Golden Tilefish TOR 1: Ecosystem and climate influences

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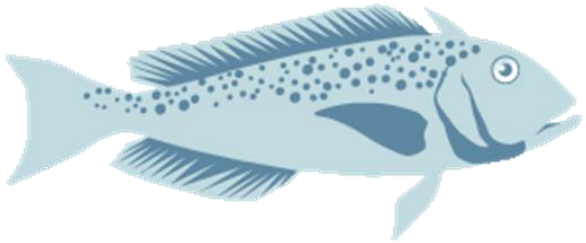
MAFMC SSC Meeting – May 14, 2024

Outline



- *Identify relevant ecosystem and climate influences on the stock. Characterize the uncertainty in the relevant sources of data and their link to stock dynamics.*
  - ESP overview
  - Literature review and indicator development
  - Data & Methods
  - Analyses
  - Supplemental analyses: Larval Distributions
  - Socioeconomic input: Industry perspective

Pathways for scientific advice

Ecosystem information can be used in decisions *even if* not directly in the stock assessment

Inform uncertainty

Provide additional context

- Do recent data seem consistent with past observations?
- Is there anything happening that might affect the stock in ways that the assessment model can't capture?

Inform assessment model…

assumptions

- Is the model consistent with the stock's life history?
- Are major biological processes accounted for?

choices

- Are parameter values consistent with existing information?
  - natural mortality, catchability
- Inform data conditioning

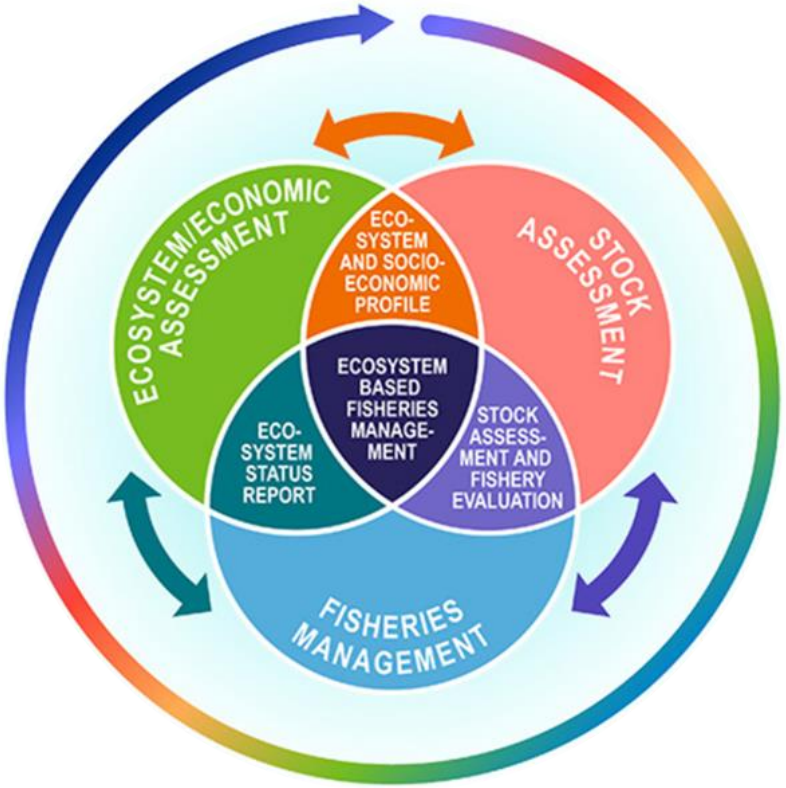
covariates

- Indicator time series directly included in a model (ex, Woods Hole Assessment Model)

Schematic courtesy of Scott Large

Ecosystem and Socioeconomic Profile - Objectives

- Leverage existing information and knowledge pathways
- Facilitate interpretation and use in management with a standardized framework and visuals
- Provide relevant ecosystem and socioeconomic information for fisheries management
- Track changes in the system over time



Graphic from Rebecca White, AFSC

What does an ESP report look like?

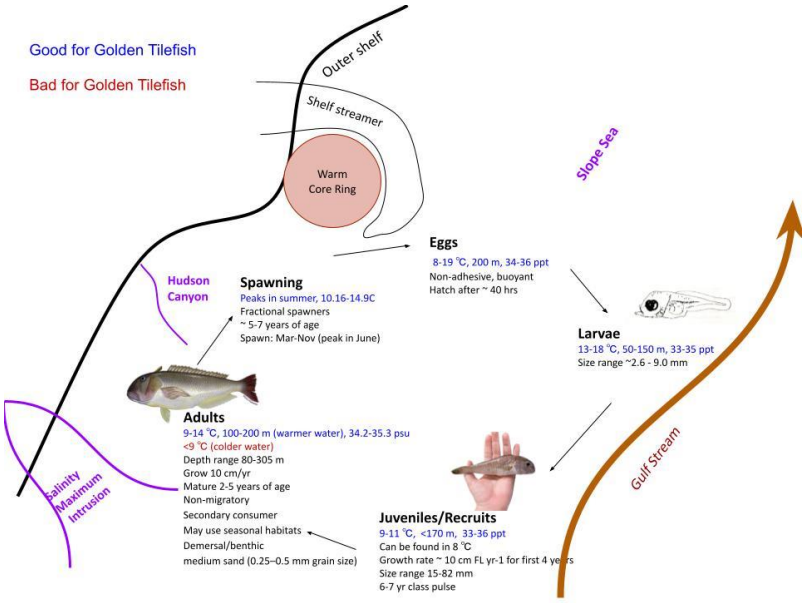
1.Literature review: identify key processes and questions; develop conceptual model
2.Indicator selection: develop suite of ecosystem and socioeconomic indicators based on data availability, feasibility, and relevance to the stock
3.Indicator analysis: test relationship of indicators to stock metrics (correlations, GAMs)
4.Scientific advice: evaluate indicators for use in scientific applications and advice
GOAL: Create an iterative framework that can inform model choices and assumptions

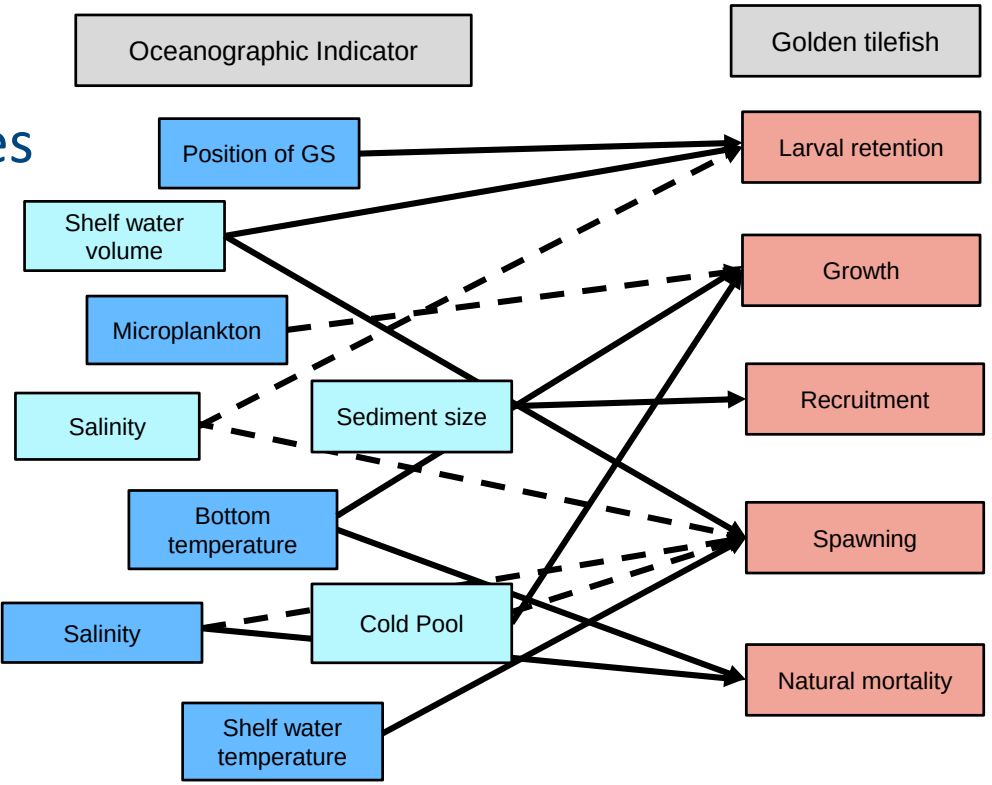
Ecosystem and Socioeconomic Profile – Literature review

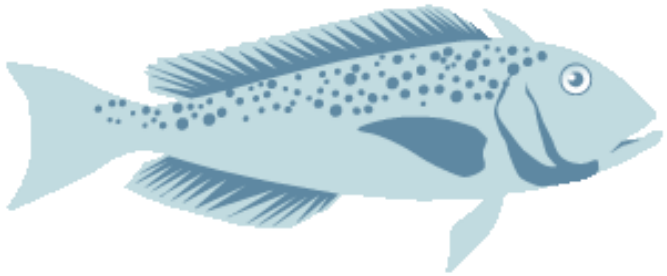
Stage	Habitat & Distribution	Phenology	Age, Length, Growth	Energetics	Diet	Predators/ Competitors
Spawning		Serial spawning; March-Nov, peaking in June	2-4 years, 60-65 cm (female) 65-70 cm (male) at maturity	2.28 mil eggs per female; 500k for first time spawner 10.16-14.9C		
Egg	Non-adhesive and buoyant in water column on shelf break; Georges Bank to Cape Hatteras 80-800 m	March-Nov	1.16-1.25 mm	8-19C; 34-36 ppt		
Larvae	Water column on outer continental shelf; Georges Bank to Cape Hatteras 50-150 m	Feb-Oct, peaks Jul-Oct	2.6-9.0 mm	13-18C; 33-35 ppt	Probably prey on zooplankton	
Juvenile	Shelf break, submarine canyon walls, and flanks; Georges Bank to Cape Hatteras Small burrows or rocks/clay 80-540 m (but usually 100-200m)	Early juveniles Apr-July	15-500 mm	8-18C; 33-36 ppt	Decapod crustaceans, small fish, benthic epifauna	Adult tilefish, goosefish, sharks, dogfish, conger eels
Pre- Recruit			Until age 4, both males and females grow 10 cm/yr. After age 4, males grow faster.			
Recruit	Shelf break, submarine canyon walls, and flanks; Georges Bank to Cape Hatteras Large vertical burrows in clay or sand 80-540m (but usually 100-200m)	Seasonal cooling in Spring may force tilefish to concentrate within preferred temperature Pulses of recruitment every 6-7 years	Females: 50-100cm; 46 years Males: 50-120cm; 39 years	Narrow band of temperatures 9-14C; 33-36 ppt	Bottom feeders: Juvenile tilefish, other fish, decapods, benthic epifauna	Sharks, lampreys

Conceptual Models

- Qualitative outline of important linkages in the system
  - Understand bottlenecks
  - Organize important information
  - Begin to understand mechanisms
  - Identify testable hypotheses



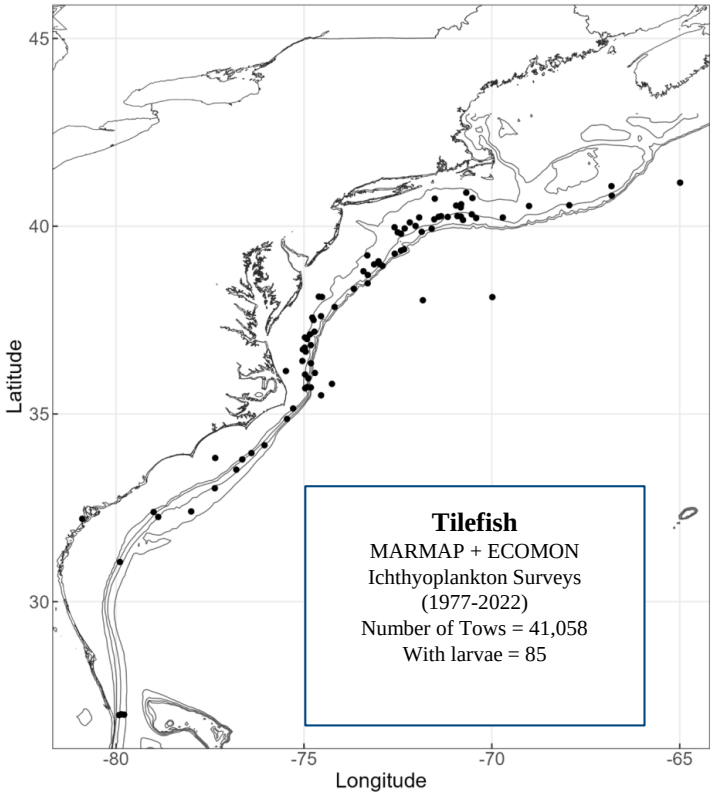


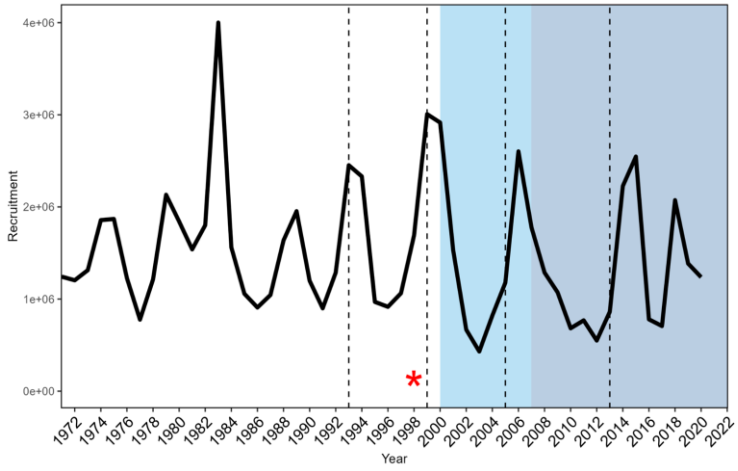


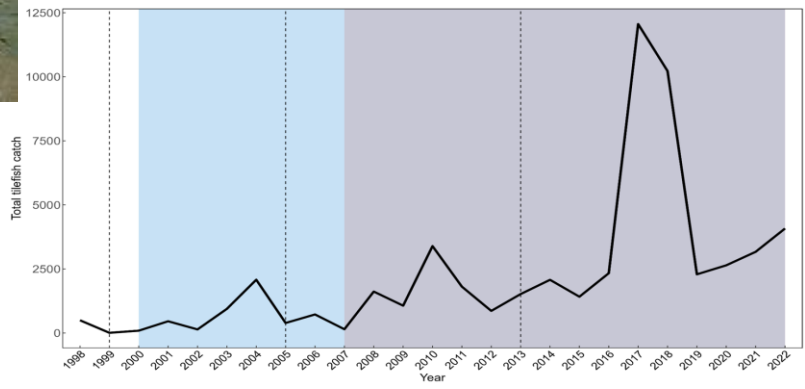
Drivers of recruitment

Data limited stock

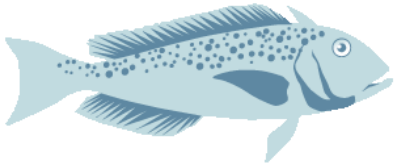
- Goal: Explore new and underexplored data sources
  - Incidental CPUE
  - Larval data
  - Recruitment index







High resolution fisheries data

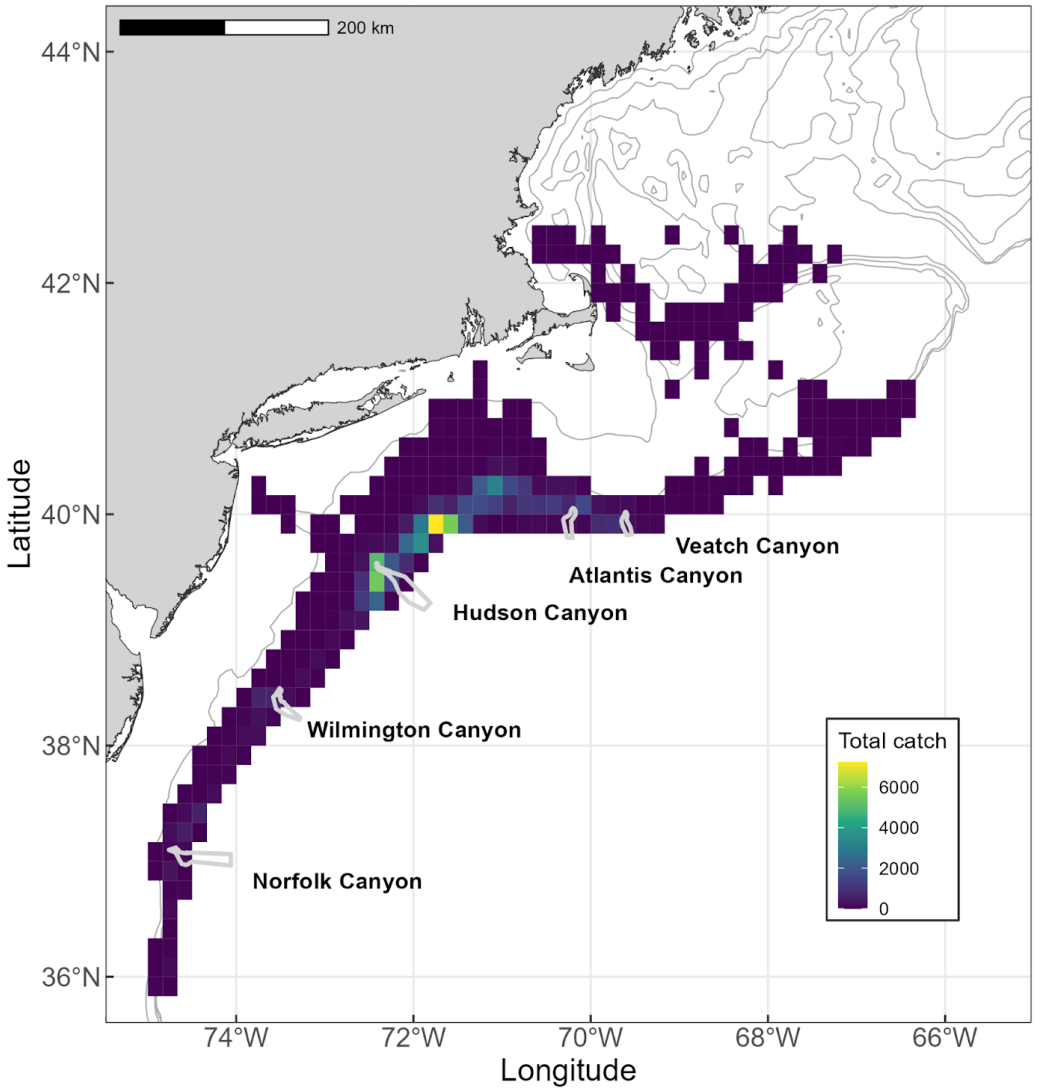


- Fishery-dependent: data collected from records of catch and effort from fishermen logbooks and other monitoring programs
- NEFSC Study Fleet: Science-industry research collaboration

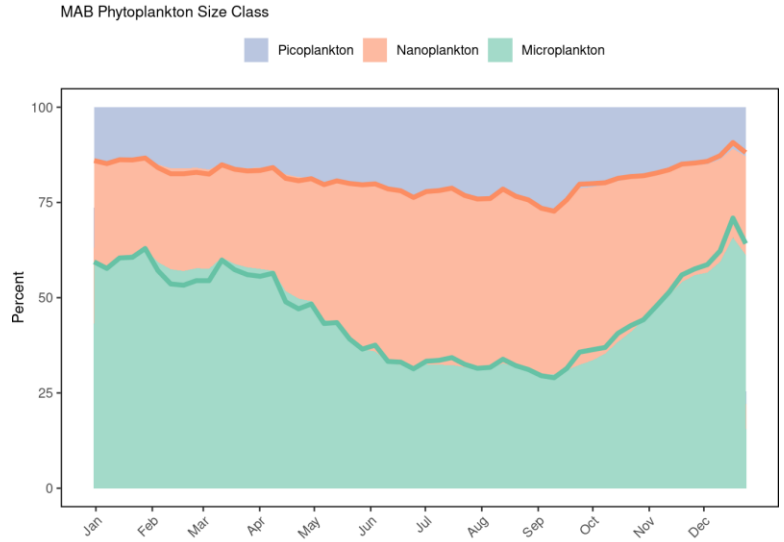
- Haul level catch and effort
- Coordinates, date, time for each haul
- Depth, temperature

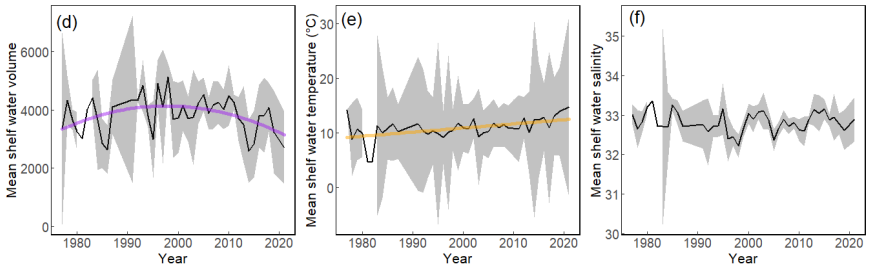
Golden tilefish incidental CPUE

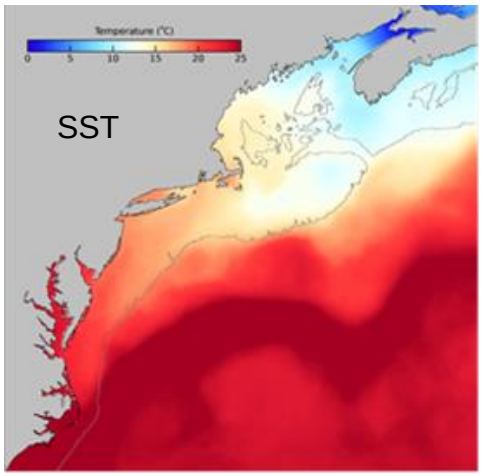
- CPUE derived from incidental catch from trawl fleet
- Indexing relatively smaller/younger fish than LPUE index
  - 3-4 year old tilefish

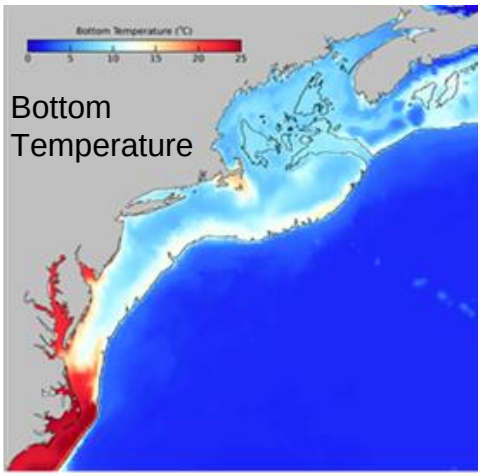


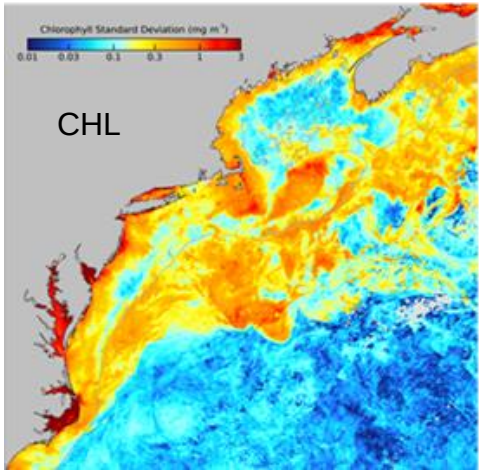
High resolution environmental data

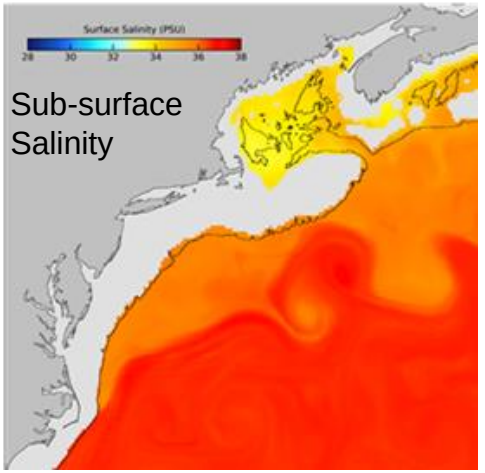












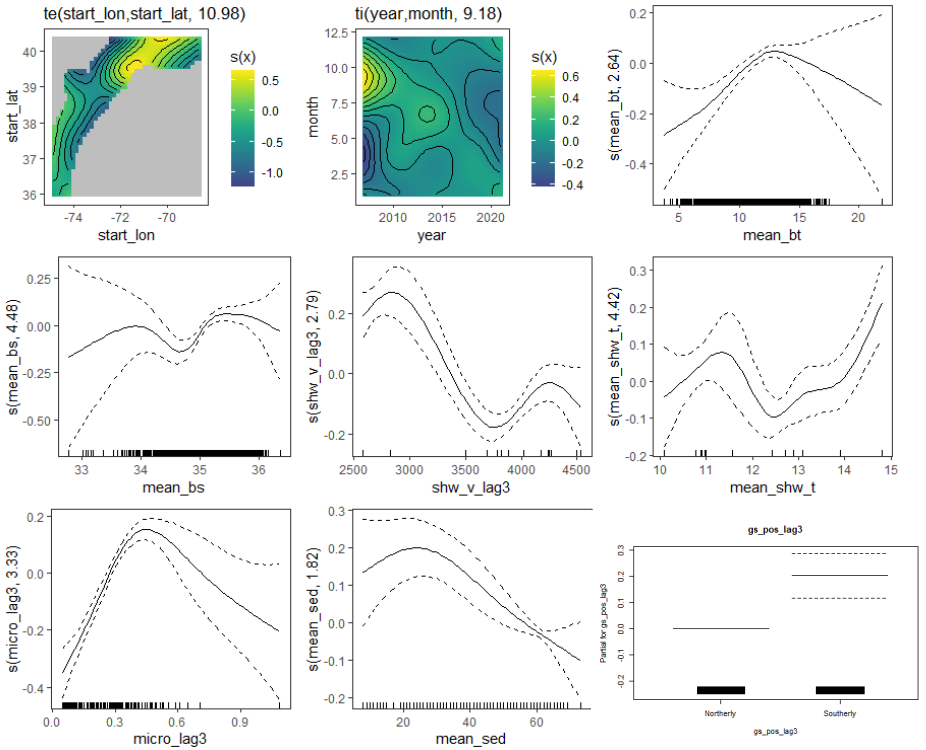
- In-situ
- Satellite data products
- Reanalysis model output

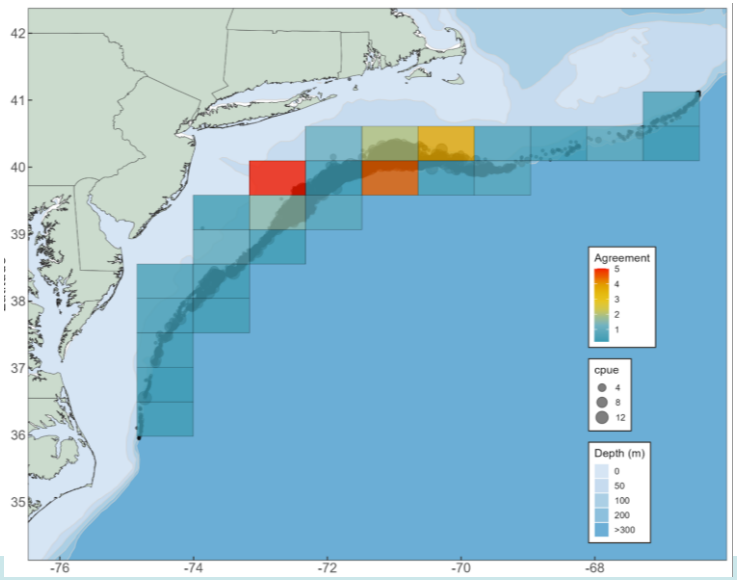
	CPUE No Lag (Year 4)	CPUE 3y Lag (Year 1)	Rec. Estimate (Year 1)	Rec. 1y Lag (Year 0)
SST	↓	↓	–	–
BT	–	–	–	–
Salinity	–	–	–	↓
SW Volume	–	↓	↓	↑ spring
SW Temp.	↓	↑	–	–
SW Salinity	–	↑	–	–
GSI	↓	↑ winter ↓ summer	–	–
CP Extent	–	↓	↓	↓
CP Persistence	–	↓	↓	↓
CP Index	–	–	↑	–
Microplankton	↑	↑ fall	–	↑ fall
CHL-a	↑		–	–

	No trend, but matches literature
	Not tested
–	No trend
↑	Positive significant trend
↓	Negative significant trend
↑ ↓	Non-significant trend (+ or -)

Golden Tilefish CPUE

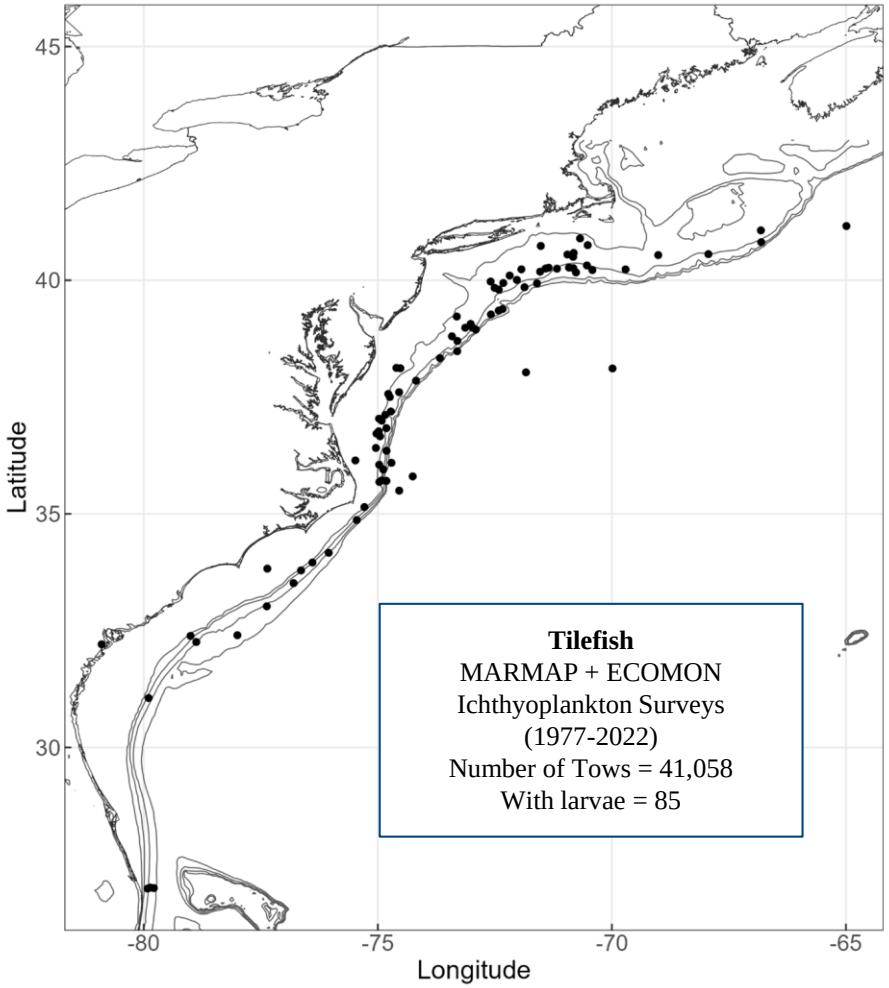
- Spatial/temporal effects
- Bottom temperatures (9-15 °C)
- Bottom salinity (34-36 psu)
- Smaller sediment grain size
- Lower shelf water volume (lag 3 yrs)
- Increased microplankton abundance (lag 3 yrs)

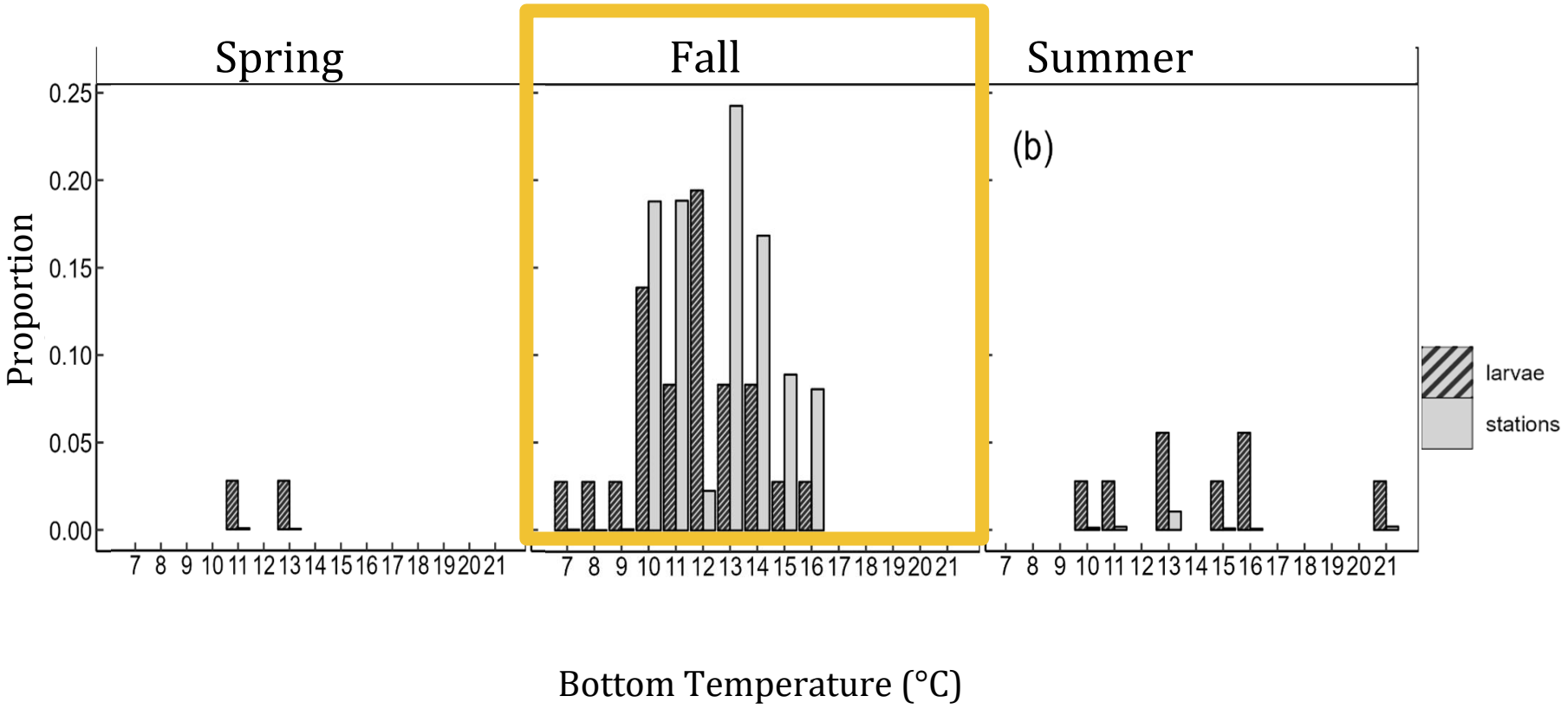




Larval Distributions

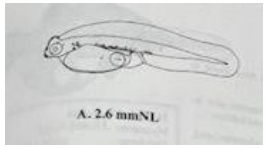
- MARMAP (1977-1987) and EcoMon (1992-2022)
- Larvae are rarely collected
  - Appear in only 11% of cruises in 33 out of 53 years
- Number of larvae caught in MARMAP vs EcoMon is not significantly different
- Average number of larvae caught has not changed over time

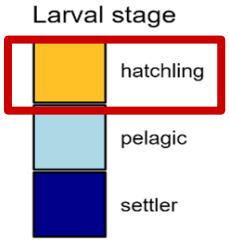


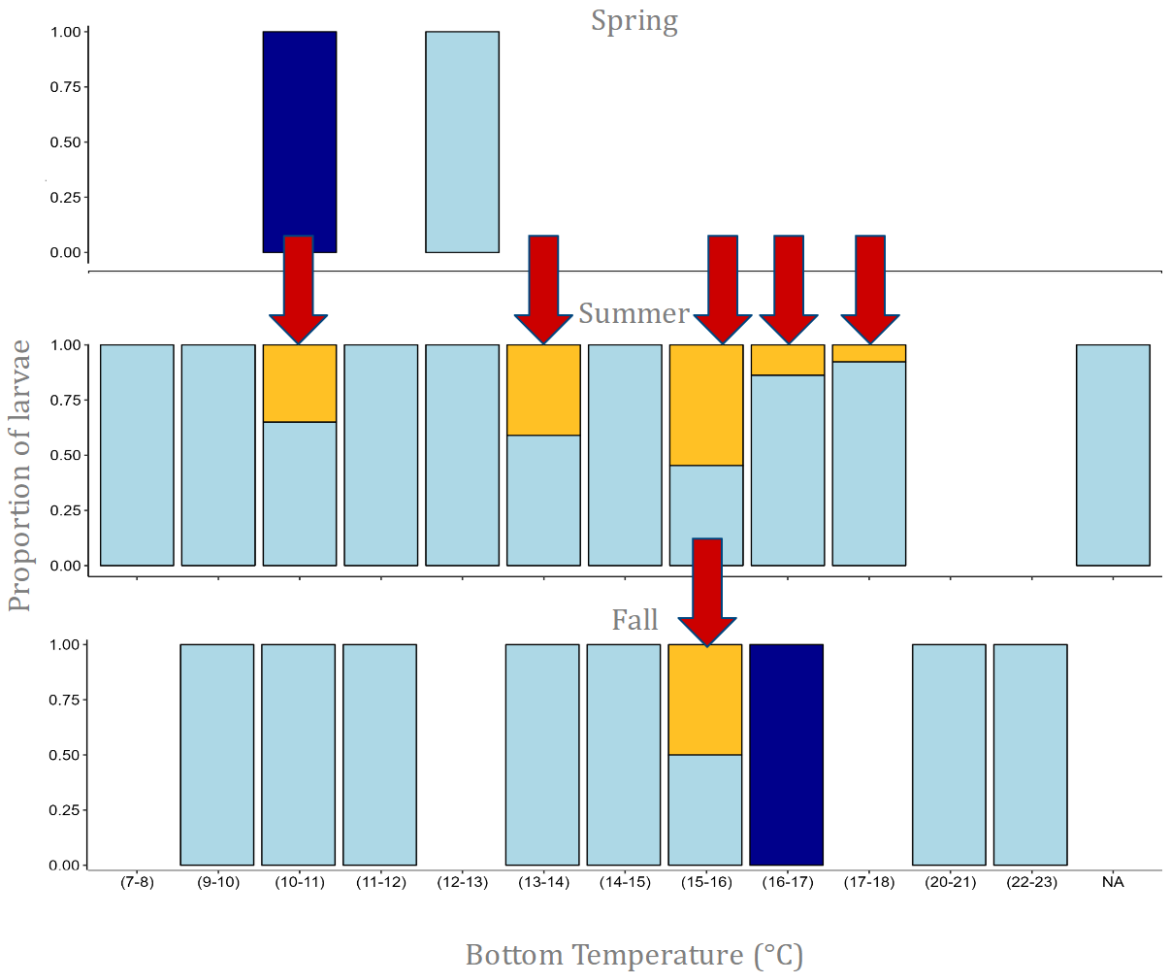


- Larvae most abundant in summer months (July, August, September)
  - Aligns with timing of peak-spawning period (Grimes et al., 1988)
- No larvae caught during January or March across all years
  - Two larval events in February (one in 1985, one in 2001), no coincident temperature, salinity

- Newly-hatched larvae (25%, n=22) only observed in the summer and fall

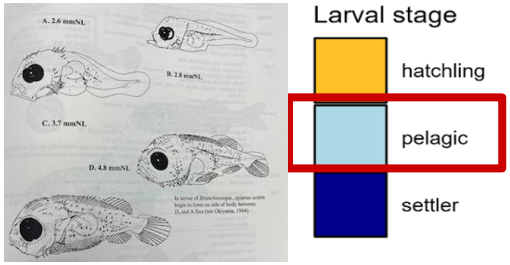


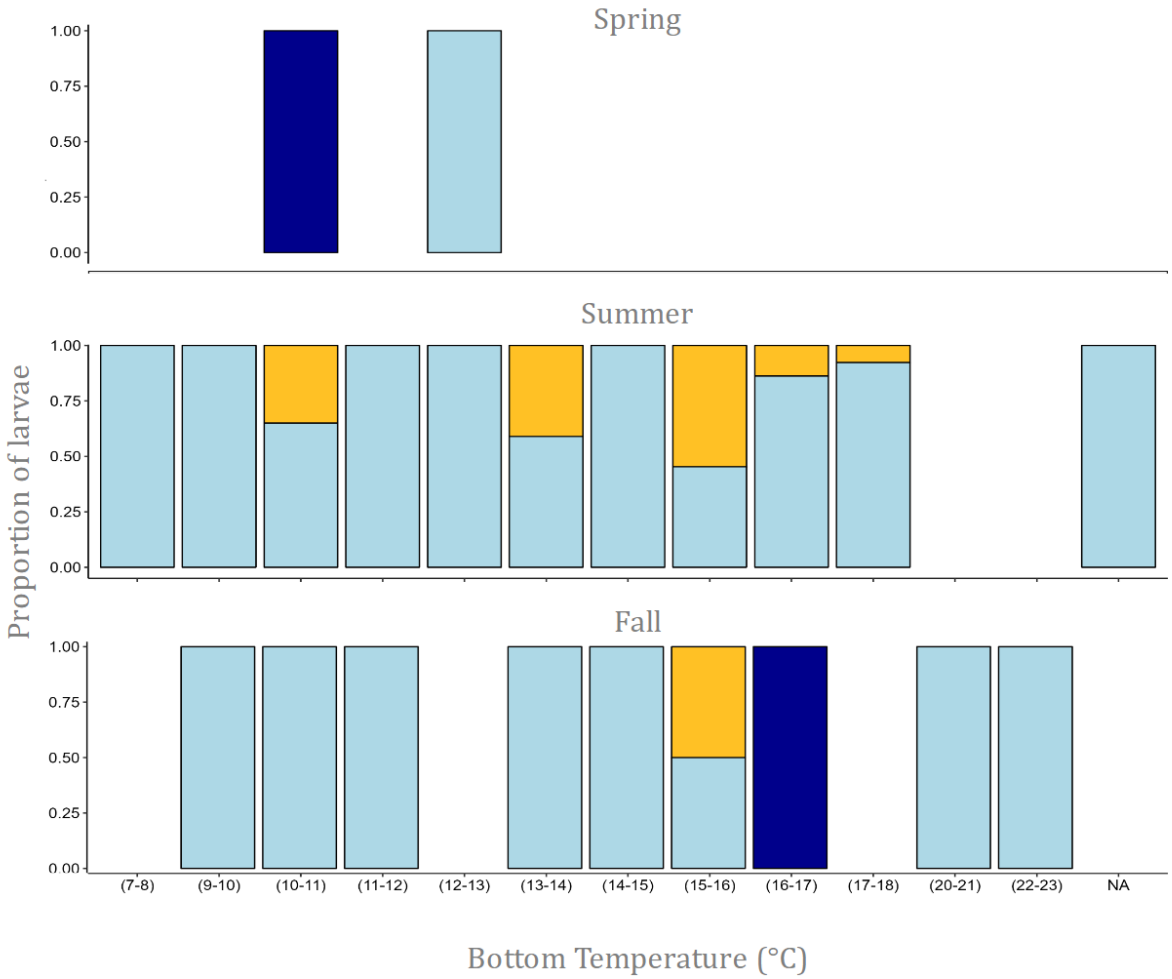




Fahay, M. P. (2007). Early stages of fishes in the Western North Atlantic Ocean. Northwest Atlantic Fisheries Organization. Dartmouth.

- Older, pelagic larvae (73%, n=66) found at a wider range of temperature (7-23°C)
- Represent the greatest proportion of larvae collected in spring and fall





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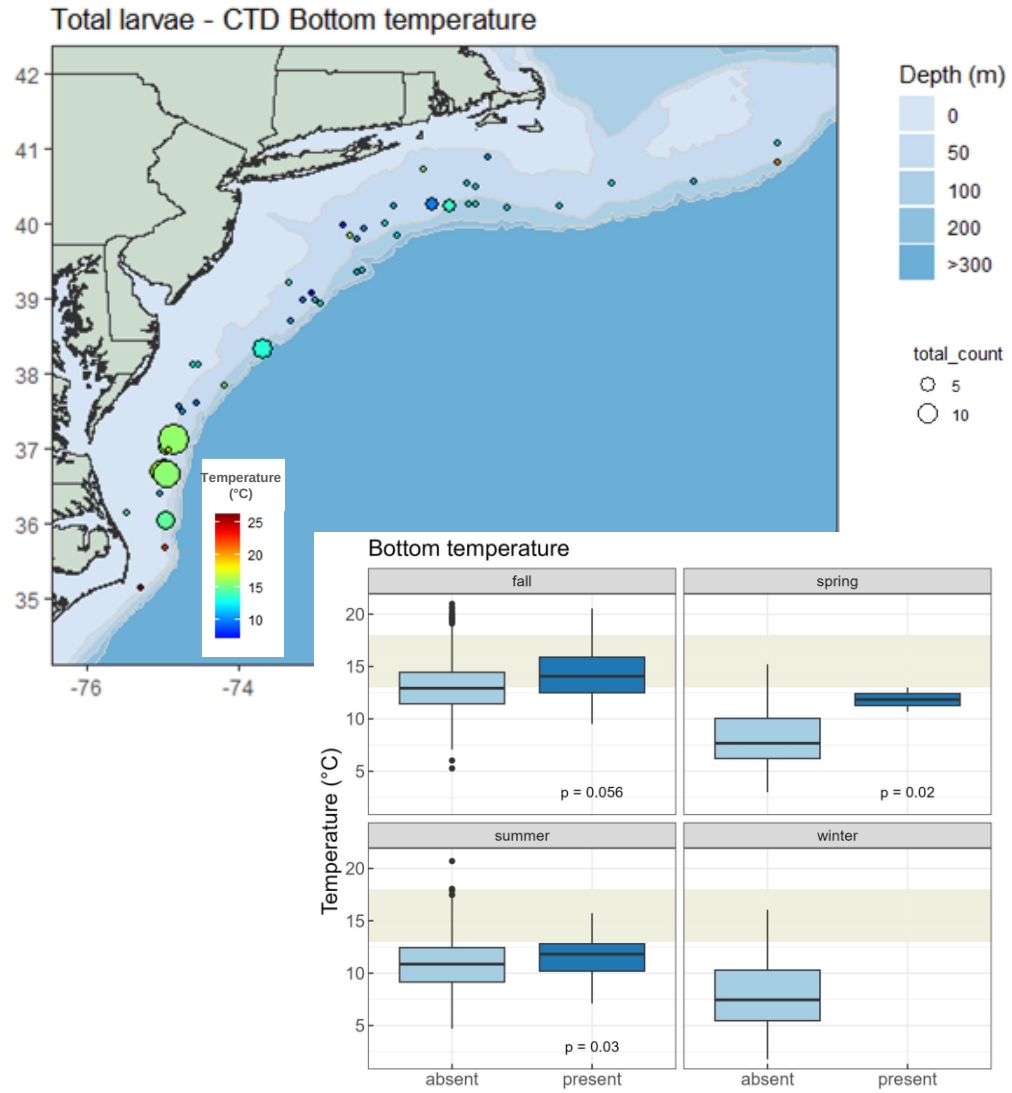
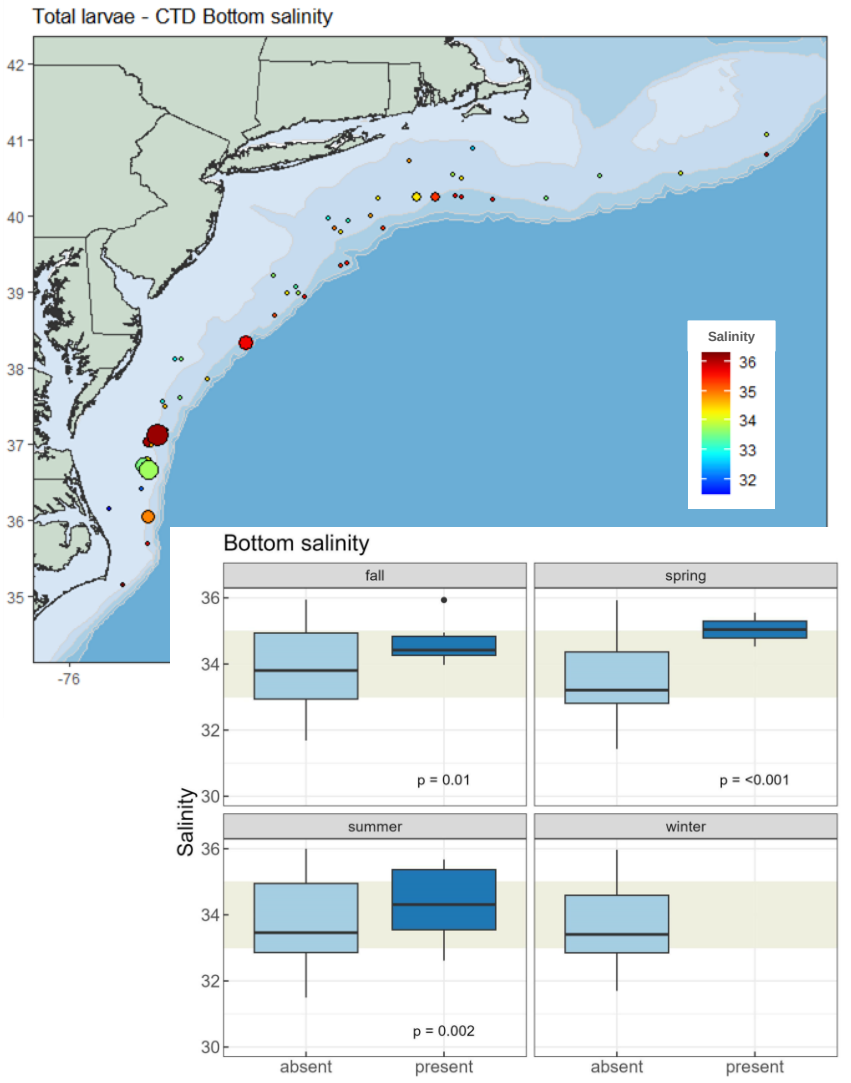
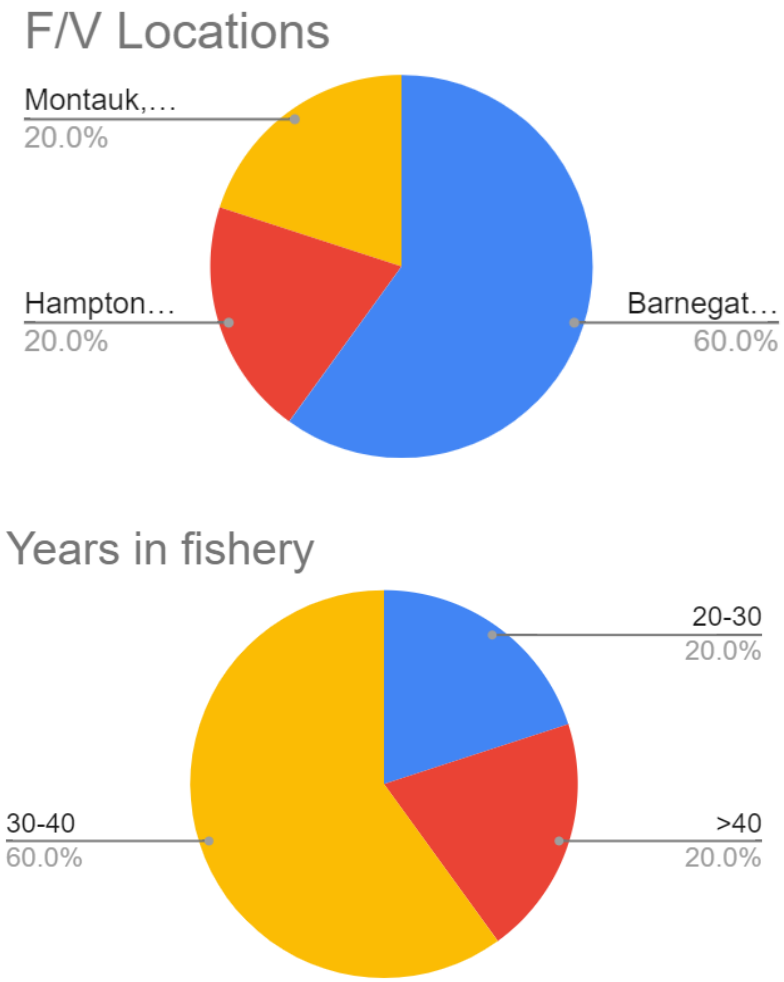




Associated with bottom temperatures 7-16°C and salinities between 31.47-36.3 psu

Socioeconomic Input: Industry Perspective



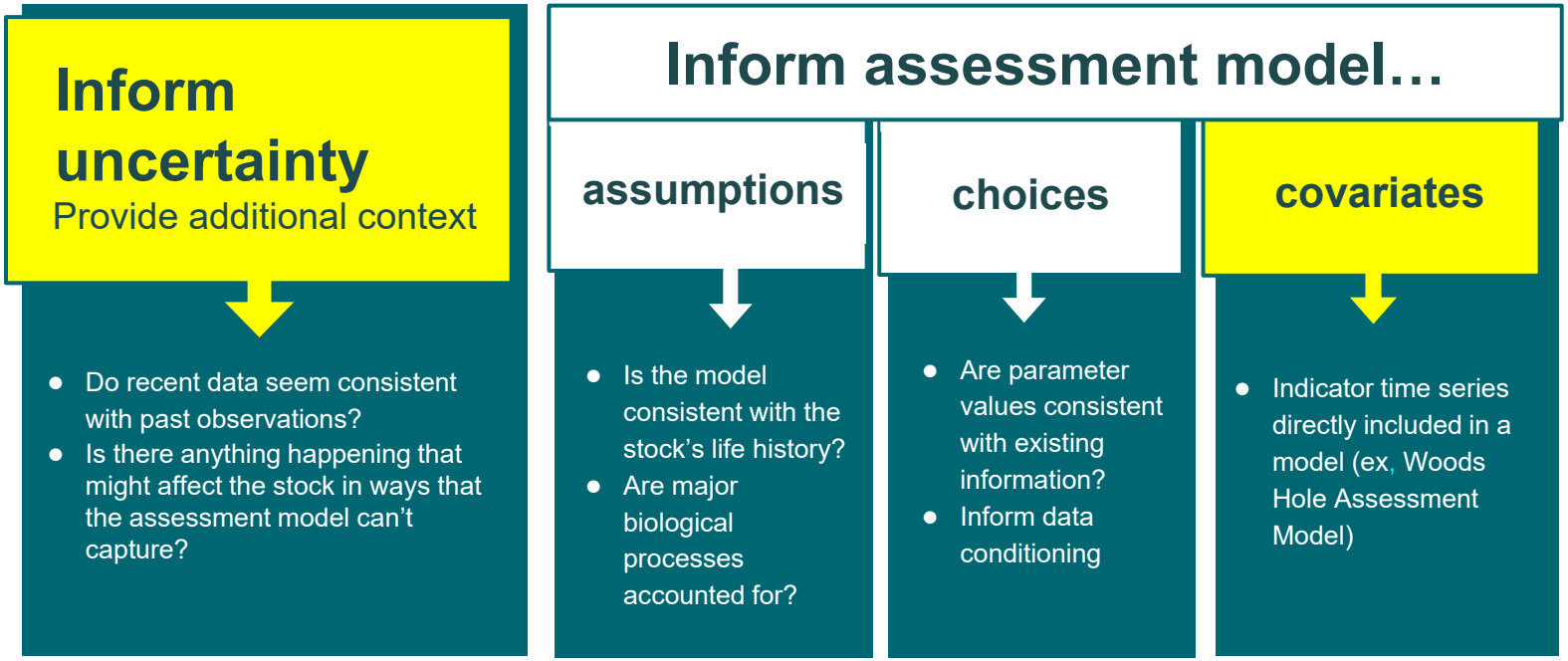
- Conversations with 5 industry members representing 4 fishing vessels
- Industry members highlighted the importance of socioeconomic indicators:
  - Quotas
  - More profitable fisheries
  - Market (value, staffing)
  - Fishing behavior
    - Weather
    - Fleet interactions, competition for space (lobster, squid)
- Competition for hooks with Dogfish, Skate

Summary

- High resolution fisheries-dependent data valuable resource for increasing understanding of ecosystem associations of data-limited stocks
- Combining FEK and scientific expertise enabled development of testable hypotheses about stock dynamics
- Development of novel / fine-scale oceanographic indicators tailored to individual stocks critical for identifying important and complex oceanographic drivers

Summary

- Provided additional context about environmental signals that may impact stock dynamics and are not captured in assessment model
- Generated a suite of research recommendations to improve understanding / overcome data limitations
- Groundwork and support for further development of indicators for future stock assessment models



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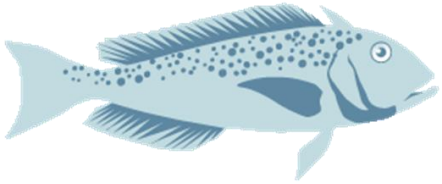

CRB, EDAB

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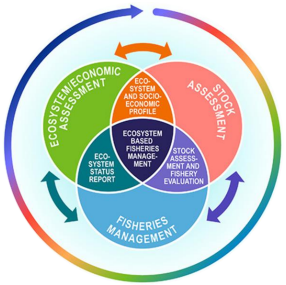
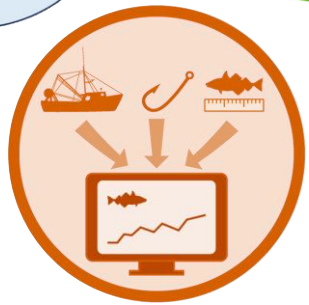
GTF RTA Working Group Members





Indicator Data Sources

Data Source	Indicators	Spatial/Temporal Extent
GLORYS12 (modeled global ocean reanalysis)	Bottom temperature Bottom salinity Sea surface temperature	Spatially-explicit locations in golden tilefish strata, averaged by month
NEFSC 'ecodata' package (compiled for State of the Ecosystem)	Cold pool index/extent/persistence Gulf Stream Index	Annual indices across Northeast Shelf
NEFSC Study Fleet and Observer Program	Sediment grain size Bottom temperature	Fishing point locations
NEFSC Survey CTD data	Shelf water volume/temperature/salinity	Spatially-explicit locations in golden tilefish strata, averaged by month
OC-CCI (Ocean Colour Climate Change Initiative) (merged satellite data)	Microplankton Chlorophyll-*a*	Spatially-explicit locations in golden tilefish strata, averaged by month