

## **Progress Report – FY2006**

**Core Name:** Monitoring, Assessment and Prediction Core

**Project Title:** Tidal Creeks Monitoring and Assessment

**Reporting Period:** 1 October 2005 to 30 September 2006

**Principal Investigator(s):** Denise Sanger, South Carolina Sea Grant Consortium, and Fred Holland, Hollings Marine Laboratory (HML)

**Associate Investigator(s):** Guy DiDonato, Hollings Marine Laboratory, Robert Van Dolah and Derk Bergquist, South Carolina Department of Natural Resources (SCDNR)

### **Background and Rationale:**

Estuarine ecosystems are characterized by high biological productivity, great ecological value, complex environmental gradients, and many interconnected processes. These systems, especially the tidal creeks and rivers that enter estuaries along the shores, are the primary hydrologic link with land-based activities and are the first zone of impact for non-point source pollution runoff. They also are critical feeding grounds, spawning areas, and nursery habitats for many species of fish, shellfish, birds, waterfowl, and mammals.

The effects of land-based development on estuarine condition and public health measures have been the foci of several research programs conducted by NOAA's HML/Center for Coastal and Environmental Health and Biomolecular Research (CCEHBR) and SCDNR for over a decade. The tidal creeks and rivers in these studies represented watersheds from 10-10,000 ha in size. Results of these studies indicate that the amount and type of watershed development are linked to changes in water quality including increased fecal coliform levels, decreased sediment quality, changes in the kinds and abundances of biota, changes in the abundance of juvenile fish, and decreases in the abundance of shrimp that use these habitats as nurseries. Impairment of water and sediment quality was observed in the headwater portion of tidal creeks when the amount of impervious cover in the drainage basins of tidal creek watersheds exceeded 10-20%. Impairment of living resources and nursery habitat functions in these tidal creek areas were generally detected when the amount of impervious cover in creek watersheds exceeded 20-30%. Similar relationships between environmental health measures and distance from pollution sources and pollutant loading from the watershed have also been identified. These findings suggest that the shallow estuarine habitats that form the primary link with the land provide early warning of impairment and are sentinels of ensuing harm from land-based activities. Tidal creeks are, in effect, the "first responders" to impacts of non-point source pollution runoff.

Unfortunately, sensitive and reliable measures of the health of individual organisms in creeks, the health risks from eating fish and shellfish collected from creeks, or swimming in the waters of these shallow estuarine ecosystems has been poorly evaluated. The Pathogen Source Tracking, Environmental Chemistry, and Applied Marine Genomics

cores at the NOAA Center of Excellence for Oceans and Human Health (OHH) at the HML will develop “new and improved” chemical, microbial, genomic, vector transport, and seafood safety indicators. The goal of the Tidal Creeks Monitoring and Assessment Project is to evaluate the improved tools and indicators of environment quality and public health risk in the “real world” environment of tidal creeks. In addition, sampling protocols and approaches for broadly applying these new technologies will also be developed. Ultimately, these technologies will be used to forecast future impacts.

**Objectives:**

- Develop the scientific information and framework for forecasting environmental and human health risks across estuarine habitats, watersheds, and regions including: (1) a conceptual model of linkages between tidal creek ecosystems and land based activities including impacts on human health and welfare, and (2) a classification framework for predicting environmental impacts across the many types and sizes of tidal creeks that exist;
- Provide a reliable “platform” for demonstrating the sensitivity and dependability of “new” approaches and measures of environmental quality and public health under real world conditions;
- Provide NOAA the capacity (information and expertise) for enhancing the design of the next generation of regional and national estuarine monitoring and assessment programs in a manner to include public health and early warning indicators of organism health with an emphasis on developing biological measures for including in Integrated Ocean Observing System (IOOS); and
- Compile the information and strategies required to determine if healthy coastal ecosystems are associated with healthy people and economies.

**Accomplishments:**

- Acquired monitoring and assessment data from South Carolina, Georgia, and North Carolina, from estuarine watersheds representing different land uses (i.e., forested, suburban, urban). The data provide valuable information on water and sediment quality, biological condition, and pathogen presence and concentrations. These data will be used to:
  - Develop an appropriate classification scheme for estuarine tidal creeks,
  - Relate estuarine habitat quality to land use patterns and human uses, and
  - Test and validate new technologies and methods being developed for the HML OHH program in comparison to more traditional measures of biological condition.
- Partnered with the Sapelo Island NERR and the North Carolina NERR to facilitate sample collection in Georgia and North Carolina.
- Finished processing samples collected in Winter and Summer, 2005.

- Continued to revise and expand conceptual model developed for evaluating the environmental quality of tidal creeks, including human health and welfare impacts. For example, the potential for flooding and the distribution of income were investigated for detecting human welfare impacts of watershed development.
- Analyzed tidal creek data from first sampling year (2005) for different parameter classes.
  - Pathogen data indicate that first order or headwater portions of tidal creeks frequently have an order of magnitude higher microbial and pollution contamination compared to the deeper creek systems. Urbanized systems typically have higher concentrations than forested systems.
  - Water nutrient data indicate that some parameters (e.g., nitrate/nitrite, phosphate) increase with increased urbanization, while other parameters (e.g., total nitrogen, total phosphate) have higher concentrations in the headwater portion and decrease along the creek longitudinal gradient.
  - Sediment quality data indicate that developed creeks have consistently more mud, and suburban creeks have elevated levels of ammonia (total ammonium nitrate and urea ammonium nitrate).
  - Preliminary analyses of benthic data suggest that total infauna densities are highest with stress-tolerant invertebrates dominating in the headwater portions of developed creeks.
- Participated in the hosting of one ARMADA teacher and one Hollings Undergraduate Scholar in the summer of 2006.

**Publications/Presentations:**

G. DiDonato, D.M. Sanger, J. Stewart, A.C. Blair, A.F. Holland. 2006. Detecting the effects of land use changes across the tidal creek longitudinal gradient: examples from South Carolina. Platform presentation at the Conference of the Southeastern Estuarine Research Society, Savannah, GA. October 2006.

A.F. Holland, D.M. Sanger. Tidal Creek Ecosystems: A Case Study & Lessons Learned at the Community Level. 2006. Presented at the SC Sea Grant Consortium's Regional Coastal Community Workshop Series in Charleston, Jasper and Horry Counties. Spring 2006

D.M. Sanger, D.M., A.F. Holland, R. VanDolah, G. DiDonato. 2006. Tidal creeks as sentinel habitats. Presentation at the 1<sup>st</sup> Annual Oceans and Human Health Conference, Charleston, SC. January 2006.

G. DiDonato, D.M. Sanger, A.F. Holland. 2005. Tidal Creek Ecosystems: Sentinel habitats for assessing the effects of watershed development on ecosystem and human health. Platform presentation at the 18<sup>th</sup> Biennial Conference of the Estuarine Research Federation, Norfolk, VA. October 2005.

A.F. Holland, D.M. Sanger. 2004. The Tidal Creeks Project: Understanding Linkages between Creeks and Urban Sprawl. Two brochures published by HML for public distribution.

A.F. Holland, D.M. Sanger, C.P. Gawle, S.B. Lerberg, M.S. Santiago, G.H.M. Riekerk, L.E. Zimmerman, G.I. Scott. 2004. Linkages between tidal creek ecosystems and the landscape and demographic attributes of their watersheds. JEMBE 298: 151-178.

## **Application/Technology Transfer relevant to OHH Strategic Goals**

### **1.0 Scientific Research and Application**

The Tidal Creeks Monitoring and Assessment research agenda will increase our knowledge of the impacts of humans on tidal creek systems as well as the potential human health and welfare risks of the alterations to these systems. In particular, the sampling design of the project investigates the environmental quality (i.e., water, sediment, ecological, and human exposure) of tidal creeks in relationship to the land use of the surrounding watershed. This direct association allows for evaluations of socioeconomic status as well as human health and welfare risks related to the environmental quality of tidal creeks.

### **2.0 Public Information and Outreach**

Information produced by the Tidal Creeks Monitoring and Assessment Project has been made available to general audiences through two brochures for public distribution, and the data we are collecting are being incorporated into Web applications that will be made available to others over the HML intranet and eventually the internet.

### **3.0 Capacity Building**

The Monitoring and Assessment Project will also build capacity within OHHI and NOAA through active research (e.g., conceptual model, classification system, socioeconomic impacts), coordination with other HML OHH programs (i.e., by serving as a platform for testing new technologies and methods), and information dissemination (e.g., by providing information that people can act upon at the sub-watershed level).

### **Project abstract:**

The Tidal Creeks Monitoring and Assessment Projects primary goal is to develop the scientific information and framework for forecasting environmental and human health risks across estuarine habitats, watersheds, and regions which includes the testing of new technologies developed by other HML OHH groups. During the second year of the program, staff successfully sampled four South Carolina, four Georgia, and three North Carolina estuarine tidal creek systems and their watersheds to obtain data on water

quality, sediment quality, biological condition, human exposure (i.e., pathogens), and land use. Creeks in Georgia and North Carolina were sampled in partnership with the state NERR personnel. Each creek was sampled from its headwaters to its junction with a large open estuary. The creeks represented the range of land use types and human uses that occur in the region, including forested, suburban, and urban watersheds. The data provide valuable information on the environmental quality and human health and welfare of these systems that will be used to (1) refine the current tidal creek classification scheme, (2) relate estuarine habitat quality to land use and human use patterns at the regional scale, and (3) test and validate new technologies and methods such as the oyster microarrays and virus measures being developed for the HML OHH program in comparison to more traditional measures of biological condition. Initial analyses of existing and new MAP data indicate the first order or headwater portions of tidal creeks frequently have an order of magnitude higher microbial and chemical contamination compared to the deeper creek systems. We have also participated in the development of a HML OHH database including the addition of historical data and new tidal creeks data. This accumulation of data into a common data management system will allow for efficient synthesis. This includes the revision of a conceptual model that was developed for evaluating the environmental quality of headwater tidal creeks to include human health and welfare responses.

**Budget Report:**

SCDNR

	Expended (through 8/16/06)	Encumbered	Balance
Personnel Salaries	\$77,558	\$27,860	\$27,860
Personnel Hourlies	\$31,353	\$17,548	\$17,548
Fringe	\$26,116	\$9,937	\$11,725
Contractual	\$32,106	\$0	\$11,845
Supplies	\$23,077	\$637	\$541
Fixed	\$3,628	\$0	\$308
Equipment	\$1,000	\$0	\$6,695
Trans/Travel	\$3,397	\$0	\$1,423
Indirect	\$4,587	\$7,874	\$19,354
Total Budgeted for Years 1 and 2 Activities		\$300,123	
Total Expended for Years 1 and 2 Activities		\$202,823	
Total Encumbered for Years 1 and 2 Activities		\$63,856	
Total Unobligated		\$32,887	