Sediment Quality in Urban Wetlands

Introduction

Wetlands provide many critical functions in urban ecosystems, including habitat for wetland-dependent fauna and enhancement of water quality. Interest in restoring or creating wetlands to enhance these functions is increasing due to the scale and extent of wetland loss and water quality problems associated with urbanization. One of the most pressing questions associated with urban wetland restoration is to what extent urban wetlands tend to concentrate contaminants, and if so, whether there is an associated risk to wildlife. The goal of this study was to better understand these potential risks, and the associated trade-offs with using wetlands to passively or actively treat urban runoff.

Study Objectives

- Quantify the sediment chemistry, toxicity and macroinvertebrate species richness of urban wetland sediments.
- Determine the contaminants responsible for observed toxicity, as indicated by sediment chemistry and sediment toxicity identification evaluations (TIEs).

Methods

- Sediment toxicity, chemistry and benthic macroinvertebrate richness were characterized for 21 freshwater urban wetlands and 2 reference sites in southern California.
- Sediments were collected at a location nearest to the primary source of urban runoff within the wetlands in order to characterize the greatest potential effect.
- All samples were analyzed for trace metals and organics (PCBs, PAHs, chlorinated pesticides and pyrethroid pesticides). These measurements were compared to the values to freshwater Probable Effects Concentrations (PECs), or mean LC50 values for pyrethroid pesticides.
- Toxicity was assessed using the Hyalella azteca 10-day survival test. Most locations that exhibited toxicity were subsequently testing with preliminary sediment TIEs. The TIE treatments for this evaluation specifically targeted pyrethroid pesticides, based on available chemistry data of the samples tested.

Results

Figure 3: Sediment concentrations for select contaminants. The dashed line indicates the Probable Effects Concentration (PEC). The average sediment LC50 for 4 sites, adjusted from Kowag et al. (2004) (benthic L-cyhalothrin). The reference sites are highlighted in yellow.

- Sediment Contaminants
  - In most wetlands, at least one constituent exceeded a freshwater sediment quality guideline.
  - The metal and chlorinated pesticide constituents that exceeded a sediment quality guideline tended to vary among the sites.
  - Pyrethroid pesticide contamination (bifenthrin, L-cyhalothrin) was prevalent at most sites, with concentrations exceeding the average sediment LC50 by as much as a factor of 13.

Figure 4: Survival of H. azteca exposed to wetland sediments. The reference sites are highlighted in yellow. Sites that are significantly different and had a survival rate <90% of the control value are considered toxic (indicated by “

- Sediment Toxicity
  - Sediments from about half of the wetland sites were toxic to amphipod survival.
  - Survival in the toxic sediments tended to be much lower (<20%) than the 80% toxicity threshold.

Figure 5: Sediment Total Iodine Equivalent Toxicity (TIE) and Total Contaminant Equivocal (mPECq). BMI Diversity

- BMI Diversity
  - Benthic macroinvertebrate diversity was found to negatively correlate with the mean Probable Effects Concentration quotient (an index of degree of sediment contamination).

Table 1: Summary of contaminants exceeding sediment quality guideline thresholds, the toxicity tests with H. azteca, and the sediment TIEs. Partial = pyrethroids implicated in the toxicity, but other contaminants may have also been responsible.

<table>
<thead>
<tr>
<th>Sediment Contaminant</th>
<th>Sediment Quality Guideline Exceedances</th>
<th>Toxicity</th>
<th>Indication of pyrethroid toxicity</th>
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<tbody>
<tr>
<td>Metal</td>
<td></td>
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<td>Chlorinated pesticide</td>
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<td>Pyrethroid pesticide</td>
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Management Recommendations

- Reduce potential for exposure and toxicity to contaminants by incorporating low impact development (LID), source control and best management practice (BMP) implementations to capture contaminants upstream of wetlands.
- Use a pretreatment system (e.g., forebay) to allow sediment and associated contaminants to settle out prior to entering the wetland.
- Use consistent monitoring protocols, including analysis of sediment chemistry and toxicity, in order to be able to compare among sites and track changes over time.

Summary

- Most sites (18 out of 21 urban wetlands) posed a risk of sediment chemistry or toxicity, or both.
- Data probably represent conservative estimates, since samples were collected near freshwater input sources.
- Pyrethroid pesticides may have been responsible for much of the toxicity.
- Metals, PAHs, DDE, and chlordane were elevated and could have caused toxicity, but at fewer sites.
- Benthic macroinvertebrate species richness was negatively correlated with sediment contamination, suggesting that toxicity may have affected organisms at the base of the food web in some of these wetlands.

References