Chapter 1

Introduction

The state of Florida is composed of six geomorphologic coastal provinces (Davis et al., 1992) (Figure 1). The west-central Florida continental shelf (WFS), part of a wide, shallow, sediment starved carbonate platform in the Gulf of Mexico, encompasses four of these provinces, and contains a variety of sedimentary features, the extent and origins of which are uncertain. The response of the limited sedimentary cover on the shelf to short-term and long-term hydrologic forcing has resulted in the spatial patterns of morphologies that have been observed there. Studies of small portions of the shelf have revealed several different types of sedimentary features. Continued study of the WFS is needed to understand its geology, identify its resources, and discover how these interact with the features on Florida's west coast, to which so much of the state's economy and infrastructure are tied.

The feasibility of conducting comprehensive studies of the WFS has been a problem. Large-scale acoustic/sonar studies of the distribution of sediment on the shelf and repeat studies to measure the variations in sedimentary morphology are expensive and time consuming. Moreover, techniques are lacking that can explain large-scale features from small-scale data, or that can integrate different spatial scale data. Researchers are also sometimes uncertain exactly *what* they are observing, based solely on remotely sensed acoustic data, and yet do not have the resources necessary to ground-truth acoustic backscatter data, nor to measure all the related hydrologic factors. There is a need, therefore, to create models, or at least to search for empirical relationships that can correlate the

Figure 1

forcing mechanisms with the observed morphologies and sedimentary properties. This study attempts to identify these types of relationships.

Below is a summary of the broad research questions that prompted this study, and that also highlight the data needed to define these relationships on the WFS:

1. What are the spatial and temporal distributions and variations in sedimentary properties and morphologies on the WFS?

2. What are the physical processes that drive sediment transport and shape the sedimentary morphology we observe on the WFS? How do these processes vary spatially and temporally?

3. What is the relationship between geotechnical sedimentary properties and morphology and our observations and interpretations of remotely sensed acoustic data? Can this relationship be modeled or quantified?

4. Can observations at small spatial and temporal scales be linked to large-scale variations? Can observing changes in grain size/mineralogy, small-scale bedforms, or large-scale bedforms in a particular area over time be used to explain the overall morphology we observe on the WFS?

These questions can be addressed by studying temporal changes in sedimentary properties and the shapes of sedimentary features, and by analyzing spatial differences between areas with similar features but different hydrologic conditions.

Two areas of the WFS were investigated, one 8-10 km from shore in ~6-8 m water depth, and the other 25 km from shore in ~18 m water depth. Side-scan sonar was used to image seafloor morphology over a period of 2 1/2 years. Interpretation of the resulting images were ground-truthed by collection of surface sediments, sub-bottom sediment cores, and electromagnetic current meter data near the seabed. The objectives of the study were to:

1. Determine the magnitude of spatial and temporal changes in sedimentary morphology in the two study areas.

2. Compare and interpret the sedimentary characteristics of each study area by collecting and analyzing sedimentary samples concurrent with each sonar survey.

3. Determine the relationships (if any) between the sedimentary properties of the collected samples and the observed side-scan signals in each survey.

4. Interpret underlying sedimentary features, from which past sediment transport and depositional processes can be inferred.

5. Determine the hydrologic processes at work within each study area and their effects on the observed sedimentary morphology.

6. Integrate the micro-scale, meso-scale, and macro-scale data from these two study areas into a broader interpretation of the fluid forcing mechanisms and sedimentary responses on the WFS.

Within the two study areas encompassed by the research in this study, the data collected addressed the broader questions concerning the WFS by testing the following hypotheses:

1. The first-order, large-scale sand ridges will not show evidence of sediment transport through changes in shape, size or border position over the study time period of 2 1/2 years. Small features, such as hummocky structures adjacent to the sand ridges and linear bedforms across the sand ridges, will show evidence of some reorganization by changing shape, size, orientation and/or relative position.

2. Spatially, the two areas will differ in morphology, with larger, more widespread features expected in the outer area and smaller, more closely spaced features in the inner area.

3. Little to no temporal variations in sediment properties (grain size distribution, sorting, carbonate content) will be observed in either area. Sediment properties will vary spatially between the two study areas, with fine grain sizes and high carbonate content expected in the deeper study area compared to the shallower area.

4. The relationship between the side-scan sonar backscatter signal (as approximated by gray scale values from 1-256) and sedimentary properties (grain size, sorting, carbonate content, and amount of fine material) can be roughly quantified to model expected backscatter in areas with similar sedimentary characteristics.

5. Mean bottom current velocities will not be sufficient to mobilize sediments, based on existing models which predict critical thresholds from sedimentary properties. Bottom current velocities resulting from the effects of wave action, however, will be strong enough to entrain and move sediments.

6. The sub-bottom cores will contain sedimentary structures resulting from storm-induced transport events.

The remainder of this dissertation is outlined as follows: Previous studies which have used sonar, box core, sedimentary, and/or current meter analyses to interpret sedimentary bedforms, morphology and transport processes on both the WFS and in other areas are reviewed in the next chapter, Shelf Sedimentary Morphology and Transport Processes. A brief description of the geologic, oceanographic, and climatologic characteristics of the study areas then follows in Study Areas and Setting. The Methods chapter details data collection and processing procedures. Descriptions and analyses of the sonar, box core, sedimentary, and current meter data sets follow in Observations and Analyses. These data sets are then interpreted in relation to the research questions and hypotheses listed above in the Discussion chapter. In the final chapter, Conclusions, the extent to which the data have tested the above hypotheses and addressed or answered the major research questions is summarized. Implications of the results and potential future research directions are outlined as well in this final chapter.