

The Multiple Lines of Defense Strategy to Sustain Coastal Louisiana

Lake Pontchartrain Basin Foundation

Coastal Sustainability Program

John Lopez, Ph.D.

February 2006

LACPR workshop

Supporting Documents

The Multiple Lines of Defense Strategy to Sustain Coastal Louisiana, 2005

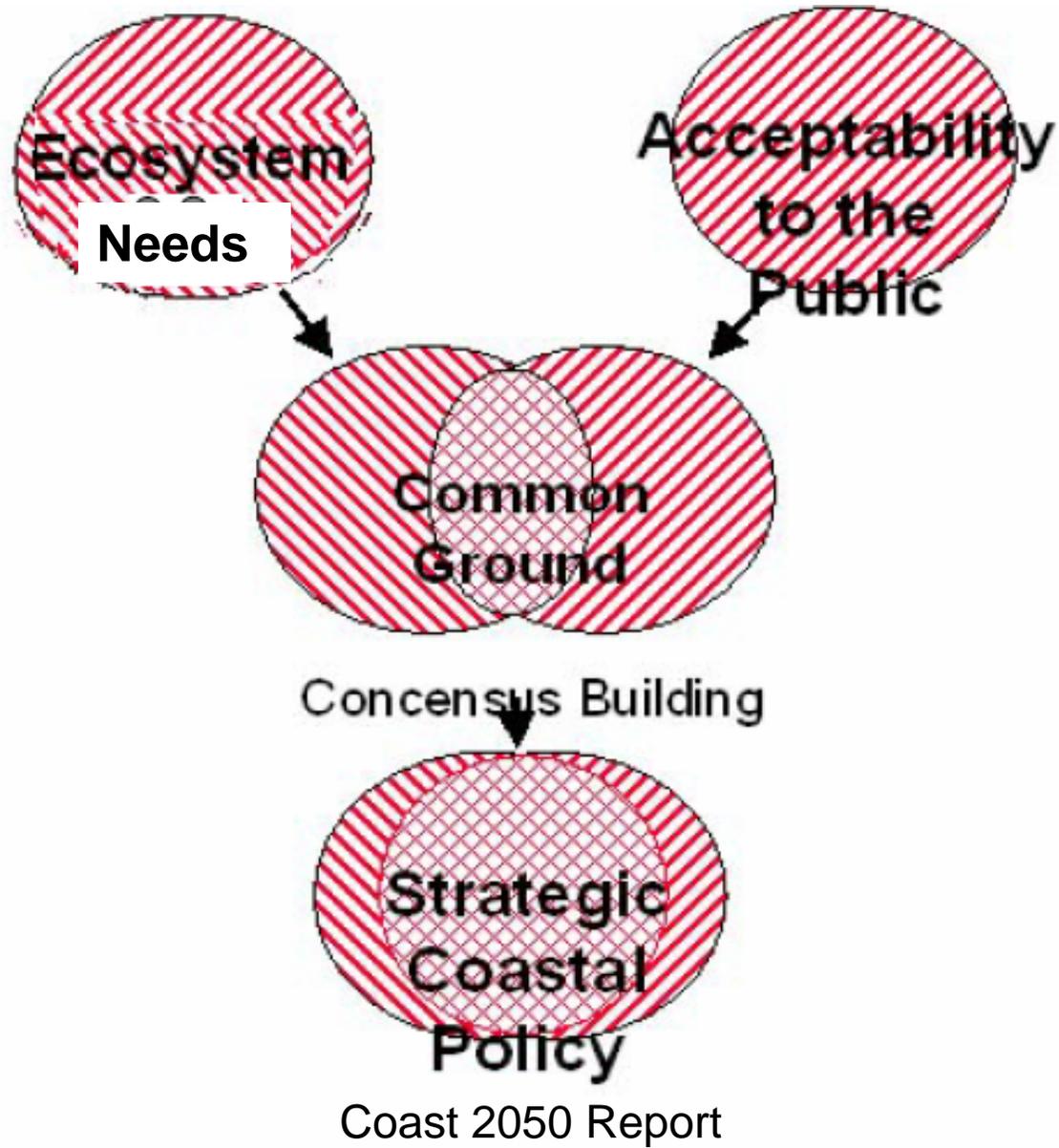
Comprehensive Habitat Management Plan for the Lake Pontchartrain Basin, 2006

Pontchartrain Coastal Lines of Defense Program, 2006

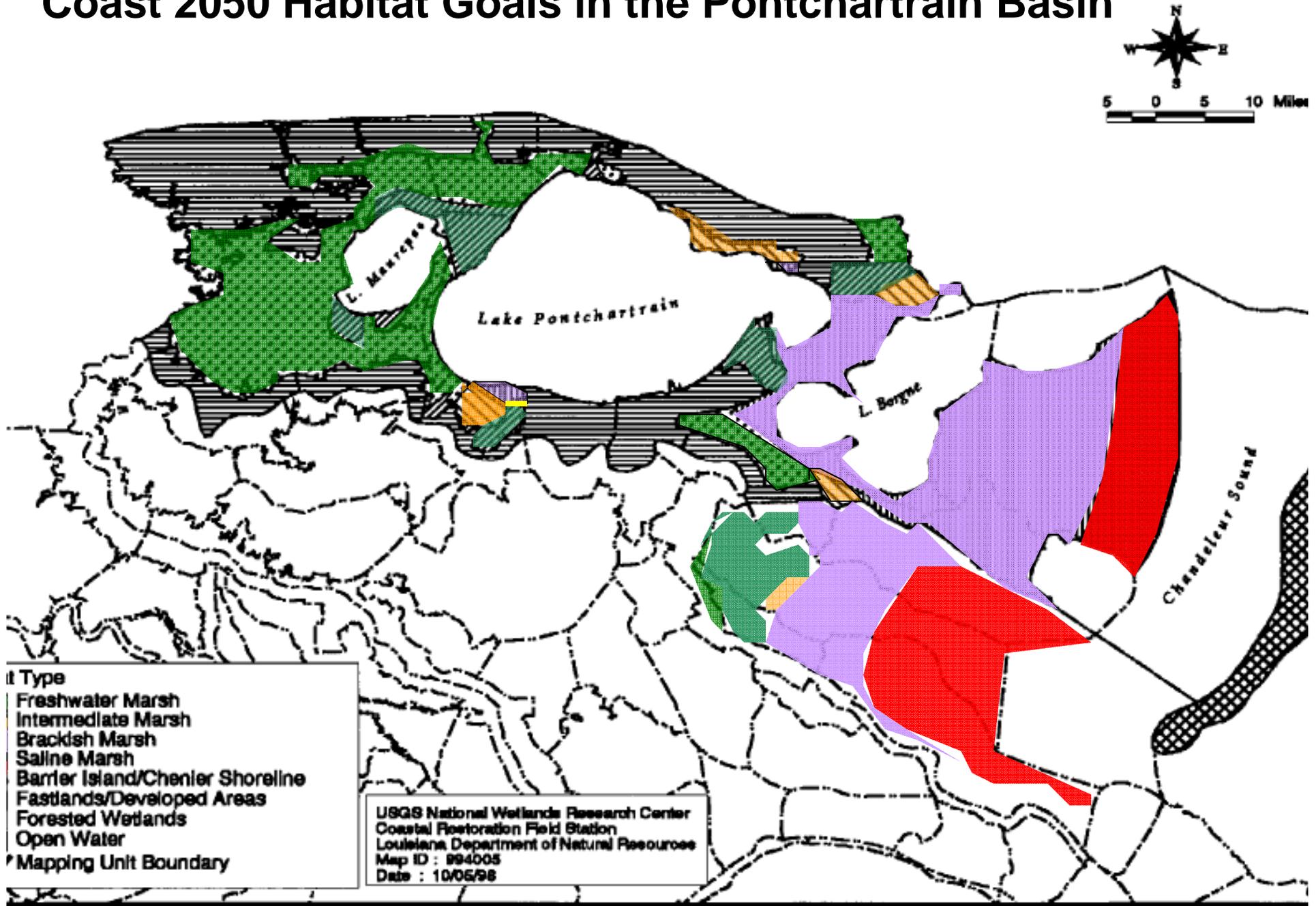
see SAVEOURLAKE.org



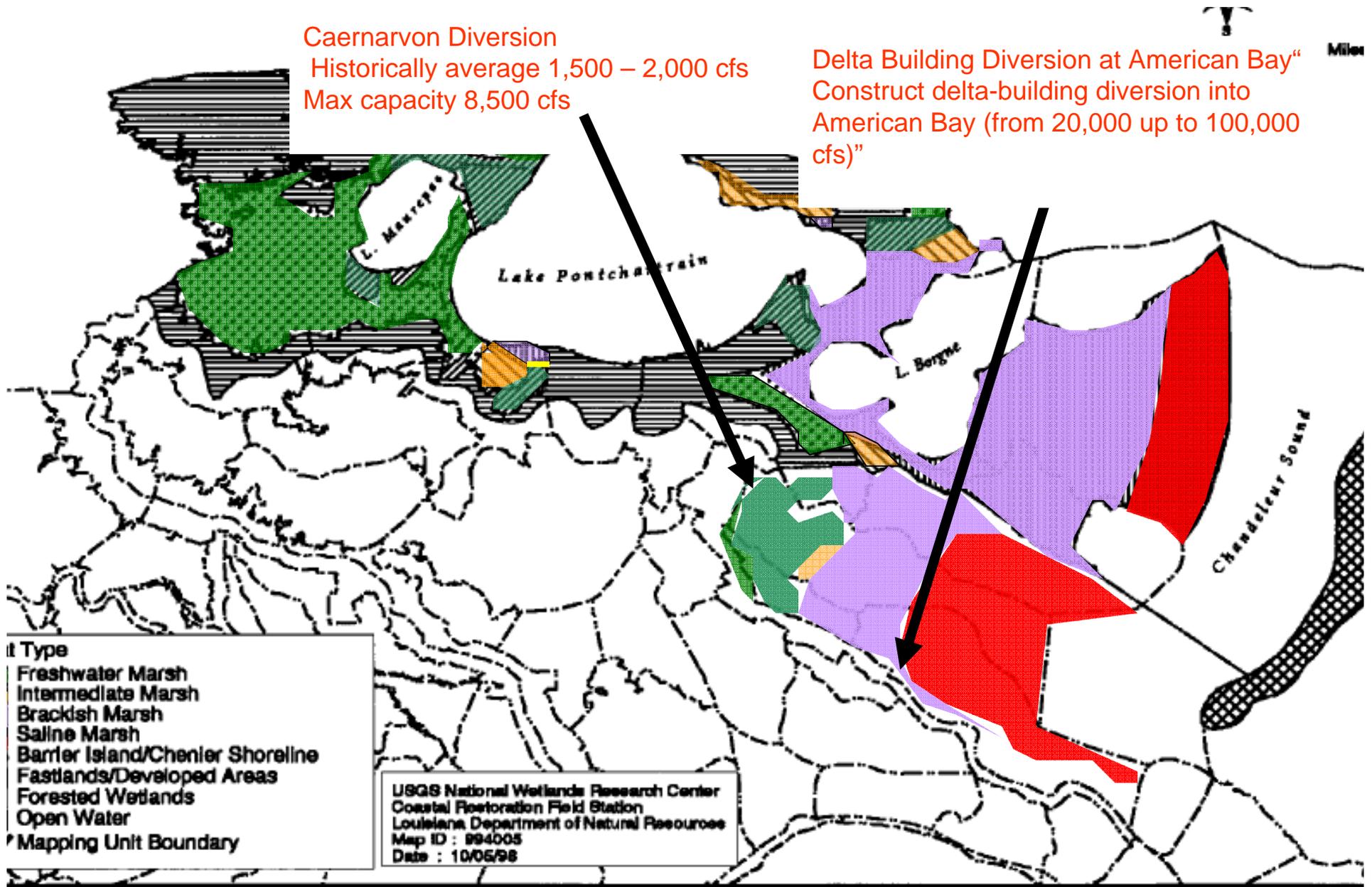
Coast 2050 paradigm



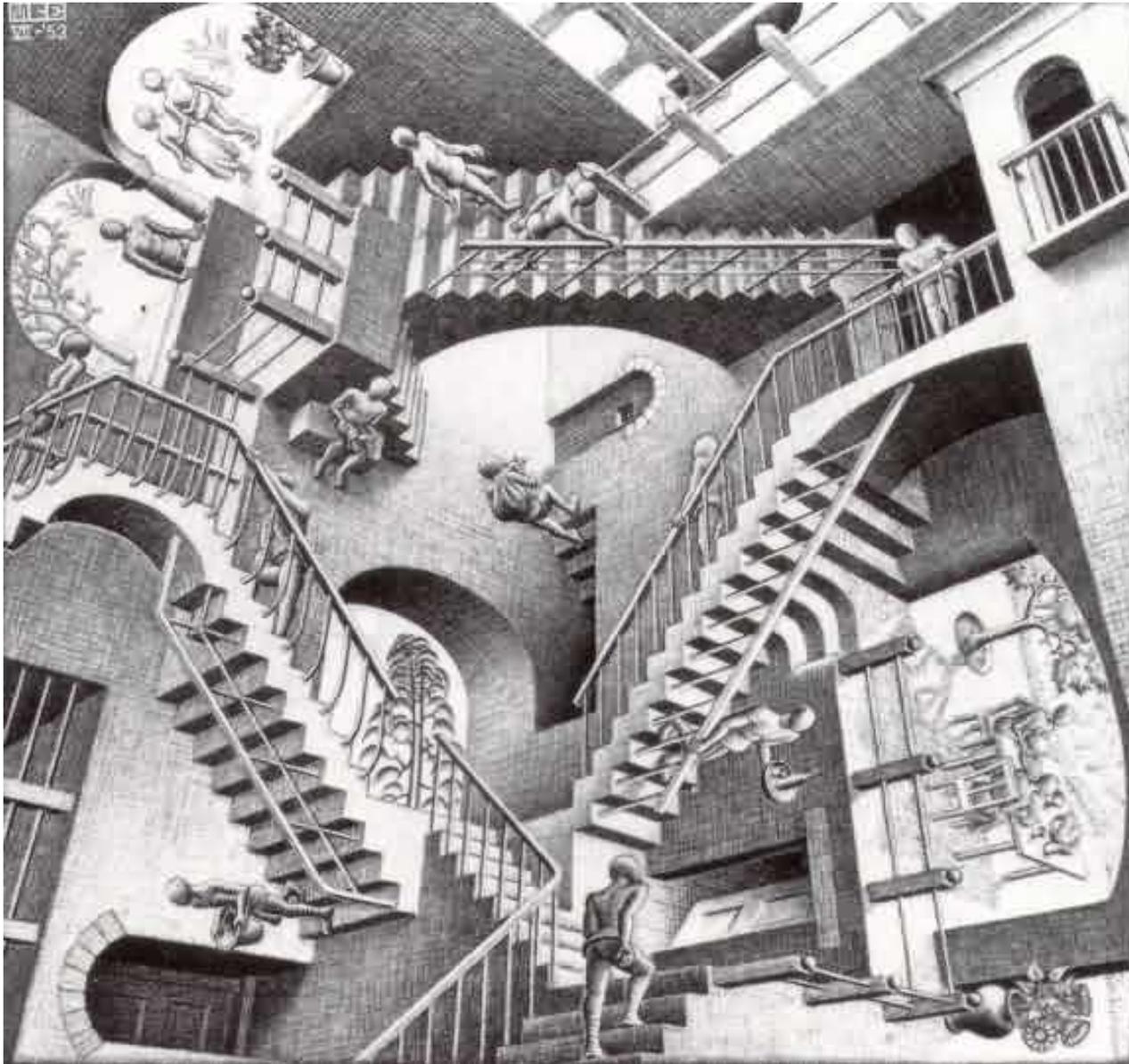
Coast 2050 Habitat Goals in the Pontchartrain Basin



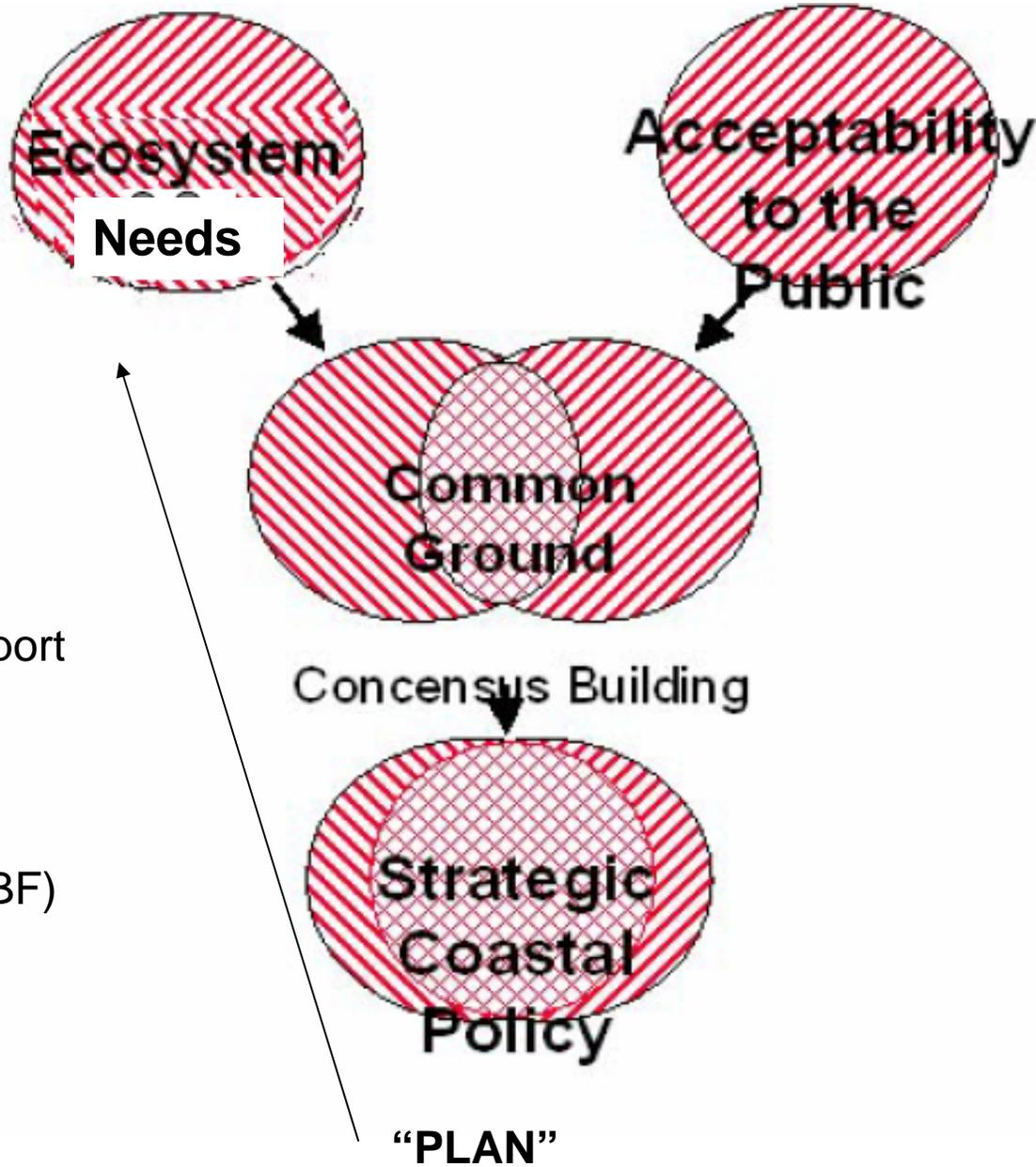
2050 Habitat Goals for the Pontchartrain Basin: **Non-scientific & Non-sustainable** “Escher Map”



M. C. Escher Drawing of Stairs



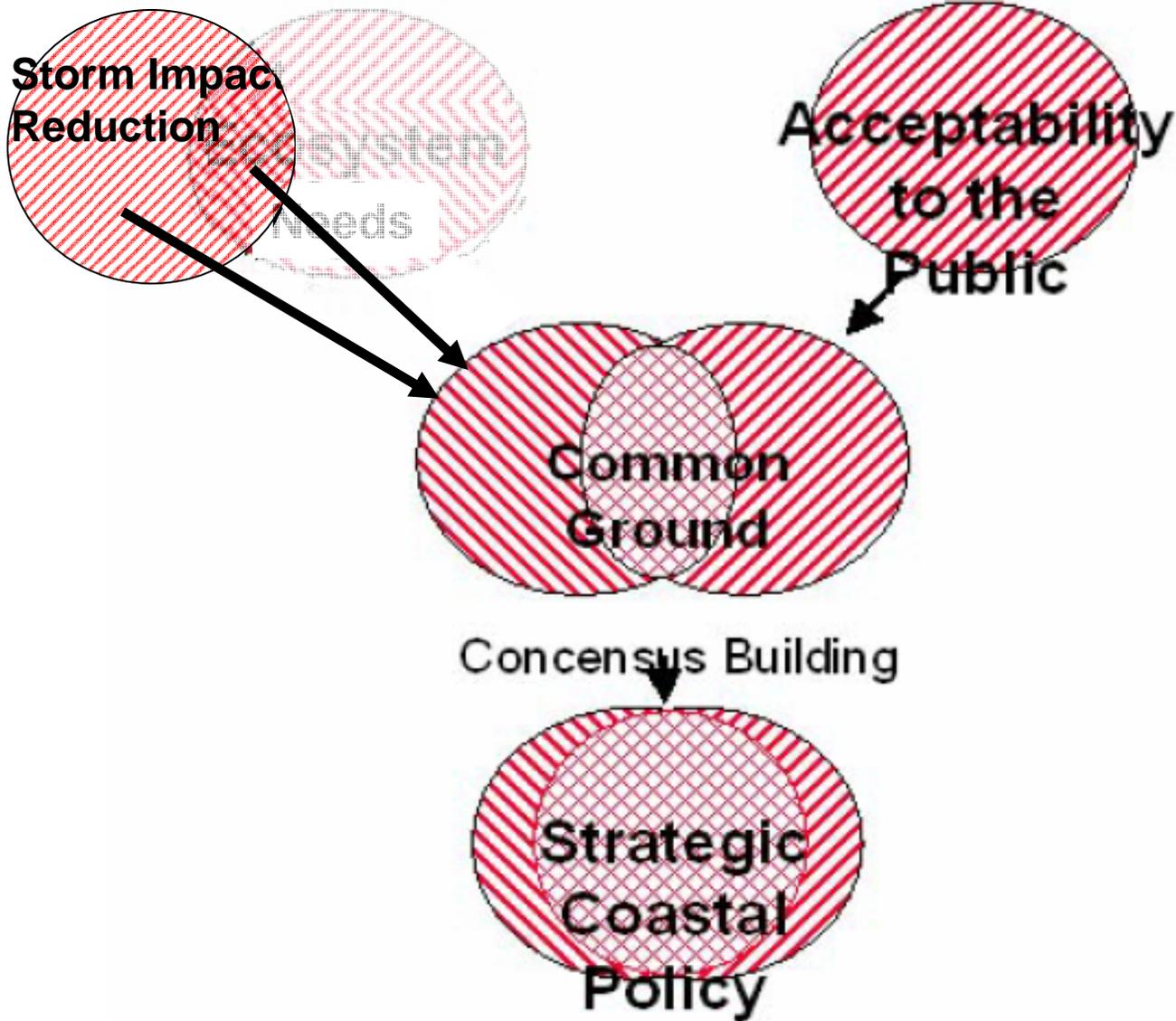
Pre-Katrina Paradigm



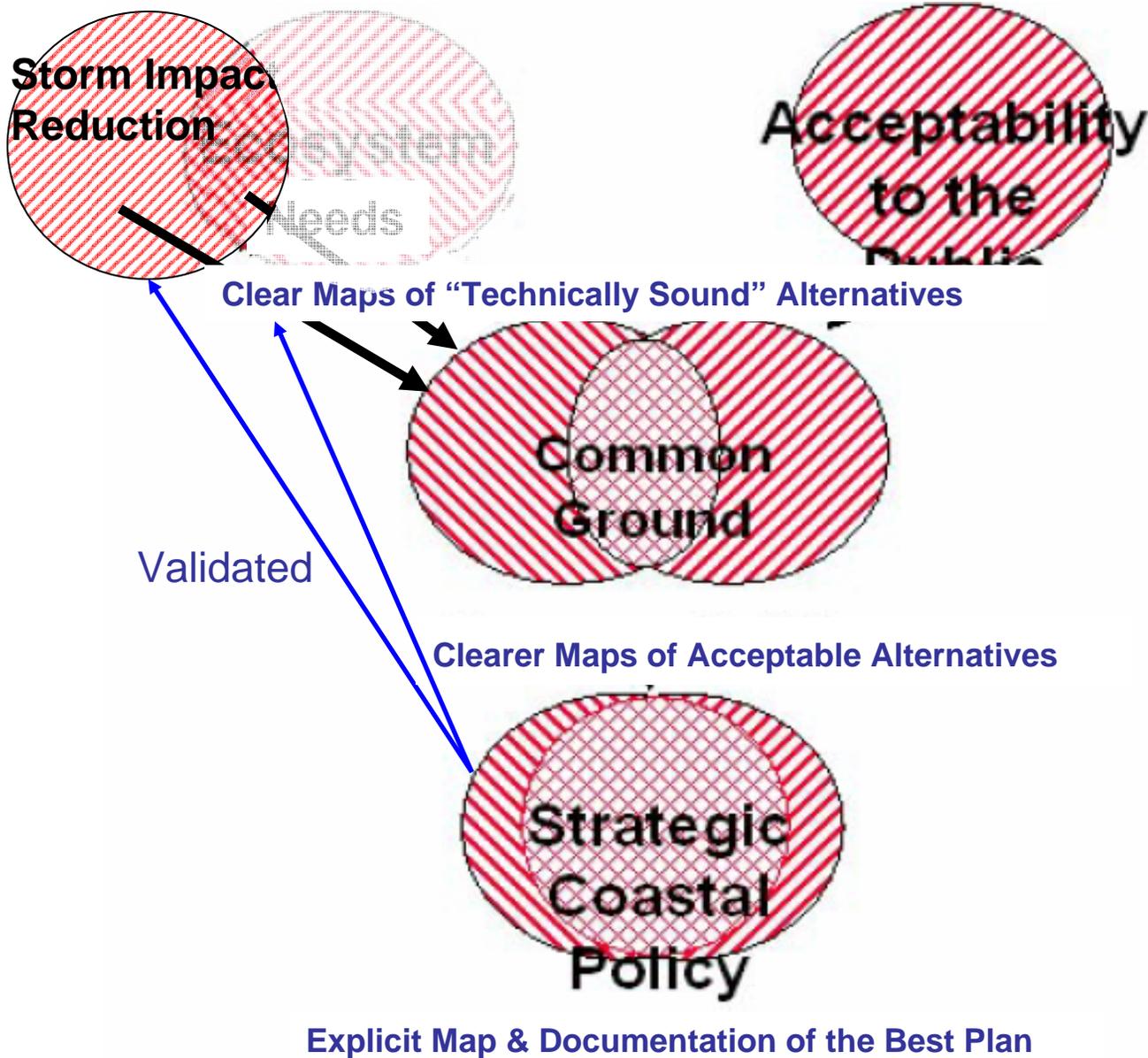
Inadequate:

- Coast 2050 Report
 - LPBF CMP
 - LCA
- (NRC, CRS, LPBF)

Post - Katrina Paradigm



Post - Katrina Paradigm



"To Achieve this, the development of an explicit map of the future landscape of coastal Louisiana should be a priority as the implementation of the LCA study moves ahead." National Research Council 2005

Maps \neq Panacea

Maps are not:

- A replacement for basic science and engineering
- The sole product of a restoration plan
- The only medium for analysis

Maps are:

- The best articulation of the landscape plan & goals
- A dynamic medium that may be adjusted when and where appropriate
- **Inadequate without a compliment of technical reports**

Inadequate maps are symptomatic of other challenges

Traditional Model Addressing Coastal Restoration and Flood Protection

Natural Resource Agencies

\$\$



Flood Protections Agencies

\$\$



Incompatible visions

equals

non- Sustainable Coast

Current Model: No Integration

The Future Model to Integrate of Coastal Restoration and Flood Protection

Natural Resource Agencies

Flood Protection Agencies



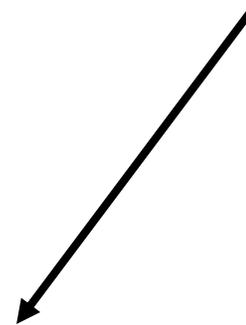
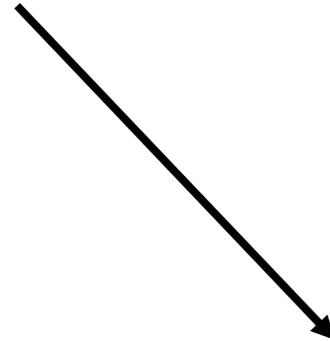
Future Model: Common Vision

How do you Technically Integrate Dual Goals?

The Multiple Lines of Defense Strategy

Define Target Habitat Types and Sustain

Define the Lines of
Defense and Sustain



A Landscape Map of Goals
of a Sustainable Coast

Integrate of Coastal Restoration and Flood Protection

Define **Habitat Types**

Ecologic Engine

Define the **Lines of Defense**

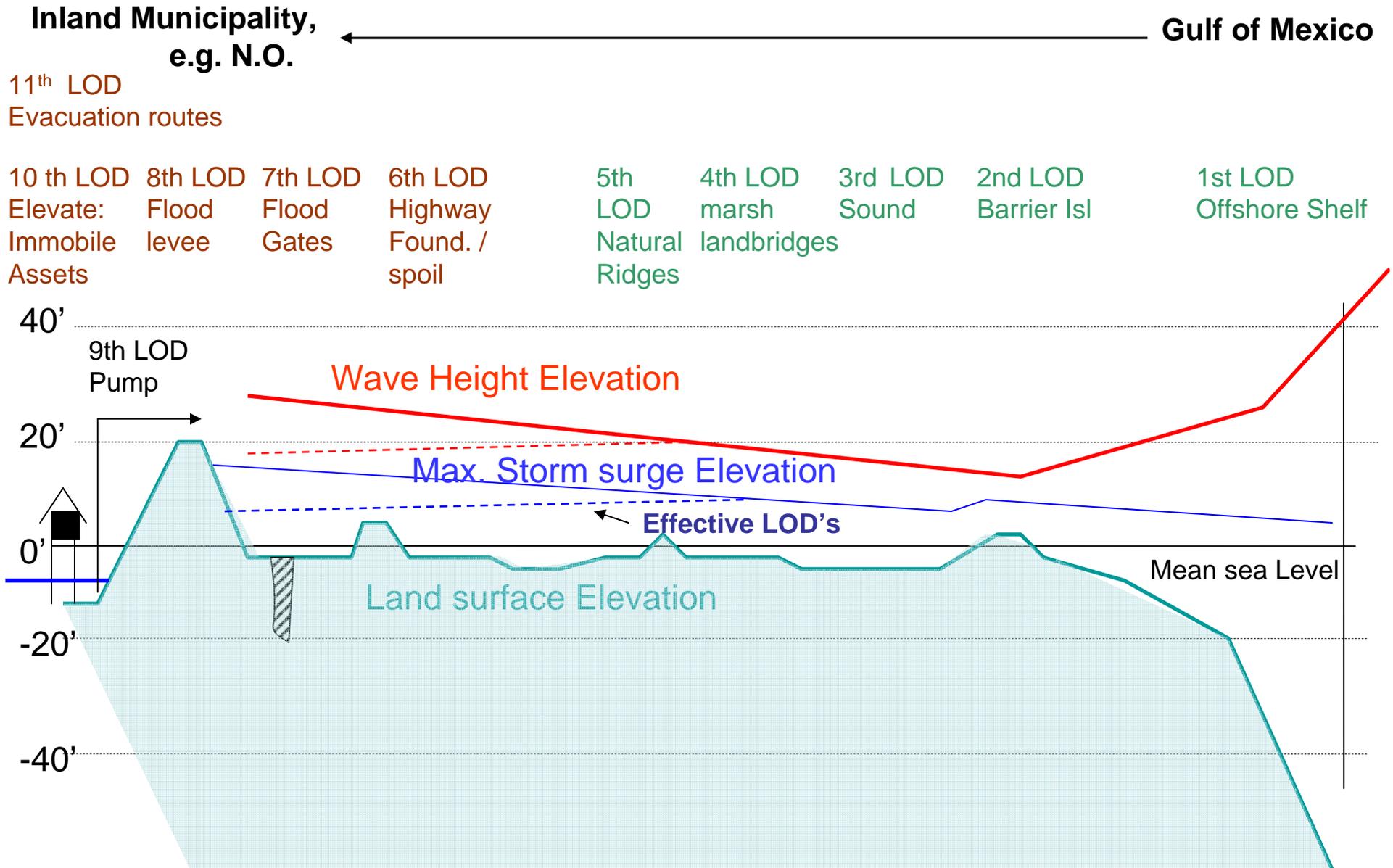
Economic Engine

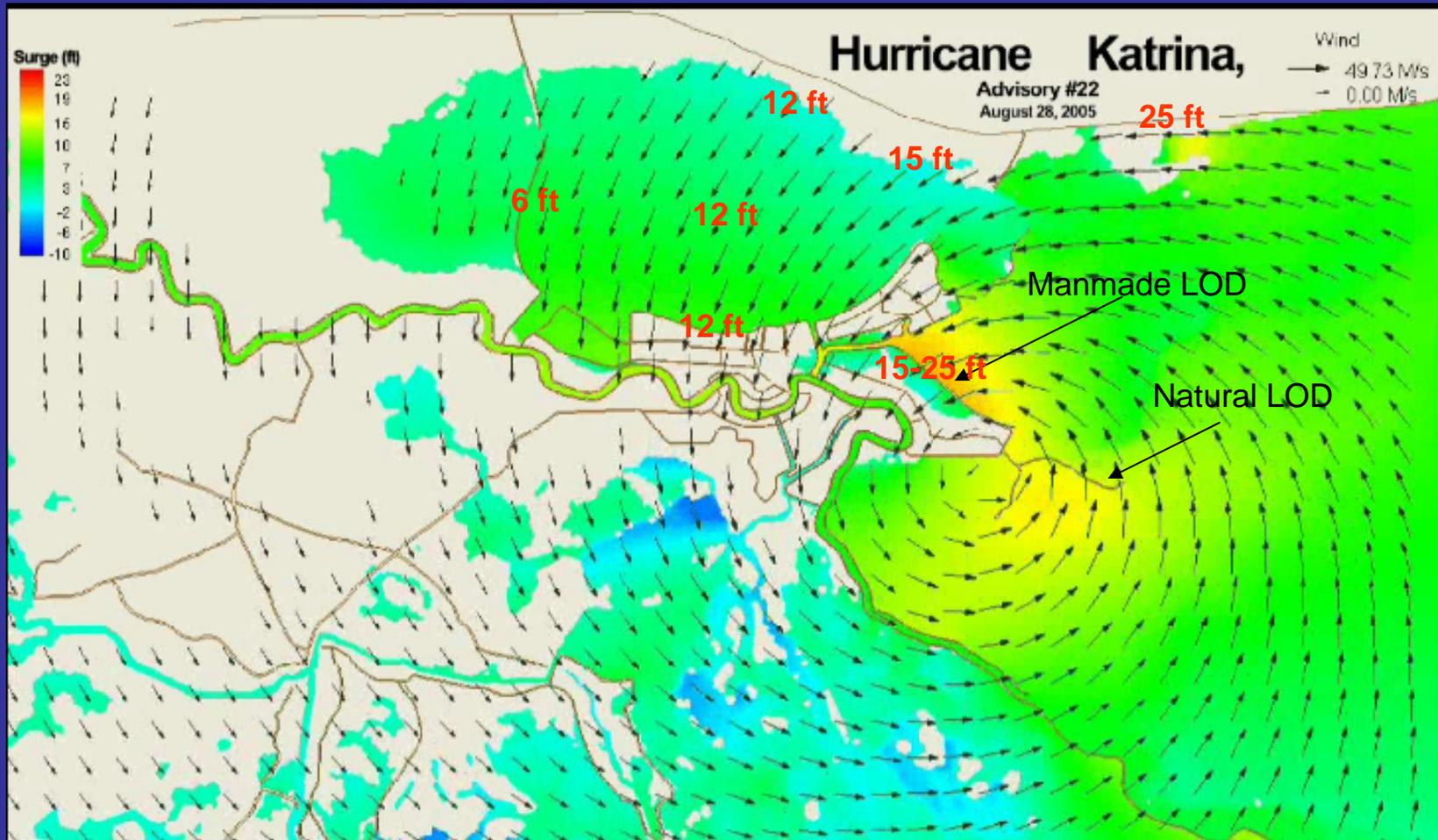


Lines of Defense (LOD) are definable geographic areas in which certain **natural or manmade features or activities are promoted or implemented, resulting in the reduction of impacts by tropical weather systems in the Louisiana coast.**

(The order of LOD's derived from the physical location of the LOD's moving from the Gulf of Mexico inland. The order is not intended to indicate a relative significance, just relative physical position.)

Model of Multiple “Lines of Defense” (LOD) to Reduce the Impact of Tropical Weather Systems to the Louisiana coast (Scale is vertically exaggerated and approximate)





Model from the LSU Hurricane Center of a projected Hurricane Katrina track. Actual track was a few miles east. Colors indicate expected storm surge. Orange color east of St. Bernard along the MRGO indicate excess surge levels from the “funnel effect” near the westward convergence of the MRGO spoil bank with the flood levees along the Gulf Intracoastal Waterway. Note also Bayou la Loutre ridge impeding storm surge.

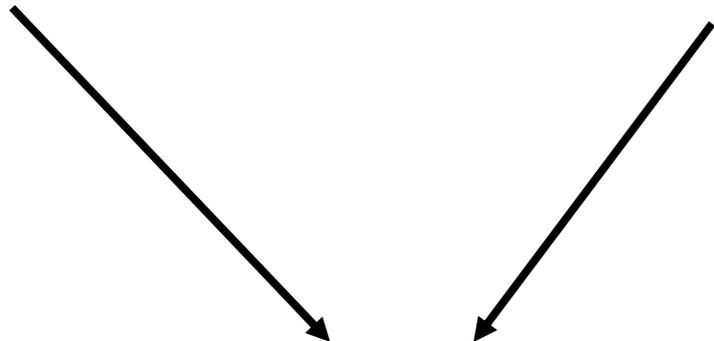
Image courtesy of the LSU Hurricane Center

How do you Technically Integrate Dual Goals?

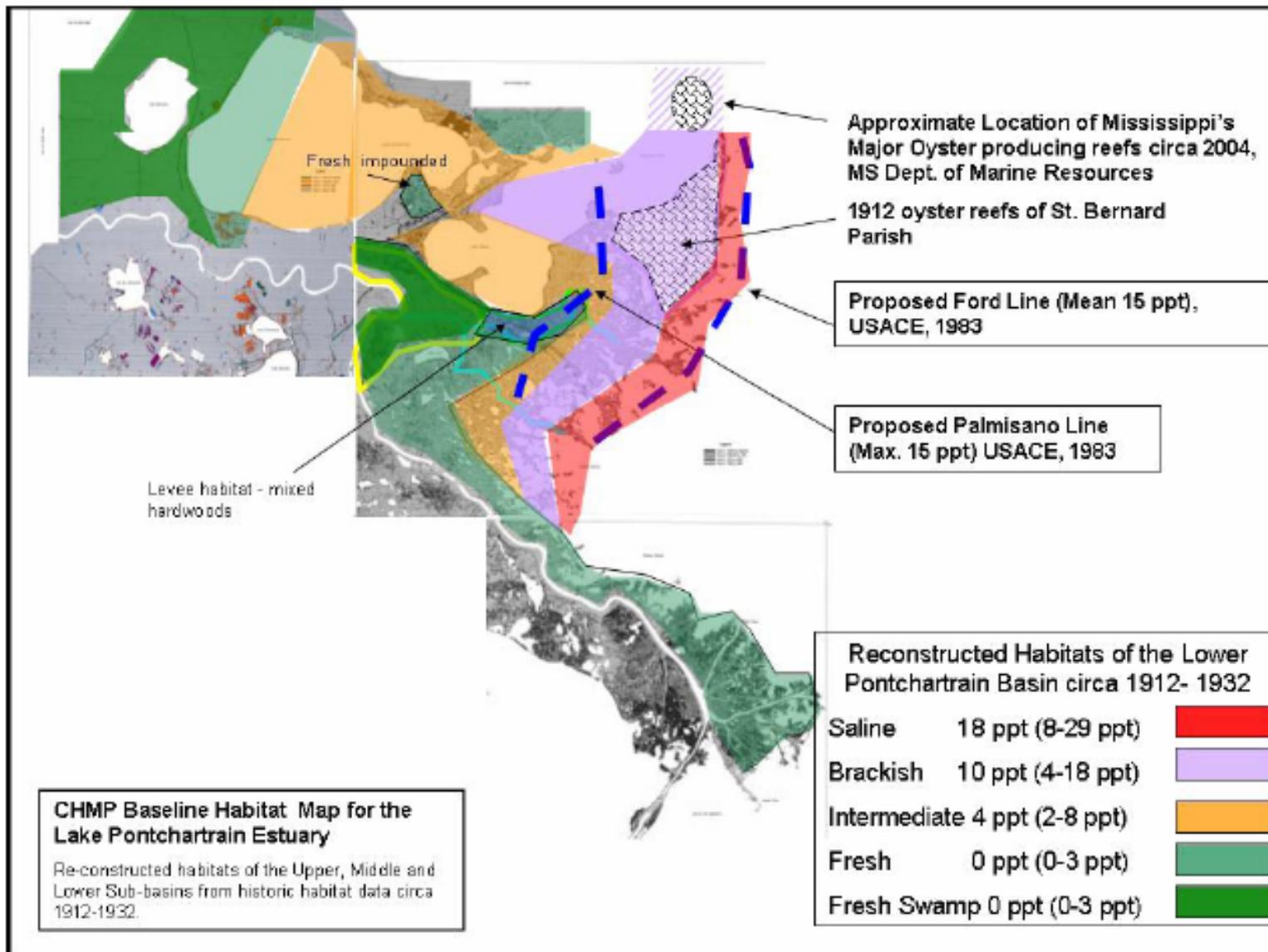
The Multiple Lines of Defense Strategy

Define Target Habitat Types and Sustain

Define the Lines of
Defense and Sustain



A Landscape Map of Goals
of a Sustainable Coast



CHMP – Figure 17 p 78

Why is the target habitat map essential?

It is the “floor plan” for a functional estuary (defining the salinity regime, vegetation & topography)

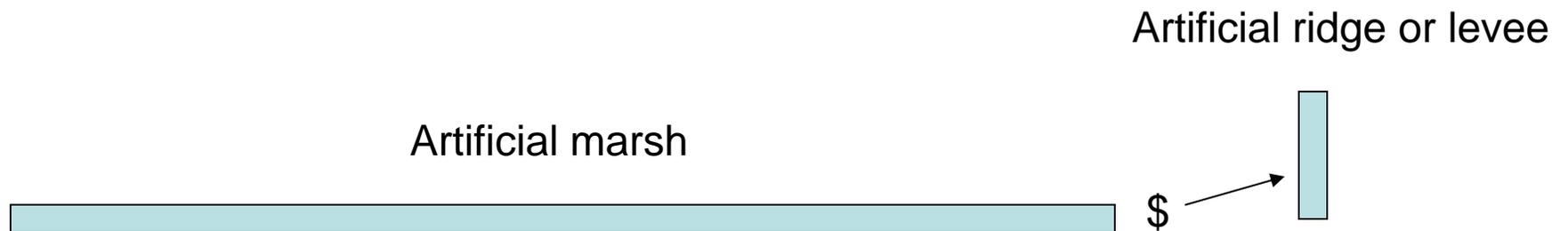
It shifts the coast to a more riverine and sustainable condition

It delineates the future natural landscape resources promoting the economy (including fur, fin and feather)

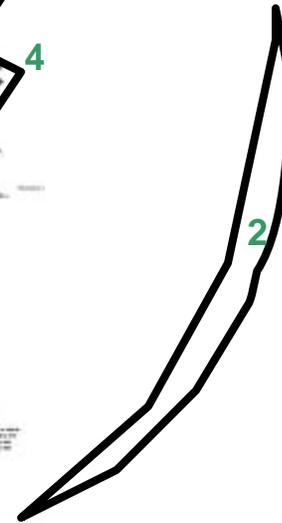
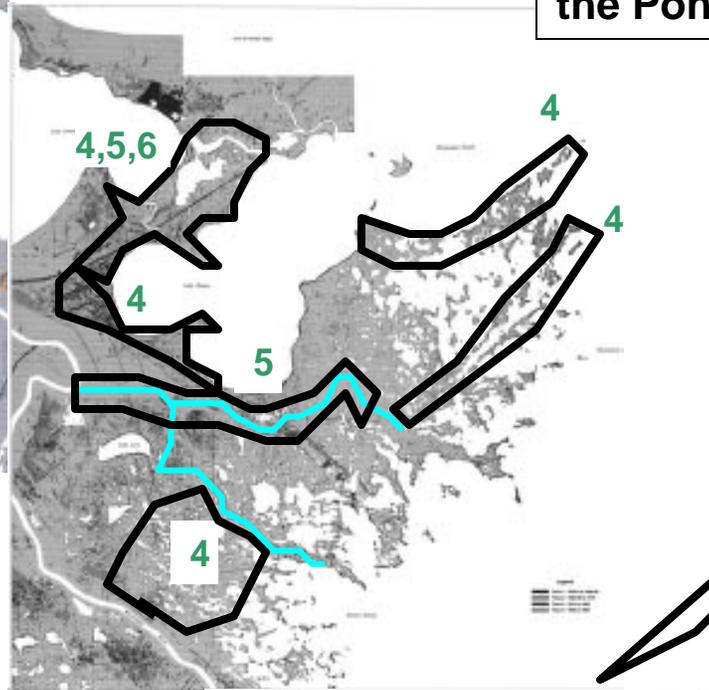
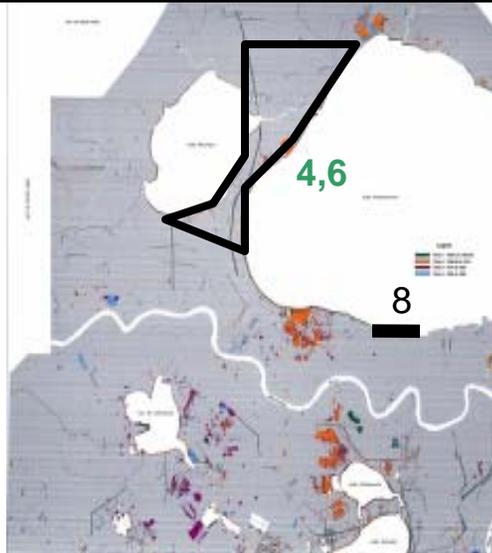
It allows (and forces) all stakeholders to align their programs toward the goals

The “flood-protection service” provided by the natural landscape requires more than just elevation, it requires biologic functionality.

If was just about elevation, we would not have marsh creation projects and we would not have a functional estuary.



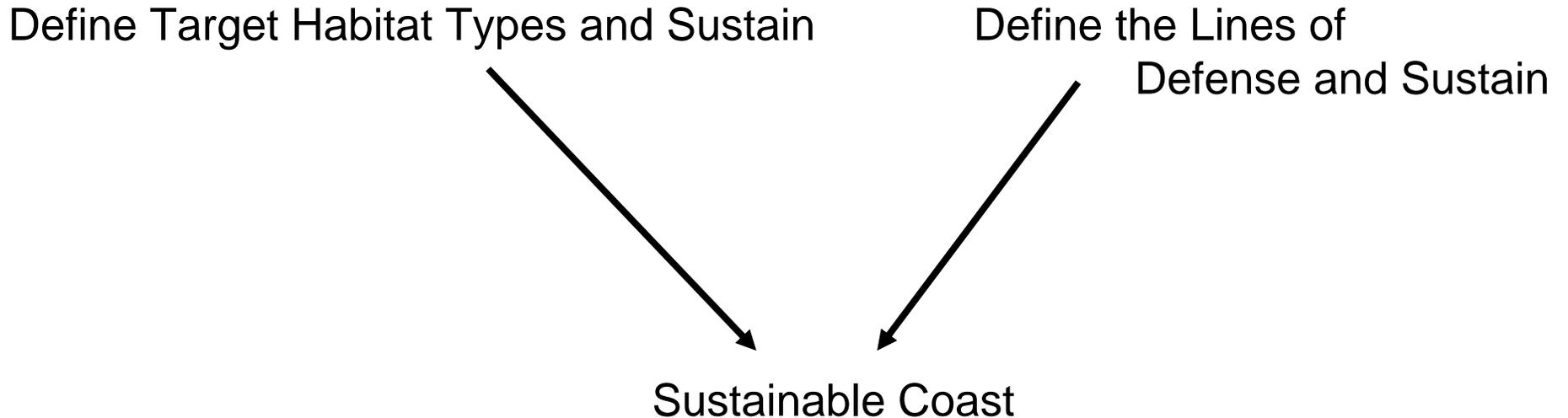
The Nine Coastal Lines of Defense in the Pontchartrain Basin For Restoration



Eleven Lines of Defense

- 1) Offshore shelf
- 2) Barrier Islands
- 3) Sounds
- 4) Marsh landbridges
- 5) Natural ridges
- 6) RR/Hwy Foundations
- 7) Flood gates
- 8) Flood levees
- 9) Pump Capacity
- 10) Elevate immobile assets
- 11) Evacuation routes

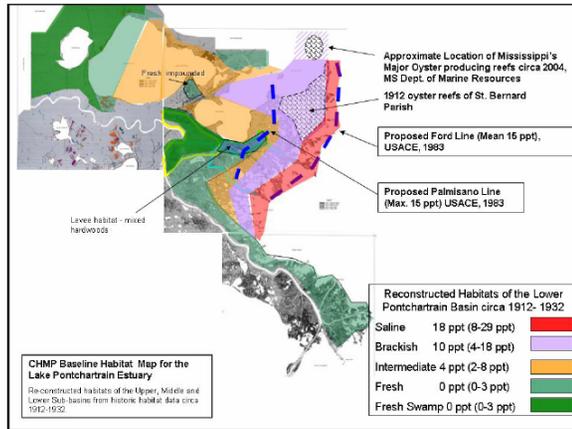
How do you Align Natural Resource and Flood Protection Agencies?



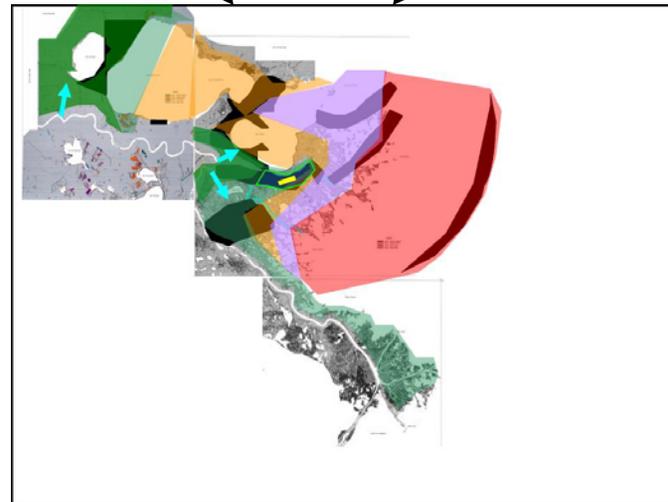
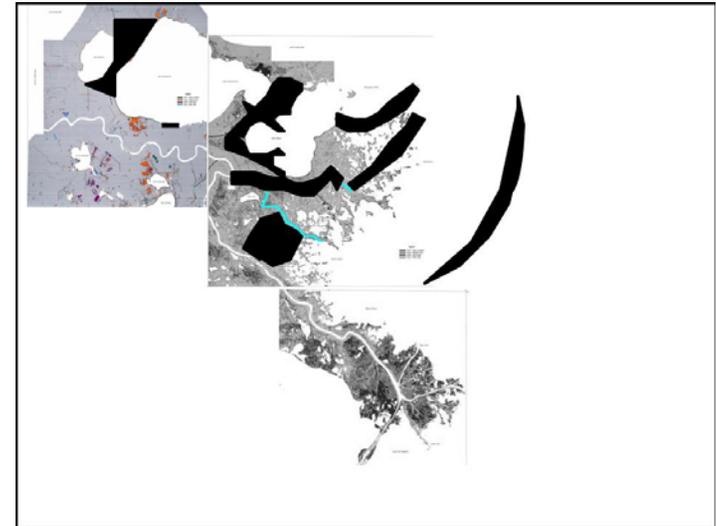
Answer:

Integrate of Coastal Restoration and Flood Protection using the Multiple Lines of Defense Strategy, which creates a unified vision of habitat goals and flood protection elements.

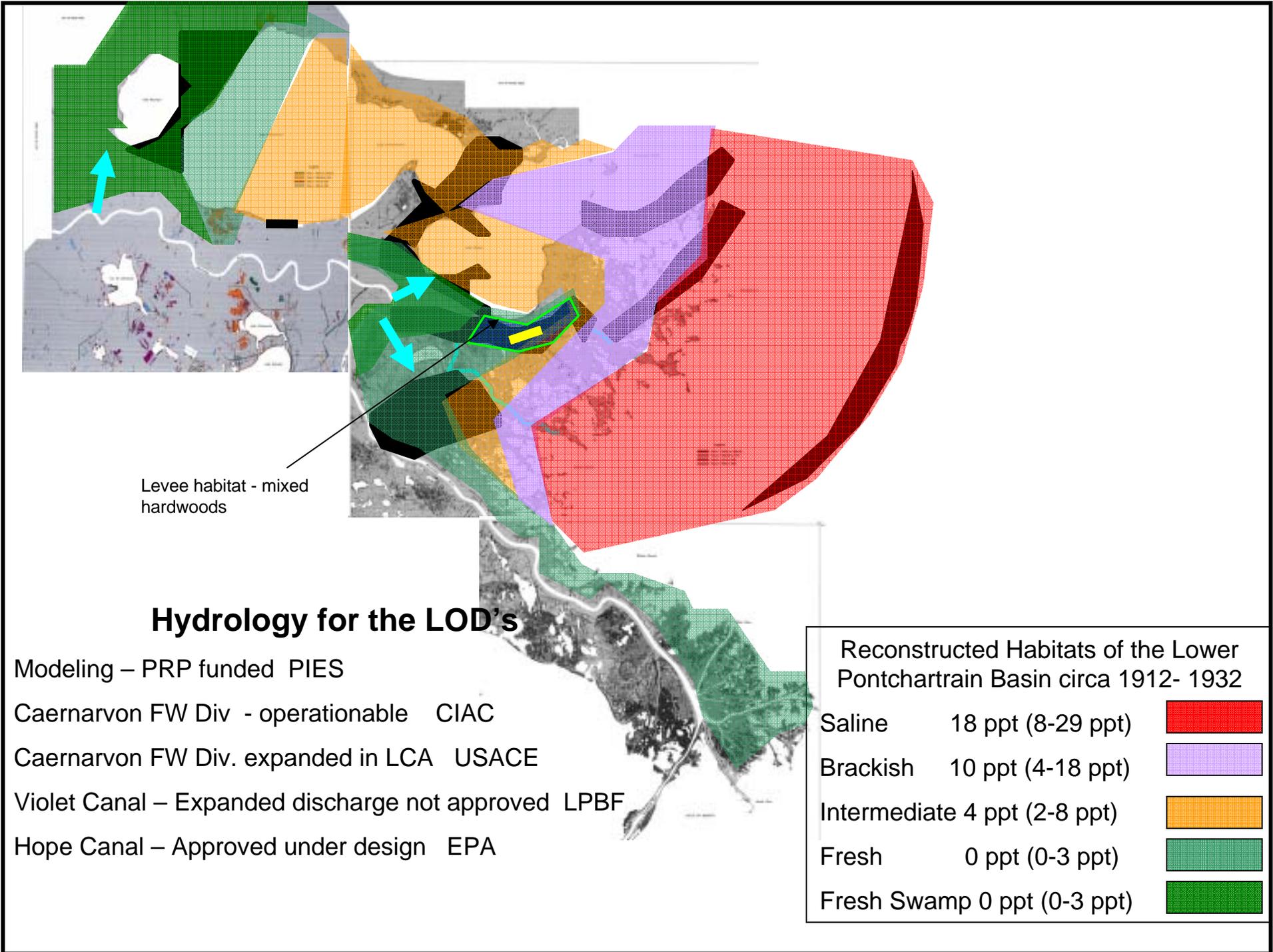
Habitats



Lines of Defense



A common Vision of a Sustainable Ecosystem and Economy



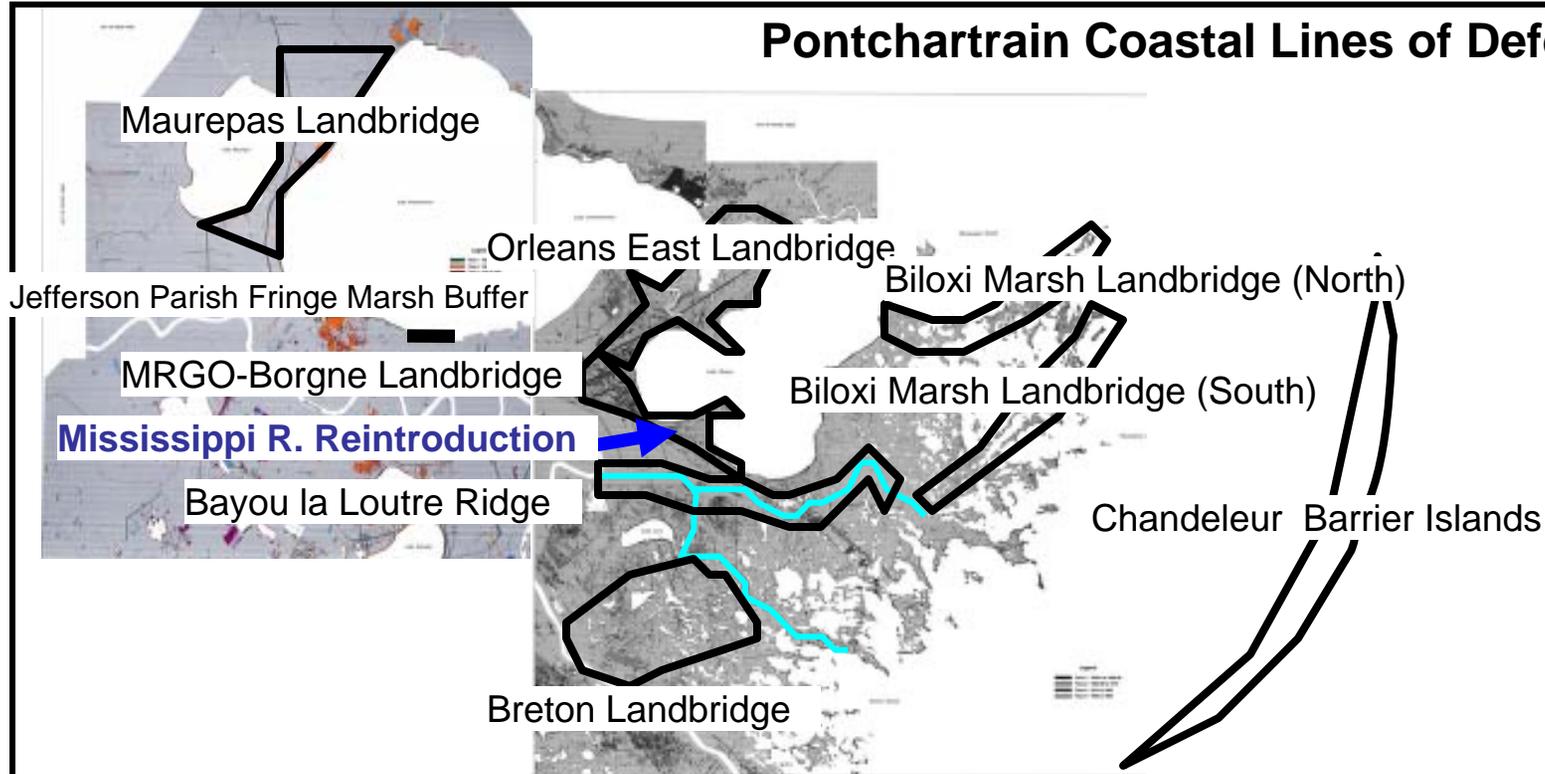
Levee habitat - mixed hardwoods

Hydrology for the LOD's

- Modeling – PRP funded PIES
- Caernarvon FW Div - operationable CIAC
- Caernarvon FW Div. expanded in LCA USACE
- Violet Canal – Expanded discharge not approved LPBF
- Hope Canal – Approved under design EPA

Reconstructed Habitats of the Lower Pontchartrain Basin circa 1912- 1932		
Saline	18 ppt (8-29 ppt)	
Brackish	10 ppt (4-18 ppt)	
Intermediate	4 ppt (2-8 ppt)	
Fresh	0 ppt (0-3 ppt)	
Fresh Swamp	0 ppt (0-3 ppt)	

Pontchartrain Coastal Lines of Defense Program

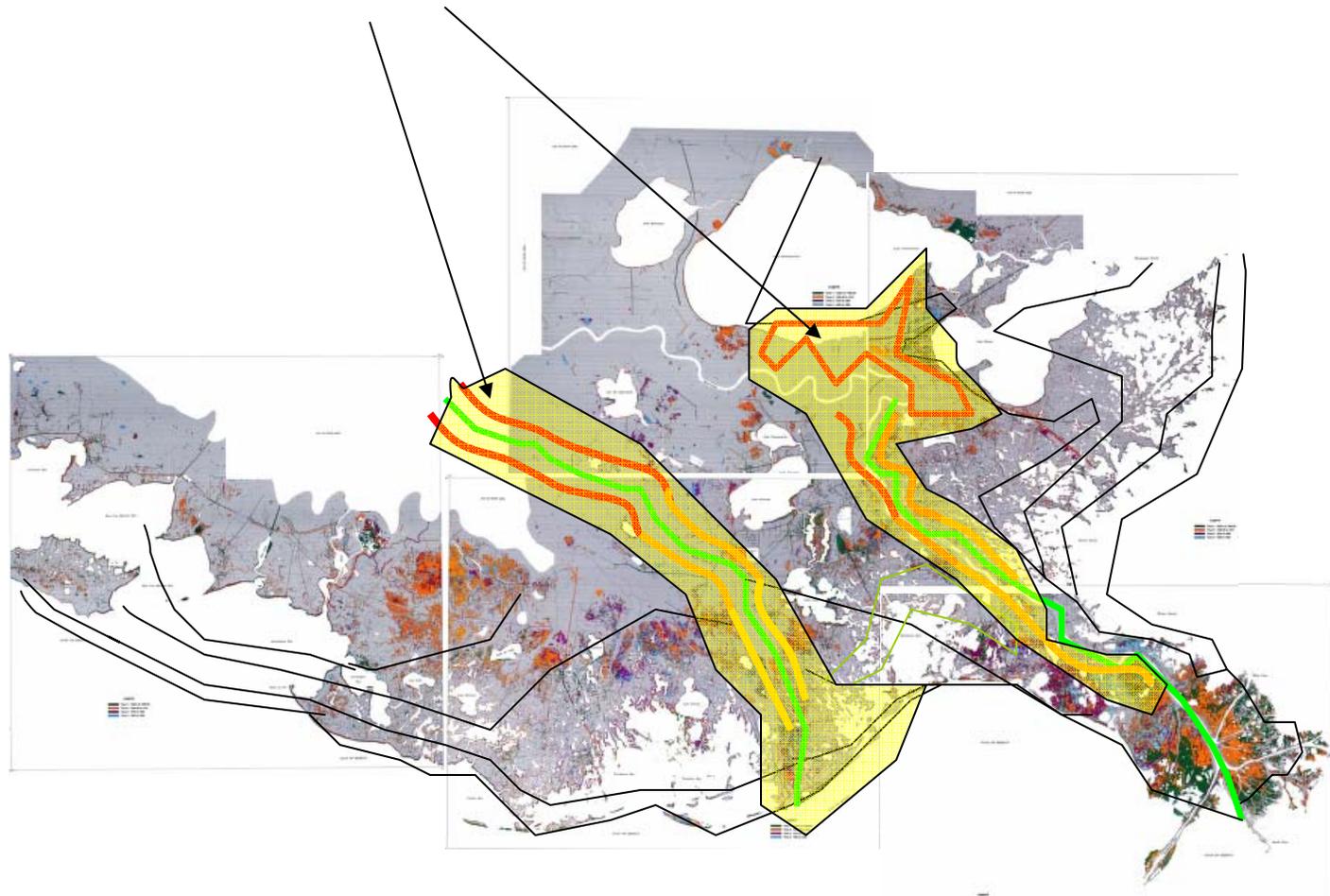


Pontchartrain Coastal Lines of Defense Program

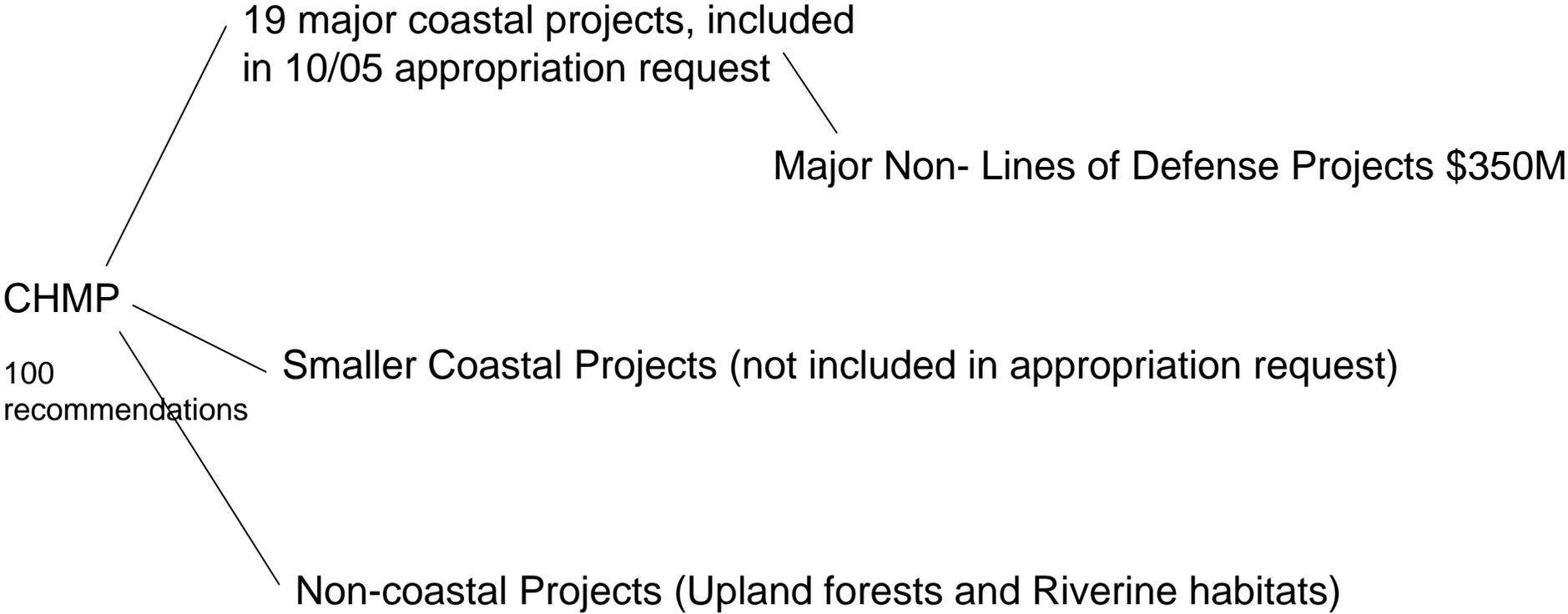
- 1) Maintain the MRGO-Lake Borgne Landbridge
- 2) Restore the Bayou la Loutre Ridge:
(includes constriction of MRGO to GIWW dimensions)
- 3) Restore the Chandeleur Barrier Islands
- 4) Jefferson Parish Shoreline Restoration and Protection
- 5) Mississippi R. Reintroduction at Violet, La to maintain target habitats in Borgne-Biloxi estuary in LA and MS
- 6) Maintain and restore the Biloxi Marsh Landbridge and reefs (South)
- 7) Maintain and restore Breton Landbridge with the Caernarvon Diversion and marsh creation
- 8) Maintain critical marsh shorelines and ridges of the East Orleans Landbridge
- 9) Maintain and restore Biloxi Marsh Landbridge and barrier reefs (North)
- 10) Maintain and enhance the Maurepas Landbridge with Maurepas Reintroduction & Conservation

Integration of Development Corridors Routes into the LOD's

Example Development Corridors



Pontchartrain Lines of Defense Program



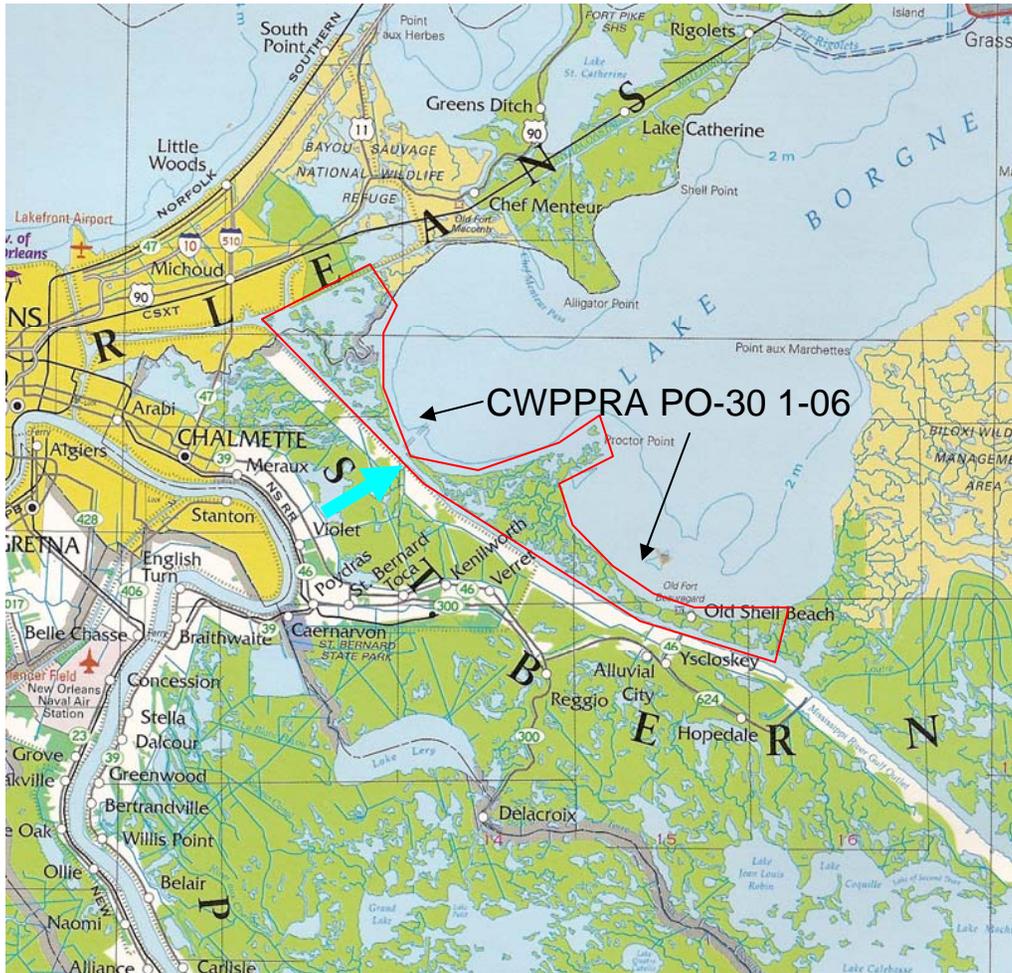
Pontchartrain Lines of Defense Program:

Prioritized Projects Utilizing the Multiple Lines of Defense Strategy in the Pontchartrain Basin, i.e. providing dual benefits Current

Funding Request

1. Maintain the MRGO-Lake Borgne Landbridge LCA
2. Restore the Bayou la Loutre Ridge (includes constriction of MRGO to ICW dimensions)
3. Restore the Chandeleur Barrier Islands
4. Construct the Jefferson Parish fringe marsh buffer
5. Construct the Violet Reintroduction to maintain target salinity in LA and MS
6. Maintain and restore the Biloxi Marsh Landbridge and reefs (South)
7. Maintain and restore Breton Landbridge with Caernarvon and marsh creation
8. Maintain critical marsh shorelines and ridges of the East Orleans Landbridge
9. Maintain and restore Biloxi Marsh Landbridge and barrier reefs (North)
10. Maintain and enhance the Maurepas Landbridge with Maurepas Reintroduction CWPPRA

4% of the Pontchartrain Basin
7% of Pontchartrain Estuary
20% of Pontchartrain wetlands



Where: MRGO-Borgne Land Bridge

What: Extensive Rock armoring, local marsh creation, Intermediate marsh

Who: Construction Team

US Army Corps of Engineers - Lead agency

EPA

LSU Hurricane Center

St. Bernard Parish

DNR

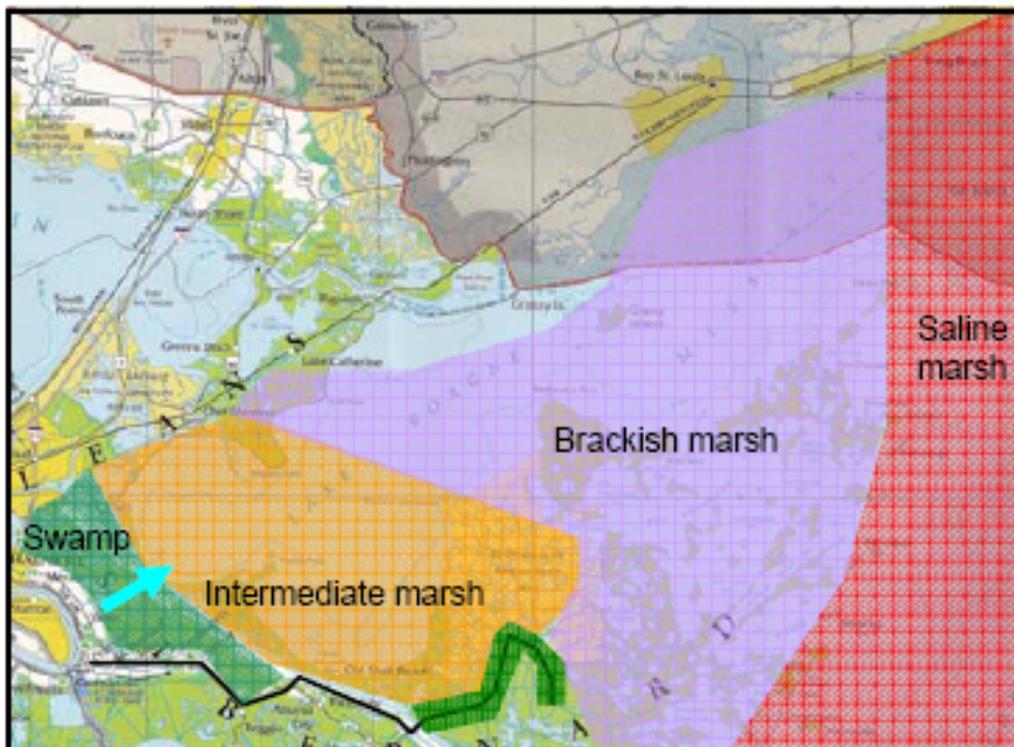
Lake Pontchartrain Basin Foundation

Cost: \$110,000,000

Performance Goals

Flood Protection: Wetland buffer to St. Bernard levees and minimize encroachment of Lake Borgne into the MRGO

Habitat Restoration: Typical intermediate marsh nursery, recreational and commercial fishing



Where: Mississippi R. Reintroduction at Violet, LA

What: Reintroduce Mississippi R. water to achieve habitat goals of baseline, re-establish cypress forest, Swamp, intermediate to saline marsh

Who:

National Marine Fisheries Service

EPA

MS Dept. of Marine Resources

St. Bernard Parish

DNR

Lake Pontchartrain Basin Foundation

Estimated Cost: \$135,000,000

Performance Goals

Flood Protection: maintain salinity targets to develop a denser and more mature wetland forest east of Chalmette to buffer to St. Bernard levees, and to enhance oyster growth in the outer Biloxi marsh to maintain marsh reduce surge into Mississippi Sound and Lake Borgne

Habitat Restoration: Reduce salinity intrusion into swamp or fresh marsh habitat, increase primary and secondary productivity including commercial species such as shrimp, blue crab and oysters. Typical intermediate marsh nursery and fringe marsh benefiting recreational and commercial fishing

**Suggested Integration Design Guidance
For the Multiple Lines of Defense Strategy**

“Weakest Link”

If coastal restoration is integral to our flood protection system,

The twenty-year project/planning cycle for coastal restoration is too short and should be on-par with the project life of engineered lines of defense such as levees.

Therefore, restoration of natural lines of defense must emphasize self-sustainability and cost-effectiveness to restore.

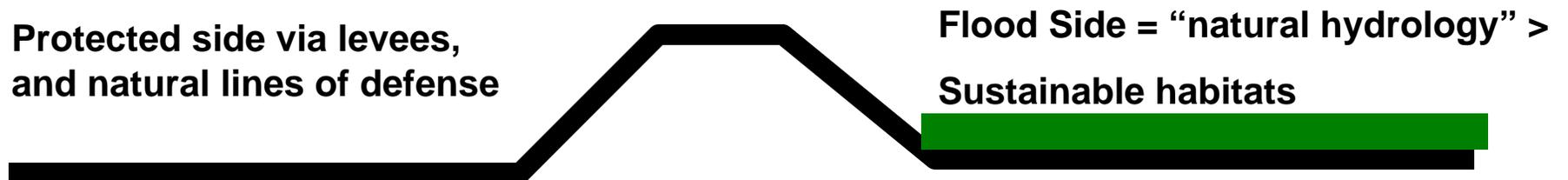
“System Integrity”

Natural coastal wetland habitats are positioned on the flood side of levees.

Why:

Better protection for levees due to wetland buffer

Better to sustain habitats due to hydrology and reduced development impacts



“Don’t throw good money after bad”

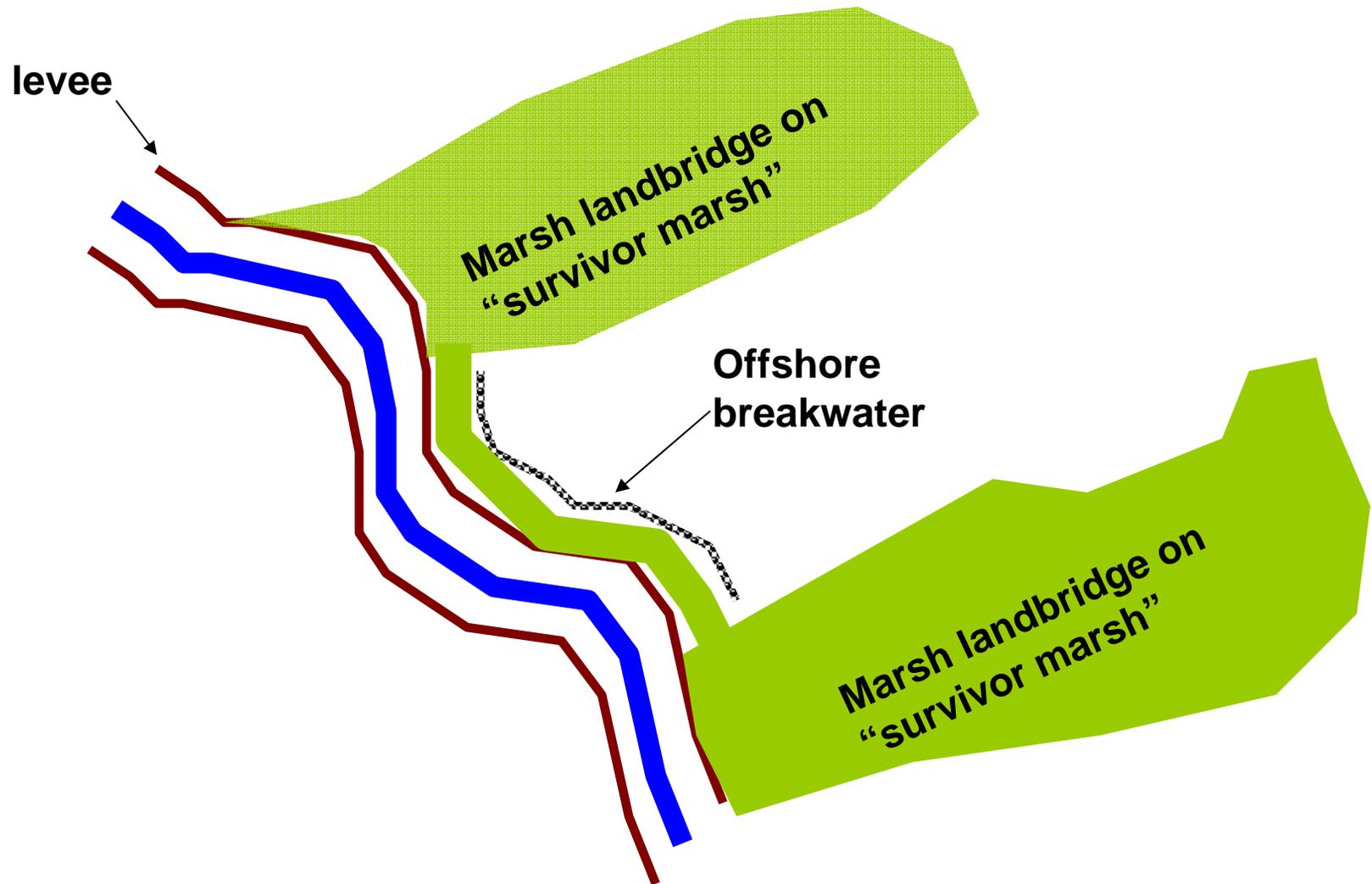
**Marsh landbridges should be defined as much as possible by existing
“survivor marsh”**

Why?

Historical precedent of sustainability

“Surge elevation benefit vs. wave energy reduction benefit”

Exposed levees or infrastructure not buffered by a natural line of defense should have alternative buffers e.g. see below. Example sites Bayou Lafourche near Leeville, Jefferson Parish levee at Lake Pontchartrain, Hwy 90 at Lake Catherine, Mississippi River



“Don’t compromise coastal restoration for flood protection”

Enhance coastal habitats and the flood protection service without compromising the ecological services.

Why?

Coastal restoration is expensive and ecological functionality promotes sustainability, i.e. reduces O&M

“Restore Some Form & All Function”

Don't just rebuild barrier islands

Rather rebuild restore the longshore sediment transport of the gulf shoreline including barrier islands and headlands

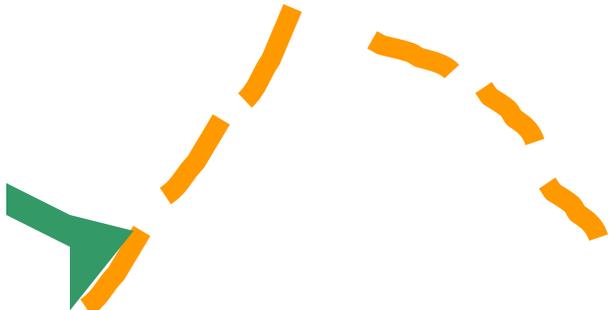
For example:

Minimize passes

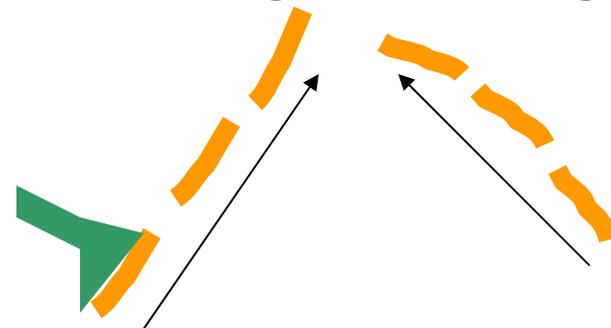
Minimize potential to breach

Manage sand sinks and sources

six \$ capped, individual barrier island projects



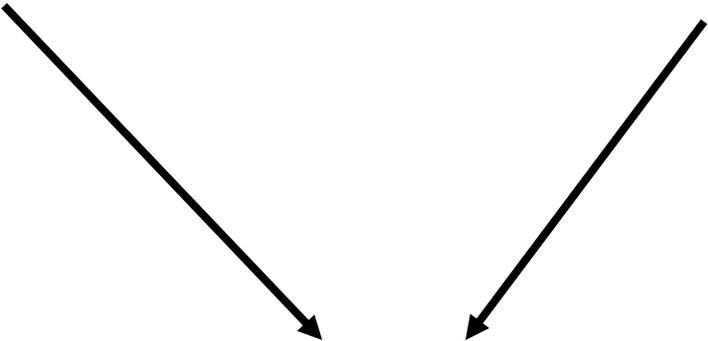
two integrated functional gulf shorelines



The Multiple Lines of Defense Strategy to Save Louisiana's Coast

Define Habitat Types and Sustain

Define the Lines of
Defense and Sustain



An integrated map of landscape goals

Does it define a Sustainable Coast?

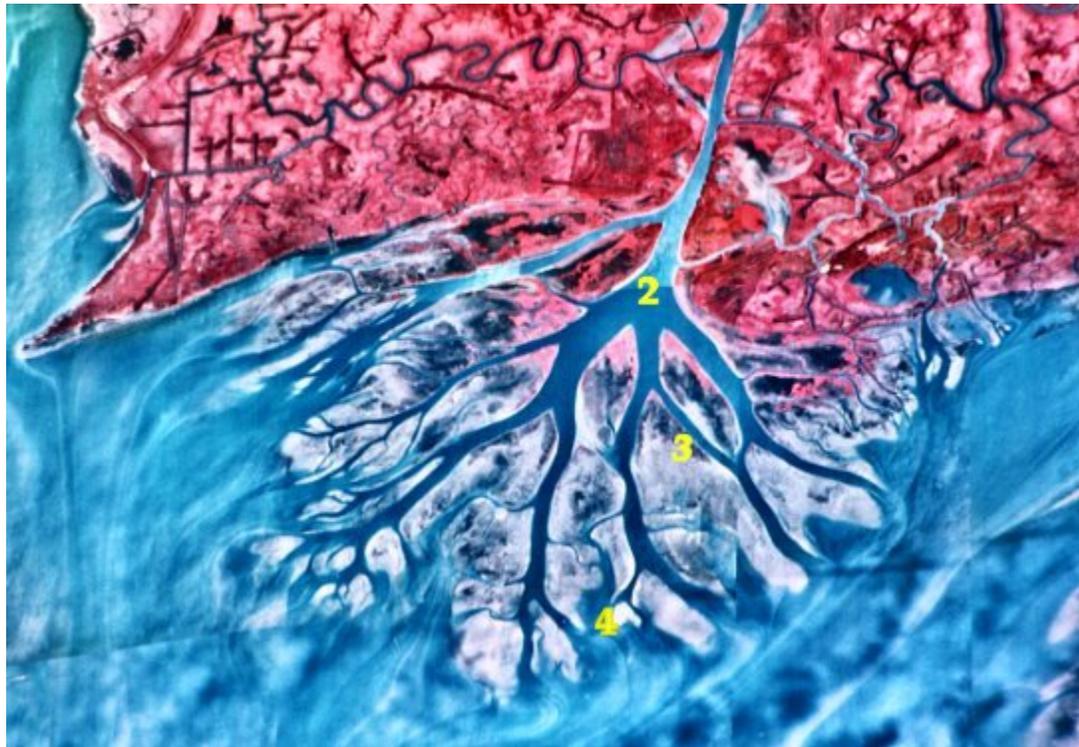
Efficient Use of Restoration or Flood Protection Funding

focuses limited restoration funding on a limited number of features which together are a framework for the coastal estuaries and flood protection.



Shifts Toward a More Stable & Riverine Influenced Hydrology

aligns all coastal resource managers, coastal restoration programs to a common natural habitat and resource architecture utilizing riverine resources



Wax Lake delta: Lafayette Geological Society website

Fundamental Economic Compatibility

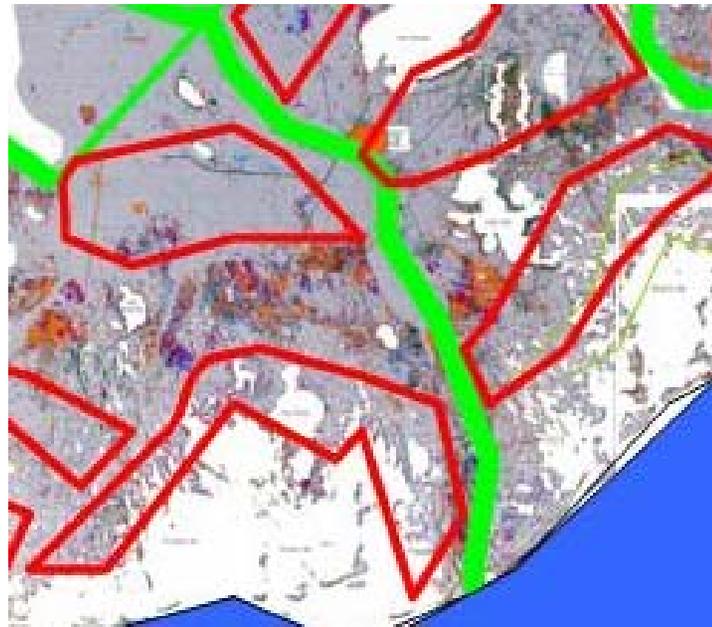
Bayou natural ridges are compatible with ecologic restoration while continuing to be economic corridors, evacuation routes etc.



2000 Landsat imagery

Invests in Survivor Marsh

Marsh landbridges are largely the residual marsh and, in general, should have less potential to be loss due to processes of subsidence, faulting etc.



Potential marsh landbridge Lines of Defense

Models Assess Strategy

Quantitative hydrologic and ecosystem models will help define the map and guide toward sustainability

COASTAL FLOOD PROTECTION VIGNETTES

1. Storm Surge Impacts

Natural Channel	Navigation Channel
<p>The movement of storm surge inland can be dampened in the natural flow surrounding natural, meandering channels and healthy marshes. Wetlands also provide natural buffers. Likewise, natural channels allow for additional and natural exchange with the landscape.</p> <p>Shallow, narrow channels are generally increased by having canals and other non-natural features.</p>	<p>The movement of storm surge inland is increased when flowing through straight, deep navigation channels. Large storm surges not only carry salt water into freshwater systems (e.g., freshwater wetlands), they also require the construction and maintenance of large flood protection levees. Levee channels inhibit natural and natural exchange with the landscape.</p> <p>Over time, navigation channels tend to widen and deepen, as a result of storm surge and waves induced by high, commercial vessels.</p>

Chenier Deltaic

Coastal Louisiana Features

The Chenier and Deltaic Plains of coastal Louisiana are comprised of a complex and highly dynamic ecosystem created by 7,000 years of sediment deposition from the Mississippi River. The diversity of coastal habitats and landforms range from natural levees, beach ridges, chenier ridges and barrier islands to the expanses of forested wetlands and fresh, brackish, and saline marshes, and seagrass beds. These unique habitats are hydrologically connected to each other and to the Gulf of Mexico. These coastal ecosystems support migratory routes for waterfowl, neotropical songbirds, various fish species, and commercially important shellfish including white shrimp, brown shrimp, blue crabs, and oysters. Longshore transport of sediments and inshore water currents move from east to west. Sediment accretion is exceeded by sediment subsidence throughout coastal Louisiana, but the net subsidence is highest across the deltaic plain.

The coastal wetlands are also a center for a culturally diverse society that relies heavily on the utilization of these resources. Oil and gas activities, navigation, levees, agriculture, and other land uses have disrupted the natural hydrologic and sediment transport processes, and along with natural factors such as land subsidence, sea level change and storm events, significant coastal erosion and land loss have occurred. As blue marine waters inchoad further into the brown, sediment rich coastal waters, salinity increases resulting in the loss of forested wetlands and freshwater marshes. Coastal protection and restoration features are designed to work with nature to provide the necessary freshwater, sediment, and nutrients to sustain coastal systems.

3. Storm Protection

Historic	Current
<p>Barrier islands, and continuous marshes act as buffers to reduce storm surge penetration and wave impacts along the coast. With the presence of healthy, intact barrier islands and natural flood protection levees, no additional protection is required.</p>	<p>As barrier islands are lost, the buffering capacity is also lost. Storm surge and wave impacts penetrate further inland with increased magnitude and frequency. This results in the need to build and maintain larger levees and more complex pumping systems to protect communities and commercial infrastructure.</p> <p>Penetration of salt water into freshwater ecosystems that results in the loss of forested wetlands and freshwater marshes.</p>

2. Altered Productivity

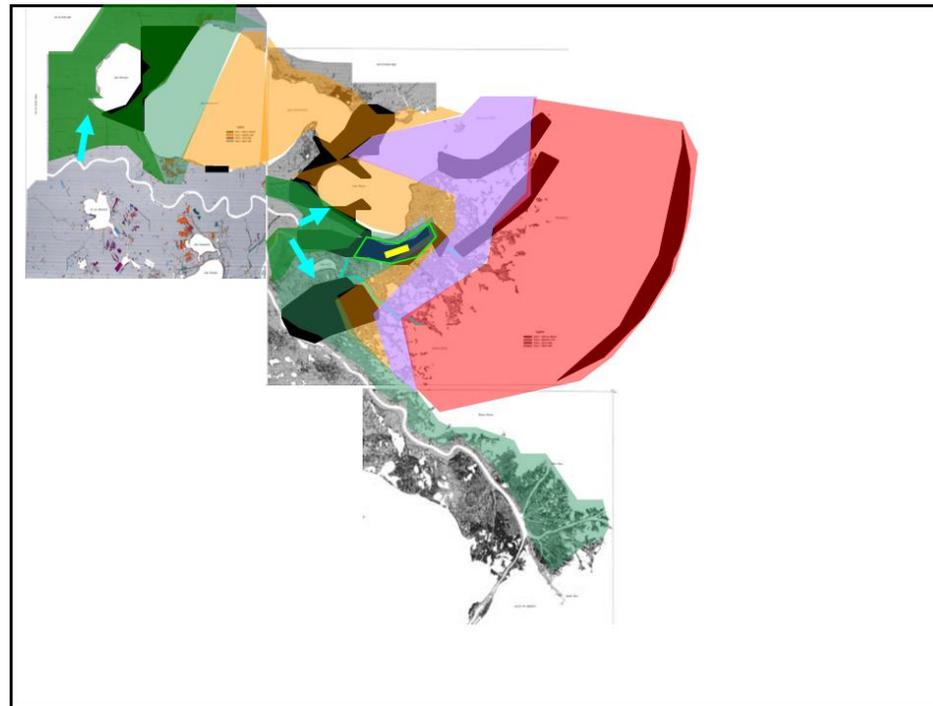
Historic	Current
<p>Healthy coastal wetlands support diverse flora and fauna. Fish and wildlife and grow along the marsh edge, and migrate and reproduce in higher areas in the coastal wetlands during periods of high water.</p> <p>In natural systems, wetland subsidence is compensated by sediment accretion (input from rivers and coastal resuspension). This subsidence process keeps the marshes healthy, intact, and above the water level.</p>	<p>Human intervention in these processes has converted natural wetlands to pasture, agriculture, levees, and other that require higher levees and larger pumps for flood protection.</p> <p>By removing the sediment and nutrient input from the river, wetland accretion is reduced. Marshes are unable to maintain their elevation against the opposing forces of subsidence, and eventually the lands begin to sink below the waterline.</p>

4. Maintaining Flood Protection

Natural Environment	Human Environment
<p>Features</p> <ul style="list-style-type: none"> Healthy, continuous marshes cover organic soils Wetlands contribute to sediment accretion River levees prevent salt water intrusion <p>Processes</p> <ul style="list-style-type: none"> Sea level rise is compensated by natural sediment accretion From rivers and coastal resuspension Wetland accretion balances sediment subsidence Sediment accretion is exceeded along river banks 	<p>Features</p> <ul style="list-style-type: none"> Sea level rise results in marsh erosion and land loss Levees before sea level rise and prevent water pumping to avoid flooding River levees and flood protection levees require additional Sediment accretion much less than wetland subsidence <p>Processes</p> <ul style="list-style-type: none"> Sea level rise results in marsh erosion and land loss Levees before sea level rise and prevent water pumping to avoid flooding River levees and flood protection levees require additional Sediment accretion much less than wetland subsidence

Adaptive Management

Goals are definable and measurable allowing for feedback to ongoing coastal management



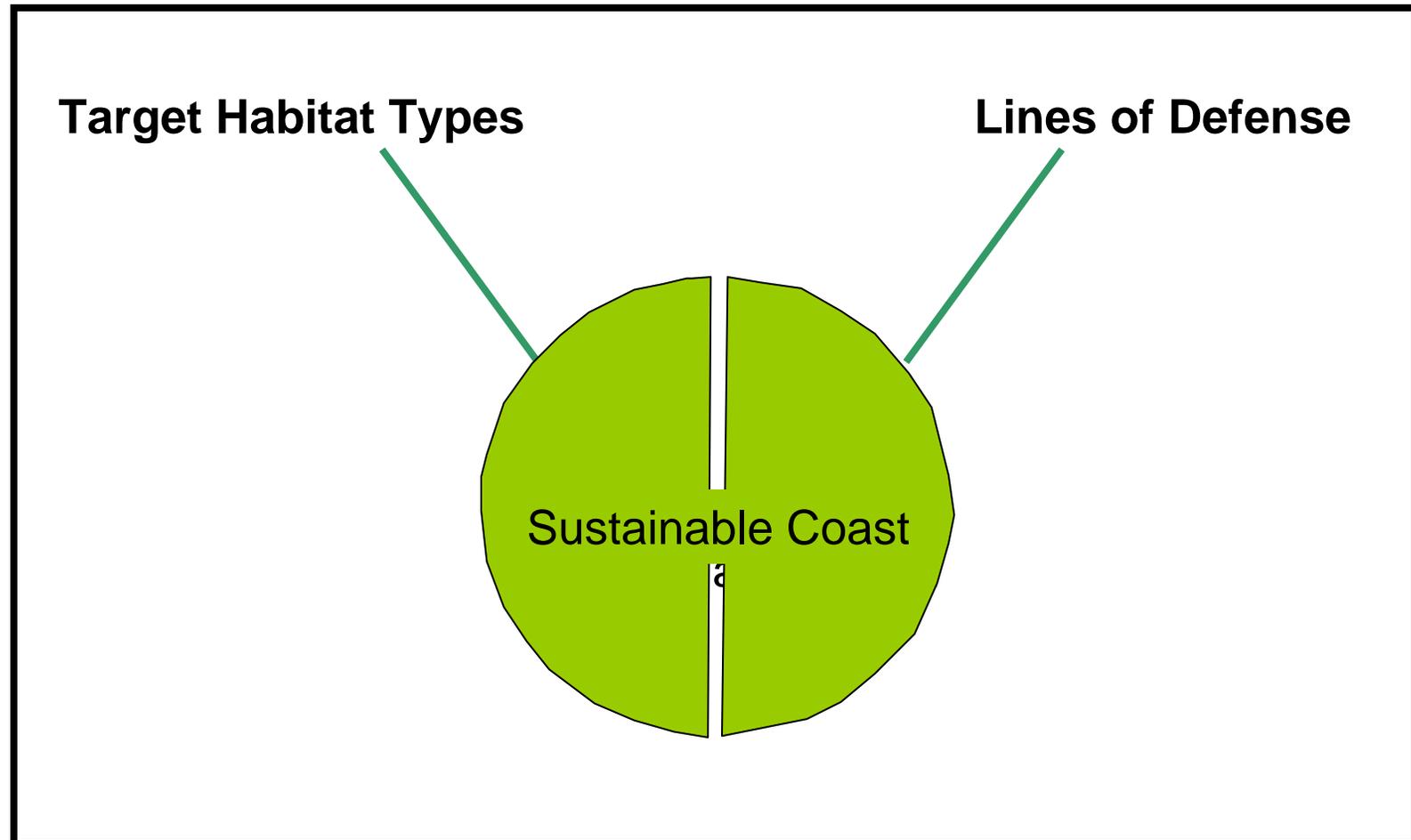
Institutional Commitment & Economic Viability

Natural Lines of defense are designated with a commitment in perpetuity just as manmade lines of defense such as a levee



The economic viability of the region will be enhanced and available to maintain the lines of defense framework .

Multiple Lines of Defense Strategy



Lake Pontchartrain Basin Foundation

THE PUBLIC'S INDEPENDENT VOICE DEDICATED TO RESTORING AND PRESERVING THE PONTCHARTRAIN BASIN

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Coastal Sustainability Program

Although the LPBF has been active in coastal restoration since its inception in 1989, it was in June 2005 that a formal program with a director was created. This aggressive commitment to the coast was triggered by the realization that the coastal wetlands were getting worse and not better in spite of ongoing authorized restoration programs. The revised [Comprehensive Management Plan](#) is the blue print for restoration of all the habitats in the Pontchartrain Basin. Because of the great need for flood protection the CHMP was prioritized using the [Multiple Lines of Defense Strategy](#). The [Pontchartrain Lines of Defense Program](#) has identified [coastal restoration projects](#) that provide significant habitat restoration and flood protection.

Comprehensive Habitat Management Plan (CHMP)

[CHMP Table of Contents](#)
[CHMP Project Recommendation Table](#)
[CHMP Full Report](#)

Pontchartrain Coastal Lines of Defense Program

[Pontchartrain Coastal Lines of Defense Webpage](#)
[Pontchartrain Coastal Lines of Defense Summary Report](#)
[Pontchartrain Coastal Lines of Defense Summary powerpoint](#) (in pdf)
[Multiple Lines of Defense Strategy Summary Report](#)
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Map Resources

[Wetland Restoration Projects Map](#)
[Targeted Habitat Map](#)
[LACoast.gov Maps](#)



Before Katrina, the Pontchartrain Basin was in remarkable condition because of years of dedication from its supporters. Lake Pontchartrain and the Basin are going to recover. But it is going to need financial support. [Click Here to Help](#)

SaveOurLake.org