128 mm, diameter; Figure 97). Nine cold-water patches were detected, totaling 42.2 m² (Figure 97). Average temperature in the patch was 15.2° C, and average temperature adjacent to the patch was 17.0° C. The dominant substrate types within these cold-water patches were fine sediment (n = 4), small gravel (n = 1), small cobble (n = 3), and large cobble (n = 1). There were no potential barriers to Chum Salmon migration in this reach.

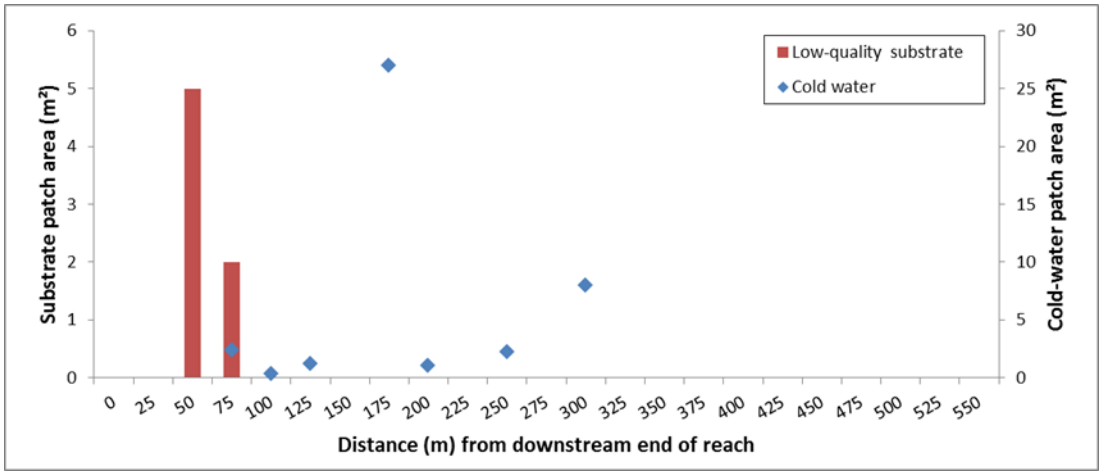

Figure 97. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 1 of Ferris Creek, southeast of Svensen, OR, in August 2014. For cold water and for low-quality substrate, patch area was summed and binned into 50 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Little Ferris Creek

REACH DESCRIPTION:

The reach on Little Ferris Creek started at the end of Schoolhouse Road (Lat: 46.15744900, Long: -123.62401000) and ended 75 m upstream at a small beaver dam (Lat: 46.15725700, Long: -123.62320200; Figure 98; Figure 99, panel A); Mainstem thalweg length was 75 m, and there were no side channels. The stream flowed through a low gradient area that appeared to be regularly inundated. The riparian vegetation consisted of large firs, spruces, and cedars, with land use being determined as rural residential and young timber. The creek was stagnant, with numerous pieces of small woody debris and a silt laden streambed (Figure 99, panel B).

Elk scat and hoof prints were observed in and around the stream, and a live beaver was observed upstream from the surveyed reach.

Figure 98. Map of reach 1 (red line) on Little Ferris Creek, including start and end points (blue dots) and a beaver dam (BD).

Figure 99. Survey pictures on Little Ferris Creek showing a beaver dam barrier marking the upstream end of the reach (panel A) and a stagnant channel with fine sediment (panel B).

RESULTS:

No suitable gravel patches minimum criteria were observed in Little Ferris Creek. No cold-water patches that were ≥ 0.5° C colder than the main channel water temperature were observed. There were no potential barriers to Chum Salmon migration, though a Beaver Dam with a height of 0.9 m was noted at the upstream end of the survey reach (Figure 99 panel A).

Hillcrest Creek

SURVEY DATES: July 21, August 5, and August 12, 2014

SURVEY CREW: Brian Alfonse, John Cox, and Lorana McCalester

GENERAL DESCRIPTION:

The Hillcrest Creek habitat survey (Township: 8N Range: 8W Section: 23D) started at a culvert under a small farm road 450 m upstream from the Old Highway 30 bridge and ended 2.3 km upstream at a point 300 m upstream from the third Hillcrest Loop Road bridge. Approximately 150 m of this section was not surveyed due a landowner denial between reach 1 and 2. Surveys on Hillcrest Creek were delineated into three reaches: two mainstem reaches and one tributary reach (Figure 100).

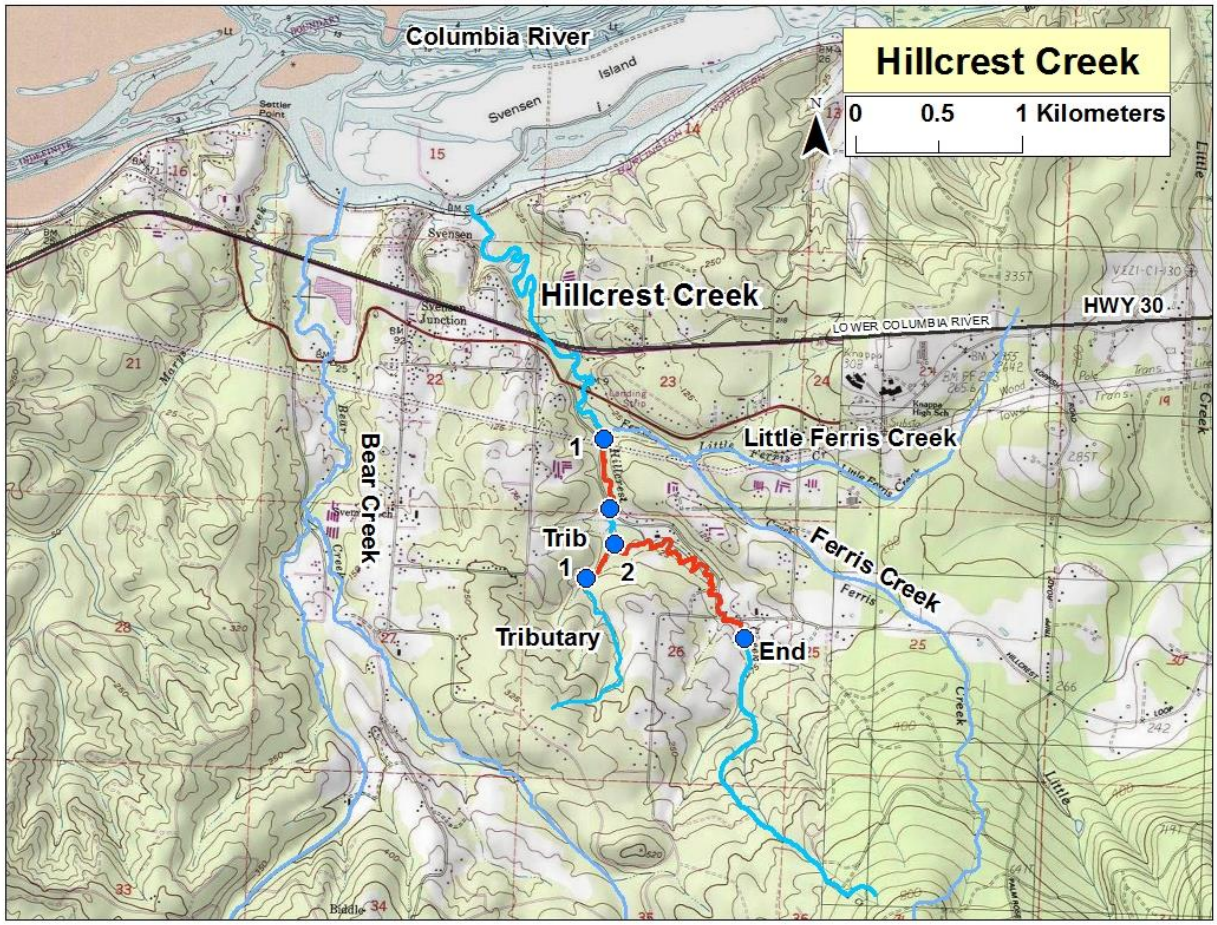

Figure 100. Map of reaches (red line) surveyed on Hillcrest Creek, located southeast of Knappa, OR. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started at a culvert under a small farm road 450 m upstream from the Old Highway 30 bridge (Lat: 46.15873, Long: -123.644642) and ended 150 m upstream from the first Hillcrest Loop Road bridge (Lat: 46.155549, Long: -123.643871; Figure 101). The mainstem thalweg length of this reach was 436 m, and there were no side channels and few meanders. The riparian zone was densely vegetated with shrubs, grass, ferns, and several large fir trees (Figure 102, panel A). Land use was rural residential and young timber.

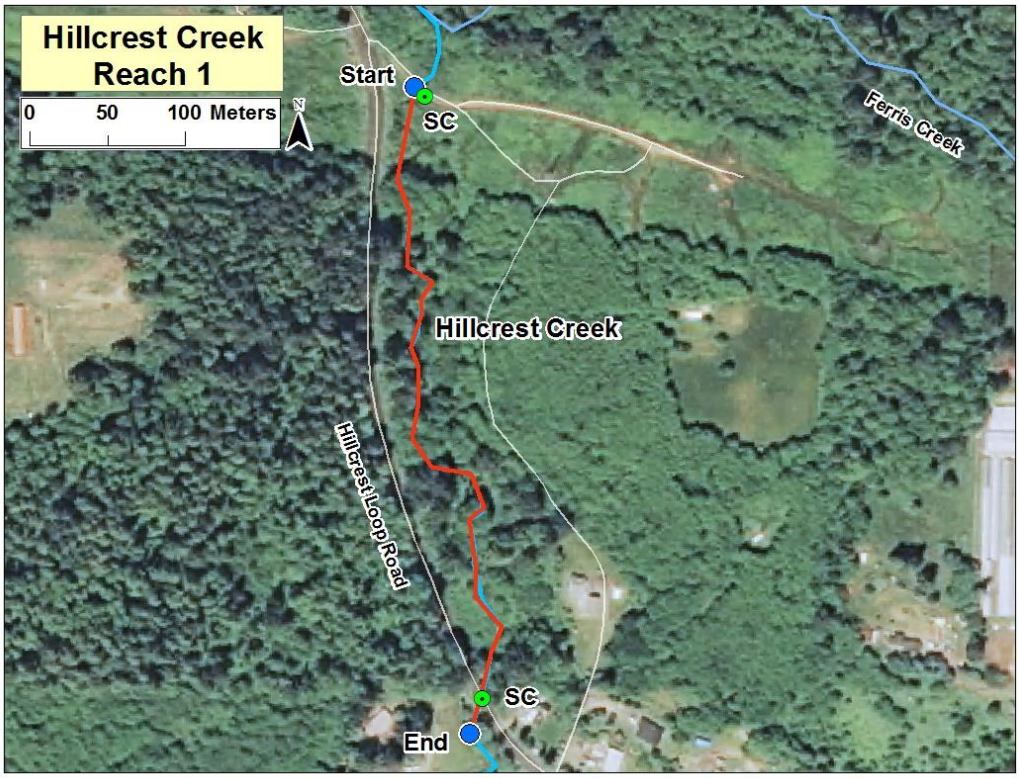

Figure 101. Map of reach 1 (red line) on Hillcrest Creek, including start and end points (blue dots) and two semicircular culverts (SC).

Figure 102. Survey pictures on reach 1 of Hillcrest Creek showing dense riparian vegetation consisting of shrubs, grass, ferns and sparse trees (panel A), the streambed filled with mud and silt (panel B), and a semicircular culvert located near the upstream end of the reach (panel C).

RESULTS:

Stream channel consisted of mud, silt (< 4 mm diameter) and a small amount of gravel-sized substrate (4–45 mm, diameter; Figure 102, panel B). No gravel patches that met established minimum criteria were found in reach 1 of Hillcrest Creek. Two cold-water patches were detected, with a combined surface area of 4.9 m² Average temperature in these patches was 15.4° C, and average temperature adjacent to these patches was 16.2° C. The dominant substrate type within these cold-water patches was fine sediment (< 4 mm diameter). One of these cold-water patches was located between 50 m and 75 m and another between 350 m and 375 m from the downstream end of the reach. There were two potential barriers to Chum Salmon migration in this reach (Figure 102; Table 36). These barriers were semicircular culverts located at Hillcrest Loop Road bridges (Table 36; Figure 102, panel C).

Table 36. List of barriers, types, barrier heights, barrier widths (across stream), barrier lengths (upstream and downstream), and max pool depths downstream of the barriers in reach 1 of Hillcrest Creek, southeast of Svensen, OR, in July 2014.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Semicircular culvert	0	1.3	7	0.9
2	Semicircular culvert	0	1.8	16	0.05

REACH 2

REACH DESCRIPTION:

Reach 2 started at the confluence with a small, unnamed tributary 250 m upstream from the first Hillcrest Loop Road bridge (Lat: 46.153603, Long: -123.643382) and ended at a point 300 m upstream from the third Hillcrest Loop Road bridge. (Lat: 46.148787, Long: -123.632979; Figure 103). The mainstem thalweg length of this reach was 1,688 m, and there were no side channels. The stream channel meandered as it flowed through a residential area, and the primary land use was a mix of rural residential and light grazing. The riparian vegetation was highly variable with some areas that were densely vegetated with shrubs, firs, and alders, and other areas that were grass-dominated (Figure 104, panel A). Channel-spanning large woody debris was abundant throughout the reach (Figure 104, panel B), as was broken glass and trash.

Several livestock or wildlife crossing were observed in the downstream half of the reach (Figure 104, panel C).

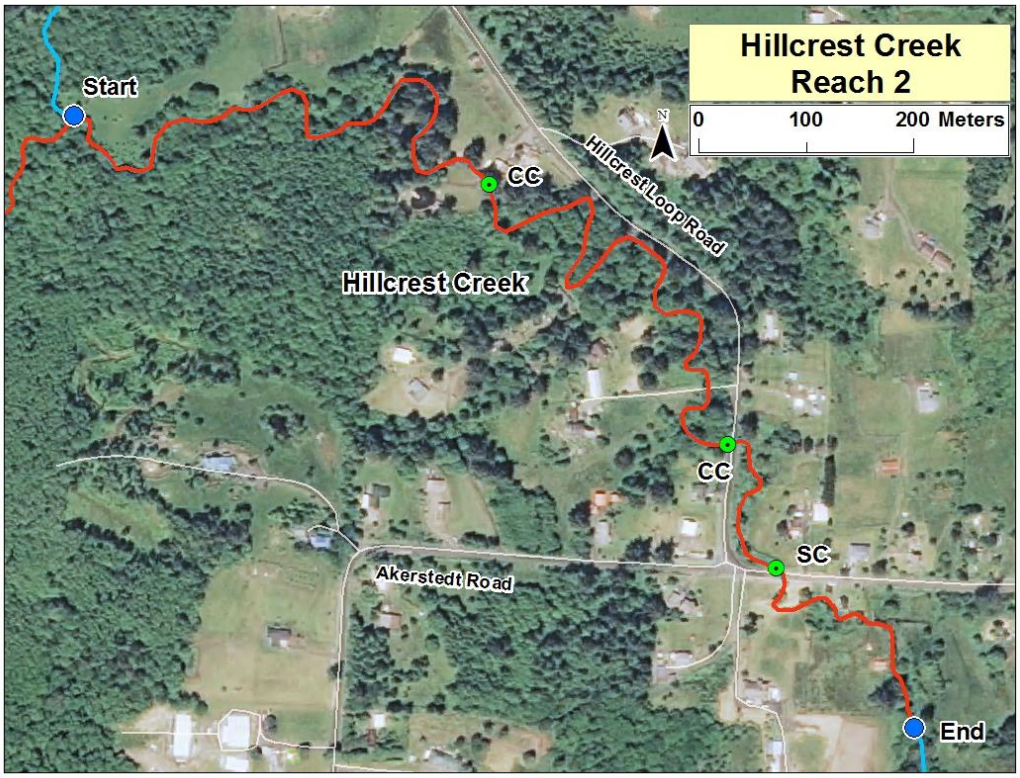

Figure 103. Map of reach 2 (red line) on Hillcrest Creek, including start and end points (blue dots), one semicircular culvert (SC), and two circular culverts (CC).

Figure 104. Survey pictures on reach 2 of Hillcrest Creek showing section of stream with a grass-dominated riparian zone (panel A), large woody debris spanning the stream channel (panel B), signs of livestock crossing the creek (panel C), a double circular culvert barrier located under a small residential road (panel D), a triple circular culvert barrier located under the second Hillcrest Loop Road bridge (panel E), and a semicircular culvert barrier located under the third Hillcrest Loop Road bridge (panel F).

RESULTS:

Gravel substrate in reach 2 of Hillcrest Creek (4–45 mm, diameter) was common within this reach, however because fine sediment levels were > 20%, no suitable spawning habitat was identified. Eleven cold-water patches were detected, with a combined surface area of 5.6 m² (Figure 105). Average temperature in these patches was 15.5° C, and average temperature adjacent to these patches was 16.4° C. The dominant substrate types within these cold-water patches were fine sediment (n = 10) and bedrock (n = 1). There were three potential barriers to Chum Salmon migration in this reach: (1) two adjacent circular culverts located under a

residential road, (2) three adjacent circular culverts located under the second Hillcrest Loop Road bridge, and (3) a semicircular culvert located under the third Hillcrest Loop Road bridge (Table 37; Figure 104, panels D–F).

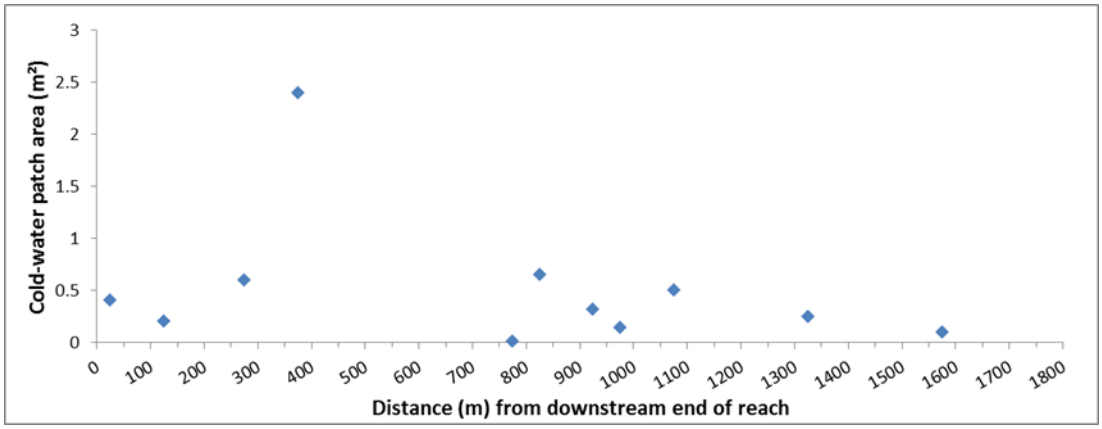

Figure 105. Location cold-water patches measured as distance from downstream end of survey in reach 2 of Hillcrest Creek, southeast of Svensen, OR, in July 2014. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel, and patch area was summed and binned into 50 m units.

Table 37. List of barriers, types, barrier heights, barrier widths (across stream), barrier lengths (upstream and downstream), and max pool depths downstream of the barrier in reach 2 of Hillcrest Creek, southeast of Svensen, OR, in July 2014. ** data not collected

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1a	Double circular culvert	0	1.4	10	0.7
1b	Double circular culvert	**	1.4	10	0.7
2a	Triple circular culvert	0	1	6	0.35
2b	Triple circular culvert	0	1	6	0.35
2c	Triple circular culvert	0	1	6	0.35
3	Semicircular culvert	**	1.7	15	0.4

Hillcrest Creek Tributary

REACH DESCRIPTION:

Reach 1 started at the confluence with Hillcrest Creek (Lat: 46.153625, Long: -123.64333) and continued upstream to an old farm road bridge (Lat: 46.15176, Long: -123.64543; Figure 106). The mainstem thalweg length of this reach was 337 m, with no side channels and multiple meanders. The confluence of this tributary with Hillcrest Creek has moved 50 m upstream from where it is surveyed on the map. The riparian vegetation was a dense thicket of salmonberry, ferns and small alders (Figure 107, panel A), and land use was rural residential. The survey ended at a crushed culvert located under an old logging road (Figure 107, panel B). The upstream end of this culvert was not visible due to heavy sediment accumulation.

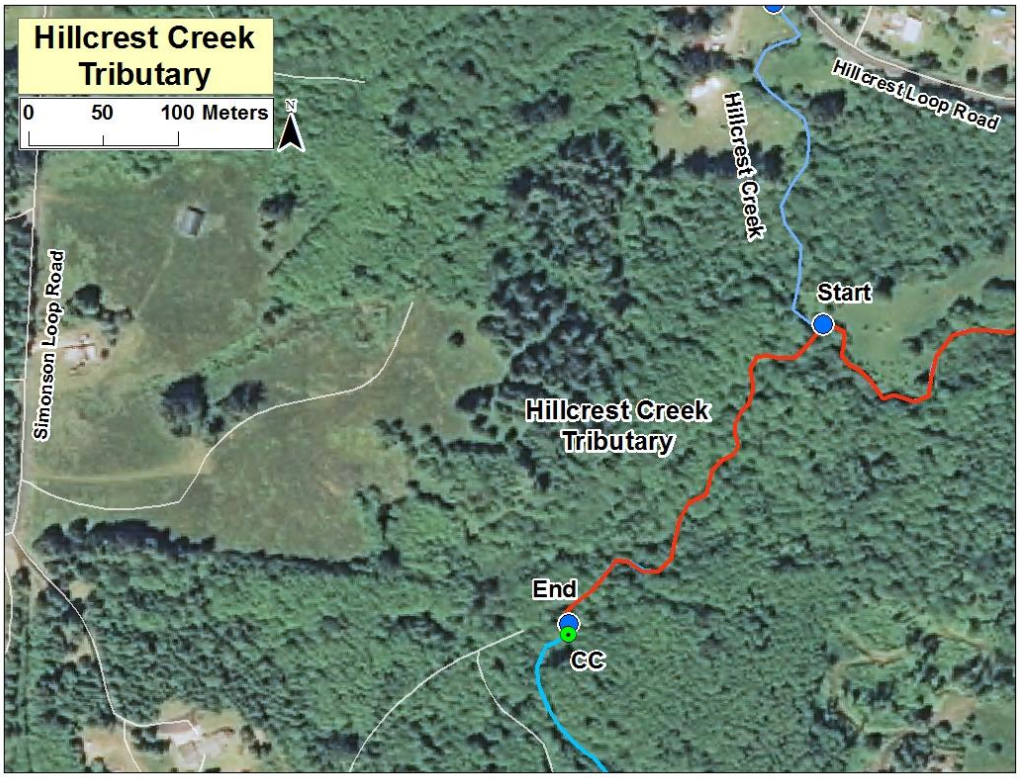

Figure 106. Map of reach 1 (red line) on Hillcrest Creek tributary, including start and end points (blue dots) and one circular culvert (CC).

Figure 107. Survey pictures of an unnamed tributary of Hillcrest Creek show a densely-vegetated riparian zone with shrubs, ferns, alders, and maples (panel A) and a crushed circular culvert at the upstream end of the reach (panel B).

RESULTS:

The substrate of the Hillcrest Creek Tributary consisted entirely of silt and mud (< 4 mm diameter), as such no gravel patches that met minimum established criteria were found. No cold-water patches were detected. At the upstream end of the reach, a crushed circular culvert was a complete migration barrier (Figure 106; Table 38; Figure 107, panel B).

Table 38. Barrier type, barrier height, barrier width (across stream), barrier length (upstream and downstream), and max pool depth downstream of the barrier in reach 1 of Hillcrest Creek Tributary, southeast of Svensen, OR, in August 2014.

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Circular culvert	1	0.35	8	0.1

Little Creek

SURVEY DATES: August 4 and August 6, 2014

SURVEY CREW: Brian Alfonse, Kris Homel, John Cox, and Lorana McCalester

GENERAL DESCRIPTION:

The Little Creek habitat survey (Township: 8N Range: 7W Section: 18B) started 500 m upstream from the Old Highway 30 bridge and continued upstream 2.2 km (Figure 108). Historically the confluence of Little Creek and Big Creek was within Knappa Slough; however, following an avulsion event Big Creek migrated to the west and captured the flow from Little Creek. The lower portion of Little Creek below this breach has no flowing water, although there were

isolated pools observed. Surveys on Little Creek were delineated into three reaches: reaches 1 and 2.1 occurred below the breach and reach 2.2 occurred above the breach. Adult Chum Salmon are routinely observed in reach 2.2 during spawning surveys.

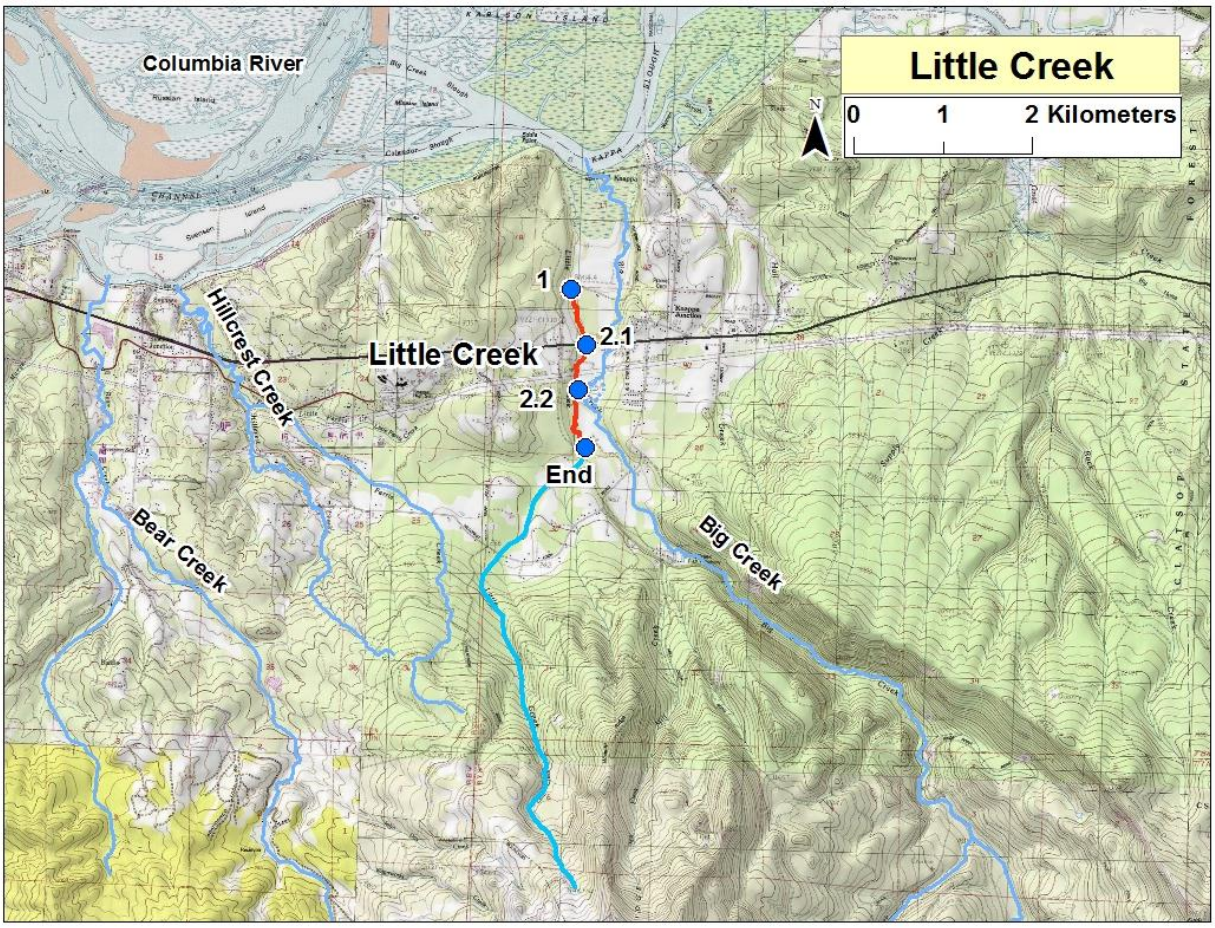

Figure 108. Map of reaches (red line) surveyed on Little Creek, located south of Knappa, OR, in August 2014. Reach break labels correspond to the downstream end of each reach.

REACH 1

REACH DESCRIPTION:

Reach 1 started 500 m upstream from the Old Highway 30 bridge (Lat: 46.171435, Long: -123.597772) and continued upstream to the Highway 30 bridge (Lat: 46.162597, Long: -123.596674; Figure 109). The mainstem thalweg length of this reach was 750 m. There was one side channel (thalweg length = 12 m) and few meanders. The survey started at tidewater; below this point, the stream was deep, and the water was stagnant and brown (Figure 110,

panel A). The riparian vegetation in this reach was predominantly grass, with some shrubs, blackberry bushes, and sparse trees (Figure 110, panel B). Land use was rural residential. The stream channel consisted of small, shallow pools separated by long dry channel sections with some areas of gravel (Figure 110, panel C).

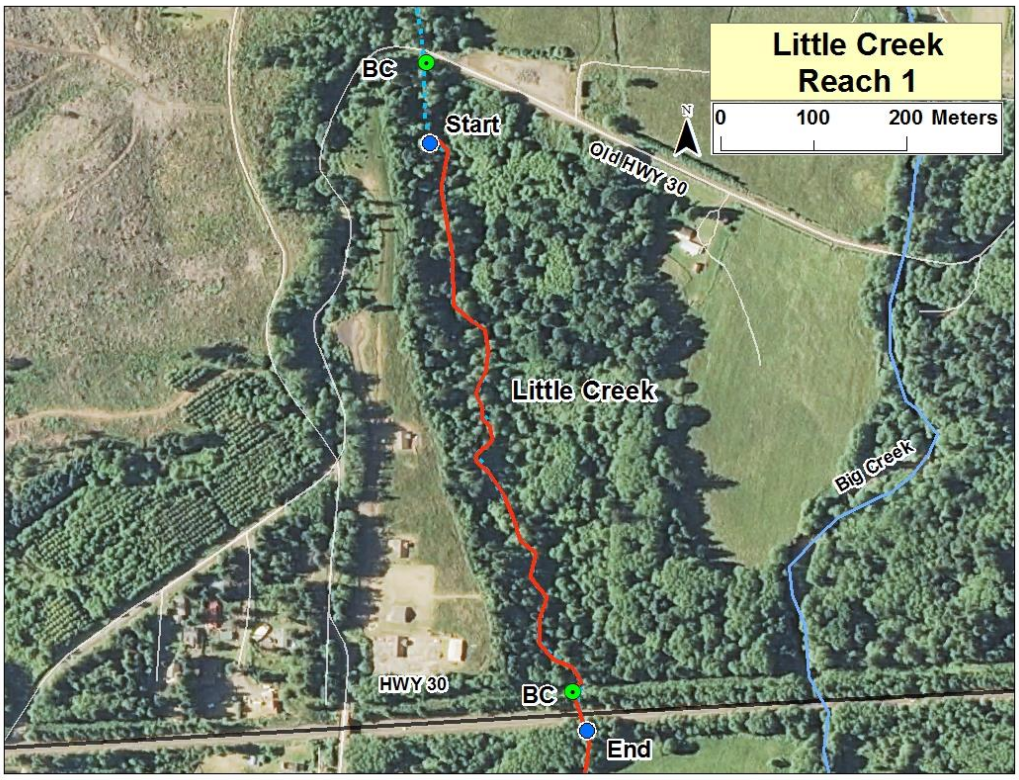

Figure 109. Map of reach 1 (red line) on Little Creek, including, start and end points (blue dots) and two box culverts (BC).

Figure 110. Survey pictures on reach 1 of Little Creek showing a tidal slough downstream from Old Highway 30 (panel A), riparian vegetation consisting of dense grass, shrubs and some sparse trees (panel B), an isolated pool with adjacent gravel substrate (panel C), and a box culvert under the Highway 30 bridge (panel D).

RESULTS:

Seven patches of suitable spawning substrate were found in reach 1 of Little Creek (Table 39; Figure 111), measuring a total of 29 m^2. None of these patches were categorized as "high" quality, two patches were of "moderate" quality, and five patches were of "low" quality (Table 39; Figure 111). Thirty cold-water patches were detected, totaling 508.4 m^2 (Figure 111). Average temperature in these patches was 15.3° C, and average temperature adjacent to these patches was 16.6° C. All patches were isolated pools. The dominant substrate types within these cold-water patches were fine sediment (n = 23), small cobble (n = 2), large cobble (n = 3), and bedrock (n = 2). Two potential barriers were identified: (1) a box culvert at the Old Highway 30 bridge, approximately 500 m downstream of reach 1, and (2) a box culvert at the Highway 30 bridge (Figures 109; Figure 110, panel D; Table 40).

Table 39. Total number and area (m²) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and 25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 1 of Little Creek, south of Knappa, OR, in August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	1	1
moderate	0-10	0	50	50	1	1
low	0-10	0	25	75	2	7
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	0	0
low	11-20	0	75	25	1	2
low	11-20	0	50	50	2	18
low	11-20	0	25	75	0	0
low	11-20	0	0	100	0	0

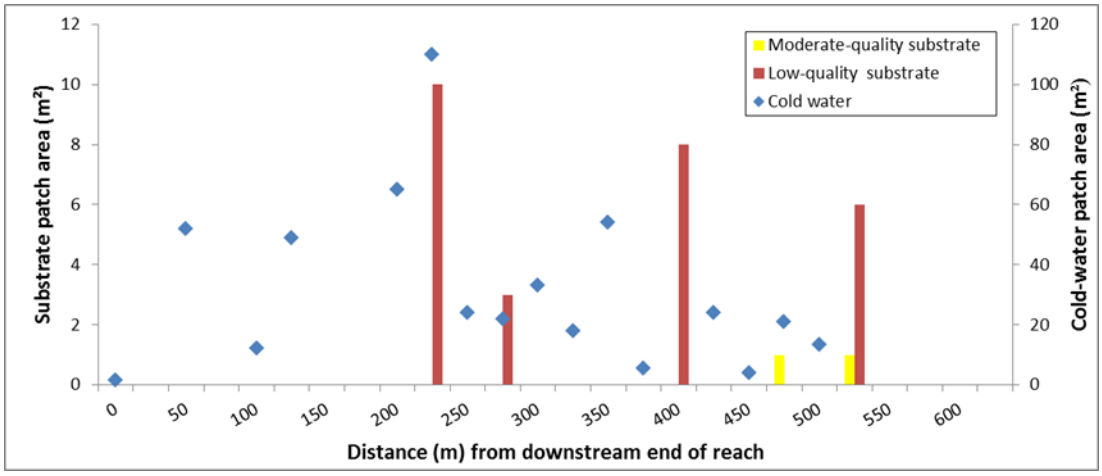

Figure 111. Location of substrate patches measured as distance from downstream end of survey in reach 1 of Little Creek, south of Knappa, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 25 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

Table 40. List of barriers, types, barrier heights, barrier widths (across stream), barrier lengths (upstream and downstream), and max pool depths downstream of the barrier in reach 1 of Little Creek, south of Knappa, OR, in August 2014. ** indicates data not collected

Barrier number	Barrier type	Drop (m)	Width (m)	Length (m)	Max pool depth (m)
1	Box culvert	0	2	15	N/A
2	Box culvert	0	2.4	40	0.7

REACH 2.1

REACH DESCRIPTION:

Reach 2.1 started at the Highway 30 bridge (Lat: 46.167522, Long: -123.595896) and continued upstream to where Little Creek now connects with Big Creek (Lat: 46.16262, Long: -123.596682; Figure 112). The thalweg length of this reach was 666 m, with no side channels and multiple meanders. The riparian zone was sparsely vegetated with young alders and grass (Figure 113, panel A), and land use was rural residential. Much of the stream channel in this reach was dry, however some isolated pools were also present (Figure 113, panel B). There was a small farm bridge in the downstream half of the reach (Figure 113, panel C). Power lines crossed near the middle of the reach, with this riparian area consisting of grasses (Figure 113, panel D).

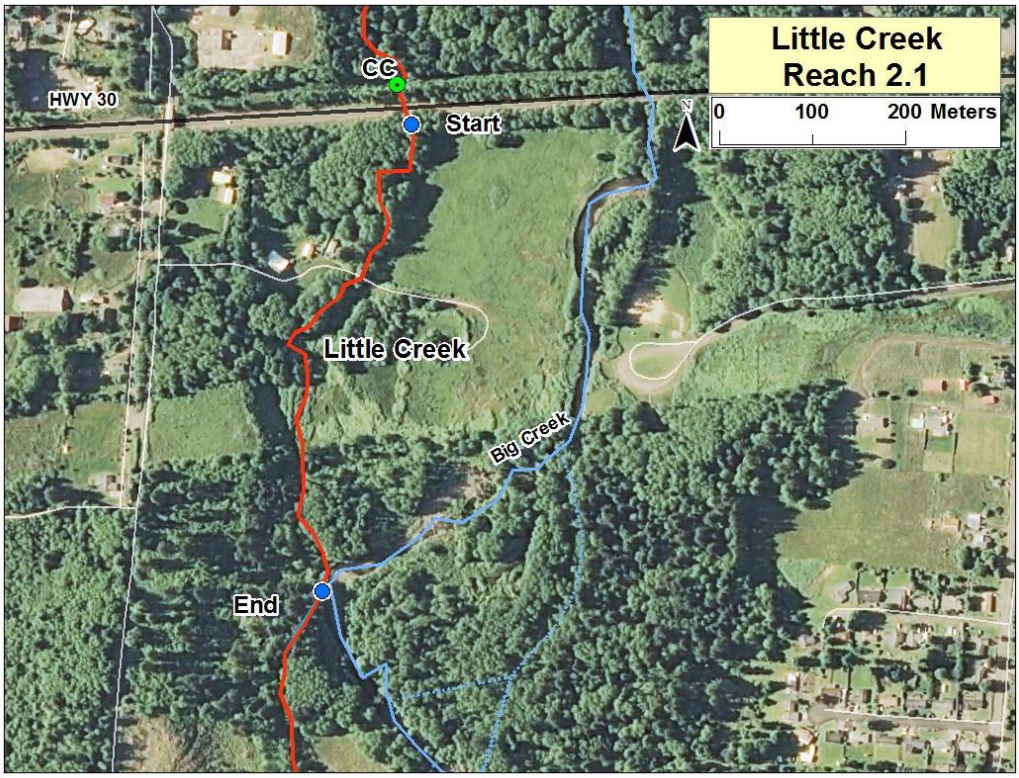

Figure 112. Map of reach 2.1 (red line) on Little Creek, including start and end points (blue dots).

Figure 113. Survey pictures on reach 2.1 of Little Creek showing a ripairan zone dominated by alders, shrubs, and grass (panel A), a short riffle connecting two pools (panel B), a small bridge (panel C), and a section of stream where the riparian zone is dominated by dense grass underneath powerlines (panel D).

RESULTS:

One patch of suitable spawning substrate was found in Little Creek Reach 2.1. This patch was 1 m^2, consisted of 75% large gravel (12–45 mm, diameter), 25 % small cobble (46–128 mm, diameter), and was categorized as "low" quality (Figure 114). Eleven cold-water patches were detected, totaling 102.5 m^2 (Figure 114). Average temperature in these patches was 16.2° C, and average temperature adjacent to these patches was 19.1° C. The dominant substrate type within these cold-water patches was fine sediment (< 4 mm diameter). There were no potential barriers to Chum Salmon migration in this reach.

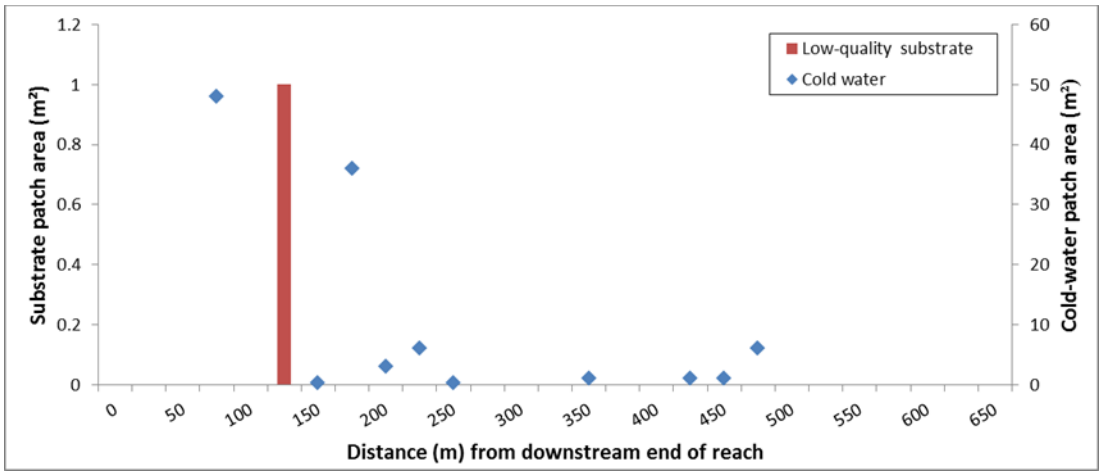

Figure 114. Location of substrate and cold-water patches measured as distance from downstream end of survey in reach 2.1 of Little Creek, south of Knappa, OR, in August 2014. Cold water and substrate patch areas were summed and binned into 25 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.

REACH 2.2

REACH DESCRIPTION:

Reach 2.2 started at the confluence of Little Cr and Big Creek (Lat: 46.16262, Long: -123.596682), and continued to the upstream end of county tax lot 8N7W1900 2200 (Lat: 46.156783, Long: -123.595257; Figure 115). The mainstem thalweg length of this reach was 805 m. There were also two side channels with a combined thalweg length of 31 m. Channel form in this reach was unconfined and braided. Within this reach an actively flowing channel was consistently present upstream from the point that Big Creek captured Little Creek (Figure 116, panel A). The riparian vegetation included multiple tree and shrub species, and land use was primarily young timber, timber harvest, and some light grazing. Several pools were created by beaver dams, and signs of beaver activity were also observed in the riparian zone. (Figure 116, panel C). Fencing limited livestock grazing along the riparian zone to a short 5 m section (Figure 116, panel D).

Figure 115. Map of reach 2.2 (red line) on Little Creek, including start and end points (blue dots).

Figure 116. Survey pictures on reach 2.2 of Little Creek showing the confluence of Little and Big Creeks at the downstream end of the reach (panel A), a substrate patch with large gravel and small cobble (panel B), a small beaver dam with a pool upstream (panel C), and a livestock fence across the stream channel (panel D).

RESULTS:

Substrate in the size range suitable for Chum Salmon spawning was observed throughout reach 2.2 of Little Creek (Figure 116, panel B); however, because fine sediment levels were > 20%, little suitable spawning habitat was identified. Fourteen patches of suitable spawning substrate were found (Table 41; Figure 117), measuring a total of 129 m^2. None of these patches were categorized as "high" quality, three patches were of "moderate" quality, and 11 patches were of "low" quality (Table 41; Figure 117). Twelve cold-water patches were detected, totaling 15.9 m^2 (Figure 117). Average temperature in these patches was 15.5° C, and average temperature adjacent to these patches was 16.4° C. The dominant substrate types within these cold-water patches were fine sediment (n = 10), and large gravel (n = 2). There were no potential barriers to Chum Salmon migration in this reach.

Table 41. Total number and area (m^2) of suitable spawning substrate patches separated into three quality grades (low, medium, and high) classified by the percentage of fines (0–10% and 11–20%) and

25% categories of small gravel (4–11 mm), large gravel (12–45 mm), and small cobble (46–128 mm), observed in reach 2.2 of Little Creek, south of Knappa, OR, in August 2014.

Substrate Quality	Percent of Substrate Type				Number Patches	Patch Area
	Fines	Small Gravel	Large Gravel	Small Cobble		
high	0-10	100	0	0	0	0
high	0-10	75	25	0	0	0
high	0-10	50	50	0	0	0
high	0-10	25	75	0	0	0
high	0-10	0	100	0	0	0
moderate	0-10	0	75	25	1	3
moderate	0-10	0	50	50	1	12
low	0-10	0	25	75	2	5
low	0-10	0	0	100	0	0
moderate	11-20	100	0	0	0	0
moderate	11-20	75	25	0	0	0
moderate	11-20	50	50	0	0	0
moderate	11-20	25	75	0	0	0
moderate	11-20	0	100	0	1	12
low	11-20	0	75	25	4	41
low	11-20	0	50	50	3	30
low	11-20	0	25	75	2	26
low	11-20	0	0	100	0	0

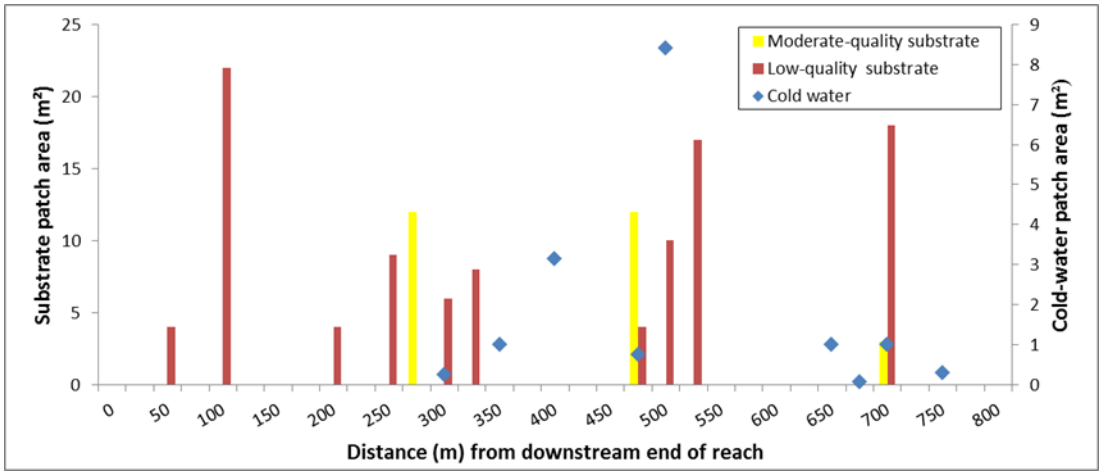

Figure 117. Location of substrate patches measured as distance from downstream end of survey in reach 2.2 of Little Creek, south of Knappa, OR, in August 2014. For cold water and for each category of substrate quality, patch area was summed and binned into 25 m units. Cold-water patches were ≥ 1.0° C colder than the temperature in the main channel.