Classification of Estuaries of the Conterminous United States

Virginia Engle, Jan Kurtz, Lisa Smith, Cynthia Chancy, Linda Harwell, Naomi Detenbeck

U.S. EPA Office of Research and Development

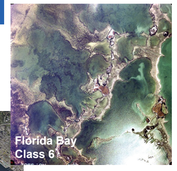
National Health and Environmental Effects Research Laboratory

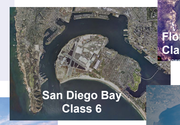
LTG 2 Poster 11

Science Questions

How can we identify estuaries with different sensitivities to single and multiple stressors using existing information?

How can knowledge of these varying and differential sensitivities be used to streamline the 303(d) listing and TMDL processes, and to manage estuaries for which there are few data?



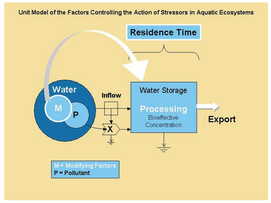


How Research Addresses the Water Quality MYP Goals

ORD has developed an estuarine classification tool that groups US estuaries based on existing physical and hydrological data, properties that may influence their susceptibility to increased nutrient loading, increased toxic inputs, altered sediment loading, or changes in habitat characteristics. Knowledge of susceptibility to particular causes may streamline and provide strength of evidence to the process of diagnosing cause of impairment.

Research Objectives

- Examine existing classification systems for their ability to group like systems based on stressor susceptibility
- Develop a conceptual model
- Define distinct coastal spatial units for classification
- Gather data on physical and hydrologic characteristics, stressor loads and concentrations, and modifying factors for these units
- Classify coastal units into similar groups by using multli-variate statistics
- Identify key factors or forcing functions that define or separate the groups



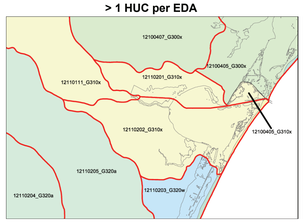
Research Methods & Collaboration

This research was conducted by the NHEERL Aquatic Stressors Diagnostics Workgroup, with representatives from three of NHEERL's ecology divisions: AED, MED and GED. In addition to the authors, the following people provided comments or input to the development of this classification framework: D. Campbell, M. Pelletier, B. Hill, K. Ho, R. Burgess, K. Perez, V. Snarski, M. Lewis, and T. Norberg-King.

In collaboration with USGS, spatial units were defined.

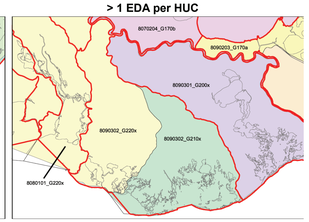
- 277 USGS 8-digit Hydrologic Unit Codes (HUCs)
- 203 NOAA Estuarine/Coastal Drainage Areas (EDA/CDAs)

> 1 HUC per EDA



EDA G310x (Corpus Christi Bay) overlapped 4 HUCs resulting in 4 unique spatial units. Yellow area = EDA and red outline = HUC.

> 1 EDA per HUC



HUC 8090302 (West Central Louisiana Coastal) overlapped 2 EDAs (G210X and G220X) resulting in 2 unique spatial units. Yellow area = EDA and red outline = HUC.

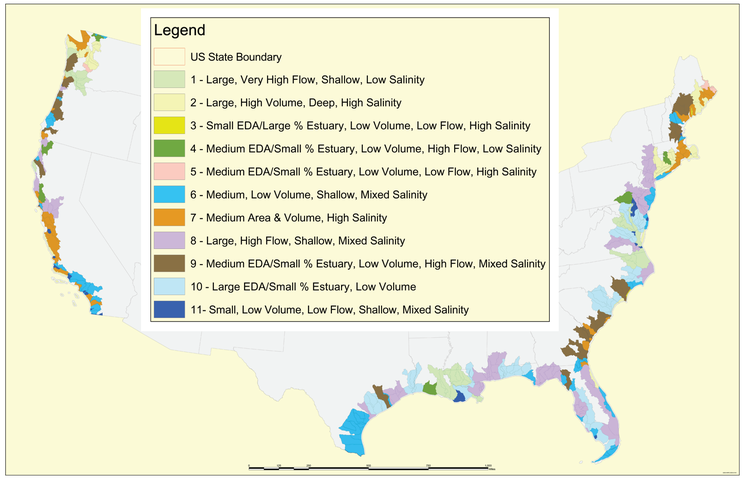
In collaboration with NOAA, pertinent physical and hydrological data were identified.

PHYSICAL AND HYDROLOGIC DATA FOR CLASSIFICATION OF COASTAL SYSTEMS	
Data	**Source**
Estuarine Drainage Area code Area of Estuary (km²) Area of Estuarine Drainage Area (km²) Mixing Zone Surface Area (km²) Seawater Zone Surface Area (km²) Tidal Freshwater Zone Surface Area (km²) Average Tide Height (m) Average Monthly River Flow (m³/day) Maximum Monthly River Flow (m³/day) Estuarine Volume (billion m³) Tidal Prism Volume (billion m³)	NOAA/NOS/Special Projects Office Coastal Assessment & Data Synthesis (CA&DS) system http://spo.nos.noaa.gov/projects/cads/ftp_data_download.html NOAA's Estuarine Eutrophication Survey – Volumes 1-5 NOAA, Office of Ocean Resources Conservation Assessment 1996
Average Bottom Salinity (ppt) Average Depth (m)	Environmental Monitoring and Assessment Program (EMAP) 1990-1997 National Coastal Assessment (NCA) 2000
Average Surface Salinity (ppt)	Environmental Monitoring and Assessment Program (EMAP) 1990-1997 National Coastal Assessment (NCA) 2000 NOAA's Estuarine Eutrophication Survey – Volumes 1-5 NOAA, Office of Ocean Resources Conservation Assessment 1996
Dissolved Concentration Potential of Pollutant (DCP in mg/L) Time for Freshwater to Displace Entire Volume of Estuary (PRE)	National Oceanic and Atmospheric Administration (NOAA). 1989. Susceptibility and Status of Gulf of Mexico Estuaries to Nutrient Discharges. Silver Spring, MD. Office of Oceanography and Marine Assessment.

- Matrix was compressed to 203 EDA/CDAs because of high frequency of missing values.
- Numeric values were log-transformed.
- Missing values were imputed by using PROC MI (SAS Institute).
- Average-linkage cluster analysis was performed on normalized euclidean distances by using PRIMER software (Plymouth Marine Lab).

Research Results

Eleven clusters or groups of EDA/CDAs were identified from examining the dendrogram results from the cluster analysis. Box-plots for each variable used in the cluster analysis were examined to compare the mean, median, 25th and 75th percentiles, minimum and maximum values across clusters. From this examination, we derived descriptive labels for each cluster of EDA/CDAs.



Research Conclusions & Future Directions

Conclusions:

This research demonstrates that estuaries can be grouped by physical and hydrological properties that are known to influence response to aquatic stressors. The resulting classification presents the opportunity to extrapolate application of criteria guidelines, TMDL development, and remediation strategies from well studied estuaries to those for which we have little data.

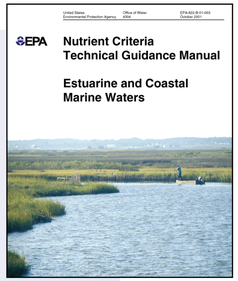
Future Directions:

We have compiled data on stressor loads, factors that modify the effects of stressors, and biological effects. Our next steps will be to test the classification we have developed based on physical and hydrologic properties with stressor and response data. These tests will either validate the utility of the classification or will demonstrate a direction for modifications.

Interactions with Customers

Office of Water (OW)

Just as Omernik's eco-region Classification has been used extensively by OW, regions and states to set and implement nutrient criteria, estuarine classification will assist the Office of Water in providing guidance to states for setting nutrient criteria for estuaries. Classification efforts will also assist states with predicting impairment, defining reference conditions, listing impaired waters, determining the cause of impairment, and subsequently developing TMDLs.



Gulf of Mexico Program (GOMP)

GOMP projects address the ecological and economic health of the region encompassed by the 5 Gulf states. Estuarine classification assists with extrapolating sediment and nutrient criteria-setting processes, water quality modeling and community restoration efforts.

National Estuary Program (NEP)

Estuarine classification assists the NEP by grouping estuaries with similar characteristics or conditions. Applications group the 27 NEPs into 5 classes based on ecosystem properties rather than political boundaries.

How Research Contributes to Outcomes

The Office of Water is currently developing guidance on development of nutrient criteria for estuaries, taking this 2001 document a step further to assist regional nutrient coordinators and states. Estuarine classification will be used as a tool and organizing component, similar to the way Ecoregional Classification has aided nutrient criteria-setting for surface waters. As estuarine criteria are developed, reference conditions are determined, estuaries are listed as impaired, and remediation strategies are considered, classification will be expanded and refined.