Coastal Wetlands Formation, Functions, and Susceptibility

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What is a wetland?

• Wetlands are distinguished by the presence of water, either at the surface or within the root zone
• Wetlands have unique soil conditions that differ from adjacent uplands
• Wetlands support vegetation adapted to the wet conditions - flood-intolerant plants are absent, as well
Satilla River, GA
Atlamaha River Watershed, Georgia
Wetland Components

- Hydrology
  - Frequency
  - Duration
  - Intensity
  - Flow
- Several sources
  - Rain
  - Surface flow (flooding from rivers streams)
  - Groundwater
  - Tides
Wetland Components

• Multiple pathways out of the wetland
  – Evaporation/plant use
  – Seepage into groundwater
  – Flow/tides

• Directly influences soil and plants
Wetland Components

• First, what is soil?
  – Composed of mineral material (sand, silt, clay)
  – Upper limit is air or shallow water
  – Lower limit is bedrock or limit of biological activity
  – Consists of “horizons” formed through additions, losses, and transformations
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Wetland Components

• Soils influence
  – Water flow and storage
  – Nutrient (nitrogen and phosphorus) storage
  – Oxygen availability
  – Plant type and abundance
Wetland Components

• Wetland Plants
  – Tolerate flooding
    • Low oxygen in soil
  – Structural adaptations to flooded conditions
  – Able to disperse
  – More competitive than “upland” plants
So how do coastal wetlands form?

1. Water delivers sediment
2. Sediment stores water, plants colonize
3. Plants trap sediment, accumulate subsurface “stuff”
4. Feedback continues
Louisiana’s Coastal Wetlands

- Over 30,000 km² of wetlands
- Losses of >100 km² per year over the last 50 years
- Accounts for 80% of coastal wetland loss in US
- More on this later...
Louisiana’s Coastal Wetlands

Salt Marsh Food Web Relay

1. Salt marsh plants
2. Small invertebrates
3. Fish
4. Shrimp

Basic Saltmarsh Zones

- Submerged
- Intertidal
- Supratidal

Spring High Tide
High Tide
Low Tide

- Marine Algae
- Saltmarsh Cordgrass
- Saltmeadow Cordgrass
- Giant Reed
Louisiana’s Coastal Wetlands

• Refuge for fin and shellfish
  – 1.1 billion lbs/year in landings (75% depends on wetlands)
  – Accounts for 16% of nations fisheries harvest
Louisiana’s Coastal Wetlands

- Water storage
- Coastal protection from floods and hurricanes
  - Slow the movement of water
  - Dampen the strength of storm surge

Source: Barbier et al. (2013) PLoS ONE
Dauphin Island, Alabama
Louisiana’s Coastal Wetlands

• Important sinks for nutrients (nitrogen and phosphorus)
  - Water quality

• Stores carbon (carbon sequestration)

• A quick primer on microbes...
Think of microbes as little people...

Hi, I’m a microbe!

...who need to eat (carbon) and breathe (oxygen)

This is what we do, we need oxygen to get the energy from our carbon source (food)
Think of microbes as little people...

This is called denitrification, and it removes nitrogen from the landscape.

...who need to eat (carbon) and breathe (oxygen)

This is why microbes are cooler than we are...
Think of microbes as little people...

This is called sulfate reduction

...who need to eat (carbon) and breathe (oxygen)

Out of nitrate? That’s fine!
Louisiana’s Coastal Wetlands

- These are known as anaerobic processes (no oxygen)

- Much slower and less efficient than aerobic respiration (involves oxygen)

- Therefore, the carbon source is stored in the soil
  - Less CO₂ emitted to the atmosphere
Why remove nitrogen at all?

Bottom-water dissolved oxygen across the Louisiana shelf from July 22-28, 2013

Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University
Funded by: NOAA, Center for Sponsored Coastal Ocean Research

Distribution of the concentration of bottom-water dissolved oxygen along the Louisiana-Texas shelf, July 22-28, 2013. The dark line delineates the area where the dissolved oxygen is less than 2 milligrams per liter, or hypoxia.
Why remove nitrogen at all?

- Nitrate in the water causes a bloom of algae.
- Microbes consume the algae, and the oxygen.
- Wetlands can “filter” the water (think of them as the kidneys of the landscape).
Where does the nitrogen come from?
Louisiana’s Coastal Wetlands

- Over 30,000 km² of wetlands
- Losses of >100 km² per year over the last 50 years
- Accounts for 80% of coastal wetland loss in US
- And now it’s later...
Figure 19. Average annual net loss and gain estimates for the conterminous United States, 1951 to 2009. Estimates of error are not graphically represented. Sources: Frayer et al. 1988; Dahl and Johnson 1991; Dahl 2000; 2006; and this study.
Susceptibility

• There are two primary drivers of coastal wetland loss in Louisiana
  – Lack of sediment delivery
  – Salt water intrusion

• These are big picture threats
  – Can be direct and indirect
The Non-Powered Dams with Potential Capacity Greater than 1 MW

Figure ES-1: Locations of the top non-powered dams with potential hydropower capacities greater than 1 MW
MASTER PLAN TO PROTECT AND RESTORE LOUISIANA'S COAST

Draft master plan would spend $50 billion over 50 years on hurricane protection and coastal restoration, including 500-year protection for New Orleans, and the use of sediment diversions, dredging and pipelines to rebuild wetlands throughout the area.

SHORELINE PROTECTION
Breakwaters to reduce wave energy on shorelines in bays, lakes, sounds, bayous and navigation channels.

MARSH CREATION
Building wetlands in open water by sediment dredging and placement. Most projects involve moving sediment by pipeline.

SEDIMENT DIVERSIONS
Use of channels or structures to divert river water and sediment to build and nourish wetlands.

DIVERSION INFLUENCE AREAS
Outline of areas where new wetlands are likely to grow or be nourished by diversions.

BARRIER ISLAND/HEADLAND RESTORATION
Creation and restoration of dune, beach and back barrier marsh along coast.

RIDGE RESTORATION
Re-establishment of historic ridges with sediment, vegetation to create “speed bumps” for storm surge, habitat for wildlife.

CONVEYANCE CHANNEL
New or realigned channel to divert river water and sediment to wetlands.
But sediment is only one problem...
This is where microbes come in as major players...
Think of microbes as little people...

This speeds up respiration (eats up the carbon in the soil), leads to subsidence

This is called sulfate reduction

...who need to eat (carbon) and breath (oxygen)

Remember this?
100+ Years of Land Change for Coastal Louisiana

SUMMARY

Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2006, coastal Louisiana has lost 1,968 square miles of land, roughly as large as the state of Delaware. If nothing is done to stop this loss, Louisiana could potentially lose approximately 700 square miles of land, or almost equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years. Further, Louisiana accounted for an estimated 90 percent of the coastal marsh loss in the lower 48 states during the 1990s.
Wasn’t there an oil spill?
Results?
Greenhouse Gas Fluxes

Spatial pattern only present in unoiled marshes
Results?
Greenhouse Gas Fluxes

Spatial patterns differ between oiled and unoiled marshes
Questions?