Report period:	April 2001-May 2002
Date of Report:	May 10, 2002
Title:	Stabilization of eroding shorelines in estuarine wave climates with constructed fringe wetlands incorporating offshore breakwaters
Investigators:	Scott L. Douglass and Judy Stout
Project Period:	8/99-12/02
Objectives:	To investigate the use of low-crested offshore breakwaters in the construction of fringe wetlands as an alternative to bulkheading.

Progress: Wave stress is one of a number of factors that influences the survival of *Spartina alterniflora* wetlands. Despite its importance, the existing methods to quantitatively estimate critical levels of wave energy are not based on wave height but rather some surrogate parameter such as fetch distance or some relative "exposure index" based on windspeeds and fetches. This research attempts to quantify wave stress by developing an estimate of the wave climate through wave hindcasting.

A relatively simple wave hindcasting methodology was used to estimate the wave climate at six specific locations along the shores of the eastern end of Mississippi Sound and Mobile Bay. The locations were selected because they have different levels of existing *S. alterniflora* wetlands along the waters edge. Two locations have wetlands and two locations have sandy beaches and no wetlands (although they have wetlands landward of the sandy beach "wrack line"). Two other locations were selected because the nature of the shoreline is intermediate between those extremes. One has an obviously eroding wetland (visible scarps and slump blocks) and one has non-continuous stands of *S. alterniflora* mixed with sandy shores. Wave climate was hindcast using hourly wind observations from east end of Dauphin Island for eight years (1993-2000). The wave generation methodology of the US Army Shore Protection Manual (1984) was used. This methodology uses the parametric form of Hasselmann's (1976) equations modified for shallow water. It requires, for each wind direction, an estimate of fetch and average depth across that fetch. These were scaled from the NOS charts and depths were adjusted to mean water level. The result is an estimate of the significant wave height at each site for each hour for eight years.

The areas with *Spartina* had milder estimated wave climates than the other areas and the areas with the sandy shorelines had the most severe estimated wave climates. This was true for all levels of frequency of occurrence. For example, the median wave height, H(50%), estimates were 9.1 cm and 9.2 cm for the two areas with the wetlands and were 22 cm and 23 cm for the two areas with sandy beaches. Since wetland existence may not be not controlled by the median wave height but by less frequent portions of the wave climate (i.e. storms), other less frequently occurring wave heights can be compared. For example, the 90^{th}-percentile significant wave height (90% of waves are less than this level), H(90%), estimates were 20 cm and 19 cm for the two locations with wetlands and 45 cm and 47 cm for the two locations with sandy beaches. The other two sites had wave climates that were less severe than the locations with sandy beaches but more severe than the other locations with wetlands. Thus, it appears that wave hindcasting can be used to investigate wave climate adequately enough for determining a critical limit of wave energy for wetland existence.

The primary accomplishment of this research is the development of a quantitative estimate of the upper level of wave energy that a *S.alterniflora* wetland can tolerate in coastal Alabama. Such an estimate is apparently not available in the literature. However, such an estimate will be valuable because, while significant engineering guidance exists for the design of offshore breakwaters requiring wave height reduction for boat protection (i.e. port and marina applications) and beach stabilization, similar guidance for breakwater design for wetlands stabilization does not exist. The design of such systems is typically done with a rather "seat of the pants" approach. The one fundamental piece of knowledge that is missing is an understanding of the critical, or upper, level of wave energy that a wetland can tolerate. Given that level, the existing body of knowledge on wave attenuation by breakwaters could be used in the rational, engineering design of breakwaters for wetland stabilization.

Future plans: The initial research plan was based on monitoring two constructed wetlands projects that were planned at that time. The first project wasn't built as planned and construction was just completed several weeks ago and the second project wasn't built at all because of permit concerns. The first wetland was to be planted on the south side of Mobile Bay in the lee of new breakwaters on land managed by the Bon Secour National Wildlife Refuge. This construction was originally supposed to be completed in late 1999. As part of this research, pre-construction surveys of the site and adjacent shorelines were obtained. Construction delays and problems combined to prevent completion and planting of the wetland species until several weeks ago in March 2002. The primary problem was the use of "red clay" silt as the fill material instead of clean sand as originally designed. This was apparently done by the contractor in violation of the coastal construction permit. The silt created a visible plume in the water column for months after construction during any moderate wave action. The second wetland planting was to be constructed with ACES funding as part of this research project. A site was selected (near the Bon Secour site) and a site-specific engineering design was prepared to meet the goals of this research project by including breakwaters of different heights with a limited sandy backfill. Draft coastal construction permit documents were prepared for submittal. However, discussions with state-level permit agency personnel in April and May 2001 made it clear that no other breakwaters with fill were going to permitted until the scientific community in coastal Alabama came to some consensus as to the desirability of these types of projects. Thus, the primary goals of the both the science and engineering aspects of this research based on the monitoring were not going to be achieved within the originally planned three-year time frame. In the summer of 2001, the decision was made to put the research on monitoring of the two projects on hold but to continue the development of the analysis for quantifying an upper limit of the wave stress as described above. Now, the advice of the SAC is requested concerning whether this research effort should continue with a no cost extension or whether the ACES program can use the remaining funds more effectively in funding other research.