A Spatial Analysis of Urban Runoff Mortality Syndrome in Coho Salmon *(Oncorhynchus kisutch)* in Puget Sound.

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Introduction:

- Coho (*Oncorhynchus Kisutch)* urban mortality syndrome (URMS) is a relatively new phenomenon that causes Coho to die as they enter streams and rivers to spawn.
- URMS is characterized by gasping for air, loss of equilibrium, finning, and premature death (Feist et al 2017).
- A tire preservative compound has been identified as the main contributor to this phenomenon.
- Using GIS, this study aims to find the statistical correlation between Coho mortality rates and a gradient of urbanization – specifically impervious surfaces and road density - across the Puget Sound.

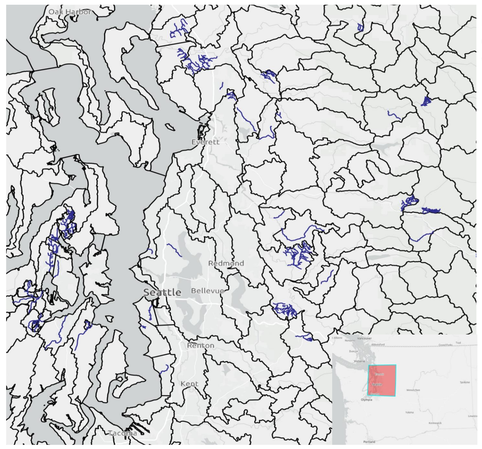


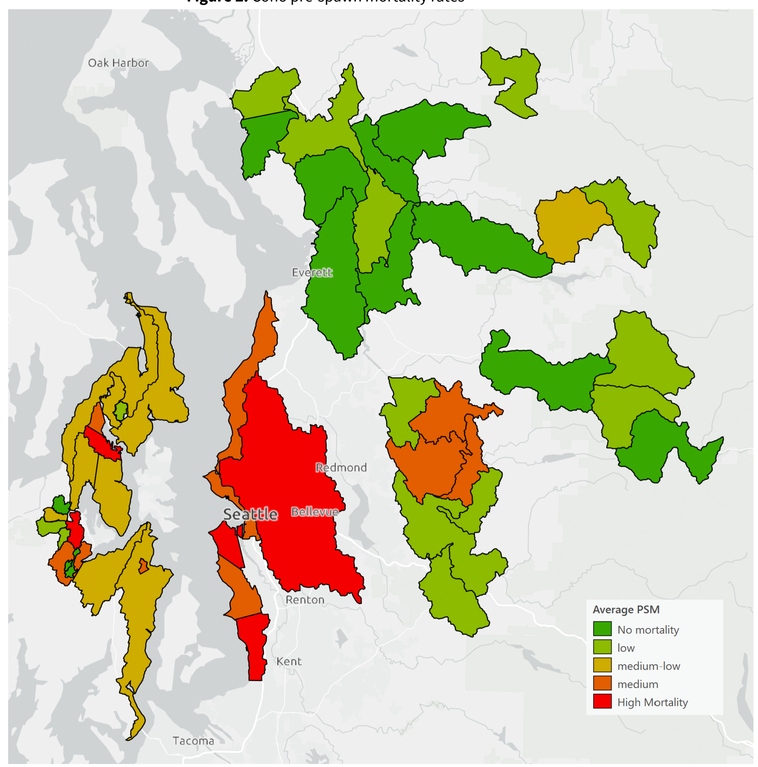
Figure 1. Location of streams and watersheds.

Methods

Watersheds and streams were retrieved from the National Hydrology Dataset, with the smallest watersheds layer used. Using a unique identifier from the mortality data tables, each stream was identified by hand and given a new field which the mortality table could then be joined to. While most of the selected streams were held within their own individual watershed, some watersheds had multiple streams of interest, which needed to be assigned their own basin/ sub-watershed. A DEM was analyzed through several tools within the hydrology toolbox of ArcPro. After all watersheds and sub-basins were delineated, the watershed layer was joined to the mortality for each river within them.

The summarize within tool was used to find the road density and average imperviousness within each watershed. After creating these summarized layers, their attribute table was exported to excel for the final analysis. The correlation tool was used, putting mortality rates against average imperviousness, and then putting mortality rates against road densities.

Figure 2. Coho pre-spawn mortality rates



Results:

- Correlation between mortality rates and imperviousness is strong ($R^2 = 0.584$)
- Correlation between mortality rates and road density is even stronger ($R^2 = 0.601$).
- The 5 watersheds with the highest mortality rates are also selected and compared separately to see if the correlation is more significant in highly urban areas.
  - these 5 streams also had the most data collected on their mortality rates, dating back 8-10 years.
  - The correlation between these watersheds' mortality and the road density within them was very strong (R^2= 0.708).
  - However, the correlation between mortality rates and imperviousness the correlation dropped to (R^2= 0.264).

Discussion:

- The summarize within tool also returns the majority and minority impervious surface code seen within each watershed. In addition, this gave the percentage of the area that the majority and minority covered.
  - All but 4 of the watersheds had a majority grid code of 1. The four watersheds with a majority grid code of 7 (meaning 70% of each raster cell is impervious) had some of the highest mortality rates, each over 40%.
- These strong correlations show that Urban Mortality Syndrome in Coho Salmon is strongly related to the level of imperviousness within each watershed.
- The correlation between road density is even stronger. This supports the newer hypothesis that mortality is mainly caused by a tire preservative. Where there are more roads, there are typically more cars and therefore more particles from tire wear.

Figure 4. Road density.

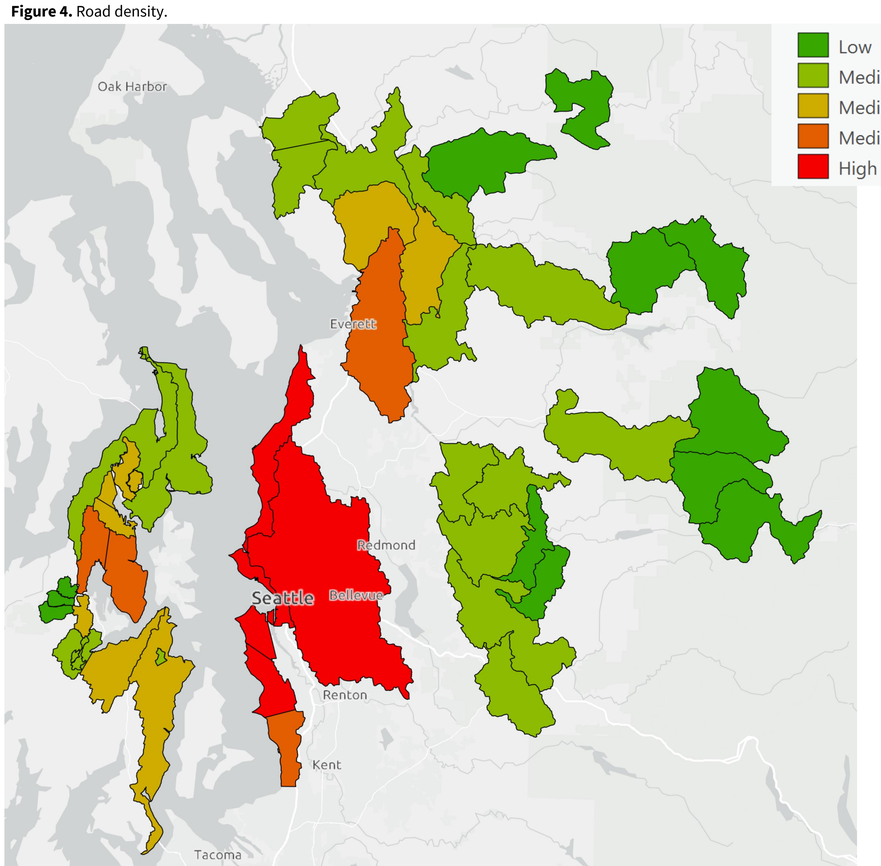
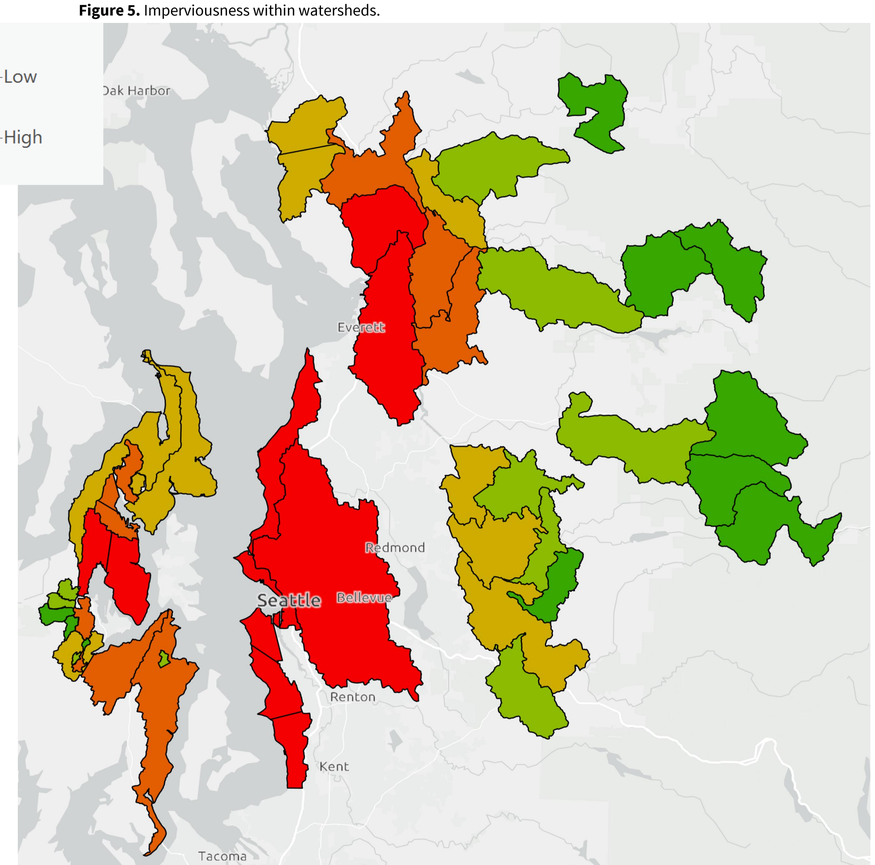


Figure 5. Imperviousness within watersheds.



Watersheds with 5 highest pre-spawn mortality rates	Mortality rate	Road Density (roads/ sq. mile)	Average Imperviousness	Majority GridCode/ %area	Minority Gridcode / %area.
Des Moines Creek	0.633	12.577	6.294	7/16.05	2/3.07
Thornton Creek	0.866	17.845	4.911	2/3.14	1/30.47
Big Scandia Creek	0.508	6.678	2.429	1/52.82	10/0.92
Longfellow Creek	0.770	16.479	5.759	7 / 21.05	2/3.45
Chico Creek	0.749	7.018	1.604	1 / 69.77	11 / 0.45
	Correlation	.708	.264		

Citations

Coho mortality data:
Feist, B.E., Buhle, E.R., Baldwin, D.H., Spromberg, J.A., Damm, S.E., Davis, J.W., and Scholz, N.L. (2017). Roads to ruin: conservation threats to a sentinel salmon species across an urban gradient. *Ecological Applications*, 27: 2382–2396. doi:10.1002/eap.1615.
Other data Sources:
National Land Cover Database
Pierce County open data portal. Kitsap County GIS department. Koordinates.com-Snohomish county. King County open data portal.
National Hydrology Dataset- Washington state
Analysis: Completed by Cameron Artz for the Certificate in GIS with consultation and help from Matthew Kelley PhD. March 2022. NAD 1983 HARN StatePlane Washington South FIPS 4602 (US Feet). Completed in ESRI ArcPro 2.9.