CLASSIFICATION OF STREAM SENSITIVITY: A FRAMEWORK FOR MONITORING, ASSESSMENT, CRITERIA DEVELOPMENT, AND DIAGNOSIS

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LTG 2 Poster 10

Science Questions

How does one determine the most appropriate and efficient scale for application of diagnostic methods within the TMDL and 303(d) process?

How Research Addresses the Water Quality MYP Goals

EPA Regions, States and Tribes are faced with the challenge of efficiently identifying all impaired waters, determining causes and sources of impairment for the 33,953 impaired waters listed on 303(d) reports, and determining management strategies for reducing pollutant loads or alleviating other stressors to restore designated uses in these water bodies. The main objective of this research is to derive a hydrology-based watershed classification scheme that can predict the sensitivity of water bodies to nonpoint source pollution. Watershed classification schemes provide the states with an integrative framework for linking monitoring designs with assessment, criteria development, diagnosis, and the development of common management strategies for classes of watersheds. Diagnosis of cause of impairment is facilitated by partitioning variation in stressor-response curves among watershed classes, thus allowing more accurate predictive relationships to be developed. Efficiency of the TMDL process is enhanced by providing a mechanism for "bundling" TMDLs.

Research Objectives

- Using existing information, identify watersheds with different sensitivities to nonpoint source stressors
  - to stratify and reduce variability in stressor-response relationships
  - to predict impairment
- Apply a watershed-based probabilistic sampling design both
  - to assess condition with known confidence
  - to efficiently identify/predict impaired waters

Research Objectives

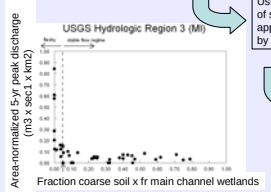
Predicting impairment and/or sensitivity: Watershed classification by hydrologic regime

Characterize watersheds that have available long-term streamflow data, using variables in USGS nonlinear regressions to predict peak flow

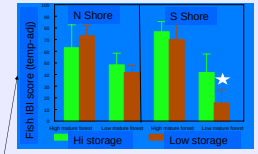
Graphical and CART analysis to determine flow thresholds separating stable from flashy flow regimes

Using watershed characteristics of sites lacking long-term flow records, apply thresholds to classify sites by expected flow regime

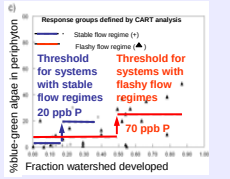
Apply watershed classes *a priori* as strata in probabilistic sampling framework or *a posteriori* to refine stressor-response relationships



Research Results - Examples



Predicting probability of impairment for L. Superior tributaries



Predicting differential sensitivity of L Michigan coastal wetlands

Research Conclusions & Future Directions

- In humid regions, watershed indicators of depressional, channel, and/or soil storage predict shifts from systems with stable hydrology to flashy flow regimes
- Flow responsiveness linked to habitat degradation (bank erosion and scouring), increased pollutant loading, and probability of biological impairment
- Hydrologic regime affects sensitivity of stream and coastal riverine wetlands to NPS pollution
- Watershed classification successfully used to provide strata for probability-based statewide survey design (some mod'ns needed for montane region)

In progress

- Watershed classification to refine nutrient-response relationships for all Region 5 states in support of effects-based criteria
- Linkage of watershed with coastal classification (LTG2/Poster 11)

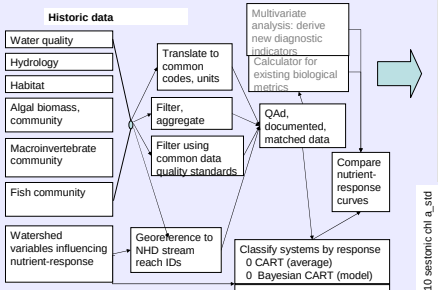
Potential future applications

- Continuous reach-level classification based on watershed characteristics using flow-accumulation techniques
- Application of watershed classification to refine suspended-and-bedded-sediment (SABS) – response relationships for EPA Region 5
- Extension to additional regions, including arid and semi-arid systems
- Web-based decision support system

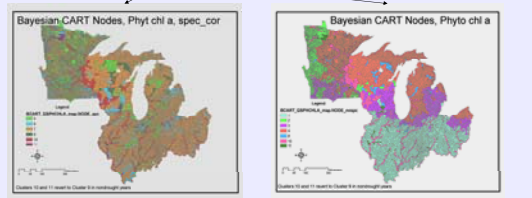
Interactions with Customers

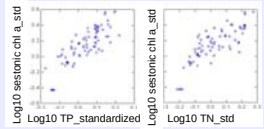
- Collaborative studies with Regions, States, and Tribes
  - Watershed classification framework for survey design for sampling WV wadeable streams (R-EMAP, WV DNR + DEP, EPA Reg 3, USGS, CVI)
  - *A posteriori* application of watershed classification framework to Lake Michigan coastal riverine wetlands sampled as part of Great Lakes R-EMAP project (EPA Region 5, Great Lake States, USGS, USFWS)
  - Development and testing of watershed classification framework for all 6 states in EPA Region 5 in support of nutrient criteria development for streams and rivers (EPA Region 5, Reg. Tech. Advisory Group (RTAG) for nutrient criteria development, EPA Biological Advisory Committee (BAC), states and tribes, USGS, USDA, interstate comm'ns, EPA Off. Env'l Inf'n)
- Outreach/technical transfer
  - *Manuscripts*
  - *Presentations* – EPA STAR grant reviews, Region 3, Canaan Valley Institute, Region 5 nutrient criteria RTAG and Surface Water Monitoring and Assessment meetings, All-states nutrient criteria meeting (planned), EPA BAC, EPA OEI and EMAP National meetings, ASLO, ESA, NABS
  - *Workshops* – EPA Region 3 and state TMDL coordinators, EPA Regions 1,4,5,7 and state/tribal nutrient coordinators, National Water Quality Monitoring Conf
  - *Web* - presentation with links to supporting information (ORD site), Region 5 nutrient criteria web site (in progress), database/analysis tool (w EPA Office of Environmental Information)

Refining stressor-response relationships: Empirical techniques for watershed classification



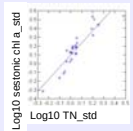
Null Model (No classification): $n=526$, $r2=0.26$, $p<0.0001$), $log10(phyt\ chl\ a) = 1.34 + 0.40log10(TP) + 0.19log10(TN)$





node 10, r2=0.71,p<0.0001)
log10(sestonic chl a)= 1.77 + 0.76log10(TP) + 0.62log10(TN)

Watershed classification by Bayesian CART analysis significantly improved variance explained for sestonic chlorophyll a, from 26% for all combined to up to a maximum of 83% for one watershed class.



node 2, r2=0.83, p<0.0001)
log10(sestonic chl a)= 0.88 + 1.21log10(TN)

How Research Contributes to Outcomes

- Provided monitoring design to link WV state needs for 305b reporting with 303d listings, TMDLs, and restoration efforts
- Supporting effects-based nutrient criteria development by states and tribes in EPA Reg 5
- Engaging clients (states (WV, Great Lakes states), tribes, Regions 3 and 5, Office of Water) in developing, testing, and transferring tools to potential users
- Engaged the academic community through an RFA for the STAR grant program on watershed classification