Habitat and Water Quality Considerations for Southern Flounder

Martin Posey and Troy Alphin
UNC Wilmington

Students and collaborators

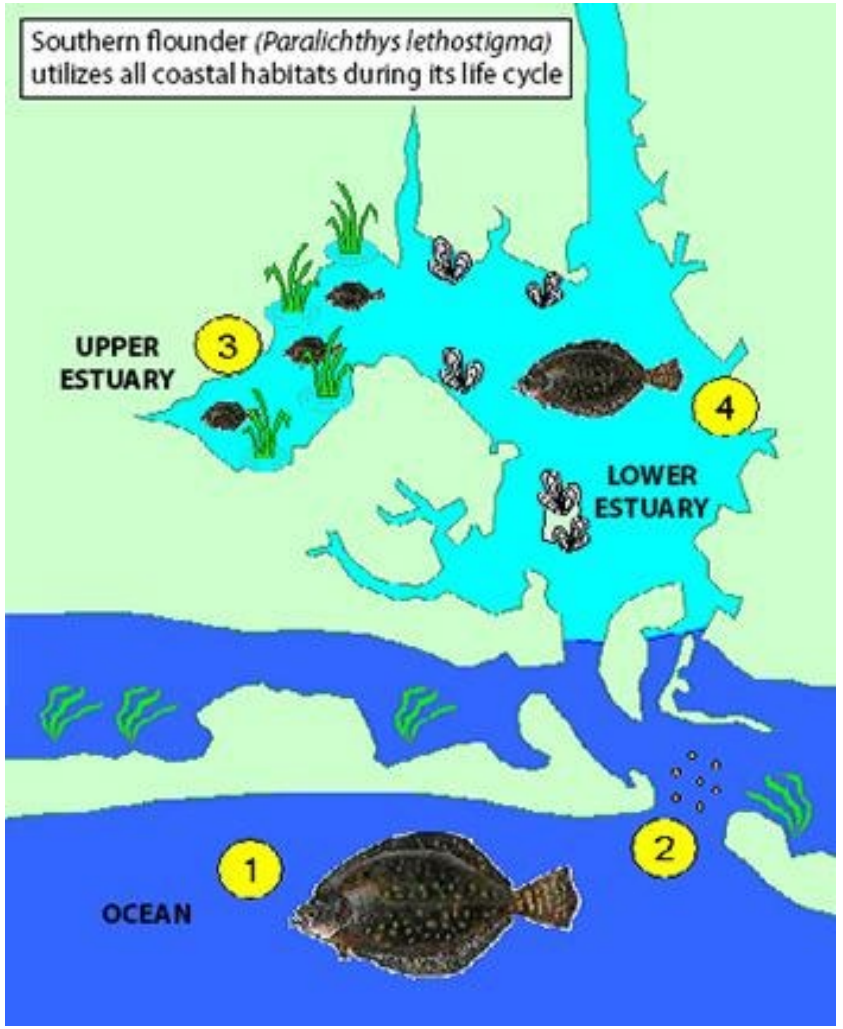
- Allison Lapinsky
- George Easterly
- Sam Shores
- Zachary Coyne
- Ed Arb
- Jocelyn Fifer
- Many others …

Funding

- US Army Corps of Engineers
- NC Sea Grant
- Lower Cape Fear River Program
- CRFL Program
- National Science Foundation

Quick reminder of lifecycle

- Ocean spawning
- Juveniles recruit into estuary in spring, generally into low salinity areas
  - Some will move into freshwater
  - Some may stay in low salinity estuarine areas
  - Transient between areas?
- Move down estuary as they mature



Importance of juveniles to fishery

- Today I will concentrate on juvenile southern flounder habitat use
  - Have basic understanding of adult habitat use until they leave the estuary
  - Juvenile habitat is less well understood
- Why juveniles?
  - Mortality and growth during juvenile stages can be an important contributing factor for adult populations / fisheries
    - Examples: blue crab, striped bass, others …
  - Susceptible to predation, sometimes more sensitive to environmental changes and extremes, food availability, other factors
  - Habitat and water quality can be important factors affecting juvenile survival
  - But specific critical habitat characteristics often difficult to determine
    - Sampling and other logistic challenges
    - Changes with growth
    - Understanding of scale - space and time

NC SeaGrant

Current understanding of southern flounder juvenile habitat

NCDEQ

NC Natural Heritage Program

NCDEQ

- Salinity relations
  - Migration into freshwater and low salinity areas as early juveniles
- Temperature and DO can affect general distribution
- Several studies suggest shallow water use, but some uncertainty as to degree
- Use of submerged vegetation where present
  - May use edge as opposed to center of dense meadows
  - Vallisneria, Milfoil, Hydrilla, etc. in freshwater,
  - Seagrasses in some more estuarine areas (e.g. Ruppia)
- Marsh creeks, areas with structural habitats; but turbidity a factor
- Substrate type – sand in some studies, finer sediments in others
- Food availability: mysids, polychaetas, small fish, amphipods and other small crustaceans, move to primarily fish diet as they grow. May vary with salinity.
- Recruitment may vary with hydrodynamic factors
- May vary strongly with scale

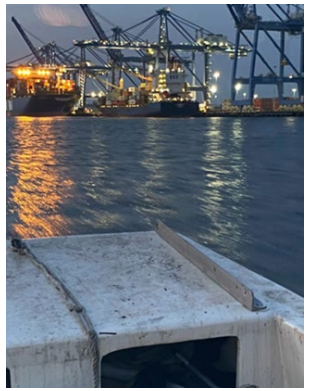


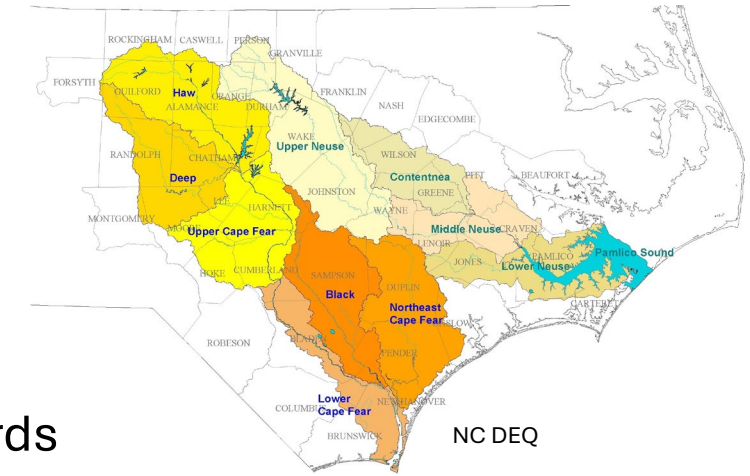
Table 1. Water quality parameter ranges and habitats associated with different life stages of southern flounder.

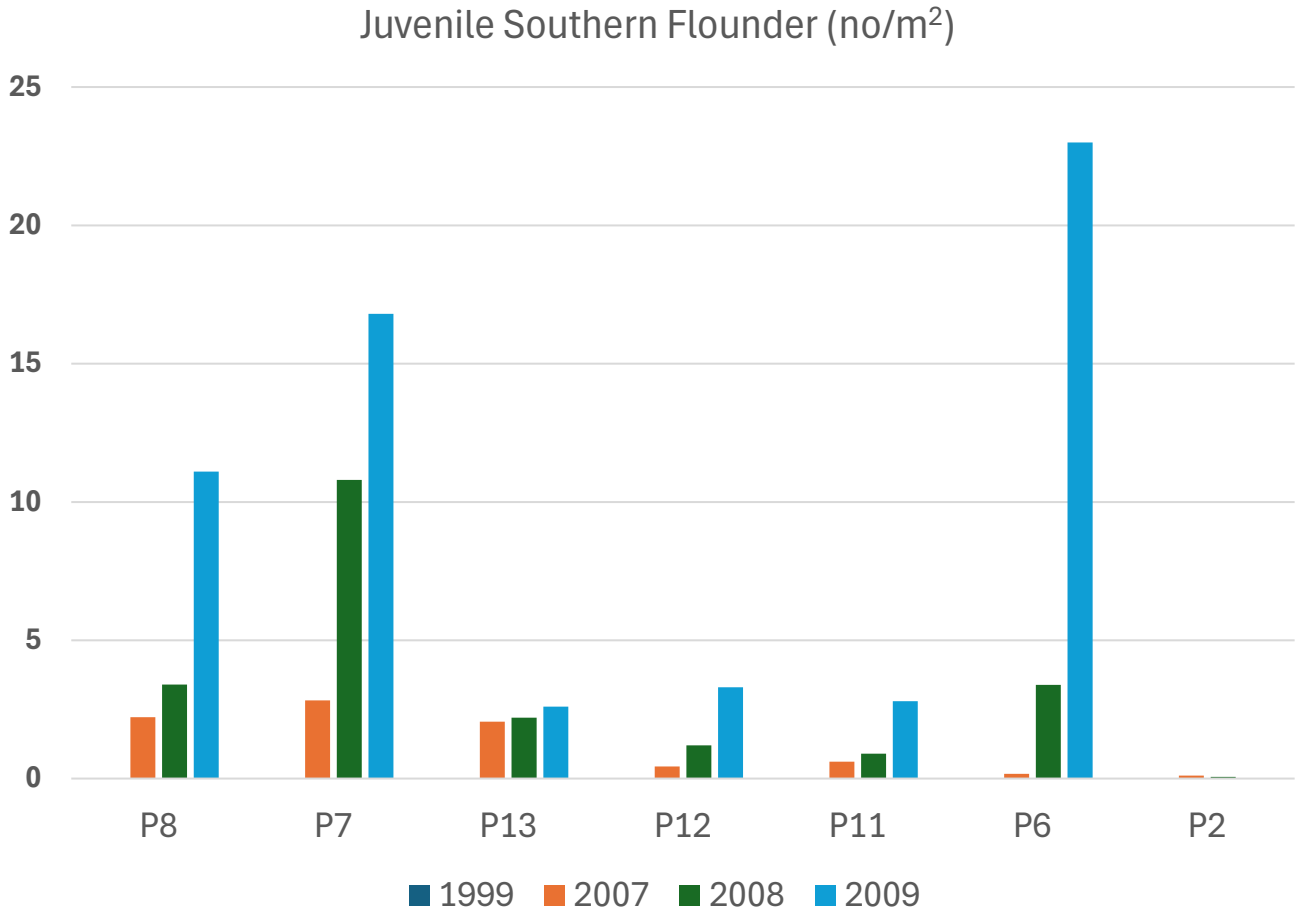
Life Stage	Salinity (ppt)	Temperature (°C)	Dissolved Oxygen (mg/L)	Associated Habitats	Related literature
Adult	0–36	4–35	Greater than 5.0	Entire estuary and ocean	Reagan and Wingo 1985; Farmer et al. 2013; NCDEQ 2016
Larvae	9–36	16–35	Greater than 3.7	Inlet and ocean water column, estuarine soft bottom	Williams and Duebler 1968; Reagan and Wingo 1985; Burke et al. 1991; Moustakas et al. 2004; NCDEQ 2016
Juveniles	0.02–35	16–35	Greater than 3.7	Wetlands, SAV, shell bottom, soft bottom	Reagan and Wingo 1985; Taylor et al. 2000; Taylor and Miller 2001; Del Toro-Silva et al. 2008; Nañez-James et al. 2009; Lowe et al. 2011; Farmer et al. 2013; NCDEQ 2016

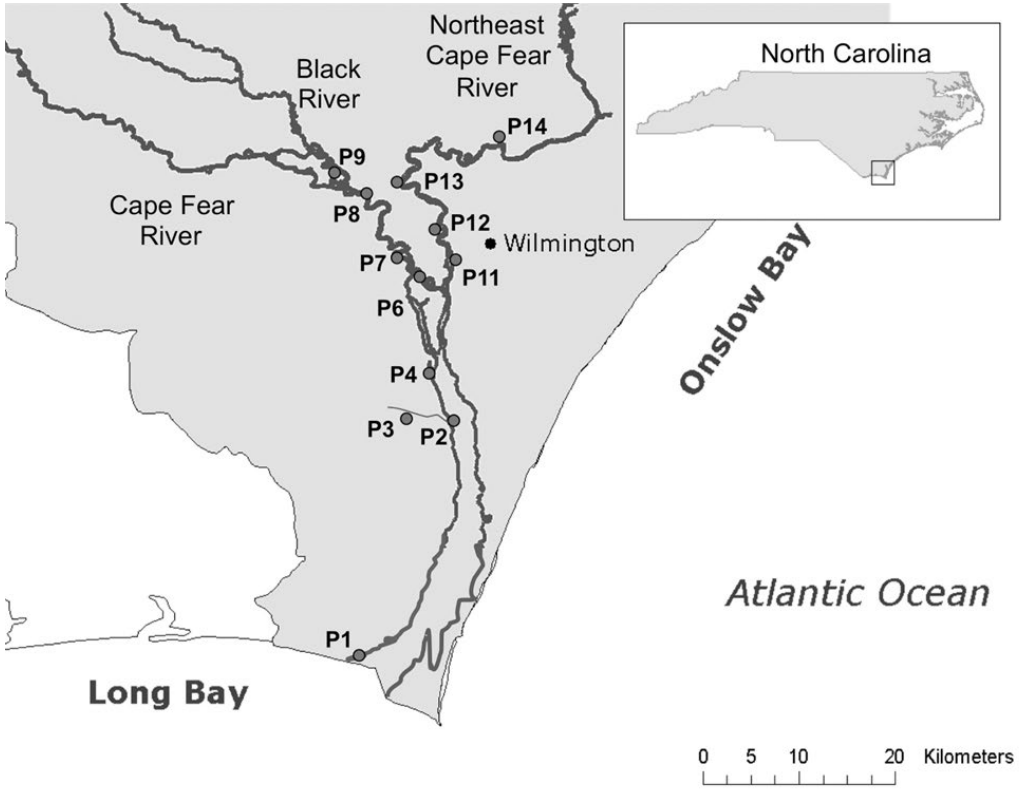
NC southern flounder management plan amendment 3

Potentially important aspects of habitat to be considered

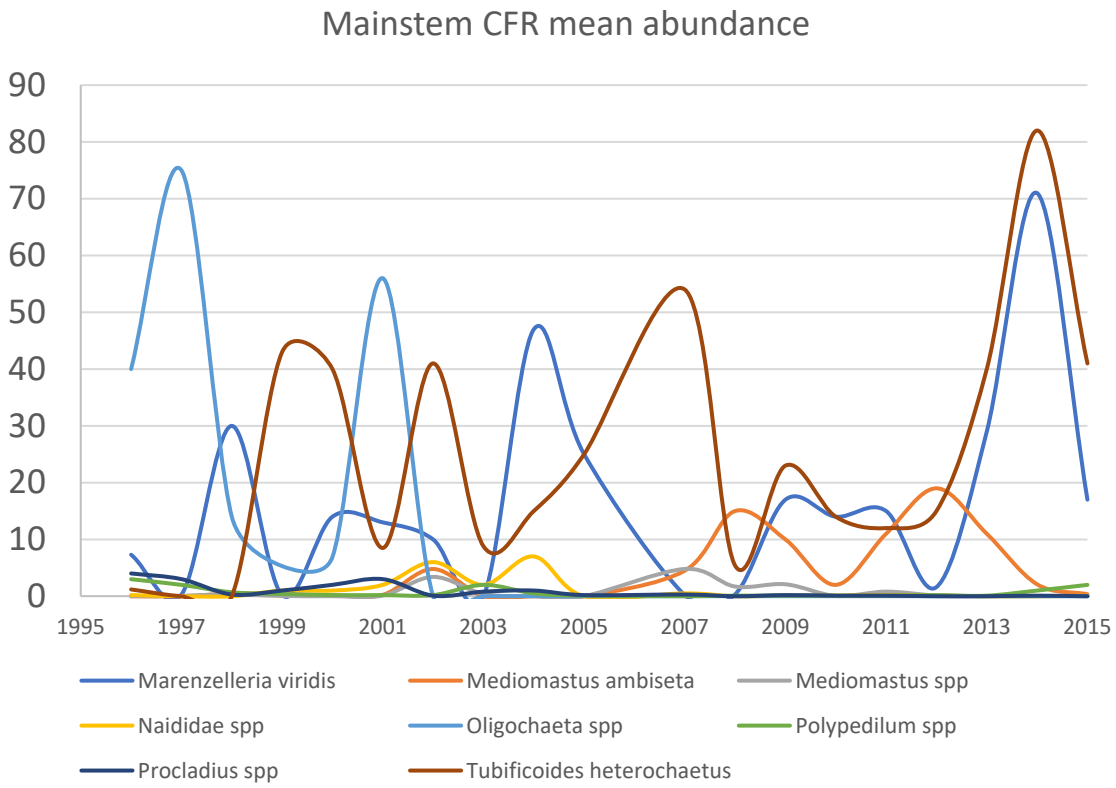
- Among watershed variability
  - Nutrient, sediment, other inputs
- Within watershed variability
- Specific characteristics of optimal habitat
  - Not all wetland or shoreline areas the same
  - What types of habitats are preferred
  - Structured vs. unstructured (many sampling methods biased towards unstructured habitats where seines or trawls can be pulled)
- Scale of patchiness and relation to specific habitat characteristics
- Water quality impacts
  - Direct and indirect
- Rest of today's talk will look at these aspects using the Cape Fear system as a model
  - Cape Fear system relative the NE Cape Fear
  - Variation within the Cape Fear River estuary
  - Smaller scale variation from exposed shore to adjacent sheltered shore
  - Variation among vegetation types over 10's of meters
  - Potential interaction with water quality parameters

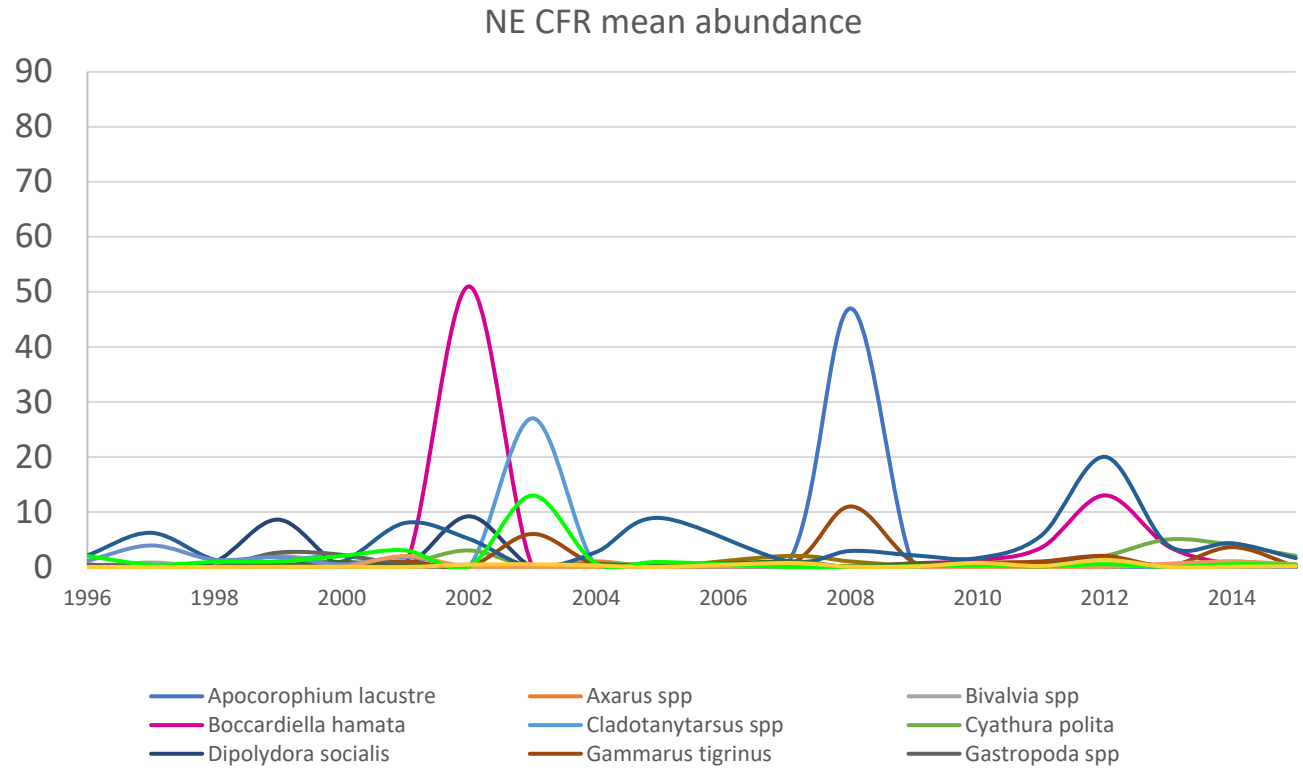






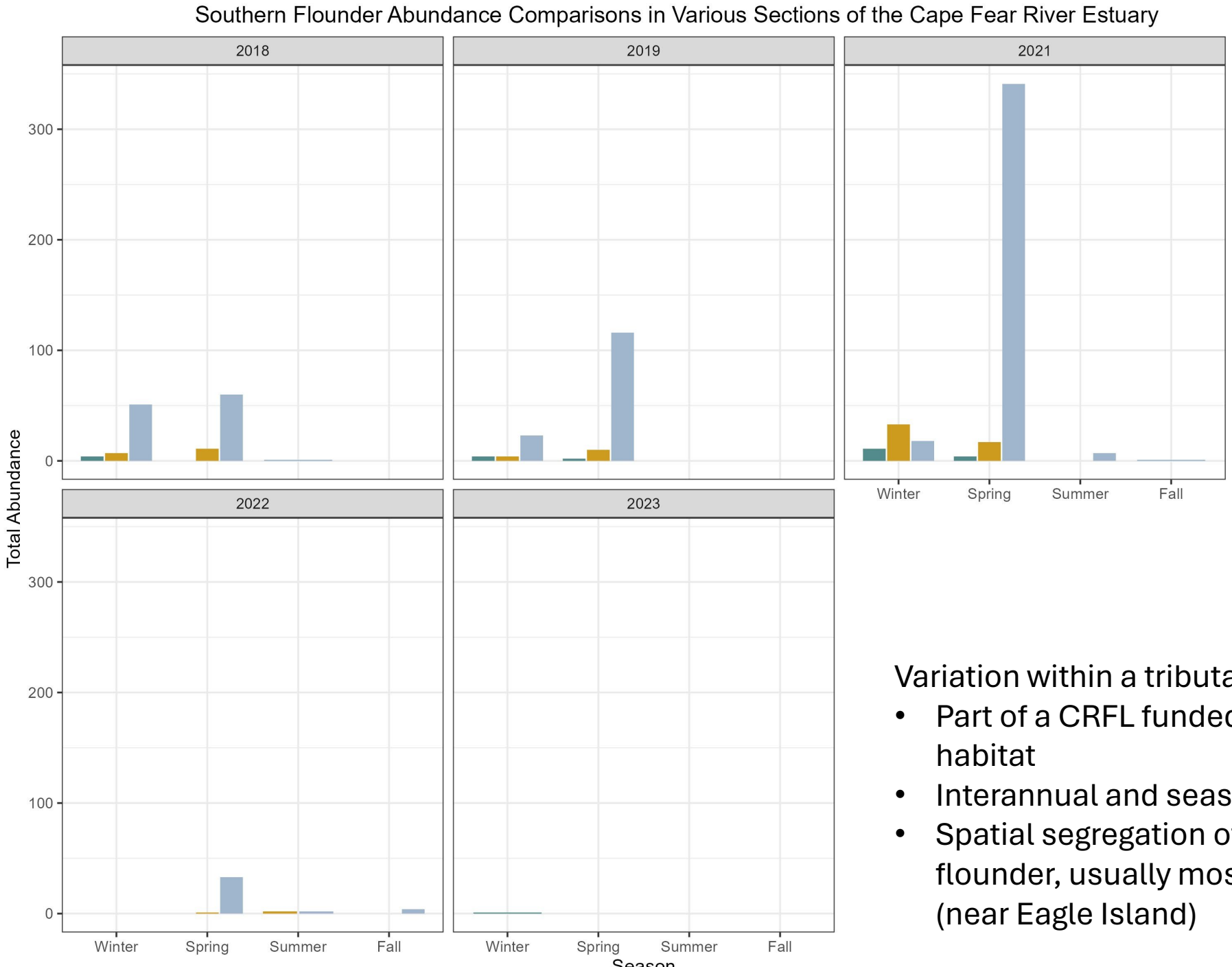
- Part of multi-year study examining river channel deepening impacts that provided an opportunity to observe freshwater to mid estuary patterns
  - Drop trap sampling over varied bottom types
- Salinity relation observed for mainstem Cape Fear River
- Observed difference between mainstem Cape Fear River and Northeast Cape Fear River
- Interannual variability

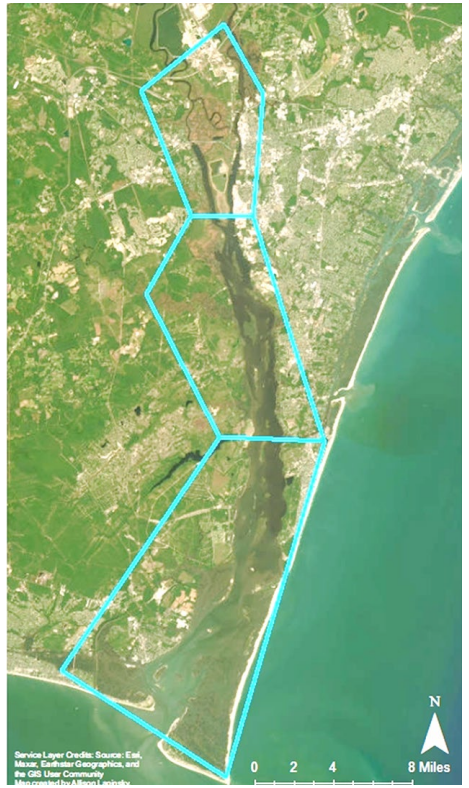




Differences among watersheds:

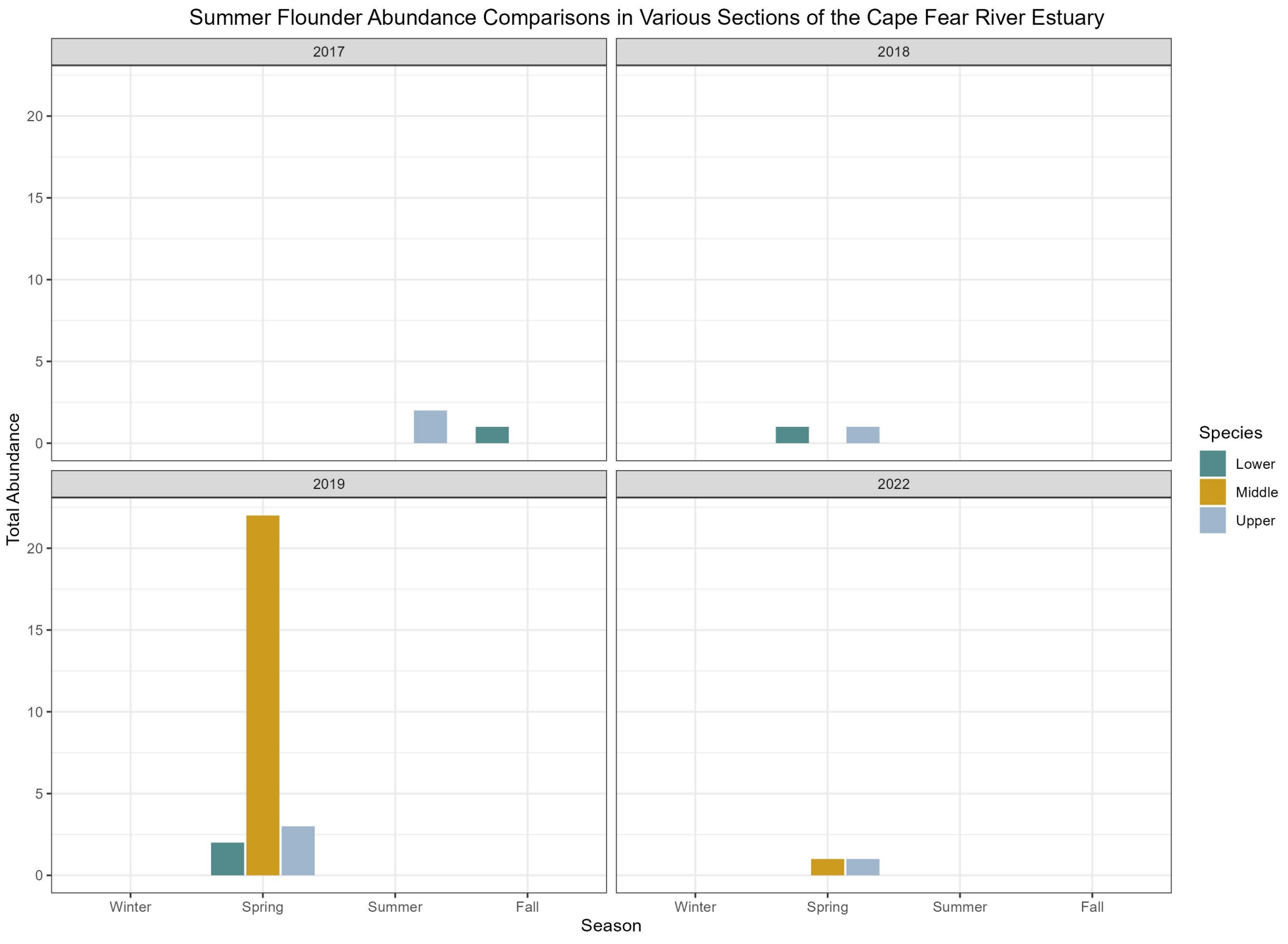
- Blackwater coastal system versus extended drainage to Piedmont
- Upstream inputs
- Local productivity
- Benthic and small nekton resources

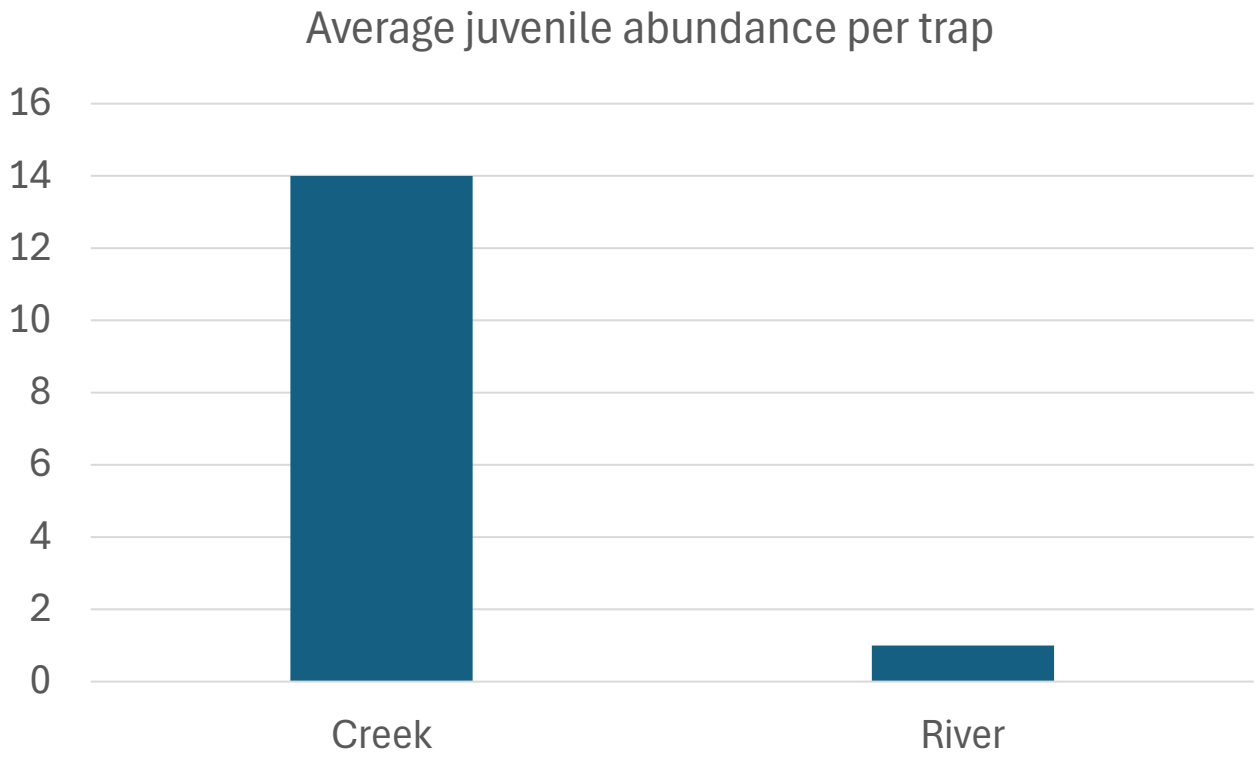




Variation within a tributary section

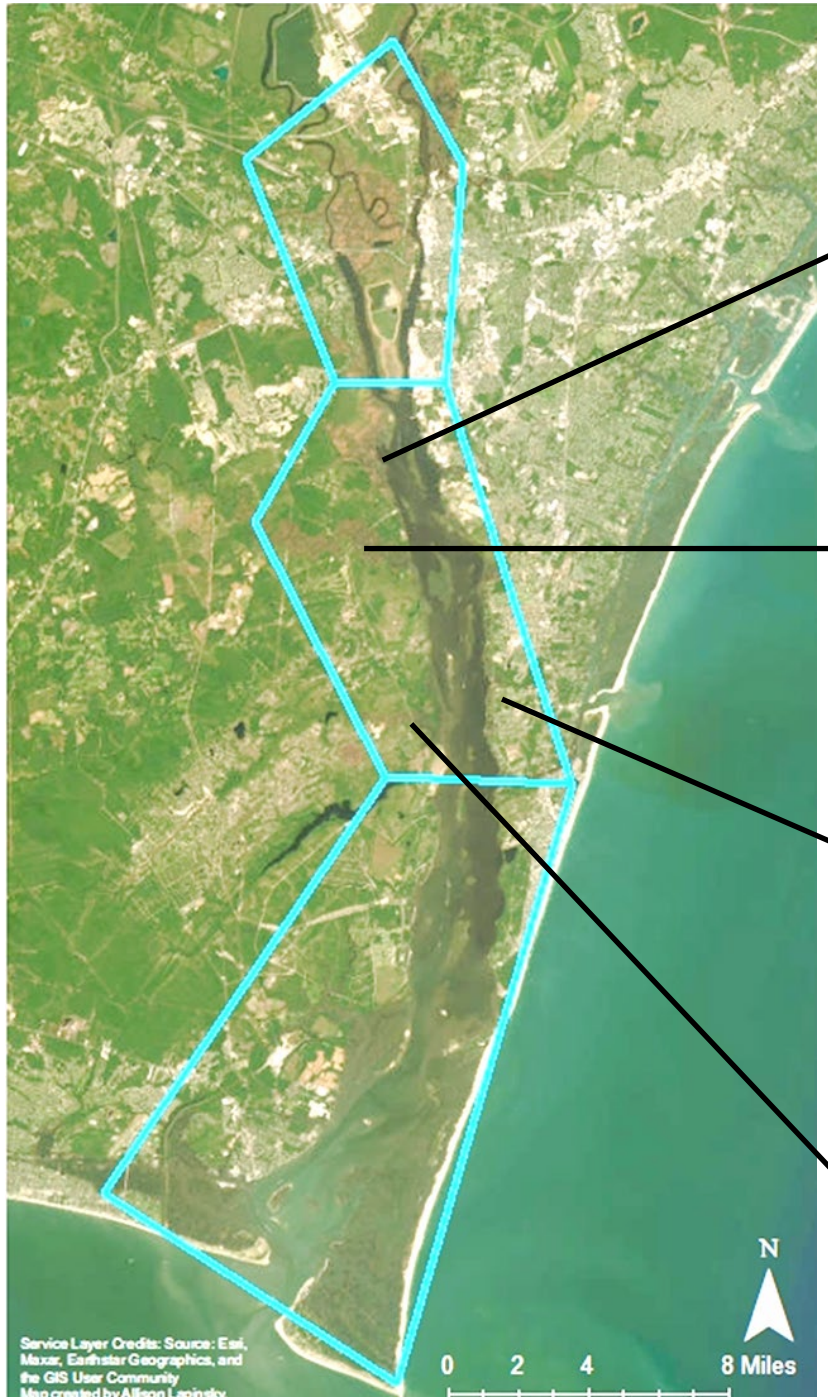
- Part of a CRFL funded study looking at nursery habitat
- Interannual and seasonal variability
- Spatial segregation of juvenile southern flounder, usually most common in upper areas (near Eagle Island)


Summer Flounder Abundance Comparisons in Various Sections of the Cape Fear River Estuary
2017
2018
2019
2022
Total Abundance
0
5
10
15
20
Winter
Spring
Summer
Fall
Season
Species
Lower
Middle
Upper



Transition from exposed edge to protected creek (<500m)

- Clover trap sampling - maintained natural structure
- Significant variation over this spatial scale
- 2021 – year of high abundance based on companion seine sampling



Mallary Creek

Town Creek

Motts Creek

Lilliput Creek

Do nekton discriminate among habitat over short distance (5-10m)?

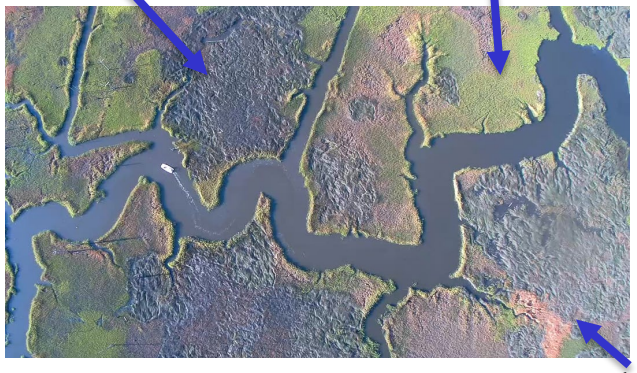
- Closely spaced patches of *Spartina*, *Phragmites* and *Juncus*
- Use of modified fyke nets to maintain natural structures
- All marsh edge habitats

Marsh mosaics in the Cape Fear

Juncus

Spartina

Mallory Creek

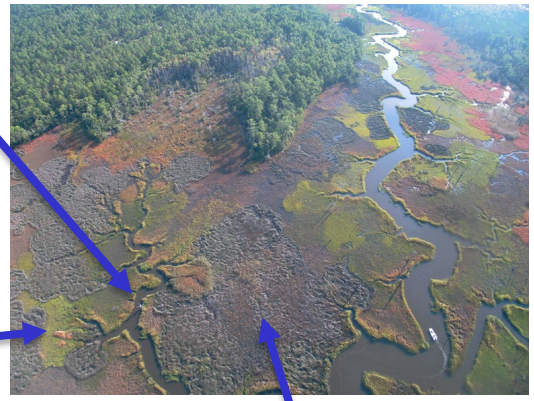


Phragmites

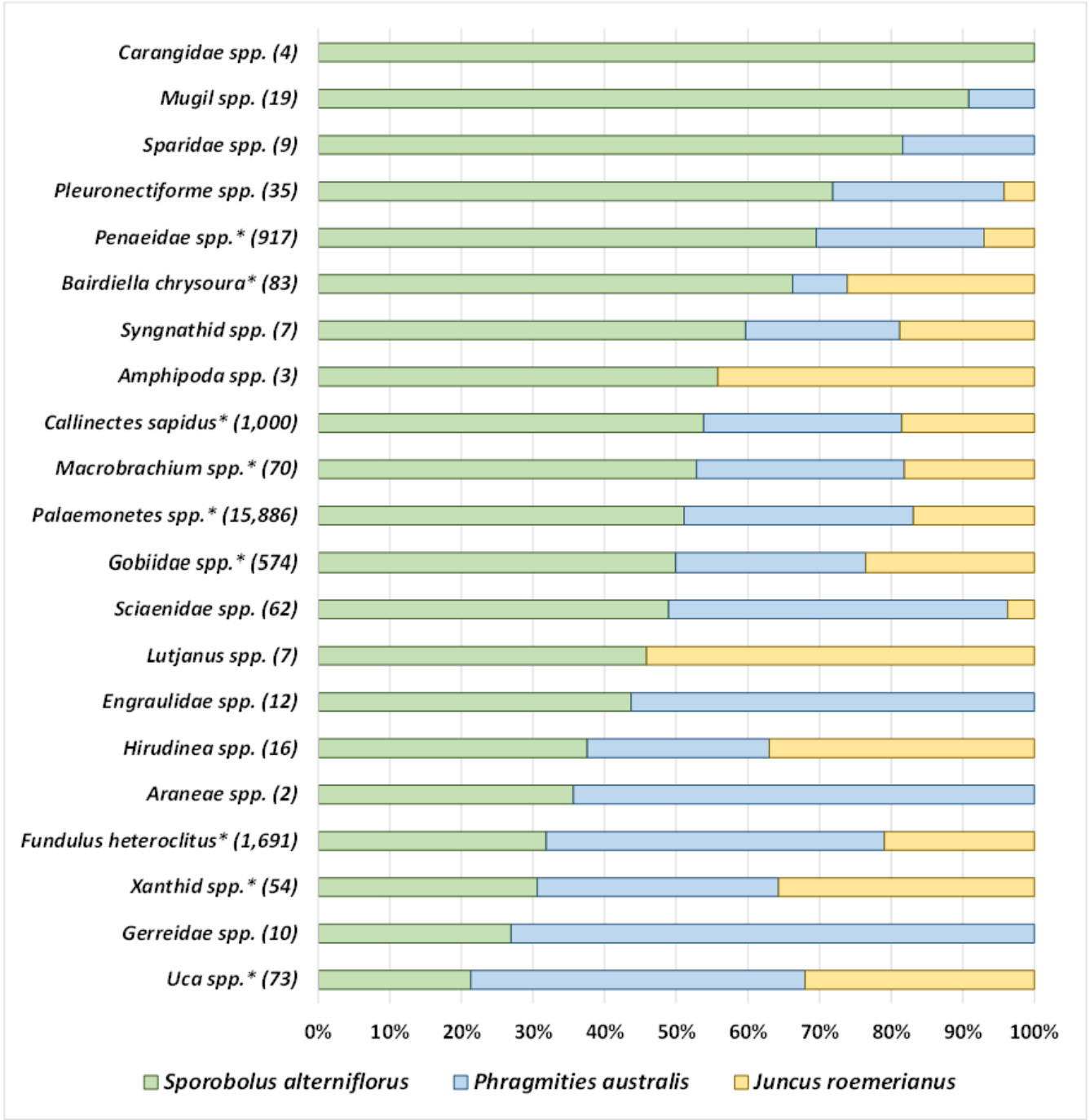
Phragmites

Motts Creek

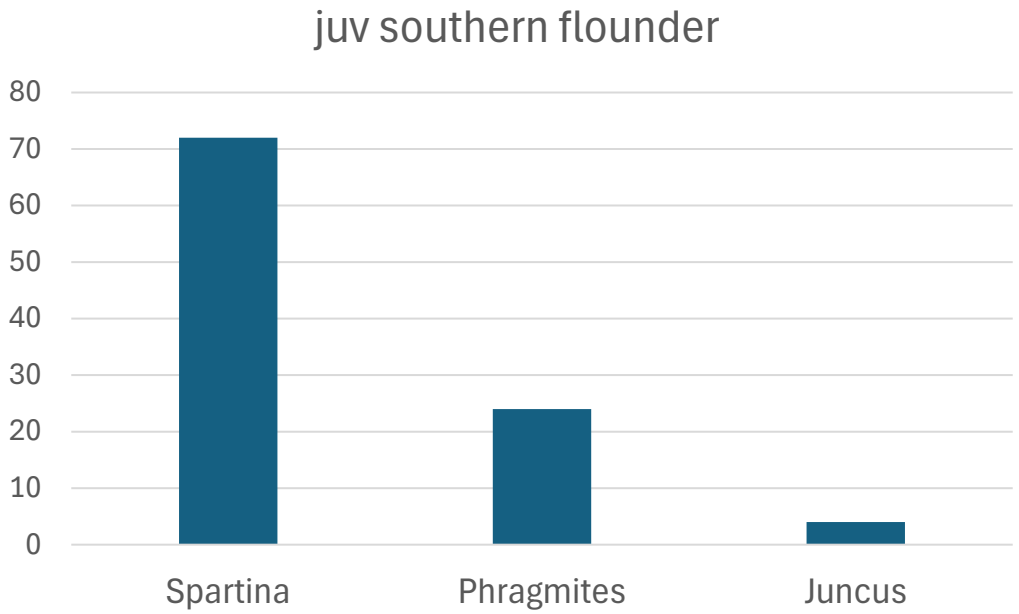
Spartina

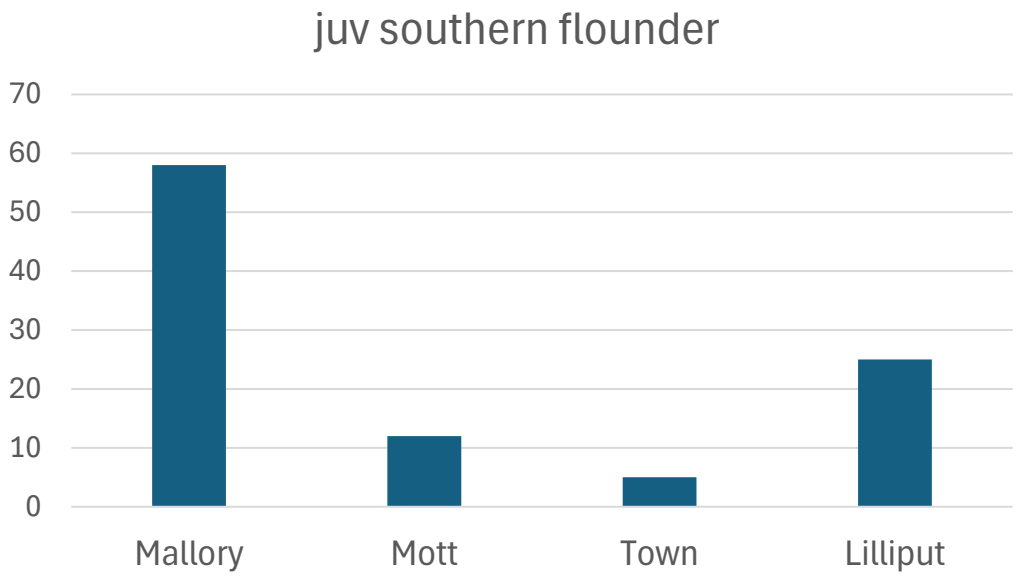


Juncus

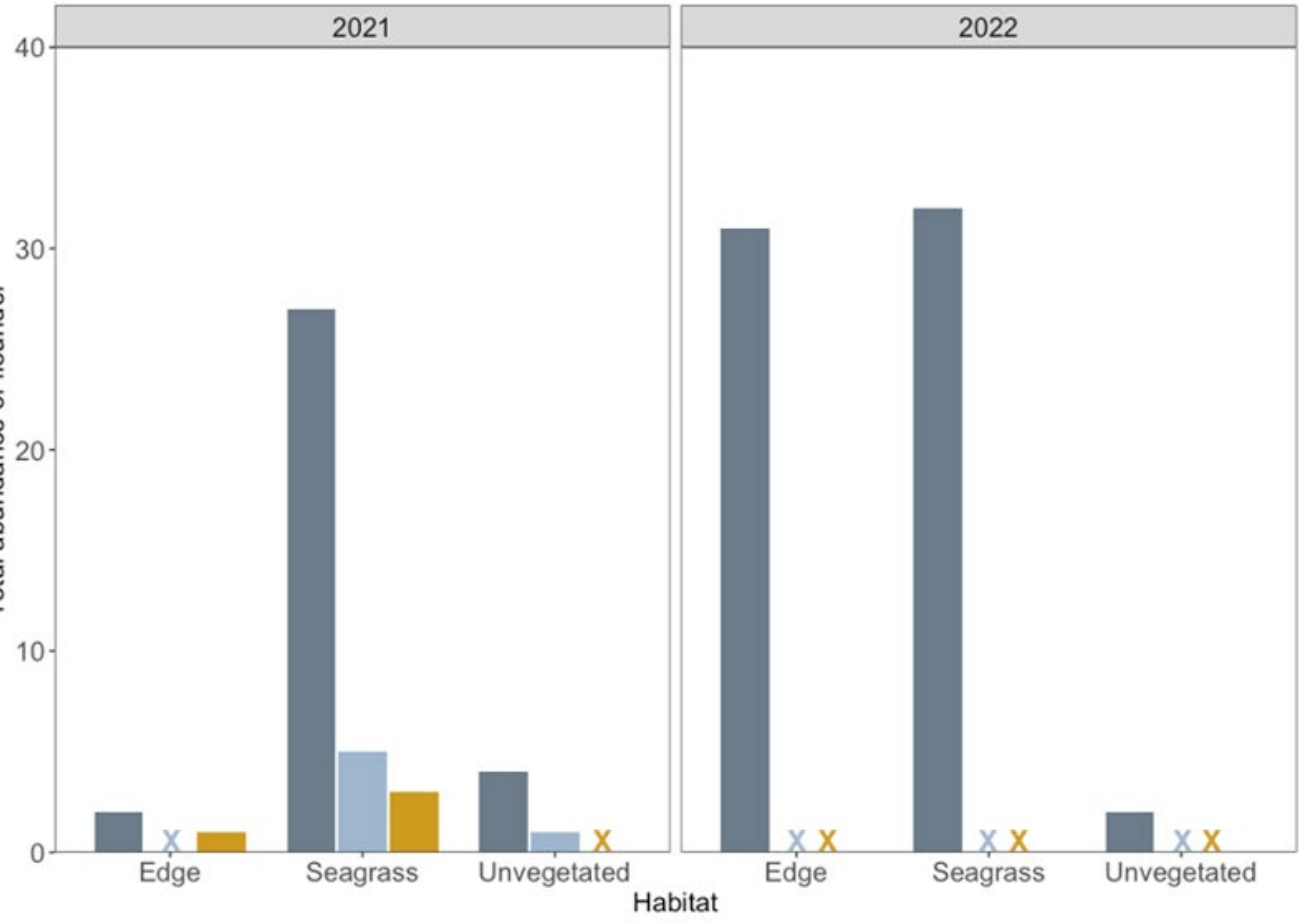


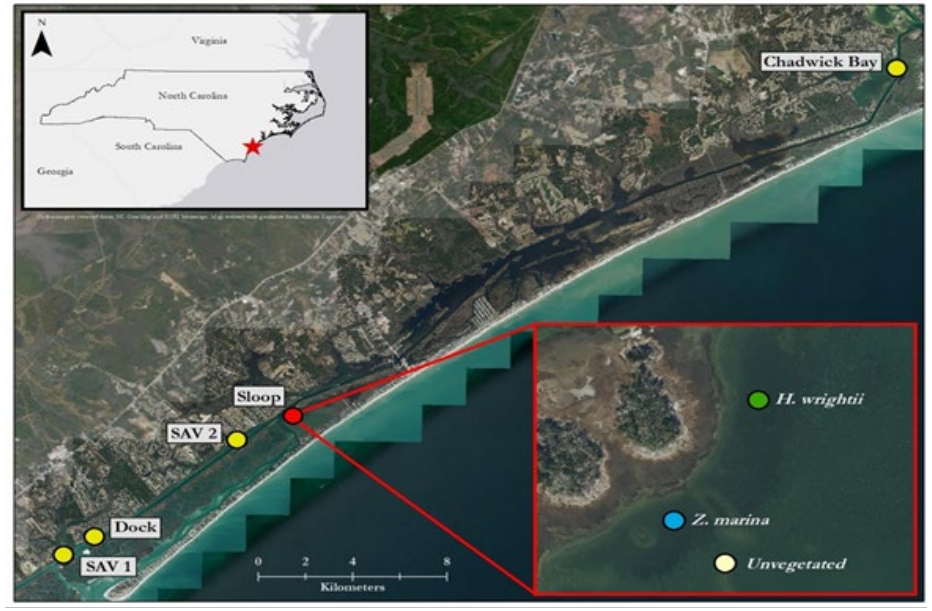
Significant small scale habitat discrimination by several nekton





- Creek differences, not strictly related to salinity
- Small scale (10's of meters) differences related to vegetation type





- Use of seagrass habitat (mixed *Halodule* and *Zostera)* in Topsail Sound. Spring-fall sampling each year.
- Approximately 10 m among habitat areas

Interactive Factors

- Suspended sediments / turbidity
  - Direct effects: foraging ability for a visual predator; other sensory impacts
  - Indirect:
    - Substrate impacts – coating on substrates
    - Food type and availability
    - Impacts on marsh habitat
    - Impacts on submerged aquatic vegetation
    - Other …
- Eutrophication
  - Algal bloom, hypoxia
  - Where hypoxia occurs, compression of predators and competitors
  - Indirect food web impacts on prey species
  - Impacts on vegetation
- Introduced / invasive species
- Shoreline modification
  - Impacts on shallow water habitats
- Dredging
- Other ….

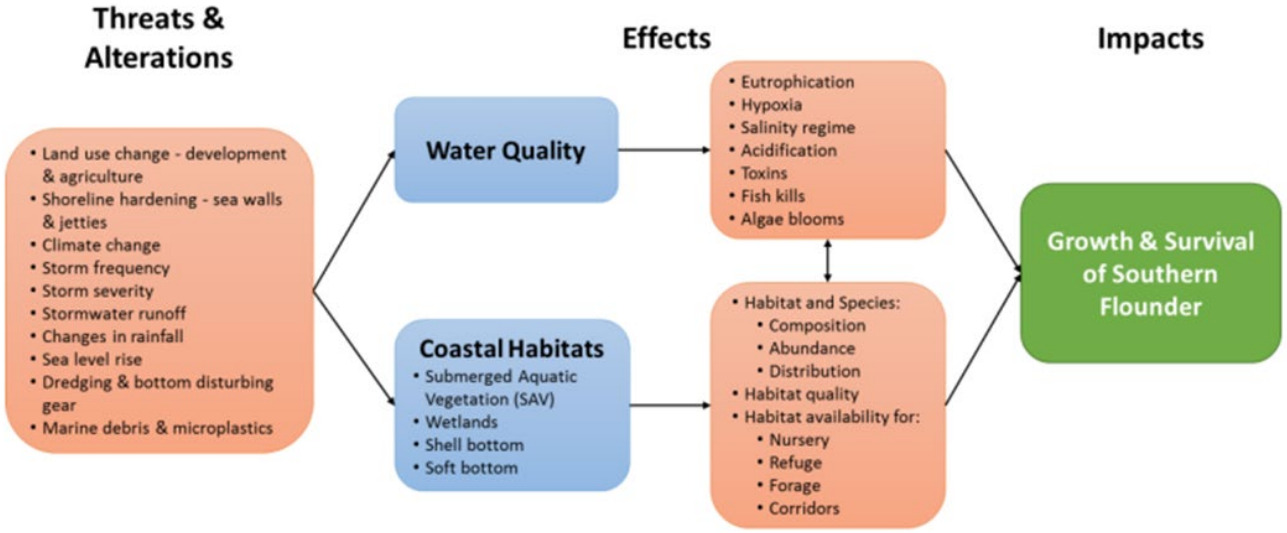


Figure 9. Effects of threats and alterations on water quality and coastal habitats and their ultimate impact on the growth and survival of southern flounder.

NC southern flounder management plan amendment 3

Habitat Considerations

- Though we have a general understanding of juvenile southern flounder distribution, we are still learning about details of preferred habitat
  - Watershed variations
  - Important local habitat characteristics (e.g. vegetation, shallow versus deep, edge versus interior, use of woody debris))
  - Interactions with other factors
  - Details of ontogenic changes in habitat use
- Retain diversity of habitats and linkages/corridors among habitats until we have more detailed information on specific habitat preferences
  - Not all habitats are utilized to the same degree.

Questions?