Holocene sedimentary history of Weeks Bay, AL: human and natural impacts on deposition in a Gulf Coast estuary. **Year Three Progress Report**

D. Haywick and M. Fearn (PIs)

Introduction

This study is now well into its third and final year. All cores and samples that were originally planed for in our proposal have been collected. Three additional deep borings were examined in late 2001 during geotechnical testing by the Alabama Department of Transportation prior to construction of a new bridge over the Fish River just north of Weeks Bay. These new cores are discussed under the sedimentology portion of this progress report. The only remaining major portion of the study yet to be initiated are north-south and east-west geophysical transects across the bay. Unfortunately we have encountered numerous problems in obtaining these data. The investigator responsible for this component of our study (Bartek) left Alabama during the first year of this study and we have to date, been unable to find a replacement geophysicist. Apart from this problem, the study has yielded significant new paleoecological, sedimentological and geochemical data from Weeks Bay. We can confidently state that is one of the best documented late Holocene (less than 6000 year BP) estuary-fill sequences in the Gulf Coast region.

Work status

Sedimentology and Stratigraphy

A total of 17 shallow cores (1 to 4.5 m recovery each) were collected during 3 years of field work related to this component of our study (Figure 1). These cores were sampled for grain size, and petrographic composition on a 1 to 3 cm basis. The lowest portion of each core was dated using AMS or bulk radiocarbon methods. In total, these cores yield over 1500 separate grain size samples the majority of which were processed by undergraduate students as part of independent directed research projects (students: Capello, Harvell, Sanders, Hathorn, Harrison, Stober, Garcia). Grain size analyses of the cores were completed in early 2002, but we are still processing some data. Nevertheless, four conference presentations discussing grain size variation in Weeks Bay cores have already been delivered (Stober et al. 2001; Jenkins, et al., 2001; Haywick et al., 2000; 2001) and additional abstracts are in the works (e.g., Haywick et al., 2002).

Each core preserves a record of sedimentation in a specific area of Weeks Bay. In some areas, grain size increases upwards (i.e., coarsens upwards) indicating progradation of coarser grained facies such as distributary mouth bars, tidal bars or beaches (see Figure 2). Other cores suggest that sedimentation has remained relatively consistent for three or four thousand years or fined upwards. We penetrated though the Holocene sedimentary record in the western and eastern most areas of the bay during the study (cores X and XV; Figure 1). Pre-Holocene sediment is typically orange to yellow, pebbly to peaty, sandy silt.

Processing the vast amount of grain size data collected in this study will take time, especially converting it into a format suitable for access via the internet. It is also our intention to construct a series of sedimentary and stratigraphic profiles across Weeks Bay to compliment surface sediment distribution maps produced during the earliest portion of the study. Preliminary cross sections are presently being refined and first drafts should be completed before the end of the year.

One of us (Kempton) was fortunate to have be present when the Alabama Department of Transportation drilled 4 deep split-spoon borings up to 120 feet deep on either side of the Fish River just north of Weeks Bay. This provided unexpected but very welcome stratigraphic data from below the Holocene interval we are studying in the Bay. Kempton produced detailed profiles of the borings and collected samples at every possible interval (usually every 2.5 feet).

The Weeks Bay Research Foundation kindly agreed to pay laboratory costs in order to obtain three radiocarbon dates for peat layers found within the Fish River borings. These data are invaluable as they will provide lower bounding surfaces by which to define the Holocene sedimentary fill record of Weeks Bay. The first peat we selected below the surface dated at >39000 years BP. We will choose the remaining two peat intervals for analysis during the summer of 2002.

Geochemistry

Four cores were analyzed for heavy metal contamination (generally Hg) by investigator Yokel between 2000 and 2001. For each core, 4 samples were collected from approximately 20, 40, 60 and 80 cm below the sediment-water interface. A seventeenth sample collected from the base of Core III provided pre-industrial (background) Hg levels. All 17 samples were analyzed for Hg at Severn-Trent Laboratories in Mobile. No elevated mercury levels were found within the sediment analyzed from any of the cores in Weeks Bay.

Foraminifera

Cores and surface sediment samples collected from Weeks Bay were devoid of foraminifera and other marine microfossils.

Pollen

Pollen work on Core IX is nearing completion. We are currently recounting some levels to verify results. Overall, Core IX shows little variation in pollen percentages throughout the core. *Pinus* (pine) and *Quercus* (oak) dominate the assemblage, and *Taxodium* (cypress) is the dominant wetland tree. In the upper 70 cm, there is a slight increase in percentages of *Myrica* (wax myrtle) and combined Asteraceae. This probably indicates a more open environment associated with land clearance. There is no detectable *Ambrosia* (ragweed) rise, but the sampling interval of 6 cm may be too coarse to resolve it or it may have been destroyed by a mixing event. The most interesting thing about the pollen diagrams is the concentration, not the percentages. Between about 70 cm and 160 cm total concentrations are almost two times as high as they are in samples both above and below this interval. This pattern is especially evident for pine. High pollen concentrations, like those shown by pine, can be associated with low sedimentation rates for clastic material. In contrast, Asteraceae is two times as high in the upper 70 cm as in any of the lower samples. The onset of human disturbance indicators seems to be at about 70 cm.

A 2 cm slice from half of the core (55-57 cm) was submitted for AMS dating. That date came back as 890 $\pm$ 40 BP. Such a date would be totally incompatible with pollen and diatom evidence that suggests that indicators of human settlement start at 70 cm. To confirm or refute the radiocarbon date, 5 cm slices from the core were analyzed for Cesium-137. Significant Cesium activity was recorded to a depth of approximately 70 cm. This is comparable to Cesium depths found in Rabbit Creek in the Dog River Watershed on the western side of Mobile Bay. However, the Rabbit Creek Cesium profile shows clear peaks that reflect actual Cesium fallout rates, whereas the Weeks Bay profile is more of a flat line which might be expected after a mixing event.

Preliminary pollen counting on Core I suggests a similar pattern for pine with higher pollen concentrations starting at 50 cm. This core, currently only sampled at 10 cm intervals, is also dominated by pine and oak and shows little variation in pollen percentages.

Three undergraduate students (Hathorn, Meeks, and Jordan) participated in the pollen component of this research during the past year.

Diatoms

The Marine Sciences graduate student working on the diatoms of Weeks Bay (Stapleton) attended the Iowa Lakeside Lab diatom class during the summer of 2001. He also bought a microscope adequate to the task of identifying the many small diatoms detected in Weeks Bay. With this newly acquired skill and equipment, he has begun counting diatoms in earnest. Several of the species may turn out to be new to diatom researchers. Like pollen, diatoms seem to exhibit a change across the 70 cm boundary in Core IX. Smaller diatoms and higher species richness typify samples above 70 cm, and broken or robust diatoms and lower species richness characterize sediments below 70 cm. One explanation offered for smaller more diverse diatoms is nutrient enrichment in a silica rich environment. This suggests that nutrient enrichment associated with agriculture/sewage in the watershed is evidenced by sediments in the upper 70 cm of the core.

Conclusions

The majority of the cores yielded consistent and predicable grain size and age trends; however, Core IX, the most studied to date, 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 (eutrophication?) 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. Several other storm related events (including sand beds) have also been identified in the Weeks Bay cores (e.g., Stober et al., 2001).

Future plans

During summer 2002, we will complete pollen recounting on Core IX as well as process at closer intervals and complete counting on Core I. The use of pollen to identify the settlement horizon in Core IX is limited because of resuspension events associated with the estuarine environment. Diatoms may shed additional light on this problem. Diatom work should progress at a steady pace now that expertise and equipment are in place. We anticipate completing this work by fall 2002. The stratigraphic and sedimentological work including all grain size processing is also on target for completion in the latter part of 2002, however, we anticipate that some work (especially geophysical profiling and development of the Weeks Bay web page) may not be completed before 2003. If so, we will apply for a no-cost extension of the grant.

Publication/ and References cited

Fearn, M.L.; Haywick, D; Sanders, J.; Stapleton, C; and Hathorn, J. 2002. Estuarine paleoecology: a study of Weeks Bay, Alabama. Poster presented at Association of American Geographers, 98th Annual Meeting, March, 2002, Los Angeles.

Junkins, V., Yokel, L., Kempton, J. & Haywick, D.W., 2001. Preliminary results of shallow coring in Weeks Bay, Baldwin County, Alabama *78th Annual Meeting of the Alabama Academy of Sciences, Montgomery Alabama, March 2001.*

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.*

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*

Haywick, D. W., Fearn, M., Kepton, J and Yokel, L., 2002 (accepted). Holocene sedimentary fill in Weeks Bay, Alabama: a 6000 year record of human- and storm-impacted deposition in a United States Gulf Coast estuary. *16th International Association of Sedimentologists Congress, Johannesburg, South Africa July 2002*

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. *78th Annual Meeting of the Alabama Academy of Sciences, Montgomery Alabama, March 2001*