

## **Final Report Executive Summary**

**Period Covered:** January 1, 1999 to December 31, 2003  
**Date of Report:** March 31, 2004  
**EPA Agreement Number:** R83065101-0  
**Title:** Holocene sedimentary history of Weeks Bay, AL: human and natural impacts on deposition in a Gulf Coast estuary  
**Investigators:** Douglas Haywick, Miriam Fearn, John Kempton, Lee Yokel and others  
**Institution:** University of South Alabama  
**Research category:** Regular grant  
**Project period:** January 1, 1999 to December 31, 2003

### **Objectives of the Research Project:**

Marginal marine environments such as estuaries, lagoons and bays are important repositories for fine-grained sedimentation. As such, they provide unrivalled records by which to resolve depositional processes that operate in coastal environments, climatic change, and Holocene (e.g., less than 10,000 years BP) oscillations in sea-level. This project examines the Recent sedimentary record preserved within Weeks Bay, a small estuary in southwestern Alabama. In particular, the study sought to:

- 1) Characterize Holocene stratigraphy of sediment fill in Weeks Bay.
- 2) Document the sedimentology of Weeks Bay sediment to gauge the relative importance of storms, marine and fluvial processes as sedimentation mechanisms in Weeks Bay.
- 3) Determine the biostratigraphy of Weeks Bay using diatoms, pollen and foraminifera.
- 4) Assess geochemical levels of Cd, Zn and Hg in Weeks Bay bottom sediment

Information gained from the various components of this study will be of use to scientists interested in the geology and ecology of northern Gulf of Mexico coastal embayments. It will also prove useful to individuals interested in the interplay between natural and human-induced impacts in sensitive coastal environments.

### **Progress Summary/Accomplishments:**

The majority of the 17 sedimentological cores yielded consistent and predictable grain size and age trends. Those nearest major inputs of sediment (e.g., Fish River, Magnolia River, Pelican Point), contain significant amounts of sand-sized sediment. In some areas, especially the mouth of the Fish River, sand content has increased over the past several hundred to thousand years. This coarsening upward trend reflects the propagation of a semi-submerged sand bar into Weeks Bay. Cores extracted from other portions of Weeks Bay were dominated by silt and clay, but almost all had thin (<2cm thick) intervals of sand which we interpret as event deposits (storms, floods etc). Basal portions of cores dated from approximately 2000 to 6000 years BP.

Core IX, the most comprehensively studied, displayed interesting characteristics with respect to pollen and Cesium. The most parsimonious explanation for the obvious differences in the upper 70 cm of the core is that they were caused by a mixing or resuspension/resedimentation event(s) that destroyed small scale stratigraphic

relationships. Such events may have preferentially removed and carried fine material (including pollen) out into Mobile Bay. Both loss on ignition and grain size analysis show changes at the same level, with the top 70 cm being slightly more organic and slightly more sandy. The higher pollen concentrations between 70 cm and 160 cm correspond to an interval of low sand percentages, which might translate into a lower energy environment in which smaller particles like pollen can settle out. Although pollen is a viable tool for reconstructing past vegetation, it has its limits in estuarine systems if the coring location happens to have been subject to any scouring action. These events alter the “real picture” and leave behind “missing data” as well as “blended pollen signatures.” This appears to be the situation with core IX. Although the local Corps of Engineers states that no dredging has taken place in Weeks Bay except for shoreline piers, etc., Hurricane Danny in 1997 probably did a natural dredging job on the bay. Core IX may record two events like this. The earlier one predated 1954 when Cesium-137 fallout became significant, but occurred after settlement because the mixed material contains *Ambrosia* pollen. The second event occurred after 1963 and mixed Cesium-137 evenly downcore.

Paleo-reconstruction of core IX in Weeks Bay using diatom paleoecology has provided valuable information regarding Weeks Bay’s environmental history. Resolvable changes over large-scale time periods are clearly indicated by diatom assemblages in the core and changes in the diatom assemblages over large-scale time periods are present in the data to indicate the onset of human settlement. No specific indicator species were found in the data for the presence of human settlement, however, the benthic centric *Paralia sulcata* may be useful to indicate the onset of siltation brought about by land clearing and subsequent soil erosion.

While these data did not yield positive indicators for sea level change, the lack of diatoms in a major portion of the mid to lower core strongly suggest that breakage and dissolution from storms and other resuspension events are common in Weeks Bay. Overall, anthropogenic changes do not appear to have significantly impacted Weeks Bay environment. Increasing diatom diversity appears to indicate that Weeks Bay is in a healthy condition at this time.

Techniques and data gleaned from the Weeks Bay study will provide important material, information and useful direction for ongoing research now being conducted in Mobile Bay. The database now established, with over 300 species identified, will be crucial for future monitoring of Weeks Bay and for ongoing research in Mobile Bay and the Mobile delta area.

Mercury content in bottom sediment within five representative cores from Weeks Bay is within the limits established by EPA for sludge. Aluminum content is relatively high, but is typical of estuaries because of high smectite clay content. Cadmium and zinc content is low, generally within normal parameters for coastal embayments.

#### Education/Outreach

This study involved 25 undergraduate students and 1 masters candidate. In addition to his research, many undergraduate students majoring in geology, geography and biology have had their directed research projects supported through this grant. Apart from the opportunity to conduct hands-on research in the field and the laboratory, many of the students authored presentations at professional meetings (see attached list).

**Presentations:**

- Taylor, M., Johnston, E., Fisher, A., Haywick, D., And Allison, D., 2000. Land-Use Change In The Weeks Bay Watershed Of Southern Baldwin County, Alabama: An Undergraduate GIS-Aerial Photography Study. *Geological Society of America SE Section Meeting, Charleston, SC, April 2000*
- Gatewood, M., Young, D. Haywick, D. Fisher A. and Allison, D., 2000. A Year By Year Sedimentation Record Within Weeks Bay, Baldwin County, Alabama. *77<sup>th</sup> Annual Meeting of the Alabama Academy of Sciences, Birmingham, AL, March 2000*
- Fisher, A., Gatewood, M., McLaney, G., Young, D., Haywick, D., and Allison, D., 2000. GIS As A Means Of Monitoring Sedimentation In Gulf Coast Estuaries. *Geological Society of America Southeastern section Meeting, Charleston, SC, April 2000*
- Young, D. M., A. J. Fisher, M. P. Gattwood, G. McClaney, D.W. Haywick and D.T. Allison, 2000. Student-lead research as a means of monitoring sedimentation events in Gulf Coast estuaries. *Gulf of Mexico Symposium 2000, Mobile, AL April 9-12, 2000*
- Haywick, D.W., Allison, D.T., Beebe, V.E., Benton, P., Chadwell, M.H., Fisher, A., Kersch, J.L., Stober A.M. And Stober, L.F. 2000. Human impact and episodic controls of grain size distribution in a Gulf Coast estuary. *Geological Society of America National Meeting, Reno, NV, November, 2000*
- Junkins, V., Yokel, L., Kempton, J. & Haywick, D.W., 2001. Preliminary results of shallow coring in Weeks Bay, Baldwin County, Alabama *78<sup>th</sup> Annual Meeting of the Alabama Academy of Sciences, Montgomery Alabama, March 2001*
- Stober, L., Beebe, V., Haywick, D.W., & Allison, D. T., 2001. Evidence of storm and human impacts on estuarine sedimentation, Weeks Bay, Baldwin County, Alabama. *78<sup>th</sup> Annual Meeting of the Alabama Academy of Sciences, Montgomery Alabama, March 2001*
- Haywick, D.W., Kempton, J., Yokel, L, Capello, S, Harvell, J, Haberecht, M. and Stober, L., 2001 Sedimentological and stratigraphic characterization of Holocene estuarine fill in Weeks Bay, Alabama. *Geological Society of America National Meeting, Boston, November, 2001*
- Fearn, M., Hathorn, J., Stapleton, C., Sanders, J. and Haywick, D., 2002. Estuarine Paleocology: a study of Weeks Bay, Alabama. *Annual Meeting, American Association of Geographers, Los Angeles, CA Mar 19-23*
- Haywick, D.W., Fearn, M.L., Kempton, J.P. and Yokel, L.S., 2002. Holocene sedimentary fill in Weeks Bay Alabama: a 6000 year record of human- and storm-induced deposition in a United States Gulf Coast Estuary. *16<sup>th</sup> International Sedimentological Congress, July 8-12, Johannesburg, South Africa.*
- Capello, S. and Haywick, D.W., 2002. Integration of undergraduate research with academic development of junior-level geology majors: a successful example from a liberal arts university in Alabama. *Geological Society of America National Meeting, Denver, October, 2002*

Haywick, D.W., Sebastian, G.R., and Fearn, M.L. 2003. Cross-discipline approaches to enhance geoscience education on the Gulf Coast of Alabama. *GeoSciED IV, Calgary, Canada, August, 2003.*

\* excludes non-reviewed presentations

**Publications:**

Capello, V.C. and Haywick, D.W. (under review). She said, He said: student-teacher perspectives of collaborative freshmen undergraduate research in geology. *Council on Undergraduate Research Quarterly.*

Haywick, D.W. (in prep): Three years in the life of a Gulf Coast Estuary. *Journal of Sedimentary Research* (July 2004 submission date)

Haywick D.W. and Fearn, M.L. (in prep): A 600 year history of sediment and vegetation changes in Weeks Bay, Alabama. *Estuarine, Coastal and Shelf Science* (September 2004 submission date)

Stapleton, C.A., (in prep) *Pinnularia fearnii* sp. nov. A New Diatom from Mobile Bay Alabama. *Diatom Research*

Stapleton, C.A. (in prep) The effects of storms on paleo-reconstruction in a Northern Gulf Coast

MS Dissertation (Charles Stapleton): A 6000 Year Record of Diatom Assemblages in a Storm Influenced Estuary (completion date July, 2004)

**Supplemental Keywords:**

watersheds, ecosystem, geology, ecology, surveys, EPA Region 4.

**Relevant Web Site:**

<http://www.usouthal.edu/geology/data.htm>

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