Spatial Correlation of Historical Salmon Spawning Sites to Historical Splash Dam Locations in the Oregon Coast Range

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Geo 565 Option 2 Final

Photo 1: Assen Brothers Splash Dam in 1912, Middle Creek Oregon. Photo courtesy of Coos County Historical Society

Introduction

Splash dams were a tool used to transport timber in Oregon between 1880's-1957. The dams spanned the width of the stream (Photo 1) and timber would accumulate behind the dam; loggers would release the spillway and the logs would float to downstream mills. Historical anecdotal and photographic evidence suggests in concurrent with log 'splashes', stream substrates such as gravels and cobbles were washed away.

> *…the stream environment was often adversely affected by splashing. Moving logs gouged furrows in the gravel and many instances the suddenly increased flows scoured or moved the gravel bars, leaving only barren bedrock or heavy boulders…Dam operators have stated that fish runs reaching the dams were reduced within 3-4 years after initial construction (Wendler 1955).*

In-channel substrates are critical for successful for salmon redd building and spawning. The Oregon Fish Commission, later known as Oregon Department of Fish and Wildlife (ODFW), began coho salmon (*Oncorhynchus kisutch)* spawning surveys in 1948. At that time, standard protocol called for ODFW to select reliable sites that were known to be good spawning areas (Jacobs and Cooney, 1997). Since the spawning areas were spatially selected as being reliably productive, we can use this fact to see if there is any spatial correlation between the location of these historically reliable spawning areas and splash dam sites.

Study Importance

Much literature (Allen, 2004, Swetnam, 1999, Foster, 2003) cites the operation of splash dams in streams as one of the key culprits in the decline in salmonid populations through anecdotal evidence and 'rural legends.' Yet, there have been no quantitative landscape level study to assess the environmental legacy impacts of splash dams.

Data Analysis

Goal 1: To determine spatially if there is a disproportionate amount of historical spawning survey sites located in non-splashed areas to splashed areas. This will be done by creating a density analysis of splash dams and overlaying the density polygon to stream survey sites.

Goal 2: To determine if there is a lower total count of spawners located in splashed areas between 1950-1970. This will be done by comparing the total spawners between all splashed sites to un-splashed sites with a similar basin area and gradient. Spawning Surveys located within 4 km of a splash dam site or paired non-splashed basin will be included. (The 4 km is along the splash dammed mainstem stream network, and does not follow up tributaries)

Datasets

Splash Dams Data Layer- Western Oregon splash dam sites were located by searching 14 museums and 2 courthouses for literature documentation, historical maps, and photographs. We conducted interviews with current & retired fisheries biologists, local historians and one splash dam operator. Splash dam locations were mapped as a point and attributes were entered into a geodatabase using Arc/View 9.3. Data points were mapped at the Oregon Lambert Projection, 1:24,000 scale.

ODFW Spawning Survey Index Sites- A shape file (lines) of all spawning survey sites was obtained from ODFW. In the attribute table, each survey line has an associated ID number, this ID number corresponds to an Excel table that summarizes spawning counts for each year, categorized as Adults and Jacks. I chose the earliest 20 year period (1950-1970) to splash damming operations, because 1) the closer in time the data sets are to splashing, there will be a greater chance to see a difference due to the splashing itself and not other factors such as el Niño (although presumably all populations would experience el Niño similarly) 2) protocols slightly changed in the 1970's, with many sites removed due to budget cuts. Data was projected to Oregon Lambert.

Coastal Landscape Analysi and Modeling Streams (CLAMS)- A US Forest Service stream layer derived from 10m DEM's and calculated channel slope and basin area. This dataset is included as ancillary data to compare splashed and non-splashed areas of similar basin area and channel slope. Basin Area and channel slope are important covariates in describing physical channel conditions.

Methods/Processing Steps

Goal 1: *To determine spatially if there is a disproportionate amount of historical spawning survey sites located in non-splashed areas to splashed areas.*

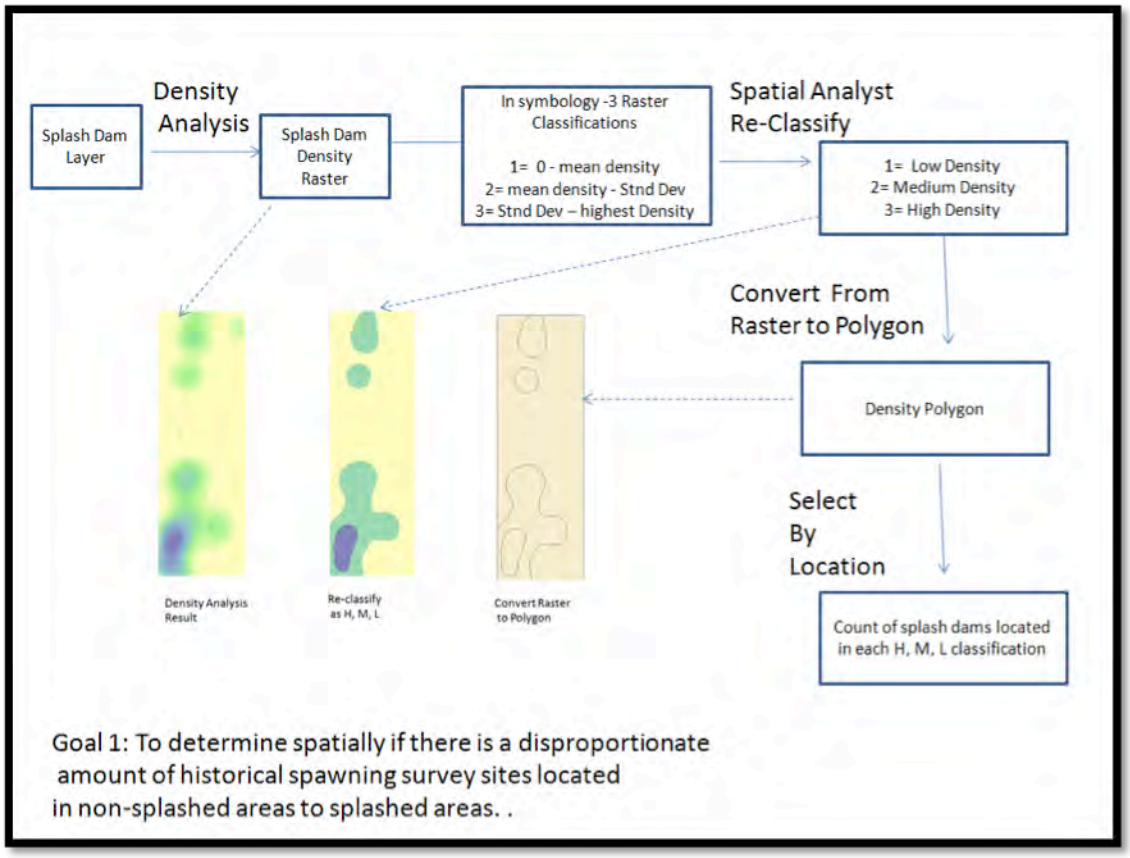
Step 1- Use Spatial Analysis DENSITY to create grid raster, change search radius to 100,000km (larger the search radius, the larger the 'window').

Step 2- In Symbology classify the splash dam density to 3 categories L, M, H. Where L = 0 to mean density; M=mean density-standard deviation; and H standard deviation-largest splash dam density.

Step 3- In Spatial Analyst, RE-CLASSIFY a new layer where L=1, M=2 and H=3.

Step 4-Convert my re-classified raster to polygon.

Step 5 – Used 'Select by location' for count of all stream surveys located within density classifications.



Goal 2: *To determine if there is a lower total count of spawners located in splashed areas between 1950-1970.*

Step 1- Prepare the data for study area: Splash dam location layer was CLIPPED to ODFW historical stream survey study area (west crest of Coast Range).

Step 2- ODFW excel spreadsheet ID numbers and data were transposed. A SPATIAL JOIN added the excel table to ODFW historical stream survey line layer.

Step 3- All splash dam sites were BUFFERED by 4000m.

Step 4- 'Select by Location' was used to locate all spawning surveys located within 4000m all splash dam sites buffer.

Step 5- Measure tool was used to calculate final distance between the splash dam and spawning survey site along the mainstem stream network. If measure tool found that the distance along the network was greater than 4000m, the site was excluded from analysis.

Step 6: *For every splashed basin that met the inclusion criteria, identify a paired non-splashed basin of similar Basin Area and Channel Slope.* The 'Select by Attributes' function was used on the CLAMS data layer, for all stream network lines +/- 10 km2 of paired non-splashed basin.

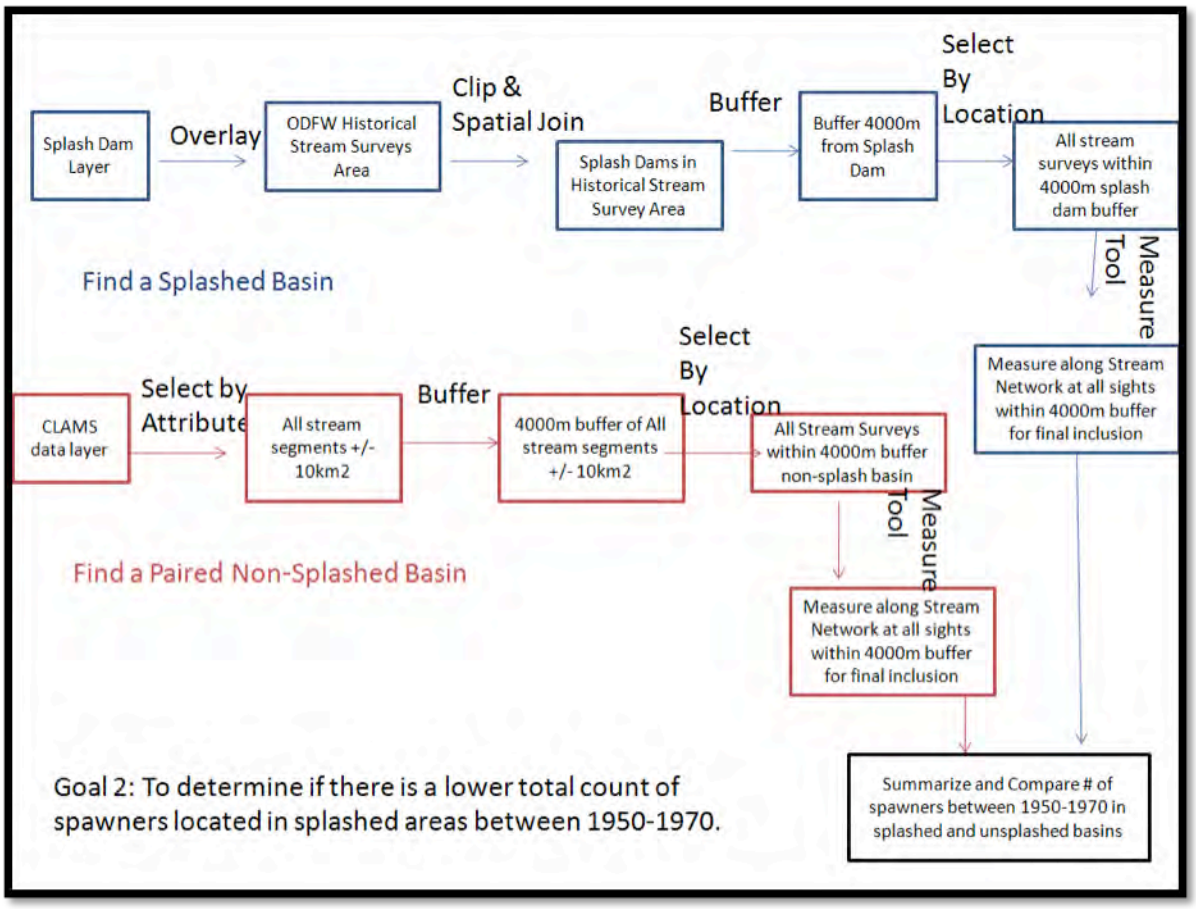
Step 7: Selected network lines were buffered by 4000m.

Step 8: 'Select by Location' function for historical spawning survey located within the non-splashed 4000m buffer.

Step 9: If multiple spawning surveys were found with the same basin area size, the spawning site closest to the splash site was used. (1st law in geography)

Step 10: Repeat Step 6-10, to pair every splashed basin to a non-splashed basin.

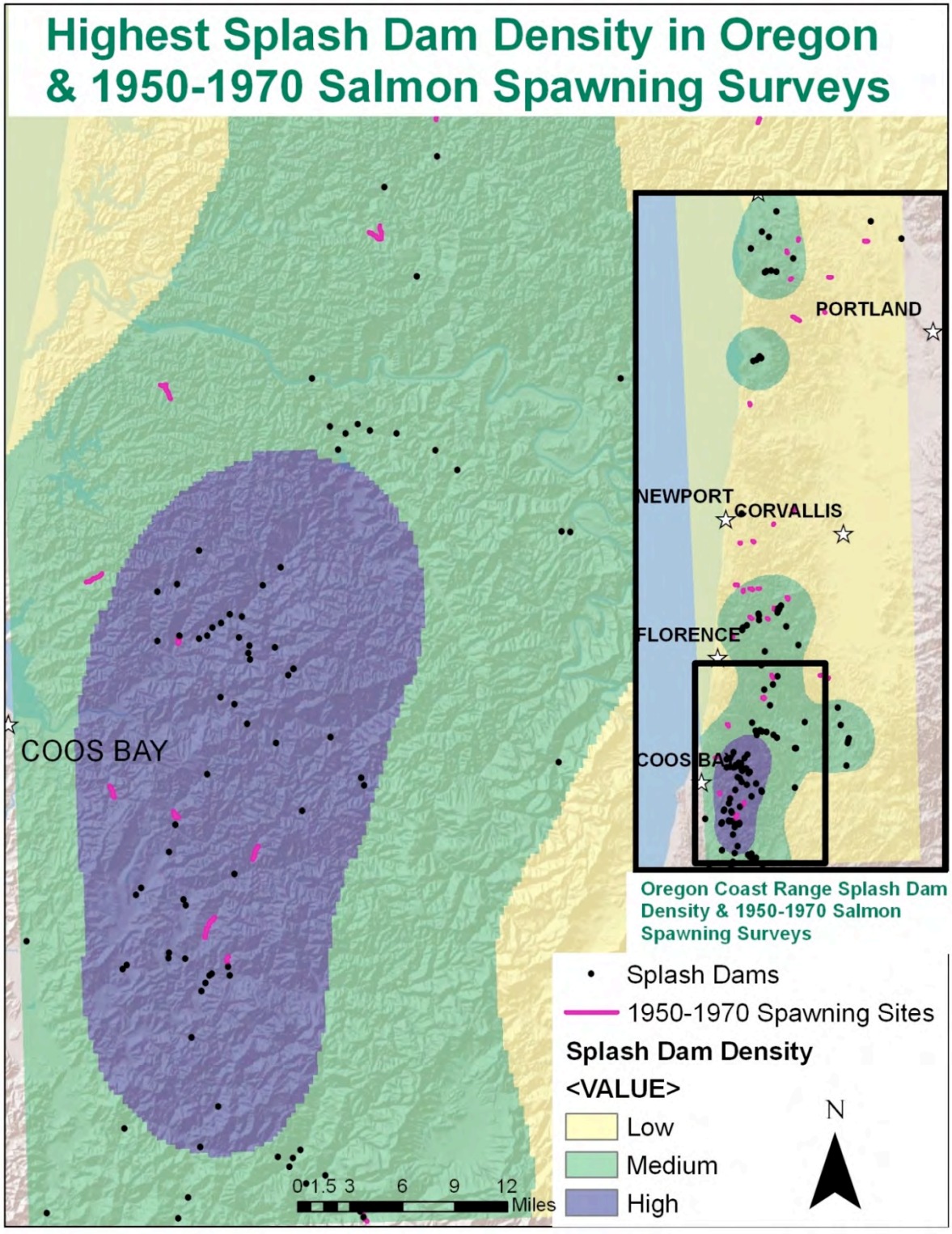
Step 11: Summarize total number of spawners/mile in splashed basins to un-splashed basins.



Results:

Goal 1: *To determine spatially if there is a disproportionate amount of historical spawning survey sites located in non-splashed areas to splashed areas.*

There were 6 coho spawning surveys in the High Density, 16 in the Medium Density classification, and 12 in the Low Density (Map 1).



Map 1: Splash Dam Density and Historical Spawning Sites

Goal 2: *To determine if there is a lower total count of spawners located in splashed areas between 1950-1970.*

The spatial query found 3 of 121 splash dams that were located within 4km of a historical spawning area (Table 1). I was able to match 2 splashed sites to 2 un-splashed sites. No pairing was found for the 3rd splash dam site –N.F. Coquille, as the basin area was so large that no matching non-splashed spawning area existed (Map 2).

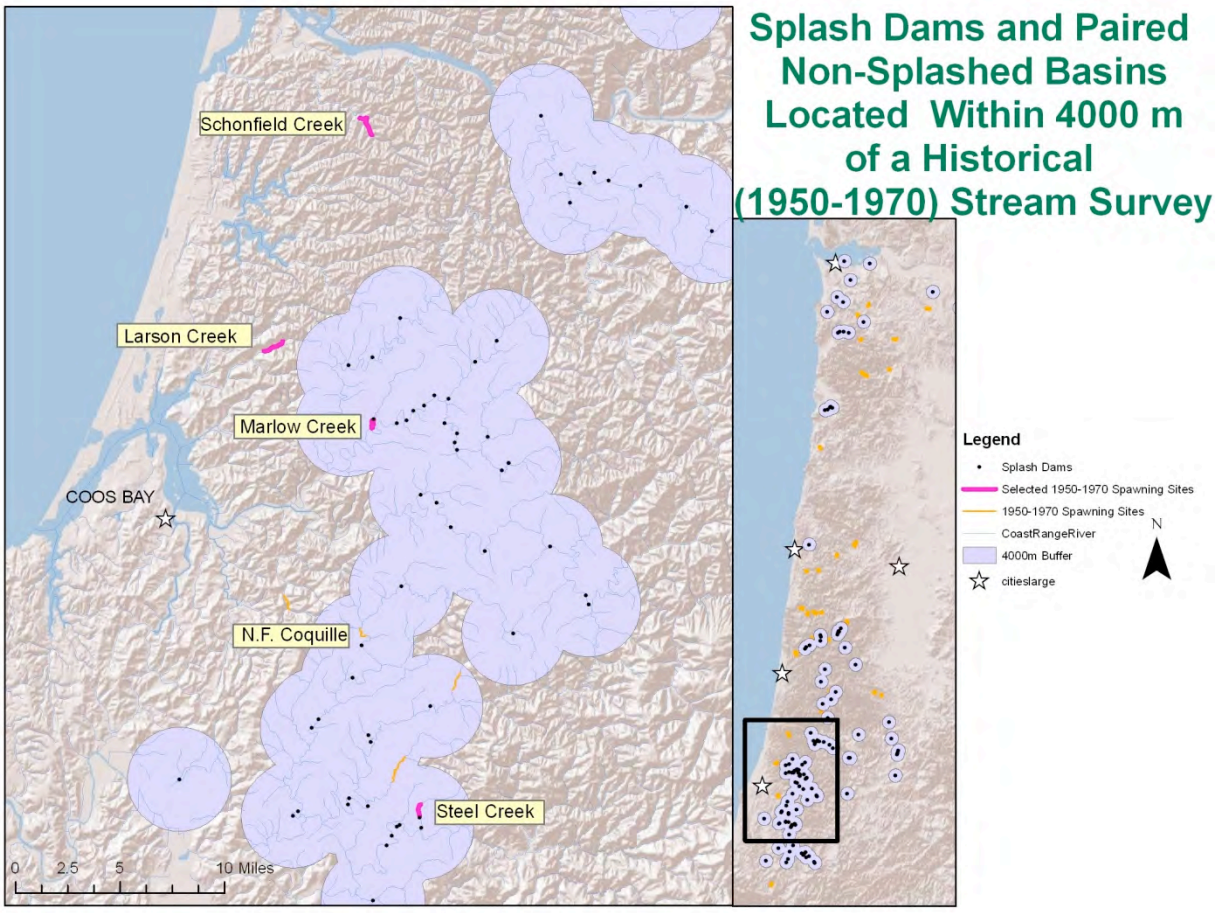
Splashed Creek	Basin Area	Gradient	Non-Splashed Creek (Paired)	Basin Area	Gradient
Steel Creek	10.2	0.01	Larson Creek	8.1	0.01
N.F. Coquille	73.68	0.002	-	-	-
Marlow Creek	17.33	0.01	Schonfield Creek	16.76	0.003

Table 1: Physical Characteristics of paired splashed and non-splashed basins

There was more than twice the total number of coho spawners between 1950-1970 in splashed basin than non-splashed basins (Table 2, Map 2). On average, there were 937 more total spawners per mile in un-splashed basins than splashed basins.

Splashed Creek	Total Number of Spawners between 1950-1970/mile	Non-Splashed Creek (Paired)	Total Number of Spawners between 1950-1970/mile	Mean Difference
Steel Creek	915	Larson Creek	1545	630
Marlow Creek	527	Schonfield Creek	1773	1246
Sum	1442		3317	1875
Average	*721*		*1658*	*937*

Table 2: Number of Spawners in splashed and non-splashed basins



Map2: Splash basins and paired non-splashed basins located within 4000m of a historical stream survey

Discussion/Sources of Error

Goal 1: *To determine spatially if there is a disproportionate amount of historical spawning survey sites located in non-splashed areas to splashed areas.*

It does not visually appear that there is a spatial correlation between historical splash dam sites and historically abundant coho spawning sites. There was a disproportionate amount of historical spawning sites in low density sites (12) than high density sites (6). However, the total numbers do not reflect the whole story. One source of error is that a greater area of the coast range is in the low density category,

so naturally there are more spawning survey sites (12 in total) in the low density category. Similarly, only a small area is in the high density category, so there are far fewer spawning surveys (6 in total).

The splash dam density classification of H, M, L changes slightly when splash dams east of the Coast Range crest are included (In the analysis only the west crest was used, as this was the study area of spawning surveys). When splash dams found on both crests of the Cost Ranger are included, a high density patch is located in the central coast (Figure 3). With the inclusion of the east crest splash dams, area, the number of splash dams in each density classification changes to Low=9, Medium=19 and High=6.

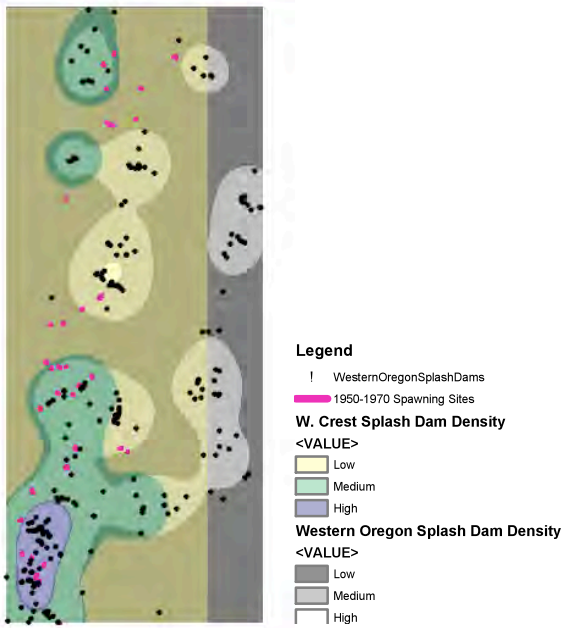


Figure 3: Density comparison with W. Crest and All Splash Dam sites

Goal 2: *To determine if there is a lower total count of spawners located in splashed areas between 1950-1970.*

A result of more than twice the amount of spawners was counted in non-splashed creeks. Conceptually and theoretically, one would expect to see a difference, but to actually see such a large quantitative mean difference result was rather exciting. However, this excitement should be tempered with a bit of caution. The coverage of spawning sites, didn't match up as well as I would have liked, and this resulted in a small sample size. Only 3 of the 34 spawning survey sites match with splash dam sites, this low ratio of matched sites could be due to Coho biology as spawning areas tend to be in smaller tributaries while splash dams are located on larger mainstem creeks. The small sample size (2 pairs) may not reflect the true pattern of the number of spawners in splashed and unsplashed basins. It is possible that the 2 un-splashed sites for the paired basin comparison, (Larson and Schonfield Creeks) are not representative. One confounding variable is that the matched un-splashed creeks themselves are spatially located closer to the ocean, so salmon don't have to migrate as far to spawn. Two physical parameters that were not included, land use cover or basin geology, might also influence result. One unknown that should be investigated is where historical hatchery supplementation occurred.

References:

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