Modeling the Impacts of River Discharge on Trophic Pathways in an Estuarine Food Web

DYLAN SINNICKSON, DR. DAVID CHAGARIS, DR. MICHEAL ALLEN

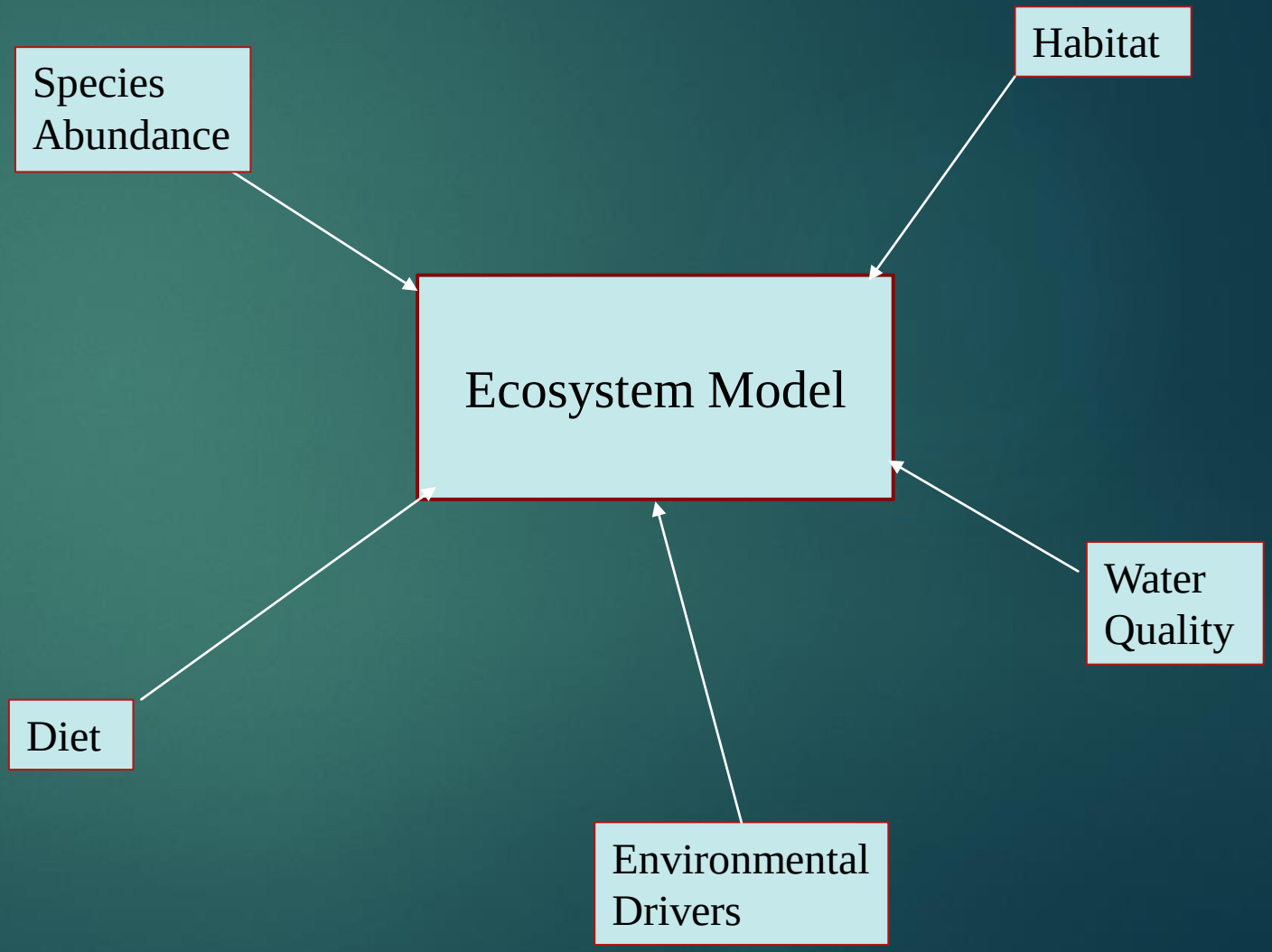
https://climate.nasa.gov/climate_resources/178/suwannee-blackwater-river-meets-the-sea/

Research Goals and Objectives

- Understand how estuarine ecosystem responds to changes in freshwater flow
  - How does energy flow through system?
  - Identify time lags in biological productivity to changes in discharge
  - What are the indirect effects relating to trophic interactions?
  - Can we make future predictions about ecological productivity?

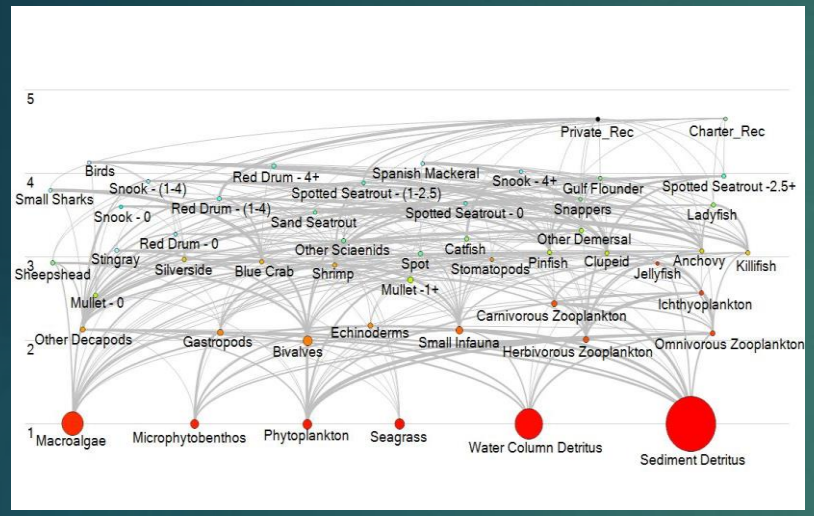
Ecosystem Models as a Research and Management Tool

- Integrate data from multiple sources
- Simulate response to changes in ecosystem



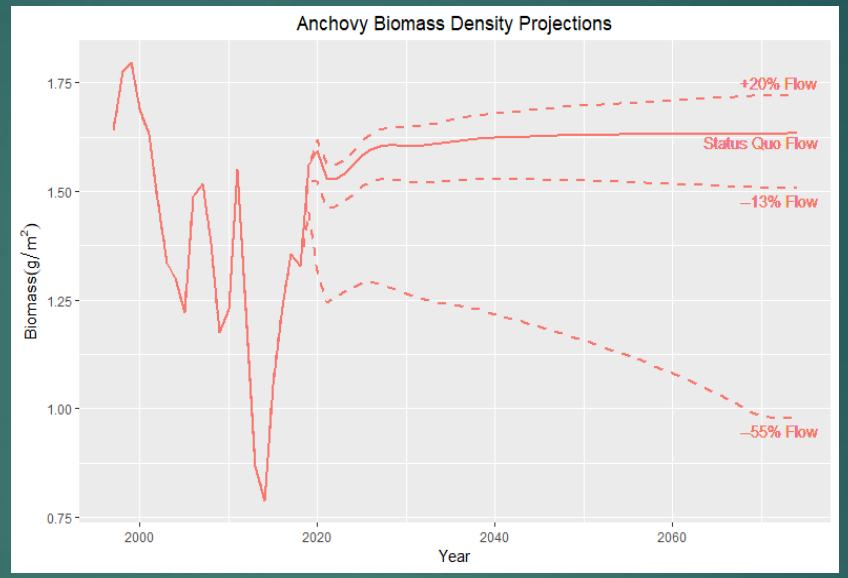
Ecopath Modeling

Ecopath



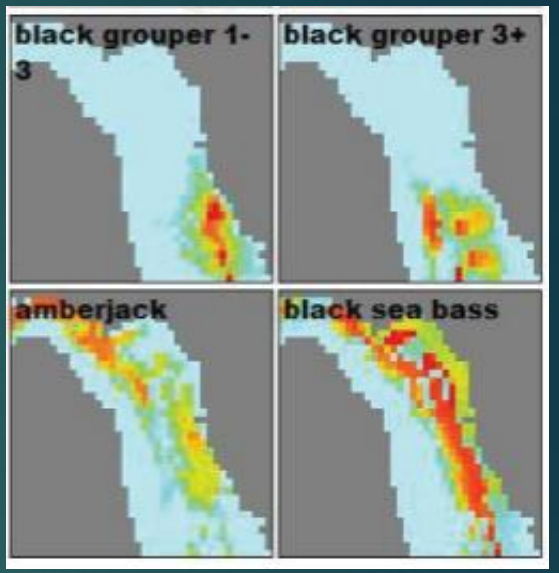
- Functional groups linked together from known diet compositions
- Model is fit to a known time series of biomass densities and environmental conditions

Ecosim



- Project biomass densities of fish through time in different ecological conditions

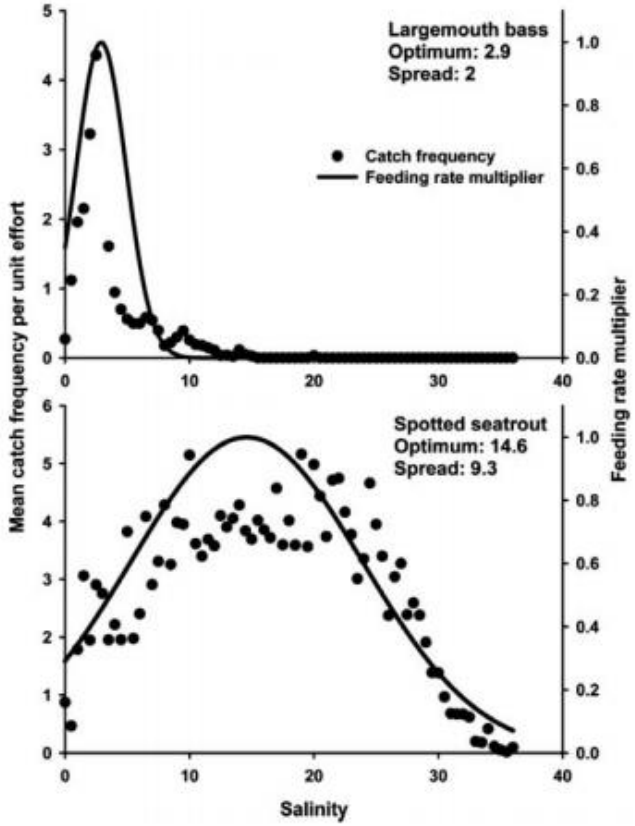
Ecospace



- Predict distributions of fish species in different environmental scenarios

Applications of EwE in Estuaries

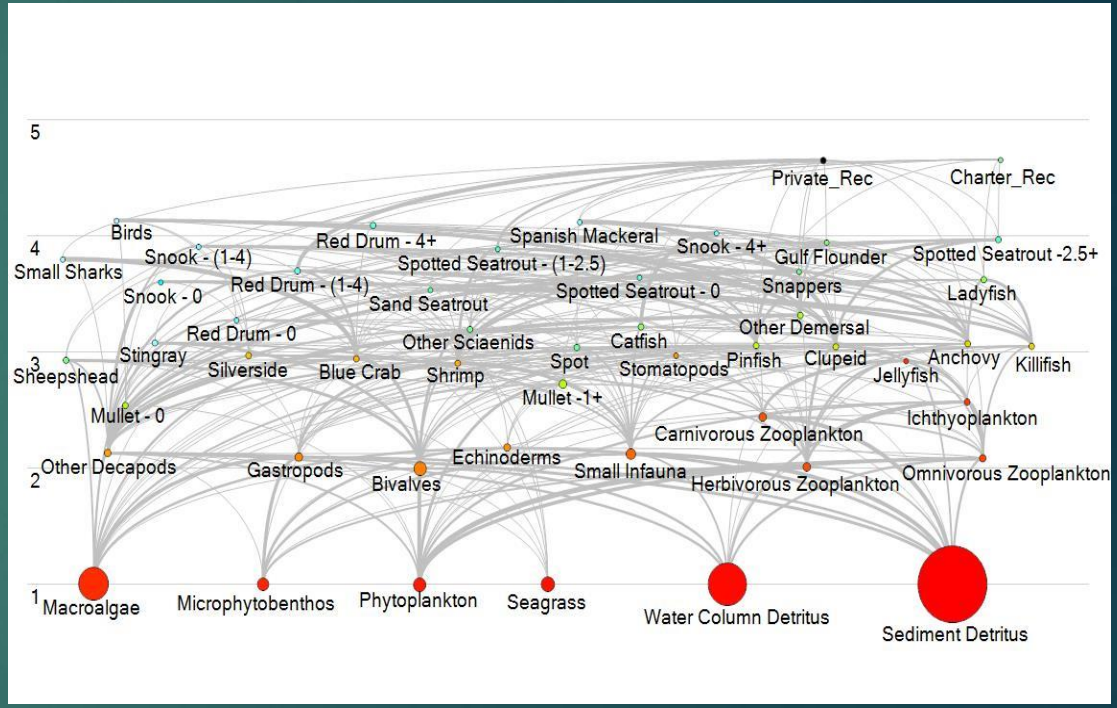
- Chesapeake Bay – model impacts of water quality and fishing (bottom-up / top-down) (Townsend, 2014)
- Northern Gulf– simulate effect of river diversions on salinity and fish distribution (de Mutsert et al,. 2012)



Salinity tolerance of seatrout and largemouth bass (de Mutsert et al., 2012)

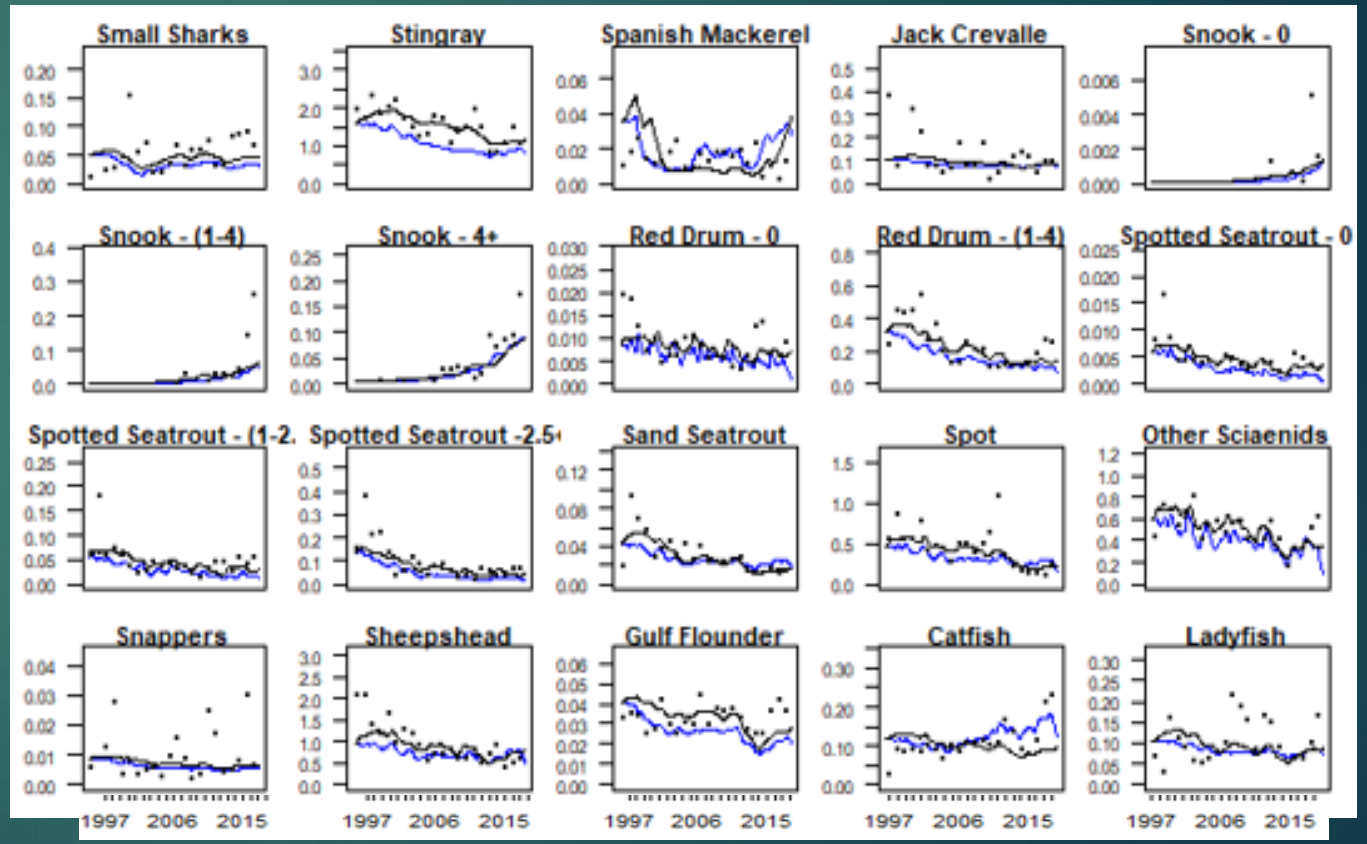
Suwannee River Estuary Model

- Model structure
  - 59 functional groups (85 fish species)
  - Age structured stanza – redfish, snook, seatrout, mullet
  - 10 invertebrate groups
  - 4 primary producers
- Fishing fleets: Private, charter, redfish, and seatrout
- Environmental drivers
  - Suwannee River discharge
  - Nutrient concentrations
  - Mangrove densities



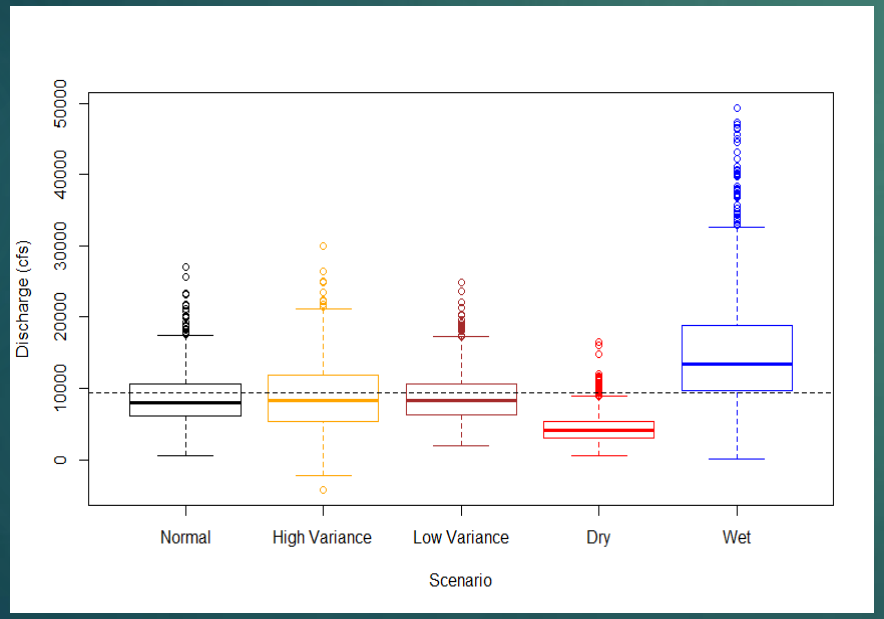
Ecosim Model Calibration

- Model fit to FIM data from 1997 – 2018
- Driven by forcing time series of discharge, nutrients, and fishing effort
- Environmental forcing functions used to drive snook densities

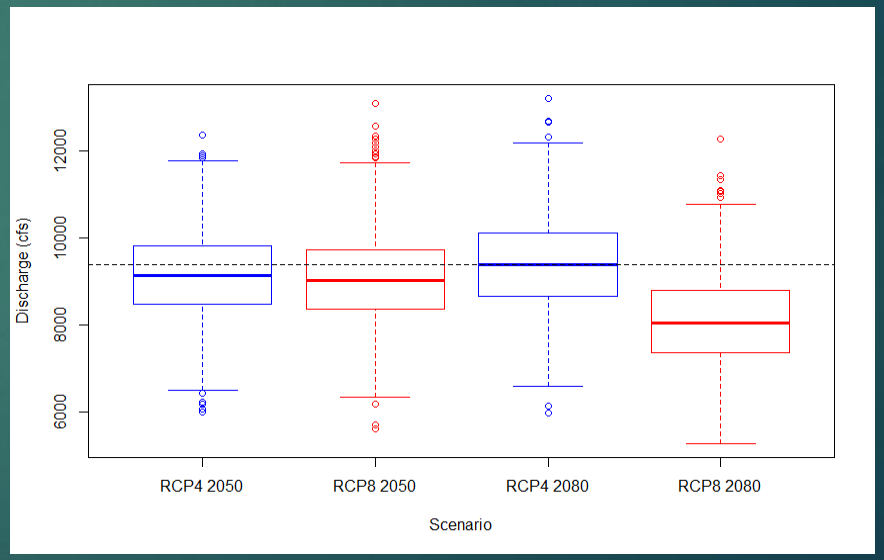


Projecting Future Flow Scenarios

- Short-term projections (3 years)
  - Based on projected levels discharge/nutrient
  - High/low variance (Random Component * ± 30%)
  - Wet (+1 SD), dry (-1 SD), and normal conditions

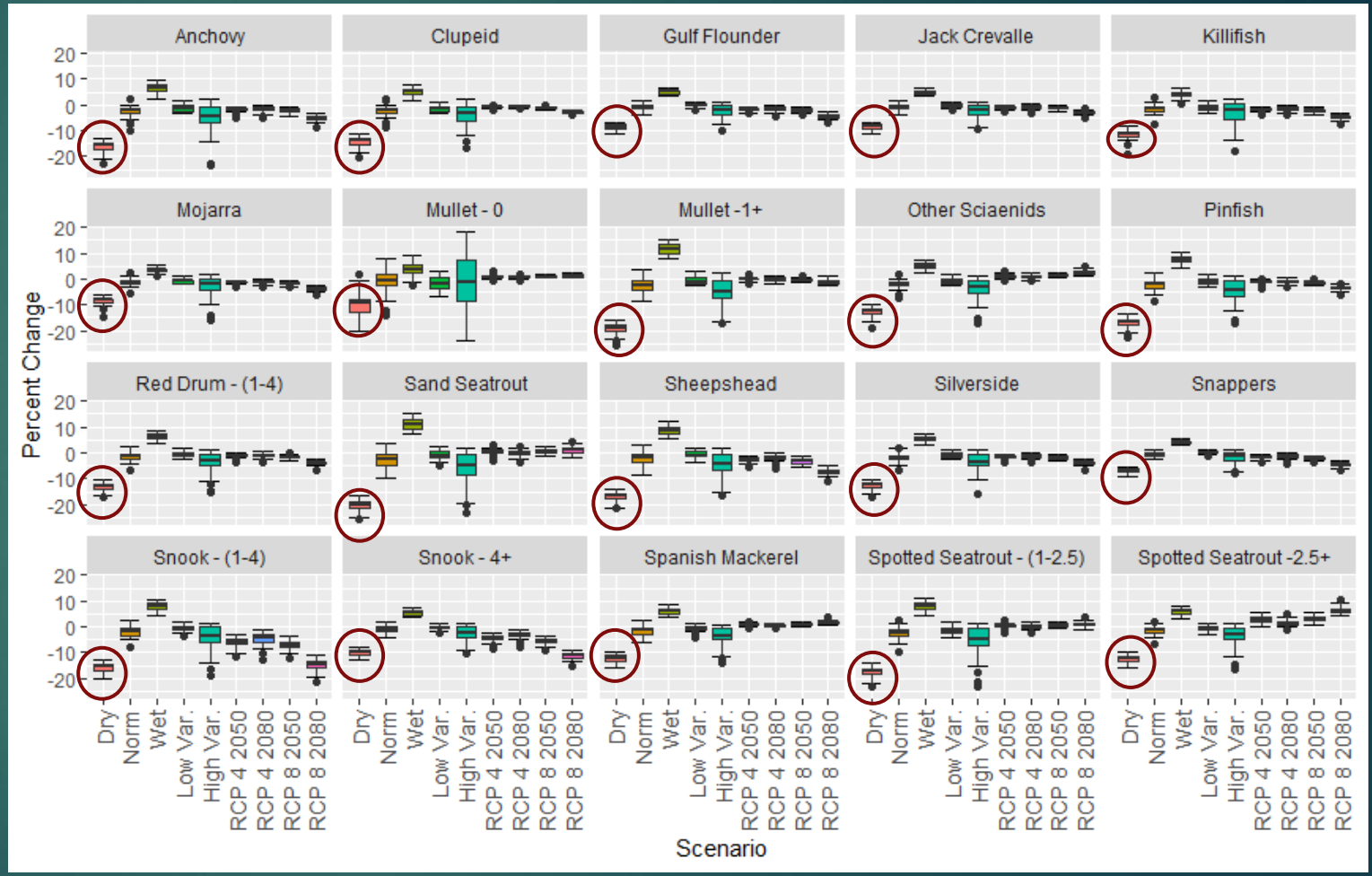


- Long-term projections from 2019 – 2068
- Four different flow scenarios (Neupane et al., 2019)
  - 30 and 50 year climate projections at low/high emissions



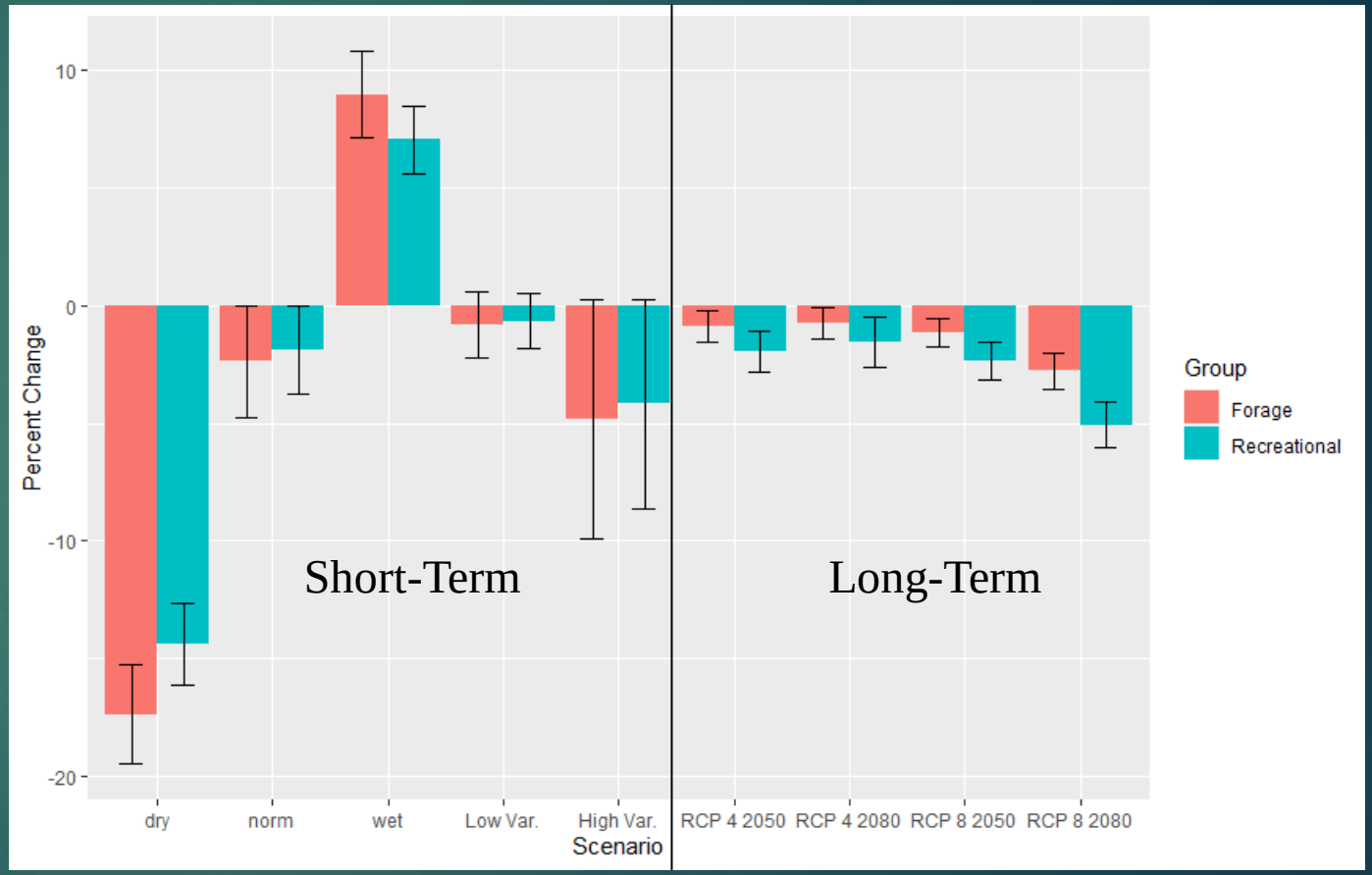
Fish Responses to Future Flow Scenarios

- Largest changes observed in the anomalous short-term scenarios
- Droughts have greater impacts than floods



Fish Responses to Future Flow Scenarios

- Short-term - Larger changes observed in forage fish groups
- Long-term - Larger changes observed in recreational groups



Model Applications and Research Recommendations

1. Inform policy regarding minimum flow requirements of Suwannee River
2. Model the effects of climate change and tropicalization
   - Identify impacts of snook range expansion and effect on other gamefish and forage fish
3. Utilize a spatial model – Ecospace
   - Model the impact of environmental gradients (e.g. salinity) on distribution of fish species
4. Simulate changes in habitat
   - Oyster restoration, seagrass loss, salt marsh to mangrove habitat transition, etc.

https://serc.si.edu/research/laboratories/animal-plant-interaction/projects/mangrove-expansion-response-climate-change

Acknowledgments

UF IFAS UNIVERSITY of FLORIDA

Florida FORAGE FISH

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

SFRC School of FOREST RESOURCES & CONSERVATION

NATURE COAST BIOLOGICAL STATION