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Urban Aquatic Ecosystems are different

Urban Stream Syndrome

Urban Stream Ecology

Urban Watershed Continuum Concept

Walsh et al. 2005

What about wetlands?

Kaushal & Belt 2012
Urban Wetlands & Water Quality

- Ubiquitous
- Relied on & invested in for water quality
- Understudied
Northeast Ohio Urban Wetlands: Assessing hydrologic and water quality function

http://www.gcbl.org/explore/water/rivers/cuyahoga-river
Cleveland Metroparks’ Watershed Stewardship Center
“Working Wetland”
Cleveland Metroparks’ Watershed Stewardship Center
“Working Wetland”

Monitored Hydrology and Water Quality
June 2015 - October 2016

Inflows & Outflows
“Working Wetland” Water Quality
Wetland Chloride Concentrations

Outflow: 3-1260 mg/L
Inflow: 2-492 mg/L
Interior: 18-2053 mg/L

Evaporative Concentration

Summer 2016: Extreme Drying & Reflooding
EPA Freshwater toxicity criteria:
chronic = 230 mg/L
acute = 860 mg/L
Chloride (Cl\textsuperscript{-}): Rural to Urban Comparison

# of Wetland Sites:

NE Ohio
Urban

27
N=382

3-2050
Biogeochemical effects of salt?

Organismal toxicity

\[ \text{Road Salt (NaCl, CaCl}_2, \text{ and others)} \]

\[ \text{N release due to cationic exchange} \]

\[ \text{Effects on P retention (e.g., phosphate sorption) are unknown} \]

\[ \text{P?} \]
Sulfate ($\text{SO}_4^{2-}$): Rural to Urban Comparison

- MI Restored Wetland
- MI Wetlands
- NE Ohio Non-Urban
- NE Ohio Urban

# of Wetland Sites:
- 1
- 24
- 46
- 27

N=298
N=50
N=98
N=382
Cascading effects of high sulfate?

SO$_4^{2-}$ → H$_2$S, HS$^-$

Anoxic conditions → Sulfate reduction → Sulfide

Iron binding & P release

Inhibits denitrification

NO$_3^-$ → N$_2$O, N$_2$

Metal binding & detoxification

CuS NiS

Mercury methylation

MeHg$^+$

Inhibits methanogenesis

CO$_2$ → CH$_4$
Emerging Hypothesis

• In urban wetlands, the biogeochemical rules are the same, but the players are different:
  – “Freshwater Salinization Syndrome”

• Novel urban chemical stressors may lessen wetlands’ nutrient removal capacity
  – N release due to Na cationic exchange
  – P release due to S binding with Fe

Kaushal et al. 2018
Better understanding of urban wetland biogeochemistry will help:

– to quantify services & disservices under management scenarios
– Set realistic goals
Dry & Disconnected

July 15, 2016
Where are Cl & SO4 coming from?
Evidence for S in wetland: CMP high Acid Volatile Sulfides
4/19/2016: “Opened top board of water control structure to provide storage volume for next rain event”

4/20/2016: “Closed top board”

Discharge events w/ no associated rain events
Chloride (Cl⁻) vs. # of Wetland Sites:

- **NE Ohio Urban**: 27
- **N=141**

**Road Salt (NaCl)**

- Na⁺ Cl⁻
- NH₄⁺ Cl⁻
- Na⁺ NH₄⁺
- Cl⁻ NH₄⁺

**Web Link**: www.troutnut.com
Sulfate (SO$_4^{2-}$) levels in wetland sites:

- MI Restored Wetland: 1 site, N=357
- MI Wetlands: 24 sites, N=104
- NE Ohio Non-Urban: 46 sites, N=77
- NE Ohio Urban: 27 sites, N=141

Range of sulfate levels:
- 0-36 mg/L
- 0-67 mg/L
- 0-75 mg/L
- 0.8-720 mg/L
Water Level Management

Discharge events w/ no associated rain events due to board removal.
Interannual Variability: A Tale of Two Summers

Rainfall (mm)

Level (m)

Flow Rate (m3/s)

Extreme Drying & Reflooding