



Coastal Protection and
Restoration Authority of Louisiana

System Wide Assessment and Monitoring Water Quality

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Coastal Protection and Restoration Authority

7/31/2017

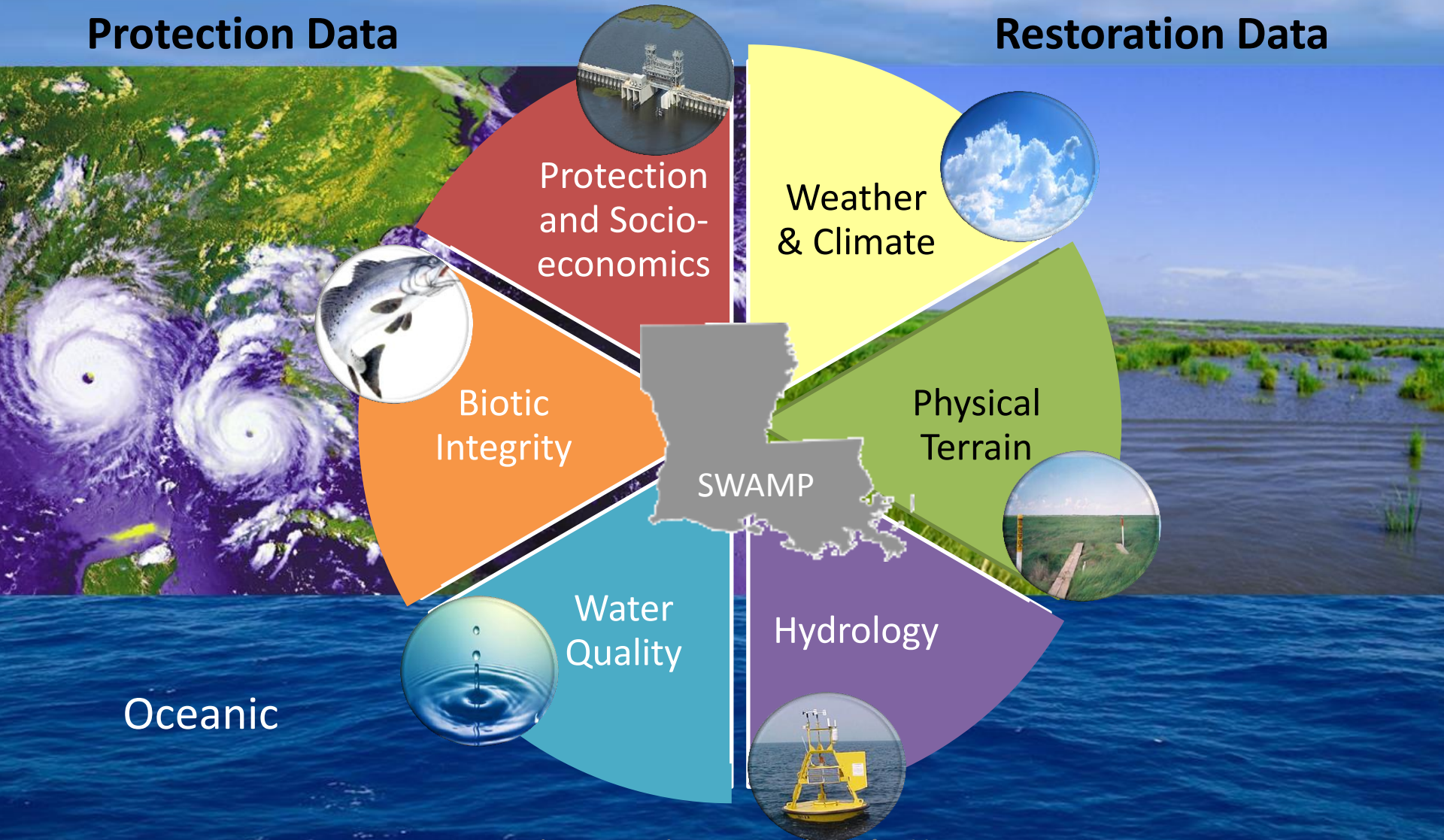


System-Wide Assessment and Monitoring Program

Atmospheric

Protection Data

Restoration Data



Oceanic

Where We Started

- Coastwide Reference Monitoring System (CRMS) (*2005-present*)
- Barrier Island Comprehensive Monitoring Program (BICM) (*2006-present*)
- Other agencies & entities...



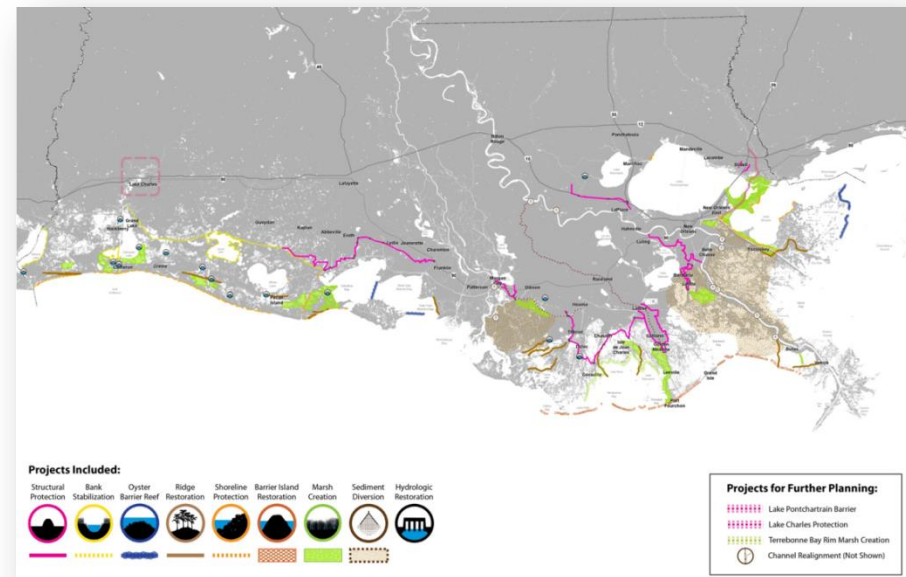
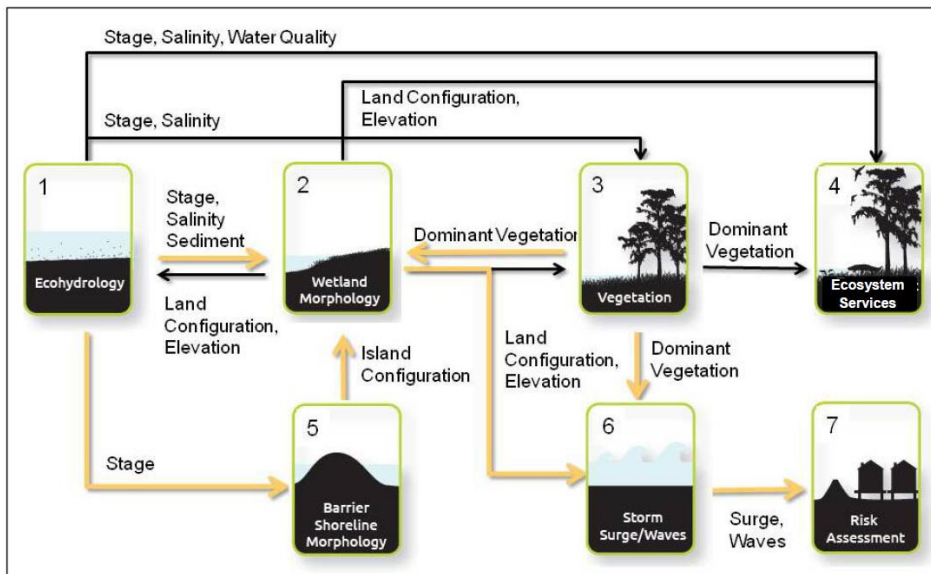
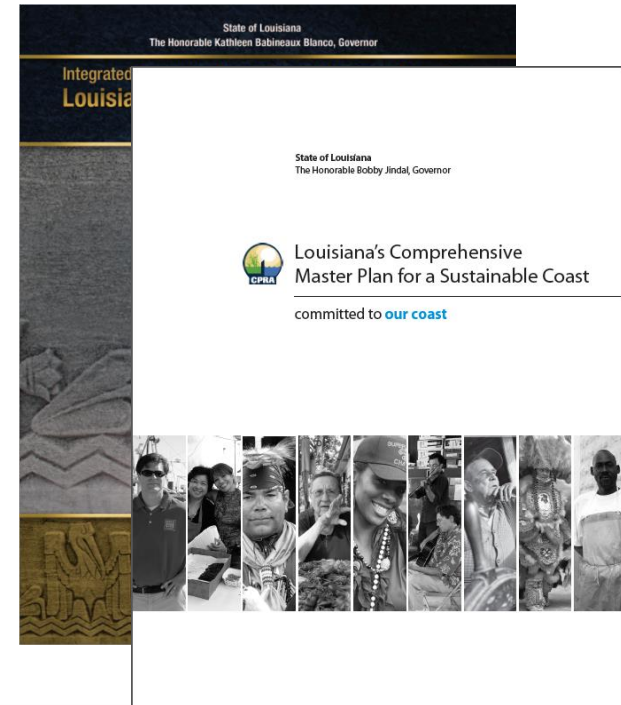
Office of Coast Survey

Louisiana Barrier Island Comprehensive Monitoring (BICM) Program Summary Report: Data and Analyses 2006 through 2010



Changing Data Needs

- Support Master Plan tools
- Resolve Uncertainties
- Actively and adaptively manage projects and programs
- Evaluate effectiveness of projects and collective effects
- Evaluate socio-economics
- Evaluate risk reduction



System-Wide Assessment and Monitoring Program (SWAMP)

- Vision is for integrated protection and restoration monitoring (*cutting edge and robust*)
- Data network will support Master Plan models, program performance metrics (*measure success/change in human and natural systems*)
- Include opportunities for leveraging and partnership among a variety of agencies (*building on existing monitoring programs*)

SWAMP Development: Data Categories

Natural System	Human System
Weather and Climate	Population & Demographics
Biotic Integrity	Housing & Community Characteristics
Water Quality	Economy & Employment
Hydrology	Ecosystem Dependency
Physical Terrain	Residential Properties Protection
	Critical Infrastructure & Essential Services Protection

SWAMP Natural System

Barataria Pilot

- **Biotic Integrity**
 - Nekton community composition
 - Oyster biomass
 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition
- **Water Quality**
 - Chlorophyll *a*
 - Dissolved Oxygen
 - Nutrient constituents (N, P, Silica)
 - Salinity
 - Turbidity
 - Suspended sediment concentration
- **Weather and Climate**
 - Potential Evapotranspiration
 - Precipitation
 - Wind
- **Hydrology**
 - Current velocity
 - Water level
 - Waves
- **Physical Terrain**
 - Surface elevation
 - Bathymetry
 - Land area

Continuous

Water Quality



Water Quality
USGS (Sal, Temp,
Water Level)

Water Quality
Chlorophyll a
Dissolved Oxygen
Nutrient constituents (N, P, Silica)
Salinity
Turbidity
Suspended sediment concentration

0 10 20 km



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Continuous

Water Quality



Water Quality

-  USGS (Sal, Temp, Water Level)
-  Add Chl, DO, Turb

Water Quality

- Chlorophyll a**
- Dissolved Oxygen**
- Nutrient constituents (N, P, Silica)
- Salinity**
- Turbidity**
- Suspended sediment concentration

0 10 20 km




Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Continuous

Water Quality



Water Quality

-  USGS (Sal, Temp, Water Level)
-  Add Chl, DO, Turb
-  New Stations

Water Quality

- Chlorophyll a**
- Dissolved Oxygen**
- Nutrient constituents (N, P, Silica)
- Salinity**
- Turbidity**
- Suspended sediment concentration

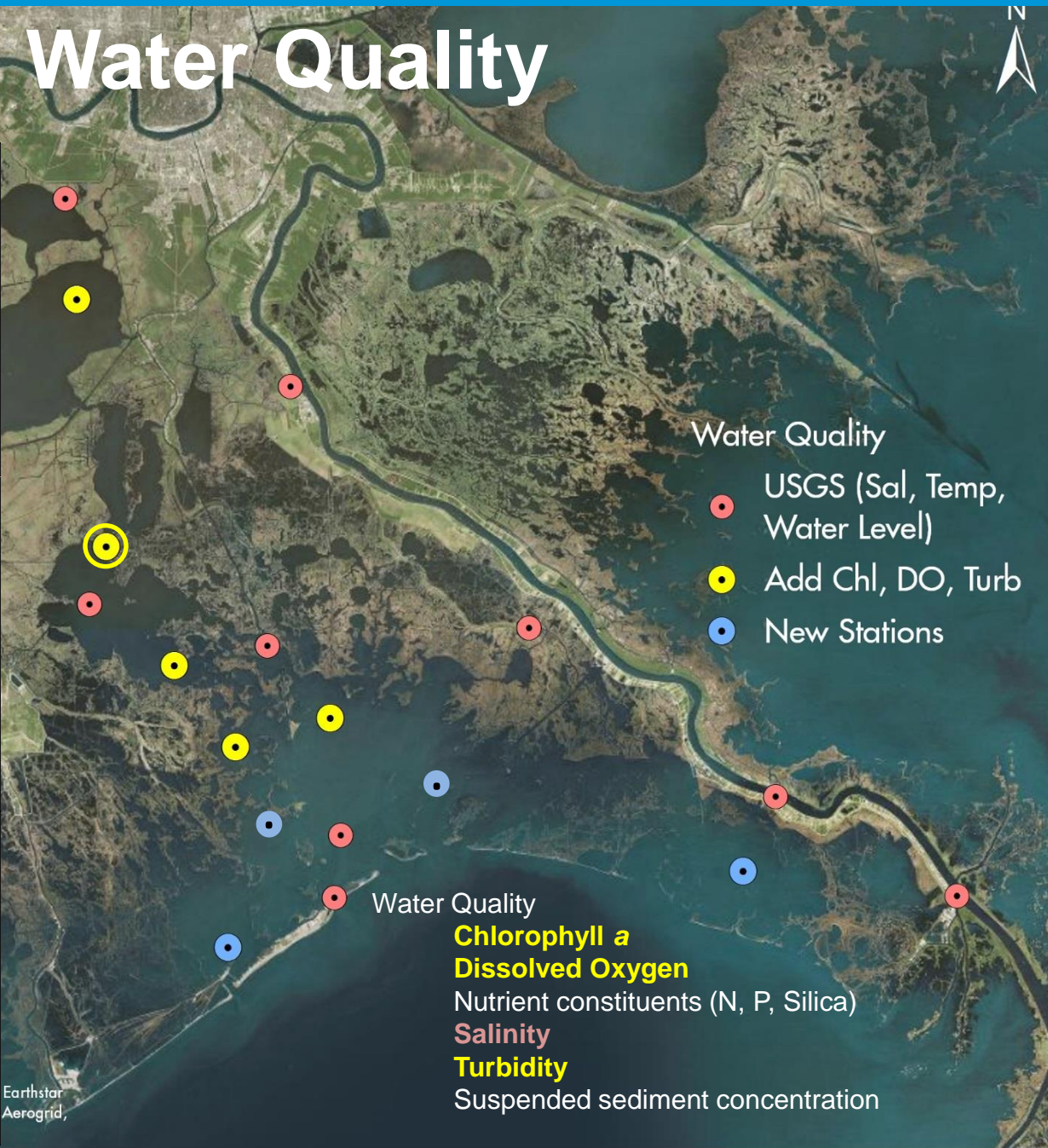
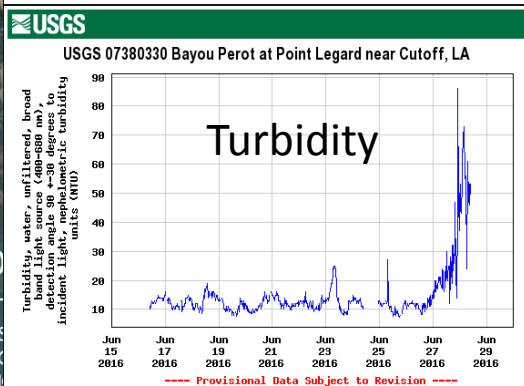
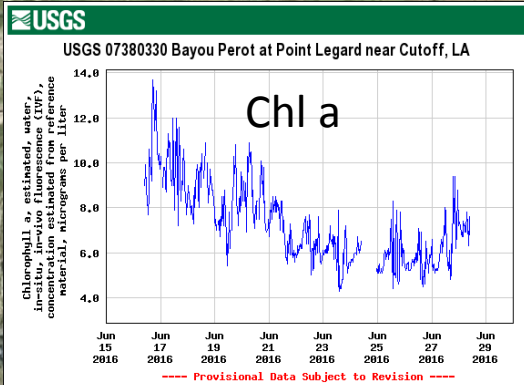
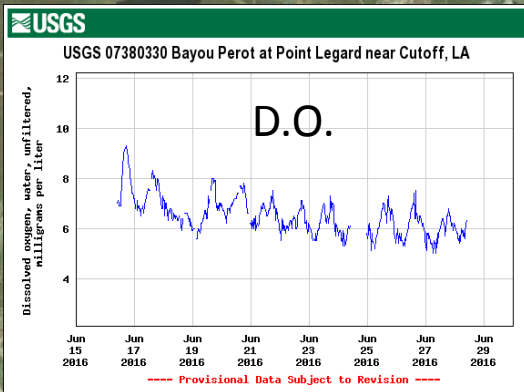
SWAMP 24 not implemented

0 10 20 km

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Continuous

Water Quality



Water Quality

- USGS (Sal, Temp, Water Level)
- Add Chl, DO, Turb
- New Stations

Water Quality

- Chlorophyll a
- Dissolved Oxygen
- Nutrient constituents (N, P, Silica)
- Salinity
- Turbidity
- Suspended sediment concentration

Earthstar
Aerogrid,

Discrete

Water Quality



Water Quality

● Boat-Based
Monthly Sampling

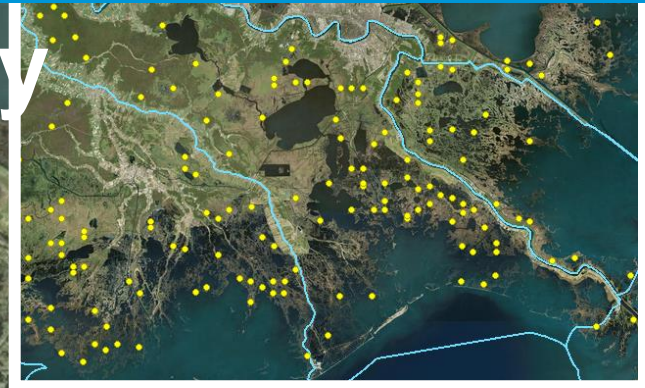
Water Quality

- Chlorophyll *a*
- Dissolved Oxygen
- Nutrient constituents (N, P, Silica)
- Salinity
- Turbidity
- Suspended sediment concentration

0 10 20 km

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Water Quality



Water Quality

- USGS (Sal, Temp, Water Level)
- Add Chl, DO, Turb
- New Stations
- Boat-Based Monthly Stations (plus TSS, TN, TP)

- Water Quality
- Chlorophyll a
- Dissolved Oxygen
- Nutrient constituents (N, P, Silica)
- Salinity
- Turbidity
- Suspended sediment concentration

0 10 20 km

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SWAMP Natural System

Barataria Pilot

- **Biotic Integrity**
 - Nekton community composition
 - Oyster biomass
 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition
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 - Salinity
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- **Weather and Climate**
 - Potential Evapotranspiration
 - Precipitation
 - Wind
- **Hydrology**
 - Current velocity
 - Water level
 - Waves
- **Physical Terrain**
 - Surface elevation
 - Bathymetry
 - Land area

Physical Terrain

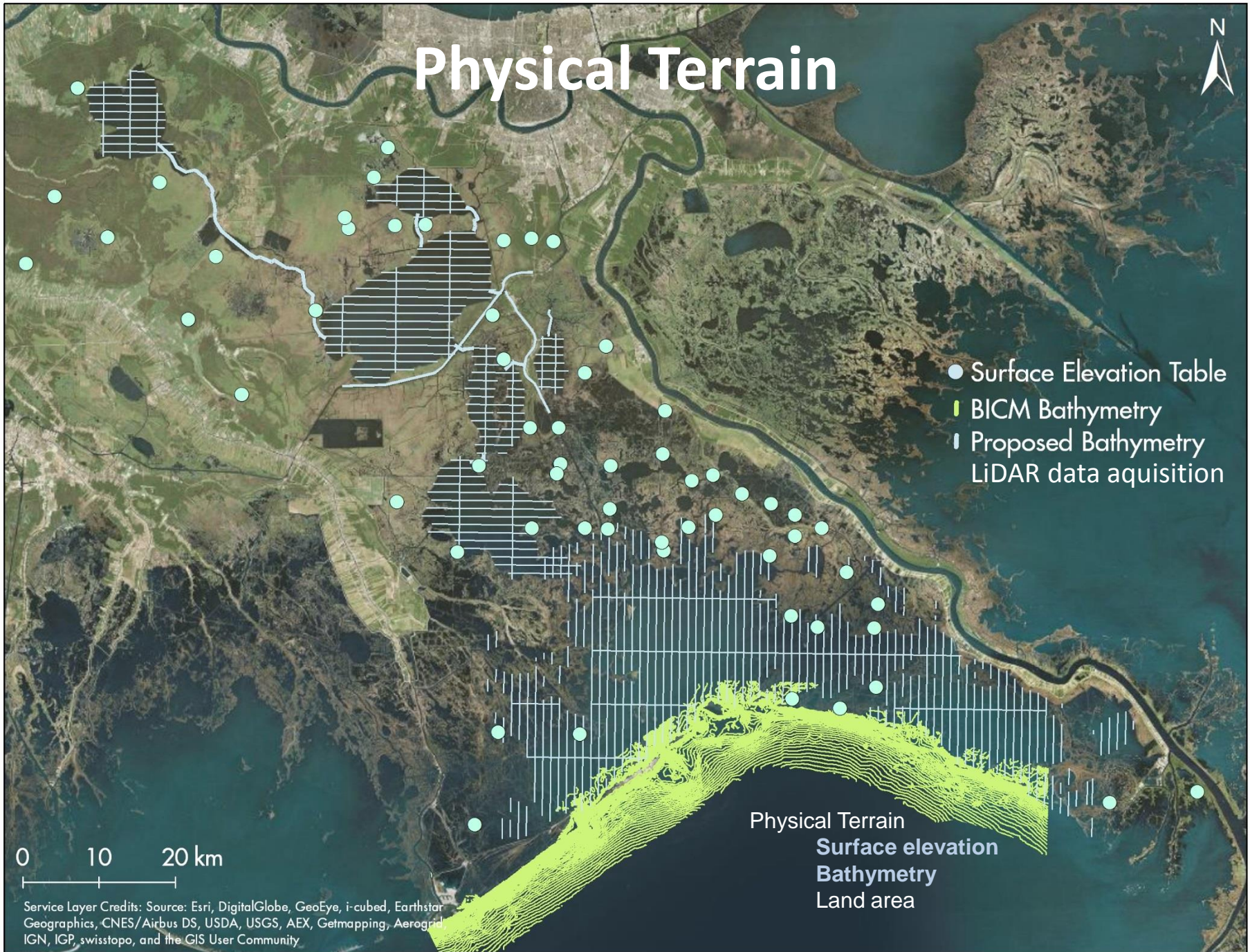


- Surface Elevation Table
- BICM Bathymetry
- ▮ Proposed Bathymetry
- ▮ LiDAR data aquisition

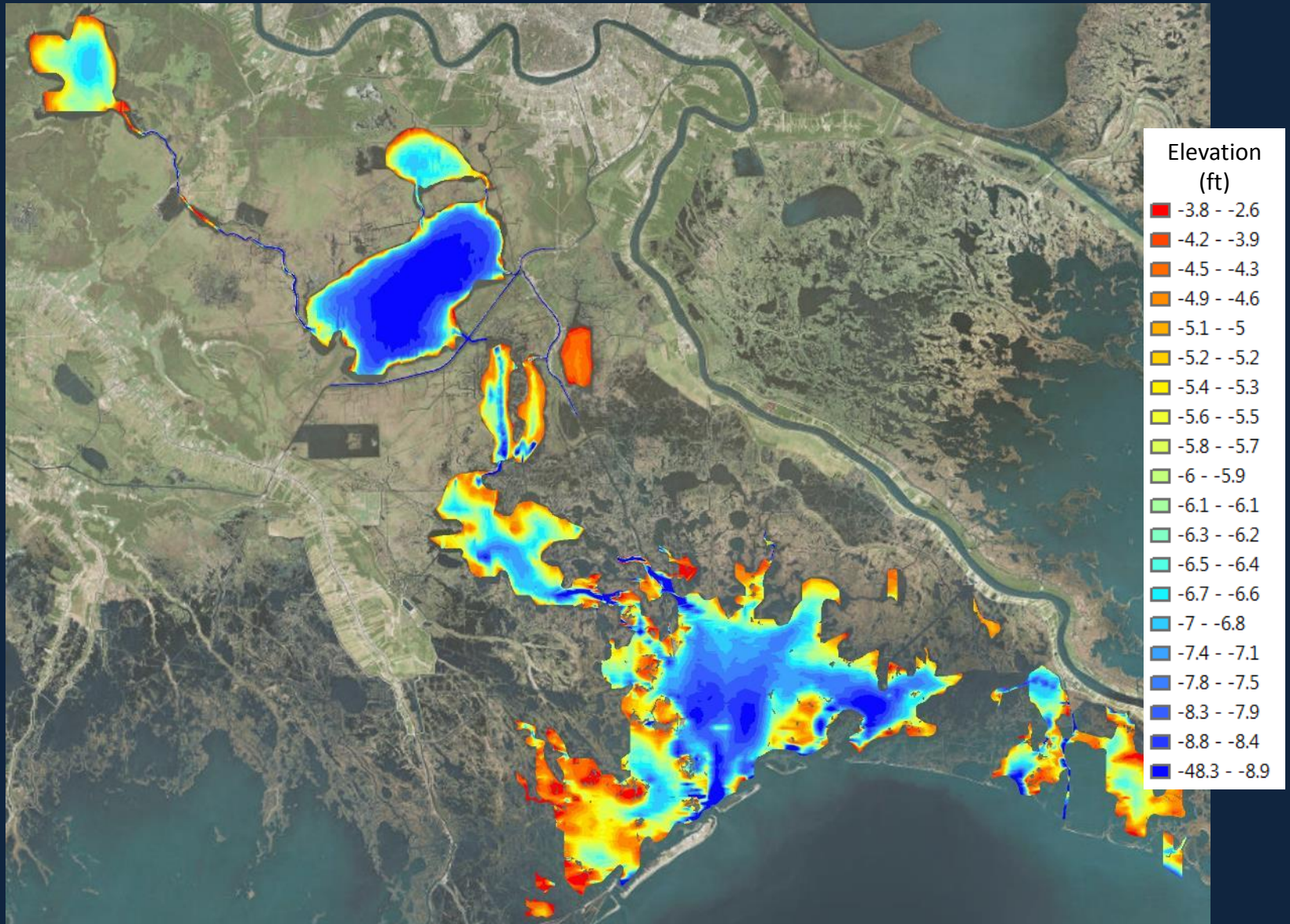
0 10 20 km

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Physical Terrain
Surface elevation
Bathymetry
Land area



Bathymetric Map - Overview



SWAMP Natural System

Barataria Pilot

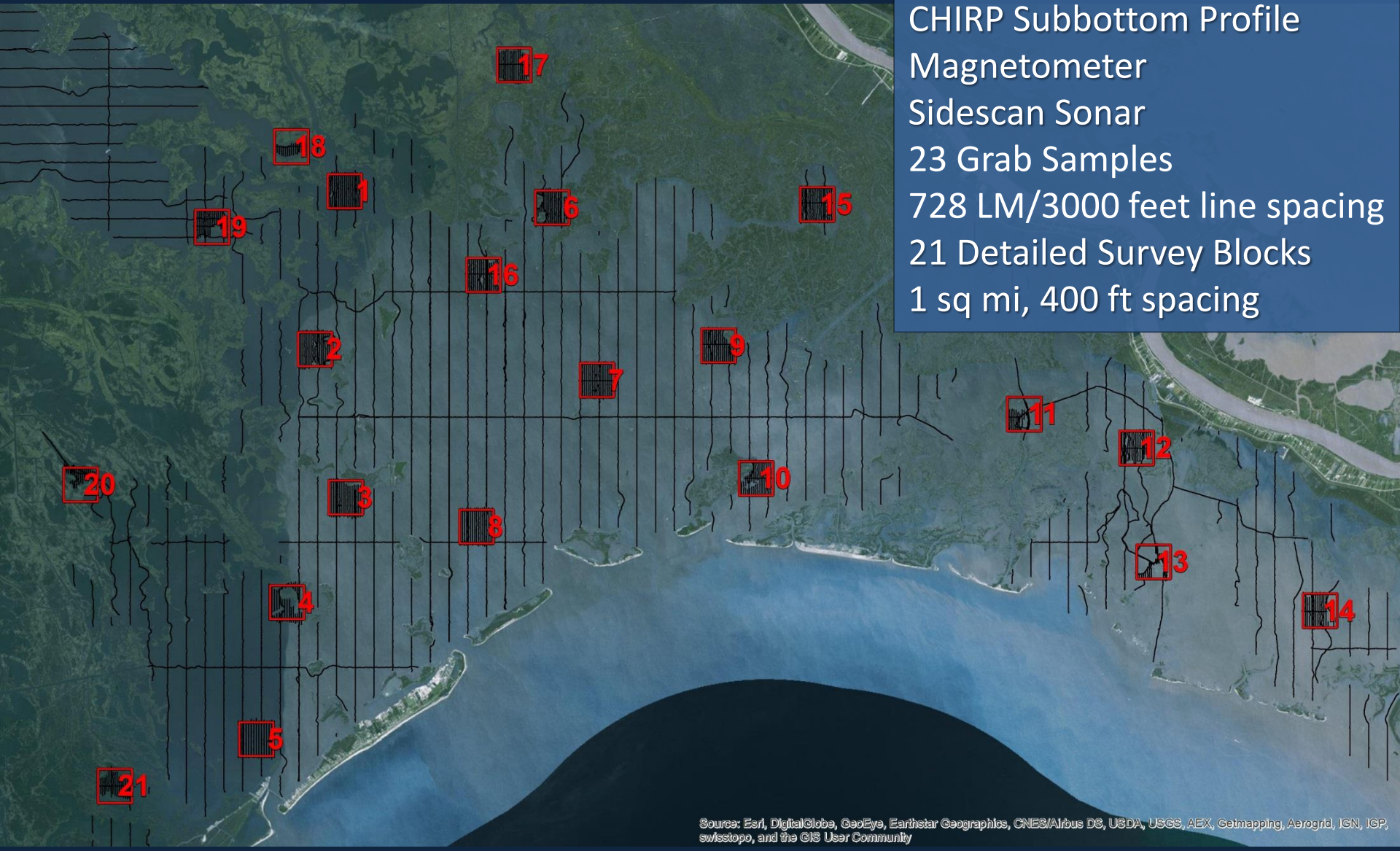
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Ecological Role of Oysters

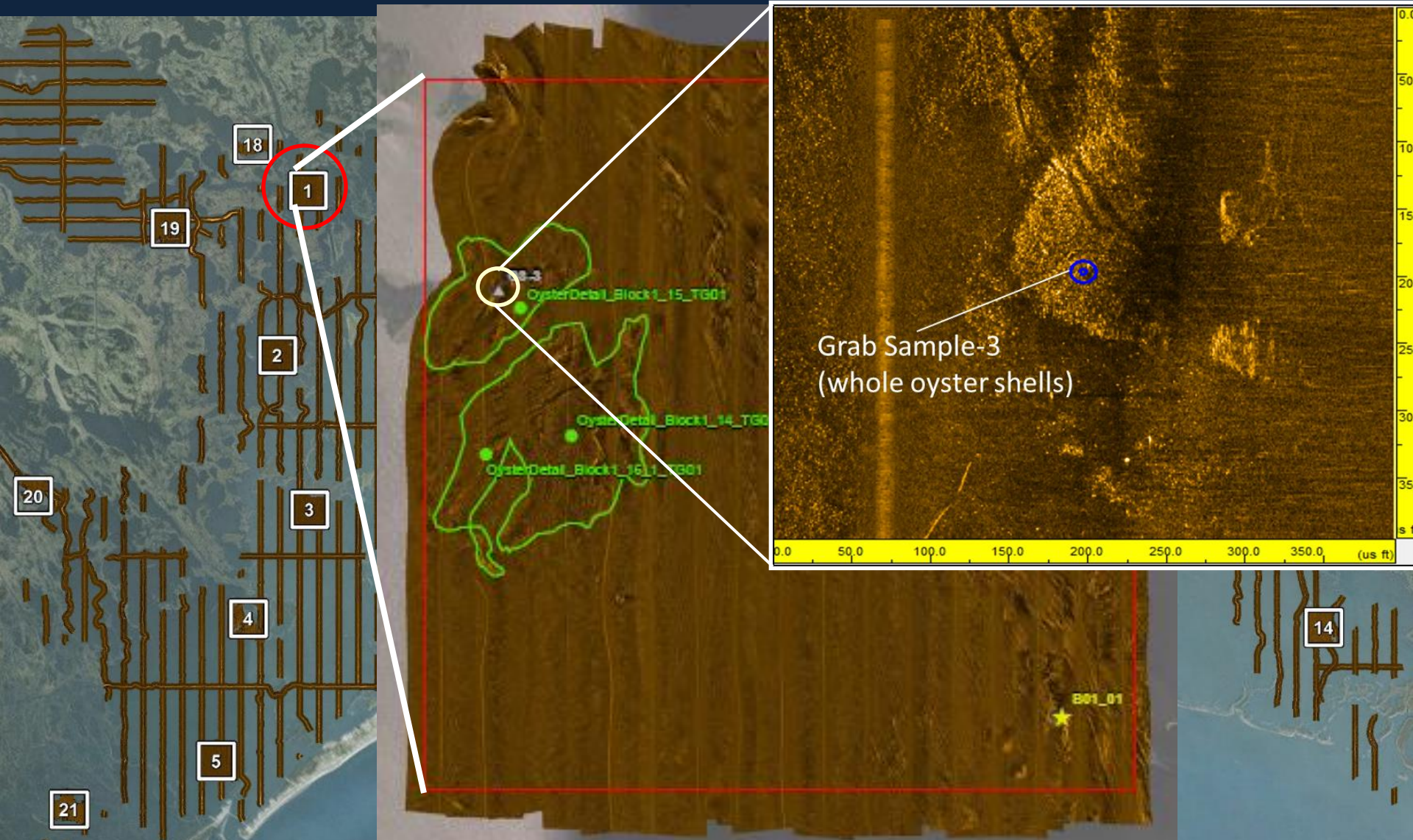
- Oysters play an **important ecological role** in the estuarine ecosystem.
- Oyster reefs **provide the majority of hard substrate** required by other sessile invertebrate species, such as barnacles.
- Oyster reefs are also **utilized as shelter and forage** habitat for many species of crabs, worms, and fish.
- **Estuarine water quality can be enhanced** by the filter-feeding activities of oysters.
- Reefs may also play a role in **stabilizing shorelines**.

Detailed Survey Blocks

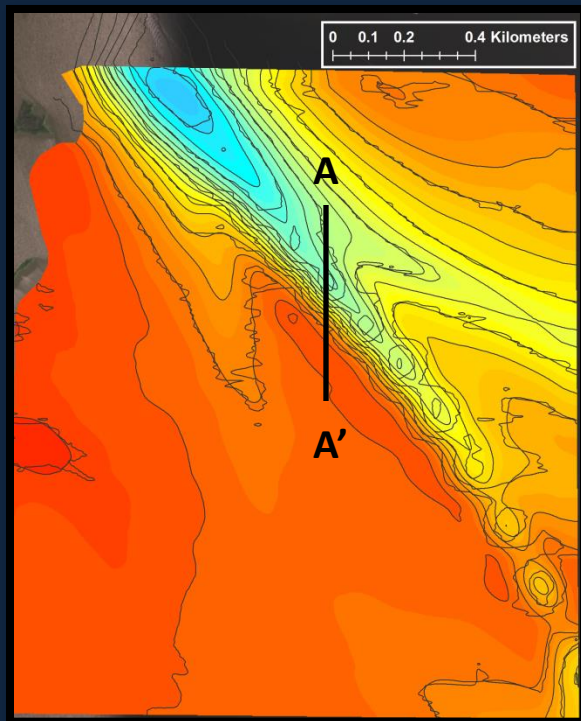
Single Beam Bathymetry
CHIRP Subbottom Profile
Magnetometer
Sidescan Sonar
23 Grab Samples
728 LM/3000 feet line spacing
21 Detailed Survey Blocks
1 sq mi, 400 ft spacing



Data Interpretation



Applying Geophysical Techniques

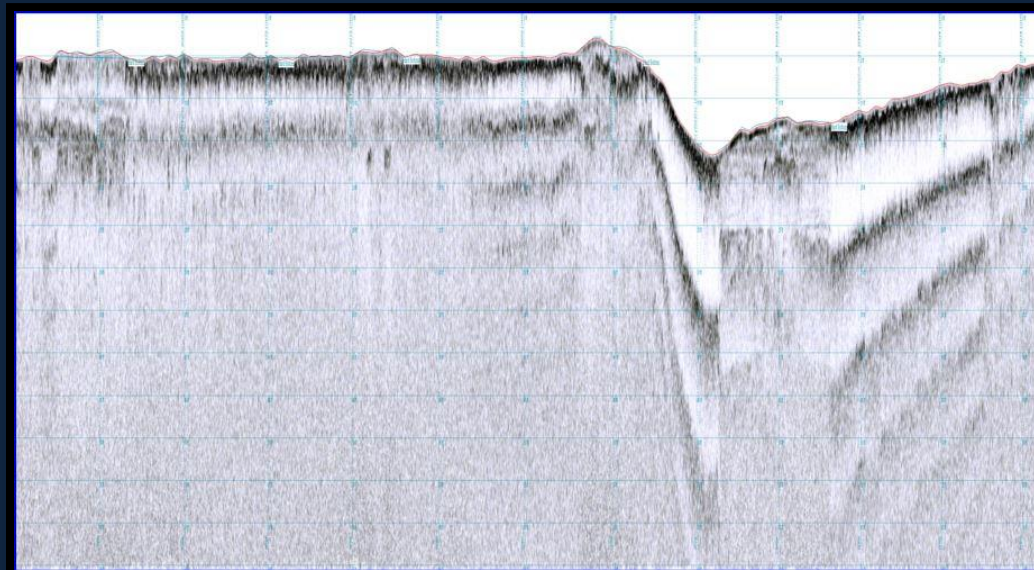


Bathymetry of block (above) shows a channel with depths up to 18 feet running NW-SE through the survey block. Possible hardbottom areas are found along and in the channel.

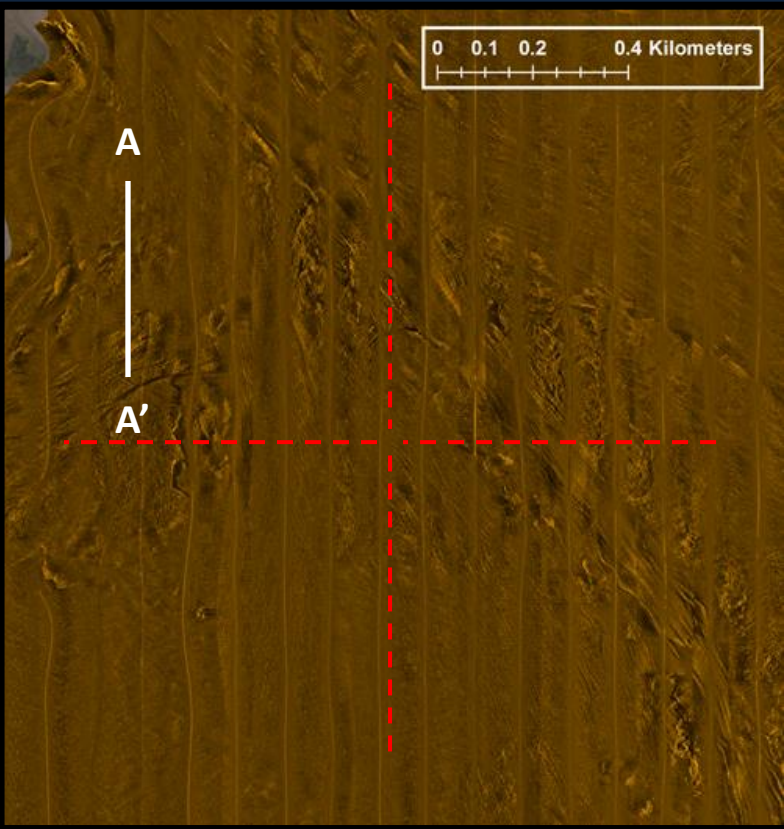
Seismic line 8 (below) runs North-South in the center of the detailed block. The image shows potential hardbottom areas to either side and even within the channel. Areas of hardbottom abutting sand and mud deposits are not uncommon in this block.

North (A)

South (A')

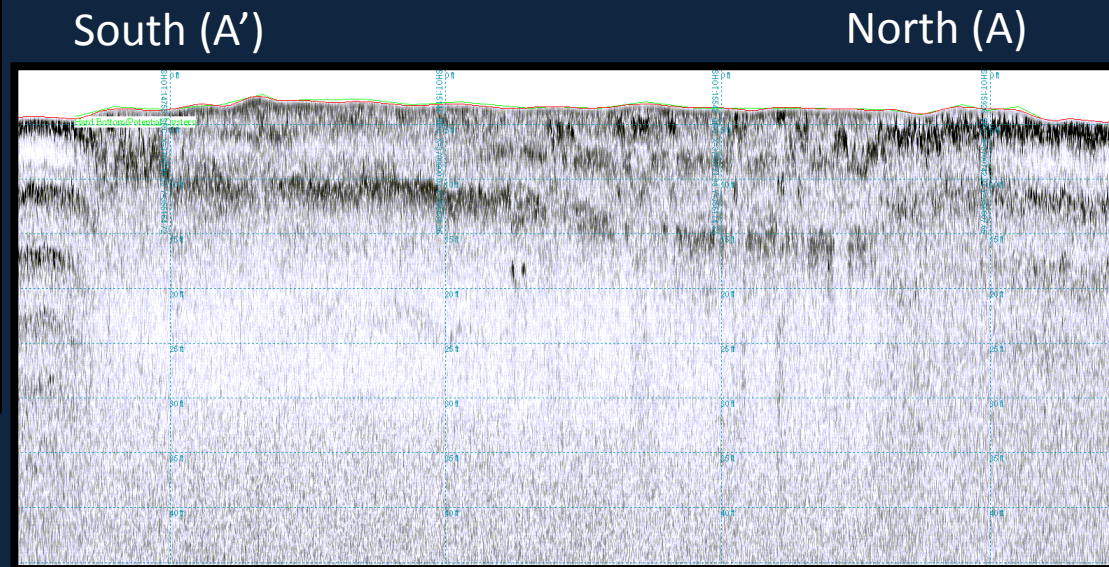


Sidescan and CHIRP Detailed Block

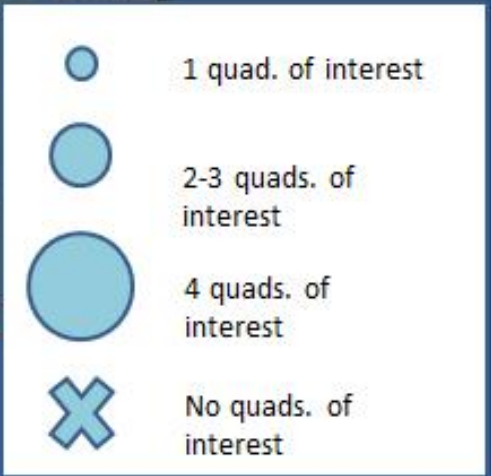
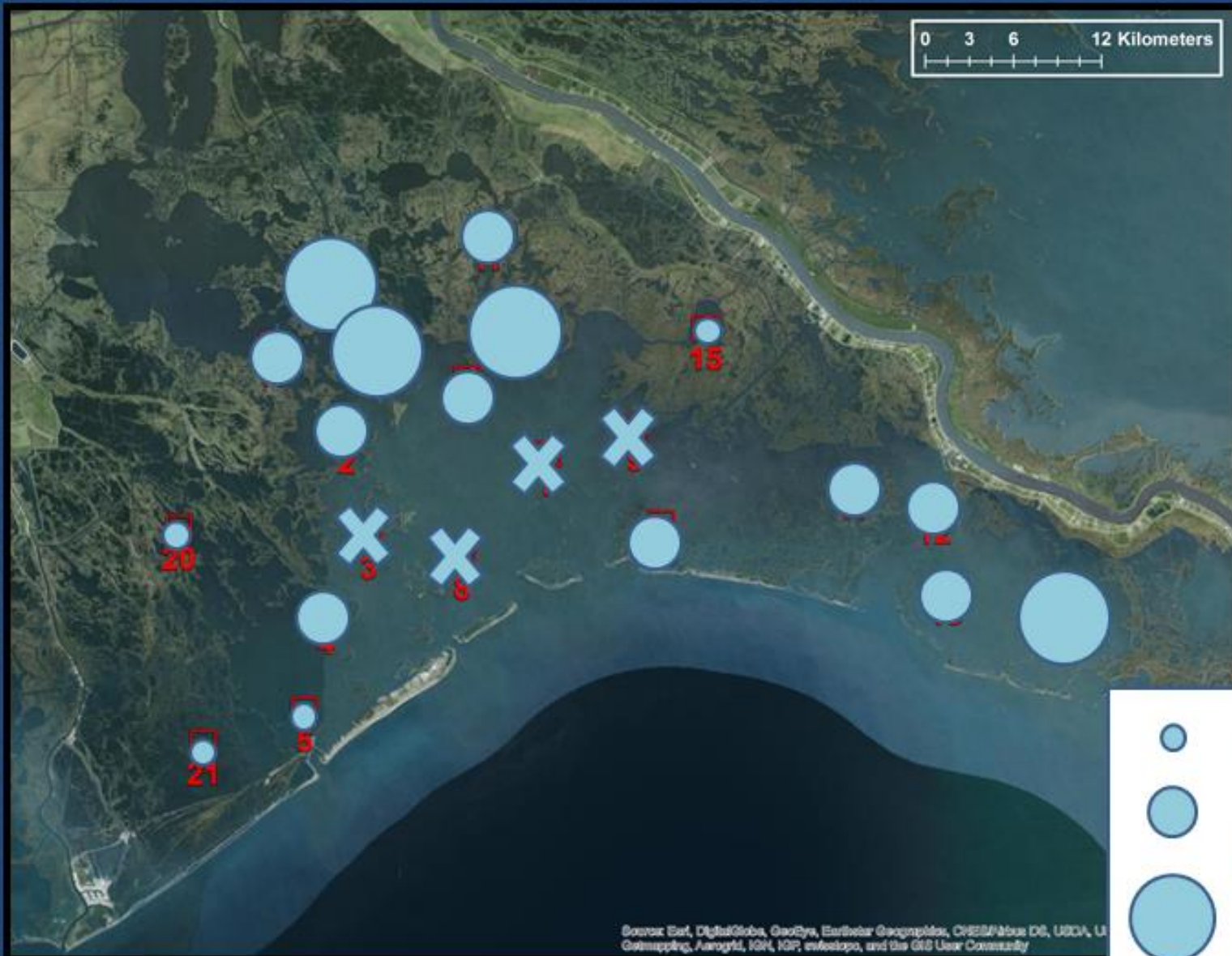


Sidescan of Block shows evidence of hardbottom in all 4 quadrants.

Seismic line 8 (below) runs South-North in the NW quadrant of block. The image shows potential hardbottom areas, and some indication of oyster mounds.



Potential for Hardbottom and Oysters



Freeman, O'Connor et al., Restore America's Estuaries Conference (2016)

Biotic Integrity Fish



Fisheries Independent Sampling

- Square Meter
- ▲ Gill Net
- Seine
- Trawl
- New Trawl Sites

- Biotic Integrity
- Nekton community composition (↑ stations)
 - Oyster biomass (↑ freq, ↑ coverage)
 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition

0 10 20 km

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Biotic Integrity Fish



Fisheries Independent Sampling

- Square Meter
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- New Trawl Sites

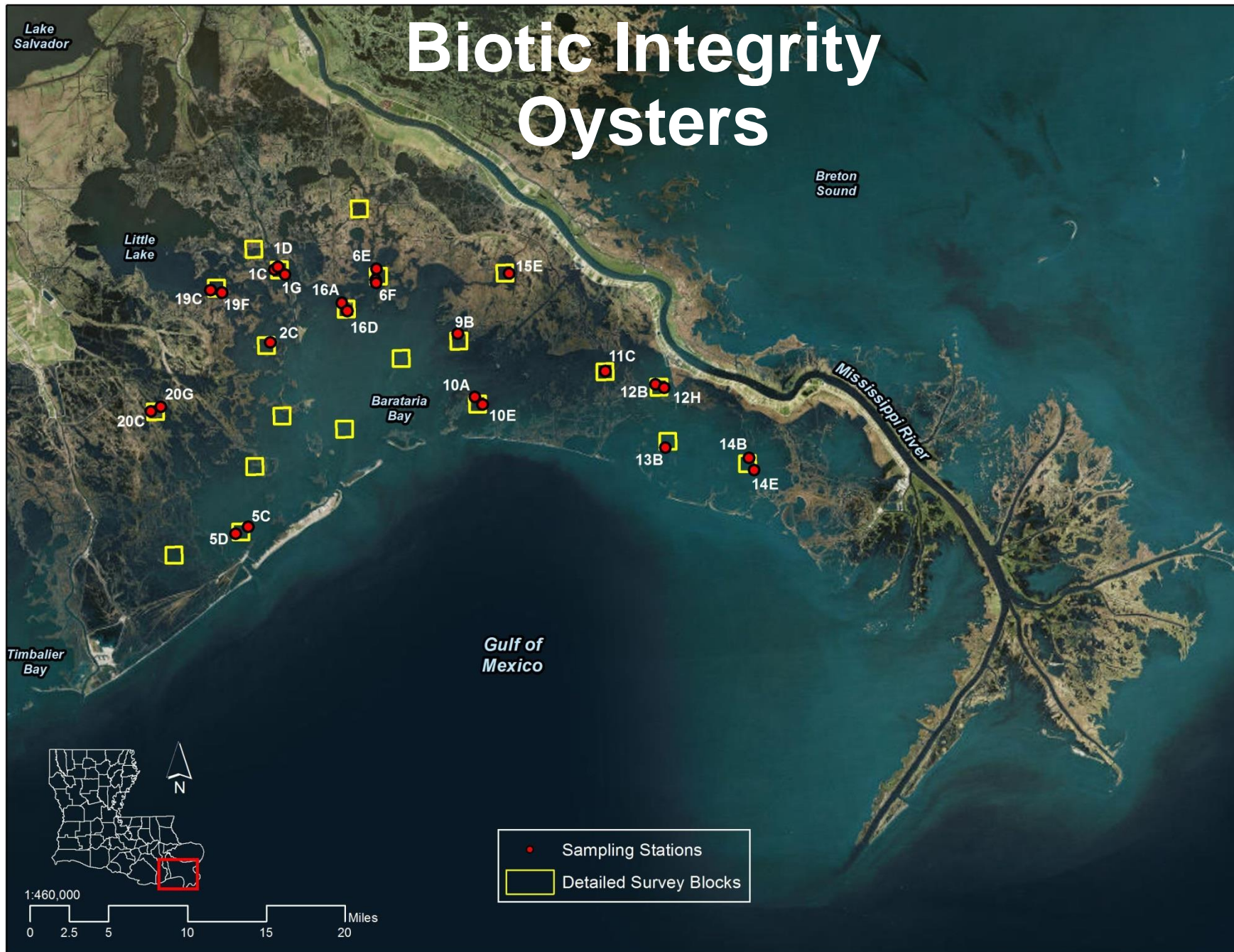
Biotic Integrity

- Nekton community composition (↑ stations)
- Oyster biomass (↑ freq, ↑ coverage)
- Soil condition
- Wetland vegetation biomass
- Vegetative community composition

0 10 20 km

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Biotic Integrity Oysters



SWAMP 1: Barataria

Table B.1. Recommended sample sizes for Barataria Basin monitoring plan.

The sample sizes are provided as a range depending on the level of change (i.e., effect size) that can be detected. The ranges are representative of the minimum and maximum for the collective set of variables within a category. See Appendix II for change detecting information on an individual variable basis.

MONITORING CATEGORY	VARIABLE	EXISTING MONITORING IN BARATARIA BASIN: NUMBER OF SITES	EXISTING MONITORING IN BARATARIA BASIN: SAMPLING FREQUENCY	NEW SITES FOR BARATARIA BASIN: NUMBER OF ADDITIONAL SITES	NEW SITES FOR BARATARIA BASIN: SAMPLING FREQUENCY	SAMPLE SIZE METHOD	SITE SELECTION METHOD
Weather and Climate	Potential Evapo-transpiration	Calculated, not measured directly.					
	Precipitation	16 sites plus gridded datasets from NOAA	Subhourly	3	Subhourly	Expert Knowledge	Utilize existing platforms
	Wind	14 sites plus gridded datasets from NOAA	Subhourly	3	Subhourly	Expert Knowledge	Utilize existing platforms
Biotic Integrity	Nekton Community Composition	25 gillnet, 15 trawl, 20 seine sites; 16 electrofishing	Variable: Weekly to quarterly	10 16-foot trawls; supplement 50-foot seines with drop samplers	Monthly	Power Analysis	GRTS
	Oyster biomass	7 square meter	Annually	15	Semi-annually to Quarterly	Expert knowledge	Should conduct oyster mapping prior to site selection
	Soil condition	CRMS: 11 forested wetlands and 54 herbaceous wetlands	Once every ten years	None	N/A	Power Analysis on herbaceous wetlands only	Utilize existing CRMS sites
	Wetland vegetation biomass	CPRA: 7 CRMS	Once	14 plus revisit 7 existing sites	Once every five years	Power Analysis on herbaceous wetlands only	Utilize existing CRMS sites
	Wetland vegetation community composition	CRMS: 11 forested wetlands and 54 herbaceous wetlands	Annually	None	Annually	Power Analysis	Utilize existing CRMS sites
Water Quality	Chlorophyll a	No existing sites	N/A	22	Monthly	Power Analysis	GRTS
				6	Sub-hourly	Expert knowledge	
	Dissolved oxygen (DO)	LDEQ: 8 within larger open waterbodies LDWF: 60 within the mid to lower basin	LDEQ: Monthly, every four years LDWF: Variable	0	Monthly	Power Analysis	GRTS
				3-6	Subhourly	Expert Knowledge	
	Nutrient constituents	LDEQ: 8 within larger open waterbodies	Monthly, every four years	22	Monthly	Power Analysis	GRTS
	Salinity	USGS: 10 CPRA: 65	Hourly	6	Hourly	Power Analysis	GRTS
	Turbidity	LDEQ: 8 within larger open waterbodies LDWF: 60 within the mid to lower basin	LDEQ: Monthly, every four years LDWF: Variable	22	Monthly	Power Analysis	GRTS
6				Sub-hourly	Expert knowledge		
Total Suspended Solids	LDEQ: 8 within larger open waterbodies LDWF: 60 within the mid to lower basin	LDEQ: Monthly, every four years LDWF: Variable	22	Monthly	Power Analysis	GRTS	

SWAMP 1: Barataria

MONITORING CATEGORY	VARIABLE	EXISTING MONITORING IN BARATARIA BASIN: NUMBER OF SITES	EXISTING MONITORING IN BARATARIA BASIN: SAMPLING FREQUENCY	NEW SITES FOR BARATARIA BASIN: NUMBER OF ADDITIONAL SITES (MIN-MAX)	NEW SITES FOR BARATARIA BASIN: SAMPLING FREQUENCY	SAMPLE SIZE METHOD	SITE SELECTION METHOD
Hydrology	Current Velocity	No existing sites	N/A	4	Hourly	Expert Knowledge	Expert Knowledge
	Water level	USGS: 10 CPRA: 65	Hourly	6	Hourly	Power Analysis	GRTS; Expert Knowledge
	Waves	WAVCIS: 1 Oil Platform: 1	Hourly	2	Hourly	Expert Knowledge	Utilize existing USGS platforms
Physical Terrain	Bathymetry	CPRA: Barrier islands (BICM)	BICM every 5-10 years	Tidal inlets; regularly spaced transects in open water bodies; single-track multibeam down canals	Variable (annual to decadal)	Expert Knowledge	Expert Knowledge
	Land Area	CRMS Coastwide	3-5 years	None	N/A	Expert Knowledge	None
	Surface Elevation	CPRA: 65 SET's NOAA: 2 CORS (in planning phase)	Semiannually	None	N/A	Expert Knowledge	None

SWAMP Natural System

Barataria and East of Mississippi River

- **Biotic Integrity**
 - Nekton community composition
 - Oyster biomass
 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition
- **Water Quality**
 - Chlorophyll *a*
 - Dissolved Oxygen
 - Nutrient constituents (N, P, Silica)
 - Salinity
 - Turbidity
 - Suspended sediment concentration
- **Weather and Climate**
 - Potential Evapotranspiration
 - Precipitation
 - Wind
- **Hydrology**
 - Current velocity
 - Water level
 - Waves
- **Physical Terrain**
 - Surface elevation
 - Bathymetry
 - Land area

Active and Proposed SWAMP Water Quality

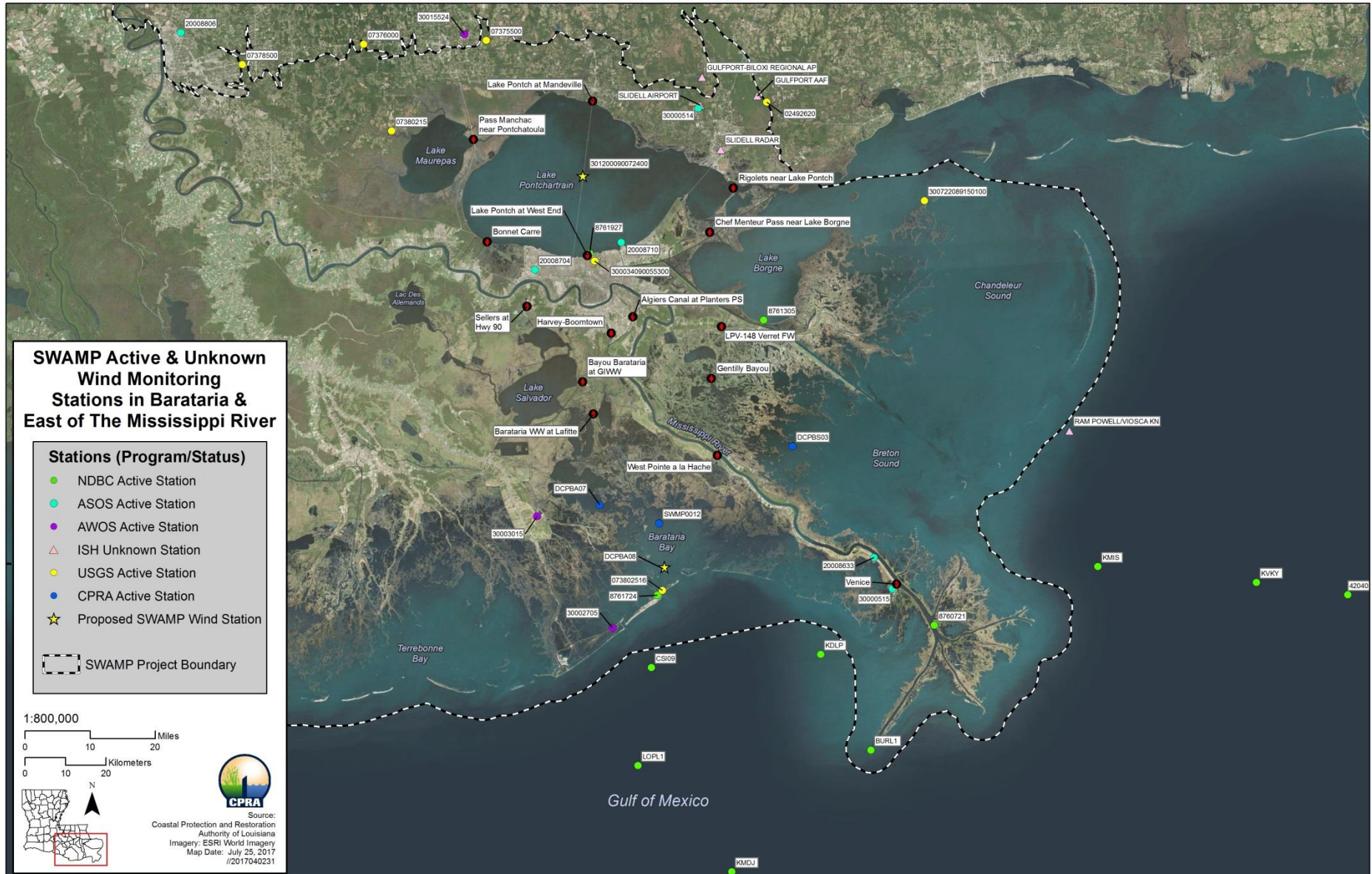


SWAMP Natural System

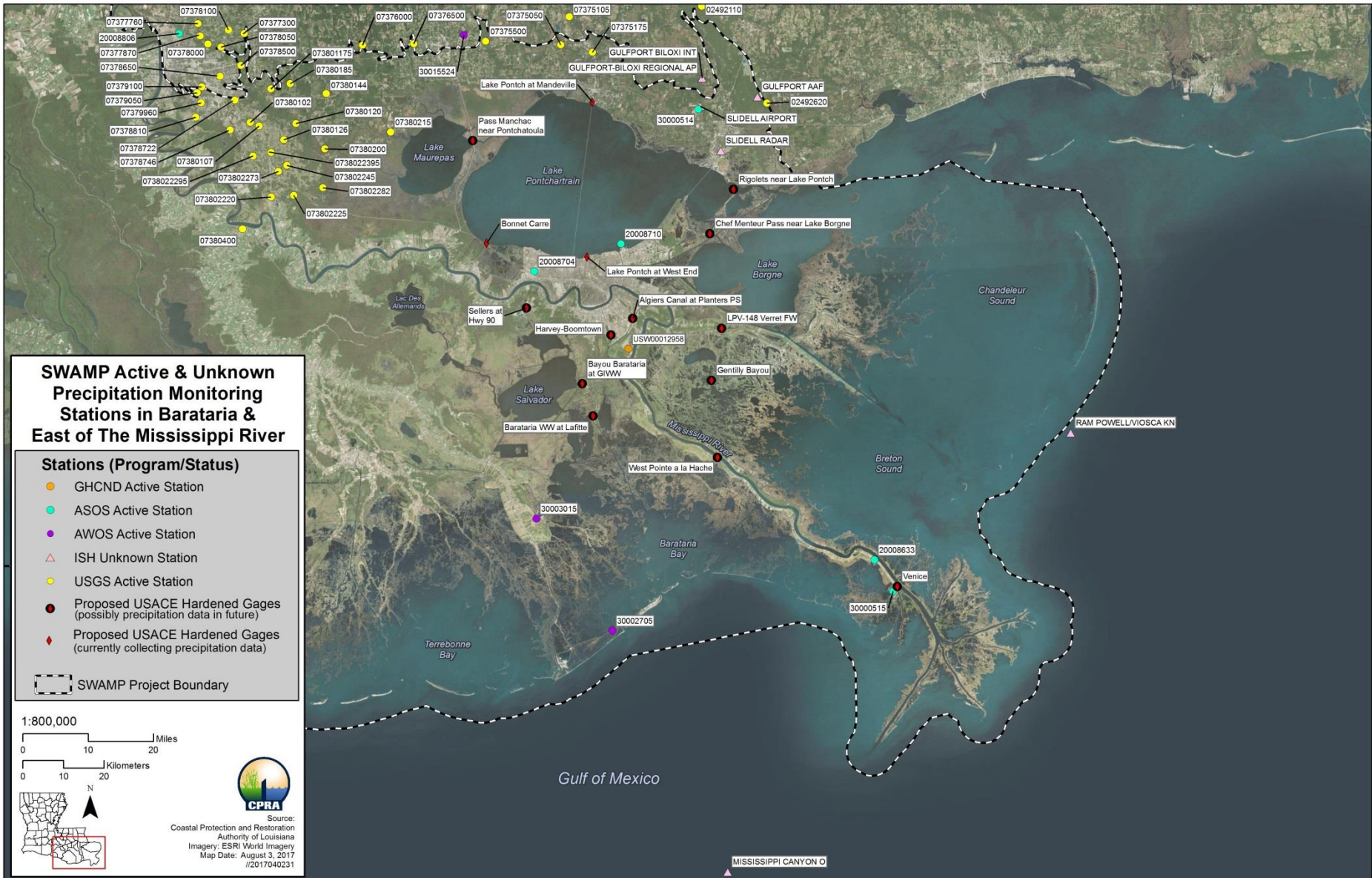
Barataria and East of Mississippi River

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Active and Proposed SWAMP Wind Stations



Active Precipitation Stations

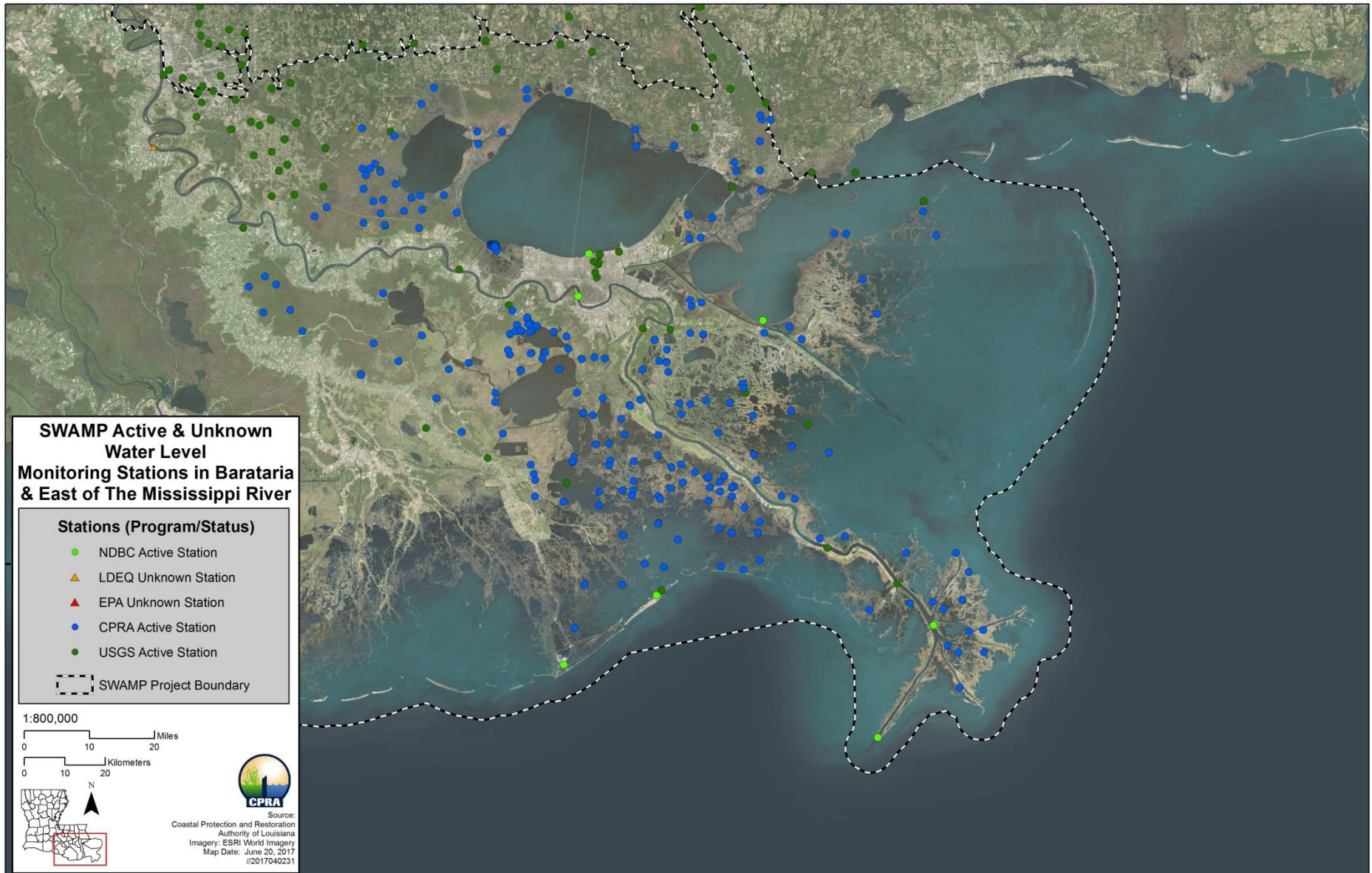


SWAMP Natural System

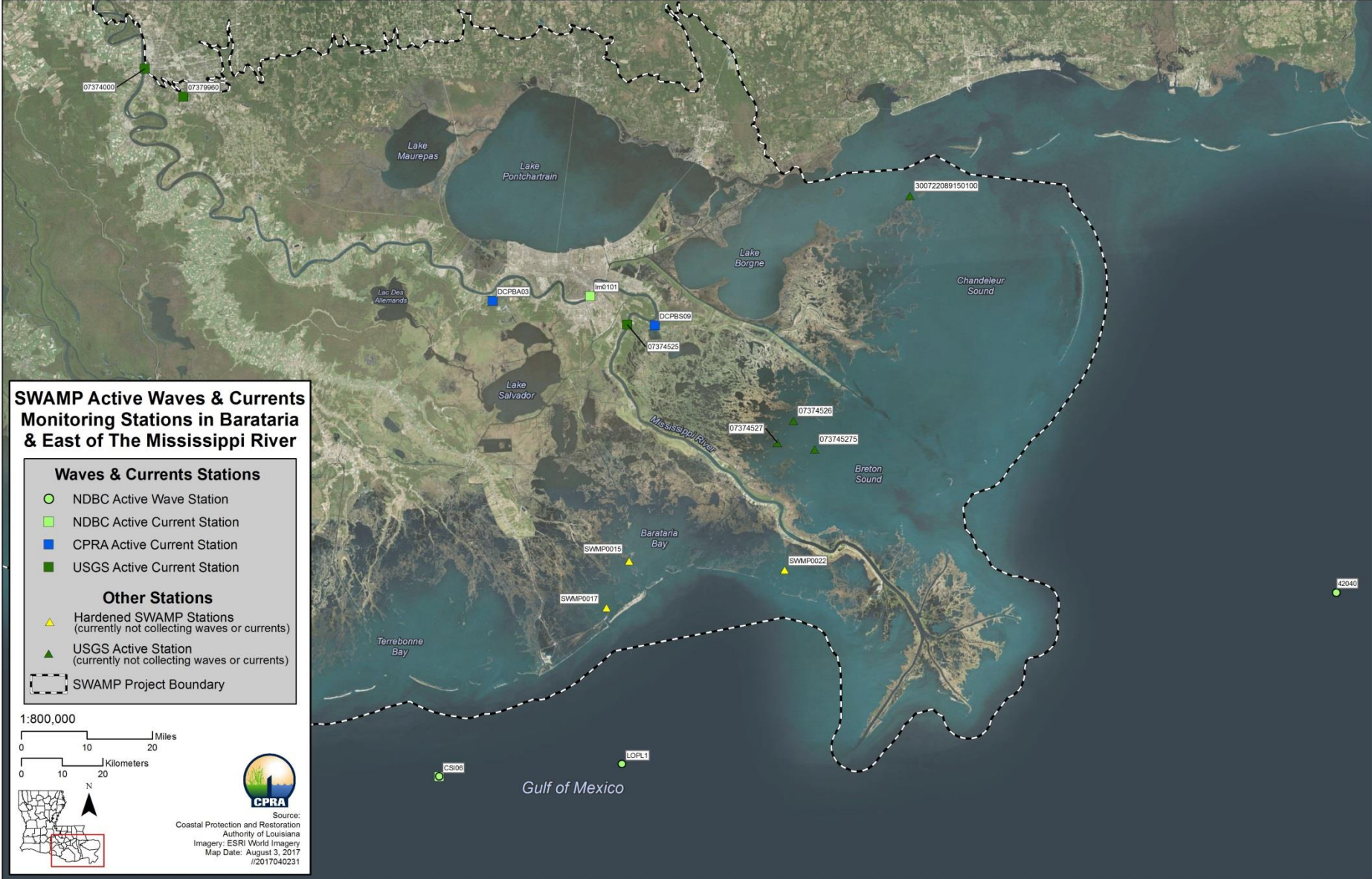
Barataria and East of Mississippi River

- **Biotic Integrity**
 - Nekton community composition
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 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition
- **Water Quality**
 - Chlorophyll *a*
 - Dissolved Oxygen
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- **Weather and Climate**
 - Potential Evapotranspiration
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- **Hydrology**
 - Current velocity
 - Water level
 - Waves
- **Physical Terrain**
 - Surface elevation
 - Bathymetry
 - Land area

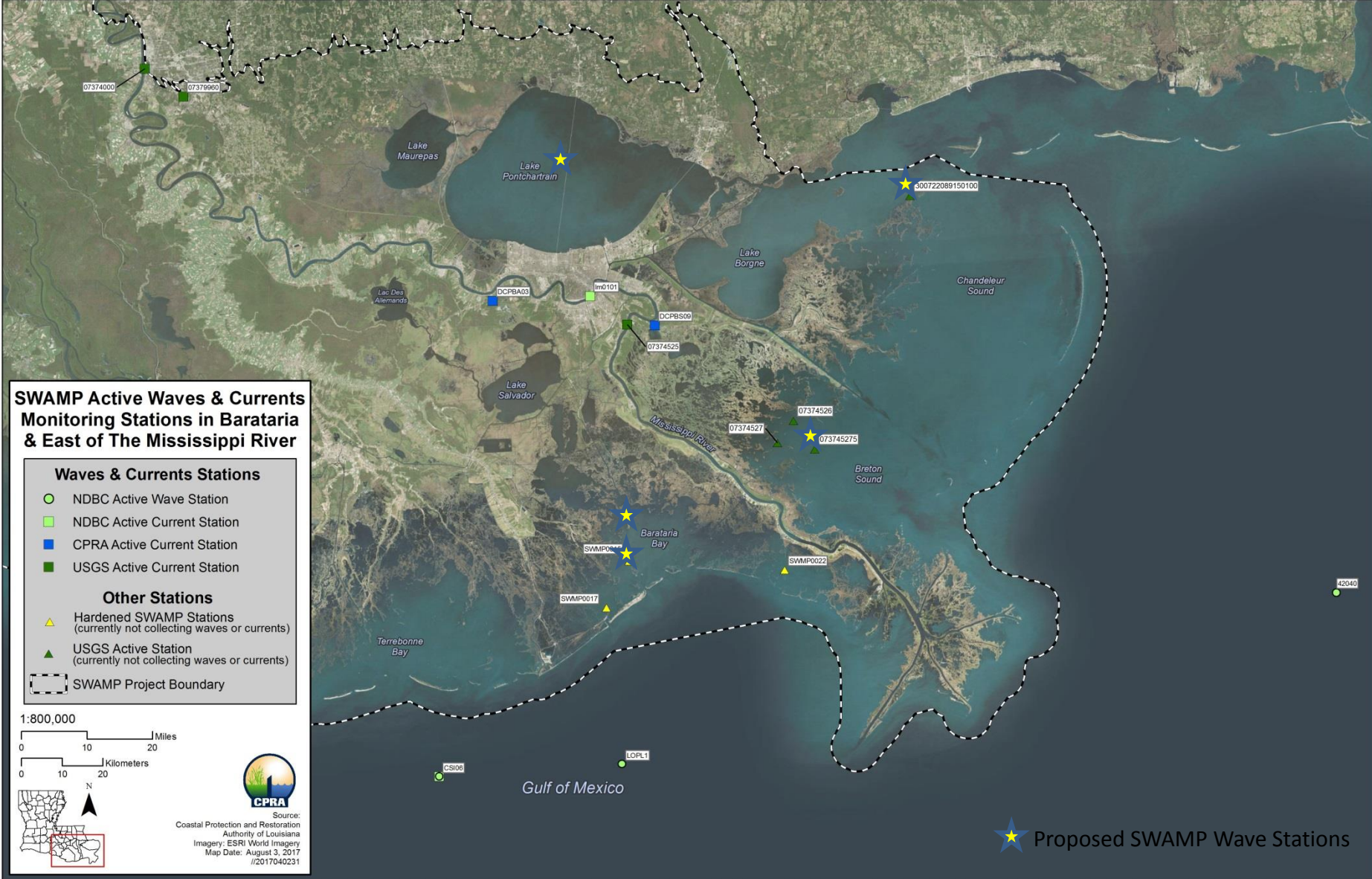
Active Water Level Stations



Active Wave & Current Stations



Active and Proposed Wave & Current Stations



SWAMP Natural System

East of Mississippi River

- **Biotic Integrity**
 - Nekton community composition
 - Oyster biomass
 - Soil condition
 - Wetland vegetation biomass
 - Vegetative community composition
- **Water Quality**
 - Chlorophyll *a*
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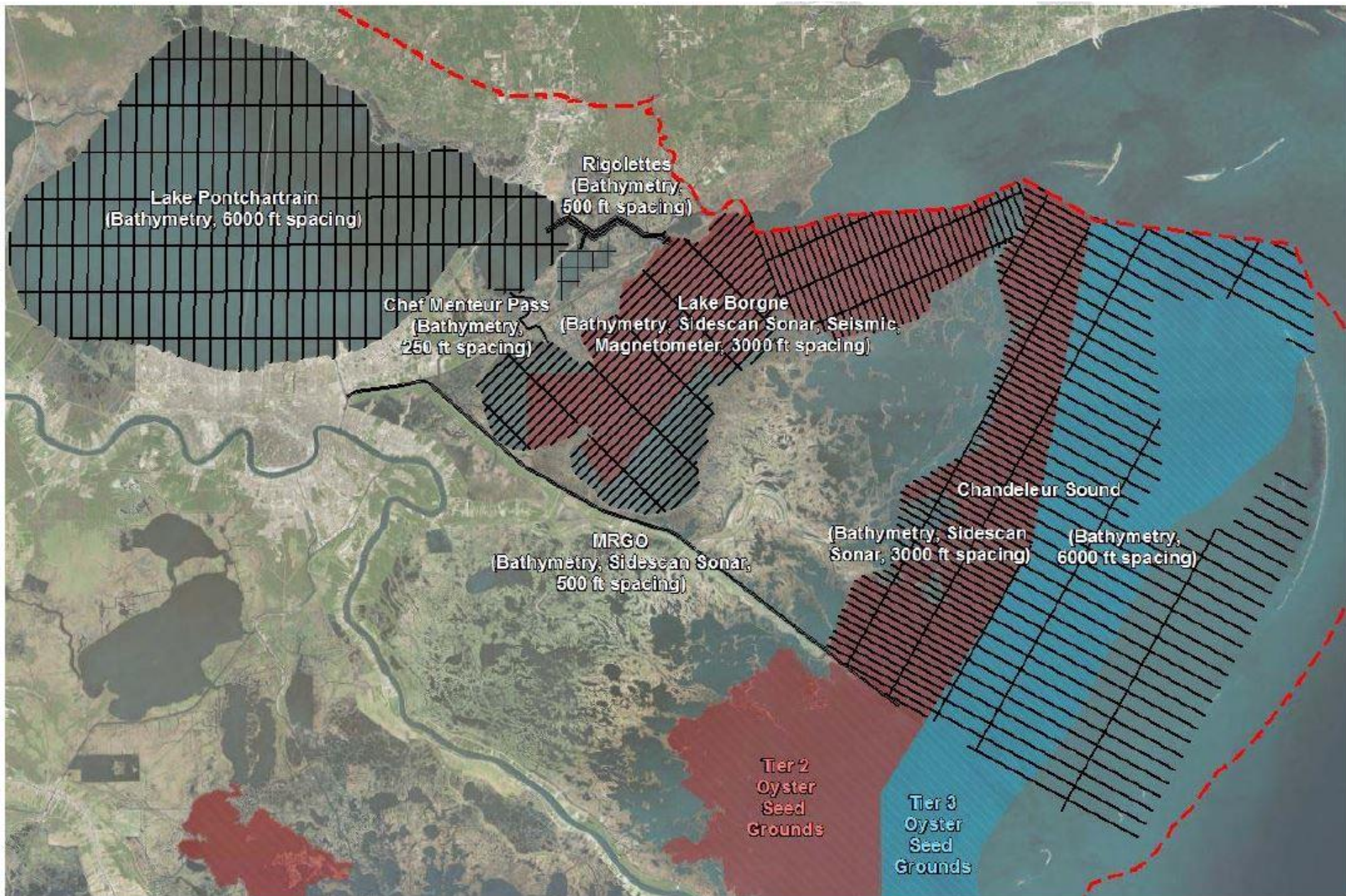
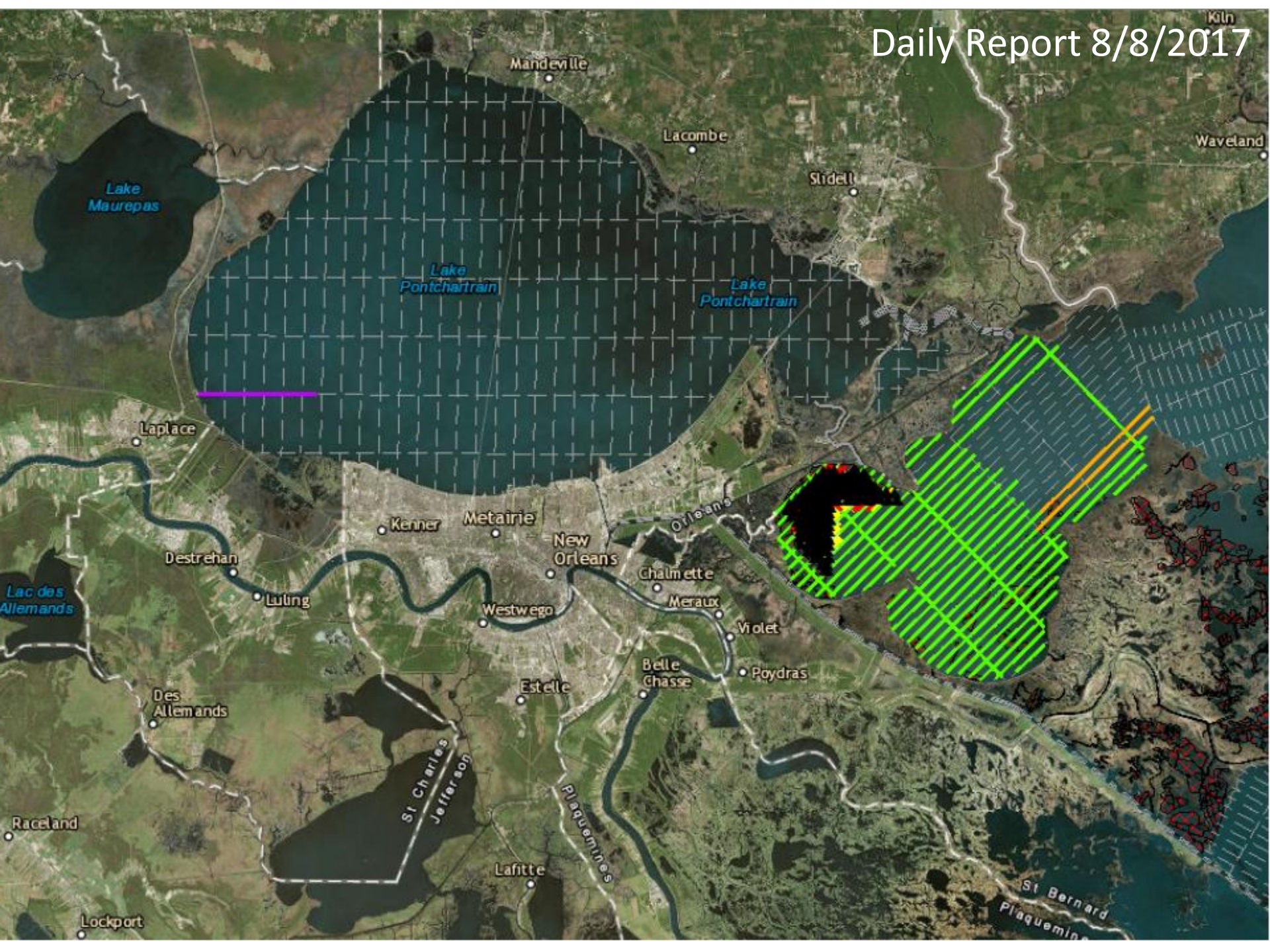
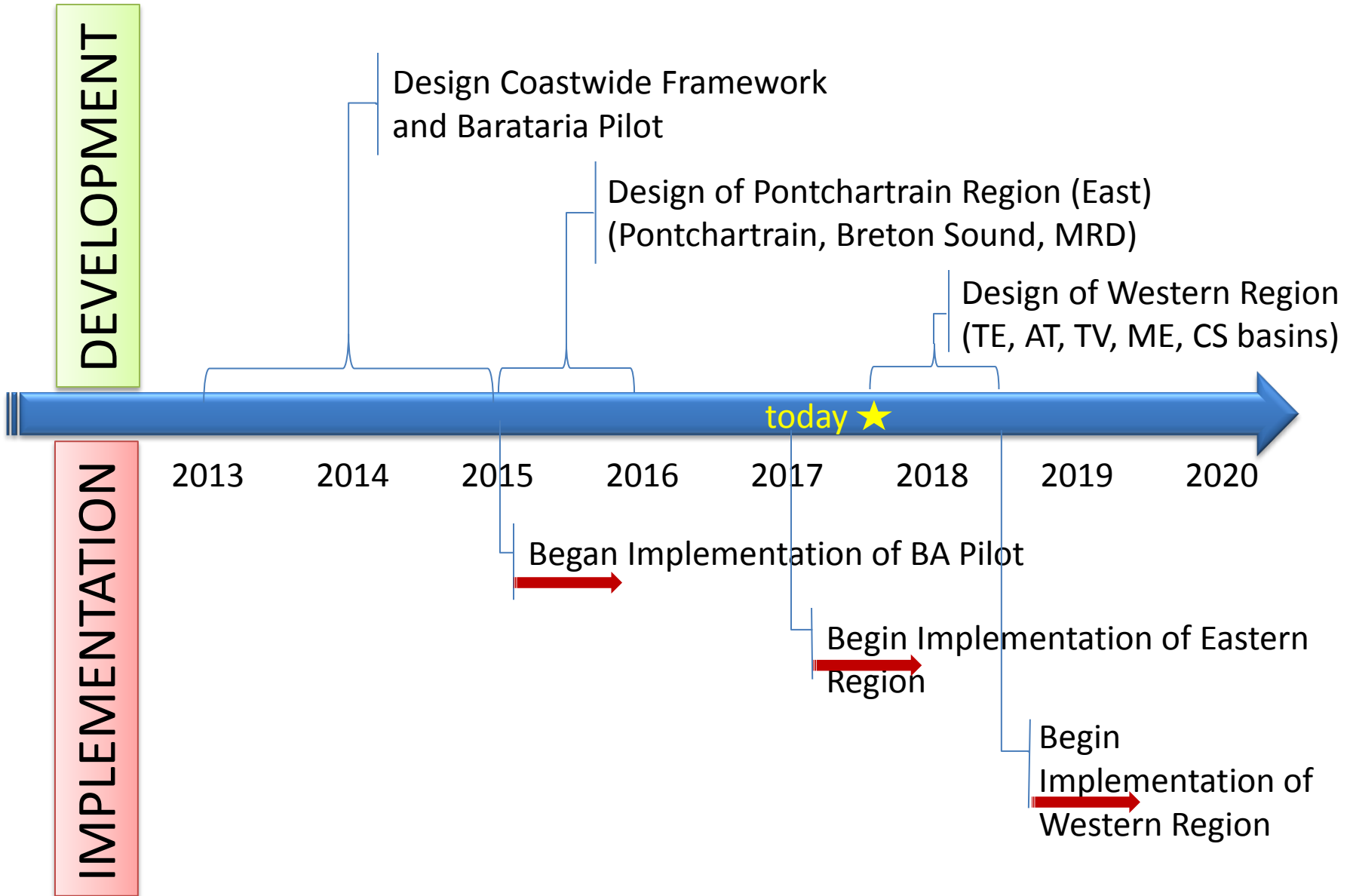


Figure 1. Planned survey tracklines.

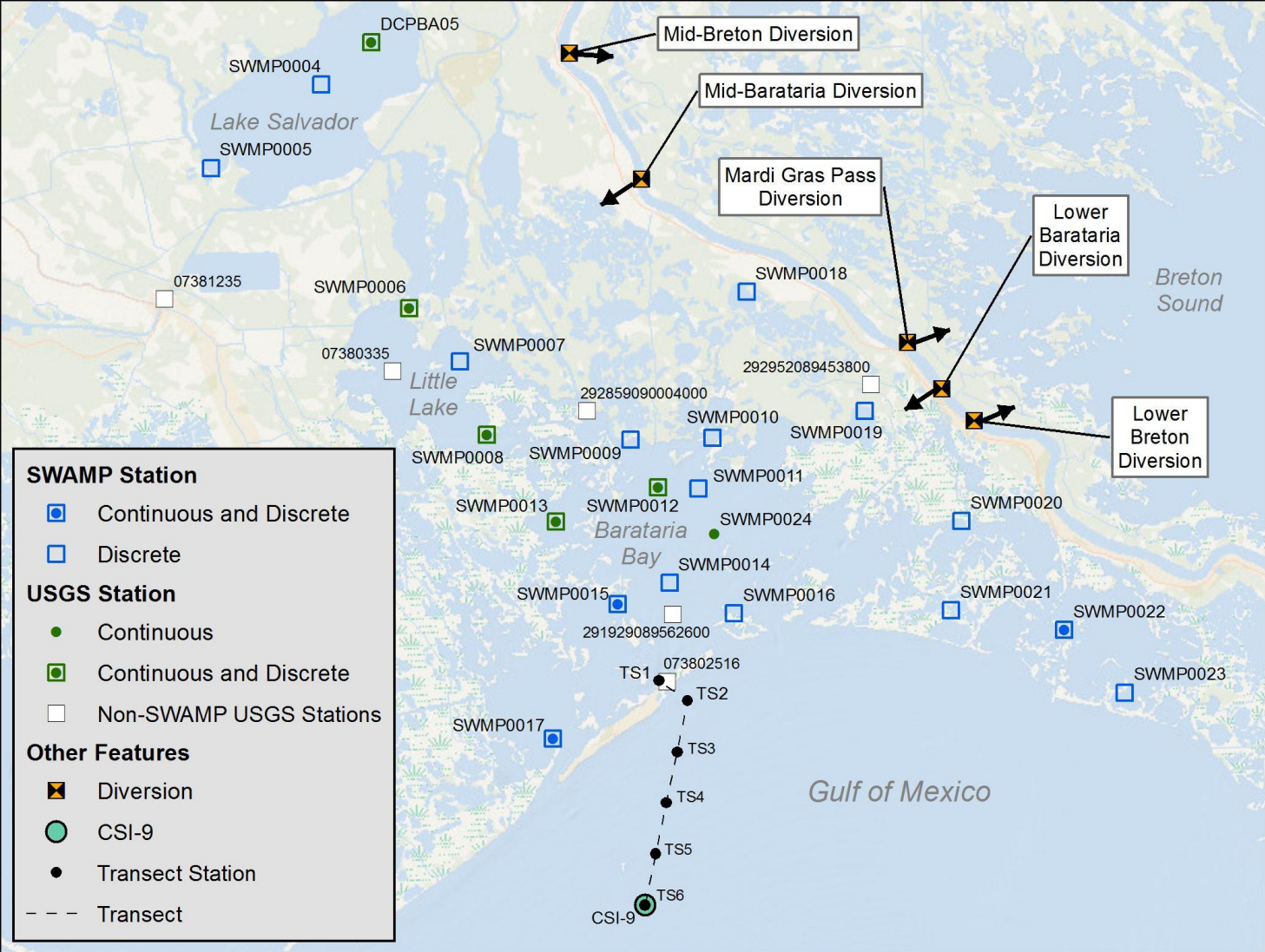


SWAMP Timeline



Monitoring Transect from Barataria Pass to Inner Shelf

State of Louisiana Coastal Monitoring Workgroup



Extra Slides

Biotic Integrity Vegetation



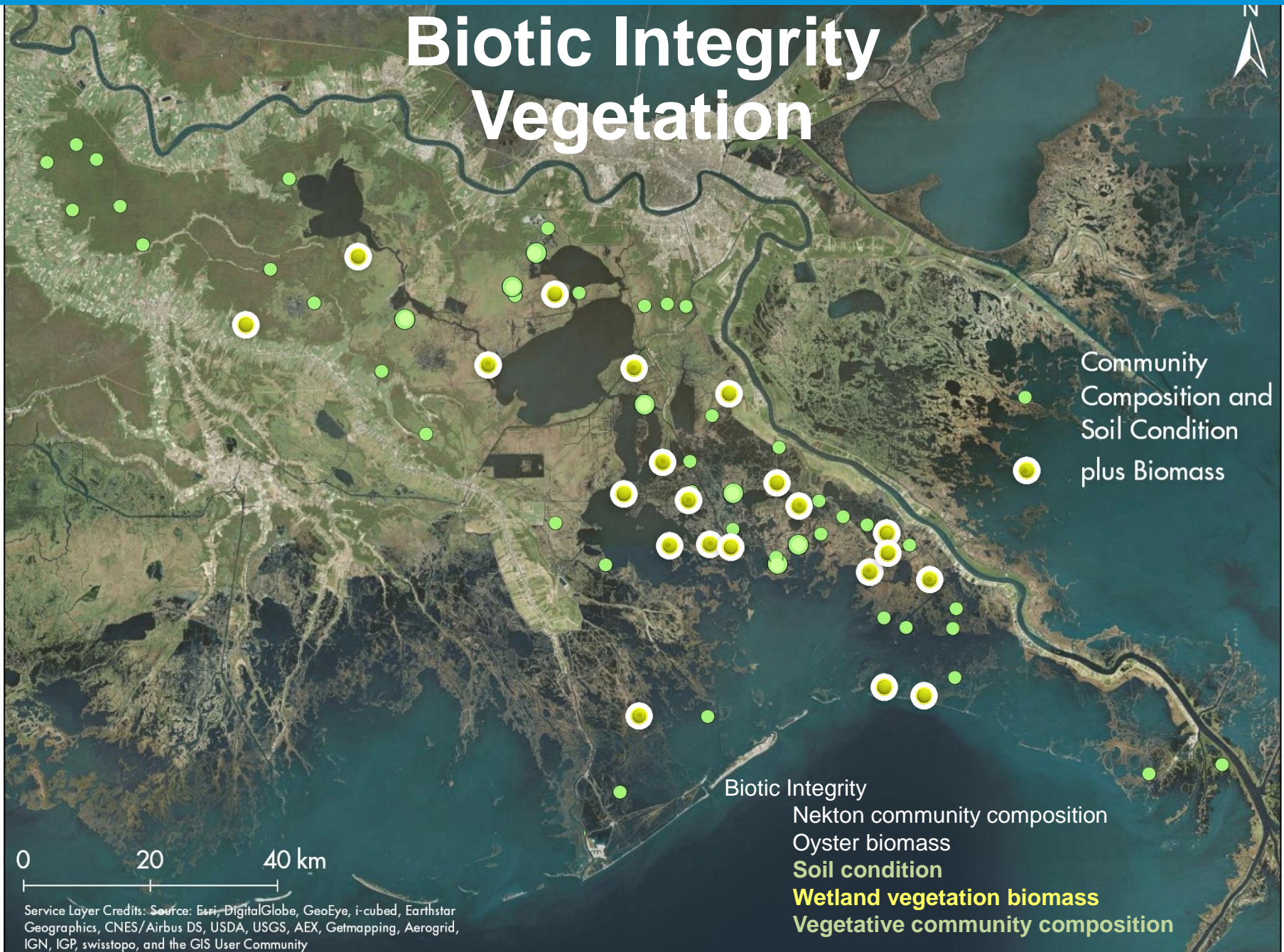
Community
Composition and
Soil Condition
plus Biomass

Biotic Integrity
Nekton community composition
Oyster biomass
Soil condition
Wetland vegetation biomass
Vegetative community composition

0 20 40 km

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar
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Biotic Integrity Vegetation



Community
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Soil Condition
plus Biomass

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Tidal Passes



SWAMP 2: BS, MRD, Pontchartrain

Table B:2. Recommended sample sizes for the Pontchartrain Region natural system monitoring plan.

See Appendix II for change detecting information on an individual variable basis.

MONITORING CATEGORY	VARIABLE	EXISTING MONITORING IN PONTCHARTRAIN REGION: NUMBER OF SITES	EXISTING MONITORING IN PONTCHARTRAIN REGION: SAMPLING FREQUENCY	NEW SITES FOR PONTCHARTRAIN REGION: NUMBER OF ADDITIONAL SITES	NEW SITES FOR PONTCHARTRAIN REGION: SAMPLING FREQUENCY	SAMPLE SIZE METHOD	SITE SELECTION METHOD
Weather and Climate	Potential Evapo-transpiration	Calculated, not measured directly.					
	Precipitation	49 sites plus gridded datasets from NOAA	Subhourly	2	Subhourly	Expert Knowledge	Utilize existing platforms
	Wind	20 sites plus gridded datasets from NOAA	Subhourly	2	Subhourly	Expert Knowledge	Utilize existing platforms
Biotic Integrity	Nekton Community Composition	31 gillnet, 31 trawl, 29 seine sites; 27 electrofishing	Variable: Weekly to quarterly	None	Monthly	Power Analysis	N/A
	Oyster biomass	44 square meter	Annually	None	Increase to semi-annually to quarterly	Expert knowledge	Should conduct oyster mapping prior to site selection
	Soil condition	CRMS: 27 forested wetlands and 62 herbaceous wetlands	Once every ten years	None	N/A	Power Analysis on herbaceous wetlands only	Utilize existing CRMS sites
	Wetland vegetation biomass	CPRA: 7 CRMS	Once	13 plus revisit 8 existing sites	Once every five years	Power Analysis on herbaceous wetlands only	Utilize existing CRMS sites
	Wetland vegetation community composition	CRMS: 27 forested wetlands and 62 herbaceous wetlands	Annually	None	Annually	Power Analysis	Utilize existing CRMS sites

SWAMP 2: BS, MRD, PO

MONITORING CATEGORY	VARIABLE	EXISTING MONITORING IN PONTCHARTRAIN REGION: NUMBER OF SITES	EXISTING MONITORING IN PONTCHARTRAIN REGION: SAMPLING FREQUENCY	NEW SITES FOR BPONTCHARTRAIN REGION: NUMBER OF ADDITIONAL SITES	NEW SITES FOR PONTCHARTRAIN REGION: SAMPLING FREQUENCY	SAMPLE SIZE METHOD	SITE SELECTION METHOD
Water Quality	Chlorophyll a	No existing sites	N/A	22	Monthly	Power Analysis	GRTS
				6	Sub-hourly	Expert knowledge	
	Dissolved oxygen (DO)	LDEQ: 62	LDEQ: Monthly, every four years LDWF: Variable	27 (plus additional 13 for pilot study)	Monthly	Power Analysis	GRTS
				8	Subhourly	Expert Knowledge	
	Nutrient constituents	LDEQ: 62	Monthly, every four years	27 (plus additional 13 for pilot study)	Monthly	Power Analysis	GRTS
	Salinity	USGS: 62 CPRA: 89	Hourly	8	Hourly	Power Analysis	GRTS
	Turbidity	LDEQ: 62	LDEQ: Monthly, every four years LDWF: Variable	27 (plus additional 13 for pilot study)	Monthly	Power Analysis	GRTS
8				Sub-hourly	Expert knowledge		
Total Suspended Solids	LDEQ: 62	LDEQ: Monthly, every four years LDWF: Variable	27 (plus additional 13 for pilot study)	Monthly	Power Analysis	GRTS	
Hydrology	Current Velocity	No existing sites	N/A	None	Hourly	Expert Knowledge	Expert Knowledge
	Water level	USGS: 62 CPRA: 89	Hourly	8	Hourly	Power Analysis	GRTS; Expert Knowledge
	Waves	NDBC: 1	Hourly	5	Hourly	Expert Knowledge	Utilize existing USGS platforms
Physical Terrain	Bathymetry	CPRA: Barrier islands (BICM)	BICM every 5-10 years	Regularly spaced transects in open water bodies; single-track multibeam down canals	Decadal	Expert Knowledge	Expert Knowledge
	Land Area	CRMS Coastwide	3-5 years	None	N/A	Expert Knowledge	None
	Surface Elevation	CPRA: 89 SETs	Semiannually	None	N/A	Expert Knowledge	None