The effects of dredging to remediate the lower Fox River, WI, EPA Superfund Site on water quality, clarity and invertebrate species diversity

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INTRODUCTION

Water bodies adjacent to paper mills and other industries are often contaminated by polychlorinated biphenyl (PCBs). Remediation via dredging to remove contaminated sediments may have unintended consequences for the local water clarity, quality and species diversity. Measuring the biodiversity of invertebrates can provide a direct measure of dredging effects on the entire ecosystem (Luoma 1977). Dredging resuspends potentially harmful sediment particles, and may negatively affect the surrounding water quality, and diversity of zooplankton and macroinvertebrates.

The lower Fox River, an EPA Superfund site in Brown County Wisconsin, is currently being dredged to remove naturally capped contaminated sediments. Species diversity of zooplankton and macroinvertebrates, water quality, and clarity in a dredged site, and upstream and downstream of the dredged site, were measured to assess the effects of the remediation efforts on the aquatic ecosystem. We hypothesized that the dredged site would have lower species diversity, water clarity and water quality compared to the upstream and downstream sites. We also hypothesized that the water conditions at the dredged site would contain more pollution-tolerant macroinvertebrate species (Hilsenhoff 1988).

METHODS

- Samples were collected on 11 and 23 July and 7 and 22 August 2012 at three sites along the Fox River; an upstream, a downstream, and an actively dredged site (Figure 1).
- Macroinvertebrate and zooplankton samples were collected using a D net and a Wisconsin net, respectively
- Species diversity of zooplankton and macroinvertebrates were calculated using the Shannon-Weiner Index (H')
- The Hilsenhoff Biotic Index (HBI) was used to determine water quality relative to macroinvertebrate species (Hilsenhoff 1988)
- Total suspended solids (TSS), total phosphorus (TP), and soluble reactive phosphorus (SRP) were collected to assess water quality and clarity

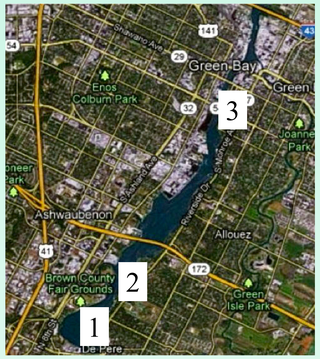

Figure 1: Sampling locations along the lower Fox River; 1: Voyageur Park, upstream of the dredging; 2: Fox Point Boat Launch, actively dredged site; 3: Fox Harbor docks, downstream of the dredging. (Google Maps 2013)

RESULTS

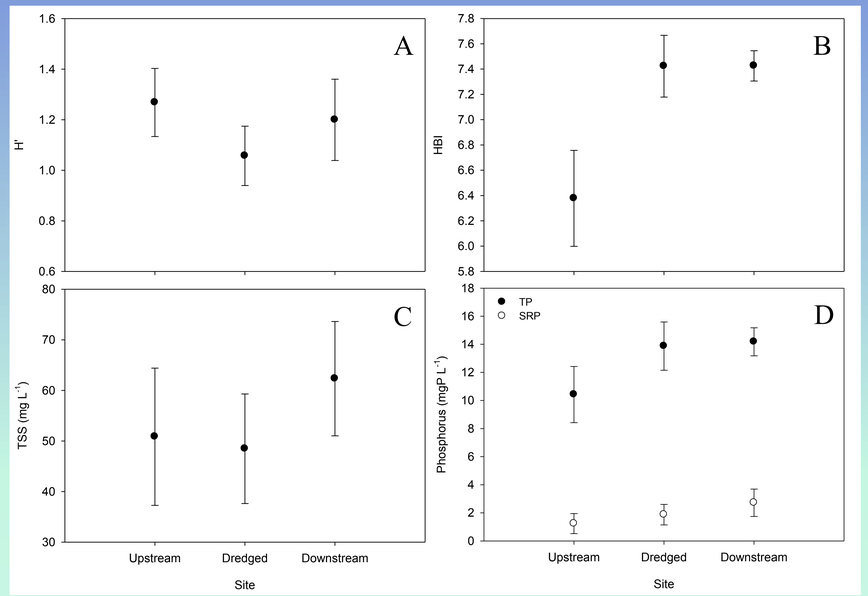

Figure 2. Zooplankton species diversity (H') (A), HBI water quality degree (B), total suspended solids (mg L^{-1}) (C), and total phosphorus (TP) and soluble reactive phosphorus (SRP) concentrations (mg L^{-1}) (D) sampled from 11 July - 22 August 2012. Note: HBI values range from 0 (excellent water quality) to 10 (severe pollution); values 4.51-5.50 indicate good water quality with some pollution; 5.51-6.50 indicate fair quality with fairly significant pollution; 6.51-7.50 indicate fairly poor water quality with significant pollution; 7.51-8.50 indicate poor water quality with very significant pollution.

- Zooplankton species diversity was significantly lower at the dredged site ($F_{2,18} = 11.43$, $p = 0.009$; Figure 2A). Macroinvertebrate species diversity did not differ across sites ($F_{2,18} = 1.55$, $p = 0.29$).
- Hilsenhoff Biotic Index (HBI) values indicate significantly poorer water quality at the dredged and downstream sites ($F_{2,18} = 9.00$, $p = 0.015$ Figure 2B).
- TSS changed significantly over time ($F_{1,18} = 6.76$, $p = 0.0007$; Figure 2C) demonstrating an increasing trend over the course of the experiment. TSS was greater at the downstream site compared to the upstream site on all sample dates.
- TP and SRP varied by site (Figure 2D).

CONCLUSIONS

- Dredging activity decreased zooplankton species diversity, pollution-intolerant macroinvertebrate species, and water quality, and increased turbidity.
- Low zooplankton species diversity at the dredged site suggests that zooplankton are more sensitive to dredging compared to macroinvertebrates.
- Dredging may contribute to the decreased water quality at the dredged and downstream sites as determined by HBI.
- Higher TSS at the downstream site suggests that dredging activity may have contributed to higher downstream turbidity.
- Dredging may affect additional trophic levels of the aquatic ecosystem.

ACKNOWLEDGEMENTS

We would like to thank D. Poister, K. Kniech, T. Hartwick, and C. Jones for assistance in the field and lab; L. Last, WDNR, T. Valencia, and Green Bay Metropolitan Sewerage District for access to historical reports and data and D. Bailey for assistance with data analyses. Funding for this research was from the A.M. Keefe Scholarship, the SNC Student-Faculty Collaborative Research Award and the SNC Student-Faculty Development Endowment Fund.

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