Preliminary Historical Overview of Marsh Changes in the Inland Bays, 1938-2007

Andrew R. Homsey, Richard T. Field, Young-Heon Jo, Kelly Somers, Kurt Philipp

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Introduction

• With Center for the Inland Bays (Chris Bason, Bart Wilson)

• PIs: Jo Young, Richard Field UD CEOE

• USEPA Regional Applied Research Efforts (RARE) Grant

• Coordinated with DNREC personnel

• Three year project
Introduction

• Three main parts

1. Long-term tidal analysis
2. TM-based biomass analysis -- LNBI
Study Area

- Inland Bays of Delaware
- Study focus
  - Estuarine wetlands plus contiguous non-tidal wetlands
  - 300 m buffer inland to assess contiguous upland conditions and changes
Project Overview

• Tidal analysis
  – Based on Lewes tide gauge
  – Isolate various long-term signals: seasonal, annual, El Nino, decadal cycle
  – Correlate RSL with historic imagery
  – SLAMM based prediction (feasibility study)
Satellite RADAR altimetry, Lewes

- Signal
- Intraseasonal
- Annual
- Interannual Signals
- Decadal
- Residual=Trend
Tides, Lewes and Rehoboth Bays

Table 2-1. Tidal Datums at Lewes, DE and Indian River Inlet, DE

<table>
<thead>
<tr>
<th>Tidal Datum</th>
<th>Lewes (ft)</th>
<th>Indian River Inlet (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Higher High Water (MHHW)</td>
<td>4.65</td>
<td>2.94</td>
</tr>
<tr>
<td>Mean High Water (MHW)</td>
<td>4.23</td>
<td>2.67</td>
</tr>
<tr>
<td>North American Vertical Datum-1988 (NAVD)</td>
<td>2.63</td>
<td>1.82</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>2.23</td>
<td>1.48</td>
</tr>
<tr>
<td>Mean Tide Level (MTL)</td>
<td>2.19</td>
<td>1.41</td>
</tr>
<tr>
<td>National Geodetic Vertical Datum-1929 (NGVD)</td>
<td>1.87</td>
<td>1.05</td>
</tr>
<tr>
<td>Mean Low Water (MLW)</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>Mean Lower Low Water (MLLW)</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Water level changes in response to El Nino and La Nina events

- Climatological events such as El Nino and La Nina affect sea level changes
- More El Nino/La Nina events since 1980 (< every 4 years)
Monthly mean sea level (MSL) at Lewes

- 4mm/yr between 2012 to 1937
- 3.74mm/yr 2007 - 1993
- 1.39mm/yr 1992 - 1969
- 6.2mm/yr 1968 - 1938
Project Overview

• LNBI (Locally Normalized Biomass Indicator)
  – Uses “Greenness Index”, Modified Soil Adjusted Vegetation Index (MSAVI)
  – Calculate variations from the norm, for each zone
    – 1987 to 1994
    – 1994 to 1997
    – 1997 to 2004
    – 2004 to 2007
  – Is biomass change over the period significantly different from change entire zone?
<table>
<thead>
<tr>
<th>Code</th>
<th>Loss/Gain</th>
<th>Percentile</th>
<th>Z-Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Major loss</td>
<td>Bottom 10th</td>
<td>&lt; -1.275 σ</td>
</tr>
<tr>
<td>2</td>
<td>Significant loss</td>
<td>10-20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Minor loss</td>
<td>20-30</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>N/C</td>
<td>30-70</td>
<td>-05. to +0.5 σ</td>
</tr>
<tr>
<td>5</td>
<td>Minor gain</td>
<td>70-80</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Significant gain</td>
<td>80-90</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Major gain</td>
<td>Top 10th</td>
<td>&gt; +1.275 σ</td>
</tr>
</tbody>
</table>
Project Overview

• GIS Analysis: Historic condition mapping and change analysis
  • Pre-process as necessary
  • Digital and traditional stereoscopy
Project Overview

• Supporting datasets
  • 1992 SWMP, 2009 SWMP/NWI
  • 1992 and 2007 LULC
  • High marsh from NVCS (Robert Coxe/DNREC),
  • Other supporting info (e.g., Daiber wetlands maps), BING
Project Overview

- Time periods for GIS analysis
  - 1938 to 1968 = 30 years
  - 1968 to 1992 = 24 years
  - 1992 to 2007 = 15 years
Project Overview

- **Potential uses**
  - Analyze SWD
  - Assess effects of RSLR
  - Identify potential for “strategic retreat”
  - Track shoreline migration
  - Quantify wetland loss, land cover conversion and buffer condition,
  - Anticipate, guide, and plan for future changes
For wetlands and land cover, use later dates as basis for previous dates

- Generate an aggregating unit on which to summarize marsh metrics
  - 60 m grid chosen after experimentation
- Zonal analysis: Back Barrier, Bay Fringe, Drowned River Valley
Ancillary Features

- Hardening of upland/wetland boundary
- Fractured pooling
Ancillary Features

• Presence of ditching
• Excavation (human agency)
### Classification

<table>
<thead>
<tr>
<th>Class</th>
<th>CIB_Code (1992, 2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrub Shrub/Forested Salt Marsh</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Emergent Forest/Wetland</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Marsh P</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Marsh C</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Boat Ba</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Marsh Ir</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Marsh D</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Tidal Ca</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Open B</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Marine</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Tidal Sh</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Tidal Fr</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Freshwater Emergent Wetland</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Agriculture/Pasture/Scrub/Scrub</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Forest, Developed/Transitional</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Forest, Open Freshwater</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Forest, Beach</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Agriculture</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Dune Complex</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Transitional</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Freshwater Reservoir or Impoundment</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Beach</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Dune Complex</td>
<td>(1992, 2007)</td>
</tr>
<tr>
<td>Shrub/Brush Rangeland</td>
<td>(1992, 2007)</td>
</tr>
</tbody>
</table>
Developed Area (Ha), Inland Bays by Year

- **1938**
- **1968**
- **1992**
- **2007**

### Forest Area (Ha), Inland Bays by Year

### Wetland Area (Ha), Inland Bays by Year

### Agriculture Area (Ha), Inland Bays by Year

### Developed Area (Ha), Inland Bays by Year

- **Back Barrier**
- **Fringing Marsh**
- **Drowned Valley**
Fractured Pooling (Ha), Inland Bays, by Year

- Back Barrier
- Fringing Marsh
- Drowned Valley

Hectares

- 1938
- 1968
- 1992
- 2007
• Special thanks to
  – Richard Field, Jo Young, Vic Klemas, Geri Pepe (CEOE)
  – Kelly Somers (Drexel, PDE)
  – Kurt Philipp, Water Research Services
  – Chris Bason, Bart Wilson, CIB
  – Mark Biddle, Amy Jacobs, Robert Coxe
  DNREC