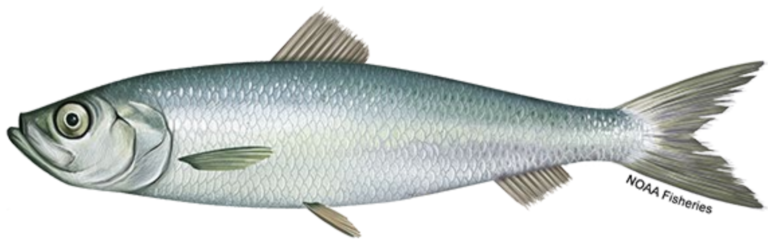
Atlantic Herring Fishery Management Plan

Amendment ## or Framework Adjustment



Appendix III

Atlantic Herring Plan Development Team
Analysis for River Herring and Shad

DRAFT

June 11, 2026

Prepared for the

New England Fishery Management Council

Overview

After an extended pause, the Council considered resuming work on Amendment 10 (A10) during its annual priority setting at the December 2025 meeting. The Council decided to shift the river herring and shad aspects of A10 into this action.

The following summarizes Council tasking to the Plan Development Team (PDT) for the river herring and shad analysis.

Council – June 24, 2024

1. That the Atlantic Herring Plan Development Team assess data availability and analyze and develop alternatives for Amendment 10 that implement time/area closures for portions of Atlantic Herring Management Areas 2 and 3 where aggregations of river herring and shad overlap with the directed Atlantic herring fishery.
2. That the Atlantic Herring Plan Development Team assess data availability and analyze and develop alternatives for Amendment 10 that implement revisions to the basis of river herring and shad catch cap values that: (1) are reflective of regional river herring/shad abundance, and (2) scale (with ceilings and floors) to changes in Atlantic herring abundance and/or regional river herring abundance.
3. That the Atlantic Herring Plan Development Team analyze and develop recommendations for implementing improvements to the accuracy and precision of river herring and shad catch estimates in the directed Atlantic herring fishery.

The Council's motions discussion is in Herring Committee audio.

This draft appendix includes PDT progress reports on Council task #1 and #2, and a PDT final report on Council task #3.

Atlantic Herring Plan Development Team Progress Report

Task #1: River Herring and Shad Time and Area Analyses

January 13, 2025

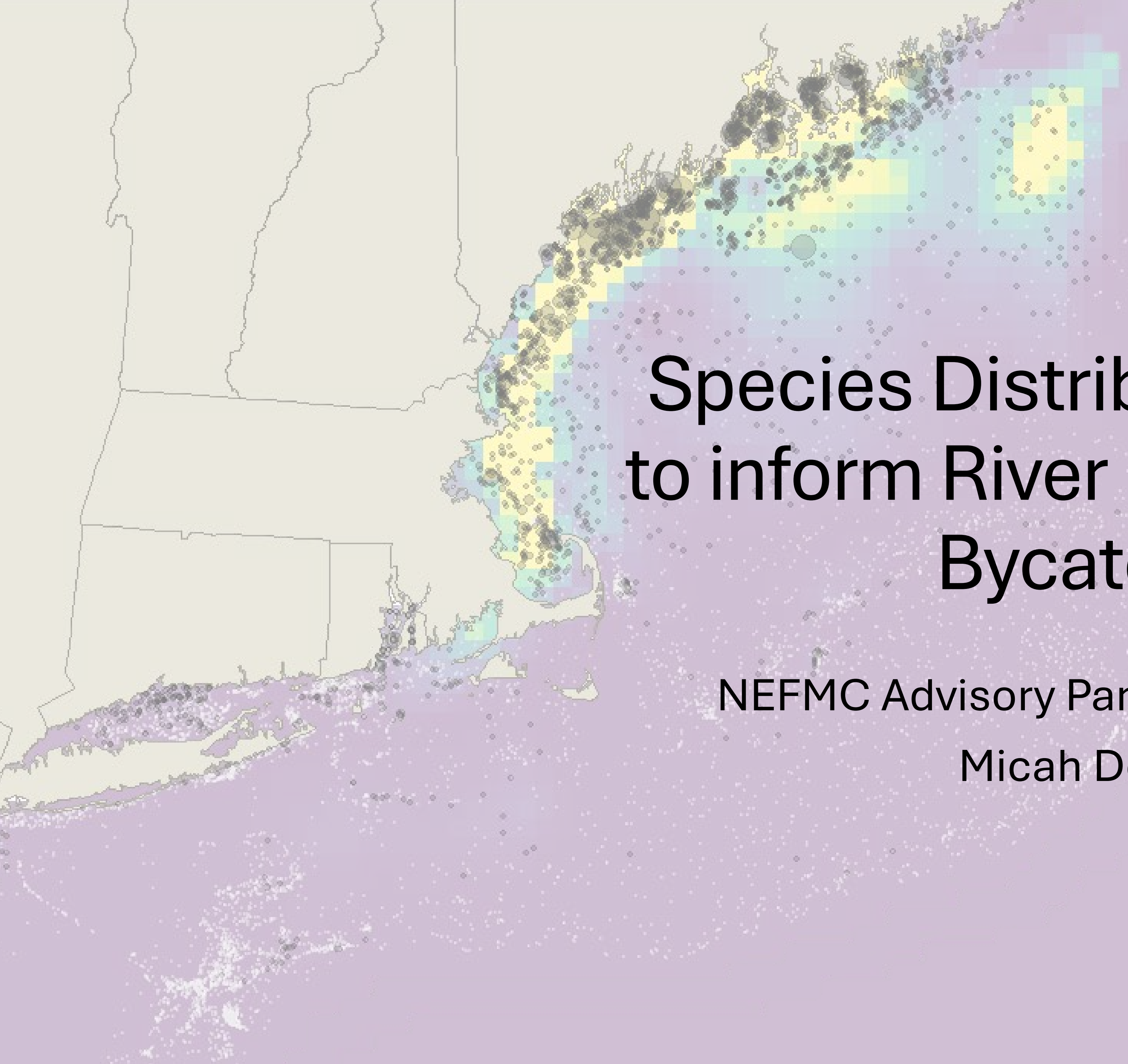
The PDT discussed preliminary work to explore the use of species distribution models (SDMs) for river herring, shad and Atlantic herring. This work could potentially inform the development of static bycatch closures that might either partially or wholly replace the need for the catch cap system as it exists now. The PDT summarized federal and state bottom-trawl survey and observed fishery data that could be used in the models, including an overview of possible environmental predictors (e.g., depth, temperature, etc.) by species. The PDT examined a preliminary model for alewife. The PDT planned to continue working on the SDMs and provide an update at a future PDT meeting.

May 26, 2026

The PDT discussed the latest version of the species distribution models for Atlantic herring, river herring, and shad. They discussed the data used from fishery independent and dependent sources. They noted the importance of explaining that the probability of encounters (illustrated in the model, which is based on occurrence) does not equal magnitude of an encounter, though reducing the probability of an encounter would inherently reduce the magnitude. There was some discussion about potential closure areas, which could be different sizes and shapes based on the occurrence data, though a static closure may not capture annual variation. The model may be used to understand how closure areas would balance impacts on fishing and the species.

June 8-9, 2026

The PDT provided an overview of the model at the joint Committee and Advisory Panel meeting on June 8, 2026. See attached for the presentation. The PDT also discussed feedback from the group at its meeting on June 9, 2026.



Species Distribution Models (SDM) to inform River Herring & Shad (RHS) Bycatch Closures

NEFMC Advisory Panel / Herring Committee Meeting

Micah Dean – June 8th, 2026

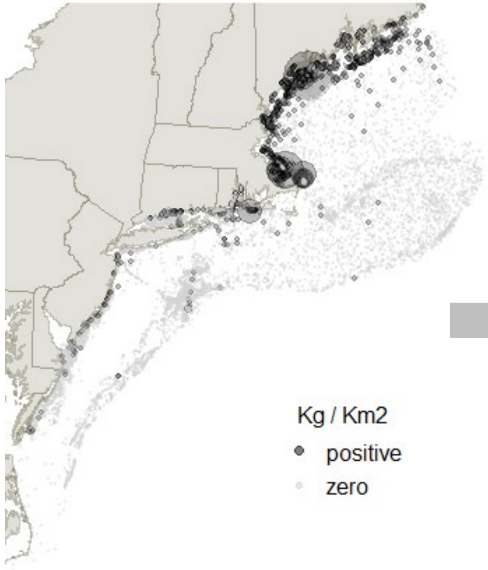
Why are we doing this work?

- Time-area closures = a practical alternative to bycatch caps?

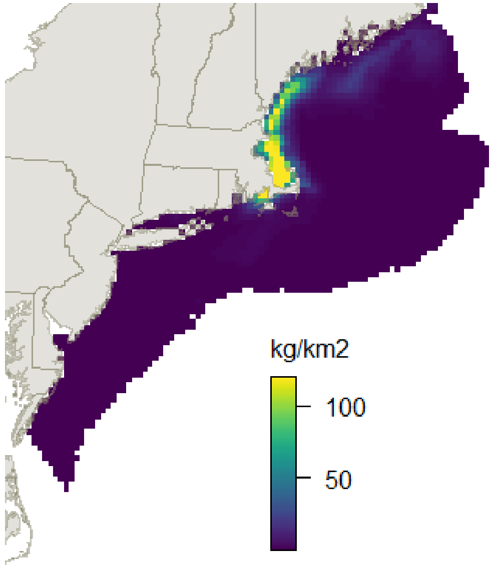
	Bycatch Caps	Time-Area Closures
In-season monitoring, forecasting, communication	Substantial	None
Closure size	Very Large	Small
Requires analytical assessments for RHS species	Yes	No

How Species Distribution Models (SDMs) work

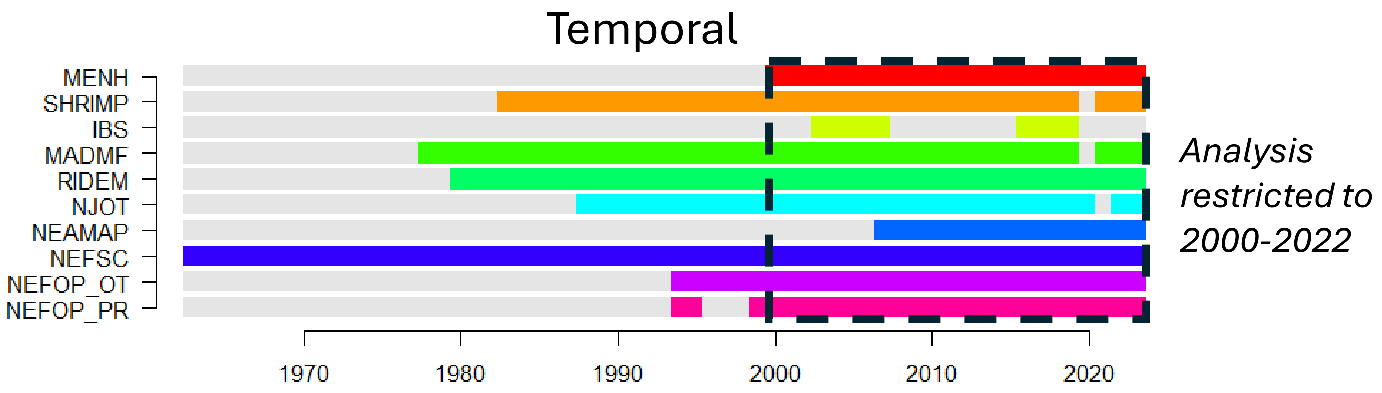
Observed CPUE

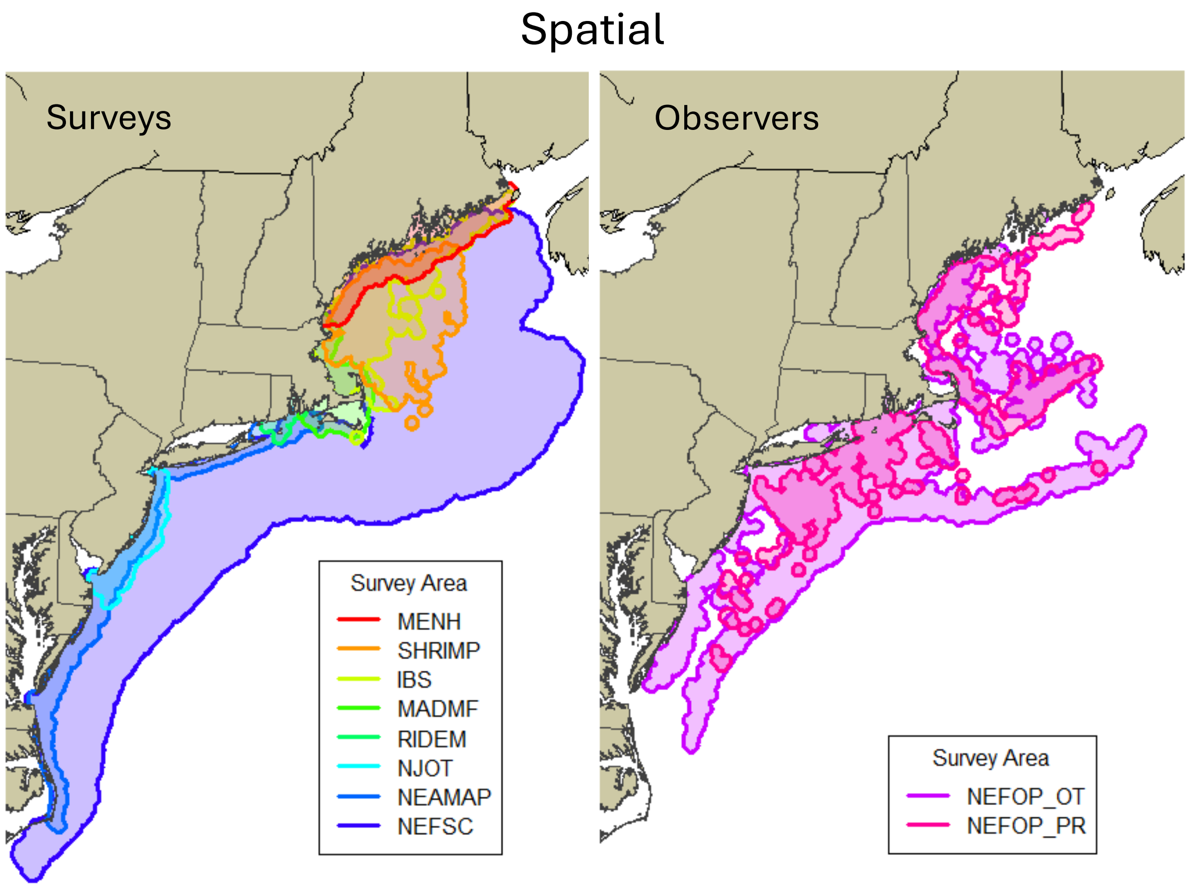


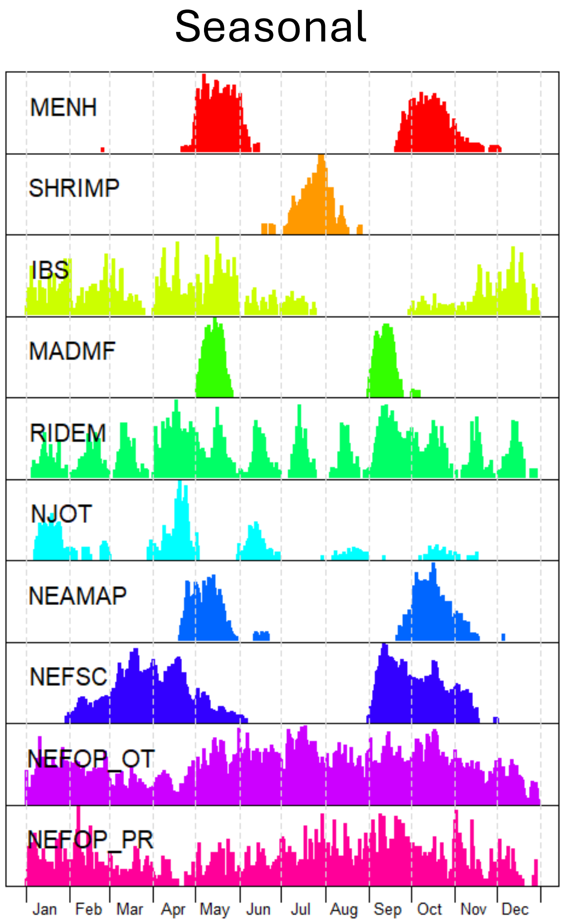
Predicted Abundance

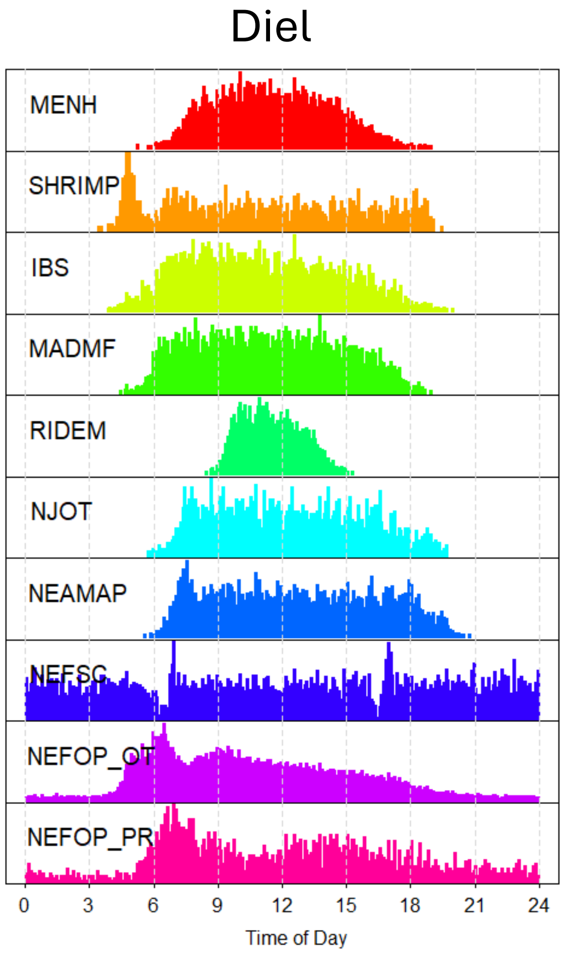


Dataset Extents









Sample Sizes

N = 81,458 { 90% for training; 10% for testing

% Positive

- Alewife = 26%
- Blueback herring = 13%
- American shad = 15%
- Atlantic herring = 29%

SOURCE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
MENH	0	1	0	33	1770	298	0	0	214	1384	224	13	**3937**
SHRIMP	0	0	0	0	0	40	918	483	0	0	0	0	**1441**
IBS	467	374	310	493	625	135	126	0	0	124	290	522	**3466**
MADMF	0	0	0	0	2187	0	0	0	2026	36	0	0	**4249**
RIDEM	230	246	263	703	459	305	289	274	703	498	264	276	**4510**
CTLISTS	0	0	0	637	864	827	4	0	769	731	110	5	**3947**
NJOT	447	100	25	601	26	263	1	58	4	61	8	0	**1594**
NEAMAP	0	0	0	186	1357	63	0	0	164	1626	100	0	**3496**
NEFSC	16	1013	3372	3164	1042	40	0	0	3498	2839	1035	13	**16032**
NEFOP_SMBT	2563	2454	1828	1720	3381	3809	4578	3369	3575	4321	2659	2054	**36311**
NEFOP_MWT	220	220	139	63	190	150	265	283	378	243	205	119	**2475**
Total	**3943**	**4408**	**5937**	**7600**	**11901**	**5930**	**6181**	**4467**	**11331**	**11863**	**4895**	**3002**	**81458**

SOURCE	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
CTLISTS	185	195	187	189	186	187	112	186	153	191	76	167	191	196	194	199	192	142	164	198	0	135	165	**3947**
IBS	0	0	0	121	811	868	340	347	0	0	0	0	0	0	0	0	259	324	350	46	0	0	0	**3466**
MADMF	190	194	189	189	182	186	195	202	201	197	192	195	192	197	202	193	187	195	188	192	0	191	200	**4249**
MENH	78	132	119	112	121	107	163	162	158	170	171	169	185	182	190	203	201	221	213	219	91	207	188	**3937**
NEAMAP	0	0	0	0	0	0	0	116	231	254	237	235	238	235	236	234	235	179	238	234	120	237	237	**3496**
NEFOP_SMBT	166	255	364	485	1073	1016	983	668	704	1802	1834	2735	1531	2191	2476	1920	2784	4544	3525	2607	444	773	1431	**36311**
NEFOP_MWT	2	2	1	28	90	232	69	47	126	192	350	219	376	262	177	33	91	67	19	16	11	9	56	**2475**
NEFSC	777	813	798	737	767	747	825	811	705	740	734	696	725	747	701	741	716	477	557	696	129	664	664	**16032**
NJOT	76	72	76	85	86	85	75	71	84	91	66	82	69	82	73	72	63	60	67	30	25	0	60	**1594**
RIDEM	157	157	170	166	165	183	172	193	212	205	211	212	206	215	203	192	211	218	204	205	218	217	218	**4510**
SHRIMP	54	54	54	60	48	67	41	73	59	75	72	76	80	74	65	40	70	73	81	105	0	60	60	**1441**
Total	**1685**	**1874**	**1958**	**2172**	**3529**	**3678**	**2975**	**2876**	**2633**	**3917**	**3943**	**4786**	**3793**	**4381**	**4517**	**3827**	**5009**	**6500**	**5606**	**4548**	**1038**	**2493**	**3279**	**81458**

Model Selection

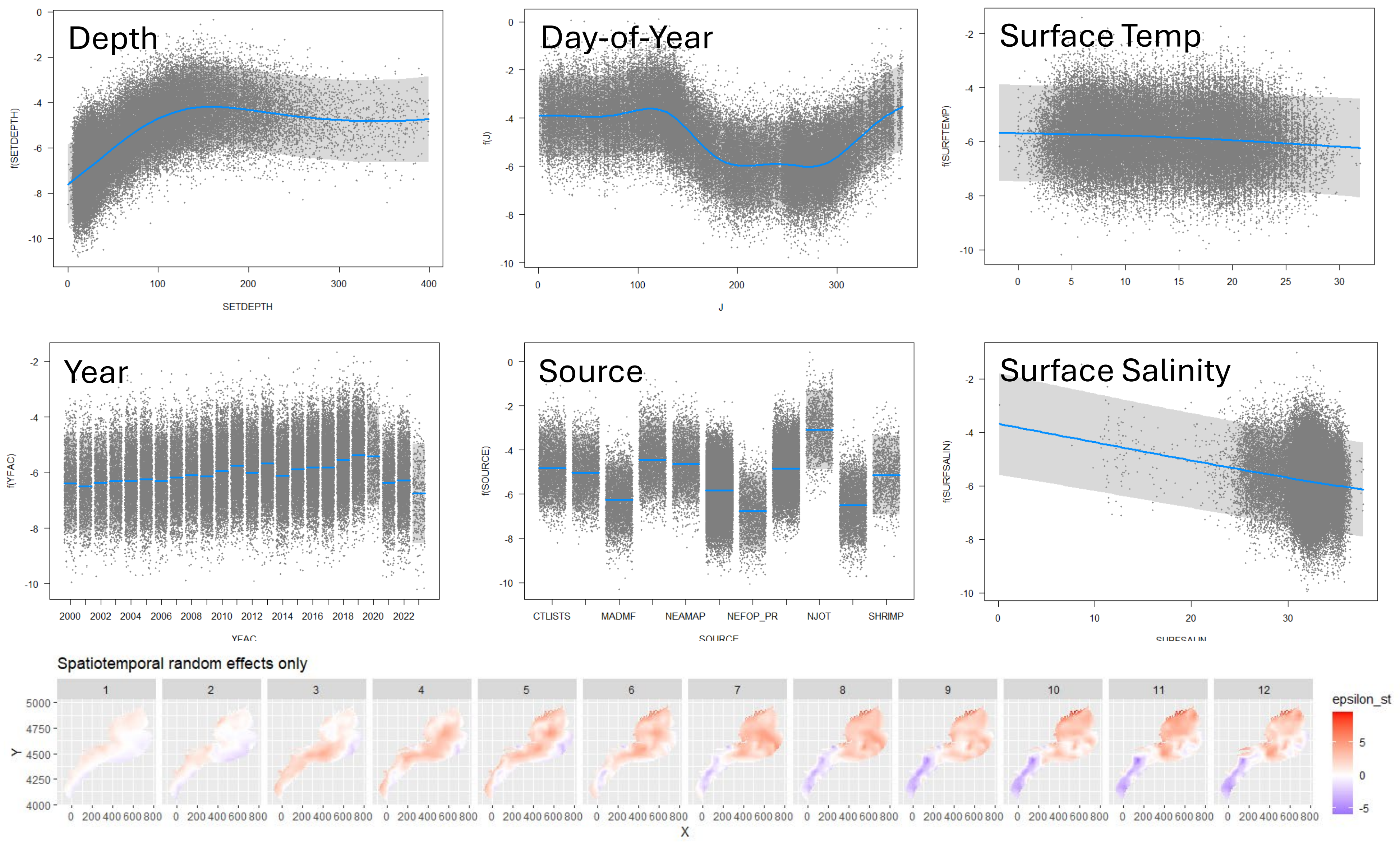
Candidate Variables

- Factors - Source, Season
- Random effects - Year
- Continuous - Depth, SurfTemp, BotTemp, SurfSal, BotSal, DistShore, Month, DayOfYear
- Spatial random effects – Spatial, Spatial:Year, Spatial:Month

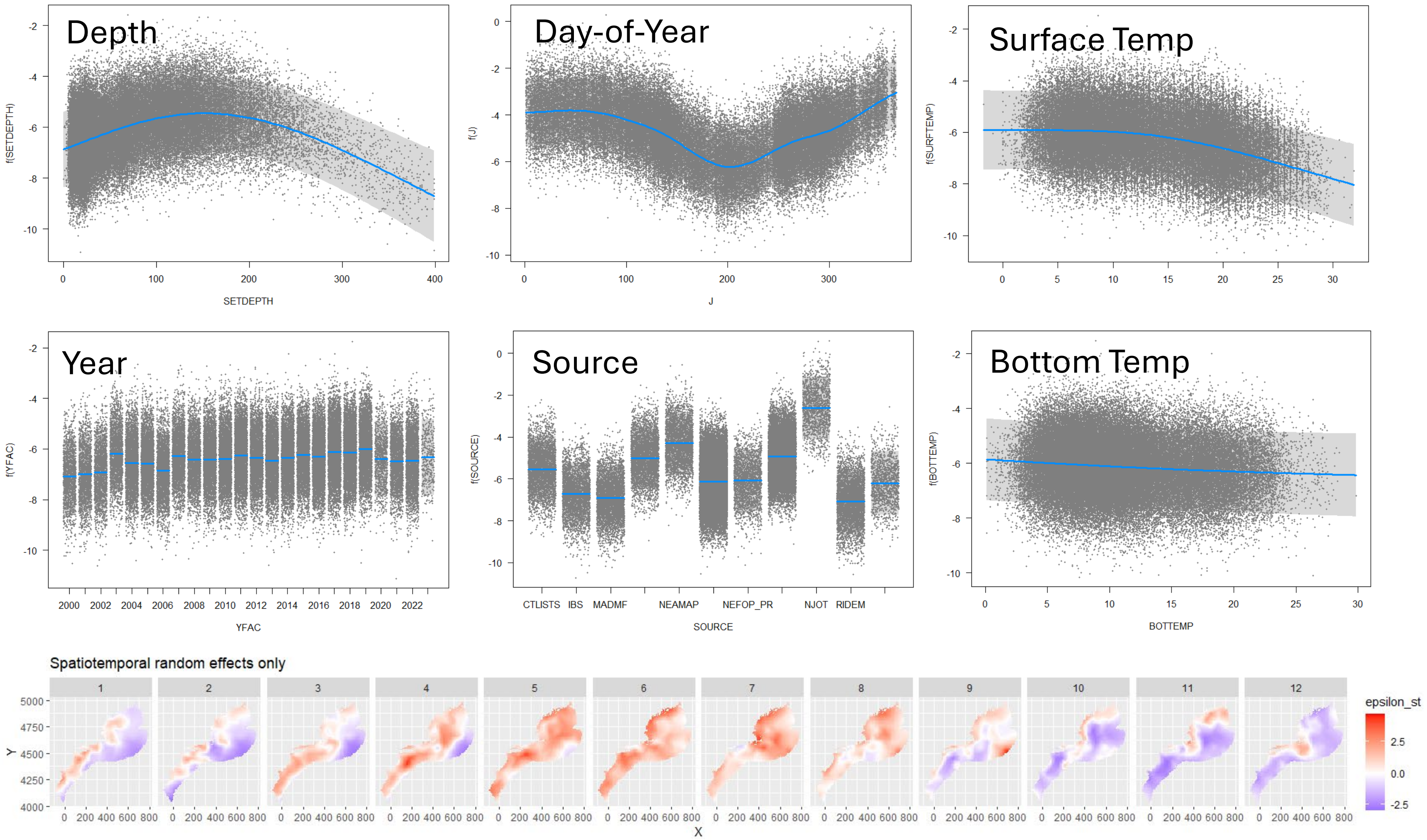
Selected Models

- Alewife ~ Source + Year + SurfTemp + Depth:DayOfYear + SurfSalin:DayOfYear + Spatial:Month
- Blueback ~ Source + Year + Depth + SurfTemp + BotTemp:DayOfYear + Spatial:Month
- Am Shad ~ Source + Year + Depth:Season + SurfTemp:DayOfYear + Spatial:Month

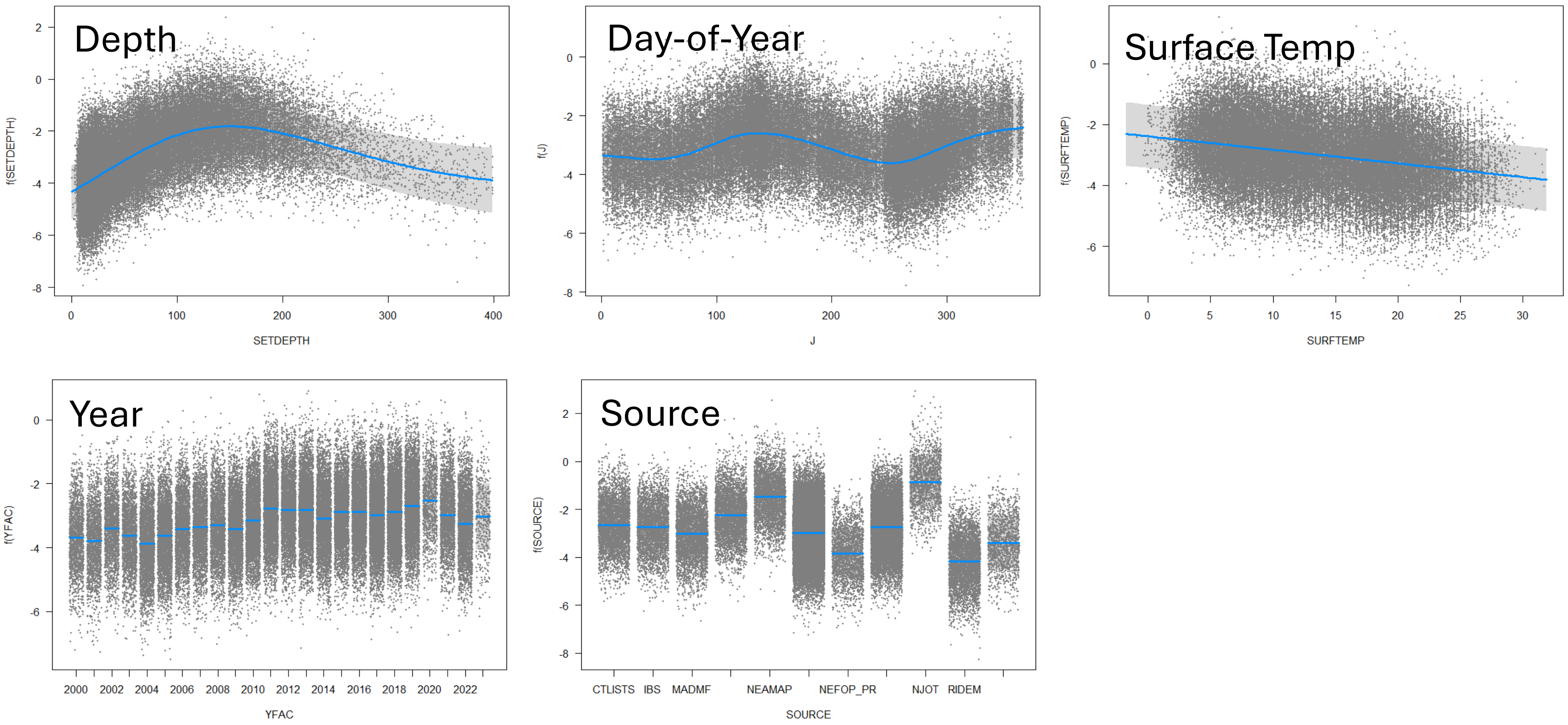
Marginal Effects of Predictors   Alewife

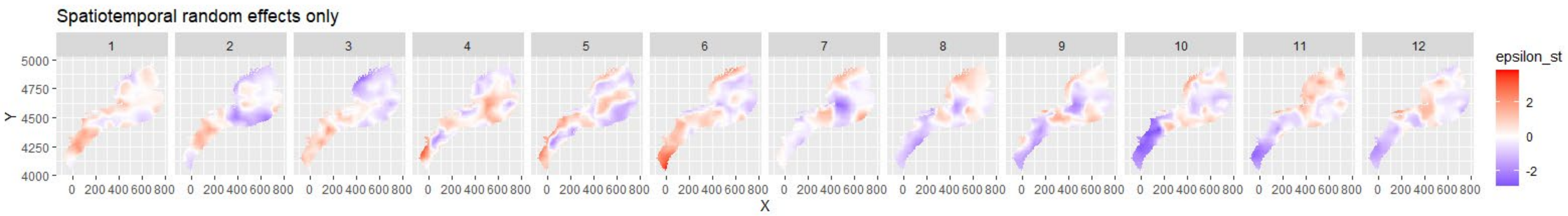


Marginal Effects of Predictors Blueback



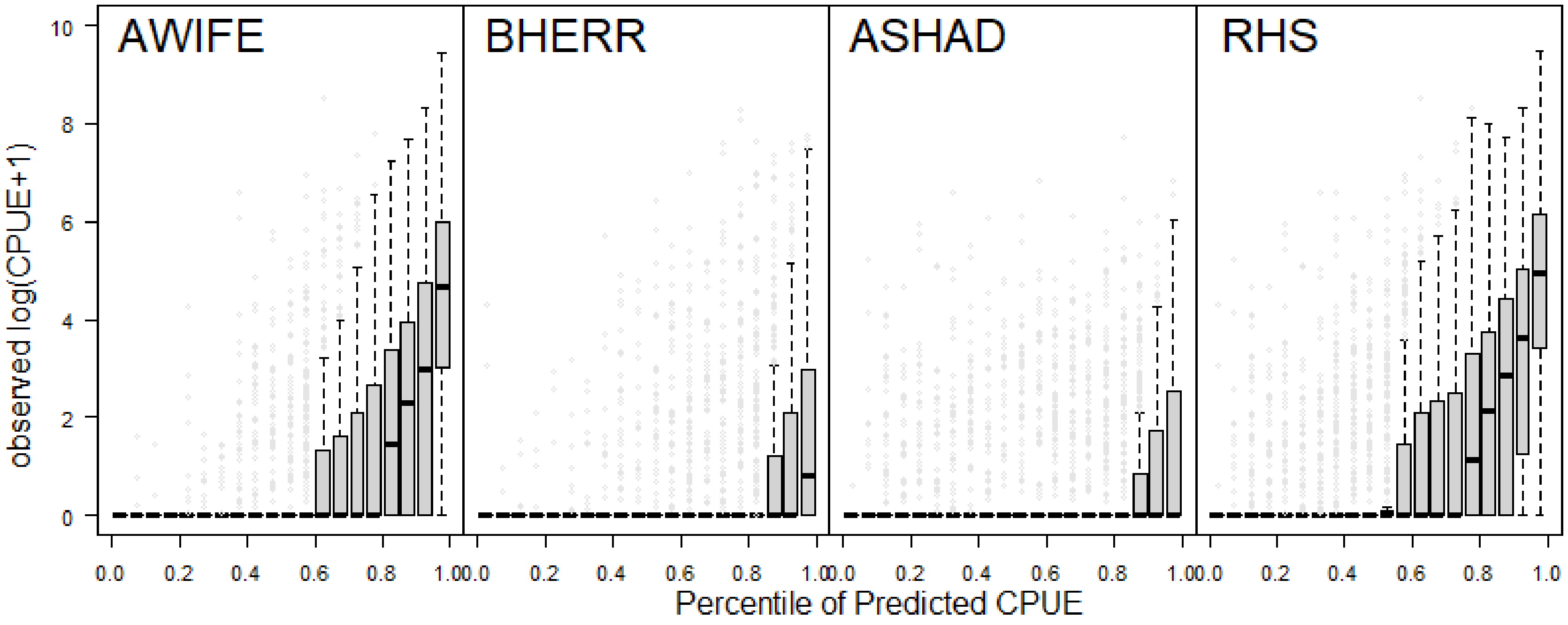
Marginal Effects of Predictors Am Shad





Comparison to Test Dataset

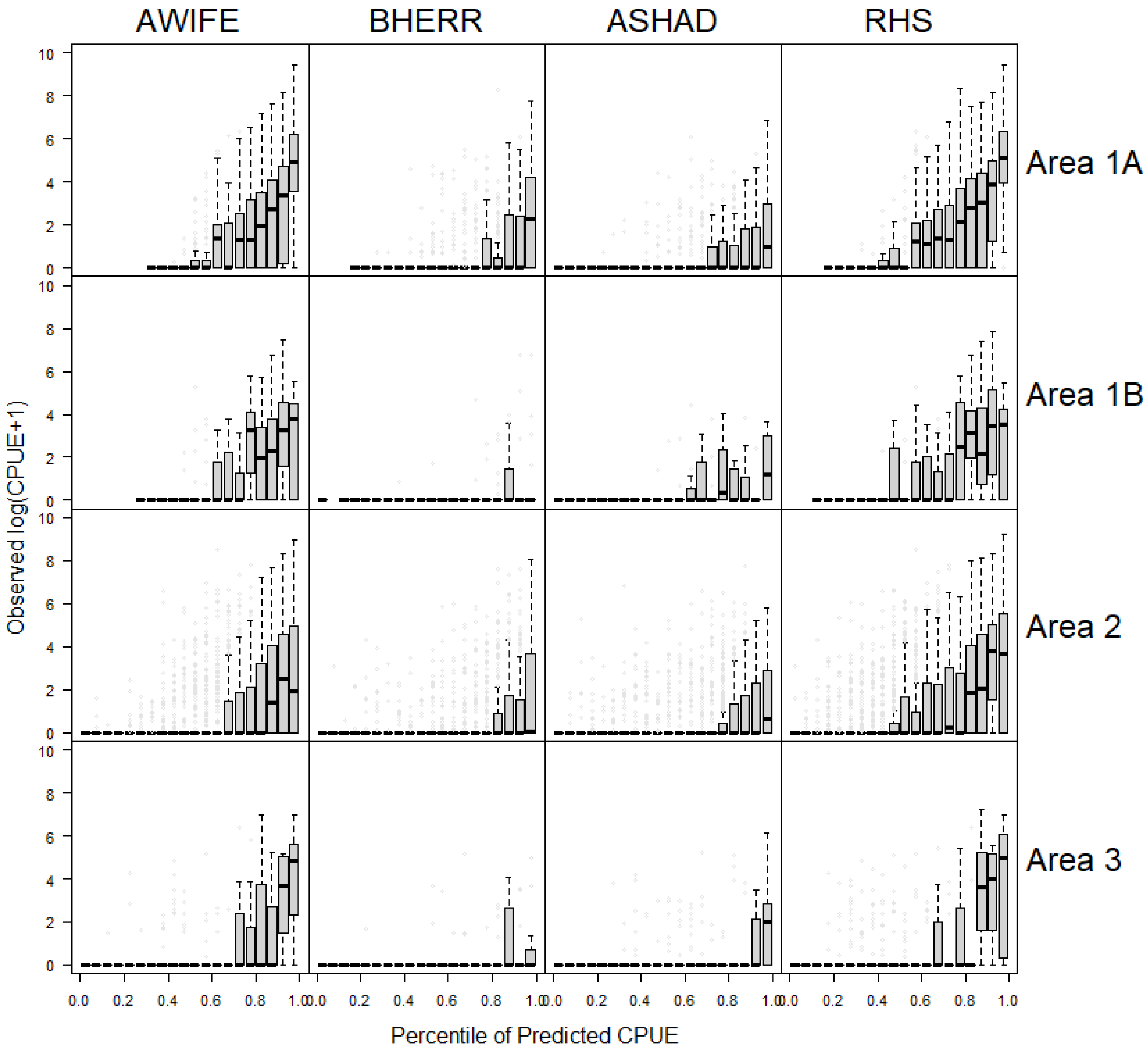
- How well does the SDM predict RHS catch rates?



Strong relationship between observed and predicted CPUE

Comparison to Test Dataset

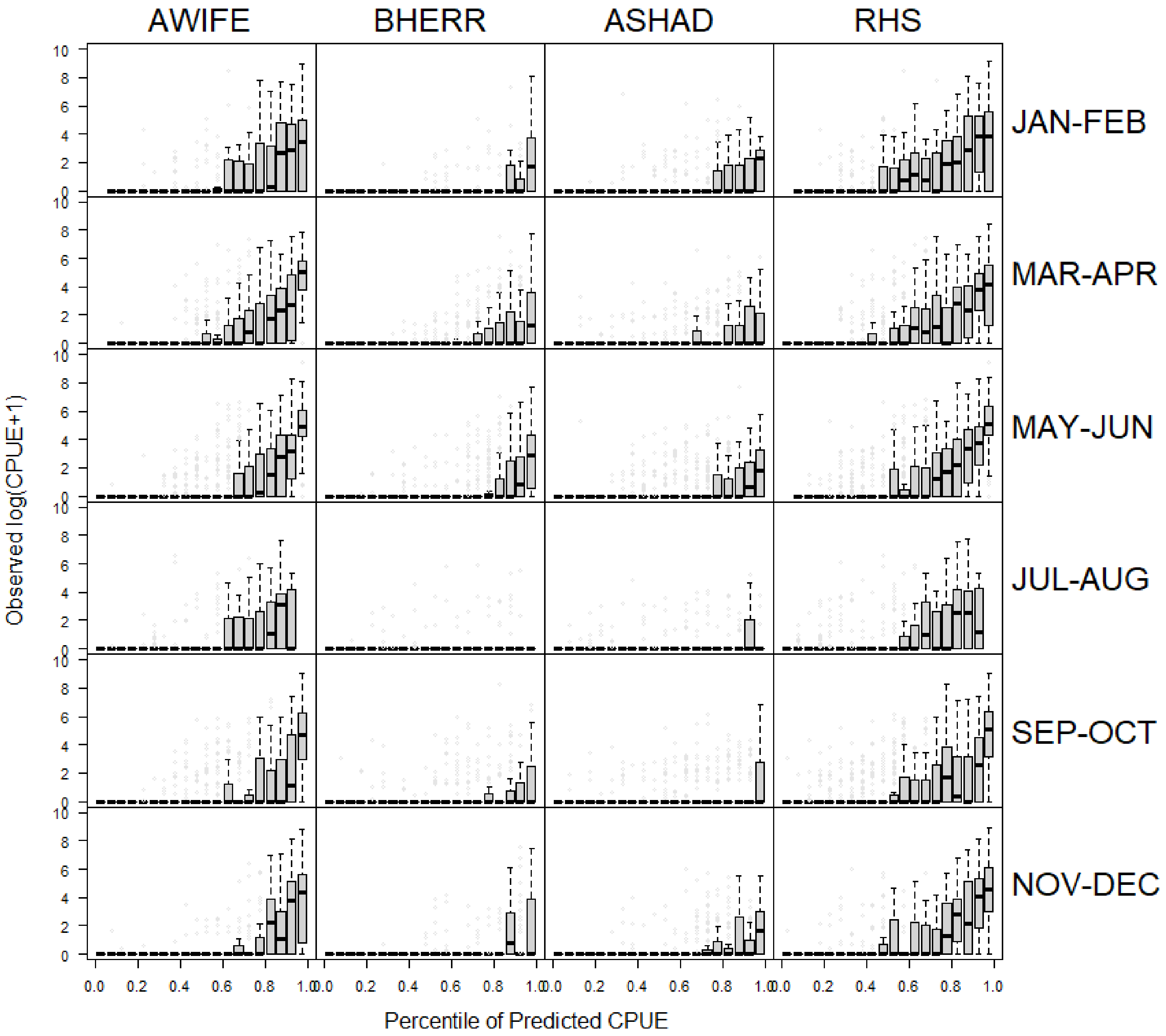
- How well does the SDM predict RHS catch rates?



Relationship is present in each management area

Comparison to Test Dataset

- How well does the SDM predict RHS catch rates?

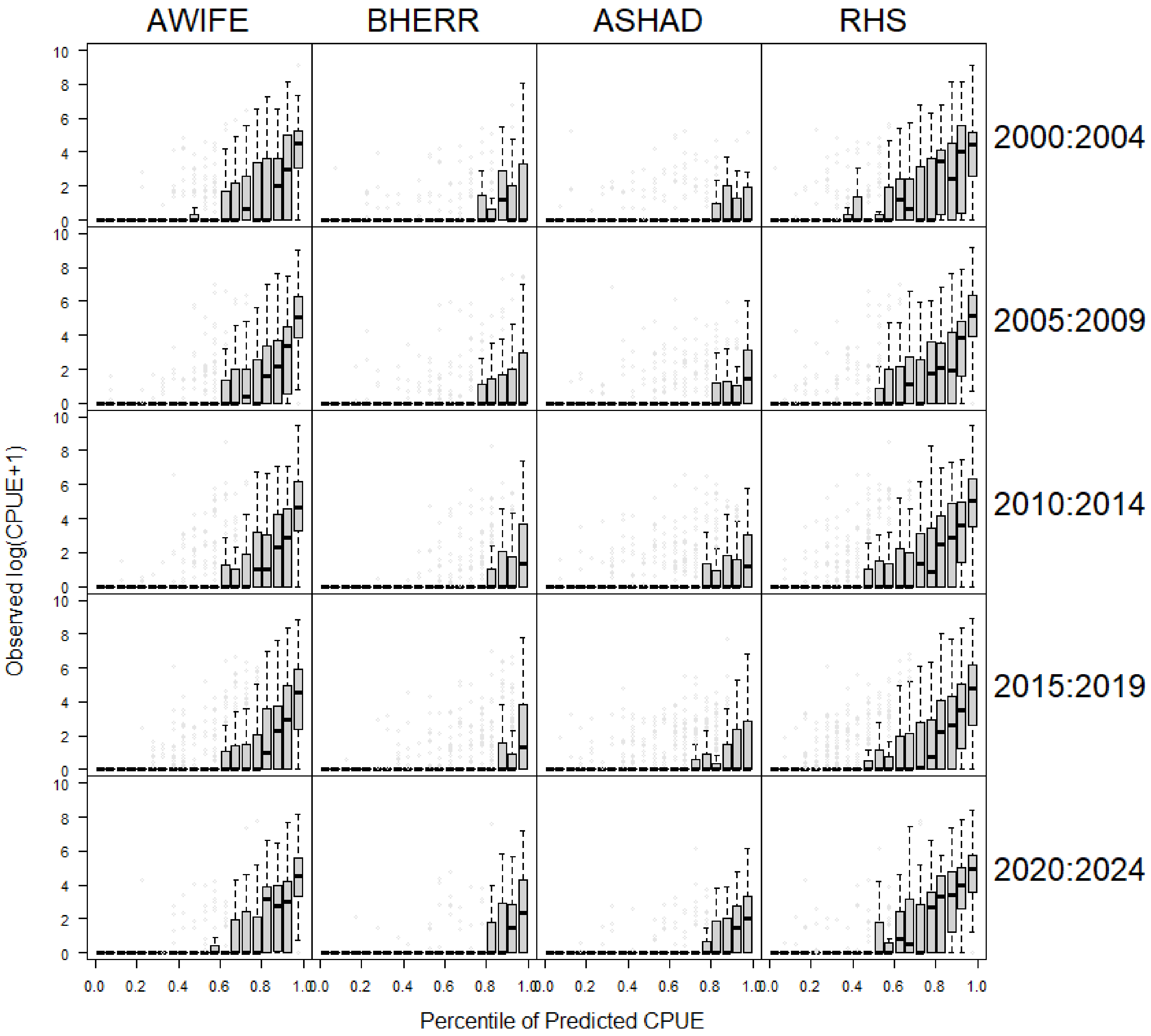


Relationship is stable across all seasons

Comparison to Test Dataset

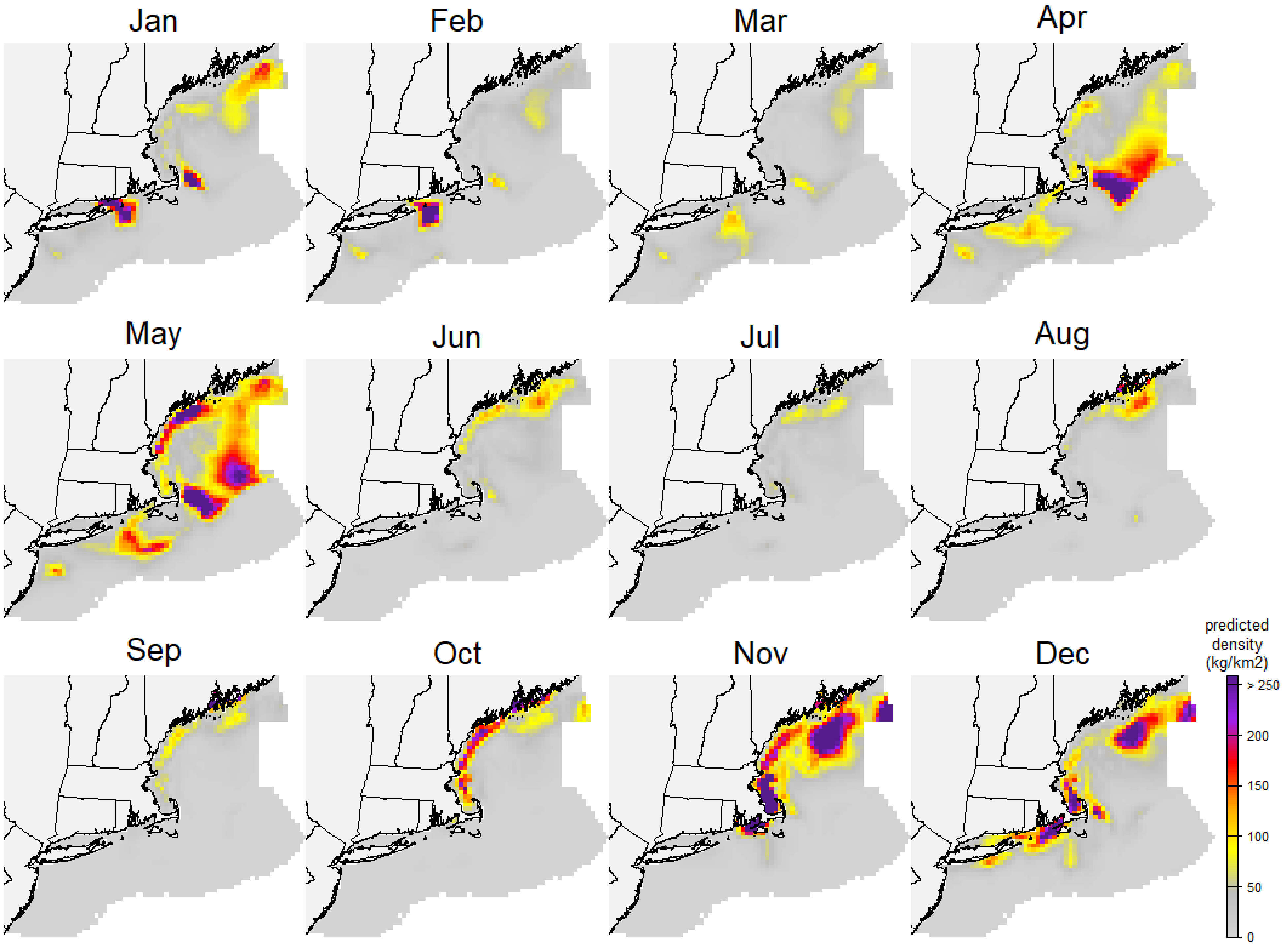
- How well does the SDM predict RHS catch rates?

Relationship is stable over time



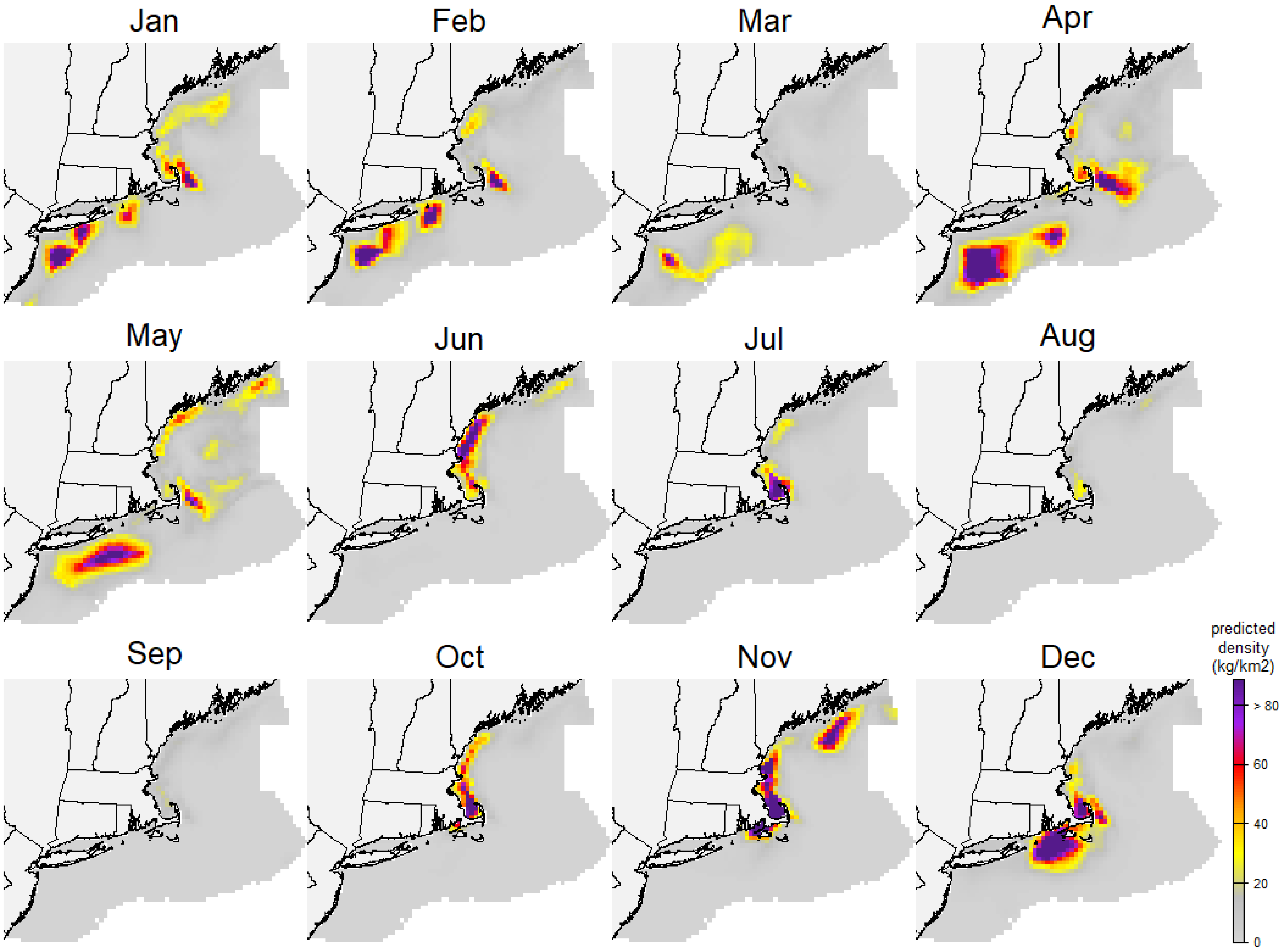
Model Predictions

- **Alewife**
- Predicted Abundance (kg/km2)



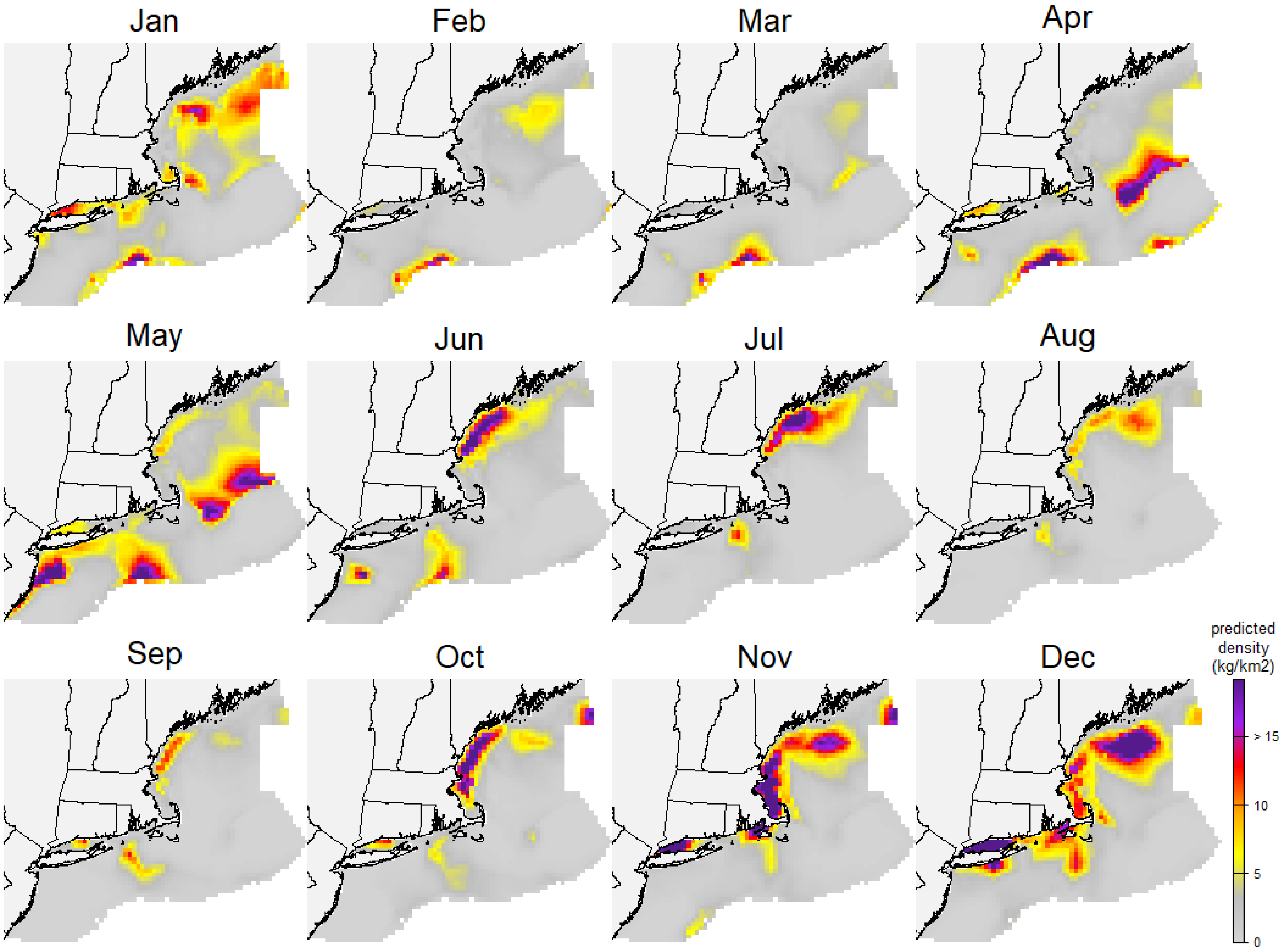
Model Predictions

- **Blueback Herring**
- Predicted Abundance (kg/km2)



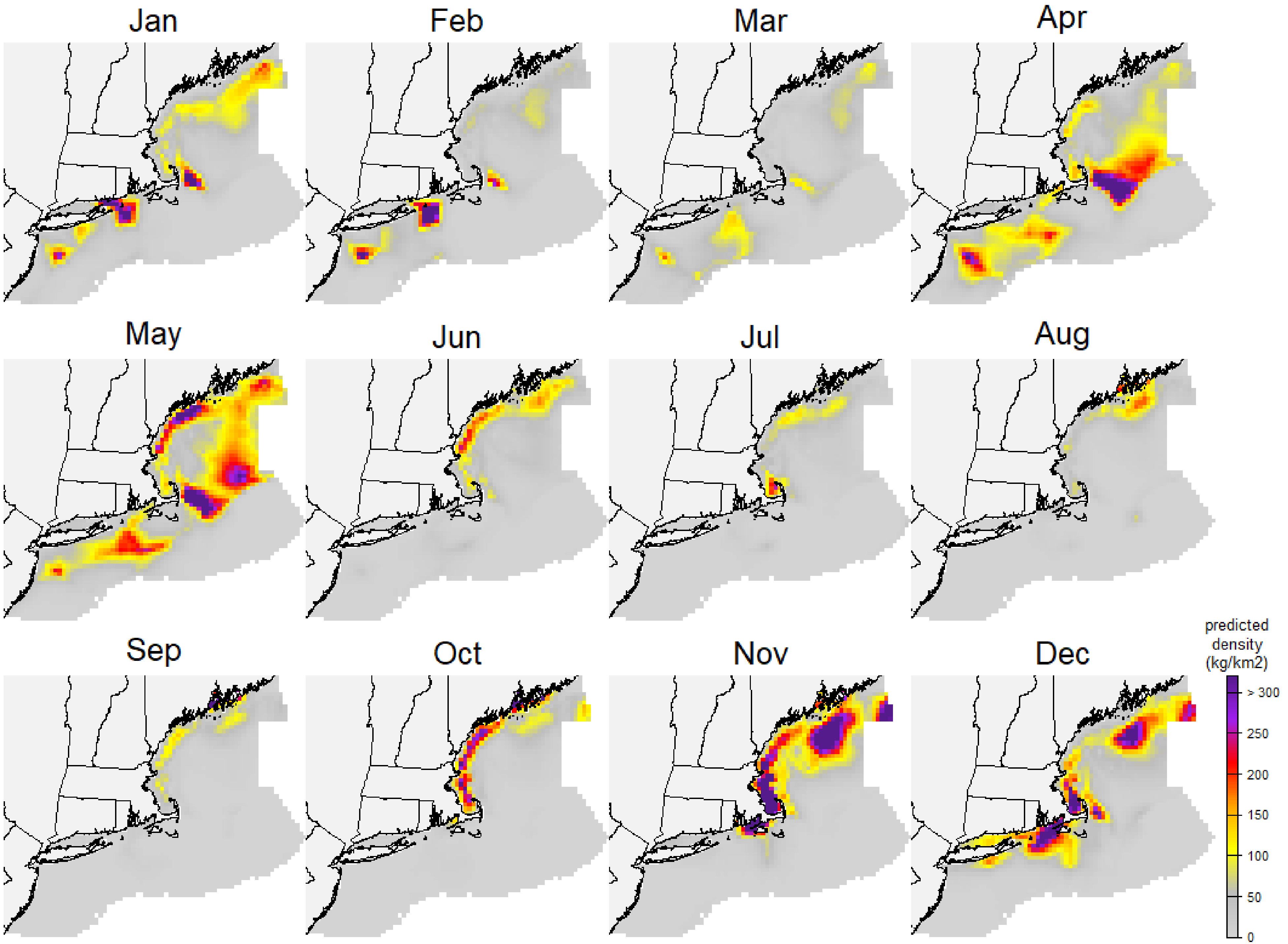
Model Predictions

- **American Shad**
- Predicted Abundance (kg/km2)



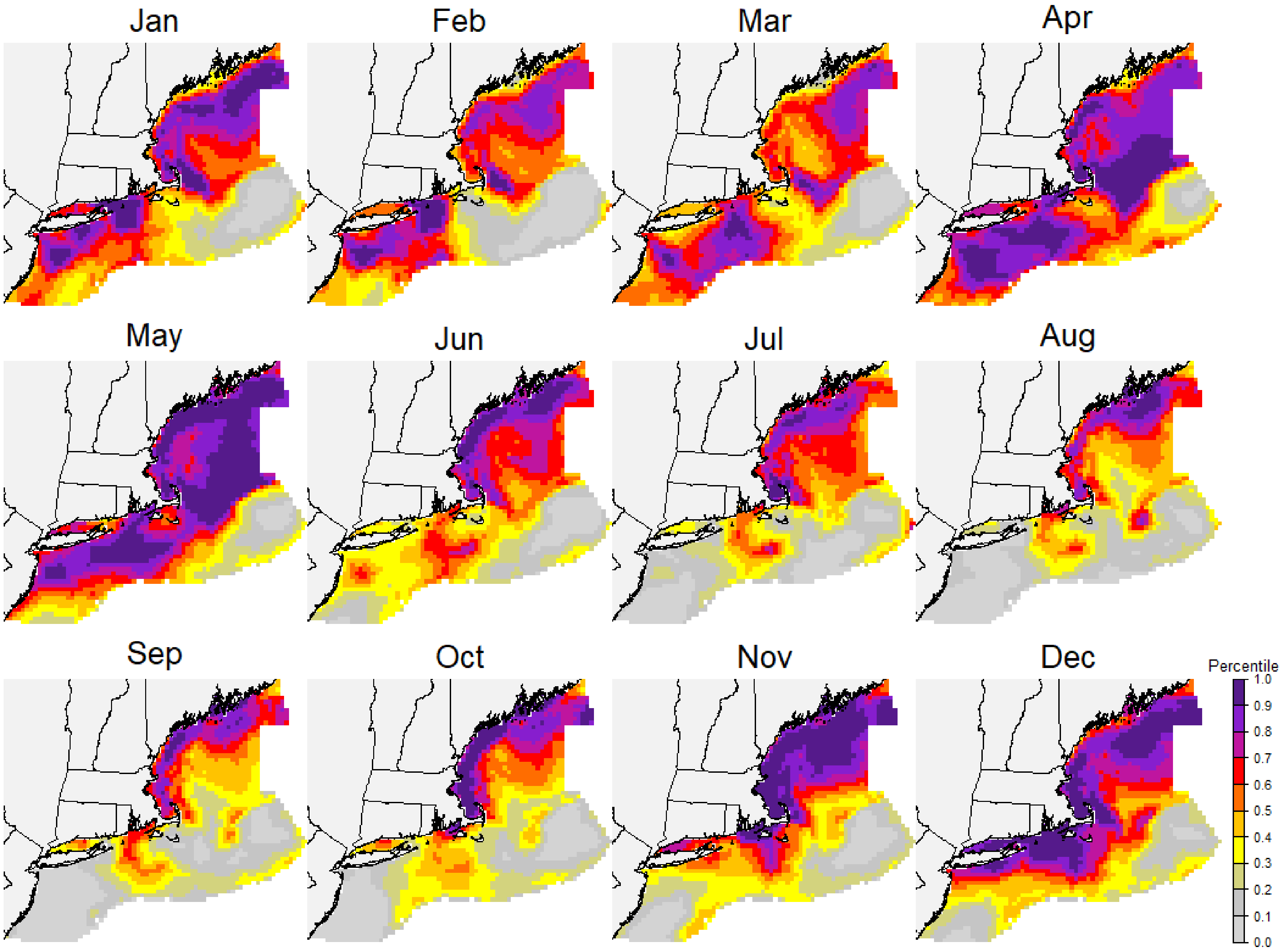
Model Predictions

- **All RHS**
- Predicted Abundance (kg/km2)



Model Predictions

- **All RHS**
- Area Percentiles

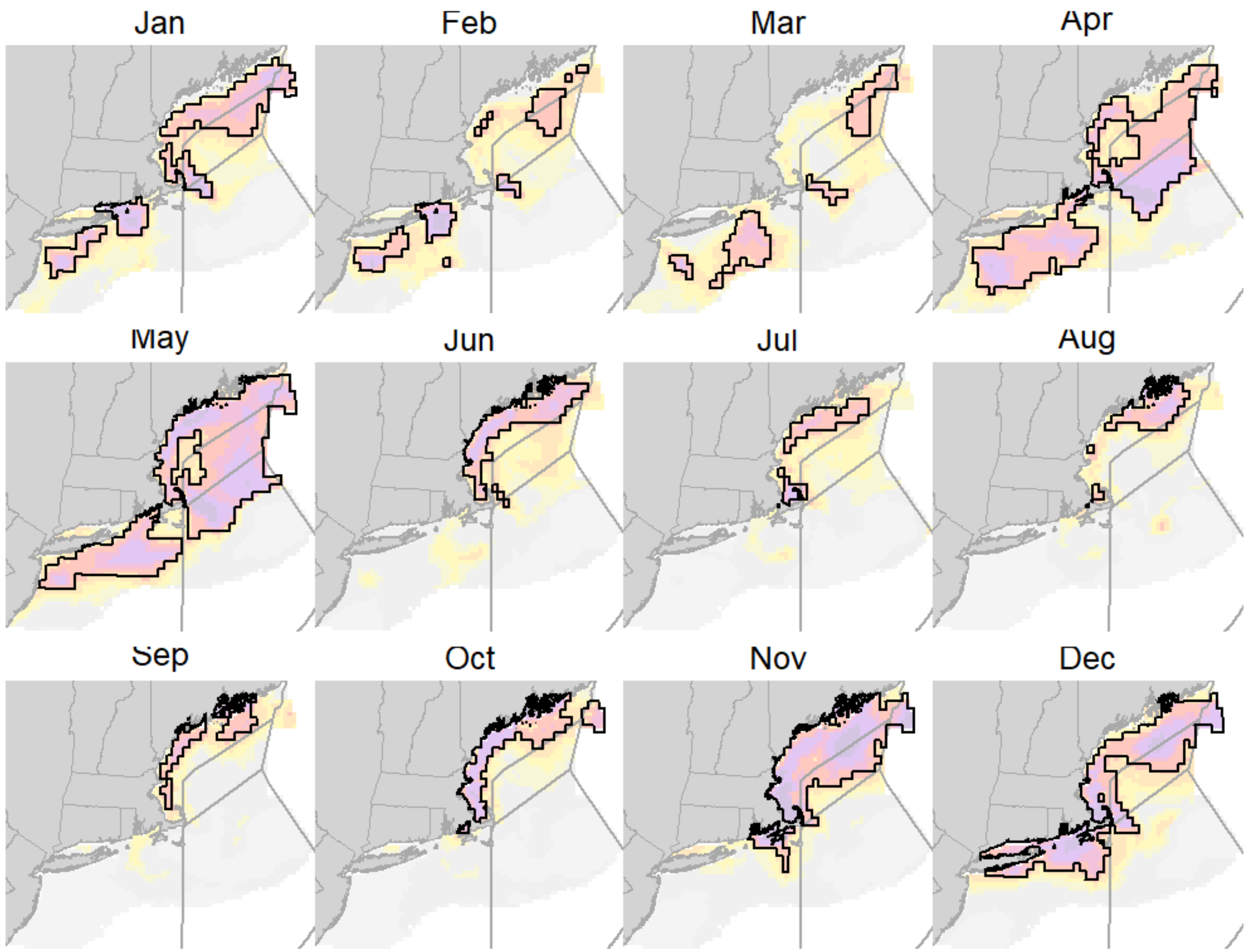


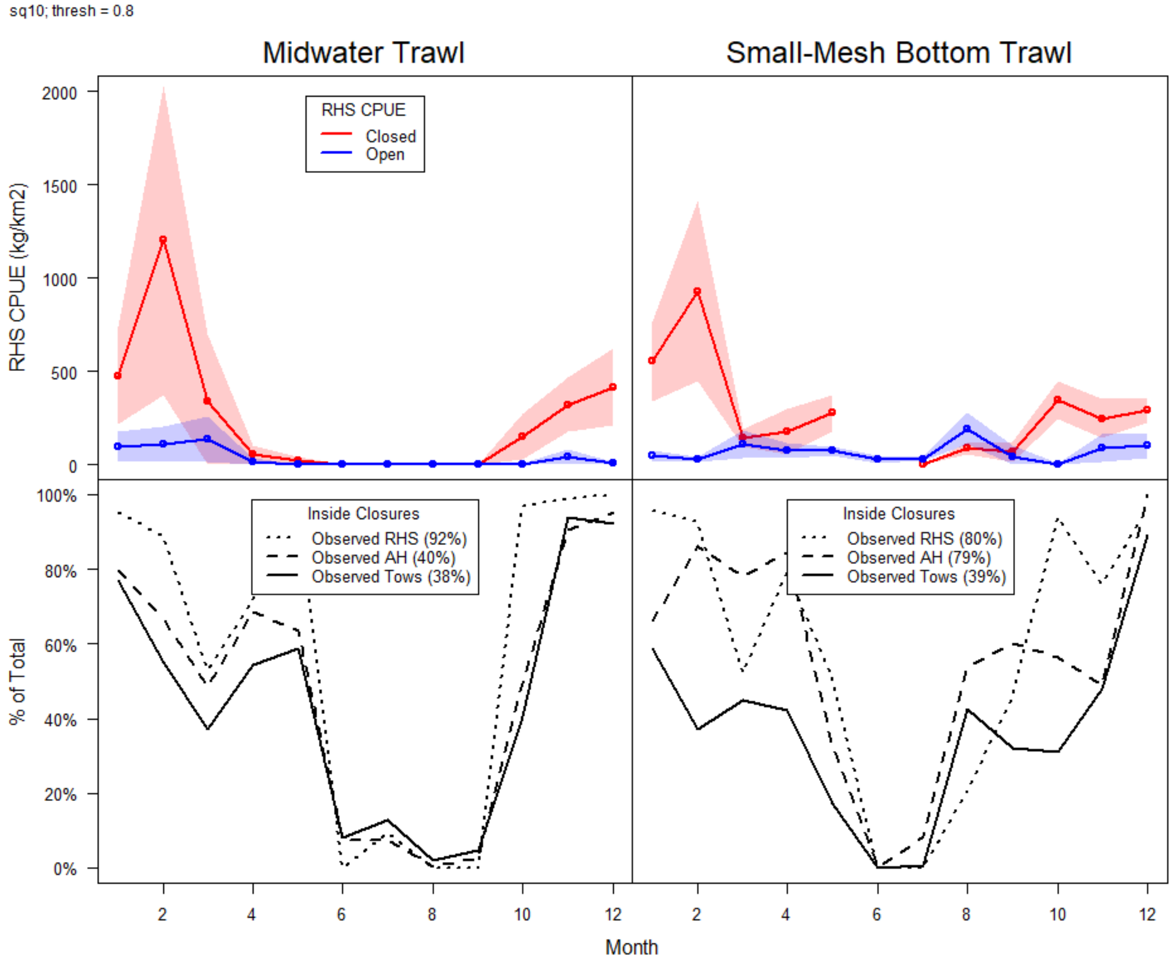
Evaluation Metrics for Closure Alternatives

- Dataset = Observed Fishery Tows with Atlantic Herring 2000-2022
  - CPUE of RHS species – closed vs open
  - % of total observed RHS catch in closed area
  - % of total observed Atl Herring catch in closed area
  - % of observed tows in closed area

Hypothetical Closure Scenario

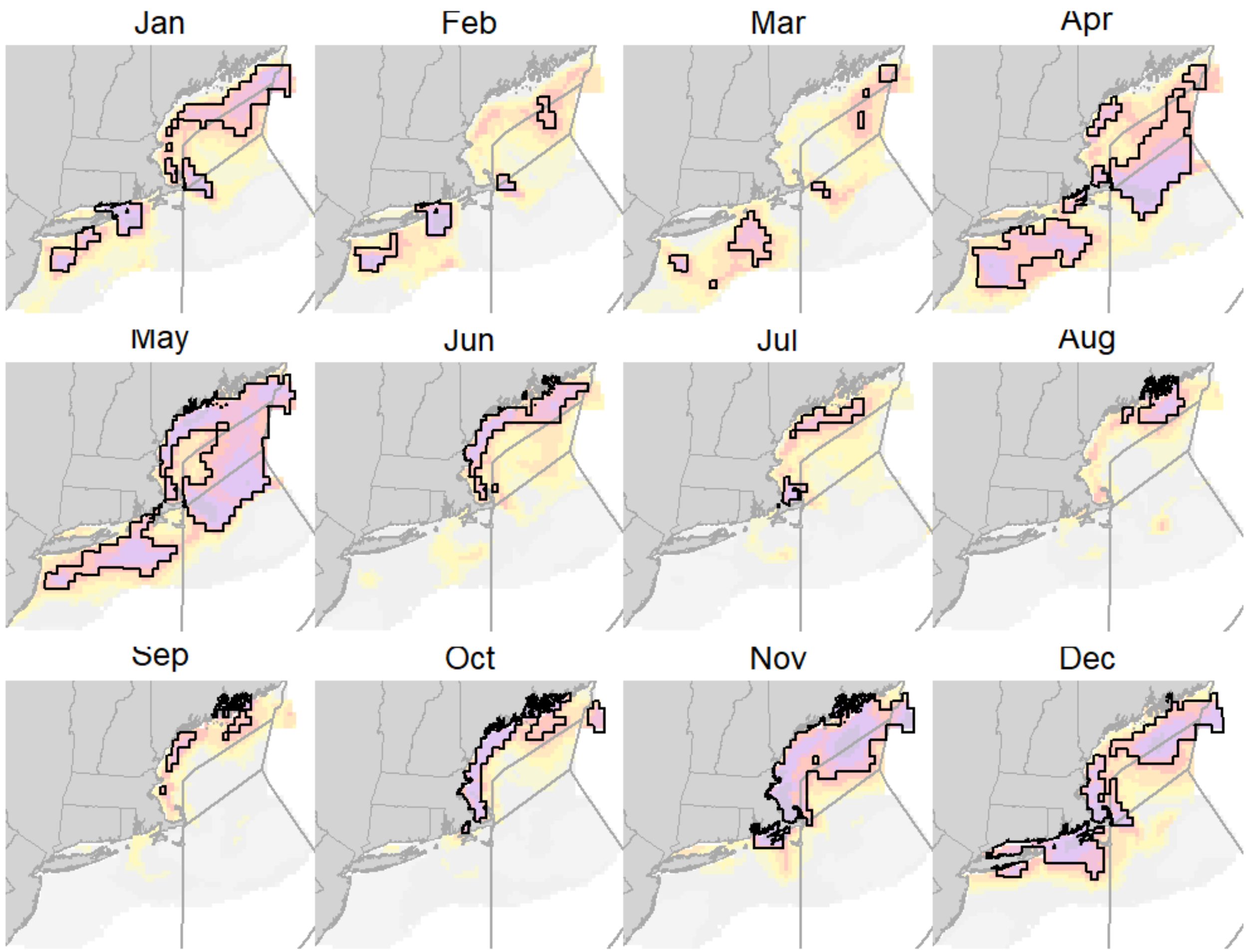
Dataset = RHS area percentiles
Threshold = 0.80 (top 20 % of areas)
Boundaries = 10-min squares

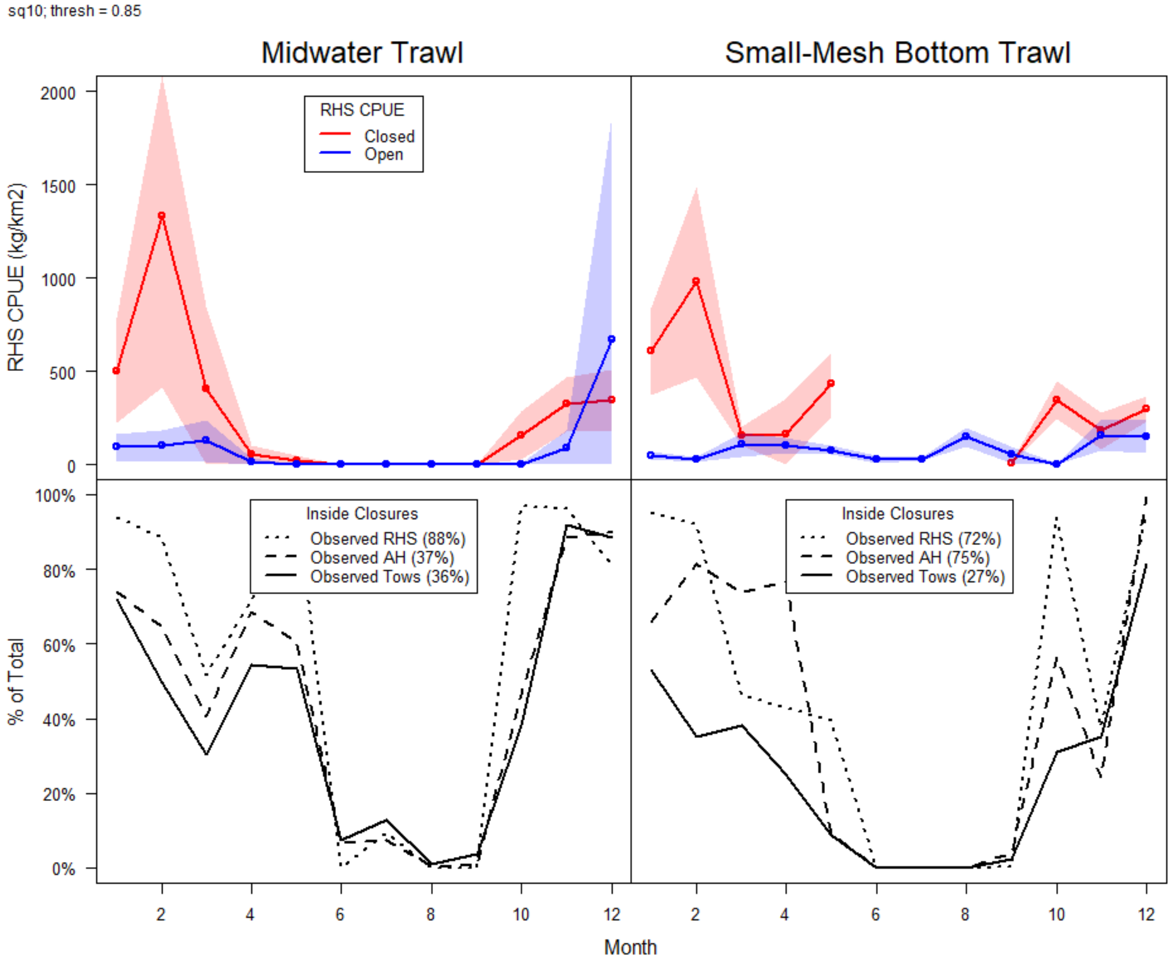




Hypothetical Closure Scenario

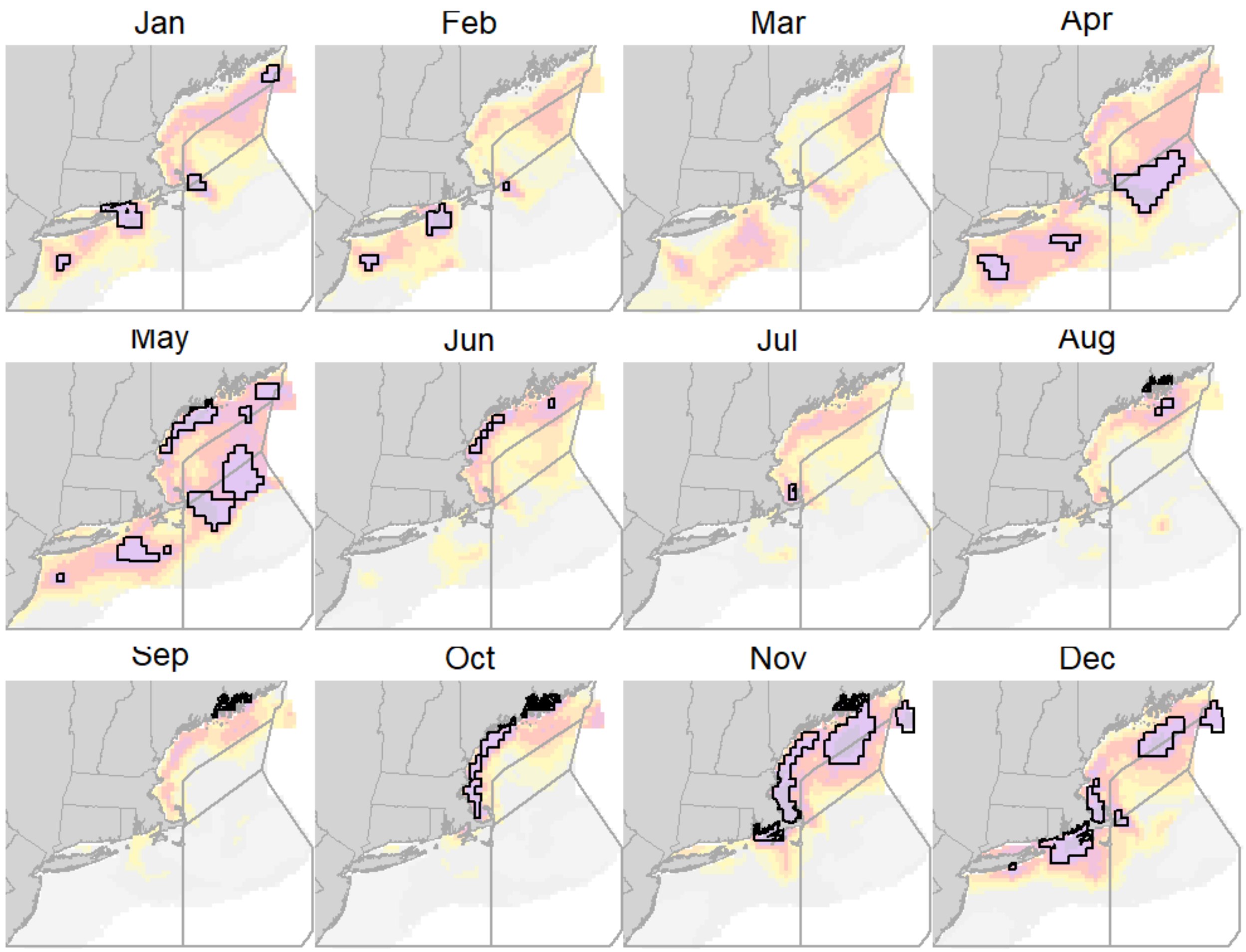
Threshold = 0.85 (top 15% of areas)
Boundaries = 10-min squares

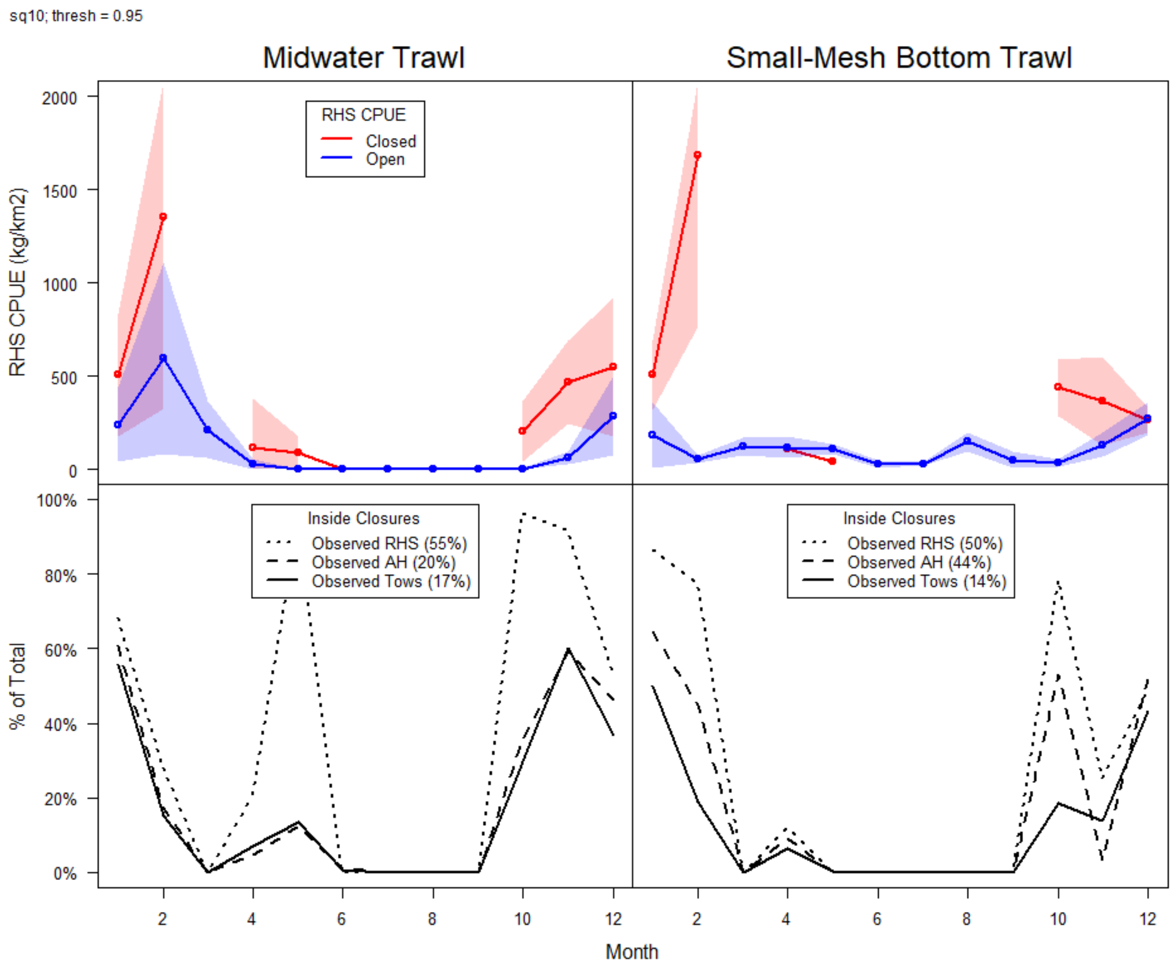




Hypothetical Closure Scenario

Threshold = 0.95 (top 5 % of areas)
Boundaries = 10-min squares



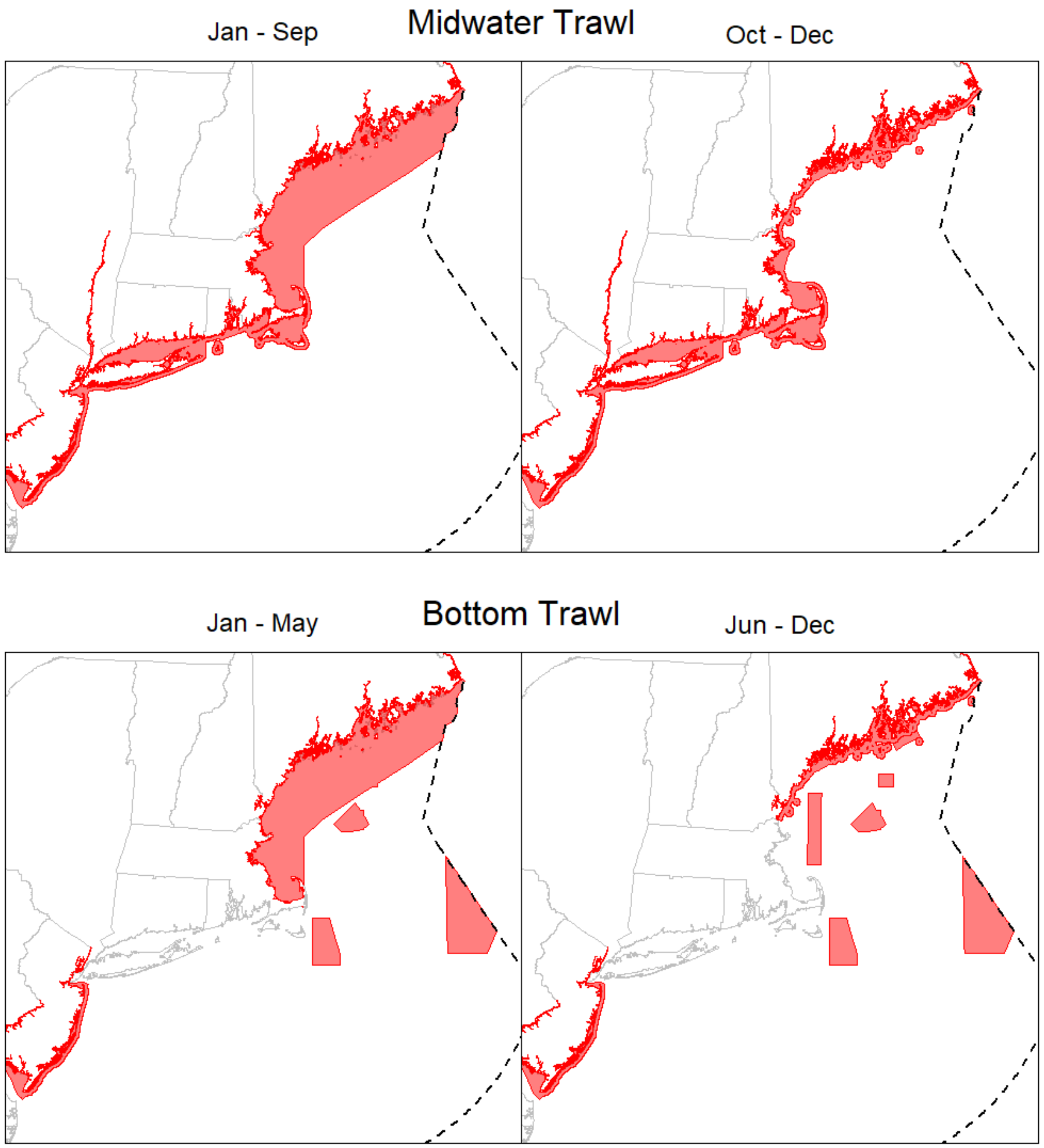


Next Steps

- Finalize models
  - Is abundance better than %-occurrence?
- Finalize evaluation metrics
  - Just *directed* herring fishery (> 2000 lbs)?
  - % of Atlantic Herring affected (from SDM)?
  - Account for existing closures?
- Develop closure alternatives
  - 30-minute squares?
  - Custom polygons/rectangles?
  - Focus on winter only?

Existing Closures

- Midwater Trawl
  - Area 1A – Jan to Sep
  - State Waters – ME to NJ
- Bottom Trawl
  - Area 1A – Jan to May
  - State Waters – ME, NH, NJ
  - Groundfish closed areas
  - Habitat management areas



Atlantic Herring Plan Development Team Progress Report

Task #2 River Herring and Shad Catch Caps
Catch Cap Approaches, Methods and Examples, DRAFT – Updated May 12, 2026

Catch Cap Approach	Description/ Methods	Notes
River herring & shad catch ratios with expansion factor (NEFMC river herring and shad catch caps)	Original Methods: - Used data from NEFOP (sea sampling), MA DMF/ ME DMR portside sampling, ME DMR sea sampling; trips landing >6,600 lb Atlantic herring by gear/ catch cap area, 2008-2012 - Derive RHS catch ratio for each qualifying sampled trip (RHS catch (kept and discards) / k-all) - Multiply catch ratios by total k-all on all trips landing >6,600 lb herring - Multiply amount by expansion factor standardized to 2013-2015 ACL (total ACL in a given year/ total ACL in 2013-2015) Updates in 2015 (for 2016-18 specs): - Added data from 2013 & 2014 to reference period - Estimated total kept RHS using at-sea and portside observations of landed catch; estimated RHS discards using at-sea observation data. Summed variances for kept and discards to calculate variance of total RHS catch - Minor data/method changes (included previously omitted shad landings, trips; improved matching of trips sampled by multiple agencies; using NOAA-reconciled dealer/fishermen database for Kall)	- Developed 4 options (minimum, maximum, median, mean levels of catch) to present to Council; used median value of catch estimates for caps - For 2016-2018 RH/S catch caps, the PDT recommended using the weighted mean of catch estimates for caps - Sources: FW 3, Appendix II (original methods), 2016-2018 Herring Specifications Appendix I (updates)
River herring & shad catch ratios (MAFMC Atlantic mackerel RH/S catch cap)	- Initial catch cap (2014): 236 mt o Based on analysis of the estimated median amount of RH/S that would have been caught had the commercial mackerel fishery landed its 2014 quota of 33,821 mt over	- The Council has kept the RH/S cap at 129 MT despite lower mackerel quotas because lower RH/S caps may be impracticable to monitor. For example, at lower

	2005-2012 given RH/S catch rates in those years. - Current catch cap: 129 MT o Amount of RH/S if the ratio of cap to all catch on mackerel trips was about 0.53% and applied to the 2019 quota of 17,371 MT.	caps the mackerel fishery would be more likely to close before 5 observer trips have occurred, forcing use of prior-year data. - Sources: EA for 2015 Atl mackerel specifications, MAFMC's RHS Biennial (2025) Update; Mackerel FW 17 SIR (2026)
Set percentage of sub-ACL (NEFMC GB haddock catch cap)	- Catch cap is equal to a percentage of GB haddock sub-ACL – between 1-2%	- Groundfish PDT reviews catch cap percentages following GB haddock stock assessments and determine whether they are appropriate

Dynamic catch caps (Proof-of-concept example/analysis from 2024 River Herring Benchmark Stock Assessment; NOT recommended for management purposes in the assessment)	- Use iSmooth or iSlope method to develop a catch multiplier, applied with other multipliers to slope & average catch at the discretion of managers
	- Calculating multipliers
	  o iSmooth: slope of loess-smoothed index in last 3 years
	  o iSlope: log-linear regression of last 5 years of index (unsmoothed)
	- Would allow caps to increase/decrease with increasing/decreasing river herring abundance
		Challenges for applying to river herring:
		- Bycatch fishery operating on a mixed stock population → proportion of each run/genetic stock region present in bycatch is function of abundance and time/area where fishery is operating
		- Available RH indices do not overlap well with bycatch fishery
		- No mechanistic population model underlying methods to estimate level of sustainable removals; declines only partially driven by ocean bycatch
		- Source: River Herring Benchmark Stock Assessment & Peer Review Report

Annual bycatch limit – number of individuals (ex. Bering Sea	- Hard cap set for number of individual fish that can be	- Vessels participate in an incentive plan agreement (IPA), which allows for a

Chinook salmon bycatch caps for pollock fisheries)	caught; indexed to projected abundance of Chinook salmon - Cap can be lowered based on abundance in 3 river runs; below average run size in previous year triggers lower cap - Each pollock fishery sector is allocated a portion of the total cap; performance standard requires that the sector not exceed lower limit 3 out of 7 years. If reached, lower limit becomes hard cap in perpetuity	slightly higher catch cap; lower catch cap if there are no other incentives to minimize bycatch in operation - Requires full retention of species, 100% observer coverage - Sources: Salmon Bycatch FAQ 2023; Framework 91 Proposed Rule

Overarching Considerations for Catch Caps:

- Data availability (observer coverage, fishing effort/activity)
  - Framework 3 Appendix I and II have more information on the data used to calculate the original catch caps. Generally, fishing effort has declined in recent years, leading to fewer herring trips overall and fewer observed trips used to calculate river herring and shad catch ratios.
  - The Herring PDT Task 3 report also discusses data considerations for the river herring and shad catch caps.
  - MAFMC documents have flagged concerns about challenges with monitoring under low catch caps for the mackerel fishery due to data availability and the seasonality of the fishery.
  - The River Herring Stock Assessment document noted that the bycatch cap is resource-intensive, and that "Increased observer coverage is needed to provide more precise, species-specific estimates of bycatch, and in order to avoid depleting individual runs or even stock-regions, the genetic composition of the catch would have to be monitored."

Atlantic Herring PDT Methods for RHS Caps (Excerpt from Framework 3 Appendix II):

For each sampled trip, the amount of RH/S catch (kept and discarded) was divided by the total landed catch of all species ("kept-all") to derive a RH/S catch ratio. The mean RH/S catch ratio was then calculated for each year, gear, and area combination. These ratios were then multiplied by the total amount of kept-all on all trips that caught >6,600 lbs of Atlantic herring. To account for annual changes in the scale of the fishery, each RH/S amount was further multiplied by an expansion factor, standardized to the 2013-2015 Atlantic herring catch limit (ACL)*. The resulting values represent the estimated amount of RH/S catch that would have occurred in a year, gear, area combination if the fishery operated at the scale of the 2013-2015 Atlantic herring ACL.** Due to the natural variability of RH/S catch estimates and low sample sizes, the confidence intervals for some scaled RH/S catch amounts are quite high (see Figure 2).

**RH/S cap areas for the GOM, CC, and GB do not coincide with the herring sub-ACL designations; therefore, the expansion factors for these areas were calculated using the ratio of the total ACL in a given year to the total ACL in 2013-2015.*

***Since the RH/S cap area for southern New England/Mid-Atlantic does coincide with Herring Management Area 2, the expansion factor for SNE/MA was calculated using the ratio of Area 2 herring landings in a given year to the Area 2 sub-ACL for 2013-2015.*

Description of River Herring Catch Caps Proof-of-Concept (Excerpt from ASMFC River Herring Benchmark Stock Assessment, 2024)

4.8 Bycatch Caps/Bycatch Mitigation Approaches
Ocean bycatch of river herring is a significant component of overall removals of river herring along the Atlantic coast, in some years exceeding the directed commercial fishery (Figure 23). Genetic work suggests that much of this bycatch is coming from runs in southern New England that are already at low levels (Palkovacs et al. 2014; Reid et al. 2022), adding to concerns that ocean bycatch is hindering the rebuilding of these species.

NOAA Fisheries implemented a set of bycatch caps in the Atlantic herring and Atlantic mackerel fisheries in 2014 (Section 1.3.18), but the caps are based on historical levels of alosine bycatch in those fisheries, not biological metrics.

4.8.1 Data-Limited Catch Caps
The SAS developed a proof-of-concept example for a bycatch cap based on the data-limited index-based methods simulation-tested as part of the 2020 SAW/SARC Research Track "Topics" Assessment, specifically the Plan B Smooth (aka iSmooth) and iSlope approaches (NEFSC 2020). In the simulations, these approaches were able to rebuild stocks above SSBMSY on average in the long term, and also had the highest median catch among the methods that achieved rebuilding more than 50% of the time (NEFSC 2020).

These methods are conceptually simple and intuitive: if the index of abundance for a species is trending down, total allowable catch should be reduced. If the index is trending up, catch can be increased. iSmooth uses the slope of the loess-smoothed index in the last three years to develop the catch multiplier, while iSlope uses the log-linear regression on the last five years of the index, unsmoothed to develop the multiplier, which is applied in conjunction with additional multipliers on the slope and the average catch depending on how conservative managers want to be.

While the concept is simple, the application is challenging for river herring. The bycatch fishery is operating on the mixed stock population, and the proportion of each run or genetic stock-region that is present in the bycatch is a function of the abundance of each run as well as the time and area where the fishery is operating. The available indices for river herring (predominately the NEFSC, NEAMAP, and state trawl surveys in the ocean, and run counts and YOY indices in the rivers) do not overlap well spatially and temporally with the majority of the bycatch fishery. For this example, the NEFSC and NEAMAP surveys were used as ocean/mixed-stock indices, and an index from run counts from stock-regions identified as significant contributors to bycatch in the midwater trawl fishery by Reid et al. (2022) was used as a sensitivity run (SNE for alewife, MAT for blueback herring). The index value for 2020 was missing, as the surveys were not completed due to the COVID-19 pandemic. For the iSmooth approach, which uses only a 3-year average, the 2019 index and catch values were used as a proxy for the 2020 values, to avoid using only two years of data in the analysis. For iSlope, which uses a 5-year average, 2020 was treated as missing.

These approaches were applied to the coastwide estimates of bycatch to develop a coastwide cap, but they could also be applied to the existing caps that are stratified by fishery, gear, and region to produce caps that align with the current management framework for the Atlantic herring and mackerel fisheries. The current caps are not species-specific; for iSlope, which uses the recent quotas to provide catch advice, the observed proportion of alewife and blueback herring in estimates of river herring and shad bycatch were used to derive recent species-specific quotas. These methods can also be used in conjunction with a constraint to prevent next year's catch advice from deviating too far from the current advice, to prevent large swings in the cap.

The iSmooth and iSlope approaches utilize available information on river herring abundance to adjust the bycatch caps instead of using a fixed, historical level. This allows the caps to decrease when river herring abundance is decreasing and increase as river herring abundance increases, making them more responsive to trends in the river herring population. However, there is no mechanistic population model underlying these methods to provide an estimate of what a sustainable level of removals for these populations are. In addition, declines in river herring are only partially driven by ocean bycatch, so reducing incidental catch may not lead to increases in abundance and the TAC would continue to be reduced if the population continued to decline.

This is presented as a proof-of-concept; additional consultation with management would be needed to evaluate risk tolerance to select an appropriate method as well as deal with the question of whether caps would be species-specific and if so, how to deal with the shad and unknown herring component of the current bycatch monitoring.

While improved biological data and population models for river herring would improve the estimates of sustainable bycatch caps, the bycatch cap approach is still very resource intensive to implement appropriately. Increased observer coverage is needed to provide more precise, species-specific estimates of bycatch, and in order to avoid depleting individual runs or even stock-regions, the genetic composition of the catch would have to be monitored.

4.8.2 Spatial Distribution Models

The SAS was in favor of the time-area closure model as an alternative or complement to the catch cap approach to reduce river bycatch. Turner et al. (2016, 2017) explored using habitat associations to predict incidental catch hotspots for river herring and Roberts et al. (2023) extended this method to use sub-seasonal forecasts of ocean conditions to identify these hotspots in-season in a changing environment. By identifying these areas of overlap between river herring, commercially targeted species, and the fisheries, time-area closures could be implemented to mitigate fisheries interactions with river herring and reduce bycatch.

The benefit of this approach is that it relies on widely, rapidly available environmental data and subseasonal forecasts instead of the intensive levels of observer coverage necessary to estimate bycatch reliably against a cap. These models have been based on the NEFSC trawl survey data, but incorporating additional surveys, especially more inshore state surveys, and fishery dependent data could significantly improve their predictive power. For example, Roberts et al. (2023) were only able to develop estimates of bycatch risk for the spring and fall, due to the lack of summer survey data. There is a summer spawning closure for the Atlantic herring fishery in the Gulf of Maine (Section 1.3.18), but Roberts et al. (2023) did not evaluate the risk of bycatch for that season. More comprehensive models could evaluate the effects of closures like this on river herring bycatch, as well as providing more fine-scale hotspot identification with higher confidence to make time-area closures feasible on a management scale.

However, the development of that kind of model was beyond the scope of this assessment.

Peer Review Discussion of River Herring Catch Caps Proof-of-Concept (Excerpt from River Herring Stock Assessment Peer Review Report)

Bycatch Cap Limit
The SAS explored the use of data-limited methods to estimate a bycatch cap based on trends in abundance. The SAS clearly indicated this was a proof-of-concept analysis and not being recommended for management purposes. Five methods were explored: the iSmooth method, used to adjust the ABC for a number of stocks in New England, and four variations of the iSlope method. Both the iSmooth and iSlope methods were selected because they performed well in simulation testing conducted by an Index-Based Methods Working Group (NEFSC 2020). Both iSmooth and iSlope adjust recent average catches based on trends in abundance. The SAS used recent bycatch estimates, and explored adjusting the catch using two indices of abundance: the NMFS trawl survey (ME-NC), and summed run counts from the SNE stock region for alewife and from the MAT region. The SAS also conducted a retrospective analysis to quantify the interannual change in bycatch cap that would have resulted if each method had been applied previously.

The panel felt this was a useful exploration and worthy of further consideration. There was some concern about the interannual variability in cap estimates, particularly for the iSmooth method. The iSlope variations were less variable than iSmooth, although there was considerable variation for blueback herring in some years. The variability was largely due to spikes in bycatch in certain years. There was discussion that using bycatch magnitude as the catch cap could be problematic. If this approach were to be used, the current bycatch cap should be adjusted up or down (and not the recent average bycatch) based on trends in the index. The panel was also unsure how the approach could be operationalized to set a bycatch cap that includes four species (also American and hickory shad), and feels that further consideration of how to do so is needed.

Spatial Distribution Models
The SAS also presented the potential use of habitat models to predict species distribution in the marine environment and identify bycatch hotspots. The models would inform future development of time-area closures and could be explored as an alternative to management using a bycatch cap. The panel agreed the methods held promise and supported continued exploration, while cautioning that a fully spatial approach would not inherently track the magnitude of bycatch. Thus, there is the potential that some type of bycatch cap would need to be implemented concurrently with spatial management. The panel also noted there are numerous steps to developing and validating various options for time area closures, and these require clear management objectives to be defined a priori (Bowlby et al. 2024).

Atlantic Herring Plan Development Team Report
Task #3: River Herring and Shad Catch Cap Estimation Analyses

The PDT reviewed its sub-group's work under task #3 at its meeting on March 2, 2026. The PDT agreed with the findings and worked by correspondence to finalize this as a PDT report.

The New England Fishery Management Council (NEFMC) tasked the Atlantic Herring Plan Development Team (PDT) to analyze and develop recommendations for implementing improvements to the accuracy and precision of river herring and shad (RHS) catch estimates in the directed Atlantic herring fishery as part of Amendment 10. The PDT created a sub-group to address this task. Between November 2024 and March 2025, the sub-group met via Google Meet five times. Participants included staff from the NEFMC, the Mid-Atlantic Fishery Management Council (MAFMC), the Greater Atlantic Regional Fisheries Office (GARFO), the Northeast Fisheries Science Center, the Maine Department of Marine Resources, the New Hampshire Fish and Game, the Massachusetts Division of Marine Fisheries, the Rhode Island Department of Environmental Management, and the Connecticut Department of Energy and Environmental Protection. This document describes the meeting discussions and analyses explored by the sub-group.

The sub-group began by reviewing the current QM methodology used by GARFO for RHS catch cap estimation in the Atlantic herring fishery and discussing summary statistics (Table 1). Sub-group members noted that Atlantic herring fishery behavior has changed since the catch caps were established in 2014. A variety of reasons have caused challenges in achieving five or more observed trips every year within each catch cap stratification. In recent years, there have been lower Atlantic herring quotas, reduced effort, derby style fishing, and intermittent observer coverage. With higher quotas, vessels had more time to communicate with each other about interactions with RHS and promote avoidance particularly through the bycatch avoidance program (Bethoney et al. 2017). With lower quotas there's less time to communicate and avoid RHS before quotas are harvested. The bycatch avoidance program also ended in 2021. Reduced Atlantic mackerel catch limits have affected the herring fisheries ability to catch herring. The catch caps have all been affected differently in recent years. Atlantic herring availability has declined in Southern New England, resulting in reduced effort and bycatch for the midwater trawl catch cap. Midwater trawling in the Gulf of Maine (Area 1A) is prohibited from June-September, reducing the catch of RHS during most of the year (Figure 1). There was 100% observer coverage in the Gulf of Maine midwater trawl catch cap in 2022 partly because of the herring Industry Funded Monitoring (IFM) program, but herring IFM was suspended in April 2023. Changes in restrictions on Atlantic herring catch have also affected herring effort and subsequent RHS catch, particularly for the Cape Cod Midwater Trawl catch cap area. An inshore midwater trawling restricted area was implemented in 2021 through Amendment 8 that prohibited the use of midwater trawl gear inshore of 12 nautical miles from the U.S./Canada border to the Rhode Island/Connecticut border and inshore of 20 nautical miles off the east coast of Cape Cod, but the restricted area was vacated in 2022. Additionally, the Area 1B closure from January-April was removed in 2021 via Framework 8, but due to accountability measures, Atlantic herring fishing was prohibited in Area 1B and the sub-ACL was set to zero in 2021. Since 2022, Atlantic herring fishing has occurred early in the year in Area 1B, causing increased RHS catch estimates. Maintaining observer coverage across catch caps has been difficult due to sporadic fishing effort from the herring fleet, the reduced amount of Sea Days allocated through the Standardized Bycatch Reduction Methodology (SBRM) for midwater trawl gear, and SBRMs goal of spreading out midwater trawl observer coverage throughout the SBRM year which starts on April 1. RHS are not federally managed species and are not part of the SBRM analysis that determines observer coverage.

The sub-group discussed the GARFO 2016 discard methodology peer review. The terms of reference for the discard methodology review were similar to the sub-groups tasking. Analyses were conducted for the catch caps to determine if more optimal stratifications could have been achieved (McAfee 2016). Due to the short amount of time that the catch caps were in place at the time of the review, there was a lack of data to analyze. No viable alternatives were identified to increase RHS catch caps estimation precision within the cumulative discard methodology. Reviewers suggested model-based approaches be explored in future analyses. A hierarchical Bayesian modelling framework was proposed for instances of low sample size which would allow observer data to be utilized across stratifications. Time series models were also suggested to overcome the need for transition rates. GARFO's response to reviewers expressed interest in model exploration, but had concerns about model fitting complexity and ease of explanation to stakeholders. A member of the sub-group developed a zero inflated Bayesian model to predict RHS bycatch (kept and discards were modeled independently) on unobserved trips by RHS species individually. Year was modeled as a random effect, meaning years with low observer coverage relied more heavily on earlier years of observed data prior to 2020 when there were a greater number of observed trips each year. This led to questions about whether older observer data is representative of current fishery behavior. This model is still in development, but one advantage of a model-based approach is that the predicted estimates of RHS bycatch at the subtrip level would have a distribution similar to the distribution of catch in the observer data which is not the case with a cumulative ratio estimator.

The sub-group defined the scope of possible analyses to be explored as staying within the current quota monitoring (QM) methodology (i.e. the cumulative ratio estimator) used in RHS quota monitoring and to determine if improvements could be made during estimation when there are less than five observed trips in a catch cap stratification. If modifications fall within the current QM methodology then they would only require internal GARFO review. If the methodology changed from the ratio estimator to a model-based approach, an external peer review would be required.

The sub-group explored observer data from midwater trawl and bottom trawl vessels that occurred in catch cap areas. Questions arose about whether observed trips that landed less than 6,600 lbs of herring could be used as a way to increase the number of observed trips used in estimation. Atlantic herring open access category D vessels have a 6,600 pound daily herring possession limit. When implemented, the intention of the catch caps was to apply to limited-access herring vessels only. The majority of observed trips that landed 1 to 6,600 pounds of herring between 2015 and 2024 were from Southern New England bottom trawl vessels where the catch rate of RHS was higher than observed trips where greater than 6,600 pounds of Atlantic herring were landed. There were concerns about applying rates with observed data on trips with less than 6,600 pounds of Atlantic herring to unobserved trips that landed greater than 6,600 pounds of herring. The sub-group decided that observed trips where less than 6,600 pounds of herring was landed should continue to be excluded from catch cap estimation.

A series of analyses were identified by the sub-group to modify the current QM methodology for estimating RHS in an effort to improve precision. These included 1) a global rate that was gear type (midwater trawl or bottom trawl) specific instead of across midwater trawl and bottom trawl gears as currently defined, 2) a transition rate that includes all previous catch cap years of observer data instead of just the previous year, 3) a transition rate that used three prior years of data instead of just one previous year, and 4) observer data that was stratified according to SBRM standards instead of by catch cap area. These analyses were compared to the current QM catch cap methodology for 2016-2024 using annual estimates and coefficients of variation (CVs) for monitored catch caps.

Analysis 1: Gear specific global rates

To address concerns about a global rate being calculated from combined bottom trawl and midwater trawl observed trips in catch cap areas, we modified the global rate to be gear specific between the two trawl types. For catch cap estimation, the global rate is used in a transition rate when there are no observed trips in the previous year for a catch cap stratification and less than 5 observed trips in a catch cap stratification for the current year. It is also used when there are no observed trips for a catch cap stratification in the current or previous fishing year. An initial issue arose when performing the analysis because there were some years that had no observed midwater trawl or bottom trawl trips in catch cap areas landing greater than 6,600 lbs of herring. The analysis was modified to use a gear specific global rate when the data was available, otherwise a global rate across gears (midwater and bottom trawl) was used. In practice, the full global rate has only been used once in 2020 for the Southern New England bottom trawl catch cap (Table 1). Modifying the rate to be gear specific in that instance was not possible because there were no observed bottom trawl trips in 2019. The global rate was used in a transition rate in 2019 for the Gulf of Maine midwater trawl catch cap, in 2022 for the Southern New England midwater trawl catch cap, and in 2023 for the Cape Cod midwater trawl catch cap. There were no major differences in estimated RHS removals and CVs between the current QM methodology and a modified global rate (Figure 2). The sub-group supported using a gear specific global rate when data are available.

Analysis 2: All years transition rate

Instead of using only observed trips from the previous fishing year in a transition rate, the sub-group tested a transition rate that used all previous years of observed data within a catch cap stratification, from 2015 to 2024. The effect of this process was that a global rate was never necessary. Differences in the annual estimated RHS for monitored catch caps between the current QM methodology and the all years transition approach were highest in 2019, 2020, and 2024 (Figure 3). CVs were also slightly higher for the all years transition rate approach in those years. The sub-group felt that lack of improvement in precision, the changes that have occurred in the fishery since 2015, and the life history of RHS did not support adopting this approach. The sub-group proposed testing a transition rate that used more years of observer data, but not all catch cap years. Discard estimation for other federally managed species at GARFO only use one previous year of observer data. There was also discussion about whether a quarterly or half-year transition rate could be used. This has not been implemented for any federally managed species and may be even more difficult to achieve for RHS catch estimates given limited observer data availability and the seasonal nature of the herring fishery.

Analysis 3: Three-year transition rate

Following the subgroup's advice on an all years transition rate, a three year transition rate was tested with a modified global rate that was gear type specific when gear specific data was available. This method used three previous years of observer data instead of only the previous year. Annual estimates between the current QM methodology and three-year transition rate approach differed the most in 2019, 2020, and 2021. The current QM methodology had slightly lower CVs in those years compared to the three-year transition rate (Figure 4). When the three-year transition rate is used, it causes a dampening effect on year to year rate variability. If rates were much higher three years ago compared to one year ago, then the bycatch rate and estimate will be higher (e.g., in 2021). Conversely, if the rate from three years previous was much lower than the current year, like in 2017, then the resulting bycatch rate will be lower than using a single year transition rate (e.g. in 2020). The sub-group concluded that the lack of improved precision and inter-annual variability of the fishery bycatch did not support the use of a three year transition rate with modified global rate. Using a fixed number of samples was discussed for cases where a transition rate was needed. In practice this could create bias if the number of samples available within a stratification exceeded the fixed amount of samples desired and selection of particular observed trips was necessary.

Analysis 4: SBRM stratification

Modifying catch cap observer data stratification was raised as a potential solution to improve accuracy and precision. The current QM methodology has catch cap area and gear specific bycatch rates. Gaps in observer information could potentially be reconciled with broader spatial stratification. We tested SBRM-like stratifications of observer data, where areas were defined as Northern and Southern regions. Gear categories were not changed from the current QM methodology (midwater and bottom trawl) because they are effectively the same in the SBRM. The definition of region in our analysis was slightly different from the SBRM designation, and followed the definitions in the Catch Accounting and Monitoring System (CAMS). Region for SBRM is based on the port where catch was landed and state (B McAfee pers. comm. Feb 2025) while CAMS defines regions based on statistical area fished (‘Northern’ is <= 600, ‘Southern’ is >600, ‘Other’ is area = ‘000’)(Figure 5). Annual estimated catch caps of RHS differed between the current QM methodology and the SBRM-like approach more drastically in some years (e.g. 2017, 2019, 2023 and 2024) compared to others. The SBRM-like estimates were higher than the current QM approach in 2017, 2018, 2019, and 2023, but lower than the QM approach in 2016, 2020, and 2024. The SBRM-like approach had consistently higher annual CVs except in 2023 (Figure 6). The higher uncertainty for the SBRM-like approach is likely due to the Cape Cod, Gulf of Maine, and part of the Southern New England areas being combined to form the Northern area. The sub-group discussed the biological and seasonal interactions of the fishery, e.g., how RHS stage in unique places before spawning. The sub-group concluded broader, SBRM-like spatial configuration did not make biological sense. The lack of improvement in precision further supported the conclusion.

Findings

The sub-group did not find suitable methods that improved accuracy and precision and ultimately did not recommend major changes to the current QM methodology for RHS estimation. A gear specific global rate was supported when data was available. Modifying the transition rate or geographic extent of observer data stratifications did not produce more precise estimates. Additional observer coverage for the midwater trawl fleet would likely reduce the frequency of when a transition rate or global rate is needed and improve in-season estimations.

The MAFMC had a 2025 “possible additions” Implementation Plan priority to evaluate increasing midwater trawl observer coverage through an SBRM modification, but additional staff time did not materialize, and the MAFMC did not include this task in its 2026 Implementation Plan.

References

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McAfee, B. 2016. Cumulative discard methodology review for catch cap monitoring in the Atlantic herring (Clupea harengus) and Atlantic mackerel (Scomber scombrus) fisheries. Cumulative Discard Methodology Peer Review Working Paper #4. NOAA Fisheries. https://www.greateratlantic.fisheries.noaa.gov/public/nema/apsd/dmr_wp4_hadd_rhs_bmcafee_v161103.pdf

Tables

Table 1. Summary statistics of RHS catch caps.

Catch Cap	Year	Permit Count	Trip Count	RHS Catch Rate[2]	Est. RHS (mt)	Herring (mt)	Mackerel (mt)	KALL (mt)	Inseason RHS Catch Rate[3]	Observed Trips	CV[4]	Coverage Percent	Global Rate
RHS Mackerel	2015	13	55	0.0014	12.5	3,564	4,591	8,739	0.0016	4	0.23	7.30%	0.0014
	2016	13	55	0.0015	13.5	5,682	4,336	10,172	0.0015	13	0.68	23.60%	0.0015
	2017	17	71	0.0033	39.5	6,477	5,780	12,472	0.0033	17	0.38	23.90%	0.0033
	2018	12	57	0.0089	109	4,067	7,927	12,143	0.0101	4	0.34	7.00%	0.0089
	2019	11	32	0.0135	91.7	2,780	3,973	6,756	C	C	C	C	0.0135
	2020	15	94	0.0022	23.1	2,615	7,504	10,277	0.0022	6	0.59	6.40%	0.0022
	2021	12	44	0.0006	3.4	1,335	4,904	6,387	0	3	1.24	6.80%	0.0006
	2022	9	14	0.002	6.8	1,963	1,203	3,242	0.002	8	0.37	57.10%	0.002
	2023	12	33	0.0202	109.4	2,543	2,605	5,266	0.0202	5	0.57	15.20%	0.0202
	2024[1]												0.0059
RHS Herring: CC MW	2015	11	70	0.0001	0.7	12,364	58	12,424	0.0001	7	0.81	10.00%	0.0051
	2016	12	63	0.0018	17.8	7,786	121	7,909	0.0018	10	0.82	15.90%	0.0014
	2017	12	54	0.0037	27.1	6,713	1,262	7,978	0.0037	15	0.44	27.80%	0.0045
	2018	9	60	0.0075	66.6	8,642	265	8,912	0.0075	5	1.01	8.30%	0.0144
	2019	7	40	0.0066	21.1	3,218	2	3,220	C	C		C	0.0191
	2020	6	45	0.001	3.8	2,805	1,025	3,851	0	3		6.70%	0.0034
	2021	2	C	C	C	C	C	C	C	C		C	0.0002
	2022												0.0015
	2023	7	14	0.0105	31.1	1,717	903	2,620	C	C	C	C	0.0126
	2024[1]	7	10	0.0311	36.2	1,163	2	1,165				0.00%	0.0028
RHS Herring: GOM MW	2015	11	45	0.0017	11.3	6,378	220	6,598	0.002	4	0.95	8.90%	0.0051
	2016	10	44	0.0001	0.6	4,098	1,876	5,981	0.0001	17	0.48	38.60%	0.0014
	2017	9	67	0.0002	1.9	9,166	2,236	11,402	0.0002	6	0.65	9.00%	0.0045
	2018	6	25	0.0002	0.5	2,830	4	2,834				0.00%	0.0144
	2019	5	13	0.0256	24.7	929	21	950	0.029	3	0.62	23.10%	0.0191
	2020	7	11	0.0203	33.5	1,615	193	1,808	C	C	C	C	0.0034
	2021	4	5	0.0001	0.1	1,140	-	1,158				0.00%	0.0002
	2022	7	7	0.0022	5.2	1,285	816	2,105	0.0022	7	0	100.00%	0.0015
	2023	10	13	0.0026	3.8	1,464	2	1,466				0.00%	0.0126
	2024[1]	6	14	0.0036	4.8	724	5	729	0.0036	6	0.73	42.90%	0.0028
RHS Herring: SNE BT	2015	11	140	0.0256	103.7	3,742	155	4,047	0.0256	20	0.25	14.30%	0.0051
	2016	15	161	0.0134	55.1	3,525	378	4,142	0.0134	18	0.34	11.20%	0.0014
	2017	10	83	0.0142	35	1,789	164	2,471	0.0142	10	0.71	12.00%	0.0045
	2018	8	36	0.0225	48.4	846	1,247	2,128	0.0251	3	0.25	8.30%	0.0144
	2019	3	10	0.0251	14.1	300	260	561				0.00%	0.0191
	2020	5	19	0.0034	2.1	162	424	632				0.00%	0.0034
	2021	4	24	0.0043	0.7	143	0	144	C	C	C	C	0.0002
	2022	2	C	C	C	C	C	C	C	C	C	C	0.0015
	2023	5	34		42.7	310	54	491	0.0956	4	0.49	11.80%	0.0126
	2024[1]	2	C	C	C	C	C	C				0.00%	0.0028
RHS Herring: SNE MW	2015	15	126	0.0052	64.4	10,969	1,450	12,437	0.0065	3	0.12	2.40%	0.0051
	2016	14	119	0.0045	43.1	9,345	125	9,657	0.0045	6	0.38	5.00%	0.0014
	2017	10	38	0.0097	28.7	1,900	874	2,858	0.0108	4	0.48	10.50%	0.0045
	2018	10	53	0.0146	135.1	6,077	3,084	9,284	0.0158	3	0.87	5.70%	0.0144
	2019	11	37	0.0155	120.4	4,398	3,402	7,803	C	C	C	C	0.0191
	2020	5	5	0.0153	5.2	100	236	343				0.00%	0.0034
	2021												0.0002
	2022	1	C	C	C	C	C	C	C	C	C	C	0.0015
	2023	1	C	C	C	C	C	C	C	C	C	C	0.0126
	2024[1]												0.0028

Source: GARFO DMIS, CAMS and OBDBS databases as of 2024-11-25

[1]2024 data are preliminary.

[2]RHS catch rate used to extrapolate RHS catch. Transition rates are used when < 5 observed trips occur within the catch cap year and are highlighted in grey.

[3]RHS catch rate of observed trips occurring within catch cap year. Rate will be different than RHS CATCH RATE column when transition rates were used.

[4]Coefficient of Variation (CV) of inseason observed trips.

"C" denotes confidential vessel activity information

Figures

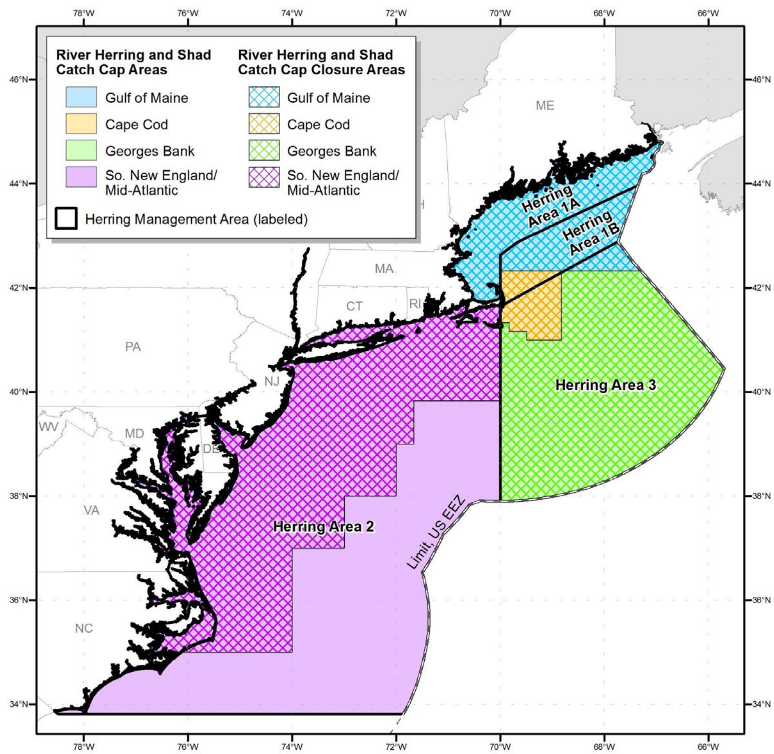

Figure 1. Map of River herring and shad catch cap areas and herring management areas.

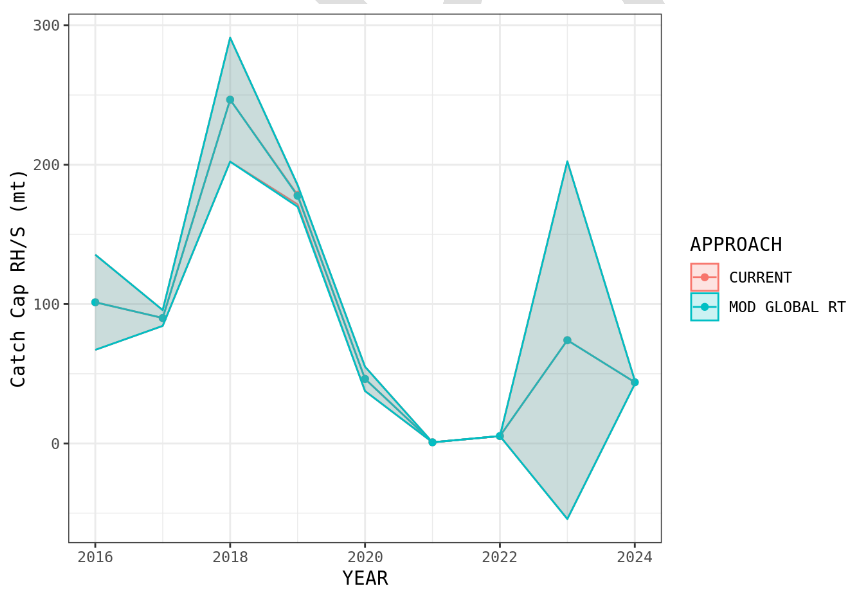

Figure 2. Comparison of annual RHS catch cap estimates and 95% confidence intervals between the current QM methodology approach and a modified global rate.

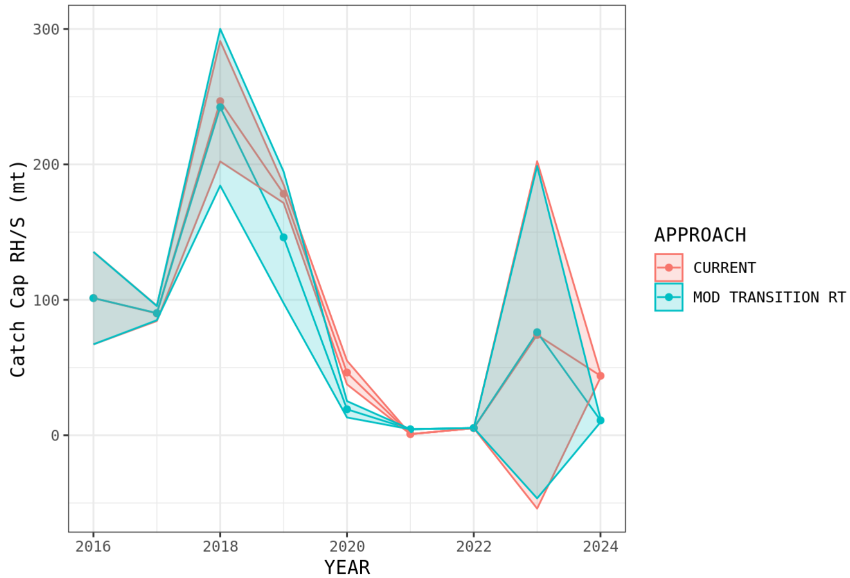

Figure 3. Comparison of annual RHS catch cap estimates and 95% confidence intervals between the current QM methodology and a modified transition rate that uses all catch cap years of data back to 2015.

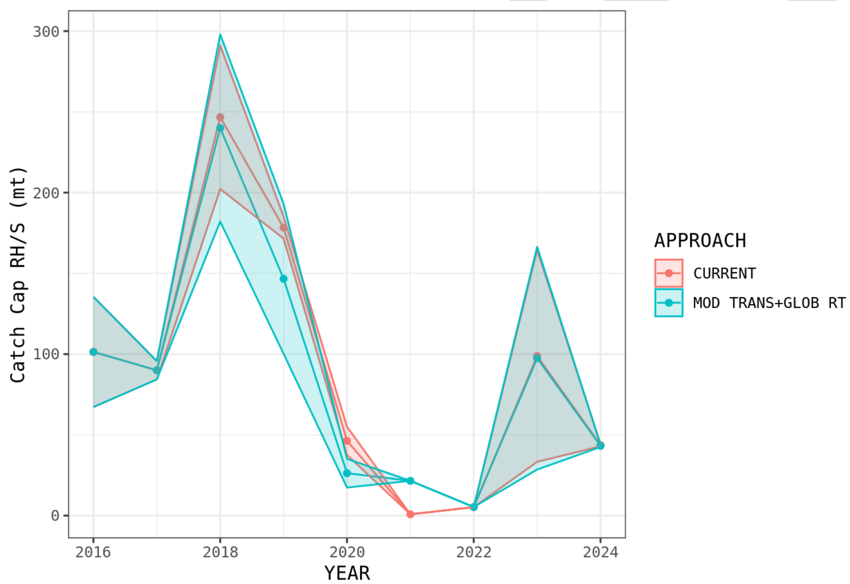

Figure 4. Comparison of annual RHS catch cap estimates and 95% confidence intervals between the current QM methodology and a modified transition rate that uses three previous years and a modified global rate.

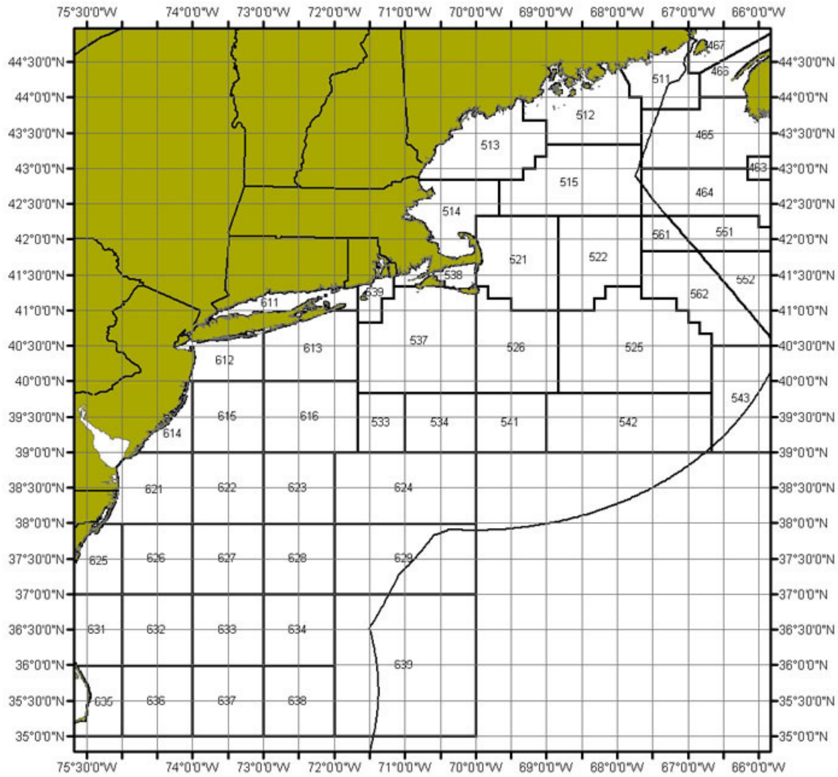

Figure 5. NOAA GARFO statistical reporting areas.

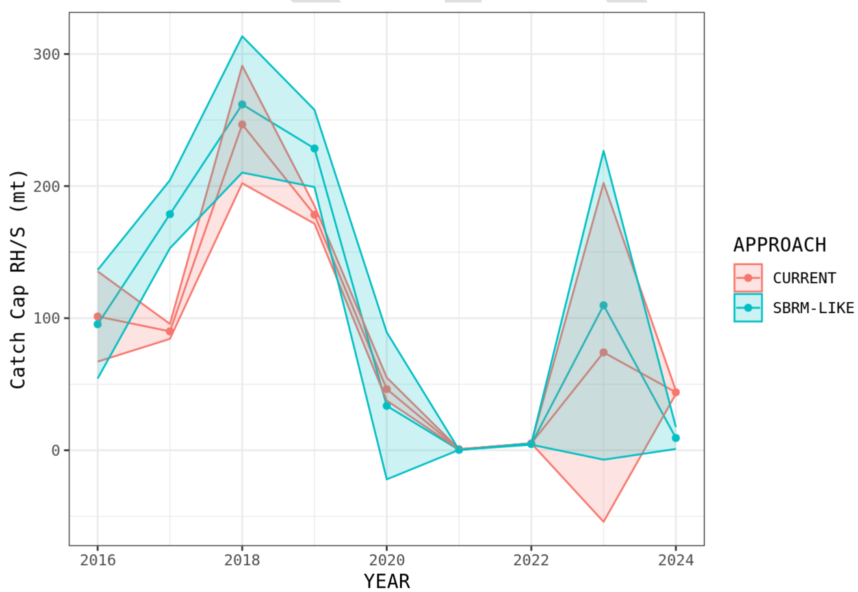

Figure 6. Comparison of annual RHS catch cap estimates and 95% confidence intervals between the current QM methodology and SBRM-like stratifications.