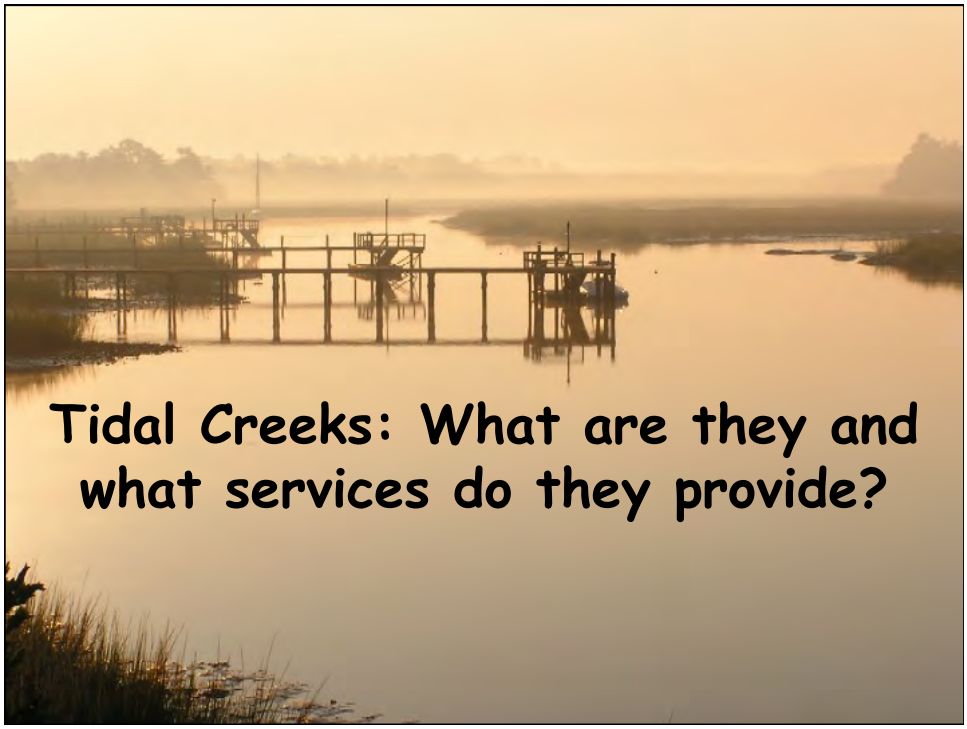
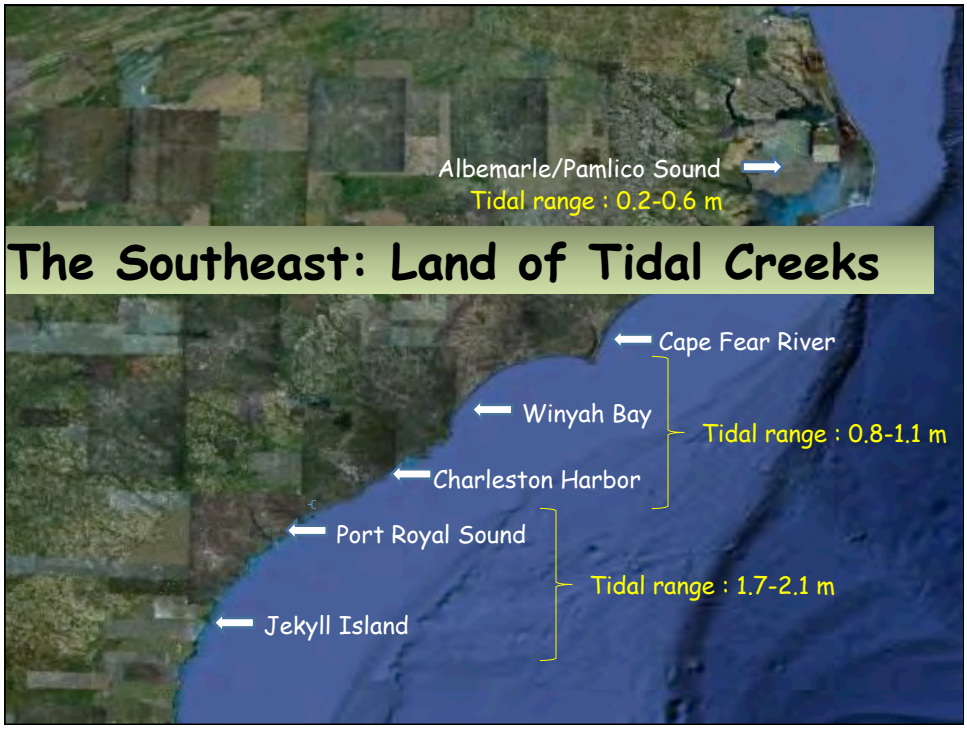


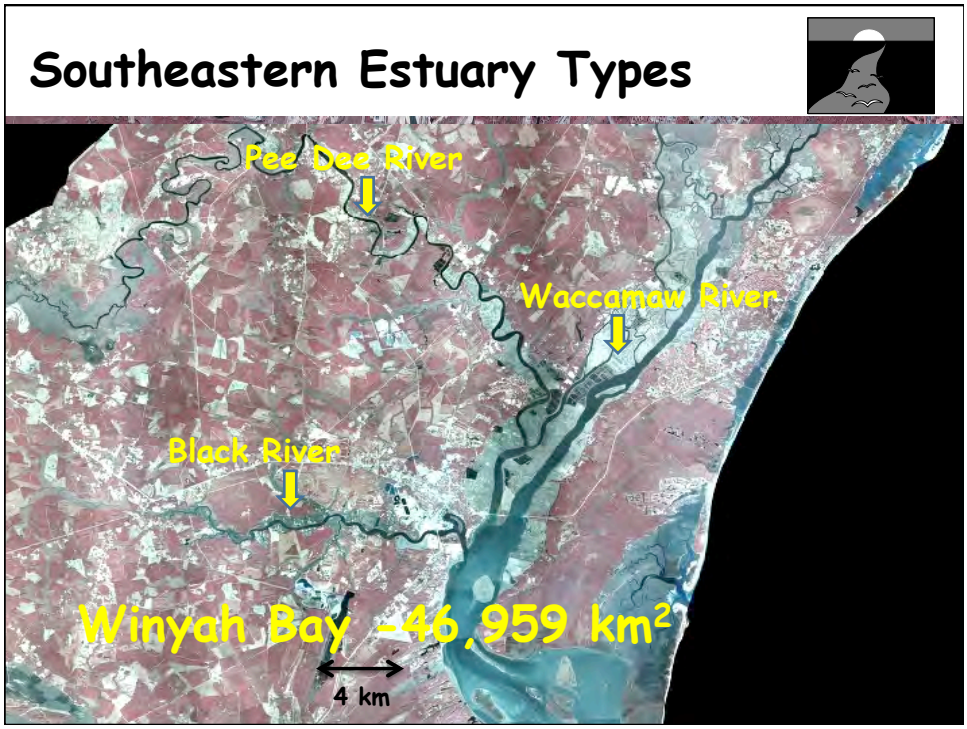
Tidal Creeks: What are they and what services do they provide?

Objectives of this Presentation

- Provide a perspective for the presentations that follow:
  - An overview of the ecology of tidal creeks ecosystems.
    - Services, key characteristics
  - Identify major threats to condition & sustainability.
  - Suggest a framework for research, management & restoration activities.

Tidal Creeks Project


Albemarle/Pamlico Sound
Tidal range : 0.2-0.6 m
The Southeast: Land of Tidal Creeks
Cape Fear River
Winyah Bay
Tidal range : 0.8-1.1 m
Charleston Harbor
Port Royal Sound
Tidal range : 1.7-2.1 m
Jekyll Island

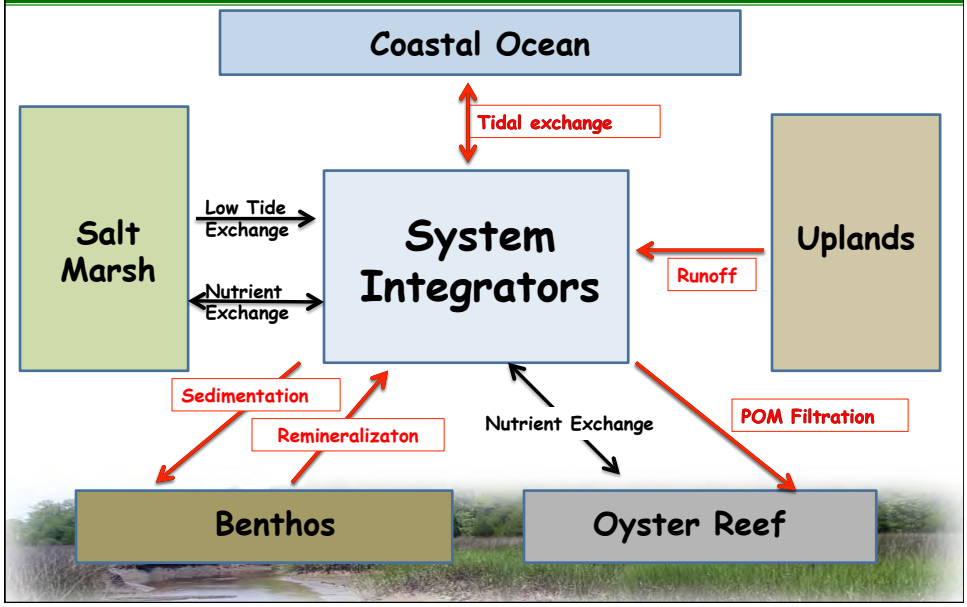

Southeastern Estuary Types
Pee Dee River
Waccamaw River
Black River
Winyah Bay ~46,959 km²
4 km

Southeastern Estuary Types

Estuary Type	Drainage Area (km^2)	Estuarine Area (km2)	Proportion as Salt Marsh & Tidal Creeks
Bar Built	10's-100's	10's	Large
Coastal Plain	100's-1000's	10's - 100's	Moderate
Piedmont	1,000's-10,000's	1,00's-1,000's	Small

Tidal Creek Subsystems & Processes

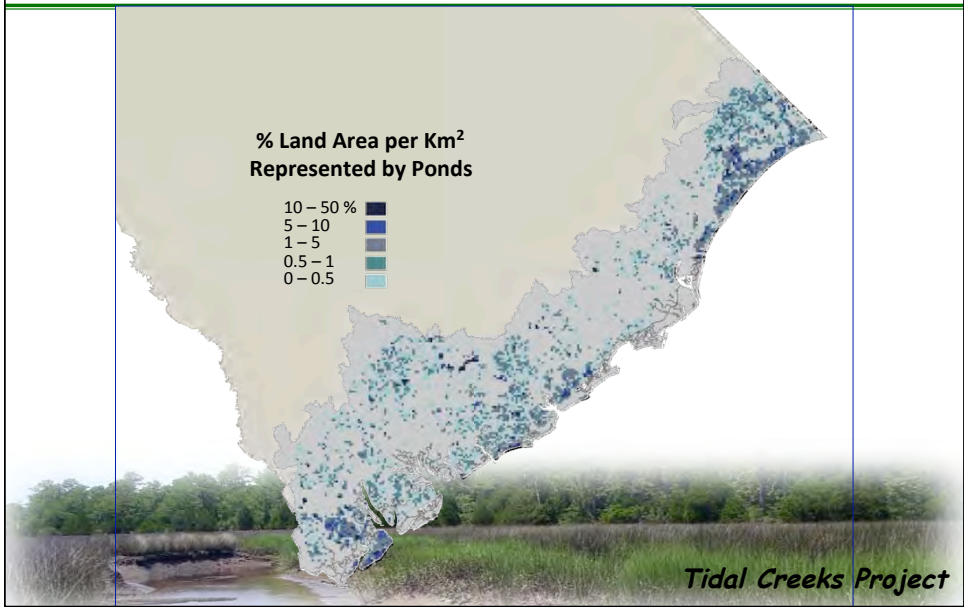
Modified from Childers et al. 1993



Classes of Creeks

Created open-water ponds in SC coastal zone

From Erik Smith, North Inlet NERR

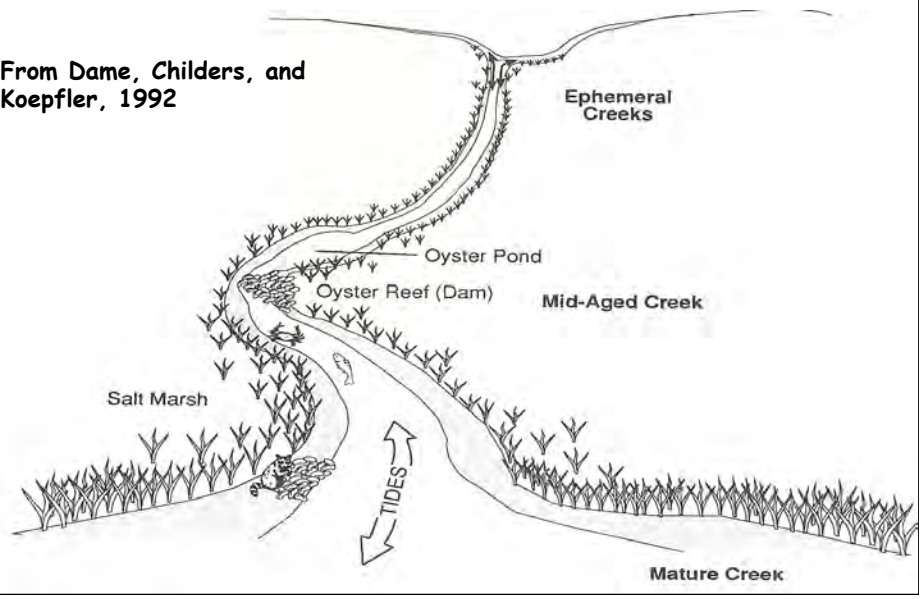


Odum 1984 Creek Classification

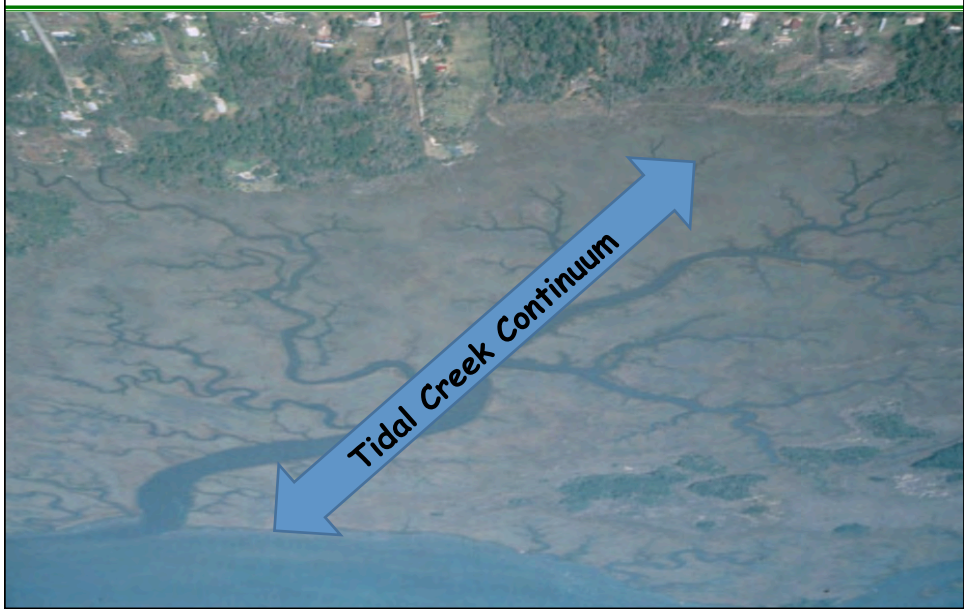
Approximate Characteristics of Marsh Creeks by Stream Order (Modified from Odum 1984)			
Stream Order	**Drainage Basin (ha)**	**Stream Width (m)**	**Comments**
First order	0.25	1	Drains completely at low tide
Second order	5	3	~ 75% of volume drains at low tide
Third order	100's	10	~ 50% of volume drains at low tide
Fourth order	1000's	50+	~ 25% or less drains at low tide.
Embayments	10-100,000's		

Tidal Creek Continuum

From Dame, Childers, and Koepfler, 1992



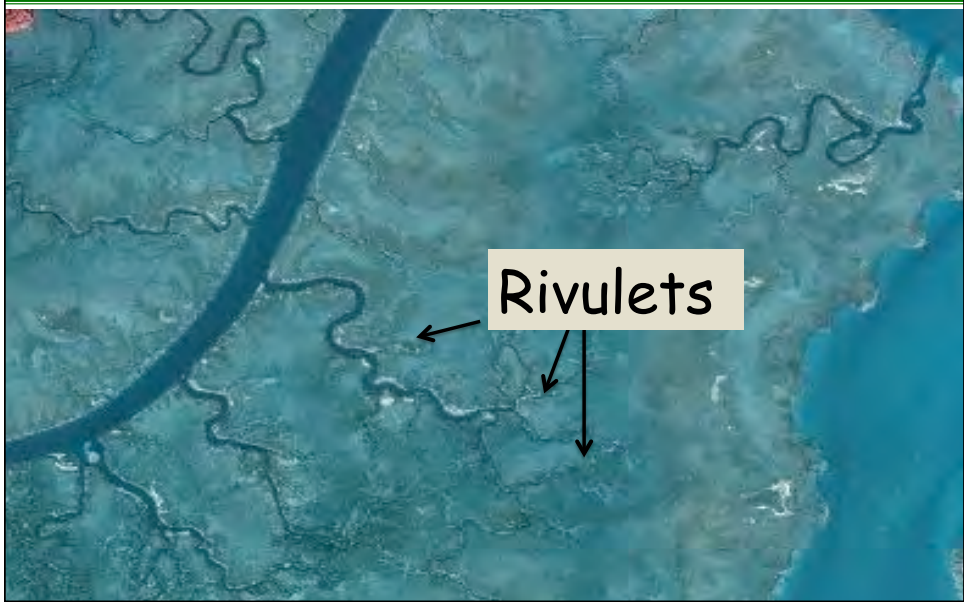
Why is a classification framework needed?



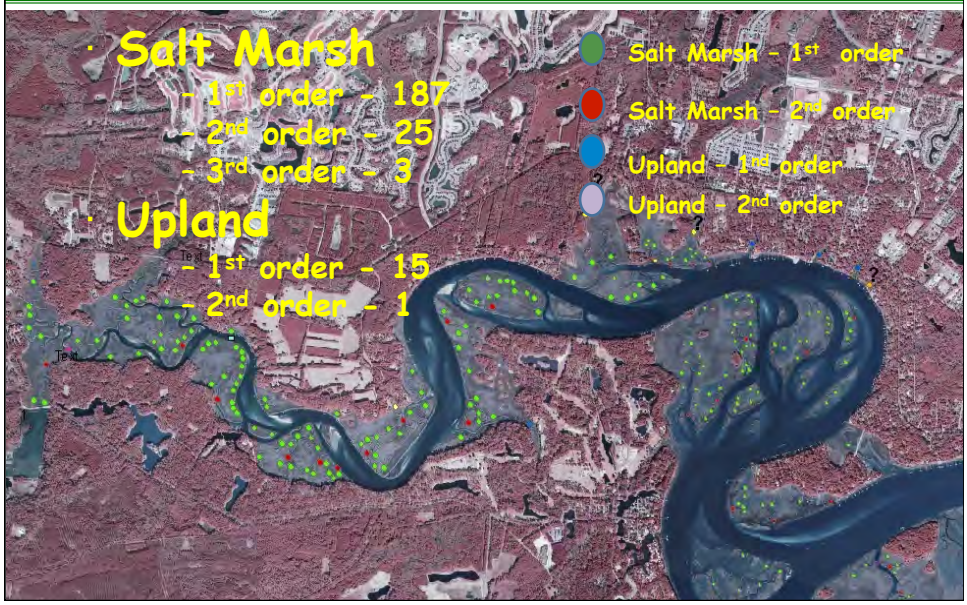
Unified Classification Framework

Characteristics of NC/SC/GA upland & salt marsh creeks by stream order					
Stream Order	Upland Creeks		Marsh Creeks		Comments
	Drainage Basin (ha)	Stream Width (m)	Drainage Basin (ha)	Stream Width (m)	
Rivulet	<1	<1-2	<1	<1-2	Drains completely at low tide
First order	62-2,425 **Median = 377**	1-10	15-30 **Median = 27**	1-10	~75% of volume drains at low tide
Second order	322-5,501 **Median= 1,650**	10-100	50-300 **Median = 167**	10-50	~ 50% of volume drains at low tide
Third order/ Tidal River	>5,000	>100	>300	50-100	~25% of volume drains at low tide

Example Classification



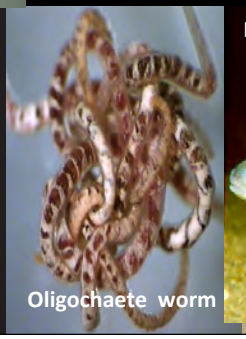
Tidal Creek Abundance by Class



Tidal Creek Ecosystem Services

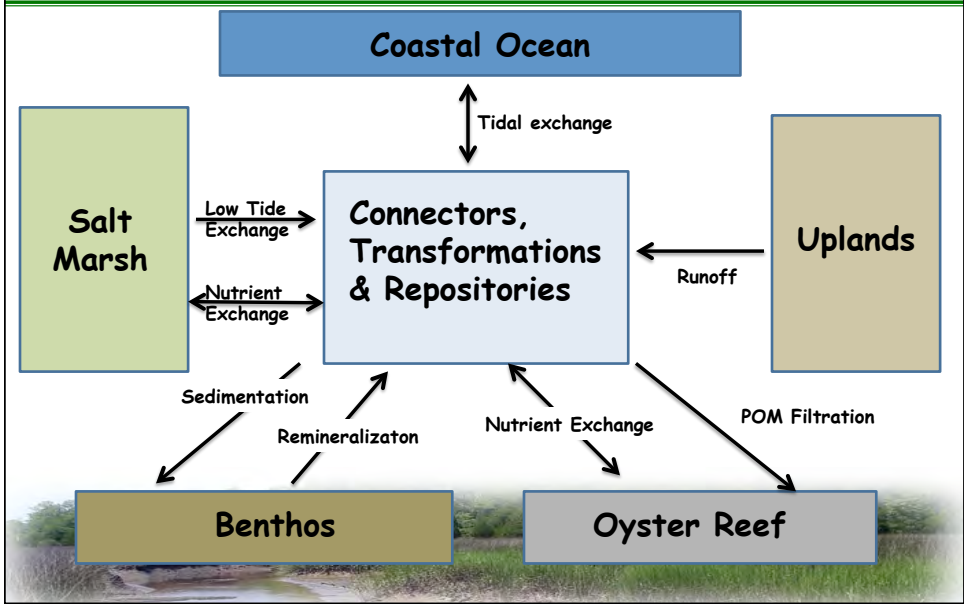
- Nurseries & refuges
- Connectors and transport routes
- Biogeochemical transformations
- Pollutant Repositories
- Feeding grounds
- Trophic transfer vehicles
- Storm protection
- Coastal vistas

Nurseries & Refuges

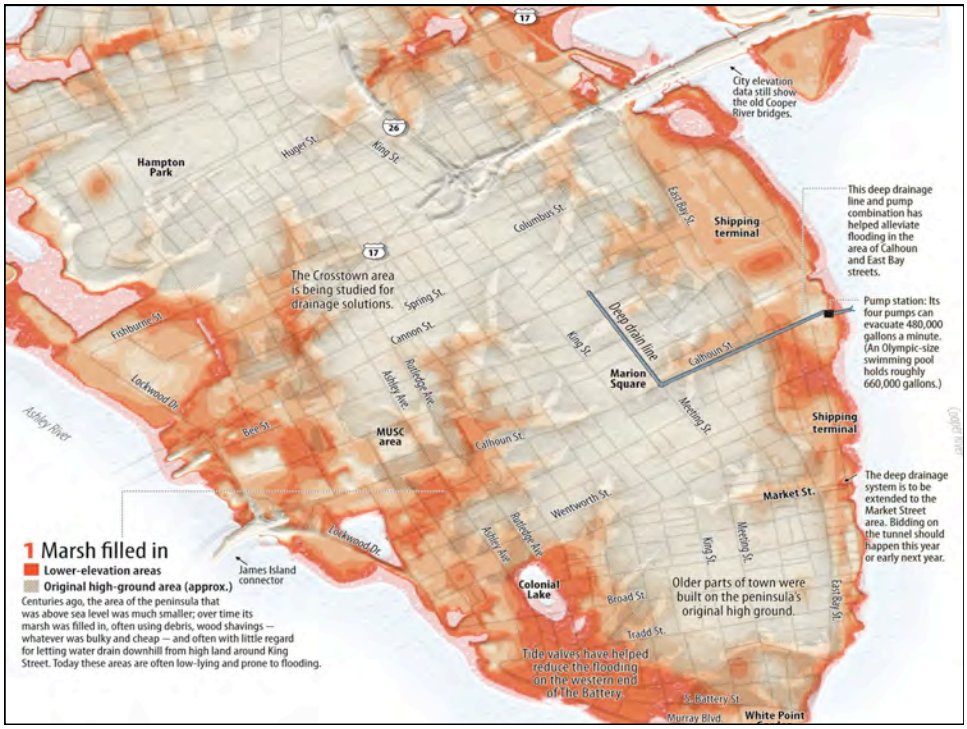


Connectors, Transformations, Repositories

Modified from Childers et al. 1993



Storm Protection


City elevation data still show the old Cooper River bridges.
Hampton Park
Huger St.
King St.
Columbus St.
East Bay St.
Shipping terminal
This deep drainage line and pump combination has helped alleviate flooding in the area of Calhoun and East Bay streets.
The Crosstown area is being studied for drainage solutions.
Spring St.
Cannon St.
Fishburne St.
Lockwood Dr.
Ashley River
Bee St.
MUSC area
Ashley Ave.
Rutledge Ave.
Deep drain line
King St.
Calhoun St.
Marion Square
Meeting St.
Shipping terminal
Pump station: Its four pumps can evacuate 480,000 gallons a minute. (An Olympic-size swimming pool holds roughly 660,000 gallons.)
Market St.
The deep drainage system is to be extended to the Market Street area. Bidding on the tunnel should happen this year or early next year.
Wentworth St.
1 Marsh filled in
Lower-elevation areas
Original high-ground area (approx.)
James Island connector
Centuries ago, the area of the peninsula that was above sea level was much smaller; over time its marsh was filled in, often using debris, wood shavings — whatever was bulky and cheap — and often with little regard for letting water drain downhill from high land around King Street. Today these areas are often low-lying and prone to flooding.
Colonial Lake
Broad St.
Older parts of town were built on the peninsula's original high ground.
Tradd St.
East Bay St.
Tide valves have helped reduce the flooding on the western end of the Battery.
S. Battery St.
Murray Blvd.
White Point

Threats & Concerns

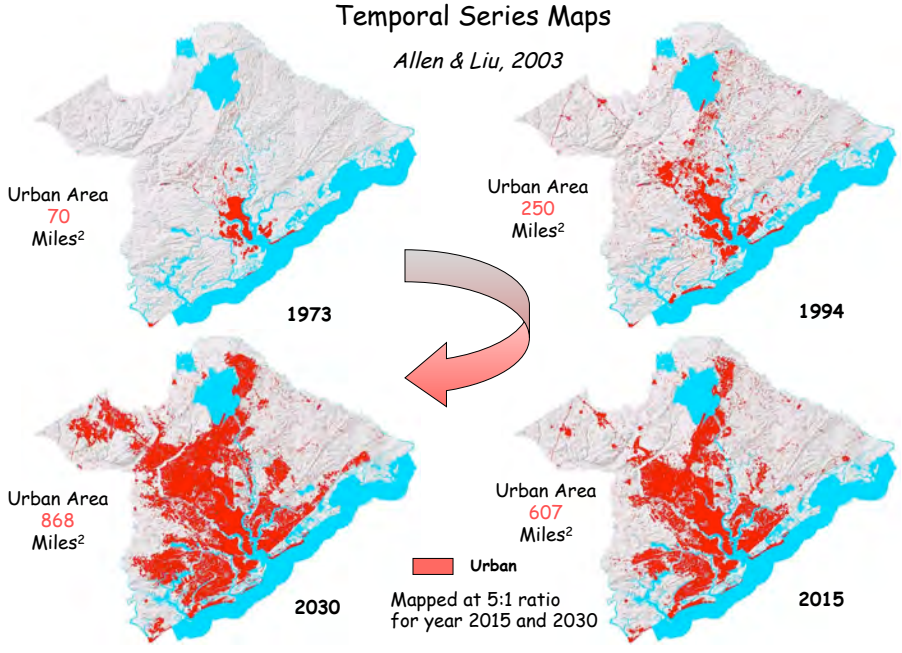
- Coastal Development & Modified Hydrography
- Sea Level Rise & Climate Change
- Regulatory & Resource Responsibilities
- Lack of Science-based Restoration

Tidal Creeks Project

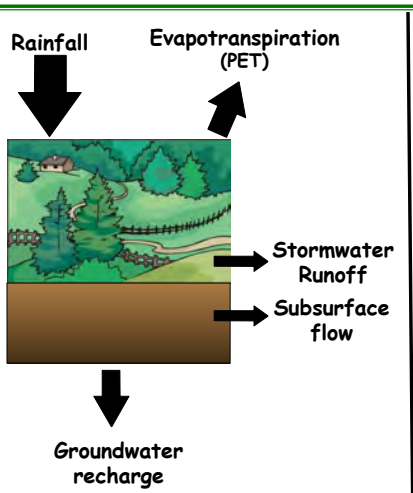
Charleston Urban Growth

Temporal Series Maps

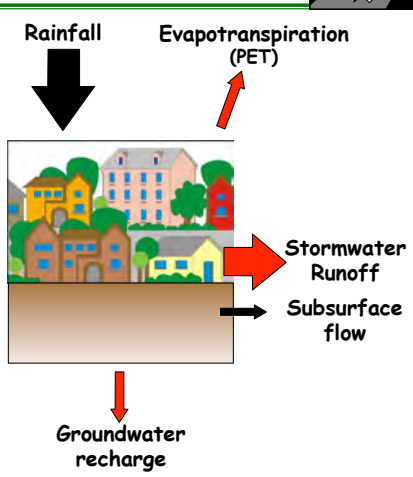
Allen & Liu, 2003



Water Budgets: Forested vs. Developed



Forested Watershed



Developed Watershed

Threats & Concerns

- Coastal Development & Modified Hydrography
- Sea Level Rise & Climate Change
- Regulatory & Resource Responsibilities
- Lack of Science-based Restoration

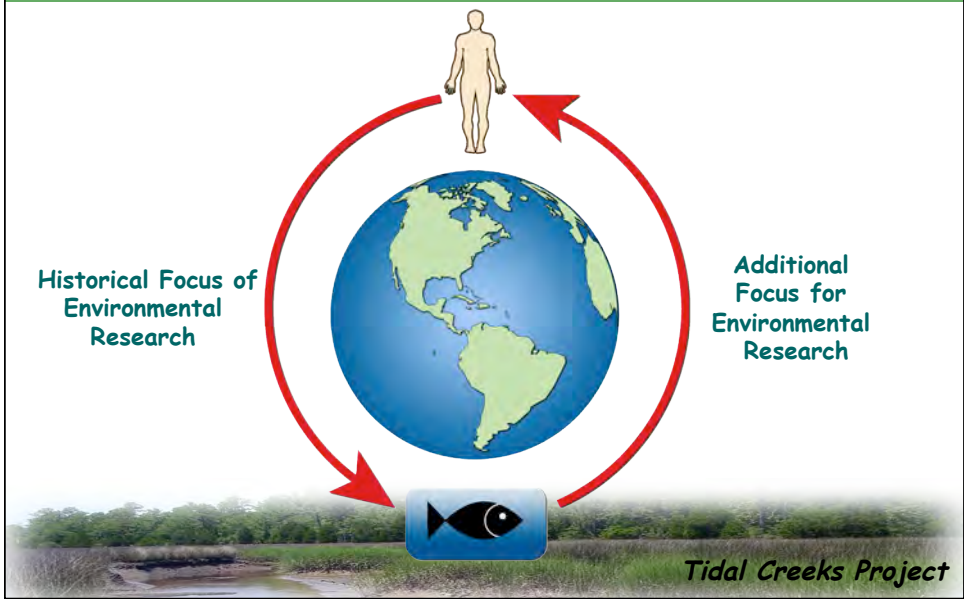
Management Issues

- Not generally managed using a coordinated ecosystem-based approach.
  - Land use
  - Water quality
  - Natural resources

Who is responsible for change through time?

- Historically management focused on protecting environmental quality (mainly water quality) and valued species with little emphasis on human health and well-being.
  - Our ability to safely eat the seafood and swim in the water is not disconnected from ecological processes

Human Health and Well-being

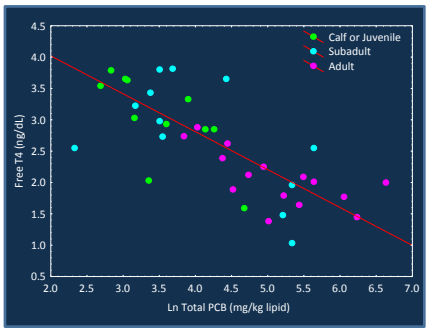


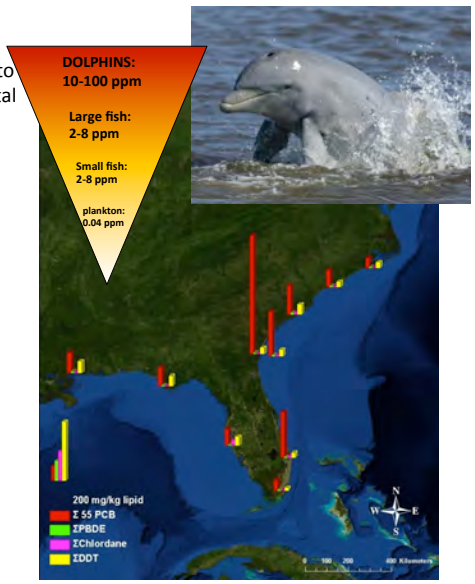
National Centers for Coastal Ocean Science

HML Capabilities: Pollution

Sentinel Species: PCB Levels in Coastal Dolphins and Insights into Human Health

- PCBs are not just sticking in the marine sediments near the immediate site or washing into the ocean to be diluted, they are making their way into the coastal food web
- Dolphins demonstrate that health impacts can be significant and include thyroid disruption and immune suppression





Schwacke *et al.* 2011, *Proceedings of the Royal Society B.*
Kucklick *et al.* 2011, *Environmental Science & Technology.*
Balmer *et al.* 2011, *Science of the Total Environment.*

Restoration Concerns

- Not conducted in a coordinated ecosystem-based approach
  - Who is responsible? NOAA Fisheries, NOAA Restoration Center, EPA, State
- Failure to use place specific restoration
  - Pervasive use of "One size fits all" approaches
  - Upland creeks – control & restore watet budget and runoff volume
  - Salt marsh creeks – restore & protect tidal hydrology

Future Directions

- Creek classification system acceptable to regulatory and scientific community
  - First step toward place-based ecosystem management
- Standardized forecasting tools for predicting runoff and pollution loadings
  - Available via web & relatively simple
  - Training
- More inclusive monitoring of tidal creek waters
  - Abundance of creeks by class

Tidal Creeks Project

Unraveling Tidal Creek Mysteries

- Tidal creek ecosystems are complex places.
  - Biogeochemical transformations & processes
  - Food webs
- Spatial variability is great.
  - May exceed temporal variability
  - Continuum from headwaters to mouth
- Understanding the water budget is critical
  - Loadings
- Classification framework is required to understand complexity.

Save & Restore Our Creeks

- "Save The Bay" is the rallying cry for the Chesapeake Bay and has maintained public and political support for over 30 years.
- We need a slogan and public information campaign that inspires public and political support.
  - SE: Land of Tidal Creeks
  - Save our Creeks
  - Save and Restore Our Creeks before we are up the creek!