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GEOLOGIC INVESTIGATIONS PROGRAM

SAND-QUALITY CHARACTERISTICS OF ALABAMA BEACH SEDIMENT, ENVIRONMENTAL CONDITIONS, AND COMPARISON TO OFFSHORE SAND RESOURCES

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by

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INTRODUCTION

The Minerals Management Service (MMS) and the Geological Survey of Alabama (GSA) have long cooperated in the study of Alabama's coastal area (published results cited in this report). The MMS and GSA are now conducting a five-year study of Alabama beach sand quality and possible sources of sand for beach nourishment in Federal waters off the Alabama coast, especially MMS Study Areas 1 and 2 (fig. 1). These two areas were previously targeted as potential sand sources to replenish beaches in Baldwin County, Alabama. This report presents the results of the first year of the five-year study.

The tasks to be accomplished during this year were as follows:

- Further develop GIS data layers
- Monitor sedimentary and erosional regimes and mollusks on beaches
- Develop a sand-quality database
- Continue to network and disseminate information
- Submit quarterly reports and annual report on CD-ROM

The chief accomplishments during this reporting period were collection of sand and shell data, photographs, and samples from beaches in July and September 2004, sieving of sand samples, interpretation of beach and offshore sieve data, evaluation of beach-nourishment potential of MMS Study Areas 1 and 2, development of a database of sieve data from beach and offshore samples, and study of shell taxonomy, taphonomy, and distribution. Offshore cores in storage were inventoried. Samples and field photographs taken for this study are a valuable archive representing conditions before Hurricane Ivan in September 2004.

During the study period, the coastal sediment-sampling program that was begun during previous studies was completed (fig. 1, table 1). The purposes of this sampling program were to establish baseline data on beach sediment (statistical parameters and trends), to compare sediment on recently nourished beaches to other beaches, to compare beach sediment to nearshore sediment, and to evaluate the effects of tropical

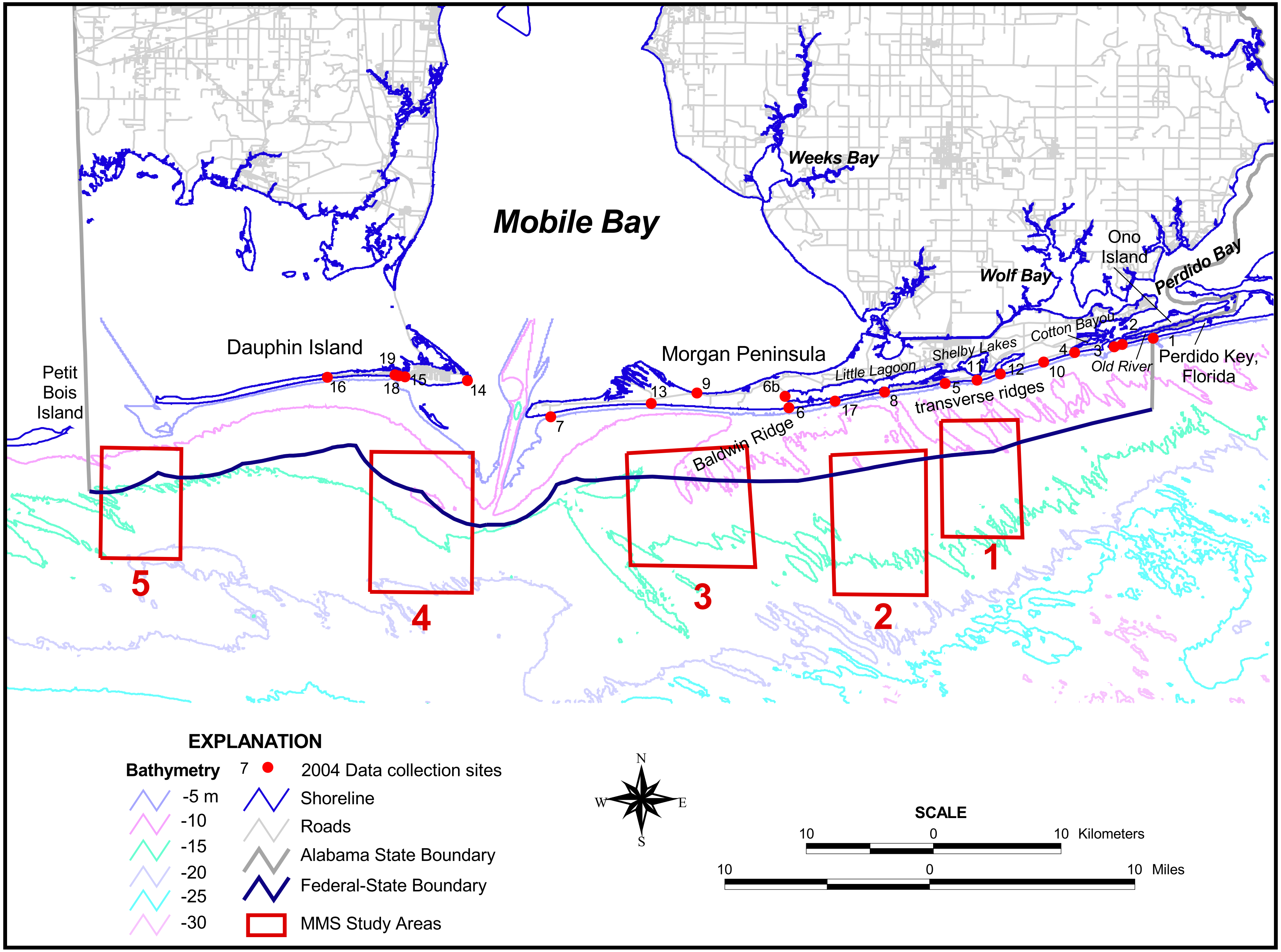

Figure 1.--Coastal and offshore Alabama, showing 2004 data collection sites, MMS offshore study areas, and bathymetry.

cyclones (hurricanes and tropical storms) on beach-sediment characteristics. Particular goals of the sampling program included documentation of beach sand particle-size characteristics for comparison to sand in Areas 1 and 2, and comparison of the abundance and condition of shells on nourished and other beaches. Temporal and spatial trends in sediment characteristics are each of concern in this study.

Table 1. Locations of beach sediment stations. GSP = Gulf State Park.

Station number	Station	Latitude	Longitude	Quadrangle
1	Alabama-Florida state line	30.27970	-87.51818	Orange Beach
2	Florida Point East (GSP)	30.27503	-87.54322	Orange Beach
3	Florida Point West (GSP)	30.27326	-87.54987	Orange Beach
4	Cotton Bayou (GSP)	30.26899	-87.58215	Orange Beach
5	Gulf Shores Public Beach (GSP)	30.24684	-87.68754	Gulf Shores
6	Pine Beach	30.22865	-87.81492	Pine Beach
6B	Little Lagoon	30.23699	-87.81815	Pine Beach
7	Fort Morgan East	30.22111	-88.00942	Fort Morgan
8	Little Lagoon Pass	30.24034	-87.73698	Gulf Shores
9	Pines public boat access	30.23864	-87.89011	St. Andrews Bay
10	Romar Beach	30.26214	-87.67070	Orange Beach
11	Gulf State Park Convention Center	30.24935	-87.66176	Gulf Shores
12	Gulf State Park Pavilion	30.25359	-87.64273	Gulf Shores
13	Cortez Street	30.23093	-87.92757	Pine Beach
14	Dauphin Island Sea Lab	30.24615	-88.07760	Fort Morgan
15	Dauphin Island Public Beach	30.24824	-88.12831	Fort Morgan NW
16	West End	30.24759	-88.19179	Fort Morgan NW
17	Alabama Highway 182 mile 2	30.23374	-87.77723	Pine Beach
18	Old pass East, Dauphin Island	30.24894	-88.13360	Fort Morgan NW
19	Old pass West, Dauphin Island	30.24959	-88.13674	Fort Morgan NW

In this report, "Previous Work" summarizes the relevant published literature, and detailed procedures are covered in "Methods." “Coastal and Nearshore Settings” are briefly described based largely on previous literature, focusing on coastal processes that affect the deposition and erosion of beaches in Alabama. This is followed by summaries of findings on beach-collected sand and shells as they relate to local environmental conditions (“Geographic and Temporal Trends” and “Beach Shells and Offshore Sand”). The beach-nourishment potential of offshore sand resources is addressed in a preliminary fashion in “Beach-Nourishment Potential of Federal Sand”. “Summary” concludes the main part of the text. Appendices contain a list of samples collected during the project period (appendix 1), raw particle-size data from beach and offshore stations (appendices 2, 3, and 4), inventories of offshore cores archived at the GSA (appendices 5 and 6), and data on beach-collected shells (appendices 7, 8, and 9).

ACKNOWLEDGMENTS

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PREVIOUS WORK

Considerable study of the Alabama coast has yielded significant insights, but, partly because the coast is continually changing, much remains to be done. Only a few of the broadest works are cited here. The bibliographies of Lipp and Chermock (1975), O'Neil and others (1982), and Davies (1995) list many additional publications.

Coastal maps and charts date back almost 400 years to the Spanish discovery of Mobile Bay, but the first accurate charts were drawn only about 300 years ago by French explorers (Blake, 1972). The charts show that the coastline has changed dramatically. For example, all or part of the western spit of Dauphin Island has repeatedly been submerged after hurricanes. The bathymetry of coastal waters has also undergone great changes during the past three centuries. However, some features, such as Ecor Rouge (Red Bluff) on Mobile Bay, have remained relatively constant until recently. Documented sea-level rise has added urgency to the study of coastal geomorphology and processes (Fairbanks, 1989).

The study of shallow offshore waters is closely connected with that of beaches. The basic data consist largely of soundings, bottom samples, cores, and well cuttings. The bathymetry of Alabama coastal waters has been charted in detail since 1847 by the U.S. Coast and Geodetic Survey (Ryan, 1969). Crance (1971) and Chermock (1974) summarized current knowledge of water depths in Alabama estuaries. Ryan (1969) analyzed water depths in Mobile Bay before and after channels were dredged for navigation. Parker (1968) described the current bathymetry and facies of Perdido Bay. Boone (1972, 1973) described offshore depositional facies in relation to bathymetry. Hydrography, including salinity and inferred circulation, were studied by McPhearson (1970), Bault (1972), and Eleuterius (1976) among others.

The geomorphology and stratigraphy of Alabama coastal counties record former positions of shorelines. Carlston (1950) was the first to study the Pleistocene shorelines and stratigraphy of Alabama in detail, using topographic maps. Otvos (1976, 1981, 1982) addressed the problems of barrier island development, ancient shorelines, possible growth faulting, and other topics in a series of papers of which only a few are cited here. Hardin and others (1976), Otvos (1990), and Smith (1986, 1988, 1989, 1991, 1992) tackled the problem of shoreline erosion, using borehole logs as well as maps and aerial photographs. Maps and aerial photographs were also the basis of studies of the Morgan Peninsula dunes (Bearden and Hummell, 1990). Hummell (1990, 1996, 1998, 1999), Rindsberg (1992), Davies (1994), Haywick and others (1994), Hummell and Parker (1995a, b), and Hummell and Smith (1998) used vibracores to study the subsurface stratigraphy of estuarine and coastal Alabama.

The offshore sedimentology of coastal Alabama has received close attention. The first thorough study of the surface sediments was that of Priddy and others (1955). Rainwater (1964) investigated the subsurface sediments in a transect of cores between Beauvoir and Ship Island, Mississippi. Ryan and Goodell (1972) and Isphording and Lamb (1980a, b) sampled the modern substrates of Mobile Bay and Mississippi Sound in Alabama, and the Geological Survey of Alabama (1992) presented analyses of vibracores from the same area. Raymond and others (1992) examined the Pliocene to Holocene subsurface deposits using well cuttings.

Measurements of Alabama beach profiles date back at least 17 years. Smith and Parker (1990, 1993) surveyed beaches from 1988 to 1992. Sanchez and Douglass (1996), Douglass (1994, 1995, 2001, 2002), and Douglass and others (1999) measured beach profiles from 1992 to 2002. Jones (2004) continued the work of monitoring Alabama beach profiles at 25 stations beginning in September 2003. As closely as possible, Jones followed the same data-collection procedures as previous researchers, but used more sophisticated analytic methods such as linear regression.

The environment of coastal Alabama, including geologic and biologic aspects, was summarized within the Cooperative Gulf of Mexico Estuarine Inventory (Crance, 1971; Swingle, 1971). Chermock (1974) summarized much of the Alabama work in *The Environment of Offshore and Coastal Alabama*. This work was followed by the Alabama Coastal Region Ecological Characterization (O'Neil and others, 1982; O'Neil and Mettee, 1982; Friend and others, 1982). These works include much original material as well as summaries of previous literature. A series of symposium volumes contains many papers pertaining to Alabama coastal waters (Loyacano and Smith, 1979; Kelly, 1981; Shabica and others, 1983; Lowery, 1987).

Biological studies in coastal Alabama also include much information appropriate to research on beaches and offshore sand. Moore (1961) recorded the molluscan fauna of Mississippi Sound. Heard (1982) provided a guide to the tidal marsh invertebrates, including some mollusks. Phillips (1971), Pryor (1975), Kent and others (1976), Chestnut (1981), and Rindsberg (1992) presented information on animal burrows and other biogenic sedimentary structures.

METHODS

FIELD PROCEDURE

Two GSA staff members typically worked together at each field site. Sand samples of at least 100 grams (g) were collected from the high-tide windrow. Where beach cusps were present, samples were collected in swales. The samples were put in plastic freezer bags, which were labeled with the sample numbers (including codes for site and date). In some cases, additional samples were collected from storm windrows, dunes, or berm. Sample numbers indicate locations on the beach from which the samples were taken. The time was recorded, as well as the temperature of the air, water, and wet intertidal sand.

A quadrat 0.3 meters (m) (1 foot (ft)) on a side was used to estimate the population density of living *Donax* surf clams in the sediment. The quadrat was excavated about 15 centimeters (cm) (0.5 ft) and the clams were counted. The number of clams was documented for three or more quadrats per site.

A quantitative collection of dead shells was made from the windrow. All shells from the topmost lamina were collected in a 1 m^2 (10.8 ft^2) quadrat and bagged. “Picked samples” of additional shells, including species not represented in the quadrat sample, were collected separately from each windrow (including storm windrows) and the surf zone.

Other observations made at each site included the nature and presence of offshore bars and beach cusps. Four digital photographs were made at each site from the windrow: north (landward) and south (seaward), and east and west (alongshore). Brief notes were made of selected biota and unusual conditions.

LABORATORY PROCEDURE

In the laboratory, sand samples were investigated in reverse order of collection because of the large backlog. Using a spreadsheet, each sample was tracked through the laboratory process. Samples collected from cusp swales at high tide were preferred for the sake of consistency.

Sand samples were washed in warm tapwater in 1,000-milliliter beakers, excess water being decanted. If necessary, the procedure was repeated six or more times to remove dirty foam and plant debris; otherwise, the sample tended to stick to interior surfaces of the splitter at a later stage. Water was decanted a final time and the beakers were dried in an oven at about 150ºC (300ºF) for 4 or more hours. About a dozen samples were processed at a time in this manner.

The dried samples were evenly divided to the desired weight of 50 ±10 g in a clean splitter. Splits were dumped out onto a prefolded sheet of paper. Most of the excess sand was discarded but one or two unused splits were retained in envelopes.

One split from each sample was sieved. We used standard screens at quarter-phi intervals shaken in a Ro-Tap® for 30 minutes. The large number of screens required two 30-minute runs for each sample. Each sieve held one sand fraction, which was individually weighed and recorded on a standardized form. Measurements were later entered in a spreadsheet.

A more detailed description of the method used for analyzing particle-size distribution can be found in Kopaska-Merkel and Rindsberg (2002, appendix 6).

STATISTICAL ANALYSIS

Particle-size data presented in this report were analyzed using standard methods. The geometric mean is used to represent the central tendency of particle-size distributions; standard deviation represents variation about the central tendency. We use the geometric mean rather than the arithmetic mean because the sizes of sieve openings used to analyze the particle-size distribution form a geometric series of the form [1, 2, 4, 8, . . .]. Such distributions generally are studied using the geometric mean. In addition, skewed distributions, like those found on Alabama beaches, are best analyzed using geometric means (Folk, 1974; Davis, 1986). The words “geometric mean” and “mean” are used interchangeably in this report to refer to the geometric mean. Sorting, skewness, and kurtosis are commonly used to summarize sample particle-size distributions and were also used in this study. Simple univariate and bivariate plots and linear-regression models graphically present sieve data.

The mode has been successfully used in particle-size analysis of beach sand (for example, Tamura, 2004). In that study, the mode was used because mixing of sediment from two sources resulted in a bimodal particle-size distribution for some samples. Because most samples analyzed for this study are clearly unimodal (appendix 2), and virtually all sand on the Alabama Gulf coast comes from unimodal sand in the littoral system of panhandle Florida, we chose to use the geometric mean rather than the mode in our analysis. However, when we sieve samples from sediment cores collected from MMS Study Areas 1 and 2, we may encounter polymodal data and will use the mode in addition to the geometric mean where appropriate.

QUALITY CONTROL

The samples and fractions were weighed on a Sartorius® electronic balance with a precision of ±0.001 g. Repeated weighing of empty clean beakers indicated that the combination of balance accuracy and beaker cleaning techniques yielded measurements accurate within 0.003 g. In addition, residue of fine dust retrieved from coarse sieves indicated that no more than 0.001 g of inappropriately fine material is dislodged from sieves by our methods.

The magnitude of analytical error was evaluated by measuring the particle-size characteristics of pairs of replicate analyses (Kopaska-Merkel and Rindsberg, 2002). Comparisons were made using the phi arithmetic mean (Folk, 1974, p. 50). In addition, pairs of adjacent samples and pairs of neighboring cusp-ridge and swale samples were analyzed to determine the magnitude of differences among distinct but similar samples. The results show that the analytical error measured by replicate analysis is less than the differences among adjacent samples (Kopaska-Merkel and Rindsberg, 2002).

Another measure of analytical error is the amount of sediment gained or lost during sieving. The average change in sample weight during sieving (33 samples) was 0.678 percent, well within the acceptable range (Kopaska-Merkel and Rindsberg, 2002). One sample exceeded 2 percent change, which is a generally accepted rule of thumb for the highest acceptable amount of change in sample weight.

COASTAL AND NEARSHORE SETTING

This brief section is a general review of conditions and processes that influence sand quality on Alabama beaches and offshore. Most of this section is summarized from reports by Hummell and Smith (1995), Parker and others (1997), and Hummell (1999).

The marine part of coastal Alabama is part of the East Louisiana-Mississippi-Alabama Shelf, a triangular area that includes part of northwest Florida in addition to the named states (Parker, 1990). The western part of the coastal region includes Dauphin Island, Pelican Island, and two large estuaries: Mississippi Sound and Mobile Bay. To the east, the Morgan Peninsula forms the southern boundary of eastern Mobile Bay and merges eastward with a part of the coastal plain that contains small estuaries and lakes.

The seafloor off Dauphin Island is relatively smooth and steep. It is bounded to the east by a broad topographic high, the ebb-tidal delta of Mobile Bay (fig. 2). The seafloor east of the ebb-tidal delta lacks islands, but has greater bathymetric relief than off Dauphin Island.

East of Mobile Pass, relict coastal features survived reworking by marine transgression, followed by Holocene fluvio-deltaic sedimentation and growth of shelf sand ridges (Vittor and Associates, 1985). Larger bathymetric features off Baldwin County include the eastern part of the Mobile Bay ebb-tidal delta and a large sand ridge west of a series of transverse ridges and swales (figs. 1, 2). The eastern part of the ebb-tidal delta occupies a triangular area south of the western tip of the Morgan Peninsula. From there, the seafloor slopes southeastward into a large depression. The large sand ridge, here called “Baldwin Ridge” for the adjacent county, is anchored to the shoreline not far west of Pine Beach.

Transverse sand ridges occupy the proximal part of the seafloor from about Pine Beach eastward to the state line and beyond. These sand ridges are oriented approximately north-northwest south-southeast. Many of the ridges are attached to the shoreline. The ridges formed chiefly through storm transport but have been modified by fair-weather currents (Parker and others, 1997).

Data were collected this year primarily from beaches. For the purposes of this report, beaches consist, from land to sea, of one or more lines of dunes almost parallel to the shoreline, a nearly level backshore or berm, and a foreshore that slopes more steeply to the water. It is convenient to include at least the closest longshore bar as part of the foreshore, because longshore bars migrate landward, weld to the beach, and

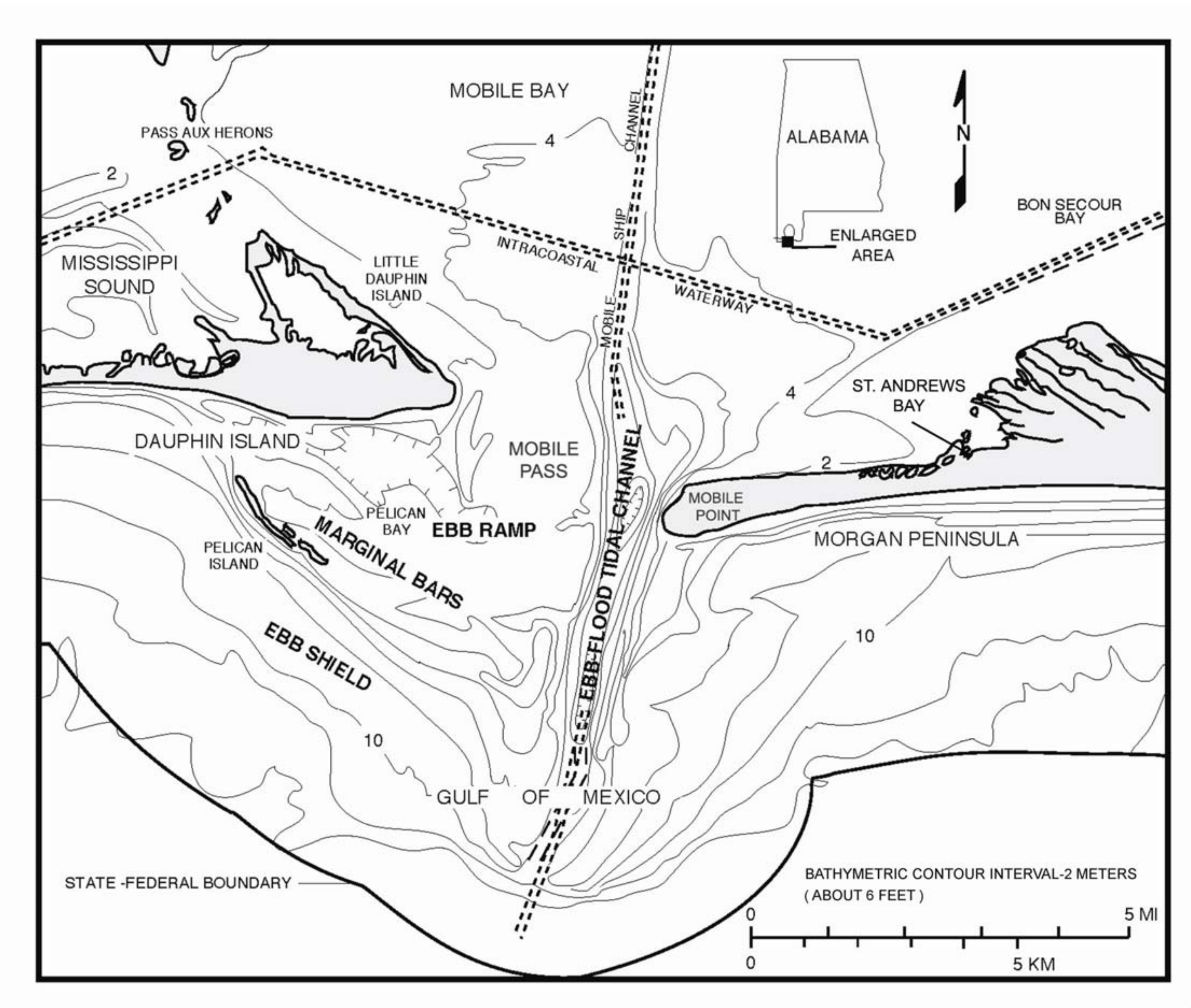

Figure 2.—Geomorphology of the ebb-tidal delta of Mobile Bay (modified from Hummell, 1990)

ultimately become part of the subaerial beach (Aagaard and others, 2004). While a bar is being welded to the beach, a ridge and runnel system develops in which the ridge is the former bar and the runnel is the remnant of open water landward of the former bar (Aagaard and others, 2004). The longshore bars and transverse ridges are distinctly different and are nearly normal to one another (fig. 1). Although some authors do not consider dunes to be part of the beach (Friedman and others, 1992), we include dunes along with the beach proper because dunes and beaches share location, vulnerability to storms and to human activities, and protective function. Most urban beaches have been highly modified from this natural state.

The sand on Alabama beaches comes primarily from the marine environment because there are no significant available onshore sources of beach-quality sand. Along the seaward sides of Dauphin Island and Morgan Peninsula, longshore currents appear to affect the transport of sediment more strongly than other mechanisms (Parker, 1990). Longshore currents typically move east to west (Foxworth and others, 1962). Sustained northwesterly or westerly winds may cause temporary reversals in the longshore current direction (Abston and others, 1987).

Westward longshore currents have controlled sediment movement throughout the Holocene (Parker and others, 1993). Holocene sediment at depth is generally much muddier west of Mobile Pass, suggesting that muddy plumes of water exiting Mobile Bay have long been deflected westward. Except in modern shelf sand ridges, the mode and degree of lateral variation in surface and subsurface lithofacies distribution are similar in both strike and dip directions.

Bulk quantities of sediment in Alabama’s longshore drift system were summarized by Hummell (1999). Estimates of the volume of sand moving in the littoral system range widely (Cooper and Pilkey, 2004). However, Garcia (1977) determined the total net littoral transport at Dauphin Island to be about 179,000 m^3 (196,000 cubic yards (yd^3)) per year. This agrees well with the U.S. Army Corps of Engineers’ (1955) estimate of 182,976 m^3 (200,105 yd^3) per year at Perdido Pass and 193,954 m^3 (212,111 yd^3) per year at Petit Bois Island, Mississippi, west of Dauphin Island, Alabama (U.S. Army Corps of Engineers, 1984). This would be enough sand to cover a strip of beach about 30 m (100 ft) wide and 5 km (3 mi) long with about 0.3 m (1 ft) of sand.

In order to locate sources of sand for beach restoration, the GSA conducted studies, funded in part by the MMS, in state and federal waters throughout the 1990s. Previous researchers identified several offshore areas underlain by relatively clean sand on the Alabama shelf (for example, Hummell, 1999; Olsen Associates, 2001) (fig. 1). Research conducted at the GSA during the 1990s (fig. 3) is the most comprehensive and detailed analysis of continental shelf sediment quality off Alabama. However, these studies do not suffice to distinguish beach-quality sand from coarser or finer clean sand. Local studies in state waters describe the distribution and thickness of clean sand bodies in some detail, but the work was conducted in state waters and covered only a minute fraction of the total area. Byrnes and others (1999) collected 80 grab samples from MMS Study Areas 1 and 2, but they only reported the proportions of gravel, sand, silt, and clay. This is not sufficient to match continental shelf sediment to Alabama beach sand because the beaches consist predominantly of medium sand. Alabama beach sediment includes little fine or coarse sand and almost no very fine or very coarse sand (see "Geographic and Temporal Trends" and appendix 2). Because fine-grained sand is transported more readily than medium-grained sand, a good match is important.

Some additional information can be gleaned by comparing continental shelf and beach particle-size data to detailed continental shelf lithofacies maps. Ludwick (1964) divided the Mississippi-Alabama shelf into six facies. A surface sediment texture map was published by the U.S. Army Corps of Engineers (1984). Parker and others (1993) constructed a surface sediment texture map for the Alabama Exclusive Economic Zone (EEZ) using the U.S. Army Corps of Engineers (1984) map and additional data. A new map of lithofacies distribution (fig. 3), based on data collected by the GSA in the 1990s, summarizes surficial lithofacies using the classification developed by Parker and others (1993). Lithofacies in this classification scheme (table 2) are expressed as volumes of sediment of consistent physical characteristics. The more recent classification of Hummell (1999) is less useful for the present purpose because it is based on environmental facies rather than lithofacies. Environments are interpretations further removed from raw data than lithofacies, which are spatially integrated sets of observations. Moreover, what is of most interest for beach-nourishment purposes is the distribution of sand with a narrow range of particle sizes and a mean particle size close to that on the beach. These criteria are most likely to be satisfied by ancient beach deposits submerged on the shelf during the Holocene transgression. Environments as defined by Hummell (1999) do not correspond as directly to sand quality as lithofacies do.

Table 2.—Lithofacies of continental shelf sediments off Alabama (after Parker and others, 1993).

Lithofacies	Subfacies
Graded Shelly Sand	
Clean Sand	Orthoquartzite Echinoid Sand Shelly Sand Sand with Mud Burrows
Dirty Sand	Muddy Sand Muddy Shelly Sand
Biogenic Sediments	Oyster Biostrome Peat
Muddy Sediment	Silty/clayey Sand Sand-Silt-Clay Mud-Sand Interbeds
pre-Holocene	

RESULTS

The sand-quality characteristics of Alabama beach sands were investigated using two complementary approaches. First, selected sand samples were sieved in order to determine particle-size distributions. Second, shells accumulated in windrows were studied in order to describe this coarse component of the beach sediment. Shells represent less than 1 percent of Alabama beach sediment but their significance to sand quality is disproportionate because they are large, visible, and hazardous when freshly broken. Excessive shell content can make an offshore sand source unsuitable for beach restoration without screening (Pilkey and others, 2004).

The particle-size characteristics of Alabama beach sand are here described in detail for the first time. Average geometric mean particle size on Alabama beaches is about 330 micrometers (µm) (medium sand; standard deviation 73 µm). Most samples are well sorted to very well sorted, but many contain small shell fragments that are significantly larger than the sand particles. Alabama beach sediment is of medium- to coarse-sand size (fig. 4), unimodal, positively skewed (excess coarse particles and a fine tail; 0.848 to 15.60, mean 4.91), but of variable kurtosis (particle-size distribution ranging from broad and low to tall and narrow; 4.46 to 329, mean 64.7) (Kopaska-Merkel, 2005). In all of these respects, Alabama beaches are typical of sandy beaches the world over (compare Allen, 1970).

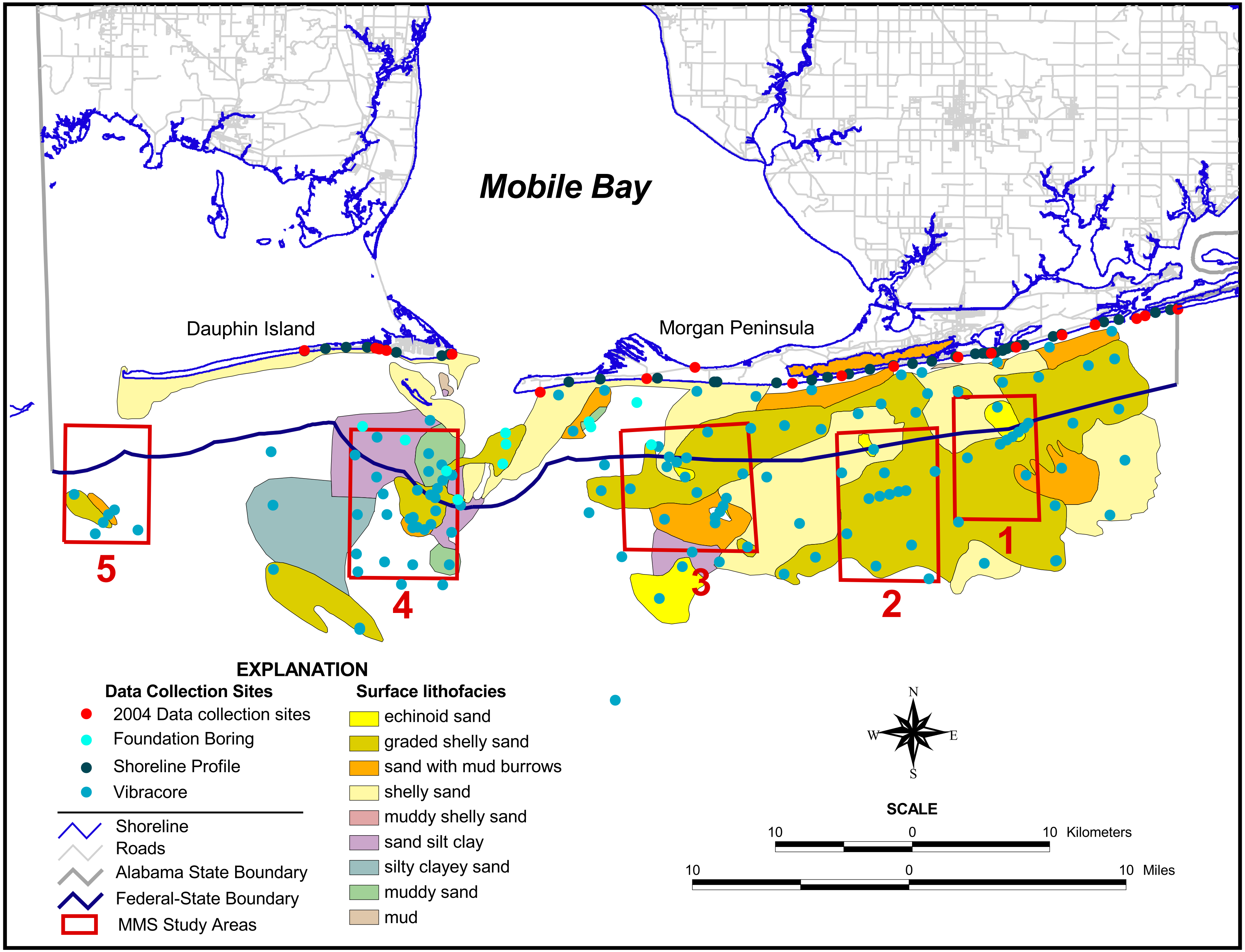

Figure 3.--Map of surface sediment texture on the Alabama shelf, with lithofacies defined by Parker and others (1993).

Natural Alabama beach sand contains a little rounded (eroded) shelly debris, although shells are seasonally abundant in windrows. Fresh shells include beach-dwelling coquina clams *Donax* spp. and other mollusks that live just offshore. Shelly windrows are especially prominent during winter, during spring tides, and after storms.

By contrast, offshore sand sources for beach nourishment may contain large amounts of shells. In 2000, the Gulf Shores Beach nourishment project emplaced a considerable amount of angular broken shell debris on the Gulf Shores Public Beach, leading to complaints from the barefoot public (Kopaska-Merkel and Rindsberg, 2002; compare Pilkey and others, 2004, p. 139-141). By July 2004, shell debris was still abundant at this beach, but with edges partly rounded; also, by this time most fragments were oriented subhorizontally (fig. 5) (Rindsberg, 2005).

Many more sand samples have been collected than have been sieved. During Year 1, we sieved the most recently collected samples first, working our way back in time to cover the entire Alabama coastline. We measured samples mainly from the July 2003, November 2004, and July 2004 trips. As yet, too few samples from fair-weather and storm windrows have been analyzed from Alabama beaches to support a high level of confidence in the calculated particle-size parameters. This applies to individual sites as well as combinations of sites. Conclusions about particle size reported here should be regarded as provisional.

GEOGRAPHIC AND TEMPORAL TRENDS

Although Alabama beach sand is relatively homogeneous, temporal and geographic trends in sand quality can yield insights into processes that affect the beaches. In addition, an understanding of variation in beach-sand quality improves matching of potential sources of sand to the beaches themselves. In this section we describe what is currently known about trends in particle size on Alabama beaches.

Seventy-three samples of Alabama beach sand from 18 regularly visited sites over a period of 3 years have been sieved as part of the Sand Resources project, which is enough to frame robust trends in particle size (Koch and Link, 1970). Certain relationships, such as that between seasons and particle size, are expected on the basis of previous work on other beaches, but cannot be recognized in our limited data set. For example, only two fair-weather winter samples have been sieved. Nevertheless,some hypothesized relationships can be confirmed and others eliminated. Five topics are discussed in this section: seasonal cycles, variation alongshore, urbanization, storms, and coarse outliers.

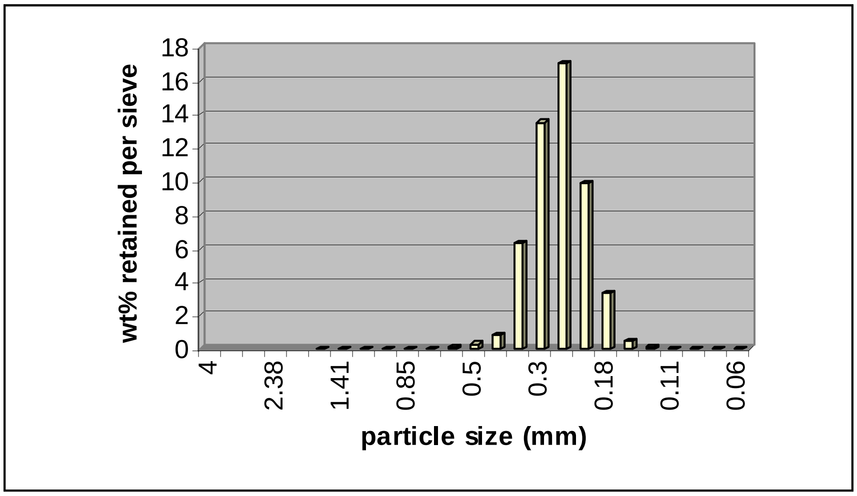

Figure 4.—Particle-size distribution of a typical Alabama beach sand (Alabama-Florida state line, sample 020311-1-3A).

Figure 5.—Shelly sand two years after emplacement on Gulf Shores Public Beach, November 7, 2003. Scale in centimeters.

SEASONAL CYCLES

In general, the exposed parts of Gulf beaches become steeper and particle size becomes coarser during winter, and longshore bars move farther offshore. These regular changes in beach sediment characteristics should be superposed on the effects of storm events and trends resulting from human activities such as beach nourishment and dredging. The sieve data measured so far are too limited to show seasonal trends. However, some Alabama beaches are steeper and narrower in winter than in summer. Paired photographs illustrate seasonal differences (fig. 6).

Figure 6.—Photographs taken in March (left) and July 2003 (right)
at Cotton Bayou, Gulf State Park.

VARIATION ALONGSHORE

Because most of the samples sieved so far were collected in summer, spatial trends can be studied without the complication of seasonal fluctuations. Based on samples from single trips, Alabama beach sand varies little in size alongshore (fig. 7) except for being markedly coarser in two places. One of the areas having coarser sand, at and west of the Gulf Shores Public Beach, may result from the beach nourishment project that was completed there in 2000. However, no baseline particle-size data of comparable analytical precision were collected before beach nourishment (Olsen Associates, 2001).

Data from 2003 (fig. 7b) and 2004 (fig. 7c) show that the beach sand at Dauphin Island's West End (the western end of the inhabited area) also is noticeably coarser than at most other sites. This may be because West End has undergone persistent erosion for many years.

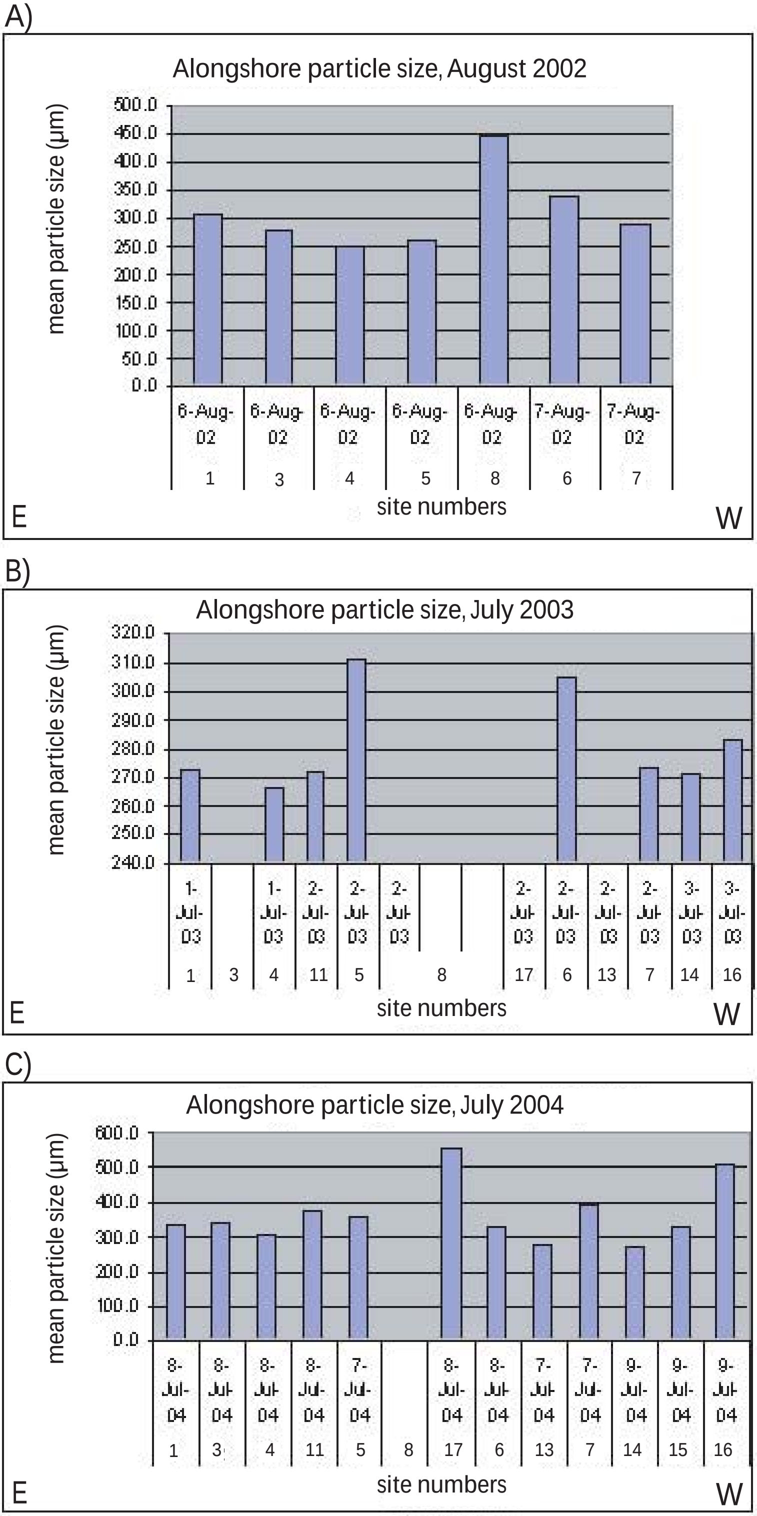

Figure 7.-Alongshore trends in beach sand quality at three points in time. Geometric mean particle size is compared for August 2002, July 2003, and July 2004.

Data aggregated over time, however, offer another explanation for the coarse sand in western Baldwin County. There seems to be a general trend from the Alabama-Florida state line westward to Fort Morgan East of increasing particle size on the beaches under fair-weather conditions (table 3; Kopaska-Merkel, 2005). This trend could result from gradual winnowing as sediment moves westward under the influence of longshore drift.

The observed trend on the beach may be related to nearshore bathymetry (fig. 1) Study of Alabama beach profiles and aerial photographs suggests that bar geometry and beach profile style correlate with particle size on the foreshore and perhaps vary with beach erosion or deposition (Douglass, 2001, 2002; Jones, 2004). For more than a decade before Hurricane Ivan, longshore bars were of low relief or absent off the eastern part of Baldwin County; farther to the west, longshore bars were more robust. At least in Baldwin County, relatively fine-grained beaches (fig. 8) are associated with poorly developed or absent longshore bars, and relatively coarse-grained beaches (fig. 9) are associated with high-relief, well-developed longshore bars.

Table 3.—Mean particle size on Baldwin County beaches, fair-weather conditions.

Sites	Number of samples	Mean particle size (µm)
1, 2, 3	8	338
10, 12	2	311.1
5, 11	4	360.8
8	1	502.7
7	4	377.2

The disagreement between data from single trips to the coast and pooled data may result from substantial spatiotemporal fluctuations in particle-size distributions. Because geometric mean particle size ranges up to about 300 µm and is controlled by several different factors (including longshore drift, waves, local erosional regimes, and major storms), well over 100 fair-weather samples would be required statistically to show how particle size varies in space and time. Pooled data may correspond to, but not adequately represent, a non-normally distributed population of beach sand-quality conditions. A similar argument can be made about the data from single trips. Few trips are represented and none are represented by all sites. Therefore, conclusions about apparent synoptic longshore particle-size trends may be erroneous. Because both synoptic and pooled data are based on limited observations, reconciliation of mutually incompatible trends suggested by these two approaches must await additional sieve data.

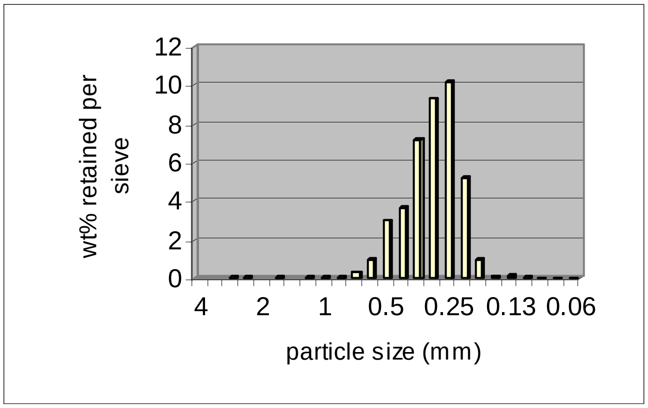

Figure 8.—Histogram of particle-size distribution of relatively fine sample from Alabama-Florida state line (sample 040708-1LHT).

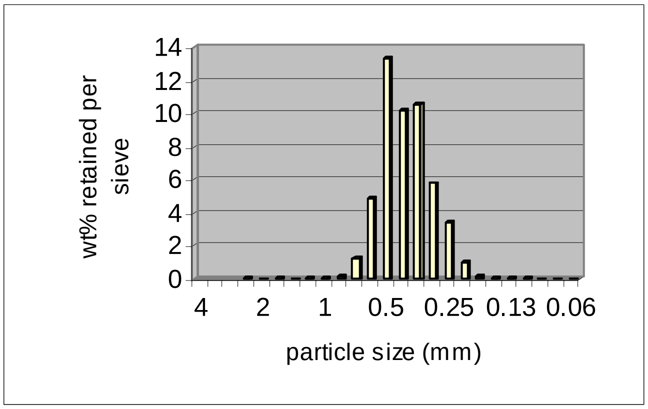

Figure 9.—Histogram of particle-size distribution of relatively coarse sample (mean = 446.7 µm) from Little Lagoon Pass (sample 020806-8-1A).

URBANIZATION

Alabama's coast exhibits a broad variation in development ranging from nearly natural to heavily urbanized, and this variation can be expected to affect the sand on beaches. In general, eolian coastal sand dunes are derived from beach sand but are finer than beach sand because of winnowing and abrasion. Hence, beaches backed by dunes might be expected to coarsen as dunes develop. Because heavily urbanized coasts lack natural dunes, particle-size distribution might vary systematically with level of urbanization. However, as table 4 shows, existing data reveal no statistically significant effect of urbanization on particle size in the foreshore.

Table 4.—Effect of urbanization on particle size on the foreshore.

Beach development	Fair weather mean particle size (µm)	Standard deviation	Number of samples	Storm mean particle size (µm)	Standard deviation	Number of samples
Undeveloped (6 sites)*	334.2	71.2	16	328.8	76.9	10
Suburban (8 sites)*	382.2	110.9	10	342.4	57.2	10
Urban (5 sites)*	326.6	77.8	12	299.2	42.8	8

*Undeveloped sites: 2,3,6,7,9,12; suburban sites: 8,11,13,14,15,16,17,19; urban sites: 1,4,5,10,18.

STORMS

Limited data collected as part of this study (table 5) indicate that storm windrows are either coarser or finer than fair-weather windrows. On average, fair-weather windrows are slightly coarser, but the difference is not statistically significant. Some storm windrows consist of small *Sargassum* fragments (fig. 10) lying upon sand that was deposited under different energy conditions. Because beach sand generally coarsens from berm to lower foreshore, chances are that a *Sargassum* windrow lying on top of berm sand would yield anomalously fine sand when compared to a fair-weather windrow located lower on the beach. The deposition of storm windrows consisting of plant debris where eolian sand (finer than water-laid foreshore sand) is normally deposited is supported by our observation of eolian sand on a *Sargassum* windrow, the sand deposited partly by adhering to wet surfaces (fig. 11). The same anomaly would likely result with a berm-top windrow consisting of any other kind of plant debris (fig. 12). All sieved storm samples came from the primary storm windrow, which contained abundant large tufts of *Sargassum* and shell debris, and not from the finer storm windrow (located lower on the beach), consisting of *Sargassum* floats.

In general, major storms coarsen beach sediment by washing away the finer particles. This effect is temporary, because much of the finer sediment is redeposited on the upper shoreface and is soon returned to the foreshore by fair-weather waves. The temporary coarsening of foreshores generally is most pronounced in urban areas because the solid walls of buildings reflect storm wave energy back onto the beach. Our quarterly data cannot address this idea. As shown in table 4, our evidence does not indicate permanent coarsening on Alabama beaches.

Table 5.—Differences between fair-weather and storm windrow geometric mean particle sizes for pairs of samples collected on the same date and at the same site.

Site (site number), east to west	Season	Storm (µm)	Fair (µm)	Difference (µm)*
Florida Point West (3)	Summer 2002	321.4	277.6	43.9
Little Lagoon Pass (8)	Summer 2002	299.1	446.7	-147.6
Fort Morgan East (7)	Summer 2002	260.0	290.1	-30.1
Cotton Bayou (4)	Summer 2002	315.8	248.4	67.4
Pine Beach (6)	Summer 2002	350.7	338.7	12.0
Gulf Shores Public Beach (5)	Summer 2002	299.4	261.4	38.0
Florida Point East (2)	Summer 2002	289.9	328.2	-38.3
Cortez Street (13)	Summer 2004	323.6	279.4	44.2
Gulf State Park Convention Center (11)	Summer 2004	405.4	372.6	32.8
Alabama Highway 182 mile 2 (17)	Summer 2004	375.3	550.7	-175.4
Pine Beach (6)	Summer 2004	532.3	329.7	202.6
West End (16)	Summer 2004	365.2	510.3	-145.1
Old pass, Dauphin Island (19)	Summer 2004	297.7	286.6	11.0

*Difference is storm windrow minus fair-weather windrow; measurements are geometric means. Mean differences are -6.5 µm; -7.8 µm; and -5.0 µm, for all samples, 2002 samples, and 2004 samples, respectively.

Standard deviations are 103.2 µm, 72.8 µm, and 138.5 µm, respectively. Some difference values are affected by rounding.

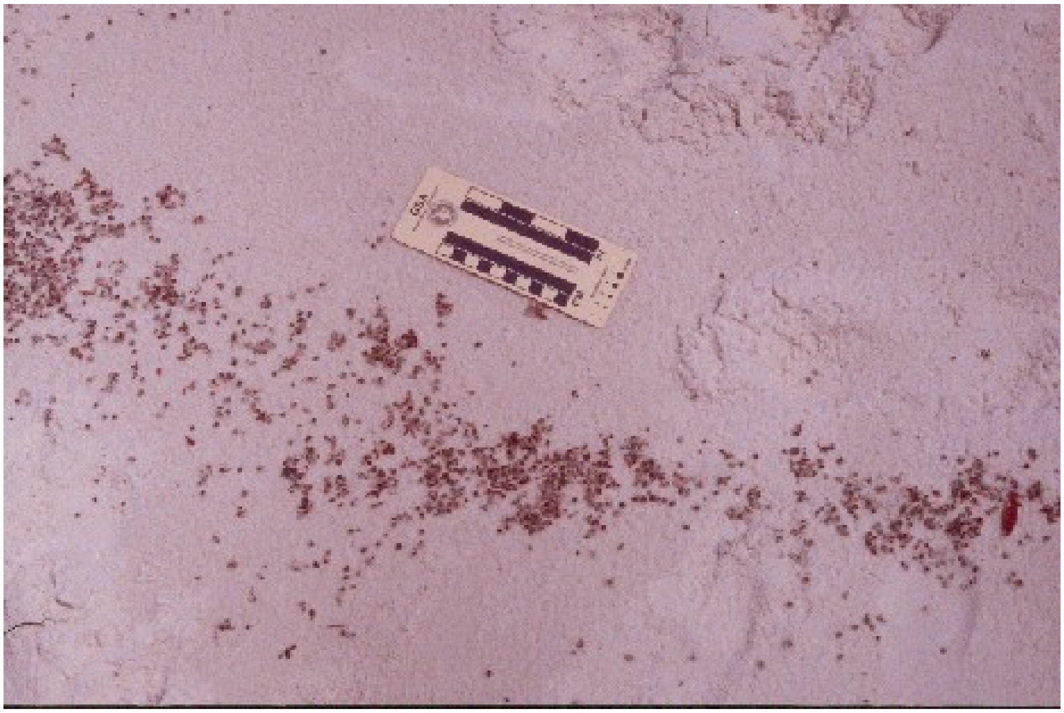

Figure 10.—Storm windrow consisting of *Sargassum* floats following Tropical Storm Bertha at Florida Point East, August 6, 2002.

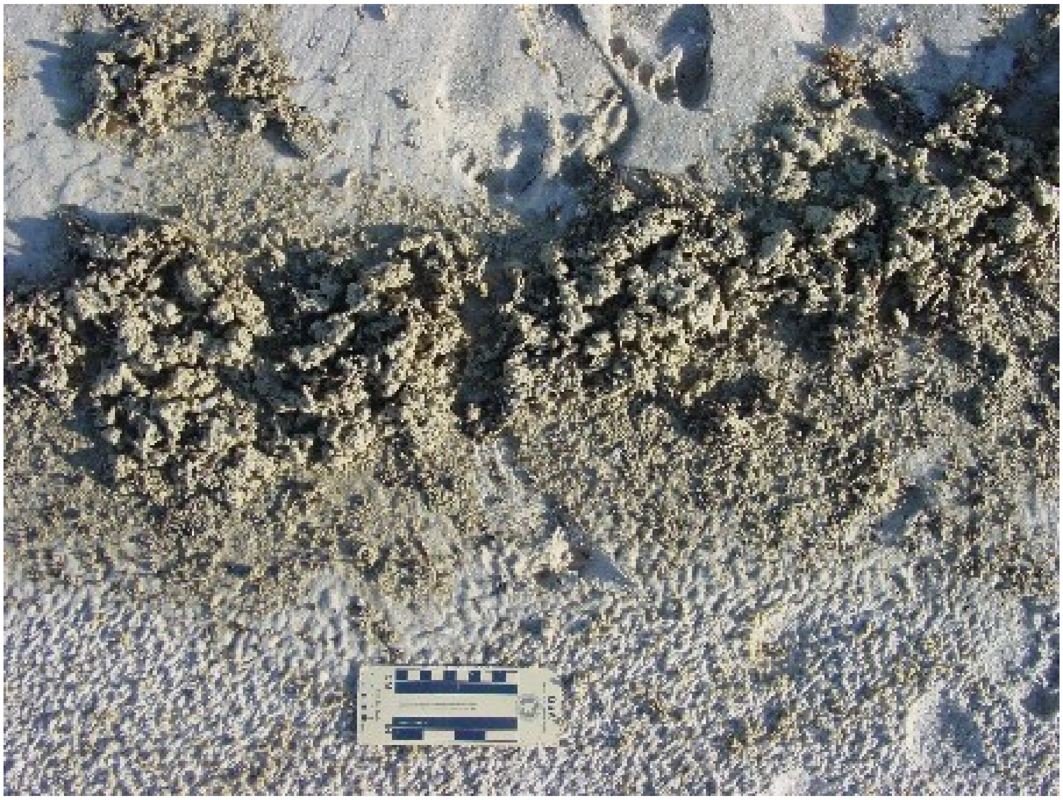

Figure 11.—Dry sand adhering to wet sand (at scale in cm) and to *Sargassum* (above scale) at Gulf State Park Pavilion, July 1, 2003.

Figure 12.—Storm windrow consisting of plant debris following
Tropical Storm Bertha at Pine Beach, August 6, 2002.

UNUSUALLY COARSE SAMPLES

A handful of relatively coarse samples (fig. 13; table 6) were collected from several areas. The six coarsest samples lie more than two standard deviations above the mean and therefore are considered to be outliers (Kopaska-Merkel, 2005). The shapes of the particle-size distributions of these samples are similar to those of other Alabama beach samples analyzed for this study. Relatively coarse samples indicate the former occurrence of transient conditions that seem to be related to tidal cycles, as explained below. If the causes of such transient conditions are identified, this might help explain the disagreement between pooled and synoptic data. This is because only three of the six outliers are included in the synoptic data.

These six outliers were collected at different times from five widely spaced sites and do not correspond to storm events or to particular seasons. The origins of these relatively coarse samples are episodic events that affect the beach infrequently. The six samples were collected on only two of the six sampling trips represented by the sieve data (table 6). However, samples collected at other sites on these days yielded finer and

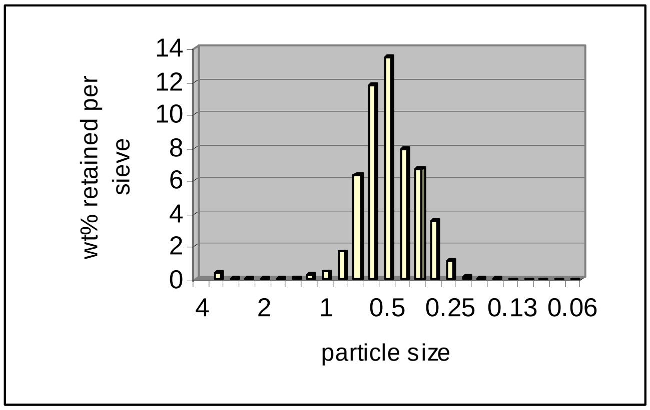

Figure 13.—Particle-size distribution of unusually coarse Alabama beach sand (Pine Beach, sample 031106-6C). Compare to typical Alabama beach sand (fig. 8).

Table 6.—Samples with geometric mean particle size greater than 500 µm.

Site (site number), east to west	Date	Mean particle size (µm)
Alabama-Florida state line (1)	November 6, 2003	538.7
Pine Beach (6)	November 6, 2003	554.3
Little Lagoon Pass (8)	November 7, 2003	502.7
Alabama Highway 182, mile 2 (17)	July 8, 2004	550.7
Pine Beach (6)	July 8, 2004	532.3
West End (16)	July 9, 2004	510.3

more typical sieve results. In addition, the two sampling trips on which outliers were collected yielded outliers from different sites; the cause of the unusually coarse samples is not site specific. Both of these sampling trips took place at or near neap tides (NOAA, 2004). Of the other four trips, three roughly corresponded to spring tides (mid-March 2002, early August 2002, and early July 2003), and one (early June 2002) to a neap tide. Only one sample collected in early June 2002 has been sieved, so it may well be that outliers were collected on that trip as on the other neap-tide trips. Variation in sediment characteristics resulting from tidal effects, including neap-spring cycles, is well known (Boersma, 1969; Visser, 1980). It appears that windrow sediment sampled during this study is coarser during neap tides (Kopaska-Merkel, 2005), perhaps because, on average, the windrow is then located lower in the intertidal zone. Sediment on Alabama’s beaches, as on many sandy beaches (Fox and others, 1966; Allen, 1970, p. 168-173), generally coarsens seaward across the foreshore to the breaker zone. Details of shore-normal particle-size variation across the foreshore on Alabama beaches are not yet known. Four shore-normal transects measured in Gulf State Park and in Gulf Shores showed sand coarsening from the berm crest to the water line (Olsen Associates, 2001), although samples were collected only at the berm crest and at the water line. Observations of particle-size distributions on the foreshore can be made qualitatively with this degree of precision and confirm the conclusions of Olsen Associates.

If the relatively coarse samples are coarse because they were collected during neap tides and from locations significantly lower on the beach than spring-tide samples, then our sampling protocol should be revised. The simplest solution would be to collect all samples at the high-tide line during the neap part of the tidal cycle. This is preferable to collecting samples only at spring tides, because at neap tides more of the beach can be studied, on the average. Taking this approach would test the hypothesis that the neap/spring tidal cycle is responsible for the collection of both leptokurtic medium sand and leptokurtic medium-coarse sand samples.

Other possible explanations for the distribution of relatively coarse and relatively fine samples are not compelling. The two trips on which the coarse samples were collected (November 6-7, 2003, and July 7-9, 2004) are also the two most recent trips for which particle-size data were measured. We know of no events that affected Alabama's coast during 2003-04 that could have yielded the observed distribution of coarse samples. The relatively coarse samples came from five sample sites. However, these sites are not uniformly located with respect to beach nourishment projects, ongoing coastal erosion, or other factors known to affect beach particle size.

Collector bias is unlikely. Samples sieved for this project were collected by one staff member in 2002 and 2003 and by another in 2003 and 2004. However, the only consistent difference in particle size between collectors is that the six relatively coarse samples were all collected by one person. Relatively coarse samples were collected by her on only two of three trips, which corresponded to neap tides. Her other trip was made at the time of a spring tide and no relatively coarse samples were collected then.

BEACH SHELLS AND OFFSHORE SAND

Dead shells cast up on the beach can reflect molluscan faunas living just offshore. Although they do not accurately represent offshore communities, the study of dead shells has the advantage of being relatively quick. Unfortunately, little is known of the molluscan communities inhabiting the offshore areas under consideration as sand sources for beach nourishment.

In addition, beach visitors enjoy seashells, but sharp shell fragments can be hazardous and unpleasant. Tourists complained about sharp, broken shells on the nourished beach at Gulf Shores (Kopaska-Merkel and Rindsberg, 2002), so an investigation of beach shells was included in this year's study. Shells and their living conditions are also important clues to the geologic origins of and current conditions on beaches and adjacent offshore areas. Offshore surficial sediment lithofacies can be predicted from beach shell facies.

Shells are not usually considered to be a problem in Gulf and Atlantic beach nourishment projects, but in some cases their abundance alters the character of a nourished beach. Sand nourishment at Pine Knoll Shores, North Carolina, covered parts of the beach with hard shells and shell fragments, making the beach unpleasant for barefoot visitors (Pilkey and others, 2004, p. 139-141); results were similar on the south end of Tybee Island, Georgia (Anonymous, 2004). The State of Georgia requires that shells be screened from offshore sand before it is pumped onto a beach, despite the added cost of this procedure.

In this section we discuss the relationships of beach mollusks and their inferred living conditions to offshore sediment lithofacies, with particular attention to the problem of sharp shell fragments on restored beaches.

Most Alabama beach shells are of dead animals that dwell offshore, especially bivalves, with minor gastropods, echinoids, coral, bryozoans, serpulids, and barnacles (appendix 8). The coquina clams (*Donax* spp.) are a special case because they live on the beach itself. Results on live *Donax* are presented first, followed by results on dead shells.

DONAX **SPP.**

Donax spp. are of particular interest because these bivalve live intertidally and are thus vulnerable to beach restoration efforts. Two species are common on Alabama beaches: the larger, *Donax variabilis,* lives chiefly in the swash zone, whereas the smaller, *D*. *texasianus,* lives in slightly deeper water. Populations are seasonal; the clams are most abundant during the warmer months.

The patchiness of *Donax* populations makes it difficult to census them accurately. For this study, we did not attempt to distinguish different species of living in

Donax quadrats, but probably nearly all were *Donax variabilis*. Samples only a short distance apart often yielded very different numbers of clams (appendix 9) and the results are difficult to interpret. *Donax* populations do not seem to be directly related to the degree of urban development along a beach, for instance.

Donax populations do seem to respond positively to natural water turbidity. In Alabama, populations are particularly dense near inlets such as Perdido Pass and Little Lagoon Pass. However, no definite trend is seen west of Mobile Pass despite the fact that turbidity within the muddy plume exiting Mobile Bay is relatively high there year round. As a suspension feeder, *Donax* probably thrives within a certain range of turbidity, and particularly where the turbid water is rich in organic particles rather than clay and silt, which must be filtered out. The muddy plume, rich in clay and silt as well as organics, may not be ideal for *Donax*.

Donax tends to be more numerous at all stations on Perdido Key (stations 1 to 3) than in Orange Beach and Gulf Shores to the west. Perdido Key apparently has somewhat cleaner water, with less foaming and dark color encountered in sand samples. Alabama *Donax* apparently responds positively to natural organic particle content of seawater and negatively to foamy water. Population sizes are difficult to estimate. However, measurements are rapid and few other beach-dwelling organisms are so abundant, so the *Donax* measurements are recommended. Seawater color and clarity should be recorded at the same stations.

Previous studies (summarized by Greene, 2002, p. 25-27) have shown that the animals are least affected during beach restoration when the sand is pumped onto the backshore rather than in the foreshore where *Donax* lives.

RELATIONSHIP OF DEAD SHELLS TO OFFSHORE LITHOFACIES

Each kilometer has its own fauna of dead shells (appendices 8, 9; table 7), underscoring the value of intensive sampling on beaches before restoration. To avoid sharp shells on renourished beaches, sampling of sediment and shells from potential sand source sites is essential. However, preliminary study of beach samples permits initial rapid assessment of offshore shelly faunas.

Beach shells in Alabama are related to offshore lithofacies. Shells are not transported far without breaking, so they correspond well to offshore environments. Nearshore substrates of the Alabama continental shelf are dominated by sand, but also include muddy sand, silt, soft and firm clay, and peat, as well as local hard substrates such as wood and concrete. Also, the seafloors east and west of the Mobile ebb-tidal delta have markedly different faunas. This is largely because turbidity is relatively high west of Mobile Pass due to the plume of muddy water emanating from Mobile Bay. It is thus best to consider the eastern and western areas separately.

East of Mobile Pass in Baldwin County (fig. 1), the water is relatively clear. Beaches that face sandy ridges offshore have a diverse fauna of shells dominated by robust forms, especially suspension-feeders such as *Anadara, Noetia,* and *Dinocardium*. Organisms living on shells (epibionts), such as serpulids, barnacles, and bryozoans, are also common. Surficial sediment offshore from sandy ridges is assigned to the Shelly Sand and Graded Shelly Sand lithofacies (fig. 3). Beaches that face finer grained swales have many of the same species, but fragile suspension-feeding bivalves such as *Atrina* and *Cyrtopleura* are also present, including forms that bore in firm clay and peat. The presence of a few Pleistocene(?) fossils suggests offshore erosion in places. Lithofacies offshore from swales are dominated by the Sand with Mud Burrows and (locally) Mud lithofacies.

West of Mobile Bay in Mobile County, the water is turbid owing to the flux of suspended sediment through Mobile Pass (figs. 1, 2). Beaches from the Public Beach westward face an erosional sandy shelf that slopes relatively steeply seaward. These beaches have a molluscan fauna that includes many of the same robust forms as in Baldwin County, but with a significant addition of forms that tolerate high turbidity, such as *Mulinia, Nuculana, Agriopoma,* and tellins. Offshore Pleistocene deposits yield estuarine *Rangia* and *Crassostrea*. Marine sediment near the beach is assigned to the Shelly Sand lithofacies. Farther offshore, away from the high velocity erosive currents that affect the beaches, surface sediment is assigned to the Muddy Sand, Silty Clayey Sand, and Sand Silt Clay lithofacies (fig. 3).

Sand for beach restoration at Gulf Shores was derived from an offshore ridge of the Shelly Sand Lithofacies (fig. 3). This fauna includes a large number of species that yield dangerously sharp fragments. Newly broken shells were especially hazardous because many were oriented with edges and corners pointing up in the newly pumped sand. These include robustly ribbed bivalves that break along ribs (*Dinocardium, Trachycardium, Argopecten*). Smoother, convex bivalves break irregularly (*Macrocallista, Mercenaria, Ostrea*); flattish, smooth *Dosinia* yields sharp triangles. Over months, waves reoriented bivalve fragments to horizontal and eventually rounded off sharp edges. However, robust, strongly curved snails (*Oliva, Phalium, Polinices, Strombus*) present a sharp surface upward in a range of positions.

Table 7.—Common bivalves on the Alabama Gulf Coast.

Family	Species
Nuculanidae	*Nuculana* sp.
Arcidae	*Anadara baughmani* *Anadara brasiliana* *Anadara floridana* *Anadara ovalis* *Anadara notabilis* *Anadara transversa* *Noetia ponderosa*
Pinnidae	*Atrina serrata*
Plicatulidae	*Plicatula gibbosa*
Pectinidae	*Argopecten gibbus*
Anomiidae	*Anomia simplex*
Ostreidae	*Crassostrea virginica* *Ostreola equestris*
Carditidae	*Carditamera floridana* *Venericardia tridentata*
Ungulinidae	*Diplodonta punctata*
Lucinidae	*Divaricella quadrisulcata* *Lucina pensylvanica* *Phacoides nassula* *Pseudomiltha floridana*
Cardiidae	*Dinocardium robustum* *Laevicardium laevigatum* *Trachycardium muricatum*
Veneridae	*Agriopoma texasianum* *Anomalocardia auberiana* *Chione cancellata* *Chione grus* *Chione intapurpurea* *Dosinia discus* *Gemma gemma* *Macrocallista nimbosa* *Mercenaria campechiensis* *Pitar fulminata*
Tellinidae	*Tellina alternata*
Semelidae	*Semele* sp.
Donacidae	*Donax texasianus* *Donax variabilis*
Sanguinolariidae	*Tagelus plebeius*
Mactridae	*Mactra fragilis* *Mulinia lateralis* *Raeta plicatella* *Rangia cuneata* *Spisula similis*
Corbulidae	Corbulids
Pholadidae	*Cyrtopleura costata*
Pandoridae	*Pandora* sp.

BEACH-NOURISHMENT POTENTIAL OF FEDERAL SAND

Alabama beach sand quality has been described to permit comparison to offshore sand quality. It is now possible to determine, more accurately than before, which offshore sand deposits are most appropriate for beach nourishment. Further, it is clear what additional information is needed in order to improve mapping of the highest quality beach sand source material in MMS Study Areas 1 and 2. In this section we compare the characteristics of beach sand to those of offshore sand.

Comparison of the new continental shelf lithofacies map with a bathymetric map (figs. 1, 3) reveals that the two large areas underlain by the Graded Shelly Sand lithofacies south and southeast of Morgan Peninsula correspond to large and poorly defined ridges that extend west-southwest from the present shoreline around the city of Gulf Shores and near the Alabama-Florida state line, respectively. These two ridges resemble in size and shape the modern Morgan Peninsula, which contains many related environments including sandy hammocks, dunefields, beaches, nearshore sand bars, tidal passes, lagoons, marshes, swamps, and even oyster middens. It is therefore not surprising that the surficial sediment of these ridges varies greatly in particle-size characteristics. To our knowledge, no depositional facies analysis of these ridges has been completed.

Only one of the clean sand lithofacies of Parker and others (1993) is characterized by particles as large as those found on the beach: the Graded Shelly Sand lithofacies (figs. 3, 14; Kopaska-Merkel, 2005). In fact, samples collected from this lithofacies are, on the average, coarser than those on Alabama beaches. Geometric mean particle size in samples of this lithofacies is 400 µm. By contrast, equivalent values for the Shelly Sand and Sand with Mud Burrows lithofacies are 267 and 231 µm, respectively. These are the most widely distributed clean sand lithofacies in the area of interest. Geometric mean particle size for all beach samples combined is 331 µm ±73 µm. The Graded Shelly Sand lithofacies is much more variable than Alabama beach sand, having a standard deviation of 284.5 µm (n = 14). By contrast, the Shelly Sand and Sand with Mud Burrows lithofacies have standard deviations of 33.4 µm (n = 14) and 30.4 µm (n = 11) respectively. Previously unpublished sieve analyses of 65 samples collected by GSA staff in federal waters off Alabama are reproduced as appendices 3 and 4 (compare Parker and others, 1993).

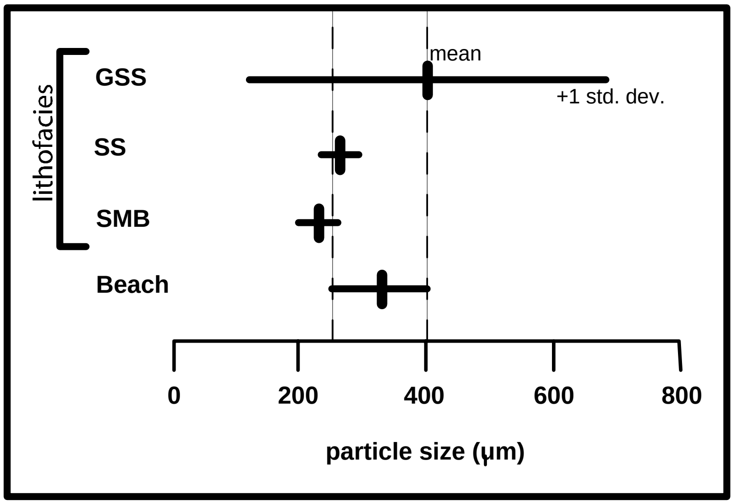

Figure 14.—Geometric means and standard deviations of selected continental shelf lithofacies and Alabama beach sand. GSS, Graded Shelly Sand lithofacies; SS, Shelly Sand lithofacies; SMB, Sand with Mud Burrows lithofacies; Beach, modern Alabama beach sand. Horizontal bars, plus or minus one standard deviation about the geometric mean; vertical bars, geometric mean.

Thus, in the present state of knowledge, the Shelly Sand lithofacies is the most appropriate for nourishing Alabama beaches, because (1) its mean particle size, and more than half of its sediment, is within 1 standard deviation of the geometric mean particle size of modern beach sand, and (2) it is relatively homogeneous. The Sand with Mud Burrows lithofacies would be unsuitable as a source of nourishment for Alabama beaches, because its finer particles would be too readily washed away by fair-weather waves, let alone major storms. Most Sand with Mud Burrows sediment is finer than two-thirds of Alabama beach sediment. The Graded Shelly Sand lithofacies also would be an inappropriate choice, unless detailed mapping can show areas underlain by graded shelly sand that approximates the particle-size distribution of Alabama beach sand. Failing this, mining graded shelly sand for Alabama beach nourishment could easily yield sediment that was predominantly too coarse. Unfortunately, most of Areas 1 and 2 are underlain by the Graded Shelly Sand lithofacies (fig. 3). Consequently, detailed sedimentologic study of existing cores from these areas is recommended so that the spatial distribution of sediment particle size can be mapped more precisely in order to maximize the efficiency of beach restoration while minimizing environmental impact.

SUMMARY

New sieve data have been collected from Alabama beach sand and compared to previously unpublished sieve data from within and near MMS Study Areas 1 and 2. Alabama beach sediment consists of well to very well sorted, medium to coarse, positively skewed, nearly pure quartz sand averaging 331 µm in diameter (±73 µm; 258 to 404 µm). About 90 percent of analyzed samples are of medium sand size, and the remainder is noticeably coarser, consisting of medium to coarse sand.

The following observations are made about Alabama beach sand quality, its relationship to offshore sediment characteristics, and the nature and significance of shelly faunas on the beach.

- Baldwin County beach sand coarsens westward in a trend consistent with variation in longshore bar morphology related to construction along the shore. The bars are absent or of lower relief to the east. Moreover, bars are commonly of lower relief directly adjacent to buildings that were built especially close to the beach. Variation in beach and nearshore geomorphology correlates with variation in beach sand quality.
- Eolian coastal sand dunes are derived from but are finer than beach sand. Hence, beaches backed by dunes commonly coarsen as the dunes develop. Because heavily urbanized coasts lack natural dunes, particle-size distribution was expected to vary systematically with level of urbanization. However, data from 66 samples reveal no permanent effect of urbanization on particle size in the foreshore.
- Differences are likely in sand quality between fair-weather and storm conditions. Sieve data collected so far are insufficient to adequately define these differences, which may be subtle. However, examination of sand quality associated with storm windrows consisting of plant matter (for example, *Sargassum* fragments) indicates that storm windrows can be deposited on sediment that was itself laid down under quite different hydraulic conditions. This suggests a need to modify future sampling strategy.
- Anomalously coarse sand samples collected from the high tide line correspond to neap tides. These samples are coarse because some neap high tide lines occur lower on the foreshore, where beach sand is coarser than on the upper foreshore.
- Shells are not ordinarily transported far from their points of origin. Different stretches of natural beach have shells representing different environments, topography, and

ancient deposits just offshore. Beach shell faunas can assist preliminary mapping of offshore sediment facies.

- In 2000, the Gulf Shores Beach nourishment project emplaced a considerable amount of angular, broken shell debris on the Gulf Shores Public Beach. Within a couple of years, angular shell fragments became partially rounded and rotated into subhorizontal positions. Screening of excess shell from pumped sand can be costly; however, it is required in Georgia. Determining the shell content of potential sand sources offshore could save money and please beach-goers.
- The distribution of *Donax* spp. (coquina clams) on Alabama beaches is too complex to be explained by any one known factor, and beach restoration prior to Hurricane Ivan did not eradicate the clams. Instead, *Donax* is intermittently present at nearly every studied station. Alabama *Donax* responds positively to natural organic particle content of seawater and negatively to foamy water.
- The Shelly Sand lithofacies is suitable (though not ideal) for nourishing Alabama's beaches. This lithofacies is composed of sand similar to, but slightly finer than, Alabama beach sand. Geometric mean particle size of the Shelly Sand lithofacies is 267 ±33.4 µm (233.6 to 300.4 µm). Hence, nourishment of Alabama beaches using sand from this lithofacies would be inefficient because so much of the added sand would be quickly washed away. The Graded Shelly Sand lithofacies is highly variable (geometric mean particle size is 400 ±284.5 µm (115.5 to 684.5 µm)). Some samples of this lithofacies are nearly perfect matches for Alabama beach sand but other samples are significantly coarser.

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APPENDIX 1. SAND RESOURCES BEACH SAMPLE COLLECTION PROGRAM*

Year-month-day	Field no.	Station**	Environment	Sample type	Notes
02-03-11	02-03-11-1-1	1 Alabama-Florida state line	DL (dune line)	sand	
02-03-11	02-03-11-1-2	1 Alabama-Florida state line	midway betw. HTL (high tide line) and DL	sand	
02-03-11	02-03-11-1-3	1 Alabama-Florida state line	cusp swale	sand	
02-03-11	02-03-11-1-4	1 Alabama-Florida state line	cusp ridge	sand	
02-03-11	02-03-11-1-5	1 Alabama-Florida state line	windrow in cusp swale	sand	
02-03-11	02-03-11-1-6a	1 Alabama-Florida state line	swale swash zone	sand	
02-03-11	02-03-11-1-6b	1 Alabama-Florida state line	ridge swash zone	sand	
02-03-11	02-03-11-2-1	2 Florida Point East	DL	sand	
02-03-11	02-03-11-2-2	2 Florida Point East	midway betw. HTL and DL	sand	
02-03-11	02-03-11-2-3	2 Florida Point East	cusp swale	sand	
02-03-11	02-03-11-2-4	2 Florida Point East	cusp ridge	sand	
02-03-11	02-03-11-2-5	2 Florida Point East	windrow in cusp swale	sand	
02-03-11	02-03-11-2-6a	2 Florida Point East	swale swash zone	sand	
02-03-11	02-03-11-2-6b	2 Florida Point East	ridge swash zone	sand	
02-03-11	02-03-11-3-1a	3 Florida Point West	swash	sand	
02-03-11	02-03-11-3-1b	3 Florida Point West	swash	sand	
02-03-11	02-03-11-4-1	4 Cotton Bayou	DL	sand	
02-03-11	02-03-11-4-2	4 Cotton Bayou	midway betw. HTL and DL	sand	
02-03-11	02-03-11-4-3	4 Cotton Bayou	cusp swale	sand	
02-03-11	02-03-11-4-4	4 Cotton Bayou	cusp ridge	sand	
02-03-11	02-03-11-4-5	4 Cotton Bayou	swash	sand	
02-03-11	02-03-11-5-1a	5 Gulf Shores Public Beach	berm	shells	
02-03-11	02-03-11-5-1b	5 Gulf Shores Public Beach	berm	sand	
02-03-11	02-03-11-5-2a	5 Gulf Shores Public Beach	cusp swale windrow	sand	
02-03-11	02-03-11-5-2b	5 Gulf Shores Public Beach	cusp swale windrow	sand	
02-03-11	02-03-11-5-3a	5 Gulf Shores Public Beach	cusp ridge windrow	sand	
02-03-11	02-03-11-5-3b	5 Gulf Shores Public Beach	cusp ridge windrow	sand	
02-03-11	02-03-11-5-4a	5 Gulf Shores Public Beach	swash	sand	
02-03-11	02-03-11-5-4b	5 Gulf Shores Public Beach	swash	sand	
02-03-12	02-03-12-1-1a	6 Pine Beach	dune	sand	
02-03-12	02-03-12-1-1b	6 Pine Beach	dune	sand	
02-03-12	02-03-12-1-2a	6 Pine Beach	berm	sand	
02-03-12	02-03-12-1-2b	6 Pine Beach	berm	sand	
02-03-12	02-03-12-1-3a	6 Pine Beach	cusp swale windrow	sand	
02-03-12	02-03-12-1-3b	6 Pine Beach	cusp swale windrow	sand	
02-03-12	02-03-12-1-4a	6 Pine Beach	cusp ridge windrow	sand	
02-03-12	02-03-12-1-4b	6 Pine Beach	cusp ridge windrow	sand	
02-03-12	02-03-12-1-5a	6 Pine Beach	swash	sand	
02-03-12	02-03-12-1-5b	6 Pine Beach	swash	sand	
02-03-12	02-03-12-2-1a	7 Fort Morgan East	windrow	sand	
02-03-12	02-03-12-2-1b	7 Fort Morgan East	windrow	sand	
02-06-06	02-06-06-1-1	1 Alabama-Florida state line	cusp swale windrow	sand	
02-06-06	02-06-06-1-2	1 Alabama-Florida state line	cusp ridge windrow	sand	
02-06-06	02-06-06-2-1	2 Florida Point East	cusp swale windrow	sand	
02-06-06	02-06-06-2-2	2 Florida Point East	cusp ridge windrow	sand	
02-06-06	02-06-06-2-3	2 Florida Point East	windrow	shells	
02-06-06	02-06-06-3-1	3 Florida Point West	cusp swale windrow	sand	
02-06-06	02-06-06-3-2	3 Florida Point West	cusp ridge windrow	sand	
02-06-06	02-06-06-3-3	3 Florida Point West	windrow	shells	
02-06-06	02-06-06-4-1	4 Cotton Bayou	windrow	sand	
02-06-06	02-06-06-4-2	4 Cotton Bayou	windrow	sand	
02-06-06	02-06-06-4-3	4 Cotton Bayou	windrow	shells (none)	
02-06-07	02-06-07-5-1	5 Gulf Shores Public Beach	windrow	sand	
02-06-07	02-06-07-5-2a	5 Gulf Shores Public Beach	upper (main) berm	shells	
02-06-07	02-06-07-5-2b	5 Gulf Shores Public Beach	upper (main) berm	sand	
02-06-07	02-06-07-5-3	5 Gulf Shores Public Beach	windrow	shells	
02-06-07	02-06-07-6-1	6 Pine Beach	windrow	sand	
02-06-07	02-06-07-6-2	6 Pine Beach	berm	sand	
02-06-07	02-06-07-6-3	6 Pine Beach	lagoon windrow	sand	
02-06-07	02-06-07-6-4	6 Pine Beach	DL	sand	

Year-month-day	Field no.	Station	Environment	Sample type	Notes
02-06-07	02-06-07-6-5	6 Pine Beach	windrow	shells	
02-06-07	02-06-07-7-1	7 Fort Morgan East	cusp swale windrow	sand	
02-06-07	02-06-07-7-2	7 Fort Morgan East	cusp ridge windrow	sand	
02-06-07	02-06-07-7-3	7 Fort Morgan East	berm	sand	
02-06-07	02-06-07-7-4	7 Fort Morgan East	windrow	shells?	
02-06-07	02-06-07-8-1	8 Little Lagoon Pass	cusp swale windrow	sand	
02-06-07	02-06-07-8-2	8 Little Lagoon Pass	cusp ridge windrow	sand	
02-06-07	02-06-07-8-3	8 Little Lagoon Pass	berm	sand	
02-06-07	02-06-07-8-4	8 Little Lagoon Pass	windrow	shells	
02-06-07	02-06-07-9-1	9 Pines Ramp	windrow	sand	
02-08-06	02-08-06-1-1	1 Alabama-Florida state line	cusp ridge windrow	sand	
02-08-06	02-08-06-1-2	1 Alabama-Florida state line	cusp swale windrow	sand	
02-08-06	02-08-06-1-3	1 Alabama-Florida state line	windrow	shells	
02-08-06	02-08-06-2-1	2 Florida Point East	cusp ridge windrow	sand	T.S. Bertha
02-08-06	02-08-06-2-2	2 Florida Point East	cusp swale windrow	sand	T.S. Bertha
02-08-06	02-08-06-2-3	2 Florida Point East	storm windrow	shells	T.S. Bertha
02-08-06	02-08-06-2-4	2 Florida Point East	storm windrow	sand	T.S. Bertha
02-08-06	02-08-06-3-1	3 Florida Point West	cusp ridge windrow	sand	T.S. Bertha
02-08-06	02-08-06-3-2	3 Florida Point West	cusp swale windrow	sand	T.S. Bertha
02-08-06	02-08-06-3-3	3 Florida Point West	storm windrow	shells	T.S. Bertha
02-08-06	02-08-06-3-4	3 Florida Point West	storm windrow	sand	T.S. Bertha
02-08-06	02-08-06-4-1	4 Cotton Bayou	cusp ridge windrow	sand	T.S. Bertha
02-08-06	02-08-06-4-2	4 Cotton Bayou	cusp swale windrow	sand	T.S. Bertha
02-08-06	02-08-06-4-3	4 Cotton Bayou	storm windrow	shells	T.S. Bertha
02-08-06	02-08-06-4-4	4 Cotton Bayou	storm windrow	sand	T.S. Bertha
02-08-06	02-08-06-5-1	5 Gulf Shores Public Beach	windrow	sand	T.S. Bertha
02-08-06	02-08-06-5-3a	5 Gulf Shores Public Beach	below fair-weather windrow	shells	T.S. Bertha
02-08-06	02-08-06-5-3b	5 Gulf Shores Public Beach	fair-weather windrow	shells	T.S. Bertha
02-08-06	02-08-06-5-4	5 Gulf Shores Public Beach	storm windrow	sand	T.S. Bertha
02-08-06	02-08-06-8-1	8 Little Lagoon Pass	windrow	sand	T.S. Bertha
02-08-06	02-08-06-8-3	8 Little Lagoon Pass	windrow	shells	T.S. Bertha
02-08-06	02-08-06-8-4	8 Little Lagoon Pass	storm windrow	sand	T.S. Bertha
02-08-07	02-08-07-6-1	6 Pine Beach	cusp ridge windrow	sand	T.S. Bertha
02-08-07	02-08-07-6-2	6 Pine Beach	cusp swale windrow	sand	T.S. Bertha
02-08-07	02-08-07-6-3	6 Pine Beach	windrow	shells	T.S. Bertha
02-08-07	02-08-07-6-4	6 Pine Beach	storm windrow	sand	T.S. Bertha
02-08-07	02-08-07-7-1	7 Fort Morgan East	cusp ridge windrow	sand	T.S. Bertha
02-08-07	02-08-07-7-2	7 Fort Morgan East	cusp swale windrow	sand	T.S. Bertha
02-08-07	02-08-07-7-3	7 Fort Morgan East	windrow	shells	T.S. Bertha
02-08-07	02-08-07-7-4	7 Fort Morgan East	storm windrow	sand	T.S. Bertha
02-09-03	02-09-03-1-1	1 Alabama-Florida state line	cusp ridge windrow	sand	
02-09-03	02-09-03-1-2	1 Alabama-Florida state line	cusp swale windrow	sand	
02-09-03	02-09-03-1-3	1 Alabama-Florida state line	windrow	shells	
02-09-03	02-09-03-2-1	2 Florida Point East	cusp ridge windrow	sand	
02-09-03	02-09-03-2-2	2 Florida Point East	cusp swale windrow	sand	
02-09-03	02-09-03-2-3	2 Florida Point East	windrow	shells	
02-09-03	02-09-03-3-1	3 Florida Point West	cusp ridge windrow	sand	
02-09-03	02-09-03-3-2	3 Florida Point West	cusp swale windrow	sand	
02-09-03	02-09-03-3-3	3 Florida Point West	windrow	shells	
02-09-03	02-09-03-4-1	4 Cotton Bayou	cusp ridge windrow	sand	
02-09-03	02-09-03-4-2	4 Cotton Bayou	cusp swale windrow	sand	
02-09-03	02-09-03-4-3	4 Cotton Bayou	windrow	shells	
02-09-03	02-09-03-5-1	5 Gulf Shores Public Beach	windrow	sand	
02-09-03	02-09-03-5-2	5 Gulf Shores Public Beach	berm	sand	
02-09-03	02-09-03-5-3	5 Gulf Shores Public Beach	windrow	shells	
02-09-03	02-09-03-8-1	8 Little Lagoon Pass	windrow	sand	
02-09-03	02-09-03-8-3	8 Little Lagoon Pass	windrow	shells	
02-09-03	02-09-03-8-4	8 Little Lagoon Pass	below windrow	encrusted shell	
02-09-04	02-09-04-6-1	6 Pine Beach	cusp ridge windrow	sand	
02-09-04	02-09-04-6-2	6 Pine Beach	cusp swale windrow	sand	
02-09-04	02-09-04-6-3	6 Pine Beach	windrow	shells	
02-09-04	02-09-04-7-1	7 Fort Morgan East	windrow	sand	
02-09-04	02-09-04-7-3	7 Fort Morgan East	windrow	shells	
02-09-16	02-09-16-1-1	1 Alabama-Florida state line	cusp ridge windrow	sand	T. S. Hanna
02-09-16	02-09-16-1-2	1 Alabama-Florida state line	cusp swale windrow	sand	T. S. Hanna

Year-month-day	Field no.	Station	Environment	Sample type	Notes
02-09-16	02-09-16-1-3	1 Alabama-Florida state line	windrow	shells	T. S. Hanna
02-09-16	02-09-16-1-4	1 Alabama-Florida state line	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-2-1	2 Florida Point East	cusp ridge windrow	sand	T. S. Hanna
02-09-16	02-09-16-2-2	2 Florida Point East	cusp swale windrow	sand	T. S. Hanna
02-09-16	02-09-16-2-3	2 Florida Point East	windrow	shells	T. S. Hanna
02-09-16	02-09-16-2-4	2 Florida Point East	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-3-1	3 Florida Point West	cusp ridge windrow	sand	T. S. Hanna
02-09-16	02-09-16-3-2	3 Florida Point West	cusp swale windrow	sand	T. S. Hanna
02-09-16	02-09-16-3-3	3 Florida Point West	windrow	shells	T. S. Hanna
02-09-16	02-09-16-3-4	3 Florida Point West	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-4-1	4 Cotton Bayou	windrow	sand	T. S. Hanna
02-09-16	02-09-16-4-3	4 Cotton Bayou	windrow	shells	T. S. Hanna
02-09-16	02-09-16-4-4	4 Cotton Bayou	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-5-1	5 Gulf Shores Public Beach	cusp ridge windrow	sand	T. S. Hanna
02-09-16	02-09-16-5-2	5 Gulf Shores Public Beach	cusp swale windrow	sand	T. S. Hanna
02-09-16	02-09-16-5-3	5 Gulf Shores Public Beach	windrow	shells	T. S. Hanna
02-09-16	02-09-16-5-4	5 Gulf Shores Public Beach	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-8-1	8 Little Lagoon Pass	windrow	sand	T. S. Hanna
02-09-16	02-09-16-8-3	8 Little Lagoon Pass	windrow	shells	T. S. Hanna
02-09-16	02-09-16-8-4	8 Little Lagoon Pass	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-7-1	7 Fort Morgan East	cusp ridge windrow	sand	T. S. Hanna
02-09-16	02-09-16-7-2	7 Fort Morgan East	cusp swale windrow	sand	T. S. Hanna
02-09-16	02-09-16-7-3	7 Fort Morgan East	windrow	shells	T. S. Hanna
02-09-16	02-09-16-7-4	7 Fort Morgan East	storm windrow	sand	T. S. Hanna
02-09-16	02-09-16-7-5	7 Fort Morgan East	shell lag just below storm windrow	shells	T. S. Hanna
02-09-17	02-09-17-6-1	6 Pine Beach	cusp ridge windrow	sand	T. S. Hanna
02-09-17	02-09-17-6-2	6 Pine Beach	cusp swale windrow	sand	T. S. Hanna
02-09-17	02-09-17-6-3	6 Pine Beach	windrow	shells	T. S. Hanna
02-09-17	02-09-17-6-4	6 Pine Beach	storm windrow	sand	T. S. Hanna
02-09-17	02-09-17-6-5	6 Pine Beach	upper storm windrow	sand	T. S. Hanna
02-09-29	02-09-29-1-1	1 Alabama-Florida state line	cusp ridge windrow	sand	T.S. Isidore
02-09-29	02-09-29-1-2	1 Alabama-Florida state line	cusp swale windrow	sand	T.S. Isidore
02-09-29	02-09-29-1-3	1 Alabama-Florida state line	windrow	shells	T.S. Isidore
02-09-29	02-09-29-1-4	1 Alabama-Florida state line	upper storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-1-5	1 Alabama-Florida state line	runnel wrack	shells	T.S. Isidore
02-09-29	02-09-29-1-6	1 Alabama-Florida state line	submerged shell gravel	shells	T.S. Isidore
02-09-29	02-09-29-2-1	2 Florida Point East	windrow	sand	T.S. Isidore
02-09-29	02-09-29-2-2	2 Florida Point East	landward side lower storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-2-3	2 Florida Point East	landward side lower storm windrow	shells	T.S. Isidore
02-09-29	02-09-29-2-4	2 Florida Point East	upper storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-2-5	2 Florida Point East	picked, upper side lower storm windrow	shells	T.S. Isidore
02-09-29	02-09-29-2-6	2 Florida Point East	windrow	shells	T.S. Isidore
02-09-29	02-09-29-3-1	3 Florida Point West	cusp ridge windrow	sand	T.S. Isidore
02-09-29	02-09-29-3-2	3 Florida Point West	cusp swale windrow	sand	T.S. Isidore
02-09-29	02-09-29-3-3	3 Florida Point West	windrow	shells	T.S. Isidore
02-09-29	02-09-29-3-4	3 Florida Point West	upper storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-3-5	3 Florida Point West	picked storm windrow	shells	T.S. Isidore
02-09-29	02-09-29-4-1	4 Cotton Bayou	windrow	sand	T.S. Isidore
02-09-29	02-09-29-4-2	4 Cotton Bayou	lower storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-4-3	4 Cotton Bayou	windrow	shells	T.S. Isidore
02-09-29	02-09-29-4-4	4 Cotton Bayou	upper storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-4-5	4 Cotton Bayou	lower storm windrow	shells	T.S. Isidore
02-09-29	02-09-29-5-1	5 Gulf Shores Public Beach	windrow	sand	T.S. Isidore
02-09-29	02-09-29-5-2	5 Gulf Shores Public Beach	middle storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-5-3	5 Gulf Shores Public Beach	windrow	shells	T.S. Isidore
02-09-29	02-09-29-5-4	5 Gulf Shores Public Beach	upper storm windrow	sand	T.S. Isidore
02-09-29	02-09-29-5-5	5 Gulf Shores Public Beach	upper storm windrow	shells	T.S. Isidore
02-09-29	02-09-29-5-6	5 Gulf Shores Public Beach	middle storm windrow	shells	T.S. Isidore
02-09-30	02-09-29-6-1	6 Pine Beach	windrow	sand	T.S. Isidore
02-09-30	02-09-29-6-2	6 Pine Beach	runnel wrack	sand	T.S. Isidore
02-09-30	02-09-29-6-3	6 Pine Beach	windrow	shells	T.S. Isidore
02-09-30	02-09-29-6-4	6 Pine Beach	upper storm windrow	sand	T.S. Isidore
02-09-30	02-09-29-6-5	6 Pine Beach	lower storm windrow	shells	T.S. Isidore
02-09-30	02-09-29-6-6	6 Pine Beach	upper storm windrow	shells	T.S. Isidore
02-09-30	02-09-29-6-7	6 Pine Beach	outer part outer bar	sand	T.S. Isidore

Year-month-day	Field no.	Station	Environment	Sample type	Notes
02-09-30	02-09-29-6-8	6 Pine Beach	outer part outer bar	sand	T.S. Isidore
02-09-30	02-09-29-7-1	7 Fort Morgan East	windrow landward of runnel	sand	T.S. Isidore
02-09-30	02-09-29-7-2	7 Fort Morgan East	runnel wrack	sand	T.S. Isidore
02-09-30	02-09-29-7-3	7 Fort Morgan East	windrow landward of runnel	shells	T.S. Isidore
02-09-30	02-09-29-7-4	7 Fort Morgan East	windrow on dune	sand	T.S. Isidore
02-09-30	02-09-29-7-5	7 Fort Morgan East	bar	shells	T.S. Isidore
02-09-30	02-09-30-7-6	7 Fort Morgan East	outer part outer bar	sand	T.S. Isidore
02-09-30	02-09-30-8-1	8 Little Lagoon Pass	windrow	sand	T.S. Isidore
02-09-30	02-09-30-8-2	8 Little Lagoon Pass	runnel wrack	sand	T.S. Isidore
02-09-30	02-09-30-8-3	8 Little Lagoon Pass	windrow	shell	T.S. Isidore
02-09-30	02-09-30-8-4	8 Little Lagoon Pass	upper storm windrow	sand	T.S. Isidore
02-09-30	02-09-30-8-5	8 Little Lagoon Pass	lower storm windrow	shells	T.S. Isidore
02-09-30	02-09-30-8-6	8 Little Lagoon Pass	middle storm windrow	shells	T.S. Isidore
02-09-30	02-09-30-8-7	8 Little Lagoon Pass	pile of dredged sand	sand	T.S. Isidore
02-12-03	02-12-03-1-1	1 Alabama-Florida state line	HTL ridge	sand	
02-12-03	02-12-03-1-2	1 Alabama-Florida state line	HTL swale	sand	
02-12-03	02-12-03-1-3	1 Alabama-Florida state line	swash	shells (picked)	
02-12-03	02-12-03-1-4	1 Alabama-Florida state line	HTL ridge	shells (picked)	
02-12-03	02-12-03-1-5	1 Alabama-Florida state line	upper beach	shells (picked)	
02-12-03	02-12-03-2-1	2 Florida Point East	high water	sand	
02-12-03	02-12-03-2-2	2 Florida Point East	high water	shells (picked)	
02-12-03	02-12-03-2-3	2 Florida Point East	mid-beach windrow	shells (picked)	
02-12-03	02-12-03-2-4	2 Florida Point East	high-beach windrow	shells (picked)	
02-12-03	02-12-03-3-1	3 Florida Point West	old ridge	sand	
02-12-03	02-12-03-3-2	3 Florida Point West	swale	sand	
02-12-03	02-12-03-3-3	3 Florida Point West	swash	shells (picked)	
02-12-03	02-12-03-3-4	3 Florida Point West	lower mid-beach windrow (HTL)	shells (picked)	
02-12-03	02-12-03-3-5	3 Florida Point West	upper mid-beach windrow	shells (picked)	
02-12-03	02-12-03-4-1a	4 Cotton Bayou	HTL ridge	sand	
02-12-03	02-12-03-4-1b	4 Cotton Bayou	HTL swale	sand	
02-12-03	02-12-03-4-2	4 Cotton Bayou	swash	shells (picked)	
02-12-03	02-12-03-4-3	4 Cotton Bayou	HTL windrow	shells (picked)	
02-12-03	02-12-03-4-4	4 Cotton Bayou	mid-beach windrow	shells (picked)	
02-12-03	02-12-03-5-1	10 Romar Beach	HTL	sand	
02-12-03	02-12-03-5-2	10 Romar Beach	swash = HTL	shells (picked)	
02-12-03	02-12-03-6-1	12 Gulf State Park Pavilion	HTL ridge	sand	
02-12-03	02-12-03-6-2	12 Gulf State Park Pavilion	HTL swale	sand	
02-12-03	02-12-03-6-3	12 Gulf State Park Pavilion	swash	shells (picked)	
02-12-03	02-12-03-6-4	12 Gulf State Park Pavilion	HTL	shells (picked)	
02-12-03	02-12-03-6-5	12 Gulf State Park Pavilion	mid-beach windrow	shells (picked)	
02-12-03	02-12-03-6-6	12 Gulf State Park Pavilion	second mid-beach windrow	shells (picked)	
02-12-03	02-12-03-7-1	5 Gulf Shores Public Beach	HTL	sand	
02-12-03	02-12-03-7-2	5 Gulf Shores Public Beach	swash	shells (picked)	
02-12-03	02-12-03-7-3	5 Gulf Shores Public Beach	HTL	shells (picked)	
02-12-03	02-12-03-7-4	5 Gulf Shores Public Beach	mid-beach windrow	shells (picked)	
02-12-03	02-12-03-7-5	5 Gulf Shores Public Beach	swash	shells (extra)	
02-12-03	02-12-03-8-1	8 Little Lagoon Pass	swale	sand	
02-12-03	02-12-03-8-2	8 Little Lagoon Pass	ridge	sand	
02-12-03	02-12-03-8-3	8 Little Lagoon Pass	swash	shells (picked)	
02-12-03	02-12-03-8-4	8 Little Lagoon Pass	HTL	shells (picked)	
02-12-03	02-12-03-8-5	8 Little Lagoon Pass	mid-beach windrow	shells (picked)	
02-12-04	02-12-04-1-1	6 Pine Beach	HTL	sand	
02-12-04	02-12-04-1-2	6 Pine Beach	swash	shells (picked)	
02-12-04	02-12-04-1-3	6 Pine Beach	HTL	shells (picked)	
02-12-04	02-12-04-1-4	6 Pine Beach	windrow higher than HTL	shells (picked)	
02-12-04	02-12-04-1-5	6 Pine Beach	just seaward of berm crest	shells (picked)	
02-12-04	02-12-04-1-6	6 Pine Beach	upper beach	shells (picked)	
02-12-04	02-12-04-2-1	13 Cortez Street	HTL = swash	sand	
02-12-04	02-12-04-2-2	13 Cortez Street	HTL = swash	shells (picked)	
02-12-04	02-12-04-2-3	13 Cortez Street	midbeach	shells (picked)	
02-12-04	02-12-04-3-1	7 Fort Morgan East	HTL, N side of runnel	sand	
02-12-04	02-12-04-3-2	7 Fort Morgan East	HTL, S side of runnel	sand	
02-12-04	02-12-04-3-3	7 Fort Morgan East	HTL	shells (picked)	
02-12-04	02-12-04-3-4	7 Fort Morgan East	midbeach	shells (picked)	
02-12-04	02-12-04-4-1	11 Gulf State Park Convention Ctr	N side of runnel	sand	

Year-month-day	Field no.	Station	Environment	Sample type	Notes
02-12-04	02-12-04-4-2	11 Gulf State Park Convention Ctr	S side of runnel	sand	
02-12-04	02-12-04-4-3	11 Gulf State Park Convention Ctr	HTL	shells (picked)	
02-12-04	02-12-04-4-4	11 Gulf State Park Convention Ctr	midbeach	shells (picked)	
02-12-05	02-12-05-1-1	14 Dauphin Island Sea Lab	HTL	sand	
02-12-05	02-12-05-1-2	14 Dauphin Island Sea Lab	swash = LTL	shells (picked)	
02-12-05	02-12-05-1-3	14 Dauphin Island Sea Lab	HTL or slightly lower	shells (picked)	
02-12-05	02-12-05-2-1	16 West End	swash = LTL	sand	
02-12-05	02-12-05-2-	16 West End	HTL	sand	
02-12-05	02-12-05-2-	16 West End	swash = LTL	shells (picked)	
02-12-05	02-12-05-2-	16 West End	HTL	shells (picked)	
02-12-05	02-12-05-3-	15 Dauphin Island Public Beach	HTL	sand	
02-12-05	02-12-05-3-	15 Dauphin Island Public Beach	LTL	shells (picked)	
02-12-05	02-12-05-3-	15 Dauphin Island Public Beach	HTL	shells (picked)	
02-12-21	02-12-28-1	Audubon Refuge (no site number)	beach	shells (picked)	
03-03-19	030319-16-1	16 West End	HTL	sand	
03-03-19	030319-16-2	16 West End	HTL	shells (quadrat)	
03-03-19	030319-16-3	16 West End	HTL and beach	shells (picked)	
03-03-19	030319-15-1	15 Dauphin Island Public Beach	HTL	sand	
03-03-19	030319-15-2	15 Dauphin Island Public Beach	HTL	shells (quadrat)	
03-03-19	030319-15-3	15 Dauphin Island Public Beach	HTL and swash	shells (picked)	
03-03-19	030319-14-1	14 Dauphin Island Sea Lab	HTL	sand	
03-03-19	030319-14-2	14 Dauphin Island Sea Lab	HTL	shells (quadrat)	
03-03-19	030319-14-3	14 Dauphin Island Sea Lab	HTL and swash	shells (picked)	
03-03-19	030319-7-1	7 Fort Morgan East	HTL landward of runnel	sand	
03-03-19	030319-7-2	7 Fort Morgan East	runnel wrack	shells (quadrat)	
03-03-19	030319-7-3	7 Fort Morgan East		shells (picked)	
03-03-19	030319-7-4	7 Fort Morgan East	swash	shells (quadrat)	
03-03-20	03-03-20-1	1 Alabama-Florida state line		photos	
03-03-20	03-03-20-2	3 Florida Point West		photos	
03-03-20	03-03-20-3	5 Gulf Shores Public Beach		photos	
03-03-20	03032013-1	13 Cortez Street	cusp ridge HTL	sand	
03-03-20	03032013-2	13 Cortez Street	HTL	shells (quadrat)	
03-03-20	03032013-3	13 Cortez Street			
03-03-20	03032013-4	13 Cortez Street	old HTL	shells (quadrat)	
03-03-20	03032013-5	13 Cortez Street		shells (picked)	
03-03-20	030320-6-1	6 Pine Beach	HTL	sand	
03-03-20	030320-6-2	6 Pine Beach	HTL	shells (quadrat)	
03-03-20	030320-6-3	6 Pine Beach	HTL	shells (picked)	
03-03-20	030320-8-	8 Little Lagoon Pass	cusp ridge lower HTL	sand	
03-03-20	030320-8-	8 Little Lagoon Pass	HTL and older HTL	shells (picked)	
03-03-21	03-03-21-1	1 Alabama-Florida state line	cusp ridge HTL	sand	
03-03-21	03-03-21-2	1 Alabama-Florida state line	HTL	shells (quadrat)	
03-03-21	03-03-21-__	1 Alabama-Florida state line		shells (picked)	
03-03-21	030321-3-1	3 Florida Point West	cusp ridge HTL	sand	
03-03-21	030321-3-2	3 Florida Point West	HTL	shells (quadrat)	
03-03-21	030321-4-1	4 Cotton Bayou	cusp ridge HTL	sand	
03-03-21	030321-4-2	4 Cotton Bayou	HTL	shells (quadrat)	
03-03-21	030321-4-3	4 Cotton Bayou	cusp swale HTL	sand	
03-03-21	030321-4-4	4 Cotton Bayou		shells (picked)	
03-03-21	030321-4-1	10 Romar Beach	cusp ridge HTL	sand	
03-03-21	030321-4-2	10 Romar Beach	HTL	shells (quadrat)	
03-03-21	030321-4-3	10 Romar Beach	cusp swale HTL	sand	
03-03-21	030321-4-4	10 Romar Beach		shells (picked)	
03-03-21	030321-12-1	12 Gulf State Park Pavilion	HTL	sand	
03-03-21	030321-12-2	12 Gulf State Park Pavilion	HTL	shells (quadrat)	
03-03-21	030321-12-3	12 Gulf State Park Pavilion		shells (picked)	
03-03-21	030321-11-1	11 Gulf State Park Convention Ctr	HTL	sand	
03-03-21	030321-11-2	11 Gulf State Park Convention Ctr	HTL	shells (quadrat)	
03-03-21	030321-11-3	11 Gulf State Park Convention Ctr		shells (picked)	
03-03-21	030321-5-1	5 Gulf Shores Public Beach	HTL	sand	
03-03-21	030321-5-2	5 Gulf Shores Public Beach	HTL	shells (quadrat)	
03-03-21	030321-5-3	5 Gulf Shores Public Beach		shells (picked)	
03-03-21	030321-8-4	8 Little Lagoon Pass	HTL	shells (quadrat)	
03-03-21	030321-17-1	17 AL Highway 182 mile 2	HTL	sand	
03-03-21	030321-17-__	17 AL Highway 182 mile 2	beach scarp	organic layer	no number

Year-month-day	Field no.	Station	Environment	Sample type	Notes
03-07-01	030701-1A	1 Alabama-Florida state line	HTL	sand	T.S. Bill
03-07-01	030701-1B	1 Alabama-Florida state line	cusp ridge	sand	T.S. Bill
03-07-01	030701-1C	1 Alabama-Florida state line	cusp swale	sand	T.S. Bill
03-07-01	030701-1D	1 Alabama-Florida state line	swash	sand	T.S. Bill
03-07-01	030701-1E	1 Alabama-Florida state line	HTL	shells (picked)	T.S. Bill
03-07-01	030701-1F	1 Alabama-Florida state line	HTL	shells (quadrat)	T.S. Bill
03-07-01	030701-3A	3 Florida Point West	HTL	sand	T.S. Bill
03-07-01	030701-3B	3 Florida Point West	cusp ridge	sand	T.S. Bill
03-07-01	030701-3C	3 Florida Point West	cusp swale	sand	T.S. Bill
03-07-01	030701-3D	3 Florida Point West	swash	sand	T.S. Bill
03-07-01	030701-3E	3 Florida Point West	HTL	shells (quadrat)	T.S. Bill
03-07-01	030701-3F	3 Florida Point West	HTL	shells (picked)	T.S. Bill
03-07-01	030701-4A	4 Cotton Bayou	HTL	sand	T.S. Bill
03-07-01	030701-4B	4 Cotton Bayou	cusp ridge	sand	T.S. Bill
03-07-01	030701-4E	4 Cotton Bayou	HTL	shells (picked)	T.S. Bill
03-07-01	030701-4F	4 Cotton Bayou	HTL	shells (quadrat)	T.S. Bill
03-07-01	030701-4G	4 Cotton Bayou	swash	shells (picked)	T.S. Bill
03-07-01	030701-12A	12 Gulf State Park Pavilion	HTL	sand	T.S. Bill
03-07-01	030701-12B	12 Gulf State Park Pavilion	cusp ridge	sand	T.S. Bill
03-07-01	030701-12C	12 Gulf State Park Pavilion	cusp swale	sand	T.S. Bill
03-07-01	030701-12D	12 Gulf State Park Pavilion	swash	sand	T.S. Bill
03-07-01	030701-12F	12 Gulf State Park Pavilion	HTL	shells (quadrat)	T.S. Bill
03-07-01	030701-12G	12 Gulf State Park Pavilion	swash	shells (picked)	T.S. Bill
03-07-02	030702-6A	6 Pine Beach	HTL	sand	T.S. Bill
03-07-02	030702-6B	6 Pine Beach	cusp ridge	sand	T.S. Bill
03-07-02	030702-6C	6 Pine Beach	cusp swale	sand	T.S. Bill
03-07-02	030702-6D	6 Pine Beach	swash	sand	T.S. Bill
03-07-02	030702-6E	6 Pine Beach	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-6F	6 Pine Beach	swash	shells (picked)	T.S. Bill
03-07-02	030702-6G	6 Pine Beach	swash	shells (picked)	T.S. Bill
03-07-02	030702-6A	7 Fort Morgan East	HTL	sand	T.S. Bill
03-07-02	030702-6B	7 Fort Morgan East	cusp ridge	sand	T.S. Bill
03-07-02	030702-6C	7 Fort Morgan East	cusp swale	sand	T.S. Bill
03-07-02	030702-6D	7 Fort Morgan East	swash	sand	T.S. Bill
03-07-02	030702-6E	7 Fort Morgan East	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-6F	7 Fort Morgan East	swash	shells (picked)	T.S. Bill
03-07-02	030702-6G	7 Fort Morgan East	swash	shells (picked)	T.S. Bill
03-07-02	030702-13A	13 Cortez Street	storm surge	sand	T.S. Bill
03-07-02	030702-13B	13 Cortez Street	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-13C	13 Cortez Street	cusp swale at swash	sand	T.S. Bill
03-07-02	030702-13E	13 Cortez Street	HTL	shells (picked)	T.S. Bill
03-07-02	030702-13F	13 Cortez Street	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-13G	13 Cortez Street	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-5A	5 Gulf Shores Public Beach	storm surge	sand	T.S. Bill
03-07-02	030702-5B	5 Gulf Shores Public Beach	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-5C	5 Gulf Shores Public Beach	cusp swale at swash	sand	T.S. Bill
03-07-02	030702-5E	5 Gulf Shores Public Beach	HTL	shells (picked)	T.S. Bill
03-07-02	030702-5F	5 Gulf Shores Public Beach	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-5G	5 Gulf Shores Public Beach	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-5H	5 Gulf Shores Public Beach	storm surge	shells (quadrat)	T.S. Bill
03-07-02	030702-8A	8 Little Lagoon Pass	storm surge	sand	T.S. Bill
03-07-02	030702-8B	8 Little Lagoon Pass	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-8C	8 Little Lagoon Pass	cusp swale at swash	sand	T.S. Bill
03-07-02	030702-8D	8 Little Lagoon Pass	HTL	shells (picked)	T.S. Bill
03-07-02	030702-8E	8 Little Lagoon Pass	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-8F	8 Little Lagoon Pass	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-8G	8 Little Lagoon Pass	storm surge	shells (quadrat)	T.S. Bill
03-07-02	030702-17A	17 AL Highway 182 mile 2	storm surge	sand	T.S. Bill
03-07-02	030702-17B	17 AL Highway 182 mile 2	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-17C	17 AL Highway 182 mile 2	cusp swale at swash	sand	T.S. Bill

Year-month-day	Field no.	Station	Environment	Sample type	Notes
03-07-02	030702-17E	17 AL Highway 182 mile 2	HTL	shells (picked)	T.S. Bill
03-07-02	030702-17F	17 AL Highway 182 mile 2	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-17G	17 AL Highway 182 mile 2	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-17H	17 AL Highway 182 mile 2	storm surge	shells (quadrat)	T.S. Bill
03-07-02	030702-11A	11 Gulf State Park Convention Ctr	storm surge	sand	T.S. Bill
03-07-02	030702-11B	11 Gulf State Park Convention Ctr	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-11C	11 Gulf State Park Convention Ctr	cusp swale at swash	sand	T.S. Bill
03-07-02	030702-11E	11 Gulf State Park Convention Ctr	HTL	shells (picked)	T.S. Bill
03-07-02	030702-11F	11 Gulf State Park Convention Ctr	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-11G	11 Gulf State Park Convention Ctr	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-11H	11 Gulf State Park Convention Ctr	storm surge	shells (quadrat)	T.S. Bill
03-07-02	030702-10A	10 Romar Beach	storm surge	sand	T.S. Bill
03-07-02	030702-10B	10 Romar Beach	cusp ridge at swash	sand	T.S. Bill
03-07-02	030702-10C	10 Romar Beach	cusp swale at swash	sand	T.S. Bill
03-07-02	030702-10E	10 Romar Beach	HTL	shells (picked)	T.S. Bill
03-07-02	030702-10F	10 Romar Beach	HTL	shells (quadrat)	T.S. Bill
03-07-02	030702-10G	10 Romar Beach	storm surge	shells (picked)	T.S. Bill
03-07-02	030702-10H	10 Romar Beach	storm surge	shells (quadrat)	T.S. Bill
03-07-03	030703-14A	14 Dauphin Island Sea Lab	storm surge	sand	T.S. Bill
03-07-03	030703-14B	14 Dauphin Island Sea Lab	swash (relatively high)	sand	T.S. Bill
03-07-03	030703-14C	14 Dauphin Island Sea Lab	swash (relatively low)	sand	T.S. Bill
03-07-03	030703-14D	14 Dauphin Island Sea Lab	HTL	sand	T.S. Bill
03-07-03	030703-14E	14 Dauphin Island Sea Lab	HTL	shells (picked)	T.S. Bill
03-07-03	030703-14F	14 Dauphin Island Sea Lab	HTL	shells (quadrat)	T.S. Bill
03-07-03	030703-14G	14 Dauphin Island Sea Lab	storm surge	shells (picked)	T.S. Bill
03-07-03	030703-14I	14 Dauphin Island Sea Lab	swash	shells (picked)	T.S. Bill
03-07-03	030703-16A	16 West End	dune	sand	T.S. Bill
03-07-03	030703-16B	16 West End	HTL	sand	T.S. Bill
03-07-03	030703-16C	16 West End	HTL 15 feet from B	sand	T.S. Bill
03-07-03	030703-16E	16 West End	HTL	shells (picked)	T.S. Bill
03-07-03	030703-16F	16 West End	HTL	shells (quadrat)	T.S. Bill
03-07-03	030703-16G	16 West End	dune	shells (picked)	T.S. Bill
03-07-03	030703-15	15 Dauphin Island Public Beach	multiple samples		T.S. Bill
03-11-05	031105-16A	16 West End	cusp swale, swash	sand	
03-11-05	031105-16B	16 West End	cusp ridge, swash	sand	
03-11-05	031105-16C	16 West End	HTL	sand	
03-11-05	031105-16D	16 West End	storm surge	sand	
03-11-05	031105-16E	16 West End	HTL	shells (quadrat)	
03-11-05	031105-16F	16 West End	storm surge	shells (quadrat)	
03-11-05	031105-16G	16 West End	swash	shells (picked)	
03-11-05	031105-15A	15 Dauphin Island Public Beach	swash	sand	
03-11-05	031105-15C	15 Dauphin Island Public Beach	HTL	sand	
03-11-05	031105-15D	15 Dauphin Island Public Beach	previous HTL	sand	
03-11-05	031105-15E	15 Dauphin Island Public Beach	previous HTL	shells (quadrat)	
03-11-05	031105-15F	15 Dauphin Island Public Beach	swash to HTL	shells (picked)	
03-11-05	031105-18	18 W of condos W of station 15	storm surge	shells (picked)	
03-11-05	031105-19A	19 Old pass, Dauphin Island	swash	shells (picked)	
03-11-05	031105-19B	19 Old pass, Dauphin Island	storm surge	shells (picked)	
03-11-05	031105-14A	14 Dauphin Island Sea Lab	swash	sand	
03-11-05	031105-14C	14 Dauphin Island Sea Lab	storm surge = HTL	sand	
03-11-05	031105-14D	14 Dauphin Island Sea Lab	HTL	shells (quadrat)	
03-11-05	031105-14E	14 Dauphin Island Sea Lab	HTL	shells (picked)	
03-11-05	031105-14F	14 Dauphin Island Sea Lab	swash	shells (picked)	
03-11-06	031106-1A	1 Alabama-Florida state line	cusp swale, swash	sand	
03-11-06	031106-1B	1 Alabama-Florida state line	cusp ridge, swash	sand	
03-11-06	031106-1C	1 Alabama-Florida state line	HTL	sand	
03-11-06	031106-1D	1 Alabama-Florida state line	storm surge	sand	
03-11-06	031106-1E	1 Alabama-Florida state line	storm surge	shells (quadrat)	
03-11-06	031106-1F	1 Alabama-Florida state line	swash	shells (picked)	
03-11-06	031106-1G	1 Alabama-Florida state line	slope break in swash zone	shells (picked)	
03-11-06	031106-3a	3 Florida Point West	cusp swale, swash	sand	
03-11-06	031106-3B	3 Florida Point West	cusp ridge, swash	sand	
03-11-06	031106-3C	3 Florida Point West	HTL	sand	
03-11-06	031106-3E	3 Florida Point West	storm surge of November 4	shells (quadrat)	
03-11-06	031106-3F	3 Florida Point West	swash	shells (quadrat)	

Year-month-day	Field no.	Station	Environment	Sample type	Notes
03-11-06	031106-3G	3 Florida Point West	swash	shells (picked)	
03-11-06	031106-4A	4 Cotton Bayou	cusp swale, swash	sand	
03-11-06	031106-4B	4 Cotton Bayou	cusp ridge, swash	sand	
03-11-06	031106-4C	4 Cotton Bayou	HTL	sand	
03-11-06	031106-4D	4 Cotton Bayou	storm surge of November 4	shells (quadrat)	
03-11-06	031106-4E	4 Cotton Bayou	storm surge	shells (quadrat)	
03-11-06	031106-4F	4 Cotton Bayou	swash	shells (picked)	
03-11-06	031106-10A	10 Romar Beach	cusp swale, swash	sand	
03-11-06	031106-10B	10 Romar Beach	cusp ridge, swash	sand	
03-11-06	031106-10C	10 Romar Beach	storm surge of November 4	sand	
03-11-06	031106-10E	10 Romar Beach	storm surge of November 4	shells (quadrat)	
03-11-06	031106-10F	10 Romar Beach	swash	shells (quadrat)	
03-11-06	031106-10G	10 Romar Beach	swash	shells (picked)	
03-11-06	031106-12A	12 Gulf State Park Pavilion	swash	sand	
03-11-06	031106-12C	12 Gulf State Park Pavilion	HTL	sand	
03-11-06	031106-12D	12 Gulf State Park Pavilion	storm surge	sand	
03-11-06	031106-12E	12 Gulf State Park Pavilion	storm surge	shells (quadrat)	
03-11-06	031106-12F	12 Gulf State Park Pavilion	HTL	shells (quadrat)	
03-11-06	031106-12G	12 Gulf State Park Pavilion	swash	shells (picked)	
03-11-06	031106-11A	11 Gulf State Park Convention Ctr	swash	sand	
03-11-06	031106-11C	11 Gulf State Park Convention Ctr	HTL	sand	
03-11-06	031106-11D	11 Gulf State Park Convention Ctr	storm surge	sand	
03-11-06	031106-11E	11 Gulf State Park Convention Ctr	storm surge	shells (quadrat)	
03-11-06	031106-11F	11 Gulf State Park Convention Ctr	swash	shells (quadrat)	
03-11-06	031106-11G	11 Gulf State Park Convention Ctr	swash	shells (picked)	
03-11-06	031106-6	6 Pine Beach	multiple samples		
03-11-07	031107-5A	5 Gulf Shores Public Beach	runnel swale	sand	
03-11-07	031107-5B	5 Gulf Shores Public Beach	runnel ridge	sand	
03-11-07	031107-5C	5 Gulf Shores Public Beach	HTL	sand	
03-11-07	031107-5D	5 Gulf Shores Public Beach	storm surge of November 4	sand	
03-11-07	031107-5E	5 Gulf Shores Public Beach	storm surge of November 4	shells (quadrat)	
03-11-07	031107-5F	5 Gulf Shores Public Beach	HTL	shells (quadrat)	
03-11-07	031107-5G	5 Gulf Shores Public Beach	swash to HTL	shells (picked)	
03-11-07	031107-5H	5 Gulf Shores Public Beach	HTL	shells (extra)	
03-11-07	031107-8A	8 Little Lagoon Pass	swash	sand	
03-11-07	031107-8C	8 Little Lagoon Pass	HTL	sand	
03-11-07	031107-8D	8 Little Lagoon Pass	storm surge	sand	
03-11-07	031107-8E	8 Little Lagoon Pass	storm surge	shells (picked)	
03-11-07	031107-8F	8 Little Lagoon Pass	HTL	shells (quadrat)	
03-11-07	031107-8G	8 Little Lagoon Pass	swash to HTL	shells (picked)	
03-11-07	031107-17A	17 AL Highway 182 mile 2	cusp swale, swash	sand	
03-11-07	031107-17B	17 AL Highway 182 mile 2	cusp ridge, swash	sand	
03-11-07	031107-17C	17 AL Highway 182 mile 2	HTL	sand	
03-11-07	031107-17D	17 AL Highway 182 mile 2	storm surge	sand	
03-11-07	031107-17E	17 AL Highway 182 mile 2	storm surge	shells (quadrat)	
03-11-07	031107-17F	17 AL Highway 182 mile 2	HTL	shells (quadrat)	
03-11-07	031107-17G	17 AL Highway 182 mile 2	swash	shells (picked)	
03-11-07	031107-13A	13 Cortez Street	cusp swale, swash	sand	
03-11-07	031107-13B	13 Cortez Street	cusp ridge, swash	sand	
03-11-07	031107-13C	13 Cortez Street	HTL	sand	
03-11-07	031107-13D	13 Cortez Street	storm surge	sand	
03-11-07	031107-13E	13 Cortez Street	storm surge	shells (quadrat)	
03-11-07	031107-13F	13 Cortez Street	HTL	shells (quadrat)	
03-11-07	031107-13G	13 Cortez Street	swash	shells (picked)	
03-11-07	031107-7A	7 Fort Morgan East	cusp swale, swash	sand	
03-11-07	031107-7B	7 Fort Morgan East	cusp ridge, swash	sand	
03-11-07	031107-7C	7 Fort Morgan East	HTL	sand	
03-11-07	031107-7D	7 Fort Morgan East	storm surge	sand	
03-11-07	031107-7E	7 Fort Morgan East	storm surge	shells (quadrat)	
03-11-07	031107-7F	7 Fort Morgan East	HTL	shells (quadrat)	
03-11-07	031107-7G	7 Fort Morgan East	swash	shells (picked)	

*Appendix 3 contains particle-size data acquired by sieving samples selected from among those listed here.

**Latitude and longitude data provided in ArcView project.

APPENDIX 2. RAW PARTICLE-SIZE DATA OF SELECTED SAMPLES FROM ALABAMA BEACHES*

		Phi units of sieves/millimeter sieve sizes/interval midpoints in millimeters																										
Sample**	initial net weight (grams)	-2	-1.75	-1.5	-1.25	-1	-0.75	-0.5	-0.25	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	pan	mean
		4	3.36	2.83	2.38	2	1.7	1.41	1.17	1	0.85	0.71	0.6	0.5	0.425	0.355	0.3	0.25	0.212	0.18	0.15	0.125	0.106	0.088	0.075	0.063		
			3.68	3.095	2.605	2.19	1.85	1.555	1.29	1.085	0.925	0.78	0.655	0.55	0.463	0.39	0.328	0.275	0.231	0.196	0.165	0.138	0.116	0.097	0.082	0.069		
020311-1-3a	52.906						0.021	0.003	0.054	0.042	0.059	0.051	0.157	0.313	0.884	6.349	13.53	17.01	9.884	3.355	0.521	0.122	0.054	0.011	0.009	0.004	0.012	0.269
020311-1-4a	52.566						0.02	0.014	0.18	0.102	0.106	0.287	0.857	2.38	3.18	9.488	12.78	13.7	7.018	1.487	0.147	0.04	0.033	0.012	0.014	0.008	0.017	0.307
020311-1-5a	35.805	0.528			0.006	0.01	0.008	1E-03	0.016	0.006	0.013	0.028	0.119	0.212	0.238	1.883	5.931	11.23	10.54	4.235	0.623	0.093	0.068	0.014	0.012	0.005	0.02	0.248
020311-1-5a_2	41.84				0.001	0.004	0.013	0.001	0.036	0.015	0.013	0.018	0.074	0.192	0.253	2.236	6.814	15.15	11.62	4.199	0.758	0.102	0.057	0.018	0.013	0.008	0.014	0.247
020311-1-6a	41.644						0.009	0.019	0.058	0.059	0.055	0.211	1.173	4.843	5.909	10.53	9.231	6.624	2.37	0.497	0.08	0.025	0.026	0.015	0.013	0.007	0.01	0.355
020607-3-2a	51.865						0.005	0.002	0.04	0.02	0.034	0.17	0.741	4.108	5.996	12.4	12.35	10.35	4.393	1.142	0.173	0.079	0.067	0.022	0.024	0.009	0.002	0.331
020806-1-1a	44.44					1E-03	0.011		0.009	1E-03	0.02	0.143	0.498	1.551	2.511	6.534	10.28	12.98	7.907	2.057	0.141	0.029	0.015	0.007	0.009	0.005	0.025	0.293
020806-1-2a	35.837								0.032	0.012	0.007	0.023	0.175	0.434	1.204	5.111	9.13	11.78	6.613	1.584	0.124	0.024	0.021	0.008	0.01	0.005	0.026	0.282
020806-2-1a	33.293								0.019	0.005	0.018	0.174	1.084	3.695	2.731	4.208	6.176	7.959	5.484	1.631	0.172	0.037	0.026	0.009	0.009	0.004	0.021	0.320
020806-2-1a_2	32.123				0.004				0.009	0.008	0.011	0.185	1.085	3.43	2.751	4.155	5.871	7.573	5.217	1.719	0.177	0.036	0.022	0.01	0.009	0.005	0.023	0.320
020806-2-1b	52.743		0.019						0.009	0.01	0.013	0.138	0.587	2.013	3.293	7.127	10.27	13.96	10.76	3.87	0.39	0.055	0.03	0.01	0.01	0.005	0.029	0.286
020806-2-1b_2	53.171								0.002	0.009	0.006	0.13	0.557	1.946	2.981	6.86	10.25	14.37	11.37	3.99	0.429	0.078	0.031	0.013	0.011	0.005	0.034	0.282
020806-2-2a	54.527								0.034	0.007	0.016	0.028	0.102	0.54	2.032	7.058	11.39	16.25	11.95	4.323	0.473	0.067	0.025	0.009	0.008	0.005	0.025	0.269
020806-2-2a_2	44.313								0.006	0.006	0.005	0.015	0.044	0.399	1.744	5.712	9.563	13.16	9.606	3.525	0.399	0.05	0.024	0.008	0.009	0.004	0.028	0.269
020806-2-2b	31.745								0.013	0.012	0.009	0.01	0.047	0.289	1.45	4.658	7.762	9.748	5.962	1.671	0.147	0.028	0.011	0.007	0.008	0.004	0.021	0.279
020806-2-4a	36.701								0.025	0.004	0.006	0.029	0.124	0.542	1.458	4.433	8.305	11.7	7.571	2.174	0.202	0.045	0.035	0.01	0.009	0.004	0.027	0.274
020806-3-1a	50.334						0.012		0.016	0.005	0.003	0.014	0.124	0.45	1.292	4.705	9.415	16.38	12.46	4.057	0.387	0.044	0.021	0.007	0.006	0.003	0.013	0.257
020806-3-2a	30.611								0.037	0.008	1E-03	0.021	0.164	0.633	1.423	3.768	6.792	9.697	6.709	1.786	0.142	0.026	0.022	0.011	0.011	0.005	0.025	0.283
020806-3-2b	41.61							1E-03	0.009	0.006	0.003	0.006	0.035	0.31	1.199	4.088	8.614	13.97	10.48	3.129	0.231	0.03	0.013	0.009	0.008	0.004	0.024	0.266
020806-3-4a	54.326		0.001				0.002		0.009	0.004	0.011	0.019	0.466	2.853	4.788	10.64	12.7	12.6	7.012	2.211	0.321	0.072	0.061	0.013	0.012	0.005	0.015	0.303
020806-4-1a	36.456				0.001		0.008	0.002	0.018	0.007	0.013	0.017	0.053	0.17	0.242	1.234	4.353	10.71	12.02	5.998	1.131	0.244	0.253	0.033	0.014	0.006	0.011	0.235
020806-4-2a	32.708							0.002	0.01	0.012	0.016	0.015	0.051	0.086	0.058	0.483	3.228	10.37	12.25	5.384	0.669	0.077	0.037	0.013	0.01	0.006	0.021	0.231
020806-4-4a	33.741								0.01	0.007	0.004	0.032	0.151	1.193	2.609	6.495	8.599	8.725	4.536	1.23	0.146	0.033	0.019	0.008	0.007	0.003	0.027	0.300
020806-5-1a	27.63						0.002	1E-03	0.015	0.009	0.012	0.017	0.06	0.132	0.348	1.612	4.849	8.876	7.683	3.451	0.689	0.165	0.138	0.019	0.008	0.003	0.012	0.251
020806-5-4a	39.456		0.246	0.042	0.072	0.074	0.064	0.119	0.12	0.104	0.168	0.489	0.721	1.674	1.954	3.846	5.884	8.931	8.198	4.736	1.36	0.201	0.197	0.031	0.023	0.01	0.049	0.319
020806-8-1a	51.949				0.024	0.005	0.031	0.007	0.025	0.061	0.161	1.272	4.915	13.37	10.18	10.54	5.79	3.419	0.994	0.191	0.032	0.019	0.023	0.011	0.011	0.006	0.012	0.420
020806-8-4a	33.188								0.009	0.007	0.003	0.02	0.075	0.631	1.636	4.985	8.327	9.879	5.858	1.549	0.162	0.03	0.015	0.006	0.007	0.003	0.024	0.283
020807-6-1a	32.802			0.026			0.01	0.004	0.019	0.017	0.018	0.138	0.552	1.876	3.124	7.26	8.553	7.865	2.986	0.453	0.044	0.012	0.015	0.008	0.009	0.004	0.012	0.326
020807-6-2a	34.666								0.038	0.021	0.024	0.035	0.165	0.768	1.836	5.931	9.809	10.55	4.532	0.956	0.087	0.015	0.009	0.006	0.007	0.004	0.022	0.295
020807-6-2a_2	34.475								0.018	0.019	0.03	0.044	0.174	0.78	1.95	5.84	9.903	10.47	4.391	0.857	0.089	0.016	0.013	0.005	0.005	0.003	0.026	0.295
020807-6-4a	38.127				0.006	0.002	0.01		0.006	0.01	0.032	0.165	0.655	3.357	4.927	8.897	8.599	7.228	3.226	0.746	0.108	0.038	0.024	0.008	0.007	0.003	0.023	0.334
020807-7-1a	57.516						0.008	1E-03	0.036	0.031	0.039	0.186	0.507	2.267	2.526	6.361	10.18	16.01	13.27	5.107	0.55	0.045	0.029	0.011	0.011	0.005	0.012	0.276
020807-7-4a	42.349					1E-03			0.005		0.003	0.011	0.038	0.28	0.937	2.922	6.386	11.78	12.03	6.267	1.182	0.198	0.092	0.022	0.013	0.006	0.028	0.245
030701-12 a	47.735						0.015	0.005	0.018	0.012	0.013	0.029	0.131	0.291	0.689	3.252	9.43	17.17	12	3.984	0.438	0.088	0.025	0.009	0.009	0.005	0.019	0.256
030701-1a	49.754		0.456	0.006	0.033	0.014	0.01	0.02	0.04	0.041	0.077	0.729	2.261	6.676	6.962	10.46	9.714	7.897	3.54	0.698	0.084	0.021	0.023	0.012	0.014	0.006	0.04	0.392
030701-4 a	49.107				0.007					0.01	0.013	0.027	0.085	0.471	1.224	3.665	7.871	14.86	13.93	5.666	0.936	0.188	0.09	0.01	0.008	0.003	0.013	0.252
030702-11 c	40.151								0.02	0.011	0.003	0.003	0.014	0.011	0.07	1.632	9.031	17.33	9.729	2.071	0.183	0.026	0.01	0.008	0.012	0.005	0.018	0.253
030702-13 c	57.029										0.011	0.053	0.376	2.598	6.179	14.95	16.5	11.5	4.258	0.822	0.103	0.022	0.015	0.005	0.004	0.003	0.011	0.323
030702-17 c	48.176									0.013		0.009	0.05	0.316	1.087	4.331	10.09	15.21	11.95	4.584	0.506	0.048	0.02	0.012	0.01	0.005	0.032	0.259
030702-5 a	48.842		0.028	0.069	0.014	0.043	0.023	0.036	0.067	0.082	0.122	0.418	0.976	2.871	3.484	6.928	8.693	10.71	8.543	4.241	0.944	0.218	0.098	0.029	0.022	0.01	0.056	0.308
030702-6 a	47.285								0.006	0.014	0.02	0.099	0.404	1.515	2.822	7.829	11.15	12.76	7.39	2.754	0.525	0.109	0.045	0.01	0.008	0.006	0.018	0.294
030702-7 a	45.927							1E-03	0.006	0.011	0.003	0.006	0.031	0.264	1.235	4.49	8.394	14.58	11.66	4.477	0.524	0.174	0.039	0.004	0.005	0.006	0.013	0.258
030702-8 a	49.297		0.406	0.056	0.036	0.01	0.021	0.021	0.034	0.027	0.065	0.417	1.247	4.177	4.923	9.937	12.07	10.13	4.189	1.047	0.144	0.035	0.019	0.01	0.008	0.006	0.024	0.362
030702-8 c	47.395				0.025			0.008	0.013	0.016	0.017	0.136	0.569	4.094	7.52	13.9	11.14	7.253	2.47	0.495	0.061	0.012	0.018	0.008	0.009	0.006	0.025	0.348
030703-14 d htl	48.27									0.01		0.006	0.041	0.238	0.979	3.783	9.264	15.97	11.88	4.552	0.723	0.148	0.036	0.006	0.003	0.002	0.009	0.252
030703-16 b	54.005									0.025	0.013	0.01	0.028	0.039	0.079	2.047	15.83	26.81	7.774	1.062	0.119	0.023	0.014	0.006	0.006	0.005	0.014	0.262
03110601c	51.141		1.631	0.388	0.321	0.163	0.161	0.104	0.305	0.211	0.726	2.938	6.985	12.52	9.275	8.342	4.506	1.901	0.429	0.085	0.02	0.012	0.014	0.006	0.008	0.006	0.029	0.599
031106-6 c	54.617		0.455	0.079	0.053	0.081	0.066	0.117	0.339	0.486	1.697	6.344	11.79	13.42	7.889	6.668	3.513	1.123	0.191	0.041	0.012	0.01	0.011	0.006	0.006	0.004	0.013	0.550
031107-5 c	40.246							0.004	0.007	0.012	0.006	0.027	0.138	0.54	1.5	4.447	7.749	11.55	9.328	4.012	0.75	0.216	0.164	0.035	0.018	0.006	0.033	0.266

APPENDIX 2. RAW PARTICLE-SIZE DATA OF SELECTED SAMPLES FROM ALABAMA BEACHES*

		Phi units of sieves/millimeter sieve sizes/interval midpoints in millimeters																										
Sample**	initial net weight (grams)	-2	-1.75	-1.5	-1.25	-1	-0.75	-0.5	-0.25	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	pan	mean
		4	3.36	2.83	2.38	2	1.7	1.41	1.17	1	0.85	0.71	0.6	0.5	0.425	0.355	0.3	0.25	0.212	0.18	0.15	0.125	0.106	0.088	0.075	0.063		
			3.68	3.095	2.605	2.19	1.85	1.555	1.29	1.085	0.925	0.78	0.655	0.55	0.463	0.39	0.328	0.275	0.231	0.196	0.165	0.138	0.116	0.097	0.082	0.069		
031107-8 c	48.655		1.726	0.158	0.212	0.162	0.099	0.082	0.218	0.223	0.675	2.092	5.399	10.89	8.731	7.591	4.828	3.571	1.551	0.29	0.037	0.009	0.009	0.007	0.008	0.004	0.016	0.570
040707-13 a swale	55.54					0.016	0.022	0.009	0.051	0.038	0.039	0.139	0.318	1.033	1.972	5.353	10.46	15.83	13.28	6.108	1	0.09	0.042	0.014	0.016	0.008	0.041	0.269
040707-13 b ss	51.942		0.123						0.041	0.029	0.026	0.098	0.322	1.582	3.864	10.32	14.84	13.62	5.795	1.065	0.113	0.035	0.017	0.01	0.006	0.005	0.014	0.311
040707-5 lht	42.107		0.262	0.012	0.043	0.069	0.047	0.062	0.085	0.078	0.118	0.631	1.319	3.952	4.775	7.686	8.198	8.079	4.804	1.616	0.208	0.034	0.008	0.015	0.006	0.004	0.017	0.366
040707-7 a lht	47.335		0.025	0.054	0.084	0.066	0.079	0.071	0.211	0.171	0.318	0.988	2.227	6.181	7.573	11.02	7.951	5.203	2.866	1.578	0.453	0.105	0.031	0.01	0.009	0.005	0.03	0.389
040707-7 b ht	48.59					0.007		0.012	0.016	0.013	0.021	0.094	0.309	1.57	2.614	5.653	8.517	12	10.74	5.664	1.118	0.194	0.045	0.013	0.008	0.012	0.025	0.273
040708-1 lht	41.071			0.032	0.011		0.026		0.018	0.052	0.059	0.318	0.955	2.995	3.669	7.171	9.302	10.22	5.245	1.011	0.094	0.114	0.017	0.01	0.01	0.006	0.028	0.325
040708-10 lht	51.413		0.066	0.145		0.031	0.045	0.014	0.03	0.054	0.082	0.424	1.065	3.505	4.756	9.539	11.56		12.12	6.647	1.339	0.091	0.02	0.013	0.008	0.006	0.034	4.907
040708-11	59.032		0.845	0.011	0.024	0.032	0.058	0.041	0.071	0.083	0.229	1.063	2.425	5.958	6.967	10.98	11.37	10.85	6.16	1.535	0.14	0.019	0.007	0.005	0.005	0.003	0.015	9.546
040708-11 ss	50.1		0.797	0.226	0.223	0.242	0.246	0.192	0.54	0.457	1.391	3.194	4.532	4.831	3.093	3.982	5.982	8.837	7.541	3.084	0.383	0.067	0.042	0.011	0.01	0.004	0.02	6.419
040708-12 lht	59.025		0.072	0.012	0.008				0.055	0.05	0.069	0.1	0.129	0.623	2.12	9.727	18.04	17.49	8.431	1.769	0.118	0.018	0.014	0.003	0.01	0.029	0.025	8.480
040708-17 lht	52.111		0.318	0.073	0.016	0.048	0.17	0.506	1.246	1.418	3.115	5.989	7.302	9.563	7.029	7.698	4.662	1.984	0.486	0.1	0.025	0.016	0.015	0.01	0.011	0.008	0.035	3.442
040708-17 ss	47.629		0.545	0.096	0.027	0.086	0.055	0.167	0.314	0.298	0.55	1.131	1.151	2.932	3.828	10.17	12.53	9.635	3.103	0.617	0.102	0.032	0.02	0.007	0.009	0.003	0.029	7.051
040708-3	43.202		0.344	0.108	0.059	0.036	0.027	0.02	0.084	0.106	0.29	1.303	2.815	6.4	6.628	8.686	7.807	5.883	2.007	0.341	0.04	0.015	0.014	0.005	0.006	0.003	0.015	7.233
040708-3 ht	47.946		0.11	0.025			0.011	0.005	0.059	0.013	0.075	0.175	0.544	2.769	4.822	10.57	12.15	10.87	4.779	0.935	0.098	0.022	0.015	0.007	0.008	0.004	0.034	8.787
040708-4 lht	45.378			0.068	0.007	0.016	0.023	0.009	0.018	0.062	0.077	0.318	0.769	2.419	3.109	5.938	8.159	10.84	8.972	4.029	0.467	0.046	0.019	0.01	0.01	0.006	0.036	8.816
040708-6a lht	48.036				0.031	0.013	0.027	0.009	0.07	0.055	0.076	0.204	0.417	1.617	3.721	9.662	14.39	12.89	4.362	0.576	0.051	0.013	0.013	0.009	0.012	0.006	0.032	13.073
040708-6c ss	49.905		0.33	0.19	0.2	0.079	0.15	0.148	0.363	0.35	1.019	4.122	9.357	14.04	7.472	5.446	3.453	2.036	0.735	0.19	0.035	0.012	0.009	0.006	0.004	0.003	0.017	7.803
040708-8 lht	53.279				0.021		0.012		0.029	0.067	0.048	0.355	0.983	3.377	1.841	9.753	11.41	12.11	7.545	2.226	0.223	0.042	0.023	0.005	0.004	0.002	0.012	3.643
040709-14 lht	45.158				0.008	1E-03	0.006		0.031	0.02	0.016	0.016	0.06	0.275	0.781	2.662	7.201	16.34	13.08	4.067	0.439	0.143	0.037	0.009	0.006	0.003	0.013	8.775
040709-14 lht	54.023		0.282	0.017	0.063	0.043	0.057	0.036	0.121	0.168	0.56	2.112	4.01	8.574	8.433	11.91	9.399	5.924	1.729	0.253	0.029	0.007	0.004	0.01	0.007	0.005	0.012	6.548
040709-15 lht	45.695			0.028	0.021	0.001	0.021	0.026	0.117	0.103	0.28	0.933	1.552	3.52	4.177	6.829	8.066	8.733	6.114	3.364	0.994	0.424	0.096	0.013	0.013	0.008	0.033	8.196
040709-16 lht	60.07		0.141	0.052	0.042	0.086	0.116	0.18	0.805	0.897	2.533	6.11	9.014	11.59	8.624	8.752	6.104	3.584	1.127	0.213	0.033	0.012	0.012	0.008	0.009	0.005	0.028	4.857
040709-16 ss	57.212			0.014	0.008	0.012	0.007	0.015	0.128	0.067	0.123	0.659	1.742	5.785	7.912	13.37	12.56	8.962	3.744	1.257	0.313	0.112	0.056	0.011	0.009	0.004	0.016	6.320
040709-19 lht	44.853				0.011		0.007	0.003		0.017	0.009	0.017	0.059	0.289	1.108	5.161	11.2	15.02	8.86	2.571	0.311	0.05	0.022	0.01	0.01	0.008	0.04	5.885
040709-19 ss	41.576		0.077	0.041	0.023	0.008	0.019	0.02	0.095	0.052	0.11	0.214	0.517	0.553	2.345	5.086	8.711	11.36	7.593	2.957	0.75	0.174	0.092	0.021	0.013	0.02	0.045	8.315

* Analysts: David C. Kopaska-Merkel, Andrew K. Rindsberg, Wiley Phillip Henderson, Jr., Sydney S. DeJarnette, Karen E Richter. Some data entered by Gary L. Scruggs.

**See Appendix 1 for complete list of samples through 2003.

APPENDIX 3. SIEVE ANALYSES OF GULF OF MEXICO BOTTOM GRAB SAMPLES*

SCREEN	SR-1-BG**	SR-2-BG	SR-3-BG	SR-4-BG	SR-5-BG	SR-6-BG	SR-7-BG	SR-8-BG	SR-9-BG	SR-10-BG	SR-11-BG	SR-12-BG	SR-13-BG	SR-14-BG	SR-15-BG
OPENING	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND
(phi units)															
-2	0.015	0	0	0	0	0.418	0.118	0.036	0	0	10.562	0.146	1.075	0.486	0.095
-1.5	0.058	0	0	0	0	0.471	0.171	0.024	0	0.027	1.08	0.047	0.142	0.494	0.076
-1	0.129	0	0.005	0.089	0.054	0.994	0.189	0.044	0	0.066	0.914	0.078	0.251	0.739	0.1
-0.5	0.139	0.03	0.036	0.107	0.049	1.012	0.261	0.065	0.011	0.149	0.779	0.145	0.314	0.561	0.153
0	0.177	0.056	0.041	0.175	0.112	1.107	0.398	0.108	0.022	0.156	0.533	0.139	0.414	0.828	0.211
0.5	0.228	0.086	0.057	0.225	0.197	1.613	0.56	0.131	0.063	0.324	1.065	0.287	0.495	1.501	0.323
1	0.284	0.332	0.267	0.953	0.887	6.138	2.058	0.532	0.512	2.006	4.188	1.459	0.536	6.913	0.812
1.5	0.639	1.984	1.465	4.878	4.236	13.019	8.356	2.125	4.057	7.628	8.046	5.335	0.852	14.981	1.895
2	3.234	9.434	6.64	16.102	14.554	15.945	20.347	8.308	16.52	19.855	12.519	16.011	4.131	16.506	4.476
2.5	11.868	21.171	17.079	23.324	21	8.247	14.496	20.958	21.55	15.971	11.453	20.308	12.163	8.298	8.964
3	17.262	12.009	16.387	6.333	5.076	1.76	2.639	16.132	8.828	4.274	2.368	5.07	14.589	1.99	16.321
3.5	13.011	2.297	4.129	0.787	0.74	0.395	0.377	2.578	2.66	0.809	0.582	0.848	12.175	0.471	12.456
4	3.492	0.079	0.144	0.022	0.016	0.027	0.019	0.145	0.215	0.04	0.026	0.046	3.622	0.039	4.367
PAN	0.837	0.051	0.058	0.022	0.019	0.032	0.024	0.051	0.065	0.021	0.048	0.026	0.936	0.041	1.261
net spl wt***	51.373	47.529	46.308	53.017	46.94	51.178	50.013	51.237	54.503	51.326	54.163	49.945	51.695	53.848	51.51

*Summary data reported by Parker and others (1997). All weights in grams.

**Site number plus suffix indicating bottom grab sample.

***Sum of weights of sieve fractions.

APPENDIX 3. SIEVE ANALYSES OF GULF OF MEXICO BOTTOM GRAB SAMPLES*--continued

SCREEN	SR-16-BG	SR-17-BG	SR-18-BG	SR-19-BG	SR-20-BG	SR-21-BG	SR-22-BG	SR-23-BG	SR-24-BG	SR-25-BG	SR-26-BG	SR-27-BG	SR-28-BG	SR-29-BG	SR-30-BG
OPENING	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND
(phi units)															
-2	2.346	0.041	0.06	0.068	0	0.216	0	6.778	0	0	0.026	11.773	0.048	0	0.058
-1.5	0.551	0.037	0.08	0.218	0	0.13	0.043	2.171	0	0.029	0	3.193	0.058	0.006	0
-1	0.349	0.07	0.243	0.165	0.036	0.097	0.101	2.074	0.046	0.002	0.017	2.603	0.087	0.043	0.058
-0.5	0.251	0.114	0.219	0.288	0.018	0.083	0.137	2.245	0.035	0.03	0.033	2.321	0.169	0.077	0.032
0	0.296	0.126	0.323	0.402	0.033	0.135	0.218	3.315	0.104	0.096	0.062	2.163	0.199	0.063	0.046
0.5	0.332	0.133	0.385	0.71	0.091	0.281	0.612	8.568	0.23	0.313	0.144	2.257	0.23	0.134	0.091
1	0.862	0.292	1.075	1.626	0.485	1.111	2.476	13.38	1.221	1.92	0.909	3.764	0.885	0.954	0.419
1.5	2.301	1.271	4.339	3.766	2.428	3.107	7.187	8.284	3.463	5.517	2.949	3.543	4.677	3.535	1.713
2	7.632	7.099	19.044	6.85	11.341	11.972	17.844	4.612	10.772	14.299	9.848	4.432	20.528	12.019	7.538
2.5	16.55	23.095	22.493	12.819	24.613	24.327	17.712	1.638	20.29	23.227	22.393	4.981	18.578	20.778	21.185
3	13.964	14.051	2.971	11.068	10.89	7.728	4.156	0.255	9.512	7.661	12.129	4.569	3.657	8.46	16.003
3.5	6.033	2.495	0.5	6.091	1.995	1.989	0.811	0.122	1.769	1.346	2.299	4.106	0.7	1.58	3.999
4	0.902	0.198	0.024	1.733	0.073	0.17	0.048	0.03	0.083	0.052	0.099	0.482	0.024	0.062	0.189
PAN	0.238	0.066	0.024	0.41	0.025	0.055	0.026	0.064	0.044	0.03	0.043	0.178	0.013	0.025	0.062
net spl wt***	52.607	49.088	51.78	46.214	52.028	51.401	51.371	53.536	47.569	54.522	50.951	50.365	49.853	47.736	51.393

APPENDIX 3. SIEVE ANALYSES OF GULF OF MEXICO BOTTOM GRAB SAMPLES*--continued

SCREEN	**SR-31-BG**	**SR-32-BG**	**SR-33-BG**	**SR-34-BG**	**SR-35-BG**	**SR-36-BG**	**SR-37-BG**	**SR-38-BG**	**SR-39-BG**	**SR-40-BG**	**SR-41-BG**	**SR-42-BG**	**SR-43-BG**	**SR-44-BG**	**SR-45-BG**
OPENING	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**	**SAND**
(phi units)															
-2	0.032	0.038	5.419	0.418	0.147	0	0.036	1.289	0	0.506	0	0.421	0.734	0.14	0.09
-1.5	0.247	0.071	1.353	0.344	0.275	0.043	0.08	0.328	0.02	0.167	0	0.037	0.117	0.072	0.127
-1	0.156	0.222	1.626	0.5	0.302	0.121	0.104	0.354	0.01	0.114	0.003	0.095	0.201	0.105	0.095
-0.5	0.372	0.223	1.203	0.672	0.295	0.078	0.175	0.452	0.049	0.238	0.038	0.082	0.151	0.152	0.099
0	0.509	0.292	0.974	0.681	0.347	0.147	0.25	0.559	0.072	0.286	0.052	0.091	0.308	0.243	0.155
0.5	0.893	0.457	0.922	1.126	0.953	0.162	0.461	1.278	0.089	0.653	0.123	0.186	0.804	0.529	0.387
1	4.779	2.692	1.247	4.331	4.111	0.374	1.651	4.401	0.345	2.739	1.246	1.09	3.073	2.322	2.251
1.5	12.022	9.136	2.112	10.259	9.117	0.892	4.87	8.567	1.419	6.876	7.251	4.485	6.999	5.968	7.429
2	18.431	21.501	4.402	15.29	16.529	4.35	11.052	14.133	6.243	15.911	21.99	11.103	15.808	13.306	20.709
2.5	12.49	13.917	11.02	12.415	16.102	18.169	19.419	14.545	21.683	16.263	16.768	14.939	19.393	19.005	17.931
3	3.507	2.59	12.843	3.991	4.623	21.013	11.248	6.453	17.26	4.859	2.473	11.998	5.741	7.092	2.427
3.5	1.095	0.547	7.965	0.835	1.014	7.559	2.343	2.031	2.7	0.979	0.513	3.667	1.196	1.355	0.815
4	0.059	0.029	0.87	0.034	0.034	0.897	0.12	0.066	0.071	0.019	0.008	0.107	0.028	0.018	0.012
PAN	0.032	0.029	0.227	0.032	0.027	0.256	0.044	0.056	0.045	0.017	0.013	0.038	0.024	0.019	0.024
net spl wt***	54.624	51.744	52.183	50.928	53.876	54.061	51.853	54.512	50.006	49.627	50.478	48.339	54.577	50.326	52.551

APPENDIX 3. SIEVE ANALYSES OF GULF OF MEXICO BOTTOM GRAB SAMPLES*--continued

SCREEN	SR-46-BG	SR-47-BG	SR-48-BG	SR-49-BG	SR-50-BG	SR-51-BG	SR-52-BG	SR-53-BG	SR-54-BG	SR-55-BG	SR-56-BG	SR-57-BG	SR-58-BG	SR-59-BG
OPENING	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND	SAND
(phi units)														
-2	0.414	0.746	0	0	0	0.039	0.862	0.5	1.43	0.592	0.08	1.713	0.264	0.294
-1.5	0.311	0.092	0.023	0.064	0	0.035	0.207	0	0.304	0.268	0.216	1.267	0.159	0.559
-1	0.088	0.056	0.086	0.204	0	0.119	0.167	0.072	0.219	0.175	0.172	1.539	0.166	0.86
-0.5	0.087	0.107	0.123	0.112	0	0.171	0.237	0.149	0.373	0.331	0.259	1.984	0.265	1.077
0	0.164	0.189	0.272	0.159	0.024	0.413	0.243	0.286	0.495	0.556	0.329	2.431	0.376	1.161
0.5	0.224	0.273	0.37	0.207	0.061	0.626	0.368	0.715	0.835	1.368	0.597	2.791	0.8	1.441
1	0.448	0.531	0.828	0.324	0.087	1.251	0.747	1.986	2.116	2.941	1.775	6.456	1.863	5.15
1.5	0.893	1.299	3.153	1.305	0.435	4.595	1.636	4.293	3.424	3.674	3.373	14.144	2.722	16.765
2	2.971	5.018	10.909	6.365	4.734	18.732	4.751	9.805	7.331	6.526	10.854	14.073	6.536	21.648
2.5	8.465	12.138	11.835	17.177	12.905	19.926	6.861	13.097	10.983	14.511	23.482	5.596	13.327	5
3	20.245	12.441	13.694	18.54	17.761	4.365	11.073	9.925	10.647	13.453	8.44	1.322	8.222	0.496
3.5	12.168	9.635	7.974	8.073	9.941	1.29	14.264	4.97	11.025	8.727	2.041	0.409	10.084	0.237
4	3.627	3.017	0.864	1.016	1.705	0.111	5.027	0.612	3.903	1.567	0.198	0.04	4.153	0.052
PAN	1.227	0.923	0.246	0.212	0.349	0.039	1.448	0.15	0.947	0.442	0.069	0.041	1.016	0.049
net spl wt***	51.332	46.465	50.377	53.758	48.002	51.712	47.891	46.56	54.032	55.131	51.885	53.806	49.953	54.789

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA

Sample Identity*	SR-20-100	SR-20-200	SR-20-300	SR-20-400	SR-27-40	SR-28-100	SR-28-200	SR-29-100	SR-29-180	SR-30-60	SR-31-30
Initial Sample Weight (g)	50.71	51.361	54.729	49.12	51.499	52.233	54.598	54.901	52.454	49.365	52.725
Sieve size (µm)	Weights**										
4000	0.020	0.315	0.804		0.831	0.045	0.158	0.046	1.415		4.426
2800	0.064	0.421	0.416		0.490	0.031	0.257		0.497		1.489
2000	0.069	0.349	0.285	0.038	0.342	0.049	0.464	0.042	0.474	0.014	1.286
1400	0.116	0.317	0.348	0.067	0.298	0.072	0.651	0.268	0.535	0.029	1.358
1000	0.169	0.306	0.216	0.055	0.274	0.197	0.906	0.355	0.494	0.115	1.238
710	0.246	0.407	0.420	0.062	0.247	0.361	1.160	0.528	0.543	0.220	2.790
500	0.972	1.475	1.655	0.339	0.439	1.686	3.542	1.630	1.595	1.099	9.957
355	3.298	4.305	5.119	1.891	0.921	6.078	8.801	3.751	3.382	4.137	12.663
250	12.341	13.335	14.979	10.356	3.013	19.297	18.821	10.635	9.725	11.935	10.605
180	23.482	21.319	22.062	24.495	8.061	19.164	15.536	22.059	19.915	20.033	5.109
125	7.979	6.964	6.694	9.616	16.549	4.326	3.538	12.115	10.828	9.197	1.230
90	1.834	1.726	1.621	2.033	13.266	0.860	0.708	3.164	2.788	2.334	0.519
63	0.076	0.092	0.070	0.126	4.924	0.047	0.031	0.225	0.186	0.177	0.025

*Core numbers plus depths in core (cm)

**Weights (g) of sample sieve size fractions

Data were summarized by Parker and others (1993).

Site locations are presented in the ArcView project.

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continuec

Sample Identity*	SR-32-100	SR-32-175	SR-32-195	SR-32-215	SR-32-250	SR-32-350	SR-32-450	SR-34-150	SR-34-250	SR-34-300
Initial Sample Weight (g)	54.101	51.784	50.301	38.273	51.269	49.66	50.068	53.284	52.267	51.462
Sieve size (µm)										
4000	0.182	3.582	1.355	2.122			0.336			0.206
2800	0.189	0.771	0.374	1.728	0.064		0.509	0.031	0.153	0.336
2000	0.235	0.594	0.363	1.176	0.169	0.030	0.314	0.008	0.106	0.921
1400	0.415	0.363	0.367	1.174	0.140	0.013	0.187	0.021	0.214	1.736
1000	0.550	0.462	0.456	1.445	0.150	0.020	0.141	0.084	0.681	2.733
710	0.767	0.659	0.428	1.330	0.144	0.025	0.102	0.174	1.768	3.697
500	3.207	2.499	1.222	0.949	0.338	0.059	0.133	1.031	7.411	5.969
355	8.917	7.085	3.319	0.603	0.853	0.142	0.246	5.680	9.898	7.682
250	20.267	17.095	10.142	1.139	3.390	1.088	1.083	14.043	11.612	9.640
180	15.194	14.351	17.803	3.692	9.349	8.815	8.415	20.187	12.956	11.352
125	3.209	3.317	9.241	6.408	11.745	14.971	17.309	9.980	6.115	5.817
90	0.889	0.918	3.687	9.546	12.386	12.945	11.623	1.932	1.282	1.295
63	0.047	0.052	1.118	5.573	8.973	8.359	7.265	0.078	0.044	0.055

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continuec

Sample Identity*	SR-34-350	SR-39-100	SR-39-180	SR-39-230	SR-39-330	SR-40-100	SR-40-200	SR-40-300	SR-40-395	SR-40-460
Initial Sample Weight (g)	47.081	50.072	52.994	50.347	49.992	51.628	52.821	49.694	48.138	48.342
Sieve size (µm)										
4000	24.304		0.044	0.338	0.104			0.032	0.763	
2800	1.426	0.071	0.350	0.271	0.101			0.122	0.257	0.043
2000	0.907	0.082	0.777	0.118	0.123	0.020	0.012	0.176	0.156	0.060
1400	0.601	0.042	1.009	0.117	0.255	0.014	0.071	0.187	0.142	0.115
1000	0.531	0.079	1.489	0.138	0.245	0.035	0.106	0.202	0.138	0.097
710	0.568	0.103	3.625	0.176	0.283	0.100	0.257	0.567	0.166	0.103
500	1.257	0.515	5.287	1.288	0.335	0.526	0.985	1.529	0.271	0.171
355	2.154	3.320	7.159	5.993	0.422	1.833	2.368	2.831	1.204	0.596
250	4.184	14.628	18.557	23.890	1.077	11.367	12.430	10.862	7.533	2.492
180	6.459	20.128	13.094	16.628	2.542	27.003	26.445	23.513	18.628	4.927
125	3.627	9.073	0.987	0.698	9.250	9.184	8.717	8.351	10.654	9.425
90	0.907	1.910	0.502	0.528	20.330	1.355	1.277	1.137	5.950	15.141
63	0.055	0.088	0.083	0.130	12.398	0.138	0.123	0.132	1.702	11.497

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continued

Sample Identity* Initial Sample Weight (g) Sieve size (µm)	SR-41-100 52.824	SR-41-200 52.819	SR-41-250 47.726	SR-42-75 54.047	SR-43-100 53.045	SR-43-175 51.725	SR-43-250 51.59	SR-44-100 50.893	SR-44-150 51.56	SR-45-100 53.168
4000		0.771	0.109		1.264	0.264	1.386		0.169	0.095
2800	0.071	0.322	0.236	0.059	0.896	0.100	0.090	0.056	0.393	0.117
2000	0.128	0.199	0.227	0.192	0.815	0.149	0.075	0.218	0.470	0.240
1400	0.138	0.240	0.254	0.375	0.475	0.173	0.166	0.344	0.771	0.348
1000	0.239	0.227	0.281	0.376	0.667	0.198	0.200	0.361	1.148	0.360
710	0.497	0.394	0.342	0.939	1.112	0.209	0.169	0.545	2.333	0.726
500	1.991	1.300	0.608	5.134	3.015	0.248	0.188	1.371	4.830	2.460
355	6.928	4.071	1.158	11.173	4.907	0.362	0.479	2.745	4.744	5.639
250	20.651	16.688	3.388	17.158	10.287	1.490	2.143	6.339	5.874	15.455
180	18.470	22.812	8.505	12.150	16.614	12.997	4.501	15.171	10.948	21.273
125	2.965	4.843	19.817	5.014	10.326	26.576	14.517	16.737	13.003	5.518
90	0.681	0.906	11.062	1.395	2.460	7.979	20.980	6.350	6.131	0.879
63	0.045	0.031	1.314	0.053	0.161	0.761	5.835	0.507	0.557	0.035

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continuec

Sample Identity*	**SR-45-200**	**SR-45-300**	**SR-45-400**	**sr-46-100**	**SR-47-100**	**SR-47-300**	**SR-48-130**	**SR-54-250**	**SR-55-100**	**SR-56-55**
Initial Sample Weight (g)	53.211	48.564	48.566	48.045	51.01	46.454	52.46	52.919	50.223	52.738
Sieve size (µm)										
4000	0.921	0.409	0.394	0.377	1.997			3.974		
2800	1.009	0.151	0.245	0.226	0.210			1.014		
2000	1.216	0.325	0.373	0.351	0.155	0.015	0.054	0.976	0.019	0.013
1400	1.108	0.239	0.215	0.256	0.278	0.003	0.107	0.846	0.010	0.074
1000	0.813	0.209	0.297	0.336	0.398	0.021	0.146	1.032	0.157	0.272
710	1.621	0.343	0.241	0.627	0.528	0.059	0.293	1.621	1.004	0.879
500	3.386	0.946	0.586	1.484	0.940	0.644	1.020	3.463	4.390	4.323
355	5.216	2.555	1.531	2.979	1.856	4.835	3.499	4.029	7.377	10.715
250	12.027	8.489	5.507	7.502	5.515	22.900	11.716	7.196	8.208	12.922
180	18.272	20.583	16.097	11.021	10.853	11.406	18.523	9.549	9.380	13.778
125	6.196	12.113	14.658	9.889	11.542	1.700	11.951	7.609	8.007	6.454
90	1.336	2.048	6.557	9.532	12.045	1.060	3.983	8.518	8.133	2.680
63	0.062	0.114	1.494	2.844	3.771	2.454	0.795	2.476	2.898	0.464

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continued

Sample Identity*	SR-56-125	SR-56-170	SR-57-100	SR-58-100	SR-58-250	SR-59-100	SR-59-200	SR-1-60	SR-1-120	SR-2-60
Initial Sample Weight (g)	50.984	54.803	53.345	50.093	51.481	53.241	51.379	47.129	49.292	54.315
Sieve size (µm)										
4000	1.539	0.072		0.472	0.104		0.030	0.364	0.767	0.249
2800	1.504	0.540	0.087	0.311	0.230		0.039	0.620	0.869	0.161
2000	1.076	1.469	0.632	0.229	0.211	0.002	0.106	0.680	1.118	0.229
1400	1.165	2.898	2.007	0.314	0.236	0.025	0.383	0.574	0.750	0.210
1000	1.412	3.543	2.834	0.602	0.338	0.194	0.728	0.726	0.702	0.402
710	2.086	4.372	3.691	1.287	1.219	0.338	1.339	0.548	0.369	0.446
500	5.698	10.390	7.927	3.000	3.739	1.898	4.602	0.529	0.571	1.025
355	7.028	9.773	8.652	3.498	6.424	7.283	10.395	1.036	0.535	3.258
250	8.527	7.831	8.474	7.223	12.803	21.003	19.389	4.224	1.377	11.121
180	11.496	8.194	10.198	13.512	17.168	17.432	11.769	10.243	3.399	21.086
125	5.811	3.623	6.615	7.477	6.198	2.808	1.537	14.884	10.364	12.766
90	2.815	1.661	1.950	8.631	1.808	2.082	0.872	10.267	16.698	3.100
63	0.573	0.290	0.197	2.989	0.765	0.138	0.151	1.959	8.612	0.189

APPENDIX 4. SELECTED PARTICLE-SIZE DATA FROM SAMPLES COLLECTED IN FEDERAL WATERS OFF ALABAMA--continuec

Sample Identity*	**SR-2-120**	**SR-2-160**	**SR-3-15**	**SR-3-60**
Initial Sample Weight (g)	48.404	50.911	49.208	52.636
Sieve size (µm)				
4000	0.280	0.237		
2800	0.298	0.157	0.074	
2000	0.172	0.335	0.145	0.015
1400	0.191	0.531	0.149	0.050
1000	0.282	0.718	0.233	0.089
710	0.314	0.777	0.234	0.141
500	0.623	0.919	0.226	0.408
355	1.824	2.051	0.310	2.552
250	6.492	9.373	2.843	13.498
180	16.437	20.262	19.625	22.081
125	15.815	11.627	20.589	11.270
90	5.204	3.577	4.552	2.394
63	0.383	0.259	0.156	0.093

APPENDIX 5. OFFSHORE CORE INVENTORY: VIBRACORE STORAGE RACK, CORE FACILITY, STATE OIL AND GAS BOARD OF ALABAMA

This appendix shows the locations of offshore vibracores on the rack.
For an index of locations arranged by core number, see appendix 6.

Shelf no.	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
10	SR 1-13	peels	peels	peels	peels	rock cores
9						empty
8	SR 1-15	DI 1-10	G 1-5, 16-24	SR 83, 86-88	MS 31-49	empty
7	SR 15-20	half-cores	MS 1-8, 20-24	SR 88-90	SR 104-105	empty
6	SR 20-29	SR 66, 69-74	M 1-12	SR 91-92, 100	SR 106-108	coal
5	SR 30-39	SR 18-39 (discontinuous)	M 3, 9-24	SR 92-94	SR 108-110	empty
4	SR 40-49	SR 40-57	M 10-20, MS 22-23	SR 94-97	SR 110-112	SR 68
3	SR 49-59	SR 60-66 +	M 10, 27-31	SR 97-99	SR 113-115	SR 67
2	SR 73-83	G 6-15, MP 1-4	M 17-26	SR 100-101	SR 115-117	empty
1	DI 9, M 32, SR 83-84	whole cores	whole cores	SR 102-103	SR 118-119	4 unlabeled half-cores

Floor

DI = Dauphin Island
G = ?
M = Mobile Bay
MP = ?
MS = Mississippi Sound
SR = Sand Resources

Shelves 8-9 constitute one double-deep shelf in Columns 1-5.
A. K. Rindsberg, August 20, 2004

APPENDIX 6. OFFSHORE CORE INVENTORY:
STORAGE LOCATIONS OF VIBRACORES,
CORE FACILITY, STATE OIL AND GAS BOARD OF ALABAMA

This appendix indexes the location of vibracores in the Core Facility by core number.
For a general index of location on the rack, see Appendix 5.
Each half-core section (A through E) is 1 m (3 ft) long (or less, in the case of the basal section).
Section A is the uppermost, B is the next section downcore, and so on.

Station no.	Storage loc. 1	Storage loc. 2	Storage loc. 3	Storage loc. 4	Peel location
	Column-shelf (columns numbered left to right; shelves numbered from floor up)				
Dauphin Island					
DI-1A,B	2-8				
DI-2A	2-8(A,A)				
D1-3	2-8				
DI-5A,B	2-8				
DI-6	2-8				
DI-7	2-8(both halves)				
DI-8	2-8				
DI-9A,B,C	1-1(A,B,B,C)				
DI-10B	2-8(B,B)				
G series					
G-1A	3-8				
G-2A	3-8				
G-3A,B,C	3-8				
G-6	2-2				
G-7	2-2				
G-8	2-2				
G-9	2-2				
G-10	2-2				
G-11	2-2				
G-12	2-2				
G-13	2-2				
G-14	2-2				
G-15	2-2				
G-16A,B,C,D,E	3-8				
G-17A	3-8				
G-18	3-8				
G-19	3-8				
G-20	3-8				
G-21B,C,D	3-8				
G-22A	3-8				
G-24	3-8				
Mobile Bay					
M-1A,B,C	3-6				
M-2A,C	3-6				
M-3A,B,C	3-6(A,B,C)	3-5(B)			
M-4A,B,C,D	3-6				
M-5A,B,C,D	3-6				

Station no.	Storage loc. 1	Storage loc. 2	Storage loc. 3	Storage loc. 4	Peel location
	Column-shelf (columns numbered left to right; shelves numbered from floor up)				
M-6A,B	3-6				
M-7A,C,D	3-6				
M-8A,B,C,D	3-6				
M-9A,B,C	3-6	3-5			
M-10A,B,C,D	3-6(C)	3-5(A,B)	3-4(A,B)	3-3(D)	
M-11A,B,C	3-6(B)	3-5(A,C)	3-4(A)		
M-12A,B,C,D,E	3-6(A,B)	3-5(A)	3-4(C,D,E)		
M-13A,B,C	3-5(A)	3-4(A,B,C)			
M-14A,B,C	3-5	3-4(A,B,C,D)			
M-15A,B,C	3-5(A,B)	3-4(A,B,C)			
M-16A,B	3-5(A)	3-4(A,B)			
M-17A,B,C,D	3-5(A,B)	3-4(A,B,C,D)	3-2(no letter)		
M-18A,B,C,D	3-5(A)	3-4(A,B,C,D)			
M-19A,B	3-5(A,B)	3-4(A)	3-2(B)		
M-20A,C	3-4(A.C)				
M-21A	3-5	3-2(A,B,C,D)			
M-22A,B,C,D	3-2(A,B,C,D)				
M-23A,B,C	3-2(A,B,C,C)				
M-24A,B	3-5(B)	3-2(A,B)			
M-25A,B	3-2				
M-26A,C,D	3-2				
M-27A,B,C	3-5(A)	3-3(A,B,C)			
M-28A,B,C,D,E	3-3(A,A,B,C,D,E)				
M-29A,B	3-3(A,A,B)				
M-30A,B,C,D	3-3				
M-31A,B,C	3-3				
M-32A,B,C	1-1(A,A,B,C,C)				
MP series					
MP-1	2-2				
MP-2A,B	2-2				
MP-3A,B	2-2				
MP-4A	2-2				
Mississippi Sound					
MS-1A,B	3-7				
MS-3A.D	3-7				
MS-4A,B	3-7				
MS-5A,B	3-7				
MS-6B,C	3-7				
MS-7A	3-7				
MS-8A	3-7				
MS-20A	3-7				
MS-21B	3-7				
MS-22A,B	3-4				
MS-23A,B,C	3-4				
MS-24A	3-7				
MS-31A	5-8				
MS-32A,B	5-8				

Station no.	Storage loc. 1	Storage loc. 2	Storage loc. 3	Storage loc. 4	Peel location
	Column-shelf (columns numbered left to right; shelves numbered from floor up)				
MS-33A,B	5-8				
MS-34A,B	5-8				
MS-35A,B	5-8				
MS-36A,B	5-8				
MS-37A	5-8				
MS-38A	5-8				
MS-39A	5-8				
MS-40A	5-8				
MS-41A	5-8				
MS-42A,B	5-8				
MS-43A	5-8				
MS-44A	5-8				
MS-45A	5-8				
MS-46A,B	5-8				
MS-47A,B	5-8				
MS-48A	5-8				
MS-49A	5-8				
SLP series					
SLP-13					5-10
Sand Resources					
SR-1A,B	1-10	1-8			
SR-2A	1-10	1-8			
SR-3A,B	1-10	1-8			
SR-4A,B	1-10	1-8			
SR-5A,B,C,D	1-10(A,B,C,D)	1-8 (A,B,C)	2-4(A,C) [error for 50?]		
SR-7A,B	1-8				3-10(B)
SR-8A,B,C,D	1-8 (A,A,B,B,D,D)				
SR-8B,C,D	1-10				
SR-9	1-10	1-8			
SR-10A,B,C,D	1-10 (A,C only)	1-8			
SR-11A,B,C	1-10 (B,C only)	1-8			
SR-12A,B,C,D	1-10 (A,C only)	1-8			
SR-13A,B,C,D	1-10 (A only)	1-8 (A,B,B,C,D)			
SR-14A,B	1-8(A,A,B,B)				
SR-15A,B	1-7				
SR-16A,B	1-7(A,A,B,B)				
SR-17A,B	1-7(A,A,B,B)				
SR-18A,B,C	1-7(A,A,B,C)	2-5(B)			
SR-19A,B	1-7(A,B)	2-5(A,B)			
SR-20A,B,C,D	1-7(B)	1-6(A,D)	2-5(A,B,C)		
SR-21	1-6	2-7			
SR-22A,B	1-6(A,B)	2-5(A)			5-10(B)
SR-23A,B	1-6(A,A,B)				
SR-24A,B	1-6(A,A,B)				5-10(B)
SR-25A,B,C	1-6				
SR-26A,B,C	1-6				
SR-27	2-5				

Station no.	Storage loc. 1	Storage loc. 2	Storage loc. 3	Storage loc. 4	Peel location
	Column-shelf (columns numbered left to right; shelves numbered from floor up)				
SR-28A,B	1-6				
SR-29A,B,D	1-6				
SR-30	1-5				
SR-31	1-5				
SR-32C,D	1-5	2-5(B)			
SR-33	2-5				4-10
SR-34A,B	1-5(B)				5-10(A)
SR-35A,B,C	1-5				2-10(C)
SR-36A,B	1-5(A,B)	2-5(A)			3-10(B)
SR-37A,B,C	1-5(A,C)	2-5(A,B,B,C)			
SR-38A,B,C,D	1-5(A,A,B,C,D)	2-5(B,C)			
SR-39A,B,C	1-5(A,B,C)	2-5(A,B,C)			
SR-40A,B,C,D	1-4(A,B,C)	2-7(D)	2-4(A,B,C,D)		
SR-41A,B	2-4(A,B,B)				5-10(A)
SR-42	1-4(both halves)				
SR-43A,B	1-4(A,B)	2-4(A)			4-10(B)
SR-44A,B	1-4(A)	2-4(A)			5-10(B)
SR-45A,B,C,D	1-4(A,B,C,C,D)	2-4(A,B)			4-10(D)
SR-46B,C	1-4(B,B)	2-7(C)	2-4(A,C)		
SR-47A,B,D	1-4(A,B)	2-7(A)	2-4(D)		4-10(B,D)
SR-48	1-4	2-4			
SR-49A,B,C,D	1-4(A,D)	1-3(B,C)	2-4(B)		2-10(A), 3-10(B), 5-10(D)
SR-50A	1-3(A)				5-10(no letter)
SR-51	1-3				
SR-52A,B,C	1-3(B,C)	2-4(A)			
SR-53A,B	1-3(A,B)				5-10(B)
SR-54A,B,C	1-3(A,B)	2-4(A,B,C)			5-10(C)
SR-55A,B,C	1-3(A,B)	2-4(C)			2-10(A), 5-10(B)
SR-56A,B	1-3(A,B)				5-10(B)
SR-57A	2-4(no letter)				4-10(A)
SR-58A,B	1-3(A,B)				4-10(B)
SR-59A,B	1-3(A,B)				4-10(A)
SR-60A,C	2-3				
SR-61A,B,C,D	2-3				
SR-62B,C,D	2-3				
SR-64A,B	2-3				
SR-66B,C	2-6©	2-3(B)			
SR-67A,B,C	6-3				
SR-68A,B	6-4				
SR-69A,B,C,D	2-6				
SR-70A,B,C,D	2-6				
SR-71A,B,C,D	2-6				
SR-72A,B,C,D	2-6				
SR-73A,B	1-2(A)	2-6(A,B)			
SR-74A,B,C,D	2-6				
SR-75B,C,D	1-2				
SR-76A,B,C	1-2				
SR-77A,B,C,D	1-2				
SR-78A,B,C,D	1-2				

Station no.	Storage loc. 1	Storage loc. 2	Storage loc. 3	Storage loc. 4	Peel location
	Column-shelf (columns numbered left to right; shelves numbered from floor up)				
SR-79A,B	1-2				
SR-80A,B	1-2				
SR-81A,B,C	1-2				
SR-82A,B,C	1-2				
SR-83A,B,E	1-2(A,B)	1-1(E)	4-8(A)		
SR-84A,B,C	1-1				
SR-86A,B	4-8				
SR-87A,B	4-8				
SR-88A,B,C	4-8(A)	4-7(B,C)			
SR-89A,B,C	4-7				
SR-90A	4-7				
SR-91A,B,C	4-6				
SR-92A,B,C	4-6(A,B)	4-5(C)			
SR-93A,B,C	4-5				
SR-94A,B,C	4-5(A,B)	4-4(C)			
SR-95A,B	4-4				
SR-96A	4-4				
SR-97A,B,C	4-4(A,B)	4-3(C)			
SR-98A,B,C	4-3				
SR-99A,B	4-3				
SR-100A,B,C	4-6(B)	4-2(A,B,C)			
SR-101A,B,C	4-2				
SR-102A,B,C	4-1				
SR-103A,B,C	4-1				
SR-104A,B,C	5-7				
SR-105A,B,C	5-7				
SR-106A	5-6				
SR-107A,B,C	5-6				
SR-108A,B,C	5-6(A)	5-5(B,C)			
SR-109A,B,C	5-5				
SR-110A,B	5-5(A)	5-4(B)			
SR-111A,B	5-4				
SR-112A,B,C	5-4				
SR-113A,B	5-3				
SR-114A,B,C	5-3				
SR-115A,B,C	5-3(A)	5-2(B,C)			
SR-116A,B	5-2				
SR-117A,B	5-2				
SR-118A,B,C	5-1				
SR-119A,B,C	5-1				

APPENDIX 7. TAXONOMY OF SHELLS ON ALABAMA BEACHES

Higher group	**Family**	**Species**	**Author, date**	**Abbott (1974) no.**
Bivalvia	Nuculanidae	*Nuculana* sp.		
Bivalvia	Arcidae	*Anadara baughmani*	Hertlein, 1951	4976
Bivalvia	Arcidae	*Anadara brasiliana*	(Lamarck, 1819)	4983
Bivalvia	Arcidae	*Anadara floridana*	(Conrad, 1869)	4979
Bivalvia	Arcidae	*Anadara notabilis*	(Röding, 1798)	4975
Bivalvia	Arcidae	*Anadara ovalis*	(Bruguière, 1789)	4982
Bivalvia	Arcidae	*Anadara transversa*	(Say, 1822)	4977
Bivalvia	Arcidae	*Noetia ponderosa*	(Say, 1822)	4995
Bivalvia	Pinnidae	*Atrina serrata*	(Sowerby, 1825)	5115
Bivalvia	Plicatulidae	*Plicatula gibbosa*	Lamarck, 1801	5216
Bivalvia	Pectinidae	*Argopecten gibbus*	(Linnaeus, 1758)	5198
Bivalvia	Anomiidae	*Anomia simplex*	Orbigny, 1842	5232
Bivalvia	Ostreidae	*Crassostrea virginica*	(Gmelin, 1791)	5274
Bivalvia	Ostreidae	*Ostreola equestris*	(Say, 1834)	5265
Bivalvia	Carditidae	*Carditamera floridana*	Conrad, 1838	5478
Bivalvia	Carditidae	*Venericardia tridentata*	(Say, 1826)	5489
Bivalvia	Ungulinidae	*Diplodonta punctata*	(Say, 1822)	5365
Bivalvia	Lucinidae	*Divaricella quadrisulcata*	(Orbigny, 1842)	5331
Bivalvia	Lucinidae	*Lucina pensylvanica*	(Linnaeus, 1758)	5282
Bivalvia	Lucinidae	*Phacoides nassula*	(Conrad, 1846)	5306
Bivalvia	Lucinidae	*Pseudomiltha floridana*	(Conrad, 1833)	5329
Bivalvia	Cardiidae	*Dinocardium robustum*	(Lightfoot, 1786)	5580
Bivalvia	Cardiidae	*Laevicardium laevigatum*	(Linnaeus, 1758)	5572
Bivalvia	Cardiidae	*Trachycardium muricatum*	(Linnaeus, 1758)	5549
Bivalvia	Veneridae	*Agriopoma texasianum*	(Dall, 1892)	5953
Bivalvia	Veneridae	*Anomalocardia auberiana*	(Orbigny, 1842)	5887
Bivalvia	Veneridae	*Chione cancellata*	(Linnaeus, 1767)	5865
Bivalvia	Veneridae	*Chione grus*	(Holmes, 1858)	5883
Bivalvia	Veneridae	*Chione intapurpurea*	(Conrad, 1849)	5867
Bivalvia	Veneridae	*Chione* sp. indet., juvenile		
Bivalvia	Veneridae	*Dosinia discus*	(Reeve, 1850)	5960
Bivalvia	Veneridae	*Gemma gemma*	(Totten, 1834)	5967
Bivalvia	Veneridae	*Macrocallista nimbosa*	(Lightfoot, 1786)	5949
Bivalvia	Veneridae	*Mercenaria campechiensis*	(Gmelin, 1791)	5864
Bivalvia	Veneridae	*Pitar fulminatus*	(Menke, 1828)	5930
Bivalvia	Tellinidae	*Tellina alternata*	Say, 1822	5661
Bivalvia	Semelidae	*Semele* sp.		
Bivalvia	Donacidae	*Donax texasianus*	Philippi, 1847	5756
Bivalvia	Donacidae	*Donax variabilis*	Say, 1822	5753
Bivalvia	Sanguinolariidae	*Tagelus plebeius*	(Lightfoot, 1786)	5812
Bivalvia	Mactridae	*Mactra fragilis*	Gmelin, 1791	5587
Bivalvia	Mactridae	*Mulinia lateralis*	(Say, 1822)	5602
Bivalvia	Mactridae	*Raeta plicatella*	(Lamarck, 1818)	5612

Higher group	**Family**	**Species**	**Author, date**	**Abbott (1974) no.**
Bivalvia	Mactridae	*Rangia cuneata*	(Sowerby, 1831)	5605
Bivalvia	Mactridae	*Spisula similis*	(Say, 1822)	5592
Bivalvia	Corbulidae	corbulids indet.		
Bivalvia	Pholadidae	*Cyrtopleura costata*	(Linnaeus, 1758)	6034
Bivalvia	Pandoridae	*Pandora* sp.		
Bivalvia	Bivalvia indet.	Bivalvia indet.		
Bivalvia	Bivalvia indet.	bivalve borings in shells		
Gastropoda	Melonginidae	*Busycon* fragments		
Gastropoda	Crepidulidae	*Crepidula fornicata*	(Linnaeus, 1758)	1557
Gastropoda	Crepidulidae	*Crepidula plana*	Say, 1822	1570
Gastropoda	Naticidae	Naticidae fragments		
Gastropoda	Olividae	*Oliva sayana*	Ravenel, 1834	2537
Gastropoda	Cassidae	*Phalium granulatum*	(Born, 1778)	1737
Gastropoda	Naticidae	*Polinices duplicatus*	(Say, 1822)	1677
Gastropoda	Muricidae	*Thais haemastoma floridana*	(Conrad, 1837)	1893
Gastropoda		pteropods		
Gastropoda		drillholes		
Gastropoda		Gastropoda indet.		
Porifera	Clionaidae	clionaid borings in shells		
Bryozoa				
Polychaeta		sand-lined tubes		
Polychaeta		shell-lined tubes		
Polychaeta	Spionidae	*Polydora* borings in shells		
Polychaeta	Serpulidae	Serpulidae indet.		
Crustacea		crabs		
Crustacea	Balanidae	balanids		
Echinoidea		*Mellita quinquiesperforata*	(Leske, 1778)	

APPENDIX 8. GEOGRAPHIC DISTRIBUTION OF SHELL TAXA ON ALABAMA BEACHES*

Station E to W▶	**1**	**2**	**3**	**4**	**10**	**12**	**11**	**5**	**8**	**17**	**6**	**13**	**7**	**14**	**15**	**18**	**19**	**16**
Taxon ▼																		
Nucula																		p
Nuculana		p						p				p			p		p	c to a
Anadara baughmani								p	?p	?p								
Anadara brasiliana		p	p					p	p			p			c		p	p
Anadara ovalis		p	p			p	p	p	p		p	p	p		c	c	c to a	p to c
Anadara transversa	?p	?p		?p	?p	?p	?c	?p	?p to a	?p	?p	?p	?p		?p	?p	?p	?p
Barbatia candida			p					c										
Noetia ponderosa	p	p	p	p	p	p		c to a	p to a	p	p	p to a	p		p	p	p to c	p
Atrina serrata	p	p		p							p				p			
Plicatula gibbosa		p		p				p	p									
Argopecten gibbus		p	?p	p	p	?p	p	c	p to a	p	p		p				p	
Anomia simplex		p	p	p	p	p	p	p to c	p to c	p	p	p	p		p	p	p	p
Crassostrea virginica		p	p					p	p	p	p to c	?p		p	p to c	p	?p to c	p
Ostreola equestris	p		p	p	p	p to c	p	p	p	?p	p	p	p		p			
Carditamera floridana	p		p	p			p	p	p to c	p	p	p	p					p
Venericardia tridentata		p	p	p	p	p	p	p	c	p		p to c			p			p
Diplodonta punctata	p		p			p	p to c			?p	p to c	p to c			?p		?p	
Divaricella quadrisulcata		p	a	p	p	p to c	p to c	p	p to a	p to c		p to c	p		p	p	p	p
Lucina pectinata											c							
Lucina radians										?p								
Pseudomiltha floridana					p to c		p	c	p to c		p							?p
Dinocardium robustum	p	p	p	p	p	p to c	p	p to a	p to c	p	p to a	p to c	p		p	p	p to c	p
Laevicardium laevigatum									p	p		p			p			p
Laevicardium mortoni									?p									
Trachycardium egmontianum											p							
Trachycardium muricatum								p	p									p
Pteria colymbus		p				p												
Agriopoma texasianum										p					p to c	p	p	p
Anomalocardia auberiana									p	p								
Chione cancellata	p	p	p	p	p		p	a	p to a	p to c	c to a	p	p					p
Chione grus	p	p	p		p to c	p	p	p	p	p		p						p
Chione intapurpurea	p	p	p	p	p	p	p	p to c	p to c	p	p to c	p to c	p					p
Chione sp. indet., juvenile	p				c	p	p	p	p									
Dosinia discus			p					p	p	p					p			p
Dosinia elegans											p	p						

APPENDIX 8. GEOGRAPHIC DISTRIBUTION OF SHELL TAXA ON ALABAMA BEACHES*

Station E to W►	**1**	**2**	**3**	**4**	**10**	**12**	**11**	**5**	**8**	**17**	**6**	**13**	**7**	**14**	**15**	**18**	**19**	**16**
Taxon ▼																		
Gemma gemma	p	p	p		?p	p to c	?p		?p	p to c		p						
Macrocallista nimbosa		p	p		p		p	p to c	p to c	p to c	p	p						
Mercenaria campechiensis		p									p					p		p
Mercenaria sp.			p		p			p to c	p	p	p							
Mytilidae									p			p						
Ischadium recurvum														p				
Petricola pholadiformis												p						
Tellina		p							p				p	p	p	p	p	p
Tellina versicolor																		p
Abra aequalis					p		?p											
Semele bellastriata							p											
Solenidae							p											
Donax texasianus	p	c	c	p	p to c	p to c	p to c	p	p to c	p to c		p to c			p	p	p	p
Donax variabilis	p	c	c	p	p to c	p to a	c	p	p to c	p to c	p to a	p to c	p		p to c	p	p to c	p
Tagelus plebeius										?p					?p			p
Anatina anatina	p										p	p						
Mactra fragilis					?p	?p	?p	?p	?p	?p to c		?p			?p to c	?p		?p to c
Mulinia lateralis			c	p	p	p	p	p	p	p		p to c			p to c	c	a	c
Raeta plicatella	p	p				p			p	p	?p				p		p	p
Rangia cuneata					c	p		p	p	p	p	p			p	p		p
Spisula similis		?p	p	p	p		p	p	p	p	p	p	p		p	c		p
Corbulidae						p	p	c	p	p		p			p			p
Cyrtopleura costata										?p	p	p			?p		p	p
Pholas campechiensis										?p	p				p			
Pandora			p						p	p								
unidentified bivalves	p	p	p	p	p	p	p	p	p	p	c	p			p		p	p
Thyasira trisinuata										?p								
bivalve borings in shells								p	p		p				p			p
Busycon		p	p			p			p	p	p					p		
Busycon canaliculatum		p													p			p
Cassis									p									
Cerithium atratum								p										
Crepidula sp.				p		p	p	p	p	p			p					p
Diodora								p										

APPENDIX 8. GEOGRAPHIC DISTRIBUTION OF SHELL TAXA ON ALABAMA BEACHES*

Station E to W▶	**1**	**2**	**3**	**4**	**10**	**12**	**11**	**5**	**8**	**17**	**6**	**13**	**7**	**14**	**15**	**18**	**19**	**16**
Taxon ▼																		
Epitonium humphreysi						?p		p							?p			
Ficus communis															p			
Naticidae			p			p		p	p			p					p	p
Oliva sayana			p					p to c	p	p					p			
Phalium granulatum	p		p	p				p	p to c		p				p			
Polinices duplicatus		p	?p	?p				p	p				?p		p to c	p		
Sinum perspectivum								p							p			p
Strombus alatus		p		?p				p	p									
Terebra dislocata								c										
pteropods						p				p								
unidentified gastropods		p	p	p	p		p	c	p	p	p	p	p		p	p		p
drillholes		p		p	p	p	p	p	p		p	p	p		p			p
Scaphopoda								c										
clionaid borings in shells	p	p			p	p	p	p	p		p	p	p	p	p			p
corals	p		p					p	p to c				p		p			
Bryozoa	p						p	p	p to c		p	?p		p				p
sand-lined tubes															p			
shell-lined tubes								p		p		p			p			
polydorid borings in shells	p		p	p	p		p	p	p to c		p	p to c						p
Serpulidae	p			p		p		p	p to c		p		p			p		p
crabs									p	p		p			p			
balanids	p			p	p		p	p	p to c	p				p	p	p	p	p
Mellita quinquiesperforata	p		p	p	p	p	p	p	p to c	p	p	p	p		p	p	p	
fish vertebrae																	p	
landsnail														p				
limestone gravel									p	p	p	p			p			p
quartz gravel											p				p			
quartz sandstone gravel									p									
claystone gravel											p							
cement pebble		p								p					p			
asphalt gravel										p								

p = present
c = common (5 or more in one sample)
a = abundant

APPENDIX 9. COUNTS OF *DONAX* SPP. ON ALABAMA BEACHES

Each number refers to a count of *Donax* spp. in one 0.3 m² quadrat of beach sand.
Three or more counts were made at each site from December 2002 onward.

Station no.	Location name	Mar 2002	Dec 2002	Mar 2003	Jul 2003	Nov 2003	Jul 2004
1	Alabama-Florida state line	0	4, 15, 51		3, 4, 6	0, 0, 0	0, 0, 0
2	Florida Point East	0	5, 7, 36				
3	Florida Point West	0	20, 33, 46		0, 1, 7	0, 0, 0	0, 0, 2
4	Cotton Bayou	0, 0, 3	0, 2, 3		0, 0, 0	0, 0, 1	0, 0, 1
10	Romar Beach		0, 0, 1		0, 3, 3	0, 1, 2	0, 0, 0
12	Gulf State Park Pavilion		0, 0, 1		0, 0, 4	0, 0, 0	0, 15, 25
11	Gulf State Park Convention Center		0, 1, 1, 2		2, 3, 7	0, 0, 1	0, 0, 0, 0, 1
5	Gulf Shores Public Beach	0	0, 0, 0		0, 2, 3	0, 0, 0, 0, 0	0, 3, 4
8	Little Lagoon Pass		0, 0, 0	5, 5, 6	0, 3, 20	3, 4, 7	0, 0, 2
17	Alabama Highway 182 mile 2				1, 3, 7	2, 3, 3	3, 7, 9
6	Pine Beach	present	0, 0, 0, 0		0, 0, 0	0, 0, 0, 0	0, 0, 0, 0
13	Cortez Street		2, 3, 8		0, 0, 0	3, 5, 7	0, 0, 0
7	Fort Morgan East		0, 1, 2, 3	0, 0, 0, 0	0, 0, 1	0, 1, 1	0, 0, 0
14	Dauphin Island Sea Lab		0, 0, 0	0, 0, 0	0, 0, 0, 0, 0	0, 3, 4	5, 7, 13
14	Dauphin Island Sea Lab		0, 0, 0	0, 0, 0	0, 0, 0, 0, 0	0, 3, 4	5, 7, 13
15	Dauphin Island Public Beach		0, 0, 0	0, 0, 0, 0, 0	0, 0, 0	0, 0, 0	0, 0, 0, 0
15	Dauphin Island Public Beach		0, 0, 0	0, 0, 0, 0, 0	0, 0, 0	0, 0, 0	0, 0, 0, 0
19	Old pass, Dauphin Island						0, 2, 3, 20
16	West End		0, 1, 2	0, 0, 0, 0, 0	0, 0, 0, 0	0, 0, 0	0, 0, 0

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