New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
Eric Reid, *Chair* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: April 7, 2023

TO: Herring Committee

FROM: Herring Plan Development Team

SUBJECT: **River herring and shad catch in the Atlantic herring fishery, 2020-2022**

One of the Council's 2023 Atlantic herring priorities is:

> *An analysis to investigate what combination of factors (e.g., sampling intensity, estimation methodology, inherent assumptions) may have led to low 2020-2022 GARFO shad/river herring bycatch estimates in the Atlantic herring fishery.*

The Herring Plan Development Team (PDT) met by webinar on Feb. 13, Mar. 8, and Mar. 28, 2023 to prepare an analysis to address this priority. The following memorandum summarizes the PDT's analysis to date.

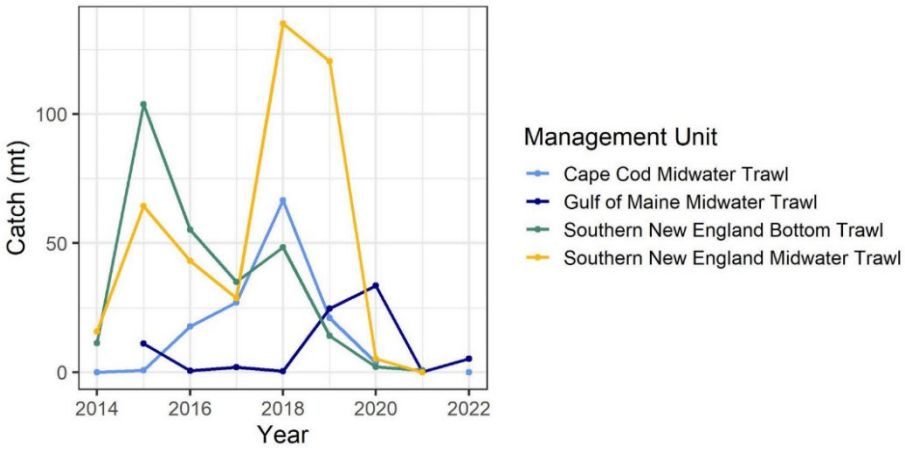
Outline

1. Summary of Conclusions
2. River Herring and Shad Background, ASMFC
3. Current River Herring / Shad Catch Caps and Accountability Measures
4. River Herring and Shad Catch Estimation to Monitor Catch Caps
5. Raster Maps of Atlantic Herring Trawl Fishery Landings, 2008-2021
6. NEFSC/FMO Factors Impacting Observer Coverage, 2020-2022
7. River Herring / Shad Catches by Catch Cap, 2015-2023 In-Season
8. Example of In-Season Estimation of River Herring and Shad Catches in the Mackerel Fishery
9. Summary of the presentation by Massachusetts Division of Marine Fisheries staff summarizing collaborative research with their partners on: S*patial and temporal genetic stock composition of river herring bycatch in southern New England Atlantic herring and mackerel fisheries* and PDT Discussion

1. **Summary of Conclusions**

A. **Multiple Factors**: A combination of factors (river herring and shad life history, Atlantic herring fishing activity, and monitoring coverage of the fishery) contribute to the annual estimated catch of river herring and shad and the low values for 2020-2022 relative to the past.

Annual estimated catch of RH/S for Atlantic herring trips qualifying for catch caps

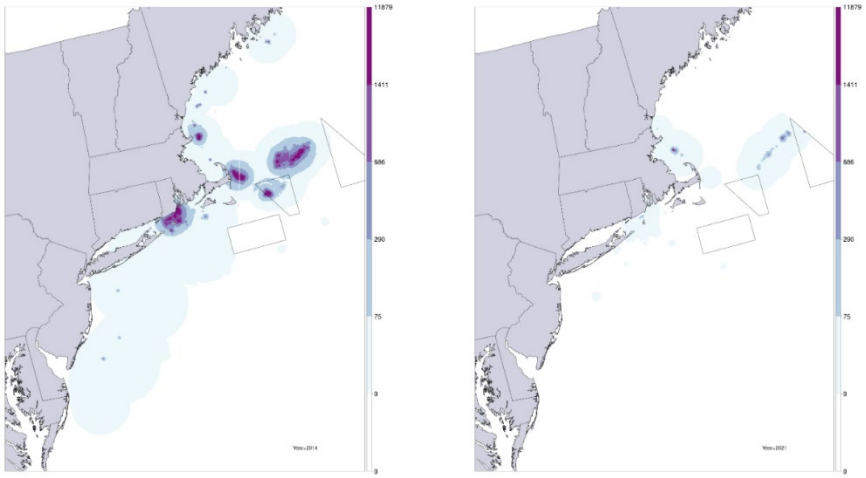


B. **Presence of River Herring and Shad in Ocean Waters**: Adult shad and river herring are most likely to be present in ocean waters in all seasons except the spring (during their spawning season in freshwater). Juvenile (immature) shad and river herring can be found in ocean waters year-round.

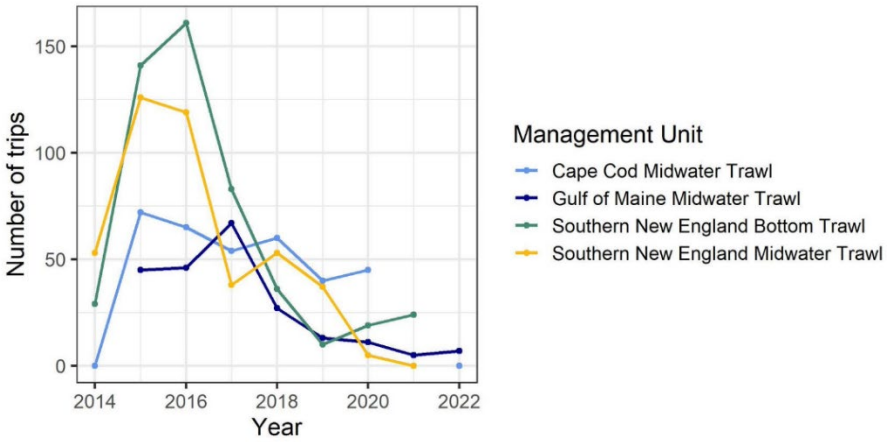
C. **Monitored Trips Under Catch Caps**: The current river herring and shad catch caps have been in place since 2016 and are based on a 'reference period' before catch caps were adopted (2008-2014). Atlantic herring trips landing greater than 6,600 lb of herring are included in the catch cap monitoring program as qualifying trips.

D. **Declines in Atlantic Herring Landings and Revenue**: Atlantic herring landings and revenue have declined in recent years along with the spatial extent of the landings. As this has occurred, the number of qualifying trips that would be monitored under the catch caps has also declined.

Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2014 (left) and 2021 (right)



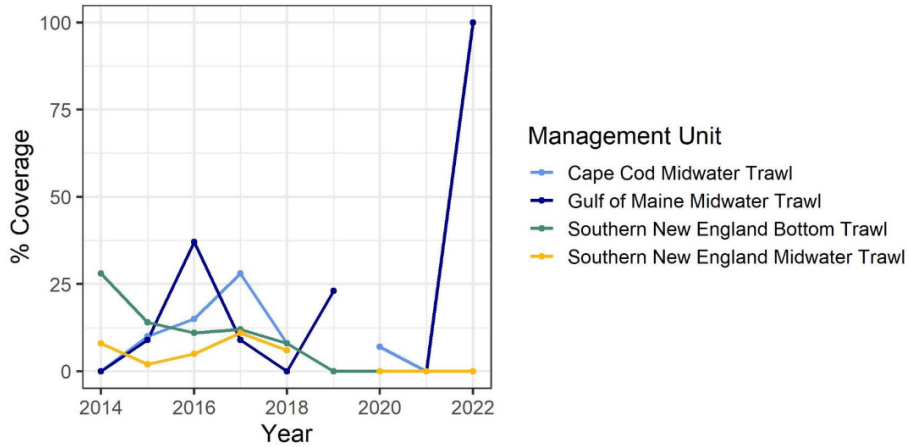
In-season number of Atlantic herring trips qualifying for RH/S catch caps



E. **Observer Coverage (Northeast Fisheries Science Center/Fisheries Monitoring Operations):**

- **COVID-19 Waivers**: In March 2020, a general waiver for observer coverage was issued to all Northeast vessels and was in place until August 2020, in response to the COVID-19 global pandemic. After August 2020, vessels were issued situational waivers which ended in June 2022.
- **Prioritized Coverage**: In 2021, observer service providers were instructed to prioritize trips depending on trip type, with Industry Funded Monitoring trips being the lowest priority, due to the ongoing challenges to accomplishing the federal Standardized Bycatch Reporting Methodology (SBRM) coverage. This prioritization ended with the start of the 2022 SBRM year in April 2022.
- **Industry Funded Monitoring Delayed Implementation:** The implementation of the IFM program was originally scheduled for April 2020, but was delayed until July 2021 due to the challenges of training new IFM observers during the beginning of the pandemic. Retention of observers is an ongoing challenge for the observer program and was only amplified by the pandemic. The recruitment and attrition rate have nearly matched over the last few years, making it difficult to maintain a cadre of available observers. Additionally, a lack of experienced observers trained in specialized gear fisheries, like herring, makes it difficult to cover these fleets.

Percent observer coverage of Atlantic herring trips qualifying for RH/S catch caps



2. **River Herring and Shad Background, ASMFC**

ASMFC staff prepared summary responses to questions from the PDT on river herring and shad.

When are river herring and shad present in federal waters?

- *Life History information from: ASMFC 2020 American Shad Benchmark Stock Assessment; ASMFC 2012 River Herring Benchmark Stock Assessment*

Adult shad and river herring are most likely to be present in ocean waters in all seasons except the spring. Juvenile (immature) shad and river herring can be found in ocean waters year-round. Shad and river herring spend the majority of their adult lives at sea, only returning to freshwater in the spring to spawn. Immature shad and river herring leave their natal river within the first year, and then are likely to be present in state and federal ocean waters year-round for the next 3-6 years until they reach maturity. Once mature, they begin the spring spawning migration to their natal rivers.

Shad: In early to late summer, juvenile shad migrate out of their nursery areas to the sea. Juvenile shad leave their natal river within the first year and will spend the next few years at sea, schooling with shad from other regions. Upon reaching maturity – usually at about age four – shad will return to the streams they were born in to spawn. American shad spring spawning migrations begin in the south and move gradually north as the season progresses and water temperatures increase. In the Mid-Atlantic region, American shad can begin spawning in March. In New England, American shad typically begin spawning in May. At the northernmost end of the range (parts of Maine and into Canada), American shad spawning typically begins in June. Spawning runs typically last 2-3 months, but may vary depending on weather conditions. Generally, American shad that spawn north of Cape Hatteras are iteroparous (spawn more than once), while American shad spawning south of Cape Hatteras are semelparous (die after one spawning season).

River Herring: Juvenile alewives and blueback herring begin migrating from their nursery areas as water temperatures decline in the fall. Little information is available on the life history of juvenile and adult river herring after they emigrate to the sea and before they mature and return to freshwater to spawn. Most river herring reach sexual maturity between 3 and 6 years of age. The onset of spring spawning is related to temperature and varies with latitude. At the southern end of their range, alewives spawn from late February to June. In the Mid-Atlantic region and into parts of Southern New England, alewives typically begin spawning in late March or early April. In New England, alewives typically begin spawning in April or May. At the northernmost end of the range (parts of Maine and into Canada), alewives may not begin spawning until June. Blueback herring begin spawning as early as December or January at the extreme southern end of their range. In the Mid-Atlantic region and into parts of Southern New England, blueback herring typically begin spawning in April. In New England, blueback herring typically begin spawning in May. At the northernmost end of the range, blueback herring may not spawn until June and spawning can continue through August. Adults leave the spawning grounds soon after spawning concludes, reaching deep water by fall.

What is the current stock status? Is there an estimate of population size?

- *Stock Status information from: ASMFC 2020 American Shad Benchmark Stock Assessment; ASMFC 2017 River Herring Stock Assessment Update*

Shad and river herring are assessed on an individual river system basis where the data are available. Trend analysis is used for many river systems to identify trends in available data sets. To date, available data have not been robust enough to specify biologically-based catch caps that reflect shad and river herring abundance.

The 2023 River Herring Benchmark Stock Assessment is currently underway through ASMFC, and includes a term of reference related to river herring catch caps: *If possible, develop methods to calculate a biologically-based cap or limit on bycatch of river herring in ocean fisheries.* Development of a biologically-based catch cap will be dependent on available data, and the Stock Assessment Subcommittee may be limited by available modeling approaches. Peer review of the 2023 assessment is expected to take place in late 2023. The Shad & River Herring Management Board will consider the assessment and peer review report in early 2024.

The 2017 River Herring Stock Assessment Update (data through 2015) concluded the coastwide meta-complex of river herring stocks on the U.S. Atlantic coast remains depleted to near historic lows. There is evidence for declines in abundance due to several factors, but their relative importance could not be determined. The overfished and overfishing status is unknown for the coastwide stock complex, as estimates of total biomass, fishing mortality rates, and corresponding reference points could not be developed. While status on a coastwide basis remains unchanged, there are some positive signs of improvement for some river systems, with increasing abundance trends for several rivers in the Mid-Atlantic throughout New England region. While abundance in these river systems are still at low levels, dam removals and improvements to fish passage have had a positive impact on run returns.

The 2020 American Shad Benchmark Stock Assessment (data through 2017) and Peer Review Report indicate American shad remain depleted on a coastwide basis. Multiple factors, such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change are likely responsible for shad decline from historic abundance levels. Additionally, the assessment finds that shad recovery is limited by restricted access to spawning habitat. Current barriers partly or completely block 40% of historic shad spawning habitat, which may equate to a loss of more than a third of spawning adults. The "depleted" determination was used instead of "overfished" because the impact of fishing on American shad stocks cannot be separated from the impacts of all other factors responsible for changes in abundance. The benchmark assessment was endorsed by the Peer Review Panel and accepted by the Shad & River Herring Management Board for management use.

What are recent trends in river herring and shad abundance? Are there certain rivers the PDT could highlight with available trend data near the Gulf of Maine and Southern New England?

Trend information by river is summarized in the following tables from the most recent shad and river herring stock assessments with data through 2015 or 2017:

- Shad (data through 2017): https://asmfc.org/images/Shad_RH/ShadTable-Blue.jpg
- River herring (data through 2015): https://asmfc.org/images/Shad_RH/RiverHerringTable_2019.jpg

For more recent state survey and indices, the state agencies would be the best source of information. Indices are currently being compiled for the 2023 River Herring Assessment, however those indices have not been finalized for release.

Indices of relative abundance from the NEFSC bottom trawl survey are included in the suite of fishery-independent data sources in both the shad (data through 2017) and river herring assessments (data through 2015). The NEFSC bottom trawl survey samples both inshore and offshore sites during the fall and spring from Maine through North Carolina.

For more recent NEFSC trawl survey indices, NEFSC would be the best source of information. Indices are currently being compiled for the 2023 River Herring Assessment, however those indices have not been finalized for release.

References
ASMFC. 2020. American Shad Benchmark Stock Assessment and Peer Review Report. Atlantic States Marine Fisheries Commission. Arlington, VA. 1208 p.

ASMFC. 2017. River Herring Stock Assessment Update. Arlington, VA. 724 p.

ASMFC. 2012. River Herring Stock Assessment Report for Peer Review. Atlantic States Marine Fisheries Commission, Stock Assessment Report No. 12-2 (supplement), 1049 p.

3. Current River Herring / Shad Catch Caps and Accountability Measures

The 2023-2025 Atlantic herring specifications were implemented on March 23, 2023 and include the current river herring and shad catch caps. These values have been in place since 2016 though several specifications cycles (2016-2018; 2019-2021; 2021-2023 and 2023-2025). Section 4.3.7 of Framework Adjustment 8 includes a description of the methodology used by the PDT during the 2016-2018 specification process to determine catch cap values based on a 'reference period' before catch caps were adopted (2008-2014). At that time, the PDT did not recommend adding additional years to this reference period, as including years that the fishery is under a cap may provide incentive for fishermen to increase their river herring and shad catch. River herring and shad catch caps were enacted to provide an incentive for the industry to continue to avoid river herring/shad and reduce river herring/shad catch to the extent practicable.

Table 1. Summary of river herring and shad (RH/S) catch caps (mt) for 2023-2025 by gear type and catch cap area.

	2023	2024	2025
Midwater Trawl Gulf of Maine	76.7	76.7	76.7
Midwater Trawl Cape Cod	32.4	32.4	32.4
Midwater Trawl Southern New England and Mid-Atlantic	129.6	129.6	129.6
Bottom Trawl Southern New England and Mid-Atlantic	122.3	122.3	122.3

The river herring and shad catch caps are monitored based on the Atlantic herring fishing year (January 1-December 31). The catch cap regulations specify that:

- The catch from all trips that land more than 6,600 lb (3 mt) of herring shall apply to the river herring and shad catch cap in the herring fishery.
- Beginning on the date that NOAA Fisheries projects that river herring and shad catch will reach 95 percent of a catch cap for specified gear for a specific catch cap area, NOAA Fisheries shall prohibit vessels from fishing for, possessing, catching, transferring, or landing more than 2,000 lb of Atlantic herring per trip or day using that gear in the applicable catch cap closure area for the remainder of the fishing year.

4. River Herring and Shad Catch Estimation to Monitor Catch Caps

In the Atlantic herring fishery, area and gear-specific catch caps limit river herring and shad (RH/S) catch on trips landing more than 6,600 lbs of Atlantic herring. There are four RH/S catch cap areas: Gulf of Maine, Cape Cod, Southern New England/Mid-Atlantic, and Georges Bank (Figure 1). The catch caps are defined spatially and by gear type: Gulf of Maine Midwater Trawl, Cape Cod Midwater Trawl, Southern New England Midwater Trawl, and Southern New England Bottom Trawl. Presently, the Georges Bank Catch Cap Area does not have a specification[1]. In the Atlantic mackerel fishery, any trip landing 20,001 lbs or more of mackerel is counted against the catch cap, which is an annual allocation not divided by season, area or gear type.

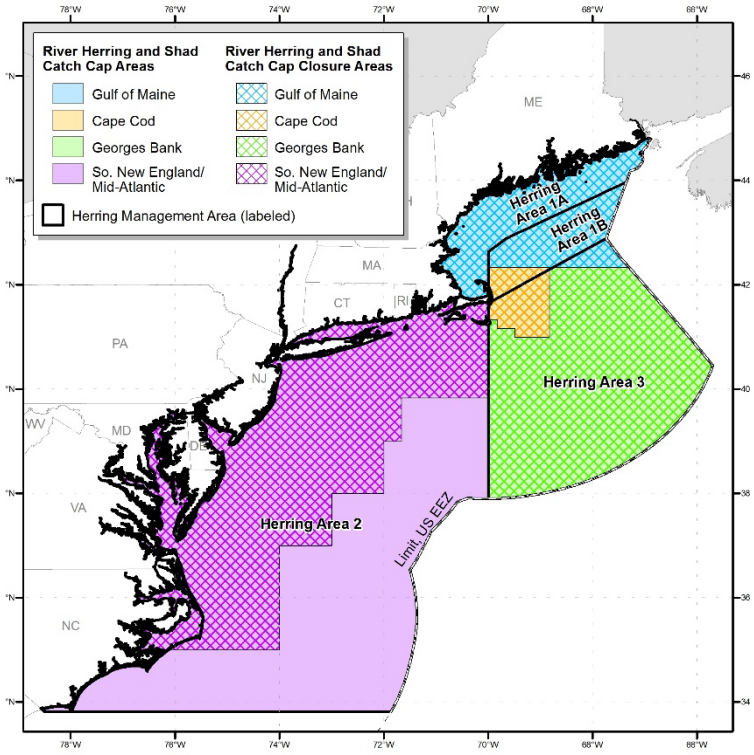


Figure 1: Map of River Herring and Shad catch cap areas in Northeast/Mid-Atlantic waters. Map Source: NOAA Fisheries.

The Greater Atlantic Regional Fisheries Office (GARFO) developed the following methodology to calculate the catch estimates which was peer reviewed in 2016. An estimation of RH/S catch rate by area and gear type is first calculated using data from observed hauls to extrapolate values for unobserved hauls within the same area and gear type. Several key data sources contribute to these efforts, including:

- *Northeast Fishery Observer Program (NEFOP):* Fisheries Observers are present on vessels to collect data and biological samples from commercial fishing trips, including RH/S catch estimates. Preliminary data is made available to GARFO's Analysis and Program Support Division within seven days of an observed trip.

[1] The Georges Bank Catch Cap Area was defined through Framework 3 along with the other catch cap areas. River herring and shad catch was considered very low on Georges Bank at the time and therefore a catch cap was not specified. If the catch of river herring and shad is documented to increase in the George Bank Catch Cap Area, a catch cap would automatically be considered during the following Atlantic herring fishery specifications process. The last review of George Bank catch data occurred for the 2016-2018 specifications and a catch cap was not specified.

- *Federal Dealers:* Federally permitted Atlantic herring dealers are required to submit weekly reports including the weight of each species purchased from both federally permitted and non-federally permitted vessels.
- *Vessel Trip Reports:* Federally permitted vessels must submit fishing vessel trip reports, which include the weights of each species kept and discarded. For federally permitted Atlantic herring vessels, these reports must be submitted weekly.
- *Industry-Funded Monitoring (IFM):* IFM data collection occurs through portside sampling of vessels with an Electronic Monitoring Exempted Fishing Permit as well as at-sea monitoring, with a targeted coverage rate of 50 percent of declared Atlantic herring trips for herring vessels with a Category A or Category B permit. The data is made available to GARFO's Analysis and Program Support Division within seven days of an observed trip. Atlantic herring trips will no longer be eligible for IFM coverage starting on April 1, 2023 until federal funds to cover NOAA Fisheries' costs are available.

There are four different RH/S catch rates for each of the Atlantic herring fishery catch caps that are updated throughout the fishing year. The RH/S catch rates are calculated by dividing observed RH/S catch (landings and discards) in pounds by observed kept for all species in pounds for each catch cap area and gear type. This rate is then multiplied by the total kept weight of all species caught, providing an estimation of total RH/S catch for unobserved trips landing more than 6,600 lbs of Atlantic herring in a particular catch cap area and gear. Observed trips do not get an estimate, rather the actual observed catch value of RH/S is used. The catch rate for an area is calculated using the year-to-date sum of all observed RH/S catch divided by the year-to-date sum of all observed kept species, meaning that over time, the catch rate for each specific area and gear type will change as more data is collected.

$$\frac{Observed\ RH/S\ catch\ (landings\ and\ discards)}{Observed\ Kept\ (all\ species)} \times Kept\ (all\ species) = Estimated\ RH/S\ catch$$

When there are zero observed trips from the current fishing year to estimate the RH/S catch rate for a specific area and gear type, the estimated rate from the previous year is used until observed trip data is collected for the current year. GARFO staff use a transition rate (as shown in the formula below) when fewer than five trips have occurred for a catch cap and gear type to move from the previous year's data to the current year.

$$\left(\frac{0.7}{Trip\ Count}\right) \times Assumed\ Rate + \left(1 - \left(\frac{0.7}{Trip\ Count}\right)\right) \times In\ Season\ Rate$$

If there are no observed trips in the previous year for an area/gear, GARFO calculates the transition rate using the 'global' catch rate. This rate is calculated across all of the catch cap areas/gears in the previous year (from observed trips that landed greater than 6,600lb of herring and used bottom trawl or midwater trawl gear).

5. **Raster Maps of Atlantic Herring Trawl Fishery Landings, 2008-2021**

Preliminary Analysis: Atlantic Herring Trawl Fishery Landings and Revenue, 2008-2021
Building on similar analyses conducted during the development of Amendment 8 and Framework Adjustment 7 to the Atlantic Herring Fishery Management Plan, the following figures illustrate Atlantic herring trawl (combined midwater, paired midwater, and small mesh bottom trawl gears) effort through landings and revenue data for the years 2008-2021. Data from vessel trip reports (VTR) was collected and interpreted to create the visualizations, variations of which can be found on NOAA Fisheries' Fishing Footprints webpage for many commercially fished species. Polygons designating the Nantucket Lightship, Closed Area I, and Closed Area II groundfish closure areas (from left to right) are included in each figure for reference. See Attachment I for maps.

6. **NEFSC/FMO Factors Impacting Observer Coverage, 2020-2022**

Fisheries Monitoring Operations (FMO) branch, Northeast Fisheries Observer Program (NEFOP) brief summary in response to the Atlantic Herring PDT's questions regarding low observer coverage within from 2020-2022, March 1, 2023

In March 2020, a general waiver for observer coverage was issued to all Northeast vessels and was in place until August 2020, in response to the global pandemic. After August 2020, vessels were issued situational waivers if they were taking stringent precautions against COVID-19 or if a crew member had symptoms or tested positive for COVID-19. These situational waivers ended in June 2022. In 2021, observer service providers were instructed to prioritize trips depending on trip type, with IFM trips being the lowest priority, due to the ongoing challenges to accomplishing the federal SBRM coverage. This prioritization ended with the start of the 2022 SBRM year in April 2022.

The implementation of the IFM program was originally scheduled for April 2020, but was delayed until July 2021 due to the challenges of training new IFM observers during the beginning of the pandemic. Retention of observers is an ongoing challenge for the observer program and was only amplified by the pandemic (Figure 1). The recruitment and attrition rate have nearly matched over the last few years, making it difficult to maintain a cadre of available observers. Additionally, a lack of experienced observers trained in specialized gear fisheries, like herring, makes it difficult to cover these fleets (Figure 1 and Figure 2).

Figure 3 shows the percentage of realized coverage outcome reasons (COR) for trips selected for both IFM and SBRM coverage compared to the total number of sailed herring trips in PTNS in a given month. In 2020, there were 4 trips with a COR of observed. This is mainly due to the general waiver issued for COVID-19 (represented by the high percentage of random waivers) and a lack of available observers due to retention issues and ongoing concerns about the pandemic. After the general waiver period, vessels were still offered situational waivers for COVID-19 (waiver - COVID19) (note, admin waivers may be issued due to system or technical issues, trip entry errors, and/or programmatic policies and are not necessarily due to impacts from the pandemic). The percentage of trips with a COR of observed in a given month improved between

2021 and 2022; however fishing effort became much more sporadic with longer periods with zero trips. Observer availability continued to be an issue in 2021 and 2022 as seen by high percentages of provider waived trips. The data in Figure 3 includes both IFM eligible and IFM exempt trips, and months where the percentage of random waivers was high is likely due to a high number of IFM exempt trips and a lack of SBRM days. Issues with PTNS compliance shortly following the new notification requirement (April 2020) also made it difficult to cover herring trips. Since then compliance improved substantially and has rarely impacted coverage opportunities.

Despite the challenges from the COVID-19 pandemic, the NEFOP provider was still able to accomplish a high number of herring SBRM sea days between 2020-2022 (Figure 4). Sea days allocated to the small mesh otter trawl in New England was not accomplished in 2020, but was exceeded in 2021 and 2022. In 2020, about 85% (22 of 26 days) of the New England midwater trawl days were accomplished and in 2021-2022 90% or more of the days were accomplished. The NEFOP provider was not able to accomplish any of the Mid-Atlantic midwater trawl days between 2020-2022; however this is due mainly to the lack of trips in this area.

Over the last several years herring quotas have been decreasing year to year, which has changed how the fishery operates. With limited quotas effort tends to increase for short periods of time before reducing to nearly zero as quotas fill and areas close. This method of fishing has impacted coverage in a couple different ways. First, the NEFOP provider is encouraged to accomplish as many sea days as possible while vessels are active. This leaves very few to no sea days for any sporadic effort during other periods of the year. Second, coverage during these short periods of effort is greatly limited by the number of available observers. Low effort makes it difficult to maintain a cadre of observers certified in these specialized gear types.

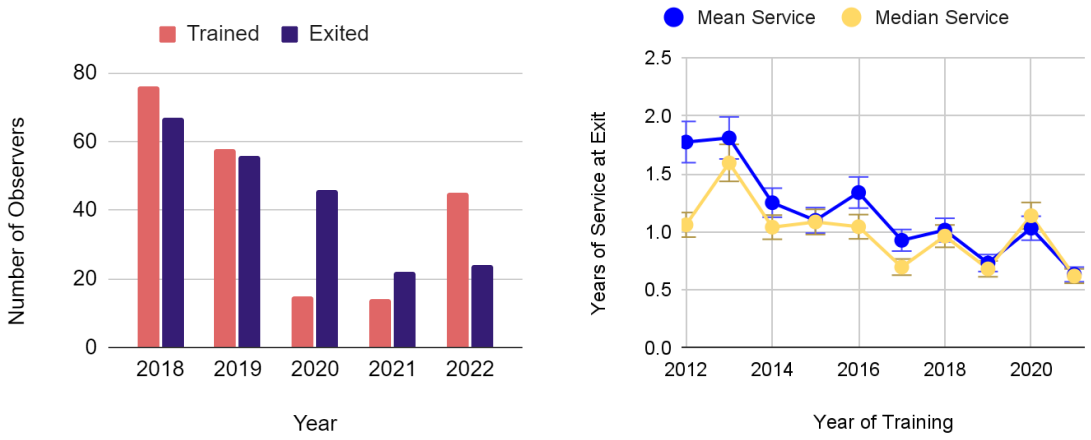


Figure 1: NEFOP program observer retention statistics. The recruitment and attrition rates have nearly matched for the last several years (left). Retention of experienced observers (observers with 1+ years of experience) has declined and remains an ongoing challenge (right).

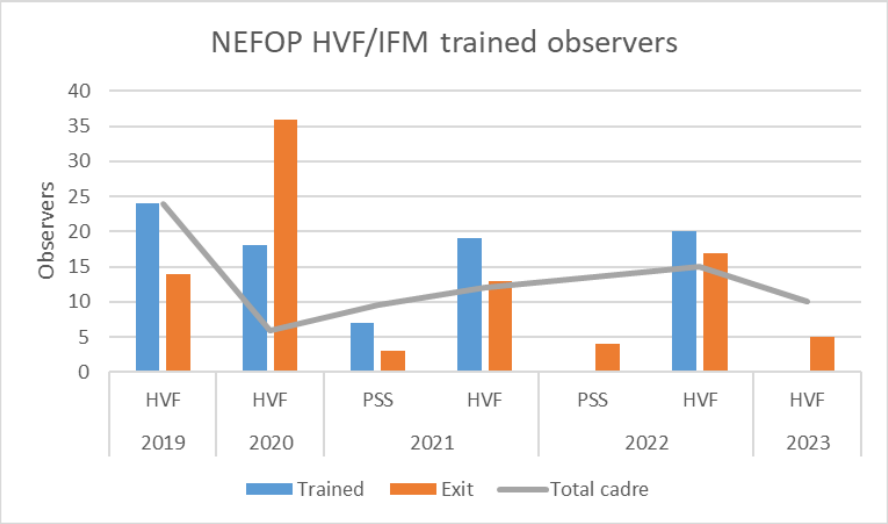


Figure 2: Recruitment and retention of observers eligible to deploy on at-sea herring trips (HVF) and herring portside sampling trips (PSS). Note, the exit category in this graph includes

Observers who exited the program or did not complete the certification process. This data excludes observers who went on a leave of absence after being trained. The gray line represents the available cadre of HVF observers after accounting for recruitment and attrition.

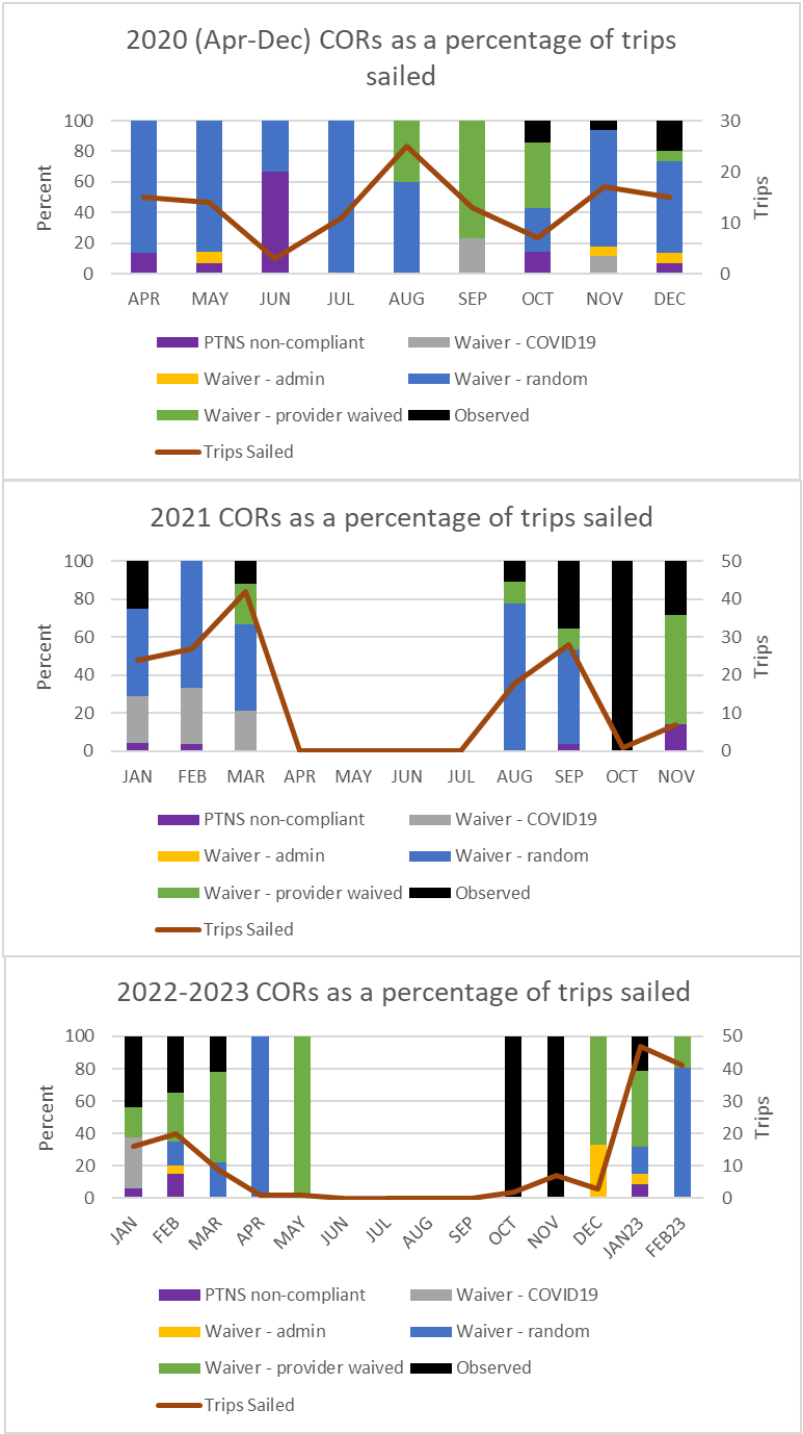


Figure 3: PTNS coverage outcome reasons (COR) between April 2020-February 2023 as a percentage of total trips sailed in PTNS for a given month (red line).

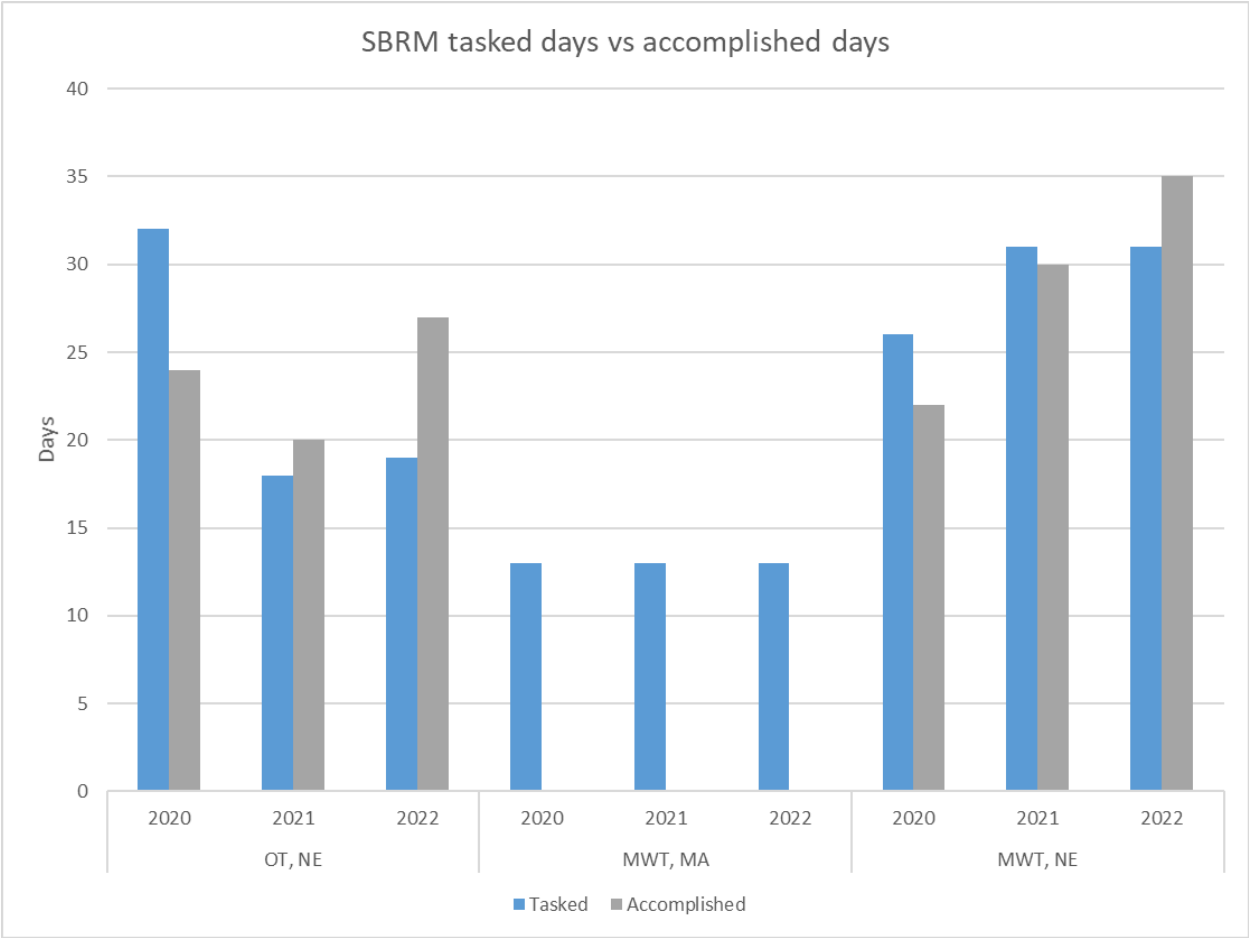


Figure 4: SBRM tasked days vs days accomplished for herring gear types between 2020-2022.

7. River Herring / Shad Catches by Catch Cap, 2015-2023 In-Season

The PDT conducted an analysis of river herring and shad (RH/S) catch by catch cap, including data from 2015 to 2023. GARFO monitors RH/S bycatch in both the mackerel and herring fisheries. These catch caps apply to vessels landing greater than 20,000+ lbs of mackerel per trip or greater than 6,600+ lbs of herring per trip. If a trip meets the landing threshold, it can be counted as both a herring and mackerel trip.

For the analysis, observer data (from NEFOP and IFM) and catch data from trips that met the landings threshold were stratified by area and gear. For each area and gear type, GARFO calculates total observed RH/S catch, then uses the total observed catch to calculate a catch rate that can be applied to unobserved trips. Actual observed RH/S catch values are applied to observed trips. The catch rate is updated throughout the season and is retroactively updated as more data is collected. If there are less than 5 observed trips per strata, GARFO looks at previous years observed trips for the strata to estimate the catch rate and uses a transition rate until enough data is collected for the current year. If there was no observer data collected the previous year's strata, GARFO uses data from other catch cap areas and gears to inform the catch ratio, preventing a default to zero if there is no observer data

RH/S Catch Cap Overlaps Between the Atlantic Herring and Mackerel Fisheries—The PDT prepared summary statistics of the overlap between trips that contribute to both the Atlantic herring and mackerel catch caps. From 2015 to 2022, there were generally few observed trips that qualified for both catch caps—out of the 8 years of data, 5 overlap values were confidential. This may partially be reflective of low observer coverage from 2019-2021, but, notably, there was a 60% overlap in 2022, the highest in recent years.

Atlantic Mackerel Fishery and Cap —Overall, there has been a decline in Atlantic mackerel fishing effort in recent years. From 2021-2023, there were fewer active permits and a corresponding decline in trip count than from 2015-2017. There was also a slight decline in overall landings from 2021-2023 compared to previous years. The RH/S catch rate was relatively high in 2019 and 2023, but generally has been lower in recent years. Observer coverage was relatively low in 2020 and 2021, just 6.4% and 6.8% respectively, but jumped to 57.1% for the 2022 fishing year, the highest coverage rate since 2015 in the mackerel fishery.

Cape Cod Midwater Trawl—Similar to the mackerel fishery, the Cape Cod area experienced a decreased fishing effort in recent years for Atlantic herring and mackerel. Fishing effort was close to or reached zero in 2021 and 2022, but rebounded in 2023, with 6 permits and 9 trips already included in the analysis. It is worth noting that the midwater trawl restriction implemented with Amendment 8 to the Atlantic Herring Fishery Management Plan was in place from February 10, 2021 to March 29, 2022. The restriction was applied to a 12-mile buffer along the coast from Rhode Island to Maine with a 20-mile buffer along the eastern edge of Cape Cod. Observer coverage has also been relatively low since 2019, with 3 or fewer observed trips from 2019-2021 and no observed trips in 2022.

Gulf of Maine Midwater Trawl—The Gulf of Maine catch cap area also saw similar trends of lower fishing effort for Atlantic herring and mackerel and lower total catch in recent years when compared to 2015-2017 effort. Bycatch rates were relatively high in 2019 and 2020, reaching a

peak of 0.0256 in 2019, then decreased to 0.0001 in 2021, but increased again in 2022. Observer coverage has been low to non-existent since 2018 (except for 2019) but increased drastically in 2022 when there was 100% observer coverage for the 7 trips conducted in the Gulf of Maine.

Southern New England Bottom Trawl—In this area, fishing effort for Atlantic herring and mackerel has generally decreased over time, from 15 permits and 161 trips in 2016 to just 2 permits and less than 3 trips in 2022. However, in 2023, there are 4 permitted vessels which have conducted 13 trips at the time of the analysis, which is similar to prior years' fishing effort. Bycatch rates in the Southern New England bottom trawl areas reached a low of 0.0034 in 2020, with a very slight increase in 2021 and confidential values in 2022. However, the rate has increased to 0.0161 in 2023, which is within the range of bycatch rates from 2015 on. Observer coverage has been zero or confidential since 2019, with an increase to 23.1% in the 2023 fishing year thus far.

Southern New England Midwater Trawl—As with the other catch cap areas, fishing effort for Atlantic herring and in the SNE midwater trawl area has decreased over time, with zero active permits in 2020 and just 1 active permit in 2022 and 2023. As a result, bycatch rates have been zero or confidential since 2021. In addition, observer coverage in this area over recent years is relatively low when compared to other catch cap areas and has been confidential or zero since 2019.

Tables and Figures

Table 1. River Herring/Shad Catch Cap Performance, 2015-2023[1]

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
RHS Mackerel	2015	13	55	0.0014	12.5	3,564	4,591	8,739	0.0016	4	0.23	7.3%
	2016	13	55	0.0015	13.5	5,682	4,336	10,172	0.0015	13	0.68	23.6%
	2017	17	71	0.0033	39.5	6,477	5,780	12,472	0.0033	17	0.38	23.9%
	2018	12	57	0.0089	109.0	4,067	7,927	12,143	0.0101	4	0.34	7.0%
	2019	11	32	0.0135	91.7	2,780	3,973	6,756	C	C	C	C
	2020	15	94	0.0022	23.1	2,615	7,504	10,277	0.0022	6	0.59	6.4%
	2021	12	44	0.0006	3.4	1,335	4,904	6,387	0.0000	3	1.24	6.8%
	2022	9	14	0.0020	6.8	1,963	1,203	3,242	0.0020	8	0.37	57.1%
	2023[1]	9	12	0.0120	26.3	1,372	815	2,186	C	C	C	C
RHS Herring: CC MW	2015	11	70	0.0001	0.7	12,364	58	12,424	0.0001	7	0.81	10.0%
	2016	12	63	0.0018	17.8	7,786	121	7,909	0.0018	10	0.82	15.9%
	2017	12	54	0.0037	27.1	6,713	1,262	7,978	0.0037	15	0.44	27.8%
	2018	9	60	0.0075	66.6	8,642	265	8,912	0.0075	5	1.01	8.3%
	2019	7	40	0.0066	21.1	3,218	2	3,220	C	C		C
	2020	6	45	0.0010	3.8	2,805	1,025	3,851	0.0000	3		6.7%
	2021	2	C	C	C	C	C	C	C	C		C
	2022											
	2023[1]	6	9	0.0117	24.5	1,227	565	1,792	C	C		C
RHS Herring: GOM MW	2015	11	45	0.0017	11.3	6,378	220	6,598	0.0020	4	0.95	8.9%
	2016	10	44	0.0001	0.6	4,098	1,876	5,981	0.0001	17	0.48	38.6%
	2017	9	67	0.0002	1.9	9,166	2,236	11,402	0.0002	6	0.65	9.0%
	2018	6	25	0.0002	0.5	2,830	4	2,834				0.0%
	2019	5	13	0.0256	24.7	929	21	950	0.0290	3	0.62	23.1%
	2020	7	11	0.0203	33.5	1,615	193	1,808	C	C	C	C
	2021	4	5	0.0001	0.1	1,140	-	1,158				0.0%
	2022	7	7	0.0022	5.2	1,285	816	2,105	0.0022	7	0.00	100.0%
	2023[1]											
RHS Herring: SNE BT	2015	11	140	0.0256	103.7	3,742	155	4,047	0.0256	20	0.25	14.3%
	2016	15	161	0.0134	55.1	3,525	378	4,142	0.0134	18	0.34	11.2%
	2017	10	83	0.0142	35.0	1,789	164	2,471	0.0142	10	0.71	12.0%
	2018	8	36	0.0225	48.4	846	1,247	2,128	0.0251	3	0.25	8.3%
	2019	3	10	0.0251	14.1	300	260	561				0.0%
	2020	5	19	0.0034	2.1	162	424	632				0.0%
	2021	4	24	0.0043	0.7	143	0	144	C	C	C	C
	2022	2	C	C	C	C	C	C	C	C	C	C
	2023[1]	4	13	0.0165	3.5	149	59	207	0.0190	3	0.50	23.1%
RHS Herring: SNE MW	2015	15	126	0.0052	64.4	10,969	1,450	12,437	0.0065	3	0.12	2.4%
	2016	14	119	0.0045	43.1	9,345	125	9,657	0.0045	6	0.38	5.0%
	2017	10	38	0.0097	28.7	1,900	874	2,858	0.0108	4	0.48	10.5%
	2018	10	53	0.0146	135.1	6,077	3,084	9,284	0.0158	3	0.87	5.7%
	2019	11	37	0.0155	120.4	4,398	3,402	7,803	C	C	C	C
	2020	5	5	0.0153	5.2	100	236	343				
	2021											
	2022	1	C	C	C	C	C	C	C	C	C	C
	2023[1]	1	C	C	C	C	C	C	C	C	C	C

Source: GARFO DMIS and OBDBS databases as of 2023-01-31

[1]2023 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

Table 2. Observed Atlantic Herring and Mackerel trips qualifying for both catch caps.

Year	Total Number of Observed Trips in Herring and/or Mackerel Caps	Number of Observed Trips in both Herring and Mackerel Caps
2015	37	C
2016	55	9
2017	39	13
2018	13	C
2019	6	C
2020	8	C
2021	4	C
2022	10	6
Source: GARFO OBDBS pulled on 23-FEB-23 "C" denotes confidential vessel activity data		

Figure 1. Annual estimated catch of RH/S for Atlantic herring trips qualifying for catch caps

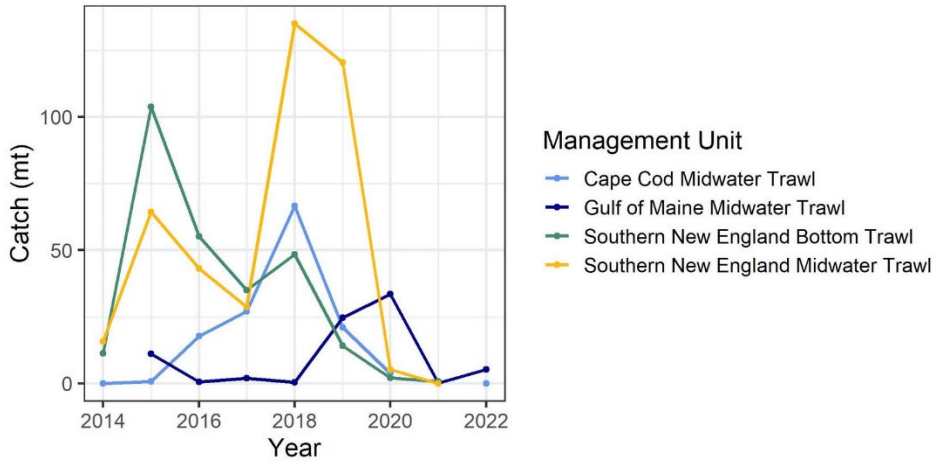


Figure 2. Annual percentage of RH/S quota caught for Atlantic herring trips qualifying for catch caps

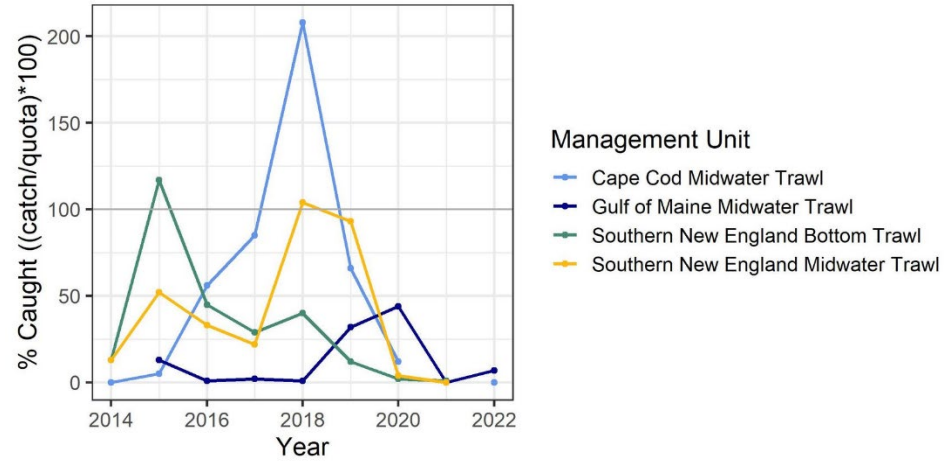


Figure 3. In-season number of Atlantic herring trips qualifying for RH/S catch caps

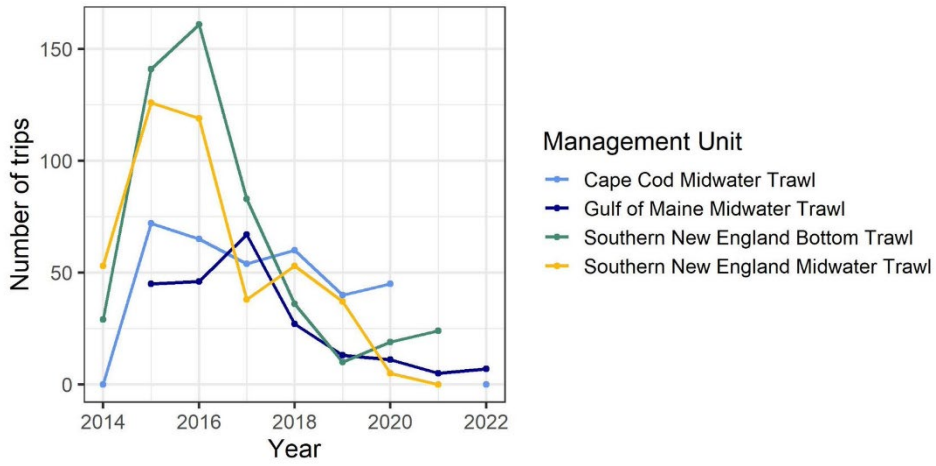


Figure 4. In-season number of Atlantic herring observed trips qualifying for RH/S catch caps

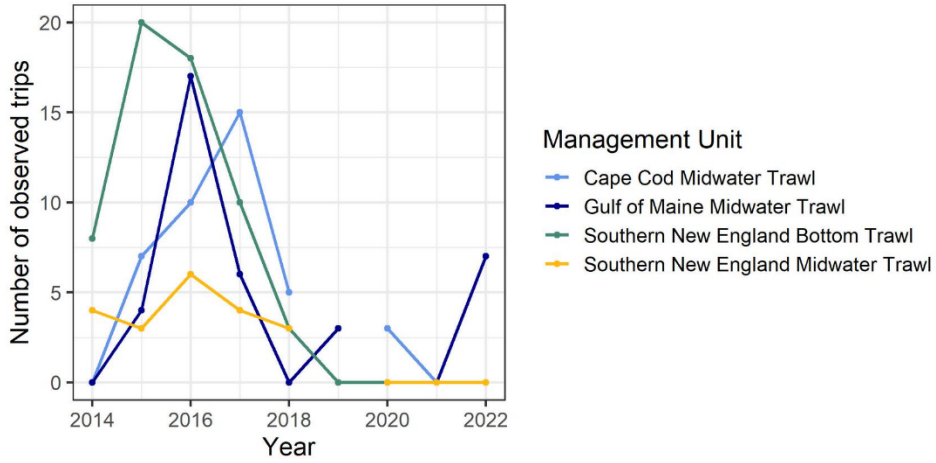


Figure 5. Percent observer coverage of Atlantic herring trips qualifying for RH/S catch caps

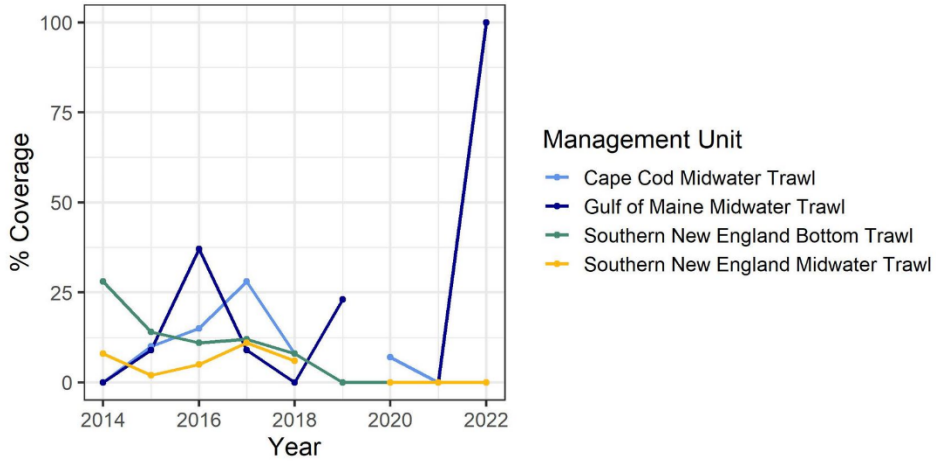


Figure 6. Catch rate (bycatch ratio) used at year-end for Atlantic herring RH/S catch caps

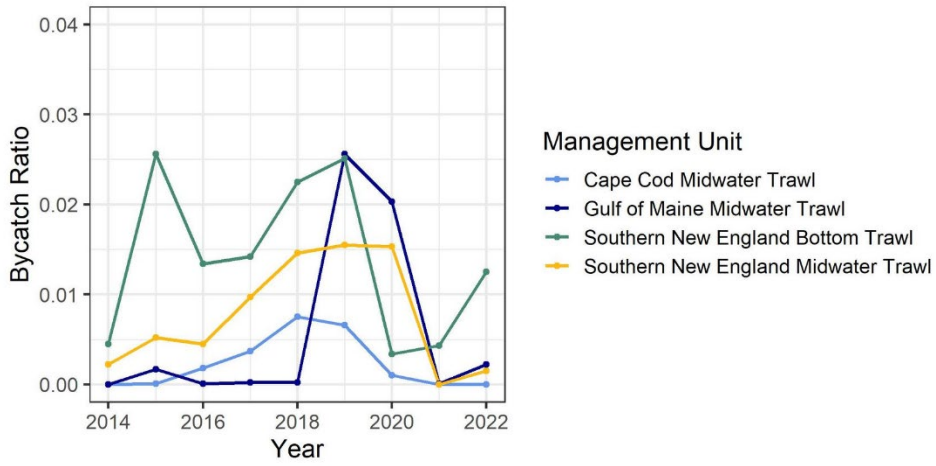


Figure 7. Annual estimated catch of RH/S for Atlantic mackerel trips under catch cap

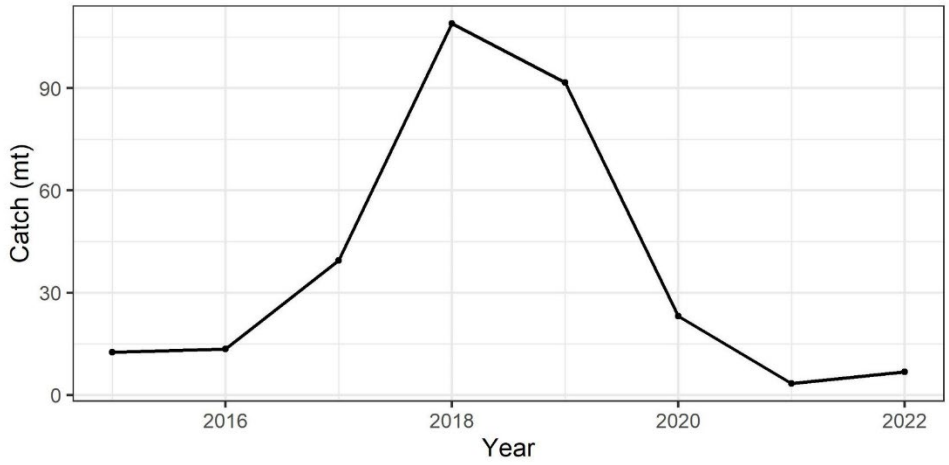


Figure 8. Annual percentage of RH/S quota caught for Atlantic mackerel trips under catch cap

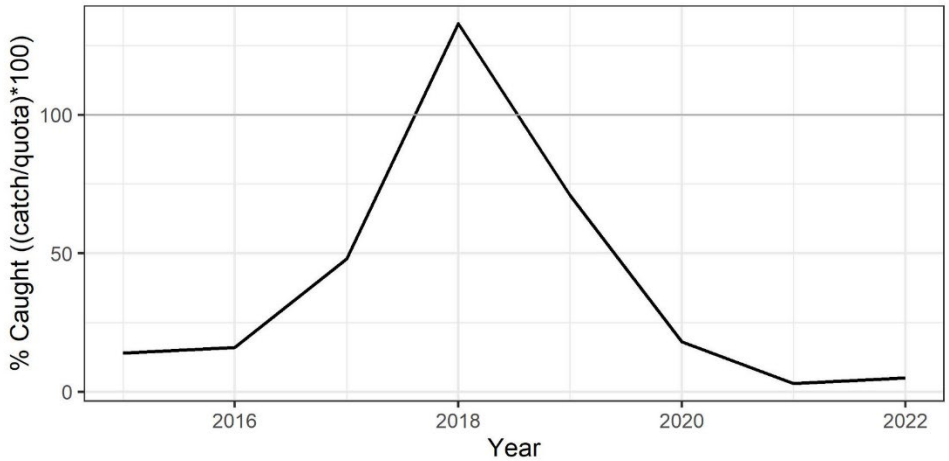


Figure 9. In-season number of Atlantic mackerel trips qualifying for RH/S catch caps

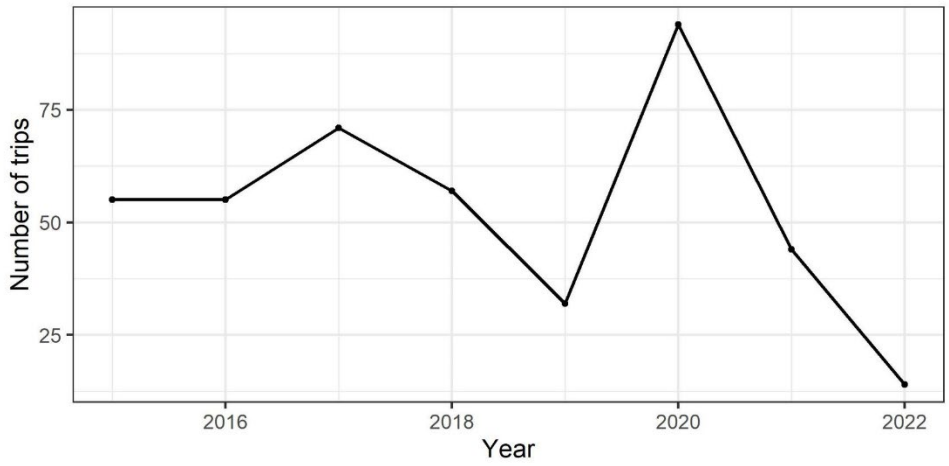


Figure 10. In-season number of Atlantic mackerel observed trips qualifying for RH/S catch caps

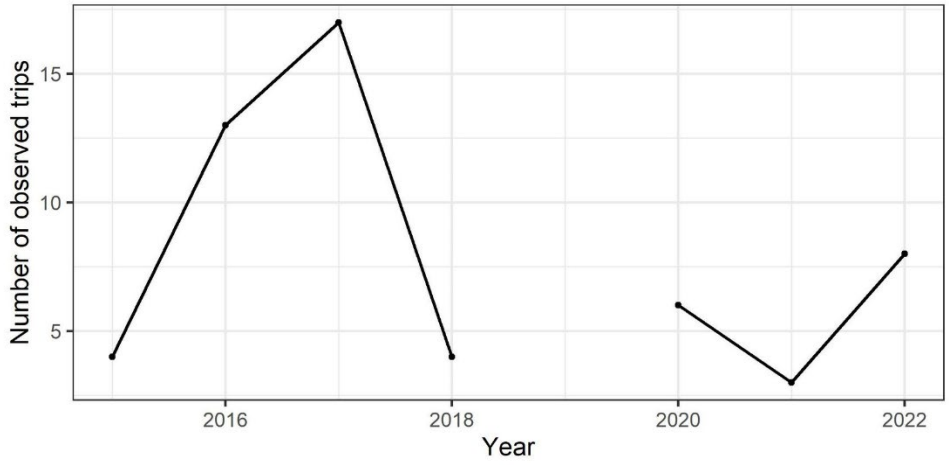


Figure 11. Percent observer coverage of Atlantic mackerel trips qualifying for RH/S catch caps

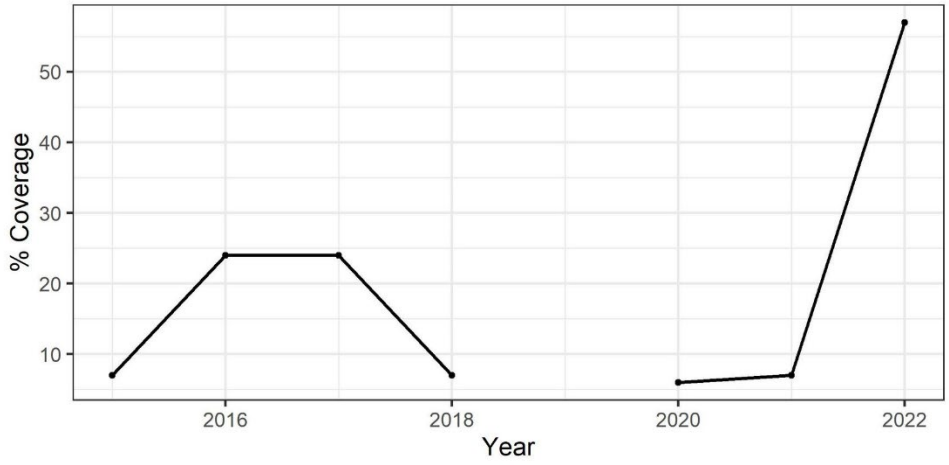
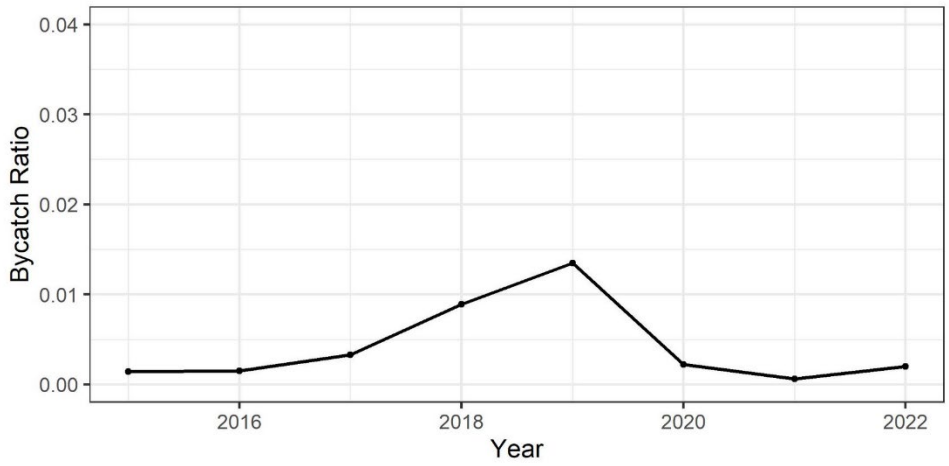


Figure 12. Bycatch ratio used at year-end for Atlantic mackerel RH/S catch caps



8. **Example of In-Season Estimation of River Herring and Shad Catches in the Mackerel Fishery**

The following table provides summary statistics of the River Herring/Shad catch cap in the mackerel fishery from in-season quota monitoring in fishing year 2020. This example demonstrates how the in-season estimate of the bycatch ratio and overall RH/S estimate can fluctuate within the fishing year.

Year	Number of Permits	Number of Trips	Number of Observed Trips	Bycatch Ratio	RH/S Bycatch (lbs)	Run Date
2020	3	3	3	0.00356	3,103	29-Jan-20
2020	4	5	3	0.00356	3,938	5-Feb-20
2020	12	29	4	0.00349	19,374	13-Feb-20
2020	14	51	5	0.00094	12,171	28-Feb-20
2020	15	78	6	0.00075	14,394	30-Apr-20
2020	15	86	6	0.00224	46,819	19-Jun-20
2020	15	86	6	0.00224	46,819	20-Aug-20
2020	15	87	6	0.00224	46,371	22-Oct-20
2020	15	94	6	0.00224	50,938	31-Dec-20

Source: GARFO in season quota monitoring reports for FY20

9. **Summary of the presentation by Massachusetts Division of Marine Fisheries staff summarizing collaborative research with their partners on: S*patial and temporal genetic stock composition of river herring bycatch in southern New England Atlantic herring and mackerel fisheries* and PDT Discussion**

A copy of the MA MDF presentation is provided under Attachment #2.

The Reid et al. (2022) paper provided interesting context regarding the spatial distribution of river herring reporting groups and how they interact with the Atlantic herring fishery between 2012 and 2015. The PDT emphasized the importance of the result that, within the polygon analyzed in the study, many of the river herring caught as bycatch originated from nearby reporting groups. Though the presenters cautioned against extrapolating this result to the entire region, it is still notable, and provides support for prior ideas about the origins of river herring being caught as bycatch in the fishery. To contextualize the results of the study, the PDT suggested looking at the degree of overlap between the reference years used for developing river herring and shad catch caps and the years when data was collected for the study.

Additional discussion focused on the efficacy of river herring and shad catch caps as a management measure—because of the limited population data for these species, it is difficult to determine whether the catch caps are low enough to offer protections for river herring and shad populations or if they are unnecessarily restrictive. When river herring and shad catch caps were first introduced as a management option, the PDT was reluctant to recommend instituting these caps at the time due to the lack of biological data, but the caps were ultimately implemented to prevent negative impacts to river herring and shad populations. The catch caps have not changed since 2018 due to the lack of relevant data. The PDT also noted that time-area closures, developed by identifying areas and seasons that are important for certain life history stages and preventing the use of certain impactful fishing gears at those times, are used to prevent overharvesting in other fishery management processes. The presenters also emphasized that there has been an observed decline in river herring populations, with some reporting groups experiencing more drastic declines than others, and that bycatch with high proportions of these more depleted groups could have significant impacts to localized populations.

The PDT recognized that data integral to making conclusions regarding low river herring and shad bycatch in recent years, most notably a lack of a coastwide population estimate for these species, would also be important for developing and adjusting biologically-based catch caps. At this time, the PDT is unsure of how catch caps might change if this data were made available, or whether there may be more appropriate management tools that could be used to address river herring and shad bycatch. The ASMFC is conducting a stock assessment for river herring, which is currently slated to be peer-reviewed sometime in 2023 and reported to its Shad and River Herring Management Board in early 2024. The stock assessment, which includes a term of reference[2] specifically addressing developing biologically-based river herring catch caps, may provide data that could inform subsequent PDT discussion and analysis of these catch caps as well as river herring and shad bycatch more broadly. The PDT also discussed the impacts of other fisheries such as Atlantic mackerel and squid on river herring and shad, noting that an analysis of bycatch removals from other fisheries has been conducted in the past.

[2] Term of Reference #6: If possible, develop methods to calculate a biologically-based cap or limit on bycatch of river herring in ocean fisheries. ASMFC, July 2022.

Preliminary Analysis: Atlantic Herring Fishery Landings and Revenue, 2008-2021

Building on similar analyses conducted during the development of Amendment 8 and Framework Adjustment 7 to the Atlantic Herring Fishery Management Plan, the following figures illustrate Atlantic Herring fishing effort through landings and revenue data for the years 2008-2021. Data from vessel trip reports (VTR) was collected and interpreted to create the visualizations, variations of which can be found on NOAA Fisheries' Fishing Footprints webpage for many commercially fished species. Polygons designating the Nantucket Lightship, Closed Area I, and Closed Area II groundfish closure areas (from left to right) are included in each figure for reference.

Atlantic Herring Fishery Landings (pounds per square kilometer), 2008-2021

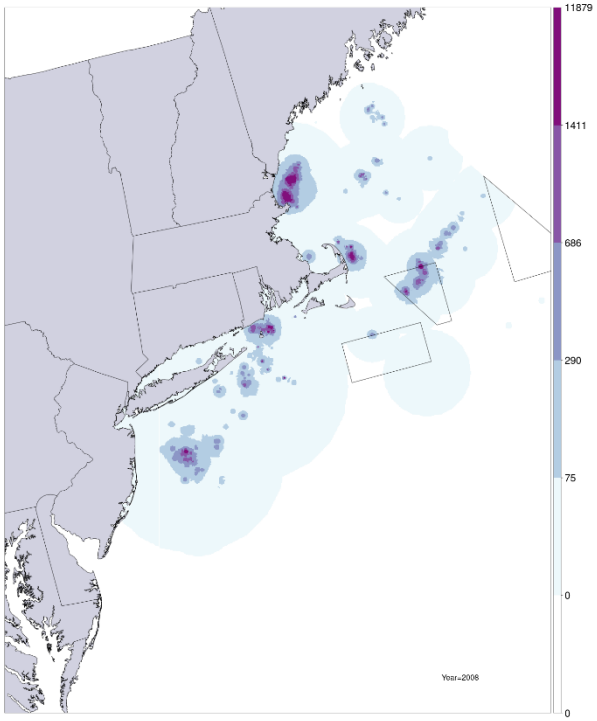


Figure 1 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2008.

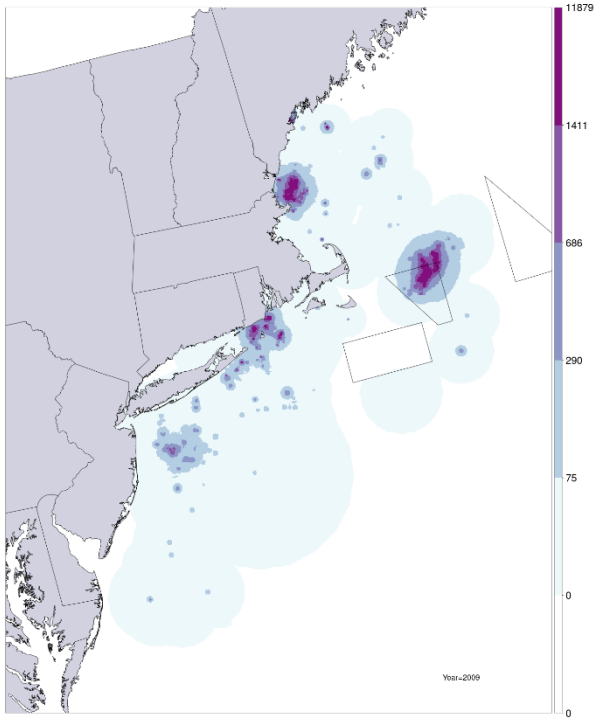


Figure 2 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2009.

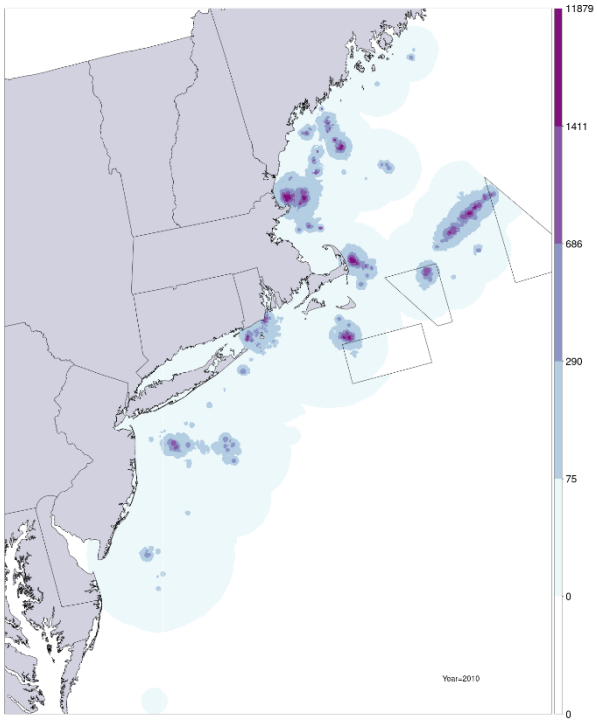


Figure 3 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2010.

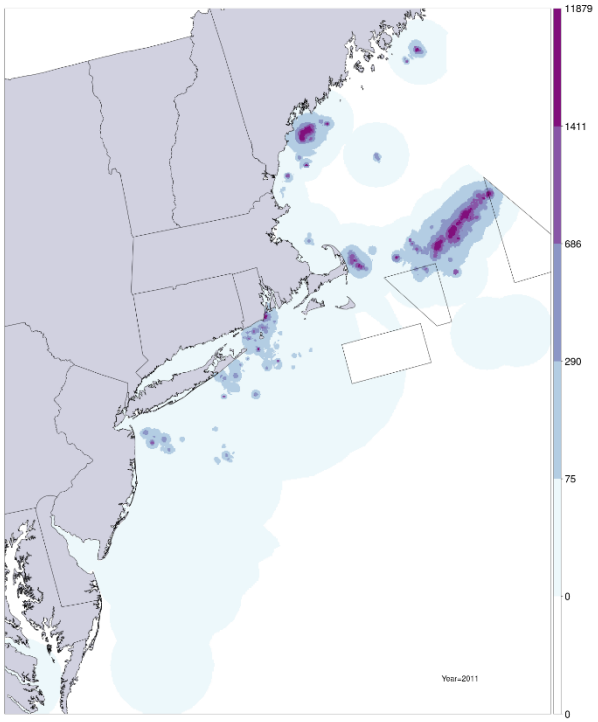


Figure 4 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2011.

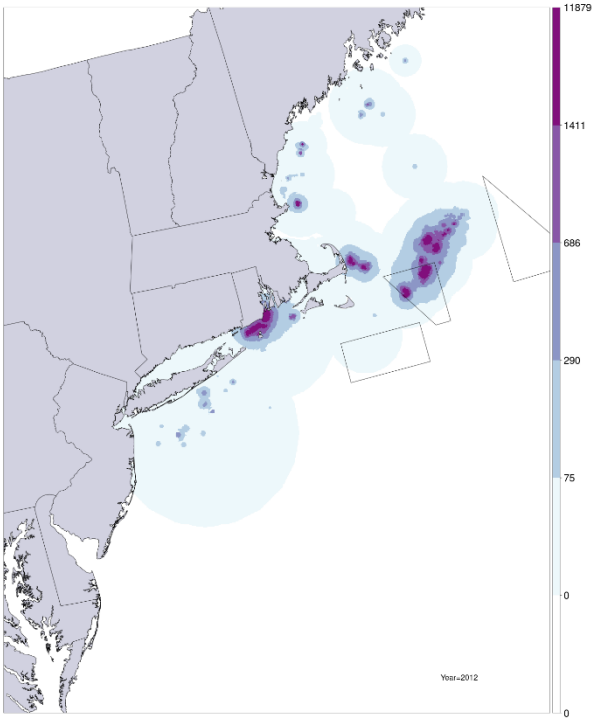


Figure 5 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2012.

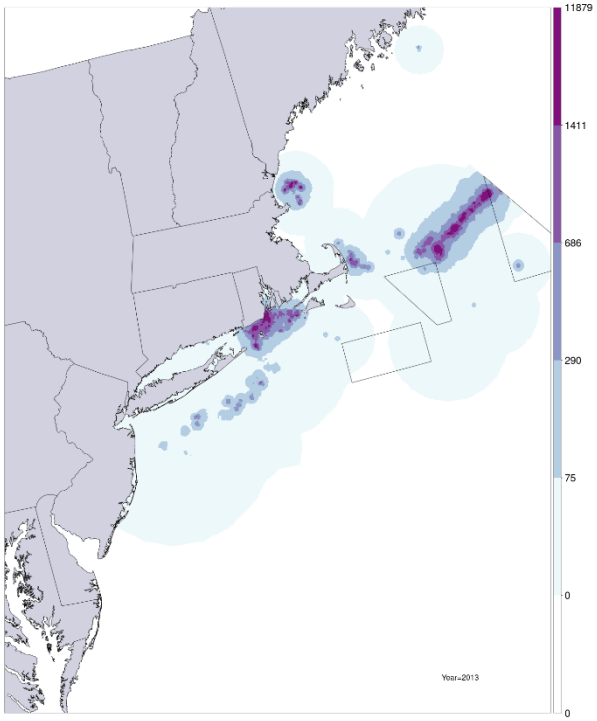


Figure 6 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2013.

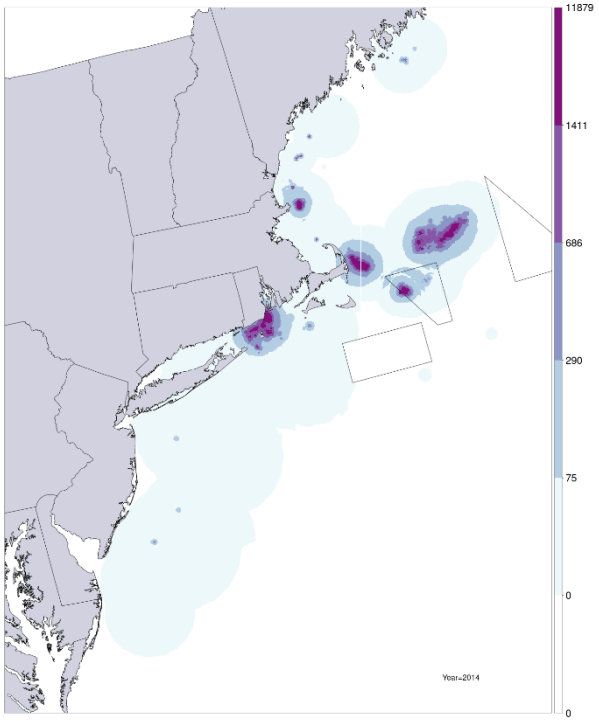


Figure 7 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2014.

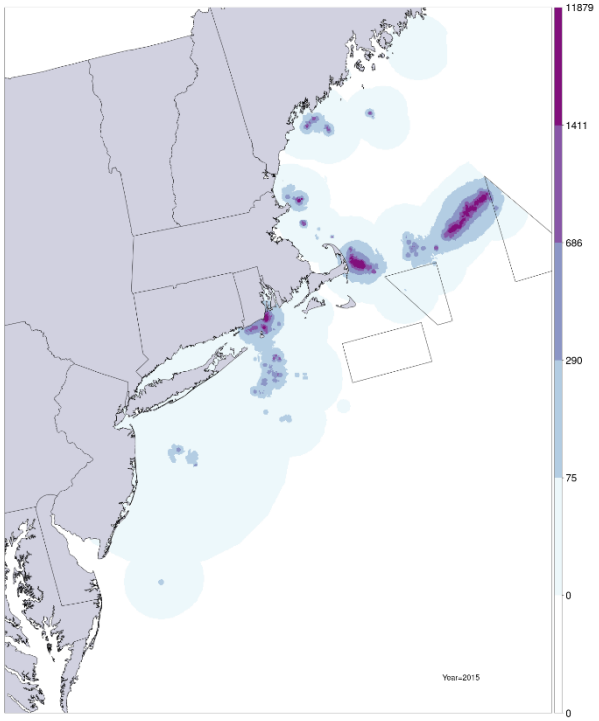


Figure 8 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2015.

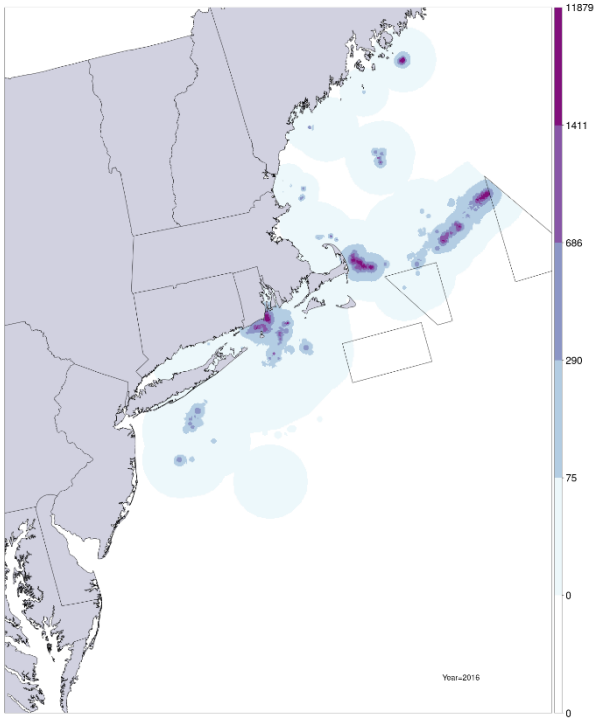


Figure 9 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2016.

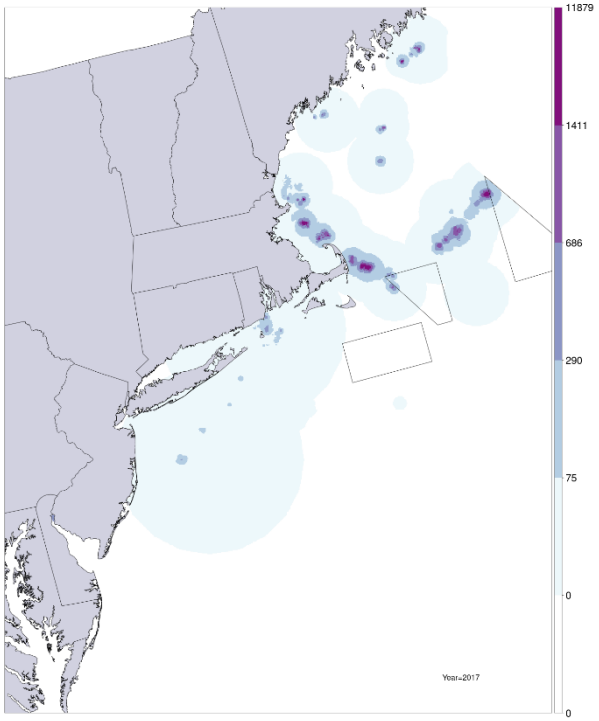


Figure 10 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2017.

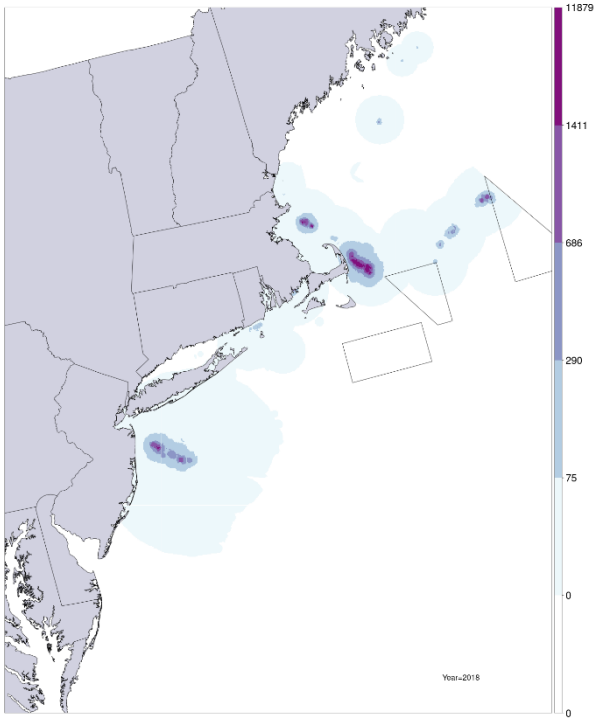


Figure 11 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2018.

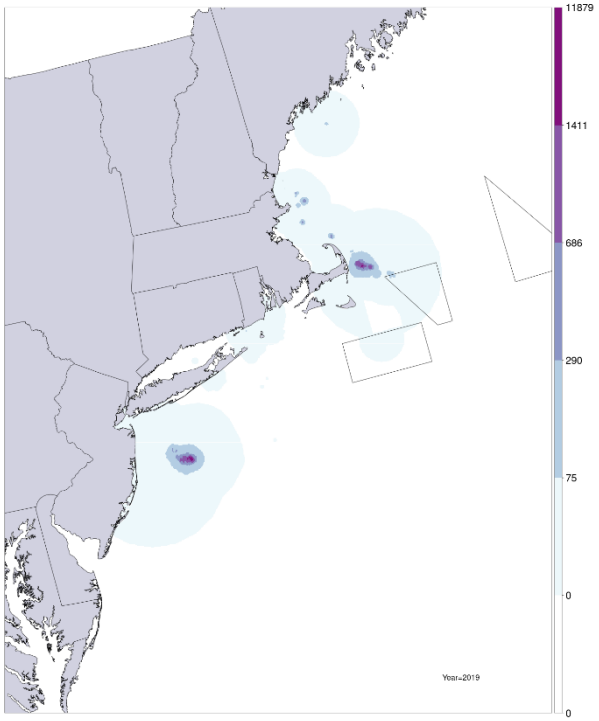


Figure 12 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2019.

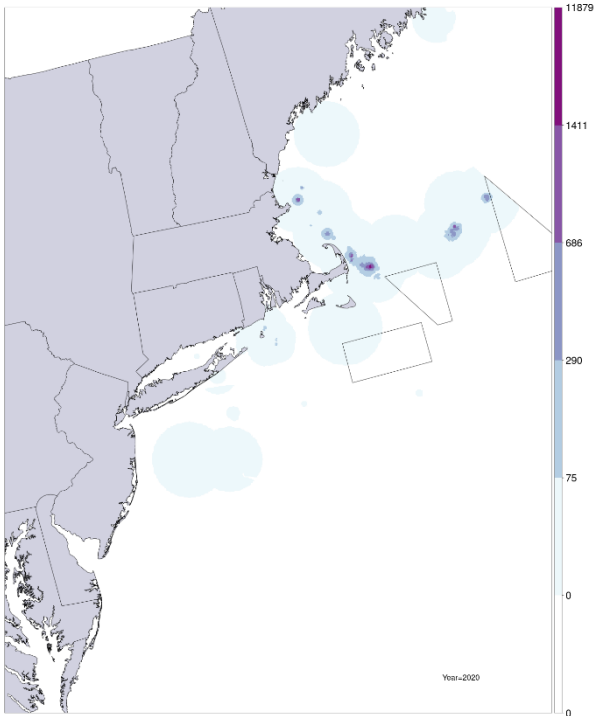


Figure 13 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2020.

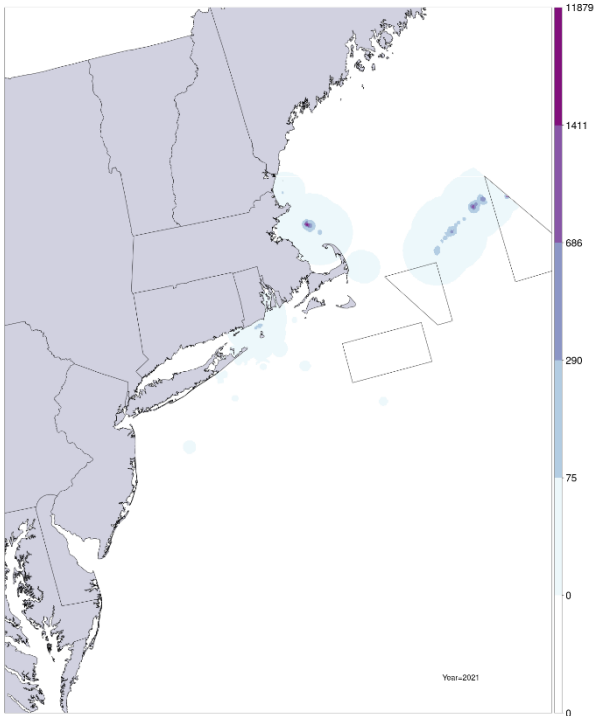


Figure 14 Atlantic Herring Landings (pounds per square kilometer) from the midwater and small mesh otter trawl fleets in 2021.

Atlantic Herring Fishery Revenue (real 2020 Q2 dollars per square kilometer), 2008-2021

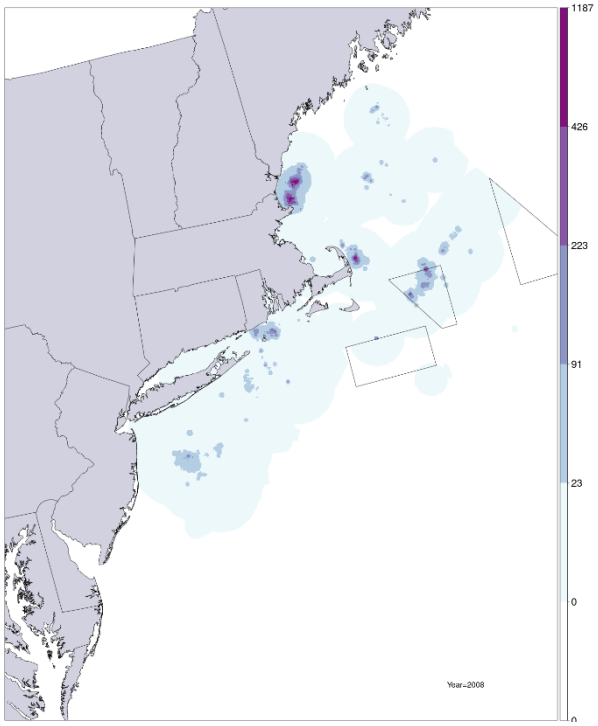


Figure 15 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2008.

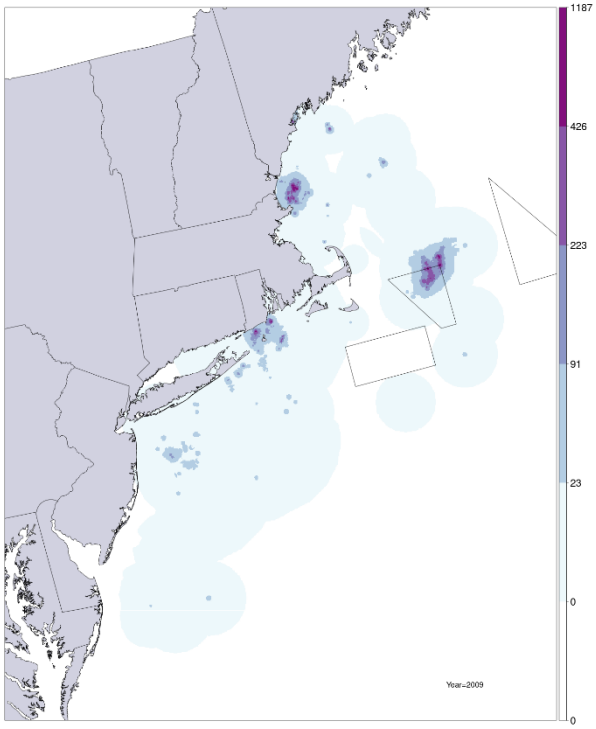


Figure 16 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2009.

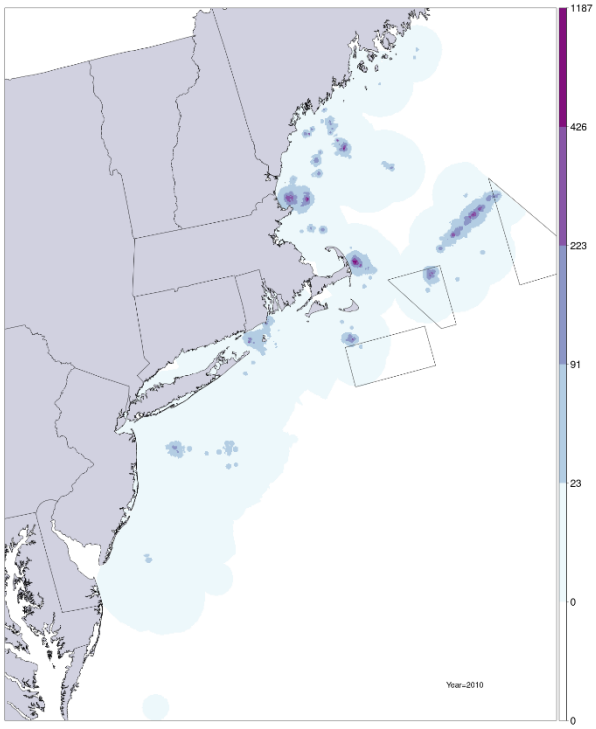


Figure 17 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2010.

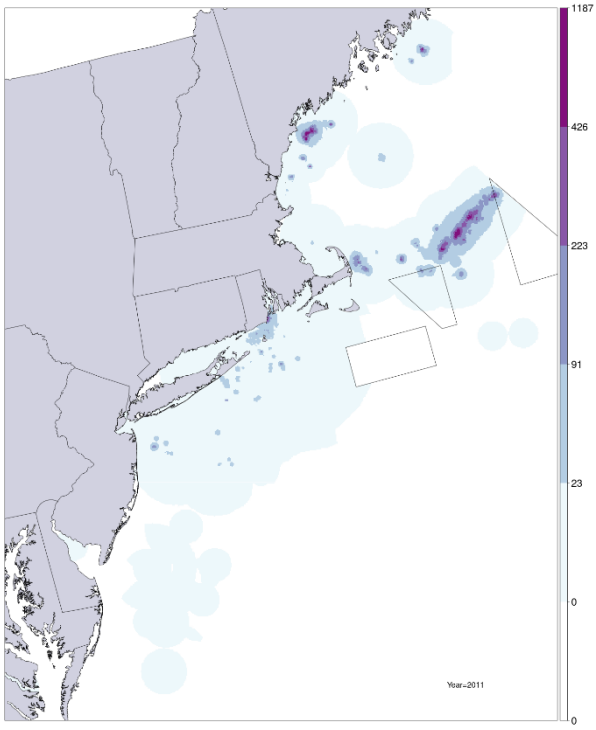


Figure 18 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2011.

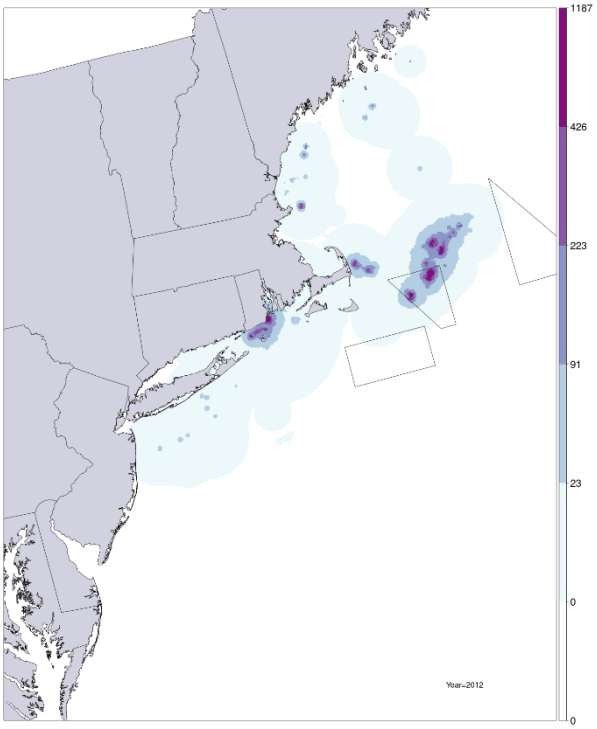


Figure 19 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2012.

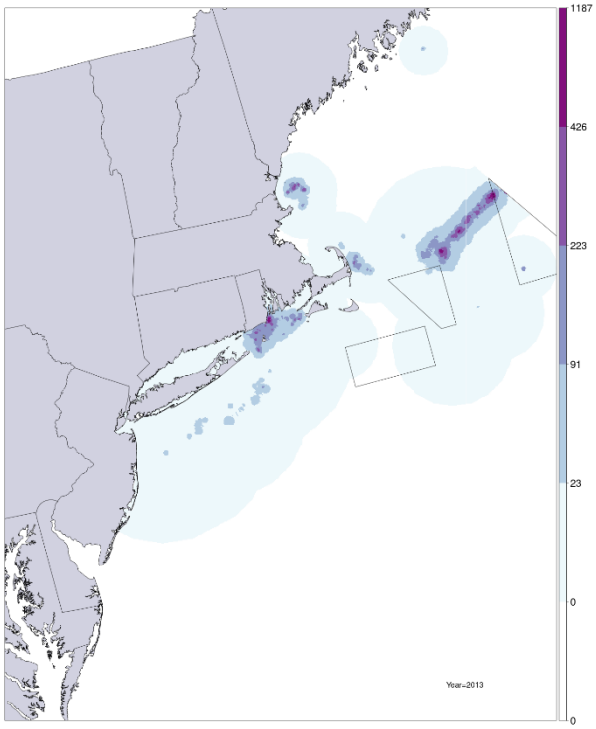


Figure 20 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2013.

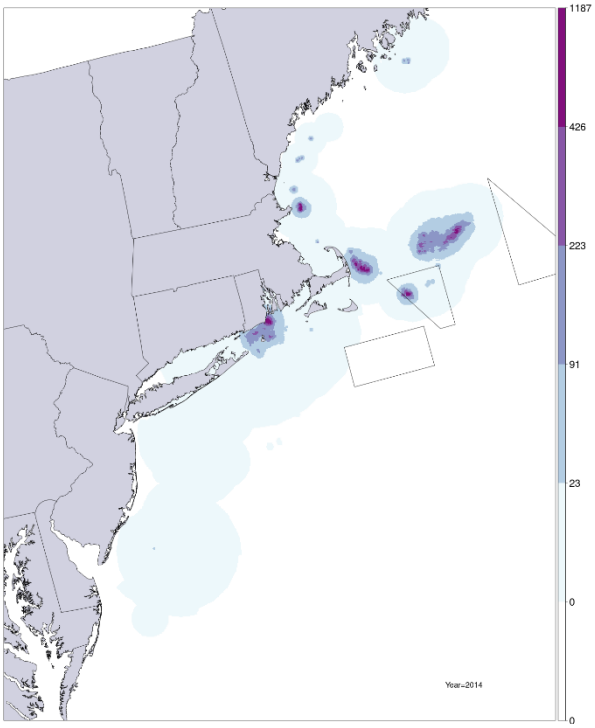


Figure 21 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2014.

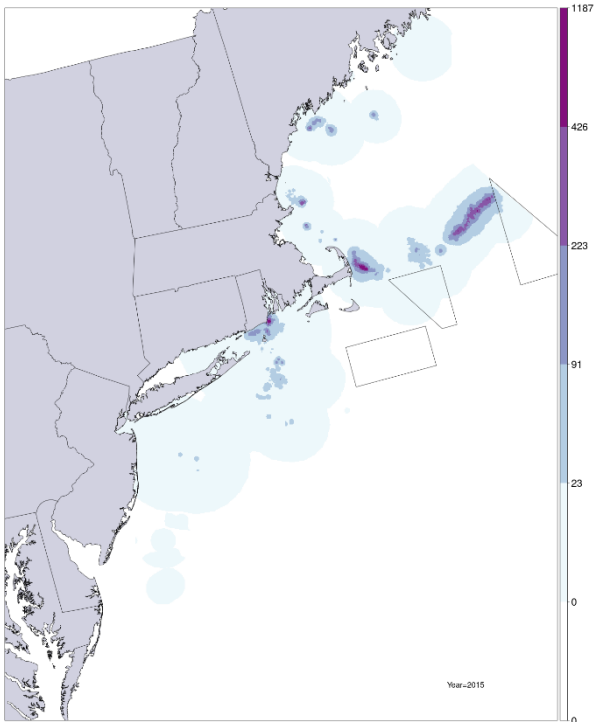


Figure 22 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2015.

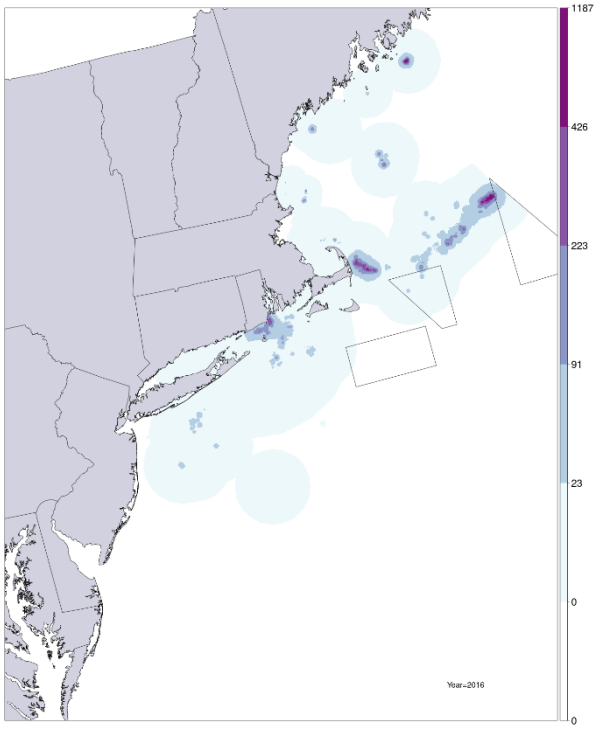


Figure 23 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2016.

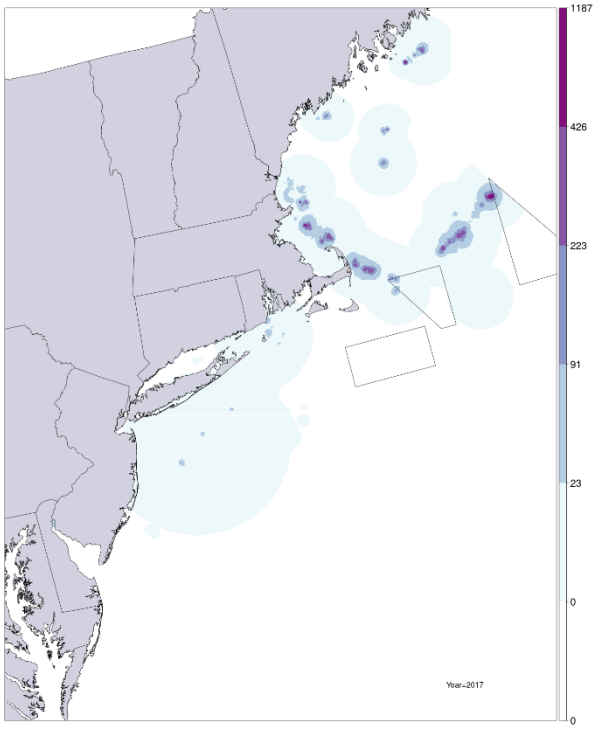


Figure 24 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2017.

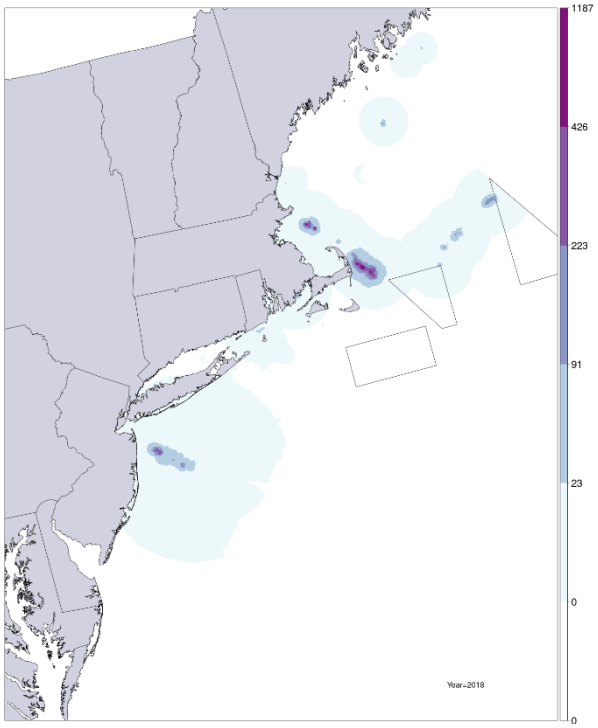


Figure 25 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2018.

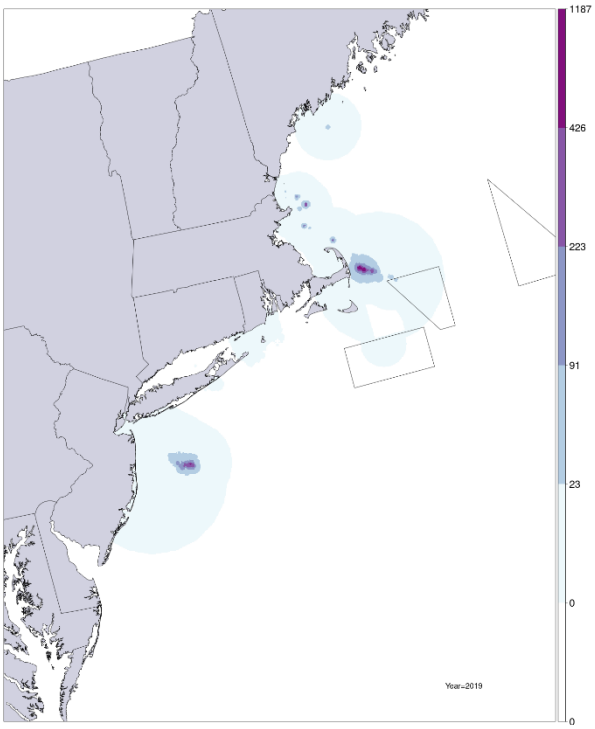


Figure 26 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2019.

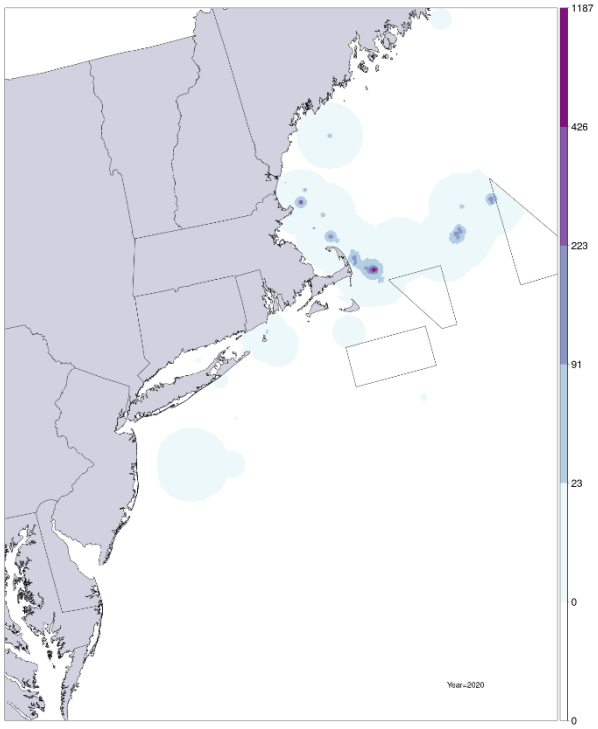


Figure 27 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2020.

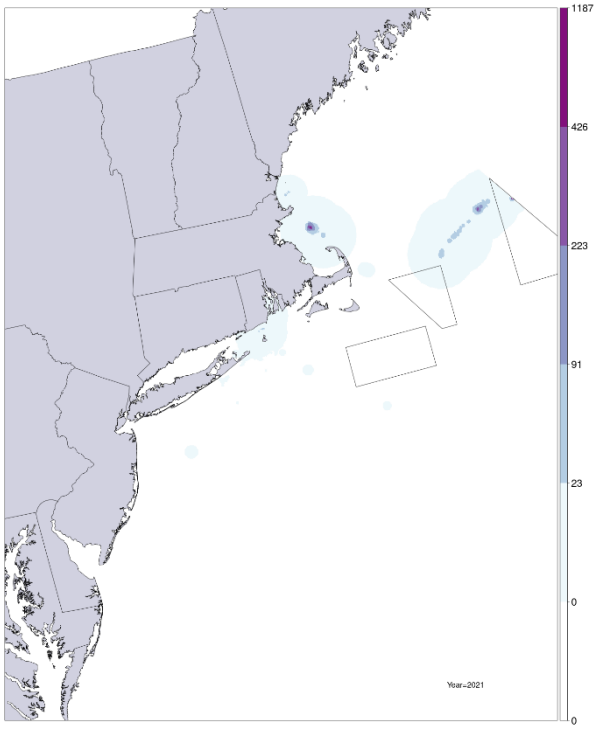


Figure 28 Atlantic Herring Revenue (real 2020 Q2 dollars per square kilometer) from the midwater and small mesh otter trawl fleets in 2021.

Spatial and temporal genetic stock composition of river herring bycatch in southern New England Atlantic herring and mackerel fisheries

NEFMC HERRING PDT MEETING 3/28/2023

KERRY REID, JENNIFER HOEY, *BEN GAHAGAN, BRAD SCHONDELMEIER*, DAN HASSELMAN, ALISON BOWDEN, MIKE ARMSTRONG, CARLOS GARZA, AND ERIC PALKOVACS

Evolutionary Applications
Open Access
Evolutionary Applications ISSN 1752-4571

ORIGINAL ARTICLE

Combining genetic and demographic information to prioritize conservation efforts for anadromous alewife and blueback herring

Eric P. Palkovacs,[1] Daniel J. Hasselman,[1] Emily E. Argo,[1] Stephen R. Gephard,[2] Karin E. Limburg,[3] David M. Post,[4] Thomas F. Schultz[5] and Theodore V. Willis[6]

- Microsatellite markers
- Focused collections
  - Targeted 50 fish per spawning system for each species
  - United States only
  - 38 Alewife rivers and 28 Blueback (some overlap)
- Used STRUCTURE and BAPS to explore stock structure, also examined isolation by distance

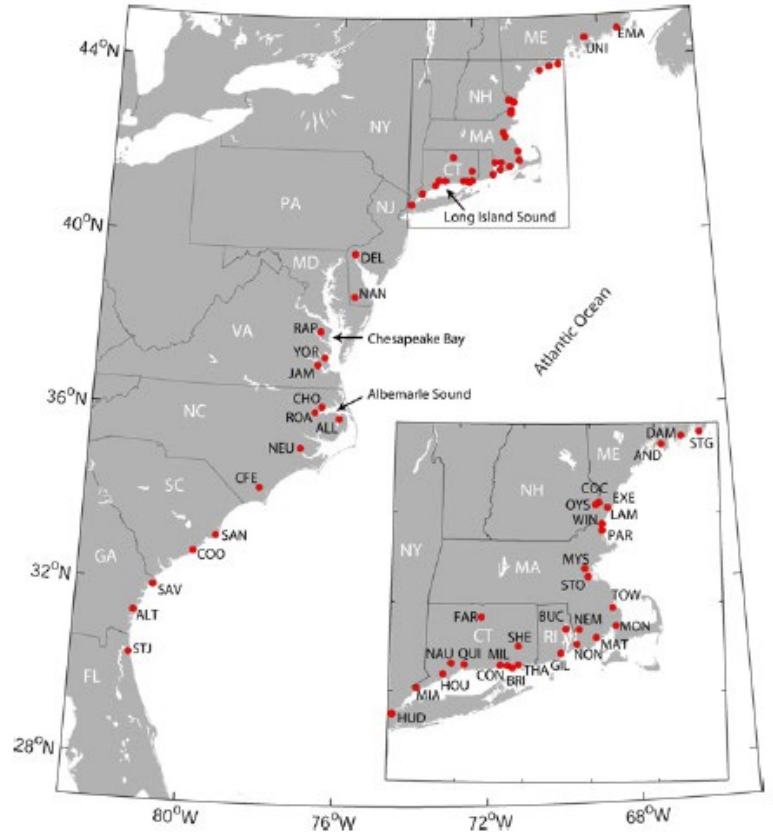


Figure 1 Coastal rivers in Eastern North America examined in this study spanned the US range of alewife and blueback herring. Sites indicated on the map include rivers sampled for genetic analysis and rivers included in the analysis of demographic time series data. River names and datasets associated with each sample code are provided in Table 1.

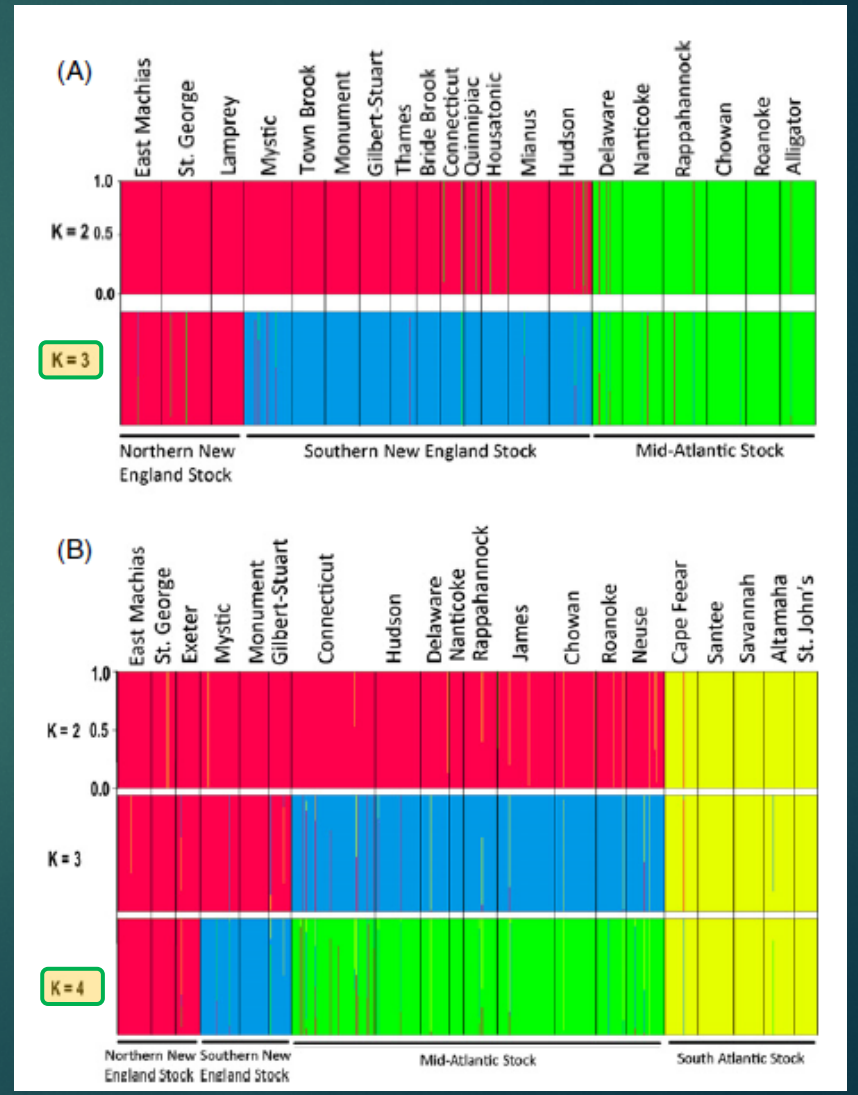
Evolutionary Applications
Open Access
Evolutionary Applications ISSN 1752-4571

ORIGINAL ARTICLE

Combining genetic and demographic information to prioritize conservation efforts for anadromous alewife and blueback herring

Eric P. Palkovacs,[1] Daniel J. Hasselman,[1] Emily E. Argo,[1] Stephen R. Gephard,[2] Karin E. Limburg,[3] David M. Post,[4] Thomas F. Schultz[5] and Theodore V. Willis[6]

- Genetically, rivers within larger regions formed stock complexes
  - STRUCTURE and BAPS produced concurring results for Alewife, indicating 3 stock complexes
  - For Bluebacks, evidence supported 4 stock complexes



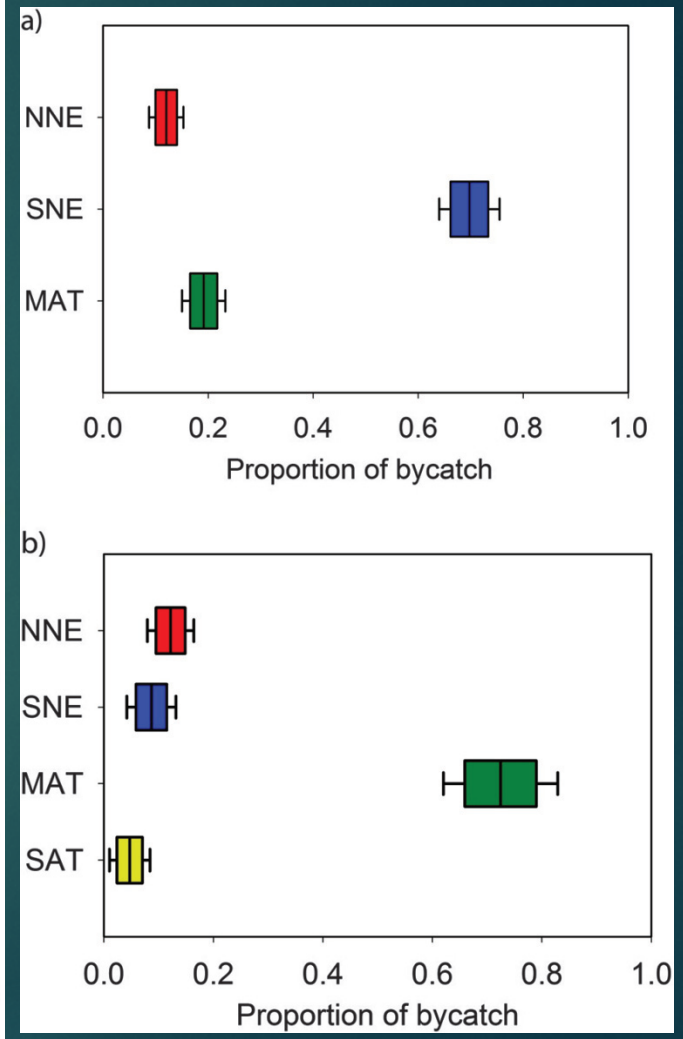
NRC Research Press

ARTICLE

Genetic stock composition of marine bycatch reveals disproportional impacts on depleted river herring genetic stocks

Daniel J. Hasselman, Eric C. Anderson, Emily E. Argo, N. David Bethoney, Stephen R. Gephard, David M. Post, Bradley P. Schondelmeier, Thomas F. Schultz, Theodore V. Willis, and Eric P. Palkovacs

- Hasselman et al. used the Palkovacs developed microsatellite baseline to assign mixed stock catches from 2012 and 2013 back to reporting groups
- Sampled bycatch from Atlantic herring, Atlantic cod, shrimp, and longfin squid trips
- SNE was highest proportion for Alewife and mid-Atlantic for Blueback Herring



NRC Research Press

ARTICLE

Genetic stock composition of marine bycatch reveals disproportional impacts on depleted river herring genetic stocks

Daniel J. Hasselman, Eric C. Anderson, Emily E. Argo, N. David Bethoney, Stephen R. Gephard, David M. Post, Bradley P. Schondelmeier, Thomas F. Schultz, Theodore V. Willis, and Eric P. Palkovacs

- Showed latitudinal gradient in origin of catch for Alewife but less evidence for that in

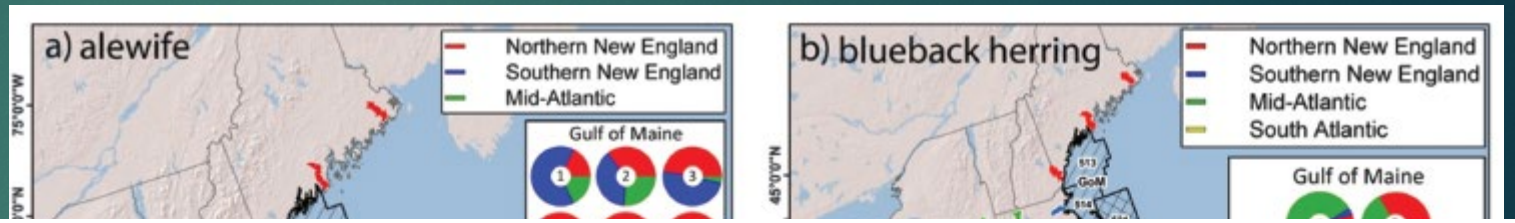


Table 2. Number of alewife and blueback herring estimated to be removed from various genetic stocks by the Atlantic herring fishery off the coast of southern New England (SA 537, 539, 611) in 2012 and 2013 by midwater trawl and bottom trawl fishing gear.

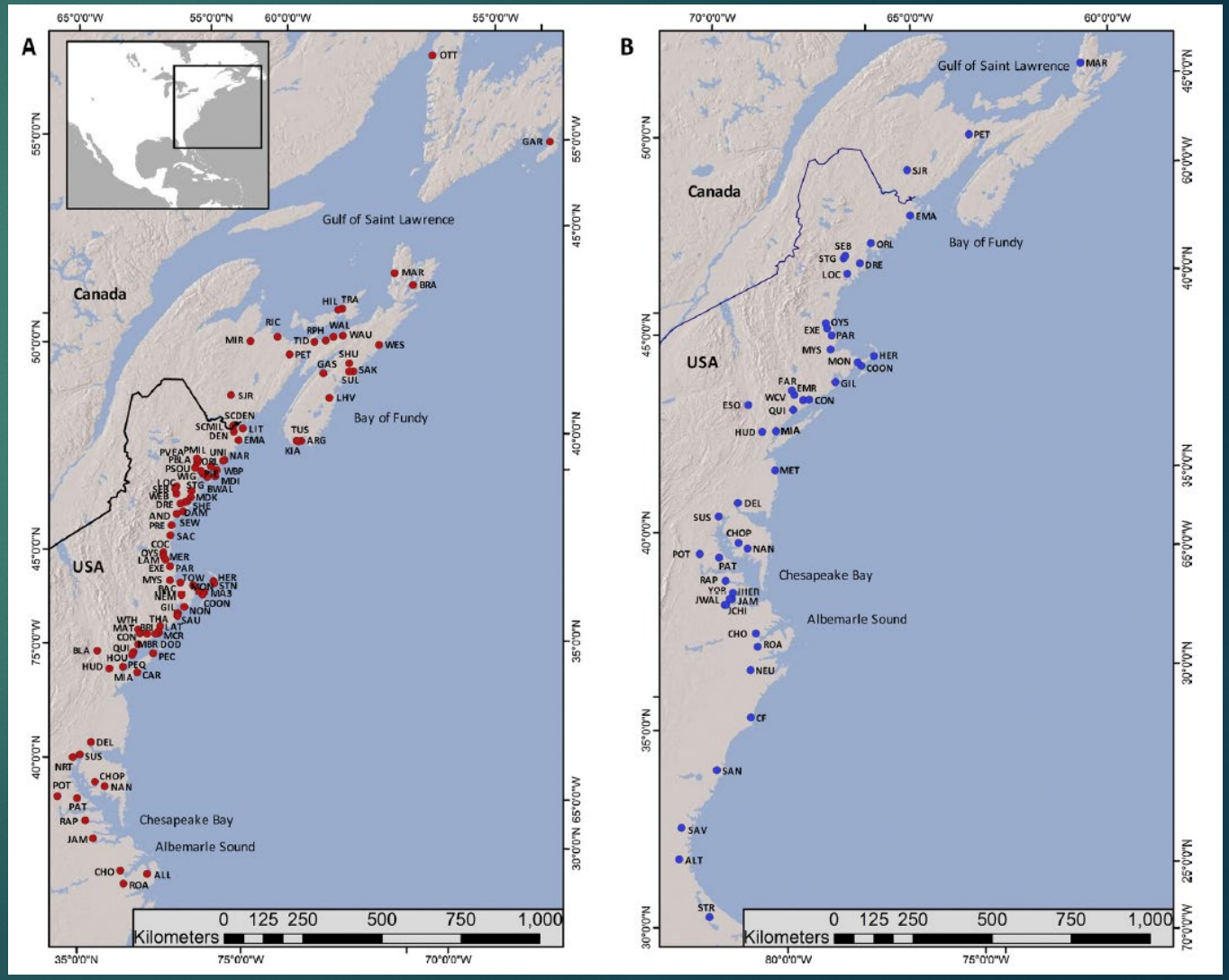
	2012		2013		
	Midwater	Bottom	Midwater	Bottom	Total
Alewife					
Northern New England	20 400 (9 000–31 300)	9 800 (4 300–15 000)	127 300 (56 600–195 500)	108 300 (48 200–166 400)	265 800 (118 100–408 200)
Southern New England	201 300 (181 500–222 700)	96 000 (86 500–106 200)	1 255 900 (1 132 200–1 388 900)	1 068 200 (963 000–1 181 400)	2 621 400 (2 363 200–2 899 200)
Mid-Atlantic	55 900 (45 900–64 700)	26 600 (21 900–30 900)	348 500 (286 100–403 900)	296 400 (243 400–343 600)	727 400 (597 300–843 100)
Subtotal	277 600 (236 400–318 700)	132 400 (112 700–52 100)	1 731 700 (1 474 900–1 988 300)	1 472 900 (1 254 600–1 691 400)	3 614 600 (3 078 600–4 150 500)
Blueback herring					
Northern New England	75 400 (40 500–113 200)	9 300 (5 000–14 000)	3 900 (2 100–5 700)	38 600 (20 800–58 000)	127 200 (68 400–190 900)
Southern New England	72 700 (35 800–107 500)	9 100 (4 500–13 200)	3 700 (1 800–5 400)	37 200 (18 400–55 100)	122 700 (60 500–181 200)
Mid-Atlantic	633 600 (537 100–715 000)	78 200 (66 400–88 300)	32 400 (27 400–36 500)	324 800 (275 300–366 500)	1 069 000 (906 200–1 206 300)
South Atlantic	10 400 (700–34 400)	1 400 (100–4 200)	500 (0–1 800)	5 300 (300–17 600)	17 600 (1 100–58 000)
Subtotal	792 100 (614 100–970 100)	98 000 (76 000–119 700)	40 500 (31 300–49 400)	405 900 (314 800–497 200)	1 336 500 (1 036 200–1 636 400)
Grand total	1 069 700 (850 500–1 288 800)	230 400 (188 700–271 800)	1 722 200 (1 506 200–2 037 700)	1 878 000 (1 569 400–2 188 600)	4 951 100 (4 114 800–5 786 900)

Note: The range represents 95% credible intervals of estimated mixing proportions.

Comprehensive evaluation of genetic population structure for anadromous river herring with single nucleotide polymorphism data

Kerry Reid[a,b], Eric P. Palkovacs[a], Daniel J. Hasselman[a,1], Diana Baetscher[b,c], Jared Kibele[d], Ben Gahagan[e], Paul Bentzen[f], Meghan C. McBride[f], John Carlos Garza[b,c,*]

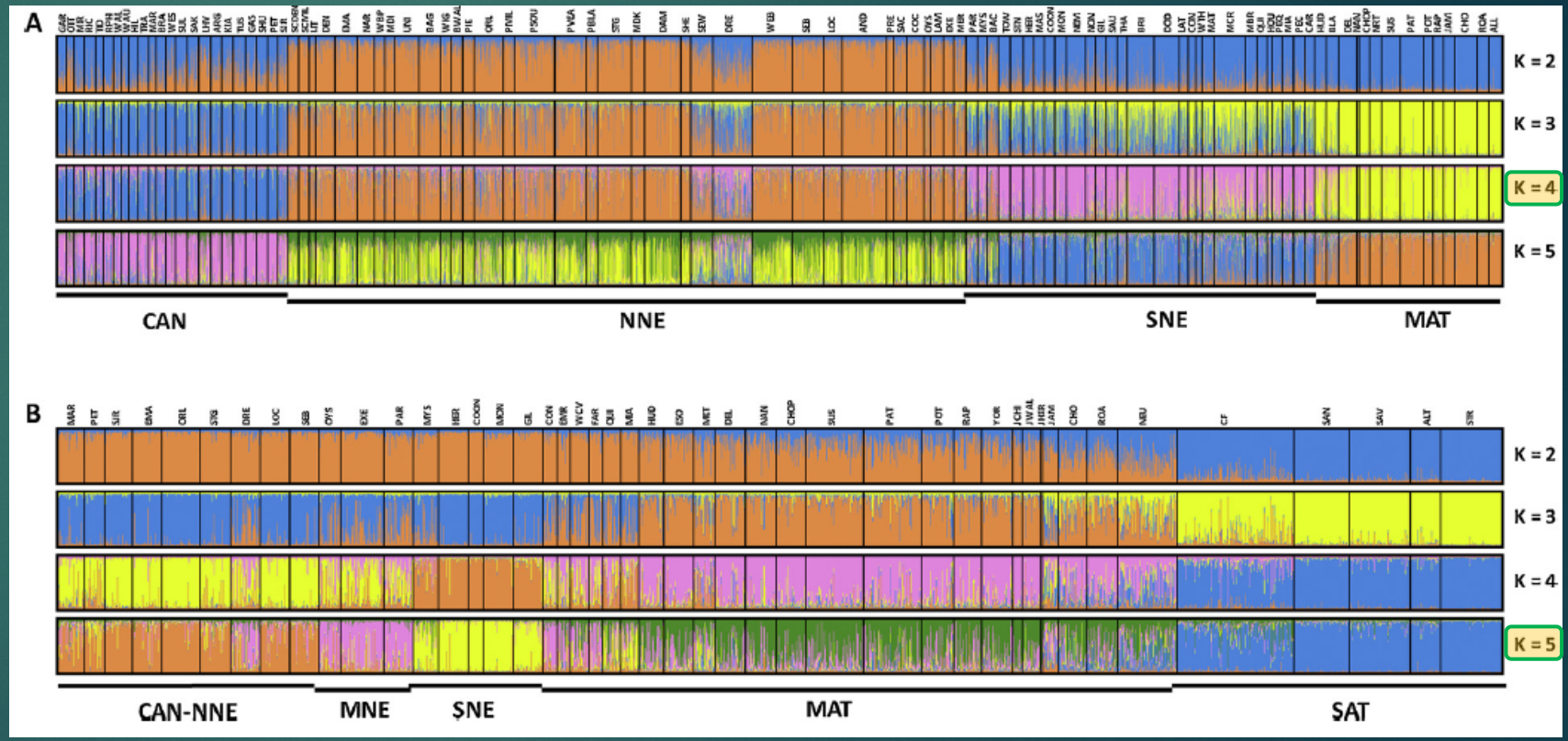
- Expanded collection
  - Covers the entire range of both species
  - 108 locations and >8,000 fish
    - Alewife: 6,783 fish from 137 locations
    - Blueback: 2,502 fish from 54 locations
- SNPs are more transportable among labs, can provide more discriminatory power (96 SNP vs 13 microsats), and suited for high throughput analyses

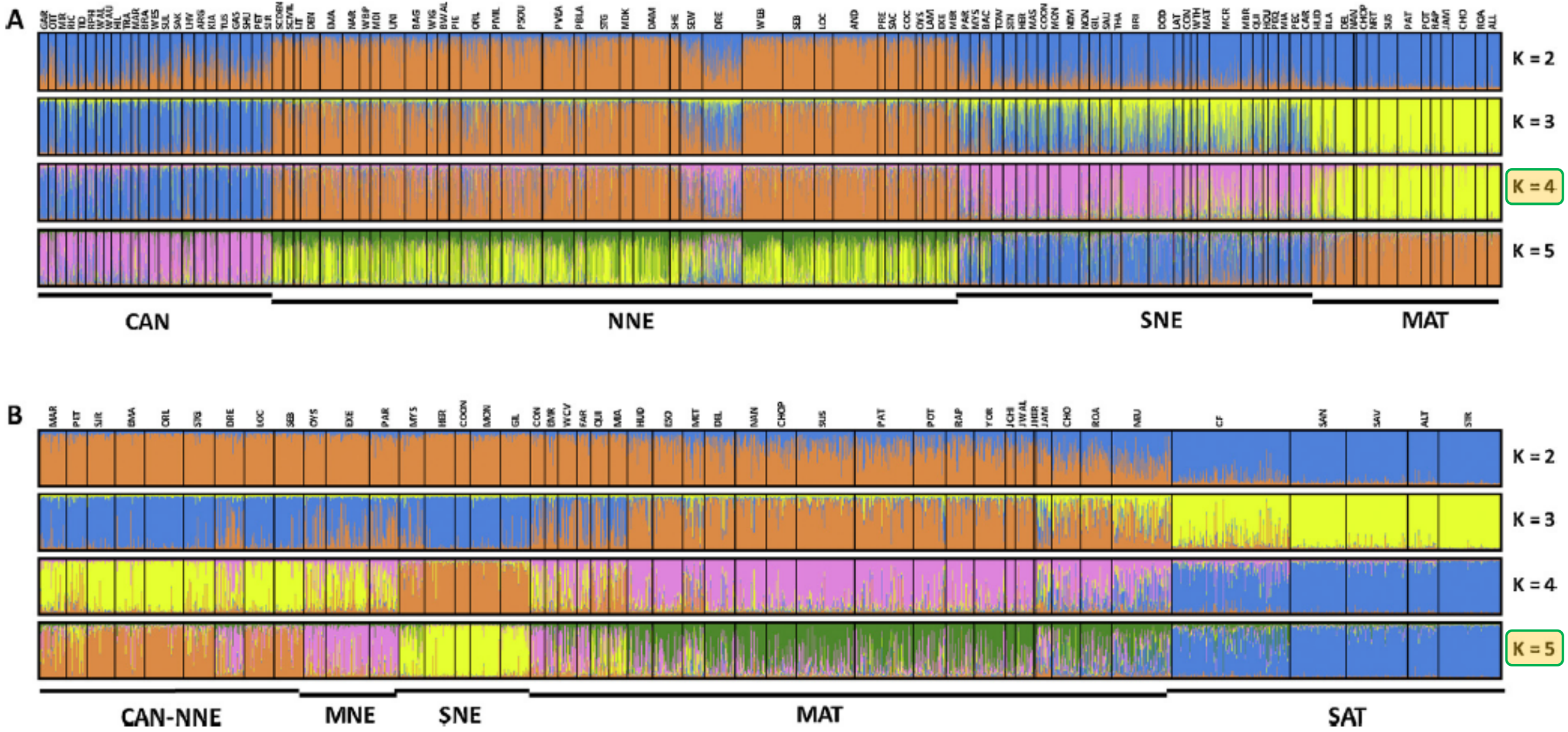


Comprehensive evaluation of genetic population structure for anadromous river herring with single nucleotide polymorphism data

Kerry Reid[a,b], Eric P. Palkovacs[a], Daniel J. Hasselman[a,1], Diana Baetscher[b,c], Jared Kibele[d], Ben Gahagan[e], Paul Bentzen[f], Meghan C. McBride[f], John Carlos Garza[b,c,*]

- STRUCTURE and DAPC concurred, addition of 1 stock complex to each species
  - Hudson ALE shifted to MAT from SNE
- Gene flow among proximate runs across regional groupings




A
K = 2
K = 3
K = 4
K = 5
CAN
NNE
SNE
MAT
B
K = 2
K = 3
K = 4
K = 5
CAN-NNE
MNE
SNE
MAT
SAT

Stock Complex Maps

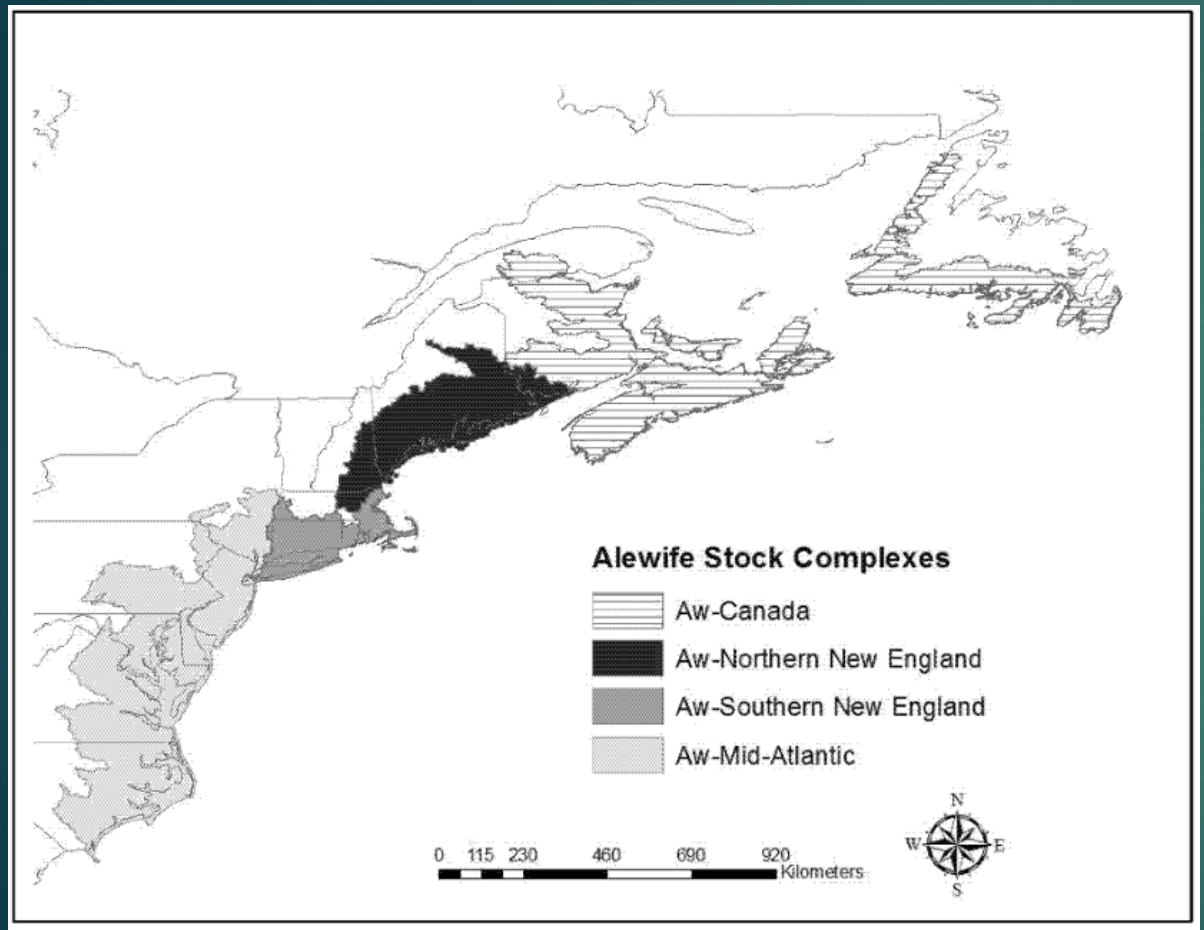


Figure 1. Map of Alewife regional stock complexes: Aw-Canada; Aw-Northern New England; Aw-Southern New England; and Aw-Mid-Atlantic.

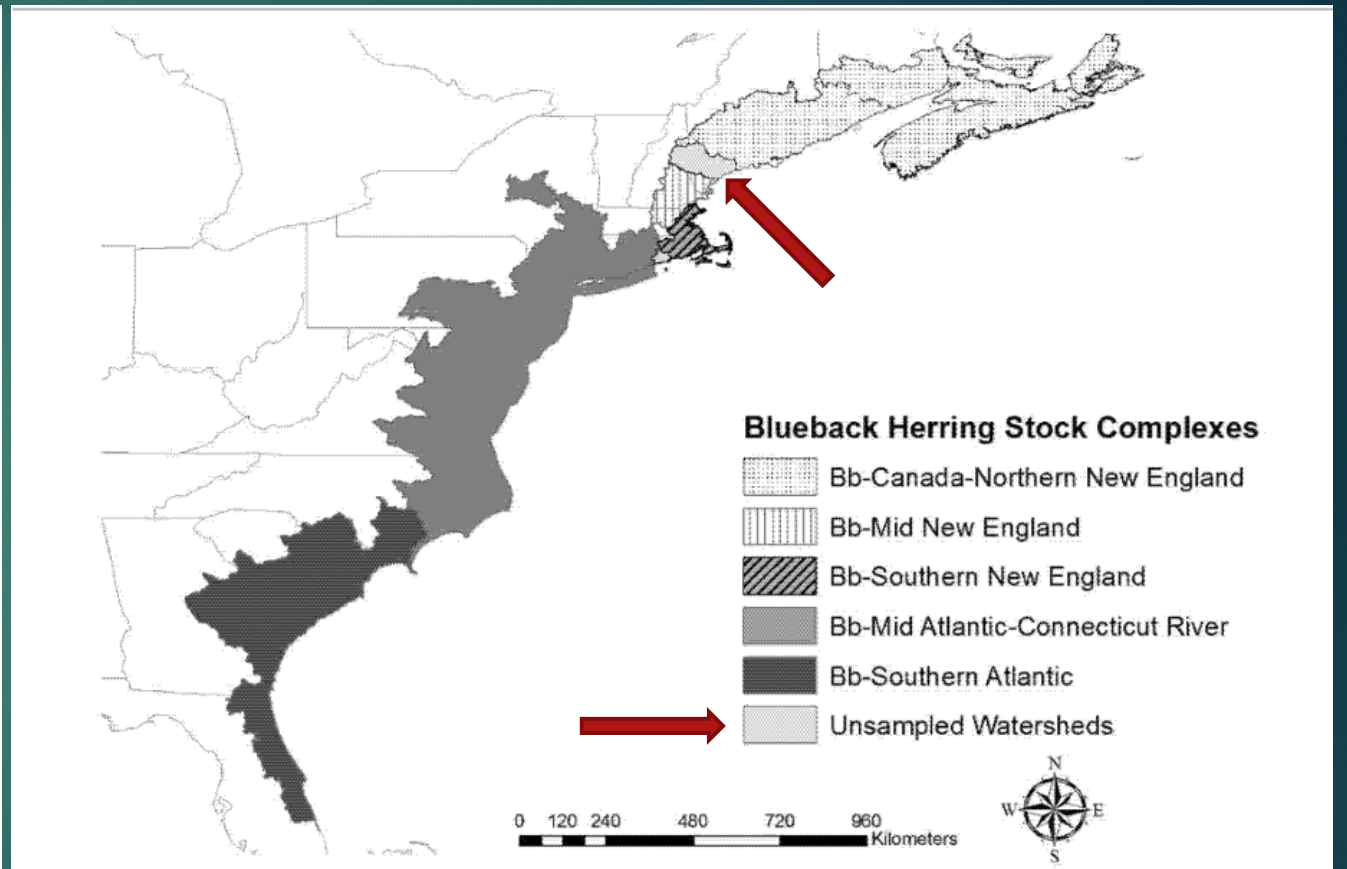
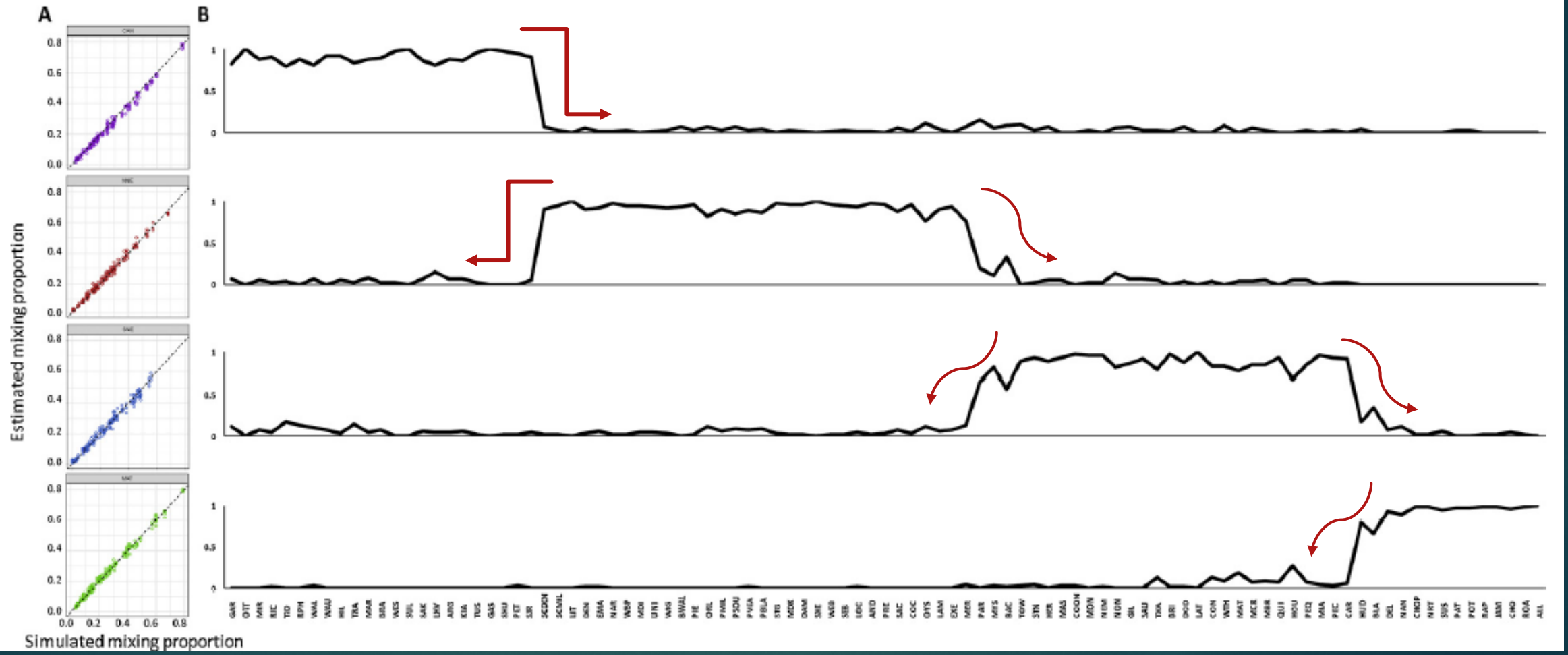
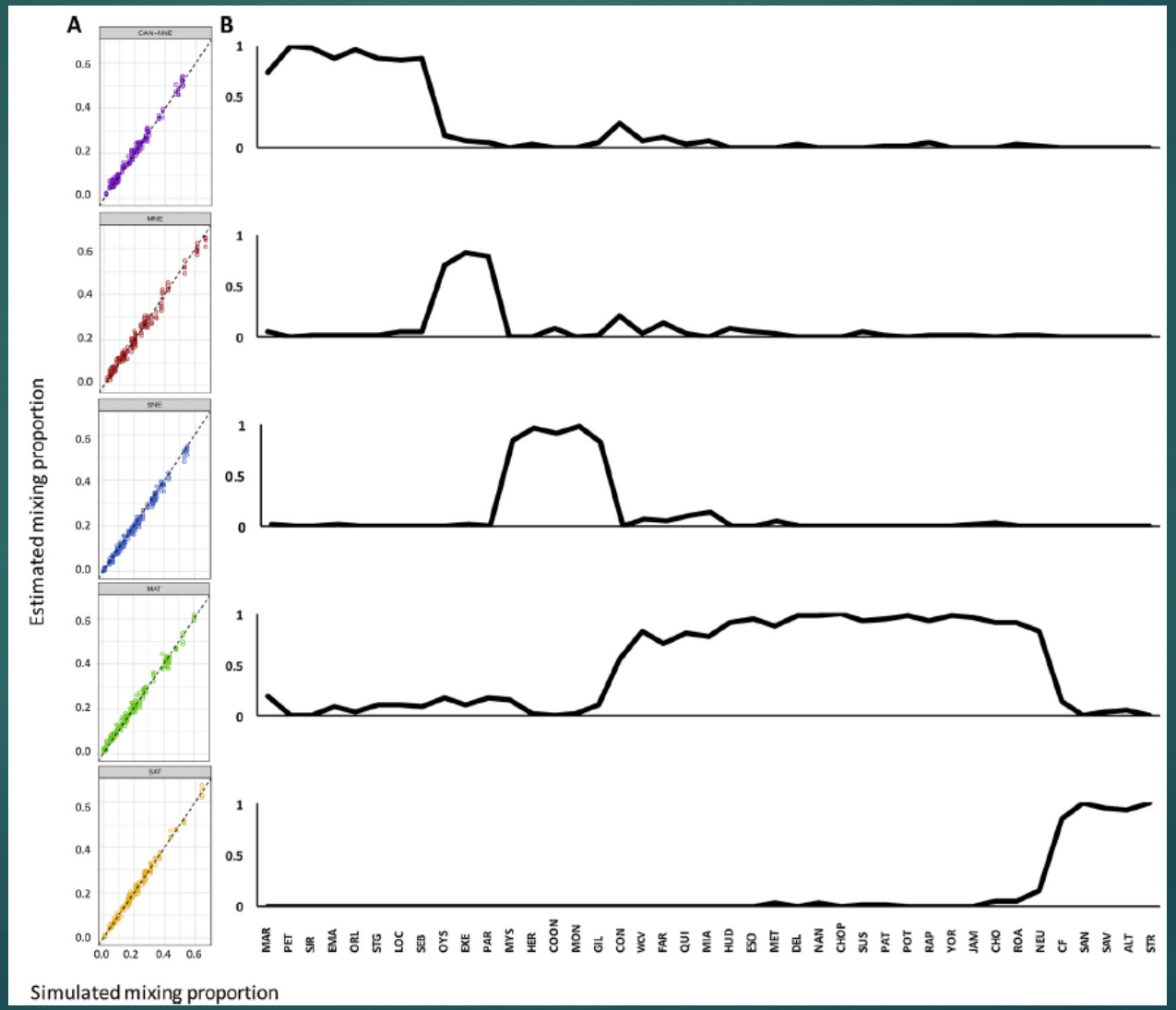


Figure 2. Map of Blueback herring regional stock complexes: Bb-Canada/Northern New England, Bb-Mid-New England, Bb-Southern New England, Bb-Mid-Atlantic; and, Bb-Southern Atlantic.

Alewife mixing simulation and self-assignment tests



Blueback mixing simulation and self-assignment tests



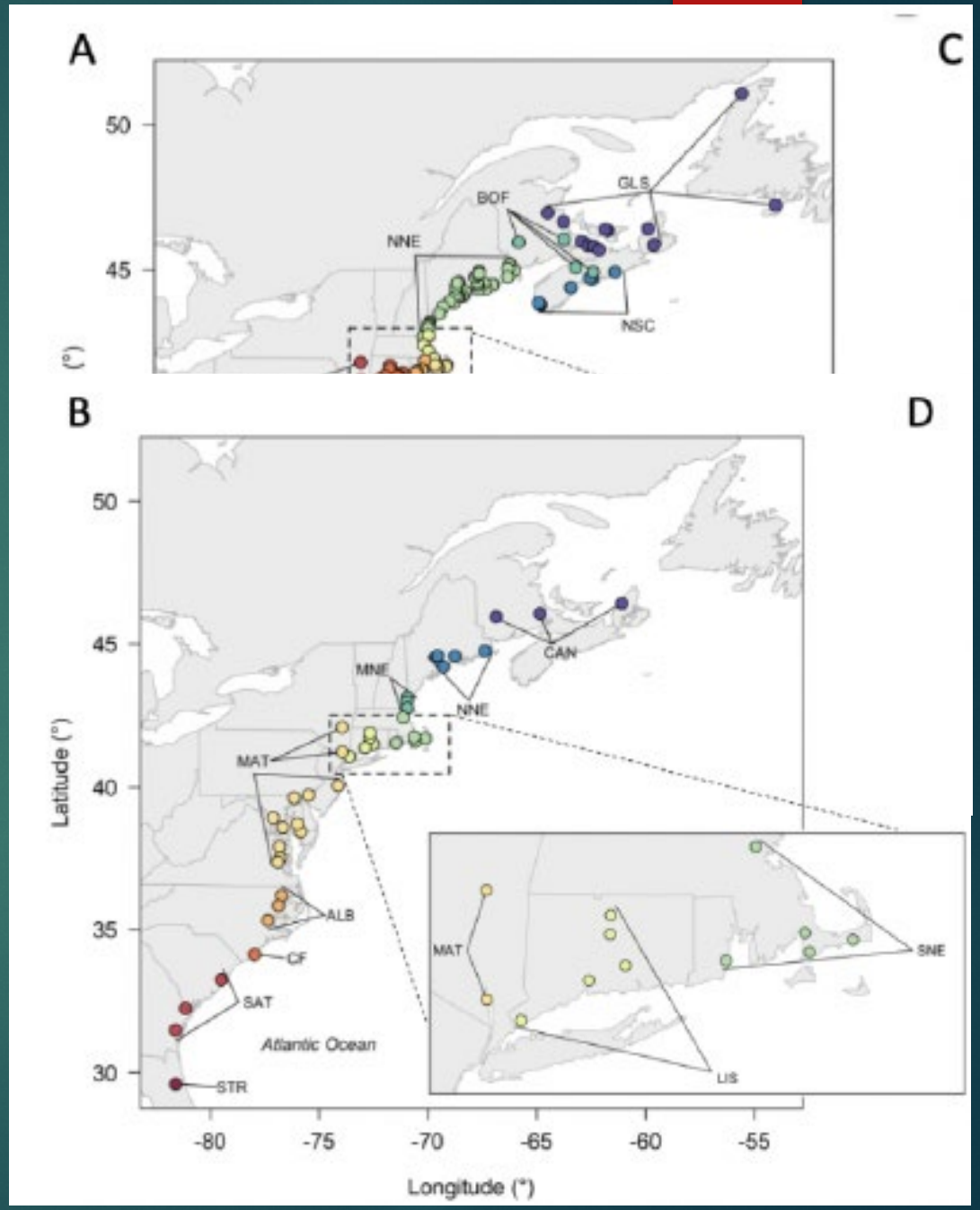
OPEN ACCESS | Research Article

Spatial and temporal genetic stock composition of river herring bycatch in southern New England Atlantic herring and mackerel fisheries

Authors: Kerry Reid, PhD, Jennifer A. Hoey, Benjamin I. Gahagan, Bradley P. Schondelmeier, Daniel J. Hasselman, Alison A Bowden, Michael P. Armstrong, John Carlos Garza, and Eric P Palkovacs | AUTHORS INFO & AFFILIATIONS

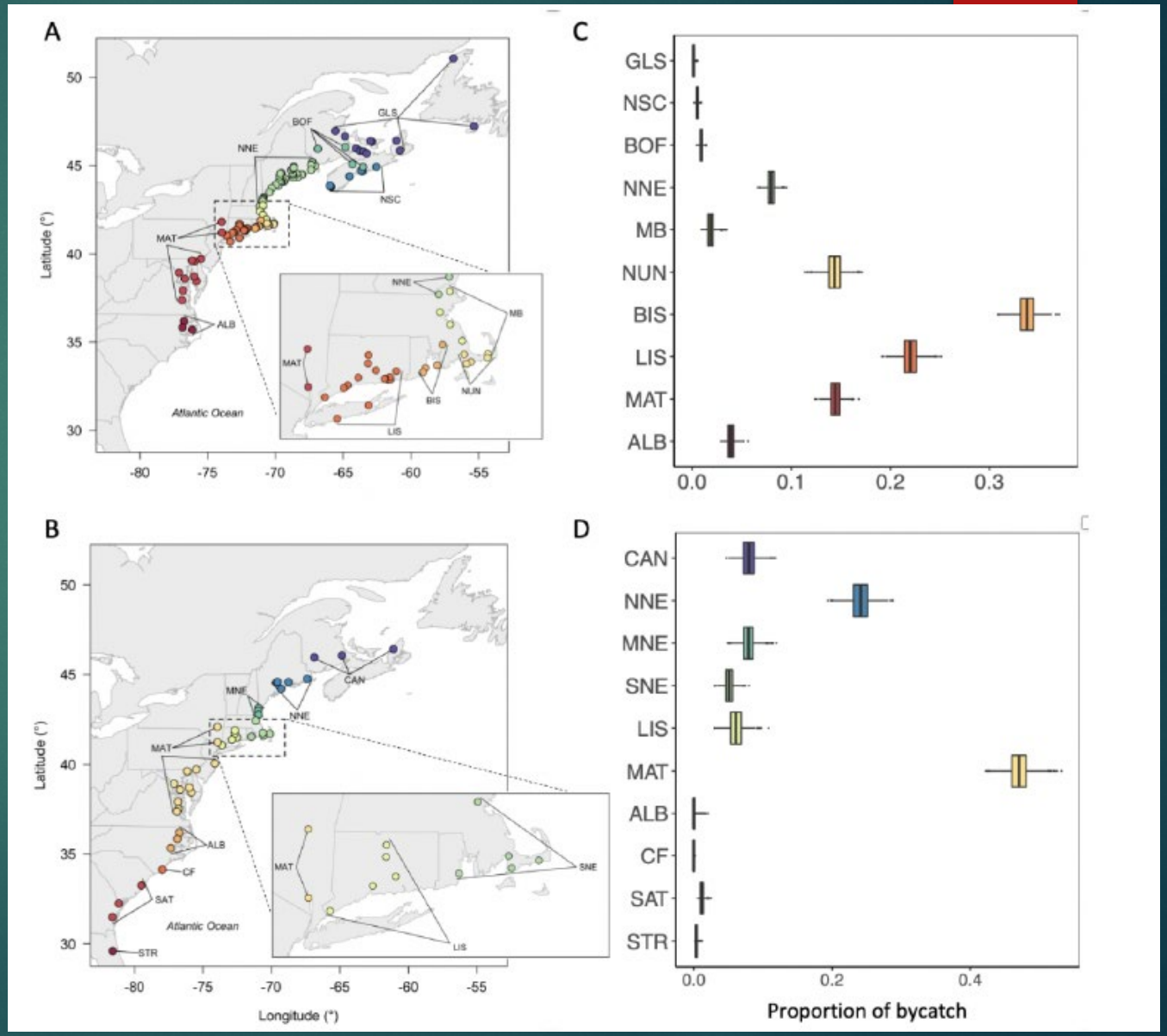
Publication: Canadian Journal of Fisheries and Aquatic Sciences • 2 November 2022 • https://doi.org/10.1139/cjfas-2022-0144

- SNPs and further analysis allowed us to expand some complexes to more defined "reporting groups".
- For total pool of samples (n=7,925, 2012-2015), we could determine the composition of bycatch, but ***not*** estimate the amount of bycatch (not enough sampled trips to estimate overall harvest).
- For a more limited but meaningful area we could estimate total removals of river herring in the Atlantic herring and mackerel fisheries.



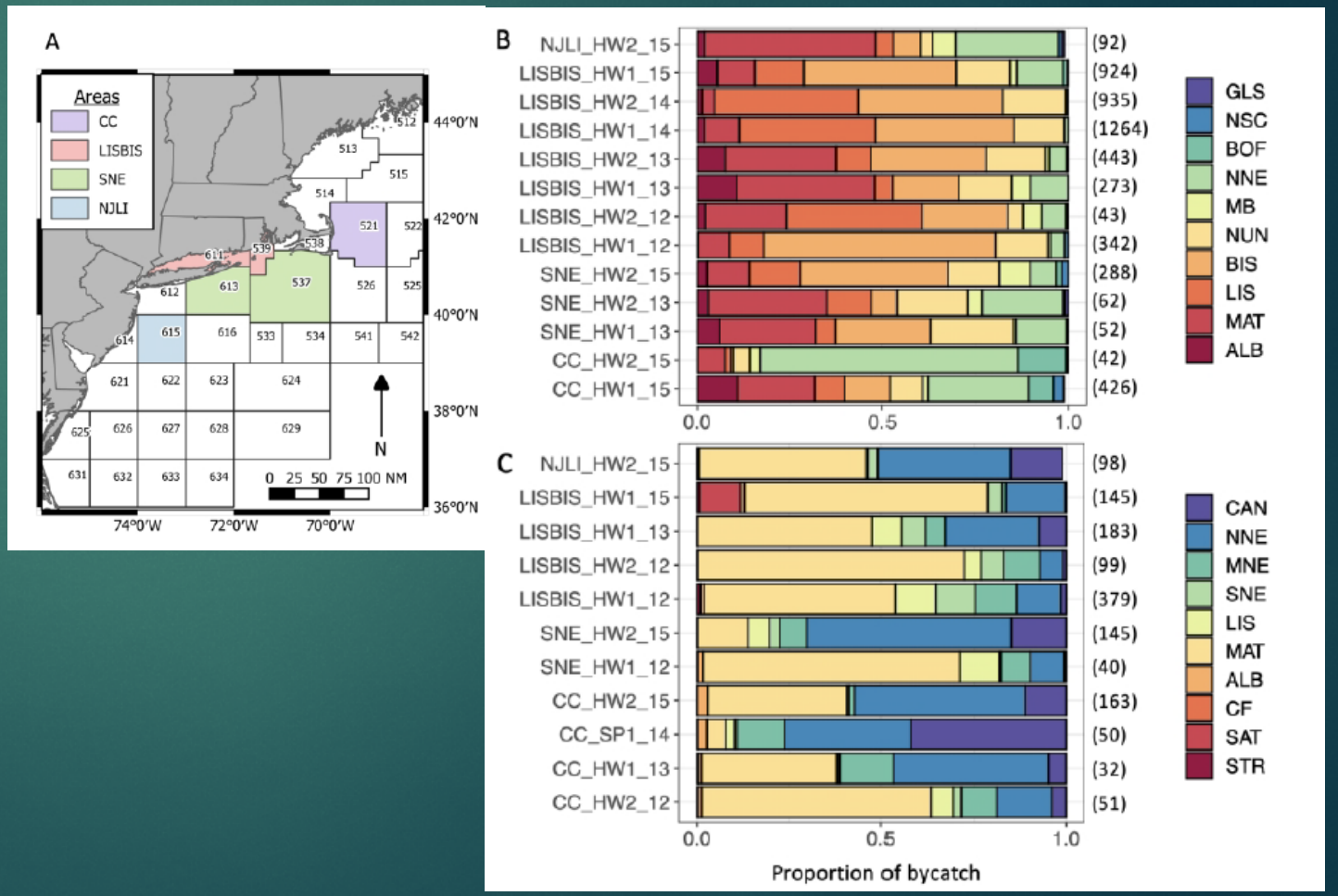
Overall Composition

- Samples came from identified bycatch interaction areas (Stat areas 615, 613, 611, 537, 539, 521)
- For Alewife, the overall sample was mainly composed of Block Island Sound runs followed by Long Island Sound and then equal percentages of Nantucket Sound and Mid-Atlantic origin fish
- For Blueback Herring, Mid-Atlantic origin fish comprised the greatest part of the sample with Northern New England also contributing more than 20%. Other northeastern groups were present but southeastern origin fish were rarely present in the sample.



Composition by half-winter

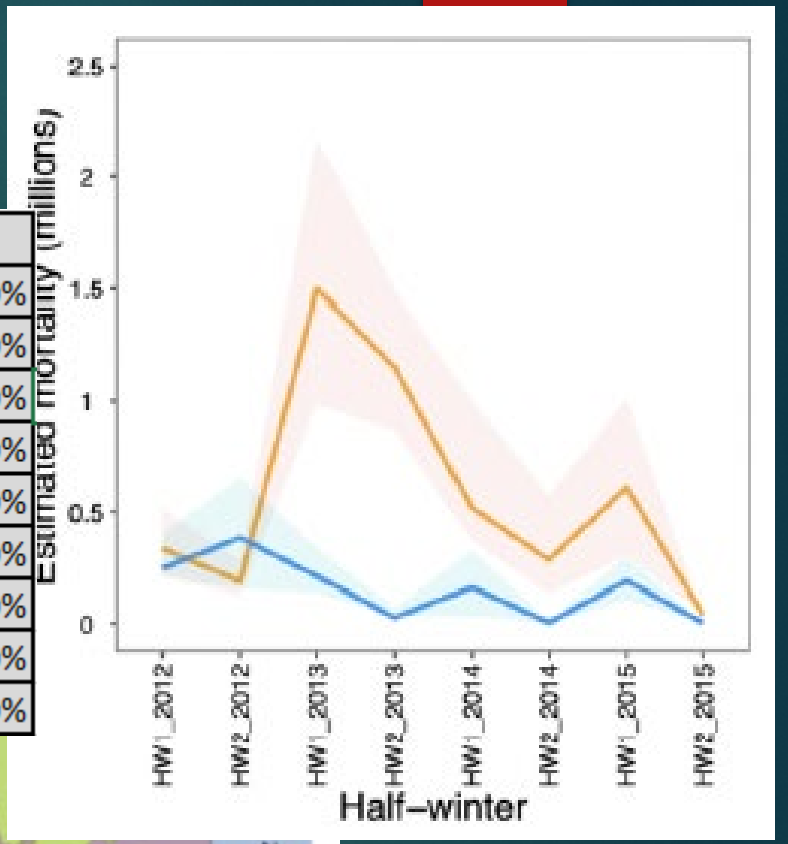
- Results by half-winter show variation in origin by year but reinforce that BIS is typically most common in all area-time combinations for Alewife and MAT for BBH.
- CC (Area 521) more varied than others for alewife and to lesser extent BBH, but does show more northern origin fish in both species
- Presence of >10% MNE origin fish in most BBH samples notable given conservation status of that group.

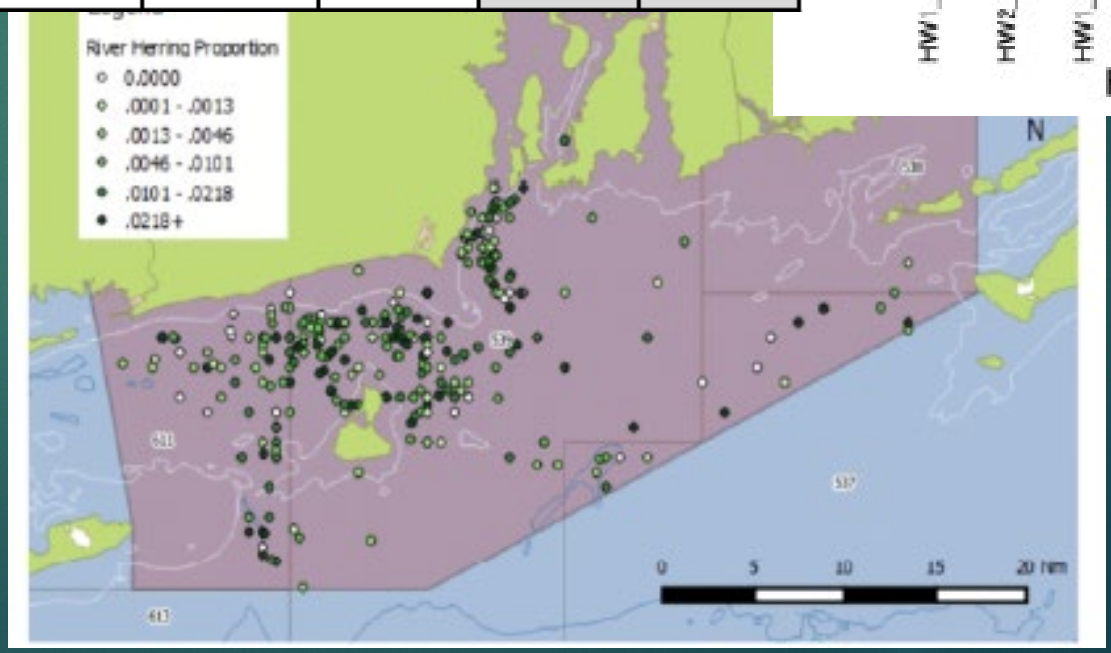


Bycatch in focal area

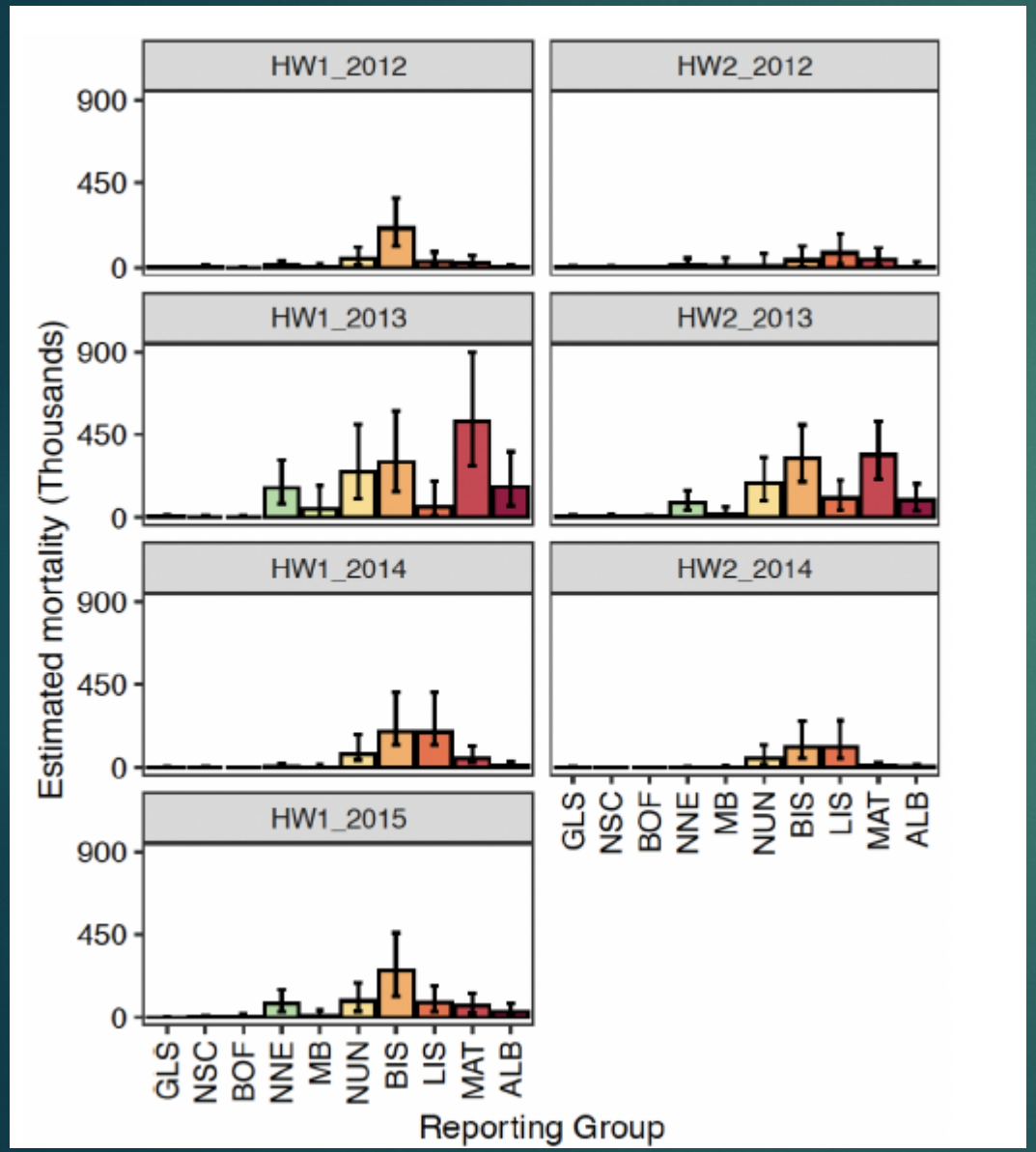
- Polygon defined by the area with best available data to support accurate genomic and bycatch magnitude estimates. Area encompassed 79.7% of all trips, 84.8% of sampled trips and 76.7% of samples.
- Represents the area of highest mid-water and small mesh bottom trawl effort during the study period of 2012-2015.
- Alewife catch in the "polygon" was more variable and higher than Blueback Herring in all but one half-winter.

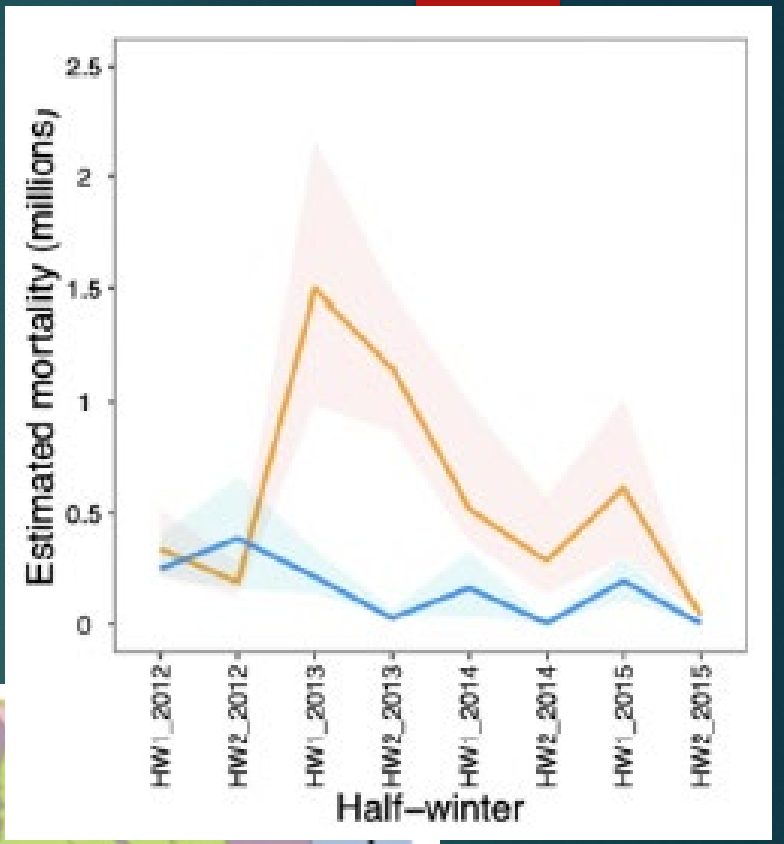
HW#	ale_mt	bbh_mt	n_trips	covg%
HW1	25.21	19.61	56	37.10%
HW2	15.16	27.31	32	40.00%
HW3	143.47	11.97	60	33.50%
HW4	82.49	1.77	72	48.00%
HW5	31.77	15.74	75	23.10%
HW6	8.97	0.09	27	38.60%
HW7	63.85	18.95	54	28.60%
HW8	2.78	0.14	1	14.30%
total	373.72	95.59	377	32.80%

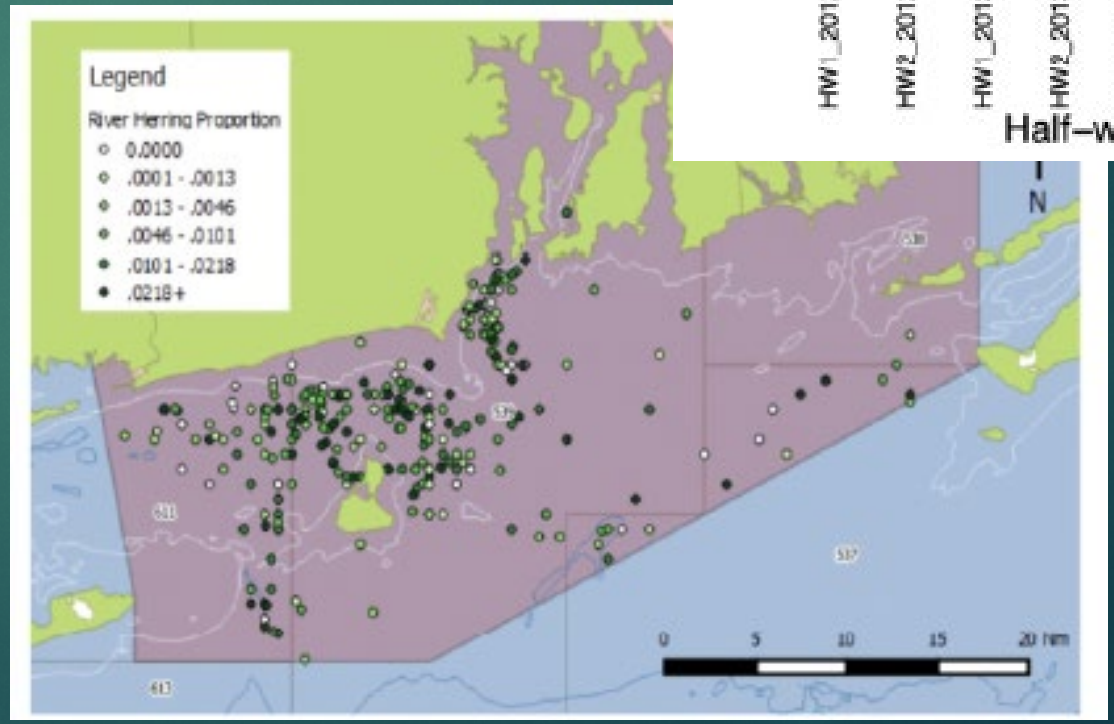




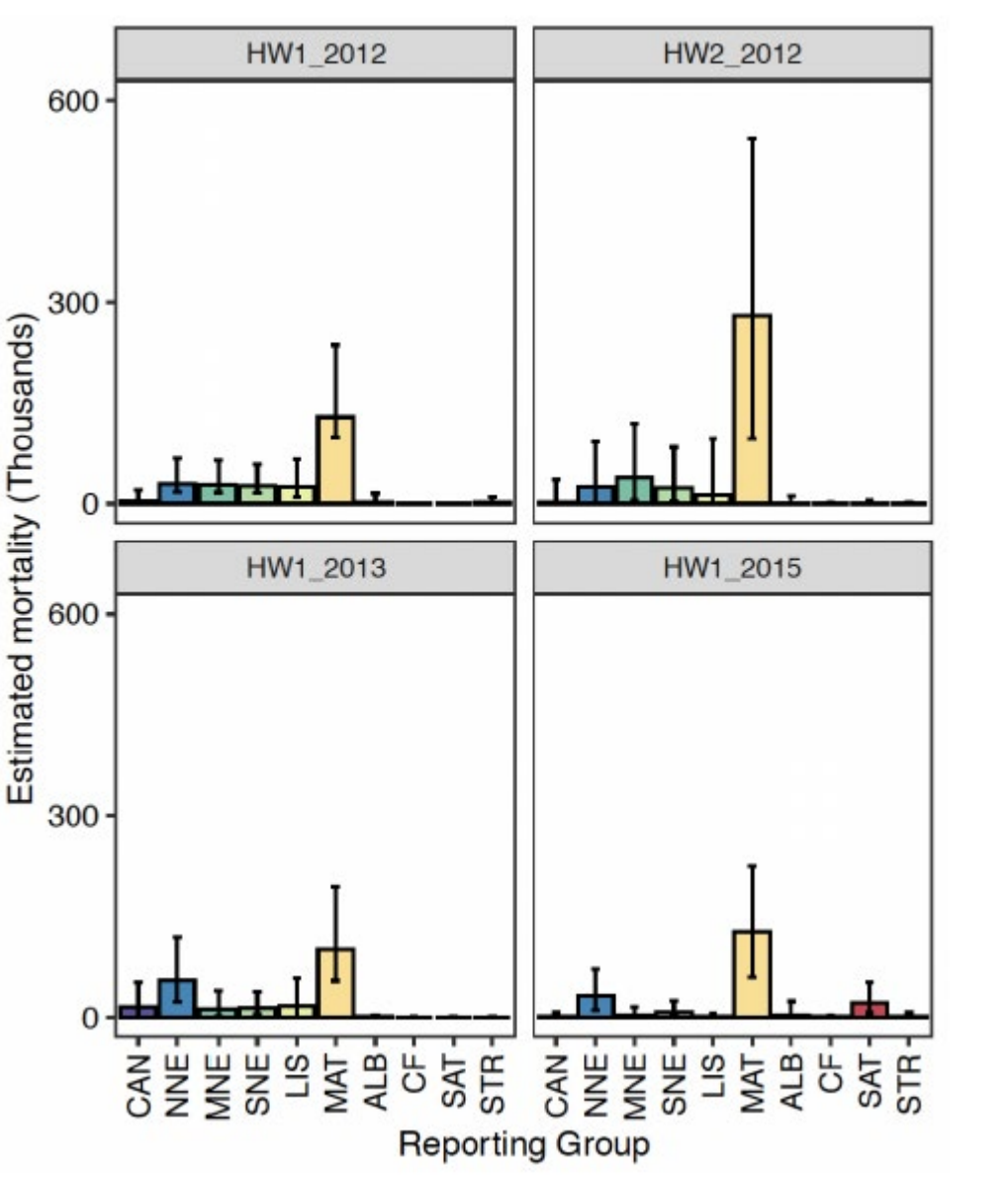
Ale bycatch in focal area

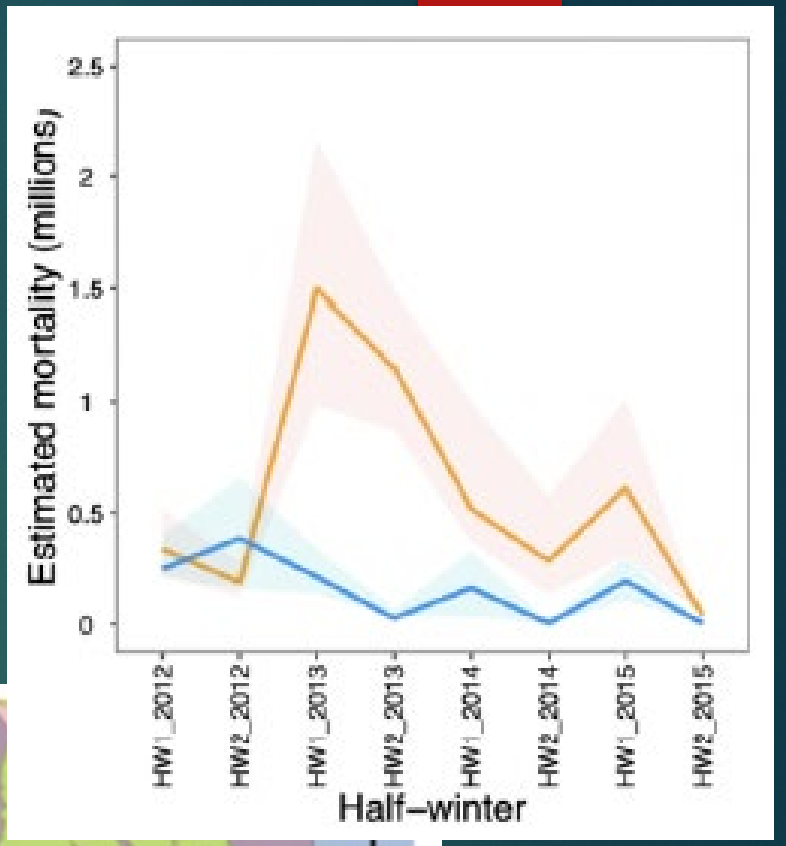


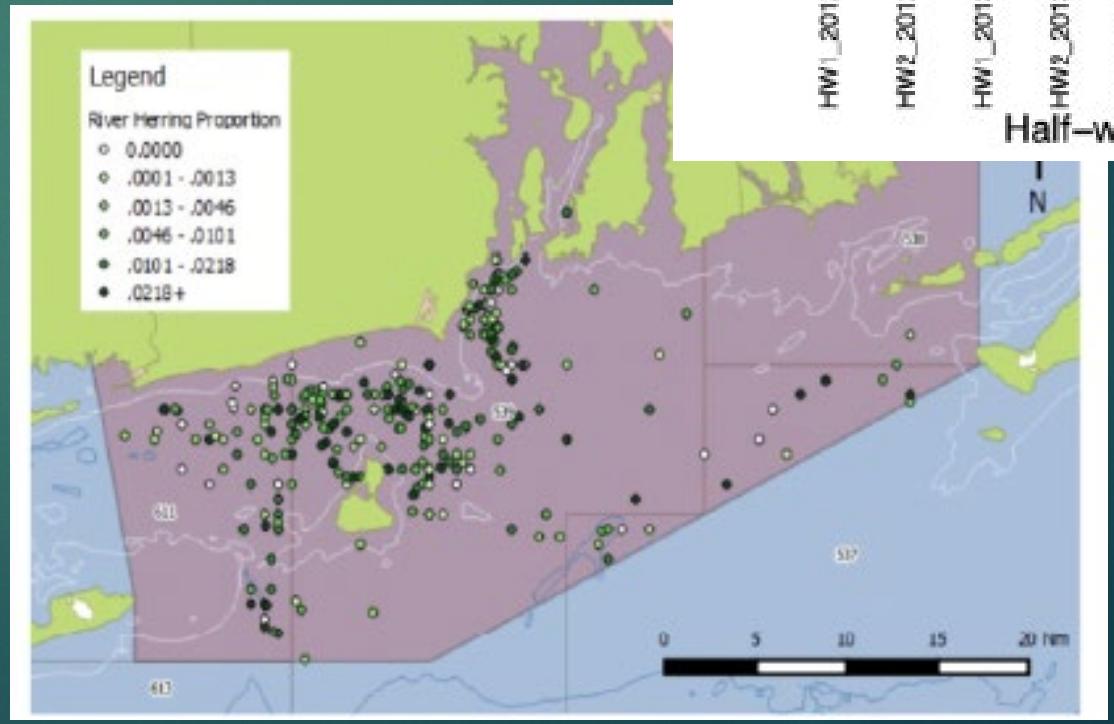




Blueback bycatch in focal area







Conclusions

- Removals are significant and consistently impacted populations in the proximity of the fishery and occasionally more distant groups.
- More alewife caught than bluebacks, as expected with relative stock sizes
- These data are from the tail end of the period of impact. Beginning in 2017, fleet effort was reduced, then greatly restricted in 2019, although bycatch amounts in these fisheries did not change as quickly.
- Tools exist to effectively monitor river herring bycatch in any fishery or survey but what about the infrastructure and funding to execute proper monitoring?

- Atlantic Herring Quota (mt)
  - 2012: 90,683 Area 2: 22,146 (22,482)
  - 2013: 106,375 Area 2: 30,000 (26,562)
  - 2014: 104,088 Area 2: 28,764 (19,626)
  - 2015: 112,517 Area 2: 32,100 (15,114)
  - 2016: 107,360 Area 2: 31,277 (13,462)
  - 2017: 101,656 Area 2: 31,277 (3,617)
  - 2018: 49,900 Area 2: 8,200 (7,071)
  - 2019: 9,762 Area 2: 4,062 (4,750)
  - 2020: 12,195 Area 2: 3,120 (353)
  - 2021: 5,128 Area 2: 652 (185)
  - 2022: 4,813 Area 2: 1,300 (74)

https://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/quota_monitoring_archive.html