ACES Final Report Executive Summary

Part 1 Web Summary Report

Period covered by report: October 2001 to December 2003
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Award Number: R-827072-01-1
Title: Changes in water conditions and sedimentation rates associated with construction of the Mobile Bay Causeway
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Institution: University of South Alabama
Research category: Regular grant
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Objectives: This research focuses on Chocalata Bay, a floodbasin now isolated from the larger estuary of Mobile Bay by the Mobile Bay Causeway. Sediment cores from selected locations to the north and south of the Causeway are used to give information on pre and post construction conditions in and around Chocalata Bay that can help decision-makers to determine the best course of action to take in mitigating the environmental impact of the Causeway. The study uses (1) diatom analysis as an indicator of water conditions; (2) pollen and phytoliths as indicators of vegetation change; (3) grain size analysis as an indicator of energy conditions; and (4) Cesium-137 (Cs-137), and Lead-210 (Pb-210) to provide dating control for critical horizons in the cores.

Summary of Findings:

<u>Fieldwork</u> was accomplished during the summer of 2002. At least three sediment cores were taken at each of four sites in Chocalata Bay. The longest core (Core 1, 190 cm) was retrieved from the northernmost site. Cores in Chocalata Bay north of the Causeway are at least 1 meter long, those south of the Causeway are slightly shorter. During 2003, work focused on processing samples for pollen and biogenic silica, counting pollen and diatoms, determining organic carbon content and grain size, and completing Cesium-137 and Lead-210 counts. This project <u>provided research experience</u> for one graduate student from marine sciences and eight undergraduate students (2 from physics, 2 from biology, 3 from geography, and 1 from geology). Diatom investigations related to this research will later be part of a Ph.D. dissertation for one graduate student.

<u>Results</u>

Cesium-137 is present only in the top 20 cm of cores inside Chocalata Bay while analysis of the core south of the Causeway has Cesium-137 down to 50 cm. Other cores from sub-estuaries around Mobile Bay have Cesium-137 down to 50-100 cm. This suggests that the sedimentation rate in Chocalata Bay is low because it is currently isolated from Mobile Bay, its primary sediment source. Claims that the Causeway made Chocalata Bay fill up faster with sediment are not supported by our Cesium data. If we extrapolate that sedimentation rate back in time, the sediments corresponding to Causeway construction are about 40 cm downcore.

Lead-210 dating provides a different picture of the sedimentation rate although it does confirm that sediment about 40 cm down in Core 1 corresponds to the late 1920s when the Causeway was built. Pb-210 implies that the sedimentation rate before Causeway construction was about 0.15 cm per year; after construction, 0.61 cm/yr. Although this indicates that sedimentation is 4 times greater now than before, only a few Pb-210 data points exist to substantiate this scenario.

Grain size analysis of the sediment cores indicates that Chocalata Bay was changing from an estuarine to a deltaic environment before Causeway construction. Mobile Bay/delta regional processes controlled the depositional environment. After construction, more specific local influences dominated. Core 1 at the northern end of Chocalata is most representative of the bay itself, while Core 3 appears to be influenced strongly by a nearby channel. Core 4 between the Causeway and the Interstate 10 Bayway, is too short to show pre Causeway conditions plus it appears strongly influenced by the Apalachee River.

Pollen analysis of Core 1 (and others) shows that pine, bald cypress, oak and sedges have always been the dominant pollen contributing taxa; however, at about 40 cm in Chocalata Bay cores, disturbance indicators become important. This coincides well with our extrapolation from the Cesium-137 data and from the Lead-210 data that this level marks Causeway construction. Interestingly, water milfoil (*Myriophyllum*) pollen is not apparent until about 30 cm downcore, some 20 years after the Causeway was built. Although some Mobilians blame the Causeway for the proliferation of this invasive aquatic species, our data does not confirm the relationship.

Phytolith analysis of Cores 1 and 4 shows relatively stable percentages of these grass type indicators. In the upper part of Core 1, there is a slight increase in dumbbell shapes characteristic of drier, better drained soils. This is likely related to the habitat available along the Causeway itself. Sponge spicules counted in the biogenic silica samples do show a dramatic change across the Causeway boundary. Whether this represents a change in the material transported into Chocalata Bay or a change in sponges living in the bay itself is still unknown.

Diatom analysis confirms that Chocalata Bay became calmer and fresher after the Causeway was built. Biraphid diatoms increase in importance in the upper 40 cm of Core 1 inside Chocalata Bay. In general, biraphid diatoms are mobile while all others attach to plants or sediment. Biraphids are more common in lower energy environments. The upper 40 cm also has slightly higher percentages of freshwater diatom taxa. This is consistent with grain size data and with isolation from Mobile Bay. Diatom diversity shows little change pre post Causeway suggesting that Chocalata Bay remains a productive habitat.

These data all confirm that about 40 cm of sediment has accumulated in Chocalata Bay since the mid-1920s when the Mobile Bay Causeway was built. Conditions in the bay became calmer and slightly fresher after Causeway construction. With isolation from Mobile Bay, sedimentation rates seem to have increased if Lead-210 data is correct or to be lower than rates in other estuaries if Cesium levels are believed. Although the Causeway obviously had an effect on Chocalata Bay, no dramatic changes are evident in the sedimentary record except for the change in sponge spicules. Efforts to remove parts of the Causeway will disturb the habitat that now exists and may not lead to "restoration" of the original conditions. This study focused on Chocaclata Bay itself. Effects of Causeway construction on Mobile Bay is beyond the scope of this research.

Publications/Presentations:

Fearn, M. and McCullough, C. 2004. Ecological impacts of causeway construction. In: 2004 Abstract Volume, The Association of American Geographers 100th Annual Meeting, Philadelphia, Pennsylvania, CD-ROM.

Fearn, M.L., 2004. Ecological Impacts of Causeway Construction, Southeastern Coastal and Atmospheric Processes Symposium, University of South Alabama, March 27.

McCullough, C., Ellison, P. and Fearn, M. 2004. Did Causeway Construction Change Conditions in Chocalata Bay? University of South Alabama Research Forum.

Thomas, K., McCullough, C., and Fearn, M. 2004. Phytolith Analysis of Chocalata Bay. University of South Alabama, University Committee for Undergraduate Research.

Haywick, D.W., Fearn, M.L. and Sanders, J.M.. 2003. Sedimentation rates in marginal marine environments in southern Alabama, In: 2003 Abstracts with Programs, Geological Society of America, 2003 Annual Meeting, November 2-5, Seattle, WA. Geological Society of America.

Future Activities: A geography undergraduate is currently doing a directed study on sponges to help resolve the questions surrounding the sponge spicules found in Chocalata Bay.

Supplemental keywords: estuary, ecosystem, pollen, diatoms, phytoliths, Cesium-137, Lead-210, indicators, decision making, Alabama, EPA Region 4.

Relevant web sites: http://www.usouthal.edu/geography/fearn/Causeway.htm
http://www.coastdata.southalabama.edu

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