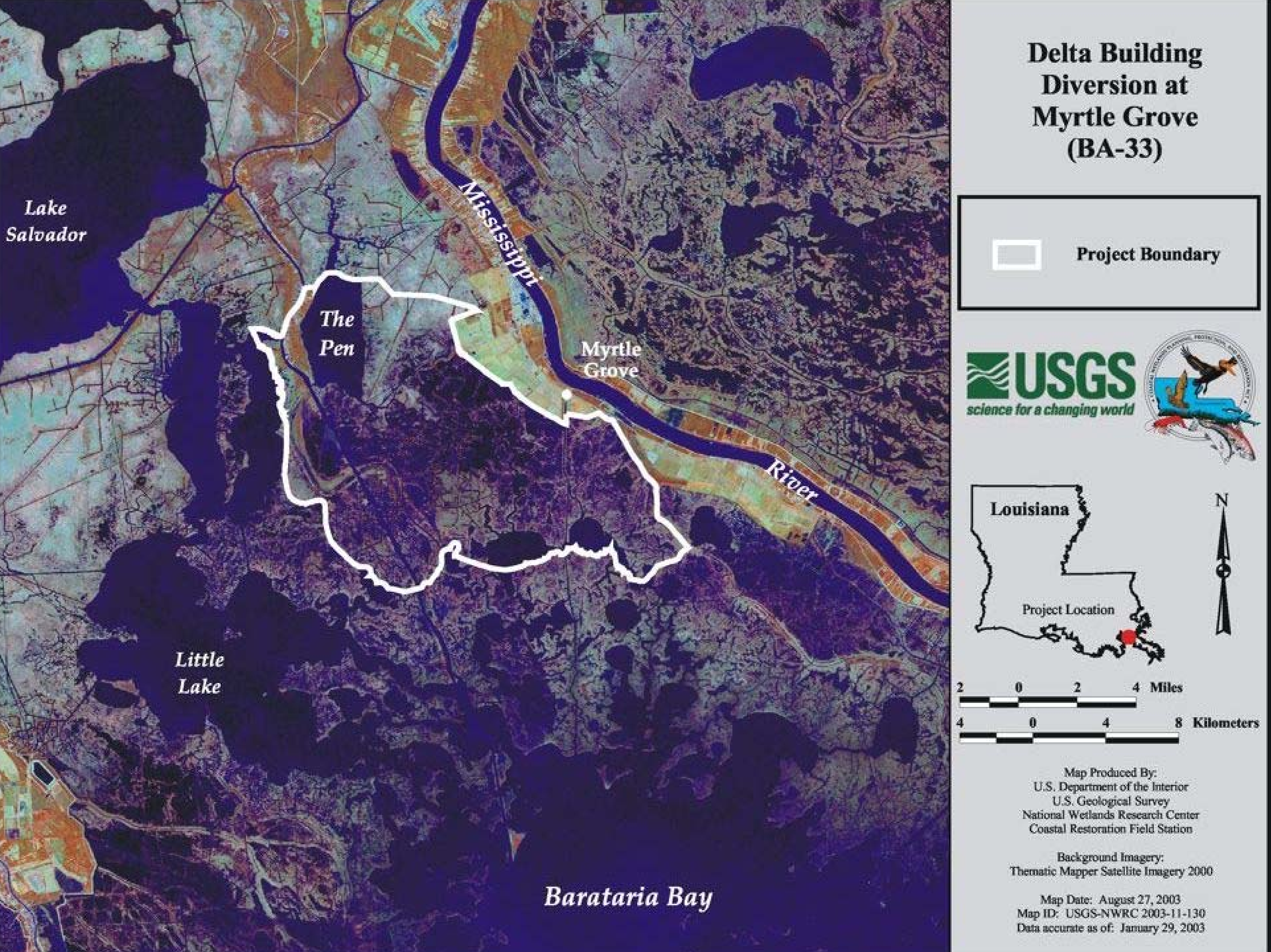
Numerical Model Study of the Barataria Basin

Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Project, Delta Building Diversion at Myrtle Grove (BA-33)

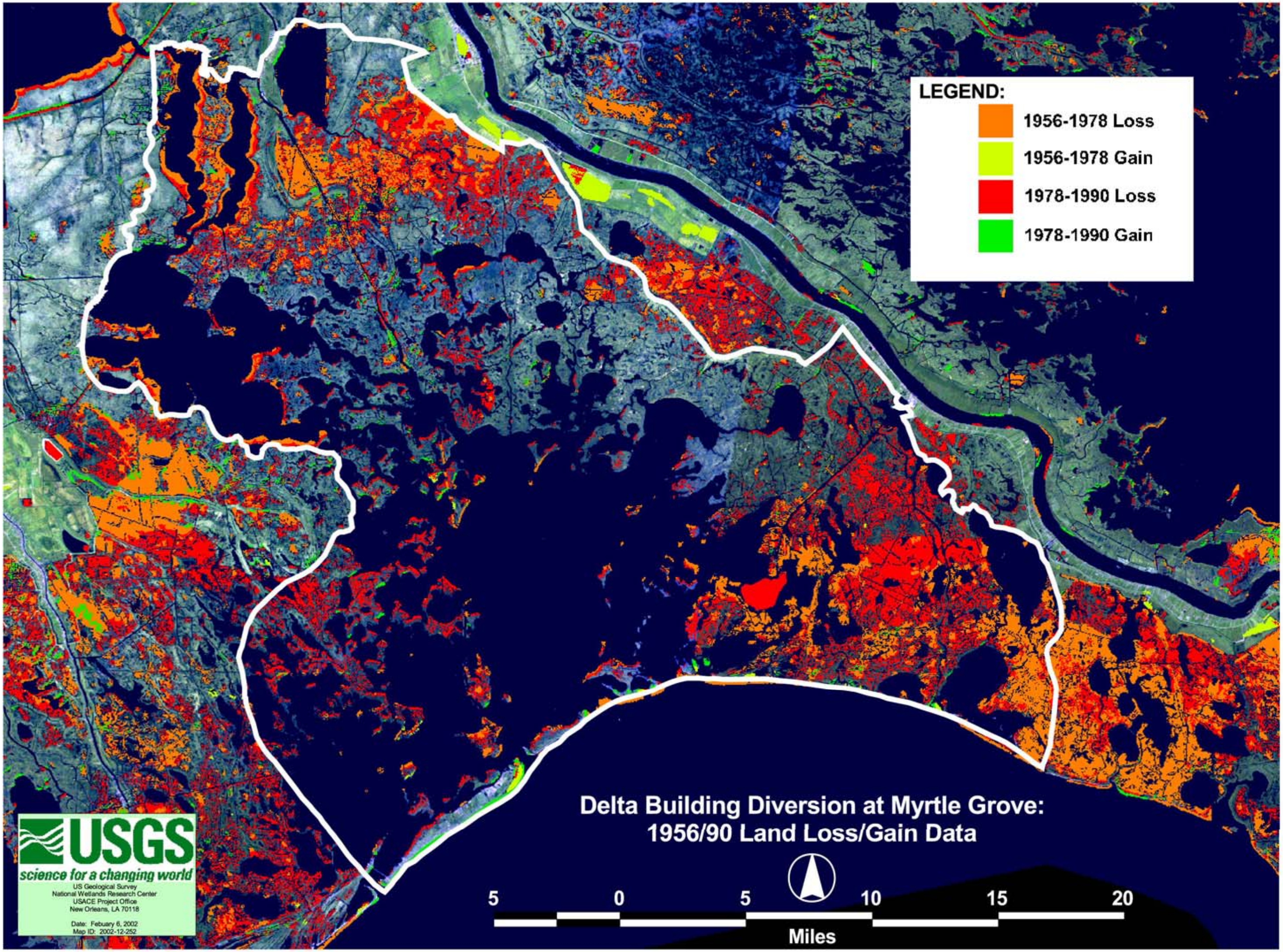

Delta Building
Diversion at
Myrtle Grove
(BA-33)
Project Boundary
USGS
science for a changing world
Louisiana
Project Location
N
2 0 2 4 Miles
4 0 4 8 Kilometers
Map Produced By:
U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
Coastal Restoration Field Station
Background Imagery:
Thematic Mapper Satellite Imagery 2000
Map Date: August 27, 2003
Map ID: USGS-NWRC 2003-11-130
Data accurate as of: January 29, 2003
Lake Salvador
The Pen
Mississippi
Myrtle Grove
River
Little Lake
Barataria Bay

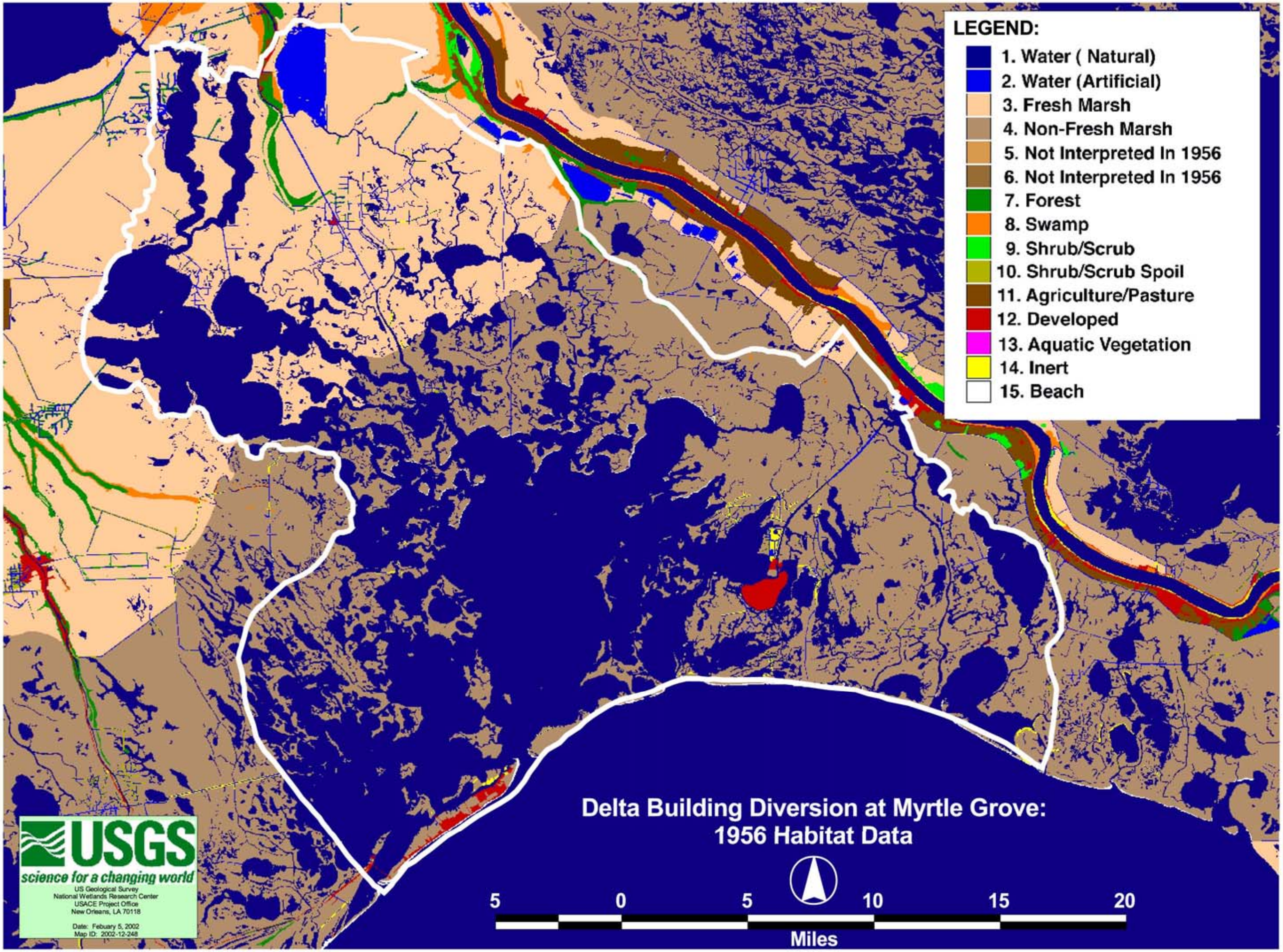
Project Overview

Project area has undergone substantial loss of wetlands and a significant habitat shift to more saline marshes in the last 50 years due to subsidence, altered hydrology due to navigation and flood control projects, as well as oil and gas activities.

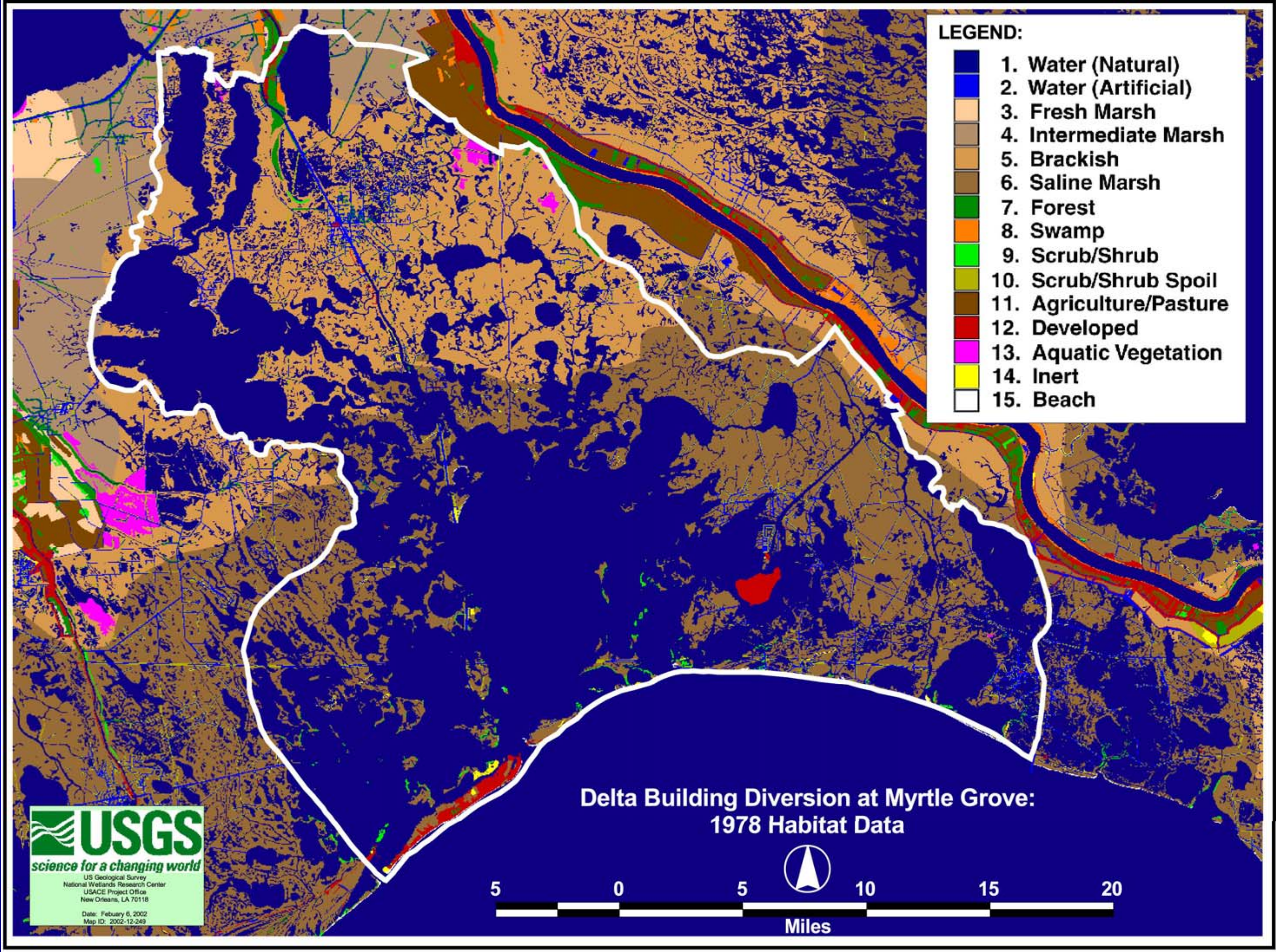
Without remediation, it is anticipated that approximately 14,500 acres of wetlands will be lost in the project area over the next 20 years.

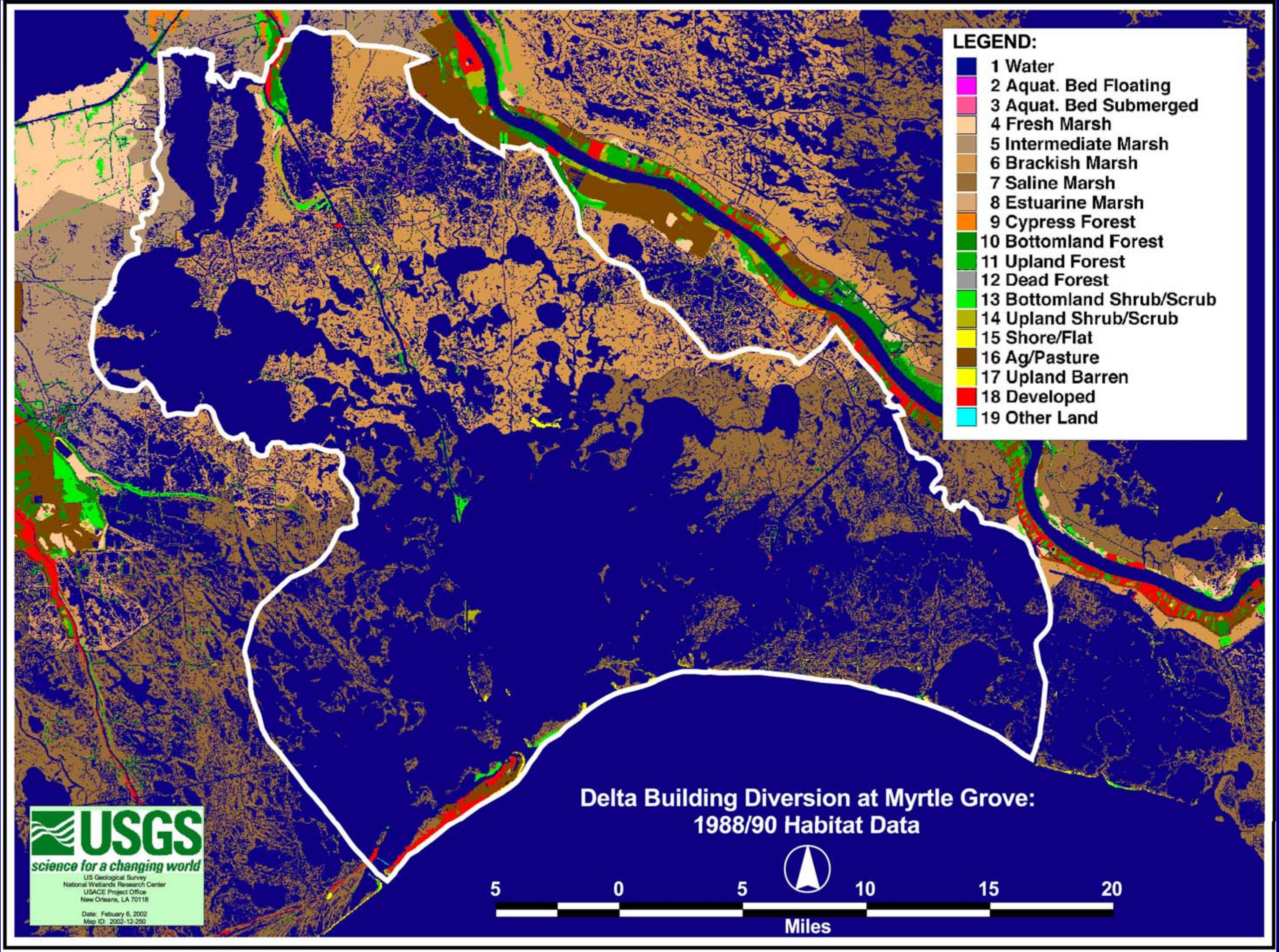
Wetland types will continue to shift towards more saline habitats.


LEGEND:
1956-1978 Loss
1956-1978 Gain
1978-1990 Loss
1978-1990 Gain
Delta Building Diversion at Myrtle Grove:
1956/90 Land Loss/Gain Data
5 0 5 10 15 20
Miles
USGS
science for a changing world
US Geological Survey
National Wetlands Research Center
USACE Project Office
New Orleans, LA 70118
Date: Febuary 6, 2002
Map ID: 2002-12-252



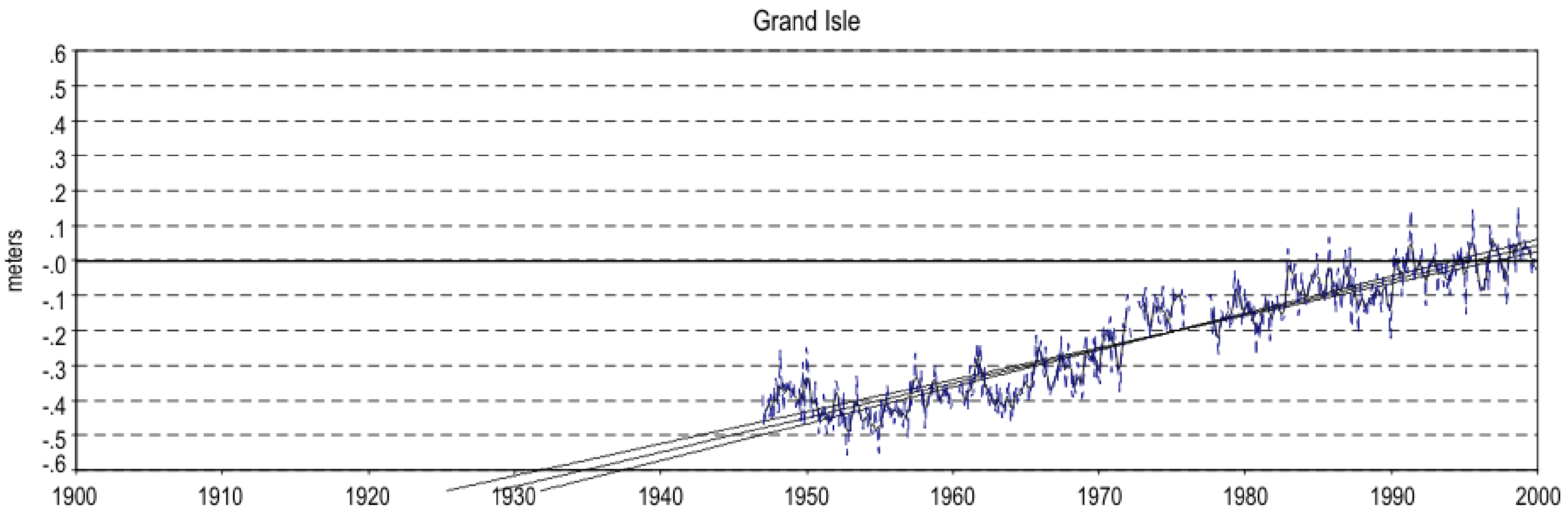
LEGEND:
1. Water (Natural)
2. Water (Artificial)
3. Fresh Marsh
4. Non-Fresh Marsh
5. Not Interpreted In 1956
6. Not Interpreted In 1956
7. Forest
8. Swamp
9. Shrub/Scrub
10. Shrub/Scrub Spoil
11. Agriculture/Pasture
12. Developed
13. Aquatic Vegetation
14. Inert
15. Beach
Delta Building Diversion at Myrtle Grove:
1956 Habitat Data
5 0 5 10 15 20
Miles
USGS
science for a changing world
US Geological Survey
National Wetlands Research Center
USACE Project Office
New Orleans, LA 70118
Date: Febuary 5, 2002
Map ID: 2002-12-248


LEGEND:
1. Water (Natural)
2. Water (Artificial)
3. Fresh Marsh
4. Intermediate Marsh
5. Brackish
6. Saline Marsh
7. Forest
8. Swamp
9. Scrub/Shrub
10. Scrub/Shrub Spoil
11. Agriculture/Pasture
12. Developed
13. Aquatic Vegetation
14. Inert
15. Beach
Delta Building Diversion at Myrtle Grove:
1978 Habitat Data
5 0 5 10 15 20
Miles
USGS
science for a changing world
US Geological Survey
National Wetlands Research Center
USACE Project Office
New Orleans, LA 70118
Date: Febuary 6, 2002
Map ID: 2002-12-249


LEGEND:
1 Water
2 Aquat. Bed Floating
3 Aquat. Bed Submerged
4 Fresh Marsh
5 Intermediate Marsh
6 Brackish Marsh
7 Saline Marsh
8 Estuarine Marsh
9 Cypress Forest
10 Bottomland Forest
11 Upland Forest
12 Dead Forest
13 Bottomland Shrub/Scrub
14 Upland Shrub/Scrub
15 Shore/Flat
16 Ag/Pasture
17 Upland Barren
18 Developed
19 Other Land
Delta Building Diversion at Myrtle Grove:
1988/90 Habitat Data
5 0 5 10 15 20
Miles
USGS
science for a changing world
US Geological Survey
National Wetlands Research Center
USACE Project Office
New Orleans, LA 70118
Date: Febuary 6, 2002
Map ID: 2002-12-250

Mean Sea Level Trend
8761724 Grand Isle, Louisiana

The mean sea level trend is 9.85 millimeters/year (3.23 feet/century) with a standard error of 0.35 mm/yr based on monthly mean sea level data from 1947 to 1999.



Project Overview

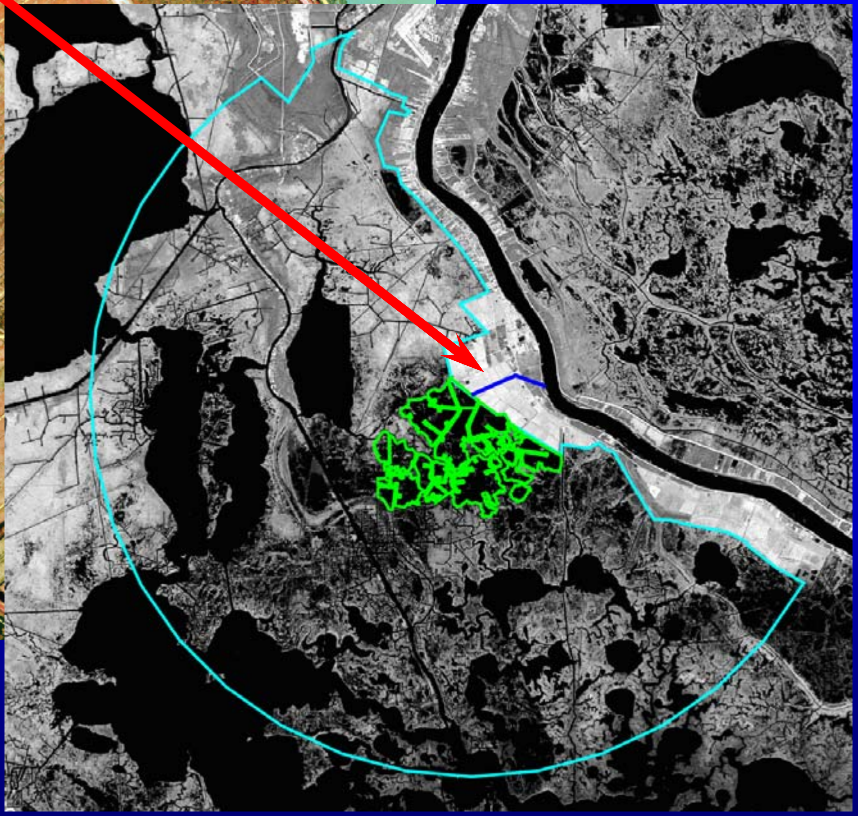
Project Features:

- Gated box culverts on the west bank of the Mississippi River to divert freshwater and sediment
- Dedicated dredging to create marsh in the vicinity of Bayou Dupont, the Barataria Bay Waterway, and the Wilkinson Canal
- Combination of these features

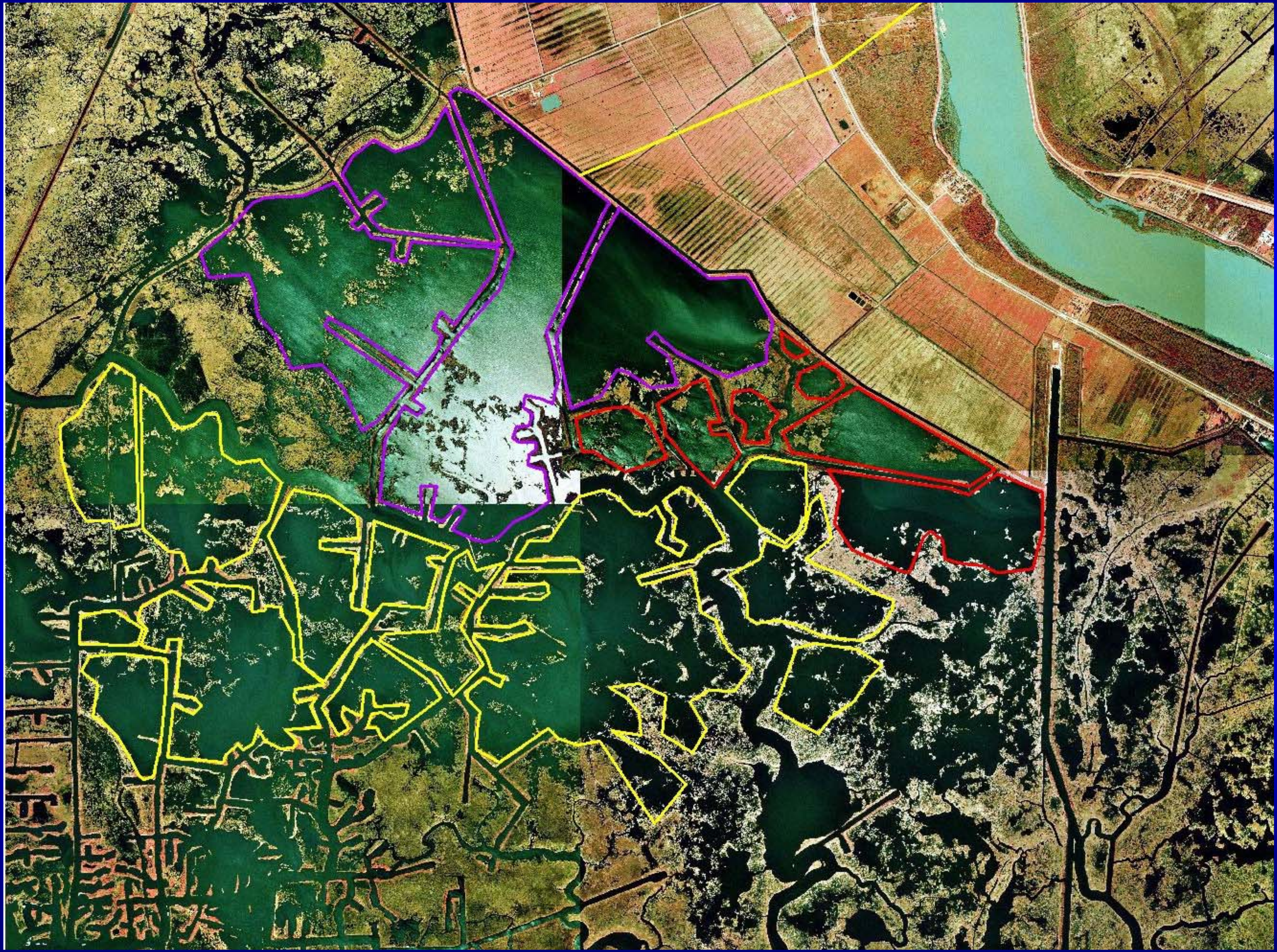
Myrtle Grove Alternatives

1. 2,500 cfs diversion
2. 5,000 cfs diversion
3. 5,000 cfs diversion, w/ sediment retention - outfall management
4. 15,000 cfs diversion
5. 15,000 cfs diversion, w/ sediment retention - outfall management
6. 15,000 cfs diversion, w/ sediment enrichment
7. 5,000 cfs diversion 4/5 years, 15,000 cfs diversion 1/5 years
8. 5,000 cfs diversion 4/5 years, 15,000 cfs diversion 1/5 years, w/ sediment retention outfall management
9. 5,000 cfs diversion 4/5 years, 15,000 cfs diversion w/ sediment enrichment 1/5 years
10. Scales of dedicated dredging from the Mississippi River (additional locations to be determined)
11. Dedicated dredge material placement near Texaco and Magnolia Canals
12. Dedicated dredging from Bayou Dupont

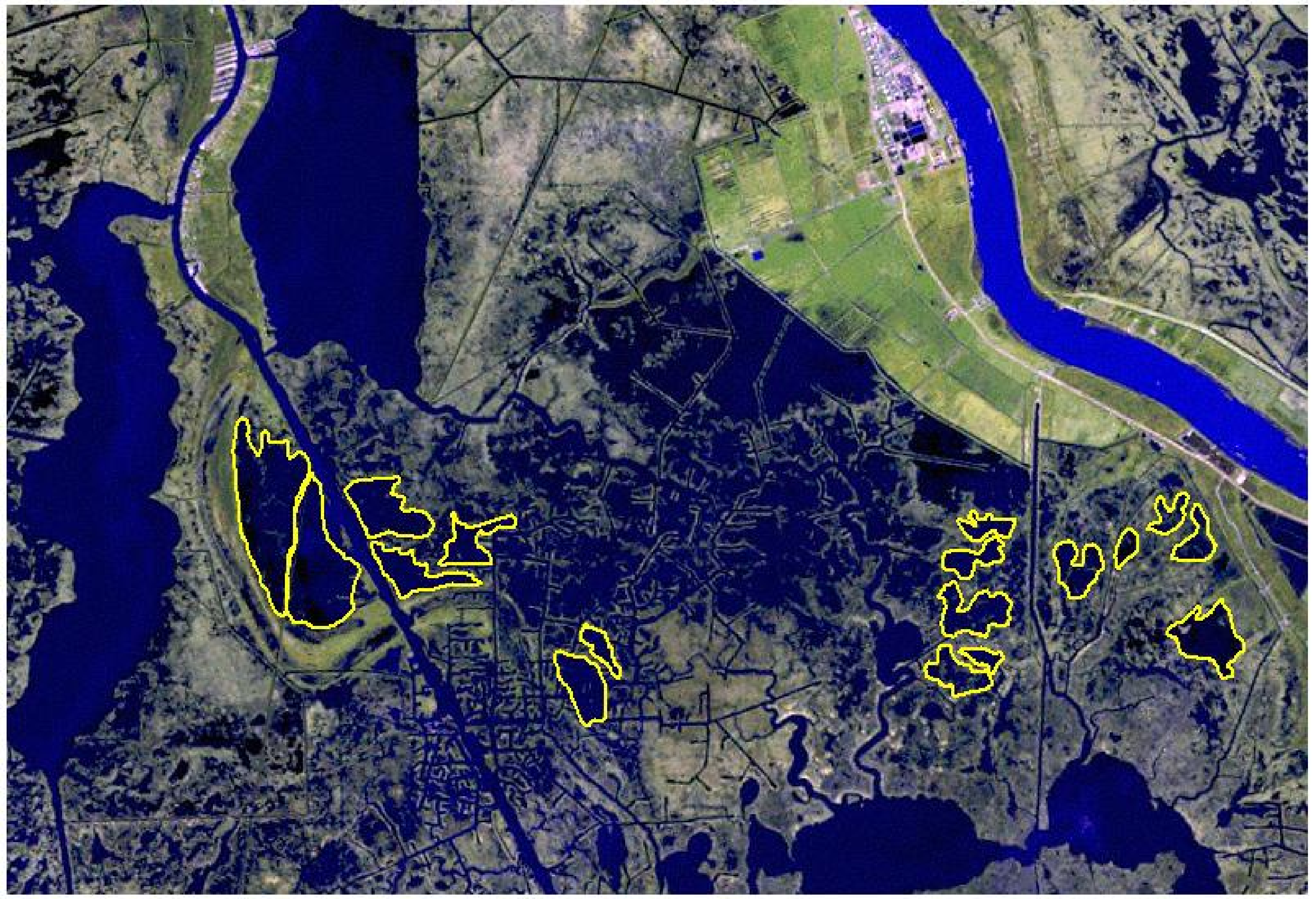
Myrtle Grove Diversion Channel Alignment



Myrtle Grove Dredge Material Placement Areas



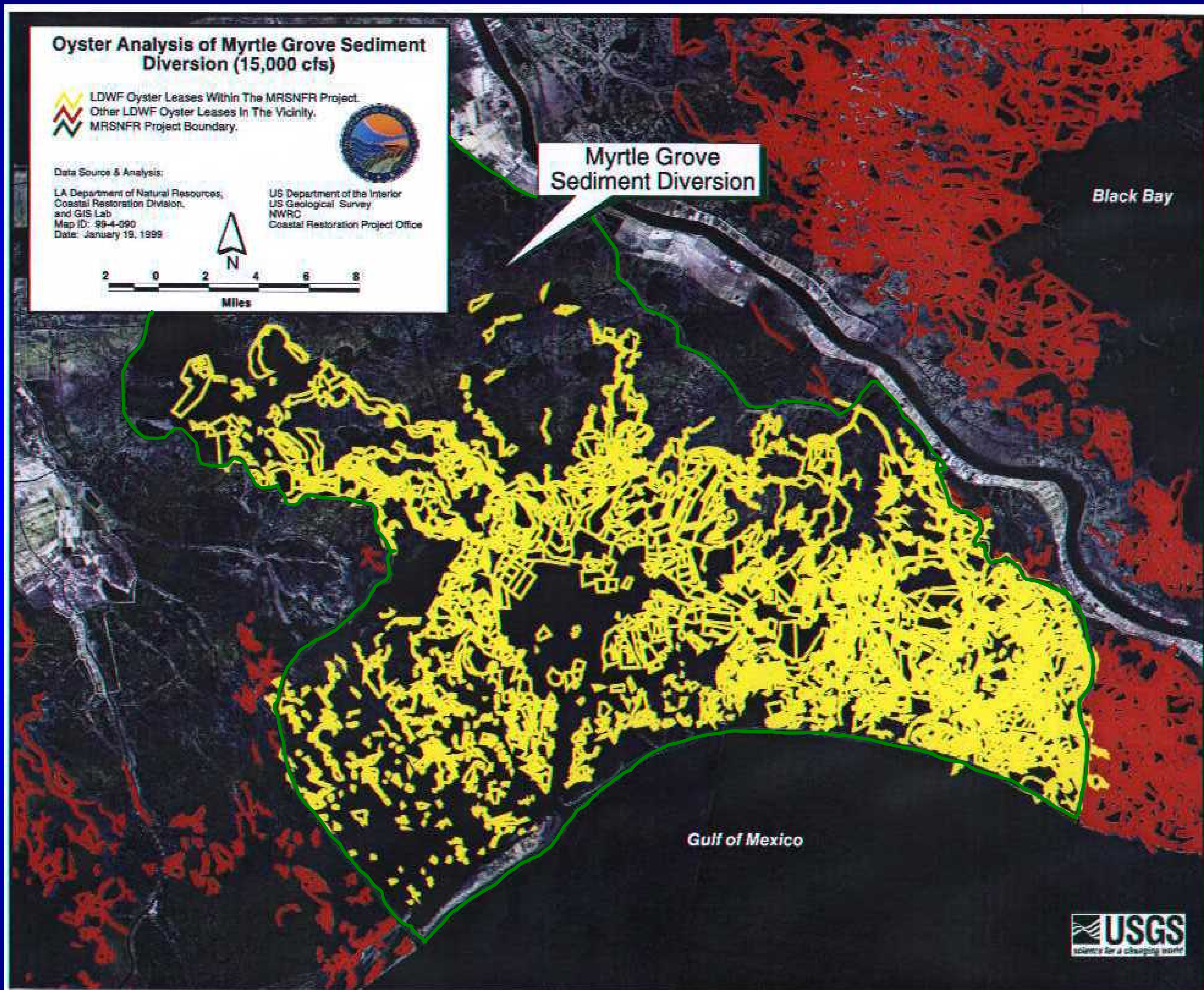
Supplemental Myrtle Grove Dredge Material Placement Areas



Purpose of Model Study

Analyze the potential impact to the region of the proposed Mississippi River diversion located near Myrtle Grove, LA.

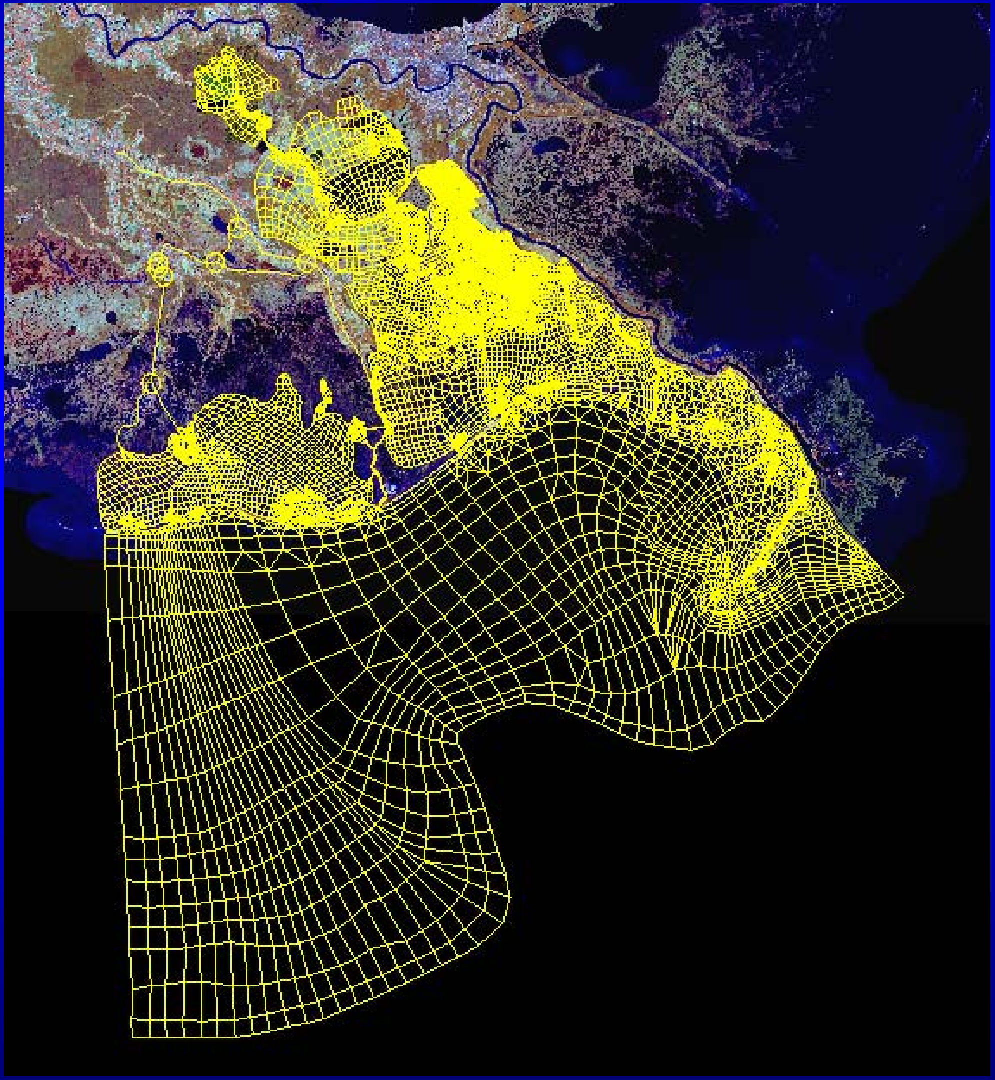
Specifically examine the seasonal impact on the salinity regime of the Barataria Basin given a diversion rate of 2,500 to 15,000 cfs.


Oyster Analysis of Myrtle Grove Sediment Diversion (15,000 cfs)
LDWF Oyster Leases Within The MRSNFR Project.
Other LDWF Oyster Leases In The Vicinity.
MRSNFR Project Boundary.
Data Source & Analysis:
LA Department of Natural Resources, Coastal Restoration Division, and GIS Lab
Map ID: 99-4-090
Date: January 19, 1999
US Department of the Interior
US Geological Survey
NWRC
Coastal Restoration Project Office
N
2 0 2 4 6 8
Miles
Myrtle Grove Sediment Diversion
Black Bay
Gulf of Mexico
USGS
science for a changing world

Modeling Approach

- Use TABS RMA-2 and RMA-4
- Year long simulation
- Average River year with corresponding boundary conditions
- 2003 Hydrologic conditions chosen for boundary conditions

Latest Generation TABS mesh



19,448 Elements
53,383 Nodes
Combination of 1-d and 2-d features

Running RMA2 on ERDC HPC supercomputer "Ruby" using 16 processors simultaneously

About 7 hour run time for a month long simulation with a 1-hour time step

SGI Origin 3000 “Ruby”

Performance Features

CPUS - 1,024 700-Mhz processors

Computational Processors - 1008

Computational Capacity – 1.434 TFLOPS

Aggregate Memory Size – 1.024 TB

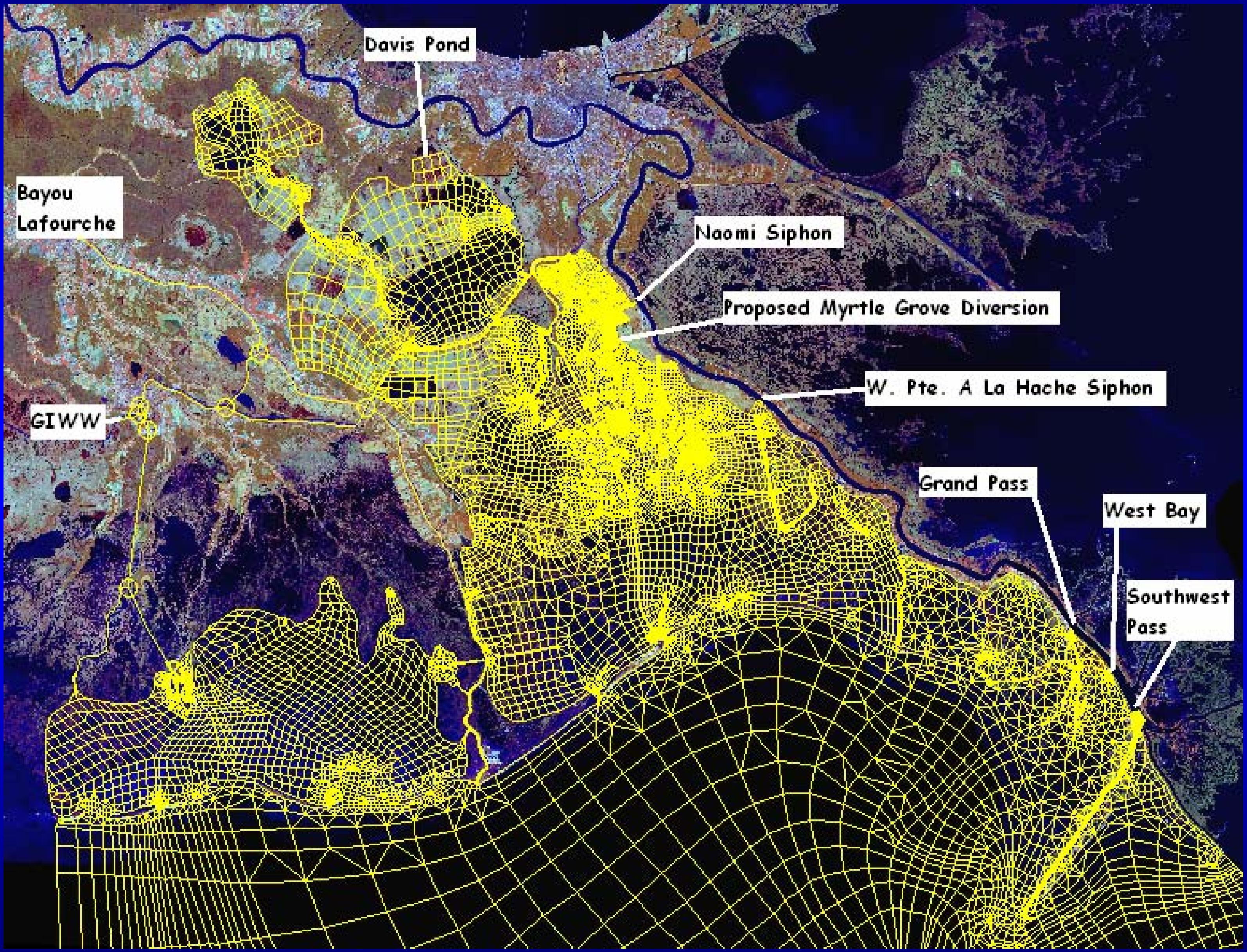
Total Disk Storage – 20 TB, Fibre Channel Raid5

Network Interface – Gigabit Ethernet

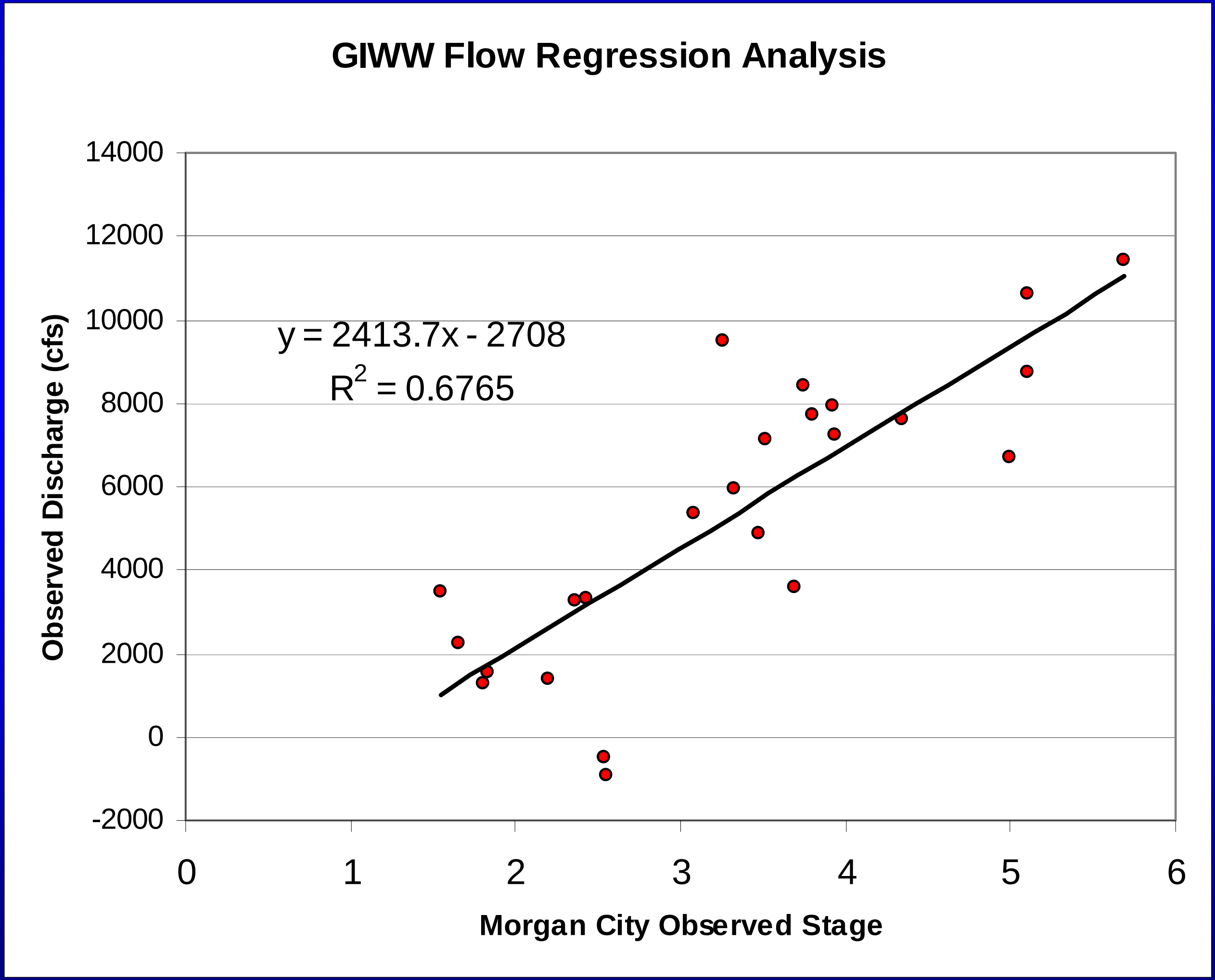
Hydrodynamic Model Boundaries

- **Nine dynamic flow boundaries**
  - **Gulf Intracoastal Waterway**
  - **Bayou Lafourche (200 cfs pump diversion)**
  - **Davis Pond (Controlled Flow)**
  - **Naomi Siphon (Controlled Flow)**
  - **West Pointe A La Hache Siphon (Controlled Flow)**
  - **Grand Pass**
  - **West Bay Diversion**
  - **Southwest Pass**
  - **Proposed Diversion at Myrtle Grove**
- **One dynamic stage boundary**
  - **Gulf of Mexico (-500 foot contour)**

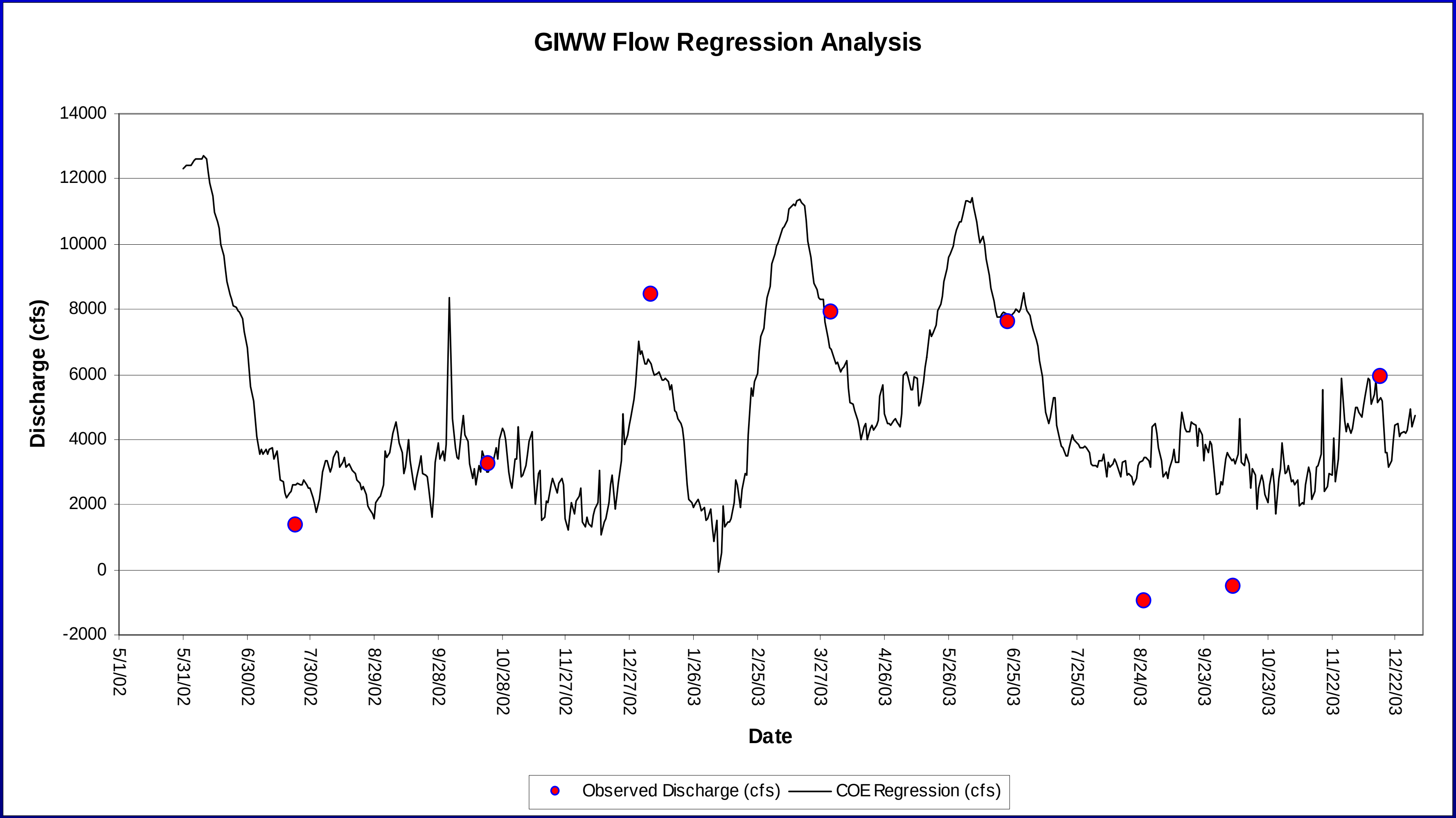
Nine Dynamic Flow Boundaries



GIWW Flow Boundary



GIWW Flow Boundary



Grand Pass Flow Boundary

	Tarbert Discharge (cfs)	Grand Pass Discharge (cfs)	% Tarbert
19-Jul-03	367438	32938	9.0%
19-Mar-03	880000	74805	8.5%
24-Jan-03	429000	47841	11.2%
2-Nov-02	337245	55480	16.5%
25-May-02	885082	77565	8.8%
1-Sep-01	204084	-7043	-3.5%
9-Mar-01	1111511	84700	7.6%
25-Aug-00	265000	31998	12.1%
4-Mar-99	775000	69196	8.9%
22-Sep-98	214000	28574	13.4%
3-Jun-98	693000	70000	10.1%
22-Mar-97	1414000	98220	6.9%
22-Feb-97	868000	74293	8.6%
20-Jul-96	403000	36334	9.0%
31-Jul-91	285000	25400	8.9%
11-Mar-90	1066000	59247	5.6%
28-Mar-89	997000	69800	7.0%
14-Mar-89	1134000	74900	6.6%
4-6 jun 84	1165667	76848	6.6%
20-May-83	1246000	61270	4.9%
9-11 jun 81	697000	44083	6.3%
16-18 oct 79	366000	27362	7.5%
		Average	**8.2%**

Southwest Pass Flow Boundary

	Tarbert Discharge	Southwest Pass Discharge	
	(cfs)	**(cfs)**	**% Tarbert**
19-Jul-03	367438	112714	30.7%
19-Mar-03	880000	241890	27.5%
24-Jan-03	429000	169138	39.4%
2-Nov-02	337245	161314	47.8%
25-May-02	885082	278202	31.4%
1-Sep-01	204084	-20250	-9.9%
9-Mar-01	1111511	371400	33.4%
25-Aug-00	265000	123692	46.7%
4-Mar-99	775000	257343	33.2%
22-Sep-98	214000	53172	24.8%
3-Jun-98	693000	234000	33.8%
22-Mar-97	1414000	387216	27.4%
22-Feb-97	868000	380035	43.8%
20-Jul-96	403000	266060	66.0%
21-Jun-96	984000	339900	34.5%
11-Mar-90	1066000	284000	26.6%
28-Mar-89	997000	195600	19.6%
4-6 jun 84	1165667	373000	32.0%
20-May-83	1246000	428000	34.3%
9-11 jun 81	697000	255735	36.7%
16-18 oct 79	366000	116812	31.9%
		Average	**32.9%**

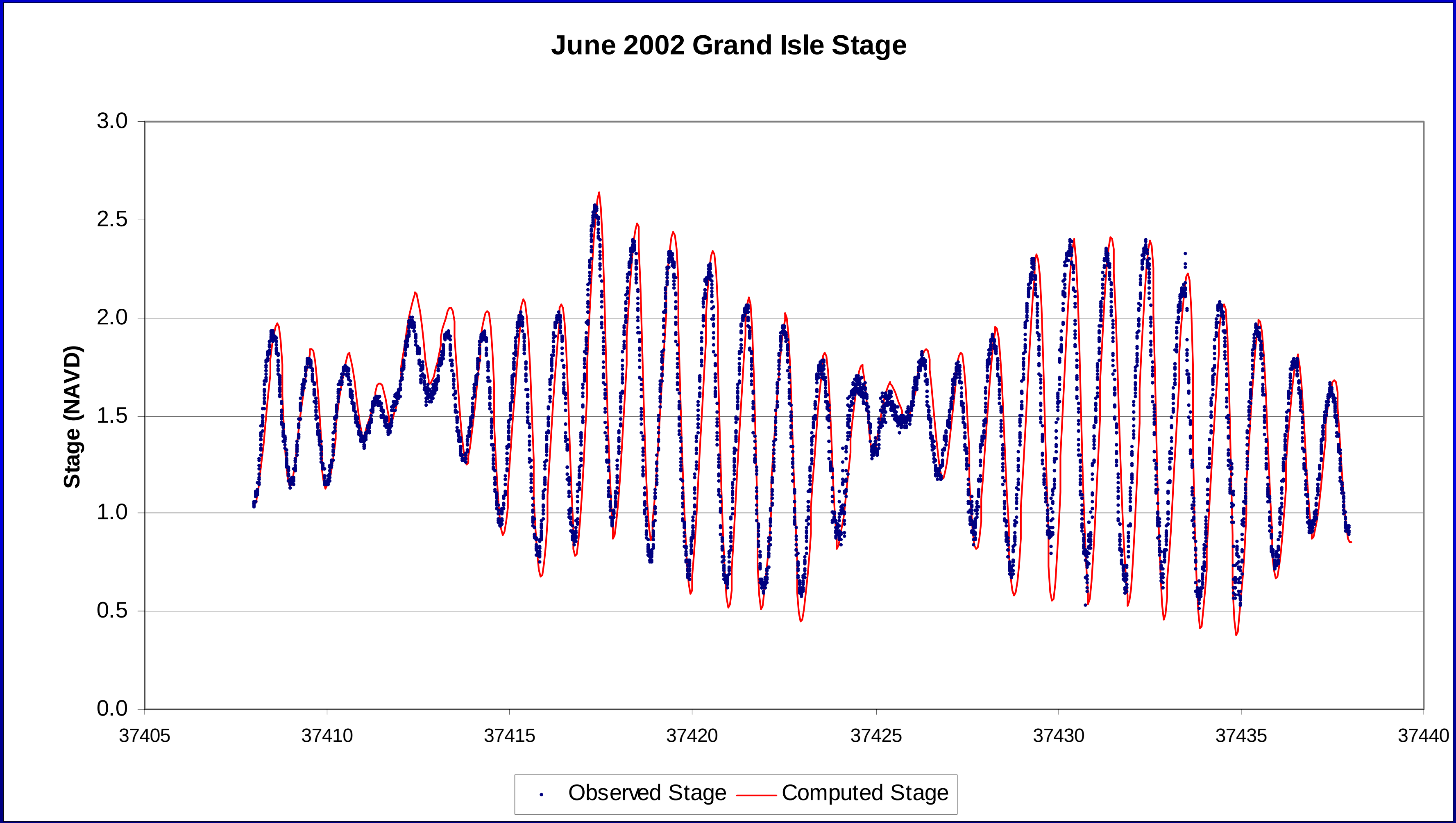
Tidal Stage Boundary

Using NOAA Tidal Gage at Grand Isle, LA.

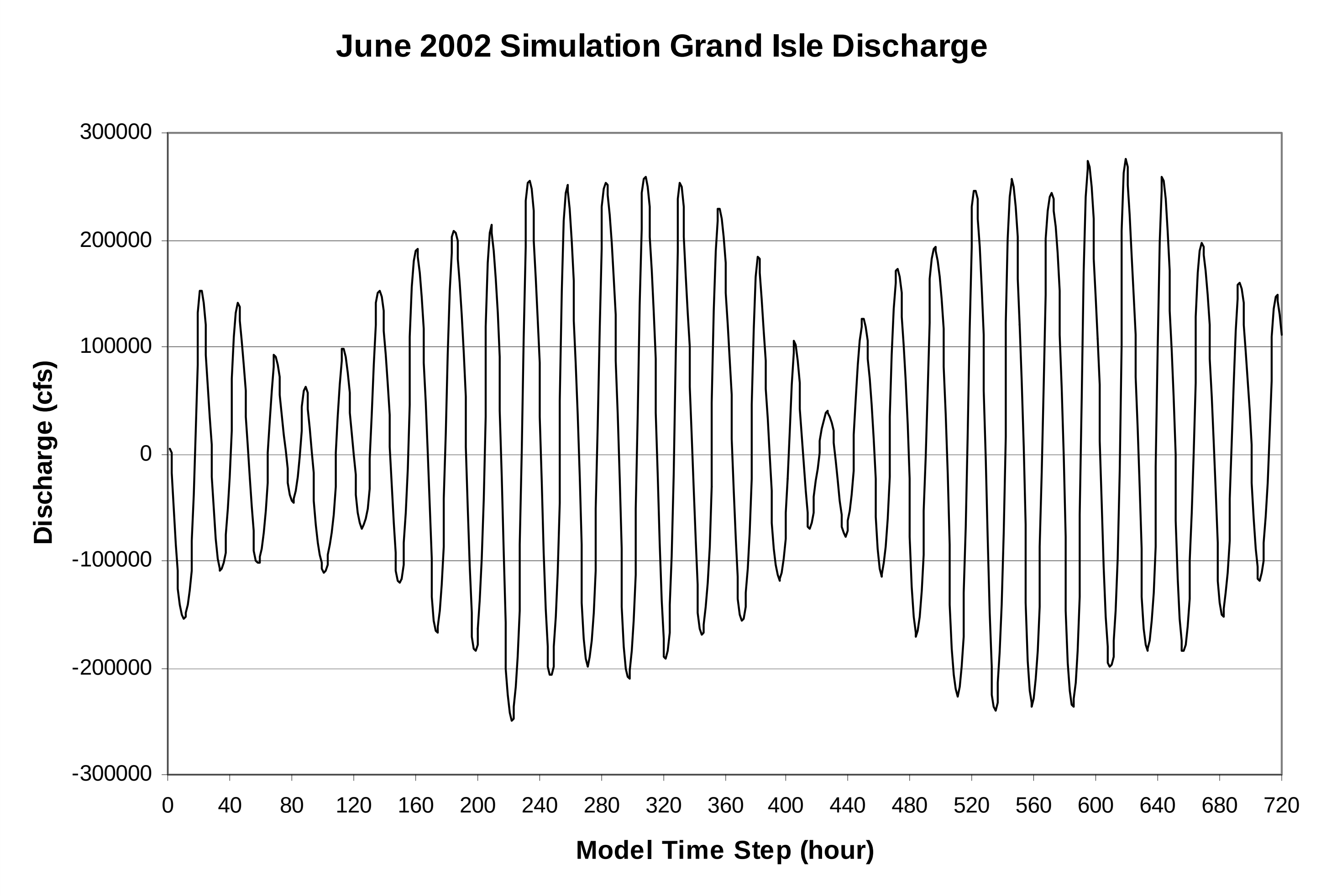
Data is amplified by a factor of 1.2 and vertically shifted by a factor of -0.25. No temporal shift is applied.

((Gage reading) x 1.2) – 0.25

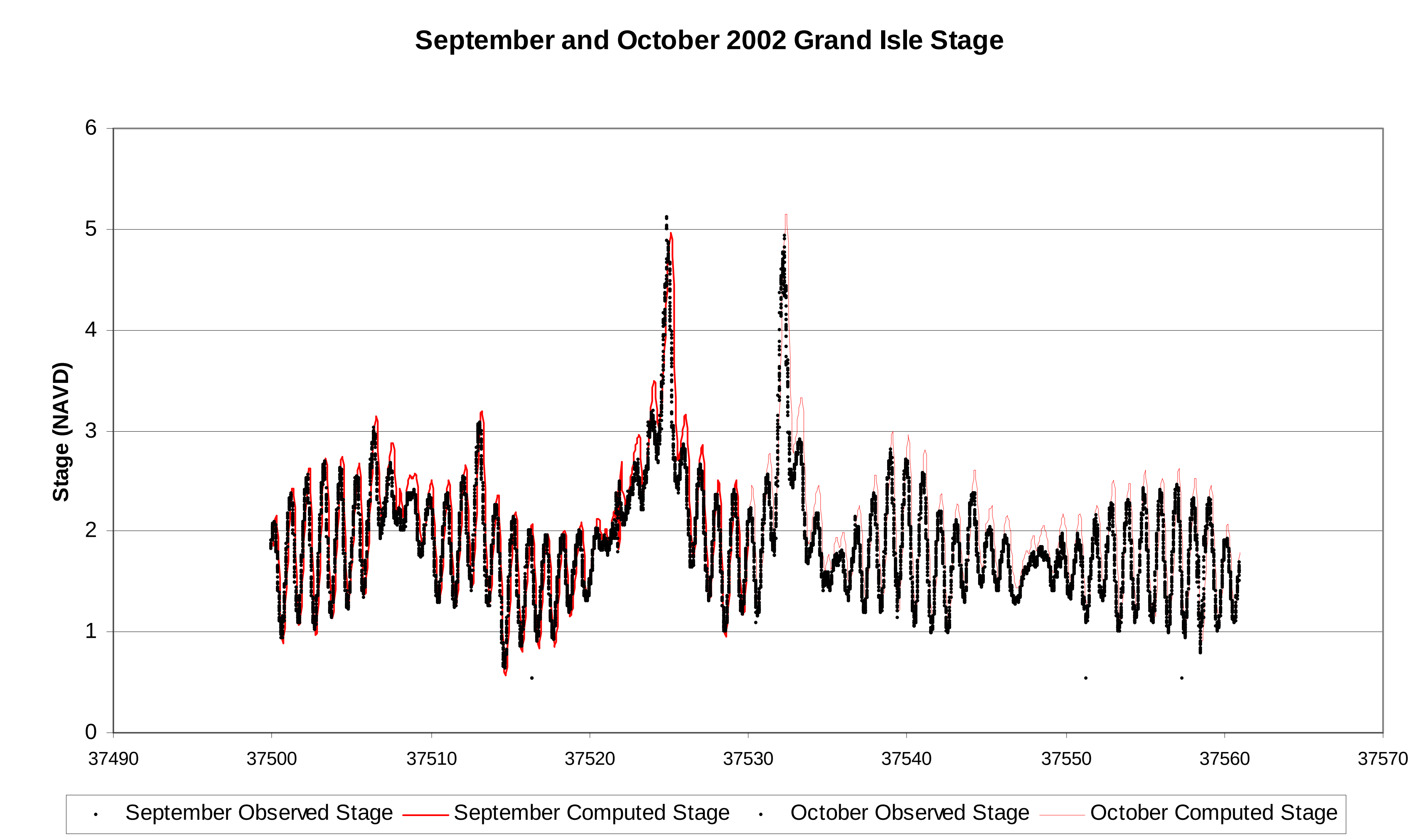
Grand Isle Model Verification



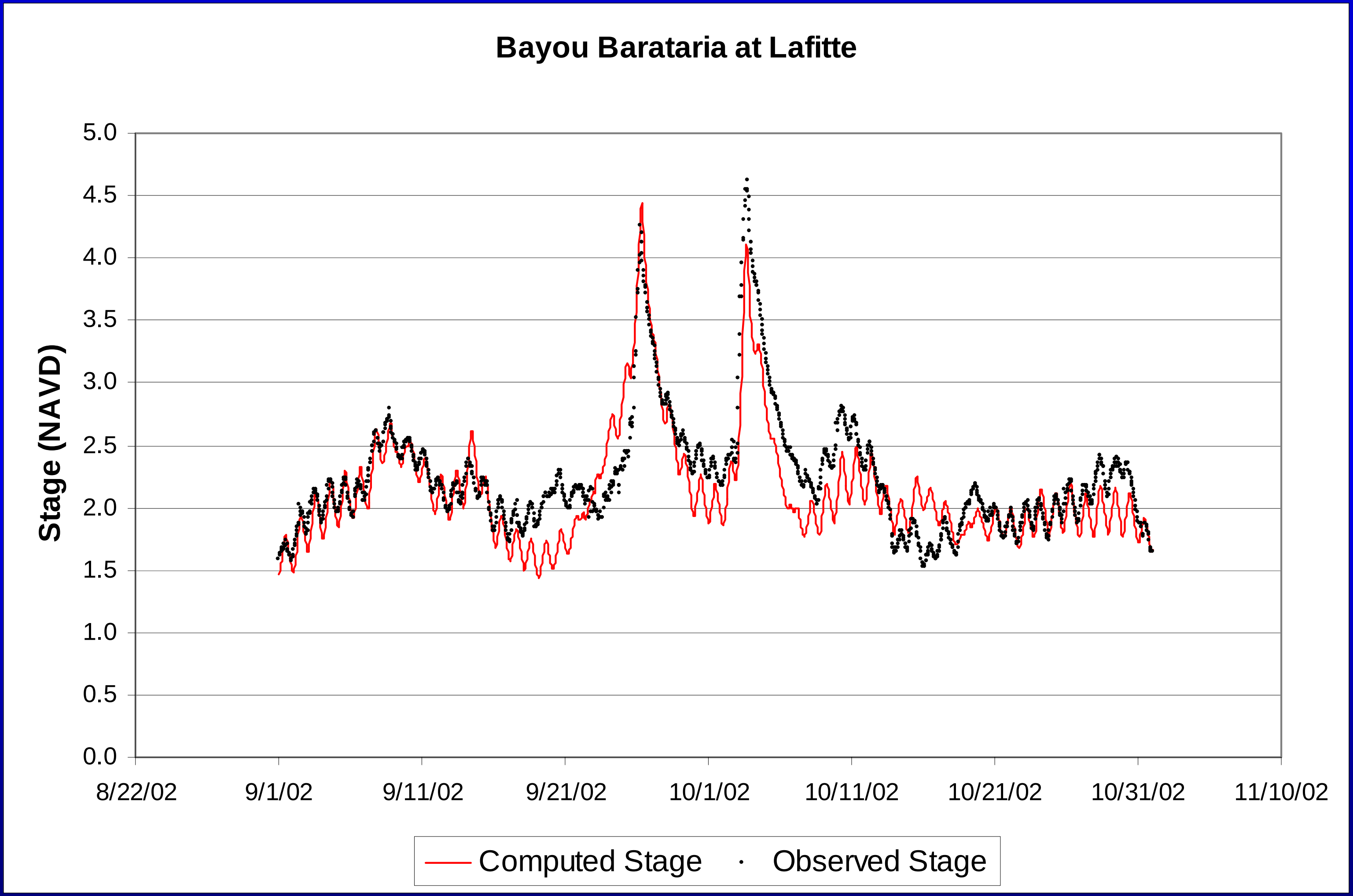
Grand Isle Computed Discharge



Grand Isle Model Verification



Bayou Barataria at Lafitte Model Verification



What’s Next?

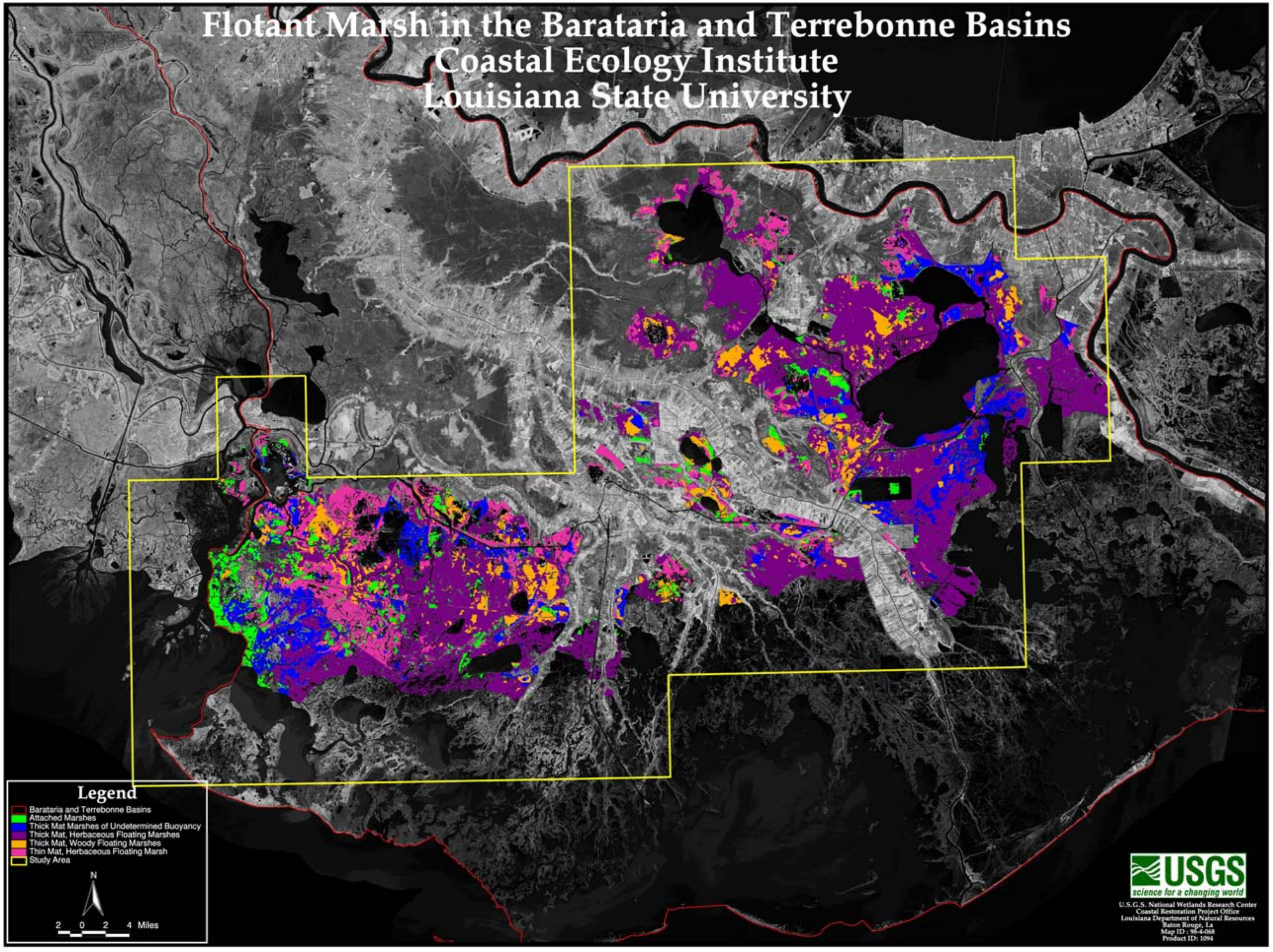
- Finalize calibration of Hydrodynamic model (RMA-2)
- Calibrate and verify for salinity levels using RMA-4
- Alternative analysis
- Refine Mississippi River contribution perhaps with additional model studies
- Look at other climatological factors such as precipitation, wind patterns, sea level rise, etc…

Davis Pond Freshwater Diversion

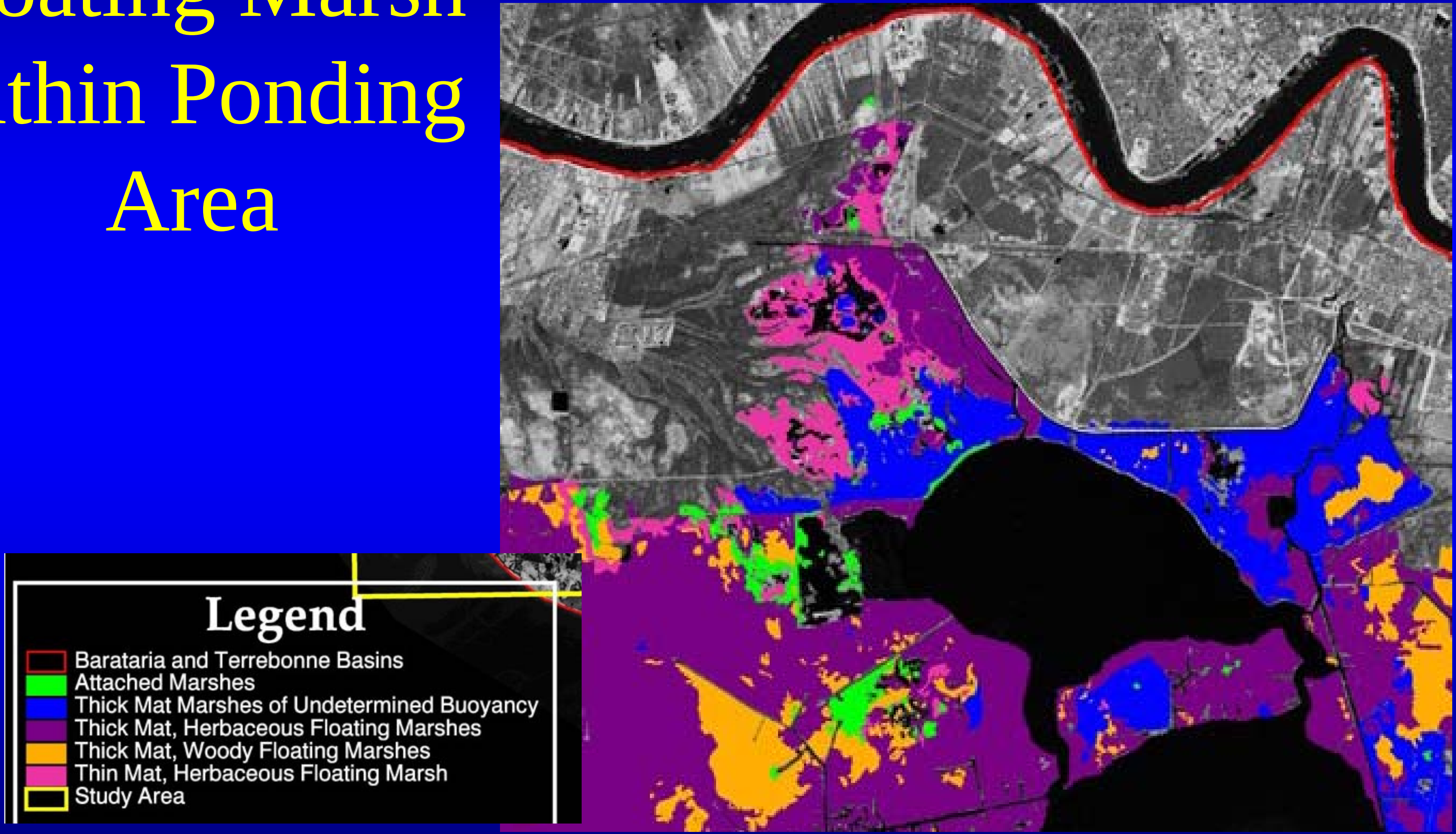
Goals of Study

- Evaluate the performance of 9,390 acre ponding area to evacuate 10,650 cfs capacity diversion
- Test alternatives to achieve flow profiles that remain within the guide levees (3.6 to 6.6 ft NAVD88)

Test Diversion


Flotant Marsh in the Barataria and Terrebonne Basins
Coastal Ecology Institute
Louisiana State University
Legend
Barataria and Terrebonne Basins
Attached Marshes
Thick Mat Marshes of Undetermined Buoyancy
Thick Mat, Herbaceous Floating Marshes
Thick Mat, Woody Floating Marshes
Thin Mat, Herbaceous Floating Marsh
Study Area
N
2 0 2 4 Miles
USGS
science for a changing world
U.S.G.S. National Wetlands Research Center
Coastal Restoration Project Office
Louisiana Department of Natural Resources
Baton Rouge, La
Map ID : 98-4-068
Product ID: 1094

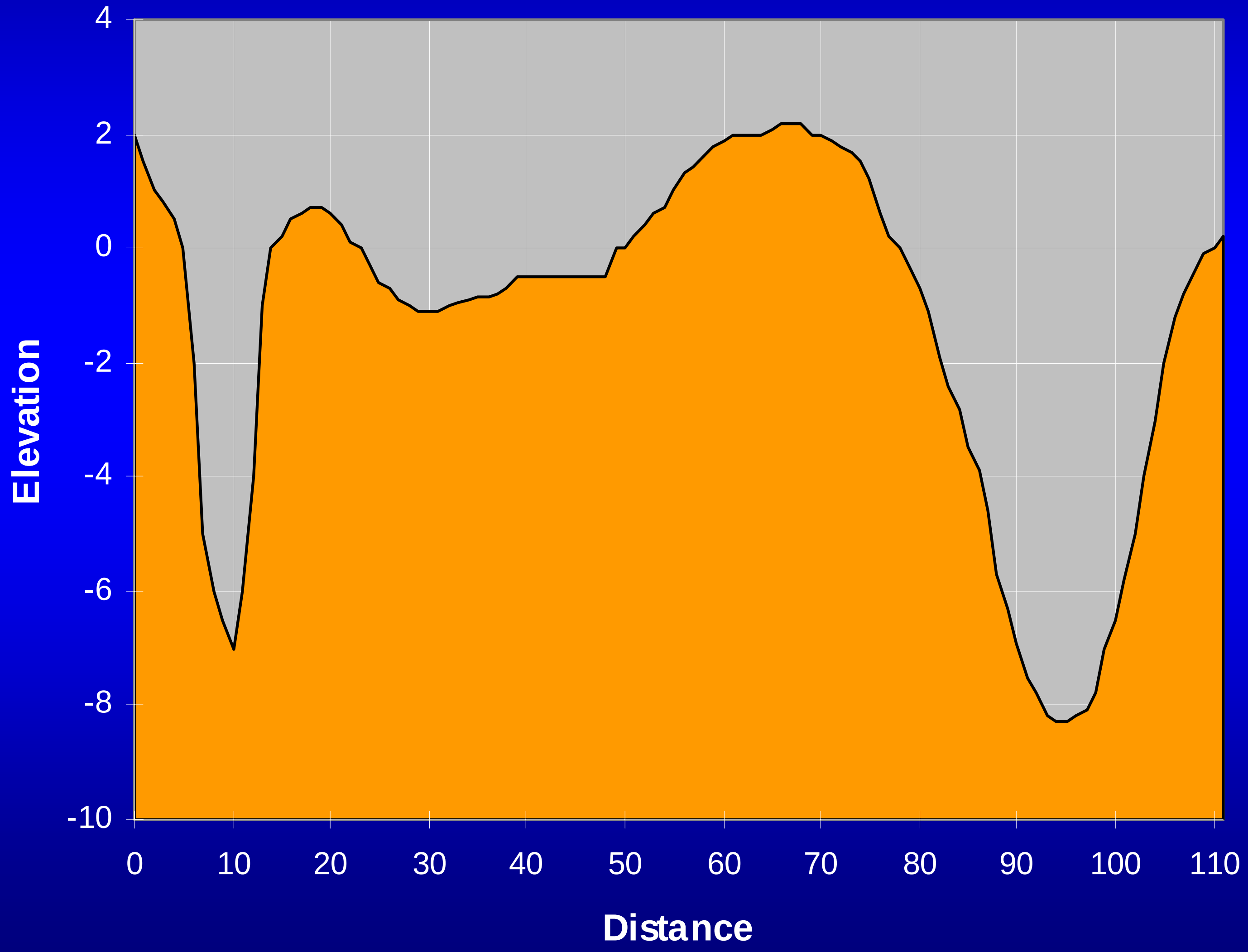
Floating Marsh within Ponding Area



RMA2 Marsh Porosity

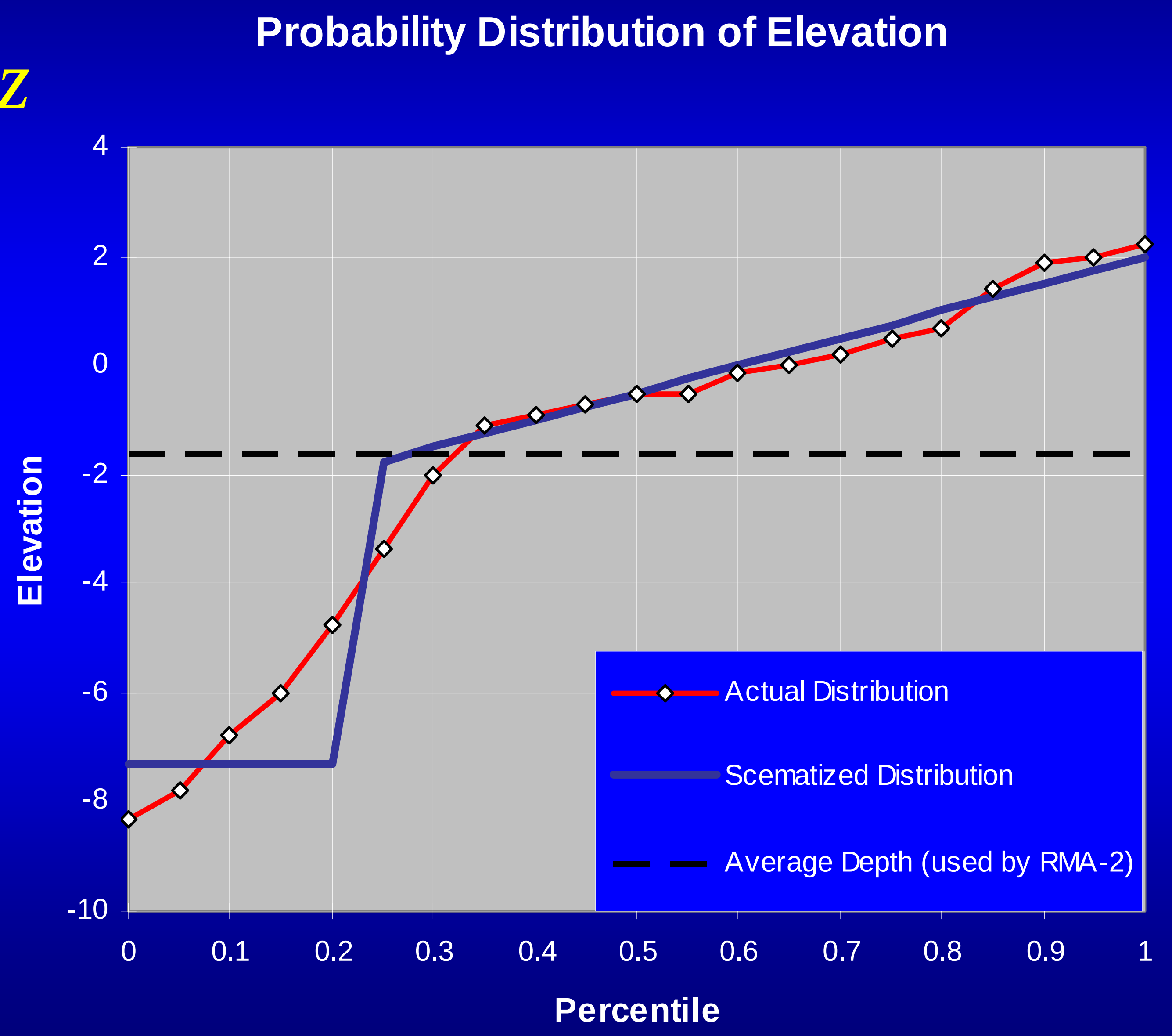
- Technique for handling complex topography/bathymetry as a sub-scale statistical variation
- Used to estimate the effects of floating marsh

Example Wetland to be Handled with Marsh Porosity

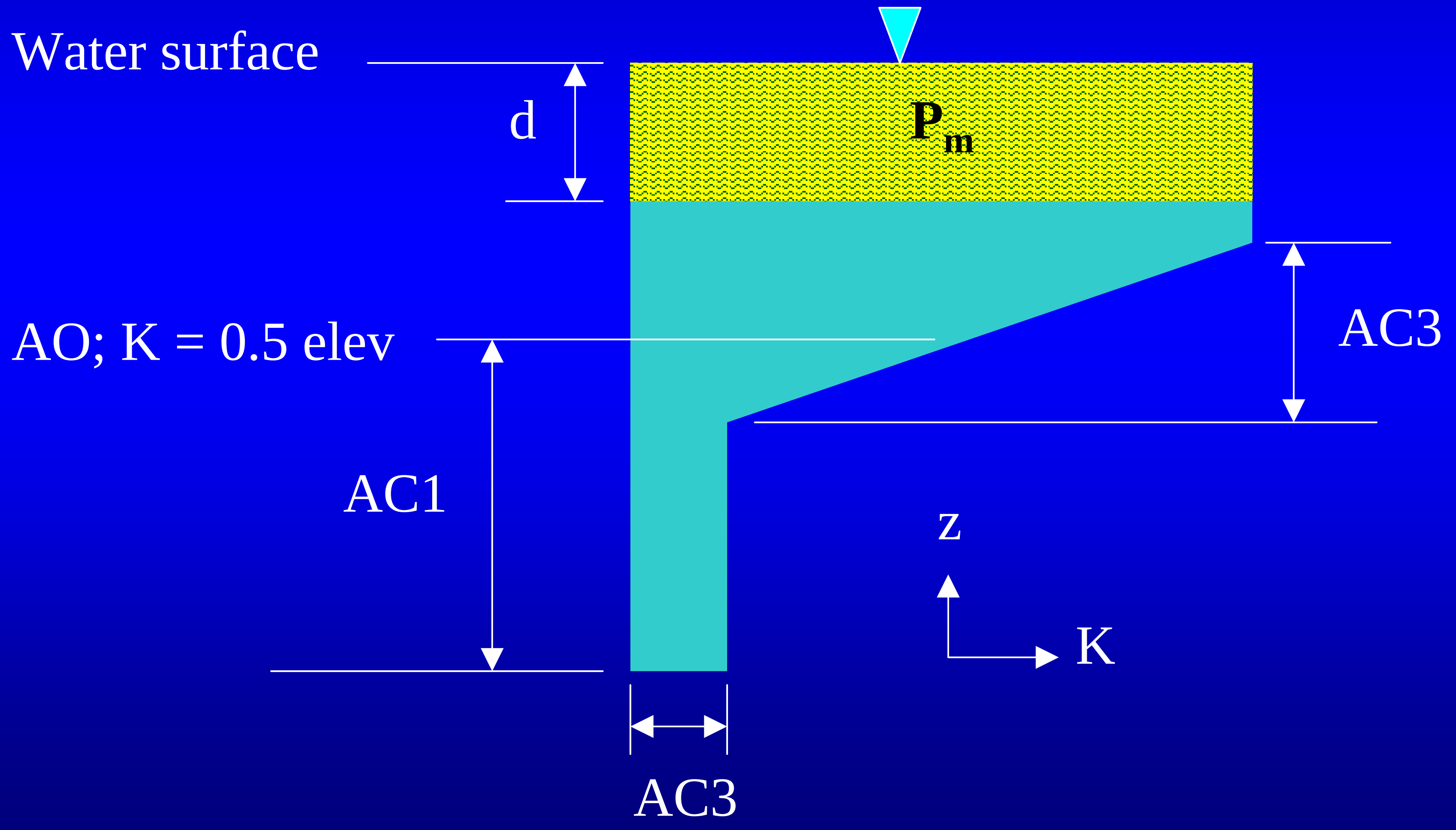


Effective Depth

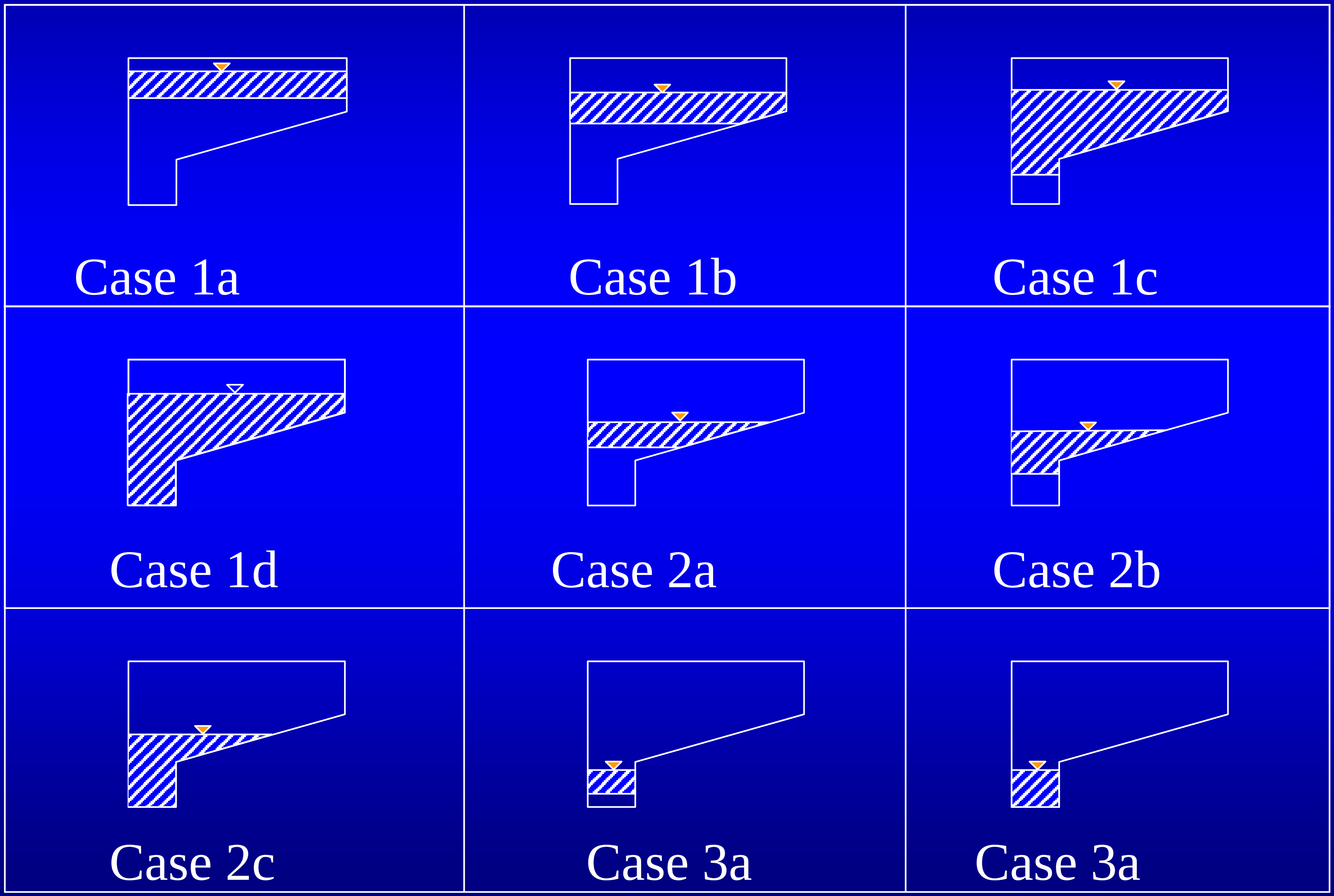
$$h_\sigma = \int_0^h K dz$$



Marsh Porosity with Floating Marsh



Marsh Porosity with Floating Marsh



Adjustmesnts for Floating Marsh

Conventional marsh porosity

$$h_\sigma = \int_0^h K\,dz = \int_0^{z_{bot}} AC3\,dz + \int_{z_{bot}}^{z_{top}} \left[AC3 + \frac{(1-AC3)(z-z_{bot})}{AC2} \right] dz + \int_{z_{top}}^{h} dz$$

$$= h - \frac{(1-AC3)\left(z_{top}+z_{bot}\right)}{2}$$

Effects of floating marsh (d=submerged marsh depth, P_m = porosity of marsh

$$h_\sigma = \int_0^h K dz = \int_0^{h-d} AC3\;dz + \int_{h-d}^{z_{bot}} AC3\;P_m\;dz +$$

$$+ \int_{z_{bot}}^{z_{top}} P_m \left\{ AC3 + \frac{(1-AC3)}{AC2}\left(z - z_{bot}\right) \right\} dz + \int_{z_{top}}^{h} P_m dz$$

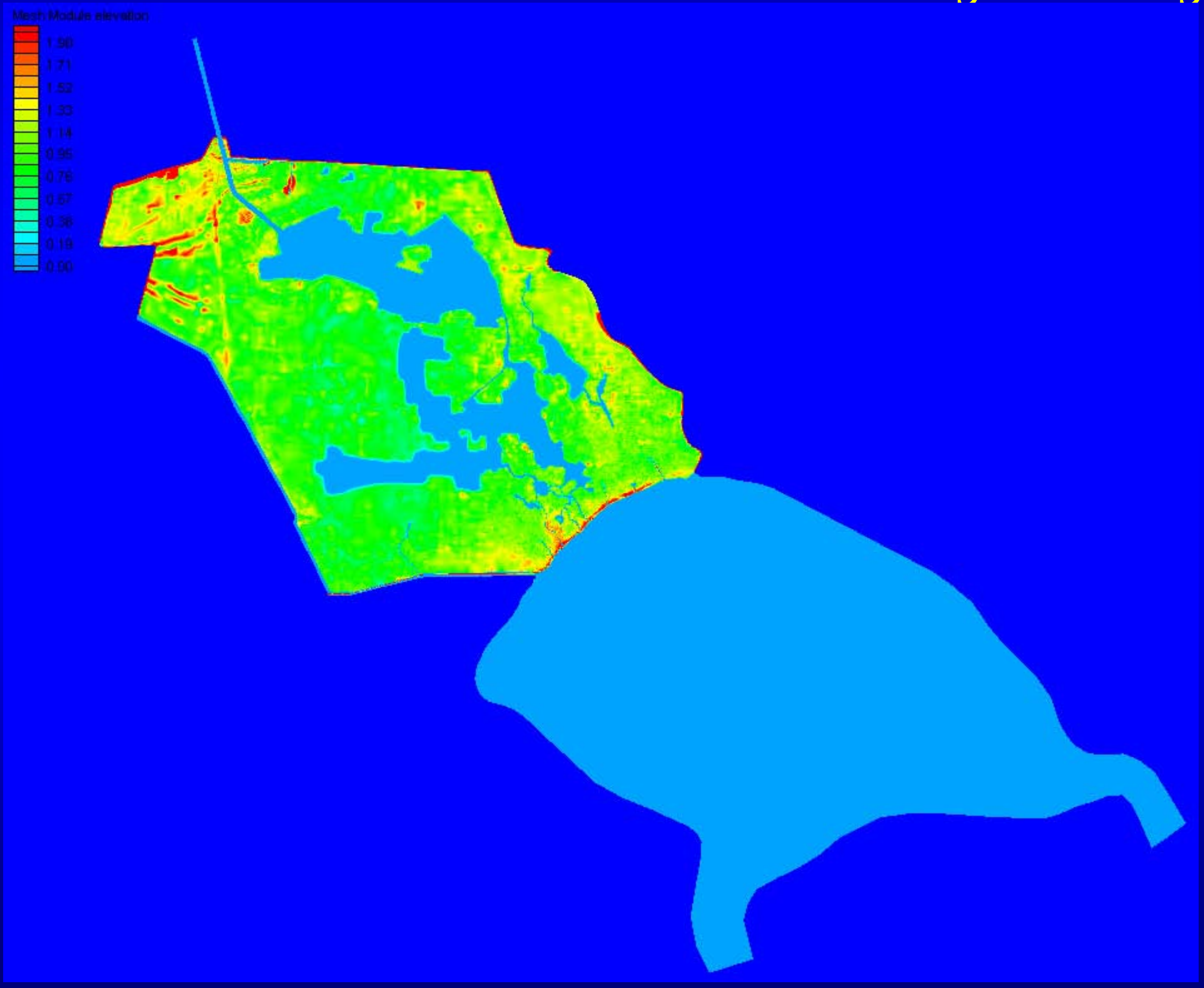
$$= AC3\left[\left(1-P_m\right)\left(h-d\right) + P_m z_{top}\right] + P_m \left\{ \frac{\left(1-AC3\right)AC2}{2} + h - z_{top} \right\}$$

Friction Formulation

- Depth dependence in two modes

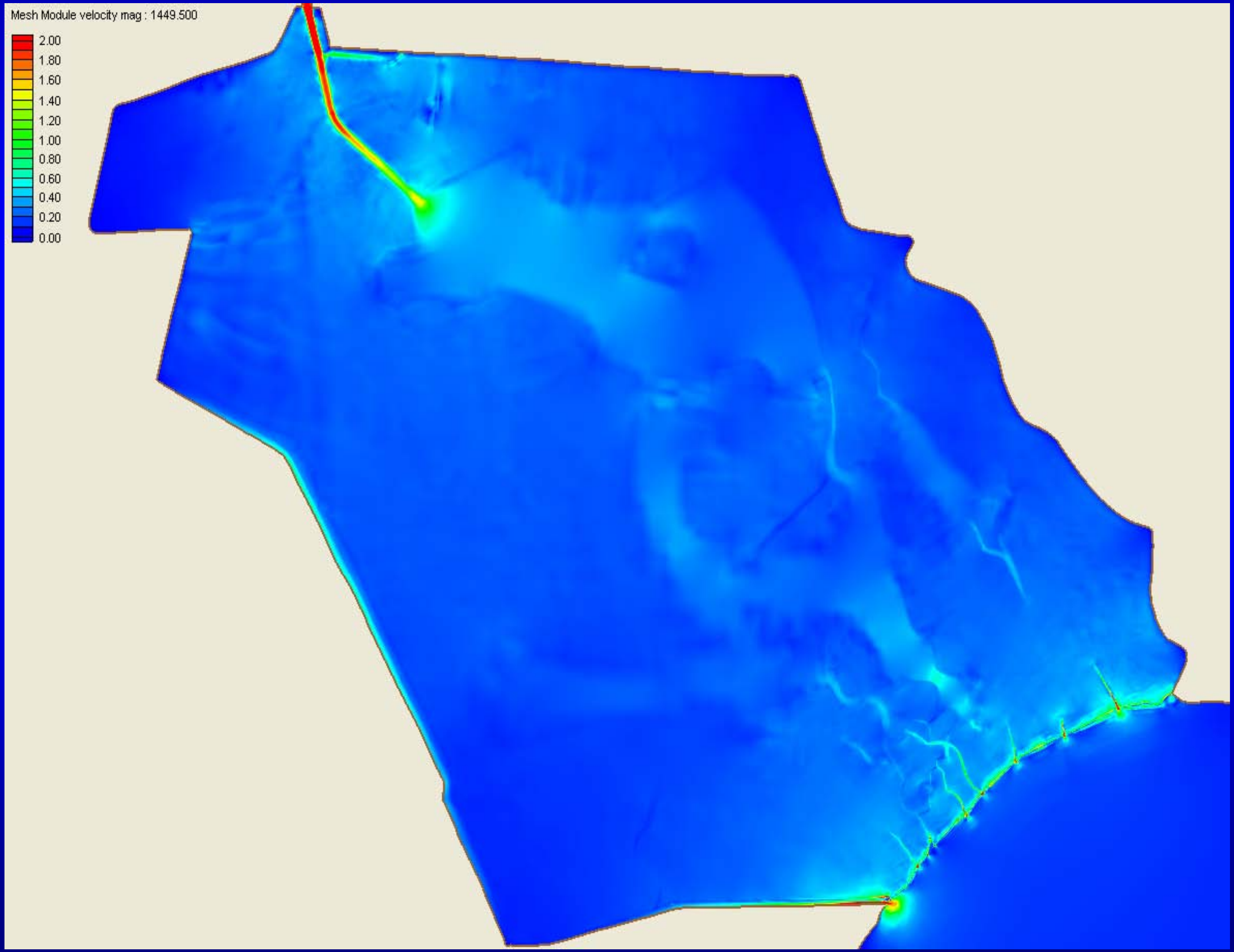
$$n = \frac{n_0}{d^{\alpha}} + n_v e^{-d/d_0}$$

Davis Pond Freshwater Diversion Model Domain and Bathymetry

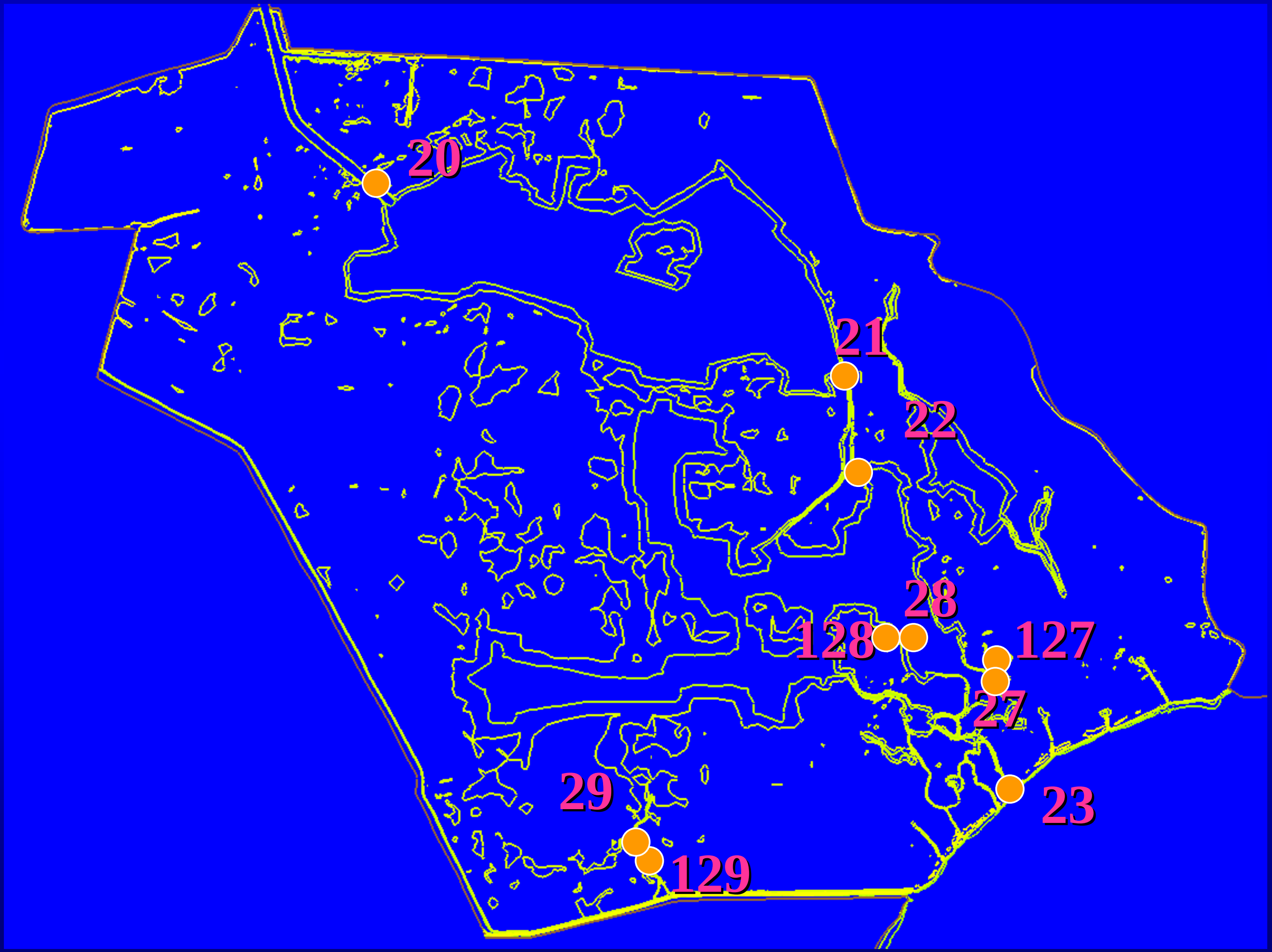


Davis Pond Diversion

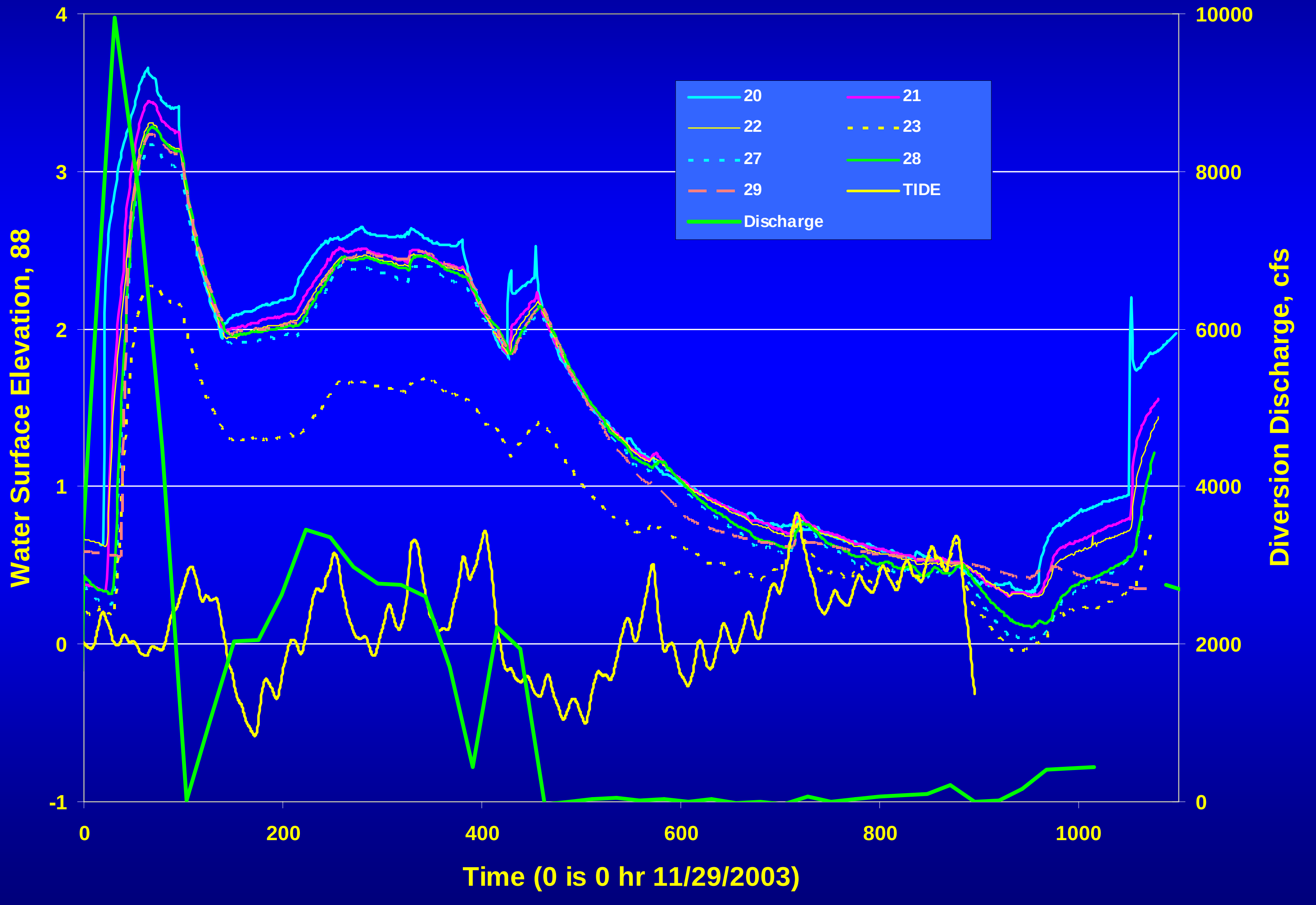
Current
Velocity
Magnitude



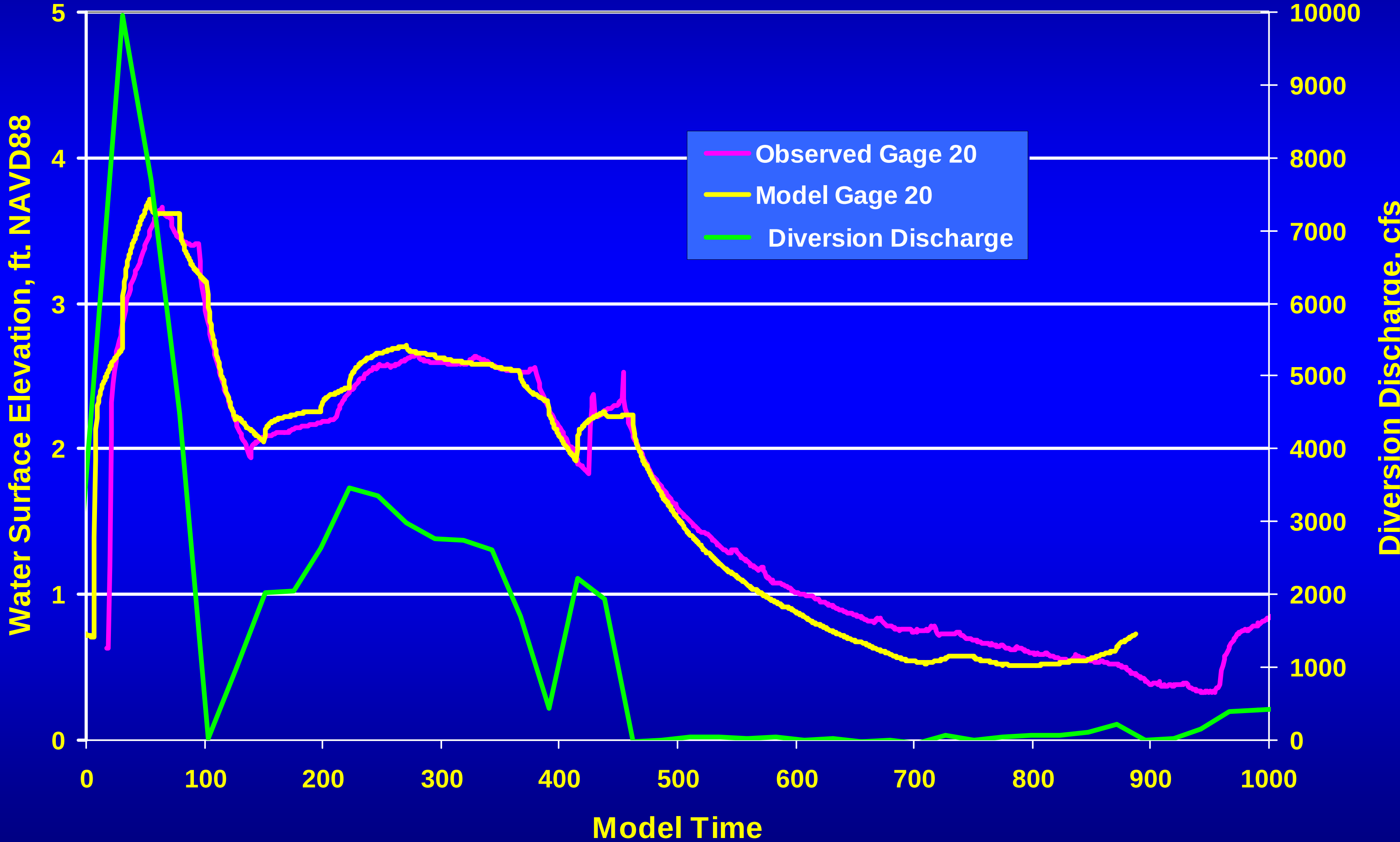
Filed Observation Stations



Observed Water Level Data

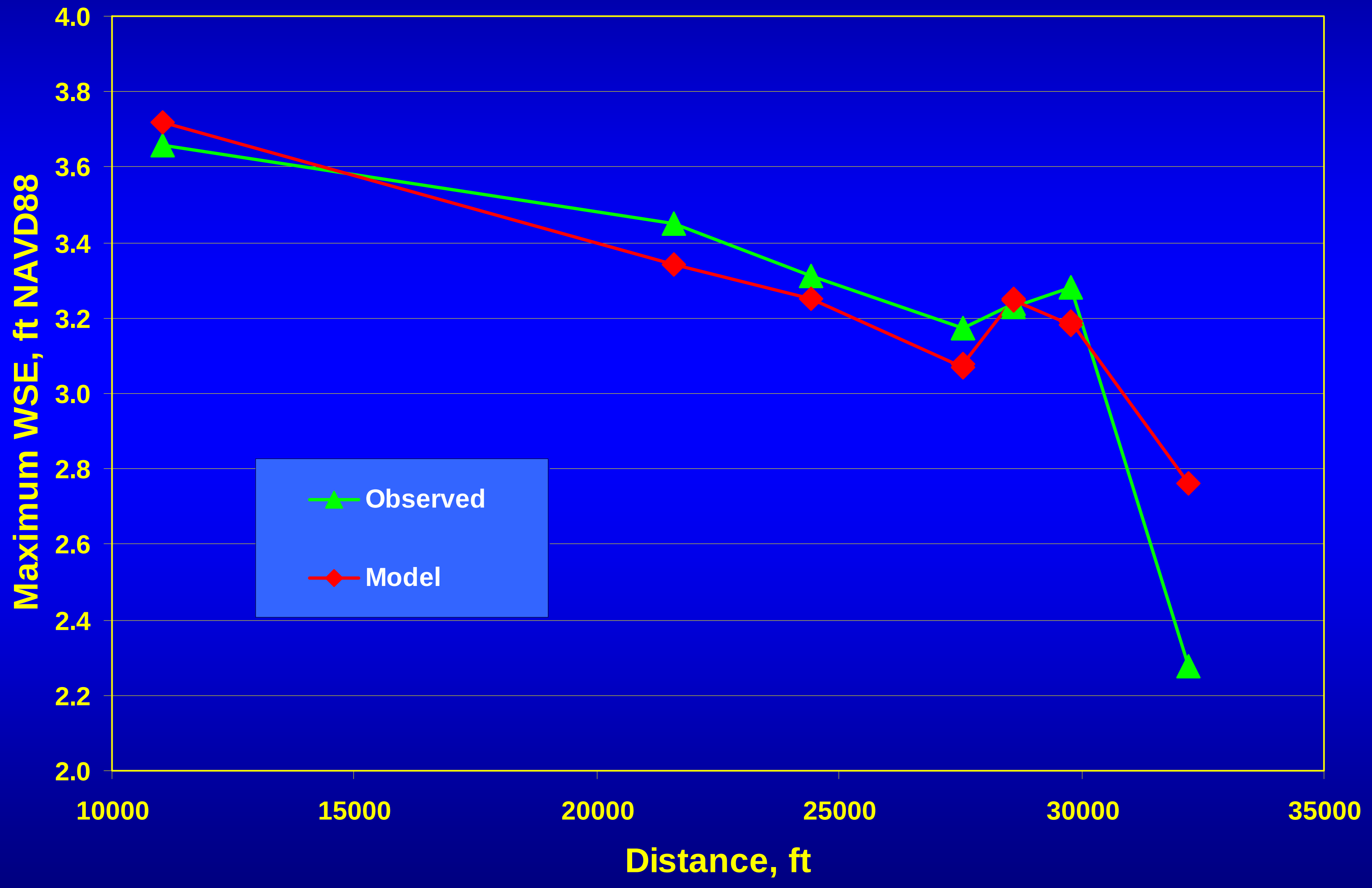


Model Verification at Gage 20

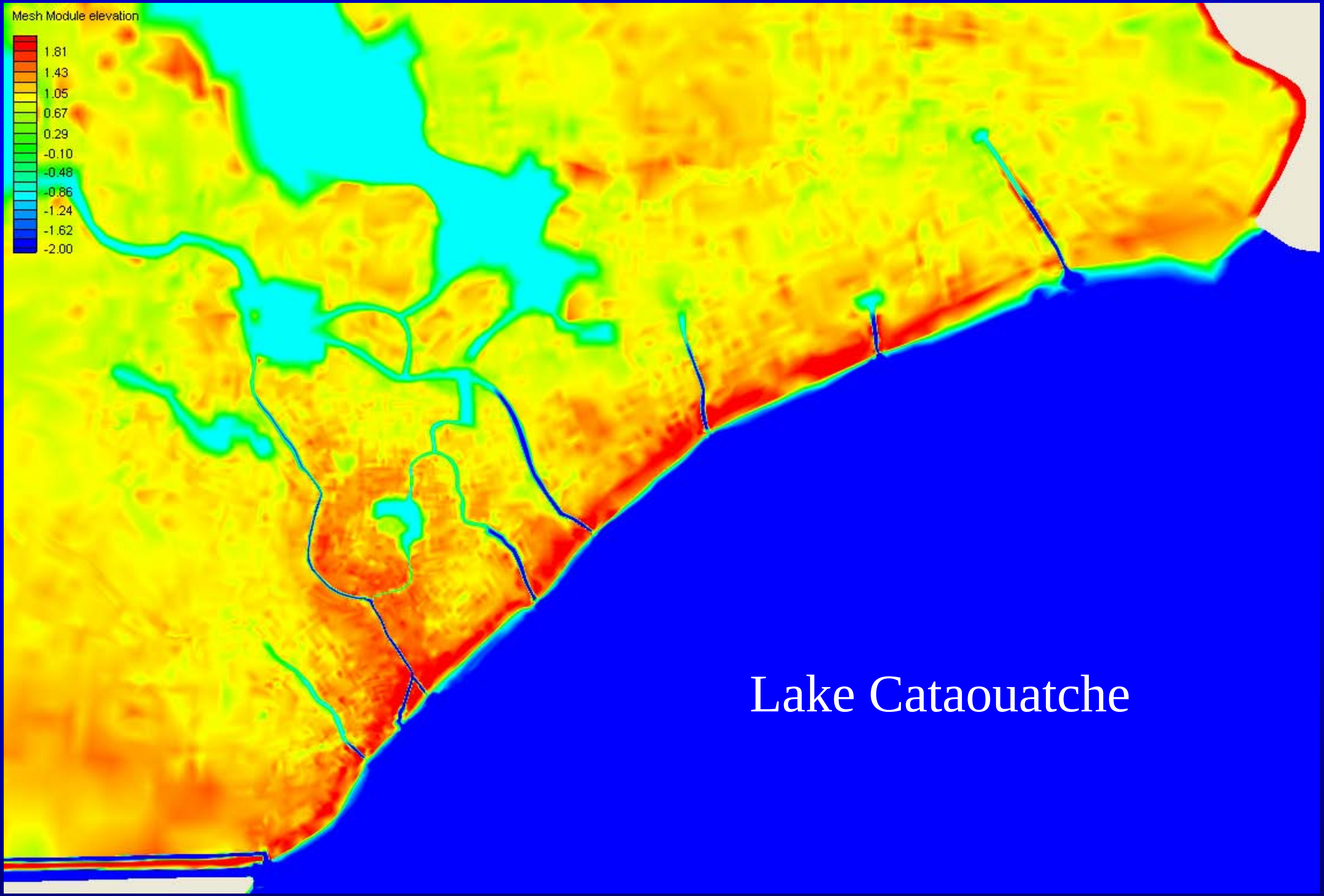


Model Verification at Gage 23

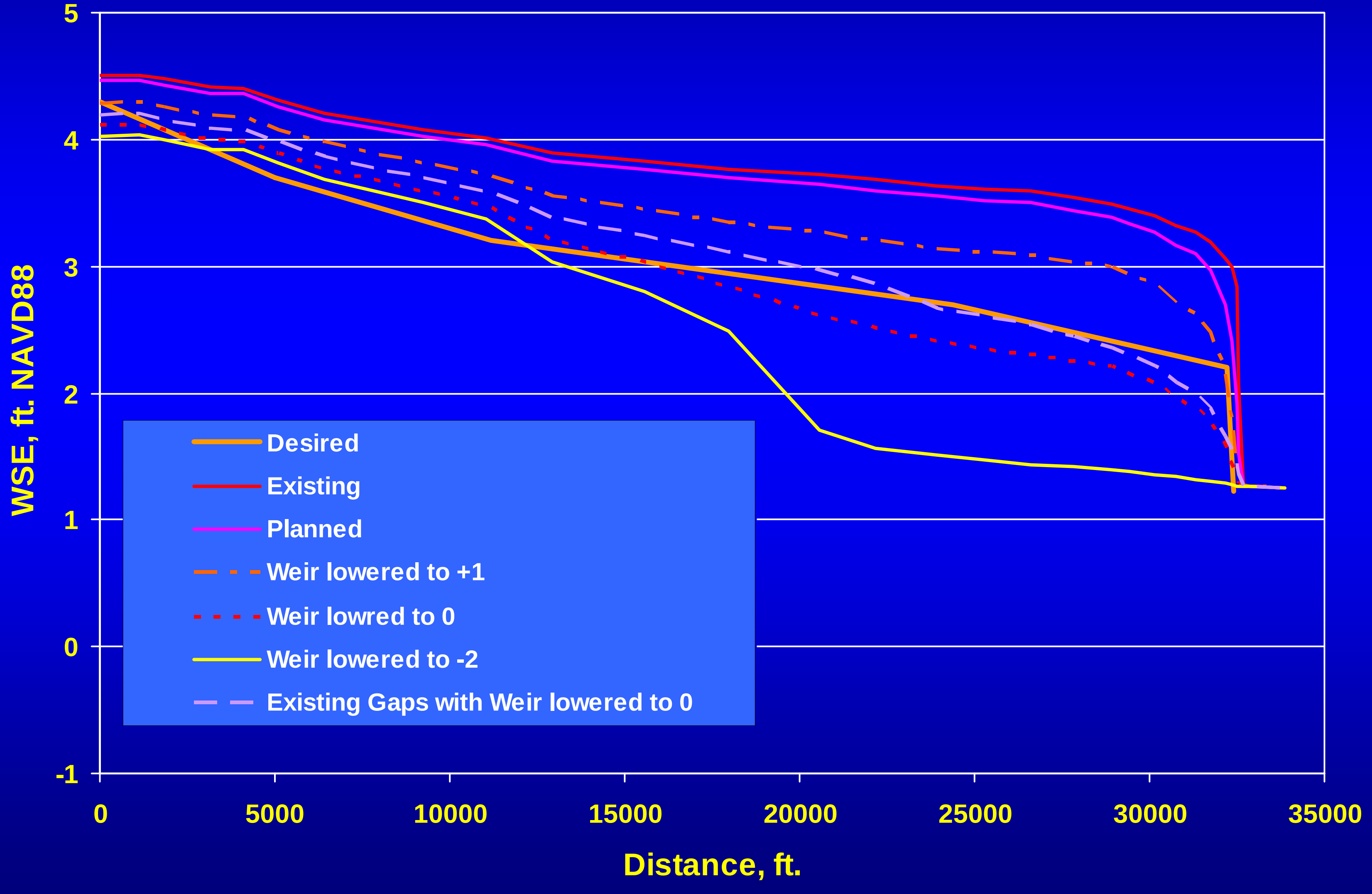
Verification of Peak Profile



Existing Topography at Weir



Evaluation of Alternatives



Conclusions

- To pass the design flow may require significant excavation along the weir
- Floating vegetative marsh can be addressed dynamically and implicitly with marsh porosity and a frictional formulation as a function of flow depth
- Complex geometric/hydrodynamic problems need spatial flexibility in velocity distributions to properly distribute energy losses