2024 River Herring Benchmark Stock Assessment

Margaret Conroy, SAS Chair

August 7, 2024

River Herring SAS & TC

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Advancements Since 2012 Benchmark

- Improved understanding of stock structure
- Added new data sets
  - Abundance trends and/or mortality estimates for 84 rivers, representing 105 stocks of river herring
- Refined methods for trend analysis and Z estimates
- New modeling approaches:
  - Hierarchical growth model for each species
  - Stochastic SPR reference point model
  - Habitat model
  - Data-limited bycatch cap options

Outline

- Stock Structure
- Data
- Methods
- Stock Status
- Bycatch Caps
- Research Recommendations

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- **Stock Structure**
- Data
- Methods
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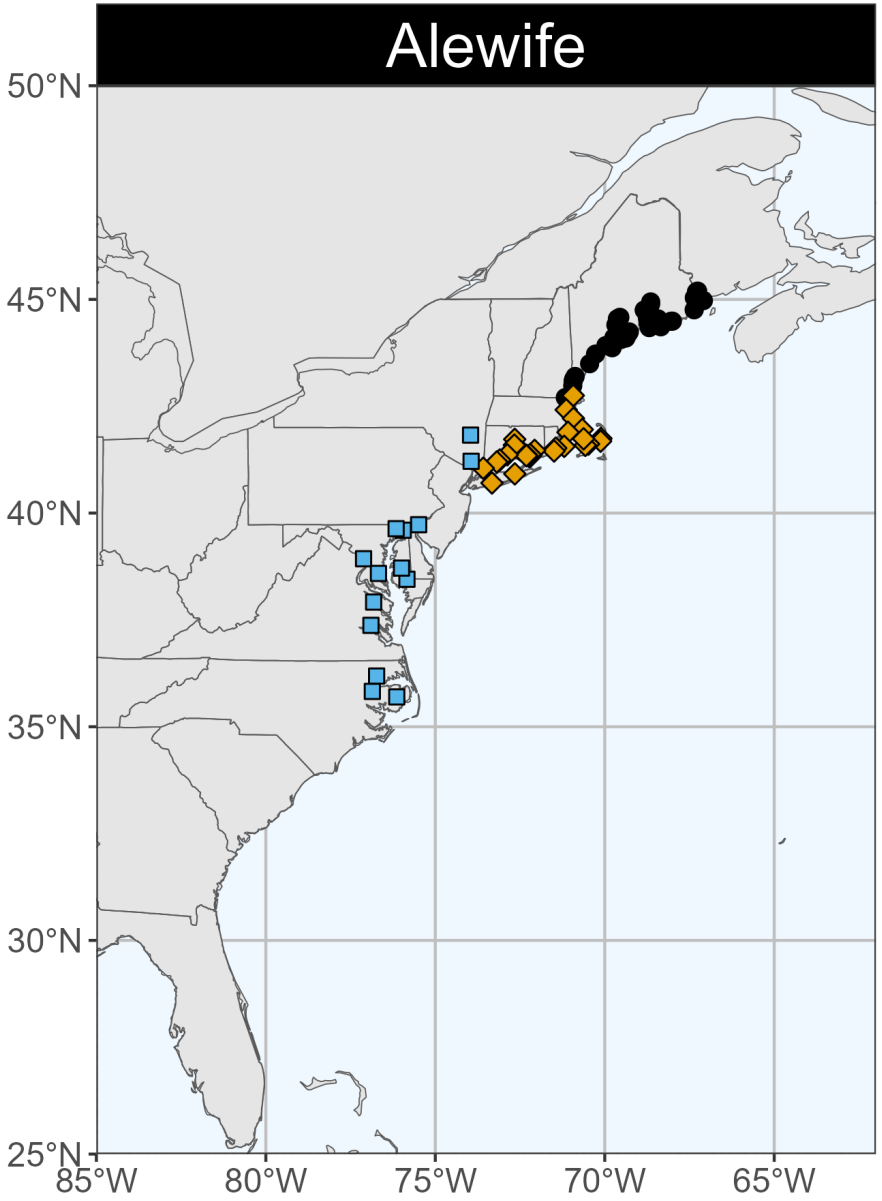
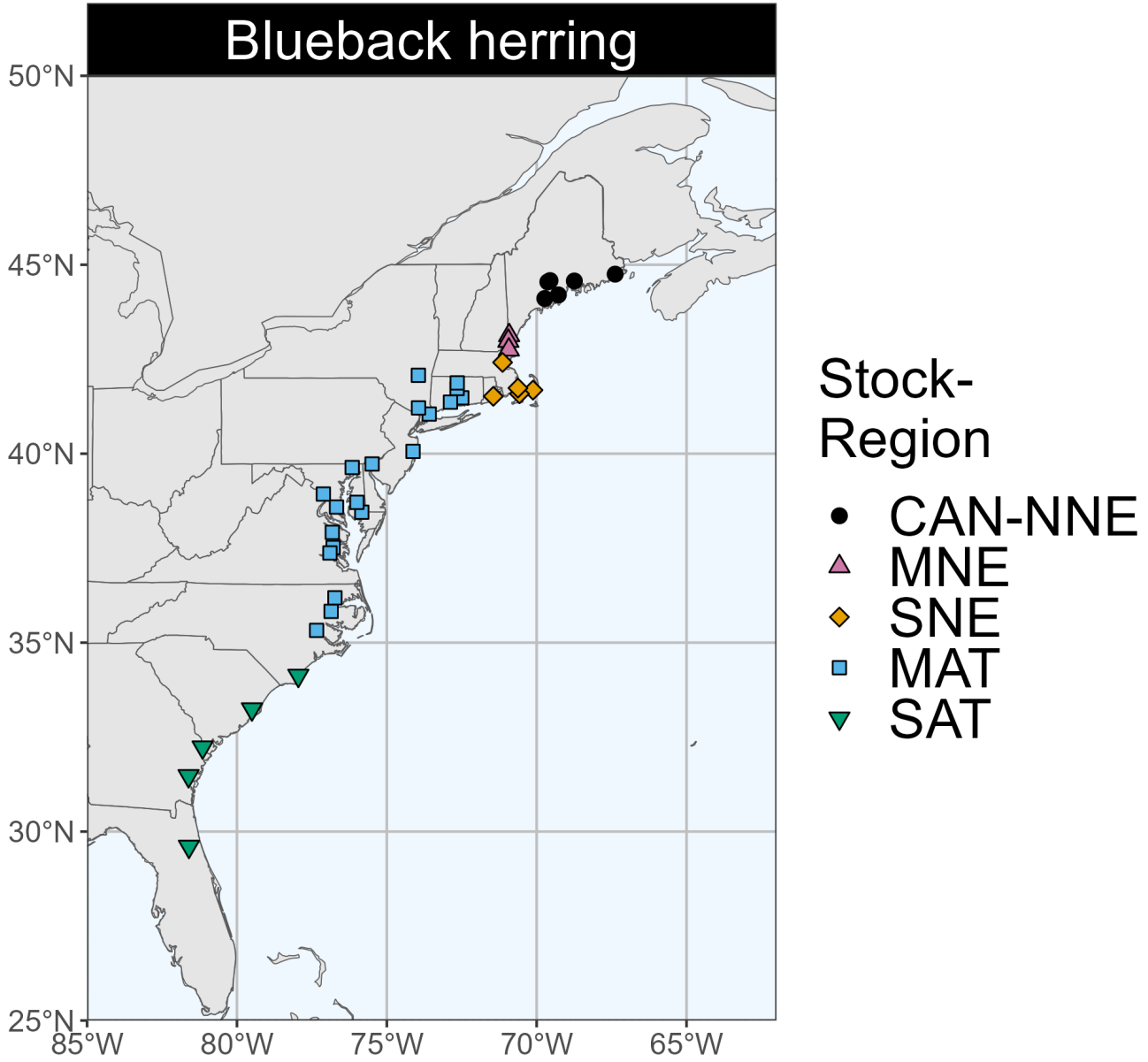
- Research Recommendations

Stock Structure

- Assessed alewife and blueback herring at the river level wherever possible
- Used genetic stock-regions to pool data where necessary for reference points and summarize trends
- Based on genetic work by Reid et al. (2018)

Stock Structure





Outline

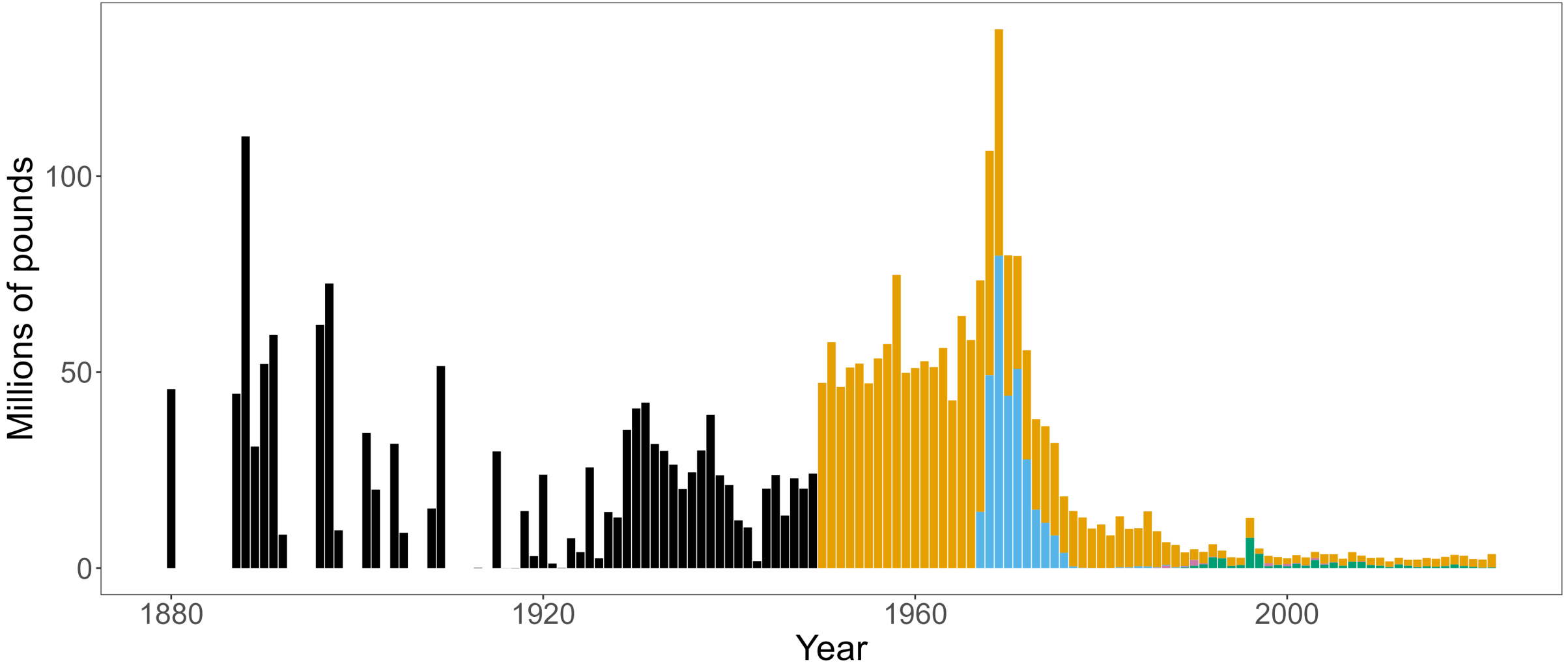
- Stock Structure
- **Data**
  - **Landings and bycatch**
  - **Indices and run counts**
- Methods
- Stock Status
- Bycatch Caps
- Research Recommendations

Data: Total Removals

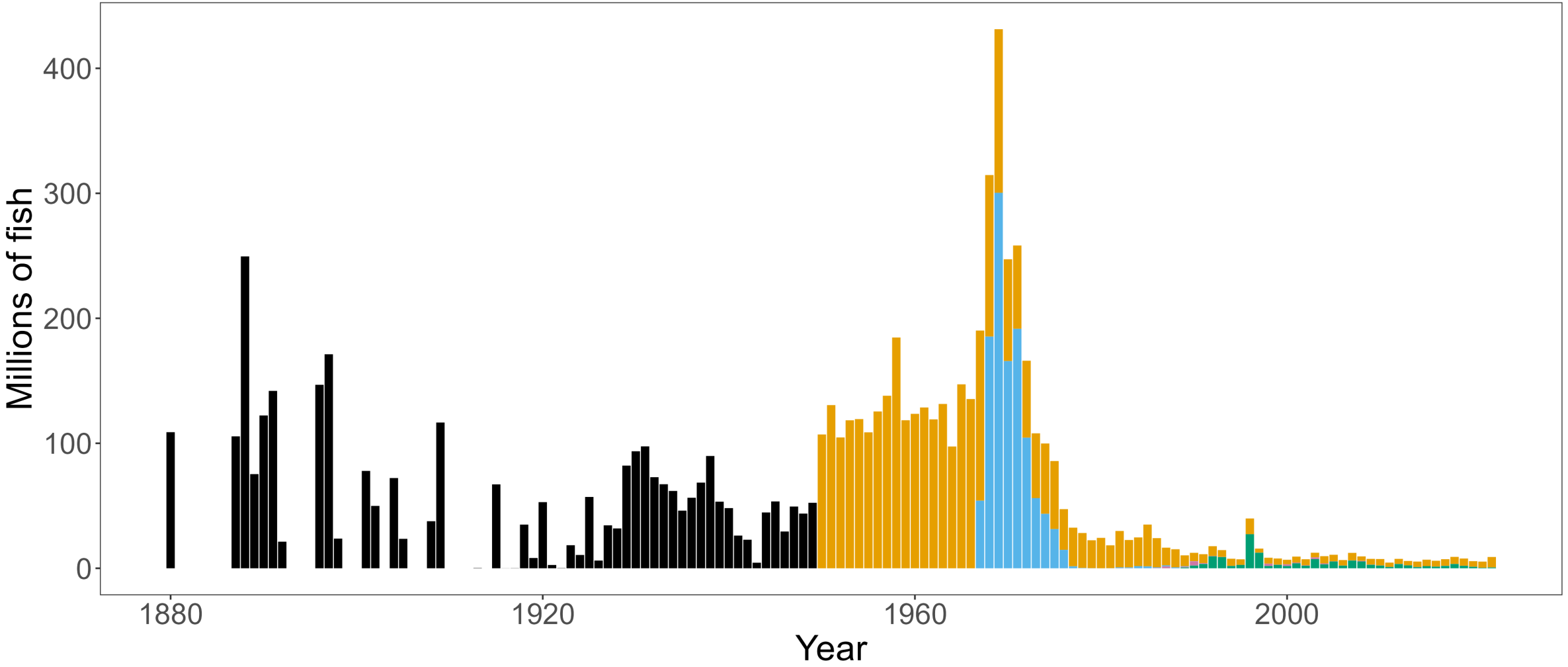
- Presented as “river herring” removals because it’s difficult to separate by species, especially for the historical landings

- Presented in weight and numbers
  - Commercial landings and bycatch in weight converted to numbers
  - Recreational total catch in numbers converted to weight
  - Based on average size of river herring for each sector where sampling was available

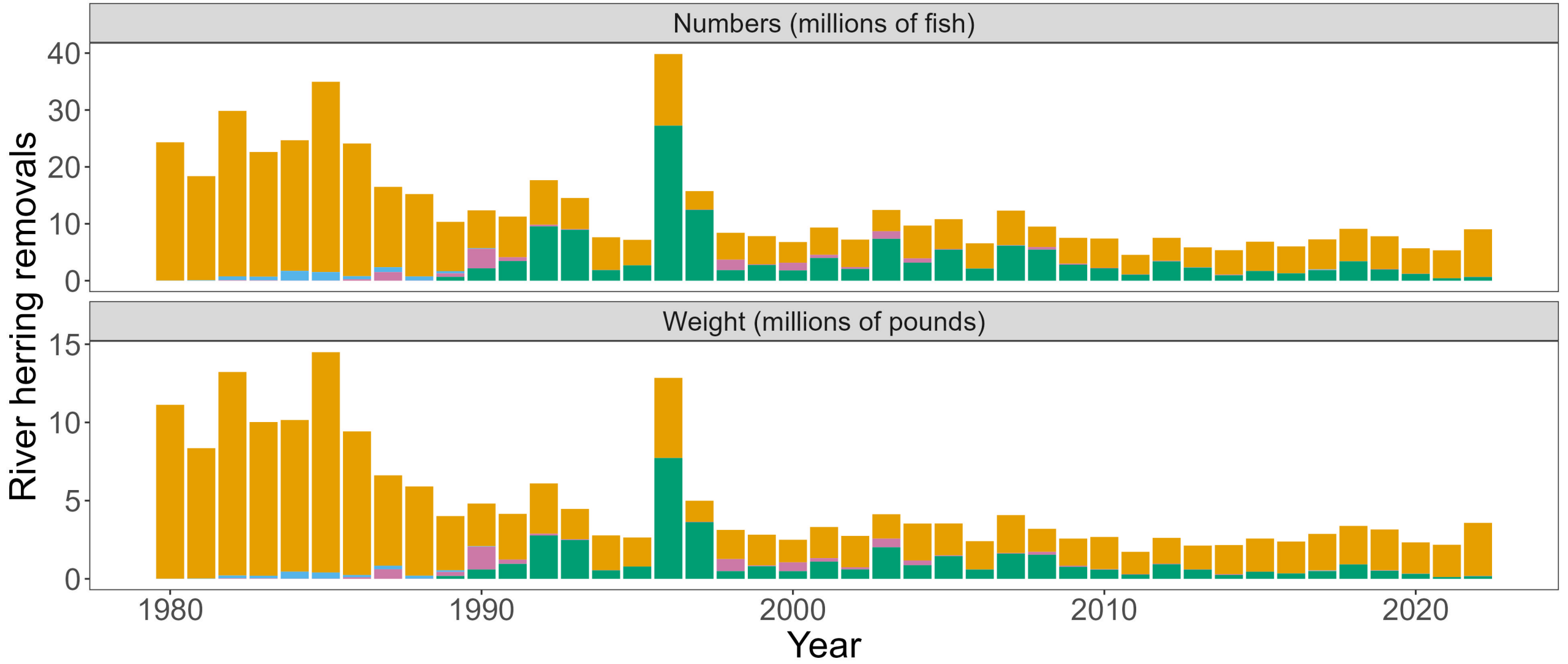
Total Removals in Weight



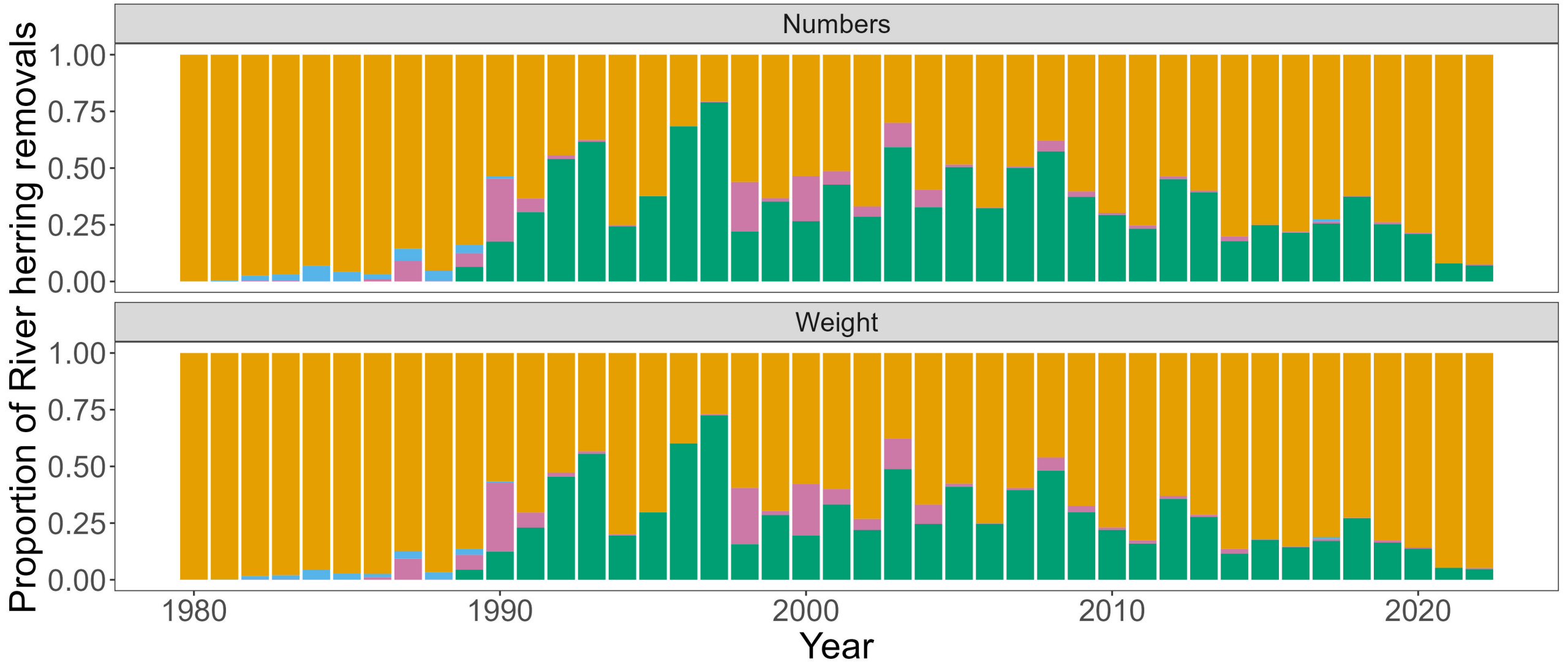
Total Removals in Numbers



Total Removals: 1980-2022



Bycatch vs. Directed Fisheries



Bycatch: recent change

2005-2019

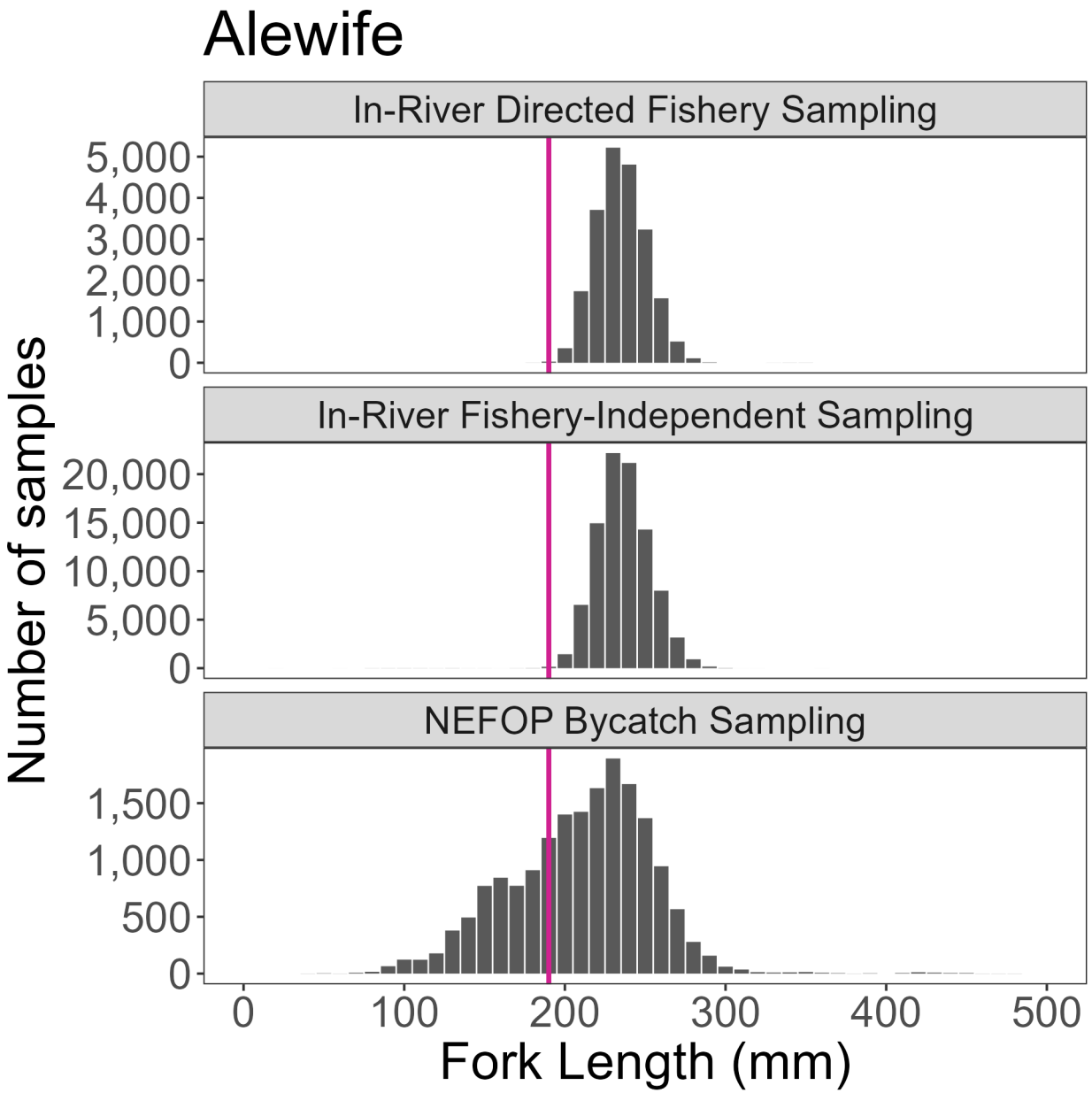
- Averaged 343 mt (757,000 lbs) per year
- 2.81 million fish per year
- 27% of total removals in weight
- 35% of total removals in numbers

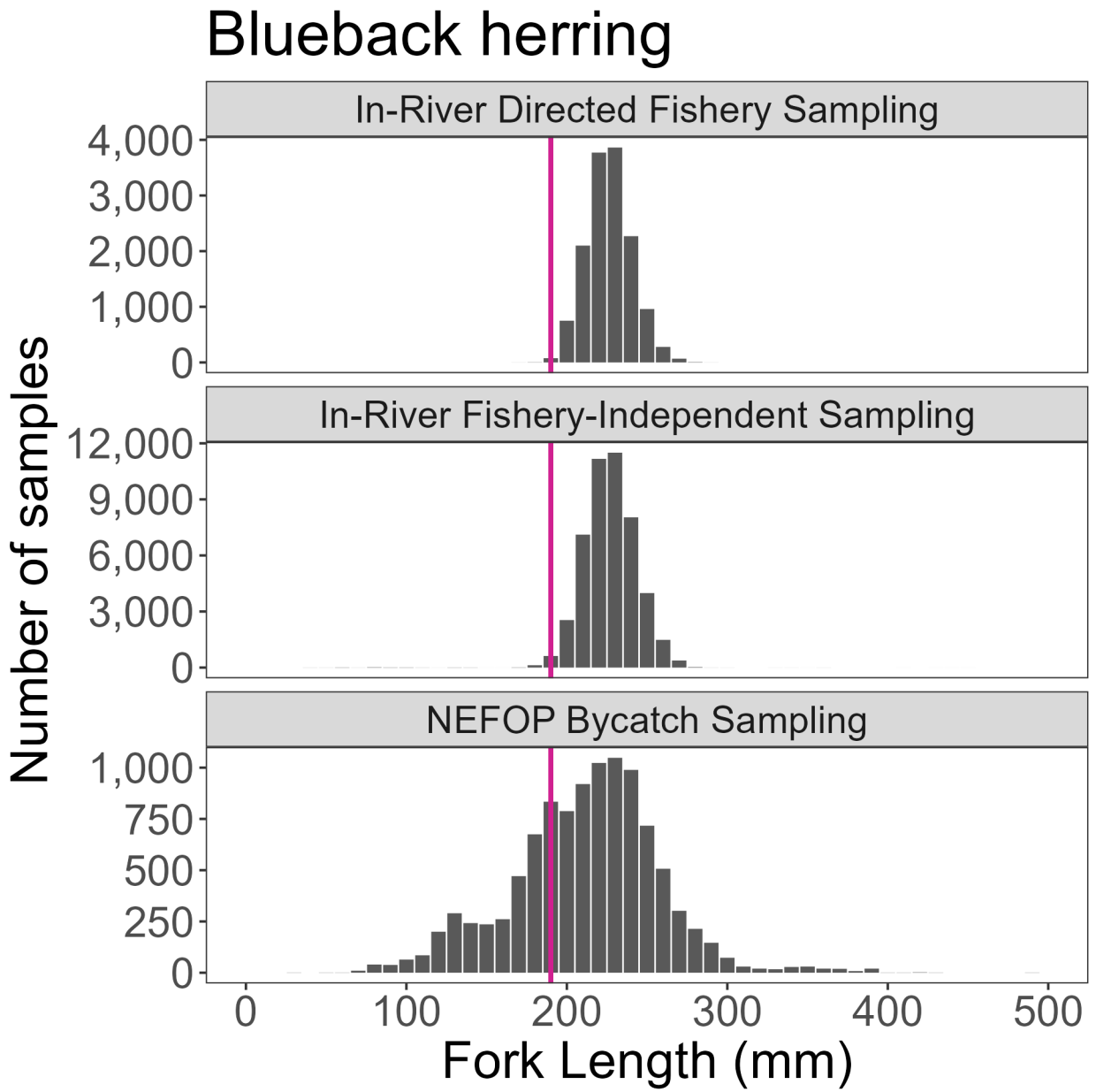
2020-2022

- Averaged 91 mt (200,000 lbs) per year
- 0.75 million fish per year
- 7.5% of total removals in weight
- 10% of total removals in numbers

→ Due to lower effort in Atlantic herring & mackerel fleets in recent years, but also lower observer coverage and port sampling in those years, especially in mid-Atlantic midwater trawls

Bycatch Length Composition





Data: Run Counts and Indices

- TC reviewed a wide range of state, federal, and academic datasets

- A run count or survey was used in the trend analysis if it:
  - Had 10 or more years of data
  - Had consistent methodology or changes in the methods were accounted for
  - Encountered river herring in at least 10% of the tows, hauls, etc. over the time series

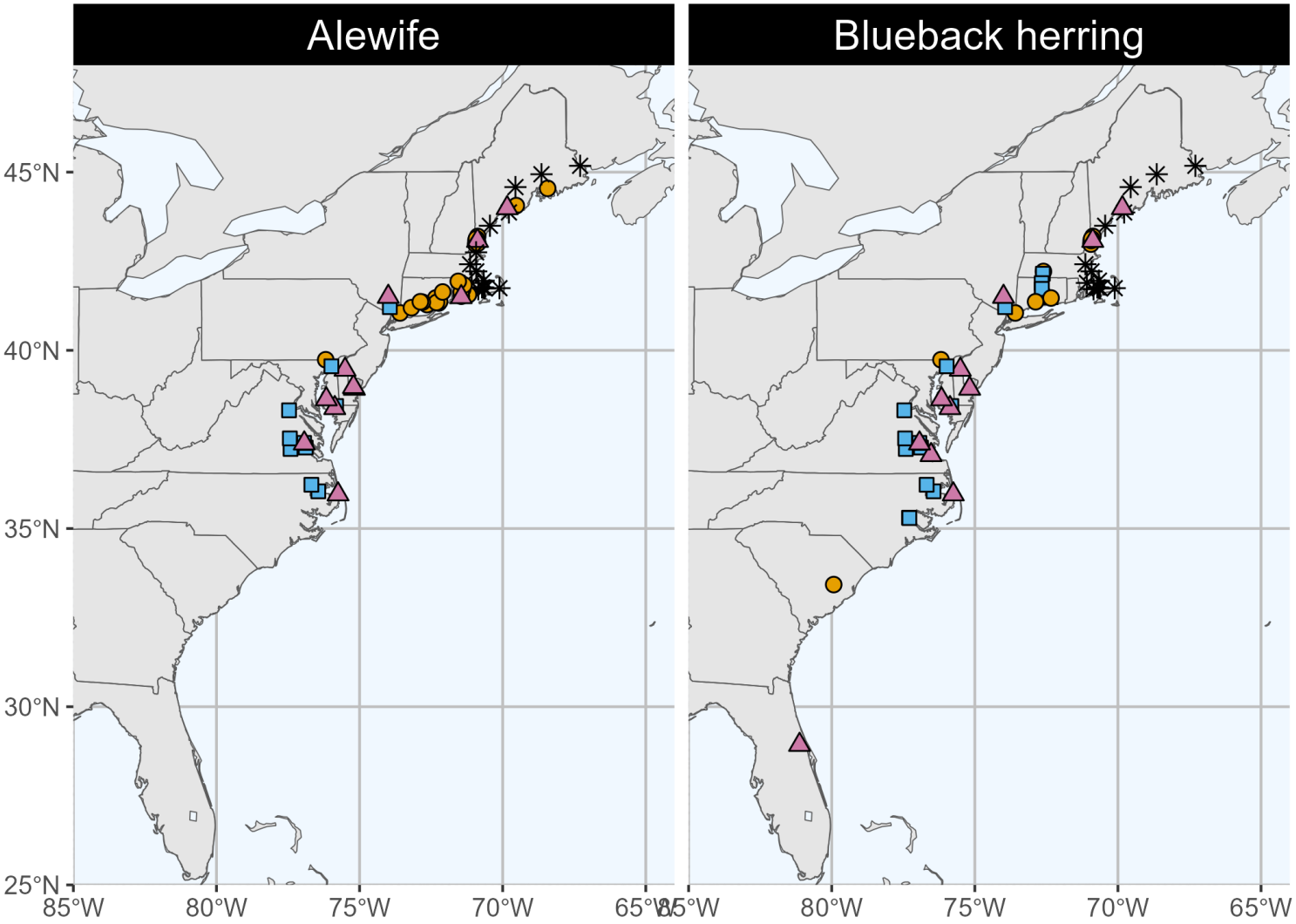
Data: Run Counts and Indices

- Alewife: 52 datasets for trend analysis
  - 23 run counts
  - 10 adult in-river surveys
  - 11 recruitment (YOY/age-1) surveys
  - 8 ocean/mixed stock surveys (adults and juveniles)

- Blueback herring: 42 datasets for trend analysis
  - 10 run counts
  - 13 adult in-river surveys
  - 12 recruitment (YOY/age-1 surveys) surveys
  - 7 ocean/mixed stock surveys (adults and juveniles)

- “River Herring”: 14 run counts not separated to species

Data: Run Counts and Indices



Data Source

- Run Count (Species-specific)
- Run Count (Combined species)
- Adult FI Survey
- YOY/Juvenile Index

Outline

- Stock Structure
- Data
- **Methods**
  - **Trend analysis**
  - **Z comparisons to reference points**
  - **Habitat Model**
- Stock Status
- Bycatch Caps
- Research Recommendations

Trend Analysis

- Mann-Kendall: detects an increasing or decreasing trend over the time-series

- ARIMA: probability that the terminal year is greater than the reference year (2009) or greater than the 25th percentile of the time series

- Applied to run counts, indices, and life history characteristics (mean length, percent repeat spawners, etc.)

Life History Trend Analysis

- Very few significant trends for maximum age, mean length, mean length-at-age, and percent repeat spawners

- Difficult to interpret
  - Does declining repeat spawner percent indicate decreasing survival on older fish or higher recruitment/more first time spawners? Hard to tell without other data on recruitment or abundance

- TC/SAS did not rely on these results for status information
  - See assessment report for detailed results

Total Mortality (Z)

- Estimated Z from age data from in-river monitoring using the Poisson GLM method
  - Used age of full maturity as age of full selectivity (age-5 for most stock-regions)
  - Only applied for years with at least 30 samples of at least 3 fully selected ages

- Stochastic $Z_{40\%SPR}$ reference point
  - Instead of using point estimates for inputs like M, maturity, etc., draw from distribution of parameters to create a distribution of $Z_{40\%SPR}$ estimates
  - Developed reference points for each stock-region

- Probability of Z being above $Z_{40\%SPR}$ incorporates uncertainty from the Z estimate and the reference point

Habitat Model

- Habitat Model
  - Simulation model to look at the effects of habitat loss on the productivity of alewife and blueback herring in each stock-region
  - Similar to model used for American shad during the 2020 benchmark, but life history information and habitat data were updated to reflect alewife and blueback herring stock-regions

Results

- Results are summarized coastwide and by stock-region in this presentation

- See Table 28 and Table 39 in the full assessment report for a river-by-river summary of stock status

Outline

- Stock Structure
- Data
- Methods
- **Stock Status**
  - **Habitat Model**
  - **Mann-Kendall Trends**
  - **ARIMA comparison to reference**
  - **Total Mortality comparison to reference**
- Bycatch Caps
- Research Recommendations

Stock Status Challenges

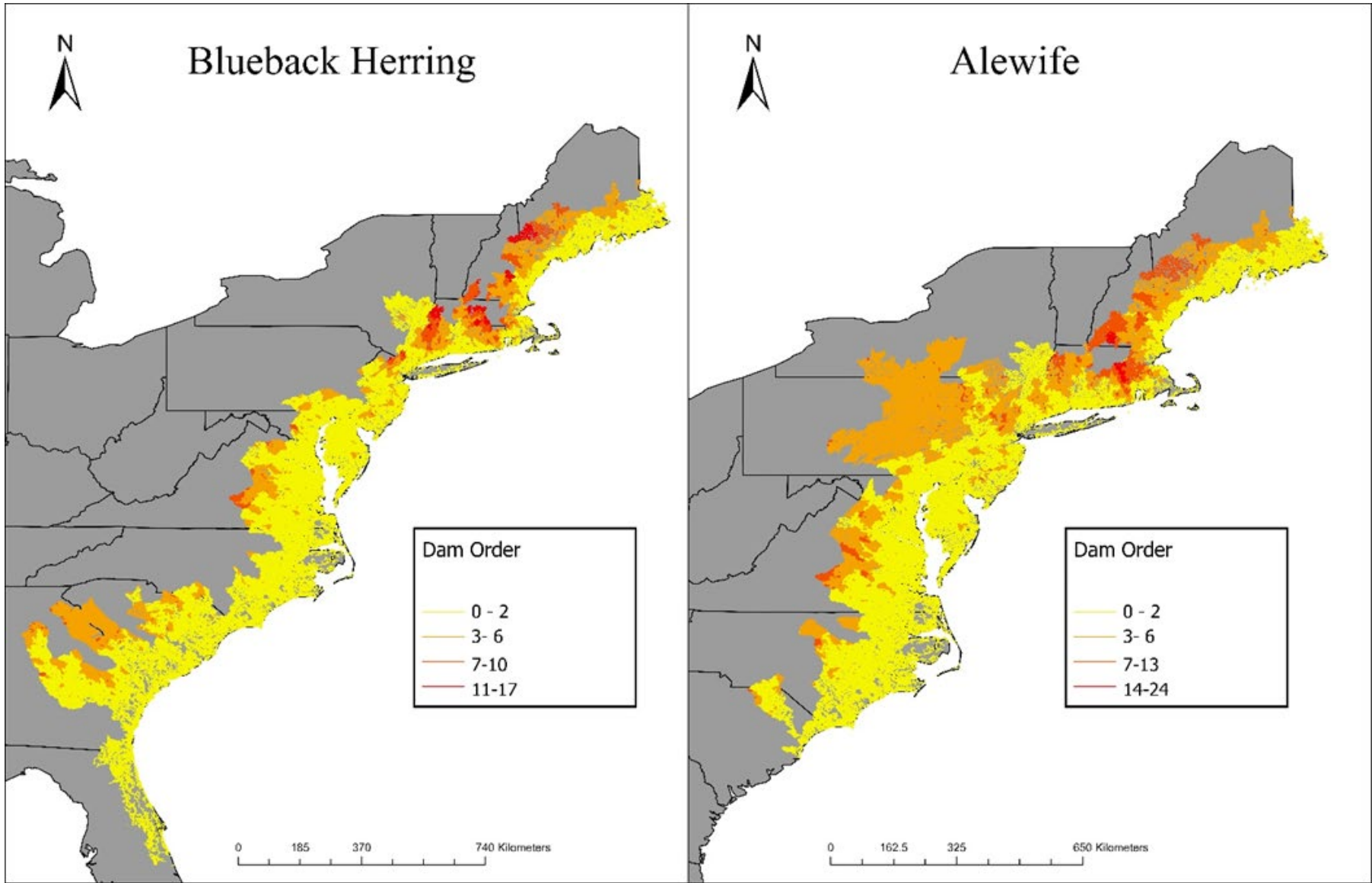
- River herring abundance is affected by a number of factors
  - Directed fishing
  - Bycatch
  - Habitat loss and degradation
  - Passage mortality
  - Environmental factors including predation and climate change

- Each river system has its own challenges, and for almost all stocks, we only have one data source

- All of our datasets on abundance and mortality start well after the peak of the directed fishery in the 1960s and the collapse in landings during the 1970s

Habitat Model

A significant amount of river herring spawning habitat has been lost or made difficult to access due to dams

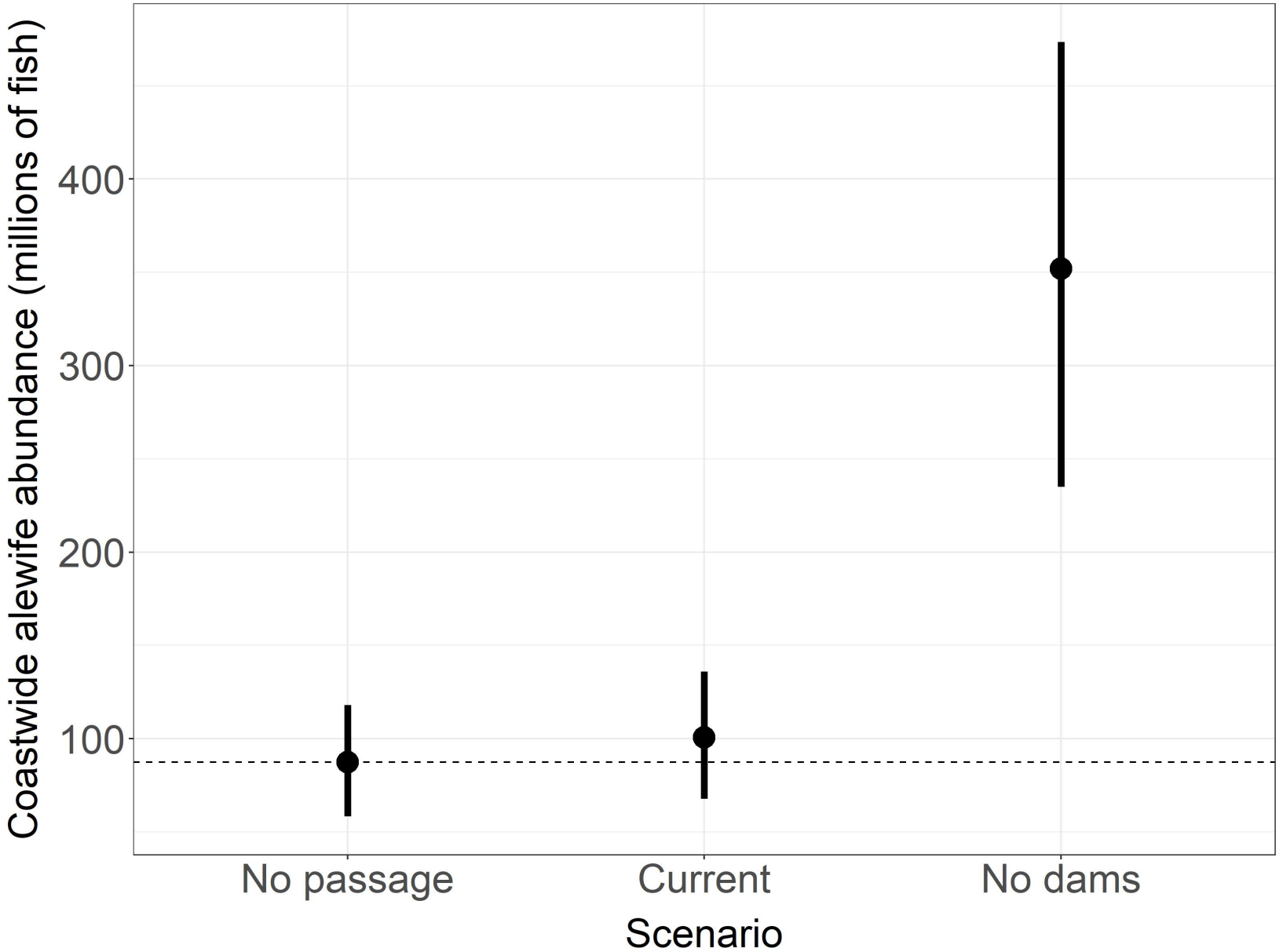


Habitat Model: Alewife

Loss of access to spawning habitat results in a lower potential abundance

Alewife:

- 75% lower potential abundance coastwide under a no passage scenario

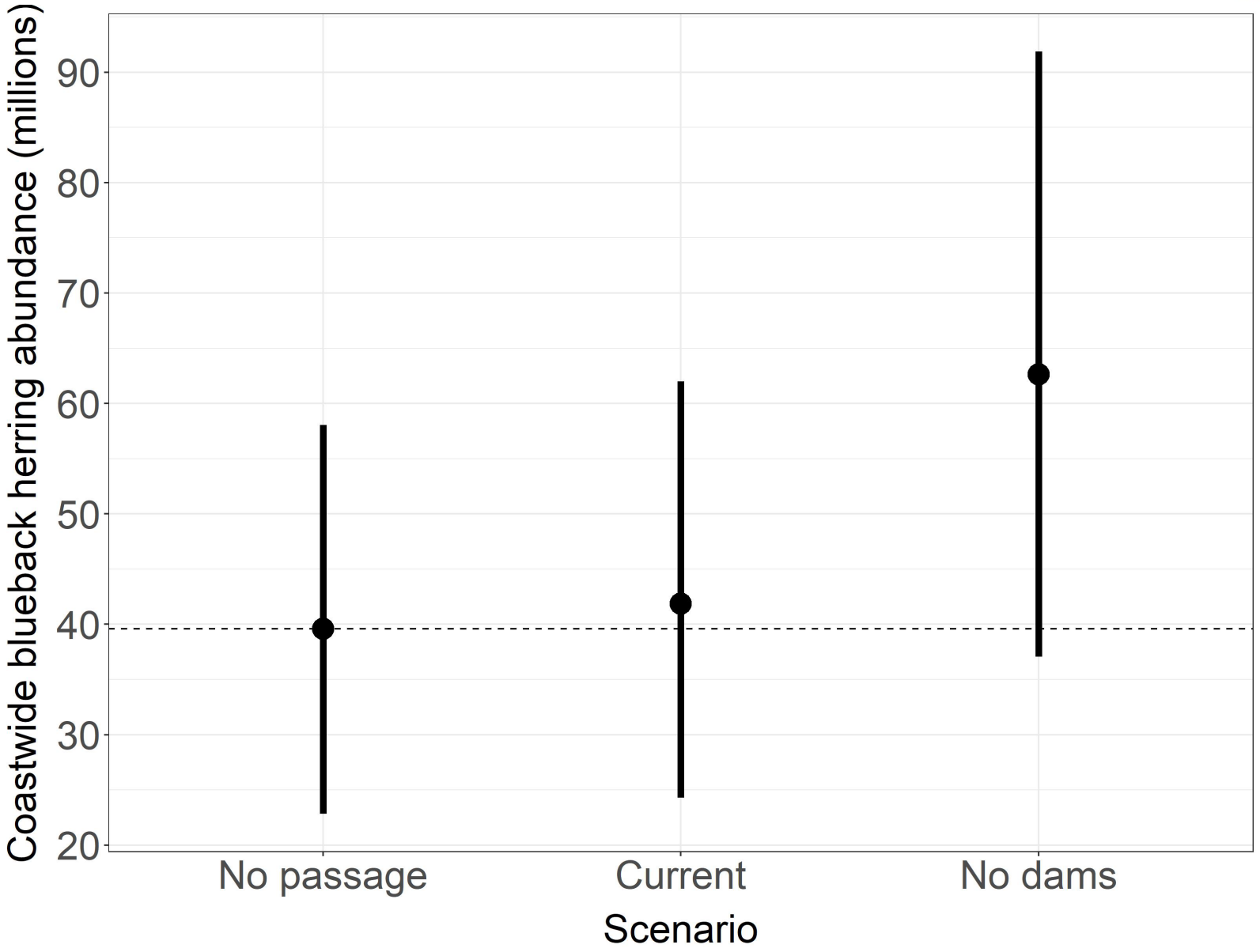


Habitat Model: Blueback Herring

Loss of access to spawning habitat results in a lower potential abundance

Blueback herring:

- 35% lower potential abundance coastwide under a no passage scenario

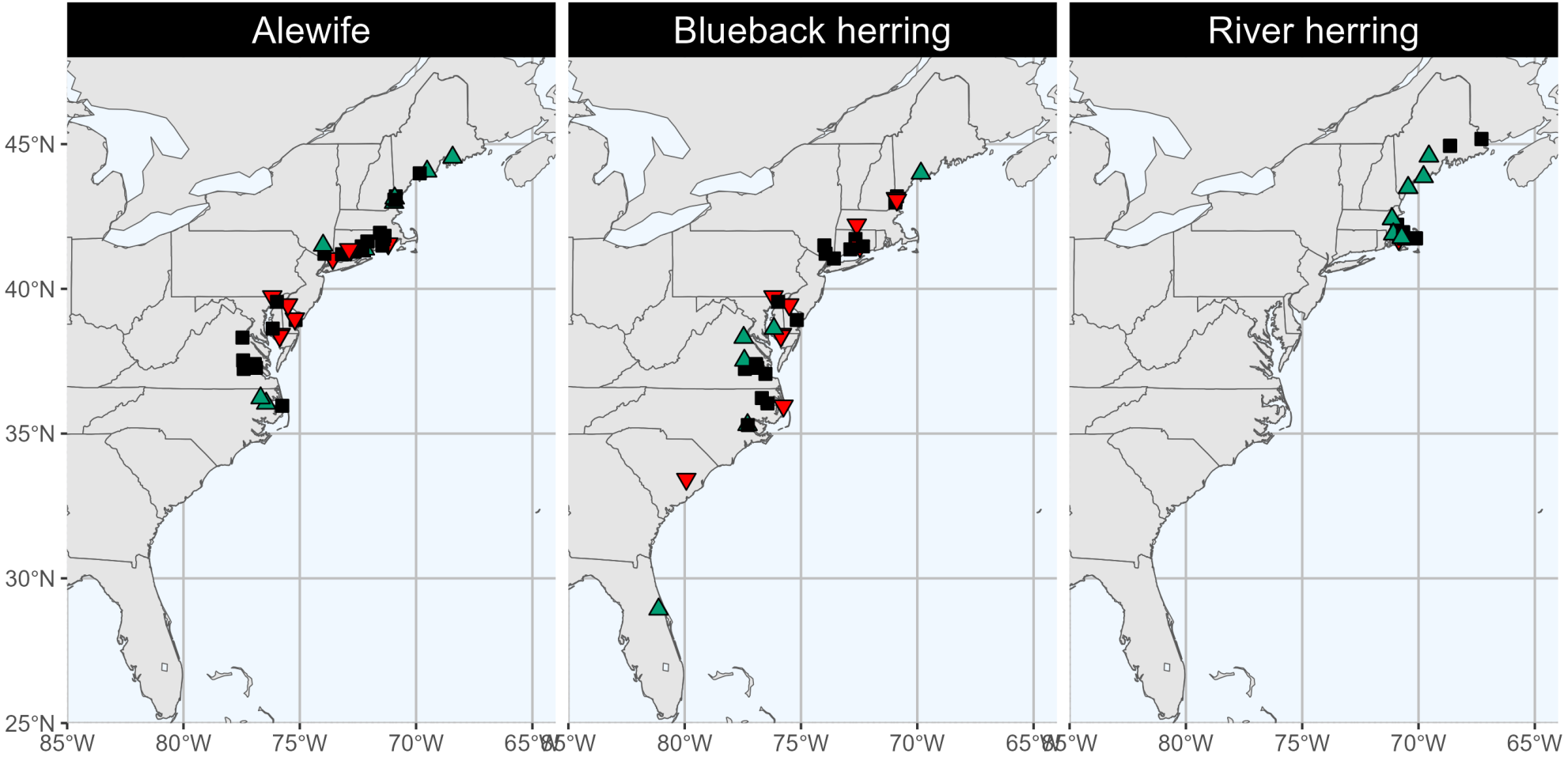


Stock Status – Habitat Model

- Alewife and blueback herring are depleted relative to historic levels
- Habitat model indicates the overall productivity of the stock is lower now that it was for an unexploited population in an unaltered landscape
- Does not incorporate fishing mortality, so it does not provide an estimate of true current abundance

Full Time-Series Trends

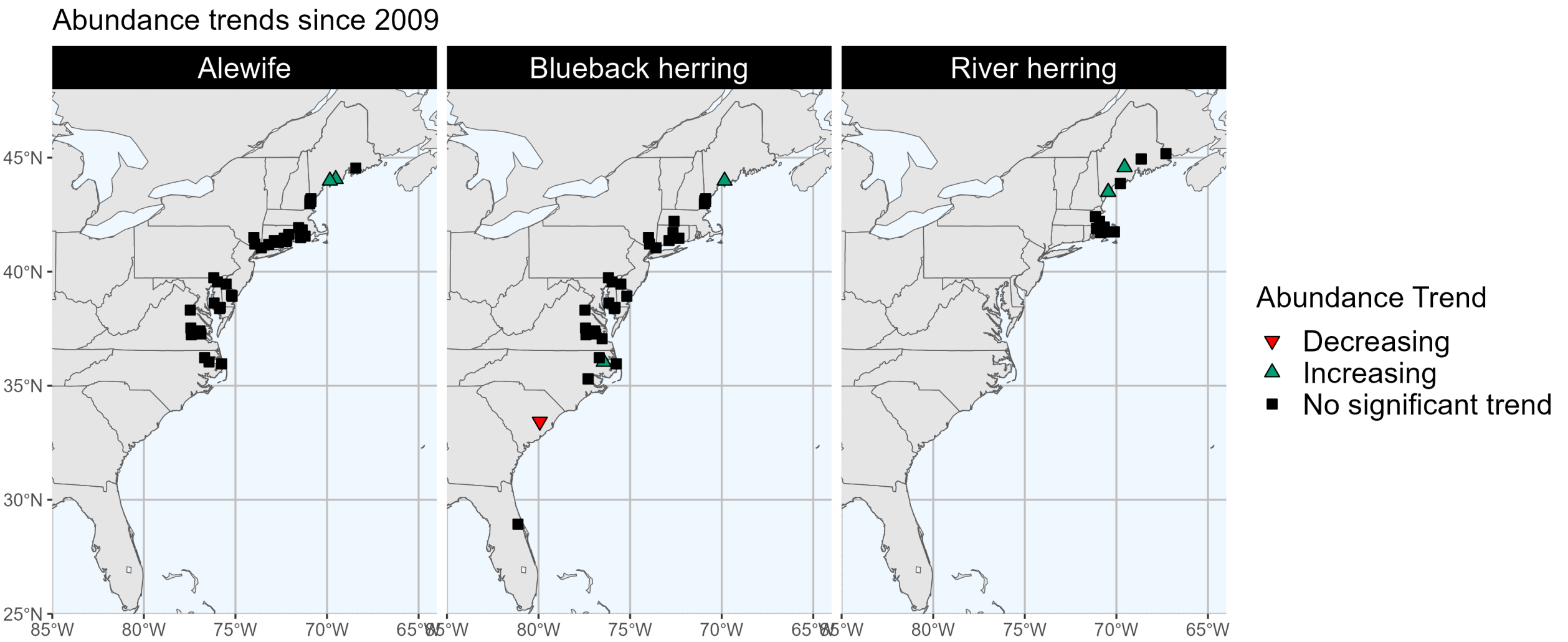
Abundance trends over the full time series



Abundance Trend

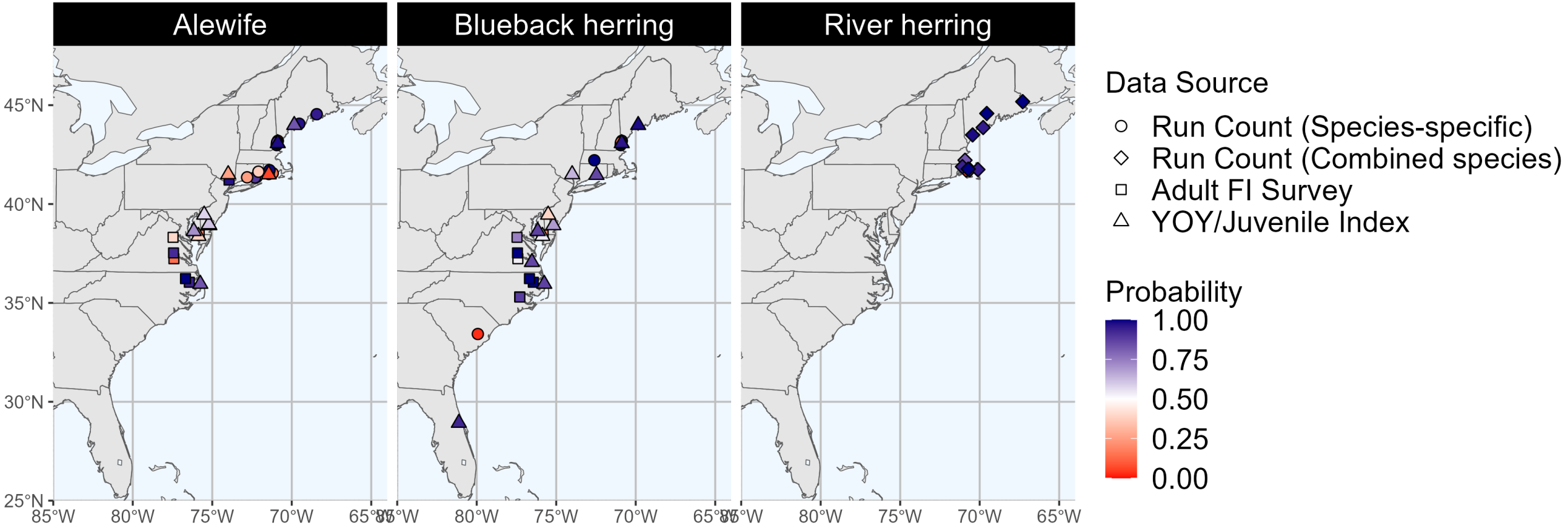
- Decreasing
- Increasing
- No significant trend

Trends since 2009



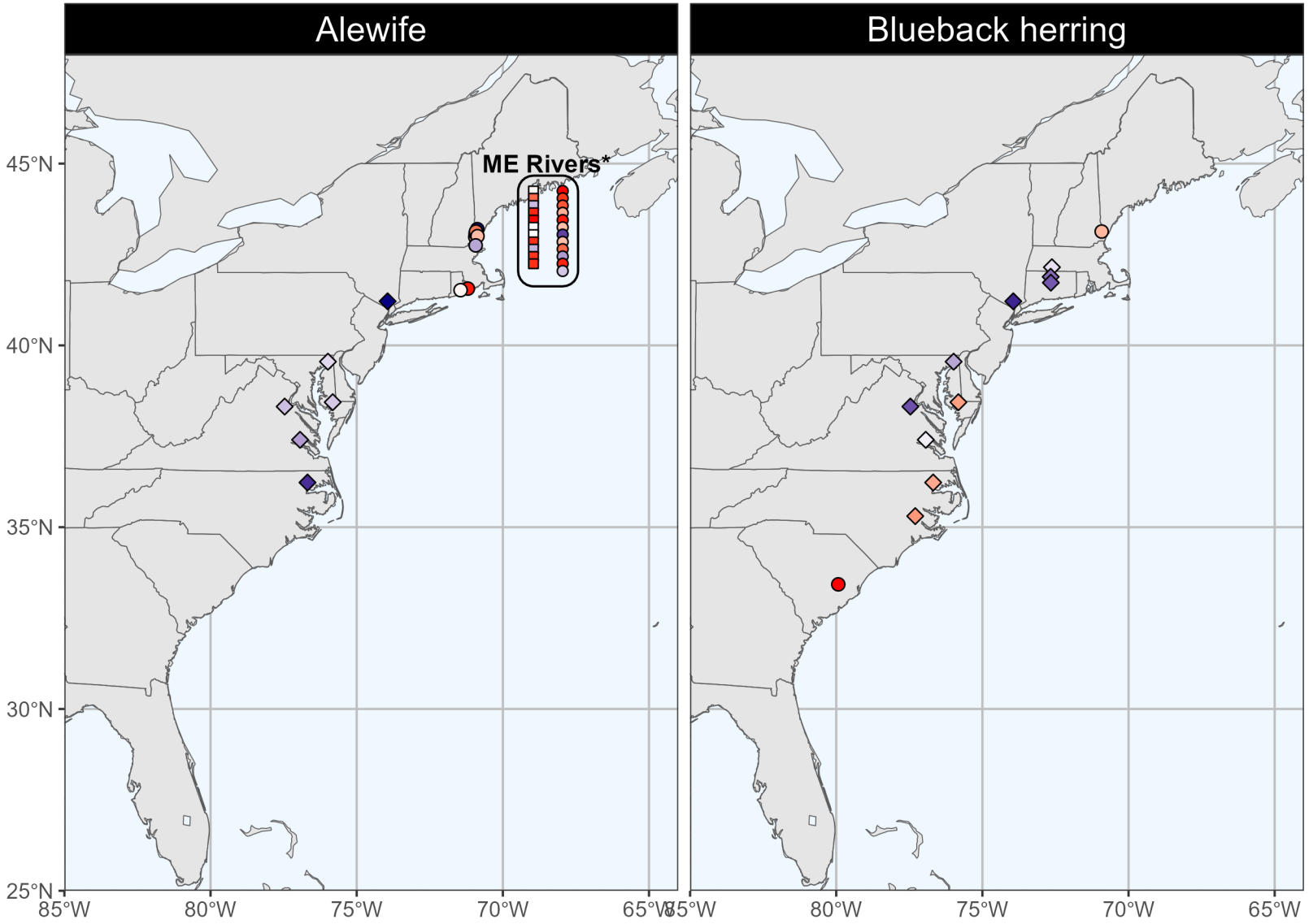
ARIMA Results 2009 Reference Year

Probability of the most recent year of the index being above 2009 value



Total Mortality

Probability of the most recent Z estimate being above the Z reference point



Probability
1.00
0.75
0.50
0.25
0.00

Data Source
- Run Count Sampling
- Adult FI Survey
- Fishery Sampling

*: Maine rivers are not plotted geographically to preserve confidentiality

Stock Status: Alewife

	Time-Series Trends since 2009			Number of datasets with a >50% probability of terminal year being greater than 2009 value	Number of rivers with a >50% probability Z > $Z_{40\%SPR}$
	↓ Trend	No trend	↑ Trend		
NNE	0	6	1	12/13 (92%)	21/29 (72%)
SNE	0	17	0	10/15 (67%)	7/9 (78%)
MAT	0	21	0	11/17 (65%)	0/6 (0%)
Mixed stock (ocean)	0	14	3	6/9 (67%)	

Stock Status: Blueback Herring

	Time-Series Trends since 2009			Number of datasets with a >50% probability of terminal year being greater than 2009 value	Number of rivers with a >50% probability Z > $Z_{40\%SPR}$
	↓ Trend	No trend	↑ Trend		
CAN-NNE	0	0	1	1/1 (100%)	
MNE	0	3	0	4/5 (80%)	1/1 (100%)
SNE					2/2 (100%)
MAT	0	26	1	16/18 (89%)	3/10 (30%)
SAT	1	1	0	2/3 (67%)	1/1 (100%)
Mixed stock (ocean)	0	5	2	4/7 (57%)	

Stock Status

- No clear coastwide trends since Amendment 2
  - Some systems showing positive trends, some negative, many no detectable trends

- Northern regions seem to have more positive trends, but a lot of variability even within regions. Run count increasing trends may be influenced by increasing passage efficiency.

Stock Status

- Northern regions have put a lot of effort into habitat restoration and dam removal, but so have states further south and they have not seen the same positive trends in run counts and indices

- NNE stock-region also accounts for the majority of directed catch in recent years, while states in the MNE, SNE, and MAT stock-regions have closed their fisheries

- What other factors affecting river herring abundance?

Stock Status: bycatch influence

- Reid et al. (2022) looked at the genetic composition of ocean bycatch from the Cape Cod/Long Island Sound/New Jersey area, which has historically had high fishing effort and high estimates of river herring bycatch

- In this area, the majority of alewife bycatch was from the SNE stock-region and the majority of blueback herring bycatch was from the MAT stock-region, two stock-regions that have more negative trends in recent years despite habitat restoration efforts and directed fishery closures

Outline

- Stock Structure
- Data
  - Landings and bycatch
  - Indices and run counts
- Methods
- Stock Status
- **Bycatch Caps**
- Research Recommendations

Bycatch Caps

- TOR #6: If possible, develop methods to calculate a biologically-based cap or limit on bycatch of river herring in ocean fisheries

Bycatch Caps

- A proof-of-concept approach was developed using data-limited methods to set bycatch caps based on trends in alewife and blueback herring abundance

- Used iSmooth and iSlope methods
  - Peer reviewed through SAW/SARC in the 2020 Index Based Methods and Control Rules Research Track Assessment
  - Had the highest median catch among the methods that achieved rebuilding more than 50% of the time

Bycatch Cap Methods

- iSmooth and iSlope are conceptually very similar

- The slope of the index in recent years is used to develop a multiplier that is applied to recent catch, with or without additional buffers

→ If the index is decreasing, the bycatch cap would decrease; if the index increases, the cap would increase

Bycatch Cap Methods: Data Required

- Catch data
  - NEFSC species-specific coastwide bycatch estimates

- Index data
  - Ocean mixed-stock indices: NEFSC Bottom Trawl and NEAMAP
  - Run counts
    - Alewife: sum of SNE run counts
    - Blueback herring: sum of MAT run counts

    → Stock-regions comprising most of the bycatch in Reid et al. 2022

Index-based Bycatch Caps

- Final numbers depended on the method, choice of index, and what kind of buffers are applied

- All cap estimates were:
  - Lower than current bycatch caps
  - Lower than coastwide bycatch estimates
  - Higher than recent estimates of catch against the current caps (not all coastwide bycatch of river herring counts against the current caps)

Index-based Bycatch Cap: Pros and Cons

- Pros: more biologically based than current historical average approach
  - As indices decline, caps will decline; if indices increase, caps can go up

- Cons:
  - Based on index data only, not a population model
  - Assumes a relationship between bycatch and population abundance although we know bycatch is only one factor affecting river herring abundance

Index-based Bycatch Cap Proof-of-Concept Only

- Needs more work/consultation with managers on scope and implementation
  - This is species-specific; current caps are shad and river herring combined
  - These caps are coastwide; current caps are based on specific fisheries and gear/area combinations
  - Data-limited methods need more management input on risk and buffer levels
  - Monitoring at a biologically meaningful scale is difficult; not all bycatch affects all rivers/stock-regions equally and current monitoring does not include genetics

Alternative Approach

- TC/SAS strongly supported the species distribution modeling approach as an alternative or complement to catch caps

- Model river herring distributions and identify potential “hot spots” where risk of bycatch is increased & use time-area closures to minimize bycatch instead of an in-season cap approach

- Avoids some of the issues with intensive monitoring needs of the catch cap approach but models need to be developed further

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- Bycatch Caps
- **Research Recommendations**

Research Recommendations

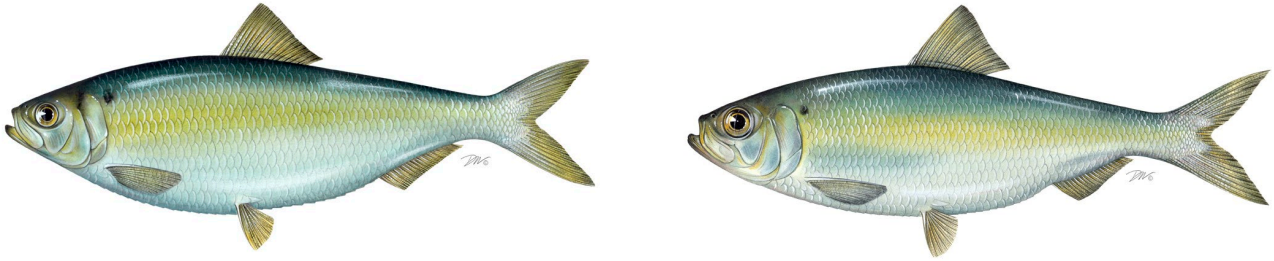
- High-priority short term research recommendation for assessment methodology:
  - Continued development of the habitat model or similar models to predict the potential impacts of climate change on river herring distribution and stock persistence and develop targets for rivers undergoing restoration (dam removals, fishways, supplemental stocking, etc.)

Research Recommendations

- High priority short-term recommendations for research and data collection:
  - Develop consistent ageing protocols across all states
  - Establish a database of existing data sources with comprehensive metadata and recommendations for use
  - Expand observer and port sampling coverage including genetic sampling to better quantify incidental catch of river herring
  - Studies to quantify, improve, and implement standard practices for fish passage efficiency
  - Evaluate and validate hydroacoustic methods to quantify river herring spawning run numbers in major river systems.

QUESTIONS?

River Herring Stock Assessment Peer Review Report



Shad and River Herring Fishery Management Board

August 7, 2024

Stock Assessment Peer Review Process

- River Herring Technical Committee and Stock Assessment Subcommittee developed new stock assessment

- Review Workshop: June 4-7, 2024, Arlington, Virginia

- Scientific review focused on data inputs, analytical methods, results, and overall quality of stock assessment

Products

- ASMFC Stock Assessment and Review Report
- www.asmfc.org/species/shad-river-herring

Review Process

Scientific Review Panel

Chair + 2 additional Technical Reviewers, with expertise in

- Anadromous fish ecology and population dynamics
- Stock assessment modeling
- Data limited methods, fish passage, and bycatch estimation

Dr. Adrian Jordaan (Chair), University of Massachusetts

Dr. Heather Bowlby, Fisheries and Ocean Canada

Dr. John Wiedenmann, Rutgers University

Fisheries and Oceans Canada

RUTGERS

Review Panel Overall Findings

- River herring stocks remain depleted from a coastwide perspective, with a decade or more of effort in restoration and moratoria not leading to improved status.

- Most population trends were flat, although high variability resulted in low power to detect trends

- No official statement was made regarding current rates of mortality, however total mortality is high in many stocks

Review Panel Overall Findings

- Marine mortality high, and there is a lack of data to determine cause. Concerns over the potential for high levels of discard mortality, and the current lack of monitoring

- New habitat-based model shows promise and indicates lower productivity due to dams and habitat loss, continued development was encouraged

- Based on the current methodology, analyses, and interpretation of results, the assessment provides the best available science.

Review Findings

✓ **ToR 1:** Evaluate choice of stock structure

Conclusions

- Good a job as possible accumulating all the current genetic data on river herring to characterize broad regions.
- Since river-specific mortality is important and the only level where mortality/growth/life history is monitored, the river unit is still considered the stock unit

Recommendations (for future assessment work)

- Continued data collection from populations, and fisheries, for apportionment of discards and at-sea surveys
- Filling geographic gaps in genetic data

Review Findings

✓ **ToR 2:** Evaluate the data used in the stock assessment

Conclusions

- Good a job as possible accumulating all the data on river herring from both fisheries dependent and independent sources
- Significant data limitations remain an issue for these stocks, particularly with the lack of standardized methods for ageing and abundance indices

Recommendations (for future assessment work)

- Missing discard data, port/dock side monitoring
- Develop more indices of abundance and sentinel populations (like the Monument River)

Review Findings

✓ **ToR 3:** Evaluate the assessment methods and models

Conclusions

- Remains a data poor assessment, and the majority of river systems, only one type of monitoring data existed that could be used as an abundance index
- Catch curve estimation of total mortality (Z) compared to reference point from spawning stock biomass per recruit model (SPR) analysis deemed appropriate
- Trend analysis (Mann-Kendall and ARIMA) on survey CPUE and run sizes, mean length, and mean length-at-age at the river level seemed to provide little additional information
- Previously-developed statistical catch at age assessment models were updated for three rivers and suggested high at sea mortality

Review Findings

✓ **ToR 3:** Evaluate the assessment methods and models

Conclusions

- Continued development of data-limited methods for developing a bycatch cap based on trends in abundance was encouraged, although a number of issues were identified, particularly interannual variability in cap estimates
- The review panel was concerned a fully spatial bycatch avoidance approach would not inherently track the magnitude of bycatch and that a bycatch cap might 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

Review Findings

✓ **ToR 4:** Identify best estimates of stock abundance, total mortality, and exploitation for management use

Conclusions

- For the majority of river systems, only one type of monitoring data existed and this limited interpretation
- Trend analysis on survey CPUE and run sizes, mean length, and mean length-at-age at the river level gave mixed results, and had low power
- SPR analyses demonstrated high mortality, frequently exceeding the $F_{40\%}$ BRP
- SCA modeling suggested high at-sea mortality
- Habitat model suggested continued need for improved habitat access

Review Findings

✓ **ToR 4:** Identify best estimates of stock abundance, total mortality, and exploitation for management use

Conclusions

- Continued development of data-limited methods for developing a bycatch cap based on trends in abundance was encouraged

Recommendations

- Have some sentinel sites tracking more data
- Move SCA to more of a population viability
- Overall, we encourage the SAS to continue development of the habitat modeling approach
- Work with NEFMC PDTs on approaches to limit bycatch

Review Findings

✓ **ToR 5:** Evaluate reference points and stock status determination

Panel Conclusions and Recommendations:

- River herring stocks remain depleted, although there is low power to detect trends. Increased monitoring is needed, including better standardization of techniques.
- Mortality exceeded BRPs in many rivers, and at-sea mortality appeared to be high
- River herring remain data poor and status determinations are not possible
- Lack of recovery giving the past decade of restoration is troubling
- Lack of discard mortality monitoring remains a missing element

Review Findings

✓ **ToR 6:** Review and prioritize research recommendations

Panel Conclusions and Recommendations

- The panel recognizes the need for improved estimation of bycatch and discard mortality, including comparison of analytical techniques in a sensitivity analysis to assess their relative predictive ability for estimating total bycatch

- The manner in which iSlope or other methods could be implemented as catch caps should be explored. Since incidental catch seems to comprise the largest source of ongoing fishing mortality, and mortality remains high for many populations, the focus on bycatch is urgent.

- Improve the habitat model by incorporating all major sources of mortality, and then to use observed data to ground truth the outputs.

Review Findings

✓ **ToR 6:** Review and prioritize research recommendations

<u>Panel Conclusions and Recommendations</u>

- Of equal priority, but with implementation over a longer time period, is improved monitoring via port sampling to collect morphological and species data from bycatch. This would require portside monitoring to be reinstated and expanded for full-retention fisheries.
- The panel also sees a high priority in continued improvement of enumeration techniques, including hydroacoustics, eDNA, and run count video image processing with machine learning.

Medium Priority:

- The panel recognized the need to implement sampling programs where data are collected over the whole life stage on a single river.

Review Findings

✓ **ToR 6:** Review and prioritize research recommendations

Panel Conclusions and Recommendations

- A detailed river history and inventory that captures current population numbers, details of restoration, and documents data collection methods would be very informative when trying to interpret current status.

- River herring specific surveys would be of great benefit to the assessment, and the panel suggests interspecies and interstate collaboration on survey design.

- The panel considered most of the other medium and high priority research objectives identified by the SAS (short and long term) to be less important, primarily because they would have a lower likelihood of leading to information useful for assessment and management.

Review Findings

✓ **ToR 7:** Recommend timing of future stock assessments

- The review panel agreed with the SAS that an assessment update in 5 years and a benchmark assessment in 10 years would be appropriate.

Review Panel Conclusions

Closing comments

- The NE SSC just approved significant cuts to Atlantic herring fishery, which offers a reprieve and an opportunity to better understand impacts from bycatch mortality
- Continued collaboration with the relevant PDTs is critical moving forward for bycatch caps and spatial management
- Cautionary tale however from my own research, that now river herring are more likely to be relied upon for forage since herring is so much lower

Questions?