Resistance:
Thin Layer Sediment Augmentation Project
Seal Beach National Wildlife Refuge
Field observations of sea level rise
Project Evolution

- Seal Beach NWR Comprehensive Conservation Plan
- USGS SLR studies
- Climate change adaptation planning
- Sediment augmentation project
From Planning to Augmentation

2012 – Seal Beach National Wildlife Refuge Comprehensive Conservation Plan is completed. Several areas on the Refuge identified for future thin-layer augmentation.

15-year management plan

• Identified issues (marsh subsidence, loss of natural nesting areas for rails)

• Met with agencies, researchers, public to refine issues and develop strategies

Goal 1: Support recovery and protection efforts for the federally and State listed threatened and endangered species and species of concern that occur within the Seal Beach NWR.
From Planning to Augmentation

2011 - 2013 – Sea level rise studies on the Refuge

2014 – 2015 Climate change adaptation planning process for Seal Beach NWR and portions of Naval Weapons Station Seal Beach

2014 – Coordination with public agencies and researchers to permit and implement the augmentation project underway

June 2015 - $3,305,554 in grant funding secured for augmentation and pre- and post-augmentation monitoring
Detailed studies of elevations, vegetation, tidal flows, and sediment flux at the Seal Beach NWR by USGS.
Seal Beach NWR had the lowest mean elevation and mean elevation relative to MHW out of 8 CA marshes studied by UCLA and USGS.

- We conducted surveys with a Leica Real Time Kinematic GPS (± 2 cm x, y, z, accuracy)
- Surveyed along transects every 12.5m; transects separated by 50 m
- 4757 elevation measurements; 266 hectares
Diversion of freshwater and sediment inputs into Seal Beach NWR

Figure 4-10. Anaheim Bay-Huntington Harbour Watershed

Figure 4-4. Aerial View of Anaheim Bay and Salt Marsh Complex in 1922
Sea level rise – historic and future

9410580 Newport Beach, California

Linear Mean Sea Level Trend
Upper 95% Confidence Interval
Lower 95% Confidence Interval
Monthly mean sea level with the average seasonal cycle removed

2.22 +/- 1.04 mm/yr

http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=9410580
Subsidence occurring at Naval Weapons Station Seal Beach at a rate of -4.13 mm/year.

Seal Beach NWR is experiencing a relative sea level rise three times more (-6.23 mm/year) compared to other similar southern California marshes not experiencing subsidence.
• Identify priority conservation targets and threats in consultation with the Refuge and the U. S. Navy

• Model environmental response of natural resources to sea-level rise

• Assess the vulnerability of conservation targets to climate change

• Identify the optimal set of management actions
Wetland Accretion Rate Model for Ecosystem Resilience (WARMER)

Field Data/Inputs

- Elevation
- Sea-level rise
- Water level
- Plant communities
- Sediment Budget & Cores

Conceptual Model

Relative sea-level rise

Above ground productivity

Sediment input

Root Growth

Compaction

Decay

Cohort based model with an annual timestep
Seal Beach

Vegetation Zones

Elevation Relative to MHHW (m)

- >0.62 (Upland)
- 0.43 - 0.62 (Transition Marsh)
- 0.04 - 0.43 (High Marsh)
- -0.23 - 0.04 (Mid Marsh)
- -0.90 - -0.23 (Low Marsh)
- -1.55 - -0.90 (Mudflat)
- <= -1.55 (Subtidal)

USGS – Climate Change Adaptation and Planning Team,
Karen Thorne Ph. D., 2015
## Top Rated Management Actions

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<tr>
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<tbody>
<tr>
<td>Predator management*</td>
<td>18.23</td>
<td>15.67</td>
<td>12.70</td>
<td>10.87</td>
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<tr>
<td>Tidal marsh restoration on Navy Lands*</td>
<td>6.70</td>
<td>11.90</td>
<td>15.50</td>
<td>17.97</td>
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<tr>
<td>Marsh sediment augmentation (active placement of dredge material to raise marsh elevations)*</td>
<td>8.73</td>
<td>11.53</td>
<td>14.47</td>
<td>16.13</td>
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<td>Plant restoration: marsh transition zone, upland*</td>
<td>11.67</td>
<td>11.07</td>
<td>10.88</td>
<td>10.62</td>
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<td>Off-site actions to conserve marsh-associated targets</td>
<td>6.15</td>
<td>8.28</td>
<td>9.48</td>
<td>10.68</td>
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<td>Eelgrass study: understand factors that influence eelgrass distribution on the refuge (including future climate change)</td>
<td>6.80</td>
<td>5.13</td>
<td>1.97</td>
<td>1.63</td>
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<tr>
<td>Culvert maintenance*</td>
<td>6.25</td>
<td>5.07</td>
<td>2.97</td>
<td>0.07</td>
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<td>Tern island substrate enhancement: place shells, vegetation management*</td>
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<td>4.33</td>
<td>2.47</td>
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<td>Re-engineer CA least tern nest site*</td>
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<td>3.33</td>
<td>2.82</td>
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<td>Invasive plant management</td>
<td>4.23</td>
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<tr>
<td>Light-footed clapper rail nest platforms</td>
<td>3.33</td>
<td>2.87</td>
<td>2.33</td>
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</table>
End goal is to implement and evaluate the success of thin layer sediment augmentation as a regional sea level rise and climate change adaptation strategy that can be used at regular intervals to ensure the long term sustainability of Pacific coast marshes.
Refuge Purpose

“Preserve and manage the habitat necessary for the perpetuation of two endangered species – the light-footed clapper rail and CA least tern.”

“Preserve habitat used by migratory waterfowl, shorebirds, and other water birds.”