



## **WATER RESOURCES RESEARCH GRANT PROPOSAL**

**TITLE:** Reestablishment of an Estuarine Marsh and Waterway after Causeway Removal

**FOCUS CATEGORIES:** WL, WQL, HYDROL

**KEYWORDS:** Marshes, Ecosystems, Estuaries, Fish Ecology, Water Quality Monitoring, Geochemistry, Sedimentation, Model Studies

**DURATION:** From August 1, 1999 to July 31, 2001

**FEDERAL FUNDS:** Direct: \$36,778 Indirect: \$0 Total: \$36,778

**NON-FEDERAL FUNDS PLEDGED:** Direct: \$36,760 Indirect: \$22,414 Total: \$59,174

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**CONGRESSIONAL DISTRICT:** Second, South Carolina

### **CRITICAL REGIONAL WATER PROBLEMS**

The U.S. Geological Survey has identified "Aquatic and Environmental Protection" as one of its research priorities. Specifically, this priority area states "research needs in this area include studies of wetlands, swamps and marshes, fish and other biota, and the quality of life." The goal of the proposed study is within this research priority area.

The goal of the proposed two-year project is to study the ecological and morphological effects caused by the reduction in length of dirt causeways (accompanying bridge replacement) over a tidal waterway (Cowan Creek) and marsh in Beaufort County, South Carolina. Specific objectives to accomplish the stated goal include: 1) studying the effects of the bridge/causeway changes on tidal- and wind-induced circulation through Cowan Creek and the resulting morphologic changes in the creek and adjacent tidal marshes; 2) evaluating the change in the nektonic community in the creek and tidal marshes in terms of species composition and density; 3) determining whether the percentage of parasitized grass shrimp changes after the changes to the causeways; 4) monitoring the benthic meiofaunal community in the area by collecting sediment cores; 5) determining the amount of oyster spat settlement on the oyster beds in the creek; and 6) monitoring several surface water quality parameters to allow an assessment of changes associated with the altered hydraulics in Cowan Creek. Based on previous research, the

following changes are predicted to occur in Cowan Creek and the adjacent marshes after completion of the new bridge: 1) increases in water flow and sediment transport rates; 2) change in sediment composition; 3) change in marsh geomorphology and size (i.e., surface area); 4) change in habitat utilization by nekton; and 5) change in various water quality parameters. It is also anticipated that the increase in bridge deck elevation and length, and the potential increase in water depth under the bridge will make this creek a viable transportation route between Port Royal and St. Helena Sounds, thus restoring it to its historic importance. These changes would also enhance recreational usage and enable fisherman to catch the species known to exist there at present (Curran, in prep.). Some of this work will be directly comparable to the extensive survey conducted in a similar habitat in northern South Carolina (Ogburn et al. 1988). Our study will result in a better understanding of how causeways alter flow in tidal creeks and the concomitant change in sediment transport, water quality, sediment composition of marsh habitat, and nekton utilization of estuarine habitats.

### **Nature, Scope, and Objectives of the Research**

Beaufort County, which consists almost entirely of low-lying barrier islands, is one of the fastest growing counties in the country. With the increase in human population and concomitant coastal development, roads are being widened, new bridges are being constructed, and existing bridges are being replaced. In particular, the Route 21 bridge over Cowan Creek, near Beaufort, South Carolina is going to be replaced within the next two years. Construction of bridges over wide inland waterways, such as Cowan Creek, have historically involved the construction of dirt causeways (i.e., elongated highway embankments) to reduce the length, and therefore the cost of the bridge.

Causeways have been shown to reduce the circulation through waterways in that they act as restrictions to flow, and thus greatly decrease the hydraulic efficiency of the waterway (Lee et al. 1994). The reduced flow often results in the deposition of sediments and organic detritus, which, over time, leads to the formation of marshes. For example, the tidal marshes adjacent to Cowan Creek are approximately 2,000 ft wide. Historic French and English nautical charts (circa 1780) show that the width of the waterway has been reduced from 2,000 ft to its present day width of approximately 80 ft. This proposal raises an interesting philosophical argument. Is the "restoration" of this estuary to its historical state desirable, if this indeed does occur after the planned reduction in length of the causeways, when it will most likely result in the reduction of marsh habitat and perhaps alter the community of organisms that utilize marsh and adjacent estuarine habitat?

Cowan Creek is a tidal waterway that connects St. Helena Sound and the Beaufort River. The mean tidal range at the Route 21 bridge is 7.1 ft, whereas the spring tidal range varies from 9.5 to 11 ft. The South Carolina Department of Transportation (SCDOT) is initiating work that will eventually reduce the lengths of the two dirt embankments across Cowan Creek by 425 percent and replace the existing 120 ft bridge with a new 510 ft bridge. Our proposed study will document the changes in the flow regime, tidal marsh geomorphology, utilization of marsh habitat by nekton, and water quality that will occur

with the replacement of the existing bridge over Cowan Creek. This study would be unique because it would address the impact of the removal (not addition) of a man-made structure (i.e., dirt causeways). We predict that the following changes will occur in Cowan Creek and the adjacent marshes after completion of the bridge replacement: 1) an increase in water flow and sediment transport rates; 2) a change in sediment composition; 3) a change in marsh geomorphology and size (i.e., surface area); 4) a change in habitat utilization by nekton; and 5) a change in various water quality parameters. It is also anticipated that the increase in bridge deck elevation and potential increase in water depth will make this creek a viable transportation route between Port Royal and St. Helena Sounds, thus restoring it to its historic importance. These changes would also enhance recreational usage and enable fisherman to catch the species known to exist there at present (Curran, in prep.). Some of this work will be directly comparable to the extensive survey conducted in a similar habitat in northern South Carolina (Ogburn et al. 1988).

Our request to initiate this research this summer is crucial because work on bridge replacement is scheduled to commence in the spring of 1999. The South Carolina Sea Grant Consortium (SCSGC) has approved additional funding (\$7,000) to initiate this research in January 1999. The proposed two-year study is an extension of the limited one-year study to be funded by the SCSGC. At present, no changes to the marsh or Cowan Creek have occurred, but we need to initiate the research as soon as possible to complete an assessment of the site before changes do occur following the removal of the causeways in the fall of 1999. The proposed research is part of a broader-scale interest in the estuaries of Beaufort County. We will be able to integrate the results of the proposed study with those collected from our study sites on Pritchards Island. In particular, we are currently monitoring the changes in abundance of juvenile fishes in two connected marsh creeks. Additionally, a study of larval and juvenile nekton utilization of a developing overwash impacted barrier island marsh (containing sandy sediments) with an adjacent established marsh (containing natural mud sediments) indicated that juvenile nekton use of marsh habitat at similar tidal elevations is markedly different (Cross, in prep). These differences may be related to differences in benthic metazoan food resources available in the different sediment types (Cross, in prep). Other information concerning the importance of sediment associated factors to nekton utilization of intertidal marshes may be found from studies of artificially created marshes in the early stages of development which contain sediments with a large sand component. Comparisons of these marshes to established, natural marshes have demonstrated reduced densities of juvenile *Fundulus* and harpacticoid copepods in the created marshes (Moy and Levin 1991), both of which are important food sources. Numbers of commercial species may also decrease. We anticipate a change in sediment composition over time at Cowan Creek due to altered hydrology and system morphology. Thus, accumulating evidence suggests that differences in sediment composition can alter nekton utilization of marsh habitats and benthic metazoan food resources upon which they feed. In summary, this research will result in a better understanding of how causeways alter flow in tidal creeks and the concomitant change in sediment transport, water quality, availability and sediment composition of marsh habitat, and nekton utilization of estuarine habitats.

The goal of this project is to initiate a multi-year study of the ecological and morphological effects caused by the reduction in length of the Highway 21 dirt causeways over Cowan Creek. Specific objectives to accomplish the stated goal of the herein proposed two-year study are:

- a. to study the effects of the bridge/causeway changes on tidal- and wind-induced circulation through Cowan Creek and the resulting morphologic changes in the creek and adjacent tidal marshes. Changes in morphology will be determined by a GIS using pre- and post-construction surveys.
- b. to evaluate the change in the nektonic community in the creek and tidal marshes in terms of species composition and density;
- c. to determine whether the percentage of parasitized grass shrimp changes after removal of the causeways;
- d. to continue monitoring the benthic meiofaunal community in the area by collecting sediment cores;
- e. to determine the amount of oyster spat settlement on the oyster beds in the creek;
- f. to monitor several surface water quality parameters to allow an assessment of changes associated with altered hydrology. Parameters measured will include: concentrations of ammonia, reactive phosphorus, and dissolved oxygen, turbidity, suspended sediments, suspended particulate organic matter, temperature and salinity.