University of Wisconsin-Stevens Point

Benthic macroinvertebrate community responses to wastewater treatment plant discharges in central Wisconsin

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Introduction

Municipal wastewater treatment plants (WWTPs) discharge treated effluents, potentially impacting the water quality of receiving waterbodies.
Aquatic macroinvertebrate community metrics can provide valuable insights on the ecological condition of waterways. Understanding the impacts of WWTP effluents is important to better manage water quality.
I investigated macroinvertebrate community responses at four central Wisconsin mid-sized WWTPs. I hypothesized aquatic macroinvertebrate metrics would reflect a decrease in water quality downstream of the WWTPs.

Methods

Selected WWTPs for similar service area populations and size of receiving waters (Figure 1)
Established sample sites up- and downstream of each plant
Recorded physical characteristics and water chemistry at each site (Table 1)
Sampled macroinvertebrates at each site (Figure 2)
- Three pseudo-replicate samples
- Standardized kick-net method
- Multi-habitat samples

Sorted samples using stratified grid subsample procedure
- 100-specimen target

Performed family-level identifications and enumerations

Figure 1. Map of WWTP sites.

Figure 2. Sampling for macroinvertebrates.

Figure 3. (right) pH values recorded upstream and downstream of each WWTP.

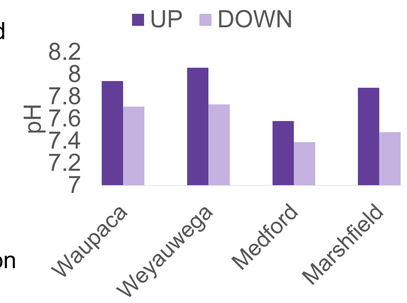
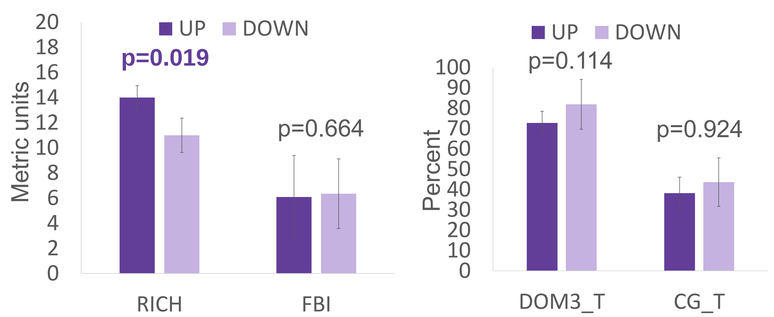


Table 1. (below) Summary of water chemistry and substrate composition at each site.

Site	Temp (ºC)	pH	SpC (µS/cm)	DO (mg/L)	DO (%)	1º Substrate	2ºSubstrate
Waupaca Up	11.37	7.94	486.7	11.35	107	Fine Gravel	Coarse Gravel
Waupaca Down	10.40	7.71	488.3	11.45	106	Small Cobble	Coarse Gravel
Weyauwega Up	12.30	8.06	459.6	10.22	99	Sand	Fine Gravel
Weyauwega Down	12.46	7.73	459.8	9.95	97	Sand	Fine Gravel
Medford Up	8.96	7.58	206.7	11.47	103	Medium Gravel	Coarse Gravel
Medford Down	9.46	7.39	425.5	10.92	99	Sand	Coarse Gravel
Marshfield Up	9.57	7.88	647.6	16.05	147	Sand	Silt
Marshfield Down	15.30	7.48	1581.0	11.54	119	Sand	Silt

Computed twelve metrics for community composition, richness, tolerance, and trophic function. Selected metric with lowest coefficient of variation from each category.
- Taxa richness (RICH) (richness)
- Family Biotic Index (FBI) (tolerance)
- % dominant three taxa (DOM3_T) (composition)
- % collector-gatherer taxa (CG_T) (trophic function)

Ran two-tailed paired student t-tests (α=0.05)
to determine if significant differences existed between the means of metrics upstream and downstream.



Figures 4 & 5. Metric response upstream and downstream of the WWTPs, including paired student t-test result.

Results and Discussion

Metrics generally responded as expected (Figures 4 & 5)
- Richness decreased downstream at all sites
- FBI and %DOM3_T metrics responded as expected at all sites except Weyauwega
- %CG_T increased downstream at all sites except Medford and Weyauwega
- Reason for Weyauwega's status as frequent exception remains unclear

Only richness exhibited significant change up- and downstream (p=0.019)
- Factors causing significant difference in richness were not identifiable
- Richness might be more informative at lower levels of taxonomy

Figure 6. Elmidae larva.

Trends in metrics tracked with consistent decreasing trend in pH downstream (Figure 3)
- No strong correlation found in these data, but richness has been shown to decrease with decreasing pH

Single-attribute metrics may not completely describe community responses
- Multi-metric approach may provide further insight
- Larger sample size might also produce more statistically valid differences

My hypothesis was not fully supported by these data
- WWTPs sampled appear to be managing their effluents well

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References

(1) Bouchard, R.W., Jr. 2004. Guide to aquatic macroinvertebrates of the Upper Midwest. Water Resources Center, University of Minnesota, St. Paul, MN. 208 pp.
(2) Lillie, R.A., S.W. Szczytko, and M.A. Miller. 2003. Macroinvertebrate data interpretation guidance manual. Wisconsin Department of Natural Resources, Madison, WI. 58 pp.
(3) MPCA. 2014. Development of a macroinvertebrate-based Index of Biological Integrity for assessment of Minnesota's rivers and streams. Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division, St. Paul, MN. iv + 52 pp.