# Striped Bass Survey Assessment and Habitat Connections

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**About the Scientific and Technical Advisory Committee**

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. For additional information about STAC, please visit the STAC website at www.chesapeake.org/stac.

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## Executive Summary

This report summarizes the **Striped Bass Survey Assessment and Habitat Connections** workshop, an event held in February 2025 that was dedicated to understanding the ongoing decline in Chesapeake Bay striped bass recruitment. The workshop, organized by the Scientific and Technical Advisory Committee (STAC) in support of the Chesapeake Bay Program's Fish Habitat and Forage Fish Outcomes, brought together researchers, managers, and stakeholders to evaluate the current state of science related to striped bass.

Key themes addressed during the workshop included:

- **Surveys and Stock Assessment:** Discussions highlighted the importance and methodologies of current striped bass monitoring programs in Maryland and Virginia, including the Adult Spawning Stock Survey and Juvenile Index Survey. The session also provided an overview of the coastwide stock assessment framework.
- **Habitat and Early Life History:** This session explored the links between habitat conditions and early life stages, focusing on spawning and recruitment dynamics. Topics included environmental influences on egg and larval survival, the impact of microplastics on juvenile striped bass, and modeling efforts to understand recruitment variability. A speculative hypothesis on blue catfish predation impacting striped bass recruitment was also presented.
- **Movement:** Discussions centered on striped bass migration and movement within the Chesapeake Bay, emphasizing how fish respond to environmental conditions and utilize different habitats. Research was presented, revealing patterns in seasonal migration, habitat selection, and juvenile dispersal.
- **Mortality:** This session examined drivers of striped bass mortality, including recreational release mortality, the effects of warming waters and degraded habitat, and disease prevalence (e.g., mycobacteriosis).

A pre-workshop public engagement survey gathered diverse stakeholder perspectives on juvenile abundance drivers, monitoring program accuracy, changing environmental conditions, and migration/mortality influences.

Structured breakout group discussions on distribution, recruitment, juvenile sampling, migration drivers, natural mortality, and knowledge gaps led to several cross-cutting priorities. These include the need to:

- Rebuild prey-field information through zooplankton time series and updated juvenile diet analyses.
- Modernize movement and mortality inputs via expanded acoustic receiver coverage, genetic sampling, and quantification of predator effects (e.g., blue catfish).
- Preserve the existing juvenile-index design while adding early life-stage metrics and environmental covariates.
- Re-evaluate mid-1990s reference points given sustained low recruitment.

- Align plain-language survey summaries across institutions for improved public transparency.

The report concludes with actionable recommendations categorized for the Atlantic States Marine Fisheries Commission (ASMFC) and the Chesapeake Bay Program (CBP). Recommendations for ASMFC and partners focus on maintaining survey integrity, supplementing surveys with targeted efforts, quantifying mortality through tagging studies, bounding expectations for future recruitment under environmental conditions, and investigating shifting spawning patterns. Recommendations for the CBP and its partners emphasize improving public transparency of survey design and results, establishing a formal fish habitat outcome within the Bay Program, and assessing the coherence of striped bass trends with other species to understand broader estuarine changes. These recommendations aim to refine understanding, prioritize research, and integrate ecosystem-based indicators to support the recovery and sustainable management of striped bass in a changing Chesapeake Bay.

## Introduction

Striped bass recruitment in the Chesapeake Bay has remained persistently below the long-term average since 2019, posing a significant challenge to population rebuilding efforts across the Atlantic Coast. This was the first workshop dedicated to the issue since 2009, highlighting both the urgency and the need for updated science. This decline raises critical questions about underlying causes, which may include shifting habitat conditions (e.g., water quality degradation, altered flow, and climate-related stressors), insufficient survey methodologies, or compounded pressures from predation and forage availability, including predation by both native and invasive species such as blue catfish. Given that Chesapeake Bay spawning grounds produce up to 90% of the coastal striped bass population, understanding these dynamics across all life stages is essential to safeguarding this ecologically and economically vital species. The workshop convened to address these uncertainties, focusing on the interplay between environmental drivers, life-stage vulnerabilities, and management-ready science.

Held in direct support of both the Chesapeake Bay Program's (CBP) Fish Habitat Outcome and Forage Fish Outcome, the workshop brought together researchers, managers, and stakeholders to evaluate the state of the science on striped bass. Key themes included spatiotemporal shifts in distribution, recruitment bottlenecks, migration dynamics, and mortality trends, with particular attention to survey design robustness and emerging stressors like invasive species (e.g., blue catfish) and changing water conditions (temperature, salinity, dissolved oxygen). Participants examined gaps in data collection and explored how existing monitoring programs might adapt to better capture population trends and ecosystem linkages. Workshop outcomes were intended to directly inform management agencies including Maryland Department of Natural Resources (MD DNR), Virginia Marine Resources Commission (VMRC), Potomac River Fisheries Commission (PRFC), DC Department of Energy and Environment (DC DOEE), and the Atlantic States Marine Fisheries Commission (ASMFC), as well as contribute to the STAC consensus report, the Comprehensive Evaluation of System Response (CESR) report, and guide the next iteration of Fish Habitat and Forage Outcomes beyond 2025.

The workshop structured discussions around pressing questions, such as:

- How have distribution shifts impacted the efficacy of Chesapeake Bay surveys?
- What biotic and abiotic factors most strongly influence recruitment success?
- What drivers underlie observed changes in migration patterns and mortality rates?
- How do catch-and-release practices and environmental conditions affect discard mortality?

Through these focused dialogues, the workshop identified actionable recommendations to refine surveys, prioritize research, and integrate ecosystem-based indicators into management. This report synthesizes those findings, highlighting consensus areas, knowledge gaps, and collaborative pathways forward to support striped bass recovery in a rapidly changing Chesapeake Bay.

To accommodate both in-person collaboration and federal travel restrictions in spring 2025, the workshop was designed as a hybrid event. While in-person attendance was strongly encouraged to facilitate discussion, virtual participation options were made available for both speakers and attendees. Additionally, the workshop proceedings were live-streamed to allow members of the public to observe the discussions. The complete workshop agenda can be found in Appendix A, while a full list of participants is provided in Appendix B.

**Pre-Workshop Public Engagement Survey**
To gather diverse stakeholder perspectives prior to the workshop, the MD DNR distributed a bilingual (English/Spanish) public survey titled "Striped Bass Monitoring and Associated Habitats in Chesapeake Bay" in early 2025. The survey received 170 responses from researchers, conservationists, anglers, and concerned citizens.

The 10-minute questionnaire addressed four key themes:

- Juvenile abundance drivers (e.g., water quality, predation by invasive species like Blue Catfish)
- Accuracy of current monitoring programs (Spawning Stock Survey, Juvenile Index)
- Changing environmental conditions (temperature shifts, seasonal changes)
- Migration/mortality influences (fishing practices, forage availability)

Notable findings from the pre-workshop survey can be found in Appendix D.

Survey results were synthesized and presented during workshop plenary sessions to ground discussions in community-identified priorities. Full anonymized responses are available upon request from Maryland DNR.

## Presentation Summaries

Workshop talks are summarized in the following section. Workshop presentation slides are available on the STAC *Striped Bass Survey Assessment and Habitat Connections* workshop webpage, accessible using the at https://www.chesapeake.org/stac/events/striped-bass-survey-assessment-and-habitat-connections/.

The workshop was organized into three main sessions, each focused on a critical aspect of striped bass science and management: (1) Surveys and Stock Assessment, (2) Habitat and Early Life History, and (3) Movement and Mortality. Descriptions of each session, including presentation topics and speakers, are provided below.

### Session 1: Surveys and Stock Assessment

This session provided an overview of current striped bass monitoring programs and stock assessment efforts across Maryland and Virginia. Presenters highlighted key methodologies, long-term trends, and the role of survey data in informing management decisions. The session also included a general overview of the coastwide stock assessment framework, helping to contextualize regional monitoring within the broader Atlantic striped bass population assessment. Invited Talks:

- Beth Versak and Eric Durell (MD DNR) – Overview of Maryland Striped Bass Surveys
- Troy Tuckey (VIMS) – Overview of Virginia Striped Bass Surveys
- Gary Nelson (Massachusetts Division of Marine Fisheries) – General Overview of the Stock Assessment

### Overview of MD Striped Bass Surveys – *Beth Versak (MD DNR)* and *Eric Durell (MD DNR)*

The MD DNR Striped Bass Program conducts fishery dependent and independent surveys throughout the year that produce important components of the coast-wide stock assessment. Since 1985, the annual Adult Spawning Stock Survey has been conducted during April and May in the upper Bay and Potomac River spawning areas. Experimental multifilament drift gill nets are fished daily at randomly selected sites within each area. Gill nets are approximately 1,500 feet long with 10 mesh sizes from 3 to 10 inches. Results include estimates of relative abundance-at-age, expressed as catch-per-unit-effort (CPUE). CPUEs are selectivity corrected, calculated by age, area and sex, and combined and weighted by spawning area. Aggregated CPUE estimates and age composition data are key indices in the stock assessment.

The annual Juvenile Index Survey has been conducted since 1954, producing an index of relative abundance of young-of-year (YOY) striped bass. The YOY index is accepted as the best measure of striped bass spawning success and is a proven indicator of future adult abundance. The survey is conducted at 22 sites in four major spawning areas that constitute 96% of spawning areas in the Bay: the Potomac, Choptank and Nanticoke rivers, and the Head of the Bay. A 100 ft X 4 ft X ¼ inch mesh seine is stretched from shore by hand and swept in a large arc. Fish are sorted, identified, counted and a subsample is measured. The YOY index is calculated as the arithmetic mean (AM) catch per seine haul of YOY striped bass. The geometric mean (GM) catch per haul, used in stock assessment, has been below average for the past six years.

Fishery dependent surveys include monitoring the commercial fishery harvest and sampling the resident stock from pound nets. MD DNR has sampled commercial harvest from the Bay and the Atlantic Ocean since 1993. Resident striped bass are sampled from commercial pound nets around the Bay. Data from these surveys are used to construct age-length keys and catch-at-age matrices for commercial and recreational fisheries. These products are important components of the stock assessment.

Survey methods and results have recently received criticism from constituents who believe that fish are being missed in time and space, and that the survey designs contribute to the lower catches of fish. To address these concerns, additional gill netting was conducted on the spawning grounds in March 2024. Striped Bass were present, but none had spawned, and water temperatures were too low to initiate spawning. Additional fish community surveys sampled several rivers in the middle-Bay region using the same methods as the Juvenile Index Survey. Results were consistent with the official Juvenile Index, indicating that large unknown populations of YOY striped bass were not present in these areas. The Department continues to promote information to better explain its surveys and methods.

**Overview of VA Striped Bass Surveys – *Troy Tuckey (VIMS)***

The Virginia Institute of Marine Science (VIMS) conducts multiple surveys that capture Atlantic striped bass including the Striped Bass Seine Survey, Juvenile Fish Trawl Survey, Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), and the Striped Bass Tagging Program.

The Striped Bass Seine Survey (SBSS) has been in operation since 1967 (with a gap between 1974 and 1979) and targets juvenile striped bass in Virginia nursery habitats (Rappahannock, York, Mattaponi, Pamunkey, Chickahominy, and James rivers). Thirty-nine fixed sites are visited five times every summer and sampled with a 30.5-m beach seine (6.4 mm mesh). Site locations were chosen above and below, as well as within, the core nursery area for striped bass to allow for expansion and contraction of the nursery resulting from variation in year-class strength and river flow. At index stations, two hauls are conducted with a 30-min break in between hauls and at auxiliary stations only a single haul is collected. An index of abundance is calculated using both hauls from index sites and the resulting index is used as a recruitment index to track spawning success and for use in the ASMFC stock assessment.

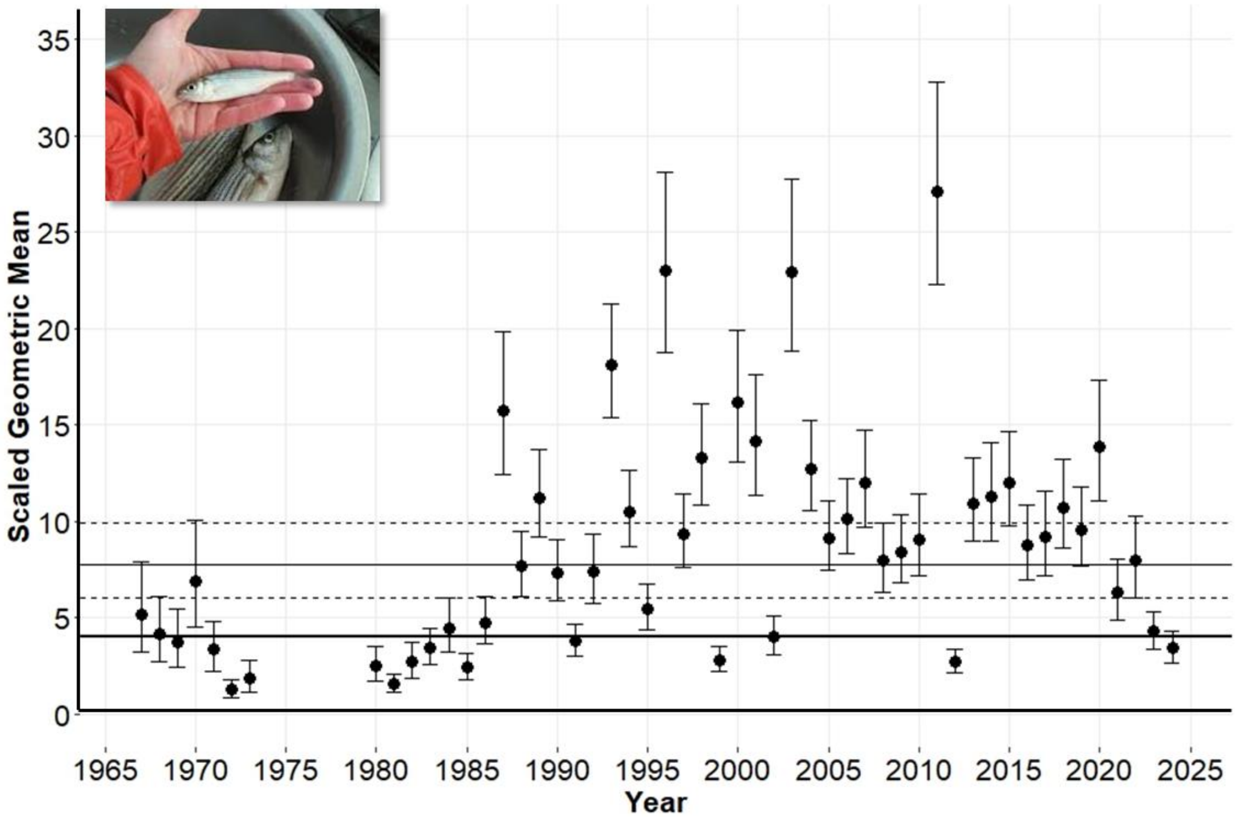


**Figure 1.** Scaled geometric mean of young-of-the-year Striped Bass in the primary nursery areas of Virginia (index stations) by year. Vertical bars are 95% confidence intervals as estimated by ± 2 standard errors of mean. Horizontal lines indicate the arithmetic mean (thin solid), confidence intervals (dashed) and 1st quartile (thick solid) during the reference period from 1980-2009 (ASFMC 2010).

Data from the SBSS are also used to address research questions focused on striped bass biology and ecology. For example, Phillips (2020) examined hatch date distributions of juvenile striped bass and found a shift to earlier hatch dates in recent years (1996-2017) compared with historic years (pre-1995). The shift could be the result of an increase in older females in the spawning stock, which tend to spawn earlier than younger females. Phillips (2020) also examined growth and condition of juvenile striped bass and found that mean daily growth rates were higher in the James River compared with the Rappahannock River while mean condition was higher in the Rappahannock River. Furthermore, the mean daily growth rate in 2011, a year with the highest index of abundance, was slower than growth rates in 2016 and 2017, suggesting density-dependent growth. Dixon et al. (2024) used data from the VIMS SBSS and the MD DNR SBSS to examine habitat suitability of age-0 striped bass in the Chesapeake Bay. Modeling results found that surface dissolved oxygen and two current speed metrics explained 78% of the variation in abundance of age-0 striped bass and during late summer there is a significant relationship between the extent of optimal habitat and abundance of age-0 striped bass. Dixon et al. (2024) also found that habitat suitability varied throughout the summer and among years (1996 – 2017). Some areas of the bay consistently supported suitable habitat for age-0 striped bass including the Potomac, Nanticoke, and Pocomoke rivers.

The Juvenile Fish Trawl Survey (JTS) samples the Virginia portion of Chesapeake Bay and the estuarine portion of the Rappahannock, York, and James rivers using a 6.4-m otter trawl (12.8 mm mesh with 6.4 mm liner) under a stratified-random sampling design. Twenty-two stations in each river and 45 stations in the Bay are sampled monthly except that the bay is not sampled during January or March. Consistent sampling has occurred since 1988 though data are available back to1955. Age-0 striped bass abundance indices between the VIMS SBSS and JTS are significantly correlated (Spearman's rho, $P < 0.001$) lending support that they are both tracking year-class strength of the age-0 cohort of striped bass. Schloesser and Fabrizio (2019) examined age-0 striped bass condition collected from the James, York, and Rappahannock rivers. During winter months (November – March) age-0 striped bass were only collected in the estuaries and none were encountered in the Bay showing a preference for estuarine nursery habitats. However, striped bass condition varied within and among the estuaries indicating that not all estuarine areas are equal.

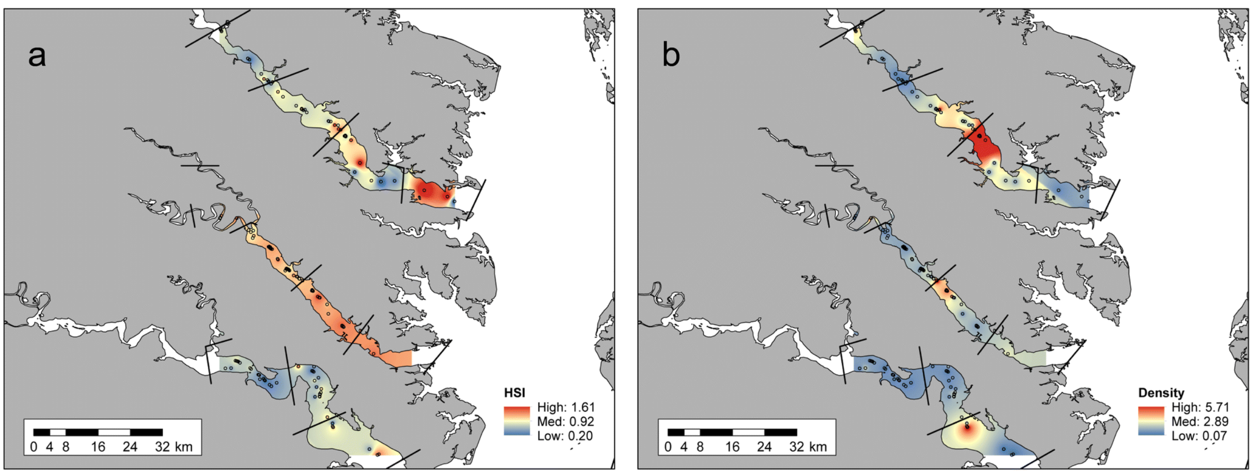


**Figure 2.** Spatial patterns in (a) juvenile Striped Bass body condition (measured as log-transformed, time-adjusted Hepatosomatic Index, HSI) and (b) juvenile density (individuals per 100 m²) at sampled sites (circles) during winter months (November–March, 2010–2013). Warmer colors (red) indicate higher mean condition or density; cooler colors (blue) indicate lower values. Maps show interpolated estimates based on optimal spatial weighting. Note: Juvenile Striped Bass were not collected in the Chesapeake Bay, Mobjack Bay, or the coastal lagoon during this study period.
*Source: Schloesser and Fabrizio (2019), "Nursery Habitat Quality Assessed by the Condition of Juvenile Fishes: Not All Estuarine Areas Are Equal".*

The VIMS ChesMMAP began in 2002 and samples the mainstem portion of the Chesapeake Bay. Cruises are conducted in March, June, September, and November. All striped bass are measured, weighed and fish are processed for otoliths (scales are taken from a subset of fish for comparison with otolith ages), stomach contents, and Mycobacteriosis. Age-specific abundance indices and diet data are available using the following link: https://www.vims.edu/research/units/programs/multispecies_fisheries_research/

The Striped Bass Tagging Program began in 1991 and from 1991 to 2017 striped bass were tagged from pound nets fished in the Rappahannock River. Beginning in 2018, striped bass are collected by electrofishing in the James, Rappahannock, and Mattaponi rivers from March to May and fish are measured, tagged and released. To collect adult striped bass for biological samples, multi-panel gill nets are fished in the James and Rappahannock rivers from mid-

February to May. Gill nets are fished for 24 hours and the catch is sorted and striped bass are processed for length, weight, and age (otoliths and scales). Striped bass indices of abundance are available from 2018 – 2024 for the James and Rappahannock rivers from this survey.

**General Overview of the Stock Assessment – *Gary Nelson (Massachusetts Division of Marine Fisheries)***

A stock assessment update for striped bass was conducted in 2024 to estimate age-specific abundances and fishing mortality rates that are used to determine stock status. The current peer-reviewed model is the single-stock statistical catch-at-age model that requires data on age-specific total removals (harvest plus dead discarded/released fish), relative abundance indices, and age-specific biological information (natural mortality rates, female sex proportion, spawning stock biomass weights, and female maturity proportions). The time series of striped bass removals, split into "Chesapeake Bay" and "Ocean" fleets, and indices for 14 relative abundance surveys were updated to include data from 2022-2023. All indices included in the assessment model had been critically examined by the ASMFC Technical Committee using inclusion criteria established in the 2007 ASMFC Indices Workshop. The index data used in the modelling include Maryland, Virginia, New Jersey, and New York young-of-the-year surveys, Maryland and New York age-1 surveys, and multiple age composite surveys: ChesMMAP, Maryland Gill Net, Delaware's Trawl, Delaware electrofishing, New Jersey Ocean trawl, Connecticut Long Island Sound and an MRIP catch per trip index.

Results from the stock assessment update indicate that the Atlantic striped bass stock was overfished in 2023. Fishing mortality was above the *F* target, but below the *F* threshold, indicating overfishing was not occurring. Female spawning stock biomass in 2023 was estimated at 86,536 metric tons (191 million pounds) which is below the updated SSB threshold of 89,513 metric tons (197 million pounds), and below the updated SSB target of 111,892 metric tons (247 million pounds). Total fishing mortality in 2023 was estimated at 0.18 which is below the updated *F* threshold of 0.21 per year, but above the updated *F* target of 0.17 per year. Although the stock is not experiencing overfishing, these results trip the *F* target trigger in Amendment 7 since *F* has exceeded the *F* target for two consecutive years while SSB is below the SSB target.

Additional analyses were conducted to show that fluctuations observed in the Maryland young-of-the-year index adequately represent year-class strength. Standardized total catch-per-trip indices from MRIP data were developed for Maryland, Massachusetts, and Maine using a delta-gamma model, and then the Maryland index was lagged to different ages and compared to the standardized indices using stepwise AIC to determine best lagged predictors. Results showed the pattern in total catch-per-trip for each state is predicted well by the lagged Maryland index, indicating fishing rates are driven by year-class strength, which is measured by the Maryland (YOY) index.

**Session 2: Habitat and Early Life History (TOR: Spawning, Recruitment)**

This session explored the connections between habitat conditions and early life stages of striped bass, with an emphasis on spawning and recruitment dynamics. Presentations addressed a range of topics including environmental influences on egg and larval survival, advancements in monitoring technologies, microplastic exposure in juveniles, and modeling efforts to understand recruitment variability across tributaries. The session concluded with a group discussion aimed at identifying key research gaps and future directions. Invited Talks:

- Jim Uphoff (MD DNR) – Habitat Impacts on Early Life History
- Hongsheng Bi (UMCES) – Adapting Plankton Scope Technology for Monitoring Eggs in Spawning Areas
- Ryan Woodland (UMCES) and Robert Murphy (TetraTech) – A First Look at Microplastics in Juvenile Striped Bass
- Simon Brown (MD DNR) – Examining Striped Bass Recruitment-Environment Relationships With Quantile Regression
- Julie Gross (VIMS) – Modeling the Effects of Environmental Conditions on Poor Striped Bass Recruitment, as Measured by the Juvenile Abundance Index
- Rachel Dixon (VIMS) – Investigating Synchrony in Striped Bass Recruitment Indices Across Chesapeake Bay Tributaries
- Dave Secor (UMCES) – Over-Predation of Striped Bass by Blue Catfish: A Speculative Hypothesis

**Applying lessons of the past to understand current poor Striped Bass recruitment year-class success – *Jim Uphoff (MD DNR)***

Year-class success of Chesapeake Bay Striped Bass is largely determined within the first three weeks of life in early spring and reflects highly variable, independent mortality at the egg-prolarval, and postlarval stages. Surveys of eggs or larvae on the Striped Bass spawning and nursery grounds conducted since 2013 provided information on egg dispersion and spawning status, water quality (temperature, pH, conductivity, salinity, dissolved oxygen, and alkalinity), and feeding success on zooplankton. Recent estimates were compared to past ones, some of which were readily available (the Maryland juvenile index or JI and USGS river discharge; 1957–2024 time series) and others developed from old data sheets, printouts, files, and reports.

The most prominent factor identified in Nanticoke and Choptank rivers was progressive shortening of Striped Bass spawning season due to warming temperatures since about 2000 (1954-2024 time-series). Spawning has become concentrated earlier in the season when temperatures can be volatile and lethally low for eggs and prolarvae. Preliminary analyses indicated connections of spawning temperature milestones to regional winter temperatures and the North Atlantic Oscillation Index. An egg presence index of spawning stock status and dispersion was not low enough in recent years to negatively influence year-class success (1955-2024 time-series). Even though feeding incidences of first-feeding Striped Bass postlarvae on cladocerans and copepods in Choptank River during 2023-2024 were comparable to years of high survival and year-class success during 1980s surveys, 2023-2024 year-classes were poor. River discharges for the four main spawning areas have exhibited lower highs and more frequent lows since 2011. Poor year-classes are highly likely when flows are low, but feeding success on zooplankton in the Choptank River has not supported a flow-related match or mismatch of zooplankton. Alkalinity and pH, implicated in toxic conditions in some areas during the 1980s, improved markedly in the Choptank River since 2013. Trends of Baywide JIs of Striped Bass, White Perch, and Yellow Perch were highly and positively correlated ($r = 0.73$-$0.86$; $P < 0.0001$), indicating an issue reflecting shared larval habitat. Correlation of the Potomac River Striped Bass JI and adult Blue Catfish relative abundance was weak ($r = -0.23$, $P = 0.21$, 1995-

2024) and did not provide much support for high predation on early life stages by this predator.

**Adapting Plankton Scope Technology for Monitoring Eggs in Spawning Areas – *Hongsheng Bi (UMCES)***

Zooplankton play a fundamental role in marine ecosystems, serving as a critical food source for fish larvae and influencing overall ecosystem productivity. In the Chesapeake Bay, the large copepod Eurytemora is a key prey species for striped bass larvae, making its seasonal abundance and distribution important for recruitment success. This study examines the impact of winter storms on zooplankton population dynamics using high-resolution in situ imaging. The PlanktonScope system was deployed at the CBL research pier to capture detailed plankton images, generating a high-resolution time series of plankton data. Results reveal strong seasonal fluctuations and storm-driven shifts in zooplankton abundance, underscoring the importance of high-frequency monitoring to detect rapid ecological changes. Additionally, deep learning models, including LSTM and NBEATS-x, enhance both the accuracy and capability of forecasting plankton dynamics. This research improves our understanding of wintertime plankton dynamics and underscores the potential of machine learning for ecosystem prediction and management. Furthermore, in situ underwater plankton imaging systems can provide critical insights into prey availability in striped bass spawning habitats.

**A First Look at Microplastics in Juvenile Striped Bass – *Ryan Woodland (UMCES)* and *Robert Murphy (TetraTech)***

Microplastic pollution is ubiquitous throughout the world’s aquatic ecosystems. In the Chesapeake Bay watershed, microplastics have been documented in all regions and habitats in which sampling has occurred. Recent research in the Potomac and Anacostia rivers in the Washington, DC, metro area showed that microplastics are present in the stomachs of a wide range of functional trophic guilds of fish, from planktivores to piscivores (Murphy and Woodland 2022). As part of that study, a pilot analysis of YOY striped bass collected from the oligo- to mesohaline reaches of the Potomac River found 25% of fish had microplastics in their stomachs (Murphy and Woodland 2022). It is unclear what effect(s) microplastics have on YOY striped bass in the Chesapeake Bay but studies on other aquatic species (including fish) have documented a range of potential negative physiological effects (i.e., reduced consumption, growth, reproduction, survival; Foley et al. 2018).

Following up on these preliminary findings, researchers at Tetra Tech, Inc. and the University of Maryland Center for Environmental Science (UMCES) are evaluating the potential for trophic transfer of microplastics to YOY striped bass and evidence of short-term physiological effects of microplastic ingestion for YOY striped bass. A meta-analysis of published YOY striped bass diet in the Potomac River identified mysids as an important prey taxon (Murphy, Flippin, Woodland 2021); as a result, a field study was conducted on the Potomac and Patuxent rivers to evaluate the evidence that mysids could serve as a source of microplastics to YOY striped bass via trophic transfer in those systems. In both rivers, microplastics were present in the stomach contents of mysids, supporting the hypothesis that YOY striped bass could be exposed to microplastics by consuming mysids. Further, mysid consumption of microplastics has been shown to further fragment microplastics into much smaller pieces, suggesting mysids may also serve as a trophic vector for nano-scale plastics that have the potential to traverse the stomach lining and accumulate in other tissues. Future work will assess evidence of physiological responses of YOY striped bass fed microplastics-dosed mysids under laboratory conditions.

**Examining Striped Bass Recruitment-Environment Relationships With Quantile Regression – *Simon Brown (MD DNR)***

Quantile regression provides a method for assessing how environmental factors limit an organism's ecological response (e.g., the 90th conditional quantile). Previous studies have established that spring river discharge and winter temperatures influence striped bass recruitment through larval transport and food-web dynamics. However, due to complex ecosystem interactions involving numerous unmeasured or unknown variables, recruitment outcomes remain unpredictable. Quantile regression was used to estimate the conditional probability distribution of striped bass recruitment in response to specific levels of spring river discharge and winter temperature, offering insight into how recruitment has responded to environmental conditions. The recent period of poor recruitment (2019–2024) despite moderate spawning stock biomass appears to be driven by anomalously warm winters. In contrast, the environmental conditions considered were generally favorable during the historically low recruitment period (1982–1988), when the spawning stock was severely depleted.

**Modeling the Effects of Environmental Conditions on Poor Striped Bass Recruitment, as Measured by the Juvenile Abundance Index – *Julie Gross (VIMS)***

A recent study characterized patterns of recruitment for 7 distinct striped bass populations in major Chesapeake Bay tributaries using the "poor-recruitment paradigm" (Gross et al. 2022, Fish. Res. 252, 106329) approach which states that extreme (i.e., lethal) environmental conditions lead to increased juvenile mortality which, subsequently, will consistently cause poor recruitment. Age-0 juvenile abundance indices (as a measure of recruitment) were examined in relation to the average annual spring river discharge which is a factor known to impact juvenile striped bass survival. Researchers defined "extreme" environmental conditions as the lowest $1/3^{rd}$ of river discharges values; the remaining $2/3^{rd}$ were therefore considered "non-extreme". Then, for each of these environmental categories, three metrics were calculated to describe recruitment patterns: the median recruitment, the standard deviation of recruitment, and the proportion of years that recruitment was considered "poor" (defined as being below the median recruitment of non-extreme conditions). During extreme river discharge conditions, the median recruitment was significantly reduced for all 7 tributaries (Table 1) as compared to non-extreme conditions. Poor recruitment was also a consistent outcome during extreme river discharge conditions, as evidenced by standard deviations that were notably lower than those of non-extreme conditions.

To model these patterns of poor recruitment, the study recommended using a three-parameter hockey stick model which emphasizes a linear environment-recruitment relationship for extreme values of environmental conditions; once environmental conditions are non-extreme, the relationship switches to a constant value of recruitment signifying that the environmental variable has become uninformative (in terms of recruitment prediction). Cross validation of the hockey stick model showed that its recruitment predictions perform better (i.e., had lower prediction error) than using a simple mean or a recent 5-year mean. This result suggests that, in the case of striped bass, inclusion of influential environmental variables in a recruitment prediction model can be beneficial. Additionally, the estimated location of the change point of the hockey stick model has the potential to be used as a biological reference point that identifies sufficient environmental conditions which will result in decreased recruitment.

| River | Choptank | James | Patuxent | Potomac | Rappahannock | Susquehanna | York |
|---|---|---|---|---|---|---|---|
| % reduction median recruitment | 67.2% | 40.3% | 40.0% | 22.6% | 67.8% | 69.4% | 52.6% |

**Table 1.** Percent reduction in the median recruitment for each of the 7 tributary data sets examined. Percent reduction is defined as the difference between median recruitment in extreme and non-extreme environmental categories, divided by the median recruitment in non-extreme years.

### Investigating Synchrony in Striped Bass Recruitment Indices Across Chesapeake Bay Tributaries – *Rachel Dixon (VIMS)*

The Chesapeake Bay is the major estuarine producing area for Atlantic striped bass (Morone saxatilis) and overall dynamics of the coastwide stock most closely resemble patterns of relative abundance of age-0 fish produced in this region. The annual abundance of age-0 striped bass can vary more than 30-fold at 150 days post-hatch, and relative abundances of age-0 fish also vary among multiple tributaries and the upper Bay. Divergent behaviors or patterns of habitat use across space can result in differences in vital population rates such as recruitment among groups of fish. Synchrony of these individual population components in response to change can result in depressed productivity; conversely, asynchrony may confer stability and promote resilience to disturbance. The degree of synchrony in striped bass recruitment among Chesapeake Bay tributaries, and drivers of divergent production within the Bay, remain largely unexplored. To address this question, catch data of juvenile (age-0) striped bass from fishery-independent surveys – VIMS Juvenile SBSS and MD DNR Juvenile Striped Bass Survey – were used to generate time series of recruitment from 8 sub-watersheds in the Chesapeake Bay. Dynamic factor analysis was applied to identify common trends across all time series for a 37-year period from 1985-2021. The relationship between trends in recruitment and several variables hypothesized or established to impact year-class strength and production in this species were investigated, including spawning stock biomass, spring temperature and freshwater discharge, and human population in coastal Bay counties. Patterns in recruitment were found to be best represented by multiple common trends, with some evidence of synchrony (shared patterns of recruitment) between specific tributaries. Spawning stock biomass, freshwater discharge, and coastal population were all found to influence recruitment, but no single factor had a significant impact on production across all eight tributaries. Given the current overfished status of this species, identifying the level of synchrony evident in recruitment within this major producing area could afford insights on mechanisms driving regional population dynamics and inform future management efforts.

**Over-Predation of Striped Bass by Blue Catfish: A speculative hypothesis – *Dave Secor (UMCES)***

Sustained periods of depressed abundance in forage fish species occur as a result of efficient predation by co-occurring predators (Bakun 2006). This depensatory state, also termed a predator pit, emulates a Type III (logistic) predator-prey function (Houde and Shekter 1980), where prey are held in check at a depressed constant abundance level because they do not satiate predators at higher prey abundances, and at lower scarce prey abundances, they are less likely to be consumed owing to increased capture costs. Corollaries of the predator pit hypothesis include, (1) prey abundances persist at a low and constant (low variance) level; (2) escape from the predator pit require large food web changes in the abundance/behaviors of predator and/or prey; (3) with a very abundant predator(s), prey species can be held in check sustainably for long periods of time, emulating a regime change (Secor 2015).

Highly correlated and synchronous responses of distributed individuals and/or populations indicate a common ecological driver (Manderson 2008). For instance, white perch juveniles distributed across tributaries showed high correlations between some tributary pairs, and this correlation was driven by river discharge, suggesting a common driver (Kraus and Secor 2005).

Premises, evidence of a MD juvenile striped bass predator pit:

- Hyper-abundance and high trophic demand by blue catfish in Chesapeake Bay tributaries.
    - The irruption (geometric increase in abundance and spatial extent) of blue catfish in Maryland waters likely occurred over the past 5-7 years according to state landings and MD Department of Natural Resource scientists.
    - Side-scan surveys for Atlantic sturgeon in the Marshyhope Creek (striped bass nursery and tributary to the Nanticoke River), during August-September (2020-present; Coleman et al. 2024) showed large numbers of 0.5-1 m targets. Coincident trawling captured a predominance of blue catfish. For a 2000 survey, images were sampled indicating these "blue catfish" targets occurred at ~1 fish per 30 $m^2$, or 125 targets per acre. This estimate aligns with another (220 per acre) from a striped bass nursery region of the James River (Fabrizio et al. 2018).
    - Trophic demand by blue catfish was estimated for tributaries of the James River based on springtime diet collections, yielding an estimated 5.4 metric tons of striped bass per year for the entire James River (Hilling et al. 2023).
    - Converted to summer time juvenile striped bass predation (60 mm TL, 1 gram), this equates to 5.4 million juveniles, which is comparable to estimates of total juvenile abundance (1.7 and 4.6 million in 1992 and 1993) estimated for the Nanticoke River (Secor et al. 2017).
- Long-term depressed and synchronous juvenile abundance among MD tributaries.
    - Since 2019, the geometric mean catch (0.8) and associated coefficient of variance (CV=11%) are at record lows in comparison to the geometric mean (3.7) and CV (154%) for the full time series (Figure 1).
    - MD DNR scientists also report that site-to-site catches are consistently low within tributaries during the recent period.
    - In contrast, this dramatic shift towards depressed abundance and increased synchrony is not observed in the VIMS Virginia tributary seine survey.

Evidence supports blue catfish control of striped bass recruitments in MD but perhaps not in VA: Within MD tributaries, blue catfish are likely exerting top-down predation control on early life stages of striped bass and other native fishes. Direct evidence could be obtained through improved estimates of blue catfish density and trophic demand and diet selectivity studies. Such science could support ongoing CBP and state efforts to control blue catfish abundance and set expectations for future recruitment levels in the assessment and management of Chesapeake and shelf striped bass fisheries.

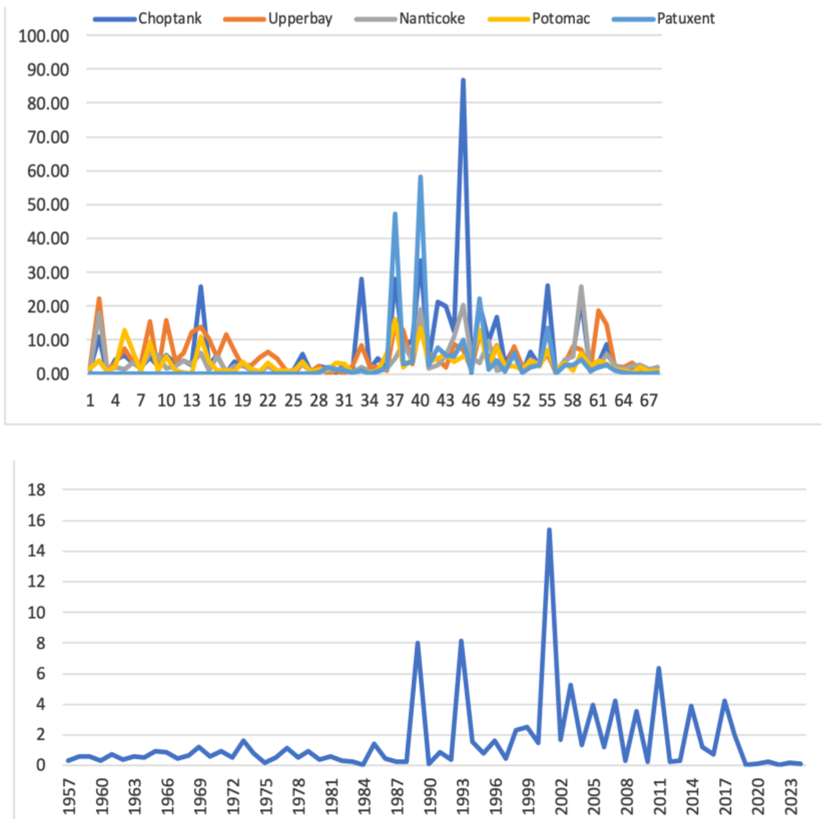


**Figure 3.** Trends from the Maryland Department of Natural Resources (DNR) striped bass seine survey, showing the geometric mean catch (top) and the coefficient of variation (CV, expressed as %CV × 100) (bottom) for each tributary. Source: MD DNR Juvenile Index.

## Session 3: Movement

This session focused on striped bass migration and movement dynamics within the Chesapeake Bay, with an emphasis on how fish respond to environmental conditions and use different habitats throughout their life stages. Presentations featured telemetry-based research that is helping to reveal patterns in seasonal migration, habitat selection, and juvenile dispersal. Understanding these patterns is key to informing management strategies that reflect the spatial and temporal complexity of striped bass behavior. Invited Talks:

- Pat Geer and Ethan Simpson (Virginia Marine Resources Commission) – Demonstrating the Value of the Chesapeake Bay Backbone Telemetry Array
- Dave Secor (UMCES) – Migrations, Water Quality Selection, and Mortality of Chesapeake Striped Bass: Inferences from Telemetry
- Rob Aguilar (SERC) – Diet and Movement of Young Striped Bass Within and Among Shallow Tributary Habitats of Chesapeake Bay

**Demonstrating the Value of the Chesapeake Bay Backbone Telemetry Array – *Pat Geer (VMRC)* and *Ethan Simpson (VMRC)***

VMRC has been partnering with MD DNR and UMCES in an acoustic telemetry program through NOAA Chesapeake Bay Office (NCBO) since 2021. The array sections act as "gates" in the Bay with transects across the upper Bay near the Chesapeake Bay Bridge (MD DNR), mid Bay near Solomons Island, and the Bay mouth across the Chesapeake Bay Bridge Tunnel (VMRC). The purpose is to track movement of tagged fishes as the migrate into, reside, and emigrate from the Bay. The Bay mouth array includes 16 receivers adjacent to the CBBT and has been collecting data since 2021. A total of 759 uniquely tagged fish have been detected by the array through the Fall of 2024 (N=64,589 total detections) from 32 different projects across 11 states. Nearly 80% of the detections are from Atlantic Sturgeon, Spotted Seatrout, and Cobia. The furthest fish was from Sarasota, FL and the most interesting was a sawfish initially released in Florida.

In addition to maintaining the array, VMRC received funds from ASMFC and the Virginia Secretary of Natural Resources to tag adult striped bass to study their migration patterns. Fourty-six fish were tagged in the James and Rappahannock Rivers between 2022 and 2024 with the help of the VIMS Electrofishing Survey. Nine examples were presented with: 1) one male overwintering on the James River spawning grounds; 2) seven fish migrating to, and residing off, Long Island and Block Island during the summer months: 3) two fish were detected on the mid-bay and upper Bay arrays; 4) two fish spent time in Delaware Bay, one in the Hudson River and three in the Gulf of Maine; 5) seven of the nine fish made the northward migration during the summer and returning to the Bay spawning grounds the following spring; and 6) One fish has accomplished that migration three years in a row with similar locations and timing annually. VMRC is hoping to secure funding in the future to continue these tagging efforts with the addition of red drum and cobia.

**Migrations, Water Quality Selection, and Mortality of Chesapeake Striped Bass: Inferences from telemetry – *Dave Secor (UMCES)***

Particularly during summer months (June-August), biotelemetry studies support that resident striped bass select waters <27 C and dissolved oxygen levels >30% saturation (Itakura et al. 2021; Kraus et al. 2015), generally aligning with previous concepts of habitat selection (Coutant 1985) and Chesapeake Bay Program water quality criteria (Batiuk et al. 2009; Bay Program 1992). Depth-sensor tags showed that striped bass in the Patuxent River avoided hypoxic sub-pycnocline waters during summer months; during other months with no stratification, striped bass occurred throughout the water column (Kraus et al. 2015). Approximately half of the tagged striped bass in the Patuxent River study (size 42-69 cm total length) left during summer months, suggesting a partial evacuation behavior, perhaps caused by habitat compression within the Patuxent River (Wingate et al. 2011). Still, during spring and summer months, resident striped bass, principally tagged and released into the Potomac River selected lower salinity conditions <15 ppt, than in fall and winter when the selected salinities >15 ppt (Itakura et al. 2021).

Conventional tagging and telemetry-based mortality estimates for resident striped bass are very high. Fall telemetry-tagged Potomac River striped bass, predominantly less than 60 cm total length experienced 70% loss rate during the first year following tagging (Secor et al. 2020). For Chesapeake striped bass with conventional external tags, annual loss rates (total mortality) also exceed 50% per year (NEFSC 2019; Groner et al. 2018; Schoenfeld 2023). Tributaries can become particularly thermally stressed during summer months, leading to positive feedback between thermal stress, infection severity by mycobacteriosis, and catch and release mortality; in a directed tagging study, mortality approached 80% for severely infected fish (Groner et al. 2018). As a result, Chesapeake Bay jurisdictions have all but closed summertime striped bass fisheries, a likely casualty of climate warming (Secor and Gary 2024).

Striped bass show high plasticity in migration behaviors (Mansueti 1961; Secor 1999). Ocean incidence varies by sex and increases with size and age (aka "differential migration;" Chapoton and Sykes 1961; Mansueti 1961), although high abundance of smaller immature striped bass has been noted in near shelf waters (Hollema et al. 2017; Merriman 1941). Conversely, a minority of large adult striped bass never migrate to shelf waters (Secor and Piccoli 2007). Analyzing striped bass tagged in the Potomac River (Chesapeake Bay), Kohlenstein advanced an early hypothesis related to differential migration: that young striped bass remain in or near the tributary in which they were spawned for two or three years (Kohlenstein 1980). After this age, a substantial proportion (~50%) of immature females emigrate from the Bay, while the remaining immature and mature males remain in the Bay throughout their lives. In a Bayesian framework applied to conventional tagging data (n = 56 ocean returns), Dorazio et al. contrasted patterns of likely size-specific egress by Chesapeake Bay and Hudson River striped bass and predicted that ~50% of striped bass egress at sizes >80 cm total length, regardless of sex (Dorazio et al. 1994). Based on otolith tracer analysis of 82 females and 40 males, Secor and Piccoli also detected a trend of increasing egress with length, with approximately 40% predicted to egress at >80 cm TL (Secor and Piccoli 2007).

Dorazio's prediction of differential migration by striped bass at a relatively large size (>80 cm TL) was confirmed in a recent large telemetry study, which tagged 100 Potomac River striped bass (40 – 120 cm TL) and tracked them over a 5-year period (Secor et al. 2020). Knife-edge recruitment to the shelf stock was predicted at 80 cm, regardless of sex. Further, fish tagged at <80 cm were shown to join the shelf stock as they grew and exceeded 80 cm TL during the 5-year study. Spring shelf migrations were rapid. Chesapeake Bay striped bass joined with members of other populations and within weeks arrived in Massachusetts waters where they persisted throughout summer and early fall months (Rothermel et al. 2024; Secor et al. 2024; Secor et al. 2020).

A recent genetics study supports early hypotheses that small Chesapeake Bay striped bass enter shelf waters (Mansueti 1961; Merriman 1941). Samples drawn from coastal regions of Massachusetts in 2018 were screened with SNP genetic markers and compared to baseline reference samples representing classified striped bass populations (Kennebec-Hudson, Delaware-Chesapeake, and North Carolina) (Gahagan 2024). Estimated proportions of the Delaware-Chesapeake population ranged between 77% and 89%. The Buzzards Bay/Vineyard Sound sample, with most individuals <71 cm, yielded the highest contribution rate (89%). The presence of Chesapeake striped bass <71 cm in shelf waters suggests that there may be a smaller contingent of 1- and 2-year-old striped bass leaving the Chesapeake Bay (note, these fish were not sampled in the Secor et al. 2020 study).

**Diet and Movement of Young Striped Bass (*Morone saxatilis*) Within and Among Shallow Tributary Habitats of Chesapeake Bay – *Rob Aguilar (SERC)***

Striped bass (Morone saxatilis) are large anadromous fish native to eastern North America that migrate annually from offshore areas to freshwater spawning habitats and serve as dominant predators within these systems. Although both the diet and movement of adult striped bass have been studied extensively, their spatiotemporal patterns across ontogeny remain poorly understood, particularly for young fish in shallow nursery habitats. This study examines the diet and movement of YOY and juvenile striped bass in the Chesapeake Bay.

During the summer and fall of 2018, the stomach contents of 241 striped bass were collected across nine Chesapeake Bay (MD & VA) tributaries using either morphological or metabarcoding methodologies. In combination, numerous key prey taxa were identified as underrepresented in adult diets, including insects (primarily dipterans), grass shrimp (*Palaemon* spp.), killifish (*Fundulus* spp.), silversides (*Menidia* spp.), and small bivalves (e.g., *Mya arenaria*). Metabarcoding produced a large number of species level assignments for important prey taxa, including fish, polychaetes, crustaceans, and mollusks, far exceeding morphological examinations. Most strikingly were multiple sequences of the non-native amphipod *Grandidierella japonica*, the first report for Chesapeake Bay (Lohan et al. 2023).

During July–October 2020, 40 young (269–575 mm TL; mean ±SE = 349 ±11 mm) striped bass with acoustic transmitters (Innovasea V9; lifespan = 803 days) were tagged in the Rhode River, Chesapeake Bay, MD. Tagged fish were detected by multiple arrays of receivers deployed in Chesapeake Bay, as well as additional receivers in the Atlantic Cooperative Telemetry (ACT) network (https://theactnetwork.com). Striped bass displayed a high degree of residency in Chesapeake Bay (with substantial movement among tributaries), though roughly a third of fish made forays into Delaware Bay via the Chesapeake & Delaware Canal, with nearly all returning to the Chesapeake Bay, and three fish were detected along the mid-Atlantic coast, as far north as Cape Cod, MA. This study provides key diet and movement information for an ecologically and commercially important predator species and further demonstrates the utility of metabarcoding in producing high-resolution taxonomic identifications and ability of cooperative telemetry networks to improve data-sharing over large geographic scales.

**Session 4: Mortality**

This session examined the key drivers of striped bass mortality in the Chesapeake Bay, with a focus on both environmental and anthropogenic factors. Presentations addressed topics such as recreational release mortality, the impacts of warming and degraded habitat, disease prevalence, and population-level implications. Speakers shared recent research findings and discussed challenges to accurately quantifying mortality, as well as potential management strategies to mitigate it and support population sustainability. Invited Talks:

- T. Reid Nelson (GMU) – Recreational Release Mortality in the Chesapeake Bay
- Tom Parham (MD DNR) – Impacts of Changing Bay Habitat Conditions on Summertime Resident Striped Bass
- Genny Nesslage (UMCES) – Trends in Mycobacteriosis and Associated Relative Mortality in Striped Bass in Maryland Waters of the Chesapeake Bay

**Recreational Release Mortality in the Chesapeake Bay – *T. Reid Nelson (GMU)***

Striped bass, one of the most popular Atlantic coast recreational fisheries, is currently overfished with catch-and-release mortality (CRM) constituting ~50% of recreational removals. This 50% is derived from a fixed CRM rate of 9% that does not account for regional and seasonal variations resulting from fluctuations in temperature or other environmental factors. As a result, the fixed CRM rate may be inaccurate, especially as summer temperatures continue to increase. The objectives of our study were to estimate CRM for striped bass, and the relationship of CRM with temperature. Considering the Chesapeake Bay is the greatest contributor to the coastal migratory stock, this study was conducted in a Chesapeake tributary amenable to study, the Patuxent River, MD.

Following collection with hook and line using light tackle and artificial lures (mimicking the recreational fishery), fish were tagged with a novel timed-release external acoustic tag, and detections were used to infer fates post-release. Striped bass were tagged during spring (n = 47), summer (n = 28), and fall (n = 22) 2024, and catch-and-release mortality (CRM) was modeled using a Bayesian multistate capture–recapture model consisting of three states: (1) alive, (2) mortality, and (3) emigration. Additionally, three fish were euthanized and tagged to confirm detection histories representative of release mortality. Results followed expected patterns, with the highest median CRM estimate of 11.4% (1.2%–28.6%, 95% CrI) in summer, followed by spring at 6.9% (2.9%–16.4%) and fall at 0.3% (0–14.7%), with an overall mean estimate of 7.4% (3%–15.2%). These results highlight the importance of restricting striped bass fishing during summer to reduce CRM in the Chesapeake Bay.

**Developing water temperature and dissolved oxygen criteria and visualizing the effect on summer habitat for resident Striped Bass in Maryland's portion of the Chesapeake Bay – *Tom Parham (MD DNR)***

Habitat criteria were developed from a literature review of Chesapeake Bay striped bass *Morone saxatilis* studies that evaluated temperature and-or dissolved oxygen (DO), and the update of the Temperature Oxygen Squeeze (TOS) hypothesis developed in southeastern United States reservoirs. The criteria development was confined to the size of striped bass likely to be Chesapeake Bay residents that do not participate in the Atlantic coast migration (mostly 3- to 6-year-old males along with some young, immature females) and constitute a year-round population providing Maryland's major saltwater recreational fishery and an important commercial fishery.

Four categories were defined for summer temperature and DO conditions for striped bass in Chesapeake Bay (suitable, tolerable, marginal, and unsuitable) and results from each study were interpreted and placed into these categories. Not all studies provided water temperature and DO values for all the categories. The DO criterion for suitable habitat determined differed from DO concentrations that are considered desirable for many Chesapeake Bay living resources (5 mg/L or greater) and have been adopted for tidal waters in Maryland, Virginia, and the District of Columbia's water quality standards regulations.

The newly developed criteria were applied to the Chesapeake Bay long-term and shallow water monitoring data collected over 501 cruises occurring between 1986 and 2019. Monitoring data were interpolated to create three-dimensional representations of Maryland's portion of the Chesapeake Bay water temperature and DO conditions. Visualizations were developed to show how the new criteria characterized Maryland resident striped bass in Chesapeake Bay waters from 1986 through 2019. Results show that beginning around 2010, there has been an increase in the frequency, severity and duration of striped bass habitat degradation between June and August. Despite substantial nutrient reduction efforts since 1986 designed to reduce hypoxia and ultimately provide more oxygenated habitat, major striped bass habitat declines have occurred and are driven by climate change induced water temperatures increases. Furthermore, analyzing future scenarios based on projected water quality and 2055 climate conditions suggests that the Chesapeake Bay is likely to face more frequent, prolonged, and more severely degraded habitat conditions for adult striped bass.

**Trends in mycobacteriosis and associated relative mortality in Striped Bass in Maryland waters of the Chesapeake Bay – *Genny Nesslage (UMCES)***

Long-term striped bass health monitoring data from the Maryland portion of the Chesapeake Bay collected by the MD DNR Fish Health Program were analyzed to identify mycobacteriosis trends and potential drivers. Apparent prevalence of mycobacteriosis for striped bass ages 1-10+ during 1998–2017 increased with a peak of 67% in 2016. Disease severity increased with age at similar rates for both sexes. Disease prevalence in age-0–1 striped bass was related to high water temperature duration, hypoxic volume, and fish condition. Severe external disease symptoms were related to high water temperature duration, hypoxic volume, fish condition, age, and sex. Relative mortality of severely diseased fish implied by our severity model approximately doubled across the range of environmental conditions examined. Relative mortality rates for severely diseased fish estimated in this study were similar to rates estimated in mark-recapture studies conducted in Virginia and mainstem waters of the Chesapeake Bay.

**Breakout Group Discussions**

As a central component of the workshop, participants engaged in structured breakout group discussions on both Day 1 and Day 2. Each day's discussions were guided by a consistent set of questions and concluded with a brief report-out to all participants.

- Day 1: Four groups (three in-person, one virtual) addressed distribution, recruitment, and juvenile sampling in the Chesapeake Bay.
- Day 2: Three new groups discussed migration, natural mortality, and key knowledge gaps.

The following sections summarize responses across groups for each guiding question, highlighting shared observations, emerging hypotheses, and opportunities for further research.

***Day 1 Breakout Summary: Distribution, Recruitment, and Juvenile Sampling***

**Distribution and survey efficacy**

Participants agreed the Maryland and Virginia juvenile index (JI) seine programs continue to bracket the primary spawning and nursery habitats in the Chesapeake Bay. Programs in DC/MD and complementary gillnet work do not indicate a wholesale shift of juveniles to deeper water, nor a consistent timing change attributable to warming. Bay-wide JI patterns remain congruent with independent indicators (e.g., MRIP; neighboring programs). Several groups framed recent weak year classes and early adult returns as contraction relative to historically strong cohorts rather than redistribution. One discussion noted that juveniles commonly occupy polyhaline waters in other systems, which cautions against over-interpreting isolated polyhaline observations as a new shift.

At tributary scales, confidence is lower. Fixed sites (≈40 in Virginia) are bracketed with auxiliary stations upstream and downstream, but catch is evaluated against covariates such as temperature, salinity, turbidity maximum, or Secchi depth, nor with prey-field information. Multiple groups recommended bringing select adult monitoring stations online before April (around ~50°F) and keeping them on later around the spawning window to capture peak conditions and early losses. Several suggested mapping catch densities in GIS to document coverage within state-defined spawning reaches, and adding short, targeted tributary studies or pilot checks in deeper/polyhaline reaches where feasible. Egg sampling is limited and often recorded as presence/absence, which constrains inference about spatial shifts.

**Recruitment controls and research needs**

Recruitment success was described as the product of  environmental conditions such as temperature and flow which affect prey phenology, habitat suitability (including hypoxic "squeeze"), f predation, and disease, with climate variability (e.g., warm winters, NAO) as a backdrop. Bay-wide zooplankton monitoring has been sporadic for roughly two decades; without contemporaneous prey data, match–mismatch hypotheses for larvae and age-0 fish remain speculative though existing data are being evaluated and potentially published. Several groups emphasized that zooplankton signals can be patchy and short-lived, so sampling needs to be time-windowed during spawning and early feeding.

Participants encouraged an energetics framework (models of female condition and ovary development under changing temperatures) and additional analyses that link environmental variability to individual growth (e.g., quantile approaches, added-variable plots) and stage-specific survival rather than only to abundance. Existing juvenile diet material could be reanalyzed (with attention to potential bias from compromised fish), and sentinel sampling for microplastics was suggested in YOY habitats near agriculture and wastewater discharges. Pairwise tests for synchrony among tributaries, and comparisons with adjacent stocks, were proposed to distinguish movement from habitat effects. Several groups noted that warmer winters extend fishing opportunity and increase pre-spawn interactions with adult striped bass (often catch-and-release), with potential effects on spawning condition and recruitment.

**Appropriateness of juvenile sampling**
The JI time series remains fit for purpose and should be protected; continuity is central to trend detection and assessment inputs. Practical additions that would not break comparability include tracking egg quality/viability (live vs. dead counts against historical work), adding larval condition metrics, clarifying forage context for adults, and improving a single plain-language explanation when annual indices diverge across jurisdictions. Given strong signals reported farther north, partners should remain ready to detect a wholesale northward shift in productivity if one emerges. Some discussion pointed to managing F for a sustained low-recruitment regime rather than keying solely to SSB-based reference points from the mid-1990s.

**Near-term actions**
- Expand tagging infrastructure (including double-curtain acoustic arrays at key corridors); integrate movement with temperature/wind and seasonal forage data; add genetics to resolve mixing and thermal tolerance.
- Re-establish fixed-station zooplankton sampling; update larval diet analyses; apply energetics-focused models.
- Develop seasonal recreational discard-mortality estimates using condition-based metrics; evaluate mitigation measures (e.g., terminal gear, time/area).
- Pilot tributary-scale studies and selective deeper/polyhaline checks; expand ichthyoplankton where feasible; use GIS catch-density maps to document coverage. Maintain JI design; add early life-stage context; present unified public-facing explanations when indices diverge; consider coverage gaps in smaller/developed rivers (subject to permitting).

***Day 2 Breakout Summary***

**Egg distribution and Migration Drivers**
Groups took a biology-first view: life stage and size set the template for movement; seasonal temperature and forage distributions modulate it. Warming and persistent low oxygen compress suitable habitat, with plausible effects on timing and on the fraction of the stock that exits the Bay. Year-class strength and density dependence likely influence residency. Flow-driven egg dispersion was highlighted as a pathway to downstream survival effects. Notes referenced mixing between basins via the Chesapeake & Delaware (C&D) Canal and, in some years, more time spent in adjacent estuaries, with several participants questioning whether coastal adults now overwinter farther north (e.g., VA rather than NC) compared to prior decades, distinct from age-

0 in-Bay overwintering. Participants called for expanded acoustic coverage (including double-curtain arrays) coordinated Floy tagging, and integration with fine-scale temperature, wind, and seasonal forage data. Genetics was recommended to test for mixing and shifting tolerances; some tagging programs have smaller sample sizes than in the past and could be rebuilt.

**Patterns in natural mortality (M)**
Likely contributors to elevated M in young fish include habitat degradation and summer oxygen squeeze that depress condition; predation by blue catfish (with snakehead, red drum, and cobia also noted); and overwinter mortality of age-0. Disease, especially mycobacteriosis, was raised often; a uniform protocol for lesions and disease metrics would improve use in assessments. Menhaden signals were mixed (seine programs in several jurisdictions reported recent increases in positive hauls and counts), and localized-depletion claims remain unresolved without clearer trophic linkages. Several groups emphasized size- and season-specific M estimates, explicit treatment of density-dependent mortality when habitat is compressed, and better accounting for recreational discard mortality in warm, low-oxygen periods. Field observations have found striped bass eggs in predator stomachs in some systems, highlighting the need to quantify early-life mortality pathways. Harmful Algal Blooms (HABs) were discussed as an additional stressor in some tributaries.

**Gaps that limit management uptake**
Movement and mixing remain under-resolved without broader acoustic coverage; the Bay still relies on coastwide SSB proxies rather than Bay-specific indicators; and the ecosystem context, multispecies interactions (including invasive vs. native priorities) and winter forage availability (including invertebrates), is incomplete. Seasonal estimates of recreational discard mortality are sparse and often recall-based; condition-based field scoring during release was suggested as more informative. For forage, available nearshore diet datasets and wind-energy/environmental surveys could be mined further, but coverage is uneven. Several discussions called for a clear ecosystem objective and for bringing technical work and management needs closer together.

**Near-term actions**

- Expand tagging infrastructure (including double-curtain sections at key corridors); integrate movement with temperature/wind and seasonal forage data; add genetics to resolve mixing and thermal tolerance.
- Update size-/season-specific M (including overwinter) and incorporate standardized disease metrics; quantify blue catfish impacts via comparative tributary studies and carry results into assessment models.
- Develop seasonal recreational discard-mortality estimates using condition-based metrics; evaluate mitigation (gear, time/area).
- Advance Bay-specific spawning-stock indicators; strengthen forage-assemblage information through winter; incorporate HAB observations where relevant.

*Day 2: Survey & Stock Assessment Summary Discussion Following Breakout Group Reports*

The discussion on surveys and stock assessments identified two key questions: whether current surveys accurately reflect striped bass population trends and why recruitment remains low. Participants agreed that existing surveys provide valuable data and consistency over time. Rather than overhauling survey methods, the focus should be on understanding recruitment drivers. Broad-scale consistency across multiple jurisdictions suggests that the surveys remain effective, though targeted geographic expansions, particularly in under-sampled tributaries, could enhance coverage.

Additional data collection efforts, such as passive telemetry monitoring, were suggested to address discrepancies between survey data and anecdotal reports of fish presence. Expanding sampling into areas where striped bass are reported but not currently sampled could provide further insights. Predation, habitat degradation, and environmental stressors were highlighted as significant factors that could be affecting striped bass populations. Quantifying blue catfish predation through tagging studies was identified as a research need, as was assessing whether striped bass recruitment is being suppressed by a predator pit, where high predation on early life stages limits population recovery. Additionally, habitat degradation, harmful algal blooms (HABs) and shifting plankton bloom dynamics (timing/composition), and declining forage availability were noted as potential contributors to recruitment challenges.

A major theme of the discussion was the need for improved communication about survey results and their broader applications. There was a consensus that survey data supports multiple analyses beyond generating population indices, and that this should be communicated more effectively to stakeholders. To enhance transparency, a public-facing one-pager summarizing survey value and key findings was recommended. The Chesapeake Bay Program's (CBP) successful alignment of funding with fisheries and habitat outcomes was also recognized as a model for continuing efforts.

From a management perspective, stock assessments should explicitly model environment-driven components of natural mortality, for example, temperature/low-DO habitat squeeze, heat events, overwinter stress, and harmful algal blooms (HABs), rather than treating mortality as constant or misattributing it to fishing. Participants also recommended expanding telemetry-informed mortality estimation to better separate natural, discard, and predation sources. They emphasized prioritizing research gaps that directly support near-term management decisions, balancing new data collection with actionable analyses. Finally, the group supported reconvening a striped bass science workshop in 2–5 years and suggested similar workshops for other key species to address broader ecosystem concerns.

***Cross-cutting Priorities***

Breakout groups identified needs spanning jurisdictions and research partners: rebuild prey-field information by restarting Bay-wide zooplankton time series and updating post-larval diet analyses to resolve spawn–prey timing; modernize movement and mortality inputs by expanding acoustic receiver coverage and genetic sampling, estimating size- and season-specific M, and first quantifying predator effects within each tributary (e.g., blue catfish) via tributary-specific studies, then comparing across tributaries to flag hotspots and prioritize management; preserve juvenile-index design while adding early life-stage metrics and paired environmental covariates; re-evaluate mid-1990s reference points under sustained low recruitment; and align plain-language survey summaries across institutions.

## Recommendations

These recommendations were developed during the final session of the FY2025 STAC Striped Bass Science Workshop, following two days of presentations, breakout discussions, and plenary. Participants focused on identifying priority next steps to improve understanding of striped bass population dynamics and support effective management.

As suggested during the closing discussion, the recommendations are organized into two categories to reflect different paths for implementation:

- Recommendations for the Atlantic States Marine Fisheries Commission (ASMFC) and technical groups focused on stock assessment and fishery-specific management.
- Recommendations for the Chesapeake Bay Program (CBP) and its Goal Implementation Teams, workgroups, and affiliated partners engaged in habitat, monitoring, and ecosystem-level restoration.

This structure recognizes that different entities "pull different levers" and that effective progress will require aligned, but distinct, actions across both fisheries and restoration communities. Additional detail is provided beneath each recommendation where relevant. Where the workshop suggested a clear champion or lead entity, it is included.

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*Recommendations to Support Stock Assessment and Fishery-Specific Management (ASMFC and Partners)*

1. Maintain the integrity and continuity of existing striped bass surveys by preserving current sampling methods, timing, and locations. Avoid major design changes that could compromise the ability to detect long-term trends. Current surveys are performing as intended and are generating reliable, comparable data on striped bass populations across tributaries and the Atlantic Coast. The need for a second haul at each station should be re-evaluated.
2. Supplement existing, long term surveys with short, targeted efforts in areas that are not routinely sampled using similar protocols, or longer-term monitoring with passive technologies.
   Examples include habitat sampling throughout non-traditional survey sites or long-term passive acoustic telemetry in tributaries like the Severn and Patapsco Rivers, where striped bass are reportedly present but not sampled by standard surveys. Also investigate whether mismatches in timing or habitat use are leading to reports of fish in areas not monitored by surveys.
3. Use tagging studies to quantify release mortality, predation, and juvenile mortality. Expand acoustic tagging with mortality and temperature sensors to estimate survival of juvenile striped bass and better understand the impact of predators like blue catfish.
4. Bound expectations for future recruitment under current and future environmental conditions.
   Use existing data to develop forward-looking scenarios that incorporate environmental variation, stock size, and plausible mortality factors. Tools such as species distribution models (SDMs) or habitat suitability indices (HSIs) may provide additional insight into

recruitment under changing conditions. While full causal resolution may not be possible, managers can still make informed projections.
   - Champion: ASMFC Striped Bass Stock Assessment Subcommittee and Management Board
5. Investigate whether striped bass are shifting spawning.
   Evaluate whether recruitment is increasingly successful in cooler systems and declining in warming estuarine habitats. Consider patterns in other anadromous and coastal species to test this hypothesis. Analytical approaches such as species distribution models (SDMs) or habitat suitability indices (HSIs) could be used to assess how environmental gradients influence spawning locations and recruitment success under changing conditions.
   - Champion: ASMFC Striped Bass Stock Assessment Subcommittee and Management Board
6. Address gaps in understanding of plankton blooms and early life-stage stressors.
   Shifts in bloom timing and intensity, particularly in winter and spring under changing environmental conditions, may affect larval and juvenile survival. Future work should explore how these dynamics coincide with early life-stage mortality and recruitment.
   - Maryland DNR could act as the data holder and work with academic partners or graduate students to analyze existing datasets, supported by researchers with expertise in plankton ecology and early life-stage stressors.
7. Develop communication products that synthesize and translate workshop findings, along with communicating ongoing monitoring efforts, findings, and partnerships.
   Produce a two-page, public-facing summary of the workshop, and coordinate a series of outreach articles through the CBP Communications Office. Messaging should emphasize what is known, what is being done, and how current data are used.

*Recommendations to Support Chesapeake Bay Program and Ecosystem-Based Management*

1. Do not re-engineer surveys ; instead, improve public transparency.
   Communicate clearly why the existing surveys are trusted by scientists and how the data are used for more than just the juvenile index. Lack of understanding was noted as a source of mistrust. Evidence supporting appropriate survey design and implementation should be documented and made accessible. To further build trust and visibility, consider developing an annual report on striped bass status in the Chesapeake, modeled after the blue crab report, that synthesizes survey findings and management implications in an accessible format.
   - Champion: CBP Sustainable Fisheries Goal Implementation Team; CBP Communications Office
2. Establish a fish habitat outcome within the Bay Program.
   Explore specific integration of striped bass into the revised Chesapeake Bay Agreement under the Fish Habitat outcome. This would support alignment of monitoring, modeling, and restoration efforts related to striped bass and similar species. This could build on the forage fish outcome and be coordinated by the Sustainable Fisheries Goal Implementation Team. Recognizing that limiting development pressures is largely beyond the Program's influence, such an outcome could instead emphasize measurable actions within reach - such as shoreline protection and restoration practices (e.g., Virginia's living shoreline requirements). Building on the forage fish outcome and

Sustainable Fisheries GIT coordination, this could create practical, trackable targets that strengthen connections between fish habitat and fisheries management.

- Champion: CBP Sustainable Fisheries Goal Implementation Team

3. Assess coherence of striped bass trends with other species.
   Analyze survey data across species such as white perch, spot, and alewife to determine whether recruitment declines reflect species-specific dynamics or broader estuarine change.
   - Champion: CBP Sustainable Fisheries Goal Implementation Team; NOAA Chesapeake Bay Office in coordination with state partners

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## APPENDIX A: Workshop Agenda

Chesapeake Bay Program's (CBP)
Scientific and Technical Advisory Committee (STAC)

**Striped Bass Survey Assessment and Habitat Connections**
Smithsonian Environmental Research Center (SERC)
Edgewater, MD

**Thursday, February 13, 2025**

**8:45 am** **Coffee & Light Breakfast (Provided)**

**9:10 am** **Welcome and Introductions**
Steering Committee members will introduce the Sustainable Fisheries Goal Implementation Team (Fish GIT), provide the context for the workshop, and give an overview of the workshop purpose and objectives. STAC Staff will provide a brief overview of workshop logistics. Each participant will then have an opportunity to briefly introduce themselves.

***Session 1: Surveys and Stock Assessment***

**9:30 am** **Overview of MD Striped Bass Surveys** – *Beth Versak* and *Eric Durell (MD DNR)*
Presentations on Maryland's three surveys and short discussion.

**10:10 am** **Overview of VA Striped Bass Surveys –** *Troy Tuckey (VIMS)*
Presentations on Virginia's three surveys and short discussion.

**10:50 am** **10-minute Break**

**11:00 am** **General Overview of the Stock Assessment**
– *Gary Nelson (Massachusetts Division of Marine Fisheries)*

**11:40 pm** **Overview of Session 2: Speakers, Presentations, Instructions for Q&A**

**11:50 am** **Lunch (Provided)**

***Session 2: Habitat and Early Life History (TOR: Spawning, Recruitment)***

**12:40 pm** **Habitat and Early Life History (TOR: Spawning, Recruitment)**
This session will explore the critical linkages between habitat conditions and early life history stages of striped bass, with a focus on spawning and recruitment dynamics. Presentations will highlight recent research and innovative approaches to understanding how environmental factors influence survival and recruitment success. Key topics include habitat impacts on early life stages, advancements in monitoring techniques, and the effects of flow and temperature on recruitment. The session will also examine covariance patterns in recruitment indices across tributaries and present modeling efforts to assess the impacts of environmental conditions on striped bass recruitment.

**Presenters (20-minutes each):**
- Jim Uphoff (MD DNR) – Habitat Impacts on Early Life History
- Hongsheng Bi (UMCES) – Adapting Plankton Scope Technology for Monitoring Eggs in Spawning Areas

- Ryan Woodland (UMCES) and Robert Murphy (TetraTech) – A First Look at Microplastics in Juvenile Striped Bass
- Simon Brown (MD DNR) – Examining Striped Bass Recruitment-Environment Relationships With Quantile Regression

**2:00 pm** **15-minute Break**

- Julie Gross (VIMS) – Modeling the Effects of Environmental Conditions on Poor Striped Bass Recruitment, as Measured by the Juvenile Abundance Index
- Rachel Dixon (VIMS) – Investigating Synchrony in Striped Bass Recruitment Indices Across Chesapeake Bay Tributaries
- Dave Secor (UMCES) – Over-Predation of Striped Bass by Blue Catfish: A speculative hypothesis

**3:15 pm** **Session 2: Q & A (15-minutes)**

**3:30 pm** **Break Out Group Instructions and Overview**

**3:35 pm** **Break Out Group Discussion (1 hr)**

**4:35 pm** **Break Out Group Report Out**
Groups will report out and participants discuss common threads

**4:55 pm** **Wrap Up**
The day will wrap up with a recap of the key discussion points.

**5:00 pm** **Recess**

**Friday, February 14, 2025**

**8:45 am** **Coffee & Light Breakfast (Provided)**

**9:30 am** **Day 2 Introduction**
Steering Committee members will provide a brief recap of key points from Day 1 and review the context and purpose of the workshop and introduce the discussion topic for Day 2.

***Session 3: Movement***

**9:45 am** **Migration Patterns in the Chesapeake Bay**
This session will focus on current research and predictions regarding growth and migration patterns of striped bass in the Chesapeake Bay, with an emphasis on how these patterns may change over time. While growth information may be of lower priority compared to other issues impacting striped bass, the session will explore relevant aspects such as forage availability and ageing, which could provide valuable insights.

**Presenters (30 minutes each, 10-minutes for Q&A each):**
- Pat Geer and Ethan Simpson (Virginia Marine Resource Commission) – Demonstrating the Value of the Chesapeake Bay Backbone Telemetry Array
- Dave Secor (UMCES) – Migrations, Water Quality Selection, and Mortality of Chesapeake Striped Bass: Inferences from telemetry

**10:45 am** **15-minute Break**

***Session 4: Mortality***

**11:00 am** **Mortality (20 minutes each)**

This session will examine the various factors influencing striped bass mortality, with a focus on both natural and human-induced causes. Presentations will cover key topics such as recreational release mortality, changing Bay habitat conditions, influence of disease and population modeling, and the impacts of fishing practices. Experts will share insights from recent research and discuss potential strategies to mitigate mortality and support sustainable striped bass populations.

**Presenters:**

- T. Reid Nelson (GMU) – Recreational Release Mortality in the Chesapeake Bay
- Tom Parham (MD DNR) – Impacts of Changing Bay Habitat Conditions on Summertime Resident Striped Bass
- Genny Nesslage (UMCES) – Trends in mycobacteriosis and associated relative mortality in Striped Bass in Maryland waters of the Chesapeake Bay

***Session 3: Movement (Continued)***

- Rob Aguilar (SERC) – Diet and Movement of Young Striped Bass (Morone Saxatilis) Within and Among Shallow Tributary Habitats of Chesapeake Bay

**12:20 pm** **Session 3: Q & A (15 minutes)**

**12:35 pm** **Lunch (provided)**

**1:30 pm** **Break Out Group Instructions and Overview**

**1:35 pm** **Break Out Group Discussion (1 hr)**

Participants will break out into groups to discuss

**2:35 pm** **Break Out Group Report Out**

Groups will report out and participants discuss common threads

**3:00 pm** **Plenary: Final Recommendations**

Led by the steering committee, workshop participants will distill key priority recommendations resulting from their small group discussions.

**3:30 pm** **Wrap Up**

The workshop will wrap up with a recap of the major take-aways and a discussion about next steps.

**3:45 pm** **Workshop Adjourns**

**3:45 pm** **Workshop Steering Committee Meets**

## APPENDIX B: Workshop Participants

| Participant | Email | Affiliation |
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## APPENDIX C: Breakout Group Questions

On both days of the workshop, participants engaged in concurrent in-person and virtual breakout groups to explore targeted discussion questions based on the topics and research presented earlier in the day.

Day 1 breakouts followed Sessions 1 and 2 on surveys, stock assessment, and habitat–early life history connections. Groups discussed the following questions:

- Have spatiotemporal patterns of striped bass distribution shifted in a manner that impacts Chesapeake Bay surveys' efficacy?
- What factors are impacting recruitment success and what further research is needed?
- Is the Juvenile Sampling appropriate given these changing environmental conditions?

Day 2 breakouts built on Sessions 3 and 4, which addressed movement, migration patterns, and mortality drivers. Groups discussed the following questions:

- What factors are influencing migration patterns?
- What is driving any temporal trends or spatial patterns in natural mortality?
- Where are the gaps?

These sessions provided an opportunity for participants to synthesize presentation content, share expertise, and identify priority areas for future investigation.

## APPENDIX D: Pre-workshop Public Engagement Survey

Ahead of the February 2025 STAC workshop *Striped Bass Survey Assessment and Habitat Connections*, a public survey was distributed via Google Forms to gather input from researchers, managers, anglers, and other stakeholders across the Chesapeake Bay region. The goal was to collect perspectives on factors influencing striped bass populations, the accuracy of current monitoring programs, and emerging habitat and management concerns.

The survey was advertised across multiple platforms, including the Maryland Department of Natural Resources (MD DNR) website, and was made available in both English and Spanish to broaden participation. Designed to take approximately 10 minutes, the survey included questions on respondents' prior involvement in striped bass research or management, perceptions of juvenile abundance drivers, views on the effectiveness of current monitoring efforts, concerns about climate-related stressors, and factors influencing migration and mortality. An open-ended section invited additional insights and emerging issues for consideration during the workshop.

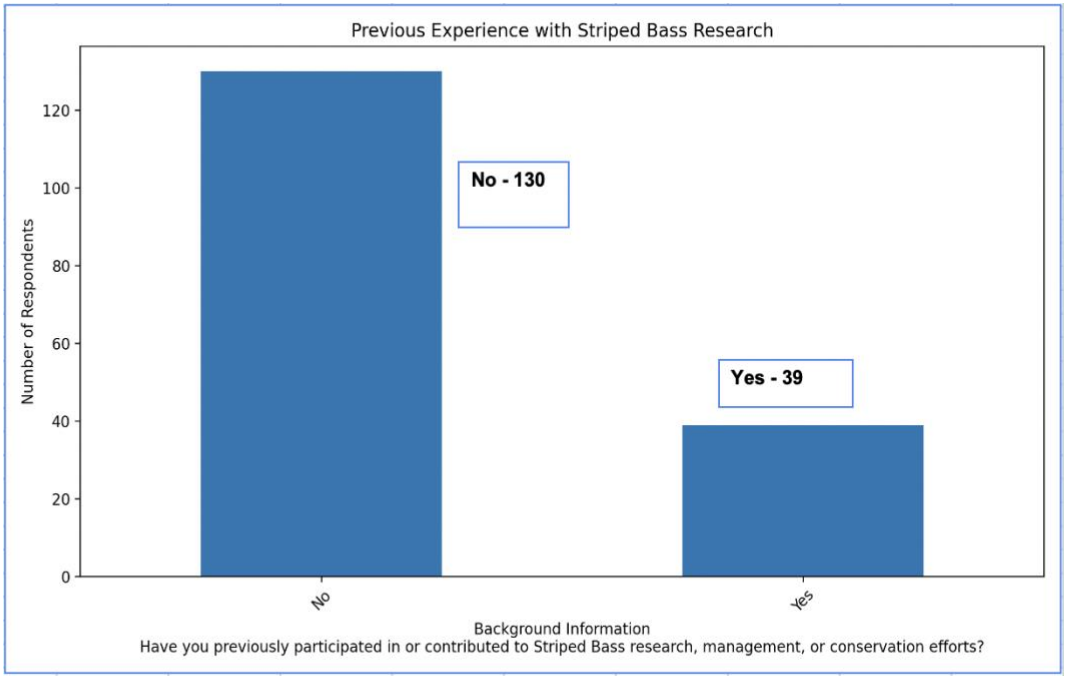
Survey results helped inform breakout group discussions and identify priority areas for further research and management action.

### *Survey Questions*

1. **Background Information** – Have you previously participated in or contributed to Striped Bass research, management, or conservation efforts? If yes, please briefly describe your involvement.
2. **Juvenile Abundance** – What factors do you believe most impact Striped Bass juvenile abundance in the Chesapeake Bay? (Select all that apply)
3. **Accuracy of Population Monitoring** – Do you think our current monitoring studies accurately reflect adult & juvenile abundance? (1 = Very reflective, 5 = Not reflective at all) – Links to monitoring studies: Spawning Stock Survey, Juvenile Index, VIMS Striped Bass Seine Survey. If you think monitoring studies are not reflective, please share how they could be improved.
4. **Climate and Environmental Stressors** – How concerned are you about the impact of climate-related changes (e.g., temperature, seasonal shifts) on Striped Bass populations? (1 = Not concerned at all, 5 = Very concerned). If you are aware of specific data or research that could help address these impacts, please describe it here.
5. **Migration and Mortality Factors** – What factors do you think most influence Striped Bass migration patterns and mortality rates?
6. **Additional Insights** – Are there any other factors or emerging issues you think should be considered when discussing Striped Bass population management and habitat restoration in the Chesapeake Bay?

### *Summary of Survey Responses*

A total of 170 people responded to the English version of the survey.




**Participation Background**
A notable proportion of respondents reported prior involvement in striped bass research, management, or conservation, with experiences ranging from scientific monitoring to habitat restoration, fisheries management, and advocacy.

**Juvenile Abundance Drivers**
Recurring themes included:

- Food source availability – especially menhaden – as a critical factor.
- Spawning conditions and habitat-related issues, often linked to environmental change.
- Fishing-related impacts, particularly commercial harvest and restrictions, cited almost as frequently as environmental drivers.
- Responses often combined multiple factors, highlighting the interplay between human activity, habitat change, and ecological conditions.

**Accuracy of Monitoring**
While some respondents considered current monitoring adequate, many suggested improvements, such as:

- Expanding survey locations and frequency.
- Incorporating real-time or more current data.
- Including input from recreational fishers.
- Adjusting for seasonal patterns that may affect detectability.

**Climate and Environmental Stressors**
High concern levels were common, with respondents noting temperature changes, seasonal shifts, and related habitat effects as significant threats. Suggestions for further research included

long-term temperature trend analyses and studies linking climate variables to recruitment success.

**Migration and Mortality**
The most cited influences were:

- Environmental factors – particularly seasonal temperature shifts and salinity/flow changes.
- Human impacts – notably fishing practices such as catch-and-release and gear type.
- Forage availability – viewed as a limiting factor in sustaining populations.
- Predation was mentioned less frequently but still recognized as a contributing factor.

**Additional Insights**
Top concerns and recommendations included:

- Commercial and recreational fishing impacts – with calls for stricter limits or moratoria, seasonal closures, and gear restrictions.
- Ecosystem-wide issues – including the menhaden–striped bass relationship, invasive species (blue catfish, snakeheads), and oyster restoration for water quality.
- Enforcement challenges – addressing illegal and unlicensed fishing.
- Long-term changes – concerns over warming waters shifting nursery areas, possibly outside the Chesapeake, and the need for adaptive management.

## APPENDIX E: List of Figures

## APPENDIX F: List of Tables