Incorporating Fishermen's Knowledge into Standardized Catch-per-Unit-Effort Indices for the Commercial Monkfish Fishery

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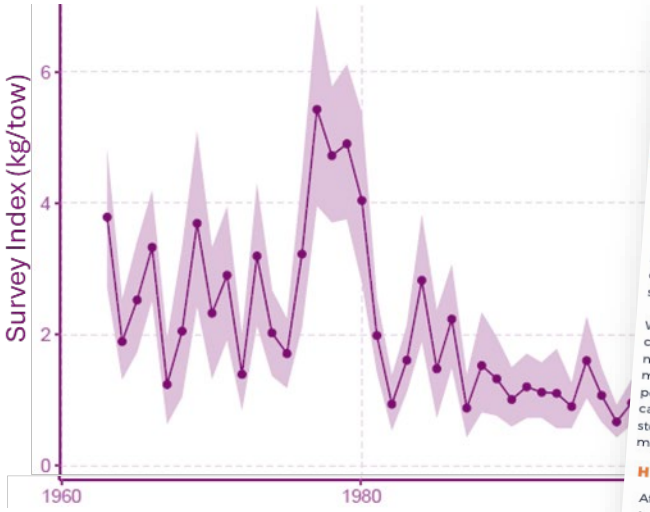
New England Fishery Management Council, Scientific and Statistical Committee Sub-Panel

March 13, 2026

Standardized Monkfish Catch Rates

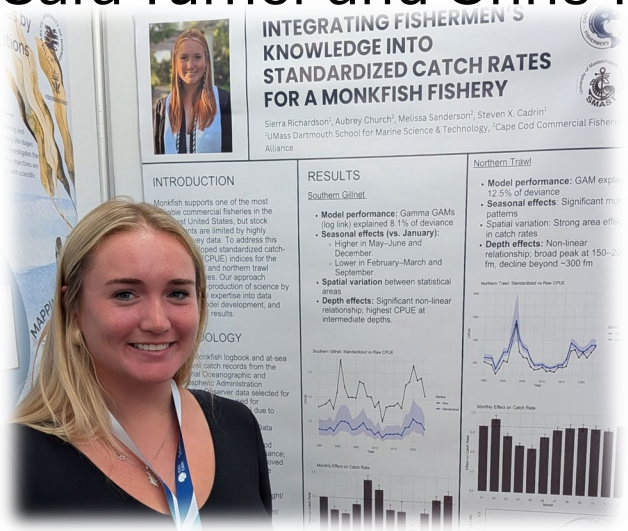
- Background
  - monkfish assessment & management
  - Research Set-Aside Project
- Methods
  - Industry Workshops
  - Logbook & Observer Data
  - Standardization Models
- Results
  - Southern Gillnet Indices
  - Northern Trawl Indices
- Interpretations
  - Common trends and potential stock indices

$$\widehat{CPUE}_{i,t} = f(year, month, area, depth, vessel\ length) + \varepsilon_i$$



Acknowledgments

- Funding from Monkfish Research Set-Aside Program, Cape Cod Commercial Fishermen's Alliance, & New England Fishery Management Council
  - Sierra Richardson: data explorations and analyses
  - Mel Sanderson & Aubrey Church: industry outreach and compensation trips
  - Industry Working Group: Greg Connors, Sam Linnell, Greg Mataronas, Patrick Duckworth, and Ted Platz
  - Other monkfish fishermen, NEFMC Skate & Monkfish Advisory Panel and Committee, Jenny Couture, Andy Jones and Pingguo He.
  - Sara Turner and Chris Tholke (NOAA) for providing data.



Monkfish Catch Rates – Project Objectives

1. Elicit fishermen's ecological knowledge to understand the monkfish fishery and fishery monitoring data;
2. Develop standardized catch rate indices for the commercial directed monkish gillnet fishery and possibly the multispecies trawl fishery; and
3. Compare alternative standardized indices with NEFSC survey trends to evaluate consistency in interannual trends.

2023–2024 Monkfish Research Set-Aside Awards

Institution	Project Title	Research Budget	Allocation (DAS)
Cornell Cooperative Extension Association of Suffolk County	Addressing Monkfish Management Needs by Developing a Standardized Catch per Unit Effort Time Series	$140,209	2023: 250 2024: 150
Cape Cod Commercial Fishermen's Alliance, Inc.	Incorporating Fishermen's Knowledge into a Standardized Catch Per Unit Effort Index for the Commercial Monkfish Gillnet Fishery	$150,344	2023: 250 2024: 200

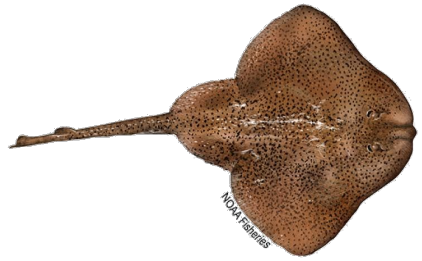
Industry Meetings

- Meetings with monkfish fishermen and scientists in the summer of 2024 to review the project objectives and general approach.
- In-person industry workshops:
  - Point Judith, Rhode Island (October 21, 2024)
  - New Bedford, Massachusetts (October 24, 2024)
  - Portland, Maine (November 4, 2024)
  - Chatham, Massachusetts (November 6, 2024)
  - Gloucester, Massachusetts (November 12, 2024).
- Virtual workshop with fishermen from New Jersey and New York (October 22, 2024).
- Meetings with the Council's Monkfish Advisory Panel and Committee (September 9, 2024; May 13, 2025; July 28, 2025; October 20, 2025).

Monkfish Fishery Data

- Logbook (Vessel Trip Reports) landings and fishing effort for all trips that caught monkfish, 1999-2023
- Northeast Fisheries Observer Program and At-Sea Monitoring samples of catch (kept + discarded) and fishing effort for all trips that caught monkfish, 1989-2023
- Catch and effort records were grouped by sink gillnets in the southern area and bottom otter trawls in the northern area.
- Alternative measures of fishing effort were examined for their suitability in the catch-per-unit effort calculations.
  - For gillnet trips - soak duration, days-at-sea, soak duration x number of nets, or soak duration x number of nets x panel length.
  - For trawl trips - tow duration or days-at-sea.
  - Gillnet soak duration and trawl duration were selected because of data quality problems with more precise metrics of effort.

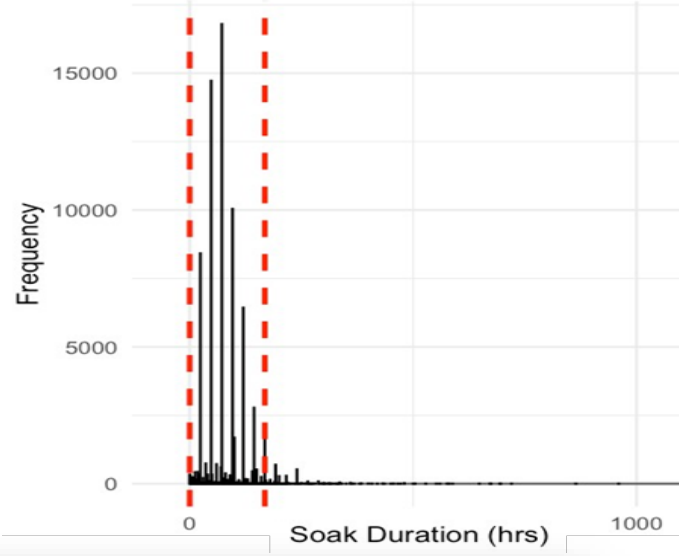
Industry Meetings

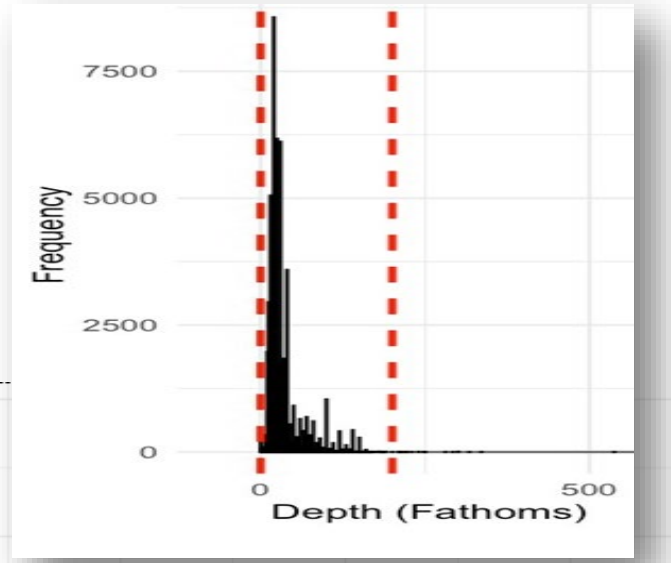


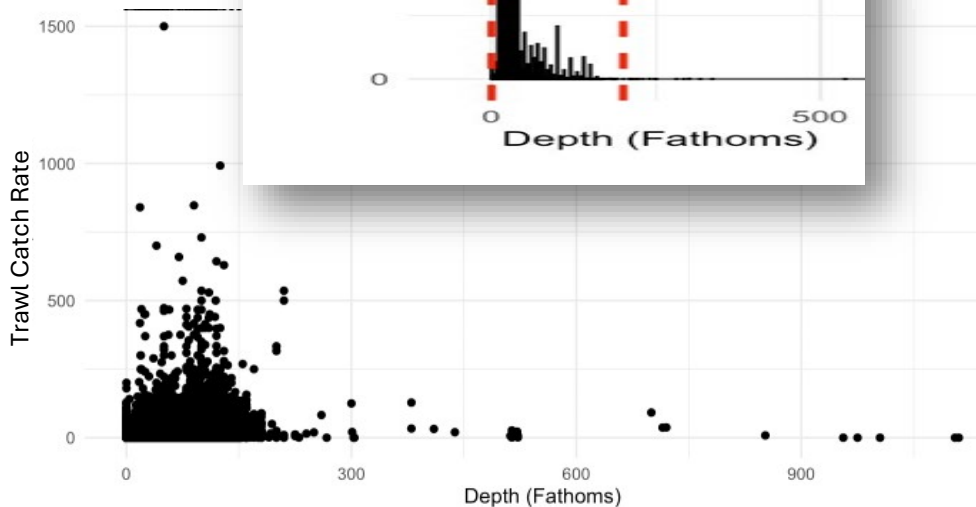
- Fishermen reported that recent declines in monkfish landings from were primarily from increased skate catch in the gillnet fishery, market weakness, and regulatory constraints rather than reduced monkfish availability.
- Workshop participants emphasized differences in fishing behavior and gear, including shifts toward larger mesh sizes, variation in gillnet soak duration by season and depth, and the influence of seasonal migrations on depth distribution.
- Industry feedback also highlighted problems in the quality of logbook and observer data (e.g., inconsistent gear fields and effort metrics) and suggested improvements for future analysis.
- Reasonable data ranges were considered to identify monkfish-directed fishing effort, including standard gear used and typical fishing practices.
- Workshops provided crucial operational context for interpreting catch rate indices and guided model refinement and data filtering decisions.

Monkfish Fishery Data ‘Cleaning’

- Data selection removed erroneous or non-representative observations identified from industry workshops.
  - Trawl tow speed >6 knots (0.8% of northern trawl observations).
  - Gillnet soak >7 days (<5% of southern gillnet observations)
  - Gillnet mesh <10” or >15” (5.3% of southern gillnet observations)
  - Gillnet panel <200’ or >400’ (4.9% of southern gillnet observations)
  - Depth >200 fathoms (<1% of observations)
  - Extreme catch rate values above the 99th percentile
- Other data exclusions for sensitivity analyses
  - trips that caught >50% skates
  - trips that caught <50%, <60%, or <70% monkfish





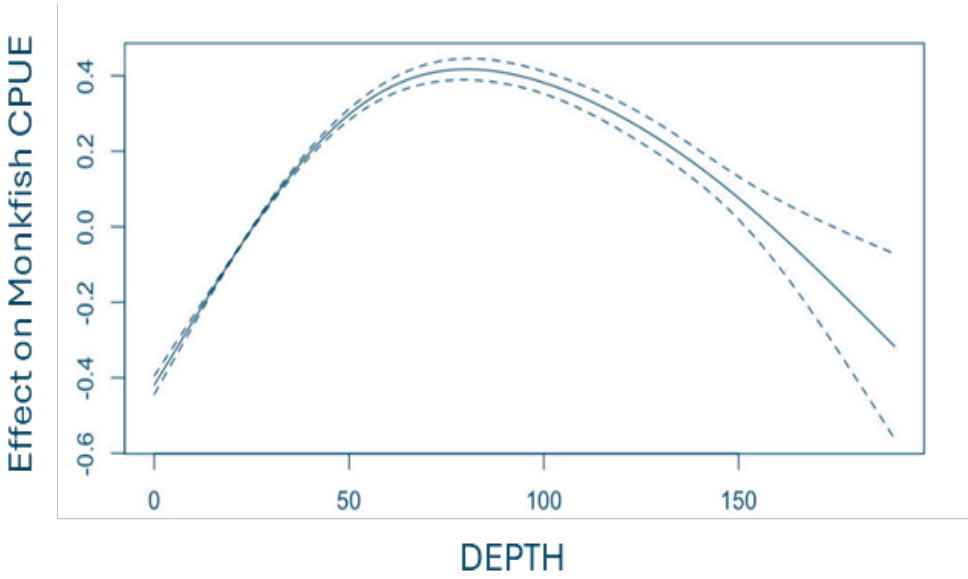


Monkfish Catch Rate Standardizations

- Generalized Additive Models (GAMs) were used to standardize nonlinear effects on catch-per-unit-effort (CPUE) and predictor variables.

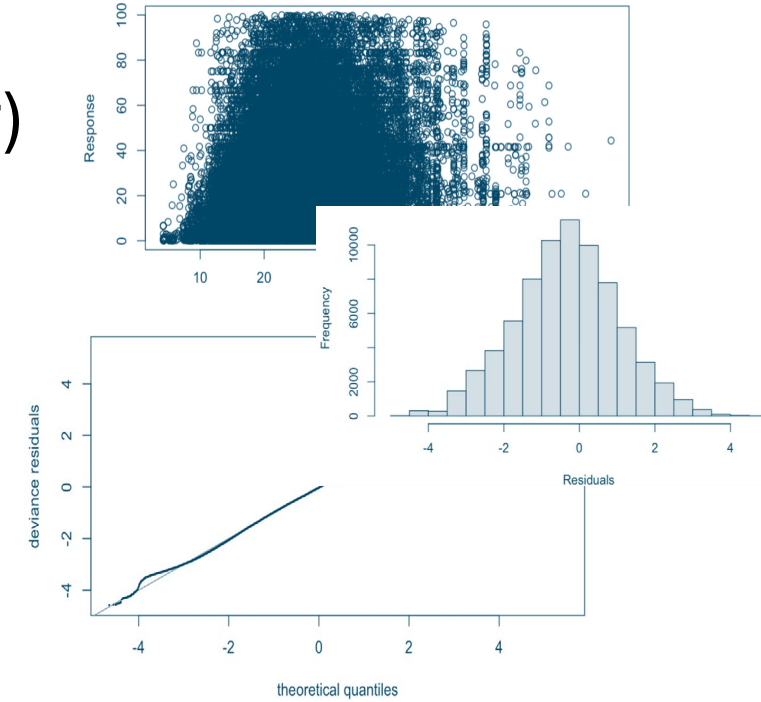
$$\widehat{CPUE}_{i,t} = f(year, month, area, depth, vessel\ length) + \varepsilon_i$$

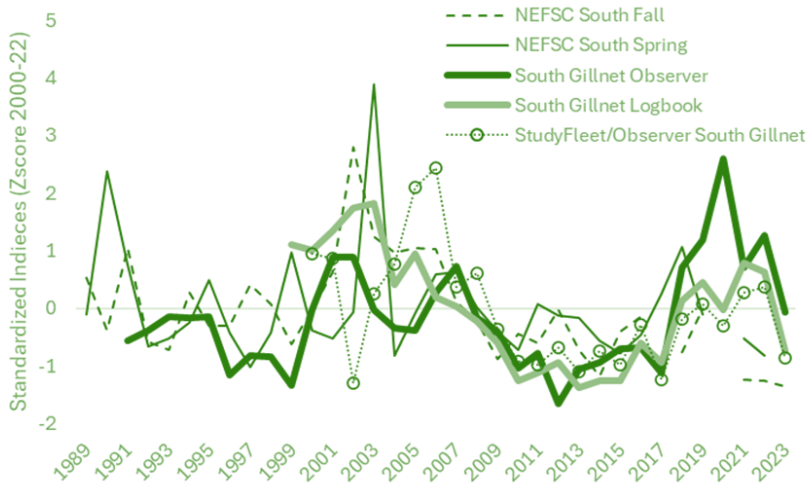
  - A range of potential predictor variables were tested (year, statistical area, month, depth, latitude, longitude, mesh size, tow speed, gillnet tiedowns, vessel length, vessel tonnage, horsepower, skate CPUE, depth x area, area x month interactions) based on guidance from fishermen.
  - For correlated predictor variables, only the variable that had the strongest effect on CPUE was retained.
  - The Tweedie statistical distribution was selected among alternatives (Gamma, Gaussian families) for its flexibility and fit to the monkfish catch rate data .



Monkfish Catch Rate Standardizations

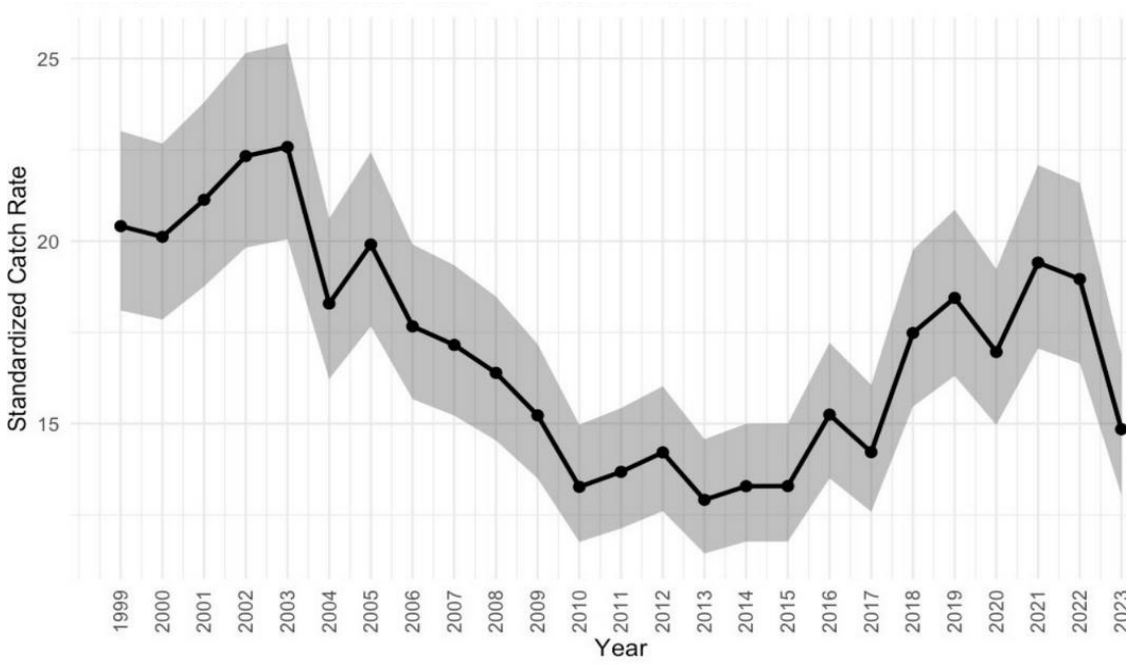
- Four candidate models were selected to represent each combination of data source (logbook or observer) and fleet (northern trawl or southern gillnet).
- Among the alternative model specifications, the optimal models were selected based on statistical diagnostics (convergence, residuals, AIC, % deviance explained, adjusted R^2) and practical considerations informed by fishery workshops.
- Standardized catch rate series were compared to NEFSC spring and fall bottom-trawl survey indices (NEFSC 2025) and high-resolution monkfish CPUE indices from NEFSC study fleet and observer data (Jones & Legault, 2026).

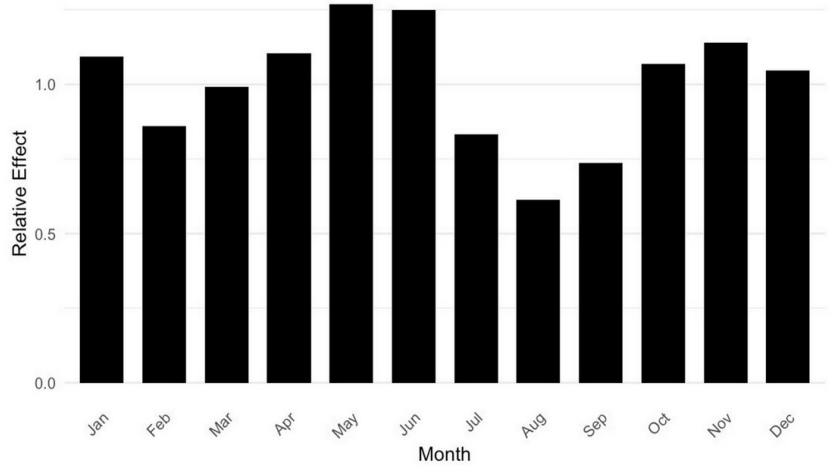


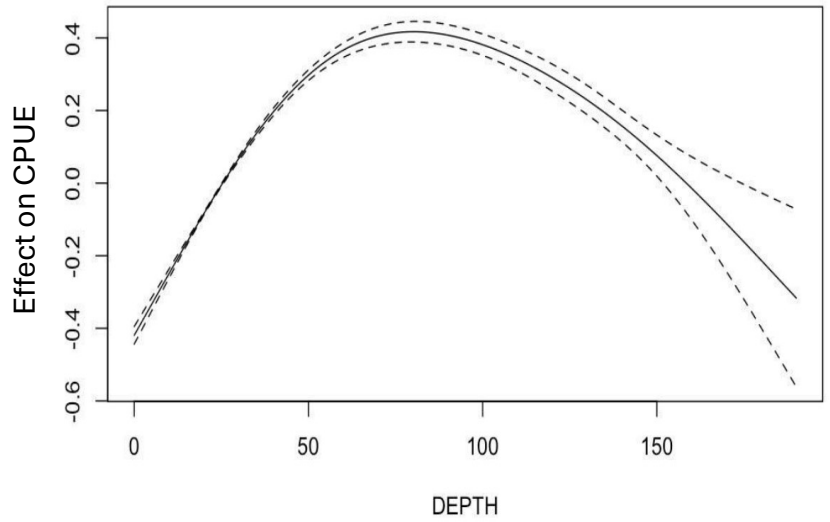


Results – Southern Gillnet Logbook Model

- Significant year, month, statistical area, and depth effects.

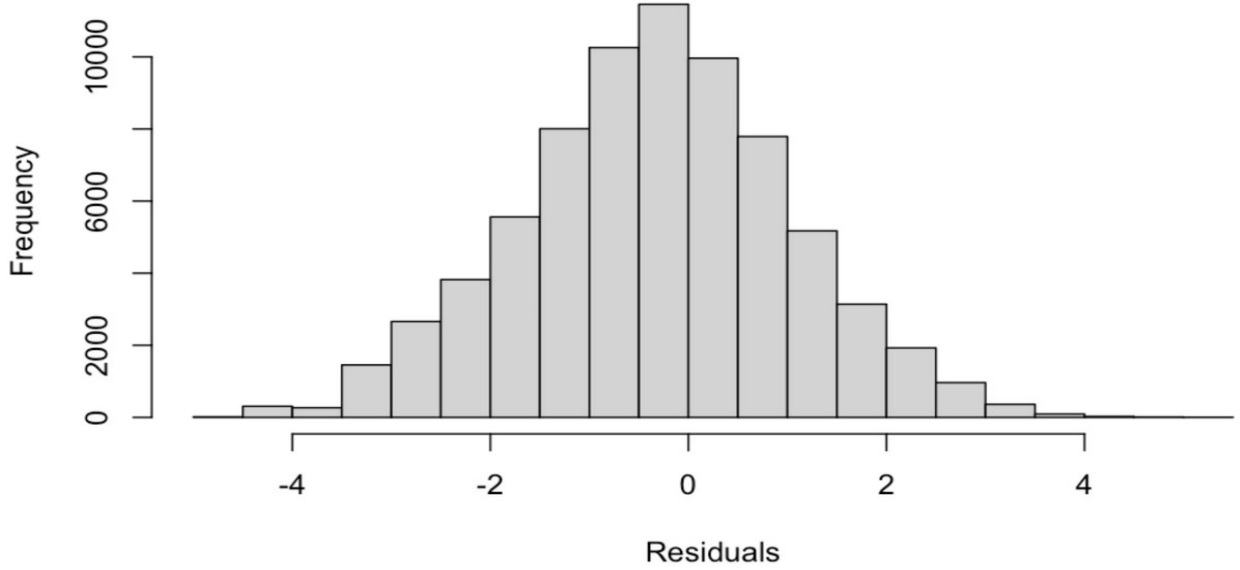


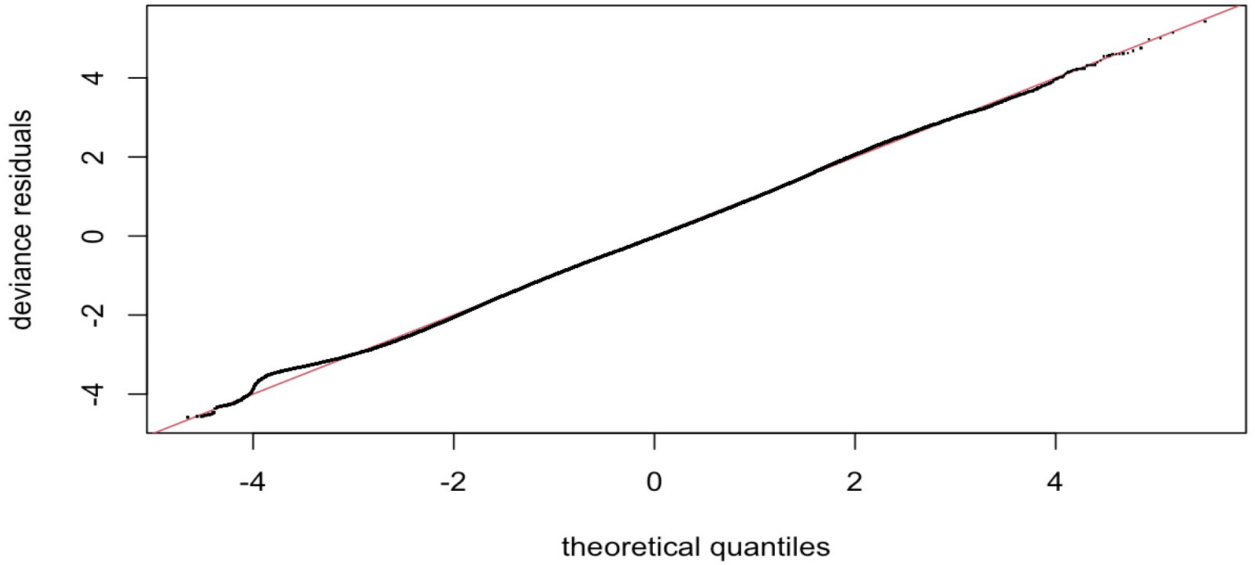


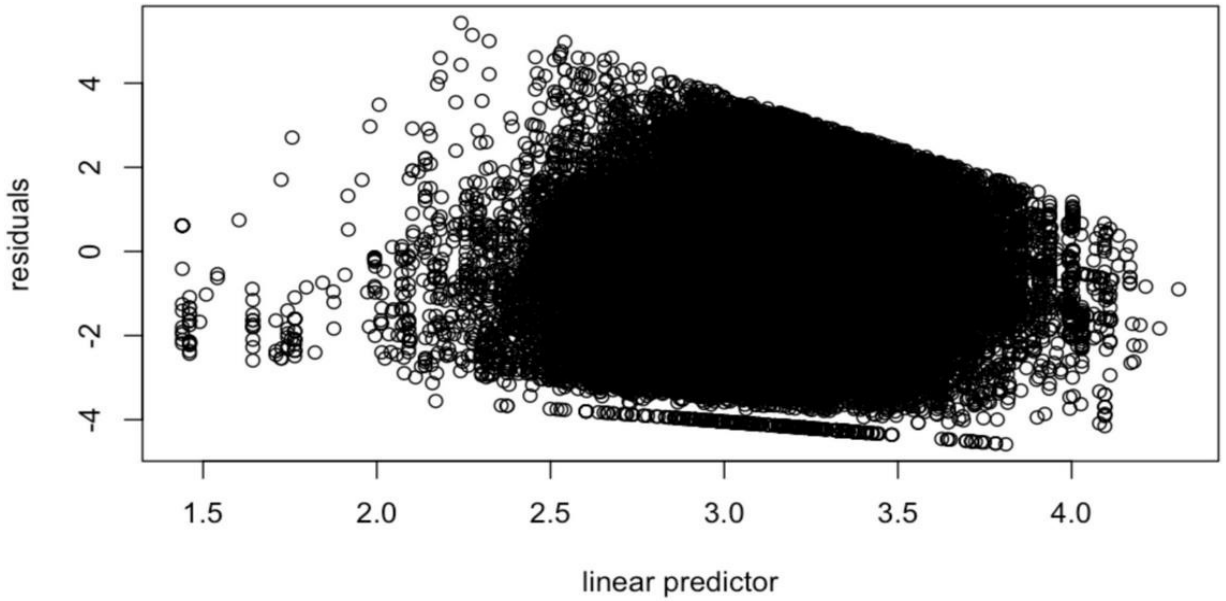


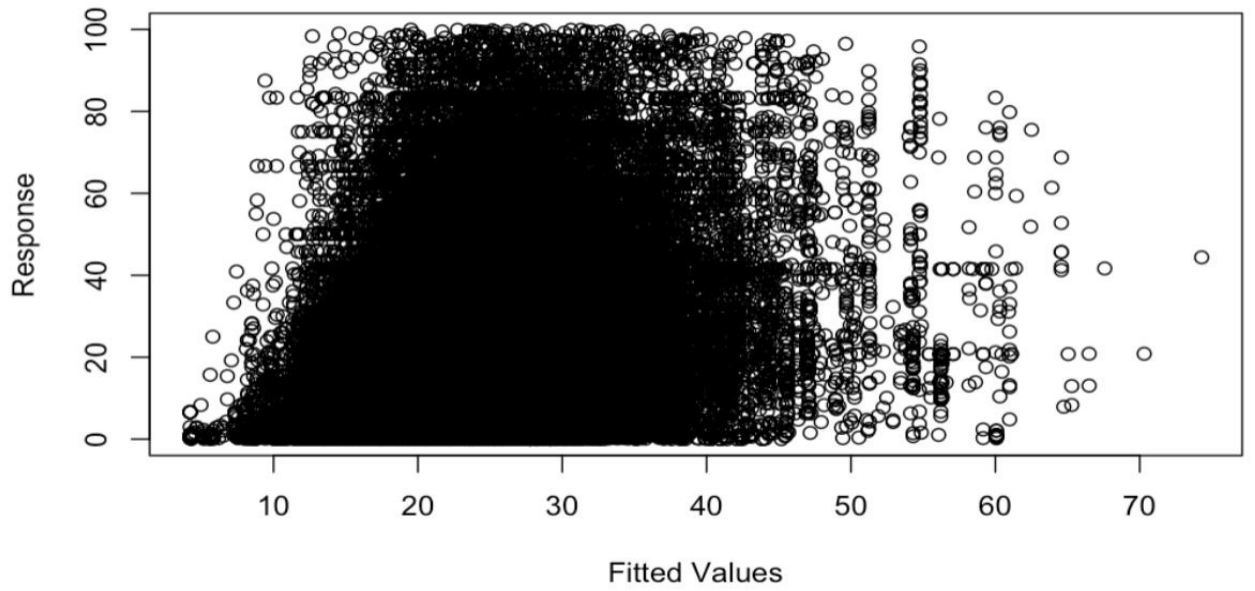
Area	Estimate	Std. Error	t value
526	0.184	0.065	2.83
537	0.177	0.059	2.99
538	-0.385	0.073	-5.26
539	0.198	0.06	3.28
552	0.478	0.171	2.79
562	-0.342	0.178	-1.92
611	0.317	0.066	4.79
612	0.303	0.06	5.06
613	0.462	0.06	7.73
614	0.175	0.063	2.78
615	0.277	0.06	4.64
616	0.355	0.064	5.6
621	0.554	0.062	8.86
622	0.385	0.078	4.95
623	0.559	0.218	2.57
625	0.42	0.064	6.56
626	0.67	0.061	10.96
627	0.666	0.123	5.41
631	0.143	0.076	1.87
632	-0.202	0.218	-0.93
635	0.464	0.067	6.9
636	-0.107	0.104	-1.03

Results – Southern Gillnet Logbook Model



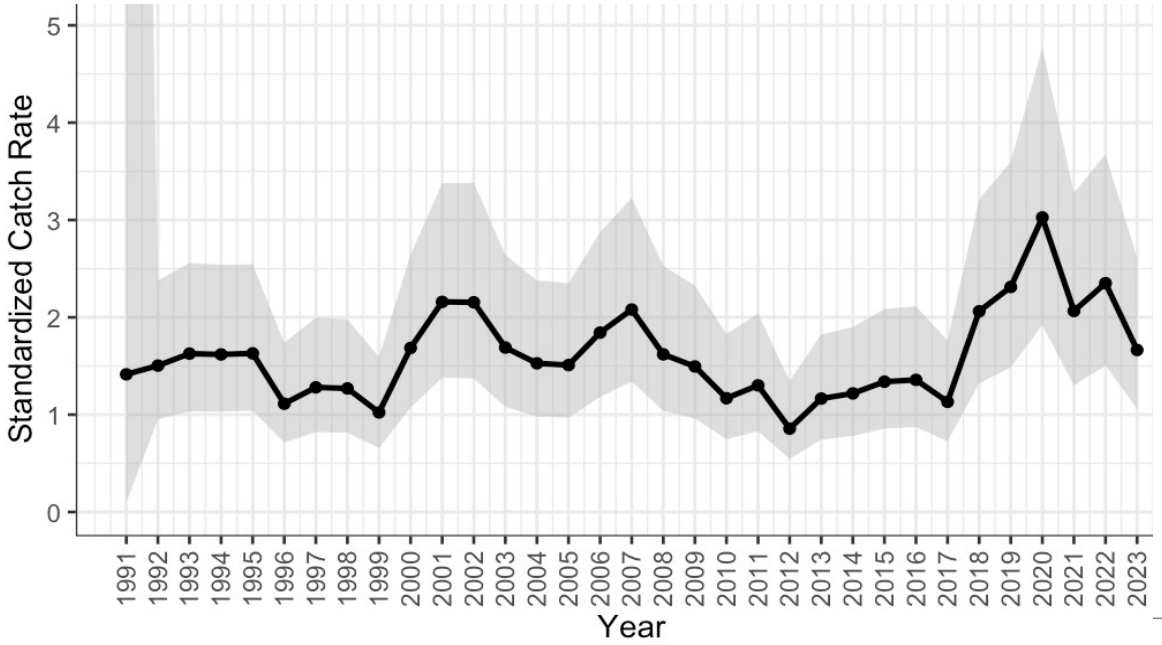


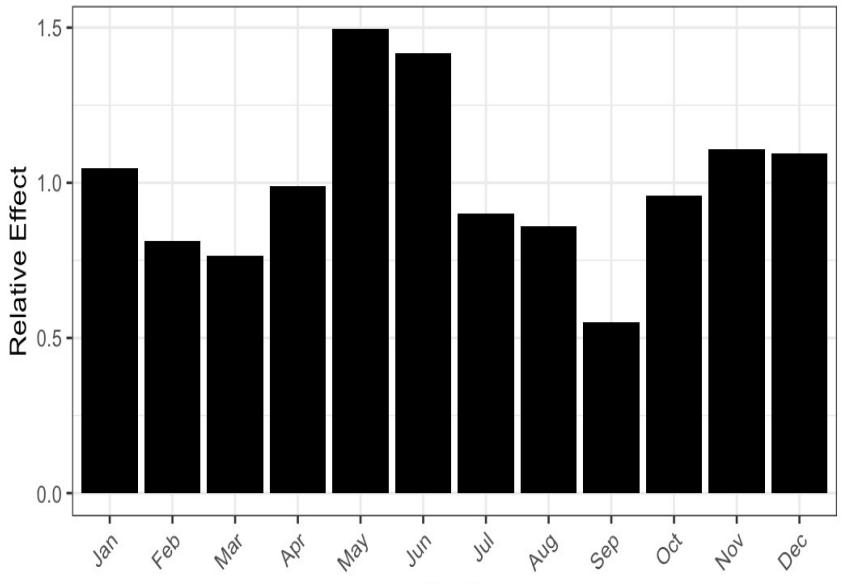




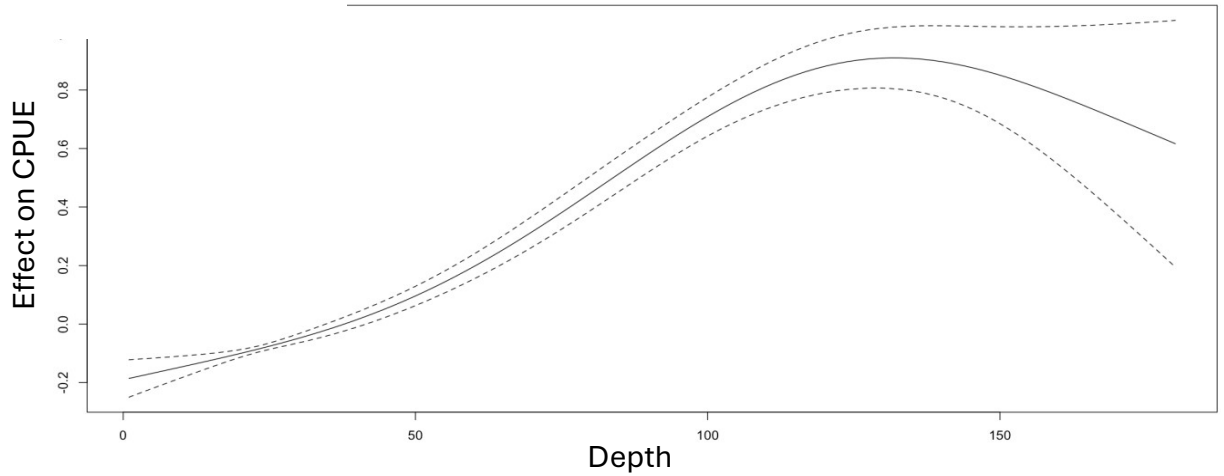
Results – Southern Gillnet Observer Model

- Significant year, month, area, tiedown presence, and depth effects





Area	Estimate	SE	t
526	0.824	0.229	3.6
537	0.772	0.223	3.47
538	0.41	0.319	1.28
539	0.662	0.224	2.96
562	0.879	0.911	0.96
611	0.187	0.467	0.4
612	1.137	0.224	5.08
613	1.072	0.223	4.8
614	0.681	0.242	2.82
615	1.236	0.223	5.53
616	1.352	0.229	5.91
621	0.954	0.226	4.22
622	1.181	0.29	4.07
625	1.479	0.229	6.46
626	1.278	0.225	5.67
631	1.067	0.239	4.47
635	1.593	0.229	6.97
636	2.375	0.279	8.52



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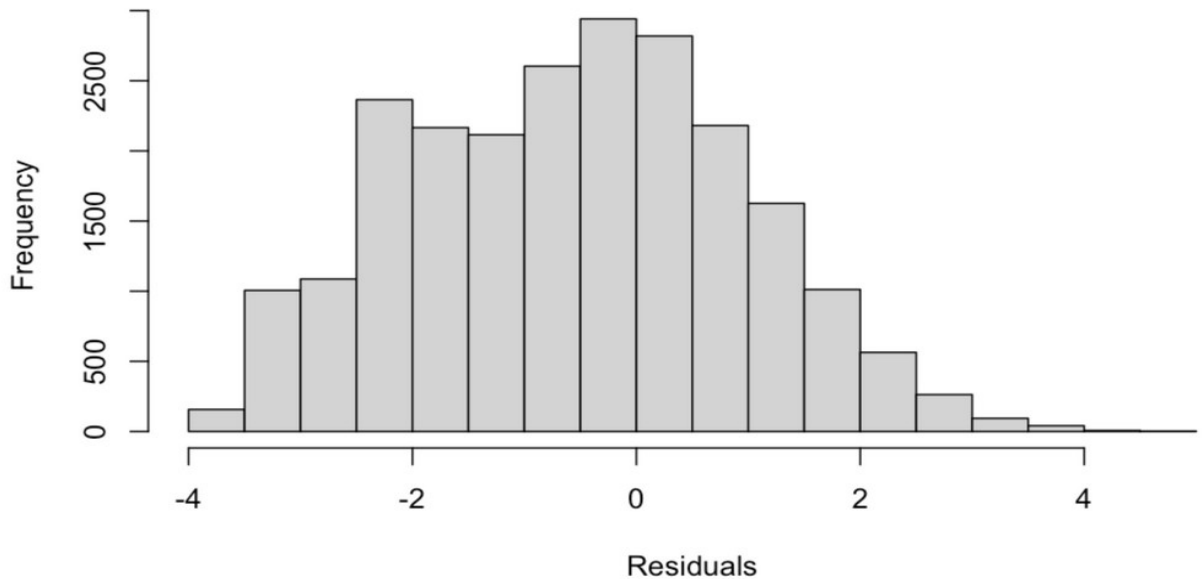
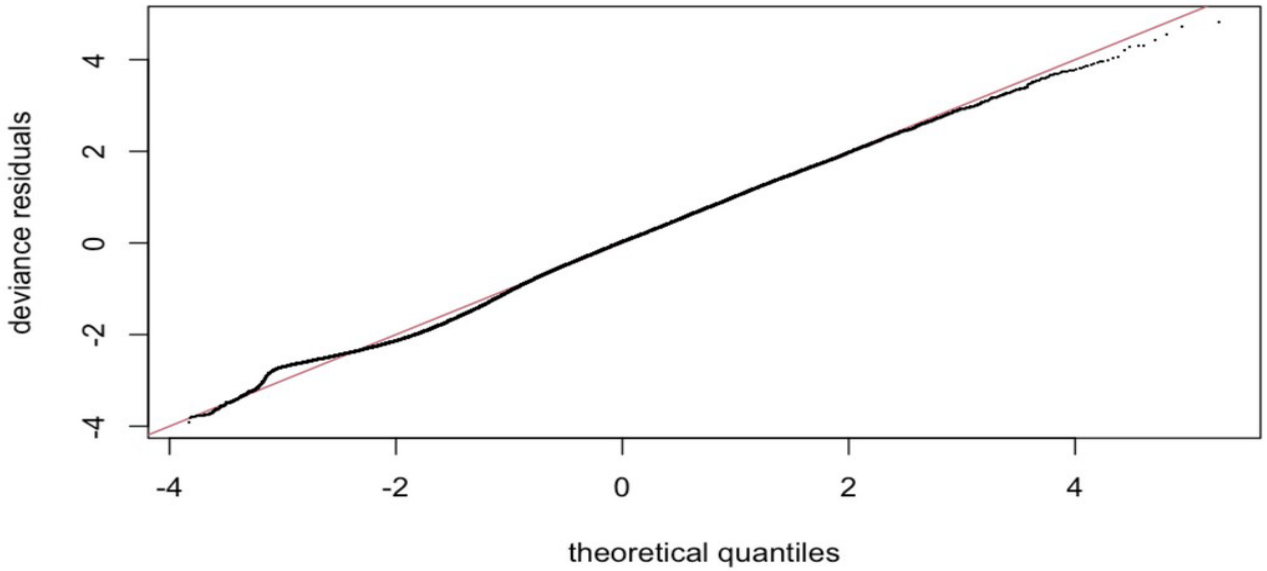
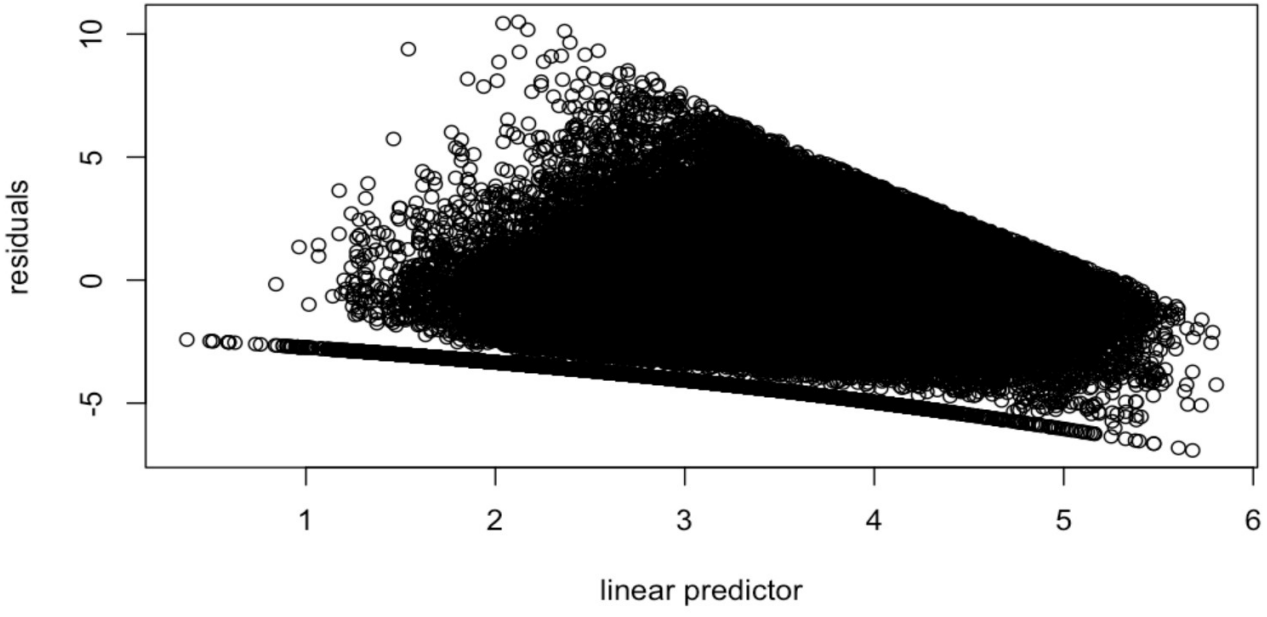
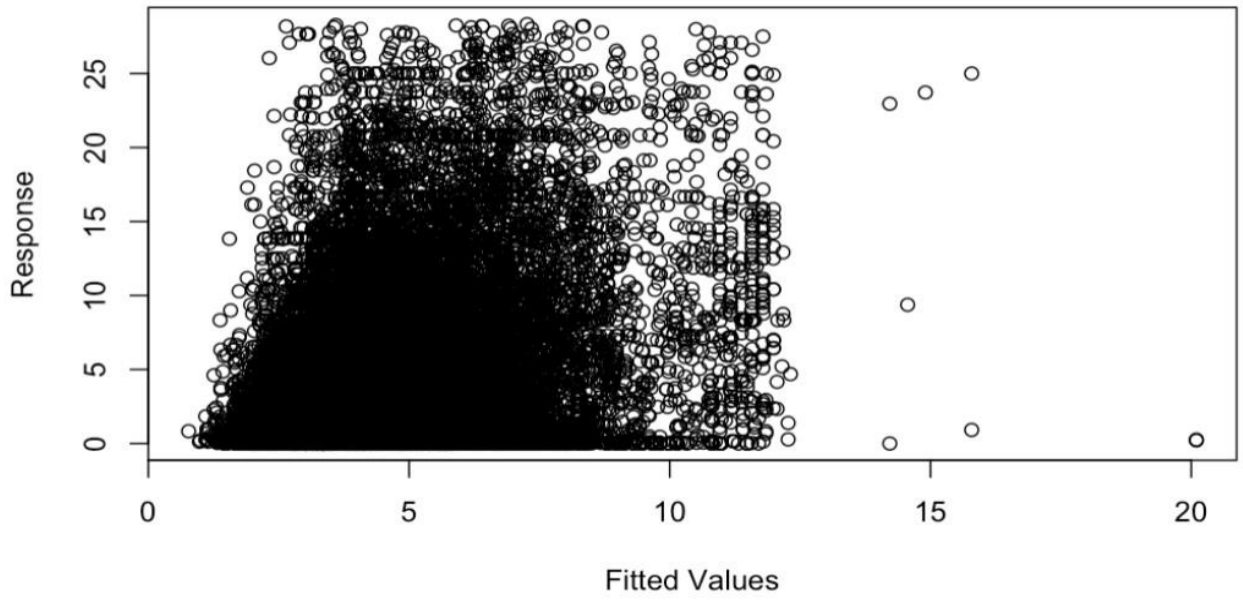


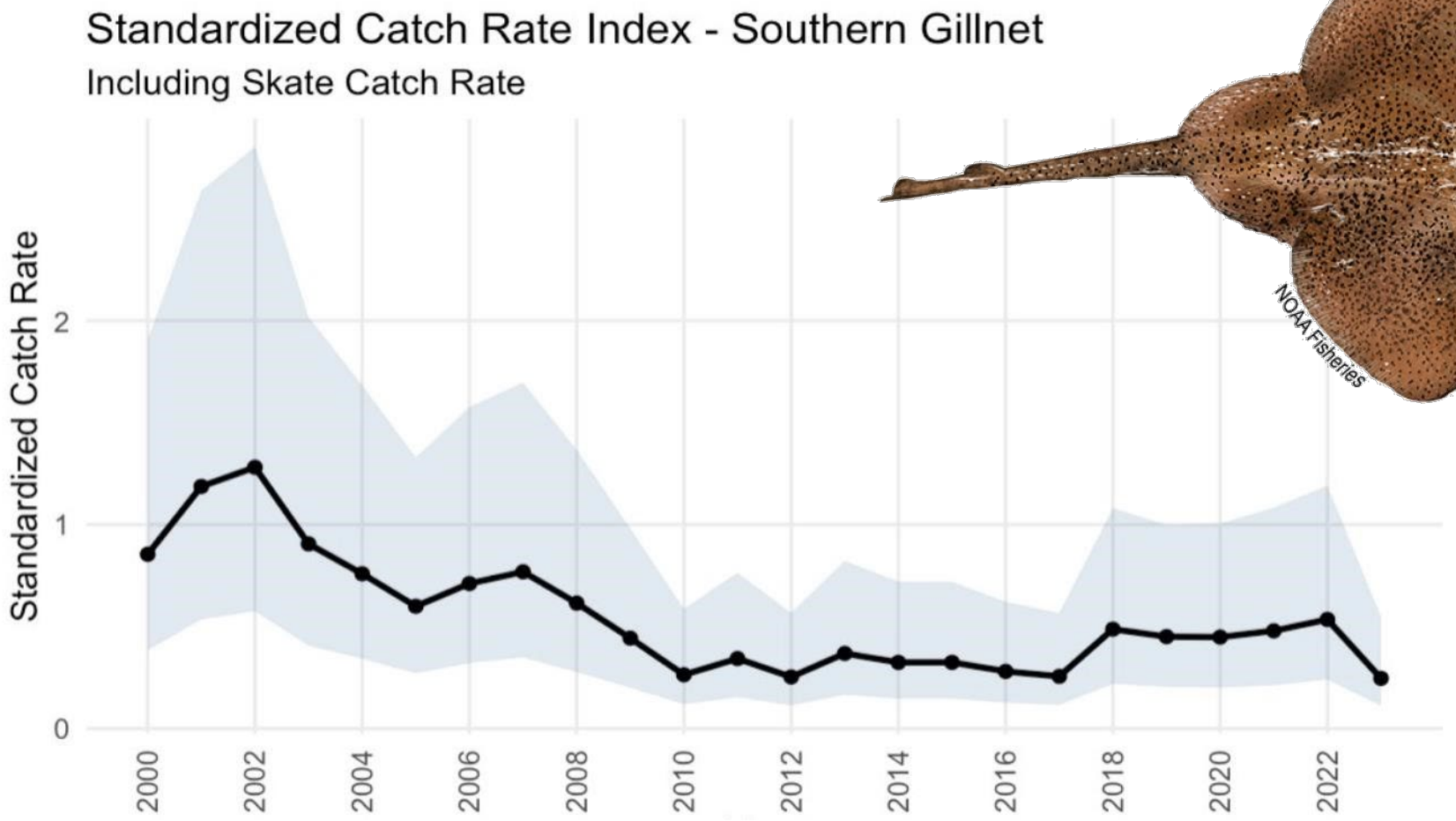






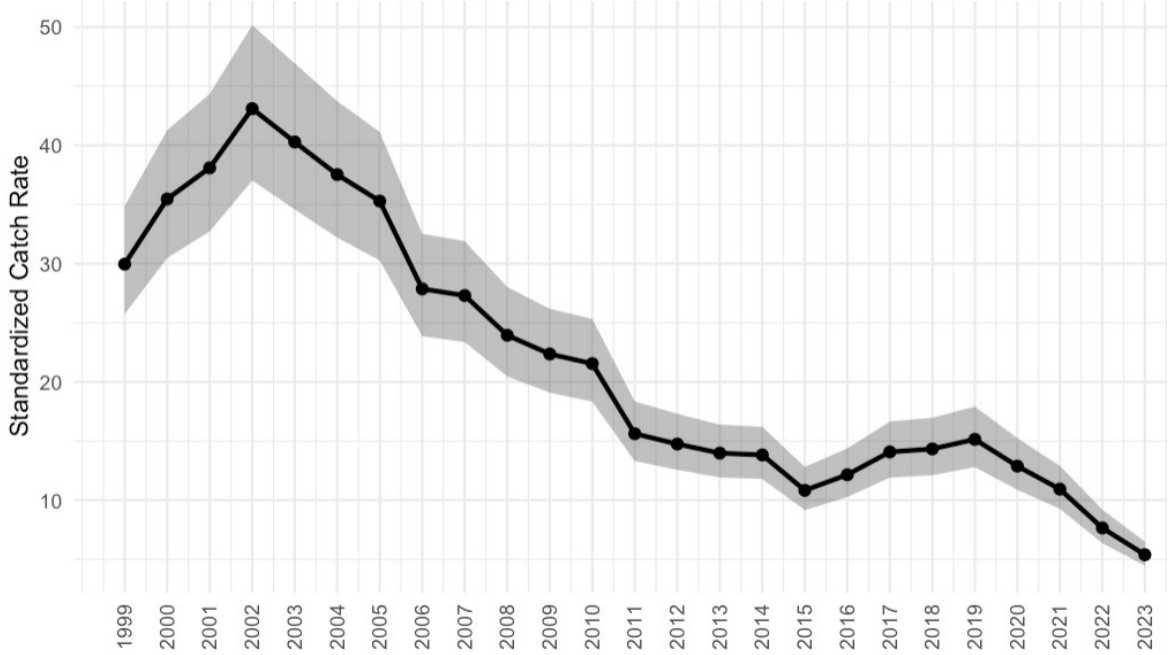
Results – Southern Gillnet Observer Sensitivity

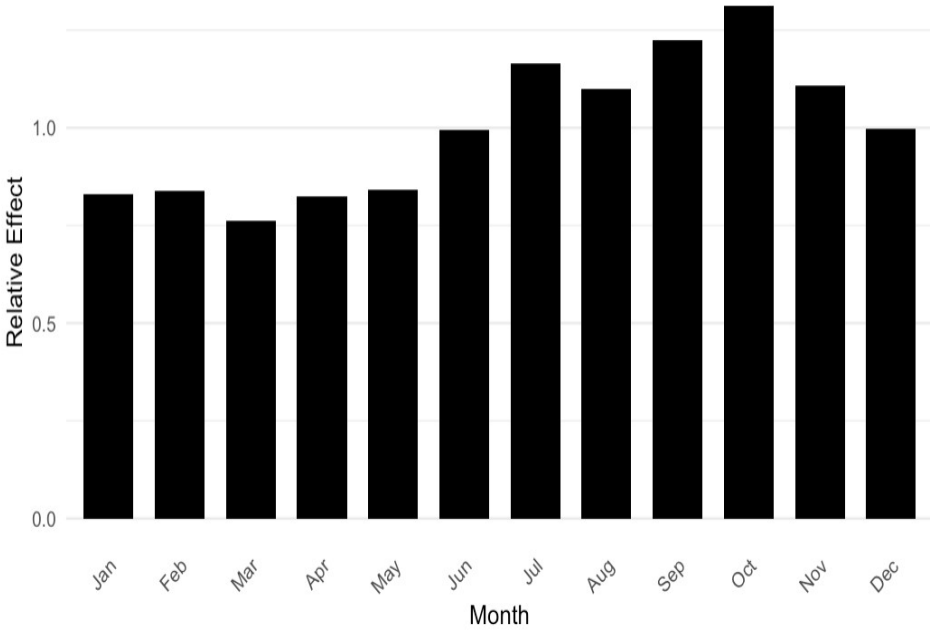
- Adding skate catch rate as a predictor variable or filtering trips with >50% skates or <50% <60% or <70% monkfish did not have acceptable model fit or stable parameter estimates.



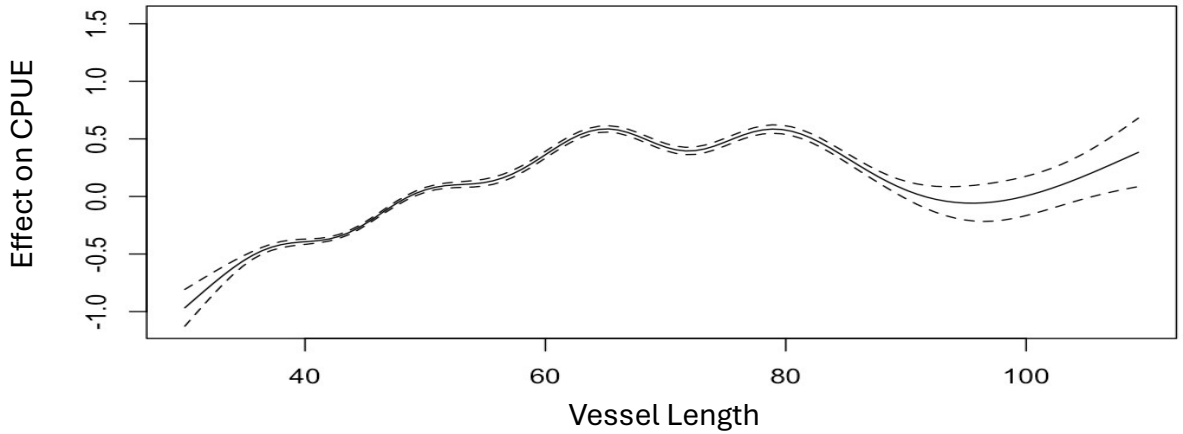
Results – Northern Trawl Logbook Model

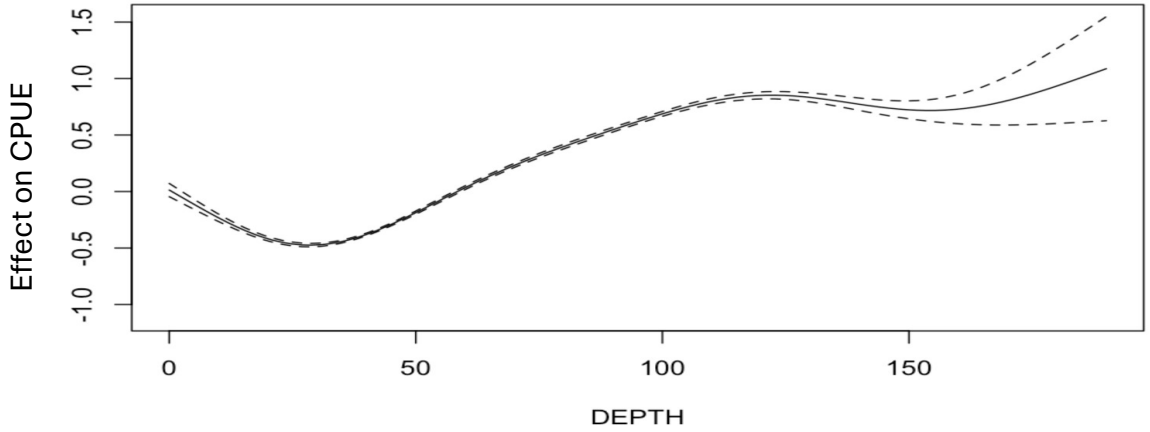
- Significant year, month, depth, statistical area, and vessel length effects





Area	Estimate	SE	t
465	0.311	0.108	2.87
511	0.065	0.097	0.66
512	0.38	0.083	4.61
513	0.127	0.079	1.6
514	-0.355	0.079	-4.48
515	0.344	0.08	4.32
521	0.338	0.079	4.28
522	0.427	0.08	5.36
561	0.354	0.083	4.26





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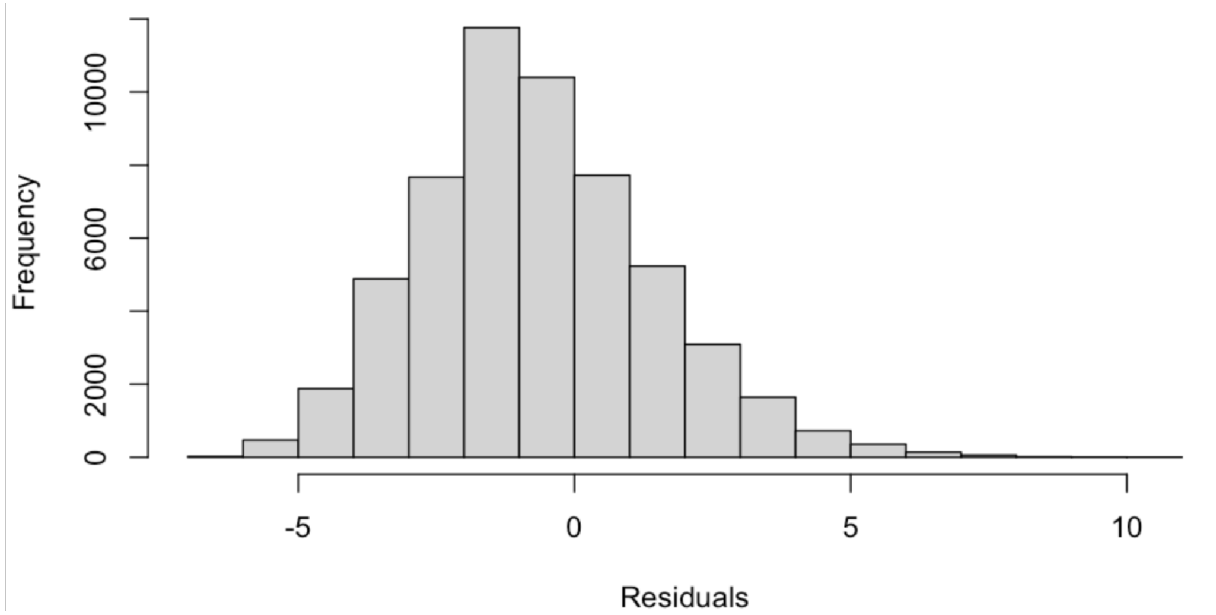
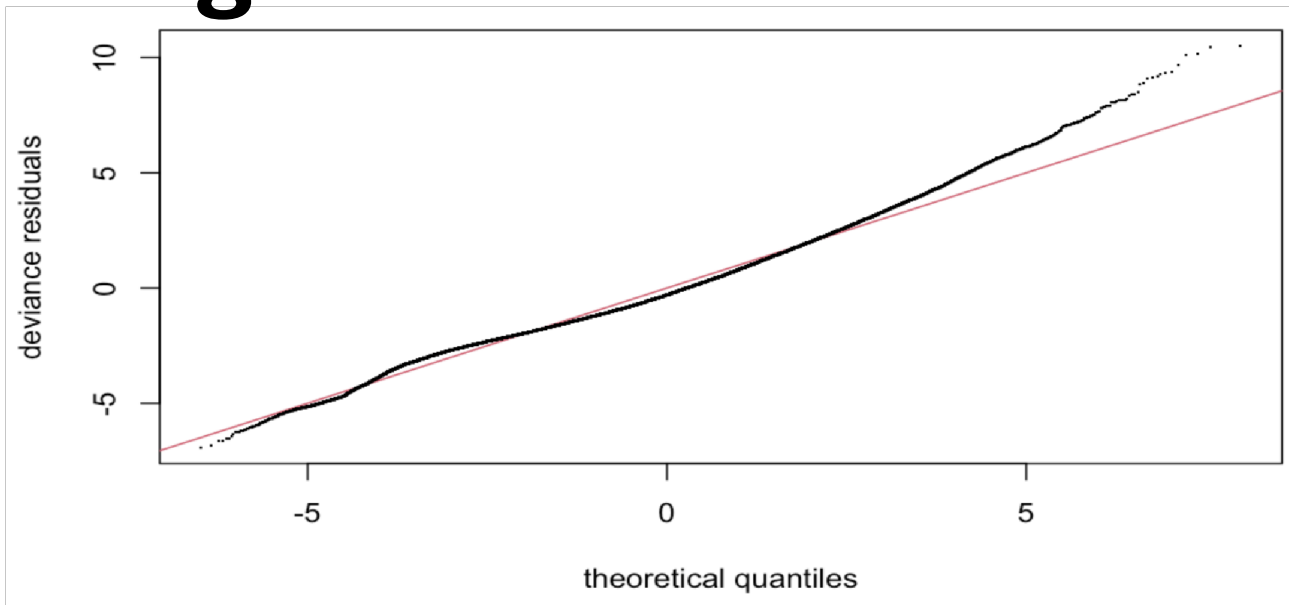
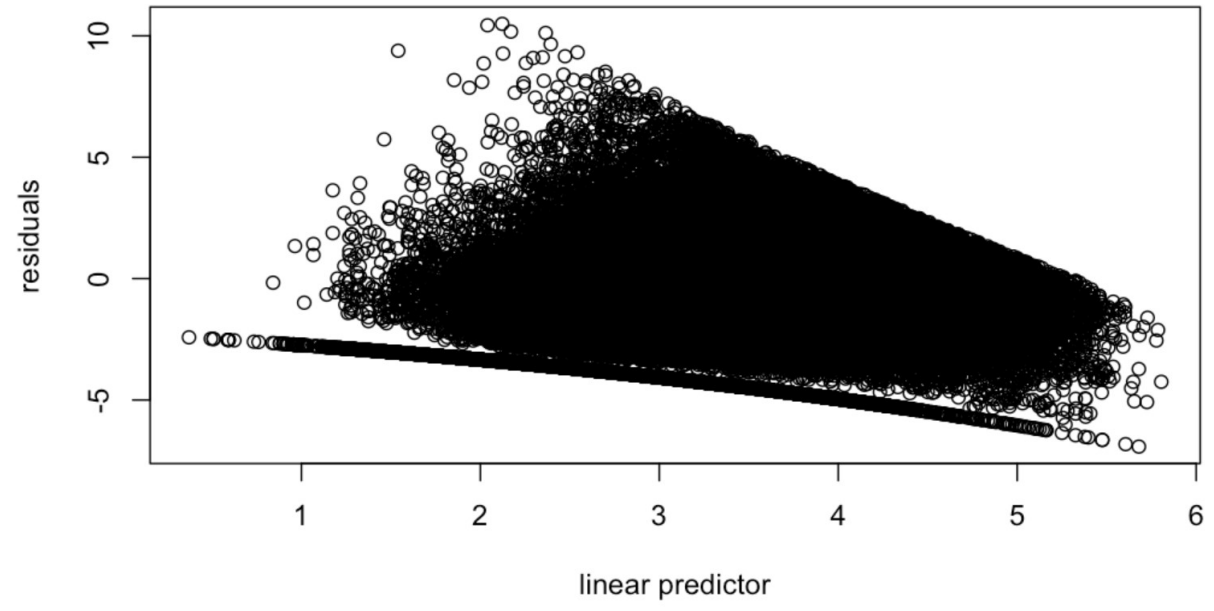
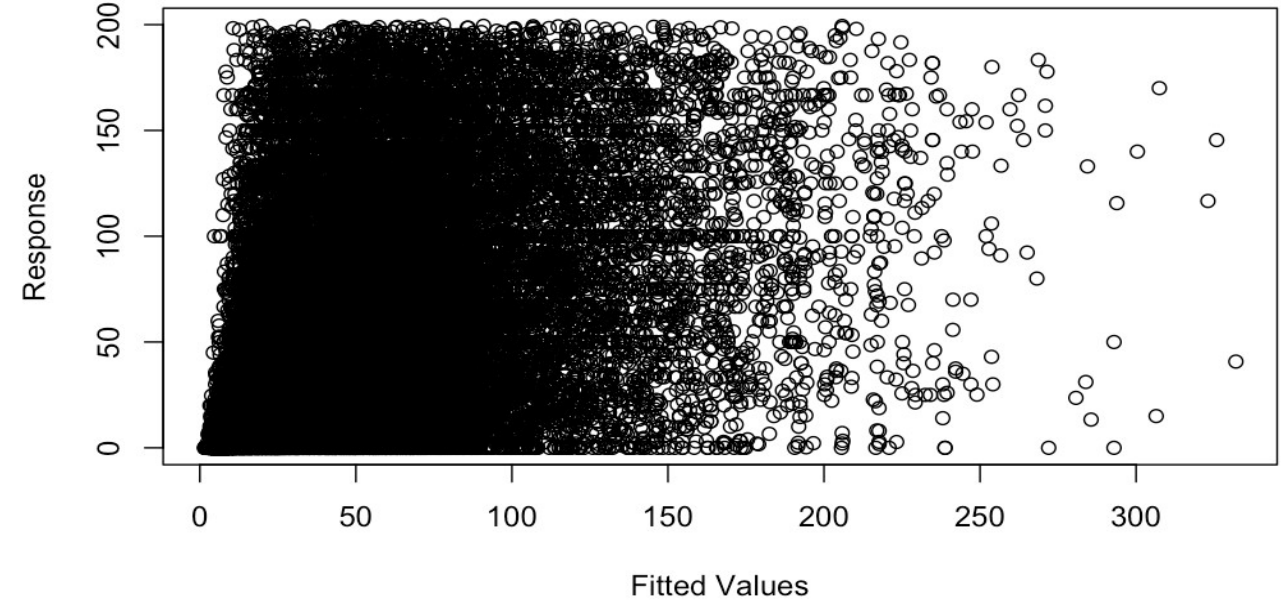


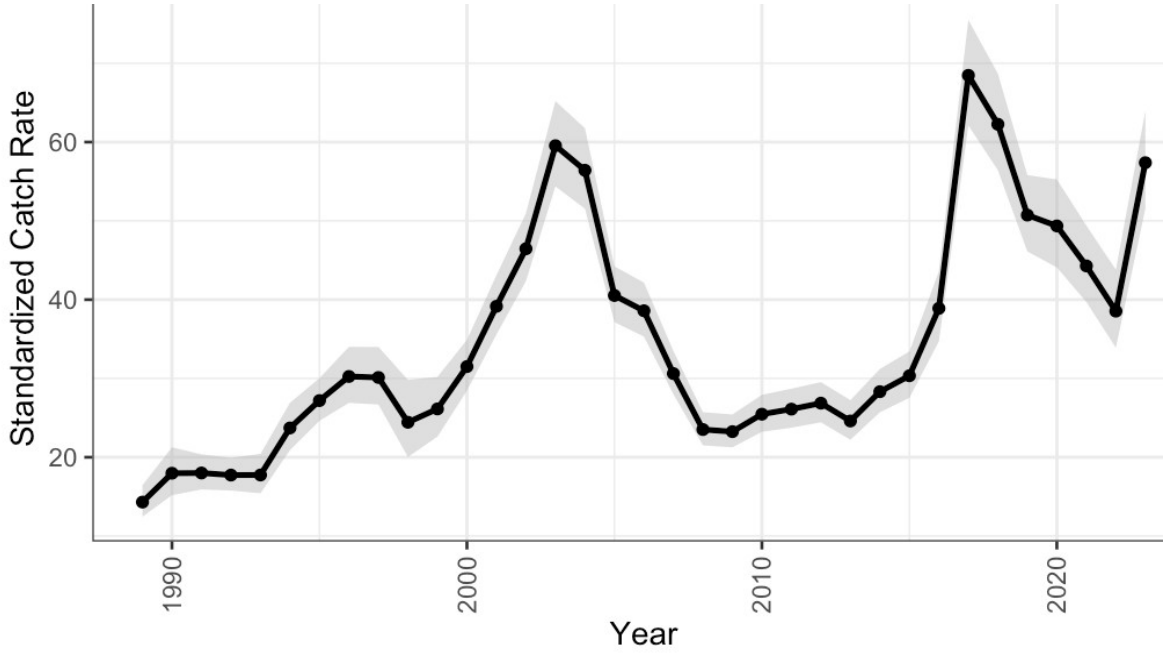


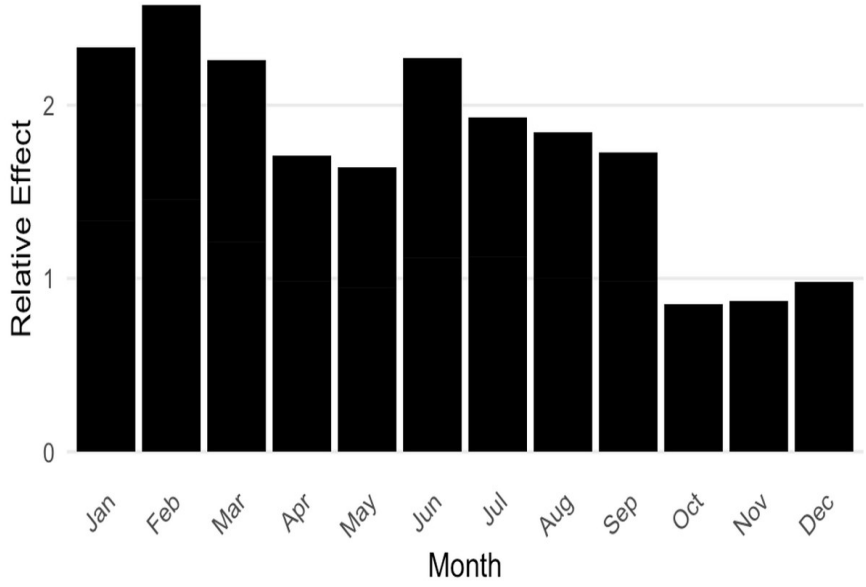




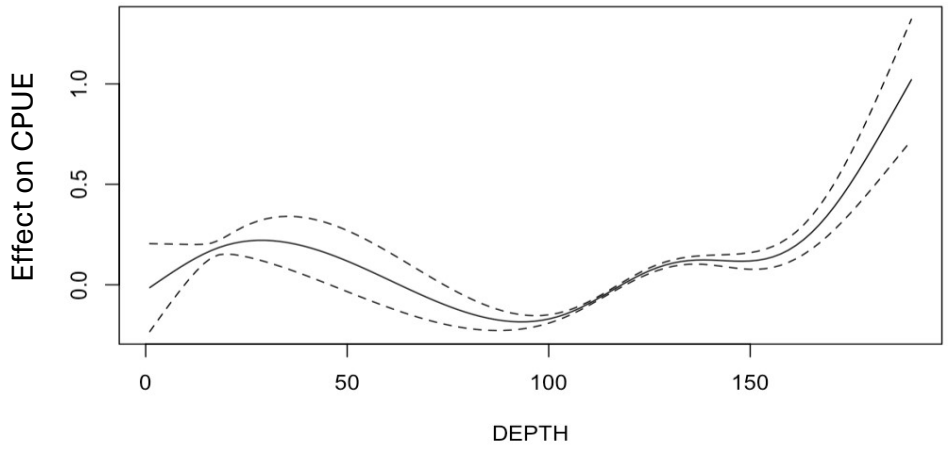
Results – Northern Trawl Observer Model

- Significant year, month, statistical area, and depth effects

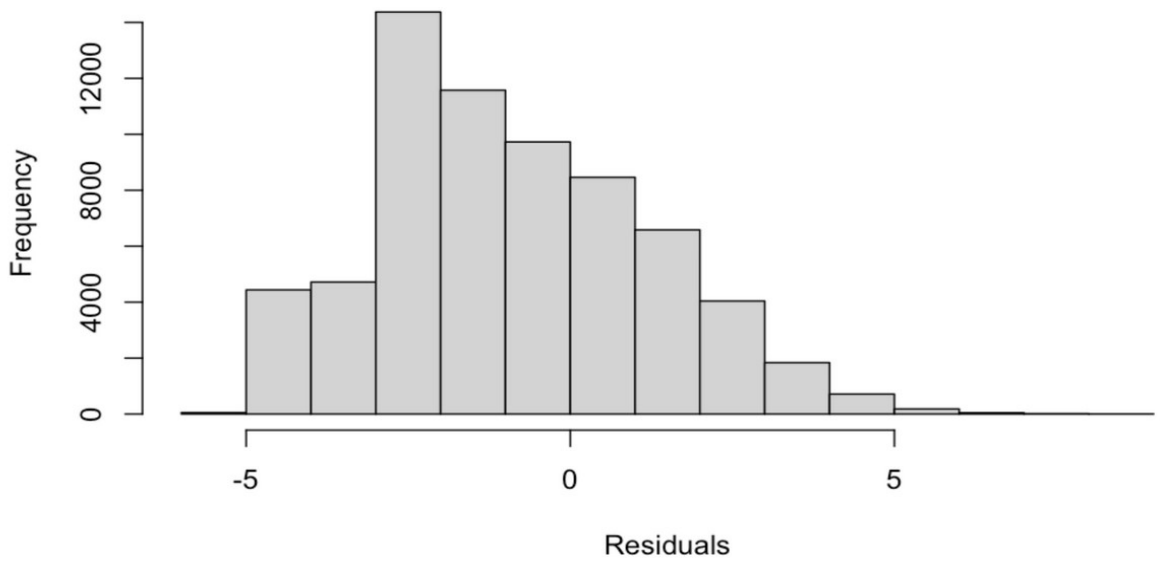


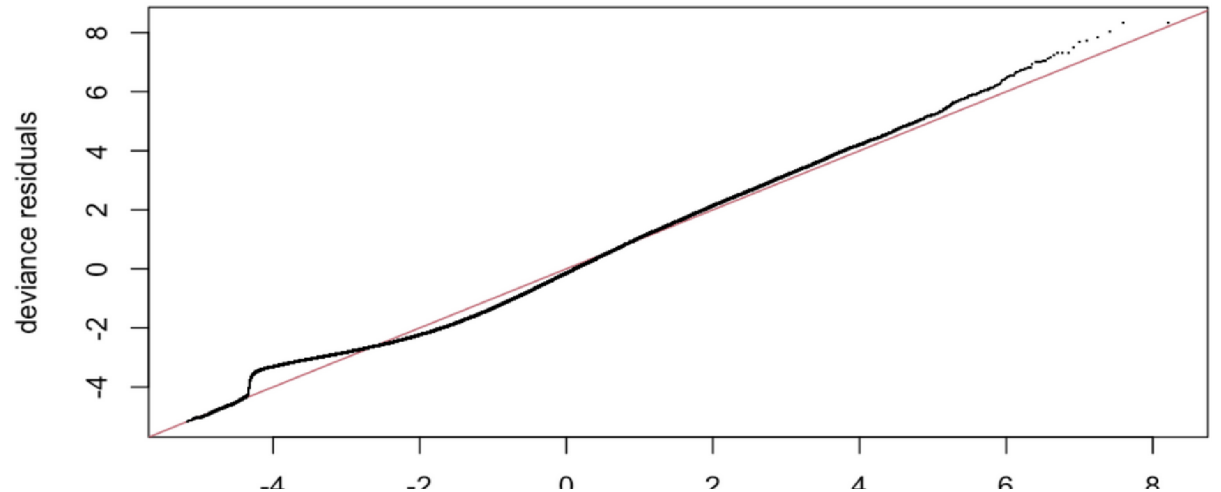


Area	Estimate	SE	t
465	-0.222	0.061	-3.65
511	-0.332	0.077	-4.31
512	-0.056	0.048	-1.16
513	-0.026	0.045	-0.58
514	-0.199	0.044	-4.53
515	0.026	0.043	0.59
521	-0.183	0.043	-4.2
522	0.125	0.043	2.88
561	-0.168	0.046	-3.68

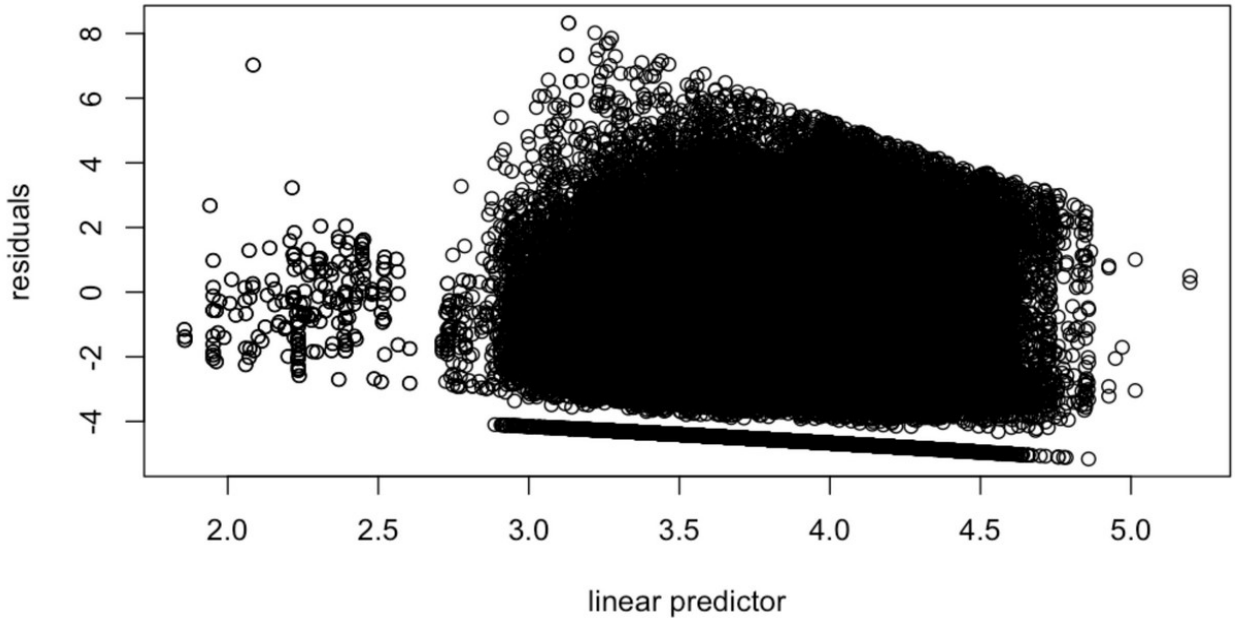


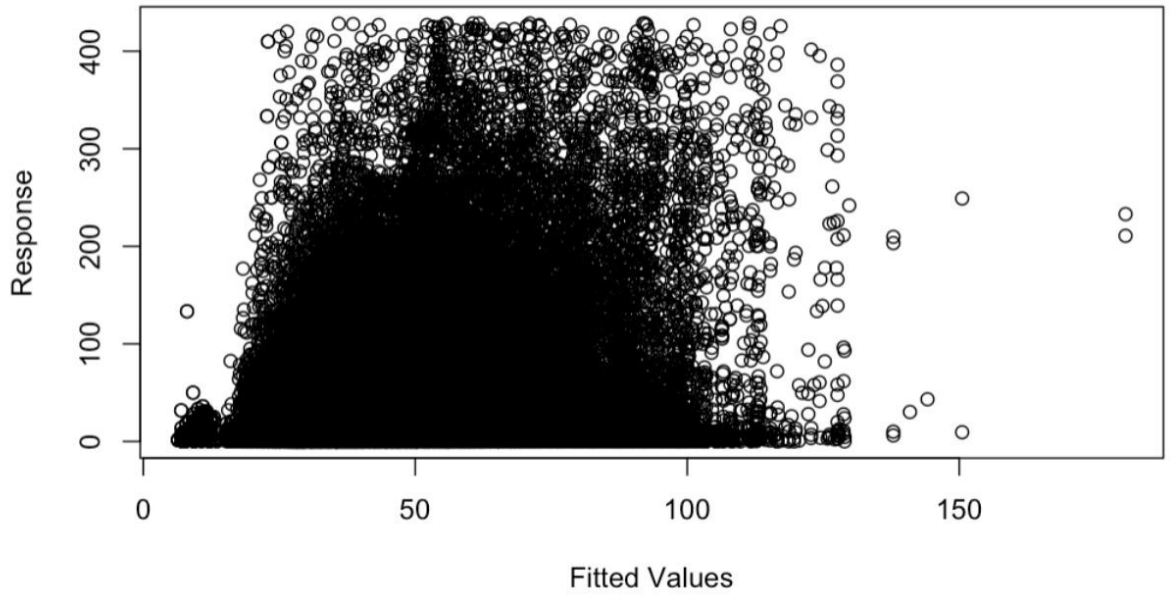
Results – Northern Trawl Observer Model





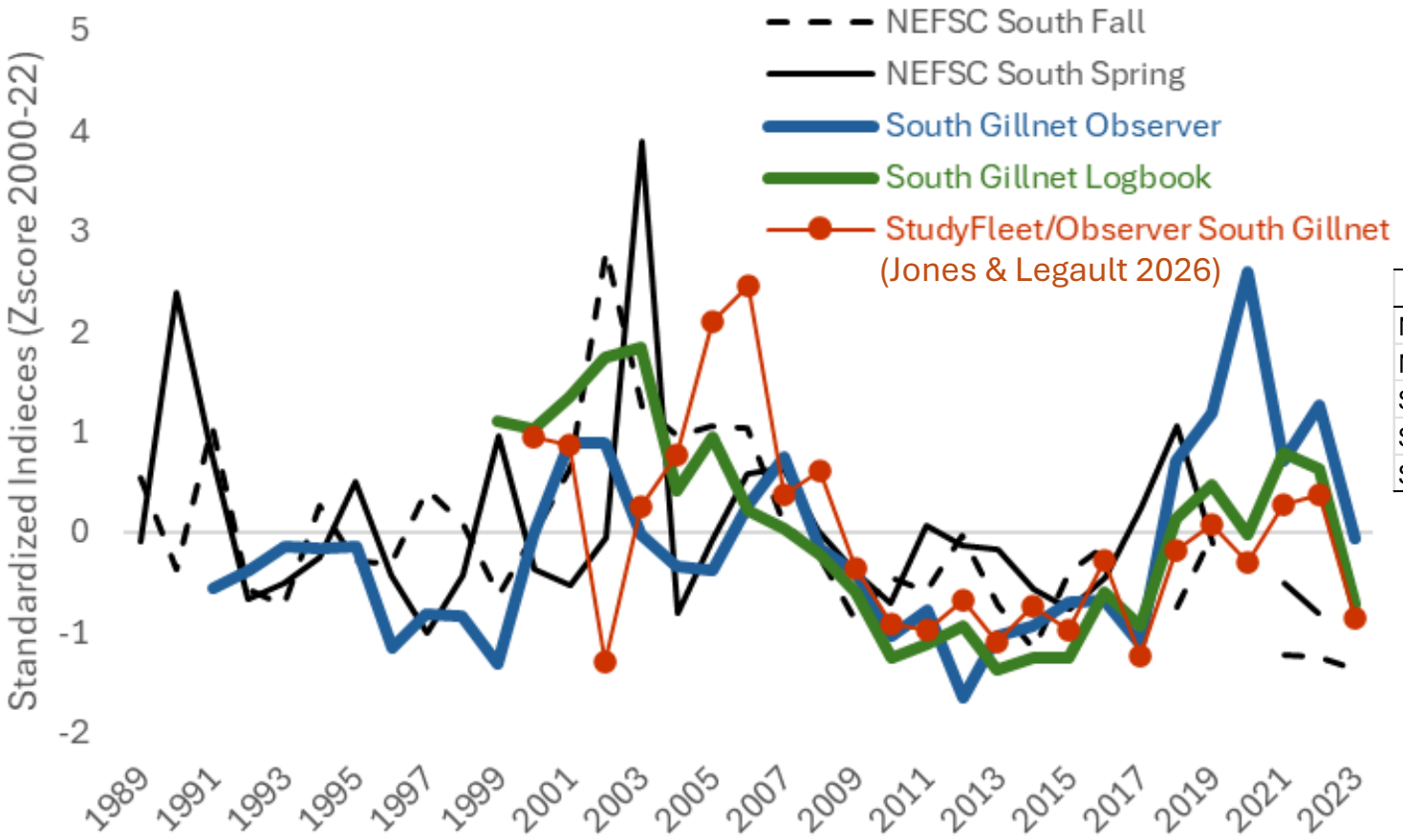
Response vs. Fitted Values





Southern Index Comparisons

- All suggest relatively high biomass in the early 2000s, decreasing to low biomass in the early 2010s and increasing since 2017 (consistent with 2015 recruitment event) and a decrease in the last year.

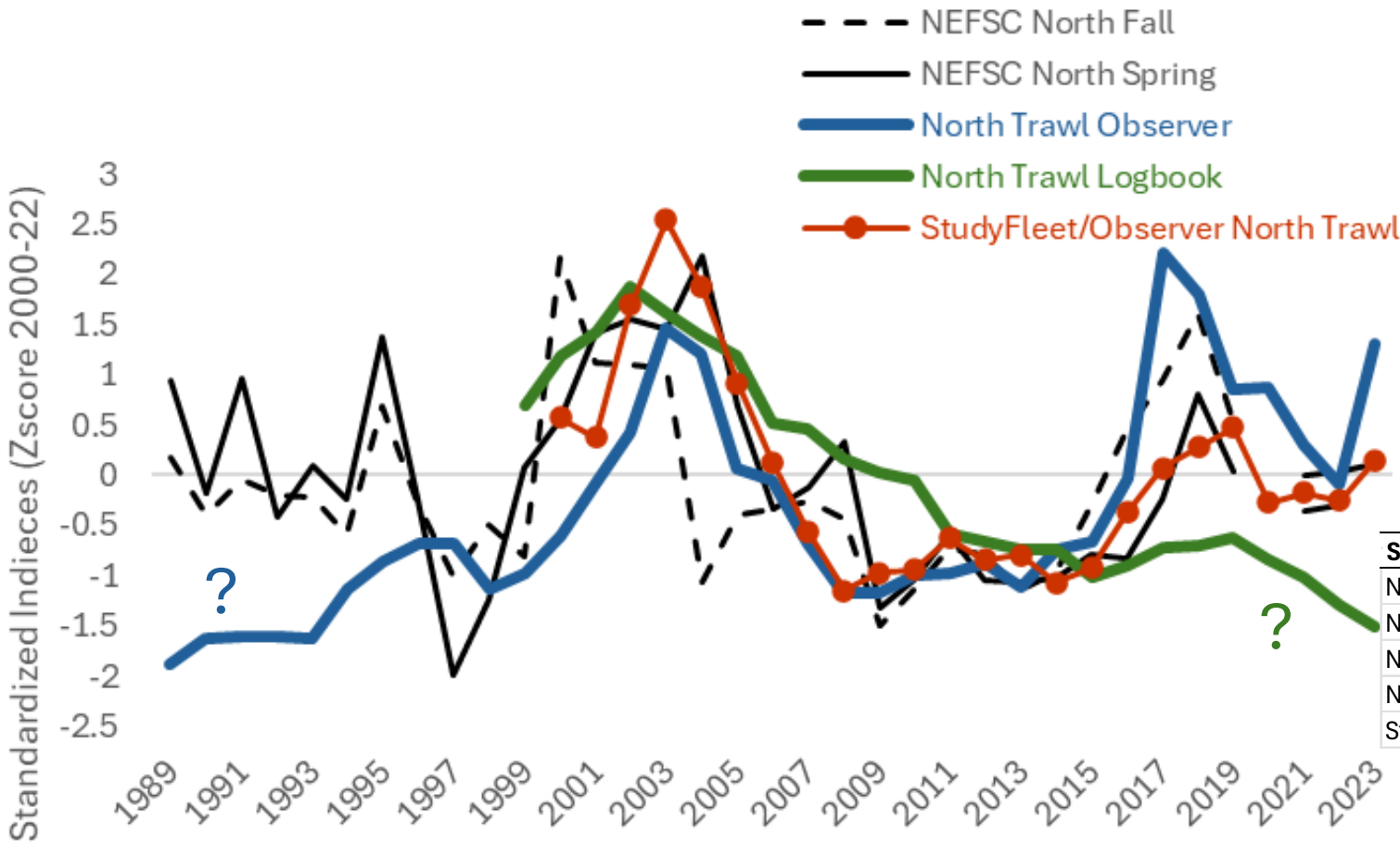


Correlations Among Indices

	NEFSC S. Fall	NEFSC S. Spring	S. Gillnet OB	S. Gillnet VTR
NEFSC South Fall	1.00			
NEFSC South Spring	0.24	1.00		
South Gillnet Observer	0.16	0.09	1.00	
South Gillnet Logbook	0.58	0.40	0.50	1.00
StudyFleet South Gillnet	0.31	0.11	0.29	0.54

Northern Index Comparisons

- All suggest relatively high biomass in the early 2000s, decreasing to low biomass in the early 2010s, and all except logbook suggest increasing since 2017 (consistent with 2015 recruitment event).



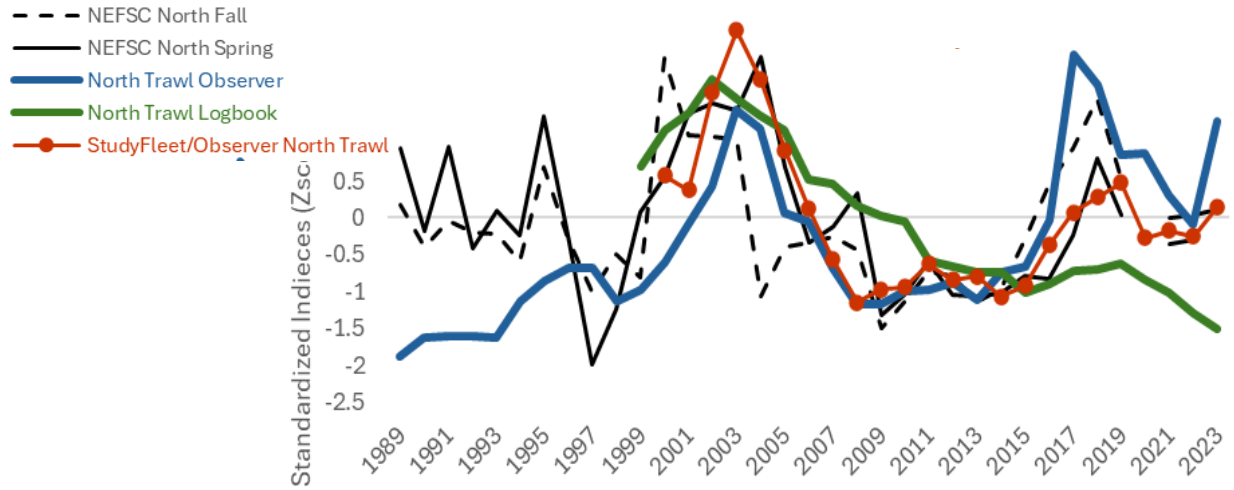
Correlations Among Indices

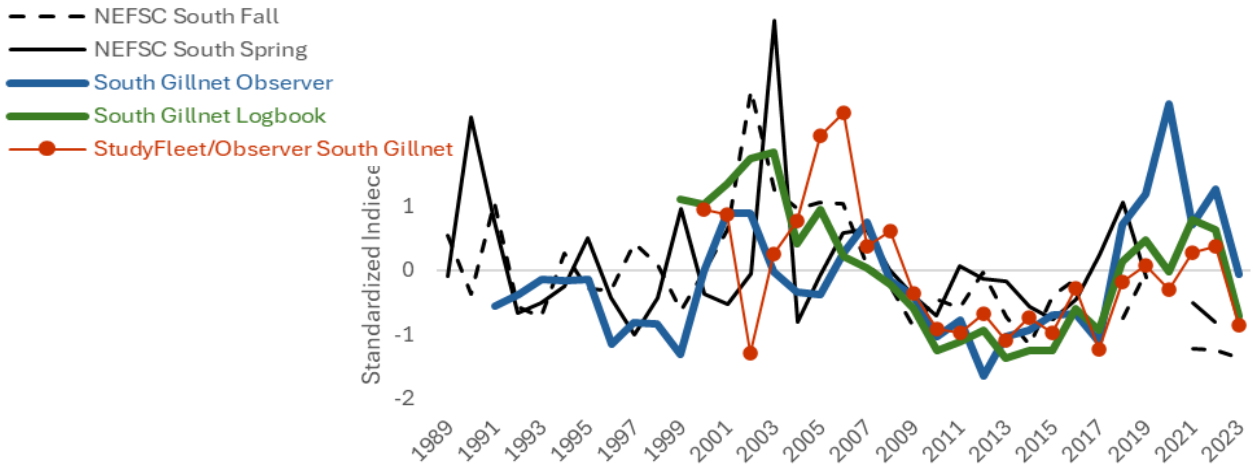
South Gillnet	NEFSC N. Fall	NEFSC N. Spring	N. Trawl OB	N. Trawl VTR
NEFSC North Fall	1.00			
NEFSC North Spring	0.55	1.00		
North Trawl Observer	0.48	0.35	1.00	
North Trawl Logbook	0.23	0.76	-0.01	1.00
StudyFleet North Trawl	0.51	0.86	0.65	0.67

Index Comparisons

- Common trends in the northern and southern areas support the conclusions of a single population of American monkfish in U.S. waters (Richards, 2016).

South Gillnet	NEFSC N. Fall	NEFSC N. Spring	N. Trawl OB	N. Trawl VTR	StudyFleet N. Trawl	NEFSC S. Fall	NEFSC S. Spring	S. Gillnet OB	S. Gillnet VTR
NEFSC North Fall	1.00								
NEFSC North Spring	0.55	1.00							
North Trawl Observer	0.48	0.35	1.00						
North Trawl Logbook	0.23	0.76	-0.01	1.00					
StudyFleet North Trawl	0.51	0.86	0.65	0.67	1.00				
NEFSC South Fall	0.26	0.54	0.16	0.82	0.70	1.00			
NEFSC South Spring	0.29	0.35	0.22	0.35	0.50	0.24	1.00		
South Gillnet Observer	0.51	0.45	0.40	0.04	0.28	0.16	0.09	1.00	
South Gillnet Logbook	0.54	0.78	0.30	0.70	0.79	0.58	0.40	0.50	1.00
StudyFleet South Gillnet	0.11	0.38	0.01	0.46	0.31	0.31	0.11	0.29	0.54





‘Technology Creep’ in Fisheries

- Some variation in catchability can be standardized with gear and vessel variables.
- Other advances in fishing technology may be difficult to standardize, but the major technologies that increased commercial gillnet and bottom trawl fisheries occurred before the time period of these monkfish indices:
  - diesel engines in the 1930s;
  - sonar, freezing technology, and hydraulic haulers, net reels or winches in the 1950s;
  - synthetic nets in the 1960s (monofilament gillnets, Collins 1979); and
  - GPS plotters in the 1970s (Robins et al. 1998)
  - Door and net sensors in the 1980s (Kumar 2002)
- Monkfish fishermen explained that gillnet gear and configuration has not changed much in the last 25 years.
- ‘Effort creep’ includes gradual learning on how to target a species more efficiently over time (Hoyle et al., 2024).
  - New England fleets have been targeting monkfish since the 1980s (Richards et al. 2008)
  - The fishing community is ageing with little recruitment of new fishermen (NOAA, 2022).

Monkfish CPUE as Stock Indices

- Standardized catch rates can complement surveys as stock indices.
- Relative merits among data, fleets, and models (*following presentation*)
- Stock indices for assessment models
  - For size-based or age-based stock assessment models, standardized CPUE could index the exploitable monkfish stock based on estimates of fishery selectivity.
  - For aggregate production models, standardized CPUE could index exploitable biomass (e.g., survey indices of >43cm).
  - Time of year was standardized by month effects so CPUE can index mid-year biomass.