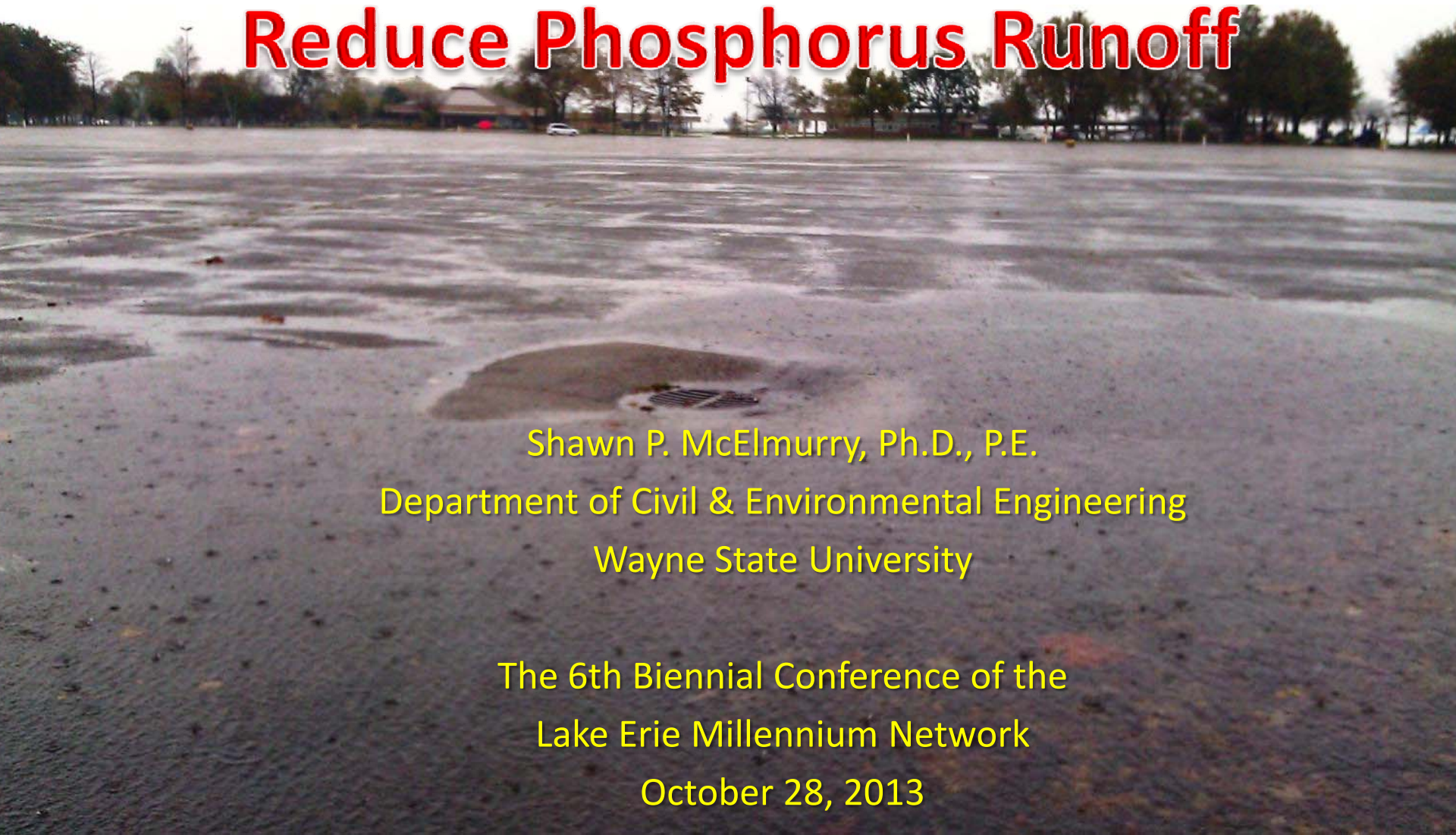
Effectiveness of Urban Best Management Practices to Reduce Phosphorus Runoff



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Lake Erie Millennium Network
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Purpose: Review agricultural and urban BMPs used to reduce phosphorous discharges with a focus on BMPs implemented within the Lake Erie basin

Why Urban?

Urban stormwater is the primary source of water quality impairments for 13% of all rivers, 18% of all lakes and 32% of all estuaries in the United States based on the 2000 National Water Quality Inventory, despite comprising only 3% of the land mass in the US (NRC 2008)

"all highly urban watersheds produce severely degraded receiving waters"

Why urban?

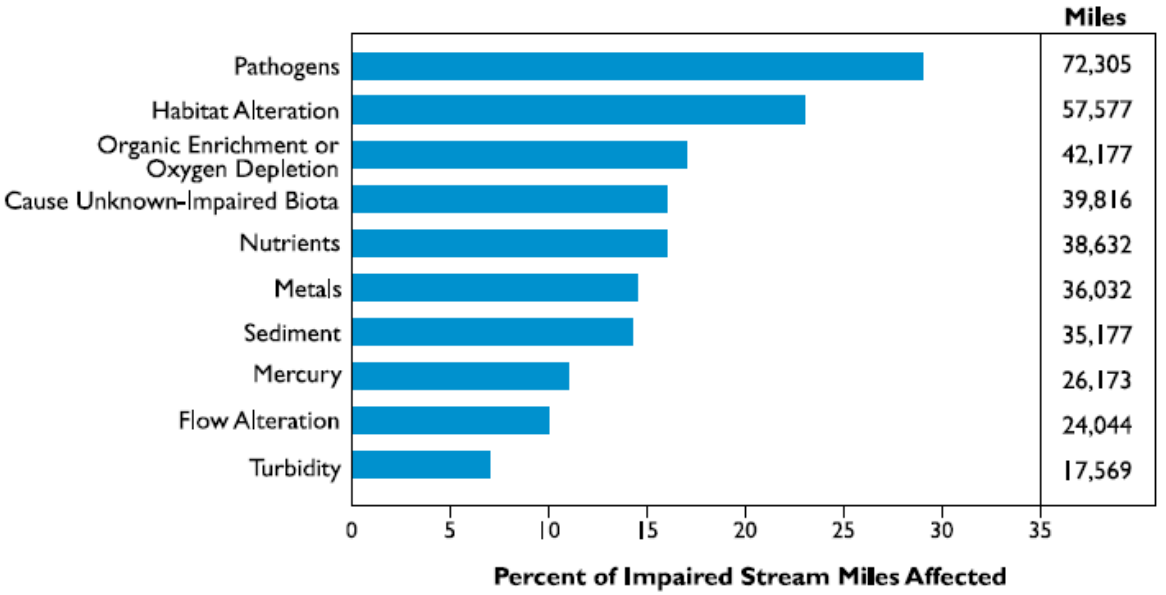
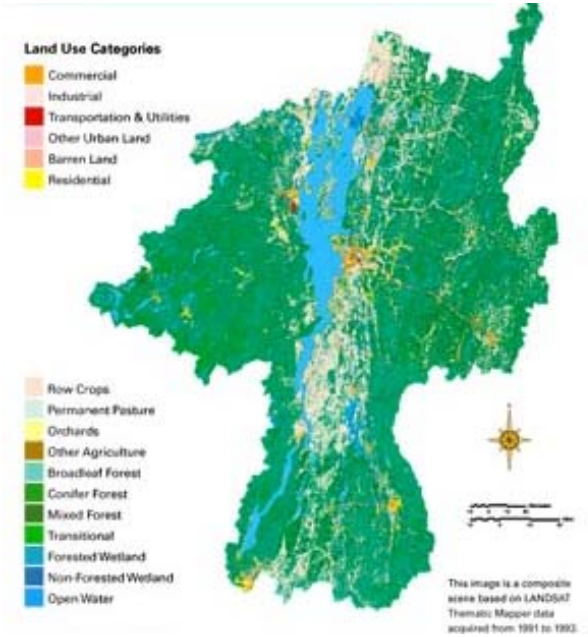


Figure 2. Top 10 causes of impairment in assessed rivers and streams.



3% of the land cover within the Lake Champlain watershed, urban sources have been estimated to contribute 18% of the estimated P load (Meals and Budd 1998)

Loadings from urban land cover:

- 0.57 lb of P/acre/year of DRP
- 0.98 lb of P/acre/year of total P

(Kluesener 1971)

Review over 240 primary source documents focused on agricultural and urban BMPs used to reduce phosphorous discharges within* the Lake Erie basin.

**While we attempted to focus on BMPs implemented within Lake Erie watershed, many BMPs were outside of region*

Overall Findings & Conclusions

1. Rigorous assessment of BMPs lacking
2. Most studies outside of Lake Erie watershed
3. BMP effectiveness *varies* greatly (often conflicting)
4. Assessment complicated by BMP combinations
5. Conversion to dissolved reactive form a problem
6. Extreme weather events threaten performance

Urban BMPs

FILTRATION ⟷ **DETENTION**

ARTIFICIAL

Porous Pavement

Monomedia (sand)

Mixed Media

Native Soils

Inlet devices

CSO Facilities

Green Roofs

Bioswales

Bioretention Basins

Detention Basin (wet or dry)

Raingardens

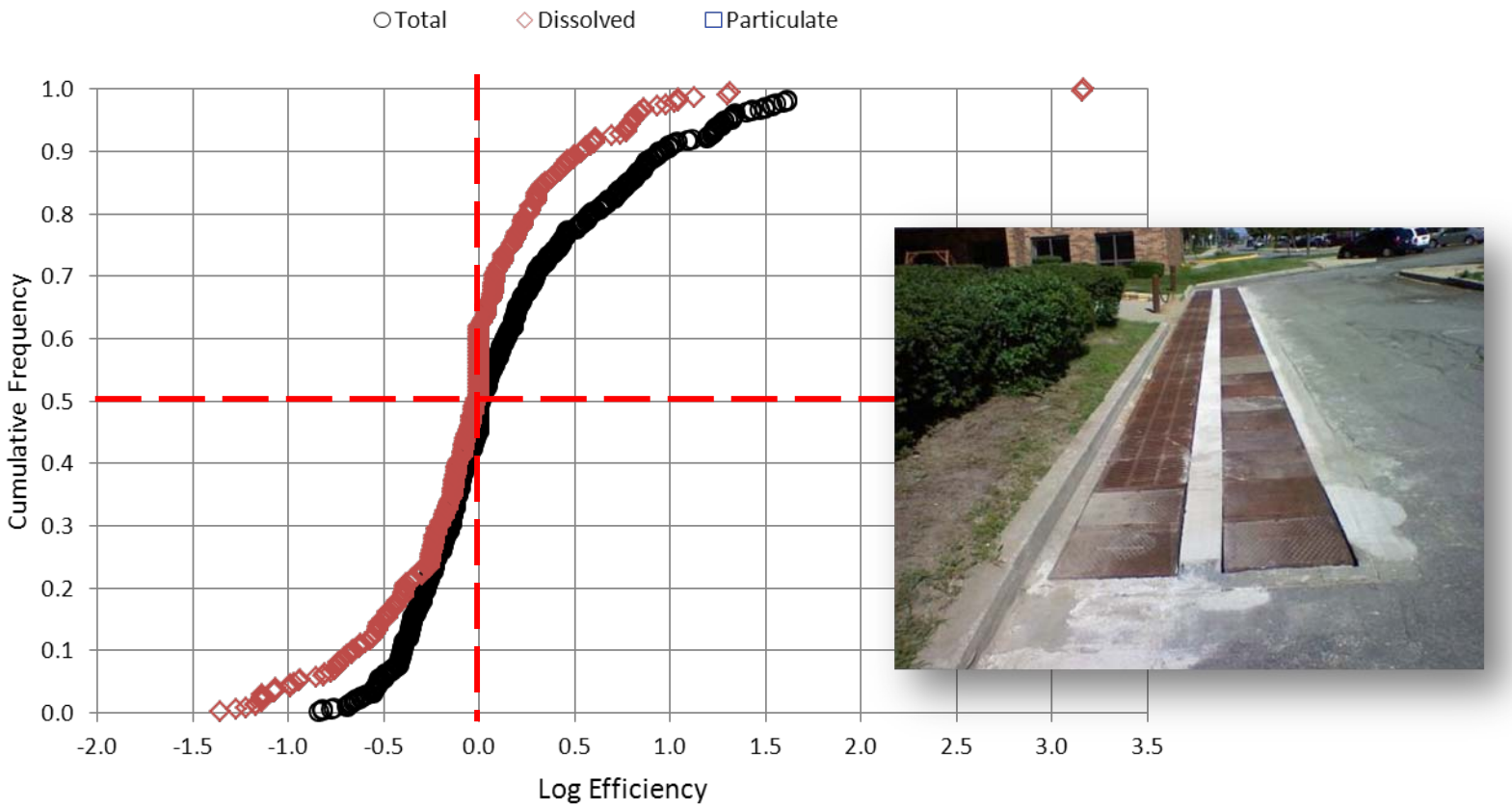
Subsurface Flow Wetland

Biofiltration

Open Water Wetland

NATURAL

Media Filter



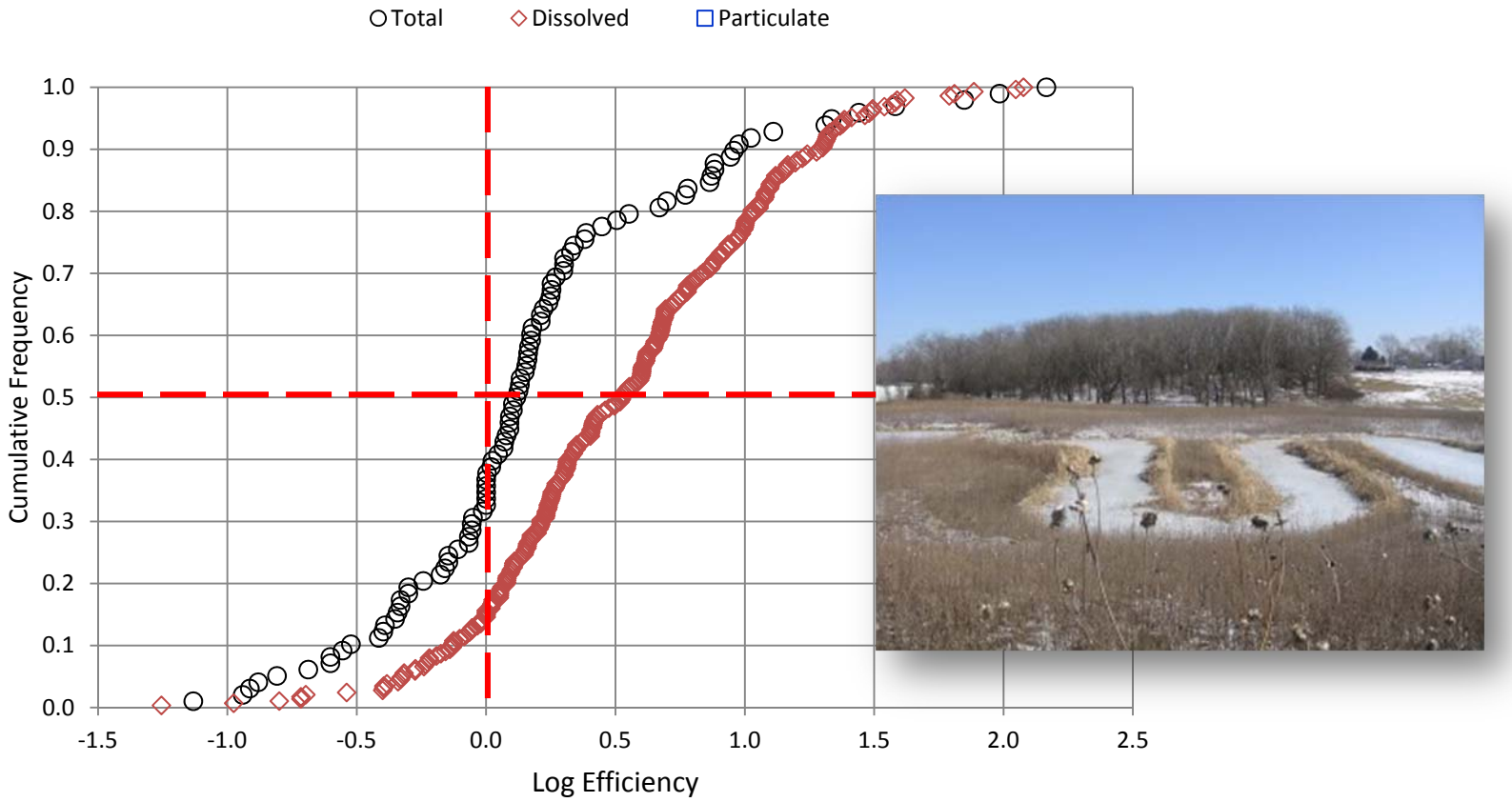
P load reduction

P load increase

Data collected from www.bmpdatabase.org/
Paired data (Location, Storm, EMC)
216 BMP sites

$$\log \beta = \log \left(\frac{M_{out}}{M_{in}} \right)$$

Wetland Channel



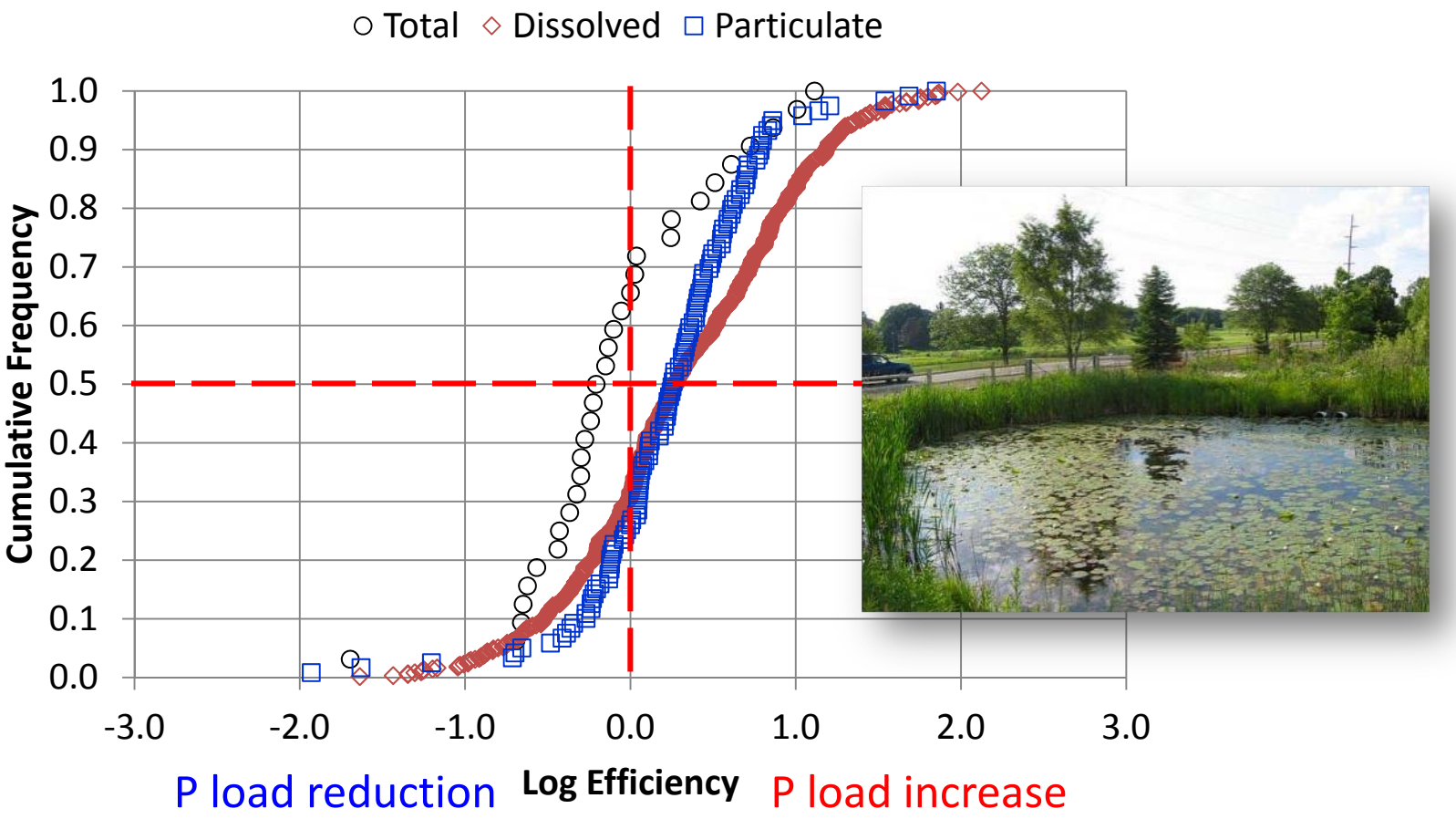
P load reduction

P load increase

Data collected from www.bmpdatabase.org/
Paired data (Location, Storm, EMC)
216 BMP sites

$$\log \beta = \log \left(\frac{M_{out}}{M_{in}} \right)$$

Wetland Basin



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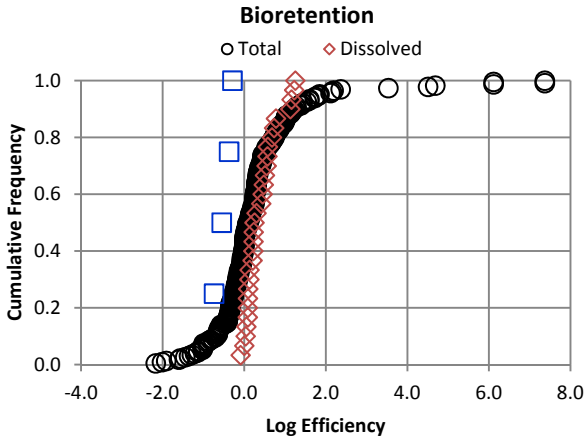
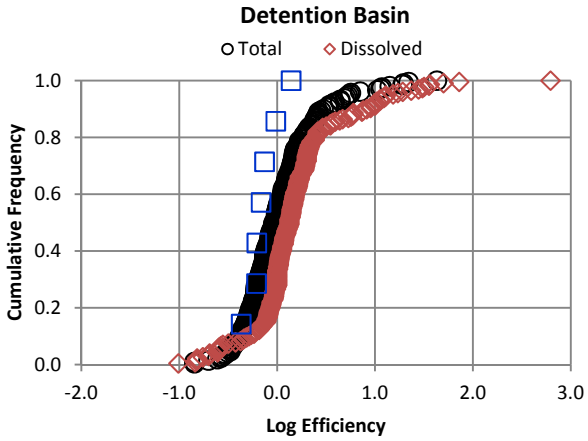
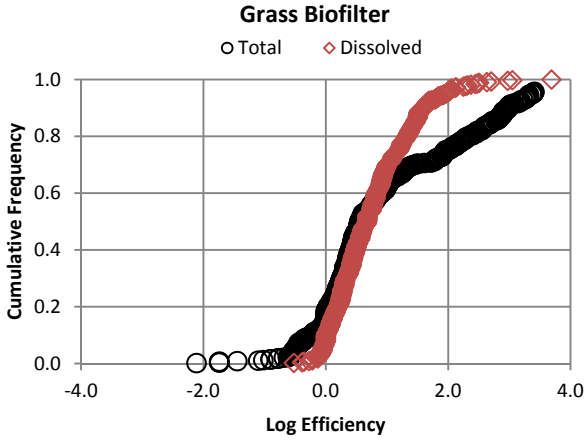


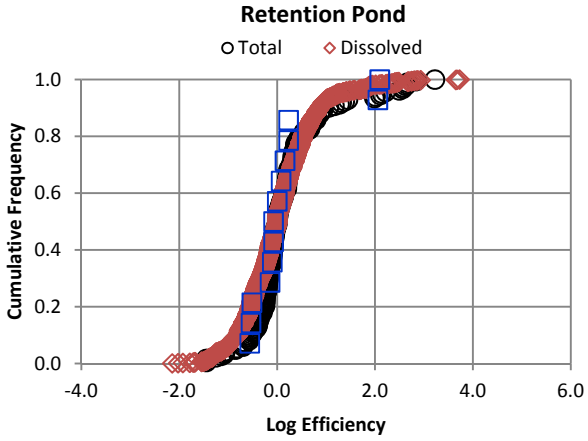


$$\log \beta = \log \left(\frac{M_{out}}{M_{in}} \right)$$

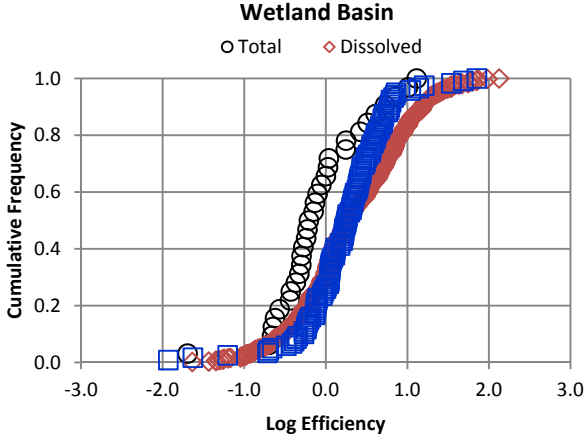
Log β < 0 → P load reduction

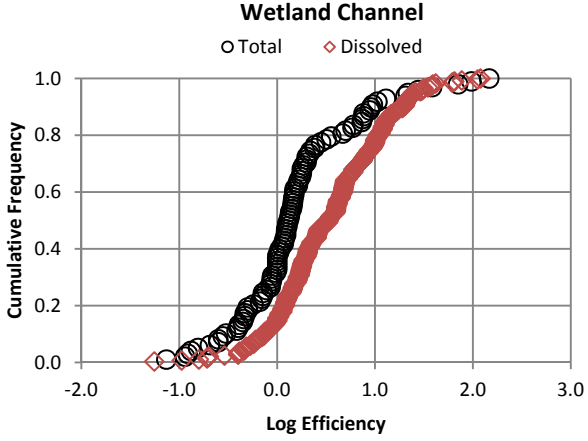
Log β > 0 → P load increase





total P removal was observed in <15% of bioswale - storms events





Total P removal was observed in 55% of detention basin – storm events

Key Findings & Conclusions

1. Few studies quantify non-point source P loads
2. Few studies evaluate BPM performance
3. Monitoring focused on total P
4. Assessing the effectiveness complicated by BMP combinations
5. Most monitoring too short
6. Few urban BMPs are effective!

Recommendations

1. **No GRAB samples!**

   At the least, measure event-mean-concentrations (EMCs) to estimate P loadings – flow-weighted average

2. **Measure more than Total P**

   While this may provide an estimate loads, it is not sufficient to assessing processes for BMP functions that are required to enhance the design of structural BMPs - need to move toward understanding speciation

3. **Long-term monitoring**

   Multiple storm events are required to accurately describe the effectiveness of urban BMPs as well as their sustainability

4. **Layered monitoring**

   Because multiple BMPs are often employed and community engagement is often critical to maintaining performance, multi-scale monitoring is required to evaluate performance

Emerging Science & Research

1. Quantify non-point source pollutants
2. Predict P removal by urban BMPs
3. Improve (mechanistic) understanding of P retention by green infrastructure
4. P speciation dynamics
5. Removal efficiency of CSO treatment basins
6. Incorporate impact of climate change

Thank You!

Shawn McElmurry

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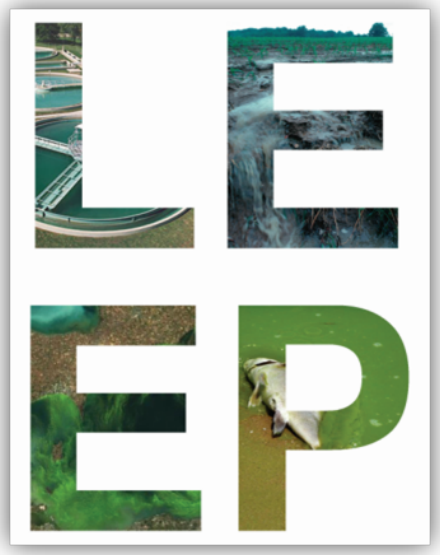
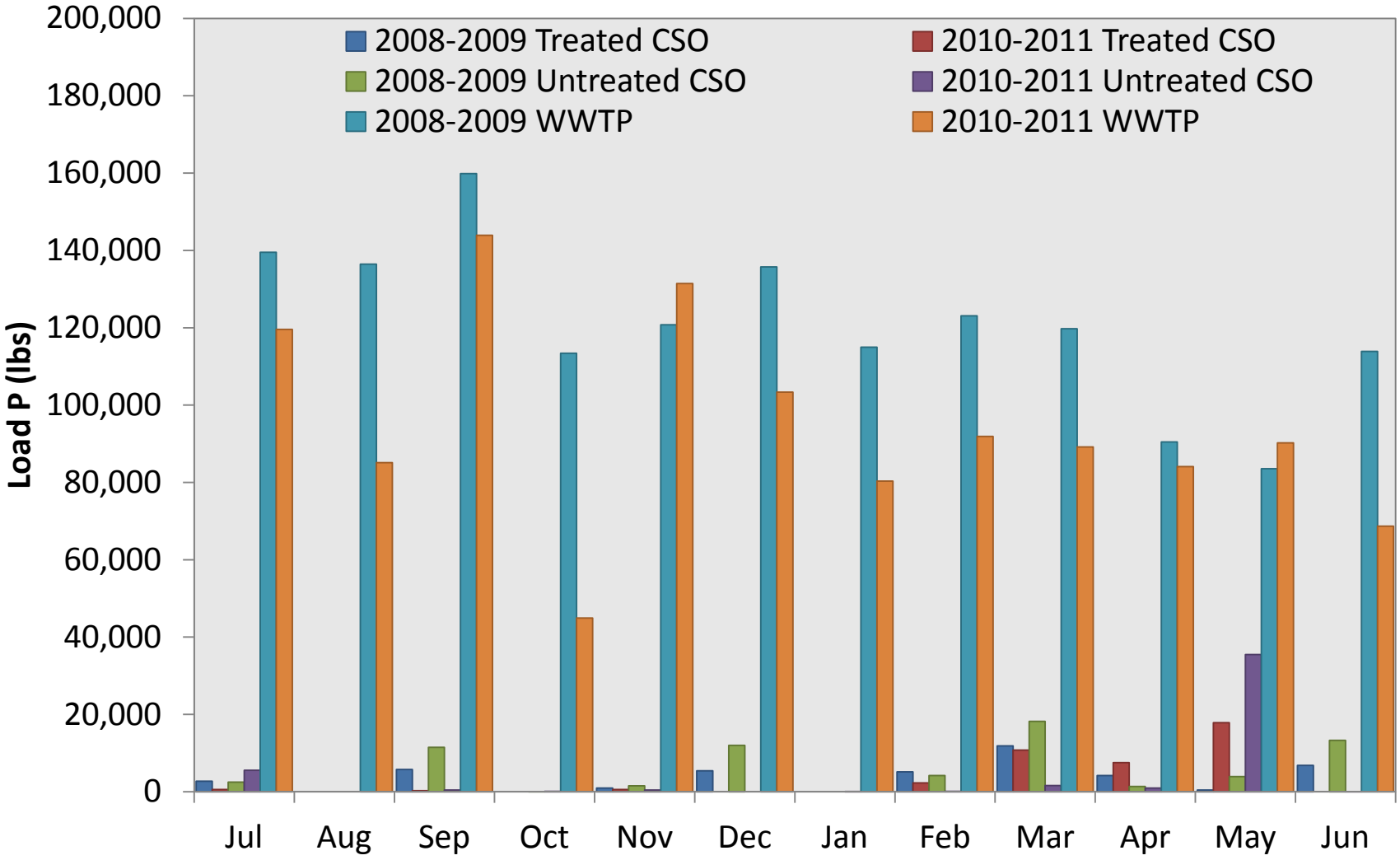
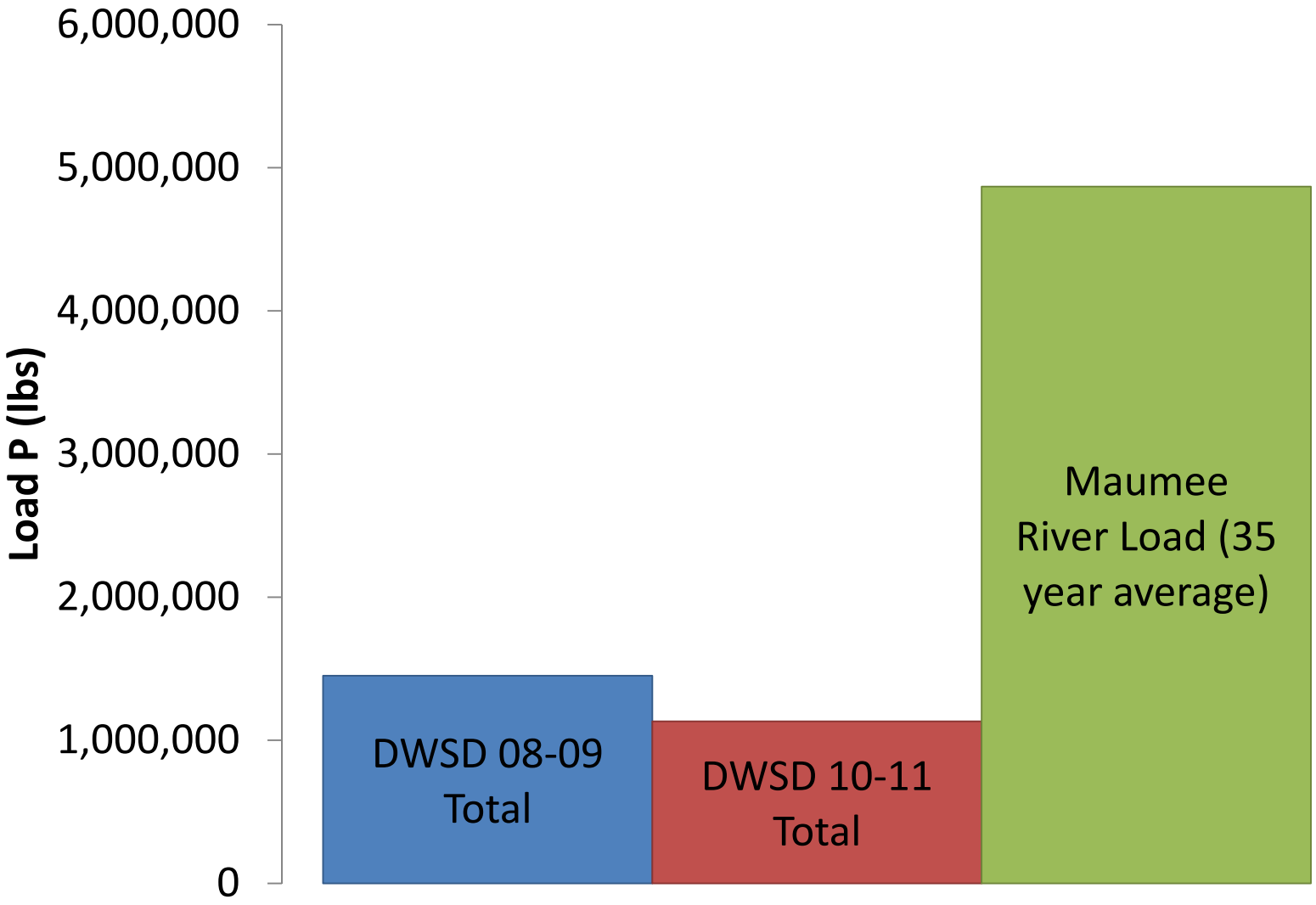


http://ijc.org/en_/leep/draft_report

DWSD P Loading



DWSD P Loading



DWSD P Loading