Estimating Benefits of Hydrologic Restoration and Freshwater Introduction Projects in Coastal Wetlands

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Based on O'Neil 1949, Gosselink 1984, Sasser 1994, Swarzenski et al. 2008
Annual Land Change Rates

Prograding (Land Gain)

Degrading (Land Loss)

Inputs = organic + mineral accretion; Outputs = subsidence + erosion + SLR
**NSED2 Model:** Calculates a benefit from nutrient and sediment introduction.

**SPROD2 Model:** Calculates benefit from reduction in salinity.

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**Salinity Reduction**

**In situ Organic Production**

- **Export**
- **Denitrification**
- **Burial (Immobilization)**

**Organic soil fraction**

**Mineral soil fraction**

**Export**

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**Nutrients**

**Sediment**
Patterns → Consistency → Predictability → Model

“remarkably constant”

Gosselink et al. 1984
About 0.026 g cm\(^{-3}\) organic carbon in all soils

* Nyman et al. 1990, Hatton et al. 1983
** Faulkner and Poach 1996
Bulk Density = 0.16 g cm\(^{-3}\) (Brackish Marsh)

% Organic = 16.25%

Organic Fraction = BD * % Organic

Organic Fraction = 0.16 * 0.1625 = 0.026 g cm\(^{-3}\)

Production Rate (PR) = 2653 g m\(^{-2}\) y\(^{-1}\)

= 0.2653 g cm\(^{-2}\) y\(^{-1}\)

= 0.2653 g cm\(^{-3}\) y\(^{-1}\) (at 1 cm depth)

% of Production in BD = (Organic Fraction)/(PR)

(0.16 g cm\(^{-3}\))*(0.1625) ÷ (0.2653 g cm\(^{-3}\)) = 9.8%
% Maximum Productivity

Salinity (ppt)

Reproduced from Snedden and Swenson 2012
Central Terrebonne Freshwater Enhancement Project (TE-66)

Project Area – 48,446 acres
19,421 acres wetland
29,025 acres water

Loss Rate = -0.46%/y
(89.3 acres/y)
Problem:
Expanded breach in historic ridge that allows for more direct transfer of higher saline gulf marine waters to penetrate deep into the upper Central Terrebonne fresh and intermediate marshes.

Goals:
Reestablish historic hydrologic and salinity conditions by reducing the intrusion of gulf marine waters via the Grand Pass into the Central Terrebonne marshes.

Solution:
Construction of rock barge bay in pass to reduce 900 ft wide x 37 ft deep opening by 90% to 150 ft x 16 ft.

Model: SPROD2 (STELLA 10.0.4)
**SPROD2 Model** – Calculates the benefits of salinity reduction from freshwater introduction and/or structural features.
Module 1- Salinity Dilution Box Model
Calculates the percent difference in salinity with the project.
Module 2 – Marsh production factor calculator
Calculates the percent difference in production within each marsh zone.

Example of brackish marsh results.
Module 3-Land Change Calculators
Calculates the acres of land benefit within each marsh zone based upon the increase in organic production from salinity reduction.
**SPROD2**  
*Salinity/Production Model*

**Annual Net Change Calculator**

**Annual Land Loss Reduction Percent Calculator**

- **14.3% reduction in land loss rate**
- **233 net acres in 20 yrs**

**Land Loss Spreadsheet**

- **Annual Land Loss Reduction Percent**
  - **ANNUAL LLR PERCENT | 0.143096**

**Annual Net Change**

- **ANNUAL NET CHANGE | 12.12**
Cameron-Creole Freshwater Introduction Project (CS-49)

Project Area = 22,240 acres
7,659 acres wetland
14,581 acres water

Loss Rate = -0.76%/y
(58.2 acres/y)
**Problem:**
Experiencing increased tidal exchange, saltwater intrusion, and reduced freshwater retention associated with the Calcasieu Ship Channel and the GIWW. Also recently impacted by hurricanes.

**Goals:**
The project would restore the function, value, and sustainability to approximately 22,247 acres of marsh and open water.

**Solution:**
Construction of ten 48-inch culverts in the bank of the GIWW to establish freshwater flow from the GIWW into the Cameron-Creole marshes.

**Model:** NSED2 (STELLA 10.0.4)
NSED2
Nutrient/Sediment Model
Nutrient Module: calculates the acres of benefit from increase in nutrients.
Sediment Module: calculates the acres of benefit from increase in sediments.
Annual Net Change and Land Loss Reduction Percent Calculators

156 net acres in 20 yrs
Conclusions

• Desktop modeling has allowed us to quantify benefits of introducing nutrients, sediments and lowering salinities in a way that allows equitable comparison to all project types.

• By quantifying the benefits of nutrient, sediment and salinity reduction, we are able to provide estimates of cost/benefit to allow decision makers to make more informed decisions in selecting projects for funding.
Questions?

Weeds or Organic Production?