Call of the Wild

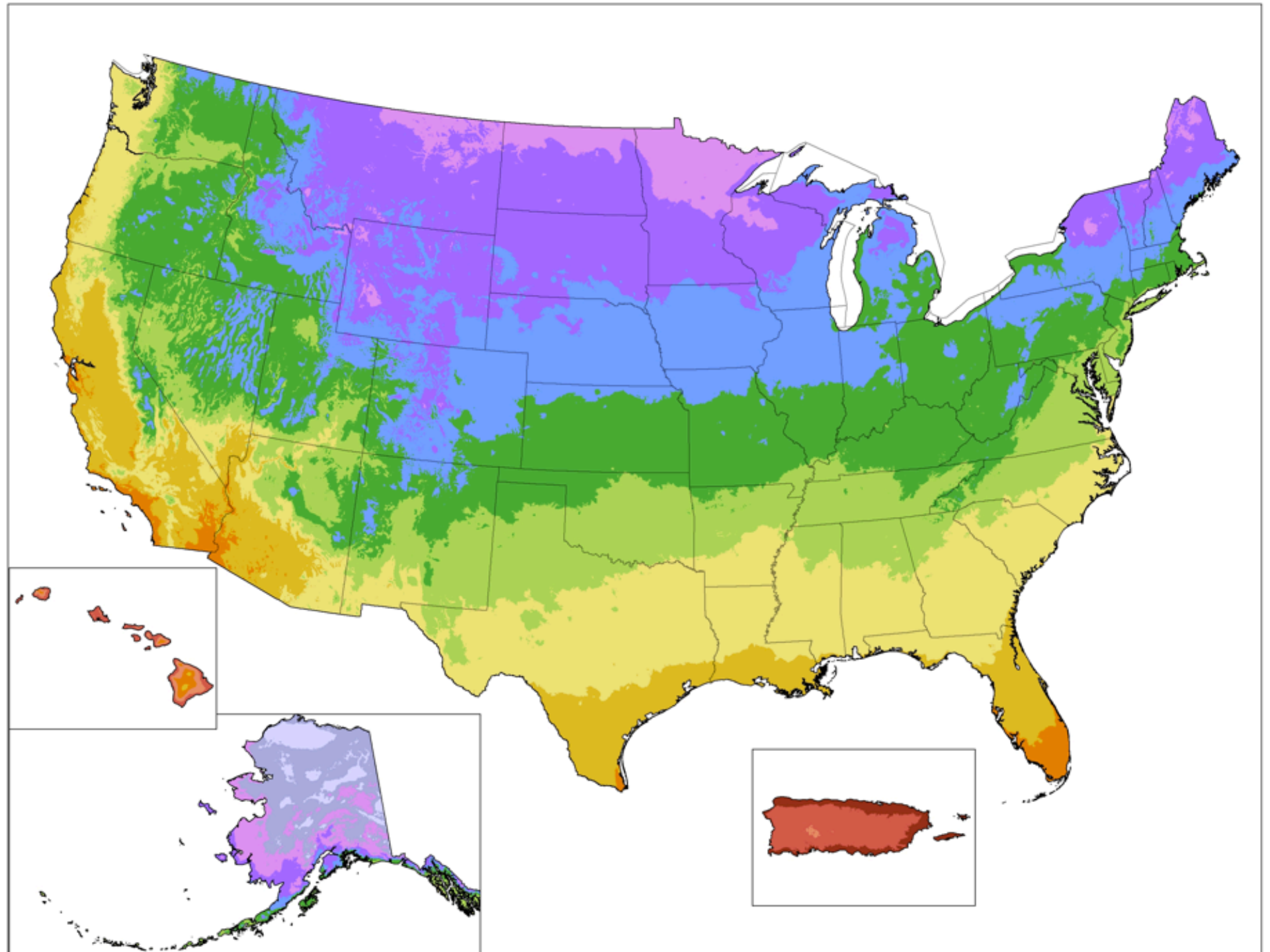
CLIMATE CHANGE AND SEA LEVEL RISE: IMPACTS TO WETLANDS

Juliana Barrett

Connecticut Sea Grant UConn Extension

Sea Grant Connecticut

UCONN | COLLEGE OF AGRICULTURE AND NATURAL RESOURCES EXTENSION



Changes in climate are …

- changing plant and animal ranges, migrations on land and water systems
- disrupting food webs
- increasing pathogens, parasites and disease
- changing extinction risks
- impacting hydrologic regimes

All of which change ecosystems and ecosystem services

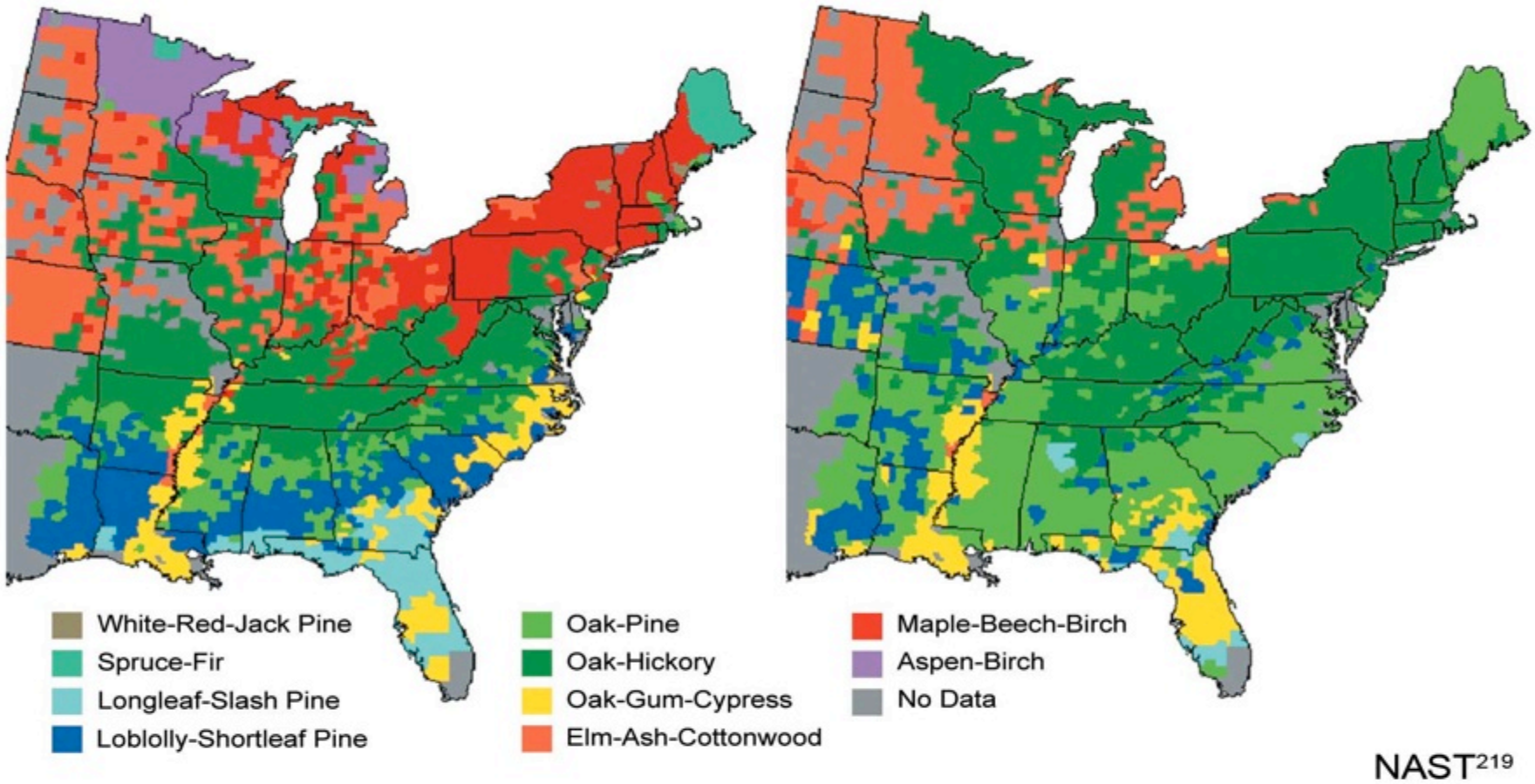
In the US, spring now arrives 10 to 14 days earlier than it did 20 years ago

Obvious changes related to the timing of the seasons: when plants bud in spring; when birds and other animals migrate

Shifts in tree species on mountains in New England (largely in the transition zones)

Shifts in fish populations as rivers warm





The maps show current and projected forest types. Major changes are projected for many regions. For example, in the Northeast, under a mid-range warming scenario, the currently dominant maple-beech-birch forest type is projected to be completely displaced by other forest types in a warmer future.[243]

In nature, timing is everything. It can influence recreation, agriculture—even economics. Whether people come to see the fall colors, watch migrating whales or catch a glimpse of rare birds, visitors to the Northeast impact the economy to the tune of millions of dollars. As the timing of nature's events change, so will the timing of the tourist seasons.





Habitats at the Highest Risk from Climate Change in Connecticut

1. Cold Water Streams
2. Tidal Marsh
3. Open Water Marine
4. Freshwater Wetlands
5. Forested Swamps
6. Major Rivers
7. Beaches and Dunes
8. Offshore Islands

From: The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health 2010

Wetland Functions and Values

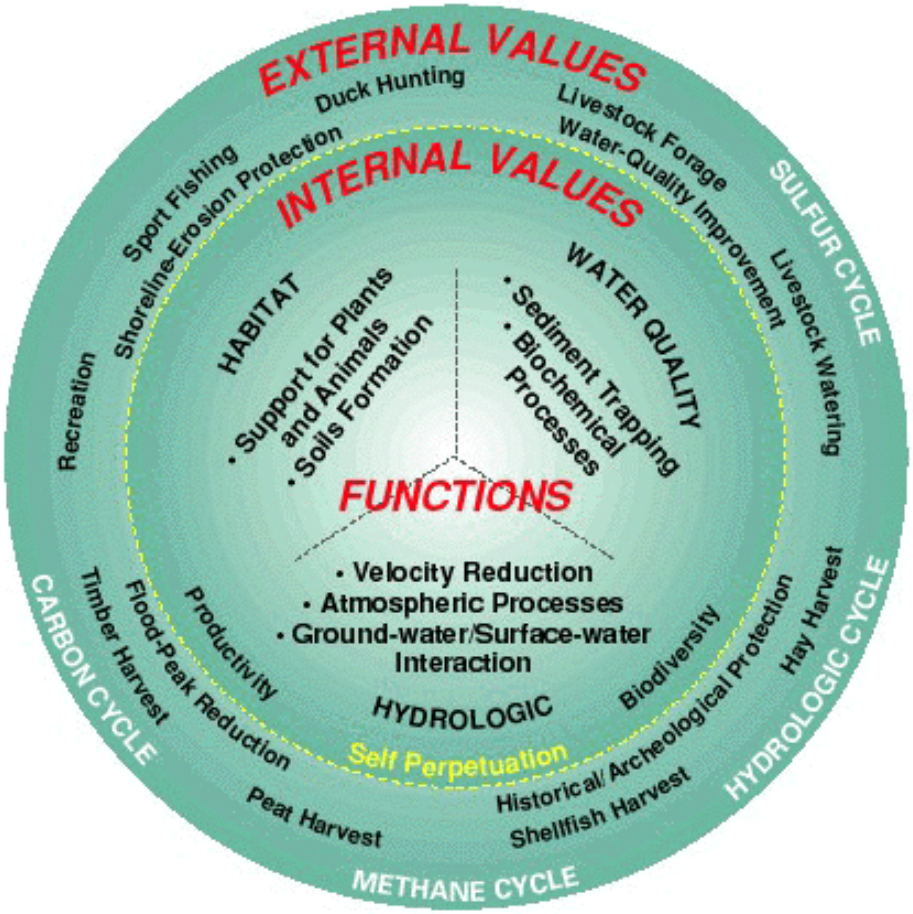
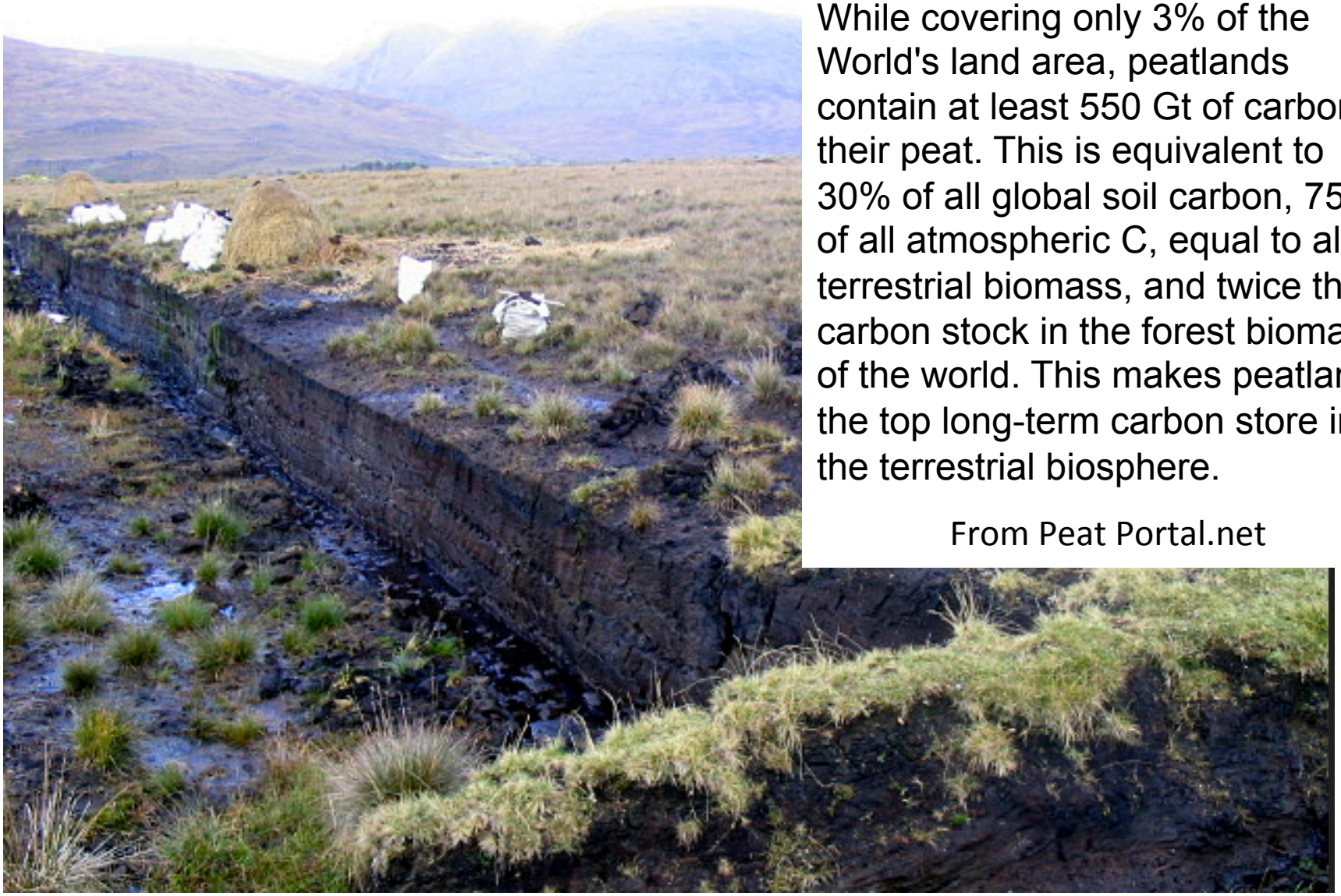


Figure 51. Wetland functions and internal and external values.

Climate change impacts that will affect wetlands

- Increased mean annual air temperatures
- Changes in precipitation patterns (amount, timing, intensity)
- Increases in average water temperatures
- Sea level rise
- Intense storm events (hurricanes, nor'easters)

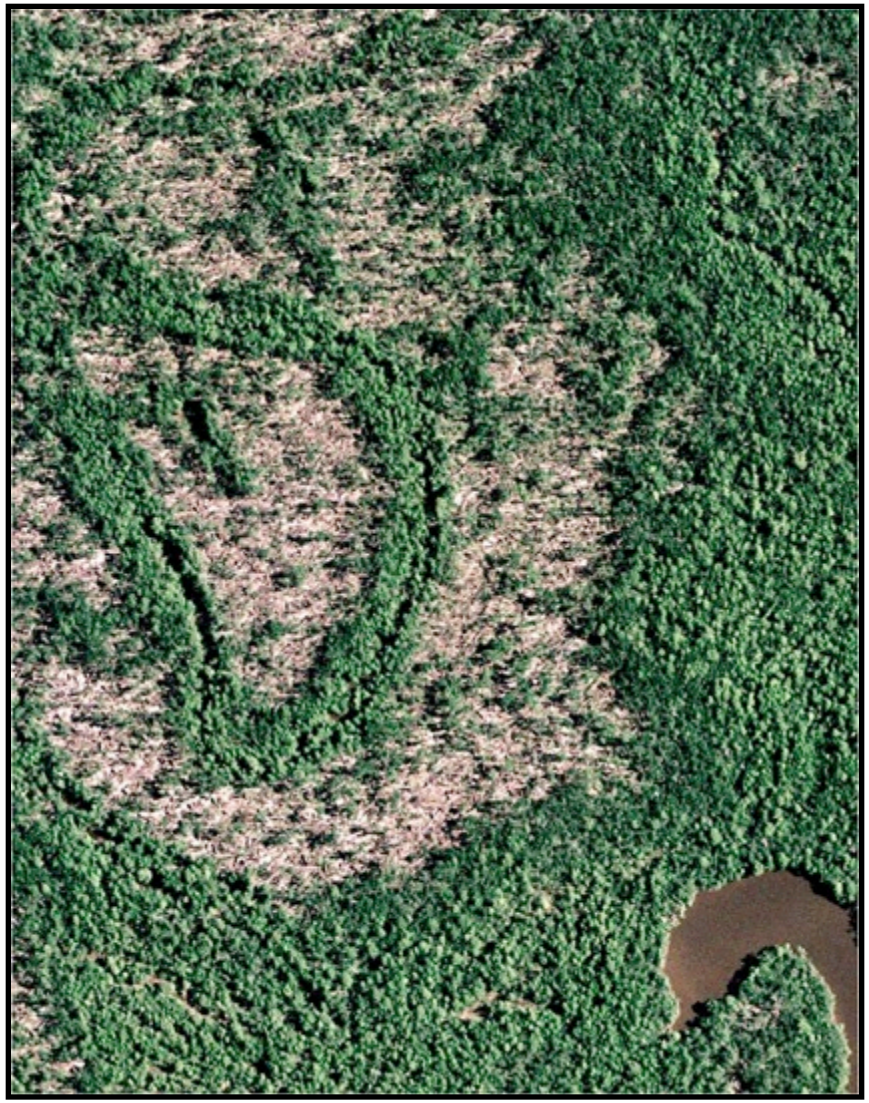
Wetlands represent a significant storage reservoir of carbon in the global carbon cycle



While covering only 3% of the World's land area, peatlands contain at least 550 Gt of carbon in their peat. This is equivalent to 30% of all global soil carbon, 75% of all atmospheric C, equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world. This makes peatlands the top long-term carbon store in the terrestrial biosphere.

From Peat Portal.net

Climate Change and Disturbance to Wetlands



Wind damage to wetland forests in the Pearl River Basin caused by Hurricane *Katrina* changed carbon sinks to carbon sources

Louisiana State University





- Less winter precipitation falling as snow and more as rain will change hydrologic regimes
- Reduced snowpack and earlier breakup of winter ice on lakes and rivers
- Earlier spring snowmelt leading to earlier peak river flows
- Ground water levels, runoff, soil moisture
- Sea level rise

Climate Factor	Direct Impacts	Indirect/Interactive Impacts	Exacerbating Human-Development Impacts	Ecosystem Responses
Sea level	• Inundation • Erosion • Saltwater intrusion	• Altered patterns of flooding • Upstream salinity changes • Soil salinity changes	• Freshwater extraction • Sea walls/coastal armoring	• Wetland drowning and migration • Reduced viability of mangroves • Beach and mudflat loss
Extreme events	• Storm surge • Waves • Wind scour • Erosion • Drought	• Flooding • Altered flushing and residence times	• Sea walls/coastal armoring • Urban development/ impervious surfaces	• Beach and mudflat loss • Habitat destruction • Altered food webs
Precipitation	• Soil moisture • Hydrologic changes	• Salinity changes • Altered water residence times • Increased nutrient loading and eutrophication • Reduced stream flows	• Urban development/ impervious surfaces • Altered nutrient runoff concentrations • Altered sediment delivery • Agriculture/fertilizers and pesticides	• Changes in distribution of fresh and salt water biota • Altered productivity of fisheries species • Increased harmful algal blooms
Temperature	• Soil moisture • Salinity changes • Permafrost thawing	• Reduced stream flows • Altered nutrient and toxin concentrations • Eutrophication	• Freshwater extraction • Urban development/heat islands	• Altered metabolism and growth rates • Altered plant and animal distributions • Local extinctions • Increased harmful algal blooms
Wave regimes	• Shoreline retreat • Erosion	• Altered patterns of flooding	• Sea walls/coastal armoring	• Beach and mudflat loss • Wetland edge loss

Table 3-1. *Examples of impacts of climate change and human exacerbating factors on coastal ecosystems.*

Coastal Wetlands

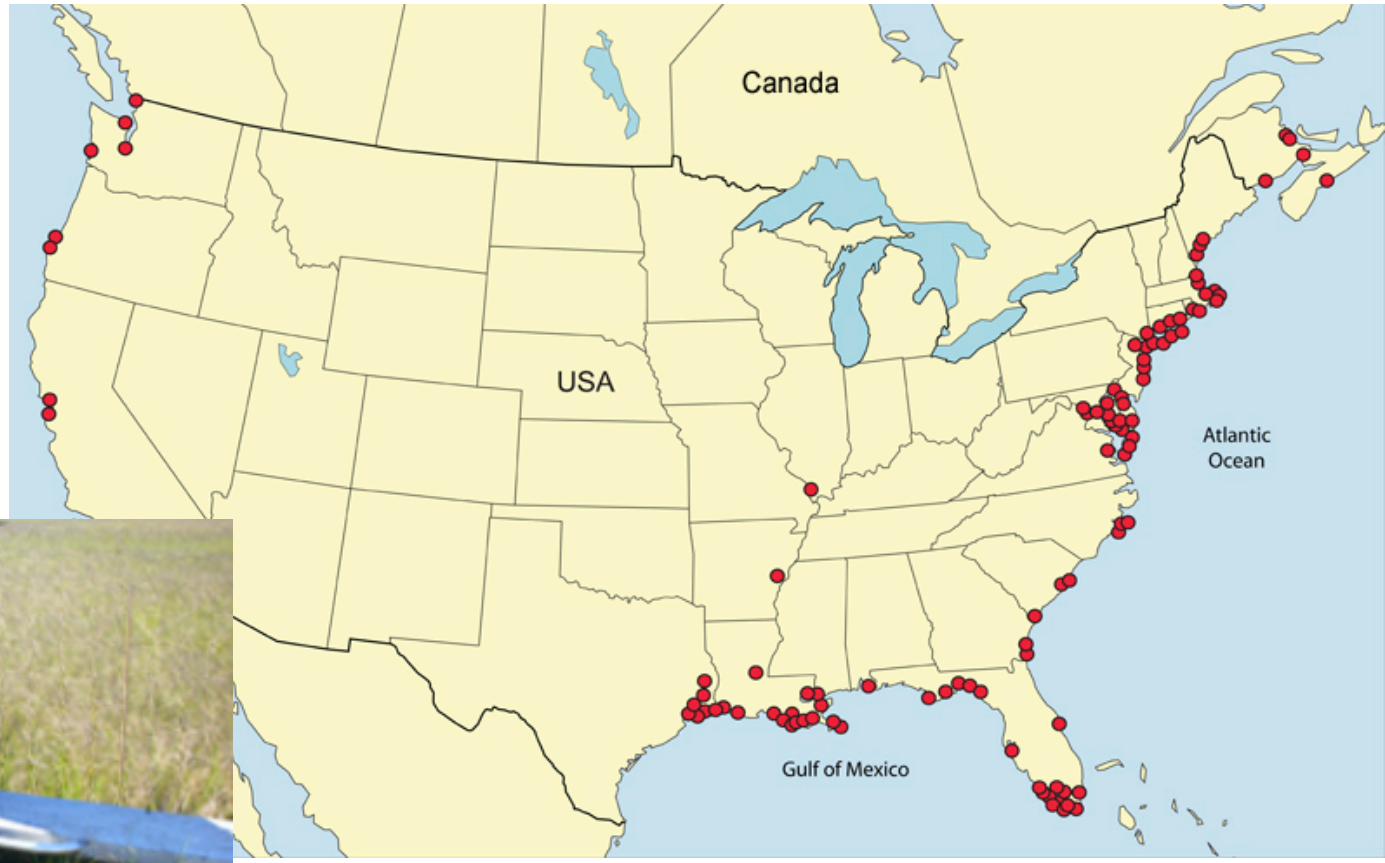
- Horizontal and vertical accretion
- New England salt marshes – little sediment, dependent on primary productivity for vertical accretion
- Threshold (Plum Island): 5mm/yr SLR
- SLR: about 4.5 mm/yr in the last decade

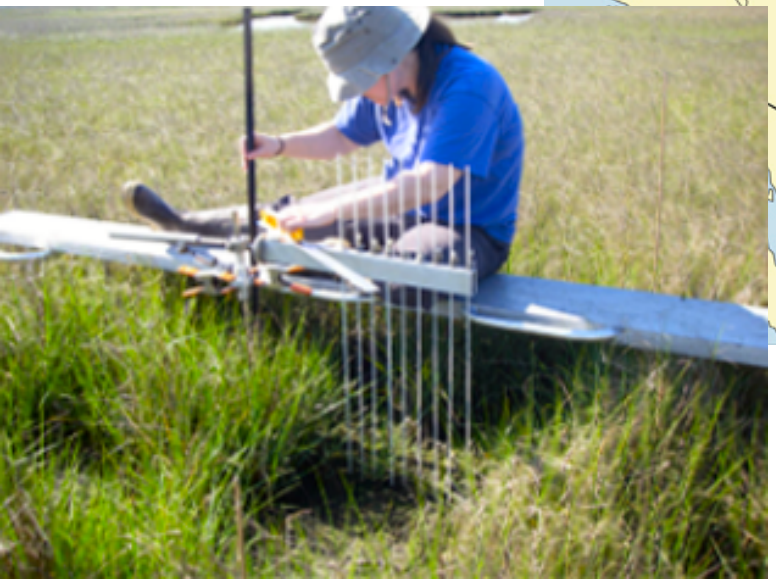
So the issue is where can the marshes go horizontally?

SLAMM Model Process Overview (Sea level affecting marshes model)

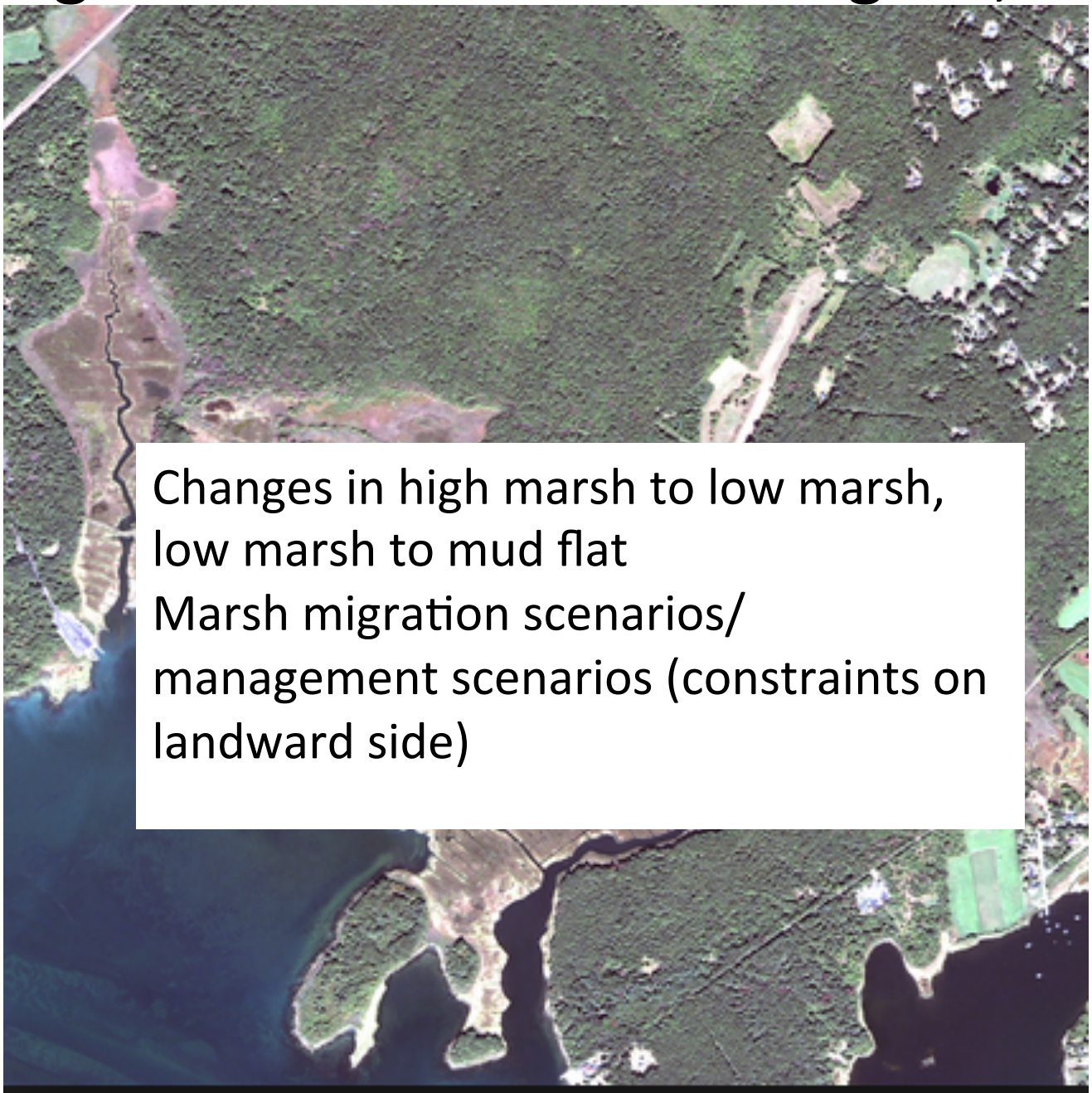
- Inundation: Calculated based on the minimum elevation and slope of the cell.
- Erosion: Triggered given a maximum fetch threshold and proximity of the marsh to estuarine water or open ocean.
- Accretion: Vertical rise of marsh due to buildup of organic and inorganic matter on the marsh surface. Rate differs by marsh-type.
- Salinity: Optional model or linkage to existing model. Salinity affects habitat switching in areas with significant freshwater flows
- Overwash: Barrier islands undergo overwash at a fixed storm interval. Beach migration and transport of sediments are calculated.
- Saturation: Migration of coastal swamps and fresh marshes onto adjacent uplands-- response of the water table to rising sea level.

The Surface Elevation Table (SET) is a portable mechanical leveling device for measuring the relative elevation change of wetland sediments.





Changes at Barn Island Stonington, CT



Changes in high marsh to low marsh, low marsh to mud flat

Marsh migration scenarios/ management scenarios (constraints on landward side)

Connecticut River



Salt wedge may move further upriver with sea level rise. Some of the freshwater tidal wetlands may transition to brackish, and brackish wetlands to salt marshes.

Changes in the timing of the spring freshet will also impact wetlands.

Vernal pools may decrease in size or dry up

Wetland types may change such as from marsh to forest

Associated flora and fauna may change as wetlands change

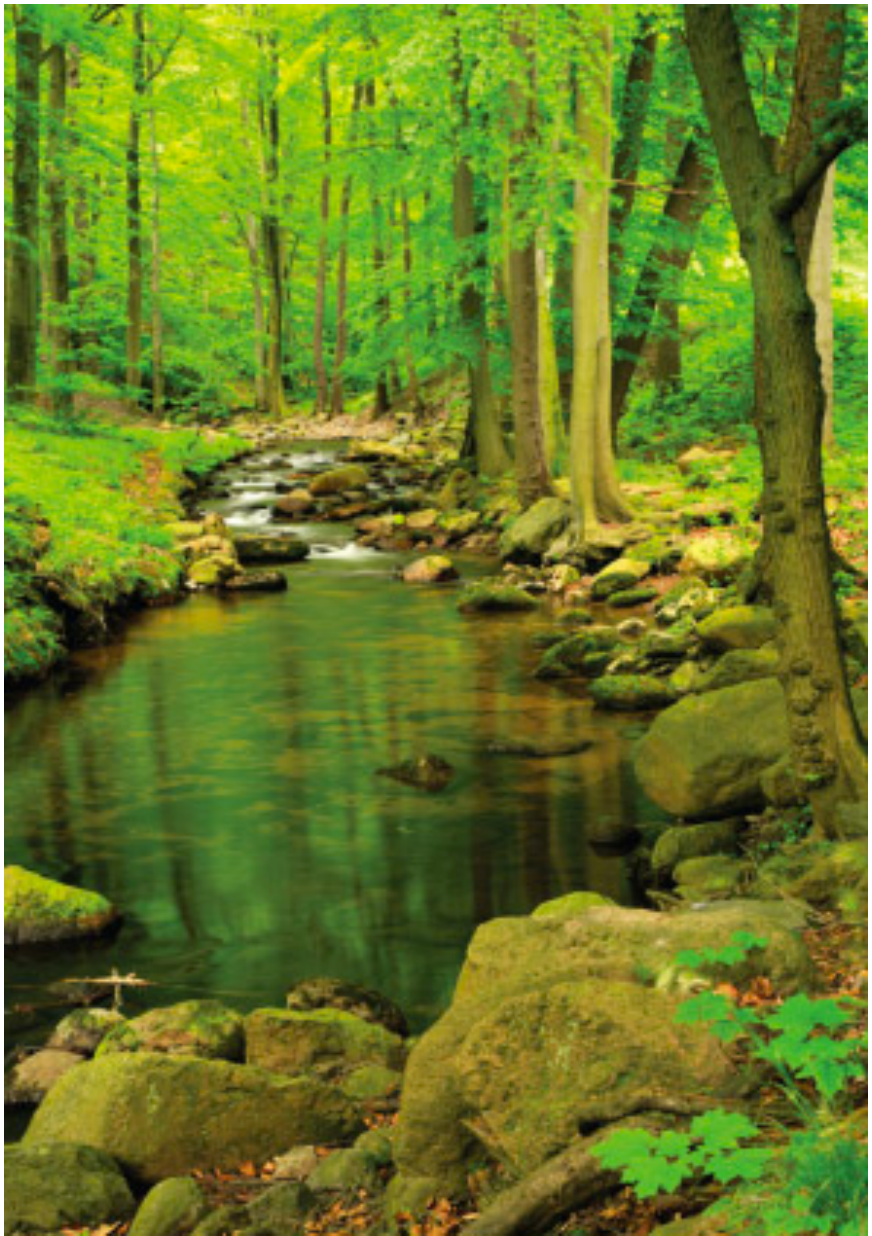


What can we do?

Identification of at risk wetlands statewide (eg tidal marshes, vernal pools, shallow to groundwater wetlands, poor fens)



Vegetated buffers and setbacks



Tidal marshes – protection of surrounding land to allow for marsh migration (depending on elevations)



Wetlands restoration



Wetlands protection



Control of Invasive Species



Invasive species – ecological and economic impacts

Purple Loosestife: It has been spreading at a rate of 115,000 ha/year and has been blamed for reducing the biomass of 44 native plants and endangered wildlife, including bog turtles and several species of ducks that depend on native plants. Loosestrife now occurs in 48 states and costs $45 million per year in control costs and forage losses.

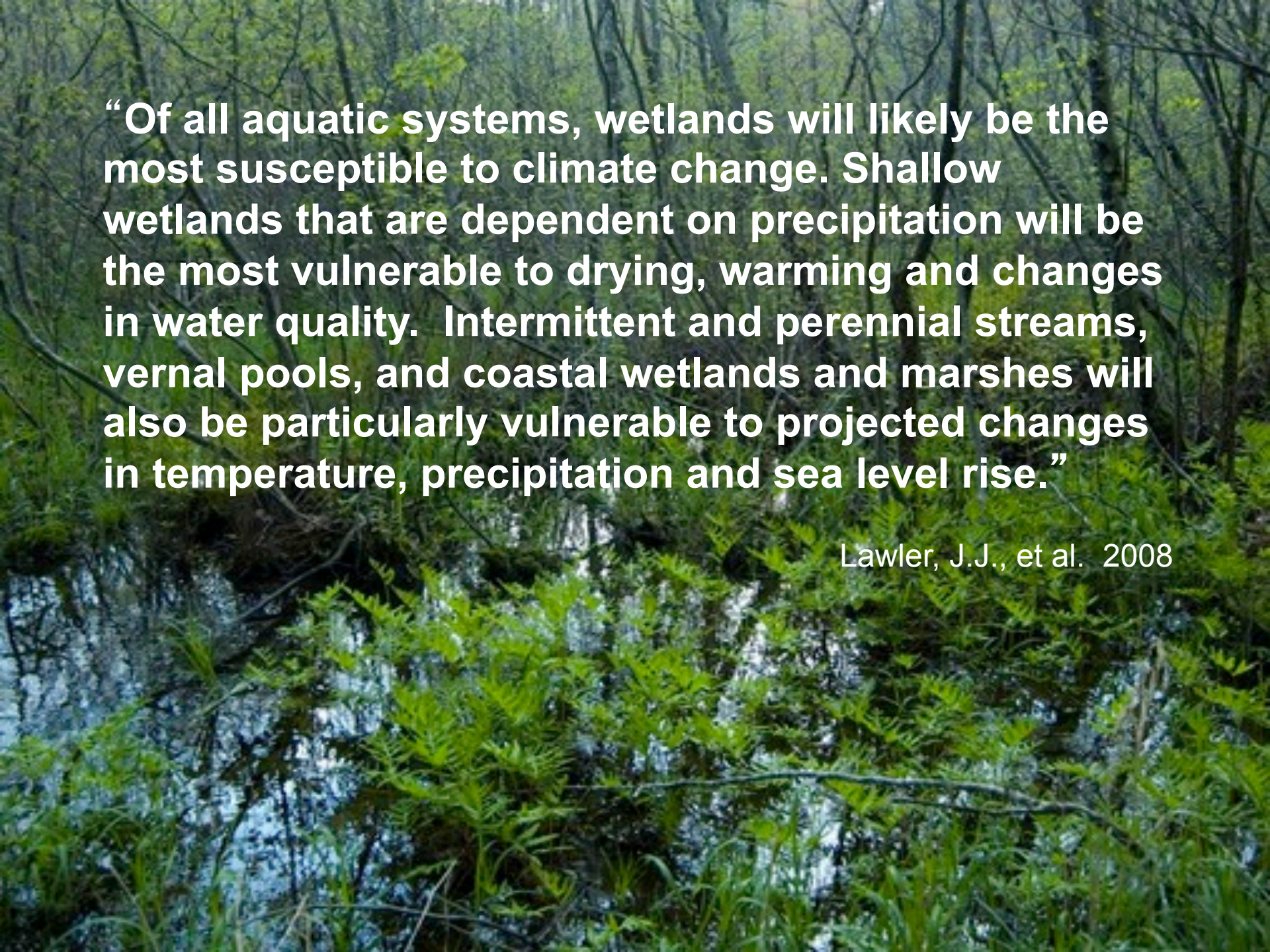
Water Control Structures

- Drop pipe
- Flap gate structure
- Flash boards or stoplogs









"Of all aquatic systems, wetlands will likely be the most susceptible to climate change. Shallow wetlands that are dependent on precipitation will be the most vulnerable to drying, warming and changes in water quality. Intermittent and perennial streams, vernal pools, and coastal wetlands and marshes will also be particularly vulnerable to projected changes in temperature, precipitation and sea level rise."

Lawler, J.J., et al. 2008

Wetlands and Global Scale Changes

- Wetlands are significant sources and sinks of greenhouse gases and play an important role in global climate change
- Wetlands are very vulnerable to the effects of global climate change
- Sea level rise driven by climate change is the greatest threat to coastal wetlands
- Increases in temperature pose the greatest threat to inland wetlands