geosciences

MDPI

Supplementary Materials: Controls on the Spatial Distribution of Trace Metal Concentrations along the Bedrock-Dominated South Fork New River, North Carolina

Jerry R. Miller [1,*], Xaviera Watkins [2], Thomas O'Shea [3] and Cynthia Atterholt [4]

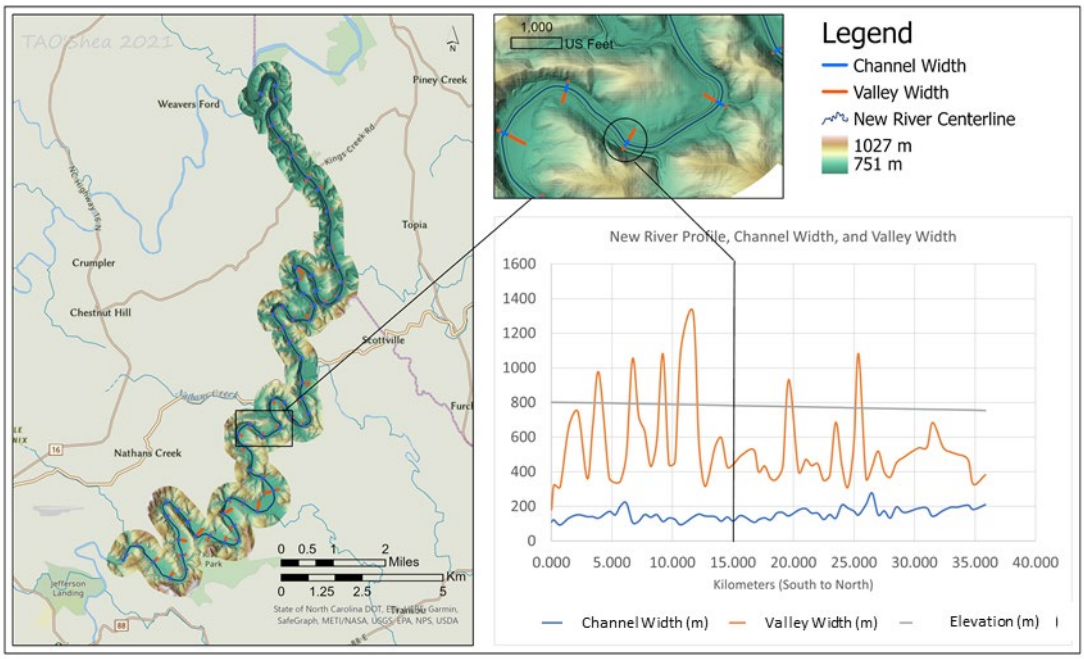

Figure S1. Images showing the process used to determine channel and valley width along the river from 1 m resolution LiDAR DEMs.

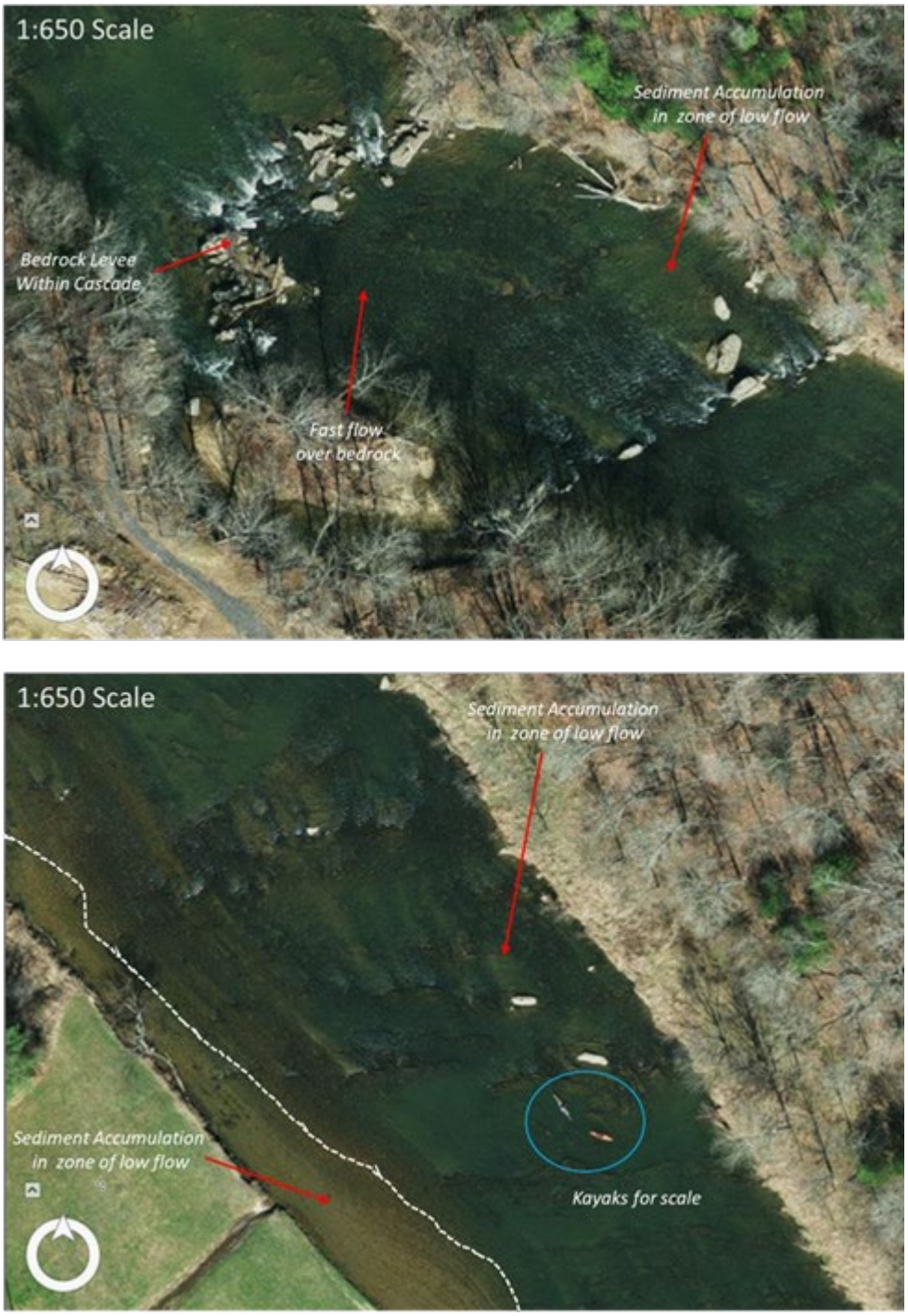

Figure S2. Representative images of bedrock reaches showing the general nature of cascades and the distribution of unconsolidated sediments in the vicinity of cascades. Cascades generally consist of resistant topographically high ribs separated by topographically low pools that obliquely traverse the channel (images from NC Center for Geographic Information and Analysis, December 6, 2018. Available: NC One Map, https://www.nconemap.gov/pages/imagery (accessed 6 August 2021)).

Table S1. Summary of organic matter content, % fine sediment, and metal concentrations in channel bed sediments of the SFNR.

Parameter	Mean	Minimum	Maximum	Std. Dev.	Crustal Ave.[a]
% Fine Sediment	4.01	<2	31.20	7.14	NA
% Organic Matter	0.69	0.16	5.21	1.03	NA
Al (mg/kg)	55,294	30,961	91,613	15,136	81,497
Cr (mg/kg)	53.54	19.09	161.54	29.14	92
Cu (mg/kg)	19.54	3.67	60.47	15.35	32
Fe (mg/kg)	32,351	4,676	70,362	17,811	39,000
Mn (mg/kg)	797	69	1,852	475	775
Si (mg/kg)					
Zn (mg/kg)	61.45	2.17	195	47.61	67

[a]Average composition of upper continental crust [1].

Table S2. Summary of Manning-Whitney U test results showing statistical differences between background sites (NR 2 - NR 10) and potentially mine contaminated sites (NR11 - NR26). The null hypothesis is that the distribution between background and potentially contaminated sites are similar. Level of significance set at 95 % confidence level.

Metal	Level of Significance	Decision
Fine Sediment	0.846	Accept null hypothesis - similar
Organic Matter	0.187	Accept null hypothesis - similar
Cr	0.169	Accept null hypothesis - similar
Cu	0.329	Accept null hypothesis - similar
Fe	0.169	Accept null hypothesis - similar
Mn	0.934	Accept null hypothesis - similar
Zn	0.487	Accept null hypothesis - similar
Cr/Si	0.074	Accept null hypothesis - similar
Cu/Si	0.301	Accept null hypothesis - similar
Fe/Si	0.152	Accept null hypothesis - similar
Mn/Si	0.667	Accept null hypothesis - similar
Zn/Si	0.357	Accept null hypothesis - similar
Al/Si	0.229	Accept null hypothesis - similar

Table S3. Summary of Emergency Response actions taken by the USEPA in 2011 at the Ore Knob Mine Site.

Primary objective:
Stabilization of the main tailings impoundment dam to prevent a catastrophic release of tailings to downstream waters.
Specific actions:
• Removed 12,333 m^3 of tailings from the main tailings impoundment sediment pond; action allowed the pond to continue to capture additional sediment;
• Constructed a diversion channel around the main tailings impoundment area to direct storm water downstream. Action intended to minimize erosion of the dam face and limit acid mine drainage.
• Filled four ponds adjacent to the main tailings impoundment area to reduce surface water infiltration into the tailings wastes.
• Re-faced the main tailings impoundment area.
• Removed 45873 m^3 of mine tailings from the tailings dam at the 1950s mine and mill area.
• Constructed catchment basins to minimize the flow of sediment into the diversion channel.
• Reconstructed the sediment pond embankment to provide more stability and increase sediment pond capacity.

(from USEPA – Ore Knob Mine Superfund Site Summary: https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0409895, accessed 6 August 2021) [2].

Table S4. General description of geological units underlying the South Fork New River (from NC One Map; Published July 2009; accessed 8 October 2021; URL - https://www.nconemap.gov/datasets/geology/explore?location=35.154912%2C-79.920500%2C7.20, accessed 6 August 2021.

Rock Unit (formation)	Estimated Age	General Description
Amphibolite	Late Proterozoic	Equigranular, massive to well foliated, interlayered, rarely discordant, metamorphosed intrusive and extrusive mafic rock; may include metasedimentary rock
Muscovite-biotite gneiss	Late Proterozoic	Locally sulfidic; interlayered and gradational with mica schist, minor amphibolite, and hornblende gneiss
Biotite granitic gneiss	Middle Proterozoic	Pinkish gray to light gray, massive to well foliated, granitic to quartz monzonitic; includes variably mylonitized orthogneiss and paragneiss, interlayered amphibolite, calc-silicate rock, and marble. Includes
Mica Schist	Late Proterozoic	Locally sulfidic and graphitic; minor interlayered mica gneiss and amphibolite
Gneiss	Late Proterozoic	Finely laminated to thin layered; locally contains massive gneiss and micaceous granule conglomerate; includes schist, phyllite, and amphibolite

Table S5. Summary of Kruskal-Wallis test results showing statistical differences between bedrock types. sites along entire study reach (NR 2 - NR 26). Three bedrock units were including a gneiss, an amphibolite, and a granitic gneiss. Local outcrops of mica schist and metasedimentary rock (which each underlaid two sites each) were not included given their small sample size. The null hypothesis is that the distribution across all bedrock units is similar. Level of significance set at 95 % confidence level.

Metal	Level of Significance	Decision
Fine Sediment	0.330	Accept null hypothesis - similar
Organic Matter	0.255	Accept null hypothesis - similar
Cr	0.410	Accept null hypothesis - similar
Cu	0.131	Accept null hypothesis - similar
Fe	0.0556	Accept null hypothesis - similar
Mn	0.074	Accept null hypothesis - similar
Zn	0.054	Accept null hypothesis - similar
Cr/Si	0.402	Accept null hypothesis - similar
Cu/Si	0.207	Accept null hypothesis - similar
Fe/Si	0.065	Accept null hypothesis - similar
Mn/Si	0.365	Accept null hypothesis - similar
Zn/Si	0.058	Accept null hypothesis - similar
Al/Si	0.452	Accept null hypothesis - similar

Figure S3. Areal view of sampling sites NR 21 and NR 26. Both sites exhibit relatively high fine sediment contents and are located in close proximity to bedrock cascades that obstruct flow. Google Earth images obtained on 10 June 2021; Date images taken: 23 October 2019.

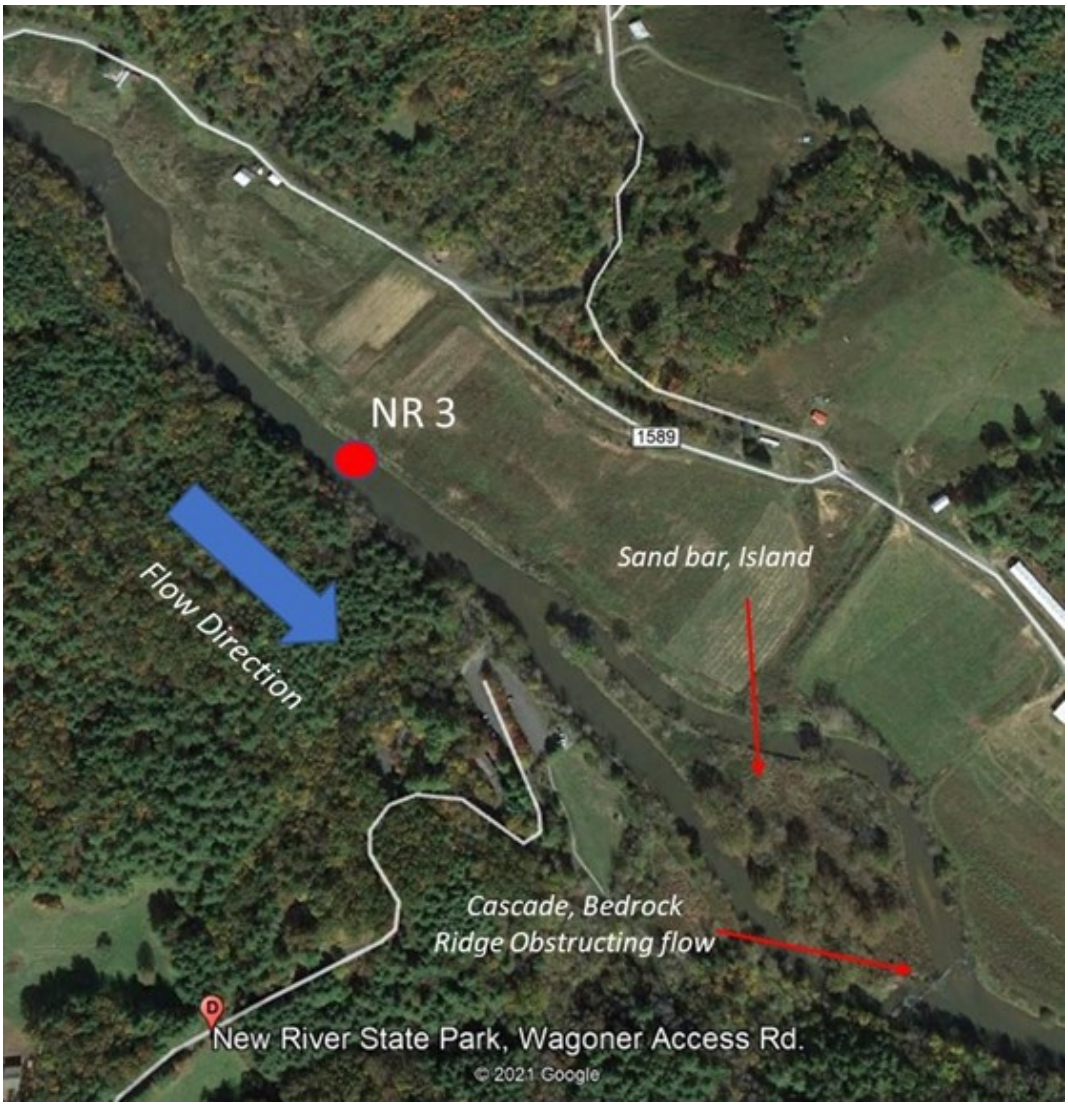

Figure S4. Areal view of sampling sites NR 3. All three exhibit relatively high fine sediment contents and are located in close proximity to bedrock cascades that obstruct flow. Google Earth images obtained on 10 June 2021; Date images taken: 23 October 2019.

Table S6. Summary of Manning-Whitney U test results showing statistical differences between pool and riffle sites along entire study reach (NR 2 - NR 26). The null hypothesis is that the distribution between background and potentially contaminated sites are similar. Level of significance set at 95 % confidence level.

Metal	Level of Significance	Decision
Fine Sediment	0.611	Accept null hypothesis - similar
Organic Matter	0.111	Accept null hypothesis - similar
Cr	0.695	Accept null hypothesis - similar
Cu	0.852	Accept null hypothesis - similar
Fe	0.782	Accept null hypothesis - similar
Mn	0.376	Accept null hypothesis - similar
Zn	0.894	Accept null hypothesis - similar
Cr/Si	0.186	Accept null hypothesis - similar
Cu/Si	0.689	Accept null hypothesis - similar
Fe/Si	0.689	Accept null hypothesis - similar
Mn/Si	0.769	Accept null hypothesis - similar
Zn/Si	0.894	Accept null hypothesis - similar
Al/Si	0.538	Accept null hypothesis - similar