Peer Review '07

Development of Decision Support Tools

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AGENCY PROBLEM:

A number of framework and decision support tools exist to assist managers in making appropriate decisions to ensure the health and integrity of watersheds and water bodies. These frameworks (*e.g.*, e-Estuary) are only as effective as the tools that populate them. Effective tools that can identify active stressors in a system and determine the source of the stressor are critical to ensure the success of a number of activities such as the establishing Total Maximum Daily Loads (TMDL) for pollutants and restoring land and waters under the Superfund program. These tools can also inform Office of Water and Office of Pollution Prevention and Toxics as to the effectiveness of current regulations and identify potential regulatory needs in the future. We have been developing tools to identify eutrophic and toxicity impacted watersheds and are testing them with an approach that links source, stressor and effect in retrospective and prospective case studies.

RESEARCH GOALS:

Few decision support tools exist for identifying the causative agents in watersheds listed as impaired. This research is designed to developed and evaluate these types of tools by doing the following:

1) Develop diagnostic tools to identify nutrients stressors in watersheds.
2) Develop diagnostic tools to identify toxic stressors in watersheds.
3) Test tools in a case study approach linking source, stressor and effect to identify causative agent(s).
4) Identify community level indicators specific to nutrient impairment.
5) Differentiating between effects of diffuse nonpoint-source pollution and local point-source or legacy contaminated sediments on stream benthos.

PROACH - 1. Nutrient Tools

mparative Estuaries Approach

pare levels of primary nutrients (e.g., dissolved inorganic nitrogen (DIN)) tuaries with similar geophysical and biochemical traits

dity regime
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els of DIN in
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ess than concentrations
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approach allows for
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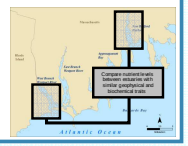
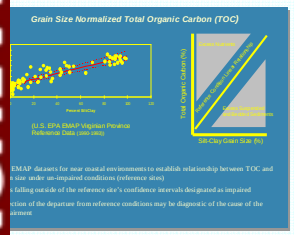


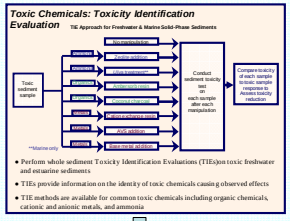


EMAP datasets for near coastal environments to establish relationship between TOC and size under un-impaired conditions (reference sites)
falling outside of the reference site's confidence intervals designated as impaired
ction of the departure from reference conditions may be diagnostic of the cause of the ainment

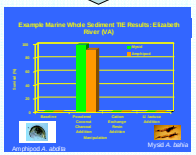
ULTS

f these tools have the potential to diagnose eutrophic or over enriched areas. The ative estuary approach is data intensive but is effective at the watershed level. ain size normalized TOC approach requires relatively little data and appears to be ctive tool to diagnose over enrichment based upon field results.

APPROACH - 2. Toxic Chemical Tools

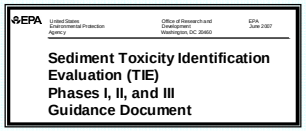


- Perform whole sediment Toxicity Identification Evaluations (TIEs)on toxic freshwater and estuarine sediments
- TIEs provide information on the identity of toxic chemicals causing observed effects
- TIE methods are available for common toxic chemicals including organic chemicals, cationic and anionic metals, and ammonia



RESULTS

TIEs are an affective method to identify toxic stressors. They are useful within a number of frameworks included TMDL approaches, e-Estuary and SIE.



APPROACH - 3. Evaluate Tools in a Case Study Approach

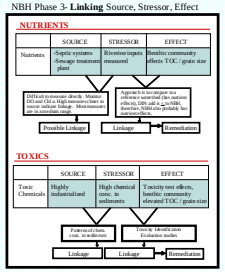
- The research evaluates diagnostic tools (measures and approaches) that can be used to identify specific stressors. Each stressor is linked to the observed biological effect and its source in a *source-stressor-effect* relationship.
- Based on Office of Water input, toxic chemicals, excess nutrients, and suspended and bedded sediments (SABS) are the focus of this research.
- Tenets of this approach are outlined in the Stressor Identification (SI) guidance (U.S. EPA 2000) and will be useful in e-Estuary technical support.
- Case studies in two estuaries, New Bedford Harbor (MA) and Narragansett Bay (RI) were used to evaluate this approach:

Case Study	Clients	Source of Data	Measures	Diagnostic Tools
New Bedford Harbor (MA)	State of MA, U.S. EPA Region 1	Existing	- Sediment toxicity - benthic community analysis - total organic carbon - grain size distribution, - chlorophyll a - suspended solids - dissolved oxygen	- Grain size/TOC relationship - Comparative estuary approach - Toxicity Identification Evaluation (TIE)
Narragansett Bay (RI)	State of RI, U.S. EPA Region 1	Existing and newly collected	- Sediment toxicity - benthic community analysis - total organic carbon - grain size distribution, - chlorophyll a - suspended solids - dissolved oxygen	- Grain size/TOC relationship - Comparative estuary approach - Toxicity Identification Evaluation (TIE)

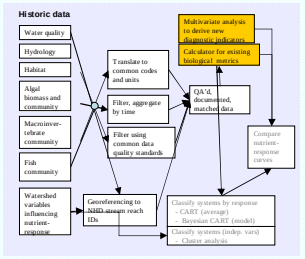
RESULTS

- Using source-stressor-effect relationships is an effective approach to identify unknown pollutants causing biological impairment.
- Diagnostic tools including the TOC/grain size relationship, the comparative estuaries approach and TIE methods have potential to be effective diagnostic tools in causal analysis.
- New Bedford Harbor (MA) is a biologically impaired estuary affected by both toxic chemicals and excess nutrients.
- Preliminary data from Narragansett Bay indicates sites historically contaminated with toxic chemicals are not toxic.
- Preliminary data from Narragansett Bay indicates excess nutrient stress is a likely cause of biological impairment in several embayments.
- Identification of nutrient sources in Narragansett Bay is underway.

Retrospective Study-
NBH Phase 3- **Linking** Source, Stressor, Effect



APPROACH - 4. Identifying community-level indicators specific to nutrient impairment



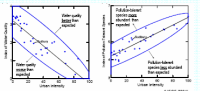
Regional Methods Initiative Project with EPA Region 5 Nutrient Regional Technical Advisory Group (RTAG (states, tribes, interstate commissions, USGS, USDA)

Analytical Approach

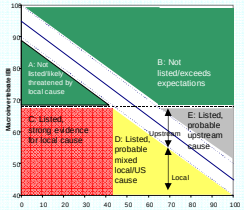
- Standardize taxonomy coding with ITIS
- Standardize level of taxonomic resolution with IDAS
- Factor out watershed size and ecoregional effects
- Relate Observed/Expected ratios for taxon and trophic group diversity and relative abundance to nutrient, algal biomass, and D.O. gradients
- Relate algal trophic guild relative abundance to nutrient gradients
- Determine thresholds of response using piece-wise regression and CART statistical methods
- Apply indicator analysis to derive new diagnostic indicators

APPROACH - 5. Differentiating between effects of diffuse nonpoint-source pollution and local point-source or legacy contaminated sediments on stream benthos Collaborative EPA RARE project (w EPA Region 1, CT, ME, USGS)

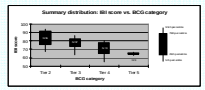
- Refine an index of watershed development for New England building off of USGS work on index of urban intensity (Coles *et al.*, 2004).
- Develop watershed development – biological or water quality condition relationships as a tool to predict diffuse watershed effects (nonpoint source) and separate these from local impacts (point source)
- Test the utility of the watershed development index tool for evaluation of partitioning cause-effect relationships in TMDL applications.



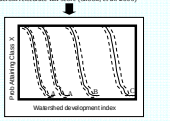
Risks can be attributed to contaminants to the extent that responses deviate from expected on the basis of the stressor-response model (Rusia and Coles 2005).



Probable interpretation of macroinvertebrate IBI scores under regulatory framework based on single threshold value for impairment.



Tiered aquatic life use categories versus macroinvertebrate IBI score (Snook, *et al.* 2006)



CLUSIONS

ification of the cause of stress or pollutant within a watershed has application in a er of Agency Programs. The TMDL program relies upon the identification of a or before sources can be identified and remediated. Products like the USEPA TIE ance Document (2007) gives regional, state, and tribal managers methods they can upon to aid in the identification of toxic stressors. Decision makers benefit from e research that broadens TIE methods into the class of emerging compounds as well ines Phase II (Identification) and Phase III (Verification) methods. Examples that porate TIEs into the TMDL approach would also be useful.

the comparative estuaries approach and the grain size normalized TOC tool have the tial to be useful tools to identify nutrients or over-enrichment as a stressor. The arative estuary approach is effective at a watershed level but has greater data nds. The grain size normalized TOC approach is effective at a number of different levels but may have nationwide regional differences. These tools need to be tested in different biogeographic provinces throughout the country to determine if there are regional differences. Their use can be disseminated through technical support frameworks such as e-Estuary.

- The two case studies provided field testing of the above tools in a modified SI approach linking source-stressor-effect. This approach was effective in the retrospective analysis of New Bedford Harbor identifying toxics and nutrients as active stressors. Narragansett Bay data analysis is still underway.
- Once we have derived community-level indicators of nutrient impairment for streams and rivers based on meta-analysis of the historical database for EPA Region 5, we will set up simple queries within the database to allow states and regions to automatically calculate these indicators from raw community data. This database will also support development of diagnostic indicators for suspended and bedded sediments in streams and rivers.

IMPACTS AND OUTCOMES

- These tools help State and Regional water quality managers to conduct TMDLs in an effective manner by identifying stressors in watersheds that have been designated as impaired (with no known cause). The use of these methods as demonstrated in the case studies will allow for the timely identification and remediation of TMDL 305 (d) listed sites.
- These tools can be used to populate frameworks and technical support systems such as e-Estuary, and augment Stressor Identification guidance
- **Principal Clients and Partners:**
  - Region 5 Regional Methods Initiative (RMI) Project, (EPA R5, tribes, MN, WI, MI, OH, IL, IN)
  - Region 1: Narragansett Bay and New Bedford Harbor case studies (RI)
  - RMI project on TIE method development (Regions 2, 6, 9): Use of TIEs in the TMDL process (NY/NJ, TX, CA)

FUTURE DIRECTIONS

- The regulated community would benefit from TIE tools that are effective in identifying emerging compounds as well as refining Phase II (Identification) and Phase III (Verification) methods. Examples that incorporate TIEs into the TMDL approach would also be useful.
- Tools to identify eutrophication and over enrichment need to be tested in different bio-geographical areas throughout the country to determine if there are regional differences. Their use can be disseminated through technical support frameworks such as e-Estuary.
- Analysis of the final year of data collected from the case study in Narragansett Bay will help to solidify the use of these tools within an approach that identifies stressors by linking source-stressor-effect.
- Integrate diagnostic tools into web-based interfaces (e-Estuary, Watershed Central) for common use by local, state, and regional stakeholders

References

Rusia, C. and J. Coles. 2005. *Standardizing Sediment Risk Characterization on the Basis of Urban Intensity of the Watershed*. US EPAScience Forum, Washington, DC.

Snook, H. R. Langdon, S.P. Davies, D. Neils, E. Prantzos, J. Gerritsen and B.K. Jessup. 2006. *The New England Wadeable Stream Survey (NEWS): Development of Common Assessment in theFramework of the Biological Condition Gradient*, Report prepared for the U.S. EPA Office of Science and Technology, U.S. EPA Office of Watersheds, and New England InterstateWater Pollution Control Board, November 14, 2006.

U.S. EPA 2000. Stressor Identification Guidance Document, Office of Water, Office of Research and Development. Washington, DC., EPA-822-B-00-025

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