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

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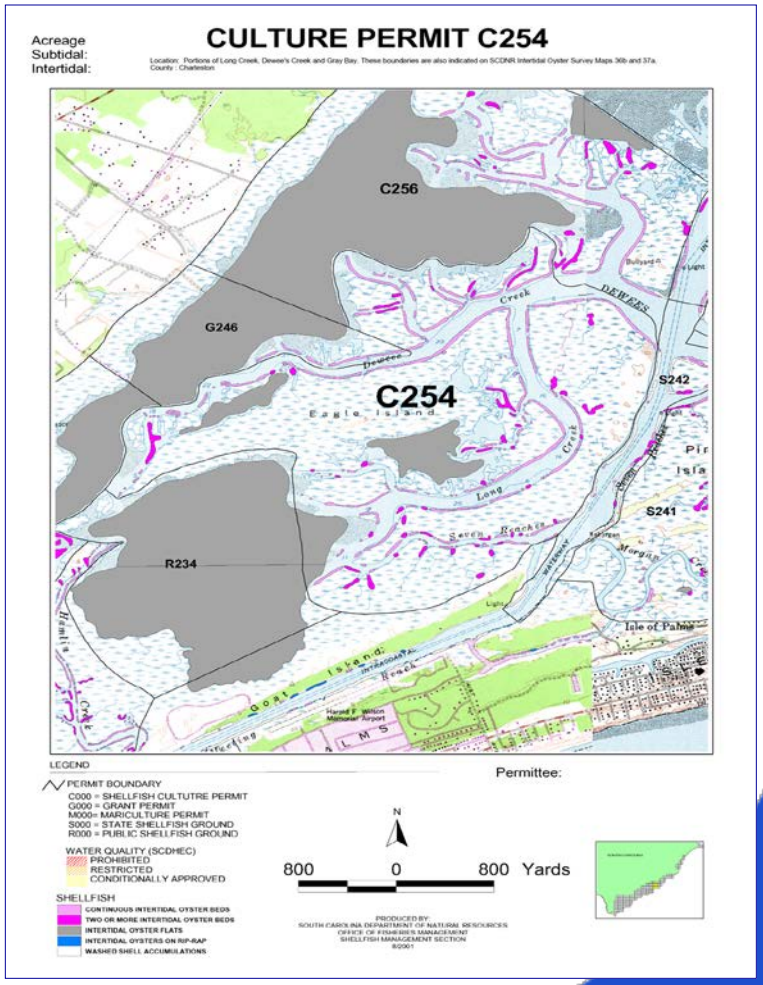
Overall Project Goals

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



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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

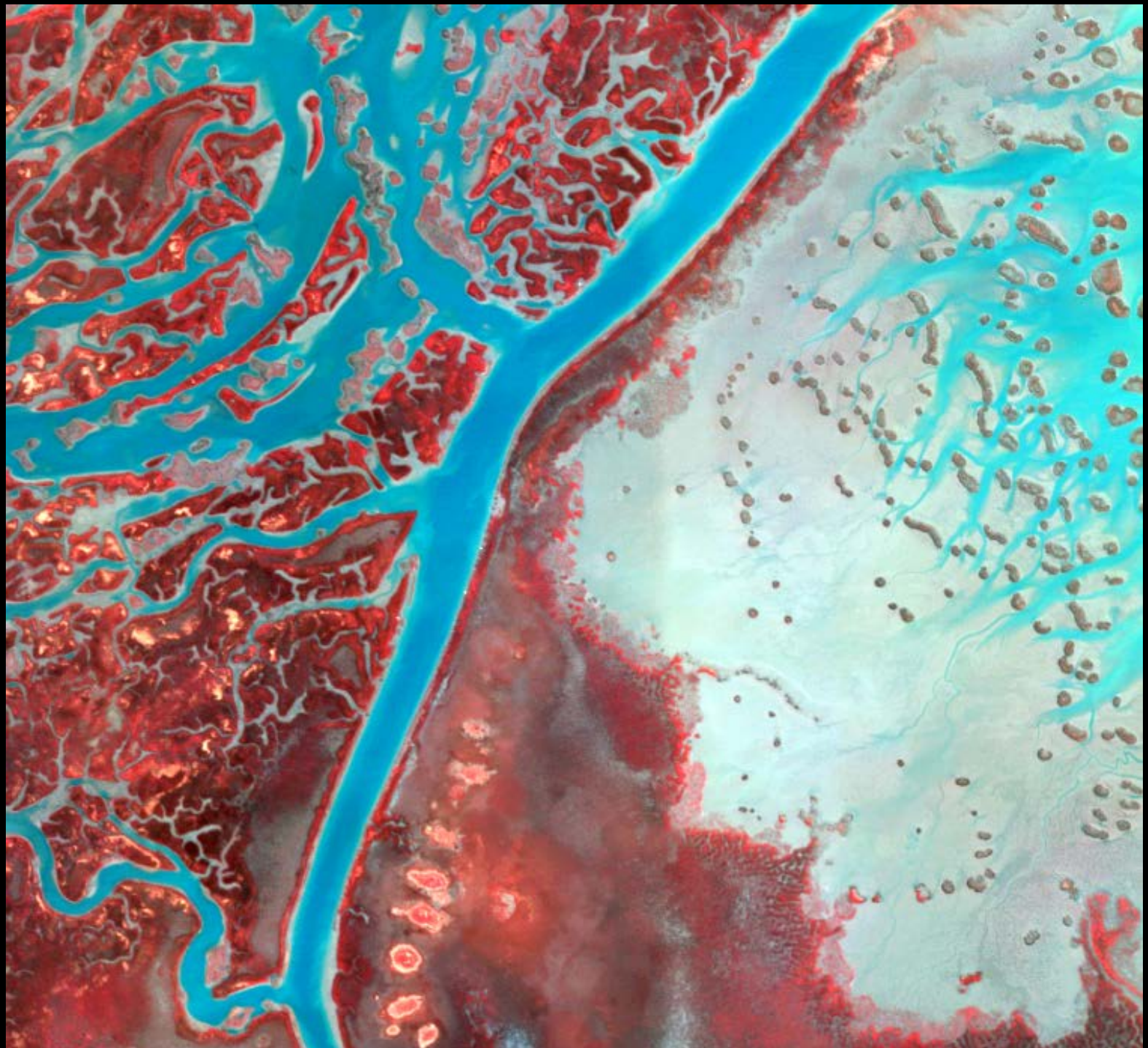
Analog Image Source

- 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

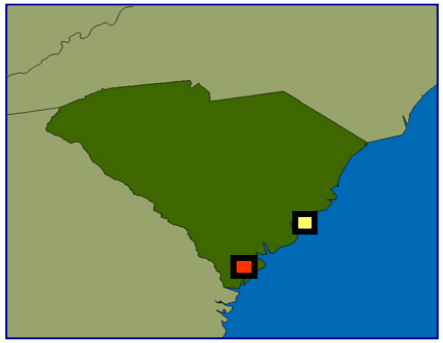
Digital Image Source

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

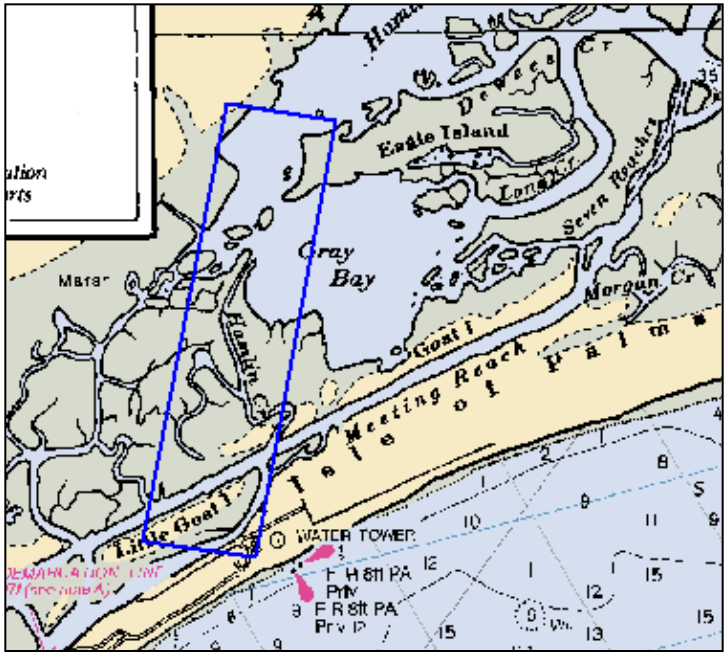


Pilot Areas

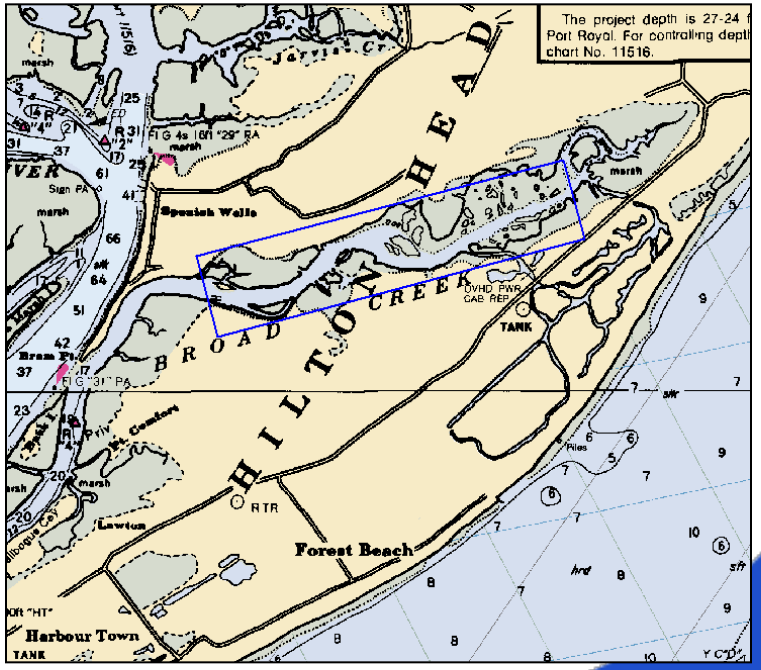
- Lunar-low tide acquisition
- Low or offshore winds
- Variable environmental settings



Hamlin Creek - Charleston County



Broad Creek - Beaufort County



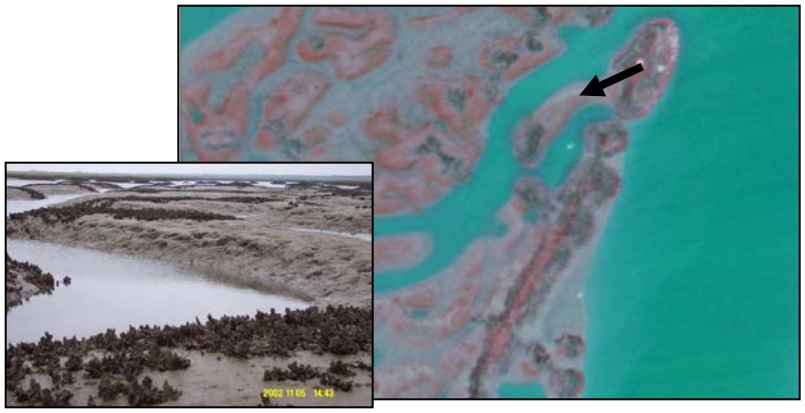
Evaluating Potential Methods

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

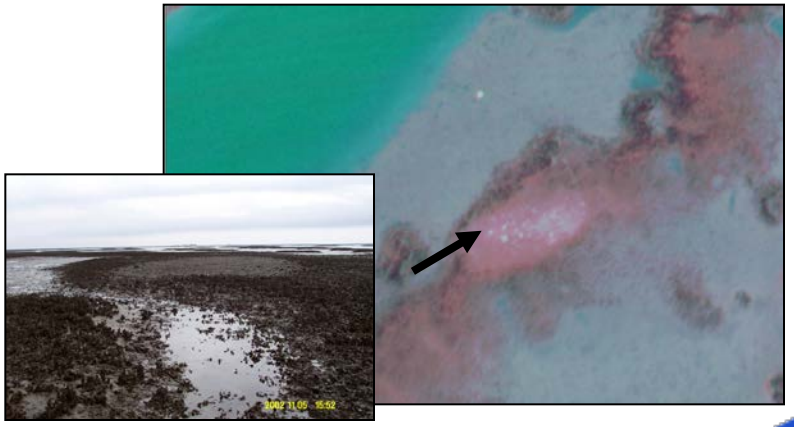
Overall goal: Get the process into the hands of the most people who really know this resource.

Field Efforts

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



View looking southwest



View looking northeast

Methods

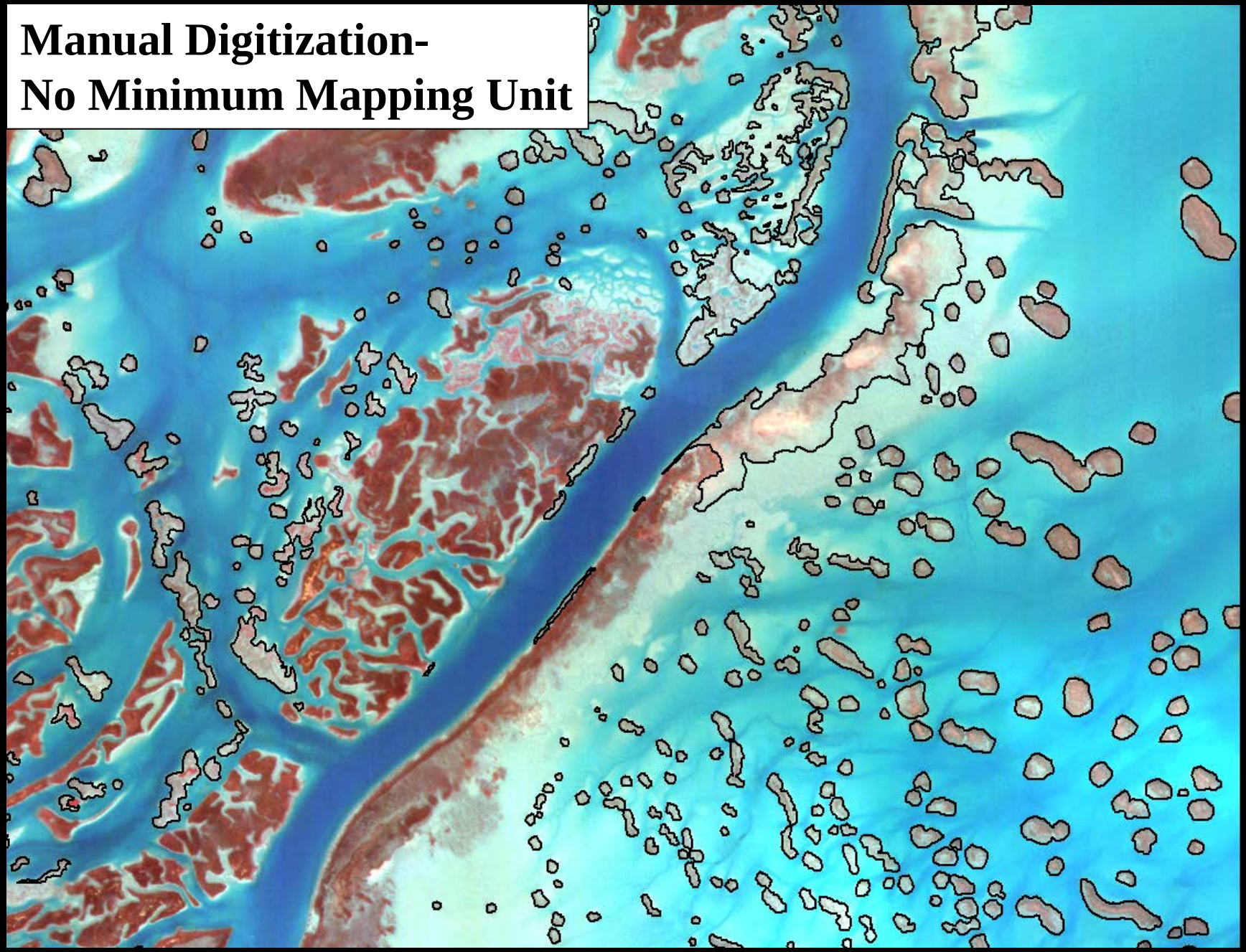
Manual digitization-

- **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.

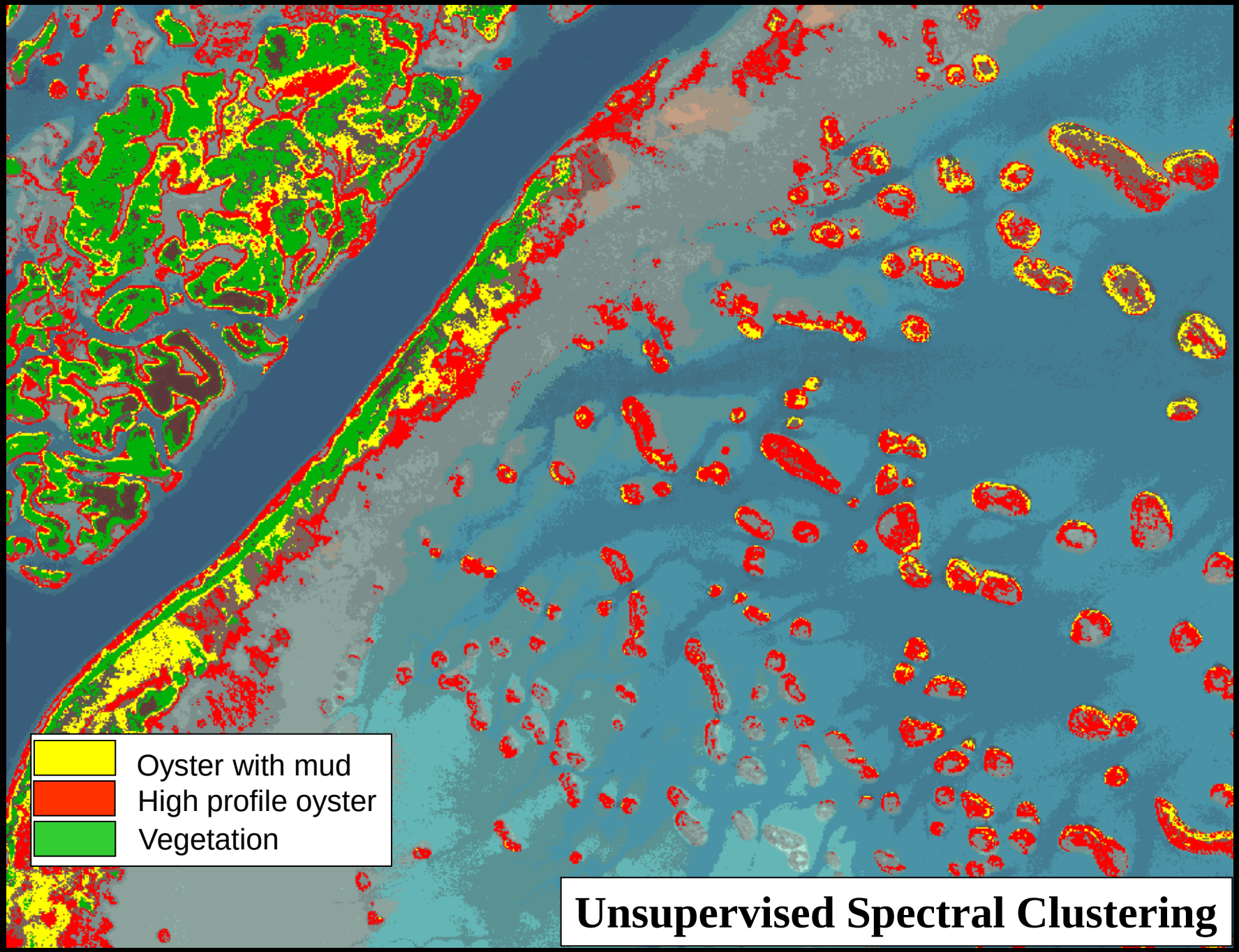
- **Cost Benefit –**
  Effort – 7 Results – 7+

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


Oyster with mud
High profile oyster
Vegetation
Unsupervised Spectral Clustering

Methods

Supervised spectral clustering-

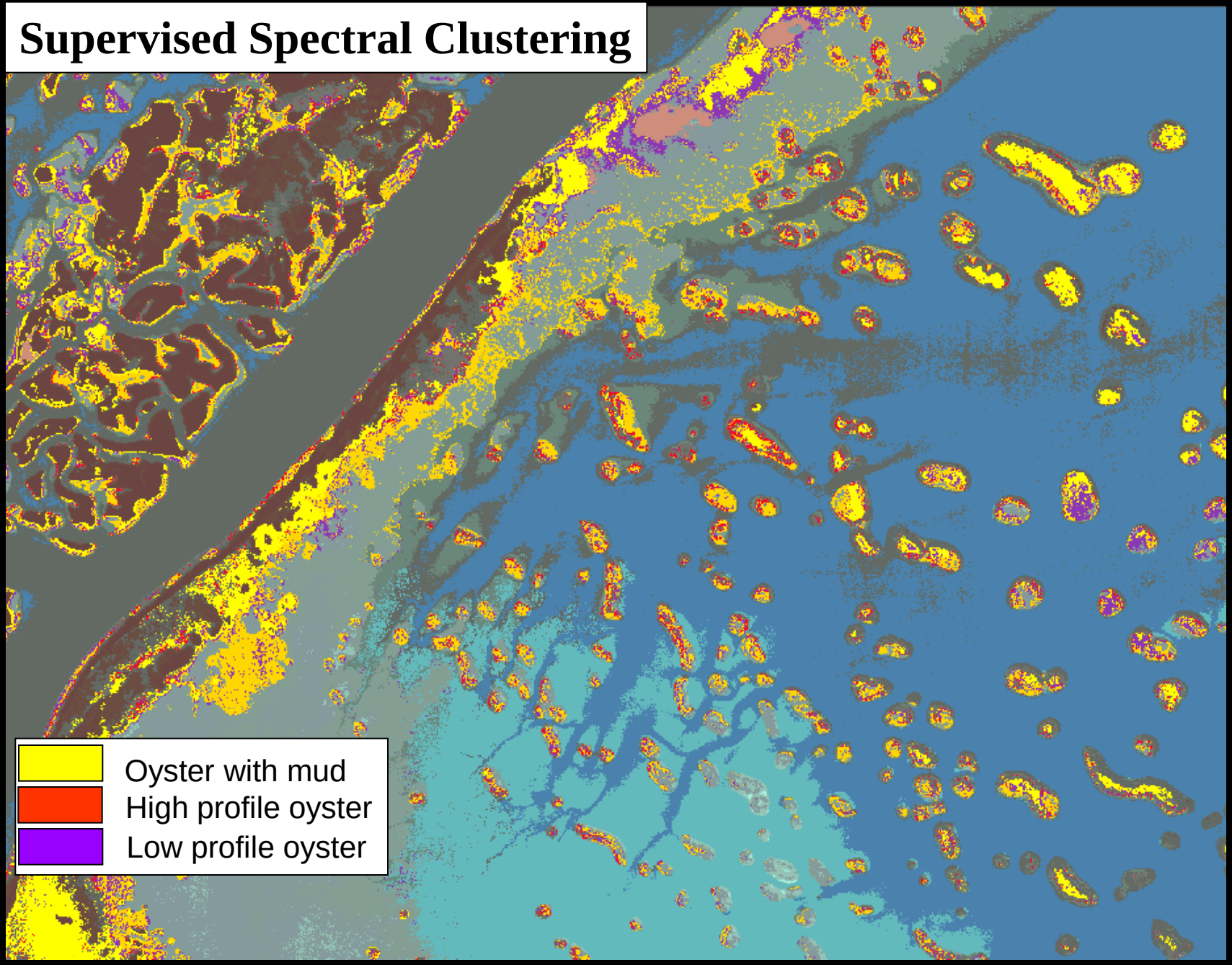
- **Imagery –** GeoScanner (0.5m)
- **Software –** ERDAS Imagine
  - **Hamlin:** Better results than unsupervised.
  - **Broad:** More confusion than unsupervised.

    AOIs pulling in mixed signatures.

- **Cost Benefit –**

  Effort – 5 Results - 5

Supervised Spectral Clustering

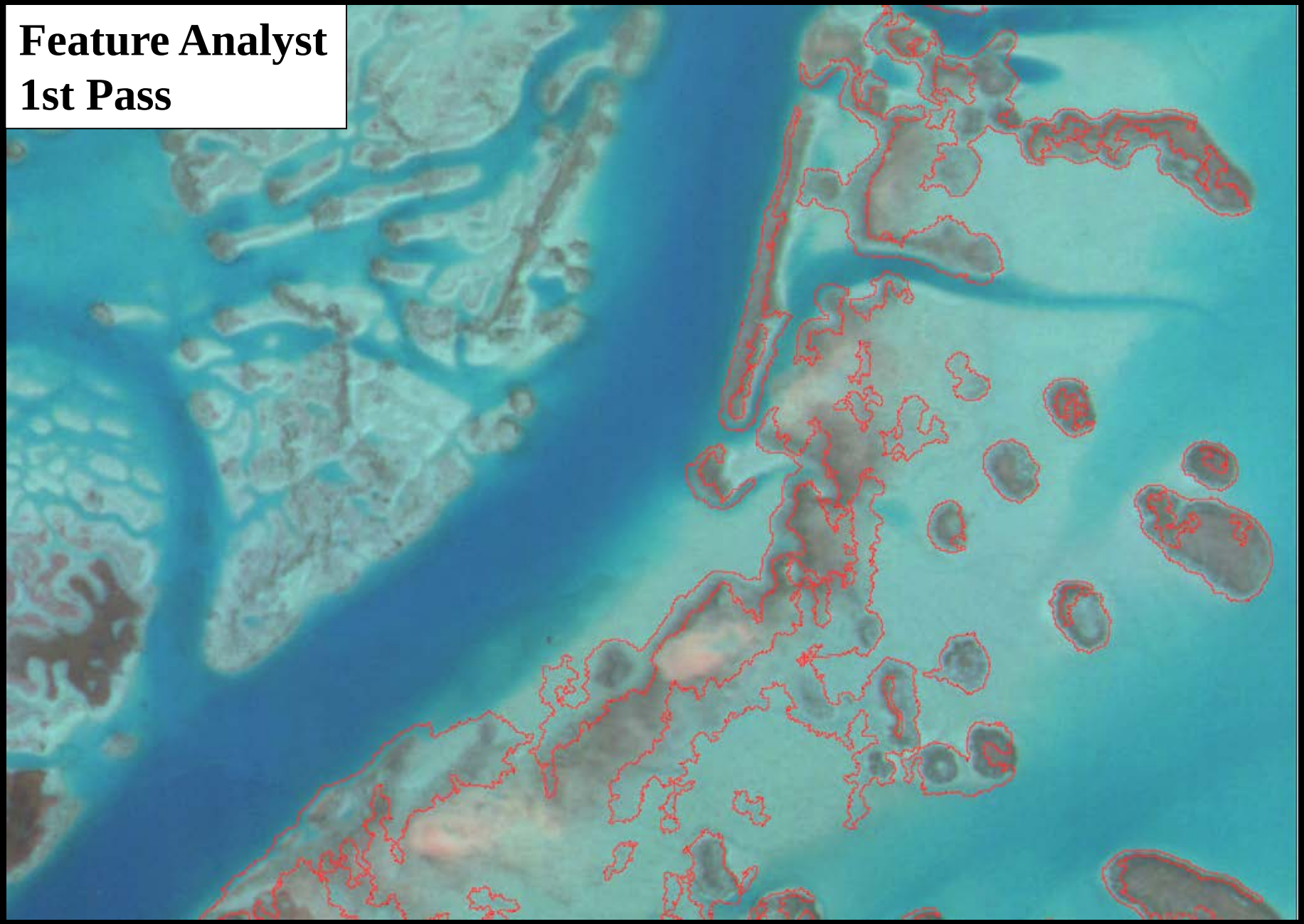


Methods

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

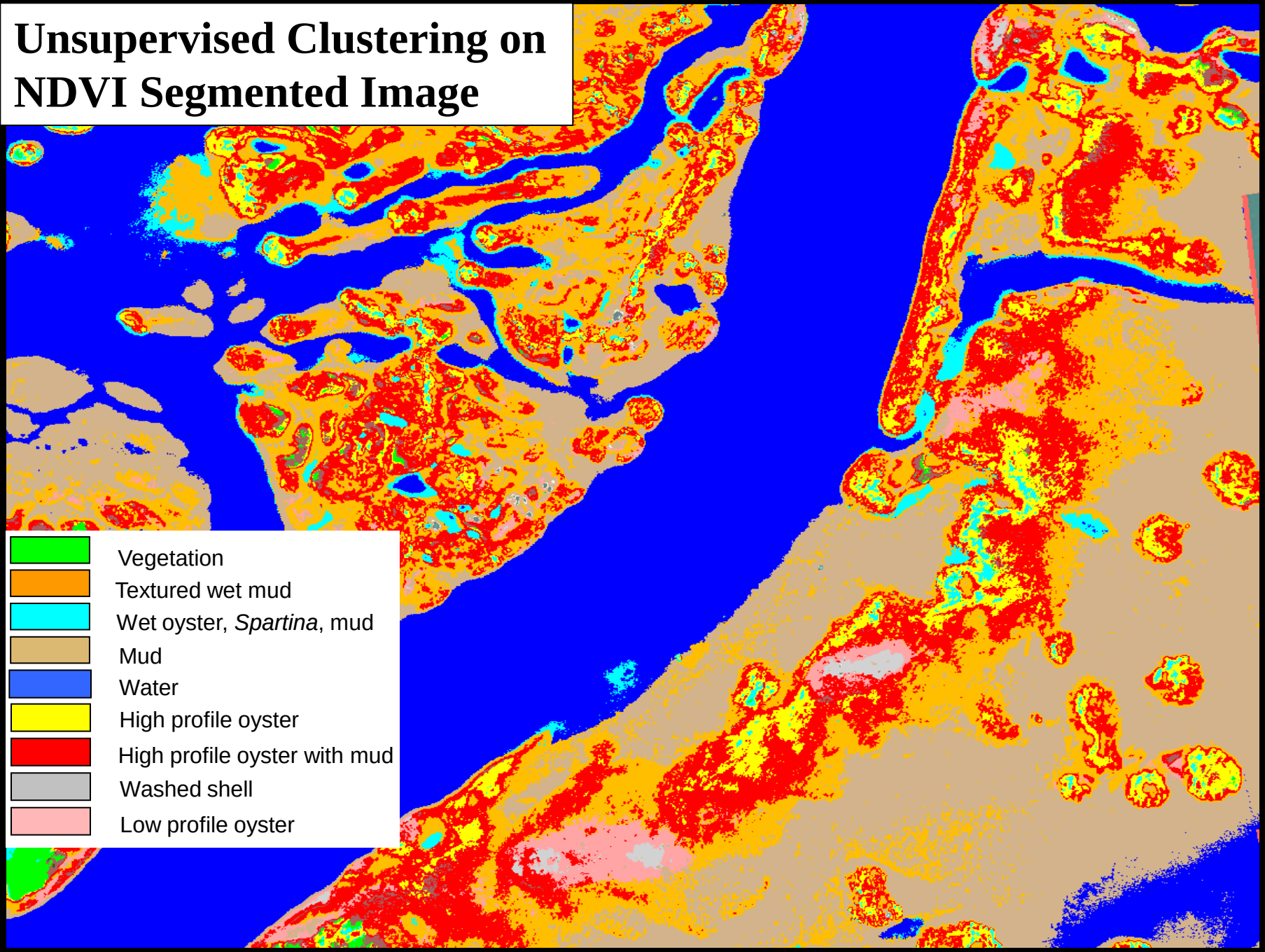
Derived products (NDVI, PCA) -

- **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

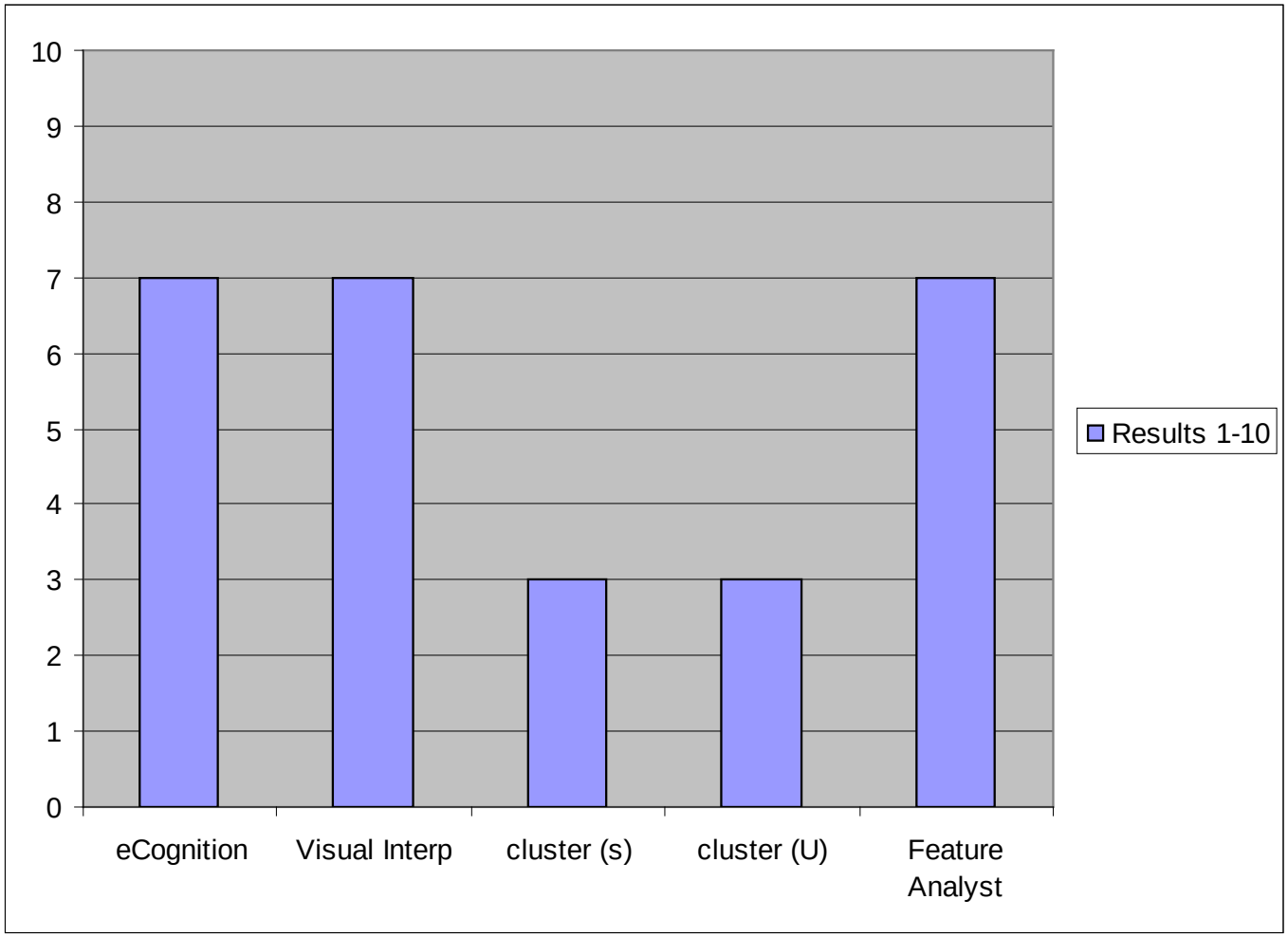
Unsupervised Clustering on NDVI Segmented Image



Relative Detail

10 = all strata - all boundaries

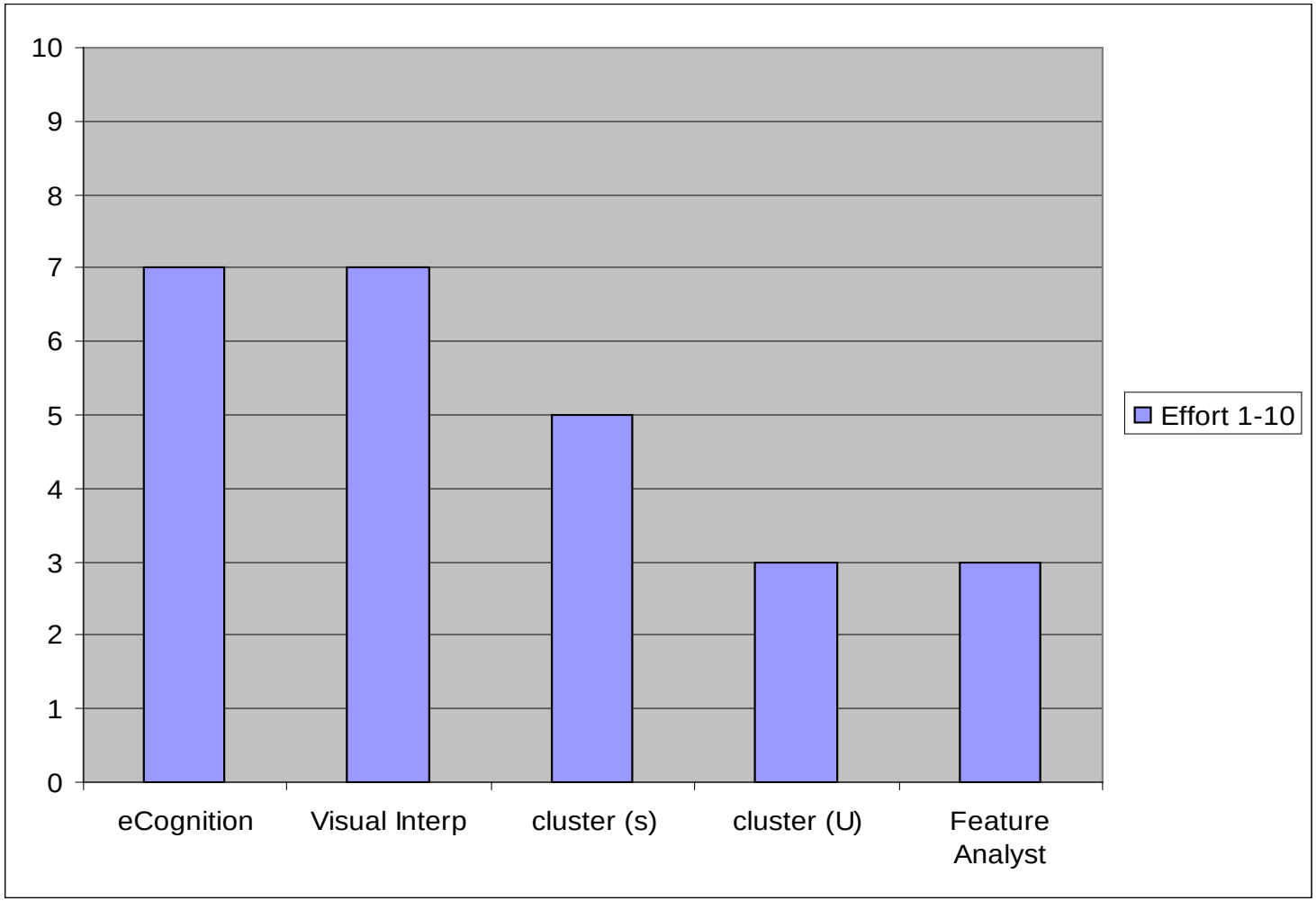
3 = some boundaries



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

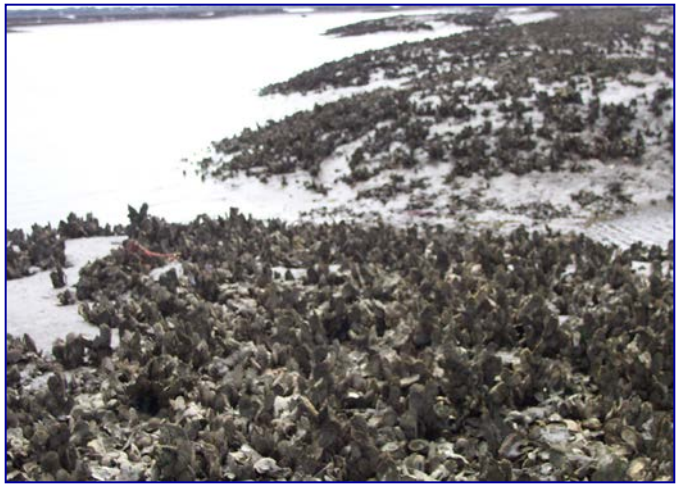
1:3K and **1:2K** = Continued improvement on above.

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***

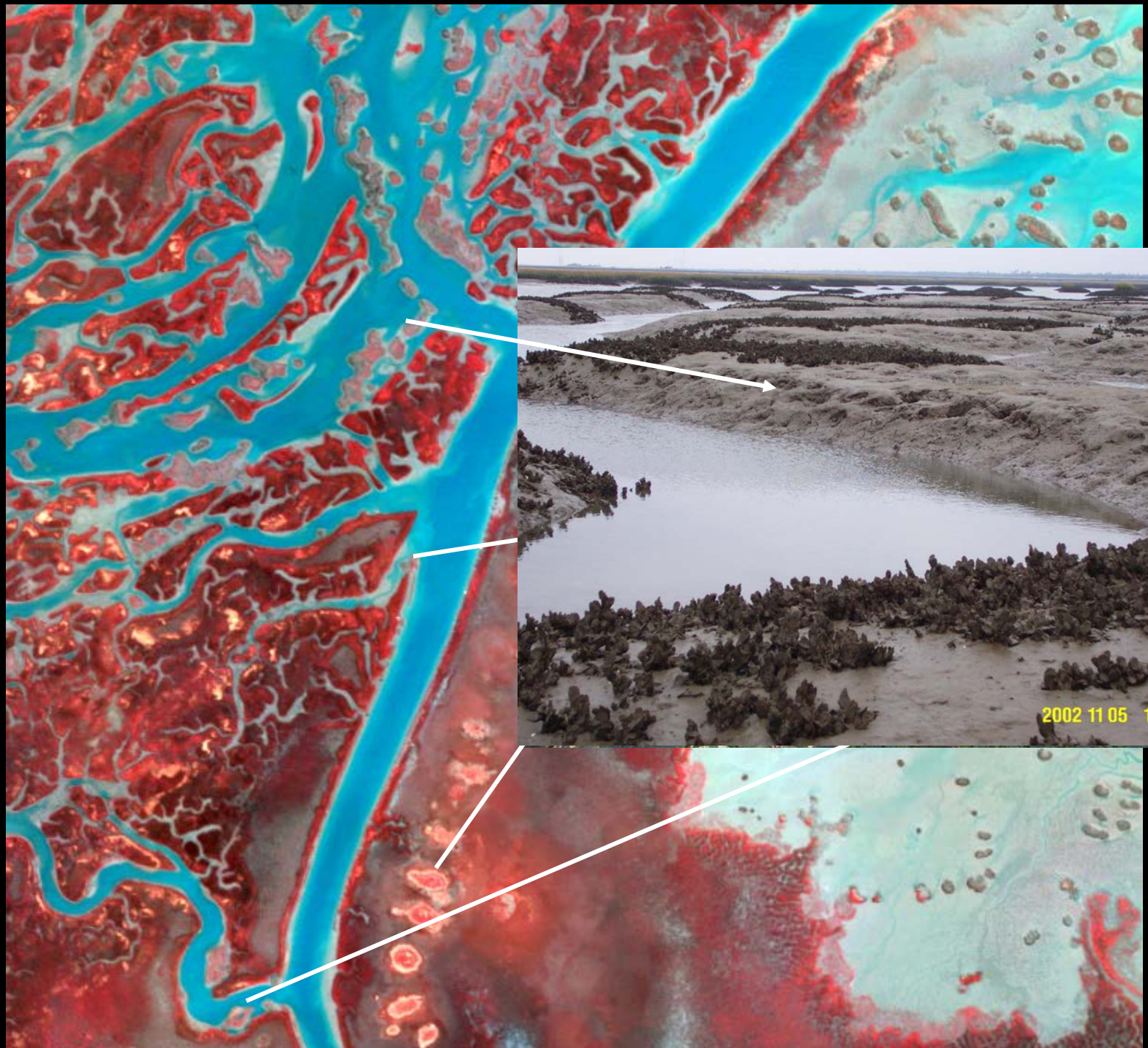
- **GeoScanner 0.25 meter captures more fringing reefs and several strata**

Challenges

Spartina with oyster mixed in

Textured mud vs. oyster

Diatoms affect oyster's appearance on imagery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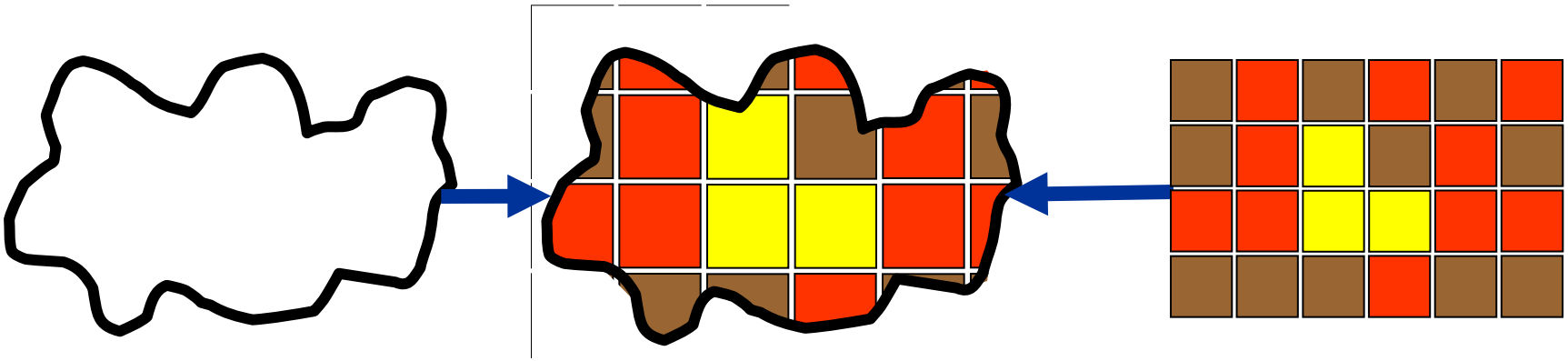
Proposed Approach

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

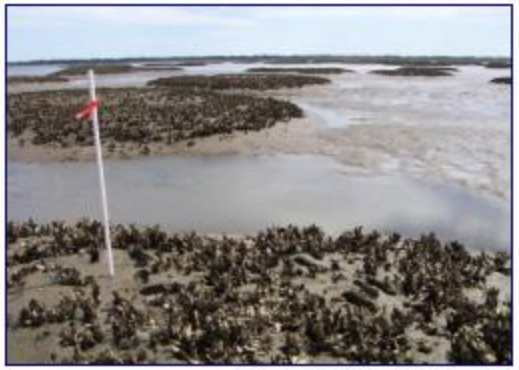
Raster data allows determination of reef condition

Summary

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

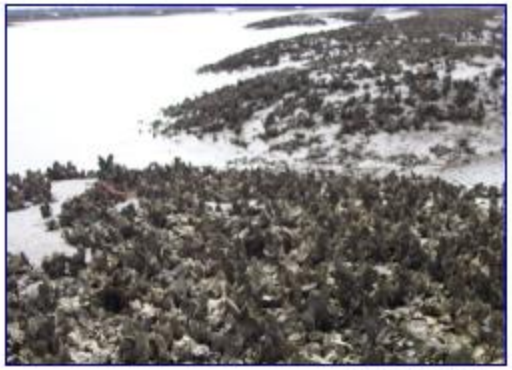
Strata Examples

Washed Shell (Dead)



High Profile with Mud

Low Profile



High Profile

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