USFWS Region 5 Impoundment Vulnerability Project

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Restore America’s Estuaries 8th National Summit on Coastal and Estuarine Restoration and 25th Biennial Meeting of The Coastal Society Our Coasts, Our Future, Our Choice

Storming Back 3: Wildlife Impoundments, Ditch Legacies, and Living Shorelines
Coastal Impoundments in Region 5

Man-made water bodies, contained by embankments, with water control structures.

Drained in the spring to expose mudflats for migrating shorebirds.

Greater Snow Goose, Chincoteague NWR.

Water is raised in the fall to provide open water for ducks and other waterbirds through the winter.

Attract birds by the thousands during migration, which in turn attracts thousands of wildlife watchers to wildlife drives at Refuges.

American Avocet, Bombay Hook NWR.
Recent storms have shown that impoundments on Refuges are vulnerable to damaging and expensive breaches (Ernesto [2006], Irene [2011], Sandy [2012], Joaquin [2015], Jan 2016 Northeaster).

SLR and increasing storm activity escalate the likelihood that impoundments will breach and convert to saltwater systems.
Some impoundments are currently buffered by eroding marsh platforms.

Many basins are below adjacent marsh platform elevations.

5 Pools Complex, Blackwater NWR, 2015.

Raymond, Shearness and Bear Swamp Pools, Bombay Hook NWR, 2015.
Impoundment Vulnerability Project

• FWS is using Sandy disaster relief funds to assess vulnerability of impoundments to catastrophic wetland loss

• Modeling to predict likelihood of breaching/conversion to open water and inform management decisions

• Detailed topobathy models and local water level data are critical

Potential decisions:
• Shore up failing dikes?
• Breach dikes in a controlled way?
• Re-contour interiors to raise elevations?
• Remove or replace water control structures?

Chinoteague NWR, 2010.
Impoundment Vulnerability Project

Assessment Questions

Is the current elevation of the impoundment bottom below mean sea level (current and predicted) if the impoundment is breached?

How much is between MLW and MHW and possibly capable of supporting tidal marsh?

If we shore up impoundment infrastructure (e.g. reinforce walls, repair water control structures) will it be submerged within decades, anyway, due to SLR?
Data Sources

1. High accuracy DEMs (in-house surveys)
2. Elevation distribution of salt marsh vegetation in adjacent marsh platforms (in house surveys)
3. Local Tidal water levels (NOAA and/or USGS)
4. Tidal Datums Calculated from VDATUM (http://vdatum.noaa.gov/welcome.html)

4. Local Hurricane Sandy Storm Tide Elevations (http://pubs.usgs.gov/of/2013/1043/)
6. SLR Estimates using USCOE Sea Level Rise Curve Calculator (http://www.corpsclimate.us/ccaceslcurves.cfm)
Topographic Survey Techniques

- Total Station
- RTK GPS
- Differential leveling
- Raymond Pool, Bombay Hook NWR - 8,000 elevation points
Swan Cove Pool, Chincoteague, VA
**Tidal Datums**

**Method: VDATUM**
- Projection: US Survey Feet, SPCS, Virginia South
- Location: Outfall of Swan Cove Pool into Tom’s Cove

**Method: USGS tide gage Chincoteague Bay**
- One year of data
- Fair agreement with VDATUM estimate of MSL

<table>
<thead>
<tr>
<th>Tidal Datum</th>
<th>NAVD 88 (ft)</th>
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<tbody>
<tr>
<td>MLLW</td>
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<td>MHW</td>
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<table>
<thead>
<tr>
<th>Water Level</th>
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<tr>
<td>Mean</td>
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<tr>
<td>Max</td>
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<tr>
<td>Min</td>
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</table>
Elevation Distribution of Salt Marsh at Swan Cove Pool

- 150 elevation points in *S. Alterniflora* and *S. Patens* habitat
- Boundary between the two vegetation types is close to MHW elevation of 1.6 ft calculated by VDATUM
In the event of a complete breach, 17% is below MSL.
55% of Swan Cove is between MLW and MHW.

In the event of a complete breach...
In the event of a complete breach

30% of Swan Cove Pool has potential for Low Marsh, 27% to be High Marsh.
Sea Level Rise Rate Estimates

- USCOE tool to estimate relative rates of Sea Level Rise (SLR) at different tide gages under different SLR scenarios
- Use Ocean City Inlet, MD gage to estimate rates for Swan Cove Pool
- [http://www.corpsclimate.us/ccaceslcurves.cfm](http://www.corpsclimate.us/ccaceslcurves.cfm)

### Estimated Relative Sea Level Change from 2010 To 2100

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<tr>
<th>Year</th>
<th>NOAA Low</th>
<th>NOAA Int Low</th>
<th>NOAA Int High</th>
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## Sea Level Rise Estimates from USCOE for Ocean City, MD

### Critical Elevations:
- **Bottom of Swan Cove Pool Outlet:** -0.77 ft
- **Top of Swan Cove Pool Outlet:** 4.6 ft
- **Top of Swan Cove Pool Dike:** 5.1 ft

- By 2050: Outlet’s ability to drain impoundment is impaired in High SLR scenarios
- By 2070: Outlet’s ability to drain impoundment is compromised under all SLR scenarios
- By 2070: Dike is regularly overtopped by high tides under High SLR scenarios

### Tidal Datum

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<td>3.5</td>
<td>4.6</td>
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Results: Sea Level Rise Predictions 2050

2050: Low SLR Scenario
92 acres or 25% Below MSL

2050: High SLR Scenario
266 acres or 73% Below MSL
Is the current elevation of the impoundment bottom below mean sea level (current and predicted) if the impoundment is breached? Yes. **Approximately 17% of the impoundment bottom is below mean sea level if the impoundment is breached.**

How much is between MLW and MHW and possibly capable of supporting tidal marsh? **Approximately 55%-57% of the impoundment is potentially capable of supporting tidal marsh.**

If we shore up impoundment infrastructure (e.g. reinforce walls, repair water control structures) when will it be submerged, due to SLR? **Estimate that the ability to control drainage from the impoundment will be limited by 2050 due to SLR.**

**Estimate that by 2070 the ability to control drainage will be compromised and high tides will regularly overtop the impoundment’s dike.**
Next Steps

• Investigate **substrate properties:**
  • organic content (increased sulfate availability may increase carbon recycling/ reduce organic matter in soils)
  • Depth of peat layers (potential additional subsidence to be accounted for)
• Examine **local rates of marsh accretion** (is there potential for a recovering marsh to maintain elevation in the face of higher SL)
• Characterize **flow/velocity** in channels to be connected
• Perform **hydrodynamic modeling**
  • Calculate reasonable inlet dimensions given the initial tidal prism (based on the present topography with respect to mean sea level).
  • Estimate tidal flooding depths (which controls primary vegetation type) and velocity of tidal flows under various channel reconstruction scenarios
We can do this slowly, or we can do it fast....