SURFACE COAL MINING IN CENTERAL APPALACHIA: IS BIOACCUMULATION OCCURRING IN THE HEADWATER STREAMS?

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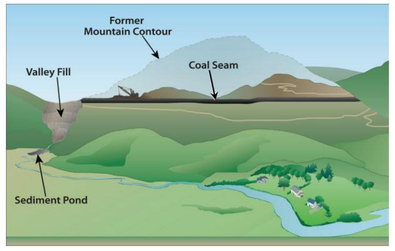
Background

- Strip mining removes the upper layer of soil and rock from a mountaintop to allow access to coal
- Material removed from mountaintop is usually deposited in nearby valley, known as a valley fill
- Headwater streams can be affected by unearthed elements now leaching into headwater streams



https://www.epa.gov/sc-mining/basic-information-about-surface-coal-mining-appalachia

https://timeecocentric.files.wordpress.com/2011/12/mountaintop_mining.jpg?w=611&h=404&crop=1

Objectives and Methods

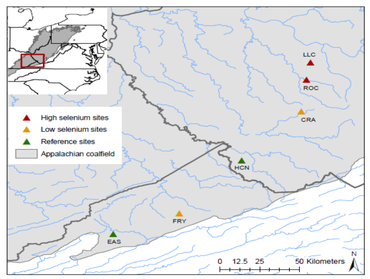


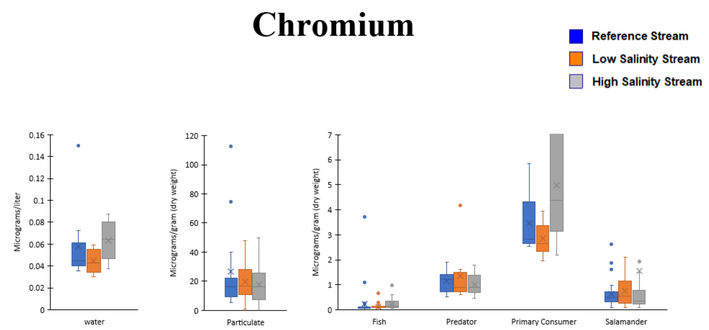
Figure 1

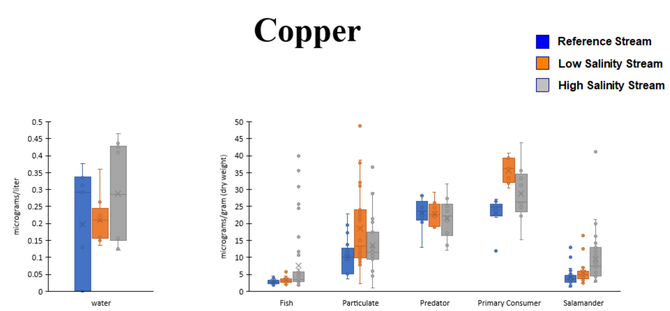
Timpano, A. J. (2017). *Toward improved assessment of freshwater salinization as a benthic macroinvertebrate stressor* (Doctoral dissertation, Virginia Tech).

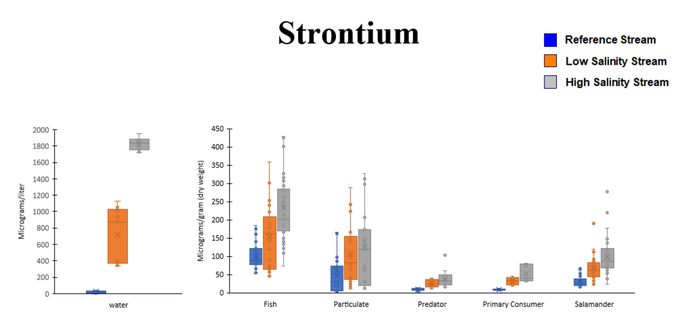
Figure 2

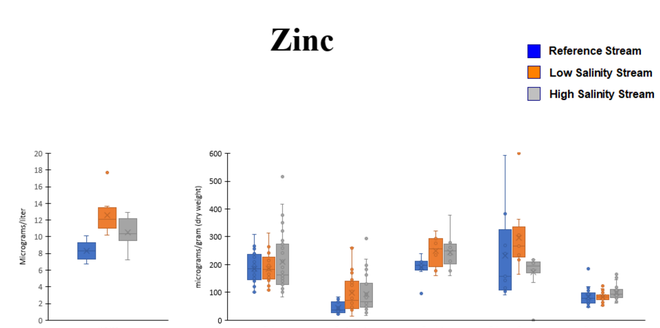
- Figure 1: 6 locations where samples were collected
  - 2 non-mined reference streams
  - 2 low salinity streams
  - 2 high salinity streams
- Figure 2: A stream where data was collected
- Media type collected: water, particulate matter, primary consumers, predators, salamanders, and fish
- Elements tested from media types: arsenic, cadmium, chromium, cobalt, copper, nickel, selenium, strontium, and zinc

Elemental Data Graphs









Statistical Analysis

Before being able to test for bioaccumulation, it must be determined if each of the three categories (reference, low salinity, high salinity) are normally distributed. If so, then a one-way ANOVA is run to determine if there is a significant difference between the three. If the three are not normally distributed, then a Kruskal Wallis H Test is used.

Strontium Fish - Reference		Strontium Fish - Low Salinity		Strontium Fish - High Salinity	
160.36		*358.49*		*191.2215758*	
Mean	97.71363636	Mean	147.8346875	Mean	234.3531714
Standard Error	5.773482498	Standard Error	14.24866728	Standard Error	14.68836788
Median	88.39	Median	152.63	Median	207.73
Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviatior	33.1661319	Standard Deviatior	80.60263403	Standard Deviatior	95.19150351
Sample Variance	1099.992305	Sample Variance	6496.784613	Sample Variance	9061.422341
Kurtosis	0.612220604	Kurtosis	-1.009623035	Kurtosis	1.7611793
Skewness	0.977856548	Skewness	0.295808042	Skewness	1.177692655
Range	131.39	Range	263.49	Range	469.9156377
Minimum	53.46	Minimum	45.78	Minimum	73.46436231
Maximum	184.85	Maximum	309.27	Maximum	543.38
Sum	3224.55	Sum	4730.71	Sum	9842.8332
Count	33	Count	32	Count	42

Excel - Testing for normal distribution

HO	All populations are distributed the same way				
HA	At least one of the populations is distributed differently				
Rank	=RANK(AO3,$AO$3:$AQ$12,1)	=RANK(AP3,$AO$3:$AQ$12,1)	=RANK(AQ3,$AO$3:$AQ$12,1)		
	=RANK(AO4,$AO$3:$AQ$12,1)	=RANK(AP4,$AO$3:$AQ$12,1)	=RANK(AQ4,$AO$3:$AQ$12,1)		
	=RANK(AO5,$AO$3:$AQ$12,1)	=RANK(AP5,$AO$3:$AQ$12,1)	=RANK(AQ5,$AO$3:$AQ$12,1)		
	=RANK(AO6,$AO$3:$AQ$12,1)	=RANK(AP6,$AO$3:$AQ$12,1)	=RANK(AQ6,$AO$3:$AQ$12,1)		
	=RANK(AO7,$AO$3:$AQ$12,1)	=RANK(AP7,$AO$3:$AQ$12,1)	=RANK(AQ7,$AO$3:$AQ$12,1)		
	=RANK(AO8,$AO$3:$AQ$12,1)	=RANK(AP8,$AO$3:$AQ$12,1)	=RANK(AQ8,$AO$3:$AQ$12,1)		
	=RANK(AO9,$AO$3:$AQ$12,1)	=RANK(AP9,$AO$3:$AQ$12,1)	=RANK(AQ9,$AO$3:$AQ$12,1)		
	=RANK(AO10,$AO$3:$AQ$12,1)	=RANK(AP10,$AO$3:$AQ$12,1)	=RANK(AQ10,$AO$3:$AQ$12,1)		
	=RANK(AO11,$AO$3:$AQ$12,1)		=RANK(AQ11,$AO$3:$AQ$12,1)		
			=RANK(AQ12,$AO$3:$AQ$12,1)		
Sum of ranks	=SUM(AO17:AO25)	=SUM(AP17:AP25)	=SUM(AQ17:AQ25)		
Count	=COUNT(AO17:AO26)	=COUNT(AP17:AP26)	=COUNT(AQ17:AQ26)	=SUM(AO28:AQ28)	
sum of squares^2/count	=AO27^2/AO28	=AP27^2/AP28	=AQ27^2/AQ28	=SUM(AO29:AQ29)	<<<sum
K	=(12/(AR28*(AR28+1)))*AR29-3*(AR28+1)				
Critical Value	=CHIINV(0.05,2)				
P-value	=CHIDIST(AO31,2)				

Excel - Formulas created to run a Kruskal Wallis H Test

Conclusions and Future Work

Excel was used to analyze data and help determine one-way Analysis of Variance and Kruskal Wallis H tests, but a more powerful program such as R should be used to finish comparing data relationships to look for bioaccumulation.

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