Analyzing the Potential Impacts to Cultural Resources at Significant Sand Extraction Areas: Geological and Physical Processes Investigations

Quin Robertson
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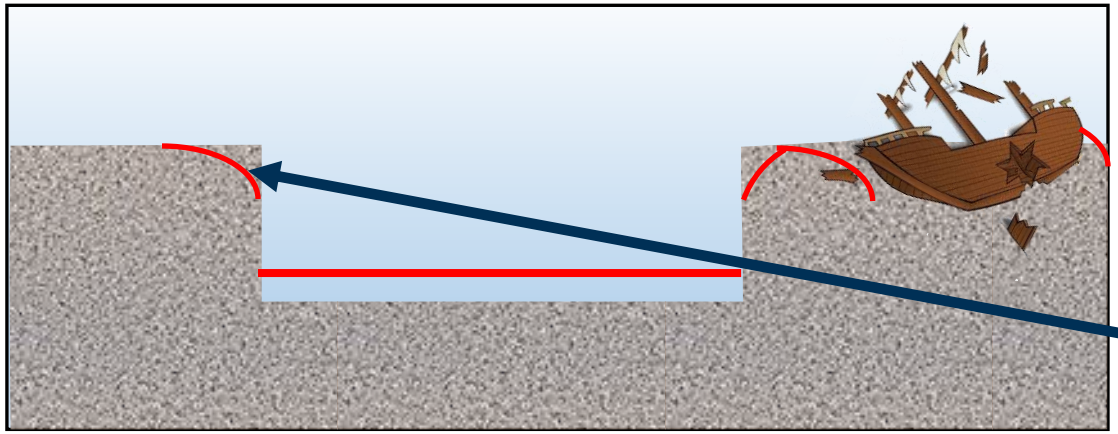
Beth Forrest

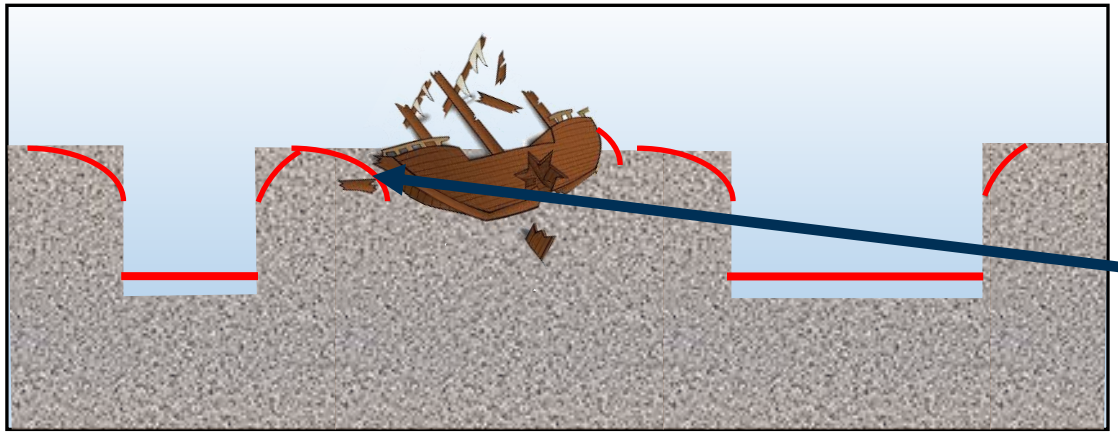
Gordon Watts
Robin Arnold
Doug Jones

Who is Aptim Environmental & Infrastructure, Inc. (APTIM)?

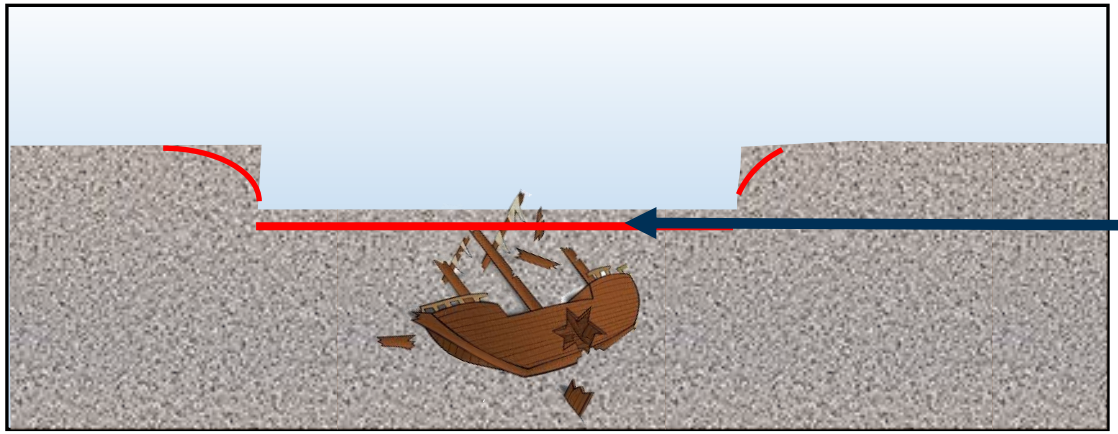
Conceptual Model



LSU Study (Narin)



Scour (Quinn)



Erosion (ebb scour)

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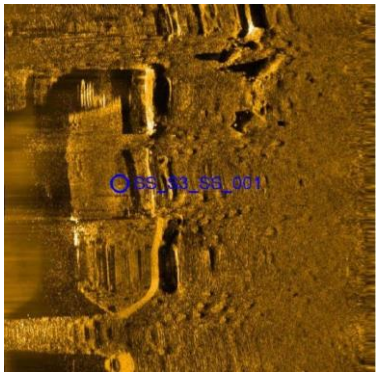
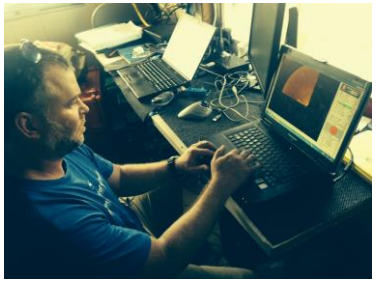
Goals

- Provide information on the location and preservation of potential shipwrecks within or near selected sand borrow areas
- Help BOEM comply with Section 106 responsibilities
- Provide guidance on best management strategies that should be employed for cultural resource sites
- Develop public outreach tools to highlight BOEM's Marine Minerals and Archaeology Programs





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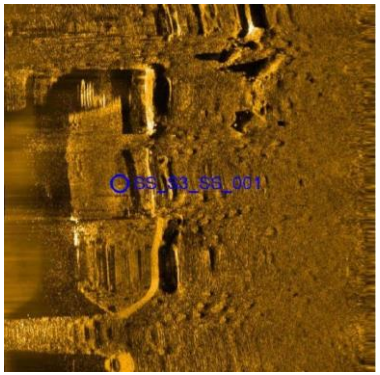
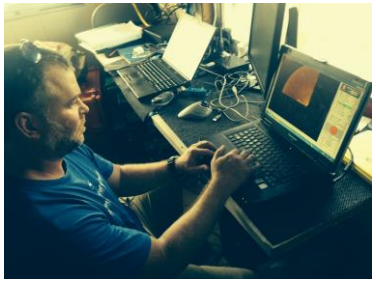
Tasks

1. **Literature search, data collection and review**
   - Site selection
   - Geophysical surveys
2. **Analysis of data collected during Task 1**
   - Archaeological field investigations
   - Collection of geotechnical data
3. **Primary and secondary source archival research**
4. **National Register nomination forms**

   A. Development of predictive conceptual model
5. **Public outreach**





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Task 1 - Literature Search and Data Review

- **Existing in house data & data provided by BOEM**
  - Bathymetry
  - Sub-bottom
  - Sidescan sonar
  - Magnetometer
  - Cultural resource reports
  - Core borings & grab samples
  - Oil & gas infrastructure
  - Existing avoidance areas
  - Shipwrecks
  - Isopachs
  - Borrow areas

500+ datasets compiled and reviewed

Used to facilitate planning for additional survey and wreck assessment activities

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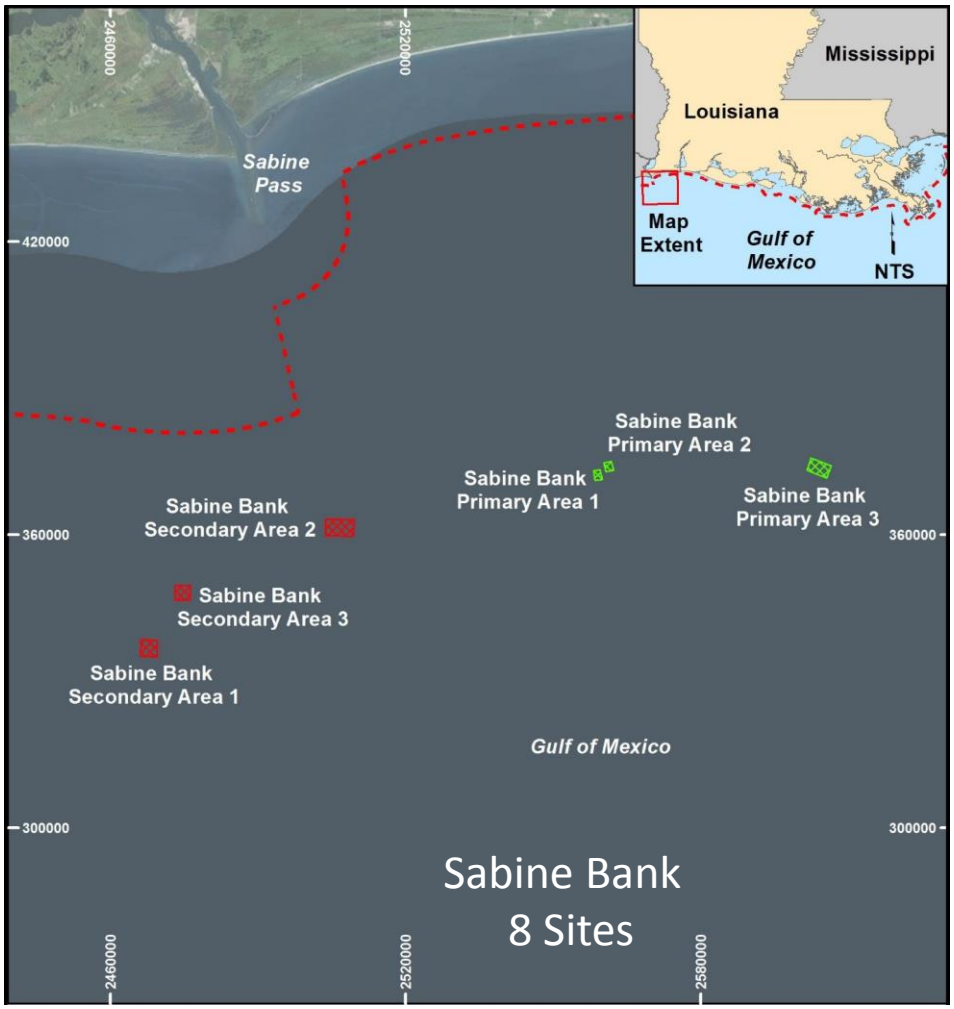
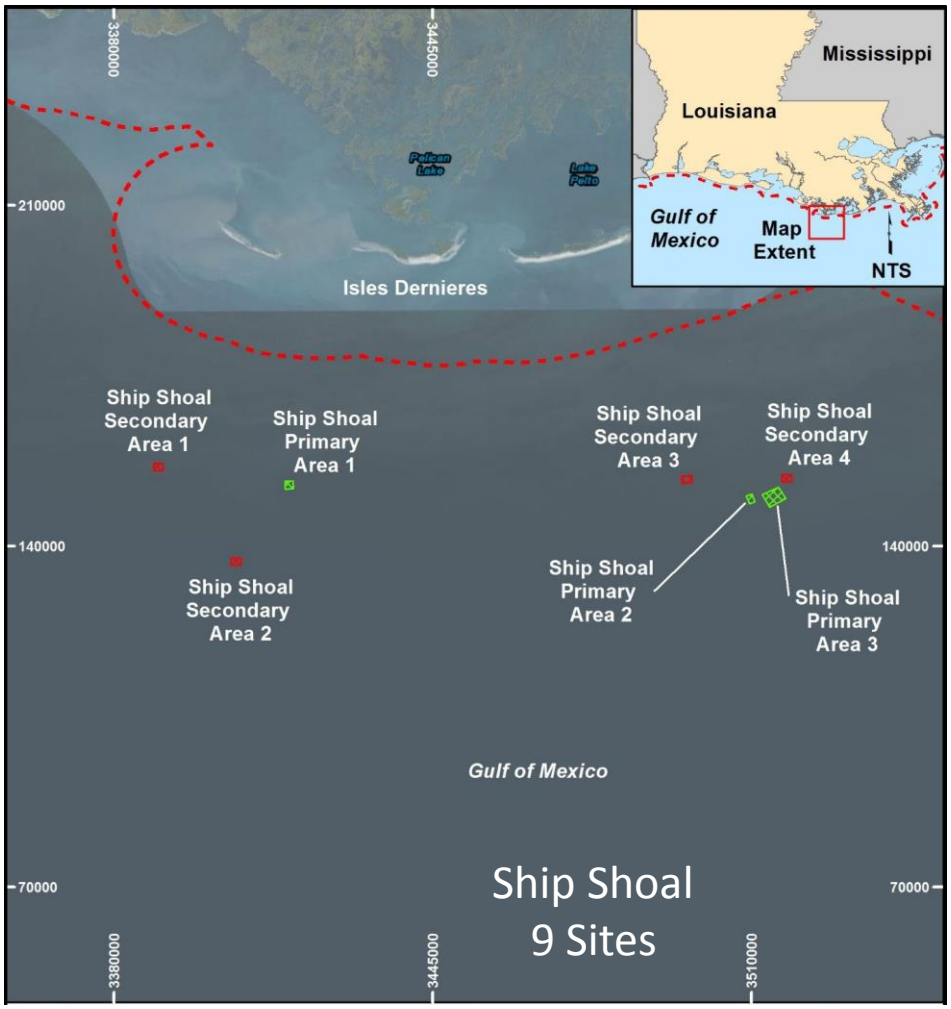
Task 1 - Site Selection

- Charted wrecks and obstructions
- Previously identified magnetic anomalies and sonar targets
- Anomaly and target signature characteristics
- Proximity to borrow area
- Sediment type
- Borrow area geometry
- Wave climate

Task 1 - Site Selection





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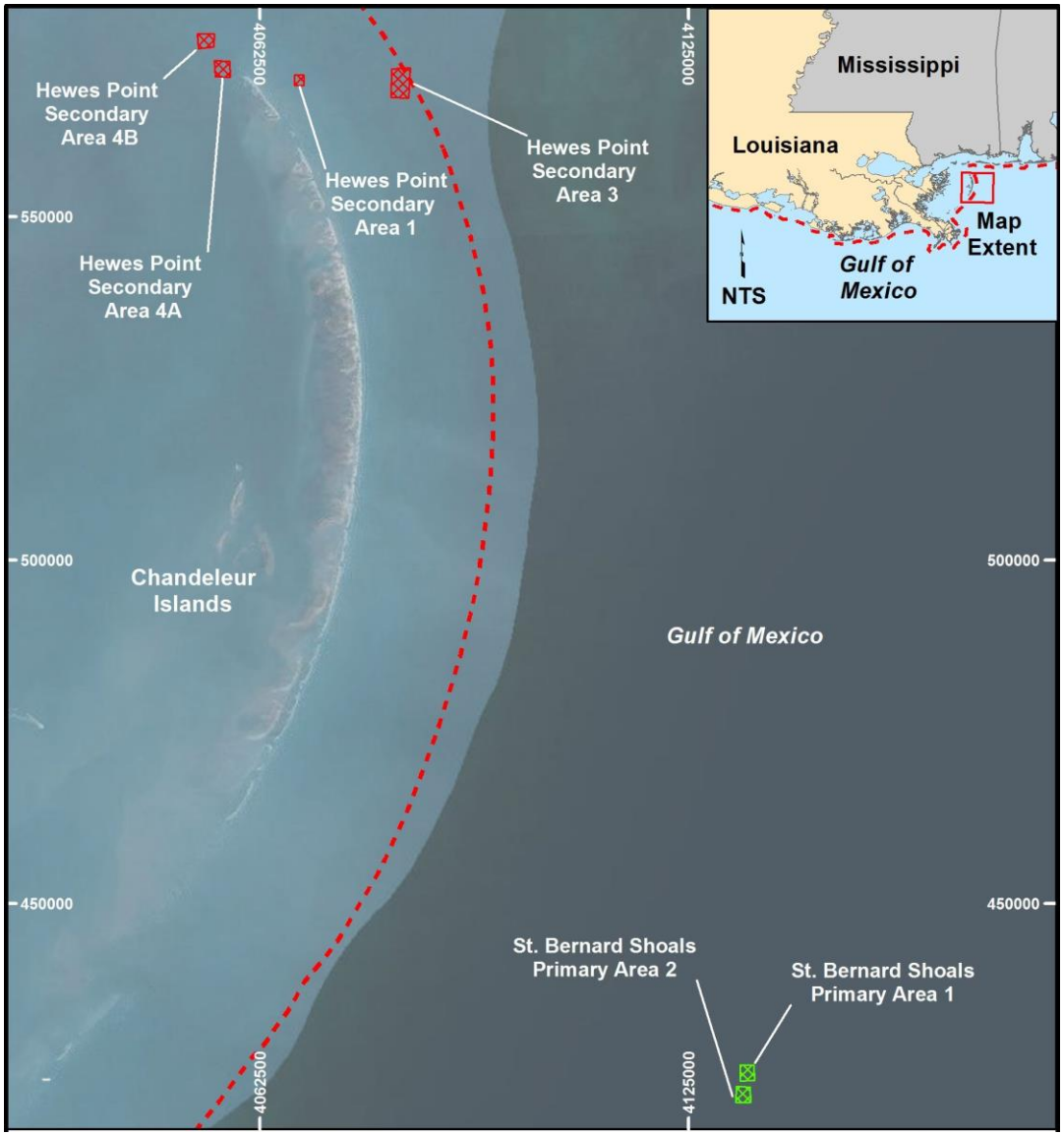
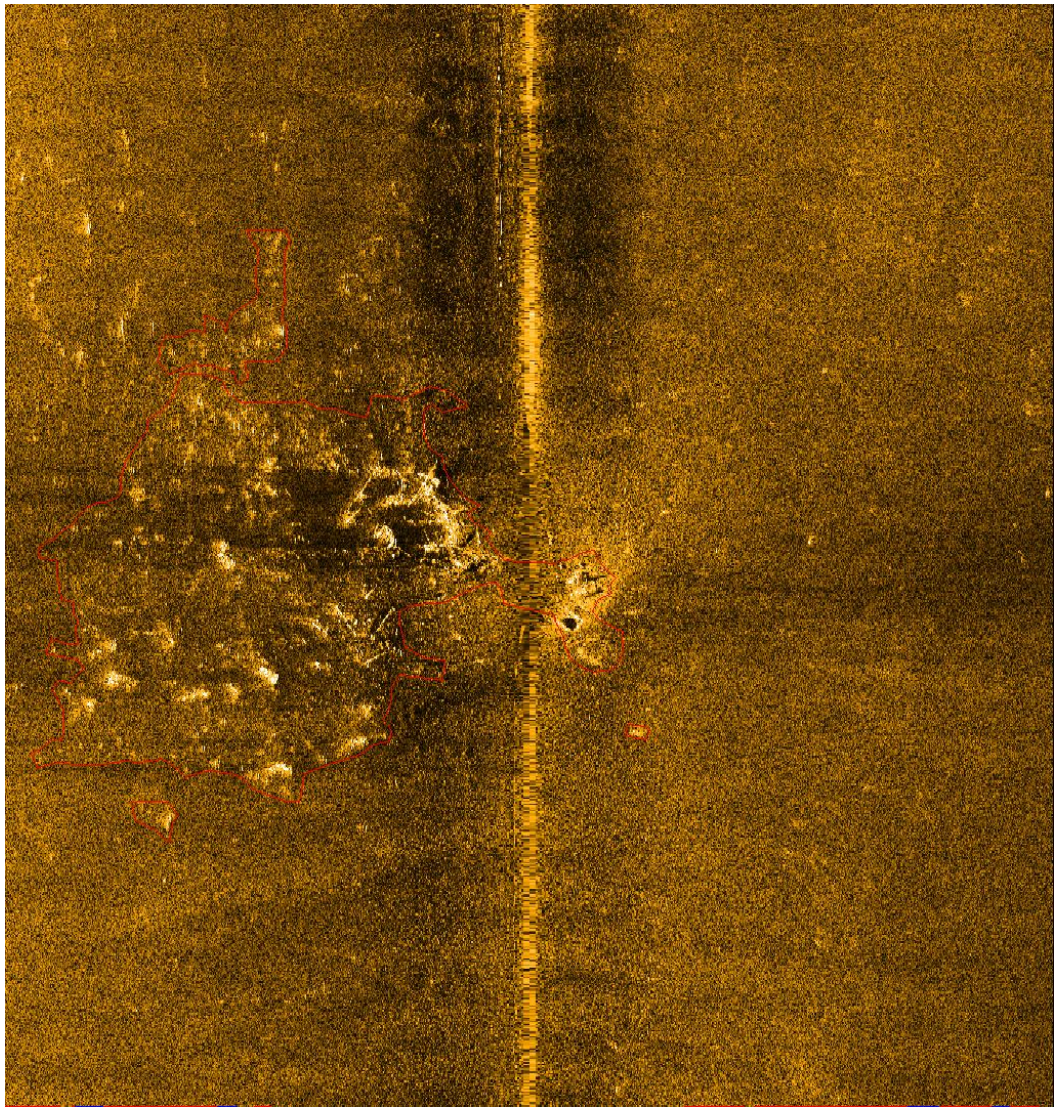
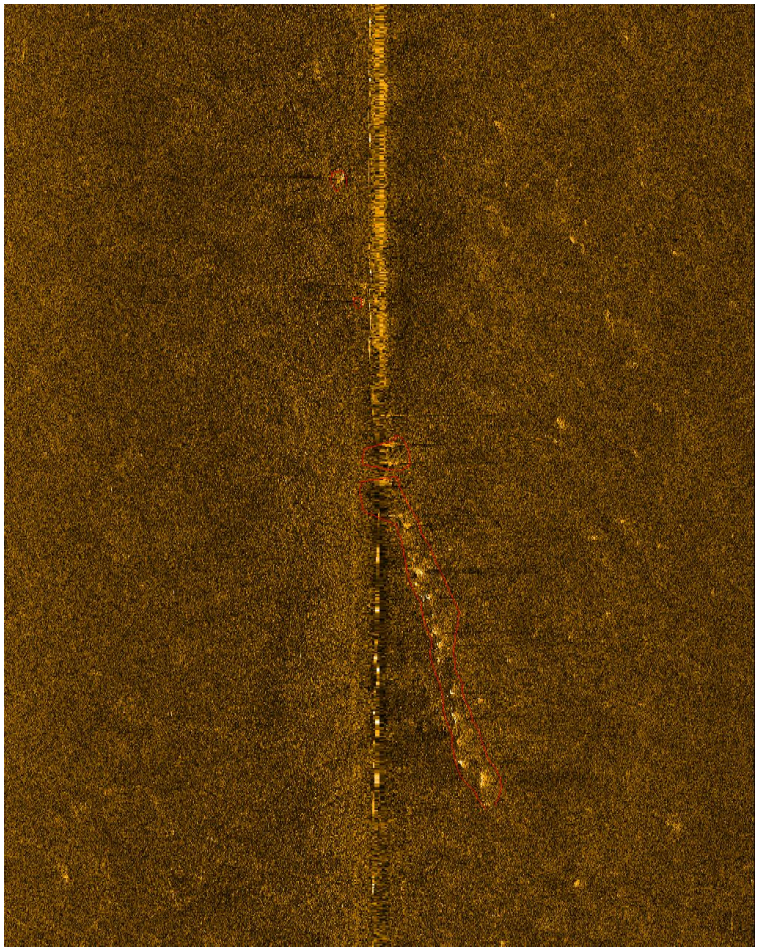
Task 1 - Site Selection

- St. Bernard Shoal: 9 sites
- Hewes Point: 4 sites
- Chandeleur Islands: 1 site
  - Ballast Pile



Hewes Point Lighthouse





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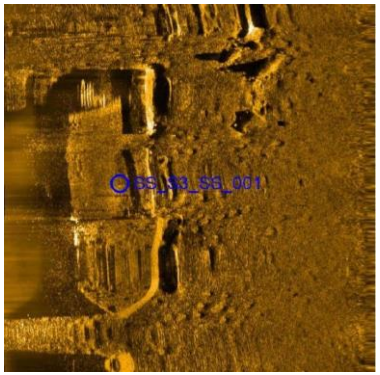
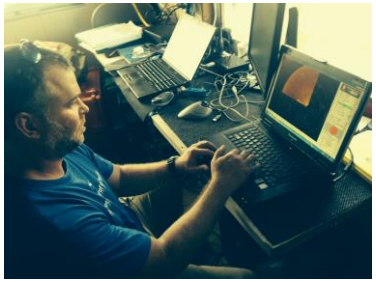
Task 1 - Remote Sensing Surveys

- **Geophysical data were collected to:**
  - Characterize sand resources
  - Morphologic evolution and sediment dynamics of dredge pits (difference from historic data)
  - Assess effectiveness of dredging setback buffers





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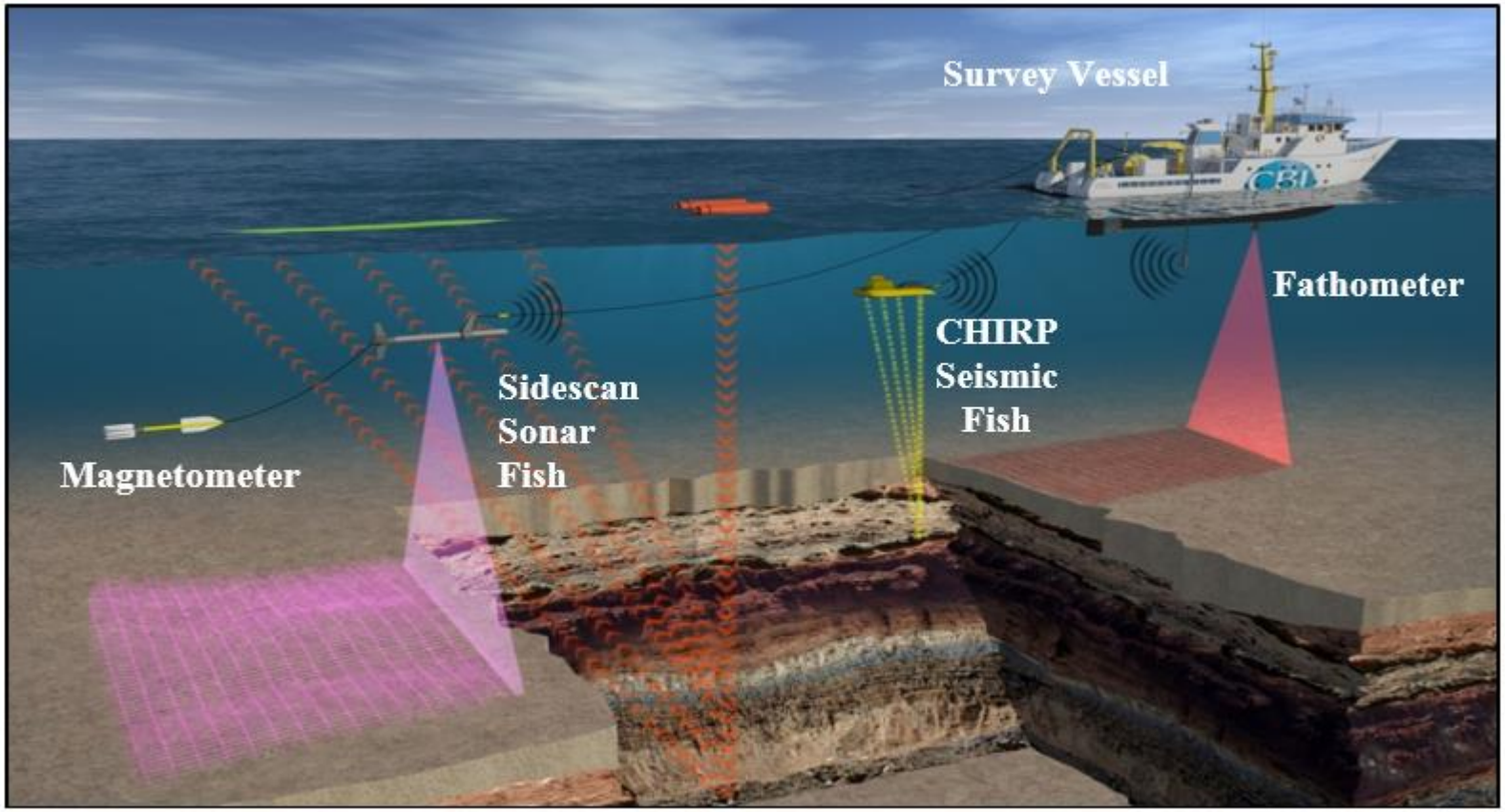
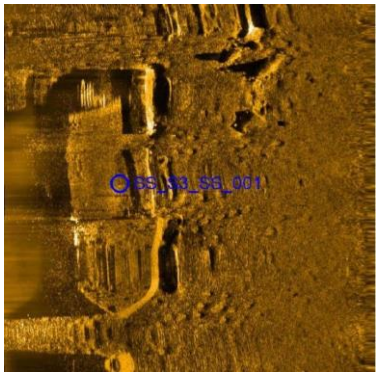
Task 1 - Remote Sensing Surveys

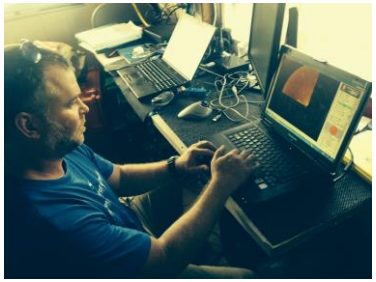
- Fathometer, magnetometer, sidescan sonar, subbottom profiler with maximum transect spacing of 30 m



Task 1-Remote Sensing Surveys

Survey Area	Date Surveyed	Total Line Miles (nautical miles)
Sabine Bank Primary Area 1	09/06/2013-09/07/2013	13.89
Sabine Bank Primary Area 2	09/06/2013	14.19
Sabine Bank Primary Area 3	09/05/2013	24.97
Sabine Bank Secondary Area 1	09/07/2013	11.20
Sabine Bank Secondary Area 2	09/07/2013	5.63
Sabine Bank Secondary Area 3	09/07/2013	8.34
Ship Shoal Primary Area 1	09/08/2013-09/09/2013	13.74
Ship Shoal Primary Area 2	09/10/2013	5.00
Ship Shoal Primary Area 3	09/10/2013	22.77
Ship Shoal Secondary Area 1	09/09/2013	9.93
Ship Shoal Secondary Area 2	09/09/2013	10.99
Ship Shoal Secondary Area 3	09/10/2013	4.75
Ship Shoal Secondary Area 4	09/11/2013	9.27
Ship Shoal Secondary Area 5	09/11/2013	4.75
Hewes Point Secondary Area 1	09/14/2013	12.38
Hewes Point Secondary Area 3	09/12/2013-09/13/2013	21.42
Hewes Point Secondary Area 4A	09/14/2013	1.49
Hewes Point Secondary Area 4B	09/14/2013	1.38
St. Bernard Shoals Primary Areas 1&2	09/14/2013-09/15/2013	30.00
TOTAL:		**226.09**





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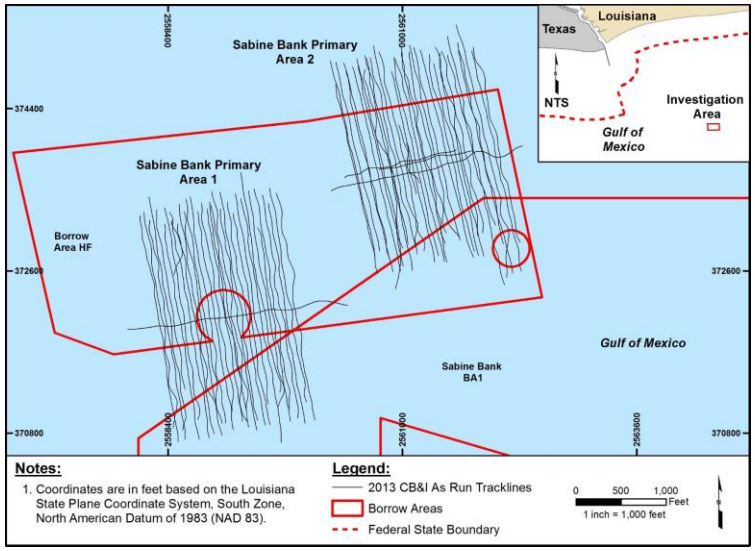
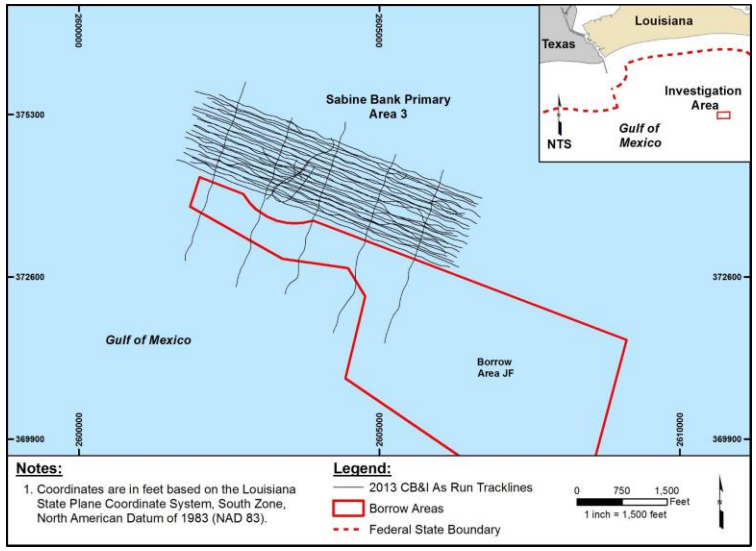
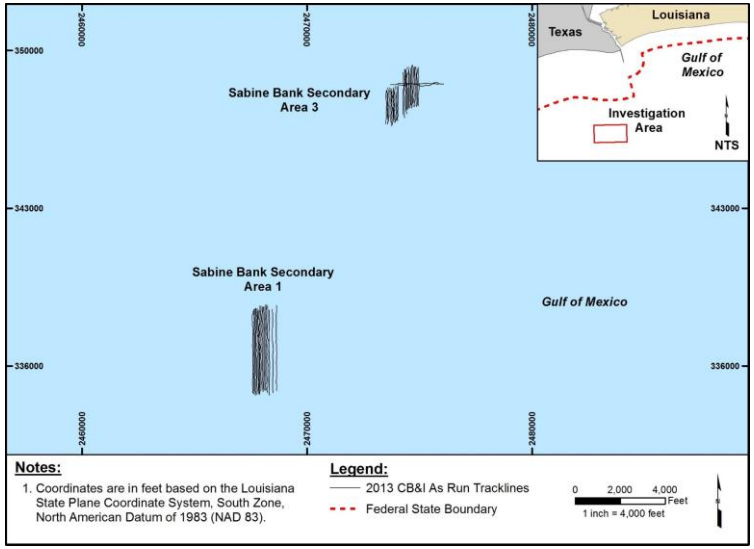
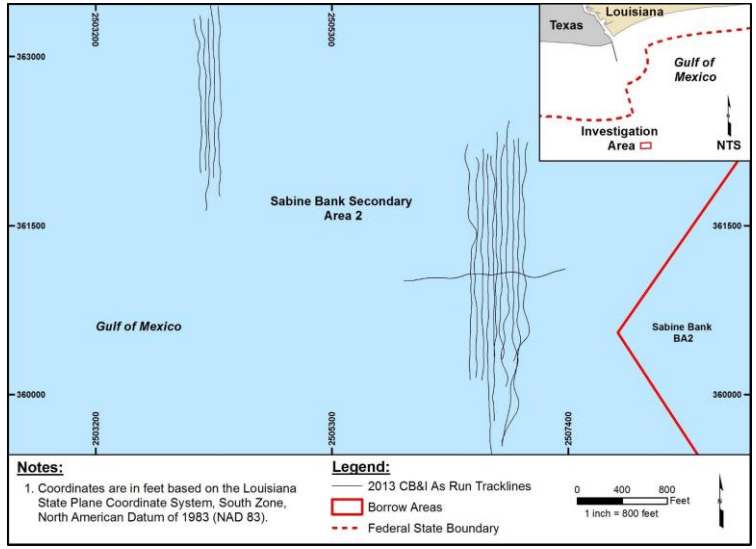
Task 1 - Remote Sensing Surveys: Sabine Bank









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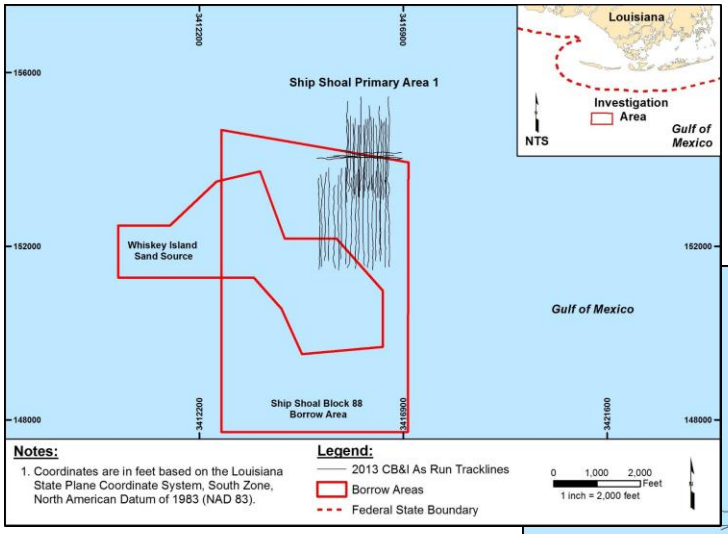
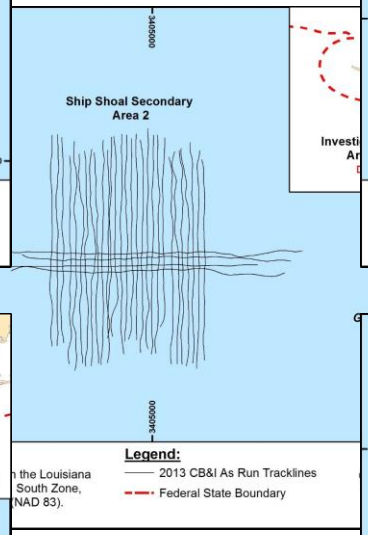
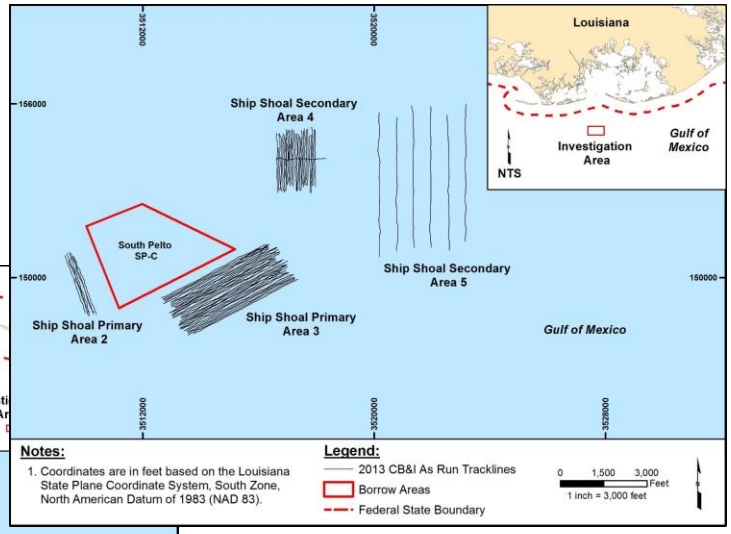
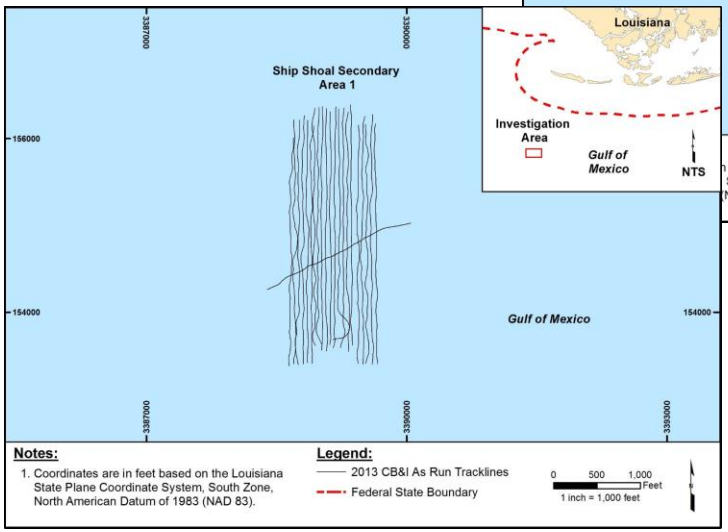
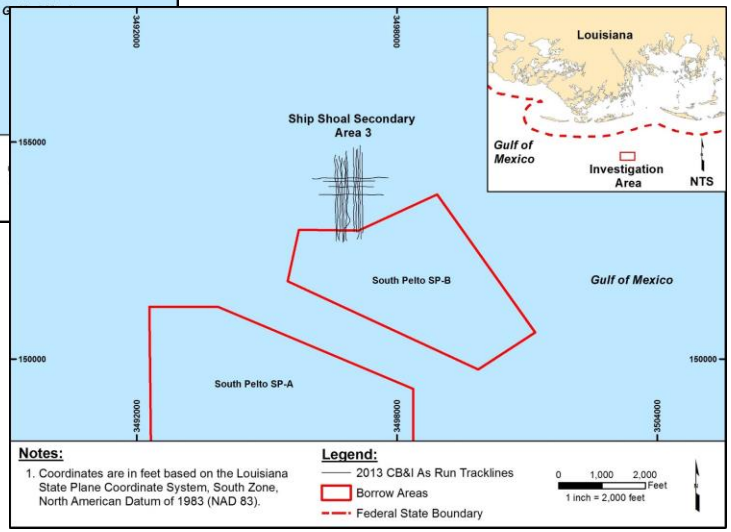
Task 1-Remote Sensing Surveys: Ship Shoal











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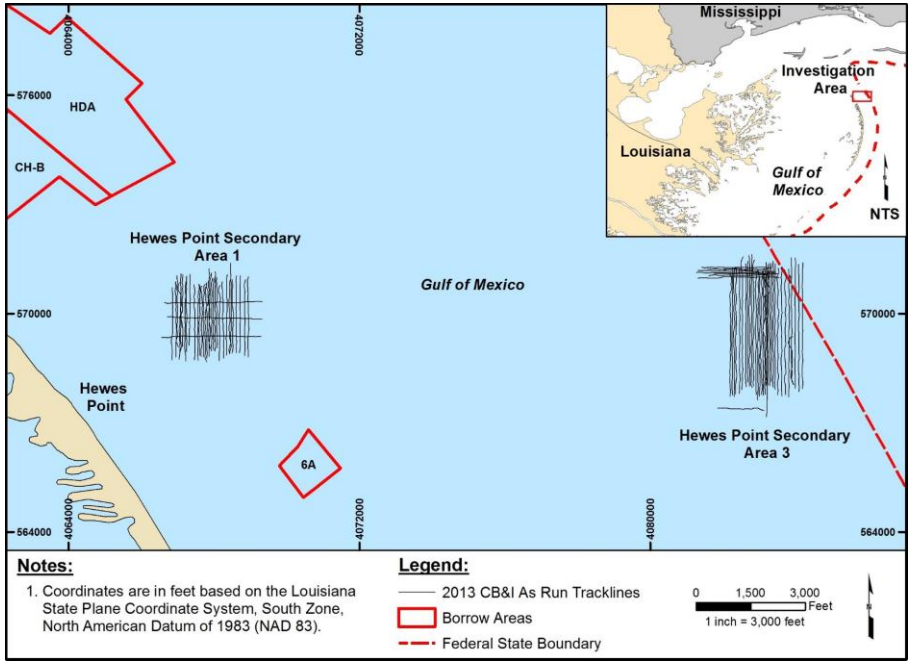
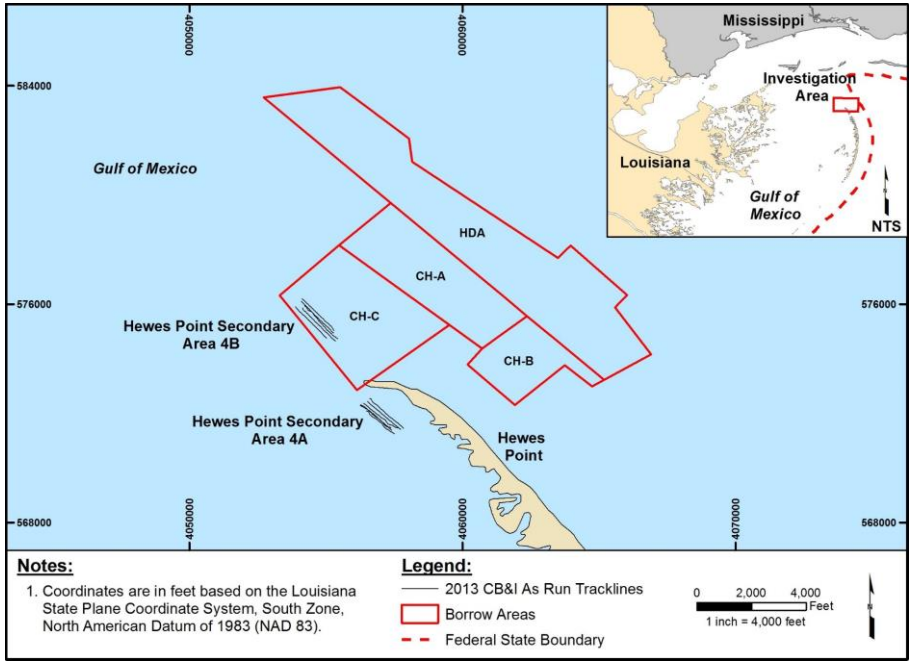
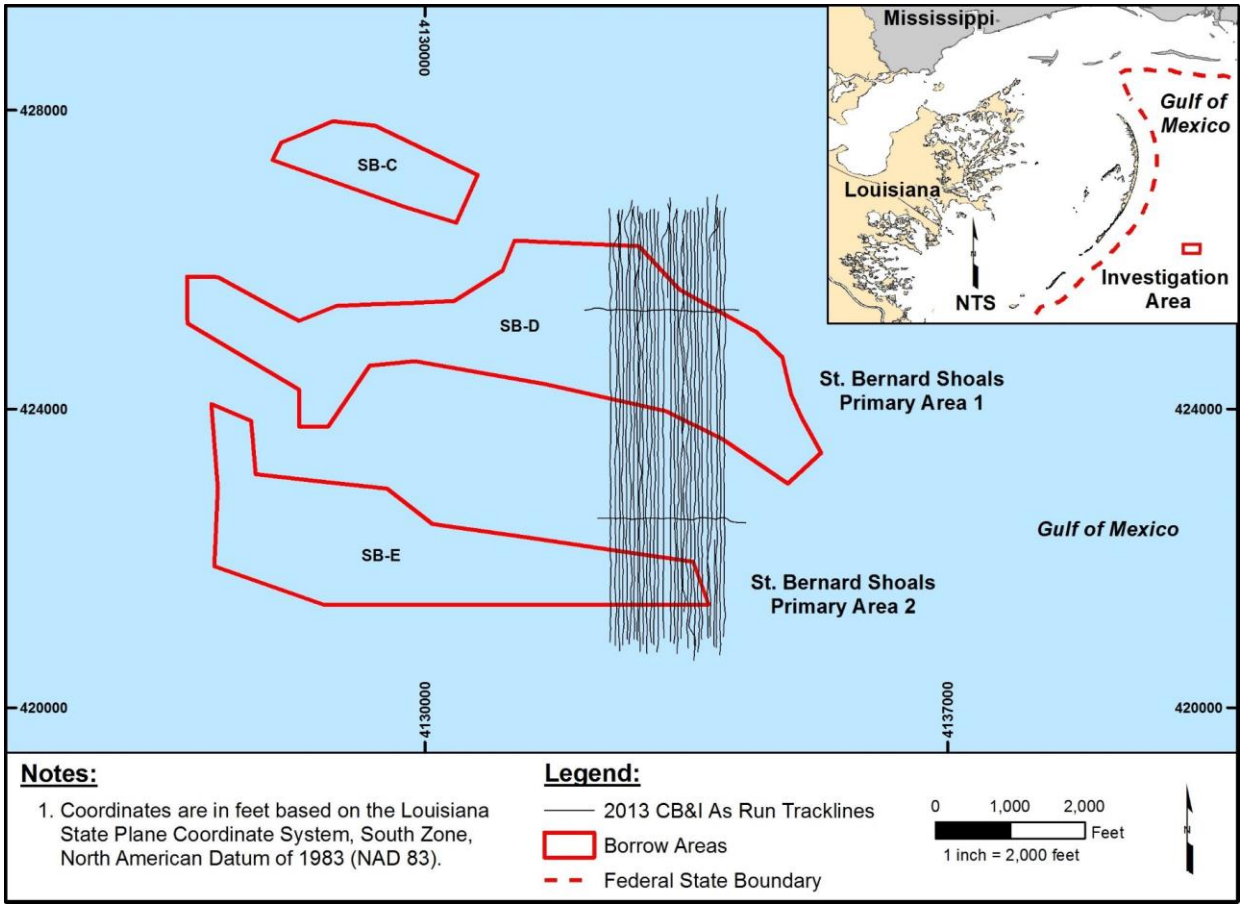
Task 1 - Remote Sensing Surveys: Hewes Point



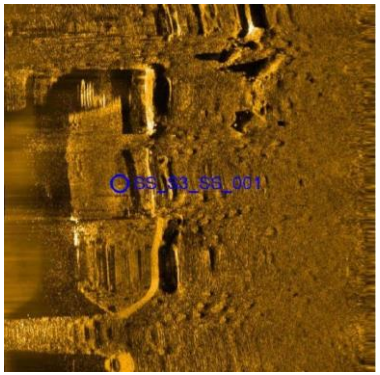


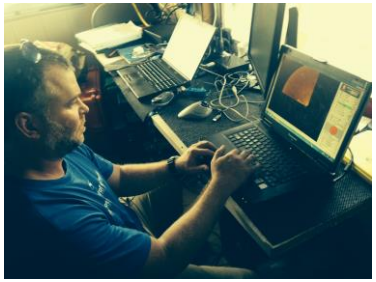
Task 1 - Remote Sensing Surveys: St. Bernard Shoal



Task 2 - Analysis of Task 1 Data

- 10 sites initially selected for diver investigation
- 12 sites ultimately investigated:
  - Ship Shoal Primary Area 2
  - Ship Shoal Secondary Area 2
  - Ship Shoal Secondary Area 3
  - Sabine Bank Primary Area 1
  - Sabine Bank Primary Area 3
  - Sabine Bank Secondary Area 1
  - Sabine Bank Secondary Area 2
  - Sabine Bank Secondary Area 3
  - Hewes Point Secondary Area 4A
  - Hewes Point Secondary Area 4B
- 2 additional sites (ballast pile)





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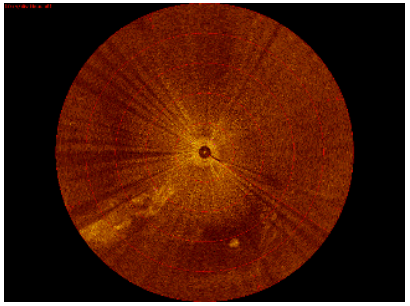
Task 2 - Geotechnical Investigation

- 10 core borings from Sabine Bank (pneumatic)
- Sector search



Boring Designation SBVC-15-01

DRILLING LOG

1. PROJECT	BOEM Cultural Resource Investigation Ship Shoal/Sabine, Louisiana
2. BORING DESIGNATION	SBVC-15-01
LOCATION COORDINATES	X = 2,468,302 Y = 336,642
3. DRILLING AGENCY	American Vibracore Services, Inc.
CONTRACTOR FILE NO.	
4. NAME OF DRILLER	Brian McCord
5. DIRECTION OF BORING	☒ VERTICAL ☐ INCLINED
DEG. FROM VERTICAL	
BEARING	
6. THICKNESS OF OVERBURDEN	0.0 Ft.
7. DEPTH DRILLED INTO ROCK	0.0 Ft.
8. TOTAL DEPTH OF BORING	20.0 Ft.
9. SIZE AND TYPE OF BIT	3.5 In.
10. COORDINATE SYSTEM/DATUM	HORIZONTAL: Louisiana South State Plane, NAD 1983; VERTICAL: NAVD 88
11. MANUFACTURER'S DESIGNATION OF DRILL	Apine Pneumatic Vibracore
AUTO HAMMER / MANUAL HAMMER	
12. TOTAL SAMPLES	DISTURBED / UNDISTURBED (UD)
13. TOTAL NUMBER CORE BOXES	
14. ELEVATION GROUND WATER	
15. DATE BORING	STARTED 02-03-15 08:23; COMPLETED 02-03-15 08:24
16. ELEVATION TOP OF BORING	-34.7 Ft.
17. TOTAL RECOVERY FOR BORING	18.3 Ft.
18. SIGNATURE AND TITLE OF INSPECTOR	DA

ELEV. (ft)	DEPTH (ft)	CLASSIFICATION OF MATERIALS (Depths and elevations based on measured values)	% REC.	SAMPLE OR CORE NO.	REMARKS
-34.7	0.0	CLAY, trace sand, sand distributed in pockets, very dark gray (2.5Y-3/1), (CL).		T1	Sample #T1, Depth = 0.7' Ave. Field Vane (tsf): 0.13
-36.3	1.6				Sample #1, Depth = 1.6'
-36.7	2.0	SILT, trace sand, trace shell fragments, very dark gray (2.5Y-3/1), (ML).		1	Mean (mm): 0.15, Phi Sorting: 0.91 Fines (230): 76.97% (ML)
-37.8	3.1	SAND, fine grained, quartz, trace clay, trace shell fragments, (4.0"x1.75") pocket of clay at 2-3', dark gray (2.5Y-4/1), (SW-SC).		2	
-38.7	4.0	CLAY, very dark gray (2.5Y-3/1), (CL).		T2	Sample #T2, Depth = 3.6' Ave. Field Vane (tsf): 0.06
-42.8	8.1	SAND, fine grained, quartz, trace clay, trace shell fragments, clay distributed in pockets up to 0.5", (2.5-4/1), (SW-SC).		2	Sample #2, Depth = 6.4' Mean (mm): 0.21, Phi Sorting: 1.22 Fines (230): 4.85% (SW-SC)
-45.4	10.7	SAND, fine grained, quartz, some clay, trace shell fragments, very dark gray (2.5Y-3/1), (SC).		3	Sample #3, Depth = 9.4' Mean (mm): 0.16, Phi Sorting: 0.75 Fines (230): 20.79% (SC)
-48.7	14.0	SAND, fine grained, quartz, some clay, trace shell fragments, very dark gray (2.5Y-3/1), (SC).			
-50.3	15.6	Clayey SAND, fine grained, quartz, trace shell fragments, very dark gray (2.5Y-3/1), (SC).			
-53.0	18.3	Sandy CLAY, trace shell fragments, (2.0"x0.75") rock at 18.2', very dark gray (2.5Y-3/1), (CL).			
-54.7	20.0	No Recovery.			
		End of Boring.			

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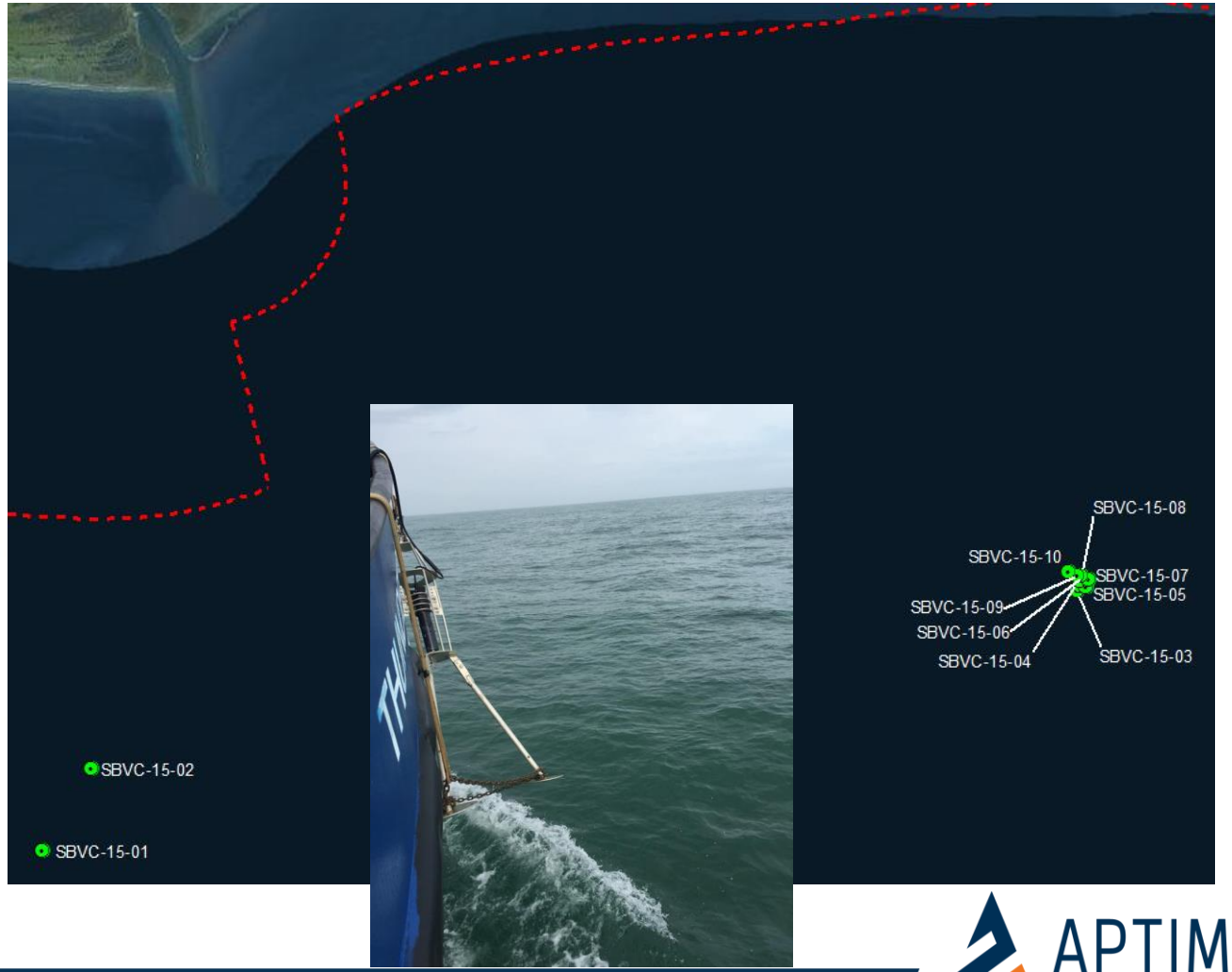

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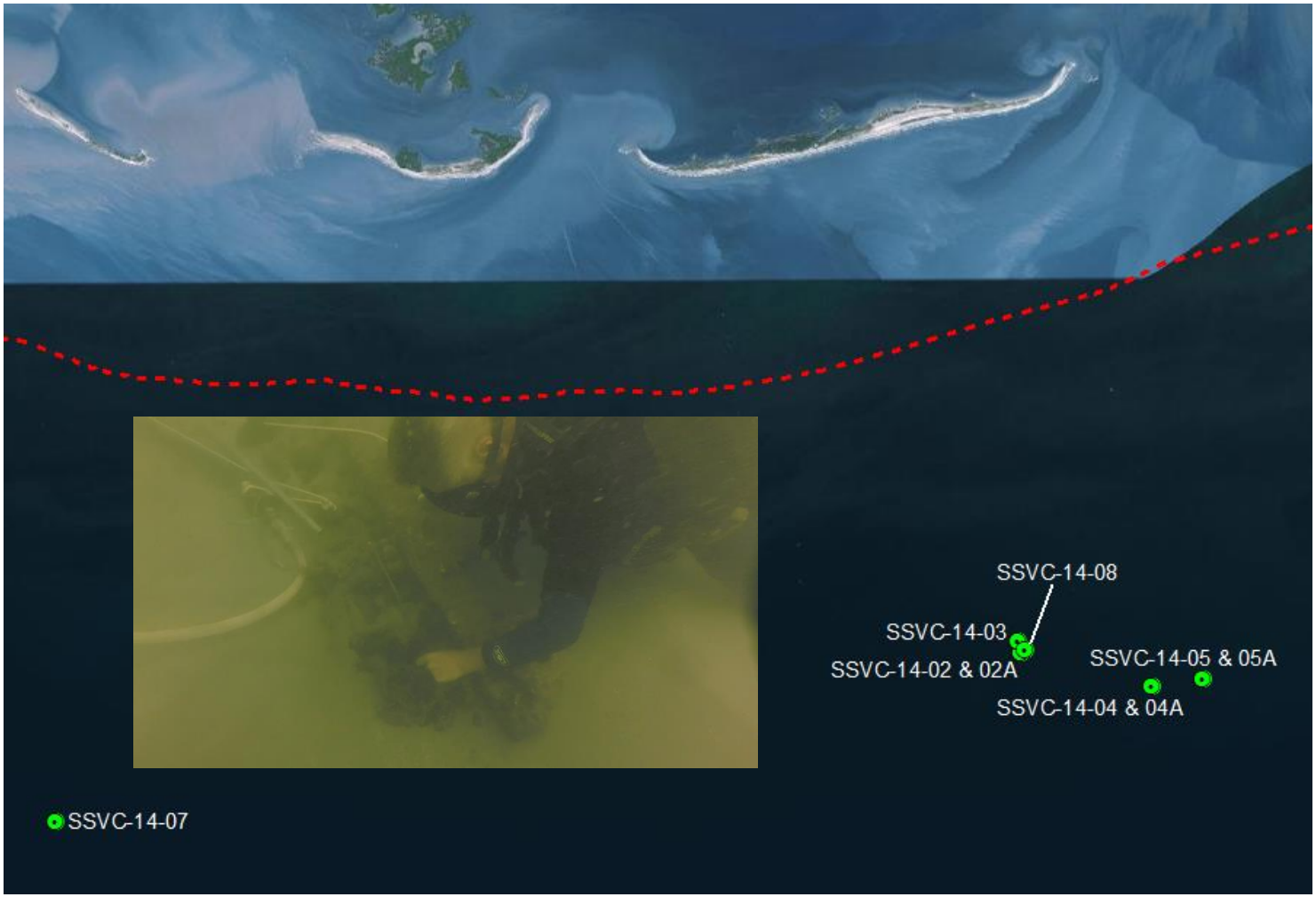
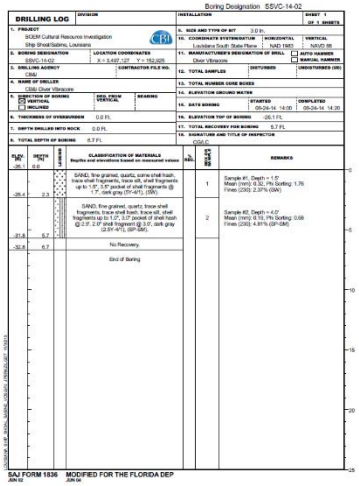
Task 2 - Geotechnical Investigation

- 9 core borings from Ship Shoal (diver collected)




Boring Designation SSVC-14-02

DRILLING LOG

1. PROJECT	SCDM Cultural Resource Investigation Ship Shoal Salomi, Louisiana
2. BORING DESIGNATION	SSVC-14-02
3. DRILLING AGENCY	CBI
4. NAME OF DRILLER	CBI Dive Vibracore
5. DIRECTION OF BORING	VERTICAL
6. THICKNESS OF OVERBURDEN	0.0 Ft.
7. DEPTH DRILLED INTO ROCK	0.0 Ft.
8. TOTAL DEPTH OF BORING	6.7 Ft.
9. SIZE AND TYPE OF BIT	3.0 In.
10. COORDINATE SYSTEM/DATUM	HORIZONTAL: Louisiana South State Plane, NAD 1983; VERTICAL: NAVD 88
11. MANUFACTURER'S DESIGNATION OF DRILL	Diver Vibracore
12. TOTAL SAMPLES	DISTURBED: 2; UNDISTURBED (SS):
13. TOTAL NUMBER CORE BOXES	
14. ELEVATION GROUND WATER	
15. DATE BORING	STARTED: 05-26-14 14:00; COMPLETED: 05-26-14 14:20
16. ELEVATION TOP OF BORING	-26.1 Ft.
17. TOTAL RECOVERY FOR BORING	6.7 Ft.
18. SIGNATURE AND TITLE OF INSPECTOR	Diver

ELEV. (Ft.)	DEPTH (Ft.)	LEGEND	CLASSIFICATION OF MATERIALS (Depths and elevations based on measured values)	NO.	BLOW COUNTS	REMARKS
-26.1	0.0		GRAD, fine grained, quartz, some shell hash, trace shell fragments, trace silt, shell fragments up to 1.0", 1.0' pocket of shell fragments @ 1.0', dark gray (5Y-4/1) (SW).	1		Sample #1, Depth = 1.5' Mean (mm): 0.32, Ph Sorting: 1.76 Fines (230): 2.37% (SW)
-28.4	2.3		SAND, fine grained, quartz, trace-shell fragments, trace shell hash, trace silt, shell fragments up to 1.0", 1.0' pocket of shell hash @ 2.3', 2.0" shell fragment @ 3.0', dark gray (2.5Y-4/1), (SP-SM).	2		Sample #2, Depth = 4.0' Mean (mm): 0.10, Ph Sorting: 0.68 Fines (230): 4.91% (SP-SM)
-31.8	5.7		No Recovery.			
-32.4	6.7		End of Boring			

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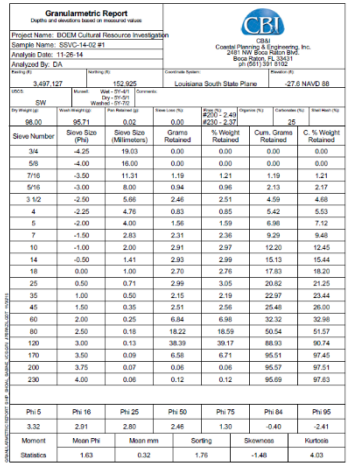
Granulometric Report
Depths and elevations based on measured values

CBI
Coastal Planning & Engineering, Inc.
2481 NW Boca Raton Blvd.
Boca Raton, FL 33431
ph (561) 391 8102

Project Name: BOEM Cultural Resource Investigation					
Sample Name: SSVC-14-02 #1					
Analysis Date: 11-26-14					
Analyzed By: DA					
Easting (ft): 3,497,127	Northing (ft): 152,925	Coordinate System: Louisiana South State Plane	Elevation (ft): -27.0 NAVD 88		
USCS: SW	Munsell: Wet - 5Y-4/1 Dry - 5Y-5/1 Washed - 5Y-7/2	Comments:			
Dry Weight (g): 98.00	Wash Weight (g): 95.71	Pan Retained (g): 0.02	Sieve Loss (%): 0.00	Fines (%): #200 - 2.40 #230 - 2.37	Organics (%): 26	Carbonates (%):	Wash Mesh (%):

Sieve Number	Sieve Size (Phi)	Sieve Size (Millimeters)	Grams Retained	% Weight Retained	Cum. Grams Retained	C. % Weight Retained
3/4	-4.25	19.03	0.00	0.00	0.00	0.00
5/8	-4.00	16.00	0.00	0.00	0.00	0.00
7/16	-3.50	11.31	1.19	1.21	1.19	1.21
5/16	-3.00	8.00	0.94	0.96	2.13	2.17
3 1/2	-2.50	5.66	2.46	2.51	4.59	4.68
4	-2.25	4.76	0.83	0.85	5.42	5.53
5	-2.00	4.00	1.56	1.59	6.98	7.12
7	-1.50	2.83	2.31	2.36	9.29	9.48
10	-1.00	2.00	2.91	2.97	12.20	12.45
14	-0.50	1.41	2.93	2.99	15.13	15.44
18	0.00	1.00	2.70	2.76	17.83	18.20
25	0.50	0.71	2.99	3.05	20.82	21.25
35	1.00	0.50	2.15	2.19	22.97	23.44
45	1.50	0.35	2.51	2.56	25.48	26.00
60	2.00	0.25	6.84	6.98	32.32	32.98
80	2.50	0.18	18.22	18.59	50.54	51.57
120	3.00	0.13	38.39	39.17	88.93	90.74
170	3.50	0.09	6.58	6.71	95.51	97.45
200	3.75	0.07	0.06	0.06	95.57	97.51
230	4.00	0.06	0.12	0.12	95.69	97.63

Phi 5	Phi 16	Phi 25	Phi 50	Phi 75	Phi 84	Phi 95
3.32	2.91	2.80	2.46	1.30	-0.40	-2.41

Moment Statistics	Mean Phi	Mean mm	Sorting	Skewness	Kurtosis
	1.63	0.32	1.76	-1.48	4.03

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Task 2 – Archeological Field Investigation

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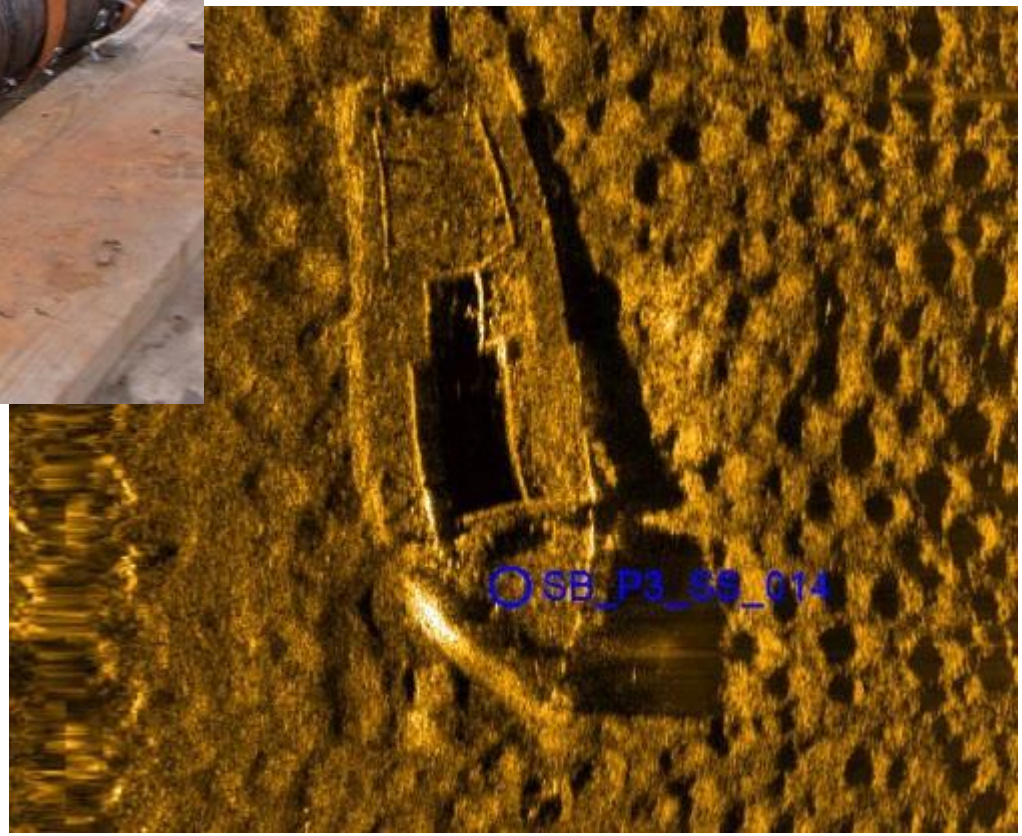
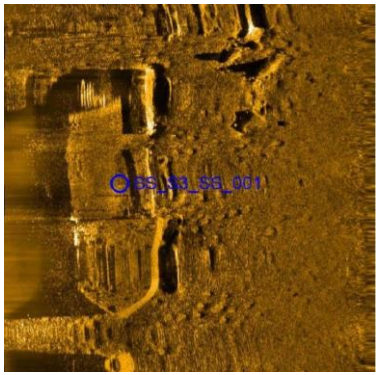
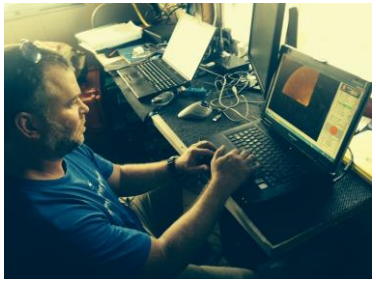
Task 3 : Archival Research



Task 4 - Predictive Conceptual Model

- Develop conceptual plan for modeling potential borrow area impacts to nearby cultural resources
  - Modeling literature review
  - Identify existing datasets
  - Data gap analysis
- Existing data
  - Bathymetry
  - Sidescan
  - Seismic
  - Magnetometer
  - Vibracore
- Data needed
  - Waves & currents





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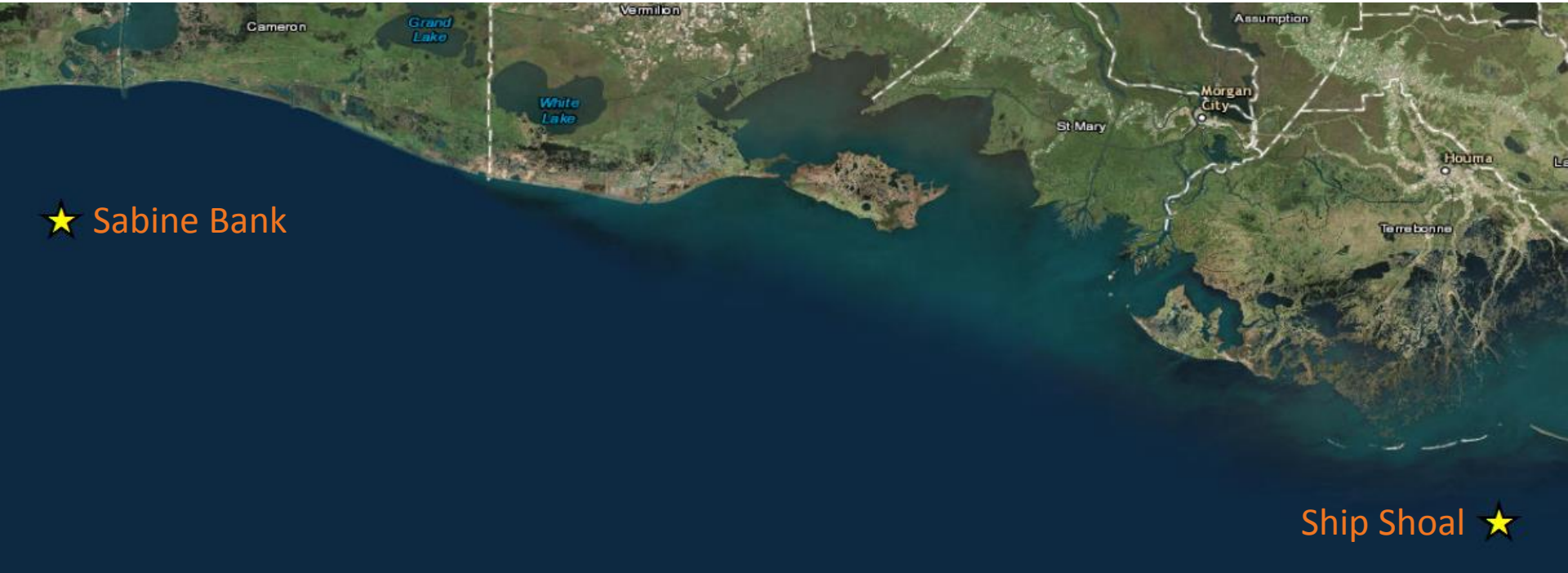
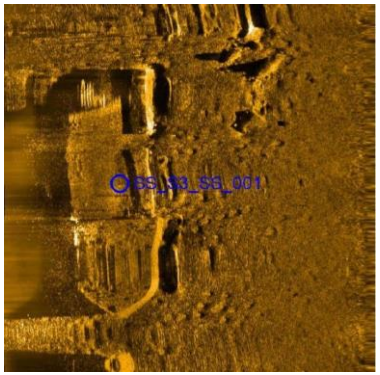
Task 4 – ADCP Deployment

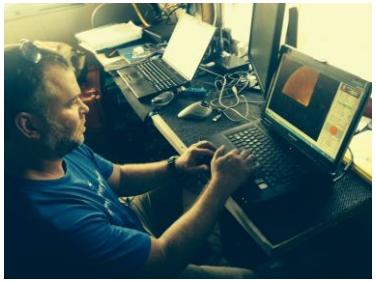
- ADCP's deployed at sites at Sabine Banks and Ship Shoal to obtain measurements of:
  - Surface waves
  - Tidal fluctuations
  - Current speeds
  - Current directions



Task 4 - Predictive Conceptual Model

- Physical processes to be modelled
  - Waves
  - Currents
  - Sediment transport
- Numerical model should be set up and calibrated using:
  - Locally measured water level
  - Wave data
  - Current data
  - Geophysical data
  - Geotechnical data
- Model grid resolution shall resolve:
  - Borrow areas
  - Adjacent coastal and submerged features (cultural resources)





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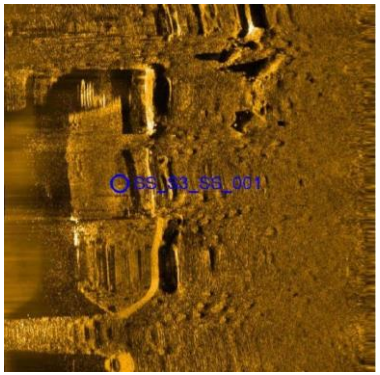
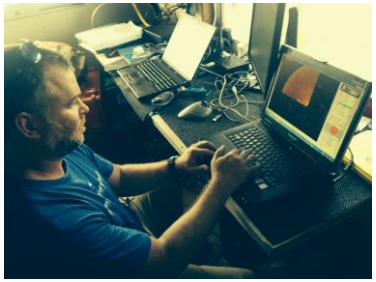
Task 4 – Recommended Model

- **Waves**
  - SWAN
- **Currents**
  - Delft-3D FLOW
    - Changes to tidal currents.
    - Changes to currents adjacent to and at the coast
    - Changes to currents over submerged features (cultural resources)
    - Scour and slope stability



- **Morphology**
  - Beach erosion
  - Interruption of sediment supply
  - Changes to sedimentary processes on sand shoals
  - Changes to longshore transport and erosion/deposition patterns
  - Changes to longshore transport and erosion/deposition patterns over and adjacent to submerged features (cultural resources)



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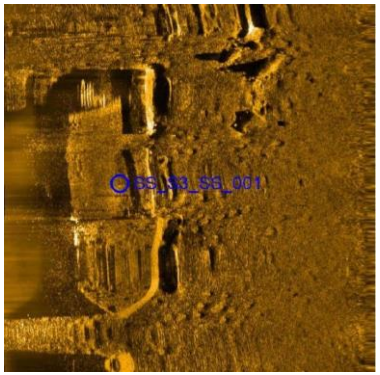
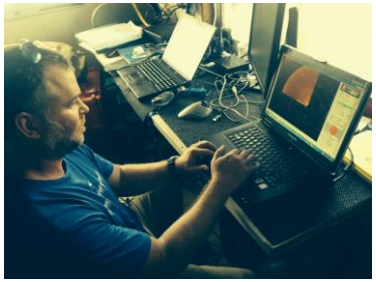
Outreach

- **Public website**
  - Project maps
  - Project metadata
  - Data hosting TBD





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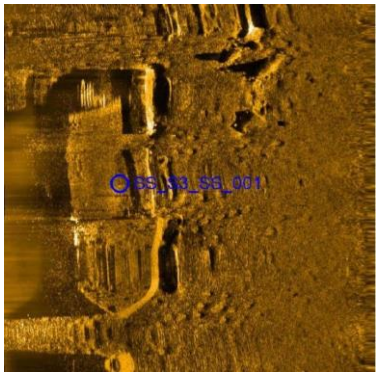
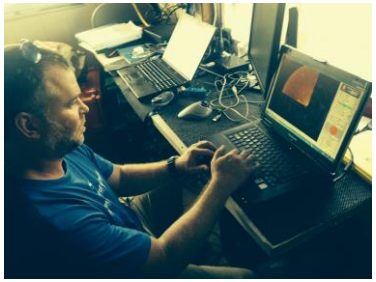
  - Modeling
    - Lindino Benedet, Andy Wycklendt, Joao Dobrochinski
  - Reporting, Data Management
    - Kristina McCoy, Beth Forrest





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