



# Use of IKONOS Data in Cultural Resource Surveys of Areas Subject to Coast 2050 Wetland Mitigation

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Stennis Space Center, MS



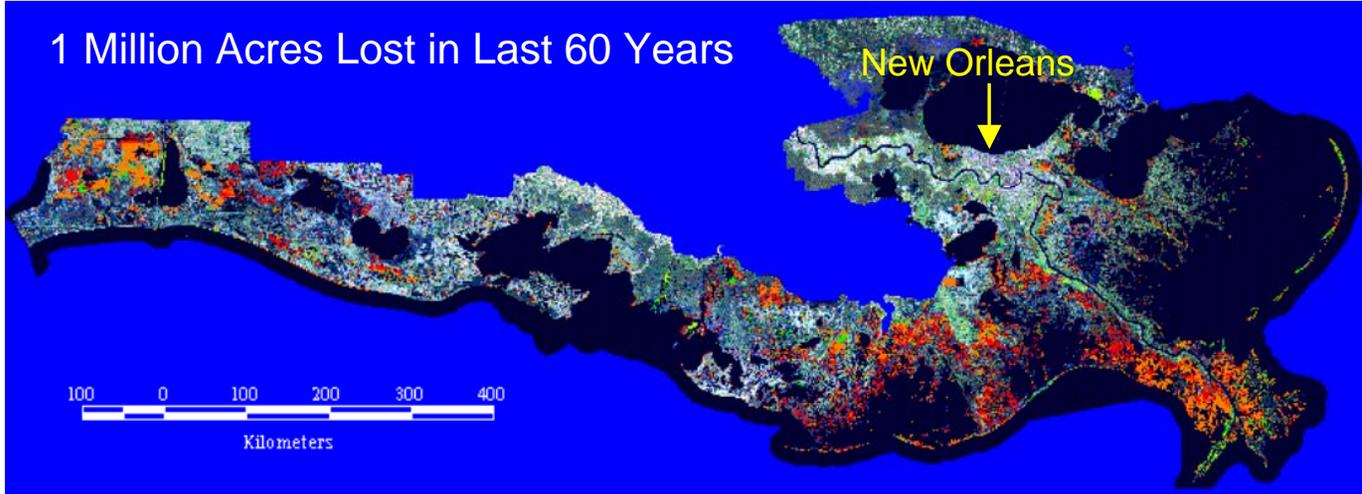
Joint Agency for Commercial Imagery Evaluation Workshop  
Reston, Virginia, USA  
May 21-23, 2003



# Louisiana Coastal Land Loss 1956-1990

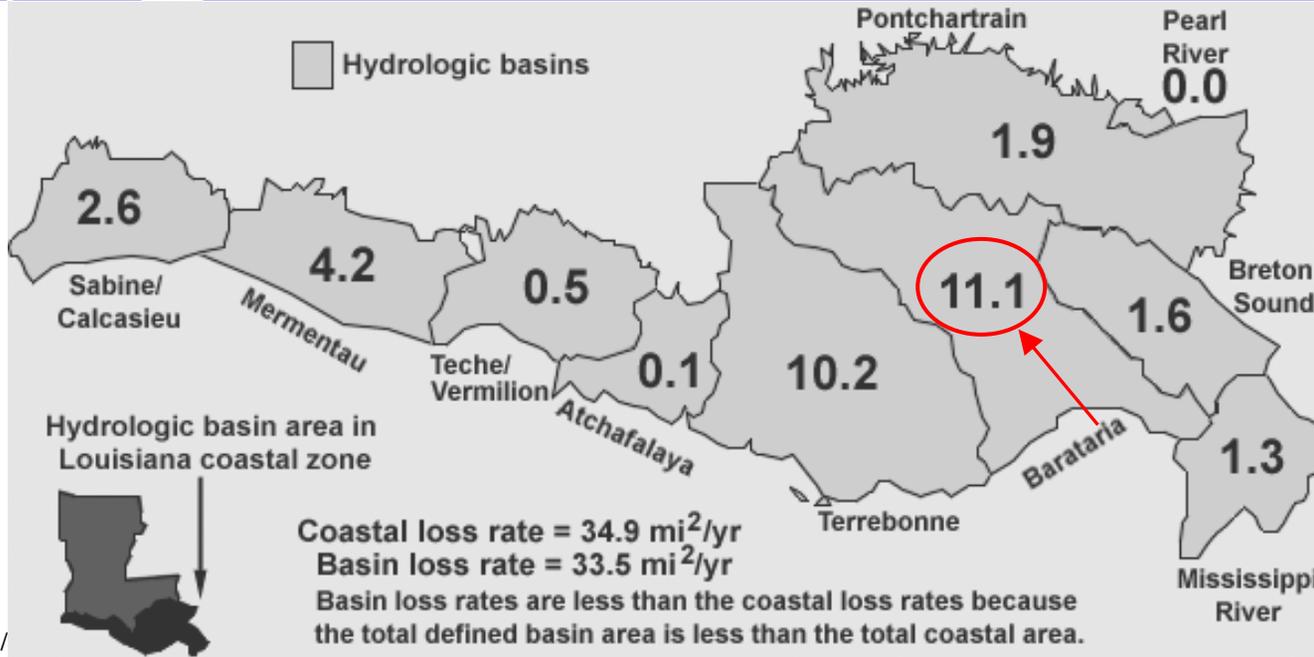
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1 Million Acres Lost in Last 60 Years



## Legend

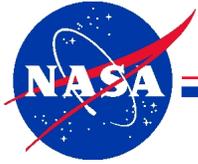
- Loss 1956-1978
- Gain 1956-1978
- Loss 1978-1990
- Gain 1978-1990



Source of maps:

USGS Report  
Barras et al. (1994)

USACE Report  
Dunbar et al. (1992)



# Background on Coast 2050

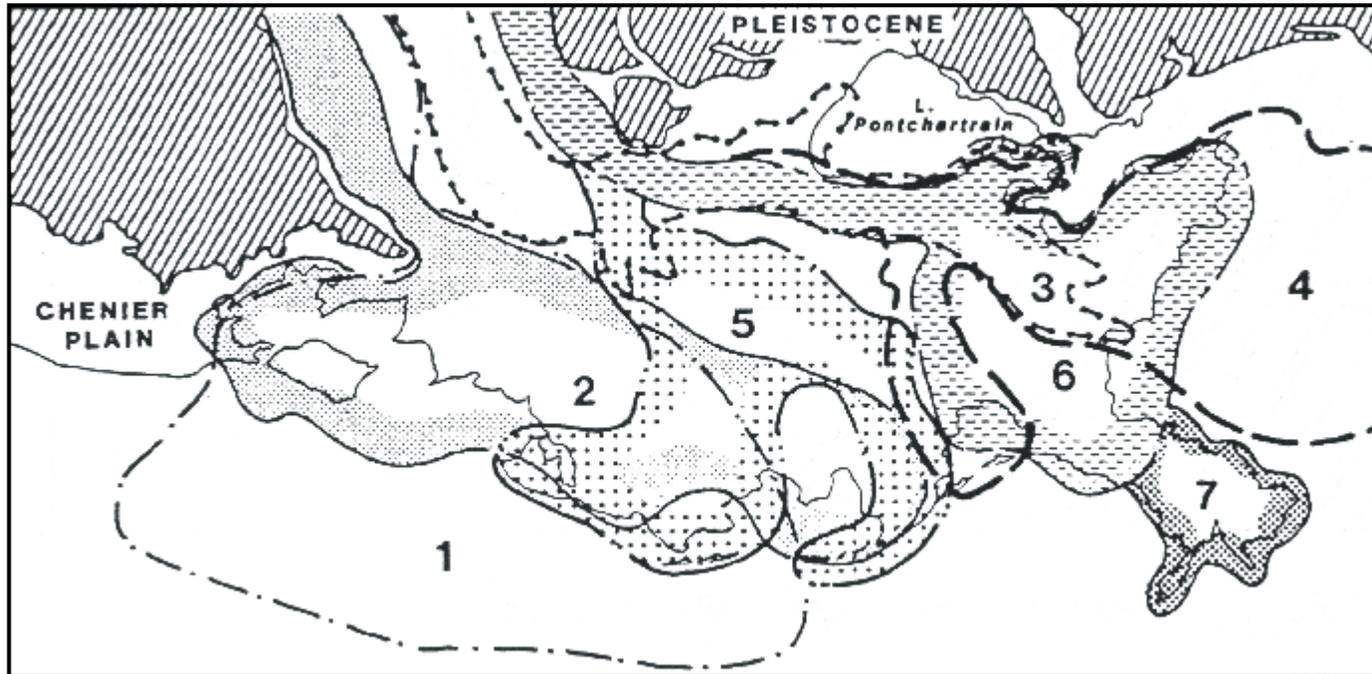
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- Louisiana loses ~25 square miles of coast per year. Coastal land loss causes environmental damage and flooding risk to New Orleans.
- In response, Coast 2050 is being implemented as a multi-billion dollar wetland mitigation effort.
- Coast 2050 is mandated by the 1990 Coastal Wetland Planning, Protection and Restoration Act (Breux Act).
- Louisiana is implementing Coast 2050 with the help of Federal agencies (e.g., USACE, USGS, NOAA, USFWS, and EPA).
- Coast 2050 is a federally funded wetland mitigation process that requires environmental impact assessments of cultural resources.



# Deltaic Lobes of the Mississippi Delta

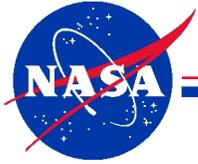
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DELTA	YEARS B.P.
1 MARINGOUIN	9000-6500
2 TECHE	5800-3900
3 METAIRIE	4800-3400
4 LA LOUTRE (St. Bernard)	3400-1800
5 LAFOURCHE-TERREBONNE	2000-0
6 PLAQUEMINES	1000-0
7 BALIZE	600-0

Dating based in part on  
archeological artifact analysis from  
prehistoric sites  
across the Mississippi Delta

# Coast 2050 Cultural Resource Surveys



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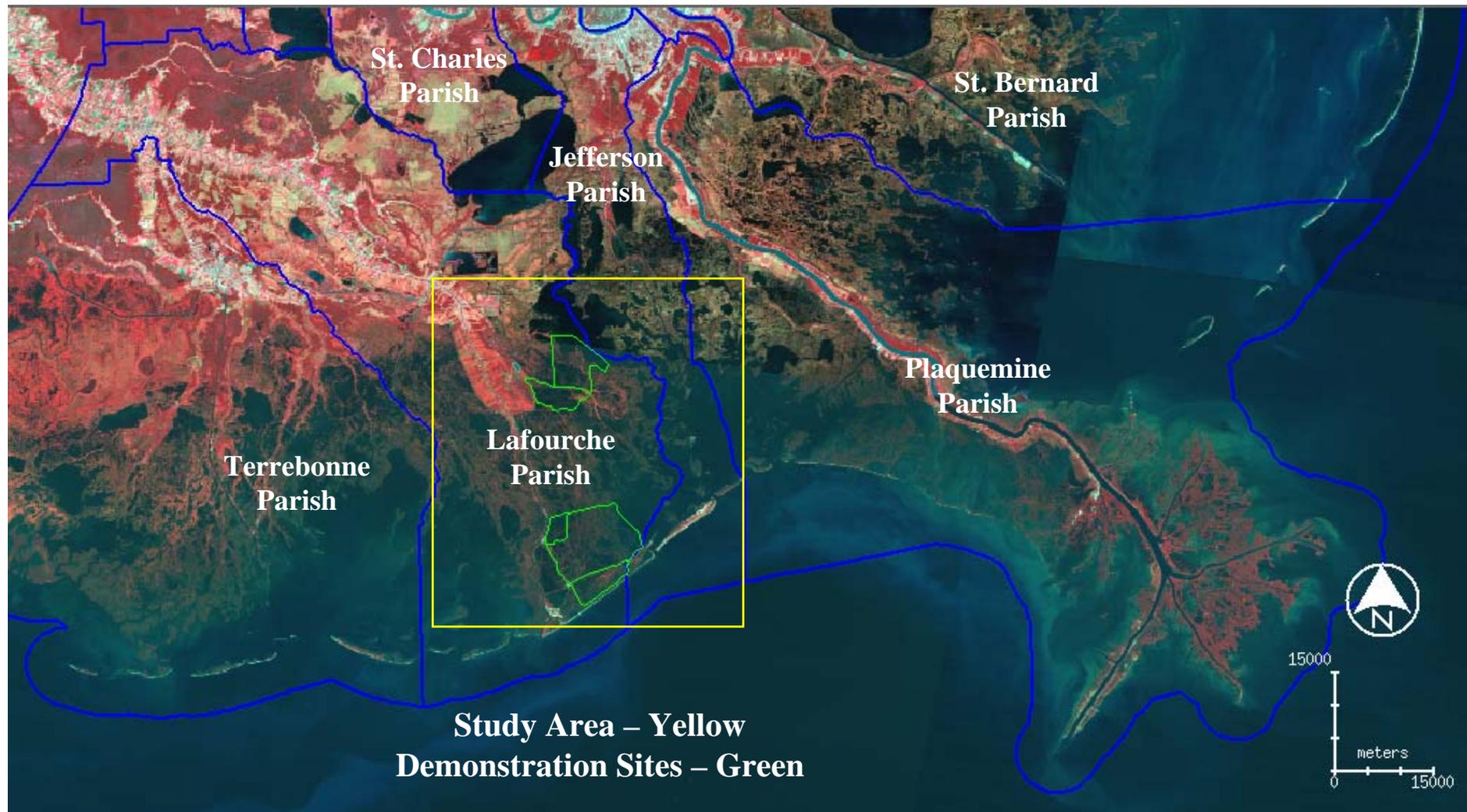
- The USACE is conducting cultural resource surveys of Coast 2050 wetland mitigation sites.
- Because of large expanse of wetland mitigation areas, the USACE wants to increase the efficiency and effectiveness of cultural resource surveys compared to traditional methods.
- In response, the USACE and NASA signed a Space Act agreement in June 2002 to assess remote sensing jointly for improving cultural resource survey process used for National Environmental Policy Act compliance.
- This remote sensing study utilizes the Coast 2050 demonstration area in Lafourche Parish.

# Location of Coast 2050 Remote Sensing Study



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## Location of Wetland Restoration Areas in Southern Portion of Lafourche Parish





# Coast 2050 Project Goal and Objectives

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- Goal – Assess synoptic remote sensing technologies for aiding cultural resource surveys of areas subject to Coast 2050 Wetland Mitigation.
- Objective 1 – Assess multispectral remote sensing data for ability to predict elevated natural levee areas with high potential for containing prehistoric and historic cultural remains.
- Objective 2 – Evaluate spatial resolution requirements needed for mapping natural land cover known associated with prehistoric cultural remains.

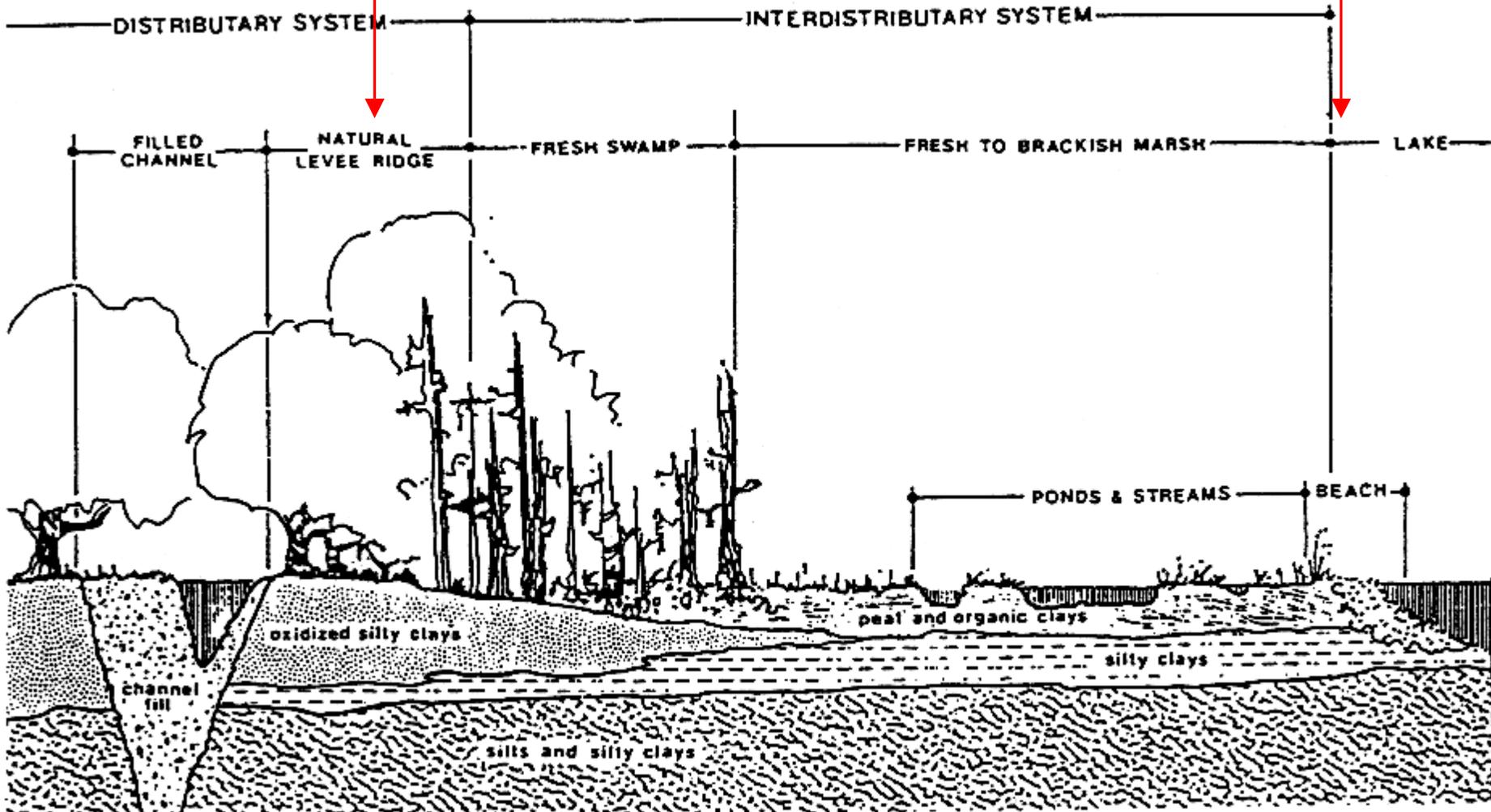
# Common Landforms of Coastal Louisiana



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Secondary Target  
(Shell Beach)

Primary Target

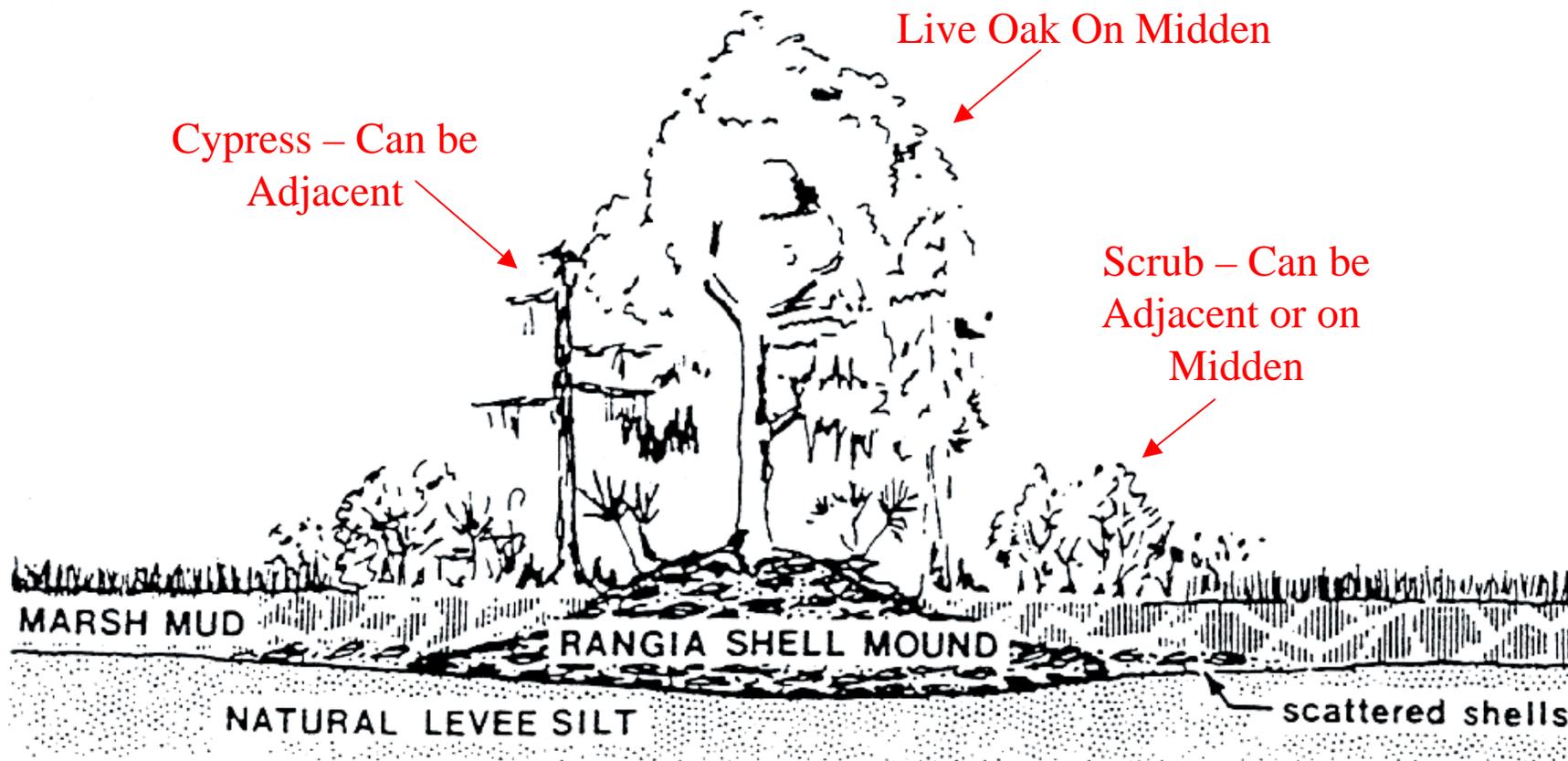


# Example of Prehistoric Aboriginal Midden Site

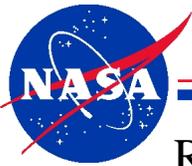


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Such Sites Contain Live Oak Forest/Scrub Overstory, Above Shell Midden Deposits



Graphic from ACE Report to SCS by Perrault et al. (1994)  
Originally drawn from Russell (1967)



# Remote Sensing Data Acquisition

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Remote Sensing Data Acquired in Southeastern Louisiana – Examples Shown Below

- Landsat TM and ETM
- IKONOS – many areas
- ASTER MS – 1 area
- ATLAS Airborne MS – 4 areas
- AVIRIS – 20 m – 1 area
- SIR-C SAR – ~30 m – 1 area
- USGS CIR DOQQs
- Field Photography

IKONOS Zoom



Field Photo at Site



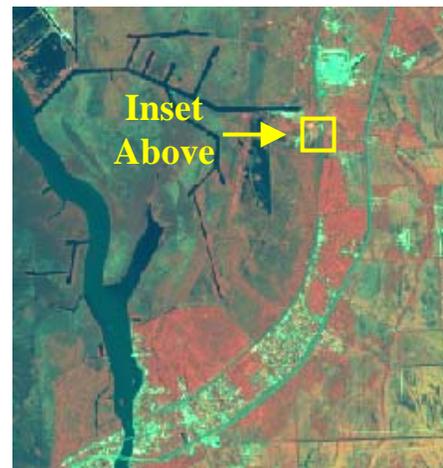
ASTER VNIR



Landsat TM



IKONOS



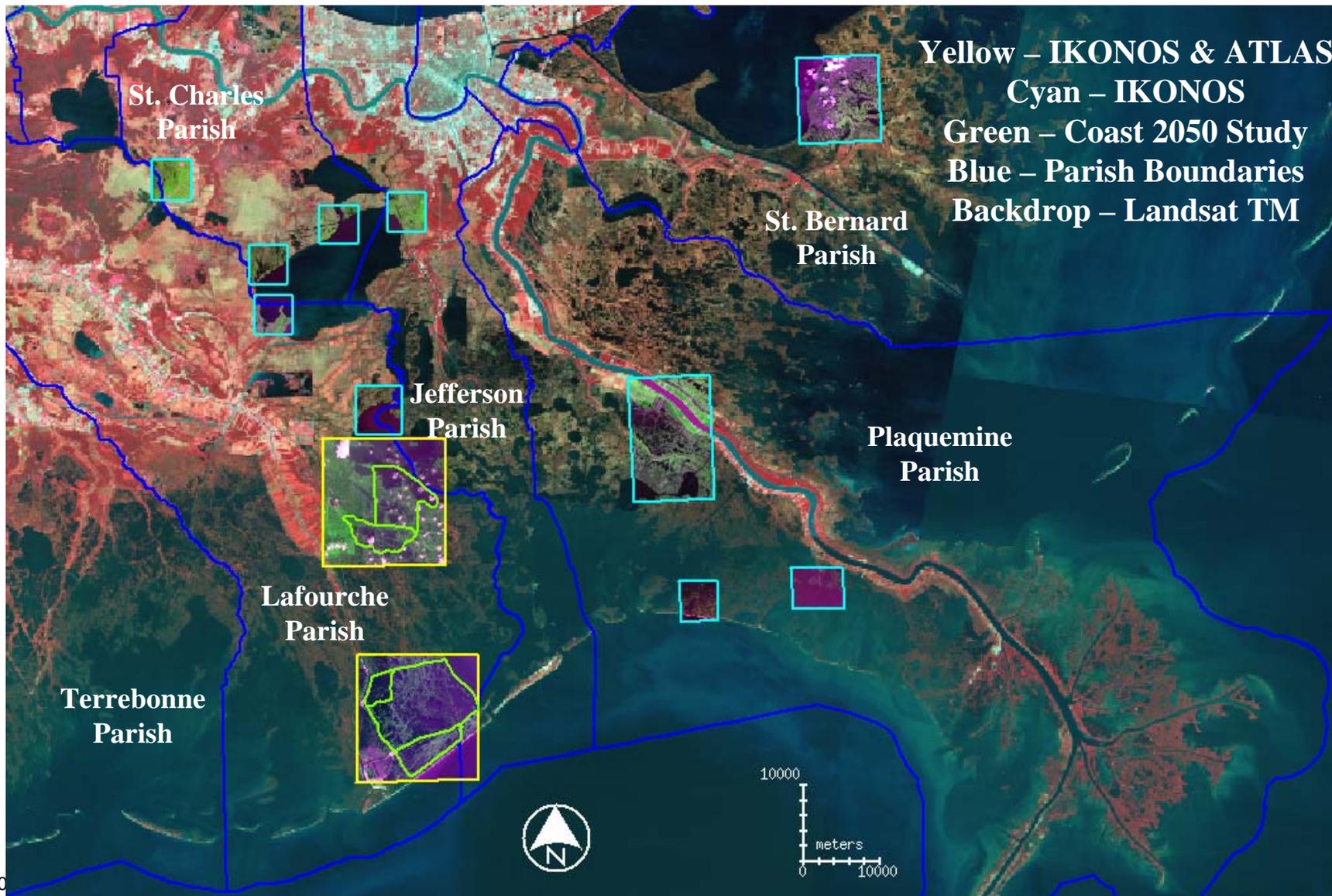
DOQQ CIR





# IKONOS Data Collection Footprints

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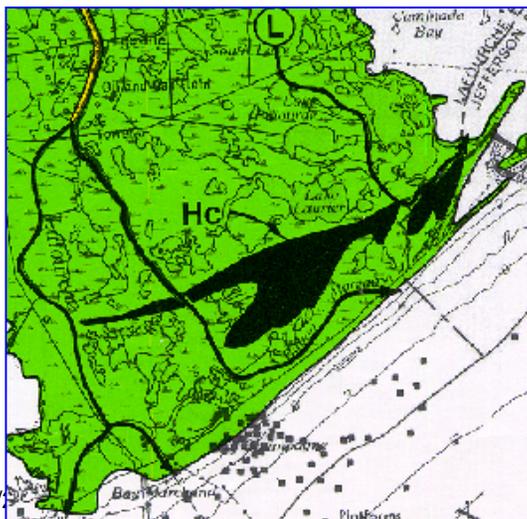


# GIS Data Acquired

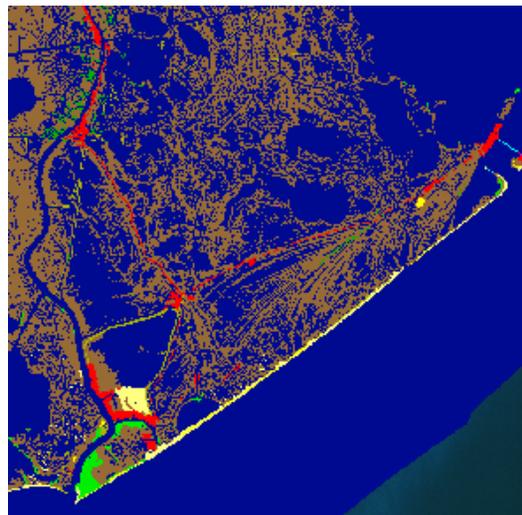
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- Coastal Vegetation Maps (USGS) – Multiple Dates (1949 to 2000)
- NWI Wetlands (USFWS) – LA Coastal Zone – 25-meter Cells
- Hydrologic Basins (USGS) – Sub-basin Scale
- DLG (USGS) – 1:100,000 Scale – Including Hydrography
- DRG Topo Sheets (USGS) – Multiple Scales
- DEM 30-meter Data (USGS) – NED and SRTM
- Geomorphology (USACE – Saucier) – 1:250,000 Scale
- Geology and Soils (USGS) – Broad Regional Scale
- LA Division of Archeology State Sites (MS Excel – Point Data)
- Field Surveys with GPS, Digital Photography, and Map Annotation

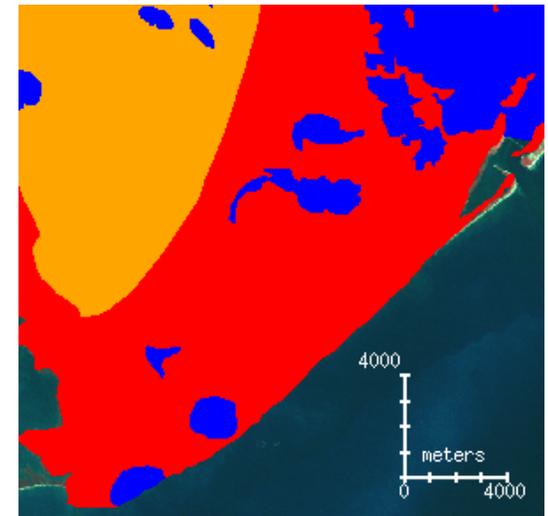
Geomorphology



NWI 1988 Land Cover



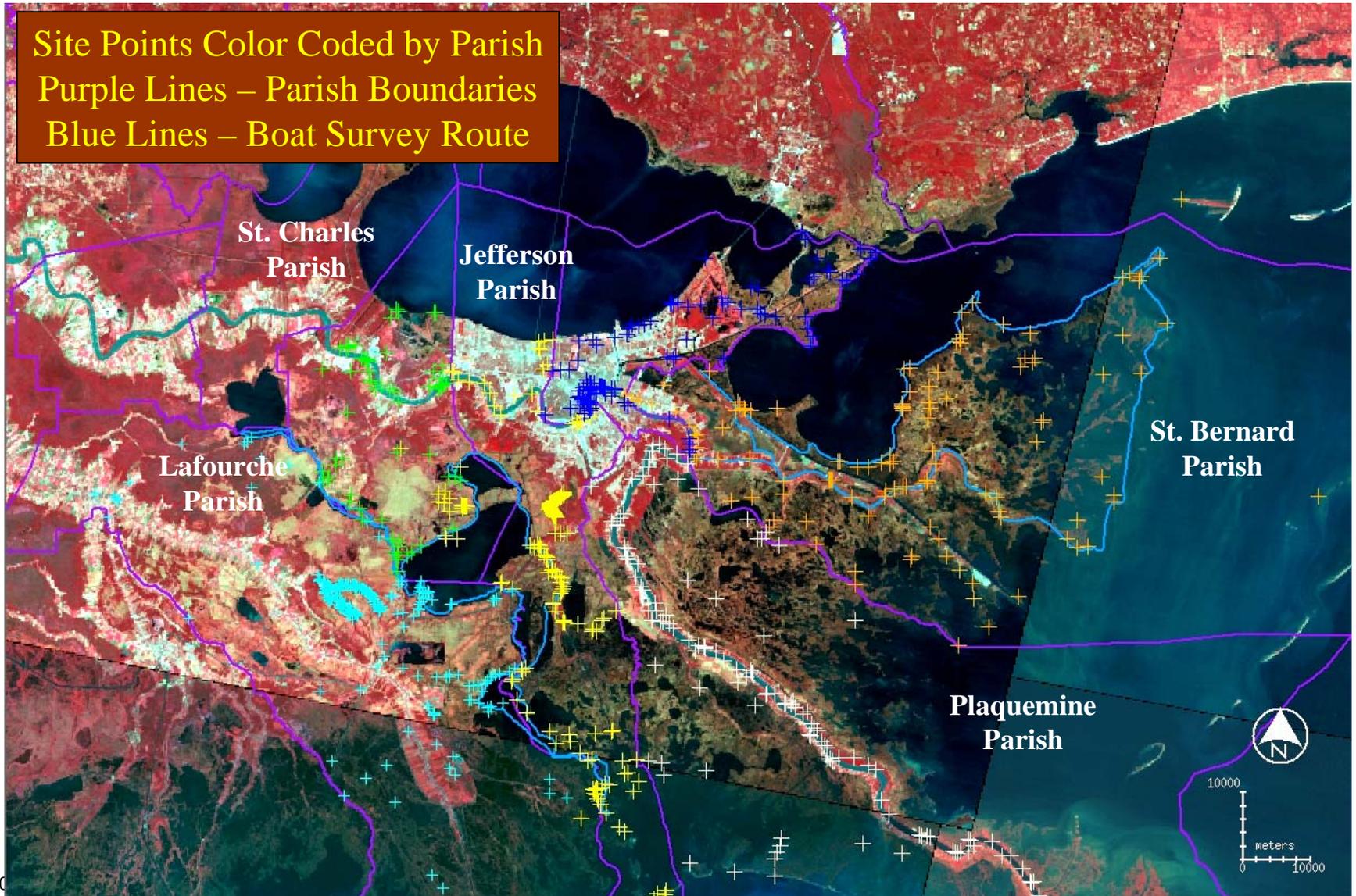
1949 Marsh Types





# State of Louisiana Archeology Site Files

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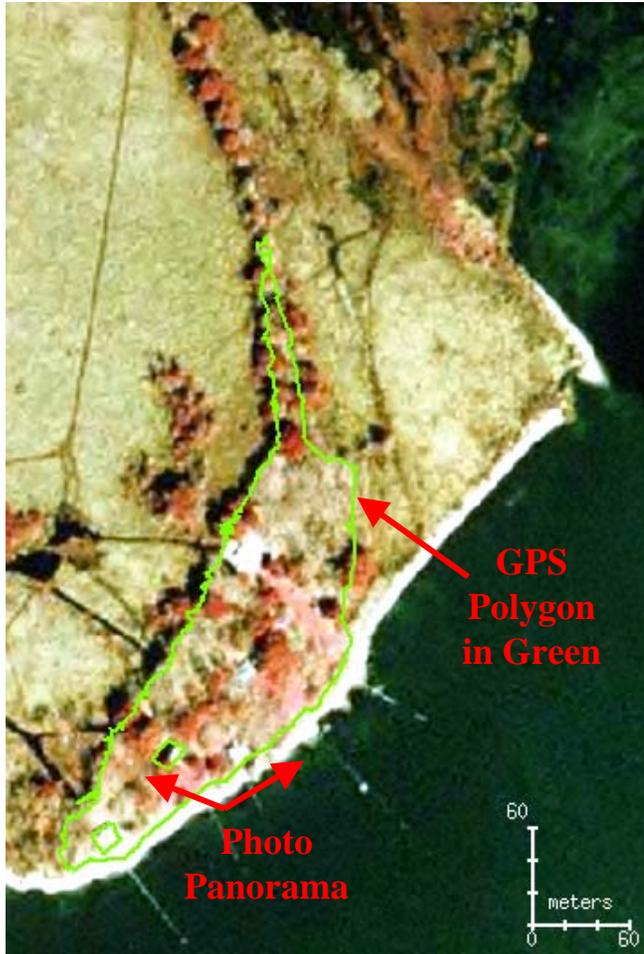




# GPS Survey of Bois Chactas (16SC4), Lake Salvador

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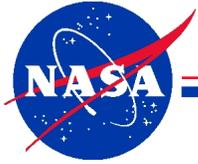
GPS Survey Data for Bois Chactas Site  
(16SC4) Displayed on USGS DOQQ



Panorama Photograph of Extensive Shell  
Midden at Bois Chactas Site  
Looking North



GPS Surveys were done to delineate extent of  
prehistoric shell midden deposits.



# Remote Sensing Data Processing and Analysis

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- Performed geospatial data processing and analysis with ERDAS IMAGINE, ESRI, and ENVI software.
- Classified Landsat and IKONOS imagery using unsupervised ISODATA clustering.
  - Landsat classifications employed VNIR and SWIR bands plus 3 band ratios (NDVI, NDMI (moisture index) with bands 4 and 5, NDMI with bands 4 and 7).
  - IKONOS classifications employed MS and pan-sharpened MS data without any band ratios.



# Remote Sensing Data Processing and Analysis (cont.)

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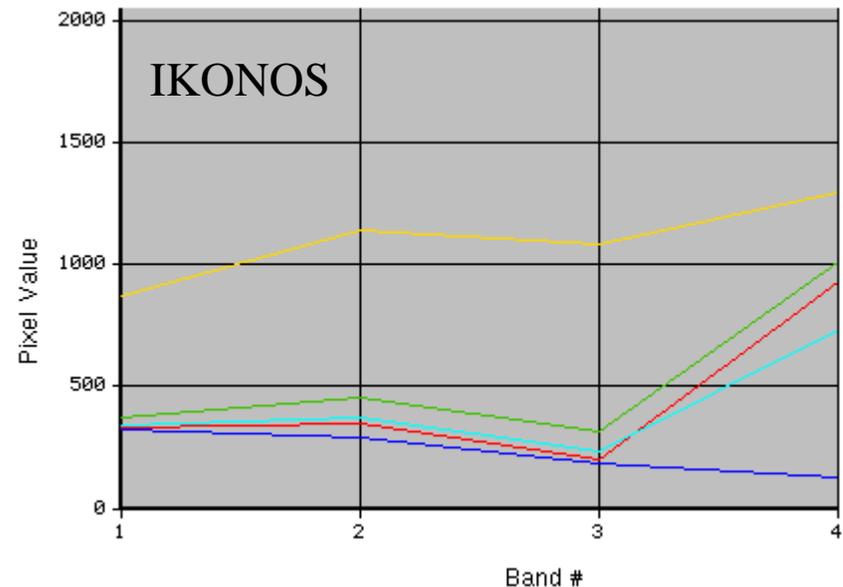
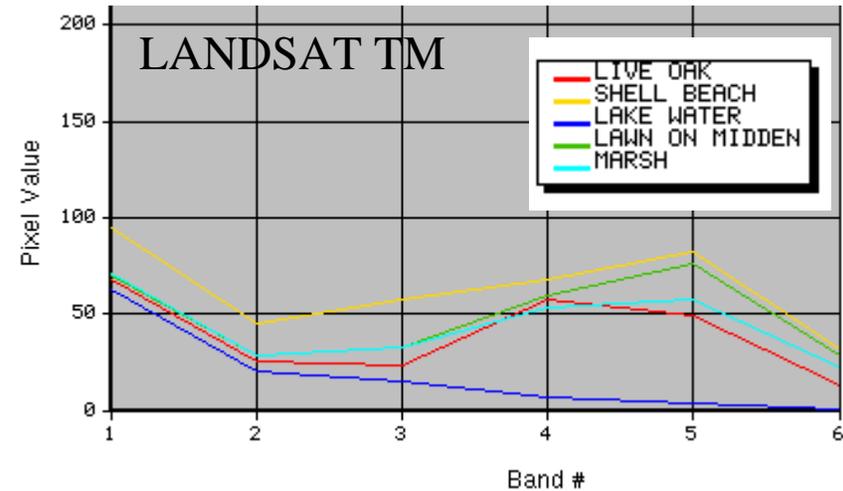
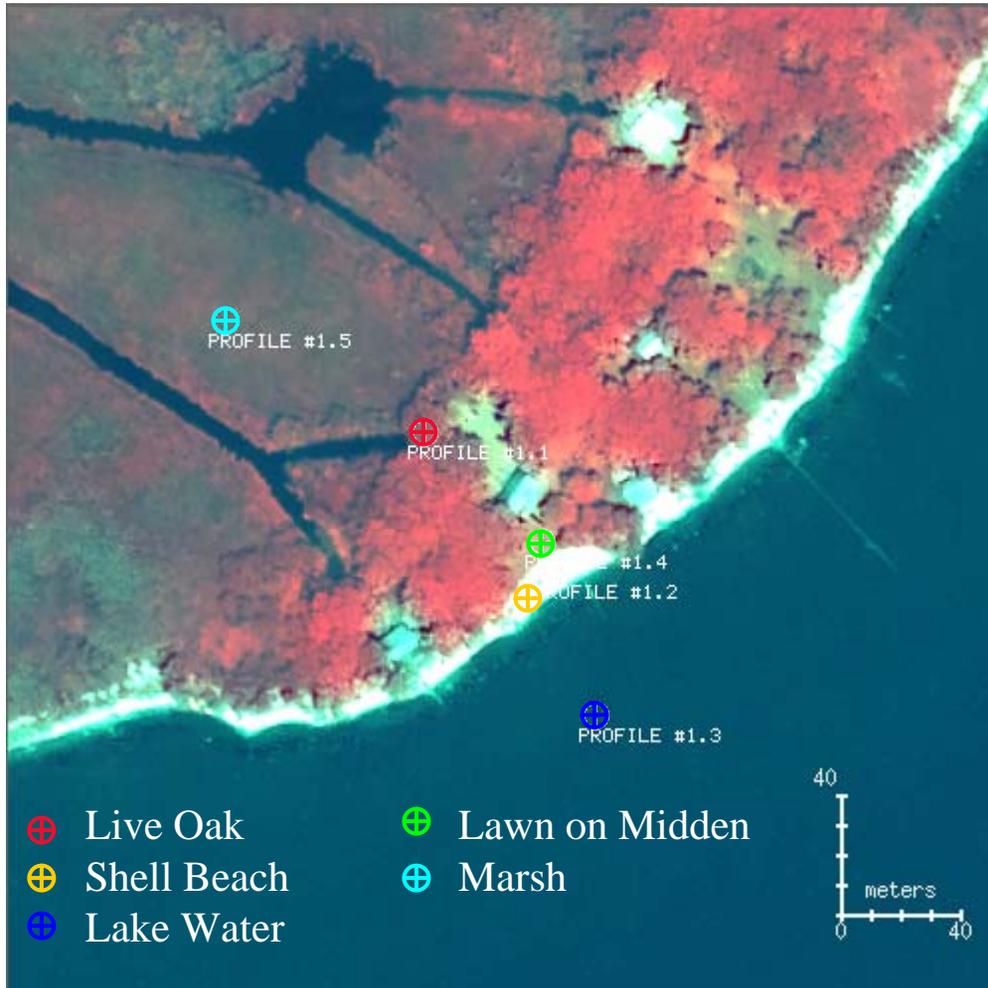
- Compared RS classifications to IKONOS RGBs, field survey data, plus GIS data on coastal vegetation type, archeology sites, hydrology, and terrain. Refined classifications with cluster busting technique.
- Performed spatial image degradation analyses on IKONOS data to assess spatial resolution requirements for mapping land cover associated with prehistoric archaeological sites.



# Spectral Curves of Targeted Features

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IKONOS 1-meter, Pan-sharpened MS Data  
Bois Chactas Site (16SC4), Lake Salvador





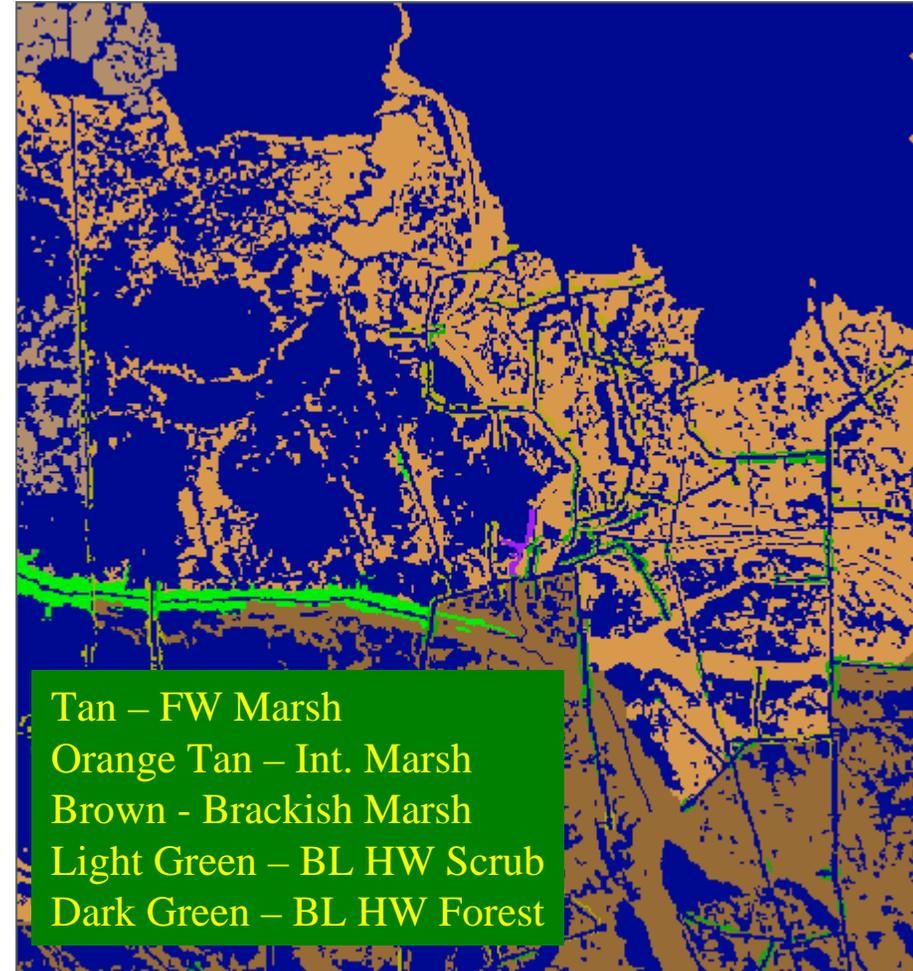
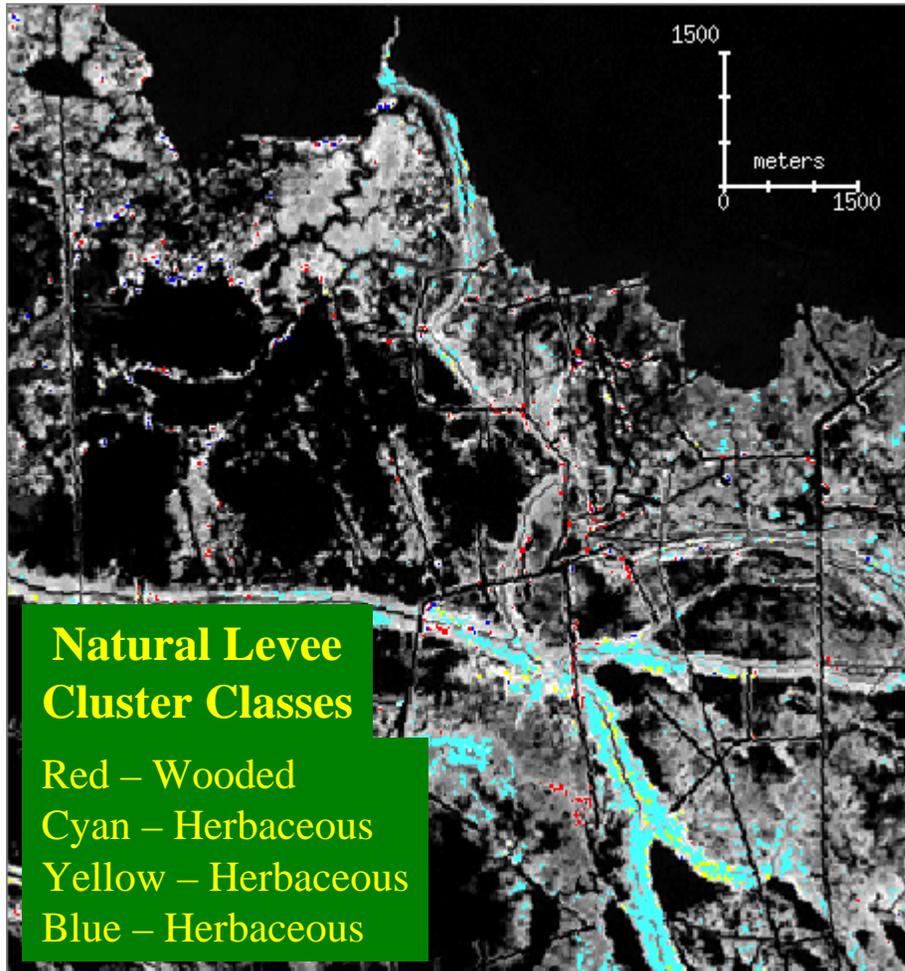
# Landsat ETM Classification vs. NWI Map

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Site Location: Bayou L'Ours (16LF54)

Landsat ETM Classification

NWI 1988 Land Cover





# IKONOS vs. Landsat Classifications

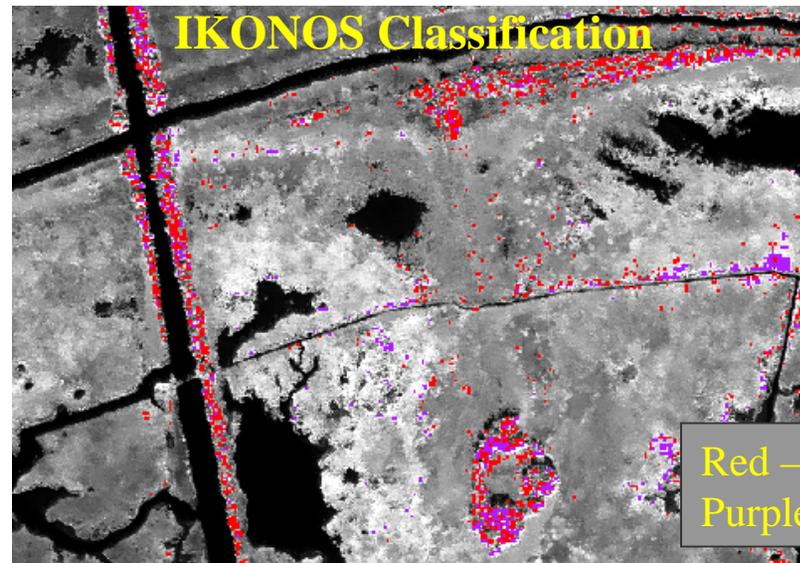
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Site Location: Pelican Mounds (16PL159), Bayou Grand Chenier

IKONOS 1 m RGB

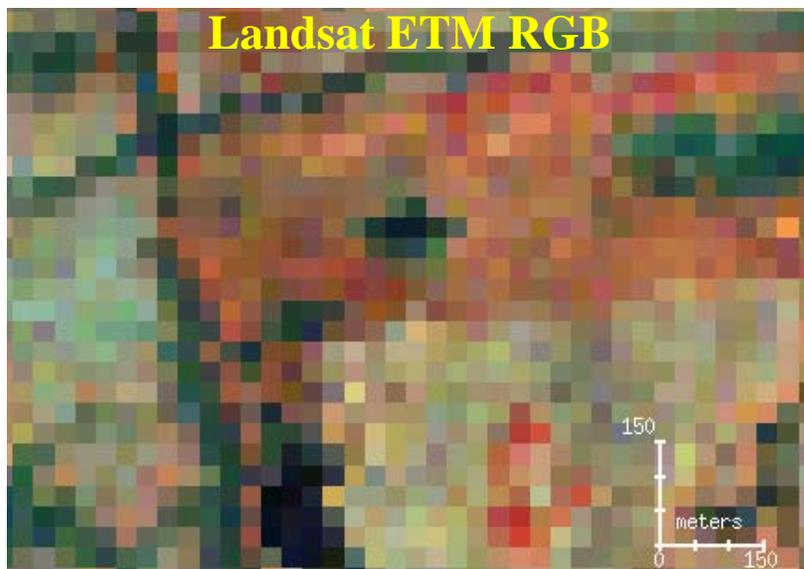


IKONOS Classification

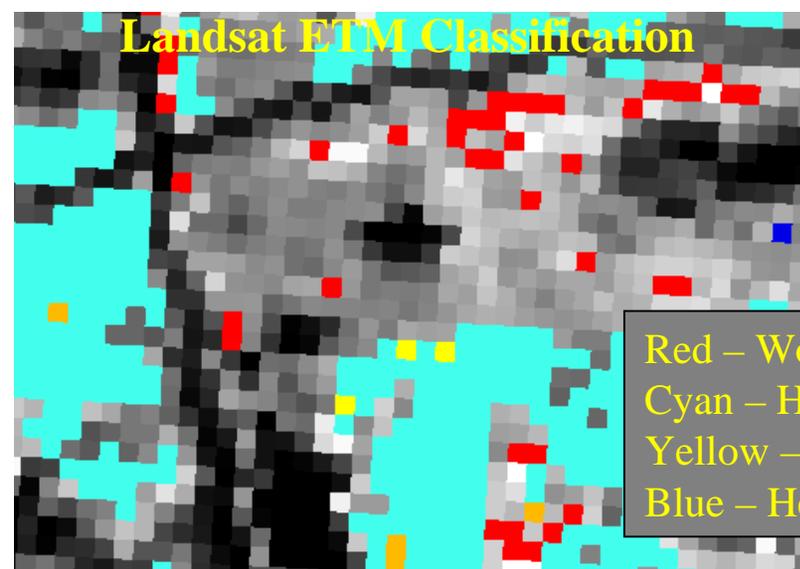


Red – Wooded  
Purple – Wooded

Landsat ETM RGB



Landsat ETM Classification



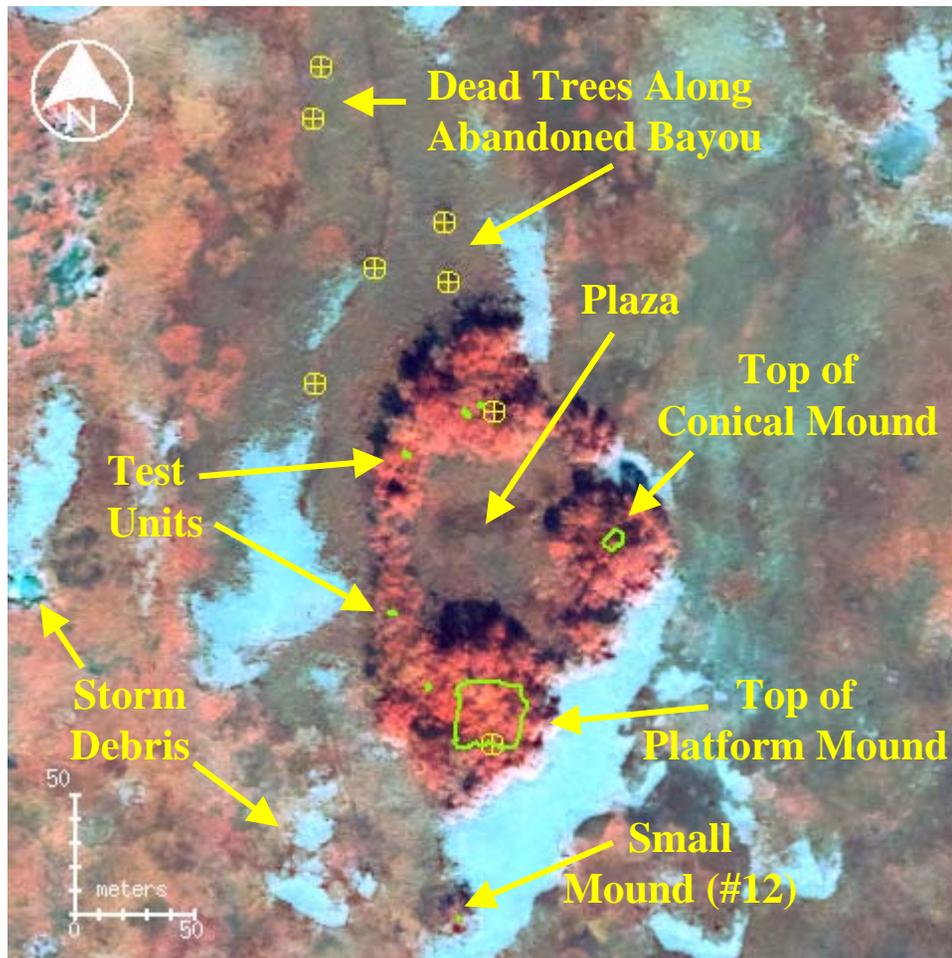
Red – Wooded  
Cyan – Herbaceous  
Yellow – Herbaceous  
Blue – Herbaceous

# Field Data for Pelican Mounds, Plaquemines Parish



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GPS Survey Data for Pelican Mounds (16PL159)  
Overlay onto IKONOS Imagery



Photograph of Pelican Mounds  
View from West



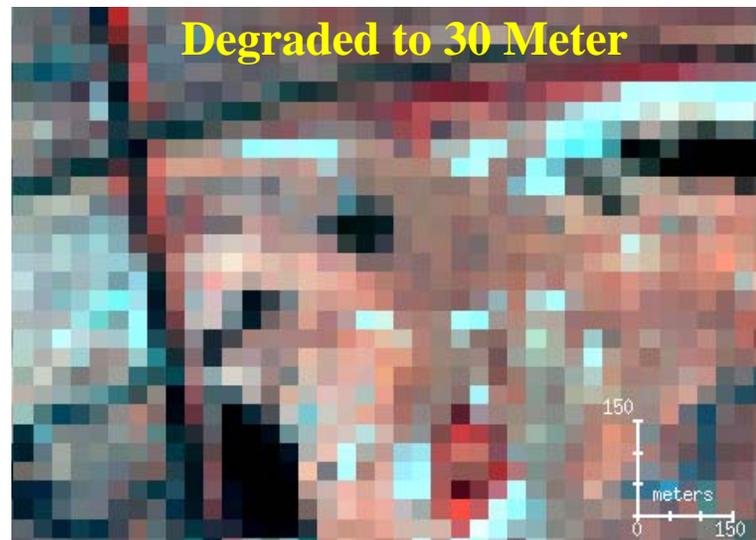
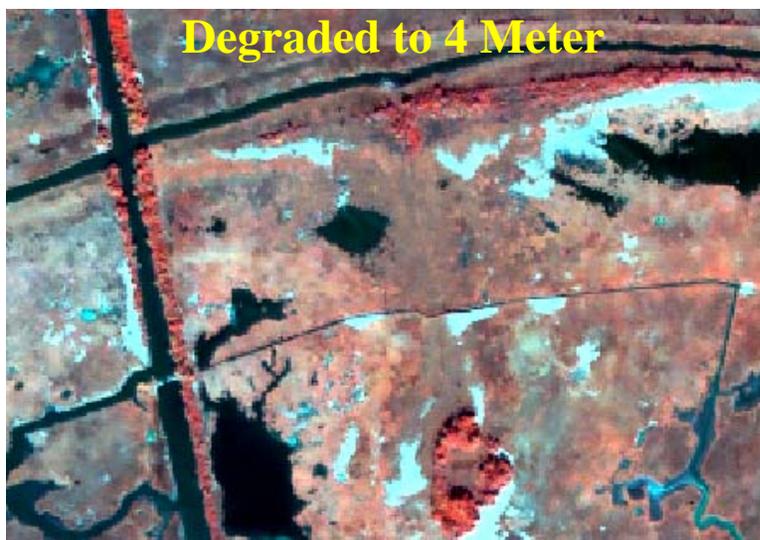
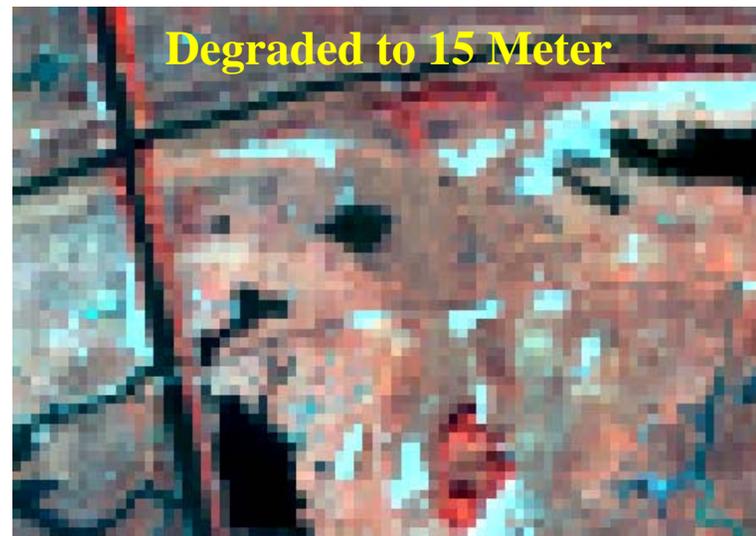
Photo of Mound #12 in South

# Remote Sensing Spatial Resolution Requirements



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Site Location: Pelican Mounds (16PL159), Bayou Grand Chenier

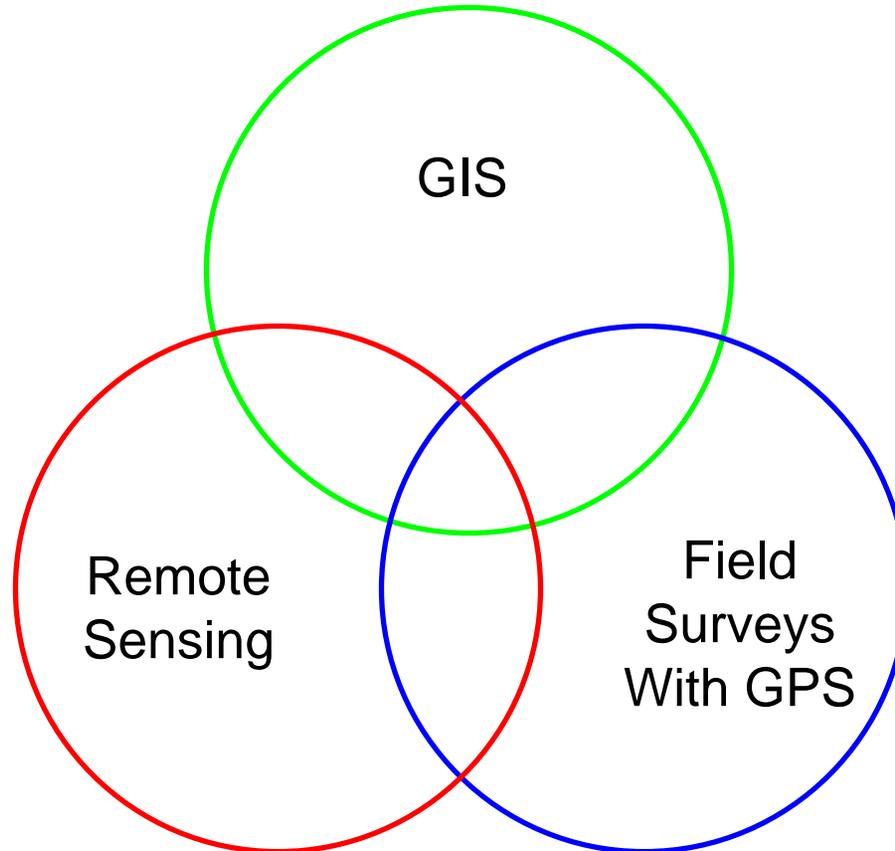




# Technologies Used in Archaeological Site Prediction

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In many cases, integrated use of geospatial technologies is the way to go...especially in areas with subtle terrain.



In this project, GIS data from field surveys and land cover maps played a key role.



# Concluding Remarks

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- Live-oak-dominated bottomland forest and shell beach are well known potential sites and can be viewed on Landsat and IKONOS RGBs as long as the patch of interest is big enough spatially. Such features appear to be classifiable on Landsat and IKONOS if they are big enough to be seen on RGBs.
- Landsat showed promise for producing up-to-date regional maps of bottomland forest. A coast-wide 1988 NWI land-cover map shows regional distribution of bottomland forest, useful in assessing Landsat classifications.



# Concluding Remarks (cont.)

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- Landsat and IKONOS appear to be able to map a type of herbaceous land cover occurring on natural levees among fresh to brackish water marsh, although more research is needed to quantify the potential of this type for containing sites.
- Future work:
  - IKONOS, ASTER, and Landsat data will be analyzed further to refine maps of high potential archaeological zones and to validate these products quantitatively, especially for subsided, salt-marsh-areas.
  - Additional field validation will be performed by NASA and by the USACE to assess the use of NASA and commercial remote sensing assets for aiding field surveys of cultural resources in Coast 2050 wetland mitigation areas.



# The End

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Photo credit: WaterMarks Magazine, February 2003, <http://www.lacoast.gov/watermarks/2003-02/WaterMarks-2003-02.pdf>  
For more information on Louisiana coastal issues, see <http://www.lacoast.gov>



# Cited Literature

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- Barras, J. A., P. E. Bourgeois, and L. R. Handley, 1994, "Land Loss in Coastal Louisiana 1956--1990," U.S. Department of the Interior, National Biological Service, National Wetlands Research Center, Open File Report 94-01. 4 pp.
- Dunbar, J.B., Britsch, L.D., and Kemp, E.B., III, 1992, "Land Loss Rates, Report 3, Louisiana Coastal Plain," U.S. Army Corps of Engineers Technical Report GL-90-2, p. 28.
- Perrault, S.L., C.E. Pearson, R.A. Weinstein, K. Debuchere, and W.D. Reeves, 1994, "Cultural Resources Survey and Testing, Bayou L'ours Shoreline Protection and Marsh Restoration Project, Lafourche Parish, Louisiana," Report by Coastal Environments, Inc., Published by: U.S. Army Corps Engineers, Cultural Resources Series Report Number: COELMN/PD – 94/06, p. 131.
- Russell, R. J., 1967, "*River Plains and Sea Coasts*," Univ. of California Press, Los Angeles, CA, p. 173.



# Notes on Landsat Classifications

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- Landsat classifications identified regional occurrence of two elevated natural levee land cover types: (1) bottomland hardwood forest/scrub, and (2) marsh apparently predominant on natural levee. The classification tended to omit patches of bottomland forest/scrub <30 meters wide.
- Landsat RGBs provided sparse indication of areas lakeside covered by shell beach. Shell beach was not clearly identified on classifications because the features were much less than 30 meters wide.
- Field surveys plus high-resolution IKONOS and DOQQ imagery were invaluable for assessing Landsat image classifications. GIS data on land cover and marsh type also aided this process.



# Notes on Landsat Classifications (cont.)

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- Landsat ETM classifications worked best when band ratios were used with raw VNIR/SWIR bands and when water was masked out.

# Notes on IKONOS Classifications



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- IKONOS classification analyses used pan-sharpened RGBs, DOQQs and field survey data for reference purposes.
- IKONOS classifications also showed elevated natural levee forest and herbaceous areas plus narrow strips of shell beach along waterways.
- The IKONOS pan-sharpened RGBs showed shell beach cover much better than 4-meter IKONOS data. However, a high tide could limit the detection of narrow shell deposits along waterways.
- Pan-sharpened IKONOS RGBs showed prominent abandoned distributary channels, though certain elements of these old channels (e.g., tree snags) could not be detected.



# Notes on IKONOS Classifications (cont.)

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- Large IKONOS scenes can be quite voluminous, especially when pan-sharpened and in 16-bit format. The large data volume caused challenges in terms of data management, processing, and analysis.