ASSESSMENT OF MIDDLE CREEK USING WATER QUALITY INDEX (WQI) AND DIATOM METRICS

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Abstract

It is believed that small streams and waterways of the Susquehanna River cause the problems in the Chesapeake Bay. This study helps develop a better understanding of how these small streams are affecting Susquehanna River and eventually the Chesapeake Bay. Water Quality Index (WQI), Shannon Diversity Index, Pollution Tolerance Index, and Cocconeis percentage were uses to assess the water quality of Middle Creek; a small stream located in Snyder County, PA. In addition, this study establishes possible trends among these indices. In the biological components, Diatoms were used to generate indices while eleven parameters including physical and chemical properties were used in the WQI. Data analysis showed visible interaction between the water quality and the diversity in aquatic species. A cause and effect dynamic was observed between WQI and diversity. As the WQI changes, the diversity was affected further downstream. The WQI seems to have a direct affect on % Cocconeis and in turn it affects the diversity. This study establishes that looking at one biological index does not indicate water quality because of the inter-dependence of the organisms on each other. Generally, the water quality of MC remains good yet the runoff from the agricultural land and the two lakes do affect the water and the diversity downstream to a certain degree.

Site Description

The sites were labeled A, B, C, D, E, F, G, H, I, Walker Lake (WL) and Faylor Lake (FL) (Figure 1). This study focuses on the analysis of the WQI compared against the biological indices. The sites were sampled during the period between June and July of 2012 and July of 2013. Temperature, pH, conductivity, TDS, DO and ORP were measured in the field while nutrient (PO_4^{3-}, NO_2^-, NH_3 and NO_3^-), ion concentrations and COD, BOD_5 and TSS were measured in laboratory. Biological assessment were also performed following EPA guidelines for wadeable streams. Periphytometers were left for 6 weeks in MC to allow periphyton to grow. After collection one side of the slide was scraped and the scraping was placed in a 50 mL falcon tube. The other half of the slide was then treated with 1:5 diluted carosafe. After spending a week soaking in carosafe, the slides were then fixed and viewed under a diffraction microscope. 300 individual taxa were counted from each of the 5 slides. The counted diatoms were used to create a Shannon Diversity Index and number of taxa relative to each site (Table 2). Bray-Curtis similarity graph was created to show site similarity (Table 1).

A										0-19
B	0.95492									20-39
C	0.95701	0.95013								40-59
D	0.96164	0.97084	0.95852							60-79
E	0.91869	0.93777	0.91952	0.94342						80-100
F	0.4707	0.48579	0.48342	0.465	0.45598					
H	0.91153	0.9319	0.91428	0.93817	0.98795	0.46154				
J	0.56484	0.57995	0.57566	0.56234	0.55699	0.73175	0.55699			
Walker	0.07178	0.06535	0.07254	0.06924	0.06473	0.12607	0.07234	0.10435		
Faylor	0.94579	0.94019	0.9397	0.95272	0.91096	0.46181	0.91163	0.5517	0.0761	
	A	B	C	D	E	F	H	J	Walker	Faylor

Table 1: Bray-Curtis trends

	WQI	TAXA	SHANNON	%COCCONEIS	PTI
MAIN STEM					
A	91.575	20	0.5531	92.5	2.913
B	91.73	14	0.4321	94.0	2.975
C	90.422	21	0.6461	90.6	2.870
D	90.076	14	0.4697	94.8	2.966
E	90.959	9	0.1446	98.2	2.983
WEST BRANCH					
F	88.99	27	1.8060	56.3	3.603
FAYLOR	87.615	8	0.3922	97.5	2.985
G	91.692	33	2.0214	1.9	2.622
NORTH BRANCH					
H	89.812	15	0.4626	91.2	2.959
WALKER	82.809	22	1.0037	5.3	2.113
I	91.076	25	1.4387	53.5	2.729

Table 2: Summary of the data

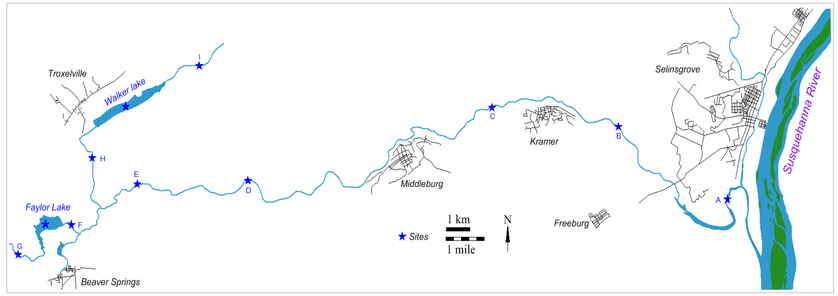

Figure 1: Location of Middle Creek and the eleven sample sites.

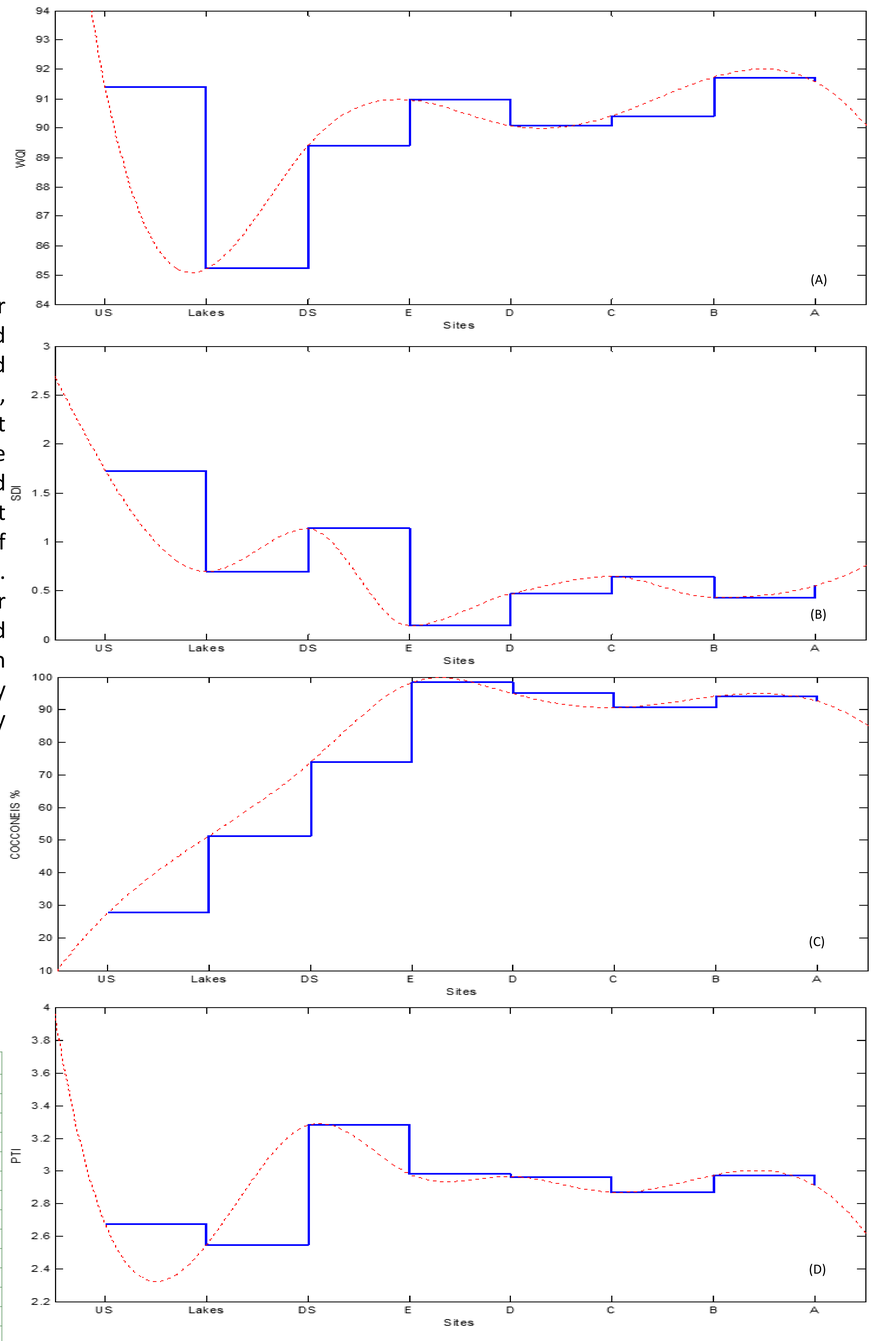

Figure 2: Plots of data, and averages of upstream sites, lakes, and downstream sites. Diatom metrics follow a cause and affect dynamics.

Results

- **WQI shows** evidence of impacting the diversity of Diatoms in Middle Creek.
- **Headwaters showed** WQI averaged at 91.384 or excellent water and the SDI is averaged at 1.7 or relatively high diversity observed on MC. Farther downstream.
- ***C. plancentula*** has a lower PTI of three which means it is affected by water quality yet in the headwaters where water is excellent C. plancetula is in low quantity.
- **WQI vs SDI** shows a dynamic of cause and affect. Water from upstream impacts the diversity downstream.
- **WQI vs % Cocceneis** is not a good indicator of WQI because it is not abundant in the head waters yet follows the trend of the water quality. Ex sites E→A
- **WQI vs PTI** is not a good indicator of water quality for Middle Creek because of the over abundance of C. plancentula. PTI may work in other locations where diversity is high.
- **Water Quality** starts out as excellent (90-100) at the headwaters, but once it enters the lakes it falls to only good water (80-89). After lakes the water can re-oxygenate and becomes excellent again.
- **Water** exhibits **dynamic** characteristics → Affects the water both at that site and downstream of the site.

Discussion

- The presents of the lakes in this experiment shows problems because they affect the water quality downstream of the lakes and could be the reason for C. plancentulas abundance. The low water quality of the lakes could have inhibited the diversity and other species while promoted C. plancentula.
- Water flows towards base level and affects the organisms downstream; But also affects the organisms at that site.
- In this farming community the run off from farms could be the causing the promotion of C. plancentula.
- Using single one parameter biological indices cannot indicate water quality just by themselves, while WQI uses multiple parameters to achieve the waters quality. A new "Biological Water Quality Index" should be created that uses the same ideas of multiple indicies to create one large index i.e. PTI, and SDI.
- Further work should be done focusing on *C. plancentula* in order to identify what is promoting its presence over other species, and in comparing MC with other streams in the area that are not impacted so heavily by the lake.

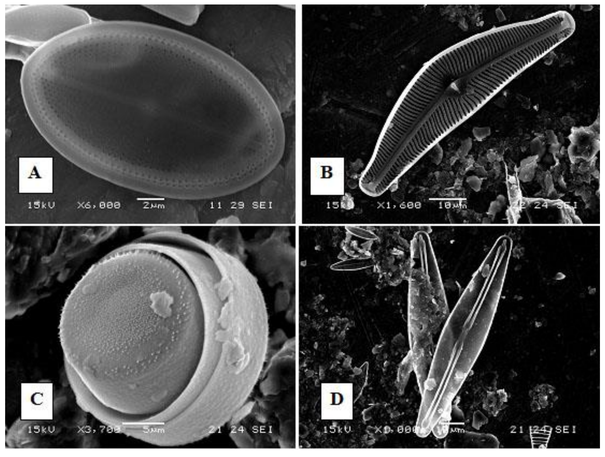

Figure 2. SEM micrographs of diatoms collected from sites in Middle Creek.
A: *Cocconeis placentula*. B: *Cymbella cistula*
C. *Melosira varians*. D*: Frustulia rhomboides*

Acknowledgments:

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