DETERIORATION AND RESTORATION OF THE GRANDE BATTURE ISLANDS, MISSISSIPPI

Klaus J. Meyer-Arendt
Department of Geology and Geography
Mississippi State University

and

Karen A. Kramer
James M. Montgomery, Consulting Engineers, Inc.
Walnut Creek, CA 94598

ABSTRACT
The remnant shoals of the Grande Batture Islands comprise the seaward margins of a late Pleistocene/Holocene delta lobe of the Pascagoula- Escatawpa fluvial system. Sediment discharge into Mississippi Sound via the Bayou Cumbest distributary initiated phases of aggradation and progradation. As fluvial inputs decreased, wave action and longshore drift processes reworked the deltaic headland and produced the Grande Batture Islands. Historically, these islands sheltered the extensive nutrient-rich intertidal marshes as well as productive oyster beds in Pt. aux Chenes Bay and Grand Bay. An 1853 survey delineated about 450 acres of barrier island complex extending over 5 miles in length, yet by the 1950s it had been reduced to shoals. Shoreline erosion rates have averaged 15 ft/yr since 1853, and the remaining headland is presently retreating at even higher rates.

Proposed nourishment of the Grande Batture shoals with 6,000,000 cubic yards of dredged material would not only restore the former barrier chain, but would also slow rates of bayshore erosion and marsh deterioration. Optimal salinity regimes for oyster production might also be re-established. Preliminary indications are that the costs of island restoration and periodic renourishment would be offset by the benefits derived.

INTRODUCTION
Barrier islands and marshes have been receiving much attention in recent years, both for their value as recreational resources and also as integral components of estuarine ecosystems (Mitsch and Gosselink, 1986). Tidal marshes constitute nursery grounds for shrimp and finfish, and estuarine bays are valued for oyster production (Gosselink, 1984). Barrier island/tidal inlet complexes often shelter tidal marshes by acting as buffers against severe storms and high waves (van Beek and Meyer-Arendt, 1982). When these barriers disappear, marshes become exposed to increased marine forces (including wave erosion, enhanced tidal exchange, and saltwater intrusion), and the commercial and recreational resource base erodes away. These trends most likely will accelerate in the future if predictions of increasing sea level
rise rates become realized (National Research Council, 1987; Titus, 1988). In view of present trends and future scenarios, a dilemma arises: should a natural course of environmental degradation continue, or should humans intervene in natural processes to preserve a sustainable resource base? If preservation of habitat is the goal, then perhaps the latter is the optimal course to pursue if it can be done economically. One means by which environmental enhancement in one area can be relatively easily attained is by offsetting (i.e., mitigating) human-induced negative environmental impacts in another area (Kusler et al., 1988). These are the kinds of questions currently being raised in Jackson County, Mississippi, where:

a) 4000 acres of the historically deteriorating Bayou Cum best deltaic headland (also known as the Grande Batture headland) have been acquired under the Coastal Mississippi Wetlands Initiative and are slated to be incorporated into the 12,000 acre Grand Bay National Wildlife Refuge, and b) enlargement of the Pascagoula River ship channel and the Bayou Casotte Industrial Harbor will require the dredging and disposal of six million cubic yards of sediment. It is the purpose of this paper to: a) document the geologic evolution and environmental deterioration of the Grande Batture headland, and b) to evaluate the mechanics as well as the costs and benefits of island restoration via creative disposal of dredge spoil.

GEOLOGIC HISTORY

The remnant shoals of the Grande Batture Islands (Figure 1) and the retreating wetlands of the Grande Batture headland comprise the remaining seaward margins of a late Pleistocene/Holocene delta, which has been linked to the Pascagoula River by Gazzier (1977) and to the Escatawpa River by Otvos (1985). Sediment discharge of the Pascagoula/ Escatawpa fluvial system into Mississippi Sound via the Bayou Cumbest distributary initiated phases of aggradation and progradation (Kramer, 1990). A reduction in fluvial sedimentation coupled with an enhancement of coastal processes led to a sequence of geomorphic events similar to those seen in abandoned Mississippi River delta lobes in southeastern Louisiana. These events are described in a 3-stage model proposed by Penland and Boyd (1981), which may be applied to the Grande Batture area as follows:

1. As fluvial inputs diminished, shoreface processes transformed the delta into an erosional headland, and delta-front sands were reworked and redistributed by shore-parallel transport in the form of flanking barrier spits (Figure 2). This is seen on 1853 coastal survey charts which show the Grande Batture Islands as a continuous sand body attached to an erosional headland (USCGS, 1853).

2. The flanking barrier spits were fragmented into islands during storm events as seen on the 1920 coastal survey charts and 1940 aerial photographs (USCGS, 1933; Tobin Research Inc., 1940). Local transgression attributed to a combination of subsidence, sea level rise, storms, and lack of sediment influx caused the continued disintegration of the headland and the islands.

3. The final stage of the model is seen on modern 1985 color infrared aerial photographs in which the Grande Batture Islands have completely disappeared (USDA-ASCS, 1985). Bathymetric surveys revealed that the islands have been reduced to shoals (Kramer, 1990). The historic role of these islands in sheltering the extensive nutrient-rich deltaic marshes and productive oyster beds of Pt. aux Chenes Bay and Grand Bay has now also disappeared.

RECENT ACCELERATION OF EROSION RATES

The earliest accurate maps -- the 1853 United States Coast and Geodetic Survey maps -- delineated about 450 acres of the Grande Batture barrier island complex extending over 5 miles in length. By 1940, the area had been reduced to 120 acres, and by the 1950s the flanking islands had turned to shoals. From 1853 to 1988, the Grande Batture headland (a.k.a. South Rigolets Island) has witnessed shore retreat of over 2000 ft, or an average of 15 ft/yr. Comparison of 1988 aerial photos with 1977 imagery revealed retreat rates averaging 18 ft/yr, and exceeding 34 ft/yr in some reaches (Meyer-Arendt and Kramer, 1990).

Shoreline retreat appears to have been more severe in the 1977-1988 period than in the 1940-1977 period. Erosion rates along the western shore of Pt. aux Chenes Bay increased from 4-5 ft/yr to 7-8 ft/yr, and similar increases were observed along the northern shore of the bay. Even the Pt. aux Chenes headland, immediately to the east of the area known as the Tenneco marshes, saw retreat rates increase from under 10 ft/yr to over 13 ft/yr from the 1940-1977 to the 1977-1988 period (Meyer-Arendt and Gazzier, 1990).

The entire area is presently not only losing at least 7 acres of marsh annually, but Pt. aux Chenes Bay has witnessed such
changes in tidal and salinity regimes that oyster production is no longer possible (USFWS, 1989). Further resource loss is anticipated as present trends continue.

DREDGED MATERIAL AS A NATURAL RESOURCE

In conjunction with expansion of the Ingalls shipyard, establishment of the Navy homeport in Pascagoula, and general port improvements, plans call for widening and deepening the Pascagoula River ship channel (which includes the Bayou Casotte industrial channel). The ship channel is to be deepened from 38 to 42 ft and widened from 225 to 300 ft. As mitigation for the various construction and industrial expansion projects which will negatively impact wetlands, archeological sites, and bay bottoms, it has been proposed by the U.S. Army Corps of Engineers to utilize dredged material for environmental enhancement. Instead of disposing of dredged spoil in deep water south of Mississippi Sound (as has historically been done), the Corps has proposed considering several alternatives for wetlands restoration and wetlands creation. These include: 1) several options for on-land disposal in the Tenneco marshes, 2) renourishment of Round Island, which is in danger of succumbing to shoreline erosion, and 3) reconstruction of the Grande Batture Islands (USFWS, 1989).

The idea of utilizing dredged material for natural resource creation has been around for decades. In 1973, the Dredged Material Research Program (DMRP) was initiated for exactly such purposes at the U.S. Army Engineer Waterways Experiment Station in Vicksburg (Walsh, 1977). Although direct barrier island beach nourishment has not been a specific focus of DMRP studies, considerable work has been done in evaluating the feasibility of spoil island creation and the enhancement of spoil habitats in marsh environments (Walsh, 1977; Saucier et al., 1978). Numerous DMRP publications outline the detailed steps in such procedures.

Although barrier island nourishment with dredged material was conducted on Mississippi’s Ship Island in 1975 to keep Fort Massachusetts from crumbling into the sea, perhaps a better prototype for the Grande Batture area is Eastern Isle Derniere in Terrebonne Parish, Louisiana. The Isles Dernieres island chain is a typical deltaic headland barrier arc which has undergone considerable deterioration as a result of being in advanced stages of the Penland/Boyd model (Meyer-Arendt and Templet, 1983). Terrebonne Parish, recognizing the severity of the problem after several years of studies (Templet and Meyer-Arendt, 1982), embarked upon nourishing a critical section of Eastern Isle Derniere in 1984 (Jones and Edmonson, 1987). The $1 million project was quite successful, and the island suffered minimal erosion during the severe hurricane season of 1985 (Penland et al., 1986). Similar nourishment/breach closure projects have been proposed for other critically eroding segments of the Louisiana coast.

COSTS AND BENEFITS OF ISLAND RESTORATION

It has been proposed that to mitigate wetland losses associated with channel dredging (and perhaps with on-land

Figure 2. Deterioration of the Grande Batture headland, 1853-1985 (maps compiled from USCGS, 1853; USCGS, 1933; Tobin Research Inc., 1940; and USDA-ASCS, 1985).
disposal of the spoil) the Grande Batture shoals be nourished with 6,000,000 cubic yards of dredged material. This would not only restore the former barrier chain, but would also slow rates of bayshore erosion and marsh deterioration because of decreased wave and tidal action. Although valuable waterbottoms will be lost in the island restoration process, resource gains will more than offset resource losses. The U. S. Fish and Wildlife Service, which endorses this proposal as the No. 1 mitigation option, estimates that land loss will be reduced by 5 acres per year. In terms of resource and recreation value, the Fish and Wildlife Service estimates an annual net benefit of $30,000 per acre, or $150,000 total. Perhaps even more importantly, preliminary studies show that optimal salinity regimes for oyster production would be re-established in Pt. aux Chenes Bay. Even if production in the bay only reaches 75% of that in nearby Bangs Lake, a resultant harvest of 375 sacks/acre at $25/sack over 4200 acres of bay yields $39 million/year (USFWS, 1989).

The pumping of the dredge spoil and technology of proper restoration will not come cheaply. The slurrying of spoil via pipeline over a distance of 5 to 8 miles will require barge-mounted or land-based booster stations spaced about every mile. Problems with bad weather and mechanical breakdown make realistic transport costs exceed $4/cubic yard. Once pumped into place, retention levees will need to be built for controlled dewatering of the slurried sediment. The use of hay bales for retention on the sound side, originally proposed by the Corps of Engineers, may not be sufficiently sturdy (USFWS, 1989). However, the construction of more solid retention walls will minimize turbidity and sediment infilling of the bay.

For a similar situation along Shell Island in Louisiana’s Plaquemines Parish, where an 8000-ft long breach had developed, a restoration project called for construction of a 600-ft wide, 12,000-ft long sand barrier requiring about 1.3 million cubic yards of sediment fill. Because tidal exchange processes had become well established following the breaching of the island, potential problems with hydraulic forces were anticipated during the reconstruction effort and it was proposed that retention wall construction be conducted on a...
REFERENCES CITED


National Research Council (NRC), 1987, Responding to changes in sea level: Washington, D.C., National Academy Press.


Tobin Research Inc., 1940, 11-7-40, Grand Bay Southwest Quadrangle: black and white aerial photograph, GSQ roll 1, frame 92, scale 1:24,000.

United States Coast and Geodetic Survey (USCGS), 1853, Coastal Survey of Mississippi Sound, scale 1:20,000.

United States Coast and Geodetic Survey (USCGS), 1933, United States Coast and Geodetic Survey (USCGS), 1933 (surveys to 1920), Mississippi Sound and Approaches, Dauphin Island to Cat Island: chart #1267, scale 1:40,000.

