Carbon Sequestration Potential from Coastal Wetlands Restoration Sites

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Background

Tidal salt marsh habitat was once common in southern California

Only a fraction remain today

- Intentional filling
- Habitat degradation

Many that remain are impacted:

- Drainage from urban or agricultural land-use.
- Fed by highly channelized water conveyances.

Can experience increased sediment loading.
Carpinteria Sat Marsh
Study Site Carpinteria Salt Marsh

230 acres, 3 Basins

Largest basin (130 acres) is maintained through the University of California Natural Reserve System

Habitat

- Intertidal estuarine wetlands
- Adjacent palustrine wetlands
- Subtidal deep water habitat in channels.
Carpinteria Salt Marsh

Surrounded by developed land
Fed by channelized urban-creeks
Receives large amount of agricultural runoff
Narrow ocean mouth
- Sand plug present from beach sands
- Reduced intertidal flushing since mid-90s
Mountain wildfires increase sediment loading
Anecdotal history of a tsunami in 1812
Carpinteria Sat Marsh
Carpinteria Land Use

Marsh
Agricultural
Residential
Commercial
Restoration

Restoration is designed to improve water flow to historical areas and levels

- Dredging to restore the central lagoon
  - Removal of the Sand Plug
  - Removal of sand bars in Main Channel
- Replacement of basin connectivity
- Removal of greenhouse discharges (nutrients) to stream inputs.
California AB32 – Global Warming Solution Act 2006

- Requires all projects in CA to account for and report GHG emissions.
- Requires all projects to be carbon neutral

Carpinteria Salt Marsh Restoration

- Project will generate 85 metric tons of CO₂ equivalents
  - Dredging
  - Disposal
  - Culvert operations
  - Road work
  - Plant restoration
Restoration

What is the potential for the sequestration of GHGs (Carbon) over the life of the restoration? Can this be used to offset the 85 mT of CO$_{2e}$ generated in the project?

- Reviewed the GHG and Carbon Sequestration literature.
- Developed a simple box model for sequestration
- Developed site-specific information on key model input parameters
Carbon flux in a wetland

$\text{NEE} = \text{P} - \text{ER}$

- $\text{P} - \text{Photosynthesis}$
  - (CO$_2$)
- $\text{ER} - \text{Ecosystem Respiration}$
- $\text{Plant respiration}$
  - (CO$_2$)
- $\text{Soil respiration}$
  - (CO$_2$)
- $\text{Methane flux}$
  - (CH$_4$)
  - methane oxidation
  - methanogenesis
  - water export
    - (DOC, DIC, CH$_4$)

The world’s leading sustainability consultancy
Sequestration in a salt marsh wetland is a function of the natural accretion rate of sediment in the marsh, the organic carbon loading in the sediment, and plant respiration.

\[ A_c = S_d \times C_f \times U_v \times D_s \times U_a \]

Where:

- \( A_c \) = Annual rate of carbon accretion per unit area (kg/m\(^2\)/yr)
- \( S_d \) = Sediment bulk density (kg/m\(^3\))
- \( C_f \) = Fraction of carbon in sediment (kg C/kg sediment)
- \( D_s \) = Annual rate of sediment deposition (mm/yr)
- \( U_a \) = Area units conversion factor = 10\(^6\) (mm\(^2\)/m\(^2\))
Sediment Deposition Study

Need to understand the deposition rate of sediment in the marsh

- 7 Sampling points in Basin 3
- $^{210}$Pb (7 cores)
- $^{137}$Cs (2 cores)

Results showed good relationship across the marsh
Sediment Sampling
Sediment Deposition Study Results

Sediment Deposition Rates (cm/yr)

- 0.1
- 0.2
- 0.3
- 0.7

Location:
- A
- B
- C
- D
- E
- F
- G
- H

Radionuclides:
- $^{210}$Pb
- $^{137}$Cs
Sediment Characterisation Study

Sediment characterization was focused on measurements of other physical parameters.

- Total Organic Carbon
- Grain Size
- Bulk Density

- Collected 36 surface sediment samples across the marsh
  - Sand Plug
  - March Surface
  - Channels
  - Inlet
Sediment Characterization Study Results
Model Results

Modeled output for two end states:

- One year post construction
- Seven years post construction

Modeled output for two levels of uncertainty:

- Upper and lower bounds on input parameters from field studies
Model Output

- Total CO2 Equivalent (Metric Tons):
  - Year 1 Estimate Bounds:
    - Salt Marsh Enhancement Project Construction: 85
    - Salt Marsh Sequestration (Year 1- Low): -17
    - Salt Marsh Sequestration (Year 1- High): -259
  - Year 7 Estimate Bounds:
    - Salt Marsh Sequestration (Year 7- Low): -108
    - Salt Marsh Sequestration (Year 7- High): -1118
Conclusions

■ Model was successful in helping determine the sequestration potential for project alternatives.

■ The low end estimate shows that it may take the full seven years to reach the potential to offset the project development CO$_{2e}$ output.

■ The high end estimate indicates that the project may significantly sequester more CO$_{2e}$ than the project development output.

■ This approach may be useful in determining the potential for other restoration sites.

■ The more site-specific data you have the better the model output.
Any Questions?