Tampa Bay Oyster Bar Mapping and Assessment Project

Presentation to Florida Oyster Reef Restoration Workshop

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FWC/FWRI

Project Overview

2 Components: Mapping and Assessment

- Mapping
  - Create GIS map layer from Historic Nautical Charts (1927-1988)
  - Create Detailed GIS map layer of oyster beds and fringing reefs
    - Test use of hyperspectral imagery obtained at low tide with proprietary classification algorithms
    - Use Feature Analyst supervised automated approach to mapping
    - Use 2004 ADS40 Digital Orthophotos and traditional approach to mapping
- Assessment
  - Extensive field reconnaissance
    - Provide field collection points to “train” the analyses
    - Identify errors of commission and omission within the hyperspectral data set
  - Obtain data points to be used in the accuracy assessment and error matrix.

Goals

- Provide base data source for future mapping projects
  - 80-90% Thematic map accuracy
  - Map 80-90% of all oysters in Tampa Bay (Current Conditions)
- Allow trend analysis to be performed to further aid scientists in monitoring efforts
  - Historic maps available as reference in digital format
  - Change Analysis Framework in on-line environment
- Comparison of technologies
  - Hyperspectral
  - Learning Algorithms
  - Traditional Photointerpretation

Study Area

Tampa Bay

Boca Ciega Bay

and

The Narrows

Mapping Component

Principle Investigator: Kathleen O'Keife

FWC Technical Staff: Dave Reed

Galileo Group Technical Staff
Dr. Zhihong Pan
Michael Franks

Assessment Component

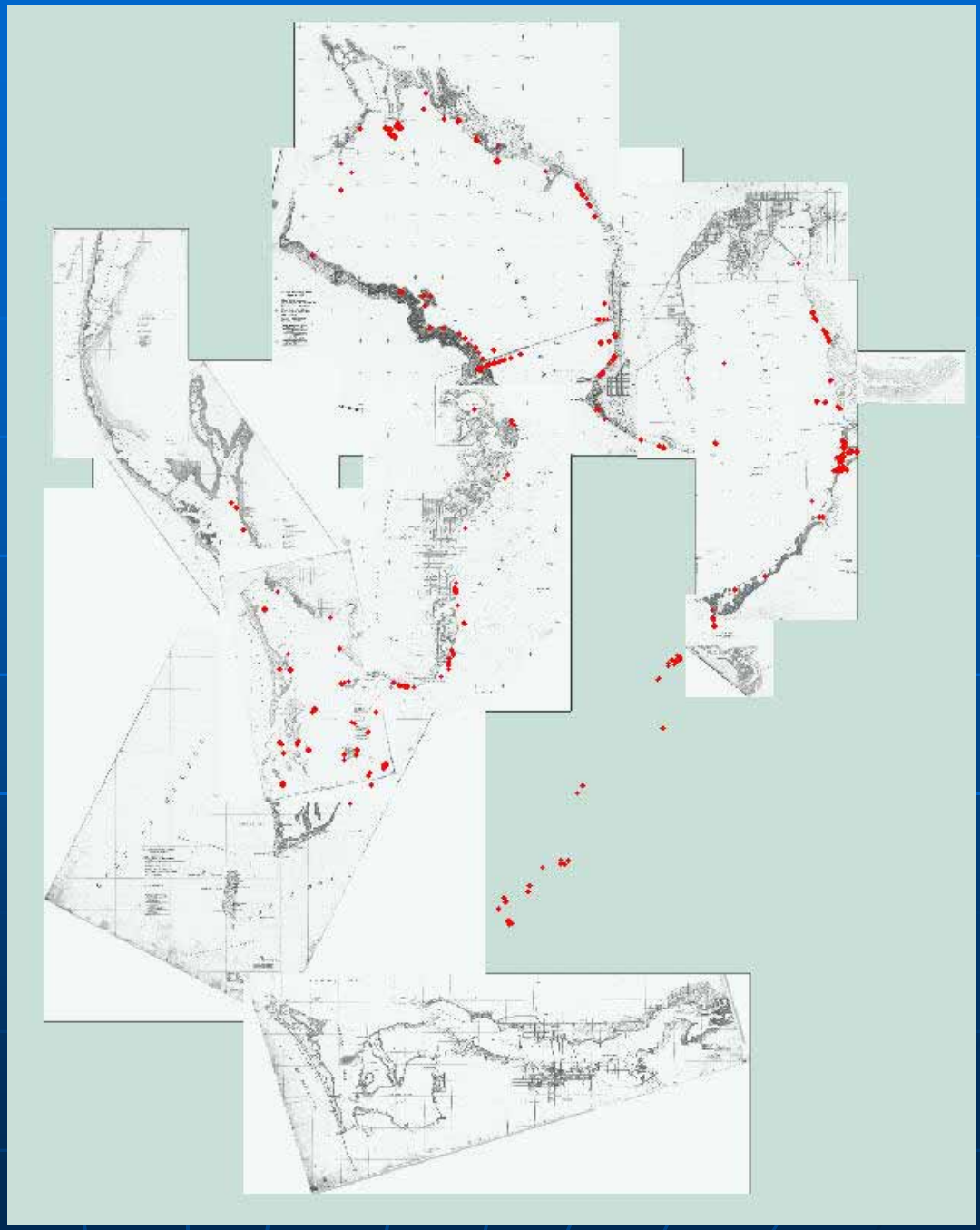
Principal Investigator: Bill Arnold

Field and Technical Support Staff:
Janessa Cobb
Brett Pittinger
Carla Beals
Mark Gambordella

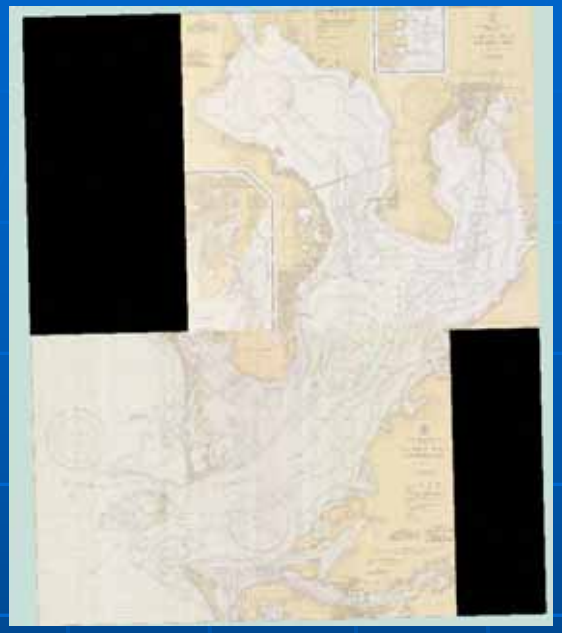
Historic Data

- Mosaics of historical charts for the Tampa Bay area.
  - 1927 T-Sheet
  - 1927, 1928, 1930, 1935, 1943, 1959, 1969, 1978, and 1988 Nautical Charts were acquired from the USGS.
- Problem: No legends could be located for any of the maps, so no historical oyster bed information could be reliably identified.
- Decision to geo-reference and serve as a layer on the TBEP Image Server so that changes over time could be easily ascertained

Historical T-Sheet with super-imposed classification of current conditions oyster data



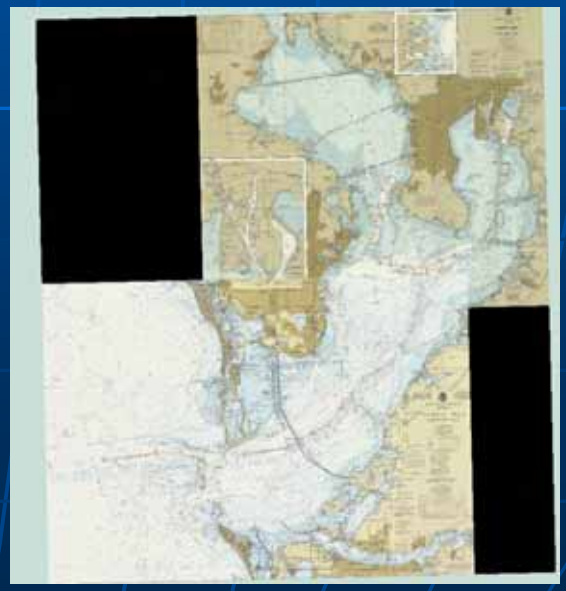
Historical Nautical acquired from the USGS



1928

1935

1978



1988

Current Conditions: Remote Sensing Option

- Considered Approaches
  - Hyperspectral imaging and supervised classification
  - Learning algorithm software (Feature Analyst)
  - Traditional photointerpretation
- Selected Technologies
  - Hyperspectral solution through a vendor (Galileo Group) that could mobilize quickly
  - Feature Analyst
  - 2004 ADS DOQQs used as ancillary source

Benefits of Hyperspectral Approach

- Hyperspectral data images (128 bands)
- Additional uses for data (seagrass mapping, assessment of vigor)
- Entire coastline captured to 6 meter isobath
- Imagery flown at low tide
- Timely turn-around
- Cost savings when doing large area due to number of bands captured

Challenges of Hyperspectral Approach

- Little or no vertical relief of oyster beds
- Sparse oyster beds mixed with seagrass, mud, sand
- “Dirty sand” may be confused
- Rubble/rocks may be confused

Benefits of Feature Analyst

- ArcMap extension (in-house processing)
- Supervised classification (user defined training set)
- Visual Learning System (ability to “train” software)
- Use of 2004 ADS40 DOQQ’s

Challenges with Feature Analyst

- Little or no vertical relief of oyster beds
  - FA has the ability to detect vertical relief in images
- Muddy water may be a confused signature
- Shadows with fringing reefs
- Only as good as training set

Helicopter survey flight around Tampa Bay

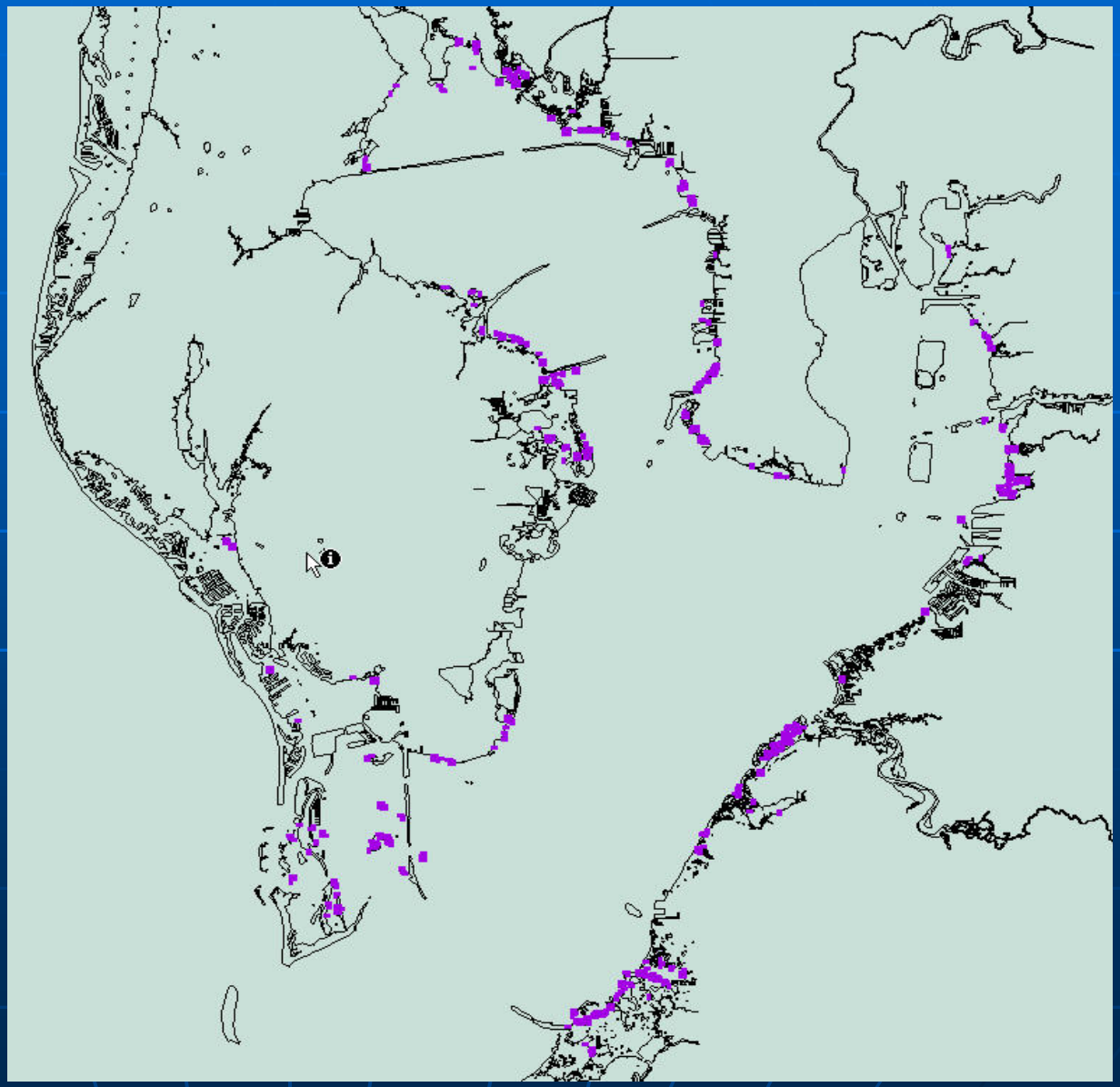
Familiarization with reef locations

Photos

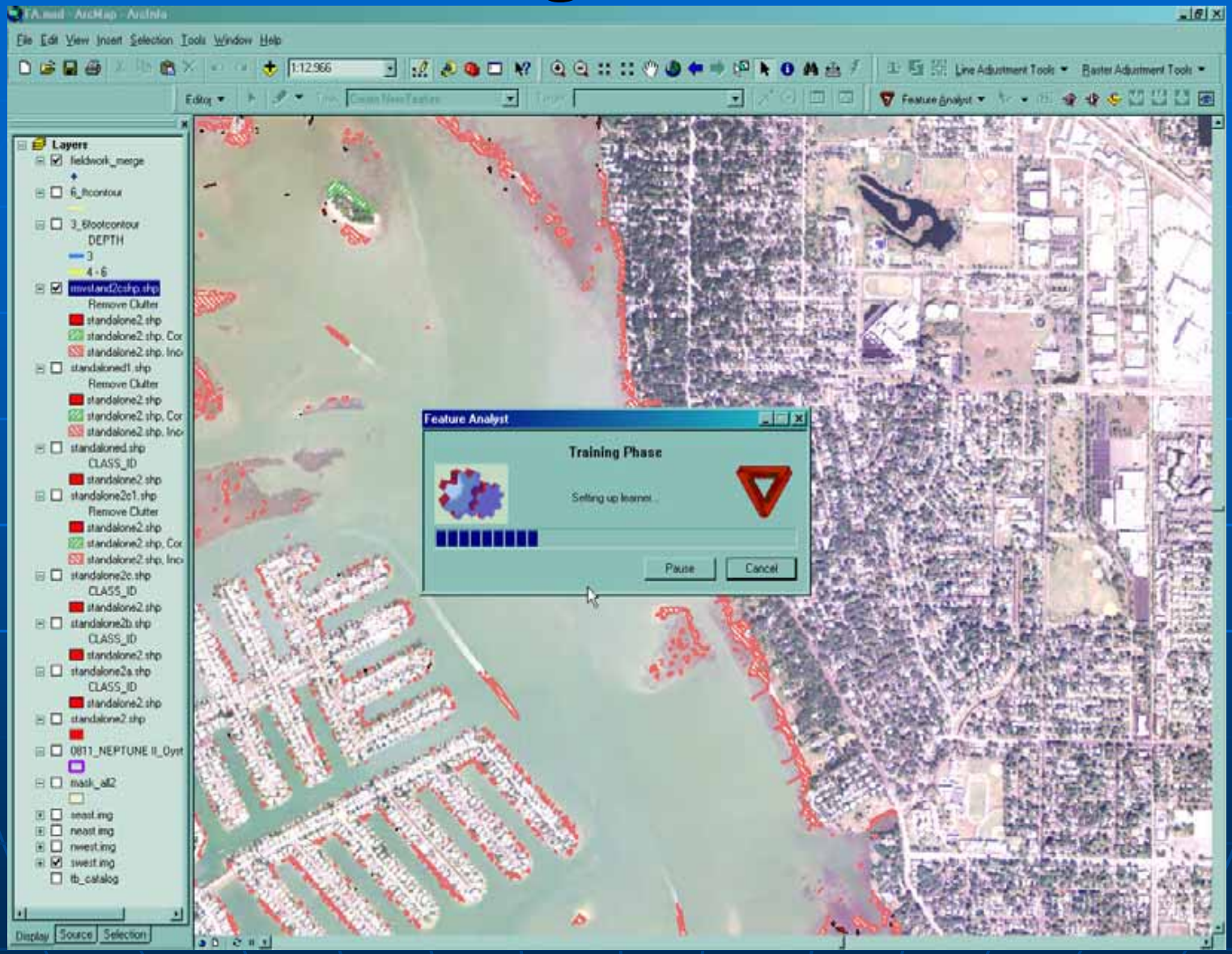
GPS link to photo ID

Deliverables from Galileo

- Hyperspectral imagery for entire Tampa Bay area
- Mosaic photo image of Tampa Bay
- Oyster bed shapefile



Training the Software



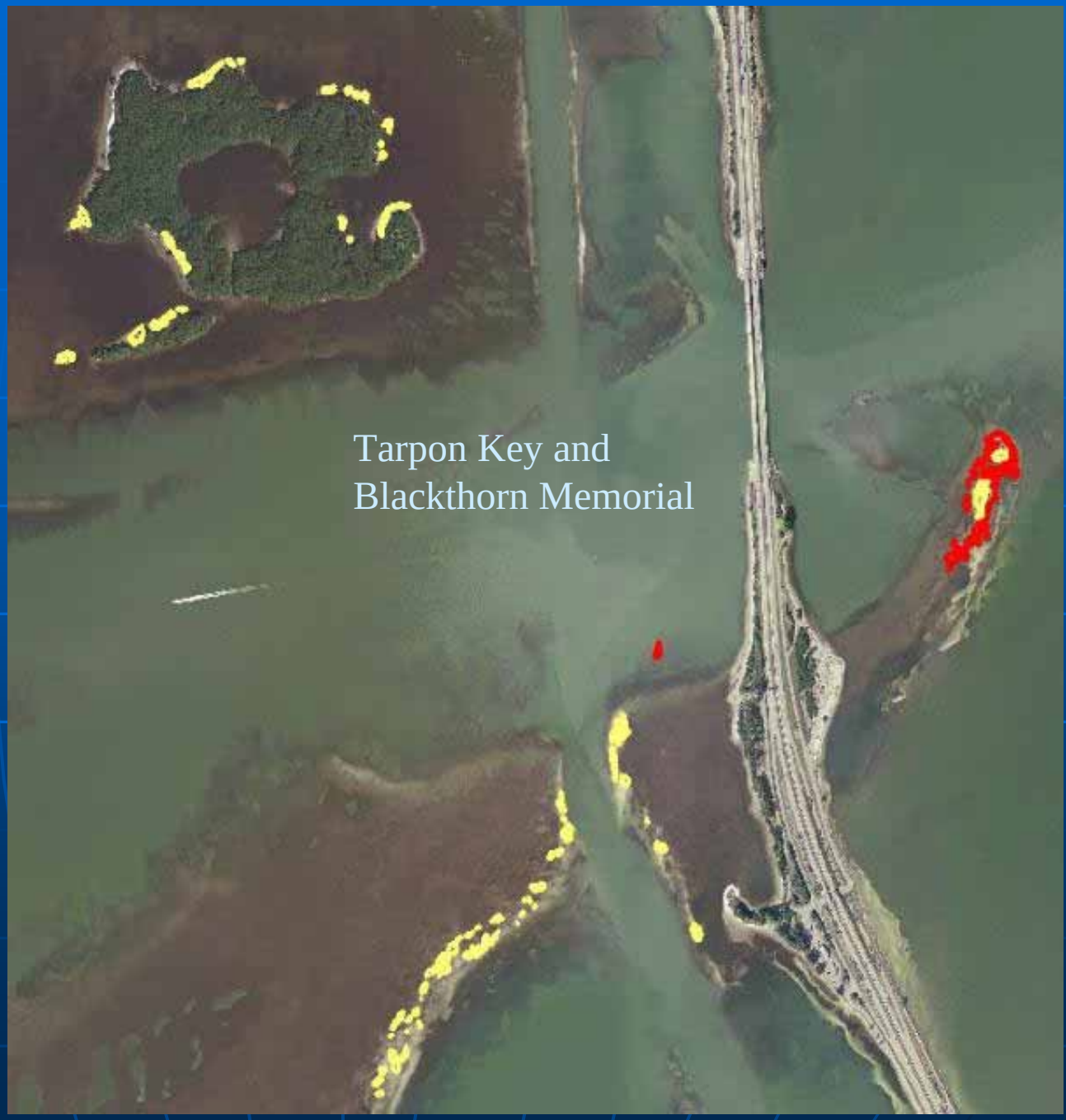
Red = First pass

Green = Training set

Galileo's 1st classification using the original supervised training sets obtained on the overflight and the first field excursion

Galileo's 2nd classification super-imposed over the first attempt

2nd deliverable in Yellow



Final product superimposed over 1st & 2nd deliverables

Final deliverable in Purple

Feature Analyst Output

Tarpon Key and

Blackthorn Memorial

Training set consisted of random field locations

Galileo vs. Feature Analyst

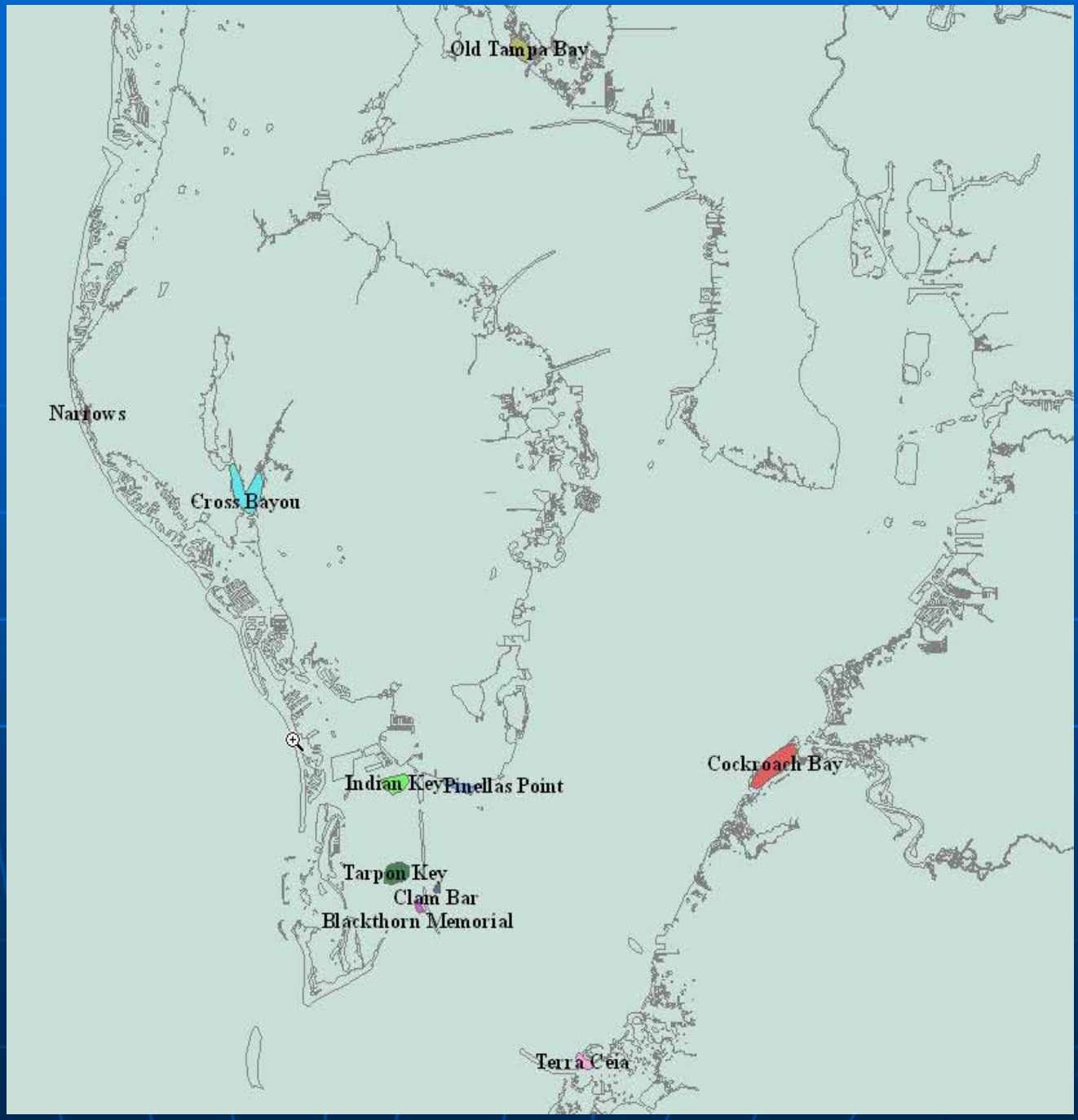
Tarpon Key and
Blackthorn Memorial

Galileo Final Product in Purple
FA first output in red

Assessment Approach

- Characterize up to 10 pre-selected oysters reefs
  - Choice of reefs based upon characteristics of reef, correspondence between photo images and Galileo predictions
  - Work at much larger scale to match resolution of hyperspectral images
- Assess surface composition at multiple points within reef, using Galileo predictions as a guide
- Results allow estimation of error rate of hyperspectral approach, also allows for identification of possible causes of error
- Accuracy Assessment performed on all datasets.

Validation Sites:
Ten sites selected for spread around the bay, fringing or open reefs, healthy or sparse, and information derived from Galileo images



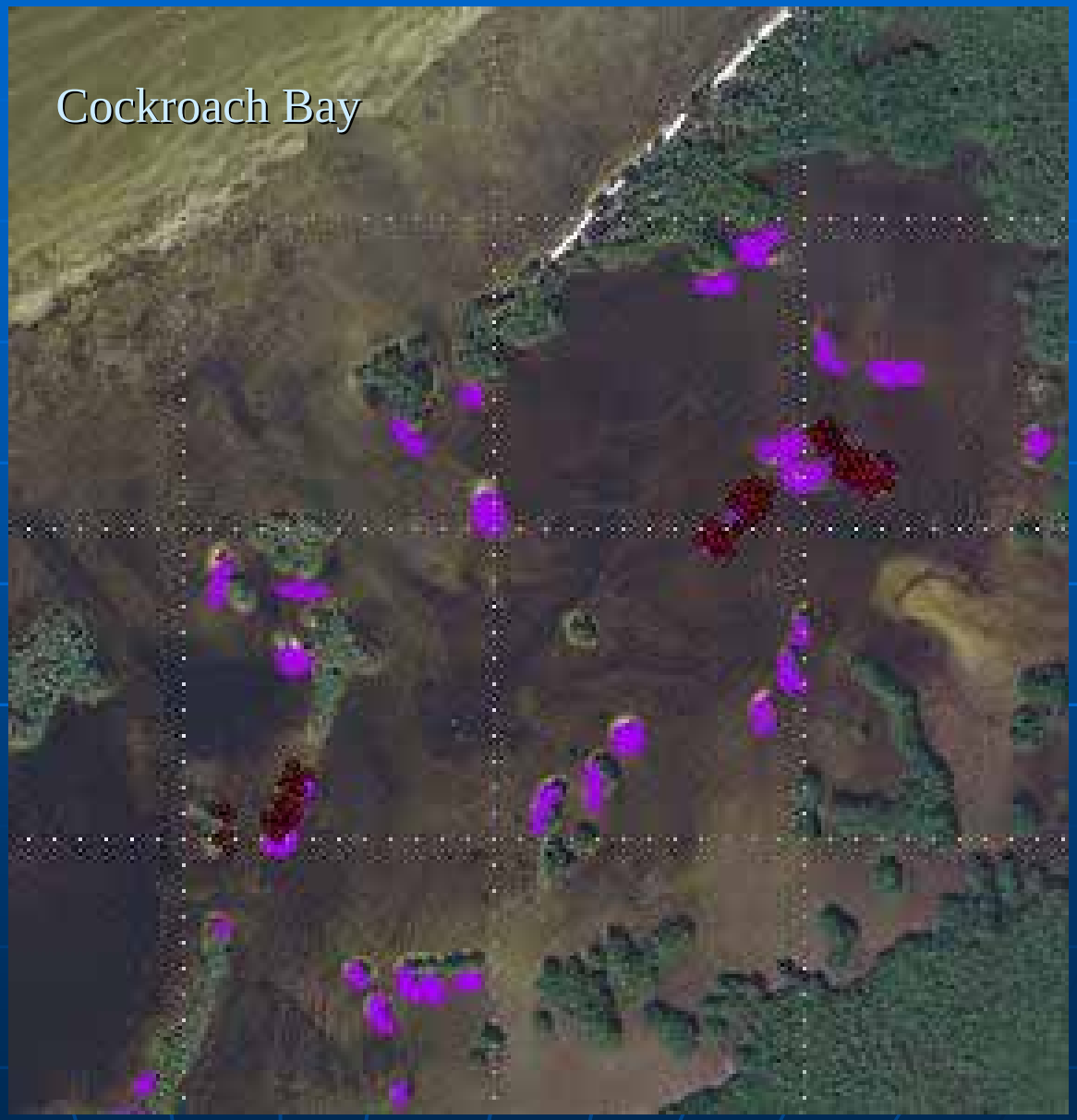
Error Matrix

FWRI \ Galileo	
Yes/Yes: both agree that the point is oysters	Yes/No: Galileo says oysters but actually some other substrate
No/Yes: Galileo says no oysters but actually oysters	No/No: Galileo says no oysters and there are no oysters

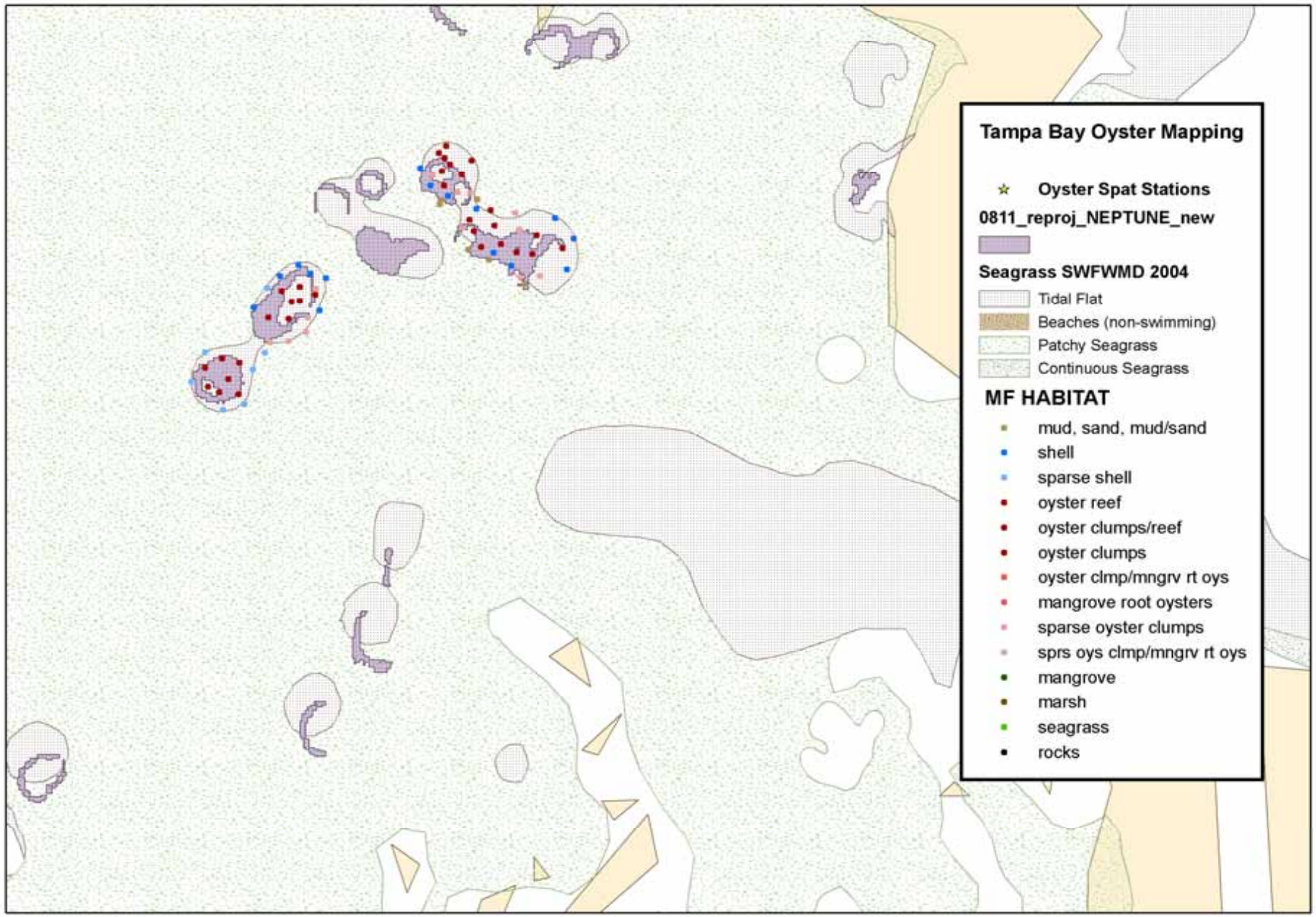
Must establish an acceptable error rate

Ground truthing consists of selecting numerous points, some random and some in response to Galileo output, and identifying actual substrate composition

Galileo Final Output with ground truth sample sites



Cockroach Bay



Change the Plan!!

- As we assessed the accuracy it became clear that the automated and semi-automated approaches were not producing expected results
- Plan B: The Old "*Tried and True*"
- Traditional photointerpretation techniques

All Results

Tarpon Key

FA final output in Red

Galileo final output in Orange

PhotoInterpretation in Yellow

Conclusions

- Helicopter overflights revealed an extensive oyster reef system in Tampa Bay, including almost pristine reefs in the Cross Bayou area

- Hyperspectral approach was not deemed a successful methodology.
  - Able to detect many oyster reefs in Tampa Bay, but problems were encountered due to low relief and confused signatures.
  - Overall Accuracy of product 32%. Both errors of omission and comission.

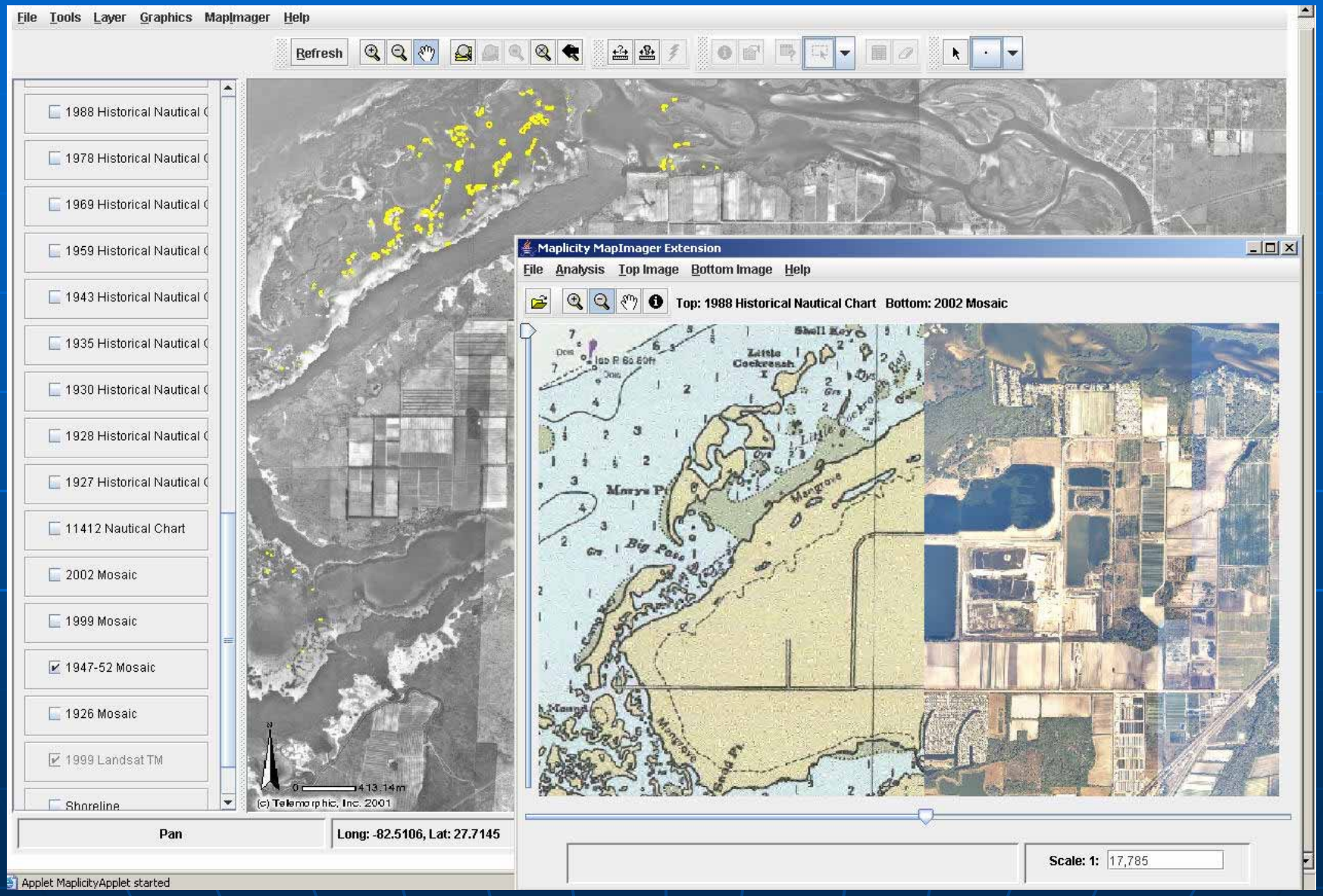
Conclusions

- Feature Analyst Learning Algorithms show promise but were unable to differentiate between confused signatures. Only a 10% accuracy was realized after 4 full iterations so this approach was abandoned in favor of a traditional approach to mapping.

- Traditional Photo Interpretation Techniques yielded best result. Primarily errors of omission due to fringing reefs that were concealed by shadow or mangrove. 85% accuracy on free-standing reefs and 78% accuracy overall.

- Oblique Imaging may be tested to improve mapping of fringing reefs, estimated at ~30% of total of oysters observed.

TBEP Image Server



http://ocean.floridamarine.org/tbep

For More Information:

Data Review:

- http://ocean.floridamarine.org/tbep

Data Download:

- http://ocean.floridamarine.org/mrgis

Questions:

- Kathleen.OKeife@myfwc.com

Thank You for your Attention!