LOUISIANA'S MAJOR COASTAL NAVIGATION CHANNELS

by

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
OFFICE OF COASTAL RESTORATION AND MANAGEMENT

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Louisiana's Major Coastal Navigation Channels

Gulf of Mexico

- GULF INTRACOASTAL WATERWAY
- MISS. RIVER
- MISS. RIVER OUTLET
- BATARA BAY WATERWAY
- HORUMA NAVIGATION CANAL
- BATOU
- LAFOURCHE
- FRESHWATER BATOU
- WESTFALLA RIVER
- CAULCEAUL MERMENTAU RIVER
- GULF INLET NAVIGATION WAY

Major Cities:
- New Orleans
- Morgan City
- Houma
- Lafayette
- Lake Charles
- Baton Rouge

Coastal Zone Boundary

Distance Marks:
- 0
- 10
- 20
- 30
- 40 Miles
- 0
- 20
- 25
- 50 Kilometers

Map Legend:
- N
- 89°
- 91°
- 93°
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<td>Impacts</td>
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<td>Calcasieou River Ship Channel</td>
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<tr>
<td>General Description</td>
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<tr>
<td>Project History</td>
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<tr>
<td>Benefits</td>
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<td>Impacts</td>
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<tr>
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EXECUTIVE SUMMARY

Louisiana's coastal wetlands are the "fish basket" of the gulf coast, and provide numerous other benefits of national importance. These same wetlands are currently disappearing at an alarming rate of 35 square miles per year (figure 1). While initiatives exist at the federal, state, local, and private level to address various aspects of this land loss problem, one of the major contributing factors remains virtually ignored: the huge primary and secondary wetland losses attributable to federal navigation channels. Primary losses, resulting from construction (figure 2), are estimated at somewhere between 58,000 acres and 96,000 acres. Losses due to bank erosion are estimated at 35,000 acres (table 1), and total secondary losses have been estimated at 274,000 acres.

Louisiana's coastal navigation channels were congressionally authorized subsequent to a determination that such projects would produce benefits to the nation in excess of project costs. However, the state's residents and businesses continue to suffer from the many economic and quality-of-life impacts resulting from this loss of wetland habitat. These adverse impacts should be addressed quickly in order to protect the overall economic viability of Louisiana's coast.

It is currently estimated that it would cost approximately $140 million (table 2) to address the most critical erosion problems along Louisiana federal navigation channels, and federal funds are needed to address these problems. Because these channels were constructed in the national interest, and because the on-going operation of these channels causes tremendous adverse impacts to Louisiana's coastal wetlands, it is the position of the state that the responsibility for rectifying and addressing those impacts clearly lies not with coastal wetlands conservation and restoration programs, but with the federal agencies and private industries whose activities have caused the impacts.

A number of projects have been constructed which demonstrate that this problem can be addressed. A lot has been learned that, if implemented, would benefit not only the wetlands, but the federal government and the navigation industry as well: as bank erosion decreases, maintenance costs also decrease and navigability increases.
This document is intended as an overview of Louisiana's major navigation channels (figure 3), the associated wetland loss problems, and recommended strategies for addressing these problems. Information from completed projects is provided which sheds light on some of these alternatives, but more importantly, demonstrates that these problems can be addressed with available technology.
Figure 1. 1978-90 loss rates for coastal hydrologic basins (sq. mi/yr) and total coastal Louisiana. (Barras et al. 1994)
Primary Losses

A. During channel construction, conversion from vegetated marsh to open water represents direct wetland loss equal to the area of the canal. The disposal of dredged soil material also results in direct loss by killing existing vegetation and converting functional wetlands into upland areas.

Secondary Losses

B. Increased wave energy and water drawdown created by ships using the waterway, saltwater intrusion, and other hydrologic modifications result in further conversion of vegetated wetlands to open water through bank erosion and the breakup of interior marsh.

C. As exposed marsh edges continue to erode, bank erosion can result in a blowout where direct connections between a channel and inland water body are formed.

D. After a blowout, increased wave and wind energies and saltwater intrusion destroy fragile interior marsh which was previously unexposed to these effects.

Figure 2. Primary & Secondary Wetland Loss Progression Associated with Navigational Channels.
<table>
<thead>
<tr>
<th>NAVIGATION CHANNEL</th>
<th>ORIGINAL BANK WIDTH (FT)</th>
<th>CURRENT BANK WIDTH (FT)</th>
<th>PRIMARY EXCAVATION LOSS (ACRES)</th>
<th>TOTAL PRIMARY LOSS (ACRES)</th>
<th>BANK EROSION LOSS TO DATE (ACRES)</th>
<th>BANK EROSION LOSS % OF EXCAVATION</th>
<th>BANK EROSION LOSS % OF TOTAL PRIMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISSISSIPPI RIVER GULF OUTLET</td>
<td>644</td>
<td>1,672</td>
<td>6,160</td>
<td>18,540</td>
<td>11,784</td>
<td>191%</td>
<td>64%</td>
</tr>
<tr>
<td>GIWW EAST OF MISSISSIPPI RIVER</td>
<td>198</td>
<td>607</td>
<td>873</td>
<td>2,619</td>
<td>1,803</td>
<td>207%</td>
<td>69%</td>
</tr>
<tr>
<td>GIWW BETWEEN ATACHAF. &amp; MISS</td>
<td>173</td>
<td>659</td>
<td>2,002</td>
<td>6,006</td>
<td>5,624</td>
<td>261%</td>
<td>94%</td>
</tr>
<tr>
<td>GIWW WEST OF THE ATCHAFALAYA</td>
<td>173</td>
<td>600</td>
<td>3,575</td>
<td>10,725</td>
<td>6,943</td>
<td>194%</td>
<td>95%</td>
</tr>
<tr>
<td>BARATARIA BAY WATERWAY</td>
<td>173</td>
<td>693</td>
<td>582</td>
<td>1,745</td>
<td>1,748</td>
<td>301%</td>
<td>100%</td>
</tr>
<tr>
<td>HOUMA NAVIGATION CANAL</td>
<td>210</td>
<td>658</td>
<td>613</td>
<td>1,838</td>
<td>1,307</td>
<td>213%</td>
<td>71%</td>
</tr>
<tr>
<td>MERMENTAUX R. NAVIGATION CHANNEL</td>
<td>200</td>
<td>796</td>
<td>258</td>
<td>773</td>
<td>768</td>
<td>298%</td>
<td>99%</td>
</tr>
<tr>
<td>FRESHWATER BAYOU</td>
<td>173</td>
<td>583</td>
<td>474</td>
<td>1,423</td>
<td>1,124</td>
<td>237%</td>
<td>79%</td>
</tr>
<tr>
<td>CALCASIEU RIVER SHIP CHANNEL</td>
<td>600</td>
<td>1,672</td>
<td>2,591</td>
<td>7,774</td>
<td>3,766</td>
<td>145%</td>
<td>48%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>17,148</strong></td>
<td><strong>51,443</strong></td>
<td><strong>34,886</strong></td>
<td><strong>203%</strong></td>
<td><strong>68%</strong></td>
</tr>
</tbody>
</table>

Table 1. Navigation Channel Construction and Subsequent Bank Erosion Losses in Louisiana. Original bank widths are based on bank slopes specified in LDNR, 1994. Original primary loss includes canal excavation and spoil bank area (where available) from Tuner and Cahoon (1987) and LDNR (1994). Current bank width is based on average widths from 1990 aerial photography (LDNR 1995). Bank erosion losses were based on difference between current and original width.
Table 2

Bank Stabilization Projects Recommended by CWPPRA Restoration Plan

<table>
<thead>
<tr>
<th>WATERWAY</th>
<th>Critical Miles Needing Protection</th>
<th>Preliminary Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mississippi River Gulf Outlet</td>
<td>37</td>
<td>$55 Million</td>
</tr>
<tr>
<td>Gulf Intracoastal Waterway</td>
<td>44</td>
<td>$53 Million</td>
</tr>
<tr>
<td>Barataria Bay Waterway</td>
<td>N/A</td>
<td>$3 Million</td>
</tr>
<tr>
<td>Houma Navigational Canal</td>
<td>2</td>
<td>$2 Million</td>
</tr>
<tr>
<td>Mermentau River Navigation Channel</td>
<td>6</td>
<td>$1 Million</td>
</tr>
<tr>
<td>Freshwater Bayou</td>
<td>38</td>
<td>$18 Million</td>
</tr>
<tr>
<td>Calcascieu River Ship Channel</td>
<td>9</td>
<td>$8 Million</td>
</tr>
<tr>
<td>Atchafalaya, Mississippi River, Bayou LaFourche</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>136</td>
<td>$140 Million</td>
</tr>
</tbody>
</table>

* Whereas it is acknowledged that the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) Restoration Plan recommends these projects, it is the State's position that funding for these projects should not be born by our Wetlands Restoration and Conservation Program. More appropriate funding is currently being sought (State of Louisiana).
INTRODUCTION

The Value of Coastal Louisiana

The Mississippi River built coastal Louisiana by depositing enormous quantities of sediment into overlapping delta lobes, creating a region of coastal wetlands which currently cover approximately 3.3 million acres of the state. These wetlands are one of the biologically richest in the world and are considered an ecological, social, and economic treasure of the nation.

Louisiana’s coastal wetlands provide valuable functions in terms of wildlife protection and sustenance, including:

- Contributing 28% of the total volume of U.S. fisheries (USDOI 1994; Keithly and Liebzeit 1987); $1 billion annual dockside value (LCWCRTF 1993);
- Providing habitat for five million wintering waterfowl (LCWCRTF 1993); and
- Providing habitat for six federally listed threatened and endangered species, including the brown pelican and the bald eagle (USDOI, 1994)

Louisiana coastal wetlands also house and protect a nationally-significant commercial and industrial complex from coastal storms and hurricanes, including:

- Deep-draft ports, including New Orleans, handling 25% of the nation’s export commodities by tonnage (LCWCRTF, 1993);
- Production of 21% of the nation’s annual output of natural gas (valued at $7.4 billion) from fields in the coastal zone and adjacent offshore areas (LCWCRTF 1993); and
- Production of $30 billion annually of petroleum products for the domestic market from coastal zone refineries (LCWCRTF 1993).

The Problem of Coastal Louisiana: Wetland Loss

The natural processes that created coastal Louisiana have been compromised by human development and resource consumption. The construction of flood protection levees along the Mississippi River began in the eighteenth century. During the nineteenth century, navigation improvements were begun along the Mississippi River and other waterways. In the twentieth century, oil and gas exploration and production, land reclamation, and the construction of commercial and industrial facilities further impacted our coastal region.
Additionally, the Old River Control Structure has frozen the natural delta building and switching cycle that historically allowed coastal Louisiana to maintain itself during the past 6,000 years. This has shifted the balanced of natural wetland growth and loss processes to the point where wetland loss far exceeds wetland growth. Exacerbating this interruption has been land-use changes resulting from urbanization along with the development of commercial and industrial infrastructures, construction of navigation channels, mineral exploration, and production facilities, which have further altered coastal hydrology.

The net effect has been the loss of over one million acres of coastal wetlands in the last 60 years (LCWCRTF 1993).

While Louisiana contains about 40% of the coastal wetlands in the contiguous United States (Turner 1990), the current wetland loss in Louisiana accounts for almost 80% of the coastal wetland loss in the entire United States (LCWCRTF 1993; USDOI 1994).

Current estimates of the loss rate range between 25 and 35 square miles (16,000 to 22,000 acres) per year, or about an acre every 25 minutes (LCWCRTF 1993; Barras et al. 1994, figure 1).

At the current rate of loss, half of Louisiana's existing historical coastal wetlands, equivalent to 20% of coastal wetlands of the contiguous United States, will be lost over the next 100 years (USDOI 1994).

The Role of Coastal Navigation Channels

Coastal Louisiana is dissected by a network of ten major federal navigation channels, which range in depth from 12 feet to 45 feet, and are between 125 and 1,000 feet wide. The majority of these channels were constructed by the federal government through the New Orleans District United States Army Corps of Engineers, beginning in the mid-1800's with the primary purpose of providing national economic benefits. The federal involvement in coastal waterborne commerce has resulted in a 2,800 mile matrix of shallow and deep-draft channels. Approximately 800 miles of federal channels traverse the Louisiana Coastal Zone, with the major channels representing approximately 550 miles of navigation channels constructed in areas of coastal wetlands.

Three deep-draft and 7 shallow-draft channels comprising approximately 1,000 miles traverse coastal Louisiana.

The federal government has spent over $280 million to construct the major federal navigation channels in coastal Louisiana. Additionally $40 million are required annually for maintenance dredging of this system.
Approximately 685 million tons of cargo move along Louisiana coastal channels annually.

Coastal navigation channels have played a major role in wetland loss. The losses resulting from channels are categorized as either primary losses (i.e., those resulting directly from construction) or secondary losses (i.e., those long term losses induced by presence of the channels). Primary losses include the impacts resulting from the excavation of the channel and the placement of the resulting dredged material, while secondary wetland losses are caused by 1) hydrologic modifications resulting from the channel (e.g., saltwater intrusion and disruption of natural sheet flow, and 2) erosion of the channel bank resulting from vessel-generated wave wash (figure 2).

Erosion of the banks of navigation channels results primarily from the wakes and wave washes of vessels using the channels. Passing vessels create "boat wakes" which break along channel banks, eroding fragile wetland soils and adversely impacting the vegetative communities. Vessels may also displace significant quantities of water from the channel, pushing the water into adjacent wetland areas which causes severe and rapid changes in water levels and scour soil and vegetation from the wetlands. As erosion progresses beyond original channel banks or adjacent spoil banks and into interior, more fragile wetland areas, losses accelerate dramatically (figure 2). In coastal Louisiana, the wetland losses which have resulted from erosion of the banks exceeds the losses caused by the original excavation of the channels.

Navigation channels are responsible (directly and indirectly) for between 20% (Johnson and Gosselink, 1982) and 50% (Boesch et al., 1983) of the total wetland loss in coastal Louisiana.

Estimates of primary loss of coastal wetlands due to the construction of federal navigation channels in coastal Louisiana range from 58,000 acres (LDNR 1995) to 96,000 acres (USDOI 1994).

Total secondary wetland losses (bankline erosion plus other secondary losses), which have resulted from major federal navigation channels in coastal Louisiana, have been estimated at 274,000 acres since the late 1800's (USDOI 1994).

Based on information contained in a report prepared by the U.S. Department of the Interior (USDOI 1994), wetland losses resulting from bankline erosion could range from 17,000 to 100,000 acres coast-wide. DNR has estimated that bankline erosion in the Coastal Zone has resulted in the loss of 35,000 acres of coastal wetlands.

**Solutions to the Wetland Losses Associated with Bankline Erosion**

Wetlands losses which are induced by erosion of channel banks is one of the major
wetlands loss causes which can be easily remedied. Solutions which are technically feasible are available, and in contrast to many other wetland restoration techniques which often have significant effects on user groups and associated resources, implementation of such solutions would have minimal adverse social, environmental, or cultural impacts.

The Louisiana Coastal Wetlands Conservation and Restoration Task Force (LCWCRTF) has estimated that addressing the most pressing bankline erosion problems in coastal Louisiana would cost approximately $140 million.

Adequate engineering and project construction experience and information exists to develop solutions which are technically sound and are tailored to site-specific conditions.

The Restoration Plan includes many projects with only preliminary cost estimates for the most costly and permanent solutions. Arriving at the most cost effective and efficient type of project to achieve the goal of stopping bankline erosion may involve further study in some situations.

Emphasis on quality solutions to the problems presented is crucial to minimizing the long term cost. Fragile soils and structural soundness combine to challenge the best of technology which translates into front-loaded cost in most every project. Less than quality solutions with acceptable levels of risk will result only in very expensive maintenance and/or rebuilding costs over time. This consideration is of great concern to the state due to its frequent responsibility for long term project operation and maintenance.

Several types of experimental projects have been constructed and monitored for different types of bankline erosion, with technical information developed to determine the effective limits of each type. These various types, including rock dikes, wave damping fences, brush pens, and vegetative plantings, are discussed and illustrated in the Techniques Applicable to Navigation Channel Erosion beginning on page 38.
Pros and cons of the various protective measures are depicted below:

<table>
<thead>
<tr>
<th>Type of Protection</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Dikes</td>
<td>Relative Permanency, Low Maintenance, Useful in High Energy Applications, Limited by Soil Conditions</td>
<td>Navigational Hazard, High Cost, Not Environmentally Friendly</td>
</tr>
<tr>
<td>Wave Damping Fences</td>
<td>Natural Appearance, Medium Cost, Medium Maintenance Costs</td>
<td>Medium to Low Energy Applications Only</td>
</tr>
<tr>
<td>Vegetative Plantings</td>
<td>Natural Appearance, Low Cost</td>
<td>Low Energy Applications Only, Medium Maintenance Costs</td>
</tr>
<tr>
<td>Gabion Rock Filled Mats</td>
<td>Semi-permanent, Low Maintenance, Useful in High Energy Applications, Good in Poor Soil Conditions</td>
<td>Navigational Hazard, High Cost</td>
</tr>
<tr>
<td>Sand-filled and Armored Geotextile Tubes</td>
<td>Semi-permanent, Medium Maintenance, Good Range of Energy Applications, Low-Medium Cost</td>
<td>Requires Local Filling Sands to be Cost Effective</td>
</tr>
<tr>
<td>Flexible Concrete Mats Over Geofabric</td>
<td>Good In Most All Energy Conditions</td>
<td>High Cost</td>
</tr>
</tbody>
</table>
NAVIGATION CHANNELS: HISTORY, BENEFITS, IMPACTS, AND SOLUTIONS

Overview of Coastal Navigation Channels

New Orleans is located at the gateway to the entire Mississippi River Valley, and is currently the nation's largest deep-draft port complex. Port facilities located between the mouth of the river and Baton Rouge handle over 230 million tons of cargo annually, valued in excess of $30 billion. The cargoes managed by these port facilities exceed the total volume of commodities handled by all West Coast port facilities combined, and comprise approximately 25% of the nation's total exported commodities (LCWCRTF 1993).

Louisiana has ten major federal navigation channels (figure 3) that provide access to the port facilities. These channels are either one of two basic project types. The first project type consist of channels constructed and operated for the primary purpose of providing navigation benefits; such projects include the Mississippi River, the deep-draft Mississippi River Gulf Outlet and Calcasieu River Ship Channel and the shallow-draft Houma Navigation Canal and Barataria Bay Waterway. The other project type consists of navigation channels that are part of larger, more comprehensive water resource development projects, which provide other benefits in addition to the navigation features. They are the Gulf Intracoastal Waterway, the Mermentau River Navigation Channel, the Freshwater Bayou Channel, the Atchafalaya River, and the LaFourche Bayou.

The Mississippi River navigation project is part of the comprehensive Mississippi River and Tributaries (MR&T) project, which provides navigation, flood control, water supply, and recreational benefits. The U.S. Army Corps of Engineers (USACE) has been involved in the construction, operation and maintenance of MR&T since 1928 when Congress directed the USACE to develop a comprehensive flood protection program for the Mississippi River alluvial valley. Today, the resulting project includes over 10,000 miles of navigable waterways stretching from Cairo, Illinois, to the Gulf of Mexico (the Gulf), 4,000 miles of levees to control and manage the flood waters that drain from 41% of the contiguous United States, supplementary flood outlets and spillways, and water control structures. Expenditures for construction of the MR&T project were estimated at $4 billion dollars in 1985, with estimated average annual maintenance of $46 million. In response to this investment, the MR&T project has produced benefits to the nation of over $85 billion (USACE 1989). As a whole, these channels form a network providing critical transfer links in international and national trade as well as vital transportation routes to the oil and gas industry.

Each channel and navigation improvement was authorized by Congress after a determination that such projects produce benefits not only to the states and regions they are located in, but more importantly, to the nation as a whole. However, while those channels have produced tremendous economic and social benefits for the southeast region and the entire nation, Louisiana's federal navigation channels have also resulted in enormous adverse impacts to the state's coastal wetlands. Today, coastal Louisiana is dissected by over 1,000 miles of navigation
channels constructed and/or maintained by the federal government.

Overview of Adverse Impacts Associated with Navigation Channels

Navigation channels and associated spoil banks retard the flow of riverine fresh water, nutrients, and suspended sediment into coastal marshes, and therefore pose significant primary (direct) and secondary (indirect) threats to both wetland areas and overall habitat quality. Primary impacts include original marsh area converted to open water at the time of channel construction (or enlargement), and spoil bank areas where disposal of the material generated from excavation results in undesirable habitat shifts. Secondary impacts include subsequent bank erosion, increased tidal energy, damage because of saltwater intrusion, blowouts, disruption of sheetflow, and other hydrologic alterations. The proportion of total wetland loss attributed to the combination of primary and secondary impacts of channelization and canalization ranges from 20% (Johnson and Gosselink 1982) to 50% (Boesch et al., 1983) with regional impacts as high as 90% of total wetland loss (Turner and Cahoon, 1987). These primary and secondary losses are described in more detail below.

Clearly, the direct conversion from vegetated marsh to open water during canal construction (canal area) represents a direct loss of wetlands. In addition, when dredged spoil material resulting from this construction is disposed of on areas of vegetated marsh, other primary losses result. Spoil disposal kills existing vegetation and results in upland areas which are unable to perform basic wetland habitat, water quality, and hydrologic functions. With regard to primary losses, the United States Department of Interior (USDOI) estimated that 17,000 acres of wetlands were converted to open water because of the construction of the 550 miles of major navigation channels. In addition, 77,000 acres of wetlands were converted to uplands because of the disposal of the dredged material associated with this construction, resulting in a total primary loss of 96,000 acres (USDOI 1994). Other studies suggest ratios of 1:2 for open water versus spoil bank loss resulting in a total primary loss of between 50,000 and 60,000 acres (LDNR 1995; Turner and Cahoon, 1987). This primary loss represents 6% of total wetland losses in coastal Louisiana (Turner and Cahoon 1987).

While primary navigation impacts contribute to a significant portion of Louisiana's total wetland loss, secondary impacts have proven even more destructive. Secondary losses associated with navigation channels result from erosion of channel banklines and hydrologic modifications. Erosion of the channel banks is caused by wave-wash and water drawdown created by ships and boats using the waterway, and results in further conversion of vegetated wetlands to open water. The USDOI estimates that the doubling rate for navigation channel widths averages between 5 and 35 years (USDOI 1994). Based on this doubling rate, known construction dates, and initial areas of Louisiana's navigation canals, secondary bank erosion losses are currently estimated to fall between 17,000 and 100,000 acres since the late 1800's. An analysis conducted by the LDNR in 1995 estimates bank erosion losses at more than 57,000 acres, almost 250% of losses associated with original excavation of the ten major navigation channels in Louisiana's coastal zone (table 1). In every case, losses attributed to bank erosion exceeded primary losses due to
canal construction (figure 4), resulting in at least a doubling of the initial channel area.

Secondary losses associated with hydrologic modifications are generally more complex and can involve increased marine influences on less saline wetland complexes, disruption of sheet flow and other surface hydrologic patterns (figure 2). Marine influences including salt water, sulfates, and tides all contribute to fresh and intermediate marsh loss. Salt water contributes to severe alteration of the plant community and tidal energy and wave action disperses soil materials. As salt-intolerant species become stressed and die, they lose their root-binding effect on the organic soil layers. These dispersed organic soil particles are transported from the marsh area via tidal outflow. Higher sulfate concentrations present in sea water inhibit nutrient uptake by marsh vegetation and result in plant stress (Mendelshohn, et al. 1982). The result of prolonged erosion of these soils is generally the conversion of marsh to open water areas from a few inches to 40 inches deep (LCWCRTF 1993).

In areas where saltwater intrusion destroyed fresh and low-salinity vegetation, large areas of shallow open water now exist. Wind-induced wave action continues to erode exposed marsh edges. Additionally, strong winds often create flow patterns conducive to exporting eroded soils, and discharging interior fresh water and/or introducing salt water. Unless this erosive cycle is interrupted, this erosion process will continue.

Other secondary adverse impacts related to bank erosion include blowouts (figure 2). Blowouts result when shoreline erosion reaches the point where direct connections between a channel and an inland water body form. This connection can result in erosion due to increased wave and wind effects and saltwater intrusion on fragile marsh which was previously unexposed to these effects.

It is important to note that the only secondary wetland loss quantified in this report is that based on bank erosion, and thus does not include other secondary impacts due to salt water intrusion, blowouts, sheetflow disruption, and other hydrologic alterations. However, as exemplified with blowouts, a direct relationship between bank erosion and other secondary losses exists. In fact, Turner and Rao (1990) suggest that canals and their spoil banks are related to wetland-to-water conversions at least up to 2 km away from the canals and that marsh fragmentation in wetland interiors generally exceeds losses associated with bank erosion.

The discussion following summarizes the history, benefits, and adverse impacts associated with Louisiana's major navigation channels.
Figure 4. Excavation & Bank Erosion Losses Due to Navigation Channels (LDNR 1995).
Channel Analysis

Mississippi River

General Description

The portion of the Mississippi River, Baton Rouge to the Gulf of Mexico, and Mississippi River Ship Channel projects that generally lie in and affect the Louisiana Coastal Zone is that reach extending from New Orleans to the Gulf of Mexico (figure 5). Current dimensions of the navigation channel between New Orleans and the Gulf are 45 feet deep and between 600 and 1,000 feet wide (navigation channel bottom width).

Project History

Federal investment in navigation along the lower Mississippi River began in 1866 when Congress authorized improvements to the mouth of the river to ensure adequate navigability. Construction of the jetties at South Pass was undertaken during the 1870's, and resulted in a stable, 30-foot deep channel in South Pass by the end of the decade.

Navigation improvements to the Mississippi River have continued regularly during the last century. The combination of dredging, channel revetment, channel training, and the construction and maintenance of jetties have allowed the river to be the principle artery for waterborne commerce in the United States.

Annual maintenance dredging of the river south of New Orleans generally requires the removal and disposal of approximately 30 million cubic yards of material at a yearly cost of over 10 million dollars (LCWCRTF 1993; USACE 1995).

Benefits

The lower Mississippi River is the deep-draft navigation route for the ports of New Orleans, Baton Rouge, South Louisiana, and Plaquemines. The Port of South Louisiana, which incorporates the reach between New Orleans and Baton Rouge, ranks highest in the nation in terms of tonnage shipped through its facilities (LCWCRTF 1993). Cumulative economic effects of these ports exceeds over ten billion dollars annually (LCWCRTF 1993).

The Port of New Orleans is located approximately 120 miles upstream from the Gulf of Mexico and is the largest port in the United States. The Port of Baton Rouge, located 135 miles upstream of New Orleans, is the fifth largest port in the nation. Between 1978 and 1987, the average annual traffic on the Mississippi River between the Gulf and Baton Rouge was 552,882,000 tons, composed largely of grain, crude petroleum, and coal (USACE 1985).
Impacts

While sea level rise and land subsidence caused by sediment compression and de-watering were historically compensated by influxes of sediment from the Mississippi River and organic production from vegetation in the past, the suspended load of the lower Mississippi River has decreased 80% since 1850, resulting in a net loss of coastal wetlands (Kesel 1989). In particular, since the record flood of 1927, the stabilization of the Mississippi River's channel has eliminated seasonal freshwater and sediment-laden overbank flow that once nourished adjacent wetland areas in the Pontchartrain, Breton Sound, and Barataria basins of Southeastern Louisiana (Kesel 1989; Turner and Rao 1990; LCWCRTF 1993).

In recent years, sediment deposition has occurred only at the mouth of the Mississippi River's Plaquemines-Balize delta, in the area defined as the Mississippi River Delta Basin. This delta is located on the edge of the continental shelf of the Gulf of Mexico and is the deep-draft navigation route for the ports, including New Orleans, Baton Rouge, South Louisiana, and Plaquemines.

In the Mississippi River Delta Basin, the construction and maintenance of the deep-draft navigation project in the delta area has resulted in the channelization of the Mississippi River and Southwest Pass. These activities have diverted more of the sediment into deep water areas and, subsequently, resulted in greater land loss.

Mississippi River Gulf Outlet

General Description

The Mississippi River Gulf Outlet (MRGO) was constructed to provide a shorter deep-draft navigation route from the Gulf to New Orleans (figure 6). This channel extends southeast approximately 76 miles from the intersection of the Gulf Intracoastal Waterway and the Inner Harbor Navigation Canal in the vicinity of New Orleans, through the Chandeleur Island chain, to the Gulf of Mexico. Current channel dimensions are 36 feet deep and a 500-foot bottom width. Jetties in Breton Sound reduce maintenance dredging requirements of the channel through the bay area.

Project History

Construction of the MRGO was authorized in 1956 as a modification to the Mississippi River Baton Rouge to the Gulf of Mexico project to provide a shortened and more reliable route from the Gulf of Mexico to New Orleans. Construction was initiated in 1958, and the channel was opened to traffic in 1968.
Figure 6. Mississippi River Gulf Outlet.
Total project cost for construction, operation and maintenance through 1987 was $509 million federal money with a non-federal contribution of $273 million (USACE 1989).

Approximately 18 million cubic yards of material is dredged each year to maintain navigability along the MRGO, at an average annual cost of $9.4 million. (USACE 1995).

Benefits

Average annual tonnage shipped on the MRGO between 1979 and 1986 averaged approximately six and one-half million tons per year. In 1990, 7.1 million tons or 29% of the total Port of New Orleans tonnage, were shipped on the MRGO (USACE 1989). Dry bulk, crude materials, chemicals, and general container cargo comprise the majority of the deep-draft tonnage transported on the MRGO, while oil and gas service, supply and drilling vessels, and commercial and recreational fisheries are the major shallow-draft cargoes.

Impacts

The MRGO has not only contributed to increased salinities, but ship-induced waves erode its north bank at a rate of 15 feet per year (USACE 1994). Much of the bank erosion in the MRGO is caused by wave-wash and drawdown from large vessels. When vessels pass through the waterway, large volumes of water are rapidly displaced from the channel into the adjacent marsh and back to the channel again. The resultant forces from these water level fluctuations cause the fragile marsh adjacent to the channel to break apart and fall into the waterway. The bank width of the MRGO increased from approximately 650 feet in 1968 to an average of almost 1,900 ft in 1990 (LDNR 1995; USACE 1994).

Construction of the MRGO resulted in the direct destruction of between 18,540 acres (Turner and Cahoon, 1987) and 24,000 acres (Rounsfell 1964) of marsh. Of the higher estimate, 6,659 acres (2,695 ha) of loss was for the channel area and 17,344 acres (7,019 ha) was by spoil deposition.

Secondary losses associated with this bank erosion (table 1) are estimated at almost 12,000 acres since construction (LDNR 1995). This secondary loss is almost twice the primary excavation loss area.

Recommended Solution to the MRGO Land Loss Challenge

A series of nine different strategies and eleven methods and combinations thereof have been proposed to address the rapidly accelerating land loss along the entire channel. The recommend long term solution is simply to close it.

This is obviously easier said than accomplished, since the socioeconomic impacts are highly significant. However, over time, a phase-out approach would be achievable with deliberate
planning and public cooperation. This approach involves closure structures and relocation cost approaching one billion dollars. The over-riding consideration for closure preference, regardless of cost, is to stop the deep penetration of saltwater into the interior of the hydrologic basin.

Stabilization of the 37 miles of shoreline in the interim, taking into account the poor soil conditions along the waterway, would cost in excess of fifty-five million dollars.

**Gulf Intracoastal Waterway**

**General Description**

The portion of the Gulf Intracoastal Waterway (GIWW) that traverses coastal Louisiana is the "mainstem reach," which extends 302 miles from the Mississippi-Louisiana border to the Louisiana-Texas border, providing inland, shallow-draft route (12 feet deep and 125 to 150 feet bottom width) from New Orleans, through Houma and Morgan City, to Lake Charles (figure 7). Six locks located along the GIWW provide for navigation passage and the control of saltwater intrusion into interior wetlands.

**Project History**

Construction of the GIWW was authorized by the Rivers and Harbors Act of 1925. Authority to deepen the GIWW to 16 feet was granted by Congress in 1962; however, no deepening has occurred to date, and that portion of the federal project is consequently being deauthorized.

The federal government spends approximately $13 million/year for operation and maintenance of the Louisiana portion of the GIWW, with $3 million expended on maintenance dredging, and the remaining $10 million used for lock operation and maintenance (USACE 1995).

**Benefits**

Average annual tonnage on the GIWW was approximately 94 million tons during the period from 1981 to 1986. During 1988, tonnages transported in Louisiana GIWW locks ranged from 25 million to 47 million per lock (USACE 1989).

**Impacts**

The GIWW has played a significant role in negatively altering historical freshwater and sediment distribution along the entire length of Louisiana's coastal marshes. For example, while during periods of high Atchafalaya River stages, the GIWW can carry a substantial eastward flow of fresh river water; during low river stages or drought, the GIWW provides direct lateral access for salt water into interior marshes, which had previously little or no exposure to higher saline water.
Given that the GIWW traverse nearly all of Louisiana's coastal basins, problems associated with the GIWW are somewhat basin-specific. For example, abnormally high water levels are held within the Mermentau basin by the Schooner Bayou, Leland Bowman, Freshwater Bayou, Catfish Point, and Calcasieu locks. As a result, many wetlands are drowning because of excessive water levels, and edge erosion is exacerbated. Feasibility studies are needed immediately to determine if more active operation of the lock system could alleviate this problem. Of particular interest is the Calcasieu lock on the GIWW, which could possibly be utilized to move freshwater from the Mermentau basin, where it is overabundant, to the Calcasieu/Sabine basin, where it is needed.

In the Calcasieu River basin, physical erosion of marshes around the perimeters of Willow Lake and Sweet Lake will eventually result in one large open-water body between the GIWW and the coastal prairie to the north. This large water body could exacerbate shoreline erosion of Cameron-Creole marshes south of the GIWW and compromise the effectiveness of the Cameron-Creole Watershed Project (LCWCRTF 1993).

Vessel traffic on the GIWW can be a major source of erosion of the typically fresh and intermediate marshes through which the GIWW passes. Shoreline erosion and subsequent "blow outs" are commonly observed along the banks of the GIWW. Although it only had an authorized bank width of between 150 and 200 feet (LCWCRTF 1993), erosion has resulted in a current bank width ranging from 500–600 feet, and up to 775 feet wide in some areas (LDNR 1995).

**Recommended Solution to the GIWW Land Loss Challenge**

More than 44 miles of shoreline are in critical need of protection in order to prevent destruction of adjacent marshlands.

The minimum cost of this effort is likely to exceed fifty-three million dollars.

**Barataria Bay Waterway**

**General Description**

The Barataria Bay Waterway (BBWW) is a shallow draft channel (12 feet deep, bottom width 125 feet) which extends 37 miles south from the GIWW in the vicinity of Crown Point, along the western shore of Barataria Bay, to the Gulf of Mexico adjacent to Grand Isle (figure 8).

**Project History**

Federal involvement in the BBWW began in the early 1920s with the excavation of the original five-foot deep channel. In 1958, Congress authorized the enlargement of the channel to its current dimensions (12 feet by 125 feet). Construction of the enlarged channel was complete by 1963.
Maintenance dredging of the channel occurs approximately every five years, and produces about 3 million cubic yards of dredged material at an average cost of $1 million per dredging event (USACE 1995).

Benefits

Average annual traffic moved through BBWW was approximately 1.6 million tons during the 1977 to 1986 period (USACE 1989). The majority of traffic is composed of oil, gas, and sulphur supply, crew and service vessels, and recreational and commercial fisheries vessels.

Impacts

The original direct loss associated with excavation of the BBWW was 224 acres, including open water; however, the project modification which increased the channel dimensions to 12 feet deep by 125 feet wide increased direct channel loss to more than 560 acres, and also exacerbated secondary losses in the Barataria Basin because of intrusion of marine processes (table 1). Turner and Cahoon (1987) estimate primary wetland loss including channel loss and spoil banks for the Barataria Waterway at 1,745 acres. At 1,748 acres (table 1), secondary losses are estimated at approximately three times the primary excavation loss (LDNR 1995).

Recommended Solution to the Barataria Waterway Land Loss Challenge

A long-term strategy to beneficially use dredged material along the lower 16 miles of the Barataria Waterway has been adopted and is in the beginning stages of implementation. In addition, shoreline protection appropriations to limit the continuous expansion of the authorized channel widths must be pursued.

The cost of protecting the most serious erosion problems along the waterway will exceed three million dollars.
Houma Navigation Canal

General Description

The Houma Navigation Canal (HNC) is a 15-foot deep, 150-foot wide (bottom width) channel which dissect Terrebonne Parish from the northern extreme at the GIWW to the southern boundary of the Gulf of Mexico (figure 9).

Project History

The HNC was constructed from 1960–1962 by local interests and extends for about 27 miles south from the city of Houma to Terrebonne Bay. Federal assumption of maintenance dredging occurred in 1963.

Benefits

During the period from 1979 to 1986, approximately 1.3 million tons were moved along the HNC per year; the majority of vessels traffic and cargo was related to oil and gas service, supply and drilling, and commercial and recreational fisheries (USACE 1989).

Impacts

The original excavation of the HNC resulted in the direct loss of approximately 982 acres of coastal wetlands. Turner and Cahoon (1987) estimated total primary losses because of channel area and spoil banks at 1,838 acres.

Since the HNC is a north-south channel, it serves as a major conduit for movement of salt water into the Terrebonne basin, resulting in significant secondary losses. While small amounts of marsh in Terrebonne basin have been developed from maintenance dredged spoil, the shoreline has more than doubled its original bank width resulting in estimated bank erosion losses of more than 1,307 acres (table 1) (LDNR 1995).

Recommended Solution to the Houma Navigational Canal Land Loss Challenge

A long-term strategy to beneficially use dredged material along the Houma Navigation Canal with a sill and/or a lock and bankline stabilization are primary methods being proposed to thwart the land loss along this waterway.

Protecting about two miles of existing bankline, imminently in danger of breakthrough to interior marshes, and considering the soils and navigation traffic, will exceed two million dollars.
Figure 9. Houma Navigation Canal.
**Atchafalaya River**

**General Description**

The current navigable portion of the Atchafalaya River that affects coastal wetlands is the Atchafalaya River and Bayous Chene, Boeuf, and Black navigation project, which is a 20-foot deep, 400-foot wide channel, extending from the general vicinity of Morgan City southward in the Lower Atchafalaya River to its mouth, and through Atchafalaya Bay to the Gulf of Mexico (figure 9).

**Project History**

Federal involvement in navigation along the Lower Atchafalaya River began in 1910 with the Congressional authorization of a 20-foot deep, 200-foot wide navigation channel from Morgan City to the Gulf of Mexico. Maintenance of that channel occurred only intermittently (due to low cargo movement and usage) between 1910 and 1974. The Rivers and Harbors Act of 1968 authorized the construction of the Atchafalaya River and Bayous Chene, Boeuf, and Black project, which included expansion of the channel between Morgan City and the Gulf to the current project dimensions. That expansion occurred from 1974 to 1981.

**Benefits**

Average annual traffic during the 1979 to 1984 period was approximately 2,859,000 tons; major vessel types are oil and gas drilling, supply and service vessels, and commercial fishing vessels (USACE 1989).

**Impacts**

Delta growth in the Atchafalaya Basin is a recent occurrence. Prior to 1952, most sediment carried by the Lower Atchafalaya River to the Atchafalaya Bay did not deposit in the bay. A subaqueous delta began to form at the mouth of the Lower Atchafalaya River during the period between 1952 and 1962 with the introduction of silts and fine sands to the bay. Before this period, these sediments were filling the lakes within the Atchafalaya Basin Floodway system to the north.

While the USACE works with the Louisiana Department of Wildlife and Fisheries (LDWF) to beneficially use dredged material to create new wetlands, erosion losses have resulted in an average bank width in the lower Atchafalaya River of more than 4,500 feet (LDNR, 1995). Since the original bank widths of the lower Atchafalaya River (a natural water body) is unknown, the secondary erosion losses are not quantified in this report.
Figure 10. Atchafalaya River.
Mermentau River Navigation Channel

General Description

Like a shallow-draft version of the Mississippi and Atchafalaya rivers projects, the Mermentau River Navigation Channel (MRNC) is part of a comprehensive, basin-wide project that provides flood control and water supply benefits in addition to navigation features. The navigation features generally affecting coastal resources is the five-mile portion of the MRNC project that traverses Lower Mud Lake and extends into the Gulf of Mexico (figure 11). Authorized project dimensions of this segment are 15 feet deep and between 100 and 200 feet bottom width.

Project History

Federal involvement in managing the Mermentau basin initiated with the Flood Control Act of 1941, which together with project modifications approved by Congress through the Rivers and Harbors Act of 1946, provided for the enlargement of existing channels between grand and White lakes, and south of Grand Lake, to provide adequate passage for flood waters to discharge from the basin. Control structures (locks) were constructed at Catfish Point and Schooner Bayou to reduce saltwater intrusion resulting from those flood protection measures. Two additional locks in the Mermentau basin, the Leland Bowman and Calcasieu locks, were constructed as part of the GIWW project to reduce saltwater intrusion.

The Rivers and Harbors Act of 1965 authorized various navigation improvements along the Mermentau River, such as channel realignment and enlargement, and clearing and snagging of the natural waterway. The cutoff between Lower Mud Lake and the Gulf of Mexico was constructed by local interests in 1971, and federal maintenance of that cutoff was integrated into the overall federal navigation project in 1976.

Maintenance dredging to provide adequate navigation occurs approximately every three years, and results in the removal of 700,000 cubic yards of dredged material at a cost of about $600,000 (USACE 1995).

Benefits

Average annual tonnage along the Mermentau River was 1.5 million tons between 1978 and 1983 (USACE 1989).

Impacts

Deepening the lower Mermentau River south of the Catfish Point Control Structure and the construction of the MRNC has caused saltwater intrusion and marsh loss in marshes south of Grand Lake and in the western portion of the lake's Subbasin. The navigation channel bypasses

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Figure Mermentau River Navigation Channel
the natural river mouth and its shallow river mouth bars, and saltwater intrusion affects marshes up the Mermentau River to the Catfish Point Control Structure. Where salt water enters a fresh marsh area, severe marsh loss occurs. Marshes within the Little Pecan Bayou area are slightly affected.

According to a study performed by Turner and Cahoon (1987), total primary wetland loss due to the Lower Mermentau River is 773 acres (313 hectares), with 258 acres attributed to the excavation area. With an almost fourfold increase in bank width by 1990, bank erosion impacts have resulted in the additional loss of 768 acres of coastal wetlands (table 1) (LDNR 1995). Additionally, as mentioned earlier, the locks are retaining water levels in the Mermentau basin.

**Recommended Solution to the Mermentau Basin Land Loss Challenge**

This basin has the GIWW crossing it in an east-west direction, the Mermentau River and Freshwater Bayou traversing it in the north-south direction, and the Gulf of Mexico invading from the south. As a result, it has the second highest rate of wetland loss based upon existing basin wetlands (%), and the third highest square mile loss of wetlands, in the entire coastal zone. (see figure 1, page 3)

Long-term strategies have been proposed for beneficial use of dredged material along all the navigation channels. Additional authorization to limit the further encroachment of the waterways into the marshes is necessary. Also a feasibility study is needed to investigate the possibility of lowering of water levels in the basin through more active operation of the locks or other means.

Protecting approximately 44 miles of existing banklines of the Mermentau and Freshwater Bayou waterways from further erosion will exceed nineteen million dollars.

**Freshwater Bayou Channel**

**General Description**

Freshwater Bayou is a 12-foot deep, 125-foot wide (bottom width) channel that extends southward from the GIWW at Intracoastal City to the Gulf of Mexico. A lock located at the Gulf of Mexico reduces saltwater intrusion into interior wetlands (figure 12).

**Project History**

Freshwater Bayou Channel was constructed between 1965 and 1967; the channel and lock opened to vessel traffic in 1968.
Figure 12. Freshwater Bayou Channel.
Benefits

Approximately 300,000 tons of cargo moved along Freshwater Bayou between 1979 and 1986; major vessel types were oil and gas service and supply vessels, as well as recreational and commercial fisheries traffic (USACE 1989).

Impacts

Freshwater Bayou Channel has resulted in saltwater intrusion affecting interior marshes between the Gulf of Mexico and the GIWW (Intracoastal City). Throughout most of the area adjacent to the Freshwater Bayou Channel, canal spoil banks provide some protection against the saltwater impact on adjacent coastal wetlands. However, rapid erosion affects several spoil bank locations along the Freshwater Bayou Channel, threatening adjacent fresh and low salinity marshes. The Freshwater Bayou Lock was designed to prevent saltwater intrusion into interior wetlands. However, since this channel is connected to Vermilion Bay, salt water can reach the interior wetlands from the northern end.

Turner and Cahoon (1987) estimated direct losses associated with channel construction at 1,423 acres (table 1), 474 acres of which are attributed to excavation losses. Subsequent bank erosion has resulted in an additional 1,124 lost acres (LDNR 1995), more than tripling the original channel area.

Calcasieu River Ship Channel

General Description

That portion of the Calcasieu River Ship Channel (CRSC) affecting coastal resources is the 40-foot deep, 400-foot wide (bottom width) navigation channel which begins in the city of Lake Charles and extends southward through Calcasieu Lake to the Gulf of Mexico (figure 13).

Project History

While the CRSC was originally constructed to 125 feet bottom width in 1941, it was widened in 1951 and again in 1968 to its current depth of 40 feet and bottom width of 400 feet (original bank width was approximately 600 feet). Construction of a barrier to reduce the intrusion of salt water into the river above Lake Charles was authorized in 1962, initiated in 1965, and completed in 1968.

Benefits

Average annual traffic on the CRSC was 24,096,000 tons between 1978 and 1986, with crude petroleum, petroleum products, and chemicals accounting for the majority of the cargo (USACE 1989).
Figure 13  Calcasieu River Ship Channel
Impacts

Before the Calcasieu Lock was completed in 1950, the CRSC exacerbated saltwater intrusion into the GIWW and, ultimately, to fresh marshes within the northwest portion of the Mermentau basin. In addition the CRSC, in conjunction with the GIWW and the Sabine-Neches Waterway, has hydrologically isolated the western Calcasieu River Basin from the rest of the state.

Shoreline erosion along the banks of the CRSC have more than doubled the 1968 bank width. As Table 1 indicates, while primary acreage loss in the CRSC was 7,774 acres (with 2,591 acres attributed to original canal area), subsequent bank erosion has resulted in an estimated 3,766 additional acreage loss (LDNR 1995). While estimated losses due to bank erosion are the lowest relative to construction losses for the CRSC (among the 10 channels discussed in this report), these losses rank fourth highest in absolute terms and still exceed primary losses associated with construction of the CRSC (table 1).

Recommended Solution to the CRSC Land Loss Challenge

Because of the interconnection of the Calcasieu Ship Channel with the GIWW and the Sabine-Neches Waterway, the effect on the interior marshes is magnified. The long-term control of this waterway includes construction of a series of locks after in depth study and Congressional authorization.

The interim bank stabilization control measures along the critical parts of the waterway will cost upwards of eight million dollars.

As previously mentioned, a feasibility study is needed to investigate the possibility of increasing freshwater input to the Calcasieu/Sabine Basin, and reducing freshwater levels in the Mermentau Basin through more active operation of the Calcasieu Lock or other means.