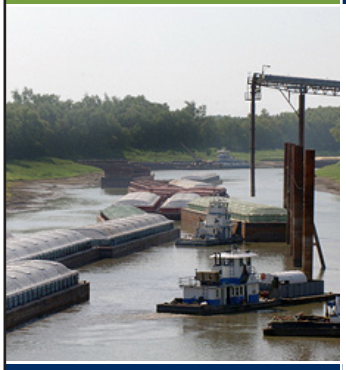
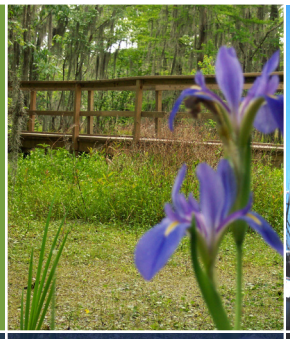


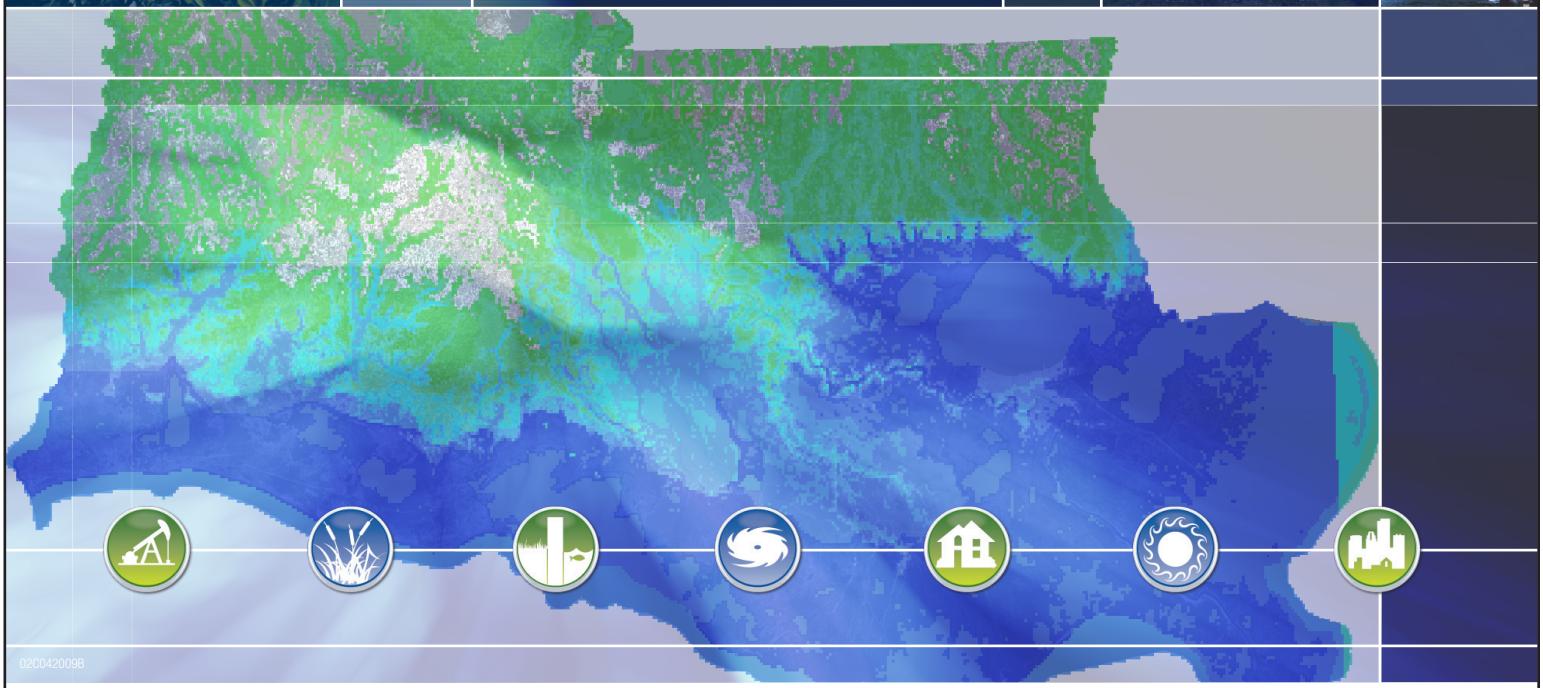
Defining Louisiana's Coastal Zone:

A Science-based Evaluation of the Louisiana Coastal Zone Inland Boundary

Prepared by the Louisiana Department of Natural Resources,
Office of Coastal Management

Revised October 2010





Submitted by the Louisiana Coastal Protection and Restoration Authority pursuant to the request made by Senate Concurrent Resolution No. 60 of the 2009 Regular Session of the Louisiana Legislature

Defining Louisiana's Coastal Zone: A Science Based Evaluation of the Louisiana Coastal Zone Inland Boundary

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This document was prepared for the Louisiana Coastal Protection and Restoration Authority by the Department of Natural Resources, Office of Coastal Management in cooperation with Shaw Environmental and Infrastructure, Comite Resources, Inc. and Louisiana Sea Grant Law and Policy Program in fulfillment of the request of Senate Concurrent Resolution 60 of the 2009 Regular Session of the Louisiana Legislature.

This document was prepared by an inter-disciplinary team lead by Dr. John Day, including Ms. Vickie Duffourc, Dr. Rachael Hunter, Dr. Terry Howey, Mr. James Wilkins, J.D., Michael Wascom, J.D., Dr. Ed Britton, Ms. Lily Hassan, Mr. Ben Holt, Ms. Ana Young, and Ms. Melissa Trosclair Daigle, J.D.
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Revised October 2010

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Executive Summary

This document presents the findings of a comprehensive science-based evaluation of the adequacy of the current inland boundary to meet the state's present and future needs to manage, protect, and restore its coastal resources. A guiding principle for this study was the need for balance between creating an overly expansive coastal zone and identifying a coastal zone that was sufficient to manage emerging coastal issues over the next several decades, especially those pertaining to climate change, sea level rise, nonpoint source pollution, and coastal and marine spatial planning. In addition, a critical factor to consider was delineating a management area based on science and geography that would allow for coastal management in the area covered by the Louisiana Comprehensive Master Plan for a Sustainable Coast.

The Louisiana Legislature, by Senate Concurrent Resolution 60 of 2009, directed the Coastal Protection and Restoration Authority (CPRA) to undertake a comprehensive science-based evaluation of Louisiana's currently defined Coastal Zone Boundary (CZB). The purpose of the study was to determine if changes (e.g., sea-level rise, regional subsidence, and wetland loss) that have occurred since the original boundary was established over 30 years ago have altered the coastline, such that the current CZB is no longer adequate for the current and future coastal zone management needs of the state. The CPRA selected the Louisiana Department of Natural Resources (LDNR), Office of Coastal Management (OCM) to lead the study.

The Coastal Zone Management Act of 1972 (CZMA) defines the coastal zone as the coastal waters and adjacent shorelands that extend inland only to the extent necessary to include areas that have a direct and significant impact on coastal waters and/or are likely to be affected by, or vulnerable to, sea-level rise. Louisiana's current CZB was first recommended in 1975 based on an analysis of biophysical parameters, but was revised to incorporate legal and governmental considerations. The resulting CZB included all or parts of 19 parishes and approximately 5.3 million acres. It was widely believed that the inland boundary of the coastal zone was, from its inception, insufficient to adequately manage Louisiana's coastal resources. Three primary deficiencies of the inland boundary were listed by Emmer (1989): 1) Water quality in the coastal zone can be significantly affected by activities occurring outside the coastal zone; 2) Some parishes, or parts of parishes, outside the coastal zone have the same physical and biological characteristics as lands inside the coastal zone; and 3) Riparian wetlands along rivers which influence the coastal zone were not included in the coastal zone. In addition, there are a number of State and Federal coastal programs established in south Louisiana (e.g., Coastal Wetlands Planning, Protection, and Restoration Act and Barataria-Terrebonne National Estuary Program) with boundaries that encompass part or all of the CZB, and in some instances, extend past the current CZB. Integrating the state's federally approved coastal zone with these existing coastal programs and the enforceable

policies and management mechanisms pertaining to coastal areas of Louisiana has been an important consideration in evaluating the CZB.

Involving the stakeholders of coastal Louisiana has also been critical in identifying concerns and potential changes to the current coastal zone boundary. The stakeholders who have participated in the public involvement aspect represent a diverse group, including governments, civic groups, industry representatives, and individual citizens. Contribution and participation was sought from these groups by holding a series of workshops, meetings, and presentations in strategic locations throughout southern Louisiana.

When the first CZB was proposed, 22 biophysical parameters were evaluated to determine if there was any one parameter that controlled the distribution of any, or all, of the other parameters. Best-fit correlations showed that the line of Pleistocene/Recent contact, which is approximated by the 5-foot contour line, provided the best measure approximation of the boundary line. To evaluate the current CZB, several tasks were necessary, including: 1) Analysis of parameters used in delineating the original CZB; 2) Collection and analysis of data that were unavailable at the time of the original study; and 3) Compilation of data sets into comparable Geographic Information System (GIS) layers for analysis and delineation of the CZB. In addition, during the evaluation of the current CZB, it was necessary to be aware of constraints and directions included in both the CZMA (16 USC 33:1451 et seq.) and the SLCRMA (R.S. 49:214.21 et seq.). Based on these two statutes, a number of objective criteria became clear, including that the redefined CZB needed to include:

- The inland extent of area needed to fully implement the state Master Plan;
- The inland extent of coastal waters as defined by law;
- The inland extent of tidal influence;
- The inland extent of wetland vegetation closely associated with coastal ecosystems;
- The inland extent of fish and wildlife closely associated with coastal ecosystems;
- The inland extent of coastal watersheds;
- The inland extent of projected effects of climate change, including sea level rise, storm surge, back water flooding and other coastal hazards;
- The inland extent of basic geological features frequently associated with shorelines, such as the Pleistocene terrace;
- The inland extent of the location of coastal dependent or coastal enhanced industry or other commercial activities closely related to the coast;
- The inland extent of coastal recreational activities; and
- The inland extent of population centers economically tied to coastal dependent or enhanced economic activities.

Technology has improved since 1975, and more data were available for the CZB re-evaluation than were available 30 years ago. Data acquired that were not available in 1975 included National Oceanic and

Atmospheric Administration (NOAA) Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model outputs, Light Detecting and Ranging (LIDAR) Elevation data, National Resource Conservation Service (NRCS) State Soil Geographic (STATSGO) soils data, Multi-resolution Land Characteristics Consortium (MLCD) National Land Cover (NLC) vegetation data, and sea-level rise predictions for the next century. The SLOSH model is the primary computer model used by NOAA to forecast the inland extent of storm surge; the forecast is based the Maximum Envelope of Water (MEOW) and Maximum of the MEOWs (MOMs) plots that result from the model runs. LIDAR data were used to determine elevation contours. The NRCS STATSGO soil data were utilized to identify riparian areas within watersheds that touch the coast. MLCD NLC vegetation data were found to be more extensive within the area of interest than United States Geological Survey (USGS) marsh data. In addition, as sea levels rise and the Louisiana coast subsides, changes in the coastline are expected to occur, which should have an impact on coastal zone management. Thus, sea level predictions were given consideration when re-evaluating the CZB. Animal habitat data were not included in the present study. Instead, extensive regional vegetation data were relied upon to determine the inland extent of saltwater intrusion. The boundary of LDNR's Coastal Nonpoint Pollution Control Program (CNPCP) was included to evaluate the impact of drainage basins in watersheds that drain to the Gulf of Mexico. These data are discussed in more detail in the body of this report.

GIS layers of data sets included in the current study were compiled, then a series of questions were applied to the layers in order to numerically define areas of the coastal zone. The area to which questions were applied was limited to major watersheds that touch the coast (e.g., the study area). The study area was separated into a series of 1-km^2 areas that were approximately 247 acres each, for a total of 39,764 1-km^2 areas. Each question was asked in each of the 1-km^2 areas and the resulting answer could be either "Yes" or "No". The questions included:

1) Is any part of the 1-km^2 area at or below the line of contact between Pleistocene and Holocene sediments?
2) Is any part of the 1-km^2 area within the current coastal zone?
3) Is any part of the 1-km^2 area within the boundary of the existing CNPCP area?
4) Does the 1-km^2 area contain emergent herbaceous wetlands (fresh, intermediate, brackish or salt marsh)?
5) Is any part of the 1-km^2 area contained within the inland extent of storm surge, per the Maximum of MEOWs (MOMs) map?
6) Is any part of the 1-km^2 area at an elevation of 5 feet or lower?
7) Is any part of the 1-km^2 area at an elevation of 8 feet or lower?
8) Is any part of the 1-km^2 area at an elevation of 10 feet or lower?
9) Does the 1-km^2 area contain soils classified as floodplains, marsh, backswamp, or water?

If the answer was "Yes", then the 1-km^2 area received a score of 1 and if the answer was "No" the area received a score of 0. If any part of the 1-km^2 area contained the vegetation, elevation, etc for the query,

the answer for the entire 1-km^2 area was "Yes". Values of 1 or 0 for each 1-km^2 grid were recorded in an attribute table and summed for the nine data layers queried, resulting in scores ranging from 0 to 9 for each grid. A score of 7 to 9 represented areas with a high level of coastal influence. A score of 3 to 6 represented areas with a moderate level of coastal influence. A score of 1 or 2 indicated a low level of coastal influence; and a score of 0 represented areas with no coastal influence. Scores for grids within the current CZB were examined and it was found that approximately 95% of the grids scored 7 or greater, with 99.9% scoring 3 or greater. Only four grids within the current CZB received a score of 2, and no grids received scores of 1 or 0.

The 1-km^2 areas were grouped according to the four levels of coastal influence and color coded for visual display. There were fairly distinct strata associated with areas highly influenced by coastal processes and those moderately impacted by coastal process. But, the areas barely influenced by coastal processes and those areas not influenced by coastal processes under normal circumstances tended to be more sporadic, with coastal processes extending to the limits of the study area in many of the 1-km^2 areas. Therefore, all 1-km^2 areas scoring between 0 – 2 were grouped together.

Based on scientific analyses performed for this report, a broader coastal management area designated the 2020 Science-Based Boundary (2010 SBB), with an adjacent planning area, is recommended to allow the state to effectively manage, protect, and restore its coastal resources. The 2010 SBB encompasses all areas subject to high and moderate coastal processes and divides coastal Louisiana into two management areas based on the degree of coastal influence and the nature and degree of management required. The SBB employs a hierarchical management structure, consisting of two distinct management areas: the coastal zone, or Coastal Use Permit (CUP) management area; and the contiguous area of moderate coastal influence adjacent to the coastal zone, or the Intergovernmental Coordination (IGC) management area. Activities in the coastal zone would be subject to the enforceable policies of the SLCRMA, and subject to regulation by the coastal use permit process. Whereas, activities in the IGC management area would not be "regulated" in the strict sense of the word. Rather, these activities would be subject to state and federal consistency, based on the same enforceable policies that are used to evaluate permits. In the IGC area, the OCM would evaluate proposed actions by governmental bodies that involve major hydrological modifications, because these activities have the potential to affect the coastal zone or Master Plan implementation. The individual actions of residents, private businesses, private industry, and landowners on a project-by-project basis would not be scrutinized within the IGC area. Thus, the 2010 SBB includes the updated coastal zone, which is called the Coastal Use Permit (CUP) management area to distinguish it from the current coastal zone, and the Intergovernmental Coordination (IGC) management area, which will be subject to oversight by the OCM, but will not be part of the regulated coastal zone. Areas not within the 2010 SBB, but contained within, or adjacent to, watersheds with potential coastal influence, are included in the Watershed Planning (WSP) management area located north of the IGC area; activities in the WSP area would not be subject to the enforceable policies of the SLCRMA, unless an activity specific effect on coastal waters was demonstrated.

The recommended management areas would include:

- Coastal Use Permit (CUP) Management Area
  - Zone of direct interaction
  - High level of coastal influence, based on the data set evaluation (Score 7-9)
  - Located within, and synonymous with, the regulated coastal zone
  - Permits would be required for certain activities pursuant to existing regulations as set forth in R.S. 49§214.30 or revisions thereto

- Intergovernmental Coordination (IGC) Area
  - Zone of direct influence
  - Moderate level of coastal influence, based on the data set evaluation (Score 3-6)
  - Located within the coastal management area, but outside of the regulated coastal zone
  - Consistency determinations, pursuant to existing authorities and state law, would be required for major hydrological modifications which are direct actions of governmental bodies

- Watershed Planning (WSP) Area
  - Zone of indirect influence
  - Low or no coastal influence, based on the data set evaluation (Score 0-2)
  - Located outside of the coastal management area, but within the identified planning area
  - Coastal zone management program might choose to participate in coastal planning efforts, with or without contributing funding, if the particular planning effort will have coastal ramifications.

The newly delineated coastal management area, with the proposed boundaries of the IGC and CUP areas, is shown on Figure ES 1 (Text Figure 30). The parishes included in each area, in whole or in part, are listed in Table ES 1 (Text Table 10). The generally proposed boundary for each area is described in Section 3.5.1: Management Areas. Adoption of the CUP area proposed inland boundary would add only a single new parish, a portion of Ascension, to the area now subject to coastal use permitting. Act 956 of the 2010 Regular Session of the Louisiana Legislature provides authorization to add all or any portion of Ascension within six months of approval of the boundary change for that parish by the CPRA. While it is true that other areas of the proposed CUP area are expanded by this proposal, certain areas in Livingston and Tangipahoa parishes are proposed to be deleted from the area subject to coastal use permitting, although they would remain in the IGC area of the broader coastal zone.

While this report provides a framework for establishing an expanded coastal management area and hierarchical management, the only required change to state law is to amend the boundary section of the SLCRMA to enlarge the coastal zone, so that it encompasses all of the CUP area. Implementation of the IGC area can be accomplished administratively, through existing state and federal law and regulations

under the CZMA and the SLCRMA. Thus, the only statutory change would be to amend the current coastal zone boundary statute, La. R.S. 49:214.24. Legal considerations, if the recommendations included in this report are accepted, are discussed in 4.0 Next Steps: Implementing an Updated Coastal Zone.

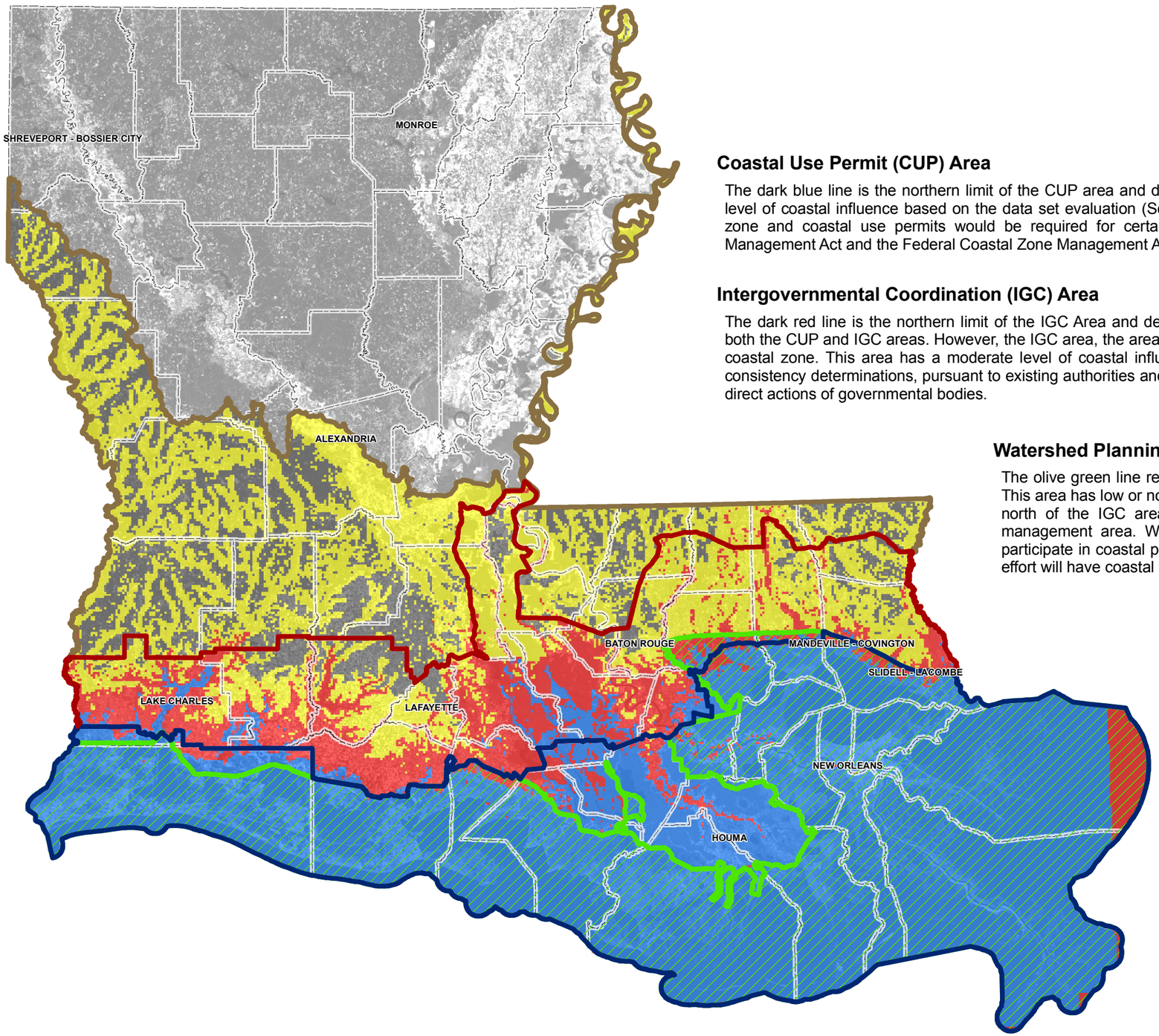
The coastal management area, consisting of the two management areas recommended in this report, could be implemented at the state level through regulation or statue. The Legislature enacts statutes. Administrative agencies adopt, amend and repeal regulations under the authority granted to them by statutes, and in accordance with the Administrative Procedure Act. Other coastal states have used both methods in establishing their coastal zones. This report recommends that the boundary section of the SLCRMA be amended to authorize the OCM, through rulemaking via the Administrative Procedures Act process, to make changes to the inland boundary following a periodic review, and that the CUP area boundary be implemented as the state's inland coastal zone boundary.

If the Legislature chooses to update Louisiana's coastal zone, regardless of the implementation approach chosen, it is recommended that the CUP and IGC boundaries be re-analyzed every ten years to evaluate the effects on the landscape, coastal populations, and infrastructure. The re-evaluations should use a GIS approach, and methods similar to those used in this study. New technology and approaches should be incorporated, as appropriate. Additionally, the coastal zone boundary and the IGC management area boundary should be maintained in an electronic GIS format on a website that is publically available. In this way, it can be consulted by any person or group considering any activity in coastal Louisiana.

Table ES 1. Alternative Coastal Zone Boundary Matrix

CRITERIA		Current Coastal Zone Boundary				2010 Science-Based Recommendation Boundary (CUP & IGC Areas)			
		Entire Parish located inside CZB	Portion of Parish located in CZB	Local coastal program approved	Local coastal program being developed	Entire Parish located inside CUP area	Portion of Parish located inside CUP area	Entire Parish located inside IGC area	Portion of Parish located inside IGC area
PARISH	Acadia							●	
	Assumption		●			●			
	Ascension						●		●
	Avoyelles								●
	Calcasieu		●	●			●		●
	Cameron		●	●		●			
	Concordia								●
	East Feliciana								●
	East Baton Rouge								●
	Iberia		●		●		●		●
	Iberville							●	
	Jefferson	●		●		●			
	Jefferson Davis							●	
	Lafayette							●	
	Lafourche		●	●		●			
	Livingston		●				●		●
	Orleans	●		●		●			
	Plaquemines	●		●		●			
	Pointe Coupee								●
	St. Bernard	●		●		●			
	St. Charles	●			●	●			
	St. Helena								●
	St. James	●		●		●			
	St. John the Baptist	●				●			
	St. Martin		●				●		●
	St. Mary		●			●			
	St. Landry								●
	St. Tammany		●	●			●		●
	Tangipahoa		●				●		●
	Terrebonne		●	●		●			
	Vermilion		●		●		●		●
	Washington								●
	West Baton Rouge								●

Figure ES-1
2010 Science-Based Boundary
CUP, IGC, and WSP Management Areas



Coastal Use Permit (CUP) Area

The dark blue line is the northern limit of the CUP area and delineates the proposed inland coastal zone boundary. This area has a high level of coastal influence based on the data set evaluation (Score 7-9). The area south of the dark blue line will be the regulated coastal zone and coastal use permits would be required for certain activities in accordance with the State and Local Coastal Resources Management Act and the Federal Coastal Zone Management Act.

Intergovernmental Coordination (IGC) Area

The dark red line is the northern limit of the IGC Area and delineates the limits of the broader coastal management area which includes both the CUP and IGC areas. However, the IGC area, the area between the dark red line and the dark blue line, is not part of the regulated coastal zone. This area has a moderate level of coastal influence based on the data set evaluation (Score 3-6). Within the IGC area, consistency determinations, pursuant to existing authorities and state law, would be required for major hydrological modifications which are direct actions of governmental bodies.

Watershed Planning (WSP) Area

The olive green line represents the study area's northern boundary and delineates the WSP area. This area has low or no coastal influence based on the data set evaluation (Score 0-2). The WSP is north of the IGC area and is not part of the regulated coastal zone or the broader coastal management area. Within the WSP area, the coastal management program might choose to participate in coastal planning efforts, with or without contributing funding, if the particular planning effort will have coastal ramifications.

Legend

2010 Proposed Boundary

- Coastal Use Permit (CUP) Area
- Intergovernmental Coordination (IGC) Area
- Watershed Planning (WSP) Area

Analysis Grid Score

- 7 - 9
- 3 - 6
- 1 - 2
- 0
- Current Coastal Zone Boundary
- Parish Boundary

REFERENCE:
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

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Table of Contents

List of Tables

List of Figures

List of Appendices

List of Acronyms

AEC	Areas of Environmental Concern
BMP	Best Management Practices
CIAP	Coastal Impact Assistance Program
CNPCP	Coastal Nonpoint Pollution Control Program
COE	Corps of Engineers
CPRA	Coastal Protection and Restoration Authority
CRTF	Coastal Resources Trust Fund
CUP	Coastal Use Permit
CWA	Clean Water Act
CWCP	Coastal Wetlands Conservation Plan
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
CZARA	Coastal Zone Reauthorization Amendments
CZB	Coastal Zone Boundary
CZMA	Coastal Zone Management Act

CZMP	Coastal Zone Management Program
DEQ	Department of Environmental Quality
DNR	Department of Natural Resources
ESLR	Eustatic Sea-Level Rise
EPA	Environmental Protection Agency
GIS	Geographic Information System
GOHSEP	Governor's Office of Homeland Security and Emergency Preparedness
GOMESA	Gulf of Mexico Energy Security Act
HUC	Hydrologic Unit Codes
IGC	Intergovernmental Coordination
IPCC	Intergovernmental Panel on Climate Change
LCA	Louisiana Coastal Area Ecosystem Restoration Plan 2004
LCES	Louisiana Cooperative Extension Service
LCNPCP	Louisiana Coastal Nonpoint Pollution Control Program
LCP	Local Coastal Program
LDAF	Louisiana Department of Agriculture and Forestry
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
LIDAR	Light Detection and Ranging
LSGCP	Louisiana Sea Grant College Program
MEOW	Maximum Envelope of Water
MOM	Maximum of the MEOWs
MHW	Mean High Watermark
MLCD	Multi-Resolution Land Characteristics Consortium
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHC	National Hurricane Center
NLC	National Land Cover
NOAA	National Oceanic and Atmospheric Administration
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NWRC	National Wetlands Resource Center
OCM	Office of Coastal Management
OCPR	Office of Coastal Protection and Restoration
OCS	Outer Continental Shelf
PACE	Parishes Against Coastal Erosion
PGP	Programmatic General Permit
SAG	Stakeholder Advisory Group
SBB	Science-based Boundary
SCR	Senate Concurrent Resolution
SLCRMA	State and Local Coastal Resources Management Act
SLOSH	Sea, Lake and Overland Surge from Hurricanes
STATSGO	State Soil Geographic data

USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WSP	Watershed Planning
WSR	Weather Surveillance Radar

1.0 Introduction

1.1 Authorization

In 2009, the Louisiana legislature questioned the adequacy of the inland boundary of the Louisiana coastal zone. During recent years, significant weather events including hurricanes, droughts, and regional sea-level rise, as well as coastal land loss, advances in measuring and monitoring ecological change, and state and federal legislative actions and programs have focused attention on that part of Louisiana subject to coastal processes. For these reasons, the Louisiana legislature determined that an evaluation of the adequacy of the current inland coastal zone boundary was needed 31 years after the current boundary was established by Act 361 of 1978, which was the State and Local Coastal Resources Management Act (SLCRMA). To conduct the evaluation, the legislature passed Senate Concurrent Resolution 60 (SCR 60, Appendix A) in 2009, which directed the Louisiana Coastal Protection and Restoration Authority (CPRA) to undertake a comprehensive, science-based evaluation of the current inland boundary. The boundary, if revised, would need to meet Louisiana's future goals to manage, protect and restore its coastal resources. The CPRA, by Resolution dated June 29, 2009 (Appendix B), tasked the Louisiana Department of Natural Resources (LDNR), Office of Coastal Management (OCM) to carry out this effort based upon "…its unique knowledge of intricacies of Louisiana's existing coastal zone boundary and the challenges that surround any effort to evaluate and/or make recommendations to redraw this line." The OCM worked in cooperation with CPRA member agencies and additional state, local, and federal organizations to carry out this evaluation. The OCM retained contractual services to provide expert technical, scientific, and legal services to assist its staff in carrying out this task. This report presents the background, methodology, findings, and recommendations of the science-based evaluation of the inland boundary of the Louisiana coastal zone.

1.2 Evolution of the Current Coastal Zone Boundary

The federal Coastal Zone Management Act of 1972 (CZMA) defines the coastal zone of a state as the coastal waters and adjacent shoreland, which should extend inland only to the extent necessary to control shorelands on which activities have direct and significant impact on coastal waters, and/or are likely to be affected by or be vulnerable to sea-level rise. Excluded from the coastal zone are those lands subject solely to the discretion of, or held in trust by, the Federal Government, its officers or agents (16 U.S.C. § 1453 § 304(1)).

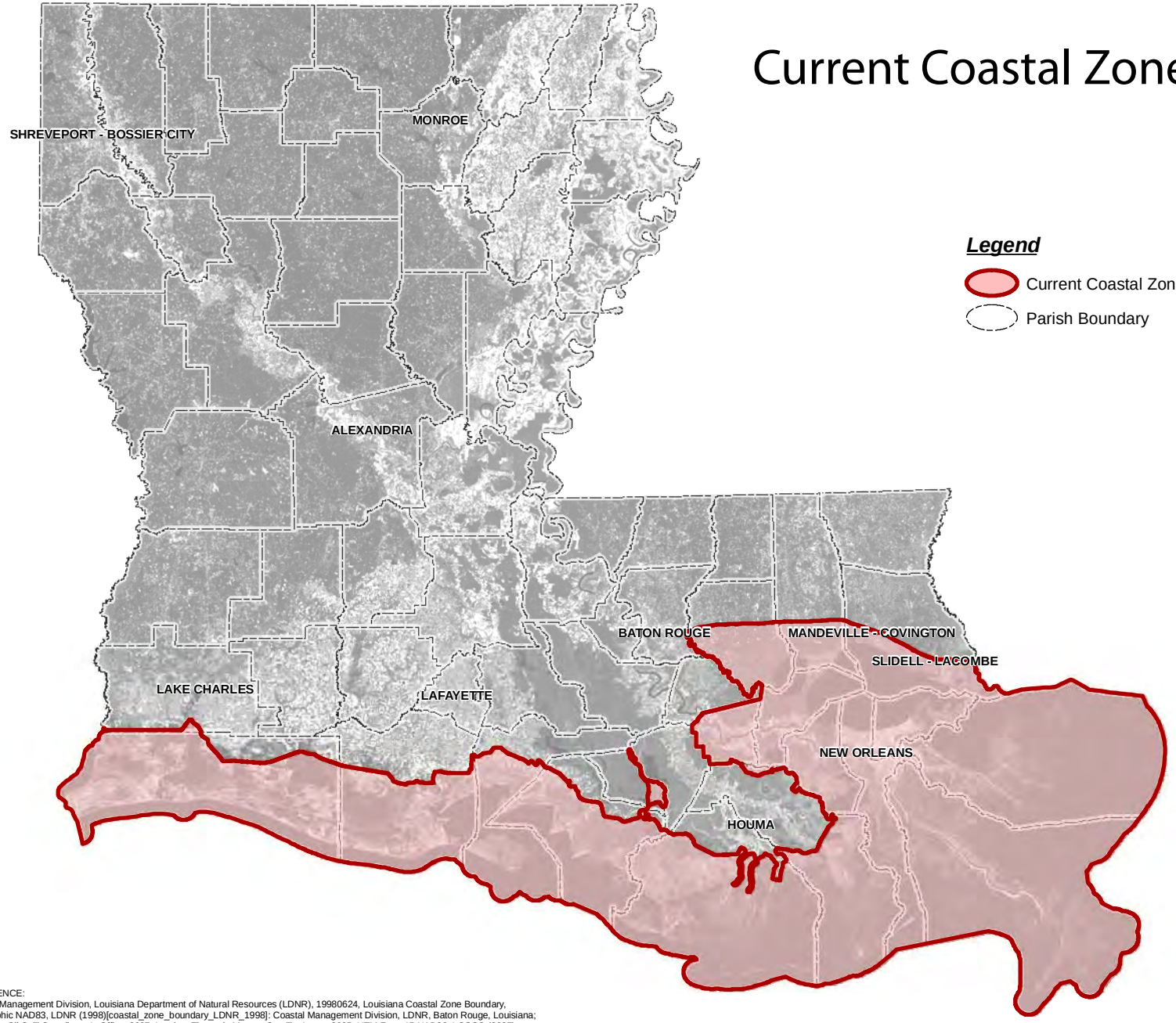
Louisiana's first formal coastal zone boundary (CZB) was proposed in 1975 based on research sponsored by the National Oceanic and Atmospheric Administration (NOAA), of the U.S. Department of Commerce (McIntire et al. 1975). That proposed inland boundary was based on an analysis of biophysical parameters and it served as a baseline for legislative deliberations to establish a CZB so that Louisiana could receive federal approval for a coastal zone management program under the CZMA.

The inland boundary first established for the Louisiana coastal zone by Act 705 of the Regular Session of the 1975 Louisiana Legislature encompassed only a narrow band of shoreland extending landward three miles from the Gulf of Mexico. This boundary was deemed by NOAA to be inadequate to support a federally approved coastal management program, and therefore, was not approved.

After additional deliberation and consultation with NOAA, the state developed and adopted an approved CZB by Act 361 of the 1978 Regular Session of the Louisiana Legislature, the SLCRMA. Since that time changes have been made to the inland CZB on three occasions (Emmer 1989). First, minor changes allowed by the language of Act 361 were made to the boundary line around corporate limits of communities as the official boundary maps were drawn. Then, in 1979 the CZB was legislatively amended to include all of St. James, St. John the Baptist, and St. Charles parishes, along with additional areas of Livingston, Lafourche, St. Mary, and Assumption parishes. Finally, in 1980 the CZB was again amended to include a portion of St. Martin parish.

Currently, the Louisiana coastal zone includes all or part of 19 parishes and an area of approximately 5.3 million acres (Emmer 1989; Figure 1). A more detailed legislative history of Louisiana's coastal zone boundary is provided in Appendix C.

Figure 1
Current Coastal Zone Boundary



REFERENCE:
Coastal Management Division, Louisiana Department of Natural Resources (LDNR), 19980624, Louisiana Coastal Zone Boundary, Geographic NAD83, LDNR (1998)[coastal_zone_boundary_LDNR_1998]: Coastal Management Division, LDNR, Baton Rouge, Louisiana; Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

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1.3 Concerns with the Current Coastal Zone Boundary

From 1975 to 1978, when determinations were being made as to where the inland CZB would be, there was much debate regarding how far inland the coastal zone should extend. The boundary that was finally adopted represented a compromise between the minimalist view represented by Act 705 and the science-based recommendation of the time developed by MacIntire et al. (1975). The resultant boundary was, therefore, not fully based on science. Furthermore, since the adoption of the CZB in 1978, much has changed in coastal Louisiana.

It was widely believed that the inland boundary of the coastal zone was, from the start, insufficient to adequately manage Louisiana's coastal resources. Three primary deficiencies of the inland boundary were listed by Emmer (1989): 1) Water quality in the coastal zone can be significantly affected by activities occurring outside the coastal zone; 2) Some parishes, or parts of parishes, outside the coastal zone have the same physical and biological characteristics as lands inside the coastal zone; and 3) Riparian wetlands along rivers which influence the coastal zone are not included in the coastal zone.

In the time since the establishment of the coastal zone, additional state and federal coastal programs have been established in south Louisiana, which are based on some aspect of coastal science, but which also conform to particular coastal policy criteria. The boundaries established for these programs encompass not only most or all of the coastal zone as it now exists, but often extend far beyond the current inland boundary. These programs include the Atchafalaya Basin Program, the Barataria-Terrebonne National Estuary Program (BTNEP), the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), Louisiana Coastal Wetlands Conservation Plan, Louisiana Coastal Area (LCA) Ecosystem Restoration Plan 2004, the Louisiana Coastal Nonpoint Pollution Control Program (LCNPCP; CZARA § 6217), the Louisiana Nonpoint Source Management Program (CWA § 319), and the Louisiana Comprehensive Master Plan for a Sustainable Coast. The boundaries of these various programs are depicted in Figure 2, and Table 1 summarizes the programs and their features. Integrating the state's federally approved coastal zone with existing coastal programs and the enforceable policies and management mechanisms pertaining to its coastal areas has been an important consideration in evaluating the current CZB.

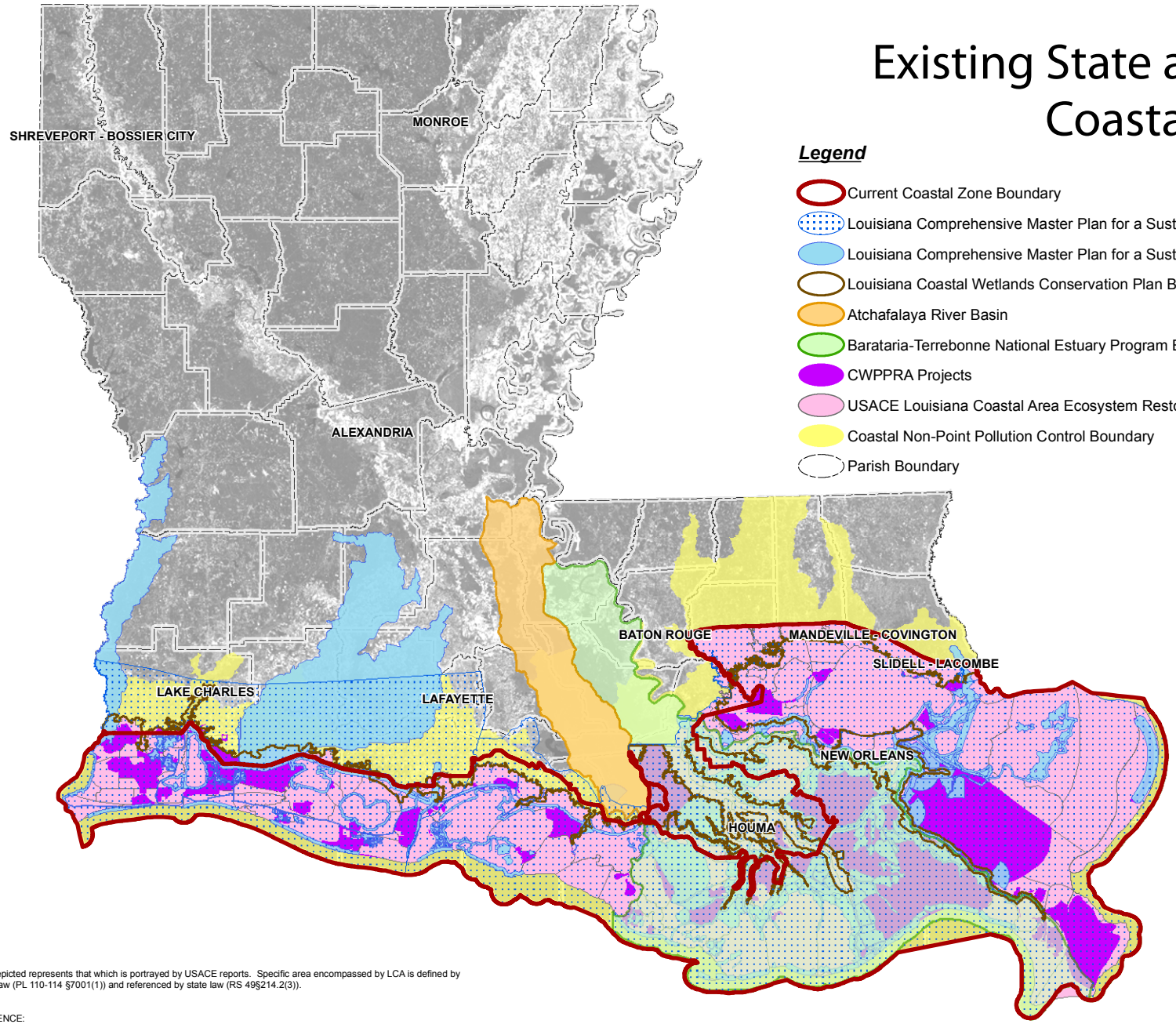
Another important consideration when evaluating the current CZB is that the Louisiana coastline has changed in the past several decades due to land loss, subsidence, and sea-level rise. In the 1975 boundary study, the line of contact between Pleistocene and recent geological surfaces was the parameter found to be most closely associated with other factors evaluated in this study. That contact line closely approximated the 5-foot contour in 1975, however, the 5-foot contour line is no longer consistent with the contact line due to changes in the coastline. Thus, a re-evaluation of the boundary line is needed to adequately consider the environmental changes that have occurred since the original boundary was delineated.

Table 1. Summary of Existing State and Federal Coastal Programs

Program Title	Agency Sponsors	Summary of Program
Atchafalaya Basin Program	LDNR/USACE	The state Department of Natural Resources oversees the management of the state master plan for the Atchafalaya Basin Floodway System. The Atchafalaya Basin Program (ABP) operates under the authority of Act 3 of 1998 and Act 920 of 1999. LDNR, the federal U.S. Army Corps of Engineers, and the basin parishes work together in creating projects by executing cooperative endeavors or agreements that protect and enhance the basin. Several other state agencies, like the departments of Wildlife and Fisheries and Culture, Recreation and Tourism, also work to establish projects aimed at enhancing the basin.
Barataria Terrebonne National Estuary Program	EPA/LUMCON	The BTNEP was established by Congress through section 320 of the Clean Water Act in 1987 and administrated by the Environmental Protection Agency. The EPA and the State of Louisiana committed to a cooperative agreement under the National Estuary Program to form the BTNEP. Established in 1991, the mission of the BTNEP is the preservation and restoration of the estuarine system, the 4.2 million acre region between the Atchafalaya and Mississippi Rivers. The goal of the National Estuary Program is to prevent activities that: threaten an estuary's public water supply; are harmful to shellfish, fish and wildlife populations; and, negatively impact recreational opportunities for estuary residents.
Coastal Wetlands Planning, Protection and Restoration Act	CWPPRA Task Force	The Coastal Wetlands Planning, Protection and Restoration Act program (CWPPRA or "Breaux Act") provides for targeted funds to be used for planning and implementing projects that create, protect, restore and enhance wetlands in coastal Louisiana. It was passed in 1990, and is authorized until 2019. By July 2008, 145 active CWPPRA projects have been approved, 74 have been constructed, 17 are under construction, and 26 have been de-authorized or transferred to another program. The Task Force is composed of the State of Louisiana and five Federal agencies: the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the Natural Resource Conservation Service (NRCS), the Environmental Protection Agency (EPA), the National Marnie Fisheries Service (NMFS), and the State of Louisiana, Governor's Office of Coastal Activities (OCA).
Louisiana Coastal Wetlands Conservation Plan Area	LDNR/CWPPRA	Louisiana's unique wetland resources have been seriously depleted and degraded. Recognizing this, the Coastal Wetlands Planning, Protection, and Restoration Act of 1990 has special provisions for the State. It called for the development of both Restoration and Conservation Plans specifically for Louisiana's wetlands. The LCWCP boundary includes the tidally influenced coastal region three feet or lower in elevation.
Louisiana Coastal Area	LDNR/CWPPRA	With Coast 2050 as its blueprint, USACE began the Louisiana Coastal Area (LCA) Ecosystem Restoration Study in 1999. The study was completed in 2004. The study area, which includes 20 parishes in the Louisiana coastal area from Mississippi to Texas, is comprised of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the closely linked Chenier Plain, both of which are influenced by the Mississippi River.

Louisiana Coastal Non-point Pollution Control Program CZARA § 6217	LDNR/LDEQ	Section 6217 of the Federal Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 required that states with federally approved coastal zone management programs develop and implement Coastal Nonpoint Pollution Control Programs (CNPCP) through the adoption of management measures approved by NOAA and EPA and designed to control runoff from six main sources: forestry; agriculture; urban runoff; marinas and recreational boating; hydromodification (shoreline and stream channel modification); and, wetlands, riparian areas, and vegetated treatment systems. Louisiana's CNPCP management area includes watersheds (6-digit subsections) that occur within the Louisiana Coastal Zone boundary; are adjacent to the Louisiana Coastal Zone boundary; and/or occur in the LCWCP area. It includes all or part of 30 parishes.
Louisiana Nonpoint Source Management Program (CWA § 319)	LDEQ	Section 319 of the Clean Water Act (CWA) required that states develop a Non-Point Source Management Plan to reduce and control nonpoint sources of pollution from the various types of land-uses that contribute to water quality problems across the United States. In response to Section 319 of the Clean Water Act (PL 100-4), the Louisiana Legislature designated the Department of Environmental Quality as the state's lead agency to develop and implement a Nonpoint Source (NPS) Management Program (La. R.S. 30:2011). The program's goal is to educate people about NPS pollution and best management practices (BMPs) that can be implemented to reduce and control this type of pollution. Unlike the coastal NPS pollution control program, the Section 319 program boundary includes all watersheds within Louisiana.
Louisiana's Comprehensive Master Plan for a Sustainable Coast	LDNR-OCPR/CPRA	The Master Plan was developed to fulfill the mandates of Act 8, which was passed by the Louisiana Legislature in 2005 to integrate flood control projects and coastal restoration. The act created the CPRA and charged it with coordinating the efforts of local, state, and federal agencies to achieve long-term and comprehensive coastal protection and restoration. All state agencies are required to administer their regulatory practices, programs, contracts, grants, and all other functions vested in them in a manner consistent with the Master Plan and public interest to the maximum extent possible (Executive Order No. BJ 2008-7). The Master Plan boundary includes the coastal area potentially at risk under an extreme storm event (the 0.2% annual probability was used during plan formulation). The Master Plan coastal area extends much further inland than the current coastal zone boundary. Therefore, a Master Plan Buffer boundary was established around proposed Master Plan measures to define the area within which an activity could potentially impact implementation of the measure (Halcrow, 2008).

Figure 2
Existing State and Federal Coastal Programs



*Area depicted represents that which is portrayed by USACE reports. Specific area encompassed by LCA is defined by federal law (PL 110-114 §7001(1)) and referenced by state law (RS 49§214.2(3)).

REFERENCE:
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0017_coastal_programs.mxd

1.4 Public Involvement

Involving the stakeholders of coastal Louisiana was critical in identifying concerns and potential changes to the current coastal zone boundary. The stakeholders who participated in the public involvement aspect represent a diverse group of governmental entities, civic groups, industry representatives, and individual citizens. Contribution and participation was sought from these groups by holding a series of workshops, meetings, and presentations in strategic locations throughout southern Louisiana. The dates and locations of these events are shown in Table 2.

Table 2. Stakeholder Events

Stakeholder Group	Location	Date
CPRA Meeting	Baton Rouge	July 29, 2009
Stakeholder Advisory Group (SAG) Meeting	Baton Rouge	August 1, 2009
OCPR Stakeholder Workshop	New Orleans	September 1, 2009
OCPR Stakeholder Workshop	Houma	September 2, 2009
OCPR Stakeholder Workshop	Lake Charles	September 3, 2009
CPRA Meeting	New Orleans	December 9, 2009
Stakeholder Advisory Group (SAG) Meeting	Baton Rouge	December 11, 2009
CPRA Meeting	Baton Rouge	August 18, 2010
Governor's Coastal Advisory Committee Meeting	Lake Charles	August 19, 2010
Stakeholder Advisory Group (SAG) Meeting	Baton Rouge	August 20, 2010

The CZB study Stakeholder Advisory Group (SAG) was created to represent the interests of non-government organizations, university researchers, industry leaders, and civic group members. Local government interests were also represented through members of the Parishes Against Coastal Erosion (PACE) group. The OCM conducted two (2) separate meetings with the SAG to receive input for development of the study. The purpose of the initial SAG meeting was to receive input on which vital data parameters should be included in the study and evaluation, while the second meeting was to present a methodology concept and the data sets that were to be analyzed. Stakeholders provided feedback and additional input regarding data analysis and other potential data sets.

The Office of Coastal Protection and Restoration (OCPR) stakeholder workshops were an opportunity to present the outline of the study during previously scheduled coastal restoration workshops in New Orleans, Houma, and Lake Charles. Although the OCPR workshops were not originally designated for the purpose of introducing the study to the public, concerned citizens who attended these events were given a study presentation and participated in a CZB study question and answer period with the OCM.

Members of the Coastal Protection Restoration Authority (CPRA) were also presented with an overview of the study and its progress. The CPRA includes representatives from numerous state agencies. The status presentation was a part of the monthly meeting for December 2009.

During these events, stakeholders provided valuable input to the process, progress, and goals of this study. Several commenters suggested areas and factors that should be included in the re-evaluation of the boundary. These suggestions consisted of reconsidering the current fastland exemption, evaluating the inclusion of the Atchafalaya Basin and the Old River Control Structure within the CZB, considering the impacts of salinity intrusion in western Louisiana, and determining the effects of downstream flooding from watersheds outside of the current coastal zone. Stakeholders additionally suggested the study team consider data such as fault lines, wind, and the actions of surrounding states as possible data evaluation parameters. The expansion of the role of local and state programs if the current boundary is enlarged was also discussed at several events. The potential for these programs to become overburdened financially and the possibility of existing coastal funding being divided between more parishes were concerns repeated by several stakeholders. Although funding allocation is beyond the scope of the current study, the study team considered several potential solutions to this obstacle. Additional sources such as increased federal funding through NOAA grants and Clean Water Act 319 funds will be explored if the coastal zone is enlarged.

1.5 Challenges Facing the Louisiana Coast

Coastal Louisiana contains 40% of the wetlands and 30% of the coastal marsh found in the lower 48 states. Current estimates are that coastal Louisiana has lost about 1352 square miles (mi^2) of coastal wetlands between 1956 and 2006 (~27 mi^2/yr; Barras et al., 2008). In addition, according to land loss estimates, Hurricanes Katrina and Rita transformed 217 mi^2 of marsh to open water in coastal Louisiana (USGS 2006). The Intergovernmental Panel on Climate Change (IPCC) concludes that the rate of global sea-level rise is increasing, with a predicted eustatic (global) sea-level rise of 0.2-0.6 m (0.7-2 ft) by the year 2100 (Meehl et al. 2007). However, recent reports indicate that eustatic sea-level rise will likely be one meter (3 ft) or more by 2100 (Vermeer and Rhamstorf 2009). Accelerated rates of eustatic sea-level rise combined with deltaic subsidence significantly increase rates of relative sea-level rise and, subsequently, coastal land loss (Blum and Roberts 2009).

Coastal land loss in Louisiana is critical primarily because of the enormous economic value of this area to the state and because of the value of coastal wetlands for storm protection, urban development, and fish and wildlife habitat. Louisiana produces or transports nearly one-third of the nation's oil and gas supply and is tied to 50% of the nation's refining capacity. Ten major navigation routes are located in south Louisiana, along with five of the busiest ports in the U.S. Louisiana provides 26% (by weight) of the commercial fish landings in the lower 48 states and more than five million migratory waterfowl spend the winter in Louisiana's marshes. Forested wetlands also provide stopover habitats for neo-tropical migratory birds crossing the Gulf of Mexico (CPRA 2007). In addition, more than 60% of the state's population lives in Louisiana's coastal parishes (U.S. Census 2008). Coastal land loss is also a contributing factor to the water quality challenges facing the Gulf of Mexico. Wetlands reduce nitrogen and phosphorous in nonpoint source pollution, filter and trap sediments in surface water, and remove

some chemical pollutants such as pesticides and heavy metals from water. These wetlands also play an important role in recharging local and regional aquifers.

Land loss in coastal Louisiana is directly tied to the forces that formed the coast (Day et al. 2007). Prior to human modification, seasonal overbank flooding of the Mississippi and Atchafalaya rivers deposited large amounts of sediments into the interdistributary wetlands of the Mississippi deltaic plain. Not only did these floods provide an allochthonous source of mineral sediments, which contributed directly to vertical accretion, but the nutrients associated with these sediments also promoted vertical accretion through increased autochthonous organic matter production and deposition, and the formation of soil through increased root growth. This vertical growth of the wetland surface helped offset high relative sea-level rise caused by natural subsidence of the delta plain, which is as high as 1.5 cm/year (Cahoon et al. 1995, 1999).

The construction of flood control levees and closure of distributary channels began soon after colonization of New Orleans by the French in 1719 (Welder 1959, Boesch 1996, Colten 2000). After the great flood of 1927, levees were upgraded and made continuous through the deltaic plain, hydrologically isolating wetlands from nearby rivers and resulting in vertical accretion deficits (relative sea-level rise > accretion) throughout the coastal region. Wetlands have been shown to persist in the face of relative sea-level rise when vertical accretion equals or exceeds the rate of subsidence (Baumann et al. 1984; Delaune et al. 1983; Stevenson et al. 1986), but without the annual flooding and subsequent distribution of sediments, accretion rates decline and wetlands degrade. Even without the problems attributed to flood control levees and the closure of channels, Blum and Roberts (2009) estimated that the sediment load of the Mississippi River has declined by 50% through dam construction in the Mississippi Basin, which further compounds the problem of subsidence.

Contributing further to vertical accretion deficits, many wetlands in the deltaic region have been hydrologically isolated from surrounding marshes, swamps and bayous due to the construction of canals and spoil banks during the past century (Turner and Cordes 1987). In addition to impeding drainage and physically impounding wetlands, spoil banks prevent the overland flow of sediments and nutrients into coastal wetlands, creating essentially ombrotrophic systems from what were naturally eutrophic or mesotrophic systems. In addition, canals promote saltwater intrusion and limit freshwater exchange (Bass and Turner 1977, Deegan 1984, Swenson and Turner 1987).

The low-lying lands of southern Louisiana constitute an extremely dynamic environment. It is, therefore, very appropriate that the legally defined area of the coastal zone be reviewed and updated periodically. This report has been designed to provide information necessary for decision makers to consider possible changes to the CZB for the continued effective management of the Louisiana coastal zone.

2.0 Framework

2.1 Criteria for a Redefined Coastal Zone

In determining appropriate criteria for evaluating Louisiana's current coastal zone and recommending changes that may be desirable, it was necessary to be aware of constraints and directions included in both the CZMA (16 USC 33:1451 *et seq*.) and the SLCRMA (R.S. 49:214.21 *et seq*.). Each statute provides guidance and definitions of the term "coastal zone" which govern the area appropriate for inclusion in the coastal zone. While the Louisiana SLCRMA could possibly be amended if necessary, attempting to amend the CZMA for this purpose would likely be a long, arduous proposition with little chance of success.

In determining what area should be included in the coastal zone of any state, reference must be made to the federal definition of "coastal zone" found in §1453(1) of the CZMA, that states:

> *"The term 'coastal zone' means the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelands of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. …The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters, and to control those geographical areas which are likely to be affected or vulnerable to sea level rise. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents."*

The coastal zone has been defined by law in the SLCRMA at §214.23(5) as:

> *"…the coastal waters and adjacent shorelands within the boundaries of the coastal zone established by R. S. 49:214.23, which are strongly influenced by each other, and in proximity to the shorelines, and uses of which have a direct and significant impact on coastal waters."*

To further understand the context of the definition of the "coastal zone" it is necessary to refer to the definition of "coastal waters" defined in the SLCRMA at §214.23(4) as:

> *"…bays, lakes, inlets, estuaries, rivers, bayous, and other bodies of water within the boundaries of the coastal zone which have measurable seawater content (under normal weather conditions over a period of years)."*

This definition is essentially the same as that which is in the CZMA at §1453 for "coastal waters".

Louisiana law has a second definition of "coastal waters" located in another statute. This definition was developed for the purpose of oil spill contingency planning included in R.S. 30:§2454(2) and states:

> *"Coastal waters means the waters and bed of the Gulf of Mexico and within the jurisdiction of the state of Louisiana, including the arms of the Gulf of Mexico subject to tidal influence, estuaries, and any other waters within the state if such other waters are navigated by vessels with a capacity to carry ten thousand gallons or more of oil as fuel or cargo."*

To further understand the legal criteria for a CZB meeting federal standards under the CZMA, it is useful to review the federal definition in the CZMA at §1453(2) for the term "coastal resource of national significance" defined as:

> *"…any coastal wetland, beach, dune, barrier island, reef, estuary, or fish and wildlife habitat, if any such area is determined by a coastal state to be of substantial biological or natural storm protection value."*

Because the state coastal zone management program is a federally approved program, any change to the CZB must be approved by NOAA through procedures specified in the CZMA before the new boundary can be recognized as part of the state's approved management program. Federal CZM Program Regulations for implementation of the CZMA set forth the requirements for state coastal management program approval, review of approved programs, and any amendments to an approved program (15 CFR §923.1 *et seq*.). These regulations reiterate that "geographic areas likely to be affected by or vulnerable to sea-level rise" are subject to the management program, and that an approved program must enable a state to manage certain coastal features and resources through policies that specifically:

> *"…provide for management of those land and water uses having a direct and significant impact on coastal waters and those geographic areas which are likely to be affected by or vulnerable to sea level rise… minimize the destruction, loss or degradation of wetlands and preserve and enhance their natural values… reduce risks of flood loss, minimize the impact of floods on human safety, health and welfare, and preserve the natural, beneficial values served by floodplains…"*

The regulations also state at 15 CFR §932.3(d) that:

> *"The policies in the program must be appropriate to the nature and degree of management needed for uses, areas, and resources identified as subject to the program."*

Subpart D of the CZM Program Regulations (15 CFR §923.30 – 923.34) sets forth the requirements for management program approvability with respect to boundaries of the coastal zone. Section 923.31 *et seq*. gives specific requirements with respect to procedures for determining and identifying the inland

boundary. These requirements specify that the inland boundary should be described by easy to understand landmarks, stating in part:

> *"The inland boundary must be presented in a manner that is clear and exact enough to permit determination of whether property or an activity is located within the management area. …an inland coastal zone boundary defined in terms of political jurisdiction (e.g., county, township or municipal lines) cultural features (e.g., highways, railroads), planning areas (e.g., regional agency jurisdictions, census enumeration districts), or a uniform setback line is acceptable so long as it includes the areas identified."*

The section on inland boundaries also states that the inland boundary of a state's coastal zone may include:

> *"Watersheds – A state may determine some uses within entire watersheds which have direct and significant impact on coastal waters or are likely to be affected by or vulnerable to sea level rise. In such cases it may be appropriate to define the coastal zone as including these watersheds."*

> *"Areas of tidal influence that extend further inland than waters under saline influence; particularly in estuaries, deltas and rivers where uses inland could have direct and significant impacts on coastal waters or areas that are likely to be affected by or vulnerable to sea level rise."*

Louisiana's changing coastal landscape and the management goals and mandates of the CZMA and the SLCRMA provide ample guidance for justifying a revision to the area encompassed by the inland portion of the CZB of Louisiana. This is particularly relevant in light of the great strides made over the past 30 years in the understanding of ecosystem- and watershed-based natural resource management, and with the increased awareness and appreciation for the need to restore and to protect the coast of Louisiana. In the post-Katrina/Rita era of coastal zone management in Louisiana, the scale of management needed is much greater than was thought in the mid-1970s when coastal zone management concepts were just being developed. But both the CZMA and the SLCRMA continue to provide a viable framework for modern ecosystem-based management. The CZMA, as originally drafted, provides criteria for addressing sea-level rise, which now is better understood and regarded more broadly as multiple effects of climate change. In addition, Louisiana amended the SLCRMA in 2007 to restate public policy in coastal zone management to provide for adaptation to climate change within the program. This adaptation is included in the SLCRMA at R. S. 49:§214.22(8) as:

> *"To support sustainable development in the coastal zone that accounts for potential impacts from hurricanes and other natural disasters and avoids environmental degradation resulting from damage to infrastructure caused by natural disasters."*

From this there are clearly suggested a number of objective criteria, in both the natural and social sciences, which are appropriately considered to define the state's coastal zone. These are:

- The inland extent of area needed to fully implement the state Master Plan.
- The inland extent of coastal waters as defined by law.
- The inland extent of tidal influence.
- The inland extent of wetland vegetation closely associated with coastal ecosystems.
- The inland extent of fish and wildlife closely associated with coastal ecosystems.
- The inland extent of coastal watersheds.
- The inland extent of projected effects of climate change, including sea-level rise, storm surge, back water flooding and other coastal hazards.
- The inland extent of basic geological features frequently associated with shorelines, such as the Pleistocene terrace.
- The inland extent of the location of coastal dependent or coastal enhanced industry or other commercial activities closely related to the coast.
- The inland extent of coastal recreational activities.
- The inland extent of population centers economically tied to coastal dependent or enhanced economic activities.

Thus, there is a clear nexus drawn between the goals and objectives of coastal zone management under the CZMA and SLCRMA and guidance provided regarding the area for inclusion in the state's coastal zone. It is both reasonable and proper for a state to revise and adjust its CZB as conditions change and better scientific information emerges.

2.2 Management Scenario for a Redefined Coastal Zone

Louisiana is one of 35 states and territories eligible to establish a Coastal Zone Management Program (CZMP) under the federal CZMA, and it has had an approved program since 1980. Many of the eligible states and territories have faced coastal management challenges in delineating the inland extent of their boundaries. Therefore, the coastal zone management programs for other eligible coastal states and territories were evaluated to determine if certain management approaches would be compatible with the Louisiana coastal zone. A matrix was developed to demonstrate the CZMPs based on inland boundary parameters, level of management, and federal, state, and local government involvement (Table 3).

States with CZMPs similar to those of Louisiana's existing CZMP were reviewed to determine if specifics from these plans would be of use in the re-evaluation of the coastal zone. An updated inland CZB for Louisiana should encompass all areas subject to coastal processes and all uses which have the potential to impact coastal waters. However, the degree of management needed may vary by location and use. Accordingly, states with hierarchical management or "tiered" approaches were analyzed more intensely to evaluate the implementation of a stratified CZB that would include regulation, intergovernmental coordination, and planning area.

Eight of the programs reviewed included the entire state or territory within their CZB. Puerto Rico was the only island program that did not include all of its land within its CZB, but rather limited the CZB to land within 1000 feet of the mean high watermark (MHW). Although all of Florida was included inside of its CZB, regulatory authority and program funding were limited to Gulf and Atlantic coastal cities and counties that are contiguous to state water bodies and dominated by marine species of vegetation. Similarly, a total of 16 other programs reviewed utilized some form of management hierarchy to delineate regulatory and/or funding priorities.

Like Florida, Rhode Island includes the entire state within its CZB, but limits regulatory authority through a combination of coastal setbacks (200 feet inland from any coastal feature), watersheds and use designations. North Carolina's CZB includes the 20 counties adjacent to the Atlantic Ocean or coastal sound(s) and has further delineated lands into Areas of Environmental Concern (AEC) and those lands adjacent to AEC. AEC are subject to more thorough regulatory controls. Land uses outside of the AEC that have the potential to affect coastal waters are also regulated. Alaska's CZB has three tiers based on biophysical relationships, including: the zone of direct interaction, the zone of direct influence, and the zone of indirect influence. Connecticut has a two-tiered CZB, which includes 36 coastal townships. The highest regulatory management occurs in the first tier which is delineated by 1000 feet setbacks measured from the MHW mark in coastal waters or tidal wetlands; the second tier includes the area between the first tier and the inland boundary of the 36 coastal townships.

Table 3. Coastal States and Territories Matrix

STATE*	Alaska	Alabama	California	Connecticut	Delaware	Florida	Georgia	Hawaii	Illinois	Indiana	Louisiana	Maine	Maryland	Massachusetts	Michigan	Minnesota	Mississippi	New Hampshire	New Jersey	New York	North Carolina	Ohio	Oregon	Pennsylvania	Rhode Island	South Carolina	Texas	Virginia	Washington	Wisconsin	Puerto Rico	Guam	US Virgin Islands	American Samoa	Northern Mariana Islands	Totals (# of States)	%
Entire State is Inside the CZB					•	•		•																	•							•	•	•	•	8	22.86%
CZB Determined by Elevation		•									•																									2	5.71%
Inland CZB Determined by Physical or Bio-physical Features	•		•	•				•	•						•		•				•	•	•	•	•			•			•					14	40.00%
Inland CZB Determined by Political or Geographical Features						•	•			•	•	•	•	•		•	•	•	•	•	•	•	•			•	•	•	•	•							20	57.14%
Inland CZB Determined by Region			•													•			•	•								•									5	14.29%
Varied levels of Management Approach	•			•		•	•		•		•	•		•	•				•		•				•	•	•	•					•		•	17	48.57%
Levels of Management Determined by Physical Parameters							•				•																						•		•	4	11.43%
Levels of Management Determined by Political Boundaries																									•			•							•	3	8.57%
Regulatory Authority is Limited to Specific Activities		•										•		•					•					•	•		•							•	8	22.86%
AEC Outside of Inland CZB Under Authority															•						•														2	5.71%
Direct Regulation by State Coastal Agency	•	•	•	•		•		•			•	•	•	•			•		•		•		•		•	•	•	•					•			19	54.29%
Supplementary Parish or County Programs	•	•	•	•		•	•				•	•	•	•			•			•	•	•	•											•		16	45.71%
Coastal Funds Limited by Physical Boundaries						•									•						•					•			•	•						6	17.14%
Participant in the NPS Coastal Program	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			32	91.43%
Conditional NPS Program Approval by NOAA	•	•					•	•		•	•				•		•					•	•				•		•				•			13	37.14%
Fully Approved NPS Program by NOAA			•	•	•	•						•	•	•		•		•	•	•	•			•	•	•		•		•	•	•				19	54.29%
Uses Federal Consistency Provisions	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	33	94.29%
Considering Sea Level Rise as Coastal Factor				•	•							•		•				•	•	•				•	•			•								10	28.57%

**A precusory review was performed on the 36 coastal states and territories. Therefore the absence of a mark does not necessarily indicate a states non-participation.*

Based on the success of hierarchical management in other states, a stratified CZB with management levels for regulatory permits, coastal consistency determinations, and planning is proposed for consideration in Louisiana. Clearly, the area of coastal Louisiana subject to a high level of coastal processes where activities would result in impacts to wetlands and have direct and significant impacts on coastal waters should be included within the updated CZB and should be managed by the strongest tool available, the coastal use permit (CUP) process. Those areas subject to a moderate level of coastal influence adjacent to or having a direct nexus to the CUP strata should also be managed through the coastal management program, but the nature and degree of management could be less stringent than the CUP process.

Therefore, the proposed hierarchical management approach for coastal Louisiana would include management authority defined for areas subject to high and moderate levels of coastal influence. Each of the two management areas would be defined by science-based parameters that describe the level of application of the enforceable policies and mechanisms of the state's coastal management program. Areas not in the coastal zone or the coastal management area contiguous to the coastal zone, but contained within or adjacent to watersheds which have potential coastal impacts would be designated as the watershed planning area; activities in the planning area would not be subject to the enforceable policies of the SLCRMA unless an activity's specific effect on coastal waters was demonstrated. However, within the watershed planning area, the coastal management program might choose to participate in coastal planning efforts, with or without contributing funding, if the particular planning effort will have coastal ramifications.

Nomenclature from Alaska's CZMP was adapted for use in defining hierarchical management for Louisiana. The proposed hierarchical management for coastal Louisiana is described below.

2.2.1 Coastal Use Permit (CUP) Management Area (Zone of Direct Interaction)

Regulatory management by means of the Coastal Use Permitting (CUP) procedure would be the primary management tool used to regulate activities having a direct and significant impact on coastal waters in this zone of direct interaction. Additional management tools would also be used when appropriate. This portion of the newly defined coastal zone would include most of the presently defined coastal zone plus any contiguous wetlands which are directly part of, or connected to, the existing estuarine system of south Louisiana.

The boundary for the CUP or regulated coastal zone area would be based on the results of the science-based analysis and would include to the maximum extent practical all areas subject to a high level of coastal processes. The CUP management area would be included within the updated CZB and would be subject to the permit requirements of the SLCRMA.

2.2.2 *Intergovernmental Coordination (IGC) Management Area (Zone of Direct Influence)*

The primary management tool in this zone of direct influence would be by means of intergovernmental coordination (IGC). Activities by private individuals, companies, and landowners would not be subject to management policies directly. The management goal would be to implement Louisiana's Comprehensive Master Plan for a Sustainable Coast through use of intergovernmental coordination mechanisms already in the SLCRMA by their application to governmental bodies at the state and federal level as provided for in the CZMA. Federal consistency review (15 CFR § 930.1 *et seq*.) and other management tools would also be used when appropriate.

The IGC management area, the contiguous area of moderate coastal influence adjacent to the coastal zone, would include areas adjacent to wetlands but at an elevation that generally excludes them from being considered subject to coastal use permitting. It would also include areas that could reasonably be subjected to sea-level rise and storm surge. The management mechanism for the coordination area would be through review of Corps of Engineers, or other federal and state permits under the federal permit or license provisions, federal assistance, or direct federal action provisions of the CZMA. This mechanism would provide the state the option of influencing the outcome of proposed activities that are not subject to coastal use permit requirements when they were in conflict with the state Master Plan.

Activities within the IGC area, particularly those activities related to water quality, hydrologic modifications, sediment budgets, or flood damage reduction, can affect coastal waters and coastal resources of the state. Delineation of an IGC management area would provide a focus area for more intense review of governmental activities in this zone of direct influence, but would in no way limit the authority granted to the Louisiana CZMP through the federal consistency provisions (Section 307 of the federal CZMA), or through any provisions of the existing SLCRMA, to review an activity within or outside the coastal zone for consistency with the Louisiana Coastal Management Program when that activity affects any land or water use or natural resource of the coastal zone.

The boundary for the IGC management area would be based on the results of the science-based analysis and would include to the maximum extent practical all areas subject to a moderate level of coastal processes. The IGC management area would not be included within the updated coastal zone, but governmental activities that could potentially affect hydrology or proposed Master Plan measures would nonetheless be subject to management in accordance with existing authorities and state law.

2.2.3 *Watershed Planning Management (WSP) Area (Zone of Indirect Influence)*

Non-regulatory management through incentive programs and planning initiatives would be utilized in the Watershed Planning (WSP) management area. Designating the zone of indirect influence as a WSP management area would enhance the state Coastal Nonpoint Pollution Control Program (CNPCP) by increasing awareness of the area's importance as a buffer to prevent pollutants from entering the coastal zone. Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) requires states and

territories with approved CZM programs to develop a CNPCP to address nonpoint pollution problems in coastal waters. The primary goals of Louisiana's CNPCP are to: 1) Identify Best Management Practices (BMPs) appropriate for all applicable pollutant source categories (i.e., agriculture, forestry, hydromodifications, marinas and recreational boating, urban runoff, and wetlands, riparian areas, and vegetated treatment systems), and 2) Implement initiatives in public education, technical assistance, and development of enforcement protocols in order to get BMPs implemented on the land. The CNPCP does not require compliance through permitting but encourages the implementation of BMPs in conjunction with such agencies as the LDEQ and Louisiana Department of Agriculture and Forestry (LDAF).

This zone would be the geographic area adjacent to the CUP and IGC areas where only certain activities affect the coastal zone and which are subject to coastal processes only in extreme events related to climate change, such as inundation by a severe hurricane or other rainfall event. State influence over land use activities in this management area would be through incentive programs or adoption of watershed or other land use plans. In rare instances, certain uses in the WSP area, such as a major hydrologic modification, could still be subject to review for consistency with the Louisiana coastal management program. The WSP management area would not be included within the updated CZB and would not be subject to the management requirements of the SLCRMA unless an activity specific effect on coastal waters was demonstrated.

2.3 Data Set Selection

When the CZB was first proposed by McIntire et al. (1975), 22 biophysical parameters were evaluated to determine if there was any one parameter that controlled the distribution of any or all of the other parameters. Best-fit correlations showed that the line of Pleistocene/Recent contact, which closely fits the 5-foot contour line, provided the best approximation of the boundary line. Because the 5-foot contour line is not easily recognizable in most areas of Louisiana, features such as township lines, rights-of-way, or other identifiable features close to the 5-foot contour were used to define the boundary.

2.3.1 Review and evaluation of biophysical parameters from the 1975 study

Many parameters were evaluated for determination of the CZB when the study was first implemented in 1975 and, of the parameters evaluated, some were eliminated due to lack of data or lack of relevance. When completed, twenty-two parameters were evaluated in the study to determine the inland extent of coastal processes.

1. Geology – Pleistocene/Recent deposition line of contact
2. Elevation – 5- and 25-foot contours
3. Soils – Wetland/Non-wetland boundary

4. Vegetation – Wetland/Non-wetland boundary
5. Hundred-Year Flood and Tidal Inundation Level
6. Salinity – Inland intrusion
7. Occurrence of *Rangia cuneata* (Brackish water clam)
8. Inland records of *Callinectes sapidus* (Blue crab)
9. Inland records of *Dasyatis sabina* (Atlantic stingray)
10. Inland records of *Trinectes maculates* (Hogchoker)
11. Inland records of *Strongylura marina* (Atlantic needlefish)
12. Inland records of *Mugil cephalus* Linnaeus (Striped mullet)
13. Range of *Scalopus aquaticus* (Eastern mole)
14. Range of *Cryptotis parva* (Least shrew)
15. Range of *Blarina brevicauda* (Short-tailed shrew)
16. Range of *Ondatra zibethicus* (Muskrat)
17. Range of *Urocyon cinereoargenteus* (Gray fox)
18. Range of *Sceloporus undulatus* (Fence lizard)
19. Range of *Micrurus fulvius* (Coral snake)
20. Range of *Virginia striatula* (Rough earth snake)
21. Range of *Storeria occipitomaculata* (Red-bellied snake)
22. Coastal hiatus of spring migrating birds

These parameters, as used in 1975 to delineate the original proposed boundary, are discussed in more detail below.

2.3.1.1 Geology – Pleistocene/Recent deposition line of contact

The Pleistocene is the epoch from about 2.6 million to 12,000 years before present and covers the world's recent period of repeated glaciations. The Pleistocene epoch is followed by the Holocene epoch. Most surface exposures in Louisiana consist of Pleistocene and Holocene sediment. Holocene deposits include alluvium of the Mississippi, Red, Ouachita, and other rivers and smaller tributaries and coastal marsh deposits (Mossa 1996). Holocene deposits occupy about 55% of the surface of Louisiana. Pleistocene deposits consist of sand, gravel, and mud, but underlie raised, flat surfaces with varying

degrees of tilt and dissection depending on their relative age. These deposits occupy about 20% of the state's surface and are remnants of pre-existing flood plains, forming along the major rivers in north Louisiana and coast-parallel belts in southern Louisiana. Pleistocene deposits were raised as the coastal plain tilted in response to downwarping of the crustal floor of the Gulf of Mexico. A topographic break occurs at the contact between the Pleistocene and Holocene deposits and this break generally trends in an east-west direction across the state between river basins and north-south along basin corridors. The line of contact is useful in defining the distinction between coastal and non-coastal and wetland and non-wetland characteristics (McIntire et al. 1975). Data for determining the line of contact were obtained from Saucier 1974. The accuracy of the map depicting the Pleistocene/Recent boundary is limited by the lack of detail at the original mapping scale of 1:1,267,200.

2.3.1.2 *Elevation – 5- and 25-foot contours*

The 5- and 25-foot contour lines were derived from official maps at the scale of 1:24,000 (Louisiana Quadrangle Maps). The 5-foot contour is the lowest elevation delineated on the 1:24,000 maps produced by the US Geological Survey. The line was identified on each quadrangle map and transferred to the 1:250,000 base map. Considerable smoothing was conducted, as the degree of detail available at 1:24,000 could not be represented at 1:250,000. The 25-foot contour line is the lowest elevation delineated on the 1:250,000 maps produced by the US Geological Survey. The 25-foot contour line was taken directly from these maps. The 5-foot contour line was found to generally follow the line of Pleistocene/Recent contact.

2.3.1.3 *Soils-Wetland/Non-wetland boundary*

Data for wetland (hydric) and non-wetland (non-hydric) soils were derived from the U.S. Soil Conservation Service parish soil maps. Some soils associations could not be placed into a definite category because they contained series of both hydric and non-hydric soils and, thus, they were categorized as transitional and were mapped with Pleistocene or Recent soils based on the dominant percentage of each type. Those transitional soils associated with the Teche-Mississippi Meander Belt on the western margin of the Atchafalaya Basin were so complex that they could not be logically mapped as either hydric or non-hydric. In general, the boundary between hydric and non-hydric soils was closely correlated to the line of Pleistocene/Recent contact and the 5-foot contour line.

2.3.1.4 *Vegetation – Wetland/Non-wetland boundary*

Vegetation distribution information was collected from several sources (Chabreck 1968, 1972, Palmisano 1970), refined by use of National Aeronautics and Space Administration (NASA) high altitude imagery, and mapped at a scale of 1:250,000. No attempt was made to separate marsh and swamp vegetation because other boundary criteria extended above the line separating the two zones. As with the boundary between hydric and non-hydric soils, the wetland/non-wetland vegetation boundary was closely correlated to the line of Pleistocene/Recent contact and the 5-foot contour line.

2.3.1.5 *Hundred-Year Flood and Tidal Inundation Level*

Data concerning the 100-year flood and tidal inundation level provide supporting information for inland coastal zone boundary delineation. Areas inundated by the 100-year flood were plotted on a map at a scale of 1:250,000 based on information compiled by the United States Geological Survey (USGS; 1969-1974) and the USACE in 1:62,500 and 1:24,000 scale maps. Flood information was also obtained from a Federal Insurance Administration Type 5 study made by the USACE (1970), which outlines the flooded areas for 100-year and standard project hurricanes on flood hazard maps and which provides flood height-frequency relationships at certain locations. Extreme water levels reach above the 5-foot contour, particularly in river floodplain areas. The tide height-frequency data were obtained from USGS stream gauge records, USACE stream gauge records, personal observations, and high water marks left by floods. Flood peaks were plotted on a vertical axis against stream miles to obtain a stream bed profile to indicate the general direction of valley flood flow. In general, the 100-year flood and tidal boundary lies between the 10 and 15-foot elevation contours (above mean sea level) in areas inland from the marsh.

2.3.1.6 *Salinity – Inland intrusion*

Inland intrusion of saltwater was included in determining the coastal zone boundary because recording stations along multiple rivers (i.e., Sabine, Calcasieu, Mermentau, Vermilion, Atchafalaya, Mississippi, Amite, Tangipahoa, Tickfaw, Tchefuncta, Pearl, Bayou Bonafuca-Bayou Liverty, and Bayou Lacombe) show pulses of saltwater which extend inland for several miles. Both published and unpublished data were collected, compiled, and analyzed from many different sources, including the USACE (1963), USGS (1969, 1972), Louisiana Wildlife and Fisheries Commission, the Texas Water Quality Board, and the Sabine River Authority of Texas.

2.3.1.7 *Occurrence of Rangia cuneata (brackish water clam)*

This clam, although it can survive in freshwater, depends on the marine habitat during the early stages of its development and, thus, it was chosen as an indicator of the general extent of inland marine influence at both the present (i.e., 1975) and recent historical times. Only those areas useful in delineating the inland extent of saline waters were mapped. Surveys were conducted west of the Atchafalaya River by Hoese (1972) and in Lakes Pontchartrain and Maurepas by Tarver and Dugas (1973). Point records were gleaned from the literature and from personal interviews. Other data on historical range of the clam were derived from data on Indian shell middens, which are refuse heaps of shucked shells at dwelling sites (Kane 1961, Kniffen 1936, 1938).

2.3.1.8 *Inland records of crabs and marine fish*

Although some species inhabit freshwater areas, survival during some part of their life cycle ties them to the marine environment. Thus, distribution of these species can be a good indicator of areas influenced by coastal processes. Published records of inland occurrence of blue crabs are sparse (Jawarski 1972,

Parrett 1967), and therefore many of the records on the range map produced come from interviews with local residents. Data for inland records of marine fishes were obtained from published reports and interviews with local residents.

2.3.1.9 *Mammal and reptile ranges*

Distribution of five species of mammals and four species of reptiles whose range boundaries showed a coast-wide orientation were selected because of their preference for non-wetland environments. Data for mammal and reptile ranges were obtained from published and unpublished reports (Dundee and Rossman 1989, Lowery 1974).

2.3.1.10 *Coastal hiatus of spring migrating birds*

Between approximately April 15 and May 15, the northern Gulf coast is used by migratory birds. Birds select appropriate habitat while aloft (usually inland forested areas) and the collective response of a number of species indicate the boundary between coastal and inland areas. Data on landing areas of trans-Gulf migrants in southern Louisiana were taken from radar displays of the WSR-57 radars located at the National Weather Service stations in New Orleans and Lake Charles, Louisiana. Ninety-five trans-Gulf flights were used in the analysis.

2.3.2 Rationale for integration of data from 1975 and current study

Because technology has improved since 1975, more data are available today for the selected parameters than were available 30 years ago. This is especially true for spatial data, such as Light Detection And Ranging (LIDAR) and Geographic Information System (GIS), which were extremely useful for completing this project. Table 4 provides a comparison between data utilized in 1975 and data currently available. Much of the data used in the 1975 study were not included in the current study, either because another data source was found to be better suited to the project or because data were available that were not available in 1975.

For the delineation of the line of contact between Pleistocene and Holocene sediments, the original study utilized a map provided by Saucier (1974). For the current study a GIS layer (USGS 1998) was available that illustrated the boundary between the two depositional periods. This GIS layer provided a more accurate delineation of the line than was available from Saucier (1974).

To identify the 5-foot contour in the 1975 study, the line was transferred from quadrangle maps. LIDAR data was available for the current study showing contour lines in 1-foot increments and these data are more accurate than data available in 1975. Eight- and 10-foot contours from LIDAR data were also used in the current study, but these data were not available in the 1975 study.

In the 1975 study, soils data were utilized from Louisiana parish soil maps. These data were used as an indicator of wetlands and uplands (i.e., hydric and non-hydric soils). Because extensive data specifically

delineating vegetation type now exist, the soils data were considered unnecessary, and were not included in the current study. In the 1975 study, data from NASA high altitude false-color infrared photography were used to identify coastal marshes and swamps, but no attempt was made to separate the two. Although recent data exist for coastal vegetation types (Sasser et al. 2008), the data set does not extend past the current CZB. In some parishes, the data do not even extend to the current boundary. For the present study, data from the Multi-Resolution Land Characteristics Consortium (MLCD) – National Land Cover (NLC) classification were used because these data more fully covered the area of interest than the Sasser et al. (2008) data.

Areas inundated by the 100-year flood and tidal inundation were plotted on a map based on information compiled by the USGS and the USACE for the 1975 boundary delineation. Instead of using these data for the current study, data generated by the National Hurricane Center (NHC) using the SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model to estimate storm surge heights and winds were used (http://www.nhc.noaa.gov/HAW2/english/surge/slosh.shtml). This model utilizes information about air pressure, hurricane size and speed, and winds and displays color-coded storm surge heights for a particular area in feet above the reference level (the National Geodetic vertical datum). The SLOSH model is generally accurate within plus or minus 20 percent.

For inland intrusion of salinity, point-source data were examined and plotted on a map for the 1975 boundary delineation. Because salinity can vary with season and weather (e.g., hurricane or storm passage) and because long-term continuous monitoring were not available, point-source salinity was not considered a reliable indicator of long-term patterns. In addition, salinity was used primarily to indicate areas of intermediate, brackish, and salt marsh. However, vegetation data are considered to be a better indicator of salinity than point-source data. As such, the NLC data has been used for the current study.

In the 1975 study, habitat data for *Rangia cuneata*, *Callinectes sapidus*, and various fishes were evaluated to help delineate the inland extent of marine influence along the coast, but these data were spotty and ranges of different species can vary from year to year. Habitat data for mammals, reptiles, and birds were also utilized to help delineate non-wetland areas, but the same limitations as previously mentioned for *R. cuneata* and *C. sapidus* apply. Thus, these data were not included in the present study, but rather the extensive vegetation data available for the region were relied upon to delineate fresh and saltwater (including intermediate and brackish) habitats.

2.3.3 Additional Data Included in the Current Study

Several types of data were available that were not available in 1975. These data include LIDAR elevation data, Natural Resource Conservation Service (NRCS) State Soil Geographic (STATSGO) data, and sea-level rise predictions. These data and their sources are described in the following section.

Table 4. Data sources for parameters included in the 1975 study and the current study to delineate the coastal zone boundary.

Parameter	1975 Study	Current Study
8-digit watershed classification	Data not included	Watershed layer for the Louisiana GIS data set
Pleistocene/Recent contact	Saucier 1974	Louisiana GIS Digital Map, May 2007; Louisiana Geology, Geographic NAD83, NWRC (1998) [geology_NWRC_1998]
5- and 25-foot contours	1:24,000 and 1:62,000 scale maps	5-foot contour from Louisiana State LIDAR, 2003; 25-foot contour not included
8- and 10-foot contours	Data not included	8-foot contour and 10-foot contours, Louisiana State LIDAR, 2003
Hydric/Non-hydric soils	SCS parish soil maps	Data not included
Wetland/Non-wetland vegetation	Chabreck 1968, 1972, Palmisano 1970	MLCD National Land Cover Data, wetland vegetation classifications
100-year flood/tidal level	USGS and USACE maps (1969-1974)	Used inland extent of storm surge based on NOAA SLOSH modeling of composite worst-case scenario storm surges (see below)
Salinity	USGS 1969, 1972, USACE 1963, and others	Data not included
Occurrence of brackish water clam	Hoese 1972, Kniffen 1936, 1938, Tarver 1973	Data not included
Inland record of blue crab	Interviews with local residents, Jaworski 1972, Perrett 1967	Data not included
Inland records of marine fish	Numerous published reports and interviews with local residents	Data not included
Mammal ranges	Lowery 1974	Data not included
Reptile ranges	Dundee and Rossman unpublished report	Data not included
Coastal migration of birds	National Weather Service radar displays	Data not included
Boundary of the Coastal Non-point Source Pollution Control Program	Data not included	CMD LDNR (1995)
Current Coastal Zone Boundary	Data not included	La. R.S. 49:214.24
Inland extent of storm surge	Data not included	NOAA MOMS map generated from SLOSH model outputs
Riparian floodplains	Data not included	STATSGO soil data
Sea-Level Rise	Data not included	IPCC predictions

2.4 Description of Data

2.4.1 Watershed Boundary Data

A watershed is an area of land that drains into a river or other water body. Watersheds often cross political boundaries and several watersheds in Louisiana are shared with the neighboring states of Arkansas, Mississippi, and Texas. The Mississippi River watershed includes all or parts of 31 states. The USGS Office of Water Data Coordination, the U.S. Water Resources Council, and the USGS Resources and Land Information Program initiated the original production of the standard map series called "hydrologic unit maps," which presented codes, names, and boundaries of large watersheds (called hydrologic units) in the U.S. and the U.S. territories in the Caribbean areas (Wilson et al. 2008). In that USGS national map series, the U.S. is divided into 21 major regions and these 21 regions were then subdivided into 222 subregions, 352 accounting units, and 2,150 cataloging units (each of these subdivisions also being represented by 2-digit numbers) to establish the original 8-digit hydrologic unit codes (HUC). For example, for the 8-digit cataloging unit 08060201, the 2-digit region is 08, the 4-digit subregion is 0806, and the 6-digit accounting unit is 080602 (Wilson et al. 2008).

The Louisiana Department of Environmental Quality (LDEQ) uses a coding system similar to that described above. However, the hydrologic coding system for the LDEQ watershed data is based on subdivisions of the 12 major watersheds or river basins (Table 5) into smaller sub-watersheds or management segments. A six-digit number describes the geographic extent of a management area representing the hydrologic basin, watershed segment, and sub-segment. The first two digits represent the hydrologic river basin followed by four more digits that subdivide the basin into two more increments. The hydrology is described with regard to man-made features such as dams and weirs. This coding system, specific to Louisiana, was developed in response to the Clean Water Act of 1972, and is still in use today for many of the state's regulatory programs.

Table 5. Major Watersheds of Louisiana

Basin Name	Basin No.
Atchafalaya	1
Barataria	2
Calcasieu	3
Lake Pontchartrain	4
Mermentau	5
Vermilion-Teche	6
Mississippi	7
Ouachita	8
Pearl	9
Red River	10
Sabine River	11
Terrebonne	12

Comparison between the HUC coding system and the LDEQ coding system was made and the greatest conformity between watershed areas was between the LDEQ river basins and a grouping of the 8-digit HUCs (see Figure 3). While the USGS HUC coding system is the newest generation of watershed, and may become the standard in the future, the LDEQ watershed coding system was used for this study to maintain geographic continuity with other state level regulatory and management policies.

Of the 12 major watersheds defined by the LDEQ, 10 ultimately drain directly into state coastal waters by their major rivers (or basins), including the Atchafalaya, Barataria Basin, Calcasieu, Mermentau, Mississippi, Pearl, Pontchartrain, Sabine, Terrebonne Basin, and Vermilian-Teche (Figure 4). Because these 10 watersheds drain into the Gulf, their waters have the capacity to directly and significantly impact coastal waters. Thus, delineation of the CZB began at the broadest scale where those 10 watersheds were defined as the study area from which to delineate a coastal zone.

As described previously, the line of contact between Pleistocene and more recent (Holocene) sediments provides a basic break between coastal and non-coastal areas. The National Wetlands Resource Center (NWRC) 1998 geology data layer from the May 2007 Louisiana GIS Digital Map compilation DVD was used for the current study. The data set was digitized from a scanned version of a 1:500,000-scale hard copy map of the Geologic Map of Louisiana developed by the Louisiana Geological Survey. The classified data were derived from actual field identification and sampling performed by the Louisiana Geological Survey. These data cover the entire state of Louisiana (USGS, 1998).

Figure 3. Comparison of Watershed Basins

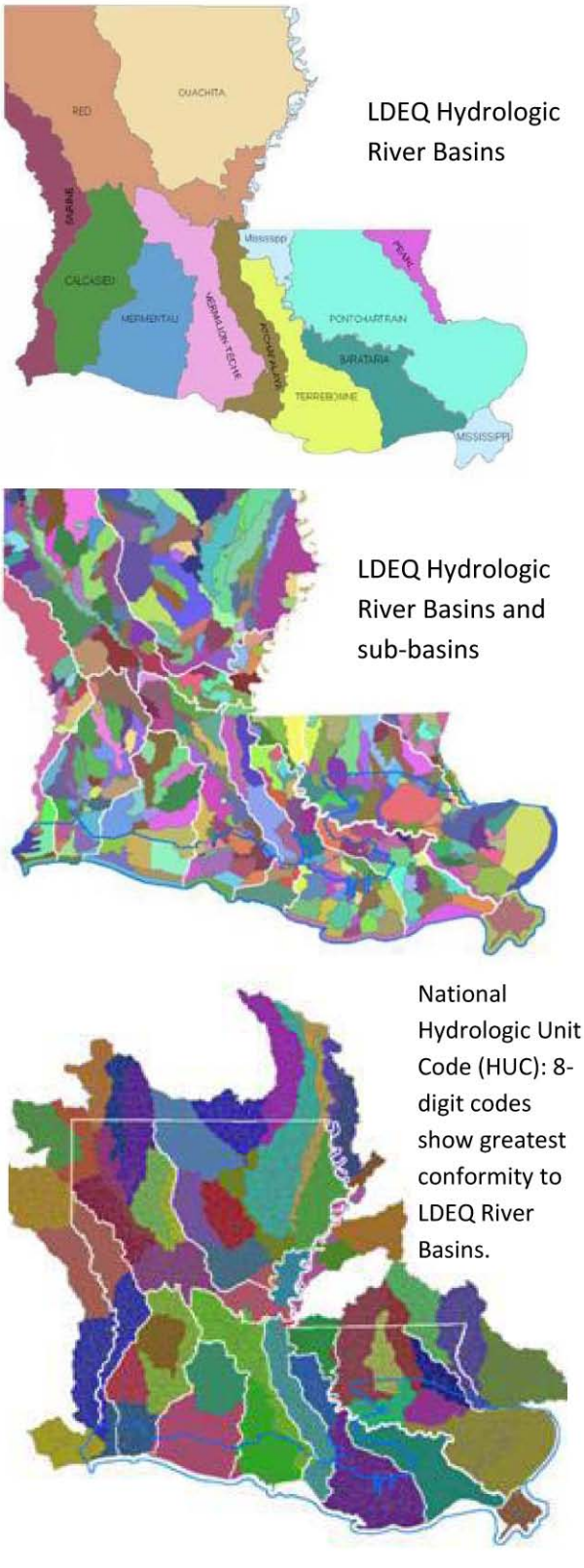
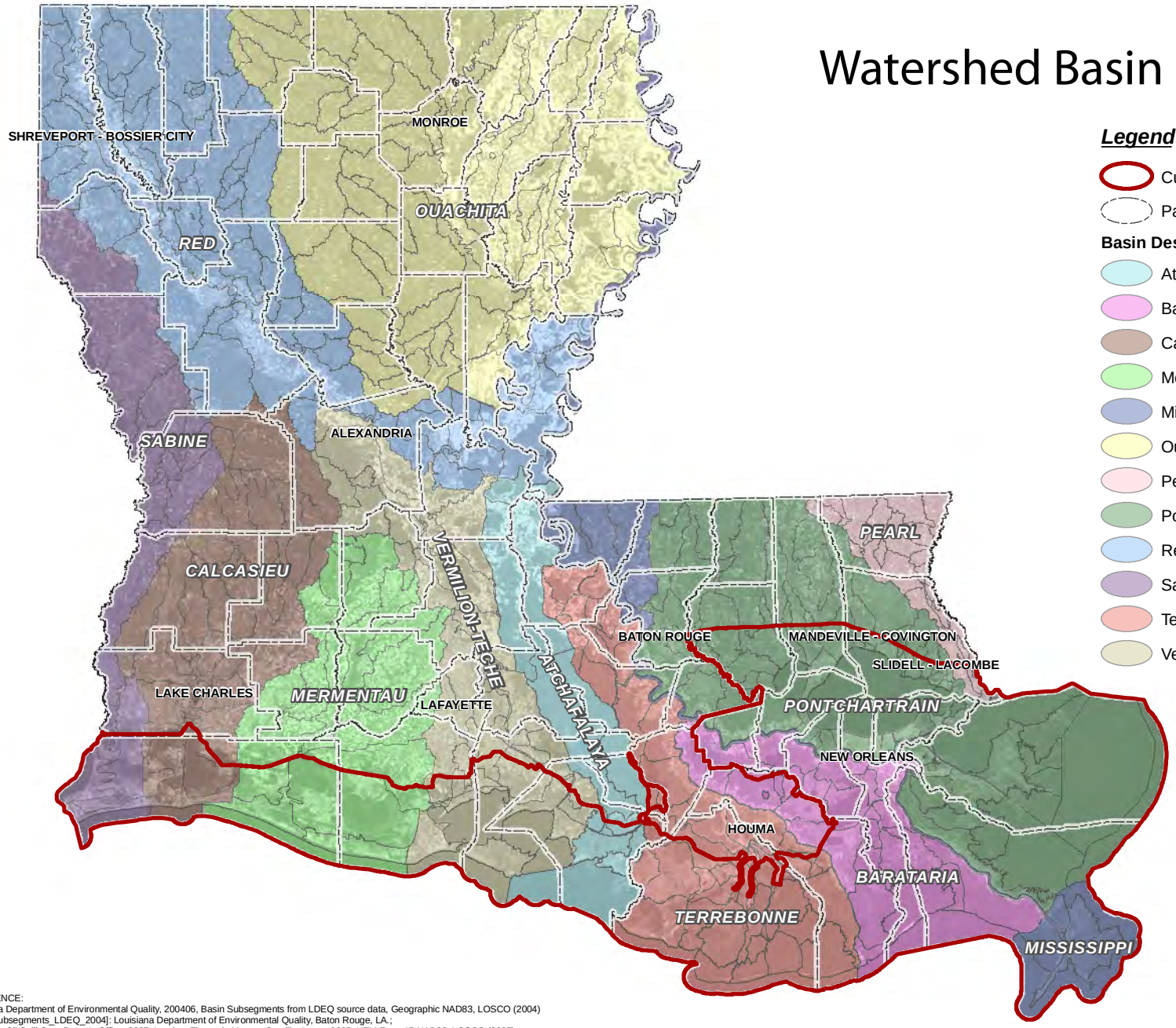


Figure 4
Watershed Basin Boundaries



Legend

- Current Coastal Zone Boundary
- Parish Boundary

Basin Designation

- Atchafalaya
- Barataria
- Calcasieu
- Mermentau
- Mississippi
- Ouachita
- Pearl
- Pontchartrain
- Red
- Sabine
- Terrebonne
- Vermilion-Teche

REFERENCE:
Louisiana Department of Environmental Quality, 200406, Basin Subsegments from LDEQ source data, Geographic NAD83, LOSCO (2004) [basin_subsegments_LDEQ_2004]: Louisiana Department of Environmental Quality, Baton Rouge, LA.;
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0002_watersheds.mxd

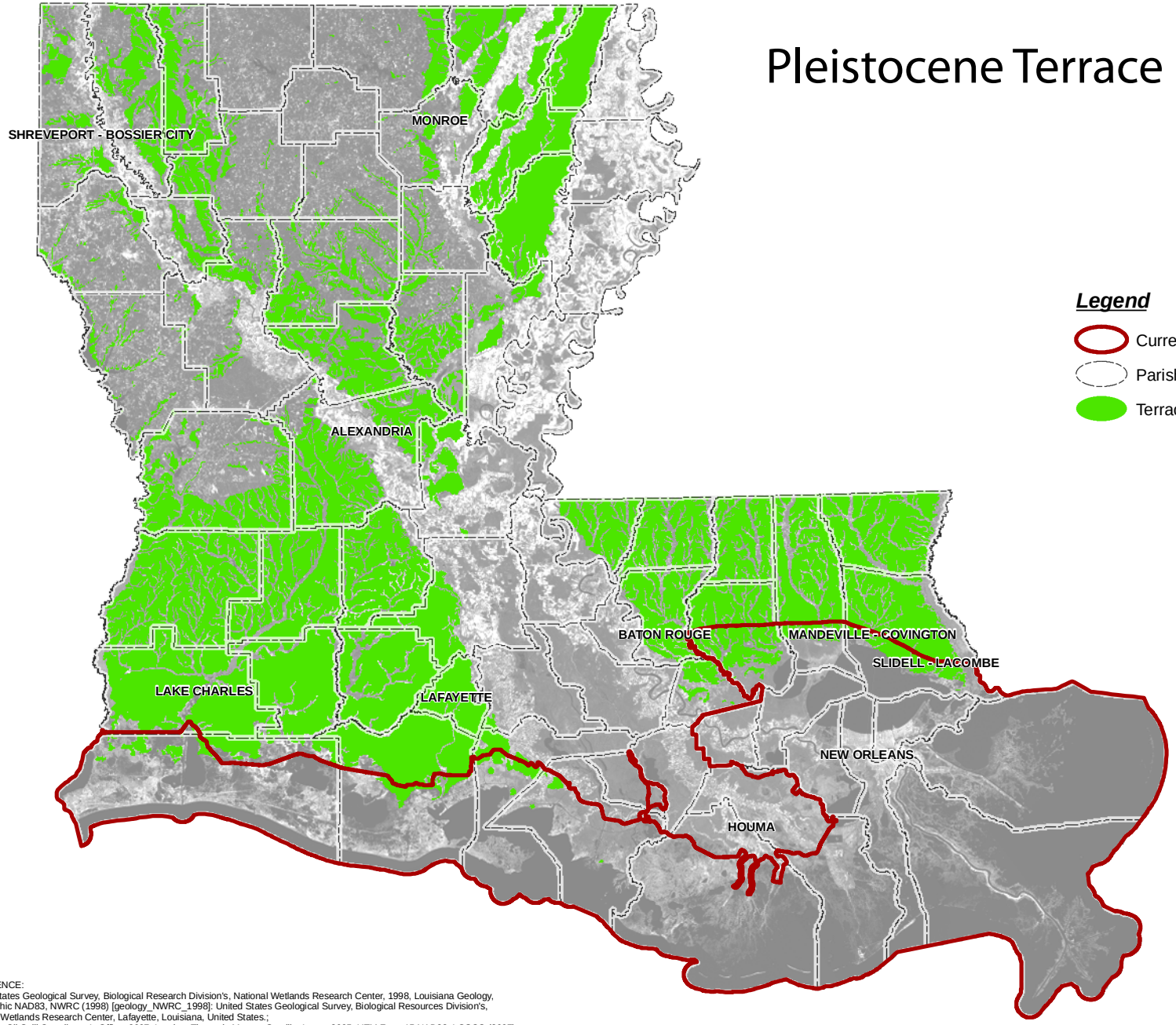
The Pleistocene terrace layer of the data set was used to determine the break between Pleistocene and Holocene sediments (Figure 5). These data show a clear line of contact along the eastern and western areas of the delta, but in the central part of the state alluvial Holocene sediments extend far inland along the Mississippi floodplain. In order to draw the line of contact in the floodplain, Louisiana's Coastal Wetlands Conservation Plan (CWCP) inland boundary, which closely approximates the Louisiana Coastal Area (LCA) Ecosystem Restoration Study boundary line, was also used. The northernmost CWCP designated boundary overlaps the current CZB, falling in and outside of that boundary as determined by the inland limit of tidally influenced fresh marsh and bald cypress/tupelo gum swamps (LDNR 2009; Figure 6).

2.4.2 Description of elevation data set

NOAA defines LIDAR as a remote sensing system used to collect topographic data. This technology is used by NOAA and the NASA scientists to document topographic changes along shorelines. These data are collected with aircraft-mounted lasers capable of recording elevation measurements at a rate of 2,000 to 5,000 pulses per second with a vertical precision of 15 centimeters (6 inches). The most commonly used source of LIDAR data is dated 2003 and is obtained from the USGS and Louisiana State University's Atlas website (http://atlas.lsu.edu/). The 2003 LIDAR data were used to evaluate elevation for the current study (Figure 7). Five-, eight- and ten-foot elevation contours were evaluated. The five-foot contour was used because this elevation is generally accepted as the breakpoint between coastal wetland and non-wetland areas. The eight- and ten-foot elevation contours were considered when defining the coastal zone because of the potential for sea-level rise to change coastal land elevation. If the "worst case" predictions of eustatic sea-level rise are realized, then land which is currently at an elevation of 5 feet will be at an elevation of 2 feet by the year 2100. If this occurs, land that is currently at an elevation of 8 feet will have an elevation of 5 ft by 2100 and land that currently has an elevation of 10 feet will have an elevation of 7 feet by 2100. Consideration of changes in sea-level rise are important when delineating a new coastal boundary because, particularly in Louisiana, changes in sea level will have significant impacts on coastal areas.

It should be noted that while LIDAR data are extremely convenient and typically accurate to plus or minus six inches, the data are not error free especially in densely developed areas where buildings and man-made structures interfere with the detection of true ground elevation. In the absence of ground-truthed data, which have a much greater degree of accuracy but are expensive to collect, LIDAR data are widely used and accepted as a common source for topographic data.

Figure 5
Pleistocene Terrace Boundaries



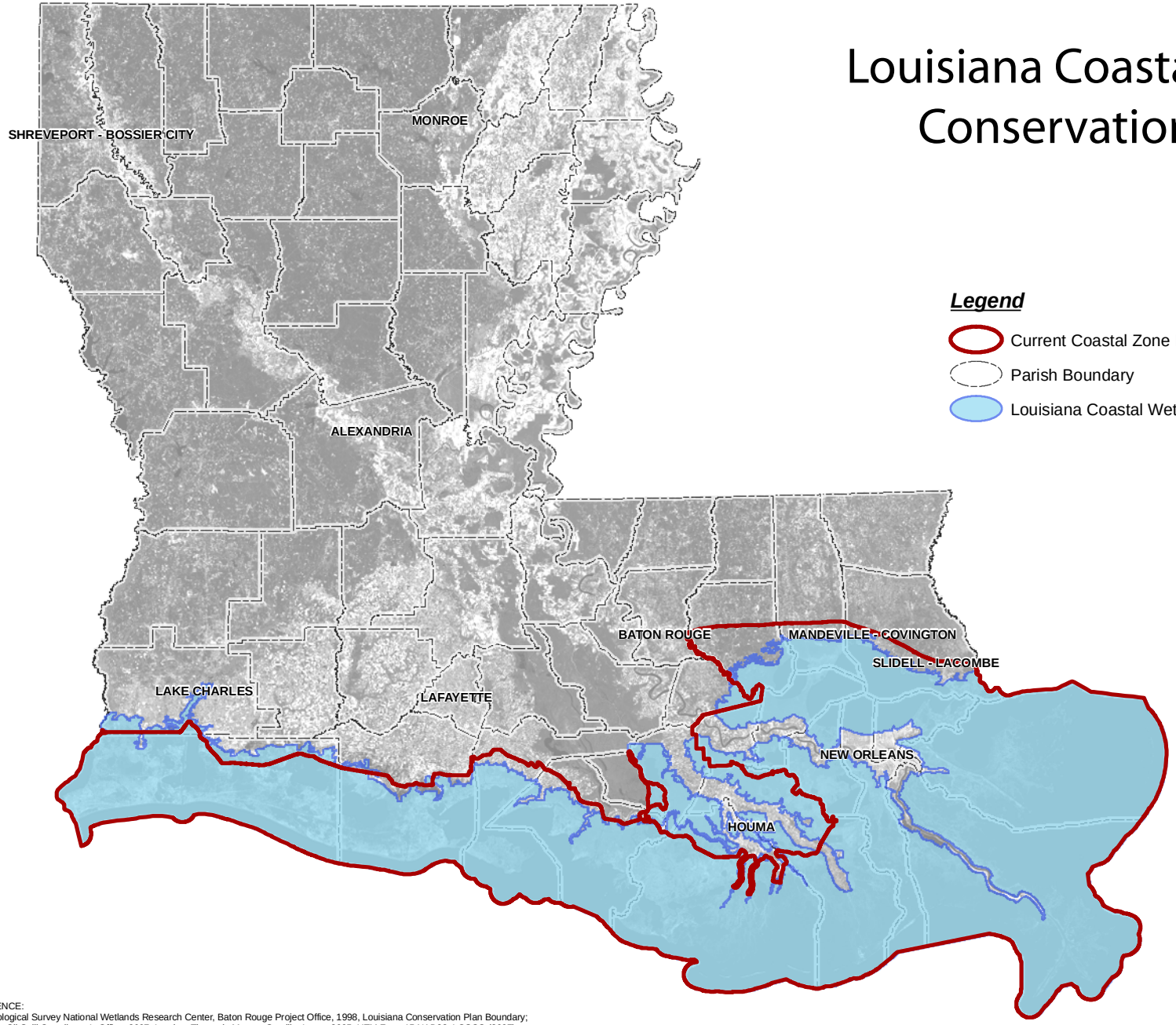
Legend

- Current Coastal Zone Boundary
- Parish Boundary
- Terraces

REFERENCE:
United States Geological Survey, Biological Research Division's, National Wetlands Research Center, 1998, Louisiana Geology, Geographic NAD83, NWRC (1998) [geology_NWRC_1998]: United States Geological Survey, Biological Resources Division's, National Wetlands Research Center, Lafayette, Louisiana, United States.;
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0003_terraces.mxd

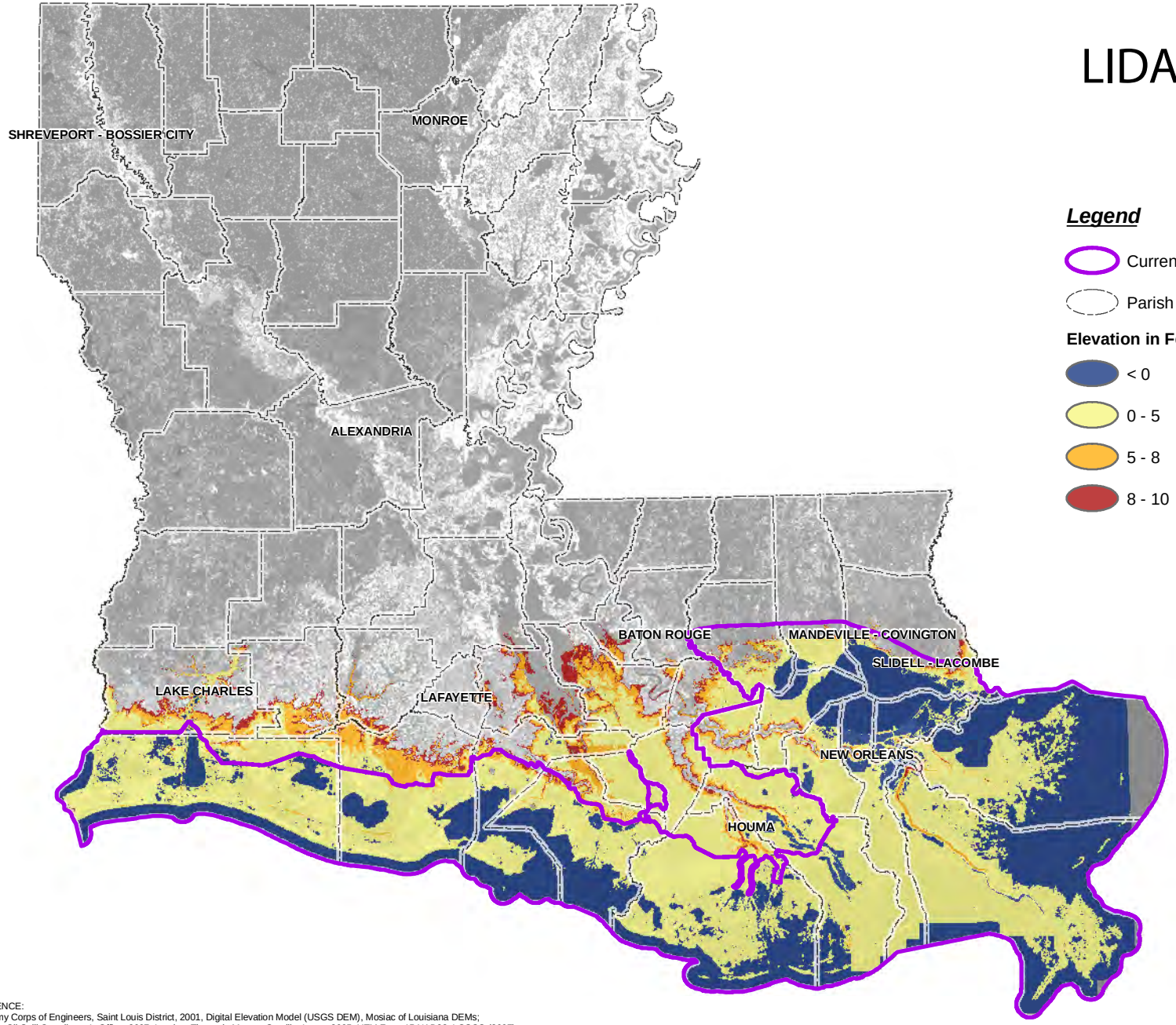
Figure 6
Louisiana Coastal Wetlands Conservation Boundary



REFERENCE:
U.S. Geological Survey National Wetlands Research Center, Baton Rouge Project Office, 1998, Louisiana Conservation Plan Boundary; Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0004_lca_conservation.mxd

Figure 7
LIDAR Elevation



Legend

- Current Coastal Zone Boundary
- Parish Boundary

Elevation in Feet

- < 0
- 0 - 5
- 5 - 8
- 8 - 10

REFERENCE:
U. S. Army Corps of Engineers, Saint Louis District, 2001, Digital Elevation Model (USGS DEM), Mosiac of Louisiana DEMs;
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007)
[landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0005_lidar.mxd

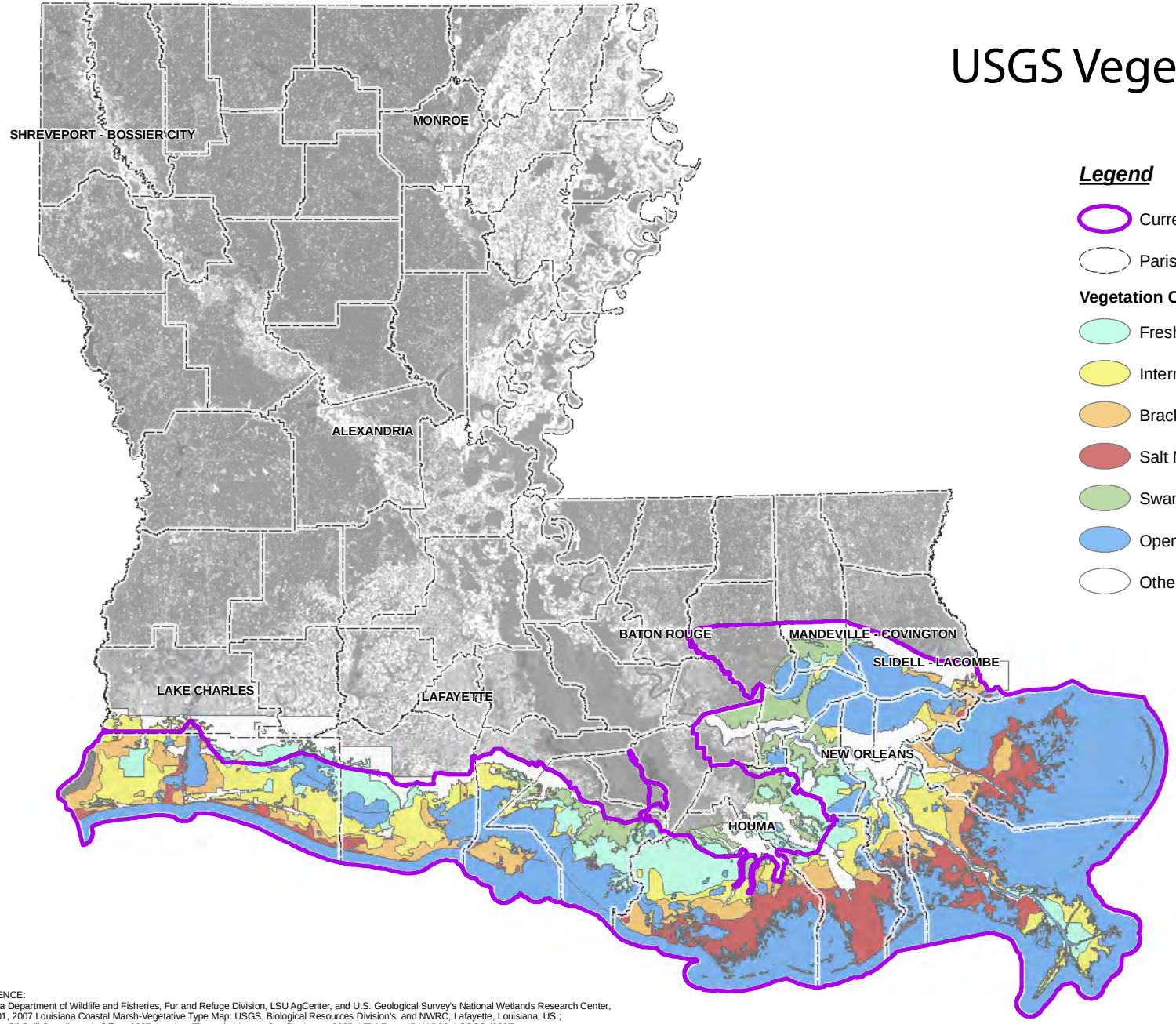
2.4.3 Description of vegetative land cover data sets

The primary vegetation data sources selected for evaluating the Louisiana CZB were the USGS marsh type classification maps and the MLCD NLC data. The USGS data set encompasses the southern extent of Louisiana (Figure 8) and depicts fresh, intermediate, brackish, and saline marsh. The data were collected by recording vegetation type at pre-determined points along north to south ground transects at evenly spaced intervals. Ground truth points were interpolated and converted into digital polygons that represent marsh type for different years, including 1949, 1968, 1978, 1988, and 2007. The marsh change data layers were derived from digital change detection between years.

The MLCD is composed of several federal agencies working together to provide land cover data to the nation. Some of the federal entities include the USGS, Environmental Protection Agency (EPA), NOAA, U.S. Forest Service (USFS), NASA, U.S. Fish and Wildlife Service (USFWS), and NRCS. The NLC data set is a result of multivariate statistical analysis of digital brightness values derived from a satellite sensor. It characterizes the land cover of Louisiana from a regional perspective for year 2001 (Figure 9). Its native digital format can discern land cover types by its spectral reflectance properties using color infrared light. The NLC data set has fifteen land cover classifications, which include nine vegetative attributes.

The MLCD data are a result of multivariate statistical analysis of digital brightness values. A pixel representing 30 square meters on the earth's surface is classified into a land cover category. Thirty square meter representation is intended to capture general categories such as wetlands, forests, and urban developed land cover as opposed to the more specific USGS marsh type classification. The NLC emergent herbaceous wetlands land cover category used for this study is roughly equivalent to the fresh, intermediate, brackish and salt marsh categories in the USGS data set (Figure 10). Although collected using different methods, the NLC satellite sensor and USGS marsh type data can be integrated to convey a more comprehensive evaluation of Louisiana's coastal zone. However, for the purposes of this study, only the NLC data set was used because it covered more area than the USGS data set, which primarily characterized marsh vegetation below the current CZB.

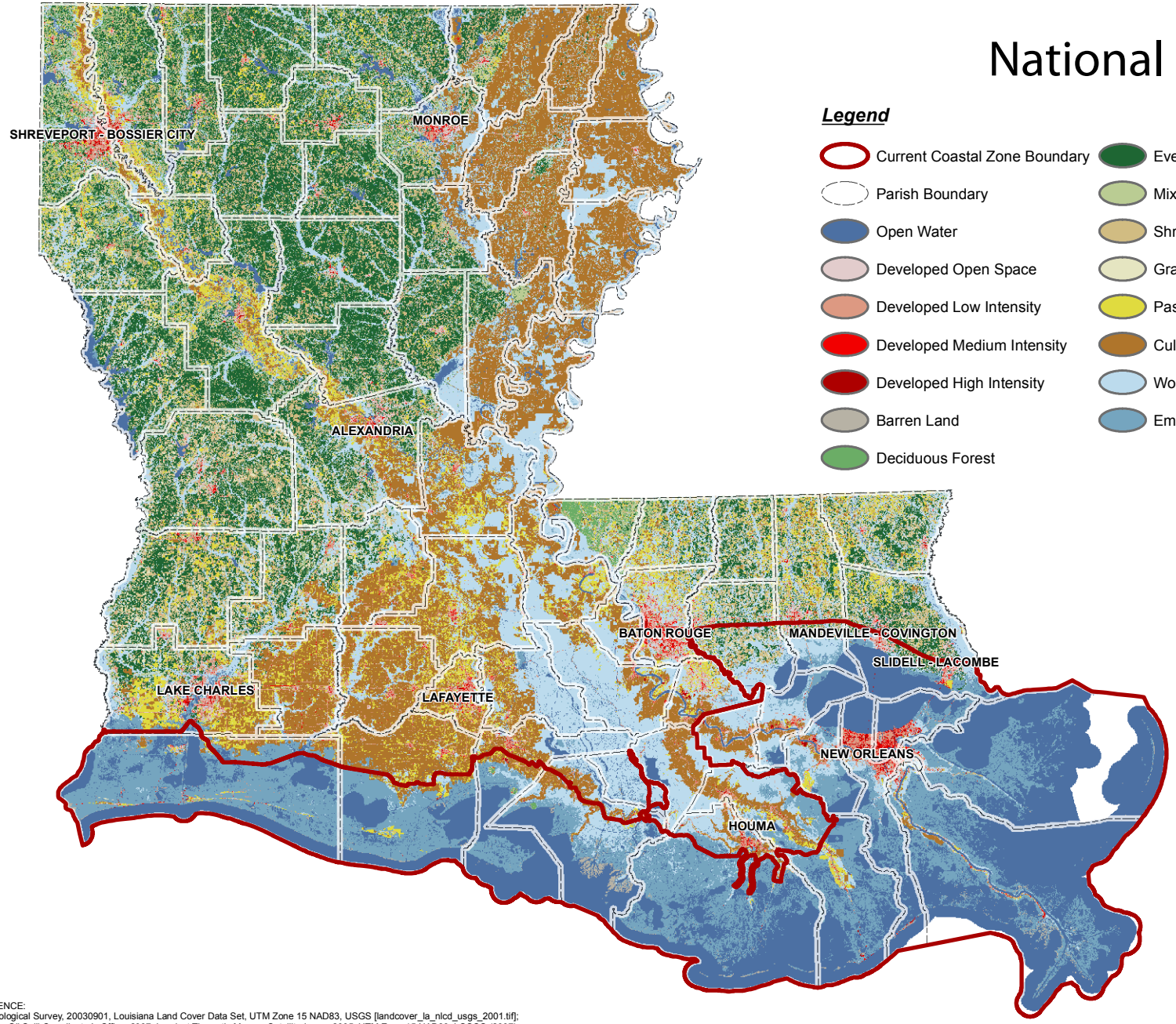
Figure 8
USGS Vegetation Data



REFERENCE:
Louisiana Department of Wildlife and Fisheries, Fur and Refuge Division, LSU AgCenter, and U.S. Geological Survey's National Wetlands Research Center, 20080301, 2007 Louisiana Coastal Marsh-Vegetative Type Map: USGS, Biological Resources Division's, and NWRC, Lafayette, Louisiana, US.; Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0006_vegetation.mxd

Figure 9
National Land Cover



Legend

- Current Coastal Zone Boundary
- Parish Boundary
- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

REFERENCE:
U.S. Geological Survey, 20030901, Louisiana Land Cover Data Set, UTM Zone 15 NAD83, USGS [landcover_la_nlcd_usgs_2001.tif];
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007)
[landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0007_nlcd.mxd

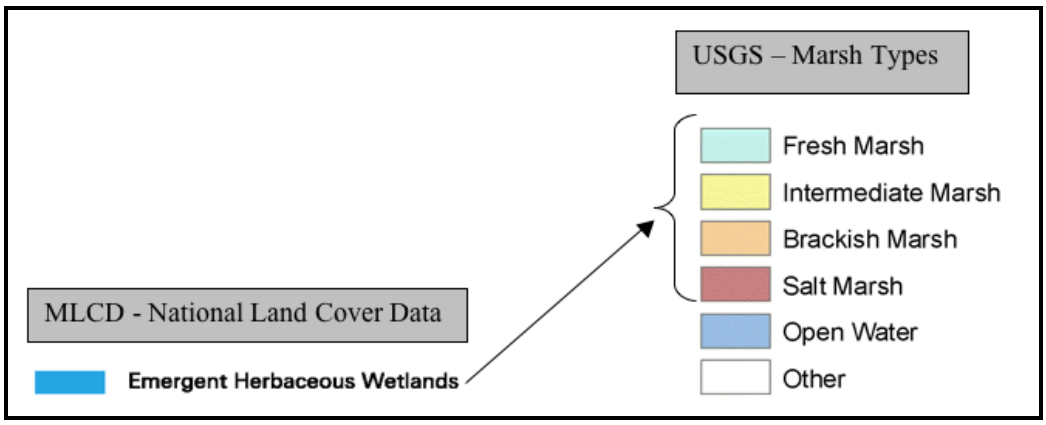
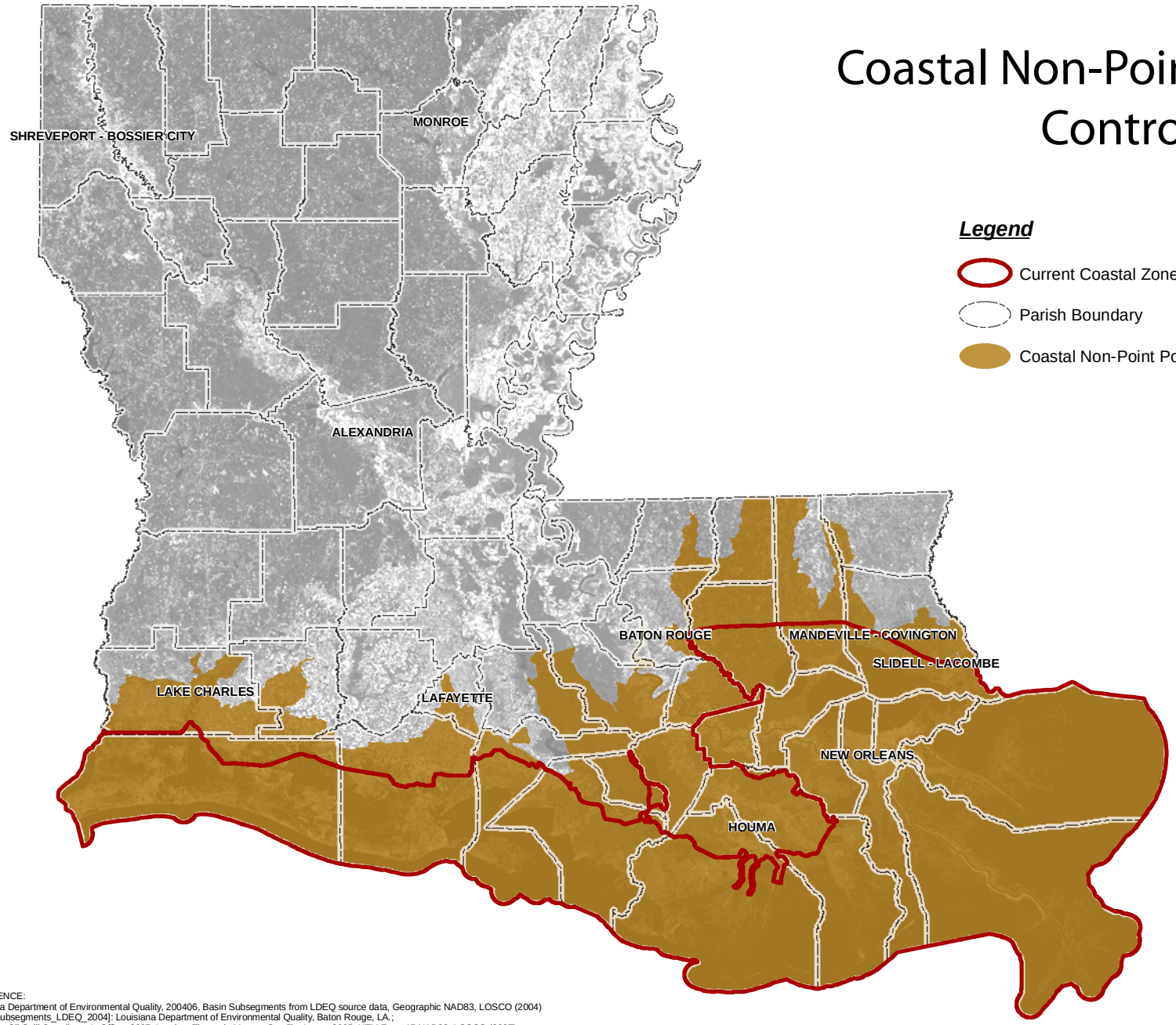


Figure 10. Comparison of the MLCD land cover classification to the USGS marsh type vegetation cover.

2.4.4 Coastal Nonpoint Source Pollution Control Boundary

Nonpoint source pollution (NPS) is a type of water pollution that is not generated from a discrete conveyance, such as a discharge pipe, but is generated during rainfall events. In Louisiana, activities such as agriculture, forestry, urban runoff, home sewage systems, sand and gravel mining, construction and hydromodifications contribute to NPS pollution when proper management practices are not followed. While NPS pollution was not considered in the 1975 study, it was important in the current study to include the contribution of NPS pollution to coastal eutrophication in watersheds that drain to the Gulf of Mexico. Louisiana's Coastal Nonpoint Pollution Control Program (CNPCP) is managed by the LDNR and was established after the U.S. Congress passed the Coastal Zone Act Reauthorization Amendments that entrusted states to develop and implement coastal nonpoint source pollution control programs. Nonpoint source pollution is important to consider when delineating a new coastal zone boundary because there are 10 watersheds that ultimately drain to the Gulf of Mexico within Louisiana. Thus, in order to protect coastal waters, nutrients and sediments draining from these watersheds must be managed. The CNPCP has legally defined boundaries which identify the legal jurisdiction of the program and which identifies those areas most in need of NPS pollution management to reduce impacts to the Gulf of Mexico (Figure 11). The CNPCP boundary includes sub-watersheds that occur within the CZB, are adjacent to the CZB, and/or occur in the Louisiana Coastal Wetlands Conservation Plan boundary (LDNR 2009). The CNPCP boundary was included in the delineation of a new CZB because it is a legally defined boundary that encompasses areas that can impact coastal waters.

Figure 11
Coastal Non-Point Pollution Control Boundary



Legend

- Current Coastal Zone Boundary
- Parish Boundary
- Coastal Non-Point Pollution Control Boundary

REFERENCE:
Louisiana Department of Environmental Quality, 200406, Basin Subsegments from LDEQ source data, Geographic NAD83, LOSCO (2004) [basin_subsegments_LDEQ_2004]: Louisiana Department of Environmental Quality, Baton Rouge, LA.;
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0008_nonpoint.mxd

2.4.5 Description of inundation data set

The primary computer model used by the NHC to forecast storm surge is the SLOSH model (http://slosh.nws.noaa.gov/sloshPub/indew.php). This model divides the U.S. coast into 20 or so separate grids (called basins) and simulates storm surge in each basin. If one takes the maximum the water reaches at any point in time at every grid cell in a SLOSH basin, a composite "Maximum Envelope of Water" (MEOW) plot can be made. MEOW plots are created for every category of storm moving in a particular direction, usually stratified by forward speed and tide elevation. Simulations are run using a variety of storm sizes. If the maximum storm surge height for all the MEOW plots at every grid cell is taken, a worst-case storm surge for the coast for each Saffir-Simpson hurricane categories (Category 1, 2, 3, 4, and 5) can be generated. The "Maximum Of the MEOWs", or "MOMs" are plotted in the SLOSH storm surge images (Figure 12) and are the composite worst-case scenario storm surges from about 15,000 different hypothetical hurricanes for each SLOSH basin. All of the MOM images provided in this analysis are for high tide and were performed using the 2009 version of the NOAA SLOSH Display Package. The colors show either the water depth as pure surge above the vertical datum level (at mean tide), or the storm tide (i.e., the height above the vertical datum level of the storm surge plus an additional rise in case the storm hits at high tide).

The geographic extent of the state Master Plan was defined by the area potentially at risk of inundation under the 0.2% annual probability of occurrence (1 in 500 years) storm event (Halcrow, 2008). Thus, the inundation data set also serves as a surrogate for the Master Plan boundary.

2.4.6 Description of riparian zone data

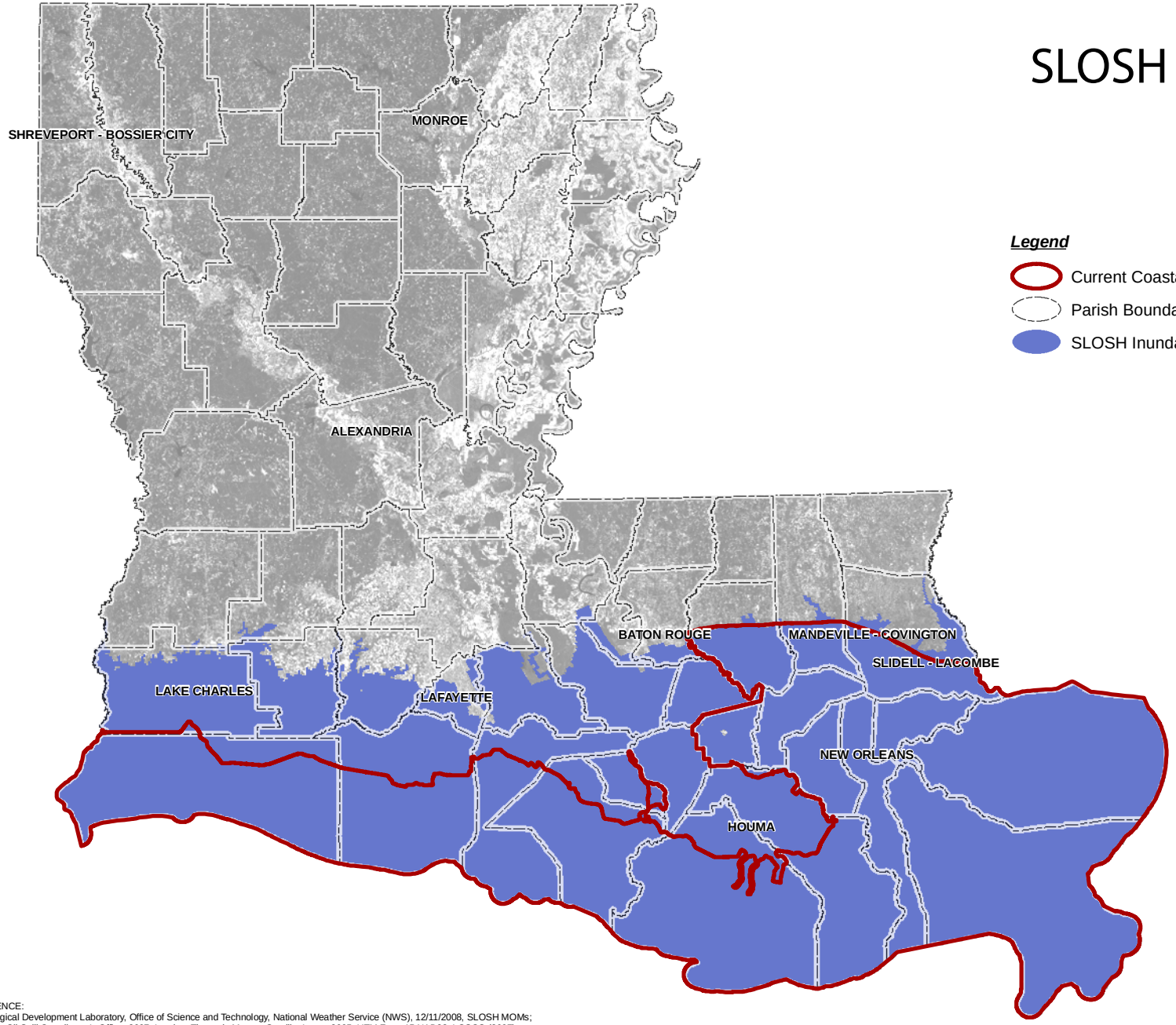
Riparian areas along rivers and streams, both within and draining into areas within the CZB, must be considered. Riparian areas are defined as those areas located in the floodplain of natural water courses. Because these areas can drain into the adjacent waterway, management of these areas may reduce coastal eutrophication. To define riparian areas for the current study, data from the STATSGO Database were used (Figure 13). These data are spatial and tabular data that were revised and updated by the NRCS in 2006. By utilizing soils data for marshes and forested wetlands, including backswamp areas, floodplain areas along rivers in the 10 watersheds draining to the coast were delineated.

2.4.7 Description of sea-level rise data

The rate of eustatic sea-level rise (ESLR) has been accelerating throughout the 20th century, increasing 15 to 20 cm during this time (Gornitz 1995, FitzGerald et al. 2008, Figure 14). Recent observations have revealed an ESLR rate of 1.8 mm/yr for the period 1961- 1993 and a rate of 3.1 mm/year for the period 1993 – 2003, compared to the background rate of 1 to 2 mm/yr for the 19th and early 20th century (Meehl et al. 2007). A number of recent studies suggest that ESLR will likely be one meter (3 ft) by the end of the 21st century (Rahmstorf 2007, Pfeffer et al. 2008). These conclusions are based on temperature/sea-level rise relationships in the 20th century and on a better understanding of ice sheet

dynamics in a warming world. In addition to sea-level rise, the Louisiana coast is also subsiding. Thus, management for coastal Louisiana should include planning for sea-level rise. To accommodate future estimated sea-level rise of about 3 feet, the 8-foot contour line was evaluated as the future 5-foot contour line.

Figure 12
SLOSH Inundation



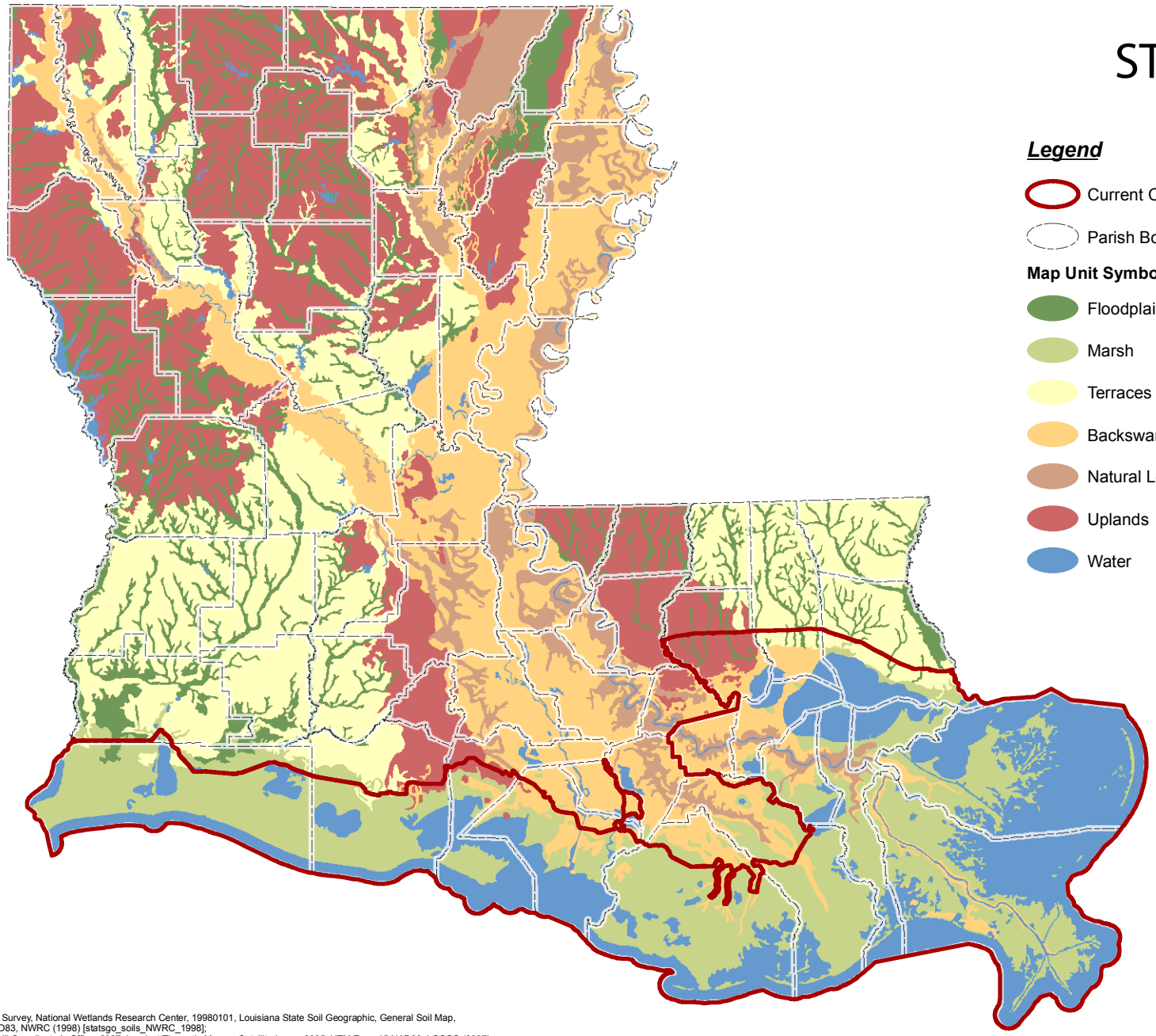
Legend

- Current Coastal Zone Boundary
- Parish Boundary
- SLOSH Inundation Boundary

REFERENCE:
Meterological Development Laboratory, Office of Science and Technology, National Weather Service (NWS), 12/11/2008, SLOSH MOMs; Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0009_inundation.mxd

Figure 13
STATSGO Soil



Legend

- Current Coastal Zone Boundary
- Parish Boundary

Map Unit Symbol (combined)

- Floodplains
- Marsh
- Terraces
- Backswamps
- Natural Levees
- Uplands
- Water

REFERENCE:
U.S. Geological Survey, National Wetlands Research Center, 19980101, Louisiana State Soil Geographic, General Soil Map, Geographic NAD83, NWRC (1998) [statsgo_soils_NWRC_1998];
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0010_statsgo.mxd

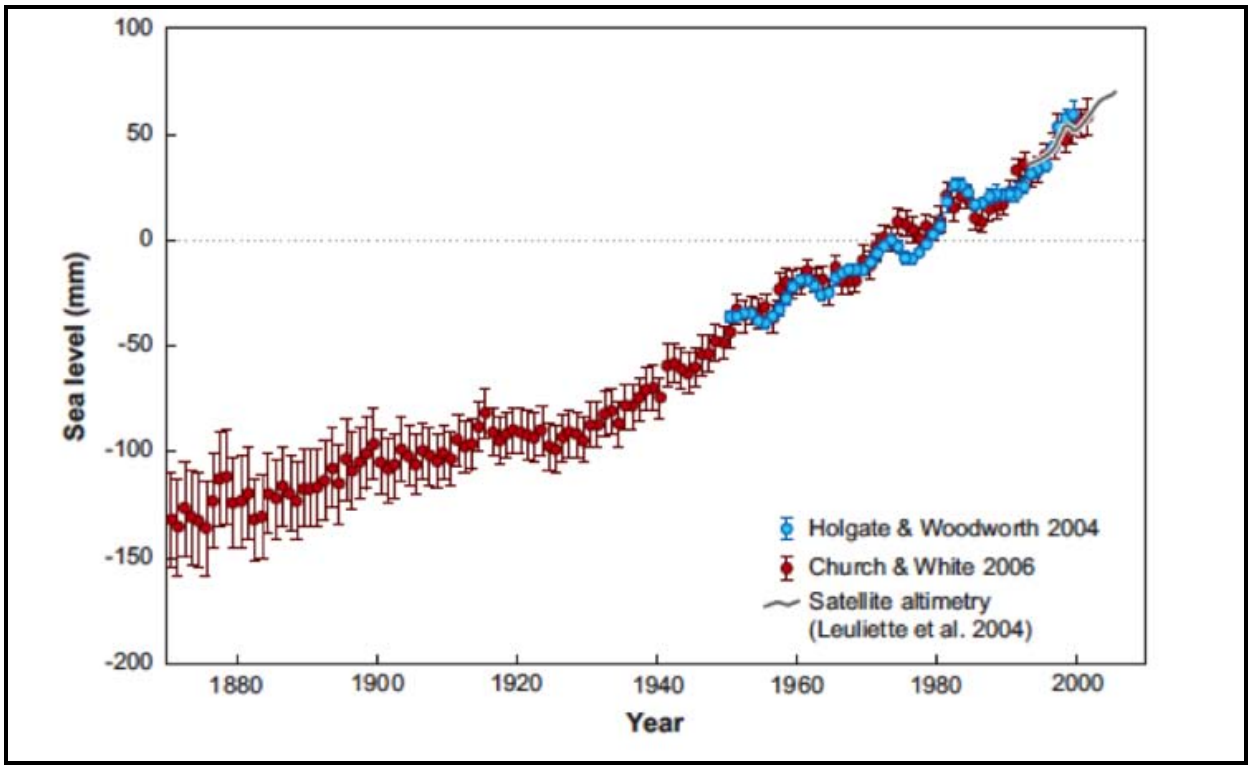


Figure 14. Annual averages of global mean sea level from IPCC (2007).

The red data are updated from Church and White (2006), the blue data are from Holgate and Woodworth (2004), and the curve is based on satellite altimetry from Leuliette et al. (2004). Error bars show the 90% confidence limits. Zero represents the 1961-1990 averages for red and blue data. The gray curve represents a deviation from red data for the period 1993 – 2001. Graph from FitzGerald et al. 2008.

2.5 Additional Information

2.5.1 Socioeconomic Data Considerations

The importance of Louisiana's coastal zone is reflected in the socioeconomic data. In 2008, more than 60% of the state's population lived in Louisiana's coastal parishes (U.S. Census 2008). The portion of the population living in the coastal zone is growing at a faster pace than the rest of the state.

Among the 50 states in 2007, Louisiana ranked 1st in oil production, and 2nd in marketed gas production. Louisiana ranked 3rd in natural gas reserves in 2007. Thousands of miles of pipelines cross the coastal wetlands carrying crude oil from the Gulf of Mexico to refineries in Louisiana and other states and transporting natural gas and refined products such as gasoline to all parts of the U.S. Employment in nonagricultural jobs for 2007 show 46,764 in oil and gas production, 25,998 in the chemical industry, 12,233 in petroleum and 1,168 in the pipeline industry (LA Energy Facts Annual 2008). Oil and gas resources are found in large reserves offshore from Louisiana in the federally controlled Outer

Continental Shelf (OCS) in the Gulf of Mexico. The Gulf of Mexico OCS is the largest U.S. oil-producing region and contains some of the nation's largest oil fields. Crude oil reserves in Louisiana account for approximately 2 percent of total U.S. oil reserves, and about 5 percent of U.S. natural gas reserves. Employment in the oil and gas industry provides 320,000 jobs, producing more than $12.7 billion in household income, and creating $70.2 billion in sales for Louisiana companies (Louisiana Economic Development 2009).

Louisiana ranked 1st in water transportation (tonnage) by state in 2007 (USACE). Louisiana's extensive port systems, including both deep-water and shallow-draft ports, are one of the largest port systems in the world, carrying millions of tons of cargo in and out of the United States (Table 6). The Port of South Louisiana is the largest single port in the U.S., ranked by tonnage. The ports of New Orleans, Lake Charles, Greater Baton Rouge and Plaquemines all are in the top 15. An extensive network of over 2,300 miles of navigable inland waterways in the coastal wetlands connects the state's six deep-water ports to eight coastal ports (Figure 15).

Table 6. Ranking and total tonnage of ports in coastal Louisiana.

Louisiana Port	2007 Ranking	Total Tonnage
Port of South Louisiana	1st	229,040,085
Port of New Orleans	8th	76,045,540
Port of Lake Charles	11th	64,234,040
Plaquemines Port	12th	58,816,539
Port of Greater Baton Rouge	14th	54,623,559

(Louisiana Economic Development, 2009)

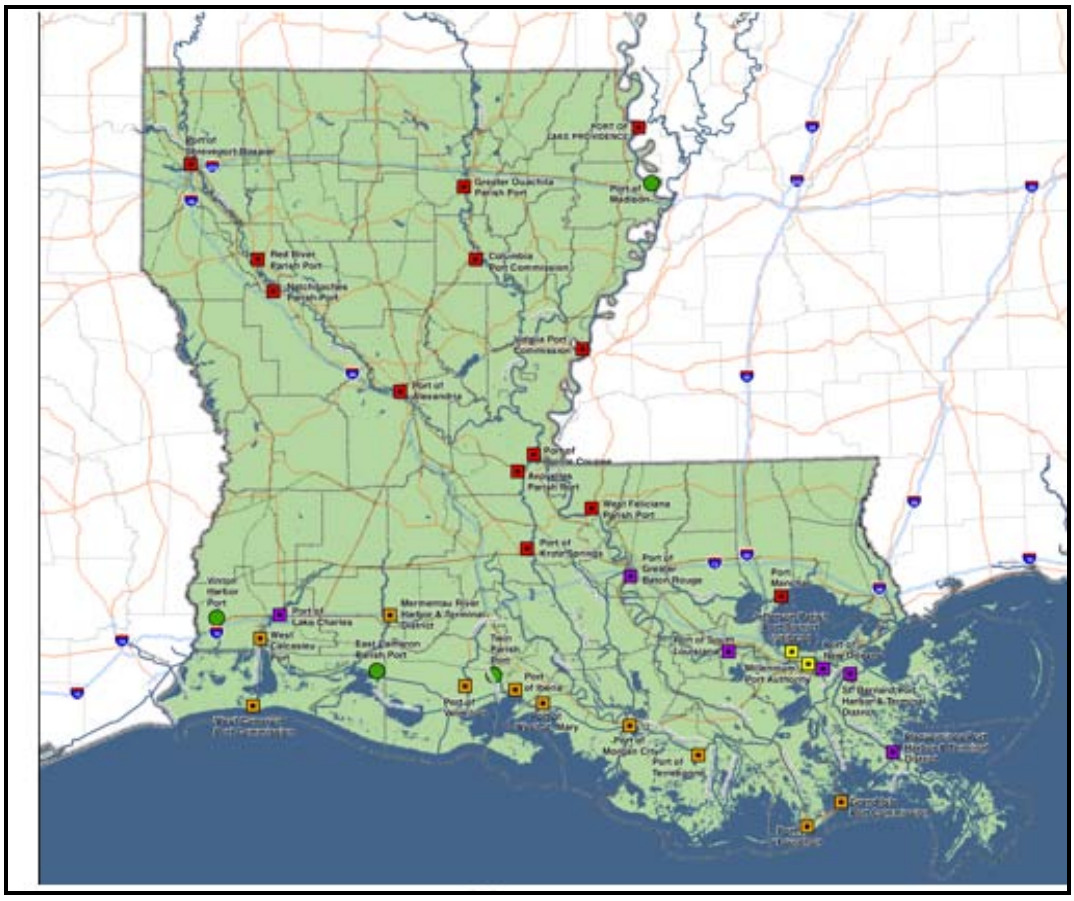


Figure 15. Location of Louisiana ports. *(Shaw Environmental and Infrastructure, Inc. 2007)*

The total economic impact of recreational hunting in Louisiana in 2006 was $975 million. This total includes big game, small game, migratory bird, deer and turkey hunting (Louisiana Department of Wildlife and Fisheries (LDWF) http://www.wlf.louisiana.gov/). Freshwater recreational fishing had a total economic impact of $952 million in 2006; and the economic impact of saltwater recreational fishing was $757 million in 2006. The economic impact of fur harvesting in 2006 was $2.8 million (LDWF http://www.wlf.louisiana.gov/).

2.5.2 Managing Louisiana's Coastal Zone for Natural Disaster Risk Reduction

Louisiana's coastal zone is subject to many hazards including storms, flooding, and erosion. The effects of these hazards are magnified due to increasing coastal populations and the continued loss of natural protection features such as coastal wetlands and barrier islands. As Louisiana residents know too well, the economic impacts of natural disasters on businesses, private citizens, the public sector, and infrastructure can be quite significant. Therefore, reducing the risks from coastal hazards is a key component of the Louisiana CZMP.

Population changes and development pressures on the coast have led to construction in hazard areas, and the most desirable locations are often the most at risk. Life, property, and economic livelihoods are better protected through the management of development in areas of known risk. After all, the fundamental objectives of development are increased security for individuals and stability for planning and investment. The socioeconomic realities of Louisiana's working coast require continued development. Managing development in a sustainable manner can help to reduce risk, but the only way to effectively protect people is evacuation. Figure 16 and Figure 17 depict phased evacuation areas and designated evacuation routes.

The Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) has developed an evacuation plan for coastal Louisiana which includes phased evacuation (Figure 16). A threat of a hurricane will begin a phased evacuation of citizens based on the location and time the storm is forecasted to impact coastal areas. Phase I will begin 50 hours before onset of tropical storm winds and include areas south of the Intracoastal Waterway. These areas are outside any hurricane protection levee system and are vulnerable to Category 1 and 2 storms. These areas are depicted in red on the Evacuation Map. During Phase I, there are no route restrictions. Phase II will begin 40 hours before onset of tropical storm winds and will include areas south of the Mississippi River that are levee protected but remain vulnerable to Category 2 or higher storms. These areas are depicted in orange on the Evacuation Map. During Phase II, there are no route restrictions. Phase III will begin 30 Hours before onset of tropical storm winds and will include areas on the East Bank of the Mississippi River in the New Orleans Metropolitan Area that are within the levee protection system, but remain vulnerable to a slow-moving Category 3 or any Category 4 or 5 storm. These areas are depicted in yellow on the Evacuation Map. During Phase III, certain routes will be directed and the Contraflow Plan will be implemented (http://www.dotd.louisiana.gov/maps/).

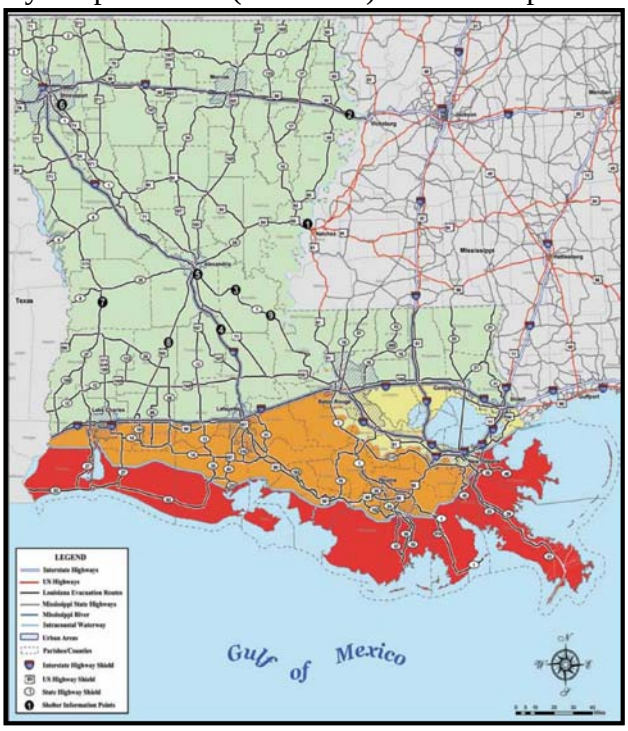
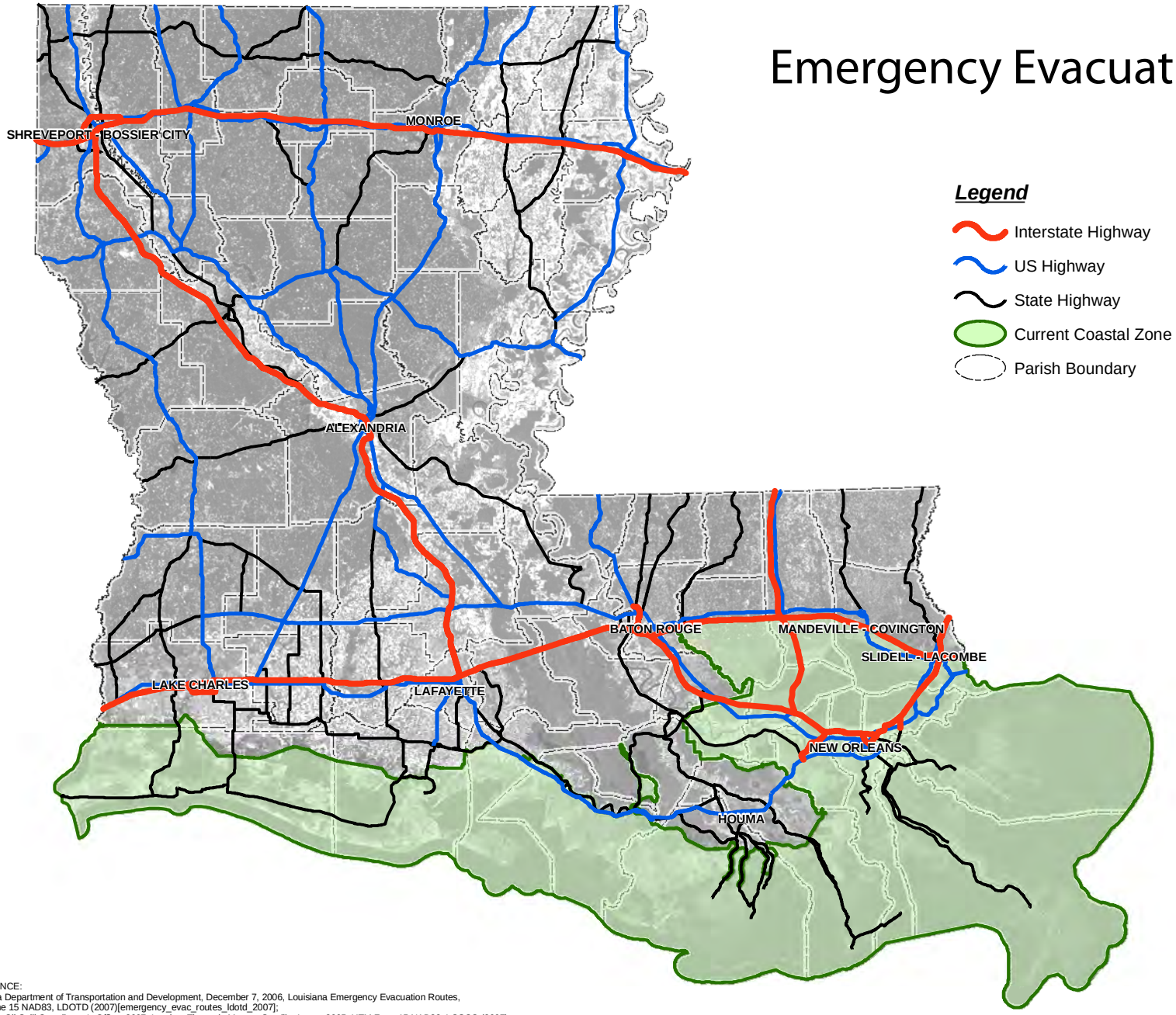


Figure 16: Phased Evacuation Map

Figure 17
Emergency Evacuation Routes



REFERENCE:
Louisiana Department of Transportation and Development, December 7, 2006, Louisiana Emergency Evacuation Routes,
UTM Zone 15 NAD83, LDOTD (2007)[emergency_evac_routes_ldotd_2007];
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007)
[landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

ldnr_137893_0015_evac_routes.mxd

2.5.3 Socioeconomic Implications of Sea-Level Rise

The Mississippi River Delta ecosystems provide at least $12 to $47 billion in benefits to people every year. If this natural capital were treated as an economic asset, the delta's minimum asset value would be $330 billion to $1.3 trillion (Batker et al. 2009). Valuable goods and ecosystems services of marine waters, wetlands, swamps, agricultural lands, and forests include hurricane and flood protection, water supply, water quality, recreation, and fisheries. The Mississippi River Delta is a vast natural asset and it was built by building land with sediment, fresh water, and the energy of the Mississippi River (Batker et al. 2009). However, rising sea levels, along with other factors such as levee construction and subsidence, cause land loss and, thus, result in a loss of economic assets.

Rising sea level will have serious socioeconomic implications for the state of Louisiana. As shown earlier in the report, it is likely that sea level will rise by at least one meter by 2100. Two recent reports suggest that sea-level rise will be between 1.0 and 1.5 m by 2100 (Pfeffer et al. 2008, Vermeer and Rahmstorf 2009). The projected rates of sea-level increase by Vermeer and Rahmstorf are shown in Figure 18. The lower three bars of Figure 18 show earlier projected sea-level rise using a 3.2 mm/year rise. Sea level is currently rising at between 3.5 and 4.0 mm/year. The curves in Figure 18 show new estimates for sea-level rise. The range of estimates is from 0.75 to 1.90 meters with best estimate mid range projections of 1.0 to 1.5 m. Such high rates of sea-level rise have serious implications for coastal Louisiana.

Blum and Roberts (2009) developed a projection for coastal wetlands taking into consideration accelerated sea-level rise and reduction of sediment transport in the Mississippi River. They used a sea-level rise rate of 0.4 m by 2100. This is about one third to one half of current projections for sea-level rise, so the results of Blum and Roberts should be considered conservative. They produced a map of the loss of coastal wetlands that shows that most wetlands will be lost by 2100 (Figure 19).

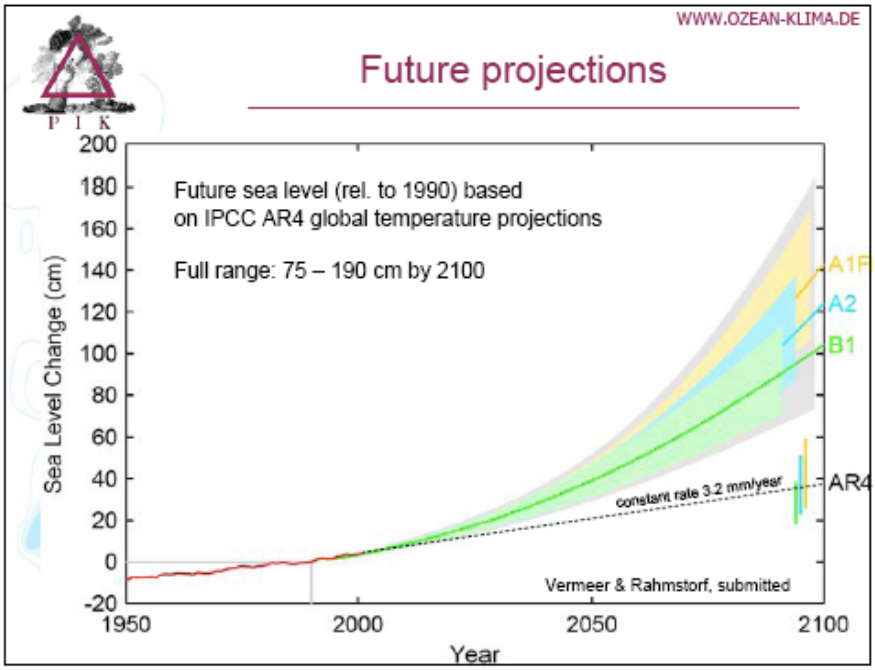


Figure 18. Projections of eustatic sea-level rise to 2100 from Vermeer and Rahmstorf (2009). The full range of projections is 75 to 190 cm with most probable increases of 1.0 to 1.5 m.

Over half of the population of Louisiana lives in the southern part of the state and according to NOAA

about one third, or about 1.3 million people live at or below sea level. Over 70% of the population of Jefferson and Orleans parishes live below sea level. Rising sea levels will put these people at increasing risk. There is also a tremendous amount of infrastructure in the coastal zone that is at increasing risk because of sea-level rise.

Source: Mississippi Delta in 2100. Blum and Roberts (2009), Nature GeoScience.

Figure 19. Projections from Blum and Roberts (2009) of the location of the coastline and loss of wetlands by 2100. This projection uses a sea-level rise of 40 cm by 2100.

3.0 Data Set Evaluation

Data set evaluation was based on integrated coastal zone management and ecosystem-based management planning tools, and included ArcGIS analysis of available data layers. The term "integrated coastal zone management" was coined in 1992 during the Earth Summit in Rio de Janeiro and it describes an adaptive, integrated approach for achieving sustainable resource management that seeks to balance economic development and use of the coastal region, protection and preservation of coastal areas, minimization of loss of human life and property, and public access to the coastal zone. Ecosystem-based management aims to protect ecosystem structure, functioning, and processes; recognize the interconnectedness within and among systems; integrate ecological, social, economic, and institutional perspectives; and be place-based or area-based (NOAA, 2010).

Effective coastal spatial planning has three essential attributes. They are:

1. Multi-objective - Coastal spatial planning balances ecological, social, economic, and governance objectives.
2. Spatially focused - The coastal area to be managed must be clearly defined and large enough to incorporate relevant ecosystem processes.
3. Integrated - The planning process should address the interrelationships and interdependence of each component within the defined management area, including natural processes, activities, and authorities.

To delineate coastal management areas based on available spatial data, a modified version of the ArcGIS natural breaks method was used. This method uses a statistical formula, known as Jenks algorithm, to determine natural clusters of attribute values. The Jenks algorithm is a standard method for dividing a dataset into a certain number of homogenous classes or zones. The purpose is to minimize the variance within a class and to maximize the variance between classes. The natural breaks method can be used on many different types of data, as long as the data are represented spatially. One example of the use of this method in coastal zone management is described below.

Paxinos et al. (2008) describes a GIS-based zoning methodology for the development of marine planning in South Australia. The goal of this ecosystem-based approach was to create a zoning system using habitat and species occurring within the marine environment, and to identify and define spatial boundaries of each zone. The key assumption of this type of approach was that the data available reasonably reflected the correct spatial distribution of the ecological parameters fundamental to the function of the ecosystem and its biological diversity. GIS data for the planning area were collected and approximately 70 GIS spatial layers were developed based on environmental and habitat data. The planning area was then divided into grid cells of equal size (5x5 km). The natural breaks method was

then used to identify break points in the data which resulted in a four-zone system based on amount of marine, coastal and estuarine habitats and species that reflected each zone's importance to the health and function of the marine ecosystem as a whole.

3.1 Data Layers Used in Evaluation

The series of questions listed in Table 7 were applied to the GIS database in order to numerically define management areas of coastal Louisiana (e.g., areas requiring Coastal Use Permits, areas requiring intergovernmental coordination, etc.). Each question was asked in a 1-km^2 area (approximately 247 acres) and the resulting answer could be either "Yes" or "No". If the answer was "Yes", then the 1-km^2 area received a score of 1 and if the answer was "No" the area received a score of 0. If any part of the 1-km^2 area contained the vegetation, elevation, etc. requested for in the query, the answer for the entire 1-km^2 area was "Yes." The maps and information shown below describe the GIS layers that were utilized for assigning numerical values to 1-km^2 areas within the study area. The study area is bounded on the south, east and west by the Louisiana state line and extends inland to the northern boundary of the watershed basins that touch the coast.

Table 7. Criteria Used for GIS Runs/Data Set Analysis.

	Data Layer	Question
1	Geology - GIS layer illustrating the boundary of the Pleistocene terrace in Louisiana	Is any part of the 1-km^2 area at or below the line of contact between Pleistocene and Holocene sediments?
2	Existing boundaries supported by enforceable policies of the state – GIS layer illustrating the established Coastal Zone boundary defined at La. R.S. 49:214.24	Is any part of the 1-km^2 area within the current Coastal Zone?
3	Existing boundaries supported by enforceable policies of the state – GIS layer illustrating the Coastal Non-Point Source Pollution Control boundary established pursuant to Section 6217 of Coastal Zone Act Reauthorization Amendments of 1990.	Is any part of the 1-km^2 area within the boundary of the existing Coastal Non-Point Source Pollution Control area?
4	Vegetation – GIS layer illustrating emergent herbaceous wetlands as delineated by national land cover data.	Does any part of the 1-km^2 area contain emergent herbaceous wetlands (fresh, intermediate, brackish or salt marsh)?
5	Inundation – GIS layer illustrating inland extent of storm surge based on NOAA MOM maps that are generated from SLOSH model outputs.	Is any part of the 1-km^2 area contained within the inland extent of storm surge per the MOMS map?
6	Elevation – GIS layer illustrating current land elevations as delineated by LIDAR data – 5 foot contour.	Is any part of the 1-km^2 area at an elevation of 5 feet or lower?
7	Elevation – GIS layer illustrating current land elevations as delineated by LIDAR data – 8 foot contour (indicates areas affected by or vulnerable to sea-level rise).	Is any part of the 1-km^2 area at an elevation of 8 feet or lower?
8	Elevation – GIS layer illustrating current land elevations as delineated by LIDAR data – 10 foot contour.	Is any part of the 1-km^2 at an elevation of 10 feet or lower?
9	Riparian Zone – GIS layer illustrating 100-year flood zone adjacent to rivers and stream as delineated by grouping certain soil layers from the NRCS State Soil Geographic Database (STATSGO).	Does any part of the 1-km^2 area contain soils classified as floodplains, marsh, backswamps or water?

3.2 Questions for Assigning Numerical Values

If all or part of the 1-km^2 area was at or below the line of contact between Pleistocene and Holocene sediments, the area was assigned a value of 1. If all or part of the area was above this line of contact, the area was assigned a value of 0. Within the Mississippi alluvial plain, the sediments were deposited within the Holocene epoch and, thus, no line of contact is present between Pleistocene and Holocene sediments. As discussed previously, to delineate a breakpoint within this alluvial plain, the Louisiana Coastal Wetlands Conservation Plan Boundary was used. By combining this boundary with the line of contact between Pleistocene and recent sediments, an area was defined to receive a value of 1 for this question. If the area was not below the line of contact, the area received a value of 0 (Figure 20).

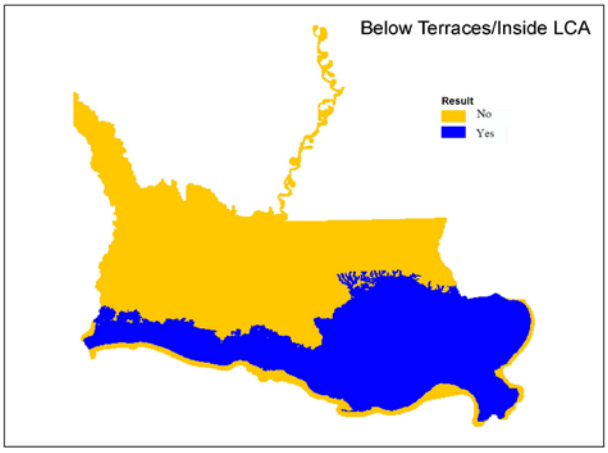


Figure 20. Pleistocene and Holocene Results

If all or part of the 1-km^2 area was located within the current Coastal Zone, the answer to the question was "Yes" and the area received a value of 1 (Figure 21). If the area was outside the current Coastal Zone, the area received a value of 0.

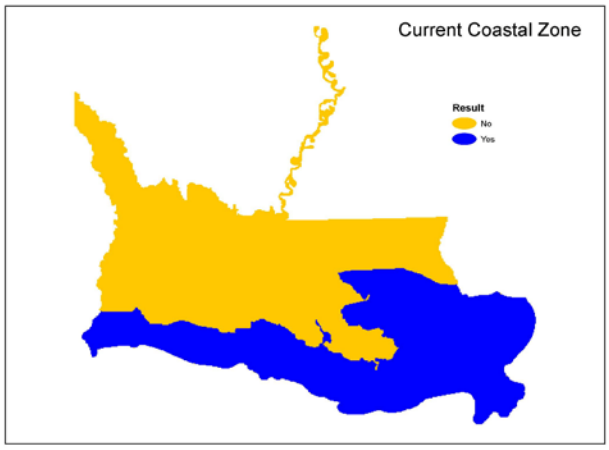


Figure 21. Areas within the study area that are inside (blue) and outside (yellow) the current CZB.

If all or part of the 1-km^2 area was within the boundary of the existing Coastal Nonpoint Source Pollution Program administered by LDNR, the area received a value of 1 (Figure 22). If the area was outside this boundary, the area received a value of 0.

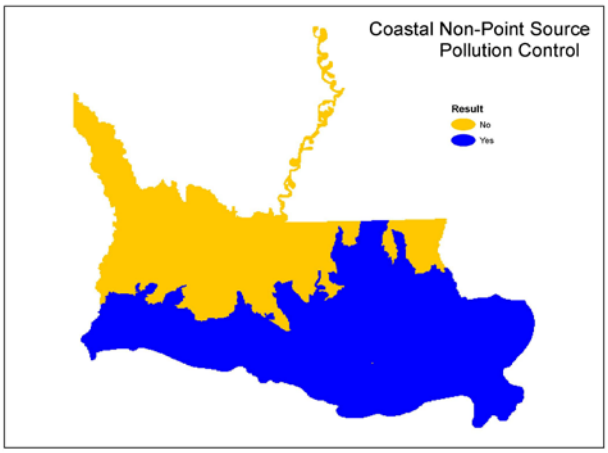


Figure 22. Coastal Nonpoint Source Pollution Control Boundary results

If all or part of the 1-km^2 area contained emergent, herbaceous wetlands (fresh, intermediate, brackish, or salt marsh), then the area received a value of 1 (Figure 23). If the area did not contain this vegetation, it received a value of 0.

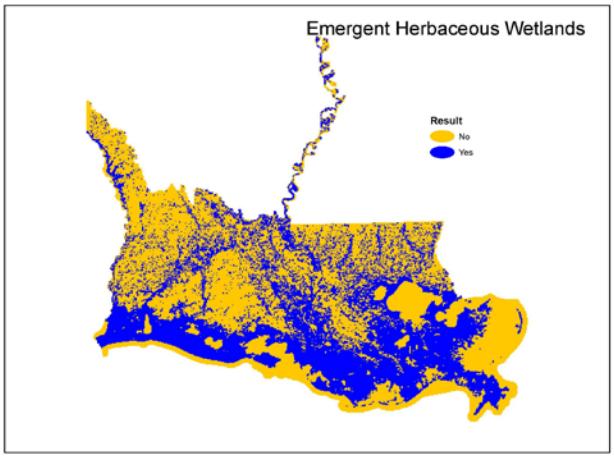


Figure 23. Emergent wetlands results

If all or part of the 1-km^2 area was contained within the inland extent of storm surge per the MOMS map, the area received a value of 1 (Figure 24). If the area was not impacted by storm surge, it received a value of 0.

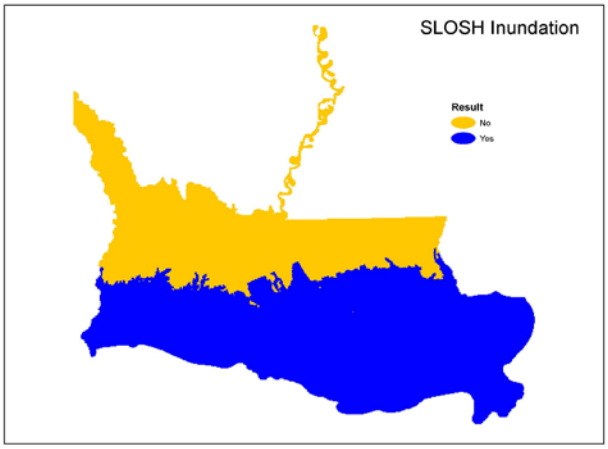


Figure 24. Storm Surge results

The elevation data were examined three times, once each for the presence of land elevations less than 5 feet, 8 feet and 10 feet. As such, any km2 area had the potential to receive three "Yes" answers, ultimately leading to a value of 3 if the area was at 5 feet or lower. If all or part of the 1-km2 area contained land with an elevation of 5 feet or lower, then the area received a value of 1 (Figure 25).

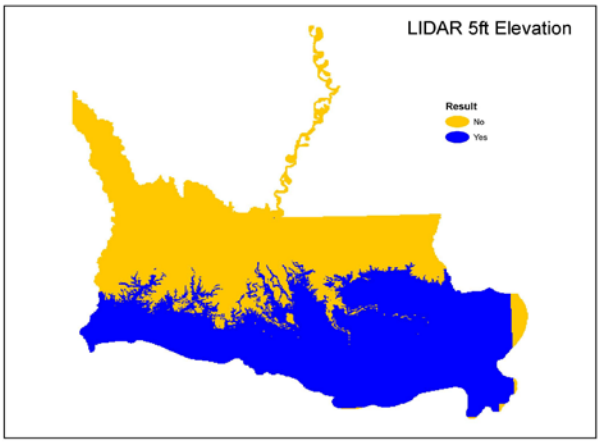


Figure 25. Elevation of 5 ft or lower results

If all or part of the 1-km^2 area contained land with an elevation of 8 feet or lower, then the area received a value of 1 (Figure 26).

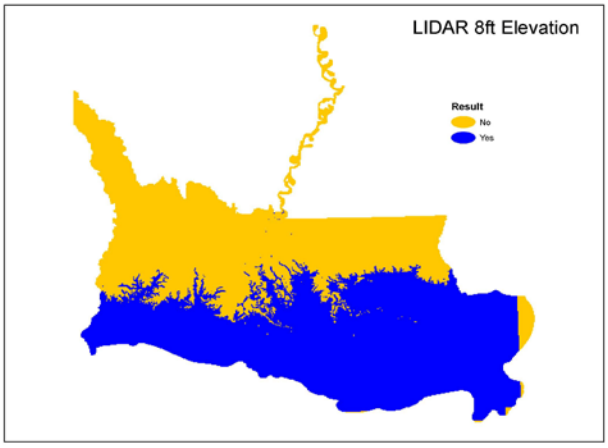


Figure 26. Elevation of 8 ft or lower results

If all or part of the 1-km^2 area contained land with an elevation of 10 feet or lower, then the area received a value of 1 (Figure 27). Any area with an elevation higher than 10 feet received a value of 0.

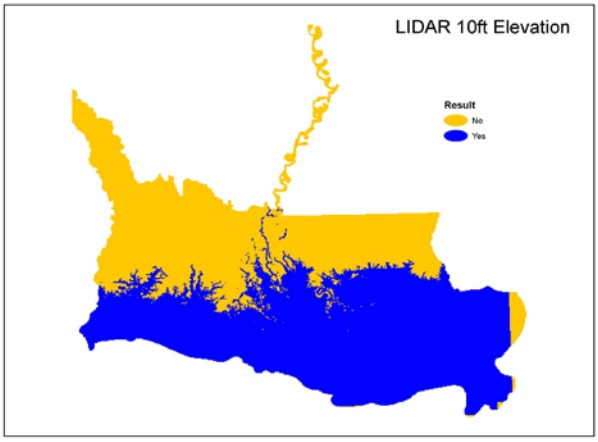


Figure 27. Elevation of 10 ft or lower results

If all or part of the 1-km^2 area contained soils classified as floodplain, marsh, or backswamp, then the area received a value of 1 (Figure 28).

If the area contained soils with a different classification, the area received a value of 0.

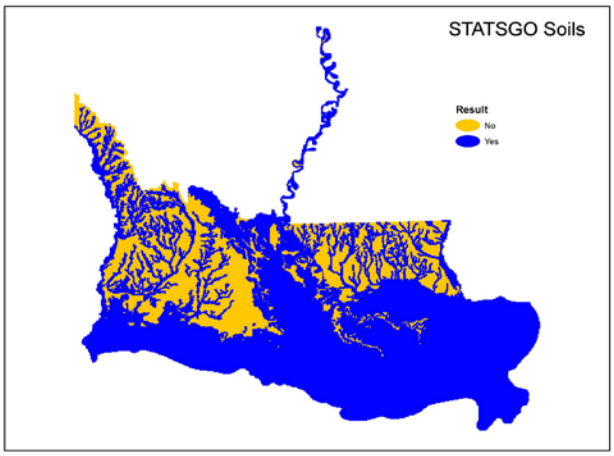


Figure 28. Soils classified as floodplain, marsh, or backswamp results

3.3 Scoring Criteria

Values for each 1-km^2 area were recorded in an attribute table and summed for the nine data layers queried, resulting in scores ranging from 0 to 9 for each 1-km^2 area within the study area. These data were analyzed using GIS to produce a graphical depiction of the study area in which each 1-km^2 area was assigned an ecological rating depending on its' level of coastal influence. Higher scores indicated a greater degree of coastal influence over the area. Scores for grids within the current CZB were examined, and approximately 95% of the grids scored 7 or greater, with 99.9% scoring 3 or greater. Only four grids within the current CZB received a score of 2, and no grids received scores of 1 or 0 (Table 8). These results indicate that the data layers selected and the queries conducted did provide an accurate ecological rating of areas subject to coastal processes.

Grid score results from the current CZB boundary were used as a guideline to establish four levels of coastal influence.

- Score of 7-9: High level of coastal influence
- Score of 3-6: Moderate level of coastal influence
- Score of 1-2: Low level of coastal influence
- Score of 0: Not subject to coastal influence under normal circumstances

Table 8. Current Coastal Zone Boundary Scoring Results

Grid Cell Score	Total Number of 1-km^2 areas receiving score	Number of Acres	Percentage of Total Area	Cumulative Percentage of Total Area
9	20,882.00	5,160,054.6	52.5%	52.5%
8	12,245.00	3,025,805.4	30.8%	83.3%
7	4,726.00	1,167,820.0	11.9%	95.2%
6	412	101,807.4	1.0%	96.2%
5	682	168,525.9	1.7%	98.0%
4	641	158,394.5	1.6%	99.6%
3	172	42,502.1	0.4%	100.0%
2	4	988.4	0.0%	100.0%
1	0	0	0.0%	
0	0	0	0.0%	
TOTAL	**39,764.00**	**9,825,898.40**	**100%**	

Scores for grids across the study area were examined (see Table 9) and compared with the current CZB scoring results. The grid tally for cells scoring 9 were the same in both the current CZB and the study area, since one of the variables was dependent upon whether the grid was within the current CZB. Therefore, the highest value a grid outside of the current CZB could receive was an 8. It was found that 2,253 grids outside of the current CZB received a score of 8 and another 3,415 received a score of 7, indicating that approximately 1.4 million acres of land subject to a high level of coastal influence are outside of the current CZB.

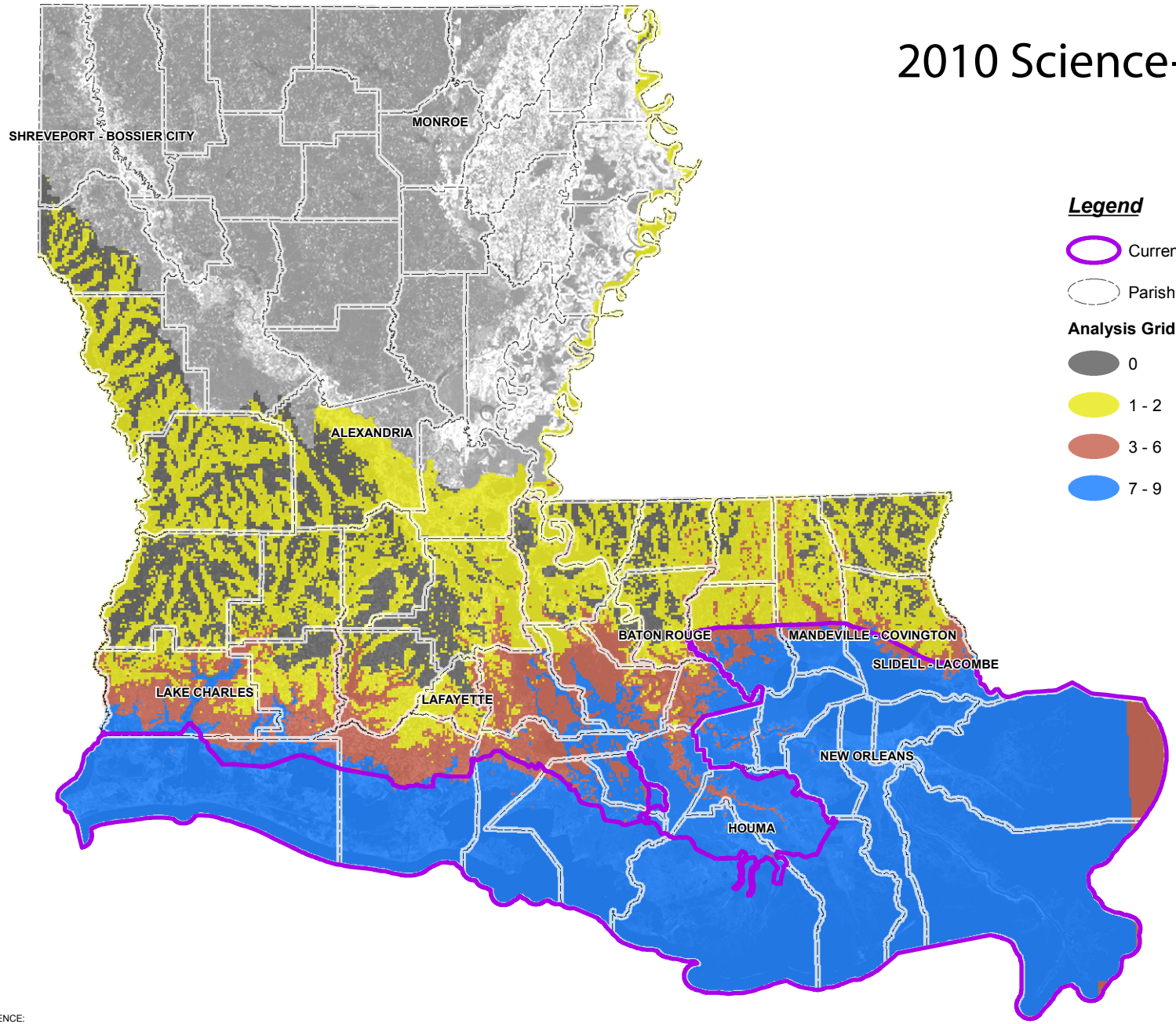
Table 9. Study Area Scoring Results

Grid Cell Score	Total Number of 1-km^2 areas receiving score	Number of Acres	Percentage of Total Area	Cumulative Percentage of Total Area
9	20,882	5,160,055	22.8%	22.8%
8	14,498	3,582,534	15.8%	38.6%
7	8,141	2,011,685	8.9%	47.5%
6	3,052	754,166	3.3%	50.8%
5	3,268	807,540	3.6%	54.4%
4	2,372	586,134	2.6%	57.0%
3	2,479	612,574	2.7%	59.7%
2	9,434	2,331,192	10.3%	70.0%
1	16,129	3,985,563	17.6%	87.6%
0	11,393	2,815,272	12.4%	100.0%
TOTAL	**91,648**	**22,646,714**	100%	

3.4 Scoring Analysis

There were 91,648 cells in the study area which were categorized for 9 factors so the composite maps from which alternative lines were derived were based on the integration of 824,000 data cell scores. The 1-km^2 areas were grouped according to the levels of coastal influence and color coded for visual display. It was anticipated that the resulting composite map would show a four-level stratification that would indicate the inland extent of coastal process within the study area and provide a coarse delineation that could be used to establish a hierarchical management consisting of a regulatory permit area, an intergovernmental coordination area, and a watershed planning area. However, this was not the case. As shown in Figure 29, there were fairly distinct strata associated with areas subject to a high level of coastal processes and those subject to a moderate level of coastal process. But, the areas subject to a low level of coastal processes and those areas not subject to coastal influence under normal circumstances tended to be more sporadic, with coastal processes extending to the limits of the study area in many of the 1-km^2 areas. These results indicate that since Louisiana is basically a huge estuarine area, the elevation gradient is so slight and over such a wide distance that a sharp line of demarcation does not exist between the area of low affinity to coastal processes and the area of no affinity.

Figure 29
2010 Science-Based Grid



REFERENCE:
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

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3.5 Recommended Alternative for an Updated Coastal Zone Inland Boundary

Based on analyses performed for this report, a proposed updated coastal management boundary for Louisiana, which employs a hierarchical management structure, is presented below. Designated the 2010 Science-Based Boundary (2010 SBB), it was developed based on the scientific analysis described in the previous section of this report and it divides coastal Louisiana into two management areas based on the degree of coastal influence and the nature and degree of management required. The SBB includes two distinct areas: the coastal zone and the contiguous area of moderate coastal influence adjacent to the coastal zone. Activities in the coastal zone would be subject to the enforceable policies of the SLCRMA, and subject to regulation by the coastal use permit process. In the contiguous area of moderate coastal influence adjacent to the coastal zone, intergovernmental coordination mechanisms of existing authorities and state law would be used to evaluate certain activities, particularly major hydrological modifications which are direct actions of governmental bodies, for consistency with state coastal plans and policies. Thus, the 2010 SBB includes the updated coastal zone, which is called the Coastal Use Permit (CUP) management area to distinguish it from the current coastal zone, and the Intergovernmental Coordination (IGC) management area, which will be subject to oversight by the OCM, but will not be part of the regulated coastal zone. Areas not within the 2010 SBB, but contained within or adjacent to watersheds which have potential coastal impacts, are included in the Watershed Planning (WSP) management area. Activities in the WSP area would not be subject to the enforceable policies of the SLCRMA, unless an activity specific effect on coastal waters was demonstrated.

3.5.1 Management Areas

The Coastal Use Permit (CUP) area is defined by this report as including all areas of southern Louisiana subject to a high level of coastal processes as measured by the methodology employed by this project that resulted in a grid score of 7-9. Because this area is highly influenced by coastal processes, it is the area in need of a high level of management. The CUP area was found to be most of the current coastal zone, but it extends farther north in much of the study area as generally described below. The management methods employed for the CUP area, or updated coastal zone, would be as they are for the current coastal zone, relying primarily on the coastal use permit authority of the state to manage land and water activities. Appropriate intergovernmental coordination management methods would also apply in this area.

The Intergovernmental Coordination (IGC) area would consist of that portion of the study area subject to a moderate level of coastal processes and, as measured by the ecological analysis methodology employed for this project, receiving a grid score of 3-6. The IGC areas would be contiguous to the coastal zone, but would not be part of the regulated coastal zone. The management strategy proposed for the IGC is to use existing authorities of the CZMA and the SLCRMA to conduct consistency review of major hydrological modifications which are the direct actions of governmental bodies that occur within the IGC and will or may affect the coastal zone or state Master Plan implementation. But within this

area the individual actions of residents, private businesses, private industry, and landowners on a project-by-project basis would not be scrutinized.

A Watershed Planning (WSP) area, in addition to the two management areas contained within the 2010 SBB, is also recommended. The adjacent watershed planning area (WSP) located north of and adjacent to the IGC area, would not be a part of the coastal zone, but would be eligible for participation in certain broad, watershed planning efforts that overlap portions of the legally defined coastal zone. The WSP would be the area defined as having a low score of coastal affinity, based on the ecological analysis methodology used for this project, and receiving a ranking score lower than 3. This could include some areas with a score of 0 in the ecological analysis, but that are nonetheless important areas where planning initiatives relative to water quality, ecosystem protection and flood control would be appropriate.

3.5.2 Geographic Limits of Coastal Zone Areas Described

The newly delineated coastal management area, with the proposed boundaries of the IGC and CUP areas, is shown on Figure 30, and the parishes included in each area, in whole or in part, are listed in Table 10. The generally proposed boundary for each area is described in this section.

The inland boundary of the IGC area would comprise the inland boundary of the broader coastal management area, although individual permits would not be required in this area. The proposed boundary line tracks generally West to East beginning at the Louisiana-Texas state line in Calcasieu parish and ending at the Washington-St. Tammany parish boundary where it meets the Louisiana-Mississippi state line. From West to East, the boundary follows the northern parish boundaries of Calcasieu, Jefferson Davis, Acadia, Lafayette and upper St. Martin parishes until it intersects the west Atchafalaya levee, then proceeds north to the Old River Control Structure, then south along the east Atchafalaya levee to its intersection with US 190, then eastward along US 190 to its intersection with Louisiana Highway 67 (LA 67) then northerly along LA 67 to its intersection with Louisiana Highway 10 (LA 10), then east along LA 10 to its intersection with U.S. Highway 51 (LA 51), then north along US 51 to its intersection with Louisiana Highway 38 (LA 38), then east along LA 38 to its intersection with Louisiana Highway 1061 (LA 1061) then south along LA 1061 to its intersection with Louisiana Highway 10 (LA 10), then east along LA 10 to the Louisiana-Mississippi state line.

As proposed, the IGC boundary would include the geographic extent of all Master Plan measures and their respective buffer areas, with the exception of two buffer areas. The two buffer areas that extend northward of the IGC boundary are associated with watershed management plan features for the Mermentau and Sabine basins.

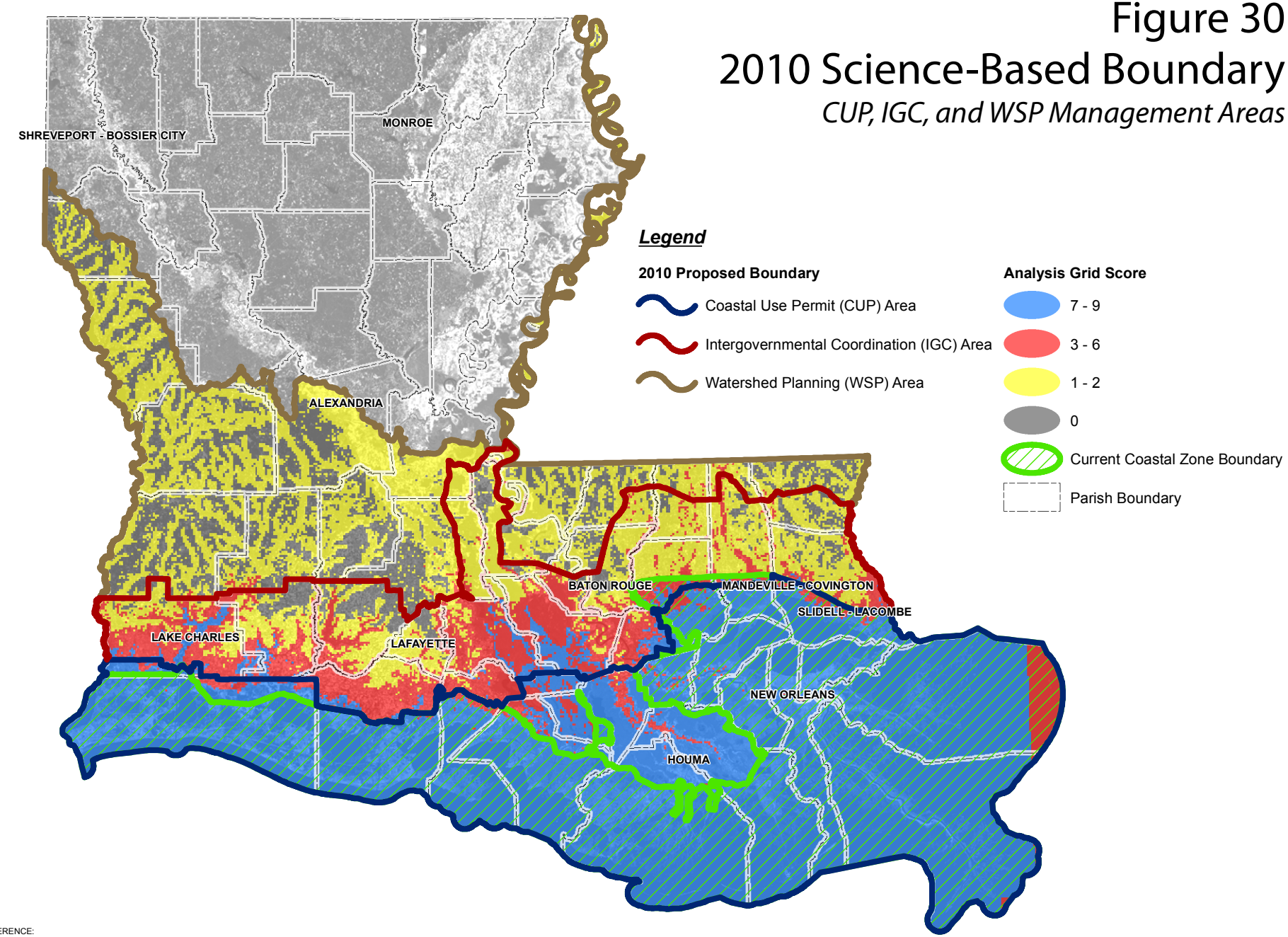
Within the broader coastal management area, as described above for the IGC area, the CUP area comprises a smaller geographic area with greater affinity to coastal processes and nearer to the coastline. The CUP area is a term used to describe the revised or updated coastal zone to distinguish it from the

current or existing coastal zone and to clearly delineate the two distinct management areas, CUP and IGC, within the 2010 SBB. The CUP area, as defined by the project analysis approximates, and in some cases follows, the science-based CZB line recommended by the 1975 study. The CUP area line generally trends from west to east beginning at the Louisiana-Texas state line in Calcasieu parish just north of the Cameron parish line and ending at the Louisiana-Mississippi state line slightly north and east of the city of Slidell, in St. Tammany parish. This proposed new CUP inland boundary tracks slightly north of the existing coastal zone boundary in the Chenier plain. Farther east, the newly proposed line follows the current coastal zone boundary along the Gulf Intracoastal Waterway through Vermilion parish then loops northward in Iberia parish to include Lake Peigneur. More of the Atchafalaya River basin area would be included in the proposed CUP area where the proposed boundary would cross following the southern parish lines of upper St. Martin and Iberville parishes. In the central region of the state the proposed CUP area would be expanded to include all of Terrebonne, Lafourche and Assumption parishes. East of the Mississippi River, the updated CUP area boundary would pass through Ascension parish beginning at the intersection of the southern border of Ascension Parish and an Entergy right-of-way (ROW), then proceed northward following the eastern side of the ROW to a point on the northern ROW of U.S. Interstate Highway 10 (I-10), then proceeding southeasterly along the I-10 northern ROW to a point along the east section line of Section 26, Township 10 South, Range 4 East, then northerly along section lines to the northern drainage servitude of the New River Canal, then westerly along said northern canal drainage servitude to its intersection with the east drainage servitude of Sevario Canal, then northwardly along said canal's east drainage servitude to an intersection with an existing protection levee, then northwardly following the existing protection levee and crossing Louisiana Highway 22 (LA 22) to the north ROW of the Laurel Ridge Canal levee, then proceeding northwesterly and westerly along said canal levee, thence northwesterly to a point in Section 3, Township 8 South, Range 3 East, south of and near Louisiana Highway 42 (LA 42), then from said point northeasterly, and southeasterly following LA 42, then northeasterly along LA 42 to the intersection of the Ascension-Livingston parish line, then following LA 42 to the Ascension-Livingston parish line. The boundary then proceeds south along the Ascension-Livingston parish line to LA 22, then follows LA 22 to its intersection with Louisiana Highway 16 (LA 16), then continues northward to the junction with LA 42. In the parishes north of Lake Pontchartrain, the boundary is proposed to move southwards slightly and transfer a portion of what is the current regulated coastal zone into the IGC management area by traversing the following route through Livingston, Tangipahoa and St. Tammany parishes. From LA 16, following LA 42 eastward to the town of Springfield, then continuing eastward on LA 22 to the St. Tammany parish line, then northward along the parish line to its intersection with U.S. Interstate Highway 12 (I-12), then eastward along I-12 to its intersection with I-10, and continuing eastward following I-10 to the Louisiana-Mississippi state line.

Table 10. Alternative Coastal Zone Boundary Matrix

		Current Coastal Zone Boundary					2010 Science-Based Recommendation Boundary (CUP & IGC Areas)			
CRITERIA		Entire Parish located inside CZB	Portion of Parish located in CZB	Local coastal program approved	Local coastal program being developed		Entire Parish located inside CUP area	Portion of Parish located inside CUP area	Entire Parish located inside IGC area	Portion of Parish located inside IGC area
PARISH	Acadia								●	
	Assumption		●				●			
	Ascension							●		●
	Avoyelles									●
	Calcasieu		●	●				●		●
	Cameron		●	●			●			
	Concordia									●
	East Feliciana									●
	East Baton Rouge									●
	Iberia		●		●			●		●
	Iberville								●	
	Jefferson	●		●			●			
	Jefferson Davis								●	
	Lafayette								●	
	Lafourche		●	●			●			
	Livingston		●					●		●
	Orleans	●		●			●			
	Plaquemines	●		●			●			
	Pointe Coupee									●
	St. Bernard	●		●			●			
	St. Charles	●			●		●			
	St. Helena									●
	St. James	●		●			●			
	St. John the Baptist	●					●			
	St. Martin		●					●		●
	St. Mary		●				●			
	St. Landry									●
	St. Tammany		●	●				●		●
	Tangipahoa		●					●		●
	Terrebonne		●	●			●			
	Vermilion		●		●			●		●
	Washington									●
	West Baton Rouge									●

Figure 30
2010 Science-Based Boundary
CUP, IGC, and WSP Management Areas



REFERENCE:
Louisiana Oil Spill Coordinator's Office, 2007, Landsat Thematic Mapper Satellite Image 2005, UTM Zone 15 NAD83, LOSCO (2007) [landsat5tm_la_lsu_2005.sid]: Louisiana Oil Spill Coordinator's Office, Baton Rouge, LA.

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Adoption of the proposed CUP area coastal zone inland boundary would add only a single new parish, a portion of Ascension, to the area now subject to coastal use permitting. While it is true that other areas of the proposed CUP area are expanded by this proposal, certain areas in Livingston and Tangipahoa parishes are proposed to be deleted from the area subject to coastal use permitting, although they would remain in the IGC area of the broader coastal management area.

An analysis of the proposed inland boundary for the CUP management area of the coastal zone shows that there will be a net increase of 1,939 mi^2 (Table 11) in that portion of the coastal zone subject to regulation through the coastal use permit program of OCM. While this may initially seem to be a large area to add to the regulated coastal zone, when considered in the context of long-term land loss in the Louisiana coastal zone, it is not nearly so large. The USGS (Barras et al., 2004) has projected the amount of land loss in coastal Louisiana to be 2,038 mi^2 between the years 1956-2050. Assuming this to be the case, and that the proposed CUP boundary were to be adopted, the land area of the CUP management zone could actually be 99 mi^2 smaller in the year 2050 than it was in 1956.

Table 11: Changes in Area Subject to Regulatory Permit

Parish	Increased (Square Miles)	Decreased (Square Miles)
Ascension	52	
Assumption	370	
Calcasieu	102	
Cameron	242	
Iberia	123	
Lafourche	560	
St. Martin	181	
St. Mary	202	
Terrebonne	294	
Livingston		137
Tangipahoa		50
TOTAL	**2125**	**186**

4.0 Next Steps: Implementing an Updated Coastal Zone

This document presents the findings of a comprehensive science-based evaluation of the adequacy of the current inland coastal zone boundary to meet the state's present and future needs to manage, protect, and restore its coastal resources. A guiding principle for this study was the need for balance between creating an overly expansive coastal zone and identifying a coastal zone which was sufficient to manage emerging coastal issues over the next several decades, especially those pertaining to climate change, sea-level rise, nonpoint source pollution, and coastal and marine spatial planning. In addition, a critical factor to consider was delineating a management area based on science and geography that would allow for coastal management in the area covered by the Louisiana Comprehensive Master Plan for a Sustainable Coast. The Coastal Management Program and the Master Plan should work in tandem to protect coastal waters and coastal resources, and to insure that upstream activities do not inadvertently limit the state's ability to implement Master Plan measures. Based on the analyses presented in this document, it is recommended that the current coastal zone boundary be expanded, and that a broader coastal management area with a hierarchical management approach be adopted to allow the state to effectively manage, protect, and restore its coastal resources. The expanded coastal management area, as delineated by the 2010 SBB, would include two management areas encompassing all areas subject to high and moderate coastal processes. Activities in the CUP management area, or updated coastal zone, would be subject to the enforceable policies of the SLCRMA. However, activities in the IGC management area would not be "regulated" in the strict sense of the word. Rather, they would be subject to state and federal consistency based on the same enforceable policies that are used to evaluate permits. In the IGC area, the OCM would evaluate proposed actions by governmental bodies that include major hydrological modifications having the potential to affect the coastal zone or Master Plan implementation; the individual actions of residents, private businesses, private industry, and landowners on a project-by-project basis would not be scrutinized. Areas not in the broader coastal management area, but contained within or adjacent to watersheds that could potentially affect the coastal zone, would be managed by planning initiatives; activities in the planning area would not be subject to the enforceable policies of the SLCRMA, unless an activity specific effect on coastal waters was demonstrated.

The recommended management areas would include:

- Coastal Use Permit (CUP) Management Area
  - Zone of direct interaction
  - High level of coastal influence based on the data set evaluation (Score 7-9)
  - Located within, and synonymous with, the regulated coastal zone
  - Permits would be required for certain activities pursuant to existing regulations as set forth in R.S. 49§214.30, or revisions thereto

- Intergovernmental Coordination (IGC) Area
  - Zone of direct influence
  - Moderate level of coastal influence based on the data set evaluation (Score 3-6)
  - Located within the coastal management area, but outside of the regulated coastal zone
  - Consistency determinations, pursuant to existing authorities and state law, would be required for major hydrological modifications which are direct actions of governmental bodies

- Watershed Planning (WSP) Area
  - Zone of indirect influence
  - Low or no coastal influence based on the data set evaluation (Score 0-2)
  - Located outside of the coastal management area but within the identified planning area
  - Coastal zone management program might choose to participate in coastal planning efforts, with or without contributing funding, if the particular planning effort will have coastal ramifications.

There are potential benefits to an expanded coastal management area. Increased planning initiatives in watersheds that are partially within the coastal management area, or adjacent to watersheds that touch the coastal management area, will strengthen the state's ability to work with local governments to reduce nonpoint source pollution and limit other factors which could potentially affect coastal waters and coastal resources. Increased oversight in the IGC management area of riparian activities and public works projects that include hydrologic modifications would insure that these activities do not limit the long term planning goals established by the state Master Plan. Table 12 lists some potential advantages of being in the coastal zone and Table 13 provides a comparison between the CUP and IGC management areas.

Table 12: Potential Advantages of Being in the Coastal Zone

CUP Management Area	IGC Management Area
CUP applicants are eligible for federal USACE Programmatic General Permit (PGP) approvals, providing "one stop permit shop" permitting for wetlands projects.	Area eligible for consideration for restoration.
Projects in this area may receive priority consideration for state restoration project selection.	State controleed GOMESA funds, if available, can be spent in parishes with qualifying projects..
Parishes eligible to receive funding for ongoing implementation of Local Coastal Programs.	Activities subject to limited federal consistency CZMA authority under CZMA to direct actions of government.
Parishes in this area with an approved Local Coastal Program (LCP) process CUPs for local concern uses.	Parishes are able to provide comments on federal government activities in their area to a state agency with regulatory authority over the activities.
Activities subject to full force and power of state's federal consistency authority under CZMA.	More opportunities and options for certain mitigation activities may be available.
Nineteen original coastal parishes continue to be eligible for direct Gulf of Mexico Energy Securities Act (GOMESA) funding.	Provide increased consistency with Master Plan goals in the IGC management area by oversight in the broader coastal zone for riparian activities and hydrologic modifications by governmental bodies which could affect Master Plan implementation.
More opportunities and options for certain mitigation activities may be available.	
Permit tracking available through OCM web based system.	

Table 13: Comparison of CUP and IGC Management Areas of the Proposed Coastal Zone

CUP Management Area	IGC Management Area
CUP applicants are eligible for federal USACE PGP approvals, providing "one stop permit shop" permitting for wetlands projects.	CUP applicants must continue to have wetlands permits issued through federal USACE process; state PGP will not apply.
Projects in this area may receive priority consideration for state restoration project selection.	Area eligible for consideration for restoration, but receives no priority CZM consideration.
Parishes eligible to receive funding for ongoing implementation of Local Coastal Programs.	Parishes may receive funding for specific projects only when funding becomes available
Parishes in this area with an approved LCP process CUPs for local concern uses.	Parishes are not eligible to establish LCPs or to process CUPs for local concern uses.
Activities subject to full force and power of state's federal consistency authority under CZMA.	Activities subject to limited federal consistency CZMA authority under CZMA to direct actions of government.
Nineteen original coastal parishes continue to be eligible for direct GOMESA funding.	.State controlled GOMESA funds, if available, can be spent in parishes with qualifying projects
More opportunities and options for mitigation activities available.	More opportunities and options for certain mitigation activities may be available.

4.1 Necessary Changes in State Law

While this report provides a framework for establishing an expanded coastal management area with hierarchical management, the only required change to state law is to amend the boundary section of the SLCRMA to enlarge the coastal zone so that it encompasses all of the CUP area. Implementation of the IGC area can be accomplished administratively through existing state and federal law and regulations under the CZMA and the SLCRMA. Thus, the only statutory change would be to amend the current coastal zone boundary statute, La. R.S. 49:214.24. The current inland boundary of the Louisiana coastal zone is very complex and, in some places, seems illogical when viewed on a map of the state, or when traveling along one of the highways or waterways that serves as a designated boundary. Consider, one example, the three "fingers" of ridge land that are outside of the coastal use permit area in the Terrebonne-Lafourche basin. The Bayou Dularge, Bayou Petit Caillou, and Bayou Grand Caillou ridges all are outside of the current boundary but are surrounded by land that is within the coastal zone. Further, the law defines the boundary as the "edge of the ridge" which is somewhat subjective and, given the high rate of subsidence and low elevations, this boundary can change over time. Similarly, in western Louisiana, the Intracoastal Waterway serves as the coastal zone boundary, but the environment outside the coastal zone is indistinguishable from that inside the coastal zone. Likewise, in southeastern Louisiana, the coastal zone boundary meanders along waterways and parish boundaries in a convoluted way that excludes nearly all of Assumption and Ascension parishes, despite the fact that there are extensive "coastal" wetlands in both parishes that are contiguous with wetlands included in the coastal zone.

Delineating an expanded coastal zone for permitting would correct many of the deficiencies of an outdated coastal zone boundary that was established in an era when the importance of coastal resources, particularly for storm surge reduction, was not fully appreciated. It would also help to reduce some of the confusion that the public experiences with regard to wetlands permitting. Many people cannot recognize wetlands subject to USACE Section 404 jurisdiction and erroneously believe that a permit is not needed if an area is outside of the coastal zone and is not marsh. This may lead to the issuance of a USACE cease and desist order or other action, which can be very costly in terms of time and money.

Inclusion of an IGC management area within the broader coastal management area, but outside of the regulated coastal zone, would allow the state to more efficiently manage alterations of water resources that may affect surface water flows, including addressing issues of flooding and stormwater treatment. The management goal of the IGC area is to provide consistency review of major hydrological modifications proposed by governmental bodies. These types of alterations are generally associated with public works projects and are often well beyond the planning stage before they come under review for potential effects on coastal waters or coastal resources. While current coastal management regulations allow the OCM to review these types of governmental activities for consistency with the coastal management plan, they are not subject to routine review, and many activities are fully implemented before their effects are realized. Because the Master Plan and coastal zone boundaries do

not coincide, the effects of activities outside of the current coastal zone could result in consequences that are inconsistent with the Master Plan. The IGC boundary would identify those areas where hydrologic modifications have a higher potential to affect downstream resources or Master Plan measures and provide a process for governmental agencies to apply for a consistency concurrence prior to committing funds to a project that may come under scrutiny down the line. Further, including areas subject to a moderate level of coastal affinity within the coastal management area would relieve the OCM from the often time-consuming task of substantiating that a particular project outside of the coastal zone would impact coastal waters or coastal resources, every time a project was reviewed outside the CUP area.

The concept of a stratified or tiered coastal management area, with resources managed through two regulatory scenarios and an adjacent planning zone that includes coastal watersheds adjacent to the coastal management area, would not necessarily expand governmental control, but would memorialize Executive Order BJ 08-07 which states:

> *"All state agencies shall administer their regulatory practices, programs, contracts, grants, and all other functions vested in them in a manner consistent with the Master Plan and public interest to the maximum extent possible."*

The updated coastal management area would also expand the defined area of concern for the state with regard to federal agency policy and action in the IGC under federal law. For example, federal operation of the Old River Control Structure would be a direct federal action performed in the IGC management area. These operations would, therefore, require a consistency determination from the state prior to a direct federal action. As the coastal policy exists now, the state would first have to document how the direct federal action would impact the coastal zone prior to reviewing the action for coastal consistency.

Many circumstances have changed over time in the arena of coastal resource management, along with advances in the science on which that management is based. As the state moves forward with its coastal restoration initiative, it has become increasingly evident that the rejection of the 1975 science-based coastal zone boundary in favor of a smaller, more politically acceptable coastal zone has unwittingly created challenges that must be overcome. A prime example is Bayou Lafourche. Poorly planned development in the bayou's riparian zone, and hydrologic modifications that limit the freshwater flow, are challenges that must be overcome in order to protect the drinking water source for over 300,000 citizens, and restore the region's coastal wetlands south of the Mississippi River. Reconnecting Bayou Lafourche and the Mississippi River is imperative to the survival of the region, but the fear of flooding and negative impacts to bayou side facilities and other structures built close to the water's edge have hampered efforts to reintroduce freshwater into the bayou.

Congress is currently poised to reconsider the CZMA legislation, which is likely to be reauthorized with significant modification; and, Louisiana has initiated the 2012 Master Plan Update. For these reasons, it is both timely and appropriate to update Louisiana's coastal zone boundary to more accurately reflect

current conditions, and to incorporate the current paradigm of integrated coastal management for sustainable development into state policy through the adoption of an expanded coastal management area. An expanded coastal management area that includes two management levels and an adjacent planning area would allow for appropriate management of coastal Louisiana, based on the nature and degree of management needed for specific uses, areas and resources.

It should be noted that the Louisiana Legislature has already approved the addition of Ascension parish to the Louisiana coastal zone. Senate Bill 65, adopted in the 2010 Regular Session and enrolled as Act No. 956, established that "the inland boundary of the coastal zone shall also include all or any portions of the parishes of Ascension and Iberville recommended for inclusion in the coastal zone by the final report of the Coastal Protection and Restoration Authority of Louisiana prepared in response to Senate Concurrent Resolution No. 60 of the 2009 Regular Session." Accordingly, Ascension parish will be incorporated into the Louisiana Coastal Zone six months after the approval of the boundary change for that parish by the CPRA.

4.1.1 Implementation Mechanisms

As previously stated, the IGC area provisions can be accomplished under existing state and federal law. Only one section of law, La. RS 214.24, the coastal zone boundary section of the SLCRMA, needs to be revised to implement an expanded coastal zone as recommended in this report. One approach to implementing the updated coastal zone boundary is to allow the Secretary of the LDNR, through the OCM, to determine the exact boundary based on the results of this study, and to implement it through either rulemaking or by resolution approved by the legislature. This means the inland coastal zone boundary would no longer be legislatively defined. La. R.S. 49:214.24 would remain largely the same and the seaward and interstate boundaries would not change. However, subsection C, governing the inland coastal zone boundary, would be modified to allow the Secretary to define the inland boundary in accordance with the Louisiana Administrative Procedure Act. Subsection D would also be modified to authorize the secretary to amend the boundary in accordance with the Louisiana Administrative Procedure Act. Lastly, a subsection E could be written to require the Secretary to conduct periodic reviews of the inland boundary to ensure the coastal zone covers all areas necessary for effective management of the state's coastal resources.

A second approach would be to parallel the way the current boundary is regulated in the SLCRMA. La. R.S. 49:214.24 would remain largely the same, and the seaward and interstate boundaries would not change. However, subsection C, governing the inland boundary, would be modified by legislative act to define the inland boundary of the coastal zone using the boundary description for the CUP management area recommended in this report.

Thus, the updated regulated coastal zone boundary, consisting of the CUP management area recommended in this report, could be implemented through regulation or statue. The Legislature enacts

statutes. Administrative agencies adopt, amend and repeal regulations under the authority granted to them by statutes and in accordance with the Administrative Procedure Act. Other coastal states have used both methods in establishing their coastal zone, with many providing a brief boundary description in their coastal management program enabling legislation which then refers to the full boundary description contained in the coastal zone management plan, as approved by NOAA. Other states make reference to official boundary maps maintained by the regulatory agency. This referencing of the approved NOAA plan or official maps seems to rely on the rule-making process since a specific boundary description is usually not included elsewhere in the statue. The statute method is more often used when the boundary is simple and based on political subdivisions. For example, the coastal zone of Mississippi is defined by statute as comprising all of Hancock, Harrison and Jackson Counties (Mississippi Code, 15§57-15-6(f)), and the coastal zone of Georgia is defined as:

> *"…all tidally influenced waters and submerged land seaward to the state's jurisdictional limits and all lands, submerged lands, waters, and other resources within the Counties of Brantley, Bryan, Camden, Charlton, Chatham, Effingham, Glynn, Long, Liberty, McIntosh, and Wayne." (OCGA 12-5-320* et seq.*)*

The states of Alabama, North Carolina, Rhode Island and Texas all use the administrative rule making process to define their coastal zones. Alabama uses a coastal zone definition adapted from the federal CZMA in its statue:

> *"COASTAL AREA. The coastal waters, including the lands therein and thereunder, and the adjacent shorelands, including the waters therein and thereunder, strongly influenced by each and in proximity to the shorelines of Alabama and including transitional and intertidal areas, salt marshes, wetlands, and beaches. The area extends seaward to the outer limit of the United States territorial sea and extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters." (Code of Alabama 1975, §9-7-10(1)*

The Alabama Department of Environmental Management is responsible for developing rules and regulations through the administrative rule making process:

> *"The department shall develop and promulgate, after notice and opportunity for full participation by relevant federal agencies, state agencies, local governments, regional organizations, port authorities and other interested parties, both public and private, such rules and regulations as may be necessary to carry out the management program provided for in this chapter." (Code of Alabama 1975, § 9-7-16)*

The inland coastal zone boundary for the state of Alabama, which extends inland to the continuous 10-foot contour in Mobile and Baldwin Counties, is detailed in the Alabama Department of Environmental Management Administrative Code, Code R. 335-8-1-02(k):

> *"'Coastal Area' means the waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) lying seaward of the continuous 10 foot contour (as defined below) extending seaward to the outer limit of the United States territorial sea. The inland boundaries of the coastal area are described as follows: begin at the southernmost point of the Mississippi-Alabama state line where the land surface elevation reaches 10 feet above mean sea level and continue in a general easterly direction along the 10-foot contour to the proximity of Mobile Bay; continue in a northerly direction on the 10-foot contour along the western shore of Mobile Bay and the Mobile River delta to the north line of Mobile County; thence southeastward along the north line of Mobile County to the intersection with the Baldwin County line in the Mobile River; thence along the west and north lines of Baldwin County in the Mobile and Alabama Rivers to the intersection of the westernmost point of Baldwin County where the land surface altitude reaches 10 feet above mean sea level; thence along the 10-foot contour in a southwesterly and southern direction along the Alabama River, the Mobile River delta and the east shore of Mobile Bay to the proximity of Bon Secour; thence continue along the 10-foot contour in an easterly and northeasterly direction to the Alabama-Florida state line."*

The state of Indiana's coastal management program operates in accordance with the coastal zone management program document, which includes boundary descriptions, submitted to and approved by NOAA, and is not codified by statute or administrative rule.

Regardless of the implementation approach chosen to update Louisiana's coastal zone, future evaluations of the CZB should be conducted. Because of the dynamic nature of the coast and the implications of rising sea level, it is recommended that the CZB be re-analyzed periodically to evaluate the effects on the landscape, coastal populations, and infrastructure. Because of the rapidity of change, this should be done every ten years. The re-evaluations should use a GIS approach and similar methods as were used in this study. New technology and approaches should be incorporated as appropriate.

Additionally, the CUP area/coastal zone boundary and IGC area boundary should be maintained in an electronic GIS format on a website that is publically available. This will allow any person or group considering any activity in coastal Louisiana to easily consult a map to see what management area the land in question is in at the start of the project.

4.2 Federal Requirements for Amending the State's Coastal Zone Management Program

In order to maintain a national CZM program with an updated boundary, the NOAA program change process must be conducted. The NOAA Office of Office of Coastal Resource Management (OCRM) reviews all program change requests, whether an amendment or a routine program change (RPC), on a case-by-case basis to determine if the program change is approvable. The key in determining whether a program change is an amendment or an RPC is whether a change in one or more of the five program areas is "substantial". The five program areas include:

1. Uses Subject to Management (15 C.F.R. Part 923, Subpart B)
2. Special Management Areas (15 C.F.R. Part 923, Subpart C)
3. Boundaries (15 C.F.R. Part 923, Subpart D)
4. Authorities and Organization (15 C.F.R. Part 923, Subpart E)
5. Coordination, Public Involvement and National Interest (15 C.F.R. Part 923, Subpart F)

Under NOAA's CZM program, a substantial change in a state's coastal zone boundary is considered an "amendment" to its coastal zone program as opposed to a "routine program change," which has a different set of procedures that are generally less burdensome. Coastal states are allowed to amend their approved coastal zone management programs, including their coastal zone boundary, but only under certain conditions. Proposed changes must be submitted by the head of the state agency in charge of the management program (for Louisiana: Secretary of the Department of Natural Resources) to the Assistant Administrator for Ocean Services and Coastal Zone Management for approval. A public notice and public comment period, which could include a public hearing, are also required.

For a complete review of the statutory requirements for amending a coastal zone management program see 15 CFR 923.80 *et seq*. and 16 USC 1455(e) and the OCRM's final program change guidance document: Program Change Guidance, The Coastal Zone Management Act and Changes to State and Territory Coastal Management Programs, July 1996.

4.3 Financial Effects of Amending the Coastal Zone Boundary

The overall goal for amending the coastal management area is effective management over the full range of south Louisiana that is subject to coastal processes. However, recognizing that governmental resources are finite, the implemented plan should not expand state government obligations without providing options for also growing the resources needed to implement the recommended management strategy, and then only to the minimum extent necessary.

The recommended CUP and IGC management areas would only add one parish, Ascension, to the management area subject to CUP regulation, increasing the number of parishes in the coastal zone from 19 to 20. Increased regulatory responsibility requiring additional resources will be a concern, especially

for parish governments having or contemplating an LCP. This is a valid concern for parishes where management by CUP could be expanded, but less so for those which would be essentially the same. In addition to the potential for an increase in workload, parishes that currently have an approved LCP might require additional resources to review and to update their coastal management program documents. Parishes now in the coastal zone, but currently without local programs, would create additional costs to the state OCM, if these parishes establish an approved local coastal program. Potential funding options include the use of either the state or local portion of GOMESA funds, except for Ascension parish, which would not be eligible for local GOMESA funds unless federal laws were changed. But, more importantly, state GOMESA funds could be used for any parish in the defined coastal zone under current GOMESA guidelines.

Only parishes with an approved LCP that regulates uses in the CUP management area should be afforded full funding, since this management strategy would require the greatest level of effort. Other parishes could be funded at a lesser level, when additional funds become available. Funding should be contingent upon the development of a source of recurring revenue, such as state GOMESA funds, which might support a coastal advisory committee or similar parish entity at some determined level. Because of their potential to be affected by global sea level rise, IGC parishes should also be eligible for inclusion in any emerging revenue stream, such as an Ocean and Coastal Trust Fund at the national level, to facilitate coastal planning. Both the Pew Oceans Commission and the U.S. Commission on Ocean Policy support a permanent Ocean Policy Trust Fund or similar permanent fund with dedicated sources of revenues to fund coastal and ocean policy (Pew Oceans Commission, 2003; U.S. Commission on Ocean Policy. 2004).

Planning initiatives and development of watershed management plans for the IGC and WSP areas would be eligible for funding on a project by project basis for planning and implementation, especially as they might pertain to implementing and advancing the goals of the CNPCP.

4.3.1 Increase in Permitting Jurisdiction

Louisiana's CZMP is funded in large part by a grant from NOAA, authorized under Section 306 of the CZMA. Louisiana receives $2,000,000 per year under this grant; this amount is the maximum that any one state may receive. This money must be matched by the state dollar for dollar. Fees related to permitting and consistency determinations, as well as other fees generated by the CZMP, are deposited into the Coastal Resources Trust Fund (CRTF) and used to match the NOAA grant. Logically, an increase in the size of the coastal zone would equate to a larger area that would be subject to coastal use permitting. The CZMP also receives state money from the Coastal Protection and Restoration Trust Fund each year, which is also used as match for federal CZMA funds. LDNR, in running Louisiana's CZMP, is responsible for facilitating the permitting process, and the agency incurs costs in doing so. However, some of these administrative costs would likely be covered by the fees attached to permitting applications and consistency determinations. It is difficult to determine whether LDNR would suffer a

significant financial burden from increased permitting. Based on an examination of USACE regulatory data, it is estimated that the increased number of permit applications received by the state would not increase significantly, when compared to the normal yearly fluctuation of permit application numbers received. The increase in permit applications is estimated to be approximately 7%, while the annual variability over the history of the coastal management program is over 20%. Coupled with permit processing efficiency improvements implemented by OCM over the past two years, the anticipated increase in permit load is expected to be within the capacity of current OCM resources. However, one additional parish would be added to the coastal zone. This newly added parish, plus parishes already in the coastal zone that do not presently have local programs, could seek to have their own local coastal management programs. LDNR shares the costs of establishing such programs with the local authority. The funds LDNR currently receives would likely be insufficient to cover the costs of establishing new local coastal management programs.

LDNR should seek other sources of funding or cut expenditures in other areas, in order to meet its share of the cost of establishing new local programs. Another solution is to petition the Congressional Appropriations Committee to remove the $2,000,000 cap on coastal management funds, seeking higher appropriations from NOAA's CZMA budget. Under the formula for awarding such funds, Louisiana would receive an increase in funds if the cap were removed. Lastly, GOMESA funds could be used to help cover the costs associated with establishing local programs, since the SLCRMA is a federally-approved coastal management plan, and implementation of a federally-approved marine, coastal, or comprehensive conservation management plan is an authorized use of GOMESA funds.

4.3.2 Effects on Parishes Already in the Coastal Zone

Adopting an updated inland boundary to the regulated coastal zone will have limited effect on most of the 19 parishes already in the Louisiana coastal zone. And, as previously discussed, the primary effects will be associated with increased workloads in those parishes with an approved local coastal program when the regulated coastal zone area is enlarged, and from potentially diminished opportunities for funding of local coastal programs should one or more additional parishes ultimately choose to establish an approved local program. Clearly, parishes whose coastal zone boundaries are expanding, and which have an approved local coastal program, will need a one time update of their local coastal program document, and the OCM should seek priority funding to support this effort. It is worth noting that only 10 of the 19 eligible coastal parishes currently have approved local programs funded by OCM. Several other parishes have expressed an interest in establishing such programs, so OCM's limited ability to fund local programs is already stretched. The issue that the state should focus on is securing sufficient funding to adequately support the implementation of local coastal programs as discussed elsewhere in this report. The recommendations made in this document will not significantly alter the state's ability to fund existing local programs, when compared to the pressure already potentially present from eligible parishes not yet seeking local programs.

Certain federal programs related to OCS revenue sharing have attracted the attention of coastal parishes. The Coastal Impact Assistance Program (CIAP) allocates $250 million of Outer Continental Shelf revenues per year (from 2007 - 2010) to eligible states. Some of this money can go directly to a parish if it is included in Louisiana's coastal zone. However, newly included parishes would not qualify to receive the funds due to certain time and geographic restrictions. The state could spend CIAP money on projects in newly included parishes only in very limited circumstances because of authorized use restrictions. Funding through GOMESA is under restrictions that are similar to CIAP, and CIAP will soon expire unless reauthorized.

CPRA has "discretion to approve all requests for integrated coastal protection programs and projects in the coastal area, insofar as such requests are for funds to be appropriated from the Coastal Protection and Restoration Fund." Coastal Protection and Restoration funds are not allocated to parishes within the coastal area on any type of pro-rata basis but rather on a project specific basis. Projects are thoroughly evaluated and subject to a "project benefit scoring procedure" before being selected for funding. These checks and balances would prevent an increase in the coastal zone size from significantly decreasing the CPRA funds available for projects in parishes already in the coastal zone. Therefore, even though parishes receive some funds on the basis of being in the coastal zone, an increase in the coastal zone is likely to have little effect on those funds. Other programs were identified as being sources of funds for coastal protection and restoration, but did not have provisions relating to the coastal zone and would therefore be unaffected by an increase in the coastal zone. Both issues are covered in greater detail in Appendix D.

5.0 Conclusions and Recommendations

The purpose of this study was to conduct a science-based evaluation of the adequacy of the current inland boundary of the coastal zone of Louisiana to meet the state's current and future needs to manage, protect and restore its coastal resources, as directed by Senate Concurrent Resolution No. 60, Regular Session 2009 of the Louisiana Legislature. A guiding principle for this study was the need for balance between creating an overly expansive coastal zone and identifying a coastal zone which was sufficient to manage emerging coastal issues over the next several decades, especially those pertaining to climate change, sea-level rise, nonpoint source pollution, and coastal and marine spatial planning. In addition, a critical factor to consider was delineating a management area based on science and geography that would allow for coastal management in the area covered by the Louisiana Comprehensive Master Plan for a Sustainable Coast.

Based on the analyses presented in this document, it is recommended that an expanded coastal management area boundary and a hierarchical management approach be adopted. The expanded coastal management area would include two management areas and would encompass all areas subject to high and moderate coastal processes. Activities in the CUP management area, or regulated coastal zone, would be subject to the enforceable policies of the SLCRMA. Certain activities in the contiguous IGC area would be subject to consistency determinations in accordance with existing authorities and state law. Figure 30 depicts the recommended 2010 Science-Based coastal management area which includes the updated coastal zone boundary (CUP management area) and the newly defined IGC management area; the IGC area is not a part of the regulated coastal zone. Areas not in the coastal management area, but contained within or adjacent to watersheds that could potentially affect the coastal zone or proposed Master Plan measures, would be managed by planning initiatives. Activities in the planning area would not be subject to the enforceable policies of the SLCRMA unless an activity specific effect on coastal waters was demonstrated.

The two recommended management areas delineated within the 2010 Science- Based Boundary include a Coastal Use Permit (CUP) area, and an Intergovernmental Coordination (IGC) area. A Watershed Planning area (WSP) is also recommended north of the IGC area.

The Coastal Use Permit (CUP) area is defined by this report as that area of coastal Louisiana having a high level of affinity for coastal processes as measured by the methodology employed by this project, a grid score of 7-9. This area, which is most subject to coastal processes and most in need of a high level of management, will be designated as the regulated coastal zone in accordance with the CZMA. The CUP area was found to be most of the current coastal zone, but extends farther north in much of the study area as shown in Figure 30. The management methods employed for the CUP area would be as

they are for the current coastal zone, relying primarily on the coastal use permit authority of the state to manage land and water activities. Appropriate intergovernmental coordination management methods would also apply in this area.

Delineating an expanded coastal zone for permitting would correct many of the deficiencies of an outdated coastal zone boundary that was established in an era when the importance of coastal resources, particularly for storm surge reduction, was not fully appreciated. It would also help to reduce some of the confusion that the public experiences with regard to wetlands permitting. Activities in wetland areas, even those outside of the current coastal zone, are already regulated by the USACE. Expanding the CUP boundary will bring more area under state management, thereby expanding the area where activities might be eligible for permits through the programmatic general permit process, which is much simpler and faster than the USACE Section 404 permit process.

The Intergovernmental Coordination (IGC) area would consist of that portion of the study area having moderate association with coastal processes as measured by the ecological analysis methodology employed for this project, a grid score of 3-6. The management strategy used in the IGC is proposed to be the management of the direct actions of governmental bodies having the potential to affect hydrology or proposed Master Plan measures. Within this area, the individual actions of residents, private businesses, private industry, and landowners on a project-by-project basis would not be scrutinized. The IGC area would not be part of the regulated coastal zone as defined by the CZMA.

Inclusion of an IGC management area within the coastal management area would allow the state to more efficiently regulate alterations of water resources that may affect surface water flows, including addressing issues of flooding and stormwater treatment. While current coastal management regulations allow the OCM to review these types of governmental activities for consistency with the coastal management plan, they are not subject to routine review and many activities are fully implemented before their effects are realized. The IGC boundary would identify those areas where activities have a higher potential to affect downstream resources, allowing governmental agencies to apply for a consistency concurrence prior to committing funds to a project that may come under scrutiny down the line. Including areas subject to a moderate level of coastal affinity within the state's coastal policy would relieve the OCM from the often time-consuming task of substantiating that a particular project outside of the coastal zone would impact coastal waters or coastal resources.

A Watershed Planning Area (WPA) north of and adjacent to the IGC area is also recommended, in addition to the two management areas contained within the 2010 science-based boundary. The WPA would not be a part of the coastal zone, but would be eligible for participation in certain broad watershed planning efforts that overlap portions of the legally defined coastal zone or the IGC management area. The WPA was determined to be the area defined as having a low score of coastal affinity, based on the ecological analysis methodology used for this project, a ranking score lower than three.

The recommended CUP area, or updated coastal zone, would increase the number of parishes in the regulated coastal zone from 19 to 20. The additional parish added to the coastal zone would be Ascension. Act 956 of the 2010 Regular Session of the Louisiana Legislature provides authorization to add all or any portion of Ascension to the coastal zone within six months of approval of the boundary change for that parish by the CPRA. Additional parishes would be identified for enhanced review of governmental activities affecting hydrology through inclusion, wholly or partially, within the IGC management area. Some parishes would also be included in the adjacent WSP area. Parishes in the IGC and WSP management areas would not be part of the coastal zone, nor eligible to establish a local coastal program. Adding one parish within the CUP area could slightly reduce resources, if alternative funding is not identified. An increase in the size of the coastal zone would equate to a larger area that would be subject to coastal use permitting and, thus, an increase in fees related to permitting and consistency determinations, as well as other fees generated by the Coastal Zone Management Program. The Department of Natural Resources coastal use permit program will incur some increase in permit applications at both the state and local program level. However, a review of USACE permit applications from areas affected by a possible boundary change, suggests that the increase will be modest, and well within normal fluctuations of the current permit load.

There are certain benefits to an expanded coastal zone, establishment of an IGC management area, and recognition of an adjacent watershed planning area:

- It was widely believed that the inland boundary of the coastal zone was, from its inception, insufficient to adequately manage Louisiana's coastal resources.
- Data set evaluation for this study was based on integrated coastal zone management and ecosystem-based management planning tools, including ArcGIS analysis of available data layers. This analysis found that approximately 1.4 million acres of land subject to a high level of coastal influence are outside of the current CZB.
- In the time since the establishment of the coastal zone, numerous other state and federal coastal programs have been established in south Louisiana, which are based on some aspect of coastal science, but which also conform to particular coastal policy criteria. The boundaries established for these programs often extend far beyond the current inland coastal zone boundary. Of particular note are the boundaries of the Coastal Non-point Pollution Control Program (CNPCP) and the Louisiana Comprehensive Master Plan for a Sustainable Coast.
- A significant area of the CNPCP outside of the current inland CZB exists along critical watersheds. Activities in these watersheds, which have downstream impacts, are not reviewed as stringently as activities inside the boundary in regards to coastal effects. Benefits of an expanded coastal management area for the CNPCP would include an improvement in coastal water quality by increasing the participation of state and federal agencies, and by expanding the

implementation of voluntary management measures and those implemented through incentive programs.

- Increased planning initiatives in watersheds that are partially within the coastal management area, or adjacent to watersheds that touch the coastal management area, will strengthen the state's ability to work with local governments to reduce nonpoint source pollution, and to limit other factors which could potentially affect coastal waters and coastal resources

- A broader coastal management area would also provide enforceable policies in the CUP and IGC management areas that would help control nonpoint source pollution in much of the CNPCP area.

- In addition, the inclusion of watersheds with critical downstream impacts in the WSP area strengthens the ability of coastal management to influence and to reduce nonpoint source pollution.

- In the post-Katrina/Rita era of coastal policy in Louisiana, the scale of management needed is much greater than was thought in the mid-1970s when coastal zone management concepts were just being developed. The state Master Plan was developed to fulfill the mandates of Act 8, which was passed by the Louisiana Legislature in 2005 to integrate flood control projects and coastal restoration.

- Pursuant to Executive Order No. BJ 2009-7, state agencies are already required to conduct their activities in a manner consistent with the Master Plan. Implementation of an expanded inland coastal management area with two levels of management, CUP and IGC, would provide a formal process through which the recommendations of the Master Plan are incorporated into the review of proposed coastal activities.

- As proposed, the updated coastal management area would include the geographic extent of all Master Plan measures and their respective buffer areas, with the exception of two buffer areas. The two buffer areas that extend outside of the proposed coastal management area are both watershed management features; these two features would be within the WPA.

The low-lying lands of southern Louisiana constitute an extremely dynamic environment. It is, therefore, very appropriate that the legally defined area of the coastal zone, and the area subject to the state's coastal policies, be reviewed and updated periodically. The Louisiana coastline has changed in the past several decades due to land loss, subsidence, and sea-level rise. Management for coastal Louisiana should include planning for sea-level rise.

- Based on evidence presented in a number of scientific studies, it is likely that sea level will rise by at least one meter by 2100.

- Rising sea level will have serious socioeconomic implications for the state of Louisiana.
- Over half of the population of Louisiana lives in the southern part of the state and, according to NOAA, about one third or about 1.3 million people live at or below sea level. Rising sea levels will put these people at increasing risk.
- There is also a tremendous amount of infrastructure in coastal management areas that is at increasing risk because of sea-level rise.

The federal Coastal Zone Management Act (CZMA), as originally drafted, provides criteria for addressing sea-level rise, which now is better understood and regarded more broadly as multiple effects of climate change.

Louisiana's changing coastal landscape, and the management goals and mandates of the CZMA and the SLCRMA, provide ample guidance for justifying a revision to the area encompassed by the inland portion of the CZB of Louisiana. This report provides a framework for establishing a broader coastal management area and hierarchical management. The only changes in state law required for implementation would be the coastal boundary section of SLCRMA. Additionally, in order to maintain a national CZM program with an updated boundary, the NOAA program change process must be undertaken.

The NOAA Office of Coastal Resource Management (OCRM) reviews all program change requests on a case-by-case basis to determine if the program change is approvable. Coastal states are allowed to make changes to their approved coastal zone management programs, but only under certain conditions. Proposed changes must be submitted by the head of the state agency in charge of the management program (for Louisiana: Secretary of the Department of Natural Resources), and to NOAA's Assistant Administrator for Ocean Services and Coastal Zone Management for approval.

The coastal management area, consisting of the two management areas recommended in this report, could be implemented at the state level through regulation or statue. The Legislature enacts statutes. Administrative agencies adopt, amend and repeal regulations under the authority granted to them by statutes, and in accordance with the Administrative Procedure Act. Other coastal states have used both methods in establishing their coastal zones. This report recommends that the boundary section of the SLCRMA be amended to provide that the OCM, through rulemaking via the Administrative Procedures Act process, may make changes to the inland boundary following a periodic review, and that the CUP area boundary be implemented as the state's inland coastal zone boundary.

If the Legislature chooses to update Louisiana's coastal zone, regardless of the implementation approach chosen, it is recommended that the CUP and IGC boundaries be re-analyzed every ten years to evaluate the effects on the landscape, coastal populations, and infrastructure. The re-evaluations should use a

GIS approach and methods similar to those applied in this study. New technology and approaches should be incorporated, as appropriate. Additionally, the coastal zone boundary and the IGC management area boundary should be maintained in an electronic GIS format on a website that is publically available. In this way, it can be consulted by any person or group considering any activity in coastal Louisiana.

6.0 References

Barras, J. A., J. C. Bernier & R. A. Morton, 2008. Land area change in coastal Louisiana - A multidecadal perspective (from 1956 to 2006). U.S. Geological Survey.

Barras, J.A., S. Beville, D. Britsch, S. Hartley, S. Hawes, J. Johnston, P. Kemp, Q. Kinler, A. Martucci, J. Porthouse, D. Reed, K. Roy, S. Sapkota, and J. Suhayda. 2003. Historical and projected coastal Louisiana land changes: 1978-2050: USGS Open File Report 03-334.

Bass, A. S. and R. E. Turner. 1977. Relationships between salt marsh loss and dredged canals in three Louisiana Estuaries. Journal of Coastal Research 13:895-903.

Batker, D., I. de la Torre, R. Costanza, P. Swedeen, J. Day, R. Boumans, and K. Bagstad. 2009. Gaining Ground. Wetlands, Hurricanes and the Economy: The value of restoring the Mississippi River Delta. A report generated as a project through Earth Economics, Tacoma, Washington.

Blum, M.D. and H.H. Roberts. 2009. Drowning of the Mississippi delta due to insufficient sediment supply and global sea-level rise. Nature Geoscience DOI:10.1038/NGE0553.

Boesch, D. F. 1996. Science and management in four U.S. coastal ecosystems dominated by land-ocean interactions. Journal of Coastal Conservation 2: 103-114.

Cahoon, D. R., D. J. Reed, and J. W. Day. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. Marine Geology 128: 1-9.

Cahoon, D. R., J. W. Day, and D. J. Reed. 1999. The Influence of Surface and Shallow Subsurface soil Processes on Wetland Elevation: a Synthesis. Current Topics in Wetland Biogeochemistry 3: 72-88.

Chabreck, R.H. 1972. Vegetation, water, and soil characteristics of the Louisiana coastal region. LSU Agricultural Experiment Station, Bulletin No. 664, Baton Rouge, Louisiana.

Chabreck, R.H., J.T. Joanen, and A.W. Palmisano. 1968. Vegetative type map of the Louisiana coastal marshes. Louisiana Wildlife and fish Commission, New Orleans, Louisiana.

Colten, C., ed. 2000. Transforming New Orleans and its Environs. University of Pittsburgh Press, Pittsburgh.

Coastal Protection and Restoration Authority of Louisiana. 2007. Louisiana's Comprehensive Master Plan for a Sustainable Coast.

Day, J.W., Jr., D.F. Boesch, E.J. Clairain, G.P. Kemp, S.B. Laska, W.J. Mitsch, K. Orth, H. Mashriqui, D.J. Reed, L. Shabman, C.A. Simenstad, B.J. Streever, R.R. Twilley, C.C. Watson, J.T. Wells, and D.F. Whigham. 2007. Restoration of the Mississippi Delta: Lessons from Hurricanes Katrina and Rita. Science 315:1679-1684.

Deegan, L. A., H. M. Kennedy, and C. Neill. 1984. Natural factors and human modifications contributing to marsh loss in Louisiana's Mississippi River deltaic plain. 8:519-528.

DeLaune, R.D., C.J. Smith, W.H. Patrick, and H. H. Roberts. 1983. Rejuvenated marsh and bay-bottom accretion on rapidly subsiding coastal plain of U.S. gulf coast: a second-order effect of the emerging Atchafalaya delta. Estuarine, Coastal and Shelf Science. 25:381-389.

Dundee, H.A., and D.A. Rossman. 1989. Amphibians and reptiles of Louisiana. Museum of Natural Science, LSU, Baton Rouge, Louisiana.

Emmer, R.E. 1989. Revising Louisiana's inland coastal boundary. Coastal Zone '89, Proceedings of the Sixth Symposium on Coastal and Ocean Management, Charleston, South Carolina. Vol. 3, p 2545-2557.

FitzGerald, D., M. Fenster, B. Argow and I. Buynevich. 2008. Coastal impacts due to sea-level rise. Annual Review of Earth and Planetary Science. 36: 601-647.

Gornitz, V. 1995. Sea-level rise: A review of recent past and near-future trends. Earth Surface Processes and Landforms 20:7-20.

Halcrow *et al*., 2008. Louisiana Department of Natural Resources, Guidelines for permit consistency with Louisiana's Master Plan for a Sustainable Coast. Baton Rouge, La.

Hoese, H.D. 1972. Abundance of the low salinity clam, *Rangia cuneata* in southwestern Louisiana. Proc. Natl. Shell-fisheries Assoc. 63:99-106.

Holgate, S. J., and P. L. Woodworth. 2004. Evidence for enhanced coastal sea-level rise during the 1990s. *Geophys. Res. Lett.*, 31, L07305, doi:10.1029/2004GL019626.

IPCC [Intergovernmental Panel on Climate Change]. 2001. Climate Change 2001: The Scientific Basis, Contribution of Working Group 1 to the Third Assessment Report, Cambridge University Press, Cambridge, UK.

Jawaorski, E. 1972. The blue crab fishery, Barataria Estuary, Louisiana. Center for Wetland Resources, LSU, Baton Rouge, Louisiana. Publ. No. LSU-SG-72-01.

Kniffen, F.B. 1936. A preliminary report on the mounds and middens of Plaquemines and St. Bernard parishes, Lower Mississippi River delta. Dept. of Conservation, La. Geol. Survey Bull. No. 8, pp. 407-422.

Kniffen, F.B. 1938. The Indian mounds of Iberville parish. Dept. of Conservation, La. Geol. Survey Bull. No. 13, pp. 189-207.

Leuliette, E.W., R.S. Nerem, and G.T. Mitchum. 2004. Calibration of TOPEX/Poseidon and Jason altimeter data to construct a continuous record of mean sea level change, Marine Geodesy, 27(1–2), 79–94, 2004.

Louisiana Department of Natural Resources, Coastal Management Division. 1995. Louisiana Coastal Nonpoint Pollution Control Program, Volume 1. Baton Rouge, La.

Louisiana Department of Natural Resources, Office of Coastal Restoration and Management. 1997. Louisiana Coastal Wetlands Conservation Plan. Baton Rouge, La.

Louisiana Department of Natural Resources. 2009. State of Louisiana Coastal And Estuarine Land Conservation Program Plan: draft 2008, revisions submitted 2009. Baton Rouge, La.

Louisiana Quadrangle Maps. 7.5 Minute Topographic Series. Scale: 1:24,000. Available from USGS, Denver, Colorado 80225 or Washington DC, 20242, from the state of Louisiana, Department of Public Works, Baton Rouge, LA, or from their local agents.

Lowery, G.H., Jr. 1974. The mammals of Louisiana and its adjacent waters. LSU Press, Baton Rouge, Louisiana. 565 pp.

McIntire, W.G., M.J. Hershman, R.D. Adams, K.D. Midboe, and B.B. Barrett. 1975. A rational for determining Louisiana's coastal zone. Sea Grant Publication No. LSU-T-75-006. Report No. 1, Coastal Zone Management Series, Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana.

Meehl, G. A., Stocker, T. F., Collins, W. D., Friedlingstein, A. T., Gaye, A. T., Gregory, J. M., Kitoh, A., Knutti, R., Murphy, J. M., Noda, A., Raper, S.C.B., Watterson, I. G., Weaver, A. J. and Zhao, Z. 2007. Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, pp. 747-845.

Mossa, J. 1996. Sediment dynamics in the lowermost Mississippi River. Engineering Geology 45: 457-479.

Myers, R. S., G. P. Shaffer, and D. W. Llewellyn. 1995. Baldcypress (*Taxodium distichum* (L.) Rich.) restoration in southeast Louisiana: the relative effects of herbivory, flooding, competition, and macronutrients. 15:141-148.

National Oceanic and Atmospheric Administration. 2010. Coastal and marine spatial planning, Basic concepts. Internet URL: http://www.msp.noaa.gov/concepts/index.html.

Odum, H.T. 1975. Energy quality and carrying capacity of the earth. Tropical Ecology. 16:1-8.

Palmisano, A.W. 1970. Plant community-soil relationships in Louisiana coastal marshes. Ph.D. Dissertation, LSU, Baton Rouge, Louisiana.

Paxinos, R., A. Wright, V. Day, J. Emmett, D. Frankiewicz, and M. Goecker. 2008. Marine spatial planning: Ecosystem-based zoning methodology for marine management in South Australia. Journal of Conservation Planning 4:37-59.

Perrett, W.S. 1967. Occurrence, abundance, and size distribution of the blue crab, Callinectes sapidus, taken with otter trawl in Vermilion Bay, Louisiana, 1964-65. Proc. La. Acad. Sci. 30:63-69.

Pew Oceans Commission, 2003. America's living oceans: Charting a course for sea change. Arlington, VA

Pfeffer, W., J. Harper, and S. O'Neel. 2008. Kinematic constraints on glacier contributions to 21st-century sea-level rise. Science. 321: 1340-1343.

Rahmstorf, S. 2007. A semi-empirical approach to projecting future sea-level rise. Science 315:368-370.

Sasser, C.E., Visser, J.M., Mouton, Edmond, Linscombe, Jeb, and Hartley, S.B., 2008, Vegetation types in coastal Louisiana in 2007: U.S. Geological Survey Open-File Report 2008–1224, 1 sheet, scale 1:550,000.

Saucier, R.T. 1974. Quaternary geology of the lower Mississippi valley. Arkansas Archaeological Survey, Res. Series No. 6, Fayetteville, Arkansas.

Stevenson, J. C., L. G. Ward, and M. S. Kearney. 1986. Vertical accretion in marshes with varying rates of sea level rise. 241–59. *In* Wolfe, D. A., editor. Estuarine Variability. Academic Press. Orlando.

Swenson, E. M. and R. E. Turner 1987. Spoil banks: effects on a coastal marsh water level regime. Estuarine, Coastal, and Shelf Science 24:599-609.

Tarver, J.W., and R.J. Dugas. 1973. A study of the clam, Rangia cuneata, in Lake Pontchartrain and Lake Maurepas, Louisiana. La. Wildlife and Fisheries Comm., Oyster, Water Bottoms and Seafoods Div. Tech. Bull. No. 5. New Orleans, Louisiana.

Turner, R. and C. Cordes. 1987. Relationship between canal and levee density and coastal land loss in Louisiana. Biological Report 85(14), U.S. Fish and Wildlife Service, Washington.

U.S. Army Corps of Engineers. 2004. Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study: Final Volume 1: LCA Study - Main Report, New Orleans District, LA.

U.S. Army Corps of Engineers. 1963. Tabulations of salinity data from stations located along coastal Louisiana, 1946-1961. New Orleans District, Louisiana. 53 tables.

U.S. Army Corps of Engineers. 1970. Type 5 flood insurance study, Louisiana Gulf Coast. New Orleans District, Louisiana. 4 pp.

U.S. Census. 2008.

U.S. Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century. Final Report. Washington, DC, 2004

U. S. Geological Survey Biological Research Division's, National W, 1998, Louisiana Geology, Geographic NAD83, NWRC (1998) [geology_NWRC_1998]: United States Geological Survey, Biological Resources Division's, National Wetlands Research Center, Lafayette, Louisiana, United States.

U.S. Geological Survey Maps. Scale: 1:250,000. Available from the USGS, Denver, Colorado, 80225 or Washington D.C., 20242, or from local suppliers.

U.S. Geological Survey. 1969. Quality of surface waters of the United States, 1964. Parts 1 and 2. North Atlantic Slope Basins and South Atlantic Slope and Eastern Gulf of Mexico Basins. Geologic Survey Water-Supply Paper 1954, U.S. Government Printing Office, Washington, D.C.

U.S. Geological Survey. 1969-1974. Maps of flood-prone areas.

U.S. Geological Survey. 1972. Water resources data for Louisiana. Prepared in cooperation with the Louisiana Department of Public Works, Baton Rouge, Louisiana.

U.S. Geological Survey. U.S. Department of the Interior. 2006. USGS reports latest land change estimates for Louisiana coast. Internet URL: http://pubs.usgs.gov/of/2006/1274/.

Vermeer, M. and S. Rahmstorf. 2009. Global sea level linked to global temperature. Proceeding of the National Academy of Sciences of the United States of America, Early Edition. www.pnas.org_cgi_doi_10.1073_pnas.0907765106 PNAS.

Welder, F. A. 1959. Processes of deltaic sedimentation in the lower Mississippi River: Tech. Rept. 12, Coastal Studies Institute, Louisiana State University, Baton Rouge.

Wilson, K.V., Jr., M.G. Clair II, D.P. Turnipseed, and R.R. Rebich. 2008. Development of a watershed boundary dataset for Mississippi. USGS Open-File Report 2008-1198, Reston, Virginia.

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