Atlantic States Marine Fisheries Commission

Northern Shrimp Advisory Panel

December 12, 2024
9:00 a.m. - 11:00 a.m.
Portland, Maine

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added a necessary.

1.	Welcome/Review Agenda *(G. Libby*)	9:00 a.m.
2.	Review 2024 Stock Assessment Update Report (*K. Drew)*	9:05 a.m.
3.	Discuss Technical Committee Pilot Winter Sampling Program Proposal (*C. Tuohy & K. Drew)*	9:30 a.m.
4.	Formulate Advisory Panel Recommendations for 2025 Fishery Specifications	10:30 a.m.
5.	Other Business/Adjourn	11:00 a.m.

This meeting will be held at the Westin Portland Harborview (157 High Street, Portland, ME 04101)

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission

Northern Shrimp Section

December 12, 2024
12:00 p.m. - 3:00 p.m.
Portland, Maine

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

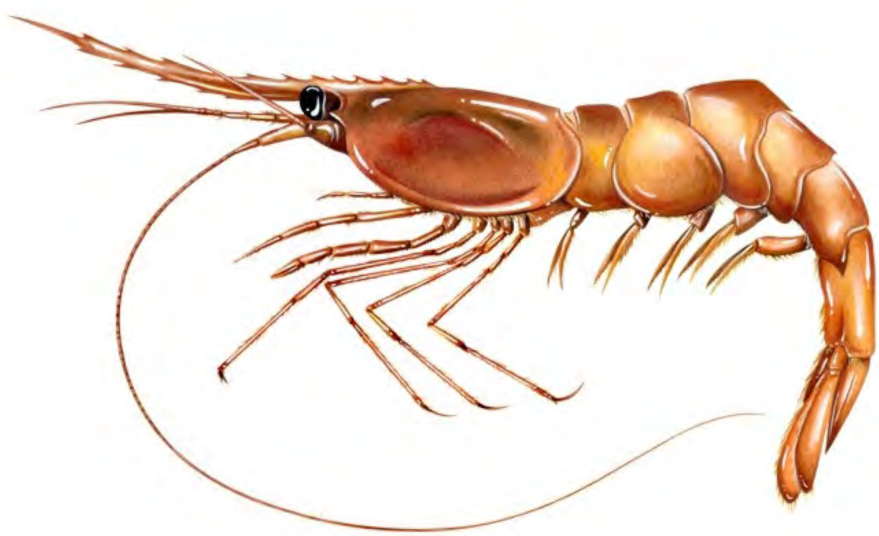
1.	Welcome/Call to Order (*D. Grout*)	12:00 p.m.
2.	Section Consent • Approval of Agenda	12:00 p.m.
3.	Public Comment	12:05 p.m.
4.	Review 2024 Stock Assessment Update Report (*K. Drew)*	12:15 p.m.
5.	Review Pilot Winter Sampling Proposal • Review Technical Committee Recommendations (*C. Tuohy & K. Drew*) • Review Advisory Panel Input (*G. Libby*)	12:45 p.m.
6.	Set 2025 Fishery Specifications **Final Action**	1:45 p.m.
7.	Consider Approval of Draft Amendment 4 for Public Comment **Action**	2:00 p.m.
8.	Other Business/Adjourn	3:00 p.m.

This meeting will be held at the Westin Portland Harborview (157 High Street, Portland, ME 04101)

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission

Northern Shrimp Stock Assessment Update 2024



Vision: Sustainably Managing Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission

Northern Shrimp Stock Assessment Update

Prepared by the
ASMFC Northern Shrimp Technical Committee

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and
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Executive Summary

The most recent benchmark assessment for Gulf of Maine northern shrimp (*Pandalus borealis)* was conducted in 2018 (ASMFC 2018a). An assessment update was completed later in 2018 (ASMFC 2018b) and 2021 (ASMFC 2021), with regular data updates since then. This stock assessment update presents new data compiled since 2021 and the results from the accepted statistical catch-at-length model and traffic light analyses. Data sources include indices of abundance and biomass from fishery-independent data sources and environmental data through 2023, with the exception of the fall survey data for 2023, which were not available at the time of this assessment. With the suspension of the summer survey after the 2023 sampling season, the only data source for 2024 was the ME-NH inshore trawl survey and the temperature time-series.

Stock status for northern shrimp continues to be poor, as illustrated by both the traffic light analyses and the catch-at-length model. The 2023 summer survey indices of abundance, biomass, and recruitment were at time-series lows, and spawning stock biomass was the lowest in the 1984-2023 time-series. Environmental conditions continue to be unfavorable for northern shrimp. The predation pressure index spiked again in 2021 compared to 2017-2019, and declined to just above the 80th percentile of the reference time period in 2023. Spring bottom temperatures and winter sea surface temperatures declined somewhat in 2023, but were still above the 80th percentile threshold.

A commercial fishing moratorium has been in place since 2014, and fishing mortality since then, attributed to several small industry sampling and research projects, has been extremely low. Spawning stock biomass in 2024 was estimated to be at 279 mt, the lowest in the time-series and well below the time-series median of 4,732 mt. Recruitment also remained low for 2022-2023, a continuation of the series of below-average year classes for the last ten years.

Model bias, illustrated by retrospective patterns, was small. After 2015, SSB was overestimated in some years and the exploitation rate was underestimated. Recruitment was consistently overestimated in the terminal year.

Long- and short-term stock projection results varied depending on assumptions about future natural mortality and recruitment levels, as well as fishing mortality. Under the recent unfavorable levels of natural mortality and recruitment, spawning stock biomass was projected to decline from 2023 levels and stabilize at an SSB level of 263 mt in the long-term. If both recruitment and natural mortality returned to their long-term values, the population would recover to 2,897 mt, still below the long-term median population size. Under the current conditions, research catches of 0.5-3.2 mt had a minimal effect on SSB, resulting in a median SSB that was less than 1% lower than SSB under the no fishing scenario, while catching 53 mt, the maximum research set aside from previous years, resulted in a median SSB that was 13% lower in 2025 than under the no fishing scenario.

Given the continued poor condition of the resource, the extremely low likelihood of being able to fish sustainably, and the value of maximizing spawning potential to rebuild the stock if environmental conditions improve, the Northern Shrimp Technical Committee (NSTC) does not

see any biological justification for harvest and recommends that the Section extend the moratorium on fishing. The NSTC based its recommendation on its assessment of current stock status, the biology of the species, and the stated management objectives to protect and maintain the northern shrimp stock at sustainable levels that will support a viable fishery and minimize the adverse impacts the shrimp fishery may have on other natural resources (Amendment 3 to the FMP, ASMFC 2017).

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TOR 1. Update fishery-dependent data (landings, discards, catch-at-age, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.
Historically, fisheries for northern shrimp occurred in Maine, New Hampshire and Massachusetts, with landings from Maine dominating the modern era (1960-present, Table 1 and Table 4, Figure 1). Fishery-dependent data were derived from a combination of dealer reports, harvester reports, port sampling, sea sampling, and licensing data. Landings were equated with removals because discarding is uncommon in this fishery.

A commercial fishery moratorium has been in place since 2014. Landings since then have been limited to industry research trips for sample collection. Removals since 2014 have included discards. No industry research trips were made in 2022-2024.

TOR 2. Update fishery-independent data (abundance indices, age-length data, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.
The time series for fishery-independent data were extended from the previous assessment update (ASMFC 2021) through 2023, with some exceptions noted below.

Fishery-independent data include abundance and biomass indices from the ASMFC summer shrimp offshore trawl survey (1984–2023), the Northeast Fisheries Science Center (NEFSC) fall bottom trawl survey (1986–2008 and 2009–2022), and the Maine-New Hampshire spring inshore trawl survey (2003–2024) (Table 2, Figure 2 and Figure 3). Length and sex-stage compositions were also developed from the summer and fall surveys. All surveys used a random stratified design. Model-based indices of abundance were developed using a spatio-temporal standardization approach and calculated using the VAST package in R. None of these surveys were conducted during 2020 due to COVID-19 restrictions, and shrimp data from the NEFSC fall 2023 and 2024 surveys had not been processed as of this report due to NEFSC staffing limitations.

A recruitment index was calculated from the summer survey standardized catch of assumed 1.5-year-old shrimp which are typically 11–18 mm dorsal carapace length (Figure 4). An index of spawning stock biomass (SSB) was estimated by applying a length-weight relationship for non-ovigerous shrimp to the abundance of females at each length, and summing over lengths. The observed proportion female-at-length from the summer survey is used to calculate SSB in the UME model.

The NEFSC fall survey vessel and gear were replaced in 2009, and this is considered the beginning of a new survey time series for shrimp; the NEFSC trawl survey is split into an Albatross index (1986-2008) and a Bigelow index (2009-2022).

In 2017 the ASMFC summer shrimp survey adopted new trawl gear, switching from Portuguese doors to lighter-weight Bison doors. Using data from alternating gear research tows, Miller and Chase (2021) found little evidence for unequal efficiencies of the two gears for shrimp. Therefore, no calibration of the summer survey data to account for the gear change was performed.

Other fishery-independent data include time series of February–March sea surface temperatures (SST) at Boothbay Harbor, Maine, spring bottom temperature anomalies from NEFSC spring bottom trawl survey strata in offshore shrimp habitat areas (also without 2020), and summer bottom temperature measured by the ASMFC summer shrimp survey.

An index of predation pressure (PPI) was developed from NEFSC survey data by weighting predator biomass indices by the long-term average percent frequency of shrimp in each predator's diet estimated from food habits sampling (Appendix 2). The average of the 2019 and 2021 PPIs was used for the missing 2020 value in the UME model.

TOR 3. Tabulate or list the life history information used in the assessment and/or model parameterization (M, age plus group, start year, maturity, sex ratio, etc.) and note any differences (e.g., new selectivity block, revised M value) from benchmark.

The University of Maine statistical catch-at-length model (UME model) used the same parameterization as the 2018 benchmark assessment (ASMFC 2018a), including time-varying M and maturity at length. Model structure is summarized in Table 3; see Appendix 2 for annual M-at-length and proportion female-at-length plots.

The 2018 benchmark assessment did not use the ME-NH spring inshore survey in the base run, but with the termination of the ASMFC summer survey after the 2023 sampling season, the NSTC chose to include the ME-NH spring inshore survey as part of the base run as it will need to be used going forward. The NSTC also chose to use 2023 as the terminal year of the assessment, as the only data available for 2024 was the ME-NH spring inshore survey. Sensitivity runs were conducted around model choice and terminal year.

TOR 4. Update accepted model(s) or trend analyses and estimate uncertainty. Include sensitivity runs and retrospective analysis if possible and compare with the benchmark assessment results.

For this assessment, the Northern Shrimp Technical Committee (NSTC) updated the Traffic Light Analysis (TLA) and the UME model for northern shrimp.

Traffic Light Approach

The TLA is an index-based approach to evaluate stock status and resource conditions and was applied to indices of abundance, fishery performance, and environmental trends from 1984 to present. Two qualitative stock status reference levels were developed for the traffic light approach. For the abundance and biomass indices, being below the 20^{th} percentile of the time series from 1984-2017 indicated an adverse state, and being above the 80^{th} percentile indicated a favorable state. For the environmental indicators, the opposite was true: being below the 20^{th} percentile indicated a favorable state while being above the 80^{th} percentile indicated an adverse state, as higher temperature and predation pressure have negative consequences for northern shrimp.

The traffic light analysis was updated with the 2022 and 2023 ASMFC summer survey data, the 2021 and 2022 NEFSC fall survey data, and the 2022-2024 ME-NH spring inshore data, as well as with 2022–2023 data for temperature indicators and the 2021-2023 data for the predation index.

The traffic light analysis of 2023 data indicated continued decline in stock status with all indices at new time-series lows (Table 5, Figure 5 - Figure 7). Environmental conditions continued to be unfavorable for northern shrimp. The predation pressure index spiked again in 2021 compared to 2017-2019, and declined to just above the 80th percentile of the reference time period in 2023. Spring bottom temperatures and winter sea surface temperatures declined somewhat in 2023, but were still above the 80th percentile threshold (Table 6, Figure 8).

UME Statistical Catch-at-Length Model

The UME model indicated total abundance and spawning stock biomass for northern shrimp continued to decline in 2022-2023 (Table 7 and Figure 9). Spawning stock biomass in 2024 was estimated to be at 279 mt, the lowest in the time-series and well below the time-series median of 4,732 mt and the 20th percentile of the reference period of 2,721 mt.

An average fishing mortality (*F*) for the time series (i.e., abundance-weighted average F on shrimp ≥22 mm carapace length) was calculated to account for differences in selectivity patterns across years and between fleets. Average fishing mortality has been extremely low since the implementation of the moratorium in 2014 (Table 7 and Figure 10). The average *F* peaked shortly before that in 2011 and 2012. Fishing mortality was extremely low in 2020 (*F*=0.002), the last year of the winter sampling program, and zero for 2022-2023.

Recruitment also remained low from 2022-2023 (Table 7, Figure 11), a continuation of the series of below average year classes in recent years. Ten of the last twelve years of recruitment have been less than the 20th percentile of the 1984-2017 estimates (equal to 1.9 billion shrimp). Recruitment in 2022 and 2023 were the lowest in the time-series, estimated to be 0.26 and 0.13 billion shrimp respectively. Variability in recruitment has increased since 2000, with higher highs and lower lows in recruitment deviations than 1984-1999 (Figure 11).

The retrospective pattern in the assessment was small, with SSB being slightly overestimated and exploitation rate being slightly underestimated in recent years; however, the pattern changed around 2015, with SSB being underestimated in some years and exploitation rate being overestimated in earlier years (Figure 12). The retrospective pattern in recruitment was more variable over the time series, but was consistently overestimated in the terminal year (Figure 12). Overall, the magnitude of the bias remained small.

Estimates of average *F* from the 2024 assessment were slightly lower than estimates from the 2021 assessment for the earliest part of the time series, and estimates of SSB from the 2024 assessment were slightly higher (Figure 13). This is due to a combination of the retrospective pattern that affected the estimates of *F* and SSB in earlier years, as well as the inclusion of the ME-NH inshore trawl survey (Figure 14).

The base run of the model included the ME-NH spring inshore survey and had a terminal year of 2023; sensitivity runs were conducted without the ME-NH survey and with a terminal year of 2024 for comparison. Model runs that included the ME-NH spring inshore survey, with a terminal year of either 2023 or 2024, resulted in slightly higher estimates of SSB and lower estimates of *F* over most of the time-series, but estimates from 2020 onward were very similar and showed the same declining trend in SSB (Figure 14). Estimates of recruitment were generally similar across all runs and showed the same strong and weak year-classes, but the model run with a terminal year of 2024 estimated a higher recruitment for 2024 when the ME-NH spring inshore survey was not included (Figure 14). This is because the model had no information on recruitment or abundance (i.e., no ASMFC summer survey or catch data) for 2024 if the ME-NH survey was not used, making the 2024 estimate of recruitment highly uncertain in that model run.

Long-term projections were carried out under different assumptions about M and recruitment. The population was projected forward for 50 years with no fishing mortality under different combinations of recent recruitment (the median of recruitment estimates from 2013-2023), long term median recruitment, recent natural mortality (the mean of natural mortality from 2019-2023), and long-term mean natural mortality (Figure 15). Under recent M and recent recruitment, the population continued to decline from 2023 levels and stabilized at an SSB level of 263 mt (Figure 16) in the long-term. If both recruitment and natural mortality returned to their long-term values, the population would increase to 2,897 mt, barely above the 20th percentile of the stable period (1984-2017) (Figure 16), due to the long series of low recruitment events in recent years which has brought long-term median recruitment down compared to the median recruitment of the stable period.

TOR 5. Update the biological reference points or trend-based indicators/metrics for the stock. Determine stock status.

There are currently no biological reference points for northern shrimp. Based on the results of the 2024 Stock Assessment Update, the northern shrimp stock in the Gulf of Maine remains depleted, with spawning stock biomass (SSB) at extremely low levels since 2013. Spawning stock biomass in 2024 was estimated to be at 279 mt, the lowest in the time-series and well below the time-series median of 4,732 mt and the 20th percentile of the reference period of 2,721 mt. In addition, recruitment continues to be low, with the 2022 and 2023 year-classes being the lowest in the time series (Table 7). Fishing mortality has been very low in recent years due to the moratorium, but high levels of natural mortality and low recruitment have hindered rebuilding.

Given the continued poor condition of the resource, the extremely low likelihood of being able to fish sustainably, and the value of maximizing spawning potential to rebuild the stock if environmental conditions improve, the NSTC does not see any biological justification for harvest and recommends that the Section extend the moratorium on fishing. The NSTC bases its recommendation on its assessment of current stock status, the biology of the species, and the stated management objectives to protect and maintain the northern shrimp stock at sustainable levels that will support a viable fishery, and minimize the adverse impacts the shrimp fishery may have on other natural resources (Amendment 3 to the FMP, ASMFC 2017).

TOR 6. Conduct short term projections when appropriate. Discuss assumptions if different from the benchmark and describe alternate runs.

Short-term projections were conducted using the same set of assumptions about M and recruitment that were used in the long-term projections (see TOR 4 above, and Figure 15), and six levels of *F*: *F*=0, *F*=the mean of the research period (2014-2020), *F*=the maximum of the research period, and values of *F* that produced catches similar to previous research catches.

Under recent levels of M and recruitment, median SSB was projected to decline 54% from 2023, even under the *F*=0 scenario (Table 8). Research catches of 0.5-3.2 mt had a minimal effect on SSB, resulting in a median SSB that was less than 1% lower than SSB under the no fishing scenario, while catching 53 mt, the maximum research set aside from previous years, resulted in a median SSB that was 13% lower in 2025 than under the no fishing scenario (Table 8).

TOR 7. Comment on research recommendations from the benchmark stock assessment and note which have been addressed or initiated. Indicate which improvements should be made before the stock undergoes a benchmark assessment.

A number of research recommendations were identified from the benchmark stock assessment in 2018. Some of the highest priority focused on efforts to improve the sampling, modeling, and biological understanding of the northern shrimp species. Due to the continued moratorium of the fishery and the COVID-19 pandemic, many of these recommendations, particularly the fishery-dependent priorities, were not addressed.

Fishery-dependent priorities included an evaluation of shrimp selectivity from the two gear types (traps and trawls), continued port, sea, and RSA sampling to confirm and potentially update length-frequency of the species, and identify by-catch in the fishery. In order to continue sample collection during the fishing moratorium, winter sampling efforts were conducted through an RSA program, however this ended in 2018. Should a fishery reopen, these recommendations could be considered.

Progress on fishery independent and life-history priorities were summarized in ASMFC (2021).

The TC supports the modeling research recommendations from the benchmark assessment, and has adopted the recommendation to include model diagnostics for the index standardization as an appendix to this report. No progress has been made on other model recommendations to date.

References

Atlantic States Marine Fisheries Commission. 2017. Amendment 3 to the interstate fishery management plan for northern shrimp. 102pp. https://www.asmfc.org/uploads/file/59f0f084NShrimpAmendment3_Oct2017.pdf

Atlantic States Marine Fisheries Commission. 2018a. Northern Shrimp Benchmark Stock Assessment and Peer Review Report. 356pp. https://www.asmfc.org/uploads/file/5bc798aaNShrimpBenchmarkAssessment_PeerReviewReport_2018_web.pdf

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Atlantic States Marine Fisheries Commission. 2021. Northern Shrimp Stock Assessment Update 2021. 38 pp. https://asmfc.org/uploads/file/63ee4ae1NShrimpAssessmentUpdateReport_2021.pdf

Miller, T.J. and Chase, P. 2021. An evaluation of efficiency differences between alternative trawl door configurations of the Gulf of Maine shrimp survey gear. Appendix 2 to ASMFC Northern Shrimp Stock Assessment Update 2021.

List of Appendices

Tables

Table 1. Total removals in metric tons by season, state, and gear type. Seasons include the previous December. The Maine fishery was "Mixed" until Trawl and Trap landings could be distinguished beginning in 2000. Removals in 2014–2020 are from RSA and winter sampling programs, and include discards. 2009 data for Massachusetts and New Hampshire are combined here to preserve reporting confidentiality.

Season	Maine			Massachusetts	New Hampshire	Total	Total	Total	Total
	Trawl	Mixed	Trap	Trawl	Trawl	Trawl	Mixed	Trap	
1985		2,946.4		968.8	216.7	1,185.5	2,946.4	0.0	**4,131.9**
1986		3,268.2		1,136.3	230.5	1,366.8	3,268.2	0.0	**4,635.0**
1987		3,680.2		1,427.9	157.9	1,585.8	3,680.2	0.0	**5,266.0**
1988		2,258.4		619.6	157.6	777.2	2,258.4	0.0	**3,035.6**
1989		2,384.0		699.9	231.5	931.4	2,384.0	0.0	**3,315.4**
1990		3,236.3		974.9	451.3	1,426.2	3,236.3	0.0	**4,662.5**
1991		2,488.6		814.6	282.1	1,096.7	2,488.6	0.0	**3,585.3**
1992		3,070.6		289.3	100.1	389.4	3,070.6	0.0	**3,460.0**
1993		1,492.5		292.8	357.6	650.4	1,492.5	0.0	**2,142.9**
1994		2,239.7		247.5	428.0	675.5	2,239.7	0.0	**2,915.2**
1995		5,013.7		670.1	772.8	1,442.9	5,013.7	0.0	**6,456.6**
1996		8,107.1		660.6	771.7	1,432.3	8,107.1	0.0	**9,539.4**
1997		6,086.9		366.4	666.2	1,032.6	6,086.9	0.0	**7,119.5**
1998		3,481.3		240.3	445.2	685.5	3,481.3	0.0	**4,166.8**
1999		1,573.2		75.7	217.0	292.7	1,573.2	0.0	**1,865.9**
2000	2,249.5		266.7	124.1	214.7	2,588.3	0.0	266.7	**2,855.0**
2001	954.0		121.2	49.4	206.4	1,209.8	0.0	121.2	**1,331.0**
2002	340.8		50.8	8.1	53.0	401.8	0.0	50.8	**452.7**
2003	987.0		216.7	27.7	113.0	1,127.7	0.0	216.7	**1,344.4**
2004	1,858.7		68.1	21.3	183.2	2,063.2	0.0	68.1	**2,131.4**
2005	1,887.1		383.1	49.6	290.3	2,227.1	0.0	383.1	**2,610.1**
2006	1,928.0		273.6	30.0	91.1	2,049.1	0.0	273.6	**2,322.7**
2007	3,986.9		482.4	27.5	382.9	4,397.3	0.0	482.4	**4,879.7**
2008	3,725.0		790.7	29.9	416.8	4,171.7	0.0	790.7	**4,962.4**
2009	1,936.3		379.4	MA & NH: 185.6		2,121.8	0.0	379.4	**2,501.2**
2010	4,517.9		1,203.5	35.1	506.8	5,059.9	0.0	1,203.5	**6,263.3**
2011	4,644.4		925.3	196.4	631.5	5,472.2	0.0	925.3	**6,397.5**
2012	2,026.8		193.1	77.8	187.8	2,292.4	0.0	193.1	**2,485.4**
2013	269.5		20.2	18.9	36.9	325.3	0.0	20.2	**345.5**
2014	0.3		0.0	0.0	0.0	0.3	0.0	0.0	**0.3**
2015	5.6		0.5	0.6	0.0	6.2	0.0	0.5	**6.7**
2016	7.4		4.1	0.0	1.8	9.2	0.0	4.1	**13.3**
2017	24.1		7.1	0.9	0.5	25.5	0.0	7.1	**32.6**
2018	0.1		0.0	1.9	1.1	3.1	0.0	0.0	**3.1**
2019	0.0		0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2020	0.0		3.1	0.0	0.0	0.0	0.0	3.1	**3.1**
2021	0.0		0.0	0.0	0.0	0.0	0.0	0.0	**0.0**

Table 2. Summary of indices used in the northern shrimp assessment update.

	ASMFC Summer Survey	NEFSC Fall Survey (Albatross)	NEFSC Fall Survey (Bigelow)	ME-NH Inshore Trawl Survey
Index Metric	Number per tow	Number per tow	Number per tow	Number per tow
Design	Stratified Random	Stratified Random	Stratified Random	Stratified Random
Standardization	VAST	VAST	VAST	VAST
Time of Year	Jul-Aug	Sep-Nov	Sep-Nov	Apr-Jun
Years	1984-2023	1986-2008	2009-2022	2003-2024
Size caught	10+mm	10+mm	10+mm	10+mm
Missing data	2020	--	2020	2020
Included in	UME, TLA	UME, TLA	UME, TLA	TLA

Table 3. Model structure and life history information used in the UME model.

Years in Model	1984-2023
Time step	Seasonal (Jan-Jun, Aug-Dec)
Size Classes	10-34mm (carapace length)
Fleets	3 (Mixed trap & trawl, trawl only, trap only)
Selectivity blocks	Mixed fleet: 1984-1999 Trawl fleet: 2000-2013, 2014-2023 Trap fleet: 2000-2013, 2014-2023
Natural mortality	Time- and length-varying
Proportion mature at length	Time-varying

Table 4. Fishery performance indicators for GOM northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or below the 20th percentile; YELLOW = between the 20th and the 80th percentiles; and GREEN = at or above the 80th percentile of the commercial fishery time series from 1984-2013. Values from 2014-2021 represent RSA/winter sampling. Dashes (-) indicate no data.

Fishing Season	Number of trips	Commercial CPUE (mt/trip)	Price per lb landed (2018 dollars)	Total landings value (2018 dollars)
1984	6,912	0.43	-	-
1985	6,857	0.60	$1.05	$9,564,744
1986	7,902	0.59	$1.45	$14,816,717
1987	12,497	0.42	$2.50	$29,023,857
1988	9,240	0.33	$2.40	$16,061,646
1989	9,561	0.35	$2.04	$14,910,780
1990	9,758	0.48	$1.43	$14,699,046
1991	7,968	0.45	$1.71	$13,516,239
1992	7,798	0.44	$1.81	$13,806,670
1993	6,158	0.35	$1.89	$8,928,900
1994	5,990	0.49	$1.30	$8,354,991
1995	10,465	0.62	$1.51	$21,493,893
1996	11,791	0.81	$1.19	$25,026,625
1997	10,734	0.66	$1.25	$19,619,763
1998	6,606	0.63	$1.50	$13,779,332
1999	3,811	0.49	$1.40	$5,759,047
2000	4,554	0.63	$1.18	$7,427,163
2001	4,133	0.32	$1.24	$3,638,596
2002	1,304	0.35	$1.54	$1,536,852
2003	3,022	0.44	$1.21	$3,586,328
2004	2,681	0.79	$0.60	$2,819,337
2005	3,866	0.68	$0.75	$4,315,765
2006	2,478	0.94	$0.47	$2,406,687
2007	4,163	1.17	$0.47	$5,056,211
2008	5,587	0.89	$0.59	$6,454,695
2009	3,002	0.83	$0.48	$2,646,864
2010	5,979	1.03	$0.61	$8,423,072
2011	7,095	0.90	$0.86	$12,129,566
2012	3,648	0.68	$1.06	$5,808,201
2013	1,322	0.23	$1.98	$1,508,183
2014	5	-	No landings	No landings
2015	50	-	$3.77	$55,446
2016	68	-	$7.11	$208,767
2017	153	-	$6.55	$470,579
2018	18	-	Confidential	Confidential
2019	0	-	-	-
2020	160	-	No landings	No landings
2021	0	-	-	-
1984-2013 mean	**6,229**	**0.60**	**$1.29**	**$10,245,509**
2014-2021 mean	**76**	**NA**	**$5.81**	**$244,931**
80th percentile (1984-2013)	**9,304**	**0.81**	**$1.75**	**$14,854,342**
20th percentile (1984-2013)	**3,523**	**0.41**	**$0.69**	**$3,617,689**

Table 5. Fishery independent indicators (model-based survey indices) for GOM northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or below the 20th percentile; YELLOW = between the 20th and 80th percentiles; and GREEN = at or above the 80th percentile of the time series from 1984-2017. Dashes (-) indicate no data.

Survey	ASMFC Summer	NEFSC Fall Albatross	NEFSC Fall Bigelow	ME-NH Spring	ASMFC Summer			
Indicator	Total Abundance	Total Abundance	Total Abundance	Total Abundance	Total Biomass	Harvestable Biomass	Spawner Biomass	Recruitment (age ~1.5)
1984	1.286				1.43	0.73	0.72	0.143
1985	1.398				1.63	1.40	0.71	0.240
1986	1.247	0.68			1.64	1.28	0.96	0.238
1987	0.882	0.40			1.09	0.87	0.58	0.199
1988	1.584	0.34			1.41	0.83	0.62	1.018
1989	1.423	0.78			1.61	0.93	0.73	0.270
1990	1.237	0.59			1.67	1.44	0.81	0.104
1991	0.826	0.32			0.98	0.80	0.68	0.338
1992	0.536	0.19			0.63	0.46	0.40	0.149
1993	1.267	1.04			0.92	0.50	0.39	0.827
1994	1.117	1.09			0.97	0.48	0.40	0.375
1995	1.141	0.59			1.19	0.83	0.77	0.254
1996	1.007	0.40			1.12	0.82	0.66	0.316
1997	1.075	0.53			0.97	0.63	0.55	0.544
1998	0.752	0.97			0.73	0.39	0.38	0.206
1999	0.671	1.21			0.73	0.51	0.43	0.197
2000	0.891	0.96			0.82	0.56	0.52	0.491
2001	0.309	0.50			0.35	0.19	0.21	0.037
2002	1.220	0.69			0.87	0.39	0.41	0.937
2003	0.861	0.40		0.55	0.91	0.47	0.54	0.130
2004	1.119	0.88		0.62	1.09	0.90	0.60	0.382
2005	2.702	2.85		1.88	2.10	1.11	1.02	1.315
2006	4.872	3.69		2.21	4.20	1.98	2.02	1.054
2007	1.867	2.41		1.93	1.91	1.25	1.09	0.235
2008	1.794	1.51		2.21	1.82	1.48	0.86	0.529
2009	1.907		4.62	2.40	2.01	1.47	1.16	0.699
2010	1.689		3.20	3.48	1.63	0.94	0.78	0.643
2011	1.010		2.45	3.30	1.08	0.64	0.65	0.281
2012	0.323		0.88	0.92	0.39	0.30	0.27	0.035
2013	0.089		0.25	0.14	0.14	0.13	0.11	0.005
2014	0.282		0.52	0.37	0.21	0.07	0.09	0.202
2015	0.080		0.21	0.15	0.11	0.09	0.09	0.005
2016	0.314		0.16	0.34	0.32	0.19	0.19	0.175
2017	0.054		0.17	0.18	0.07	0.05	0.05	0.001
2018	0.078		0.31	0.10	0.09	0.06	0.05	0.045
2019	0.054		0.19	0.08	0.08	0.06	0.06	0.002
2020								
2021	0.034		0.03	0.124	0.053	0.045	0.045	0.00151
2022	0.005		0.01	0.019	0.008	0.008	0.007	0.00005
2023	0.001			0.007	0.002	0.002	0.002	0.00000
2024				0.001				
1984-2013 mean	**1.27**	**1.00**	**2.28**	**1.78**	**1.27**	**0.82**	**0.67**	**0.41**
2014-2023 mean	**0.10**	**NA**	**0.20**	**0.15**	**0.10**	**0.06**	**0.06**	**0.05**
80th percentile	**1.49**	**1.16**	**2.75**	**2.25**	**1.64**	**1.16**	**0.79**	**0.58**
20th percentile	**0.45**	**0.40**	**0.20**	**0.31**	**0.54**	**0.35**	**0.34**	**0.14**

Table 6. Environmental condition indicators for GOM northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or above the 80th percentile; YELLOW = between the 80th and 20th percentiles; and GREEN = at or below the 20th percentile of the time series from 1984-2017. Dashes (-) indicate no data.

Survey	NEFSC	ASMFC	NEFSC	Boothbay Harbor, ME
Indicator	Predation Pressure Index	Summer Bottom Temperature	Spring Bottom Temperature	Feb-Mar Surface Temperature
1984	433.9	4.1	5.7	2.9
1985	597.5	4.0	5.2	2.8
1986	611.9	6.3	6.1	2.6
1987	390.5	6.0	5.1	1.8
1988	505.8	6.5	5.7	2.7
1989	521.1	5.6	4.9	1.9
1990	632.3	3.6	4.1	2.6
1991	509.2	6.1	5.6	3.4
1992	489.6	6.3	5.7	3.2
1993	473.9	5.8	4.4	1.2
1994	353.2	6.8	5.4	1.8
1995	637.7	6.6	5.9	3.3
1996	560.1	7.1	6.2	3.3
1997	382.0	6.8	6.1	3.7
1998	470.8	6.3	6.1	2.9
1999	745.9	6.1	5.7	2.9
2000	823.5	6.7	6.2	3.1
2001	730.5	6.5	5.8	2.9
2002	1,305.5	7.1	6.4	4.1
2003	1,054.5	5.6	4.9	2.4
2004	493.6	4.7	4.3	3.0
2005	472.4	4.9	5.1	3.0
2006	670.4	7.1	6.4	5.5
2007	712.7	5.9	5.4	2.0
2008	860.7	5.9	6.0	2.3
2009	737.7	6.0	5.5	2.6
2010	1,124.4	7.4	6.0	4.1
2011	1,117.6	7.7	7.4	2.9
2012	1,155.3	7.9	7.2	5.5
2013	742.6	7.1	6.4	3.9
2014	955.1	6.2	5.8	2.2
2015	829.4	5.8	5.2	1.4
2016	1,525.8	7.2	6.6	4.2
2017	951.7	6.9	6.1	3.8
2018	924.9	6.7	6.1	4.5
2019	674.2	7.1	6.6	3.5
2020	-	-	-	4.6
2021	1286.2	7.6	7.2	4.0
2022	1354.3	7.6	7.1	3.7
2023	956.1	7.6	-	4.6
2024	-	-	-	4.4
1984-2013 mean	**677.2**	**6.1**	**5.7**	**3.0**
2014-2023 mean	**1,062.7**	**6.9**	**6.3**	**3.6**
20th percentile (1984-2017)	**483.3**	**5.7**	**5.2**	**2.3**
80th percentile (1984-2017)	**953.0**	**7.1**	**6.2**	**3.8**

Table 7. Summary of results from the UME model.

Year	Average F	Recruitment (billions of shrimp)	Total Abundance (billions of shrimp)	Spawning Stock Biomass (mt)	Total Biomass (mt)
1984	0.208	2.03	7.67	7,065.7	24,978.2
1985	0.171	3.41	7.63	6,049.6	28,225.2
1986	0.234	2.64	5.98	7,036.3	24,255.1
1987	0.413	2.57	5.09	6,838.1	19,280.7
1988	0.209	7.04	9.73	5,970.0	21,619.4
1989	0.250	2.01	6.46	7,237.3	23,177.5
1990	0.292	1.81	4.97	4,541.7	21,568.8
1991	0.340	3.12	5.16	4,860.3	16,840.3
1992	0.365	2.12	4.44	5,805.1	14,964.4
1993	0.216	7.57	9.69	4,807.2	18,365.0
1994	0.223	3.10	7.67	6,069.8	22,774.4
1995	0.284	2.83	7.44	8,894.9	28,362.1
1996	0.497	2.02	5.05	6,972.3	21,673.5
1997	0.737	3.51	5.59	5,545.7	16,482.2
1998	0.533	2.25	5.06	4,751.7	15,486.8
1999	0.241	2.21	4.63	4,318.6	15,178.5
2000	0.654	9.13	10.75	4,082.2	17,183.2
2001	0.549	1.58	4.40	2,772.3	12,705.8
2002	0.071	42.78	44.37	4,527.5	42,035.0
2003	0.359	1.61	6.83	2,731.7	19,986.3
2004	0.225	3.98	5.76	1,727.6	13,951.2
2005	0.268	15.92	18.60	5,241.1	25,916.3
2006	0.174	17.76	26.44	6,777.7	47,167.8
2007	0.248	3.96	13.68	11,118.6	47,996.3
2008	0.178	9.93	15.27	6,360.7	42,423.5
2009	0.123	12.20	16.60	9,238.6	35,490.9
2010	0.451	21.77	27.25	7,687.6	44,686.4
2011	1.033	4.26	9.01	4,712.9	24,783.1
2012	0.555	1.00	2.80	2,706.0	10,868.0
2013	0.113	1.01	1.58	1,613.5	4,703.4
2014	0.000	4.32	4.87	1,964.2	6,669.2
2015	0.003	0.85	1.93	1,378.7	5,287.8
2016	0.004	4.82	5.46	1,797.7	7,589.9
2017	0.020	0.45	0.97	973.5	2,842.5
2018	0.002	0.94	1.21	790.4	2,486.9
2019	0.000	0.33	0.64	821.3	1,915.2
2020	0.002	1.45	1.71	736.1	2,724.3
2021	0.000	0.59	0.96	681.4	2,228.4
2022	0.000	0.26	0.42	483.4	1,177.1
2023	0.000	0.13	0.20	279.1	576.4

Table 8. Projected catch and SSB in 2025 from the UME model under different *F* scenarios using recent M and recent recruitment.

Year	F Rate	Catch	Probability that SSB_{2025} > SSB_{2023}	SSB (mt)	Change in SSB from 2023	Change in SSB_{2025} Compared to F=0
2025	F = 0	0 mt (0 lbs)	0%	127.4	-54%	--
2025	F = 0.01	0.5 mt (1,120 lbs)	0%	127.2	-54%	-0.2%
2025	F = 0.03	3.2 mt (7,092 lbs)	0%	126.5	-55%	-0.7%
2025	F = 0.07	6.7 mt (14,755 lbs)	0%	125.4	-55%	-1.6%
2025	F = 0.14	13.8 mt (30,408 lbs)	0%	123.4	-56%	-3.1%
2025	F = 0.36	32.5 mt (71,699 lbs)	0%	117.6	-58%	-7.6%
2025	F = 0.63	53 mt (116,881 lbs)	0%	110.6	-60%	-13.1%

Figures

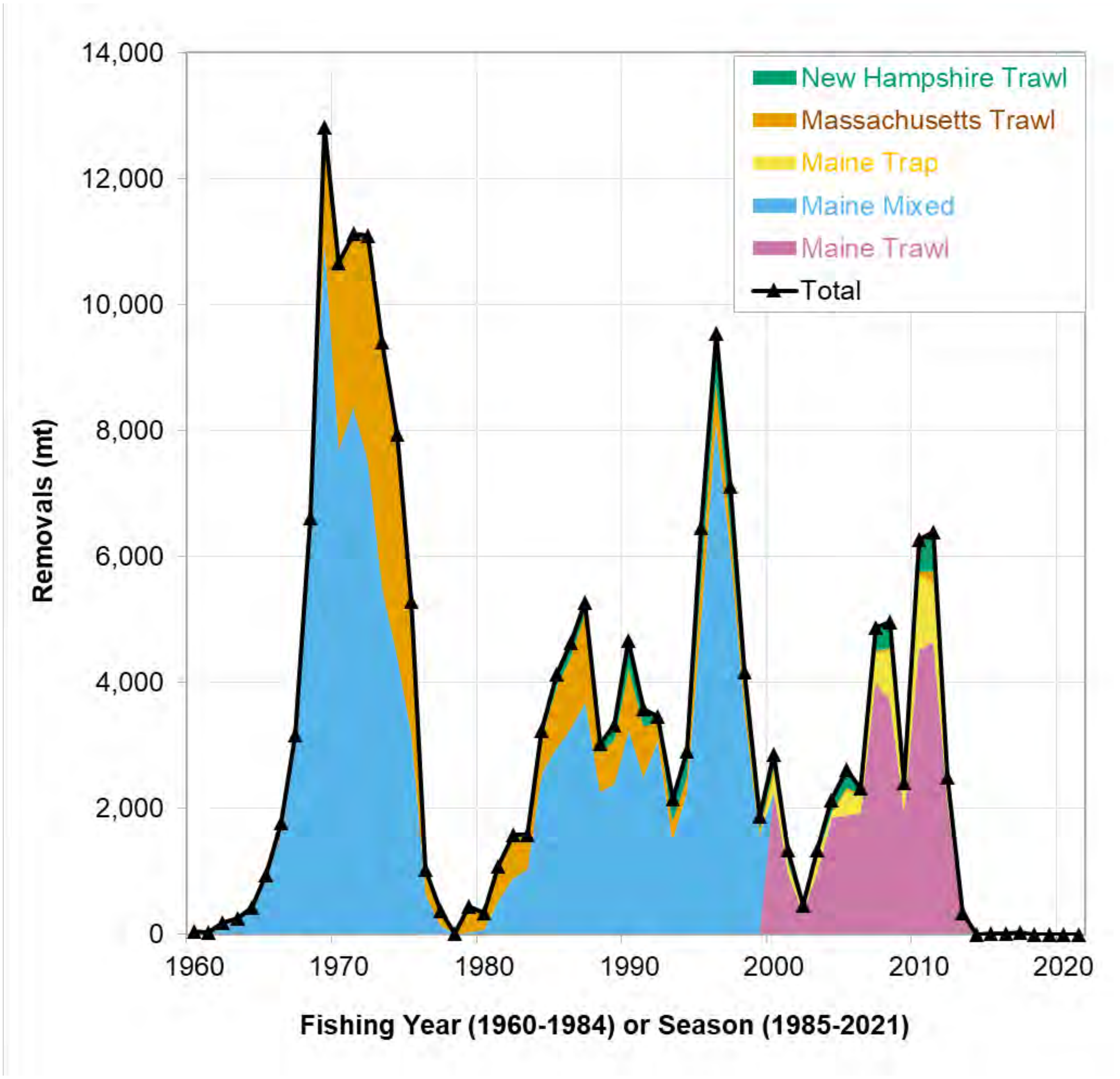


Figure 1. Northern shrimp landings from the Gulf of Maine by state and gear.

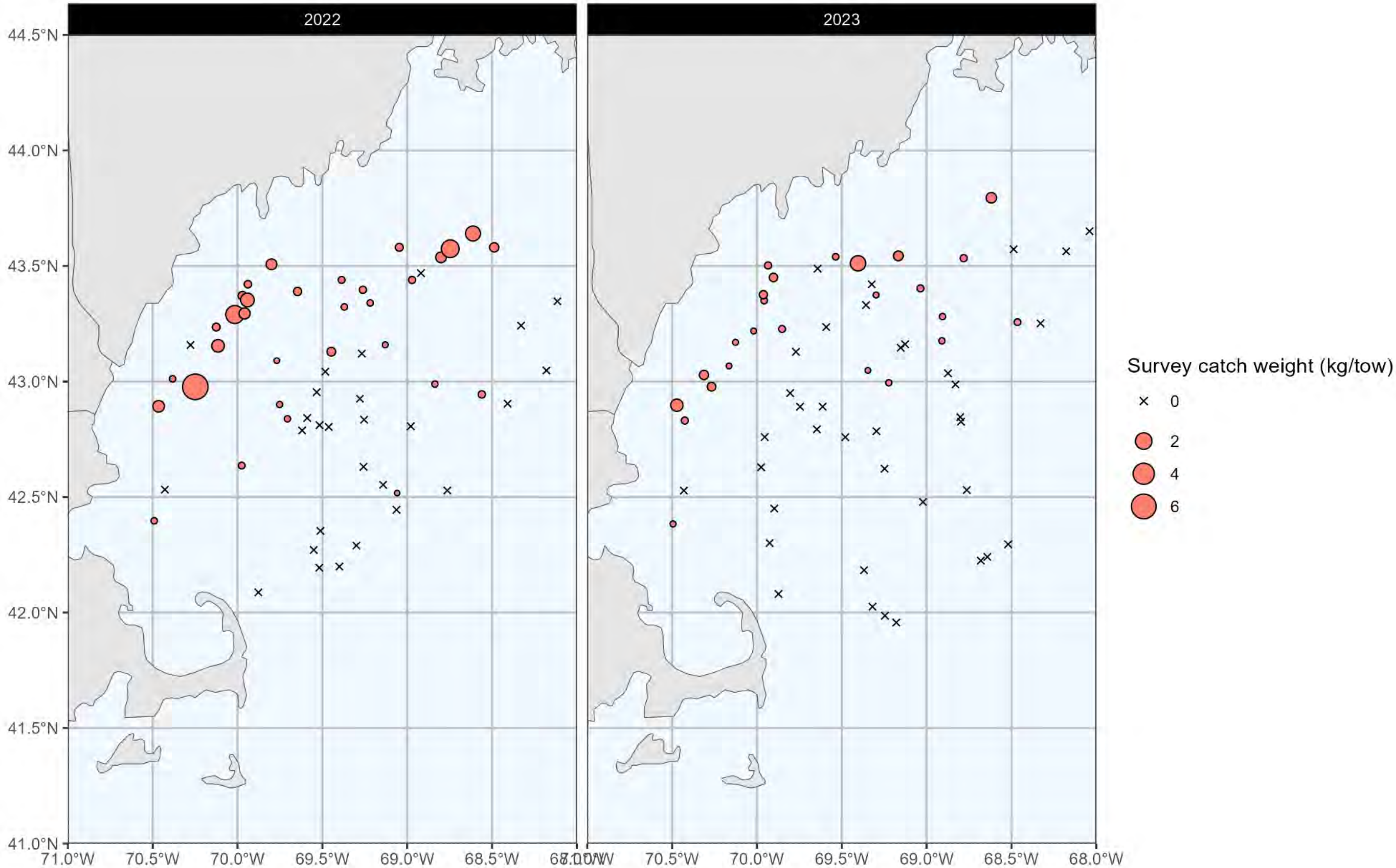


Figure 2. 2022-2023 ASMFC summer survey catches (kg per tow) by tow location.

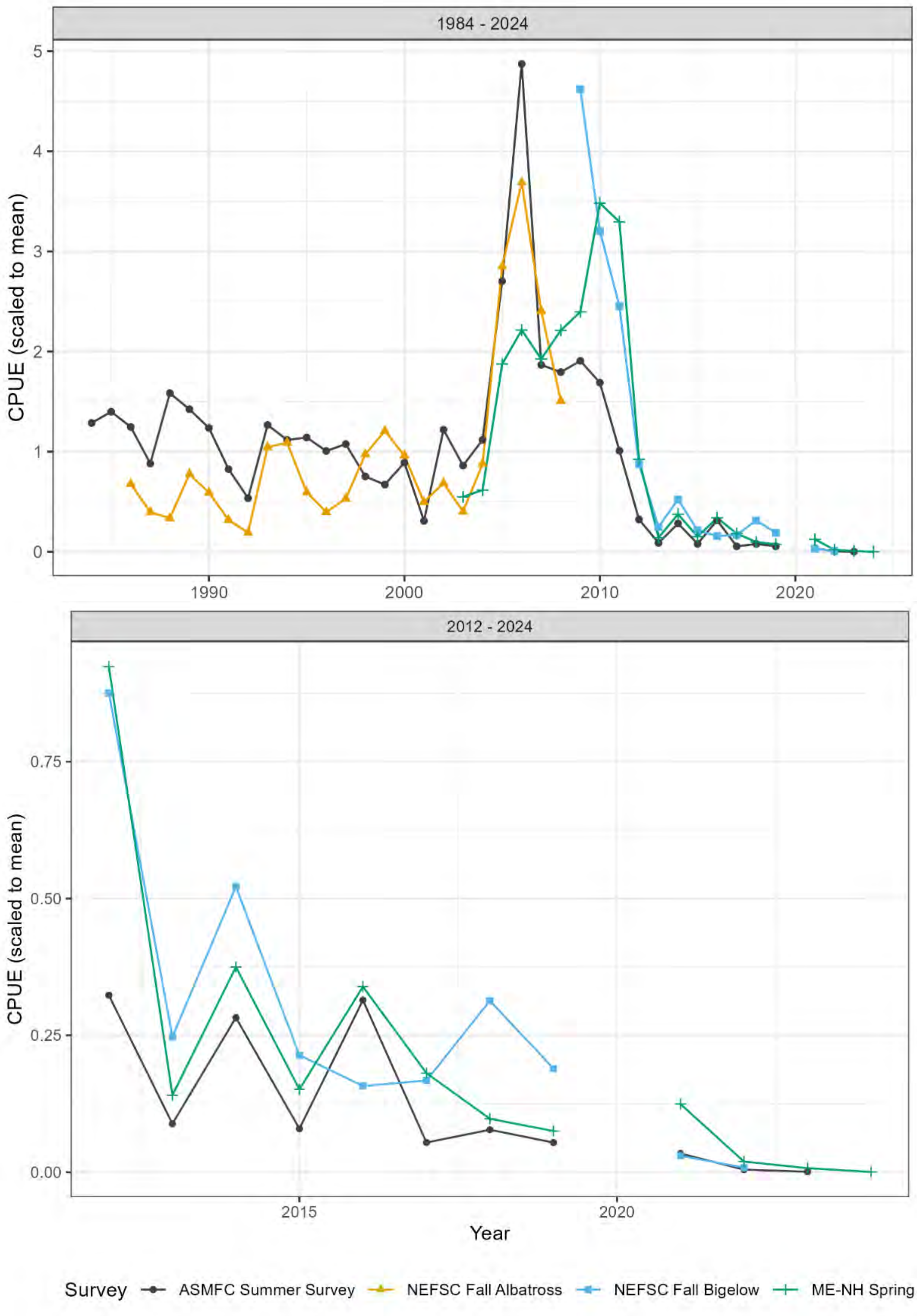


Figure 3. Standardized indices of abundance for Gulf of Maine northern shrimp for 1984-2024 (top) and truncated to 2012-2024 to show detail in recent years (bottom).

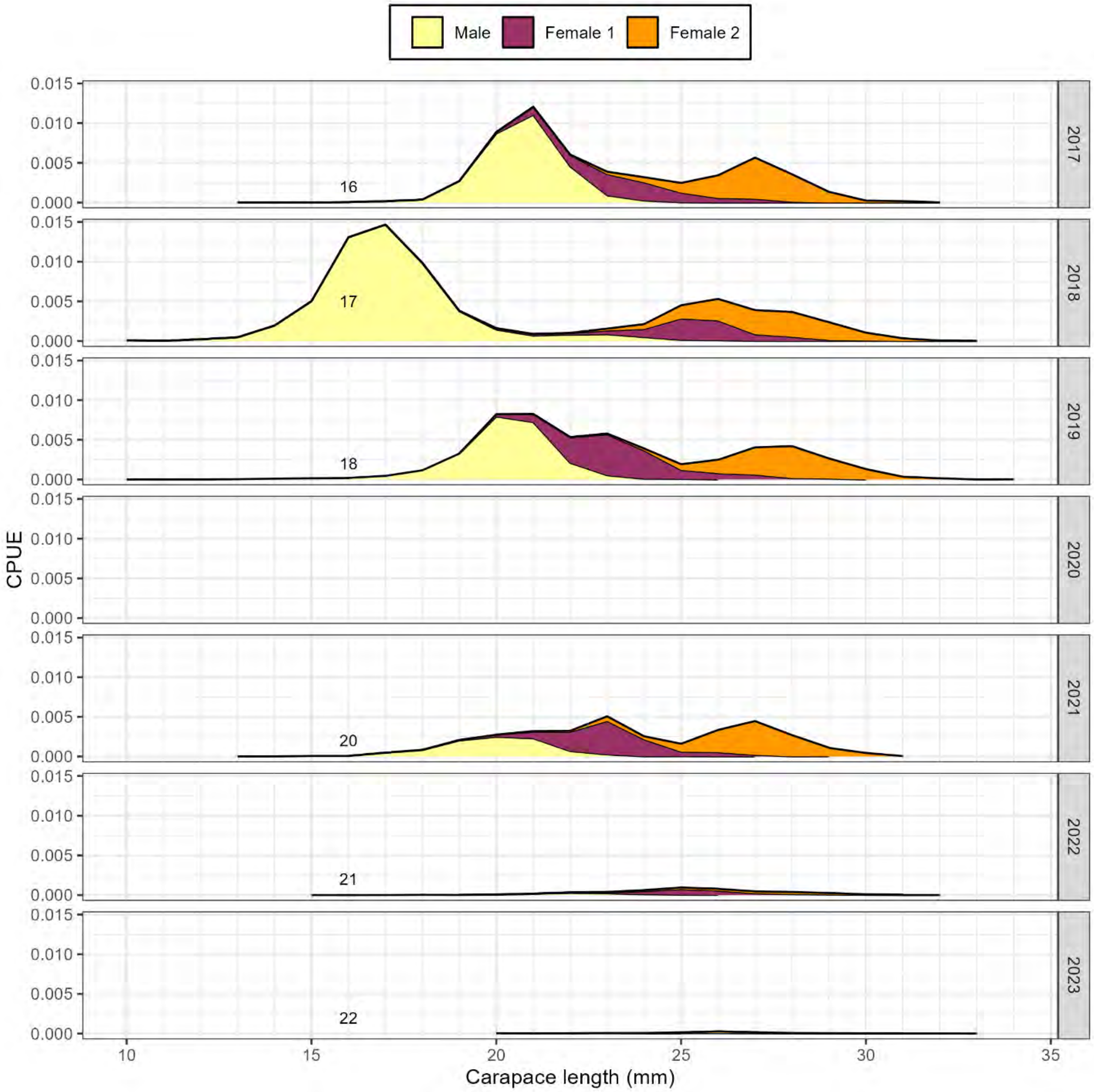


Figure 4. Gulf of Maine northern shrimp Summer Survey abundance by year, length, and development stage for 2017 – 2023. Two-digit numbers indicate the year class of the recruits. See Appendix 2 for the version of this plot with all years of data.

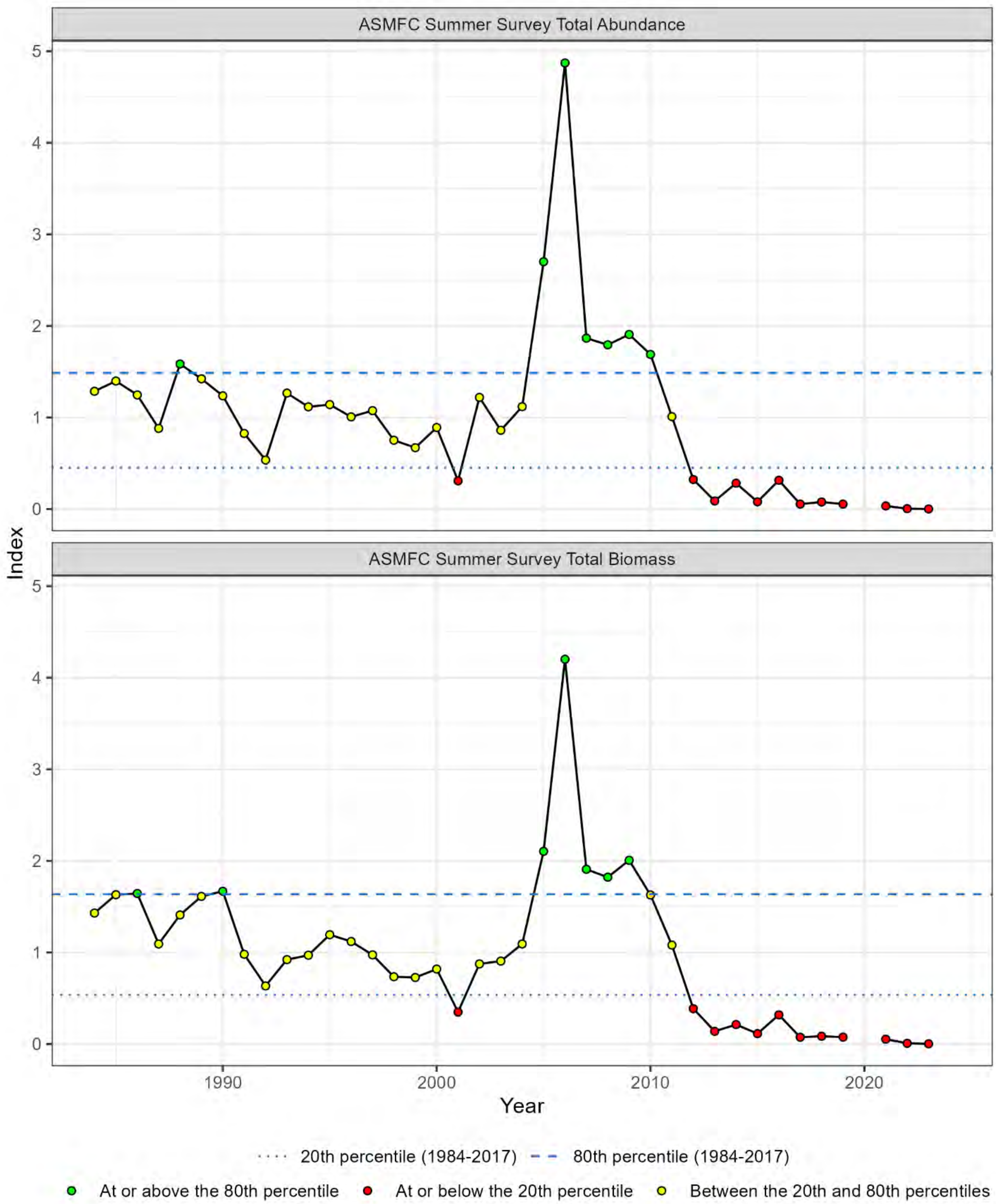


Figure 5. Traffic light analysis for the model-based index of abundance (top) and biomass (bottom) of Gulf of Maine northern shrimp from the Summer Shrimp Survey, 1984-2023. The 20th percentile of the time series from 1984-2017 delineated an adverse state, and the 80th percentile of the time series from 1984-2017 delineated a favorable state.

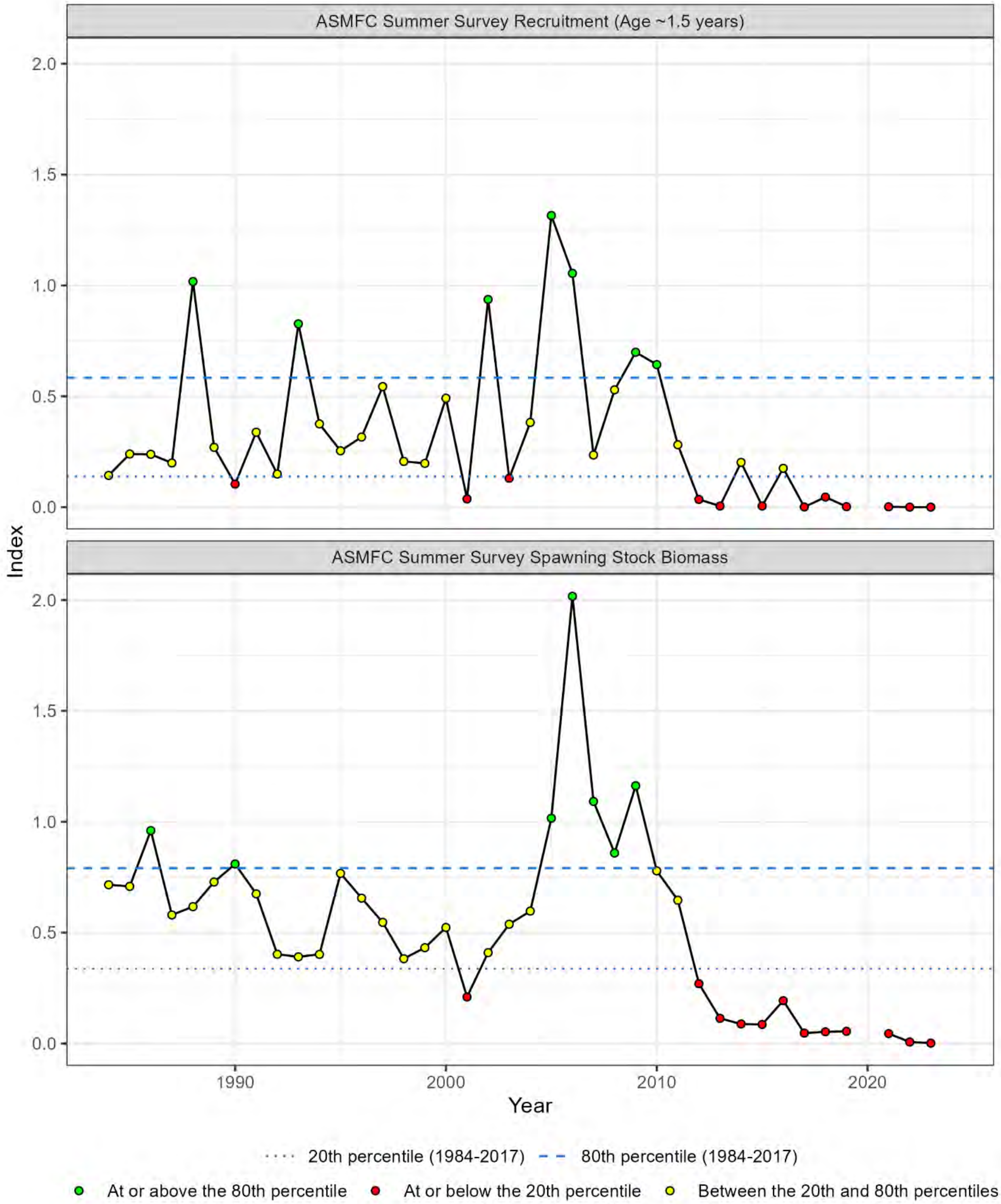


Figure 6. Traffic light analysis of recruitment (top) and spawning biomass (bottom) of Gulf of Maine northern shrimp from the Summer Shrimp survey, 1984-2023. The 20th percentile of the time series from 1984-2017 delineated an adverse state, and the 80th percentile of the time series from 1984-2017 delineated a favorable state.

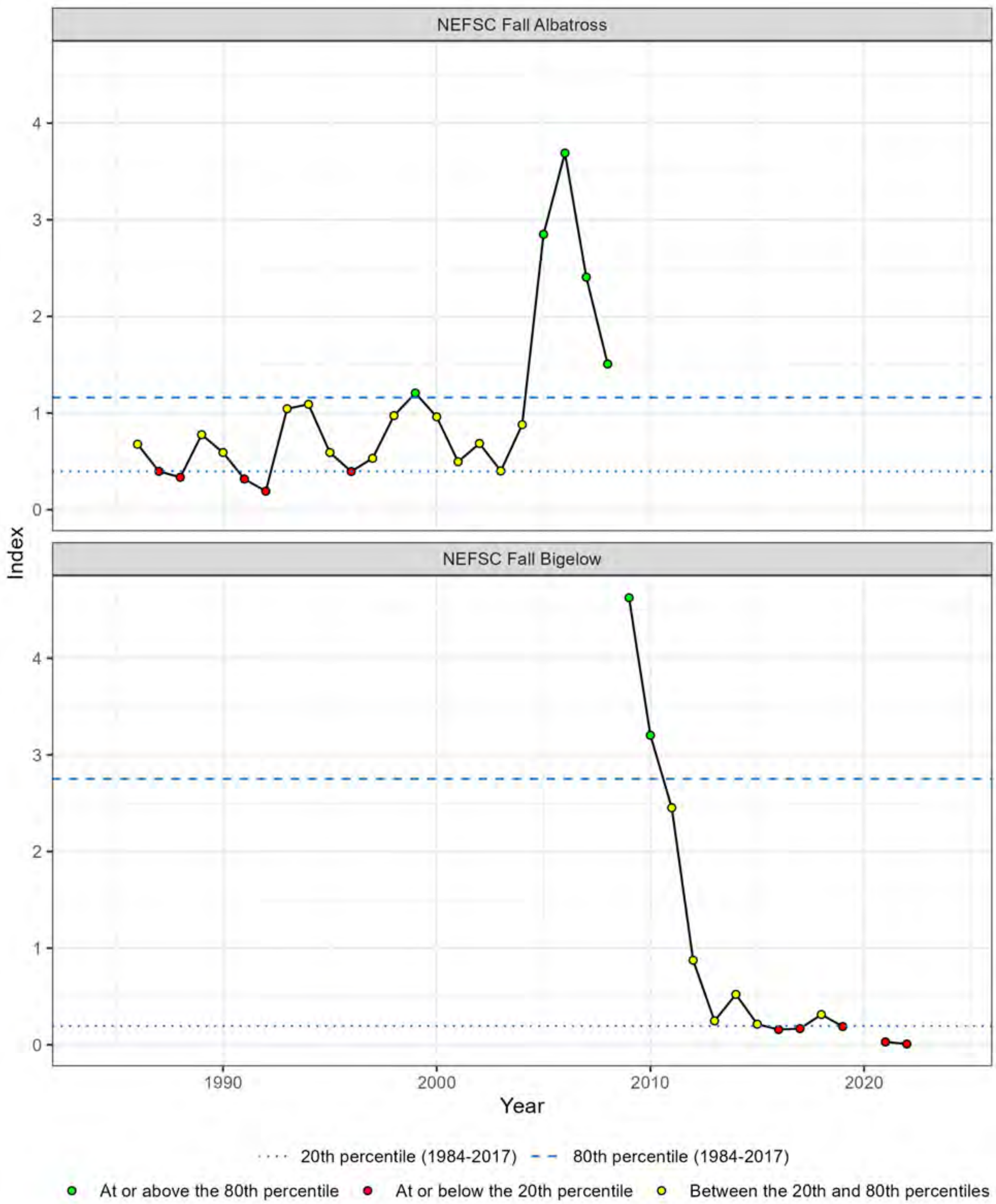


Figure 7. Traffic light analysis for the model-based index of abundance of Gulf of Maine northern shrimp from the NEFSC Fall Survey, 1984-2022 (Albatross years top, Bigelow years bottom). The 20th percentile of the time series through 2017 delineated an adverse state, and the 80th percentile of the time series through 2017 delineated a favorable state.

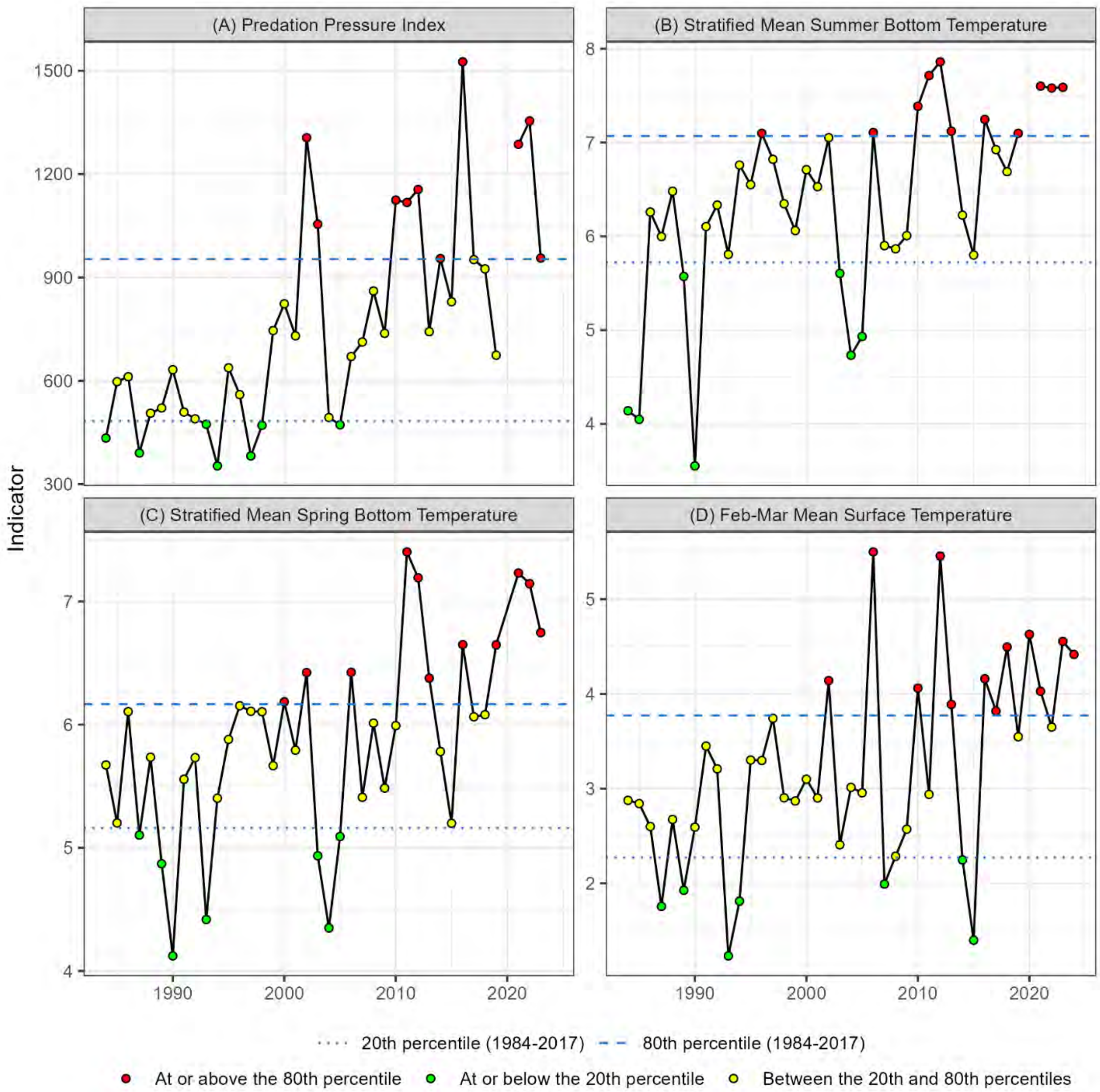


Figure 8. Traffic light analysis of environmental conditions in the Gulf of Maine 1984-2023, including predation pressure (A), summer bottom temperature (B), spring bottom temperature (C), and winter sea surface temperature (D). The 20th percentile of the time series from 1984-2017 delineated a favorable state, and the 80th percentile of the time series from 1984-2017 delineated an adverse state.

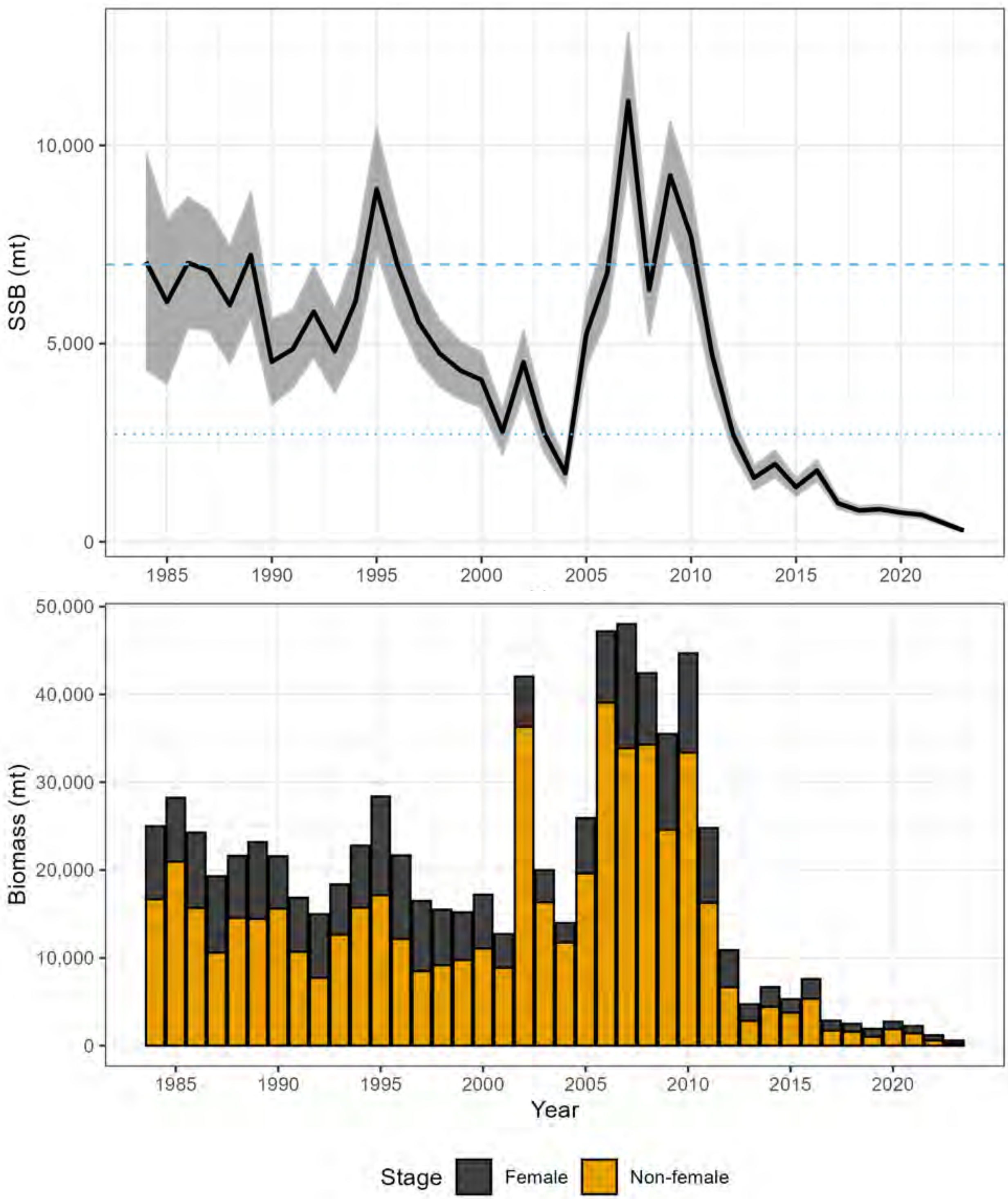


Figure 9. Estimates of Gulf of Maine northern shrimp spawning stock biomass with 95% confidence intervals (top) and total biomass by stage (bottom) from the UME model. Dashed lines in the top figure indicated the 80th and 20th percentiles of the 1984-2017 SSB estimates.

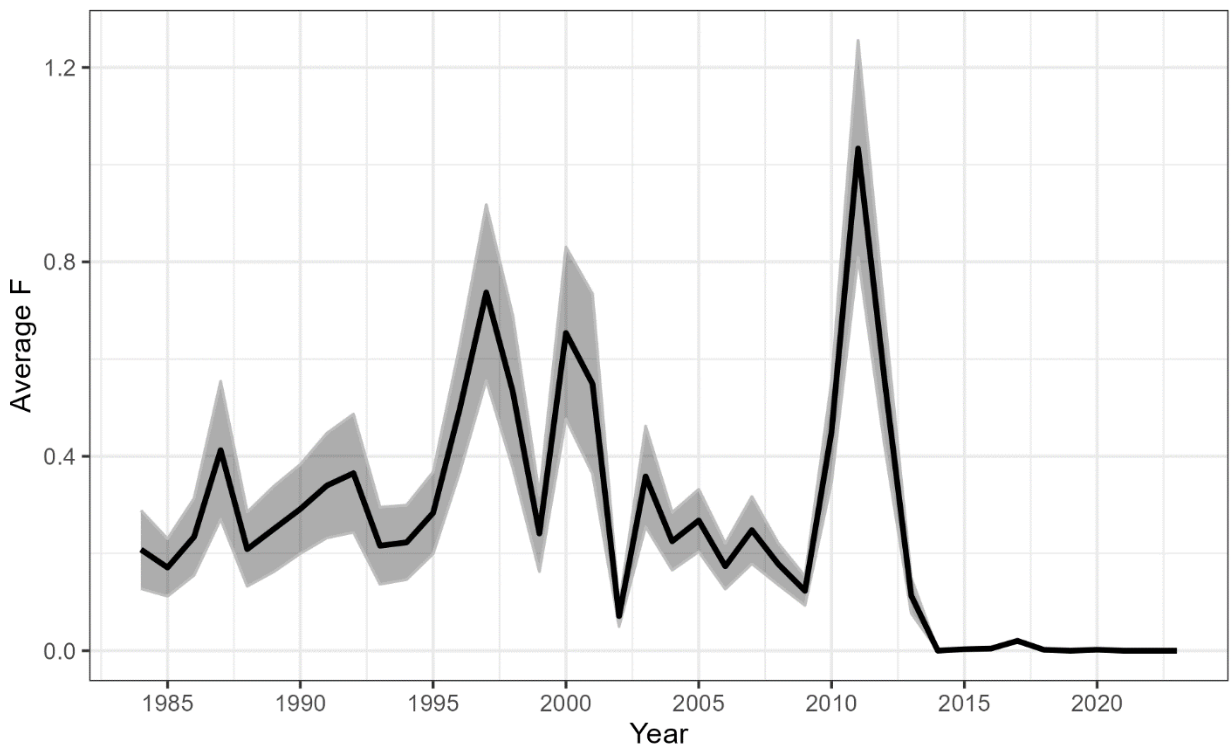


Figure 10. Average fishing mortality on Gulf of Maine northern shrimp estimated by the UME model with 95% confidence intervals.

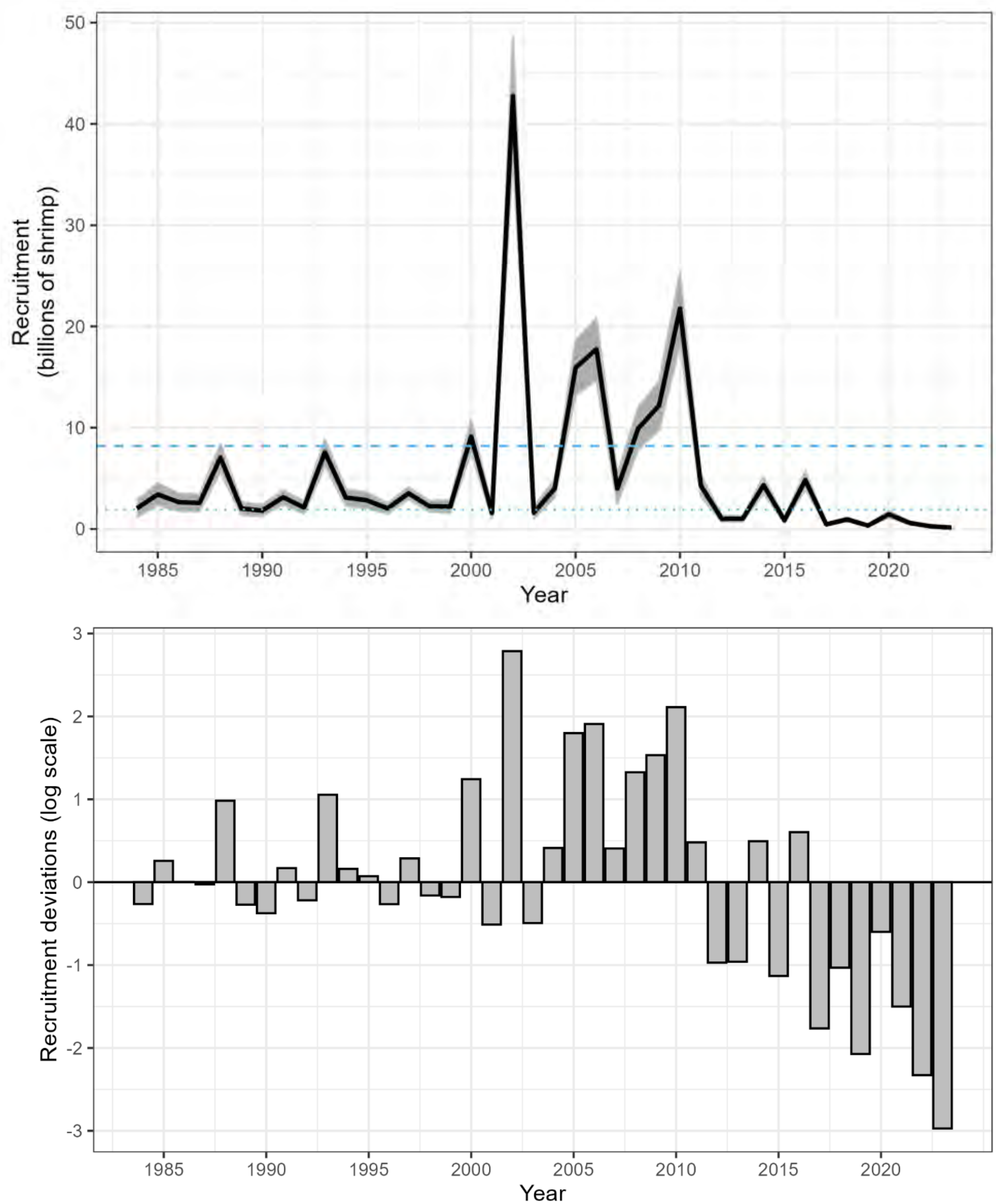


Figure 11. Estimates of total recruitment with 95% confidence intervals (top) and annual deviations from mean recruitment (bottom) for Gulf of Maine northern shrimp from the UME model. Dashed lines in the top plot indicate the 80th and 20th percentiles of the 1984-2017 estimates.

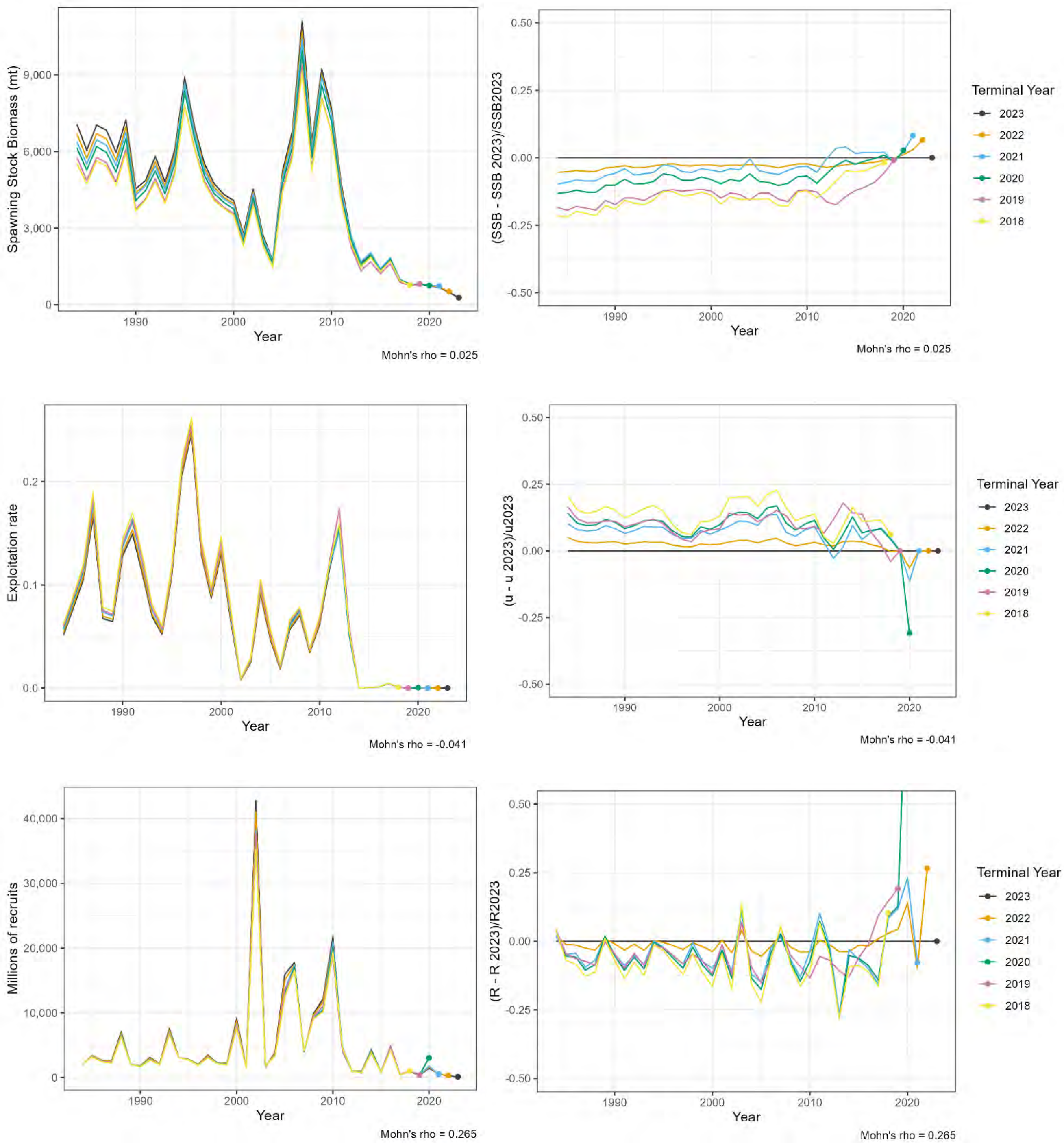


Figure 12. Retrospective analysis of UME model results for spawning stock biomass (top), exploitation rate (middle), and recruitment (bottom).

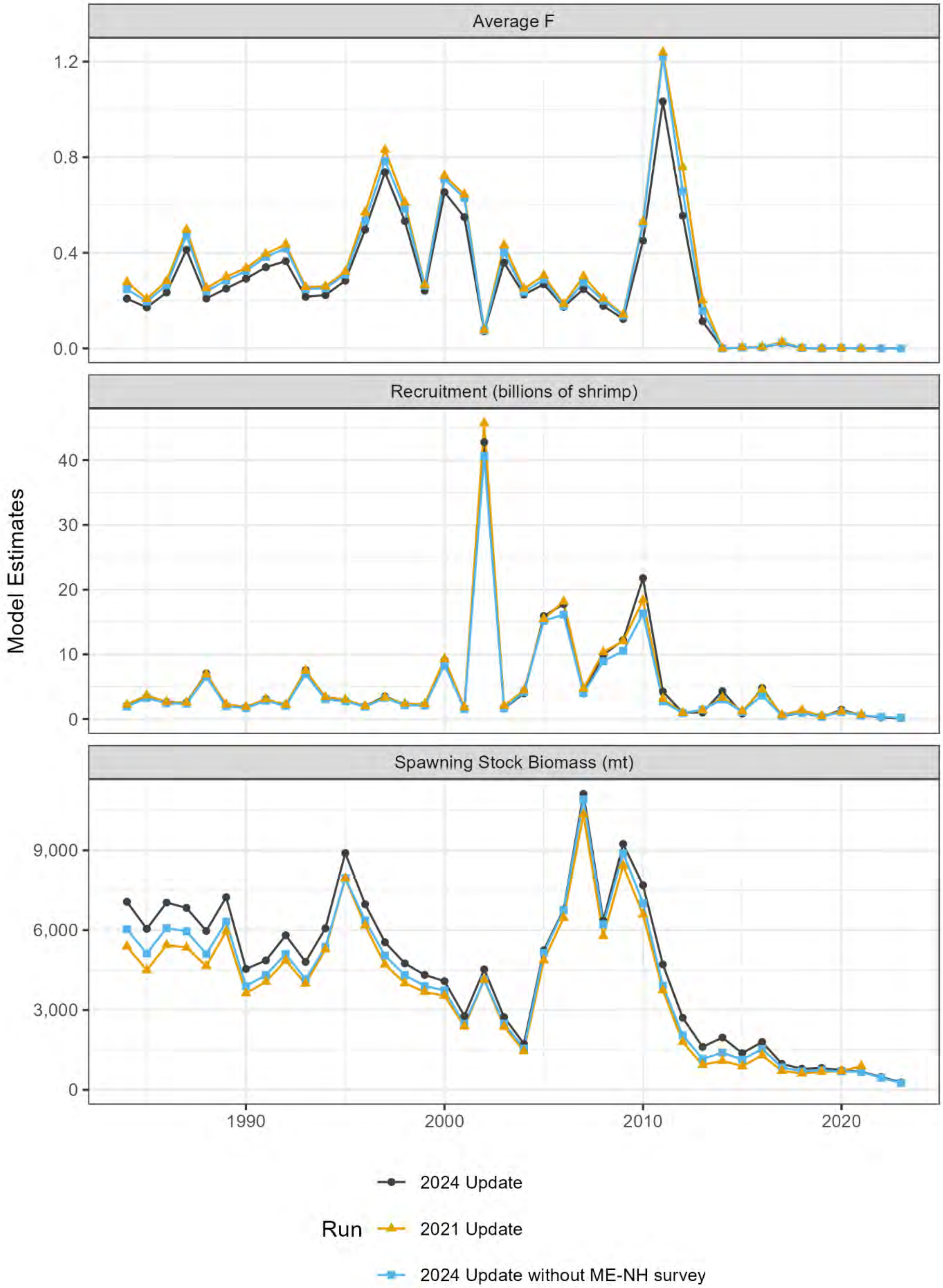


Figure 13. Comparison of results from the 2024 assessment update with and without the ME-NH survey and the 2021 assessment update.

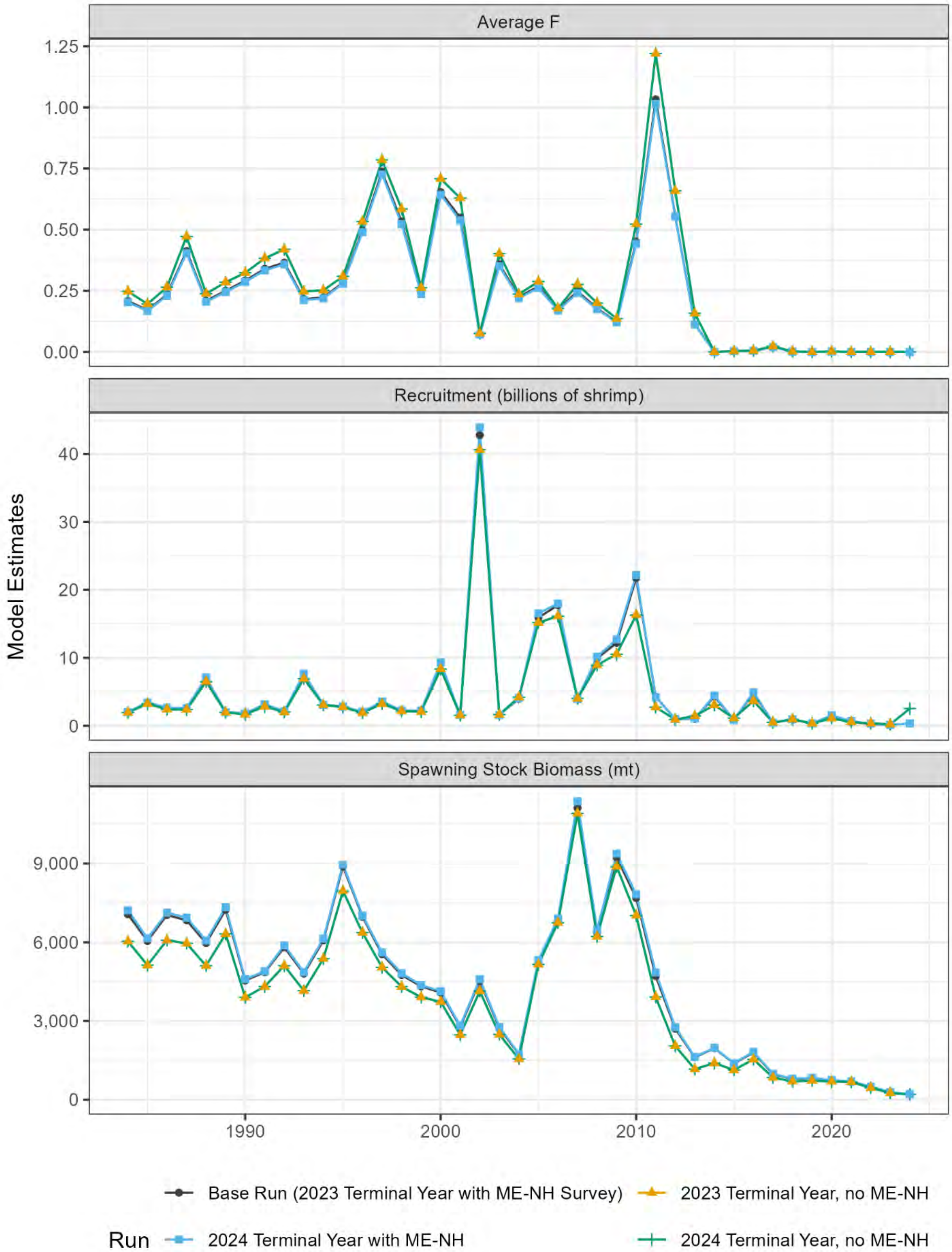


Figure 14. Comparison of results for the base model and sensitivity runs with a terminal year of 2024 and with and without the ME-NH survey.

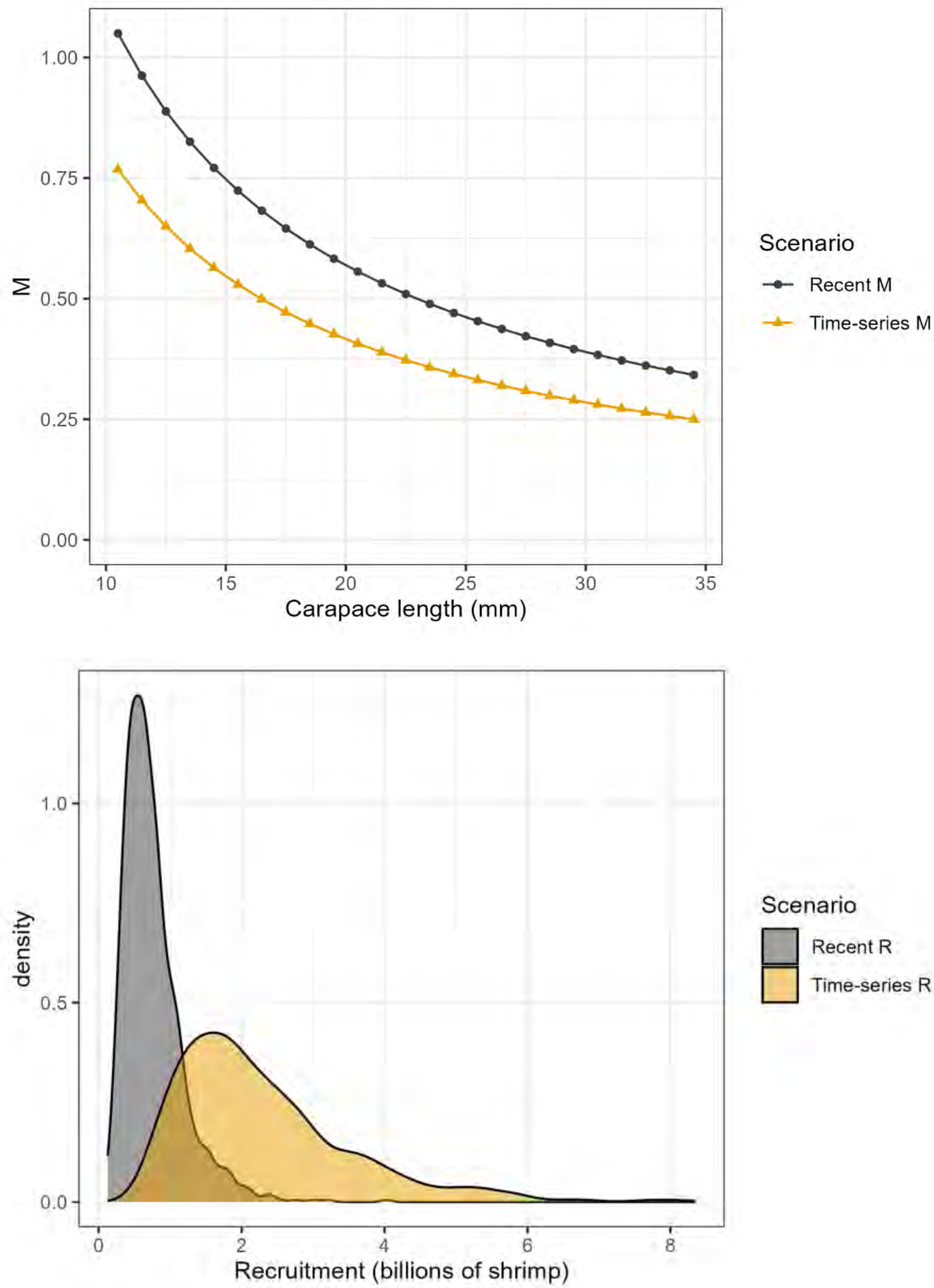


Figure 15. Estimates of M (top) and recruitment (bottom) used in the short- and long-term projections.

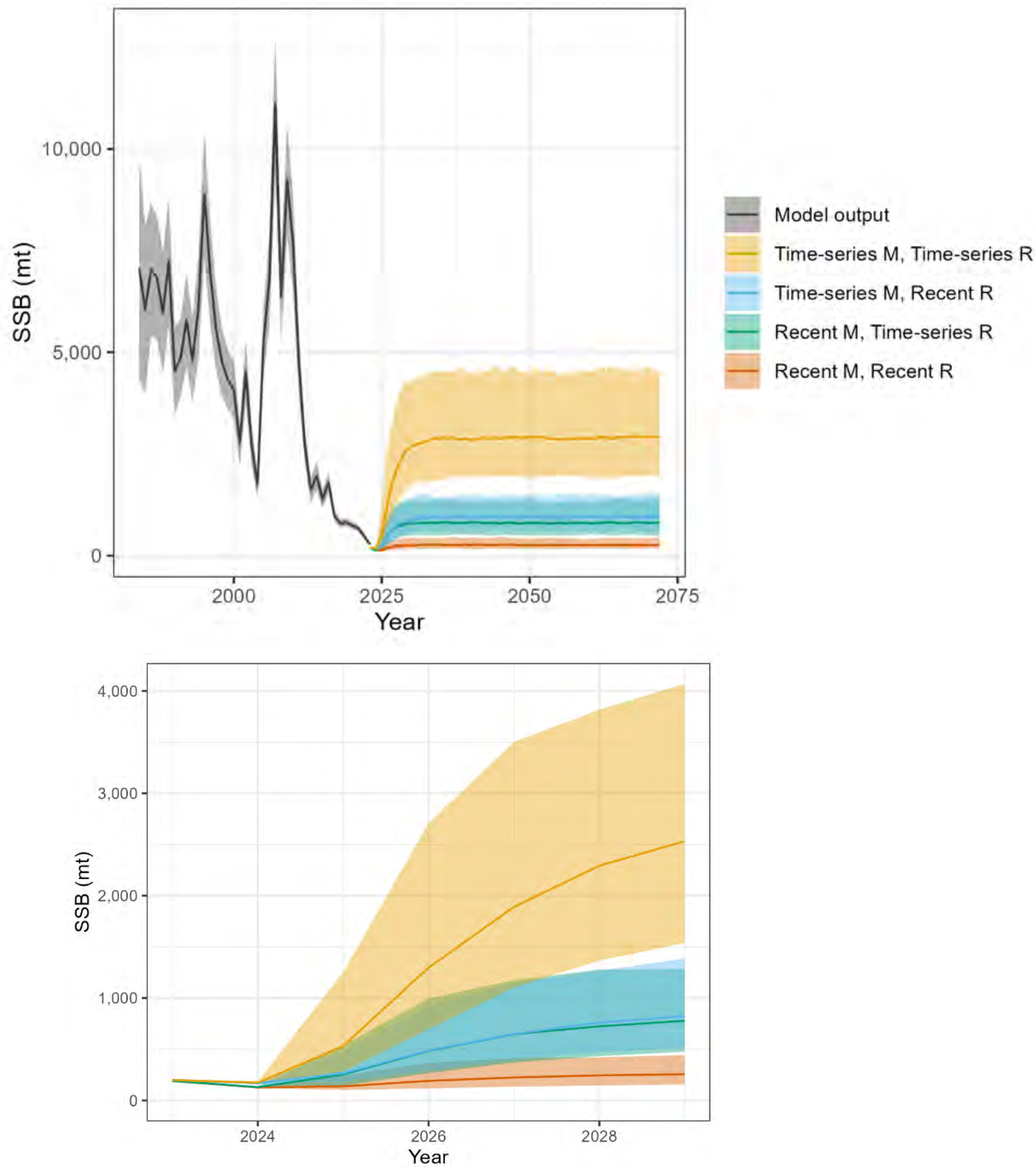


Figure 16. Trajectory of long term (top) and short term (bottom) median spawning stock biomass estimates for Gulf of Maine northern shrimp under different natural mortality and recruitment scenarios in the absence of fishing. Shaded areas indicate 95% confidence intervals.

Appendix 1: Diagnostic Plots for the VAST Index Standardization Models

N. Shrimp 2024 Assessment Update

Table 1. VAST model configuration for the ASMFC Summer Survey index standardization.

```
$Version
[1] "VAST_v13_1_0"

$n_x
[1] 100

$Region
[1] "other"

$strata.limits
     STRATA
1 All_areas

$zone
[1] NA

$FieldConfig
  Omega1 Epsilon1   Omega2 Epsilon2
       1        1        1        1

$RhoConfig
   Beta1    Beta2 Epsilon1 Epsilon2
       0        0        0        0

$VamConfig
Method   Rank Timing
     0      0      0

$OverdispersionConfig
    Vessel VesselYear
         0          0

$ObsModel
[1] 2 3

$vars_to_correct
[1] "Index_cyl" "Index_ctl"

$Options
         SD_site_density       SD_site_logdensity          Calculate_Range
Calculate_evenness
                       0                        0                        1
0
Calculate_effective_area         Calculate_Cov_SE      Calculate_Synchrony
Calculate_Coherence
                       1                        0                        0
0

$grid_size_km
[1] 25

$max_cells
[1] 2000
```

```
$knot_method
[1] "grid"

$Method
[1] "Mesh"

$use_anisotropy
[1] TRUE

$fine_scale
[1] TRUE

$bias.correct
[1] FALSE
```

Table 2. VAST model configuration for the NEFSC Fall Survey index standardization.

```
$Version
[1] "VAST_v14_0_1"

$n_x
[1] 100

$Region
[1] "other"

$strata.limits
     STRATA
1 All_areas

$zone
[1] NA

$FieldConfig
  Omega1 Epsilon1   Omega2 Epsilon2 
       1        1        1        1 

$RhoConfig
   Beta1    Beta2 Epsilon1 Epsilon2 
       0        0        0        0 

$VamConfig
Method   Rank Timing 
     0      0      0 

$OverdispersionConfig
    Vessel VesselYear 
         0          0 

$ObsModel
[1] 2 0

$vars_to_correct
[1] "Index_cyl" "Index_ctl"

$Options
         SD_site_density       SD_site_logdensity           Calculate_Range 
                       0                        0                         1 
      Calculate_evenness Calculate_effective_area          Calculate_Cov_SE 
                       0                        1                         0 
     Calculate_Synchrony      Calculate_Coherence 
                       0                        0 

$grid_size_km
[1] 25

$max_cells
[1] 2000
```

```
$knot_method
[1] "grid"

$Method
[1] "Mesh"

$use_anisotropy
[1] TRUE

$fine_scale
[1] TRUE

$bias.correct
[1] FALSE
```

Table 3. VAST model configuration for the ME-NH Spring Survey index standardization.

```
$Version
[1] "VAST_v13_1_0"

$n_x
[1] 100

$Region
[1] "other"

$strata.limits
     STRATA
1 All_areas

$zone
[1] NA

$FieldConfig
  Omega1 Epsilon1   Omega2 Epsilon2 
       1        1        1        1 

$RhoConfig
   Beta1    Beta2 Epsilon1 Epsilon2 
       0        0        0        0 

$VamConfig
Method   Rank Timing 
     0      0      0 

$OverdispersionConfig
    Vessel VesselYear 
         0          0 

$ObsModel
[1] 2 3

$vars_to_correct
[1] "Index_cyl" "Index_ctl"

$Options
         SD_site_density       SD_site_logdensity          Calculate_Range 
                       0                        0                        1 
      Calculate_evenness Calculate_effective_area         Calculate_Cov_SE 
                       0                        1                        0 
     Calculate_Synchrony      Calculate_Coherence 
                       0                        0 

$grid_size_km
[1] 25

$max_cells
[1] 2000

$knot_method
```

```
[1] "grid"

$Method
[1] "Mesh"

$use_anisotropy
[1] TRUE

$fine_scale
[1] TRUE

$bias.correct
[1] FALSE
```

Table 4. VAST parameter estimates for the ASMFC Summer Survey

Parameter	Initial Value	Lower Bound	Estimate	Upper Bound	Standard Deviation	Final Gradient
ln_H_input	-0.149	-5	-0.149	5	0.137	-2.916E-11
ln_H_input	0.297	-5	0.297	5	0.159	4.078E-09
beta1_ft	6.087	-Inf	6.087	Inf	1.890	-4.005E-09
beta1_ft	4.814	-Inf	4.814	Inf	1.661	-7.801E-09
beta1_ft	3.762	-Inf	3.762	Inf	1.387	2.585E-09
beta1_ft	4.689	-Inf	4.689	Inf	1.538	-6.990E-11
beta1_ft	5.384	-Inf	5.384	Inf	1.670	1.265E-09
beta1_ft	5.699	-Inf	5.699	Inf	2.114	-6.291E-09
beta1_ft	5.112	-Inf	5.112	Inf	1.883	-1.163E-09
beta1_ft	6.281	-Inf	6.281	Inf	1.964	-2.070E-09
beta1_ft	3.279	-Inf	3.279	Inf	1.369	2.128E-09
beta1_ft	6.328	-Inf	6.328	Inf	2.059	9.405E-10
beta1_ft	3.956	-Inf	3.956	Inf	1.607	3.808E-10
beta1_ft	5.678	-Inf	5.679	Inf	1.739	-4.982E-09
beta1_ft	3.313	-Inf	3.313	Inf	1.338	2.191E-09
beta1_ft	8.288	-Inf	8.288	Inf	3.048	-2.009E-10
beta1_ft	3.882	-Inf	3.881	Inf	1.649	-1.719E-09
beta1_ft	2.670	-Inf	2.670	Inf	1.230	3.472E-09
beta1_ft	5.507	-Inf	5.507	Inf	1.835	-8.076E-09
beta1_ft	5.093	-Inf	5.093	Inf	1.503	1.434E-09
beta1_ft	5.847	-Inf	5.847	Inf	1.788	-3.204E-09
beta1_ft	4.879	-Inf	4.879	Inf	1.489	2.077E-09
beta1_ft	4.257	-Inf	4.257	Inf	1.391	3.147E-09
beta1_ft	2.050	-Inf	2.051	Inf	1.221	-1.608E-08
beta1_ft	4.150	-Inf	4.150	Inf	1.549	1.442E-10
beta1_ft	3.949	-Inf	3.949	Inf	1.471	2.205E-09
beta1_ft	1.160	-Inf	1.160	Inf	1.222	1.515E-08
beta1_ft	1.928	-Inf	1.928	Inf	1.484	2.415E-09
beta1_ft	0.760	-Inf	0.760	Inf	1.145	-3.651E-09
beta1_ft	0.782	-Inf	0.782	Inf	1.176	3.962E-09
beta1_ft	-1.364	-Inf	-1.364	Inf	1.167	4.235E-09
beta1_ft	-2.850	-Inf	-2.850	Inf	1.199	1.016E-08
L_omega1_z	3.356	-Inf	3.356	Inf	0.628	-1.077E-08
L_epsilon1_z	1.082	-Inf	1.082	Inf	0.466	-5.604E-08
logkappa1	-2.928	-4.567	-2.928	-1.274	0.239	4.000E-08
beta2_ft	10.096	-Inf	10.096	Inf	0.810	1.941E-10
beta2_ft	10.631	-Inf	10.631	Inf	0.786	-3.895E-09
beta2_ft	10.279	-Inf	10.279	Inf	0.786	2.590E-09
beta2_ft	9.872	-Inf	9.872	Inf	0.785	3.390E-10
beta2_ft	10.040	-Inf	10.040	Inf	0.808	-7.383E-10
beta2_ft	10.365	-Inf	10.365	Inf	0.792	-7.186E-10

Parameter	Initial Value	Lower Bound	Estimate	Upper Bound	Standard Deviation	Final Gradient
beta2_ft	10.231	-Inf	10.231	Inf	0.796	7.383E-12
beta2_ft	9.897	-Inf	9.897	Inf	0.792	2.770E-10
beta2_ft	9.380	-Inf	9.380	Inf	0.791	6.821E-10
beta2_ft	10.012	-Inf	10.012	Inf	0.793	-6.528E-10
beta2_ft	9.935	-Inf	9.935	Inf	0.799	1.338E-10
beta2_ft	10.055	-Inf	10.055	Inf	0.799	1.404E-10
beta2_ft	9.477	-Inf	9.477	Inf	0.804	6.267E-10
beta2_ft	9.689	-Inf	9.688	Inf	0.803	-5.957E-10
beta2_ft	9.238	-Inf	9.238	Inf	0.794	7.796E-11
beta2_ft	9.453	-Inf	9.453	Inf	0.795	6.388E-10
beta2_ft	9.764	-Inf	9.764	Inf	0.797	-5.370E-10
beta2_ft	8.820	-Inf	8.820	Inf	0.795	-4.757E-10
beta2_ft	9.951	-Inf	9.951	Inf	0.797	1.266E-10
beta2_ft	9.682	-Inf	9.682	Inf	0.786	-2.175E-09
beta2_ft	10.129	-Inf	10.129	Inf	0.788	2.081E-09
beta2_ft	10.954	-Inf	10.954	Inf	0.782	7.522E-10
beta2_ft	11.554	-Inf	11.554	Inf	0.805	-2.011E-10
beta2_ft	10.282	-Inf	10.282	Inf	0.782	1.421E-10
beta2_ft	10.395	-Inf	10.395	Inf	0.786	-1.613E-09
beta2_ft	10.305	-Inf	10.305	Inf	0.783	-4.738E-10
beta2_ft	9.851	-Inf	9.851	Inf	0.788	-7.053E-10
beta2_ft	9.367	-Inf	9.367	Inf	0.781	-4.773E-10
beta2_ft	8.047	-Inf	8.047	Inf	0.786	-1.230E-09
beta2_ft	6.562	-Inf	6.562	Inf	0.792	1.165E-09
beta2_ft	7.810	-Inf	7.810	Inf	0.789	-3.882E-10
beta2_ft	6.800	-Inf	6.800	Inf	0.805	1.247E-10
beta2_ft	8.109	-Inf	8.109	Inf	0.788	9.616E-10
beta2_ft	6.242	-Inf	6.242	Inf	0.805	5.529E-10
beta2_ft	6.554	-Inf	6.554	Inf	0.827	2.478E-10
beta2_ft	6.092	-Inf	6.092	Inf	0.800	1.165E-09
beta2_ft	5.871	-Inf	5.871	Inf	0.804	8.794E-10
beta2_ft	4.506	-Inf	4.506	Inf	0.819	6.789E-10
beta2_ft	3.277	-Inf	3.277	Inf	0.841	1.149E-10
L_omega2_z	-1.611	-Inf	-1.611	Inf	0.188	2.427E-10
L_epsilon2_z	0.634	-Inf	0.634	Inf	0.037	-1.604E-07
logkappa2	-3.339	-4.567	-3.339	-1.274	0.106	9.099E-08
logSigmaM	-0.158	-Inf	-0.158	10	0.018	-3.581E-08

Table 5. VAST parameter estimates for the NEFSC Fall Survey

Parameter	Initial Value	Lower Bound	Estimate	Upper Bound	Standard Deviation	Final Gradient
ln_H_input	-0.395	-5	-0.395	5	0.259	5.235E-09
ln_H_input	0.312	-5	0.312	5	0.312	-6.694E-09
beta1_ft	1.961	-Inf	1.961	Inf	1.129	-1.136E-09
beta1_ft	1.016	-Inf	1.016	Inf	1.114	-2.239E-09
beta1_ft	1.043	-Inf	1.043	Inf	1.113	1.275E-09
beta1_ft	1.284	-Inf	1.284	Inf	1.112	6.741E-10
beta1_ft	0.870	-Inf	0.870	Inf	1.109	-8.746E-11
beta1_ft	1.646	-Inf	1.646	Inf	1.109	-1.868E-09
beta1_ft	1.577	-Inf	1.577	Inf	1.107	-1.174E-10
beta1_ft	1.733	-Inf	1.733	Inf	1.108	-8.925E-10
beta1_ft	0.152	-Inf	0.152	Inf	1.114	5.002E-10
beta1_ft	-0.145	-Inf	-0.145	Inf	1.114	4.466E-10
beta1_ft	-0.238	-Inf	-0.238	Inf	1.110	-3.751E-10
beta1_ft	-0.621	-Inf	-0.621	Inf	1.102	-6.009E-10
beta1_ft	-2.018	-Inf	-2.018	Inf	1.169	-4.433E-10
L_omega1_z	-2.037	-Inf	-2.037	Inf	0.412	1.034E-08
L_epsilon1_z	0.347	-Inf	0.347	Inf	0.391	-4.740E-10
logkappa1	-3.473	-4.826	-3.473	-1.155	0.284	2.545E-09
beta2_ft	9.780	-Inf	9.780	Inf	0.562	8.520E-11
beta2_ft	9.350	-Inf	9.350	Inf	0.567	1.590E-11
beta2_ft	9.040	-Inf	9.040	Inf	0.563	-8.797E-11
beta2_ft	7.980	-Inf	7.980	Inf	0.564	1.386E-11
beta2_ft	6.567	-Inf	6.567	Inf	0.576	4.965E-11
beta2_ft	7.358	-Inf	7.358	Inf	0.554	2.776E-11
beta2_ft	6.488	-Inf	6.488	Inf	0.556	-2.328E-11
beta2_ft	6.285	-Inf	6.285	Inf	0.549	-1.854E-10
beta2_ft	6.259	-Inf	6.259	Inf	0.603	3.096E-11
beta2_ft	7.013	-Inf	7.013	Inf	0.611	-7.583E-11
beta2_ft	6.564	-Inf	6.563	Inf	0.597	7.021E-12
beta2_ft	4.901	-Inf	4.901	Inf	0.608	-1.030E-11
beta2_ft	4.164	-Inf	4.164	Inf	0.733	-1.042E-10
L_omega2_z	1.604	-Inf	1.604	Inf	0.196	-2.038E-08
L_epsilon2_z	0.579	-Inf	0.579	Inf	0.181	3.319E-08
logkappa2	-2.951	-4.826	-2.951	-1.155	0.231	-2.764E-08
logSigmaM	-0.033	-Inf	-0.033	10	0.058	3.767E-08

Table 6. VAST parameter estimates for the ME-NH Spring Survey

Parameter	Initial Value	Lower Bound	Estimate	Upper Bound	Standard Deviation	Final Gradient
ln_H_input	0.535	-5	0.535	5	0.329	6.901E-11
ln_H_input	1.617	-5	1.617	5	0.731	3.598E-09
beta1_ft	1.201	-Inf	1.200	Inf	1.609	6.064E-10
beta1_ft	-0.495	-Inf	-0.496	Inf	1.609	-6.525E-10
beta1_ft	1.788	-Inf	1.787	Inf	1.610	-1.690E-09
beta1_ft	0.869	-Inf	0.868	Inf	1.607	-3.874E-09
beta1_ft	1.113	-Inf	1.112	Inf	1.609	1.413E-09
beta1_ft	1.076	-Inf	1.076	Inf	1.610	1.471E-09
beta1_ft	1.350	-Inf	1.349	Inf	1.607	1.439E-09
beta1_ft	1.097	-Inf	1.096	Inf	1.609	2.806E-10
beta1_ft	1.396	-Inf	1.395	Inf	1.611	2.324E-09
beta1_ft	0.696	-Inf	0.695	Inf	1.605	2.965E-10
beta1_ft	-0.160	-Inf	-0.161	Inf	1.611	-1.173E-09
beta1_ft	0.551	-Inf	0.550	Inf	1.606	-1.604E-09
beta1_ft	-1.383	-Inf	-1.384	Inf	1.609	-2.107E-09
beta1_ft	0.074	-Inf	0.073	Inf	1.606	4.621E-10
beta1_ft	-0.641	-Inf	-0.641	Inf	1.605	-1.679E-10
beta1_ft	-1.593	-Inf	-1.594	Inf	1.605	5.291E-09
beta1_ft	-1.937	-Inf	-1.938	Inf	1.609	3.655E-09
beta1_ft	-2.111	-Inf	-2.112	Inf	1.614	1.617E-09
beta1_ft	-2.398	-Inf	-2.399	Inf	1.623	1.165E-09
beta1_ft	-3.650	-Inf	-3.650	Inf	1.631	-9.598E-12
beta1_ft	-6.246	-Inf	-6.247	Inf	1.691	8.828E-10
L_omega1_z	5.152	-Inf	5.152	Inf	0.888	-5.679E-08
L_epsilon1_z	-0.739	-Inf	-0.739	Inf	0.209	3.328E-08
logkappa1	-2.647	-4.855	-2.647	-0.952	0.309	2.988E-07
beta2_ft	7.563	-Inf	7.563	Inf	0.832	-8.399E-10
beta2_ft	7.666	-Inf	7.666	Inf	0.841	4.506E-10
beta2_ft	9.122	-Inf	9.122	Inf	0.831	9.377E-10
beta2_ft	9.011	-Inf	9.011	Inf	0.831	4.055E-10
beta2_ft	9.134	-Inf	9.134	Inf	0.832	-2.261E-09
beta2_ft	9.131	-Inf	9.131	Inf	0.832	-8.985E-10
beta2_ft	9.400	-Inf	9.400	Inf	0.826	-7.394E-10
beta2_ft	9.984	-Inf	9.984	Inf	0.831	-1.482E-09
beta2_ft	9.659	-Inf	9.659	Inf	0.828	-5.263E-10
beta2_ft	8.340	-Inf	8.340	Inf	0.831	3.874E-10
beta2_ft	6.513	-Inf	6.513	Inf	0.840	6.786E-10
beta2_ft	7.425	-Inf	7.425	Inf	0.837	2.013E-10
beta2_ft	6.115	-Inf	6.115	Inf	0.850	3.319E-10
beta2_ft	7.367	-Inf	7.367	Inf	0.837	2.222E-10
beta2_ft	6.352	-Inf	6.352	Inf	0.840	-6.101E-11

Parameter	Initial Value	Lower Bound	Estimate	Upper Bound	Standard Deviation	Final Gradient
beta2_ft	5.617	-Inf	5.617	Inf	0.849	1.878E-10
beta2_ft	5.004	-Inf	5.004	Inf	0.853	5.513E-10
beta2_ft	6.319	-Inf	6.319	Inf	0.855	-2.159E-10
beta2_ft	4.388	-Inf	4.387	Inf	0.871	-1.167E-10
beta2_ft	4.096	-Inf	4.096	Inf	0.872	-5.384E-10
beta2_ft	1.849	-Inf	1.849	Inf	0.931	3.555E-10
L_omega2_z	3.087	-Inf	3.087	Inf	0.558	-8.998E-09
L_epsilon2_z	-0.917	-Inf	-0.917	Inf	0.146	2.334E-08
logkappa2	-2.447	-4.855	-2.447	-0.952	0.211	2.277E-08
logSigmaM	0.006	-Inf	0.006	10	0.024	-1.685E-08

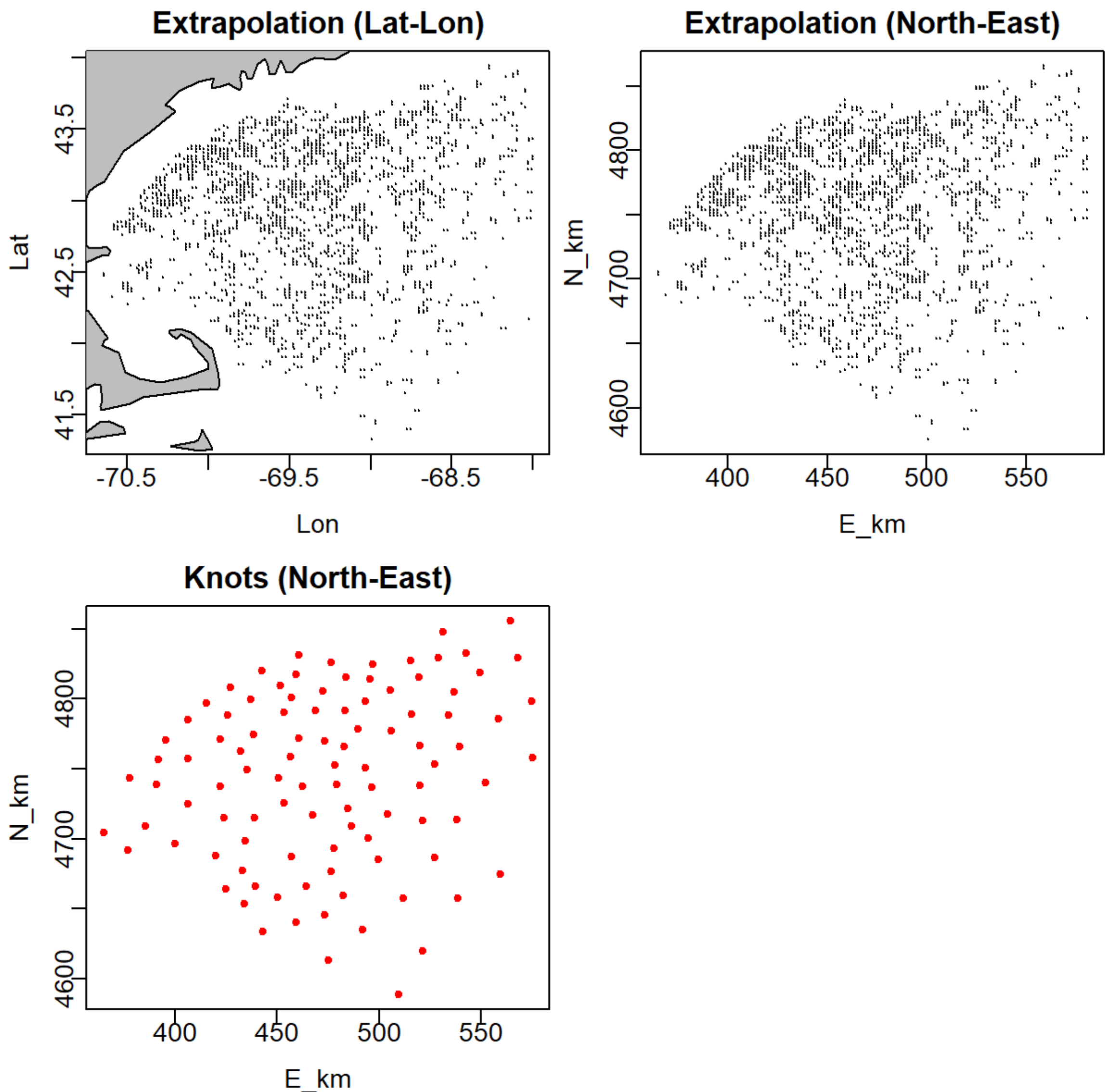


Figure 1. Extrapolation grid and knots for ASMFC Summer Survey.

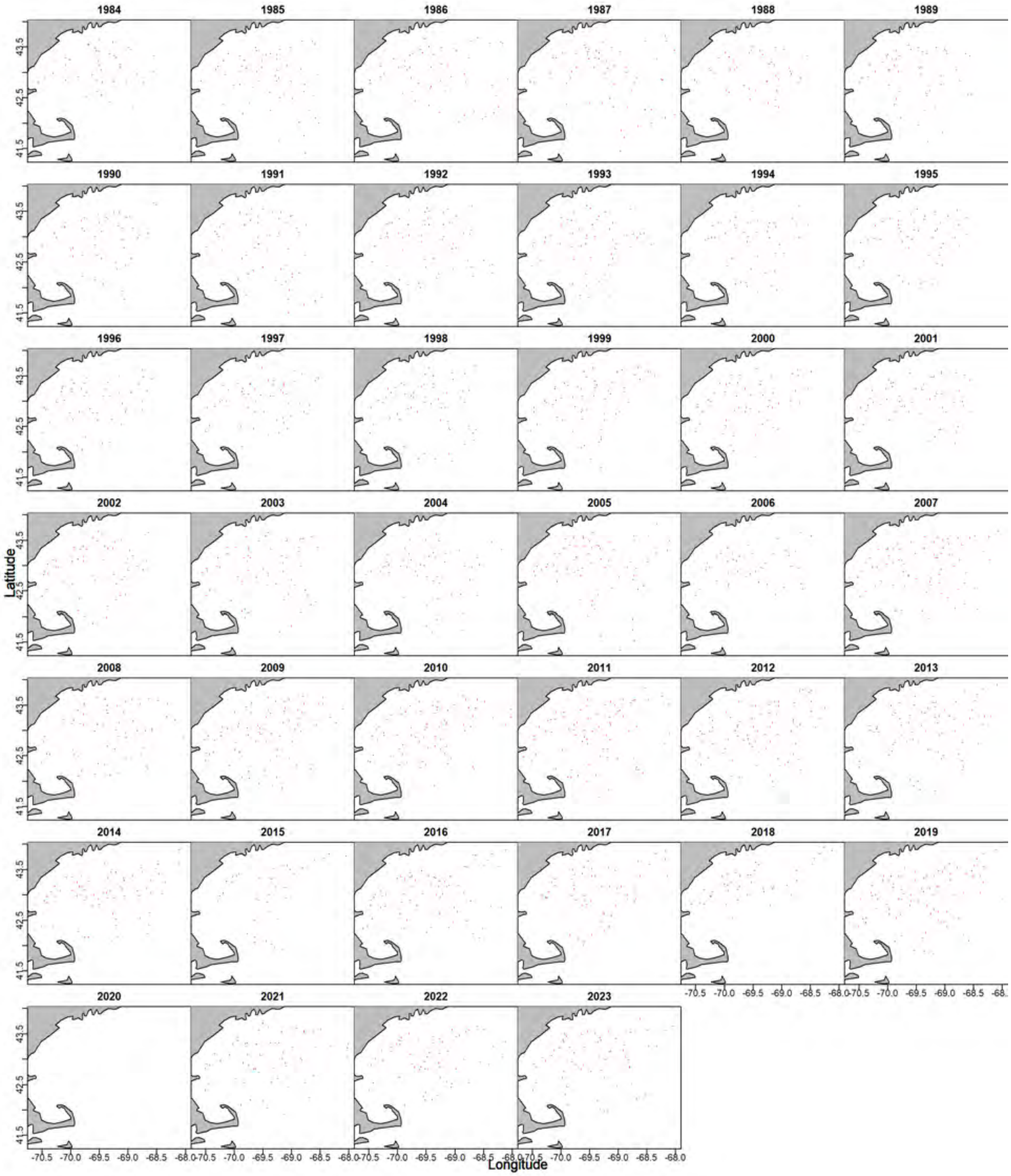


Figure 2. ASMFC Summer Survey catch locations by year.

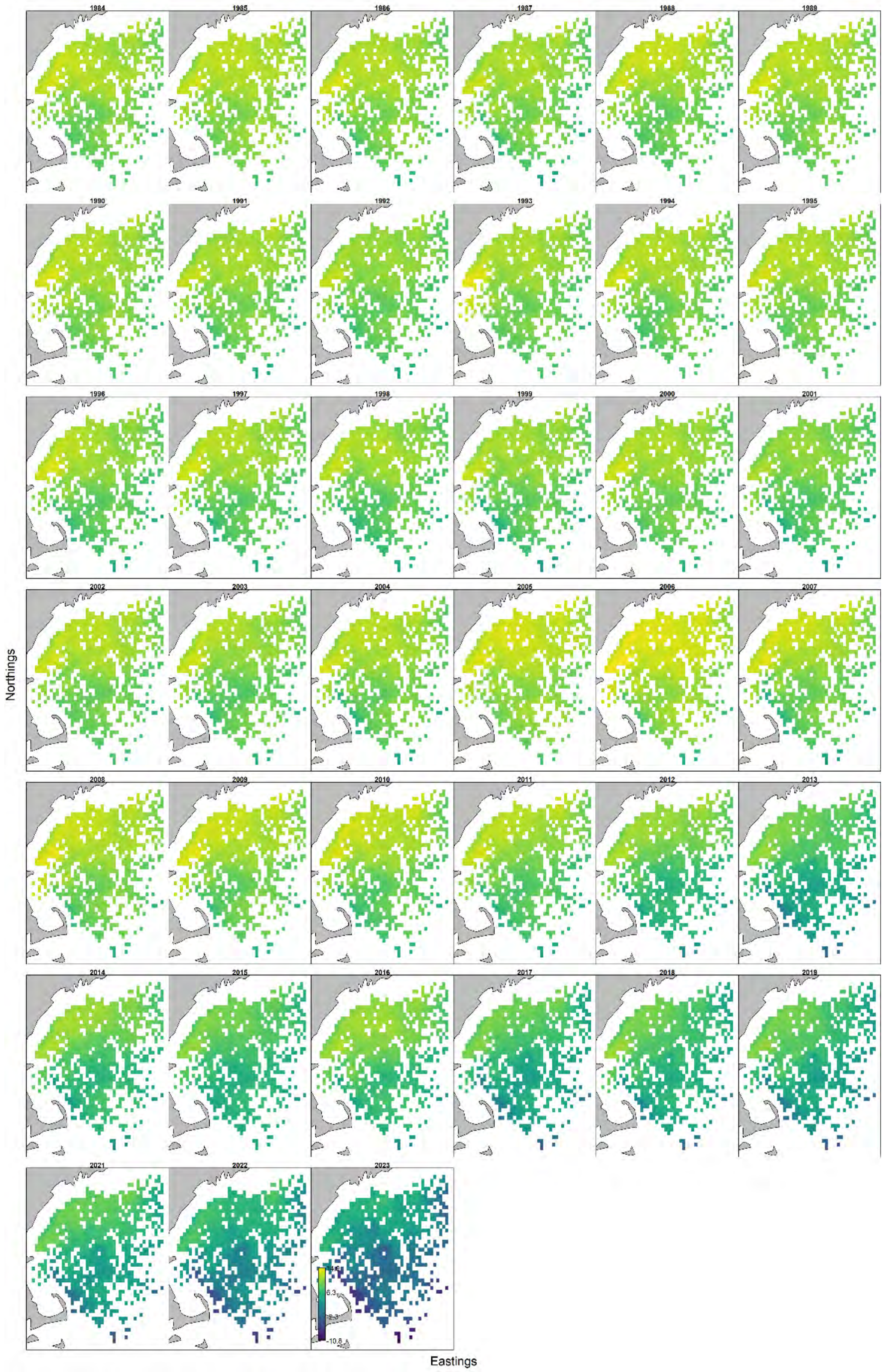


Figure 3. Annual predicted population density (log-scale) by area for the ASMFC Summer Survey.

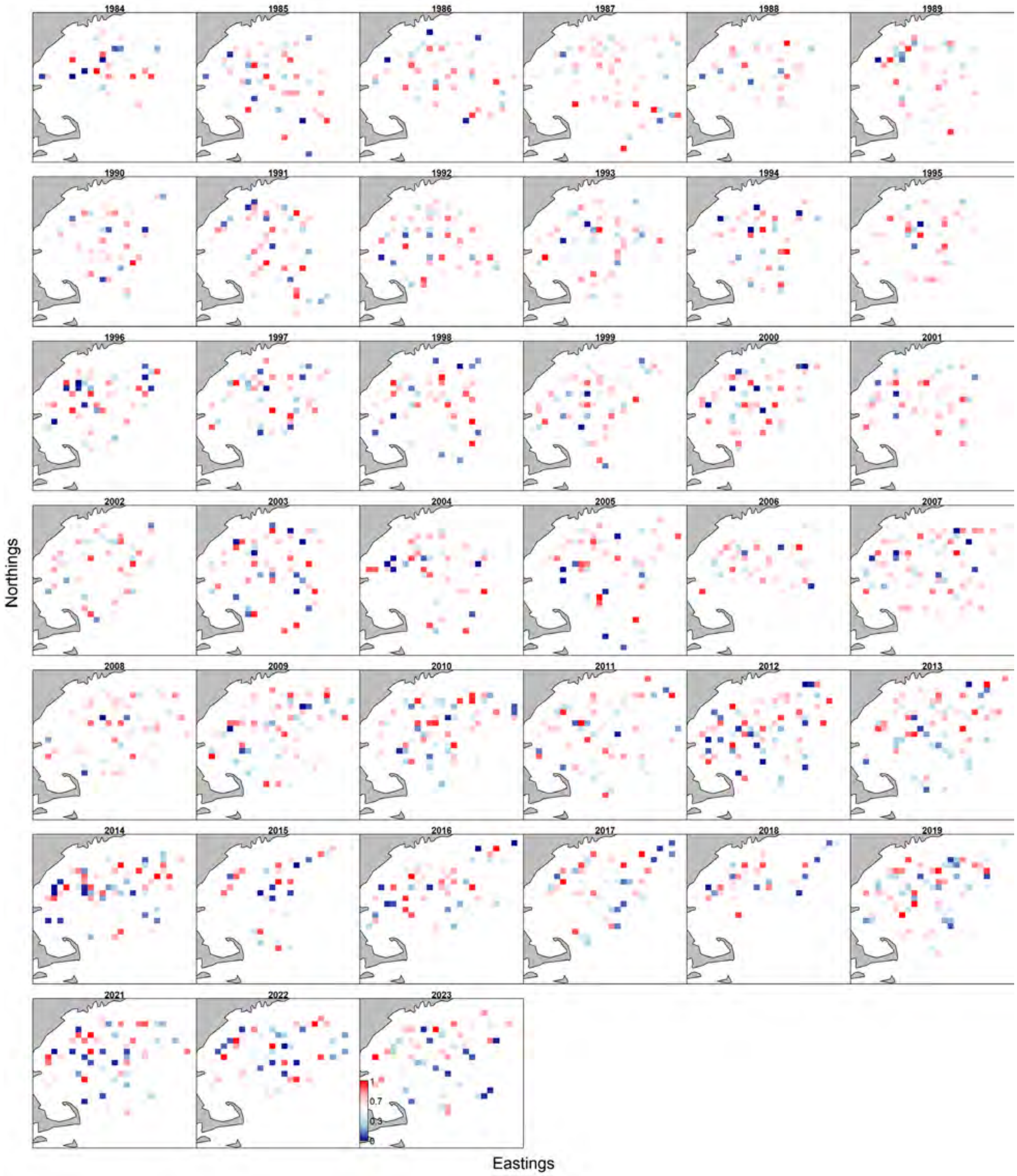


Figure 4. Annual quantile residuals by area for the ASMFC Summer Survey.

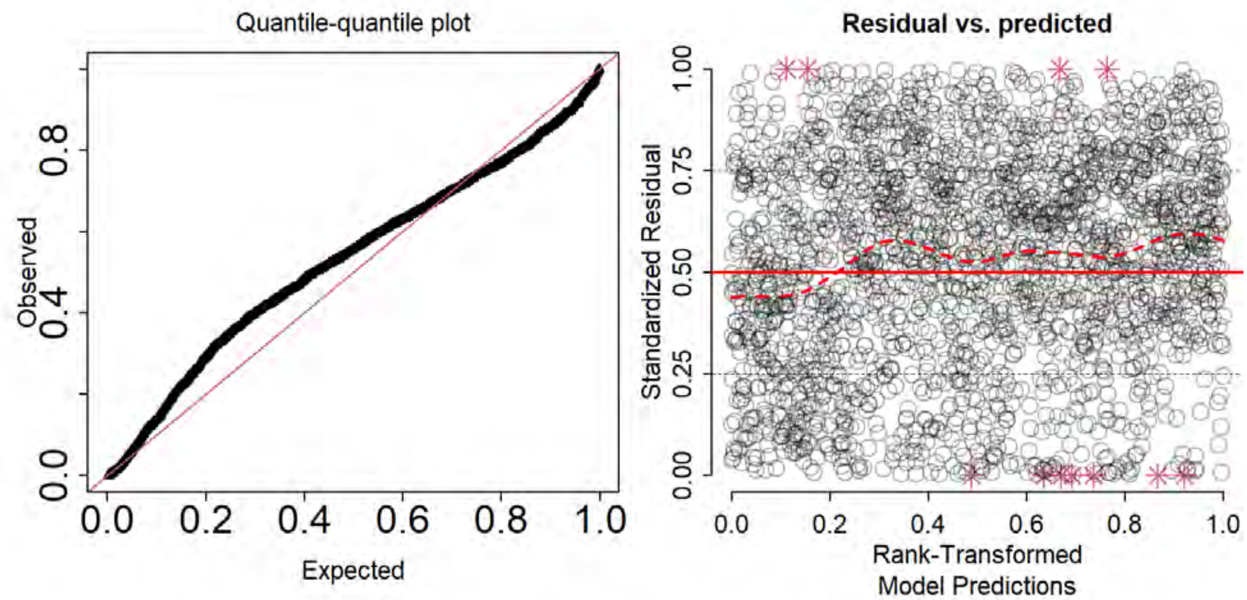


Figure 5. Quantile results for the ASMFC Summer Survey.

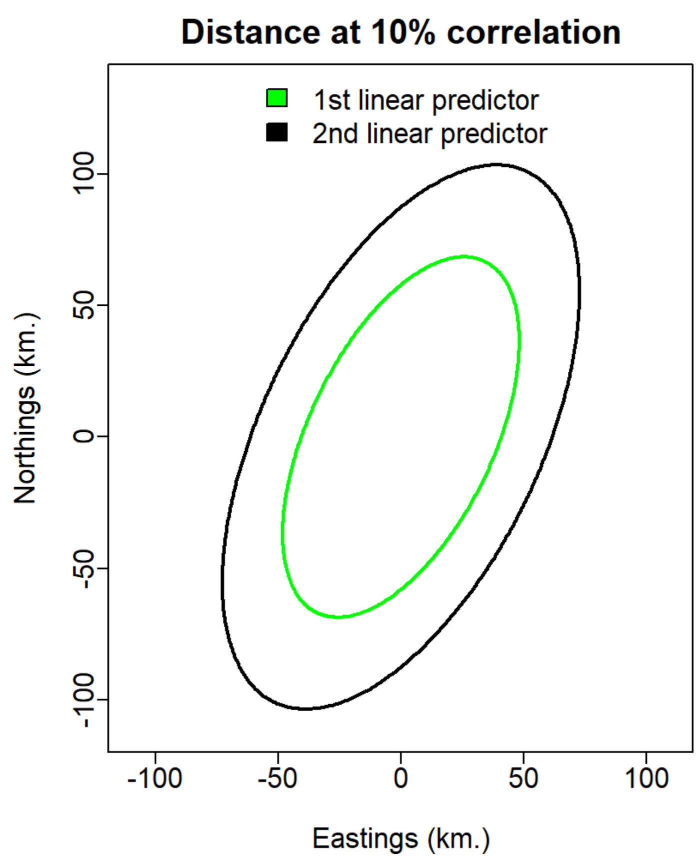


Figure 6. Direction of geometric anisotropy for the ASMFC Summer Survey.

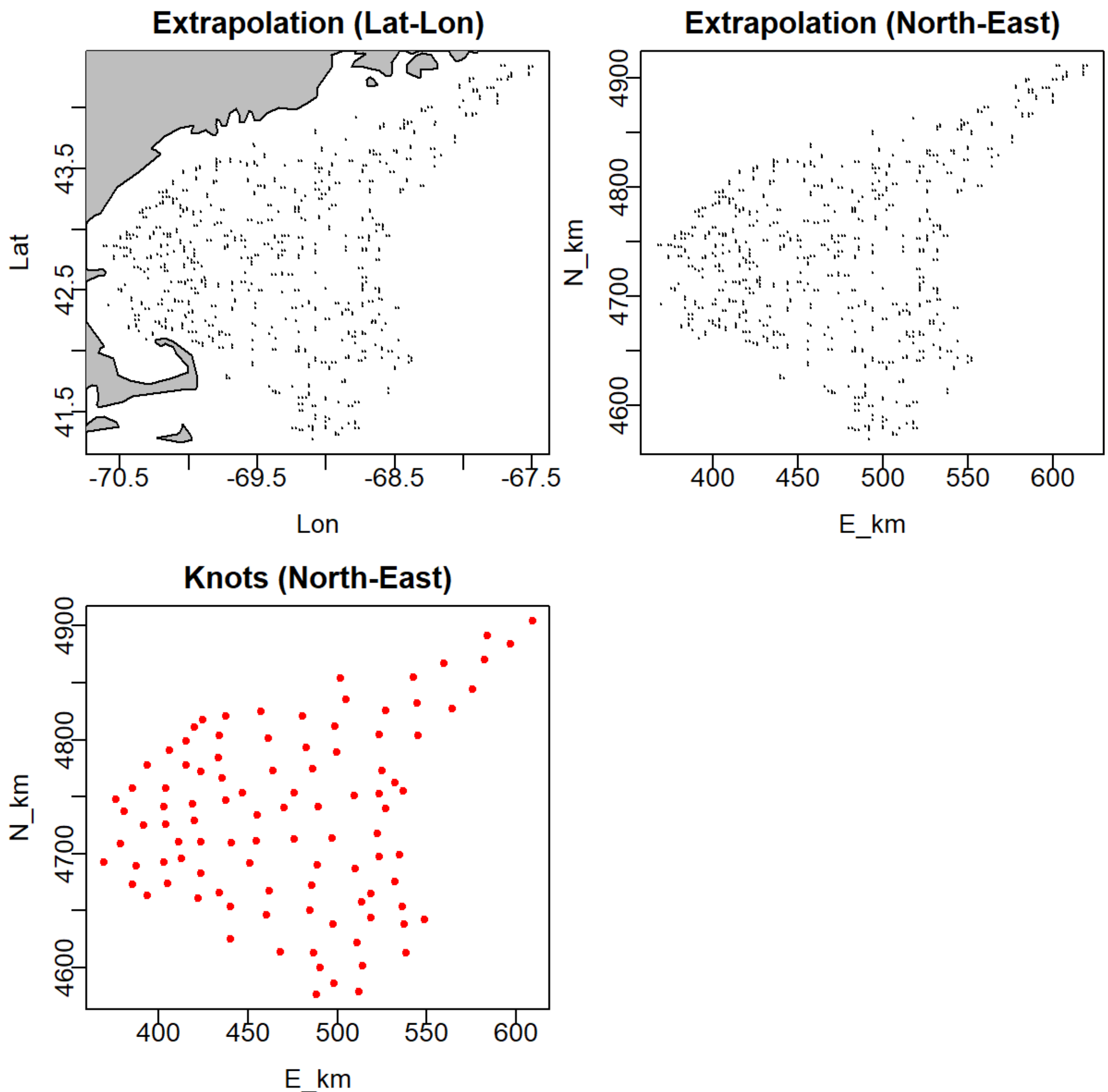


Figure 7. Extrapolation grid and knots for NEFSC Fall Survey.

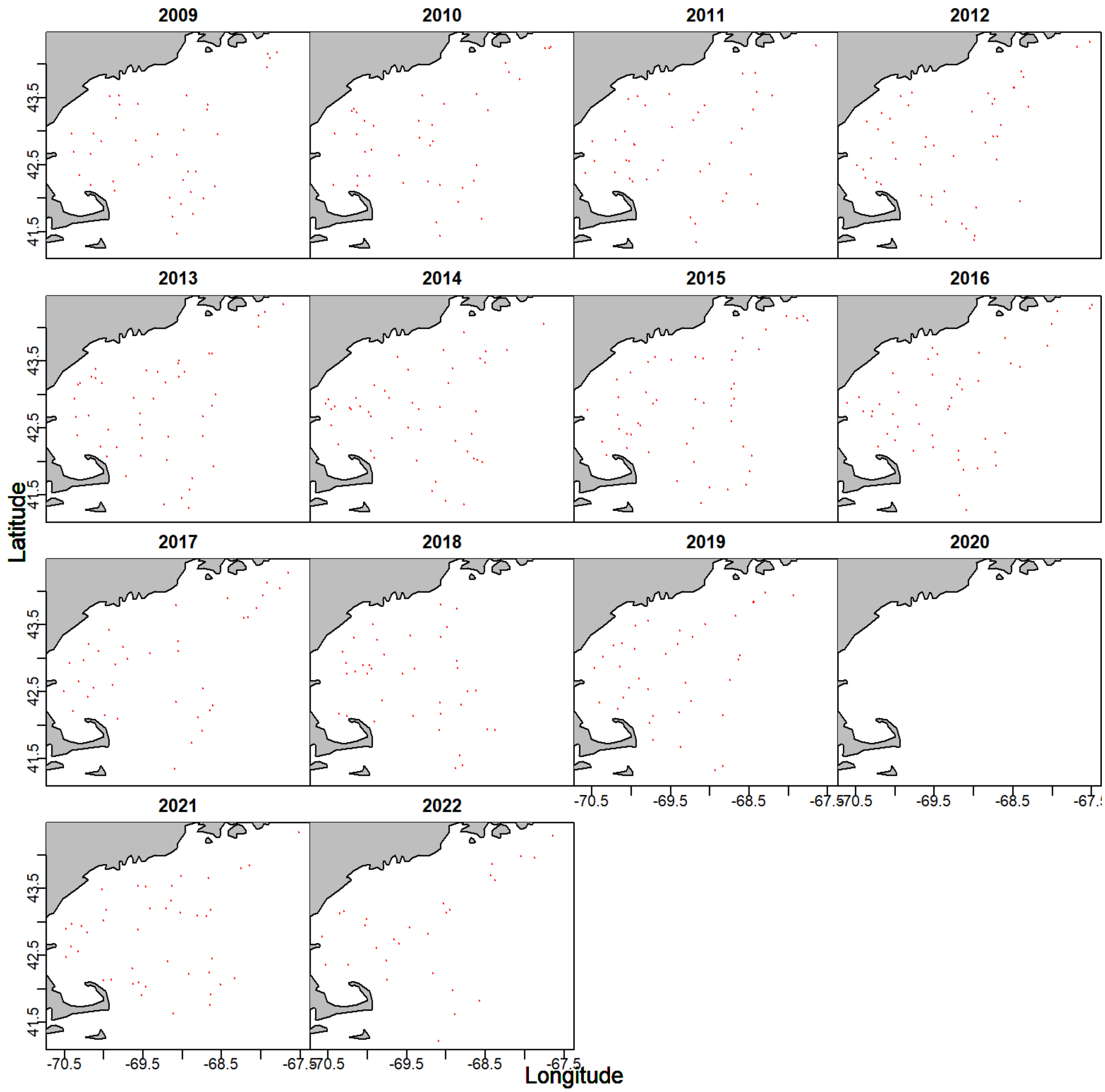


Figure 8.   NEFSC Fall Survey catch locations by year.

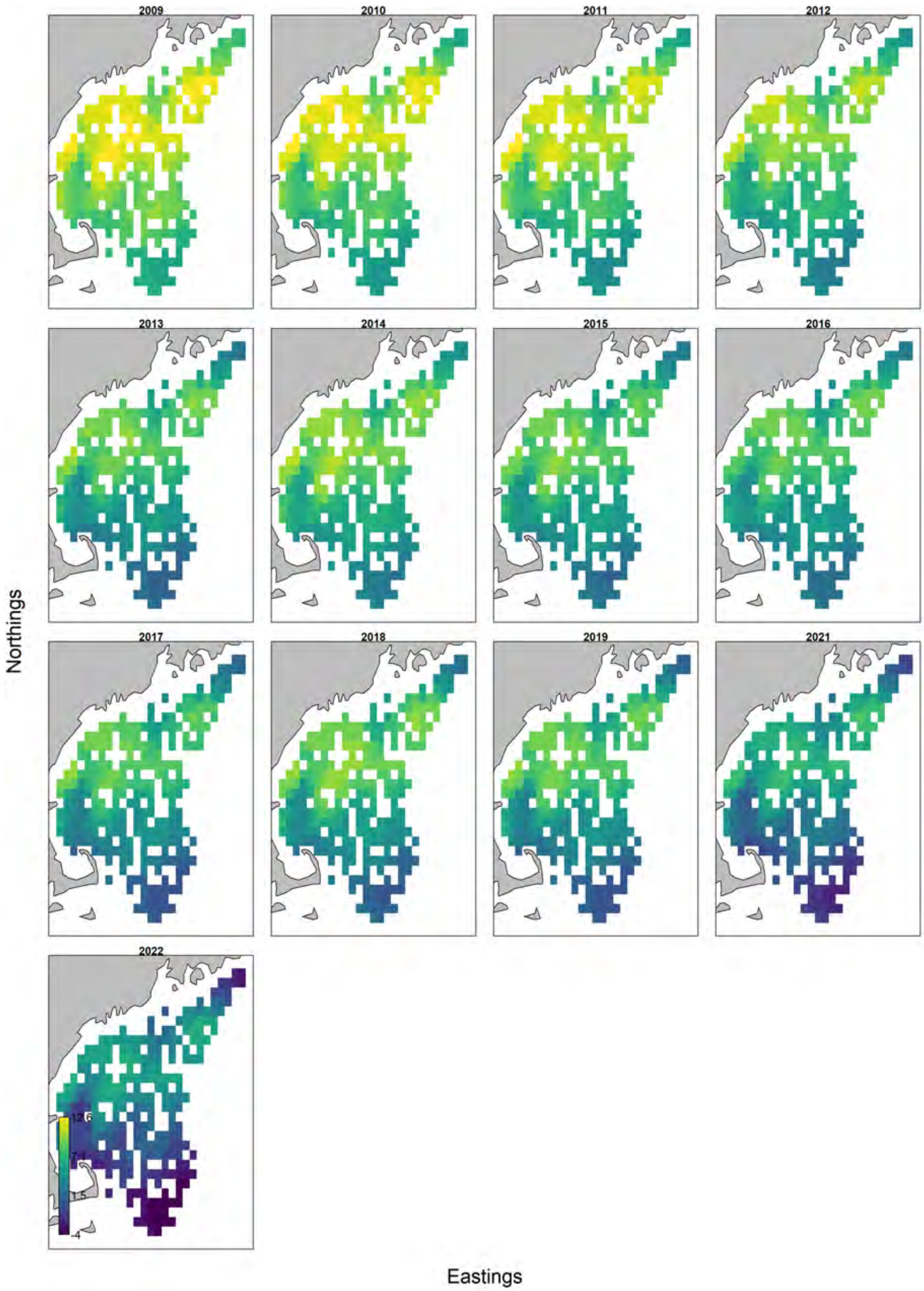


Figure 9. Annual predicted population density (log-scale) by area for the NEFSC Fall Survey.

Figure 10. Annual quantile residuals by area for the NEFSC Fall Survey.

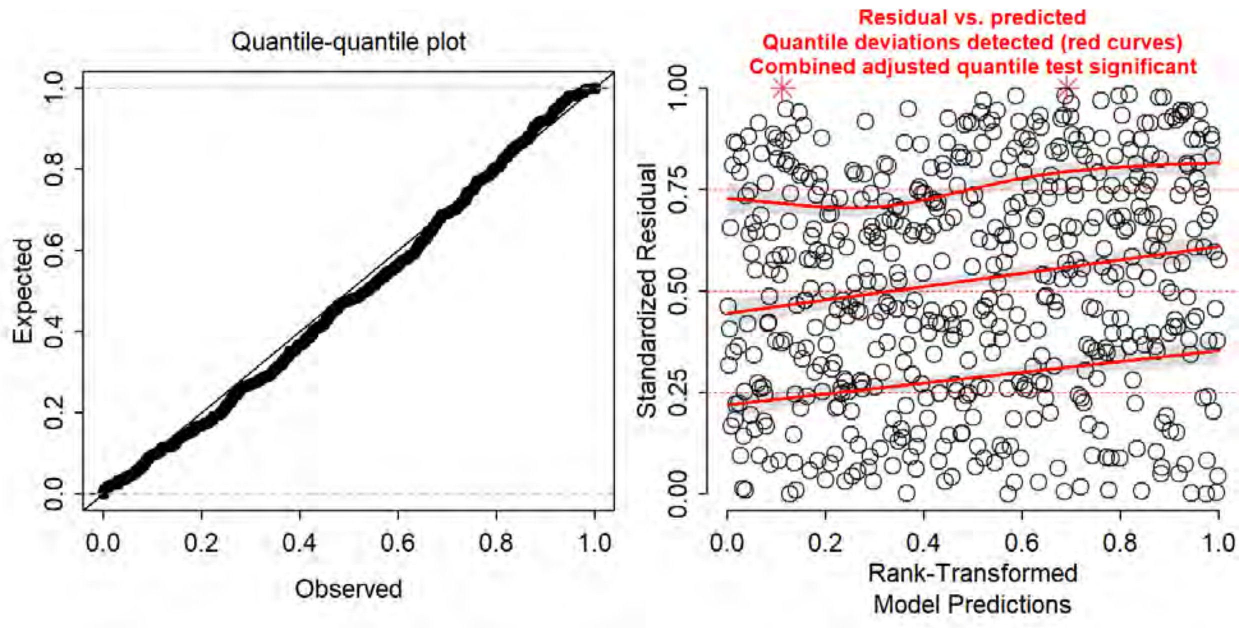


Figure 11. Quantile plots for NEFSC Fall Survey residuals.

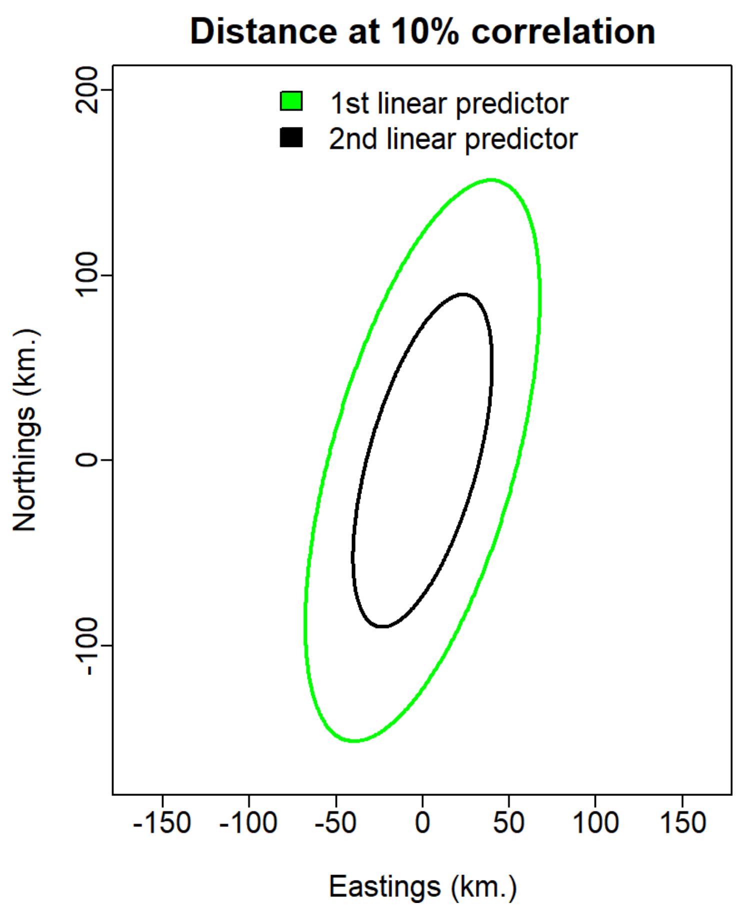


Figure 12. Direction of geometric anisotropy for the NEFSC Fall Survey.

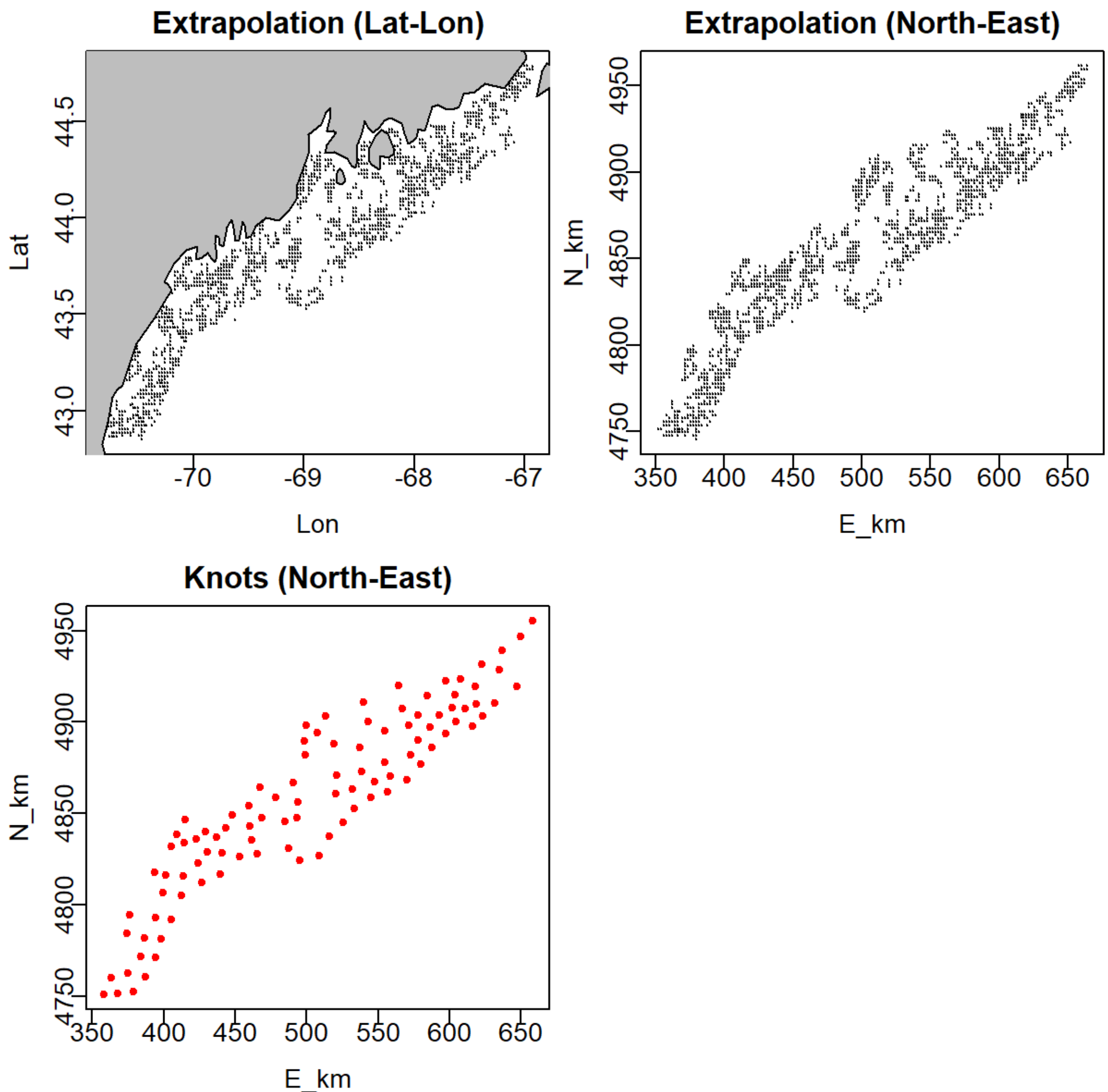


Figure 13. Extrapolation grid and knots for ME-NH Spring Survey.

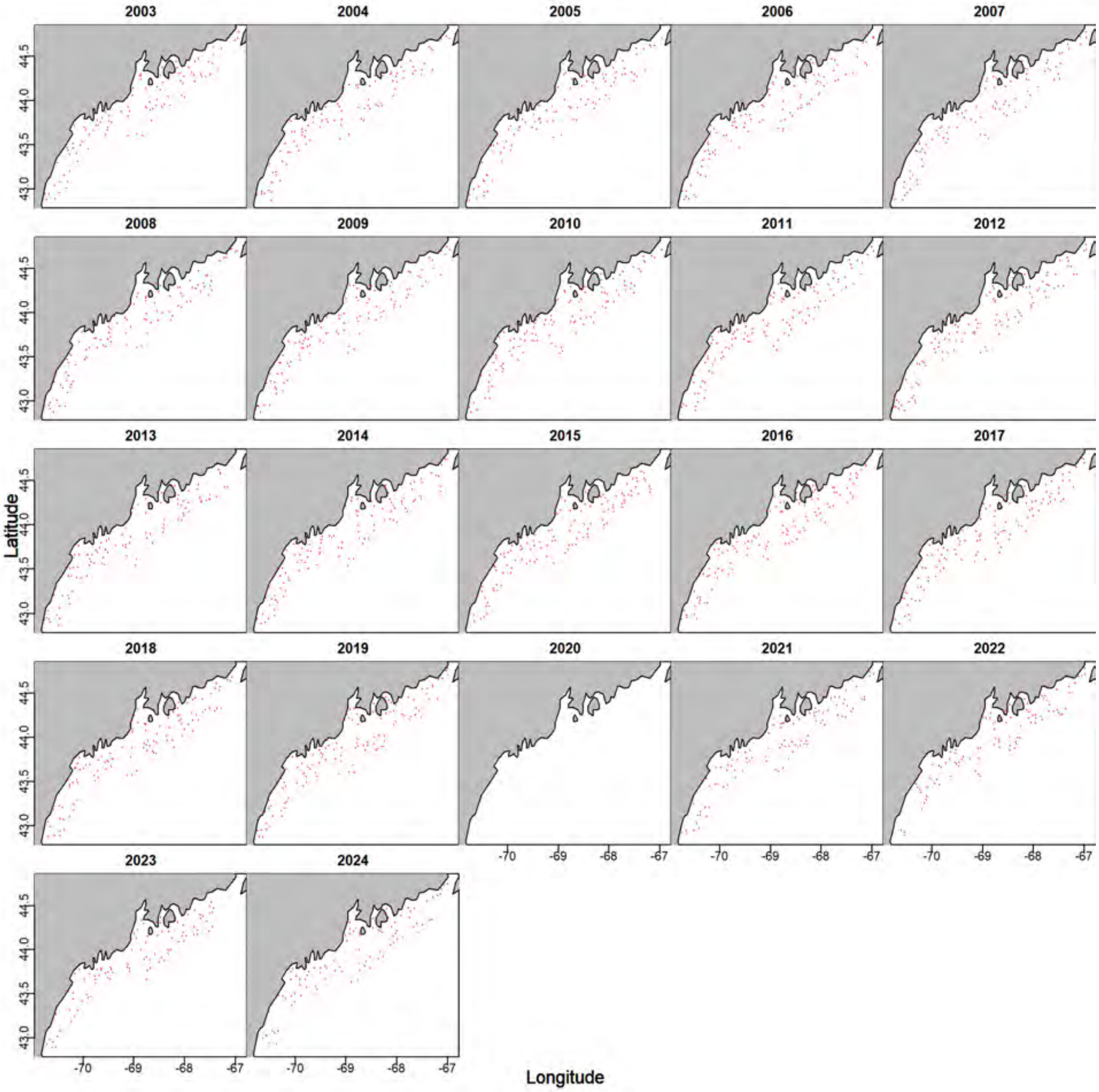


Figure 14. ME-NH Survey catch locations by year.

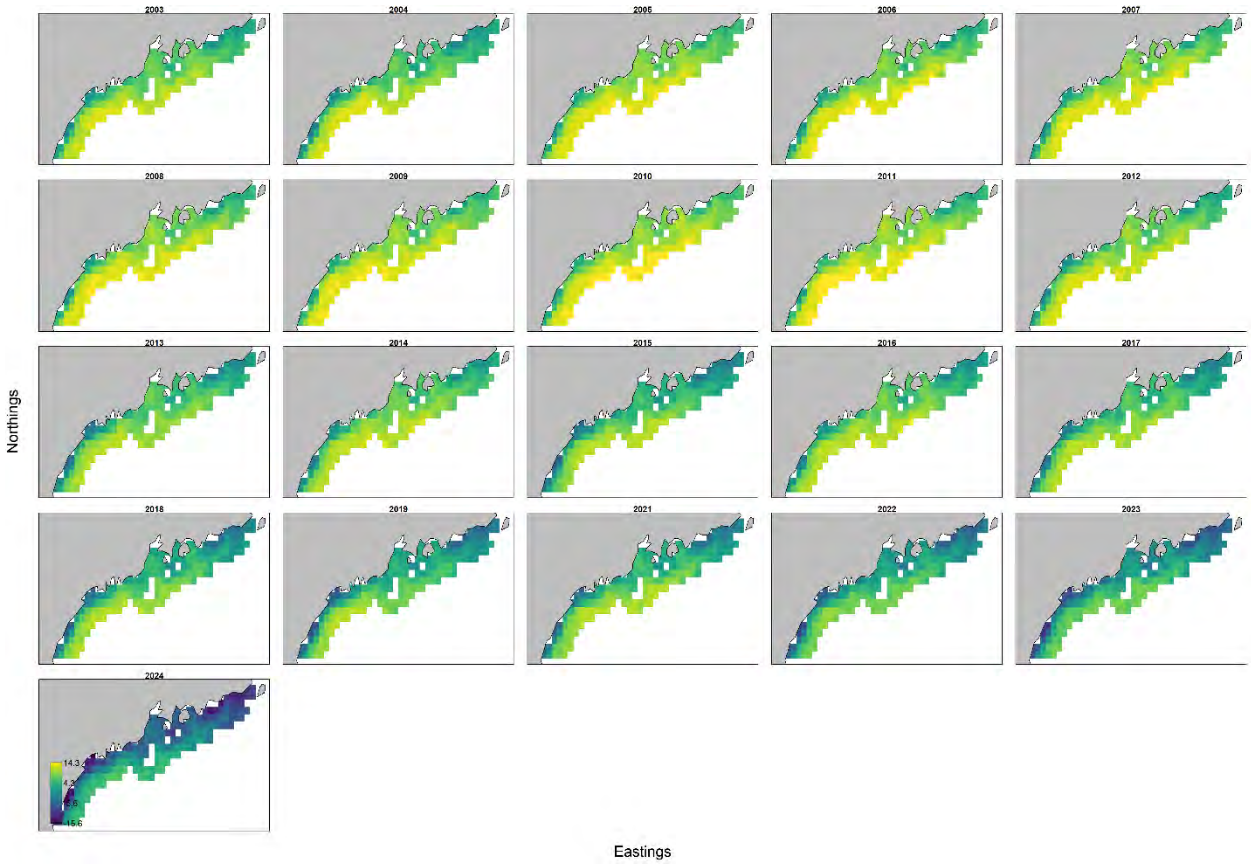


Figure 15. Annual predicted population density (log-scale) by area for the ME-NH Spring Survey.

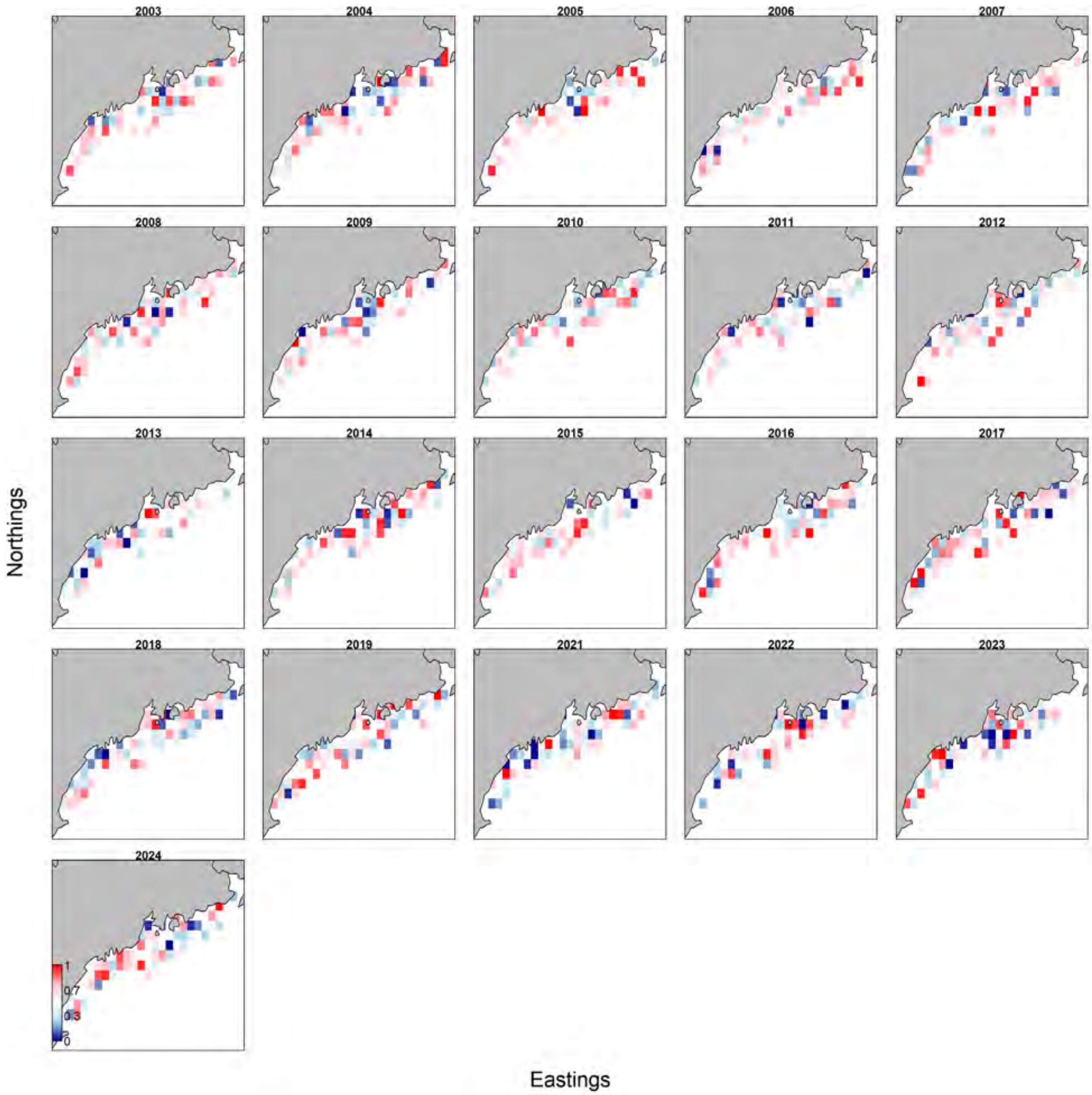


Figure 16. Quantile residuals by area for the ME-NH Spring Survey.

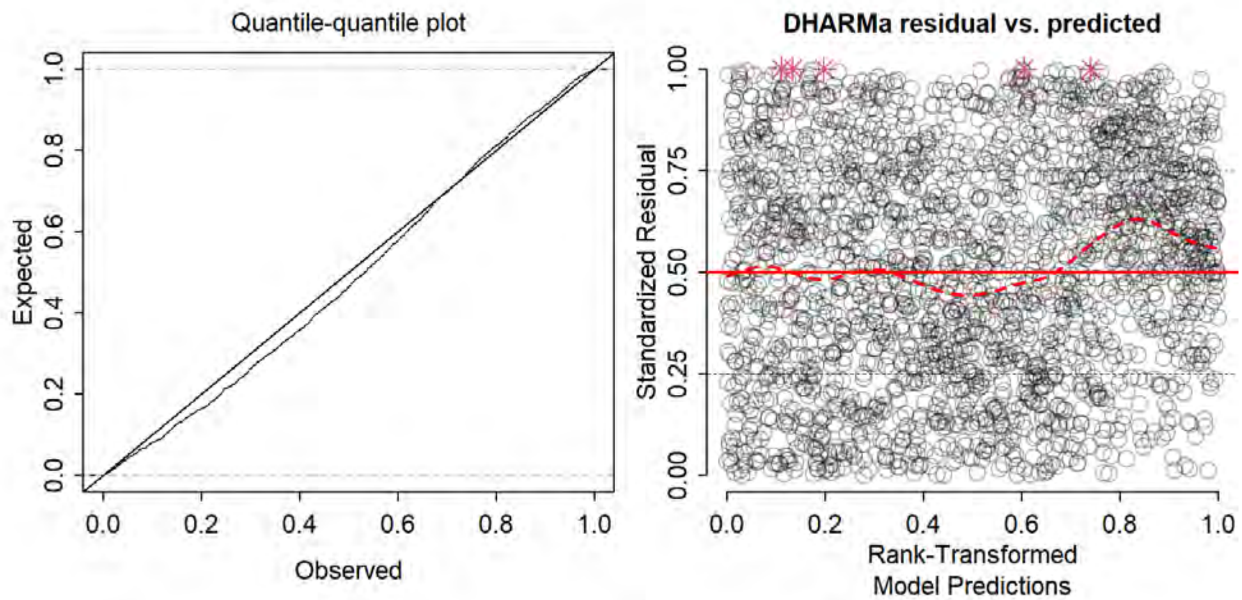


Figure 17. Quantile-plot for ME-NH Spring Survey residuals.

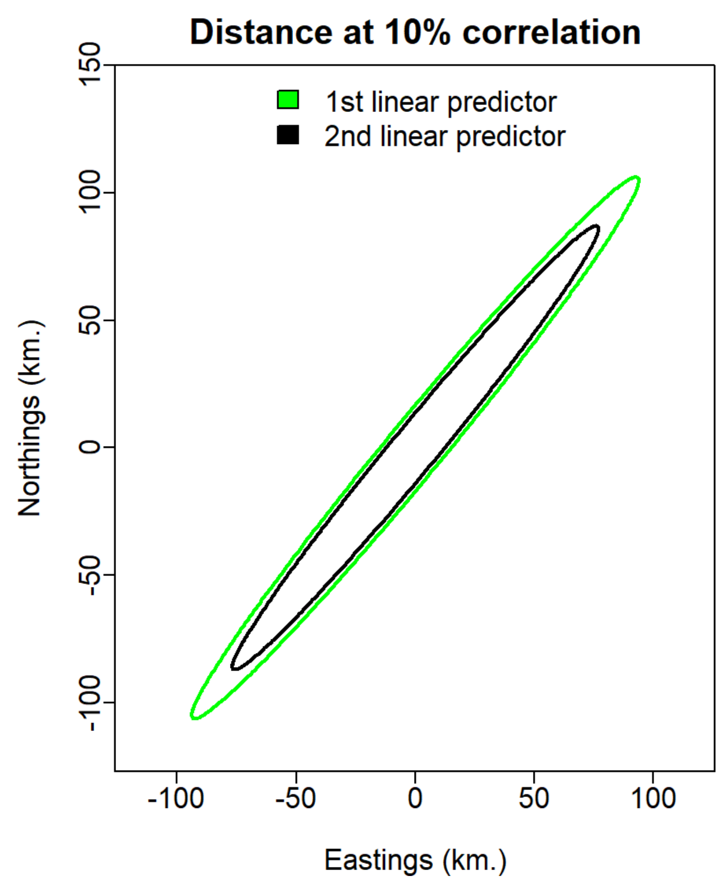


Figure 18. Direction of geometric anisotropy for the ME-NH Spring Survey.

Appendix 2: Model Input and Diagnostic Plots for the UME Statistical Catch-at-Length Model

N. Shrimp 2024 Assessment Update

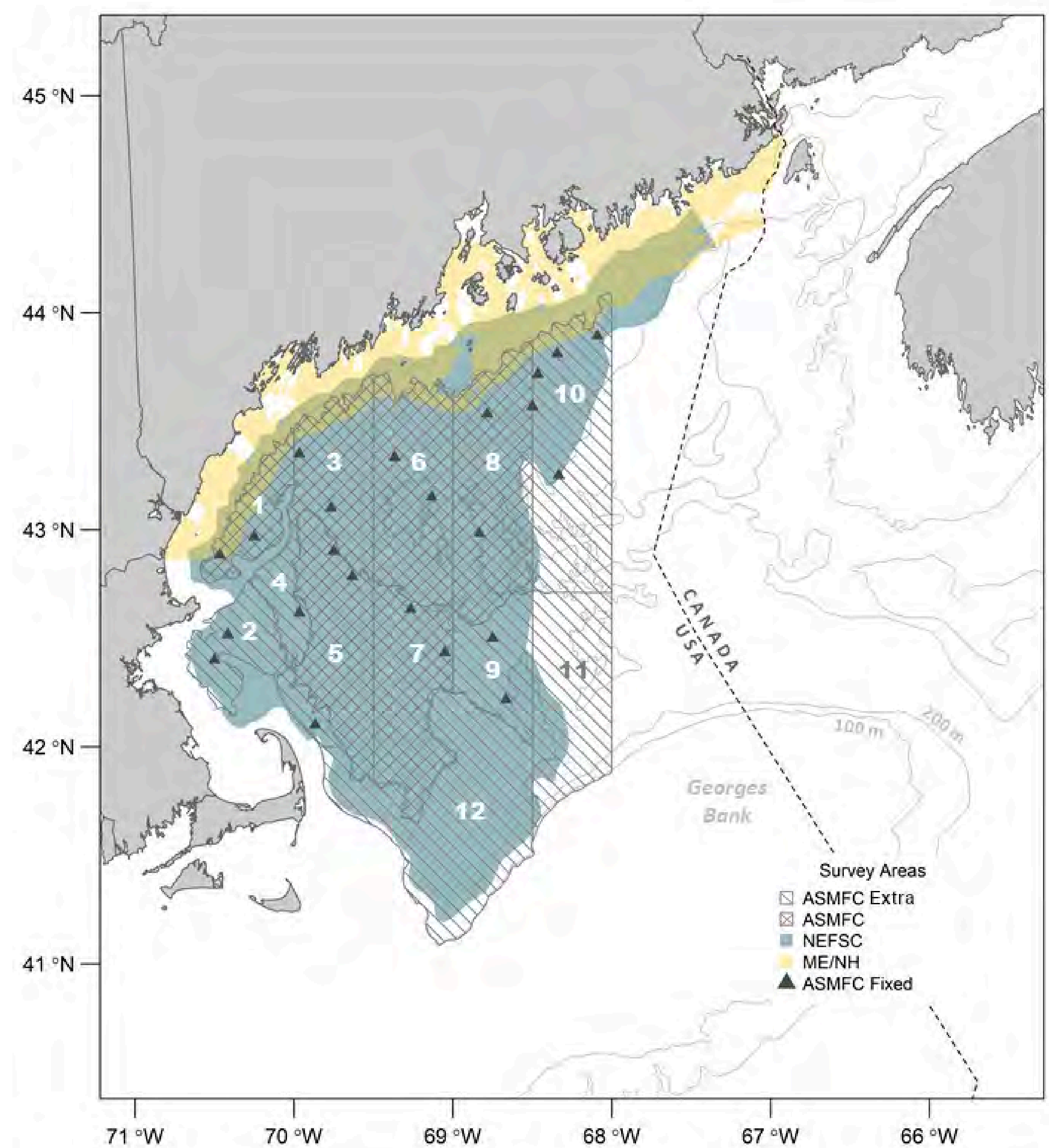


Figure 1. Area covered by the surveys used in the Gulf of Maine northern shrimp assessment. ASMFC extra strata were historically not used to develop the index of abundance, but the current assessment uses all strata.

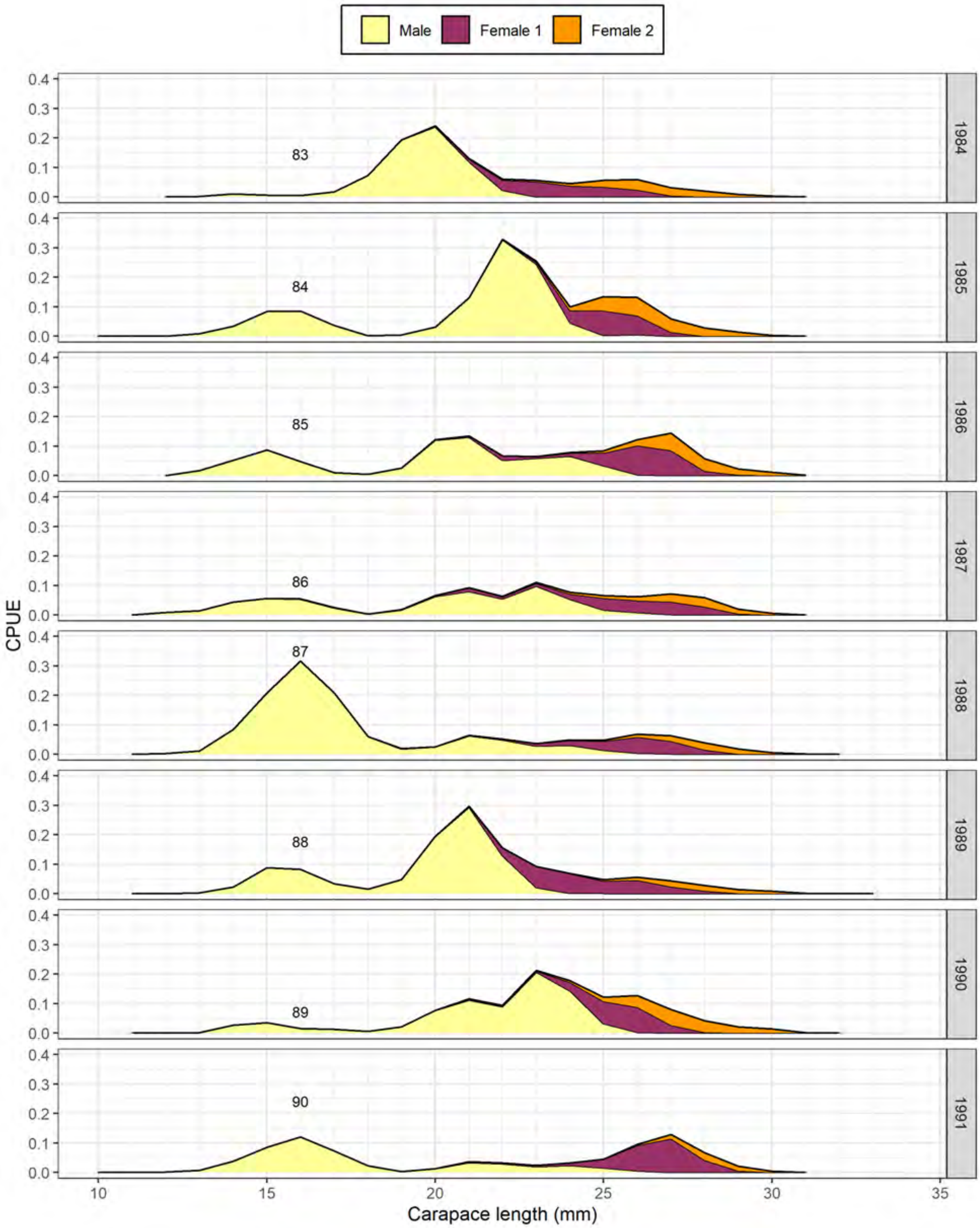


Figure 2. **Gulf of Maine northern shrimp Summer Survey index by year, length, and development stage for 1984-2021. Two-digit years on plot indicates year class at assumed age 1.5.**

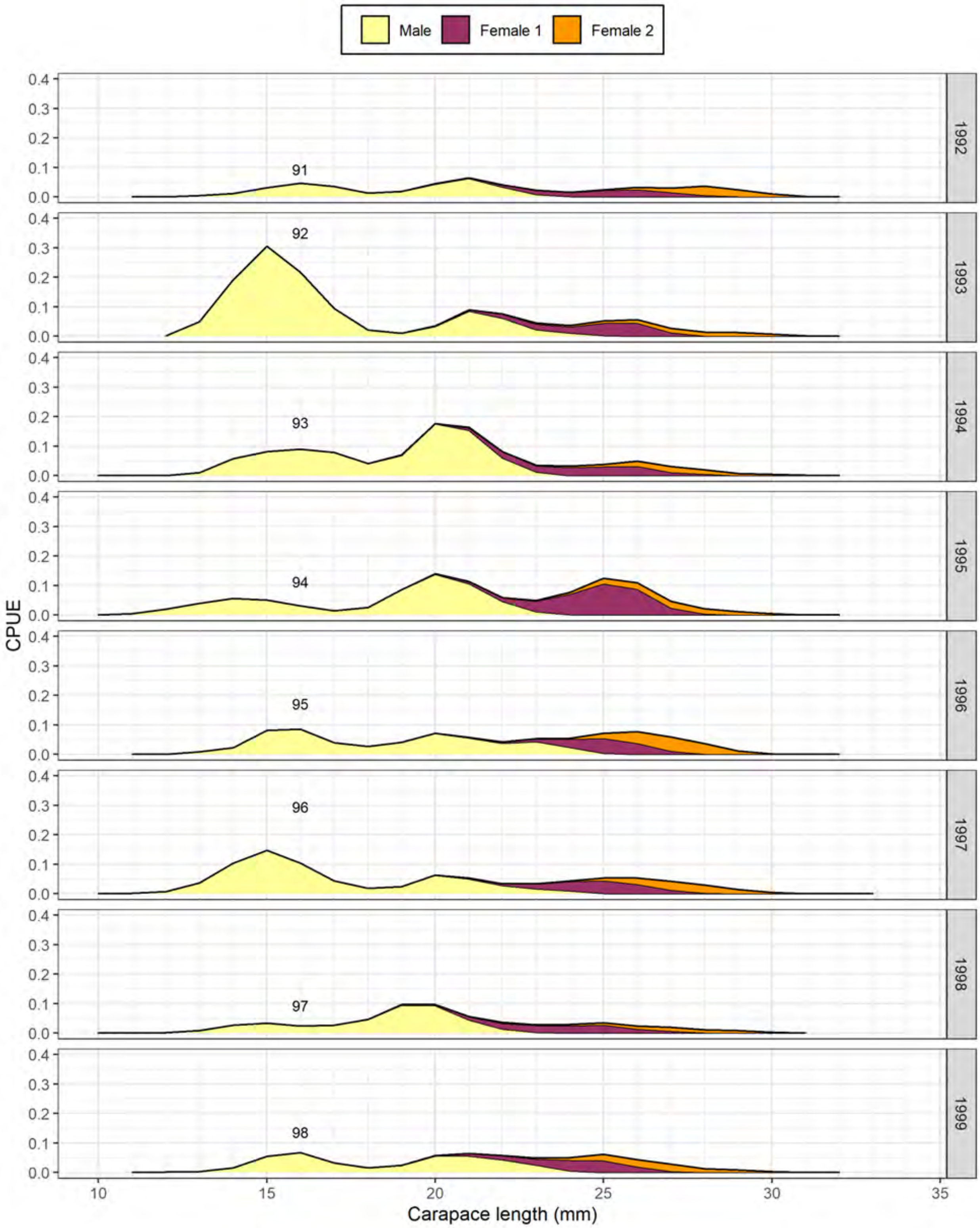


Figure 2 (cont)

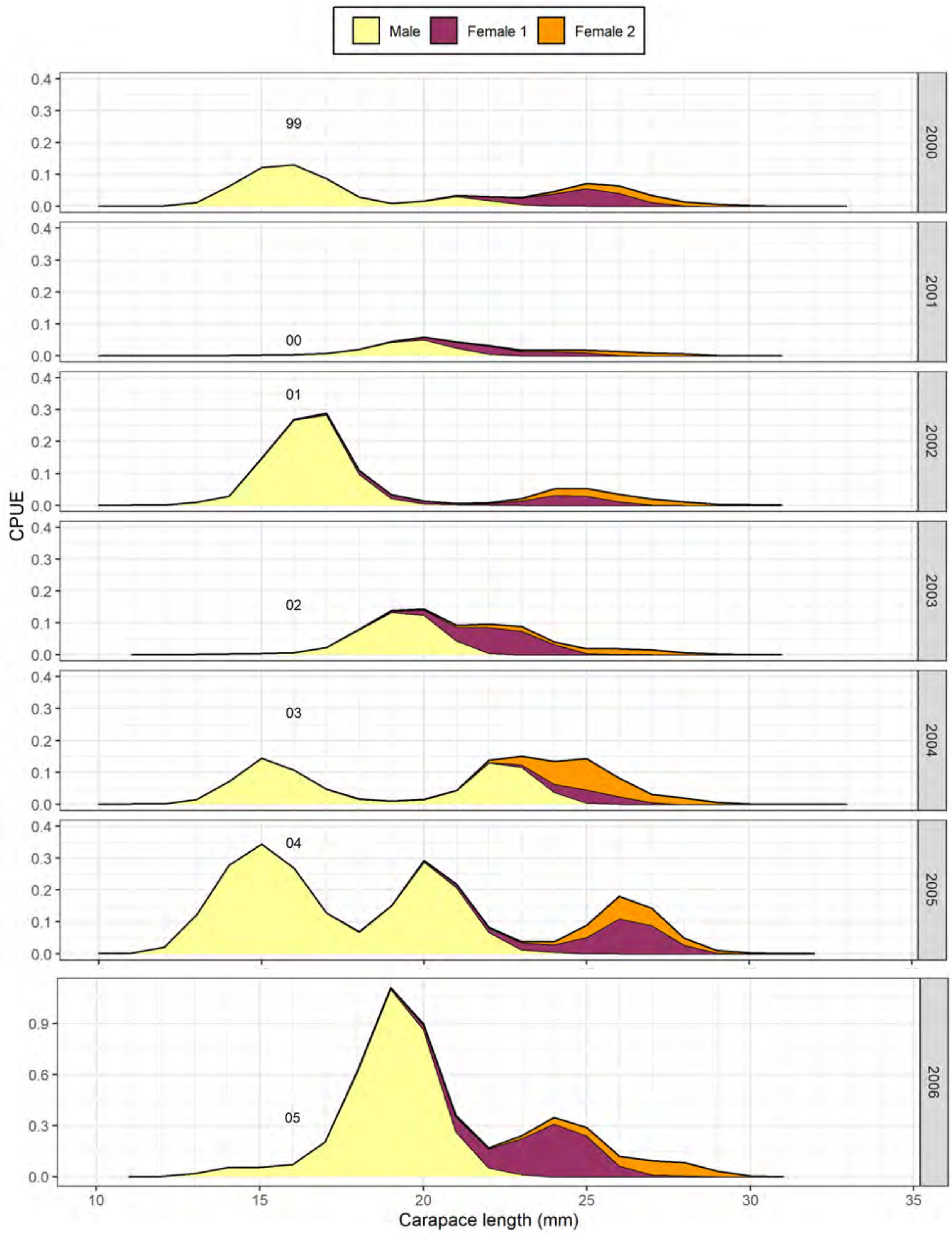


Figure 2 (cont.)

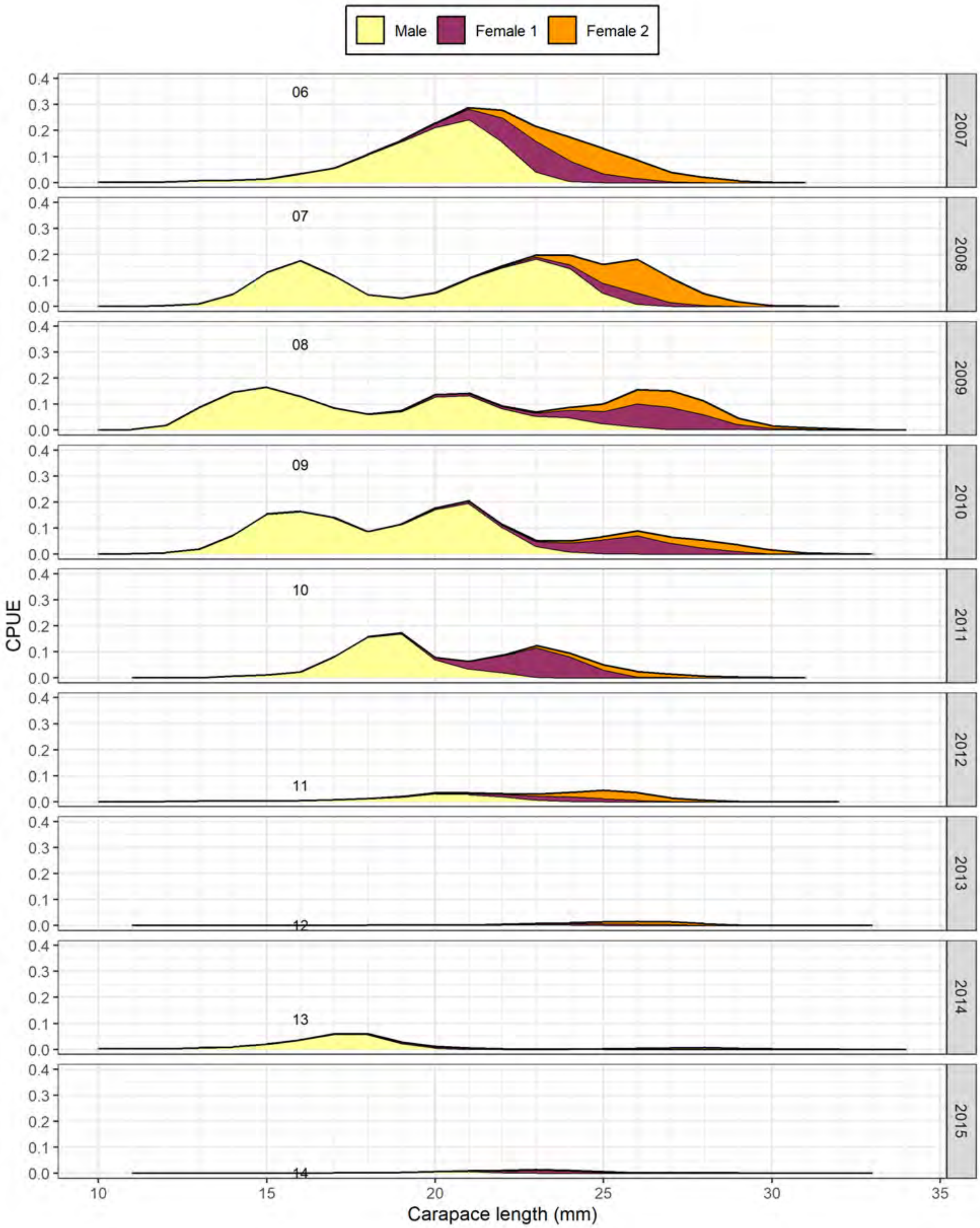


Figure 2 (cont)

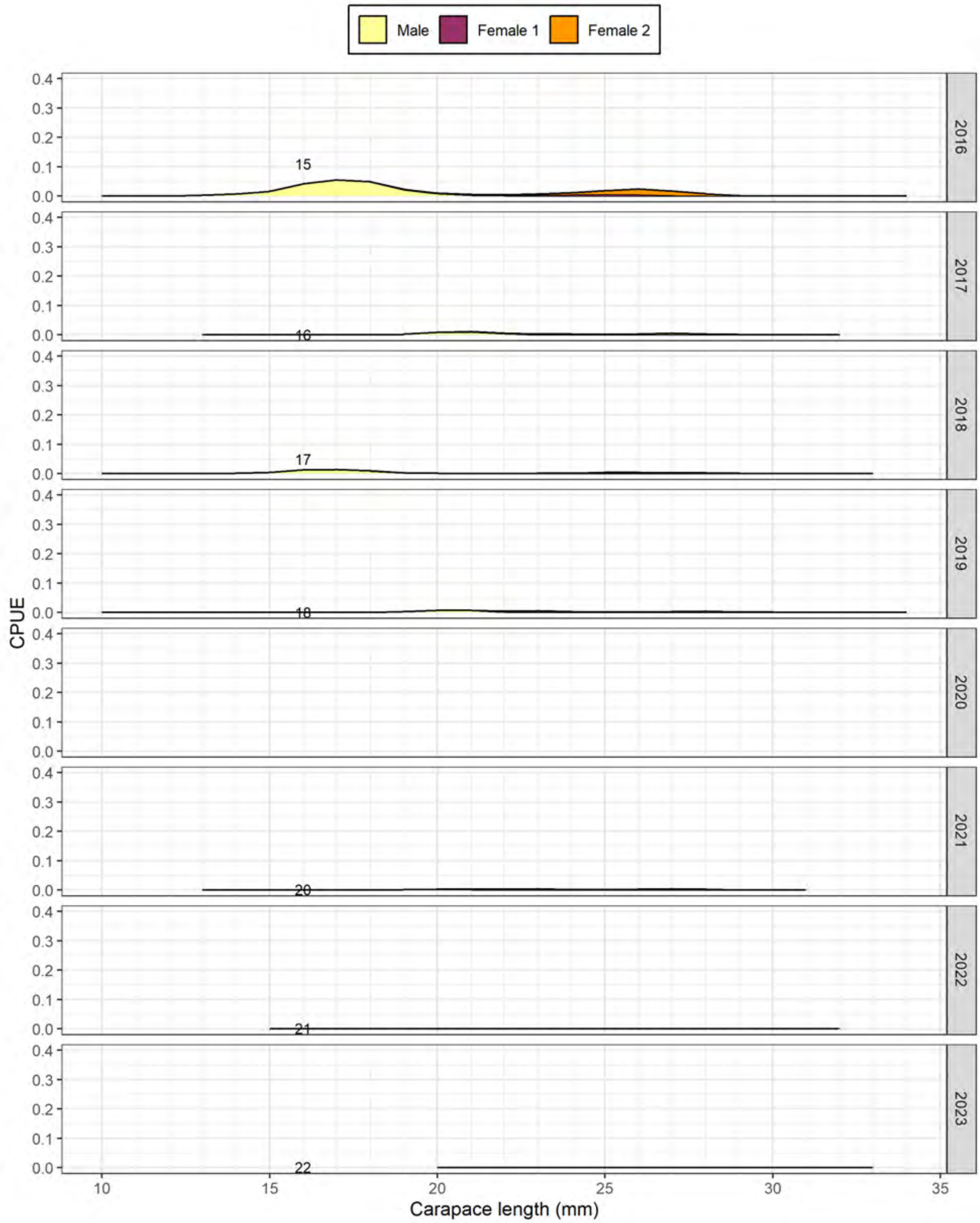


Figure 2 (cont.)

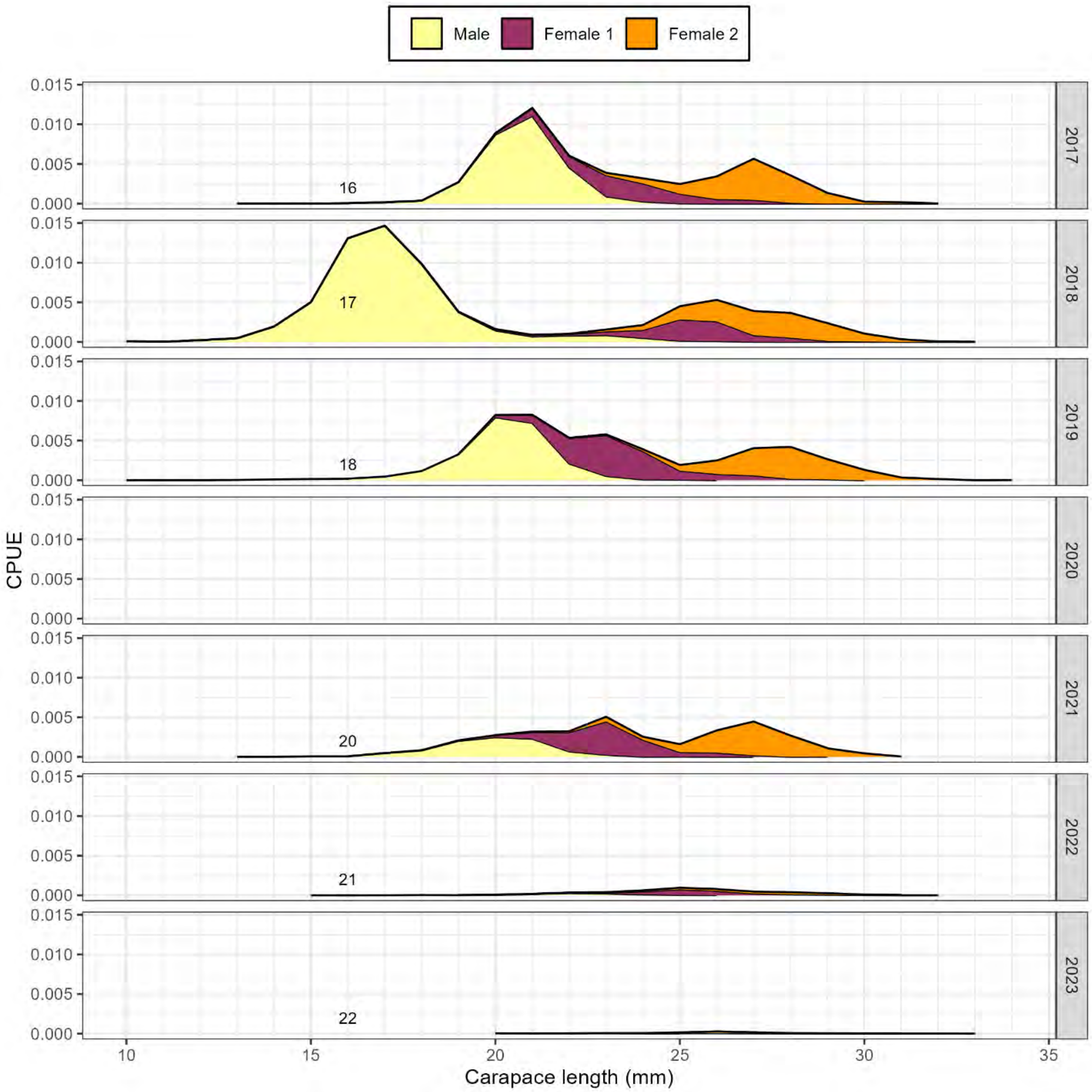


Figure 3. Gulf of Maine northern shrimp Summer Survey abundance by year, length, and development stage for 2017 – 2023 with an expanded axis to show detail. Two-digit years are year class at assumed age 1.5.

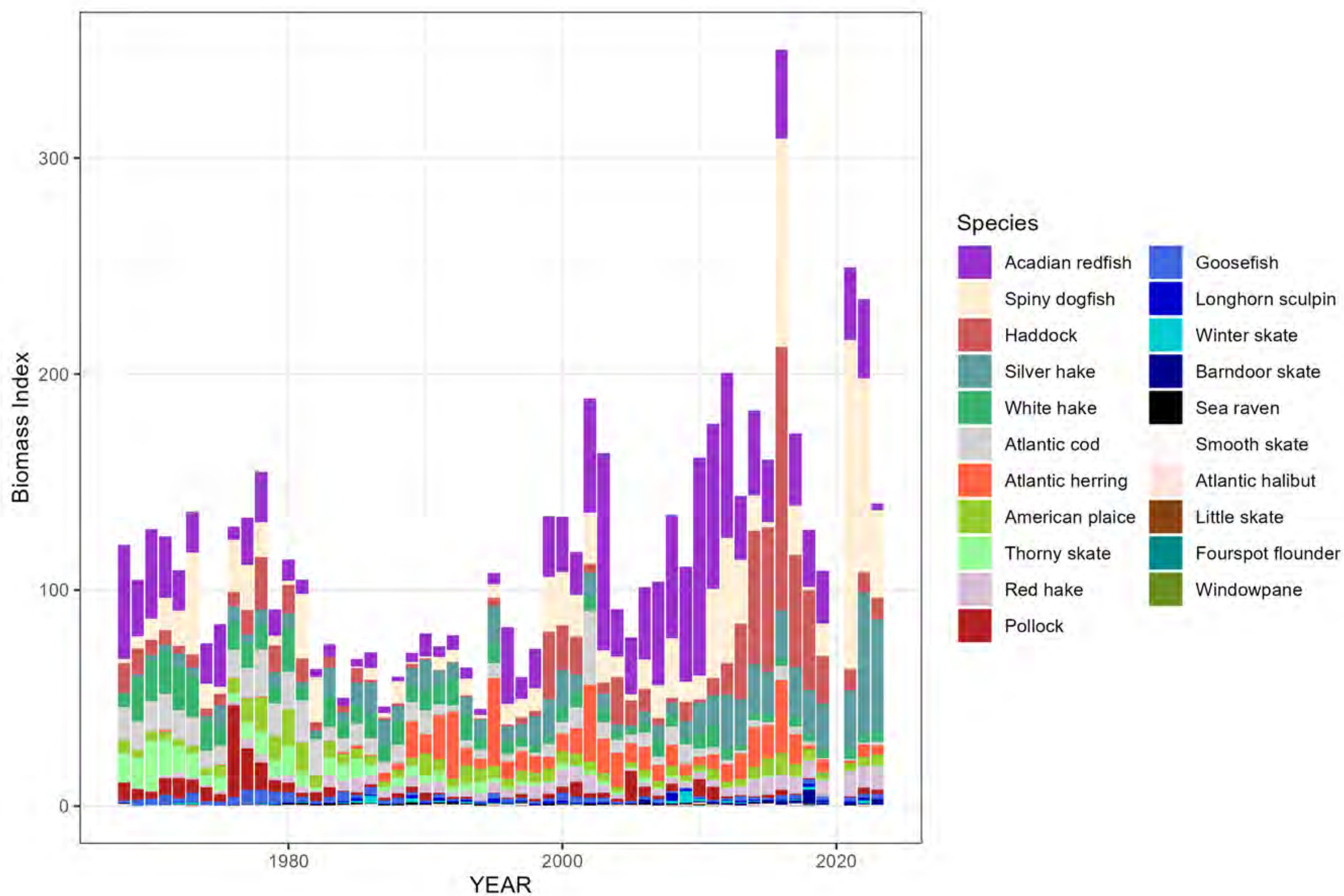
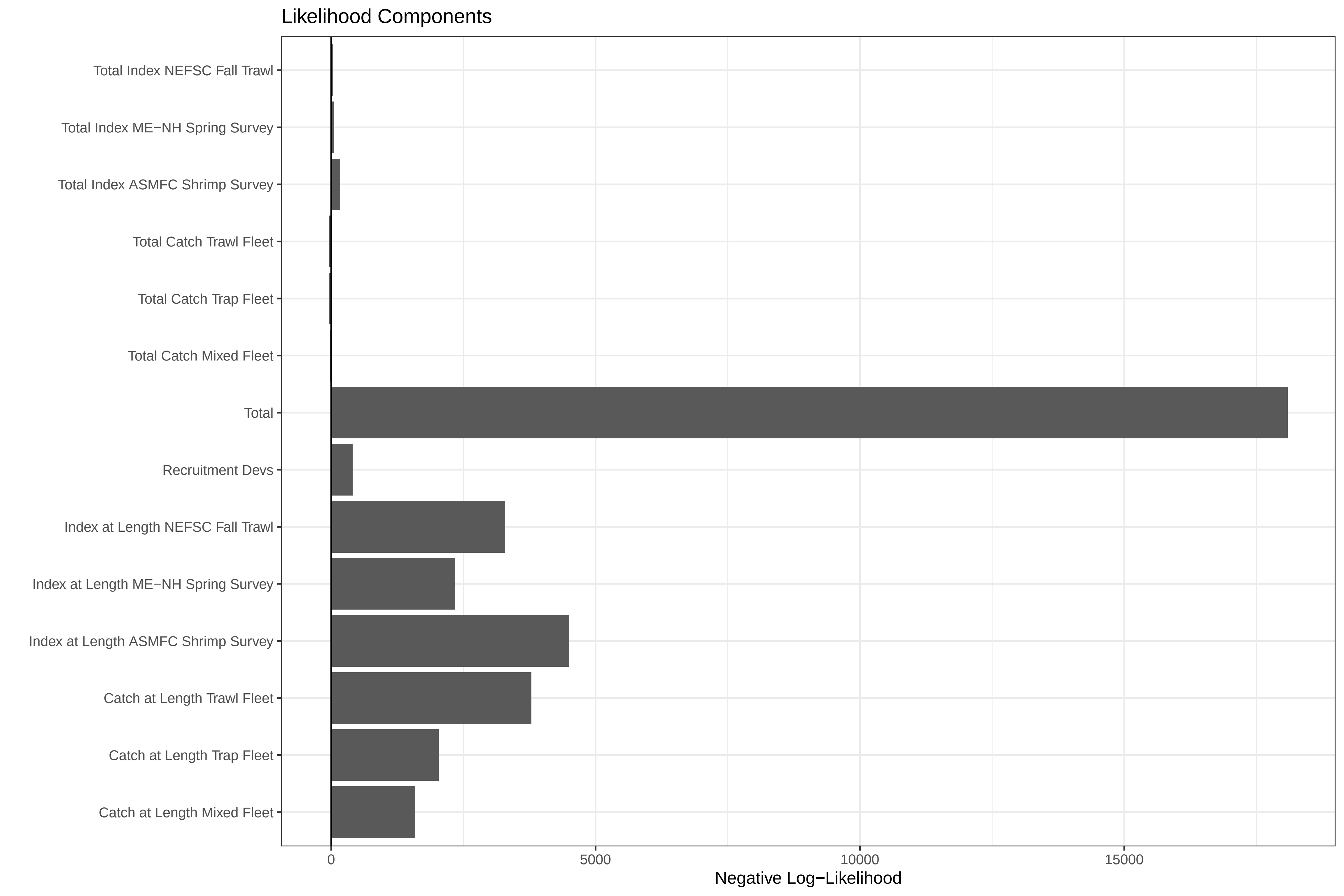
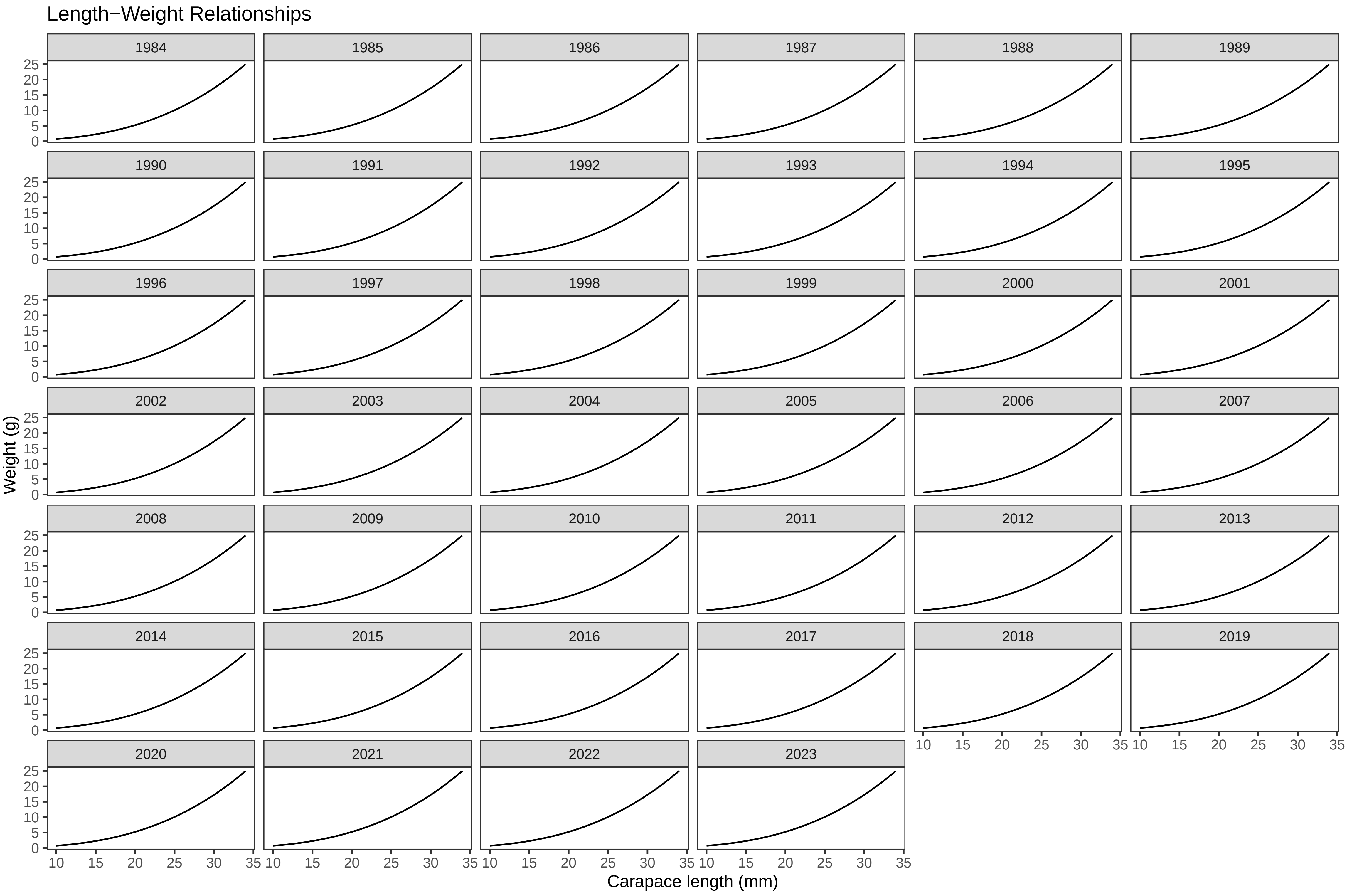


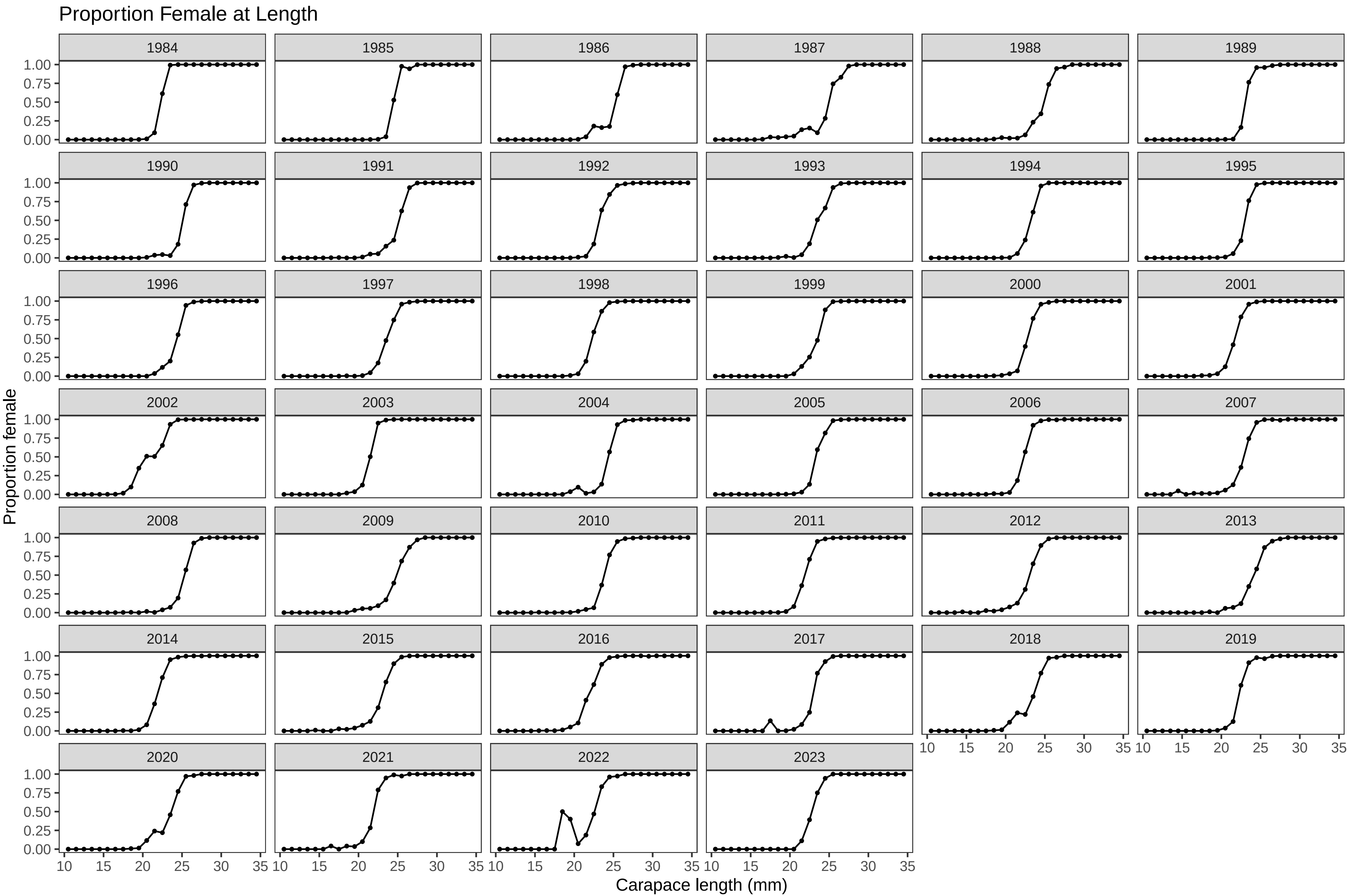
Figure 4. Biomass indices of the key northern shrimp predators used to develop the predation pressure index (PPI) used in the assessment.



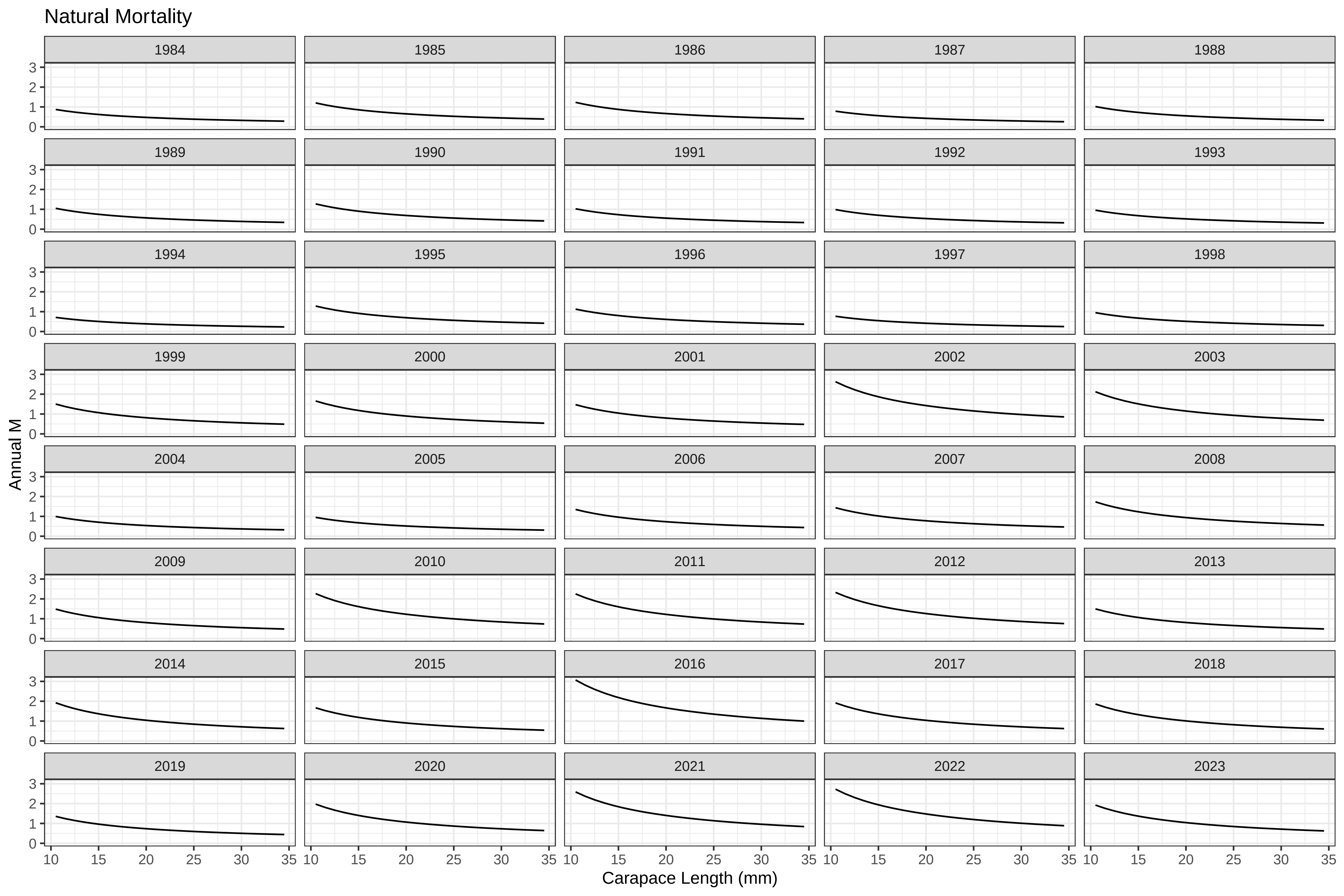
Likelihood Components
Total Index NEFSC Fall Trawl
Total Index ME−NH Spring Survey
Total Index ASMFC Shrimp Survey
Total Catch Trawl Fleet
Total Catch Trap Fleet
Total Catch Mixed Fleet
Total
Recruitment Devs
Index at Length NEFSC Fall Trawl
Index at Length ME−NH Spring Survey
Index at Length ASMFC Shrimp Survey
Catch at Length Trawl Fleet
Catch at Length Trap Fleet
Catch at Length Mixed Fleet
0
5000
10000
15000
Negative Log−Likelihood



Length−Weight Relationships
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Weight (g)
0
5
10
15
20
25
10
15
20
25
30
35
Carapace length (mm)

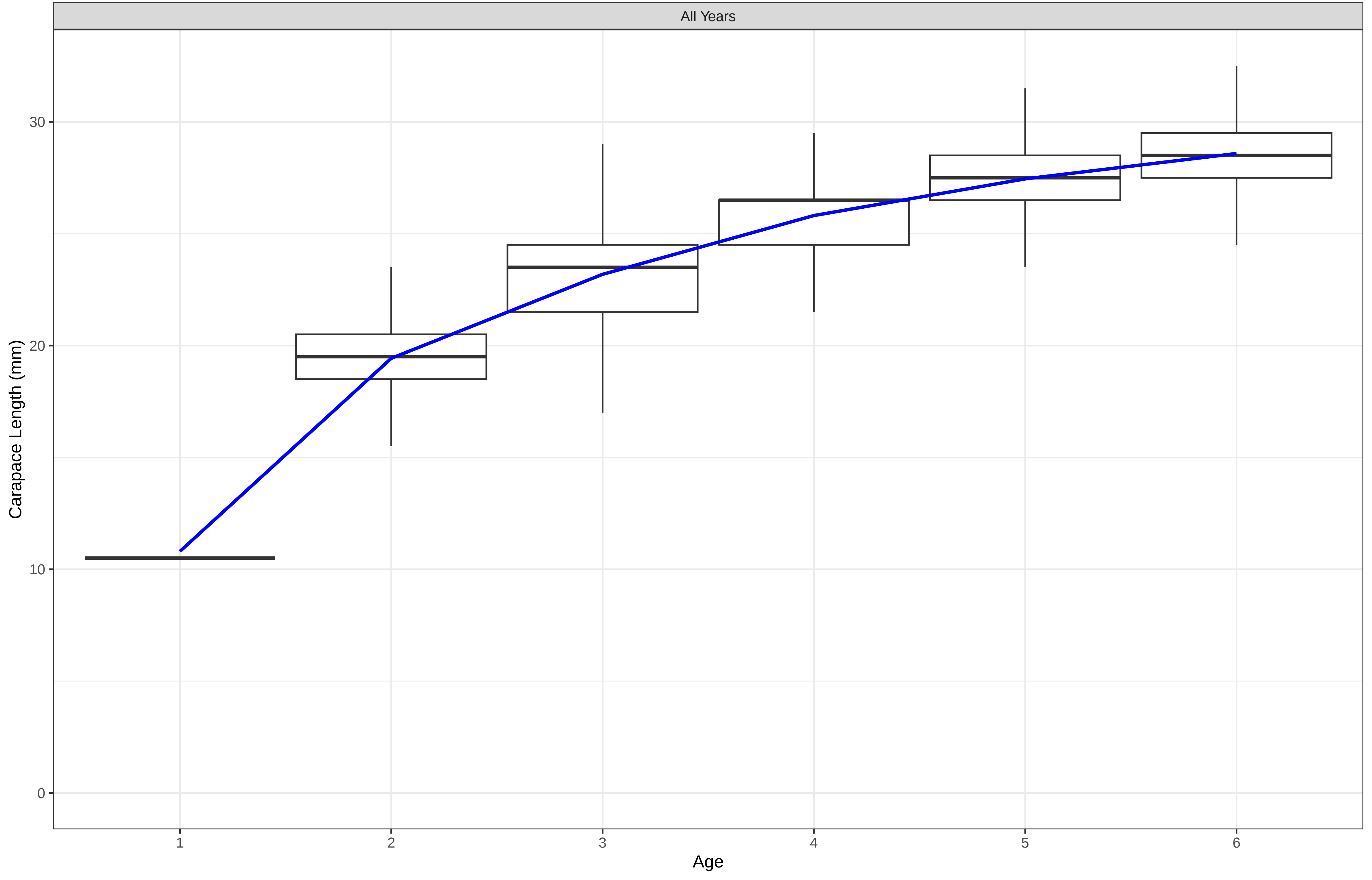


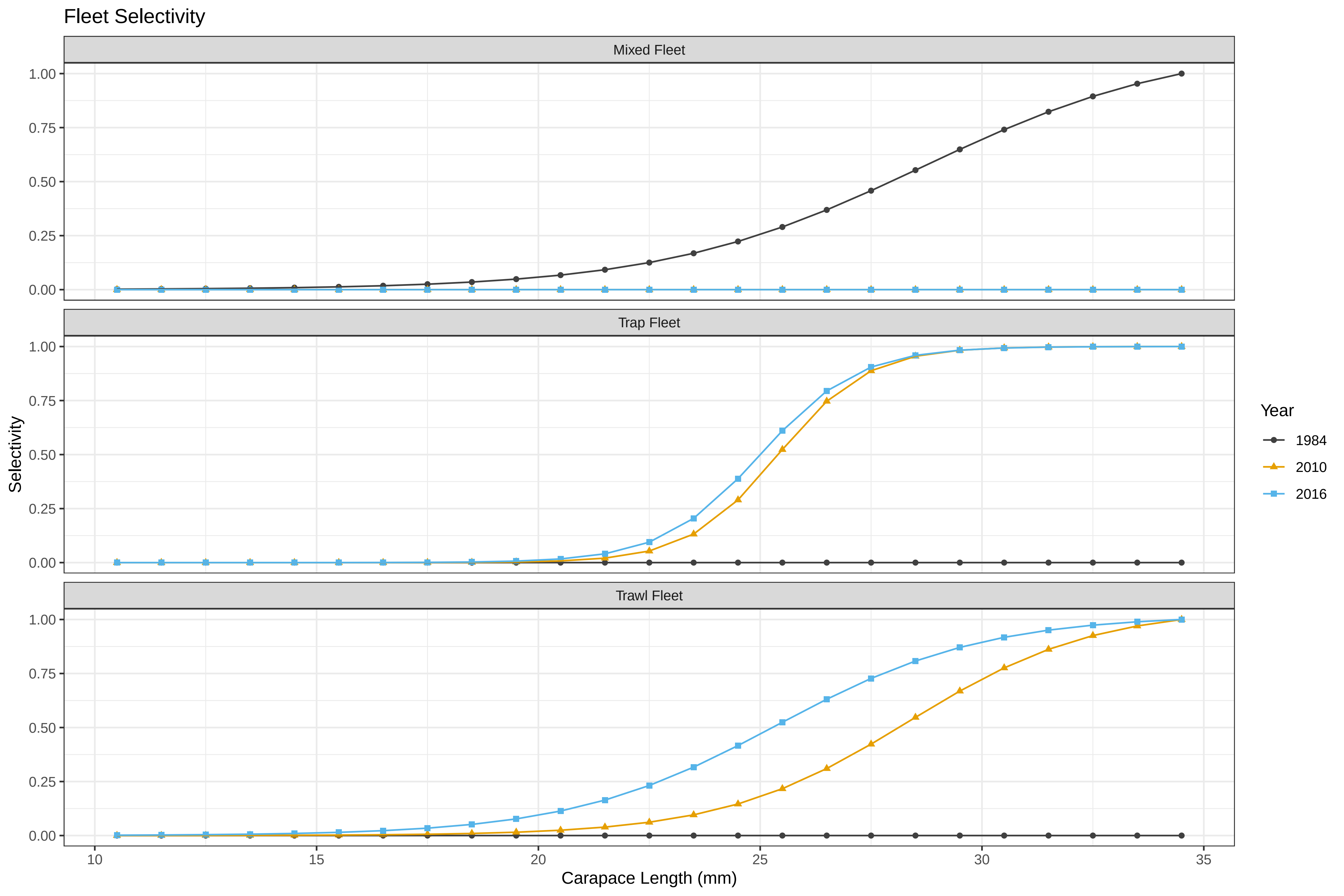
Proportion Female at Length
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Proportion female
0.00
0.25
0.50
0.75
1.00
Carapace length (mm)
10
15
20
25
30
35

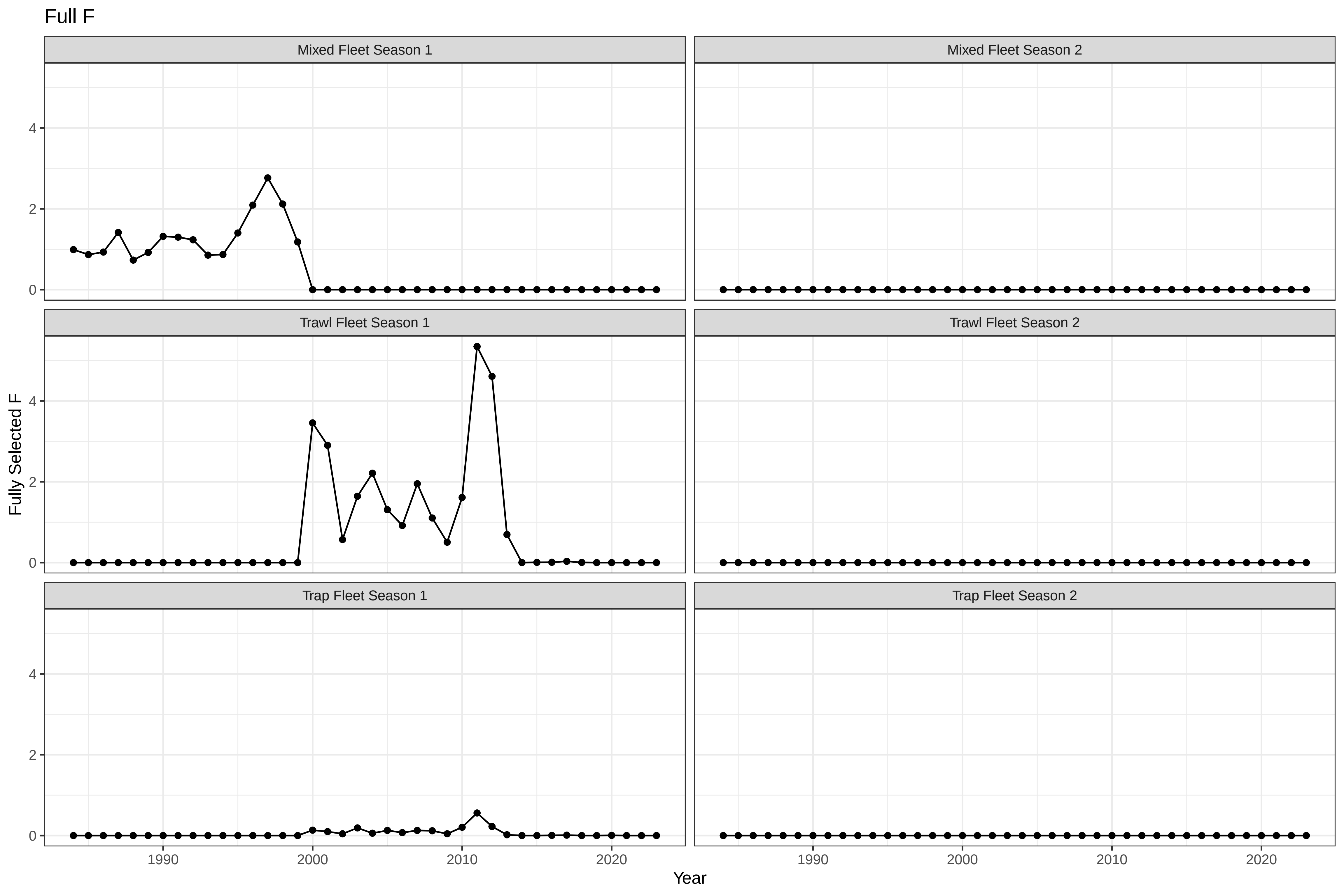


Natural Mortality
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Annual M
0
1
2
3
10
15
20
25
30
35
Carapace Length (mm)

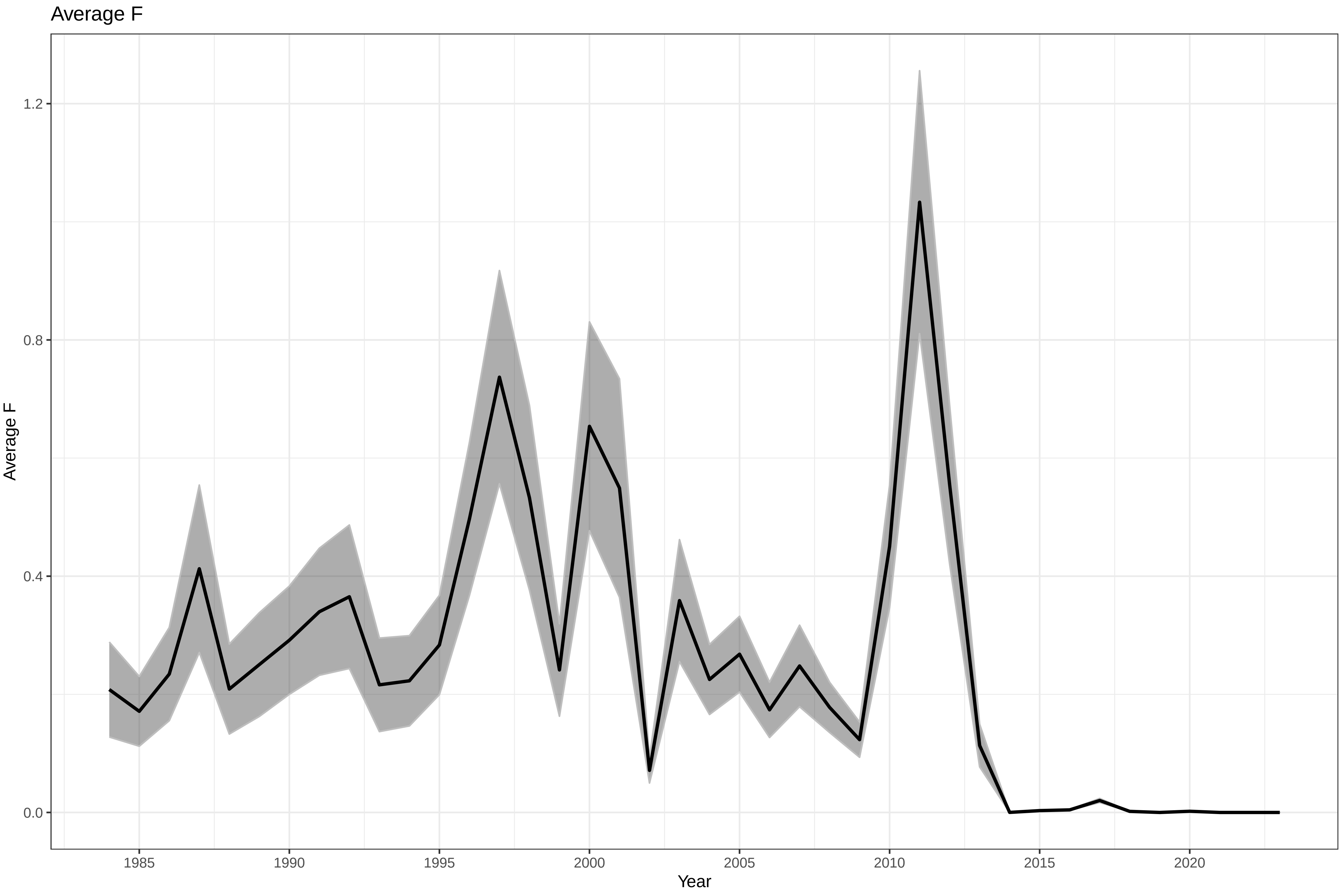
Growth Matrix

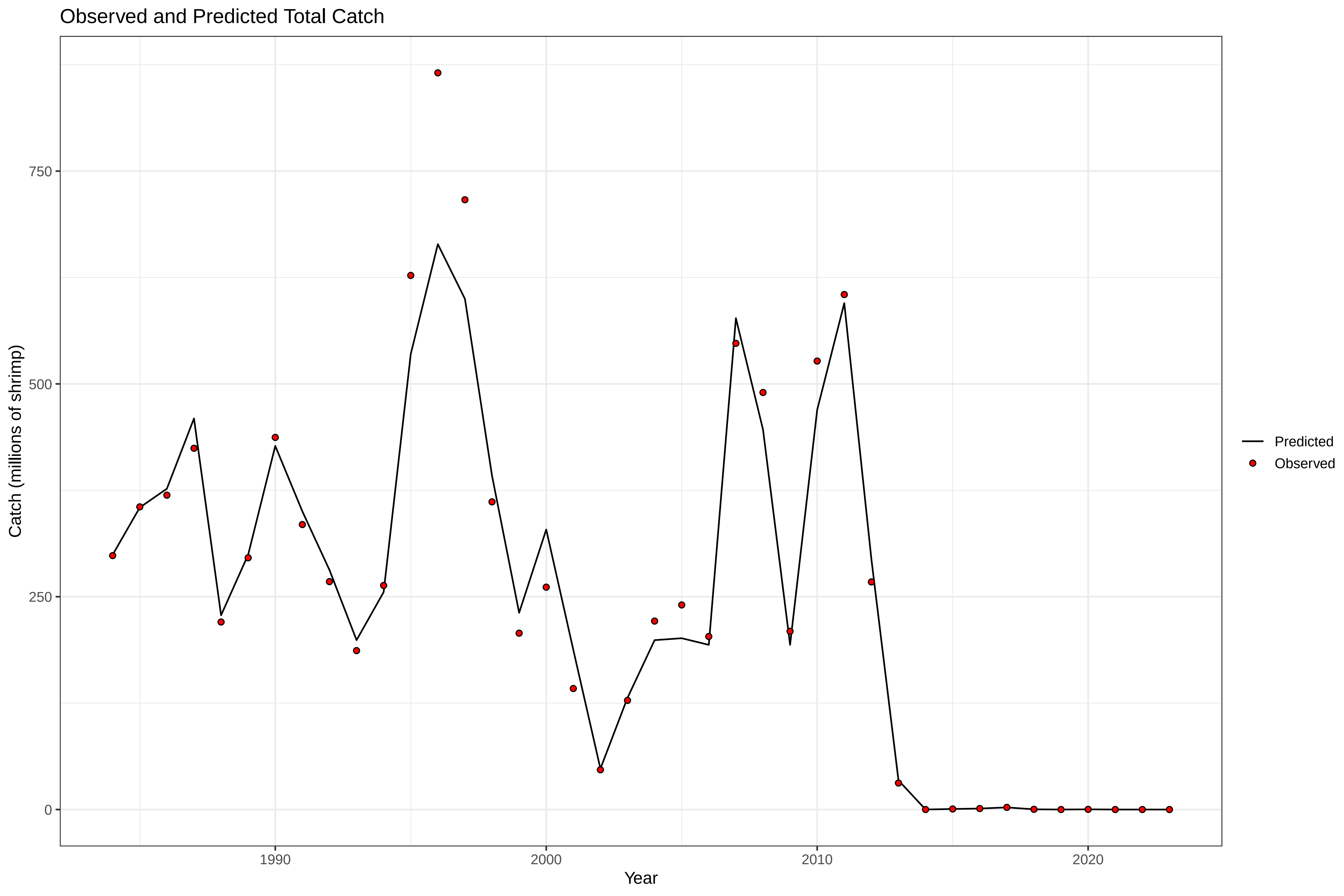



Fleet Selectivity
Mixed Fleet
Trap Fleet
Trawl Fleet
Selectivity
Carapace Length (mm)
Year
1984
2010
2016
1.00
0.75
0.50
0.25
0.00
10
15
20
25
30
35

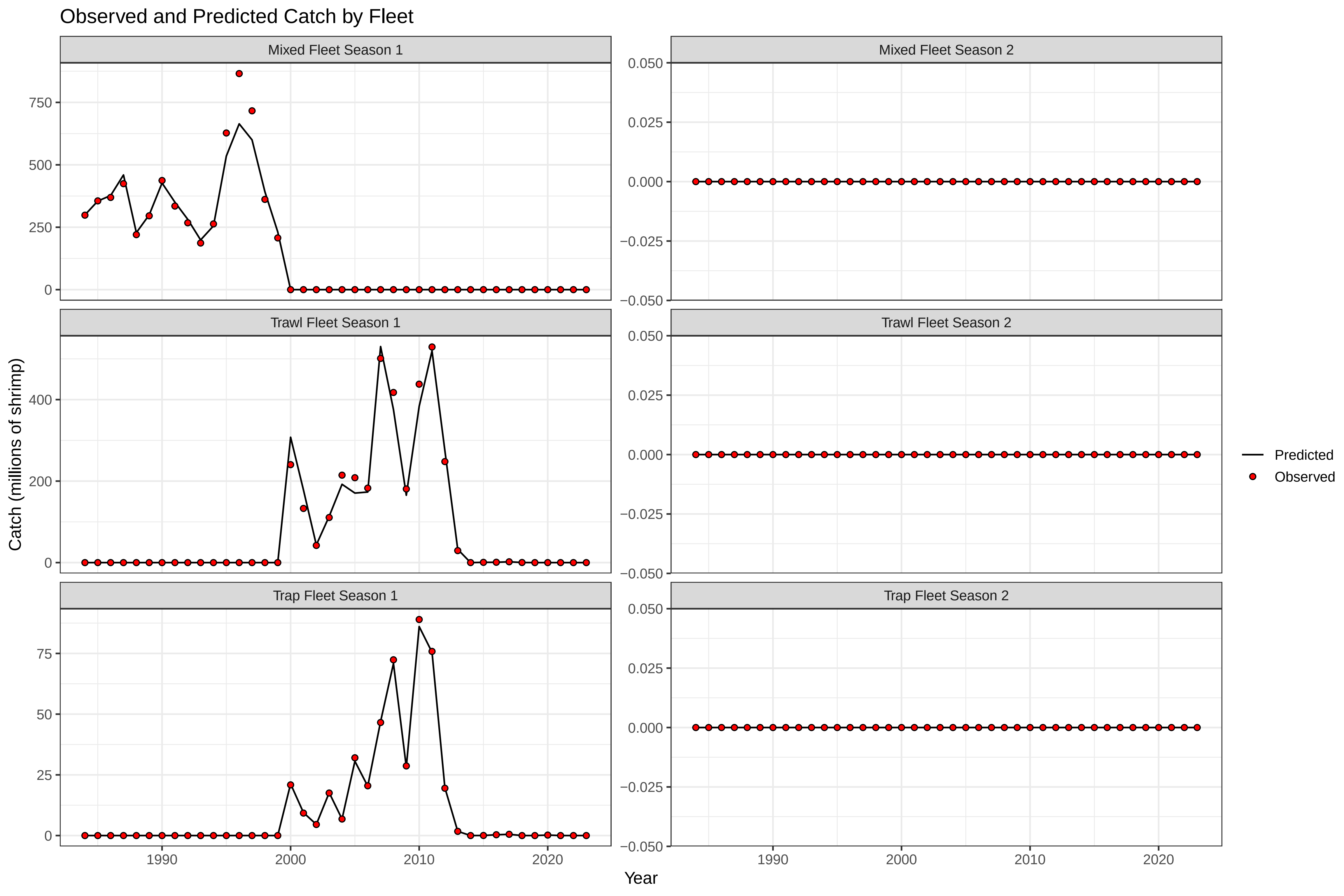


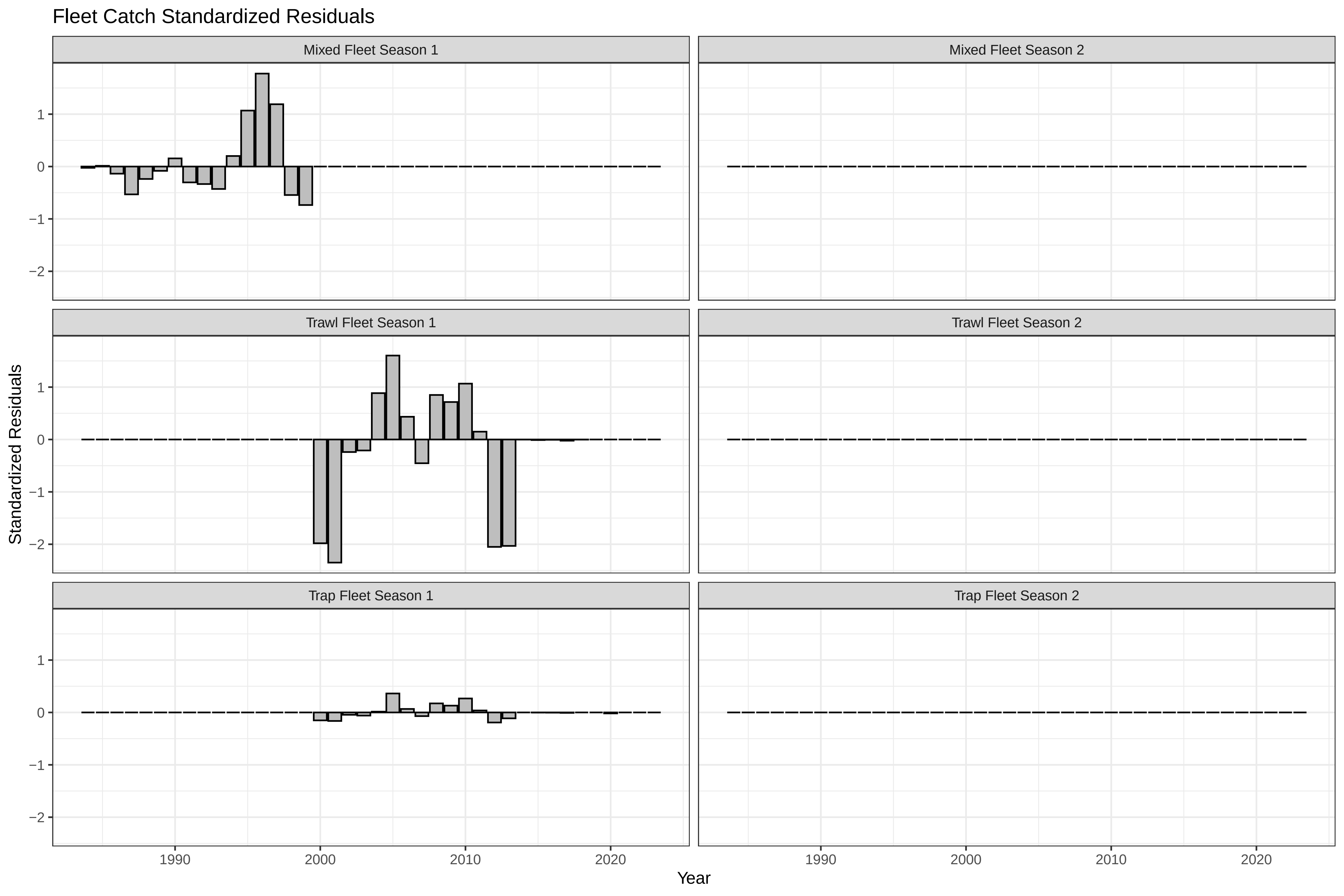
Full F
Mixed Fleet Season 1
Mixed Fleet Season 2
Trawl Fleet Season 1
Trawl Fleet Season 2
Trap Fleet Season 1
Trap Fleet Season 2
Fully Selected F
0
2
4
1990
2000
2010
2020
Year


Average F
Average F
1.2
0.8
0.4
0.0
1985
1990
1995
2000
2005
2010
2015
2020
Year

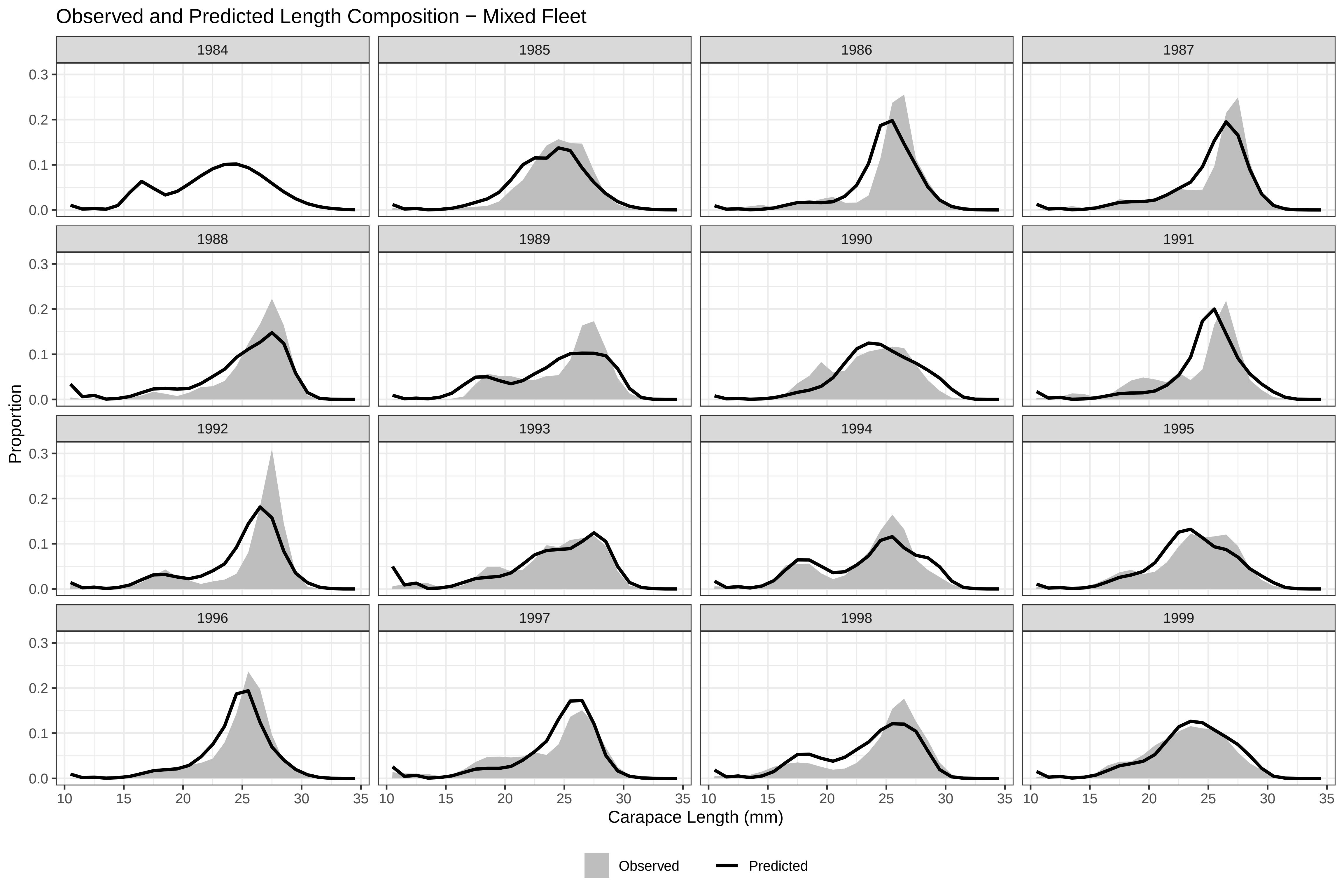


Observed and Predicted Total Catch
Catch (millions of shrimp)
750
500
250
0
1990
2000
2010
2020
Year
Predicted
Observed

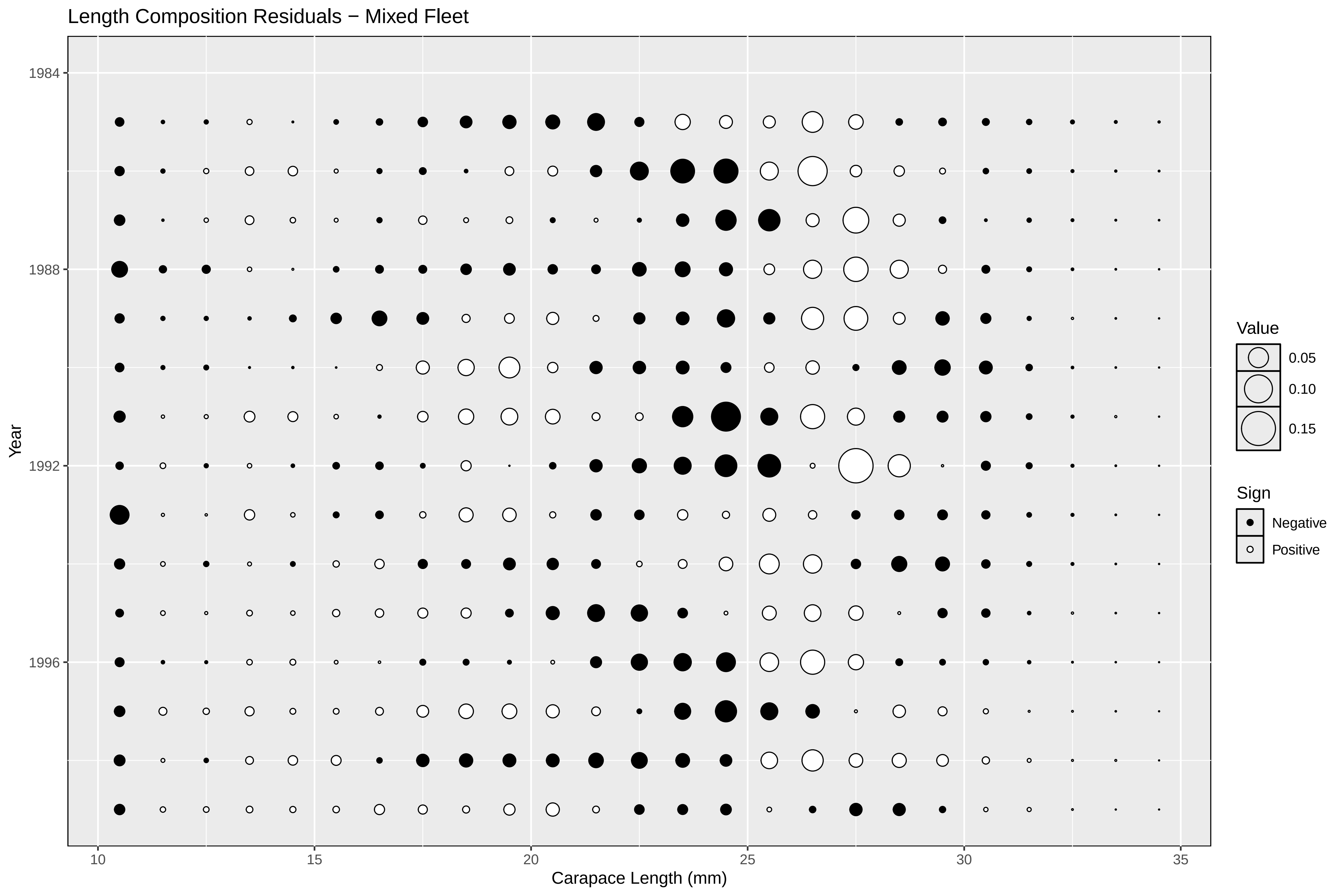

Observed and Predicted Catch by Fleet
Mixed Fleet Season 1
Mixed Fleet Season 2
Trawl Fleet Season 1
Trawl Fleet Season 2
Trap Fleet Season 1
Trap Fleet Season 2
Catch (millions of shrimp)
Year
Predicted
Observed
0
250
500
750
200
400
25
50
75
0.050
0.025
0.000
−0.025
−0.050
1990
2000
2010
2020



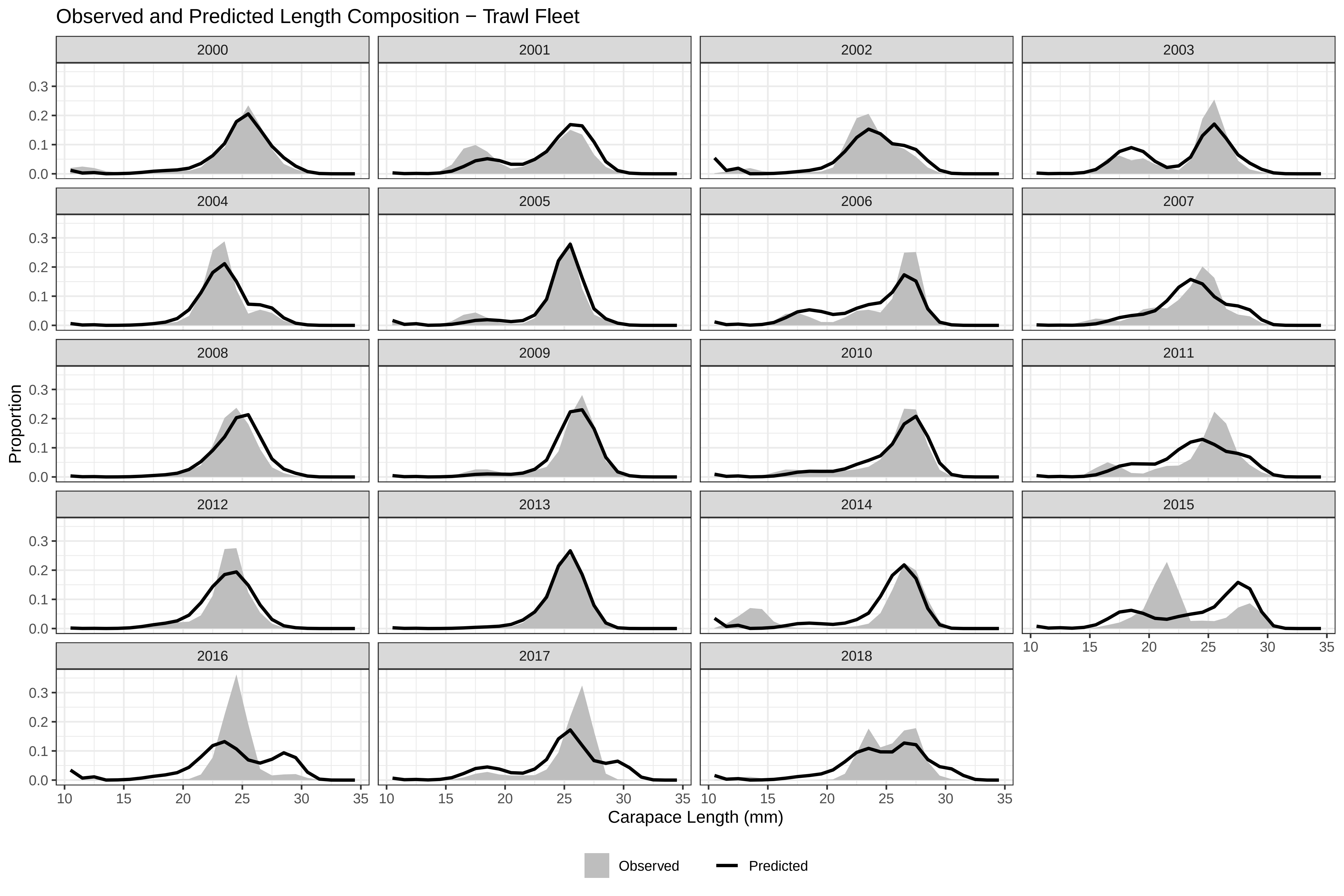
Fleet Catch Standardized Residuals
Mixed Fleet Season 1
Mixed Fleet Season 2
Trawl Fleet Season 1
Trawl Fleet Season 2
Trap Fleet Season 1
Trap Fleet Season 2
Standardized Residuals
1
0
−1
−2
1990
2000
2010
2020
Year



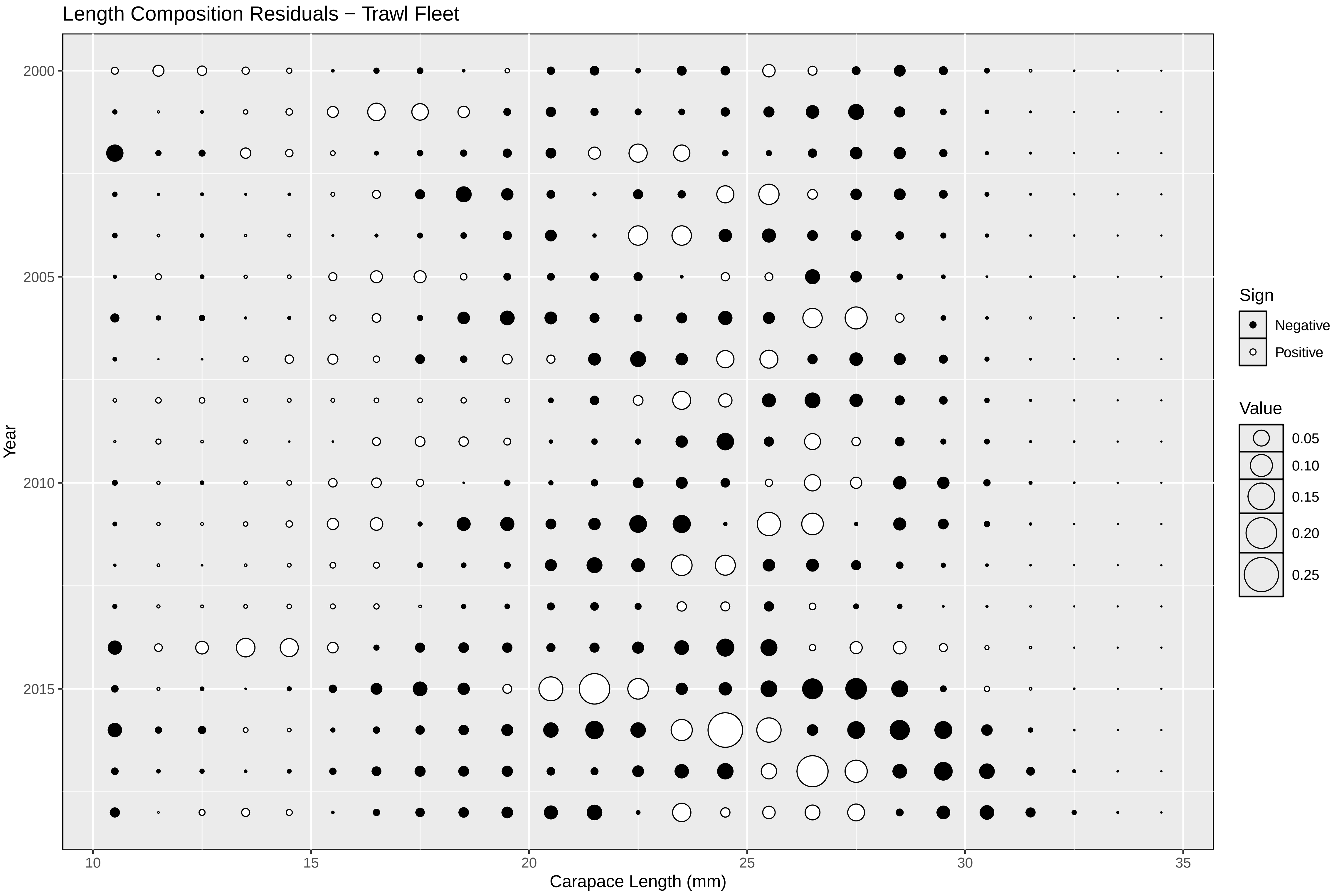
Observed and Predicted Length Composition − Mixed Fleet
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Proportion
0.0
0.1
0.2
0.3
Carapace Length (mm)
10
15
20
25
30
35
Observed
Predicted



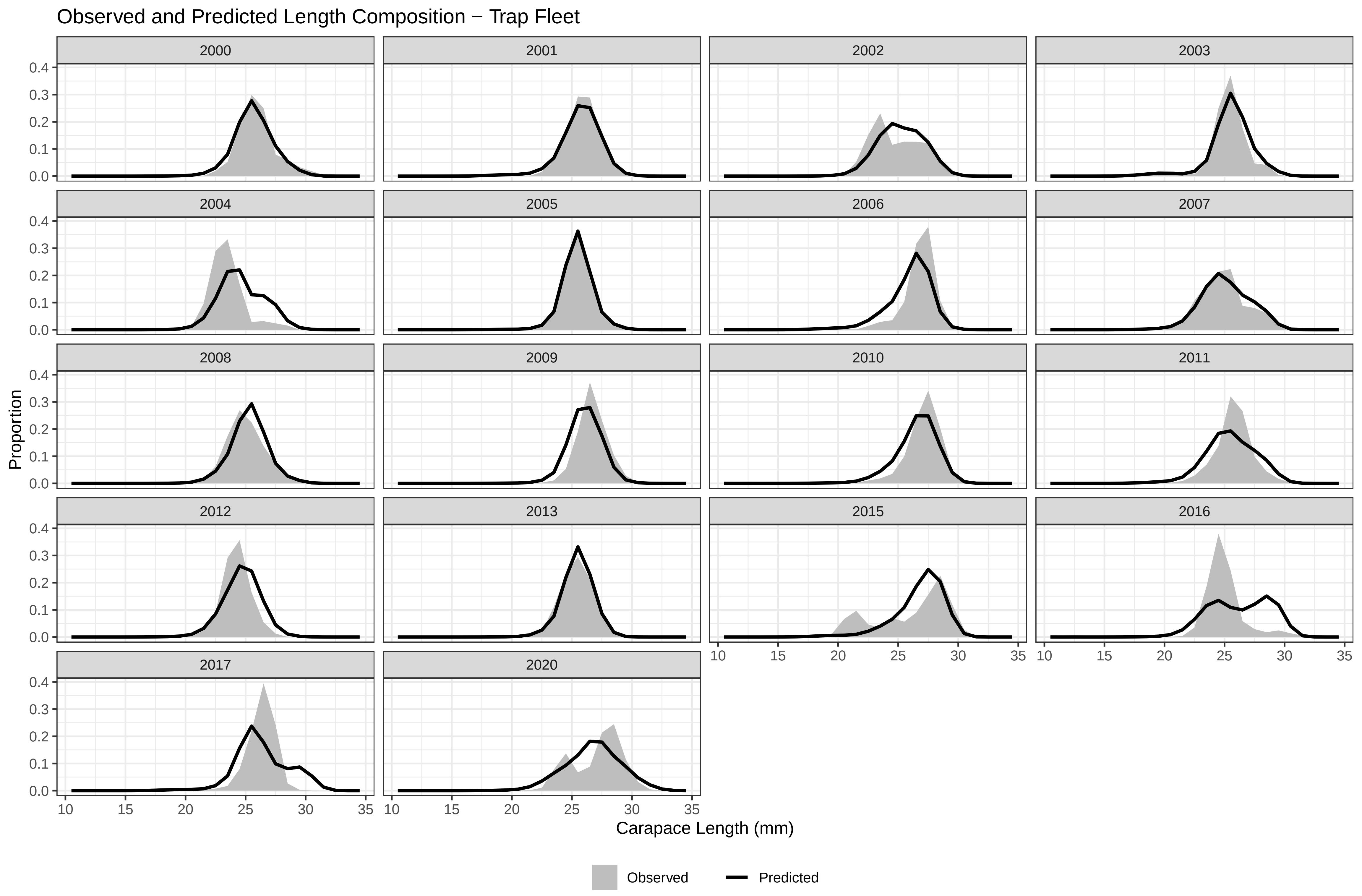
Length Composition Residuals − Mixed Fleet
Year
1984
1988
1992
1996
Carapace Length (mm)
10
15
20
25
30
35
Value
0.05
0.10
0.15
Sign
Negative
Positive



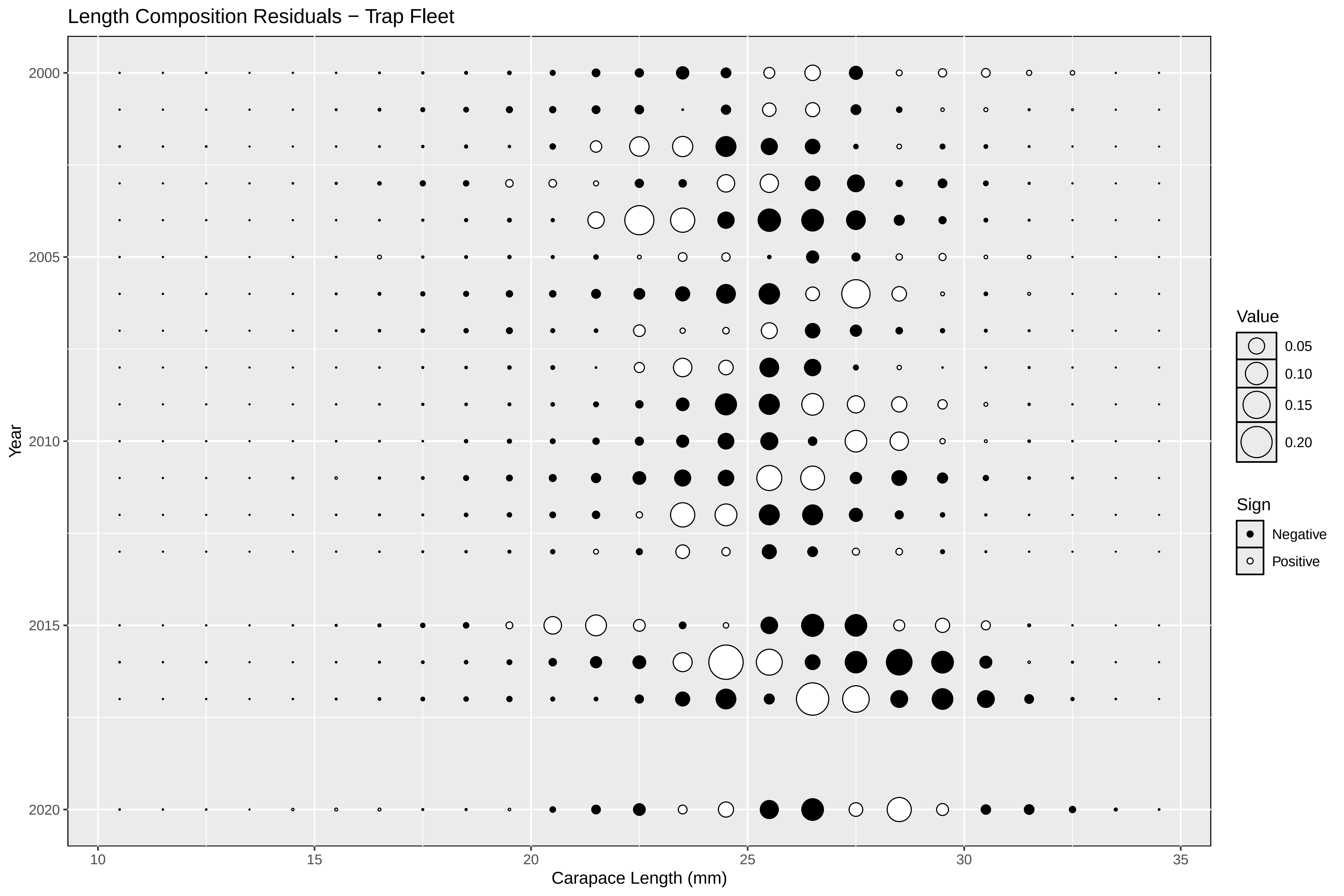
Observed and Predicted Length Composition − Trawl Fleet
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Proportion
0.0
0.1
0.2
0.3
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



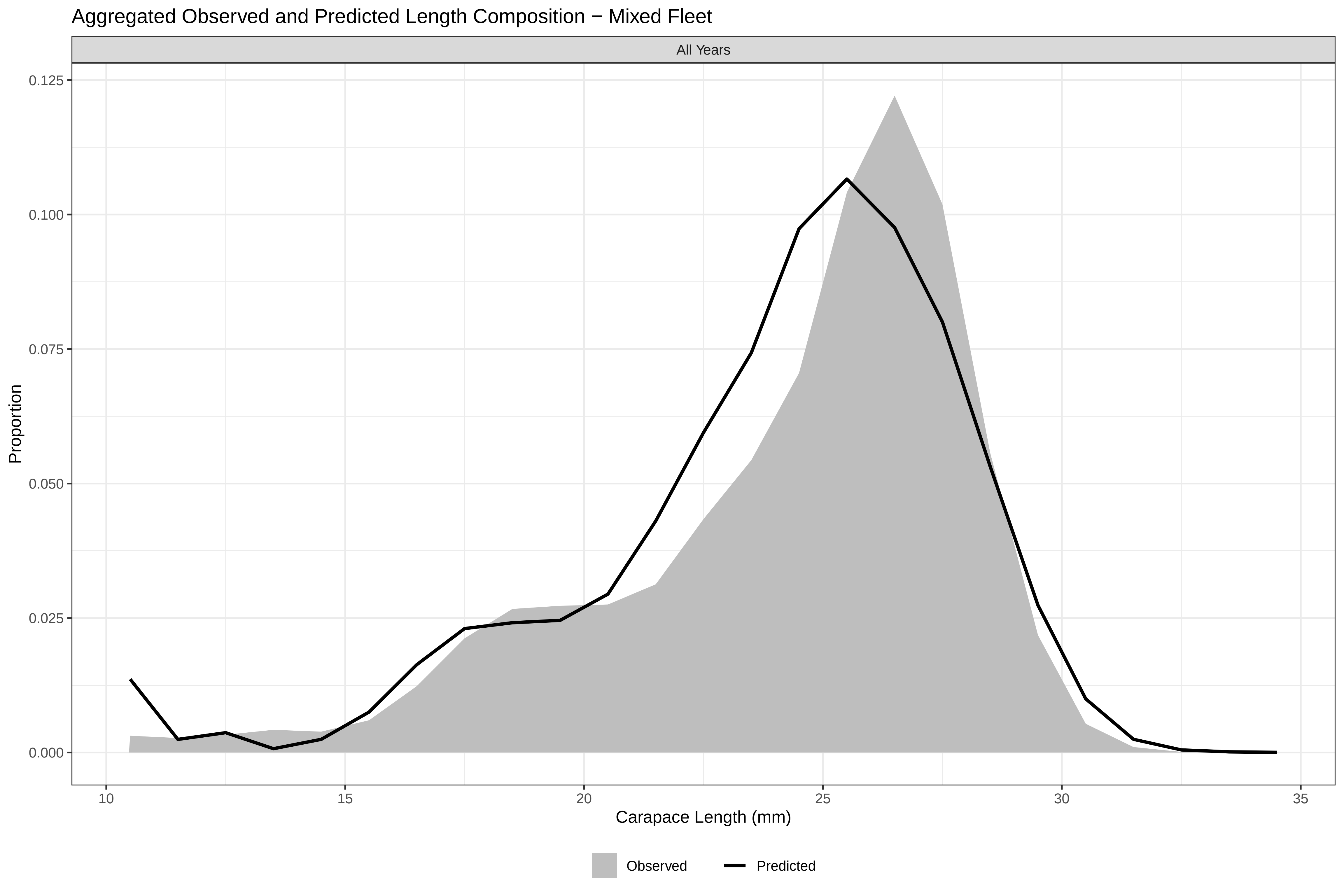
Length Composition Residuals − Trawl Fleet
Year
2000
2005
2010
2015
Carapace Length (mm)
10
15
20
25
30
35
Sign
Negative
Positive
Value
0.05
0.10
0.15
0.20
0.25



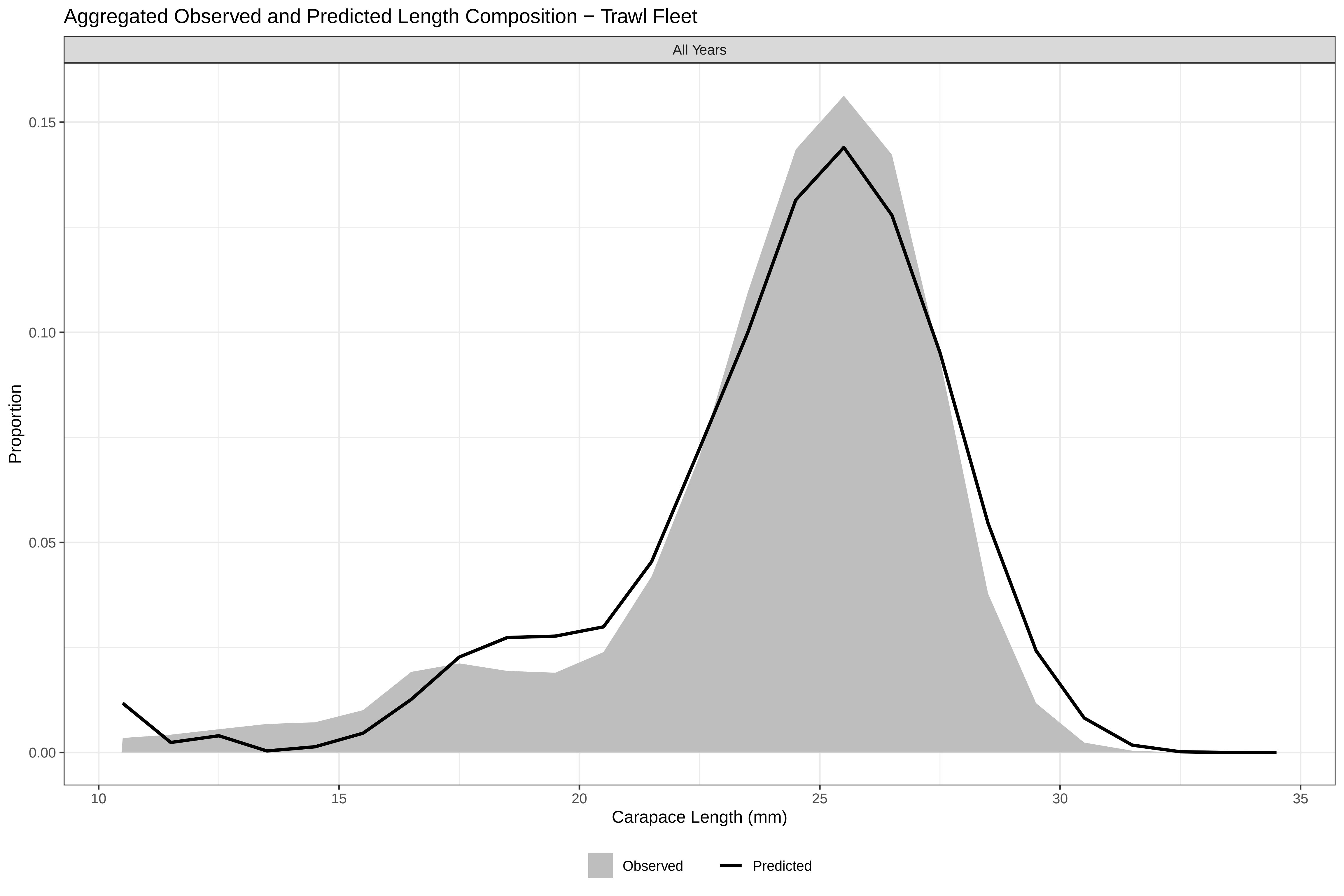
Observed and Predicted Length Composition − Trap Fleet
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2015
2016
2017
2020
Proportion
0.0
0.1
0.2
0.3
0.4
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



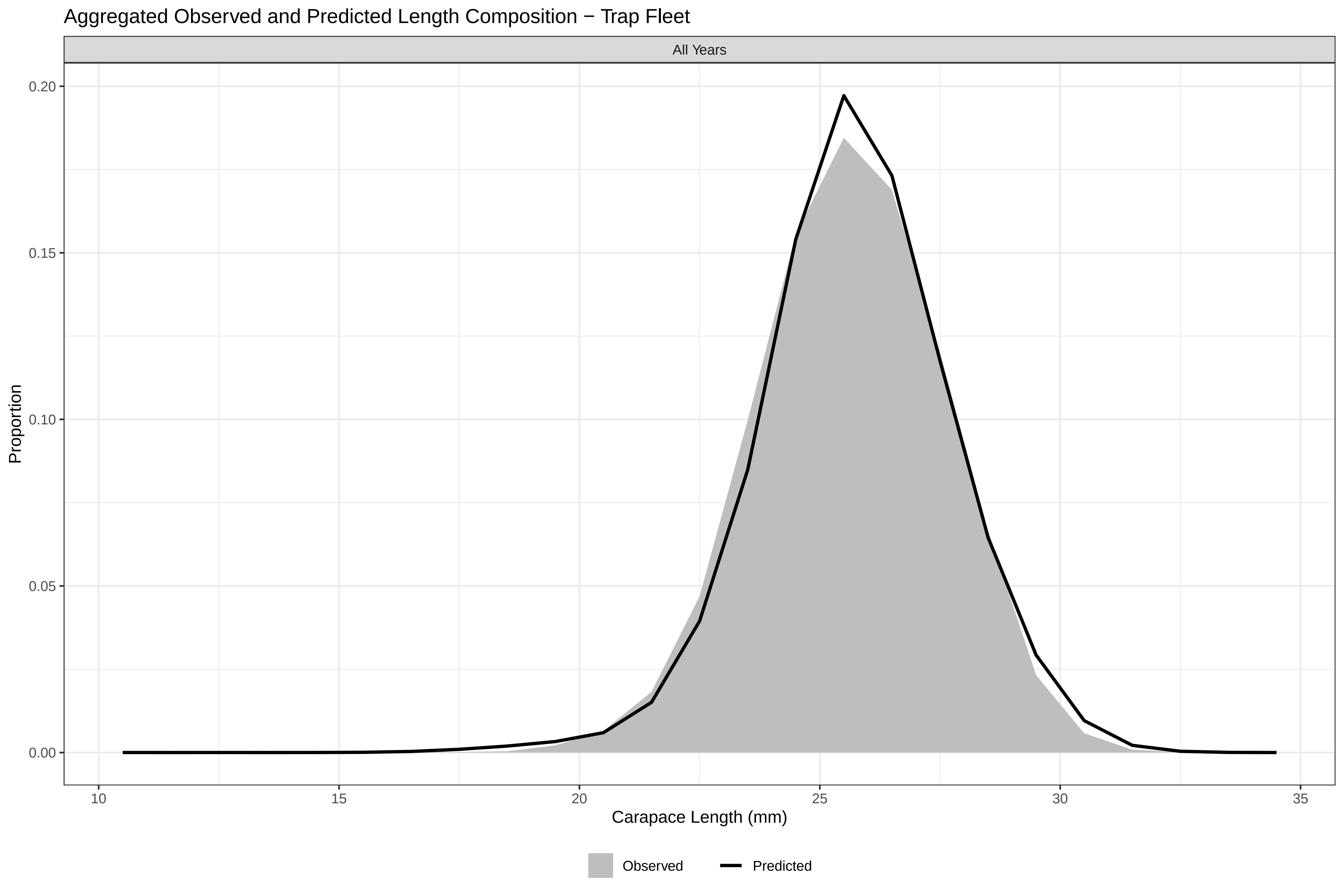
Length Composition Residuals − Trap Fleet
Year
2000
2005
2010
2015
2020
Carapace Length (mm)
10
15
20
25
30
35
Value
0.05
0.10
0.15
0.20
Sign
Negative
Positive



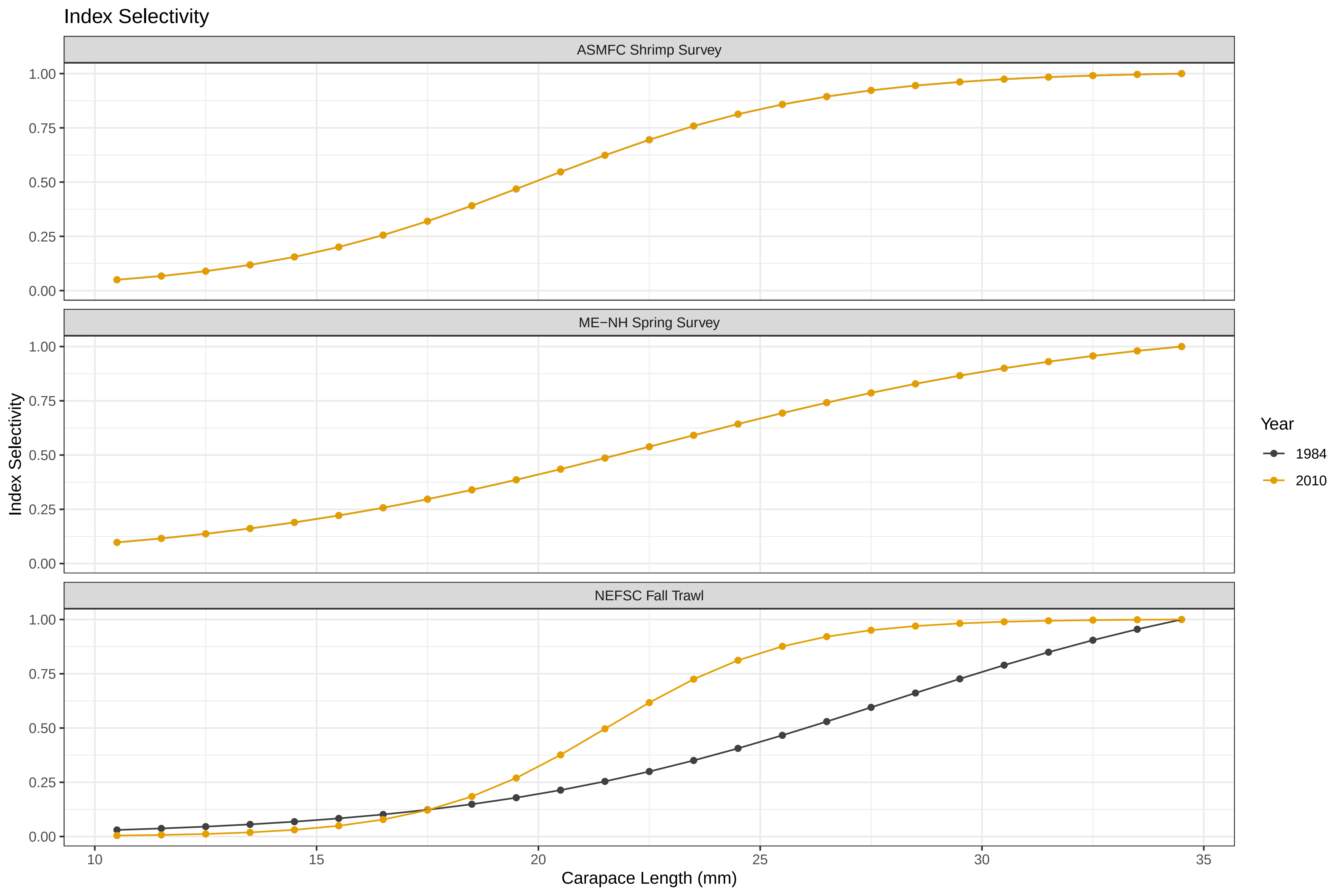
Aggregated Observed and Predicted Length Composition − Mixed Fleet
All Years
Proportion
0.125
0.100
0.075
0.050
0.025
0.000
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



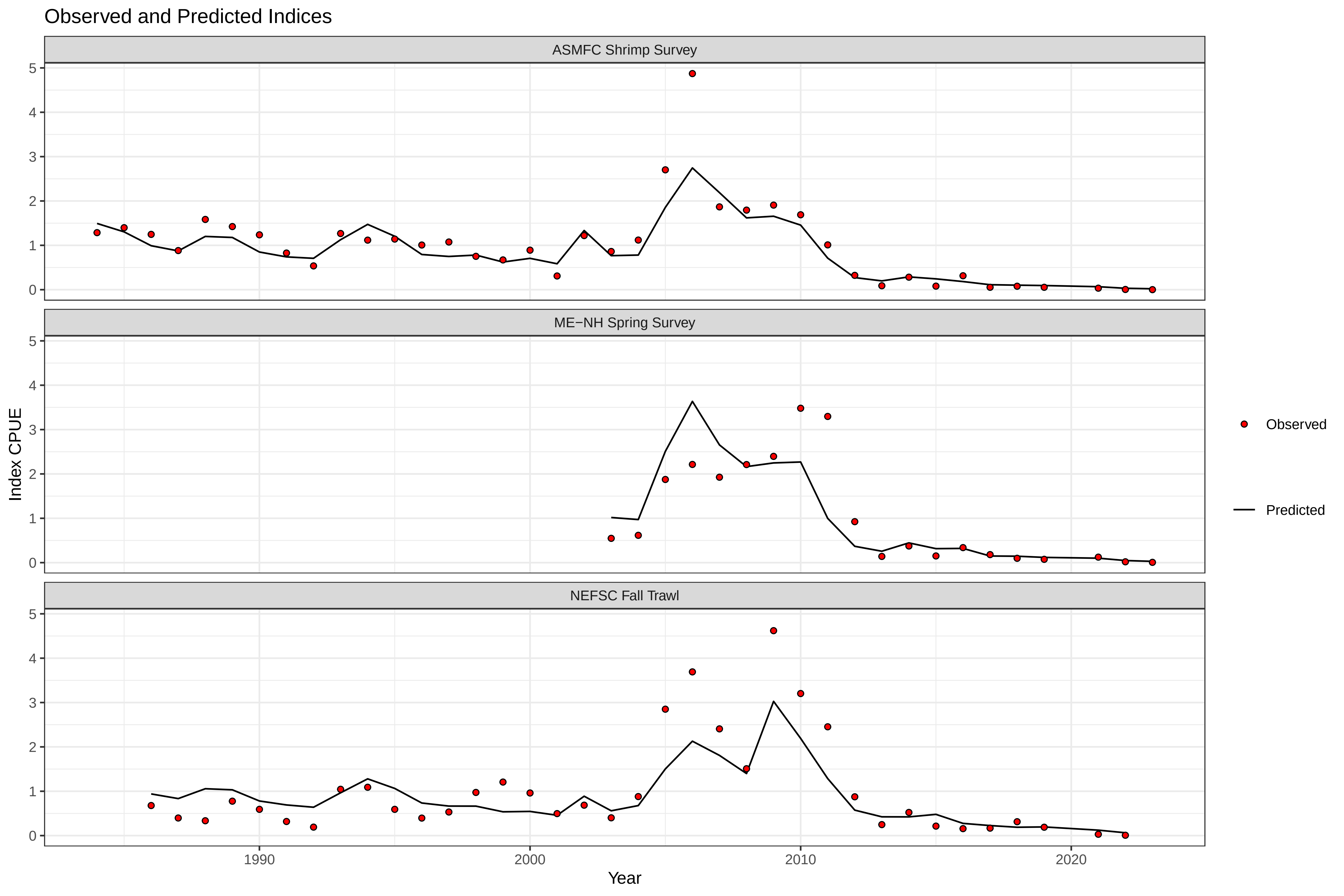
Aggregated Observed and Predicted Length Composition − Trawl Fleet
All Years
Proportion
0.15
0.10
0.05
0.00
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



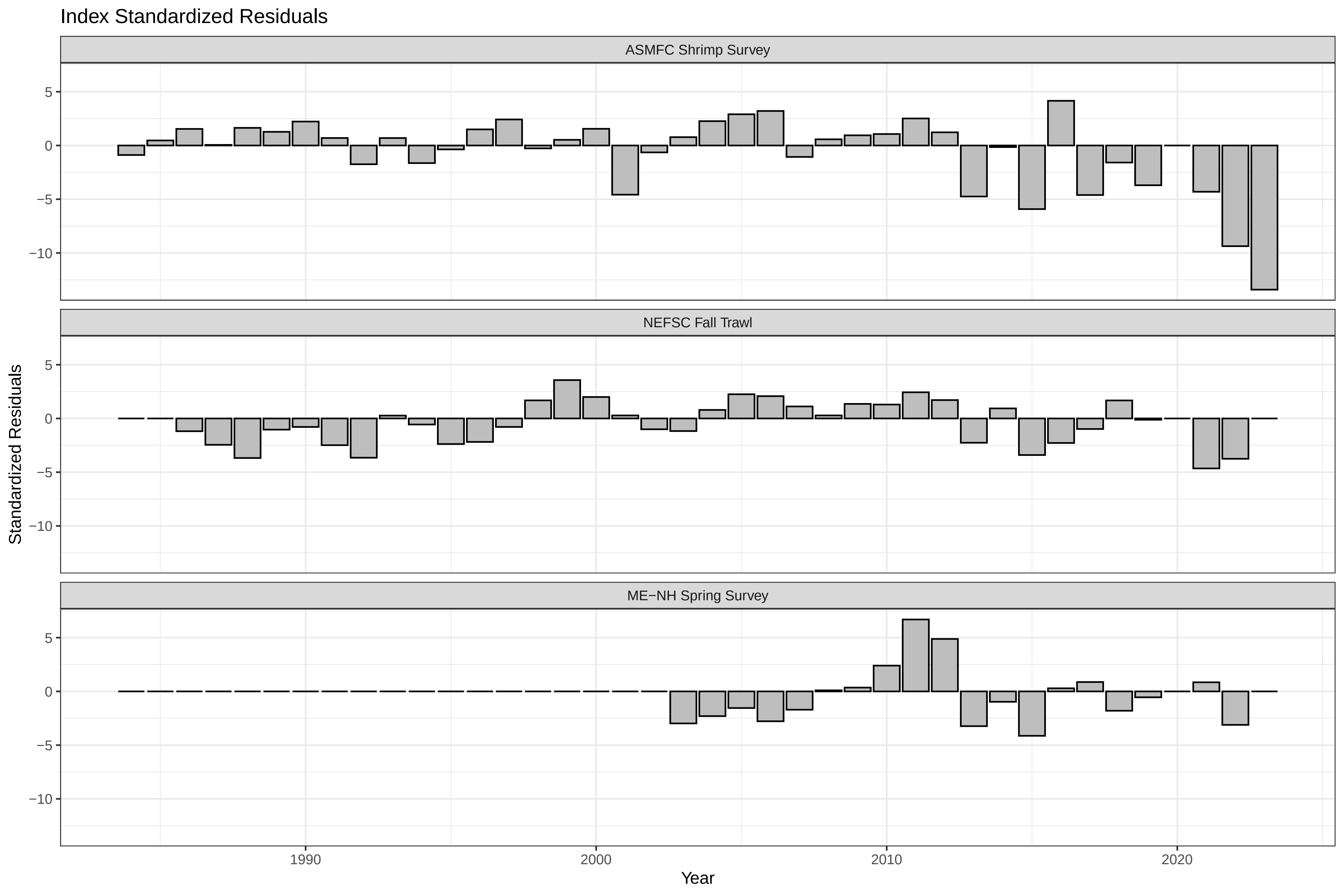
Aggregated Observed and Predicted Length Composition − Trap Fleet
All Years
Proportion
0.00
0.05
0.10
0.15
0.20
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



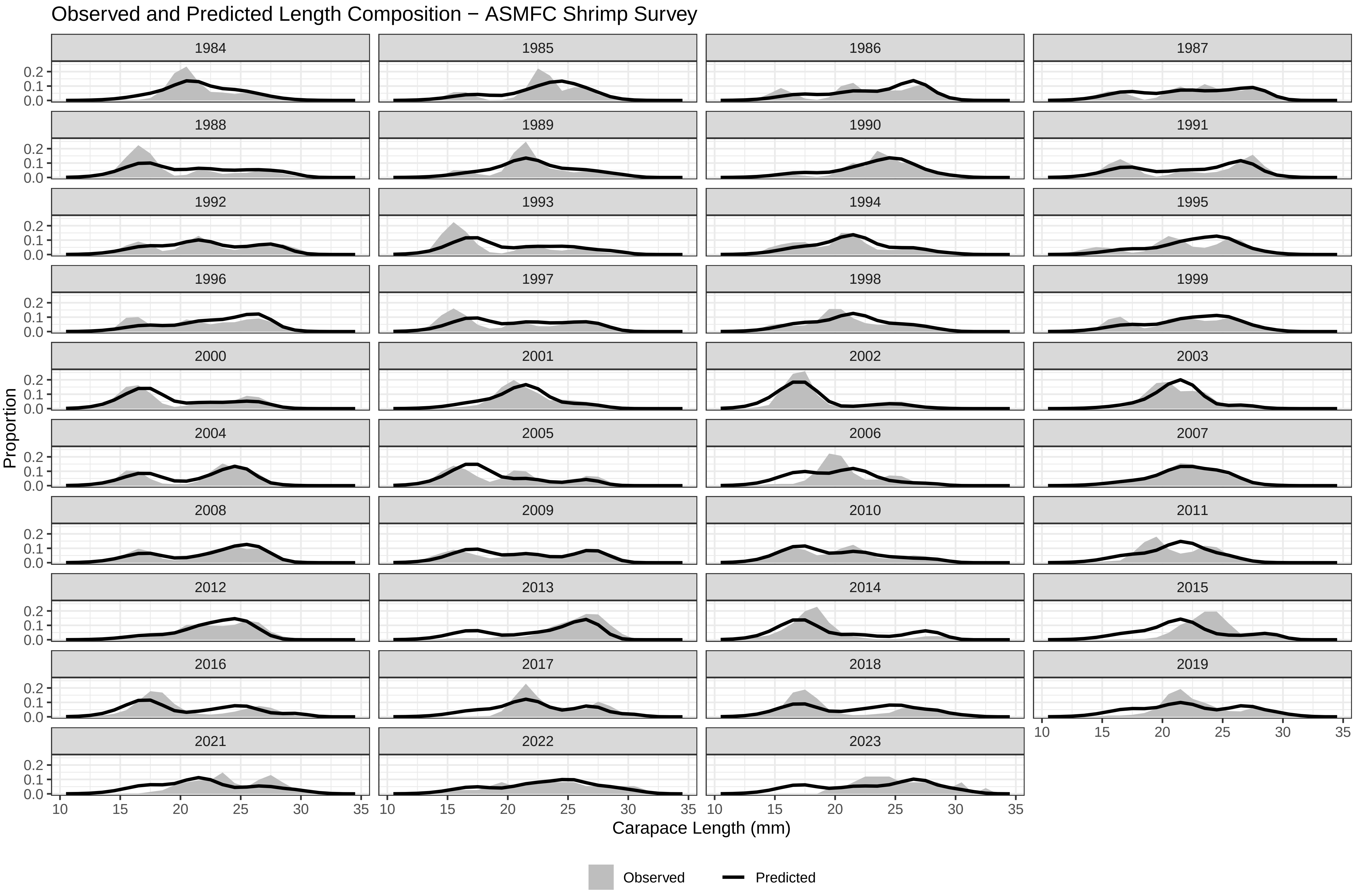
Index Selectivity
ASMFC Shrimp Survey
ME−NH Spring Survey
NEFSC Fall Trawl
1.00
0.75
0.50
0.25
0.00
Index Selectivity
10
15
20
25
30
35
Carapace Length (mm)
Year
1984
2010



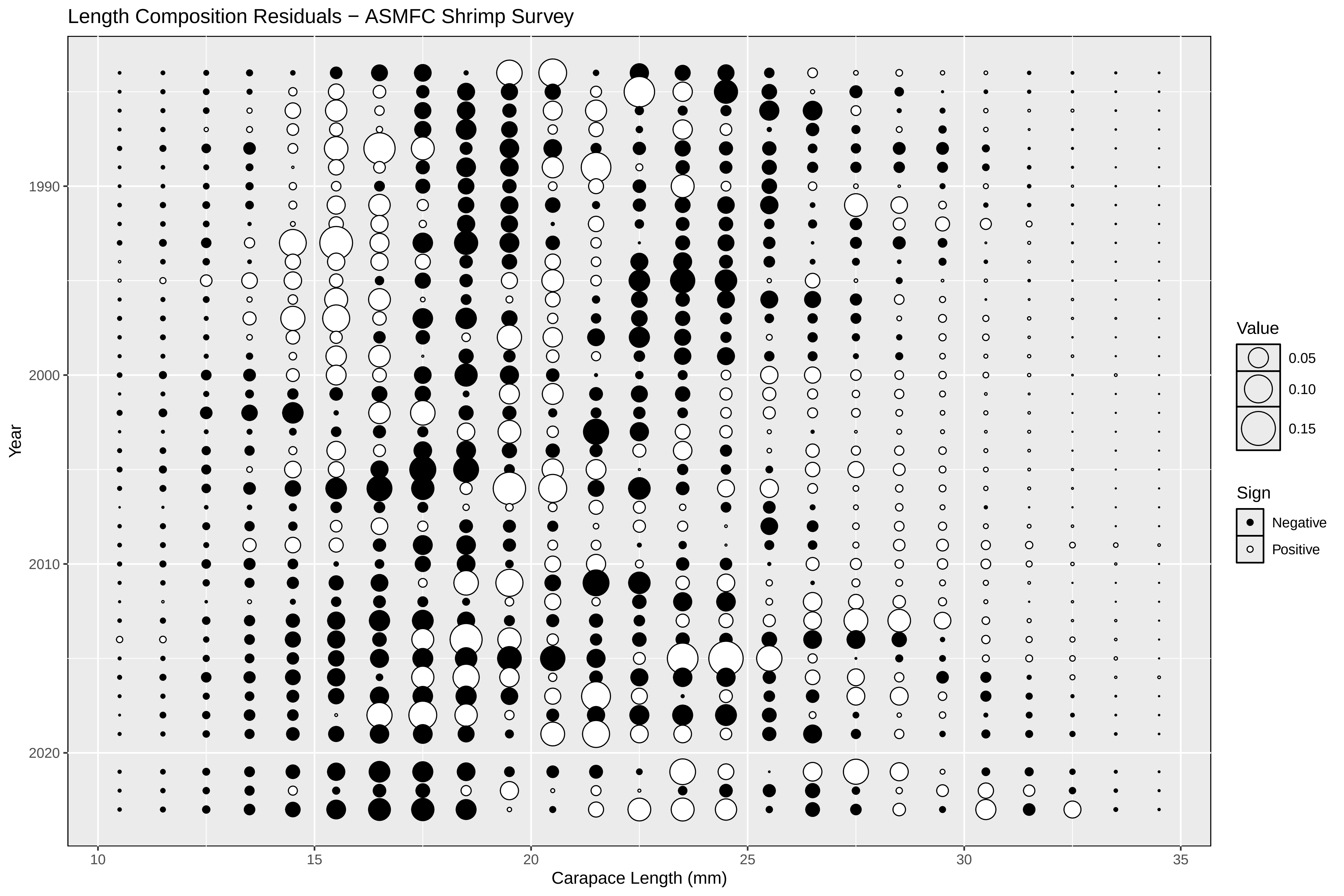
Observed and Predicted Indices
ASMFC Shrimp Survey
ME−NH Spring Survey
NEFSC Fall Trawl
Index CPUE
Year
0
1
2
3
4
5
1990
2000
2010
2020
Observed
Predicted

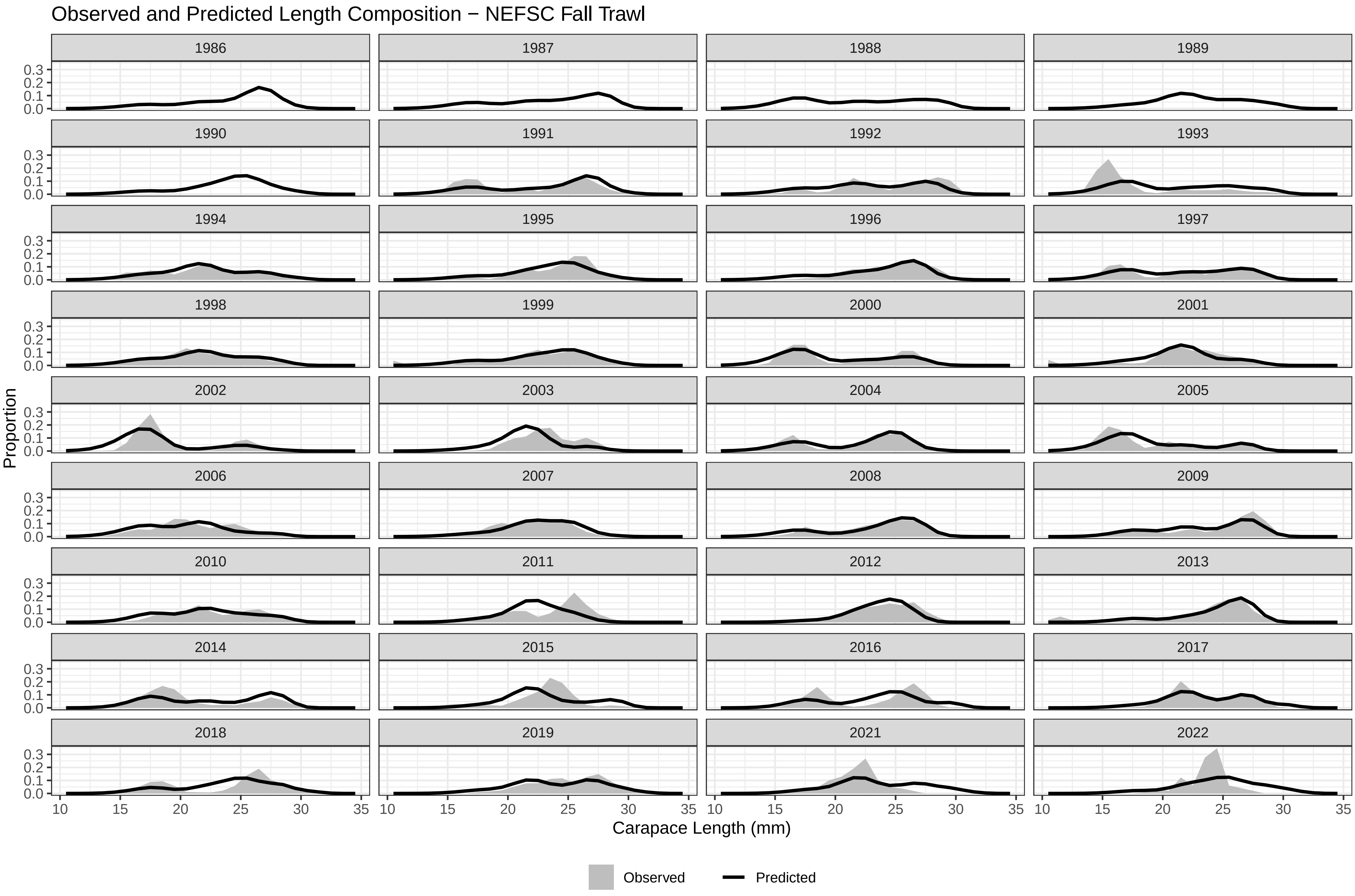


Index Standardized Residuals
ASMFC Shrimp Survey
NEFSC Fall Trawl
ME−NH Spring Survey
Standardized Residuals
Year
5
0
−5
−10
1990
2000
2010
2020

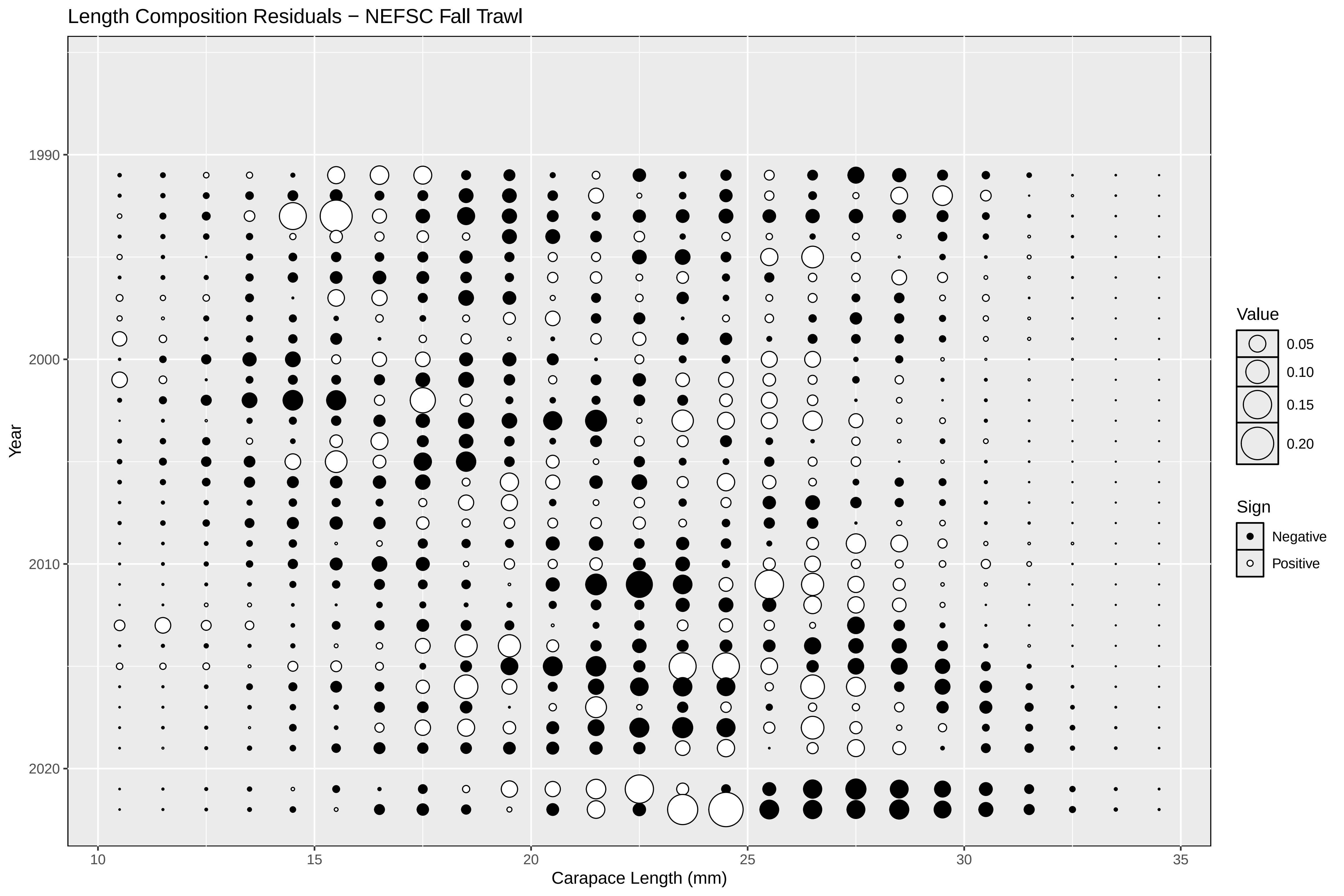


Observed and Predicted Length Composition − ASMFC Shrimp Survey
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
2023
Proportion
0.0
0.1
0.2
Carapace Length (mm)
10
15
20
25
30
35
Observed
Predicted

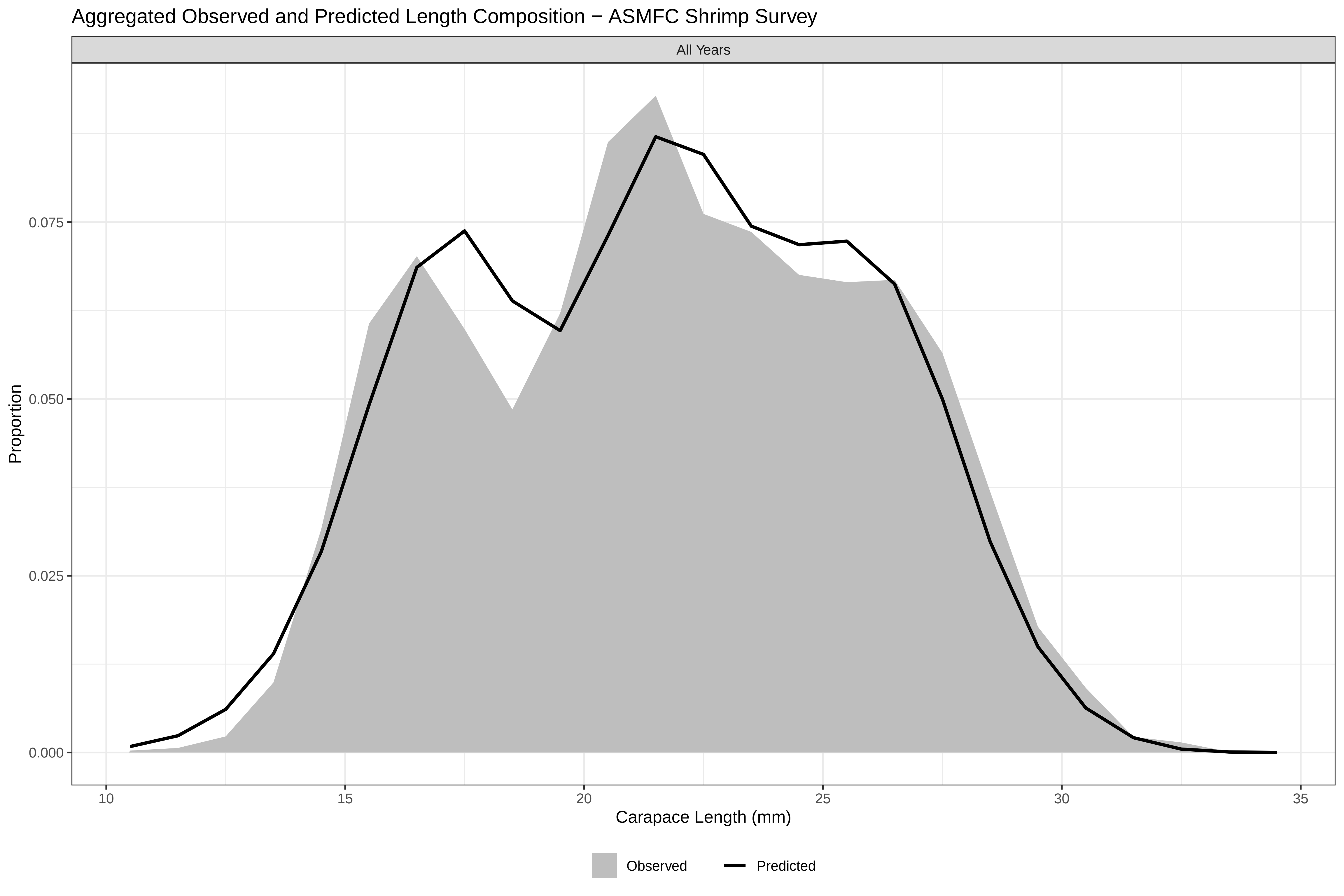

Length Composition Residuals − ASMFC Shrimp Survey
Year
1990
2000
2010
2020
Carapace Length (mm)
10
15
20
25
30
35
Value
0.05
0.10
0.15
Sign
Negative
Positive

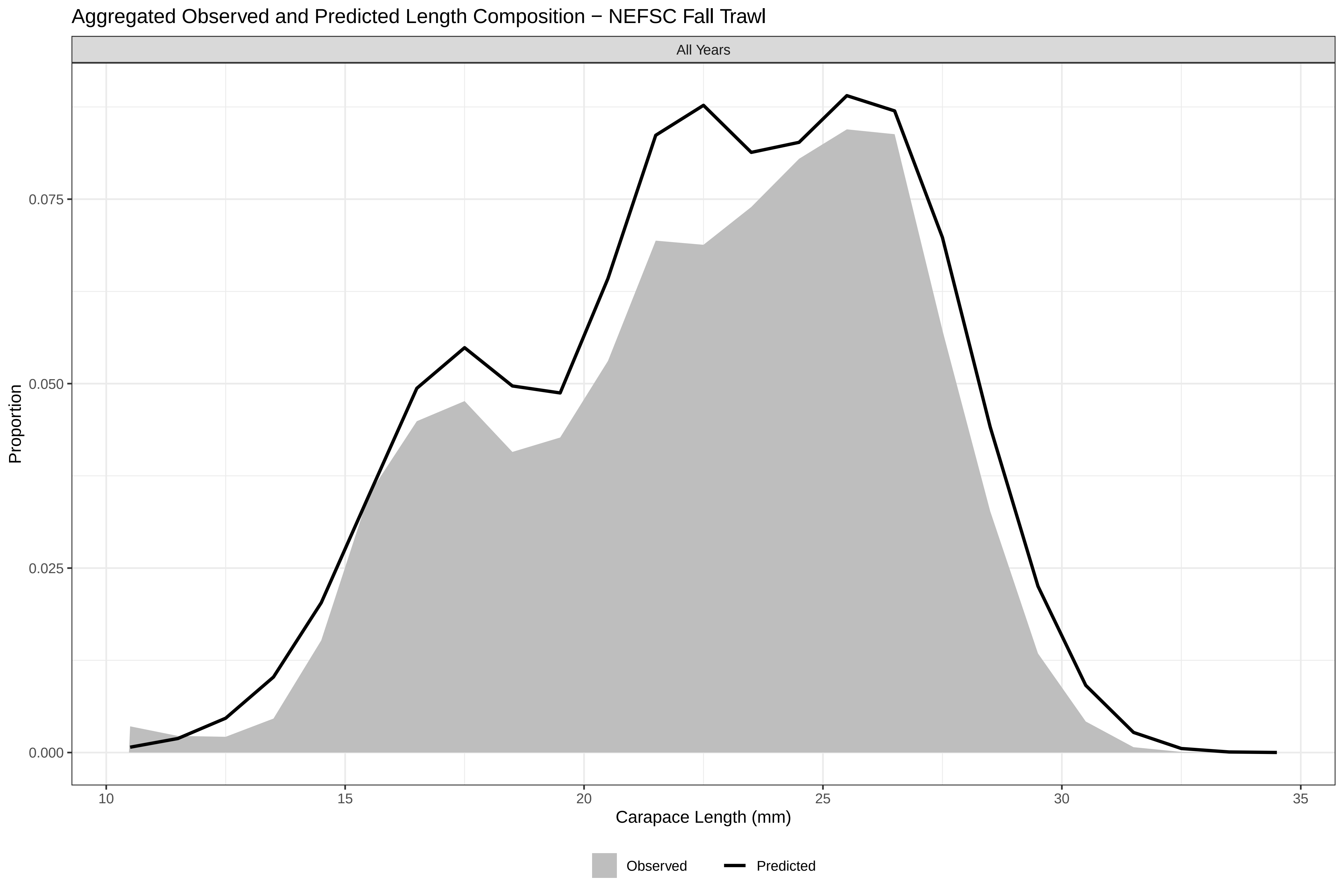


Observed and Predicted Length Composition − NEFSC Fall Trawl
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
Proportion
0.0
0.1
0.2
0.3
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted

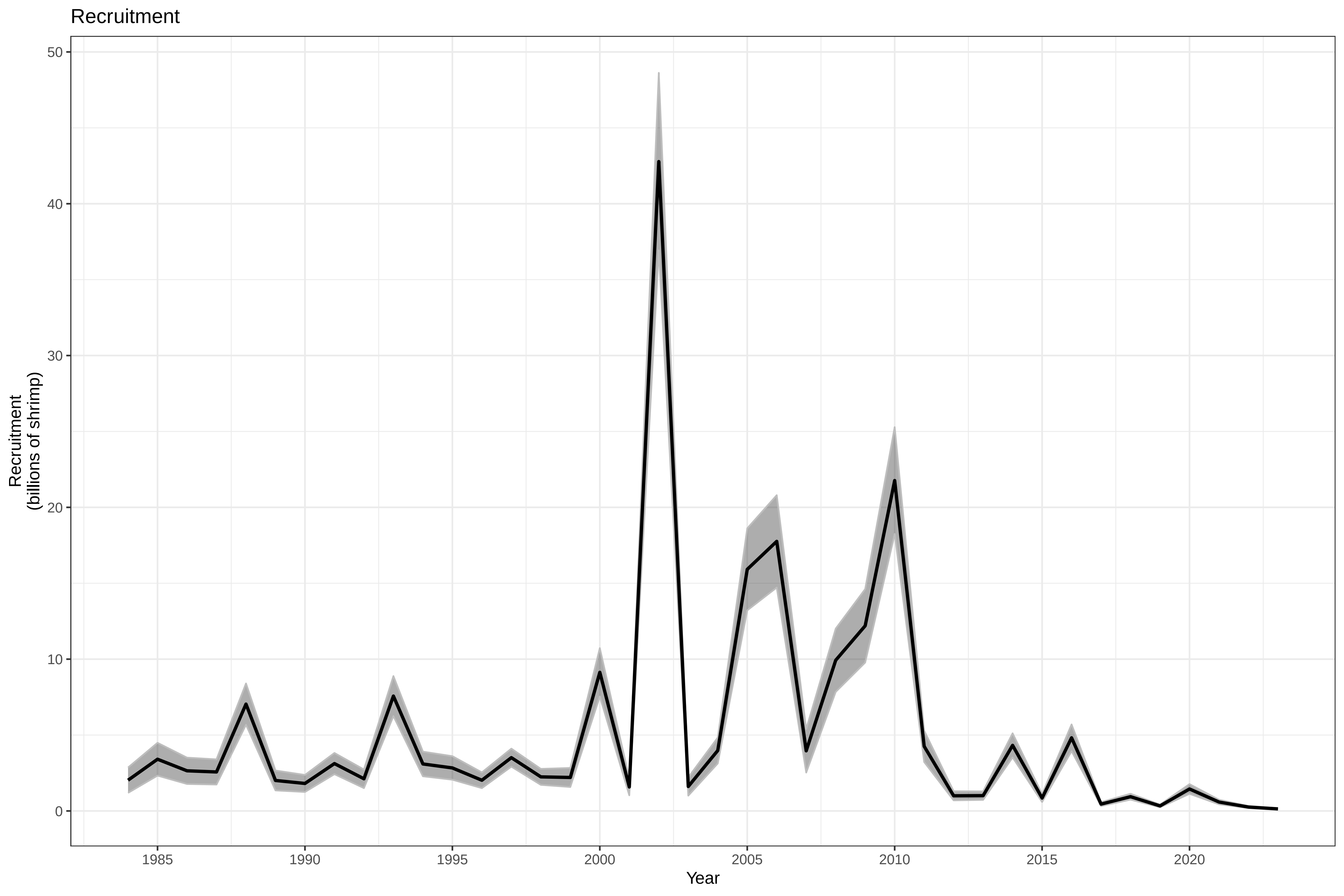


Length Composition Residuals − NEFSC Fall Trawl
Year
1990
2000
2010
2020
10
15
20
25
30
35
Carapace Length (mm)
Value
0.05
0.10
0.15
0.20
Sign
Negative
Positive

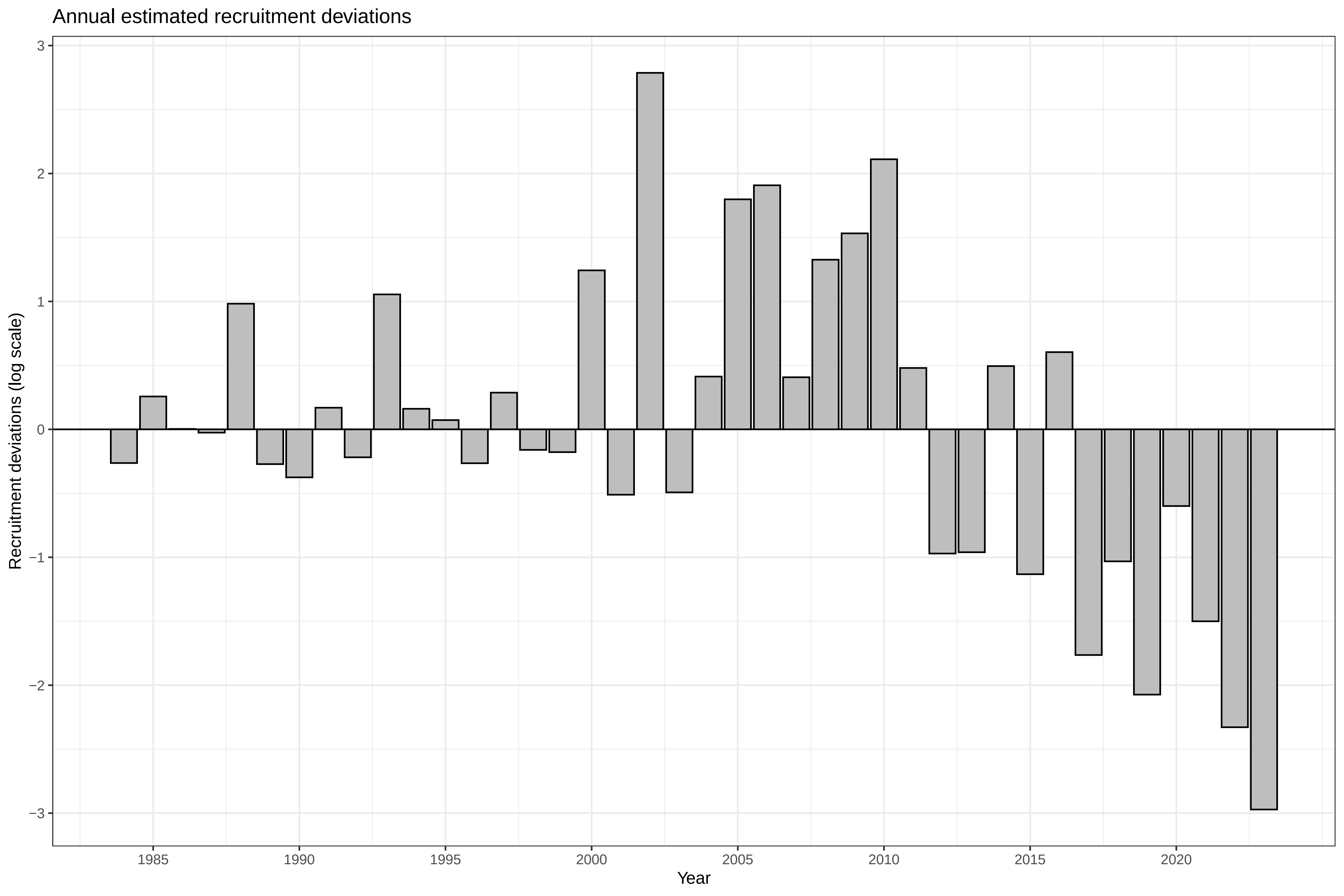

Aggregated Observed and Predicted Length Composition − ASMFC Shrimp Survey
All Years
Proportion
0.000
0.025
0.050
0.075
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



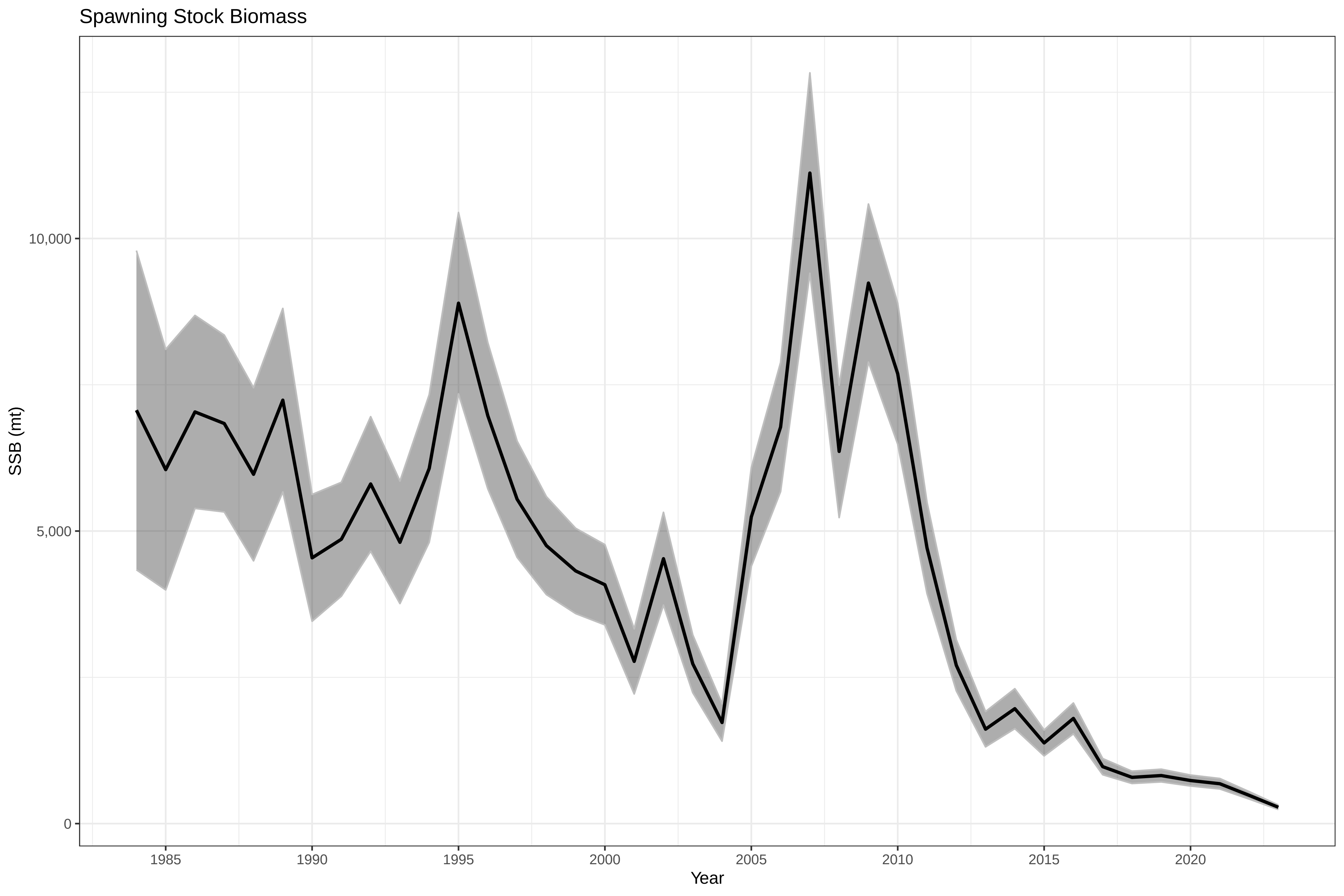
Aggregated Observed and Predicted Length Composition − NEFSC Fall Trawl
All Years
0.000
0.025
0.050
0.075
Proportion
10
15
20
25
30
35
Carapace Length (mm)
Observed
Predicted



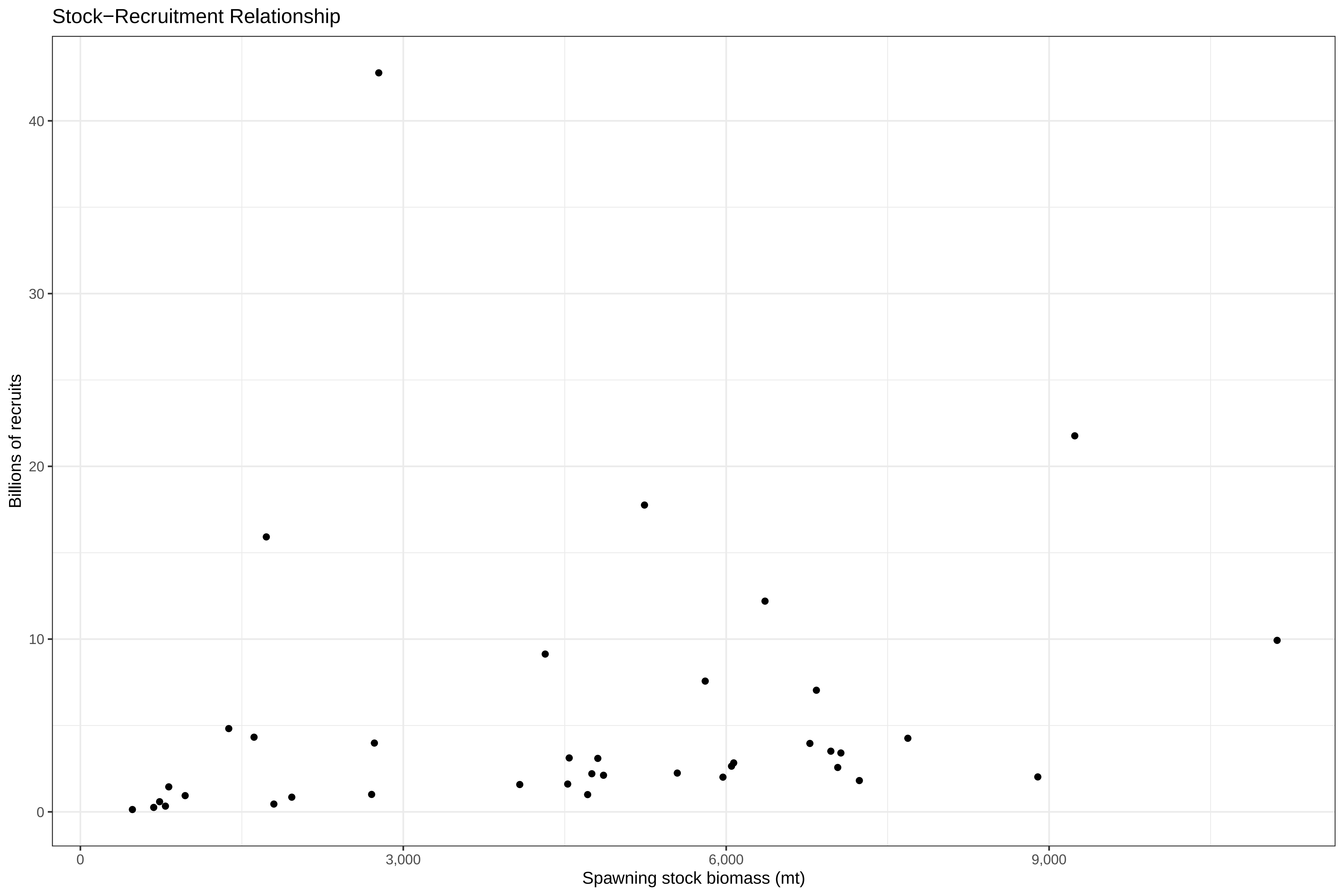
Recruitment
Recruitment
(billions of shrimp)
50
40
30
20
10
0
1985
1990
1995
2000
2005
2010
2015
2020
Year



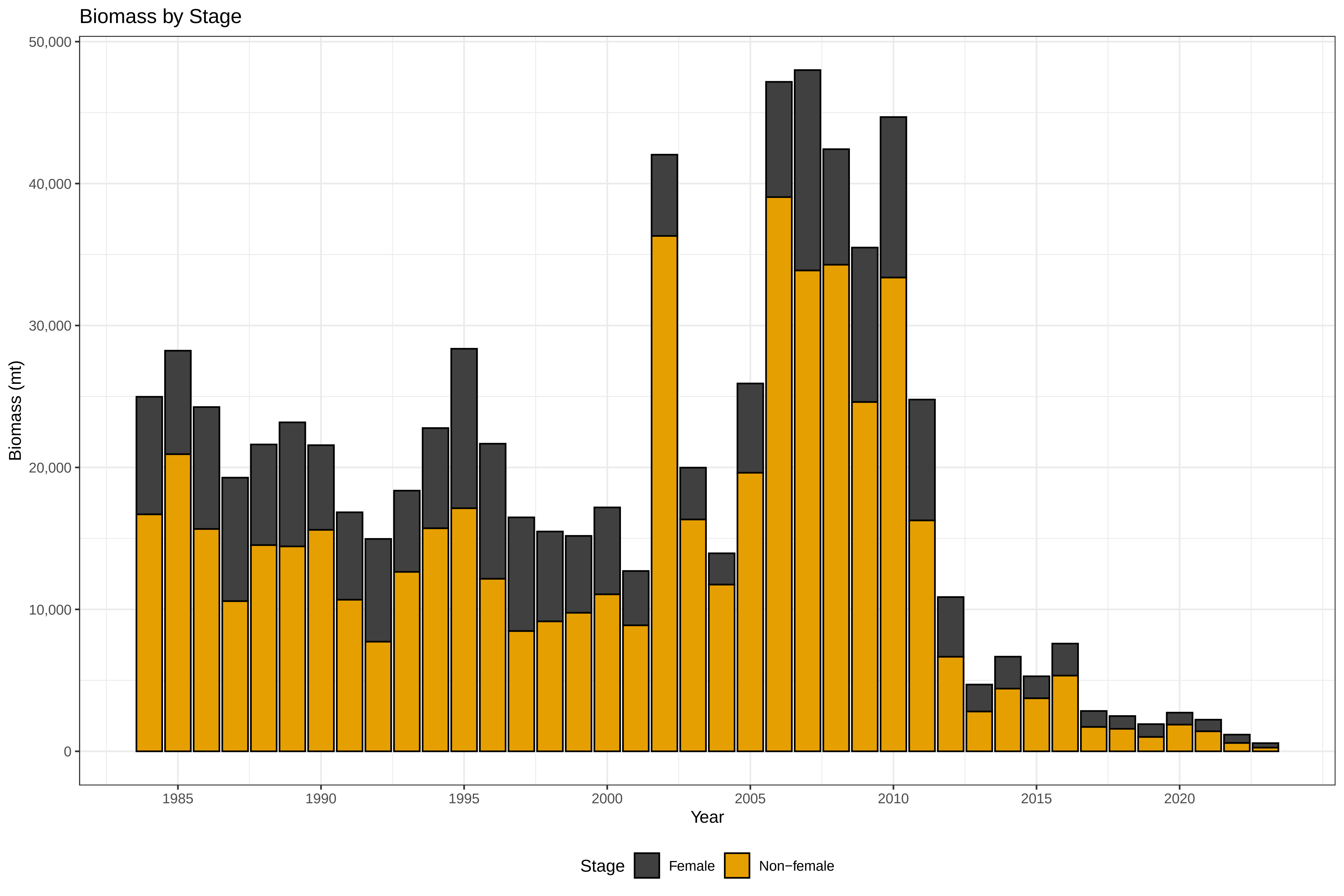
Annual estimated recruitment deviations
Recruitment deviations (log scale)
3
2
1
0
−1
−2
−3
1985
1990
1995
2000
2005
2010
2015
2020
Year



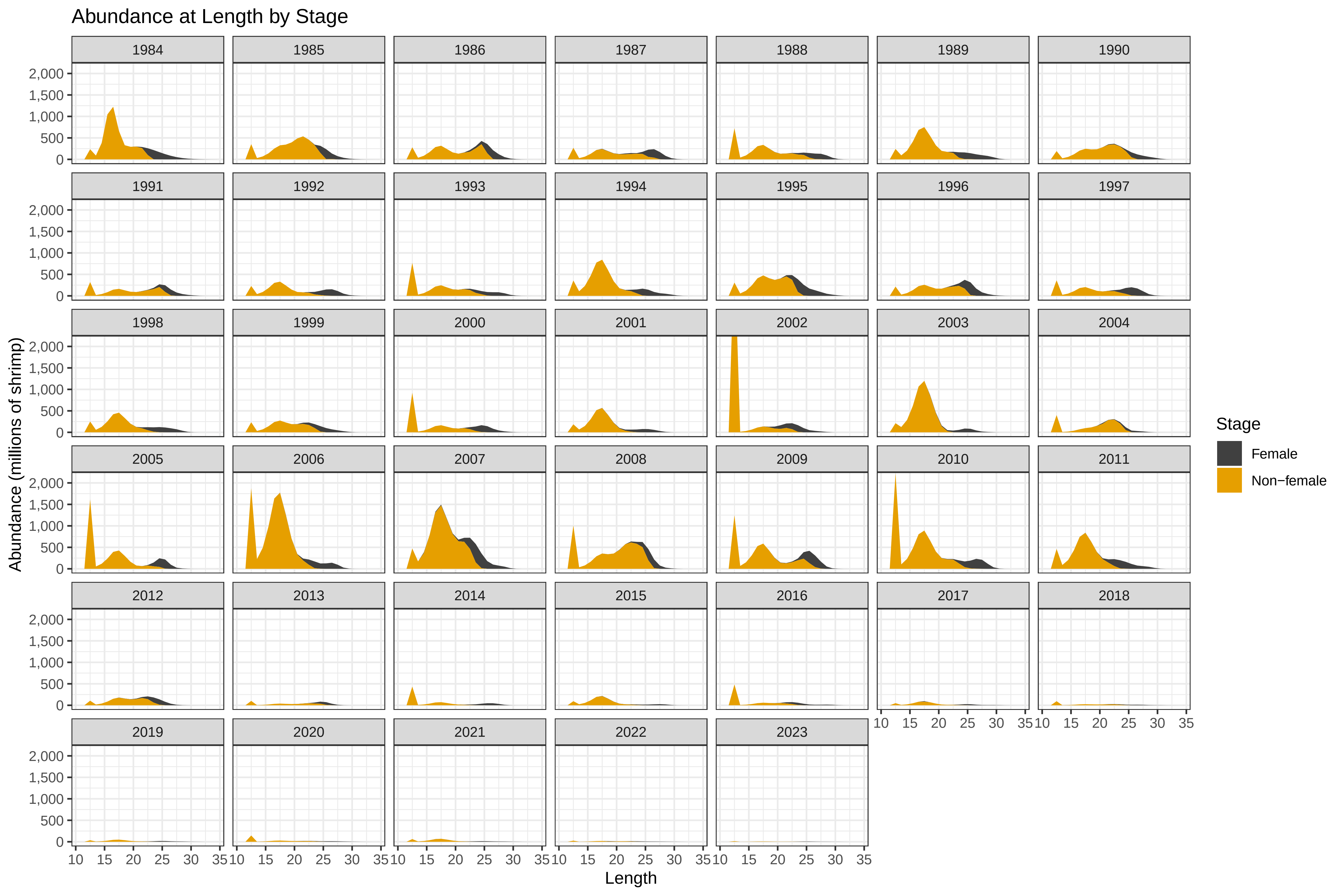
Spawning Stock Biomass
SSB (mt)
10,000
5,000
0
1985
1990
1995
2000
2005
2010
2015
2020
Year



Stock−Recruitment Relationship
Billions of recruits
0
10
20
30
40
0
3,000
6,000
9,000
Spawning stock biomass (mt)

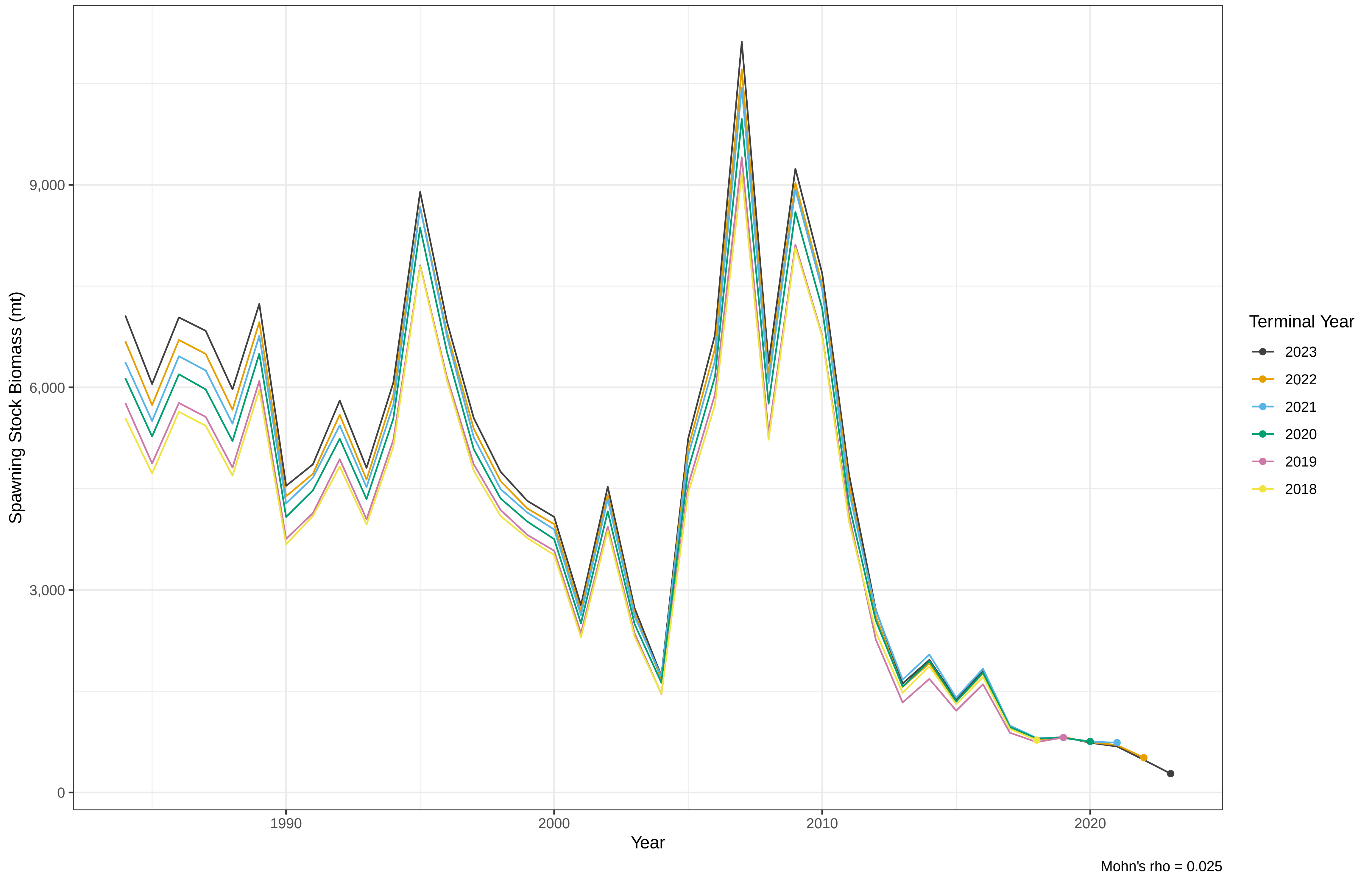


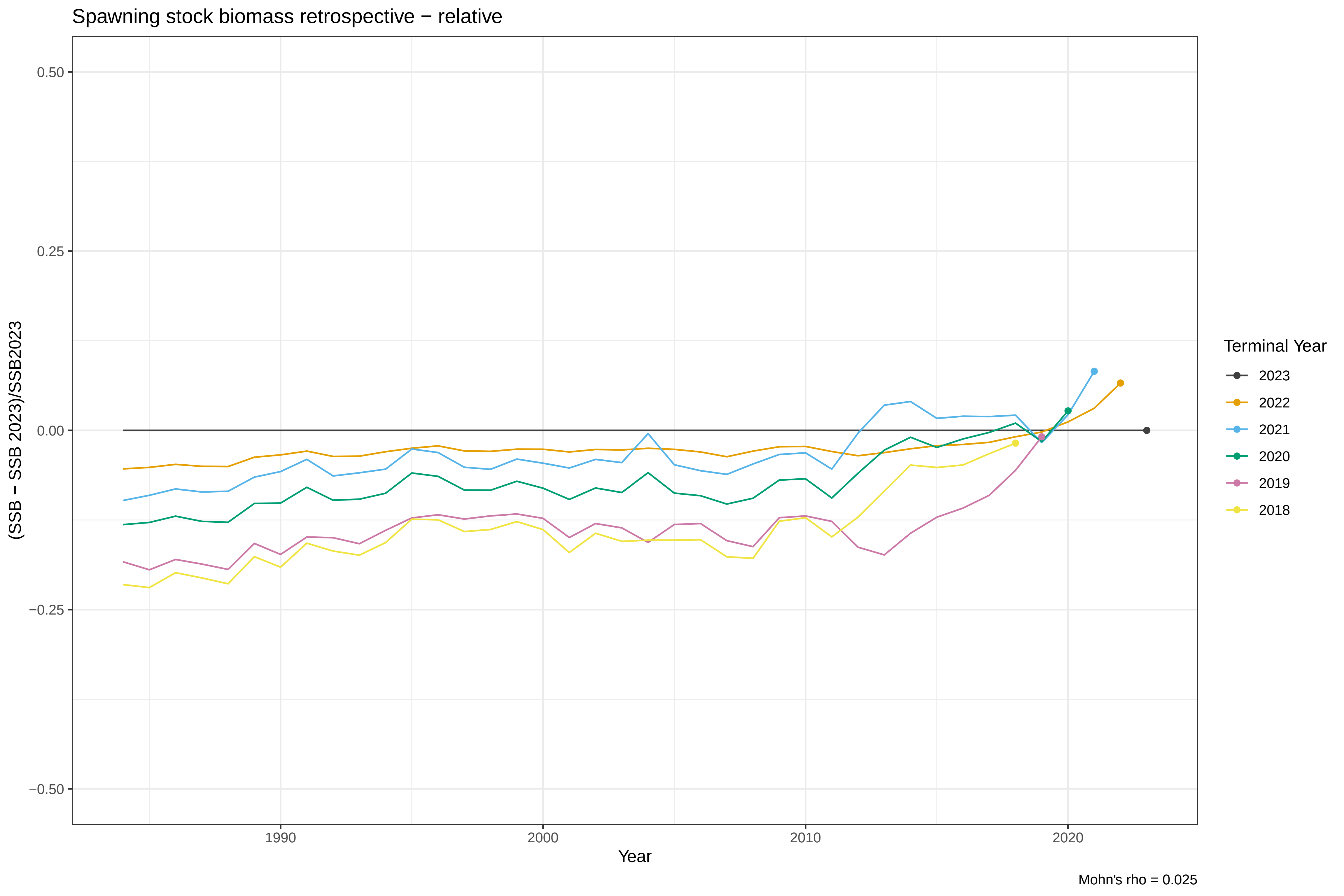
Biomass by Stage
Biomass (mt)
50,000
40,000
30,000
20,000
10,000
0
1985
1990
1995
2000
2005
2010
2015
2020
Year
Stage
Female
Non−female



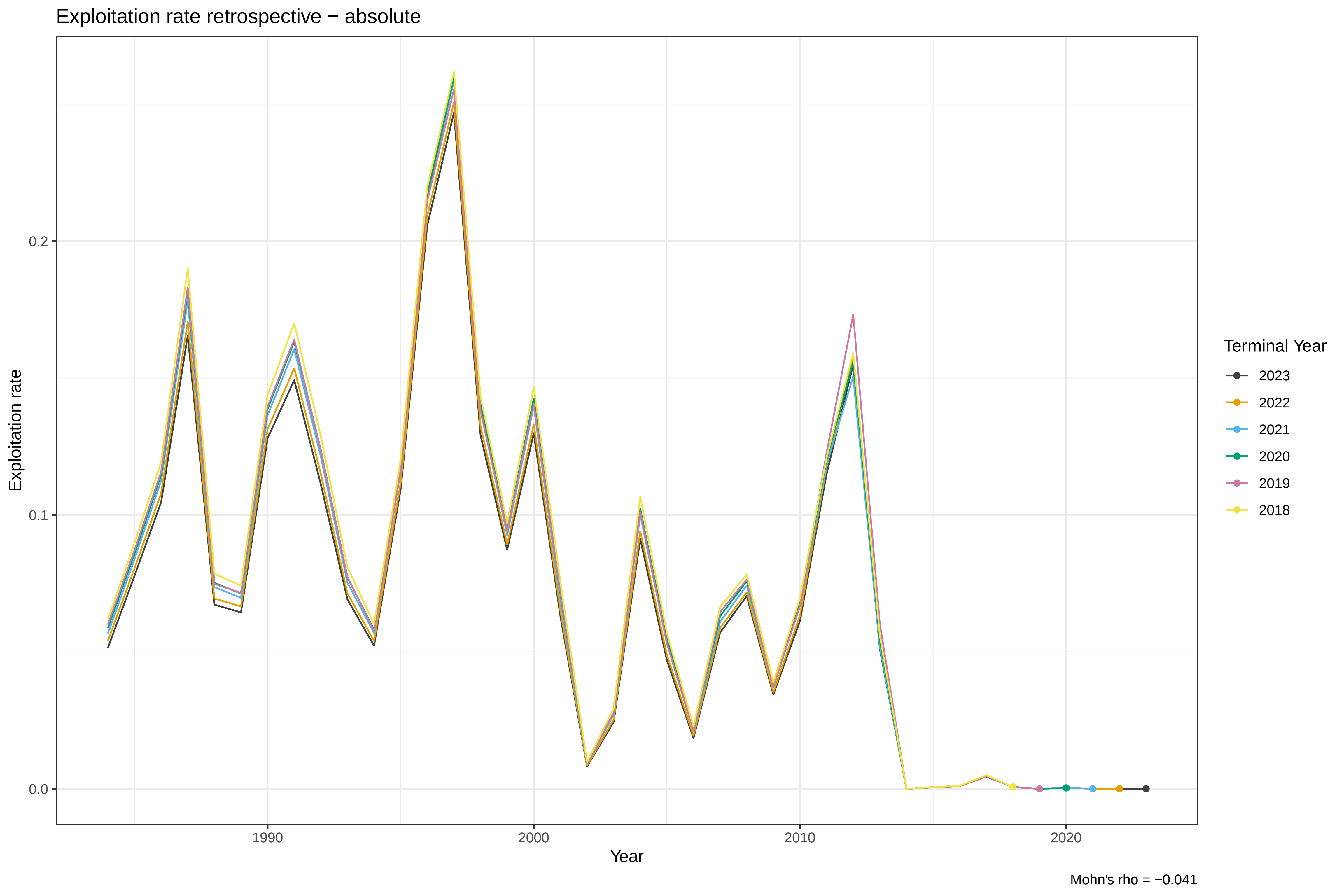
Abundance at Length by Stage
Abundance (millions of shrimp)
Length
Stage
Female
Non−female
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
0
500
1,000
1,500
2,000
10
15
20
25
30
35

Spawning stock biomass retrospective − absolute



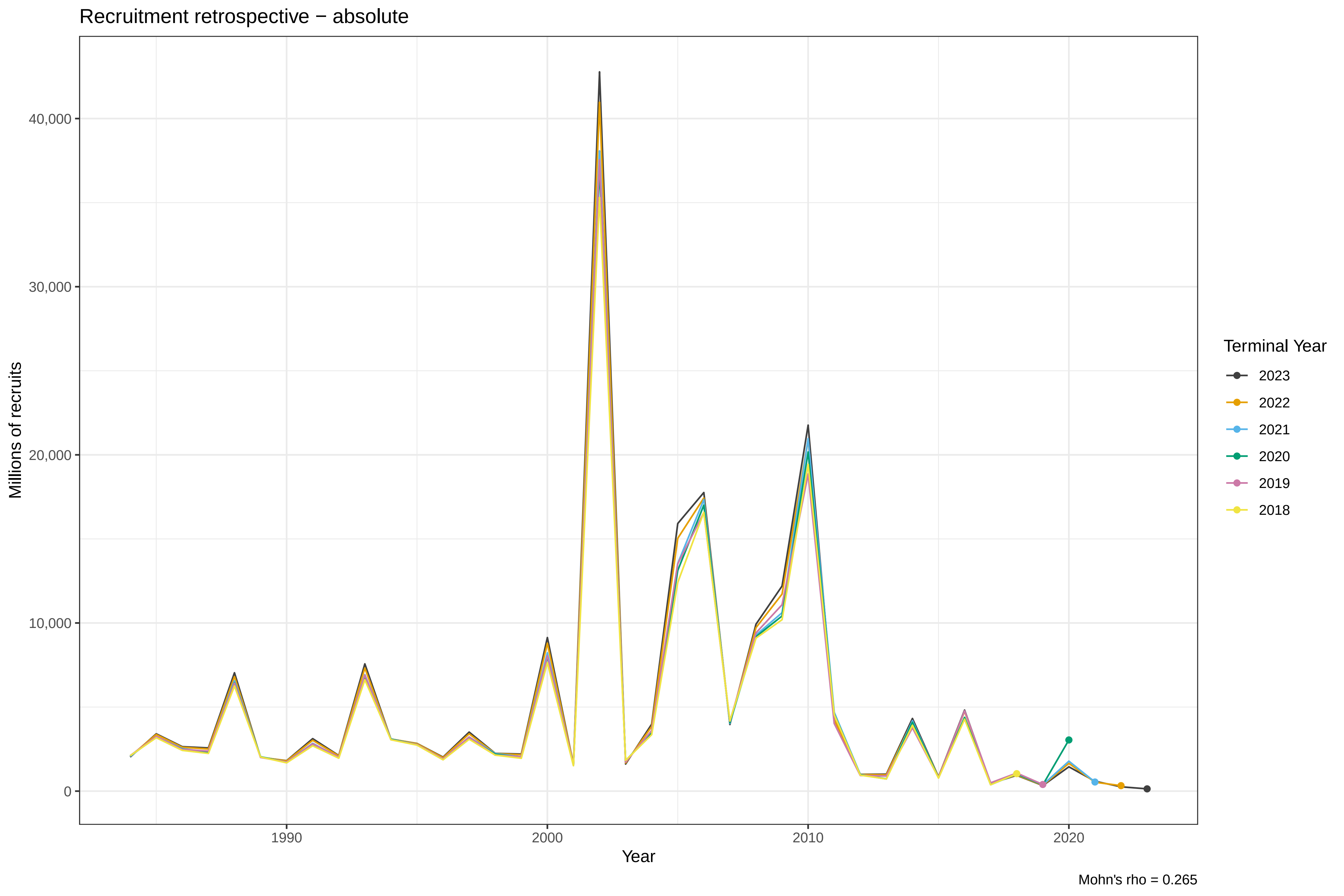


Spawning stock biomass retrospective − relative
(SSB − SSB 2023)/SSB2023
0.50
0.25
0.00
−0.25
−0.50
1990
2000
2010
2020
Year
Terminal Year
2023
2022
2021
2020
2019
2018
Mohn's rho = 0.025

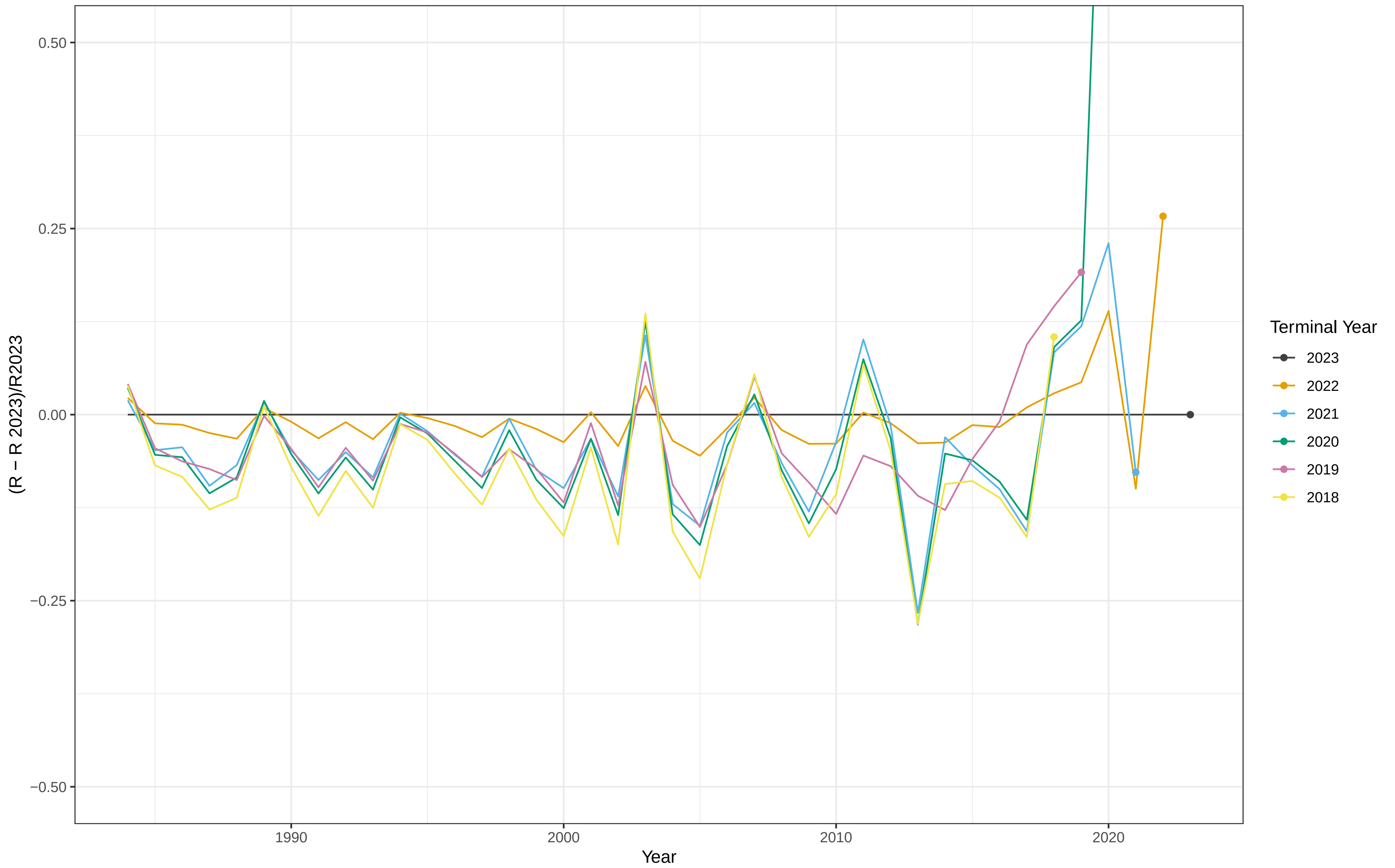


Exploitation rate retrospective − absolute
Exploitation rate
0.0
0.1
0.2
1990
2000
2010
2020
Year
Terminal Year
2023
2022
2021
2020
2019
2018
Mohn's rho = −0.041

Exploitation rate retrospective − relative
0.50
0.25
0.00
−0.25
−0.50
(u − u 2023)/u2023
1990
2000
2010
2020
Year
Terminal Year
2023
2022
2021
2020
2019
2018
Mohn's rho = −0.041


Recruitment retrospective − absolute
Millions of recruits
40,000
30,000
20,000
10,000
0
1990
2000
2010
2020
Year
Terminal Year
2023
2022
2021
2020
2019
2018
Mohn's rho = 0.265

Recruitment retrospective − relative



Mohn's rho = 0.265

Atlantic States Marine Fisheries Commission

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703.842.0740 • www.asmfc.org

MEMORANDUM

TO: **Northern Shrimp Section**

FROM: **Northern Shrimp Technical Committee**

DATE: **November 29, 2024**

SUBJECT: **2025 Pilot Winter Sampling Program Proposal**

I. Introduction

In September 2024, the Northern Shrimp Section (Section) tasked the Northern Shrimp Technical Committee (TC) to develop a pilot winter sampling program and associated research set-aside (RSA) quota options for implementation in early 2025. As a second priority task, the Section tasked the TC to investigate the potential for an industry-based summer shrimp survey and effort required of participants, which will be discussed by the TC in 2025.

The TC met three times between September and December 2024 to complete the 2024 stock assessment update for northern shrimp and develop the pilot winter sampling program and RSA quota options for Section consideration. The winter sampling program proposal and RSA recommendations are outlined in detail below. RSA quota recommendations were derived using results from the 2024 stock assessment update for northern shrimp.

II. Program Structure

The most recent research fishery for northern shrimp in the Gulf of Maine ran from 2014 through 2017. The purpose of this program was to collect samples similar to those that might have been collected from commercial shrimp catches if there had been a fishery. These samples were used to continue the TC's time series of samples from Gulf of Maine northern shrimp fishery catches and estimate the timing of egg hatch.

The TC's proposal for the 2025 pilot winter sampling program will operate similarly to the 2014-2017 research fishery. However, the 2025 pilot program will not seek to collect information on egg hatch timing to provide more flexibility for program participants. Additionally, the 2025 winter sampling program will not receive funding from the Atlantic States Marine Fisheries Commission (Commission) or the states, and will be entirely self-funded by industry participants. To encourage participation, participants shall be able to sell research catch.

Location and Participant Selection

Industry members from the states of Maine and Massachusetts have expressed interest in participation in a pilot winter sampling program. Based on this interest, the TC recommends using the same locations and participant selection criteria from the previous research fishery.

During the 2014-2017 research fishery, four regions were chosen for a majority of years, and the TC recommends continuing these regions in 2025 with 1-2 trawlers assigned to each region, pending interest in the sampling program. States soliciting participants should include a question regarding participant interest and flexibility in sampling locations in their requests for proposals. The four recommended regions include: Massachusetts-New Hampshire, Western Maine (Kittery to Phippsburg), Midcoast Maine (Phippsburg to Monhegan Island), and Eastern Maine (east of Monhegan Island). The Northern Shrimp Advisory Panel (AP) will be consulted regarding these regions prior to the Section meeting on December 12.

Selected trawl participants should have demonstrated expertise fishing for shrimp and should maintain the use of size sorting grates congruent with Amendment 3 requirements. During each trip, the captain should attempt to fish in locations in which he/she would normally fish for shrimp. For each tow, the captain must record the date, the tow number (1,2,3 etc.), the GPS coordinates of the tow, the tow start time, the tow duration (hours and minutes), the depth (fathoms), a description of the size-sorting grate if any, and an estimate of the number of pounds of shrimp caught. Any additional spatial data provided by vessels equipped with more advanced monitoring technology is beneficial to the TC, but not a requirement of the program.

For trappers, the TC recommends selection of 1-4 trappers, consistent with the most recent 2014-2017 research fishery.

For participants in Maine, the Maine Department of Marine Resources will solicit from the industry individuals interested in joining. Selected individuals will be included on a special license to fish for northern shrimp as part of the pilot winter sampling program. Work on the special license is currently in progress and will be completed once participants are selected.

Timeline, Trip Limits, and Trap Limits

The pilot winter sampling program is intended to run from January through March, 2025, or until the RSA quota is reached, whichever is sooner. Trip limits, trap limits, and number of traps per participant are not able to be established at this time. Once the Section selects an RSA quota, the TC will discuss corresponding trip/trap limit values that will aid in effort distribution over the research fishing season. Additionally, as this program will be self-funded by industry, the AP will discuss trip/trap limits at their December 12 meeting to help inform an appropriate trip/trap limit which allows for industry participation wile not endangering exceedance of the RSA quota.

III. Research Set Aside Quota Options

In December 2024, a stock assessment update was completed for the northern shrimp stock in the Gulf of Maine. The assessment update included new data compiled since 2021 and found no improvement in stock status as illustrated by both the traffic light analyses and the catch-at-length model. Long- and short-term projections were run, and form the basis of the TC's Research Set Aside (RSA) quota options.

Projections for northern shrimp indicate under no fishing mortality, the stock is expected to decline further from 2023 levels. However, research catch levels of 0.5-3.2 mt had minimal effect on median spawning stock biomass (SSB). Under these scenarios, median SSB was less than 1% lower than the scenario with no fishing mortality. Research catch levels of 6.7 mt resulted in median SSB just over 1% lower than the scenario with no fishing mortality at 1.6%. Under the maximum RSA quota from the 2014-2017 research fishery, 53 mt, median SSB was projected to be 13% lower than the no fishing scenario.

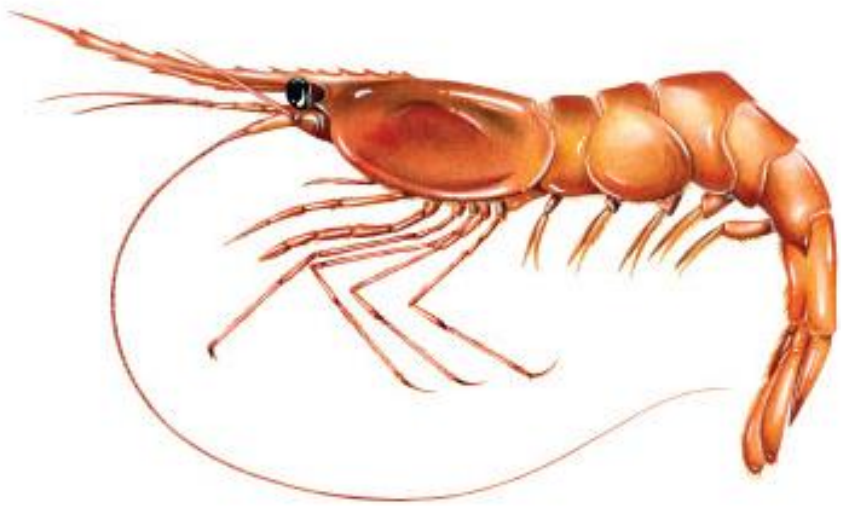
Given this information and the projections highlighted in Table 1, the TC recommends an RSA quota between 0 and 6.7 mt to balance catch incentive for industry and SSB impact.

Table 1. Projected catch and SSB in 2025 from the UME model under different *F* scenarios using recent M and recent recruitment. Source: 2024 Stock Assessment Update for Northern Shrimp.

Year	F Rate	Catch	Probability SSB_{2025} > SSB_{2023}	SSB (mt)	Change in SSB from 2023	Change in SSB_{2025} Compared to F=0
2025	F = 0	0 mt (0 lbs)	0%	127.4	-54%	--
2025	F = 0.01	0.5 mt (1,120 lbs)	0%	127.2	-54%	-0.2%
2025	F = 0.03	3.2 mt (7,092 lbs)	0%	126.5	-55%	-0.7%
2025	F = 0.07	6.7 mt (14,755 lbs)	0%	125.4	-55%	-1.6%
2025	F = 0.14	13.8 mt (30,408 lbs)	0%	123.4	-56%	-3.1%
2025	F = 0.36	32.5 mt (71,699 lbs)	0%	117.6	-58%	-7.6%
2025	F = 0.63	53 mt (116,881 lbs)	0%	110.6	-60%	-13.1%

Atlantic States Marine Fisheries Commission

Draft Amendment 4 to the Interstate Fishery Management Plan for Northern Shrimp



This draft document was developed for Northern Shrimp Section review and discussion. This document is not intended to solicit public comment as part of the Commission/State formal public input process. Comments on this draft document may be given at the appropriate time on the agenda during the scheduled meeting. If approved, a public comment period will be established to solicit input on the issues contained in the document.

December 2024

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Draft Amendment 4 to the Interstate Fishery Management Plan for Northern Shrimp

Prepared by

Atlantic States Marine Fisheries Commission
Northern Shrimp Plan Development Team

Plan Development Team Members:
Lulu Bates, Maine Department of Marine Resources
Robert Atwood, New Hampshire Fish and Game Department
Kelly Whitmore, Massachusetts Division of Marine Fisheries
Katie Drew, Atlantic States Marine Fisheries Commission
Chelsea Tuohy (Chair), Atlantic States Marine Fisheries Commission

Public Comment Process and Proposed Timeline

The Atlantic States Marine Fisheries Commission seeks your input on Draft Amendment 4 to the Northern Shrimp Fishery Management Plan.

The public is encouraged to submit comments regarding this document during the public comment period. Comments must be received by **11:59 (EST) on Month Day, Year.** Regardless of when they were sent, comments received after that time will not be included in the official record. The Northern Shrimp Section (Section) will consider public comment on this document before finalizing Amendment 4. While the Section welcomes comment on all parts of the document, public consideration and comment is specifically sought on the proposed alternative management options included in ***Sections 4.1.1, 4.1.3, 4.1.13, and 4.5.2.2***.

You may submit public comment by attending a public hearing held in your state or jurisdiction or mailing, faxing, or emailing written comments to the address below. Comments can also be referred to your state's members on the Northern Shrimp Section or Northern Shrimp Advisory Panel; however, only comments received at a public hearing or written comments submitted to the Commission will become part of the public comment record.

Mail: Chelsea Tuohy
FMP Coordinator
Atlantic States Marine Fisheries Commission
1050 North Highland Street, Suite 200 A-N
Arlington, VA 22201

Email: comments@asmfc.org
Subject line: Northern Shrimp Draft Amendment 4
Phone: (703) 842-0740

Commission's Process and Timeline

Fall 2024	Draft Amendment for Public Comment Developed
December 2024	Section Reviews Draft Amendment and Considers its Approval for Public Comment
Winter 2025 - Spring 2025	**Section Solicits Public Comment and States Conduct Public Hearings**
Spring 2025	Section Reviews Public Comment, Selects Management Options, and Considers Final Approval of Amendment 4
Spring 2025	Commission Considers Final Approval of Amendment 4
TBD	Provisions of Amendment 4 are Implemented

Executive Summary

[*To be completed following final approval*]

Draft document for Section review. Not for public comment.

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1.0 INTRODUCTION

The Atlantic States Marine Fisheries Commission (Commission) is developing an amendment to its Interstate Fishery Management Plan (FMP) for Northern Shrimp under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA). The Commission, through the coastal states of Maine, New Hampshire, and Massachusetts is responsible for managing northern shrimp in the Gulf of Maine in state waters (0-3 miles from shore). Management authority in the Exclusive Economic Zone (EEZ, 3-200 miles from shore) lies with the Secretary of Commerce through ACFCMA in the absence of a federal fishery management plan. This amendment will completely replace Amendment 3 to the Northern Shrimp FMP and Addendum I to Amendment 3, if approved for management.

1.1 BACKGROUND INFORMATION

1.1.1 Statement of the Problem

Beginning with the 2014 season, the Northern Shrimp Section (Section) imposed a moratorium on the northern shrimp fishery. The Section considered several factors prior to closing the fishery. Results of the 2013 stock status report indicated the abundance and recruitment indices in the western Gulf of Maine had declined steadily since 2006, and 2012 and 2013 were the lowest on record. Furthermore, long term trends in environmental conditions have not been favorable for northern shrimp survival in the Gulf of Maine amplifying the need to conserve spawning stock biomass. Results of each subsequent stock status report since 2013 have indicated continued poor trends in biomass, recruitment, and environmental indices which prompted the Section to extend the moratorium each year through 2024.

The Gulf of Maine northern shrimp fishery is currently managed under Amendment 3 (2017) and Addendum I to Amendment 3 (2018). The original Fishery Management Plan (FMP) for Northern Shrimp (1986) established the requirement for northern shrimp fishing seasons to be set annually by the Section after considering recommendations from the Northern Shrimp Technical Committee (NSTC) and Northern Shrimp Advisory Panel (AP). Amendment 1 (2004) and subsequent amendments to the FMP made no changes to the annual specifications requirement, with Amendment 3 stating, “The Section has the ability to set a closed season annually up to 366 days (i.e., impose a moratorium)”. Based on the current requirements of the FMP, measures subject to annual specification may only be modified through an amendment to the FMP.

Each year, the NSTC conducts a data update to incorporate the most recent fishery independent surveys and environmental indices into the longstanding timeseries, to apprise managers and stakeholders of current stock trends. While this data update provides information on the condition of the stock and Gulf of Maine environment, it does not specify management response to changing conditions. Additionally, the ability to incorporate new data streams such as industry-based research into the annual data update is limited.

The continued poor condition of the northern shrimp stock including failed recruitment, the lowest abundance indices on record, and unfavorable environmental conditions have resulted in uncertainties in the future status of the northern shrimp resource. To address these uncertainties, an amendment to the FMP was initiated to consider implementation of lengthened specifications setting timelines for closed seasons, management triggers, and the addition of the specifications setting timeline to measures subject to change under adaptive management.

1.1.2 Benefits of Implementation

Draft Amendment 4 is designed to maintain an efficient management structure that is flexible and encourages public involvement in the management process. It provides mechanisms to improve the Section's ability to effectively respond to the status of the resource. Draft Amendment 4 includes options for increased specifications setting timelines for closed seasons, the addition of management triggers for response to stock monitoring, and the addition of the specifications setting timeline to measures subject to change under adaptive management. Specific benefits of these measures include greater flexibility for the Section given the persistent poor stock conditions, management response tied to definable biological and environmental metrics through the use of management triggers, and the ability to incorporate new data streams into the specifications process through a management trigger.

Sustaining the potential for a viable shrimp fishery benefits the region by helping maintain diversity in fishing opportunities and providing opportunities to harvest, process, and further support fishing communities throughout the Gulf of Maine. Ultimately, specific benefits associated with the amendment will vary depending upon the final measures selected by the Section.

1.1.3 Ecological Benefits

Northern shrimp is an important link in marine food chains, preying on both planktonic and benthic invertebrates, and are in turn consumed by many commercially important fish species, such as cod, redfish, silver and white hake, and longfin squid. Therefore, maintaining a healthy northern shrimp population will contribute to the Gulf of Maine ecosystem. Shrimp will continue to play a role in controlling the populations of its prey, while simultaneously providing fodder for carnivorous vertebrates throughout the Gulf. *Pandalus borealis* diet was well documented by Weinberg (1981). Many species prey on *P. borealis* as a component of their diet (Shumway et al. 1985; Worm and Myers 2003; Savenkoff et al. 2006). Over many years, Wigley, Langton and Bowman from NOAA Fisheries have conducted many predator-prey studies showing the importance of *P. borealis* in the food web of the Gulf of Maine. The consideration of additional regulatory measures, such as multi-year specifications for closed seasons and management triggers with biological and/or environmental indicators, may improve the monitoring of the population of northern shrimp and response to changing conditions.

1.2 DESCRIPTION OF THE RESOURCE

1.2.1 Northern Shrimp Life History

The biology of the genetic distinct northern shrimp population (Jorde et al. 2014) in the Gulf of Maine has been studied extensively (Apollonio and Dunton 1969; Apollonio et al. 1986; Haynes and Wigley 1969), and reviewed by Shumway et al. (1985) and Bergström (2000). The species are protandrous hermaphrodites, maturing first as male and then transitioning to female. Ocean temperature has an important influence on northern shrimp in the Gulf of Maine (Apollonio et al. 1986; Richards et al. 1996; Richards et al. 2012).

1.2.1.1 Age and Growth

There is considerable information on growth of the Gulf of Maine northern shrimp stocks (Haynes and Wigley 1969; Apollonio et al. 1986; Terceiro and Idoine 1990; and Fournier at al. 1991). Differences in size at age by area and season can be ascribed to temperature effects, with more rapid growth rates at higher temperatures (Apollonio et al. 1986). Differences in size at age from year to year, and in size at sex transition, have been attributed to both environmental and stock density effects (Koeller et al. 2000, Koeller et al. 2007).

1.2.1.2 Stock Structure, Spawning and Reproduction

The species develop first as males at roughly 2½ years of age and then pass through a series of transitional stages to mature into females at roughly 3½ years of age (Figure). Northern shrimp spawn in offshore waters beginning in late July. By early fall, most adult females extrude their eggs onto the abdomen. Egg bearing females move inshore in late autumn and winter, where the eggs hatch (Figure 2). Juveniles remain in coastal waters for a year or more before migrating to deeper offshore waters, where they mature as males. Some females may survive to repeat the spawning process in succeeding years, and may live to be five or perhaps six years old.

Recruitment of northern shrimp is related to both spawning biomass and ocean temperatures, with higher spawning biomass and colder temperatures producing stronger recruitment. Experiments have shown that increased water temperatures, such as the Gulf of Maine is experiencing (Figure 4), can negatively affect the incubation of eggs in ovigerous females resulting in poor egg survival, embryonic development and larval hatching (Brillon et al. 2005).

1.2.1.3 Mortality

The natural mortality rate (M) used in previous assessments for US Gulf of Maine northern shrimp assessments (M=0.25; NEFSC 2007) was one of the lowest approximations for northern shrimp in the North Atlantic. The 2018 benchmark assessment for northern shrimp explored both constant and time- and size varying M. The final model used time and length-varying M based on predation pressure indices (PPI) and baseline M=0.5, and included the NEFSC autumn surveys but did not include the ME-NH spring inshore survey. Using a length-varying M based on the weight of each length class allows for the accounting of smaller sizes of shrimp having a larger M than larger sizes.

Time-varying (annual) M was related to inter-annual variation in predation pressure on shrimp. A weighted index of predator biomass was developed from Northeast Fisheries Science Center (NEFSC) survey data, where the weights were the long-term average percent frequency of shrimp in each predator's diet estimated from food habits sampling (NEFSC 2014; Richards and Jacobson 2016). The time series of PPI were used to adjust an assumed baseline (average) M. The adjustment to M was proportional to the long-term average of the PPI, so that M was scaled up in years with above average PPI and down in years with below average PPI. NEFSC fall surveys were used to estimate predator biomass for all species except spiny dogfish, which is more reliably estimated from spring survey data.

1.2.1.4 Stock Assessment Summary

The first analytical assessment was completed in 1997 and peer-reviewed at the 25th Northeast Regional Stock Assessment Workshop (NEFSC 1997). In addition to previously used traditional methods of assessing the stock (i.e., landings data, commercial effort and CPUE estimates, indices of abundance, etc.) quantitative tools like the Collie-Sissenwine, or Catch-Survey Analysis (CSA), the ASPIC surplus production, and yield per recruit and eggs per recruit models were introduced and continued to be used to provide guidance for management of the stock.

Between the implementation of Amendment 1 in 2004 and Amendment 3 in 2017, stock status for northern shrimp in the Gulf of Maine had been determined via comparison of terminal year estimates of fishing mortality (F) and biomass (B) to F and B-based reference points (i.e., biological reference points, or BRPs). The BRPs defined in Amendment 2 (2011) were developed via the CSA assessment model (Cadrin et al 1999), which was peer-reviewed and accepted for management use in 2007, but was not approved for management use following the 2014 benchmark assessment. Amendment 2 continued to define the BRPs (and values) used to determine stock status for northern shrimp in the Gulf of Maine. Amendment 3 (2017) broadened the criteria for stock status determination using the best available science and provides a flexible TAC recommendation process for specifications.

The 2018 benchmark assessment investigated three models, with the preferred model being a statistical catch-at-length model (UME) developed by the University of Maine. This model divides the northern shrimp stock into size groups and tracks changes in the proportion of shrimp in each size group across seasons and years to estimate fishing mortality and population size. However, the northern shrimp stock assessment undergoes a formal scientific peer-review process (i.e., a benchmark) about every five years which may result in revised or different stock status determination criteria.

1.2.1.5 Fishery-Independent Data

Trends in abundance and recruitment, among other stock assessment variables (e.g., early life stage survival) have been monitored using various fishery independent surveys conducted in the Gulf of Maine including the Northeast Fisheries Science Center (NEFSC) autumn bottom trawl survey (since the late 1960's); the Maine-New Hampshire annual spring inshore trawl survey which has been collecting data in depths greater than 55 fathoms (100 m) since 2003 and have been used in shrimp assessment since 2008; the summer shrimp surveys conducted by the State of Maine (discontinued in 1983), and the ASMFC shrimp survey initiated by the NSTC in 1984 (summer shrimp survey) to specifically assess the shrimp resource in the western Gulf of Maine. The summer shrimp survey was coordinated by the NEFSC and conducted each summer aboard the *R/V Gloria Michelle*. The survey employed a stratified random sampling design and uses gear specifically designed for Gulf of Maine conditions. This survey was considered to provide the most reliable information available on abundance, distribution, population age structure, and other biological parameters of the Gulf of Maine northern shrimp resource (Tables 4-5 and Figure 3). However, in 2023, the summer shrimp survey was indefinitely postponed marking 2023 as the last year of the survey.

1.2.3 Present Condition of the Stock

The NSTC currently utilizes the UME model, approved for management use through the 2018 benchmark assessment and an index-based Strict Traffic Light Approach (STLA), developed by Caddy (1999*a*, 1999*b*, 2004) and extended by McDonough and Rickabaugh (2014), to assess stock status of Gulf of Maine northern shrimp (ASMFC 2018b). Stock assessment updates using the UME model occur approximately every four to five years while the NSTC completes the STLA annually.

The STLA categorizes annual values of each index as one of three colors (red, yellow, or green) to illustrate the state of the population, environmental conditions, and fishery. The greater the proportion of green or red in each stacked bar, the further that year's index is in a favorable or unfavorable direction, respectively. The NSTC has used the STLA to characterize a suite of fishery independent indices including total abundance and biomass estimated from the summer shrimp survey (discontinued in 2023) and NEFSC fall surveys, and harvestable biomass, spawning stock biomass, recruitment, and early life survival estimated from the summer shrimp survey; fishery dependent indices include commercial catch per unit effort (CPUE), price per pound, and annual landings value. Environmental indices include predation pressure on Gulf of Maine northern shrimp that was developed for the 2014 benchmark assessment (NEFSC 2014; Richards and Jacobson 2016, ASMFC 2018b), and several sources of temperature data for the northern shrimp resource area. Trends have been characterized from 1984 to present (Tables 3-5 and Figure 4).

The most recent stock assessment information for the stock, the 2024 stock assessment update, presented new data collected since the last assessment update in 2021. The 2024 assessment update found stock status for northern shrimp continues to be poor, as illustrated by both the traffic light analyses and the catch-at-length model. The 2023 summer survey indices of abundance, biomass, and recruitment were at time-series lows, and spawning stock biomass was the lowest in the 1984-2023 time-series. Additionally, environmental conditions continue to be unfavorable for northern shrimp in the Gulf of Maine. The predation pressure index spiked in 2021 compared to 2017-2019, and declined to just above the 80th percentile of the reference time period in 2023. Spring bottom temperatures and winter sea surface temperatures declined somewhat in 2023, but were still above the 80th percentile threshold.

Spawning stock biomass in 2024 was estimated to be at 279 mt, the lowest in the time-series and well below the time-series median of 4,732 mt. Recruitment also remained low for 2022-2023, a continuation of the series of below-average year classes for the last ten years. Model bias, illustrated by retrospective patterns, was small. After 2015, SSB was overestimated in some years and the exploitation rate was underestimated. Recruitment was consistently overestimated in the terminal year.

Long- and short-term stock projection results varied depending on assumptions about future natural mortality and recruitment levels, as well as fishing mortality. Under the recent unfavorable levels of natural mortality and recruitment, spawning stock biomass was projected to decline from 2023 levels and stabilize at an SSB level of 263 mt in the long-term. If both recruitment and natural mortality returned to their long-term values, the population would recover to 2,897 mt, still below the long-term median population size.

1.2.3.1 *Peer Review Panel Results from the 2018 Benchmark Assessment*

The 2018 benchmark assessment peer review occurred through an Atlantic States Marine Fisheries Commission (Commission) external peer review process. The Commission coordinated a Peer Review Workshop for the Northern Shrimp Assessment on August 14-16, 2018. Participants included members of the Northern Shrimp Stock Assessment Subcommittee and a Review Panel consisting of three reviewers appointed by the Commission. The Review Panel found the following research recommendations, provided by the TC, appropriate and effectively prioritized:

Fishery-Dependent Priorities

- Evaluate selectivity of shrimp by traps and trawls *(high priority, short term)*
- Continue sampling of the northern shrimp commercial fishery, including port, sea, and RSA sampling to confirm, and if necessary update, the length-frequency of the species and identify any bycatch in the fishery *(high priority, long term)*
- Conduct a study comparing the effectiveness of the compound grate versus the double-Nordmore grate *(moderate priority, short term)*

Fishery-Independent Priorities

- Continuing sampling through summer shrimp survey despite the current low abundance of shrimp and the closure of the shrimp fishery in 2013 *(high priority, long term)*
- Explore ways to sample age 1 and younger shrimp *(moderate priority, short term)*

Modeling/Quantitative Priorities

- Continue research to refine annual estimates of consumption by predators, and include in models as appropriate *(high priority, short term)*
- Investigate growth parameters for the UME length-based model and the feasibility of adding a spatial-temporal structure to the model framework *(moderate priority, long term)*

Life History, Biological, and Habitat Priorities

- Investigate application of newly developed direct ageing methods to ground truth assumed ages based on size and stage compositions *(high priority, long term)*
- Evaluate larval and adult survival and growth, including frequency of molting and variation in growth rates, as a function of environmental factors and population density *(high priority, long term)*
- Study the effects of oceanographic and climatic variation (i.e., North Atlantic Oscillation) on the cold water refuges for shrimp in the Gulf of Maine *(high priority, long term)*
- Explore the mechanisms behind the stock-recruitment and temperature relationship for Gulf of Maine northern shrimp *(high priority, long term)*

Timing of Assessment Updates and Next Benchmark Assessment
The NSTC recommends that the assessment be updated annually to incorporate the most up-to-date data on abundance and recruitment into management recommendations. A benchmark assessment should be considered in five years if improvements in the length-based model or significant changes in the population warrant it.

1.3 DESCRIPTION OF THE FISHERY

1.3.1 Commercial Fishery

Northern shrimp occur in boreal and sub-arctic waters throughout the North Atlantic and North Pacific, where they support important commercial fisheries. In the western North Atlantic, commercial concentrations occur off Greenland, Labrador, and Newfoundland, in the Gulf of St. Lawrence, and on the Scotian Shelf. The Gulf of Maine marks the southernmost extent of its Atlantic range. Primary concentrations occur in the western Gulf where bottom temperatures are coldest. In summer, adults are most common at depths of 90-120 meters (Haynes and Wigley, 1969).

The fishery has been seasonal in nature, peaking in late winter when egg-bearing females move into inshore waters and terminating in spring under a regulatory closure. Table 1 identifies the season length and regulations for the northern shrimp fishery since 1973. Northern shrimp has been an accessible and important resource to fishermen working inshore areas in smaller vessels who otherwise have few options due to seasonal changes in availability of groundfish, lobsters and other species.

The fishery formally began in 1938, and during the 1940s and 1950s almost all of the landings were by Maine vessels from Portland and smaller Maine ports further east. This was an inshore winter fishery, directed towards egg-bearing females in inshore waters (Scattergood 1952). Landings reached a peak of 255 tons in 1945, but then declined into the 1950s and during 1954-1957 no commercial landings of shrimp were recorded (Apollonio et al. 1986).

In the late 1950s, the fishery began to recover due to the efforts of commercial interests in Portland, Maine, and presumably to improving resource conditions. Landings (Table 2) increased to a peak of 12,800 tons in 1969, of which 11,000 tons were taken by Maine vessels.

New Hampshire vessels entered the fishery in 1966, but throughout the 1960s and 1970s New Hampshire landings were less than 100 mt. Landings by Massachusetts vessels were insignificant until 1969, but in the early 1970s the fishery developed rapidly, with landings increasing from 14% of the total catch to about 40% in 1973-1975. In contrast to the historical wintertime Maine fishery, these vessels fished continually throughout the year and made significant catches during summer months. Total landings averaged 11,000 tons from 1970-1972 and then declined rapidly until 1977 when only 400 tons were landed. The fishery was closed from mid-May of 1977 to February 1979.

Between 1980 and 1998, landings and effort recovered, and then fluctuated considerably in response to recruitment from several strong year classes, varying from 2,100 tons in 1993 to 9,500 tons in 1996. In keeping with historic trends, the majority of the catch from 1985 through 1998 had been taken by Maine vessels (77%), with Massachusetts vessels accounting for most of the remainder (15%). Numbers of participating vessels fluctuated considerably, switching to shrimp trawling if the season's length, shrimp's price and accessibility warranted the effort. After 1998, landings declined, reaching a low of 450 tons in 2002, due to stock declines and management actions (shorter fishing seasons). Landings then increased steadily, peaking at 6,400 tons in 2011. Maine boats landed 87%, Massachusetts 3% and New Hampshire 10% of this total. After 2011, landings declined and the fishery was closed after the 2013 season and has not reopened, except for small research fisheries in 2014 through 2017.

Size composition collected from catches since the early 1980s indicate that trends in landings have been determined primarily by recruitment of strong year classes. According to the recruitment index from the summer shrimp survey, strong year classes include those assumed to have been hatched in 1987, 1992, 2001, 2004, and 2007-2009, which were above the 80th percentile of recruitment for the stable period (1984-2017). Conversely, the summer survey recruitment index was below the 20th percentile of the stable period for 9 of the last 11 years where data were available. The most recent three years of data (2021-2023) report time series lows for recruitment indices for the Gulf of Maine shrimp stock.

A wide variety of vessels have been used in the fishery (Bruce 1971; Wigley 1973). The predominant type during the 1960s and 1970s appears to have been side-rigged trawlers in the 14-23 m range. During the 1980s and 1990s, side trawlers either re-rigged to stern trawling, or retired from the fleet. Recently, the shrimp fleet was comprised of lobster vessels in the 9-14 m range that seasonally rig for shrimp fishing, small to mid-sized stern trawlers in the 12-17 m range, and larger trawlers primarily in the 17-24 m range. Otter trawl remains the primary gear employed and is typically chain or roller-rigged, depending on area and bottom fished. There has been a trend in recent years towards the use of heavier, larger roller and/or rockhopper gear. These innovations, in concert with substantial improvements in electronic equipment, have allowed for much more accurate positioning and towing in formerly unfishable grounds, thus greatly increasing the fishing power of the Gulf of Maine fleet.

A shrimp pot fishery has existed in mid-coastal Maine since the 1970s, where in many areas bottom topography provides favorable shrimp habitat that might be too rough or restricted for trawling. The trapped product is of good quality, as the traps target only female shrimp once they have migrated inshore. Maine trappers land fewer small shrimp, and generally are more apt to catch females after egg hatch, than trawlers (ASMFC 2010). As the trap fishery is dependent on the availability of shrimp in a specific area, there is a shorter season for traps than for trawlers. The majority of the shrimp trappers also catch lobster, so shrimp is a supplemental portion of their annual production and income. Maine trapping operations accounted for 4% to 8% of the state's trips from 1987 to 1994 (ASMFC 2000). There is some indication that trap fishing for shrimp has grown in areas such as South Bristol and Boothbay Harbor (mid-coast Maine). According to federal and state of Maine Vessel Trip Reports (VTRs), trappers averaged 12% of Maine's landings during 2001 to 2007, 18% during 2008 to 2011, 9% in 2012, and 6% in 2013 before the fishery closed in 2014. Trapping effort had also been increasing around that time, accounting for 21% of Maine's landings in 2010, but may have been lower relative to trawling in 2011 (17%) and 2012 (9%) because of the early closure of the seasons (ASMFC 2013).

Currently, if the fishery is open, the Section implements a combination of effort controls including trip limits, trap limits, and days out of the fishery to manage the commercial fishery. The FMP also allows for a research set-aside program (RSA), mandatory reporting requirements integrated through the coastwide Atlantic Coastal Cooperative Statistics Program's (ACCSP) Standard Atlantic Fisheries Information System (SAFIS), and allocation of the total allowable catch (TAC) by gear type, if desired by the state. States may determine any gear-specific allocations between the trawl and trap fisheries. The state may also choose not to divide its quota between gear types. This determination by the state can occur after the annual TAC has been set.

1.3.2 Recreational Fishery

A very limited recreational fishery exists for northern shrimp. This fishery, using traps, has been for personal use and has not been licensed.

1.3.3 Subsistence Fishing

No significant subsistence fisheries for northern shrimp have been identified at this time; however, fishermen reportedly harvested 10 or 20 pounds of shrimp for personal consumption or non-sale distribution on a regular basis prior to the 2014 moratorium.

1.3.4 Non-Consumptive Factors

Some Gulf of Maine shrimp processors have composted shrimp waste for use as garden fertilizer prior to the 2014 moratorium. There has also been experimentation in Canada with extracting chitin from shrimp for medical purposes, and in Norway with extracting carotenoids for salmon feed (Spencer Fuller, personal communication).

1.3.5 Interactions with Other Fisheries, Species, or Users

1.3.5.1 Other Species

Northern shrimp is an important link in marine food chains, preying on both plankton and benthic invertebrates and, in turn, being consumed by many commercially important fish species, such as cod, redfish, dogfish, silver and white hake, and longfin squid. *P. borealis* diet was well documented by Weinberg (1981). Species that include *P. borealis* in their diet are documented by many authors (Shumway et al. 1985; Worm and Myers 2003; Savenkoff et al. 2006; Link and Idoine 2009; Richards and Jacobson 2016; Richards and Hunter 2021). In 2021, Richards and Hunter documented time-series biomass highs for longfin squid and significant spatial overlap with northern shrimp. Evidence from this work suggests that that longfin squid predation on northern shrimp in 2012 likely significantly contributed to the northern shrimp population collapse in 2013.

1.3.5.2 Other Fisheries

In recent history, the northern shrimp fishery has been prosecuted in the winter months from December through May at a time when many other fishing activities in the Gulf of Maine are marginal or out of season.

Dunham and Mueller (1976) note that in response to shrimp harvest restrictions such as a closed season, most respondents indicated that they would fish for other species. Additionally, most would fish for species they typically target at other times of the year. This included lobster, scallop, or groundfish (mostly redfish, cod, and whiting). During the period this study took place, shrimp stock levels were extremely low, ultimately leading to the closure of the fishery in April 1977. Harvesters responded by spending more time prosecuting fisheries that they had historically participated in. This is indicated by notable increases in the landings for whiting and squid during the period.

Similarly, most shrimp harvesters today fish for other species during the year. However, the ability to switch between fisheries has decreased since the implementation of limited entry and effort restrictions in the northeast multispecies (groundfish) fishery, and Maine's lobster and scallop fisheries.

From a processor's standpoint, plants may switch between shrimp and lobster over the course of a year. However, the facilities and skills of the workers are specialized for the two species so switching can be expensive. Shrimp is highly perishable and proper handling is a requisite for a quality product.

The potential for interaction between mobile gear and fixed gear does exist. If the shrimp fishery begins in December or early January, coastal lobster harvesters have to remove their gear at the end of their season before the mobile gear vessels begin trawling for shrimp. In January through April, the fixed gear (traps) shrimp harvesters must be careful to avoid bottom where trawling gear is fished. Trap harvesters often set in and around hard bottom coves and holes where mobile gear can't reach. During the experimental shrimp fisheries in 2015 and

2016, participants reported an increase in the abundance of lobster gear in traditional shrimp trawl areas, as the lobster industry took advantage of the shrimp fishing moratorium to expand their winter range.

1.4 HABITAT CONSIDERATIONS

1.4.1 Habitat Important to the Stocks

1.4.1.1 *Description of the Habitat*

Northern shrimp has a discontinuous distribution throughout the North Atlantic, North Pacific, and Arctic Oceans. The Gulf of Maine marks the southern extent of this species' range. Water temperature, depth, and sediment type have all been cited as important factors governing shrimp distribution in the Gulf of Maine (Haynes and Wigley 1969; Apollonio et al. 1986; Clark et al. 1999).

1.4.1.1.1 Temperature

The most common temperature range for this species is 0-5˚C (Shumway et al. 1985), but adult northern shrimp have been reported to live in waters from 1.6˚C (Gorbunow 1934; Ingraham 1981) up to around 12˚C (Bjork 1913; Allen 1959), and larvae can tolerate temperatures up to at least 14˚C (Poulson 1946). During the spring, fall, and especially summer months, adult shrimp are most abundant in cold 4-6˚C waters found mainly in the deeper basins (90-180 m) in the southwestern Gulf of Maine (Haynes and Wigley 1969, Apollonio et al. 1986, Clark et al. 2000). Seasonal water temperatures in many areas of the Gulf of Maine regularly exceed the upper physiological limit for northern shrimp. In particular, available habitat is limited to the western region of the Gulf (west of 68˚W) where bottom topography and oceanographic conditions create submarine basins protected via thermal stratification from seasonal warming. In northeastern regions of the Gulf of Maine, bottom waters are not protected from seasonal warming due to continual mixing from intense tidal currents nearer the Bay of Fundy, and large shrimp populations do not persist.

Apollonio et al. (1986) suggest that the northern shrimp resource is expected to be unstable because it is at the southernmost extent of its Atlantic range and is susceptible to environmental influences. Dow (1977) found that abundance is higher with lower sea surface temperatures, and this relationship has since been corroborated by other authors, including Richards et al. (1996). While the manner by which temperature affects recruitment and abundance has not been precisely determined, record high sea surface temperatures during the early 1950s correlate with complete failure of the fishery from 1954-1957 (Clark et al. 2000). Conversely, the cold temperature years of the early to mid-1960s appear to have been very favorable for recruitment, with rapid increases in abundance and record landings from 1969-1972 (Clark et al. 2000). Determining the reason for collapse of the fishery during the 1970s is more problematic as it occurred during a period of warming temperatures combined with high and increasing levels of fishing mortality rate (Clark et al. 2000). In this case, overfishing has been strongly implicated for the collapse, but both factors were likely influential. During the next two decades, significant recruitment events have coincided with normal to below normal spring sea surface temperature anomalies. This stock appears to be one of the few for which previous relationships between environmental influences and abundance trends remained statistically significant when reexamined (Myers 1998). Richards et al. (2012) found an inverse relationship between temperature and recruitment between 1968 and 2011. Recruitment variability increased after 1999, coincident with a shift to a warmer temperature regime. Reproductive output (i.e. spawner biomass) and recruitment were positively correlated over the entire time series, but not related during the most recent and warmer period of 1999-2011. Richards and Hunter (2021) examined the collapse of the northern shrimp population in the Gulf of Maine, which experienced extreme high temperatures in 2012 and has been warmer on average since. They found that longfin squid (*Doryteuthis pealeii*), unlike other species in the Gulf of Maine, had a time-series biomass peak in 2012 and biomass has remained generally higher since. Longfin squid predation was likely a significant factor in the collapse of northern shrimp.

1.4.1.1.2 Salinity

Northern shrimp have a narrow salinity tolerance (stenohaline) and are restricted to water with moderately high salinities (Allen 1959). Their occurrence has been noted in waters with salinities ranging from a low of 23.4 up to 35.7 (Shumway et al. 1985). Given that average salinity values in the Gulf of Maine are within this range and well above the minimum (e.g., see 2001-2008 data in Deese-Riordan 2009), salinity is not likely to be a limiting factor in the distribution of the species.

1.4.1.1.3 Depth

Northern shrimp are found throughout the range of water depths occurring in the Gulf of Maine, from about 10 meters to over 300 meters (Haynes and Wigley 1969). For most of the year, juveniles and immature males occupy shallower, inshore waters and mature males and females occupy cooler, deeper offshore waters (Apollonio and Dunton 1969; Haynes and Wigley 1969, Apollonio et al. 1986). However, northern shrimp, particularly the females, undertake seasonal migrations related to temperature and their reproductive cycles.

In addition to age and seasonally correlated horizontal migrations, northern shrimp exhibit diel vertical migration in the water column. There is strong evidence that northern shrimp leave the bottom at night and distribute themselves throughout the water column, presumably to feed (Wollebaek 1903; Hjort and Ruud 1938; Barr 1970). Gut contents have been shown to include planktonic crustaceans (Horsted and Smidt 1956). In thermally stratified waters, northern shrimp will migrate up to, but not penetrate the thermocline (Apollonio and Dunton 1969). After spending the night dispersed in the water column, shrimp return to the bottom around dawn where they feed on a wide variety of soft bottom benthic invertebrates (Wienberg 1981).

1.4.1.1.4 Substrate

The winter fishery for northern shrimp extends as far south as the outer arm of Cape Cod and as far north as Jonesport, Maine (D. Schick, personal communication). Figure 5 shows the locations of these basins, mud vs. gravel and bedrock habitats, and average bottom temperatures.

Within its preferred temperature range, northern shrimp most commonly inhabit organic-rich, mud bottoms or near-bottom waters (Wollebaek 1908; Hjort and Rund 1938; Horsted and Smidt 1956; Warren and Sheldon 1968, Haynes and Wigley 1969, Clark et al. 1999). Examples include Cashes Basin, Scantum Basin (D. Schick, personal communication), and the region southeast of Mount Desert Island, Maine (Haynes and Wigley 1969). Anecdotal evidence also suggests there is small populations in deep, cold water pockets in Penobscot Bay (D. Schick, personal communication) and in the Sheepscot River (L. Watling, personal communication). During the winter and spring, when nearshore and offshore surface waters have cooled to the temperature range of shrimp, the amount of habitat available to adult shrimp increases.

Bigelow and Schroeder (1939) and Wigley (1960) found a direct correlation between shrimp abundance and sediment organic matter content, while Apollonio et al. (1986) argue that temperature, not benthic habitat type, is the most important factor driving the distributional patterns of shrimp.

However, shrimp is not limited to fine sediment substrate and have been observed on rocky substrates (Berkeley 1930; Balsiger 1981). Shrimp are also often associated with biotic or abiotic structures such as cerianthid anemone tubes (Langton and Uzmann 1989) and occasional boulders (D. Schick, personal communication).

1.4.1.1.5 Spawning Habitat

Northern shrimp populations in the Gulf of Maine comprise a single stock (Clark and Anthony 1981) that spawns in offshore waters beginning in late summer (Haynes and Wigley 1969). The precise locations of spawning grounds are not well documented, but it is reasonable to conclude that spawning occurs in offshore summer population centers in deep mud basins in the southwestern Gulf of Maine (Haynes and Wigley 1969; Apollonio et al. 1986). Ovigerous females remain in cold, stratified, bottom waters through the fall until nearshore waters have cooled at which time they begin an inshore migration to release their eggs (Haynes and Wigley 1969; Apollonio et al. 1986, Clark et al. 1999). Female shrimp are thus found in abundance in nearshore waters only during the late winter and spring when coastal waters are coldest (Clark et al. 1999). Inshore migration routes followed by the northern shrimp are not well known, but due to their well-established preference for organic-rich mud bottoms, it has been suggested that female shrimp probably move inshore over muddy substrates and are eventually concentrated in, but not limited to, mud-bottom channels nearshore (D. Schick, personal communication).

After their arrival in nearshore waters, the female shrimp's mature eggs begin to hatch. Hatching occurs as early as February and lasts through April (Haynes and Wigley 1969; Stickney and Perkins 1979), after which time female shrimp return to offshore waters in the western Gulf of Maine. The pelagic larvae are planktotrophic, feeding primarily on diatoms and zooplankton (Stickney 1980). A survey of larval shrimp distribution conducted by Apollonio and

Dunton (1969) showed that larvae were abundant almost exclusively within 10 miles of shore. Little is known about the vertical distribution of larval shrimp within the water column. While in the plankton, northern shrimp pass through six larval stages (Berkeley 1930; Stickney and Perkins 1979) before completing a final metamorphosis to a juvenile stage and settling to the bottom in nearshore waters after about 30 to 60 days (Rinaldo 1981). The timing of egg release and larval development rate are temperature-related, with colder water temperatures resulting in slower development (Allen 1959). Thus, the timing of egg release and length of pelagic larval stages may vary from year to year as a result of temperature fluctuations (Koeller et al. 2009).

1.4.1.1.6 Eggs and Larval Habitat

Koeller et al. (2009) suggested that the winter inshore migration of egg-bearing females in the Gulf of Maine may be a behavioral adaptation to delay egg development and bring hatching time closer to the time of spring phytoplankton bloom. While studies of several shrimp populations support the association between spring bloom and shrimp hatching period, there is not a match in the Gulf of Maine stock. Richards et al. (2016) compared shrimp survey and environmental data to elucidate potential mechanisms behind the relationship between cooler temperatures and better northern shrimp recruitment. Rather than assuming time periods important to larval survival, they used a rolling window analysis to reveal environmental conditions (sea surface temperature and/or chlorophyll-a) associated with hatch timing. Chlorophyll-a was negatively correlated with survival during a period about 40 days before median hatch, and again around the time of juvenile settlement. It did not appear that phytoplankton biomass was a controlling factor on survival during the study time series. Hatch period preceded the spring bloom by about two months, aligning more closely (although correlations were not statistically significant) with the smaller winter phytoplankton bloom. Sea surface temperature was negatively correlated with survival during final embryo maturation/early larval stages, and approximately two months after juvenile settlement on the seabed, i.e., lower temperatures were related to higher survival. While the causal mechanism between lower temperature and higher survival remains unclear, knowing the sensitive period should aid further studies. The first sea surface temperature correlation occurs during the coldest time of year, and the authors speculate that northern shrimp metabolism may be optimized for these low temperatures. The other sea surface temperature correlation occurs when bottom temperatures are higher, and the difference between sea surface temperatures and bottom temperatures approaches the annual maxima. Thus, lower than typical temperatures during the late summer, when shrimp are metabolically stressed, may increase survival in those years.

1.4.1.1.7 Juvenile Habitat

Regardless of the mechanisms that influence hatch success, by late summer, nearly all newly metamorphosed juveniles have settled to the bottom in relatively shallow, near-shore areas usually within 10 miles of the coast (Apollonio and Dunton 1969). These immature shrimp remain inshore for up to 20 months as they grow and develop into mature males (Apollonio and Dunton 1969). Relatively little is known about the distribution and habitat requirements of this life history stage. After as little as a year, some juveniles begin to migrate offshore to deeper waters. Eventually, all juveniles will migrate offshore where they will complete their development into mature males around 29-30 months old (Apollonio and Dunton 1969; Haynes and Wigley 1969). Their migration routes and factors triggering migration to deep, offshore, muddy basins are not well known.

1.4.1.2 *Identification and Distribution of Habitat Areas of Particular Concern*

Nearshore waters (out to 10 miles)
Nearshore waters provide habitat for the larval and juvenile stages of northern shrimp. The survival of these early life-history stages is essential to the success of the species. Nearshore habitats are impacted by a myriad of anthropogenic activities including coastal development, pollutant run-off, harbor dredging, etc. The effects of these and other human activities on habitat quality for larval and juvenile northern shrimp are not known at this time.

Deep, muddy basins in the southern region of the Gulf of Maine
Deep, muddy basins in the southwestern Gulf of Maine act as cold water refuges for adult shrimp during periods when most water in the Gulf reaches temperatures that are lethal to this arctic/sub-arctic species. Fluctuations in the oceanographic conditions due to the North Atlantic Oscillation, climate change, or other natural factors may cause warm water to intrude into some of the deep basins in the southwestern Gulf rendering this habitat unsuitable for shrimp and possibly resulting extirpation of local populations.

In addition to naturally occurring environmental changes, bottom otter trawls used to harvest groundfish can impact deep, muddy bottom habitats. Relative to shrimp trawl gear, groundfish trawls are typically fished at higher speeds, have longer sweeps, and may use larger rollers or rockhoppers. The use of mobile fishing gear has been shown to reduce structural complexity of bottom habitats (Auster et al. 1996, NEFMC 2011, and studies referenced therein). Reducing habitat structural complexity could potentially reduce the survival of adult shrimp, which may use biotic and abiotic structures on mud bottoms to avoid predation. Simpson and Watling (2006) suggested that seasonal trawling with shrimp gear on mud bottoms at approximately 100 m depth produced at least short-term changes (<3 months) in macrofaunal community structure, but did not appear to result in long-term cumulative changes.

1.4.1.3 *Present Conditions of Habitats and Habitat Areas of Particular Concern*

Near-shore waters
Near-shore habitats are impacted by a myriad of anthropogenic activities including coastal development, pollutant run-off, harbor dredging, and others. Because detailed maps of inshore habitats occupied by larval and juvenile shrimp are not available, it is not possible to identify the condition of, or specific anthropogenic threats to, these habitats.

Deep, muddy basins
The effects of temperature on shrimp abundance have long been a subject of study, however, more information is required before it is possible to predict the effect of large-scale climatic events (e.g., the North Atlantic oscillation or climate change) on the amount of suitable habitat available to adult shrimp. While the effects of mobile fishing gear on bottom habitats have

been a subject of study for over two decades; the long-term impacts of trawling on shrimp habitat in deep, muddy basins is not well understood.

1.4.1.4 *Ecosystem Considerations*

The Commission, NOAA Fisheries, and several Fishery Management Councils have been incorporating Ecosystem-Based Fisheries Management (EBFM) strategies into their fishery management programs. In general, EBFM strategies are adaptive management approaches that are specific to a geographic region, account for environmental influences and uncertainties, and strive to balance diverse ecological, social, and economic objectives.

By developing EBFM strategies, the Commission and its partner agencies are attempting to move beyond the traditional focus on single-species dynamics by considering environmental and human influences on fish populations and their sustainable harvest (e.g., multispecies interactions, climate change, and coastal development). EBFM strives to integrate ecological, social, and economic goals, and engage a diverse group of stakeholders to define problems and find solutions providing mutual benefit.

Although an EBFM strategy has not been developed for northern shrimp, its distribution throughout the Gulf of Maine and importance to the marine food web make it a good candidate for consideration (Link and Idoine 2009). Predator-prey interactions with several demersal finfish species (e.g., Atlantic cod, redfish) exist throughout the northern shrimp range (Worm and Myers 2003; Savenkoff et al. 2006). Given the data requirements necessary to incorporate multi-species interactions appropriately, it would be a challenge to use an EBFM strategy for northern shrimp. However, the Commission's Multispecies Technical Committee and Northern Shrimp Technical Committee continue to work on refining multi-species modeling approaches to be used in future assessments of managed species, including northern shrimp.

1.5 IMPACTS OF THE FISHERY MANAGEMENT PROGRAM

1.5.1 Biological and Environmental Impacts

Draft Amendment 4 provides an extensive list of management tools for managers to regulate the species in a biologically sustainable manner. Depending on the tool or combination of tools chosen, the action may have varying impacts on the Gulf of Maine northern shrimp stock.

Despite the number of tools available for management, the northern shrimp stock has remained in a moratorium each year since 2014 due to its depleted status. Additionally, the 2024 stock assessment update for the species indicated total abundance and spawning stock biomass for northern shrimp continued to decline in 2022-2023 and recruitment remained low from 2022-2023 (ASMFC 2024).

Given the continued poor condition of the stock and unfavorable environmental conditions for northern shrimp in the Gulf of Maine, Draft Amendment 4 provides options for a lengthened specifications setting timeline for closures, allowing managers to set closed seasons for more than one year at a time. In addition, Draft Amendment 4 provides options to change the specifications setting timeline in the future through an addendum to the Northern Shrimp FMP rather than an amendment. Through this action, managers will be able to more quickly respond to specifications setting needs in the future.

Draft Amendment 4 also considers options for the incorporation of management triggers that respond to observed changes in environmental and biological indicators. A management trigger outlines specific management responses tied to definable metrics that indicate changes in northern shrimp biological and/or environmental conditions. If a management trigger is implemented and the trigger remains un-tripped (no change in stock status and/or environmental conditions detected), a moratorium could be maintained. On the other hand, if the trigger is tripped, it could prompt steps to be taken such as a stock assessment update that could allow the Section to examine the potential for reopening the fishery.

1.5.2 Social Impacts

Trawls and traps are the two gears used to harvest northern shrimp. Slightly over half the boats in the Maine fishery in 2009 used traps, but trawlers landed a larger percentage of the catch (80% in 2009). The northern shrimp fishery is one of the last open access fisheries in the region and thus, as other fisheries are restricted, may be regarded as a fishery of last resort. Asked about limited entry in 2009, 62% of respondents who participate in the trap fishery opposed a controlled access management program, as did 43% of trawlers (Moffett & Wilson, 2010). A very small sample of harvesters queried in 2016 suggested that the numbers might be different if this study was conducted again, with individuals suggesting that limited entry is needed, some adding the caveat that the states should retain ownership of the permits, others suggesting that individual transferrable quotas might be preferable.

For a variety of reasons, cold-water shrimp has been primarily a secondary fishery for lobster and groundfish harvesters. It was regarded as an important winter fishery that allowed harvesters to supplement their income when lobstering was slow and/or weather and quota constraints limited groundfishing. It is not only revenue that is important, however, being able to stay active in a fishery is important to both harvesters and their vessels. Trapping had been steadily growing in Maine, from an average of about 31% of the Maine vessels and 13% of the Maine landings during 2001-2005, to 47% of vessels and 14% of landings in 2005-2009, to 48% of vessels and 23% of landings in 2010 (Maine only). Also in 2009, lobster harvesters in the region faced a serious drop in prices for their product compared to the prior three years, so it is a reasonable supposition that shrimp trapping was attempted to make up for the lost income. Even when the lobster prices and/or quantities increased, Northern shrimp was a popular fishery over the long winter.

Fluctuations in abundance, size, cost, and seasonal availability pose significant marketing challenges to the industry. In fact, in 2009, 83% of trap gear respondents and 97% of trawl gear respondents noted that their efforts in shrimp fishing were limited by the market (Moffett & Wilson 2010). This implies that should the market improve (higher prices and quantities sold), additional effort would move into the shrimp fishery. This effect was demonstrated in the 2010 and 2011 seasons when prices rose and participation and effort increased (ASMFC 2010, ASMFC 2011).

Those who formerly fished for shrimp and are still actively trawling for groundfish would most likely return to shrimp fishing if the season opened. However, there are far fewer trawlers than before due largely to the changes in groundfish regulations. Lobster harvesters might also trap shrimp. Though Rockport, Massachusetts was an active shrimp port in the past, the vessels there have removed their net reels and winches and generally use their boats for lobster fishing.

One major challenge in attempting to return to shrimp trawling is that lobster gear has moved into traditional shrimp trawling grounds. In the past, there were agreements among trawlers and lobster harvesters to keep these traditional grounds open for trawling, but there is less confidence now that those agreements could be honored.

Shrimp fishing, a winter fishery, is also problematic due to weather. New Hampshire harvesters are in the open ocean, so if the season is short, they may not have a suitable weather window to safely fish. Maine havesters have a little more flexibility since they can “hide behind on island,” if the weather closes in. t might be reasonable to have a 14-day season, but allow the harvester to select their active shrimp days depending on weather.

Northern shrimp was often purchased initially by fishermen’s coops, in both New Hampshire and Maine, then frequently sold to a major processor in Portland, ME. When shrimp fishing was consistent, there were also a few small-scale processors and a variety of roadside vendors, particularly in Maine. As the short-to-no seasons continued, both the small-scale processors and vendors sold out and/or went out of business. Some respondents in 2017 noted that roadside vendors also fell afoul of increased public health scrutiny and regulations that insisted on stainless steel sinks and bathrooms. However, some roadside vendors were seen in 2014-2017, likely selling shrimp landed as part of the RSA Program.

The fishermen’s cooperatives lost markets for shrimp, rebuilt them when shrimp returned, only to lose them again when the shrimp season was shortened or closed. When there was an open shrimp season, Portland Fish Exchange held a special Northern shrimp auction. Even now, they provide a landing facility for the shrimp boats, advising them to land in the late afternoon, so the catch can be transported to the Fulton Market in New York by midnight and bought in the morning by those supplying the Asian restaurant markets.

In the past, reduced landings, whether due to regulations or biology, had a significant impact on processors who need a steady supply of product to maintain their work force and market share. Because both the equipment and labor (grading, peeling, cooking) is specialized, it is expensive for processors to switch to processing shrimp from processing other product such as lobster. Without a predictable shrimp season or product, processors might choose not to change their operation.

While shorter seasons, trip limits and days-out restrictions limit fishing opportunities and landings, the impact of such measures on harvesters depends on what alternatives exist. Such alternatives are determined by the other permits held by the harvester but are also constrained by regulations, weather, and markets.

Since shrimp fishing was usually out of smaller ports in the region, regulations that limited access and effort had noticeable short-term negative impacts on the associated communities. Shore-side businesses such as providers of fuel and gear, in particular, were affected. However, if management is successful in ensuring a predictable and sustainable harvest, all sectors will have the opportunity to benefit over time.

The Northern shrimp fishery is not sufficiently homogeneous to accurately predict and describe the impacts of proposed regulations. What might be a minor inconvenience to one diversified multiple vessel owner could be a disaster to smaller single vessel owner. Nevertheless, a study conducted in 2009 found that on average, harvesters who responded depended on shrimp for 25% of their annual income. Furthermore, the actual impacts of regulations are not felt in isolation but are experienced in the larger context of the regulatory and economic environment of each operator and are cumulative over time. The lack of flexibility to change target species, as well as timing and geospatial decisions associated with fishing, is a negative impact commonly cited in social impact assessments of regulations that limit access. Nevertheless, if entry is not limited, it is more difficult for managers to assure that annual fishing caps are not exceeded, particularly if other fishing opportunities are limited.

As noted, the TAC was exceeded in 2010-2012 fishing years. However, recent innovations in cell phone technology, applications (apps), etc., may provide improved monitoring of catches and faster responses to avoid quota overages. Swipe cards in the American eel (elver) fishery in Maine have been very successful in monitoring the catch, as has a cell phone app in the fluke fishery in Massachusetts. Furthermore, far fewer trawlers are active due to changes in groundfish regulations, which could limit the numbers of vessels able to move into shrimp fishing.

1.5.3 Economic Impacts

The impact of management regulations will vary in relation to the dependence upon the fishery. A harvester with one vessel may be unable to cover the costs of operation in the face of a significant reduction in effort, while a more diversified harvester with multiple vessels may be able to compensate. On a larger scale, a reduction in effort is likely to have a negative short-term economic impact on a community where the fishing industry is a primary source of revenue. However, a recovery of the shrimp stock will result in the opportunity for all sectors (e.g., harvesters, processors, and dealers) to participate in the fishery for a longer term.

The small ports where shrimp constituted a significant proportion of landings consider fishing an important feature of their economy before the northern shrimp fishery was closed from 2014 to present. Fishing contributes to the overall productivity and total capital flow even if it is not the dominant industry in the community. It is often community members of the small ports who emphasize the importance of maximizing the numbers of jobs rather than maximizing income for a few individuals when choices among regulations are being made. Each of these ports, though, also face gentrification and increased competition for waterfront use.

Harvesters commonly point out that fishing has always been cyclical. A typical annual fishing season for harvesters in the smaller ports is to participate in other Northeast fisheries (e.g., lobster and groundfish) in the spring, summer and fall and then turn to shrimp fishing in winter (December-May). It is this ability to freely move in and out of the shrimp fishery in response to the relative availability of shrimp, other commercial species, market demand, the weather, and other factors that makes the shrimp fishery more valuable than the raw landings and income data may suggest. For some harvesters, even a limited shrimp harvest is sufficient to make the difference between financial stability and failure.

Both Gloucester and Portland are urban areas that have retained strong support for their fishing industry including working waterfront zoning and fisheries administrators with recognized roles in city government. By a variety of indices, Portland is classified as a primary port and “essential provider.” Gloucester ranks third (behind New Bedford and Portland) in fishing infrastructure differentiation, and low on the gentrification scale.

While the fishing industry in Portsmouth is dwarfed by the tourist industry, the city has retained a small, but complete infrastructure for the industry. When the season was open, shrimp was an essential component of the year’s fishing returns for individual vessels from Rye, Hampton and Portsmouth and for New Hampshire’s fishermen’s cooperative. Furthermore, vessels from Newburyport (Massachusetts) and York (Maine) were shrimp-landing members of the Yankee Fisherman’s Cooperatives, so the shrimp networks clearly extended beyond the borders of states and sub-regions in New England. In several of these small ports, the numbers of vessels capable of shrimp trawling, however, have been severely diminished by their inability to continue groundfish fishing. Where there were eight or nine vessels in the past, now one or two may remain active. With the increases in size and horsepower of lobster boats, there is potential untapped capacity.

Price depends on the size and quality of the shrimp. For example, the Japanese market pays a premium for larger, raw, frozen-at-sea product often available from Canada, but Japanese dealers will also purchase from the Portland auction when medium to large size, firm shrimp is available. The value of the shrimp landings in Maine in 1998-99 hovered at $1.50 per pound (Table 3), though in 1997 and 2000, the average price was estimated as $1.25 and $1.18 per pound, respectively. Average price per pound of shrimp for 2001 and 2002 was $1.24 and $1.54, respectively. Prices dropped precipitously in 2006, averaging $0.47/lb. In 2009, the season ended with $0.48/lb prices. However, prices began to recover in 2010 ($0.61/lb) and 2011 ($0.86). In 2012, in a shortened season, landings dropped down to 2185 metric tons and the price rose to $1.06/lb. In 2013, landings were only 255.51 metric tons and the price average for the year was $1.98. Without an open season, the vessel fishing under the RSA program bring in small quantities of shrimp, and the prices can be extraordinarily high for some sales, ranging from $4-$7/lb. The Asian restaurant market in New York City creates high demand.

Price is dependent on a suite of factors. The size and quality of the shrimp is important, but the quantity available also affects the market. For example, Canadian buyers need sufficient quantity to justify the expense of transporting the product. In 2000 harvesters received $.65/lb at the dock ($1.00 if they trucked it to the Portland auction) at the beginning of the season and $1/lb at the end of the season ($1.10-1.20 if trucked). Price is also affected by the size of the markets for northern shrimp.

Small-scale dealers play a significant role in the distribution of the shrimp catch. One informant estimated that a third of the product from Maine shrimp harvesters passed through the hands of small businesses. Some of these were small-processors who peeled and sold the raw product. Direct retail sale via roadside vending was common in Maine when the northern shrimp season was open. Community-supported fisheries in Maine and Massachusetts have also increased the market for northern shrimp. Tourism can affect the success of these small-scale operations and ultimately, the price, with fluctuating demand.

It is the processing sector that is apparently the most vulnerable to variability in supply and unpredictability, whether due to the diminishment of the stock size or as an artifact of regulations. The costs of preparing the facility, engaging labor, and identifying markets is significant, so this sector is less able to reconfigure in the short-term than is the harvesting sector.

Prior to the institution of the Food and Drug Administration's Hazard Analysis Critical Control Point (HACCP) regulations, when home processing was easier to pursue, the flexibility of the "cottage" industry could more easily accommodate flexibility in the harvesting sector.

1.5.4 Other Resource Management Efforts

1.5.4.1 Artificial Reef Development/Management
There are currently no artificial reefs in place in the Gulf of Maine used by the northern shrimp fishery.

1.5.4.2 Bycatch
The Northern Shrimp Section made the fishery a zero-bycatch fishery in 1993. The fishery remained a zero-bycatch fishery until 2001, when a limited amount of silver hake was allowed as bycatch. Federal multispecies regulations allow for the incidental catch of longhorn sculpin, and combined silver and offshore hake, up to an amount equal to the weight of shrimp possessed onboard or landed, but not in excess of 3,500 lbs (1,588 kg). Those vessels that also have a Federal lobster permit may keep lobster consistent with Federal lobster possession limits in 50 CFR 697.17.

Bycatch reduction improved radically with the advent of the Nordmore grate in the late 1980s. Developed in Nordmore County, Norway, this device is a grating of parallel bars mounted in the extension with an escape hole in the net in front of the grate. Testing of the Nordmore grate system by the NOAA Fisheries-Northeast Region's Fisheries Engineering Group during 1991 and 1992 proved the grate's effectiveness for the fish assemblage present in the Gulf of Maine. The results showed over 95% loss of finfish by weight and over 95% retention of shrimp (Kenney et al, 1992). The excellent escapement of finfish is seen across the length spectrum for flatfish, with a high percentage of even small flatfish escaping the net. The grate was implemented into the northern shrimp fishery for April and May 1992. Beginning in December 1992, the grate was required for the whole season.

As effective as the Nordmore grate is, an examination of male shrimp length frequency, around 15 to 20mm carapace length, reveals more shrimp of that size range retained by the cod ends behind the grates. The increased retention of these smaller shrimp is a concern because they are below the target size for shrimp of $\geq$22mm that the current minimum mesh size regulation controls. This indicates that the Nordmore grate may be affecting the mesh selection curve for shrimp in the cod end. Square mesh in the cod end may resolve shifts in selectivity produced by the Nordmore grate as many recent trials have indicated. Trials conducted in the Gulf of Maine by Maine Department of Marine Resources over several years have shown that square mesh of 1-5/8" produces a selectivity curve similar to 1-3/4" diamond mesh, but does release slightly more small shrimp.

A double Nordmore grate system was tested for reducing the amount of small shrimp caught with the single Nordmore grate. The second grate aids in releasing small shrimp and small fish that the cod end mesh size selection doesn't do very effectively. The Northern Shrimp Section approved the double Nordmore grate for use in the shrimp fishery in 1999. In 2007, He and Balzano (2007) tested a modification to the double grate system that used a size sorting grid and funnel system in front of the Nordmore grate to minimize the retention of small shrimp. The gear with the funnel increased mean size and reduced counts per pound in 13 of 14 paired 1-hr tows from mid-March and late June 2006. There have also been research trials with various combination grate systems that combine the functions of the two grates in the double grate system into one unit, a compound grate (Pinkham et al 2006). Amendment 3 to the Northern Shrimp FMP requires the use of either compound or double-Nordmore grates for vessels rigged for otter trawling for northern shrimp. The Section may modify this provision via Section action during specifications (ASMFC 2017).

Documentation of the bycatch/discard problem has occurred through a sea sampling program whereby samplers are placed aboard commercial vessels and all fish caught are recorded, whether they are landed or not. The percentage of bycatch in observed tows declined from almost 50% before the Nordmore grate was required, to about 15% afterward (Richards and Hendrickson, 2006). A more recent study by the Gulf of Maine Research Institute (GMRI) and NOAA at-sea observers documented bycatch in the northern shrimp fishery using a Nordmore grate. Eayrs et al. (2009) found only 2% of the total catch weight was bycatch of regulated species (n=243 hauls), and shrimp comprised greater than 92% of total catch by weight. This is a notable improvement considering that prior to the Nordmore grate bycatch comprised more than half of the total catch by weight (Howell and Langan 1992).

Information on the bycatch of protected species (e.g., marine mammals, sea turtles) can be found in *Section* 7.

1.5.4.3 Land/Seabed Use Permitting
There is no impact of land or seabed use permitting on the northern shrimp fishery.

1.6 LOCATION OF TECHNICAL DOCUMENTATION FOR FMP

1.6.1 Review of Resource Life History and Biological Relationships
Northern shrimp life history information was summarized by Apollonio and Dunton 1969, Haynes and Wigley 1969, Shumway et al. 1985, Apollonio *et al.* 1986, Clark et al. 2000, and Bergstrom 2000.

1.6.2 Stock Assessment Document
Detailed information pertaining to the northern shrimp stock assessment can be found in the 2018 Northern Shrimp Benchmark Stock Assessment and Peer Review Report (ASMFC 2018b). Annual data updates were prepared each year since 2018. The 2024 stock assessment update is the most recent report of the ASMFC Northern Shrimp Technical Committee and can be found on the ASMFC website.

1.6.3 Social Assessment Documents
The most recent survey of Gulf of Maine northern shrimp harvesters was conducted and published in 2010 by Moffett and Wilson.

1.6.4 Economic Assessment Document
Apart from the information in the Moffett and Wilson (2010) report, no recent studies have been conducted to assess the economic characteristics of the northern shrimp fishery. The most recent information is included in the 1986 FMP (ASMFC 1986).

1.6.5 Law Enforcement Assessment Document
The Commission's Law Enforcement Committee has prepared a document entitled "Guidelines for Resource Managers on the Enforceability of Fishery Management Measures, Sixth Edition" (2024) which can be used to evaluate the effectiveness of future measures.

1.6.6 Habitat Background Document
The background for habitat of northern shrimp is compiled in *Section 1.4* of this amendment. You can also refer to the 2018 Benchmark Stock Assessment Report for Gulf of Maine Northern Shrimp (ASMFC 2018b) for habitat and other environmental condition information.

2.0 GOALS AND OBJECTIVES

2.1 HISTORY AND PURPOSE OF THE PLAN

2.1.1 History of Prior Management Actions

The Northern Shrimp Section, consisting of representatives from Maine, New Hampshire and Massachusetts, is responsible for management based on input from the Northern Shrimp Technical Committee and industry Advisory Panel. This arrangement is one of the longest running instances of interstate cooperation in the history of fishery management in the United States.

In 1972, industry concerns over declining abundance and product quality led to exploration of options for cooperative management. Initial interest centered on curtailing harvest of small, non-marketable shrimp, which led to gear evaluation studies and implementation of a uniform stretched mesh size regulation of 44 mm (1.75 inches) in the body and cod end of the trawl. The Technical Committee also conducted a series of stock assessments beginning in 1974, which documented that the resource was overfished and that abundance was declining rapidly. As the stock deteriorated further, management became increasingly restrictive, finally culminating in closure of the fishery from May 1977 to February 1979.

In 1979, the Technical Committee prepared and submitted a draft management plan and environmental impact statement for the fishery, which recommended regulatory measures including mesh size limits, closed seasons, catch quotas and statistical reporting. Such regulations were to be implemented by the participating states through the Northern Shrimp Section, and ultimately by the Secretary of Commerce through the Fishery Conservation and Management Act of 1976 (NSSC 1979). A revised plan reflecting public comment was accepted at the November 1979 Section meeting.

In 1981, the State-Federal Fishery Management Program in the Northeast Region was restructured as the Interstate Fisheries Management Program (ISFMP) of the Commission. The Section adopted a "Statement of Policy" which (1) stated its position relative to environmental issues, i.e., that despite natural fluctuations in abundance, the northern shrimp fishery is manageable; and (2) affirmed that it would provide for a continuing management program based on Technical Committee recommendations to maintain and rebuild the stock so as to "assure a viable northern shrimp fishery over time." The Section further stated its intent to allow a fishery through the mechanism of an annual open season, with the following regulatory measures endorsed as appropriate:

1. Gear limitations, conforming to the uniform mesh size regulation (44.5 mm, 1.75 inches stretched mesh in body and cod end);
2. Seasonal limitations, open season to be set within a 183-day window beginning not earlier than December 1 and ending not later than May 31 for any one year;
3. Possession limitations; and

4. Information collection provisions, i.e., determination of participants, dealer and processor reporting, and dockside and sea sampling.

The above measures, and biological and socioeconomic research requirements for management, are embodied in the *Interstate Fishery Management Plan for the Northern Shrimp* (Pandalus borealis *Kroyer*) *Fishery in the Western Gulf of Maine* rewritten from the 1979 version (McInnes 1986). Included is substantial background information on stock assessment and survey data collection methods (Clark and Anthony 1981; Cadrin *et al*. 1999; and others). The FMP remained in effect until the passage of Amendment 1 (2004).

In the mid-1980s, with a resurgence of the resource, the Section was able to implement a gradual extension of the open season for 1982-1985 culminating in the maximum duration allowable for the 1986 and 1987 seasons. With good recruitment and continued moderate levels of exploitation, the Section was able to manage the resource effectively through closed seasons, monitoring resource trends using annual index-based assessments.

In 1993, the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) was enacted, which gave the ASMFC considerably more influence over management of coastal marine resources. ACFCMA obligated individual states to implement ASMFC-approved measures; and it authorized the Secretary of Commerce to declare a moratorium on a state's fishery for failure to comply with ASMFC plan provisions.

During the mid-1990s, effort increased rapidly, and landings reached 9,200 mt during the 1996 season – a level not seen since the early 1970s. The first analytical assessment, completed and peer-reviewed at the 25th Northeast Regional Stock Assessment Workshop (SAW) in July 1997 (NEFSC MS 1997) revealed sharp increases in fishing mortality rates and reductions in biomass in 1996 (Cadrin *et al*. 1999). Subsequent assessments indicated substantially higher levels of fishing mortality rates and sharp declines in stock biomass and recruiting year-class size.

The Section adopted Amendment 1 in 2004 to implement biological reference points to rebuild the resource. Provisions in Amendment 1 helped decrease fishing mortality rates and increase biomass through the use of a soft harvest target (i.e., total allowable catch, or TAC) and closed season. Under Amendment 1, biomass began to recover.

Despite the recovery of the stock, early season closures occurred in 2010 and 2011 because of increases in participation levels in response to good market price. Furthermore, monthly reporting led to short notice of the closures and an overharvest of the target by 28% in 2010 and 59% in 2011. In response to these issues, Amendment 2, which completely replaced Amendment 1, was approved in October 2011. In addition to establishing a more timely and comprehensive reporting system, Amendment 2 further expanded the tools available to manage northern shrimp, including options to slow catch rates throughout the season (i.e., trip limits, trap limits, and days out of the fishery). Also, Amendment 2 allowed for the initiation of a limited entry program to be pursued through the adaptive management addendum process. In November 2012, the Section approved Addendum I to Amendment 2 which refined the annual specification process, and allocated 87% of the coastwide TAC to the trawl fishery and 13% to the trap fishery based on historical landings.

Following review of the 2013 stock status report, the Northern Shrimp Section imposed a moratorium on the fishery for the 2014 season. The Section considered several factors prior to closing the fishery in 2014. Northern shrimp abundance in the western Gulf of Maine had declined steadily since 2006 and the 2012 and 2013 survey biomass indices were the lowest on record. Additionally, the stock experienced an unprecedented three consecutive years of failed recruitment (2010–2012 year classes). Subsequent stock status reports (i.e., 2014, 2015 and 2016) indicated continued poor trends in biomass, recruitment, and environmental indices which prompted the Section to maintain the moratorium, each year, through 2024. Winter sampling via selected commercial shrimp vessels occurred in each year of the moratorium from 2014 through 2017 to continue the time series of biological samples collected from the fishery.

In 2017, the Section approved Amendment 3 which completely replaced Amendment 2. Amendment 3 was designed to improve management of the northern shrimp resource in the event the fishery reopened. Specifically, the Amendment refined the FMP objectives and provided the flexibility to use the best available information to define the status of the stock and set the total allowable catch (TAC). Furthermore, the Amendment implemented a state-specific allocation program to better manage effort in the fishery; 80% of the annual TAC allocated to Maine, 10% to New Hampshire, and 10% to Massachusetts. Additionally, the Amendment strengthened catch and landings reporting requirements to ensure all harvested shrimp are being reported, and required shrimp-directed trawl vessels to use either a double-Nordmore or compound grate system. Other changes include the implementation of accountability measures (i.e., penalties if states exceed their quota), specification of a maximum fishing season length, and formalizing fishery-dependent monitoring requirements. In 2018, the Section approved Addendum I to Amendment 3 which provides states the authority to allocate their state-specific quota between gear types.

2.1.2 Purpose and Need for Action

The last time a new plan amendment to the Northern Shrimp FMP was adopted was in 2017 (Amendment 3). Since then, the status of the northern shrimp (*Pandalus borealis*) stock has remained unchanged with a depleted stock status and continued fishing moratorium. Given the poor condition of the stock, the Section supported initiation of a new plan amendment to consider several changes to the FMP including to the current management program requirement of annual specifications and addition of management triggers for stock monitoring.

The Fishery Management Plan (FMP) for Northern Shrimp (1986) established the requirement for northern shrimp fishing seasons to be set annually by the Section after considering recommendations from the Northern Shrimp Technical Committee (NSTC). Amendment 1 (2004) and subsequent amendments to the FMP made no changes to the annual specifications requirement, with Amendment 3 (2017) stating, “The Section has the ability to set a closed season annually up to 366 days (i.e., impose a moratorium)”. Based on the current requirements of the FMP, measures subject to annual specification may only be modified through an amendment to the FMP. Draft Amendment 4 considers adding the specifications setting timeline to measures subject to change through adaptive management therefore allowing the specifications setting timeline to be altered through the addendum process.

Each year, the Section meets in the late fall or early winter to discuss fishery specifications for the upcoming year. However, after the northern shrimp stock collapse in 2013, the Section has implemented a moratorium every year since 2014. Additionally, annual NSTC data updates indicate the northern shrimp stock continues to be depleted, with environmental conditions remaining unfavorable for northern shrimp in the Gulf of Maine. The 2023 data update for the species found no improvement in status, with indices of abundance, spawning stock biomass (SSB), and recruitment at new time-series lows (ASMFC, 2023). After receiving the results of the 2023 data update, the Section continued the fishing moratorium through the 2024 fishing year. The 2024 stock assessment for northern shrimp also found that stock status for northern shrimp continues to be poor, as illustrated by both the traffic light analyses and the catch-at-length model. Given the continued poor condition of the stock, the requirement of annual specifications in the Northern Shrimp FMP may no longer be appropriate. Draft Amendment 4 considers lengthening the specifications setting timeline for closed seasons to two or three years to allow for the setting of multi-year moratoriums if no improvement in stock condition is indicated.

Each year, the NSTC conducts a data update to incorporate the most recent fishery independent surveys and environmental indices into the longstanding timeseries, to apprise managers and stakeholders of current stock trends. A Strict Traffic Light Approach (TLA) is applied to a suite of survey and environmental indicators. Annual data updates provide information about the northern shrimp stock condition to the Section, but there is no pre-defined management response to data update results. Draft Amendment 4 considers the addition of management triggers to the FMP to identify specific management responses tied to definable metrics that indicate changes in northern shrimp biological and/or environmental conditions. If a management trigger were implemented, and the trigger remained un-tripped (no change in stock status), a moratorium would be maintained. On the other hand, if the trigger were to be tripped, it would prompt steps to be taken such as a stock assessment update that would allow the Section to examine the potential for reopening the fishery.

2.2 GOAL

Amendment 4 to the Interstate Fishery Management Plan for Northern Shrimp completely replaces Amendment 3 and Addendum I to Amendment 3.

The Northern Shrimp Section agrees, despite natural fluctuations in stock abundance, the northern shrimp fishery can be managed. In addition, the management program, which includes recommendations of the Technical Committee and the Advisory Panel, is designed to ensure a viable northern shrimp fishery in the Gulf of Maine over time.

The amendment's goal is to manage the northern shrimp fishery in a manner that is biologically, economically, and socially sound, while protecting the resource, its users, and opportunities for participation.

2.3 OBJECTIVES

The following objectives are selected to support the goal of this amendment:

- Protect and maintain the northern shrimp stock at sustainable levels that will support a viable fishery
- Optimize utilization of the resource within the constraints imposed by natural distribution of the resource, available fishing areas, changing environmental conditions, and harvesting, processing and marketing capacity
- Provide a mechanism for unique state level management of fishing effort
- Maintain the flexibility and timeliness of public involvement in the northern shrimp management program
- Maintain existing social and cultural features of the fishery to the extent possible
- Minimize the adverse impacts the shrimp fishery may have on other natural resources
- Minimize the adverse impacts of regulations, including increased cost to the shrimp industry and the associated coastal communities
- Promote research and improve the collection of information to better understand northern shrimp biology, ecology, population dynamics, and responses to changing environmental conditions
- Achieve compatible and equitable management measures through coordinated monitoring and law enforcement among jurisdictions throughout the fishery management unit

2.4 SPECIFICATION OF MANAGEMENT UNIT

The management unit is defined as the northern shrimp resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the shoreline to the seaward boundary of the Exclusive Economic Zone (EEZ). It is also recognized that the northern shrimp fishery, as defined here, is interstate and state-federal in nature, and that effective assessment and management can be enhanced through cooperative efforts with state and federal scientists and fishery managers.

2.5 DEFINITION OF OVERFISHING

Since the implementation of Amendment 1 in 2004 and prior to the 2018 benchmark stock assessment, stock status for northern shrimp in the Gulf of Maine had been determined via comparison of terminal year estimates of fishing mortality and biomass to fishing mortality- and biomass-based reference points (i.e., biological reference points, or BRPs). These management targets, thresholds, and limits were designed to provide managers with a guide to determine if changes in the regulations are necessary, given the current status of the stock, to sustain the resource over time. The BRPs defined in Amendment 2 were developed via the Collie-Sissenwine Analysis (CSA) assessment model (Cadrin et al. 1999), which was peer-reviewed and accepted for management use in 2007. However, the 2018 benchmark assessment for northern shrimp determined previous biological reference points that were based on estimates of F during a period in the fishery (1985-1994) when biomass and landings were considered stable and sustainable, may no longer be appropriate for the stock in the Gulf of Maine. Instead, the NSTC chose a projection-based approach to establishing reference points for the 2018 assessment. A length-based projection model in R was developed to project the population forward under various scenarios about recruitment, M, and F. The projection was repeated 1,000 times with stochastic draws of recruitment, initial abundance-at-size for non-recruits, and fishery selectivity parameters. This projection-based approach has been used in each stock assessment update since 2018.

Amendment 3 (2017) and Draft Amendment 4 allow for the incorporation of new, peer-reviewed stock status determination criteria (both the methods used to set reference points, and the reference point values), when available, through Section action. Specifically, these actions broaden the descriptions of stock status determination criteria contained within the Northern Shrimp FMP to allow for greater flexibility in incorporating changes to the definitions of the maximum fishing mortality threshold (target or limit) and/or minimum stock size threshold (target or limit) as the best scientific information becomes available, while maintaining objective and measurable status determination criteria for identifying when the stock is overfished. Similar actions have been taken with other Commission-managed species' FMPs (e.g., Addendum XIX to the FMP for Summer Flounder, Scup and Black Sea Bass, and Addendum XVI to the FMP for American Lobster).

New, peer-reviewed stock status determination criteria may be incorporated into management, as soon as it becomes available through the annual specifications process, thus significantly improving the timeliness of incorporating the best available scientific information in the management of northern shrimp. The following describes the potential sources of peer-reviewed scientific advice on status determination criteria and the current process of how that scientific advice will move forward in the development of management advice through the Section's annual specification process.

Specific definitions or modifications to the status determinations criteria, and their associated values, would result from the most recent peer-reviewed stock assessments and their panelist recommendations. The primary peer-review processes for Gulf of Maine northern shrimp that may be used are:

- The Northeast Regional Stock Assessment Workshop/ Stock Assessment Review Committee (SAW/SARC) process which is the primary mechanism utilized in the Northeast Region at present to review scientific stock assessment advice, including status determination criteria, for ASMFC- and federally-managed species.
- ASMFC Externally Contracted Reviews with Independent Experts (e.g., Center for Independent Experts - CIE) which is also subject to rigorous peer-review and may result in scientific advice to modify or change the existing stock status determination criteria.

The above list of peer-review entities does not preclude groups from bringing independent stock assessments performed for the Gulf of Maine northern shrimp stock forward to the attention of the Commission. The Commission may recommend that non-Commission reviewed stock assessments pass through either of the peer-review processes above, to ensure that sufficient peer-review of the information occurs before the scientific advice can be utilized within the management process.

The scientific advice provided with respect to status determination criteria could follow three scenarios. First, it is possible that the panelists participating in the peer-review reach consensus with respect to maintaining the current definitions of status determination criteria for northern shrimp. There may be updates to the values associated with those same definitions based on the input of more recent (i.e., additional year's data) or updated information as well; however, the Section is not required to undertake any specific action when this occurs, as using the updated values is implied in this provision of the FMP. In this case the scientific advice can then move forward such that management advice can be developed. Under the second potential scenario for scientific advice, the peer-review recommends changes or different definitions of the status determination criteria, and the panelists reach consensus as to how these status determination criteria should be modified or changed. This scientific advice can move forward such that management advice can be developed. Under these first two potential scenarios, consensus has been reached and therefore the scientific advice moving forward to the Section's management advisory groups should be clear.

The third potential scenario is the peer review scientific advice with respect to the incorporation to status determination criteria are split (consensus is not reached) or uncertain recommendations are provided (weak consensus). The scientific advice provided by the reviewers may be particularly controversial. In addition, the scientific advice may not be specific enough to provide adequate guidance as to how the maximum fishing mortality threshold and/or minimum stock size threshold should be defined or what resulting management advice should be developed from these changes. Under these circumstances, or at any time, the Section may engage their TC to review the information and recommendations provided by the peer-review group. Based on the terms of reference provided to the TC, which may include reevaluation of stock status determination criteria in light of changing environmental conditions, they may prepare a consensus report clarifying the scientific advice for the Section as to what the status determination criteria should be (e.g., modify, change, or maintain the same definitions). At that point the scientific advice on how the status determination criteria should be defined will be clear, and can move forward such that management advice can be developed.

2.6 STOCK REBUILDING PROGRAM

Based on the definition of overfished status as defined in *Section 2.5*, and should the stock biomass go below the threshold as determined by the annual stock assessment, the stock is defined as overfished and the Section is required to take action to recover the stock above the threshold. Based on the definition of overfishing status as defined in *Section 2.5*, and should fishing mortality go above the threshold as determined by the annual stock assessment, overfishing is then occurring and the Section is required to take action to reduce the fishing mortality to the target level. If fishing mortality exceeds the limit level and biomass is less than the threshold level, the Section must act immediately to reduce fishing mortality.

The Section chose not to set specific rebuilding timeframes. It maintains the flexibility to rebuild stocks within a reasonable amount of time. This flexibility is necessary for the Section to manage a species that is volatile and easily affected by change in environmental conditions.

2.7 RESOURCE COMMUNITY ASPECTS

See *Section 1.4.1* for the role northern shrimp play in ecosystem dynamics.

2.8 IMPLEMENTATION SCHEDULE

[*TBD if approved*]

3.0 MONITORING PROGRAM SPECIFICATIONS/ELEMENTS

3.1 SUMMARY OF MONITORING PROGRAMS

In order to achieve the goals and objectives of Amendment 4, the collection and maintenance of quality data continues to be necessary.

Commercial landings by state, month, and gear (trawl vs. trap) were compiled by NOAA Fisheries port agents from dealer reports until the mid-late 1990's, and are available electronically back to 1964. A dealer reporting system became mandatory in 1982 but was repealed in 1991, and NOAA Fisheries began collecting the data again. In 2004, shrimp reporting for federally permitted dealers buying from federally permitted harvesters became mandatory, but "state-only" dealers, mostly in Maine, continued to report voluntarily. Trip level reporting became mandatory for all licensed Maine shrimp dealers in 2008, although "peddlers" selling directly to the public only were not required to have a license, so catches sold in the peddler market were mostly unreported on the dealer side. This was remedied in 2013, and during the next shrimp season, anyone buying shrimp for resale will need to be licensed in Maine and report landings.

In 1994, a Vessel Trip Report (VTR) system was implemented for many federally permitted harvesters and in 1999 (but not implemented until the 2000 season), reporting became mandatory for all shrimp harvesters landing in Maine.

3.1.1 Catch and Landings Information

The need for accurate and timely reporting of all catch and landings is imperative for successful monitoring of the fishery and the TAC, and is a prerequisite for effective implementation of trip limits and days out to slow catch rates.

All states are required to implement weekly reporting of all daily sales at first point of contact (i.e., dealers, including harvester direct sales to the consumer, i.e., "peddlers"). States must require the use of electronic reporting through the Standard Atlantic Fisheries Information System (SAFIS) maintained by the Atlantic Coastal Cooperative Statistics Program (ACCSP). Negative reports (no shrimp were purchased or received during a reporting week) are required. Landing and trip information should be collected consistent with the established ACCSP data elements.

3.1.2 Fishery-Dependent Monitoring

Approximately 2-5% of commercial shrimp landings from Maine, New Hampshire and Massachusetts, have been subsampled for size and sex-stage composition data since the early 1980s (SAW/SARC 58, 2014). These data are essential for annual stock assessment, and subsequent management actions.

The states of Maine, New Hampshire, and Massachusetts are required to collect size and sex-stage composition data from subsamples with a target of at least 2% of commercial landings in that state to inform annual stock assessment.

3.1.3 Biological Information

The ACCSP provides standardized data elements and reporting medium for collected biological data on commercial, for-hire, and recreational fisheries. Biological data for commercial fisheries can be collected through port sampling programs and at-sea observers Refer to the ACCSP Program Design document for details. Priorities and target sampling levels are determined by the ACCSP Biological Review Panel, in coordination with the Bycatch Prioritization Committee.

3.1.4 Social Information

In New England today, there is no consistent, long-term monitoring program focused either on the collection and analysis of social and economic data or on the social and economic impacts of regulatory change. However, there are several steps being taken that may eventually lead to such a program. Hall-Arber et al. (2001) collected a wealth of information to serve as a baseline for such data collection in New England. A few towns in Maine have, or are in the process of developing, planning processes that include analyses of their fishing industry's current and anticipated needs. Conduct of needed research and analyses identified in this amendment would help place the necessary decision-making on a more objective foundation.

3.1.5 Economic Information

There is very little direct monitoring of economic conditions in the Gulf of Maine northern shrimp fishery for either harvesters or processors. Ex-vessel value of shrimp landings is collected for northern shrimp through mandatory electronic dealer reporting.

The 2011 through 2013 shrimp harvest seasons closed early due to landings in excess or reaching the coastwide TAC. In 2011, a total of 6,397 mt of shrimp were landed, exceeding the recommended TAC of 4,000 mt by approximately 2,400 mt (Table 2). The average price per pound was $0.86 and the estimated landed value of the catch was $12.1 million (Table 3). In 2012, the season was further restricted by having trawlers begin on January 2 with three landings days per week and trappers begin on February 1 with a 1,000 pound limit per vessel per day. The TAC was set at 2,000 mt (later increased to 2,211 mt on January 20th) and would close when the projected landings reached 95%. The season was closed on February 17; trawlers had a 21-day season and trappers had a 17-day season. Landings for 2012 were 2,485 mt and the average price per pound was $1.06 with an estimated landing value of $5.8 million. In 2013, the TAC was set at 625 mt (with 5.44 mt set aside for research tows) and would close when the projected landings reached 85% of the TAC in each fishery (trap and trawl). The trawl fishery was allocated a 539.02 mt TAC and the trap fishery was allocated an 80.54 mt TAC. Trawlers fished for 54 days and trappers fished 62 days culminating in 345.5 mt landed, which is 280 mt under the TAC. The average price per pound was $1.98 and is the highest observed since 1989 (inflation-adjusted values, Table 3) with an estimated value of $1.5 million.

With a moratorium on the northern shrimp fishery since 2014 the only landings that have been allowed have been through the research set aside (RSA) program allowing selected harvesters to conduct cooperative winter sampling of northern shrimp and provide biological samples to maintain the biological data time series (Table 2).

Vessels in the shrimp fleet complete the NOAA Fisheries Vessel Trip Reports for each trip providing fishing effort and crew size information. There is no direct source of cost data for this fleet except where a particular vessel has supplied these data to another NOAA Fisheries program such as the Capital Construction Fund or the MARFIN survey of groundfish trawlers.

Historically, there has been a modest level of at-sea sampling of the shrimp fleet by the NOAA Fisheries and state agencies. Up until about 1998, the NOAA Fisheries funded shrimp sampling trips through the observer program at the Manomet Center for Conservation Science. State agencies also conduct routine port sampling and sea sampling programs. While aboard, both state and Federal sea samplers follow the same sampling protocols that do include some economic data gathering. Observers note many physical characteristics of the vessel and the gear including gear quantity and size and the amount of electronics in the wheelhouse. If time permits there are additional economic questions in the sea sampling forms although it is expected that very few of these interviews are conducted on day trips.

As noted above, dealers and processors provide the ex-vessel price paid to boats at the first point of sale. After this point there is very little economic monitoring of the processing sector.

Much of the New England shrimp production is sold to Canada, Europe and Asia, hence U.S Customs documentation of shipments abroad is available including product form and declared value. Unfortunately, shrimp shipments leaving through a New England port of departure do not necessarily indicate that this domestic product was landed in the Gulf of Maine Pandalid fishery and further distinction of the product to the species level is not required on Customs paperwork.

Any socioeconomic data collection programs utilizing ACCP standards are quite capable of overcoming these gaps in data for this fishery. Industry acceptance of an expanded and more focused data collection program would be key to its success. Funding and the sheer scale of implementation for a northern shrimp socioeconomic study have slowed down the implementation of a socioeconomic data collection program for this fishery.

3.1.6 Observer Programs

As a condition of state and/or federal permitting, vessels should be required to carry at-sea observers when requested. The ACCSP has adopted the NOAA Fisheries National Observer Program as the standard for training and certifying at-sea observers. The ACCSP standards for commercial fisheries observer coverage is 5% of total trips for high priority fisheries, or achieving a 20-30% PSE, and 2% of total trips for all other fisheries. These target sampling-levels should be evaluated annually by fishery to determine where the variance stabilizes and to meet desired goals. A minimum set of standard data elements is defined through the ACCSP for biological or bycatch sampling data (refer to the ACCSP Program Design document for details). Specific fish species and fisheries are prioritized for sampling as well as sampling levels through the ACCSP Biological and the Discard Prioritization Committees. The ACCSP is developing a target tracking system to track the number of observed trips so that observer effort may be reallocated as targets are met. Partners should upload minimum data elements to the ACCSP tracking system before the tenth of the month following data collection. The submission timeline will allow two effort reallocations per calendar quarter. ACCSP Partners are encouraged to monitor the tracking system as required to complete targets.

3.2 ANNUAL ASSESSMENT

3.2.1 Assessment of Fishing Mortality Target and Measurement

Fishing mortality estimates for the Gulf of Maine northern shrimp fishery in the past have been generated by two separate models; the Collie-Sissenwine, or Catch-Survey Analysis (CSA), and a surplus production model (ASPIC). The CSA tracked the removals of shrimp using summer shrimp survey indices of recruits and fully recruited shrimp scaled to total catch in numbers. The surplus production analysis modeled the biomass dynamics of the stock with a longer time series of total landings and several survey indices of stock biomass. The CSA estimates of fishing mortality were used as the primary point estimates for managing the fishery, while the surplus production estimates of fishing mortality were used to corroborate results from the CSA and provide historical perspective.

The 2018 benchmark assessment for northern shrimp developed and explored a statistical catch-at-length model (UME), an age-structured model (ASAP), and a Catch Survey Analysis (CSA). The University of Maine assessment model was rigorously tested and was ultimately recommended for use in providing fishery management advice. The UME model divides the northern shrimp stock into size groups and tracks changes in the proportion of shrimp in each size group across seasons and years to estimate fishing mortality (F) and population size.

The Northern Shrimp Technical Committee will perform a northern shrimp data update on an annual basis. The Technical Committee and Advisory Panel will meet to review the data update and all other relevant data sources during specifications setting years. A data update will be prepared for the Section in order to make adjustments to the management program as necessary when setting specifications. Several primary surveys are examined, including the NOAA Fisheries fall ground fish survey. Historically, the summer shrimp survey was examined, but was discontinued in after the 2023 survey. The data update report will include at least landings, effort, and survey indices of abundance, biomass, and recruitment. Estimates of fishing mortality, yield-per-recruit and spawning potential will be provided when possible. If major changes are made to the stock assessment models used in the management process, or the Section requests a higher level of review, the Section may recommend to the ISFMP Policy Board that an external review of the stock assessment be conducted.

3.2.2 Assessment of Annual Recruitment

The mean number per tow of 1.5 year old shrimp from the available surveys and sampling programs collecting information on shrimp is used as a proxy for a recruitment index. Although the shrimp are not fully recruited to the survey gear at this age, it appears that this index is a sufficient representative of year class strength from the previous year. Historically, the summer shrimp survey was used for the recruitment index, but the summer shrimp survey was postponed indefinitely after the 2023 survey year. Now, the NSTC uses recruitment information from the Maine-New Hampshire Inshore Trawl Survey and the NEFSC Fall Bottom Trawl Survey, but these data sources may change in the future with new information.

3.2.3 Assessment of Spawning Stock Biomass

The stratified mean weight (kg) per tow of northern shrimp >= 22-mm dorsal carapace length (CL) from the summer shrimp survey historically provided the index of spawning stock biomass (SSB). After the summer shrimp survey was indefinitely postponed in 2023, the NSTC now uses information from the Maine-New Hampshire Inshore Trawl Survey and the NEFSC Fall Bottom Trawl Survey to derive the index of SSB. However, these data sources may change in the future if new information becomes available. Northern shrimp are protandric hermaphrodites, which start changing from male to female around 2.5 years of age, or 18 to 19 mm CL. The 22 mm dorsal carapace length is used as a cutoff point because at this size most shrimp are sexually mature females.

3.3 BYCATCH MONITORING PROGRAM

The ACCSP will require a combination of quantitative and qualitative methods for monitoring discard, release, and protected species interactions in the northern shrimp commercial fishery.

Commercial fisheries will be monitored through an at-sea observer program (see *Section 3.1.6*) and several qualitative programs, including strandings, entanglements, trend analysis of vessel trip and dealer reported data, and port sampling.

3.4 HABITAT PROGRAM

No habitat program is currently defined for the Gulf of Maine's Northern shrimp. Given the high uncertainty in the future prospects for the northern shrimp fishery and the current moratoriums due to the stock collapse, the long-term impacts of the fishery on shrimp habitats are highly uncertain. Current low levels of effort in the fishery likely have neutral or slightly positive habitat effects.

The New England Fisheries Management Council's Omnibus Essential Fish Habitat Amendment 2 (2018) updated Essential Fish Habitat (EFH) designations, designated new Habitat Areas of Particular Concern (HAPC), and revised habitat and groundfish management areas. The Council's evaluation during the development of the amendment considered the habitat impacts of all type of fishing occurring in federal waters in the Council's area of jurisdiction, not just fishing activities directly managed by the Council. A major goal of the amendment is to avoid and minimize to the extent practicable the adverse effects of fishing on the seabed. The Council concluded that vulnerability to fishing impacts varies based on habitat characteristics and fishing intensity (NEFMC 2011). Many of the management measures in the Omnibus EFH amendment are based on identifying specific locations where seafloor habitats are more vulnerable and implementing restrictions in these areas on gear types that have the most severe impacts.

4.0 MANAGEMENT PROGRAM IMPLEMENTATION

4.1 COMMERCIAL FISHERIES MANAGEMENT MEASURES

4.1.1 Annual Fishery Specifications and the Total Allowable Catch

Option A: Status Quo

To manage at the biological reference points in *Section 2.5,* the Northern Shrimp Section shall adjust commercial fishery management measures based on Northern Shrimp Technical Committee (NSTC), Advisory Panel, and public input. The NSTC will annually review the best available data which may include, but are not limited to, catch and landing statistics, current estimates of fishing mortality, stock status, shrimp survey indices, assessment modeling results, and target and threshold mortality levels; and recommend a hard TAC to maintain or reach healthy stock status relative to peer reviewed biological reference points, if available.

The Section will meet annually during a public meeting in the fall or early winter to review the Advisory Panel and NSTC recommendations, set a hard TAC that is associated with managing the northern shrimp fishery at the F_{target}, at the $F_{threshold}$, or between the F_{target} and $F_{threshold}$, when possible, and specify any of the following management measures for the upcoming fishing season through a majority vote.

Annual Meeting Specification Options:

a) Quota reconciliation or rollover date (*Section 4.1.2)*
b) Fishing Season (*Section 4.1.3)*
    1. Establish measures for projected season closure (*Section 4.1.3.1*)
c) Trip Limits (*Section 4.1.4)*
d) Trap Limits (*Section 4.1.5*)
e) Days out of the Fishery (*Section 4.1.6*)
f) Research Set Aside (*Section 4.1.2.1*)

The Section may further specify options b-e above by gear type (e.g., trap and trawl) and may establish harvest triggers to automatically initiate or modify any option (except trap limits). Additionally, the Section may make adjustments to the fishing season, trip limits, and days out of the fishery at any time during the fishing season at an in-person meeting or conference call. Meetings are preferable to calls, and conference calls will only be used as needed, most likely for time sensitive specification adjustments

This amendment provides the Section with a suite of management measures that can be modified through adaptive management. *Section 4.6.2* contains a list of management measures that may be implemented anytime throughout the year by the Section. However, adjustment or establishment of any of the measures listed in *Section 4.6.2* must be implemented through the addendum process. See Section 4.6 for a description of how the Section is able to implement adaptive management through the addendum process.

Once the Section approves management measures for the northern shrimp fishery, it is the individual state's responsibility to implement consistent regulations through its state agency.

Option B: Extended Specifications Setting Timeline for Moratorium Years
To manage at the biological reference points in *Section 2.5,* the Northern Shrimp Section shall adjust commercial fishery management measures based on Northern Shrimp Technical Committee (NSTC), Advisory Panel, and public input. The NSTC would review the best available data which may include, but are not limited to, catch and landing statistics, current estimates of fishing mortality, stock status, shrimp survey indices, assessment modeling results, and target and threshold mortality levels; and recommend a hard TAC during specifications setting years to maintain or reach healthy stock status relative to peer reviewed biological reference points, if available.

4.1.1.1 Moratorium Specifications
While the northern shrimp fishery remains under a moratorium, the Section may set specifications for ***up to X years at a time***. The Section would meet at least once during the moratorium years in the fall or early winter. With a longer moratorium the Section could met more than once, if desired. During these meetings, the Section would meet to review the Advisory Panel and NSTC recommendations and specify any of the following management measures for the upcoming fishing season (this can be done via Section action):

a) Fishing Season (for moratoriums only, *Section 4.1.3)*
b) Research Set Aside (*Section 4.1.2.1*)

<u>Sub-Option B.1: Moratorium specifications for up to 2 years at a time</u>
<u>Sub-Option B.2: Moratorium specifications for up to 3 years at a time</u>
<u>Sub-Option B.3: Moratorium specifications for up to 5 years at a time</u>

4.1.1.2 Open Season Specifications

In years where the fishery is open, the Section would meet ***annually*** in the fall or early winter to review the Advisory Panel and NSTC recommendations, set a hard TAC that is associated with managing the northern shrimp fishery at the F_{target}, at the $F_{threshold}$, or between the F_{target} and $F_{threshold}$, when possible, and specify any of the following management measures for the upcoming fishing season through a majority vote.

Annual Meeting Specification Options:

a) Quota reconciliation or rollover date (*Section 4.1.2)*
b) Fishing Season (*Section 4.1.3)*
    1. Establish measures for projected season closure (*Section 4.1.3.1*)
c) Trip Limits (*Section 4.1.4)*
d) Trap Limits (*Section 4.1.5*)
e) Days out of the Fishery (*Section 4.1.6*)
f) Research Set Aside (*Section 4.1.2.1*)

The Section may further specify options b-e above by gear type (e.g., trap and trawl) and may establish harvest triggers to automatically initiate or modify any option (except trap limits). Additionally, the Section may make adjustments to the fishing season, trip limits, and days out of the fishery at any time during the fishing season.

This amendment provides the Section with a suite of management measures that can be modified through adaptive management. *Section 4.6.2* contains a list of management measures that may be implemented anytime throughout the year by the Section. However, adjustment or establishment of any of the measures listed in *Section 4.6.2* must be implemented through the addendum process. See Section 4.6 for a description of how the Section is able to implement adaptive management through the addendum process.

Once the Section approves management measures for the northern shrimp fishery, it is the individual state's responsibility to implement consistent regulations through its state agency.

4.1.2 Total Allowable Catch (TAC) Allocation Program *(No changes proposed)*

The coastwide TAC as specified in *Section 4.1.1* will be allocated by state with 80% allocated to Maine, 10% allocated to New Hampshire and 10% allocated to Massachusetts. For jurisdictions with trawl and trap fisheries, the state may determine any gear-specific allocations between the trawl and trap fisheries. The state may also choose not to divide its quota between gear types. This determination by the state can occur after the annual TAC has been set.

It is the responsibility of the states to implement appropriate measures to prevent quota overages. All northern shrimp landed will be applied against the state's quota of the vessel's home port, regardless of where the northern shrimp was harvested or landed. Individuals or vessels with commercial permits cannot land northern shrimp in any state that was not allocated a commercial quota. State quota allocations may be revisited at any time through the adaptive management process (*Section 4.5*).

At the end of each fishing season, any quota underages by one or more states will be pooled and proportionately allocated using the state's quota allocation to help reconcile any quota overages. Alternatively, the Section may choose to roll over any unused quota from New Hampshire and Massachusetts to Maine's quota by a date determined during annual specifications.

4.1.2.1 Research Set Aside (RSA) Program *(No changes proposed)*

The Northern Shrimp Section may set aside a percentage of the coastwide TAC to help support research on the northern shrimp stock and fishery. The percentage of the TAC will be determined during the specifications meeting, and will be deducted from the coastwide TAC before the TAC is allocated according to *Section 4.1.2*. The Section may set a RSA quota when there is no TAC as agreed by the Section, i.e., during years of a moratorium. The research set aside program will be managed by the Northern Shrimp Section and ASMFC.

4.1.3 Fishing Season

Option A: Status Quo

At the annual specifications meeting, the Section may establish a fishing season to occur anytime between December 1 and May 31. This will be the maximum season length if a fishing season is approved, i.e., the Section may establish a fishing season shorter than, but not longer than that specified. The Section may set different seasons for the harvesting and processing sectors of the fishery to accommodate for the lag time of processing shrimp harvested late in the season. The Section may close the fishery at any time at a public meeting.

The Section has the ability to set a closed season annually (i.e., impose a moratorium) of up to 366 days.

Option B: Extended Moratoriums

When setting specifications, the Section may establish a fishing season to occur anytime between December 1 and May 31. This would be the maximum season length if a fishing season is approved, i.e., the Section may establish a fishing season shorter than, but not longer than that specified. The Section may set different seasons for the harvesting and processing sectors of the fishery to accommodate for the lag time of processing shrimp harvested late in the season. The Section may close the fishery at any time via Section action.

The Section has the ability to impose a moratorium ***for up to X consecutive years (i.e., seasons) at a time.*** The maximum moratorium would begin on December 1 of Calendar Year 1 and remain in place through May 31 of last Calendar Year of the closure. Effectively, this option represents a moratorium on fishing of up to X years, or Y days. There is no provision for setting an extended open season.

Sub-Option B.1: Moratorium for up to 2 consecutive years or 731 days
Sub-Option B.2: Moratorium for up to 3 consecutive years or 1,096 days
Sub-Option B.3: Moratorium for up to 5 consecutive years or 1,826 days

4.1.3.1 Projected Season Closure *(No changes proposed)*

The northern shrimp fishery will close when a percentage of the coastwide TAC is projected to have been caught. The exact percent, ranging between 80-95%, and the closure notification period (2-7 days) will be established by the Section during the annual specifications meeting. ASMFC will notify states when the selected percentage of the TAC is projected to be reached, and states must then close their fisheries within the specified notification period.

In projecting the season closure, the NSTC will consider these sources of uncertainty:

1. Future catch rates, which depend on weather, stock availability, catchability, gear type, location, and fishery participation. Catch rates can be expected to be high in January and February and lower in other months, with exceptions.
2. Late reporting. During the 2012 season, reporting compliance improved as the season progressed.
3. Unreported catches due to non-compliance or catches kept for personal use.

4.1.4 Trip Limits *(No changes proposed)*

The Section will vote on the start date, duration, and end date of trip limits, with the ability to initiate or modify trip limits during the season. The Section may use harvest triggers to automatically initiate or modify trip limits during the season. The Section may implement trip limits by day, week, or other time-based landing limit to control the rate of landings. The Section may establish trip limits based on gear type, and an analysis of historical harvest data. Vessels are prohibited from landing more than the specified amount during a designated trip limit period. Refer to *Appendix 1* for the Amendment 3 PDT's trip limit analysis.

4.1.5 Trap Limits *(No changes proposed)*

The Section may set trap limits during the annual specifications meeting through a majority vote. The Section may establish trap limits based on an analysis of historical harvest data. An individual permit holder is prohibited from fishing a number of traps in excess of the trap limit designated by the Section for that fishing year.

All traps fished, or aboard a vessel, must be tagged. A permanent, non-transferable trap tag shall be attached to each trap. Each trap tag shall be color-coded coastwide by fishing year and include the following information: issuing authority, year(s) tag is valid, and permit number. Trap tags must be permanently attached to the trap frame, and clearly visible for inspection. In state waters, the state licensing agency shall be the issuing authority. Each state shall issue tags to its own residents. In cases where license holders do not hold a license in their resident state, the state in which they fish shall issue tags.

4.1.6 Days Out of the Fishery *(No changes proposed)*

Days out of the fishery may be implemented to slow catch rates in order to prolong the harvest of the hard TAC, or make shrimp available when demand is greatest. The Section will vote on the start date, number of days out, and days of the week for days out. The Section may initiate or change days out specifications by taking another vote anytime during the rest of the fishing season during a meeting or conference call. All states will take the same days out of the fishery.

Days out during the fishing season are considered closed days, and it is unlawful to land any shrimp from 0001 hours to 2400 hours; and it shall be presumed that any shrimp landed or possessed by harvesters during the closed period were taken during a closed day.

4.1.7 Minimum Mesh Size *(No changes proposed)*

It is unlawful to fish for, take, transport or have in possession any northern shrimp on board any boat rigged for otter trawling with any net with a mesh opening of less than 1-3/4 inches stretched mesh opening between knots, or to have on board any net, netting or portions thereof, except an accelerator funnel of the size specified in *Section 3(c),* with an opening less than 1-3/4 inches stretched mesh opening between knots and except that a deflector panel of 1 inch mesh may be used in the cod end behind the second grate in a double grate system. The maximum length of the bottom legs of the bridle of any shrimp trawl shall not exceed 15 fathoms of uncovered or bare wire.

<u>Tolerance</u>. Due to the differences by net manufacturer, mesh measurements and other inherent variables used for enforcement of this regulation, a tolerance of 1/8 inch shall be applied to the average mesh size in the body and wings. No tolerance shall be applied to the mesh size in the cod end.

4.1.8 Fishing Gear *(No changes proposed)*

All netting used to catch shrimp shall be of one layer only, with no liners of any kind attached, except that a cod end strengthener may be used as specified, and except that an accelerator funnel may be used and must have a mesh size of no less than 1-3/8 inch stretched mesh. It shall be lawful to attach chafing gear to the lower half of the circumference of the cod end unless a cod end strengthener is used. Cod end shall mean the terminal portion of an otter trawl, pair trawl, beam trawl, Scottish seine or mid-water trawl in which the catch is normally retained.

4.1.9 Cod End Strengthener *(No changes proposed)*

An outer mesh may be used as a cod end strengthener while fishing for northern shrimp. The outer mesh must be a minimum of 6 inches and the outer mesh must be at least three times larger than the size of the inner mesh. The mesh may be single or double twine, and diamond or square in shape. The hanging ratio must be the same as the mesh size ratio. Hanging ratio shall mean the number of meshes in the circumference of the cod end to the number of meshes in the circumference of the strengthener. The mesh size ratio shall mean the number of inner meshes to the number of outer meshes. The outer mesh may only cover the cod end. No chafing gear may be used with a cod end strengthener.

Exception. Herring seines or purse seines may be transported from one location to another provided a permit is obtained from a fisheries enforcement officer or the state fishery agency.

Method of Measurements. Mesh sizes are measured by a flat wedge-shaped gauge having a taper of 4 cm in 20 cm and a thickness of 2.3 mm, inserted into the meshes under a pressure or pull of 1.90 kg. The mesh size of a net shall be taken to be the average of the measurements of a series of any 20 consecutive meshes, at least 10 meshes from the lacings, and when measured in the cod end of the net beginning at the after end and running parallel to the long axis.

4.1.10 Mechanical "Shaking" Devices *(No changes proposed)*

Mechanical "shakers" have been used to rid smaller shrimp from nets. It shall be unlawful to cull, grade, separate or shake shrimp, aboard any vessel, except by implements operated solely by hand. It is illegal to possess, aboard any vessel, any powered mechanical device used to cull, grade, separate or shake shrimp.

4.1.11 Finfish Excluder Devices *(No changes proposed)*

It shall be unlawful for any vessel rigged for otter trawling, to fish for, land or have in possession northern shrimp except by using trawls equipped with finfish excluder devices approved by the same agency that permits such vessels. Such finfish excluder devices (commonly referred to as the "Nordmore Grate System") shall consist of:

- A rigid or semi-rigid grate consisting of parallel bars attached to the frame with spaces between the bars not to exceed 1 inch in width;
- A fish outlet, or hole, in the extension of the trawl forward of the cod end and grate; and
- A webbing funnel installed in front of the grate designed to direct the catch toward the grate to maximize the retention of the shrimp may be used but may not have mesh less than 1-3/8 inch stretched mesh.
- Vessels fishing in the shrimp fishery may not possess regulated groundfish species.

4.1.12 Size Sorting Grate Systems *(No changes proposed)*

It shall be unlawful for any vessel rigged for otter trawling to fish for, land, or have in possession, northern shrimp except by using trawls equipped with either a compound grate or a double-Nordmore grate as described below. This provision may be modified via Section action during annual specifications, i.e., an addendum is not required.

The compound grate (Figure 6) is a rigid or semi-rigid planar device referred to as a "compound grate" because it has two different sections of parallel or non-parallel bars oriented vertically (up and down). The top section shall be configured as a finfish excluder device and shall consist of parallel bars attached to the frame with spaces between the bars not to exceed 1 inch in width. A fish outlet, or hole, in the extension of the trawl shall exist forward of the cod end and compound grate. The bottom section will allow the escape of small shrimp and will consist of parallel or non-parallel tapered bars oriented up and down with spacing between bars of $^{5}/_{16}$ inch to ½ inch. The lower edge of the cod end will be attached to the grate at the juncture between the top section and the bottom section, creating a shrimp outlet similar to the fish outlet described above, that will allow the escape of shrimp that pass through the bars of the bottom section of the grate. The compound grate also has the following optional provisions:

- This grate may be fished "upside down", that is, with the Finfish Excluder section and outlet on the bottom and the shrimp size separator section and outlet on the top.
- A webbing funnel may be installed in front of the grate designed to direct the catch toward the grate to maximize the retention of the shrimp may be used but may not have mesh less than 1-3/8 inch stretched mesh.

The double-Nordmore setup (Figure 7) is comprised of two separate grates; one of the grates must be a finfish excluder device (commonly referred to as the "Nordmore Grate System") and shall consist of:

- A rigid or semi-rigid grate consisting of vertical parallel bars attached to the frame with spaces between the bars not to exceed 1 inch in width;
- A fish outlet, or hole, in the extension of the trawl forward of the cod end and grate; and
- A webbing funnel installed in front of the grate designed to direct the catch toward the grate to maximize the retention of the shrimp may be used but may not have mesh less than 1-3/8 inch stretched mesh.
- Vessels fishing in the shrimp fishery shall not be allowed to possess regulated groundfish species.

The second grate may be fished in front or behind the Nordmore grate. The second grate shall consist of:

- A rigid or semi-rigid planar device with vertical bar spacing of 7/16 of an inch (tolerance – must be greater than 5/16 inch but less than ½ inch).
- The exit holes to the cod end must be at the top and no more than 10% of the surface area.
- A funnel in front of the second grate designed to direct the catch toward the grate to maximize the escape of small shrimp may be used but may not have mesh less than 1-3/8 inch stretched mesh.

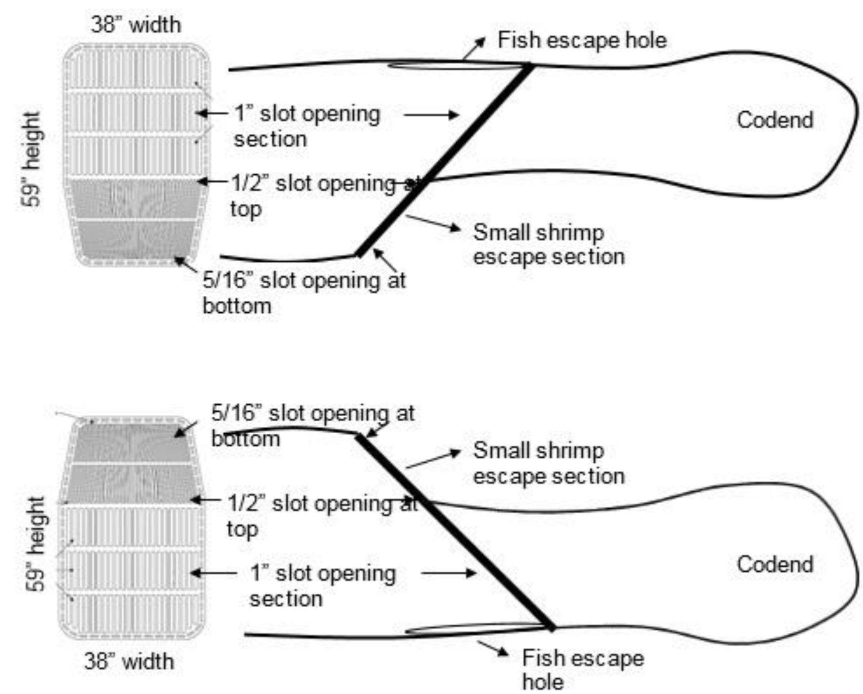

Figure 6. Schematic diagram of the compound size sorting grate to minimize the retention of small shrimp. The top panel diagrams the small shrimp size sorting section of the grate at the bottom (ventral) side of the net. The bottom panel diagrams the small shrimp size sorting section of the grate at the top (dorsal) side of the net.

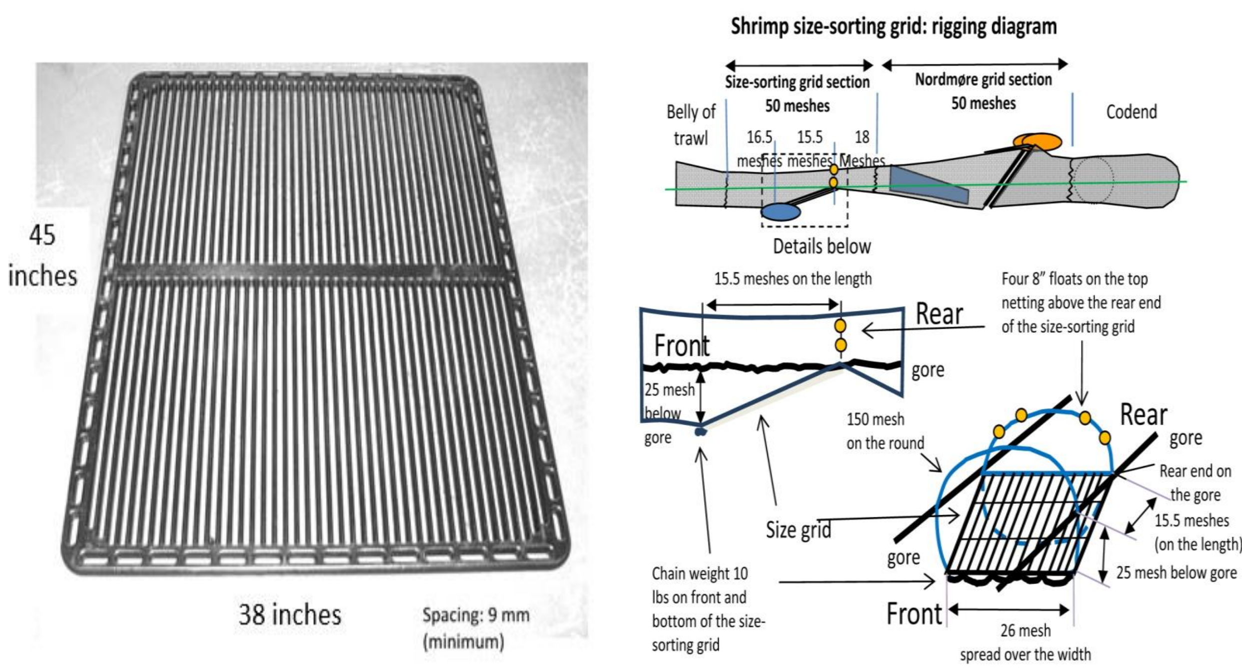

Figure 7. Schematic diagram of the double-Nordmore grate configuration (He and Balzano 2012).

4.1.13 Management Triggers

The following management trigger options have been developed to consider how to set management responses to observed changes in biological and/or environmental conditions in the northern shrimp stock. The management trigger options included in this document are intended to identify favorable trends in recruitment (i.e. year class strength and persistence through the time series) or temperature (i.e. cooler temperatures) that may indicate an increase in northern shrimp abundance. Under no option does a triggered response include the automatic opening of a northern shrimp fishing season.

Trigger options were developed to include a combination of recruitment and environmental indicators as directed by the Section. Favorable trends in recruitment include year-class strength and persistence for multiple years, as an indication of potential stock recovery. Recruitment has been identified as a preferred indicator due to higher northern shrimp landings observed in years following recruitment of dominant year classes that have survived to become spawning females. Favorable trends in environmental conditions for this stock include cooler winter surface temperature and cooler spring bottom temperature.

Given discontinuation of the summer shrimp survey, uncertainties surrounding the remaining spring and fall surveys, and the potential for industry-collected research in the future, a provision for the incorporation of new data is included in the options below to allow for the NSTC to include new data sources into a management trigger and adjust trigger thresholds in the future.

Option A: Status Quo
This option represents the status quo option where management triggers would not be used to monitor and respond to changing conditions in the northern shrimp stock or Gulf of Maine environment. If this option is selected, this section would be removed from Amendment 4.

Option B: Management Trigger(s)
Under this option, a management trigger(s) would be added to annual stock monitoring conducted by the NSTC. If the trigger(s) is reached, each sub-option below defines a management response depending on the trigger. When the Section takes final action on Amendment 4, there is an opportunity to select one or multiple of the sub-options below. In addition to the trigger sub-options, this option includes a new data provision.

<u>Sub-Option B.1: Recruitment Trigger</u>
A recruitment trigger would be annually evaluated by the NSTC. The recruitment trigger under this sub-option is defined by three consecutive years of non-failed recruitment. Non-failed recruitment is a recruit index value above the 20th percentile of the reference period (1984-2017) where strength of that year class persists through to subsequent years, as observed through length frequency analysis. For this trigger to be reached, recruitment values from both the Maine-New Hampshire Inshore Spring Survey and the NEFSC Spring

Bottom Trawl Survey must be above the 20th percentile of the reference period for three consecutive years.

In the event that either survey goes offline temporarily, the trigger could be tripped if recruitment values from one of the surveys was above the 20th percentile of the reference period for three consecutive years and the other survey was above the 20th percentile of the reference period for two consecutive years in a three-year evaluation period (five out of six recruitment values are above the 20th percentile). If the survey remains offline for more than one year, the trigger could be tripped if four out of six recruitment values from three consecutive years are above the 20th percentile. These scenarios are only applicable if a survey is suspended or temporarily offline.

If the recruitment trigger is reached, it would prompt the NSTC to conduct a full stock assessment update with projections as soon as possible. Preferably before the next meeting of the Section to inform the potential for the fishery to reopen in the following year.

If the recruitment trigger is not reached and both surveys remain online, but the NSTC finds that recruitment has been above the 20th percentile of the reference period for two consecutive years, it would prompt the Section to consider reopening the winter sampling program. Conducting a winter sampling program without the use of size sorting grates may enable the NSTC to evaluate stage and length frequencies and year class persistence before commencing a full assessment update. If this scenario were to occur in a year in which the Section is not scheduled to meet to set specifications, it would prompt a meeting of the Section in that year. While this scenario triggers the Section to meet to consider opening the winter sampling program, the Section may open the sampling program at any time regardless of the tripping or presence of a management trigger.

If the recruitment trigger and the temperature trigger (below) are both selected for implementation, the following management responses would be used when each trigger is reached:

- If just the recruitment trigger is reached (*Sub-Option B.1*) – NSTC would conduct a full stock assessment update with projections.
- If just the temperature trigger is reached (*Sub-Option B.2*) – Section would consider running winter sampling program as soon as possible with size sorting grates removed to capture recruitment information.
- If recruitment and temperature triggers are not reached, but recruitment is above the 20th percentile of the reference period for two consecutive years and both surveys remain online (*Sub-Option B.1*) – Section would consider running winter sampling program as soon as possible with size sorting grates removed to capture recruitment information.
- If recruitment and temperature triggers are both reached (*Sub-Option B.1 and B.2*) - NSTC would conduct a full stock assessment update with projections. The Section

may choose to also run the winter sampling program with the size sorting grates removed, if desired.

Sub-Option B.2: Temperature Trigger

A temperature trigger would be annually evaluated by the NSTC. The temperature trigger under this sub-option is defined by two out of three consecutive years of winter surface temperature (Boothbay Harbor, Maine) and spring bottom temperature (NEFSC Spring Bottom Trawl Survey) below the 80^{th} percentile of the reference period (1984-2017).

If the temperature trigger is reached, it would prompt the option to reopen the winter sampling program without the use of size sorting grates, if desired by the Section. By running the winter sampling program without the use of size sorting grates, the NSTC may evaluate industry-sampled recruitment. It should be noted that regardless of the presence or tripping of a temperature trigger, the Section may choose to set a research set-aside (RSA) quota and reopen the winter sampling program at any time as part of the specifications process. The temperature trigger is intended to signal that the winter sampling program would be beneficial in considering further steps to reopen the fishery such as a stock assessment update. However, temperature alone would not be sufficient indicator to run a full stock assessment update with projections unless more information is gathered about the condition of the stock.

If the recruitment trigger and the temperature trigger are both selected for implementation, the following management responses would be used when each trigger is reached:

- If just the recruitment trigger is reached (*Sub-Option B.1*) – NSTC would conduct a full stock assessment update with projections.
- If just the temperature trigger is reached (*Sub-Option B.2*) – Section would consider running winter sampling program as soon as possible with size sorting grates removed to capture recruitment information.
- If recruitment and temperature triggers are not reached, but recruitment is above the 20^{th} percentile of the reference period for two consecutive years and both surveys remain online (*Sub-Option B.1*) – Section would consider running winter sampling program as soon as possible with size sorting grates removed to capture recruitment information.
- If recruitment and temperature triggers are both reached (*Sub-Option B.1 and B.2*) - NSTC would conduct a full stock assessment update with projections. The Section may choose to also run the winter sampling program with the size sorting grates removed, if desired.

Provision for the Incorporation of New Data

In 2023, the longest running time series and only survey dedicated to understanding the Gulf of Maine northern shrimp resource, the summer shrimp survey, was indefinitely postponed. In addition to the loss of the summer survey, there is growing stakeholder concern the two supporting trawl surveys that have provided information on the northern shrimp population (dedicated groundfish surveys) do not provide robust enough information to manage the northern shrimp population.

This provision for the incorporation of new data under Option B outlines a process by which new information on northern shrimp or environmental conditions important to the stock may be incorporated into the management trigger mechanism should those data become available in the future. This data provision may also apply to defining the trigger thresholds for the recruitment and temperature triggers above. If a new time series becomes available that may be useful to include in a management trigger or to inform management trigger thresholds, the Section may task the NSTC to conduct an evaluation of the new data and/or new information as appropriate to modify management trigger data sources and thresholds. Once the NSTC evaluation of new data is complete, the NSTC would report their findings and trigger modification recommendations to the Section for Section approval via Section action (this can be done without an addendum/amendment).

4.2 RECREATIONAL FISHERIES MANAGEMENT MEASURES

No management measures are included for the recreational fisheries as this fishery is very limited, is usually carried out with the recreational lobster trap fishery, and is for personnel use.

4.3 HABITAT CONSERVATION AND RESTORATION

4.3.1 Preservation of Existing Habitat

The New England Fishery Management Council’s Omnibus Habitat Amendment 2 was implemented in 2018.

In the amendment, shrimp traps would not be restricted by any of the alternatives as there appears to have a low impact on habitat. The shrimp fishery, if available in a given year, typically begins on or around December 1, when many shrimp have already hatched their eggs for the breeding season. Therefore, no particular biological impacts are expected if the management alternatives lead to shifts in the distribution of shrimp trawling effort as the seasonality of the shrimp fishery already controls for impacts on shrimp spawning. While the fishery is open access in terms of participation, it is limited by a total allowable catch, which triggers closure of the fishery once harvested. There are also trip limits, trap limits, and days out which control the rate of harvest within the season. However, because shrimp undergo inshore/offshore migrations seasonally, the distribution of shrimp, and therefore shrimp fishing effort relative to habitat management areas, may vary from year to year.

Shrimp trawls are estimated to have an equivalent impact per unit area swept on vulnerable substrates to groundfish and other trawls. However, the fishery is conducted during a short winter season, often four to six weeks depending on how long it takes to catch the annual quota, and effort tends to occur on softer substrates given the distribution of northern shrimp.

Although shrimp fishing may cause some damage to these soft sediment habitats, the short season allows for some recovery during the remainder of the year. Based on these considerations, the Council exempted shrimp trawl gear from bottom trawling restrictions in the northwestern corner of the Western Gulf of Maine Habitat Closure Area. The shrimp exemption area identified in the amendment lies west of Jeffreys Ledge in an area historically, although not recently, used by the shrimp fishery.

Additionally, spring and autumn distributions of northern shrimp appear to have a greater dependence on local temperature conditions as opposed to habitat bottom types. An inshore shift is evident in spring when temperatures are coldest; and data from state-federal summer surveys indicate a very strong preference for bottom temperatures between 4-6˚C, the coldest observed range in the survey region at this time of year (Clark *et al*., 1999). Within this range, the species was found to be most common on fine-grained sediments (Clark et al., 1999). Highest concentrations, however, were clearly defined by the 6˚C isotherm; and to the east of Cashes Ledge and Jeffreys Bank, where temperatures tended to exceed 6˚C, abundance was observed to decline sharply, even in areas where bottom conditions are favorable.

4.3.2 Habitat Restoration, Improvement, and Enhancement

As indicated previously, temperature appears to be one of the most critical habitat factors in all life stages of northern shrimp.

Changing climate conditions are reshaping ecosystems in ways that affect resources and ecosystem services. With water temperatures in the Gulf of Maine rising at a higher rate (0.03°C per year) than the global mean rate (0.01°C per year) and a clear relationship between northern shrimp population and temperature, habitat restoration may be moot and protection of the remaining population by regulating the fishery may be the only manner to preserve the population with the current climate conditions

4.4 ALTERNATIVE STATE MANAGEMENT REGIMES

Once approved by the Northern Shrimp Section, states are required to obtain prior approval from the Section of any changes to their management program for which a compliance requirement is in effect. Other non-compliance measures must be reported to the Section but may be implemented without prior approval from the Section. A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Section's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.5*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Section and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

4.4.1 General Procedures (*No changes proposed)*

A state may submit a proposal for a change to its regulatory program or any mandatory compliance measure under this amendment to the Commission, including a proposal for *de minimis* status. Such changes shall be submitted to the Chair of the Plan Review Team, who shall distribute the proposal to the Section, the Plan Review Team, the Technical Committee and the Advisory Panel.

The Plan Review Team is responsible for gathering the comments of the Technical Committee and the Advisory Panel, and presenting these comments as soon as possible to the Section for decision.

The Section will decide whether to approve the state proposal for an alternative management program if it determines that it is consistent with the applicable target fishing mortality rate, and the goals and objectives of this amendment.

4.4.2 Management Program Equivalency (*No changes proposed)*

The Northern Shrimp Technical Committee will review any alternative state proposals under this section and provide its evaluation of the adequacy of such proposals to the Section.

4.5 ADAPTIVE MANAGEMENT

The Northern Shrimp Section may vary the requirements specified in this Amendment as a part of adaptive management in order to conserve the northern shrimp resource. The elements that can be modified by adaptive management are listed in *Section 4.5.2.2*. The process under which adaptive management can occur is provided below.

4.5.1 General Procedures (*No changes proposed)*

The Plan Review Team (PRT) will monitor the status of the fishery and the resource and report on that status to the Section annually, or when directed to do so by the Section. The PRT will consult with the Technical Committee and the Advisory Panel in making such review and report. The report will contain recommendations concerning proposed adaptive management revisions to the management program if necessary.

The Section will review the report of the PRT, and may consult further with the Technical Committee or the Advisory Panel. The Section may direct the PRT to prepare the documentation necessary to make any changes to the management program.

Should the Section deem that an addendum to the fishery management plan is necessary, the Plan Development Team (PDT) will prepare a draft addendum and shall distribute it to all states for review and comment. A public hearing will be held in any state that requests one. The PRT will also request comment from federal agencies and the public at large. After a 30-day review period, the PDT will summarize the comments and prepare a final version of the addendum for the Section.

The Section shall review the final version of the addendum prepared by the PDT, and shall also consider the public comments received and the recommendations of the Technical Committee, the Stock Assessment Subcommittee and the Advisory Panel; and shall then decide whether to adopt or revise and adopt the addendum.

Upon adoption of an addendum implementing adaptive management by the Section, states shall prepare proposals in which their plans to carry out the addendum are outlined and submit them to the Section for approval, according to a schedule to be contained in the addendum.

4.5.2 Measures Subject to Change

4.5.2.1 Limited Entry – Control Date (*No changes proposed)*

Amendment 4 does not consider limited entry as means of controlling effort in the fishery. However, this amendment maintains the control date of June 7, 2011, established during the development of Amendment 2.

The Section established this control date for in the event that development of a limited entry program through the adaptive management process (refer *Section 4.5.1*) is warranted. The intention of the control date is to notify potential new entrants to the fishery that there is a strong possibility they will be treated differently from participants in the fishery prior to the control date. The Section may use historic landings and/or participation criteria for current and past participants as the limited entry system is established.

4.5.2.2 Measures Subject to Change through Adaptive Management

Option A: Status Quo

The following measures are subject to change under adaptive management upon approval by the Northern Shrimp Section:

(1) Biological Reference Points can be changed through Section action (no addendum necessary) per *Section 2.5* of this amendment
(2) Rebuilding target and schedule
(3) Gear requirements or prohibitions
(4) Management areas
(5) Harvest set-asides
(6) Limited/controlled entry (including, but not limited to, days-at-sea and ITQs/IFQs and catch shares)
(7) Catch controls (quotas)
(8) Vessel limits
(9) Recommendations to the Secretary of Commerce for complementary action
(10) Research or monitoring requirements
(11) Frequency of stock assessments
(12) Any other management measures included in Amendment 4 that are not subject to annual specification
(13) Vessel monitoring programs

Option B: Adding Specifications Setting Timeline and Management Triggers to Adaptive Management

The following measures are subject to change under adaptive management upon approval by the Northern Shrimp Section:

(1) Biological Reference Points can be changed through Section action (no addendum necessary) per *Section 2.5* of this amendment
(2) Rebuilding target and schedule
(3) Gear requirements or prohibitions
(4) Management areas
(5) Harvest set-asides
(6) Limited/controlled entry (including, but not limited to, days-at-sea and ITQs/IFQs and catch shares)
(7) Catch controls (quotas)
(8) Vessel limits
(9) Recommendations to the Secretary of Commerce for complementary action
(10) Research or monitoring requirements
(11) Frequency of stock assessments
(12) Vessel monitoring programs
(13) Specifications setting timeline
(14) Fishing season
(15) Any management trigger modification not subject to change via the new data provision
(16) Any other management measures included in Amendment 4

4.6 EMERGENCY PROCEDURES

Emergency procedures may be used by the Northern Shrimp Section to require any emergency action that is not covered by or is an exception or change to any provision in Amendment 4. Procedures for implementation are addressed in the ASMFC ISFMP Charter, Section 6(c)(11) (ASMFC 2019).

4.7 MANAGEMENT INSTITUTIONS

4.7.1 Atlantic States Marine Fisheries Commission and ISFMP Policy Board

The Atlantic States Marine Fisheries Commission and the ISFMP Policy Board are generally responsible for the oversight and management of the Commissions fisheries management activities. The Commission must approve all fishery management plans and amendments thereto, including this Amendment; and make all final determinations concerning state compliance or noncompliance. The ISFMP Policy Board reviews recommendations of the various Management Boards and Sections and, if it concurs, forwards them on to the Commission for action.

4.7.2 Northern Shrimp Section

The Northern Shrimp Section was established by the Commission's ISFMP Policy Board and is generally responsible for carrying out all activities under this Amendment. The Section is represented by appointed members from Maine, New Hampshire, and Massachusetts. Each state's delegation consists of the three representatives (commissioners), including the director of the state's marine fisheries agency, a governor's appointee, and a legislative appointee.

The Section is responsible for the management of the northern shrimp fishery and resource through the development and implementation of the Interstate Fishery Management Plan for Northern Shrimp. This responsibility involves soliciting public participation during the development of plan amendments and addenda, as well as during the annual fishery specification process. The Section establishes and oversees the activities of the Plan Review Team and the Technical Committee and appoints relevant and qualified industry representatives to the Commission's Northern Shrimp Advisory Panel. In addition, the Section adjusts and revises the management program under adaptive management and approves state programs implementing the plan amendments and alternative state programs. The Section reviews the status of state compliance with the FMP at least annually and, if it determines that a state is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

4.7.3 Northern Shrimp Plan Development/Review Team

The Plan Development Team (PDT) and the Plan Review Team (PRT) are composed of a small group of scientists and managers whose responsibility is to provide all of the staff support necessary to carry out and document the decisions of the Section. The Commission's Northern Shrimp Fishery Management Plan Coordinator chairs both teams. The Northern Shrimp PRT is directly responsible to the Section for providing information and documentation concerning the implementation, review, monitoring and enforcement of the FMP. The Northern Shrimp PDT is comprised of personnel from state and federal agencies who have scientific and management ability, and knowledge of northern shrimp. The PDT prepared all documentation necessary for the development of Amendment 4, using the best scientific information available and the most current stock assessment information.

4.7.4 Northern Shrimp Technical Committee

The Northern Shrimp Technical Committee consists of, at a minimum, one representative from each state agency with an interest in the Northern Shrimp fishery and one representative from the National Marine Fisheries Service, and two social scientists. Its role is to act as a liaison to the individual state agencies, providing information to the management process and review and recommendations concerning the management program. The Technical Committee reports to the Section. The Section may appoint additional members to the Technical Committee, as needed.

4.7.5 Northern Shrimp Advisory Panel

Consistent with the Commission's Advisory Committee Charter, the Section appoints industry representatives to serve on the Northern Shrimp Advisory Panel. Members of the Advisory Panel are citizens who represent a cross-section of commercial fishing interests and provide guidance directly to the Section concerning the Commission's northern shrimp management program.

4.8 RECOMMENDATIONS TO THE SECRETARY FOR COMPLEMENTARY ACTIONS IN FEDERAL JURISDICTIONS

The Section may make recommendations to the Secretary of Commerce for complementary action in federal waters through the addendum or amendment process. There is no Federal representation on the Section and the Commission and states manage the fishery through the work of the Section. However, much of the fishery occurs in Federal waters and is prosecuted by fishermen with Federal fishery permits. To address this issue, NOAA Fisheries implemented exemptions to the Federal Northeast Multispecies (groundfish) Fishery to allow Federal groundfish vessels to participate in the small-mesh northern shrimp fishery. Those exemptions, set forth in 50 CFR 648.80(a)(5), allow Federal groundfish vessels to fish with a smaller mesh size when targeting shrimp, than what is allowable for the Multispecies fishery. Participants in the exemption program must also use a Nordmore grate system. Additionally, the exemption sets restrictions on incidental catch of other species such as whiting, hake, and lobster, and restricts participants to shrimping within the seasonal constraints adopted by the Commission.

4.9 COOPERATION WITH OTHER MANAGEMENT INSTITUTIONS

The Section will cooperate, when necessary, with other management institutions during the implementation of this amendment, including the National Marine Fisheries Service and the New England Fishery Management Council. There is no Federal fishery management plan for northern shrimp. Federal regulations exempt Federal groundfish vessels from the groundfish mesh sizes when participating in the shrimp fishery. The exemptions set forth incidental catch restrictions and require the use of a Nordmore grate. See *Section 4.8* for additional information.

5.0 COMPLIANCE

Full implementation of the provisions of this amendment is necessary for the management program to be equitable, efficient, and effective. States are expected to implement these measures faithfully under state laws. ASMFC will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this fishery management plan. The Section sets forth specific elements states must implement in order to be in compliance with this fishery management plan and the procedures that will govern the evaluation of compliance. Additional details of the procedures are found in the ASMFC Interstate Fishery Management Program Charter (ASMFC 2019).

5.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

A state will be determined to be out of compliance with the provision of this fishery management plan according to the terms of Section Seven of the ISFMP Charter if:

- Its regulatory and management programs to implement *Section 4* have not been approved by the Northern Shrimp Section; or
- It fails to meet any schedule required by *Section 5.1.2*, or any addendum prepared under adaptive management (*Section 4.5*); or
- It has failed to implement a change to its program when determined necessary by the Northern Shrimp Section; or
- It makes a change to its regulations required under *Section 4*, or any addendum prepared under adaptive management (*Section 4.5*), without prior approval of the Northern Shrimp Section.

5.1.1 Mandatory Elements of State Programs

To be considered in compliance with this fishery management plan, all state programs must include harvest controls on shrimp fisheries consistent with the requirements listed throughout *Section 4.0*, except that a state may propose an alternative management program under *Section 4.5*, which, if approved by the Section, may be implemented as an alternative regulatory requirement for compliance.

5.1.1.1 Regulatory Requirements

States may begin to implement Amendment 4 after final approval by the Commission. States may not implement any regulatory changes concerning northern shrimp, nor any management program changes that affect their responsibilities under this amendment, without first having those changes approved by the Section.

> [TBD: Regulatory requirements to be set should the draft amendment be approved for implementation.]

5.1.1.2 Monitoring Requirements

To be considered in compliance with this fishery management plan, all state programs must implement monitoring requirements consistent with *Section 3.1.1*.

5.1.1.3 Research Requirements

No mandatory research requirements have been identified at this time. However, elements of state plans may be added to address any needs identified through implementation of Amendment 4.

5.1.1.4 Law Enforcement Requirements

All state programs must include law enforcement capabilities adequate for successfully implementing the jurisdiction's northern shrimp regulations. The adequacy of a state's enforcement activity will be measured by annual report to the ASMFC Law Enforcement Committee and the PRT.

5.1.1.5 Habitat Requirements

No mandatory habitat requirements have been identified at this time. Habitat requirements could be added at any time through adaptive management (*Section 4.5*).

5.1.2 Compliance Schedule

States must implement the provisions of this amendment no later than **[MM DD, YYYY; TBD if approved].** States may begin implementation prior to this date when approved by the full Commission.

While not under a moratorium, each state must submit an annual report concerning its northern shrimp fisheries and management program for the previous calendar year. Reports on compliance must be submitted to the Commission by each state no later than September 30 each year. A standard compliance report format has been prepared and adopted by the ISFMP Policy Board. States should follow the format provided when completing the annual compliance report.

5.2 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven (ASMFC 2019). The following summary is not meant in any way to replace the language found in the ISFMP Charter.

In brief, all states are responsible for the full and effective implementation and enforcement of fishery management plans in areas subject to their jurisdiction. Written compliance reports as specified in the plan or amendment must be submitted annually by each state with a declared interest. Compliance with Amendment 4 will be reviewed at least annually while the fishery is not under a moratorium. The Section, Policy Board or the Commission may request the PRT to conduct a review of plan implementation and compliance at any time.

The Northern Shrimp Section will review the written findings of the PRT within 60 days of receipt of a State's compliance report. Should the Section recommend to the Policy Board that a state be determined to be out of compliance, a rationale for the recommended noncompliance finding will be included addressing specifically the required measures of Amendment 4 that the state has not implemented or enforced, a statement of how failure to implement or enforce the required measures jeopardizes northern shrimp conservation, and the actions a state must take in order to comply with Amendment 4 requirements.

The ISFMP Policy Board will review any recommendation of noncompliance from the Northern Shrimp Section within 30 days. If it concurs in the recommendation, it shall recommend at that time to the ASMFC that a state be found out of compliance.

The Commission shall consider any noncompliance recommendation from the ISFMP Policy Board within 30 days. Any state that is the subject of a recommendation for a noncompliance finding is given an opportunity to present written and/or oral testimony concerning whether it should be found out of compliance. If the Commission agrees with the recommendation of the

ISFMP Policy Board, it may determine that a state is not in compliance with Amendment 4, and specify the actions the state must take to come into compliance.

Any state that has been determined to be out of compliance may request that the Commission rescind its noncompliance findings, provided the state has revised its northern shrimp conservation measures or shown to the ISFMP Policy Board and/or Commission's satisfaction that actions taken by the state provide for conservation equivalency.

5.3 ANALYSIS OF THE ENFORCEABILITY OF PROPOSED MEASURES

The ASMFC Law Enforcement Committee will, during the implementation of this amendment, analyze the enforceability of new conservation and management measures as they are proposed.

6.0 MANAGEMENT AND RESEARCH NEEDS

6.1 RESEARCH AND DATA NEEDS

Research recommendations from the 2018 benchmark assessment for northern shrimp are provided below (ASMFC 2018b).

Fishery-Dependent Priorities

- Evaluate selectivity of shrimp by traps and trawls *(high priority, short term)*
- Continue sampling of the northern shrimp commercial fishery, including port, sea, and RSA sampling to confirm, and if necessary update, the length-frequency of the species and identify any bycatch in the fishery *(high priority, long term)*
- Conduct a study comparing the effectiveness of the compound grate versus the double-Nordmore grate *(moderate priority, short term)*

Fishery-Independent Priorities

- Continuing sampling through summer shrimp survey despite the current low abundance of shrimp and the closure of the shrimp fishery in 2013 *(high priority, long term)*
- Explore ways to sample age 1 and younger shrimp *(moderate priority, short term)*

Modeling/Quantitative Priorities

- Continue research to refine annual estimates of consumption by predators, and include in models as appropriate *(high priority, short term)*
- Investigate growth parameters for the UME length-based model and the feasibility of adding a spatial-temporal structure to the model framework *(moderate priority, long term)*

Life History, Biological, and Habitat Priorities

- Investigate application of newly developed direct ageing methods to ground truth assumed ages based on size and stage compositions *(high priority, long term)*
- Evaluate larval and adult survival and growth, including frequency of molting and variation in growth rates, as a function of environmental factors and population density *(high priority, long term)*

- Study the effects of oceanographic and climatic variation (i.e., North Atlantic Oscillation) on the cold water refuges for shrimp in the Gulf of Maine *(high priority, long term)*
- Explore the mechanisms behind the stock-recruitment and temperature relationship for Gulf of Maine northern shrimp *(high priority, long term)*

Timing of Assessment Updates and Next Benchmark Assessment
The NSTC recommends that the assessment be updated annually to incorporate the most up-to-date data on abundance and recruitment into management recommendations. A benchmark assessment should be considered in five years if improvements in the length-based model or significant changes in the population warrant it.

7.0 PROTECTED SPECIES

7.1 SPECIES PRESENT IN THE AREA

Numerous protected species occur in the affected environment of the Northern Shrimp FMP (Table 6) and could be impacted by the proposed action (i.e., there have been observed/documented interactions in the fisheries or with gear types like those used in the fisheries. These species are under the National Marine Fisheries Service (NMFS) jurisdiction and are afforded protection under the Endangered Species Act (ESA) of 1973 and/or the Marine Mammal Protection Act (MMPA) of 1972.

7.2 SPECIES AND CRITICAL HABITAT NOT LIKELY AFFECTED BY THE PROPOSED ACTION

Based on available information, it has been determined that this action is unlikely to impact multiple ESA listed and/or MMPA protected species or any designated critical habitat (Table 6). This determination has been made because either the occurrence of the species is not known to overlap with the area primarily affected by the action and/or based on the most recent ten years of information on documented interactions between the species and the primary gear type used to prosecute the northern shrimp fishery (Greater Atlantic Region (GAR) Marine Animal Incident Database, unpublished data; NMFS Marine Mammal Stock Assessment Reports (SARs) for the Atlantic Region; NMFS NEFSC observer/sea sampling database, unpublished data; NMFS NEFSC marine mammal (small cetacean, pinniped, baleen whale) serious injury and mortality Reference Documents, Publications, or Technical Memoranda; MMPA List of Fisheries (LOF); NMFS 2021a).[1] In the case of critical habitat, this determination has been made because the action will not affect the essential physical and biological features of critical habitat identified in Table 6 and therefore, will not result in the destruction or adverse modification of any species critical habitat (NMFS 2021b).

[1] For MMPA protected species, the most recent 10 years of information on estimated bycatch of small cetacean and pinnipeds in commercial fisheries covers the timeframe between 2011-2020; for large baleen whales, confirmed human caused serious injury, mortality, and entanglement reports are from 2012-2021. For ESA listed species, information on observer or documented interactions with fishing gear is from 2012-2021; the exception is Sea Turtle Disentanglement Network data, which is available through 2022.

7.3 SPECIES POTENTIALLY AFFECTED BY THE PROPOSED ACTION

Table 6 lists protected species of sea turtle, marine mammal, and fish species present in the affected environment of the northern shrimp fishery, and that may also be impacted by the operation of this fishery; that is, could become entangled or bycaught in the fishing gear used to prosecute the fishery. To help identify MMPA protected species potentially impacted by the action, NMFS Marine Mammal SARs for the Atlantic Region, MMPA List of Fisheries (LOF), NMFS (2021b), NMFS NEFSC observer/sea sampling database (unpublished data), and NMFS NEFSC marine mammal (small cetacean, pinniped, baleen whale) serious injury and mortality Reference Documents, Publications, or Technical Memoranda were referenced.

To help identify ESA listed species potentially impacted by the action, the NMFS NEFSC observer/sea sampling, Sea Turtle Disentanglement Network (STDN), and the GAR Marine Animal Incident databases for interactions were queried and the May 27, 2021, Biological Opinion issued by NMFS was reviewed (NMFS 2021a).

As the primary concern for both MMPA protected and ESA listed species is the potential for the fishery to interact (e.g., bycatch, entanglement) with these species it is necessary to consider (1) species occurrence in the affected environment of the fishery and how the fishery will overlap in time and space with this occurrence; and (2) data and observed records of protected species interaction with particular fishing gear types, in order to understand the potential risk of an interaction. Information on species occurrence in the affected environment of the northern shrimp fishery and on protected species interactions with specific fishery gear is provided below.

7.3.1 Sea Turtles

Below is a summary of the status and trends, as well as the occurrence and distribution of sea turtles in the affected environment of the northern shrimp fishery. More information on the range-wide status of affected sea turtles species, as well as a description and life history of each of these species, is in several published documents, including NMFS (2021a); sea turtle status reviews and biological reports (Conant et al. 2009; Hirth 1997; NMFS & USFWS 1995; 2007a; b; 2013; TEWG 1998; 2000; 2007; 2009), and recovery plans for the loggerhead (Northwest Atlantic DPS) sea turtle (NMFS & USFWS 2008), leatherback sea turtle (NMFS & USFWS 1992; 1998b; 2020), Kemp's ridley sea turtle (NMFS & USFWS 2011), and green sea turtle (NMFS & USFWS 1991; 1998a).

Status and Trends
Four sea turtle species could be impacted by the proposed action: Northwest Atlantic Ocean DPS of loggerhead, Kemp's ridley, North Atlantic DPS of green, and leatherback sea turtles (Table 6). Although stock assessments and similar reviews have been completed for sea turtles none have been able to develop a reliable estimate of absolute population size. As a result, nest counts are used to inform population trends for sea turtle species.

For the Northwest Atlantic Ocean DPS of loggerhead sea turtles, there are five unique recovery units that comprise the DPS. Nesting trends for each of these recovery units are variable; however, Florida index nesting beaches comprise most of the nesting in the DPS (https://myfwc.com/research/wildlife/sea- turtles/nesting/beach-survey-totals/). Overall, short-term trends for loggerhead sea turtles (Northwest Atlantic Ocean DPS) have shown increases; however, over the long-term the DPS is considered stable (NMFS 2021a).

For Kemp's ridley sea turtles, from 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and therefore, the overall trend is unclear (NMFS and USFWS 2015; Caillouett et al. 2018). In 2019, there were 11,090 nests, a 37.61% decrease from 2018 and a 54.89% decrease from 2017, which had the highest number (24,587) of nests; the reason for this recent decline is uncertain (see NMFS 2021a). Given this and continued anthropogenic threats to the species, according to NMFS (2021a), the species resilience to future perturbation is low.

For Kemp's ridley sea turtles, from 1980-2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and therefore, the overall trend is unclear (Caillouet et al. 2018; NMFS & USFWS 2015). In 2019, there were 11,090 nests, a 37.61% decrease from 2018 and a 54.89% decrease from 2017, which had the highest number (24,587) of nests; the reason for this recent decline is uncertain. Given this and continued anthropogenic threats to the species, the species resilience to future perturbation is low (NMFS 2021a).

The North Atlantic DPS of green sea turtle, overall, is showing a positive trend in nesting; however, increases in nester abundance for the North Atlantic DPS in recent years must be viewed cautiously as the datasets represent a fraction of a green sea turtle generation which is between 30 and 40 years (Seminoff et al. 2015). While anthropogenic threats to this species continue, taking into consideration the best available information on the species, NMFS (2021a), concluded that the North Atlantic DPS appears to be somewhat resilient to future perturbations.

Leatherback turtle nesting in the Northwest Atlantic is showing an overall negative trend, with the most notable decrease occurring during the most recent time frame of 2008 to 2017 (Northwest Atlantic Leatherback Working Group 2018). The leatherback status review in 2020 concluded that leatherbacks are exhibiting an overall decreasing trend in annual nesting activity (NMFS & USFWS 2020). Given continued anthropogenic threats to the species, according to NMFS , the species' resilience to additional perturbation both within the Northwest Atlantic and worldwide is low.

Occurrence and Distribution

Hard-shelled sea turtles

In U.S. Northwest Atlantic waters, hard-shelled turtles commonly occur throughout the continental shelf from Florida to Cape Cod, MA, although their presence varies with the seasons due to changes in water temperature (Blumenthal et al. 2006; Braun-McNeill & Epperly 2002; Braun-McNeill et al. 2008; Braun & Epperly 1996; Epperly, Braun & Chester 1995; Epperly, Braun, Chester, et al. 1995; Griffin et al. 2013; Hawkes et al. 2006; Hawkes et al. 2011; Mansfield et al. 2009; McClellan & Read 2007; Mitchell et al. 2003; Morreale & Standora 2005; Shoop & Kenney 1992; TEWG 2009). As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the southeast United States and also move up the Atlantic Coast (Braun-McNeill & Epperly 2002; Epperly, Braun & Chester 1995; Epperly, Braun, Chester, et al. 1995; Epperly, Braun & Veishlow 1995; Griffin et al. 2013; Morreale & Standora 2005), occurring in Virginia foraging areas as early as late April and on the most northern foraging grounds in the GOM in June (Shoop & Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the GOM by September, but some remain in Mid-Atlantic and Northeast areas until late fall (i.e., November). By December, sea turtles have migrated south to waters offshore of North Carolina, particularly south of Cape Hatteras, and further south, although it should be noted that hard-shelled sea turtles can occur year-round in waters off Cape Hatteras and south (Epperly, Braun & Chester 1995; Griffin et al. 2013; Hawkes et al. 2011; Shoop & Kenney 1992).

Leatherback sea turtles

Leatherbacks, a pelagic species, are known to use coastal waters of the U.S. continental shelf and to have a greater tolerance for colder water than hard-shelled sea turtles (Dodge et al. 2014; Eckert et al. 2006; James et al. 2005; Murphy et al. 2006; NMFS & USFWS 2013). Leatherback sea turtles engage in routine migrations between northern temperate and tropical waters (Dodge et al. 2014; James et al. 2005; James et al. 2006; NMFS & USFWS 1992). They are found in more northern waters (i.e., GOM) later in the year (i.e., similar time frame as hard-shelled sea turtles), with most leaving the Northwest Atlantic shelves by mid-November (Dodge et al. 2014; James et al. 2005; James et al. 2006).

7.3.2 Marine Mammals

7.3.2.1 Large Whales

Status and Trends

Six large whale species could be impacted by the proposed action: humpback, North Atlantic right, fin, sei, sperm, and minke whales (Table 7). Large whale stock assessment reports covering the period of 2011-2020, indicate a decreasing trend for the North Atlantic right whale population; however, for fin, humpback, minke, sperm, and sei whales, it is unknown what the population trajectory is as a trend analysis has not been conducted. The NMFS Marine Mammal SARs for the Atlantic Region has more information on the status of humpback, North Atlantic right, fin, sei, sperm, and minke whales.

Occurrence and Distribution.

North Atlantic right, humpback, fin, sei, sperm, and minke whales occur in the Northwest Atlantic Ocean. As large whales may be present in these waters throughout the year, the northern shrimp fishery and large whales are likely to co-occur in the affected area. To further assist in understanding how the northern shrimp fishery overlaps in time and space with the occurrence of large whales, Table 7 is an overview of species occurrence and distribution in the affected environment of the fishery. More information on North Atlantic right, humpback, fin, sei, sperm, and minke whales is in NMFS Marine Mammal SARs for the Atlantic Region.

7.3.2.2 Small Cetaceans

Status and Trends

Risso's, white-sided, short beaked common, and bottlenose dolphins (Western North Atlantic Offshore, Northern Migratory Coastal, and Southern Migratory Coastal stocks); long and short – finned pilot whales; and harbor porpoise could be impacted by the proposed action (Table 8). As a trend analysis has not been conducted for Risso's, white-sided, short-beaked common dolphins; long-finned pilot whales; or harbor porpoise, the population trajectory for these species is unknown (Hayes et al. 2021). For short-finned pilot whales a generalized linear model indicated no significant trend in the abundance estimates (Hayes et al. 2022). For the Western North Atlantic Offshore stock, review of the most recent information on the stock shows no statistically significant trend in population size for this species; however, the high level of uncertainty in the estimates limits the ability to detect a statistically significant trend. In regards to the Northern and Southern Migratory Coastal stocks (both considered a strategic stock under the MMPA), the most recent analysis of trends in abundance suggests a probable decline in stock size between 2010–2011 and 2016, concurrent with a large UME in the area; however, there is limited power to evaluate trends given uncertainty in stock distribution, lack of precision in abundance estimates, and a limited number of surveys (Hayes et al. 2021).

Occurrence and Distribution

Atlantic white sided dolphins, short and long finned pilot whales, Risso's dolphins, short beaked common dolphins, harbor porpoise, and several stocks of bottlenose dolphins are found throughout the year in the Northwest Atlantic Ocean (see NMFS Marine Mammal SARs for the Atlantic Region). Within this range, however, there are seasonal shifts in species distribution and abundance. To further assist in understanding how the northern shrimp fishery overlaps in time and space with the occurrence of small cetaceans, Table 8 is an overview of species occurrence and distribution in the affected environment of the fishery. More information on small cetacean occurrence and distribution in the Northwest Atlantic is in the NMFS Marine Mammal SARs for the Atlantic Region.

7.3.2.3 Pinnipeds

Status and Trends

Harbor, gray, harp and hooded seals are identified as having the potential to be impacted by the proposed action (Table 9). Based on Hayes et al. (2019; 2022), the status of the:

- Western North Atlantic harbor seal and hooded seal, relative to Optimum Sustainable Population (OSP), in the U.S. Atlantic EEZ is unknown;
- gray seal population relative to OSP in U.S. Atlantic EEZ waters is unknown, but the stock's abundance appears to be increasing in Canadian and U.S. waters; and,
- harp seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the stock's abundance appears to have stabilized.

Occurrence and Distribution
Harbor, gray, harp, and hooded seals are found in the nearshore, coastal waters of the Northwest Atlantic Ocean. Depending on species, they may be present year-round or seasonally in some portion of the affected environment of the northern shrimp fishery. To further assist in understanding how the northern shrimp fishery overlaps in time and space with the occurrence of pinnipeds, Table 9 is an overview of species occurrence and distribution in the affected environment of the fishery. More information on pinniped occurrence and distribution in the Northwest Atlantic, is in the NMFS Marine Mammal SARs for the Atlantic Region.

7.3.3 Atlantic Sturgeon

Status and Trends
Atlantic sturgeon (all five DPSs) could be impacted by the proposed action (Table 6). Population trends for Atlantic sturgeon are difficult to discern; however, the most recent stock assessment report concludes that Atlantic sturgeon, at both coastwide and DPS level, are depleted relative to historical levels (ASMFC 2017; ASSRT 2007; NMFS 2021a).

Occurrence and Distribution
The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. All five DPSs of Atlantic sturgeon could be located anywhere in this marine range (Altenritter et al. 2017; ASMFC 2017; ASSRT 2007; Breece et al. 2016; Breece, Fox, Haulsee, et al. 2018; Dadswell 2006; Dadswell et al. 1984; Dovel & Berggren 1983; Dunton et al. 2015; Dunton et al. 2010; Erickson et al. 2011; Hilton et al. 2016; Ingram et al. 2019; Kazyak et al. 2021; Kynard et al. 2000; Laney et al. 2007; Novak et al. 2017; O'Leary et al. 2014; Rothermel et al. 2020; Stein et al. 2004a; Waldman et al. 2013; Wippelhauser et al. 2017; Wirgin, Breece, et al. 2015; Wirgin, Maceda, et al. 2015).

Based on fishery-independent and dependent surveys, and data collected from genetic, tracking, and/or tagging studies in the marine environment, Atlantic sturgeon appear to typically occur inshore of the 50 meter depth contour; however, Atlantic sturgeon are not restricted to these depths, as excursions into deeper continental shelf waters have been documented (Altenritter et al. 2017; Breece et al. 2016; Breece, Fox & Oliver 2018; Collins & Smith 1997; Dunton et al. 2010; Erickson et al. 2011; Ingram et al. 2019; Novak et al. 2017; Rothermel et al. 2020; Stein et al. 2004a; b; Wippelhauser et al. 2017). In addition to depth, numerous studies have demonstrated that temperature is a key variable in Atlantic sturgeon presence and distribution in the marine environment (Altenritter et al. 2017; Breece, Fox & Oliver 2018; Erickson et al. 2011; Ingram et al. 2019; Novak et al. 2017; Rothermel et al. 2020; Wippelhauser et al. 2017). Data from fishery-independent and dependent surveys, and data collected from genetic, tracking, and/or tagging studies also indicate that Atlantic sturgeon make seasonal coastal movements from marine waters to river estuaries in the spring and from river estuaries to marine waters in the fall; however, there is no evidence to date that all Atlantic sturgeon make these seasonal movements and therefore, may be present throughout the marine environment throughout the year (Altenritter et al. 2017; Breece, Fox & Oliver 2018; Dunton et al. 2010; Erickson et al. 2011; Ingram et al. 2019; Novak et al. 2017; Rothermel et al. 2020; Wippelhauser 2012; Wippelhauser et al. 2017). When in the marine environment, Atlantic sturgeon presence and distribution in nearshore or offshore environments also appears to be seasonally variable; with preference for shallow, coastal waters in the spring, more offshore waters in the late fall- winter, and mouths of estuaries in the summer. Residency times in these areas of the marine environment are variable, with suitable environmental conditions (e.g., depth and temperature) dictating residency in an area (Altenritter et al. 2017; Breece, Fox & Oliver 2018; Erickson et al. 2011; Ingram et al. 2019; Novak et al. 2017; Rothermel et al. 2020; Wippelhauser et al. 2017).

More information on the biology and range wide distribution of each DPS of Atlantic sturgeon is in 77 FR 5880 and 77 FR 5914, the Atlantic Sturgeon Status Review Team's (ASSRT) 2007 status review of Atlantic sturgeon (ASSRT 2007); the ASMFC 2017 Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report (ASMFC 2017), and NMFS (2021a).

7.3.4 Atlantic Salmon (Gulf of Maine DPS)

Status and Trends

Atlantic salmon (GOM DPS) could be impacted by the proposed action (Table 6). There is no population growth rate available for GOM DPS Atlantic salmon; however, the consensus is that the DPS exhibits a continuing declining trend (NMFS 2021a; NMFS & USFWS 2018; NOAA 2016).

Occurrence and Distribution

The wild populations of Atlantic salmon are listed as endangered under the ESA. Their freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, while the marine range of the GOM DPS extends from the GOM (primarily the northern portion) to the coast of Greenland (Fay et al. 2006; NMFS & USFWS 2005; 2016). In general, smolts, post-smolts, and adult Atlantic salmon may be present in the GOM and coastal waters of Maine in the spring (beginning in April), and adults may be present throughout the summer and fall months (Baum 1997; Fay et al. 2006; Hyvärinen et al. 2006; Lacroix & Knox 2005; Lacroix & McCurdy 1996; Lacroix et al. 2004; NMFS & USFWS 2005; 2016; Reddin 1985; Reddin & Friedland 1993; Reddin & Short 1991; Sheehan et al. 2012; USASAC 2013). More information on the on the biology and range wide distribution of the GOM DPS of Atlantic salmon is in NMFS and USFWS (2005; 2016); Fay et al. (2006); and NMFS (2021a).

7.4 INTERACTIONS BETWEEN GEAR AND PROTECTED RESOURCES

Protected species are at risk of interacting (e.g., bycaught or entangled) with various types of fishing gear, with interaction risks associated with gear type, quantity, soak or tow duration, and degree of overlap between gear and protected species. Information on observed or documented interactions between gear and protected species is available from as early as 1989 (NMFS Marine Mammal SARs for the Atlantic Region; NMFS NEFSC observer/sea sampling database, unpublished data). As the distribution and occurrence of protected species and the operation of fisheries (and, thus, risk to protected species) have changed over the last 30 years, we use the most recent 10 years of available information to best capture the current risk to protected species from fishing gear. For marine mammals protected under the MMPA, the most recent 10 years of information on estimated bycatch of small cetacean and pinnipeds in commercial fisheries covers the timeframe between 2011-2020; for large baleen whales, confirmed human caused serious injury, mortality, and entanglement reports are from 2012-2021 (GAR Marine Animal Incident Database, unpublished data; Cole et al. 2013; Cole & Henry 2013; Hayes et al. 2017; 2018; 2019; 2020; Hayes et al. 2021; Hayes et al. 2022; 2023; Henry et al. 2017; Henry et al. 2016; Henry et al. 2020; Henry et al. 2021; 2022; 2023; Henry et al. 2019; Waring et al. 2016). For ESA listed species, the most recent ten years of data on observed or documented interactions is available from 2012-2021; the exception is Sea Turtle Disentanglement Network data, which is available through 2022 (ASMFC 2017; Kocik et al. 2014; NMFS 2021a; unpublished data: GAR Marine Animal Incident Database, NMFS NEFSC observer/sea sampling database, GAR Sea Turtle and Disentanglement Network, NMFS Sea Turtle Stranding and Salvage Network) (NMFS Marine Mammal SARs for the Atlantic Region; NMFS NEFSC protected species serious injury and mortality Reference Documents, Publications, or Technical Memoranda). Available information on gear interactions with a given species (or species group) is in the sections below. This is not a comprehensive review of all fishing gear types known to interact with a given species; emphasis is only being placed on the primary gear types used to prosecute the northern shrimp fishery.

7.4.1 Sea Turtles

Bottom Trawl Gear

Bottom trawl gear poses an injury and mortality risk to sea turtles (Sasso & Epperly 2006; NMFS Observer Program, unpublished data). Since 1989, the date of our earliest observer records for federally managed fisheries, sea turtle interactions with trawl gear have been observed in the GOM, Georges Bank, and/or the Mid-Atlantic; however, most of the observed interactions have been observed south of the GOM (Murray 2008; 2015; 2020; NMFS 2021a; Warden 2011a; b). As few sea turtle interactions have been observed in the GOM, there is insufficient data available to conduct a robust model-based analysis and bycatch estimate of sea turtle interactions with trawl gear in this region. As a result, the bycatch estimates and discussion below are for trawl gear in the Mid-Atlantic and Georges Bank.

Murray (2015) estimated that from 2009-2013, the total average annual loggerhead interactions in bottom trawl gear in the Mid-Atlantic was 231 (CV=0.13, 95% CI=182-298); this equates to approximately 33 adult equivalents. Most recently, Murray (2020) provided information on sea turtle interaction rates from 2014-2018 (the most recent five-year period that has been statistically analyzed for trawls). Interaction rates were stratified by region, latitude zone, season, and depth. The highest loggerhead interaction rate (0.43 turtles/day fished) was in waters south of 37º N during November to June in waters over 50 m deep. The most estimated interactions occurred in the Mid-Atlantic region north of 39º N, during July to October in waters under 50 m deep. In each stratum, interaction rates for non-loggerhead species were lower than rates for loggerheads (Murray 2020).

Based on Murray (2020)[2], from 2014-2018, 571 loggerhead (CV=0.29, 95% CI=318-997), 46 Kemp's ridley (CV=0.45, 95% CI=10-88), 20 leatherback (CV=0.72, 95% CI=0-50), and 16 green (CV=0.73, 95% CI=0-44) sea turtle interactions were estimated to have occurred in bottom trawl gear in the Mid- Atlantic region over the five-year period. On Georges Bank, 12 loggerheads (CV=0.70, 95% CI=0-31) and 6 leatherback (CV=1.0, 95% CI=0-20) interactions were estimated to have occurred from 2014-2018. An estimated 272 loggerhead, 23 Kemp's ridley, 13 leatherback, and 8 green sea turtle interactions resulted in mortality over this period (Murray 2020).

Pot/Trap Gear

Leatherback, loggerhead, green, and kemp's ridley sea turtles are at risk of interacting with trap/pot gear; however, review of data provided by the NEFSC Observer Program, VTR, and the NMFS Greater Atlantic Region (GAR) Sea Turtle Disentanglement Network (STDN), indicate that interactions between trap/pot gear and Kemp's ridley and green sea turtles are rare in the Greater Atlantic Region (NMFS 2021a). Sea turtle interactions with pot/trap gear are primarily associated with entanglement in vertical lines associated with this gear type; however, sea turtles can also become entangled in groundlines or surface system lines of pot/trap gear (Sea Turtle Disentanglement Network (STDN), unpublished data). Records of stranded or entangled sea turtles indicate that fishing gear can wrap around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding (Balazs 1985; STDN, unpublished data). As a result, sea turtles can incur serious injuries and, in some case, mortality immediately or at a later time.

Given few trap/pot trips have been observed by the NEFSC Observer Program over the last 10 years, and VTR reporting of incidences of interactions with sea turtles are limited, most reports of sea turtle entanglements in the vertical lines of trap/pot gear are documented by the NMFS Greater Atlantic Region (GAR; Maine through Virginia) Sea Turtle Disentanglement Network (STDN). Based on this, the STDN database, a component of the Sea Turtle Stranding and Salvage Network database, provides the most complete and best available dataset on sea turtle vertical line entanglements in the GAR. Confirmed and probable entanglement cases in the GAR STDN database from 2013-2022 were reviewed. Over this timeframe, 246 sea turtle entanglements in vertical line gear (known and unknown fishery) were documented. Of the 246 cases assessed, 233 involved leatherback sea turtles, 12 involved loggerhead sea turtles, and one involved a sea turtle of unknown species.

[2] Murray (2020) estimated interaction rates for each sea turtle species with stratified ratio estimators. This method differs from previous approaches (Murray 2008; 2015; Warden 2011a; b), where rates were estimated using generalized additive models (GAMs). Ratio estimator results may be like those using GAM or generalized linear models (GLM) if ratio estimators are stratified based on the same explanatory variables in a GAM or GLM model (Murray 2007; Murray & Orphanides 2013; Orphanides 2010).

7.4.2 Marine Mammals

Depending on species, marine mammals have been observed seriously injured or killed in bottom trawl gear. Pursuant to the MMPA, NMFS publishes a List of Fisheries (LOF) annually, classifying U.S. commercial fisheries into one of three categories based on the relative frequency of incidental serious injuries and/or mortalities of marine mammals in each fishery (i.e., Category I=frequent; Category II=occasional; Category III=remote likelihood or no known interactions). In the Northwest Atlantic, the 2023 LOF (88 FR 16899; March 21, 2023) categorizes commercial sink gillnet fisheries (Northeast and Mid-Atlantic) as a Category I fishery; and bottom trawl fisheries (Northeast or Mid-Atlantic) as a Category II fishery.

7.4.2.1 Large Cetaceans

Bottom Trawl Gear

Documented interactions between large whales and bottom trawl gear are infrequent. Review of the most recent 10 years of information on large whale entanglement in fishing gear indicates that between 2012-2021, there has been one confirmed entanglement case between a humpback whale and a full trawl net.[3] In 2020, a live, humpback whale was anchored/entangled in fishing gear, later identified by NMFS as trawl net. The animal was disentangled by trained responders from the Atlantic Large Whale Disentanglement Network. Given the disentanglement efforts, gear was removed and recovered from the animal, resulting in the whale being released alive, with non-serious injuries. Additional information on this incident can be found in the 2020 Atlantic Large Whale Entanglement Report and Henry et al. 2023.

Pot/trap Gear

Large whale interactions (entanglements) with fishing gear have been observed and documented in the waters of the Northwest Atlantic.[4] Information available on all interactions (e.g., entanglement, vessel strike, unknown cause) with large whales comes from reports documented in the GAR Marine Animal Incident Database (unpublished data). The level of information collected for each case varies, but may include details on the animal, gear, and any other information about the interaction (e.g., location, description, etc.). Each case is evaluated using defined criteria to assign the case to an injury/information category using all available information and scientific judgement. In this way, the injury severity and cause of injury/death for the event is evaluated, with serious injury and mortality determinations issued by the NEFSC.[5]

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[3] GAR Marine Animal Incident Database (unpublished data); NMFS Marine Mammal Stock Assessment Reports for the Atlantic Region; NMFS Atlantic Large Whale Entanglement Reports; MMPA List of Fisheries (LOF)

[4] NMFS Atlantic Large Whale Entanglement Reports: For years prior to 2014, contact David Morin, Large Whale Disentanglement Coordinator, David.Morin@NOAA.gov; GAR Marine Animal Incident Database (unpublished data); NMFS Marine Mammal Stock Assessment Reports for the Atlantic Region; NMFS NEFSC Baleen Whale Serious Injury and Morality Determinations Reference Documents, Publications, or Technical Memoranda; MMPA List of Fisheries; NMFS 2021a,b.

[5] NMFS NEFSC Baleen Whale Serious Injury and Morality Determinations Reference Documents, Publications, or Technical Memoranda.

Based on the best available information, the greatest entanglement risk to large whales is posed by fixed gear used in trap/pot or sink gillnet fisheries (Angliss & DeMaster 1998; Hamilton et al. 2019; Hartley et al. 2003; Henry et al. 2017; Henry et al. 2014; 2015; 2016; Henry et al. 2020; Henry et al. 2021; 2022; Henry et al. 2019; Johnson et al. 2005; Knowlton et al. 2012; NMFS 2021a; b; Sharp et al. 2019; Whittingham, Garron, et al. 2005; Whittingham, Hartley, et al. 2005) (NMFS Marine Mammal SARs for the Atlantic Region). Specifically, while foraging or transiting, large whales are at risk of becoming entangled in vertical endlines, buoy lines, or groundlines of gillnet and pot/trap gear, as well as the net panels of gillnet gear that rise into the water column (Baumgartner et al. 2017; Cassoff et al. 2011; Cole & Henry 2013; Hamilton & Kraus 2019; Hartley et al. 2003; Henry et al. 2017; Henry et al. 2014; 2015; 2016; Henry et al. 2020; Henry et al. 2021; 2022; Henry et al. 2019; Johnson et al. 2005; Kenney & Hartley 2001; Knowlton et al. 2012; Knowlton & Kraus 2001; NMFS 2021a; b; Whittingham, Garron, et al. 2005; Whittingham, Hartley, et al. 2005) (NMFS Marine Mammal SARs for the Atlantic Region).[6] Large whale interactions (entanglements) with these features of trap/pot and/or sink gillnet gear often result in the serious injury or mortality to the whale (Angliss & DeMaster 1998; Cassoff et al. 2011; Cole & Henry 2013; Henry et al. 2017; Henry et al. 2014; 2015; 2016; Henry et al. 2020; Henry et al. 2021; 2022; Henry et al. 2019; Johnson et al. 2005; Knowlton et al. 2012; Knowlton & Kraus 2001; Moore & van der Hoop 2012; NMFS 2014; 2021a; b; Pettis et al. 2018; Sharp et al. 2019; van der Hoop et al. 2016; van der Hoop et al. 2017). In fact, review of Atlantic coast-wide causes of large whale human interaction incidents between 2010 and 2019 shows that entanglement is the highest cause of mortality and serious injury for North Atlantic right, humpback, fin, and minke whales in those instances when cause of death could be determined (NMFS 2021b). As many entanglements, and therefore, serious injury or mortality events, go unobserved, and because the gear type, fishery, and/or country of origin for reported entanglement events are often not traceable, the rate of large whale entanglement, and thus, rate of serious injury and mortality due to entanglement, are likely underestimated (Hamilton et al. 2018; 2019; Knowlton et al. 2012; NMFS 2021a; b; Pace III et al. 2017; Robbins et al. 2009).

As noted above, pursuant to the MMPA, NMFS publishes a LOF annually, classifying U.S. commercial fisheries into one of three categories based on the relative frequency of incidental serious injurious and mortalities of marine mammals in each fishery. Large whales, in particular, humpback, fin, minke, and North Atlantic right whales, are known to interact with Category I and II fisheries in the Northwest Atlantic Ocean. As fin, and North Atlantic right whales are listed as endangered under the ESA, these species are considered strategic stocks under the MMPA. Section 118(f)(1) of the MMPA requires the preparation and implementation of a Take Reduction Plan for any strategic marine mammal stock that interacts with Category I or II fisheries. In response to its obligations under the MMPA, in 1996, NMFS established the Atlantic Large Whale Take Reduction Team (ALWTRT) to develop a plan (Atlantic Large Whale Take

[6] Through the ALWTRP, regulations have been implemented to reduce the risk of entanglement in in vertical endlines, buoy lines, or groundlines of gillnet and pot/trap gear, as well as the net panels of gillnet gear. ALWTRP regulations currently in effect are summarized online.

Reduction Plan (ALWTRP)) to reduce serious injury to, or mortality of large whales, specifically, humpback, fin, and North Atlantic right whales, due to incidental entanglement in U.S. commercial fishing gear.[7] In 1997, the ALWTRP was implemented; however, since 1997, it has been modified as NMFS and the ALWTRT learn more about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. In 2021, adjustments to Plan were implemented. In 2022, NOAA fisheries issued a notice of its intent to begin a rulemaking process to amend the ALWTRP to further reduce the risk of mortalities and serious injuries of NARW and other large whales caused by incidental entanglement in commercial trap/pot and gillnet fisheries along the U.S. East Coast. These recent ALWTRP actions are summarized online.

The ALWTRP consists of regulatory (e.g., universal gear requirements, modifications, and requirements; area-and season- specific gear modification requirements and restrictions; time/area closures) and non- regulatory measures (e.g., gear research and development, disentanglement, education and outreach) that, in combination, seek to assist in the recovery of North Atlantic right, humpback, and fin whales by addressing and mitigating the risk of entanglement in gear employed by commercial fisheries, specifically trap/pot and gillnet fisheries. The ALWTRP recognizes trap/pot and gillnet Management Areas in Northeast, Mid-Atlantic, and Southeast regions of the U.S, and identifies gear modification requirements and restrictions for Category I and II gillnet and trap/pot fisheries in these regions; these Category I and II fisheries must comply with all regulations of the Plan.[8] For further details on the Plan, please refer to the ALWTRP.

7.4.2.2 Small Cetaceans and Pinnipeds

Bottom Trawl Gear

Small cetaceans and pinnipeds are vulnerable to interactions with bottom trawl gear.[9] Reviewing marine mammal stock assessment and serious injury reports that cover the most recent ten years of data (i.e., 2011-2020), as well as the MMPA LOF's, Table 10 has a list of species that have been observed (incidentally) seriously injured and/or killed by MMPA LOF Category II (occasional interactions) fisheries that operate in the affected environment of the Northern Shrimp FMP. Of the species in Table 10, short-beaked common dolphins, Risso's dolphins, Atlantic white-sided dolphins, and gray seals are the most frequently observed

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[7] The measures identified in the ALWTRP are also beneficial to the survival of the minke whale, which are also known to be incidentally taken in commercial fishing gear.

[8] The fisheries currently regulated under the ALWTRP include: Northeast/Mid-Atlantic American lobster trap/pot; Atlantic blue crab trap/pot; Atlantic mixed species trap/pot; Northeast sink gillnet; Northeast anchored float gillnet; Northeast drift gillnet; Mid-Atlantic gillnet; Southeastern U.S. Atlantic shark gillnet; and Southeast Atlantic gillnet.
[15] More information on small cetacean and pinniped interactions is in: NMFS NEFSC marine mammal serious injury and mortality Reference Documents, Publications, or Technical Memoranda; NMFS Marine Mammal SARs for the Atlantic Region; MMPA LOF.
[9] More information on small cetacean and pinniped interactions is in: NMFS NEFSC marine mammal serious injury and mortality Reference Documents, Publications, or Technical Memoranda; NMFS Marine Mammal SARs for the Atlantic Region; MMPA LOF.

bycaught marine mammal species in bottom trawl gear in the GAR, followed by long-finned pilot whales, bottlenose dolphin (offshore stock), harbor porpoise, harbor seals, and harp seals (Chavez-Rosales *et al.* 2017; Lyssikatos 2015; Lyssikatos *et al.* 2020; 2021).

In 2006, the Atlantic Trawl Gear Take Reduction Team was convened to address the incidental mortality and serious injury of long-finned pilot whales, short-finned pilot whales, common dolphins, and white-sided dolphins incidental to bottom and mid-water trawl fisheries operating in both the Northeast and Mid-Atlantic regions. Because none of the marine mammal stocks of concern to the Team are classified as a "strategic stock," nor do they currently interact with a Category I fishery, a take reduction plan was not necessary.[10]

In lieu of a take reduction plan, the team agreed to develop an Atlantic Trawl Gear Take Reduction Strategy (the Strategy). The Strategy identifies informational and research tasks, as well as education and outreach needs the team believes are necessary, to decrease mortalities and serious injuries of marine mammals to insignificant levels approaching zero. The Strategy also identifies several voluntary measures that can be adopted by certain trawl fishing sectors to potentially reduce the incidental capture of marine mammals. For additional details on the Strategy, please visit: http://www.greateratlantic.fisheries.noaa.gov/Protected/mmp/atgtrp/.

Pot/Trap Gear

Observer coverage has been limited for fisheries prosecuted with trap/pot gear. In the absence of extensive observer data for these fisheries, stranding data provides the next best source of information on species interactions with trap pot gear. Based on stranding data provided in the NMFS Marine Mammal SARs for the Atlantic Region, a minimum known count of interactions with pot/trap gear type is provided and summarized below. However, because not all human caused serious injuries or mortalities to marine mammals are discovered, reported, or show signs of entanglement, stranding data alone underestimates the extent of human-related mortality and serious injury. Additionally, if gear is present, it is often difficult to definitively attribute the animal's death or serious injury to the gear interaction, or to a specific fishery. As a result, the conclusions below should be taken with these considerations in mind, and with an understanding that interactions may occur more frequently than what we are able to detect at this time.

Table 9 provides the list of small cetacean and pinniped species that may occur in the Northern Shrimp FMP area. Reviewing the most recent 10 years of data provided in the NMFS Marine Mammal SARs for the Atlantic Region (i.e., 2011-2020), of the small cetacean and pinniped species identified in Table 9, the WNA Northern and Southern Migratory stocks of bottlenose dolphins are the only species in which entanglement in trap/pot gear has been documented. Between 2011-2020, stranding data documented a total of four cases of bottlenose dolphins

[10] A strategic stock is defined under the MMPA as a marine mammal stock: for which the level of direct human-caused mortality exceeds the potential biological removal level; which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or which is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

entangled in trap/pot gear that could be ascribed to the WNA Northern Migratory Coastal stock; for the WNA Southern Migratory Coastal, there were a total of 13 cases. All cases over this timeframe resulted in the serious injury or mortality of the animal. Although the trap/pot gear involved in most of the cases were either unknown or identified to the Atlantic blue crab trap/pot fishery, given the general similarities in trap/pot gear composition (e.g., traps and vertical buoy lines); there is the potential for interactions to occur between bottlenose dolphins and pot/trap gear used in the fishery. However, given the best available information provided above, interactions with trap/pot gear, resulting in the serious injury or mortality to small cetaceans or pinnipeds are likely to be infrequent to unlikely.

7.4.3 Atlantic Sturgeon

Bottom Trawl
Interactions between Atlantic sturgeon and bottom trawl gear are likely (ASMFC 2017; Boucher & Curti 2023; Miller & Shepard 2011; NMFS 2021b; NMFS observer data). The NEFSC Observer Program has observed Atlantic sturgeon bycaught in Federal commercial bottom trawl fisheries since 1989, with recent bottom trawl bycatch estimates provided by Boucher and Curti (2023). Like gillnet gear, both environmental (e.g., depth, seasonal temperature) and operational fishing practices can affect the risk of Atlantic sturgeon being bycaught in bottom trawl gear (NMFS 2021a).

Pot/Trap Gear
To date, there have been no documented pot/trap interactions with Atlantic Sturgeon (NMFS NEFMC observer/sea sampling database, unpublished data; 2021a).

7.4.4 Atlantic Salmon

Bottom Trawl Gear
Atlantic salmon are at risk of interacting with bottom trawl (NEFSC observer/sea sampling database, unpublished data; Kocik *et al*. 2014; NMFS 2021a). Northeast Fisheries Observer Program (NEFOP) data from 1989-2019 show records of incidental bycatch of Atlantic salmon in seven of the 31 years, with a total of 15 individuals caught, nearly half of which (seven) occurred in 1992 (NMFS NEFSC observer/sea sampling database, unpublished data). Of the observed incidentally caught Atlantic salmon, ten were listed as “discarded,” which is assumed to be a live discard (Kocik, pers comm.; February 11, 2013). Out of the 15 salmon bycaught, four were observed in bottom trawl gear, with the remainder observed in gillnet gear. Given the very low number of observed Atlantic salmon interactions in bottom trawl gear, interactions with this gear type is believed to be rare in the GAR.

Pot/Trap Gear
To date, there have been no documented pot/trap interactions with Atlantic Sturgeon (NMFS NEFMC observer/sea sampling database, unpublished data; 2021a).

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9.0 TABLES AND FIGURES

TABLES

Table 1. Management of the Gulf of Maine Northern Shrimp Resource, 1973 – 2024.

Northern Shrimp Section Action Taken	
1973	Provisions for gear evaluation Establishment of studies
1974	Adoption of interim minimum mesh size regulation requiring use of trawls with stretched mesh sizes of not less than 38 mm (1.5 inches) in the body and 44.5 mm (1.75 in) in the cod end.
1975	Establishment of regulations requiring use of trawls with stretched mesh sizes of not less than 44.5 mm (1.75 inches) in the body and cod end (effective October, 1975) Closure of the fishery from July – September, 1975.
1976	Open season from January 1 – May 15, 1976, followed by indefinite closure. Continuation of mesh regulations.
1977	Open season from January 1 – May 15, 1977, followed by indefinite closure. Restrictions of 1977 harvest to 1,600 mt (3.5 million lbs) Continuation of mesh regulations.
1978	Continuation of closure through 1978.
1979	Open season from February 1 – March 31, 1979, followed by indefinite closure. Continuation of mesh regulations.
1980	Open season from February 15 – May 31, 1980, followed by indefinite closure. Continuation of mesh regulations.
1981	Open season from January 1 – May 15, 1981, followed by indefinite closure. Continuations of mesh regulations.
1982	Open season from January 1 – April 15, 1982. Continuations of mesh regulations.
1983	Open season December 15, 1982 – April 30, 1983 with possible 15 day extension with 70 count size limit. Continuation of mesh regulations.

Northern Shrimp Section Action Taken	
1984	Open season December 15, 1983 – April 30, 1984 with a possible extension of 15 days or until count exceeds 70/pound for any one trip. Continuation of mesh regulations.
1985	Open season December 1, 1984 – May 15, 1985. During May, landed count shall not exceed 70/pound or season closed immediately. Continuation of mesh regulations.
1986	Open season December 1, 1985 – May 31, 1986. Continuation of mesh regulations. Two week emergency opening June 8 – June 21 with 70 count maximum.
1987	Open season December 1, 1986 – May 31, 1987. Continuation of mesh regulations. Eliminate mesh size tolerance (1/4 Inch) in cod end by 1988 season.
1988	Full season. December 1, 1987 – May 31, 1988. 1-3/4 inch mesh required, 1/8 inch tolerance in body and wings, 2 inch mesh in cod end in April and May, 1988.
1989	Full season. December 1, 1988 – May 31, 1989. 1/8 inch tolerance in net, no tolerance in cod end. Approved separator trawl used in April and May, 1989.
1990	Full season. December 1, 1989 – May 31, 1990. 1-3/4 inch mesh net with no tolerance. Approved separator trawl must be used December, April and May.
1991	Full season. December 1, 1990 – May 31, 1991. 1-3/4 inch mesh net, separator panel must be 11 inch mesh, quarter to quarter.
1992	Season December 16, 1991 – May 15, 1992. 1-3/4 inch mesh net. No Sunday fishing. Separator trawl December 16, 1991 through March 31, 1992. Nordmore grate April 1, 1992 – May 15, 1992.
1993	Season December 14, 1992 – April 30, 1993. 1-3/4 inch mesh net. No Sunday fishing. Nordmore grate and 11 inch panel required. Exemption to Nordmore grate January – March if bycatch proven to be low.

Northern Shrimp Section Action Taken	
1994	Season December 1, 1993 – April 15, 1994. 1-3/4 inch mesh net. 15 fathom bare wire bottom legs. Nordmore grate all season, no exemptions. (122 days)
1995	Season December 1, 1994 – April 30, 1995. 1-3/4 inch mesh net. 15 Fathom bare wire bottom legs. Nordmore grate all season, no exemptions. No fishing on Sunday (or Friday as substitute). (128 days)
1996	Full season with one day/week off. Also, trappers to start January 1, 1996. (Review of effort at mid-season) (152 days)
1997	Season December 1, 1996 – May 27, 1997 with two 5-day and four 4-day blocks off. (156 days)
1998	Season December 8 – 24, 1997; January 1, 1998 – March 15, 1998; April 1, 1998 – May 22, 1998 with weekends off. (105 days)
1999	Season December 15 – 23, January 4 - 26, February 1 – 23, March 1 – 16, April 1 – 28, May 2 – 25 with weekends off. (90 days)
2000	Season January 17, 2000 – March 15, 2000. (59 days)
2001	Season January 9– March 17, 2001, April 16 – 30, 2001. (83 days)
2002	Season February 15 – March 11, 2002. (25 days)
2003	Season January 19 – March 12, 2003 with Saturdays and Sundays off. (38 days)
2004	Season January 19 – March 12, 2004 with Saturdays and Sundays off. (40 days)
2005	Season December 19 – 23, 2004; December 26 – 30, 2004 with Friday and Saturdays off; and January 3 – March 25, 2005, with Saturdays and Sundays off. (70 days)
2006	Season December 12, 2005– April 30, 2006. (140 days)

Northern Shrimp Section Action Taken	
2007	Season December 1, 2006– April 30, 2007. (151 days)
2008	Season December 1, 2007– April 30, 2008. (152 days)
2009	Season December 12, 2008– May 29, 2009. (180 days)
2010	Season December 1, 2009– May 5, 2010* (156 days) *Emergency action taken to close the fishery 24 days early
2011	Season December 1, 2010– February 28, 2011* (90 days) *Emergency action taken to close the fishery 46 days early. TAC set at 4,000 mt.
2012	Trawlers begin January 2 with three landings day per week and trappers begin on February 1 with a 1,000 pounds limit per vessel per day. TAC set at 2,211 mt. *Emergency action taken to close the fishery on February 17
2013	TAC set at 625 mt and allocated 87% to the trawl fishery and 13% to the trap fishery (with 5.44 mt set aside for RSA) and would close when 85% of the TAC in each fishery closed.
2014	Moratorium due to stock collapse; Maine DMR contracted one shrimp trawler to collect samples during the winter
2015	Moratorium; 25 mt RSA for cooperative winter sampling program Four trawlers with a 1,800 lbs/trip limit (sale of catch permitted); five trappers with 10 trap and 100 lbs/week limit (sale of catch not permitted)
2016	Moratorium; 22 mt RSA for cooperative winter sampling program Four trawlers with a 1,800 lbs/trip limit and two trappers with a 40 traps and 600 lbs/week limit. Sale of catch permitted for both trappers and trawlers.
2017	Moratorium; 53 mt RSA for winter sampling 10 trawlers fishing one trip/week for 8 consecutive weeks and a 1,200 lbs/trip limit; five trappers fishing for 8 consecutive weeks with a 500 lbs/week limit and 40 trap limit per vessel
2018	Moratorium
2019	Moratorium

2020	Moratorium
2021	Moratorium
2022	Moratorium
2023	Moratorium
2024	Moratorium

Table 2. Total removals in metric tons by season, state, and gear type. Seasons include the previous December. The Maine fishery was "Mixed" until Trawl and Trap landings could be distinguished beginning in 2000. Removals in 2014–2020 are from RSA and winter sampling programs, and include discards. 2009 data for Massachusetts and New Hampshire are combined here to preserve reporting confidentiality. Source: 2024 Northern Shrimp Stock Assessment Update.

Season	Maine			Massachusetts	New Hampshire	Total	Total	Total	Total
	Trawl	Mixed	Trap	Trawl	Trawl	Trawl	Mixed	Trap	
1985		2,946.4		968.8	216.7	1,185.5	2,946.4	0.0	**4,131.9**
1986		3,268.2		1,136.3	230.5	1,366.8	3,268.2	0.0	**4,635.0**
1987		3,680.2		1,427.9	157.9	1,585.8	3,680.2	0.0	**5,266.0**
1988		2,258.4		619.6	157.6	777.2	2,258.4	0.0	**3,035.6**
1989		2,384.0		699.9	231.5	931.4	2,384.0	0.0	**3,315.4**
1990		3,236.3		974.9	451.3	1,426.2	3,236.3	0.0	**4,662.5**
1991		2,488.6		814.6	282.1	1,096.7	2,488.6	0.0	**3,585.3**
1992		3,070.6		289.3	100.1	389.4	3,070.6	0.0	**3,460.0**
1993		1,492.5		292.8	357.6	650.4	1,492.5	0.0	**2,142.9**
1994		2,239.7		247.5	428.0	675.5	2,239.7	0.0	**2,915.2**
1995		5,013.7		670.1	772.8	1,442.9	5,013.7	0.0	**6,456.6**
1996		8,107.1		660.6	771.7	1,432.3	8,107.1	0.0	**9,539.4**
1997		6,086.9		366.4	666.2	1,032.6	6,086.9	0.0	**7,119.5**
1998		3,481.3		240.3	445.2	685.5	3,481.3	0.0	**4,166.8**
1999		1,573.2		75.7	217.0	292.7	1,573.2	0.0	**1,865.9**
2000	2,249.5		266.7	124.1	214.7	2,588.3	0.0	266.7	**2,855.0**
2001	954.0		121.2	49.4	206.4	1,209.8	0.0	121.2	**1,331.0**
2002	340.8		50.8	8.1	53.0	401.8	0.0	50.8	**452.7**
2003	987.0		216.7	27.7	113.0	1,127.7	0.0	216.7	**1,344.4**
2004	1,858.7		68.1	21.3	183.2	2,063.2	0.0	68.1	**2,131.4**
2005	1,887.1		383.1	49.6	290.3	2,227.1	0.0	383.1	**2,610.1**
2006	1,928.0		273.6	30.0	91.1	2,049.1	0.0	273.6	**2,322.7**
2007	3,986.9		482.4	27.5	382.9	4,397.3	0.0	482.4	**4,879.7**
2008	3,725.0		790.7	29.9	416.8	4,171.7	0.0	790.7	**4,962.4**
2009	1,936.3		379.4	MA & NH:	185.6	2,121.8	0.0	379.4	**2,501.2**
2010	4,517.9		1,203.5	35.1	506.8	5,059.9	0.0	1,203.5	**6,263.3**
2011	4,644.4		925.3	196.4	631.5	5,472.2	0.0	925.3	**6,397.5**
2012	2,026.8		193.1	77.8	187.8	2,292.4	0.0	193.1	**2,485.4**
2013	269.5		20.2	18.9	36.9	325.3	0.0	20.2	**345.5**
2014	0.3		0.0	0.0	0.0	0.3	0.0	0.0	**0.3**
2015	5.6		0.5	0.6	0.0	6.2	0.0	0.5	**6.7**
2016	7.4		4.1	0.0	1.8	9.2	0.0	4.1	**13.3**
2017	24.1		7.1	0.9	0.5	25.5	0.0	7.1	**32.6**
2018	0.1		0.0	1.9	1.1	3.1	0.0	0.0	**3.1**
2019	0.0		0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2020	0.0		3.1	0.0	0.0	0.0	0.0	3.1	**3.1**
2021	0.0		0.0	0.0	0.0	0.0	0.0	0.0	**0.0**

Table 3. Fishery performance indicators for Gulf of Maine northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or below the 20th percentile; YELLOW = between the 20th and the 80th percentiles; and GREEN = at or above the 80th percentile of the commercial fishery time series from 1984-2013. Values from 2014-2021 represent RSA/winter sampling. Dashes (-) indicate no data. Source: 2024 Northern Shrimp Stock Assessment Update (continued on next page).

Fishing Season	Number of trips	Commercial CPUE (mt/trip)	Price per lb landed (2018 dollars)	Total landings value (2018 dollars)
1984	6,912	0.43	-	-
1985	6,857	0.60	$1.05	$9,564,744
1986	7,902	0.59	$1.45	$14,816,717
1987	12,497	0.42	$2.50	$29,023,857
1988	9,240	0.33	$2.40	$16,061,646
1989	9,561	0.35	$2.04	$14,910,780
1990	9,758	0.48	$1.43	$14,699,046
1991	7,968	0.45	$1.71	$13,516,239
1992	7,798	0.44	$1.81	$13,806,670
1993	6,158	0.35	$1.89	$8,928,900
1994	5,990	0.49	$1.30	$8,354,991
1995	10,465	0.62	$1.51	$21,493,893
1996	11,791	0.81	$1.19	$25,026,625
1997	10,734	0.66	$1.25	$19,619,763
1998	6,606	0.63	$1.50	$13,779,332
1999	3,811	0.49	$1.40	$5,759,047
2000	4,554	0.63	$1.18	$7,427,163
2001	4,133	0.32	$1.24	$3,638,596
2002	1,304	0.35	$1.54	$1,536,852
2003	3,022	0.44	$1.21	$3,586,328
2004	2,681	0.79	$0.60	$2,819,337
2005	3,866	0.68	$0.75	$4,315,765
2006	2,478	0.94	$0.47	$2,406,687
2007	4,163	1.17	$0.47	$5,056,211
2008	5,587	0.89	$0.59	$6,454,695
2009	3,002	0.83	$0.48	$2,646,864
2010	5,979	1.03	$0.61	$8,423,072
2011	7,095	0.90	$0.86	$12,129,566
2012	3,648	0.68	$1.06	$5,808,201
2013	1,322	0.23	$1.98	$1,508,183
2014	5	-	No landings	No landings
2015	50	-	$3.77	$55,446

2016	68	-	$7.11	$208,767
2017	153	-	$6.55	$470,579
2018	18	-	Confidential	Confidential
2019	0	-	-	-
2020	160	-	No landings	No landings
2021	0	-	-	-
1984-2013 mean	**6,229**	**0.60**	**$1.29**	**$10,245,509**
2014-2021 mean	**76**	**NA**	**$5.81**	**$244,931**
80th percentile (1984-2013)	**9,304**	**0.81**	**$1.75**	**$14,854,342**
20th percentile (1984-2013)	**3,523**	**0.41**	**$0.69**	**$3,617,689**

Table 4. Fishery independent indicators (model-based survey indices) for GOM northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or below the 20th percentile; YELLOW = between the 20th and 80th percentiles; and GREEN = at or above the 80th percentile of the time series from 1984-2017. Dashes (-) indicate no data. Source: 2024 Northern Shrimp Stock Assessment Update (continued on next page).

Survey	ASMFC Summer	NEFSC Fall Albatross	NEFSC Fall Bigelow	ME-NH Spring	ASMFC Summer			
Indicator	Total Abundance	Total Abundance	Total Abundance	Total Abundance	Total Biomass	Harvestable Biomass (>22 mm CL)	Spawner Biomass	Recruitment (age ~1.5)
1984	1.286	-	-	-	1.43	0.73	0.72	0.143
1985	1.398	-	-	-	1.63	1.40	0.71	0.240
1986	1.247	0.68	-	-	1.64	1.28	0.96	0.238
1987	0.882	0.40	-	-	1.09	0.87	0.58	0.199
1988	1.584	0.34	-	-	1.41	0.83	0.62	1.018
1989	1.423	0.78	-	-	1.61	0.93	0.73	0.270
1990	1.237	0.59	-	-	1.67	1.44	0.81	0.104
1991	0.826	0.32	-	-	0.98	0.80	0.68	0.338
1992	0.536	0.19	-	-	0.63	0.46	0.40	0.149
1993	1.267	1.04	-	-	0.92	0.50	0.39	0.827
1994	1.117	1.09	-	-	0.97	0.48	0.40	0.375
1995	1.141	0.59	-	-	1.19	0.83	0.77	0.254
1996	1.007	0.40	-	-	1.12	0.82	0.66	0.316
1997	1.075	0.53	-	-	0.97	0.63	0.55	0.544
1998	0.752	0.97	-	-	0.73	0.39	0.38	0.206
1999	0.671	1.21	-	-	0.73	0.51	0.43	0.197
2000	0.891	0.96	-	-	0.82	0.56	0.52	0.491
2001	0.309	0.50	-	-	0.35	0.19	0.21	0.037
2002	1.220	0.69	-	-	0.87	0.39	0.41	0.937
2003	0.861	0.40	-	0.55	0.91	0.47	0.54	0.130
2004	1.119	0.88	-	0.62	1.09	0.90	0.60	0.382
2005	2.702	2.85	-	1.88	2.10	1.11	1.02	1.315
2006	4.872	3.69	-	2.21	4.20	1.98	2.02	1.054
2007	1.867	2.41	-	1.93	1.91	1.25	1.09	0.235
2008	1.794	1.51	-	2.21	1.82	1.48	0.86	0.529
2009	1.907	-	4.62	2.40	2.01	1.47	1.16	0.699
2010	1.689	-	3.20	3.48	1.63	0.94	0.78	0.643
2011	1.010	-	2.45	3.30	1.08	0.64	0.65	0.281
2012	0.323	-	0.88	0.92	0.39	0.30	0.27	0.035
2013	0.089	-	0.25	0.14	0.14	0.13	0.11	0.005
2014	0.282	-	0.52	0.37	0.21	0.07	0.09	0.202
2015	0.080	-	0.21	0.15	0.11	0.09	0.09	0.005
2016	0.314	-	0.16	0.34	0.32	0.19	0.19	0.175
2017	0.054	-	0.17	0.18	0.07	0.05	0.05	0.001
2018	0.078	-	0.31	0.10	0.09	0.06	0.05	0.045

2019	0.054	-	0.19	0.08	0.08	0.06	0.06	0.002
2020	-	-	-	-	-	-	-	-
2021	0.034	-	0.03	0.124	0.053	0.045	0.045	0.00151
2022	0.005	-	0.01	0.019	0.008	0.008	0.007	0.00005
2023	0.001	-	-	0.007	0.002	0.002	0.002	0.00000
2024	-	-	-	0.001	-	-	-	-
1984-2013 mean	**1.27**	**1.00**	**2.28**	**1.78**	**1.27**	**0.82**	**0.67**	**0.41**
2014-2023 mean	**0.10**	**NA**	**0.20**	**0.15**	**0.10**	**0.06**	**0.06**	**0.05**
80th percentile	**1.49**	**1.16**	**2.75**	**2.25**	**1.64**	**1.16**	**0.79**	**0.58**
20th percentile	**0.45**	**0.40**	**0.20**	**0.31**	**0.54**	**0.35**	**0.34**	**0.14**

Table 5. Environmental condition indicators for GOM northern shrimp traffic light analysis. Colors indicate status relative to reference levels, where: RED = at or above the 80th percentile; YELLOW = between the 80th and 20th percentiles; and GREEN = at or below the 20th percentile of the time series from 1984-2017. Dashes (-) indicate no data. Source: 2024 Northern Shrimp Stock Assessment Update (continued on next page).

Survey	NEFSC	ASMFC	NEFSC	Boothbay Harbor, ME
Indicator	Predation Pressure Index	Summer Bottom Temperature	Spring Bottom Temperature	Feb-Mar Surface Temperature
1984	433.9	4.1	5.7	2.9
1985	597.5	4.0	5.2	2.8
1986	611.9	6.3	6.1	2.6
1987	390.5	6.0	5.1	1.8
1988	505.8	6.5	5.7	2.7
1989	521.1	5.6	4.9	1.9
1990	632.3	3.6	4.1	2.6
1991	509.2	6.1	5.6	3.4
1992	489.6	6.3	5.7	3.2
1993	473.9	5.8	4.4	1.2
1994	353.2	6.8	5.4	1.8
1995	637.7	6.6	5.9	3.3
1996	560.1	7.1	6.2	3.3
1997	382.0	6.8	6.1	3.7
1998	470.8	6.3	6.1	2.9
1999	745.9	6.1	5.7	2.9
2000	823.5	6.7	6.2	3.1
2001	730.5	6.5	5.8	2.9
2002	1,305.5	7.1	6.4	4.1
2003	1,054.5	5.6	4.9	2.4
2004	493.6	4.7	4.3	3.0
2005	472.4	4.9	5.1	3.0
2006	670.4	7.1	6.4	5.5
2007	712.7	5.9	5.4	2.0
2008	860.7	5.9	6.0	2.3
2009	737.7	6.0	5.5	2.6
2010	1,124.4	7.4	6.0	4.1
2011	1,117.6	7.7	7.4	2.9
2012	1,155.3	7.9	7.2	5.5
2013	742.6	7.1	6.4	3.9
2014	955.1	6.2	5.8	2.2
2015	829.4	5.8	5.2	1.4
2016	1,525.8	7.2	6.6	4.2

2017	951.7	6.9	6.1	3.8
2018	924.9	6.7	6.1	4.5
2019	674.2	7.1	6.6	3.5
2020	-	-	-	4.6
2021	1286.2	7.6	7.2	4.0
2022	1354.3	7.6	7.1	3.7
2023	956.1	7.6	-	4.6
2024	-	-	-	4.4
1984-2013 mean	**677.2**	**6.1**	**5.7**	**3.0**
2014-2023 mean	**1,062.7**	**6.9**	**6.3**	**3.6**
20th percentile (1984-2017)	**483.3**	**5.7**	**5.2**	**2.3**
80th percentile (1984-2017)	**953.0**	**7.1**	**6.2**	**3.8**

Table 6. Species protected under the ESA and/or MMPA that may occur in the affected environment of the northern shrimp fishery (continued on next page).

Species	Status	Potentially impacted by this action?
Cetaceans		
North Atlantic right whale (Eubalaena glacialis)	***Endangered***	***Yes***
Humpback whale, West Indies DPS (*Megaptera novaeangliae)*	Protected (MMPA)	Yes
Fin whale (Balaenoptera physalus)	***Endangered***	***Yes***
Sei whale (Balaenoptera borealis)	***Endangered***	***Yes***
Blue whale (Balaenoptera musculus)	***Endangered***	***No***
Sperm whale (Physeter macrocephalus	***Endangered***	***Yes***
Minke whale (*Balaenoptera acutorostrata*)	Protected (MMPA)	Yes
Pilot whale (Globicephala spp.)[2]	Protected (MMPA)	Yes
Pygmy sperm whale (*Kogia breviceps*)	Protected (MMPA)	No
Dwarf sperm whale (*Kogia sima*)	Protected (MMPA)	No
Risso's dolphin (*Grampus griseus*)	Protected (MMPA)	Yes
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Protected (MMPA)	Yes
Short Beaked Common dolphin (*Delphinus delphis*)	Protected (MMPA)	Yes
Atlantic Spotted dolphin (*Stenella frontalis*)	Protected (MMPA)	No
Striped dolphin (*Stenella coeruleoalba*)	Protected (MMPA)	No
Bottlenose dolphin, Western North Atlantic (WNA) Offshore Stock (*Tursiops truncatus*)	Protected (MMPA)	Yes
Bottlenose dolphin, WNA Northern Migratory Coastal Stock (Tursiops truncatus)	***Protected (MMPA)***	***Yes***
Bottlenose dolphin, WNA Southern Migratory Coastal Stock (Trusiops truncatus)	***Protected (MMPA)***	***Yes***
Harbor porpoise (*Phocoena phocoena*)	Protected (MMPA)	Yes
Sea Turtles		
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Yes
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Yes
Green sea turtle, North Atlantic DPS (*Chelonia mydas*)	Threatened	Yes
Loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic Ocean DPS	Threatened	Yes
Hawksbill sea turtle (*Eretmochelys imbricate*)	Endangered	No
Fish		
Shortnose sturgeon (*Acipenser brevirostrum*)	Endangered	No
Giant manta ray (*Manta birostris)*	Threatened	No
Oceanic whitetip shark (*Carcharhinus longimanus*)	Threatened	No
Atlantic salmon (*Salmo salar*)	Endangered	Yes
Atlantic sturgeon *(Acipenser oxyrinchus)*		
Gulf of Maine DPS	Threatened	Yes

New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS	Endangered	Yes
Pinnipeds		
Harbor seal (*Phoca vitulina*)	Protected (MMPA)	Yes
Gray seal (*Halichoerus grypus*)	Protected (MMPA)	Yes
Harp seal (*Phoca groenlandicus*)	Protected (MMPA)	Yes
Hooded seal (*Cystophora cristata*)	Protected (MMPA)	Yes
Critical Habitat		
North Atlantic Right Whale	ESA Designated	No
Northwest Atlantic DPS of Loggerhead Sea Turtle	ESA Designated	No

Notes: Marine mammal species italicized and in bold are considered MMPA strategic stocks.[1]

[1] A strategic stock is defined under the MMPA as a marine mammal stock for which: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; and/or (3) is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA (Section 3 of the MMPA of 1972).

[2] There are two species of pilot whales: short finned (*G. melas melas*) and long finned (*G. macrorhynchus*). Due to the difficulties in identifying the species at sea, they are often just referred to as *Globicephala spp*.

Table 7. Large whale occurrence, distribution, and habitat use in the northern shrimp fishery affected environment (continued on next page).

Species	Occurrence/Distribution/Habitat Use in the Affected Environment
North Atlantic Right Whale	● Predominantly occupy waters of the continental shelf, but based on passive acoustic and telemetry data, are also known to make lengthy excursions into deep waters off the shelf. ● Visual and acoustic data demonstrate broad scale, year-round presence along the U.S. eastern seaboard (e.g., GOM, New Jersey, and Virginia). ● Surveys have demonstrated the existence of several areas where North Atlantic right whales congregate seasonally, including Cape Cod Bay; Massachusetts Bay; and the continental shelf south of New England. Although whales can be found consistently in particular locations throughout their range, there is a high inter- annual variability in right whale use of some habitats. Since 2010, acoustic and visual surveys indicate a shift in habitat use patterns, including: > Fewer individuals are detected in the Great South Channel; > Increase in the number of individuals using Cape Cod Bay in the spring; > Apparent abandonment of central GOM in the winter; and, > Large increase in the numbers of whales detected in a region south of Martha's Vineyard and Nantucket Islands. Presence in this area is almost year-round, with highest sighting rates from winter through early spring. > Passive acoustic monitoring suggests a shift to a year-round presence in the Mid-Atlantic, including year round detections in the New York Bight with the highest presence between late February and mid-May in the shelf zone and nearshore habitat).
Humpback	● Distributed throughout all continental shelf waters of the Mid-Atlantic (SNE included), GOM, and GB throughout the year. ● New England waters (GOM and GB) = Foraging Grounds (~March-November); however, acoustic detections of humpbacks indicate year-round presence in New England waters, including the waters of Stellwagen Bank. ● Mid-Atlantic waters: Increasing evidence that mid-Atlantic areas are becoming an important habitat for juvenile humpback whales. ● Since 2011, increased sightings of humpback whales in the New York-New Jersey Harbor Estuary, in waters off Long Island, and along the shelf break east of New York and New Jersey. ● Increasing visual and acoustic evidence of whales remaining in mid- and high- latitudes throughout the winter (e.g., Mid- Atlantic: waters near Chesapeake and Delaware Bays, peak presence about January through March; Massachusetts Bay: peak presence about March-May and September-December).

Fin	● Distributed throughout all continental shelf waters of the Mid-Atlantic (SNE included), GOM, and GB; ● Recent review of sighting data shows evidence that, while densities vary seasonally, fin whales are present in every season throughout most of the EEZ north of 30°N. ● New England waters (GOM and GB) = Major Foraging Ground
Sei	● Primarily found in deep waters along the shelf edge, shelf break, and ocean basins between banks; however, incursions into shallower shelf waters do occur ● Spring through summer, sightings concentrated along the northern, eastern (into Northeast Channel) and southwestern (in the area of Hydrographer Canyon) edge of Georges Bank, and south of Nantucket, MA. ● Recent acoustic detections peaked in northern latitudes in the summer, indicating feeding grounds ranging from Southern New England through the Scotian Shelf. ● Persistent year-round detections in Southern New England and the New York Bight indicate this area to be an important region for sei whales. ● The wintering habitat remains largely unknown. Passive acoustic monitoring conducted in 2015-2016 off Georges Bank detected sei whales calls from late fall through the winter along the southern Georges Bank region (off Heezen and Oceanographer Canyons).
Sperm	● Distributed on the continental shelf edge, over the continental slope, and into mid-ocean regions. ● Seasonal Occurrence in the U.S. EEZ: >**Winter**: concentrated east and northeast of Cape Hatteras; >**Spring**: center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank; >**Summer**: similar distribution to spring, but also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England; and, >**Fall**: occur in high levels south of New England, on the continental shelf. Also occur along continental shelf edge in the mid-Atlantic bight.
Minke	● Widely distributed within the U.S. EEZ. ● Spring to Fall: widespread (acoustic) occurrence on the continental shelf; most abundant in New England waters during this period of time. ● September to April: high (acoustic) occurrence in deep-ocean waters.

Sources: Baumgartner et al. (2011; 2007); Baumgartner and Mate (2005); Bort et al. (2015); Brown et al. (Brown et al. 2018; 2002); CeTAP (1982); Charif et al. (2020); Cholewiak et al. (2018); Clapham et al. (1993); Clark and Clapham (2004); Cole et al. (2013); Davis et al. (2017; 2020); Ganley et al. (2019); Good (2008); Hain et al. (1992); Hamilton and Mayo (1990); Hayes et al. (2017; 2018; 2019; 2020; 2021; 2022); Kenney et al. (1986; 1995); Khan et al. (2010; 2011; 2012; 2009); Kraus et al. (2016); Leiter et al. (2017); Mate et al. (1997); Mayo et al. (2018); McLellan et al. (2004); Moore et al. (2021); Morano et al. (2012); Muirhead et al. (2018); Murray et al. (2013); NMFS (1991; 2005; 2010; 2011; 2012; 2015; 2021a; b); NOAA (2008); Pace and Merrick (2008); Palka et al. (2017); Palka (2020); Payne et al. (1984; 1990); Pendleton et al. (2009); Record et al. (2019); Risch et al. (2013); Robbins (2007); Roberts et al. (2016)); Salisbury et al. (2016); Schevill et al. (1986); Stanistreet et al. (2018); Stone et al. (2017); Swingle et al. (1993); Vu et al. (2012); Watkins and Schevill (1982); Whitt et al. (2013); Winn et al. (1986); 81 FR 4837 (January 27, 2016); 86 FR 51970 (September 17, 2021).

Table 8. Small cetacean occurrence and distribution in the northern shrimp fishery affected environment (continued on next page).

Species	Occurrence and Distribution in the Affected Environment
Atlantic White Sided Dolphin	• Distributed throughout the continental shelf waters (primarily to 100 m) of the Mid- Atlantic (north of 35°N), SNE, GB, and GOM; however, most common in continental shelf waters from Hudson Canyon (~ 39°N) to GB, and into the GOM. • **January-May**: low densities found from GB to Jeffreys Ledge. • **June-September**: Large densities found from GB, through the GOM. • **October-December**: intermediate densities found from southern GB to southern GOM. • South of GB (SNE and Mid-Atlantic), particularly around Hudson Canyon, low densities found year-round, • Virginia (VA) and North Carolina (NC) waters represent southern extent of species range during winter months.
Short Beaked Common Dolphin	• Regularly found throughout the continental shelf-edge-slope waters (primarily between the 100-2,000 m isobaths) of the Mid-Atlantic, SNE, and GB (esp. in Oceanographer, Hydrographer, Block, and Hudson Canyons). • Less common south of Cape Hatteras, NC, although schools have been reported as far south as the Georgia/South Carolina border. • **January-May**: occur from waters off Cape Hatteras, NC, to GB (35° to 42°N). • **Mid-summer-autumn**: Occur in the GOM and on GB; Peak abundance found on GB in the autumn.
Risso's Dolphin	• **Spring through fall**: Distributed along the continental shelf edge from Cape Hatteras, NC, to GB. • **Winter**: distributed in the Mid-Atlantic Bight, extending into oceanic waters. • Rarely seen in the GOM; primarily a Mid-Atlantic continental shelf edge species (can be found year-round)
Harbor Porpoise	• Distributed throughout the continental shelf waters of the Mid-Atlantic, SNE, GB, and GOM. • **July-September**: Concentrated in the northern GOM (waters <150 meters); low numbers can be found on GB. • **October-December**: widely dispersed in waters from New Jersey (NJ) to Maine (ME); seen from the coastline to deep waters (>1,800 meters). • **January-March**: intermediate densities in waters off NJ to NC; low densities found in waters off New York (NY) to GOM. • **April-June**: widely dispersed from NJ to ME; seen from the coastline to deep waters (>1,800 meters). • Passive acoustic monitoring indicates regular presence from January through May offshore of Maryland.

<table>
<tr><td>Bottlenose Dolphin</td><td><u>Western North Atlantic Offshore Stock</u>
Distributed primarily along the outer continental shelf and continental slope in the Northwest Atlantic from GB to Florida (FL).
Depths of occurrence: ≥40 meters
<u>Western North Atlantic Northern Migratory Coastal Stock</u>
Most common in coastal waters <20 m deep.
Warm water months (e.g., July-August): distributed from the coastal waters from the shoreline to about 25-m isobaths between the mouth of the Chesapeake Bay and Long Island, NY.
Cold water months (e.g., January-March): stock occupies coastal waters from Cape Lookout, NC, to the NC/VA border.
<u>Western North Atlantic Southern Migratory Coastal Stock</u>
Most common in coastal waters <20 m deep.
October-December: appears stock occupies waters of southern NC (south of Cape Lookout)
January-March: appears stock moves as far south as northern FL.
April-June: stock moves north to waters of NC.
July-August: stock is presumed to occupy coastal waters north of Cape Lookout, NC, to the eastern shore of VA (as far north as Assateague).</td></tr>
<tr><td>Pilot Whales: Short- and Long-Finned</td><td><u>Short- Finned Pilot Whales</u>
Except for area of overlap (see below), primarily occur south of 40^{o}N (Mid-Atlantic and SNE waters); although low numbers have been found along the southern flank of GB, but no further than 41^{o}N.
Distributed primarily near the continental shelf break of the Mid-Atlantic and SNE (i.e., off Nantucket Shoals).
<u>Long-Finned Pilot Whales</u>
Except for area of overlap (see below), primarily occur north of 42^{O}N.
Winter to early spring: distributed principally along the continental shelf edge off the northeastern U.S. coast.
Late spring through fall: movements and distribution shift onto GB and into the GOM and more northern waters.
Species tends to occupy areas of high relief or submerged banks.
<u>Area of Species Overlap:</u> along the mid-Atlantic shelf break between Delaware and the southern flank of GB.</td></tr>
<tr><td colspan="2">Notes: Information is representative of small cetacean occurrence in the Northwest Atlantic continental shelf waters out to 2,000 m depth.

Sources: Hayes et al. (2017; 2018; 2019; 2020; 2022); Payne and Heinemann (1993); Payne et al. (1984); Jefferson et al. (2009).</td></tr>
</table>

Table 9. Pinniped occurrence and distribution in the northern shrimp fishery affected environment.

Species	Occurrence and Distribution in the Affected Environment
Harbor Seal	• Year-round inhabitants of Maine; • September through late May: occur seasonally along the coasts from southern New England to Virginia.
Gray Seal	• Ranges from New Jersey to Labrador, Canada.
Harp Seal	• Winter-Spring (approx. January-May): Can occur in the U.S. Atlantic Exclusive Economic Zone. • Sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey.
Hooded Seal	• Highly migratory; can occur in waters from Maine to Florida. Usually occur between January and May in New England waters, and in summer and autumn off the southeast U.S. coast and in the Caribbean.
Sources: Hayes et al. (2019, for hooded seals; 2022).	

Table 10. Small cetacean and pinniped species observed seriously injured and/or killed by Category bottom trawl fisheries in the affected environment of the Northern Shrimp FMP.

Fishery	Category	Species Observed or reported Injured/Killed
Northeast Bottom Trawl	II	Harp seal
		Harbor seal
		Gray seal
		Long-finned pilot whales
		Short-beaked common dolphin
		Atlantic white-sided dolphin
		Harbor porpoise
		Bottlenose dolphin (offshore)
		Risso's dolphin
Mid-Atlantic Bottom Trawl	II	White-sided dolphin
		Short-beaked common dolphin
		Risso's dolphin
		Bottlenose dolphin (offshore)
		Gray seal
		Harbor seal
Source: NMFS Marine Mammal SARs for the Atlantic Region; MMPA 2017-2023 LOFs.		

FIGURES

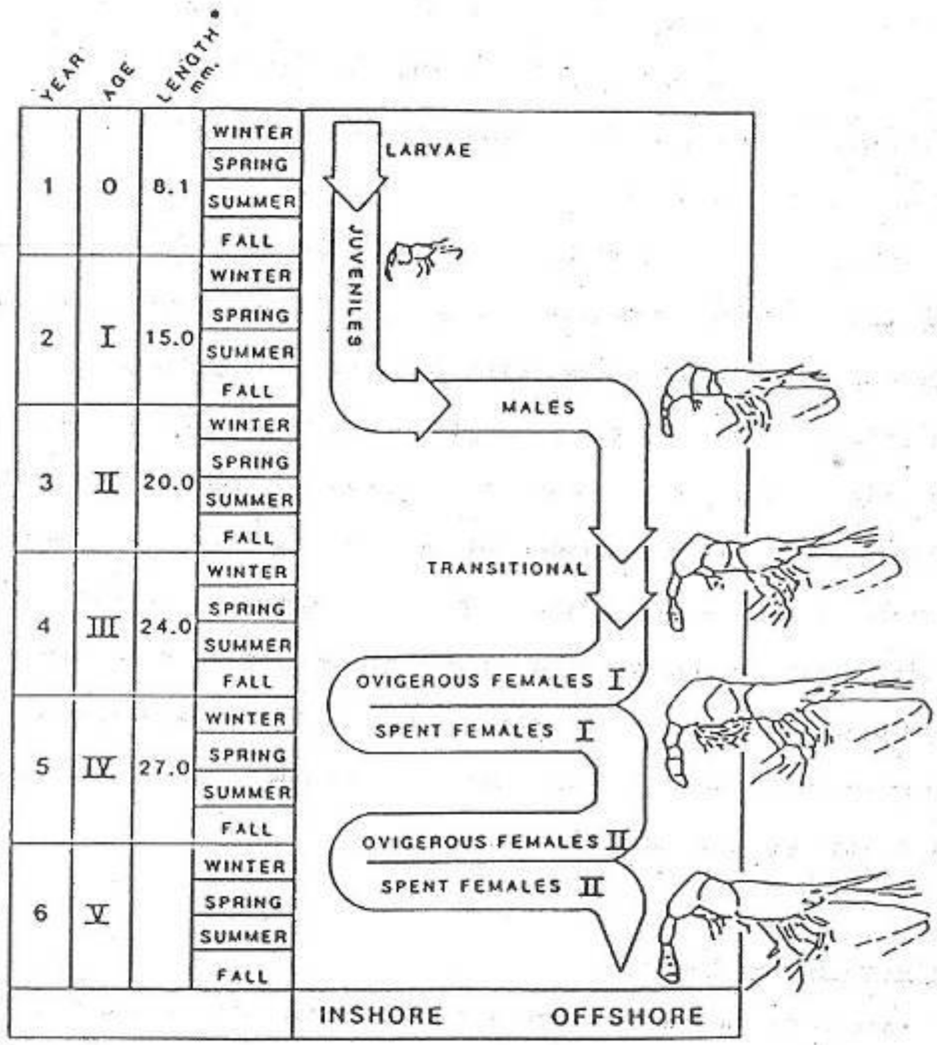

Figure 1. Schematic diagram of the life cycle of *Pandalus borealis* in the Gulf of Maine (modified from Shumway et. al. 1985)

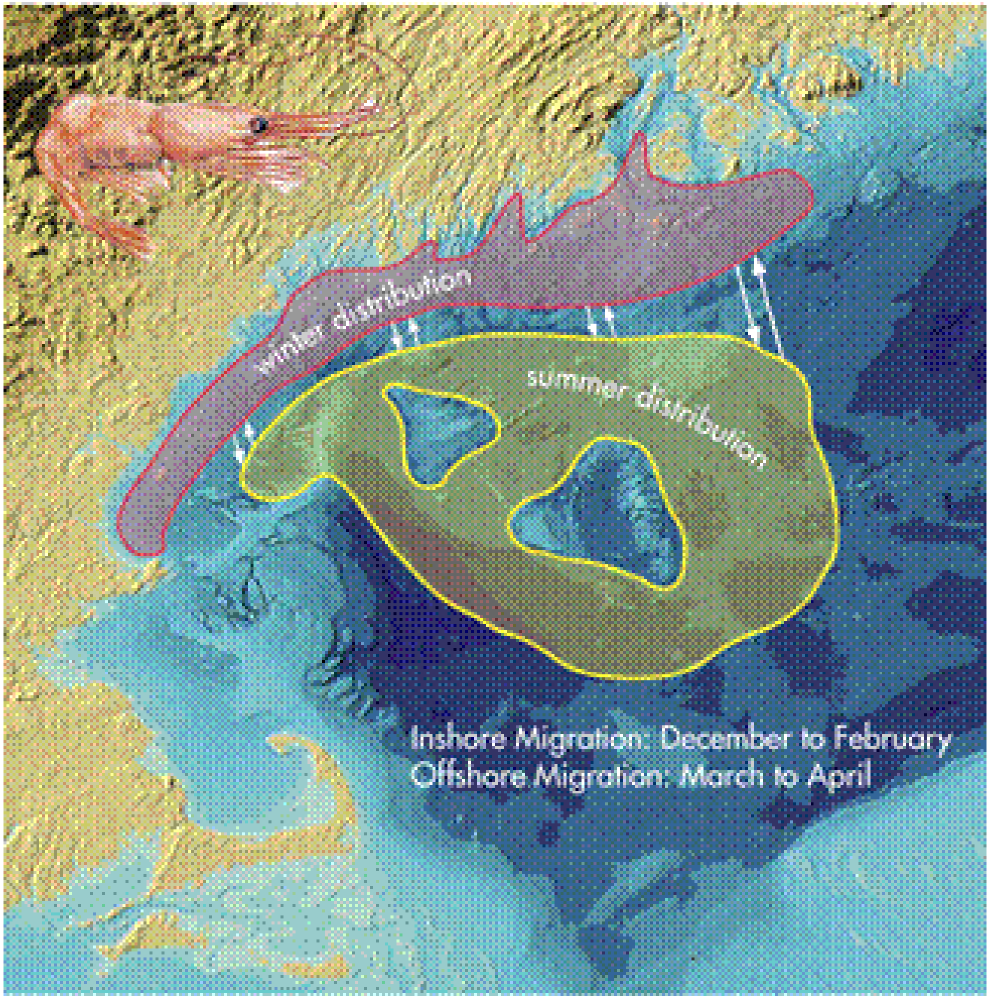

Figure 2. Distribution and migration of adult female shrimp in the Gulf of Maine (Anon. 2006 courtesy of NAMA)

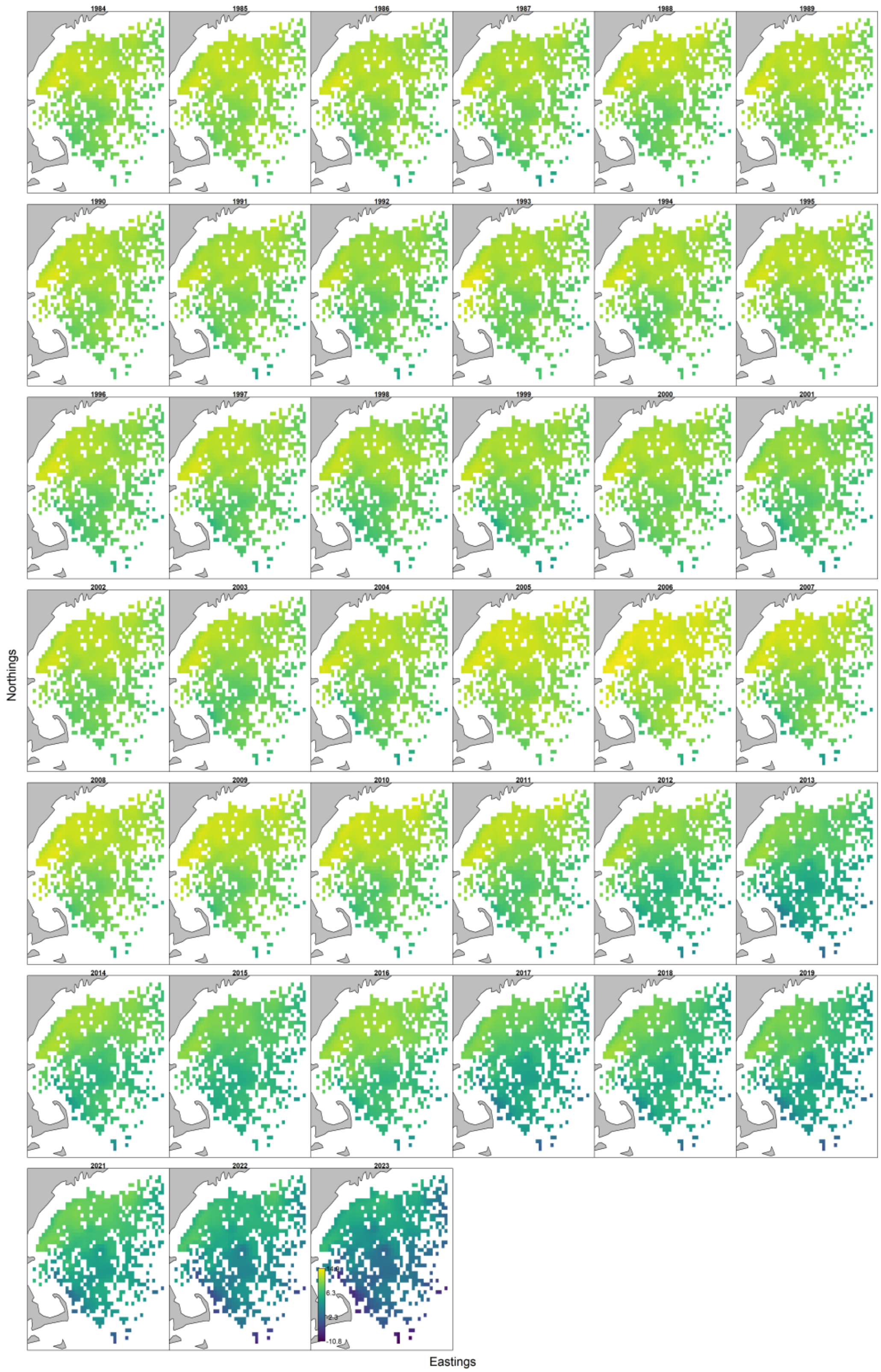

Figure 3. Heat map of shrimp abundance from the summer shrimp survey, 1984-2023. Yellows indicate higher abundance and blues indicate lower abundance. Source: 2024 Northern Shrimp Stock Assessment Update.

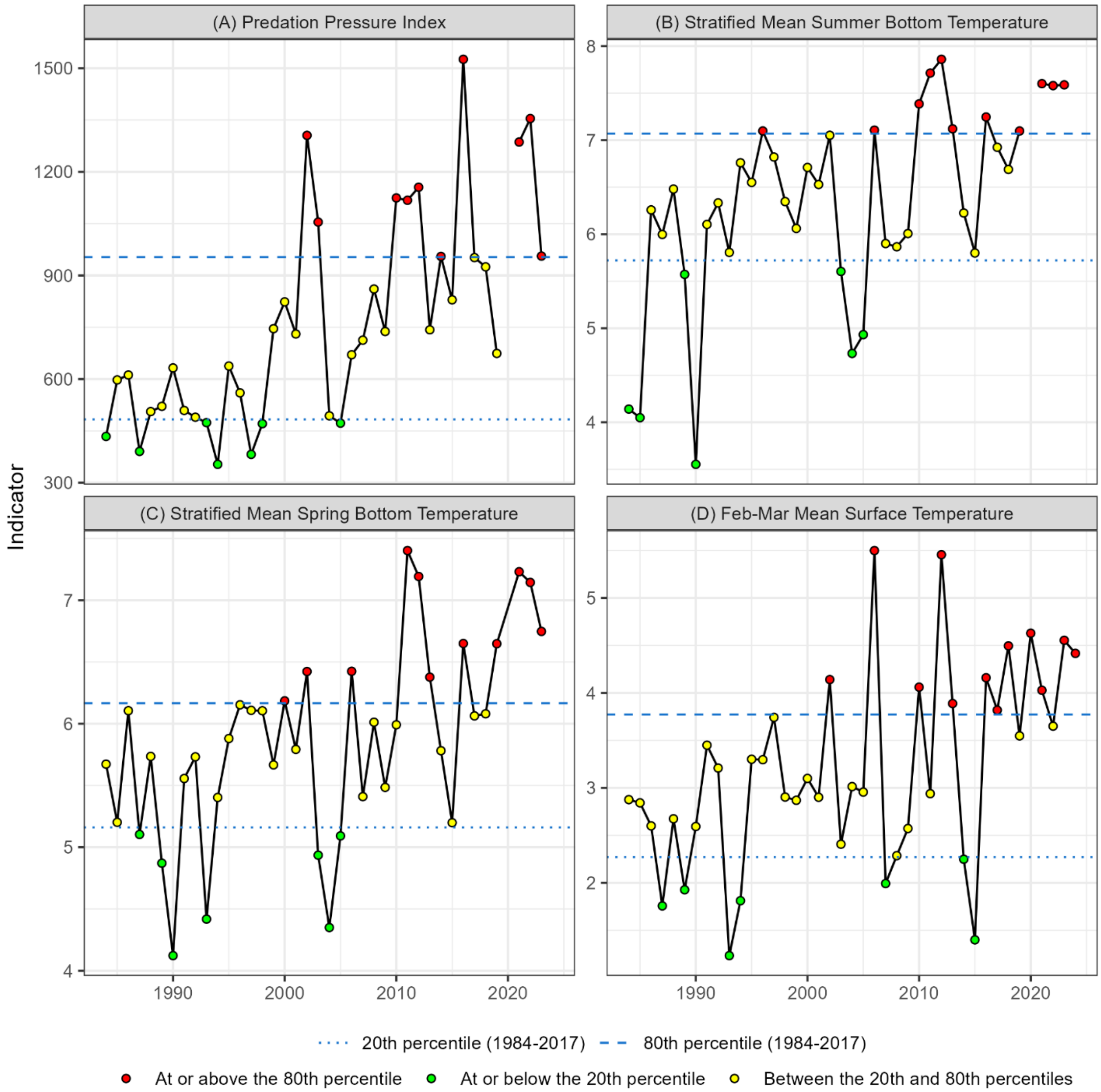

Figure 4. Traffic light analysis of environmental conditions in the Gulf of Maine 1984-2023, including predation pressure (A), summer bottom temperature (B), spring bottom temperature (C), and winter sea surface temperature (D). The 20th percentile of the time series from 1984-2017 delineated a favorable state, and the 80th percentile of the time series from 1984-2017 delineated an adverse state. Source: 2024 Northern Shrimp Stock Assessment Update.

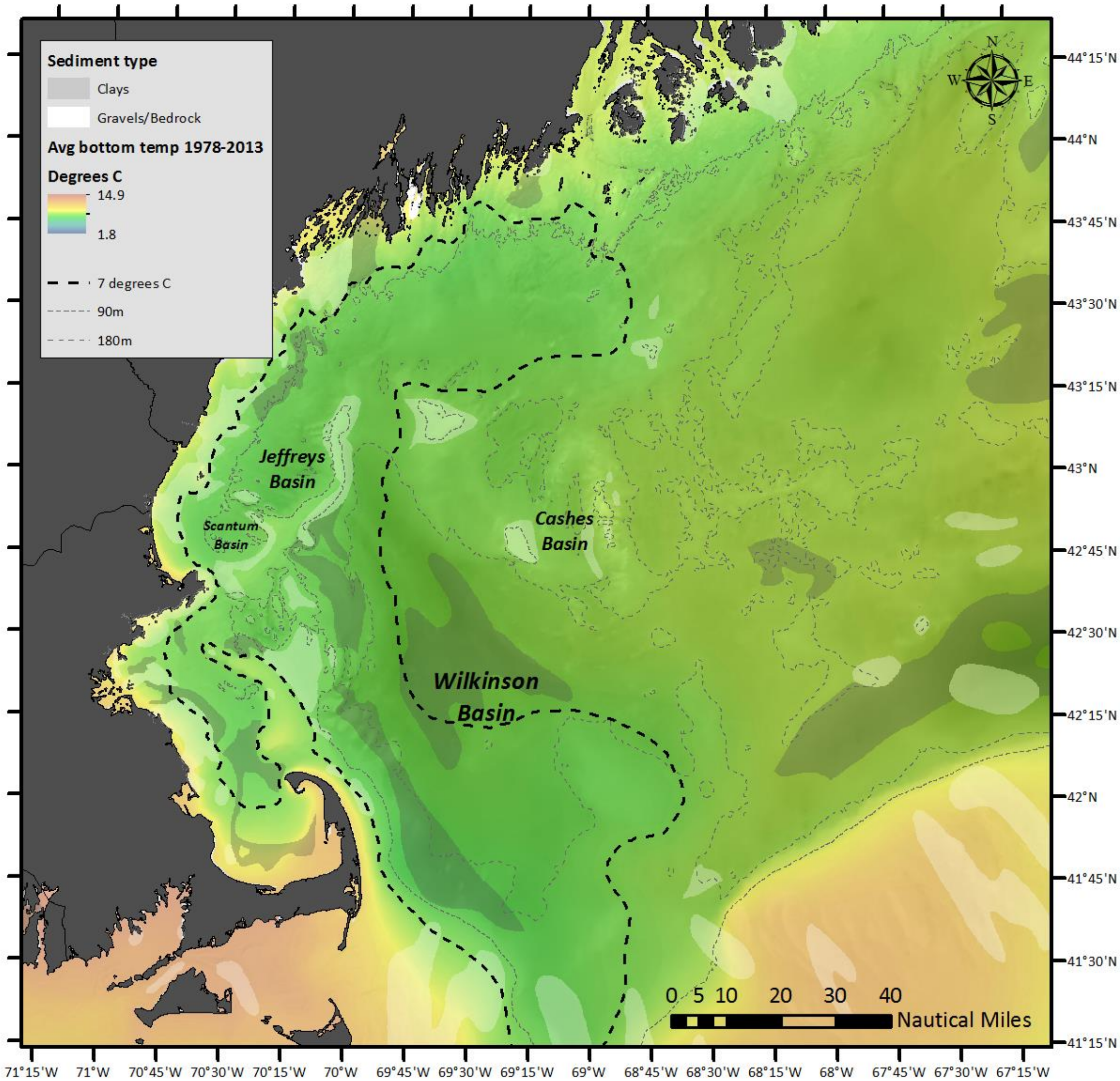

Figure 5. Habitat map for the Gulf of Maine. Colored shading indicates average annual bottom temperature based on the Finite Volume Coastal Ocean Model for the period 1978 to 2013, with the heavy dotted contour line enclosing areas where temperatures were on average below 7 degrees. Grey shaded patches indicate areas of clay or mixed clay sediments, while white patches show areas of gravel or bedrock. Other areas are sand or mixed sand/silt/clay. The light dotted lies show the 90 m and 180 m contours. Shrimp are commonly found between these depths during the spring, summer, and fall months.

10.0 APPENDIX 1

APPENDIX 1.1 Preliminary Trip Limit Analysis

The Amendment 3 PDT analyzed trip limit options by vessel catch history and gear type. The PDT developed two methodologies to evaluate trip limits. First, the PDT computed the average trip weight for each individual vessel across all trips taken from 2008 through 2011 fishing years. The PDT also applied a range of trip limits to the 2010 fishery to determine the percentage of trips that would have been impacted.

When the PDT computed average trip weight, vessels that landed zero pounds during the four-year time series were excluded from the analysis (n=169). The remaining active vessels (n=249) were placed in a matrix by average pounds landed and vessel size class to determine the percentage of vessels impacted by specific trip limits (see Appendix 1.2) The analysis for the pot fishery was not conclusive as the average pounds landed by 54% of the fleet was less than 100 pounds. Appendix 1.1 provides a breakdown of the vessels by vessel class and poundage category.

Table A.1.1. Percent of trawl vessels impacted by various trip limits based on the average pounds landed by a specific vessel for fishing years 2008 - 2011. Total number of vessels was 249.

Trip Limits (LBS)	% vessels impacted
1000	81.6%
1500	64.3%
2000	40.6%
2500	26.9%
3000	16.9%

The PDT also analyzed trip level data excluding specific vessel catch history. Appendix 1.3 shows the number of trips by state, gear, and vessel size and trip poundage categories for fishing years 2007-2011.

Appendix 1.4 details the average trip weight (pounds) by state, gear, and vessel size class fishing years 2001-2011. The table below is a subset of these results from 2008 to 2011.

Table A.1.2. Average trip weight (pounds) by state, gear, and vessel size class from 2008 to 2011. This analysis excludes vessel catch history and is the average of trip data. Cells marked by an asterisk (*) are confidential data.

State and Gear	Vessel Size Class	2008	2009	2010	2011
Maine Trawl	< 20 FT.			125	*
	21 TO 30 FT.		*	764	*
	31 TO 40 FT.	1,641	1,582	2,130	1,824
	41 TO 50 FT.	2,555	2,453	3,032	2,391
	51 TO 60 FT	3,118	2,997	3,754	3,201
	61 TO 70 FT.	*		*	4,278
	> 70 FT.	5,715	*	6,508	5,039
	ALL VESSELS COMBINED	2,307	2,216	2,744	2,437
Maine Pots	< 20 FT.	*	*	*	245
	21 TO 30 FT.	814	934	1,301	819
	31 TO 40 FT.	1,132	922	1,495	1,108
	41 TO 50 FT.	1,151	993	839	532
	ALL VESSELS COMBINED	1,110	922	1,451	1,043
State and Gear	**Vessel Size Class**	**2008**	**2009**	**2010**	**2011**
New Hampshire Trawl	31 TO 40 FT.	*	*		
	41 TO 50 FT.	2,470	2,497	2,352	2,422
	51 TO 60 FT	2,639	*	3,675	2,853
	61 TO 70 FT.				
	> 70 FT.				
	ALL VESSELS COMBINED	2,488	2,518	2,734	2,539
Massachusetts Trawl	31 TO 40 FT.	*		*	2,148
	41 TO 50 FT.	*	*	1,449	1,992
	51 TO 60 FT				*
	61 TO 70 FT.				
	> 70 FT.				*
	ALL VESSELS COMBINED	1,695	1,660	1,560	2,252

Appendix 1.5 details the impacts of 1,000, 2,000, 3,000, and 4,000 trip limits applied to data from the 2010 fishery. The analysis includes impacts on trawl, trap, and the overall fishery. In 2010, landings would have been reduced overall by 62% if a 1,000 trip limit was in effect. Trawl landings would have been reduced by 66% and trap landings by 47%. Trawlers greater than 60 feet would have been reduced by 83%. Total landings would have been reduced by 12% if a 4,000 pound trip limit was in place for the 2010 fishery.

APPENDIX 1.2. Analysis by vessel catch history, size class, and gear (trawl and pot) across 2008 to 2011 fishing years.

Number of vessels by vessel class and poundage category for the ME, NH, and MA TRAWL fishery based on the 2008 to 2011 average catch per trip

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.	Total Vessels
< = 30 FT. 31		3	3	1							7
TO 40 FT.		6	21	32	28	12	7	2	3		111
41 TO 50 FT.	1	5	6	9	27	17	11	7	8		91
51 TO 60 FT	1			1	2	5	6	3	7		25
61 TO 70 FT.					1		1	1	3	1	7
> 70 FT.					1			2	3	2	8
ALL VESSELS COMBINED	2	14	30	43	59	34	25	15	24	3	249
% of Fleet	0.80%	5.62%	12.05%	17.27%	23.69%	13.65%	10.04%	6.02%	9.64%	1.20%	
% Impacted by Trip Limit Equal to Poundage Category MAX	99.20%	93.57%	81.53%	64.26%	40.56%	26.91%	16.87%	10.84%	1.20%		

Number of vessels by vessel class and poundage category for the ME, NH, and MA POT fishery based on the 2008 to 2011 average catch per trip

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< = 30 FT.	1	4								
31 TO 40	6	7								
FT.	127	33	5	1		1	1			
41 TO 50 FT.										
51 TO 60 FT										
61 TO 70 FT.										
> 70 FT.	134	44	5	1	0	1	1	0	0	0
ALL VESSELS COMBINED	53.82%	17.67%	2.01%	0.40%	0.00%	0.40%	0.40%	0.00%	0.00%	
% of Fleet % Impacted by Trip Limit Equal to	27.96%	4.30%	1.61%	1.08%	1.08%	0.54%	0.00%	0.00%	0.00%	0.00%

APPENDIX 1.3. The number of trips by state, gear, and vessel size and trip poundage categories for fishing years 2007-2011.

Number of trips by vessel class and poundage category - N. Shrimp - 2007 MAINE- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
<30 FT.										
31 TO 40 FT.	3	64	153	140	137	127	130	80	155	65
41 TO 50 FT.	3	33	48	74	112	131	146	108	239	224
51 TO 60 FT		4	19	31	55	45	62	50	142	129
> 60 FT.	1	2	4	3	3	0	8	9	19	16
ALL VESSELS COMBINED	**6**	**101**	**220**	**245**	**304**	**303**	**338**	**238**	**536**	**418**

Number of trips by vessel class and poundage category - N. Shrimp - 2008 MAINE- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 30 FT.										
31 TO 40 FT.	17	187	325	330	272	147	88	54	101	28
41 TO 50 FT.	5	59	110	186	242	182	178	118	184	97
51 TO 60 FT	1	12	39	54	76	68	72	52	125	65
> 60 FT.	0	1	4	8	8	4	5	3	14	39
ALL VESSELS COMBINED	**23**	**258**	**474**	**570**	**590**	**397**	**338**	**224**	**410**	**190**

Number of trips by vessel class and poundage category - N. Shrimp - 2009 MAINE- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 30 FT.		*	*	*						
31 TO 40 FT.	7	93	186	182	114	62	64	28	43	10
41 TO 50 FT.	1	37	116	94	86	90	61	50	88	59
51 TO 60 FT	1	16	33	41	61	50	47	29	94	44
> 60 FT.			*	*		*		*	*	*
ALL VESSELS COMBINED	**9**	**146**	**335**	**317**	**261**	**202**	**172**	**107**	**225**	**113**

* Confidential Data

Number of trips by vessel class and poundage category - N. Shrimp - 2010 MAINE- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 30 FT.	5	6	10	5	1					
31 TO 40 FT.	10	134	292	318	283	220	193	105	163	98
41 TO 50 FT.	4	39	101	130	146	134	120	90	200	161
51 TO 60 FT	3	15	29	42	54	53	58	49	138	130
> 60 FT.			1	3	1	8	5	2	28	35
ALL VESSELS COMBINED	**17**	**188**	**422**	**490**	**483**	**407**	**371**	**244**	**501**	**389**

Number of trips by vessel class and poundage category - N. Shrimp - 2011 MAINE- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 30 FT.	*	*	*							
31 TO 40 FT.	10	137	243	341	343	218	152	76	113	20
41 TO 50 FT.	8	71	113	173	230	222	198	117	179	54
51 TO 60 FT		5	24	33	61	72	88	61	105	64
> 60 FT.		5	9	6	11	15	23	30	123	111
ALL VESSELS COMBINED	**18**	**218**	**389**	**553**	**645**	**527**	**461**	**284**	**520**	**249**

* Confidential Data

Number of trips by vessel class and poundage category - N. Shrimp - 2007 MAINE- POT Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40 FT.	100	209	251	165	130	64	40	8	3	
41 TO 50 FT.	7	14	17	9	17	8	2			1
ALL VESSELS COMBINED	**107**	**223**	**268**	**174**	**147**	**72**	**42**	**8**	**3**	**1**

Number of trips by vessel class and poundage category - N. Shrimp - 2008 MAINE- POT Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40 FT.	156	316	293	249	181	101	59	32	25	7
41 TO 50 FT.	8	28	32	38	28	11	5	1	1	
ALL VESSELS COMBINED	**164**	**344**	**325**	**287**	**209**	**112**	**64**	**33**	**26**	**7**

Number of trips by vessel class and poundage category - N. Shrimp - 2009 MAINE- POT Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40 FT.	152	171	180	172	91	30	21	14	6	2
41 TO 50 FT.	14	7	16	11	16	4	1			
ALL VESSELS COMBINED	**166**	**178**	**196**	**183**	**107**	**34**	**22**	**14**	**6**	**2**

Number of trips by vessel class and poundage category - N. Shrimp - 2010 MAINE- POT Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40 FT.	141	301	317	282	278	198	121	68	88	24
41 TO 50 FT.	6	21	14	23	7	1				
ALL VESSELS COMBINED	**147**	**322**	**331**	**305**	**285**	**199**	**121**	**68**	**88**	**24**

Number of trips by vessel class and poundage category - N. Shrimp - 2011 MAINE- POT Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40 FT.	123	348	358	348	181	94	55	25	21	2
41 TO 50 FT.	13	39	22	11	2	1				
ALL VESSELS COMBINED	**136**	**387**	**380**	**359**	**183**	**95**	**55**	**25**	**21**	**2**

Number of trips by vessel class and poundage category - N. Shrimp - 2007 New Hampshire- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 20 FT.										
21 TO 30 FT.										
31 TO 40 FT.			*		*	*				
41 TO 50 FT.		6	27	25	27	20	18	14	36	27
51 TO 60 FT		*		*		*	*	*	*	*
61 TO 70 FT.										
> 70 FT.										
ALL VESSELS COMBINED	**0**	**6**	**27**	**25**	**27**	**20**	**18**	**14**	**36**	**27**

* Confidential Data

Number of trips by vessel class and poundage category - N. Shrimp - 2008 New Hampshire- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 20 FT.										
21 TO 30 FT.										
31 TO 40 FT.	1			*	*					
41 TO 50 FT.	3	15	17	41	55	51	41	21	32	16
51 TO 60 FT		3	7	6	11	8	11	9	10	4
61 TO 70 FT.										
> 70 FT.										
ALL VESSELS COMBINED	**4**	**18**	**24**	**47**	**66**	**59**	**52**	**30**	**42**	**20**

* Confidential Data

Number of trips by vessel class and poundage category - N. Shrimp - 2009 New Hampshire- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 20 FT.										
21 TO 30 FT.										
31 TO 40 FT.			*						*	
41 TO 50 FT.		3	13	29	12	10	9	5	17	10
51 TO 60 FT			*	*	*	*	*	*	*	*
61 TO 70 FT.										
> 70 FT.										
ALL VESSELS COMBINED	**0**	**3**	**13**	**29**	**12**	**10**	**9**	**5**	**17**	**10**

* Confidential Data

Number of trips by vessel class and poundage category - N. Shrimp - 2010 New Hampshire- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 20 FT.										
21 TO 30 FT.										
31 TO 40 FT.										
41 TO 50 FT.	2	16	37	52	53	42	31	15	40	20
51 TO 60 FT	1		3	4	14	19	15	8	37	24
61 TO 70 FT.										
> 70 FT.										
ALL VESSELS COMBINED	**3**	**16**	**40**	**56**	**67**	**61**	**46**	**23**	**77**	**44**

Number of trips by vessel class and poundage category - N. Shrimp - 2011 New Hampshire- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 20 FT.										
21 TO 30 FT.										
31 TO 40 FT.										
41 TO 50 FT.	1	11	35	52	80	81	60	25	44	18
51 TO 60 FT		3	7	16	22	22	16	28	26	12
61 TO 70 FT.										
> 70 FT.										
ALL VESSELS COMBINED	**1**	**14**	**42**	**68**	**102**	**103**	**76**	**53**	**70**	**30**

Number of trips by vessel class and poundage category - N. Shrimp - 2010 Massachusetts- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40FT			1	2	5		2	1		
41 TO 50 FT.	2	6	8	9	5	3	5	2	1	
>50 FT.										
ALL VESSELS COMBINED	**2**	**6**	**9**	**11**	**10**	**3**	**7**	**3**	**1**	**0**

Number of trips by vessel class and poundage category - N. Shrimp - 2011 Massachusetts- Trawl Fishery

Vessel Size	1 to 100 lbs.	101 to 500 lbs.	501 to 1000 lbs.	1001 to 1500 lbs.	1501 to 2000 lbs.	2001 to 2500 lbs.	2501 to 3000 lbs.	3001 to 3500 lbs.	3501 to 5000 lbs.	> 5000 lbs.
< 40FT		1	4	16	21	15	9	6	6	
41 TO 50 FT.		3	3	6	6	12	7	2	1	
>50 FT.	3		2	3	9	8	8	5	14	3
ALL VESSELS COMBINED	**3**	**4**	**9**	**25**	**36**	**35**	**24**	**13**	**21**	**3**

***All MA 2007, 2008, and 2009 trip level data are confidential**

APPENDIX 1.4. Average trip weight (pounds) by state, gear, and vessel size class from 2001 to 2011.

Average trip weight (lbs) of N. Shrimp Landed - MAINE- Trawl Fishery by Vessel Class

Vessel Size	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
< 20 FT.										125	*
21 TO 30 FT.			*				*		*	764	*
31 TO 40 FT.	565	619	877	1,291	1,175	2,059	2,402	1,641	1,582	2,130	1,824
41 TO 50 FT.	836	992	1,241	2,366	1,772	2,816	3,494	2,555	2,453	3,032	2,391
51 TO 60 FT	965	1,279	1,323	2,968	2,090	3,339	3,867	3,118	2,997	3,754	3,201
61 TO 70 FT.	1,325	*	1,606	*	2,982	*	2,949	*		*	4,278
> 70 FT.	863	*	1,348	*	*	*	*	5,715	*	6,508	5,039
ALL VESSELS COMBINED	739	908	1,127	2,131	1,659	2,741	3,158	2,307	2,216	2,744	2,437

* Confidential Data

Average trip weight (lbs) of N. Shrimp Landed - MAINE- POT Fishery by Vessel Class

Vessel Size	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
< 20 FT.	188	126	*	*	*	*	790	*	*	*	245
21 TO 30 FT.	241	254	499	407	512	745	664	814	934	1,301	819
31 TO 40 FT.	493	448	709	375	1,057	805	1,028	1,132	922	1,495	1,108
41 TO 50 FT.	461	*	816	*	1,041	1,234	1,190	1,151	993	839	532
51 TO 60 FT											
61 TO 70 FT.											
> 70 FT.											
ALL VESSELS COMBINED	456	420	712	364	1,019	809	1,007	1,110	922	1,451	1,043

* Confidential Data

Average trip weight (lbs) of N. Shrimp Landed - New Hampshire- Trawl Fishery by Vessel Class

Vessel Size	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
< 20 FT.											
21 TO 30 FT.											
31 TO 40 FT.	850	512	775	1,050	1,184	*	*	*	*		
41 TO 50 FT.	880	726	1,190	1,685	1,738	1,766	2,953	2,470	2,497	2,352	2,422
51 TO 60 FT	*	*	*		1,639	*	*	2,639	*	3,675	2,853
61 TO 70 FT.											
> 70 FT.											
ALL VESSELS COMBINED	905	669	1,069	1,545	1,631	1,825	2,980	2,488	2,518	2,734	2,539

* Confidential Data

Average trip weight (lbs) of N. Shrimp Landed - Massachusetts- Trawl Fishery by Vessel Class

Vessel Size	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
< 20 FT.											
21 TO 30 FT.											
31 TO 40 FT.	622	428	647	*	1,211	*	*	*		*	2,148
41 TO 50 FT.	677	*	688	774	984	1,161	*	*	*	1,449	1,992
51 TO 60 FT		*	*		*		*				*
61 TO 70 FT.			*	*							
> 70 FT.			*								*
ALL VESSELS COMBINED	645	544	681	803	1,044	1,147	1,196	1,695	1,660	1,560	2,252

* Confidential Data

APPENDIX 1.5 Analysis of trip limit scenarios applied to 2010 northern shrimp fishery data.

Trip Limit Scenarios Applied to 2010 Northern Shrimp Fishery Data*

		2010 Actual			Landings (lbs) with Trip Limit Scenarios if catches were cut off at (lbs)…..				Percent Reduction from Actual if catches were cut off at (lbs)…..			
Trawl gear	Vessel size	No. of Vessels	No. of Trips	Landings (lbs)	1,000	2,000	3,000	4,000	1000	2000	3000	4000
Maine	20-30 ft.	6	27	19,341	16,841	19,341	19,341	19,341	13%	0%	0%	0%
	31-40 ft.	62	1,814	3,867,333	1,653,533	2,737,801	3,311,786	3,581,857	57%	29%	14%	7%
	41-50 ft.	39	1,125	3,410,622	1,073,373	1,934,979	2,526,090	2,898,241	69%	43%	26%	15%
	51-60 ft.	14	569	2,143,507	550,932	1,034,333	1,414,007	1,686,959	74%	52%	34%	21%
	61-87 ft.	4	83	499,191	82,600	162,725	234,614	296,050	83%	67%	53%	41%
Maine Totals		125	3,618	9,939,994	3,377,279	5,889,179	7,505,838	8,482,448	66%	41%	24%	15%
Mass. Totals	31-50 ft.	5	47	81,110	39,674	66,710	79,010	81,110	51%	18%	3%	0%
New Hamp.	41-50 ft.	12	281	724,543	263,051	444,084	551,630	623,894	64%	39%	24%	14%
	51-60 ft.	3	125	459,416	123,415	238,487	324,949	385,520	73%	48%	29%	16%
New Hamp. Totals		15	406	1,183,959	386,466	682,571	876,579	1,009,414	67%	42%	26%	15%
Trawl Totals		145	4,071	11,205,063	3,803,419	6,638,460	8,461,427	9,572,972	66%	41%	24%	15%
Trap gear												
Maine	17-30 ft.	9	126	149,598	91,541	131,058	146,824	150,226	39%	12%	2%	0%
	31-40 ft.	94	1,693	2,531,195	1,307,188	2,046,269	2,347,589	2,456,869	48%	19%	7%	3%
	41-50 ft.	8	73	62,087	49,596	61,887	62,087	62,087	20%	0%	0%	0%
Maine Totals		111	1,892	2,744,763	1,448,325	2,239,214	2,556,500	2,669,182	47%	18%	7%	3%
Trap Totals		111	1,892	2,744,763	1,448,325	2,239,214	2,556,500	2,669,182	47%	18%	7%	3%
Grand Totals (Trawl + Trap)		256	5,963	13,949,826	5,251,744	8,877,674	11,017,927	12,242,154	62%	36%	21%	12%

* 2010 Shrimp season harvester trip report data are preliminary, as of 7/7/11.

From: Thomas McLennan <bugga3119@hotmail.com>
Sent: Sunday, December 1, 2024 8:17 PM
To: Comments <comments@asmfc.org>
Subject: [External] maine shrimp

OPEN IT UP! if the fishermen want to rig their boats up and go fish for shrimp, let them. If there isn't anything to catch, like "you guys" say, they won't keep going if they catch nothing.

maine fishermen can't even attempt, yet canada can find them no problem!

open it up, let us fish!