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CEE 6440

Juvenile Bull Trout Distribution in the South Fork Walla Walla River, Oregon

Introduction

Bull trout (*Salvelinus confluentus)* are an endangered species historically found throughout California, Oregon, Washington, Nevada, Idaho, and Utah, but due to habitat loss, their range has significantly decreased. The population of bull trout found in the South Fork Walla Walla river is a relatively large, and successful population. This specific population has been the focus of a ten year study through Pheadra Budy (USU Professor) and the Fish and Wildlife Service. Extensive monitoring and habitat evaluations have been done to estimate survival parameters for this and other populations.

Image 1 – Study Area: Middle Columbia Watershed

Objectives

Juvenile bull trout (<170 mm) survival is essential to the recruitment of the population. The goal of this project is to potentially find any correlation between juvenile densities and channel characteristics, primarily gradient, width, confinement, and temperature. As the stream is a high mountain stream within the Umatilla National Forest (Image 2), there are no negative inputs from upstream watershed, so anthropogenic effects (Image 2) are not an area of concern for this particular stream.

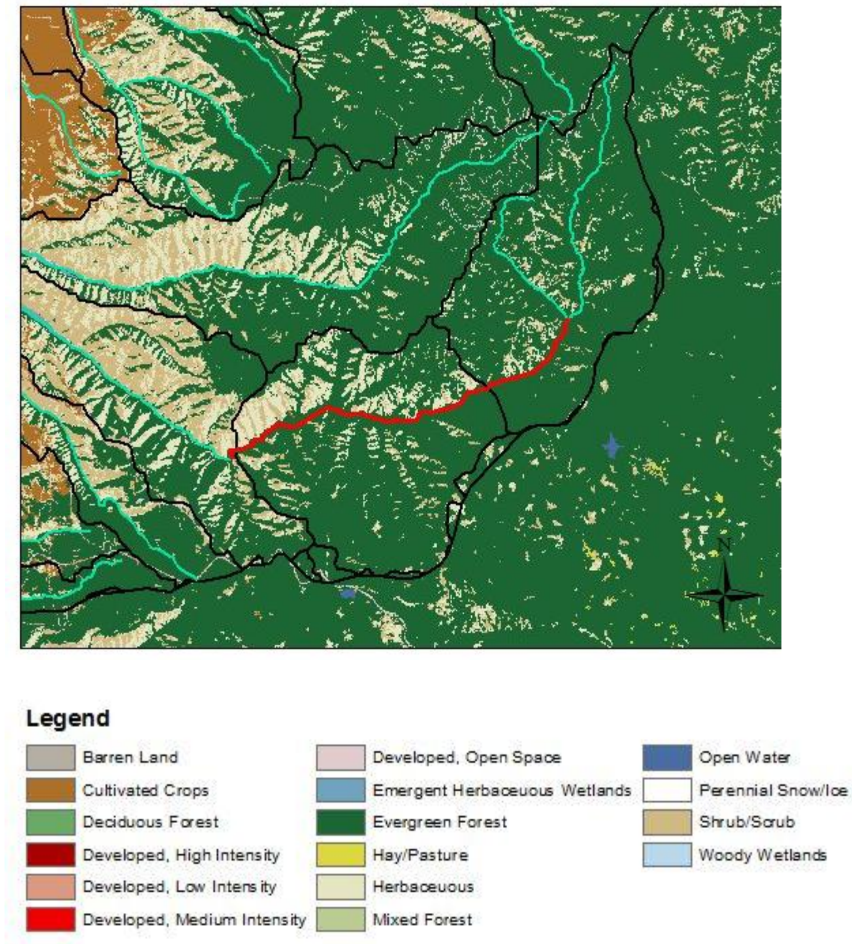
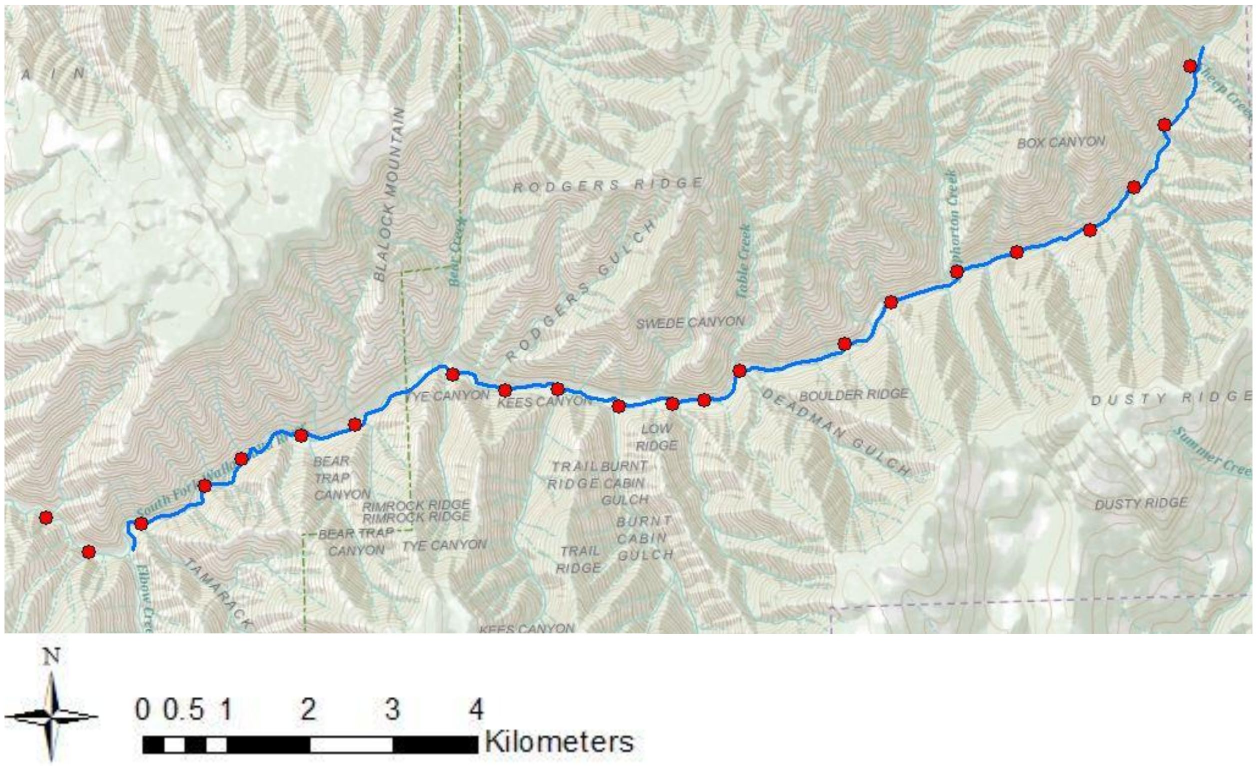


Image 2 – Land Use: Two primary classes are Evergreen Forest and Shrub Scrub.

Methods

For the 22 sampling sites along the river, the raw GPS coordinates were compiled in an excel table, imported into ArcMap, then displayed as XY data, and then projected to GCS North American 1983. Each site is numbered in the attribute table field IDENT starting at 3 going up to 103 in increments of 5 (with the exception of an added site 56)(Image 3).

Image 3 – Sample Sites



Stream reaches, and watershed boundaries were downloaded from http://oregon.gov, as well as the 30 meter digital elevation model. The reaches for just the watershed were selected out using the Select By Location tool with the specification of features contained within the source layer feature (Image 4).

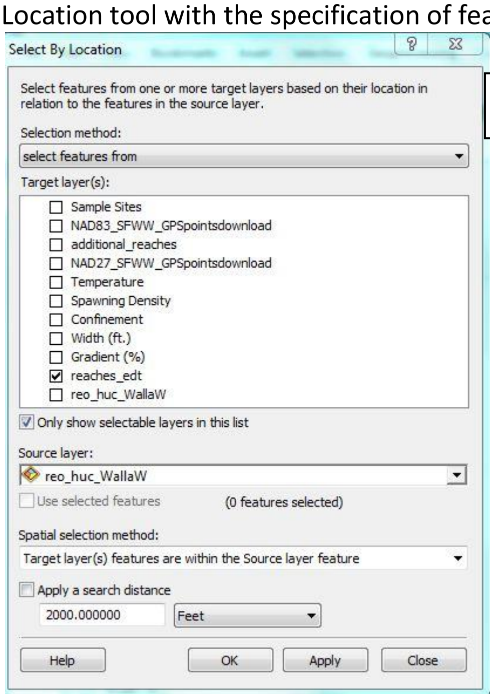
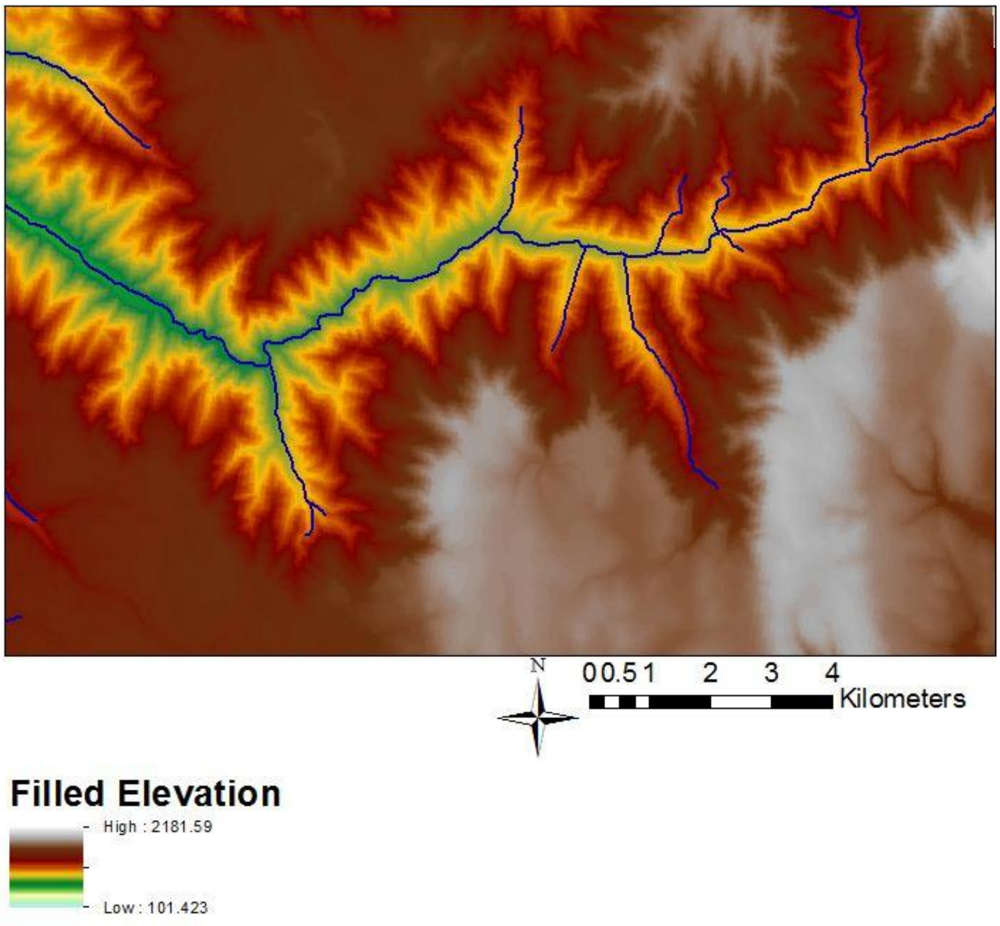


Image 4 – Select Tool

Using the spatial analyst hydrology tools, the DEM (Image 5) was run through the Fill Tool, so as to create flow direction (Image 6) and flow accumulation (Image 7) images. Flow accumulation was chosen to show the difference in flows between the tributaries and main channel. There is one USGS gaging station at the bottom of the river, but it ceased operation in the 1990’s, so annual flow data for the south fork is not available for download.

Image 5 – 30 Meter Digital Elevation Model



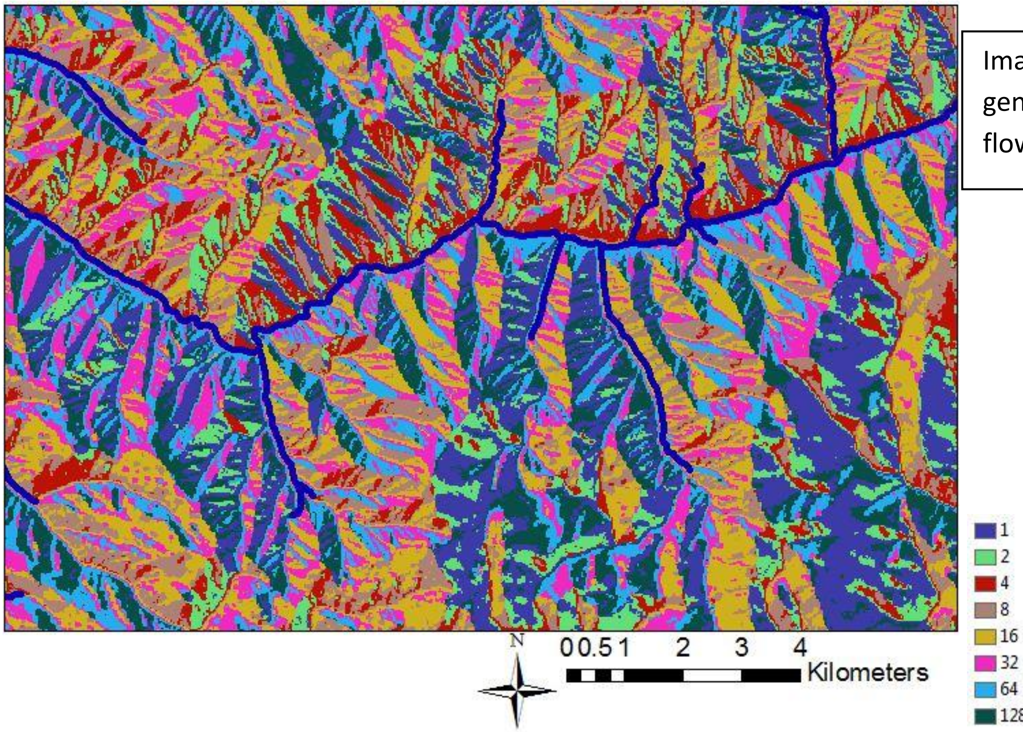


Image 6 – Flow Direction: generated in order to create flow accumulation.

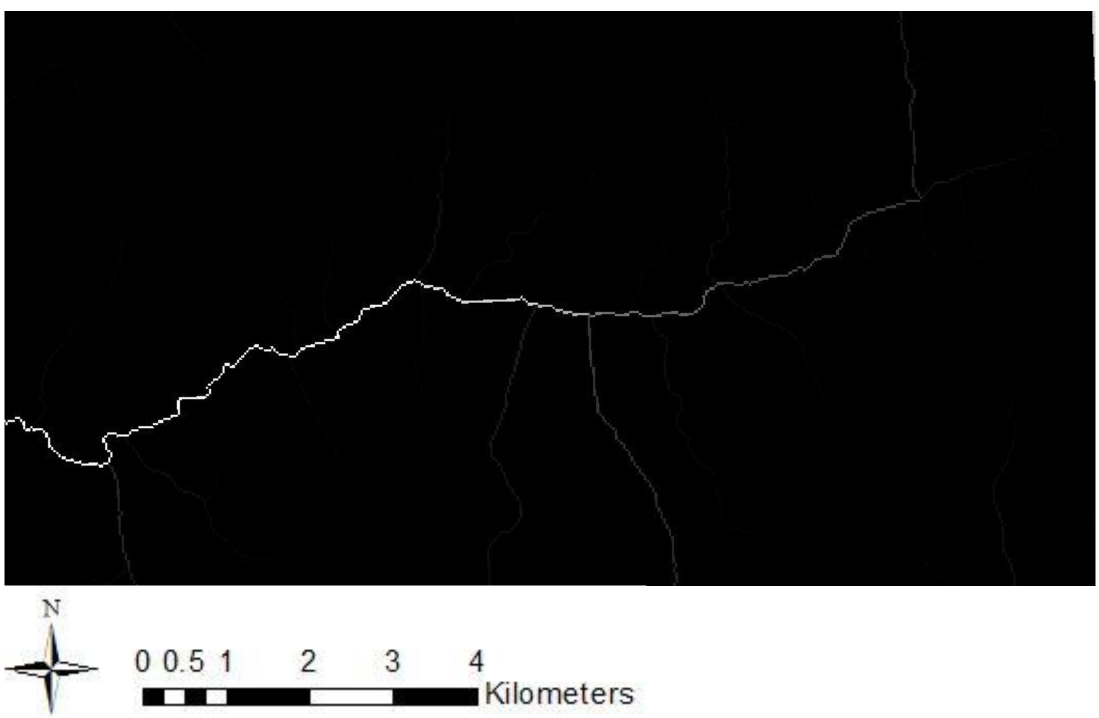


Image 7 – Flow Accumulation

The next aspect of the project involved extensive use of attribute tables. A single excel database table was compiled by the Fish and Wildlife service (provided by Tracy Bowerman, USU) containing information for 277 reaches in the watershed (Image 8). The south fork is made up of seven reaches, each of which was selected out of the database (Image 9), and then imported into ArcMap. Once imported, the excel table of reach characteristics was joined with the reach layer using Joins/Relates→ Join based on the reach name. Another database was created with the spawning and juvenile densities for each of the 22 stations. The station field was renamed IDENT before imported into ArcMap so it joined with the attribute table from the sampling stations layer.

Image 8 – Original database for the Middle Columbia Watershed.

Table

edt_reach_attributes

OID	EDT_RCHID	REACHNAME *	ALKAT	ALKAP	BDSCOURT	BDSCOURP	BENCOMRCHT	BENCOMRCHP	CHLNGTHT	CHLNGTHP	CONFINET	CONFIN
0	1386	Bear Cr	3	3	1	1	0	0	1.34	1.34	4	
1	1407	Bear Trap Sp	3	3	0.5	0.5	0	0	1.49	1.49	4	
2	1182	BeaverSlide	3	3	2.17	2.46	0	1	0.15	0.15	3.5	
3	1373	Big Meadow Canyon	3	3	2.95	2.95	0	1	1.84	1.84	4	
4	1313	BigSpringBr1	3	3	0.5	0.91	0	3	0.71	0.71	0	
5	1314	BigSpringBr2(obstruction)	-999	-999	-999	-999	-999	-999	0	0	-999	-
6	1315	BigSpringBr3	3	3	0.5	0.91	0	3	2.3	1.75	0	
7	1350	Birch1	3	3	0.95	0.97	0	0	0.72	0.45	0	
8	1351	Birch2(waterfall)	-999	-999	-999	-999	-999	-999	0	0	-999	-
9	1352	Birch3	3	3	1	1.49	0	3	3.46	3.46	0	
10	1353	Birch4(culvert)	-999	-999	-999	-999	-999	-999	0	0	-999	-
11	1354	Birch5	3	3	1	1.81	0	3	4.1	3.81	3	
12	1268	Blue1	3	3	1.91	2.38	0	0.5	2.27	2.27	1	
13	1270	Blue2	3	3	2.16	2.49	0	0.5	4.62	4.62	3.25	3
14	1285	Broken Cr	3	3	1	1	0	0	2.69	2.69	4	
15	1298	BryantUrbanStreams1A(obstruction	-999	-999	-999	-999	-999	-999	0	0	-999	-
16	1299	BryantUrbanStreams2	3	3	1.78	0.36	0	4	1.85	1.85	0	
17	1390	Burnt Cabin Gulch	3	3	1	1	0	0	2.71	2.71	4	
18	1187	BurntFk	3	3	2.17	2.53	0	0	2.81	2.81	3.5	
19	1343	Caldwell	3	3	1	1.18	0	3	2.37	2.37	0	
20	1164	Coates	3	3	2.12	2.69	0	1	0.88	0.88	3	
21	1250	Cold	3	3	2.46	3.07	0	1.5	3.21	3.21	0	
22	1139	Coppei	3	3	2.14	2.81	0	2.5	8.01	8.01	0	
23	1332	Cottonwood MF	3	3	2.24	2.23	0	3	1.82	1.82	4	

(0 out of 277 Selected)

edt_reach_attributes

Image 9 – Attribute tables for the seven extracted reaches.

Table

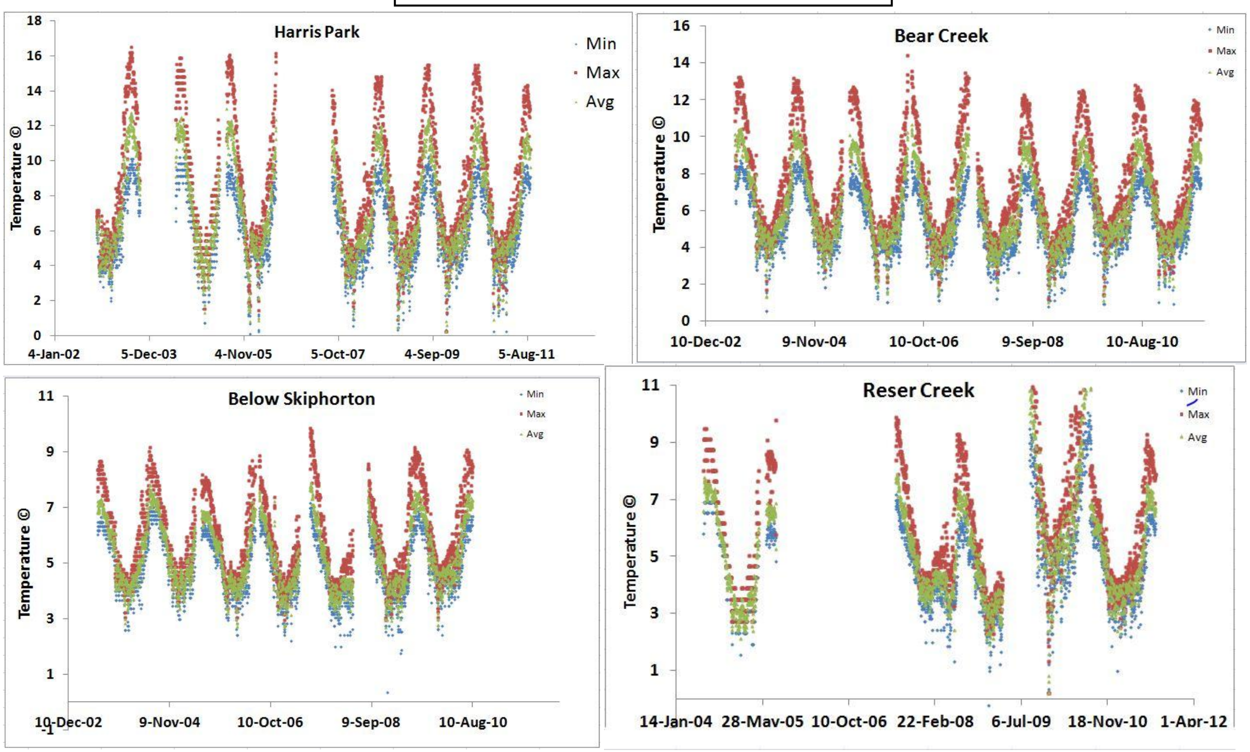
Temperature

FID	Shape *	FEAT_NAME	STATE	LLID	GEO_AREA	OID_	REACHNAME	LOCATION	EDTL
0	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	238	WallaSF11	From Skiphorton Cr to Reser Cr.	
1	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	237	WallaSF10	From Table/Deadman Cr confluence to Skiphorton Cr.	
2	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	250	WallaSF9	From Swede Canyon to Table/Deadman Cr confluence.	
3	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	249	WallaSF8	From Burnt Cabin Gulch to Swede Canyon.	
4	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	248	WallaSF7	From Kees Canyon to Burnt Cabin Gulch.	
5	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	247	WallaSF6	From Bear Cr to Kees Canyon.	
6	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	246	WallaSF5	From Demaris Cabin in section 12 to Bear Cr.	
7	Polyline	South Fork Walla Walla River	OREG	1183076458985	SF Walla Walla, Elbow to access limit	245	WallaSF4	From Elbow Cr to Demaris Cabin in section 12.	

(0 out of 8 Selected)

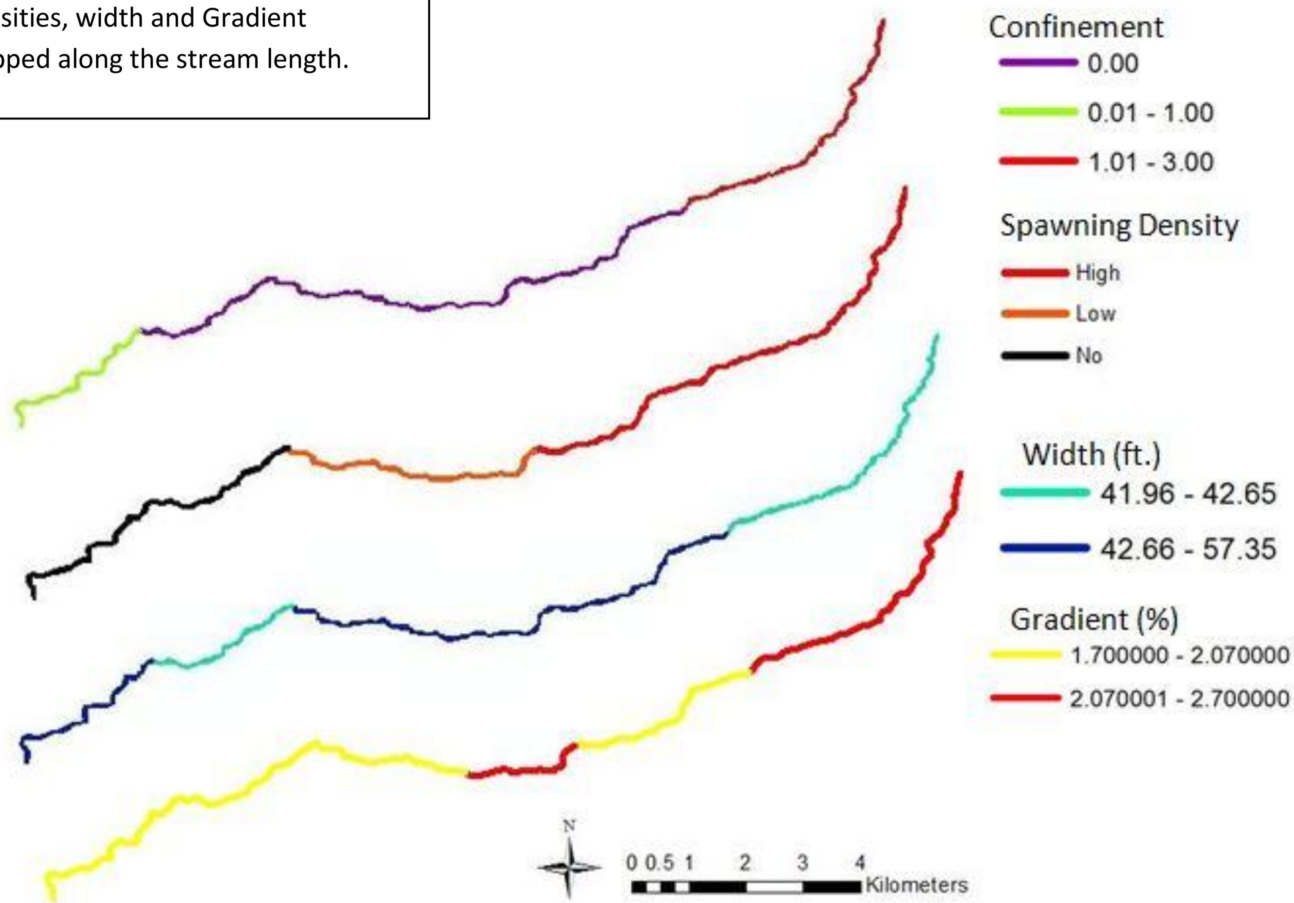
Along the river, there are four temperature logging stations, one at Site 3 Harris Park, Site 38 Bear Creek, Site 78 Skiphorton Creek, and Site 103 Reeser Creek (Image 10). Temperature data has been collected over the past ten years of this study. For the purpose of this project however, minimum mean temperature was used. Daily minimum temperature was used rather than average because bull trout are fall spawners, so their eggs must survive the winter low temperatures. If temperatures drop too low, juveniles will not be present the following year. Although high temperatures can also cause fish kills, I chose to focus on just the minimum (figure shown in results section).

Image 10 – Excel graphs of ten year high, low, and mean temperatures at Harris Park, Bear Creek, Skiphorton, and Reser Creek.



Symbology in the properties for the reach layer was the easiest and most effective way to show the channel characteristics. From previous knowledge of the river, and in working with Tracy, for the three characteristics (gradient, width, and confinement) it is known that on the river there is a large shift in these characteristics at certain points along the river. For confinement, as there were only three values, it was symbolized using Categories → Unique Values → CONFIN (field from attribute table). Spawning density was also symbolized this way, as there were only three values for spawning density. With and gradient were symbolized using Quantities → Graduated Colors → Classification → 2 Classes (Natural Breaks) (Image 11).

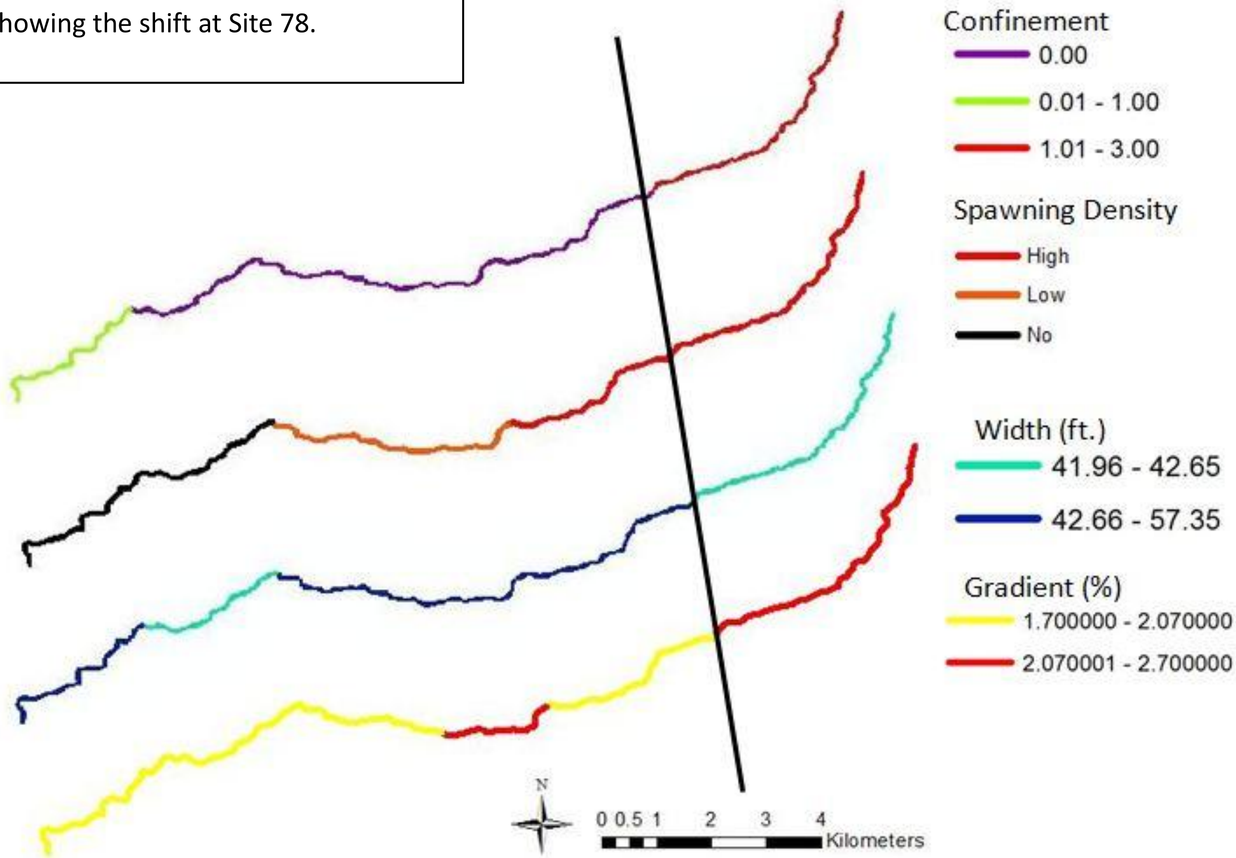
Image 11 – Confinement, Spawning Densities, width and Gradient mapped along the stream length.



Results

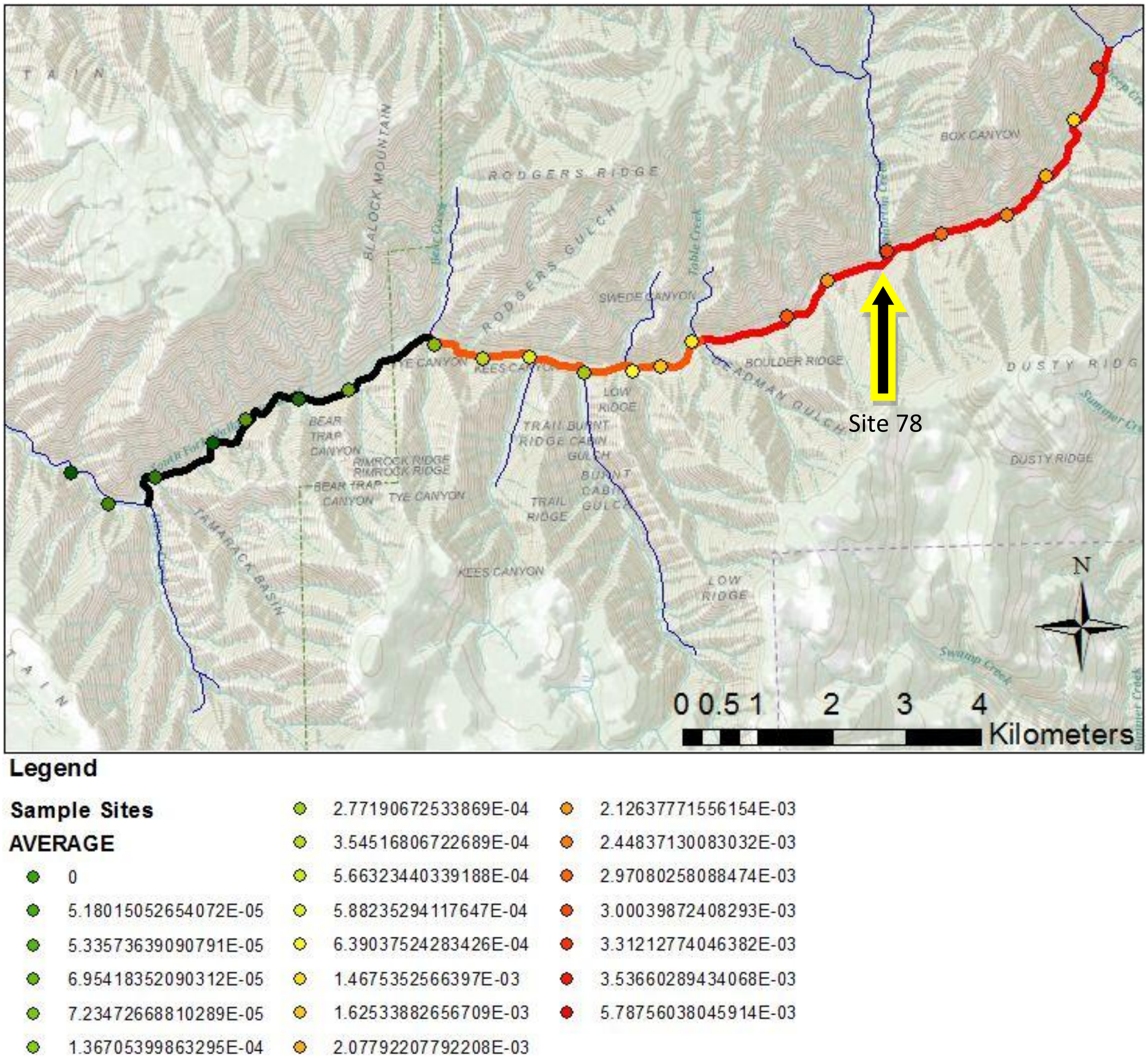
The most significant result found in this project was the river characteristics mapped all showed a large shift at sampling Site 78, which is the confluence of Skiphorton Creek and the South Fork. Skiphorton is a large tributary that does contribute a significant flow to the system. Image 12 shows the break between Site 78 upper and lower. With the exception of spawning density, all three characteristics shift.

Image 12 – Stream characteristics showing the shift at Site 78.



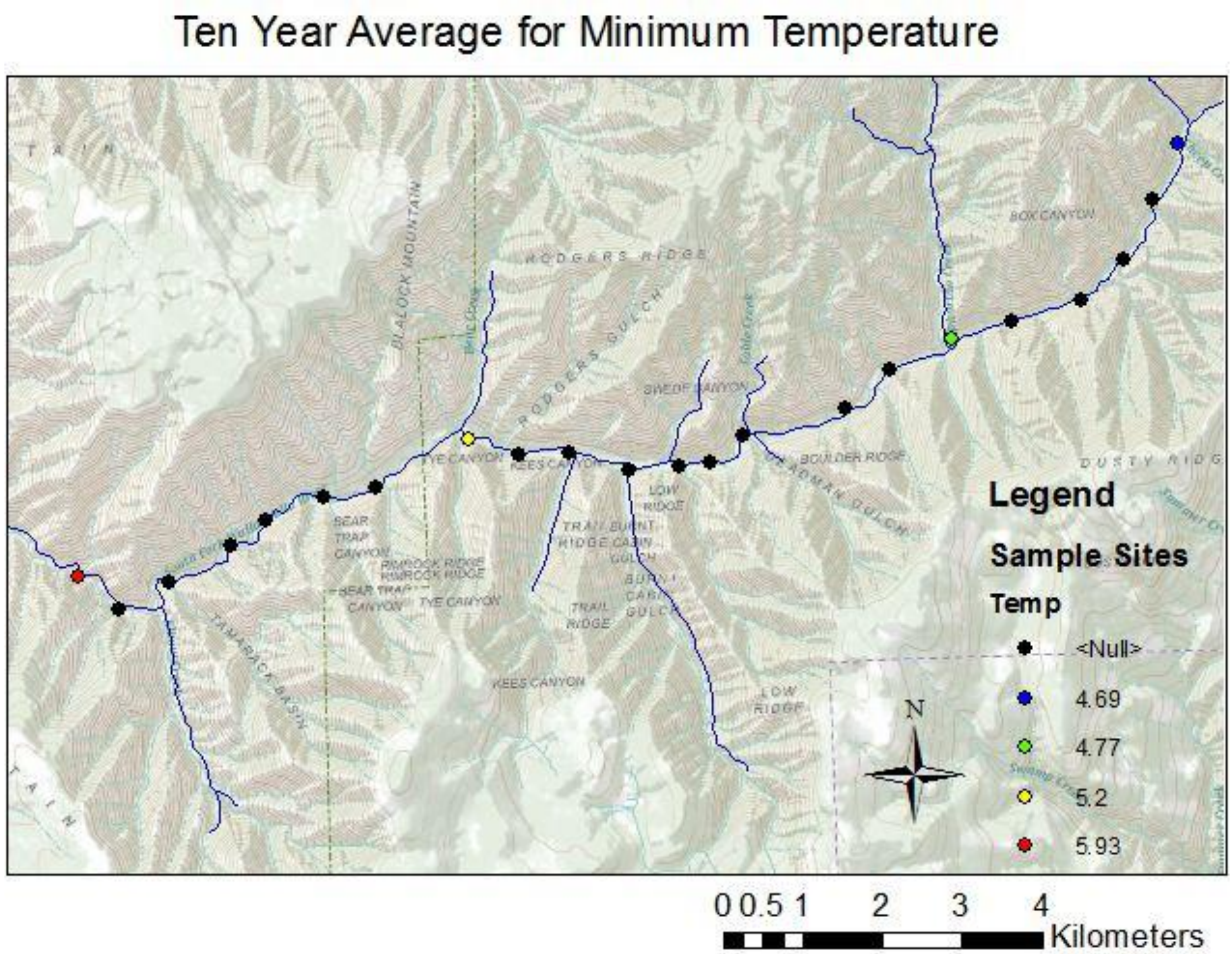
As it is shown, spawning densities are higher further up in the reach. From the above image, spawning density cannot be related to gradient, width, or confinement, as both levels of each characteristic are present in high density spawning. Juvenile densities also follow the same patterns as spawning density, showing that juveniles do not move far from their hatching grounds within the first year. However, spawning densities do increase more past Site 78 (Image 13), with the highest density being at Site 103. This can be related to width, gradient, and confinement.

Image 13 – Mean Juvenile Densities mapped along spawning density.



Temperature decreases upstream, with site 103 being the coldest. From Image 14 it can be seen that spawning density increases with lower temperatures. As juveniles do not move far from the spawning grounds, it can be inferred that juvenile densities also increase with colder temperatures. It can also be seen that juveniles can survive the minimum temperature of 4.69^{0} Celsius.

Image 14 – Mean Minimum Temperature at the four stations.



Discussion

The upper reaches of the south fork are more confined, as shown by Image 11 and Images 15 and 16. This confinement means the channel is narrower, and the flow is more concentrated so erosion may occur faster causing the steeper gradient also shown in Image 11.

Image 15 – Site 23: Taken by Hannah Moore

Image 16 – Site 93: Taken by Hannah Moore

The colder water temperatures are due to the inputs from Reeser Creek, the tributary at 103, with the highest elevation along the stream, so the snow pack lasts longer, leading to colder runoff longer in the season. This higher elevation can be seen in the DEM (Image 5). It can be seen from Image 10, that the temperature range at Site 3 Harris Park is from 2 – 18 ^{o} Celsius, while Site 78 and Site 103 only range from 2 – 9^{o} Celsius. That is a large difference in temperature ranges, leading to the conclusion that there is a relationship between juvenile densities and temperatures.

Spawning density may be a result of other species present in the system. Chinook salmon also spawn in this river, and tend to spawn in the lower reaches, which could be one factor in why bull trout spawn in the upper reaches.

Conclusion

In conclusion, width, gradient, and confinement do show a correlation to juvenile densities. These may not be the only factors that influence the density, but there is a relationship. Juvenile densities are highest in narrower, more confined reaches, with lower temperatures.

There are many other channel characteristics not analyzed here, such as substrate type, presence of other species, and flow. Future work could include comparing densities from individual years to temperatures from those specific years in order to prove a more significant relationship. This relationship could then be applied to other watersheds with struggling bull trout populations. Flow data would be very interesting to also compare densities too. Tracy is working on compiling all the flow data and converting it into CFS from discharge and stage height, but it was not available in time for this specific analysis.

Acknowledgments

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