Soils and Marsh Creek Evolution at a Marsh Augmentation Project in Seal Beach CA

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The threat of sea level rise

• Responses of salt marshes to sea level rise
  – Transgression
  – Changes in marsh plain elevation
    • Marsh plain elevation (Elevation capital)
    • Plant productivity
    • Sediment availability

• Many (but not all) California salt marshes will be able to keep pace with sea level rise until 2030 or 2050, but not after that
Management options

• Facilitate transgression
• Improve salt marsh resilience
  – Protect natural sediment supply
  – Remove other stressors
  – Add sediment to marsh plain: Thin Layer Placement
Seal Beach National Wildlife Refuge

Los Angeles

391 ha
A preview of future higher sea levels

• Subsidence from groundwater and oil extraction and removal of natural sediment source
  – Relative sea level rise 3x higher than other marshes
  – 29 cm subsidence since 1960’s
• The low elevations of the Refuge has resulted in stunted *Spartina foliosa*, providing little habitat for the endangered Light-footed Ridgway’s Rail
Beneficial Use of Dredge Material at Seal Beach to Raise the Marsh Plain Elevation

Goal: Apply 25 cm of clean sediment of appropriate grain size over 3.4 ha (8.5 acres).

After 2 years, thickness of at least 7.5 cm.
Sediment addition: January to April 2016
Pre- and post-augmentation monitoring

• Sediments
  – Suspended sediment (turbidity) in channels
  – Precise elevations (with RTK GPS)
  – Subsidence/uplift with Surface Elevation Tables
  – Accretion/erosion with feldspar markers
  – Compaction (feldspar markers and sediment stakes)

• Tidal creek morphology

• Biological community
  – Vegetation
  – Benthic invertebrates
  – Eelgrass productivity
  – Bird counts (general and Light-footed Ridgway’s Rail)

• Carbon sequestration
  – Coring
  – Greenhouse gas (methane and nitrous oxide) flux
Project sites

- Sediment Augmentation Site
- Control Site
Monitoring questions

• How does the depth of the added sediment change over time?
• How do sediment characteristics (grain size, bulk density, organic content) change over time?
• Do tidal creeks re-establish themselves after sediment addition?
How does the depth of added sediment change over time?
Feldspar plots

- Feldspar plots established in augmentation and control sites
  - Stratified random design
    - Three strata: *Spartina*, *Batis* and Pond
  - 24 in augmentation site, 16 in control site
  - Cores taken to measure depth to marker horizon
- Pre-augmentation plots established in October 2015
- Post-augmentation plots established in May 2016
Sediment Thickness: June 2016
Mean Thickness 35.5 ± 1.0 cm
Sediment Thickness: October 2016
Mean Thickness 37.0 ± 0.7cm

Target depth

High spot

Low spot

6 months
12 months

Sediment Thickness: April 2017
Mean Thickness 32.2 ± 1.2cm

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<th>April 2017 (cm)</th>
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<td>27 - 35</td>
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Target depth

Low spot

High spot
25 months

Sediment Thickness: May 2018
Mean Thickness 30.4 ± 1.2cm

Target depth

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Low spot
High spot

Low spot

Low spot

High spot
Sediment thickness decreased.
How do sediment characteristics (grain size, bulk density, organic content) change over time?
Sediment characteristics

Grain Size

3 southern CA wetlands:
Natural marsh: 33-46% sand
Restored marsh: 26-61% sand

Bulk Density

3 southern CA wetlands:
Natural marsh: 0.48-0.63 g/cm³
Restored marsh: 0.50-0.97 g/cm³

Organic Matter

3 southern CA wetlands:
Natural marsh: 12-17%
Restored marsh: 6-13%
Do tidal creeks re-establish themselves after sediment addition?
Tidal creek cross sections

Augmentation site:
2 stations per tidal creek
4 tidal creeks

Control site:
2 tidal creeks
Sediment control structures

• Hay bales and sand bags placed a tidal creek mouths to minimize sediment leaving site
  – Remained in place after sediment addition
  – Appear to have inhibited tidal creek formation

• Control structures are being removed in phases to evaluate effect on tidal creek formation
New tidal creek cross sections
Tidal creek profiles 6 months after control structure removal

New Augmentation Tidal Creek 3-3

New Augmentation Tidal Creek 4-3

Distance along Transect (m)

Distance along Transect (m)
“Aerial” surveys of tidal creek formation
Orthomosaic and Digital Surface Model
Conclusions

• Sediment depth did not change as much as expected during first year
  – Some areas actually increased in depth after sediment addition

• Little change in sediment characteristics

• Tidal creeks not re-establishing themselves (yet)
  – Sediment control structures may have reduced tidal flow, inhibiting creek formation, but even after removal there has been little development of tidal creeks

Added sediment was sandier than expected
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