

Understanding Ecological Flows in Coastal Plain Systems and Implications for Downstream Needs

February 16, 2016

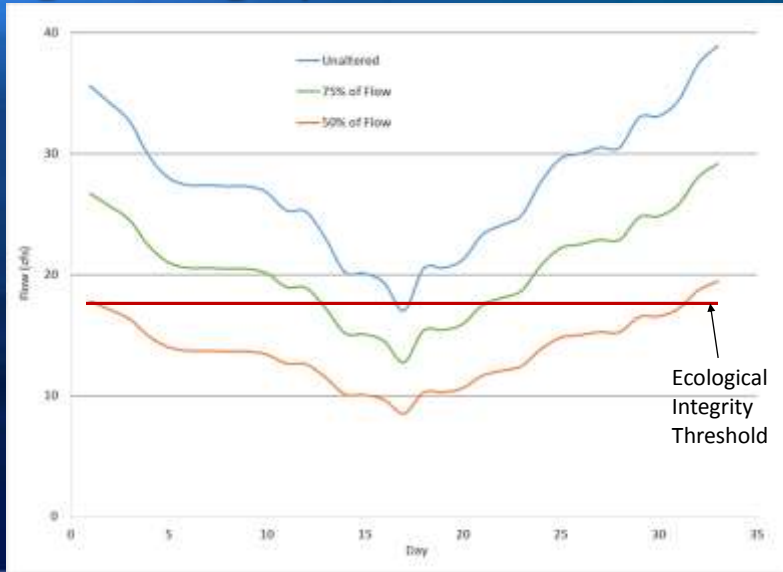
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Defining Ecological Flows

- Various definitions
 - Environmental Flows
- NC Legislation defined **ecological flows**
 - “the stream flow necessary to protect ecological integrity” – S.L 2010-143



Allowable withdrawal while protecting Ecological Integrity



Ecological Flows Science Advisory Board (EFSAB) (2010-2013)

- Help NC DENR with planning efforts on water flow modifications and impact.
- Provide advice on ways to use “ecological flows” in planning of future withdrawals
- Recommended ways to determine if future projected water modifications warrant further assessment



Overview of EFSAB activities

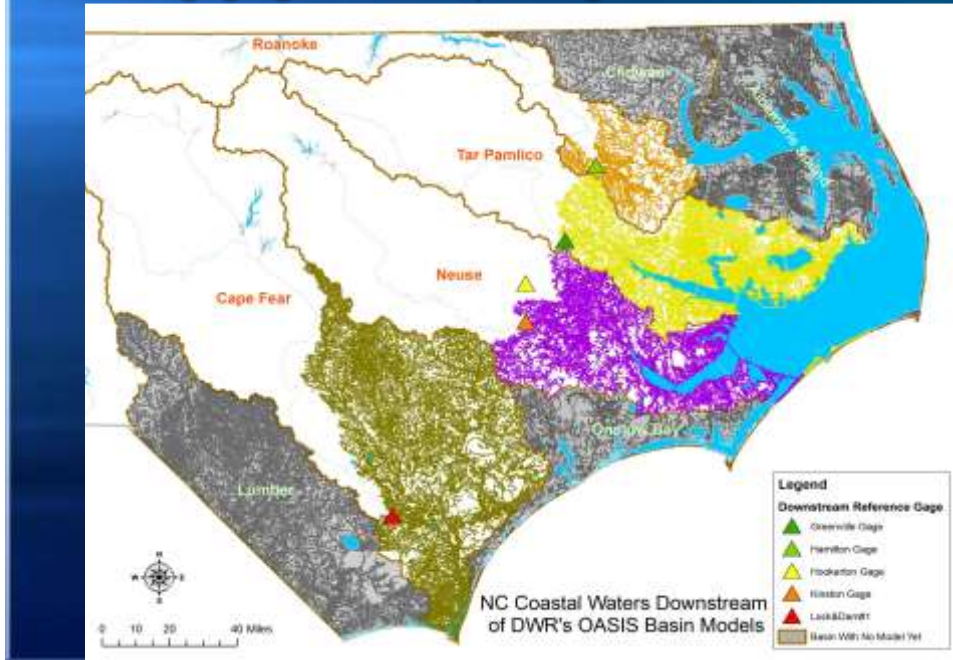
- Approaches by other states – often % flow criteria
- Stream classification – weak associations with ecology
limited basin-level distinctions
- Flow vs habitat relationships – limited opportunities
- Flow Related Indices of Community Structure – statistical support acceptable
- Hydrological models – basis for future conditions

● Two Recommended Approaches

- Percentage-of-flow strategy
- Biological-response strategy

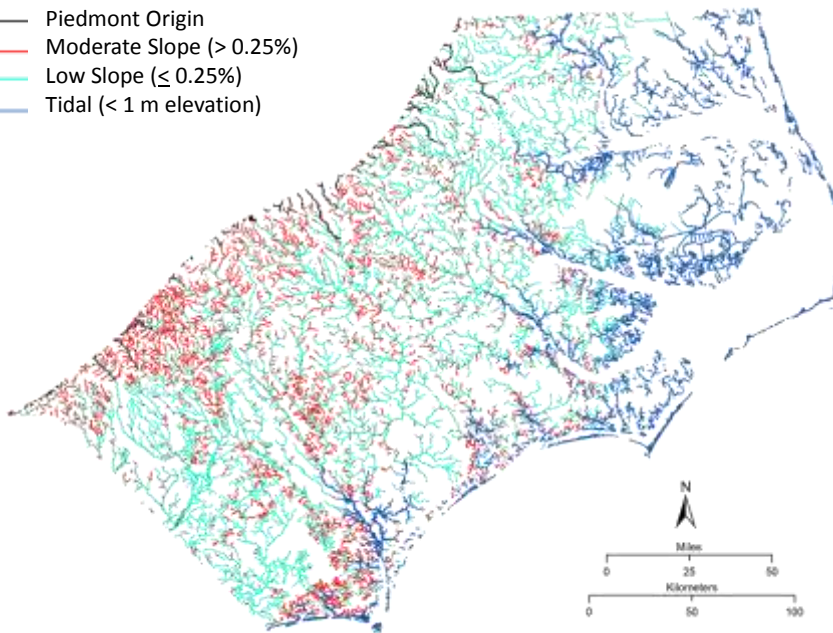


Without gaging stations hydrological models fail



Reach Classification

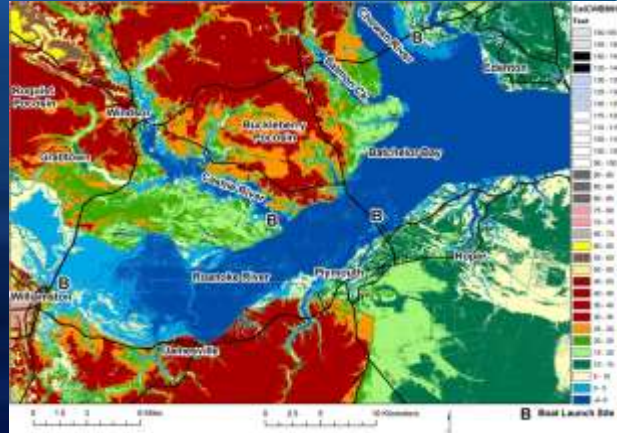
- Piedmont Origin
- Moderate Slope ($> 0.25\%$)
- Low Slope ($\leq 0.25\%$)
- Tidal (< 1 m elevation)



Eban Bean and Mike Griffin

Hydrogeomorphology: FLAT

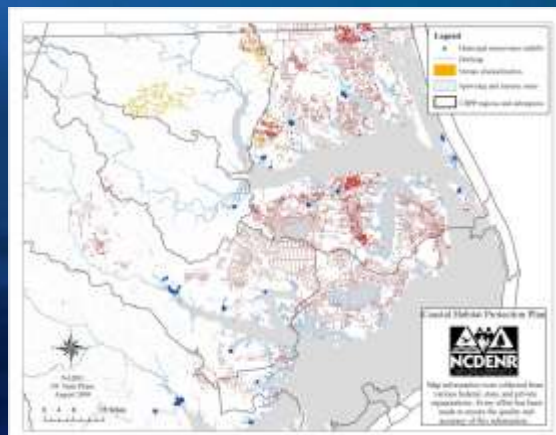
- Topographic relief makes watershed designations difficult
 - Difficult to Model Flows
- High connectivity with adjacent wetlands
- Reverse Flow
 - Backflow from larger rivers during high flows



From Riggs and Ames

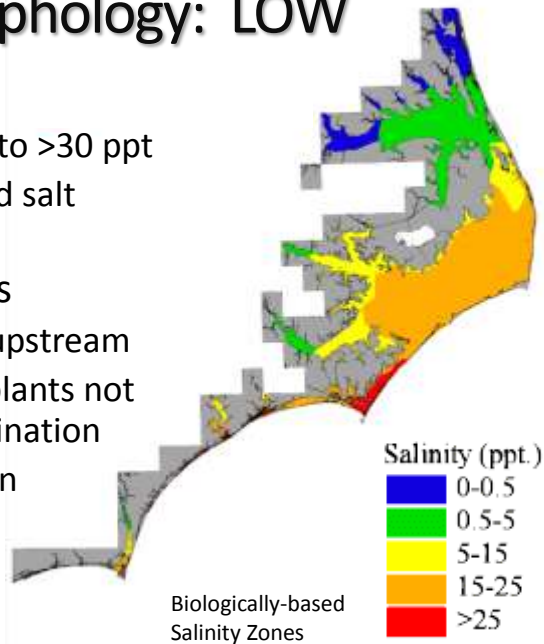
Hydrogeomorphology: FLAT

- Natural Flow is SLOW
- Human Alterations Dominate
 - Obstructions, Dams, & Culverts
 - Agricultural Ditching
 - Road Side Ditching
 - Channelization
 - Navigational Dredging



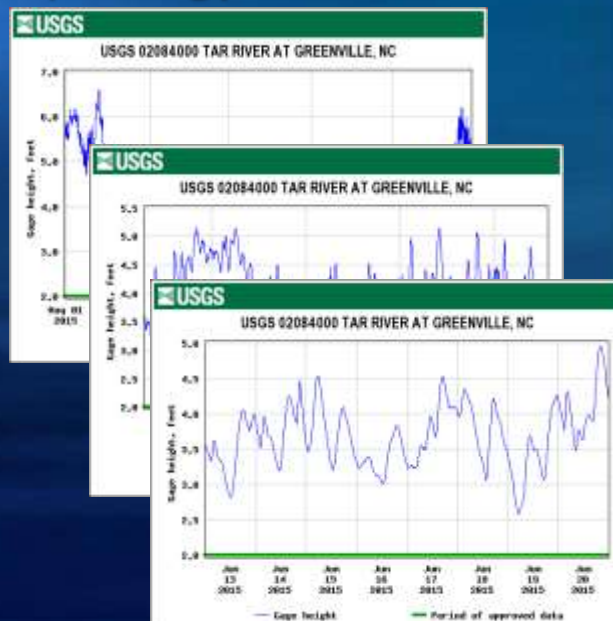
Hydrogeomorphology: LOW

- Salinity
 - May range from 0 to >30 ppt
 - Transition zone and salt wedge position
- Withdrawal Impacts
 - Migrate salinities upstream
 - Water treatment plants not designed for desalination
 - Salt-water intrusion



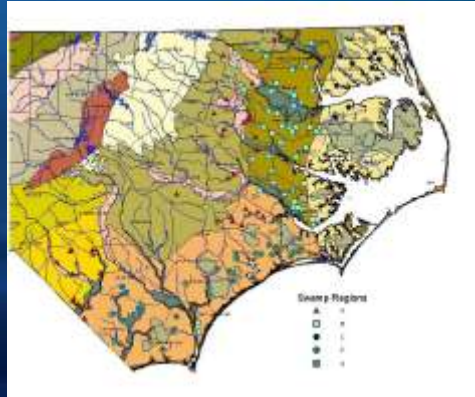
Hydrogeomorphology: LOW

- Tidal effect can extend far inland
 - Lunar
 - Wind
- Difficult to Model Flow
- Tidal Fresh Water Streams



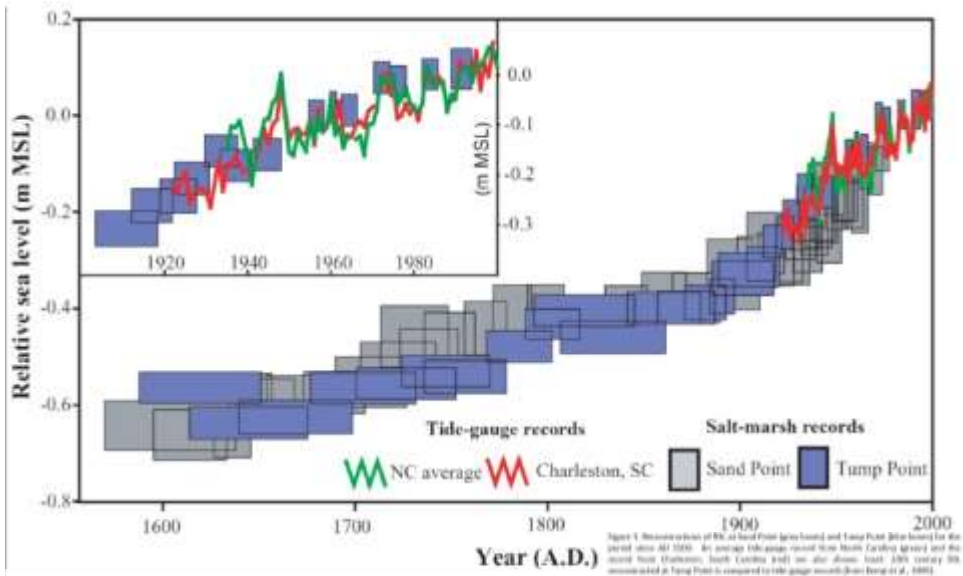
Ecology

- Unique Ecology
 - Swamp/Black Waters
 - Tidal Fresh Waters
 - Sensitivity to Salinity Duration and Levels
- Separate IBI program for coastal plain streams
- Limited information on impact of altered flow regime on ecology
 - Fish - Some require Fisheries Management Plans involving Flows
 - Benthic Macroinvertebrates



Ecology

- Species are often different than those found in inland waters or have different ecology from inland species.
- Anadromous fish (upstream spawning)
 - Blueback herring and alewife (under consideration for endangered status)
 - American shad
 - Atlantic sturgeon (endangered)
 - Shortnose sturgeon (endangered)
 - Striped bass (stock status – concern)
- Catadromous fish (marine spawning)
 - American Eel (Stock status – depleted)
- Common Low-Salinity Estuarine Species in Rivers
 - Southern Flounder
 - Atlantic Croaker
 - Spot
 - Menhaden
 - Bay Anchovy
 - Blue Crab
 - White Shrimp
 - Striped Mullet



- Sensitivity to sea-level rise
- Salty and brackish water move upstream
- Tidal influence moves upstream

Challenges of Coastal Waterways

- Hydrogeomorphological issues influence and hinder conventional modeling
- Unique ecology influencing selection of ecological integrity parameters
- Kinds of water withdrawals
- All of these contribute to the challenge of applying procedures from inland to the coastal plain.
- Creation of Coastal Plain Eco-Flows Work Group to assist with EFSAB
 - APNEP Workgroup



Limited Missing

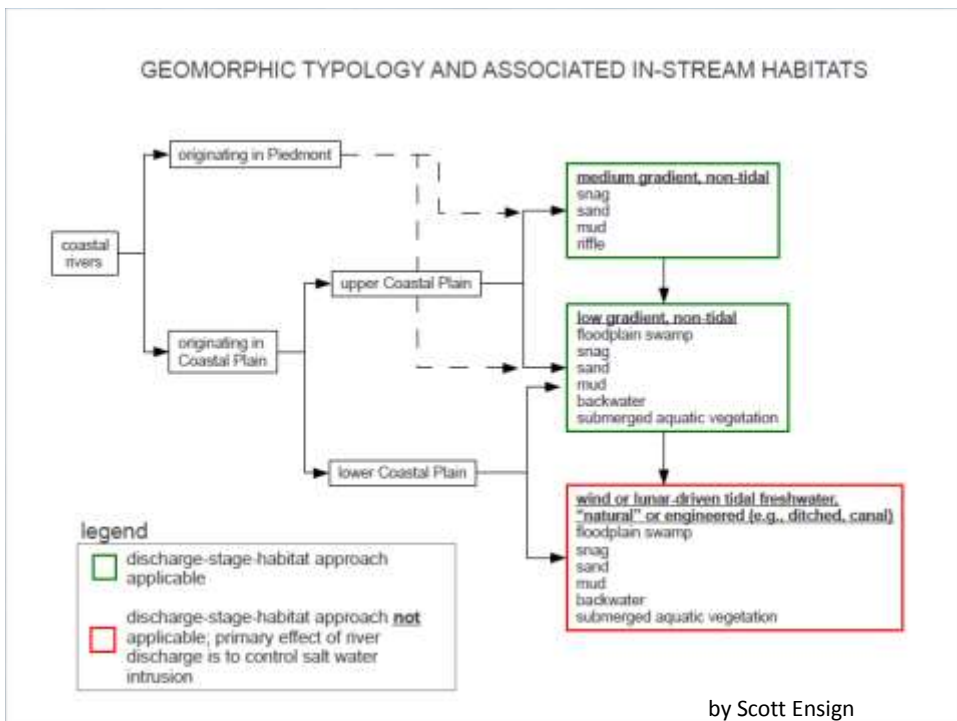
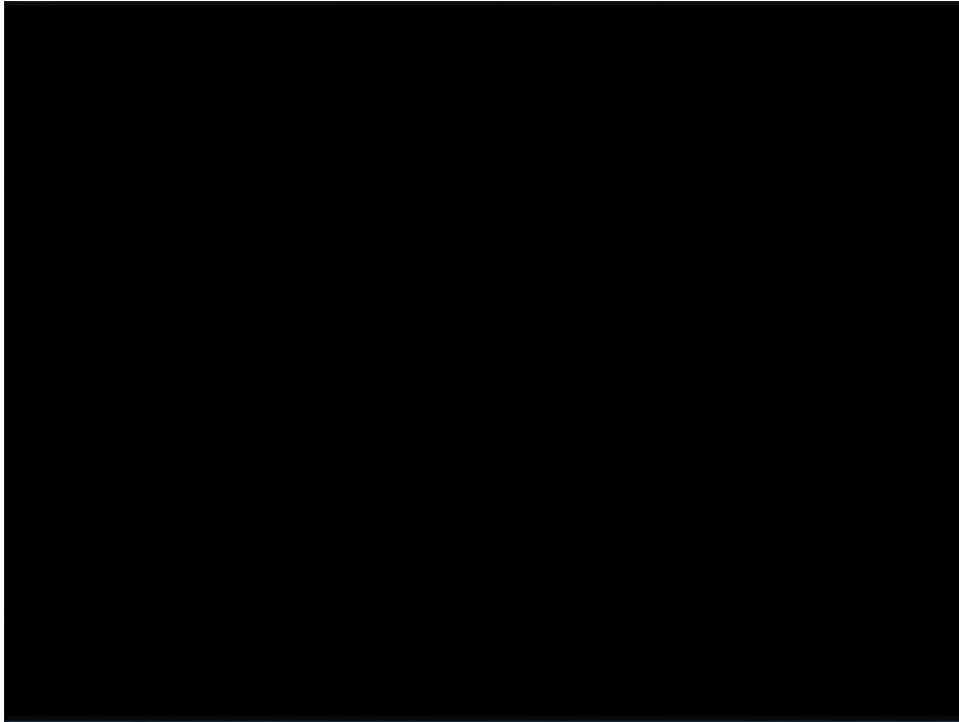
Absent Uncoordinated

DATA

Infrequent Sparse

Costly Scattered





Waterway Categories and Key Assemblages

Origin	Slope	Assemblage		
		Anadromous Fish	Resident fish	Vegetation (Foundation species)
Piedmont	Medium gradient	X		
Upper Coastal Plain	Medium gradient	X		
Upper Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Wind or tidal driven flow		X	X

Link of Stream Typology & Potential EF Determination

Origin	Slope	EF determinant			
		EFSAB extension	Discharge & Habitat	Downstream Salinity	Overbank Flow
Piedmont	Medium gradient	X	X	X	
Coastal Plain	Medium gradient	X	X	X	
Coastal Plain	Low gradient		X	X	X
Coastal Plain	Wind or tidal driven flow			X	X