Maximizing the Value of Existing Monitoring Technologies:
Stream Temperature and Dissolved Oxygen as Best Case Examples

2014 National Monitoring Conference

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The Challenge

- Restoration monitoring programs are “predestined to fail” (Ralph et al, 2003)
- Only 10% of 37,000 projects totaling $14B included monitoring (Bernhardt et al, 2005)

Proposal: Redefine Water Quality Protection

Technical Aspects
1. Finite list of “ideal” parameters (e.g., temperature, DO)
2. Rental service of sensor technology (private sector)
3. Central data analysis/storage (public sector or NGO)
   • Statistical stability is key

People Aspects
4. ‘Headwaters first’ approach,
5. ‘Restore what we can measure first’ approach

Bonus
Division of labor to assess our Nation’s waters
Water-Air Temperature Relationship

- Air temperature can be nearby weather station


95% certainty with just 3 months of data

- Data gathered in Fall 2012 near Washington, DC
- 95% confidence of the slope is extremely good
Advantages compared to maximum daily/weekly temperature

• Less sensitivity to year-to-year variability of precipitation
• Insensitive to year-to-year variability of air temperatures
• Insensitive to precision of a given sensor,
• Insensitive to sensor random error,
• **Slope** is insensitive to sensor one-way bias error,
• 95% confidence of the **slope** is extremely good.

**Conclusion** – **Slope** of Water-Air Temperature Relationship is an ideal parameter for assessing year-to-year changes.
DO-Water Temperature Relationship

- Crooked Creek, PA
- Data source: Susquehanna River Basin Commission
- Methodology proposed by Rose, unpublished
DO-Water Temperature Relationship

- Single point min DO would greatly miss the big picture
- This methodology was the most statistically robust of every option tried
- As seen, DO data is very challenging
DO-Water Temperature Relationship

Proposed Methodology

• Plot daily max DO vs daily max water temp.
• Plot daily min DO vs daily min water temp.
• Min and Max DO are surrogate measures of in-stream photosynthesis and respiration (Wang, Mullholland)
• Visual inspection of plot is also recommended

Conclusion – Slope of DO-Water Temperature Relationship is an ideal parameter for assessing year-to-year changes.

Redefining Water Quality Protection

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**Bonus** (assessment, not restoration per se)
Division of labor to assess all our Nation’s waters
Rental Service (private sector)

• Amazon.com-like experience
• User never connects the device to computer
• User never opens the battery compartment
• User never has to store data on a spreadsheet
• Data is centrally uploaded when the device is mailed back

If we value the user’s time at $50/hr, renting is less expensive for the user and society.
Data Service (public sector or NGO)

- Free online service\(^1\)
- Central data analysis and storage
- “Ideal” parameters only\(^2\)
- All data in the public domain
- Bring your own technology (or rent)
- User enters who, what, where, when, how...
- Unique ID and URL for each data set

Less expensive for the user and society.

1. If you charge just $1, people will not use it.
2. EPA already offers an “all data” storage option, without the standardized analysis feature
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'Headwaters First' Approach

- Upstream restoration benefits entire stream/river and downstream lake/estuary
- But….temperature is typically an upstream issue
- Yet...DO is typically a downstream issue

Pragmatic, Two Step Approach

1. Measure as far upstream as impacts can be detected
2. Prioritize restoration where it best impacts the in-stream measurement

‘Restore What You Can Measure First’ Approach

Surrogates
• e.g., DO instead of Phosphorus and Nitrogen

Substitution
• e.g., Temperature instead of TSS
  • Both involve planting forest buffers and mitigation stormwater

Leadership
• Take you money somewhere else
• There’s a lifetime of work, don’t obsess
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**Fictitious Goal** – In next 10 years, **assess 1M locations** for temperature and DO.

- **Permanent monitoring stations?** Too $$$
- **Professional staff?** Too $$$
- **Citizen monitoring?** No, not as currently conceived

- We need 100,000 per year
- National Audubon Society bird count = 50,000 persons/yr
- Audubon dropped their $5 fee; it was a barrier

**Solution is division of labor**

• Past, reliable citizens move to front of the line
• All participants receive newsletter (ala Audubon)
• Annually fine tune the process
Suggestions?

Volunteers?