Follow the Flow: Linking Iron Oxide Signatures in the Puyallup Watershed to Sediment Sources

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Introduction

- Rivers provide essential resources such as water supply, transportation routes, and habitats, but they can also create serious challenges through erosion and flooding.
- Recent floods in the Puyallup/White River Watershed have drawn attention to how vulnerable the region is to these hazards. The severity of flooding and erosion is closely tied to how sediment is transported downstream and where it is eventually deposited, which can alter river channels and increase risk to nearby communities and infrastructure.
- However, predicting these hazards is difficult because we must first understand where the sediment originates and the pathways it follows through the watershed.
- Such as volcanic rocks from Mt. Rainier (including lahars) contain titanomagnetite and hematite and possibly magnetite whereas Pleistocene glacial deposits probably contain hematite and some magnetite
- Without this knowledge, it is harder to identify high-risk areas or develop effective strategies for managing flood and erosion impacts.
- This study uses iron oxides found in suspended sediment as natural tracers to help identify where sediment originates and how it moves through the watershed.

Mineral Name	Composition	χ (μm^3kg^-1)	SIRM (Am^2kg^-1)
Magnetite	Fe3O4	400-560	9-22
Titanomagnetite	Fe2.4Ti0.6O4	170-200	7-12
Hematite	αFe2O3	0.6	2.40E-01

Figure 7: Table depicts both the composition and the magnetic susceptibility for common minerals that are associated with iron oxide such as Magnetite, Titanomagnetite, and Hematite

Methods

Sampling & Sample Preparation

•Suspended sediment was collected from the White, Carbon, and Puyallup Rivers during both the summer and winter seasons of 2024–2025 using an extended sampling rod and plastic bottle or a bucket.

•After collection, the sediment was dried and separated by settling and sieving into sand, silt, and clay fractions. Silt was packed into non-magnetic gelatin capsules for analyses listed below.

Analytical Methods

Three main magnetic properties were measured to distinguish differences between magnetic iron minerals in sediment sources:

- **Magnetic susceptibility (χ)**, measured on a Bartington MS-2B, indicates the concentration of iron-bearing minerals in the sediment
- **Isothermal remnant magnetization (IRM)**, measured at 1 T in a Princeton Measurements MicroMag 3900, is also related to the concentration of magnetic iron oxide minerals
- **Magnetic Coercivity of Remanence (H_{cr})**, also measured on a MicroMag 3900, helps identify the types and characteristics of iron oxide minerals

Results

Figure 1: The magnetic susceptibility of a sampling site along the White River in Washington State at mile marker 3.4 for both the winter and the summer of 2024-2025.

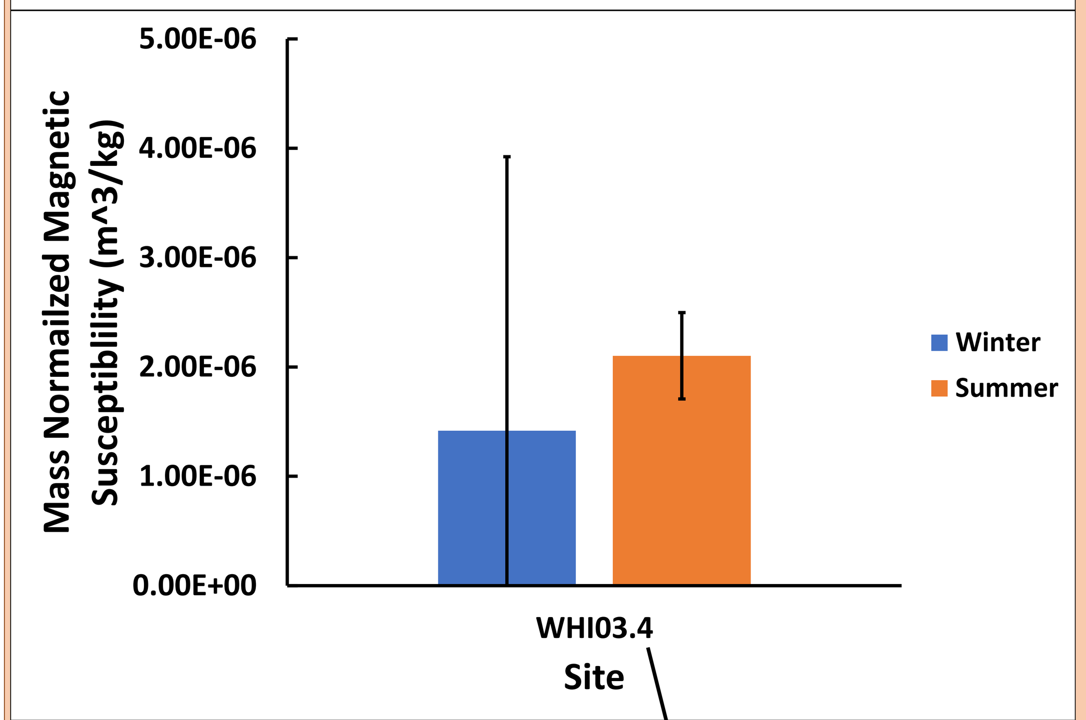
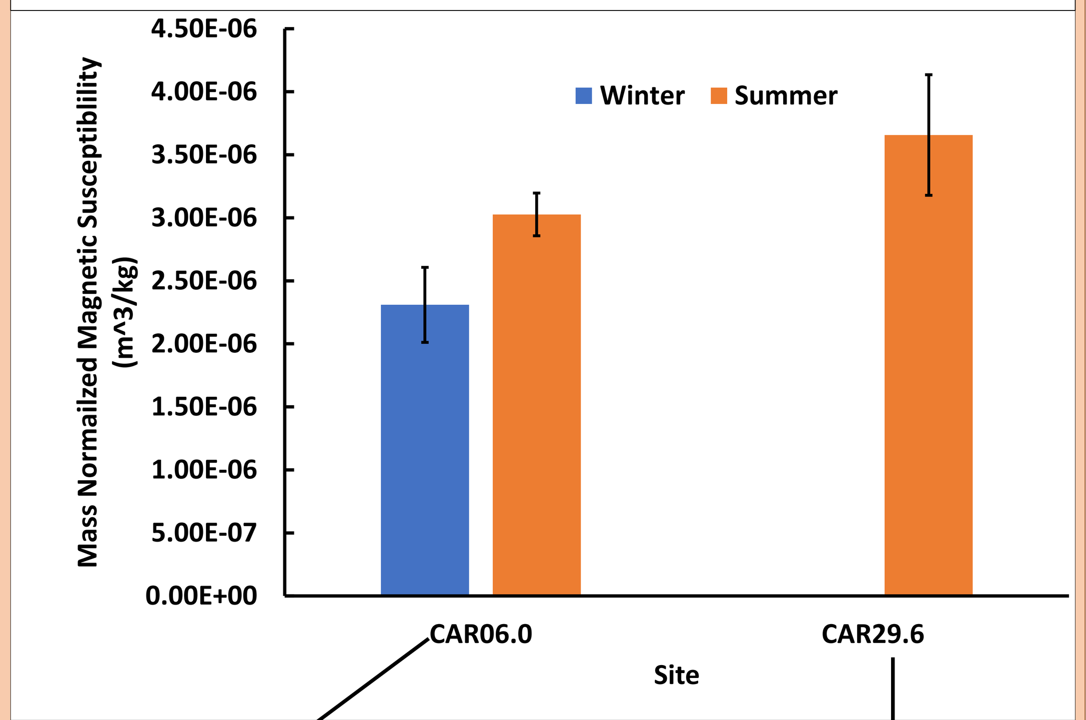


Figure 2: The magnetic susceptibility of two sampling sites along the Carbon River in Washington state at mile markers 6.0 and 29.6 for both the winter and the summer of 2024- 2025.



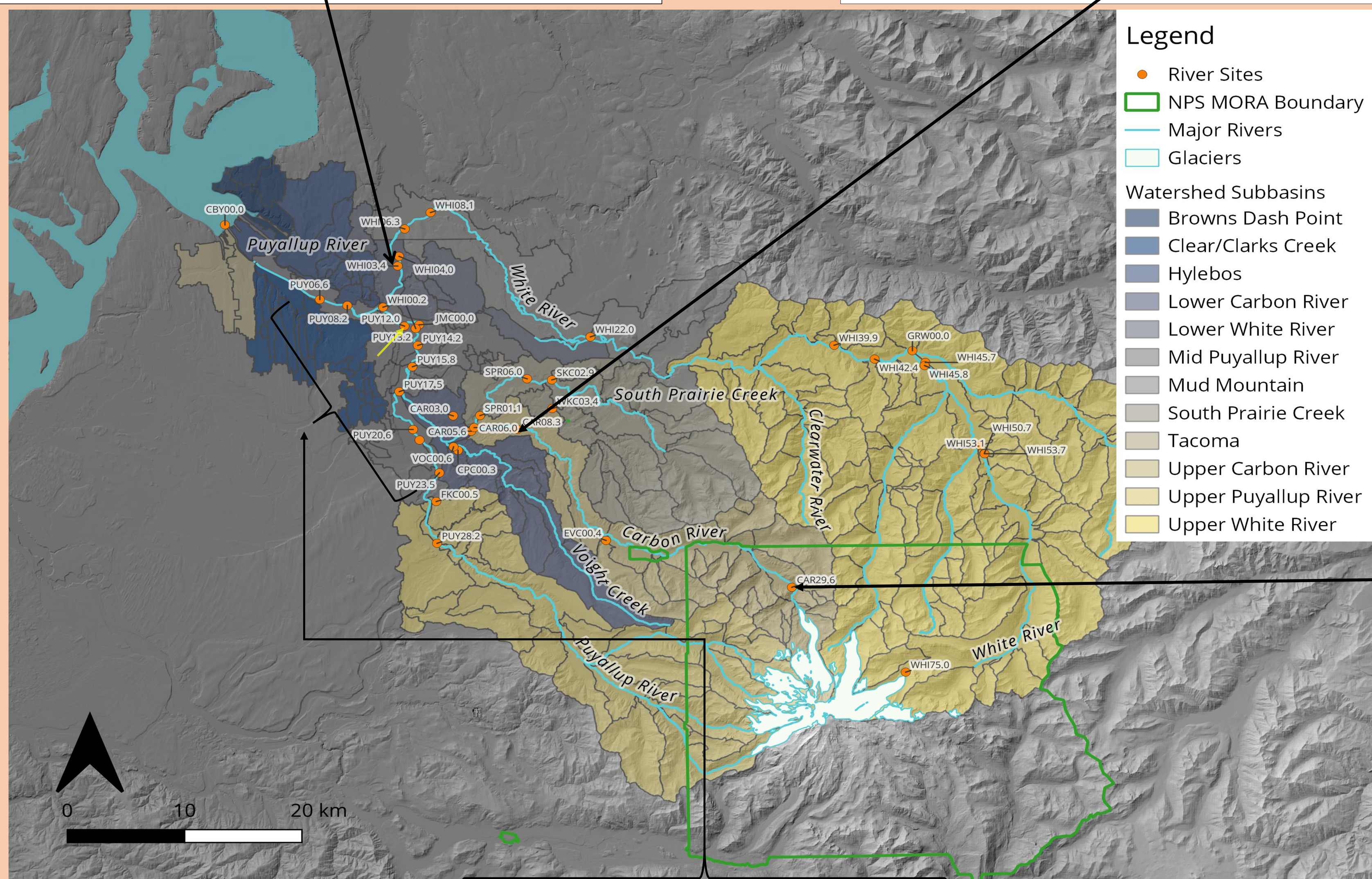


Figure 3: The Puyallup watershed river system originating from Mount Rainier and the various samples that were taken at each particular mile marker in the state of Washington.

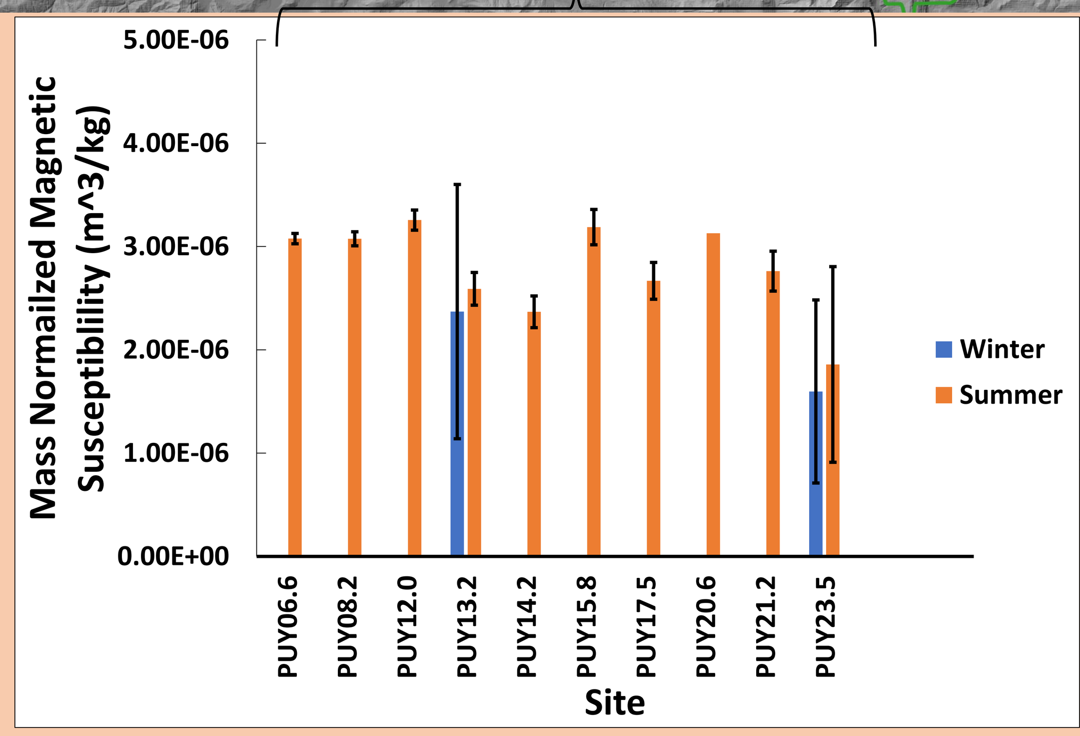


Figure 4: The magnetic susceptibility of ten sampling sites along the Puyallup River in Washington State at various mile markers for both the winter and the summer of 2024- 2025.

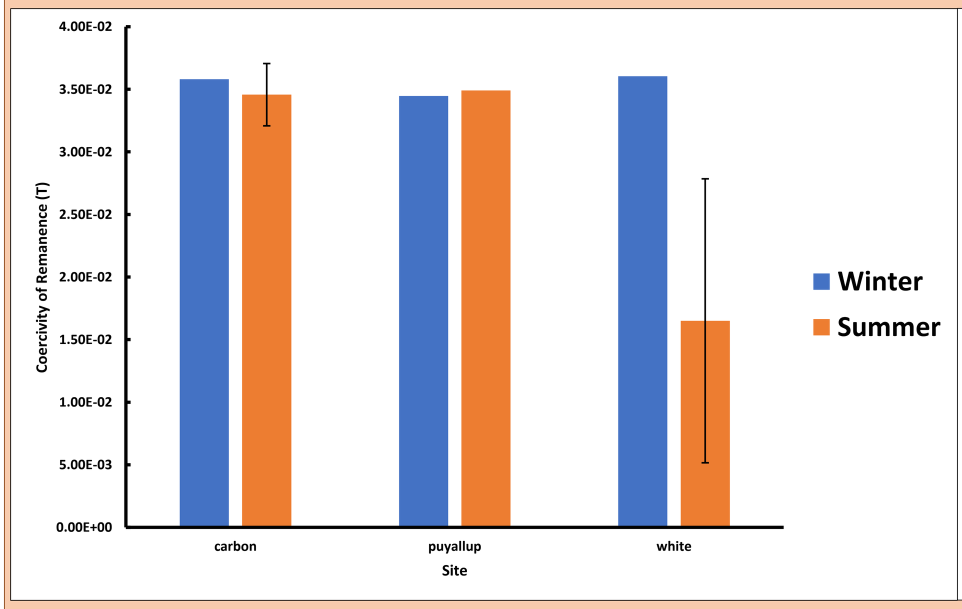


Figure 5: The Coercivity of Remanence during the summer and winter of 2024-2025 for the Puyallup, White and Carbon River within the Puyallup watershed.

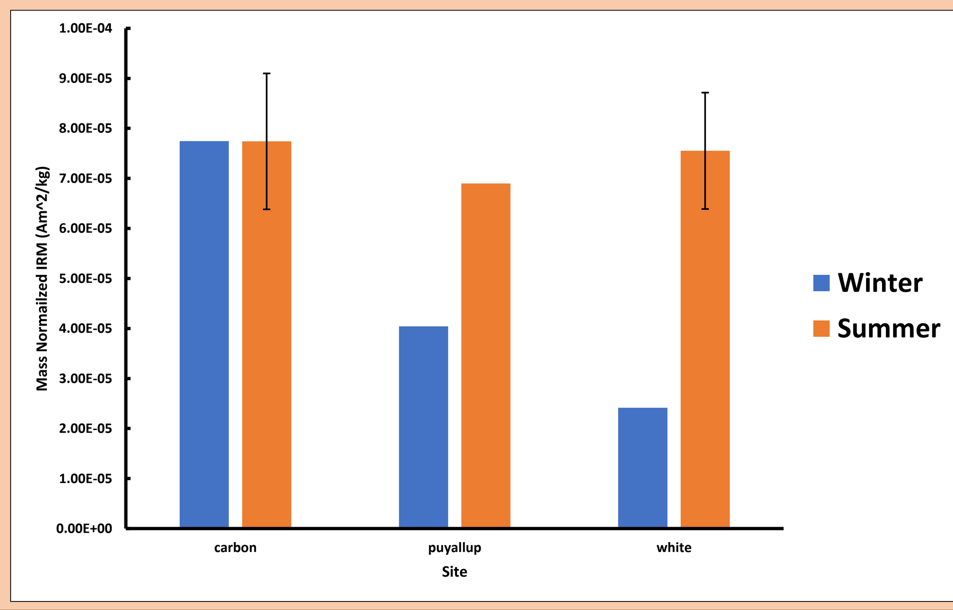


Figure 6: The values of the IRM during the summer and winter of 2024-2025 for the Puyallup, White and Carbon River.

Discussion

•**Magnetic susceptibility**: Magnetic susceptibility is higher in the summer and generally greater in the Carbon and Puyallup Rivers than in the White River, although high variability in winter makes these trends less clear and no strong relationship with distance downstream is observed.

•**Sampling limitation**: The results suggest that adding more sampling locations along each river would help clarify patterns and improve confidence in the findings.

•**IRM results**: Isothermal remnant magnetization (IRM) values are similar between the Puyallup and White Rivers during the summer but show noticeable differences in the winter samples.

•**Magnetic coercivity**: Magnetic coercivity is mostly consistent across rivers and seasons, except for distinct differences observed in the White River during the summer.

Interpretation:

Summer sediment generally contains higher concentrations of iron oxide, indicating increased delivery or transport of iron-rich material during this season. Winter sediment shows more variability in iron oxide concentrations, suggesting more mixed or inconsistent sediment sources during colder, higher-flow conditions. Additionally, the White River likely has different sediment sources or mineral characteristics compared to the Carbon and Puyallup Rivers, as indicated by its distinct magnetic properties.

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References