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Quantification of Coastal Marsh Restoration Benefits in the Northern Gulf of Mexico

Modeling the Development of Marsh Ecological Functions

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Presentation Outline

I. Introduction
II. Benefits Quantification Approach
   - Resource Equivalency Analysis (REA)
III. Model Inputs
IV. Results for Example Project
V. Potential Applications

Introduction

- Extensive salt marsh restoration is expected in the northern Gulf of Mexico, funded in part by the Deepwater Horizon settlement.
- Understanding the ecological functioning of restored marshes is integral to setting restoration targets and performance criteria and to understanding how much restoration is needed to achieve desired benefits.

Quantification of Marsh Benefits: An Approach

- Resource Equivalency Analysis (REA)
- Conceptual model to determine the amount of restoration needed to compensate for natural resource injuries
  - Primarily in context of natural resource damage assessment
- Two components:
  - Quantify injury
  - Quantify net restoration benefits


William Widmer/NYT

Quantification of Marsh Benefits: An Approach

Net Benefits* = $\text{Benefits}_{FWP^{**}}$ – $\text{Benefits}_{FWOP^{***}}$

$\text{Benefits}_{FWP^{**}}$	$\text{Benefits}_{FWOP^{***}}$
Reference Value	Reference Value
Recovery Trajectory	% Marsh
Rate of Marsh Loss_{FWP}	Rate of Marsh Loss_{FWOP}
Project Life_{FWP}	Project Life_{FWP}

* Representative ecological components:
  - Vegetation (aboveground and belowground biomass)
  - Periwinkle snail (*Littorina irrorata*)
  - Amphipod (Amphipoda)

** FWP = Future with Project
*** FWOP = Future without Project

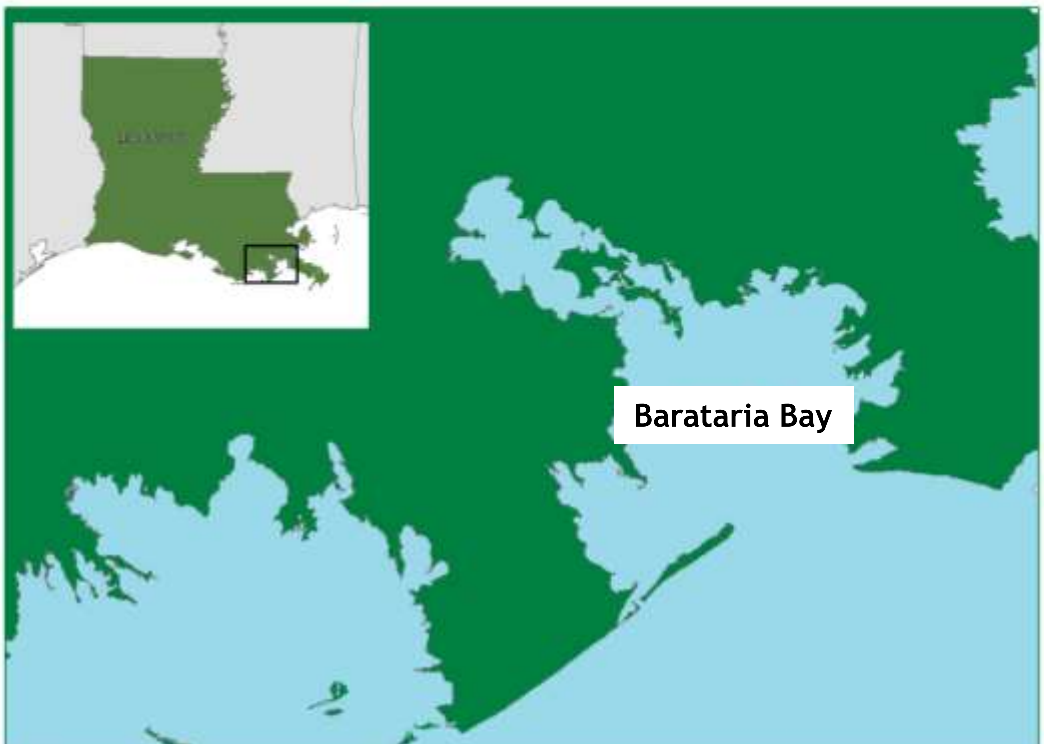
REA Inputs

For today's presentation:

- Reference Values
  - Vegetation
  - Fauna
- Recovery Trajectories
  - Vegetation
  - Fauna
- Percent Marsh (FWOP)
- Rate of Marsh Loss (FWOP and FWP)

REA Inputs: Example Project

- Salt marsh creation
- Barataria Bay, LA



REA Inputs: Reference Value of Marsh Components

- Reference densities of representative ecological components are used to calculate FWP and FWOP densities

Marsh Component Metric	Reference Density
Vegetation	
Aboveground biomass (live)	728 g dry weight m^{-2} [(a)]
Belowground biomass (total)	14,205 g dry weight m^{-3} [(a)]
Fauna	
Periwinkle density	41 sub-adults and adults m^{-2} [(b)]
Amphipod density	1,294 individuals m^{-2} [(c)]

[(a)] Derived from DWH NRDA data, available in NOAA DIVER
[(b)] Derived from literature search of Louisiana marshes
[(c)] Derived from literature search of northern Gulf of Mexico marshes

REA Inputs: Recovery Trajectory of Marsh Components (FWP)

- Rate of recovery (recovery trajectory) for representative ecological components of the marsh
- For example (from this session):
  - Marsh vegetation (Lane et al.)
  - Periwinkles (Baumann et al.)
  - Amphipods (Baumann et al.)
  - Nekton (Hollweg et al.)


Seth Blitch/TNC

REA Inputs: Percent Marsh (FWOP)

- Average percent of the FWOP site covered by marsh
- Value is used to account for marsh services prior to project implementation (Net Benefits = FWP – FWOP)
- LA Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Wetland Value Assessment (WVA) data

Restoration Technique	Vegetation Type	% Marsh
Marsh Creation	Saline	**20%**
	Brackish	23%
	Intermediate	31%
	Fresh	3%
	Grand Total	**20%**
Shoreline Protection	Saline	59%
	Brackish	51%
	Intermediate	74%
	Fresh	41%
	Grand Total	**57%**

REA Inputs: Rate of Marsh Loss (FWOP)

- Assumption: recent marsh loss rates are comparable to near-future rates
- Couvillion et al. (2011), with modifications
  - Landsat satellite imagery, 1975-2010

	Louisiana Basin								
Vegetation Type	Atchafalaya Delta	Barataria Bay	Breton Sound	Calcasieu/ Sabine	Mermentau	Miss. River Delta	Pontchar-train	Terrebonne Bay	Teche/ Vermilion
Saline	-0.860%	**-1.509%**	-0.814%	-0.184%	-0.203%	-2.694%	-0.727%	-1.084%	-0.712%
Brackish	-1.048%	-1.061%	-0.673%	-0.213%	-0.442%	-0.616%	-0.468%	-0.734%	-0.260%
Intermediate	-	-0.598%	-1.140%	-0.151%	-0.279%	0.178%	-0.300%	-0.733%	-0.274%
Fresh	0.658%	-0.030%	-0.181%	-0.168%	-0.148%	0.953%	0.098%	-0.070%	-0.071%

REA Inputs: Rate of Marsh Loss (FWP)

- Assume Rate of Marsh $Loss_{FWP}$ = Rate of Marsh $Loss_{FWOP}$ * Reduction in Marsh $Loss_{FWP}$
- Literature search did not yield enough data to derive Reduction in Marsh $Loss_{FWP}$
  - Future data from aerial surveys of CWPPRA constructed projects may help
- Marsh $Loss_{FWP}$ = 50% * Rate of Marsh $Loss_{FWOP}$
  - **50% reduction in marsh loss** is assumption used by CWPPRA WVA

Net benefits for salt marsh creation in Barataria Bay

Marsh Resource	Project Benefit[a,b]
Vegetation	
Aboveground biomass (live)	6,619 g m^{-2}
Belowground biomass (total)	80,469 g m^{-3}
Fauna	
Periwinkle	155 g m^{-2}
Amphipod	4,231 ind m^{-2}

[a] Present Value (2016)
[b] Project benefits are expressed in terms of initial project area, not in terms of remaining marsh area.

Potential Applications

- Inform expectations regarding ecological functioning of restored marsh over time
  - Set restoration targets / performance criteria
  - Determine appropriate amount of restoration needed to achieve desired benefits
- Prioritize projects based on comparison of anticipated ecological benefits
- Natural resource damage assessment

Conclusions

- Modeling multiple ecological components provides a more complete picture of marsh functioning.
- Inputs should be adapted based on site-specific information.
- Inputs should be selected to match intended model use and user's tolerance for over/under-estimating results.

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