Regional Monitoring Networks to Detect Climate Change in Streams

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Driving Questions

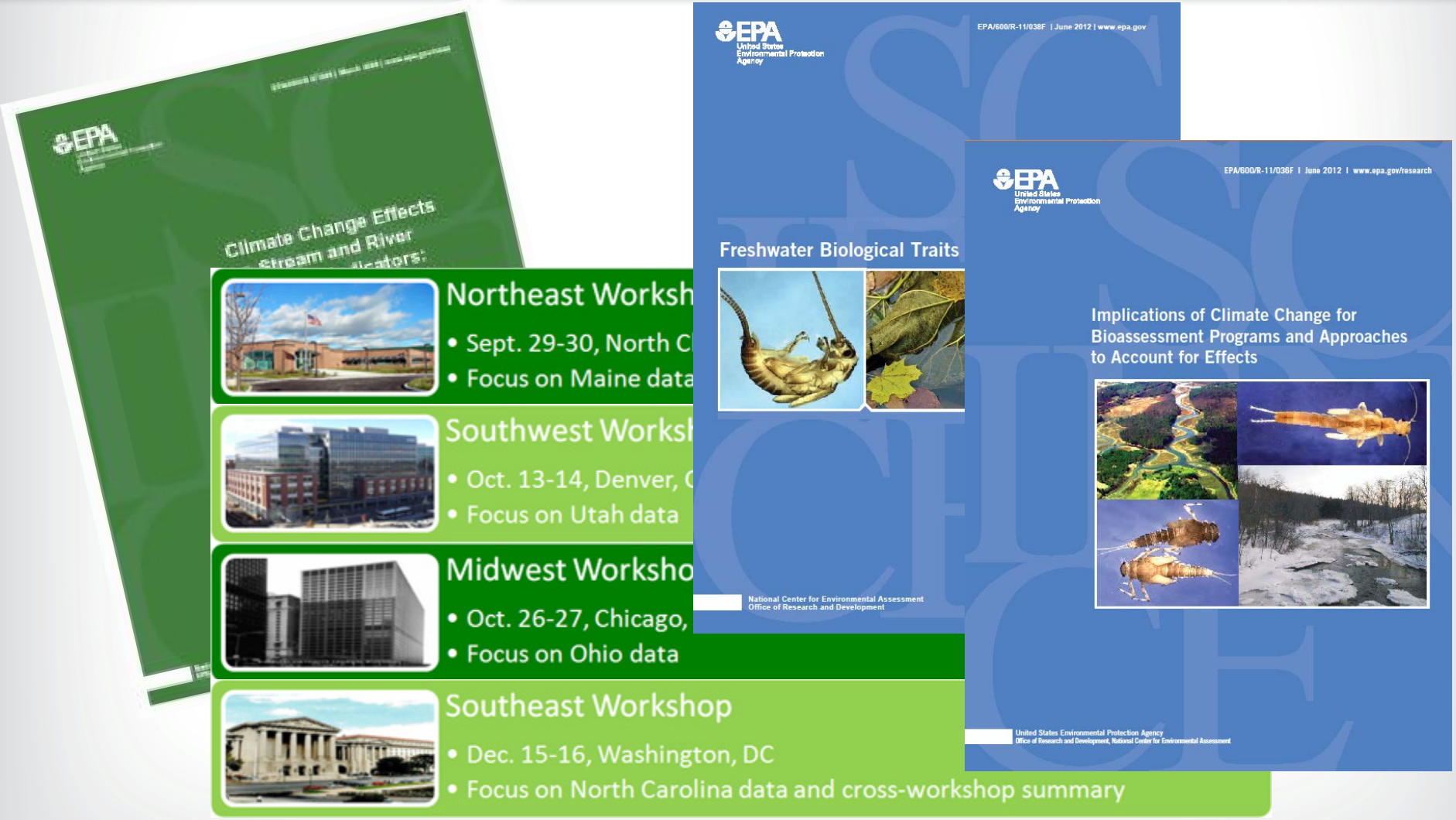
How will climate change impact aquatic ecosystems?

AND

What do bioassessment programs need to know to respond?

(How will they maintain their ability to assess condition and detect impairment?)

Why Monitoring?



Goal for Northeast

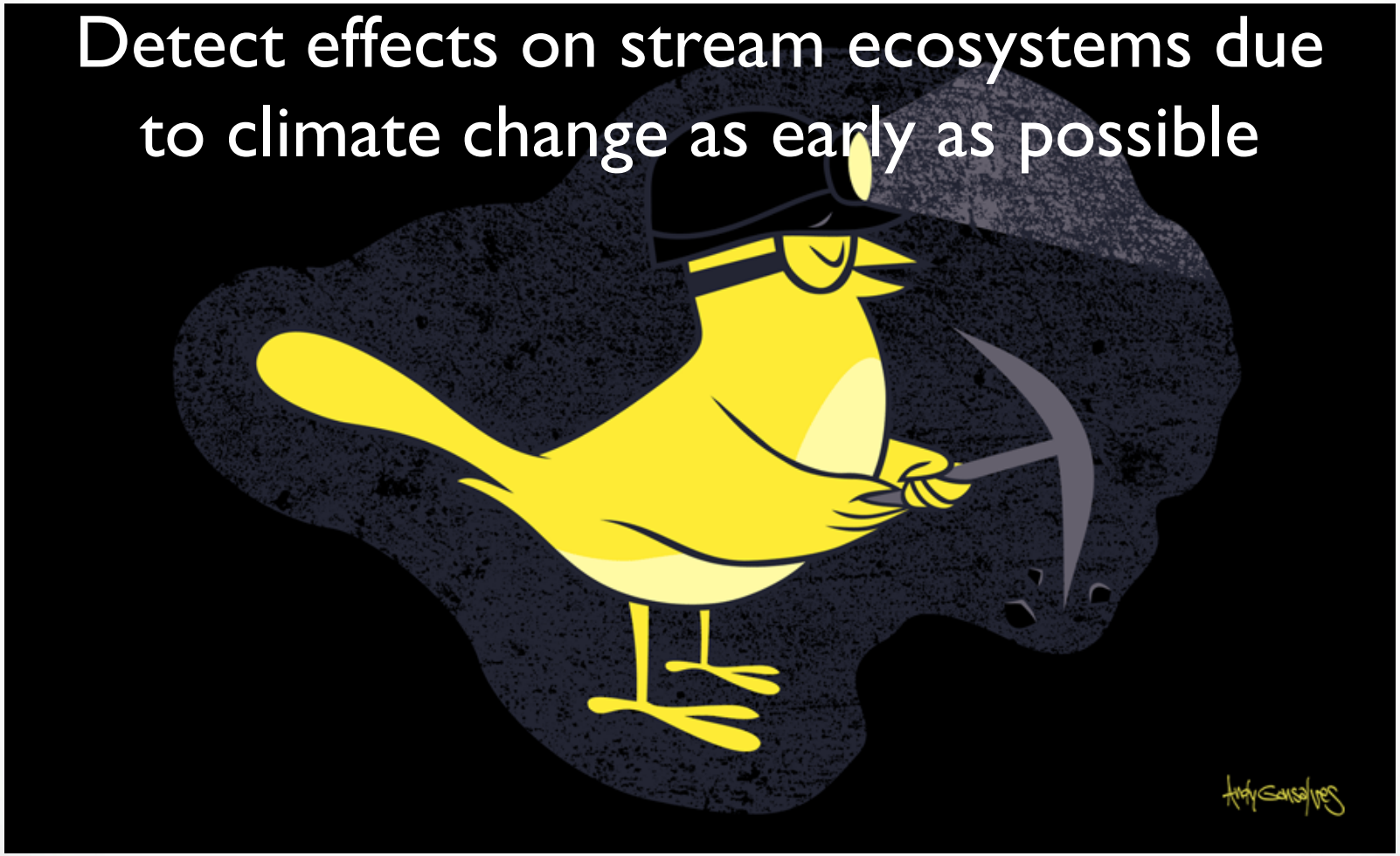


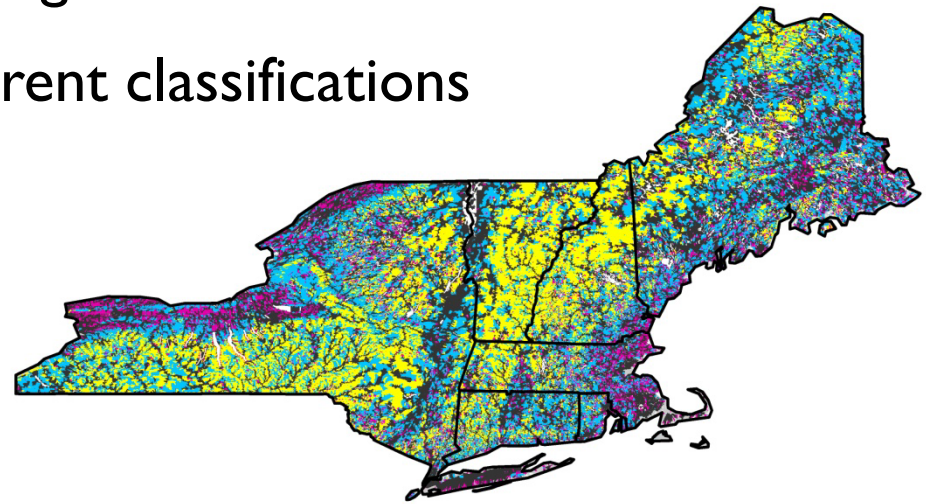
Illustration by Andy Gonsalves 2014

Initial Approach

- Stream classification and practical considerations for long-term monitoring
  - What type of sites?
  - How many?
  - For how long?
  - How frequently?
  - Monitoring what?
  - Using what methods?
- Vulnerability assessment
  - Refine site selection
  - Inform data analysis

What Type of Sites?

- Use environmental variables to define stream types across northeastern region
- Compare different classifications



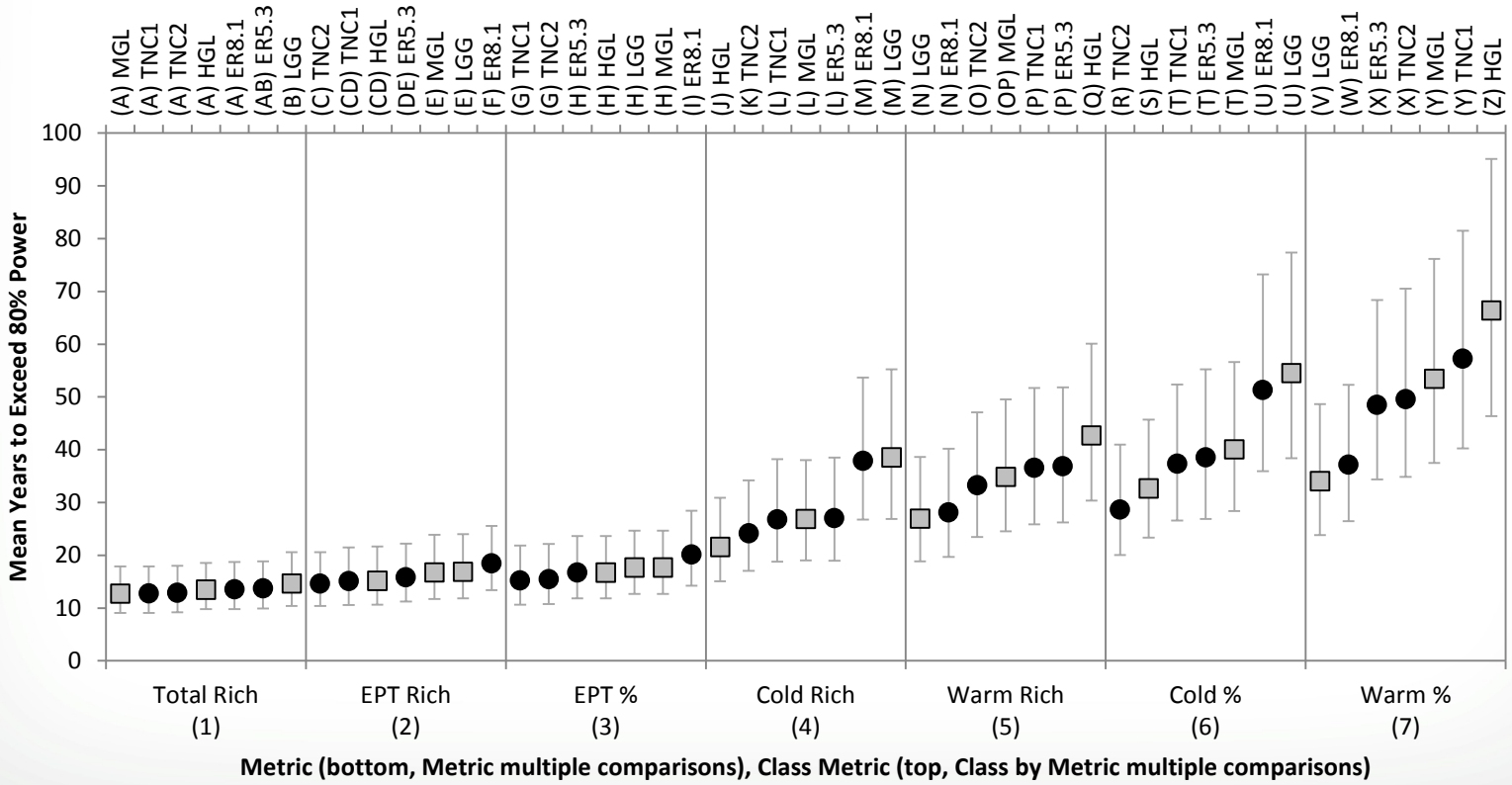
NHDPlus local catchments

Classification groups

- High gradient, drainage area < 100 km2
- Moderate gradient, drainage area < 100 km2
- Low gradient and/or drainage area >100 km2 (except 'Others' listed below)
- Other (low gradient, <10 km2; high gradient, >100 km2)
- Size and slope data not available

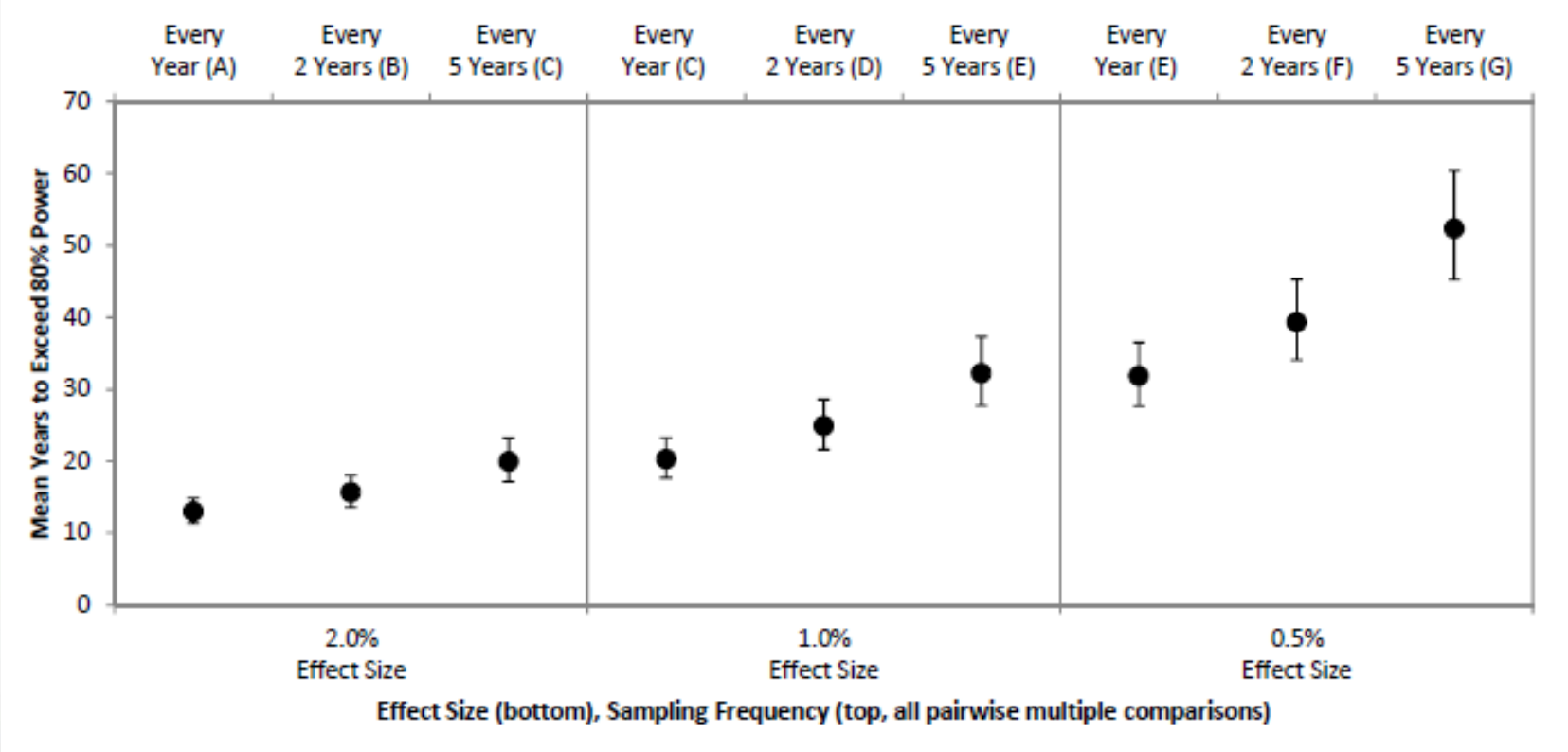
How Many & How Long?

- 30 sites, panel or re-visit (see Larsen et al. 2004)
- Duration of sampling depends on metric of interest



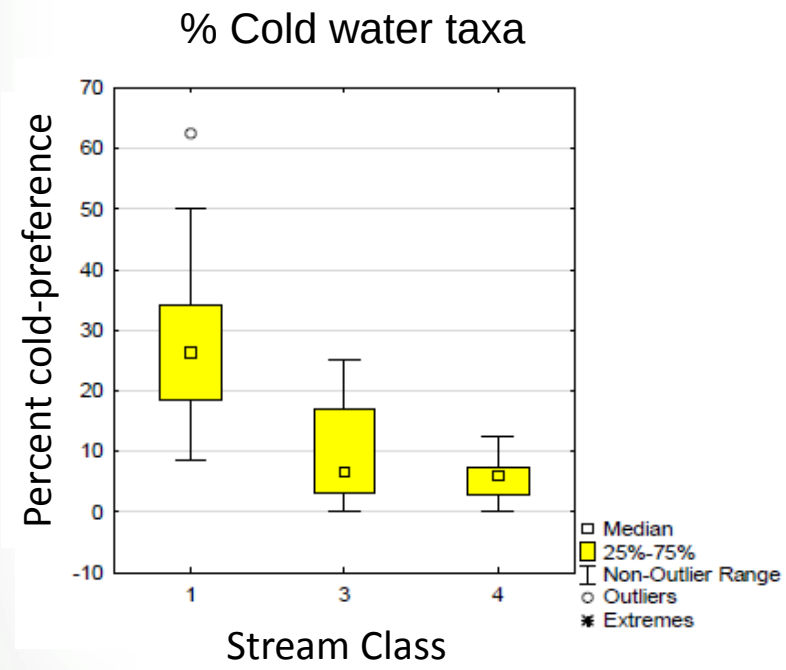
How Frequently?

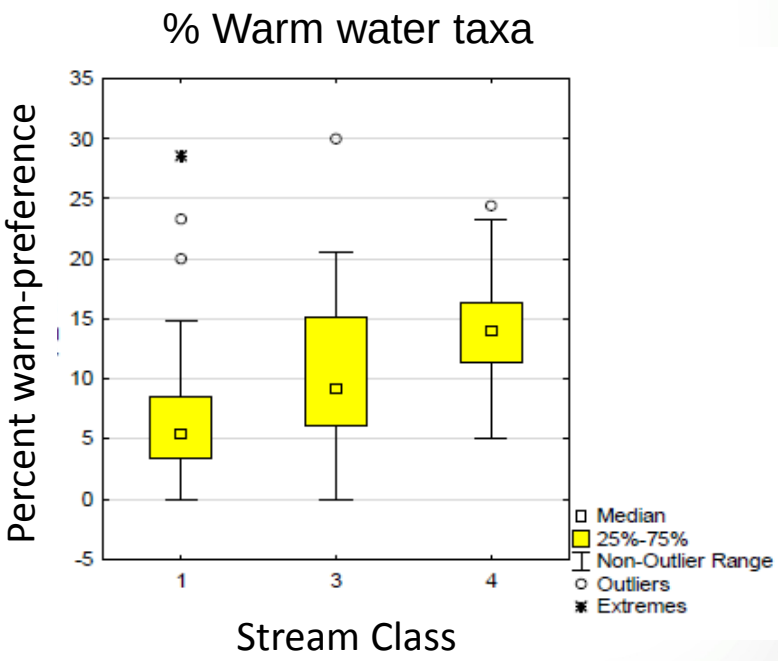
- Yearly, though every 2 years is OK
- Highly dependent on effect size



Monitoring What?

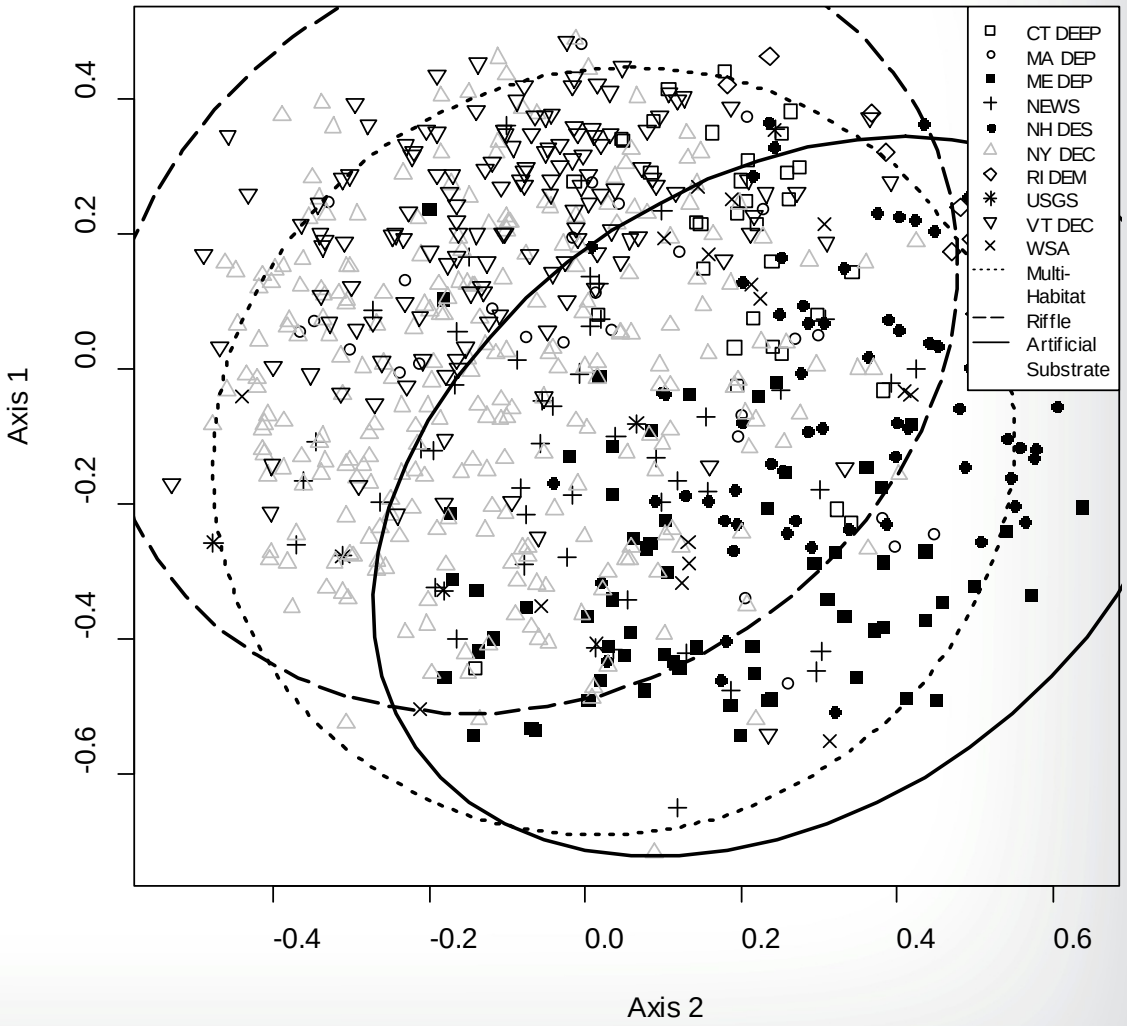
- Identify climate-sensitive traits
- Examine trait distributions among stream classes





Using What Methods?

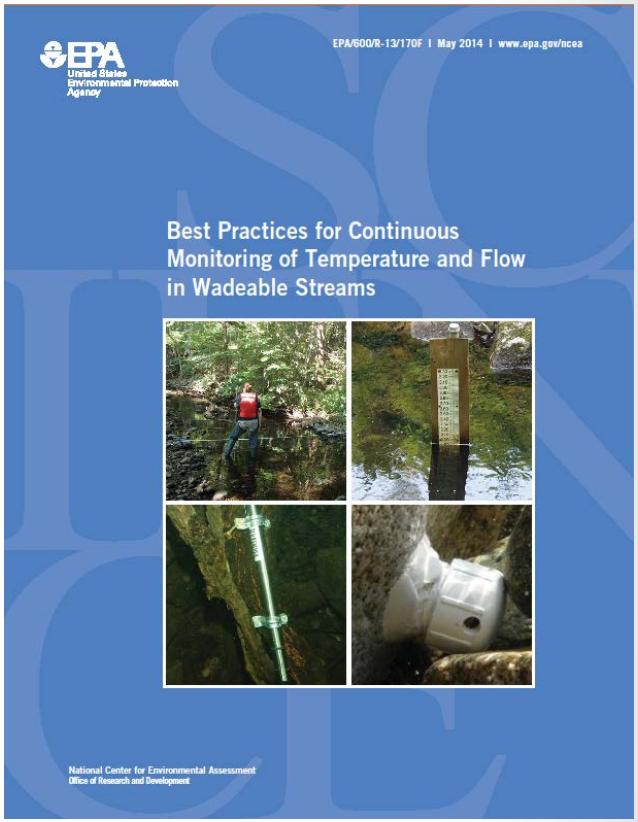
- Collection methods vary by agency
- More uniform methods decrease this source of variability in data



With growing interest, how have other states and Regions joined?

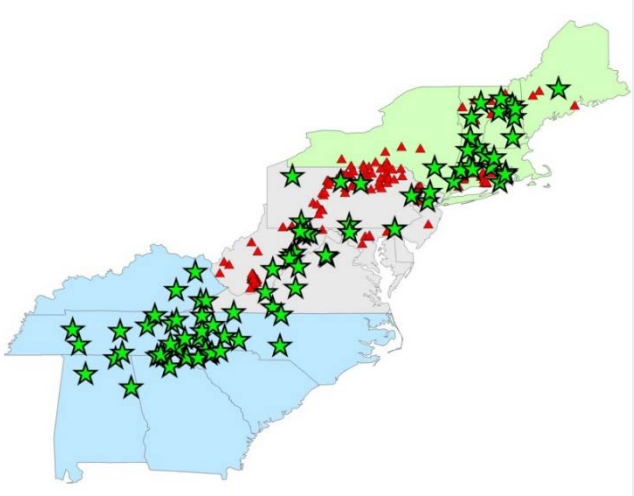
Resources to Develop RMNs

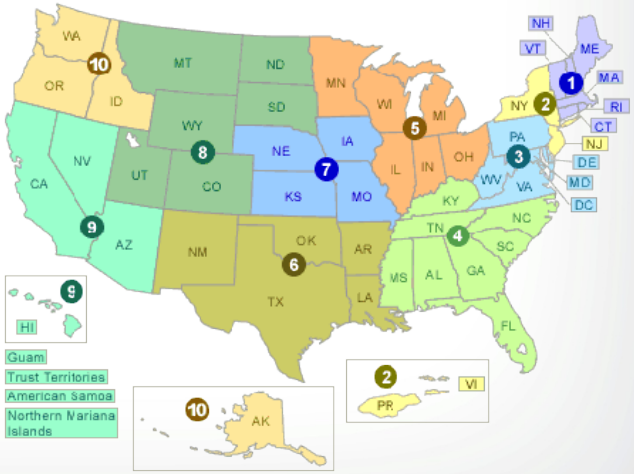
- Coordination of regional workgroups with EPA Regions, states, tribes, other organizations
- Documentation of approach for RMN development
  - External review draft Nov. 2014
  - Initiating external peer review
- Final report on best practices for continuous temperature and flow monitoring
- Workshops on sensor deployment



Report on Developing Regional Monitoring Networks

- Describes development of Regional Monitoring Networks in Northeast, Mid-Atlantic, and Southeast
- Illustrates site selection for riffle-dominated, freshwater, wadeable streams
- Describes data collection and quality assurance procedures, rationale for collecting these data, and analysis plan
- Discusses potential implementation in other regions (R5, R7, more?)



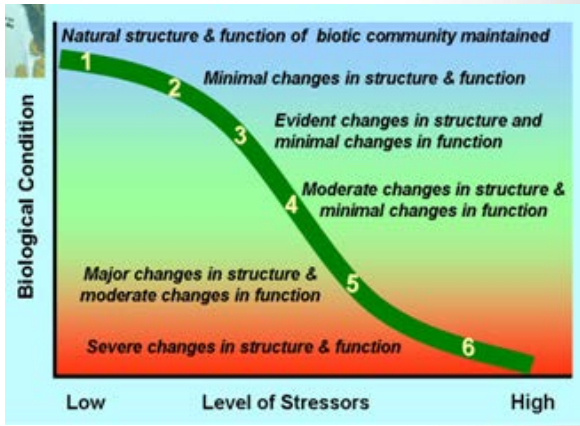


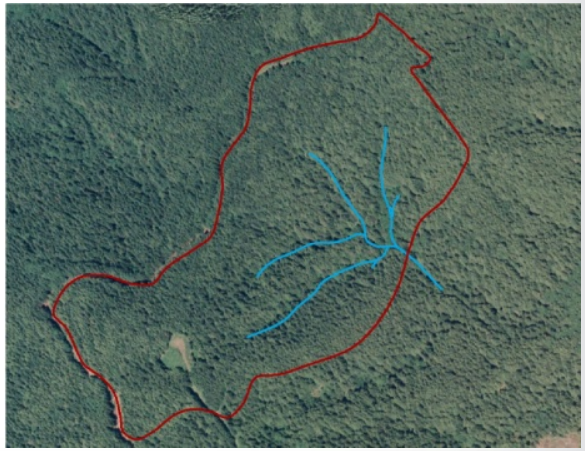
Process

- Form regional working group
- Select goal
  - Determine target stream type
  - Conduct stream classification
  - Conduct vulnerability assessment
- Discuss site selection criteria, data collection methods, and logistics
  - Utilize and build on current data collection by partners
- Identify logistical, training and equipment needs
- Develop plan for sharing and analyzing the data
- Begin implementation and data collection

Site Selection

- Apply consistent criteria
- Long-term (10+ year) sampling efforts concentrated at 'primary' sites
- Up to 15 primary sites per state (workload sometimes shared across entities)
- Well-designed networks of 30 to 50 sites monitored consistently can detect underlying changes of 1–2% per year in a variety of metrics within 10–20 years





Data Collection

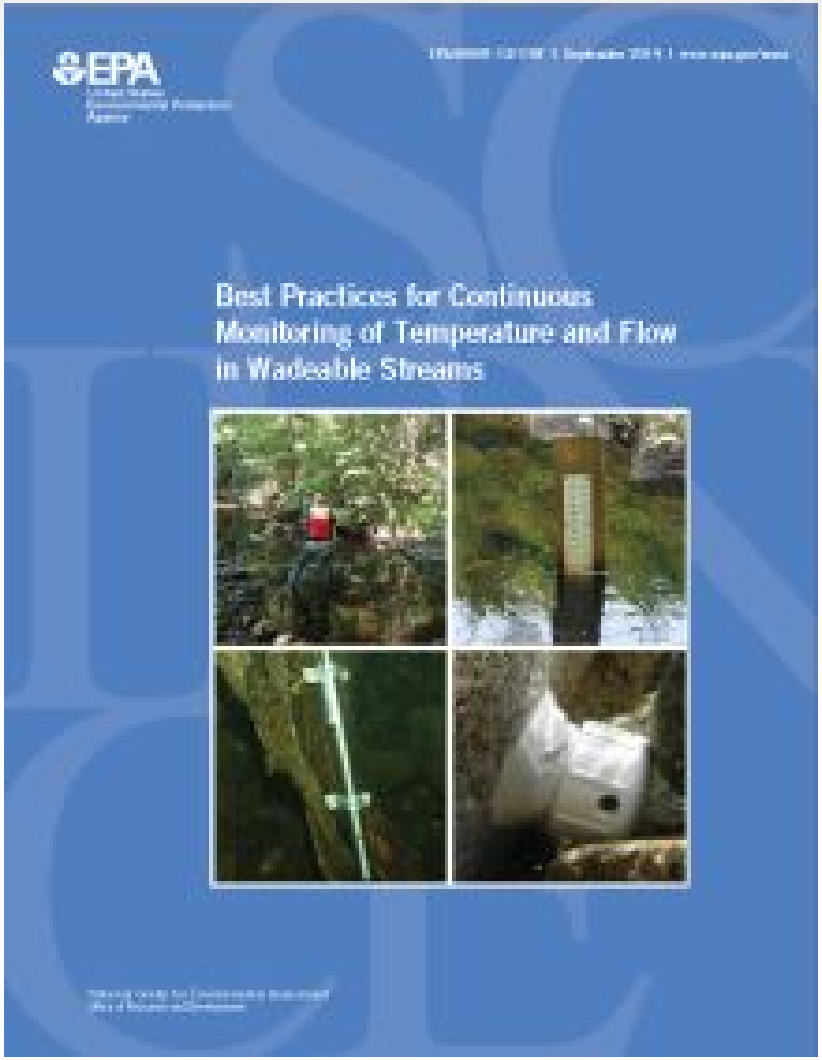
- Biological indicators
  - Benthic macroinvertebrates, optional fish and periphyton if resources permit
- Temperature
  - Continuous water and air temperature
- Hydrology
  - Continuous water level data, converted to discharge if resources permit
- Habitat (rapid visual habitat methods like USEPA RBP or state equivalent)
  - Quantitative Habitat (optional, e.g. NRSA methods)
- Water chemistry (optional, state or RBC methods)

Adaptable Framework

Level of rigor	Usability for RMNs
1 (lowest)	**Data are usable under certain or limited circumstances**. Data are not collected and processed in accordance with methods agreed upon by the regional working group, which severely limits their usefulness.
2	**Data are usable under some, but not all circumstances**. Only certain aspects of sample collection and processing are done using the protocols that are agreed upon by the regional working group, which limits their usefulness.
3 (target) ★	**Data meet the desired level of rigor**. They are collected in accordance with the methods that are agreed upon by the regional working group. Where methodological differences exist, steps have been taken to minimize biases, and data are sufficiently similar to generate comparable indicators and meet RMN objectives.
4 (optional) ★★	**Data exceed expectations**. Data include optional high quality data and meet or exceed the desired level of rigor agreed upon by the regional working group.

Macroinvertebrate Sampling

Level of rigor	Fixed Count Subsample
1 (lowest)	Presence/absence or field estimated categorical abundance (e.g., rare, common, abundant, dominant)
2	Fixed count with a target of 100 or 200 organisms
3 (target) ★	Fixed count with a target of 300 organisms
4 (optional) ★★	Fixed count with a target of more than 300 organisms



http://cfpub.epa.gov/ncea/global/recordisplay.cfm?deid=280013

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Best Practices for Continuous Monitoring Report Objectives & Contents

- Facilitate deployment of continuous temperature and water-level sensors at ungaged sites in wadeable streams
- Address challenges posed by year-round deployment
- Report describes
  - Equipment needs, options, costs
  - Equipment calibration & configuration
  - Installation
  - Maintenance
  - Data retrieval
  - Data processing
  - Lessons learned

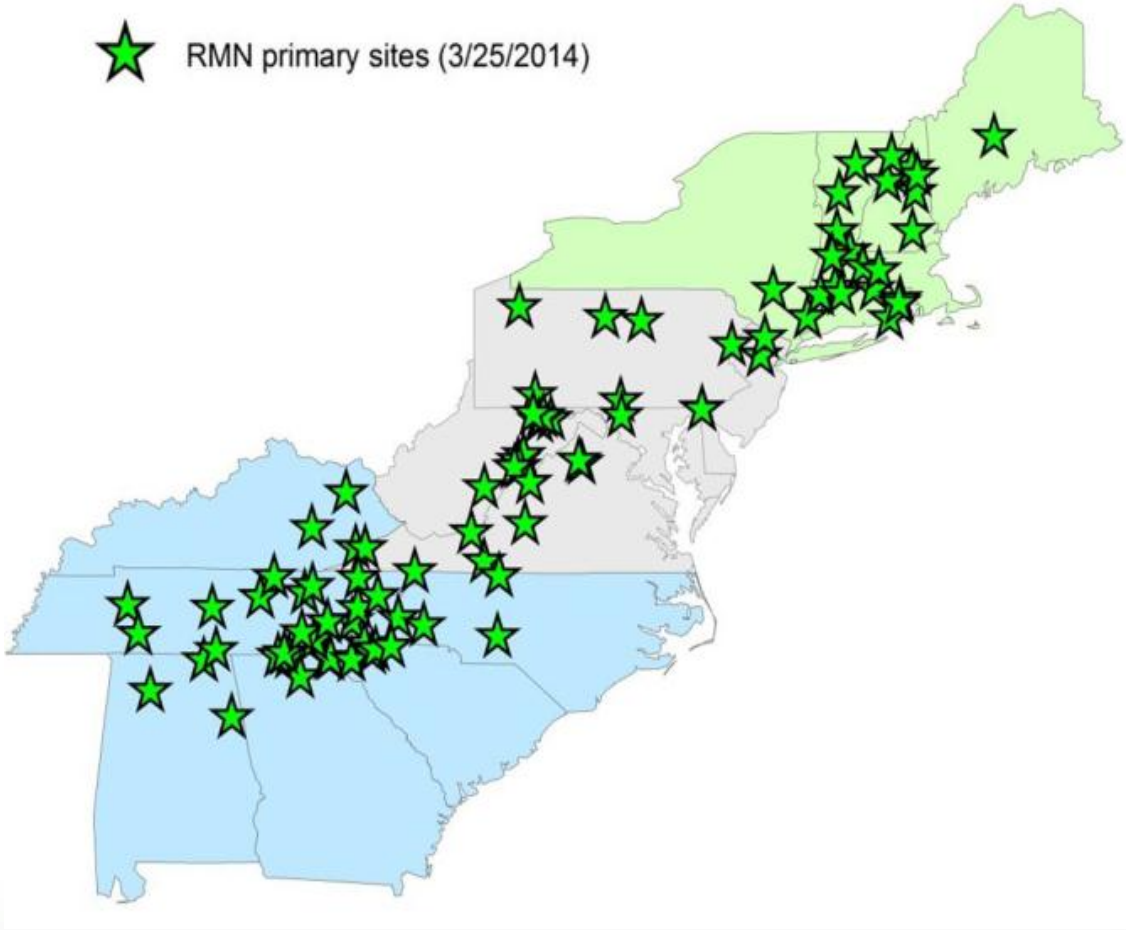
Underwater epoxy method

Vented vs. non-vented transducers

Next Steps for Best Practices Report

- Printed document
  - Contact me if you would like a copy
  - Bierwagen.britta@epa.gov
- Create online version with navigation
- Enhance online version to work in field during installations
- Facilitate updates with lessons learned from partners
- Hold additional workshops on sensor deployment?
  - YouTube videos of installations?

Current Status in East



How Can Data Be Used?

- Detect temporal trends
- Investigate relationships between biological, thermal, and hydrologic data
- Explore ecosystem responses and recovery from extreme weather events
- Test hypotheses and predictive models related to climate change
- Quantify natural variability
- Identify potential sites for restoration and adaptation

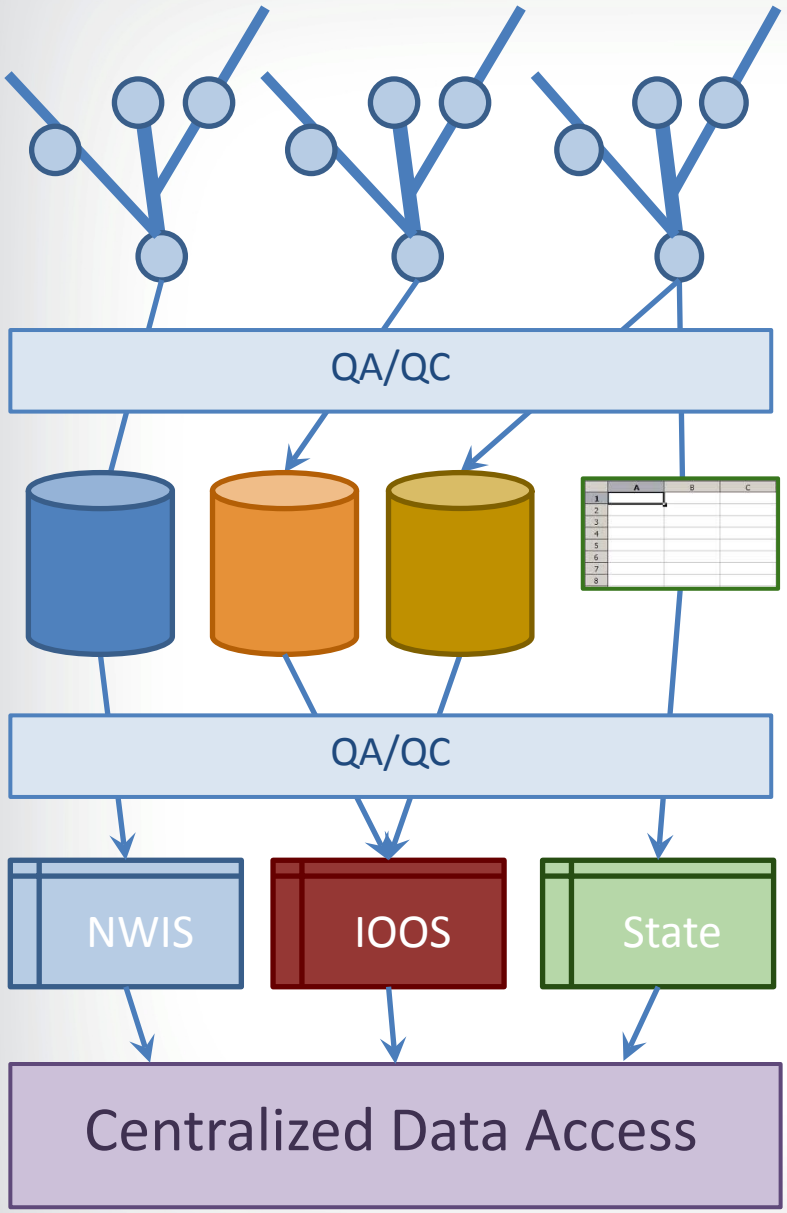
Additional Considerations Beyond East Coast

Challenges & Opportunities Engaging Additional Partners

- Different goals (not all streams resemble Eastern Woodlands)
- Selection of lower condition sites requires additional analyses
  - Vulnerability assessment gains new relevance
- Distribution of effort allows inclusion of additional sampling strata within overall network
- Fulfill multiple purposes
  - Reference condition monitoring
- Leverage expertise and resources among partners
  - Data infrastructure
  - Data sharing and analysis

Data Infrastructure

- Resources and expertise across agencies
  - EPA's WQX and Storet
  - USGS BioData, NWIS
  - Interagency Water Quality Portal
  - NorEaST Portal
  - SE CSC monitoring network portal
  - NorWeST portal
  - Interagency Global Change Information System, including Indicators system



Data Management Pilot

Sensor discovery
Data standards
QA/QC
Data management
Data sharing

Data Management Pilot

- Understand continuous data collection and management needs at local & regional scales
- Identify suitable technology solutions
  - Aquarius
  - 52 North
- Identify barriers to technology adoption
  - Expertise?
  - Applications?
  - Ease of use?
- Find new approaches to QA/QC
- Understand drivers for and barriers to partnerships that could help build a sensor web

Next Steps for Pilot

- Identify pilot partners (initial call with EPA Region 4, states, TVA)
  - Initial focus on data from temperature sensors, potentially flow
  - Additional partners from EPA Regions 1-3?
  - Additional sensor types?
- Define research questions (February - March 2015)
- Develop work plan (March - April 2015)
  - Excel » Oracle database » 52 North application?
- Lower technology adoption barriers (Spring/Summer 2015)
  - Create scripts for QA/QC, summary statistics
- Leverage partnerships (ongoing)
  - EPA Sensor Data Strategy Project, USGS QA/QC research team, NWQMC

Thank you to Regional Steering Committee members and many others who have provided data and input

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