Seagrass Resource Mapping: Aerial Photos versus Satellite Imagery

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Overview

- Study Area & Seagrass
- Aerial Photograph Interpretation
- Satellite Imagery Classification
- Comparison
- Conclusion
Study Area

- STJS & CLWN
- Intercoastal and open Gulf Waters
- Area: 95 km²
- Seagrass: ~60 km²
- Depths: ~4m
- Data: 2006–2010
Seagrass Importance
- Increase the productivity
- FOOD
- Nutrient cycling
- Detritus production
- Sediment formation
- Shelter
Seagrass Species Distribution

- **Thalassia**
  - Low-energy
  - Shallow areas

- **Halodule**
  - Very shallow or very deep
  - Widely Distributed

- **Syringodium**
  - Mid to Deep
  - Mainly STJS
Aerial Photointerpretation

- Image Acquisition
  - February 2006
  - January 2008
  - December 2010

- Classes:
  - Continuous SAV
  - Patchy SAV

- 1 meter resolution
- 0.5 acre mapping unit
- 90% Groundtruth Accuracy

(SWFWMD, 2007)
Aerial Photointerpretation

Submerged Aquatic Vegetation Maps from Aerial Photointerpretation

Legend
- Patchy SAV
- Continuous SAV
- Sand
- Land
- Water

Changes in SAV

<table>
<thead>
<tr>
<th>Year</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>14,746</td>
</tr>
<tr>
<td>2008</td>
<td>17,225</td>
</tr>
<tr>
<td>2010</td>
<td>17,289</td>
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</tbody>
</table>

Created By: C. Meyer
Project: 3G_Base_020413
Data Source: Southwest Florida Water Management District
Imagery

- EO-1 Hyperion
  - 9/29/2010
- Landsat TM 5
  - 10/04/2010
Preprocessing

- Preprocessing
  - Denoise*
  - Destripe*
  - Image Registration
  - Masking

* Zhoa et al. (2013)
SAV Delineation

- Equalization of TM bands 3, 2, 1
- Spectral Differentiation of SAV
- Defining Regions of Interest (ROIs)

Classes:
- Presence = >25% SAV
- Absence = <25% SAV
- No SAV = 0% – 25% SAV
- Patchy SAV = 25% – 75% SAV
- Continuous SAV = >75% SAV
Spectral Signatures

- Spectral Properties of ROIs
  A: Band 1
  B: Band 2
  C: Band 3

<table>
<thead>
<tr>
<th>ROI</th>
<th>Pixels</th>
<th>Band</th>
<th>Mean DN</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
<td>No SAV</td>
<td>1401</td>
<td>1</td>
<td>82.51</td>
<td>3.12</td>
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<tr>
<td></td>
<td></td>
<td>2</td>
<td>35.22</td>
<td>2.17</td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>23.68</td>
<td>2.09</td>
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<td>Patchy</td>
<td>1154</td>
<td>1</td>
<td>73.85</td>
<td>3.51</td>
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<tr>
<td></td>
<td></td>
<td>2</td>
<td>29.00</td>
<td>1.89</td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>21.48</td>
<td>2.15</td>
</tr>
<tr>
<td>Continuous</td>
<td>1493</td>
<td>1</td>
<td>68.25</td>
<td>3.65</td>
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<tr>
<td></td>
<td></td>
<td>2</td>
<td>25.40</td>
<td>2.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>18.62</td>
<td>2.04</td>
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</table>
Classification

- Unsupervised ISODATA
- Training & Test ROIs
  - Seagrass 2010 Data
- Supervised MLC (Meyer and Pu, 2012)
  - HYP – 95% OA
  - TM – 91% OA
- Composite
  - Validation: 81%
Classification

- Unsupervised ISODATA

- Validation Accuracy

<table>
<thead>
<tr>
<th></th>
<th>SAV Accuracy</th>
<th>No SAV Accuracy</th>
<th>Overall Accuracy</th>
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<tbody>
<tr>
<td>ISODATA</td>
<td>76.6</td>
<td>51.8</td>
<td>68.4</td>
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Seagrass Resource Map

<table>
<thead>
<tr>
<th></th>
<th>Area (Km)</th>
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<tbody>
<tr>
<td>Continuous</td>
<td>40</td>
</tr>
<tr>
<td>Patchy</td>
<td>23</td>
</tr>
<tr>
<td>No SAV</td>
<td>21</td>
</tr>
<tr>
<td>Unclassified</td>
<td>5</td>
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</table>
Results: Comparison

- 90% Ground-truth Accuracy
- AP Validation Accuracy

<table>
<thead>
<tr>
<th></th>
<th>SAV Accuracy %</th>
<th>No SAV Accuracy %</th>
<th>Overall Accuracy %</th>
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</thead>
<tbody>
<tr>
<td>AP</td>
<td>81.1</td>
<td>51.2</td>
<td>71.4</td>
</tr>
</tbody>
</table>
Results: Comparison

- Boat Channels
- Deep Water
- Shoreline
- Tidal Flats

Spatial Comparison
Aerial Photointerpretation versus
Maximum Likelihood Classification

Legend

Classification
- Red: Discrepancy
- Blue: Land or No SAV
- Green: SAV (same density)
- Yellow: SAV (different density)
Potential Limitations

- Spectral Variations
  - Water Clarity
  - Seasonal Change
  - Epibionts

- Other Considerations
  - Bottom type
  - SAV other than Seagrass
  - Mixed Species Composition
Conclusion:

Why bother?

- Ability to assess natural and anthropogenic events
- Develop strategies for response and mitigation of impacts
Sea Level Rise: Observed

8726724 Clearwater Beach, Florida


MM/YR

1.63  1.59  1.66  1.86  1.89  1.97  2.22  2.35  2.53  2.74
2.43  2.35  2.39  2.59  2.58  2.63  2.88  2.99  3.15  3.77
Conclusion

- Classification of spectral signatures from EO–1 HYP and Landsat 7 TM Imagery is comparable to the aerial photointerpretation.

- Additional corrections for the water column greatly increased the overall accuracy of the classification.
Acknowledgements

- Dr. Ruiliang Pu, University of South Florida
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- Southwest Florida Water Management District
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- F&AM Lodge #9
- NASA–ROSES GOMA grant
- NOAA Fisheries: Advanced Studies Program
Questions

Contact: Cynthia.Meyer@noaa.gov
Introduction:
Remote Sensing Studies

- Seagrass Spectral Signatures
  - Fyfe 2003 Australia
  - Thorhaug et al 2007 Florida

- Multispectral Seagrass Mapping
  - Dekker et al 2005 Landsat TM Australia
  - Andrefouet et al 2003 IKONOS World-wide
  - Schweizer et al 2005 Landsat TM Venezuela
  - Pasqualini et al 2005 SPOT 5 Mediterranean
  - Gullstrom et al 2006 Landsat TM Tanzania
Estimated Thresholds (C660)
- STJS = 0.3
- CLWN = 0.4

Suitable Habitat
- STJS = 43 km²
- CLWN = 17 km²

Validation Accuracy
- STJS 82%
- CLWN 95%
Bathymetry

- Florida Shelf Habitat Map Project (FLaSH)
- TIN & DEM
  - N = 30,185
- Validation (n=85)
  - Paired T-test (p=0.12)
  - Pearson Correlation (0.97)
Light Metric

- C660: Logarithmic light irradiance at the benthos
  - \( \ln(\% \text{ trans}) \)
  - Depth (m)
  - Range = 0.1–4.57
Results: Habitat Loss

- Receding from Deep Edge
- SLR 6 ft = No Suitable Habitat
Results: Habitat Loss

- Receding from Deep Edges
- SLR 5ft & 6ft = No Suitable Habitat
Results: Loss vs. Gain

STJS

Seagrass Suitable Habitat (km²)

Sea Level Rise Scenarios (ft)

CLWN

Seagrass Suitable Habitat (km²)

Sea Level Rise Scenarios (ft)