Sediment Management for Coastal Restoration in Louisiana

-Role of Mississippi and Atchafalaya Rivers

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9th INTECOL International Wetlands Conference:
Wetlands in a Complex World

Orlando, FL
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CPRA
Coastal Protection and Restoration Authority of Louisiana

committed to **our coast**

Delta Plain Degradation

Wetland Loss In Coastal Louisiana

↓

ROLE OF RIVERS

NAVIGATION, FLOOD CONTROL , ECOSYSTEM RESTORATION

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SEDIMENT

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- OFFSHORE SEDIMENT SOURCES – DEDICATED DREDGING
- FLUVIAL/RIVERINE SOURCES (RENEWABLE)
  - SEDIMENT DIVERSIONS
  - FEDERAL NAVIGATIONAL CHANNEL MAINTENANCE DREDGING
  - DEDICATED DREDGING OF RIVERBED SEDIMENT
  - DEDICATED DREDGING PLUS TRANSPORTATION BY PIPELINE

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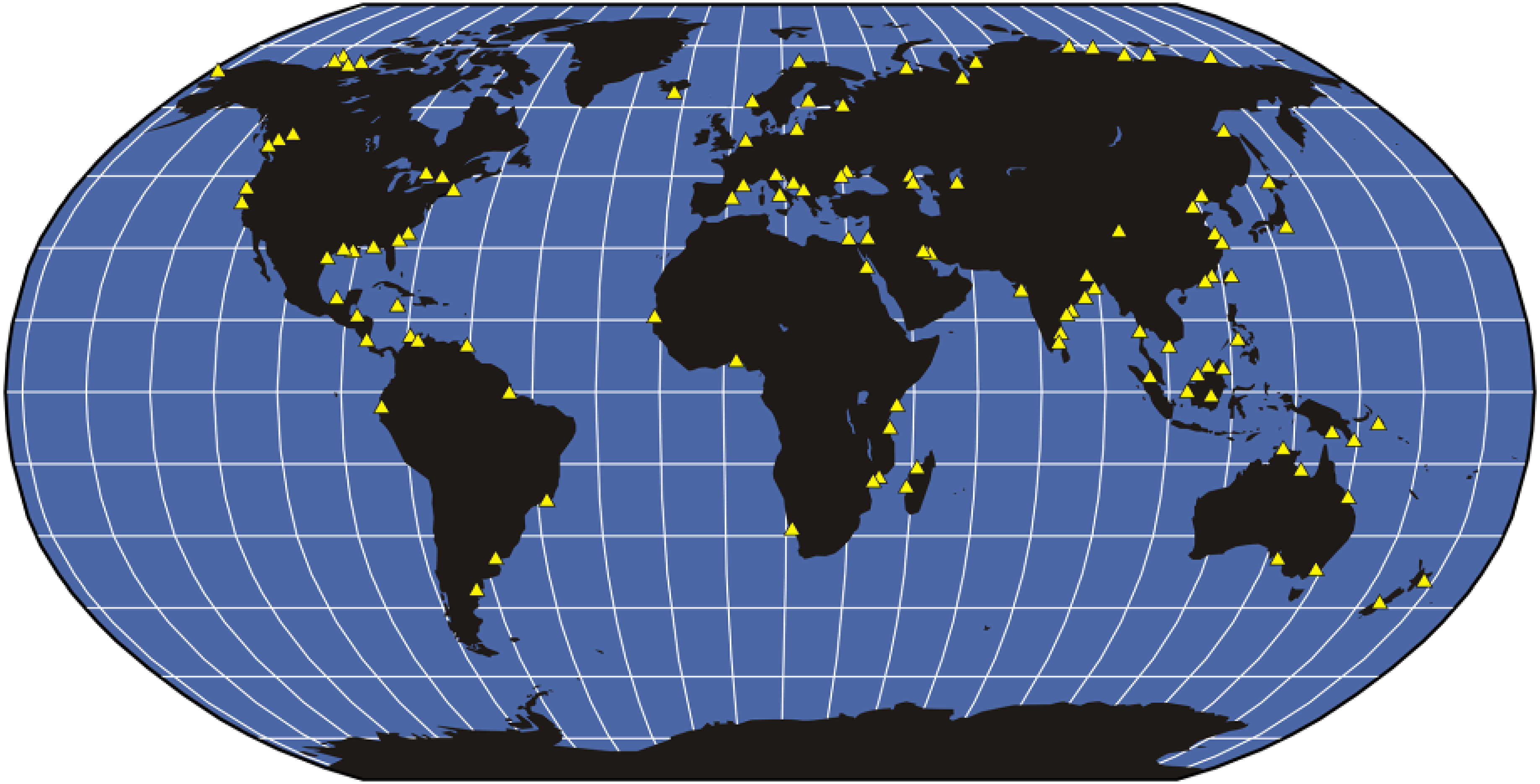
SEDIMENT MANAGEMENT - LASMP

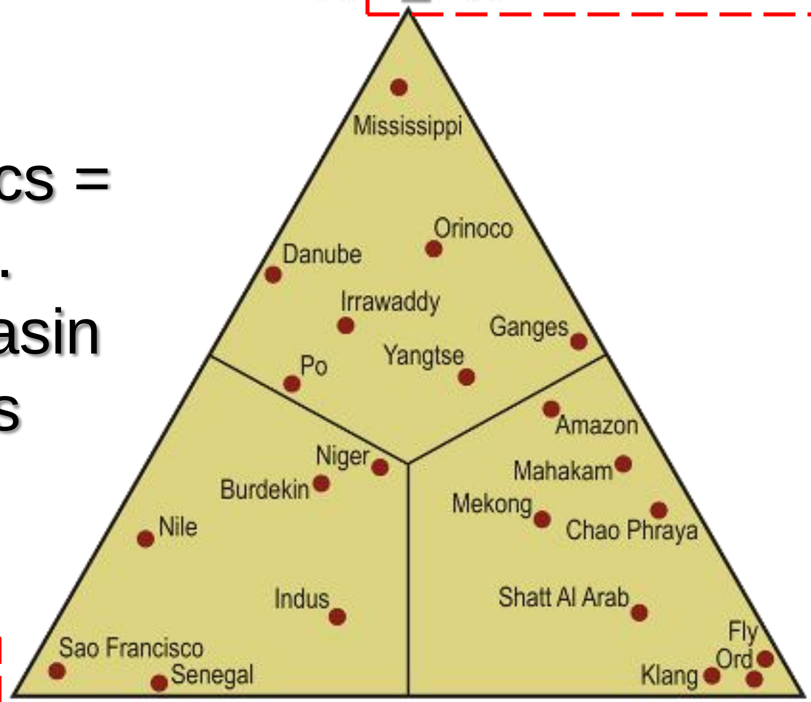
Major Deltas of the World



Delta Types by Dominant Processes *(modified Galloway, 1975)*

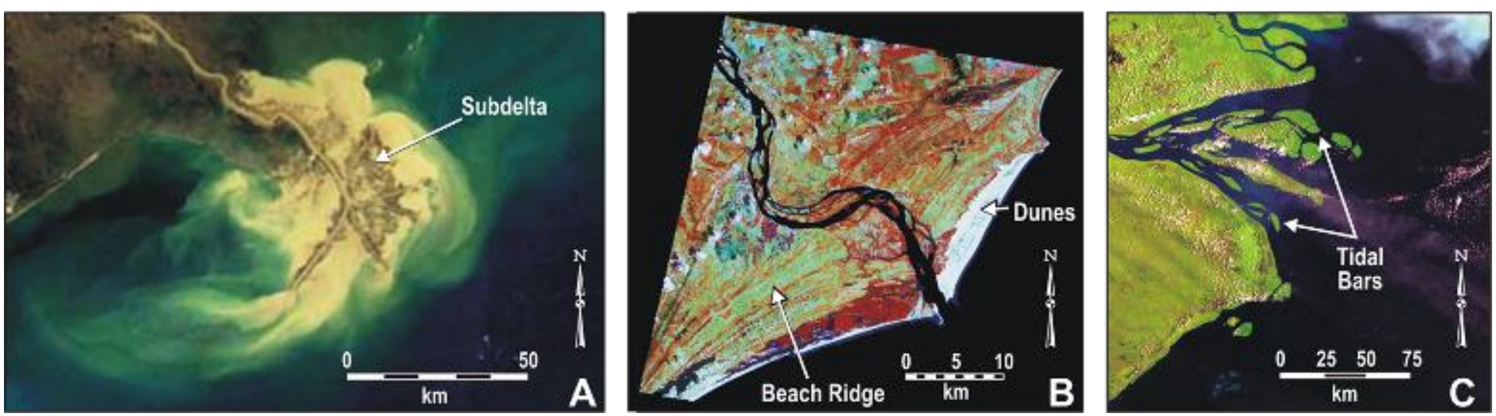
A River Dominated

Delta Characteristics = Fluvial vs. Receiving Basin Processes

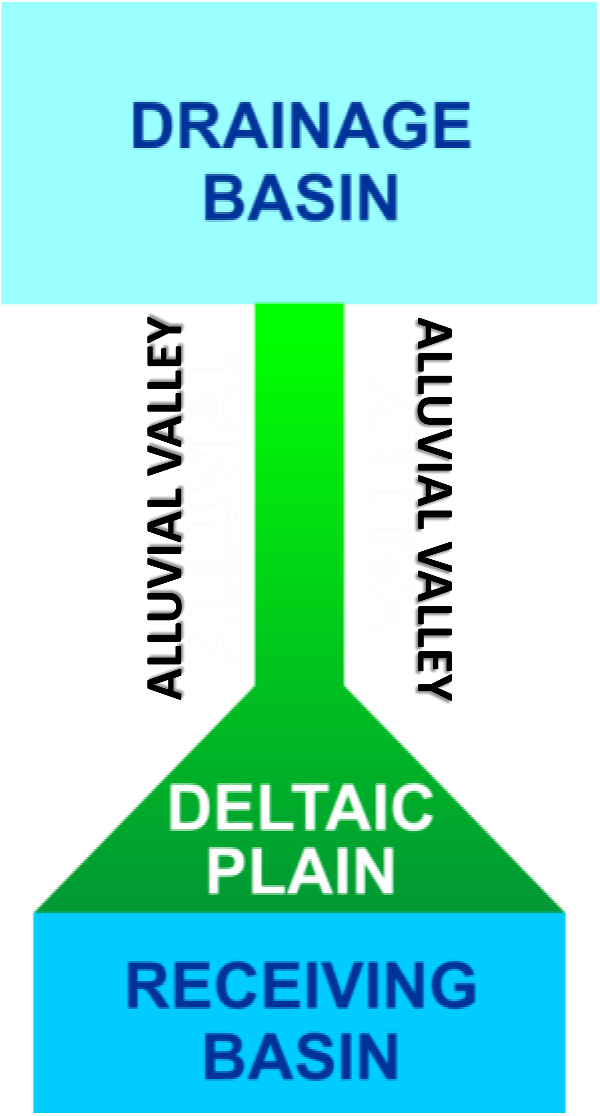


Wave Dominated **B**

C Tide Dominated

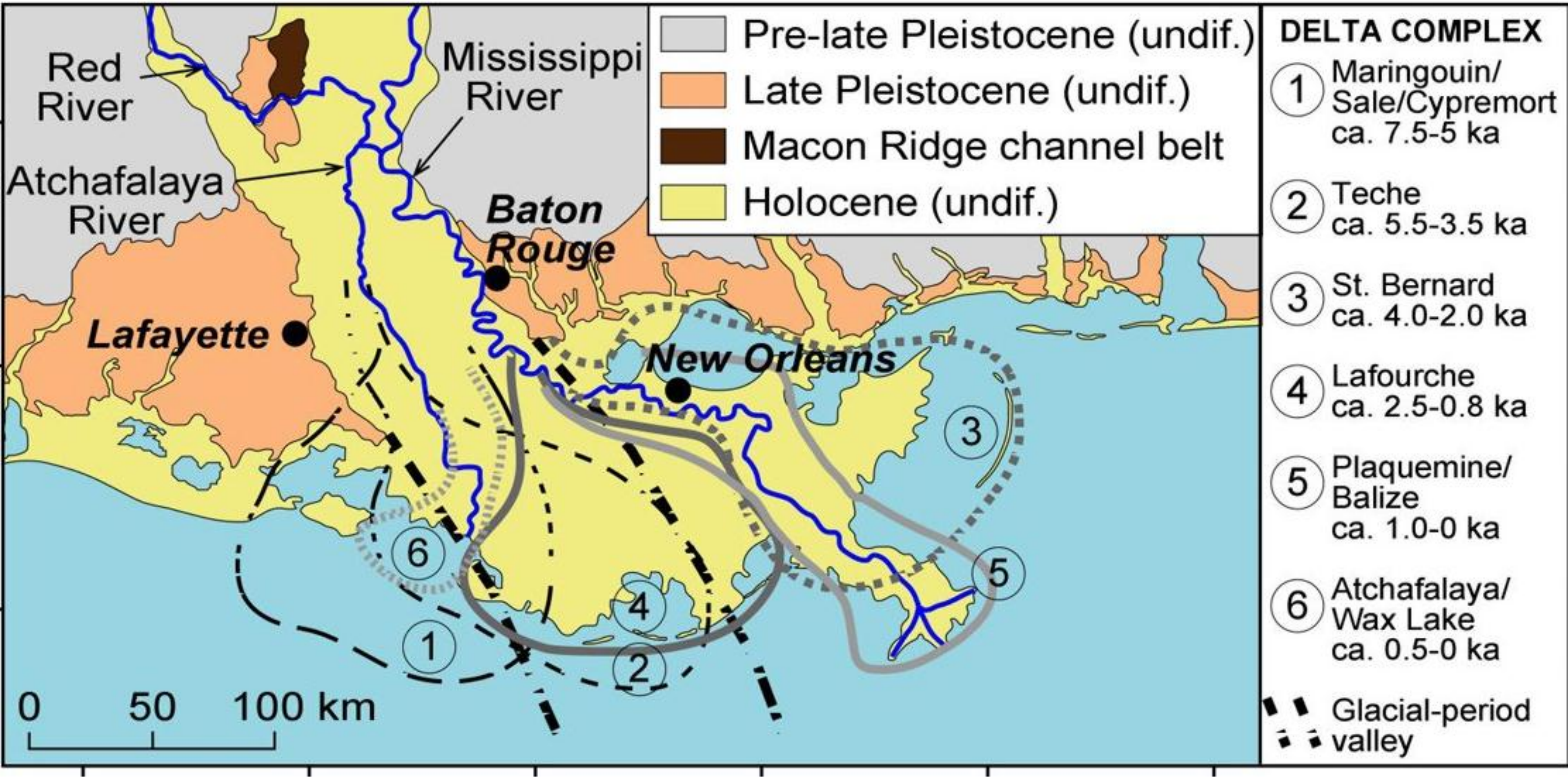


Components of a River-Delta System



Importance of Receiving Basin in Delta System

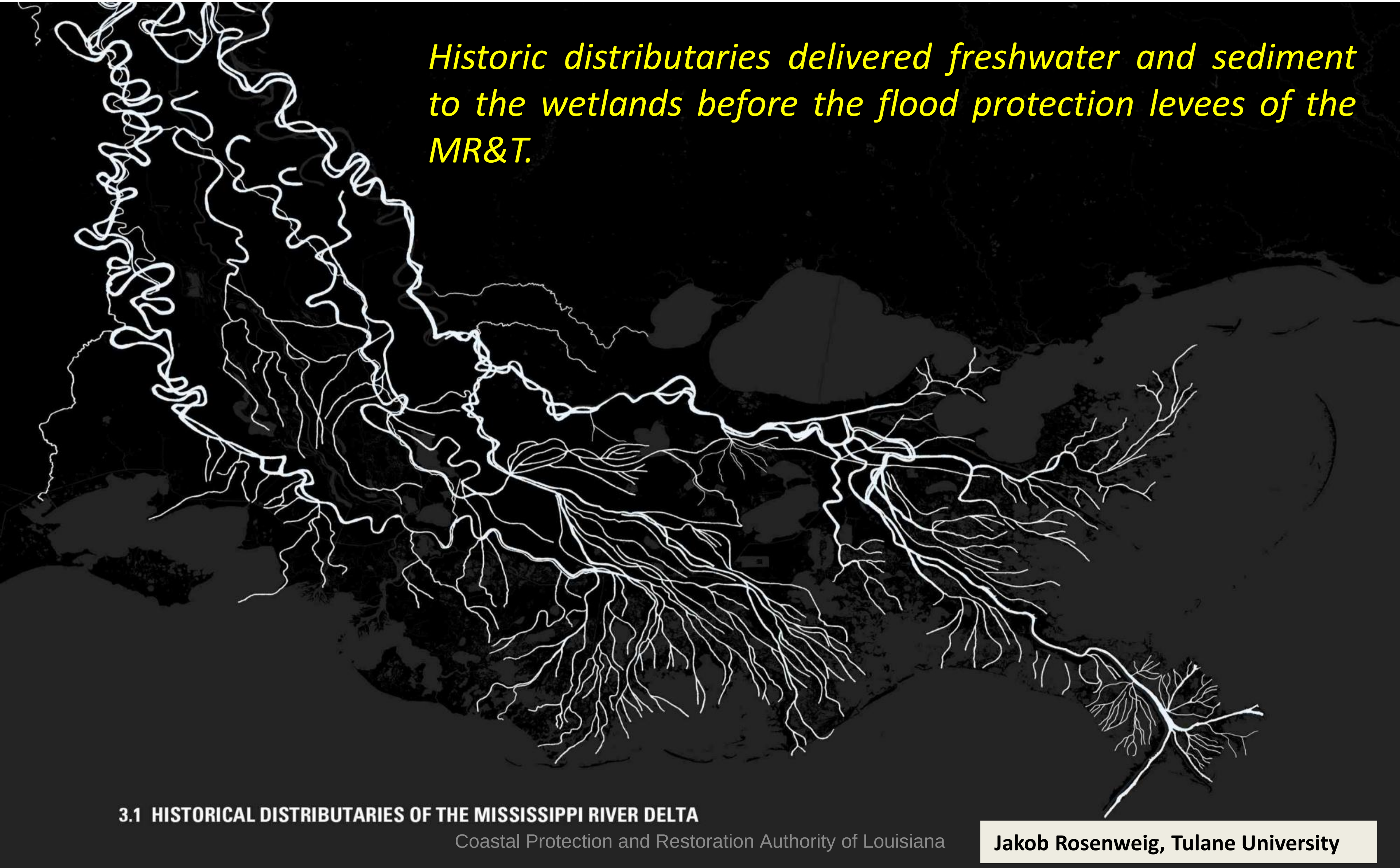
Regional Geological Framework



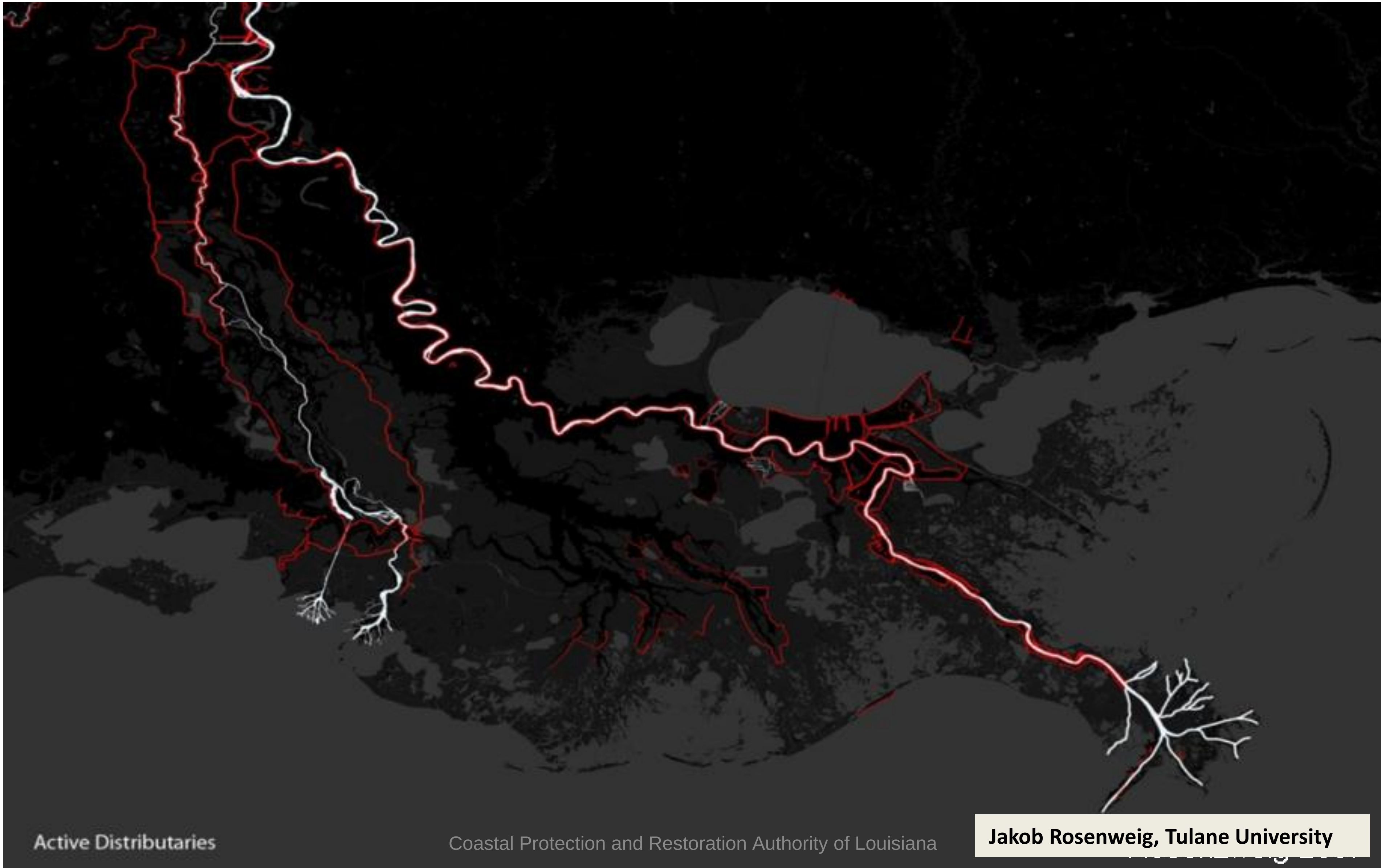
1. Sediment resources will depend upon the REGIONAL GEOLOGY which is a TYPICAL DELTAIC FRAMEWORK developed over 7000 years of geological history due to delta switching/AVULSION
2. RESTORATION STRATEGIES should be based on understanding of process

Historic LMR Distributaries Flow Paths

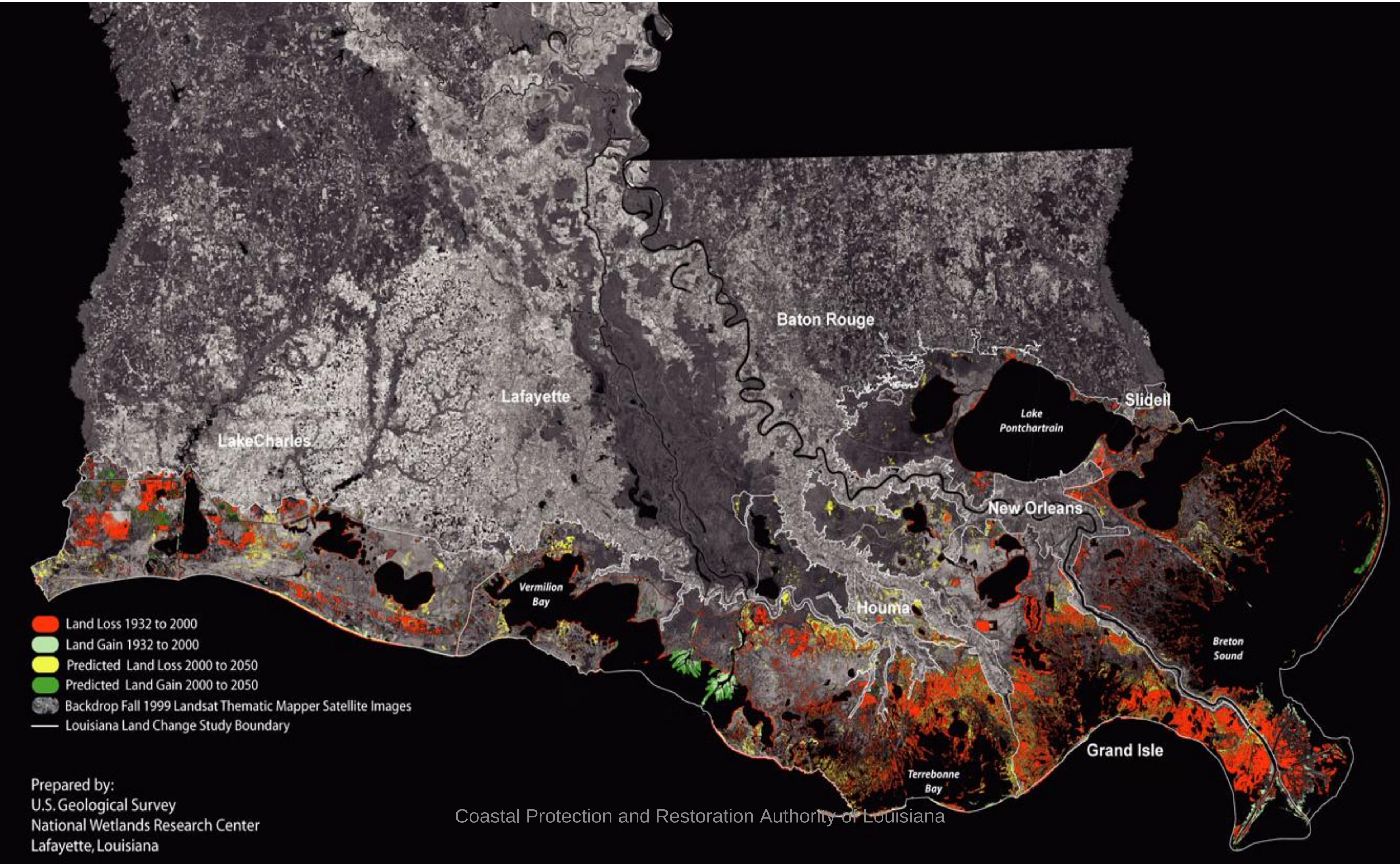
Historic distributaries delivered freshwater and sediment to the wetlands before the flood protection levees of the MR&T.



Contemporary Distributary Flow Paths



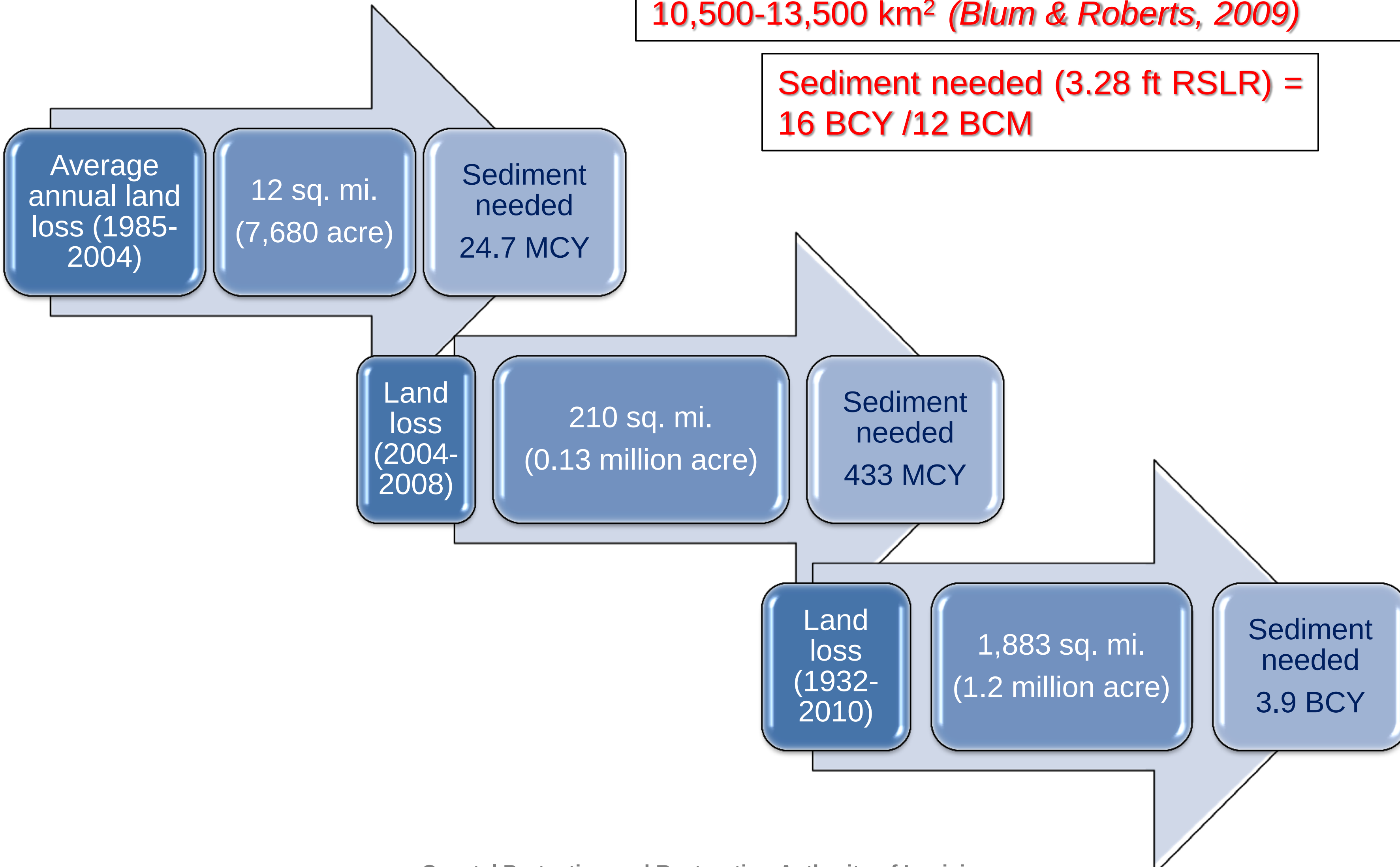
Historical and Predicted Land Loss



Sediment-Needed to Offset Land Loss

Projected future land loss = 4,056-5,214 mi^2 / 10,500-13,500 km^2 *(Blum & Roberts, 2009)*

Sediment needed (3.28 ft RSLR) = 16 BCY /12 BCM



Sediment Resources for Restoration

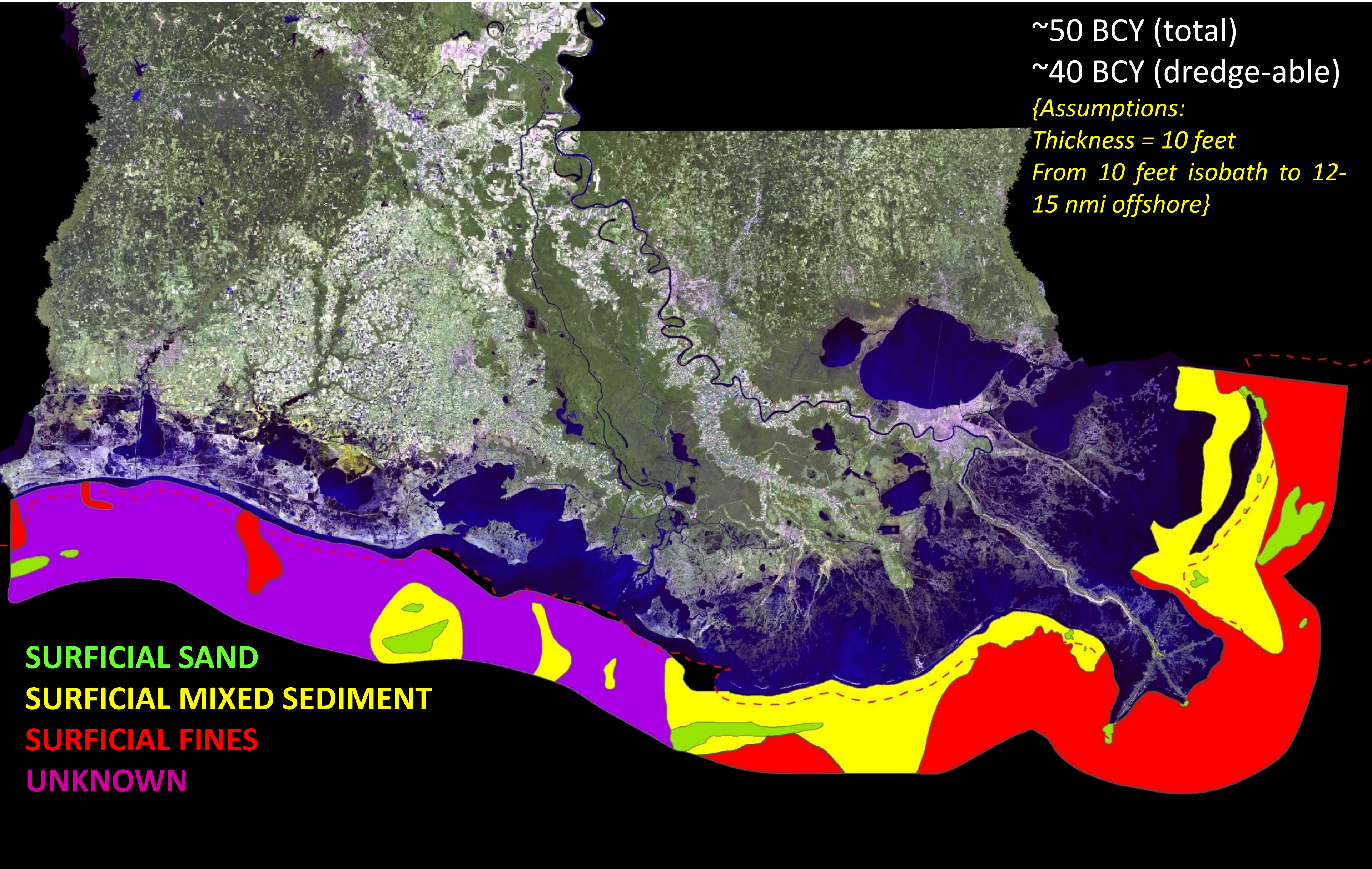
Offshore Sand/Sediment Sources

- *Buried Paleo-channels (sand bodies with silt/clay overburden)*
- *Ebb/Flood Deltas*
- *Sand Shoals (offshore* shoals containing larger volumes)

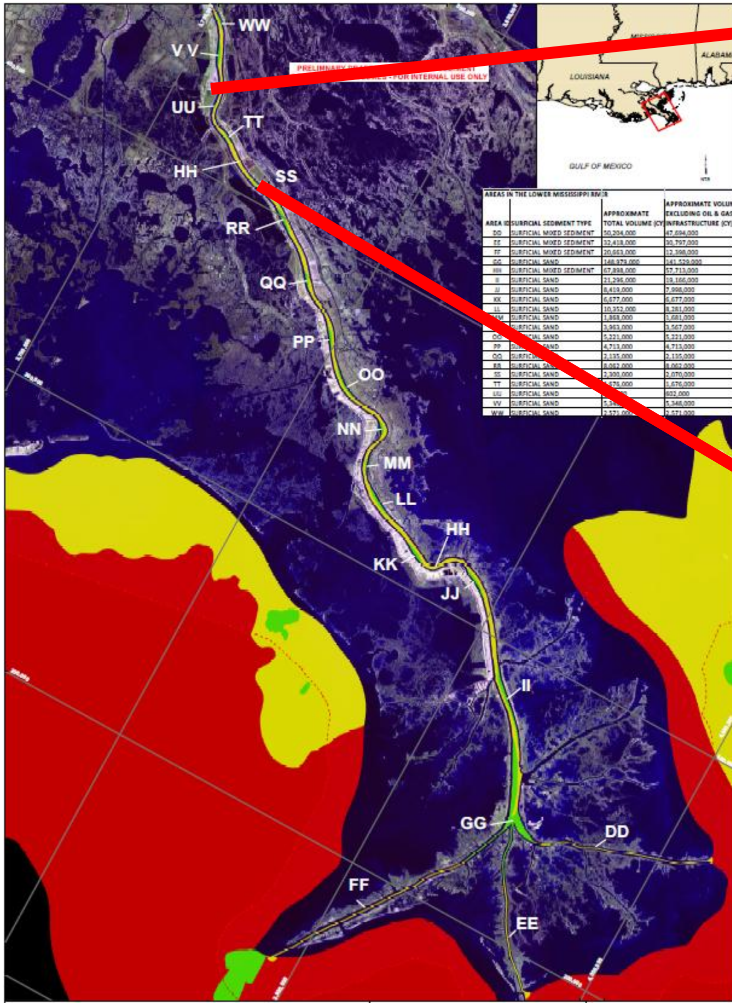
Fluvial/Riverine (Renewable) Sand/Sediment Sources

- *Sand/Sediment transported to Gulf of Mexico*
- *Sand/Sediment (suspended & bed load)*
- *Sand/sediment dredged from federal navigational channel*
- *Sand/sediment via diversion*

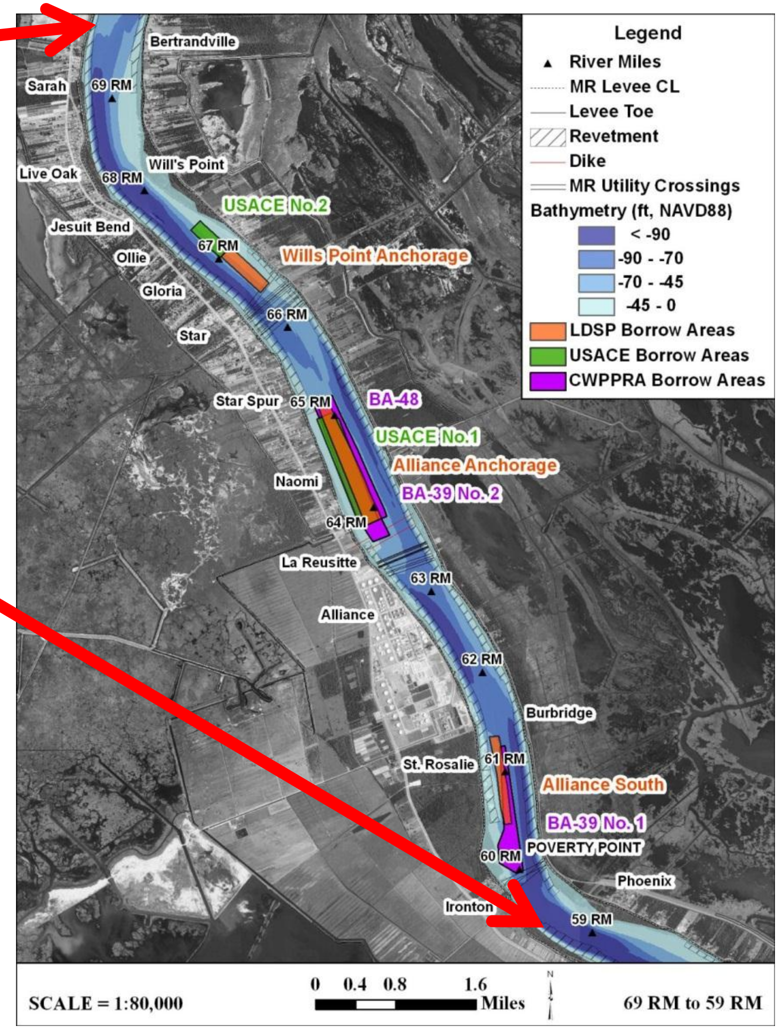
Offshore Sediment Distribution Map & Volume



L M R Sediment Distribution & Volume



AREAS IN THE LOWER MISSISSIPPI RIVER			
AREA ID	SURFICIAL SEDIMENT TYPE	APPROXIMATE TOTAL VOLUME (CY)	APPROXIMATE VOLUME EXCLUDING OIL & GAS INFRASTRUCTURE (CY)
DD	SURFICIAL MIXED SEDIMENT	50,204,000	47,694,000
EE	SURFICIAL MIXED SEDIMENT	32,418,000	30,797,000
FF	SURFICIAL MIXED SEDIMENT	20,663,000	12,398,000
GG	SURFICIAL SAND	148,979,000	141,529,000
HH	SURFICIAL MIXED SEDIMENT	67,898,000	57,713,000
II	SURFICIAL SAND	21,296,000	19,166,000
JJ	SURFICIAL SAND	8,419,000	7,998,000
KK	SURFICIAL SAND	6,677,000	6,677,000
LL	SURFICIAL SAND	10,352,000	8,281,000
MM	SURFICIAL SAND	1,868,000	1,681,000
[illegible]	SURFICIAL SAND	3,963,000	3,567,000
OO	[illegible] SAND	5,221,000	5,221,000
PP	[illegible] SAND	4,713,000	4,713,000
QQ	SURFICIAL [illegible]	2,135,000	2,135,000
RR	SURFICIAL [illegible]	8,062,000	8,062,000
SS	SURFICIAL SAND	2,300,000	2,070,000
TT	SURFICIAL SAND	[illegible]	1,676,000
UU	SURFICIAL SAND	[illegible]	602,000
VV	SURFICIAL SAND	[illegible]	5,348,000
WW	SURFICIAL SAND	2,571,000	2,571,000



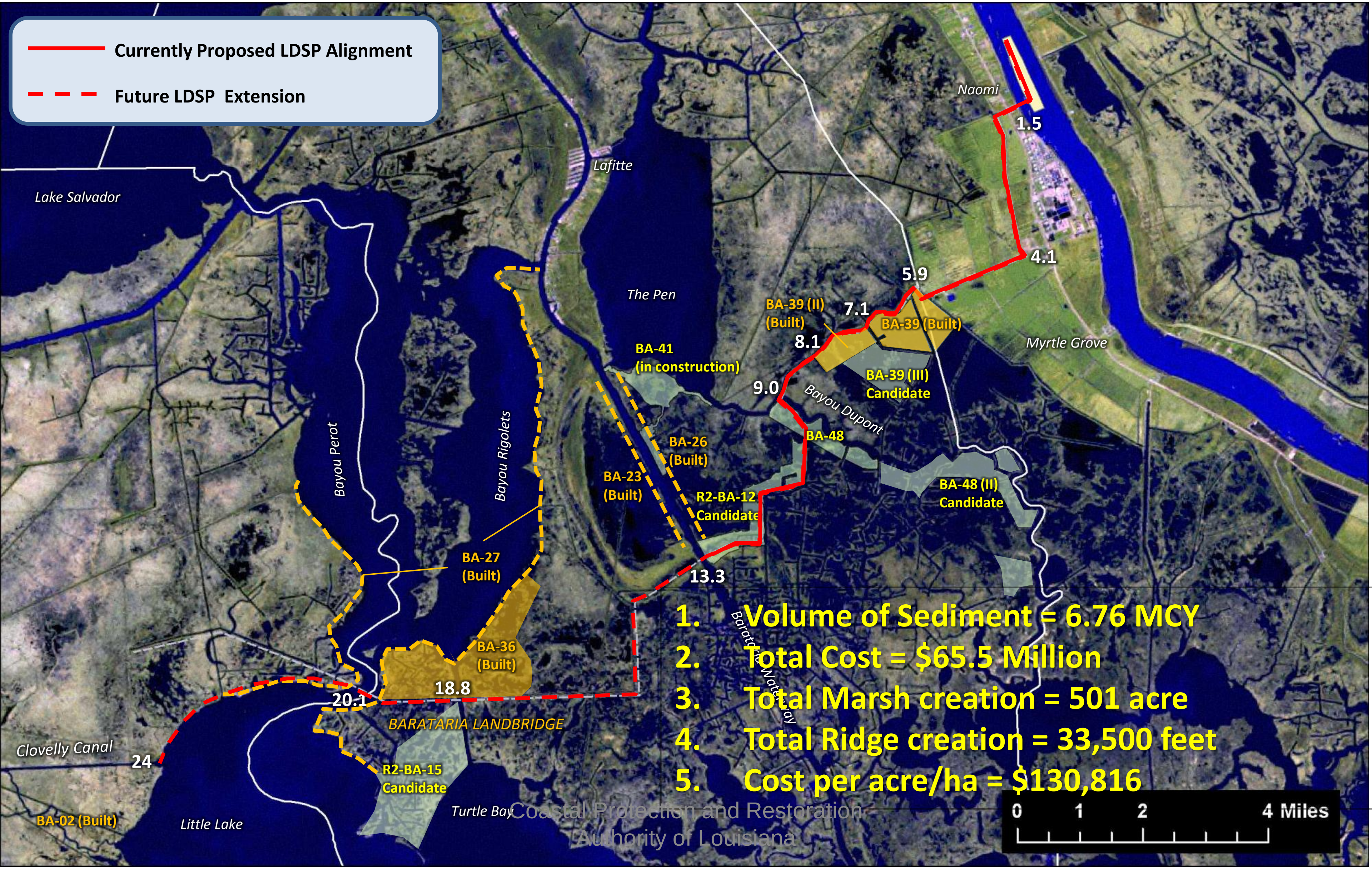
Total Sand Volume: ~0.4 BCY / 0.3 BCM

Dredge-able Sand Volume: ~0.37 BCY / 0.28 BCM

Mississippi River Sediment Delivery System Bayou Dupont (BA-39)

Total Project Budget	$31.6 million
Acres Benefited	577
Construction Completion Date	March 2011
Funding Program	CWPPRA, ARRA

Long Distance Sediment Pipeline (BA-43)



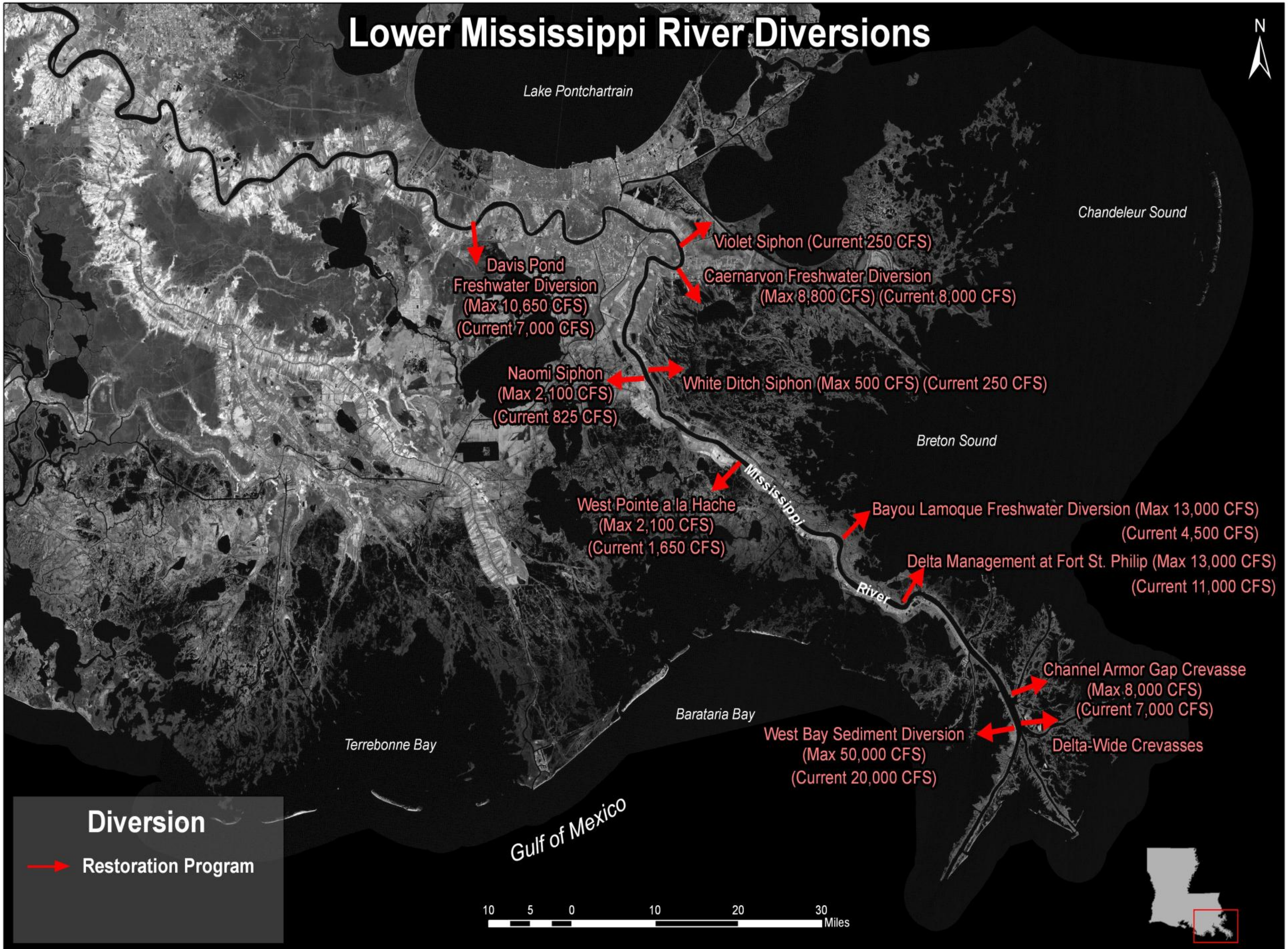
1. Volume of Sediment = 6.76 MCY
2. Total Cost = $65.5 Million
3. Total Marsh creation = 501 acre
4. Total Ridge creation = 33,500 feet
5. Cost per acre/ha = $130,816

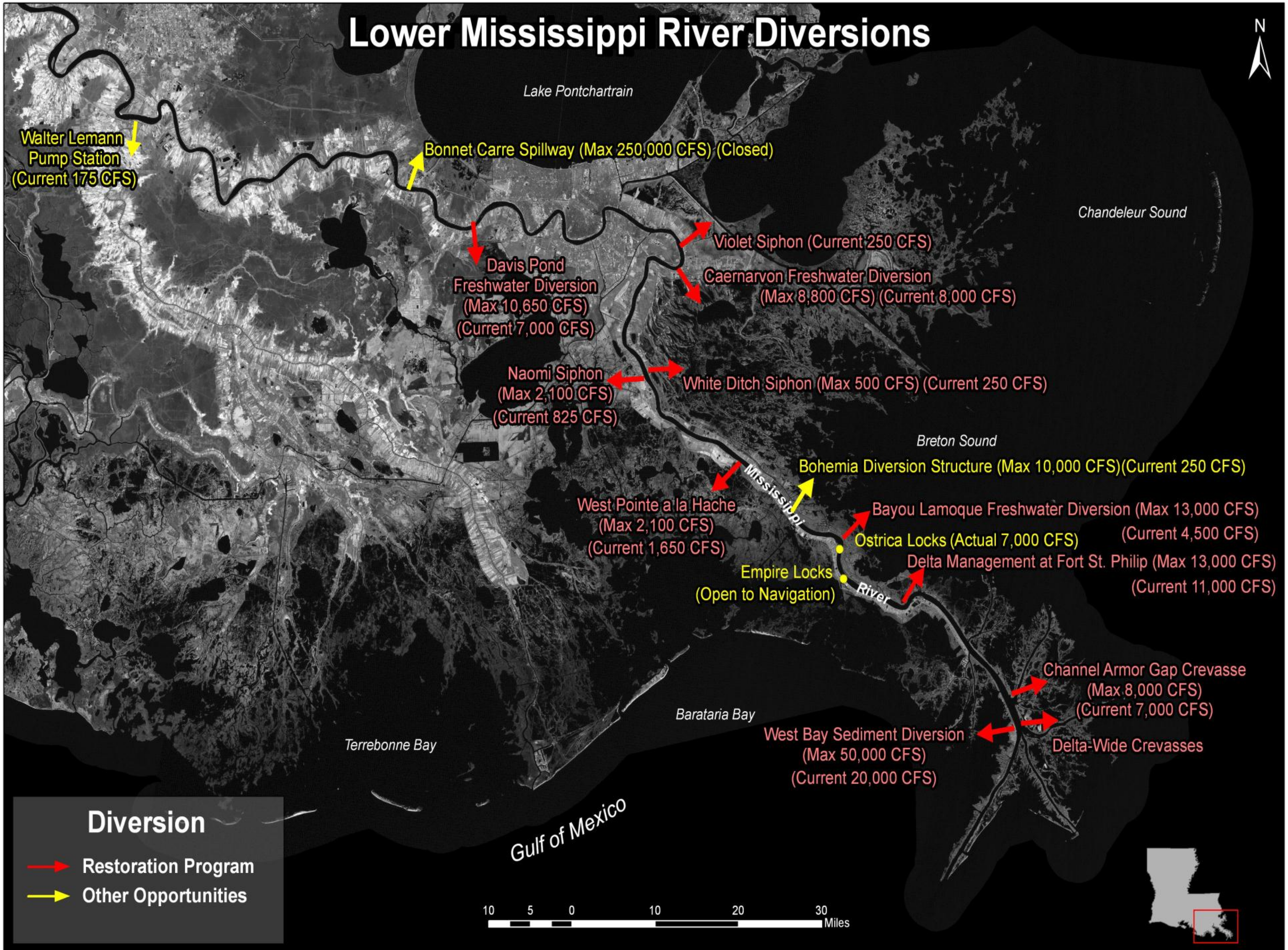
Sediment Dredged from Federal Navigation Channels

USACE 2010 Maintenance dredging program

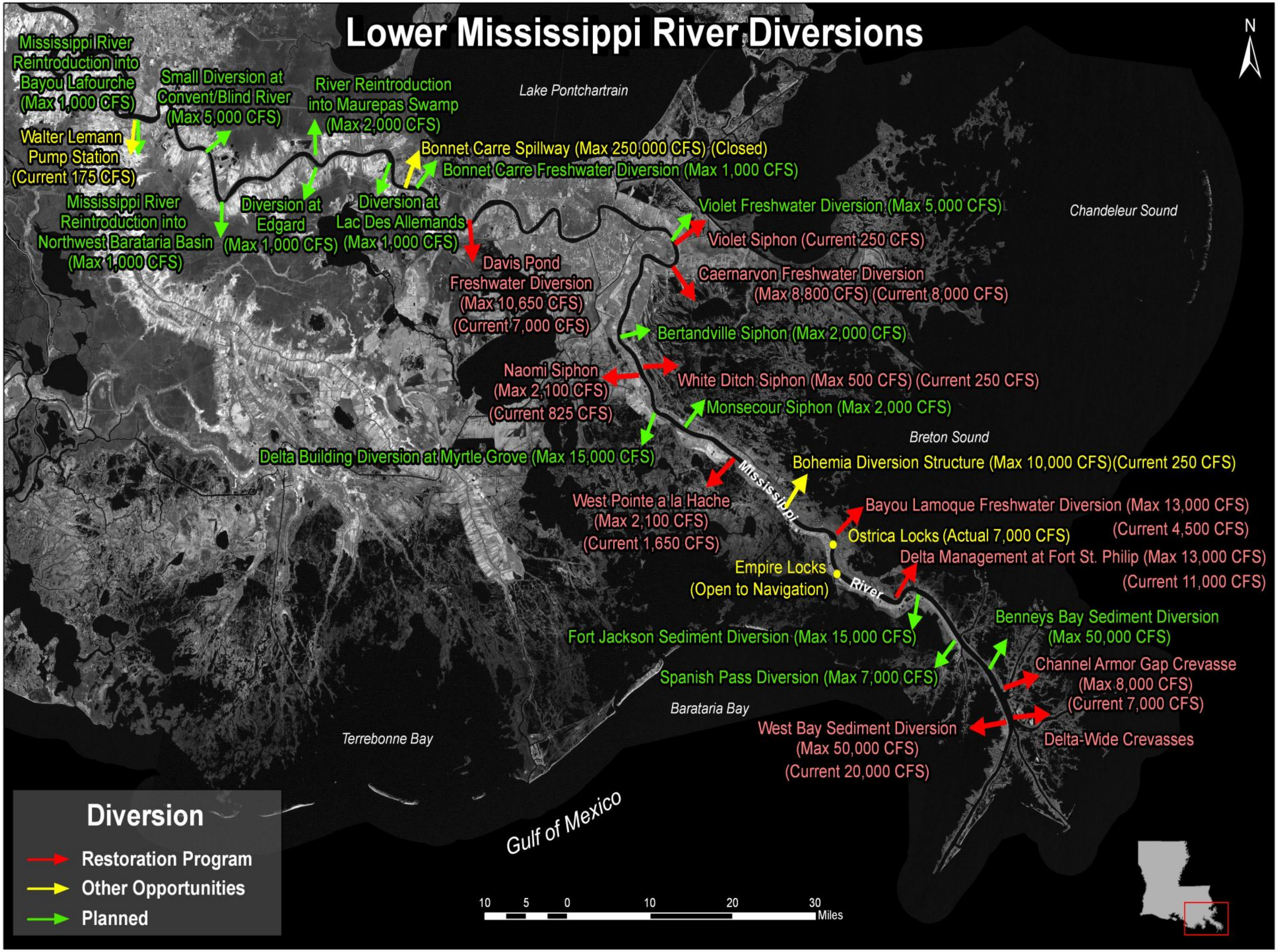
- Maintenance Dredging = 91.4 MCY / 69.9 MCM
- Beneficial Use = 20.8 MCY / 15.9 MCM (23% OR 51%)
- Fluff = 15.7 MCY / 12 MCM
- Remote Sediment = 25.1 MCY / 19.2 MCM
- Suitable for Beneficial Use but disposed= 29.8 MCY / 22.8 MCM

(Note: Sediment needed to offset one year land loss = ~25 MCY)


Lower Mississippi River Diversions
N
Lake Pontchartrain
Chandeleur Sound
Violet Siphon (Current 250 CFS)
Davis Pond
Freshwater Diversion
(Max 10,650 CFS)
(Current 7,000 CFS)
Caernarvon Freshwater Diversion
(Max 8,800 CFS) (Current 8,000 CFS)
Naomi Siphon
(Max 2,100 CFS)
(Current 825 CFS)
White Ditch Siphon (Max 500 CFS) (Current 250 CFS)
Breton Sound
Mississippi
West Pointe a la Hache
(Max 2,100 CFS)
(Current 1,650 CFS)
Bayou Lamoque Freshwater Diversion (Max 13,000 CFS)
(Current 4,500 CFS)
Delta Management at Fort St. Philip (Max 13,000 CFS)
(Current 11,000 CFS)
River
Channel Armor Gap Crevasse
(Max 8,000 CFS)
(Current 7,000 CFS)
Barataria Bay
West Bay Sediment Diversion
(Max 50,000 CFS)
(Current 20,000 CFS)
Delta-Wide Crevasses
Terrebonne Bay
Gulf of Mexico
Diversion
Restoration Program
10 5 0 10 20 30
Miles



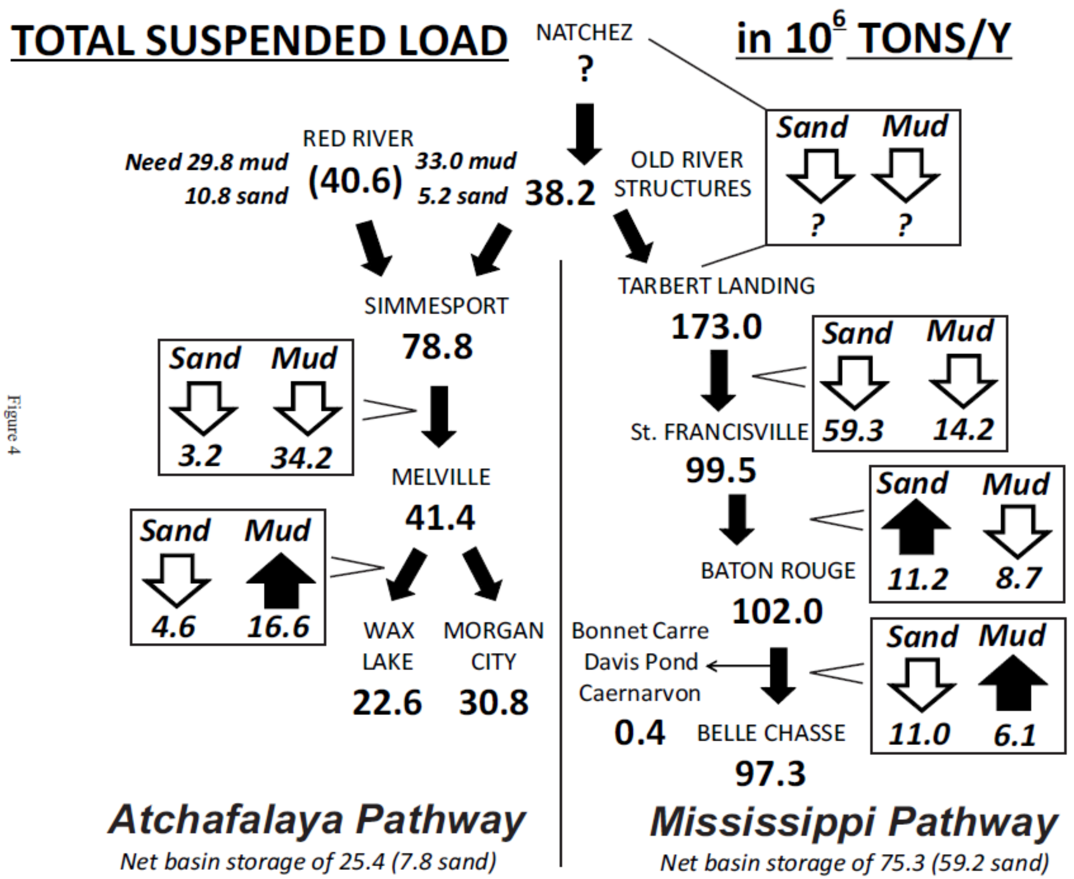
Lower Mississippi River Diversions
N
Lake Pontchartrain
Walter Lemann
Pump Station
(Current 175 CFS)
Bonnet Carre Spillway (Max 250,000 CFS) (Closed)
Chandeleur Sound
Violet Siphon (Current 250 CFS)
Davis Pond
Freshwater Diversion
(Max 10,650 CFS)
(Current 7,000 CFS)
Caernarvon Freshwater Diversion
(Max 8,800 CFS) (Current 8,000 CFS)
Naomi Siphon
(Max 2,100 CFS)
(Current 825 CFS)
White Ditch Siphon (Max 500 CFS) (Current 250 CFS)
Breton Sound
Bohemia Diversion Structure (Max 10,000 CFS)(Current 250 CFS)
West Pointe a la Hache
(Max 2,100 CFS)
(Current 1,650 CFS)
Mississippi
Bayou Lamoque Freshwater Diversion (Max 13,000 CFS)
(Current 4,500 CFS)
Ostrica Locks (Actual 7,000 CFS)
Delta Management at Fort St. Philip (Max 13,000 CFS)
(Current 11,000 CFS)
Empire Locks
(Open to Navigation)
River
Channel Armor Gap Crevasse
(Max 8,000 CFS)
(Current 7,000 CFS)
Barataria Bay
West Bay Sediment Diversion
(Max 50,000 CFS)
(Current 20,000 CFS)
Delta-Wide Crevasses
Terrebonne Bay
Gulf of Mexico
Diversion
Restoration Program
Other Opportunities
10 5 0 10 20 30
Miles


Lower Mississippi River Diversions
N
Mississippi River Reintroduction into Bayou Lafourche (Max 1,000 CFS)
Small Diversion at Convent/Blind River (Max 5,000 CFS)
River Reintroduction into Maurepas Swamp (Max 2,000 CFS)
Lake Pontchartrain
Walter Lemann Pump Station (Current 175 CFS)
Bonnet Carre Spillway (Max 250,000 CFS) (Closed)
Bonnet Carre Freshwater Diversion (Max 1,000 CFS)
Mississippi River Reintroduction into Northwest Barataria Basin (Max 1,000 CFS)
Diversion at Edgard (Max 1,000 CFS)
Diversion at Lac Des Allemands (Max 1,000 CFS)
Violet Freshwater Diversion (Max 5,000 CFS)
Chandeleur Sound
Violet Siphon (Current 250 CFS)
Davis Pond Freshwater Diversion (Max 10,650 CFS) (Current 7,000 CFS)
Caernarvon Freshwater Diversion (Max 8,800 CFS) (Current 8,000 CFS)
Bertandville Siphon (Max 2,000 CFS)
Naomi Siphon (Max 2,100 CFS) (Current 825 CFS)
White Ditch Siphon (Max 500 CFS) (Current 250 CFS)
Monsecour Siphon (Max 2,000 CFS)
Breton Sound
Delta Building Diversion at Myrtle Grove (Max 15,000 CFS)
Bohemia Diversion Structure (Max 10,000 CFS)(Current 250 CFS)
Mississippi River
West Pointe a la Hache (Max 2,100 CFS) (Current 1,650 CFS)
Bayou Lamoque Freshwater Diversion (Max 13,000 CFS) (Current 4,500 CFS)
Ostrica Locks (Actual 7,000 CFS)
Delta Management at Fort St. Philip (Max 13,000 CFS) (Current 11,000 CFS)
Empire Locks (Open to Navigation)
Benneys Bay Sediment Diversion (Max 50,000 CFS)
Fort Jackson Sediment Diversion (Max 15,000 CFS)
Channel Armor Gap Crevasse (Max 8,000 CFS) (Current 7,000 CFS)
Spanish Pass Diversion (Max 7,000 CFS)
Barataria Bay
West Bay Sediment Diversion (Max 50,000 CFS) (Current 20,000 CFS)
Delta-Wide Crevasses
Terrebonne Bay
Gulf of Mexico
Diversion
Restoration Program
Other Opportunities
Planned
10 5 0 10 20 30 Miles

Sediment Diversions

- Diversions replicate / re-establish deltaic processes by building land and transporting freshwater, sediment & nutrients.
- Building land via diversion is slow and episodic as compared to emplacement of dredged sediment to create wetland but saves energy.
- Study of fluvial sediment dynamics along with monitoring of existing diversions are important to understand the land building processes.
- River sediment dynamics/distribution have been altered by human activities in the past century.
- Diversions must be designed to optimize sediment transport than freshwater and be coupled to robust sediment management by dredging sediment from resultant downstream shoals.
- Determining the sediment budget is critical to the efficient use of diversions and beneficial use of sediment.

Mississippi and Atchafalaya Rivers Sediment Budget (2008-2010)



- Proportion of suspended sediment at ORC differs from the 70:30 water split of Mississippi and Red River discharge due to the distinct Red River suspended sediment load.
- Sand is apportioned between the LMR and Atchafalaya pathways at a 83:17 ratio, and fines at a 60:40 ratio.
- An examination of water and suspended sediment ratios of individual water exits downriver of Belle Chasse indicates that there is a progressive downstream reduction in the efficiency of these channels in passing sediment.

Allison et al. 2012

Diversions – Important Questions

- “Where” to reconnect the River with the surrounding basins to get the most out of a diversion?
- What are the criteria for placement of diversions?
- How many reconnections or diversions are optimal and why?
- What are the pros and cons of large *vs*. small sediment diversions?
- What are the obstacles in implementing large diversions of river water and sediment?
- What are the requirements to maintain and initiate marsh growth vs. diversion characteristics?
- What do the recent river-derived sediment resource evaluations tell us about how much sediment could be used for diversions and what are the ramifications of using this resource?

LCA Delta Hydrodynamic and Delta Management Feasibility Study

- To develop a calibrated hydrodynamic and sediment management model to predict changes in depositional patterns across the system and inform dredging and sediment management
- A 5-year, $25M cost-share study between CPRA and USACE (MVD and MVN)
- Initial river hydrodynamic steps include
  - River hydrodynamic and sediment transport data collection
  - Geomorphic analysis
  - One-dimensional river hydrodynamic and sediment modeling
  - Multi-dimensional river hydrodynamic and sediment modeling
  - Data management

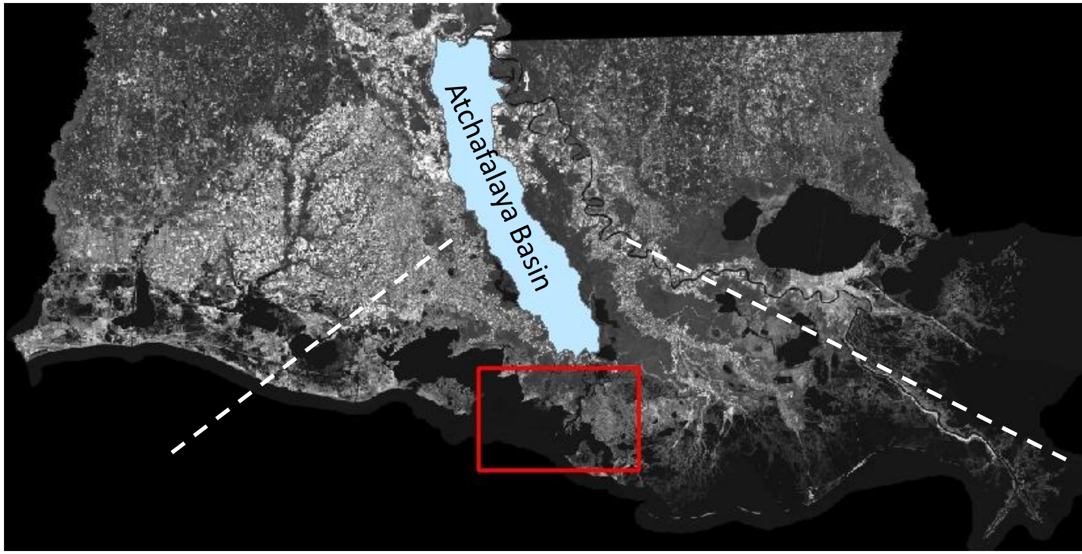
Land-building Potential
Atchafalaya and Wax Lake Deltas

Wax Lake Outlet, which built a *sub-aerial* delta only after 31 years of *sub-aqueous* deposition in Atchafalaya Bay, but which now is continuing to gain land even following the 2005 and 2008 hurricanes (Barras 2009)

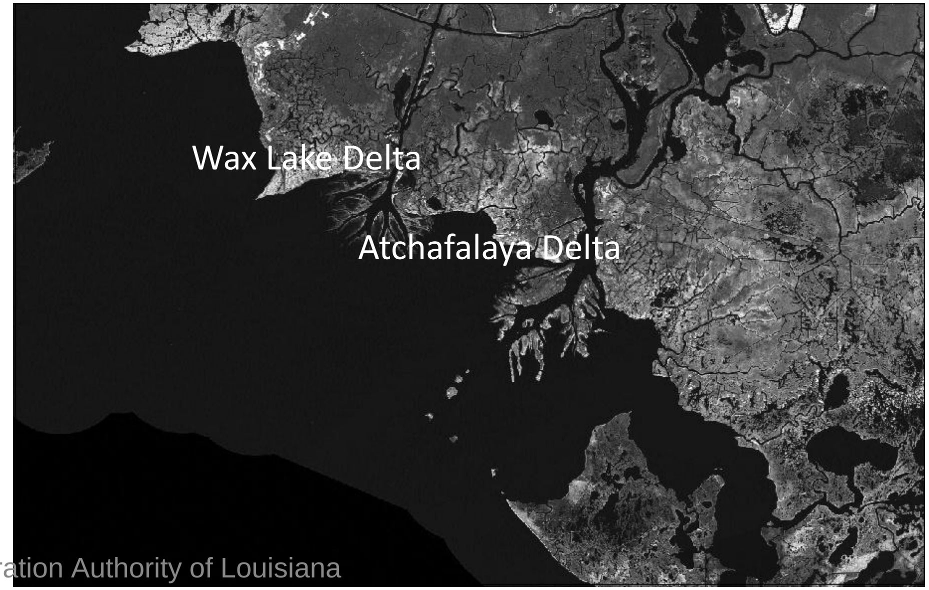
- Overall 1993-2010 growth averaged 1 km^2/yr (*Allen et al. 2012)*
- Estimates of 2008 flood deposition of sediment on the Atchafalaya delta of 4.09 Mt (Holm et al. 2009)

Studies in Atchafalaya Basin / River

Atchafalaya Basin Sediment Management Plan (ABSMP)

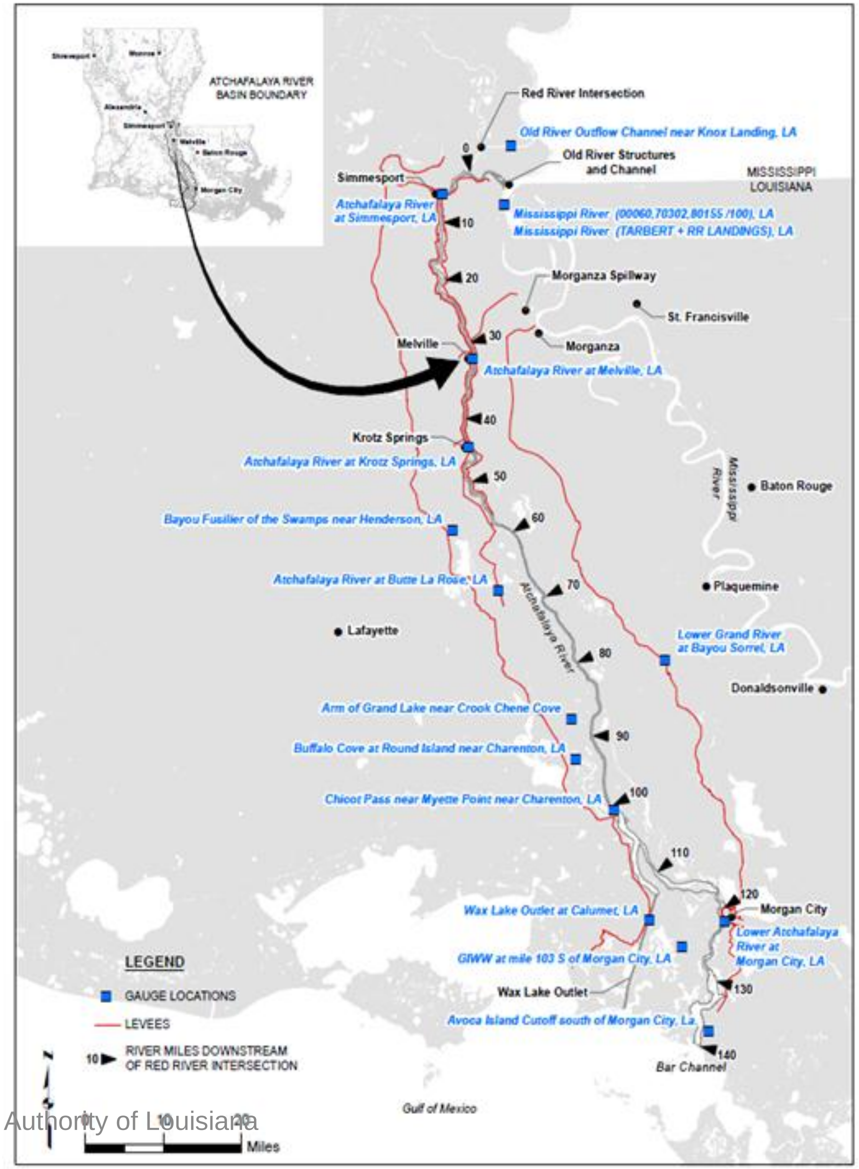


Delta Development and Coastal Marsh Accretion During Cold Front Passages and Floods: Relevance to River Diversion



Atchafalaya Basin Sediment Management Plan

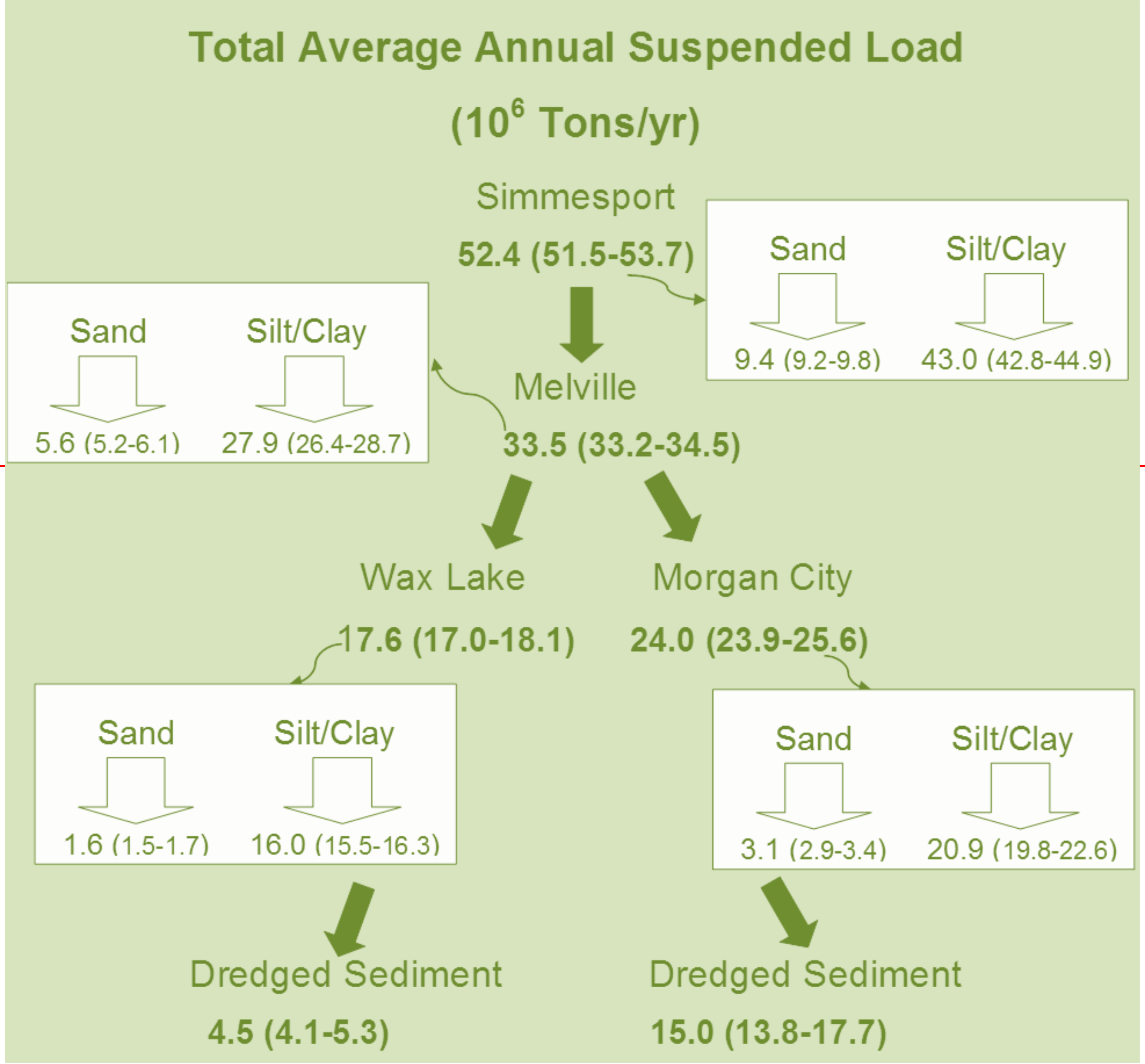
- Provide an understanding of the quantity, and quality of sediment load being delivered to and exiting the Atchafalaya Basin
- Describe how the Atchafalaya River can be managed to encourage sediment deposition in areas where sediment is needed, increase habitat continuity, and manage deltaic growth processes.
- Understanding the sediment dynamics and its management to incorporate in LMR Delta Management as it is the only place where sediment is accreting



<u>*Deliverables*</u>

1. *Inventory & catalogue of all the historical and current data*
2. *Sediment Budget*
3. *Sediment Management Plan*

Average Annual Atchafalaya Basin Sediment Budget (2000-2010)

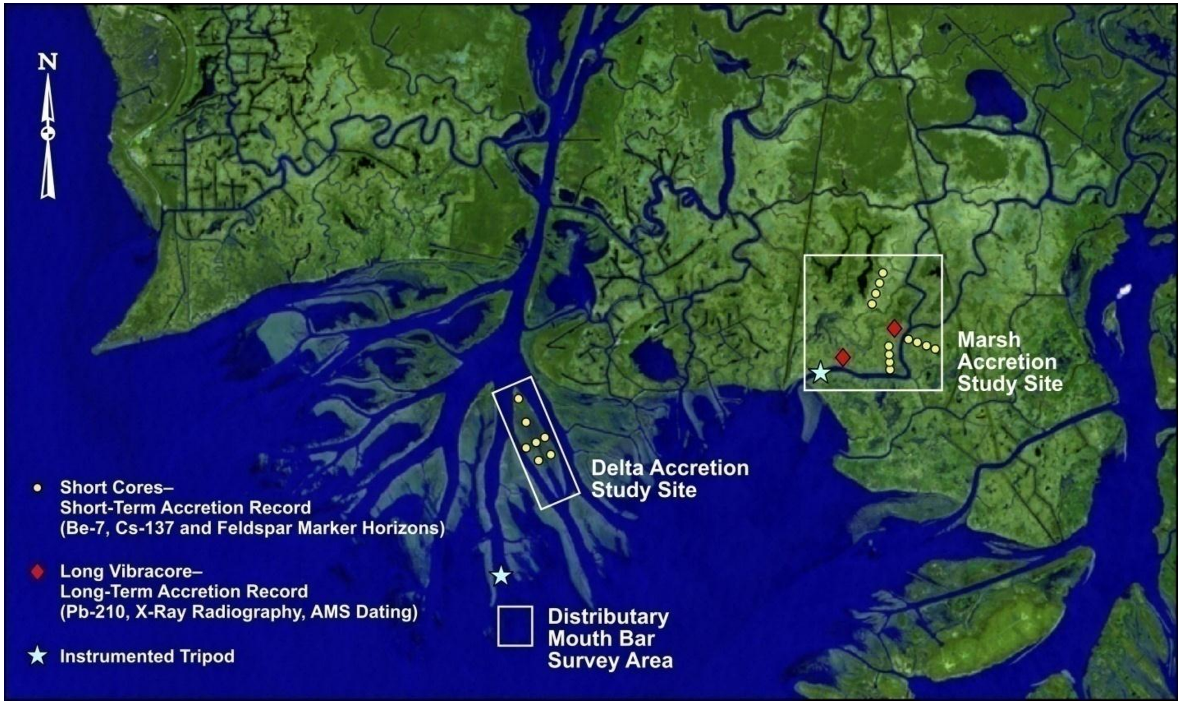


Atchafalaya Basin Sediment Management Plan
Key Points

Various options to increase sediment availability for coastal restoration are:

- Possible construction of third basin north of Morgan City
- Optimization or increase, of sediment load entering the Atchafalaya Basin at the Old River Control Structure
- Utilization of sediments deposited in Grand Lake, Big Bayou Pigeon, Bayou Darby, Murphy Lake etc.
- Sediment from Atchafalaya Basin can be used for various projects viz. river diversions, shoreline protection, marsh restoration, ridge restoration, and oyster barrier reef restoration, identified in Louisiana's 2012 Comprehensive Master Plan

Delta Development & Coastal Marsh Accretion during Cold Front Passages & Floods: *Relevance to River Diversions*



This project provides quantitative linkages between forcing physical processes, sediment transport, and deposition in the present Mississippi-Atchafalaya Rivers system.

Relevance to CPRA: It is designed to collect necessary data to help better understand sediment dynamics and sediment distribution in a system that is used to mimic what is to be expected from river diversions intended to offset coastal land loss.

SEDIMENT

OCS Waters, State Waters, Coastal Zone
Lower Mississippi & Atchafalaya River

Sediment Borrow Area

Borrow Area Monitoring
- Infilling rate
- Slope Stability Issues
- Hypoxia

Monitoring Programs
- **BICM - Barrier Island Comprehensive Monitoring Program**
- **WAVCIS - Met-Oceanic Data**
- **Eustatic Sea Level Rise**
- **Subsidence**

Borrow Area Management
- Hypoxia
- Optimal Utilization
- Location vs. project/pipeline
- Location vs. Delineation of potential sand sources in OCS

Sediment Evaluation
- **Protocol of exploration**
- **Evaluation of potential areas**
  - **Offshore/State & Federal Waters**
  - **Lower Miss River**
  - **Atchafalaya River**

- **LCA Miss River Delta Mgmt Study**
- **Atchafalaya Basin Sed Mgmt Plan**
- **Delta Development Study**

Sediment Data Management (LASARD)
- Protocol for standardization of data acquisition

Sediment Management
- **Sediment Resources**
- **Sediment Budget**
- **Diversions**
- **Sediment Dredged from Nav Channel**

Policy/ Regulation
- **Federal Standard**
- **Environment Issues**
- **Prioritization of allocation**

Pipeline/O&G
- MMS NTL

Sea Level Rise Policy

Coordination with
BOEM
Permit (G&G, CR Issues); Lease for OCS sand;
USACE
IRSM; BUDMAT;
GOMA
GRSMMP; GRMMP
LDNR/CMD
CZM; Consistency Determination; Mitigation
CWPPRA, LCA, & OTHER FEDERAL AGENCIES

LOUISIANA SEDIMENT MANAGEMENT PLAN (LASMP)

Summary

1. Utilization of renewable fluvial sediment resources is critical for ecosystem restoration but for a cost effective, systematic, and sustainable ecosystem restoration of coastal LA, sediment management (LASMP) is crucial
2. Near Term land building: Dedicated dredging of sediment from borrow areas in the river (and offshore) as well as beneficial use of sediment dredged from federal navigation channels.
3. Long-term sustainability: Re-instating the natural sediment input to coastal LA via large diversions at appropriate places to mimic delta building processes.
4. A robust sediment management plan is critical for responsible management of limited sediment resources, and ABSMP provides for the first time a comprehensive Sediment Management Plan of a river basin vis-à-vis coastal restoration