Coastal Systems and Issues Associated with Them

Bob Christian

Three overarching concerns that may challenge application of approaches to coastal plain:

- Hydrogeomorphological issues influencing modeling
- Ecological issues influencing choice of ecological integrity choices
- Kinds of water withdrawals

Hydrogeomorphology: the area is flat!!

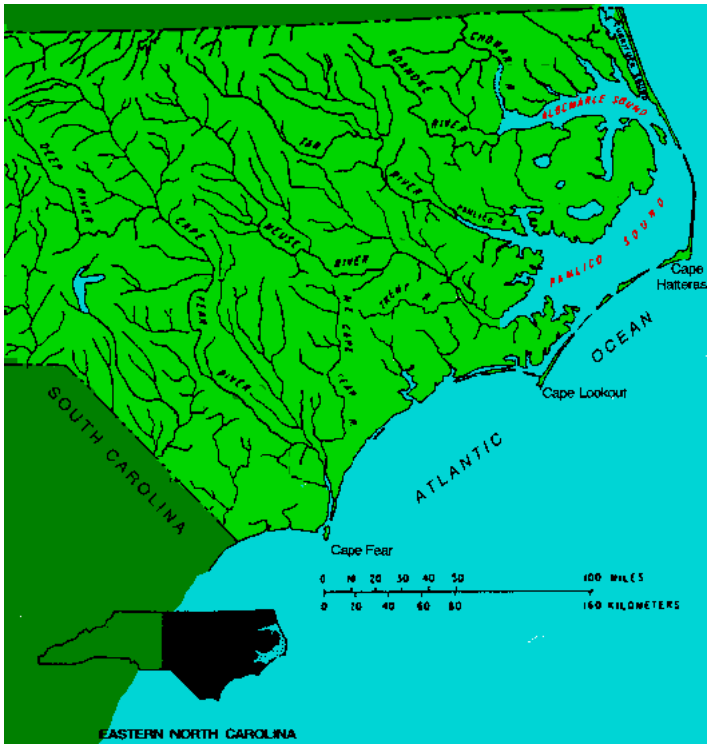
- Topographic relief makes watershed designations difficult

Hydrogeomorphology: the area is flat!!

- Slope is low
  - Flow often not high enough to move heavy material and scour
    - Riffle and pool structure with rocks less common
    - Bottom often muddier

Hydrogeomorphology: the area is flat!!

- **Reverse flow is common**
  - Tidal action
    - Significant geographic differences in tidal influence
      - » Northeast within and behind sounds – wind dominated
        - Slow frequencies, irregular and long durations
      - » Southeast – astronomically dominated
        - Short frequencies and regular
      - » A spectrum of possibilities between end-members
  - Backflow from larger rivers during high flows

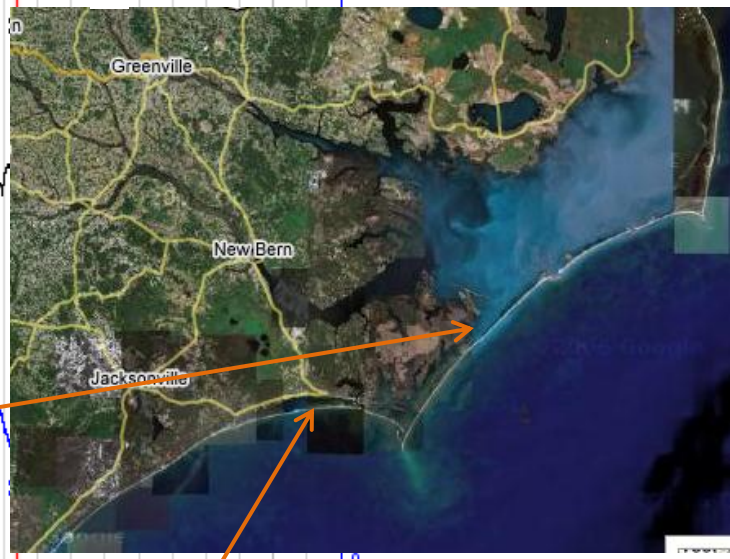


Tides

Water levels: LOLA

tidal range: ~8 cm

23%



Water levels: PKS

tidal range: ~60 cm

59%

Harmonic analysis by J.T. Morris
From Voss 2009

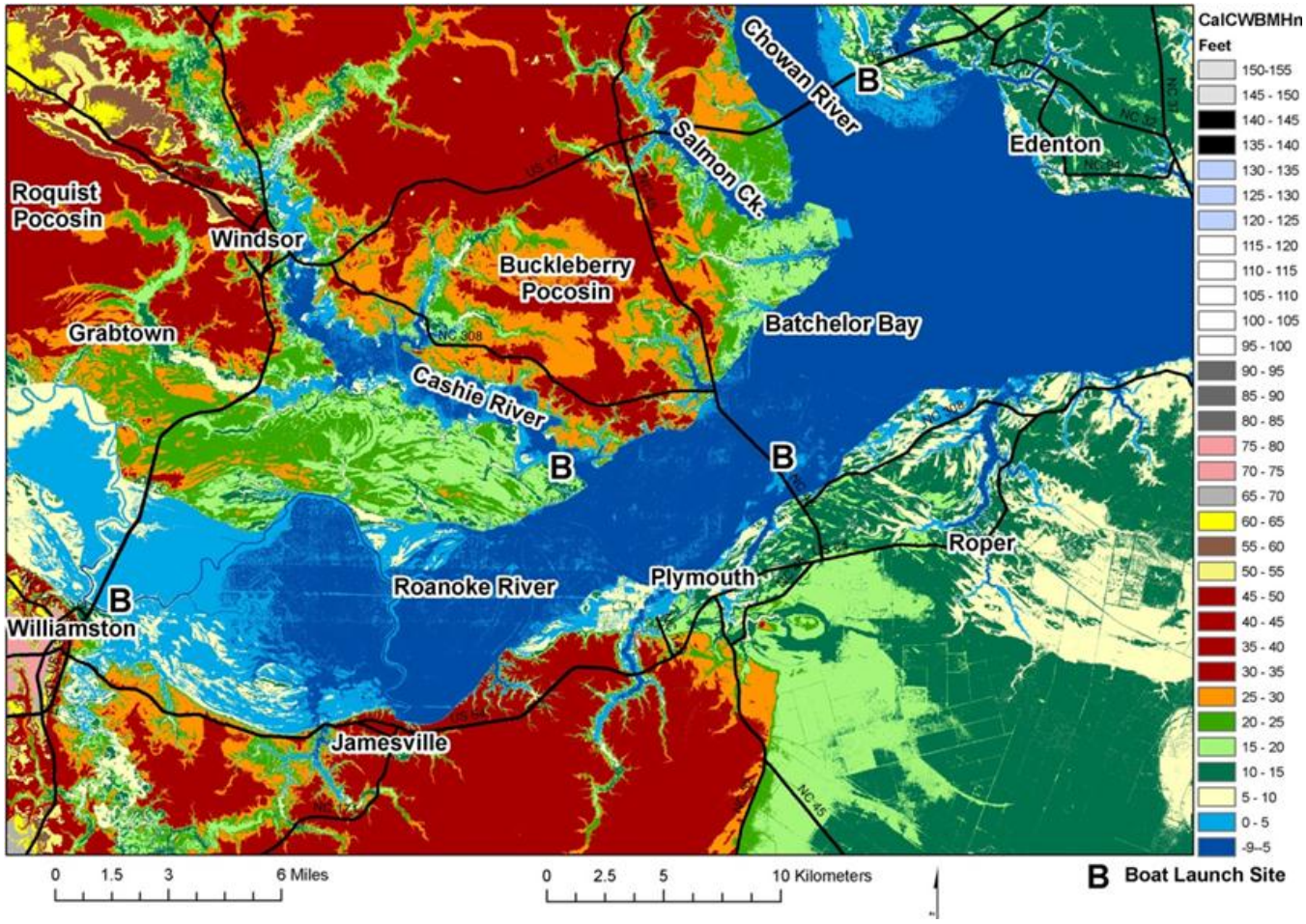
Temp, °C
Water Level, meters
Coupler Detached
Coupler Attached
End Of File
Logged
12/22/2006 16:47:17

°C

meters

Hydrogeomorphology: the area is flat!!

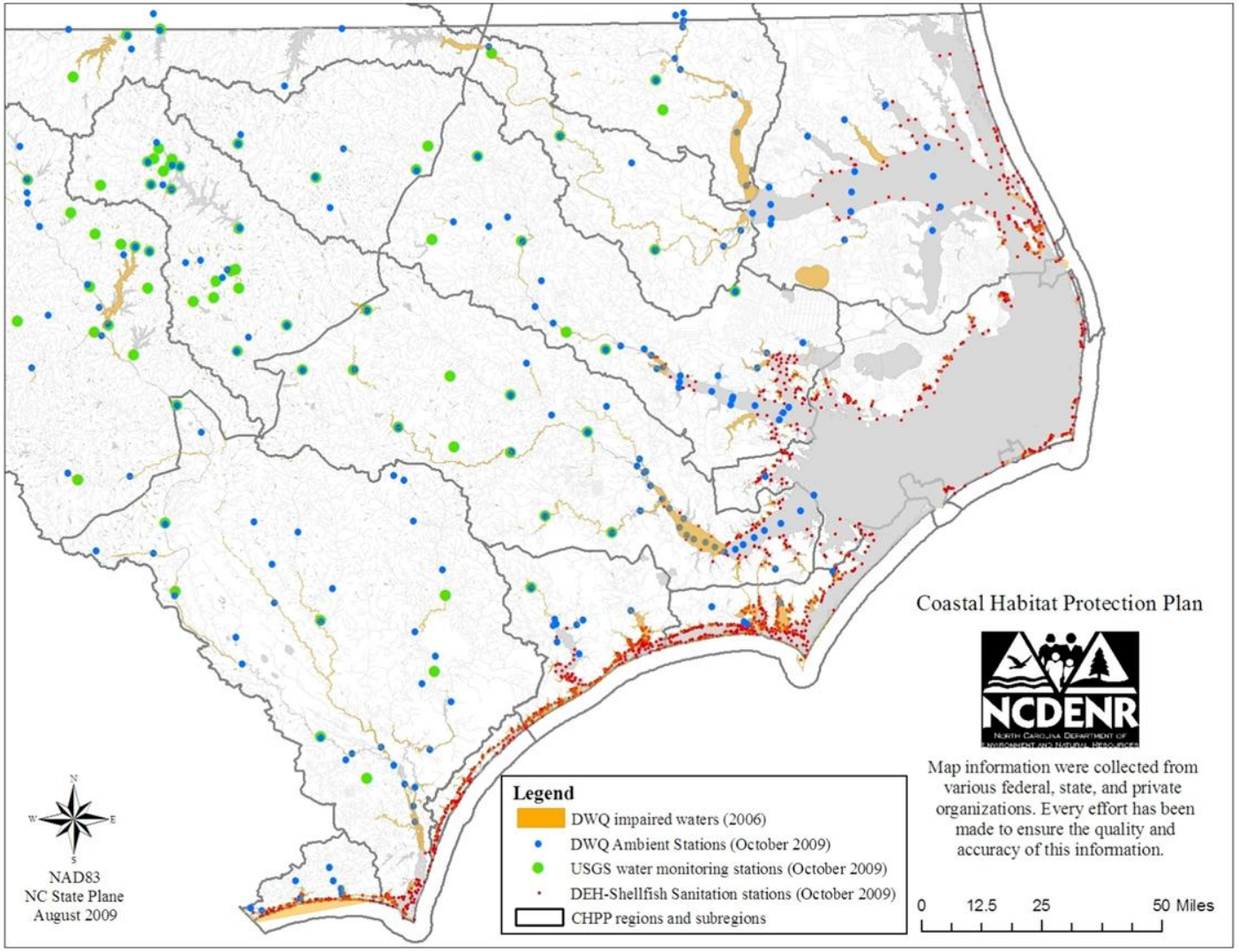
– High connectivity with adjacent wetlands
  - Overbank flow can increase cross sectional area and volume significantly



From Riggs and Ames

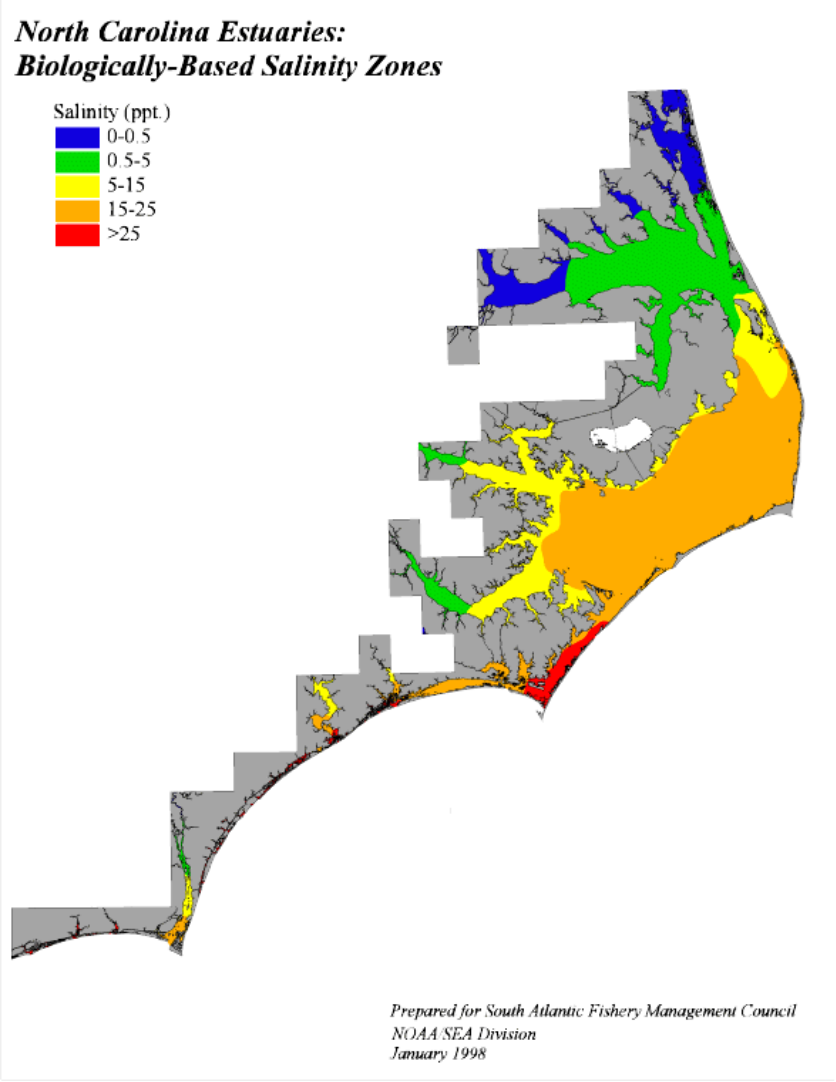
Hydrogeomorphology: the area is low!!

- Gaging stations are limited



Hydrogeomorphology: the area is low!!

- Salinity
  - May range from 0 to >30
  - May be affected by water use



Hydrogeomorphology: the area is low!!

- Sensitivity to sea-level rise

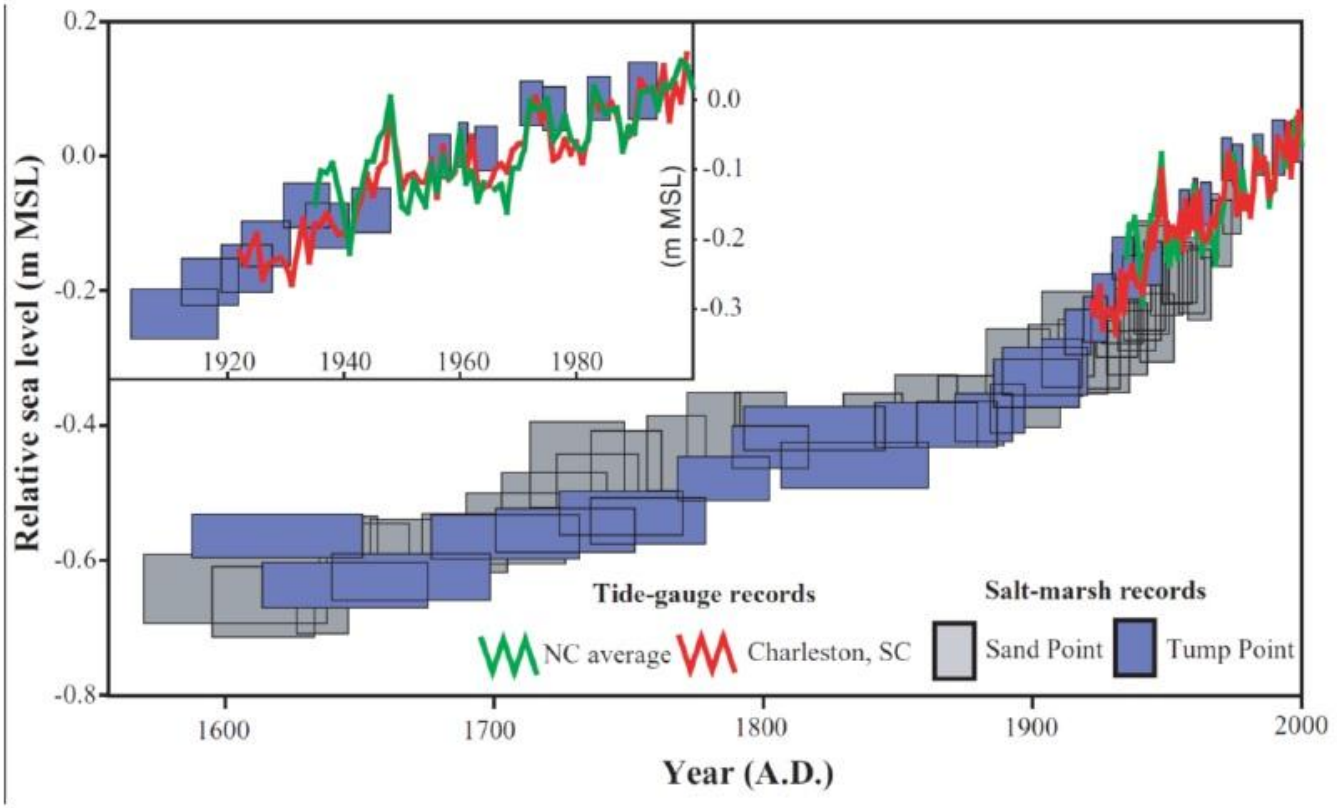
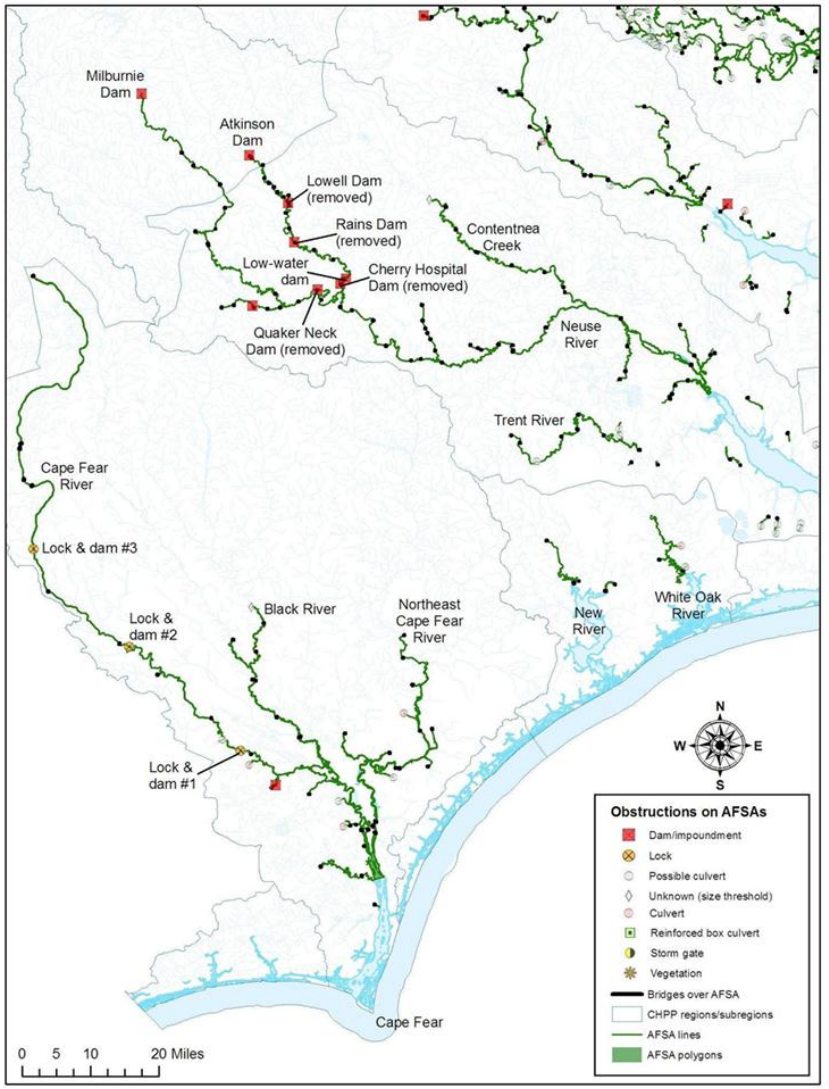
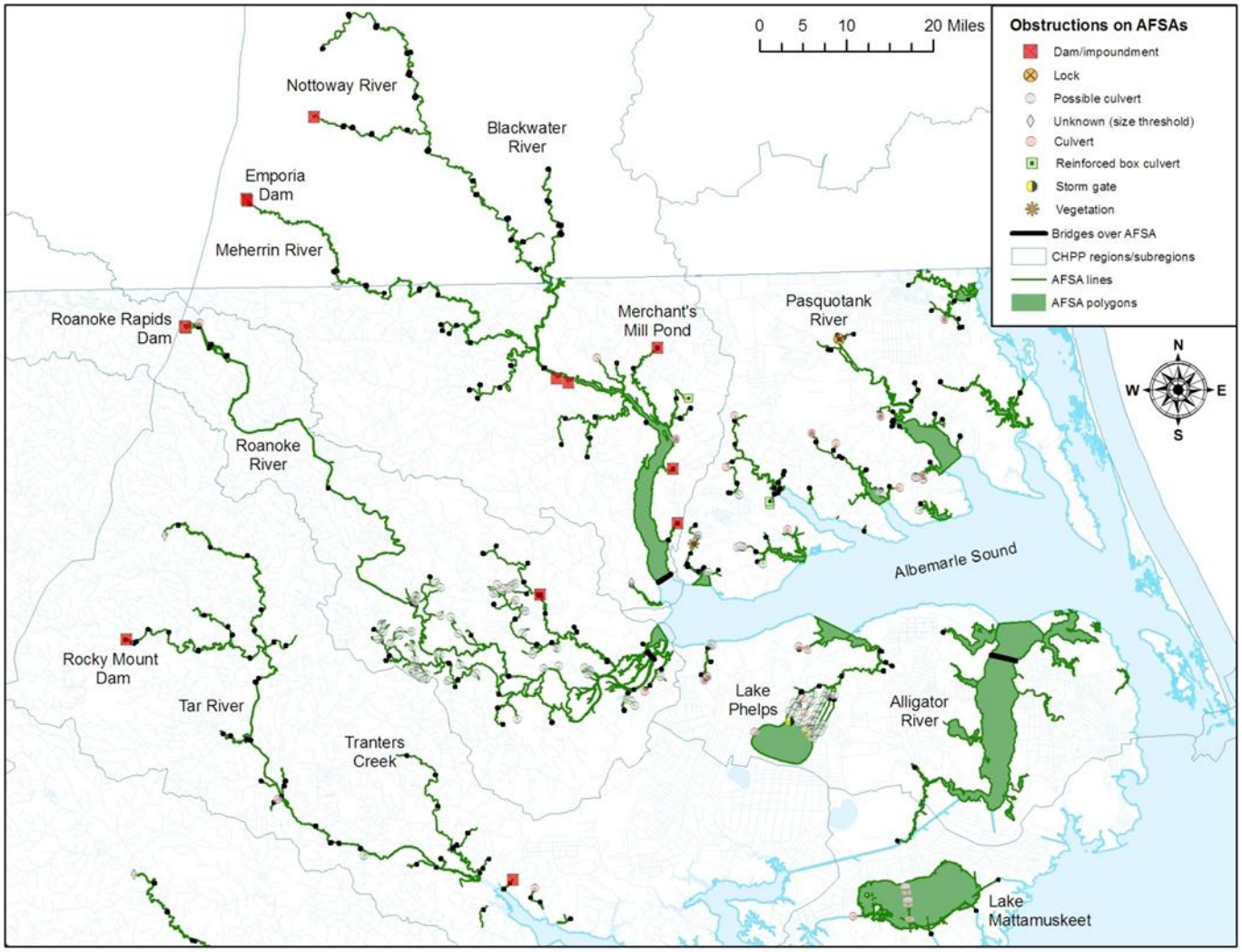


Figure 1. Reconstructions of RSL at Sand Point (grey boxes) and Tump Point (blue boxes) for the period since AD 1500. An average tide-gauge record from North Carolina (green) and the record from Charleston, South Carolina (red) are also shown. Inset: 20th century RSL reconstructed at Tump Point is compared to tide-gauge records (from Kemp et al., 2009).

Human alterations dominate

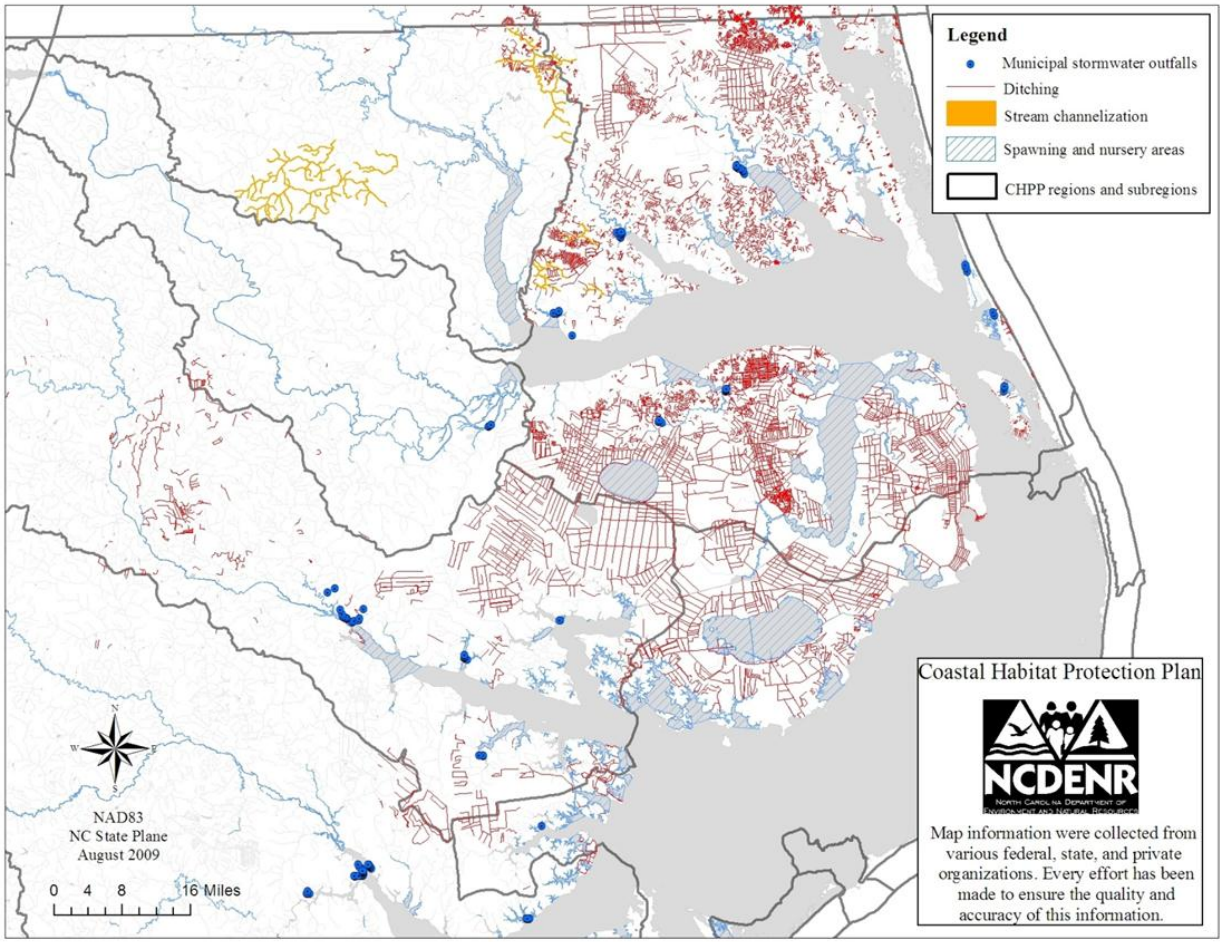
- Obstructions – dams, culverts – block fish passage and alter flows
- Channelization
- Agricultural ditching
- Road side ditching
- Desnagging/Snagging
- Navigational dredging




0 5 10 20 Miles
Obstructions on AFSAs
Dam/impoundment
Lock
Possible culvert
Unknown (size threshold)
Culvert
Reinforced box culvert
Storm gate
Vegetation
Bridges over AFSA
CHPP regions/subregions
AFSA lines
AFSA polygons
N
W
E
S
Nottoway River
Blackwater River
Emporia Dam
Meherrin River
Roanoke Rapids Dam
Roanoke River
Merchant's Mill Pond
Pasquotank River
Albemarle Sound
Rocky Mount Dam
Tar River
Tranters Creek
Lake Phelps
Alligator River
Lake Mattamuskeet

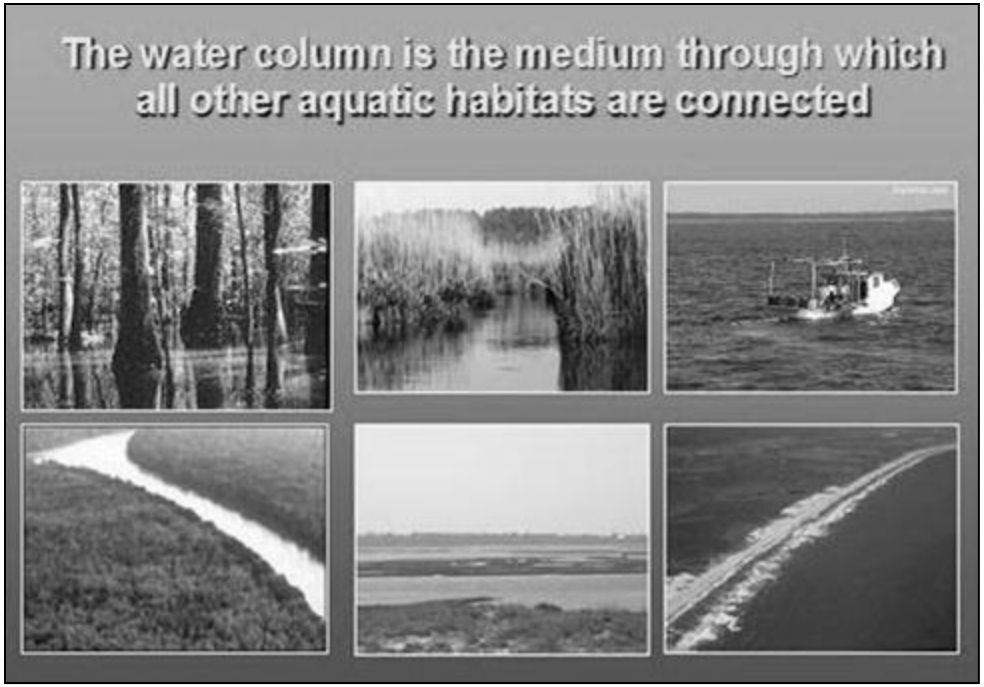
Human alterations dominate

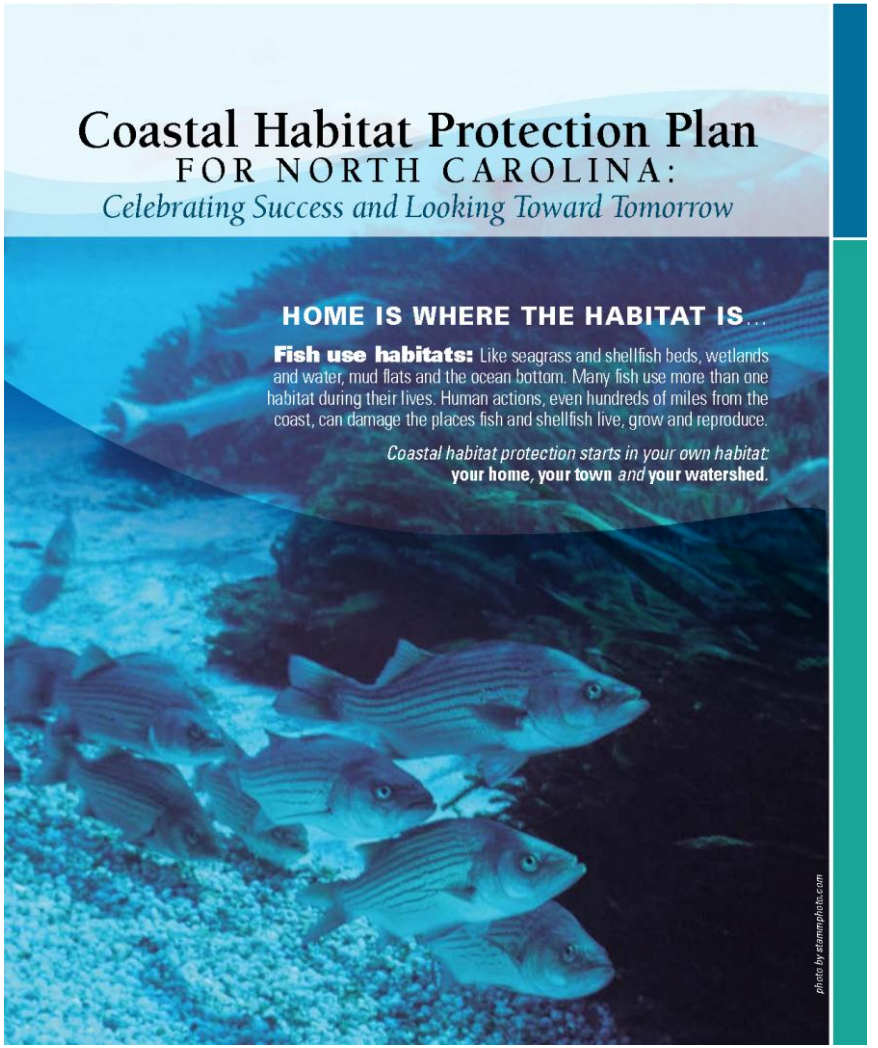
- Agricultural ditching
- Road side ditching
- Channelization
- Snagging
- Navigational dredging



Ecology

- Established habitat-based foundation through the Coastal Habitat Protection Plan (CHPP) developed by NC DMF
  - Habitats germane to EFSAB





Ecology

- Species are often different than those found in inland waters or having different ecology from that inland.
  - Examples (Some require Fisheries Management Plans involving flows)
    - 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)- eel – (stock status - depleted)
    - Estuarine species – some of the common low-salinity species that occur in river systems: southern flounder, Atlantic croaker, spot, menhaden, bay anchovy, blue crab, white shrimp, striped mullet

Spawning Location and timing are major factors in categorizing species

Species	Winter			Spring			Summer			Fall		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ANADROMOUS FISH												
Alewife		■	■	■	■							
American shad			■	■	■	■						
Blueback herring			■	■	■							
Striped bass			■	■	■	■						
ESTUARINE AND INLET SPAWNING AND NURSERY												
Atlantic silversides			▨	▨	▨	▨						
Bay anchovy				▨	▨	▨	▨	▨	▨	▨		
Bay scallop			▨	▨					▨	■	■	▨
Blue crab				■	■	■	▨	■	■			
Black drum				▨								
Cobia					▨	▨	▨	▨				
Hard clam					▨	▨	▨	▨	▨	▨		
Inland silversides			▨	▨	▨	▨	▨	▨	▨			
Oyster					▨	▨	▨	▨	▨	▨		
Red drum								▨	▨			
Spotted seatrout				▨	▨	▨	■	▨	▨			
Weakfish				▨	■	■	▨	▨	▨			
MARINE SPAWNING, LOW-HIGH SALINITY NURSERY												
Atlantic croaker	▨	▨	▨	▨	▨				▨	■	▨	▨
Atlantic menhaden	■	▨	▨								▨	■
Brown shrimp		■	■	▨						▨	▨	
Southern flounder	■	■	▨								▨	▨
Spot	■	▨									▨	■
Striped mullet	▨	▨	▨							■	■	▨
White shrimp					▨	■	▨					
MARINE SPAWNING, HIGH SALINITY NURSERY												
Black sea bass	▨	▨	■	■	■	▨						
Bluefish			▨	▨	▨	▨	▨	▨	▨	▨	▨	
Gag		■	■									
Gulf flounder	▨	▨									▨	▨
King mackerel						▨	▨	▨	▨			
Pinfish	▨	▨	▨							▨	▨	▨
Pink shrimp				▨	▨	▨	▨					
Sheepshead			▨	▨	▨							
Spanish mackerel					▨	▨	▨	▨	▨			
Southern kingfish				▨	▨	▨	▨	▨	▨			
Summer flounder	■	▨	▨								▨	■

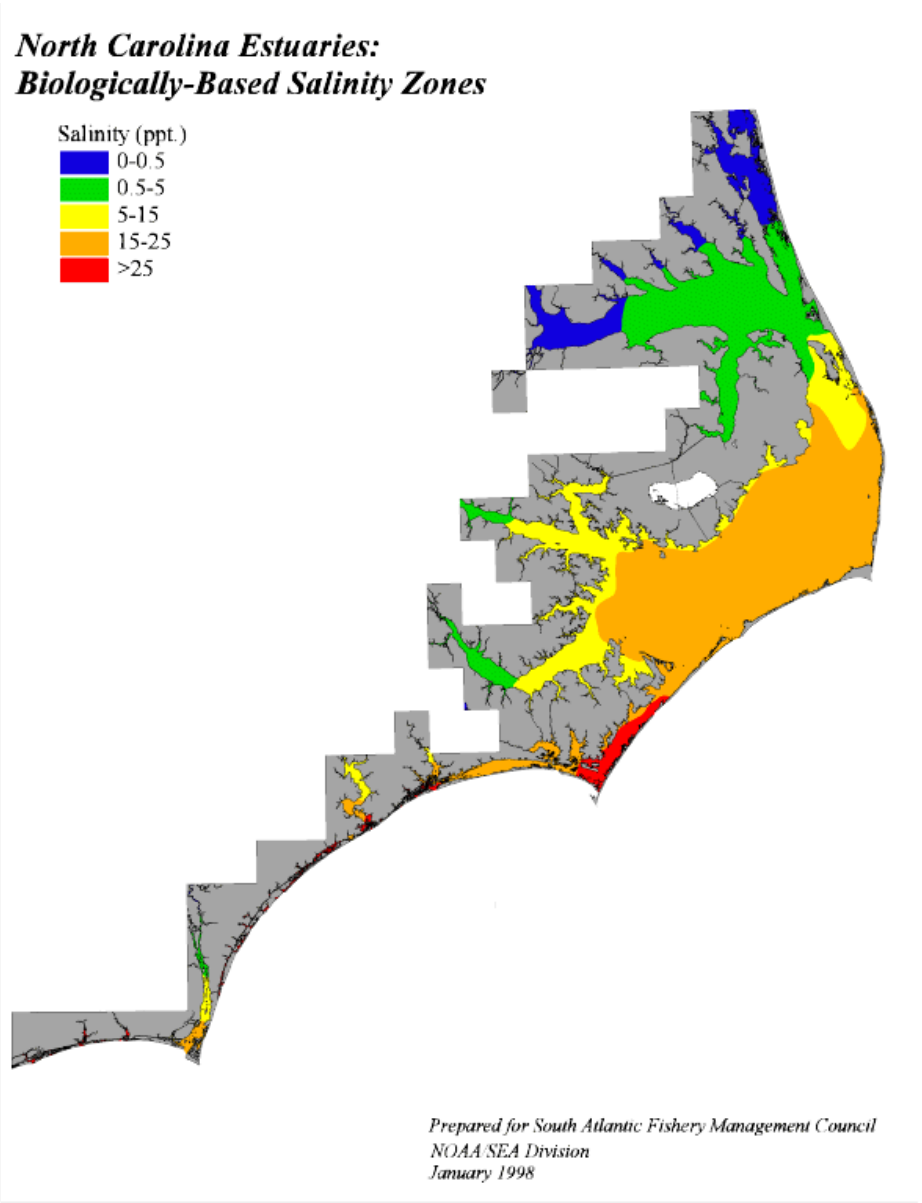
Black squares indicate peak spawning. **Cross-hatched** squares indicate spawning period.

Table 2.19. MFC and WRC fish habitat designations in CHPP management regions. Note: the area of PNA, Permanent SNA, and IPNA does not include tidal areas between the mean high water (or normal water level) and the apparent shoreline (i.e., wetland edge). The miles of AFSA includes both streams and shorelines.

Phys. region	CHPP region	PNA (acres)	PSNA (acres)	IPNA (acres)	AFSA (miles)	AFSA (acres)
Coastal Plains	1	166	168	16,269	2,413	153,894
	2	12,166	46,875	8,985	1,450	49,995
	3	14,557	0	700	101	829
	4	14,786	292	4,391	821	13,491
Piedmont	1	0	0	303	0	2
	2	0	0	0	55	375
	4	0	0	634	0	0
TOTAL	ALL	41,675	47,336	31,283	4,840	218,586

Ecology

- Some portions of coastal rivers (oligo-mesohaline) support greater species richness than polyhaline and freshwater due to overlapping ranges, seasonal variations in salinity, but will vary naturally due to environmental conditions and seasonality.



Physical factors and flow influencing select species

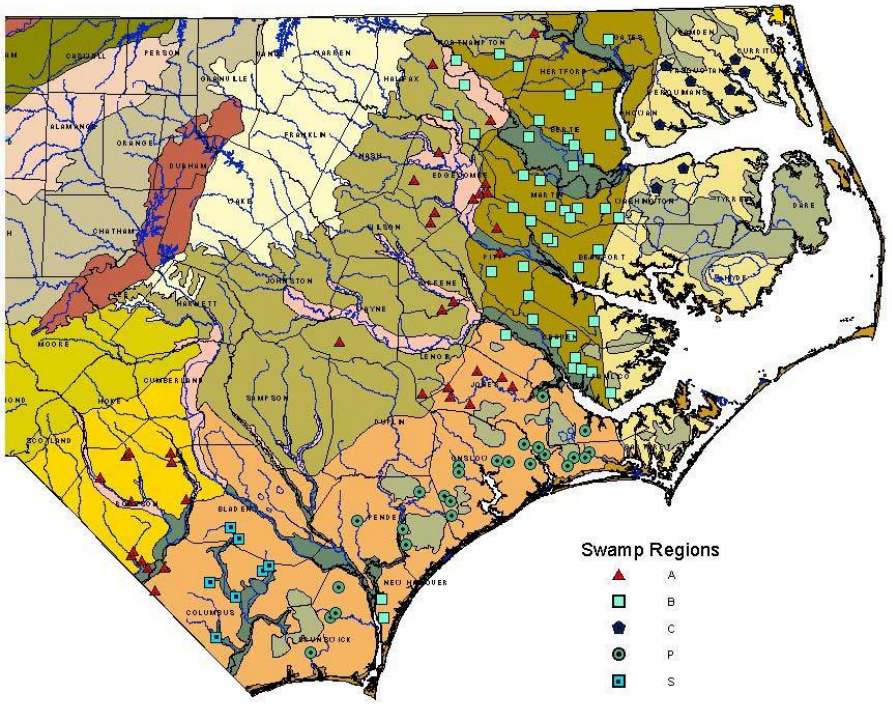
Table 2.4. Physical spawning (adult) and egg development requirements for resident freshwater and anadromous fishes inhabiting coastal North Carolina.

Species	Salinity (ppt)		Temperature (C)		Dissolved oxygen (mg/l)		Flow (cm/s)	Other parameters
	Adult	Spawn/ Egg	Adult	Spawn/ Egg	Adult	Spawn/ Egg	Spawning	Spawn/ Egg
Alewife	[S] 0-5	[S] 0-5 [O] 0-2		[S] 11-28 [O] 17-21	[S] >3.6	[S] >4	**[O] slow current**	[S] Suspended solids <1000 mg/l
American shad	[S] 0-18	[S] 0-18	[S] 10-30	[S] 13.0-26.0	[S] >5		**[S] 30-90**	
Blueback herring	[S] 0-5	[S] 0-22 [O] 0-2		[S] 14-26 [O] 20-24	[S] >5		**[O] strong current**	[S] Suspended solids <1000 mg/l
Striped bass	[S] 0-5	[S] 0.5-10	[S] 20-22	[S] 12-24, [O] ~18-22	[S] >5		**[S] 30.5-500, [O] 100-200**	
Yellow perch	[S] 0-13	[S] 0-2	[S] 6-30		[S] >5			[S] Suspended solids <1000 mg/l
White perch	[S] 5-18	[S] 0-2	[S] 10-30	[S] 12-20	[S] >5			[S] Suspended solids <100 mg/l
Sturgeon, Atlantic	[S] 0 to >30	[S] 0-5	[S] 0 to >30	[S] 11-20				
Sturgeon, Shortnose	[S] 0 to >30	[S] 0-5	[S] 0 to >30	[S] 5-15				

[S] = Suitable, and [O] = Optimum

Ecology

- DWQ has different programs for Index of Biotic Integrity for coastal plain streams.
  - Hydrogeomorphology (Very low flows, channel modifications, riparian zones, depth)
  - Biota
    - Fish
    - Benthic macroinvertebrates
      - » Swamp method
- I defer to Jay and Tom on details
- There is no estuarine IBI for coastal waters

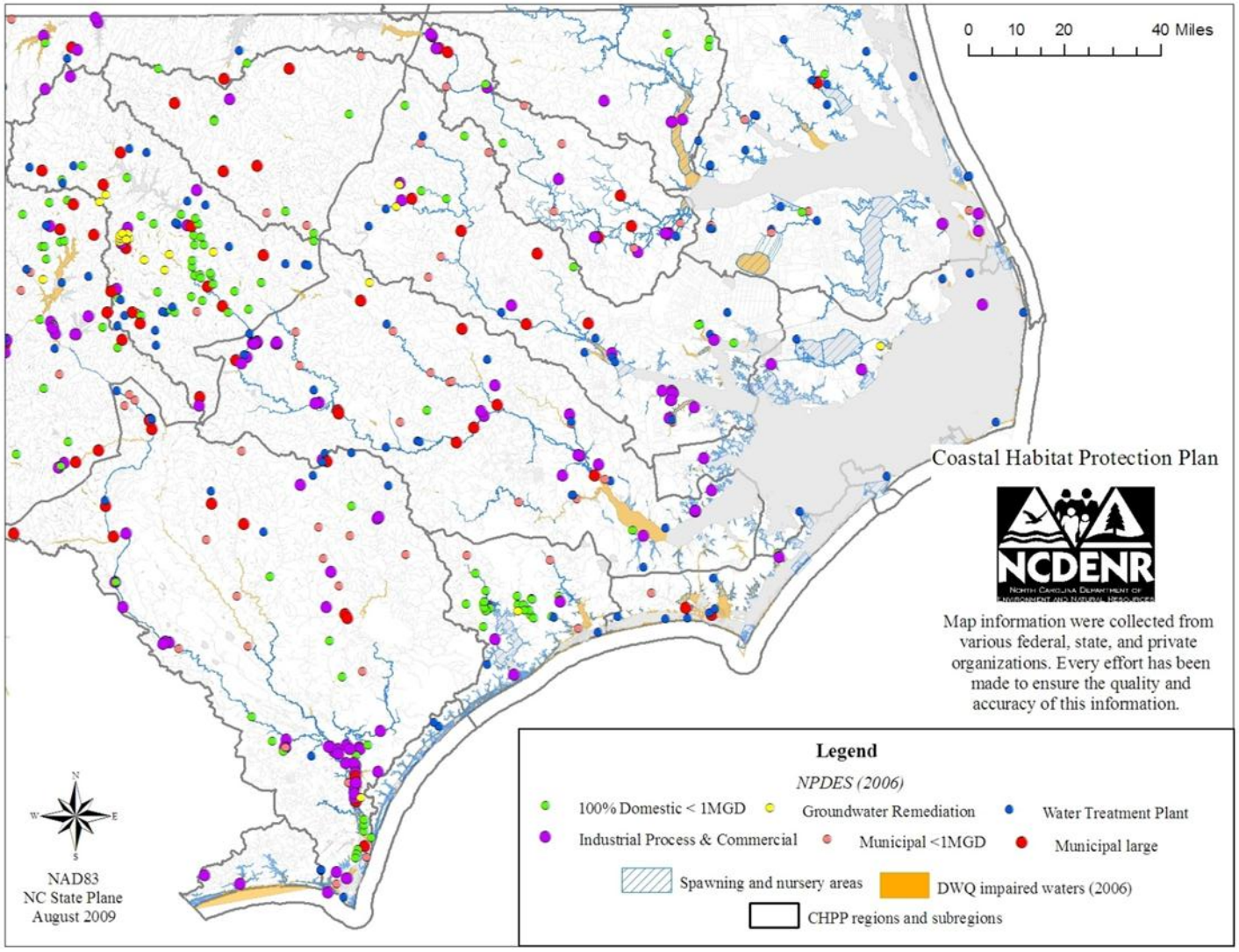


Ecology

– Wetlands and their services are inextricably linked to waterways

Kinds of water withdrawal issues

- Community water supply
  - Not necessarily based on surface withdrawal and reservoir use.
  - Groundwater and desalinization
  - Increasing demands with coastal population growth
- Non- community water supply
  - Mining
  - Agriculture
  - Industry (power plants)


0 10 20 40 Miles
Coastal Habitat Protection Plan
NCDENR
North Carolina Department of Environment and Natural Resources
Map information were collected from various federal, state, and private organizations. Every effort has been made to ensure the quality and accuracy of this information.
Legend
NPDES (2006)
100% Domestic < 1MGD
Groundwater Remediation
Water Treatment Plant
Industrial Process & Commercial
Municipal <1MGD
Municipal large
Spawning and nursery areas
DWQ impaired waters (2006)
CHPP regions and subregions
N
W
E
S
NAD83
NC State Plane
August 2009

Summary

- Coastal plain waterways are potentially different in numerous ways:
  - Hydrogeomorphological issues influencing modeling
  - Ecological issues influencing choice of ecological integrity choices
  - Kinds of water withdrawals

- All of these contribute to the challenge of applying procedures from inland to the coastal plain.

- I’ve described some of the problems. Can we find solutions?