

# Managing and Monitoring Intertidal Oyster Reefs with Remote Sensing in Coastal South Carolina

**A cooperative effort between:**

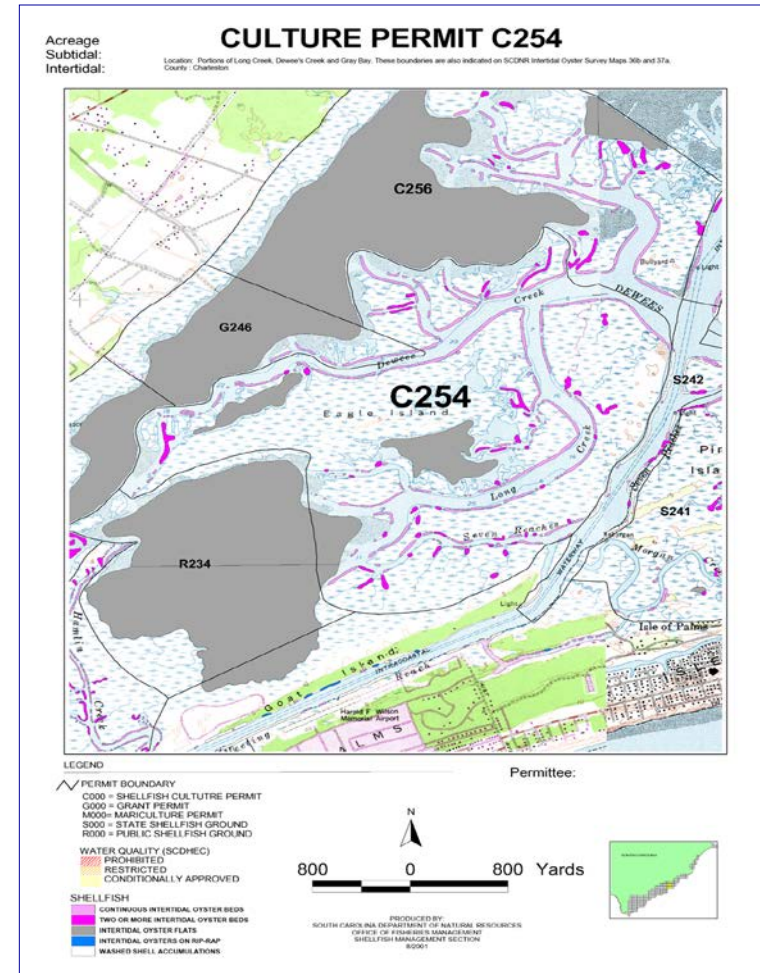
**Coastal Services Center  
South Carolina Department of Natural Resources  
City of Hilton Head Island**



**NOAA Coastal Services Center**  
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

# Overall Project Goals

- Update state's oyster database
- More efficient methodologies
- Some determination of oyster health
- Examine suspected impacts



# Remote Sensing Expectations

- Perimeter and location of beds
- Better quantification of patch reefs in flats
- Location of fringing reefs
- Dead vs. “live” oyster
- Some strata information
- Field work still anticipated



# Analog Image Source

- Metric aerial photography
- Multiple scales- 1:8K, 1:5K, 1:3K, and 1:2K
- Conventional color film (Kodak 2448) diapositives
- Metric mapping camera
- Stereo coverage



04-24-02

1:5000

NOAA-CSC

Hamlin Creek

3 - 8

SL 0595 Hamlin Creek 04/24/02 11:00:00 11:01:00 11:02:00 11:03:00 11:04:00 11:05:00 11:06:00 11:07:00 11:08:00 11:09:00 11:10:00 11:11:00 11:12:00 11:13:00 11:14:00 11:15:00 11:16:00 11:17:00 11:18:00 11:19:00 11:20:00 11:21:00 11:22:00 11:23:00 11:24:00 11:25:00 11:26:00 11:27:00 11:28:00 11:29:00 11:30:00 11:31:00 11:32:00 11:33:00 11:34:00 11:35:00 11:36:00 11:37:00 11:38:00 11:39:00 11:40:00 11:41:00 11:42:00 11:43:00 11:44:00 11:45:00 11:46:00 11:47:00 11:48:00 11:49:00 11:50:00 11:51:00 11:52:00 11:53:00 11:54:00 11:55:00 11:56:00 11:57:00 11:58:00 11:59:00 12:00:00 12:01:00 12:02:00 12:03:00 12:04:00 12:05:00 12:06:00 12:07:00 12:08:00 12:09:00 12:10:00 12:11:00 12:12:00 12:13:00 12:14:00 12:15:00 12:16:00 12:17:00 12:18:00 12:19:00 12:20:00 12:21:00 12:22:00 12:23:00 12:24:00 12:25:00 12:26:00 12:27:00 12:28:00 12:29:00 12:30:00 12:31:00 12:32:00 12:33:00 12:34:00 12:35:00 12:36:00 12:37:00 12:38:00 12:39:00 12:40:00 12:41:00 12:42:00 12:43:00 12:44:00 12:45:00 12:46:00 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FS #4 1.7 280 6/4.0 FF2.6 FC-1/3.8 SP- WP.08391 60% d1005.7 d1045 27.4V -62mb FROM 04M5307

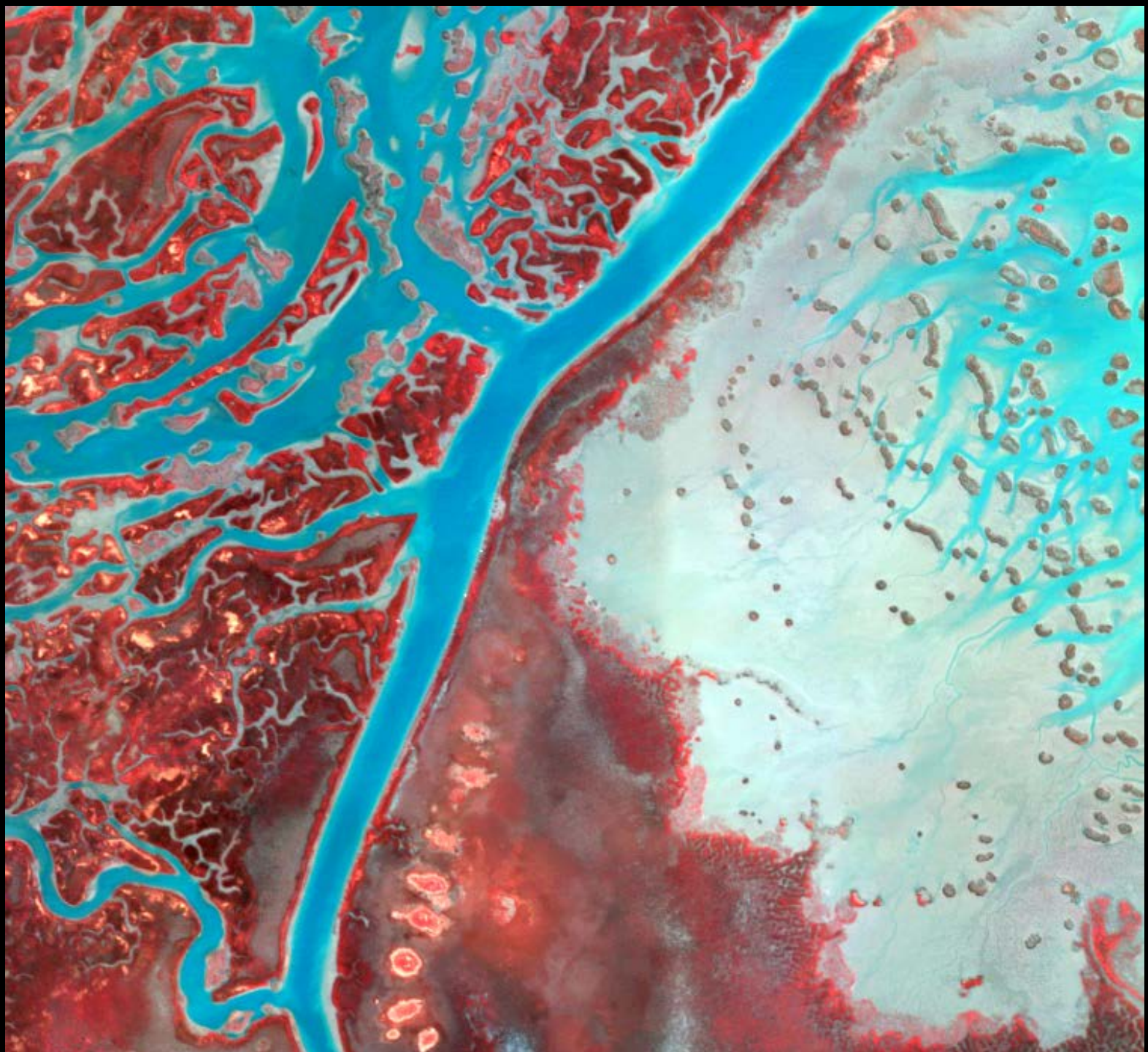
WLD 15/4 JAO-B  
No 0249 05.33

4416

# Digital Image Source

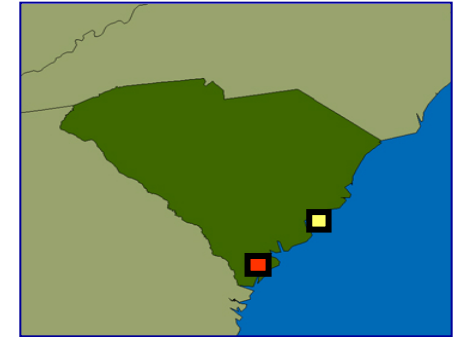
- GeoScanner mosaics and tiles
- 4 discrete spectral bands (B,G,R,NIR)
- Ortho-rectified imagery ( $\pm$  3m horizontal accuracy)
- Tuneable bands (10nm)
- Illumination normalization
- 0.5 and 0.25m spatial resolution



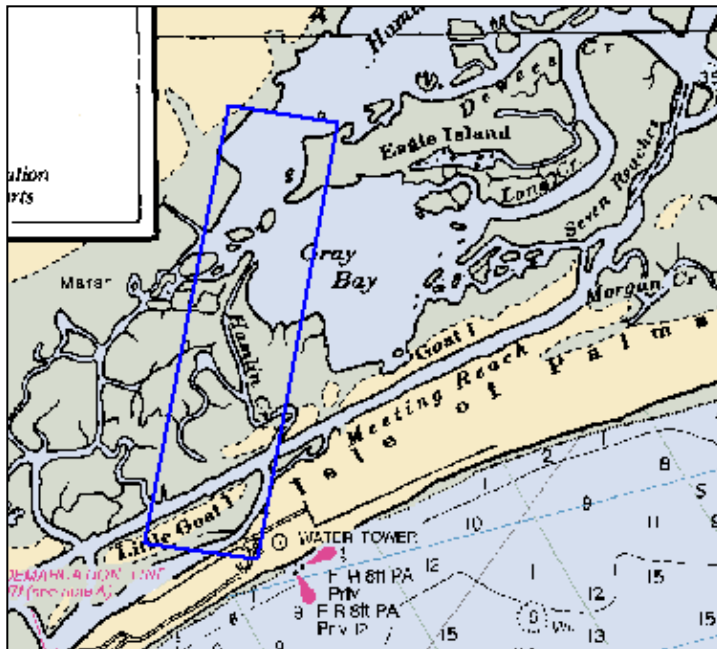


# Pilot Areas

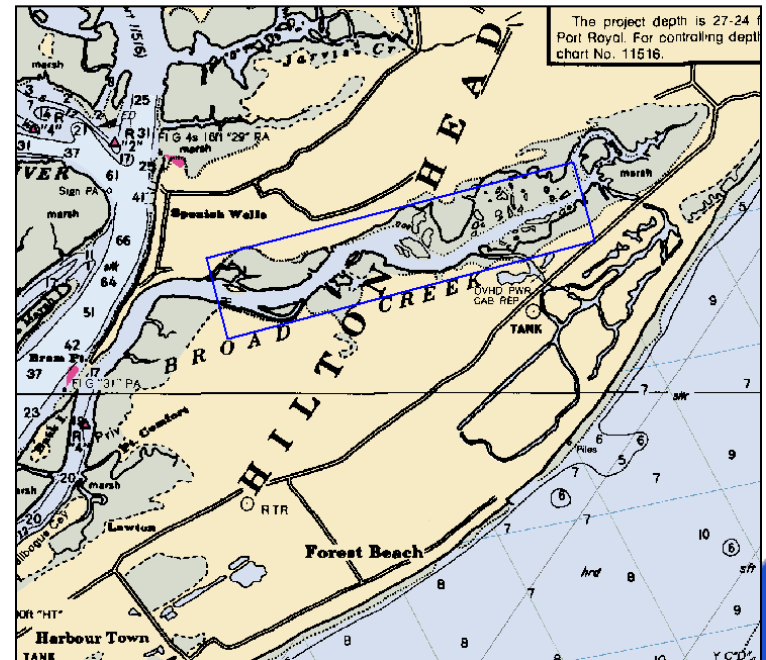
- Lunar-low tide acquisition
- Low or offshore winds
- Variable environmental settings



Hamlin Creek - Charleston County



Broad Creek - Beaufort County





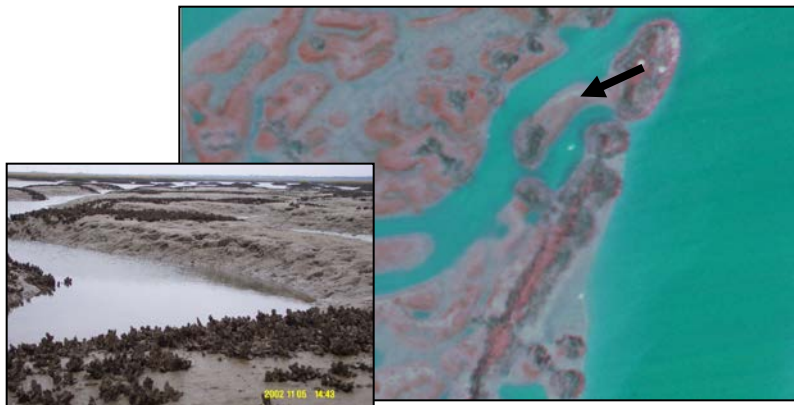
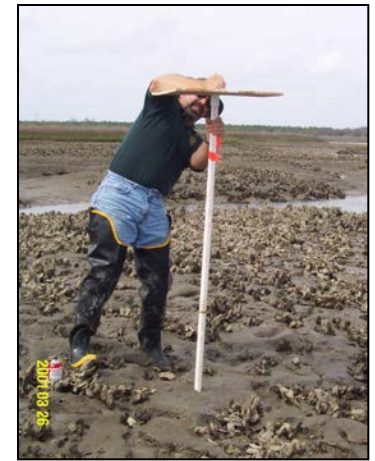
# Evaluating Potential Methods

- Cost
- Complexity of approach
- Level of effort
- Sensor availability
- Level of detail
- Infrastructure requirements

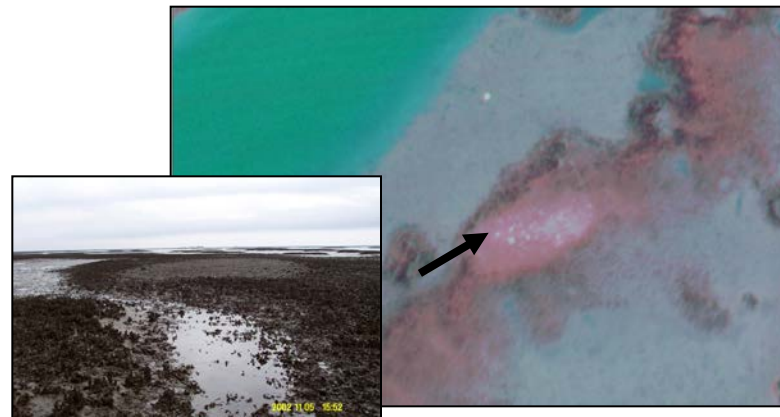
*Overall goal: Get the process into the hands of the most people who really know this resource.*

# Field Efforts

- Differential GPS controlled point observations
- GPS field digitization
- Calibration panels
- Ground photo comparison



View looking southwest



View looking northeast

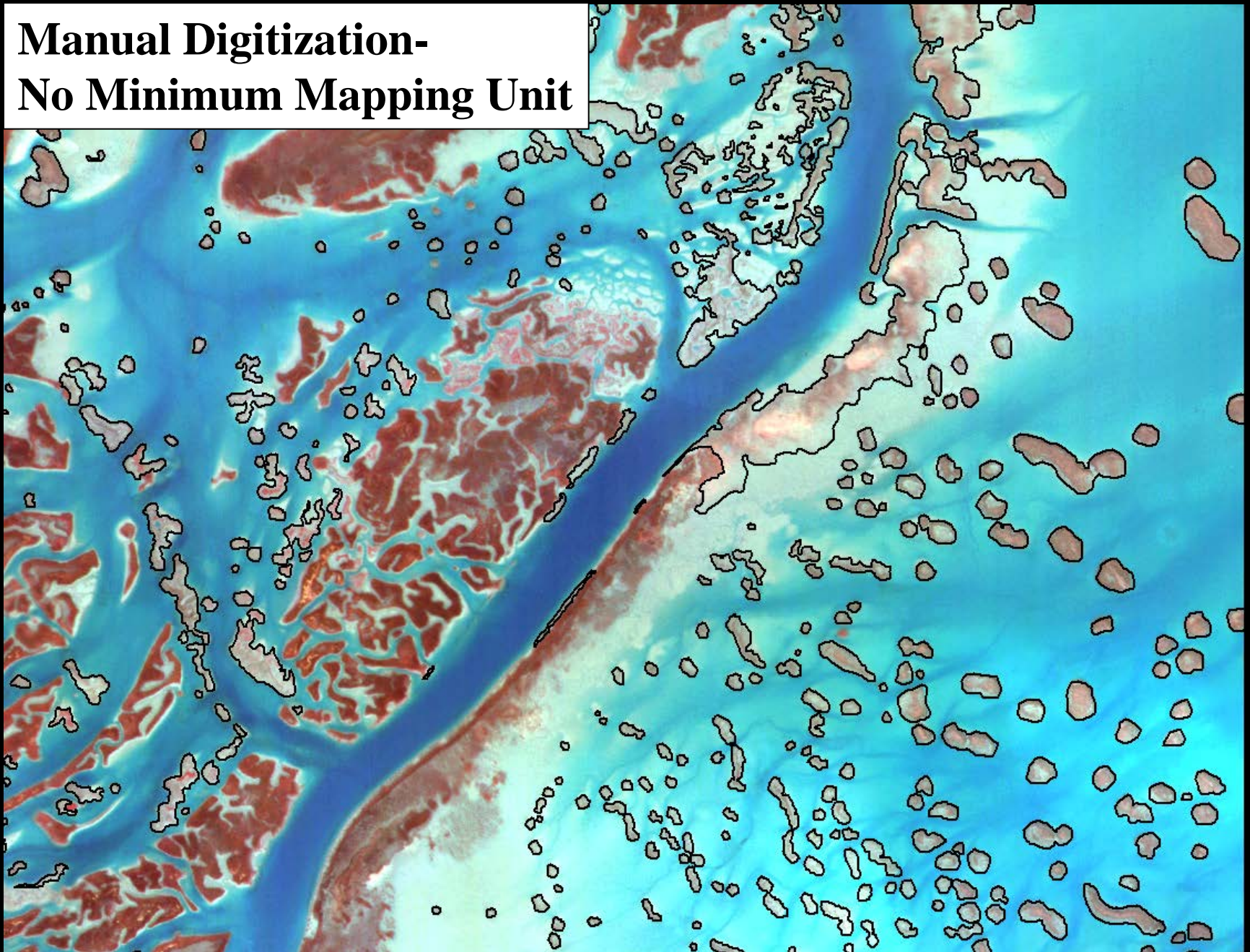
# Methods

## Manual digitization-

- **Imagery** – Photography and GeoScanner (0.5m)
- **Software** – ArcView Habitat Digitizer
  - **Hamlin:** Patch reefs especially labor intensive.  
  
Experience influences results strongly.
  - **Broad:** Field work essential
- **Cost Benefit** –  
Effort – 7                      Results – 8



## Manual Digitization- No Minimum Mapping Unit



# Methods

## Image segmentation -

- Imagery – GeoScanner (0.5m)
- Software - eCognition
  - Broad: Experience influences results strongly.
- Cost Benefit –  
Effort – 7      Results – 7+





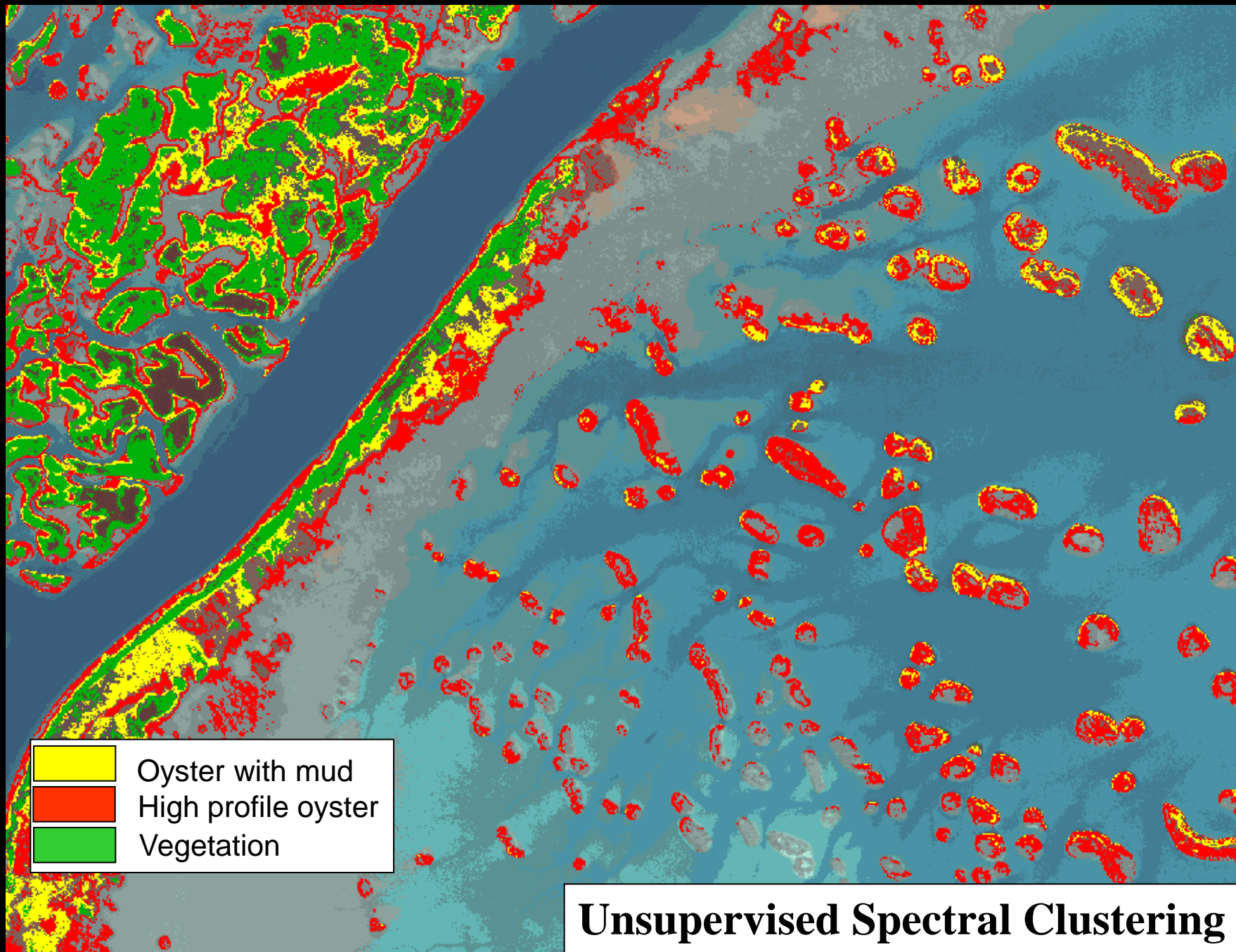
**eCognition**  
**Initial Segmentation**



# Methods

## Unsupervised spectral clustering-

- **Imagery** – GeoScanner (0.5m)
- **Software** - ERDAS Imagine (ISODATA)
  - **Hamlin:** Three good clusters.  
Good at patch reefs
  - **Broad:** Similar results to Hamlin.  
More problems with shadows
- **Cost Benefit** –  
Effort – 4                      Results - 4



# Methods

## Supervised spectral clustering-

- Imagery – GeoScanner (0.5m)
  - Software – ERDAS Imagine
    - Hamlin: Better results than unsupervised.
    - Broad: More confusion than unsupervised.
- AOIs pulling in mixed signatures.

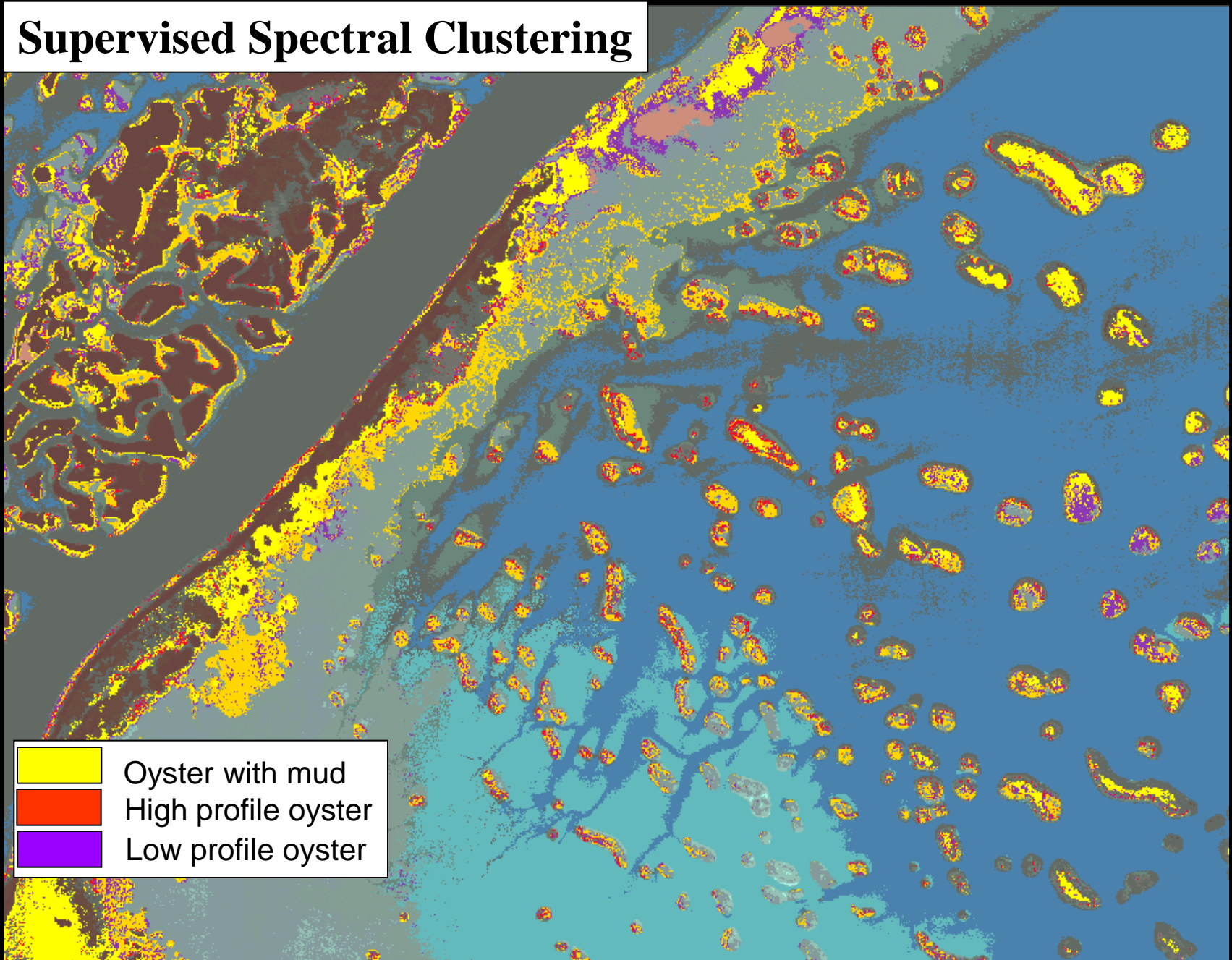
- Cost Benefit –

Effort – 5

Results - 5



# Supervised Spectral Clustering



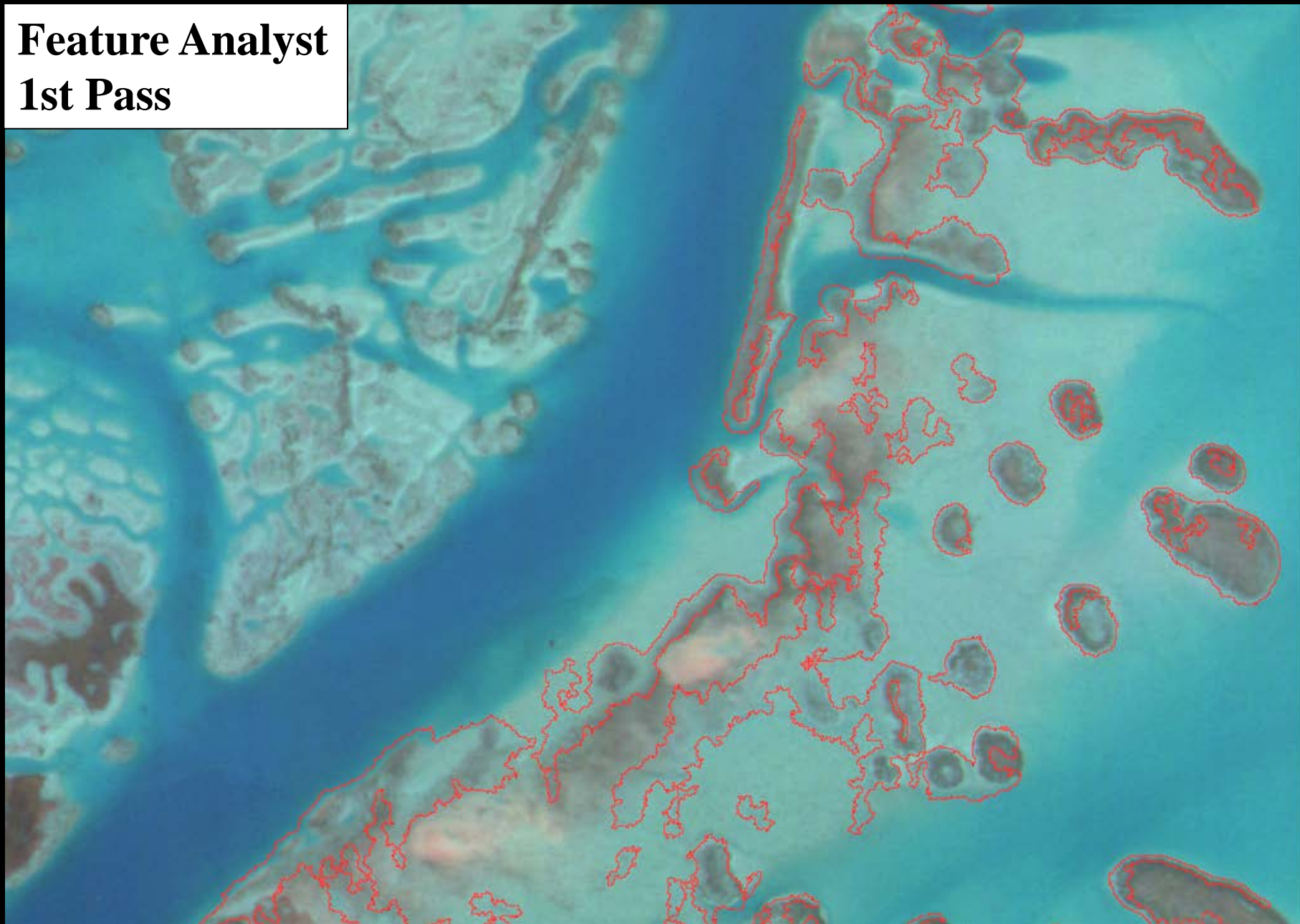
# Methods

## Texture Analysis -

- **Imagery** – **GeoScanner (0.5m)**
- **Software** – **Feature Analyst (ArcView Environment)**
  - **Broad**      **Excellent results on patch reefs.**  
**Encouraging results on fringing reefs.**
  - **Hamlin:**    **Same as Broad.**
- **Cost Benefit** –  
**Effort = 3      Results = 7**

# Feature Analyst

## 1st Pass



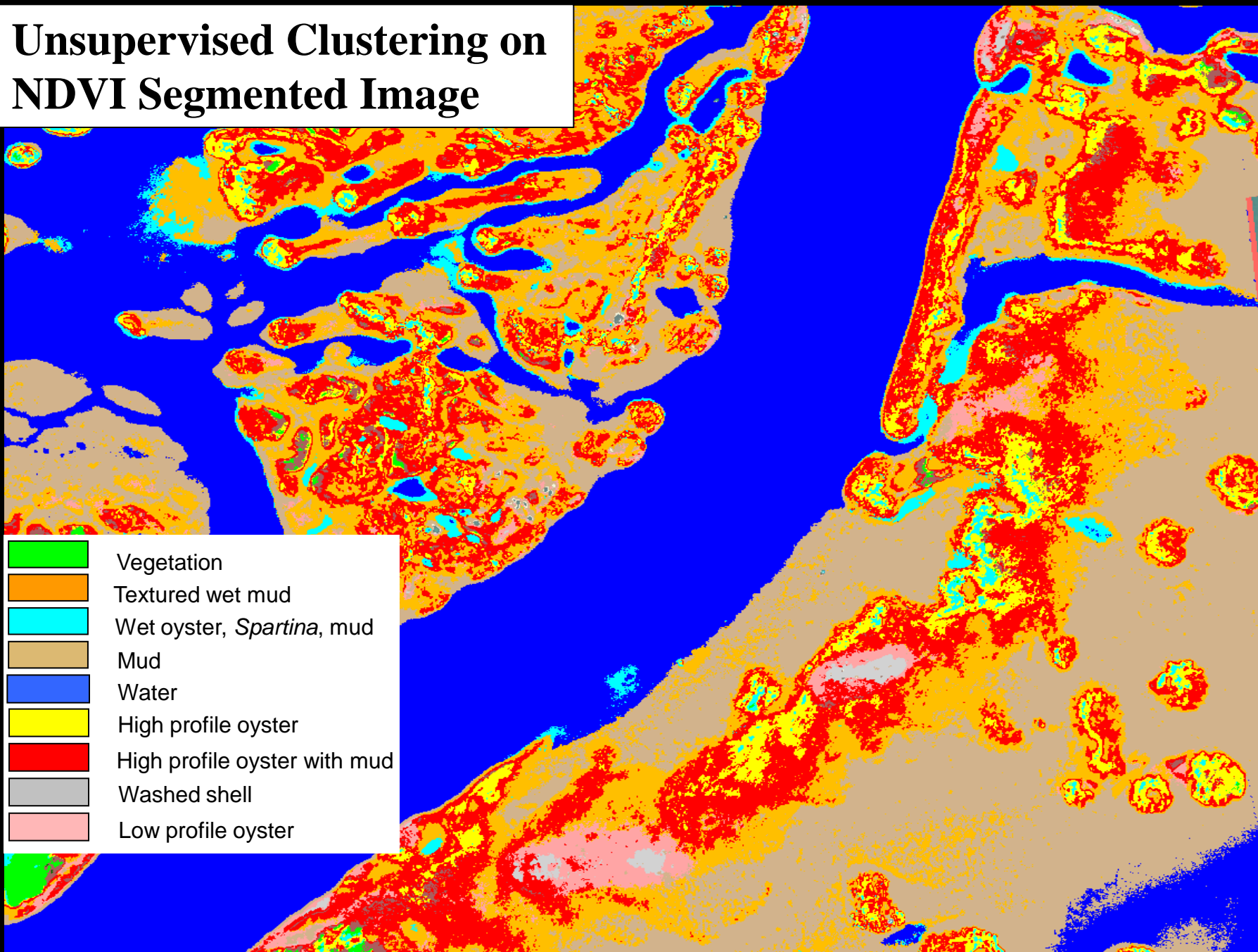


# Methods

## Derived products (NDVI, PCA) -

- **Imagery** – GeoScanner (0.25m)
- **Software** - ERDAS Imagine
  - **Hamlin:** NDVI adequate segmentation tool.  
PCA only three components.
  - **Broad:** NDVI had promising results but limited due to spartina response, confusion.
- **Cost Benefit** –  
Effort = 7      Results = 8

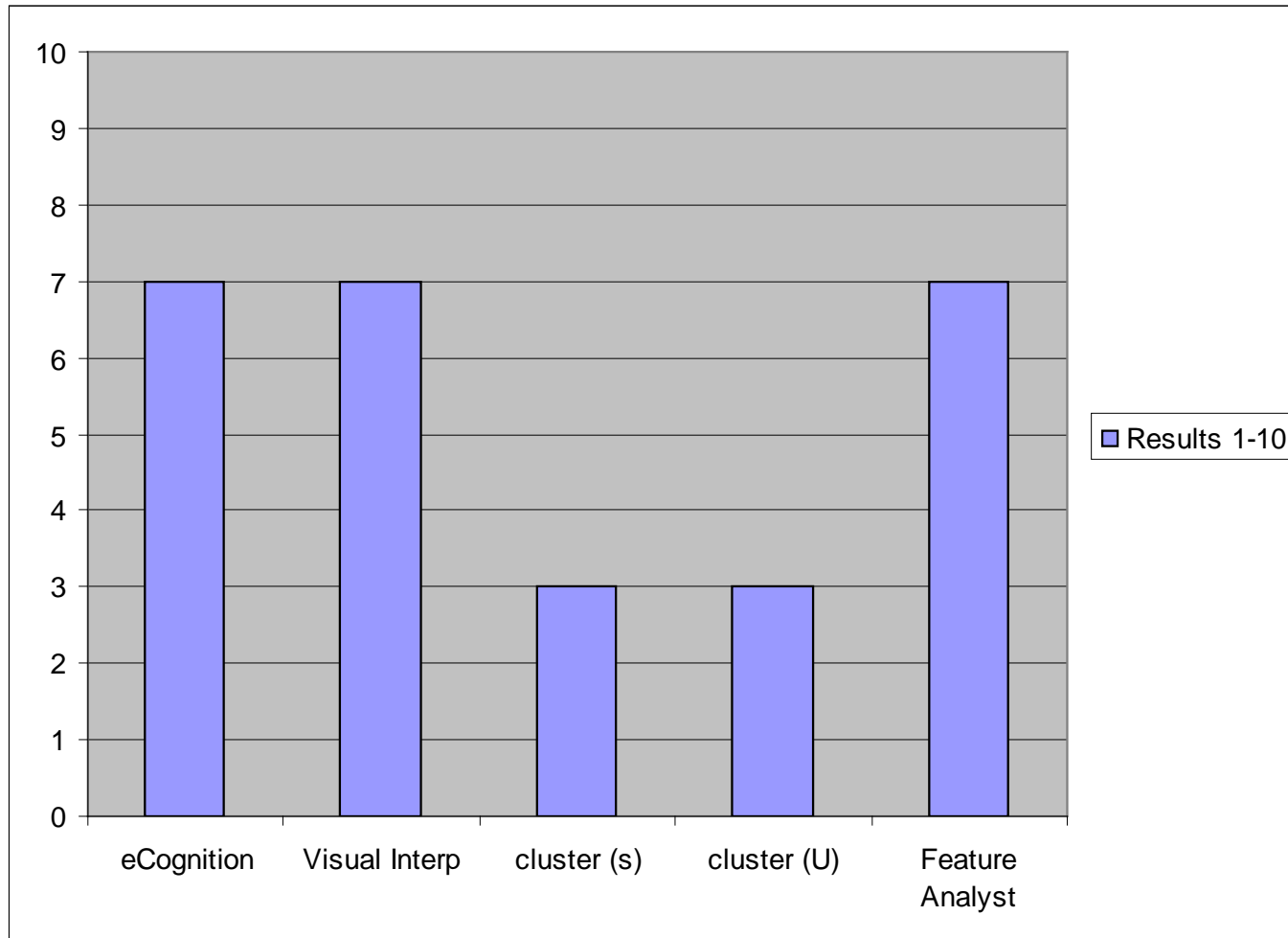
# Unsupervised Clustering on NDVI Segmented Image



# Relative Detail

10 = all strata - all boundaries

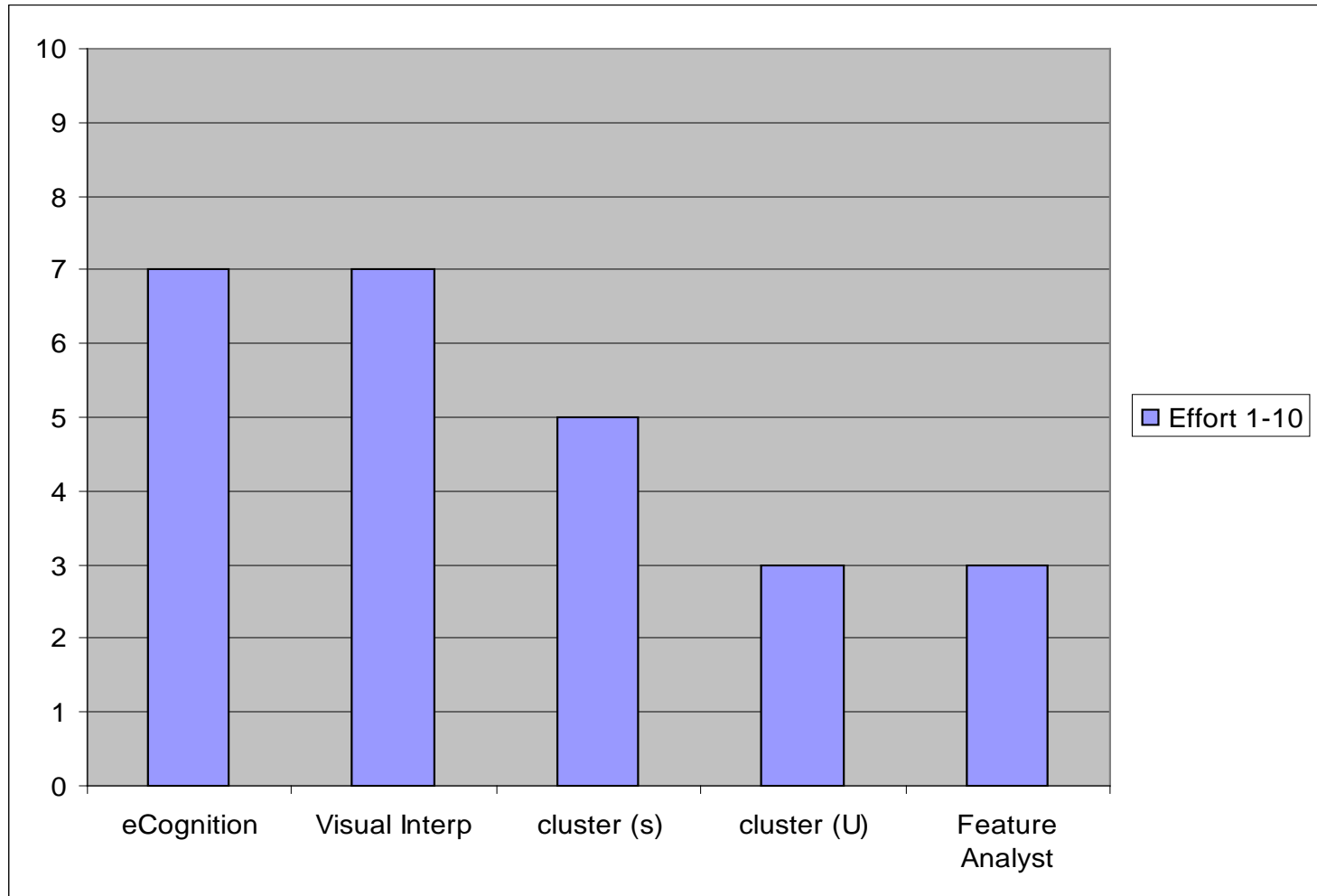
3 = some boundaries



# Relative Effort

10 = high skill, complex process, long time

1 = low skill, simple, quick





# Strata Summary

## GeoScanner -

**0.50 m** = Washed shell, other oyster

Patch reefs easy, fringing reef more difficult

**0.25m** = Washed shell, several live strata

Patch reefs easy, fringing reefs easy

## Analog -

**1:8K** = Washed shell, more than one other oyster

Patch reefs easy, fringing reef slightly more difficult

**1:5K** = Washed shell, several live strata

Patch reefs easy, fringing reefs easy

**1:3K** and **1:2K** = Continued improvement on above.

# Strata Examples



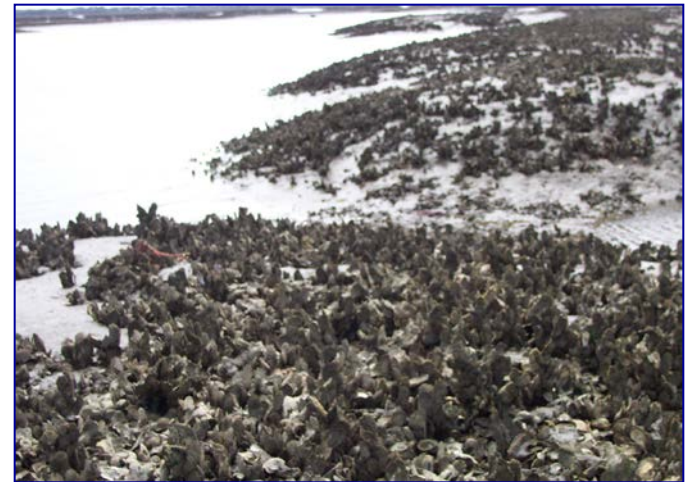
**Washed Shell (Dead)**



**High Profile with Mud**



**Low Profile**



**High Profile**

# Summary

- **GeoScanner 0.5 meter captures reef boundaries**  
*90% of patch reefs*  
*70% of fringing reefs*  
*No strata except washed shell and other*
- **GeoScanner 0.25 meter captures more fringing reefs and several strata**

## Challenges

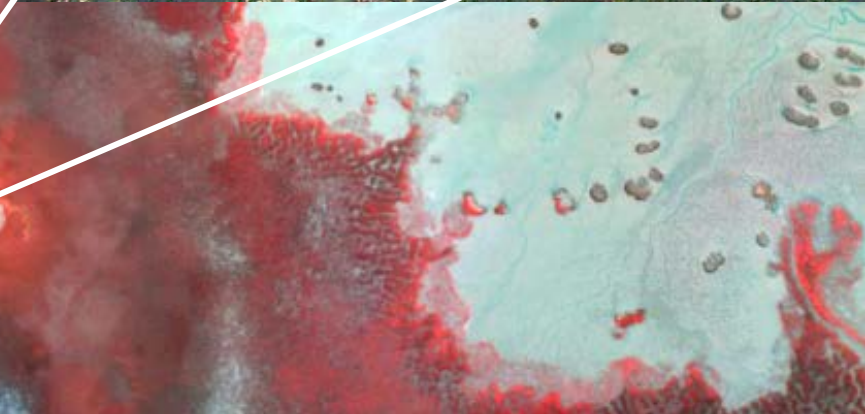
*Spartina with oyster mixed in*

*Textured mud vs. oyster*

*Diatoms affect oyster's appearance on imagery*









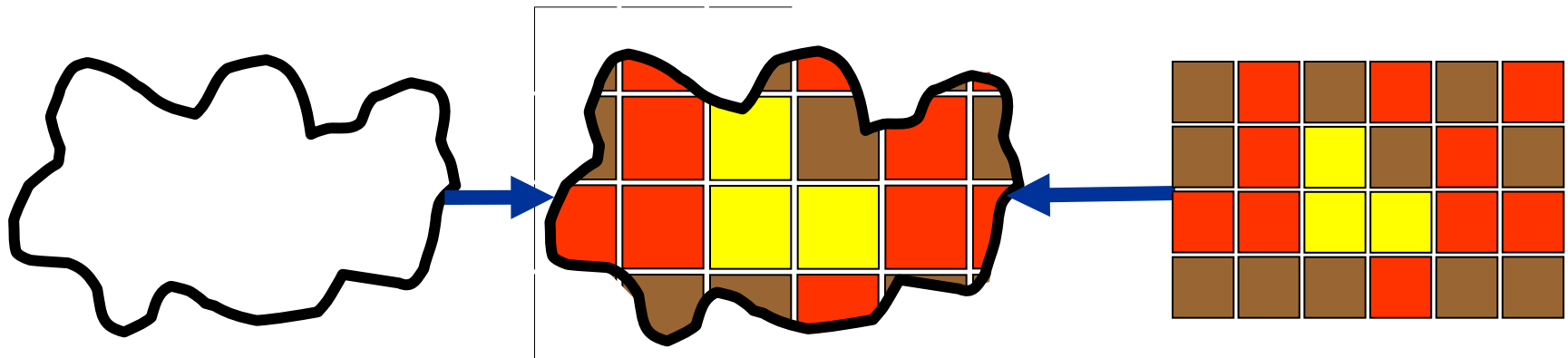
# Proposed Approach

## Polygon Information (Feature Analysis)

- Extent/Configuration
- Fringe/Patch
- Good representation of the actual feature of interest – the “oyster reef”

## Raster Information (Clustering)

- Pixel-by-pixel classification
  - Oyster – red and yellow
  - Mud – brown
- Precise representation of mix of features that makes an oyster reef
- Poor representation of the feature “oyster reef”



## Integrated Data (management solution)

Boundary allows determination of reef erosion or expansion

Raster data allows determination of reef condition

# Summary

- **Multi-spectral 0.25-meter imagery captures necessary detail to extract oyster reefs with multiple software**
- **Feature Analyst<sup>®</sup> creates single attribute polygonal data**
- **Imagine<sup>®</sup> ISODATA creates four unique classes**
- **Need to integrate these data sets for resource management and condition assessment**

# Strata Examples



**Washed Shell (Dead)**



**High Profile with Mud**



**Low Profile**



**High Profile**