USP Chapter <86> Bacterial Endotoxins Test Using Recombinant Reagents: A Step Forward, But Not a Milestone for Horseshoe Crab Conservation

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Abstract This paper evaluates the approval of the United States Pharmacopeia (USP) Chapter <86>, which introduces recombinant reagents as alternatives to *Limulus* Amebocyte Lysate (LAL) and *Tachypleus* Amebocyte Lysate (TAL) for bacterial endotoxins testing (BET). While this development marks progress in reducing dependence on horseshoe crab hemolymph for reagent production, it does not represent a significant breakthrough for horseshoe crab conservation. The primary threats to the world's four horseshoe crab species—habitat loss, unregulated economically driven harvesting in Asia, as well as other anthropogenic factors—remain largely unaddressed by the transition to recombinant reagents. Although these threats may be somewhat mitigated locally, the shift to recombinant alternatives does not sufficiently tackle the broader conservation challenges. This paper also examines the global pharmacopeial landscape, identifies barriers to industry adoption of recombinant reagents, and explains why the implementation of USP Chapter <86>, while a commendable step, falls short of making a meaningful impact on the overarching conservation issues confronting horseshoe crabs.

Keywords animal-free bacterial endotoxin testing, horseshoe crab conservation, *Limulus* Amebocyte Lysate (LAL), pharmaceutical supply chain sustainability, recombinant Cascade Reagent (rCR), recombinant Factor C (rFC), *Tachypleus* Amebocyte Lysate (TAL), USP Chapter <86>.

Introduction

The world's four extant horseshoe crab species—*Limulus polyphemus* (American horseshoe crab), found along the Atlantic coast of the United States from the Gulf of Maine to the northeastern Gulf of México and Yucatán Peninsula, and *Tachypleus tridentatus* (tri-spine horseshoe crab), *Tachypleus gigas* (coastal horseshoe crab), and *Carcinoscorpius rotundicauda* (mangrove horseshoe crab), found in coastal South and Southeast Asia—each exhibit genetic variation throughout their spawning ranges. These species are threatened by habitat loss—both marine and terrestrial—and various anthropogenic activities. The three Asian species face the threat of local extinction, driven by unregulated exploitation that varies across their range and widespread habitat destruction.

In contrast, *Limulus polyphemus*, classified by the International Union for Conservation of Nature (IUCN) Red List as Vulnerable in 2016, has benefitted from extensive management conservation efforts in the United States (ASMFC, 2024; Smith et al., 2016; Smith et al., 2023). However, certain regional populations, particularly in New York, continue to experience declines, necessitating further habitat protection as well as additional local harvest regulation (Botton et al., 2022a; Gauvry et al., 2022; Smith et al., 2016, Smith et al., 2023). Insufficient monitoring in the northeastern Gulf of México and Yucatán Peninsula, along with under-regulated marine life harvest in parts of Florida, raises additional concerns for *Limulus polyphemus* in those areas. While harvest pressures receive significant attention, the primary long-term threat to all four species remains habitat loss driven by coastal development and sea-level rise.

The Ecological Research & Development Group Inc. (ERDG) welcomes the approval of USP Chapter <86>, "Bacterial Endotoxins Test Using Recombinant Reagents," which provides animal-free alternatives to the widely used *Limulus* Amebocyte Lysate (LAL) and *Tachypleus* Amebocyte Lysate (TAL) for bacterial endotoxins testing (BET). This advancement represents significant progress in offering options that reduce reliance on horseshoe crabs for biomedical applications (USP, 2024a). However, ERDG contends that this is not a substantial milestone for global horseshoe crab conservation, especially for the three Asian species that face severe threats such as habitat loss, unregulated harvesting, and commercial pressures—challenges not mitigated by the adoption of recombinant reagents (Gauvry, 2015; Gauvry et al., 2022).

USP Chapter <86>, set for official adoption in May 2025, introduces recombinant Factor C (rFC) and recombinant Cascade Reagent (rCR) as alternatives to traditional U.S. Food and Drug Administration (FDA) licensed reagents derived from the lysed amebocyte blood cells in the hemolymph of *Limulus polyphemus*, *Tachypleus tridentatus*, and *Tachypleus gigas*. These recombinant reagents are anticipated to play a crucial role in testing of human and veterinary medicines, ensuring conformance to safety standards while offering a non-lysate test reagent alternative (USP, 2024a). Although providing a non-lysate option to the pharmaceutical industry signifies a major step in decreasing the demand for horseshoe crabs, it alone does not address the broader threats to their survival, such as habitat degradation and unregulated harvesting. To ensure the long-term viability of these species, conservation efforts must continue to prioritize these more extensive issues.

Horseshoe Crab Harvesting in the U.S. and Asia: Stark Differences

U.S. Harvesting: A Managed Practice

In the U.S., horseshoe crab populations are managed with a focus on population growth and sustainability under the oversight of the Atlantic States Marine Fisheries Commission (ASMFC), a federal body responsible for regulating animals for both LAL production and bait harvesting. In 2022, approximately 911,826 *Limulus polyphemus* were collected for LAL production, with an estimated mortality rate of 15% (approx. 145,920 crabs). In the same year 570,988 crabs were harvested for use as bait in the whelk and eel fisheries, a practice that intentionally results in 100% mortality (ASMFC, 2024).

State-by-state harvesting quotas are set by the ASMFC, and some states have imposed additional restrictions, including harvesting bans, to protect local populations. These combined efforts have led to stable or growing populations of American horseshoe crabs throughout much of their spawning range along the east coast of the United States, with a focus on future sustainability. Even though bait harvesting is regulated to ensure sustainability and reduce excessive loss of life compared to unregulated practices, the intentional sacrifice of such a large number of horseshoe crabs for bait remains deeply troubling.

However, there remains ongoing debate over the effectiveness of ASMFC's management practices, particularly regarding the unintentional mortality rate associated with LAL production. While some conservationists raise concerns about the impact of biomedical collection, it is important to note that the greatest threats to *Limulus polyphemus* stem from habitat loss—both marine and terrestrial—commercial fisheries discards, and other anthropogenic pressures (ASMFC, 2024). Thus, while the adoption of recombinant reagents may reduce the need for LAL collection and its associated mortality, it will not address the primary threats to the population that impede growth and influence management decisions. Conservation efforts must focus on these broader issues, rather than becoming complacent with recombinant reagents as if they resolve a major part of the conservation challenge (Gauvry, 2015; Gauvry, et al, 2022).

Asia: Unregulated Harvest and 100% Mortality

In contrast, the situation in Asia is far more dire, with horseshoe crab harvesting driven primarily by economic incentives rather than biomedical use. The three Asian species are heavily targeted because they are easy to collect and highly profitable. Harvesters rent two of the species *Tachypleus tridentatus* and *Tachypleus gigas* to TAL producers who bleed the horseshoe crabs for their amebocyte lysate before returning them to the harvesters. Subsequently, these harvested crabs along with the others are sold into secondary markets for human consumption, chitin production, fertilizers, and traditional medicine, resulting in 100% mortality for each harvested crab (Gauvry, 2015; Gauvry et al., 2022; Laurie et al., 2019). A very small number of TAL producers release horseshoe crabs back into the wild, the prevalent practice of renting crabs for TAL production effectively subsidizes harvesters' profit margins and makes TAL producers complicit in the decline of horseshoe crab populations.

Unlike the U.S., where harvesting is regulated under stringent sustainability practices, there are no meaningful regulations or effective enforcement mechanisms in Asia to manage horseshoe crab populations. The unregulated, economically driven market, fueled by poverty, livelihoods, social status, and corporate greed, ensures that even with the introduction of recombinant reagents, these species will continue to face unsustainable exploitation (Botton et al., 2022a; Gauvry, 2015; Gauvry, et al., 2022).

The three Asian species face varying levels of risk, with *Tachypleus tridentatus* listed as endangered (Laurie et al., 2019). The other two species, *Tachypleus gigas* and *Carcinoscorpius rotundicauda*, are currently listed as data deficient by the IUCN (IUCN, 2024). While it is premature to assign a conservation status to these two species without formal data review, most studies indicate moderate to severe threats to their local populations, exacerbated by a lack of genetic connectivity among populations. In addition to overharvesting, the greatest threat to Asian horseshoe crabs is the loss of their spawning habitat—both marine and terrestrial—from coastal development, land reclamation, sea-level rise, and other anthropogenic factors, further accelerating population decline.

Unless governments in the region coordinate conservation efforts and address the economic, social, cultural, and corporate indifference to unsustainable harvesting and habitat loss, these species will continue to lose critical habitat, genetic diversity, and overall population viability (Botton et al., 2022a; Gauvry, 2015; Gauvry, et al., 2022, Laurie et al., 2019).

Therefore, USP Chapter <86> will likely have marginal impact on the Asian horseshoe crab population unless accompanied by efforts to reduce other factors that will make it less profitable to harvest them.

Impact of Testing Modalities: Kinetic vs. Gel Clot

Endotoxin testing methods vary widely across the globe. In the U.S. and Europe, harmonized compendial kinetic tests, such as the more sensitive and quantitative kinetic chromogenic and kinetic turbidimetric methods (USP 2024b), are preferred for bacterial endotoxin testing (BET). These methods require the use of instrumentation and computers that require validation and maintenance to achieve a test result. Those users who are familiar with the instrumentation and software are generally open to new test methods requiring either the same or different instrumentation. In contrast, the compendial LAL/TAL gel clot test (USP 2024b) remains dominant in Asia, South America, and Africa. This method is simpler, requires no advanced instrumentation, and is far more affordable, making it the method of choice in less developed regions (Eckford, 2024). Although TAL producers also market kinetic chromogenic and turbidimetric lysate reagents to clients who request them, they may not have access to patented and approved recombinant alternatives to offer their customers who are currently using an instrumented assay. As a result, the reliance on harvesting and bleeding Asian horseshoe crabs for TAL will persist. The gel clot method, with its lower cost and simplicity, will likely continue to dominate in regions where more advanced testing infrastructure and support are not available.

Global Pharmacopoeial Landscape: European Pharmacopoeia vs. USP Chapter <86>

The European Pharmacopoeia (EP) has allowed the use of recombinant Factor C (rFC) since July 2020 under General Chapter 2.6.32 (EP, 2024). While Chapter 2.6.32 allows for the use of rFC, which contains only the first zymogen in the clotting cascade, it does not include information on recombinant cascade reagents (rCR), which use all three proteins from the clotting cascade, further narrowing its scope of recombinant options.

USP Chapter <86>, scheduled for adoption in May 2025, allows for the use of recombinant reagents but in addition to rFC, Chapter <86> provides guidance on the use of rCR reagents. USP Chapter <86> also requires that the user either provide validation of the test method or examine the manufacturer's primary validation package to assure that the method is appropriate for testing prior to using it routinely.

Both Chapter 2.6.32 and Chapter <86> follow the harmonized Endotoxins Test Chapter (USP Chapter <85>) with respect to standard curve preparation, and both require product-specific suitability testing (test for interfering factors) to verify that the validated method is appropriate for the product under test. Both chapters provide additional information on the use of rFC, which is a fluorometric method that is not described in Chapter <85>.

Lysate-Based vs. Recombinant Reagents

Lysate-based reagents contain all three zymogen proteins of the horseshoe crab clotting cascade: Factor C, Factor B, and the Proclotting Enzyme. Recombinant reagents, such as those currently marketed, use cloned enzymes from different horseshoe crab species (*Carcinoscorpius rotundicauda, Tachypleus tridentatus*, and *Limulus polyphemus)*, expressed using various mammalian and non-mammalian cells (Buchberger, et al, 2012; Ding & Bo,1994; Mizumura, et al, 2012). Recombinant Factor C (rFC) products use only the recombinant version of Factor C, the first enzyme in the cascade, while recombinant Cascade Reagent (rCR) products incorporate all three proteins. Importantly, none of these recombinant reagents includes the "Factor G" pathway present in lysate-based reagents, which prevents enhanced results or even false positives caused by possible glucan contamination in samples (Loverock, et al, 2010).

Global Adoption and Harmonization Challenges

Most of the world's major pharmacopeias are working toward writing and publishing chapters on the use of alternative endotoxin detection methods, including recombinant reagents. However, these chapters are not yet fully harmonized. For example, while the European Pharmacopoeia Chapter 2.6.32 allows for the use of recombinant Factor C, it does not provide for recombinant Cascade Reagents (rCR). The Indian and Korean pharmacopeias are expected to align with the USP, while the Chinese and Japanese pharmacopeias are still debating how to proceed (G. Gauvry, personal communication). The inclusion of a separate chapter for recombinant reagents reflects the distinct properties of these reagents compared to lysate-based methods.

As data become available through regulatory agencies and peer-reviewed publications, a greater understanding of recombinant methods will emerge. This will help ease any concerns that users may have and will support the broader adoption of recombinant reagents. However, until these reagents can demonstrate consistent equivalence across diverse applications, or until they are required by pharmacopeial product monographs, their widespread use will likely remain under utilized.

Challenges to Industry Adoption of Recombinant Reagents

The pharmaceutical industry's reluctance to fully adopt recombinant reagents can be attributed to several factors.

1. Patient Safety and Equivalency

Ensuring patient safety is the industry's top priority. Recombinant Factor C (rFC) and recombinant Cascade Reagent (rCR) offer certain advantages, such as non-reactivity to glucan contamination, which can cause false positives in traditional lysate-based methods. However, despite these benefits, recombinant reagents still require further validation to match the sensitivity, reliability, equivalence, and proven track record of LAL in detecting endotoxins (USP 2024c; USP 2024d). The transition to alternative reagents must be approached cautiously, as any deviation from established safety standards could pose risks to patient health.

2. Cost and Infrastructure

The cost of transitioning to recombinant reagents presents a significant barrier for many companies. Recombinant reagents are generally more expensive than their lysate-based counterparts, and shifting to these methods often requires the purchase of new laboratory equipment or requalification of existing testing systems. This financial challenge is particularly acute in regions such as Asia, where laboratories may rely heavily on the gel clot lysate test due to its affordability and the lack of advanced infrastructure needed for kinetic testing.

In addition to the direct costs, companies with large legacy portfolios face the added burden of preparing regulatory submissions for existing products. These submissions can be a significant expense, further complicating the industry's willingness to adopt recombinant methods (Eckford, 2024).

3. FDA Decision not to License Recombinant Reagents

While the USP has approved a new chapter on the use of recombinant reagents, the FDA has chosen not to regulate them as they currently do with lysate based reagents (CFR, 1973). This decision places the responsibility on individual companies to validate the safety and equivalence of recombinant Factor C (rFC) and recombinant Cascade Reagent (rCR), as well as the vendor. This lack of FDA oversight adds complexity to the transition process, as companies must ensure that their internal validation processes meet the necessary Pharmaceutical Quality Management (PQMS) standards for patient safety and product integrity (Eckford, 2024).

It's important to recognize that the USP is a standards-setting organization, not a regulatory authority or auditor of a company's PQMS. While USP Chapter <86> provides a compendial option for companies to consider non-animal-based alternatives to LAL, it does not mandate their adoption. As a result, each user must conduct appropriate risk, impact, vendor and change management assessments to ensure the safety and equivalence of these alternatives for each product without the benefit of a required FDA license as a "safety net". Validation of alternative tests, execution of proper suitability screens, and ensuring equivalency with current LAL-based methods are critical steps for compliance with patient safety requirements (Eckford, 2024; USP, 2024a; USP 2024c; USP 2024d).

4. Historical Context and Industry Reluctance

The historical evolution from the Rabbit Pyrogen Test (RPT), first introduced to USP in 1942 (McCloskey, et al, 1943), to the LAL reagent, first recognized by the FDA in 1973 (CFR 1973), spanned 30 years. Complete adoption of the lysate test in lieu of the RPT did not happen until 14 years later with the publication of FDA's "Guideline on Validation of the *Limulus* Amebocyte Lysate Test as an End-Product Endotoxin Test for Human and Animal Parenteral Drugs, Biological Products, and Medical Devices" (FDA, 1987, now retired). More recently, recombinant Factor C (rFC) was introduced in 2003, and despite its promise, it has been slow to gain traction due to high costs, relatively low sensitivity at the time of its introduction, its non-compendial status, and the FDA's reluctance to regulate its manufacture. This history demonstrates that while progress in bacterial endotoxin detection is often slow, it is ultimately achievable. However, the reluctance to fully transition to new methods, particularly in an industry that prioritizes safety and regulatory compliance, underscores the need for thorough validation and peer-reviewed studies that demonstrate equivalency with current lysate-based methods (USP, 2024a; Eckford, 2024)

The Role of the Pharmaceutical Industry in Catalyzing Change

The pharmaceutical industry has the potential to be an example and drive transformative change in endotoxins testing by providing data that will support subsequent decisions to move away from animal-derived reagents, including the use of recombinant reagents. However, this transition must be guided by two fundamental principles: the prioritization of patient safety and the development of reliable alternatives that meet the rigorous standards required for medical products worldwide.

While recombinant Factor C (rFC) and recombinant Cascade Reagent (rCR) offer promising alternatives to traditional *Limulus* Amebocyte Lysate (LAL) and *Tachypleus* Amebocyte Lysate (TAL) tests, their widespread adoption will depend on robust validation and evidence that they perform equivalently to lysate-based methods. Peer-reviewed studies demonstrating their reliability, efficacy, and safety are critical in convincing laboratory managers and regulators alike to embrace these alternatives.

Conclusion: A Step Forward, But Not a Milestone

While USP Chapter <86> represents progress toward reducing reliance on horseshoe crabs for bacterial endotoxin testing, it is not a milestone for horseshoe crab conservation. The adoption of recombinant reagents such as recombinant Factor C (rFC) and recombinant Cascade Reagent (rCR) faces significant challenges in both the U.S. and Asia. Regulatory hurdles, economic barriers, entrenched testing practices, and the prevalence of the gel clot method in less developed regions hinder the immediate widespread use of these alternatives.

More critically, the broader threats to horseshoe crab populations—habitat loss, unregulated and unsustainable harvesting, and economic pressures, especially in Asia—are not addressed by the adoption of recombinant reagents alone. Horseshoe crab populations in Asia remain vulnerable to exploitation, with unsustainable practices driven by economic incentives beyond the scope of endotoxin testing. Without concerted conservation efforts, these species will continue to face significant declines, even if the demand for LAL and TAL is reduced.

Thus, while USP Chapter <86> offers a path forward in bacterial endotoxin testing, it is important to manage expectations. It is a positive step toward reducing the use of animal-derived reagents, but it is not a definitive solution for horseshoe crab conservation. The pharmaceutical industry must continue to seek advancements in alternative bacterial endotoxin testing and adopt non-animal-based methods where feasible.

Moreover, effective supply chain management is crucial to addressing the unregulated harvesting practices in Asia. This includes divesting from TAL producers who do not adhere to best management practices that mirror or exceed those of LAL producers. Additionally, endorsing the Pharmaceutical Supply Chain Initiative (PSCI) which represents 74 of the world's largest pharmaceutical companies and their suppliers can significantly impact conservation efforts. The PSCI pledges to protect all endangered species and ceasing further TAL collection from *Tachypleus tridentatus* and *Tachypleus gigas*. By committing to no further collections from these species and discontinuing TAL use once existing supplies are exhausted, PSCI members can help alleviate commercial pressures on these vulnerable populations (PSCI, 2023).

Until these broader challenges are addressed, recombinant methods will not be the milestone that conservationists hope for. Comprehensive strategies that include regulatory reforms, ethical supply chain practices, and industry-wide commitments are essential to ensure the long-term viability of all four horseshoe crab species.

How to Cite This Paper

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References

Atlantic States Marine Fisheries Commission. (2024). Horseshoe crab stock assessment update. Atlantic States Marine Fisheries Commission. https://asmfc.org/uploads/file/663d0fcdHorseshoeCrabStockAssessmentUpdate_April2024.pdf

Botton, M. L., John, B. A., Carmichael, R. H., Mohamad, F., Bhadury, P., Zaldivar-Rae, J., Shin, P. K., Tanacredi, J. T., & Cheung, S. G. (2022a). Horseshoe crabs: “Living fossils” imperiled in the Anthropocene. In D. A. DellaSala & M. I. Goldstein (Eds.), Imperiled: The Encyclopedia of Conservation (pp. 715-726). Elsevier Inc.

Buchberger, B., Grallert, H., & Molinaro, S. (2012). US Patent 9725706B2, Method for recombinant production of horseshoe crab factor C protein in protozoa. https://patents.google.com/patent/US9725706B2/ja

Ding, J. L., & Ho, B. (1994). US Patent 5858706A, Expression of carcinoscorpius rotundicauda factor C in eukaryotes. https://patents.google.com/patent/US5858706A/en

Eckford, C. (2024). Widening Adoption of Non-Animal Reagents for Endotoxin Testing. European Pharmaceutical Review. https://www.europeanpharmaceuticalreview.com/news/227037/widening-adoption-of-animal-free-reagents-for-endotoxin-testing/

European Pharmacopeia. (2024). 2.6.32: Test for bacterial endotoxins using recombinant factor C (rFC).

U.S. Food and Drug Administration (FDA). (1987). Guideline on validation of the *Limulus* Amebocyte Lysate Test as an end-product endotoxin test for human and animal parenteral drugs, biological products, and medical devices. (Retired).

FDA. (2012). Guidance for industry: Pyrogen and endotoxins testing: Questions and answers. https://www.fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-pyrogen-and-endotoxins-testing-questions-and-answers

Gauvry, G. (2015). Current horseshoe crab harvesting practices cannot support global demand for TAL/LAL: The Pharmaceutical and Medical Device Industries' Role in the Sustainability of Horseshoe Crabs. In R. Carmichael, M. Botton, P. Shin, & S. Cheung (Eds.), Changing global perspectives on horseshoe crab biology, conservation and management, pp. 475-82. Springer. https://doi.org/10.1007/978-3-319-19542-1_27.

Gauvry, G. A., Uhlig, T., & Heed, K. (2022). LAL/TAL and animal-free rFC-based endotoxin tests: Their characteristics and impact on the horseshoe crab populations in the United States and Asia. In J. T. Tanacredi et al. (Eds.), International horseshoe crab conservation and research efforts: 2007-2020, pp.369-90. Springer. https://doi.org/ 10.1007/978-3-030-82315-3_21.

IUCN. (2024). The IUCN Red List of Threatened Species (Version 2024-1). https:// www.iucnredlist.org.

Laurie, K., Chen, C.P., Cheung, S.G., Do, V., Hsieh, H., John, A., Mohamad, F., Seino, S., Nishida, S., Shin, P., & Yang, M. (2019). *Tachypleus tridentatus* (errata version published in 2019). The IUCN Red List of Threatened Species, 2019: e.T21309A149768986. https://doi.org/10.2305/IUCN.UK.2019-3.RLTS.T21309A149768986.en

Loverock, B., Simon, B., Burgenson, A., & Baines, A. (2010). A recombinant factor C procedure for the detection of Gram-negative Bacterial Endotoxin. Pharmacopeial Forum, 36(1), 321-219.

McCloskey, W. T., Price, C. W., Van Winkle, W., Jr., Welch, H., & Calvery, H. O. (1943). Results of first U.S.P. collaborative study of pyrogens. Journal of the American Pharmaceutical Association, 32(3), 69–73.

Mizumura, H., Toshio,O., & Kawabata, S. I. (2012). European Patent EP-2930241-A1: Novel recombinant Factor C and method for producing same, and method for measuring endotoxin. https://pubchem.ncbi.nlm.nih.gov/patent/EP-2930241-A1

Pharmaceutical Supply Chain Initiative (PSCI). (2023). PSCI position paper on the use of horseshoe crabs. https://pscinitiative.org/resource?resource=1939

Smith, D. R., Beekey, M. A., Brockmann, H. J., King, T. L., Millard, M. J., & Zaldívar-Rae, J. A. (2016). *Limulus polyphemus*. The IUCN Red List of Threatened Species 2016: e.T11987A80159830. https://doi.org/10.2305/IUCN.UK.2016-1.RLTS.T11987A80159830.en

Smith, D. R., Brockmann, H. J., Carmichael, R. H., Hallerman, E. M., Watson, W., & Zaldivar-Rae, J. (2023). Assessment of recovery potential for the American horseshoe crab (*Limulus polyphemus*): An application of the IUCN green status process. Aquatic Conservation: Marine and Freshwater Ecosystems, 33(11), 1175-1199. https://doi.org/10.1002/aqc.3990

United States Code of Federal Regulations (CFR). (1973). 38 FR 1404.

United States Pharmacopeia (USP). (2024a). Chapter <86>: Bacterial endotoxins test using recombinant reagents. https://www.uspnf.com/sites/default/files/usp_pdf/EN/USPNF/usp-nf-notices/86-bacterial-endotoxins-tests-using-recombinant-reagents.pdf

United States Pharmacopeia (USP). (2024b). <85>, Bacterial endotoxins test.

United States Pharmacopeia (USP). (2024c). General Notices 6.30: Alternative Methods.

United States Pharmacopeia (USP). (2024d). <1225>, Validation of compendial methods.

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MEMORANDUM

TO: Sciaenids Management Board

FROM: Red Drum Stock Assessment Subcommittee

DATE: October 16, 2024

SUBJECT: Response to 2024 (SEDAR 93) Red Drum Review Workshop Report

The Red Drum Stock Assessment Subcommittee (SAS) expresses some concerns about the peer review panel's (Panel) report summarizing their conclusions and recommendations from review of the 2024 Red Drum Benchmark Stock Assessment. These concerns could not be addressed prior to release of the report to the Sciaenids Management Board. Per the agreed upon review workshop schedule, the report was to be made available to the SAS for review on September 6, 2024 (https://sedarweb.org/documents/sedar-93-red-drum-review-schedule_assessmentreview-pdf/), but was not made available to ASFMC staff until October 8. This delay meant the report was released to ASFMC on the date of the deadline for ASMFC Annual Meeting main meeting materials resulting in the SAS not having the opportunity to review the report, seek any necessary clarification from the Panel, or provide any comments they felt necessary to be considered with the report in main meeting materials. Although the entire Red Drum Technical Committee (TC) could not gather during the brief period between receiving the report and the deadline for Annual Meeting supplemental meeting materials (October 16), the SAS was able to outline their concerns in the following response to the report.

Stock-Recruitment Relationship Steepness

The recommendation from the Panel not to fix steepness of the stock-recruitment relationship at 0.99 is in direct conflict with the recommendation from the simulation assessment peer review panel to fix steepness at 0.99. The benchmark assessment report includes a reference to this recommendation in the simulation assessment peer review report (ASMFC 2022) as justification for fixing steepness at 0.99, and the decision was not "arbitrary and ad-hoc" as described in the Panel's report. This treatment of the stock-recruitment relationship, along with use of SPR-based proxy reference points, is a common practice among stock assessments along the US Atlantic Coast that have limited information to inform a reliable steepness parameter estimate. The Panel noted in the report that setting steepness to 0.99 implies no stock-recruitment relationship, "despite biological evidence suggesting otherwise." It is not clear what evidence the Panel is citing here, as there was not discussion about data during the workshop indicating a defined stock-recruitment relationship for Atlantic coast red drum.

The Panel requested a sensitivity run during the workshop with steepness fixed at 0.84, based on the Shertzer and Conn (2012) meta-analysis and the steepness value assumed in the simulation assessment operating model. The assessment model was not particularly sensitive to this alternative steepness value (Figures 1 and 2) and the alternative value does not affect stock status estimates. The SAS believes the steepness value of 0.99, as recommended during the simulation assessment peer review, is most appropriate. Further, it is important to note the SAS conducted a sensitivity analysis using the base model configuration with the only change being to try and estimate steepness as part of the sensitivity analysis described in the assessment report. Under this run, the estimate of steepness hit the upper bound (0.99), effectively converging on the base model run and was the observed pattern noted by the simulation assessment peer review panel, which indicates lack of information in the data to estimate a stock-recruitment relationship and was a primary reason for their recommendation to fix steepness at 0.99.

Index Data

Index Exclusion/Inclusion

The Panel expressed concern that "clear analyses were not presented to demonstrate the time series included in the assessment models were all indexing stock abundance and there were no conflicts between the time series." While the SAS recognizes these concerns, it is unclear what additional analyses would alleviate these concerns given a primary assumption of any index is that it is accurately representing true, unknown stock abundance trends for the stock being assessed. For the southern stock, the SAS provided figures during the workshop illustrating broad spatial synchrony across sub-adult and recruitment surveys during periods of temporal overlap (Figure 3). Second, at the request of the Panel, the SAS provided age-specific indices to evaluate the ability of the southern stock sub-adult surveys to track year classes through time to support the concept these surveys were representative of stock abundances (Figure 4). Unfortunately, similar analyses were not possible for the northern stock owing to only a single fishery-independent recruitment, sub-adult, and adult survey available which the model used to characterize abundance trends for the northern stock and lack of age composition data to split the sub-adult aggregate index into age-specific indices. However, the SAS did inform the Panel of a publication cited in previous red drum assessments that evaluated the NC recruitment survey and validated the index from this survey by showing strong correlations with fishery catches two years later (Bacheler et al. 2008). Third, of the ten surveys retained in the southern (n = 7) and northern (n = 3) SS models, a version of all but one (the SC rotenone survey representing recruitment in the mid- to late-1980s) was included in the previous benchmark assessment (ASMFC 2017; SEDAR 2015) as nominal indices presumably less representative as an index of stock abundance. Justification for inclusion of the additional SC rotenone survey was provided in the simulation assessment report (ASMFC 2022), which the Panel was not tasked with reviewing and was understandably missed with review focused on the benchmark assessment.

Index Standardization

The Panel expressed concern with indices used in the assessment developed from standardization methods that did not produce diagnostics they considered adequate. Although some diagnostics were not considered adequate for some indices, the SAS moved from nominal (e.g., simple arithmetic mean) indices to standardized indices that account for extraneous catchability effects during this assessment, which represents an advancement in index data treatment. While this was the first-time standardized indices have been developed for all surveys during a red drum assessment, as noted above as an advancement relative to prior assessments, previous red drum review panels have thoroughly reviewed the surveys and indices used. Therefore, the SAS approached index development as a routine process and focused extra time on other challenging areas experienced in past assessments and reviews (development of proxy size composition data for recreational discards and use of tag-recapture data).

During the review workshop, a reviewer developed an alternative index from the SC Trammel survey using spatio-temporal methods with alternative covariates considered (month as a factor instead of day of year as a continuous variable; estuary (coarser scale) instead of strata, i.e. sub-estuary, a finer scale spatial variable; the exclusion of a site level random effect; inclusion of year by area and month by area random effects). This alternative index indicated a lower relative abundance in recent years than the index used in the base assessment model (Figure 5). The reviewer noted when providing the alternative index for a requested assessment model sensitivity run that "while environmental covariates improved the fit (AIC, the qqplot did not change much), this requires some changes to the way we generate the indices i.e. making a prediction grid in space with the values of all environmental covariates for that year and location so I did not test due to lack of time". Further, it used a spatial variable deemed inferior (based on model selection criteria) to the strata spatial variable used in the SAS developed index and one not recommended for use by the data provider to characterize the spatial effect on catchability given sub-estuary red drum distribution patterns. The SAS has concerns about using an alternative index that did not have adequate time and consideration to develop. However, even with these concerns, the alternative index sensitivity run (Figures 1 and 2, Trammel) showed similar trends in both SPR and SSB as the base model run though the estimates were scaled higher.

Following the review workshop, the SAS spent additional time developing an alternative index using spatio-temporal methods, suggested by reviewers, while considering environmental covariates and evaluating diagnostics recommended by the Panel. This alternative index was similar to the original index used in the base assessment model, particularly in recent years (Figure 6). The SAS recognizes the Panel's point that the assessment model is sensitive to alternative calculations of this index, but the report does discuss stock status estimates from the assessment model run with the alternative reviewer-provided index and we do not think the model results using the alternative index developed during the workshop should be interpreted as a plausible "state of nature", the typical interpretation of final sensitivity runs, until more time and consideration goes into developing this index. We also note that it is not unexpected to see assessment model sensitivity to alternate data sets used in the fitting process.

Additional Peer Review Workshop Runs

Several analyses were conducted during the course of the review workshop that are discussed in the report, but are not supplemented with information reviewed during the workshop (e.g., comparison figures). The SAS believes these materials, which are not available for reference anywhere else, are important context to the report (Figure 1 and 2).

The report notes "plots of SPR, spawning stock biomass, and relative spawning stock biomass indicated that while most analyses resulted in proportional shifts, only the removal of the Florida haul index data and the update of the South Carolina trammel index led to a change in stock status." This is misleading, as no sensitivity runs requested during the review workshop led to a change in overfishing status. Overfished status changed for the two runs noted, but it's important to consider the change quantitatively which is not described in the report. Terminal three-year (2019-2021 fishing years) average relative SSB ($SSB/SSB_{30\%}$) used to determine overfished status changed from 0.881 in the base model to 1.008 and 1.025 in runs with the removal of the Florida haul age data and the alternative South Carolina trammel index (again, we do not think this should be considered a plausible run), respectively. A value less than one (the threshold) indicates an overfished stock status determination. With additional consideration of the consistent downward trend of SSB and the preliminary 2022 fishing year estimates, it is very likely an overfished status would be estimated in these runs using the three-year average SSB from 2020-2022.

TLA Reference Period

The Traffic Light Analysis (TLA) reference periods chosen during the assessment were based on the previous peer reviewed and management board-accepted stock assessments. The SAS used the periods when the stocks were determined not to be overfishing in these assessments, as described in the assessment report. Although the SAS thinks the methods used in the previous assessments needed improvement, the previous assessments stood as the best scientific information available (BSIA) for the SAS to consider during development of the current assessment. No improved, alternative reference period choice was recommended by the Panel for the SAS to consider against their choice during the assessment, so the SAS believes the reference periods chosen during the assessment are the best available.

The Panel notes that robustness testing is needed to understand choices of reference period. However, the SAS conducted sensitivity testing during the assessment around reference period choice and the Panel acknowledged, particularly for fishery performance measures indicative of fishing mortality, that results were "largely in agreement" across choices tested. Management strategy evaluation (MSE) was suggested by the Panel as a way to test the TLA for the purpose of operationalizing a control rule, but the SAS notes MSE is outside the scope of a traditional stock assessment and that they used the TLA in the assessment to provide qualitative stock status determinations, not to implement a specific control rule. The SAS agrees with the recommended MSE approach for testing the TLA to implement a specific control rule, but notes this would need to be a separate process similar in duration and resources as the benchmark assessment.

2025 Assessment Update

The Panel's report recommends a short-term update of the assessment in 2025 that incorporates:

- The most recent data available, including catch, biological, and abundance indices information.
- Updating the model according to Panel recommendations, specifically including the approach to standardization of abundance indices and in the testing and selection of retained abundance indices.
- Expected changes in the catches derived from MRIP, if available.

The SAS does not believe this update will result in substantial changes for reasons discussed below and has concern spending additional time, if made available, on model updates will lead to delays in action to address unfavorable stock status determinations. A red drum assessment update is not currently accounted for on the ASMFC stock assessment schedule and TC-generated updates to input data and technical analyses by the SAS would require time for other responsibilities be shifted to this unplanned assessment update.

Second, the alternative SC Trammel index developed after the review workshop and discussed above shows minimal changes to the index trend that are unlikely to change the conclusions of the assessment. This conclusion is supported by the runs conducted at the review workshop using the alternative index developed by the Panel member (see discussion above), which showed greater divergences in time series patterns (Figure 5 vs. Figure 6), and still resulted in no change in stock status (Figures 1 and 2; Trammel). Similar treatment of other southern stock SC indices post-review workshop suggest similar results, with no reason to believe changes to spatio-temporal modeling and inclusion of comparable covariates would result in large deviations in relative abundance trends.

Third, removing the longline survey data altogether, a recommended model update from the Panel, was done as a sensitivity run at the request of the Panel. The change impacted historical stock estimates, but the model was relatively insensitive to the removal of these data in recent years (Figures 1 and 2, No Longline). As discovered during model development and discussed during the review workshop, the contemporary SC longline survey provides age data critical to informing early recruitment deviations used to modify an unrealistic equilibrium age composition in the model start year (Figure 7) and is the primary data source informing the model of growth for older, mature fish. For these reasons as noted in the assessment report, the SAS believes these data are beneficial to the assessment model and should not be removed from the base model.

Finally, as discussed at the review workshop, potential MRIP catch estimate changes will not be finalized until Spring 2026. To include these data, an assessment would not be completed until late 2026 or early 2027. This would represent a significant delay in potential management action with sensitivity runs exploring the impact of a proposed constant 30% reduction in catch (both in the assessment report and additional multi-factor sensitivity changes requested during the review workshop and presented in Figures 1 and 2, herein) suggesting no change in stock status determination. While such changes affect the scale of the population (i.e., absolute SSB, absolute numbers, average recruitment), there is also a proportional change in reference points associated with $SPR_{30\%}$ and $SSB_{30\%}$. This effect was anticipated by the SAS and confirmed via these sensitivity runs and hence, while potentially a significant change to the catch stream, given the red drum fisheries are not managed via annual catch limits across both sectors, the scale changes are not as impactful for management considerations.

References

ASMFC. 2022. Red Drum Simulation Assessment and Peer Review Report. ASMFC. Arlington, VA.

Bacheler, N.M., L.M. Paramore, J.A. Buckel, and F.S. Scharf. 2008. Recruitment of juvenile red drum in North Carolina: Spatiotemporal patterns of year-class strength and validation of a seine survey. *North American Journal of Fisheries Management* 28:1086-1098.

Shertzer, K. and P. Conn. 2012. Spawner-recruit relationships of demersal marine fishes: Prior distribution of steepness. Bulletin of Marine Science 88. 10.5343/bms.2011.1019.

Figures

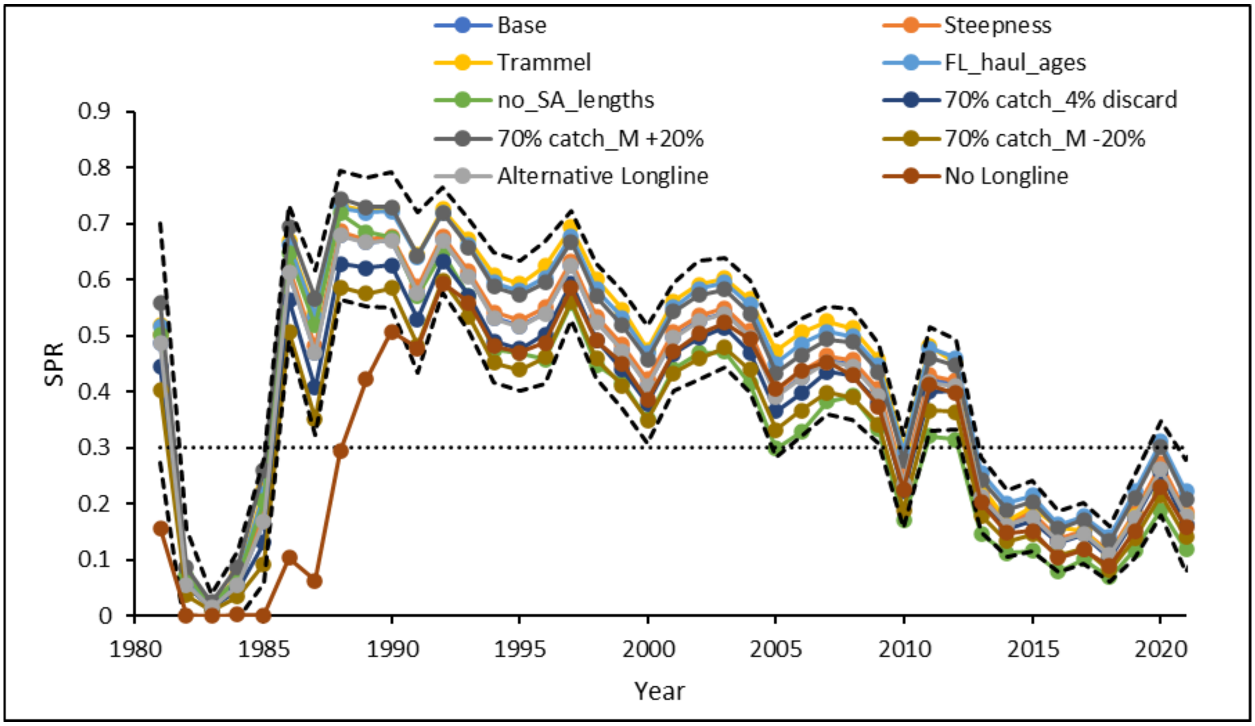


Figure 1. Spawning potential ratio (SPR) estimates from the base SS model for the southern red drum stock compared to sensitivity runs requested during the peer review workshop. The dotted line is the 30% SPR threshold. Sensitivity runs include: changing stock-recruitment steepness from 0.99 to 0.84 (Steepness), using the alternative SC Trammel index calculated during the review workshop (Trammel), excluding early years of age composition data for the FL Haul Seine survey (FL_haul_ages), excluding length composition data for sub-adult surveys (no_SA_lengths), reducing recreational catch by 30% with a 4% discard mortality instead of 8% (70% catch_4% discard), reducing recreational catch by 30% with an increase of the base natural mortality by 20% (70% catch_M +20%), reducing recreational catch by 30% with a decrease of the base natural mortality by 20% (70% catch_M -20%), using an alternative index for the SC Longline survey calculated during the review workshop (Alternative Longline), and dropping all longline survey data (No Longline).

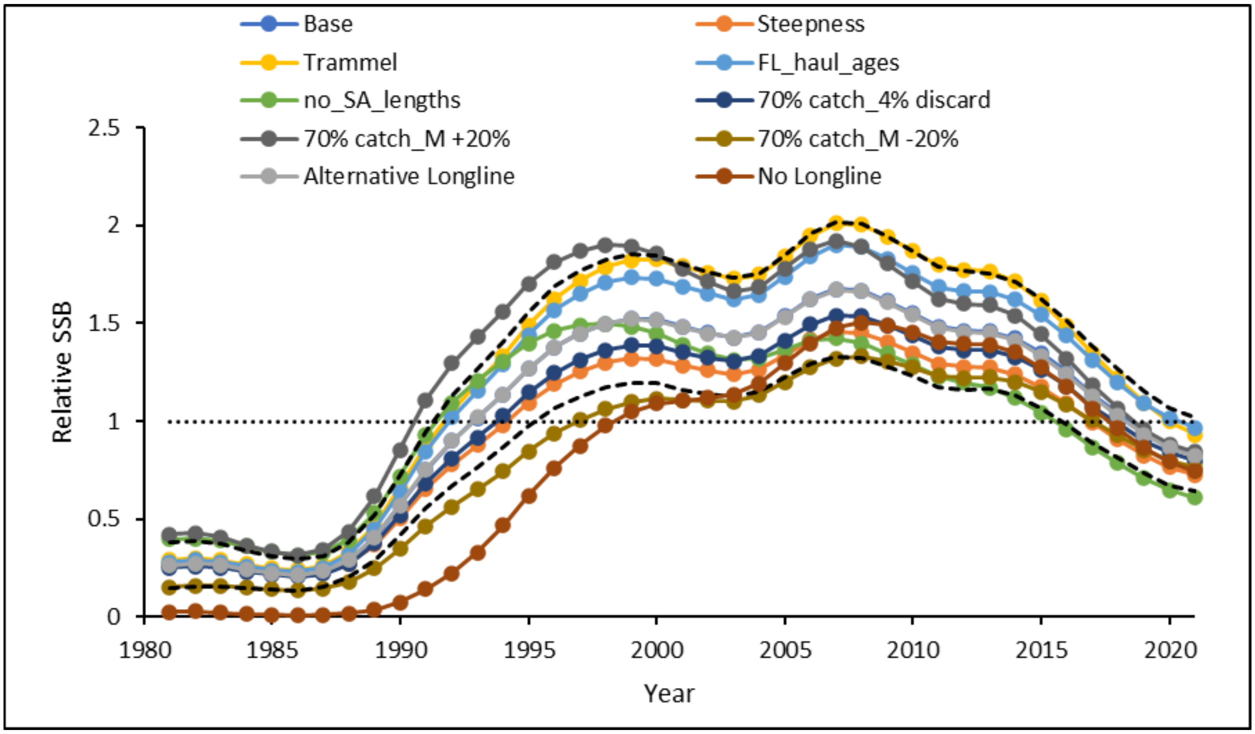


Figure 2. Relative spawning stock biomass ($SSB/SSB_{30\%}$) estimates from the base SS model for the southern red drum stock compared to sensitivity runs requested during the peer review workshop. The dotted line is the threshold (i.e., $SSB=SSB_{30\%}$). Sensitivity runs include: changing stock-recruitment steepness from 0.99 to 0.84 (Steepness), using the alternative SC Trammel index calculated during the review workshop (Trammel), excluding early years of age composition data for the FL Haul Seine survey (FL_haul_ages), excluding length composition data for sub-adult surveys (no_SA_lengths), reducing recreational catch by 30% with a 4% discard mortality instead of 8% (70% catch_4% discard), reducing recreational catch by 30% with an increase of the base natural mortality by 20% (70% catch_M +20%), reducing recreational catch by 30% with a decrease of the base natural mortality by 20% (70% catch_M -20%), using an alternative index for the SC Longline survey calculated during the review workshop (Alternative Longline), and dropping all longline survey data (No Longline).

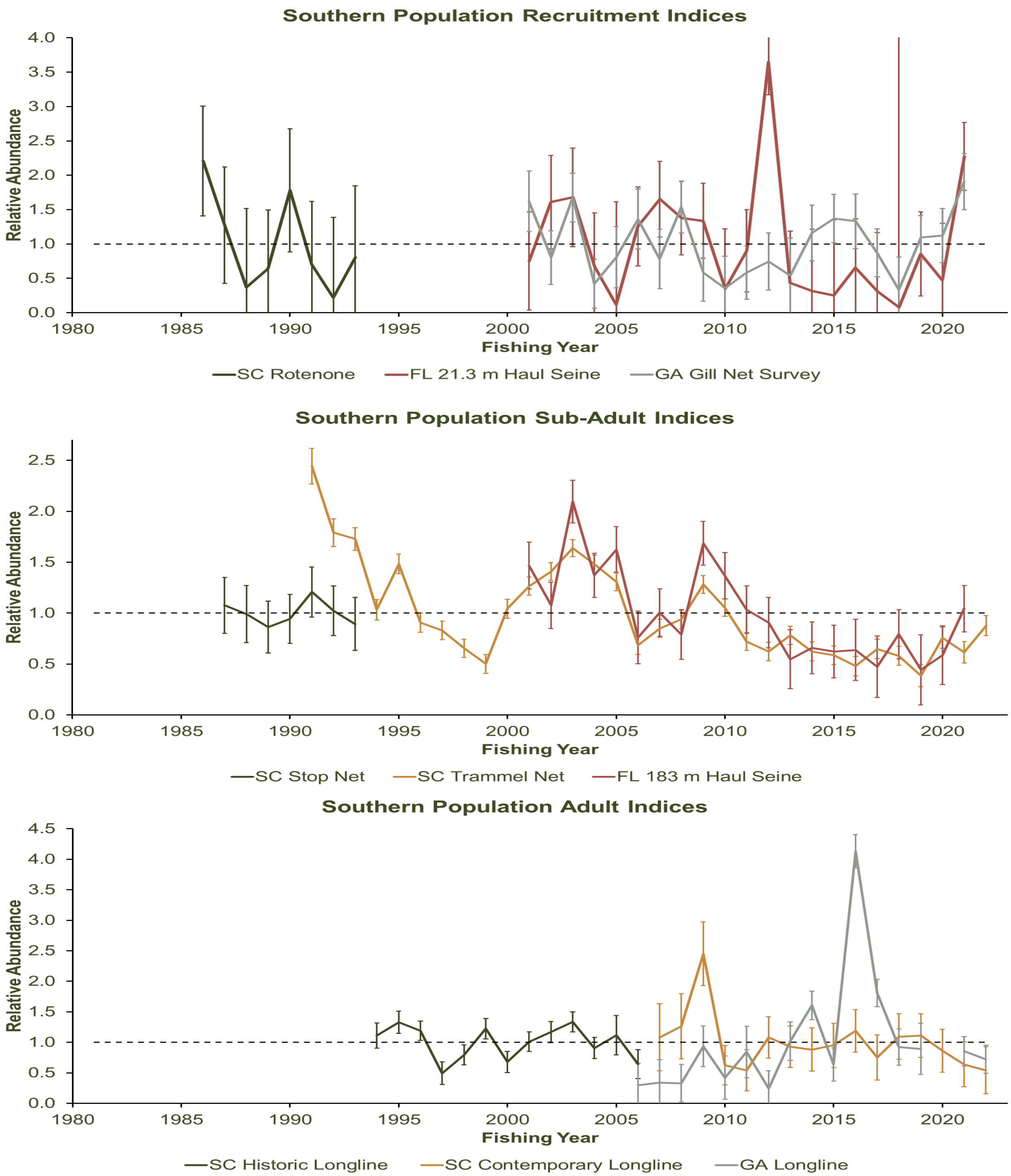


Figure 3. Combined plot of southern population recruitment indices (top panel), sub-adult indices (middle panel), and adult indices (bottom panel) illustrating broad synchrony in abundance signals across surveys encountering similar size and age red drum throughout the region. The most conflict is between the two contemporary longline surveys with the SC index suggesting stable to decreasing abundance while the GA longline suggesting stable to increasing abundance. Due to concerns regarding the ability of the GA longline survey to represent changes in adult red drum abundance due to low encounter rates, survey design changes and other factors, the SAS recommended, and the Panel concurred with, removal of the index from the base model for the southern stock.

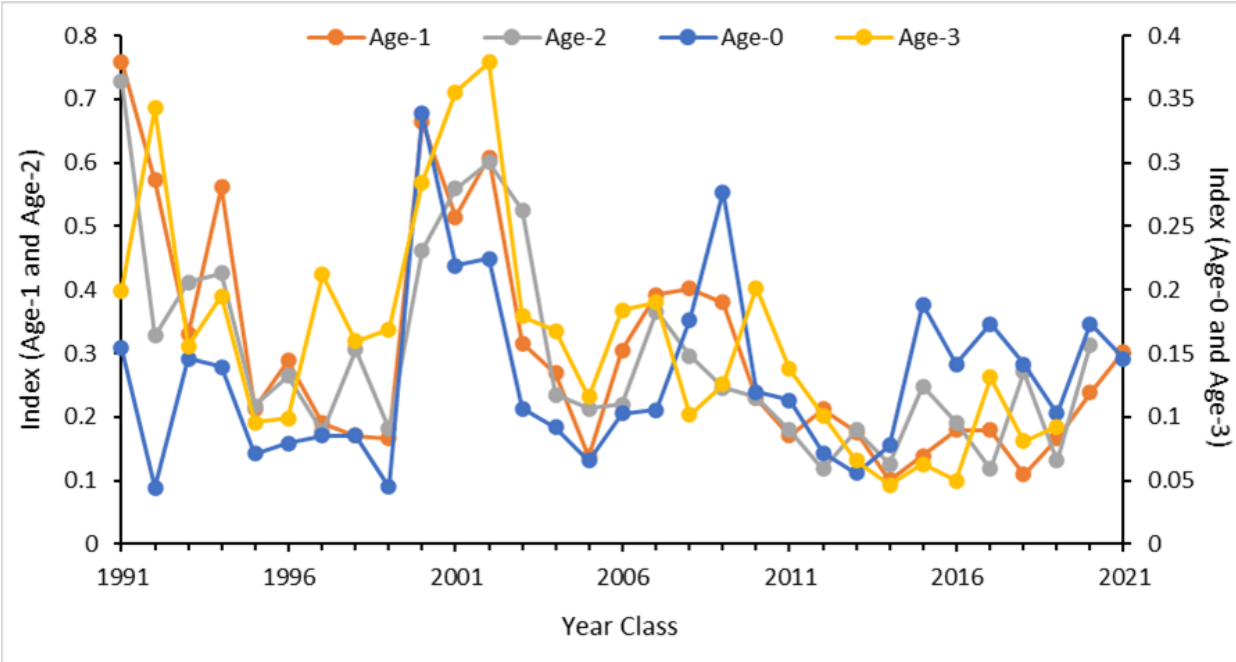


Figure 4. Age-specific indices of abundance from the SC Trammel Survey lagged, where necessary, to match their year class. Age-0 and age-3 index values are on the secondary axis due to lower catch rates of these age classes to give a better comparison of trends.

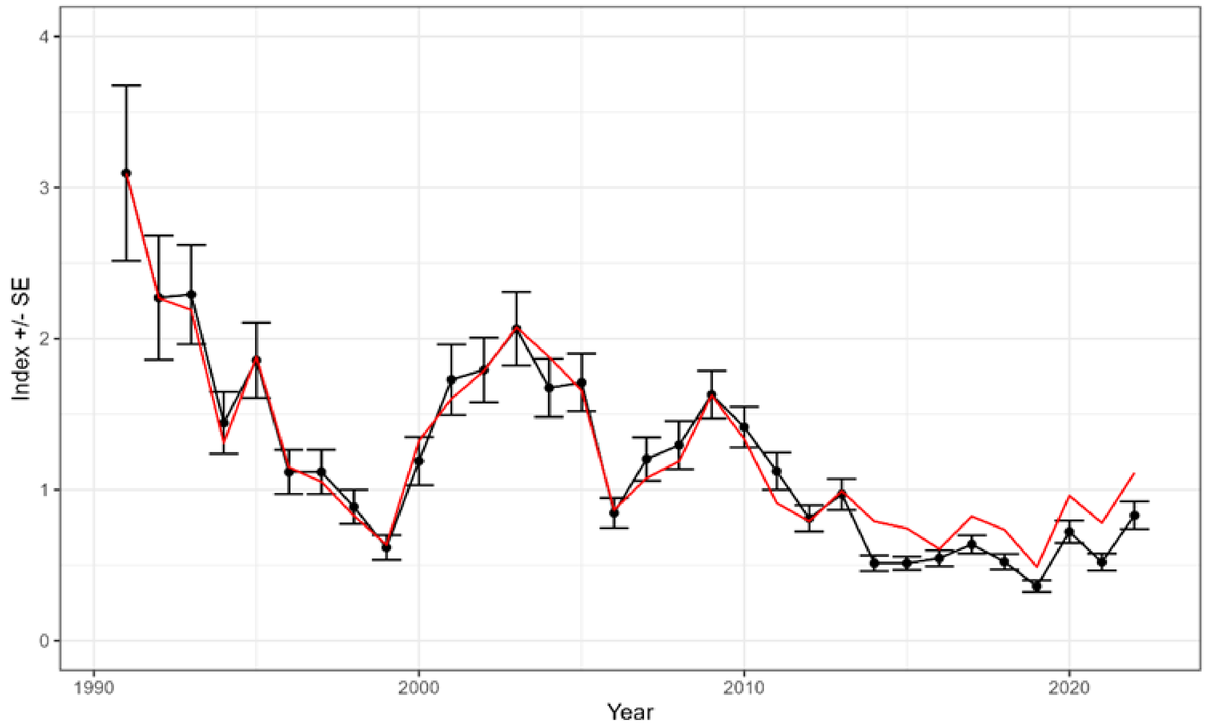


Figure 5. Alternative SC Trammel index calculated by reviewers during the review workshop (black with error bars) compared to the index used in the base assessment model (red).

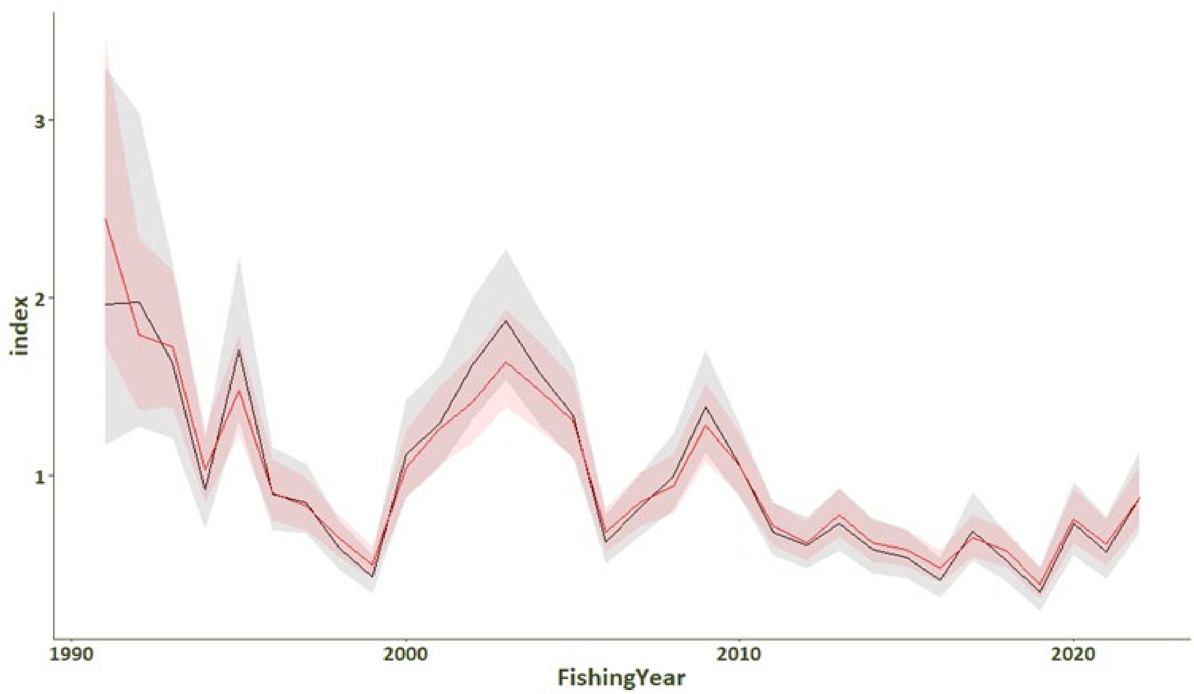
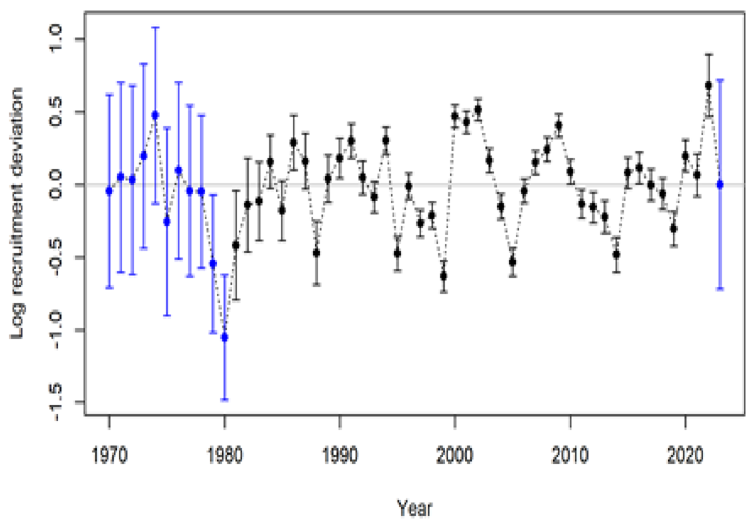


Figure 6. Alternative SC Trammel index calculated by the SAS following the review workshop using a spatiotemporal delta-truncated negative binomial model with random effect for site, and fixed effects for fishing year, month, and tidal stage in both model components (black line with grey shaded 95% CIs) compared to the index used in the assessment base model (red).



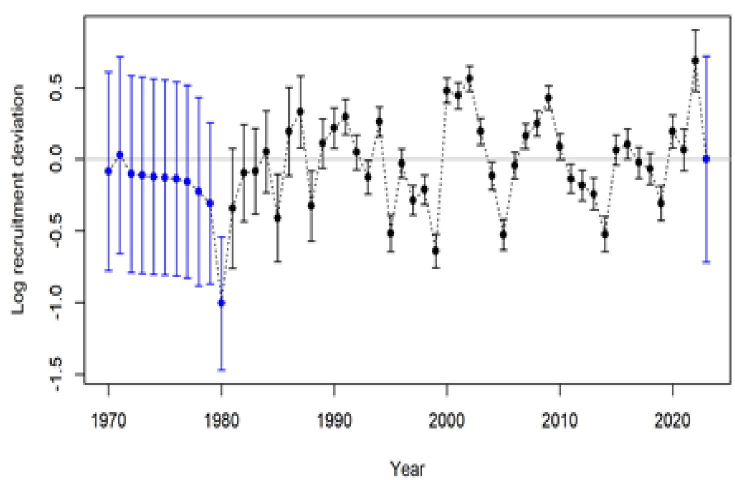


Figure 7. Recruitment deviation estimates from the southern base assessment model with (left) and without (right) SC Longline age data.

Atlantic States Marine Fisheries Commission

Preliminary Red Drum Risk and Uncertainty Report

October 2024

The following report details the preliminary inputs for the Red Drum Risk and Uncertainty Decision Tools. There are two decision tools, one for each red drum management region: New Jersey through North Carolina (northern stock) and South Carolina through the Atlantic side of Florida (southern stock). The report summarizes both technical inputs (scores) and weightings for the decision tools. The technical inputs characterize components of the red drum stock and fishery that may contribute to risk and uncertainty, while the weightings indicate the relative importance of each component to management considerations for red drum.

Preliminary Risk and Uncertainty Decision Tools for Red Drum Management Regions

Weightings in table below are only default values until Sciaenids Management Board input has been collected and summarized.

	Northern		Southern	
Decision Tool Component	Weight	Score	Weight	Score
P(SSB < SSB threshold)	0.10	0.00	0.10	1.00
P(SSB < SSB target)	0.10	0.30	0.10	1.00
P(*F* > *F* threshold)	0.10	0.00	0.10	1.00
P(*F* > *F* target)	0.10	0.80	0.10	1.00
Model uncertainty	0.10	4.00	0.10	2.00
Management uncertainty	0.10	3.75	0.10	3.50
Environmental uncertainty	0.10	4.00	0.10	4.25
Ecosystem/trophic importance	0.10	2.18	0.10	3.00
Short-term commercial socioeconomic effect	0.10	*	0.10	*
Long-term commercial socioeconomic effect	0.10	*	0.10	*
Short-term recreational socioeconomic effect	0.10	*	0.10	*
Long-term commercial socioeconomic effect	0.10	*	0.10	*

*A portion of the socioeconomic scores will only be calculated if a management action will be initiated. See the Socioeconomic Considerations for further details and socioeconomic sub-scores.

Region: New Jersey – North Carolina (Northern)

The following technical inputs were provided by the Red Drum Technical Committee.

Stock Status

All stock status inputs are based on the 2024 Red Drum Benchmark Assessment.

Spawning Stock Biomass (SSB) Threshold
Probability that SSB is less than the threshold (range: 0 – 1): 0.00
SSB Target
Probability that SSB is less than the target (range: 0 – 1): 0.30
F Threshold
Probability that fishing mortality (*F*) is more than the threshold (range: 0 – 1): 0.00
F Target
Probability that *F* is more than the target (range: 0 – 1): 0.80

<u>Additional Uncertainty Considerations</u>
Model Uncertainty
Score (range: 0 – 5): 4
Justification:

- The Traffic Light Analysis (TLA) was used to determine stock status due to instability of SS model.
- The TLA does not integrate data but rather evaluates data sets individually.
- Adult abundance metric proportion red threshold halved from grid search optimum due to concerns that the metric would fail to detect declines in older age-classes.
- Fishery performance status was found to be sensitive to the reference period (2 of 8 alternate reference periods resulted in overfishing determination).
- There are catch data for areas north of NC, but no fishery-independent abundance data.
- There were contradictory conclusions about overfishing between the preferred TLA method and the Skate method, with the Skate method identified as the more risk adverse method due to its shorter timeframe to indicate overfishing.

Management Uncertainty
Score (range: 0 – 5): 3.75
Justification:

- Uncertainty in the TLA results during the mid-to-late 2010s being influenced by the strong 2011-year class.
- Lack of abundance information north of NC and overall data limitations due to lack of good fishery dependent and independent mortality data.
- Assessment peer review concerns of unrealistic decline in abundance over the time series.
- The Skate Data Limited Control Rule method suggests F is too high in recent years, so there is trouble constraining catch.
- Uncertainty around MRIP estimates and regarding effectiveness of management actions.
- The current FMP has prescriptive goals, but its ability to assess management performance has been highly uncertain.
- Current management is restrictive (narrow slot limits and low bag limits), but legal harvest is almost exclusively of immature fish.

- Fishery trending toward overfished/experiencing overfishing and there is potential for population expansion north.

Environmental Uncertainty
Score (range: 0 – 5): 4
Justification:

- There is a link between recruitment success and environment, specifically directionality and intensity of wind during the spawning (Goldberg et al. 2021) but this link is not accounted for in the TLA.
- There is evidence of range expansion into VA and MD based on MRIP data but there is no fishery-independent data to corroborate. Climate projections tend to favor potential for expansion northward.
- The species is moderately sensitive to climate change and experiences high climate exposure according to climate change vulnerability assessments (Hare et al. 2016.)
- There is a large variation in M.

Additional Risk Considerations
Ecosystem/Trophic Importance
Score (range: 0 – 5): 2.18
Justification:

- Red drum is a higher trophic level piscivore in estuarine systems and forage fish for marine mammals.
- Since this stock is at the northern extent of range, there are other piscivores (e.g., striped bass) that are likely more important.
- There is a lower abundance of red drum in northern part of the range, so they will have less trophic interactions and ecosystem impacts.
- Effective predator at adult stages, but there is little research done to characterize their importance as a prey species.

Socioeconomic Considerations
See socioeconomic considerations section below.

Region: South Carolina – Florida (Southern)

The following technical inputs were provided by the Red Drum Technical Committee.
Stock Status
All stock status inputs are based on the 2024 Red Drum Benchmark Assessment.
Spawning Stock Biomass (SSB) Threshold
Probability that SSB is less than the threshold (range: 0 – 1): 1.00
SSB Target
Probability that SSB is less than the target (range: 0 – 1): 1.00
F Threshold
Probability that fishing mortality (*F*) is more than the threshold (range: 0 – 1): 1.00

F Target

Probability that *F* is more than the target (range: 0 – 1): 1.00

Additional Uncertainty Considerations

Model Uncertainty

Score (range: 0 – 5): 2

Justification:

- The asymptotic standard errors that were used in the SS model are considered a minimum quantification of model uncertainty.
- Relative to the management threshold of 1.0, the terminal three-year relative SSB upper 95% confidence interval limits were 1.15 (2019), 1.07 (2020), and 1.02 (2021). Relative to the management threshold of 30%, the terminal three-year SPR upper 95% confidence interval limits were 0.25 (2019), 0.35 (2020), 0.28 (2021).
- One of nine sensitivity runs estimated a different overfished status than the base model, with this run's terminal three-year relative SSB estimates above the base model 95% CI; estimates below base model 95% CI for one additional run. No sensitivity runs estimated a different overfishing status.
- No retrospective peel estimates during terminal three years were outside the base model’s 95% CIs. One retrospective peel SPR estimate was outside base model’s 95% CIs.
- The different assessment methods used in this stock assessment for the southern stock (SS, TLA, Skate) agreed on overfishing status, differed on overfished status based on the inclusion of GA Longline index in the TLA.

Management Uncertainty

Score (range: 0 – 5): 3.5

Justification:

- Lack of good fishery-dependent and -independent mortality data on the oldest and most fecund age classes.
- Potential effect of MRIP effort changes.
- State-specific assessments have indicated concern or poor stock status.
- The FMP has prescriptive goals, but its ability to assess management performance has been uncertain.
- Current management is restrictive (narrow slot limits and low bag limits), but legal harvest is almost exclusively of immature fish.
- Overfished/experiencing overfishing is likely, suggesting F is too high and indicating management has had trouble constraining catch.
- There are no effort controls, only harvest controls which appear ineffective at constraining total removals.

Environmental Uncertainty
Score (range: 0 – 5): 4.25
Justification:

- There needs to be more comprehensive abiotic/biotic metrics due to the correlations generally being weak, and there is a need to incorporate spatial aggregations.
- In Florida and other southern states, red tide and other HABs need to be considered.
- The link between recruitment success and the environment determined by Goldberg et al. 2022 is not accounted for in the 2024 assessment model and will not be accounted for explicitly in projections.
- This species is moderately sensitive to climate change and experience high climate exposure according to climate change vulnerability assessments (Hare et al. 2016.).
- There is uncertainty about annual recruitment variability due to acute environmental impacts as well as long term climate change.
- There was no spawner-recruit relationship detected in the assessment.
- There is a lack of understanding of environmental drivers' impact on recruitment and there has been depressed recruitment for 10+ yrs. Fish kills are also occurring in shallow water estuarine environments.

<u>Additional Risk Considerations</u>
Ecosystem/Trophic Importance
Score (range: 0 – 5): 3
Justification:

- Based upon assessment report, red drum does not appear to have an important link to the ecosystem.
- It is an important predator, but likely a minor threat to endangered or other managed species.
- It's an effective predator at adult stages, but little research has been done to characterize their importance as a prey species.
- There is a larger abundance in comparison to the northern region, with similar trophic interactions and ecological impacts.

<u>Socioeconomic Considerations</u>
See socioeconomic considerations section below.

<u>Socioeconomic Considerations</u>

The following technical inputs were provided by the Committee on Economics and Social Sciences (CESS). After comparing regional data, the CESS decided to provide a single coastwide score for each socioeconomic component.

Commercial Value
Score (range: 0 – 5): 1
Justification:

- The red drum commercial fishery economic value importance indicator was calculated using a three-year average of coastwide ex-vessel value.
    - A value of 0 was assigned if there were no reported commercial landings in the time period. A value of 1 was assigned if the ex-vessel value of the commercial fishery was <1 million dollars.
    - A value of 2 was assigned if the ex-vessel value of the commercial fishery was between 1-10 million dollars.
    - A value of 3 was assigned if the ex-vessel value was between 10-30 million dollars.
    - A value of 4 was assigned if the ex-vessel value was between 30-100 million dollars.
    - A value of 5 was assigned if the ex-vessel value was >100 million dollars.
- The average ex-vessel value from 2020 to 2022 was $514,347 which indicated a value of 1.

Commercial Community Dependence
Score (range: 0 – 5): 1
Justification:

- The red drum commercial fishery community dependence indicator was calculated using a ratio of the red drum ex-vessel value to the total ex-vessel value of the top ten communities each averaged over three years (2020-2022).
- In the period there were publicly available state level landings in North Carolina and Virginia, therefore the average ex-vessel value of the top ten communities included two communities, North Carolina and Virginia.
- The scores were assigned based on the relative ex-vessel value of red drum to total ex-vessel value of the commercial fleets in each community.
    - A value of 0 was assigned if there were no community fishing.
    - A value of 1 was assigned if the ratio of red drum ex-vessel value to total ex-vessel value was between 0%-5%.
    - A value of 2 was assigned if the ratio of red drum ex-vessel value to total ex-vessel value was between 5%-15%.
    - A value of 3 was assigned if the ratio of red drum ex-vessel value to total ex-vessel value was between 15%-25%.
    - A value of 4 was assigned if the ratio of red drum ex-vessel value to total ex-vessel value was between 25%-50%.
    - A value of 5 was assigned if the ratio of red drum ex-vessel value to total ex-vessel value was >50%.
- The ratio of red drum ex-vessel value was averaged from 2020 to 2022, and the total ex-vessel value was 0%, which indicated a community dependence value of 1.

Recreational Desirability

Score (range: 0 – 5): 4

Justification:

- The red drum recreational fishery importance indicator was calculated by identifying the total coastwide annual targeted trips as a percentage of the total coastwide trips averaged over three years from 2020-2022.
- Trips were defined as a trip where red drum was the primary or secondary targeted species. Using this methodology recreational trips are not cumulative across species.
    - A value of 0 was assigned if there were no recreational fishing trips where red drum were the primary or secondary target.
    - A value of 1 was assigned if the percent of Red drum trips was between 0-0.5%.
    - A value of 2 was assigned if the percent of red drum trips was between 0.5-1.5%.
    - A value of 3 was assigned if the percent of red drum trips was between 1.5-5%.
    - A value of 4 was assigned if the percent of red drum trips was between 5-10%. A value of 5 was assigned if the percent of red drum trips was >10%.
- The percent of red drum trips to total recreational trips was 8%, which indicated a score of 4.

Recreational Community Dependence

Score (range: 0 – 5): 2

Justification:

- The red drum recreational community dependence indicator was calculated by identifying the average target trips of red drum as a percent of total recreational trips for the top ten communities averaged over three years from 2020-2022.
- There were six communities where NOAA reported recreational red drum trips that were statistically different from zero. Those communities were Florida, Georgia, Maryland, North Carolina, South Carolina, and Virginia.
    - A value of 0 was assigned if there were not any red drum trips in any communities from 2020-2022.
    - A value of 1 was assigned if the number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was between 0-3%.
    - A value of 2 was assigned if the number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was between 3-10%.
    - A value of 3 was assigned if the number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was between 10-15%.
    - A value of 4 was assigned if the number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was between 15-20%.
    - A value of 5 was assigned if the number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was >20%.

- The number of red drum trips as a percentage of all recreational trips averaged over the top communities from 2020-2022 was 9%. which indicated a score of 2.

Commercial Short-term Management Change
Score (range: 0 – 1; + or – depending on direction of effect):
To be calculated if management actions are initiated.

Commercial Long-term Management Change
Score (range: 0 – 1; + or – depending on direction of effect):
To be calculated if management actions are initiated.

Recreational Short-term Management Change
Score (range: 0 – 1; + or – depending on direction of effect):
To be calculated if management actions are initiated.

Recreational Long-term Management Change
Score (range: 0 – 1; + or – depending on direction of effect):
To be calculated if management actions are initiated.

Preliminary Decision Tool Weightings

This section will be completed once Sciaenids Management Board input has been collected and summarized.

The following weightings were produced based on Red Drum Management Board input. The Board provided input on priorities for risk considerations in tautog management via a webinar poll and survey. Each component of the Risk and Uncertainty Decision Tool was scored on a scale of 1 to 5, where 1 = this component is much less important than other components, 3 = this component is equally important as other components, and 5 = this component is much more important than other components. Responses were averaged and converted to the weighting scale.

Component	Score	Weight
SSB Threshold	0.00	0.00
SSB Target		
***F* Threshold**		
***F* Target**		
Model Uncertainty		
Management Uncertainty		
Environmental Uncertainty		
Ecosystem Importance		
Commercial Short-term		
Commercial Long-term		
Recreational Short-term		
Recreational Long-term		

Literature Cited

Goldberg, D. A., Paramore, L. M., & Scharf, F. S. (2022). Analysis of environment-recruitment associations for a coastal red drum population reveals consistent link between year class strength and early shifts in nearshore winds. *Fisheries Oceanography*, *31*(1), 56-69.

Hare JA, Morrison WE, Nelson MW, Stachura MM, Teeters EJ, et al. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE 11(2): e0146756. https://doi.org/10.1371/journal.pone.0146756

Atlantic States Marine Fisheries Commission

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703.842.0740 • www.asmfc.org

MEMORANDUM

TO: Sciaenids Management Board

FROM: Black Drum Technical Committee

DATE: October 15, 2024

SUBJECT: 2024 Black Drum Data Update

Background

The 2023 Black Drum Benchmark Stock Assessment determined the Atlantic coast stock was not overfished nor experiencing overfishing in the terminal year of the assessment (2020). However, the assessment acknowledged lack of contrast in black drum data sets coupled with high uncertainty in model-based estimates**.** To this end, the Black Drum Technical Committee (TC) recommended close monitoring of empirical stock indicators annually between stock assessments to identify any concerning trends in a timely manner. The next black drum stock assessment is tentatively scheduled for 2027. Should any concerning trends occur, the TC may recommend an expedited assessment.

Indicators developed during the stock assessment include abundance (young-of-year, age 0-1, subadult, and exploitable abundance), range expansion, recreational live releases and harvest, and commercial landings. Additional details on these indicators are available in Section 6 of the 2023 stock assessment report. At the conclusion of the assessment, indicators overall did not appear negative.

The first data update was completed and presented to the Sciaenids Board (Board) at their October 2023 meeting. The update showed mixed signs of stability and declines since the assessment, but the TC did not believe there was cause for concern and recommended no change to the current black drum stock assessment schedule. During the meeting, the Board requested the TC consider the frequency of data updates given the long lifespan of the species and make any recommended changes during the next data update.

This memo provides results and recommendations from the second data update since the assessment with data through 2023.

Results

Overall, indicators showed similar conditions to the terminal year of the assessment, with signs of increases in 2023 in the South Atlantic.

- Mid-Atlantic abundance indicators (all YOY) have varied around their time series means during the three update years (Figure 1).

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- South Atlantic abundance indicators were all below their time series means, but two indicators showed consistent increases from lows in 2021 to levels above the terminal year of the assessment (Figure 2).
- The MRIP CPUE (exploitable abundance indicator) increased above the time series mean in 2023 and just below levels in the terminal year of the assessment after the previous two update years were below the mean (Figure 3).
- The range expansion indicator was not available for 2021 and remained below the time series mean in 2023 at levels similar to 2022 (Figure 4).
- Recreational live releases varied around the time series mean in the Mid-Atlantic, and in 2023 were slightly below the time series mean and the level in the terminal year of the assessment. Recreational live releases in the South Atlantic remained above the time series mean during update years and increased for the first time in five years during 2023 to levels above that in the terminal year of the assessment (Figure 5).
- Recreational harvest has varied slightly during update years within regions, with all update years below the time series mean and levels during the terminal year of the assessment in the Mid-Atlantic and all update years above the time series mean and levels during the terminal year of the assessment in the South Atlantic (Figure 6).
- Commercial landings have shown a similar pattern to the recreational harvest with all update years below the time series mean in the Mid-Atlantic and above the time series mean in the South Atlantic (Figure 7). South Atlantic commercial harvest in 2023 increased markedly and was the highest since 2008.

Recommendations

The TC met on October 2, 2024 to discuss the data update to the indicators and make recommendations to the Board for their October 2024 meeting. The TC agreed that, generally, there were no concerning trends in the indicators relative to coastwide stock status at this time, as the 2023 data continued to fall within their respective historical ranges. The TC did note increases in black drum recreational and commercial landings in the south, which could indicate higher availability of fish, that fishing pressure is increasing, or both, and that some of these increases may be driven by more localized (e.g., state-specific) changes that could cause concern at these localized levels. An example was provided for North Carolina where increased regulations for other species (i.e., southern founder) may be leading to increased fishing pressure on black drum. The TC recognizes this will be important to follow in future years.

Following the Board's direction to the TC at their October 2023 meeting, the TC next discussed the appropriate timeline for future updates to the indicators. When considering how frequently the indicators should be updated, the TC also considered the timing of future stock assessment update and benchmark stock assessments. **The TC recommends scheduling the next data update to the indicators in 2026, and moving the scheduled black drum stock assessment from 2027 to 2028.** At that time, based on the results of the stock assessment, the TC will discuss the future schedule of data updates to the indicators.

The following points were discussed by the TC, as a part of making this recommendation:

- TC members agreed the indicators do not need to be updated annually at this time, especially as the TC decided at their October 2023 call that there would need to be several years of decline to cause concern. As a result, the TC discussed moving the next data update to 2026. However, it was noted that the TC would also be gathering data for the tentatively scheduled 2027 assessment at that time. The TC felt it was unnecessary to update the indicators if an assessment is scheduled to be complete the following year. It would be more appropriate to schedule an indicator update in between assessments, unless concerning trends suggested otherwise.
- It was noted by several TC members that there will likely not be a lot of new information on black drum or new stock assessment methodologies to consider for a stock assessment in 2027. In fact, it was noted that Delaware age data collections have actually been reduced due to decreased demand for black drum. Black drum is not a high priority species for ASMFC member states, and so a majority of the research recommendations from the 2023 benchmark stock assessment will not be addressed before the tentatively scheduled stock assessment in 2027.
- The TC also discussed the possibility of delaying the assessment further, due to the aforementioned lack of new information. Several TC members opposed any delays beyond one or two years due to the issues that can arise with the stock when it is not closely examined in a full stock assessment regularly (i.e., lack of updated stock status estimates).
- Updates to Marine Recreational Information Program (MRIP) data are expected to be released in 2026. Since black drum is primarily a recreational species, it will be important to incorporate these updated MRIP data into the next black drum stock assessment. There is always the potential for a delay in the release of results by MRIP staff, so shifting the stock assessment to 2028 will ensure the updated MRIP data will be available for use in the assessment.

Figures

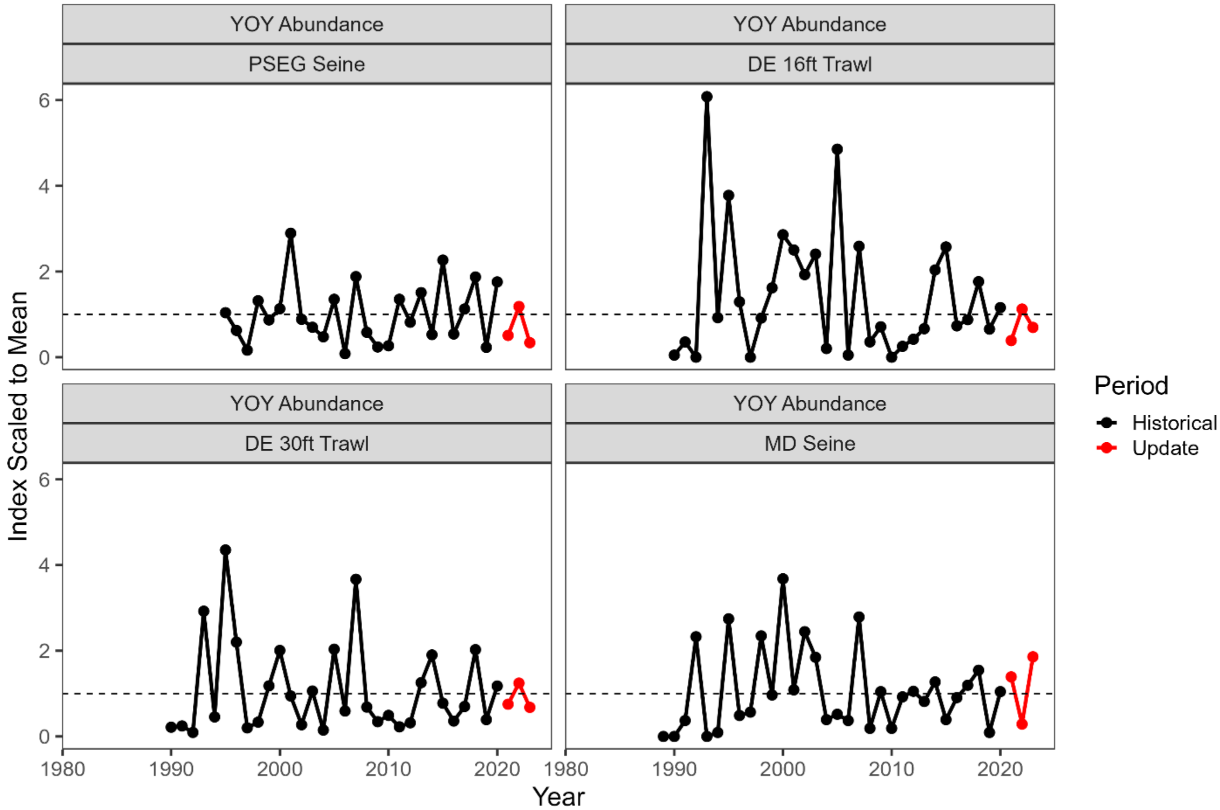

Figure 1. Mid-Atlantic abundance indicators. The dashed line is the time series mean.

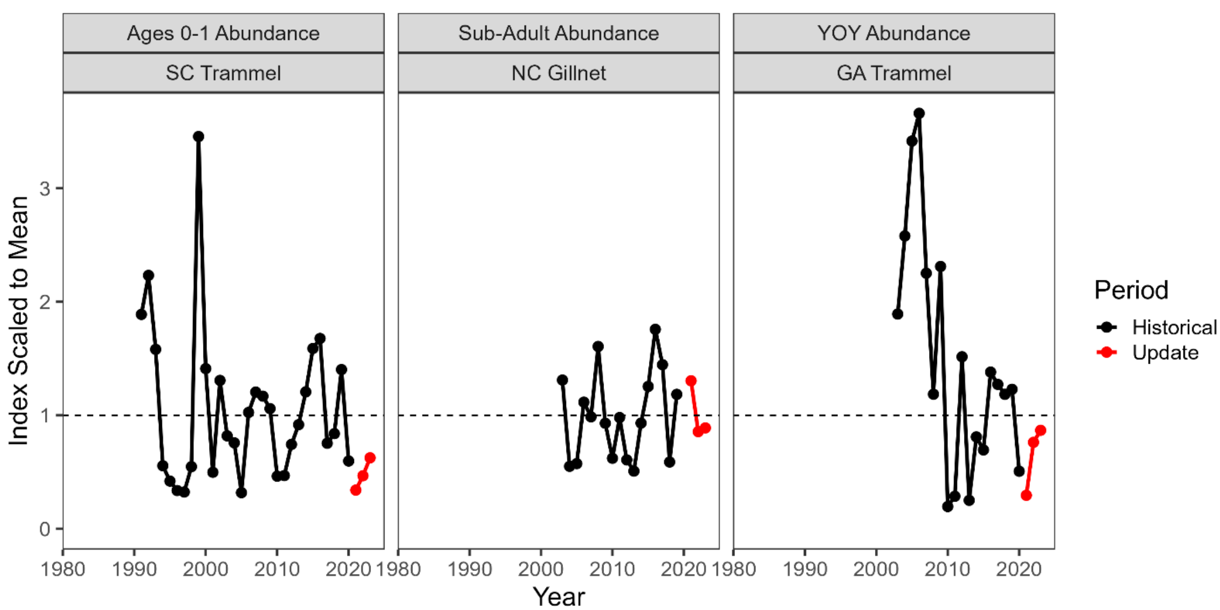

Figure 2. South Atlantic abundance indicators. The dashed line is the time series mean.

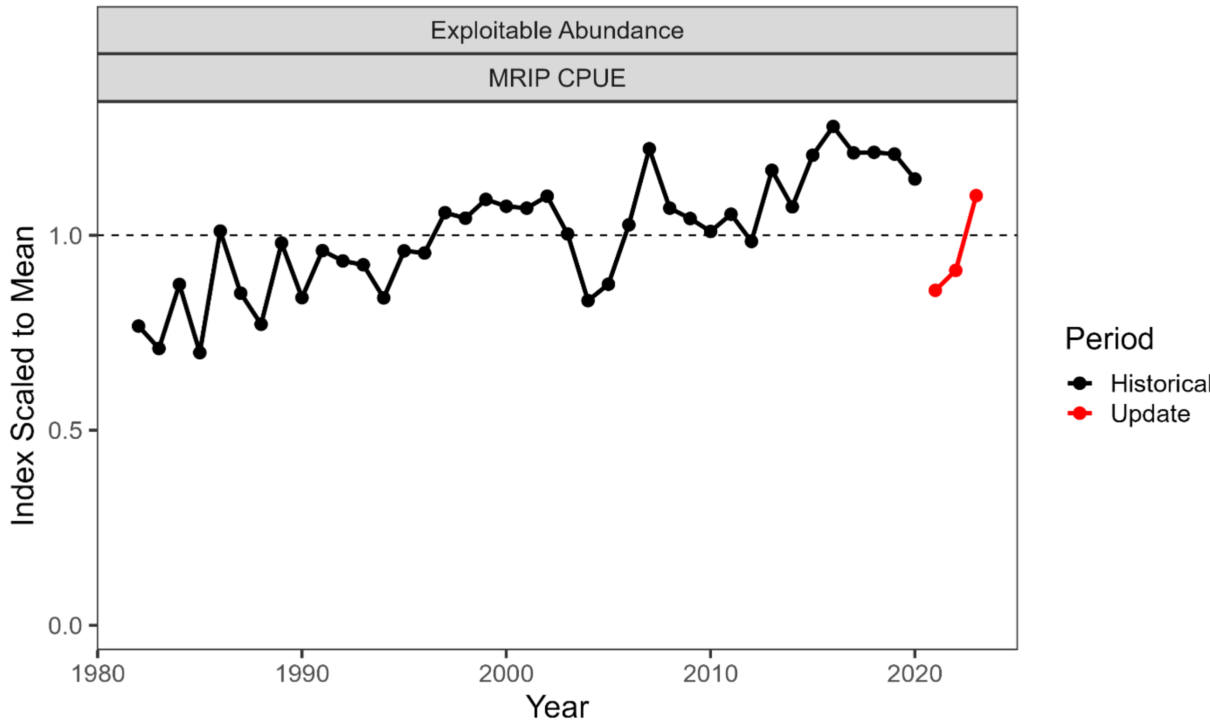

Figure 3. Coastwide abundance indicator. The dashed line is the time series mean.

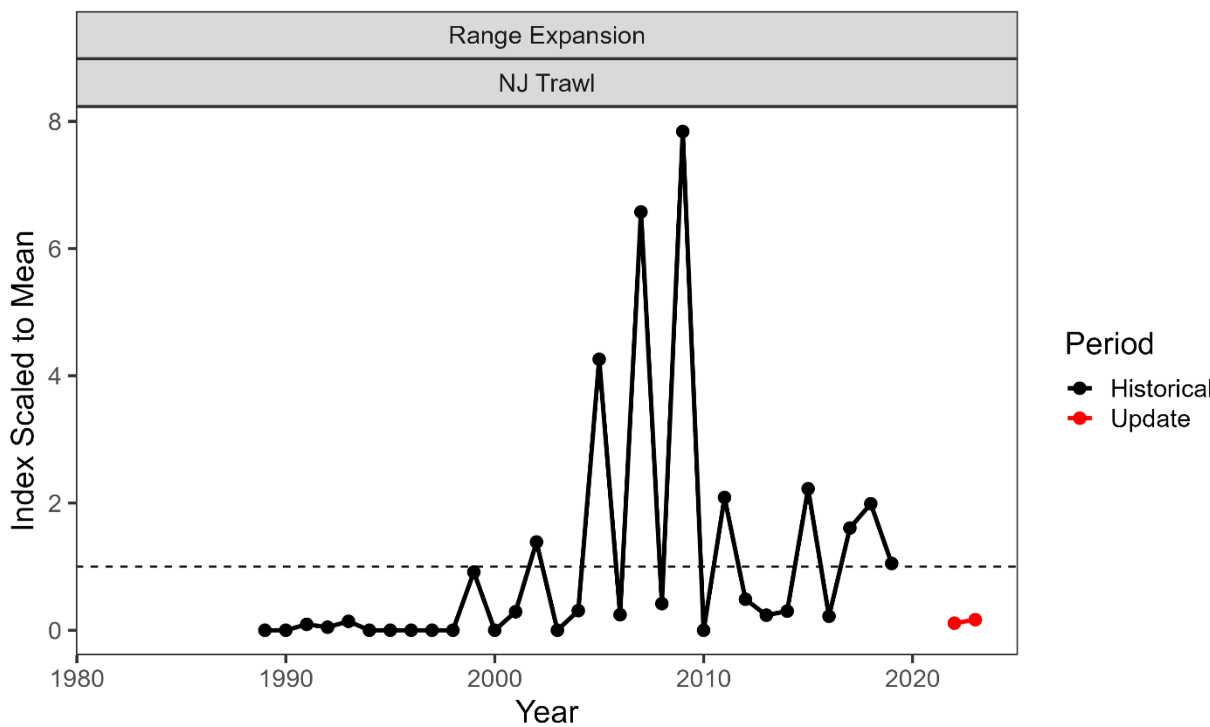

Figure 4. Range expansion indicator. The dashed line is the time series mean.

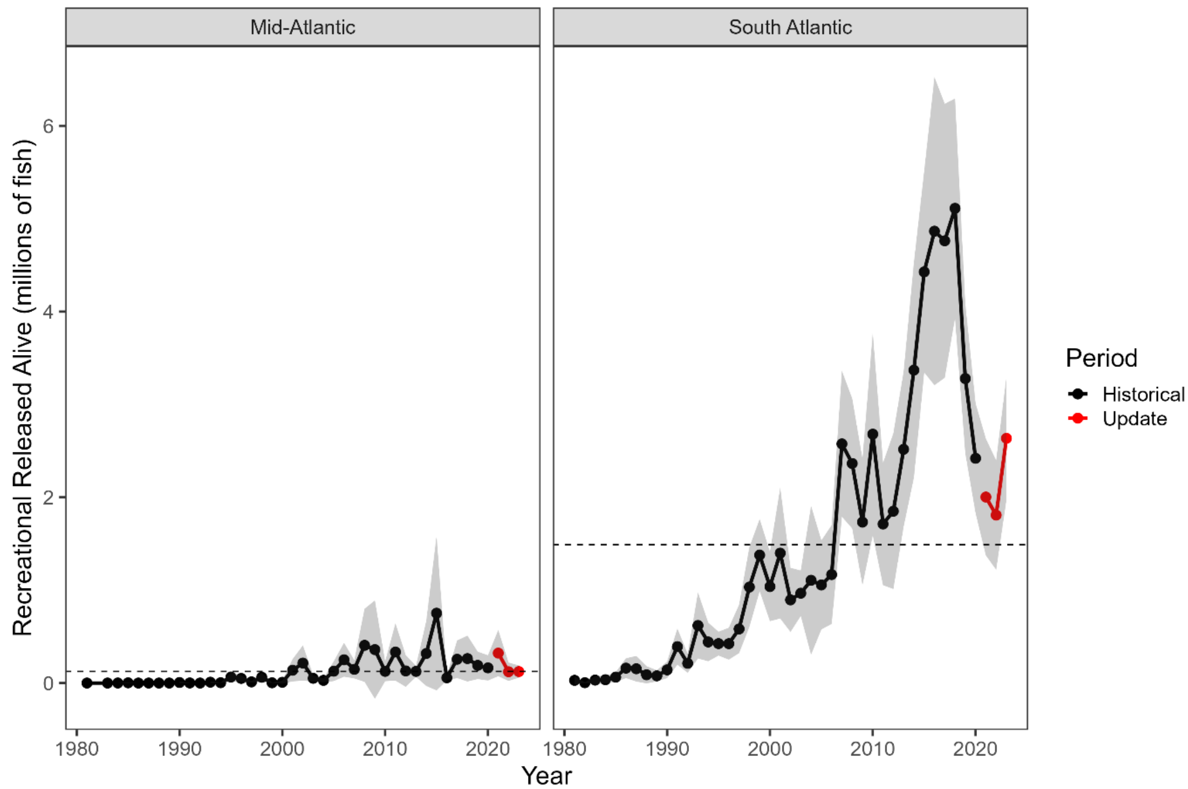

Figure 5. Recreational live release indicators. The dashed line is the time series mean.

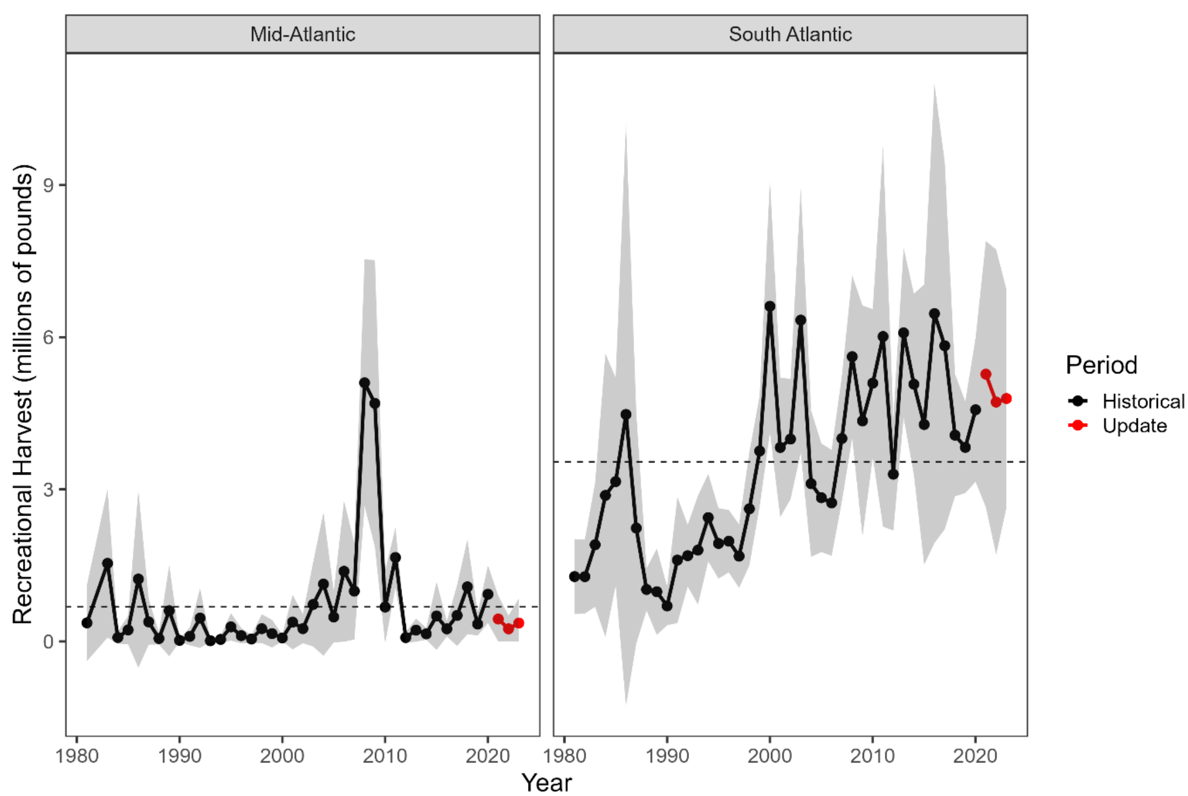

Figure 6. Recreational harvest indicators. The dashed line is the time series mean.

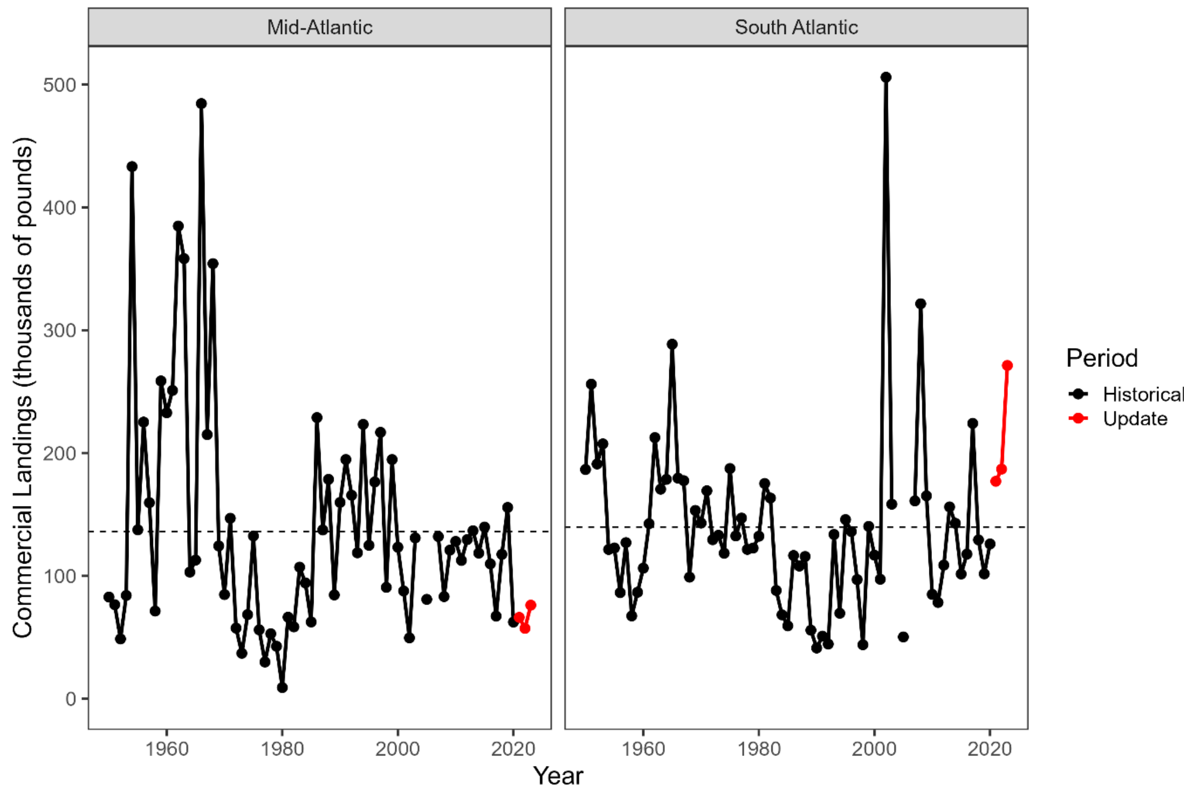

Figure 7. Commercial landings indicators. The dashed line is the time series mean.

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MEMORANDUM

TO: Atlantic Menhaden Management Board

FROM: Atlantic Menhaden Work Group

DATE: October 17, 2024

SUBJECT: Draft Definition of Problem Statement for Precautionary Management in Chesapeake Bay (Updated)

The Atlantic Menhaden Work Group was charged to "consider and evaluate options for further precautionary management of Chesapeake Bay menhaden fisheries, including time and areas closures to be protective of piscivorous birds and fish during critical points of their life cycle." [1] This charge asserts there is an inadequate supply of menhaden to support overall predatory demand in the Bay. However, the Work Group is addressing this charge without determining if there is or is not an adequate supply of menhaden to support predatory demand in the Bay. Instead, it will be developing possible management recommendations, and the Board would determine if or when it is necessary to implement them. The Work Group has drafted the below draft problem statement. It is the intent of the Work Group to have a full report to the Board by the Spring 2025 Commission meeting.

Draft Problem Statement

This charge asserts there is an inadequate availability of menhaden to support overall predatory demand in the Bay. Changes to availability of menhaden may be caused by the following: changes in total abundance, size distribution of the population, and timing of presence and spatial distribution in the Bay. This can be caused by fishing pressure, environmental conditions, habitat suitability, and/or changing predation pressures on a limited spatial and temporal scale.

Since the period of peak menhaden harvest in Chesapeake Bay, environmental conditions, introduction of invasive species, and changes in predation pressure are likely affecting the availability of menhaden.

- Environmental changes include increases in surface water temperature[2], changes in phytoplankton bloom timing,[3] and riverine inputs.[4]
- Piscivorous bird abundance in Chesapeake Bay has increased (*e.g.,* osprey, brown pelicans, and bald eagles).[5] All are known to consume menhaden as part of their diet.[6]

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[1] Meeting Summaries, Press Releases, and Motions. Atlantic States Marine Fisheries Commission 2024 Summer Meeting. https://asmfc.org/files/2024SummerMeeting/2024SummerMeetingSummary.pdf

[2] Najjar et al. 2010. Estuarine, Coastal and Shelf Science: 86:1. https://www.sciencedirect.com/science/article/abs/pii/S0272771409004582?via%3Dihub

[3] Harding et al. 2016. Nature: 6: 23773. https://www.nature.com/articles/srep23773#:~:text=Here%2C%20we%20synthesize%20long%2Dterm,over%2Denrichment%20and%20climatic%20conditions.

[4] Ross, A.,C, et al. 2021. Anthropogenic influences on extreme annual streamflow into Chesapeake Bay from the Susquehanna River. [in "Explaining Extremes of 2019 from a Climate Perspective"]. *Bull. Amer. Meteor. Soc.*, **102** (1), S59–S66, doi: https://doi.org/10.1175/BAMS-D-20-0129.1.

[5] https://www.mbr-pwrc.usgs.gov/

[6] https://ccbbirds.org/2009/09/05/flexibility-of-cormorant-and-pelican-diet-assemblages/

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- Likewise, other piscivorous fish species have increased in abundance, including red drum, cobia, and Spanish mackerel, while other species, including striped bass and weakfish, have declined in abundance. All are known to consume menhaden as part of an omnivorous diet. This shift from a historical suite of predators to new suite of predators presents an unknown impact on overall predatory demand from piscivorous fishes.

Such changes in menhaden availability may affect the species' ability to fulfill its ecological and/or economic functions.

James Boyle

From: Roberta Kellam <Roberta.Kellam@outlook.com>
Sent: Tuesday, October 15, 2024 4:58 PM
To: Comments
Subject: [External] PUBLIC COMMENTS

PLEASE PROVIDE A COMPLETE COPY OF THESE COMMENTS AND ATTACHMENTS TO THE FULL COMMISSION.

October 15, 2024
From: Roberta Kellam, Franktown, Virginia 23354
TO: Atlantic States Marine Fisheries Commission

I am a former member of Virginia's State Water Control Board (2 terms), and my husband is a former Virginia appointee to the Atlantic States Marine Fisheries Commission. We appreciate your public service and offer the following comments to assist your efforts to develop a time of year restriction on the menhaden reduction fishery in the Chesapeake Bay to address the Osprey breeding crisis.

The scientific research shows that the Osprey reproductivity levels are far below population maintenance levels in the SALINE (>10 ppt) portion of the Chesapeake Bay; whereas the Osprey reproductivity levels in the fresh or lower salinity areas of the Bay watershed are at or slightly above population maintenance levels. The focus of the Osprey-Menhaden Work Group should be on the Osprey reproduction within the Bay waters that are >10 ppt. Please see the attached map of the salinity regime of the Chesapeake Bay.

The ASMFC Osprey-Menhaden Workgroup focused on the food demands of the entire population of Osprey in the entire Chesapeake Bay, including the Osprey in the fresh and slightly saline portion of the Bay. Dr. Watts' 2024 research shows that it is only the Osprey population in the SALINE portion of the Bay that is doing poorly. It seems that Osprey breeding in waters that support the invasive blue catfish are utilizing catfish for food supply. Furthermore, the ASMFC Osprey-Menhaden work group should focus on the breeding schedule for Osprey in the saline part of the bay, mostly in the lower Chesapeake Bay in Virginia, rather than the Maryland breeding schedule as reported by USGS.

Below are the results of the 2024 Osprey Breeding Report from the College of William and Mary, Center for Conservation Biology. Attached is a map of the Bay showing the study areas and success rate. As you can see, osprey nests in the fresh areas with <1 ppt salinity in the Rappahannock and James Rivers fledged 1.31 and 1.39 young per pair, whereas the mainstem of the Chesapeake Bay with >10 ppt salinity ranged from .23 to .90 fledged per pair. Notably, the Osprey Menhaden work group has not contacted or met with Professor Watts to discuss his 2024 research or his prior several decades of research on Osprey in the Chesapeake Bay.

Table 1: Osprey breeding outcomes in the Chesapeake Bay (2024). Source – Center for Conservation Biology, William & Mary.

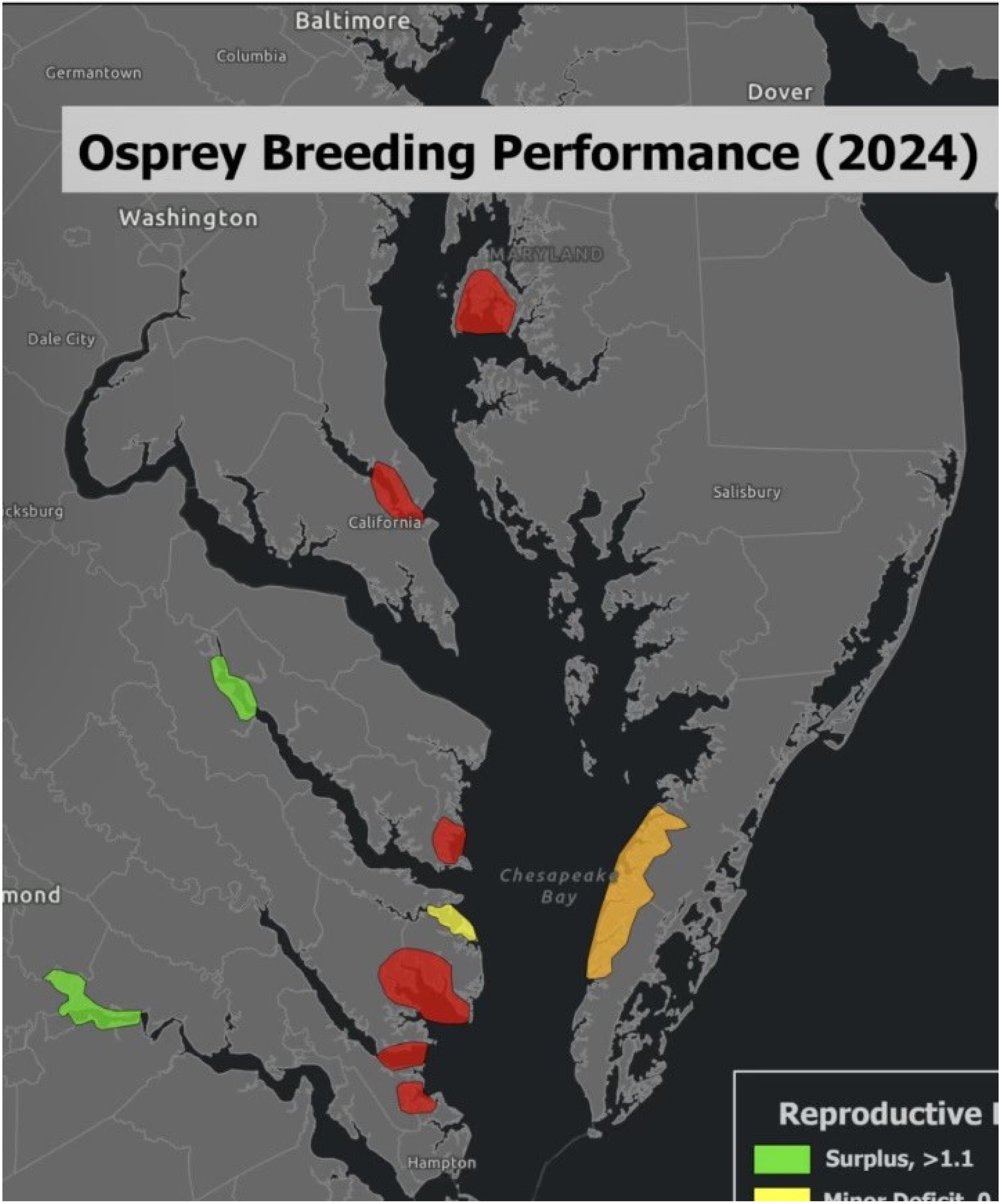
Site	Pairs	Reproductive Rate young/pr (SE)	Pairs Not Laying (%)	Successful Pairs (%)	Failed Pairs (%)	1-chick Broods (%)
Main Stem (>10 ppt)						
Choptank River	60	0.23 (0.07)	21.7	18.3	60.0	72.7
Patuxent River	49	0.51 (0.11)	22.4	34.7	42.9	58.8
Fleets Bay	38	0.08 (0.05)	57.9	7.9	34.2	100.0
Eastern Shore	57	0.75 (0.13)	14.0	40.4	45.6	44.0

Piankatank River	37	0.89 (0.16)	27.0	54.1	18.9	45.0
Mobjack Bay	75	0.40 (0.08)	30.7	29.3	40.0	68.2
York River	58	0.52 (0.12)	37.9	31.0	31.0	50.0
Poquoson River	47	0.43 (0.10)	27.7	31.9	40.4	66.6
Elizabeth River	36	0.69 (0.14)	27.8	47.2	25.0	52.9
Lynnhaven River	30	0.90 (0.19)	0.0	50.0	50.0	33.3
MAIN STEM TOTAL	**487**	**0.51 (0.04)**	**27.1**	**33.1**	**39.8**	**54.6**
Reference (<1 ppt)						
Rappahannock River	33	1.31 (0.19)	0.0	63.6	36.4	14.3
James River	51	1.39 (0.33)	5.9	66.7	27.5	20.6
REFERENCE TOTAL	**84**	**1.36 (0.12)**	**3.6**	**65.5**	**31.0**	**18.2**

Eastern Shore Creek Data listed from South to North:

Hungars Creek – 21 pairs, 28 fledged = 1.33 young/pair
Nassawaddox Creek – 18 pairs, 5 fledged = 0.28 young/pair
Occahannock Creek – 8 pairs, 4 fledged = 0.5 young/pair
Onancock Creek – 7 pairs, 5 young – 0.71 young/pair
Pungoteague Creek – 3 pairs, 1 young – 0.33 young/pair

In addition, I am providing the ASMFC with the full comments of Professor Bryan Watts that were submitted to the ASMFC Osprey-Menhaden Work Group for their October 2, 2024 meeting; these comments addressed the comments submitted by Omega Protein. Please read it thoroughly as I believe it addresses many misconceptions.
Sincerely,



Osprey Breeding Performance (2024)
Baltimore
Columbia
Germantown
Dover
Washington
MARYLAND
Dale City
Salisbury
California
Chesapeake Bay
Hampton
Reproductive
Surplus, >1.1

RESPONSE TO OMEGA COMMENTS REGARDING OSPREY AS SUBMITTED TO THE ASMFC OSPREY-MENHADEN WORK GROUP FOR THE OCTOBER 2, 2024 MEETING BY Bryan Watts, PhD, Center for Conservation Biology, William & Mary

OMEGA Comment - To put it charitably, the motion puts the proverbial horse before the cart, assuming that "further precautionary management" measures – *i.e.*, measures beyond the precautionary Chesapeake Bay reduction fishery cap 51,000 metric tons ("mt") – are needed to protect
piscivorous birds and fish. There is no evidence, however, that the menhaden bait and reduction fisheries in the Bay are having any adverse impacts on avian or fish predators. Nor is it likely that the current menhaden fishery in the Chesapeake Bay is having adverse effects given that it is currently being prosecuted at some of the lowest levels in the past 150-plus years and the unitary, migratory menhaden stock is both highly abundant and conservatively managed.
WATTS RESPONSE - To the contrary, this assessment and consideration is overdue not premature. There has been evidence for at least 20 years that consumers in the Bay (osprey and striped bass as only 2 examples) that depend on menhaden as a primary food source have been impacted by low menhaden availability. The current level of harvest relative to historic harvest is not relevant to this issue. The famous collapse of the Pacific sardine stock is a prime example of this same pattern. When a stock is limited within a specific location you do not accelerate harvest you ease back on harvest to allow for recovery.

OMEGA COMMENT - It is unclear what information the Working Group intends to base any recommendations upon. At the Summer Meeting, the Menhaden Board was presented with a detailed presentation by the U.S. Geological Survey ("USGS") on what is known, and not known, about the present state of local populations of osprey in the Chesapeake Bay region. The Board was informed that, overall, the regional osprey population increased 1,801% between 1966 and 2022. The USGS scientists noted that over a shorter timeframe – 2012-2022 – there had been a slight decline in their numbers within the mainstem of the Bay and its tributaries (though increased populations inland). That decrease appears to be more pronounced in the Maryland portion of the Bay, but it is a trend that has been seen all along the Atlantic Coast. (*See* Figure 1, below).
WATTS RESPONSE - The USGS did not present all that is known about the Bay osprey population. USGS has done minimal fieldwork with osprey in the Bay. They used breeding bird survey data (BBS) to examine regional trends. This metric is based on point counts conducted by citizens and is a poor representation of the population. It is not designed to examine fine-scale trends. Its use was not necessary in this case since we have population assessments for the Bay. Yes, it is true that the osprey population in the Bay has increased dramatically since the DDT era. As with virtually all osprey populations around the globe the Bay population declined by approximately 90% due to DDT. The population has recovered tenfold since the lows of the 1960s. We reached 3,500 pairs by 1995 and now are in the range of 10,000 pairs. However, we have seen dramatic spatial variation in recovery patterns. Pairs in lower salinity (<5 ppt) reaches have increased dramatically and this increase is continuing to present. These lower salinity subpopulations are driving the Bay-wide recovery. Subpopulations around the main stem of the Bay are either stable or declining since the mid-1990s. See Watts et al. 2004 – Status and distribution of osprey in the Chesapeake Bay. We are now seeing a hollowing out of populations along the main stem. The main stem of the Chesapeake Bay was considered a global stronghold for osprey during the DDT era and was a key population that supported the restoration of osprey populations across many states. This historic population is now suffering from an inadequate prey base.

Osprey populations are not declining along the entire Atlantic Coast. Your figure is from e-bird data which reflects reports of detections from birders. These should not be confused with systematic or benchmark surveys. What is going on in the Bay should not be conflated with what is going on elsewhere. The patterns we are seeing in the main stem of the Bay are specific to the main stem of the Bay.

OMEGA COMMENT - Importantly, the USGS does not know exactly what accounts for this trend. One of the scientists mentioned that it is not uncommon for recovering populations to increase levels past carrying capacity, though did not speculate that this is the cause of the general coastal decline in osprey populations. They did note likewise increasing trends for competitor species, such as bald eagles, cormorants, pelicans, gulls, etc. Competition can lead to intraspecific competition for nest sites and prey and depredation. Other things they identified include weather events which are becoming more frequent and severe with climate change, disease like the avian influenza epidemic currently underway,

environmental contaminants, and water quality. None of these have been specifically implicated in the current decline in breeding success seen along the Atlantic coast.
WATTS RESPONSE - There is no documented general coastal decline in osprey. Yes, there are many ways for an osprey nest to fail and these have been documented widely. The facts in this case which have been presented in several different ways and are unequivocal demonstrate that poor breeding performance in the main stem of the Bay is due to brood reduction via starvation. We have shown this in the 40+ year retrospective (see Watts et al. 2024) that indicates 1) reproductive rates have gone from surplus to deficit during the 1990s, 2) this decline is due to an increase in brood reduction (chicks starving in the nest) and 3) the brood reduction is the result of reduced provisioning rates with menhaden. We later demonstrated this deficit by conducting a food supplementation study (Academia and Watts 2023) and showed definitively that increases in menhaden provisioning will drive productivity back to surplus. The issue here is that there is not enough menhaden available to osprey to support a viable breeding population within the main stem of the Bay. In 2024, we worked throughout the main stem of the Bay and showed that 1) none of the 10 study areas broke even demographically and 2) low reproductive rates were attributed to brood reduction via starvation. Let me be clear that the issue of 1) reproductive rates for osprey in the main stem of the Bay are below that required to sustain a population and 2) the driving factor for the poor reproductive performance is brood reduction via starvation is settled. The debate needs to move on and plow new ground.

The issue of food competition continues to be brought up in this discussion. Yes, it is true that a number of species that depend on fish within the Bay have recovered from DDT lows including osprey, bald eagle, great blue heron, brown pelican, double-crested cormorants and others. However, to suggest that food competition between these birds is driving the poor reproductive performance in osprey shows no understanding of the basic metabolic demands for this community. It was shown in McLean and Byrd (1991) – (the diet of Chesapeake Bay ospreys and their impact on the local fishery) that consumption by osprey is trivial compared to harvest. Later modeling that I conducted in the 2000s showed that the entire bird community does not have the capacity to exert control on fish populations. All of the bird species combined represent a rounding error on both the commercial harvest and the estimated consumption by fish predators. The birds on their own do not have the capacity to undermine productivity. However, both the commercial harvest and the community of fish predators do.

OMEGA COMMENT - The USGS team did indicate, however, that a study is currently underway to investigate historical and present-day availability of prey for osprey. Those results are expected at the end of 2025. It would be prudent to postpone any such management actions until that study is complete.
WATTS RESPONSE - The study that USGS is referring to is mine. The intent is to compile data from osprey monitoring efforts along the entire Atlantic Coast (dozens of efforts some of which date back several decades). This includes hundreds of thousands of nest checks. Once the dataset has been compiled, we would be in a position to relate population and demographic metrics for osprey to menhaden indices over time. The amount of effort expected to collect, compile and make the monitoring data usable is significant. To date, there has been no funding made available to support this work. Without funding this effort will not be completed by the end of 2025. This project has the potential to unlock the relationship between osprey and menhaden and I encourage AMFC to provide funding to support it.

OMEGA COMMENT - Beyond the lack of scientific information to inform any management action, another reason to avoid a narrow focus on the menhaden fisheries is that it is far from the only or even most important food source for osprey. USGS presented information that only in the large mid-Bay region, where salinity is about 8-13 parts per million, do menhaden comprise a significant portion of ospreys' diet. And in that region, osprey are even more dependent on striped bass, an overfished population currently subject to a rebuilding program. In the southern portion of the Chesapeake Bay, where the reduction fishery is concentrated, menhaden comprise only about 24% of osprey diet, with spotted sea trout being the dominant forage fish.
WATTS RESPONSE - This statement is nonsensical. Ospreys nesting in waters of the Chesapeake Bay that are >10ppt (including all the way to the mouth) are menhaden-dependent. This is a very large swath of the Chesapeake and includes the lower reaches of major tributaries. Within these waters menhaden appear to be a keystone species. Historically, menhaden accounted for more than 70% of the diet and Chesapeake Bay osprey were considered from the 1960s to 1980s to be menhaden specialists. Osprey are not more dependent on striped bass which represents

a minor diet component. The importance of menhaden in the diet since the 2000s has declined to below 30% and this is why we believe that productivity has declined. I have no idea where the comment comes from about dietary percentages in the lower Bay.

Globally and within the Chesapeake, osprey take a wide range of fish species. However, all of these species are not equal. I would ask why is it that Omega does not run the reduction operation on spot or trout? It is because these species do not have the same energy density (lipid content) and they do not school in the same way. The same is true for osprey. Osprey depend on the energy density and the schooling behavior of menhaden to break even. They do not do well with a diet dominated by species with low energy density.

OMEGA COMMENT - If the primary factor in recent declines is lack of forage, then the Working Group should focus on the full suite of forage available to osprey, which, of course, are generalists when it comes to feeding. Indeed, it would be responsible to look at whether environmental factors, such as water temperature, salinity, and dissolved oxygen levels during breeding season may be influencing fish availability.
WATTS RESPONSE - Osprey are not generalists when it comes to feeding. As indicated above, menhaden are a keystone species for osprey and for other piscivores in the Bay. Their characteristics of high energy density and dense schooling make them unique in the Bay to predators.

OMEGA COMMENT - There is only one study that purports to identify the menhaden fishery as the culprit in the lack of nesting success in one small portion of the Chesapeake Bay. That report, "Food supplementation increases reproductive performance of ospreys on the lower Chesapeake Bay," authored by master's candidate Michael H. Academia and Bryan D. Watts, director of the College of William & Mary's Center for Conservation Biology ("CCB"), focuses on observed low rates of reproductive success among osprey inhabiting Mobjack Bay, an area along the western side of the lower Chesapeake Bay. The study found that providing fish to nests improves survival of the young birds.
WATTS RESPONSE - This is not the only study focused on the issue. See Watts et al. 2024 that examines a range of reproductive metrics across more than 40 years and concludes that changes in menhaden abundance and the most likely explanation for shifts in reproductive rates, provisioning rates, brood reduction, nest failure, etc.

The food supplementation study shows that not only are supplemented nests more productive than control nests but reproductive rates were pushed above maintenance levels which has implications at the population level.

OMEGA COMMENT - Going beyond the evidence, the authors conclude that the Chesapeake Bay menhaden fishery—specifically the reduction, and not the bait, fishery—could cause osprey populations to "decline precipitously, threaten population stability, and eventually lead to widespread population collapse." They call for a return to the 1980s levels of menhaden in the Bay to be accomplished by further reducing or eliminating the reduction fishery's Bay harvest. These recommendations are not supported by the study's findings. In fact, as shown below, it is highly unlikely that the fishery has any impact on foraging issues facing osprey in this small area.
WATTS RESPONSE - As indicated above, the food stress experienced by osprey pairs and the resulting poor breeding performance extends throughout the main stem of the Bay and is not restricted to Mobjack Bay.

OMEGA COMMENT - There is reason to suspect that foraging success by adult osprey in Mobjack Bay has declined based on CCB provisioning studies over the years. But nothing suggests that menhaden abundance is a cause. For example, compared to the last study in 2007, **menhaden comprised a higher percentage of fish delivered to nests in 2021**. So, while the amount of forage fish caught by or available to osprey (which are generalists when it comes prey) may be lower than years past, menhaden are *relatively* more abundant than other stocks compared to 2007.
WATTS RESPONSE - Everything in the patterns we have collected suggests that menhaden abundance is the cause of the lower provisioning rates and poor reproduction. Provisioning overall and with menhaden has declined dramatically. If you look at the energy content of the diet it has declined by 50% due to the lack of menhaden. The data we have indicates that the change in reproductive performance occurred during the 1990s and likely the late 1990s. If you don't believe the osprey in terms of menhaden declines in Mobjack Bay then listen to both the bait and reduction fisheries. During the partnership meeting in the summer of 2023, both Omega and the bait companies indicated that they used to fish for menhaden in Mobjack but have not since about 2000. Given that they are using spotter planes the

clear implication is that there are now not enough menhaden in Mobjack to make it worth their while to fish there. Their own fishing behavior suggests that there has been a change in menhaden within Mobjack Bay.

OMEGA COMMENT - Beyond that, overall menhaden biomass has been high for decades. In 2021, the year of the study, it was at its second highest level since 1961. Within the Chesapeake Bay, the menhaden young-of-the-year index for the two mid-Bay rivers, the Choptank and Patuxent, were at their highest and fifth highest levels in 2021, meaning there were abundant small menhaden in this region. For the Bay overall, recruitment of menhaden was the highest in the late 1970s and into the 1980s when environmental conditions were favorable and the striped bass population had crashed. As striped bass recovered menhaden recruitment declined, suggesting that osprey may be competing with that stock.
WATTS RESPONSE - Typical osprey fish size is 10-12 inches but will take smaller and larger fish. Most of the menhaden taken by osprey are likely in the year 2-4 classes. I do not know of any menhaden data that will help to resolve the spatial variation in menhaden abundance at the consumer level. If such data existed it would be a simple matter to relate osprey reproductive success at the subestuary level with menhaden abundance.

OMEGA COMMENT - Finally, the Chesapeake Bay menhaden fishery is currently at its lowest sustained levels on record due to decreases in the Bay reduction fishery cap and actions by Omega Protein and Ocean Harvesters to reduce their Bay footprint and minimize user conflicts. Importantly, this fishery has been prosecuted in the Chesapeake Bay since the 1850s. For most of that time, menhaden removals from the Bay have been three or more times higher than currently. More importantly, the only reduction fishing that occurred during the study period in May 2021 when most nests failed was north of Mobjack Bay and thus had no impact on that area.
WATTS RESPONSE - These comments are reminiscent of those made during the 1940s before the loss of the Pacific sardine fishery. The gross take is not the issue but rather the take relative to what the stock can sustain. Since we have no independent data on the abundance of menhaden in the Bay, we have no way of independently assessing if the current take is sustainable. Omega is the only entity that has the data to evaluate trends in menhaden over time. Release the flight logs and the catch data so that we can evaluate the trend in catch per unit search over time. Since this is the only dataset capable of resolving trends over time, without using it we will continue to twist in the wind and have unproductive debates.

OMEGA COMMENT - The researchers never asked why there are fewer forage fish of all types in Mobjack Bay, such as whether its environmental conditions have become less favorable. Given that osprey are declining all along the east coast, it appears broader forces are at work.
WATTS RESPONSE - I have been asking about fisheries data since the early 2000s. It is clear that the fisheries data is inadequate to address the questions. This is why in 2021 we did a supplementation study. If the menhaden data were available at a scale that is relevant to the consumer it would have been a simple matter to relate the two. There is no indication that osprey are declining along the entire south Atlantic. I would say that along the Atlantic north of the Chesapeake where menhaden have shown recent recovery, osprey are producing very well.

OMEGA COMMENT - The timing and location of the menhaden fishery do not suggest that it could have had an impact on the availability of menhaden in Mobjack Bay. At the recent meeting of the Ecological Reference Point Working Group meeting, Dr. Watts indicated that the highest number of nest failures in 2021 occurred in May. However, that month, none of Ocean Harvester's vessels made all of its sets above the study area, indicating that menhaden had entered the Bay, but apparently did not choose to enter Mobjack Bay in significant numbers. Likewise in June, no sets were made anywhere near the nesting sites.
WATTS RESPONSE - To suggest that the only way that harvest can impact the distribution and availability of fish is when the fleet is removing them is far too limited a perspective. It is hard to know how repeated harvest over a long time period will influence distribution. In terms of water quality, development pressures, etc. may have on menhaden in Mobjack we will never know since the menhaden data do not exist. However, poor performance across the 10 study areas monitored in 2024 which vary in many respects suggest that this is not solely a localized cause. One of the more interesting findings in 2024 was that Lynnhaven River and Eastern Shore study areas did marginally better than the other sites. These two areas are near where Omega operated during the year which may indicate that menhaden were more available in those areas. Again, we have no direct menhaden data.

OMEGA COMMENT - It is important to keep in perspective the current levels of menhaden fishing effort in the Chesapeake Bay. Due both to management action (the Bay Reduction Cap) and efforts by Ocean Harvesters to minimize its footprint in this estuary, current harvest levels are about a third of those during the 1980s when the first big osprey feeding habits study was conducted. It is also worth bearing mind that this fishery has been in operation since the mid-1800s and over most of that time, the reduction fishery in the Chesapeake Bay and coast-wide landed far more menhaden than it does today.
WATTS REPONSE - There is no question that menhaden abundance was adequate to support osprey during the 1980s. Again, the gross take is not the issue but rather the take relative to what the stock can sustain. Since we have no independent data on the abundance of menhaden in the Bay, we have no way of independently assessing if the current take is sustainable. Omega is the only entity that has the data to evaluate trends in menhaden over time. Release the flight logs and the catch data so that we can evaluate the trend in catch per unit search over time. Since this is the only dataset capable of resolving trends over time, without using it we will continue to twist in the wind and have unproductive debates.

COMMENT - The Chesapeake Bay Working Group has been given a task greater in difficulty than that of the Ecological Reference Point Working Group. Specifically, it has been asked to determine the needs of all predatory fish and birds at each life-stage and time of the year, and then to develop a highly calibrated system of time/area closures and catch levels throughout the Chesapeake Bay such that the "need" for menhaden among the full suite of predators is fully met.
RESPONSE - This is not my understanding of the charge of the working group.

COMMENT - Any pretense of an impartial, science-driven process would be informed by basic information that is simply not available. These include: dietary demands of all predators in the region relative to the time-varying amount of migratory menhaden within the Bay and biomass of all other prey species; the impact on populations of interest (*e.g.*, osprey, striped bass) of competition not only among avian predators, or among species of predatory fish, but of competition between birds, fish, terrestrial and marine mammals, etc., and humans for a fixed set of resources in specific locations and times of the year; and, of course, a basic understanding of the patterns of movement of menhaden and other prey species within the Chesapeake Bay throughout the year, along with the environmental factors favoring or disfavoring their abundance in a particular area.
RESPONSE - I would argue that policy related to harvest has never been science-driven. Aside from the ecosystem issues, how are you able to evaluate impacts of harvest levels on the stock itself without an independent measure of the Chesapeake Bay stock and a reasoned assessment of risk to the stock which we have never had. The answer is you can't. In lieu of such an independent assessment, you have set harvest limits based on the past five years of harvest. I don't believe that meets anyone's standard of science-driven. In short, decisions about harvest have been based on political influence rather than biological data.

Conservation and Management of the American Eel (*Anguilla rostrata*) by the United States Atlantic Coastal States

Atlantic Marine Fisheries Commission (ASMFC)

I. High Level Overview of the Commission's[1] and State Management

A. Legal Framework and Authorities

Photo © Brian Gratwicke

1. American eel is managed by the Commission through its American Eel Management Board. This Board is made up of each state and jurisdiction on the Atlantic Coast as well as the two federal partners (the National Oceanic and Atmospheric Administration-Fisheries and the US Fish and Wildlife Service). Each state and jurisdiction along the Atlantic coast is required to implement all the measures in the American Eel Fishery Management Plan (FMP).

2. The goal of the FMP is to conserve and protect the American eel resource to ensure its continued role in the ecosystems while providing the opportunity for its commercial, recreational, scientific, and educational use.

   The Atlantic Coastal Fisheries Cooperative Management Act is the authorizing statute that guides the Commission's fisheries management process. It specifies all states included in an FMP must implement the required provisions of the FMP to ensure the conservation of the species, as well as sharing in the resource's management responsibilities. If a state fails to implement the required provisions of the FMP, the Act establishes a "non-compliance process" whereby the Commission has the ability to forward a noncompliance finding to the Secretaries of Commerce and the Interior for action. If the Secretaries concur with the Commission's finding, the Secretaries are authorized to implement a moratorium for the state's fishery in both state and federal waters, meaning no harvest.

   Outside of the Atlantic Coast of the United States it is not common to find American eel, therefore there is minimal harvest of American eel (occasional recreational harvest of yellow eel).

[1] Reference to the "Commission" or "ASMFC" is the Atlantic States Marine Fisheries Commission.

B. Biological and Management Specialists/Competency

1. States biologists, ASMFC stock assessment scientists

   a) Stock assessments and technical committees are staffed by state, federal and academic scientists. These individuals are experts in eel biology/science stock assessment methods (often hold masters and PhD level degrees). These individuals are independent from the fishery. Stock assessments committees conduct the stock assessment and technical committees develop management options in response to the status of the eel resource for the management board to consider. Commission stock assessments are peer reviewed by independent scientists. The peer review provides independent and expert judgment on the value and appropriateness of the science and methods that produced the assessment; provides recommendations for future research and improvements of future assessments; evaluates all input parameters and biological characteristics incorporated into the stock assessment model; evaluates stock assessment methods; and evaluates the status of a stock relative to current fishery management plan goals.

Photo © Kari Fenske, University of Maryland

   b) Stock assessments for eel generally occur every 5 years.

C. Policy-level Reviews and Approval

1. Each year states submit compliance reports which are reviewed by a committee to ensure state compliance with the measures in the FMP including catch and biological monitoring, as well as management measures. Any inconsistencies with the FMP requirements are presented to the management board to resolve the inconsistency in a timely manner. If inconstancies cannot be resolved, the non-compliance process described above (section I.A.) can resolve them. The most recent review can be found here.

2. Any changes to the management of the fishery are made via the American Eel Management Board. Changes to management are typically in response to a species resource issue, and go through a vigorous scientific, enforcement and stakeholder review. For example, if the stock assessment results suggest a need to reduce harvest to improve the resource health the Eel Board can initiate a change in the FMP to reduce the coastwide quota.

D. Collaboration in Management, Monitoring, and Research (State, Federal, ASMFC, Canada)

1. The Eel FMP contains descriptions of the Management Board and committees for American eel: http://www.asmfc.org/uploads/file/amEelFMP.pdf (pgs 57-58)
2. Assessments are developed using a broad suite of fishery-independent surveys and fishery-dependent monitoring, as well as research products developed by a vast network of fisheries scientists at state, federal, and academic institutions along the Atlantic coast.
3. State and federal law enforcement agencies regularly work closely to enforce U.S. eel regulations to ensure compliance. While violations are uncommon due to strict enforcement and significant penalties, multi-agency operations have successfully caught and sentenced individuals violating U.S. regulations.

II. High Level Overview of American Eel Fishery

A. Recreational Fishery

1. Recreational harvest has been on the decline since its peak in 1985 at 160,000 eels. Harvest was last estimated to be around 6,000 eels in 2009 (the last year the Marine Recreational Information Program collected recreational data on American eel).
2. The Commission requires a maximum recreational possession limit of 25 eel/person/day, with the option to allow an exception of 50 eel/person/day for party/charter employees for bait purposes.
3. The recreational minimum size limit for eel is 9 inches.

B. Commercial Fishery

1. Glass Eel
   a) Harvest of the glass eel and elver life stage along the Atlantic coast is prohibited in all states except Maine and South Carolina.
   b) The Maine glass eel fishery is restricted to a quota of 9,688 pounds. The state has never exceeded its quota since it was put in place in 2016.
   c) More information on the Maine fishery is found in Addendum VI: http://www.asmfc.org/uploads/file/66858845AmEelAddVI_GlassEelQuota_May2024.pdf

d) The South Carolina fishery is small; annual landings do not exceed 750 pounds.

2. Yellow Eel

   a) The commercial yellow eel fishery is managed with a coastwide harvest cap to control fishing mortality. Starting in 2025 the cap was reduced to 518,281 pounds.

   b) Yellow eel fisheries exist in all Atlantic coast states and jurisdictions with the exception of Pennsylvania and the District of Columbia.

Photo © Chris Bowser, NYSDEC

   c) American eels at this stage are harvested mostly for domestic bait, but also food and export markets.

   d) The FMP requires a commercial minimum size limit of 9 inches, and a ½-by-½ minimum mesh size in commercial yellow eel pots.

   e) Coastwide landings since 2020 have remained below 330,000 pounds.

   f) State-by-state descriptions of yellow eel fisheries are found in Addendum VII to the American Eel FMP: http://www.asmfc.org/uploads/file/6644c67bAmEelAddendumVII_May2024.pdf

III. Sustainability

A. Methods of Monitoring Catch

1. Licensing and reporting

   a) States are required to institute licensing and reporting mechanisms to ensure that annual effort (including total units of gear deployed) and landings information by life stage (glass eel/elver, yellow eel, and silver eel) are provided by harvesters and/or dealers.

   b) Permits are to be issued with a requirement to report eel catch and effort on a trip-level basis. Completion of reporting is a condition of permit renewal. Reports must include soak time (how long the pot is in the water), number of units of gear fished, and pounds landed by life stage.

c) Maine's glass eel fishery is managed under a total allowable catch, which is spread amongst state license holders through individual quotas. Catch is closely monitored using a transaction tracking system to ensure quotas are not exceeded. This system electronically tracks every transaction of eels (harvester to dealer, dealer to dealer, and exports) using an Near Field Communication (NFC) token or Quick Response (QR) code. Dealers are required to submit transaction reports daily, including negative reports.


Photo © ME DMR

2. Enforcement

a) States are responsible for implementing and enforcing the requirements of the FMP. States have fines or penalties for violations including poaching, illegal possession of eel smaller than the minimum size, and illegal gear.

b) Maine's transaction tracking system allows for close monitoring of the fishery. This system tracks every dealer purchase of elvers from a harvester, and sale from a dealer to another dealer. Dealers must be able to fully account for the amount of glass eels in their possession at a given location using the transaction system. Harvesters, dealers, and aquaculture facilities may have random inspection conducted of the facility and places of harvest to ensure all rules and regulations under conditions of permit(s) are being adhered to.

c) Maine implemented a system to monitor glass eel exports (any transport of eel out of the state) in 2019. Under this program, an elver export license holder must notify the Maine Marine Patrol of their intention to prepare a shipment of elvers for export 48 hours in advance. The elver export license holder must make arrangements for Maine Marine Patrol to be present when they are preparing the elvers for shipment, including the weighing and packing of the elvers for export. Upon completion of the packaging, Maine Marine Patrol seal the shipment of elvers and mark the package of elvers with the weight of elvers contained. The absence of a seal, a broken seal, or the absence of the weight marked on the package are prima facie evidence that the elvers are illegal and subject to seizure. Maine Marine Patrol are required to provide their NFC token to complete an export transaction.

3. Methods of monitoring and ensuring/enforcing sustainability

   a) Catch and effort monitoring is required for all states. Reports must include soak time, number of units of gear fished, and pounds landed by life stage.

   b) States/jurisdictions are required to conduct annual fishery-independent surveys for young-of-year American eel to assess variation in annual recruitment to the population.

   c) As a condition of the commercial glass eel fishery, Maine is required to perform a fishery-independent life cycle survey covering glass/elver, yellow, and silver eels within at least one river system.

   d) Each state/jurisdiction is required to submit an annual report to the Commission detailing that state's regulations, catch, harvest, bycatch, fishery dependent and independent surveys, and characterization of other losses for American eel. The Commission annually reviews state compliance reports to ensure all requirements of the FMP are met and monitor sustainability of the coastwide population.

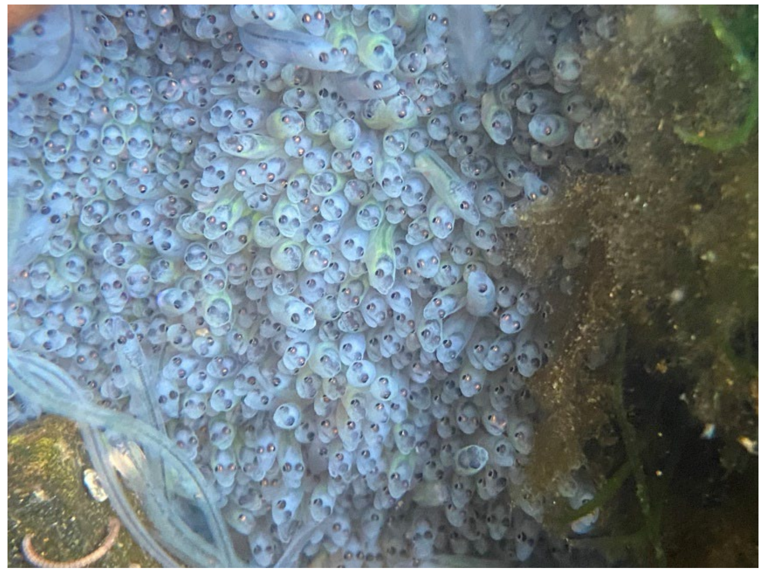


Photo © ME DMR

IV. Long-term Management

A. Commission Planning and Management Cycle

1. The coastwide landings cap for yellow eel of 518,281 pounds remains in place for three years (2025-2027). After three years, prior to the 2028 fishing year, the Board may update the coastwide cap with additional years of catch and abundance data, or maintain the same coastwide cap.

2. The 9,688-pound quota for Maine's glass eel fishery is established for three years (2025-2027). If no change to Maine's quota is desired, the Board may extend the quota for up to three years at a time via Board action.

3. The Management Board annually reviews the Fishery Management Plan and determines if management changes are warranted.

B. Depth, Schedule, Scope of Ongoing Assessments

1. Benchmark stock assessments are completed on an approximately 10-year cycle. Assessment updates, which add additional years of data into the peer-reviewed analyses from the benchmark assessment are completed every 5 years, between benchmark assessments.
2. A benchmark stock assessment for American eel was completed and underwent an independent external peer review in 2023. The Peer Review Panel endorsed the assessment as the best available science for evaluating the American eel stock on the Atlantic coast. More details can be found in the full assessment document or the brief overview of the assessment.
3. A stock assessment update is scheduled for 2028.

U.S. Fish & Wildlife Service

Understanding CITES

CITES Appendix II Supports Sustainable Use

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) entered into force in 1975. It is the only global treaty to ensure that international trade in plants and animals does not threaten the survival of the species. It provides a framework for cooperation and collaboration among nations to prevent decline in wild populations of animals and plants. Currently 184 countries (called Parties), including the United States, implement CITES.

The CITES Appendices

Cacti, iguanas, and parrots represent some of the 40,900 species protected by CITES. Species protected under CITES are listed in one of three appendices.

- Appendix I includes species threatened with extinction and provides the greatest level of protection, including restrictions on commercial trade. Examples include tigers, African grey parrots, gorillas, and sea turtles.

- Appendix II includes species that, although currently not threatened with extinction, may become so without trade controls. It also includes species that resemble other listed species and need to be regulated in order to effectively control the trade in those other listed species. Most CITES species are listed in this appendix, including American ginseng, paddlefish, lions, many freshwater turtles, American alligators and mahogany.

- Appendix III includes species for which a range country has asked other Parties to help in controlling international trade. Examples include the walrus and hellbenders.

North American River Otter, CITES Appendix II

Eric Bégin

CITES Appendix II is:

- **NOT** a list of species in which international trade is prohibited. CITES Appendix-II species may be traded internationally if accompanied by appropriate permits.

- **NOT** a list of endangered species. CITES helps support natural resource management programs in range countries to prevent endangerment.

NOT a ban or boycott of trade. CITES helps regulate and monitor trade for species vulnerable to overuse, and implements measures to attain sustainable harvest and legal trade.

Exporting CITES Appendix-II Species

CITES is implemented through an international permitting system. Each Party designates Management and Scientific Authorities to process permits, make legal and scientific findings, and

In the United States, the U.S. Fish and Wildlife Service is home to these two offices. Exporters must obtain a CITES permit from their national CITES Management Authority for each shipment that contains CITES-listed specimens. Export permits for Appendix-II specimens can be issued only when the following findings are made:

Frank Kohn/USFWS

Barrel Cactus, CITES Appendix II

A scientific finding of non-detriment: The Scientific Authority must be able to find that the export of an Appendix-II specimen is not detrimental to the survival of the species in the wild. The non-detriment finding is key to the long-term sustainability of the species. Depending on the species and activity, the Scientific Authority will either make a programmatic finding for a year or longer or a finding on a case-by-case basis. If the Scientific Authority is unable to make a positive finding, permits will not be issued for the export.

A finding that specimens were acquired legally: Evidence must be provided to show that specimens were not obtained in violation of any state, federal, or other jurisdictional law.

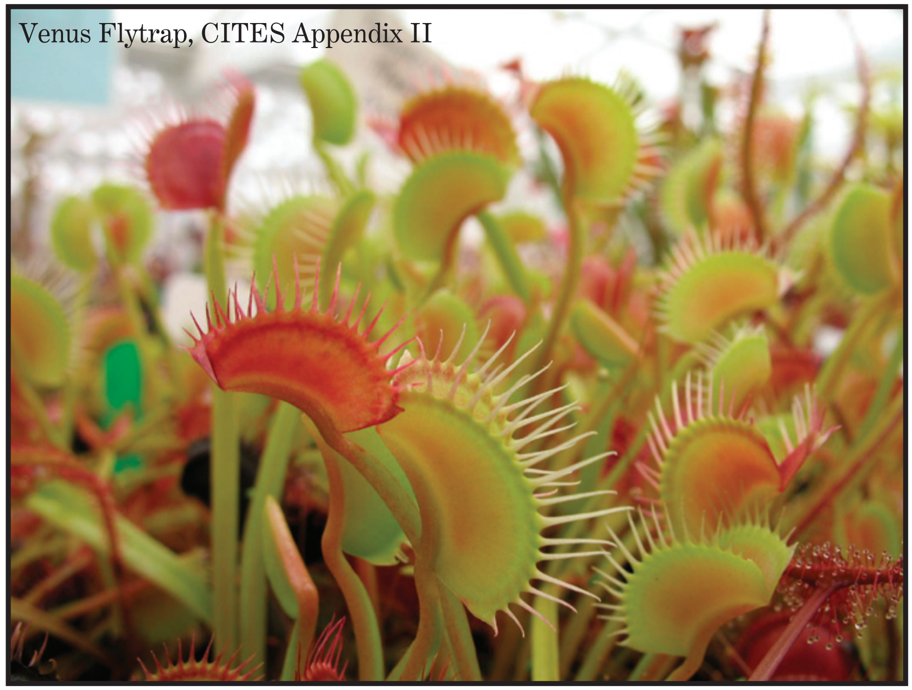
Live animal and plant shipments. All shipments of live animals and plants must be prepared to minimize risk of injury, damage to health, or cruel treatment.

In the case of air transport, animals must be shipped in accordance with International Air Transport Association (IATA) Live Animals Regulations.

Look-alike species. Sometimes species are listed in Appendix II to enable effective regulation of other listed species. Usually, this type of listing is necessary when species, or their parts or products, resemble other listed species and could cause identification difficulties. Look-alike species are monitored to ensure that they are not adversely affected by trade. Examples include the American black bear and river otter.

Captive Breeding and Artificial Propagation. CITES is concerned with the survival of species in the wild. Captive breeding of animals and artificial propagation of plants can affect the survival of the species in the wild. But, specimens produced in captivity or under controlled conditions are typically lower risk to the survival of the species than specimens collected from the wild. As such, it is usually easier for CITES authorities to make the necessary findings for animals produced in captivity and plants propagated under controlled conditions.

Potential Benefits of Appendix-II Export Controls to Commercial Interests: Longstanding international cooperation is the basis of CITES' effectiveness. The support of businesses, consumers, and the general public is vital to balancing conservation and trade needs within countries. Listing a species in Appendix II can produce the following benefits:


Venus Flytrap, CITES Appendix II

Validation (through CITES permits) that the specimen has come from legal and sustainable sources, and has met international standards;

Assurance that trade practices follow principles of sustainability;

Uniform responsibility to address illegal trade, since all countries must meet the same CITES permitting conditions and enforce CITES provisions;

Increased public awareness of the important role CITES plays to conserve animals and plants, and a broader body of information on which to base consumer decisions;

- Assurance of long-term species sustainability through control of trade, and consumer confidence that species are being used in ways that are not harmful to their role within the ecosystem.


Green Iguana, CITES Appendix II

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Understanding CITES

CITES Appendix III

What is CITES Appendix III?
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international treaty aimed at protecting species at risk of overexploitation from international trade. CITES includes 184 Party (183 countries and the European Union) members. Species are included in one of three CITES Appendices, which provide varying levels of protection.

Appendix III includes wildlife and plants that are protected in at least one country, which has sought the assistance of other CITES Parties, to regulate international trade of that species. CITES requires that any Appendix-III exports from the country that listed them have additional regulations and documentation, whereas restrictions on trade of Appendix-I and -II species apply to all CITES Parties.

What does an Appendix-III listing accomplish?
Appendix III helps a Party gain international cooperation in controlling trade in certain native wildlife and plant species that are subject to regulation domestically and provides a means of gathering trade data to assist the listing country in determining the impact of international trade of the species.

Appendix-III listings may be annotated to cover only specific parts and derivatives. The Parties have agreed that any annotation that is part of a request to include a species in Appendix III include those specimens that first appear in international trade as exports from its territory and that dominate the trade and the demand for the wild resource and is, to the extent practicable, harmonized with relevant existing annotations. As with other CITES-listed species, Appendix-III species may be traded internationally with required CITES documents.

How does Appendix III differ from Appendix II?
A Party may unilaterally include a native species in Appendix III, whereas species are included in Appendix II by a decision of the Conference of the Parties.

For the export of Appendix III specimens from the listing country, the Management Authority in that country must make a determination that the specimens to be exported were legally acquired (i.e. not obtained in contravention of that country's laws for the protection of animals and plants) and issue a CITES export permit.

Exports of Appendix-III specimens from non-listing countries must be accompanied by a CITES Certificate of origin. Re-exports of Appendix-III listed species require the issuance of CITES re-export certificates.

The export of Appendix-II specimens also requires an export permit, but its issuance depends both on the determination that the specimens were legally acquired and that their export will not be detrimental to the survival of the species.

What do country annotations mean?
Each Appendix-III listing includes an annotation, in parentheses, indicating the country (in some cases more than one country) that listed the species. The annotation signifies that a CITES export permit must accompany a specimen exported from the country that listed that species. A CITES Certificate of origin is required from all other exporting countries unless the listing is restricted to specific populations.

What does specific populations mean?
Some Appendix-III listings are limited to specific national populations (indicated by an annotation that reads, "Population of XX country"). This means that the listing country in its request to the CITES Secretariat advised that the listing is restricted only to its national population of the species.

In such cases, the listing country must issue a CITES export permit and any subsequent re-exports must be accompanied by a CITES re-export certificate.

However, no other populations are included in Appendix III, and therefore, CITES Certificates of origin are not required for exports from other range countries.

Hellbender, Appendix III


Brian Honohan/Creative Commons

Ringed map turtle, Appendix III

The Parties have agreed that restricting Appendix-III listings to specific national populations poses implementation challenges and generally should be avoided.

The United States agrees that restricting Appendix-III listings to specific national populations poses implementation challenges, and also does not align with the intent of an Appendix-III listing in regulating international trade in the species and obtaining robust trade data, and the United States will not limit any Appendix-III listings to the U.S. national population.

May Appendix-III species be imported to the United States?
Yes. To import Appendix-III species into the United States, you must present valid CITES documentation to the appropriate U.S. authorities when your shipment enters the United States.

If your specimens came directly from a country that has listed the species in Appendix III, you must present a CITES export permit issued by the Management Authority of that country.

If your specimens came directly from a country that has not listed the species in Appendix III, you must present a CITES certificate of origin issued by the Management Authority of that country.

If your specimens came from a country of re-export, you must present a CITES re-export certificate issued by the Management Authority of that country.

For Appendix-III listings limited to specific national populations, a CITES export permit is required from the listing country and re-export certificates are required for subsequent re-exports, but all other trade in the species is outside the scope of CITES and therefore, no CITES documents are required.

May Appendix-III species be exported or re-exported from the United States?
Yes. To export or e-export Appendix-III species from the United States, you must obtain CITES documents from the U.S. Management Authority to present to U.S. enforcement authorities at the point of export and to authorities of the importing country.

If the United States has included the species in Appendix III, you must obtain a CITES permit from us.

If another country has included the species in Appendix III, you must obtain a CITES certificate of origin from the U.S. Management Authority.

If you are re-exporting specimens, you must obtain a CITES re-export certificate from the U.S. Management Authority.

How do I obtain the required documents for international trade in CITES-listed species?
To apply for a U.S. CITES document, complete a standard application form and submit it with a processing fee. Visit the Service's permit website at www.fws.gov/permits for more information.

To apply for a CITES document from another country, contact their Management Authority. You can obtain names and addresses of other countries' Management Authorities from the CITES website at cites.org/eng/parties/country-profiles/national-authorities.

What kinds of species are included in CITES Appendix III?
Approximately 400 animal species and nearly 150 plant species are currently included in Appendix III.

The United States has included the hellbender (*Cryptobranchus alleganiensis*) and the genus of map turtles (*Graptemys* spp.) in Appendix III. The walrus (*Odobenus rosmarus*), included in Appendix III by Canada, is another species native to the United States.

How do I know if my wildlife or plant is included in any of the CITES Appendices?
Visit the CITES website at https://cites.org/eng/app/appendices.php to view the CITES Appendices, or search for species in the Species+ Database at speciesplus.net.

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Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

October 23, 2024
11:30 a.m. – 12:15 p.m.

Draft Agenda

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

1.	Welcome/Call to Order (*L. Fegley*)	11:30 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from August 2024	11:30 a.m.
3.	Public Comment	11:35 a.m.
4.	Consider Updates to Shad and River Herring Sustainable Fishery Management Plans (SFMPs) *(W. Eakin)* **Action** • New Hampshire River Herring SFMP and Proposal to Reopen Fishery • Maine River Herring SFMP • Massachusetts American Shad SFMP • Connecticut American Shad SFMP	11:45 a.m.
5.	Other Business/Adjourn	12:15 p.m.

The meeting will be held at The Westin Annapolis (100 Westgate Circle, Annapolis, Maryland; 888.627.8994) and via webinar; click here for details

MEETING OVERVIEW

Shad and River Herring Management Board Meeting
October 23, 2024
11:30 a.m. – 12:15 p.m.

Chair: Lynn Fegley (MD) Assumed Chairmanship: 2/23	Technical Committee Chair: Wes Eakin (NY)	Law Enforcement Committee Representative: Lt. Col. Jeffrey Sabo
Vice Chair: Phil Edwards (RI)	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: August 7, 2024
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 2024

3. Public Comment – At the beginning of the meeting public comment will be taken on items not on the agenda. Individuals that wish to speak at this time must sign-in at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Chair will not allow additional public comment on an issue. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. Consider Updates to Shad and River Herring Sustainable Fishery Management Plans (11:45 a.m.-12:05 p.m.) Action
Background • Amendments 2 and 3 to the Shad and River Herring FMP require all states and jurisdictions that have a commercial fishery to submit a sustainable fishing management plan (SFMP) for river herring and American shad, respectively. Plans are updated and reviewed by the Technical Committee (TC) every five years. • Massachusetts and Connecticut submitted updated SFMPs for American shad (**Briefing Materials**). • Maine and New Hampshire submitted updated SFMPs for river herring (**Briefing Materials**). • New Hampshire also submitted a proposal to reopen the river herring fishery, which has been closed since 2021 due to a failure to reach its fishery-independent sustainability metric in 2019 (**Briefing Materials**).
Presentations • Shad and River Herring SFMP Updates for Board Consideration by W. Eakin
Board actions for consideration at this meeting • Consider approval of updated SFMPs for Maine, New Hampshire, Massachusetts, and Connecticut, as well as approval of New Hampshire's proposal to reopen the river herring fishery.

5. Other Business/Adjourn

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MEMORANDUM

TO: **Shad and River Herring Management Board**

FROM: **Shad and River Herring Advisory Panel**

DATE: **October 15, 2024**

SUBJECT: **Advisory Panel Review of 2024 River Herring Benchmark Assessment**

The Shad and River Herring Advisory Panel (AP) met via conference call and webinar on Monday, October 7th, 2024 to review the results of the 2024 River Herring Benchmark Assessment.

AP Members in attendance*:* Pam Lyons Gromen (Chair), Byron Young (NY), Edward Hale (DE), Bill Lucey (CT), Deb Wilson (ME), Jerry Audet (MA), Mike Thalhauser (ME), Ray Brown (NC), Steve Gephard (CT), Thomas Rowe (SC)

ASMFC Staff: James Boyle, Katie Drew

Other: Margaret Conroy (SAS Chair), Matthew Jargowsky, Kevin Job, Jason Boucher, Emily Bodell, Jamie Cournane, Roger Fleming, Jaclyn Higgins

Margaret Conroy presented an overview of the 2024 River Herring Benchmark Stock Assessment, including a description of methods and results for each system. The presentation highlighted the newly incorporated regional stock structures and habitat model.

AP Discussion

Overall, AP members were concerned that river herring populations are not recovering despite the actions taken through Amendment 2 that resulted in the closure of most state fisheries. Individual AP members provided several comments related to the assessment. First, Ray Brown expressed concern with the idea of increasing harvest for either species given the results of the assessment.

Steve Gephard wanted it noted for management and the public that the 2009 reference year represents a greatly depleted stock and comparisons to 2009 do not fully convey the losses that the stock has had over the full time series. Additionally, expressed concern that recent bycatch values are artificially low due to the lack of observer coverage and that the assessment does not adequately incorporate the Area 1a Atlantic herring spawning closures into its evaluation of the relatively positive trends seen in northern New England. He would recommend that the Commission draft a comment letter in support of time/area closures in Atlantic Herring Amendment 10 by the New England Fishery Management Council.

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Jerry Audet noted that the lack of a significant positive trend coastwide since the moratorium in 2009 represents an emergency. Furthermore, he sought direction from the assessment data on the most critical areas of immediate concern to direct management efforts. It is unclear whether in-river or at-sea issues represent the most immediate threat to restoration.

Bill Lucey, through comments during and after the meeting, indicated support for exploring catch caps that are more responsive to existing river herring stock conditions by genetic sub-regions as defined by Reid et al. (2018), while also formulating time area closures based on bycatch probability such as those developed by Roberts et al. (2023). Furthermore, he advocated for the time-area closures to be more clearly defined than the rolling hotspot method but could incorporate information from that previous management effort. Finally, he emphasized that there should be a rapidly growing focus on funding in-river monitoring efforts along with any other herring specific surveys (e.g. acoustics, tagging) to look at population level responses to reduced herring and mackerel effort and evaluate fishing mortality through at-sea interception, or lack thereof due to reduced fishing effort.

Mike Thalhauser expressed concern that the assessment is not able to evaluate the stocks at small enough scales for suitable management and wishes for managers to adapt to considering individual river stocks and fisheries rather than coastwide trends. Additionally, he advocated for earlier involvement of the AP in the assessment process, including discussions with the Stock Assessment Subcommittee regarding incorporating systems that have had recent restoration efforts but do not have 10 years of data currently required for consideration.

Ed Hale emphasized the need for increased observer coverage to evaluate at-sea bycatch and for states to utilize a consistent method for ageing samples. Additionally, he spoke in support for recreational personal use harvest in state Sustainable Fishery Management Plans (SFMPs).

Paul Perra (MA) was unable to attend the meeting but sent comments in ahead of time to call for coastal buffer zones in the Atlantic herring and mackerel fisheries to reduce river herring bycatch and to express support for the research recommendations in the assessment to improve restoration efforts.

In addition to discussing the assessment, several AP members expressed disappointment with the frequency of AP meetings and requested that the AP meet more regularly to be more involved and effective as an advisory body. The last AP meeting was held after the most recent American shad assessment in January 2021.

Finally, the AP requested to convene for another meeting to further discuss recommendations and draft consensus statements for management in response to the assessment.

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MEMORANDUM

TO: **Striped Bass Management Board**

FROM: **Striped Bass Technical Committee and the Stock Assessment Subcommittee**

DATE: **October 16, 2024**

SUBJECT: **Release Mortality Calculations and No-Targeting Closure Tasks**

In August 2024, the Board tasked the Striped Bass Technical Committee (TC) with calculations to determine how decreasing recreational release mortality could contribute to any potential reduction needed to achieve rebuilding. Part of this tasking required the TC to identify a method for estimating the reduction in live releases associated with no-targeting closures. The TC met in September and October 2024 to address these tasks.

Release Mortality Calculations

Task 1. If a reduction is needed to achieve rebuilding, determine how low the release mortality rate would need to be to achieve that entire reduction through the release mortality rate alone. If the number of live releases is constant, what would the release mortality rate need to be to achieve the reduction?

Task 2. If a reduction is needed to achieve rebuilding, determine the percent reduction in number of live releases needed to achieve the entire reduction through live releases alone. Using the current 9% release mortality rate, how many fewer live releases would there need to be to achieve the reduction?

Response: For Tasks 1 and 2, the calculations depend on what proportion of total removals is attributed to recreational release mortality. In 2023, recreational release mortality was 42% of total removals so that proportion was used for these calculations. These scenarios assume that a needed reduction would be fully achieved through reducing the release mortality component of fishery removals (i.e., commercial removals and recreational harvest are assumed constant). The hypothetical release mortality rate (Task 1) and the hypothetical reduction in live releases (Task 2) were calculated for a 4% reduction, which is the lowest reduction needed to achieve the fishing mortality (*F*) rebuilding rate under the various projection scenarios in the 2024 Stock Assessment Update, and for a 15% reduction for reference. The results are summarized in the tables below.

Regarding the proportion of total removals attributed to recreational release mortality, the TC-SAS considered a range from 39% of total removals (the proportion of release mortality in 2022 when the strong 2015 year-class was available) to 50% of total removals (the

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proportion of release mortality in 2021 before the strong 2015 year-class was available). The results were not especially sensitive to that assumption over the range considered.

Task 1: Reduction in Release Mortality Rate to Achieve Reduction (assuming release mortality is 42% of total removals)

	Current Release Mortality Rate Used in Stock Assessments	Task 1 Hypothetical Release Mortality Rate to achieve entire reduction
4% reduction from total removals	9%	8.1%
15% reduction from total removals	9%	5.8%

Task 2: Reduction in Live Releases to Achieve Reduction (assuming release mortality is 42% of total removals)

	Task 2 Hypothetical Reduction in Live Releases to achieve entire reduction
4% reduction from total removals	-9.5%
15% reduction from total removals	-35.8%

If total removals need to be reduced by 4%, and that entire reduction was achieved by reducing dead recreational releases:

- a release mortality rate of 8.1% is needed if the number of striped bass caught-and-released alive remains constant; OR
- live releases would need to be reduced by 9.5% under the current 9% mortality rate.

If total removals need to be reduced by 15%, and that entire reduction was achieved by reducing dead recreational releases:

- a release mortality rate of 5.8% is needed if the number of striped bass caught-and-released alive remains constant; OR
- live releases would need to be reduced by 35.8% under the current 9% mortality rate.

Task 3. If a reduction is needed to achieve rebuilding, determine the percent reduction in number of live releases needed under the current 9% mortality rate, assuming there is an associated reduction in recreational harvest due to no-targeting closures.

Task 4. Identify the tradeoffs of implementing no-targeting closures at different times of the year with different assumed release mortality rates to help inform when/where implementing no-targeting closures would result in the highest reduction. Factors could include water temperature and salinity, with the assumption that the release mortality rate is higher when the water temperature is high and the salinity is low.

Response: The TC-SAS has identified a method to estimate the reduction in total removals associated with no-targeting closures (see below). The TC-SAS could apply that methodology coastwide with additional guidance from the Board on what percent reduction management is aiming to achieve (Task #3) in light of the 2024 Stock Assessment Update results. The TC-SAS can address Task #4 at the same time Task #3 is addressed.

Method for Quantifying the Reduction Associated with No-Targeting Closures

A. Giuliano (MDDNR) provided an overview of the evaluation of the no targeting closures implemented in the Maryland Chesapeake Bay starting in 2020 for April 1-30 (half of Wave 2) and for 16 days during Wave 4. In 2020, the Wave 4 closure was August 16 through August 31, and from 2021 onward, the closure is July 16 through July 31. In addition to these closures, Maryland implemented other recreational management changes at the same time, including a shortened trophy season (May 1 start date) and reduced bag limit for private anglers (2 fish to 1 fish). The charter bag limit stayed at 2 fish for charter boat anglers if the charter boat was enrolled in the charter electronic reporting system.

MDDNR tested various assumptions about how striped bass trips and releases would change during a no-targeting closure to estimate the decrease in live releases. The final method and assumptions used to estimate the change in live releases is as follows. Trips that were only targeting striped bass (e.g. no other species were targeted) were assumed to no longer release any striped bass. If striped bass were targeted with a second species, those trips would still release striped bass but at a lower non-targeted rate. All striped bass releases from non-targeted trips (i.e., incidental catch) would still occur.

MDDNR reviewed MRIP data for striped bass directed trips, harvest, and live releases to compare effort and removals in Wave 2 and Wave 4 for the five years prior to the no targeting closures (2015-2019) to the four years since the no targeting closures were implemented (2020-2023). There was a decrease in directed fishing effort for striped bass in Maryland's Chesapeake Bay after the closures, and harvest, live releases and total removals estimates also declined after the no targeting closures were implemented, particularly for private and shore modes. It is important to note that other factors (e.g., fish availability, year-class strength, and the private angler trip limit changing from 2 fish to 1 fish) are also contributing to these results. To reduce the effects of changing fish availability and year class strength, the results were also presented to the TC-SAS as the proportions of directed trips, harvest, and live releases across the year. These results also showed a decrease in directed fishing effort, harvest, and live releases after the no targeting closures were implemented. Anglers reported targeting other Bay species more heavily during the closures as compared to prior to the closures when striped bass was the most targeted species.

The TC-SAS asked for more information on the Wave 2 data. It appears there were some changes in effort and harvest prior to the no targeting closure between 2015-2019, so MDDNR provided additional insight on other regulation changes (e.g., trophy season size limit changes and season start dates (3rd Saturday of April)) that likely impacted decreases in directed trips observed prior to the April closure/shortening of the trophy season.

MDDNR provided a summary of predicted vs. realized reductions for recreational harvest, release mortality, and total removals (Table 1). In addition to the realized reductions, there was a shift in the species anglers reported targeting during the closure, which also points to success of the closures from MDDNR's perspective. When considering applying this methodology to the ocean, the other species anglers report targeting might be different, so the ultimate impact of a no-targeting closure in the ocean may be different than in the Chesapeake Bay. A high proportion of anglers in the Chesapeake Bay are only targeting striped bass in the summer, which may result in a larger scale reduction in the Bay as compared to a similar closure in the ocean.

The TC-SAS agreed the closures generally seem successful in reducing total removals, but uncertainties around fish availability, angler behavior, and where people are shifting their effort (to other species) are important influences on the likelihood of success of these programs to consider. Tools like recreational demand models (RDMs)[1] could be helpful in the future to get a better handle on some of these uncertainties.

Overall, the TC-SAS agreed the MDDNR method for estimating the reduction in total removals associated with no-targeting closures is appropriate to apply coastwide if the Board considers no-targeting closures as a future management action.

[1] Carr-Harris, A and S Steinback. 2020. Expected economic and biological impacts of recreational Atlantic striped bass fishing policy. Frontiers in Marine Science 6:814. https://doi.org/10.3389/fmars.2019.00814

Table 1. Comparison of Addendum VI conservation equivalency estimated vs. realized reductions for Maryland's no-targeting closures implemented in 2020. Source: Maryland Department of Natural Resources.

	Harvest		Dead Releases		Total Removals	
	Estimated Reduction (2015-2018)	Realized Reduction (2020-2023)	Estimated Reduction (2015-2018)	Realized Reduction (2020-2023)	Estimated Reduction (2015-2018)	Realized Reduction (2020-2023)
Wave 2	-100%	-99.1%* (-100%)	-20.5%	-19.2%* (-12.7%)	-77.4%	-76.1%* (-74.8%)
Wave 4	-40.6%	-55.5%	-15.3%	-56.6%	-30.4%	-56.0%
Annual	-31.6%	-44.0%	-4.8%	-51.2%	-20.6%	-47.1%

* wave 2 comparison included 2020 data which was all imputed due to COVID impacts on APAIS sampling. Parenthetical value underneath is without the 2020 data included (i.e. comparing to just 2021-2023)

Realized reduction calculated comparing the 2015-2019 average harvest/dead releases/total removals to the 2020-2023 average harvest/dead releases/total removals

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MEMORANDUM

TO: **Striped Bass Management Board**

FROM: **Striped Bass Technical Committee and the Stock Assessment Subcommittee**

DATE: **October 16, 2024**

SUBJECT: **Discussion on 2024 Stock Assessment Projections and Considerations for Management**

The Striped Bass Technical Committee (TC) and Stock Assessment Subcommittee (SAS) met via webinar on October 2, 2024 to review the 2024 Stock Assessment Update Report, discuss the projection scenarios, and discuss options and considerations for potential management response. This memorandum summarizes TC-SAS discussion on the likelihood of the different projection scenarios and considerations for management.

The Assessment Report (in Main Materials for the 2024 Annual Meeting) highlights several sources of uncertainty for the rebuilding trajectory, including 2024 removals and fishing mortality rates for 2025-2029.

2024 Removals

Projections were run for two scenarios of 2024 removals: high and low. The 2024 high removals scenario is 5.86 million fish based on the initial estimate using data through 2022 that Addendum II measures would achieve a 13.7% reduction relative to 2022 removals of 6.8 million fish. The 2024 low removals scenario is 3.89 million fish based on expanding preliminary 2024 MRIP catch estimates for Waves 2 and 3 (March-April and May-June) to the full year, based on the proportion of total removals that occurred in those Waves in earlier years, and accounting for an estimated 7% decrease in commercial removals due to the Addendum II quota reduction.

The TC-SAS considers the 2024 low removals scenario based on preliminary 2024 MRIP numbers to be more likely than the high removals scenario based on the initial Addendum II calculations. The low removals scenario is based on realized data through mid-2024, while the high removals scenario was projected before any 2024 data were available. While the high removals projection was the best information available prior to the 2024 season, realized catch estimates provide a better picture of what is happening in the fishery. Additionally, it is logical that catch would decrease in 2024 relative to 2023 (instead of increasing, as in the high removals scenario) since the age-9 2015 year-class is less available to the ocean slot limit in 2024 as compared to 2023. Preliminary MRIP numbers for 2024 Waves 2 and 3 are 36% lower than 2023 Waves 2 and 3 numbers (Figure 1), and in the previous five years, the proportion of total recreational removals from Waves 2 and 3 has been relatively consistent (Figure 2). Total

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removals in Waves 4-6 would have to increase significantly compared to what has been observed in the past to achieve the high removals estimate.

Fishing Mortality for 2025-2029

The Assessment Report presents five projection scenarios through 2029 resulting in varying probabilities of rebuilding the stock by the 2029 deadline (Figures 3-4). One scenario assumes high removals in 2024 and maintaining that constant fishing mortality (*F*) in 2025-2029. The TC-SAS considered the high 2024 removals scenario unlikely and used the low 2024 removals assumption for the rest of the scenarios. These four scenarios use the estimate of *F* in 2024 associated with the low 2024 removals scenario with varying assumptions for *F* in 2025-2029. The varying assumptions for *F* in 2025-2029 are intended to address the uncertainty of the effect of the above-average 2018 year-class entering the ocean fishery in 2025 and subsequently growing out of the ocean slot in the following years. All five scenarios are described below with input from the TC on which may be more likely than others.

Constant *F* at $F=F_{2024}$ for Low 2024 Removals: this scenario assumes *F* in 2025-2029 will be equal to the *F* in 2024 estimated under the low removals scenario. This is the best case scenario for the stock out of the scenarios considered; however, the TC-SAS considered it unlikely that *F* would remain constant from 2024 to 2025 with the 2018 year-class entering the ocean fishery. In this scenario, there is a 50% probability of rebuilding by 2029, but a 4% reduction in removals relative to 2024 would be needed to maintain *F* at F_{2024} in 2025.

F_{2024}=Low Removals, *F* Increases in 2025 Only and Returns to 2024 Low Levels: this scenario assumes the low removals scenario in 2024, a moderate increase in *F* in 2025, and a decrease and stabilization for *F* in 2026-2029 back to F_{2024}. The TC-SAS considers this scenario most likely relative to the other scenarios. The increase in F_{2025} corresponds to the above-average 2018 year-class entering the current ocean slot limit. The subsequent decrease of *F* in 2026 and stabilization through 2029 corresponds to the 2018 year-class growing out of the current ocean slot limit and the lack of strong year-classes behind it. The moderate increase in F_{2025} (+17%) is the same magnitude as the increase from 2021 to 2023 when part of the 2015 year-class was still in the newly reduced ocean slot limit, but this may be overestimating the magnitude of increase in 2025 since the 2018 year-class is not as strong as the 2015 year-class was. In this scenario, there is a 43% probability of rebuilding by 2029.

F_{2024}=Low Removals and Moderate Increase to Constant *F* for 2025-2029: this scenario assumes the low removals scenario in 2024 followed by a moderate increase in *F* in 2025, comparable to what was observed from 2021 to 2023 with the 2015 year-class, and *F* remaining constant at that increased rate for 2025-2029. The moderate increase in F_{2025} (+17%) is the same magnitude as the increase from 2021 to 2023 when the 2015 year-class was in the newly reduced ocean slot limit. This may be overestimating the magnitude of increase in 2025 since the 2018 year-class is not as strong as the 2015 year-class was. The TC-SAS considers it unlikely that *F* would remain at this elevated level from 2026 to 2029 because at some point, *F* would be expected to decrease as the 2018 year-class grows out of the current ocean slot. However, it is possible F could remain elevated due to decreasing stock abundance (i.e., lower removals but from a smaller population). In this scenario, there is a 19% probability of rebuilding by 2029.

F_{2024}=Low Removals and Large Increase to Constant F for 2025-2029: this scenario assumes the low removals scenario in 2024 followed by a large increase in F in 2025, comparable to what was observed from 2021 to 2022 with the 2015 year-class, and F remaining constant at that increased rate for 2025-2029. The large increase in F in 2025 (+39%) used in this scenario is the same magnitude as the increase from 2021 to 2022 when the 2015 year-class was in the previous Addendum VI ocean slot limit. This large increase is likely an overestimate of the magnitude of increase since the 2018 year-class is not as strong as the 2015 year-class was, and the 2022 slot limit was four inches wider than the current slot limit. The TC-SAS considers it unlikely that F would remain constant at this elevated level from 2026 to 2029 because at some point, F would be expected to decrease as the 2018 year-class grows out of the current ocean slot. In this scenario, there is a 3% probability of rebuilding by 2029.

Constant F with F=F_{2024} for High 2024 Removals: this scenario assumes F in 2025-2029 is equal to the F_{2024} estimated under the high removals scenario. This is the worst case scenario and the TC-SAS considers the high 2024 removals scenario unlikely compared to the low 2024 removals scenarios. In addition, the TC-SAS considers it unlikely that F would remain constant at this high level from 2024 to 2029 with the 2018 year-class entering and then leaving the ocean slot limit. In this scenario, there is a 0% probability of rebuilding to the SSB target by 2029, although there is a 35% probability that SSB will be above the SSB threshold.

Considering Uncertainty in the Range of Projections

These projection scenarios convey a range of different potential outcomes under different assumptions about fishing mortality rates in the near future, some of which are more pessimistic than others. Although some projections aim to capture some component of changing effort and fish availability (i.e., increased F when strong year-classes are available), angler behavior and fish availability are still sources of uncertainty. While the TC-SAS considers the scenario where F increases in 2025 and then decreases to be the most likely, there is high uncertainty in the exact F values that will occur over this period even with constant regulations. In order to have a 50% or greater probability of rebuilding in this scenario, F will have to decline below the F estimated for 2024, which is already the lowest value since 1994, which may be the result of both the extremely narrow slot limit and the lack of a strong year class in that slot. The low year-classes following the 2018 year-class will result in lower availability of harvestable fish after 2025, which may result in a decline in effort and a lower F; however, if removals remain constant on these weaker year-classes, F may not decrease as much as expected.

The projections apply the 2024 selectivity curve to all years 2024-2029. The 2024 selectivity curve was developed using an alternative method to better capture the regulation change in 2024, but how well it represents actual fishery selectivity is uncertain. Additional years of data under the same management regulations would inform a better estimate of selectivity for upcoming assessments.

Potential Management Options

The TC-SAS calculated estimated reductions in total removals associated with a range of recreational size limit changes for 2025 and various recreational harvest closure options. Pending further guidance from the Board on what type of management response and level of reduction (if any) the Board may consider for 2025, a range of options is included for reference. Additional options could be analyzed after the Board determines next steps for management.

When considering possible management response for 2025 and beyond, the Board should consider its risk tolerance. The level of risk the Board is willing to accept is a management decision. In the coming months, the TC could provide updated projections incorporating realized 2024 removals once 2024 MRIP data are available in addition to other management options, if requested by the Board.

For size limit analysis, the TC-SAS used MRIP length frequency data from 2018 and 2011 for the ocean and Chesapeake Bay, respectively, to represent fish availability in 2025 when the above-average 2018 year-class will be age-7. 2018 data were used for the ocean since the 2011 year-class was age-7 that year. Additionally, there was no slot limit in place in 2018, so the length frequency data includes legal harvest of fish above 35”, which allows for analysis of slot limits or minimum sizes higher than the current regulations. However, because catch of fish shorter than the minimum length in 2018 was not legal in most areas of the ocean fishery, the 2018 length frequency data does not provide the data necessary to analyze slot limits lower with a minimum lower than the current regulation. Therefore, no reductions for slots of smaller fish are presented for the ocean. 2011 data were used for the Chesapeake Bay since there was not a prominent, strong year class available in the Bay fishery at that time, which will be the case in 2025. Estimated reductions for a range of size limits are presented for each region in Table 1.

For harvest closure analysis, 2021-2022 MRIP data were pooled to capture recent years under the slot limit, including Chesapeake Bay closures that were implemented through Addendum VI. A constant daily harvest rate was calculated by Wave for each state and some combinations of states in each region to estimate reductions from various seasonal harvest closures (Table 2).

The TC-SAS discussed tradeoffs of changing the size limit to allow harvest of larger fish in the ocean vs. maintaining the current slot limit targeting smaller fish. If ocean harvest remains in the current 28-31” slot, the remaining larger 2015s will be protected but the incoming 2018 year-class will be subject to harvest. If harvest is shifted to larger fish, the incoming 2018s would be protected but the larger 2015s would then be subject to harvest, the very fish recent measures were designed to protect. The TC-SAS also discussed the idea of an ocean size limit below 28”, which has been the minimum size in the ocean since the stock was rebuilt. Targeting fish smaller than 28” could shift harvest away from both the 2015 and the 2018 year-classes and may be desirable by some stakeholders from a management perspective, but harvest of immature fish would increase, resulting in a loss of spawning potential for the stock. It is unclear whether the biological benefit of reducing harvest of the remaining 2015s and 2018s would outweigh the biological risk of targeting immature fish. To calculate an estimated reduction for any size limit under 28” for the ocean, the TC-SAS would need to pursue alternative data sources (e.g., state logbooks).

The TC-SAS notes that most size limits evaluated, particularly in the ocean, are estimated to achieve less than a 6% reduction. The TC didn’t believe that a regulation change designed to achieve such a reduction would be meaningful. That is, given the typical sources of uncertainty in these analyses, such a low estimated level of reduction would likely not result in a meaningful change in removals if implemented[1]. While a size limit change could be combined with a seasonal closure for a higher estimated cumulative reduction, the benefit of changing to a size limit with such a small estimated reduction may be limited.

Finally, regarding how a potential reduction should be allocated between sectors, the Board was interested in a range of options to split the reduction, and those are provided in Table 3.

[1] For example, a credible range of recreational removals (95% CI) in 2023 is between 4.18 and 5.76 million fish (or the point estimate ± 16%).

Tables

Table 1. Estimated reduction in total removals for various size limits in 2025 for the ocean and Chesapeake Bay.

Ocean		**Chesapeake Bay**	
Size Limit	**Estimated Reduction Relative to Current 28-31" Slot**	**Size Limit**	**Estimated Reduction Relative to Current 19-24" Slot**
28-30" slot limit	-4.7%	19-23" slot limit	-4.3%
32-35" slot limit	-1.8%	19-22" slot limit	-14.8%
33-36" slot limit	-3.8%	19-21" slot limit	-26.0%
35" minimum size	0%	20-25" slot limit	-1.6%
38" minimum size	-5.4%	20-24" slot limit	-8.4%
40" minimum size	-5.8%	20-23" slot limit	-12.7%

Table 2. Estimated reduction in total removals for 14-day harvest closures occurring during various Waves for states in the ocean and Chesapeake Bay.

Waves in which Ocean Closure (14 days) Occurs by State	**Estimated Reduction for 14-day Harvest Closure**	**Waves in which Chesapeake Bay Closure Occurs (14 days) by State**	**Estimated Reduction for 14-day Harvest Closure**
Wave 3 All States	-1.8%	Wave 3 MD-VA	-4.4%
Wave 4 All States	-1.7%	Wave 4 MD-VA	-3.9%
Wave 5 All States	-1.6%	Wave 5 MD-VA	-4.2%
Wave 6 All States	-3.1%	Wave 6 MD-VA	-3.8%
Wave4ME-CT; Wave6NY-NC	-4.3%	Wave4MD; Wave3VA	-4.9%
Wave4ME-MA; Wave6RI-NC	-4.1%	Wave4MD; Wave5VA	-4.1%
Wave4ME-MA; Wave3RI-NC	-2.4%	Wave4MD; Wave6VA	-4.5%
Wave4ME-NH; Wave5MA-NJ; Wave6DE-NC	-1.6%	Wave5MD; Wave3VA	-5.0%
		Wave5MD; Wave6VA	-4.6%

Table 3. Potential sector reductions for different sector splits under the best case scenario for 2025 (4% reduction to maintain $F=F_{2024}$ in 2025) and the worst case scenario for 2025 (46% reduction to achieve $F_{rebuild}$ in 2025).

	Even Reductions		**No Commercial Reduction**		**Reductions Based on Sector Contribution to Total Removals**	
Total Reduction	Comm.	Rec.	Comm.	Rec.	Comm.	Rec.
-4%	-4%	-4%	0%	-4.5%	-0.4%	-4.5%
-46%	-46%	-46%	0%	-51.7%	-5.1%	-49.1%

Figures

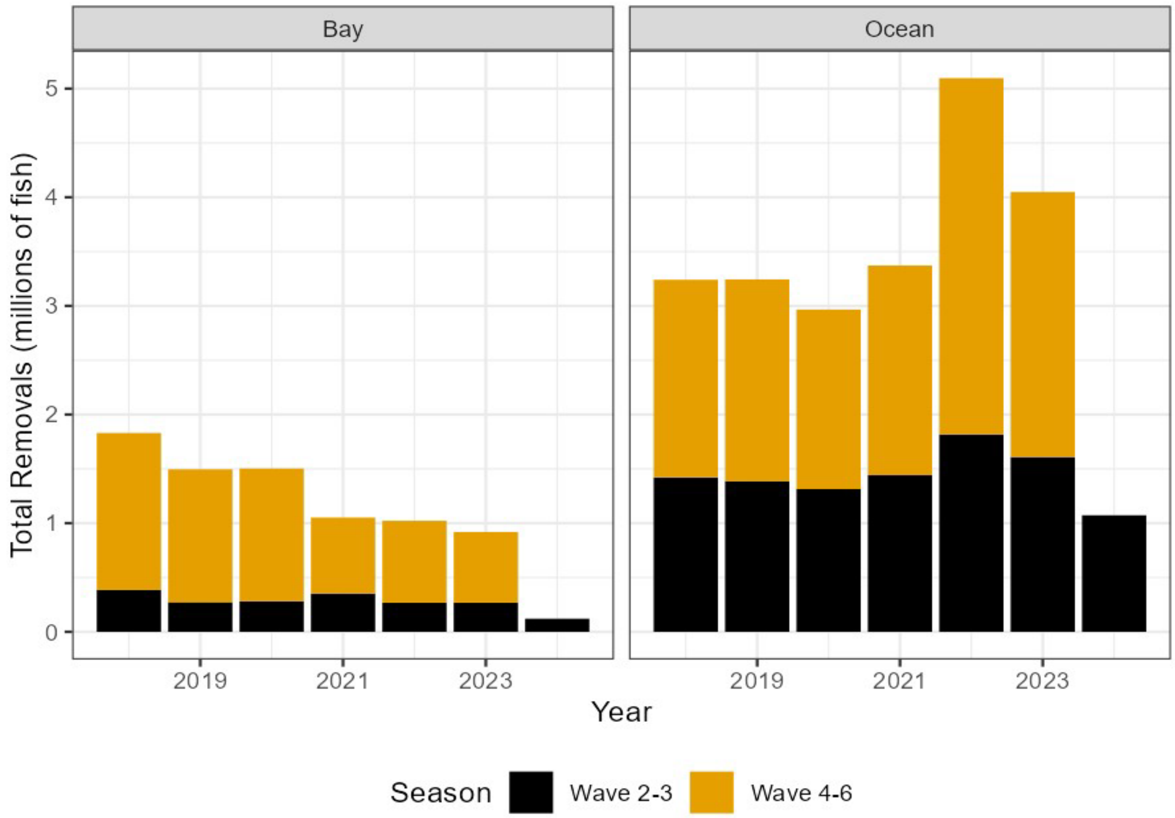

Figure 1. Total recreational removals by region separated into Waves 2-3 and 4-6. Source: MRIP.

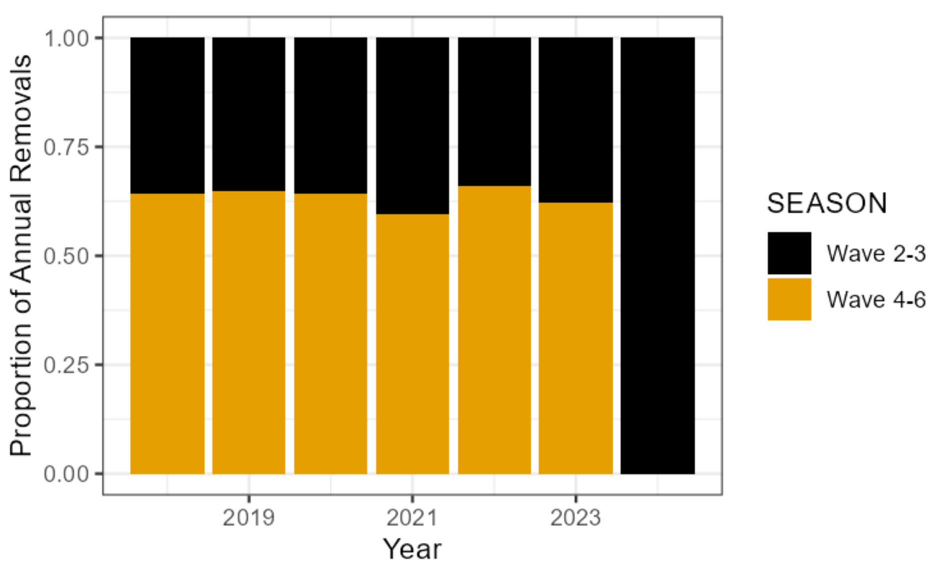

Figure 2. Proportion of total recreational removals for 2018-2024 that came from Waves 2-3 and 4-6. Source: MRIP

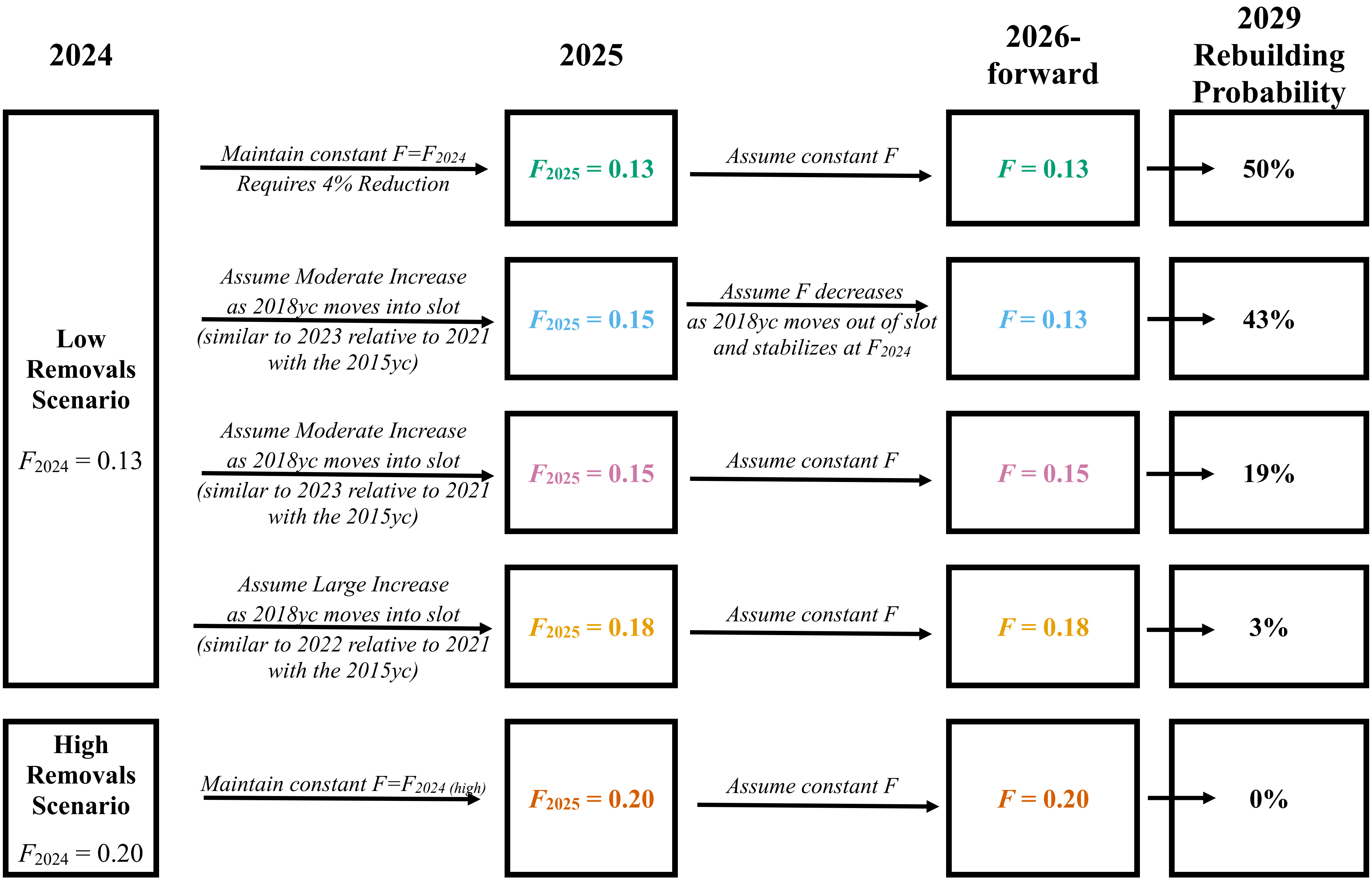

Figure 3. Projection scenarios and resulting probability of rebuilding the stock by 2029.

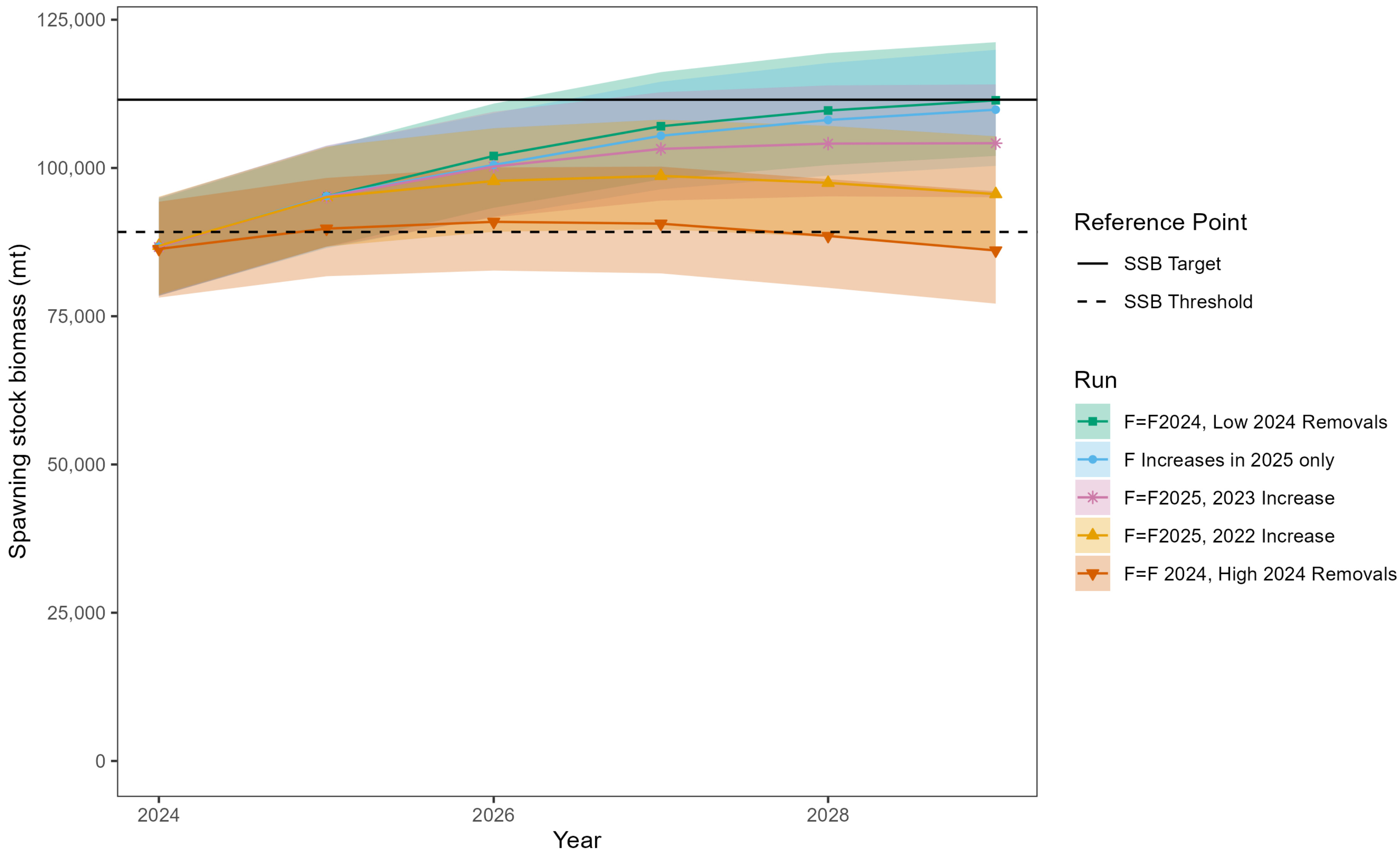

Figure 4. Projections of female spawning stock biomass through 2029 under different future *F* scenarios: assuming *F* stays the same as in 2024 under the low removals scenario (*F=F* 2024), increases in 2025 only and then returns to 2024 levels, increases at a rate comparable to what was observed in 2022 (*F=F* 2025, 2022 Increase) or 2023 (*F=F*2025, 2023 Increase), or assuming *F* stays the same as in 2024 under the high removals scenario (*F=F* 2024, High Removals).

From:	dbeauche@maine.rr.com
To:	Comments
Subject:	[External] Striped Bass Regulations
Date:	Saturday, October 12, 2024 10:00:16 AM

ASMFC Members;

I have been fishing for striped bass for nearly 65 years. I have watched the biomass collapse in the 1960's. I was thrilled when we finally rebuilt the stocks in the 1990's. Unfortunately, I now have to live through yet another cycle of the stocks collapsing. Many voice over the last 15 years have urged ASMFC to implement a more stringent plan for protecting the species. Yet we now face the reality that we are removing the species more quickly than it can reproduce itself. Doubling the problem is the ever increasing ocean temperatures. Living in Maine, scientists are finding that the Gulf of Maine is warming faster than any other body of water on Earth.

I urge you to consider implementing a moratorium on the taking of any striped bass until such time as the stocks have been replenished. That would include no commercial take and a 'catch and release' requirement of all sport fishermen. Similar to the approach that Florida took to protect Goliath Grouper, I would require all sport fishermen to remove their circle hooks 'while the fish is still in the water and prohibit them being lifted out of the water. It is embarrassingly obvious that 18 years into your 10 year plan that the current plan has totally failed.

Thank you for accepting my comments and ask that you include them in the supplemental materials for your October 23rd meeting.

Best regards,
Dennis Beauchene
Cape Neddick, ME

From:	Info (ASMFC)
To:	Emilie Franke
Subject:	FW: [External] Striped Bass
Date:	Friday, October 11, 2024 10:12:17 AM

-----Original Message-----
From: frank bell <frankbell777@gmail.com>
Sent: Thursday, October 10, 2024 8:44 PM
To: Info (ASMFC) <info@ASMFC.ORG>
Subject: [External] Striped Bass

Wake up!

Sent from my iPhone

From:	Alan
To:	Emilie Franke
Subject:	[External] Support for ASGA Striped Bass position
Date:	Sunday, October 13, 2024 10:40:07 PM

Ms Franke…i want to go on record to express my support for reducing the Striped Bass Harvest across the recreational and commercial sectors along the entire Atlantic coastline to achieve the goal of rebuilding the entire stock to previously healthy levels by 2029 as recognized by the ASGA... I also support a harvest limit to include a 1 slot fish (28-31") per angler , per season .

I'm also calling for the establishment of a no harvest spring season during spawning in known spawning rivers, bays, and estuaries along the Atlantic coastline . Along with continued angler education regarding the handling and releasing of landed Striped Bass.

Thank you for your time ..

Respectfully

Alan Berger

516-647-1391
bergersmac@gmail.com

From:	Matt Boutet
To:	Comments
Subject:	[External] 2024 Atlantic Striped Bass Stock Assessment Update
Date:	Tuesday, October 15, 2024 3:41:53 PM

The bad news for striped bass seems to be never ending, but the latest stock assessment update was particularly bad, so it was disappointing and alarming to see that this isn't being treated as an existential threat at the coming fall meeting.

These "bad" spawns appear to be the new normal, and while I think we should be doing everything we can to understand the problems and hopefully improve spawns going forward, that's at least somewhat outside of anyone's control.

What we can control is mortality on the fish already in the population, and so far everything that's even being considered seems like too little too late. Please do more, and do it quickly.

Matt Boutet
Biddeford, ME

From:	Scott Burrill
To:	Comments
Subject:	[External] Action is Needed Now
Date:	Saturday, October 12, 2024 8:38:35 AM

Hello,

I have been fishing in Casco Bay, Maine, for 25 years. This summer was one of the most alarming seasons I have witnessed regarding the striped bass population.

We observed a complete absence of young striped bass this year. The predominant fish caught were 27 or 28 inches in length or larger, and these fish were in extremely small numbers and sporadic.

This situation strongly suggests that not only has there been no young class to be caught, but the overall population is significantly lower than we have observed in recent years.

Clearly, it is imperative that stricter regulations be implemented to safeguard this invaluable resource. I implore you to take immediate action to protect this fishery.

Sincerely,

Scott Burrill

From:	Bob Campbell
To:	Comments
Subject:	[External] In support of a moratorium on striped bass harvesting now
Date:	Monday, October 14, 2024 7:32:21 AM

To the Atlantic Striped Bass Management Board of the ASMFC,

Last year I wrote to the ASMFC, expressing deep concern about the evident prolonged decline in our striped bass.

I'm asking to submit an abridged version of that correspondence here, to add my voice to those urging a moratorium now on striper harvesting. Thank you sincerely for considering my thoughts once again,
Bob Campbell

***Saving now*, more than managing, Striped Bass**

To the Committee,

I'm in my seventies, and have lived and raised our family in Massachusetts, Connecticut, New York and New Jersey.

I fished the region's salt waters throughout the 70's, during the 80's striper population crash, saw stripers rebound through the collective efforts of many reading this in the 90's and early 2000's, and see them crashing again now. This current, now prolonged, downward spiral is apparent from both the scientific data and from all our on-the-water experience, irrespective of anecdotal "good" days we still sometimes have on the water.

In the field of management consulting, my work for quite a few decades on five continents, there was one principle perhaps most central to leading major corporations and governmental entities:

Proactive action on an issue benefits all stakeholders, no matter how divergent their interests, far more than reactive remediation.

Respectfully, I've observed that despite obviously good intent, those charged with protecting our striped bass have, in attempts to satisfy expectations of diverse interests, operated more in the latter than the former mode.

May I also offer that effective management of a resource, and leadership of major objectives -- in this case preservation of an East Coast natural treasure *and* maximization of ASMFC states' revenues and residents' well being -- quite clearly call for decisive steps which won't satisfy each constituency but which will ultimately benefit most of them, the most.

There is no question for example, that municipal and state tax revenues (which benefit all residents) and local business's retail receipts from not-for-profit recreational striper fishing far exceed those from for-profit and/or commercial harvesting. Just like there is no question, according to the science, that both for-profit/commercial harvesting and not-for-profit recreational harvesting of stripers must now be curtailed for a defined time period of at least ten years.

And staying with the goal of ASMFC states' residents' well being, may I offer a last comment?

I experienced first-hand the disruption when economic and societal factors impinge on a family's source of income. Our small dairy farm in upstate New York couldn't continue and had to be sold amid the context of market realities. So I understand as do you, the voices of those who depend financially on striper harvesting. I also know from experience as do you I'm certain, the realities which change old equations and require changed strategies for wage earners because of an obvious greater good for most.

Speaking plainly, we have to acknowledge and provide some state-based consideration for those impacted by steps *right now* to temporarily end continued harvesting of the stripers that belong to all of us and to our children and grandchildren.

I ask you all to please be the managers and leaders required to preserve our striped bass for all those to come. Don't let your legacy be having *reacted* insufficiently instead of having *acted* decisively.

Again, thank you all,
Bob Campbell
28 Stratford Lane
Holmdel, New Jersey

From: GUY CANTARA
To: Comments
Cc: comments@stripersforever.org
Subject: [External] Striped bass
Date: Saturday, October 12, 2024 11:04:00 AM

I live and fish for striped bass in southern Maine and New Hampshire. I have noticed a dramatic decrease in overall numbers that I catch and release over the past several years. Where are the schoolies? Used to be acres of them. Not anymore. Please, please fix this sad situation with striped bass. Thank you much.

Sent from my Verizon, Samsung Galaxy smartphone
Get Outlook for Android

From:	Jason DeLand
To:	Comments
Subject:	[External] ASMFC "24 Annual Meeting Comments
Date:	Saturday, October 12, 2024 7:22:24 AM

Dear Atlantic States Marine Fisheries Commission,

My name is Jason DeLand, and I am a lifelong fisherman and advocate for catch-and-release (C&R) fishing, which you can find featured on my Instagram channel, @callofthesurf.

I keep detailed logs of every trip I take, and over the last five years, these logs have shown a dramatic decline in the striped bass population. In Montauk, the once-thriving blitzes are now nonexistent, and nights spent on a rock in a wetsuit, casting into ideal conditions of water, tide, and wind, have increasingly yielded no fish - becoming the norm, not the exception.

My data suggests the need for a moratorium, but one only has to look at your existing data to draw the same conclusion.

The Young of the Year (YOY) recruitment and fishing mortality rates are comparable to—if not worse than—the conditions that led to the 1980s striped bass collapse.

Young of the Year (YOY) Data Comparison:

- Maryland: In 2023, the YOY index was 2.3, only slightly above the 2.0 recorded in 1982, a key year that led to the 1985 moratorium. Over the past five years, Maryland's YOY index has averaged just 3.6, compared to a long-term average of 11.5.
- Virginia: Virginia's Chesapeake Bay surveys show consistently low recruitment, with poor trends across the James, York, and Rappahannock Rivers.
- Hudson River: In 2023, the Hudson River's YOY index was 0.96, which is lower than the 1980s average of 1.1. The Hudson has seen four consecutive years of recruitment failure, signaling a collapse similar to the one we saw in the past.

Fishing Mortality Rates:

In the 1980s, unsustainable fishing mortality rates led to a collapse, which the moratorium successfully reversed. Based on your 2022 Stock Assessment Update, fishing mortality stands at 0.31, which is c.50% higher than the ASMFC's target of 0.20

Habitat Degradation:
The same low recruitment and high fishing mortality that triggered the 1980s moratorium have returned, but this time the situation is compounded by climate change and habitat degradation. We must act with the same boldness that restored the population last time, or we risk an irreversible collapse.

The data shows the stock is in perilous shape. My question is why has there not been a moratorium issued already? Especially considering there is no data to suggest the striped bass fishery is at or near any threshold to suggest we keep fishing.

The same conditions that led to the moratorium in the 1980s are back in force, and today's situation is worsened by environmental stressors. Bold action is needed—not next year, not later—now.

The demand from me, and thousands of fishers like me, is clear: we love and respect this fishery, and we call for bold action now to save it. We cannot afford to wait any longer.

Just imagine a healthy and thriving striped bass fishery, one that brings back a healthy coast wide ecosystem. A fishery that everyone can be proud of.

Please include my comments in the supplemental materials for your upcoming meeting. I urge the ASMFC to act decisively and implement a 10-year moratorium to allow this critical species to fully and completely recover.

Sincerely,
Jason DeLand
Montauk, New York

From: Bran Dougherty-Johnson
To: Comments
Subject: [External] Urgent Request for Striped Bass Moratorium
Date: Sunday, October 13, 2024 9:04:52 AM

Dear Atlantic States Marine Fisheries Commission,

I am an avid striped bass angler from Shelter Island, NY. Over the past several years, I have witnessed a troubling decline in striped bass populations along the Atlantic coast, particularly in areas like Long Island. This iconic fishery is an integral part of our ecosystem and fishing culture, and it is in deep trouble.

Recent data on Young of the Year (YOY) recruitment and fishing mortality rates paints a clear and alarming picture. The 2023 Maryland YOY index was only 2.3, just above the levels that led to the 1985 moratorium. The Hudson River has recorded an even more concerning YOY index of 0.96, lower than the 1980s average. These low recruitment rates, coupled with current fishing mortality at 0.31, which is 50% higher than the ASMFC's target of 0.20, indicate the striped bass population is once again on the verge of collapse.

These same conditions caused the 1980s moratorium, but today the situation is worsened by climate change and habitat degradation. Half measures won't save this fishery. We need bold action now.

Please include my comments in the supplemental materials for your upcoming meeting. I urge the ASMFC to act decisively and implement a 10-year moratorium to allow this critical species to fully and completely recover.

Thank you for your attention to this urgent issue.

Sincerely,
Bran Dougherty-Johnson
Shelter Island, NY

From:	Alex
To:	Comments
Subject:	[External] ASMFC Striped Bass Meeting Comments
Date:	Sunday, October 13, 2024 1:46:33 PM

Dear ASMFC board and those involved,

This season I have fished 90 nights in the surf for striped bass in Maine. I have spent thousands of dollars on the recreational catch and release striped bass fishery, from gas to gear and tackle that supports an industry that depends on the health of the fish. Striped bass fishing represents an important part of my life.

To hear stories of how good the fishery was, and to see the insurmountable difficulty we face is grim. My knowledge is built on experience with fish to learn from. I simply cannot fathom starting in the sport today.

After years of spawning failure and over harvest, I urge the ASMFC to correct course and implement a moratorium on the recreational and commercial harvest of striped bass. Current recreational angler sentiment is so low, almost all those I interact with have expressed a favor for this action. At this time I do not support a no-target closure; that may be a difficult reality we need to face in the future if the proper steps are not implemented now.

Thank you,
Alex Dwight

From:	Lisa Eggie
To:	Comments
Cc:	comments@stripersforever.org
Subject:	[External] Striped Bass Management
Date:	Sunday, October 13, 2024 9:47:05 AM

Dear ASMFC Members,

As someone who has fished for Striped Bass for over 60 years please submit my comments below regarding the management of striped Bass at your October 23rd meeting:

As I see it, we are 18 years into a 10-year management plan that has utterly failed in its objective to rebuild striped bass stocks. Now the ASMFC is preparing to embark on yet another 10-year plan of compromise and half-measures, and stripers may not survive. Bold, decisive action is needed to prevent a collapse of the fishery like we saw in the late 1970s. An emergency moratorium was adopted in 1984, and is the only approach proven to work."

I stand behind that call and today this is my opportunity to once again send a message to the ASMFC: For the sake of the survival of wild striped bass, adopt a ten-year harvest moratorium.

Environmental conditions in the most important area for striped bass reproduction have narrowed to the point where there is no room for error, as evinced by five consecutive years of spawning failure in the upper Chesapeake. Warming water, micobacteriosis, predation by invasive species, lack of forage, increased fishing pressure, gill netting, and industrial-scale poaching are removing adults faster than they can breed. Soon we will be presented with new options that amount to little more than minor, incremental adjustments that will succeed only in delaying the bold action needed to save striped bass.

Sincerely,

Duane R. Eggie

From:	troyeggie@comcast.net
To:	Comments
Subject:	[External] Fwd: Striped Bass management input
Date:	Sunday, October 13, 2024 1:42:38 PM

Troy Eggie
Berger Realty: 17th & Boardwalk
Office: 609-391-0500
Cell: 609-425-0992 Fax: 609-391-0317 Email:
tde@bergerrealty.com troyeggie@comcast.net

Begin forwarded message:

> **From:** troyeggie@comcast.net
> **Date:** October 13, 2024 at 1:38:03 PM EDT
> **To:** Troy Eggie Cell <troyeggie@comcast.net>
> **Subject: Fwd: Striped Bass management input**
>
> Troy Eggie
> Berger Realty: 17th & Boardwalk
> Office: 609-391-0500
> Cell: 609-425-0992 Fax: 609-391-0317
> Email: tde@bergerrealty.com troyeggie@comcast.net
>
> Begin forwarded message:
>
>> **From:** TROY EGGIE <troyeggie@comcast.net>
>> **Date:** March 19, 2022 at 11:31:28 AM EDT
>> **To:** comments@asmfc.org
>> **Subject: Striped Bass management input**
>>
>> I am completely in favor of a total moratorium effective immediately. I don't feel it needs to be 10 years, 5 would do it. The last time it was imposed, there were Bass everywhere at the end. I was an eye witness to this unprecedented resurgence of the population. Stop wasting time and resources with stop gap measures that do not work! I just hope its not already too late. The following fisheries have almost completely collapsed. Delaware Bay, in-shore Southern New Jersey, in-shore Virginia and North Carolina. The only viable fishery left in the mid-Atlantic comes from the "Hudson river" strain. Still good fishing in Raritan Bay south to Barnegat inlet. In the spring and fall these fish get pounded

relentlessly by thousands upon thousands of fisherman day after day. Its common practice for boats to limit out, return to port, off load the fish and go back out for another limit. This is a prime reason "band aide" measures and limits are ineffective.

Until you folks wake up and implement a full moratorium, Bass populations will continue to decline. In the mean time, I am in favor of the following measures:

* Smaller "over" size limit.

* Outlaw snag and drop treble hook fishing. (Mortality issue).

* Mandate all hooks to be barb less. (We have had wonderful release success simply by crimping down the barb. (Mortality issue).

* Mandate all fish stay in the water when being released. (Mortality issue).

* Outlaw all gaffs. (Mortality issue)

* Outlaw all multiple hook trolling lures. Multiple fish get hooked simultaneously and are dragged by the boat to their death. Ridiculous!!! (Mortality issue).

* Outlaw light tackle that cannot land a fish quickly. (Mortality issue).

Troy Eggie

Berger Realty: 17th & Boardwalk

Office: 609-391-0500

Cell: 609-425-0992

Fax: 609-399-0317

Email: troyeggie@comcast.net

Work email: tde@bergerrealty.com

From:	paulyfish reeltherapy.com
To:	Comments
Subject:	[External] Striped bass comment submission
Date:	Tuesday, October 15, 2024 2:50:03 PM

Dear Ms. Franke and Striped Bass board members-
Please include my comments in the supplemental materials for the meeting.

Potential management options for consideration:
Reductions must be equal across sectors. Commercial reductions must be made from harvest, not quota. Many jurisdictions have not hit their quota. Therefore, taking a reduction off the quota is only a reduction on paper. It does not result in less mortality and will not help recover striped bass.

•Direct statements on the record from the Law Enforcement Committee (LEC) consistently state that no targeting closures are entirely unenforceable. The LEC rated non-targeting closures the least enforceable of 27 guidelines and gave them a 1.87 out of 5 enforceability rating, making them utterly ineffective at reducing effort.
Non-targeting closures are not equitable across the coastwide range of striped bass. Some states have much shorter seasons. Guides' businesses will also be unfairly impacted. Taking away more time on the water could end their businesses altogether.

•No harvest closures should be initiated for the 2025 season. Unlike no-targeting closures, these will have a measurable impact and are enforceable.

•Each jurisdiction should have the same percentage reduction applied to the harvest numbers for that jurisdiction. As we have seen in the past, a "coastwide" reduction would significantly impact states with shorter seasons. New Jersey cheated a reduction in the past by using this loophole. If this happens again, the Board will display its inability to learn from mistakes.

• Commercial fishing in the Chesapeake Bay and anchored gill net fisheries that intercept fecund striped bass entering their spawning estuaries must be curtailed. The striped bass commercial fishery in Maryland has not taken a reduction in over a decade while the Maryland recreational fishery has almost collapsed. It is illogical that approximately 80% of commercial landings come from Maryland while the estuary is experiencing 5 (potentially 6) years of spawning failure. This harvest, not quota, must be heavily reduced. The anchored gill net fisheries in Virginia and Delaware are no longer sustainable, considering the repeated spawning failures in both estuaries. Recreational effort has been grossly overestimated by NOAA. That means that commercial striped bass harvest is a much higher percentage of total harvest than previously estimated.

Some place blame on habitat loss and climate change. Especially if these aspects are the root cause of failed spawning, we must be more conservative and risk-averse in management. This Board doesn't manage climate change. This Board manages fishery regulations. The same conservation message holds if the root cause is overfishing for 21 of the last 24 years as documented in the data.

Striped bass are the most important recreational fish on the Atlantic coast, supporting countless coastal communities, small businesses, and fishing brands. This Board must recognize 5 years of failed spawns. Further damaging the resource and the economy through Board actions that look good only on paper is unacceptable to the striped bass conservation community.

As a fishing guide, small business owner and conservation-minded recreational angler who depends on a healthy and abundant striped bass stock I deserve better. Striped bass deserve better. If there is no action at the October Annual meeting, I will lose all faith in this body's ability to fulfill their obligation to rebuild this stock and manage striped bass effectively.

Thank you in advance for taking immediate action,

Paul Eidman

Tinton Falls NJ

Capt. Paul Eidman
732.614.3373
paulyfish@reeltherapy.com
https://linktr.ee/paulyfish

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www.reeltherapy.com
www.menhadendefenders.org
www.anglersforoffshorewind.org
Yes, ONE person can make a difference!

From:	Tyler Harper
To:	Comments
Subject:	[External] Urgent: We Need a Moratorium NOW
Date:	Saturday, October 12, 2024 12:03:25 PM

To Whom It May Concern,

I am an assistant professor of Environmental Studies at Bates College and a journalist who writes regularly (sometimes about striped bass) for various outlets. More importantly, I'm a surfcaster who spends over 80 nights a year chasing stripers in Maine and New England.

Let me be blunt: our fishery is in crisis. It is painfully obvious that our striped bass population is on the verge of collapse. I have seen the decline firsthand. Each year is worse than the last, and every single serious surfcaster I know reports their worst season ever.

We cannot continue to bury our heads in the sand. A no-harvest moratorium is needed, and it is needed now. I have deep sympathies for those fishermen who make their living from this species, and I am fully aware that recreational anglers have played our role in the decline, but the cold hard truth is that if we do not take drastic measures and stop harvesting striped bass, there will be no striped bass left for anyone — comm or rec — in a few years regardless.

The ASMFC must stop kicking the can down the road. The conditions that are present today — a few large fish left, with next to no small fish behind them — are identical to the conditions that precipitated the 1980s collapse. We have to let history be our guide, and take action before this crisis becomes a true catastrophe.

In the strongest possible terms, I implore the ASMFC to take action and implement a no-harvest moratorium. Please include my comments in the supplemental materials for the upcoming meeting.

With trust that the ASMFC will do the right thing,

Tyler Harper
Maine

Tyler Austin Harper, Ph.D.
Assistant Professor of Environmental Studies
Bates College
Lewiston, Maine 04240

From: Matt Hetterich
To: Emilie Franke
Cc: Fred W. Thiele Jr.; John Maniscalco; Jim Gilmore; Marty Gary; Emerson Hasbrouck
Subject: [External] Striped Bass Conservation
Date: Monday, October 14, 2024 12:56:04 PM

Good Afternoon,

I've been fishing my entire life (40 years old), both in the recreational and part time commercial fisheries here on Long Island,NY. A constant theme of my seasons recently has been "The striped bass fishing can't get worse than last year"...and yet, it does and has gotten worse.

I've never experienced a season with fewer striped bass than I have the past several years. The resident fish around Long Island Sound that used to be here year round are gone, fallen victim to poachers and rampant overfishing that often goes unchecked. The remaining biomass gets hammered off Montauk/Block Island or at the Cape Cod Canal and then has to make a return trip back through the same gauntlet it survived in the spring.

I ask that you please take a conservative approach to managing striped bass in the future. We know these fish are resilient enough to make it back in great numbers again, as we saw with the first moratorium in the 1980's. If you have any questions or concerns, please do not hesitate to contact me.

Thank you and be well,

Matt Hetterich
Eastern Rodworks
Phone - (631) 902-9756

Center for Ecological Economic and Ethical Education

Post Office Box 946
Ipswich, MA 01938-0946

Phone: (978) 356-2188 (w) or 617-605-3150 (c)
email: ecologicaleconomics@yahoo.com

13 October 2024

Emilie Franke
Striped Bass FMP Coordinator
Atlantic States Marine Fisheries Commission
1050 N Highland Street, Suite 200
Arlington, VA 22201
Sent by email to: **comments@asmfc.org**

RE: Comments for October 2024 Striped Bass Board Meeting, The Importance of Rebuilding Stocks!!!

Dear Ms. Franke and Striped Bass Board Members:

I have fished for striped bass now for over 65 years, mostly here in Massachusetts. I have watched this fishery through two crashes, one in the 1970s and the other right now. I am more than just disappointed in the ASMFC and its seeming disinterest in taking sufficient action to restore this fishery, despite its massive value for us.

I have reached the point where I think that it's time for a total moratorium on this fishery, as that was the only way that this fishery was restored in the late 1980s. Let's place a full coastwide moratorium on all commercial fishing for this species, and make the recreational fishery totally catch-and-release.[1] The impending loss of this fishery is quite intolerable, and so – in my humble opinion – it is long past time for you to take some sort of drastic action here. Kicking the can down the road has proven totally useless. Let's restore this special fishery.

The YOY results have been disastrous for too many years now. It is high time for radical measures.

Please be sure that this email submission is included in the supplemental materials for the meeting.

Thank you for your attention.

Frederic B. Jennings Jr., Ph.D. (economics)
Peak Dawn Anglers and
Center for Ecological Economic and Ethical Education (CEEEE)
P.O. Box 946, Ipswich, MA 01938-0946 U.S.A.
Cell Phone Number: +1-617-605-3150

[1] And if that is thought to be unfairly predjudicial for the recreational sector, then call for a total recreational moratorium as well.

From: RONALD KOVLER
To: Comments
Subject: [External] comments@stripersforever.org.
Date: Sunday, October 13, 2024 11:11:07 AM

As a licensed Captain in South Jersey for almost 20 years, I join the many voices who vehemently support a lengthy moratorium on harvesting striped bass. As someone who stands to potentially lose from this moratorium, I see the big picture first and the importance of preserving the species for generations to come. We can still fish for these magnificent creatures and to enjoy the bite, the fight and the release to fight another day and to allow them to procreate ensuring that there will be another day. Let's take that bold action immediately! —- Capt. Ron Kovler,
Next Case Fishing
Sent from my iPhone

From:	Greg Pavlov
To:	Comments
Subject:	[External] Striped Bass Management
Date:	Saturday, October 12, 2024 11:07:27 AM

As almost anyone who fishes for striped bass, particularly from shore, can attest, the striped bass stock has been in a steady, unwavering decline for at least half a dozen years now. Most disconcerting is the very, very few small bass that are around: there is simply very, very little reproduction occurring. Thus, it is time to implement a moratorium on the retention and "harvesting" of striped bass! I am now 75 years old and have been fishing for this noble species for some 40 years. It is obvious that we are heading to the complete crash of what remains of the population and the last time that happened, turned around only after the implementation of a virtual moratorium, it was quite some time before stocks replenished to a reasonable state. This time I expect that I will be gone by the time that happens.

Gregory Pavlov
Brewster, Massachusetts

--
Greg Pavlov

From:	Chris Sherman Sr.
To:	Comments
Cc:	comments@stripersforever.org
Subject:	[External] 10 Year Management plan for Stripers
Date:	Saturday, October 12, 2024 11:20:32 AM

To the ASBM Board of the ASMFC,

I am a recreational, strictly catch and release striped bass fisherman and have witnessed firsthand the dramatic decline in the species. I am gravely concerned for its future and I hope one day my grandchildren will be able to enjoy the thrill of catching a striper.

I urge you to enact an immediate moratorium, similar to action taken in 1984, to protect the future health of the striped bass fishery. It is an imperaitve!

Respectfully,

Christoher Sherman Sr.
92 Hounds Ditch Lane
Duxbury, MA 02332
617.417.2013

From: Bill Sjovall
To: Comments
Subject: [External] Striped Bass Management
Date: Saturday, October 12, 2024 11:12:27 AM

Dear ASMFC,

As a long time recreational fly rod striped bass fisherman, I would like to comment that a ten year moratorium on striped bass harvesting is needed to replenish the dwindling stock. Overharvesting, lack of adequate forage (due in part to decimation of the menhaden stock by netters), and lack of successful spawning over the last several years will lead to another predicatable crash.

I have experienced decreased catches of striped bass over the past 5 years in NJ, Cape Cod and Martha's Vineyard. Once great fisheries are no longer what they were in the past.

You have the ability to prevent a crash and restore the fisheries with proper action now. A 10 year harvest moratorium is needed.

Regards,

Bill Sjovall
Morristown, NJ

From: Mike Spinney
To: Comments
Subject: [External] Comments on Striped Bass Management
Date: Saturday, October 12, 2024 11:14:27 AM

To the ASMFC:
As of this moment the Chesapeake YoY index has not been released. Rumor has it that the result will be another near, if not complete, failure. The sixth in a row. That means, having completed a five-year spawning cycle with no meaningful reproduction, the chances for anything resembling success in the next five years are rapidly declining. And since the recreational and commercial harvest are directed at fish of spawning age, we are simultaneously hammering away at the very fish recovery needs to succeed while we see insufficient numbers entering the reproductive pipeline.

What’s more, the margin for error has narrowed significantly. Warming waters in the Chesapeake have squeezed the spawning window from approximately three weeks down to one. An untimely drought, heavy runoff, or temperature change affecting that window will doom what few eggs and fry are produced. And yet the ASMFC plans no meaningful action to do what its mandate and a majority of the fishing public demands: save striped bass from impending collapse.

In 2021 I was among the voices calling for the ASMFC to do something bold and initiate a ten-year harvest moratorium. I, and many others, asked that the fishery be shut down long enough to give striped bass a chance to recover and achieve the healthy age stratification the Commission includes among its management goals.

Today we are three years into the latest ten-year recovery plan and the arc bends ever downward.

No one who has spent more than twenty years fishing for striped bass can credibly argue that things are not as bad as they have been during that time. And for those of us with four or more decades of experience, the parallels to the collapse of the ‘80s are obvious.

What will it take for the ASMFC to find the courage to do the right thing and shut the fishery down for the sake of the future of striped bass? Pausing the commercial harvest and imposing a zero-bag limit for recreational anglers is the last, best hope for recovery.

If the Commission is serious about achieving its goals, a harvest moratorium needs to be a part of the debate.

Regards,
Michael Spinney
Townsend, MA

From:	shannon stafford
To:	Comments
Cc:	comments@stripersforever.org
Subject:	[External] Supplemental comments for meeting
Date:	Sunday, October 13, 2024 8:42:33 AM

It is important for the entire mid Atlantic fishery that we work together to save the striped bass. This is one of our most important species to preserve for our children and grandchildren and the most recent spawning results are extremely concerning. I am supportive of a harvest moratorium for as long as it takes to improve the conditions and future of striped bass. Please include these comments in the supplemental materials for the meeting on October 23rd.

Shannon Stafford
Resident of Virginia and Massachusetts

Sent from my iPhone

Carl Tiska
24 Van Zandt Ave
Newport RI 02840
carl.tiska@gmail.com

October 14, 2024

Emilie Franke
FMP Coordinator
1050 N. Highland St., Suite 200 A-N
Arlington, Virginia 22201

Dear Members of the Atlantic Striped Bass Board,

I am an avid recreational kayak angler based in Rhode Island, and principally focus on fishing to harvest for my family's personal consumption. In recent years, I have limited myself to harvesting only one striped bass each year, due to the condition of the stock.

I have read the draft letter from the American Saltwater Guide's Association and agree with their call to action to take significant measures to rebuild the striped bass stock. Specifically, I agree with their recommendations to make reductions across all sectors, to initiate no-harvest closures in 2025, to equalize the percentage of harvest reductions in each jurisdiction, and to curtail commercial fishing of striped bass in the Chesapeake Bay. I disagree however with their opposition to 'non-targeting closures,' which is why I did not sign on to their letter and am writing my own.

The argument against non-targeting closures is that they are difficult to enforce. While that is no doubt true, the Striped Bass Board should not use that as a reason to not consider non-targeting closures for the following reasons:

- In my own state of Rhode Island, the Department of Environmental Management is challenged at enforcing all fishing regulations due to the small number of DEM officers responsible for a broad range of activities, not just fisheries enforcement. Additionally, when DEM officers cite violators, Rhode Island judges typically dismiss the cases or impose minimum fines on the offenders since they do not consider violations of recreational fisheries regulations to be important. Consequently, all fisheries enforcement is difficult and while non-targeting closures would be more difficult, the board should establish management measures based on the goal of rebuilding the stock, not the level of difficulty of enforcement.
- The reason that existing fisheries regulations are generally effective is that most fishermen obey the law. If non-targeting closures are enacted, most fishermen will comply. Certainly, there would be some number of violators, but that is the case for all fisheries regulations. Additionally, guides would not be able to violate the closure without placing their business at risk, recreational anglers would hesitate to post photos of striped bass during non-targeting closure periods, and organizations that run striped bass tournaments would not be able to run those tournaments during the non-targeting periods.

Non-targeting closures would reduce catch-and-release mortality and achieve equitable reductions across both sectors of the recreational striped bass fishery, both harvest and catch-and-release.

Another action that I would recommend for the Atlantic Striped Bass Board to consider would be to prohibit striped bass tournaments. Some organizations, like the Rhode Island Saltwater Anglers

Association, no longer have a striped bass category in their annual fishing tournament. This is responsible and commendable, but unfortunately it is not universal. For instance, *On the Water* magazine runs a year long 'Striper Cup' which encourages anglers to catch the largest possible striped bass throughout the season, including the months when the water temperature is the warmest, which as is known, increases release mortality. Until the striped bass stock is rebuilt, the Board should prohibit striped bass tournaments.

Rebuilding the striped bass stock will be difficult. The Board will have to make difficult decisions, and different sectors will adamantly oppose each of those decisions. Please do not let that deter you from instituting the most conservative measures possible to rebuild the striped bass stock.

I thank you for your work in managing striped bass and for the opportunity to provide feedback through your public comment process.

Sincerely,

Carl Tiska

From: wandermann@nyc.rr.com
To: Comments
Cc: "comments@stripersforever.org"
Subject: [External] upcoming meeting
Date: Monday, October 14, 2024 11:06:20 AM

I am seventy six years old and have fished for striped bass for over 60 years. I have seen a measurable decline in the number and size of fish in the past three years in the Western end of Long Island Sound.The fishing was so poor this Spring that many of my fellow anglers and I stopped fishing. There were large schools of peanut bunker present this Spring -no fish. If the striped bass population is not protected by a moratorium on harvesting bass by both commercial and recreational fishermen, the future is bleak. Action is needed now.

Please include my comments in the supplemental materials

From: derek.j.williams
To: Comments
Cc: comments@stripersforever.org; derek.j.williams@gmail.com
Subject: [External] Striped Bass Comments
Date: Saturday, October 12, 2024 7:18:42 AM

Hello,
I support a full moratorium on harvest of all striped bass. In addition, i support advanced measures limiting the use of luve bait for catch and release, and limits on the number and type of hooks.
I have personally seen dozens of very large striped bass eaten by sharks while being fought and landed. I support measures to reduce predation.

Protection of menhaden and other forage species is critical.

Thank you,
Derek Williams

From:	Barry Woods
To:	Comments
Cc:	comments@stripersforever.org
Subject:	[External] Striped Bass Mismanagement Plan
Date:	Saturday, October 12, 2024 3:13:56 PM

Dear Directors of ASFMC-

We are in the 11th hour of striped bass management because you have failed to adequately follow the science and appreciate the risk of climate change and other variables associated with maintaining a diverse age class of brood stock. Five failed years of spawning in the Chesapeake have led and will lead this species to a point not seen since the 1970's.

I have seen only larger fish this past year and I know that the next generation of striped bass fisherman will have to learn to adapt to a vastly diminished fishery.

I urge you to take the strongest measure possible, for both recreational and commercial fishermen, and prevent further decline of this tremendous fish. I wish you had a better sense of the historical record and a better appreciation of the fishermen who find it to be a marvelous gamefish and one worth reserving beyond "maximum sustainable yield". Unfortunately MSY seems to lack an "S" in your management. But name calling is an insufficient response when action is called for. Please learn from the past five years and place a moratorium on this fish rather than increasingly arcane slot limits that have continued undue pressure on the 2015 class.

Thank you for the opportunity to comment.

Sincerely,
Barry Woods

From:	Robert Yacoub
To:	Comments
Subject:	[External] Urgent request for Striped bass moratorium
Date:	Saturday, October 12, 2024 10:07:23 PM

Dear Atlantic States Marine Fisheries Commission,

I am an avid striped bass angler. Over the past several years, I have witnessed a troubling decline in striped bass populations along the Atlantic coast, particularly in areas like Long Island. This iconic fishery is an integral part of our ecosystem and fishing culture, and it is in deep trouble.

Recent data on Young of the Year (YOY) recruitment and fishing mortality rates paints a clear and alarming picture. The 2023 Maryland YOY index was only 2.3, just above the levels that led to the 1985 moratorium. The Hudson River has recorded an even more concerning YOY index of 0.96, lower than the 1980s average. These low recruitment rates, coupled with current fishing mortality at 0.31, which is 50% higher than the ASMFC's target of 0.20, indicate the striped bass population is once again on the verge of collapse.

These same conditions caused the 1980s moratorium, but today the situation is worsened by climate change and habitat degradation. Half measures won't save this fishery. We need bold action now.

I urge the ASMFC to implement a 10-year moratorium on striped bass fishing to give this vital population the time it needs to recover. Please include my comments in the supplemental materials for your upcoming meeting.

Please include my comments in the supplemental materials for your upcoming meeting. I urge the ASMFC to act decisively and implement a 10-year moratorium to allow this critical species to fully and completely recover.

Thank you for your attention to this urgent issue.

Sincerely,
Robert Yacoub
Scarsdale, NY

Sent from my iPhone

October 15, 2024

Emilie Franke
Striped Bass FMP Coordinator
Atlantic States Marine Fisheries Commission
1050 N Highland Street, Suite 200
Arlington, VA 22201

RE: ASGA Comments for October 2024 Striped Bass Board Meeting, Rebuilding

Dear Ms. Franke and Striped Bass Board Members,

ASGA represents conservation-minded fishing guides, private anglers, and fishing businesses that believe in "Better Business through Conservation." Despite the difficulties ahead, ASGA remains focused on rebuilding the Atlantic striped bass stock by 2029.

After attending multiple Striped Bass Technical Committee and Stock Assessment Subcommittee meetings, we have deep concerns that no action will be taken at the October Annual Meeting. There is an extremely wide range of rebuilding options, from a 4% to almost 50% reduction. Both of which result in a "coin toss" 50% chance of rebuilding the stock. The one reliable constant of striped bass management is the Juvenile Abundance Index. Currently, the JAI paints a very bleak picture. Even if Maryland has a slightly better JAI in 2024, we still must contend with no less than 5 vacant year classes. Without clear direction from the SAS or TC, this lack of juvenile abundance should guide all Boards decisions.

ASGA strongly opposed the current slot because we knew it would decimate the 2015-year class, which was once the 8th-best on record. This slot resulted in a 39% and 17% increase in fishing mortality in 2022 and 2023, respectively. Because of this slot implementation, we face an almost impossible rebuilding task.

Prior to initiating the slot, ASGA submitted a letter signed by several thousand anglers, private business owners and industry brands expressing their commitment to resource-first management. During the subsequent Board meeting, not one word was mentioned about the conservation community's position. Instead, the ill-advised slot was approved, and the 2015-year class was severely damaged.

This lack of foresight with slot choice is a single example of a long list of catastrophic failures from this Board over the last twelve years. We appreciate the Commissioners who have fostered some conservation-focused actions in recent years. Unfortunately, it wasn't enough. This Board has failed a multi-billion-dollar industry just to benefit a vocal minority while minimizing the value of a healthy, abundant resource.

The evident lack of direction for the Board will open the door to "kick the can down the road" yet again. We will hear Board members say that we need more data or request to start an amendment process. The public empowered this Board to make hard decisions at this meeting without the time delay of formalized public comment. That decision exhibited an enormous amount of trust on our part. The only reason this Board would stall significant action is to buy time to exploit the 2018-year class, which is entering the slot, as was done with the 2011 and 2015-year classes.

Our community has communicated the science, educated the public, and vehemently supported striped bass conservation with integrity every step of the way. The striped bass conservation community expects the Board to move forward with equitable, enforceable, and science-based management options.

ASGA Input for Potential Management Options:

•Reductions must be equal across sectors. Commercial reductions must be made from harvest, not quota. Many jurisdictions have not hit their quota. Therefore, taking a reduction off the quota is only a reduction on paper. It does not result in less mortality and will not help recover striped bass.

•Direct statements on the record from the Law Enforcement Committee (LEC) consistently state that no targeting closures are entirely unenforceable. The LEC rated non-targeting closures the least enforceable of 27 guidelines and gave them a 1.87 out of 5 enforceability rating, making them utterly ineffective at reducing effort. Non-targeting closures are not equitable across the coastwide range of striped bass. Some states have much shorter seasons. Guides' businesses will also be unfairly impacted. Business has been hard enough for our members. Taking away more time on the water could end their businesses altogether.

•No harvest closures should be initiated for the 2025 season. Unlike no-targeting closures, these will have a measurable impact and are enforceable.

•Each jurisdiction should have the same percentage reduction applied to the harvest numbers for that jurisdiction. As we have seen in the past, a "coastwide" reduction would significantly impact states with shorter seasons. New Jersey cheated a reduction in the past by using this loophole. If this happens again, the Board will display its inability to learn from mistakes.

• Commercial fishing in the Chesapeake Bay and anchored gill net fisheries that intercept fecund striped bass entering their spawning estuaries must be curtailed. The striped bass commercial fishery in Maryland has not taken a reduction in over a decade while the Maryland recreational fishery has almost collapsed. It is illogical that approximately 80% of commercial landings come from Maryland while the estuary is experiencing 5 (potentially 6) years of spawning failure. This harvest, not quota, must be heavily reduced. The anchored gill net fisheries in Virginia and Delaware are no longer sustainable, considering the repeated spawning failures in both estuaries. Recreational effort has been grossly overestimated by NOAA. That means that commercial striped bass harvest is a much higher percentage of total harvest than previously estimated.

Some place blame on habitat loss and climate change. Especially if these aspects are the root cause of failed spawning, we must be more conservative and risk-averse in management. This Board doesn't manage climate change. This Board manages fishery regulations. The same conservation message holds if the root cause is overfishing for 21 of the last 24 years as documented in the data.

Striped bass are the most important recreational fishery on the Atlantic coast, supporting countless coastal communities, small businesses, and fishing brands. Beginning in 2012, the Striped Bass Management Board has made a litany of bad decisions and allowed bad actors to abuse the resource. We applaud the voices for conservation on the Board. The American Saltwater Guides Association will continue to support their efforts. This Board must recognize 5 years of failed spawns. Further damaging the resource and the economy through Board actions that look good only on paper is unacceptable to the striped bass conservation community.

The undersigned organizations, guides, fishing businesses, and conservation-minded recreational anglers who depend on a healthy striped bass stock deserve better. Striped bass deserve better. Over 1500 individuals and 200 businesses representing an economic impact of millions of dollars signed this letter in less than 5 days. If there is no action at the October Annual meeting, we will lose all faith in this body's ability to fulfill their obligation to rebuild this stock and manage striped bass effectively.

On behalf of striped bass,

Tony Friedrich
President & Policy Director
tony@saltwaterguidesassociation.org
(202)-744-5013

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

PATAGONIA

VAN STAAL

SIMMS FISHING

COSTA SUNGLASSES

HATCH OUTDOORS

FAR BANK

RIO FISHING PRODUCTS

OLD MAINE OUTFITTERS

SALTWATER EDGE

HOGY FISHING

SAGE RODS

HARDY FLY FISHING

REDINGTON

TEMPLE FORK OUTFITTERS

SIGHTLINES PROVISIONS

MARTHAS VINEYARD OUTFITTERS

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

REPYOURWATER	**WATER FIRST FISHING**	**BRYNNIE-B FISHING**	**ON THE FLY OUTFITTERS**
FLY FISHERMAN MAGAZINE	**SOLSTICE FLY FISHING**	**247 LURES**	**GUIDING FLOW TV**
SOUL FLY OUTFITTERS	**SUSQUEHANNA RIVER GUIDES**	**SYLVESTER OUTDOORS**	**SPRING TIDE MEDIA**
TAF SCHAEFER DESIGN	**ELDREDGE BROTHERS FLY SHOP**	**SALT OF THE EARTH SPORTFISHING**	**RISING TIDE ANGLERS**

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

RIPTIDE CHARTERS	JOE DIORIO GUIDE SERVICE	LIGHT LINES GUIDING	MOONDOG FISHING LLC
FLYWAY CHARTERS	BAREFOOT ADVENTURES	MOLDYCHUM	MARSH ON THE FLY
NO SLACK SPORTFISHNG	SIGLER GUIDE SERVICE	OUTCAST LURES	CHEEKY FISHING
BEN WHALLEY FISHING	REEL THERAPY FISHING CHARTERS	ROCK AND SAND CHARTERS	SCIENTIFIC ANGLERS

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

NORTH BAR MEDIA

WESTPORT FLY

LINE OF SIGHT

CROSS CURRENT INSURANCE

FLATWING

AHREX HOOKS

THE COASTAL SPORTSMAN

CUBALAYA OUTFITTERS

SURFCASTER'S JOURNAL

TIDEWATER CHARTERS

SALTY CAPE

ISLAND X LURES

MY FISHING CAPEC COD

FLYLORDS

KIKIHNET OUTDOORS

REGAL VISE

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

ANYCREEK

BAJIO SUNGLASSES

DISTRICT ANGLING

CONFLUENCE FISHING

YELLOW DOG COMMUNITY & CONSERVATION FOUNDATION

YELLOW DOG FLY FISHING

GET TIGHT SPORT FISHING

TIGHTLINED SLAM

HIGH ROLLER GUIDE SERVICE

COASTAL FLY ANGLER

REEL TALES MEDIA

SCHAEFER FLY FISHING

RIVER BAY OUTFITTERS

OXBOW BREWING

VEDAVOO

ALL POINTS FLY SHOP

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SOUTH SHORE FLY CASTERS	**BKLYN FLY**	**SWAGGER BAIT CO**	**FISHIONISTA**
STRIPED BASS HUNT	**NEAL AND BROWNLEE WORLDWIDE**	**WILD STEELHEAD COALITION**	**HMH FLY TYING**
AFTERHOURS CUSTOM PLUGS	**LARSON LURES**	**SALTY FLY CAPE COD**	**SEA DOG FISHING TEAM**
SKWALA	**HOUSE FLY**	**STROUDWATER FLY FISHING**	**AFUERA COFFEE CO**

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

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BRACKISH OUTFITTERS	**HESTER FLY & TACKLE CO**	**DEL MAR VACATION RENTALS**	**SIMMER DIM**
SCHULTZ OUTFITTERS	**REPYOURWILD**	**WINGO OUTDOORS**	**NORTH POINT BRANDS**
MAINE OUTDOORS	**FRIGUYS LUREWORKS**	**FISH BOSTON**	**ISLAND FLY**

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

CHOCKLETT FACTORY

ORIGIN OUTFITTERS

SAILOR'S SOUL

THE ANGLER FLEET

BIG BUCK BAITS

GOTONE

ADIPOSE BOATWORKS

DUPEAFISH

GREY DOG INSHORE FISHING

WANDERING ALBATROSS

AP FLY FISHING

3TAND

ZEEBAASS

ALPHONSE FISHING COMPANY

BROOKLYN URBAN ANGLERS ASSOCIATION

BUILT 2 CAST

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

DARK STAR SURFCASTING

HAYWARD FLY FISHING CO

JESSE'S TACKLE

HOWARD FILMS

MASS. STRIPED BASS ASSOCIATION

CAPT. TOMS CHARTERS

KRISTIN K CHARTERS

CATCH YA IN A BIT

NORTH ISLAND GUIDE SERVICE

BONEFISH MON CHARTERS

JENNY E CHARTERS

CURRENT ANGLER

EIDOLON SPORT FISHING

REEL THERAPY CHARTERS

THE IMPLICATION

KISMET OUTFITTERS

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

HOGAN BROWN FLY FISHING

RELENTLESS FLY FISHING

BAY FLY FISHING

BEARS DEN FLY FISHING

VINEYARD SOUND OUTFITTERS

ELEVATE YOUTH

CR DREAM

NORTH FLATS

KEEPER FISHING CHARTERS

JP BUCKTAILS

BROOKLYN FISHING CLUB

LIGHT BITE CHARTERS

LOON OUTDOORS

NAUITILUS FLY REELS

TOWEE BOATS

RED TOP SPORTING GOODS

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

TCO Fly Fishing	GOOSE HUMMOCK SHOPS	GUIDELINE	MAINE WAY OUTFITTERS
LITTLE RHODY CHARTERS	TIGHTLINED SLAM	LEAST COAST ANGLERS	MATT HERON FLY FISHING
CT FISH NERD	CATCHING SHADOWS	REEL DEAL CHARTERS	RS BEANERY
SKUNKED AGAIN	NEW ENGLAND FISHING COLLECTIVE	HOLDING THE LINE GUIDE SERVICE	EMERGER STRATEGIES

SUPPORTING BRANDS & BUSINESSES THAT RELY ON ABUNDANT FISHERIES:

CAPITAL DISTRICT FLY FISHERS

AMERICAN FLY FISHING TRADE ASSOCIATION

FINNS WEST

NEW YORK COALITION FOR RECREATIONAL FISHING

RAPPAHANNOCK ADVENTURES

BADFISH SUPPLY CO

ORTUS CHARTERS

FLY WATER TRAVEL

CAPE COD ON THE FLY

BIG FISH MOJO SPORTFISHING

THE COASTAL SPORTSMAN

NORTH ISLAND GUIDE SERVICE

LEDGE LORD BUCKTAILS

ON THE BITE CHARTERS

ROCK PEBBLE SAND FISHING

BADFISH FISHING CHARTERS

RECREATIONAL ANGLERS & INDIVIDUALS WHO SUPPORT THIS OFFICIAL ASGA LETTER:

Aaron Landry, Maine
Abram Pearson, Maine
Adam Smith, Massachusetts
Adam Clark, New Hampshire
Adam Eaton, Massachusetts
Adam Franceschini, South Carolina
Adam Holtz, New York
Adam Rojek, Rhode Island
Adam Sweet, Massachusetts
Adam Taylor, Massachusetts
Adam Wiles-Rosell, Maine
Adrian Asherman, Massachusetts
Aidan Mcdonnell, Connecticut
Aj Coots, Massachusetts
Al Frates, Massachusetts
Al Heath, Maine
Alan Battista, Maryland
Alan Berger, New York
Alan Gribble, Massachusetts
Alan Mackenzie, Connecticut
Alan Rosenfeld, New York
Albert Albano, New York
Albert Perrino, Connecticut
Alec Griswold, Massachusetts
Alex Blouin, Washington
Alex Brown, Rhode Island
Alex Capobianco, Connecticut
Alex Duda, Massachusetts
Alex Ford, New Jersey
Alex Ledoux, Rhode Island
Alex Mccrickard, Virginia
Alex Mccullough, Massachusetts
Alex Obregon, Maine
Alex Palfrey, Massachusetts
Alex Thurston, Massachusetts
Alexander Gangi, New York
Alexander Gust, Connecticut
Alexander Novak, Massachusetts
Alexandra Colby, Massachusetts
Alison Milam, New Hampshire
Allison Lacey, Maine
Allyn Janney, Virginia
Alyssa Hughes, Connecticut
Andrew Carothers, New York
Andrew Cheatham, New Jersey
Andrew Clingman, Colorado
Andrew Gray, Massachusetts
Andrew Kelly, Connecticut
Andrew Martineau, Massachusetts
Andrew Mauck, Massachusetts
Andrew Mayer, Maine
Andrew Murphy, Maine
Andrew Reichardt, New Hampshire
Andrew Romano, Illinois
Andrew Tenney, Massachusetts
Andrew Trostle, Maryland
Andy Jowett, New Hampshire
Andy Merrill, Connecticut
Angis Forsyth, Maine
Anthony Bernardi, New York
Anthony Durso, New York
Anthony Garcia, New York
Anthony Hancock, Maryland
Anthony Marchisotto, New York
Anthony Mastalski, Virginia
Anthony Pizzella, Maine
Anthony Rizzo, New Hampshire
Anthony Sergi, Maryland
Anthony Swentosky, Oregon
Anthony Vitti, New York
Antonio Centrella, Massachusetts
Aram Berberian, Connecticut
Arek Zenel-Walasek, New York
Ariel Gonzalez, Maryland
Art Kunisch, New Jersey
Arthur Boujoukos, Massachusetts
Arthur Brigida, Massachusetts
Arthur Howe, Maine
Ashton Leclerc, Maine
Atticus Fallon, New York

RECREATIONAL ANGLERS & INDIVIDUALS WHO SUPPORT THIS OFFICIAL ASGA LETTER:

Austin Cosler, Missouri
Austin Green, Maryland
Austin Hamler, New York
Austin Schofield, Massachusetts
Avery Deane, New Jersey
Avery Revere, Massachusetts
Bailey Musgrave, Texas
Barry Chadwick, Connecticut
Ben Ayala, New York
Ben Burdine, Connecticut
Ben Freeman, Maine
Ben Gardner, Maine
Ben Gowell, Maine
Ben Hung, Connecticut
Ben Maguire, Massachusetts
Ben Meadows, Alabama
Ben Scott, Massachusetts
Ben Tayloe, Pennsylvania
Benjamin Carlson, New York
Benjamin Gallahue, Maine
Benjamin Piggott, Massachusetts
Benjamin Smolin, Connecticut
Bennett Hight, Maine
Benny Blanco, Florida
Bernard Hamill, Florida
Beth Mccrickard, Maryland
Beverly W Landstreet, Rhode Island
Bill Benton, Delaware
Bill Benton, Pennsylvania
Bill Delizio, Connecticut
Bill Hansen, Maryland
Bill Hassan, Massachusetts
Bill Herlihy, New York
Bill Temme, New York
Billy Seneschal, Connecticut
Blaine Donner, Louisiana
Blair Krenitsky, Massachusetts
Blaise Jenner, Maine
Blane Chocklett, Virginia
Bob Burger, Connecticut
Bob Maindelle, Texas
Bob Mccarthy, Massachusetts
Bob Preble, New Hampshire
Bobby Moore, New York
Bobby Ramsdell, Tennessee
Boston Underwood, Virginia
Brad Curtin, Massachusetts
Brad Lambert, Massachusetts
Brad Test, Rhode Island
Braden Fleming, Massachusetts
Bradford Arone, Massachusetts
Braeden Cummings, Maine
Bran Dougherty-Johnson, New York
Brandon Angell, Maine
Brandon Stoner, Maryland
Brandon Weston, New York
Brendan Curley, Massachusetts
Brendan Holden, Massachusetts
Brendan Mackinson, Massachusetts
Brendan Murray, Massachusetts
Brendan Richards, Rhode Island
Brent Mcghee, Virginia
Bret Mcgowan, New York
Brett Clark, Tennessee
Brett Mccrae, Virginia
Brian Anderson, Maryland
Brian Bennett, Washington
Brian Cain, Virginia
Brian Christie, New York
Brian Cloutier, Massachusetts
Brian Connor, New York
Brian Coombs, Massachusetts
Brian Deery, Massachusetts
Brian Garnock, New York
Brian Hoover, Maryland
Brian Kelly, Connecticut
Brian Kendall, Connecticut
Brian Mcelligott, California
Brian Mulderrig, New York
Brian O’Connor, Rhode Island

RECREATIONAL ANGLERS & INDIVIDUALS WHO SUPPORT THIS OFFICIAL ASGA LETTER:

Brian Otoole, Massachusetts
Brian Potvin, Massachusetts
Brian Rooney, Rhode Island
Brian Roycroft, Massachusetts
Brian Sanders, New York
Brian Shumaker, Pennsylvania
Brian Sittlow, Rhode Island
Brian Walters, New Jersey
Brian Weber, Rhode Island
Brian Williams, New Jersey
Brighton Ernest, South Carolina
Brittany Kennedy, Connecticut
Brooks Patterson, Massachusetts
Bruce Bain, Rhode Island
Bruce Bartolomeo, Connecticut
Bruce Belfer, New Jersey
Bruce Brown, Connecticut
Bruce Martin, Massachusetts
Bryan Begley, Massachusetts
Bryan Draganosky, Pennsylvania
Bryan Kappenberg, New York
Bryan Rosa, Maine
Bryce Ingle, Rhode Island
Bryon Detwiler, New York
Bucky Burrows, Massachusetts
Caleb Green, Massachusetts
Caleb Simms, Massachusetts
Callan Noone, Connecticut
Cam St. Louis, Massachusetts
Camden Clark, Massachusetts
Camden Minotti, Maine
Camden Spear, Maine
Cameron Somerside, Massachusetts
Capt Jeff Kraynik, Florida
Capt Pete Scafaru, Louisiana
Capt Robert Smith, Virginia
Capt Tom Falco, New York
Capt. Ben Whalley, Maine
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BACKCOUNTRY
HUNTERS & ANGLERS

P.O. BOX 9257
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October 15, 2024

Via Email: comments@asmfc.org

Atlantic Striped Bass Management Board
Atlantic States Marine Fisheries Commission
1050 N. Highland Street, Suite 200 A-N
Arlington, VA 22201

Attn: Emilie Franke, Fishery Management Plan Coordinator, Striped Bass
CC: Megan Ware, Chair, ASMFC Striped Bass Management Board

Re: BHA Comments to ASMFC Atlantic Striped Bass Board – 2024 Annual Meeting

Dear ASMFC Staff and Members of the Management Board,

Backcountry Hunters & Anglers (BHA) seeks to ensure North America's outdoor heritage of hunting and fishing in a natural setting. As a component of this mission, BHA supports management policies that ensure abundant populations inhabit our public lands and waters and are accessible to the hunters and anglers who choose to pursue them.

While we recognize that this correspondence is not associated with a formal public input process, we respectfully submit these comments to make BHA's concerns and priorities known to the Striped Bass Management Board relative to topics that are on the agenda for consideration during ASMFC's 2024 Annual Meeting that have not previously gone out for public comment.

BHA's concerns and priorities can be summarized as follows, and we will expand upon each point in further detail below:

- BHA is concerned that new management triggers, including a management trigger related to sustained fishing mortality, continue to trip during rebuilding.
- BHA remains concerned about the age structure of the fishery, and how recruitment failures now will shape the future of the fishery beyond 2029.
- BHA urges the Board to take action at the 2024 Annual Meeting to further reduce fishing mortality and maximize the odds of successfully rebuilding female SSB to target by 2029.

New Management Triggers Tripped

In 2019, the Striped Bass Board's acceptance of the 2018 Benchmark Stock Assessment initiated a 10-year rebuilding timeline due to the stock being both overfished and experiencing overfishing. When the Board accepted an assessment update including data through the 2021 fishing season in November 2022 the Maryland JAI tripped an additional trigger, which resulted in the use of a low recruitment assumption for stock reference point calculations.

In their 2024 stock assessment update, the Technical Committee reports that all triggers that were tripped in 2022 remain so – the stock remains overfished, and the relative lack of spawning productivity that caused the Maryland JAI trigger to trip remains similar. Additionally, the New Jersey and Virginia JAI triggers have also tripped due to sub-average recruitment in their respective areas, and a new fishing mortality trigger has tripped because fishing mortality during the previous two fishing seasons has exceeded F target while SSB is below SSB target.

While BHA has previously expressed optimism and gratitude in public testimony relative to the Board's efforts to rebuild the stock by or before the 2029 deadline through an emergency action enacted it May 2023, and Addendum II enacted in January 2024, we cannot overstate our disappointment in the results of these efforts. While we recognize that the success of striped bass spawning relies almost exclusively on factors beyond the Board's control, enacting measures to manage fishing mortality is within the Board's reach. As a result, the fact that a new fishing mortality management trigger has tripped during a time when the Board's main objective should be curbing excess mortality while we wait for successful spawning to recur is extremely difficult to accept and calls the soundness of the Board's decision making and/or seriousness about recovering the striped bass fishery into question.

Age Structure & Recruitment

In prior correspondence BHA has raised concerns about recruitment failures in the Chesapeake Bay (Maryland) spawning area, and we re-iterate those concerns here. It is well understood that the tributaries of the Chesapeake Bay are collectively the most productive major spawning areas that contribute to the ocean striped bass fishery, and at this point the Maryland JAI has been sub-average for five consecutive years. More recently, the Virginia and New Jersey JAIs have also revealed failures to produce abundance in their respective areas. What this means, practically speaking, is that we *know* that in the future there will be voids in the age structure of the fishery. Given that female striped bass reach maturity around 7 years of age, these voids may not even begin impacting female SSB until around 2029, and assuming the fishery is recovered by the deadline, they will persist for years beyond recovery.

While BHA has been unequivocal in urging the Board to consider rebuilding by 2029 its top priority, we must also urge the Board at this point to also consider how the management changes it imposes now might impact the already-limited year classes that future spawning success and abundance will rely upon. Technically, recovery may only require that female SSB exceed SSB target by or before 2029, but successful management of the fishery also requires that the Board maintain *"an age structure that provides adequate spawning potential to sustain long-term abundance of striped bass populations"* (Amendment 7, 2.4 Objectives) beyond the deadline.

Board Action during 2024 Annual Meeting

In their proposed 2024 stock assessment update the Technical Committee describes the range of situations that the fishery might face in coming years as highly uncertain, with the necessary action required for SSB to exceed target by or before 2029 ranging from nothing at all to a reduction in fishing mortality of almost 50%. Their commentary further suggests that an increase in fishing mortality will likely occur if no change is enacted before the above-average 2018 year class enters the Addendum II slot in 2025.

The Board is unquestionably empowered to take action that further reduces fishing mortality at the 2024 Annual Meeting, should it choose to. When Addendum II was enacted, Section 3.3 - Response to Stock Assessment Updates modified the FMP such that the Board may change management options by approving a motion at a Board meeting "*if an upcoming stock assessment prior to the rebuilding deadline (currently 2029) indicates the stock is not projected to rebuild by 2029 with a probability greater than or equal to 50%",* which accurately describes all potential scenarios projected by the TC. When we commented on Addendum II, BHA and many others supported empowering the Board to take such action, with the expectation that if the scenario described in the option presented itself that the Board would follow through.

Up to this point the Board has generally been unwilling to enact measures that are predicted to have greater than 50% odds of success, quite literally giving the recovery of the striped bass the same odds as a coin toss. While this regime might be acceptable during periods of *normal* management, when the buffer between SSB target and SSB threshold is designed to account for natural fluctuations in abundance, during periods when the stock must be recovered within a timeline results thus far don't support this methodology as sufficient, or acceptable.

While we recognize that BHA is not positioned to propose specific measures for the Board's consideration, we urge the Board to take *some* action to further reduce fishing mortality immediately and increase the odds of successfully recovering the striped bass fishery by or before 2029. Further, we urge the Board to prioritize measures that are enforceable and quantifiable, and that proportionally affect the fishing mortality caused by all segments of the fishery represented in Section 1.3 of Amendment 7 to the Striped Bass FMP. If opportunities for public comments on specific management changes are provided during the Annual Meeting, we intend on making our position known relative to each proposal through verbal testimony during the meeting.

In conclusion, BHA urges the Striped Bass Board not only to take immediate action to further reduce fishing mortality and maximize the odds of recovering the fishery by or before the 2029 rebuilding deadline during the 2024 Annual Meeting, but we also urge consideration of the age structure within the fishery beyond the deadline when management decisions are made. These are the steps we feel are necessary to recover the striped bass fishery now, and to preserve the tradition of fishing for striped bass in the future.

Thank you for the opportunity to provide input, and for your consideration of our comments.

Sincerely,

Michael Woods
Saunderstown, RI
Chair, New England Chapter Board
Backcountry Hunters & Anglers

Christopher Borgatti
Newbury, MA
Eastern Policy & Conservation Manager
Backcountry Hunters & Anglers

Emilie Franke
FMP Coordinator

Atlantic States Marine Fisheries Commission
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Arlington, Virginia 22201
M: comments@asmfc.org

October 15, 2024

Stripers Forever Comments –
October 23, 2024 Atlantic Striped Bass Management Board Meeting

Writing on behalf of our leadership and thousands of members throughout the Atlantic seaboard, Stripers Forever submits an urgent plea to the Atlantic States Marine Fisheries Commission: initiate an equitable (commercial and recreational) coastwide harvest moratorium. Do it now. We are working on borrowed time.

In 2021 while Amendment 7 was debated we asked the Commission to consider implementing a ten-year harvest moratorium for both the commercial and recreational fisheries. That request was supported by the lessons of history, consistent with achieving the Commission's stated goals, and reflected the wishes of a plurality of the public who submitted their comments and spoke during the hearings.

We are now on the cusp of 2025 and the fishery has seen a steady decline, including five straight years of spawning failure. The spawning stock biomass continues to be depleted through commercial harvest and recreational removals and there are not enough young fish being recruited into the SSB to have a realistic chance to produce enough strong year classes to sustain the stock.

This situation, coupled with environmental changes, predation by invasive species, lack of forage in Chesapeake Bay, the presence of mycobacteriosis, legal gill nets and illegal ghost nets, and continued and increasing pressure and efficiency by recreational anglers, means the odds of achieving the ASMFC's goals of abundance and healthy age stratification within ten years are all but nil. In our view, incremental adjustments to the current plan will not make a difference in time to reverse the trend. What is needed is bold action befitting a dire crisis.

As we did in 2021, Stripers Forever is calling on the delegates to the ASMFC to find the courage to support a ten-year harvest moratorium. Other approaches have failed, and hope is not a plan. A harvest moratorium worked before and there is no reason to believe it will not work again. It will maximize the chances for the current SSB to reproduce in meaningful numbers and give the current year classes an opportunity to grow and mature.

A solution to the crisis is within grasp. We urge you to reach out and take it while there is still time.

T. Va

Taylor Vavra, President
Stripers Forever
taylor@stripersforever.org
(914) 522-9507

From:	Emilie Franke
To:	Emilie Franke
Subject:	FW: ASMFC - STRIPED BASS HEARING (10/23/10/24) - PLEASE DISTRIBUTE COMMENT TO ALL MEMBERS OF THE BOARD
Date:	Wednesday, October 16, 2024 11:34:31 AM

From: Rick Drew <rpdrew@hotmail.com>
Sent: Monday, October 14, 2024 12:51 PM
To: Comments <comments@asmfc.org>; Emilie Franke <EFranke@ASMFC.org>; Toni Kerns <TKerns@ASMFC.org>; Katie Drew <KDrew@ASMFC.org>
Subject: [External] ASMFC - STRIPED BASS HEARING (10/23/10/24) - PLEASE DISTRIBUTE COMMENT TO ALL MEMBERS OF THE BOARD

Dear ASMFC Chairman, Board Members, Scientists, Researchers, Et Al,

Our precious Striped Bass fishery is in peril. We have seen a precipitous decline in the Striped Bass breeder biomass over the past several years. This in conjunction with several years of poor spawning recruitment has us on the edge of a fishery collapse. We can no longer kick the can regarding stronger measures to protect and rebuild our iconic Striped Bass fishery.

The ASMFC as a board has a great responsibility to undertake its fiduciary responsibility to the public trust on this matter. To date the board has chosen to focus on a take and harvest based model of fisheries management and it has worked out very poorly. Generous quotas and size limits to the commercial fishery sector over the past couple of years when many experts were requesting protection of the 2015 class of fish has been disastrous. Continuing this practice in the absence of substantial spawning recruitment can only be interpreted as irresponsible and neglectful.

It is time for strong measures including quota reductions of take and partial seasonal closures encompassing all participants in the fishery, to ensure the remaining stocks are protected and rebuilt. My understanding is that this is the charter and responsibility of your board.

I have repeatedly commented on these hearings, encouraging standardized regulations up and down the Striper coast, including the commercial sector, which to date has gotten more generous take limits than other participants. Thus they have done more damage to the stronger classes of fish like 2015 as they can pursue them throughout much of their life cycle (26 inches to 38 inches in NY). It is extremely frustrating to provide such comments, backed by science and expert opinion going back almost 100 years, only to have it ignored and the end result be so negative.

Please respect and consider the science that should be guiding this process and do the right thing including quota reduction, standardized size limits for all participants and partial seasonal closures for all regions/states. I am available at any time to review my research and documentation some of which I attach for your review and archives.

Respectfully submitted,

Rick Drew
East Hampton, NY 11937
Cell: 631-903-0751

ATLANTIC STRIPED BASS CONSERVATION ACT

[Public Law 98–613, Approved Oct. 31, 1984, 98 Stat. 2187; 16 U.S.C. 1851 note]

[Amended through Public Law 109–479, Enacted January 12, 2007]

【Currency: This publication is a compilation of the text of Public Law 98–613. It was last amended by the public law listed in the As Amended Through note above and below at the bottom of each page of the pdf version and reflects current law through the date of the enactment of the public law listed at https://www.govinfo.gov/app/collection/comps/】

AN ACT To provide for the conservation and management of Atlantic striped bass, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Atlantic Striped Bass Conservation Act".

SEC. 2. 【16 U.S.C 5151】 FINDINGS AND PURPOSES.

(a) FINDINGS.—The Congress finds and declares the following:

(1) Atlantic striped bass are of historic commercial and recreational importance and economic benefit to the Atlantic coastal States and to the Nation.

(2) No single government entity has full management authority throughout the range of the Atlantic striped bass.

(3) The population of Atlantic striped bass—

(A) has been subject to large fluctuations due to natural causes, fishing pressure, environmental pollution, loss and alteration of habitat, inadequacy of fisheries conservation and management practices, and other causes; and

(B) risks potential depletion in the future without effective monitoring and conservation and management measures.

(4) It is in the national interest to implement effective procedures and measures to provide for effective interjurisdictional conservation and management of this species.

(b) PURPOSE.—It is therefore declared to be the purpose of the Congress in this Act to support and encourage the development, implementation, and enforcement of effective interstate action regarding the conservation and management of the Atlantic striped bass.

SEC. 3. [16 U.S.C 5152] DEFINITIONS.

As used in this Act—

(1) the term "Magnuson Act" means the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.).

(2) The term "Atlantic striped bass" means members of stocks or populations of the species Morone saxatilis, which ordinarily migrate seaward of the waters described in paragraph (3)(A)(i).

(3) The term "coastal waters" means—

(A) for each coastal State referred to in paragraph (4)(A)—

(i) all waters, whether salt or fresh, of the coastal State shoreward of the baseline from which the territorial sea of the United States is measured; and

(ii) the waters of the coastal State seaward from the baseline referred to in clause (i) to the inner boundary of the exclusive economic zone;

(B) for the District of Columbia, those waters within its jurisdiction; and

(C) for the Potomac River Fisheries Commission, those waters of the Potomac River within the boundaries established by the Potomac River Compact of 1958.

(4) The term "coastal State" means—

(A) Pennsylvania and each State of the United States bordering on the Atlantic Ocean north of the State of South Carolina;

(B) the District of Columbia; and

(C) the Potomac River Fisheries Commission established by the Potomac River Compact of 1958.

(5) The term "Commission" means the Atlantic States Marine Fisheries Commission established under the interstate compact consented to and approved by the Congress in Public Laws 77–539 and 81–721.

(6) The term "exclusive economic zone" has the meaning given such term in section 3(6) of the Magnuson Act (16 U.S.C. 1802(6)).

(7) The term "fishing" means—

(A) the catching, taking, or harvesting of Atlantic striped bass, except when incidental to harvesting that occurs in the course of commercial or recreational fish catching activities directed at a species other than Atlantic striped bass;

(B) the attempted catching, taking, or harvesting of Atlantic striped bass; and

(C) any operation at sea in support of, or in preparation for, any activity described in subparagraph (A) or (B).

The term does not include any scientific research authorized by the Federal Government or by any State government.

(8) The term "moratorium area" means the coastal waters with respect to which a declaration under section 5(a) applies.

(9) The term "moratorium period" means the period beginning on the day on which moratorium is declared under section 5(a) regarding a coastal State and ending on the day on which

the Commission notifies the Secretaries that that State has taken appropriate remedial action with respect to those matters that were the case of the moratorium being declared.

(10) The term "Plan" means a plan for managing Atlantic striped bass, or an amendment to such plan, that is prepared and adopted by the Commission.

(11) The term "Secretary" means the Secretary of Commerce or a designee of the Secretary of Commerce.

(12) The term "Secretaries" means the Secretary of Commerce and the Secretary of the Interior or their designees.

SEC. 4. [16 U.S.C 5153] MONITORING OF IMPLEMENTATION AND ENFORCEMENT BY COASTAL STATES.

(a) DETERMINATION.—During December of each fiscal year, and at any other time it deems necessary the Commission shall determine—

(1) whether each coastal State has adopted all regulatory measures necessary to fully implement the Plan in its coastal waters; and

(2) whether the enforcement of the Plan by each coastal State is satisfactory.

(b) SATISFACTORY STATE ENFORCEMENT.—For purposes of subsection (a)(2), enforcement by a coastal State shall not be considered satisfactory by the Commission if, in its view, the enforcement is being carried out in such a manner that the implementation of the Plan within the coastal waters of the State is being, or will likely be, substantially and adversely affected.

(c) NOTIFICATION OF SECRETARIES.—The Commission shall immediately notify the Secretaries of each negative determination made by it under subsection (a).

SEC. 5. [16 U.S.C 5154] MORATORIUM.

(a) SECRETARIAL ACTION AFTER NOTIFICATION.—Upon receiving notice from the Commission under section 4(c) of a negative determination regarding a coastal State, the Secretaries shall determine jointly, within 30 days, whether that coastal State is in compliance with the Plan and, if the State is not in compliance, the Secretaries shall declare jointly a moratorium on fishing for Atlantic striped bass within the coastal waters of that coastal State. In making such a determination, the Secretaries shall carefully consider and review the comments of the Commission and that coastal State in question.

(b) PROHIBITED ACTS DURING MORATORIUM.—During a moratorium period, it is unlawful for any person—

(1) to engage in fishing within the moratorium area;

(2) to land, or attempt to land, Atlantic striped bass that are caught, taken, or harvested in violation of paragraph (1);

(3) to land lawfully harvested Atlantic striped bass within the boundaries of a coastal State when a moratorium declared under subsection (a) applies to that State; or

(4) to fail to return to the water Atlantic striped bass to which the moratorium applies that are caught incidental to harvesting that occurs in the course of commercial or recreational fish catching activities, regardless of the physical condition of the striped bass when caught.

(c) CIVIL PENALTIES.—

(1) CIVIL PENALTY.—Any person who commits any act that is unlawful under subsection (b) shall be liable to the United States for a civil penalty as provided by section 308 of the Magnuson Act (16 U.S.C. 1858).

(2) CIVIL FORFEITURES.—

(A) IN GENERAL.—Any vessel (including its gear, equipment, appurtenances, stores, and cargo) used, and any fish (or the fair market value thereof) taken or retained, in any manner, in connection with, or as the result of, the commission of any act that is unlawful under subsection (b) shall be subject to forfeiture to the United States as provided in section 310 of the Magnuson Act (16 U.S.C. 1860).

(B) DISPOSAL OF FISH.—Any fish seized pursuant to this Act may be disposed of pursuant to the order of a court of competent jurisdiction, or, if perishable, in a manner prescribed in regulations.

(d) ENFORCEMENT.—A person authorized by the Secretaries or the Secretary of the department in which the Coast Guard is operating may take any action to enforce a moratorium declared under subsection (a) that an officer authorized by the Secretary under section 311(b) of the Magnuson Act (16 U.S.C. 1861(b)) may take to enforce that Act (16 U.S.C. 1801 et seq.). The Secretaries may, by agreement, on a reimbursable basis or otherwise, utilize the personnel, services, equipment (including aircraft and vessels), and facilities of any other Federal department or agency and of any agency of a State in carrying out that enforcement.

(e) REGULATIONS.—The Secretaries may issue regulations to implement this section.

SEC. 6. [16 U.S.C 5155] CONTINUING STUDIES OF STRIPED BASS POPULATIONS.

(a) IN GENERAL.—For the purposes of carrying out this Act, the Secretaries shall conduct continuing, comprehensive studies of Atlantic striped bass stocks. These studies shall include, but shall not be limited to, the following:

(1) Annual stock assessments, using fishery-dependent and fishery-independent data, for the purposes of extending the long-term population record generated by the annual striped bass study conducted by the Secretaries before 1994 and understanding the population dynamics of Atlantic striped bass.

(2) Investigations of the causes of fluctuations in Atlantic striped bass populations.

(3) Investigations of the effects of water quality, land use, and other environmental factors on the recruitment, spawning potential, mortality, and abundance of Atlantic striped bass populations, including the Delaware River population.

(4) Investigations of—

(A) the interactions between Atlantic striped bass and other fish, including bluefish, menhaden, mackerel, and other forage fish or possible competitors, stock assessments of these species, to the extent appropriate; and

(B) the effects of interspecies predation and competition on the recruitment, spawning potential mortality, and abundance of Atlantic striped bass.

(b) SOCIO-ECONOMIC STUDY.—The Secretaries, in consultation with with[1] the Atlantic States Marine Fisheries Commission, shall conduct a study of the socio-economic benefits of the Atlantic striped bass resource. The Secretaries shall issue a report to the Congress concerning the findings of this study no later than September 30, 1998.

(c) REPORTS.—The Secretaries shall make biennial reports to the Congress and to the Commission concerning the progress and findings of studies conducted under subsection (a) and shall make those reports public. Such reports shall, to the extent appropriate, contain recommendations of actions which could be taken to encourage the sustainable management of Atlantic striped bass.

SEC. 7. [16 U.S.C 5156] AUTHORIZATION OF APPROPRIATIONS; COOPERATIVE AGREEMENTS.

(a) AUTHORIZATION.—For each of fiscal years 2007, 2008, 2009, 2010, 2011, there are authorized to be appropriated to carry out this Act—

(1) $1,000,000 to the Secretary of Commerce; and

(2) $250,000 to the Secretary of the Interior.

(b) COOPERATIVE AGREEMENTS.—The Secretaries may enter into cooperative agreements with the Atlantic States Marine Fisheries Commission or with States, for the purpose of using amounts appropriated pursuant to this section to provide financial assistance for carrying out the purposes of this Act.

SEC. 8. [16 U.S.C 5157] PUBLIC PARTICIPATION IN PREPARATION OF MANAGEMENT PLANS AND AMENDMENTS.

(a) STANDARDS AND PROCEDURES.—In order to ensure the opportunity for public participation in the preparation of management plans and amendments to management plans for Atlantic striped bass, the Commission shall prepare such plans and amendments in accordance with the standards and procedures established under section 805(a)(2) of the Atlantic Coastal Fisheries Cooperative Management Act.

(b) APPLICATION.—Subsection (a) shall apply to management plans and amendments adopted by the Commission after the 6-month period beginning on the date of enactment of the Atlantic Striped Bass Conservation Act Amendments of 1997.

SEC. 9. [16 U.S.C 5158] PROTECTION OF STRIPED BASS IN THE EXCLUSIVE ECONOMIC ZONE.

(a) REGULATION OF FISHING IN EXCLUSIVE ECONOMIC ZONE.—The Secretary shall promulgate regulations governing fishing for Atlantic striped bass in the exclusive economic zone that the Secretary determines—

(1) are consistent with the national standards set forth in section 301 of the Magnuson Act (16 U.S.C. 1851);

(2) are compatible with the Plan and each Federal moratorium in effect on fishing for Atlantic striped bass within the coastal waters of a coastal State;

[1] So in law.

(3) ensure the effectiveness of State regulations on fishing for Atlantic striped bass within the coastal waters of a coastal State; and

(4) are sufficient to assure the long-term conservation of Atlantic striped bass populations.

(b) CONSULTATION; PERIODIC REVIEW OF REGULATIONS.—In preparing regulations under subsection (a), the Secretary shall consult with the Atlantic States Marine Fisheries Commission, the appropriate Regional Fishery Management Councils, and each affected Federal, State, and local government entity. The Secretary shall periodically review regulations promulgated under subsection (a), and if necessary to ensure their continued consistency with the requirements of subsection (a), shall amend those regulations.

(c) APPLICABILITY OF MAGNUSON ACT PROVISIONS.—The provisions of sections 307, 308, 309, 310, and 311 of the Magnuson Act (16 U.S.C. 1857, 1858, 1859, 1860, and 1861) regarding prohibited acts, civil penalties, criminal offenses, civil forfeitures, and enforcement shall apply with respect to regulations and any plan issued under subsection (a) of this section as if such regulations or plan were issued under the Magnuson Act.

The Economic Contributions of Recreational and Commercial Striped Bass Fishing

Produced for:

The McGraw Center for Conservation Leadership

SOUTHWICK ASSOCIATES

Revised April 12, 2019

PO Box 6435 ■ Fernandina Beach, FL 32035 ■ Office (904) 277-9765

This report updates a previous version dated January, 2018 and is based on updated, revised data sources plus correction of a calculation error detected in the original version.

Executive Summary

In 2016, an estimated 43.7 million pounds of striped bass were landed along the Atlantic coast. Commercial landings accounted for 10% of all landings and recreational anglers took the remaining 90% of the total. Including all economic activity associated with the commercial fishery (harvesting, processing, wholesale and retail), commercial landings produced less than 3% of the total economic contributions from all striped bass harvested by commercial and recreational fishing. Spending by recreational anglers accounted for more than 97% of the total economic contributions associated with striped bass fishing.

Efficient allocations of fisheries resources are best achieved by comparing the economic value associated with recreational and commercial fishing.[1] Therefore, it is beyond the scope of this study to estimate the marginal increases in fishing activity that might arise from a reallocation of striped bass between the commercial and recreational fisheries[2]. Also, it is an inappropriate to use economic impact data and static harvest data as presented within this report to set bag limits and seasons. There are more appropriate ways to do so. This report is intended to demonstrate the economic significance of striped bass to coastal economies based on the current management structure, size of the fishery and current economic conditions.

This report presents the jobs, sales, tax revenues and other economic contributions for each Atlantic coast state from Maine to North Carolina. Two years were examined: the most recent year for which data are available (2016), plus an additional year representing a peak year over the past ten years (2009) to help readers understand the economic range associated with the striper fishery.

The study was conducted using publicly available data from NOAA and using NOAA-based economic impact models. The recreational contributions are based on the trip and equipment expenditures made by anglers that can reasonably be attributed to striped bass fishing. The commercial contributions include the harvesting, processing, wholesale and retail industries involved in moving striped bass from the sea to the final consumer. Imported fish are excluded from the commercial analysis.

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[1] Economic value reflects the net economic benefit derived from a good or service and is typically measured as the amount that people are willing to pay beyond the market price. For consumers, this is typically referred to as consumer surplus. Presently, NOAA Fisheries is preparing a report on economic values associated with recreational striped bass fishing. We refer readers to that forthcoming report and encourage the development of comparable economic value data for the commercial striped bass fishery to permit adequate comparisons.

[2] Descriptions of striped management practices including commercial quotas and recreational bag and size limits are available from Atlantic States Marine Fisheries Commission, http://www.asmfc.org/species/atlantic-striped-bass. This study does not estimate the extent to which recreational restrictions are limiting angling activity.

In 2016, recreational anglers landed 90% percent of all striped bass harvested that year and supported 98% or more of the total jobs, income and GDP associated with striped bass (Table E1). The commercial fisheries are significant, with the harvesting, processing and trade sectors associated with commercial landings generating over a hundred million dollars in new economic activity and thousands of jobs.

Table E1. 2016 Comparison of commercial and recreational impacts: North Carolina to Maine

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	4,978.3	43,731.9	48,710.2	10%	90%	100%
Jobs supported	2,664	104,867	107,531	2%	98%	100%
Income ($millions)	$72.7	$4,726.0	$4,799	2%	98%	100%
GDP ($millions)	$103.2	$7,731.6	$7,835	1%	99%	100%

Table E2 provides an overview of the economic impacts, both from commercial harvests and recreational spending, of striped bass fishing for each of the states in the study. While striped bass are fished all along this part of the east coast, commercial harvests are not landed in all states.

Table E2. Comparison of commercial and recreational impacts: North Carolina to Maine, 2016.

State	Landings (000 lbs.)		GDP ($millions)		Jobs Supported		Salaries and Wages ($millions)	
	Rec.	Comm.	Rec.	Comm.	Rec.	Comm.	Rec.	Comm.
CT	912.2	0.0	$375.1	$0.0	4,418	0	$235.8	$0.0
DE	86.1	136.5	$59.1	$0.8	732	19	$36.1	$0.5
ME	189.4	0.0	$183.1	$0.0	3,110	0	$114.6	$0.0
MD	10,919.1	1,709.4	$802.8	$17.1	10,193	584	$496.9	$12.6
MA	3,730.6	938.2	$1,675.8	$8.0	20,715	383	$1,190.4	$5.9
NH	190.9	0.0	$116.3	$0.0	1,630	0	$83.0	$0.0
NJ	12,790.3	0.0	$1,609.1	$0.0	18,624	0	$1,031.2	$0.0
NY	12,052.9	539.7	$1,165.0	$4.0	13,810	161	$754.8	$2.9
NC	60.4	146.2	$136.6	$0.8	1,953	28	$85.1	$0.6
RI	1,775.6	174.7	$241.1	$1.1	3,410	42	$155.3	$1.0
VA	1,024.4	1,333.6	$106.6	$12.2	1,444	384	$67.6	$9.0

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Introduction

Recreational and commercial fishing can be a powerful contributor to coastal economies. Scientifically sound economic information is needed to understand and communicate the contributions of fisheries to local, state, and national leaders. This project measures the jobs, sales, tax revenues and other economic contributions generated by commercial and recreational marine striped bass fishing for each Atlantic coast state from Maine to North Carolina. Two years were examined: the most recent year for which data are available (2016), plus an additional year representing a peak year over the past ten years (2009) to help readers understand the economic potential from the striper fishery.

Historically, Atlantic striped bass has been a significant species for both commercial fishermen and recreational anglers, providing significant benefit to coastal economies. Changes to striped bass allocations between the commercial and recreational sectors can affect coastal and state economies. For both recreational and commercial striped bass fisheries, this study presents several important economic impact measures: retail sales, total economic (multiplier) effect, salaries and wages, jobs and contributions to GDP using standard recreational and commercial economic modeling techniques and existing NOAA Fisheries participation, landings and spending data. The goal was to quantify the retail sales, jobs, and overall economic activity resulting from current allocations of striped bass and present an idea of potential changes in economic impacts if stripers were designated as gamefish.

Please note that fisheries are allocated on the basis of “economic value” associated with recreational and commercial fisheries, not economic impact. Economic valuation measures the consumer surplus, or net intrinsic value, held by anglers after all expenses, time, hassles and satisfactions are considered. For commercial fishermen, their economic value is represented by producers’ surplus, or essentially their net profits, after all expenses are considered. Measuring these values can be costly and time consuming. At the time of this study, NOAA Fisheries was preparing a report on economic values associated with recreational striped bass fishing. We refer readers to this report and encourage development of value data for the commercial striped bass fishery to permit adequate comparisons.

Methodology

Region of Study

The figure below displays the states that are considered in this study. Any striped bass fishing in other states is too insignificant to measure. The states considered are: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, and Virginia.

Data Sources

Recreational striped bass effort data were obtained directly from NOAA Fisheries' Marine Recreational Information Program (MRIP). MRIP provides striped bass participation and effort data for each Atlantic coastal state from Maine to North Carolina. Spending data were obtained through NOAA's annual *Fisheries Economics of the United States* (FEUS) reports. The most recent FEUS report available provided data for 2016 including durable goods spending, trip spending, and commercial economic impact data for each state. Commercial striped bass landings data were obtained through NOAA National Marine Fisheries Service (NMFS) online commercial fisheries statistics queries. The economic modeling software IMPLAN was used to estimate the economic impacts of the recreational and commercial activities. NOAA's *The Economic Impact of Marine Angling Expenditures, 2011* was used to apportion trip spending across various spending categories while NOAA's *The Economic Contribution of Marine Angler Expenditures on Durable Goods in the United States, 2014* was used to apportion durable goods expenditures. Average spending per recreational fishing trip were inflated to 2016 dollars using the US Bureau of Labor Statistics' Consumer Price Index.

Definitions and Analysis

Definitions

Participation: Participation estimates include the number of trips taken by anglers. These estimations are drawn from MRIP and FEUS and include trips for any species as well as striped bass-specific trips. When examining the importance of striped bass trips, it is useful to compare striped bass trips as a percentage of all trips to determine its importance versus other species.

Trip Expenses: Trip expenses are defined as the spending made by an angler to directly support a fishing trip. The spending categories that make up trip expenditures are outlined in the findings section of the report. Trip spending specific to striped bass is not available from existing sources. Instead, average spending per trip for all types of marine recreational fishing was calculated. This average expenditure is then multiplied by the number of targeted striped bass trips. With the assumption that spending for striper trips are similar to the amounts spent in pursuit of other coastal species, the result is the total spending for striped bass trips.

Durable Goods: Durable goods expenditures are calculated in a manner which is similar to that which is used for trip expenditures. Though durable goods expenditures are not dedicated to any specific trip, they are used across many fishing trips. Examples of durable goods are boats, storage, tackle such as rods and reels, and other longer-term angling investments. These goods deteriorate with each trip and are eventually lost, upgraded, or otherwise replaced. We assume the deterioration and use of durable goods occurs at equal rates among different types of fishing trips, regardless of species targeted. With this assumption, and without data to show otherwise, we are able to estimate the average durable goods expenditure per fishing trip for all types of fishing. This average is then applied to the number of striped bass trips to estimate the amount of durable goods spending per year that can be attributed to striped bass fishing.

Commercial Landings Revenue: Commercial revenue is defined as the direct estimated revenue earned from the sale of striped bass by commercial vessels. The harvest of striped bass is estimated through commercial landings measured in pounds and multiplied by the average wholesale landed price per pound for the sale of that fish. The commercial landings revenue does not include the additional revenues generated as striped bass move from harvesters to processors, distributors, retail and restaurants. However, the additional economic impacts associated with moving the harvested fish through the entire value chain (i.e., the processors, distributors, retailers) to the final consumer is included in the estimated impacts of the commercial fishery. These data were obtained through the Commercial Fisheries Statistics provided by NOAA NMFS.

Compiling Expenditure and Revenue Estimates

Estimates of total spending by recreational striped bass anglers were calculated by matching striped bass effort with the average spent per trip and annually for durable goods, per the data sources described earlier. This was done for each state plus for the whole region. These aggregated spending categories were then apportioned across various detailed spending categories (tackle categories, boat-related, grocery stores, fuel, hotel, etc.) per details from NOAA's *The Economic Impact of Marine Angling Expenditures, 2011* for trip expenditures and NOAA's *The Economic Contribution of Marine Angler Expenditures on Durable Goods in the United States, 2014* for durable goods expenditures. These reports breakout anglers' spending into detailed categories. These spending profiles were then assessed using economic modeling software as described in the next section.

For commercial harvest, or landings, revenues, spending breakouts were not needed as the revenues received by commercial fishermen were applied to NOAA's economic models. The growth in value of striped bass products as raw fish moves through the wholesale distribution, processing and retail stages is added by the economic modeling process, as described in the next section.

Economic Modeling

Recreational Impacts

Input-output models describe how sales in one industry affect other industries. For example, once a consumer makes a purchase, the retailer buys more merchandise from wholesalers, who buy more from manufacturers, who, in turn, purchase new inputs and supplies. In addition, the salaries and wages paid by these businesses stimulate more economic activity as workers spend their incomes (in this case the portion of their incomes directly or indirectly associated to the striped-bass fishery). Simply, the first purchase creates numerous rounds of purchasing. Input-output analysis tracks the flow of dollars from the consumer through all businesses that are affected, either directly or indirectly.

Dollars spent by anglers or others, known as their "direct spending", cycle through the economy generating additional rounds of spending by businesses who provide supporting services and goods. This is known as the multiplier effect and includes 1) indirect contributions arising from spending by businesses supporting those who serve anglers as well as 2) induced contributions generated by employees of directly or indirectly affected businesses. The total economic contribution from striped bass angling as provided in this report is a sum of the direct effects of anglers' retail spending plus the measurable effects of indirect and induced spending. All economic contributions in this study were estimated using the latest state-level modeling data available from Implan© (2016) with inflation adjustments to reflect 2016 spending. Five types of economic activity are measured and reported:

Jobs: The number of full- and part-time jobs created or supported as a result of striped bass fishing;

Salaries and wages: Total payroll, including salaries, wages and benefits paid to employees and business owners;

GDP: This represents the total contribution (or "value-added") to the state or national economy from striped bass fishing;

Total multiplier effect: The total value of all economic output by businesses throughout the economy under study associated with striped bass fishing; and

Tax Revenue: All local, state, and federal taxes generated as a result of the economic activity associated with striped bass fishing.

To apply striped bass spending to the IMPLAN model, each specific expenditure was matched to the appropriate industry sector that received the initial purchase. For each set of state estimates, the results report economic impacts that occurred *within* the state. Likewise, models based on specific regions represent the economic effects within the selected region. The results do not include any economic activity or indirect contributions that leak out of a given state, of which a portion is captured in regional or national models. As a result of this leakage, economic contributions at the regional level are typically larger than the sum of corresponding state contributions.

The IMPLAN model estimates local, state and federal tax revenues based on the economic activity within each state associated with striped bass fishing. The summary estimates provided in this report represent the total taxes estimated by the IMPLAN model including all income, sales, property and other taxes and fees that accrue to the various local, state and federal taxing authorities.

Commercial Impacts

The same economic impact measures defined in the recreational impacts discussion above are also used to report contributions generated by the commercial sector. Economic impacts are reported for 2009 and 2016 to help show the change between time periods and to compare with the recreational fishing impacts.

The 2009 impacts were generated using an online economic modeling tool available from NOAA National Marine Fisheries Service[3]. This model, built using the IMPLAN modeling system that was also employed for the recreational impacts, allows the generation of economic impacts for seafood in general and not for striped bass landings, specifically. The assumption is made that the multiplier effects, or the ratio of impacts created per pound of product, is equivalent to the multiplier effects for all seafood, finfish and shellfish. To the extent that this approach under- or over-estimates the impacts unique to striped bass, the results reported here are similarly affected. The value of striped bass landings for each state and for the whole region were applied to the multiplier in this tool to generate the impacts reported here.

Updated models for 2015 and 2016 were not available online. To generate the 2016 estimates, we referred to the 2015 *Fisheries Economics of the United States* (FEUS) report from which we calculated ratios for the commercially landed harvest of all species combined. Effects from imported fish were excluded. We anticipate the modeling procedures to be comparable to the online tool also provided by NOAA, thus providing results comparable to the 2009 impact estimates.

[3] Interactive Fisheries Economic Impacts Tool: https://www.st.nmfs.noaa.gov/apex/f?p=160:7:8141721484680330

Participation and Harvest Overview

Striped Bass Fishing Overview

Total recreational trips, landings and spending across all states included in this study are summarized below, along with the revenue from commercial striped bass landings for both study years (2009 and 2016), plus all intermediate years to demonstrate trends over the past decade. The number of fish harvested includes both primary and secondary catch.

Table O-1. Striped bass recreational trips, harvest, and spending, and commercial landing values from 2009 to 2016 ($000s)

	2009	2010	2011	2012
Recreational:				
Trips	27,606,806	28,695,871	25,092,446	24,345,610
Fish harvested (#)	4,726,323	5,430,256	5,047,491	4,070,414
Spending ($millions)	$ 5,740.6	$ 5,909.9	$ 5,360.2	$ 5,545.9
Commercial Revenues ($millions)	$15.9	$15.2	$15.8	$19.5

Table O-1. Continued

	2013	2014	2015	2016
Recreational:				
Trips	24,761,679	22,547,797	21,122,399	20,873,364
Fish harvested (#)	5,217,041	4,054,830	3,128,861	3,521,196
Spending ($millions)	$ 5,448.3	$ 6,946.7	$ 6,608.6	$6,277.4
Commercial Revenues ($millions)	$24.2	$22.6	$18.0	$19.8

The number of annual striped bass trips has declined almost every year since 2010. The year with the fewest recreational trips was 2016, with just over 20.8 million trips. The peak year for commercial landings was 2013. The range of years is provided to help show the maximum potential from each fishery.

Findings

Organization of Findings

Findings are first presented for all examined states, combined, followed by details for each state. Results are provided for two years: 2016, which is the most recent year when data were available, and for 2009, when recreational participation was at a high point, showing the potential from a fishery managed for greater recreational participation.

Regional Results (North Carolina to Maine)

Recreational Participation

Millions of anglers pursue striped bass from North Carolina to Maine each year. With over 27.6 million and 20.9 million directed trips in 2009 and 2016, striped bass was a popular species accounting for nearly 30% of all trips in the region.

Table R-1. Total anglers and angler trips for all states in the study

	2009	2016	% Change
Total Anglers*	8,114,932	7,535,650	-7%
Total Fishing Trips	94,740,885	86,999,562	-8%
Striped Bass Trips	27,606,806	20,873,364	-24%
Bass Trips % of total	29%	24%	

**Total anglers is the sum of anglers across all states in the region. The number of unique anglers in the region is unknown because anglers may fish in more than one state.*

Spending & Revenues

Total regional landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table R-2. Landings, Spending and Revenues Associated with Recreational and Commercial Striped Bass Fishing: North Carolina to Maine

	2009	2016	% Change
Commercial Landings (000 lbs)	7,531.8	4,978.3	-33%
Commercial Revenue ($millions)	$15.9	$19.8	25%
Recreational Landings (000 lbs)	54,491.0	43,731.9	-20%
Recreational Spending ($millions)	$5,740.6	$6,277.4	9%
Trip Spending ($millions)	$1,440.1	$1,005.3	
Durable Goods ($millions)	$4,300.5	$5,272.1	

Recreational Impacts

The weight of striped bass landed by recreational anglers declined 20% between 2009 and 2016 while the spending by anglers increased 9% (Table R-2). Including the multiplier effects of angler spending, Table R-4 shows that the recreational fishery supported 104,867 jobs in 2016 that provided $4.7 billion of income. Across the economy, the recreational fishery created $13.0 billion of economic activity and contributed $7.7 billion to the region's GDP.

From 2009 to 2016, despite a 24% reduction in recreational striped bass fishing trips, the number of jobs supported by striped bass stayed steady (Tables R-3 & R-4).

Table R-3. 2009 Recreational Striped Bass Fishing Economic Impacts: North Carolina to Maine ($millions)

	Jobs	Salaries and Wages	GDP	Total Output	State/Local Taxes	Federal Taxes
Direct Effect	54,561	$2,156.7	$3,333.2	$4,870.1	$472.4	$520.7
Multiplier Effect	51,291	$3,155.9	$5,287.7	$9,579.7	$501.6	$782.5
Total	105,852	$5,312.6	$8,620.9	$14,449.8	$974.0	$1,303.3

Table R-4. 2016 Recreational Striped Bass Fishing Economic Impacts: North Carolina to Maine ($millions)

	Jobs	Salaries and Wages	GDP	Total Output	State/Local Taxes	Federal Taxes
Direct Effect	55,190	$2,467.7	$3,735.1	$5,246.7	$544.2	$590.7
Multiplier Effect	49,677	$2,258.3	$3,996.4	$7,732.6	$319.4	$571.0
Total	104,867	$4,726.0	$7,731.6	$12,979.3	$863.6	$1,161.7

Commercial Impacts

The weight of striped bass landed by commercial harvesters declined 34% between 2009 and 2016 while the value of the commercial landings increased 25% (Table R2). Including the multiplier effects of all industries involved in harvesting, processing, distributing and retailing striped bass to consumers, Table R-6 shows that commercially harvested striped bass supported 2,664 jobs in 2016 that provided $58.7 million of income. Across the economy, the commercial fishery created $198.8 million of economic activity and contributed $10.2 million to the region's GDP.

Table R-5. 2009 Commercial Striped Bass Economic Impacts: North Carolina to Maine ($millions)

	Jobs	Salaries and Wages	GDP	Total Output
Commercial Impacts 2009	**2,388**	**$58.7**	**$83.2**	**$160.4**
Harvesters 2009	562	$14.3	$22.2	$43.0
Processors 2009	182	$7.9	$11.0	$25.2
Wholesalers 2009	85	$3.8	$5.5	$11.6
Retailers 2009	1,559	$32.7	$44.5	$80.6

Table R-6. 2016 Commercial Striped Bass Economic Impacts: North Carolina to Maine ($millions)

	Jobs	Salaries and Wages	GDP	Total Output
Commercial Impacts 2016	**2,664**	**$72.7**	**$103.2**	**$198.8**
Harvesters 2016	628	$17.7	$27.5	$53.2
Processors 2016	203	$9.8	$13.7	$31.2
Wholesalers 2016	94	$4.7	$6.8	$14.4
Retailers 2016	1,739	$40.5	$55.2	$99.9

Comparisons Between the Fisheries

Table R-7. 2016 Comparison of commercial and recreational impacts: North Carolina to Maine

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	4,978.3	43,731.9	48,710.2	10%	90%	100%
Jobs supported	2,664	104,867	107,531	2%	98%	100%
Income ($millions)	$72.7	4,726.0	$4,726.1	< 1%	>99%	100%
GDP ($millions)	$103.2	7,731.6	$7,731.7	< 1%	>99%	100%

Connecticut

Participation

In 2009 and 2016, over 384,000 and 531,000 anglers fished in Connecticut, respectively. In each year, the average angler participated in between 6 and 12 fishing trips, of which a large portion was striped bass trips. Compared to all trips, fewer were targeted toward striped bass in 2016 when compared to 2009.

Table CT-1. Total anglers and angler trips in Connecticut

	2009	2016
Total Anglers	531,341	384,749
Total Trips	3,387,779	4,229,759
Striped Bass Trips	1,367,678	1,609,841
Bass Trips % of total	40%	38%

Table CT-2. Trip breakouts by type in Connecticut

	2009	2016
For-Hire	9%	14%
Private	70%	68%
Shore	21%	18%
Total	100%	100%

Spending & Revenues

All stripers landed within the state are caught recreationally, as Connecticut does not have a commercial striped bass fishery. Durable goods spending in Connecticut amounted to $726 million in 2009 and $331 million in 2016. Trip spending in 2009 amounted to about 5% of durable goods spending, while in 2016 trip spending amounted closer to 12% of durable good spending. These spending differences may be attributed to the different types of trips taken by anglers in 2016 when compared to 2009.

Table CT-3. Landings, Spending and Revenues Associated with Recreational and Commercial Striped Bass Fishing in Connecticut

	2009	2016
Commercial Landings (lbs)	n/a	n/a
Commercial Revenue	n/a	n/a
Recreational Landings (lbs)	1,458,023	912,159
Recreational Spending ($000s)	$760,006.3	$371,940.0
Trip Spending ($000s)	$33,995.9	$40,953.2
Durable Goods ($000s)	$726,010.3	$330,986.8

Recreational Impacts

In 2016, $375.1 million was added to the gross domestic product of Connecticut, compared to over $797.0 million in 2009. Over 4,418 jobs were supported in 2016 with 10,412 supported in 2009.

Table CT-4. 2009 Economic impacts from spending related to recreational striped bass angling in Connecticut

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	7,339	$319,391.2	$489,196.1	$624,638.9	$78,306.7	$84,477.9
Multiplier Effect	3,073	$175,657.6	$307,778.1	$481,367.1	$29,837.0	$48,739.8
Total	**10,412**	**$495,048.8**	**$796,974.2**	**$1,106,006.1**	**$108,143.7**	**$133,217.6**

Table CT-5. 2016 Economic impacts from spending related to recreational striped bass angling in Connecticut

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	3,117	$153,959.5	$231,636.4	$282,787.7	$36,284.4	$40,183.0
Multiplier Effect	1,301	$81,879.3	$143,456.2	$224,402.5	$13,965.4	$22,719.7
Total	**4,418**	**$235,838.8**	**$375,092.5**	**$507,190.2**	**$50,249.8**	**$62,902.8**

Delaware

Participation

In 2016 and 2009, over 271,000 and over 287,000 anglers fished in Delaware, respectively. In each year, the average angler participated in around 8 fishing trips, of which a moderate portion was striped bass trips.

Table DE-1. Total anglers and angler trips in Delaware

	2009	2016
Total Anglers	287,159	271,873
Total Trips	2,949,624	2,129,937
Striped Bass Trips	490,397	313,331
Bass Trips % of total	17%	15%

Table DE-2. Trip breakouts by type in Delaware

	2009	2016
For-Hire	9%	5%
Private	47%	32%
Shore	45%	63%
Total	100%	100%

Spending & Revenues

For Delaware, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the two fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table DE-3. Landings, Spending and Revenues Associated with Recreational and Commercial Striped Bass Fishing in Delaware

	2009	2016
Commercial Landings (lbs)	184,184	136,528
Commercial Revenue ($000s)	$321	$505
Recreational Landings (lbs)	940,135	86,128
Recreational Spending ($000s)	$113,143.5	$61,372.5
Trip Spending ($000s)	$31,038.5	$12,373.8
Durable Goods ($000s)	$82,105.0	$48,998.7

Recreational Economic Impacts

In 2016, $59.2 million was added to the gross domestic product of Delaware, compared to over $106.3 million in 2009. Just over 730 jobs were supported in 2016 with 1,432 supported in 2009.

Table DE-4. 2009 Economic impacts from spending related to striped bass angling in Delaware

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	1,001	$43,051.4	$67,242.5	$96,807.6	$6,330.2	$9,354.3
Multiplier Effect	431	$20,874.5	$39,097.5	$61,094.6	$3,105.5	$5,037.9
Total	**1,432**	**$63,926.0**	**$106,340.0**	**$157,902.2**	**$9,435.7**	**$14,392.2**

Table DE-5. 2016 Economic impacts from spending related to striped bass angling in Delaware

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	513	$24,410.4	$37,117.7	$52,134.2	$3,564.4	$5,237.3
Multiplier Effect	219	$11,723.4	$22,000.4	$34,549.0	$1,753.7	$2,832.3
Total	**732**	**$36,133.8**	**$59,118.1**	**$86,683.3**	**$5,318.0**	**$8,069.6**

Commercial Economic Impacts

Commercial landings in Delaware have grown since 2009, with their value having grown 55% by 2016. Commercial revenues for striped bass exceeded $505,000 and $326,000 in 2016 and 2009, respectively, supporting an estimated 19 and 14 jobs in each year and adding over $306,000 in 2009 and $840,000 in 2016 to state GDP.

Table DE-6. 2009 Economic impacts of commercial striped bass landings in Delaware

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**14**	**$339**	**$307**	**$1,598**
Harvesters 2009	7	$142	$193	$598
Processors 2009	1	$41	$78	$232
Wholesalers 2009	1	$44	$53	$117
Retailers 2009	5	$111	$219	$652

Table DE-7. 2016 Economic impacts of commercial striped bass landings in Delaware

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**19**	**$524**	**$840**	**$2,474**
Harvesters 2016	10	$220	$298	$926
Processors 2016	2	$63	$121	$358
Wholesalers 2016	1	$69	$82	$181
Retailers 2016	7	$172	$339	$1,009

Comparisons Between the Fisheries

Table DE-8. Comparison of commercial and recreational impacts: Delaware 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed	136.5	86.1	222.6	61%	39%	100%
Jobs supported	19	732	751	3%	97%	100%
Income ($000s)	$524	$36,133.8	$36,657.9	1%	99%	100%
GDP ($000s)	$840	$59,118.1	$59,958.5	1%	99%	100%

Maine

Participation

In 2016 and 2009, over 236,000 and over 453,000 anglers fished in Maine, respectively. In each year, the average angler participated in around 6 to 8 fishing trips, of which a large portion was striped bass trips. Since 2009, the number of striper trips decreased 29%.

Table ME-1. Total anglers and angler trips in Maine

	2009	2016
Total Anglers	453,318	236,650
Total Trips	2,637,343	1,948,397
Striped Bass Trips	1,849,219	1,334,047
Bass Trips % of total	70%	68%

Table ME-2. Trip breakouts by type in Maine

	2009	2016
For-Hire	7%	19%
Private	9%	39%
Shore	84%	42%
Total	100%	100%

Spending & Revenues

All stripers landed within the state are caught recreationally, as Maine does not have a commercial striped bass fishery. Durable goods spending in Maine amounted to over $159 million in 2016 and just over $171.5 million in 2009.

Table ME-3. Landings, Spending and Revenues Associated with Recreational and Commercial Striped Bass Fishing in Maine

	2009	2016
Commercial Landings (lbs)	-	-
Commercial Revenue	-	-
Recreational Landings (lbs)	780,607	189,402
Recreational Spending ($000s)	$309,115.8	$202,007.8
Trip Spending ($000s)	$137,585.2	$42,847.7
Durable Goods ($000s)	$171,530.6	$159,160.1

Recreational Impacts

In 2016, $183.5 million was added to the gross domestic product of Maine, compared to over $263.8 million in 2009. 3,110 jobs were supported in 2016 with 4,980 supported in 2009.

Table ME-4. 2009 Economic impacts from spending related to striped bass angling in Maine

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	3,372	$100,368.1	$158,205.2	$254,991.8	$26,126.2	$23,081.0
Multiplier Effect	1,608	$60,582.5	$105,606.6	$194,229.9	$11,187.1	$14,329.3
Total	**4,980**	**$160,950.6**	**$263,811.7**	**$449,221.7**	**$37,313.3**	**$37,410.2**

Table ME-5. 2016 Economic impacts from spending related to striped bass angling in Maine

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	2,115	$72,752.0	$110,024.8	$158,031.8	$19,495.9	$16,382.7
Multiplier Effect	995	$41,852.1	$73,494.0	$134,424.5	$7,773.0	$9,945.9
Total	**3,110**	**$114,604.1**	**$183,518.8**	**$292,456.3**	**$27,268.9**	**$26,328.6**

Maryland

Recreational Participation

In 2016 and 2009, over 828,000 and over 884,000 anglers fished in Maryland, respectively. In each year, the average angler participated in around 11 fishing trips, of which a large portion was striped bass trips.

Table MD-1. Total anglers and angler trips in Maryland

	2009	2016
Total Anglers	884,372	828,610
Total Trips	8,843,232	9,364,384
Striped Bass Trips	2,507,456	2,519,453
Bass Trips % of total	28%	27%

Table MD-2. Trip breakouts by type in Maryland

	2009	2016
For-Hire	15%	22%
Private	36%	47%
Shore	49%	31%
Total	100%	100%

Spending & Revenues

For Maryland, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table MD-3. Landings, Spending and Revenues Associated with Recreational and Commercial Striped Bass Fishing in Maryland

	2009	2016
Commercial Landings (lbs)	2,812,222	1,709,365
Commercial Revenue ($000s)	$5,180.4	$7,102.1
Recreational Landings (lbs)	8,810,540	10,919,144
Recreational Spending ($000s)	$705,215.8	$825,747.8
Trip Spending ($000s)	$144,707.9	$129,361.7
Durable Goods ($000s)	$560,507.8	$696,386.1

Recreational Economic Impacts

In 2016, $802.8 million was added to the gross domestic product of Maryland, compared to nearly $664.2 million in 2009. There were 10,193 jobs were supported in 2016 and 9,408 supported in 2009.

Table MD-4. 2009 Economic impact from spending related to recreational striped bass angling in Maryland

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	6,255	$254,005.6	$393,524.0	$617,593.0	$56,566.0	$61,137.2
Multiplier Effect	3,153	$154,919.1	$270,680.5	$454,571.2	$26,328.4	$38,771.4
Total	**9,408**	**$408,924.7**	**$664,204.6**	**$1,072,164.7**	**$82,894.9**	**$99,908.6**

Table MD-5. 2016 Economic impact from spending related to recreational striped bass angling in Maryland

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	6,763	$309,863.1	$475,161.0	$719,692.3	$68,736.8	$74,329.6
Multiplier Effect	3,430	$186,996.7	$327,630.2	$545,604.6	$31,834.7	$46,881.2
Total	**10,193**	**$496,859.8**	**$802,791.2**	**$1,265,296.8**	**$100,571.5**	**$121,210.7**

Commercial Economic Impacts

Commercial landings in Maryland have grown since 2009, with their value having grown 37% by 2016. Commercial harvest produced over $7.1 million in revenue in 2016 and nearly $5.2 million in 2009. These revenues created 584 and 475 jobs in 2016 and 2009, respectively.

Table MD-6. 2009 Economic impact of commercial striped bass landings in Maryland

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**475**	**$9,193**	**$12,511**	**$24,919**
Harvesters 2009	190	$2,625	$4,086	$9,153
Processors 2009	43	$1,493	$1,907	$3,831
Wholesalers 2009	14	$612	$813	$1,801
Retailers 2009	228	$4,463	$5,705	$10,134

Table MD-7. 2016 Economic impact of commercial striped bass landings in Maryland

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**584**	**$12,570**	**$17,110**	**$34,092**
Harvesters 2016	234	$3,585	$5,585	$12,524
Processors 2016	53	$2,042	$2,608	$5,241
Wholesalers 2016	17	$838	$1,112	$2,464
Retailers 2016	281	$6,105	$7,804	$13,863

Comparisons Between the Fisheries

Table MD-8. Comparison of commercial and recreational impacts: Maryland 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	1,709.4	10,919.1	12628.5	14%	86%	100%
Jobs supported	584	10,193	10,777	5%	95%	100%
Income ($000s)	$12,569.6	$496,859.8	$509,429.7	2%	98%	100%
GDP ($000s)	$17,109.7	$802,791.2	$819,900.9	2%	98%	100%

Massachusetts

Participation

In 2016 and 2009, over 836,000 and nearly 1.1 million anglers fished in Massachusetts, respectively. In each year, the average angler participated in between 8 and 12 fishing trips, of which majority were striped bass trips.

Table MA-1. Total anglers and angler trips in Massachusetts

	2009	2016
Total Anglers	1,053,717	836,879
Total Trips	12,951,528	7,244,235
Striped Bass Trips	8,112,082	3,637,888
Bass Trips % of total	63%	50%

Table MA-2. Trip breakouts by type in Massachusetts

	2009	2016
For-Hire	17%	17%
Private	29%	55%
Shore	55%	29%
Total	100%	100%

Spending & Revenues

For Massachusetts, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table MA-3. Sales and spending attributed to striped bass fishing in Massachusetts

	2009	2016
Commercial Landings (lbs)	1,134,279	938,230
Commercial Revenue ($000s)	$3,024.9	$3,812.3
Recreational Landings (lbs)	9,409,753	3,730,639
Recreational Spending ($000s)	$1,423,956.5	$1,621,406.3
Trip Spending ($000s)	$479,234.6	$239,262.1
Durable Goods ($000s)	$944,721.9	$1,382,144.2

Recreational Impacts

In 2016, $1,675.8 million was added to the gross domestic product of Massachusetts, compared to nearly $1,424.2 million in 2009. There were 20,715 jobs supported in 2016 and 19,977 supported in 2009.

Table MA-4. 2009 Economic impact from spending related to recreational striped bass angling in Massachusetts

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	12,912	$627,676.1	$785,989.0	$1,208,733.4	$88,255.0	$140,108.0
Multiplier Effect	7,065	$408,646.6	$638,183.2	$1,056,073.3	$49,963.3	$101,464.8
Total	**19,977**	**$1,036,322.7**	**$1,424,172.3**	**$2,264,806.7**	**$138,218.3**	**$241,572,.8**

Table MA-5. 2016 Economic impact from spending related to recreational striped bass angling in Massachusetts

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	13,517	$730,403.4	$949,861.1	$1,320,159.2	$99,884.1	$167,864.4
Multiplier Effect	7,198	$460,030.8	$725,941.3	$1,192,990.9	$57,177.1	$114,927.2
Total	**20,715**	**$1,190,434.2**	**$1,675,802.4**	**$2,513,150.1**	**$157,061.1**	**$282,791.5**

Commercial Impacts

Commercial landings fell between 2016 and 2009, though their value grew 26%. Commercial harvest produced over $3.8 million in revenue in 2016 and over $3.0 million in 2009. These revenues supported 383 and 337 jobs in 2016 and 2009, respectively.

Table MA-6. 2009 Economic impact of commercial striped bass landings in Massachusetts

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**337**	**$4,667**	**$6,370**	**$12,727**
Harvesters 2009	70	$1,740	$2,564	$5,536
Processors 2009	10	$479	$622	$1,255
Wholesalers 2009	6	$318	$431	$973
Retailers 2009	252	$2,129	$2,752	$4,962

Table MA-7. 2016 Economic impact of commercial striped bass landings in Massachusetts

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**383**	**$5,888**	**$8,035**	**$16,047**
Harvesters 2016	79	$2,198	$3,236	$6,979
Processors 2016	11	$604	$785	$1,583
Wholesalers 2016	7	$401	$544	$1,227
Retailers 2016	286	$2,685	$3,470	$6,257

Comparisons Between the Fisheries

Table MA-8. Comparison of commercial and recreational impacts: Massachusetts 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	938.2	3,730.6	4668.8	20%	80%	100%
Jobs supported	383	20,715	21,098	2%	98%	100%
Income ($000s)	$5,887.8	$1,190,434.2	$1,196,322.0	0%	100%	100%
GDP ($000s)	$8,035.0	$1,675,802.4	$1,683,837.4	0%	100%	100%

New Hampshire

Participation

In both 2016 and 2009, over 134,000 anglers fished in New Hampshire in each year. In each year, the average angler participated in about 6 to 8 fishing trips, of which majority were striped bass trips.

Table NH-1. Total anglers and angler trips in New Hampshire

	2009	2016
Total Anglers	134,381	134,202
Total Trips	834,862	1,060,766
Striped Bass Trips	441,003	682,573
Bass Trips % of total	53%	64%

Table NH-2. Trip breakouts by type in New Hampshire

	2009	2016
For-Hire	48%	33%
Private	27%	50%
Shore	25%	17%
Total	100%	100%

Spending & Revenues

All stripers landed within the state are caught recreationally, as New Hampshire does not have a commercial striped bass fishery. Durable goods spending in New Hampshire amounted to over $83.3 million in 2016 and over $31.7 million in 2009.

Table NH-3. Sales and spending attributed to striped bass fishing in New Hampshire

	2009	2016
Commercial Landings (lbs)	-	-
Commercial Revenue	-	-
Recreational Landings (lbs)	221,666	190,941
Recreational Spending ($000s)	$51,159.5	$112,586.5
Trip Spending ($000s)	$19,404.1	$29,284.6
Durable Goods ($000s)	$31,755.4	$83,301.9

Recreational Impacts

In 2016, $116.3 million was added to the gross domestic product of New Hampshire, compared to nearly $50.6 million in 2009. There were 1,630 jobs supported in 2016 and 802 supported in 2009.

Table NH-4. 2009 Economic impacts from spending related to striped bass angling in New Hampshire

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	516	$22,595.5	$29,051.2	$41,269.0	$1,961.9	$4,853.2
Multiplier Effect	286	$13,238.0	$21,536.4	$36,559.0	$1,627.9	$3,200.1
Total	**802**	**$35,833.5**	**$50,587.6**	**$77,828.0**	**$3,589.8**	**$8,053.3**

Table NH-5. 2016 Economic impacts from spending related to striped bass angling in New Hampshire

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	1,059	$53,709.2	$68,019.8	$86,799.4	$4,312.0	$11,497.9
Multiplier Effect	571	$29,305.9	$48,250.1	$81,549.9	$3,713.2	$7,130.9
Total	**1,630**	**$83,015.1**	**$116,269.9**	**$168,349.4**	**$8,025.2**	**$18,628.7**

New Jersey

Participation

In 2016 and 2009, over 916,000 and over 1.1 million anglers fished in New Jersey, respectively. In each year, the average angler participated in about 15 fishing trips, of which a large portion was striped bass trips.

Table NJ-1. Total anglers and angler trips in New Jersey

	2009	2016
Total Anglers	1,145,095	916,376
Total Trips	17,659,358	13,851,906
Striped Bass Trips	5,896,247	4,528,666
Bass Trips % of total	33%	33%

Table NJ-2. Trip breakouts by type in New Jersey

	2009	2016
For-Hire	17%	9%
Private	54%	64%
Shore	29%	27%
Total	100%	100%

Spending & Revenues

All stripers landed within the state were caught recreationally, as New Jersey does not have a commercial striped bass fishery. Durable goods spending in New Jersey amounted to over $1.2 billion in 2016 and over $1.0 billion in 2009.

Table NJ-3. Sales and spending attributed to striped bass fishing in New Jersey

	2009	2016
Commercial Landings (lbs)	-	-
Commercial Revenue	-	-
Recreational Landings (lbs)	17,039,685	12,790,306
Recreational Spending ($000s)	$1,331,054.9	$1,474,625.0
Trip Spending ($000s)	$303,872.3	$228,134.6
Durable Goods ($000s)	$1,027,182.6	$1,246,490.4

Recreational Impacts

In 2016, $1,609.1 million was added to the gross domestic product of New Jersey, compared to just over $1,404.2 million in 2009. There were 18,624 jobs supported in 2016 and 17,836 supported in 2009.

Table NJ-4. 2009 Economic impacts from spending related to striped bass angling in New Jersey

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	11,643	$544,091.8	$815,737.9	$1,139,502.0	$115,358.7	$137,056.4
Multiplier Effect	6,193	$350,688.8	$588,471.6	$951,984.8	$59,536.8	$92,924.1
Total	**17,836**	**$894,780.6**	**$1,404,209.4**	**$2,091,486.8**	**$174,895.5**	**$229,980.4**

Table NJ-5. 2016 Economic impacts from spending related to striped bass angling in New Jersey

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	12,205	$629,117.6	$930,385.9	$1,249,846.4	$136,849.1	$157,846.9
Multiplier Effect	6,419	$402,067.5	$678,717.8	$1,094,948.4	$68,602.0	$106,932.4
Total	**18,624**	**$1,031,185.0**	**$1,609,103.7**	**$2,344,794.7**	**$205,451.1**	**$264,779.2**

New York

Participation

In 2016 and 2008, over 921,000 and nearly 717,000 anglers fished in New York, respectively. In each year, the average angler participated in between 13 and 19 fishing trips, of which a large portion was striped bass trips.

Table NY-1. Total anglers and angler trips in New York

	2009	2016
Total Anglers	716,950	921,501
Total Trips	13,658,548	15,765,211
Striped Bass Trips	3,460,654	4,589,526
Bass Trips % of total	25%	29%

Table NY-2. Trip breakouts by type in New York

	2009	2016
For-Hire	24%	21%
Private	55%	63%
Shore	21%	16%
Total	100%	100%

Spending & Revenues

For New York, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table NY-3. Sales and spending attributed to striped bass fishing in New York

	2009	2016
Commercial Landings (lbs)	747,054	539,670
Commercial Revenue ($000s)	$1,732.1	$2,261.2
Recreational Landings (lbs)	7,991,243	12,052,880
Recreational Spending ($000s)	$453,096.9	$1,123,820.7
Trip Spending ($000s)	$103,347.9	$197,664.7
Durable Goods ($000s)	$349,748.9	$926,156.0

Recreational Impacts

In 2016, $1,165.0 million was added to the gross domestic product of New York, compared to nearly $453.4 million in 2009. There were 13,810 jobs supported in 2016 and 6,035 supported in 2009.

Table NY-4. 2009 Economic impacts from spending related to striped bass angling in New York

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	4,156	$182,653.2	$263,382.5	$385,247.7	$45,700.7	$42,464.7
Multiplier Effect	1,879	$114,718.9	$190,037.9	$300,198.8	$20,405.9	$28,567.2
Total	**6,035**	**$297,372.1**	**$453,420.3**	**$685,446.5**	**$66,106.6**	**$71,031.9**

Table NY-5. 2016 Economic impacts from spending related to striped bass angling in New York

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	9,542	$465,496.9	$681,527.2	$948,496.1	$118,589.4	$109,513.8
Multiplier Effect	4,268	$289,293.6	$483,510.3	$762,490.5	$51,822.9	$72,439.3
Total	**13,810**	**$754,790.6**	**$1,165,037.5**	**$1,710,986.6**	**$170,412.3**	**$181,953.2**

Commercial Impacts

Commercial landings decreased between 2009 and 2016, though their value grew by 30%. Commercial harvest produced over $2.2 million in revenue in 2016 and over $1.7 million in 2009. These revenues supported 161 and 138 jobs in 2016 and 2009, respectively.

Table NY-6. 2009 Economic impacts of commercial striped bass landings in New York

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**138**	**$2,225.3**	**$3,112.7**	**$6,404.6**
Harvesters 2009	64	$899.0	$1,382.5	$3,127.1
Processors 2009	5	$267.9	$347.3	$702.3
Wholesalers 2009	5	$117.0	$157.8	$346.2
Retailers 2009	64	$942.3	$1,225.1	$2,229.0

Table NY-7. 2016 Economic impacts of commercial striped bass landings in New York

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**161**	**$2,884.8**	**$4,035.1**	**$8,302.6**
Harvesters 2016	75	$1,165.4	$1,792.3	$4,054.0
Processors 2016	6	$346.2	$450.0	$910.5
Wholesalers 2016	6	$151.7	$204.6	$448.8
Retailers 2016	74	$1,221.4	$1,588.0	$2,889.2

Comparisons Between the Fisheries

Table NY-8. Comparison of commercial and recreational impacts: New York, 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed	539.7	12,052.90	12592.6	4%	96%	100%
Jobs supported	161	13,810	13971	1%	99%	100%
Income ($000s)	$2,884.8	$754,790.5	$757,675.3	0%	100%	100%
GDP ($000s)	$4,035.1	$1,165,037.5	$1,169,072.6	0%	100%	100%

North Carolina

Participation

In 2016 and 2009, over 1,888,000 and 1,680,000 anglers fished in North Carolina, respectively. In each year, the average angler participated in around 11 fishing trips, of which a small portion were striped bass trips.

Table NC-1. Total anglers and angler trips in North Carolina

	2009	2016
Total Anglers	1,680,781	1,888,821
Total Trips	19,345,187	21,158,845
Striped Bass Trips	539,658	484,444
Bass Trips % of total	3%	2%

Table NC-2. Striped bass trip breakouts by type in North Carolina

	2009	2016
For-Hire	10%	11%
Private	17%	26%
Shore	73%	63%
Total	100%	100%

Spending & Revenues

For North Carolina, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table NC-3. Sales and spending attributed to striped bass fishing in North Carolina

	2009	2016
Commercial Landings (lbs)	310,613	146,189
Commercial Revenue ($000s)	$747.3	$432.1
Recreational Landings (lbs)	262,389	60,433
Recreational Spending ($000s)	$135,753.8	$144,861.3
Trip Spending ($000s)	$53,797.3	$39,986.7
Durable Goods ($000s)	$81,956.5	$104,874.7

Recreational Impacts

In 2016, $136.6 million was added to the gross domestic product of North Carolina, compared to nearly $124.8 million in 2009. There were 1,953 jobs supported in 2016 and 2,063 supported in 2009.

Table NC-4. 2009 Economic impacts from spending related to striped bass angling in North Carolina

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	1,323	$47,548.6	$72,608.7	$114,997.1	$8,044.2	$10,806.2
Multiplier Effect	740	$29,760.3	$52,219.2	$94,983.6	$4,310.0	$7,287.1
Total	**2,063**	**$77,308.9**	**$124,827.9**	**$209,980.7**	**$12,354.2**	**$18,093.3**

Table NC-5. 2016 Economic impacts from spending related to striped bass angling in North Carolina

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	1,242	$53,126.5	$79,927.5	$119,827.8	$8,717.6	$11,971.8
Multiplier Effect	711	$32,012.2	$56,682.2	$102,574.2	$4,668.1	$7,893.2
Total	**1,953**	**$85,138.7**	**$136,609.6**	**$222,402.0**	**$13,385.7**	**$19,865.0**

Commercial Impacts

Commercial landings and revenue decreased between 2009 and 2016. Commercial harvest produced nearly $460,000 in revenue in 2016 and over $747,000 in 2009. These revenues supported 28 and 53 jobs in 2016 and 2009, respectively.

Table NC-6. 2009 Economic impacts of commercial striped bass landings in North Carolina

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**53**	**$1,818.9**	**$1,428.9**	**$1,850.7**
Harvesters 2009	23	$1,258.8	$704.5	$520.9
Processors 2009	4	$110.8	$143.1	$285.0
Wholesalers 2009	1	$49.0	$64.7	$139.8
Retailers 2009	25	$400.2	$516.5	$905.1

Table NC-7. 2016 Economic impacts of commercial striped bass landings in North Carolina

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**28**	**$625.9**	**$829.0**	**$1,510.8**
Harvesters 2016	12	$297.5	$404.3	$731.7
Processors 2016	2	$64.2	$83.0	$165.2
Wholesalers 2016	1	$28.0	$37.0	$79.7
Retailers 2016	13	$236.1	$304.7	$534.0

Comparisons Between the Fisheries

Table NC-8. Comparison of commercial and recreational impacts: North Carolina 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	146.2	60.4	206.6	71%	29%	100%
Jobs supported	28	1,953	1981	1%	99%	100%
Income ($000s)	$626.9	$85,138.7	$85,764.6	1%	99%	100%
GDP ($000s)	$829.0	$136,609.6	$137,438.6	1%	99%	100%

Rhode Island

Participation

In 2016 and 2009, over 391,000 and 320,000 anglers fished in Rhode Island, respectively. In each year, the average angler participated in around 12 fishing trips, of which a large portion was striped bass trips.

Table RI-1. Total anglers and angler trips in Rhode Island

	2009	2016
Total Anglers	320,396	391,713
Total Trips	4,062,597	2,998,761
Striped Bass Trips	1,750,240	731,404
Bass Trips % of total	43%	24%

Table RI-2. Trip breakouts by type in Rhode Island

	2009	2016
For-Hire	14%	25%
Private	38%	44%
Shore	48%	31%
Total	100%	100%

Spending & Revenues

For Rhode Island, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table RI-3. Sales and spending attributed to striped bass fishing in Rhode Island

	2009	2016
Commercial Landings (lbs)	234,790	174,701
Commercial Revenue ($000s)	$705.9	$768.7
Recreational Landings (lbs)	2,185,224	1,775,554
Recreational Spending ($000s)	$208,306.3	$229,135.4
Trip Spending ($000s)	$68,765.5	$20,920.9
Durable Goods ($000s)	$139,540.8	$208,214.5

Recreational Impacts

In 2016, $241.6 million was added to the gross domestic product of Rhode Island, compared to just over $201.6 million in 2009. There were 3,410 jobs supported in 2016 and 3,625 supported in 2009.

Table RI-4. 2009 Economic impacts from spending related to striped bass angling in Rhode Island

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	2,535	$83,924.3	$110,080.7	$178,271.0	$14,742.7	$18,504.4
Multiplier Effect	1,090	$51,667.3	$91,523.2	$151,115.9	$8,626.7	$13,176.1
Total	**3,625**	**$135,591.6**	**$201,603.9**	**$329,386.9**	**$23,369.4**	**$31,680.5**

Table RI-5. 2016 Economic impacts from spending related to striped bass angling in Rhode Island

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)	State/Local Taxes ($000s)	Federal Taxes ($000s)
Direct Effect	2,320	$98,349.4	$139,538.9	$183,589.3	$18,206.6	$23,061.8
Multiplier Effect	1,090	$56,944.1	$102,012.1	$166,994.7	$9,567.7	$14,600.9
Total	**3,410**	**$155,293.5**	**$241,551.0**	**$350,584.0**	**$27,774.3**	**$37,662.7**

Commercial Impacts

Commercial landings and revenue decreased between 2009 and 2016. Commercial harvest produced nearly $832,000 in revenue in 2016 and over $705,000 in 2009. These revenues supported 42 and 43 jobs in 2016 and 2009, respectively.

Table RI-6. 2009 Economic impacts of commercial striped bass landings in Rhode Island

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**43**	**$899.2**	**$1,262.7**	**$2,499.7**
Harvesters 2009	19	$361.8	$568.0	$1,215.9
Processors 2009	3	$111.1	$144.3	$286.6
Wholesalers 2009	1	$47.4	$62.3	$133.7
Retailers 2009	20	$378.9	$488.1	$863.5

Table RI-7. 2016 Economic impacts of commercial striped bass landings in Rhode Island

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**42**	**$984.6**	**$1,379.7**	**$2,723.2**
Harvesters 2016	19	$399.7	$623.7	$1,325.9
Processors 2016	3	$120.9	$157.1	$312.0
Wholesalers 2016	1	$51.6	$67.8	$144.6
Retailers 2016	20	$412.4	$531.1	$939.7

Comparisons Between the Fisheries

Table RI-8. Comparison of commercial and recreational impacts: Rhode Island 2016

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	174.7	1,775.6	1950.3	9%	91%	100%
Jobs supported	42	3,410	3452	1%	99%	100%
Income ($000s)	$984.6	$155,293.5	$156,278.1	1%	99%	100%
GDP ($000s)	$1379.9	$241,551.0	$242,930.9	1%	99%	100%

Virginia

Participation

In 2016 and 2009, over 724,000 and over 907,000 anglers fished in Virginia, respectively. In each year, the average angler participated in around 10 fishing trips, of which a moderate portion was striped bass trips.

Table VA-1. Anglers and angler trips in Virginia

	2009	2016
Total Anglers	907,422	724,276
Total Trips	8,410,827	7,247,361
Striped Bass Trips	1,192,172	436,169
Bass Trips % of total	14%	6%

Table VA-2. Trip distribution by type in Virginia

	2009	2016
For-Hire	4%	4%
Private	79%	68%
Shore	18%	28%

Spending & Revenues

For Virginia, total landings and their associated expenditures are presented below. We caution about using spending and revenues to make statements about the economic impacts created by the recreational and commercial fisheries, however. The multiplier effects for a dollar associated with each fishery are markedly different. A better approach is to examine each fishery's economic impacts which are in the next section.

Table VA-3. Sales and spending attributed to striped bass fishing in Virginia

	2009	2016
Commercial Landings (lbs)	2,108,685	1,333,572
Commercial Revenue ($000s)	$4,219.4	$4,968.3
Recreational Landings (lbs)	5,387,784	1,024,378
Recreational Spending ($000s)	$249,746.5	$108,002.9
Trip Spending ($000s)	$64,330.4	$22,552.0
Durable Goods ($000s)	$185,416.0	$85,450.7

Recreational Economic Impacts

In 2016, $106.6 million was added to the gross domestic product of Virginia, compared to just over $240.5 million in 2009. There were 1,444 jobs supported in 2016 and 3,582 jobs supported in 2009.

Table VA-4. 2009 Economic impacts from spending related to recreational striped bass angling in Virginia

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	2,362	$95,282.9	$142,119.2	$210,982.3	$19,266.9	$22,408.3
Multiplier Effect	1,220	$56,634.5	$98,401.3	$171,009.9	$8,227.7	$14,301.0
Total	**3,582**	**$151,917.4**	**$240,520.4**	**$381,992.2**	**$27,494.6**	**$36,711.2**

Table VA-5. 2016 Economic impacts from spending related to recreational striped bass angling in Virginia

	Jobs	**Salaries and Wages** ($000s)	**GDP** ($000s)	**Total Output** ($000s)	**State/Local Taxes** ($000s)	**Federal Taxes** ($000s)
Direct Effect	959	$42,451.4	$62,924.8	$90,355.4	$8,623.6	$10,016.5
Multiplier Effect	485	$25,099.3	$43,698.4	$75,556.7	$3,624.1	$6,350.9
Total	**1,444**	**$67,550.7**	**$106,623.3**	**$165,912.0**	**$12,247.6**	**$16,367.5**

Commercial Economic Impacts

Commercial landings and revenue decreased between 2009 and 2016. Commercial harvest produced nearly $5.0 million in revenue in 2016 and over $4.2 million in 2009. These revenues supported 384 and 369 jobs in 2016 and 2009, respectively.

Table VA-6. 2009 Economic impacts of commercial striped bass landings in Virginia

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2009	**369**	**$7,782.0**	**$10,472.8**	**$20,063.8**
Harvesters 2009	117	$2,419.2	$3,523.2	$7,201.0
Processors 2009	35	$1,219.8	$1,574.3	$3,135.3
Wholesalers 2009	12	$509.5	$679.0	$1,473.8
Retailers 2009	205	$3,633.5	$4,696.2	$8,253.7

Table VA-7. 2016 Economic impacts of commercial striped bass landings in Virginia

	Jobs	Salaries and Wages ($000s)	GDP ($000s)	Total Output ($000s)
Commercial Impacts 2016	**384**	**$9,016.0**	**$12,198.1**	**$23,576.0**
Harvesters 2016	118	$2,731.6	$4,054.1	$8,502.5
Processors 2016	37	$1,429.3	$1,844.6	$3,673.6
Wholesalers 2016	13	$597.2	$795.9	$1,727.6
Retailers 2016	216	$4,257.9	$5,503.4	$9,672.4

Comparisons Between the Fisheries

Table VA-7. Comparison of commercial and recreational impacts: Virginia

	Commercial Fishery	Recreational Fishery	Total	Commercial Fishery	Recreational Fishery	Total
Pounds landed (000s)	1,333.6	1,024.4	2358.0	57%	43%	100%
Jobs supported	384	1,444	1828	21%	79%	100%
Income ($000s)	$9,016.0	$67,550.7	$76,566.7	12%	88%	100%
GDP ($000s)	$12,198.1	$106,623.3	$118,821.4	10%	90%	100%

Sources Cited

Bureau of Labor Statistics (2017), U.S. Department of Labor, CPI Inflation Calculator: https://www.bls.gov/data/inflation_calculator.htm

Lovell, S. J., Steinback, S., & Hilger, J. (2011). *The Economic Contribution of Marine Angler Expenditures in the United States, 2011.* NOAA.

Lovell, S. J., Steinback, S., & Hutt, C. (2016). *The Economic Contribution of Marine Angler Expenditures on Durable Goods in the United States, 2014.* NOAA.

NOAA. (2009). *Fisheries Economics of the United States.* U.S. Department of Commerce.

NOAA. (2016). *Fisheries Economics of the United States.* U.S. Department of Commerce.

NOAA. (2017, December 8). *Annual Commercial Landing Statistics*. Retrieved September 2017, from NOAA Office of Science and Technology: https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index

NOAA. (2017, Sep). Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division.

APPENDIX
Detailed Recreational Spending Estimates

Striped bass trip spending by category in Connecticut

	2009	2016
Auto Fuel	$12,899,601	$14,745,452
Auto Rental	$0	$0
Bait	$6,028,920	$6,666,297
Boat Fuel	$8,401,233	$9,852,220
Boat Rental	$0	$0
Charter Fees	$2,550,466	$4,807,549
Crew Tips	$186,223	$351,025
Fish Processing	$0	$0
Food from Grocery Stores	$3,306,520	$3,813,712
Food from Restaurants	$944	$1,780
Gifts & Souvenirs	$0	$0
Ice	$387,112	$439,659
Lodging	$219,231	$257,094
Parking & Site Access	$15,659	$18,364
Public Transportation	$0	$0
Tournament Fees	$0	$0

Striped bass durable goods spending by category in Connecticut

	2009	2016
Tackle	$56,559,846	$25,785,534
Rods & Reels	$93,756,003	$42,743,197
Binoculars	$2,128,650	$970,448
Camping Equipment	$6,978,358	$3,181,421
Clothing	$18,565,446	$8,463,954
Club Dues	$3,102,608	$1,414,474
License Fees	$5,793,544	$2,641,266
Magazine Subscriptions	$5,271,422	$2,403,232
Taxidermy	$0	$0
New Boat	$42,808,966	$19,516,532
Used Boat	$80,878,673	$36,872,444
New Canoe	$2,254,160	$1,027,668
Used Canoe	$1,340,447	$611,108
New Accessory	$35,293,424	$16,090,210
Used Accessory	$195,796	$89,263
Boat Insurance	$45,284,024	$20,644,907
Boat Maintenance	$67,429,016	$30,740,770
Boat Registration	$10,256,681	$4,676,003
Boat Storage	$208,773,408	$95,179,429
Boat Purchase Fees	$1,174,774	$535,577
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$8,941,336	$4,076,339
Vehicle Insurance	$13,856,309	$6,317,067
Vehicle Maintenance	$12,470,678	$5,685,360
Vehicle Registration	$2,896,772	$1,320,633
Vehicle Purchase Fees	$0	$0
New Home Purchase	$0	$0
Second Home Insurance	$0	$0
Second Home Maintenance	$0	$0

Striped bass trip spending by category in Delaware

	2009	2016
Auto Fuel	$10,105,893	$4,150,903
Auto Rental	$0	$0
Bait	$4,566,129	$1,948,740
Boat Fuel	$3,864,916	$1,059,675
Boat Rental	$0	$0
Charter Fees	$1,338,107	$279,559
Crew Tips	$202,624	$42,333
Fish Processing	$0	$0
Food from Grocery Stores	$5,006,880	$2,115,802
Food from Restaurants	$2,425,285	$1,169,961
Gifts & Souvenirs	$182,459	$102,296
Ice	$834,665	$336,767
Lodging	$2,375,242	$1,091,667
Parking & Site Access	$136,289	$76,075
Public Transportation	$0	$0
Tournament Fees	$0	$0

Striped bass durable goods spending by category in Delaware

	2009	2016
Tackle	$11,353,004	$6,775,253
Rods & Reels	$12,377,344	$7,386,559
Binoculars	$206,141	$123,021
Camping Equipment	$1,029,431	$614,344
Clothing	$2,042,319	$1,218,816
Club Dues	$246,860	$147,321
License Fees	$4,202,978	$2,508,256
Magazine Subscriptions	$525,531	$313,627
Taxidermy	$13,997	$8,353
New Boat	$15,158,970	$9,046,580
Used Boat	$7,249,278	$4,326,229
New Canoe	$209,958	$125,299
Used Canoe	$0	$0
New Accessory	$2,165,749	$1,292,477
Used Accessory	$0	$0
Boat Insurance	$3,608,733	$2,153,622
Boat Maintenance	$8,467,035	$5,052,962
Boat Registration	$1,581,684	$943,918
Boat Storage	$5,920,817	$3,533,429
Boat Purchase Fees	$281,217	$167,825
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$17,815	$10,631
Vehicle Insurance	$2,957,227	$1,764,816
Vehicle Maintenance	$2,159,387	$1,288,680
Vehicle Registration	$329,570	$196,681
Vehicle Purchase Fees	$0	$0
New Home Purchase	$0	$0
Second Home Insurance	$0	$0
Second Home Maintenance	$0	$0

Striped bass trip spending by category in Maine

	2009	2016
Auto Fuel	$42,646,594	$11,122,087
Auto Rental	$135,248	$114,536
Bait	$2,762,752	$1,020,040
Boat Fuel	$6,610,166	$8,911,559
Boat Rental	$0	$0
Charter Fees	$4,867,610	$4,122,166
Crew Tips	$189,874	$160,796
Fish Processing	$0	$0
Food from Grocery Stores	$15,717,963	$4,046,603
Food from Restaurants	$17,735,427	$3,995,496
Gifts & Souvenirs	$5,389,884	$1,344,402
Ice	$299,450	$130,955
Lodging	$39,228,202	$7,212,667
Parking & Site Access	$1,797,352	$493,068
Public Transportation	$204,682	$173,336
Tournament Fees	$0	$0

Striped bass durable goods spending by category in Maine

	2009	2016
Tackle	$19,355,077	$17,959,222
Rods & Reels	$24,129,995	$22,389,782
Binoculars	$1,310,326	$1,215,828
Camping Equipment	$673,671	$625,087
Clothing	$10,978,611	$10,186,853
Club Dues	$1,006,805	$934,196
License Fees	$3,005,608	$2,788,848
Magazine Subscriptions	$1,117,849	$1,037,232
Taxidermy	$0	$0
New Boat	$3,623,756	$3,362,417
Used Boat	$31,718,044	$29,430,594
New Canoe	$570,029	$528,920
Used Canoe	$0	$0
New Accessory	$7,943,392	$7,370,528
Used Accessory	$0	$0
Boat Insurance	$11,774,431	$10,925,279
Boat Maintenance	$17,837,467	$16,551,060
Boat Registration	$5,507,813	$5,110,599
Boat Storage	$30,096,792	$27,926,265
Boat Purchase Fees	$162,865	$151,120
New Vehicle Purchase	$59,224	$54,953
Used Vehicle Purchase	$0	$0
Vehicle Insurance	$447,880	$415,580
Vehicle Maintenance	$0	$0
Vehicle Registration	$207,283	$192,334
Vehicle Purchase Fees	$3,701	$3,435
New Home Purchase	$0	$0
Second Home Insurance	$0	$0
Second Home Maintenance	$0	$0

Striped bass trip spending by category in Maryland

	2009	2016
Auto Fuel	$46,126,103	$38,819,419
Auto Rental	$0	$0
Bait	$15,456,411	$12,256,650
Boat Fuel	$15,167,168	$17,708,299
Boat Rental	$0	$0
Charter Fees	$7,980,390	$10,609,350
Crew Tips	$483,233	$642,424
Fish Processing	$0	$0
Food from Grocery Stores	$21,196,020	$18,348,007
Food from Restaurants	$12,074,072	$9,877,969
Gifts & Souvenirs	$148,036	$165,547
Ice	$3,440,686	$3,237,291
Lodging	$14,899,003	$9,210,549
Parking & Site Access	$3,870,015	$3,345,586
Public Transportation	$0	$0
Tournament Fees	$3,866,806	$5,140,638

Striped bass durable goods spending by category in Maryland

	2009	2016
Tackle	$59,202,621	$73,554,516
Rods & Reels	$64,387,181	$79,995,916
Binoculars	$3,135,396	$3,895,479
Camping Equipment	$9,476,647	$11,773,975
Clothing	$18,442,471	$22,913,293
Club Dues	$7,180,879	$8,921,667
License Fees	$19,534,575	$24,270,145
Magazine Subscriptions	$4,427,132	$5,500,358
Taxidermy	$0	$0
New Boat	$120,865,413	$150,165,596
Used Boat	$9,089,126	$11,292,511
New Canoe	$0	$0
Used Canoe	$0	$0
New Accessory	$33,649,729	$41,807,094
Used Accessory	$639,997	$795,145
Boat Insurance	$34,730,091	$43,149,356
Boat Maintenance	$50,982,481	$63,341,650
Boat Registration	$10,739,026	$13,342,379
Boat Storage	$57,012,541	$70,833,517
Boat Purchase Fees	$2,483,657	$3,085,744
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$35,311,372	$43,871,552
Vehicle Insurance	$9,870,039	$12,262,733
Vehicle Maintenance	$4,984,928	$6,193,373
Vehicle Registration	$2,166,594	$2,691,820
Vehicle Purchase Fees	$722,198	$897,273
New Home Purchase	$0	$0
Second Home Insurance	$322,934	$401,220
Second Home Maintenance	$1,150,820	$1,429,801

Striped bass trip spending by category in Massachusetts

	2009	2016
Auto Fuel	$113,691,535	$57,870,070
Auto Rental	$1,487,511	$423,848
Bait	$30,363,660	$15,756,588
Boat Fuel	$55,987,034	$53,066,138
Boat Rental	$438,117	$266,617
Charter Fees	$47,526,186	$23,502,651
Crew Tips	$2,764,500	$1,367,100
Fish Processing	$0	$0
Food from Grocery Stores	$63,171,930	$28,056,729
Food from Restaurants	$55,814,487	$21,613,451
Gifts & Souvenirs	$6,584,197	$2,531,033
Ice	$3,854,393	$2,403,015
Lodging	$77,661,053	$23,547,014
Parking & Site Access	$9,996,030	$5,094,303
Public Transportation	$9,815,806	$3,724,856
Tournament Fees	$78,193	$38,668

Striped bass durable goods spending by category in Massachusetts

	2009	2016
Tackle	$87,337,907	$127,776,840
Rods & Reels	$103,226,100	$151,021,537
Binoculars	$4,834,990	$7,073,673
Camping Equipment	$14,052,280	$20,558,724
Clothing	$34,995,522	$51,199,042
Club Dues	$5,576,900	$8,159,100
License Fees	$10,814,283	$15,821,479
Magazine Subscriptions	$8,142,149	$11,912,102
Taxidermy	$150,897	$220,765
New Boat	$157,372,962	$230,239,314
Used Boat	$117,592,749	$172,040,188
New Canoe	$1,276,337	$1,867,302
Used Canoe	$1,043,704	$1,526,957
New Accessory	$42,540,370	$62,237,283
Used Accessory	$188,621	$275,956
Boat Insurance	$30,267,417	$44,281,744
Boat Maintenance	$109,054,496	$159,548,578
Boat Registration	$12,071,757	$17,661,186
Boat Storage	$93,807,615	$137,242,132
Boat Purchase Fees	$1,320,348	$1,931,692
New Vehicle Purchase	$63,552,773	$92,978,785
Used Vehicle Purchase	$5,759,234	$8,425,857
Vehicle Insurance	$17,441,174	$25,516,734
Vehicle Maintenance	$17,862,428	$26,133,036
Vehicle Registration	$2,156,569	$3,155,097
Vehicle Purchase Fees	$2,037,109	$2,980,325
New Home Purchase	$0	$0
Second Home Insurance	$245,208	$358,743
Second Home Maintenance	$0	$0

Striped bass trip spending by category in New Hampshire

	2009	2016
Auto Fuel	$3,926,063	$6,266,588
Auto Rental	$3,381	$9,356
Bait	$1,142,753	$1,743,894
Boat Fuel	$2,809,600	$7,775,240
Boat Rental	$0	$0
Charter Fees	$5,860,126	$6,098,554
Crew Tips	$428,790	$446,236
Fish Processing	$0	$0
Food from Grocery Stores	$1,906,642	$2,800,154
Food from Restaurants	$1,241,623	$1,351,472
Gifts & Souvenirs	$51,903	$54,332
Ice	$173,177	$324,733
Lodging	$1,434,073	$1,501,220
Parking & Site Access	$408,073	$894,249
Public Transportation	$17,866	$18,593
Tournament Fees	$0	$0

Striped bass durable goods spending by category in New Hampshire

	2009	2016
Tackle	$4,794,746	$12,577,740
Rods & Reels	$4,952,983	$12,992,832
Binoculars	$67,208	$176,303
Camping Equipment	$319,026	$836,879
Clothing	$1,299,924	$3,410,005
Club Dues	$108,894	$285,655
License Fees	$1,055,763	$2,769,513
Magazine Subscriptions	$216,938	$569,078
Taxidermy	$0	$0
New Boat	$800,542	$2,100,009
Used Boat	$8,181,525	$21,462,052
New Canoe	$104,640	$274,496
Used Canoe	$0	$0
New Accessory	$849,885	$2,229,447
Used Accessory	$28,074	$73,645
Boat Insurance	$2,032,408	$5,331,480
Boat Maintenance	$2,848,263	$7,471,659
Boat Registration	$1,162,956	$3,050,704
Boat Storage	$966,436	$2,535,187
Boat Purchase Fees	$96,984	$254,411
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$0	$0
Vehicle Insurance	$578,500	$1,517,541
Vehicle Maintenance	$1,021,734	$2,680,246
Vehicle Registration	$267,982	$702,979
Vehicle Purchase Fees	$0	$0
New Home Purchase	$0	$0
Second Home Insurance	$0	$0
Second Home Maintenance	$0	$0

Striped bass trip spending by category in New Jersey

	2009	2016
Auto Fuel	$81,049,808	$62,301,304
Auto Rental	$0	$0
Bait	$43,780,430	$35,508,587
Boat Fuel	$52,578,269	$46,548,834
Boat Rental	$2,864,305	$1,800,973
Charter Fees	$32,165,033	$12,865,321
Crew Tips	$2,290,685	$916,225
Fish Processing	$13,015	$5,206
Food from Grocery Stores	$43,572,797	$33,135,956
Food from Restaurants	$19,771,357	$15,385,086
Gifts & Souvenirs	$593,247	$447,460
Ice	$4,847,311	$4,034,358
Lodging	$10,639,783	$7,354,648
Parking & Site Access	$9,706,217	$7,830,640
Public Transportation	$0	$0
Tournament Fees	$0	$0

Striped bass durable goods spending by category in New Jersey

	2009	2016
Tackle	$102,877,200	$124,841,914
Rods & Reels	$150,229,796	$182,304,488
Binoculars	$2,014,046	$2,444,053
Camping Equipment	$11,460,113	$13,906,896
Clothing	$41,612,888	$50,497,414
Club Dues	$8,641,736	$10,486,783
License Fees	$4,890,335	$5,934,442
Magazine Subscriptions	$10,726,563	$13,016,729
Taxidermy	$0	$0
New Boat	$35,165,367	$42,673,321
Used Boat	$74,172,222	$90,008,302
New Canoe	$1,454,231	$1,764,716
Used Canoe	$122,258	$148,361
New Accessory	$61,238,573	$74,313,266
Used Accessory	$1,055,283	$1,280,590
Boat Insurance	$50,055,150	$60,742,134
Boat Maintenance	$128,808,843	$156,310,072
Boat Registration	$9,214,420	$11,181,738
Boat Storage	$257,932,984	$313,002,759
Boat Purchase Fees	$1,081,021	$1,311,824
New Vehicle Purchase	$24,972,880	$30,304,695
Used Vehicle Purchase	$1,943,265	$2,358,160
Vehicle Insurance	$25,320,352	$30,726,353
Vehicle Maintenance	$17,109,737	$20,762,738
Vehicle Registration	$2,277,866	$2,764,200
Vehicle Purchase Fees	$836,505	$1,015,102
New Home Purchase	$0	$0
Second Home Insurance	$649,900	$788,656
Second Home Maintenance	$1,319,103	$1,600,738

Striped bass trip spending by category in New York

	2009	2016
Auto Fuel	$21,779,017	$40,037,865
Auto Rental	$0	$0
Bait	$13,584,999	$25,617,396
Boat Fuel	$27,877,148	$61,426,627
Boat Rental	$29,109	$64,142
Charter Fees	$17,679,269	$28,993,819
Crew Tips	$1,901,152	$3,117,870
Fish Processing	$0	$0
Food from Grocery Stores	$16,082,269	$30,371,819
Food from Restaurants	$2,628,535	$4,691,178
Gifts & Souvenirs	$41,784	$68,525
Ice	$1,008,602	$2,080,941
Lodging	$170,348	$279,370
Parking & Site Access	$560,894	$907,251
Public Transportation	$4,821	$7,907
Tournament Fees	$0	$0

Striped bass durable goods spending by category in New York

	2009	2016
Tackle	$44,487,847	$117,806,460
Rods & Reels	$44,648,672	$118,232,334
Binoculars	$1,884,384	$4,989,961
Camping Equipment	$4,142,003	$10,968,271
Clothing	$14,577,424	$38,601,885
Club Dues	$3,529,048	$9,345,127
License Fees	$1,741,766	$4,612,298
Magazine Subscriptions	$4,739,787	$12,551,237
Taxidermy	$0	$0
New Boat	$37,375,132	$98,971,568
Used Boat	$15,763,888	$41,743,712
New Canoe	$697,920	$1,848,134
Used Canoe	$0	$0
New Accessory	$17,344,829	$45,930,136
Used Accessory	$154,756	$409,804
Boat Insurance	$24,287,615	$64,315,047
Boat Maintenance	$52,343,999	$138,610,015
Boat Registration	$5,052,334	$13,378,880
Boat Storage	$59,116,857	$156,544,945
Boat Purchase Fees	$822,332	$2,177,583
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$4,387,793	$11,619,135
Vehicle Insurance	$7,913,806	$20,956,227
Vehicle Maintenance	$3,623,115	$9,594,224
Vehicle Registration	$974,054	$2,579,352
Vehicle Purchase Fees	$0	$0
New Home Purchase	$0	$0
Second Home Insurance	$30,344	$80,354
Second Home Maintenance	$109,240	$289,273

Striped bass trip spending by category in North Carolina

	2009	2016
Auto Fuel	$14,541,397	$10,782,072
Auto Rental	$2,356	$2,011
Bait	$2,404,158	$1,736,162
Boat Fuel	$2,694,439	$3,051,372
Boat Rental	$0	$0
Charter Fees	$2,848,260	$2,431,720
Crew Tips	$309,462	$264,205
Fish Processing	$505	$431
Food from Grocery Stores	$7,012,112	$5,151,871
Food from Restaurants	$5,204,542	$3,735,388
Gifts & Souvenirs	$936,933	$622,346
Ice	$861,175	$655,422
Lodging	$15,333,028	$10,477,052
Parking & Site Access	$1,584,644	$1,027,795
Public Transportation	$64,311	$48,806
Tournament Fees	$0	$0

Striped bass durable goods spending by category in North Carolina

	2009	2016
Tackle	$6,881,508	$8,805,838
Rods & Reels	$8,620,002	$11,030,481
Binoculars	$152,408	$195,027
Camping Equipment	$1,233,457	$1,578,378
Clothing	$2,509,498	$3,211,248
Club Dues	$231,600	$296,364
License Fees	$1,304,431	$1,669,199
Magazine Subscriptions	$507,279	$649,133
Taxidermy	$45,573	$58,317
New Boat	$25,967,588	$33,229,108
Used Boat	$12,596,798	$16,119,339
New Canoe	$0	$0
Used Canoe	$5,977	$7,648
New Accessory	$3,077,291	$3,937,818
Used Accessory	$91,146	$116,634
Boat Insurance	$2,480,361	$3,173,964
Boat Maintenance	$5,922,236	$7,578,317
Boat Registration	$822,553	$1,052,571
Boat Storage	$2,611,850	$3,342,222
Boat Purchase Fees	$632,044	$808,787
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$2,672,365	$3,419,659
Vehicle Insurance	$1,002,604	$1,282,970
Vehicle Maintenance	$1,057,142	$1,352,759
Vehicle Registration	$243,554	$311,660
Vehicle Purchase Fees	$29,884	$38,241
New Home Purchase	$0	$0
Second Home Insurance	$955,537	$1,222,741
Second Home Maintenance	$301,827	$386,229

Striped bass trip spending by category in Rhode Island

	2009	2016
Auto Fuel	$27,122,139	$6,770,910
Auto Rental	$0	$0
Bait	$7,644,614	$1,946,308
Boat Fuel	$9,634,743	$3,403,111
Boat Rental	$46,818	$25,224
Charter Fees	$5,569,278	$3,000,592
Crew Tips	$1,037,712	$559,094
Fish Processing	$0	$0
Food from Grocery Stores	$10,399,137	$2,731,563
Food from Restaurants	$4,928,849	$1,599,808
Gifts & Souvenirs	$0	$0
Ice	$476,801	$170,153
Lodging	$1,651,155	$640,614
Parking & Site Access	$185,800	$36,614
Public Transportation	$68,426	$36,866
Tournament Fees	$0	$0

Striped bass durable goods spending by category in Rhode Island

	2009	2016
Tackle	$13,917,648	$20,767,095
Rods & Reels	$15,357,098	$22,914,958
Binoculars	$424,529	$633,458
Camping Equipment	$1,672,448	$2,495,528
Clothing	$6,144,814	$9,168,929
Club Dues	$1,097,852	$1,638,151
License Fees	$1,234,097	$1,841,446
Magazine Subscriptions	$934,952	$1,395,080
Taxidermy	$1,975	$2,946
New Boat	$7,669,170	$11,443,484
Used Boat	$12,211,633	$18,221,480
New Canoe	$1,430,565	$2,134,605
Used Canoe	$0	$0
New Accessory	$6,556,508	$9,783,236
Used Accessory	$25,669	$38,302
Boat Insurance	$6,672,020	$9,955,595
Boat Maintenance	$17,394,838	$25,955,554
Boat Registration	$1,782,035	$2,659,048
Boat Storage	$32,276,069	$48,160,450
Boat Purchase Fees	$133,282	$198,876
New Vehicle Purchase	$140,193	$209,188
Used Vehicle Purchase	$5,569,231	$8,310,079
Vehicle Insurance	$3,599,613	$5,371,131
Vehicle Maintenance	$2,541,252	$3,791,906
Vehicle Registration	$491,664	$733,632
Vehicle Purchase Fees	$172,774	$257,802
New Home Purchase	$0	$0
Second Home Insurance	$43,440	$64,819
Second Home Maintenance	$45,415	$67,765

Striped bass trip spending by category in Virginia

	2009	2016
Auto Fuel	$19,232,803	$6,805,761
Auto Rental	$185,275	$102,590
Bait	$7,082,542	$2,632,612
Boat Fuel	$17,905,951	$5,422,516
Boat Rental	$0	$0
Charter Fees	$1,236,529	$468,755
Crew Tips	$66,563	$25,233
Fish Processing	$0	$0
Food from Grocery Stores	$7,438,895	$2,606,255
Food from Restaurants	$2,143,152	$815,516
Gifts & Souvenirs	$380,827	$206,263
Ice	$2,099,282	$719,374
Lodging	$4,632,018	$1,860,711
Parking & Site Access	$1,920,858	$884,431
Public Transportation	$5,711	$2,165
Tournament Fees	$0	$0

Striped bass durable goods spending by category in Virginia

	2009	2016
Tackle	$26,210,384	$12,079,301
Rods & Reels	$29,060,798	$13,392,941
Binoculars	$608,850	$280,594
Camping Equipment	$4,078,055	$1,879,410
Clothing	$6,573,098	$3,029,274
Club Dues	$738,076	$340,149
License Fees	$6,140,690	$2,829,995
Magazine Subscriptions	$1,344,441	$619,598
Taxidermy	$255,966	$117,964
New Boat	$10,156,617	$4,680,772
Used Boat	$539,267	$248,526
New Canoe	$1,650,109	$760,468
Used Canoe	$203,778	$93,913
New Accessory	$7,726,186	$3,560,685
Used Accessory	$745,531	$343,585
Boat Insurance	$14,162,604	$6,526,969
Boat Maintenance	$36,958,456	$17,032,651
Boat Registration	$2,403,095	$1,107,489
Boat Storage	$20,753,098	$9,564,259
Boat Purchase Fees	$149,106	$68,717
New Vehicle Purchase	$0	$0
Used Vehicle Purchase	$4,152,608	$1,913,768
Vehicle Insurance	$4,326,565	$1,993,938
Vehicle Maintenance	$2,564,627	$1,181,932
Vehicle Registration	$748,016	$344,730
Vehicle Purchase Fees	$106,859	$49,247
New Home Purchase	$0	$0
Second Home Insurance	$2,040,270	$940,277
Second Home Maintenance	$1,018,892	$469,566

Fish and Shellfish of the Middle Atlantic Coast

CONSERVATION BULLETIN NUMBER 38

Fish and Shellfish of the Middle Atlantic Coast

By RACHEL L. CARSON
Designed by KATHERINE L. HOWE

CONSERVATION BULLETIN NUMBER 38

UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

OFFICE OF THE COORDINATOR OF FISHERIES
Ira N. Gabrielson, Deputy Coordinator

This publication is one of a series of regional accounts of the fishes and fisheries of the United States, published as Conservation Bulletins of the United States Department of the Interior. The following bulletins in this series have already been issued and may be obtained from the Superintendent of Documents, Government Printing Office, at the prices indicated:

FOOD FROM THE SEA: FISH AND SHELLFISH OF NEW ENGLAND
by Rachel L. Carson. Conservation Bulletin No. 33. 15c.

FOOD FROM HOME WATERS: FISHES OF THE MIDDLE WEST
by Rachel L. Carson. Conservation Bulletin No. 34. 15c.

FISH AND SHELLFISH OF THE SOUTH ATLANTIC AND GULF COASTS
by Rachel L. Carson. Conservation Bulletin No. 37. 10c.

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CONTENTS

FISHING GROUNDS

Middle Atlantic fishing grounds are divided into two distinct areas: the offshore grounds which lie near the edge of the continental shelf (depth, about 100 fathoms) and the inshore grounds which include the bays and sounds. Offshore grounds are fished in winter, inshore grounds in summer. Fishing operations are controlled by the migrations of the fish, which are generally inshore and north in spring, offshore and south in autumn.

The Middle Atlantic region[1] is a natural division of the Atlantic coast in both a geographic and a biological sense. Its geographic boundaries are clearly defined: on the south Cape Hatteras, the most easterly seaward projection of the North Carolina shore; on the north Cape Cod. Biologically, the fauna of this long, curving Middle Atlantic shore is distinct from that of the North and South Atlantic coasts. Cape Hatteras and Cape Cod are natural boundaries of the marine world. There is some straying beyond them, some overlapping of ranges, but for the most part the truly southern, tropical or semi-tropical fishes live below Hatteras, the typically cold water fishes beyond and north of Cape Cod.

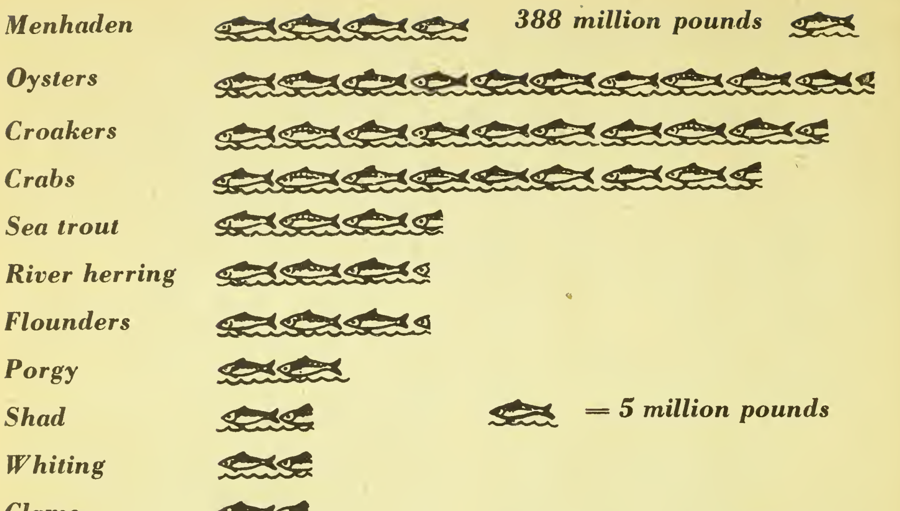
Most characteristic of the Middle Atlantic fauna is a group of 60 or more species collectively known as shore fishes. They are a migratory group, their migrations are seasonal, and for generations their movements have determined the character of the fisheries of the region. In the spring and summer, shorefish move in to coastal waters, including bays, sounds, sometimes river estuaries. They tend to be more concentrated at this season toward the northern part of their range. In the fall and early winter they migrate to offshore more southerly wintering grounds.

Formerly the shorefish were taken only during the spring, summer, and fall, when on the inshore grounds. No one knew exactly where the fish went in winter, nor how to follow and capture them. About 1930, however, the offshore winter home of the shorefish was discovered; gear and vessels were developed which were suitable for fishing these grounds in stormy winter weather. Now intensive winter fisheries have grown up, working the offshore area from about 80 miles off New York City all the way to the vicinity of Cape Hatteras, and shorefishes come into the markets throughout the year.

While the shorefishes are most typical of the Middle Atlantic fauna, they are not the most valuable aquatic resource of the region. This distinction falls to oysters, the product for which the region is best and most widely known. Since the earliest beginnings of the oyster industry, the Chesapeake Bay has held first rank as a producer of oysters. The area as a whole now provides more than half of all the oyster harvest taken in United States waters, and its fishermen receive approximately eight million dollars for this single aquatic crop. (Fishermen's income from all Middle Atlantic fishery products: about 22 million dollars.)

Other special resources give the Middle Atlantic region a unique position as a source of aquatic foods. Nearly two-thirds of the catch of Atlantic coast crabs is taken in this area, mostly in Chesapeake Bay. Receiving the drainage of the mightiest rivers of the Atlantic coast—the Hudson, the Delaware, the Susquehanna, and the Potomac—the Middle Atlantic region is the center of the fisheries for shad and river herring, species which live most of their lives in the sea, but enter fresh water to spawn. The area provides more than half the total catch of menhaden, first ranking Atlantic coast fish in volume of production. Its waters yield the first mackerel, swordfish, and tuna of the season, since each of these oceanic wanderers enters coastal waters north of Hatteras as it turns shoreward in spring.

[1] To avoid duplication of material presented in other publications of this series, only that portion of the Middle Atlantic area from Cape Hatteras to the eastern tip of Long Island is treated in this bulletin. The fishes of southern New England have been described in Conservation Bulletin No. 33.



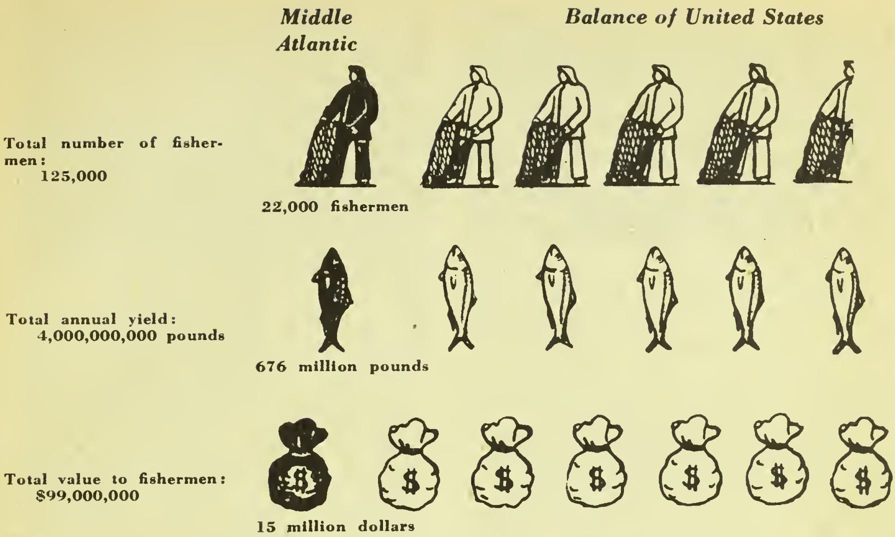
Throughout this bulletin, total statistics for the area represent New York to Virginia, inclusive.

CATCH OF PRINCIPAL SPECIES, 1940

With few exceptions the Middle Atlantic fisheries are carried on by individual fishermen or by small associations of fishermen. In this respect they contrast sharply with the fisheries of New England and the Pacific Coast, where the typical operating unit is a large company, with financial stability and large resources of material and equipment. The only important exceptions to the lack of organization in the Middle Atlantic area are the menhaden fishery, dominated by several large companies owning chains of factories and many boats, and the oyster industry of Long Island Sound and sections of New Jersey and Virginia. The pound net fisheries, as a rule, are carried on by fishermen organized into groups of some size.

The small scale of most of the Middle Atlantic fishery operations has important effects which are seen in the methods of handling the catch. With the exception of menhaden, utilized almost entirely in the production of meal and oil, most of the catch goes into the fresh fish trade. Some filleting and freezing is done. However, facilities for freezing, processing, and storing fish have been inadequate in the past, remain so at present. Efficient use of the Middle Atlantic fishery yield cannot be made until shore plant facilities are expanded. A characteristic feature of the fisheries of the region is their seasonal peaks of heavy production. Without means to process, freeze, and store fish caught during these periods, inevitable waste and inefficiency result.

Markets for the products of the Middle Atlantic fisheries are largely confined to eastern United States. The large coastal cities of the area itself — New York, Philadelphia, Baltimore, Washington, Norfolk, and Richmond—all consume large quantities of seafood, absorbing much of the local supply. From the Chesapeake Bay area, heavy shipments go south and west to Georgia, the Carolinas, Tennessee, Kentucky, and southern Ohio. Jersey-caught whiting finds a large market in St. Louis and Kansas City. With the exception of canned clams, which are distributed through the grocery trade, and the widely marketed oyster, little Middle Atlantic sea-

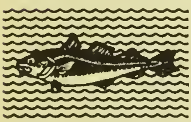


food is sold west of the Mississippi River.

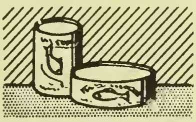
On the other hand, the Middle Atlantic area is an active market for fish and shellfish produced in other areas. New York's busy Fulton Market handles almost every kind of aquatic food taken on the Atlantic coast, even receives many Pacific coast fishes. Red snappers, shrimp, mullet and Spanish mackerel from the south; cod, hake, haddock, and herring from New England; salmon and halibut from the Pacific coast states and Alaska; spiny lobster tails from South Africa—these are only a few of the fish seen in this colorful waterside market. Here also are to be found marine oddities seldom available anywhere else, seldom eaten in America except by such cosmopolitan populations as New York's: Bushels of periwinkles or small marine snails, baskets of spine-studded sea urchins, squids, octopuses, skate wings, puffers, angler fish. Not only marine fish find ready sale in New York: this city is the largest market in the country for fresh water species. It buys large quantities of carp and buffalofish from the Mississippi River and its tributaries, almost every kind of fish caught in the Great Lakes, and lake fish from the Canadian provinces as far west as Alberta.

With the exception of some of the more bizarre items, the markets of Philadelphia, Baltimore, and Washington handle, on a smaller scale, a similar variety of seafoods. A somewhat larger proportion of fish native to the area are sold in these cities, and in the smaller cities and towns of the region the reliance upon locally produced fish becomes more marked.

THE 676 MILLION POUNDS OF FISH AND SHELLFISH TAKEN IN THE MIDDLE ATLANTIC AREA IN 1940 WERE PROCESSED AS FOLLOWS:

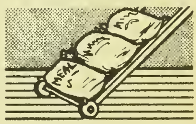


262,589,000 pounds were sold fresh or frozen.

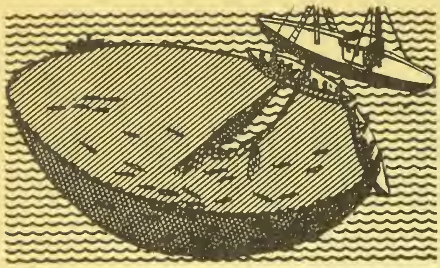


7,600,000 pounds were canned.

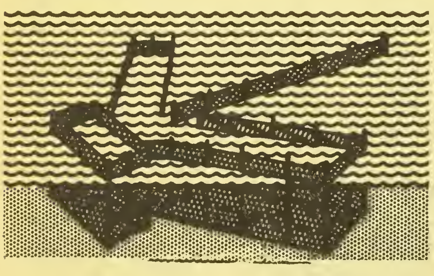
13,000,000 pounds were cured.



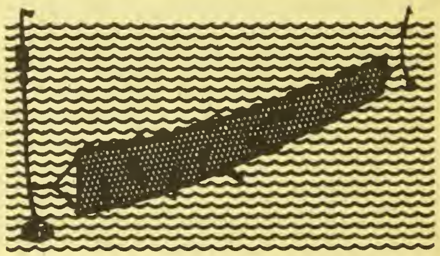
393,100,000 pounds were made into by-products.



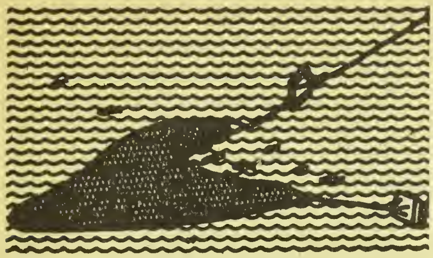
PURSE SEINES, from the standpoint of volume of production, are the most important gear in the Middle Atlantic area. They account for almost two-thirds of the total catch of the region—more than 400 million pounds annually. However, most of this catch is menhaden, a fish used in the manufacture of animal feeds and oils, seldom directly as human food. Purse seines are the chief gear of the mackerel fishery, also take sea trout, porgies, croakers. They are useful for any fish that school in large numbers at the surface where they are visible, but cannot be used when fish swim deep. Mackerel seiners on the Atlantic coast carry smaller seine boats, which do the actual work of setting the net around a school of fish. The net is then pursed by drawing in lines run through its lower border. The fish are gradually concentrated in one part of the net, then the vessel comes alongside and takes the catch aboard.



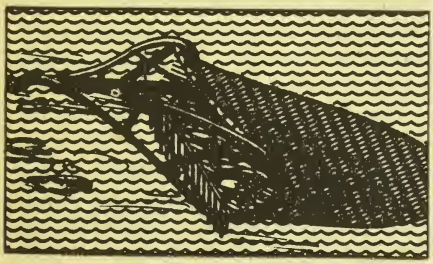
POUND NETS take most of the butterfish, porgies, sea trout, and croakers caught in the spring, summer, and fall, are the principal gear for shad and herring in North Carolina sounds and the Chesapeake Bay, also take quantities of whiting and mackerel. Most pound nets are set in rivers, bays, and sounds, making heaviest catches spring and fall when fish are migrating to and from deeper ocean waters. Large ocean pounds are used offshore. Because of the depth of the water these require poles up to 90 feet long, driven into the bottom with hydraulic jet pumps. Severe storms may destroy an entire trap, which costs $5,000 to $8,000. Netting is hung on inshore pounds as soon as the fish move shoreward in spring. Offshore pounds, more subject to weather hazards, are rigged for fishing about mid-April off New Jersey, somewhat later farther north. They are fished as late as December off New Jersey.



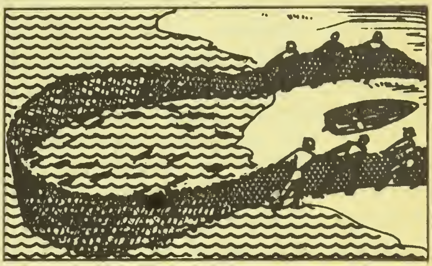
GILL NETS are set perpendicularly in the water, like a tennis net, to intercept migrating fish. In attempting to pass through the net, the fish put their heads through the meshes and become entangled by the flaps which cover their gills—hence the name. Some gill nets are anchored in position, some are attached to stakes, others are so arranged that they drift with the tide. Shad fishermen of the Hudson River use more gill nets than any other type of gear. Small but important gill net fisheries for mackerel operate offshore. Weakfish (sea trout), striped bass, and croakers are other fish taken in this gear.



OTTER TRAWLS are baglike nets which are towed along the bottom to pick up fish in their path. They are of two kinds: one a heavily weighted net which is dragged close to the ocean floor for such groundfish as flounders; the other a "balloon" net which is buoyed a little off the bottom by floats, is towed rapidly, and takes fast, schooling fishes like porgies, whiting, and butterfish. Otter trawls are especially effective gear because, unlike stationary pound nets, they can follow the fish. Small trawlers, known as draggers, operate inshore for fluke and other species all summer. By far the greater part of all winter fishing on the Middle Atlantic coast is done by otter trawlers, which fish the offshore waters all the way from Cape Hatteras to Montauk.



DREDGES, used in fisheries for oysters, clams, crabs and scallops, are operated from power boats. Largest dredges (9 to 12 feet across) are used for sea scallops, which are scattered, thus hard to find with narrower gear. Oyster dredges are 4 to 6 feet wide. Because of the weight of the oysters, the dredges have heavy frames, teeth fairly long and close together, bag wholly or in part of metal rings. Clam dredges, which are 2 to 3 feet wide, have longer teeth for digging the clams out of the bottom sand. Crab dredges have shorter teeth, are of generally lighter construction than oyster dredges, and use cotton twine bags. Dredges without teeth—known as scrapes—are used to take soft crabs.



HAUL SEINES are operated from shore to take fish that are concentrated close to the beaches. The seine is dropped in a wide circle offshore and is then hauled toward the beach, encircling the fish. Hauling is done by hand (small seines) or by power (large seines). Some of the largest haul seines are operated in the lower Chesapeake, and the sounds of North Carolina, taking spot and croakers. Weakfish (sea trout) are taken in night seining in the Peconic Bays of Long Island in summer.

OTHER GEAR used in the Middle Atlantic fisheries includes tongs for oysters and clams; trawl lines and hand lines—used especially for cod in the winter months; pots for sea bass, eels, crabs, and lobsters; rakes, forks and hoes for various shellfish. Fyke nets are used in the river fisheries for catfish, carp, and perch, also take miscellaneous other species. Baited trot lines are one of the principal gears of the Chesapeake Bay crab fishery.

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The fishing grounds of the area extend from Montauk Point at the eastern tip of Long Island to Cape Hatteras, a long, curving shore line indented by an almost continuous series of bays and sounds. Large bodies of protected water—Long Island Sound, Delaware and Chesapeake Bays, Albemarle and Pamlico Sounds — provide unusually favorable conditions for the development of fisheries. Numerous smaller inlets of the sea offer seasonal fishing for commercial fishermen and anglers.

The Middle Atlantic shore is bordered by a broad continental shelf, widest off Long Island—about 125 to 150 miles — narrowing to about 30 miles off Hatteras. This shelf provides vast feeding grounds for fish, supporting the large shorefish populations of this area. Although in places there are areas of shallow water—known to fishermen by distinctive names like Winterquarter Shoals, Five Fathom Bank —these shoals are not as numerous or as extensive as the fishing banks of North Atlantic waters, and for the most part the fishing areas are less concentrated.

Inshore, coastal fisheries have been carried on for several generations. The offshore fisheries are a more recent development. These grounds are fished not only by boats from the Middle Atlantic area itself, but draw trawlers from New England ports.

Long Island is little more than 100 miles from tip to tip, yet its shoreline measures about 600 miles. Between the mainland and the island, the Sound is famous for its oyster beds, also has its populations of clams and scallops. Principal clam beds, however, are on the ocean side of the island. This southern coast, facing the open ocean, yields larger catches of market fish than any other section of the island. Here the great ocean pounds are set; here numerous harbors offer anchorage for the trawlers. Most important, however, is the fact that this southern shore lies directly in the path of the great northward fish migrations in the spring.

Long Island has long been known for its sport fishing: weakfish, flounders, and porgies in its bays, striped bass, weakfish, and bluefish along its ocean beaches.

Chesapeake and Delaware Bays are the summer home of large segments of the shorefish populations. Heavy runs of weakfish or sea trouts, porgies, croakers, spot, and flounders enter the bays in spring, leave in the fall or early winter as the shallow waters grow cold. Pound nets within the bays intercept the runs, making their heaviest catches at these seasons. In some areas the pound net fisheries are active throughout the summer, supplemented by haul seines, gill nets, and other gear. The Chesapeake Bay in particular is noted for the oysters and crabs which thrive in its protected waters, less salty than the open ocean. Both bays are centers of sport fishing, especially for sea trout, flounders, croakers or hardheads, and striped bass.

The sounds of northern North Carolina are centers of fishing for anadromous and fresh water species. In Currituck Sound the fisheries are chiefly those for carp, catfish, gizzard shad, white perch, crabs. South and west of Currituck is Albemarle Sound, its waters freshened by the large inflow from the sluggish Chowan and the muddy Roanoke. Heavy runs of shad and herring enter the Sound, support its principal fisheries. An active fishery for catfish is carried on here. Pamlico Sound is directly in the path of the runs of shad and herring. Most of the migrating fish come in from the sea through Hatteras and Oregon Inlets, cross Pamlico Sound en route to their fresh water spawning grounds. Many pound nets are operated here, also in narrow Croatan Sound through which the runs must pass to enter Albemarle.

Conservation of the fishery resources of the Middle Atlantic region requires close interstate cooperation. To an unusual degree, the various parts of the area are dependent upon each other for the maintenance of their fisheries. This is largely because of the migratory habits of the shorefish populations. The same stock of fish may be subject to capture by fishermen of different states at different seasons of the year (examples: croakers, porgies, flounders), or at different periods in their lives (example: weakfish, see page 15). Only carefully coordinated measures to protect these stocks from depletion or to increase their productivity can be effective.

Another reason for the interdependence of the Middle Atlantic fisheries is the fact that parts of the area—notably Chesapeake Bay—are important nursery grounds, providing especially favorable conditions for spawning and survival of the young fish. Some of the fish produced in these areas migrate elsewhere, support important fisheries in other sections. Outstanding example is the striped bass: the Chesapeake Bay supplies most of the bass taken farther north along the Atlantic coast.

The anadromous fishes of the region — shad and herring — need strong positive action to restore runs and prevent further depletion. This has been done with marked success in the Hudson River. In places such as the Delaware River, there is little hope of rebuilding the runs until pollution is brought under control. In other areas, the intensity of fishing operations must be adjusted to allow more shad to spawn. Dams in some Atlantic coast rivers are absolute barriers to migrating fish. Whether satisfactory fishways can be devised for the passage of shad and herring is a problem for future solution.

The shellfish resources of the region, great as they are, suffer from lack of management by modern, scientific methods in many parts of the area. This is largely because, with few exceptions, the practice is merely to harvest the crop from the public grounds with little or no provision for replenishment, with no systematic cultivation. Legal barriers in some states have prevented the modernization of shellfish management. However, recent progress has been made in some areas toward the development of a system of state-managed cultivation.

In the Middle Atlantic region there are no new, undeveloped fishing grounds awaiting discovery and exploitation, no important resources of fish or shellfish now underutilized. The future development of the fisheries as a source of food and of economic wealth to the area depends upon better utilization of the existing resource. This requires adjustment of fishing operations in such a way as to stabilize production, a goal which can be realized only by measures based on scientific studies of the aquatic resources and by continuous observation of changing conditions. It also demands improvements in the technological field—better methods of handling, processing, and distributing the catch.

Like all other living resources, the fisheries of the Middle Atlantic region are not static, but are undergoing constant change. The nature of these changes may often be influenced or controlled by man. Whether the Middle Atlantic fisheries will realize their full importance and value to the area and to the nation depends on the character of the conservation program followed in future years.

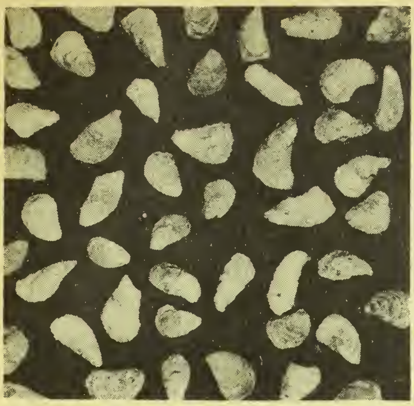
The Middle Atlantic area is the source of more than half the oysters produced in the United States, yielding annually about 50 million pounds, of which 35 million come from the Chesapeake Bay. Oysters are the most valuable aquatic crop of the region. They brought fishermen, in recent prewar years, an annual income of about 5 million dollars. In the country as a whole, they rank second only to salmon in value.

The eastern oyster is one of three species taken commercially in the United States, the other two being found on the Pacific coast. The oyster taken from Massachusetts to Texas is intermediate in size between the small Olympia oyster of Puget Sound and the giant Pacific or Japanese oyster.

Oysters are mollusks that grow best in shallow waters, never abundantly in the open ocean. They thrive in enclosed bays, sounds, and river mouths, where the salinity of the water is reduced by the flow from tributary streams. In the Chesapeake and Delaware Bays, and in Long Island Sound, they may grow some distance offshore, in water 30 or more feet deep. On good hard bottoms, where oysters are not crowded, the shells are flat and rounded. On muddy bottoms or on overcrowded reefs they tend to grow in clusters of long, misshapen shells.

Oysters spawn in the summer, earlier in the south, later in the north where the water is colder. The female oyster is very prolific, producing from 15 million to 114 million eggs at one spawning, several hundred million in a summer. This high fecundity is balanced by a high mortality rate: of the larvae developed from the fertilized eggs, comparatively few live long enough to settle down on the bottom, at the age of about two weeks, and attach themselves to clean shells, rocks, or other hard objects. Those that do survive are subject to the attacks of starfish, marine snails, boring sponges, and other natural enemies. They must, in addition, compete with their fellows for food and room to grow. Once a young oyster has "set" or become attached to the subsurface, it never moves of its own accord, except for slight changes of position made by oysters living on muddy bottom.

About half the Middle Atlantic crop of oysters comes from public grounds, half from privately leased



Yield from one square yard of cultivated ground (1,000 bushels per acre). Oysters attain full growth and desirable shape when cultivated and transplanted. Segregated by growers according to age, their size is uniform, making marketing easier.

Yield from one square yard of severely depleted uncultivated rock (11 bushels per acre). Years of fishing without reseeding the grounds or protecting the oysters from their natural enemies have reduced the yield to a worthless remnant.

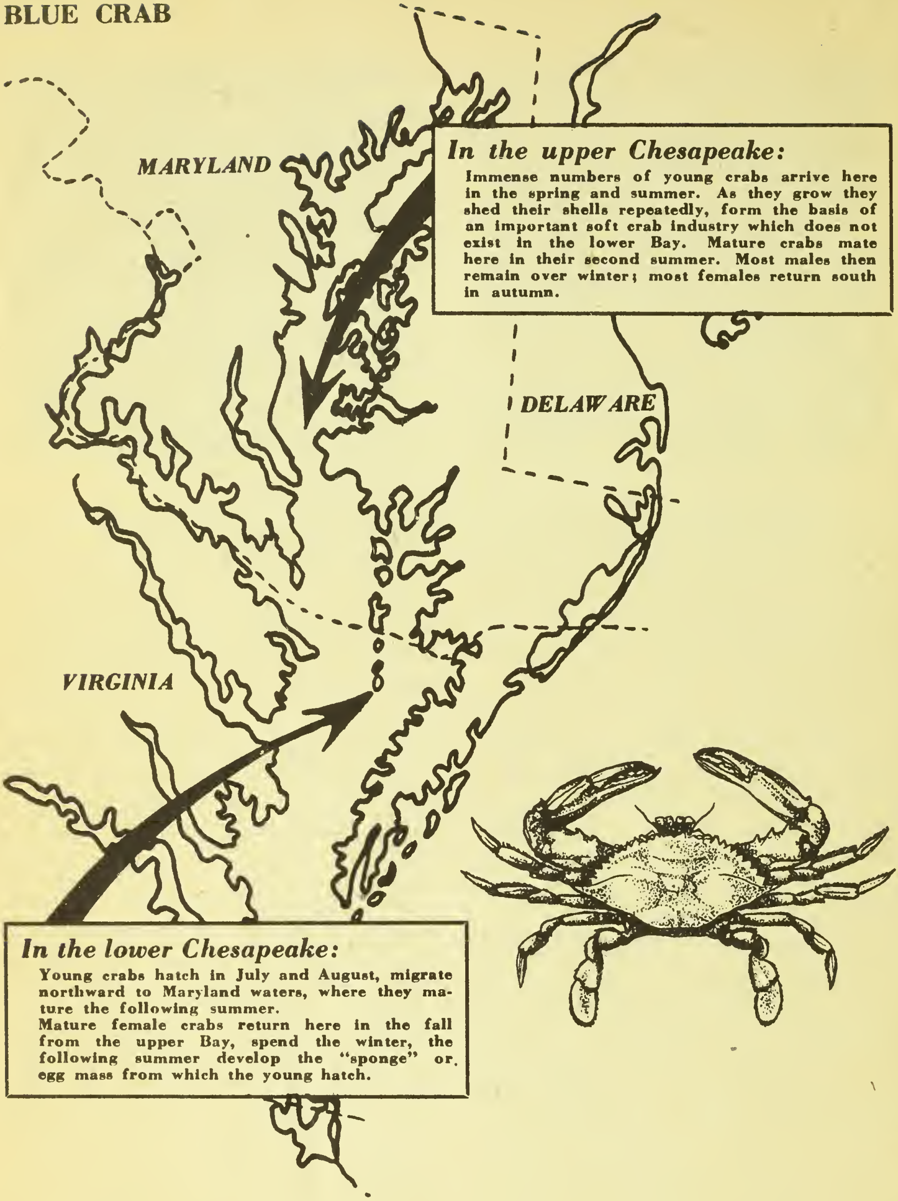
and cultivated beds. The more northerly states of the group, New York and New Jersey, follow the New England practice and have developed large private industries. Delaware takes about a third of its yield from private beds, Virginia about three-fourths. Maryland, however, which produces more oysters than any other state in the country, takes all but a negligible amount from the public rocks. The small oyster production in North Carolina is entirely from public grounds.

Oyster cultivation on underwater farms has much in common with agriculture. As in land farming, the cultivated product is superior in quality to the wild. Several basic operations are involved. The bottom is cleaned and planted with shells to receive the young oysters. After the larvae have set they are allowed to grow for several months, then, as seed, are transplanted to growing grounds. With further growth they may be transplanted one or more times to other areas, to assure them plenty of space and food. In this way full growth and a good shape are assured. Finally, the oysters are harvested, graded, and shipped to market.

Most oysters harvested in the Middle Atlantic area are sold as shucked meats. A gallon of eastern oysters contains from 150 to 300 oysters, depending on their size. Present demand for shelled oysters comes chiefly from hotels and restaurants. Canning of oysters is not carried on in this area, but is centered in the southern states.

The oyster feeds by drawing through its gills large quantities of seawater from which it strains its food—microscopic plants and animals. Because of its diet, it is a rich source of minerals such as copper, iron, and iodine. It also contains most of the essential vitamins, protein of high nutritive value, and starch in the easily digested form known as glycogen.

Area catch in 1940:
51,440,000 pounds



BLUE CRABS have an extensive range along the Atlantic coast—from Massachusetts at least to the northern part of South America. They are animals of the shallow bays, sounds, and river channels, seldom found far out at sea, sometimes reported in fresh water. In summer the crabs live close inshore, but in winter move off into deeper water to escape the cold. They do not appear to migrate extensively up and down the coast; probably each section has its own local population.

The blue crab resources of the Atlantic coast yield nearly 80 million pounds annually, of which 60 per cent is taken in the waters from New York to North Carolina. Chesapeake Bay is the chief source of crabs, yielding about 42 million pounds annually.

Crabs have an interesting and complex life history, which has been carefully studied in the Chesapeake. The seasonal migrations are especially important, having a direct bearing on the problem of conservation.

Every year between the first of June and the end of August, a new generation of crabs is produced. The female extrudes the eggs, each about one one-hundredth inch in diameter. These remain attached to the female in a large yellowish mass known as the sponge. The eggs hatch in about 15 days.

As the young crabs grow they shed their shells repeatedly and in about a month assume a crablike form. Thereafter the crab molts about 15 times before reaching maturity—at first every 6 days, then after gradually lengthening periods until about 25 days elapse between the final molts. Ordinarily the crab gains about one-third in size with each molt. Crabs reach their full growth and maturity, and cease to molt, during their second summer, when 12 to 14 months old.

The so-called "soft crab" is not a distinct species; the term is applied to any crab that has shed its old shell, in the interval until the new shell has hardened. As the soft-shelled crab is considered especially choice, large numbers of young crabs are sought in the spring and summer while they are still molting. It is customary to place crabs that show definite signs of approaching the shedding stage in floats. If thus imprisoned too early, however, the crab will die without shedding; hence State laws prohibit the impoundment of crabs which have not reached the "peeler" stage. A peeler crab can be detected by a pink "sign" on the last pair of legs, indicating that the new shell is fully formed underneath the old one.

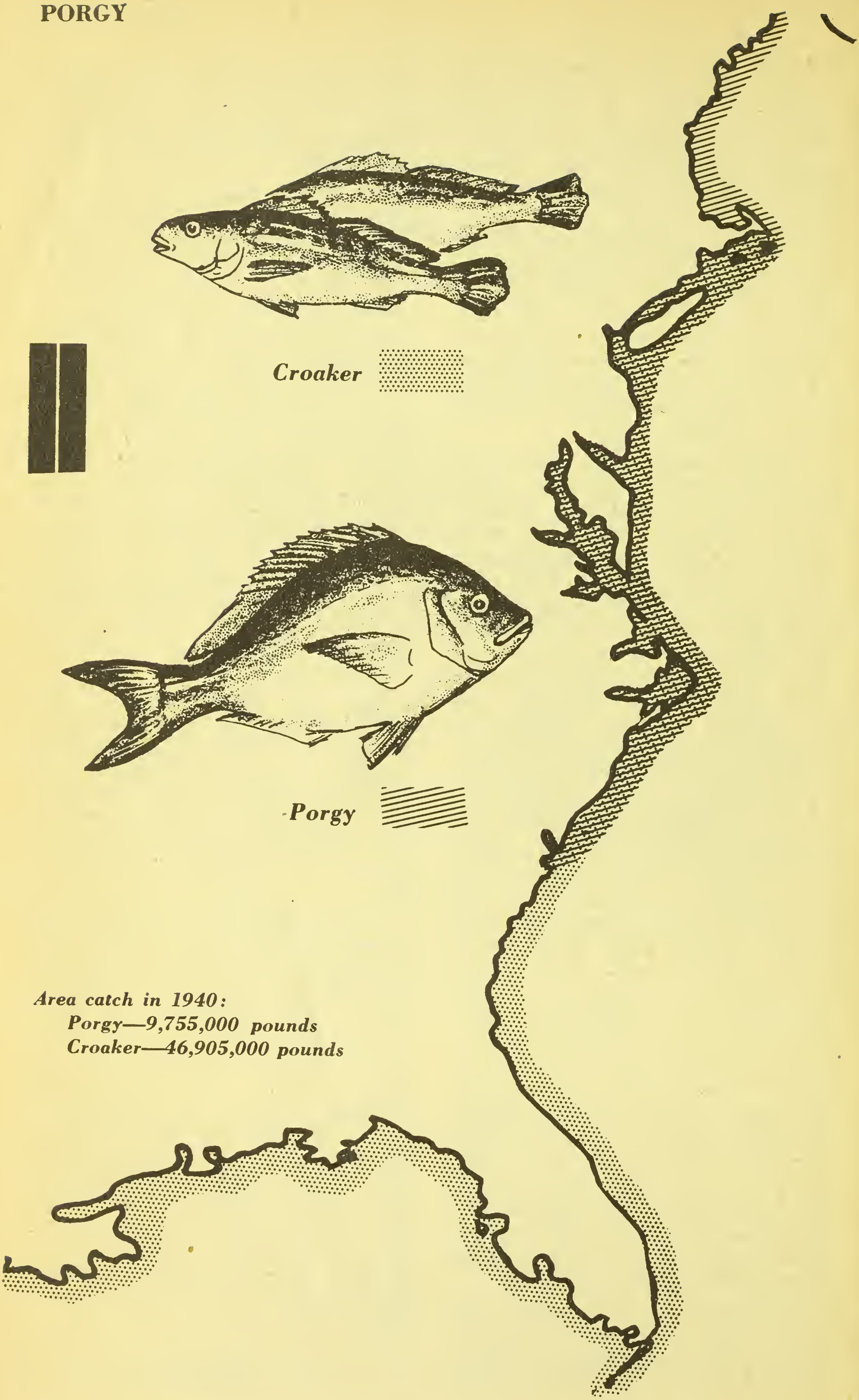
Usually the first spawning takes place when the female is about 2 years old. Some females are believed to live over another winter and deposit more eggs when 3 years old; probably few or none live longer than this. Presumably the life span of the male is about the same length.

Most of the young crabs hatched in the lower Chesapeake Bay soon begin a northward migration. Cold weather interrupts this journey, and they settle to the bottom and cease to feed or grow until conditions are more favorable. In the spring their migration is resumed, growth proceeds, and finally they reach Maryland waters as nearly mature crabs. The mating of the majority of the crabs takes place in Maryland. After mating, the females return to the lower Bay, but most of the males remain behind, spending the winter in deep holes or creeks and rivers. Only about a fifth of the crabs taken in the lower part of the Bay during the winter are males. Nearly all the sponge bearing crabs are found in Virginia waters.

Soft crabs are shipped alive to market, while most hard crabs are steamed near the place of capture, the meat picked out of the shell, and shipped to market in iced containers. Crab meat is also canned in some sections of the country, especially in South Carolina and Louisiana.

At the present time, the most important markets for fresh crab are the cities of the Atlantic seaboard. Improved handling and marketing facilities, and the further development of the canning industry, will probably create wider markets in the near future. However, the conservation problem remains to be solved. The Chesapeake crab fishery has been subject, throughout its history, to extreme fluctuations in yield, catches ranging from 20 to 60 million pounds. Studies are now under way to learn whether it is possible to control these natural fluctuations, and so stabilize production.

Area catch in 1940:
43,038,000 lbs.


Croaker
Porgy
Area catch in 1940:
Porgy—9,755,000 pounds
Croaker—46,905,000 pounds

THE PORGY—called scup in New England—is a common shore fish of the Atlantic coast, marketed chiefly in New York, Philadelphia, Norfolk, and other cities of the Middle Atlantic region. It is available throughout the year, is sold chiefly as fresh, pan-dressed fish rather than in fillets. Summer fisheries for porgies are concentrated in New Jersey, New York, and Rhode Island, winter fisheries offshore from the Jersey Capes to Hatteras.

During recent years the catch, especially in New York and New Jersey, has been increasing. This is due to several causes: temporary increase in abundance (the result of several years of unusually successful spawning) and increases in the number of boats and the effectiveness of their gear. However, a succession of poor spawning years could easily reverse the present upward trend. Rather severe fluctuations in the catch have, in fact, marked the history of this fishery.

Otter trawls take about three-fourths of the total catch of porgies. Ocean pound nets and floating traps, especially off Rhode Island, Long Island, and New Jersey, also take important quantities. The porgy is one of the principal species taken in the offshore winter trawl fisheries.

In addition to its commercial value the porgy is more and more sought by the salt water angler. Open boat fishermen go out from Montauk, the south shore of Long Island, and Cape May, N. J., to fish for it.

Porgies spawn in the inshore waters and bays of New Jersey, Long Island, and southern New England from May until August, then begin to move offshore. The young reach a length of some 4 inches by the end of their first summer. By the fifth year they average 10 inches in length, three-fourths of a pound in weight. Market sizes range from three-fourths of a pound to one and a half pounds.

THE CROAKER or HARDHEAD occurs in fishermen's catches anywhere from Cape Cod to Texas, but north of New Jersey and south of North Carolina there are no important fisheries for the species. It is, however, one of the principal market fishes of the Middle Atlantic section. After Virginia, where about three-fourths of the total catch is taken, the most important fishing centers are North Carolina and New Jersey.

Its comparatively small size — market fish averaging half a pound to about two pounds—places the croaker in the pan-fish category. It is usually sold whole, is sometimes filleted.

The croaker was once exclusively a summer fish in the Chesapeake Bay and northward, taken only during the warm months when the fish were in coastal or inside waters. Now fishermen follow them offshore in winter, and fresh croakers appear in local markets every month of the year.

In March, April, and May the pound netters in Chesapeake Bay and on the Jersey coast find the cribs of their nets filled with croakers. After the first of June they take fewer as the fish scatter. Bay anglers take many croakers during the summer. In the fall the temperature of air and water drops; the croakers begin a mass exodus from the inshore waters. Pound netters again make heavy catches. By mid-December the fish have left the coast, moving to their offshore winter grounds. There they form an important part of the catch of the winter trawlers. The total catch has increased greatly since the development of this winter fishery.

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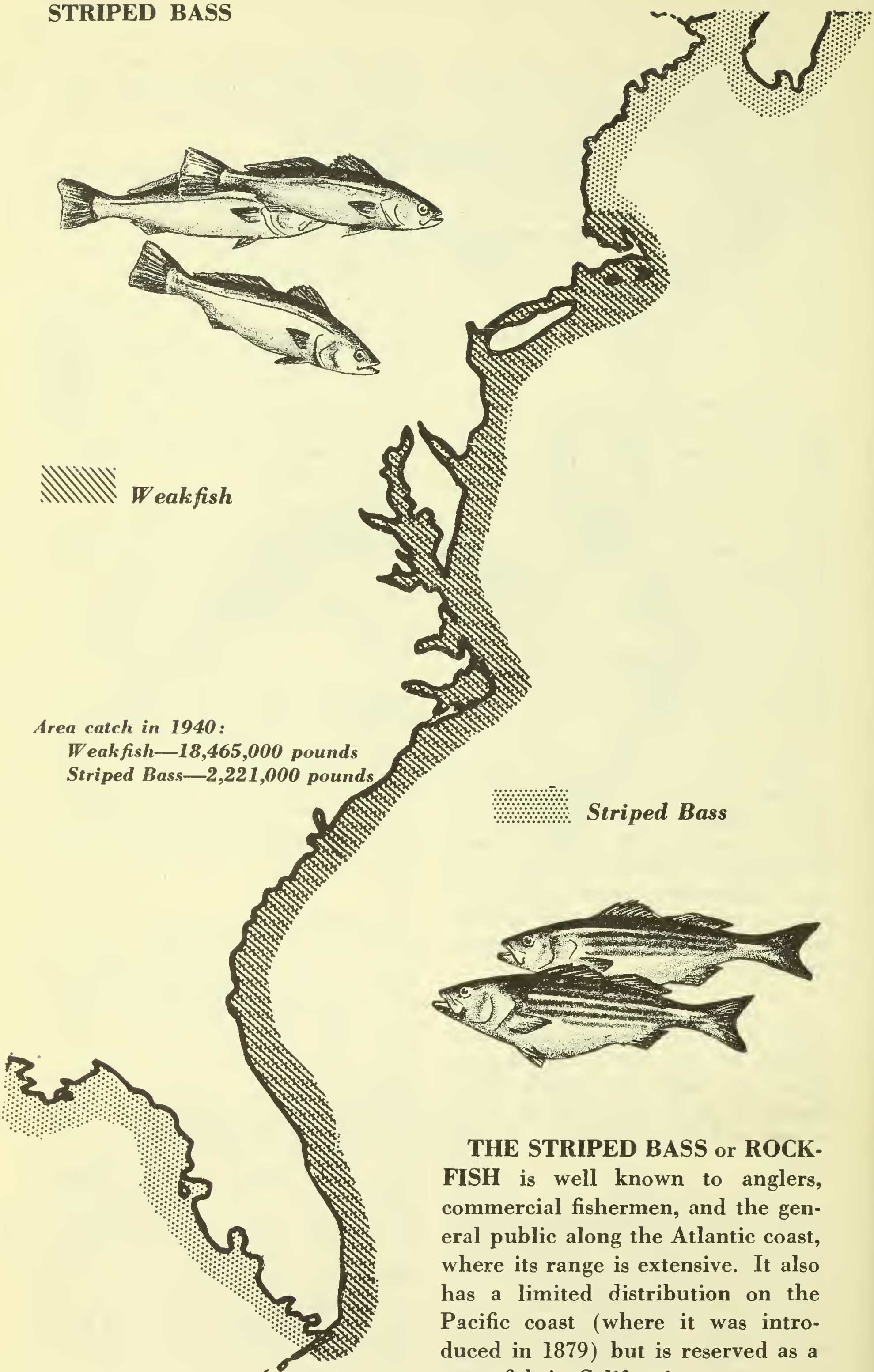


THE STRIPED BASS or **ROCKFISH** is well known to anglers, commercial fishermen, and the general public along the Atlantic coast, where its range is extensive. It also has a limited distribution on the Pacific coast (where it was introduced in 1879) but is reserved as a sport fish in California.

The Chesapeake Bay is the center of abundance of the Atlantic coast stock, furnishing two-thirds of the commercial catch. Most of the bass are taken in pound nets; smaller quantities in haul seines, gill nets, and other gear. Striped bass fisheries are active in the Chesapeake throughout the year. Largest catches in New Jersey and Long Island are made in the fall.

Hundreds of rod and reel fishermen all along the coast seek the striped bass. Surf casting and trolling are their favorite methods.

Most of the catch is sold in the fresh fish markets, but minor quantities are frozen. The larger bass are often filleted or steaked; market sizes of the whole fish run from 2 to 40 pounds. Cities of the Middle Atlantic area are all important markets for the species.

The striped bass is a fish of the coastal waters, seldom being taken more than a mile or so at sea. Although it is most often found in salt water, it sometimes ascends coastal rivers for several hundred miles.

Most important spawning and nursery areas are in the Chesapeake Bay; some spawning also takes place in the Roanoke River, the upper part of Delaware Bay, and the lower Hudson River. Females usually mature when 4 years old or 20 inches long, males when 2 years old or 12 inches long. Spring and summer months are the spawning season.

Some of the striped bass spawned in the Chesapeake (biologists estimate about 10 percent) migrate out of the bay when they are about 2 years old and wander northward at least as far as New England. These fish make up the greater part of the supply available to fishermen in northern coastal states. The striped bass populations as a whole migrate extensively, northward in spring, south in autumn. Conservation of the supply, by appropriate size limits or other methods, therefore becomes an interstate problem.

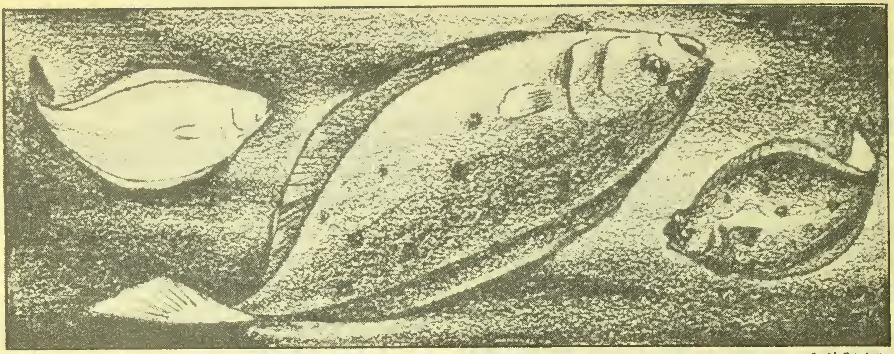
THE WEAKFISH or GRAY SEA TROUT, one of the chief market fishes of the Middle Atlantic area, is also a favorite sport fish from Long Island to North Carolina. Pound net fisheries make most of the catch in the Chesapeake, center of the fishery; haul seines are used more extensively in North Carolina, where they are fished at night. Some purse seining is done in New Jersey. Anglers usually chum the weakfish with bait shrimp.

Weakfish is sold almost entirely in fresh fish markets, sometimes in the form of fresh fillets. Small amounts are frozen, salted, or smoked. This fish is available throughout the year, being taken inshore in summer and offshore by trawlers in winter.

Weakfish probably spawn in their third summer in the larger bays from Hatteras to Cape Cod, but most intensively in the Chesapeake. They migrate widely. Most of the fish spawned in the Long Island bays move at the end of their first summer to the Chesapeake or the sounds of North Carolina, remaining in southern waters about 2 years. In their third summer they migrate northward, but return each fall to the south. Likewise, southern-spawned weakfish tend to wander north in summer. Coastal runs are therefore composed of a mixture of fish from northern and southern spawning grounds. As a result of these migratory habits, the weakfish must be treated as an interstate unit if they are to be effectively conserved.

Seeming to prefer shallow water, schools of weakfish feed in the surf on open coasts and generally keep close inshore during the summer. They usually remain near the surface, feeding on smaller fish and on crabs, shrimps, squids, and other small marine creatures.

A related form, the spotted weakfish or spotted sea trout, is taken abundantly along with the gray trout in Chesapeake Bay.



FLOUNDERS are among the most popular market fishes. Of the half dozen or more species that have commercial or recreational importance along the Atlantic coast, the summer flounder or fluke predominates in the Middle Atlantic area. This is one of the larger flounders, sometimes measuring 3 feet, weighing up to 25 pounds. Market sizes, however, range from ½ pound to 6 pounds. As dressed for market this species yields a larger fillet than most other flounders.

The summer flounder is found from Maine to northern Florida, but is most abundant from Long Island to North Carolina. On the coast as a whole, the resource yields about 11 million pounds of fish caught commercially, also supports an active sport fishery in the bays and inshore waters of Long Island, along the New Jersey coast, and in the lower Delaware Bay and adjacent seacoasts.

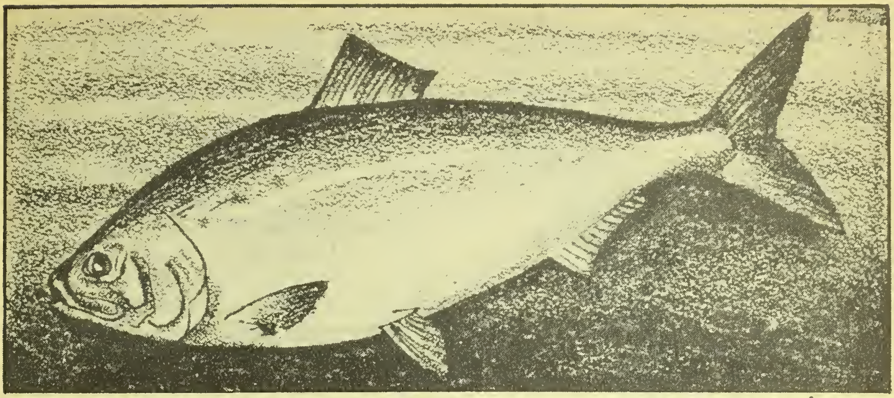
Most important summer fisheries for the summer flounder are located on the southern shore of Long Island and on the coasts of New Jersey and Delaware. In winter, the offshore catch extends from the offing of New York to Cape Hatteras, the summer flounder being the only flatfish taken in important quantities in the winter trawl fishery.

An active migrant, the summer flounder comes inshore in the spring, moves off in the fall. Its name arose from the fact that it is the most common flounder in the inshore coastal waters during the summer months. Most of the larger fish are believed to spend the summer in northern regions—northern New Jersey, southern Long Island, and southern New England; the smaller fish summer anywhere from southern New Jersey to the Virginia Capes. The older fish seem (on evidence from tagging experiments) to return to the same locality summer after summer.

These flounders spawn in the late fall or early winter, probably at sea. In the following spring the young move into coastal waters, where, like the adults, they live on or near the bottom. Probably spawning is more successful—that is, more young survive—from the Chesapeake south than in more northerly parts of the range.

Like other flatfish, the summer flounder is a predatory creature. It lives chiefly on other fishes, also eats shrimps, crabs, and other aquatic animals. Waiting for its prey, it lies partly buried in the sand, but darts up with surprising swiftness to seize a passing fish. In North Carolina, many are speared at night, by torchlight, as they lie on the bottom. Otter trawls, however are the most important gear used in the fishery.

Area catch in 1940:
6,800,000 pounds



K. HOWE

THE SHAD is one of the leading seafood delicacies of the Atlantic coast, where it enters streams from Nova Scotia to northern Florida to spawn in the spring. In the area from Cape Hatteras to Long Island, first shad runs of the season begin in February or March in North Carolina, in March in the Chesapeake Bay, usually in April along the New Jersey coast and in the Hudson River.

Once tremendously abundant all along the Atlantic coast, the shad resource has suffered from the effects of the white man's establishment along the banks of the coastal rivers. Dams, pollution, and excessive fishing have combined to deplete the runs. In the Chesapeake, present catches are about four million pounds annually, compared with some 16 million pounds half a century ago. On the Atlantic coast as a whole, the catch has declined from 50 million to 9 million pounds. Fortunately, much is now being learned about the biology of the shad as a basis for a sound program of restoration, and fishermen as well as State officials are showing an interest in rebuilding the resource. This has already been done in the Hudson River, where the runs have recovered from their low yield of 40,000 pounds in 1916 to 5 million pounds in 1944.

Shad have a peculiar life history. During the greater part of their existence they are inaccessible to the commercial fisheries. Spawned in rivers and streams, they migrate down to salt water as young fish scarcely as long as a man's finger. Little is known about their next two or three years. A few immature shad have been caught along the shores of Long Island, others off the coasts of Maine and Massachusetts, but the main populations of young shad have so far eluded fishermen's nets wherever they have been set.

Shad mature after several years of ocean life—three to four for males, four to as much as seven or eight for females. At maturity, they return to spawn in the rivers where they were hatched. In the course of this spawning migration, they are taken by commercial fishermen in bays, sounds, and rivers. Unlike the Pacific salmon, shad do not as a rule die after spawning but return to the sea from which they make repeated annual spawning migrations.

Fresh shad is available during only a limited season; frozen shad throughout the year. Some canning is done on the Pacific coast, where the shad was introduced in 1871. Frozen fillets of shad—a boneless product—have been prepared on an experimental basis, and may become an important market product after the war. Increasing quantities of fresh fillets are being marketed in the larger eastern cities.

Area catch in 1940:
8,045,000 lbs.

THE BUTTERFISH is solely a commercial species. It is taken in winter as well as summer fisheries, hence is a popular market fish throughout the year. Summer fisheries are chiefly off Long Island and the New Jersey coast. In the fall, runs of large, fat butterfish appear off these coastal areas. These fish are in demand for smoking; the resulting product has a large market in New York delicatessens. Winter fishing for butterfish is carried on from the vicinity of offshore northern New Jersey south to Cape Hatteras, on the offshore grounds where trawlers operate. Most of the winter catch is made off northern New Jersey, along a deep undersea gully, leading to New York harbor.

Market sizes of butterfish in general range from a quarter of a pound to a pound and a half, placing it in the pan-fish category. Rich in fat, it is usually broiled or fried. Chief butterfish markets are Boston, New York, Philadelphia, Baltimore, and Norfolk.

While never seen in enormous schools like those of mackerel or herring, butterfish are rather gregarious, traveling in small, loosely organized bands. Their movements are inshore in summer, a spawning migration; offshore in winter.

Because of their habit of moving in toward the shore line in summer, they are easily taken in pound nets. On Long Island, more than 90 percent of the summer catch of butterfish is made by pounds. This fact creates an important conservation problem, for pound nets are not selective, but trap fish of all sizes. In an effort to return small butterfish to the sea unharmed, many fishermen are now using a sifter device which sorts out the small sizes as the pound is fished.

Butterfish spawn in June and July, and the young, which come to resemble the adults at an early age, are about 4 inches long by the end of their first summer. Small groups of fish less than one year old are often seen under the shelter of large jellyfish during the summer.

Area catch in 1940:
11,985,000 pounds

THE SPOT is a small pan fish, common in the Chesapeake Bay but taken in some numbers all along the coast within its range. Spot fisheries, centered in North Carolina and Virginia, take about 8 million pounds yearly. Because cities near the centers of production—Norfolk, Baltimore, and Richmond — consume almost the entire catch, the spot is not as well known to the general public as its quality merits.

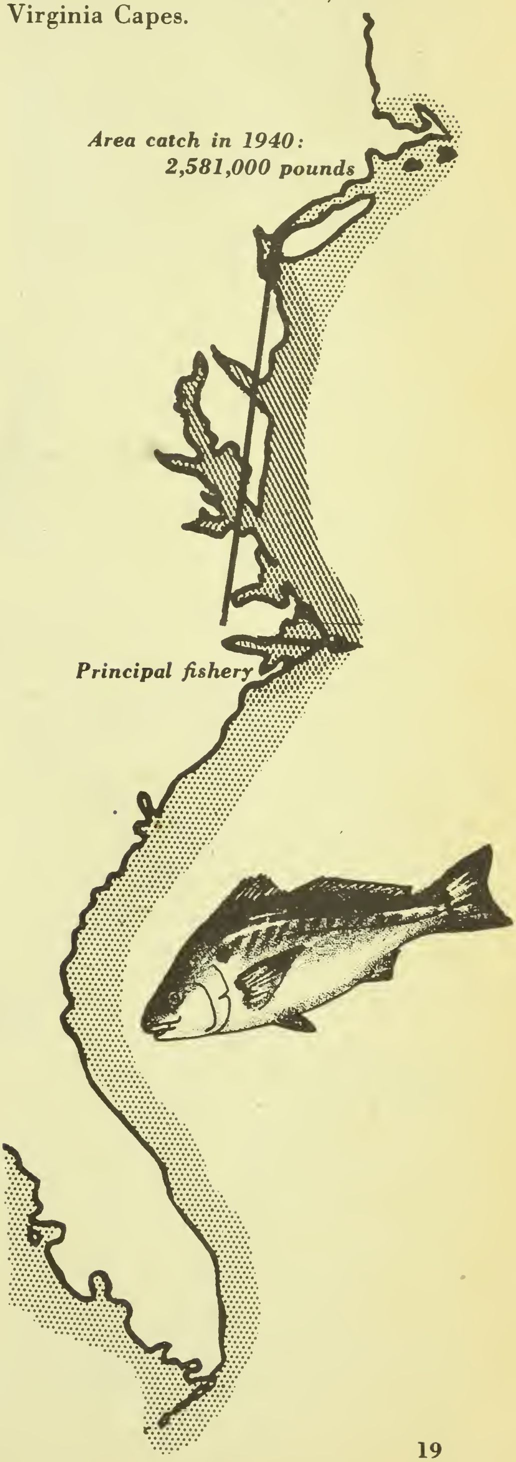
Haul seines are the chief gear used in the spot fisheries, especially in Virginia and North Carolina. Probably the largest seines are operated in the vicinity of Ocean View, Virginia. The commercial catch generally consists of fish ranging from 6 to 12 inches long, weighing up to three-quarters of a pound. Spots are usually sold whole, being too small for filleting.

The spot belongs to the croaker family. Like its relatives, the croakers, drums, and sea trouts, it is able to drum on its air bladder. However, this organ is thin-walled and the drumming muscles are not well developed, hence the sound produced is a feeble imitation of the throbbing hum of the croakers.

The habits of spot are not completely known. They spawn in late fall and early winter, after they move out of the bays and sounds. Nursery grounds are probably close inshore, for young spot are abundant in Pamlico Sound and lower Chesapeake Bay.

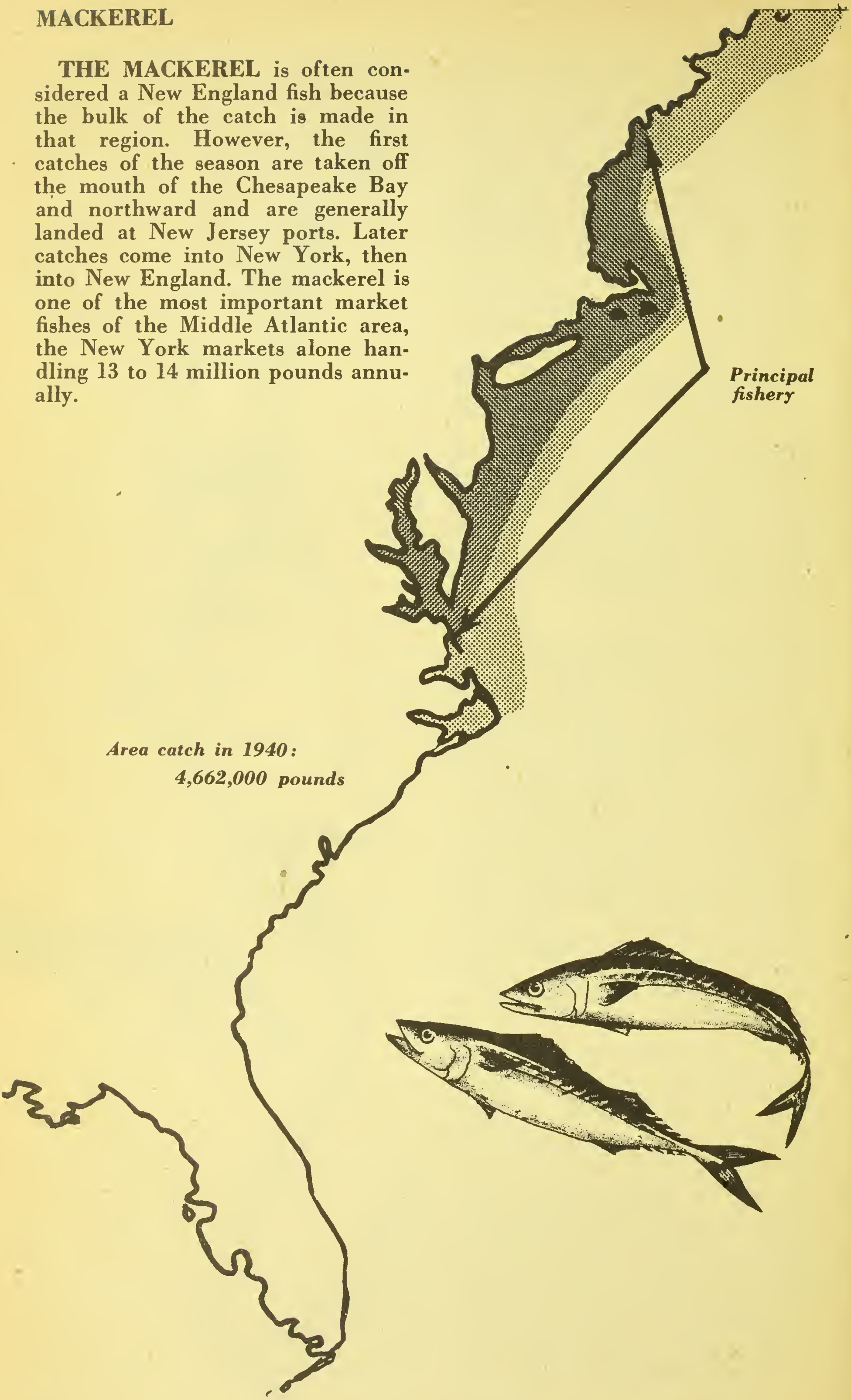
Spots are very abundant some years, scarce in others. This suggests that there are great variations in the survival of the young from year to year, probably depending on environmental conditions.

Seasons of greatest market abundance are spring and fall, when the fish are moving to and from the bays and sounds. In the fall, the movements of the spot seem to concentrate them in heavier runs, hence the fall fisheries are more active and larger catches are made then. The winter habitat of the spot is unknown, but presumably is in deep water offshore. A few are taken in the winter trawl fisheries, off the Virginia Capes.



MACKEREL

THE MACKEREL is often considered a New England fish because the bulk of the catch is made in that region. However, the first catches of the season are taken off the mouth of the Chesapeake Bay and northward and are generally landed at New Jersey ports. Later catches come into New York, then into New England. The mackerel is one of the most important market fishes of the Middle Atlantic area, the New York markets alone handling 13 to 14 million pounds annually.



Mackerel are highly migratory, their movements difficult to predict. Their seasonal migrations control the operations of the fishery, and their extreme changes in abundance from year to year set in motion a chain of economic effects, making the mackerel industry one of the most precarious ventures among the fisheries.

Every spring the mackerel migrate from the deeper waters off the coast, where they have wintered, and move shoreward in two vast divisions: one that arrives off the Chesapeake and Delaware Bays in April, another that comes inshore in the vicinity of southern New England in late May. Both groups then move in a northeasterly direction up the coast. This shoreward movement is a spawning migration. After spawning, the mackerel spend the summer feeding on the abundant surface life of the coastal waters. The southern group of mackerel summers in the Gulf of Maine, the northern in the Gulf of St. Lawrence.

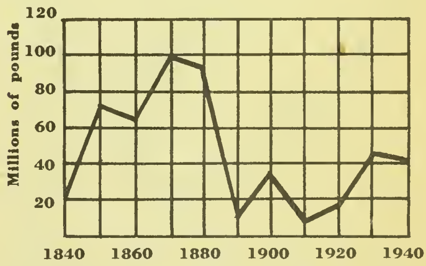
Oceanic conditions — water temperatures, distribution of feed, perhaps other factors—appear to control the movements and concentrations of mackerel. In some years the fish do not appear on their usual feeding grounds, or are widely scattered, making it difficult for fishermen to locate them.

Years of poor mackerel catches, however, usually reflect an actual scarcity. More than most fish, at least among the species that are well known, young mackerel seem to be affected by environmental conditions, attacks by natural enemies, availability of food. What happened in one year, when infant mortality must have been unusually high, serves to illustrate the point. In 1932, out of every million mackerel eggs spawned, only four young fish survived the first 2 months. This almost complete failure of the year's spawning had its inevitable result in poor catches by fishermen a few years later. However, when conditions favor survival and growth of the young mackerel, broods of enormous size may result, and subsequent catches are good.

While the conditions that determine the abundance of mackerel are of a cosmic character, and as such uncontrollable, it is possible that with further study the environmental factors may be foreseen and their effects well enough understood to allow biologists to make accurate predictions of the abundance of mackerel in advance of the fishing season.

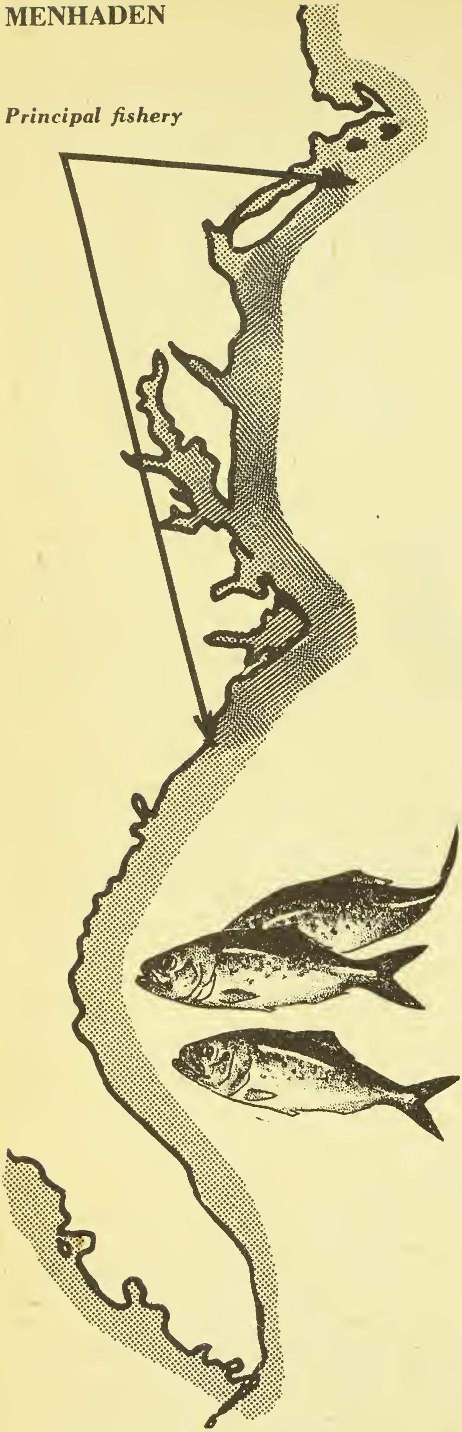
Mackerel are taken largely in purse seines. There is also a small gill net fishery, and some are taken in pound nets. Most seining is done at night, the fish being located by the phosphorescent glow which their movements create in the water.

Mackerel are caught from late March or early April into December (rarely into January) and thus are available in the fresh state during the greater part of the year. A considerable part of the catch is frozen. Although the early mackerel fishery was a salt-fish industry, today only a small part of the catch—about 6 million pounds—is salted or smoked. Smaller quantities are filleted. During the war a considerable amount of mackerel has been canned; normally, however, less than 2 million pounds are so treated.



During the history of the mackerel fishery, the catch has shown extreme fluctuations, from only a few million pounds to 100 million or more.

MENHADEN



THE MENHADEN at present has little utility as a food fish; its importance rests on the fact that it supports the largest fishery byproduct industry on the Atlantic coast and ranks second in volume of production among all fisheries of the United States.

A third of the fish meals and a fourth of the marine animal oils produced in the United States are derived from the menhaden. The meals are fed to hogs and poultry; the oils are used in preparing fortified vitamin feeding oils for poultry. Industrial uses of menhaden oil are many: as a constituent of many paints, varnishes, insect sprays, printing inks, and soap; as a lubricant for machinery; in aluminum casting; in leather tanning. Small quantities of menhaden are canned, and the roe is saved for freezing, salting, or canning.

Menhaden, of which at least three species occur on the Atlantic coast, are herringlike fish that swim in enormous schools near the surface of the water, straining out the minute forms of sea life. They form perhaps one of the chief foods of the larger predatory fishes present in the same area.

Menhaden mature during their third or fourth year, spawn in the summer and fall. They increase in oil content, and therefore in commercial value, with age and size. Also, northern menhaden are more oily than southern.

The fishery is largely controlled by the seasonal migrations of the menhaden. In the spring large schools appear in the coastal waters, entering bays, sounds, and river mouths. Fishing begins in northern New Jersey and western Long Island in early June, a little later in the Chesapeake Bay where intensive activity continues into October or November, when the fish move out of the Bay and down the coast into the region of the North Carolina fall fisheries. The purse seine is the most important gear used in the menhaden fishery.

Area catch in 1940: 388,596,000 lbs.

RIVER HERRING support one of the principal river fisheries of the Atlantic coast. They are caught in greater quantity than any other food fish in North Carolina, outrank all other aquatic products except crabs and oysters in Maryland, and are one of the chief products of the Virginia fisheries. Elsewhere in the Middle Atlantic area few are caught, but in New England, where they are called alewives, rather large fisheries exist.

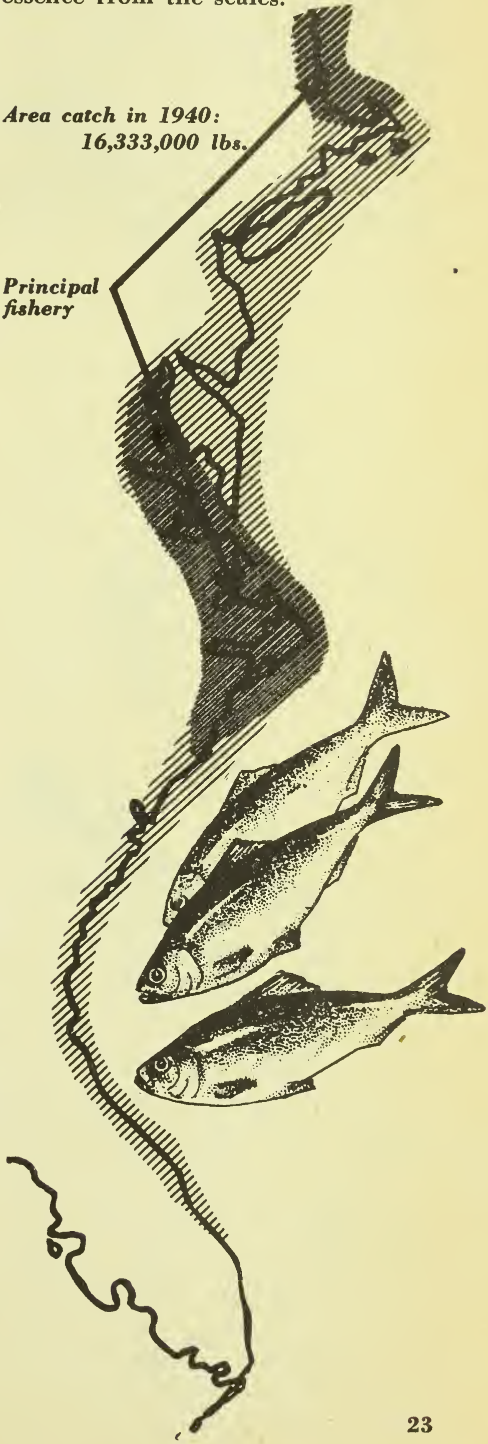
River herring enter the coastal rivers in the spring, often in company with shad, and return to the ocean after spawning. Pound nets in Albemarle Sound, Chesapeake Bay, and the lower stretches of the tributary rivers catch large quantities during this migration.

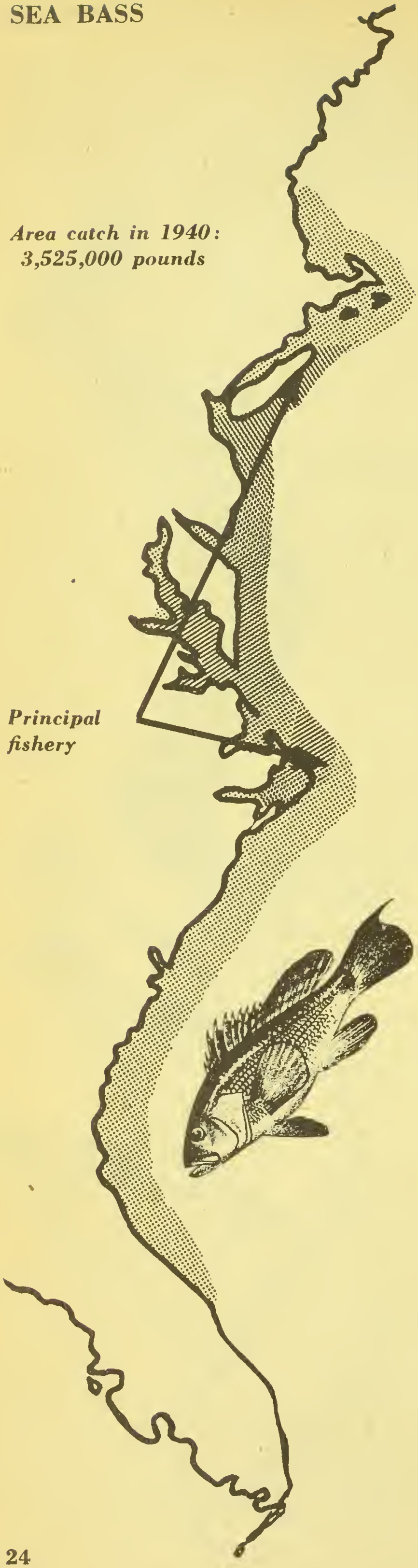
The river herring fisheries are supported by two species whose ranges overlap: the "true" alewife or branch herring (Nova Scotia to the Carolinas) and the blueback (Bay of Fundy to Florida).

The fish usually enter the streams in tremendous numbers, move upstream to the spawning grounds by day, and return to the sea immediately after spawning. The young hatch in 2 to 6 days, depending on the temperature, develop rapidly, and in the fall descend to the ocean as 2- to 4-inch fish.

The ocean life of the river herring is not well known. They are schooling, gregarious fish, wandering near the surface of the sea in summer and autumn and feeding on the minute life of the waters. In their turn, they serve as food for many of the larger, predacious fishes. Probably they winter in deep water, off the rivers of their origin.

Little of the catch is eaten fresh. The canning of river herring and their roe is one of the principal seafood canning industries of the Atlantic coast from Maryland to North Carolina. Much of the catch is salted or cured in vinegar and salt for use in making special herring products. A few are smoked. Byproducts of the industry are dry scrap for fertilizer, oil, and pearl essence from the scales.





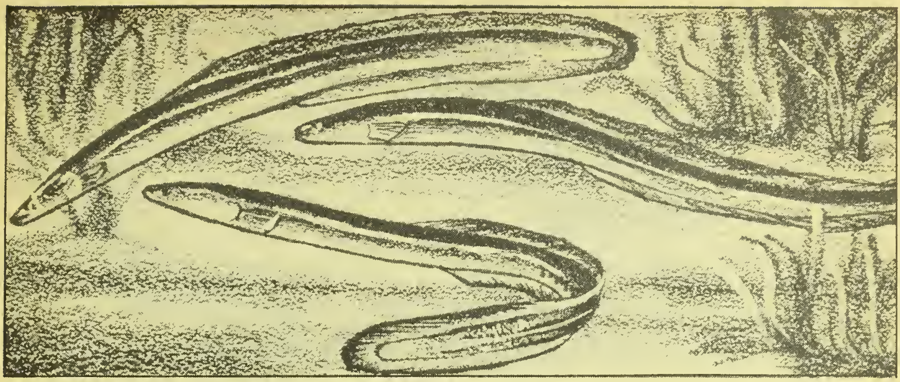
THE SEA BASS supports large sport fisheries and is also a popular market fish in the Middle Atlantic area. Center of the commercial fishery is the coast of New Jersey, which yields about 2½ million pounds, and the winter trawl fishery off the New Jersey and Virginia capes, where 3 to 4 million pounds are taken each year.

The sea bass, best known member of a large group of bottom-living, marine fishes, lurks around wrecks and wharf pilings, frequents rocky bottoms which snag fishermen's trawl nets. As a result, one of the most effective kinds of sea bass gear, especially in New Jersey, is the fish pot—much like a lobster pot with the height of the funnel increased to admit the fish. The pots are set unbaited on rough bottom, buoy lines marking their location. One fisherman sets up to 650 pots. Hazards of the pot fishery are many: passing boats may cut or foul the lines, storms carry away the pots. Hand lining, another good method of fishing on rough bottom, is common on the rocky shoals off Montauk Point, also in the North Carolina fishery. Sea bass are taken by dragging off Long Island and New Jersey in summer.

These fish move inshore and probably northward in spring, offshore and probably south in autumn. Sport and commercial fisheries for sea bass open up in May along the New Jersey coast, continue until about November.

Adult sea bass live chiefly on other creatures of the sea bottom: mussels, crabs, small lobsters, some fish, a few plants. The young eat smaller fare, mostly minute crustacea. Sea bass spawn in May and June in coastal waters.

Market sizes range from half a pound to about four pounds. Sea bass usually are sold whole, but sometimes are steaked or filleted.



THE EEL has an extraordinary history. All the eels of the Atlantic Ocean—both the European and the American eels—are born in the deep Atlantic, south of Bermuda. After hatching as minute, transparent larvae, the young eels gradually rise out of the deep, warm water to the upper layers of the ocean. There they begin a long migration which carries them to the shores from which their parents came. Remarkably, young European eels always return to Europe, young American eels to America, although the two species of larvae are mingled to some extent on the spawning grounds.

American eels reach our shores in the spring when somewhat more than a year old. They enter the bays and sounds and ascend the streams in enormous numbers. At this stage they are still transparent with only traces of pigment appearing on their glassy, rodlike bodies. The males are believed to remain in brackish water, while the females ascend the streams, sometimes to distant headwaters.

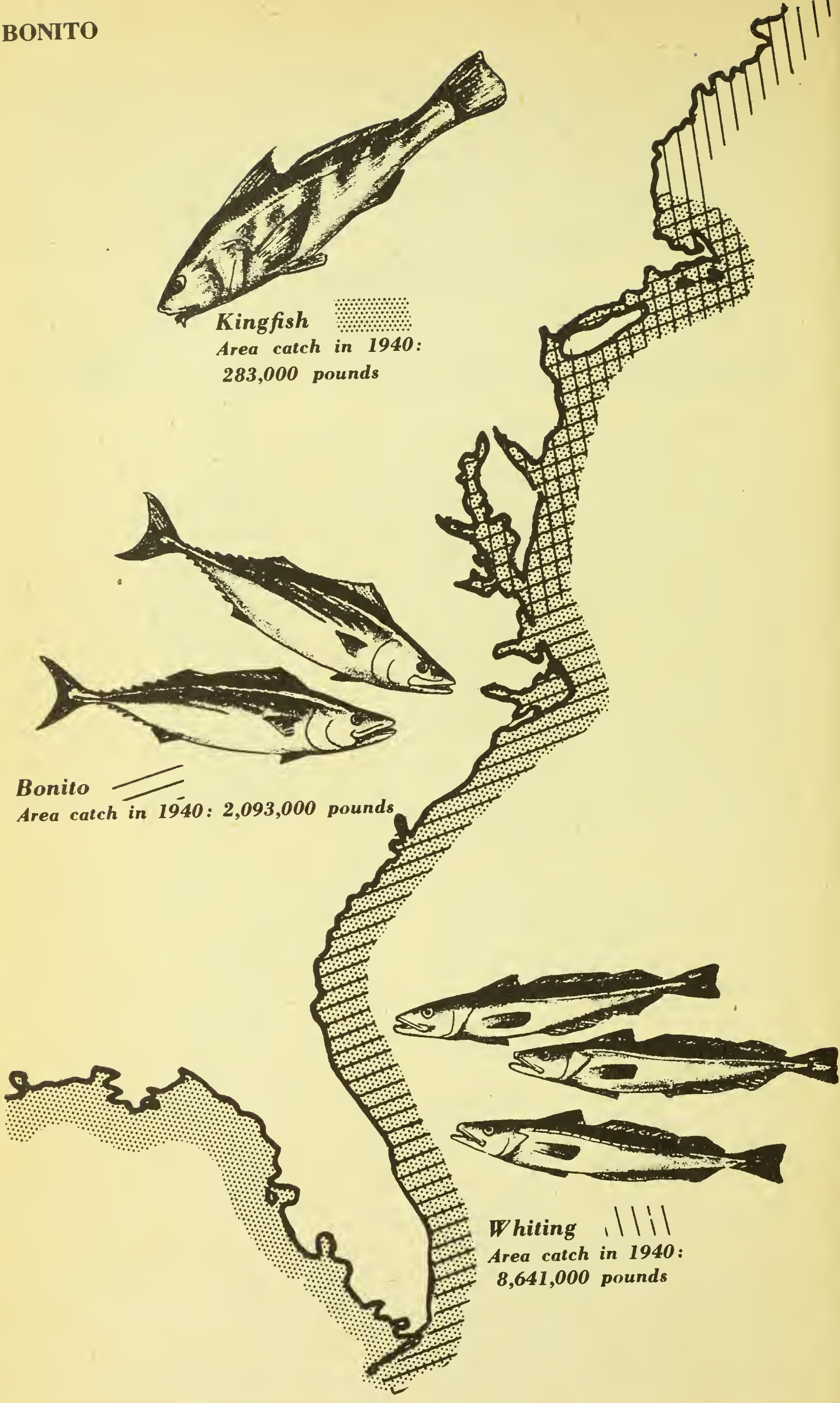
The males grow to a length of about 2 feet, females to 3 or 4. Some of the eels are believed to mature at the age of 7 or 8 years, others not until they are 12 or even older. The spawning migration of the mature eels takes place in the fall, the females descending the rivers, joining the males in the estuaries and bays, and in company with them returning to the oceanic spawning grounds. Presumably they die after this single spawning.

American eels are confined to the Atlantic and Gulf coasts and the streams which descend to them. Eel fisheries in the United States are carried on from Maine to Florida (small catches are made also in Lake Ontario and the Mississippi Valley), but are concentrated in the Middle Atlantic area. New York and New Jersey provide the largest catches.

The fisheries continue throughout the year but are most active in the late fall, when eels are sought for the Christmas market. The Italian populations of the larger cities—especially New York and Philadelphia—use eels in preparing the principal dish for the Christmas Eve supper. To supply this demand, eels are shipped in tank trucks from North Carolina, Virginia, and other areas, and a special shipment of live eels is made by barge down the St. Lawrence River, Lake Champlain, and the Hudson River.

Although the market for live eels is largely confined to the holiday season, smoked eels are sold throughout the year.

Area catch in 1940:
782,000 pounds



Kingfish
Area catch in 1940: 283,000 pounds
Bonito
Area catch in 1940: 2,093,000 pounds
Whiting
Area catch in 1940: 8,641,000 pounds

THE BONITO, a member of the mackerel tribe, inhabits the warmer parts of all the great oceans of the world—the Atlantic, the Pacific, and the Indian. Chiefly an oceanic fish, it comes inshore in pursuit of the mackerel, menhaden, squid or other fish on which it lives. Like most of its relatives it travels in schools, swims rapidly, and feeds for the most part at the surface.

A large pound net fishery for bonito is operated in New Jersey, taking nearly a million and a half pounds annually. Only small catches, ranging from a few thousand to half a million pounds, are made in other Middle Atlantic states. About a hundred thousand pounds are taken in New England, none south of North Carolina.

Very little is known about the migrations of the bonito, or its spawning habits. It is common from Massachusetts to Florida. Apparently it makes some coastwise migrations, but their extent or purpose has not been discovered. It seldom enters enclosed waters like the Chesapeake in any numbers.

Bonito run from 2 to 15 pounds in weight. They are usually cut in thick steaks.

Its strength and size make the bonito a favorite game fish, which anglers take by trolling.

THE WHITING or SILVER HAKE, a fish closely related to the cods, supports important fisheries in New York and New Jersey and is also taken in small quantities off Maryland and Virginia. Off Long Island, it is common throughout most of the year, being caught offshore by otter trawlers from November through March, inshore by pound netters in spring and fall. In deep, offshore waters, whiting range as far south as Tortugas; inshore, are seldom found south of Virginia.

Large runs of whiting appear off Long Island and New Jersey in the spring and fall. The fall run is a mixture of large fish and small or "pencil" whiting. Whether this seasonal schooling is associated with a spawning migration is not known. Whiting do, however, spawn from June until September. The eggs and young drift in the currents; the fry later descend to the bottom when about an inch long. Adult whiting often live on the bottom, but also roam through all levels of the sea, for they are active predators. They feed usually on schooling fish, or on squids, crabs, and crustaceans.

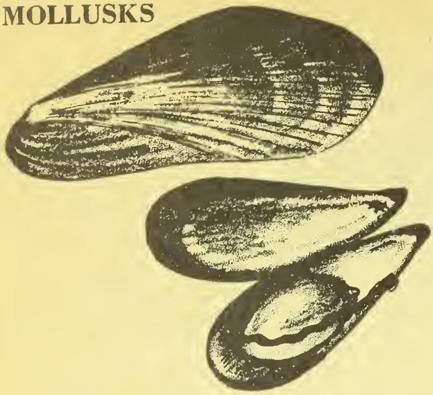
Chief markets for the whiting caught in the Middle Atlantic area are New York, Philadelphia, and Pittsburgh. Most whiting caught in New England and some frozen whiting from New Jersey is shipped to the Middle West, especially Kansas City, where it is used in fried fish sandwiches.

THE KINGFISHES, also called ground mullet, king whiting, sea mullet, or sea mink are members of the croaker family and should not be confused with the "kingfish" of the mackerel tribe. Three species, with interlapping ranges, are found along the Middle Atlantic coast.

From New York to North Carolina, kingfish are taken mainly in haul seines, gill nets, and pound nets, largest catches being made in Virginia and North Carolina. They are chiefly summer fish, those available in the winter being shipped in from the south.

Kingfish live on the bottom, tend to move inshore in summer and offshore in winter. In the summer they ascend the Chesapeake about to the mouth of the Patuxent. They are believed to mature at the age of three years. They spawn from June to August, chiefly along the ocean shores, but sometimes in inside waters.

Chief markets for kingfish are the large cities of the Middle Atlantic area, where they command a good price and are considered among the choicer varieties.

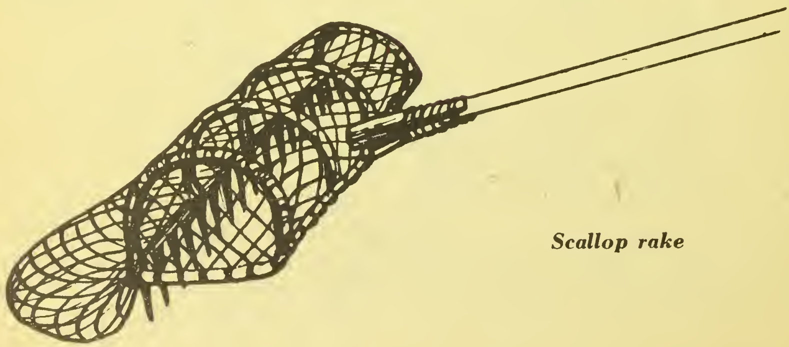


THE RIBBED MUSSEL supports one of the newest and most unusual aquatic industries of the Middle Atlantic region, supplying "provitamin D," which, on irradiation with ultraviolet light becomes transformed into vitamin D and is used in poultry feeding. Prior to 1940, United States needs for this product were supplied by the mussel fishery of Holland. When war cut off this foreign supply, chemists discovered a domestic source in the ribbed mussel, found from Nova Scotia to Georgia. An industry was developed on the ocean side of Virginia's Eastern Shore peninsula, soon becoming the country's principal source of provitamin D. Although large mussel beds are believed to exist in the Carolinas, only the Virginia resource has, up to now, been tapped. Little is known about the extent of the resource or the natural replacement rate of the mussels.

A small fishery for the related sea mussel is carried on in the Oyster Bay region of Long Island. These mussels are a food resource, as yet little utilized.

SCALLOPS taken along the Middle Atlantic coast are of two kinds: sea scallops and bay scallops. Production of sea scallops in the waters of this area is small, but about two million pounds, chiefly taken in New England, are landed at its ports. Small but intensive fisheries for the bay scallop exist in Rhode Island, Long Island, and North Carolina. Virginia formerly produced several million pounds of bay scallops and New Jersey a smaller amount. However, the scallop fisheries in these and many other areas disappeared early in the 1930's simultaneously with the destruction, by a mysterious disease, of the eel grass in which the young scallops shelter. The only portion of the scallop—either bay

or sea—that is eaten is the large muscle that controls the movements of the shells. Sea scallops are taken by dredging, sometimes at considerable depths; bay scallops in shallow water by dredges, rakes, or dip nets.



Scallop rake

THE HARD SHELL CLAM (quahog, round clam, little neck) is the most abundant clam on Middle Atlantic shores. The fisheries of New York and New Jersey yield between 2 and 3 million pounds each; the Virginia clam industry is only slightly less productive, with a yield of nearly 2 million pounds. Small quantities are taken in Delaware, Maryland, and North Carolina.

The bulk of the clam catch is sold fresh; the balance is canned—as minced clams, as chowder, or as clam cocktail.

Hard shell clams live in coastal waters, from almost the high tide level to depths of more than 50

feet. The deeper growing clams are taken by dredging or with tongs (the New York fishery is carried on entirely by tonging), while clams that live in or near the tidal zone are dug out of the sand with rakes or are picked by hand.

Because hard shell clams are well adapted to cultivation and grow within a wide depth range, the fishery could be greatly developed by extensive farming. In practice, however, cultivation has been neglected and pollution has been tolerated in otherwise good clam-growing areas; as a result only a fraction of the potential value of the clam resource is realized.

THE SURF CLAM, one of the commonest shellfish of the Middle Atlantic coast, has supported an important fishery only during the past two years, when a new industry was developed to supply wartime needs for canned products. Principal commercial operations are now carried on along the southern shore of Long Island, where the clams are taken in dredges a half mile to a mile from shore. Some are sold fresh, part are canned locally, but most are shipped to Maine for canning. With about 25 boats fishing for surf clams in 1945, average daily production was reported as about 2,000 bushels. Almost the entire production goes to the military services. The clams live on exposed coasts from Labrador to Cape Hatteras, burying themselves in the bottom to a depth of several inches. They spawn in the spring and throughout the summer. About 5 years are required to reach a length of 4½ inches.

Nutritive Value of Fish and Shellfish: Fish are good natural sources of calcium, phosphorus, iron, and copper and provide protein of unexcelled quality. Some species also furnish vitamins in appreciable quantities and sea fish are rich in iodine.

Fish are an important source of proteins, a type of food which must be included in the diet to provide the elements needed to grow and repair worn-out body tissues. Some proteins are complete in that they supply all of the elements needed; others are incomplete and must be supplemented with other protein foods if the body is to remain in normal health. Fish proteins, like those in beef, pork, and other meats, are complete in themselves and proteins of this type should supply about one-third of the daily protein requirement.

Fish are an excellent source of most of the minerals which the body needs to develop properly and perform its functions. Calcium and phosphorus (without which proper development of bones and teeth is impossible) occur in fish fillets in about the same quantities as in beef round. Marine fishes are especially rich sources of iodine, containing 50 to 200 times as much of this essential element as any other food. Oysters, shrimp, and crabmeat, compared with milk, provide half as much calcium, five times as much magnesium, and slightly more phosphorus. Iron and copper, which build up the hemoglobin content of the blood and prevent or remedy nutritional anemia, are easily obtained by eating most fish. Oysters and shrimp are the best known sources of these two minerals.

Although fish-liver oils have long been recognized as first-class sources of vitamins A and D, it is less widely known that the flesh of fish is also a source of several vitamins. On the average, daily vitamin requirements could be obtained from ordinary serving portions of fish to the following extent: vitamin A, 10 percent; vitamin D, more than adequate amounts; thiamin (vitamin B_1), 15 percent; riboflavin (vitamin B_2), and nicotinic acid (another element of the vitamin B complex), 70 percent.

General Guides for Selecting and Preparing Fish: Insist upon freshness. A fresh fish may be recognized by the following: firm and elastic flesh, scales that cling to the skin in most species, reddish gills free from disagreeable odor, eyes bright and full, not sunken. In selecting shellfish like clams and oysters, be sure that the shells are tightly shut, indicating that the animals are alive, unless you prefer to buy the meat separately as shucked shellfish. Crabs and lobsters should be bought alive or as cooked meat. However, uncooked shrimp may be bought in the shell provided it feels firm to the touch. Cooked shrimp is sold either with or without the shell, with the heads already removed.

When to buy: In general, the fish of any species are of highest food quality when most abundant, for at these periods fishermen are making their catches in the shortest time and shipping them promptly. Usually, but not always, fish are cheapest when most abundant.

Common market forms: Fresh (refrigerated) fish and completely frozen fish should be equally good if the freezing is done by the modern methods now well known to the industry. Both are marketed in a variety of convenient forms, as follows:

Whole or round fish are those marketed in the form in which they come from the water, and are of three kinds: fish that keep as well or better without dressing, small fishes, or the small sizes of larger species. Before cooking, whole or round fish are eviscerated and in all but the very small sizes, the heads, scales, and sometimes the fins are removed.

Drawn fish are those marketed with only the entrails removed. To prepare these fish for cooking the heads, scales, and (if desired) the fins are removed, and the fish may be split or cut into serving portions if too large to be cooked whole.

Dressed fish have had the head and entrails removed and the tail and fins may be cut off. If dressed fish are large they may be cut into pieces in preparation for cooking. Very large dressed fish are sometimes marketed in pieces.

Steaks are slices (usually about half an inch thick) cut across a large dressed fish.

Fillets are meaty slices cut lengthwise from the sides of the fish. Fillets contain no bones or other waste. Their weight varies with the size of the fish from which they are cut.

Sticks are crosswise or lengthwise cuts of fillets.

Canned fish: Besides the universally familiar canned salmon, tuna, and sardines, many kinds of fish are canned for use in main dishes, salads, and appetizers.

Salt or Smoked fish: Tasty variations in the menu are provided by salt or smoked fish. Salt fish ordinarily requires one-half to several hours' soaking before further preparation; while smoked fish usually is ready to eat as it is or may be heated.

Fat content of fish: For best results in preparing a fresh fish, it is always desirable to know whether it is fat or lean. Fat fish are especially suitable for baking, and may also be broiled, while lean fish are best adapted to steaming, boiling, and frying. Medium-fat fish are prepared like the lean, or may be dressed with strips of salt pork or bacon and baked. Most cook books classify fish as follows:

Fat fish are those containing more than 5 percent fat. Examples are shad, mackerel, eel, butterfish, herring, porgies, striped bass.

Lean fish are those containing less than 5 percent fat. Examples are croaker, sea bass, weakfish, oysters, crabs, flounders, spot, whiting, clams.

Sauces and garnishes: The attractiveness of almost any dish consisting of fish will be increased greatly by the use of sauces that subtly enhance or complement the flavor. Any good cook book contains excellent suggestions as to the choice and preparation of such sauces.[2] Fresh and colorful garnishes also do much to create a dish as pleasing to the eye as to the palate, thereby whetting the appetite and helping to make the serving of fish a pleasurable and often repeated experience.

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[2] Sauces for seafoods. Fishery Leaflet 53. Mimeographed, 4 pages, may be obtained on request from the Fish and Wildlife Service, Chicago 54, Ill.

BIBLIOGRAPHY

BREDER, CHARLES M., JR. Field book of marine fishes of the Atlantic coast. 332 pp., illus., 1929.

CHURCHILL, E. P., JR. Life history of the blue crab. Bulletin, U. S. Bureau of Fisheries, Vol. XXXVI, pp. 91-128, illus., 1917-1918.

——The oyster and the oyster industry of the Atlantic and Gulf coasts. Appendix VIII, Report, U. S. Commissioner of Fisheries for 1919. 51 pp., illus., 1921.

HARRISON, ROGER W. The menhaden industry. U. S. Bureau of Fisheries Investigational Report No. 1, 113 pp., illus., 1931.

HILDEBRAND, SAMUEL F., and W. C. SCHROEDER. Fishes of Chesapeake Bay. Bulletin, U. S. Bureau of Fisheries, Vol. XLIII, Part I, 366 pp., illus., 1927.

MERRIMAN, DANIEL. Studies on the striped bass (Roccus saxatilis) of the Atlantic coast. U. S. Fish and Wildlife Service, Fishery Bulletin 35. (In Fishery Bulletin of the Fish and Wildlife Service, Vol. 50). 77 pp., illus., 1941.

PEARSON, JOHN C. Winter trawl fishery off the Virginia and North Carolina coasts. U. S. Bureau of Fisheries Investigational Report No. 10. 31 pp., illus., 1932.

SETTE, OSCAR ELTON. Biology of the Atlantic mackerel (Scomber scombrus) of North America. Part I: Early life history. U. S. Fish and Wildlife Service, Fishery Bulletin 38. (In Fishery Bulletin of the Fish and Wildlife Service, vol. 50). 107 pp., illus., 1943.

SMITH, HUGH M. The fishes of North Carolina. North Carolina Geological and Economic Survey, Vol. II. 453 pp., illus., 1907.

STATE OF NEW YORK, CONSERVATION DEPT. A biological survey of the salt waters of Long Island, 1938. Part I. Supplemental to 28th Annual Report, 1938. A joint survey with the U. S. Bureau of Fisheries. 192 pp., illus., 1939.

TRESSLER, DONALD K. Marine products of commerce. 762 pp., illus., New York. 1923.

U. S. GOVERNMENT PRINTING OFFICE O—1945

From:	Rick Drew
To:	Comments; Emilie Franke; Toni Kerns; Katie Drew
Subject:	[External] Chesapeake Commercial Striped Bass Fishermen - PUBLIC COMMENT - OCT 23-24, PLEASE DISTRIBUTE TO ALL MEMBERS
Date:	Monday, October 14, 2024 3:05:30 PM

This is a picture from January, 2024 of some Chesapeake Bay commercial Striped Bass Fisherman. This type of harvest cannot be compatible with the goal of rebuilding the Striped Bass stocks. This number of prime breeding size fish being removed from an already depleted breeder bio mass is very damaging to any hope of improvement in the near term.

Why are these guys allowed to harvest so many larger fish when everyone else must comply with a 28-31" slot and we are trying to rebuild the fishery. We all take our fishing rights from the same patents, grants and practices as defined by our forefathers and mothers.

Rick Drew
East Hampton, NY
631-903-0751

From: Rick Drew <rpdrew@hotmail.com>
Sent: Monday, October 14, 2024 2:41 PM
To: Rick Drew <rpdrew@hotmail.com>
Subject: Chesapeake commercial fishermen

Sent from my iPhone

From:	Emilie Franke
To:	Emilie Franke
Subject:	FW: ASMFC Striped Bass Board Meeting October 23, October 24 - Please distribute and Read
Date:	Wednesday, October 16, 2024 11:00:55 AM

From: Rick Drew <rpdrew@hotmail.com>
Sent: Monday, October 14, 2024 12:58 PM
To: Comments <comments@asmfc.org>; Emilie Franke <EFranke@ASMFC.org>; Toni Kerns <TKerns@ASMFC.org>; Katie Drew <KDrew@ASMFC.org>
Subject: [External] ASMFC Striped Bass Board Meeting October 23, October 24 - Please distribute and Read

This document specifically discusses the need for standardized regulations up and down the Striper coast. This document is from 1941 it truly provides great practical context on the Striped Bass Fishery.

Rick Drew
East Hampton NY
631-903-0751

UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

FISH AND WILDLIFE SERVICE
Ira N. Gabrielson, Director

Fishery Bulletin 35

STUDIES ON THE STRIPED BASS (*Roccus saxatilis*) OF THE ATLANTIC COAST

By DANIEL MERRIMAN

From FISHERY BULLETIN OF THE FISH AND WILDLIFE SERVICE
Volume 50

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1941

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ABSTRACT

The results of an investigation of the striped bass (*Roccus saxatilis*) of the Atlantic coast, from April 1, 1936, to June 30, 1938, are discussed and the systematic characters of the species described in detail on the basis of the literature and material afforded by fin-ray, scale, and vertebral counts, and by measurements on more than 350 individuals.

Studies on the fluctuations in abundance of this species over long-term periods show that there has been a sharp decline in numbers. Dominant year-classes have at times raised the level of abundance, but the intensity of the fishery is such that their effects have been short lived. The dominant year-class of 1934 was the largest to be produced in the past half century, although the parental stock was probably as low as it has ever been. There is a good correlation between the production of dominant year-classes of striped bass and below-the-mean temperatures during the periods before, of, and immediately after the main spawning season.

The striped bass is strictly coastal in its distribution from the Gulf of St. Lawrence to the Gulf of Mexico, is anadromous, and spawns in spring. Sex ratios in northern waters show that males seldom make up more than 10 percent of the population, while in waters farther south the sex ratios are not so disproportionate. Females first mature as they become 4 years old, males as they become 2 years old. This difference in age at maturity may account for the small percentage of males in northern waters, for the time of the spawning season in the South coincides with the time of the spring coastal migration to the North, which is made up mainly of immature females. The age and rate of growth have been studied by scale analysis and the average sizes of the different age groups, and the growth has been calculated to the eleventh year.

Striped bass (3,937) have been tagged, and returns have shown that there is a striking migration to the North in spring, and to the South in fall. The population in northern waters in summer remains static. These migrations do not occur until the bass become 2 years old, and have their greatest intensity off the southern New England and Long Island shores. There is little encroachment by the stock in the Middle Atlantic bight on the populations in the North or South.

The available evidence from general observation, tagging, and scale analysis points to the conclusion that the dominant 1934 year-class originated chiefly in the latitude of Cheasapeake and Delaware Bays, and that those fish born as far south as North Carolina contribute directly only a relatively small fraction to the population summering in northern waters.

Stomach-content analyses show that bass are universal in their choice of food, a large variety of fishes and crustacea forming the main diet. It is suggested that the increased bulk and availability of *Menidia menidia notata* in Connecticut waters late in summer and early in fall are responsible for the increase in, or maintenance of the growth rate of striped bass in this region despite the sharp drop in water temperature at this time.

The parasites of the species are discussed and several new host records listed. It is suggested that the bilateral cataracts in a high percentage of individuals bass in the Thames River, Connecticut, are the result of a dietary deficiency.

The decline in abundance of the striped bass of the Atlantic coast over long-term periods and its causes are discussed from a theoretical point of view, and it is pointed out that the present practice of taking a large proportion of the 2-year-olds annually is apparently not an efficient utilization of the supply. It also is pointed out that both the fishery and the stock would probably benefit from the protection of these fish until 3 years old, at which time the average individual length is 41 cm. (16 inches), measured from tip of lower jaw to fork of tail.

STUDIES ON THE STRIPED BASS (*Roccus saxatilis*) OF THE ATLANTIC COAST[1]

By Daniel Merriman, *Osborn Zoological Laboratory, Yale University, formerly Temporary Investigator, Fish and Wildlife Service*[1]

CONTENTS

INTRODUCTION

The following account of the life history and habits of the striped bass (*Roccus saxatilis*) is the result of an investigation originally sponsored by the Connecticut State Board of Fisheries and Game, and undertaken by the author.

The main objectives of this investigation, throughout its entire course, were to obtain information on the life history and habits of the striped bass, to study the fluctuations in abundance of this species and their causes, and to accumulate material on the effect of the fishery—both commercial and sporting—on the present supply.

The striped bass investigation was begun on April 1, 1936, and was concluded on June 30, 1938. Its headquarters have been the Osborn Zoological Laboratory, Yale University, New Haven, Conn., and, during the summer months, the Niantic River, Conn.—an area where this species is more easily available for study than elsewhere in the immediate vicinity. During the first 3 months the work was financed by a group of Connecticut sportsmen. The Connecticut State Board of Fisheries and Game then supported the investigation through December 31, 1937, and also supplied much of the equipment essential to the progress of the work. By that time it had become apparent, as a result of tagging experiments, that the striped bass was a highly migratory species, and that therefore the problem was essentially coastwise in its scope. Clearly the objectives could not be accomplished satisfactorily by studies in one limited area. The American Wildlife Institute generously contributed a substantial sum in March 1937 when a break in the continuity of the work would have been a severe blow to its progress, and thus made it possible for the investigation to extend its scope to include a large portion of the Atlantic coast. On July 1, 1937, the United States Bureau of Fisheries insured the financial backing of the investigation for a full year from that date, and the State Board of Fisheries and Game appropriated a sufficient amount for the continuation of the work within Connecticut.

[1] The Fishery Bulletin of the Fish and Wildlife Service is a continuation of the Bulletin of the Bureau of Fisheries, which ended with vol. 49. The Fish and Wildlife Service was established on June 30, 1940, by consolidation of the Bureau of Fisheries and the Bureau of Biological Survey.

277589—41——1

The North Carolina State Department of Conservation and Development also contributed to the striped bass investigation in the fall of 1937, and thus made it possible to accumulate valuable information from the Albemarle Sound region in November 1937 and March, April, and May, 1938.

The author has published a preliminary account of the results of the striped bass investigation through December 1936 (Merriman, 1937a). A review covering much of the same material has also appeared in the Transactions of the Second North American Wildlife Conference (Merriman, 1937b), and a paper given at the New England Game Conference on February 12, 1938, and the Third North American Wildlife Conference on February 14, 1938, was published later (Merriman, 1938). Several progress reports submitted to the Connecticut State Board of Fisheries and Game have been mimeographed and sent out in limited numbers. This bulletin, therefore, incorporates some previously published material as well as the main accomplishments of the investigation from its inception to its conclusion.

ACKNOWLEDGMENTS

Since the author was a graduate student in the Department of Zoology at Yale University during the whole course of this investigation, the facilities of the Osborn Zoological Laboratory were always at his disposal. He especially wishes to acknowledge the help and advice of Prof. A. E. Parr, Director of the Peabody Museum. He is also indebted to Mr. Marshall B. Bishop of the Peabody Museum for his excellent work in the field in North Carolina in the spring of 1938, to Mr. Donald L. Pitcher of the Bingham Oceanographic Laboratory, and to many members of the Osborn Zoological Laboratory and the Peabody Museum for their assistance at various times. Furthermore, the investigation owes much of its progress to Mr. Otto J. Scheer, of New York, who made it possible to tag striped bass at Montauk, L. I., N. Y., in the spring and fall of 1937, to Mr. J. D. Chalk, Commissioner of Game and Inland Fisheries in North Carolina, to Mr. David A. Aylward and Mr. Oliver H. P. Rodman of the Massachusetts Fish and Game Association, and to a number of commercial fishermen and sport fishermen's clubs.

It is also a pleasure to acknowledge the assistance of Mr. Earl E. Sisson, who was employed by the Connecticut State Board of Fisheries and Game to aid in the seining and tagging of striped bass. And finally, the writer wishes to express his sincere thanks to his wife, who has done most of the recording in the field and has given her support in every possible way.

DESCRIPTION OF THE STRIPED BASS

During the past few years the striped bass has been called *Roccus saxatilis* and *Roccus lineatus*. These two specific names have been used about equally in the literature, and with more or less indiscrimination. Jordan, Evermann, and Clark (1930) say:

> This species is usually called *Roccus lineatus* after *Sciaena lineata* Bloch (Ausländische Fische, VI, 1792, 62); but it cannot be the same. The form, serrae of the preopercle, and the stout spines of the fin, as well as the asserted locality 'Mediterranean' indicate that the species concerned is *Dicentrarchus lupus* of Europe. The only resemblance to *Roccus* is found in the striped color; but Bloch says that the stripes on the sides are yellow.

A glance at Bloch's (loc. cit.) illustration substantiates this statement. The name *Roccus saxatilis* (Walbaum) therefore appears to be the more valid, and lately it has come into more widely accepted usage.

Two common names are regularly applied to this species. North of New Jersey "striped bass" is almost universally used, while to the south "rock" or "rockfish" is the generally accepted terminology. Among other names that have been applied in the past, but are seldom if ever heard now, are "green-heads", "squid-hounds" (Goode, 1884), and "missuckeke-kequock" (Jordan, Evermann, and Clark, loc. cit.).

The striped bass, *Roccus saxatilis*, belongs to the family Serranidae, of the order Percomorphi. It has been well described in most of the standard ichthyological references for both the Atlantic and Pacific coasts (e. g., Hildebrand and Schroeder, 1928; Bigelow and Welsh, 1925; and Walford, 1937), and the following account is based on these works and on the material afforded by fin-ray, scale, and vertebral counts, and measurements on over 350 individuals 15 cm. in length or greater studied during the investigation. The majority of these fish were taken in Connecticut waters. The numbers indicate the extremes of variation, while those in parentheses are the approximate averages.

Morphometric description.—Body elongate, moderately compressed; back little arched; greatest depth (at or slightly posterior to origin of spinous dorsal fin) 3.45 to 4.2 (3.7) (young individuals tend to be more slender than old ones), average least depth (at caudal peduncle) 9.6, average depth at anus 3.9—in standard length. Head long and pointed, 2.9 to 3.25 (3.1) in standard length. Dorsal fin rays: IX (VIII in one individual)—I, 10 to 13 (12); fourth and longest dorsal spine 2.2, first and longest dorsal soft ray 2.0 in head. Anal fin rays III, 10 to 12 (11); first and longest soft ray 2.0 in head. Ventral (pelvic) fin rays: I, 5; length of ventrals 1.9 in head. Pectoral fin rays: 15 to 17; length of pectorals 2.0 in head. The two dorsal fins approximately equal in basal length, the first (spinous) being roughly triangular in outline and originating over the posterior half of the pectoral, the second (soft) usually distinctly separate from the first, its soft rays becoming regularly shorter posteriorly. Anal fin of essentially the same shape as second dorsal and slightly smaller; situated below posterior two-thirds of second dorsal. Pectorals and ventrals of moderate size; insertion of ventrals slightly behind that of pectorals. Caudal somewhat forked. Scales: 7 to 9—57 to 67—11 to 15; typically ctenoid (the character "scales on head cycloid" as given by Jordan, 1884, for the genus *Roccus*, does not hold true in the striped bass); extending onto the bases of all the fins except the spinous dorsal. Vertebrae (including hypural): 24 or 25 (almost invariably $12+13=25$). Gill-rakers on first arch: 8 to $11+1+12$ to 15 ($10+1+14$). Eye 3 to 4.9 in head (less in smaller individuals). Mouth large, oblique, maxillary extending nearly to middle of eye (except in small individuals) and broad posteriorly (width at tip nearly two-thirds diameter of eye); lower jaw projecting. Teeth small, two parallel patches on base of tongue; also present on jaws, vomer, and palatines. Preopercle margin clearly serrate.

Color in life.—Dark olive-green to steel-blue or almost black above as a rule, but occasionally light green. Paling on the sides to silver, and white on the belly. Sometimes with a bronze luster on the sides. Sides with seven or eight prominent dark stripes, much the same color as the back. Usually the stripes follow scale rows, three or four above the lateral line, one invariably on the lateral line, and three below it. Normally the two above the lateral line, that on the lateral line, and sometimes the first below it, are the longest, reaching or coming close to the base of the caudal. None extend onto the head. All except the lowest are above the level of the pectoral fins. The highest stripes and those below the lateral line tend to decrease in length. The stripes are often variously interrupted and broken. Young of less than 6–7 cm. usually without dark longitudinal stripes, and those of 5–8 cm. often with dusky vertical crossbars ranging from 6–10 in number. Vertical fins dusky green to black, ventrals white or dusky, pectorals greenish.

Distinguishing characters.—There is little danger of confusing striped bass above 10 cm. with any other species either on the Atlantic or Pacific coast. Its prominent dark longitudinal stripes, general outline, and fin structure are sufficient to separate it at a glance from other species. The dorsal fins are usually clearly separate, but sometimes touch. In specimens less than 7 cm. it is often difficult to distinguish striped bass from the white perch (*Morone americana*), whose dorsal fins are continuous—not contiguous, as in the striped bass. The normally separate dorsals of the larger striped bass become an almost useless character here, and the stripes frequently are not present. The general body outlines of the young of these two species are much alike, although the back tends to be somewhat more arched in the white perch. The most valuable differentiating characters are: (1) The second spine of the anal fin, which is almost equal in length to the third spine and more robust in the white perch, and intermediate in length between the first and the third spines and less robust in the striped bass; (2) the relatively thicker and heavier spines in the fins of the white perch; (3) the sharp spines on the margin of the opercle, of which the striped bass has two and the white perch but one; and (4) the soft rays of the anal fin, usually 9 in the white perch and 10–12, normally 11, in the striped bass.

Two fresh-water Serranids bear a superficial resemblance to the striped bass. *Morone interrupta*, the yellow bass of the Mississippi Valley, also has seven longitudinal dark stripes, but is immediately distinguished by its slight connection of the dorsals, greater depth of the body (2.7 in standard length), lesser number of scales in the lateral line (50–54), lack of teeth on the base of tongue, and its robust spines of the dorsal and anal, as well as the more numerous spines of the first dorsal (X). *Lepibema chrysops*, the white bass of the Great Lakes region and Mississippi and Ohio Valleys, also has a number of dark longitudinal narrow stripes. Here the dorsals are separate as in the striped bass, but this species differs in having only a single patch of teeth on the base of the tongue, and in having a much deeper body (over one-third of the length) that is more compressed.

SIZE AND RANGE OF THE STRIPED BASS

The striped bass most commonly taken at present by commercial and sport fishermen on the Atlantic coast vary in size from less than 1 pound to about 10 pounds in weight. Individuals up to 25–30 pounds, however, are by no means rare, and not infrequently striped bass up to 50–60 pounds are caught, although, judging from old records, these larger fish are not as abundant as they have been in the past. Bass above 60 pounds are now decidedly rare. The largest striped bass taken in recent years was the 65-pounder caught on rod and line in Rhode Island in October 1936 and one weighing 73 pounds was taken on rod and line in Vineyard Sound, Mass., in 1913 (Walford, 1937). Authentic records show that a striped bass weighing 112 pounds was taken at Orleans, Mass., many years ago (Bigelow and Welsh, 1925), and Smith (1907) reports several weighing 125 pounds caught in a seine near Edenton, N. C., in 1891.

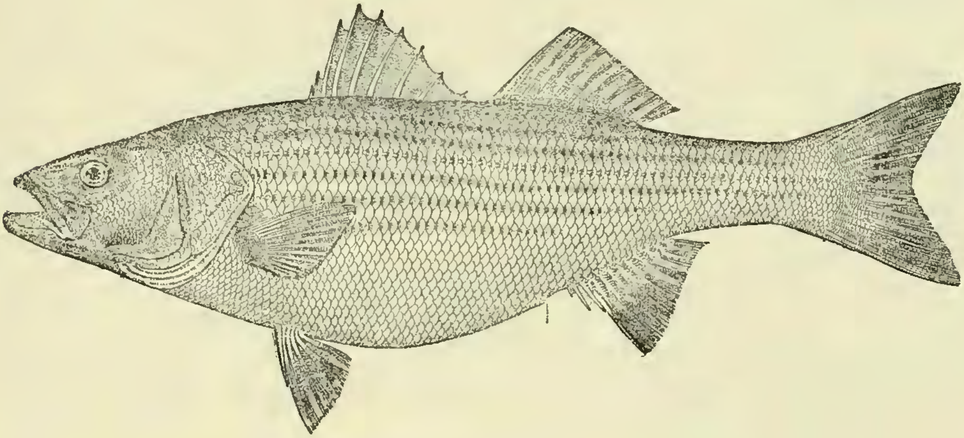

FIGURE 1.—The striped bass (*Roccus saxatilis*).

The striped bass has a range on the Atlantic coast of North America, where it is indigenous, from Florida to the Gulf of St. Lawrence, and is most common from North Carolina to Massachusetts. Jordan and Evermann (1905) state that its southern limit is the Escambia River in western Florida, on the Gulf of Mexico. Jordan (1929), however, states that the striped bass exists as far west as Louisiana. Bean (1884) records the striped bass from the Tangipahoa River, near Osyka, Miss., and this river also flows through Louisiana. Gowanloch (1933) also mentions the striped bass in his "Fishes and fishing in Louisiana."

The striped bass was introduced on the Pacific coast where its present center of abundance is the San Francisco Bay region (Scofield, 1931), and the extreme limits of its distribution are Los Angeles County, Calif., and the Columbia River (Walford, loc. cit.). Walford also states: "There is an indigenous population of bass at Coos Bay, Oreg., about 400 miles north of San Francisco."

This fish is strictly coastwise in its distribution, and records of its being taken more than several miles offshore are extremely rare. It is most commonly taken in salt water, but, since it is anadromous, its capture in brackish and even fresh water is a regular occurrence—particularly during the winter and spring months. It has been taken in the Hudson River as far north as Albany, and is caught in large quantities in the Roanoke River at Weldon, N. C., each spring. Temperature appears to play no little part in its distribution (see p. 42), yet the striped bass can be taken at the extreme limits of its range throughout the year.

REVIEW OF THE LITERATURE ON THE LIFE HISTORY OF THE STRIPED BASS

Mention of the striped bass appears early in American literature. This is undoubtedly because of its great abundance in times past and its coastal distribution—two factors that made it easily available to the early colonists.

Capt. John Smith wrote:

> The Basse is an excellent fish, both fresh & salte . . . They are so large, the head of one will give a good eater a dinner, & for daintinesse of diet they excell tho Marybones of Beefe. There are such multitudes that I have seen stopped in the river close adjoining to my house with a sande at one tide as many as will loade a ship of 100 tonnes (Jordan and Evermann, 1905).

And one of Captain Smith's contemporary divines wrote:

> There is a Fish called a Basse, a most sweet & wholesome Fish as ever I did eat . . . . . the season of their coming was begun when we came first to New England in June and so continued about three months space. Of this Fish our Fishers take many hundreds together, which I have seene lying on the shore to my admiration . . . (Jordan and Evermann, 1905).

William Wood in his New England's Prospect (1635) wrote:

> The Basse is one of the best fishes in the country . . . the way to catch them is with hooke and line: the Fisherman taking a great cod-line, to which he fasteneth a peece of Lobster, and throwes it into the sea, the fish biting at it he pulls her to him, and knockes her on the head with a sticke. . . . the English at the top of an high water doe crosse the creekes with long seanes or Basse netts, which stop in the fish; and the water ebbing from them they are left on dry ground, sometimes two or three thousand at a set . . .

Such references to the striped bass became increasingly common in the eighteenth and nineteenth centuries, all of them dealing with record catches or the abundance of this species, and extolling the virtues of the bass as a game and food fish. Probably the earliest observations of any consequence on any phase of the life history are those by S. G. Worth, who published a series of papers from 1881 to 1912 on the spawning habits and artificial propagation of the striped bass in the Roanoke River, N. C. (See under section on spawning habits and early life history.) Turning to more modern times, mention is made of the striped bass frequently, but in all the literature dealing with the fishes of the Atlantic coast there is scant information on the life history of this species. Such standard and well-recognized references as Bigelow and Welsh (1925) and Hildebrand and Schroeder (1928), sum up the available knowledge on the striped bass in a few brief pages. In the past few years, however, the need for further information on this species on the Atlantic coast has resulted in several investigations in different localities, apart from the present work. These have given rise to much interesting material and more general knowledge (e. g., see Vladykov and Wallace, 1937), a great deal of which, however, is yet to be published. Reference to some of this work is made in the following pages.

In the last quarter of the nineteenth century striped bass were introduced on the Pacific coast, where they prospered beyond all expectations and soon became the object of an intensive and prosperous fishery conducted by both commercial and sport fishermen. This fishery has been of great importance ever since. The story of this introduction of the striped bass to the Pacific coast is particularly interesting (Throckmorton, 1882; Scofield, 1931, etc.). In 1879 and 1881 a number of yearling bass were seined in New Jersey, taken across the continent in tanks by train, and planted in San Francisco Bay. A total of only 435 striped bass survived the rigors of these 2 trips. Yet by 1889, 10 years after the first plant, they were caught in gill nets and offered for sale, and in 1899 the commercial net catch alone was 1,234,000 pounds.

In 1915 the greatest catch in the history of the fishery was made, when 1,784,448 pounds of striped bass were delivered to the markets. Since the World War the annual catch has varied between 500,000 and 1,000,000 pounds. The Division of Fish and Game of California has made thorough studies on the life history of the striped bass, as well as the conservation needs of this species. These have been published in a long series of papers from 1907 to the present, of which the outstanding publication is that by Scofield (1931). But, because the conditions of the fishery on the Pacific coast differed so much from those on the Atlantic coast, much of the

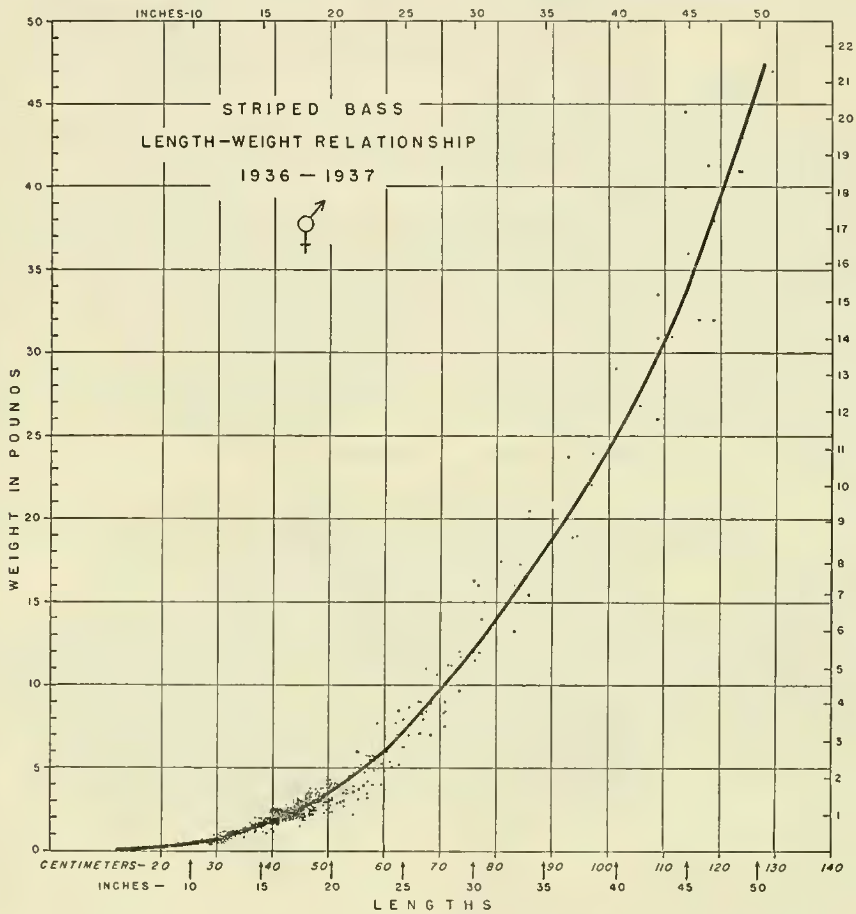

FIGURE 2.—Length-weight relationship of the striped bass, based on 526 fish. Measurements are to the fork of the tail.

information presented by the Division of Fish and Game of California cannot be applied to the striped bass of the Atlantic. On the Pacific coast the main method of capture was by gill net, and it was easy to eliminate the capture of small fish by regulating the mesh size. At the present time commercial fishing for striped bass is prohibited in California. On the Atlantic coast, however, pound-nets, seines, and other methods of capture are used, and striped bass are taken indiscriminately with a great many other species—a situation which would make it highly impractical and most unfair to the commercial fishermen involved if any attempt were made to control the size categories of striped bass taken in these nets by regulating the mesh size.

Length-weight relationship of the striped bass

[Length is stated in centimeters, measured to fork in tail; weight is in pounds]

Length	Weight	Length	Weight	Length	Weight
20	0.25	57	5.25	94	21.00
21	.25	58	5.50	95	21.25
22	.25	59	5.75	96	22.00
23	.25	60	6.00	97	22.50
24	.50	61	6.25	98	23.00
25	.50	62	6.75	99	23.50
26	.50	63	7.00	100	24.25
27	.50	64	7.25	101	25.00
28	.75	65	7.75	102	25.50
29	.75	66	8.00	103	26.00
30	.75	67	8.50	104	26.75
31	.75	68	9.00	105	27.25
32	1.00	69	9.25	106	28.00
33	1.00	70	9.75	107	28.75
34	1.00	71	10.00	108	29.25
35	1.25	72	10.50	109	30.00
36	1.25	73	11.00	110	30.75
37	1.50	74	11.25	111	31.50
38	1.50	75	11.75	112	32.25
39	1.75	76	12.00	113	33.00
40	1.75	77	12.50	114	34.00
41	2.00	78	13.00	115	35.00
42	2.00	79	13.50	116	35.75
43	2.25	80	14.00	117	36.75
44	2.25	81	14.50	118	37.50
45	2.50	82	15.00	119	38.50
46	2.50	83	15.50	120	39.50
47	2.75	84	16.00	121	40.50
48	3.00	85	16.50	122	41.50
49	3.25	86	17.00	123	42.25
50	3.50	87	17.75	124	43.25
51	3.75	88	18.00	125	44.25
52	4.00	89	18.25	126	45.25
53	4.25	90	19.00	127	46.25
54	4.50	91	19.25	128	47.25
55	4.75	92	19.75		
56	5.00	93	20.25		

FLUCTUATIONS IN ABUNDANCE OF THE STRIPED BASS

Quotations from early settlers point to the enormous abundance of striped bass in those times. Nor is it difficult to find records of unusual catches in the past century. Thus Caulkins (1852) says in a footnote:

> Four men in one night, (Jan. 5th, 1811), caught near the bridge at the head of the Niantic River with a small seine, 9,900 pounds of bass. They were sent to New York in a smack, and sold for upwards of $300. (New London Gazette.)

A quotation from a letter written by a well-known sportsman to the author, dated August 16, 1937, in which he tells of surf-casting for striped bass in the early 1900's at Montauk, Long Island, N. Y., reads as follows:

> As for quantities, almost any time through late summer and into late October, provided one knew the ropes, one could, almost literally, fill a wagon, although I, myself, seldom continued beyond local give-away—that is, until necessity more or less compelled me to become a rod-and-reel market fisherman, and I fished like one: on one occasion to the tune of just under a ton of fish in a single period of seven days.

And even in the last 2 years, when the dominant 1934 year-class of striped bass appeared along the better part of the Atlantic coast, catches reaching extraordinary proportions have been commonplace. As but one example, it is of interest to mention that 90,000 pounds of striped bass were taken by a single trap in 2 weeks in October 1936, at Point Judith, R. I.

Close examination of the available records reveals that the abundance of striped bass on the Atlantic coast has shown tremendous fluctuations over a long period of years. As will be shown below (see p. 13), this is because the striped bass is subject to year-class dominance, a phenomenon which has received increasing attention in the past quarter century, since it has been found to apply to so many different species. Briefly explained, year-class dominance may be said to be the production of such unusually large quantities of any species in a single year that the members of this age-group dominate the population for a considerable period, and are noticeably more abundant than the individuals produced in the preceding and following years. Such dominant year-classes usually make their appearance only at fairly lengthy intervals.

Year-class dominance in any species does not, of course, insure the maintenance of the population at a consistently high level. It is also clear that dominant year-classes are often produced by a comparatively small parental stock (see p. 14), and that therefore—at least down to a certain point—their appearance is not correlated with an unusual abundance of mature and spawning fish. There may even be an inverse correlation between these two factors—that is, a large production in any season by a comparatively small population of mature individuals. Such a correlation has been suggested by Bigelow and Welsh (1925) for the mackerel (*Scomber scombrus*), the "years of great production always falling when fish are both scarce and average very large . . ." This phenomenon is probably most common in particularly prolific species that produce a large number of eggs. Such a species is the striped bass, and such a production of a dominant year-class took place in 1934 (see p. 11).

In the case of the striped bass a study of the size of the stock over short-term periods may, therefore, be most deceptive. Thus the first manifestation of a large year-class might give the impression of increasing abundance, or, if the study started shortly after an exceptionally productive year, a sharp decline in the population would be apparent under the conditions of the existent intensive fishery. To get a true picture of the trend in abundance, it is therefore essential to study the fluctuations over long-term periods.

Accurate catch records, which form the most reliable means of studying the relative size of the population in different periods, are unfortunately not available farther back than the latter half of the nineteenth century. Bigelow and Welsh (1925), however, state: ". . . that a decrease was reported as early as the last half of the eighteenth century." Nor is it surprising that such a decline was noticed so long ago when it is considered that the striped bass is a strictly coastwise species, and one that is easily available throughout the year. If haddock (*Melanogrammus aeglefinus*) (Herrington, 1935), halibut (*Hippoglossus hippoglossus*) (Thompson and Herrington, 1930), and other offshore fishes have become scarcer through the intensity of fishing, and this is admitted, it is much more likely that a purely coastal species such as the striped bass, which is far more accessible and therefore unceasingly the object of fishermen's attention, should soon have shown a marked decrease in numbers. Also, the availability of the striped bass and the resultant heavy drain on the stock is not the only factor involved. Since this fish is anadromous, there has been every chance for civilization to do irreparable damage to valuable spawning areas. There is abundant evidence to show that such destruction has often occurred (see p. 16). In view of these facts it was not an unreasonable expectation that the supply should soon have diminished, and that in spite of the production of dominant year-classes the stock could not be maintained at its original high level.

Even in the absence of catch records or figures to prove the point, there can be no question but that the numbers of striped bass along the Atlantic coast have decreased during at least the past 2 centuries. There have undoubtedly been periods when the population showed sudden and pronounced increases, presumably due to the presence of unusually good year-classes. But these peaks have probably been short-lived, and the general trend over long periods has been downwards.

Two series of accurate catch records going back to the latter half of the nineteenth century have been made available to the author. Both of these bear out the above contention and substantiate such a hypothesis. The first record is that of the numbers of striped bass taken annually from 1865 to 1907, on rod and line, by the members of the Cuttyhunk Club at Cuttyhunk, Mass.[2] A graph of this material is shown in figure 3. (For the annual average poundage of the fish caught and the weight of the largest bass in each year, see table 3.) The most striking fact about this curve is its rapid decline from fairly large numbers to extremely low numbers in the 43-year period that it covers. Unfortunately a rod-and-line fishery such as this one cannot be considered a strictly reliable index of abundance—especially since the members of the club confined themselves to fishing for large bass. Moreover, there is no indication of the intensity of fishing, so that the low numbers in the twentieth century might represent the catch of only a few individuals, while the high numbers before 1880 may be the catch of a much larger group. Therefore, the annual fluctuations in this graph are perhaps not real indications of varying abundance, and the rate of decline may be too steep. Nevertheless, it is difficult to imagine from this evidence that a serious depletion did not take place. Even though such a record, lacking as it does information on the effort expended, cannot represent changes in abundance in detail, there can be little doubt that its downward trend indicates the general decline in abundance over the period it covers.

FIGURE 3.—Record of the numbers of striped bass taken by the members of the Cuttyhunk Club from 1865 to 1907 (see Table 3).

Another record of considerable interest and significance is that of the numbers of striped bass taken in pound-net catches from 1884 to 1937 at Fort Pond Bay, Long Island, N. Y. (see fig. 4 and table 4). From 1884 to 1928 these pound-nets were owned by members of the Vail family, who kept accurate records of the numbers of striped bass caught at each haul.[3] They also indicate the number of traps in operation each year. These varied from 6 to 10, and the catches shown in this graph up to 1928 have been weighted to make them equivalent to a fishing intensity of 10 pound-nets throughout. In 1928 the ownership of these nets changed hands, but the author has been able to complete the records up to the present.[4] Unfortunately no record of the number of pound-nets in operation from 1928 to 1937 had been kept, and although this number is known to have varied only from 8 to 12, a small error is thus introduced. The magnitude of the catches is such, however, that this part of the graph—indicated by the dotted line—may be properly considered a reasonably accurate continuation of that before 1929. It is of further interest that these pound-nets have occupied essentially the same position each year over the entire period covered by this record.

It is impossible to test the validity of this record as a method of sampling the total population, and thus accurately record fluctuations in abundance that occurred. However, it is probable that it gives a fair indication of the decrease in abundance from 1884 to 1935, and that the 1936 and 1937 peaks give a correct picture of the

[2] This record was placed at the author's disposal through the courtesy of Mr. Bruce Crane, Dalton, Mass.
[3] These records were made available by the U. S. Fish and Wildlife Service and the Bingham Oceanographic Foundation.
[4] These records were made available through the cooperation of Capt. Daniel D. Parsons, Montauk, Long Island, N. Y., the present owner.

magnitude of the increased abundance resulting from the 1934 dominant year-class. The peaks at 1894 and 1895, 1906, and 1922 perhaps also represent good year-classes that bolstered the stock temporarily, but there is no adequate means of checking this, since practically no other records covering the same period are available. Striped bass tend to school heavily, and the presence of several schools might easily form the main part of such a peak as the ones shown at 1906 or 1922 in figure 4. Consequently, it may have been that in these years striped bass were not more numerous, but that one or more large schools hit the traps while on migration and gave a false impression of abundance. In another year the reverse situation might have taken place—that is, that the population was unusually high, but that comparatively few bass happened to strike the pound-nets, thus producing a low point on the curve that is not a true indication of abundance. It is, therefore, best not to assume that these fluctuations represent actual changes in the size of the population—at least not until there is further evidence on this score.

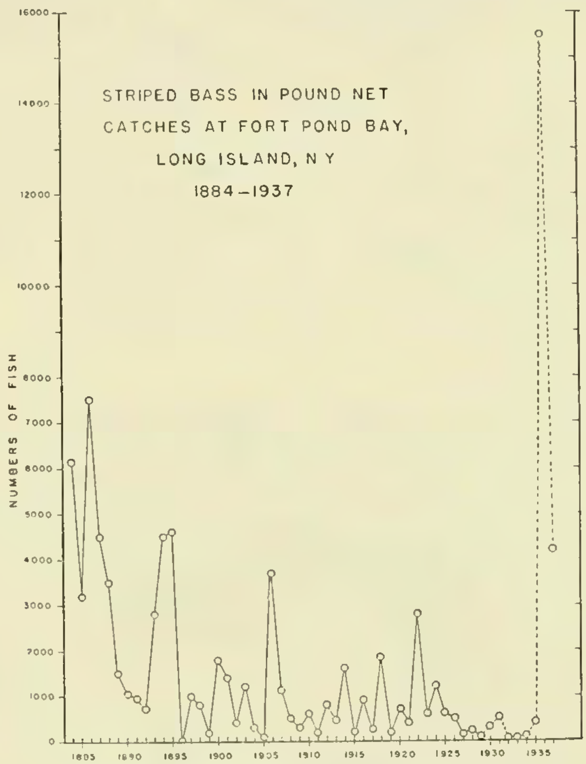

FIGURE 4.—Numbers of striped bass taken each year in the pound nets at Fort Pond Bay, L. I., N. Y., from 1884 to 1937. The fishing intensity has been equalized throughout (see Table 4).

The peak years mentioned by Bigelow and Welsh (1925) for the catches from Boston to Monomoy, Mass., from 1896 to 1921, show some discrepancy with those in figure 4. In this area 1897 and 1921 were years in which exceptional catches were made. It will be noticed, however, that these years are close to the peaks at 1895 and 1922 shown in figure 4. It may therefore be true that dominant year-classes were present from 1895 to 1897, and in 1921 and 1922, but that they made their presence felt in successive years in somewhat different areas.

The peaks at 1936 and 1937, however, are no doubt reasonably accurate indications of the increased abundance in those years. In 1936 the enormous numbers of striped bass that appeared along the Atlantic coast were mainly made up of fish 2 years old, the age at which this species first makes its appearance in the commercial and sport fishermen's catch in Long Island and New England waters. In 1937 a large proportion of the population along the Atlantic coast was composed of 3-year-olds.

The increased abundance in these 2 years was due, therefore, entirely to the 1934 year-class. This group of fish is treated in some detail in the section on age and rate of growth (p. 26), but a glance at figure 5 will sufficiently emphasize the relative abundance of the 3-year-olds in 1937. This figure is composed of three length-frequency curves made up from a random sampling of the commercial catch at different localities. Since striped bass 3 years old ranged in size roughly from 35 to 55 cm. (peak at 40 to 45 cm.) during the period these samplings were made, it is evident that the great majority of the catch was made up of 3-year-olds.

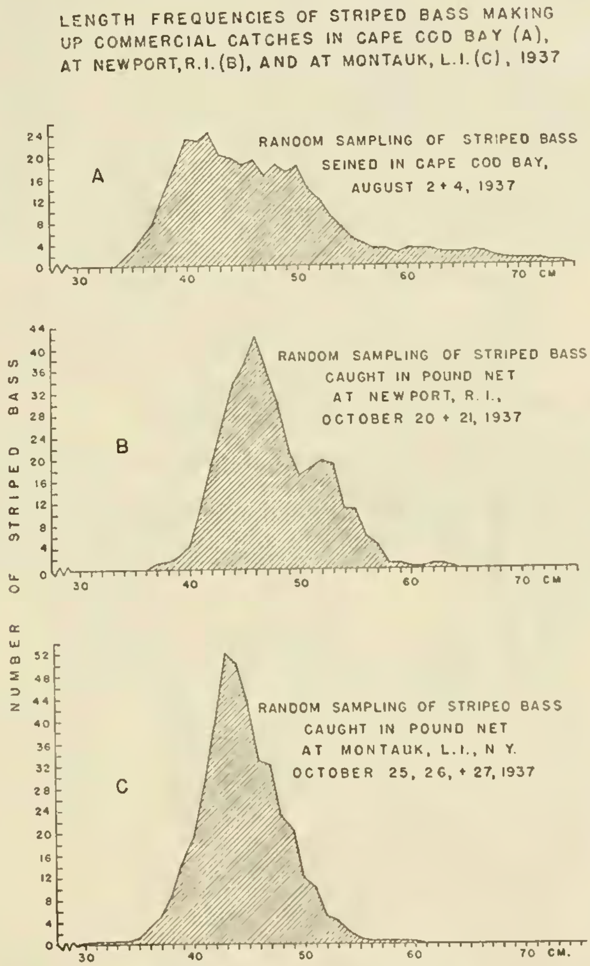

FIGURE 5.—Length-frequency curves made up from random samplings of the commercial catch in different localities in 1937. Data smoothed by threes in all cases (see Table 5 for original measurements).

Additional information on the 1934 year-class is seen in the catch records of a haule-seine fisherman at Point Judith, R. I., from 1928 to 1937.[5] (See figs. 6, 7, and 8.) Not only were the numbers and approximate poundage of the fish taken at each haul recorded, but also the date of each haul and the number of hauls annually, thus making it possible to equalize the fishing intensity throughout the entire period. The same areas were fished over this 10-year period. The annual catch in numbers of fish and total poundage are shown in figure 6, and the average weight of the striped bass taken each year is plotted in figure 7. The small proportions of the catch from 1928 to 1935 correspond well with that shown in figure 4, and the tremendous increase

[5] These records were provided through the courtesy of Mr. Chester Whaley, Wakefield, R. I.

in 1936 and 1937 is added evidence on the size of the 1934 year-class. It will be noticed, however, that the decline in the catch in 1937 is not as sharp as that shown in figure 4, probably due to the fact that this seine fishery at Point Judith took a goodly number of 2-year-olds (members of the 1935 year-class) in the spring of 1937. These fish did not make up as large a proportion of the catch at Fort Pond Bay, Long Island, N. Y., during the 1937 season. The records are not sufficiently accurate to permit an exact analysis of the relative numbers of 2- and 3-year-olds in the 1937

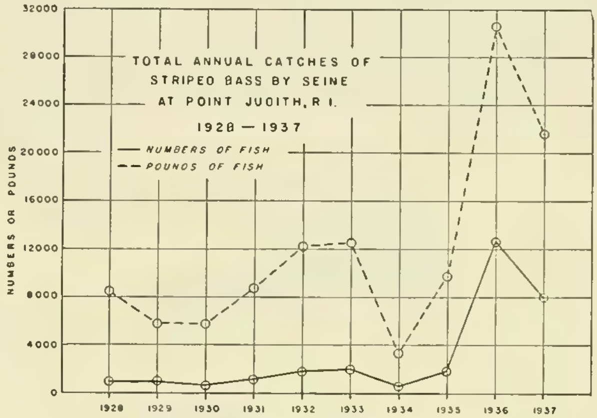

FIGURE 6.—Annual total catch of striped bass by seine at Point Judith, Rhode Island, 1928–37. Fishing intensity equalized throughout (see Table 6 for original data).

catch at Point Judith. The average annual poundage shows, however, that the catch in 1936 was composed mainly of 2-year-olds, and there is a noticeable increase in the average poundage in 1937, due to the dominance of this same 1934 age-group—at that time 3-year-olds. The decline in the average weight of the striped bass making up the annual catches by seine at Point Judith from 1930 to 1936 is quite

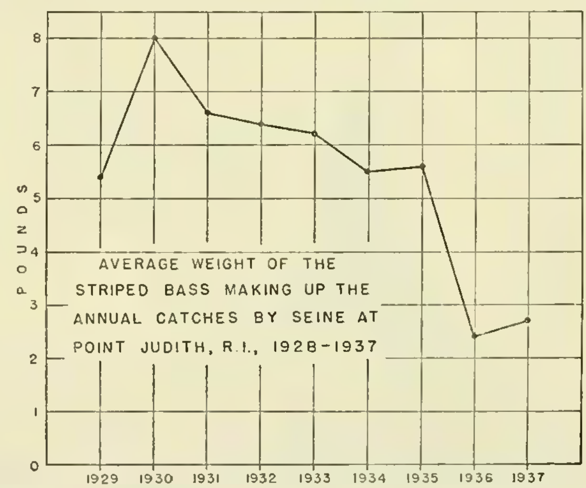

FIGURE 7.—Average weight of the striped bass making up the annual catches by seine at Point Judith, R. I., 1928–37 (see Table 6 for original data).

striking, the drop in this period being from an 8-pound average to a 2-pound average (see fig. 7). European investigators have shown a similar decline in the average annual weight making up the catch following man's intervention on a virgin stock. Thus after the World War, when the North Sea fisheries began to operate again, the larger size-categories were removed first, and in each succeeding year the catch was made up of fish of a smaller average size. In the case of the striped bass, however, the general decline in the average weight from 1930 to 1936 cannot be explained in the same manner. This is so because although this particular seine fishery at Point Judith was a new one, it was not operating on a virgin stock, for the striped bass is a highly migratory species and is the object of intensive fisheries of different types along the entire Atlantic coast. A more logical explanation is that this downward trend in annual average weight over this period was brought about by the decreasing numbers of large fish that formed the remnant of a dominant year-class produced some years before. That there was a definite decrease in the proportion of large fish making up the catch from 1930 to 1936 is evident from figure 31, in which the percentages of small, medium, and large fish taken in each year are shown. The peak in the annual average weights at 1930 (fig. 7) was caused by the comparatively great numbers of large fish that made up the catch. Thereafter the composition of the yearly catch showed a decreasing percentage of fish from the larger size-categories (except in 1935). It seems logical, therefore, that a fairly good remnant of a dominant year-class, whose members had attained a large size, existed in 1930, and that in each successive year this remnant became increasingly smaller, thus producing the downward trend in the annual average weight of bass making up the catch in these years. The sharp drop in average weight in 1936 was primarily due to the appearance of the 1934 dominant year-class in the commercial catch.

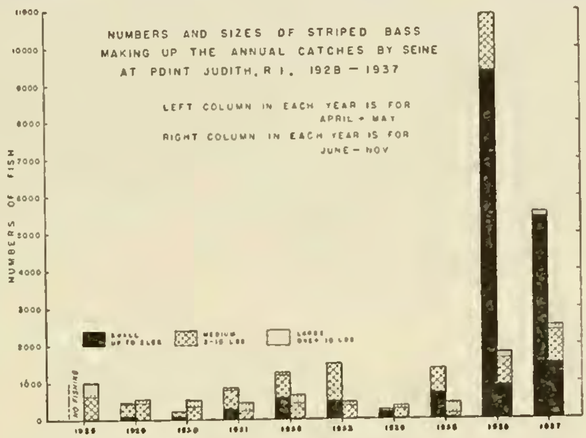

FIGURE 8.—Numbers and sizes of striped bass making up the annual catches by seine at Point Judith, R. I., 1928–37. The left column in each year is for April and May, and the right column for June to November. The fishing intensity has been equalized throughout.

The tremendous numbers of 2-year-olds in this year is well shown in fig. 8. It will also be noticed that there was an exceedingly small percentage of large fish in this year. The increase in annual average weight in 1937 was due to the increase in size of the members of the 1934 dominant year-class—at this time 3-year-olds. If no other dominant year-class comes along for a considerable period of years, it is to be expected that the annual average weight of the striped bass making up the yearly catch will climb steadily to a certain limit, i. e., until the numbers and larger size of the striped bass born in 1934 become insufficient to increase the average weight of the individuals making up the entire catch. If the production of young then continues at a low level, the annual average weight should show a steady decline until the members of another dominant year-class attain sufficient size to start it on an upward trend again. It seems likely that it is the latter part of this cycle that is shown in figures 6 and 7.

The question of precisely what caused the appearance of the dominant year-class of 1934 is of especial interest. Judging from the catch records shown in figures 4, 6, 7 and 8, there can be little doubt that this year-class represents the largest production of striped bass on the Atlantic coast in the past half century or more. Yet it is apparent, as has been pointed out, that the parental stock in 1934 was probably as small as it ever as been (see figs. 4, 6, and 8) (the catch in northern waters can be used as an indication of the size of the stock from Massachusetts to Virginia since this species is highly migratory within these limits). It would seem, therefore, that the production of a dominant year-class of striped bass is in no way dependent on the presence of a great number of mature individuals. It is thus necessary to look to other factors for the explanation of this phenomenon. Russell (1932) has pointed out that especially large dominant year-classes were produced in the North Sea in 1904 simultaneously by three different species—herring (*Clupea harengus*), cod (*Gadus morhua* [6]), and haddock (*Melanogrammus aeglefinus*). It would seem from this evidence that environmental factors apparently play some part in producing these exceptional year-classes. Russell (loc. cit.) has also mentioned the fact that ". . . there is no necessary connection between the number of eggs produced in a particular spawning season and the amount of fry which survives," and it is apparent that environmental factors are most effective in determining the percentage of survival. This is probably especially true in a species with pelagic eggs, a category to which the striped bass essentially belongs (see p. 18). Since the striped bass is anadromous, anything that might affect the rivers in which this species spawns, and the areas in which the eggs hatch and the larvae develop, is worthy of consideration. Unfortunately, the only records that are available are meteorological. Attempts have been made to correlate both temperature and precipitation, since either is capable of seriously influencing the regions where spawning and early development take place, with the prominent peaks shown in the catch records in figure 4. Such a correlation necessarily assumes that the peaks at 1894 and 1895, 1906, and 1922, represent dominant year-classes, and, as has already been mentioned, it is impossible to test the validity of such an assumption. It also takes for granted that these dominant year-classes were produced 2 years before, since striped bass first make their appearance in the commercial catch as 2-year-olds. In the case of the peak at 1936, it is definitely known that a dominant year-class was present, and it is further known that the fish that produced this peak were born 2 years before, in 1934. Figure 9 shows the deviations from the mean temperature from 1880 to 1935 at Washington, D. C., for February, March, April, and May. Washington

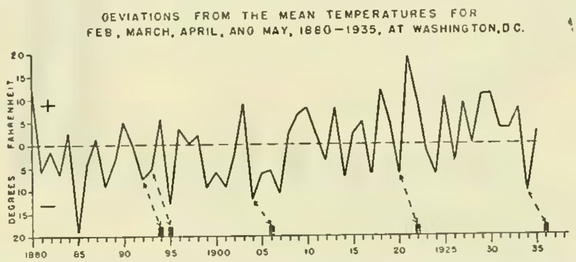

FIGURE 9.—The deviations from the mean temperature for February, March, April, and May, 1880–1935, at Washington, D. C. The black columns on the base line indicate the years when exceptionally good catches of striped bass were made, and the arrows connect them with the temperatures 2 years before, when in all probability, dominant year-classes were produced.

D. C., was chosen because it is in the general latitude of the majority of the important spawning areas for striped bass. The 4 months from February to May were chosen because May is the main spawning season (see below), and because temperatures over this period may well affect the river temperatures as late as May and thereafter. It will be seen from figure 9 that the peak years in the catch record in figure 4 invariably correspond with a below-the-mean temperature 2 years before. It seems likely, therefore, that dominant year-classes in the striped bass are produced only on a subnormal temperature. On the other hand, a low temperature during the late winter and spring months does not necessarily cause the production of a dominant year-class. There are undoubtedly other factors which must concatenate with a subnormal temperature to bring about such a production. It is impossible to state what these factors are, but examination of the precipitation records shows that there is no correlation between rainfall and the dates 2 years before the peaks at 1884 and 1885, 1906, and 1922, shown in figure 4. The inverse correlation between temperature and this catch record, however, is good. The coefficient of correlation for the entire catch record (1884–1937) and the temperature over this whole period is —.354, which is significant to the 1-percent level. It is thus highly probable that the production of dominant year-classes in the striped bass is quite closely associated with low temperatures.

[6] The spelling "*morhua*," instead of "*morrhua*" as used by most recent authors, is in keeping with Schultz and Welander (1935).

In conclusion, it may be said that there is every evidence that over a long-term period the abundance of the striped bass of the Atlantic coast has shown a sharp decline. Dominant year-classes have at times temporarily raised the level of abundance, but the intensity of the fishery is such that their effects have been short-lived. This is well shown in figure 4, where it will be noticed that the return to a state approaching the normal low abundance usually follows immediately after the appearance of a dominant year-class in the commercial catch. In the 1934 year-class, however, the numbers of striped bass reached such enormous proportions that not only did the 2-year-olds of 1936 dominate the fishery, but the 3-year-olds of 1937 also formed the main part of the catch. None the less, the sharp decline in numbers of bass taken in 1937, as compared with those caught in 1936, is clearly evident, and there can be little doubt that the members of this dominant year-class will be reduced within a few years—under the conditions of the present intensive fishery—to a point where they are negligible. The rate of removal of the different age-groups of the striped bass by the fishery is shown in some measure by the percentage of returns of tagged fish. These percentages are shown in tables 17–20, and 22. It is of interest that the extreme in percentage of recapture is seen in the case of 303 fish (predominantly 3-year-olds) tagged and released at Montauk, Long Island, N. Y., in late October 1937. Six months later over 30 percent of these tagged fish had been recaptured. Furthermore, it is not reasonable to expect that the percentage of tag returns gives a sufficiently great valuation of the rate of removal of the fish of different ages, for, among other reasons, no reward was offered for the return of tags, and it is undoubtedly true that many of the marked fish that were captured were never reported. It is roughly estimated that about 40 percent of the 2-year-olds of 1936 were taken during their first year in the fishery, and that at least 25–30 percent of the remaining 3-year-olds were caught in 1937. This means that a minimum of 50 percent of the 2-year-olds entering the fishery in the spring of 1936 had been removed by the spring of 1938, neglecting the effect of natural mortality. It thus becomes clear why dominant year-classes only raise the level of abundance over short periods, and why, in spite of the occasional increases in number, the general trend of the annual catch of striped bass has been downward. Looking to the future, there is no reason to suppose that the increased abundance caused by the 1934 dominant year-class—huge as it was—will produce any lasting effect on the stock. It is more probable that the return to the normally low level of abundance, so characteristic of the years before 1936, will soon take place, and that only the production of another dominant year-class will raise the population of striped bass to such unusually high numbers.

SPAWNING HABITS AND EARLY LIFE HISTORY OF THE STRIPED BASS

It is commonly stated in the standard ichthyological references for the Atlantic coast that striped bass are anadromous, spawning in the spring of the year from April through June, the exact time depending on the latitude and temperature (Smith, 1907, and Hildebrand and Schroeder, 1928). Most of the statements on the spawning of this species have been based on a series of papers in which S. G. Worth (1903 to 1912) discussed the problem of artificial propagation and presented many interesting sidelights on the various phases of spawning and early life history from his studies at Weldon, on the Roanoke River, N. C. Although most of the information in Worth's work is fragmentary, his observations are of value because there has been so little work on any part of the Atlantic coast to corroborate and amplify his statements. The work of Coleman and Scofield (1910) and Scofield (1931) on the Pacific coast indicates that striped bass spawn from April through June in the low-lying delta country adjacent to Suisun Bay, Calif., where the water borders between brackish and fresh.

The presence of young fry and small striped bass in the brackish waters of large rivers of the Atlantic coast offers proof that this is an anadromous species, and the absence of juvenile and yearling bass along the outer coast indicates that this species does not undertake coastal migrations until they are close to 2 years old. Thus

Mason (1882), Throckmorton (1882), Norny (1882), and Bigelow and Welsh (1925) present interesting accounts of baby bass being taken in various rivers along the coast in the past (Navesink River, N. J.; Wilmington Creek, Del.; Kennebec River, Maine). Hildebrand and Schroeder (1928) record them as being taken in Chesapeake Bay during the summer months, and Dr. Vadim D. Vladykov, while working on the survey of anadromous fishes for the State of Maryland, also took many juvenile striped bass 5–10 cm. in length on the eastern shore of Chesapeake Bay during the summer of 1936. More recently juvenile bass have been taken in the Hudson River by the New York State Conservation Department, and in the Parker River, Mass., by the author (p. 17). There is also some evidence, from the reported capture of baby bass, that isolated spawning areas still exist as far north as Nova Scotia.

There can be little doubt that striped bass in early times entered and spawned in every river of any size, where the proper conditions existed, along the greater part of the Atlantic coast, and that as cities were built and dams and pollution spoiled one area after another, the number of rivers that were suitable for spawning became fewer and fewer. At the present time there is every indication that by far the greater part of the production of striped bass along the Atlantic coast takes place from New Jersey to North Carolina, and that the addition to the stock from areas to the north is so small as to be almost insignificant and of little consequence. Thus in Connecticut, where there is much evidence—from the statements of old-time fishermen—that striped bass used to spawn, there is now every reason to believe that spawning seldom if ever occurs. During the entire course of this investigation the author has tried innumerable times in different localities to find juvenile striped bass in Connecticut waters, for since the juveniles are found close to or in areas where the adults are known to spawn, their presence in Connecticut waters would have indicated the probability of spawning occurring nearby. These efforts never met with any success. Most attention was centered on the Niantic and Thames Rivers, especially the latter, because accounts of baby bass having been caught there within the last 50 years are more numerous than for other regions. Areas similar to those where small bass were taken in the Hudson River in the summers of 1936 and 1937, as well as many other likely localities, have been worked with minnow seines and small-meshed trawls that were efficient enough to catch large numbers of young fish of many other species and occasionally even adult striped bass. However, the smallest striped bass taken in Connecticut waters was a small 2-year-old which measured 23 cm. (9 inches). If spawning occurred to any great extent, small fish 3–8 cm. long, comparable to those caught in other areas in the summer, would most certainly have been found. Plankton and bottom hauls taken at weekly intervals in the Niantic River in an area where bass were known to be present from April through November 1936, have failed to reveal the existence of anything that might be construed as evidence that striped bass spawn there. Further than this, not a single ripe fish of this species has been taken by the author in the course of this investigation in Connecticut waters, although many thousands of bass have been handled at all times of year save the winter months. Inquiries among commercial fishermen in New England and Long Island waters show that ripe striped bass have been caught so rarely and at such irregular times in recent years that their presence can be considered nothing more than abnormal. The fact that large fish that showed no signs of even approaching ripeness were commonly taken in the Niantic River during the spring and early summer months, when bass are known to be spawning in other areas, suggests that this species is not necessarily an annual spawner. The impression from the available information is that spawning does not occur in the region investigated, although it is possible that other Connecticut waters provide proper breeding grounds.

Despite the fact that there is no evidence that striped bass spawn in Connecticut waters at the present time, studies in recent years have disclosed two probable spawning areas in other northern waters. In 1936 the New York State Conservation Department took large numbers of juvenile striped bass in various localities on the Hudson River from Beacon downstream. A length-frequency curve of these fish is shown in figure 10.[7] Curran and Ries (1937) in describing the capture of juvenile striped bass in the Hudson River, say:

> During the survey few adults but many juvenile striped bass were taken throughout the stretch of river from the city of Hudson to New York. Collections of young for the year were taken first on July 20 in Newburgh Bay. At this time they were 2 inches in length and later study of their scales proved that they were 1936 fish. From Newburgh to Yonkers, about 35 miles downstream, they were found in considerable numbers. Gravelly beaches seemed to be the preferred habitat as few were taken over other types of bottom. In night seining over the gravel they were found to be associated with herring and white perch while daytime hauls showed the herring replaced by shad. Nearly every seine haul in which young striped bass were caught brought in white perch as well.

The chlorine as chlorides ranged from 10.0–8,560.0 parts per million (water of low salinity) over this stretch of the Hudson River (Biological Survey (1936), 1937). Larger individuals—up to 2 pounds— have been taken in the Hudson as far up as Albany. There can be little doubt, therefore, that the Hudson River is a spawning area for striped bass. Their capture by commercial fishermen in April and May in this region, and the not uncommon reports of ripe individuals at this time of year, is added evidence that spawning takes place in the spring in water that is at least brackish and perhaps entirely fresh.

On August 4, 1937, the author took three small striped bass in the Parker River, near Newburyport, Mass. These fish were 7.1, 7.6, and 8.5 cm. long, and subsequent

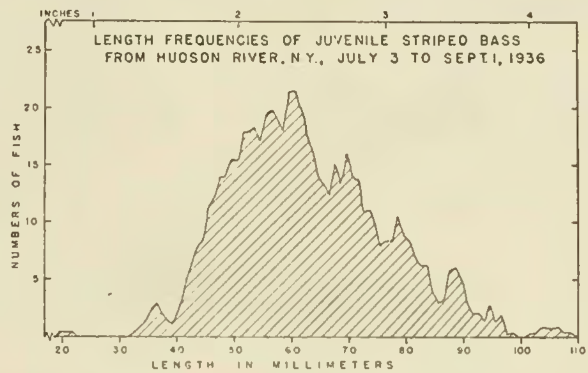

FIGURE 10.—Length-frequency curve of juvenile striped bass from the Hudson River, July 3 to Sept. 1, 1936. The number of fish making up this curve is 628. The data have been smoothed by threes. The great majority of these fish were taken in late August (see Table 7 for original measurements).

examination of their scales showed them to be juveniles. They were taken about 6 miles from the mouth of the river and about 2 miles below the Byfield Woolen Mills, where a dam prevents anadromous fishes from going further upstream. The bottom, on which these fish were seined was mostly mud and sand, with little gravel and a few scattered rocks. The salinity at this point was 10.23 parts per 1,000, and the water temperature at the surface was 25.5° C. and at the bottom 24.8° C. (ebb tide, one-third out). The depth of the river in this area at this time was 8 feet, and the width 40–50 feet. Other fish found in association with these juvenile striped bass were juvenile white perch (*Morone americana*), and various Clupeoid species; snapper bluefish (*Pomatomus saltatrix*) were also included in seine hauls in this region. The Parker River is free from pollution and is strongly tidal all the way to the Byfield Woolen Mills, where a large amount of fresh water empties into it, particularly in the spring. From this point down, the river winds through the Rowley marshes and eventually empties into Plum Island Sound. It has steep sides, and the rise and fall of the tide along the better part of its length is 5–6 feet. The failure to catch more small striped bass in this river, despite several attempts, is probably best explained by the great difficulty of seining in such an area. The steep sides of the banks and the fast tidal current both make it next to impossible to handle a seine efficiently along

[7] The entire collection of striped bass made by the members of the Biological Survey in 1936 was placed at the author's disposal in February 1938 by Dr. Dayton Stoner, State Zoologist of the New York State Museum at Albany, N. Y. Further than this, Dr. Moore, Chief Aquatic Biologist of the New York Conservation Department, and other members of the staff, gave the author much information regarding the capture of small bass in the Hudson River, before the results of the Biological Survey of 1936 were published.

this river. The capture of only three juvenile striped bass, however, is significant, and probably indicates that striped bass spawn in the Parker River. Added evidence that this is a spawning area is seen in the fact that striped bass are known to winter in this river, as is shown by their capture through the ice by bow-net fishermen. It is considered likely that this is an example of an isolated spawning area in northern waters, supported at least in part by a resident population, and possibly added to by migrants from the south in exceptional years. Although this is the northernmost point from which juveniles have been definitely reported in recent years, there can be no doubt that they were commonly taken in the coastal rivers of the Gulf of Maine in old times (Bigelow and Welsh, 1925), and there is good reason to believe that other isolated spawning areas still exist north of Cape Cod.

Another area in which juvenile striped bass were taken was in the Delaware River, near Pennsville, N. J. On November 8, 1937, the author was present when the game protectors for the State of New Jersey Board of Fish and Game Commissioners took 104 small striped bass from the intake wells of a large power plant on the Delaware River, where fish of all sorts are regularly trapped against the screens by the strong flow of water, and are removed and liberated in other regions. A length-frequency curve of this material is shown in figure 11. The examination of scales from these fish showed that the bulk of this sampling was composed of yearlings, and that only a few juveniles from about 9.0–12.5 cm. long were present. It is considered probable, therefore, that the Delaware River region, including some of the smaller streams that enter Delaware Bay, forms another area in which striped bass spawn.

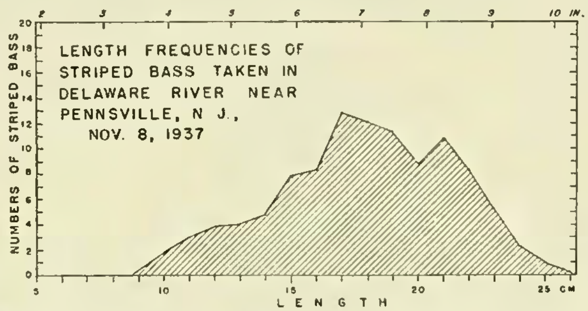

FIGURE 11.—Length-frequency curve of juvenile and yearling striped bass taken in the Delaware River, near Pennsville, N. J., on Nov. 8, 1937. The number of fish included in this graph is 104. The data have been smoothed by threes (see Table 9 for original measurements).

It has long been known from the observations of Worth (1903 to 1912) at Weldon, N. C., that striped bass spawn in the Roanoke River. The main observations on the eggs and larvae of the striped bass that are recorded in the literature for the Atlantic coast are taken from Worth's papers, and were made during the time that he conducted a hatchery at this point. Bigelow and Welsh (1925) sum up the available information as follows:

> The eggs (about 3.6 mm. in diameter) are semi-buoyant—that is, they sink but are swept up from the bottom by the slightest disturbance of the water—and this is so prolific a fish that a female of only 12 pounds weight has been known to yield 1,280,000 eggs, while a 75-pound fish probably would produce as many as 10,000,000. The eggs hatch in about 74 hours at a temperature of 58°; in 48 hours at 67°.

In recent years the hatchery at Weldon has again resumed operations, thus affording an excellent chance for the study of the eggs and larvae of the striped bass. Others have already accumulated detailed information on this subject (Pearson, 1938), and the following material (from data collected in 1937 and 1938) included herewith, is therefore nothing more than a brief account of some of the more interesting highlights of the spawning and early life history of the striped bass.

Spawning in the Roanoke River normally occurs in April and May, although occasionally there are a few stragglers that appear as late as June. It is probable that spawning takes place over a good stretch of the river from Weldon down. (Weldon is over 75 miles by river from Albemarle Sound.) At Weldon the river flows about 4 miles an hour, and is approximately 100 yards wide. Water samples taken on March 29, 1937, showed the chlorinity to be less than 5 parts per million (fresh water), the pH 7.7, and the alkalinity 53.1 estimated as milligrams of bicarbonate per liter.

In 1938 the first spawning striped bass were taken at Weldon on April 11, and by May 10 spawning was apparently completed and the fish had left this locality. This was an unusually early and short spawning season, probably due to the abnormally high temperatures during this time. From April 29 to May 11 the water temperature averaged well over 70° F. (21.11° C.) and at one time reached 77° F. (25.0° C.). During the spawning season it is a quite common occurrence to see the so-called "rock-fights" described by Worth (1903), and well known to local fishermen on the Roanoke River. These consist of a great number of small males, 1–3 pounds in weight, and apparently only a single female, appearing on the surface and causing a tremendous commotion by splashing about and creating general confusion. The activity is said to be so great that the fish often injure one another quite seriously, and fishermen who catch striped bass when they are "in fight" attest to this fact and to the number of small males, 10–50 as a rule, that take part in such a display with a single female of from 4–50 pounds. Whether or not this is actually part of the spawning act or a form of courtship does not seem to be definitely established, but general opinion favors the former view. There can be little doubt that the spawning fish at Weldon are composed mainly of males, the females probably never making up as much as 10 percent of the population. In May 1938 the examination of 127 individuals taken at Weldon showed but 6 of them to be females, and much the same sex ratio was found to obtain farther down the Roanoke River at Jamesville, N. C., at the same time.

There is no reason to doubt the accuracy of Worth's estimates of the number of eggs produced by a single female striped bass. Records kept at the hatchery at Weldon during 1928, 1929, 1931, 1932, 1937, and 1938, show that the number of eggs per female varied from 11,000 to 1,215,000 in a total of 111 individuals examined in this time. The majority of these fish yielded from 100,000 to 700,000 eggs each. Unfortunately the weights of the individual fish on which these counts were made were not taken, but a single female weighing 4½ pounds, taken at Weldon on May 4, 1938, produced 265,000 eggs.

The eggs of the striped bass average about 1.10–1.35 mm. in diameter when they become fully ripe, and at the time that they are extruded into the water. During the first hour after fertilization the vitelline membrane expands tremendously, thus creating a large perivitelline space. Measurements on a series of 50 eggs that were preserved 1 hour after fertilization in a solution of 7 percent formaldehyde gave an average measurement of 3.63 mm. in diameter, the extremes being 3.24 and 3.95 mm. Eggs similarly preserved at longer time-intervals after fertilization showed the same general measurements. So far as one can judge from preserved specimens, the description given by Bigelow and Welsh (loc. cit.) of the eggs as being semibuoyant fits perfectly. These eggs are undoubtedly swept far downstream by the strong current, and the protection against injury by jarring afforded by the large perivitelline space is probably of no small consequence in the survival of the developing embryos. The speed of development and the time to hatching is of course dependent on temperature. At 71°–72° F. (21.7°–22.2° C.) hatching occurs in about 30 hours, while at 58°–60° F. (14.4°–15.6° C.) hatching normally takes place in about 70–74 hours. In view of the fast current in the Roanoke River, and the rate at which the developing eggs are carried downstream, it is reasonable to assume that hatching probably does not take place until they are close to the mouth of the river or even in Albemarle Sound. Figure 12 shows the different stages of development of striped bass eggs and larvae that were reared in the hatchery at Weldon, N. C. These eggs were fertilized artificially and held at a temperature of 70°–72° F. (21.1°–22.2° C.). The photographs of the eggs were taken from above looking down. A side view would in reality show that the yolk, with the developing embryo and oil globule, lies at the lower pole of the whole egg as it floats normally in the water. The single large oil globule which is imbedded in the surface of the yolk always lies uppermost, and the blastodisc appears on the side of the yolk in an area that is approximately at a 90° angle with the oil globule—not just opposite the oil globule on the lower pole as Wilson (1891) has shown for the sea bass (*"Serranus atrarius"*—Wilson, loc. cit., now called *Centropistes striatus*). Hatching occurred in 30 hours in the lot under observation, and it will be seen in figure 12 (F) that 6½ days later the yolk sac was almost completely absorbed.

To the author's knowledge, the smallest striped bass that have ever been taken in their natural habitat were seined along the shore of Albemarle Sound from Mackeys to Rea's Beach, N. C., on May 11, 1938. Since the first spawning fish were taken on April 11 in this year at Weldon, it is likely that these individuals were not more than 1 month old. A length-frequency curve of the 85 juveniles taken at this time is shown in figure 14, and it will be seen that they ranged in size from 1.9–3.1 cm., the peak falling at 2.7 cm. The growth of the striped bass from this age on is further discussed in a later section.

In general, then, it may be said that all the evidence points to the fact that the striped bass is anadromous, spawning in the spring of the year, the exact time probably depending on temperature and latitude. It is not definitely established, however, how high a salinity the eggs and larvae of bass will tolerate. Considering the wide variation in the type of river in which bass are known to reproduce, it does not seem unlikely that spawning may at times take place successfully in areas where the water is at least strongly brackish and perhaps even strongly saline. Worth (loc. cit.) first noticed that in raising artificially fertilized eggs of striped bass, an apparatus similar to MacDonald jars—in which the eggs are kept in a strong circulation of water—was necessary in order to get a high percentage of normal development. It would seem, therefore, that a fairly strong current is probably essential for the development of the eggs, but that this may be either tidal, such as that in the Parker River, Mass., or mainly fresh water, as in the Roanoke River. Some possible evidence that spawning does not necessarily always take place in waters of extremely low salinity is provided by the irregular and inconstant manifestation of what appear to be distinct spawning marks on the scales of mature striped bass (see p. 24), for it is generally assumed that such marks are only found on fish that enter fresh water. It would be logical to expect that if all striped bass entered fresh water for spawning purposes, spawning marks on the scales would be more common than they actually are. Such spawning marks are, of course, particularly well-known on scales from salmon (*Salmo salar*), which do not feed to any great extent during their sojourn in fresh water for spawning purposes, and whose scales are probably partially resorbed during this period, thus forming the characteristic spawning mark. It should be pointed out, however, that striped bass undoubtedly do not stop feeding to the same extent or for a similar length of time during spawning.

SEX AND AGE AT MATURITY

It is impracticable to get large quantities of striped bass for sex determinations and stomach-content analyses anywhere along the Atlantic coast. This is so because this fish is almost universally shipped to market, and frequently even sold to the individual customers, without being cleaned; hence it was not possible to examine the body cavities in large numbers in the wholesale markets. Since there is no valid method of determining sex without inspecting the gonads, the collection of quantitative data on this phase of the work was necessarily limited to the study of fish caught on rod and line by sportsmen and cleaned by the author, to a number of small random samplings of bass that were seined during tagging operations, and to a few fish that were examined on different markets as they were being sold.

A total of 676 striped bass caught in northern waters (Long Island and New England) from April to November 1936 and 1937 were examined for sex. These fish ranged in size from 25 to over 110 cm., and in age from 2 years old to over 12 years old. Of these 676 fish, only 9.7 percent were males. One hundred and eighty-three of them were 3 years old or more, and only 4.4 percent of these were males. No males above 4 years old have been found in northern waters. The remaining 493 fish examined were 2-year-olds, 11.8 percent of which were males. Although the number of fish examined for sex is too small to permit any final conclusions, there is little doubt that the number of males in northern waters seldom reaches much over 10 percent of the entire population. And the evidence so far is that the percentage of males is greatest among the 2-year-olds—that age at which this species first undertakes the migration from further south (see p. 44), and appears in large quantities in northern waters; the percentage of males apparently decreases in the age categories above the 2-year-olds.

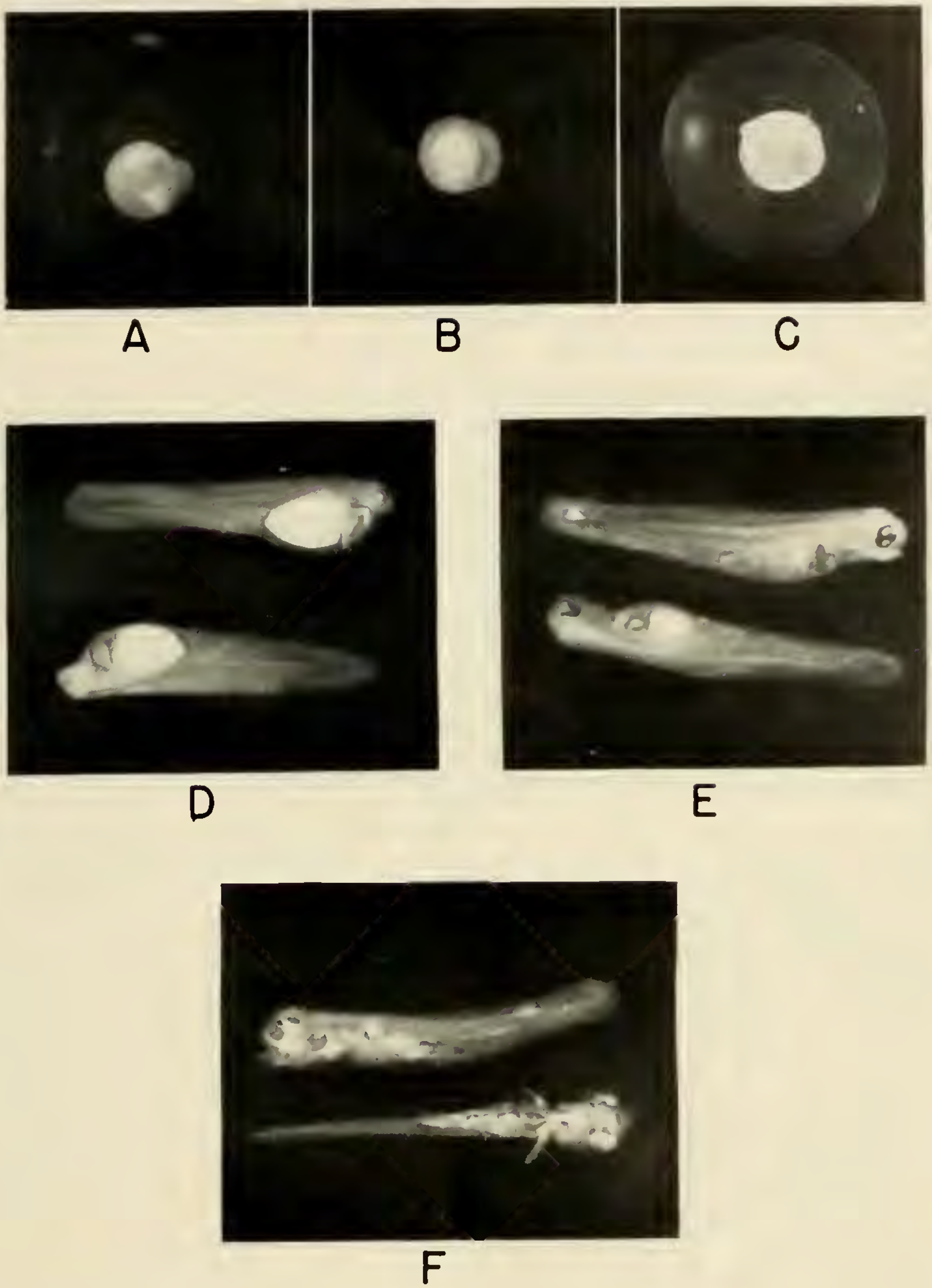

FIGURE 12.—Six developmental stages of striped bass eggs and larvae raised at the hatchery at Weldon, N. C., at a temperature of 70–72° F. Hatching occurred at 30 hours. Magnification equals ×8.2 throughout. A. 1 hour after fertilization. B. 17 hours after fertilization. C. 29 hours after fertilization. D. 20 hours after hatching. E. 60 hours after hatching. F. 6½ days after hatching.

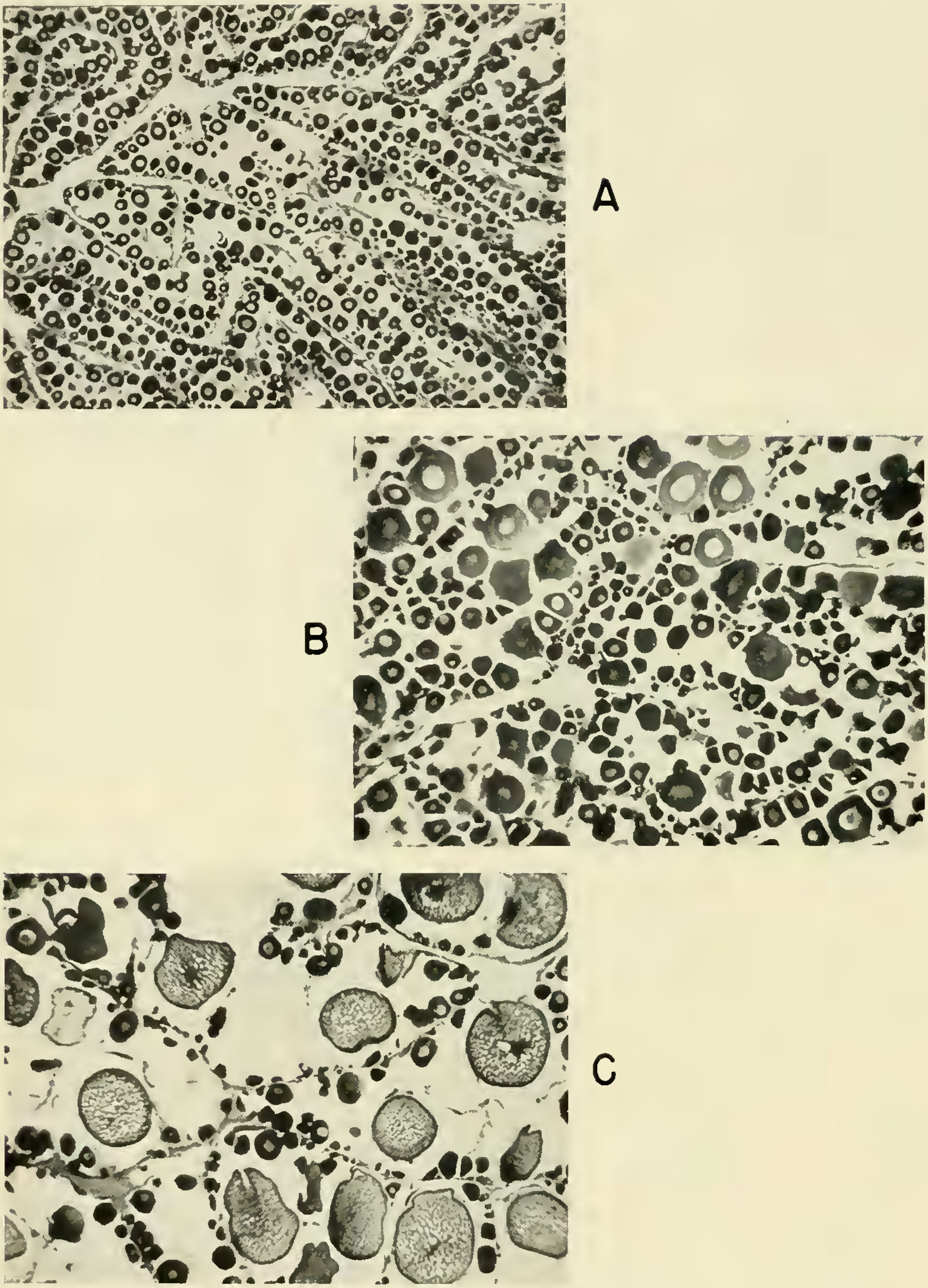

FIGURE 13.—Sections through immature and mature striped bass ovaries. A. Immature ovary. B. Mature ovary—5 to 6 months before the spawning season. C. Mature ovary—approaching full maturity. Magnification throughout ×36.

Such a disproportionate number of females to males is of course most unusual, and it seems unlikely that this condition prevails among the total population of the Atlantic coast. The examination of 29 small bass from Delaware Bay in November 1937 showed approximately 45 percent were males. A sample of 126 bass ranging in size from 21 to 42½ cm., from Albemarle Sound, N. C., in March and April 1938 was composed of 31.7 percent male fish. There is also evidence that the composition of the spawning populations of striped bass is predominantly male (p. 19). A theoretical explanation of the strikingly low percentage of males in northern waters is included in the section under migrations (p. 44).

In studies of the age at maturity, miscroscopic examination of the gonads presented the most plausible method of procedure in northern waters. The fact that ripe [8] individuals were not available in Connecticut precluded the possibility of studying the age groups making up a spawning population. Gonads from 109 female striped bass ranging in size from 32 to 110 cm. were collected at various intervals from April through November 1936 and 1937. Of these, 46 were fixed in Bouin's fluid and slices from the anterior, middle, and posterior region of each one were cleared in toluene.[9] These were sectioned, stained with Delafield's hematoxylin and eosin, and mounted. Samples of up to 50 ova from each of the three regions of the gonads from which slices were taken were then measured by means of an ocular micrometer. It was soon found that samples from the anterior, middle, and posterior parts of each ovary contained eggs of the same general sizes, and that there was no significant difference between the ova of these regions, no matter at what stage of development the gonads were. Thereafter only sections from the middle of each ovary were studied. The remaining 63 ovaries from striped bass collected from April through November 1936 and 1937 were preserved in a solution of 10 percent commercial formalin and water. Slices from the middle of each one of these gonads were then macerated mechanically, until the eggs either floated free or could be easily teased from the surrounding epithelium. Samples of up to 50 ova from each ovary were then measured under a dissecting microscope by means of an ocular micrometer. The measurements on the eggs from 109 ovaries by these 2 methods gave comparable results throughout.

A study of the measurements of the eggs from striped bass of different sizes almost immediately revealed that there were two easily distinguishable types of ovaries. (See fig. 13.) The first type had eggs whose diameters consistently averaged 0.07 mm. There were occasionally eggs as large as 0.18 mm. in diameter, but more commonly the largest eggs measured 0.11 mm. The second type contained eggs of two definite size categories; there were small eggs of the same size as all those that were seen in the first type of ovary, averaging 0.07 mm. in diameter, and there were large eggs averaging 0.216 mm. in diameter or greater, the extreme size that has been encountered being 0.576 mm. It is a reasonable assumption, especially in view of Scofield's (1931) work, that those ovaries containing only small eggs represent immature fish, and that those ovaries having eggs of both small and large size come from fish that are mature, in the sense that the large eggs are those that will be produced the following spawning season. A possible criticism of this assumption is that part of the material examined might have been composed of ovaries from fish that had just completed spawning, and that such ovaries might, therefore, contain only eggs of the small size. On the basis of the distinction between mature and immature individuals proposed above, these fish would then be considered immature, a conclusion that would be entirely erroneous. There is no evidence, however, that ovaries from fish that had completed spawning immediately before were included in the material. It has already been pointed out that spawning individuals were not found in the waters from which this material was collected, and it is most unlikely that any freshly spawned bass were studied for the purpose of determining the age of maturity. Moreover, by far the greater part of the collection of gonads of striped bass of different sizes took place in the summer and fall, by which time spawning is known to be long since past. Another possible criticism of this method of determining the age at maturity of striped bass is that some of the material may have come from fish that were not spawning the following year, for this species is not necessarily an annual

[8] The word "ripe" is used throughout to connote flowing milt or eggs.
[9] Oil of wintergreen and other clearing agents were also used at first, but in general toluene gave the most satisfactory results.

spawner (see p. 16), and might therefore not have contained eggs of the larger size although the fish were mature. It is considered unlikely, however, that any serious error in the results is introduced by this means.

The results from this method of studying the age at maturity indicate that approximately 25 percent of the female striped bass first spawn just as they are becoming 4 years old, that about 75 percent are mature as they reach 5 years of age, and that 95 percent have attained maturity by the time they are 6 years old. The average lengths of individuals of these sizes are discussed in the following section (p. 30), and table 10 gives the results of determining the age at maturity of 109 female striped bass of known length by measurements of the diameters of the ova.

The examination of spawning individuals in North Carolina in the spring of 1938 gives added evidence on the age at which female striped bass first spawn. Scale samples from 25 fully ripe females of measured length (43 to 78½ cm.) were collected in late April and early May. The smallest of these fish was 43 cm.—a bass that was just becoming 4 years old, but was somewhat smaller than the average individual of this age. There were also 5 other individuals from this lot of 25 mature females that were the same age as this smallest fish. Of the remaining 19 fish, 16 were just reaching 5, 6, or 7 years of age, while the other 3 were 8 or 9 years old. During the period when these mature females were encountered, a great many hundreds of smaller females

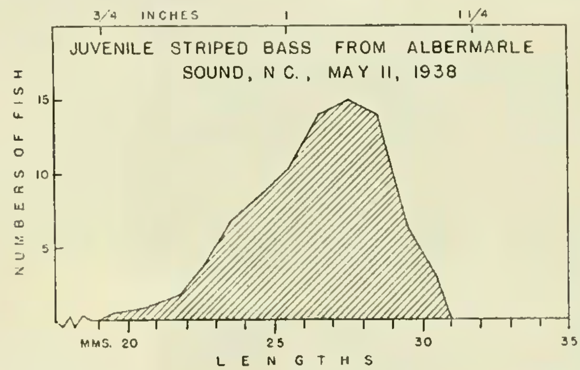

FIGURE 14.—A length-frequency curve of 85 juvenile striped bass taken in Albemarle Sound on May 11, 1938. Data smoothed by threes (see Table 9 for original measurements).

from 1 to 3 years old were handled, but none were ever found to be ripe, thus offering further proof that female striped bass do not arrive at maturity until they reach at least 4 years of age.

Male striped bass, on the other hand, become mature and first spawn at a much earlier age. A total of 303 ripe males were encountered in late April and early May in the Albemarle Sound region in 1938. The smallest of these was 21.5 cm. long and was just becoming 2 years old, although it was unusually small for a fish of this age. The largest was 51.5 cm. long, and was just becoming 5 years old. Of the 303 ripe males examined, 150 were just becoming 2 years old, and all the remainder, except the largest individual mentioned above, were becoming either 3 or 4 years old. It thus becomes apparent that a large percentage of male striped bass are mature at the time they become 2 years old, and it is probably true that close to 100 percent are mature by the time they become 3 years old. (See Vladykov and Wallace, 1937.)

AGE AND RATE OF GROWTH

It has been well established in an ever increasing number of species of fish that scales, since they present more or less concentric rings or annuli, may be used for age determinations. It is generally assumed that the formation of a true annulus is caused by the slowing down or almost complete cessation of growth in the winter, resulting in the arrangement of the circuli so that an annulus appears. Actually, in the striped bass, the annulus does not appear in the winter and only becomes evident by April or May. Further than the determination of age, scale analysis has other vitally important applications in studies on the life histories of fishes. It can be used for growth calculations, is often a method for determining the geographical point of origin of individual fish, and provides a means of studying migrations—e.g., in salmon, *Salmo salar* (Masterman, 1913), and herring, *Clupea harengus* (Dahl, 1907)—age at maturity, and the number of times spawning occurs in different individuals.

In the case of the striped bass, there had been no previous work on the Atlantic coast to determine the validity of the scale method for age and rate of growth studies, although Scofield (1931) had applied it successfully on striped bass in California. The preliminary examination of scales immediately disclosed the presence of distinct annuli, which were increasingly numerous, the larger the fish from which the scales were taken. Moreover, the number of annuli were normally constant on different scales taken from a single individual. Also the scales taken from 17 fish that were tagged in 1936 and recaptured from May to September of 1937 invariably showed that the formation of an added annulus had taken place in the winter intervening between the dates of release and recapture. In view of this and much other evidence, it seemed that the scale method was definitely applicable to the striped bass.

During the course of the investigation scale samples were taken from approximately 7,000 striped bass of measured length. Over 5,000 of these samples have been mounted and studied. It is essential that all scales be taken from the same area on the different fish if they are to be used for growth-rate studies, for the shape and size of scales from different regions of the body vary to a marked extent and thus scale measurements can only be considered comparable if the samples are homologous.

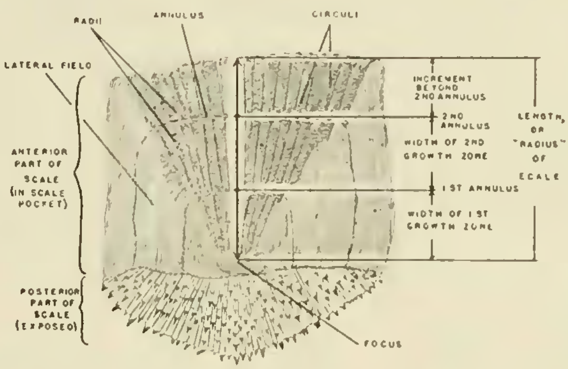

FIGURE 15.—Diagrammatic sketch of a striped bass scale to show parts and method of measurement.

Hence all scales were taken from the first or second white stripe above the lateral line in the mid-region of the body directly below the gap between the spinous and soft dorsal fins, for it was found that scales from this area were more consistently suitable for study than those from any other place. A single sample generally consisted of 4 or 5 scales.

Length measurements of all striped bass were made from the tip of the lower jaw to the fork in the center of the caudal fin, for it became evident in handling live fish which were being tagged that measurements of this type were the easiest to make and the least subject to error. All lengths given in this bulletin are to the fork in the tail, unless otherwise specified. Figure 16 is a graph for the conversion of different types of length measurements. A flat measuring board with vertical head-piece was always used, and measurements were made to the nearest half centimeter.

Scale samples were prepared for study by two different methods. The first 600 were mounted on standard 3- by 1-inch slides with ⅞-inch cover-slips, the mounting medium being corn sirup. All the remaining samples were prepared by taking the impressions of the finely sculptured outer surfaces of the scales on transparent celluloid. Lea (1918) first showed with herring scales:

> . . . that all details which are subjected to observation when the scales are used for the purpose of age determination and growth calculations, arise from the play of light on the delicately moulded relief forming the outer surface of the scales (Lea and Went, 1936).

Lea produced casts, or imprints of the outer surfaces of scales in thin celloidin films and found them ideal for study. Nesbit (1934a) devised an efficient method of producing scale impressions that was fast and at the same time gave accurate results. This method has been applied with complete success to striped bass scales. Transparent celluloid, acetate base, was obtained in sheets 20 by 50 inches and 0.050 inch thick. It was cut into pieces 1 by 2½ inches so that over 100 fitted in an ordinary wooden slide-box of 25-slide capacity. The scale-sample numbers were written on each slide with Volger's Opaque Quick-Drying Ink. The surface of a slide was then softened slightly by spreading a thin film of acetone over it with a glass slide, and the scales making up that particular sample were placed outer surface downward on the area that had been moistened with acetone. The slide and scales were next subjected to pressure under a reinforced seal press having a die approximately 1¼ inches in diameter. The scales were then removed and the impressions of their outer surfaces were left clearly imprinted on the slide. Measurements on 50 scales from striped bass of all sizes were made before they had been subjected to pressure, and then the impressions of these same scales on transparent celluloid were measured; there was no significant difference in the two measurements. Thus it is clear that no stretching takes place in the scale impression method described above. The advantages of this method are threefold: (1) The cast of the outer surface is easier to

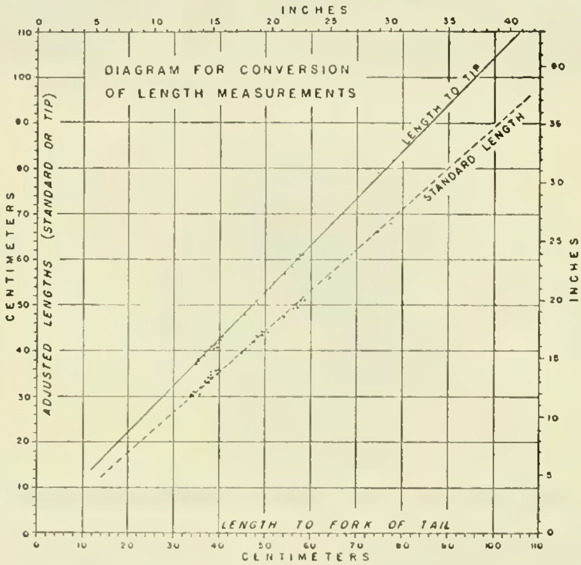

FIGURE 16.—Diagram for the conversion of different types of length measurements.

study than the scale itself because the light does not have to penetrate the fibrillar layers of the scale to show the desired marking; it is also better for photographic purposes. (2) The method is much faster. (3) The cost is far less.

All scales, or scale impressions that were studied for age determinations, or on which measurements were made, were first examined under a dissecting microscope, a magnification of about 20 times being satisfactory for most purposes. Those that were measured were then placed in a micro-projection apparatus and the necessary measurements were made on the image, which was magnified 13.75 times.

The problem of interpreting annuli correctly at all times in scales from striped bass is somewhat complicated by the occasional presence of accessory, or false annuli. Usually, however, these false annuli are different in structure, so that they are quite often easily recognizable. The false annuli are mainly of two types. The first is a broad accessory annulus that is scarlike in its appearance and is frequently seen on scales from larger fish, extremely rarely on those from smaller individuals 2 or 3 years old. This type of mark invariably appears just outside a true annulus or in close conjunction with it. It seems likely that these are spawning marks, since striped bass are anadromous and spawning occurs in the spring near the time of the formation of a true annulus (pp. 20 and 22). The second type of false annulus has much the same appearance as a true annulus, but is distinguishable on close examination by the character of the circuli that border it. This type occurs most commonly on scales that overlap a regenerated scale. It appears that the process of regeneration in a scale modifies the growth of adjacent scales sufficiently to form false annuli on the latter. This type was observed frequently, particularly on scale samples from tagged fish that had been recaptured and had regenerated scales in the area from which a sample was taken at the time of their original release. Regenerated scales were common in all samples, often forming at least 10 percent of those examined. Sometimes entire samples had to be discarded because there were no scales that were not regenerated. Up to 15 percent of the samples have been rejected on rare occasions because of false annuli, regenerated scales, and other factors which made the age determinations and scale measurements subject to serious errors. Scales from larger striped bass were found to be much more difficult to read for age than those from smaller individuals. Not only did the first annuli become indistinct, but there were likely to be more false annuli so that age determinations were confusing. For this reason growth calculations by the scale-measurement method have been confined to fish less than 5 years old. Particularly on scales from fish over 8 years old it was almost impossible to be sure that the age reading was correct, and on fish of this size or larger it was only feasible to make approximations as to the age of each individual. As a check on age determinations of striped bass of all sizes the growth rings on otoliths have frequently been counted, and it was found that on individuals up to 3 years old this method was satisfactory. The opercular and subopercular bones have also been examined for annular markings, which were best seen after these bones had been cleared in a half-and-half mixture of 5 percent glycerine and potassium hydroxide. On the whole such markings were found to be indistinct and irregular, and did not constitute an adequate means of making age determinations.

Since the youngest striped bass taken in Connecticut waters during the course of the investigation were 2 years old, age determinations and rate of growth studies on juvenile and yearling fish were necessarily confined to material from elsewhere. The growth of the larvae has already been discussed under spawning habits and early life history (p. 19). The smallest juveniles that have been taken in their natural habitat have also been described, and, as is shown in figure 14, these fish, which were not more than 1 month old at the time they were seined in Albemarle Sound, averaged about 2.7 cm. in length. Figures 10 and 11 show the range in size of juvenile bass from the Hudson River, and of juvenile and yearling bass from Delaware Bay. It is apparent that juvenile striped bass in the Hudson averaged 5–7 cm. in length by the middle of the summer (see fig. 10). The juvenile bass taken in Delaware Bay in November 1937 formed only a small part of the curve shown in figure 11, the bulk of this sample being made up of yearling fish. The juveniles at this time, however, were from 9.5–12.5 cm. long. Growth practically ceases in the winter, and when striped bass become 1 year old in the spring they average 11–12 cm. long. Six yearling individuals taken in the Hudson River in July and August, 1936 and 1937, averaged 14.3 cm. (extremes 12.0–15.9 cm.). The yearlings in the Delaware Bay region (see fig. 11) averaged approximately 19 cm. in November 1937. By the time they become 2 years old striped bass are about 20–23 cm. in length, and it is at this age that this species probably first takes any large part in the coastal migrations. It should be mentioned at this time, however, that even in juvenile and yearling striped bass there is a tremendous variation about the mean in the measurements of any age group at any one time, as can be seen from figure 11. The subject is further complicated since the populations under consideration were from different areas where in all probability slightly different growth rates occur. Thus the lengths given for striped bass of different ages throughout can only be rough approximations.

Fish 2 years old and older were sufficiently abundant to give ample material for growth-rate studies in Long Island and New England waters, particularly on the members of the dominant 1934 year-class. Figure 17 shows length-frequency curves of all striped bass measured in Connecticut waters from April through October 1936 and 1937. The prominent peaks that characterize these two curves are mainly made up of the 2-year-olds in 1936 and the 2- and 3-year-olds in 1937, and they give some idea of the relative abundance of the members of the 1934 year-class. The measurements that make up these graphs come mainly from seined individuals, but they also come from fish that were caught on rod and line and in pound-nets. Although this method of sampling the total population cannot be entirely free from error, it is probable that these curves represent the relative proportions of the different size- or age-groups to one another fairly accurately for the general region of the Niantic and Thames Rivers, Conn. The tendency of this species to school heavily, particularly among the smaller size-categories, thus making them more available and easier to catch, may have resulted in an over-emphasis on the relative numbers of the members of the 1934 year-class. And the fact that the larger fish tend to lie among the rocks in or near the surf, in places where they cannot be reached by seining, perhaps provides reason to suppose that these larger fish are not proportionately represented in these graphs. On the other hand, evidence from samplings of the striped bass population from commercial fishermen's nets in northern waters indicates that the 2-year-

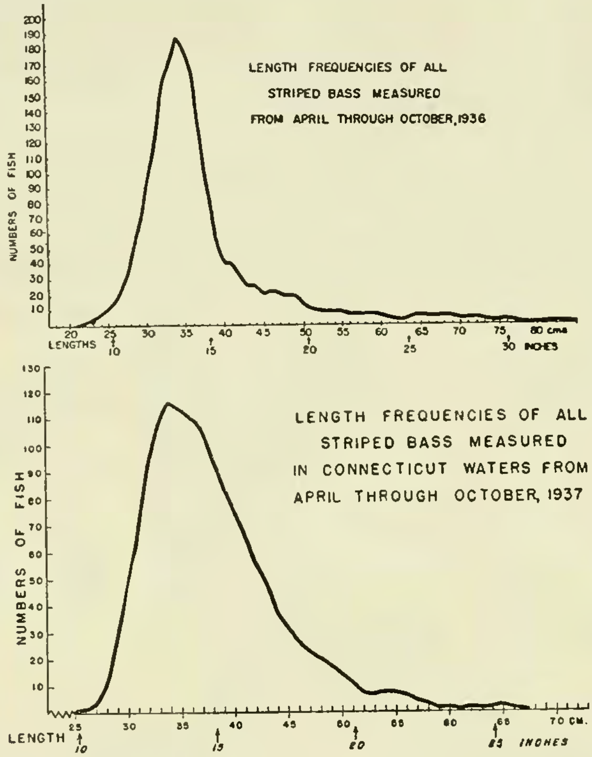

FIGURE 17.—Length-frequency curves of all the striped bass measured in Connecticut waters from April through October, 1936 and 1937. The data have been smoothed by threes throughout. See text for further discussion. See Table 11.

olds in 1936 comprised over 85 percent of the stock available at this time (see fig. 8) and that the members of this year-class continued to dominate the population in 1937 in spite of the fast rate of depletion of fish of this age due to the highly intensive fishery (see figs. 5, 6, 7, and 8). Evidence from other samplings of the stock in northern waters in the summer of 1937 shows that the 2-year-olds of 1937 are apparently represented too strongly in the length-frequency curve for this year (see fig. 17). It is difficult to account for the large proportion of 2-year-olds in the lower graph in figure 17, but it is clear that they were not relatively as abundant in 1937 in all northern waters (see fig. 5). It seems probable that the Niantic and Thames Rivers, where most of the fish that make up the length-frequencies in figure 17 were taken, are especially favorable for the smaller sized (2-year-old) bass.

The growth by months of the 2- and 3-year-olds seined in Connecticut waters from June through October for 1936 and 1937 is shown in figure 18. It will be seen that the 2-year-olds in June 1936 averaged about 29 cm., and that there was a steady progression in the monthly modes through to October 1936 where the 2-year-olds were roughly 37–38 cm. long. The 3-year-olds in 1936 showed much the same type of growth, the modes of the monthly length-frequency curves for this age-group progressing from 40–41 cm. in June to 48–49 cm. by October 1936. The 2-year-olds of

1937 exhibited approximately the same amount of growth (8–9 cm.) from June through October as fish of the same age in 1936, but it will be noticed that they consistently averaged at least 2 cm. larger over this entire period. Thus the modes of the length-frequency curves of the 2-year-olds of 1937 moved from 31 cm. in June to 39 cm. in October. However, the 3-year-olds of 1937, although growing the same amount as fish of the same age in 1936 over an equivalent period of time, averaged 2 cm. smaller throughout, the modes moving from approximately 38 cm. in June to 46 cm. in October. The comparison of any of the monthly length-frequency curves in 1936 with its counterpart in 1937 clearly shows that the 2-year-olds in 1937 were distinctly larger than those of 1936, while the 3-year-olds of 1937 were definitely smaller than fish of the same age in 1936. The members of the dominant year-class of 1934 (2 years old in 1936 and 3 years old in 1937) therefore appear to have been below average size.

GROWTH OF 2- AND 3-YEAR-OLD STRIPED BASS SEINED IN CONNECTICUT WATERS DURING 1936 AND 1937

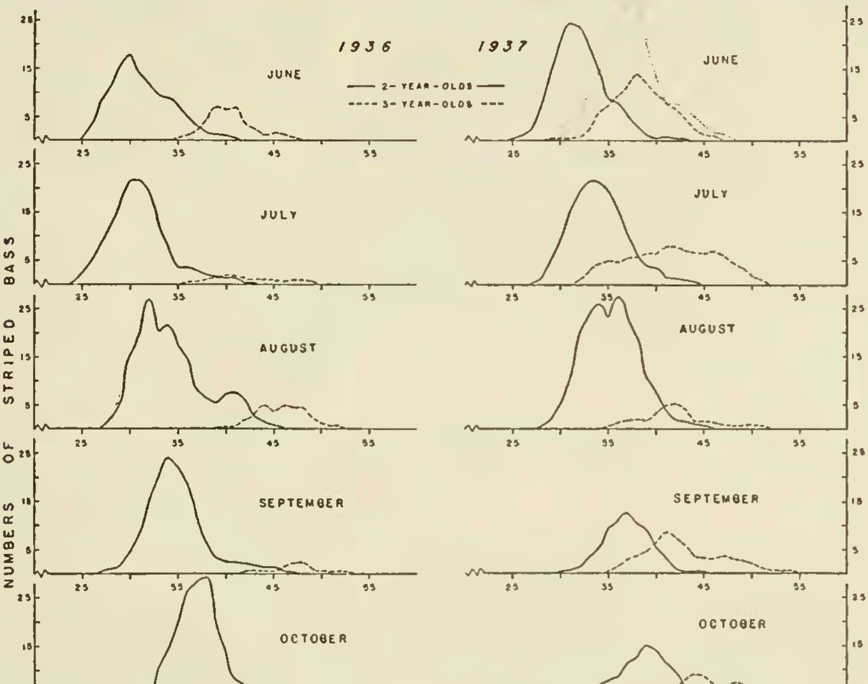

FIGURE 18.—The growth of the 2- and 3-year-old striped bass seined in Connecticut waters during 1936 and 1937. The curves are smoothed in every case by a moving average of threes. The numbers of fish making up each curve have not been equalized except in that for September 1936, where the total number of fish was divided by three. The dotted line in the June 1937, length-frequency curves is a repetition of curve for the 2-year-olds in October 1936, and is included for the purpose of comparing the 2-year-olds of October 1936, with the 3-year-olds of June 1937 (members of the same year-class) (see Table 12 for original measurements).

They were consistently smaller than the fish which were born in 1933 or 1935 were at equivalent ages; both the 1933 and 1935 year-classes were few in numbers by comparison to the dominant 1934 year-class. It is quite clear that this lesser average length of the members of the dominant 1934 year-class developed before the individuals became 2 years old. The smaller sizes of the individuals making up this dominant age-group agree well with Jensen's (1932) studies on plaice (*Pleuronectes platessa*) in the North Sea, where it was shown that a strong year-class checks the growth of the fish in this age-group. Jensen (loc. cit.) also points out that the principle of the smaller-than-average size of the individuals making up a dominant year-class, at least in plaice, also appears true from Thursby-Pelham's work, where it is shown that the rich year-class of 1922 was distinguished by a small average length. This is explained by Jensen on the basis of increased competition for food among the members of the same size category. Other European investigators, however, have not found that the same phenomenon applies in other species of fish in the North Sea. It is possible that environmental factors, such as low temperatures in the spring and early summer of 1934, played some part in the smaller-than-average size of the members of the 1934 dominant year-class of striped bass.

It will be noted in figure 18 that the growth rate of the 2- and 3-year-olds in 1936 and 1937 was fairly steady over the period from June through October. In general, the modes of the length-frequency curves for the 2-year-olds progressed about 2 cm. each month. In October 1936, however, the 2-year-olds appear to have shown an increased growth rate, the mode for this curve having progressed 3–4 cm. beyond that for September. In October 1937 the fish of this age did not exhibit a similarly increased growth rate, but the mode for this length-frequency curve progressed about 2 cm.—an amount about comparable to the growth during the summer months. Since the temperature fell sharply in late September and October in both 1936 and 1937 (see fig. 30), the normal expectation would be that the increase in length at this time would have been less than in the summer months, assuming that the food supply remained constant over this entire period. There are a number of possible explanations of this apparently higher growth rate in October. There is some chance that errors in sampling were responsible. Thus it is known that the population was starting to change late in October (see Migrations, p. 37), and there is a slight possibility that fish that had summered farther north, where they apparently grow faster despite somewhat lower average temperatures (see fig. 19) were included in the samples at the end of this month. This does not seem likely, however, for the consistent recapture of individuals tagged in this area from June through October gives good evidence to the contrary. Another explanation of the apparently greater growth rate in the fall is suggested by the skewness of the length-frequency curve for October 1936. It will be noted in figure 18 that in all curves for the 2-year-olds, except that for October 1936 the peaks come about midway between the two extremes of the range in size, or below that point. In October 1936, however, the peak falls well above the midpoint between the extremes of size, and there is also a tendency toward the same situation in the curve for October 1937. It may be, therefore, that this apparently greater growth rate is possibly the result of "compensatory growth," the name given by Watkin (1927) to the phenomenon of the smaller fish of a single age group making up a deficiency in size between themselves and the larger fish of the same age group in a relatively short period after having lagged behind for some time. The most probable explanation of the increased growth rate in the fall, however, is that the food supply or its availability increased at this time. The analysis of the stomach contents of striped bass is discussed in a later section of this paper, but for the present it is interesting to consider the fact that this species is voracious in its feeding habits and that it preys on small fish, particularly young menhaden (*Brevoortia tyrannus*) and shiners (*Menidia menidia notata*) in Connecticut waters. Both of these species spawn in the spring and early summer, and during July the young are still so small and stay so close to shore that they do not form a large part of the diet of the bass. But by late summer, and particularly early fall, they have increased in size to such an extent that they have added enormously to the available food supply. (For information on the growth rate of *Menidia*, see Food of the striped bass, p. 53, and fig. 36.) The analysis of stomach contents during September showed that striped bass continually gorged themselves on these small fish to the virtual exclusion of other types of food. Furthermore, judging from the relative numbers taken in seine hauls in 1936 and 1937, and from the statements of local fishermen, young menhaden were unusually abundant in Connecticut waters in the latter part of 1936. It is likely that these juvenile menhaden were responsible for the greater growth rate of the striped bass in the fall of 1936, and that the increased availability of the food supply in the late summer each year accounts for the maintenance of or increase in the growth rate through October despite the sharp drop in temperature at this time.

As will be shown subsequently, there is evidence that the growth rate of the striped bass varies considerably in different localities along the coast. It has already been pointed out, however, that there was a great variation about the mean in measurements of fish from any one region at any one time, and that the samples from different areas may have been composed of stocks from widely separated localities which showed different growth rates. Nevertheless, scale analysis (see Origin of the dominant 1934 year-class, pp. 46–52) points to the fact that the striped bass on which studies were made in northern waters in the summer of 1936 and 1937, were mainly of essentially the same origin and with similar growth rates in their first and second years. Figure 19 shows length-frequency curves for 2- and 3-year-old striped bass taken north and south of Cape Cod in 1937. Those taken north of Cape Cod were from Massachusetts, and those south of Cape Cod from Connecticut. The striking difference in the striped bass of the same ages from these two areas is at once apparent. The 2-year-olds north of Cape Cod show a peak at approximately 40 cm., while those south of Cape Cod have a peak near 34 cm. The 3-year-olds from the same areas present peaks at 45 and 40 cm., respectively. It is almost certain that all these fish were of southern origin (see Origin of the dominant 1934 year-class, p. 51), and that they first migrated to northern waters as 2-year-olds in the spring (see Migrations, p. 44). It is possible that the difference in size can be accounted for by differential

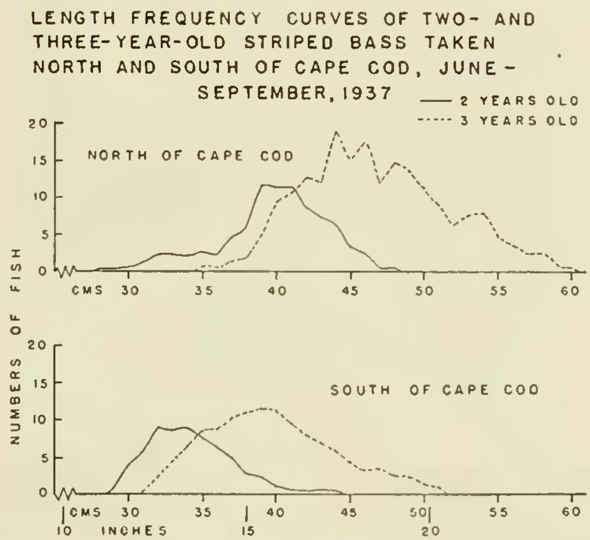

FIGURE 19.—Length-frequency curves of 2- and 3-year-old striped bass taken north and south of Cape Cod from June through September 1937. Data smoothed by a moving average of threes throughout (see Table 13 for original measurements).

migration—that is, that the larger fish of the age-categories concerned migrated farther north than the smaller individuals. This is unlikely, however, and the difference in size is probably best explained by differential growth rates in the spring, summer, and early fall in the areas under consideration. The samples from these areas are perhaps poor, in that they are composed of rod-and-line caught fish in order that they might be comparable, for it was impossible to get samplings of the population north of Cape Cod over this entire period by any other method. The differences in size may be slightly exaggerated, owing to the fact that the sampling in the early summer south of Cape Cod was somewhat more intensive than that of the middle and late summer, while the sampling north of Cape Cod was evenly distributed throughout the entire period from June through September 1937. There can be little doubt, however, that in 1937 the 2- and 3-year-old striped bass north of Cape Cod grew much faster than those in Connecticut waters from June through September.

The average length attained by striped bass each year from the first to the tenth year has been calculated by two different methods, and is shown in figure 20. It is of some interest that these lengths of striped bass at different ages compare almost exactly with those given by Scofield (1931) and Clark (1938) for striped bass on the Pacific coast. Since bass 2 years old and older were available in Connecticut waters in large numbers, it was possible to calculate the average lengths of the different age groups simply by making age determinations from the scale samples of fish of measured length. This has been done on 2,500 fish, and the results are shown by the solid line in figure 20. The average lengths of striped bass from 1 to 4 years old have been calculated from the scales of 4-year-old bass of measured length (see below). This is indicated in figure 20 by the dot-and-dash line. There is every reason to believe from the available samplings of fish of the ages covered by this part of the graph that the lengths derived by this method are accurate estimates. Further than this, it will be noticed that in the center part of the growth curve in figure 20, where the lengths at different ages calculated by both the above-mentioned methods overlap, there is an almost perfect correspondence in the estimated lengths as derived by the two different procedures. It should be emphasized again, in connection

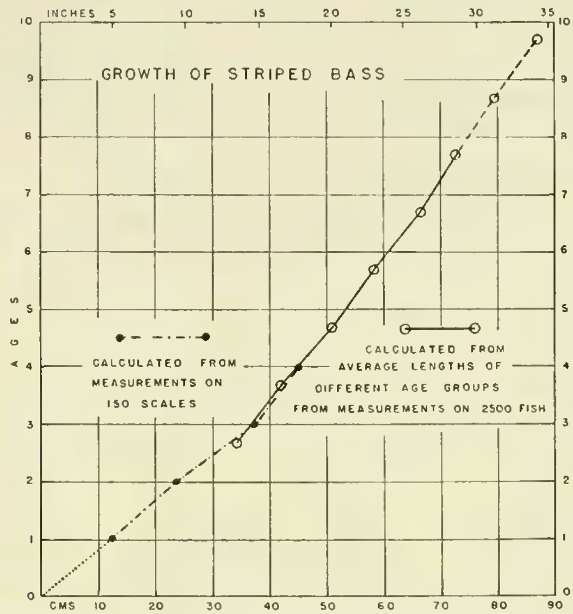

FIGURE 20.—The growth of the striped bass, as calculated from scales and the average lengths of different age groups. See Table 14 for average lengths of striped bass at the time they become 1 year old, 2 years old, etc., to 9 years old.

with figure 20, that the lengths represented on this graph are averages, and that there is a wide variation about the mean in the lengths at any age. This is of course particularly true among the larger sizes, as is indicated by the broken line at the upper end of the growth curve. In general, fish 100 cm. (nearly 40 inches) long average about 25 pounds and are about 11 or 12 years old; those 125 cm. (nearly 50 inches) long weigh approximately 50 pounds and are roughly 20 to 25 years old. The largest striped bass taken in recent years (caught in Rhode Island on rod and line in October 1936) weighed 65 pounds and measured 137 cm. (54 inches); examination of several scales leads the author to believe that this fish was 29, 30, or 31 years old.[10]

In calculating the growth of striped bass up to 4 years old by the scale method, the following formula was used:

$$L_1 = C + \frac{V_1}{V}(L - C)$$

L_1 equals the length of the fish at the end of year "x," V_1 the length of the scale included in the annulus of year "x," V the total length of the scale, L the length of the fish from which the scale is taken, and C the length of the fish when scales first appear. (The use of the factor C has various limitations, see pp. 31–32). The measurements on striped bass scales were made from the focus to the anterior edge of the scale and to the annuli along a line that bisected the angle formed by the junction of the two

[10] In connection with the age of striped bass, Bigelow and Welsh (1925) write, ". . . they are certainly long-lived, for one kept in the New York Aquarium lived to an age of about twenty-three years."

lateral fields at the focus. (See fig. 15.) Scales from striped bass that were beyond their fifth year were not used, since the annuli were often indistinct and it was therefore difficult to make precise measurements. Van Oosten (1929), Creaser (1926), and others have pointed out that the validity of the scale method of determining the length of a fish at different years in its life depends on 3 main factors: (1) That the scales remain constant in number and identity throughout the life of the fish; (2) that scale growth is proportional to the growth of the fish; and (3) that the annuli are formed yearly and at the same time of the year. Since it has been proved in many other species that scales do maintain their identity throughout the life of the fish, and because there is no evidence to the contrary in the striped bass, it has been assumed that the first requirement holds true. In testing the relation of scale growth to the growth of the fish, the radii of scales from 153 bass of measured length

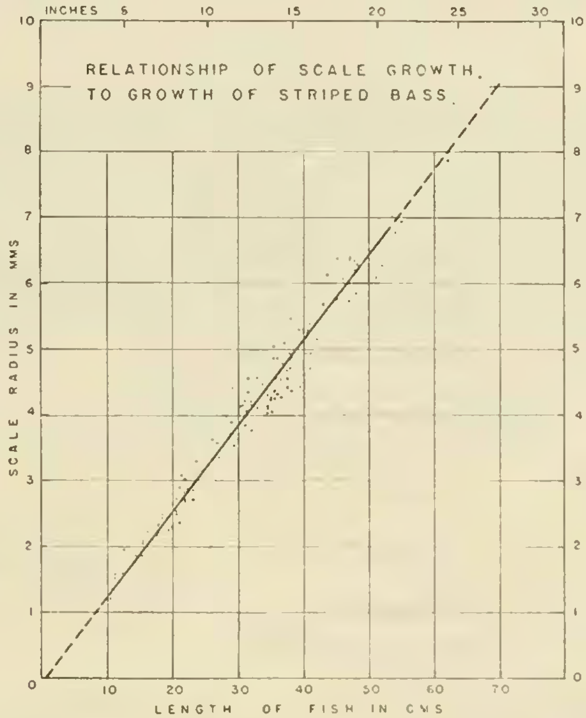

FIGURE 21.—The relationship of scale growth to body growth in the striped bass (see Table 15 for original data).

from 10.5 to 67 cm. were plotted against the lengths of the fish. (See fig. 21.) It will be noted that there is a good straight-line relationship, and that therefore the scale growth may be considered proportional to the growth of the fish within the limits studied. There is no proof, however, that scale and body growth are proportional in the smaller sizes below 11 cm., or in the extreme larger sizes above 67 cm. The formation of annuli has already been discussed, and there can be no doubt that they are formed yearly and at the same time of year—during the winter.

Since all the larval stages of development of the striped bass were not available, it was impossible to determine the factor C (that length at which scales first appear on the fish) by careful examination of preserved material. Bass down to 2.0 cm. were collected in the field, and these all showed prominent scales. Individuals up to 0.5–0.6 cm. (approximately 8 days after fertilization of the eggs and 6 days after hatching) were preserved from the hatchery at Edenton, N. C., and these did not show any signs of scale formation. It was therefore necessary to estimate at what length scales first appear on striped bass between 0.6 and 2.0 cm. by other means. The material that forms the basis of figure 21 was used for this purpose. A regression equation expressing the body-scale growth relationship of the striped bass was obtained by means of the product moments method, and it was found that the line intersected the abscissa at 0.6 cm. This value for the length at which scales first appear seems to be too low in view of the evidence mentioned above, but it has been used for the factor *C* in the scale formula for lack of any other means of determining it more accurately. There is no evidence, as shown before, that scale growth and body growth in the striped bass are proportional in individuals below 11 cm., and an error in the value of 0.6 cm. for *C* may thus be introduced, since the method applied above necessarily assumes such a relationship. It is considered likely that scales do not first appear until the bass are about 1.0 cm. long, and that scale growth is not directly

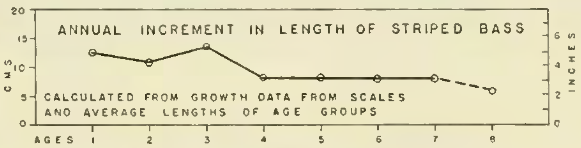

FIGURE 22.—The annual increment in the length of the striped bass. The annual increments through the fourth year are calculated from the scales from striped bass of the 1933 year-class caught in northern waters in the summer of 1937. The annual increments in the fifth to eighth years inclusive are calculated from the average lengths of the age groups involved, these lengths being taken from fish caught in northern waters in 1936 and 1937 (see Table 16 for actual figures on annual increment).

proportional to body growth until a short time after they have formed. But the error introduced in the calculation of the lengths of striped bass at different ages from the scale formula by this discrepancy in the value for *C* is negligible, and does not affect the points on the growth curve in figure 20 to a significant extent. It should be mentioned that the use of a constant, *C*, although superficially plausible, is not sound theoretically. The scale probably does not begin as a geometric point, but as a plate whose radius may well approximate the size appropriate for the fish at that time.

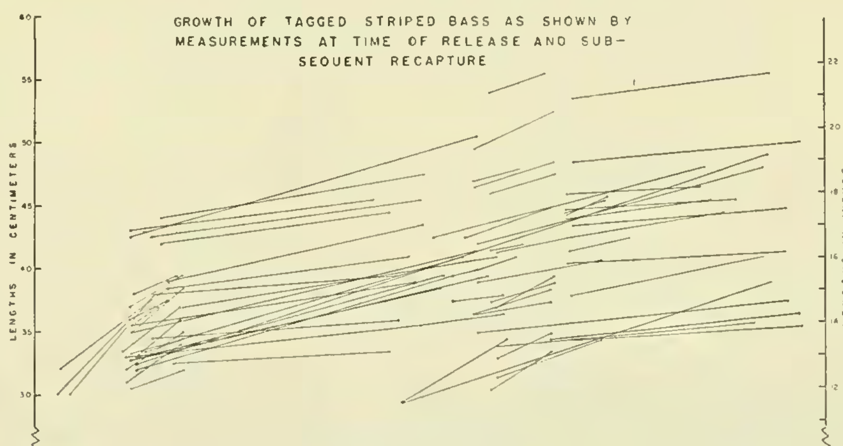

FIGURE 23.—The growth of tagged striped bass as shown by measurements at the time of release and subsequent recapture.

Thus, in the weakfish (*Cynoscion regalis*) a negative *C* would be needed to correct for the negative Lee's phenomenon observed (Nesbit, unpublished material).

The annual increment in the length of the striped bass is shown in figure 22. It is apparent that the greatest growth occurs in the third year, that age at which this species first undertakes coastal migrations to any great extent. Thereafter the increment in growth falls off sharply, particularly in the fourth year, and from then on maintains an average of about 6.5–8.0 cm. each year at least up to the eighth year. There is some evidence from the available material that the growth rate decreases still more in the eighth and succeeding years.

The growth of tagged individuals that were measured at the times of release and subsequent recapture provides a good means of checking on the calculated growth rate of the striped bass as shown in figure 20. This material is shown in figure 23.

Only measurements which came from reliable sources were included in this graph, and the great majority were on fish that were taken at or near the point of release by the author; hence the growth rates refer mainly to fish in Connecticut waters. The lines connecting any two points in this figure of course only represent the total growth in the period intervening between release and recapture. The growths of these individual tagged fish over different lengths of time and in different seasons of the year check well with the growth rates calculated from other material, and in general substantiate the previously discussed information on the growth of the striped bass. It will be noted that the fastest growths occurred in the small fish (2 years old) in the late summer and early fall of 1936, that the growth rates were slow during the winter of 1936–37 (these measurements were in all probability mainly on individuals that wintered in the north), that the growth rates picked up again in the summer of 1937, and that they slowed down once more during the winter of 1937–38. The normally faster growth rate of the 2-year-olds is also indicated by the relative steepness of the lines in the smaller size categories.

MIGRATIONS

There have been no accounts in the literature of the migrations of the striped bass on the Atlantic coast until the present investigation,[11] with the exception of Pearson's (1933) brief paper which was limited to the movements of bass within Chesapeake Bay. There was, however, much evidence to show that this species makes seasonal movements of considerable magnitude. Thus the examination of catch records of commercial fishermen over a period of years at Montauk, Long Island, N. Y., and Newport and Point Judith, R. I., shows that striped bass are caught in large quantities as a general rule only in the spring and fall of the year. This is shown in figure 24, where the bulk of the pound-net catches at Fort Pond Bay, Long Island, N. Y., from 1884 to 1928, were made either in May or October and November. It is also generally known that the date of capture of striped bass along the coast of the Middle and North Atlantic States by pound-nets and seines in great numbers in the spring is progressively later the farther north these catches are made. Moreover, the reverse is true in the fall; for example, the main catch at Point Judith, R. I., regularly preceds the time that the fishermen on the south side of Long Island make their biggest hauls. It therefore appeared logical to suppose that striped bass undertake definite coastal migrations to the north and east in the spring, and to the south and west in the fall. Various tagging experiments to demonstrate the time and extent of these migrations have been carried out during the entire course of the investigation. The results of these taggings are summarized in tables 17, 18, 19, 20, and 22.

Two methods of tagging have been carried on. External disc tags have been used the greater part of the time, and internal belly tags have also been tried on juvenile and yearling striped bass. Both of these tags were used at the suggestion of Mr. Robert A. Nesbit, of the United States Bureau of Fisheries. The external disc tag is actually a modification of the Scottish Plaice Label, the main changes consisting of reduced dimensions, the use of celluloid instead of hard rubber, the addition of printing, and the substitution of nickel pins for silver wire as the method of attachment. Sketches illustrating these methods of tagging are shown in figure 25. Scale samples were taken in most cases, and lengths and the dates and localities of release were always recorded on all striped bass that were tagged.

The external disc tag proved to be a fairly efficient and practical means of marking striped bass. A single tag of this type consisted of two discs of bright red (DuPont No. 6671) celluloid, each 0.025 inch in thickness and one-half inch in diameter, with a center hole 1/32-inch in diameter. Each pair of discs bore the same number in black print across the middle, and the necessary instructions to insure their return were printed in black around the circumference. The discs were made by printing on 0.020-inch opaque celluloid and cementing onto the side bearing the printing a

[11] In California, however, tagging experiments on the striped bass have shown that there were " . . . no definite migrations, simply a diffusion from the locality in which the bass were tagged" (Clark, 1936).

0.005-inch transparent celluloid, so that the numbers and legends were covered and protected. The first 1,500 tags bore the words, RETURN TO FISH & GAME, HARTFORD, CONN. In the remaining tags this inscription was changed to, RETURN TAG, etc., etc., since it was found that a certain number of returns were being lost because the original wording was sufficiently misleading so that some individuals thought the whole fish should be sent in and were unwilling to part with their catch. Each tag was attached to the fish by means of a pin. This pin was put through the center hole in one disc and pushed through the flesh of the back between the two dorsal fins—one-fourth to one-half inch below the dorsal contour of the body—in a horizontal plane. The matching disc was then put on that part of the pin that

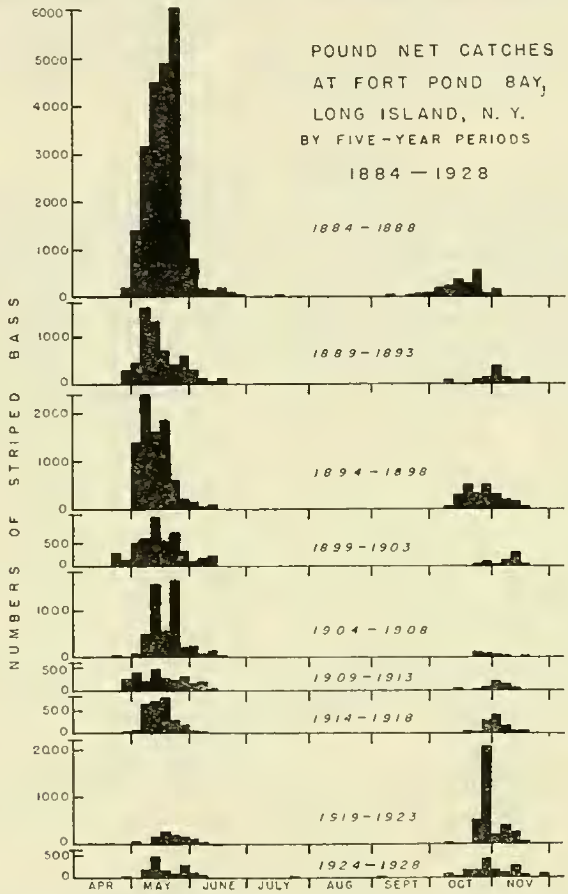

FIGURE 24.—Numbers of striped bass caught in the pound nets at Fort Pond Bay, L. I., N. Y., from 1884 to 1928, for each 5 days during the fishing season, by 5-year periods. The catches have been weighted to make them equivalent to a fishing intensity of 10 pound-nets throughout (see figure 4, table 4). Note that the catches are made only in the spring and fall of the year It is of interest to note that the size of the spring catches has shown a sharp decline over the period covered by this record, while the size of the fall catches has remained about the same during this time.

had come through the flesh on the other side of the body, and the pin was crimped over with a pair of finely pointed pliers in such a way that both discs fitted closely against the back of the fish. The printing on the tags was faced out so that it was immediately evident. It sometimes happened, however, that over periods of more than several months Bryozoans and other forms attached themselves to the tags and obscured the printing and even the color of the discs, so that it was necessary to scrape the entire surface with a sharp knife before the inscription became legible. Mussels (*Mytilus edulis*) over 1 cm. long have been found on the tags at times, and barnacles (*Balanus balanoides*) covering the entire disc were by no means uncommon. It became evident from the recapture of tagged individuals that it was best to crimp the pin to such a degree that there was less than one-sixteenth of an inch of free space between the discs and the sides of the fish. If more space was left to allow for growth, sores were created where the edges of the discs rubbed against the body, and weeds were more likely to catch on the tags and cause added irritation. Moreover, since there have been only a few recaptures of fish marked by this method more than a year after the date of release—the longest recovery of a tag of this type was from a fish that was tagged September 7, 1936, in the Niantic River, Conn., and recovered May 2, 1938, in the Hudson River, off Nyack, N. Y.—there is little point in allowing for much growth. In an attempt to preclude any possibility of chafing, both flat and saucer-shaped discs were used. The flat discs showed far less tendency to cause irritation and to pick up weeds and debris, and were in general more satisfactory, although there is some evidence from recaptures in the summer of 1938 that the saucer-shaped discs stay on longer. Two types of pins were used for attaching

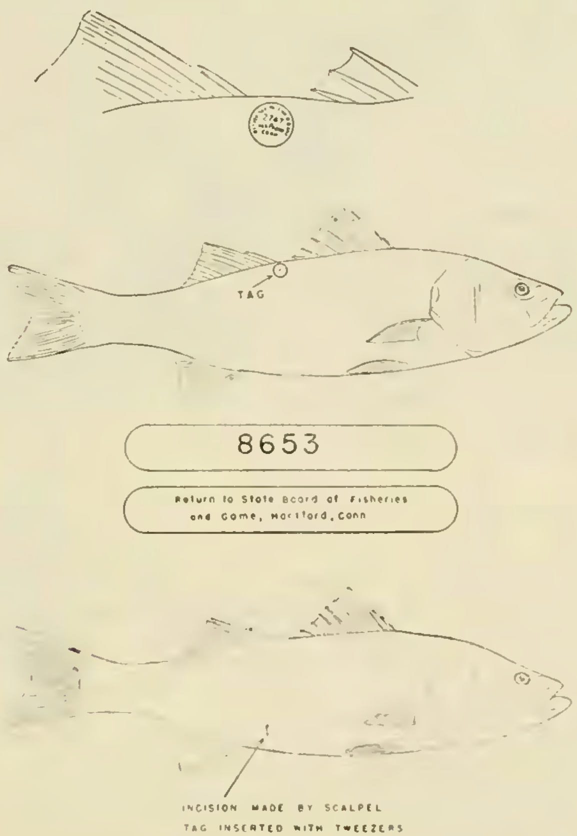

FIGURE 25.—Sketches to illustrate the external disc and internal belly tag methods of marking striped bass.

the external tags. Those tried with the first 500 bass were stainless steel insect pins. There was abundant evidence in the early work from the subsequent recapture of fish that still showed a scar in the area where they had been tagged with this type of pin, but had lost the tag, that these pins were not adequate in salt water. Not only did they become brittle and fragile after a short time (no fish marked by means of this pin was recaptured more than 2 months after its release), but their slender shafts showed a distinct tendency to cut through the flesh, thus allowing more room for the movement of the tags and causing sores. All these difficultues were fairly well obviated by the use of heavier noncorrosive nickel pins. The nickel pins were made of No. 20 B. & S. pure nickel wire. The diameter of the head of each pin was not less than 0.080 inch in diameter. The pins were ordered in two lengths, 1⅜ and 1¾ inches, for use in tagging different sizes of striped bass. These pins never showed any tendency to corrode in salt water.

The external disc tag method of marking striped bass, however, has two definite disadvantages. These are that the evidence from the recapture of fish tagged by this means shows that the discs do not usually stay on for periods much over 1 year; probably because the pins "migrate" toward the dorsal contour of the fish and are eventually sloughed off, and that it is impractical to tag bass less than 8 inches long with discs and pins of the sizes given above. The internal belly tag devised by Nesbit (1934b) has therefore been used on small striped bass (see fig. 25). Since this type of tag has been used successfully over long-term periods with small weakfish (*Cynoscion regalis*), herring (*Clupea pallasii*), and other species, it seemed logical to expect that it was applicable to juvenile and yearling striped bass. This tag consisted of a piece of bright red celluloid 0.030 inch thick, 1⅝ inches long, and ¼ inch wide, with well-rounded ends. One side of the tag bore the number, and the other side the words RETURN TO STATE BOARD OF FISHERIES AND GAME, HARTFORD, CONN., in black print. The printing was made on 0.020-inch opaque red celluloid, and a 0.005-inch transparent celluloid was cemented to each side so that the numbers and legends were well protected. This type of tag was inserted and carried in the body cavity. A small incision was made in the side of the body wall, ½ to 1 inch in front of the anus with a scalpel. The tag was then pushed through this incision into the body cavity by means of small forceps, so that it lay parallel to the antero-posterior axis of the fish but well on the side of the body cavity where it did not interfere with or displace any of the viscera. Some 581 juvenile and yearling striped bass have been tagged in this manner, and subsequent recaptures have indicated that this method is both feasible and practical with this species, although the returns to date have been few. The advantages of this method over the external disc tags are that it enables the marking of striped bass down to at least 5 inches, and that it is probably a much better long-time tag—although this latter remains to be definitely proven in this species. The only disadvantage of the internal tag with the striped bass is that this species is practically never dressed until it is sold to the individual customer, and since this fish is commonly shipped great distances to market, the tag is likely not to be found until it is difficult to discover the exact locality and date of capture of the fish that bore it.

A total of 3,937 striped bass were marked by means of the external disc and internal belly tags from April 1936 to June 1938. Of this number, 2,573 were tagged in Connecticut and Long Island waters. These were all tagged by the external disc method, and were all 2 years old or more, since there are comparatively few areas in northern waters where juvenile and yearling striped bass are available. Returns from fish tagged in this region reached 544 (21.1 percent of the total) by July 1938 and gave abundant proof of a coastwise northern migration in the spring, a relatively stable population showing no movement of any consequence in the summer, and a southern migration in the fall and early winter.

In the period from April through October 1936, 1,397 striped bass were tagged in Connecticut waters, of which 337, or 24.1 percent of the total were returned by July 1, 1938. (See fig. 26 and table 17.) In the spring of 1936 these returns showed that an eastward extension from Connecticut to Rhode Island of what undoubtedly was a mass migration to the north, reaching its peak during May in southern New England waters, definitely took place. During late April and May only a few striped bass were tagged, yet returns from the Thames River, Conn., and Point Judith and Newport, R. I., proved that many of these fish were taking part in what the spring catch records of the seines and pound-nets had suggested was a tremendous mass movement to the north. Fish tagged in the Niantic River, Conn., in May were returned from Point Judith and Newport, a distance of 40 to 50 miles in a straight line, 5 to 7 days after their release. The recapture of tagged fish in the summer and early fall showed that the striped bass population in the Niantic and Thames Rivers remained static. Only minor migrations and movements up to 10 miles from the original point of release were recorded from June to October, and it is significant that during the spring, summer, and early fall, there was not a single recapture of a marked bass to the south or west of the areas in which they were tagged. The stability of the population through the summer and up to the latter part of October was shown by the consistent recapture of tagged fish at or near the localities where they were released. An extreme example of this is that of a bass that bore tag No. 197, which was seined, tagged, and released in June in the Niantic River. This bass was caught in a trap in Niantic Harbor in July and released, caught on a rod and line in the Niantic River in September by the author and released, and caught and released again while seining for tagging purposes in the Niantic River in early October. Returns from tagged striped bass first indicated that a migration to the south was starting in late October,

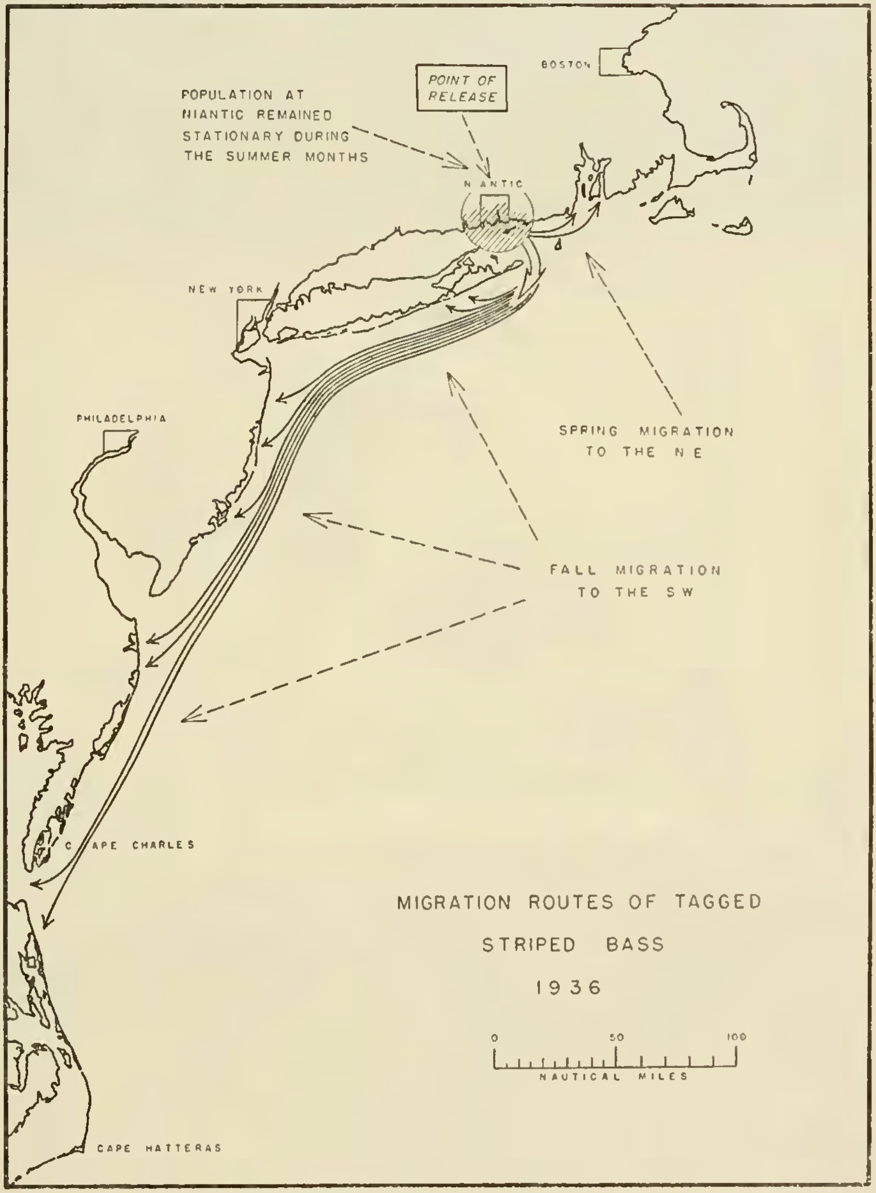

FIGURE 26.—Chart of the Atlantic coast showing the migrations of striped bass as determined by the returns from 1,397 individuals tagged from April through October 1936 (see table 17).

when two fish tagged in the Thames River were recovered in the Niantic. Although these fish had only moved about 10 miles, they were the first that had ever been taken to the south or west of the original point or release. Almost immediately thereafter bass that had been tagged in Connecticut waters during the summer began to be caught in large quantities in the pound-nets at Montauk, Long Island, N. Y., and in seines and on hook and line on the south side of Long Island. The number of returns from Montauk reached a peak during the first 10 days of November. Thereafter tags were sent in from bass caught progressively farther south as time went on. No marked fish were caught north and east of the original point of release during the fall and winter, and it was plainly evident from the examination of commercial fishermen's catch records, as well as from tag returns, that an intensive migration to the south had taken place. Scattered returns of tags throughout the winter and early spring months from New Jersey, Delaware, the entrance to Chesapeake Bay, and North Carolina showed that striped bass may go great distances on their southern migration.

In 1937 added tagging experiments were undertaken in Connecticut and Long Island waters to obtain additional information on the northern migration in the spring and the return to the south in the fall. A group of 103 striped bass were marked and released at Montauk, Long Island, N. Y., from May 15 to 19, 1937, and 14 of these, 13.6 percent were subsequently recaptured. None of these returns came from points to the south of Montauk, all recaptures being in Long Island Sound, on the New York

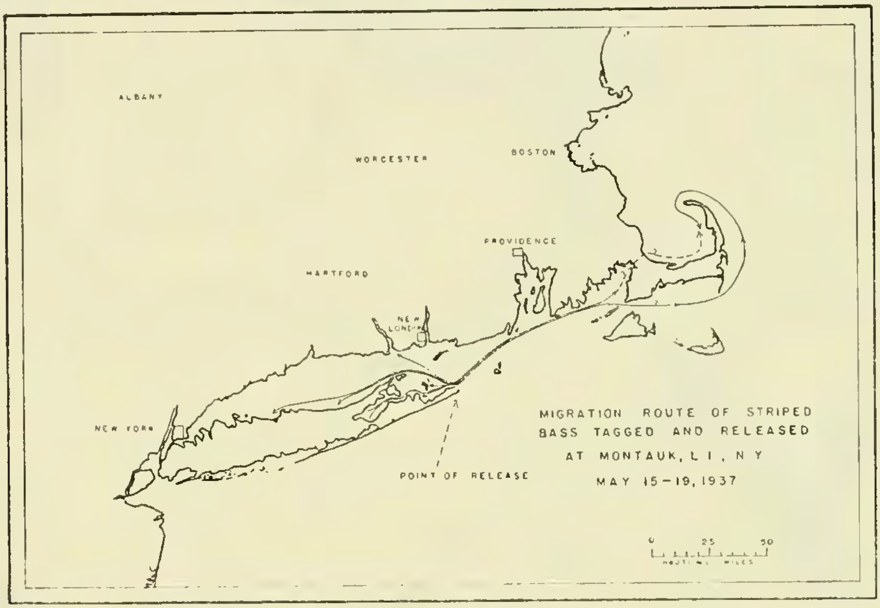

FIGURE 27.—Migration routes of striped bass tagged and released at Montauk, L. I., N. Y., May 15–19, 1937. The number of fish tagged was 103, the number of returns 14 (13.6 percent of the total). Note that there were no returns from the south, and contrast with the results of tagging from the same area in the fall as shown in figure 28 (see table 18).

and Connecticut coasts, or from Rhode Island and Massachusetts (see fig. 27 and table 18). Such results gave added evidence that these bass were being tagged near the end of their northern migration, and that an eastward extension of this movement was still taking place in May and June.

From October 25 to 27, 1937, 303 bass were marked and released at Montauk, from the same nets and in exactly the same place as those that were tagged in the spring. Six months later 95, 31.3 percent, of these fish had been reported. The only recaptures to the north of the point of release, until the following spring, occurred almost immediately after tagging took place and were so few in number and so minor in scope that they may be considered insignificant. The longest movement to the north that was recorded in the fall was less than 10 miles. On the other hand, recaptures to the south and west of the area where the tagged fish were released were so numerous as to make it certain that these fish were taking part in an intensive southern migration at that time of year (see fig. 28 and table 19). Many returns in the fall, winter, and early spring months from the south side of Long Island, New Jersey, Delaware, Chesapeake Bay, and North Carolina as far south as Pamlico Sound, indicated the approximate extent and speed of the migration, and further amplified the results of 1936. The rate at which striped bass may travel south in the fall is shown by the recapture of several fish tagged at Montauk, 450–500 miles away from the point of release, 35–40 days after the date of tagging—an average of 12 miles per day. This distance was measured in a straight line along the coast, which the fish undoubtedly did not travel. Moreover, there is no proof that the fish left the moment they were tagged or were caught at the other end of their migration as soon as they arrived. It seems likely, therefore, that they averaged far more than 12 miles per day. It is of interest that a considerable number of recaptures in the winter and early spring months were from well up large coastal rivers, where spawning occurs in May, thus indicating that some bass probably winter in or near the spawning areas. It is probable that the majority of the spawning individuals in any year do not move into these areas until the late spring,[12] particularly in southern rivers.

A total of 770 striped bass were also tagged from April to October in 1937 in the Niantic and Thames Rivers, Conn., and the returns from these further corroborated the results obtained from other marking experiments in northern waters. (See table 20.) There were an insufficient number of fish tagged in April and May to expect

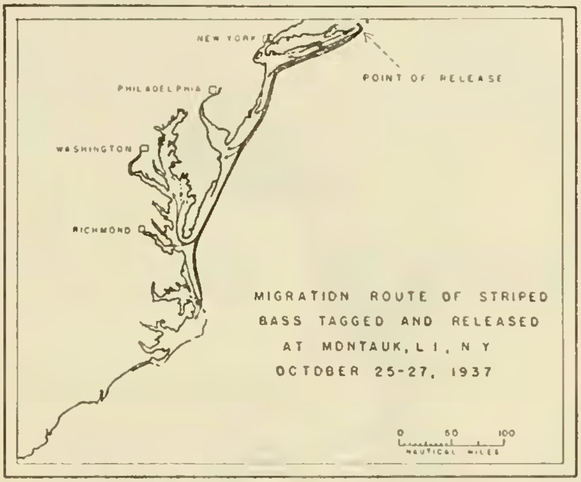

FIGURE 28.—Migration route of striped bass tagged and released at Montauk, L. I., N. Y., Oct. 25–27, 1937. The number of fish tagged was 303, the number of returns 100 (33 percent of the total). Note that there were no returns of any significance to the north of the point of release, and contrast with the results of tagging from the same area in the spring as shown in Figure 27 (see table 19).

any returns showing the northern migration at that time of year. Consistent recaptures at or near the point of release during the summer and early fall months, however, again demonstrated the stability of the population in Connecticut waters from June to October. The returns from the south in the fall and winter months offered additional proof of the migration south from northern waters in late October and November, recaptures on the south side of Long Island, in New Jersey, Delaware, and Chesapeake Bay being not infrequent. The total number of returns from the 770 striped bass that were tagged was 93, 12.1 percent, by July 1, 1938. By comparison with other tagging experiments on striped bass carried on in these waters, this was a strikingly low percentage of recapture. This may be accounted for by the fact that excessively high temperatures in the latter part of August 1937, apparently drove the bass out of the Niantic and Thames Rivers, where they are normally subject to a highly intensive fishery, to the cooler coastal waters where they were not so easily available, and because a large number of the fish tagged in 1937 were released in areas that are not so well known to local fishermen.

Thus the evidence accumulated from tagging experiments on striped bass in Connecticut and Long Island waters in 1936 and 1937, and from the examination of commercial catch records, leaves little room for doubt that there is a mass migra-

[12] In this connection, Mr. Robert A. Nesbit tagged 64 striped bass in Sandy Hook Bay, N. J., April 22–25, 1938, and recaptures in late April and May showed that many of these fish went up the Hudson River. Recaptures in the summer showed a movement to the east and north.

tion to the north in the spring and to the south in the late fall, and that the summer populations in New England waters are essentially stable. The impression created by the information derived from tagging in these waters is that the migrations of the striped bass have their maximum size and intensity along the southern New England and Long Island shores, and that the farther south the fall movement goes the smaller it becomes, as individuals and groups split off from the main lot to winter in different localities. Conversely, starting from the south in the spring, the numbers making up the mass migration northward become greater and greater as the movement proceeds up the coast, being augmented as it progresses by the fish that have wintered farther north (see fig. 29). Having once reached northern waters an increasing number of striped bass stop along the coast to summer, and the migration dwindles in size and intensity as it progresses up the New England shore line. In the fall the migration south probably starts with many of the individuals that went farthest north in the spring, and increases in size and intensity at least until it reaches southern New England and Long Island. In years directly preceding 1936, when the level of abundance was consistently low, it is probable that the northern limit of

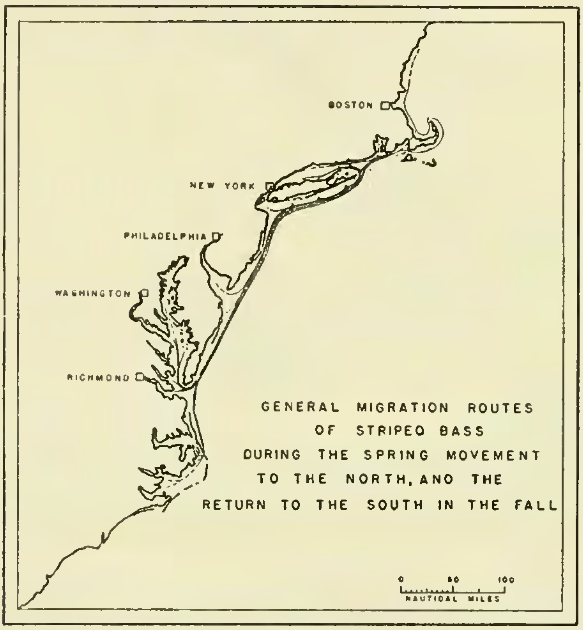

FIGURE 29.—The general migration routes of striped bass during the spring movement to the north, and the return to the south in the fall.

the striped bass migration from the south in the spring was Cape Cod, for north of this point this species was comparatively rare save in a few isolated localities that probably contained self-supporting permanently resident populations. Moreover, there is no commercial fishery for striped bass on the outer coast of Cape Cod comparable in size to those in Rhode Island and Long Island—a fact which indicates that there is no annual migration around Cape Cod of sufficient intensity to support such a fishery. In 1936 and 1937, however, when the members of the dominant 1934 year-class first reached northern waters, striped bass not only appeared in great numbers in Massachusetts north of Cape Cod, but were also commonly taken in New Hampshire and Maine. Three mackerel seiners caught 29,000 pounds of striped bass on August 2 and 4, 1937, in Cape Cod Bay. These fish were landed at the Boston Fish Pier, where it was the first time that this species had been handled in over 30 years. The study of scale samples of fish from these areas in 1937 showed them to be predominantly 3-year-olds of apparently the same origin as those taken off southern New England shores at the same time—evidence is presented later in this paper to show that the bulk of the dominant 1934 year-class was produced in the Middle Atlantic States (see p. 46). The dominant year-class of 1934 was of such tremendous size that in 1936 and 1937 its members either spread or were crowded farther north than in recent times. It is also the case that the widening and enlargement of the Cape Cod canal in the past few years has undoubtedly provided an easy means for fish to reach northern New England waters, and reliable witnesses attest to the fact that striped bass passed through the canal in large quantities in the summer of 1937.[13]

The most northerly return of a striped bass tagged in southern New England or Long Island waters was from Cape Cod Bay. But there can be little doubt from the

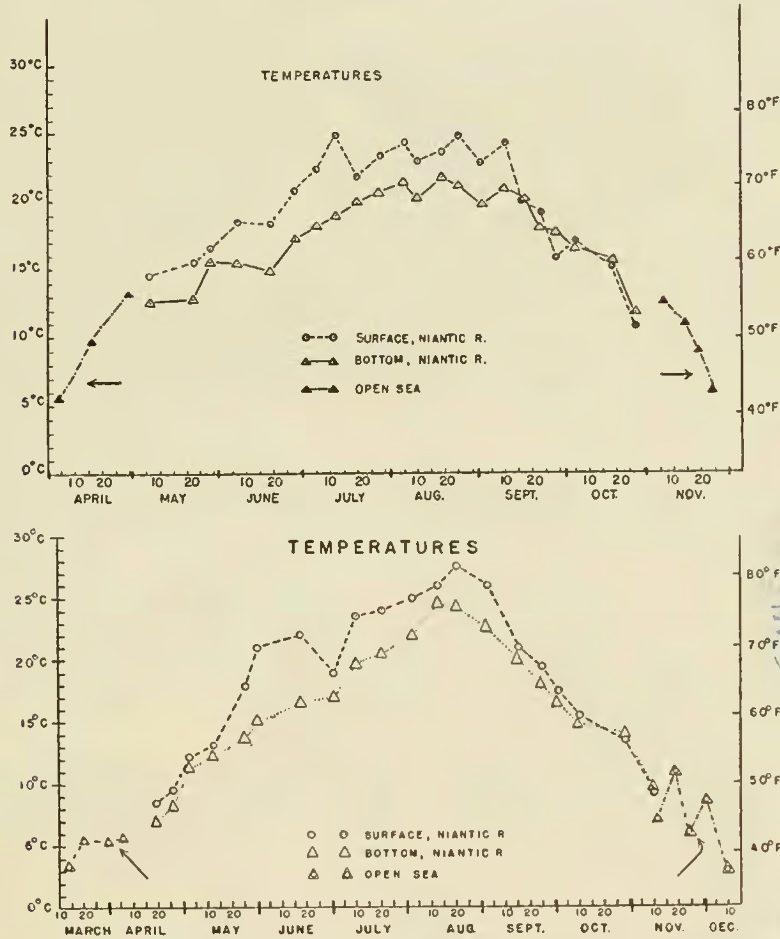

FIGURE 30.—Water temperatures in the Niantic River, Conn. The surface and bottom temperatures were taken in an area where striped bass were caught throughout the season. The open sea temperatures were taken at the mouth of the Niantic River, where the water passes through a narrow gut on the incoming tide with such force that the surface and bottom temperatures are the same. The open sea temperatures were taken during the spring and fall migrations of the striped bass. Arrows indicate when the first and last bass of the season were caught. Upper graph is for 1936, lower for 1937.

catch records and the examination of scale samples that the migration north in 1936 and 1937 at least reached Maine, and that north of Cape Cod the migrants from further south mingled with resident populations that probably had been isolated for some years past. In the summer of 1937 striped bass were taken in large quantities in Nova Scotia, but it is almost certain that there are self-supporting resident populations in various localities along the Canadian coast, and in the absence of length measurements and scale samples it is impossible to be sure of the origin of these fish. Two alternative possibilities suggest themselves in explanation of the presence of striped bass in Nova Scotia; first, that these fish are of northern origin and are completely separate from the

[13] Part of a letter to the author from Mr. John R. Webster, of the U. S. Bureau of Fisheries, dated March 8, 1938, reads, ". . . it now seems almost certain that these fish passed through the Canal. Mr. Churbuck told me the water around State Pier was loaded with bass and that people fished for them all along the banks of the Canal with great success."

populations farther south, and second, that they are made up of individuals of mixed origin—that is, that the northern stocks are added to by the migrants from the south.

The southernmost return of a striped bass tagged in Connecticut and Long Island waters was from the northern tip of Pamlico Sound, N. C. It is probable that the striped bass of the Southern Atlantic Bight—that part of the coast of United States south of Cape Hatteras—are a completely separate population, that may possibly be added to under rare circumstances by the stock from the Middle Atlantic Bight—Cape Hatteras to Cape Cod—and it seems reasonable to expect that the striped bass population of the Gulf of Mexico, which presumably extends as far west as Louisiana is entirely isolated.

The Middle Atlantic Bight is undoubtedly the center of abundance for the striped bass over its entire range, and tagging experiments indicate that there is comparatively little encroachment by this stock on the populations to the north and south. This is well in keeping with the conclusions of Parr (1933), who has shown that the shallow-water fish population of the highly heterothermal Middle Atlantic Bight is bounded on the north by a cold-water barrier in the Cape Cod-Nantucket Shoals region in the summer, and on the south by a warm-water barrier at Cape Hatteras in the winter. Parr (loc. cit.) has pointed out that ". . . in neither locality are such barriers found to be a permanent feature during all seasons." But in the case of the striped bass they exist at those times of year when they are most effective in keeping the bulk of the population of the Middle Atlantic Bight from encroaching on the areas to the north or south. Thus the cold-water barrier at Cape Cod in the summer marks the end of the northern migration in normal years, and the warm-water barrier at Cape Hatteras in the winter may play some part in delimiting the extent of the southern migration, and so at least partially separate the populations north and south of this boundary.

The question as to how much temperature influences the migration of the striped bass is one of particular interest. This is a highly eurythermal species, yet temperature variations well within the maximum and minimum limits appear to play some part in determining the time of migration. It seems to be more than coincidence that the times when the first striped bass of the year were taken—in April 1936, 1937, and 1938—and the times that the last ones of the year were caught—in November 1936 and 1937—in the Niantic River, Conn., were always when the temperature of the water was approximately the same, 6.0° to 7.5° C. (42.8° to 45.5° F.) (see fig. 30). Moreover, the migration of striped bass on the outer coast of North Carolina in late March and early April 1938 was observed to take place over a period when the water temperatures averaged 7.0° to 8.0° C. (44.6° to 46.4° F.).

The migrations north in the spring and the return to the south in the fall do not include all striped bass, for this species is caught consistently through the summer in southern waters and not uncommonly in northern waters in the winter. It is a relatively small percentage of the stock that remains north in the winter months. However, those that do stay north are of two types—the individuals that form the resident more or less isolated populations of the north Atlantic, and those that may have had their origin farther south but spend an occasional winter in northern waters. The latter may possibly bolster the northern spawning stocks, but are often composed of individuals that are not spawning in that particular year, for this species is not necessarily an annual spawner (see p. 16). Striped bass that do remain in the north through the winter months apparently become dormant and inactive in many cases and actually hibernate to much the same extent that has been described for the black bass (*Micropterus dolomieu*) in the northern part of its range by Hubbs and Bailey (1938). Their easy capture through the ice by scoop nets and by gigging testifies to their sluggish state in cold water, and the outward appearance of individuals taken in the winter and extremely early spring often shows that they are in poor condition. Striped bass certainly undergo partial hibernation as far south as New Jersey, the extent of this southern limit undoubtedly being determined by the prevailing temperatures. Dormant individuals are most commonly taken in northern waters during the winter in shallow bays and in the brackish waters of estuaries. Thus it appears that although temperatures from 6.5° to 8.0° C. play some part in causing the migrations of this species, their effect is not universal. It may be that the first and last fish of the season in such a place as the Niantic River, where striped bass are caught so consistently at approximately the same temperature in the spring and fall, are mainly winter residents, but it is also known that migratory individuals are present at the times of the earliest and latest catches. It is of interest to note that during October and November 1936, a time which was characterized by sudden drops in temperature, it was plainly indicated that with each cold snap, and resultant decline in temperature of the water, some of the striped bass in the Niantic River moved out and their place was almost immediately taken by fish that presumably came from farther up the coast. Such changes in the population were definitely observed on at least two occasions, both immediately following sharp drops in temperature. Strong winds and storms in the fall also play a part in causing the fish to undertake their migrations.

The maximum temperatures for this species appear to be in the neignborhood of 25°–27° C. (77.0°–80.6° F.), for in New England waters in the latter part of August and early September 1937 when there was a protracted period of exceptionally warm weather (see fig. 30), dead bass in considerable numbers were reported simultaneously in Connecticut and Massachusetts. Such mortality occurred chiefly in shallow-water estuaries where the water temperatures reached especially high levels. A number of dead bass were observed by the author in the Niantic and Thames Rivers at this time, and an examination of them disclosed no parasites or injuries that might possibly have been fatal. The water analyses of the Connecticut State Water Commission taken at various intervals in the Thames River near New London, Conn.—an area where many dead bass were found—showed nothing unusual nor the presence of any toxic substances during this period (see table 21). There also was a marked migration of bass that normally spend the entire summer in the Niantic and Thames Rivers out to the cooler coastal waters at the time the water temperatures were so high. This was shown by the recapture of tagged fish outside, and by the almost complete absence of bass in the rivers where they are usually found at this time of year. In view of such facts, the evidence is strong that a temperature of 25°–27° C. (77.0°–80.6° F.) marks the maximum tolerance limit. This is a water temperature which is seldom exceeded over the entire range of the striped bass.

It is of some interest to note that although a considerable number of striped bass weighing from 5 to 25 pounds were marked by external disc tags, there have been no returns from these fish save in the immediate locality at which they were released and within a short time after marking took place. Returns of tagged fish from any other area then the general point of release have been confined to individuals not more than 4 years old. It is difficult to account for this circumstance, and, although it may be that the larger bass did not take such a great part in the migrations as the younger individuals, information as to the size-categories appearing in commercial catches in previous years does not make it seem likely that this is an adequate explanation. By the same token, it is improbable that the larger fish migrate in waters farther offshore, thus reducing the chances of their being caught along the coast. It is possible that the larger individuals do not carry the external disc tags as well as the smaller fish, and that the tags are not retained for more than a short while. It is true that the larger the bass the nearer the top of the back the pin bearing the tags must be inserted, because the breadth of the fish makes it impossible for pins only 1¾ inches long to penetrate to the other side far below the dorsal contour. Other reasons for the lack of returns of the larger tagged fish are, first, the overwhelming abundance of the members of the dominant 1934 year-class, and second, the tendency of the smaller size-categories—2- and 3-year-olds—to school heavily. This schooling instinct, or schooling "synaprokrisis" (Parr, 1937), tends to make them much more available to commercial fishermen than the larger individuals which are not so strongly inclined to congregate together. The heavy schooling of the smaller fish of definite size-categories was observed countless times in the course of seining for tagging purposes in 1936 and 1937. That these schools tend to travel considerable distances without breaking up is suggested by the recapture in several instances at the same time and in the same area some distance away from the original point of release of two or three fish that had previously been tagged in a single seine haul in the Niantic River.

The recapture of tagged fish as well as observations on the commercial and sports fisheries for striped bass along the Atlantic coast from Maine to North Carolina gives abundant proof that this species is preeminently coastal in its distribution. But studies of the migrations by tagging experiments give convincing evidence that bass do at times cross open bodies of water of considerable size. Thus the spring migration route north apparently takes striped bass from the tip of Long Island straight across to Connecticut and Rhode Island shores, and in the fall the reverse appears to be true—that bass travel from Rhode Island and Connecticut to Montauk and do not follow all the way around the shore line of Long Island Sound. This is shown by the recapture of tagged fish at Montauk shortly after their release in Connecticut waters in the fall, and by the almost complete absence of tag returns at any time from the western half of Long Island Sound. A few fish do round Montauk Point and go west along the north shore of Long Island in the spring (see fig. 27), but the majority go to the north and east. Commercial fishermen of long experience in Rhode Island are convinced that in the fall migration to the south a heavy offshore wind causes the main body of fish to go straight from a point at least as far east as Newport to the tip of Long Island, and that a storm from the south causes the bass to follow down the coast of Rhode Island and part of Connecticut before crossing to Montauk. The evidence from the catch records of pound-nets under different conditions in the fall tends to confirm this view. It also is probable that striped bass often cross the mouths of Delaware and Chesapeake Bays in much the same way that they cross the tip of Long Island Sound.

It has been pointed out (see p. 20) that approximately 90 percent of the individuals examined for sex in Long Island and New England waters in 1936 and 1937 were females, and it also appears that there is an increasingly smaller percentage of males in northern waters among the large size-categories. On the other hand, this strikingly abnormal sex ratio does not exist in waters farther south, and the following theoretical explanation of this condition is offered. The spring coastal migration to the north in April and May coincides with the spawning season in the south, and is mainly composed of small immature fish and a relatively small number of individuals that are not spawners in that particular year. Because of the discrepancy in the age at maturity of the males and females, the males spawning for the first time at the end of their second year while the females do not become mature at least until the end of their fourth year, many of the males do not take part in the spring migration but stay behind to spawn with the larger females. Thus the migration northward at this time of year is largely made up of immature females 2 and 3 years old. The examination of the size-categories making up the catch in northern waters at different seasons indicates that there is a less intensive migration along the coast in June, which is composed of fish of a much larger average size. In all probability these are mainly females which have completed spawning farther south and have moved up along the coast singly or in small groups. This is demonstrated in figure 31, where the different sizes of striped bass making up the annual catch of a haul-seine fisherman at Point Judith, R. I., before and after June are shown. It is apparent that the small fish make up the bulk of the catch before June each year, but that thereafter bass of the larger size-categories comprise a far greater part of the catch. In 1936 and 1937 an unusually large percentage of the total were small fish, due to the dominance of the 1934 year-class.

There is no evidence that striped bass younger than 2 years old undertake the coastal migrations discussed above. The complete absence of juvenile and yearling individuals anywhere along the coast, save in or close to areas that have been established as being places where striped bass spawn, is proof that the coastal migrations do not occur until this species becomes 2 years old. In northern coastal waters, where the author handled many thousands of striped bass, individuals less than 2 years old were only encountered on the rarest of occasions.

Two interesting tagging experiments were conducted in North Carolina during March, April, and May, 1938. These were carried on for the purpose of determining to what extent the bass from this region take part in the spring migration to the north, and how much they contribute to the population in northern waters during the spring, summer, and fall. This whole question is discussed in some detail under the section on the origin of the dominant 1934 year-class, where evidence is presented which supports the conclusion that North Carolina does not contribute directly more than a small percentage to the supply summering in the north. In general the results of these experiments substantiate this view as far as they go. In one of the experiments a total of 506 juvenile and small yearlings—fish that were just becoming 1- and 2-year-olds—were tagged internally in the general region of the Sutton Beach haul-seine fishery, between the mouths of the Chowan and Roanoke Rivers in the western end of Albemarle Sound, N. C., with the idea that subsequent recaptures of these fish would demonstrate to what extent bass from this region contribute to the populations farther north. These fish were tagged from April 18 to 28, 1938, and 47 were recaptured in the same area before the fishery closed in May. Several others were taken within a short distance of the point of release in the spring, thus indicating that this method of tagging striped bass is satisfactory, at least for short-time returns. It is hoped that the internal tags will also prove satisfactory for long-time returns, as they have in some other species, so that it will be possible to prove the amount of North Carolina's contribution to northern waters over a period of years. The other tagging experiment in North Carolina during March and April 1938, was conducted partially at the extreme eastern end of Albemarle Sound and mostly on the outer coast in the general region of Kitty Hawk and Nags Head. In this experiment, 600 2-, 3-, and 4-year-old striped bass, of which the great majority were 2-year-olds, were marked with the external disc tags. Of these, 62 were caught in the same general

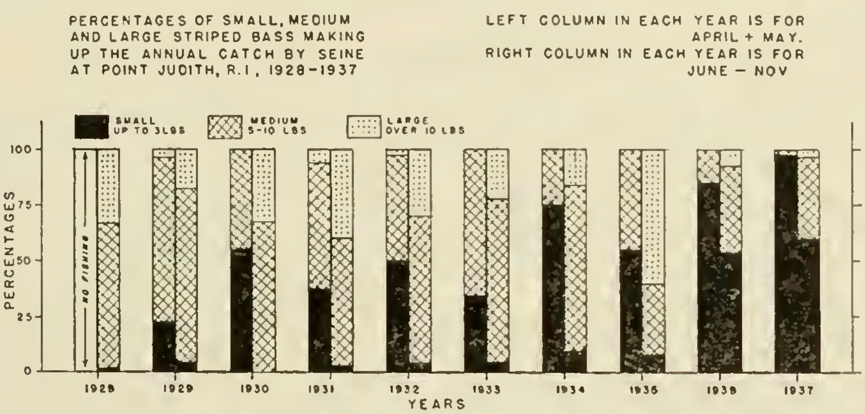

FIGURE 31.—The percentages of small, medium, and large striped bass making up the annual catch by seine before and after June at Point Judith, R. I., from 1928 to 1937. The left-hand column is for April and May, and the right-hand column for June to November in each year. See Figure 8 for the same material graphed in terms of actual numbers instead of percentages.

area within a short time after they had been tagged, and 46 were again released. By June 15, 1938, there had been 45 returns from these 600 tagged fish from areas some distance away from the point of release. Despite the fact that these fish were tagged at the time of the spring migration to the north, they did not show an intensive one-way movement such as has been proven to take place, for example, in northern waters by tagging in the fall. Thus 24 of the 45 returns were from Pamlico, Croatan, and Albemarle Sounds, indicating that many of the fish tagged on the outer coast moved south and west, some of them being taken in the extreme western tip of Albemarle Sound. The remaining 21 returns came from areas to the north of the point of release; 9 came from the Virginia Beach region; 8 from well into Chesapeake Bay (mainly from the James River and Rappahannock River sections); and 4 from more northern waters—2 from New Jersey, 1 from Wainscott, Long Island, N. Y., and the other from Point Judith, R. I. Had there been a heavy migration to the north at this time from this area, it seems reasonable to expect that in view of the highly intensive fishery for this species as shown by the percentage of recapture from other tagging experiments, there would have been a far greater number of returns from more northern waters. That this tagging experiment was not conducted at a time that was too late to coincide with the bulk of the spring migration to the north seems virtually certain, in view of the fact that tagging was started as soon as the outer-coast fishermen began to catch striped bass and was not concluded until the catches had dwindled so that few bass were being taken. Further evidence along this line appears in tables 22A, 22B, and 22C, which show that there were no returns from outside the State of North Carolina from the small number of striped bass that were released there in March and April, 1937. It does not appear, therefore, from the preliminary results of this work that the North Carolina stock contributes more than a small percentage directly to the summer population in the north. Rather, it seems that the bulk of the northern migration of the striped bass in the spring, and the corresponding return to the south in the fall, takes place between the Chesapeake Bay area and Cape Cod, and that only a relatively small number of migrants from the north and south of these regions take part in these movements.

In this connection the author is grateful to Mr. David H. Wallace, of the Chesapeake Biological Laboratory of the University of Maryland, for giving him the results of a tagging experiment conducted in conjunction with Dr. Vadim D. Vladykov's investigation of anadromous species for the State of Maryland. Of 483 bass tagged from November 15 to 19, 1937, in the east end of Albemarle Sound, in Croatan Sound, and on the outer coast of North Carolina, most of which were yearling and 2- and 3-year-old fish, only 2 had been recovered from northern waters by June 1, 1938, these coming from New Jersey. This is added evidence that North Carolina contributes only a small amount directly to the population summering in northern waters. It is of interest that 1 of these fish tagged on November 15, 1937, was caught in New Jersey on January 16, 1938, showing that some fish migrate north before the spring months.

ORIGIN OF THE DOMINANT 1934 YEAR-CLASS

The problem of the geographical point of origin of the dominant 1934 year-class, that age-group which has already been discussed at some length, is of particular interest. There is considerable evidence to support the conclusion that these fish were produced mainly in the Chesapeake Bay region. Thus, in the summer of 1935, when the members of this year-class were 1-year-olds and probably averaged 15–20 cm. (approximately 6–8 inches) in length, an unusually great abundance of striped bass of about this size and presumably of this age was observed and reported from Chesapeake Bay by many competent people. Truitt and Vladykov (1936) also "found that fish ranging from 21 to 25 cm. in standard length" seemed to be the most abundant age-category of striped bass in Chesapeake Bay during the early and midsummer in 1936. These fish were undoubtedly 2-year-olds at that time—members of the dominant 1934 year-class. Vladykov and Wallace (1937) also corroborate this information. On the other hand, diligent inquiry elicited no reports of yearling bass in 1935 from waters farther north. In the light of these observations it therefore seems logical to suppose that this large group of fish that were 2-year-olds in the summer of 1936, and first appeared in north Atlantic waters in that year, came in the majority from the Chesapeake Bay area and that general latitude. (See below for evidence that the dominant 1934 year-class did not come from farther south, p. 49.) From what is now known of the paucity of the spawning areas in the north, it is most unlikely that those regions north of the latitude covered by Delaware Bay contributed more than a small fraction to this dominant year-class—or for that matter, that they ever play more than a small and unimportant role in contributing to the total stock along the Atlantic coast under present conditions. Thus it becomes apparent that the striped bass fishery from New Jersey northward is almost entirely dependent for its existence on the stock of bass produced to the south, and on the migrations from the south to the north in the spring, which do not occur until bass become 2 years old or older.

Granting that the major portion of the production of striped bass takes place from the northern part of Delaware Bay south, it is of interest to determine how far south the stock contributes to the supply in northern waters, and to what extent different areas contribute to this supply. It is known that the Chesapeake Bay area is an important spawning center, and the work of V. D. Vladykov and D. H. Wallace (as yet unpublished) on tagging striped bass in connection with the survey of anadromous fishes for the State of Maryland has shown that the migration of bass out of Chesapeake Bay to the north in the spring is not an uncommon occurrence. Thus it seems well established that this general region contributes to the supply in the north and is an important center of production.

The question of how much the areas to the south of Chesapeake Bay contribute to the population in the north, and whether or not the dominant year-class of 1934 was produced simultaneously in Albemarle and Pamlico Sounds as well as in Chesapeake Bay, is of further interest. The author has found no evidence from talking with commercial fishermen in the Albemarle Sound region in 1937 and 1938 that there was an unusually large quantity of yearling bass in 1935 in these waters, as was the case in Chesapeake Bay. Further than this, tagging experiments in March and April in 1938 on the outer coast of North Carolina and in the eastern end of Albemarle Sound tend to show that the bass from this area do not undertake such an intensive migration to the north in the spring, and that they do not contribute a large amount to the summer population in northern waters. It has been pointed out that these tagged fish did not show an intensive one-way migration at this time, but rather a diffusion from the point of release with only a small percentage of the fish making definite movements of considerable distance to the north. This was in spite of the fact that these fish were released at exactly the time they would be expected to undertake the spring migration northward, and was in direct contrast to the one-way mass migration southward as shown by tagging in the north in the fall (see pp. 36–39 and 44–46). It is clear from this information that the stock in North Carolina waters probably contributes only a relatively small percentage directly to the populations summering in the north.

There is further evidence from the results of scale analysis that the main source of supply for the summer populations in northern waters is in the Chesapeake Bay area—or at least that general latitude (which includes Delaware Bay), and not from farther south. Unfortunately vertebral counts are of no value in showing the general point of origin of individual striped bass or for racial analysis, for this is a species with a virtually constant number (25) of vertebrae (see p. 3), and therefore the counts show no variation with latitude such as has been shown to occur in other forms (e. g., Hubbs, 1922). Scale and fin-ray counts may possibly be of some use in this respect, but they have not been used in this study because of the impracticality of making such counts, especially where the material was limited and it was desirable to tag a large proportion of the fish that were taken in northern waters. But whereas scale and fin-ray counts were not feasible in conjunction with tagging work, it was perfectly practicable to take scale samples from live fish. For these reasons, and because the scale method has given such successful results in determining points of origin in other species, scale analysis was used throughout for this purpose.

The assumption on which such a method rests in a species that spawns over a considerable latitude is that since there are likely to be different environmental factors over the entire range of spawning, there are also likely to be different growth rates which should be reflected in the scales. The problem is, then, to detect these differences in the scales from fish of different latitudes, and to establish that they are constant and therefore good criteria for determining the points of origin of the individuals from which the samples are taken. The striped bass is known to spawn over a wide latitude, and apparently does not migrate along the coast until it becomes approximately 2 years old. Thus, if there are any differences in the growth rate of this species in various localities along the coast, those that are to be used in determining points of origin must be found within that part of the scale bounded by the second annulus. With this in mind, as well as the fact that scale growth is proportional to body growth (see p. 31), the widths of the first and second growth zones of scales from striped bass of known and unknown origin were measured by the method described in the section on age and rate of growth (see fig. 15).

Figure 32 shows the length-frequencies of the widths of the growth zones in millimeters on scales from striped bass taken in different localities along the Atlantic coast in 1937. The top three series of length-frequency curves (those from scales from fish taken at (1) Cape Cod Bay, Mass., (2) Harkness Point, Conn., and (3) Montauk, Long Island, N. Y.) are from members of the 1934 dominant year-class—that group of fish whose origin is of especial interest. The samplings of fish from which these three sets of curves come, were made in the summer and fall of 1937 in northern waters. In the three sets of measurements, the widths of the first and of the second growth zones are strikingly alike throughout—a fact which at least suggests

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that the members of the dominant 1934 year-class that visited northern waters in 1937 were of much the same origin. It should be mentioned that measurements of the first and second growth zones on the scales from 2-year-old bass in Connecticut waters in 1936 (members of the 1934 dominant year-class) also gave length-frequency curves that were exactly comparable to those shown in the top three sets of curves in figure 32. Had they been of different origin—from areas scattered along the entire length of the Atlantic coast—it would be expected that the distribution of the length-frequencies of the widths of the first and second growth zones in these cases would have been much wider and not nearly as constant in the range of measurement as they actually are.

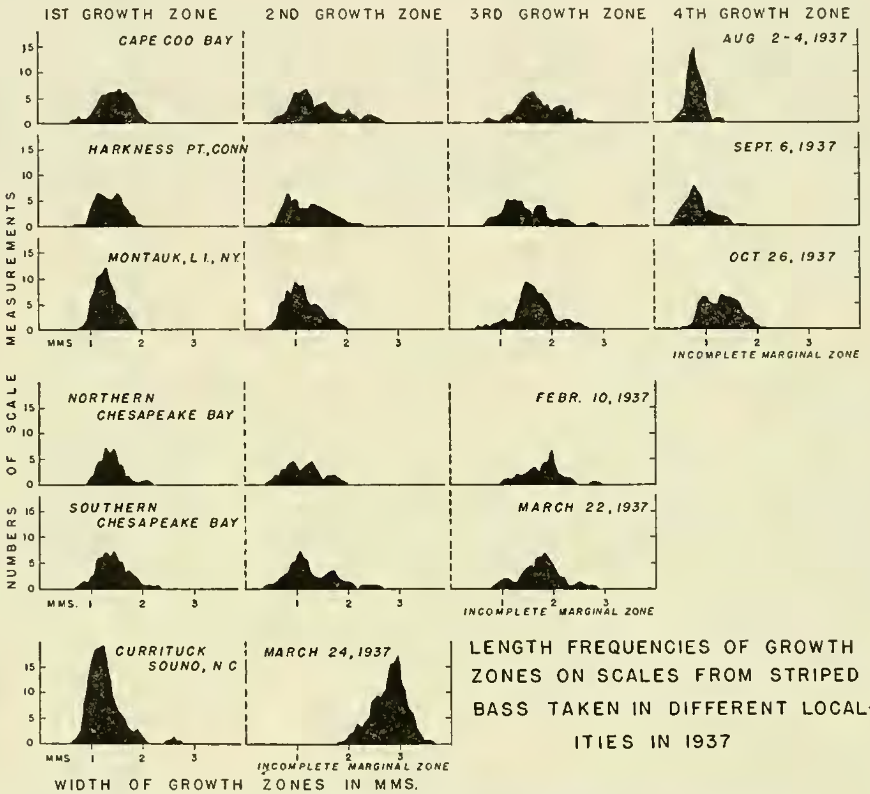

FIGURE 32.—The length-frequencies of the growth zones on scales from striped bass taken in different localities in 1937. The measurements making up each curve have been smoothed by a moving average of threes throughout.

One other point is of interest in the length-frequencies of the growth zones on the scales from these fish taken in northern waters in 1937. This is the comparison of the fourth growth zones (incomplete marginal zones) of the samples from Cape Cod Bay and Harkness Point. It has been pointed out in the section on age and rate of growth that there is much evidence that striped bass north of Cape Cod grew much faster than those south of Cape Cod during the summer of 1937 (see fig. 19 and p. 29). Since scale growth is proportional to body growth (see fig. 21), this phenomenon should be reflected in the scales, and a glance at the length frequencies of the incomplete marginal zones mentioned above (see fig. 32) shows this to be true. Thus the measurements of the fourth growth zones of the scales from fish from Cape Cod Bay present a peak slightly in advance of the similar peak for the Harkness Point sample, despite the fact that the sample from Cape Cod Bay was taken more than 1 month earlier than the one from Harkness Point. This is probably best explained by the faster growth rate of the fish summering north of Cape Cod, for if the growth rates were the same, the peak for the Harkness Point sample would have been far in advance of the one for the Cape Cod sample, since it was taken so much later in the summer.

Turning now to the two middle sets of length-frequencies in figure 32, those from scale measurements from fish taken in northern and southern Chesapeake Bay in February and March 1937, it is apparent that these are also from samples of the dominant 1934 year-class at the time its members were just becoming 3 years old, and when the third annulus was in the process of formation on the anterior margin of the scale. Looking at the widths of the first two growth zones, it is immediately apparent that the general distribution of the length frequencies and the peaks of the first growth zones and the second growth zones are similar throughout. Furthermore, they coincide almost exactly with the same growth zones of the scales from fish born in the same year but collected at a later date in northern waters—see the top three sets of curves in figure 32. It cannot be assumed, however, although it may well be true, that these samples from Chesapeake Bay are from fish that were produced in that region and had remained there, since it is known that this species often undertakes coastal migrations after it becomes 2 years old. Thus these fish might have moved into Chesapeake Bay in 1936, and might, therefore, not have had their origin in this region. On this account, it is not possible to assert that the similarity in the widths of the first growth zones and those of the second growth zones in the top five sets of curves in figure 32 is proof that the dominant year-class of 1934 originated in Chesapeake Bay. These similarities do, however, suggest that this is so.

Looking at the bottom set of curves in figure 32, those from scales from fish taken in Currituck Sound, N. C., it is again apparent that the widths of the first growth zones are much the same as those for all the other samples in this figure, although they do tend to be slightly less. The widths of the second growth zones of scales of the fish from this area, however, are strikingly different from any that precede it in figure 32. Whereas the widths of the second growth zones of the scales from fish from northern waters and from Chesapeake Bay in 1937 all range from approximately 0.5 mm. to or slightly over 2.0 mm. (with peaks at 1.0 mm.), the widths of the second growth zones of scales from fish from Currituck Sound range from about 2.0 to 3.6 mm. (with a peak at 2.9 mm.). These second growth zones of the scales from fish from Currituck Sound are labelled incomplete marginal zones in figure 32 because the second annuli, although in the process of formation on the anterior margins of the scales, were still indistinct. Therefore, the measurements of the marginal zones are to all intents and purposes equivalent to what those on the second growth zones would have been had the second annuli been completely formed. It should not be necessary to point out that if there were any differences from this factor, the widths of the second growth zones would have been even greater.

There is no doubt that these completely different and exceptionally wide second growth zones on the scales from fish from Currituck Sound are characteristic of the bass born in that general region in 1935, for these scales were taken from fish that were slightly less than 2 years old, and therefore had not undertaken any coastal migration. Thus the wide second growth zones on scales from fish born in the general Albemarle Sound region in 1935 give promise of being a means of distinguishing fish from this area from those born farther north. And since these wide growth zones are so different from the other growth zones in figure 32, they provide added evidence that the dominant 1934 year-class arose in the general latitude of Chesapeake Bay. They also tend to show that those bass born in North Carolina do not contribute a large proportion of the population that summers in northern waters. On the other hand, the fish that make up the top five sets of curves in figure 32 were all born in 1934, while those that make up the bottom set of curves (Currituck Sound) were born in 1935; and it should be pointed out that the comparison of the widths of the second growth zones of scales from fish born in different years may be fallacious. Thus there is no evidence from the single sampling in Currituck Sound in 1937 as to whether the wide second growth zone is truly a regional difference that occurs annually, or whether it was only a characteristic of the 1935 year-class. However, scale measurements from samplings of bass of the same age—2 years old in the spring of 1937—as those from Currituck Sound but taken in different areas, southern New England and southern Chesapeake Bay, appear in figure 33. (The length-frequency curves of the scale measurements of the sample from Currituck Sound shown at the bottom of fig. 32 are also repeated for the sake of comparison at the bottom of fig. 33.) These provide proof that the members of the 1935 year-class that contributed to the population summering in northern waters as 2-year-olds in 1937 came, in the main, from the Chesapeake Bay area. Thus the middle set of curves in figure 33 are measurements of the growth zones of scales from fish that were just becoming 2-year-olds in Chesapeake Bay in 1937. They are, in other words, from bass that had not yet migrated to any great extent, and the curve for the second growth zone may therefore be considered typical for bass that had been born in1935 in Chesapeake Bay. The upper set of curves in figure 33 is from measurements of the growth zones of scales from 2-year-old fish taken from northern waters in the summer of 1937. They are from bass of unknown origin that had migrated north along the coast in the spring. It will be noted immediately that the curve for the second growth zone of the scales from northern fish in the summer of 1937 compares well with the similar curve for the bass of the same year-class known to be of Chesapeake Bay origin.

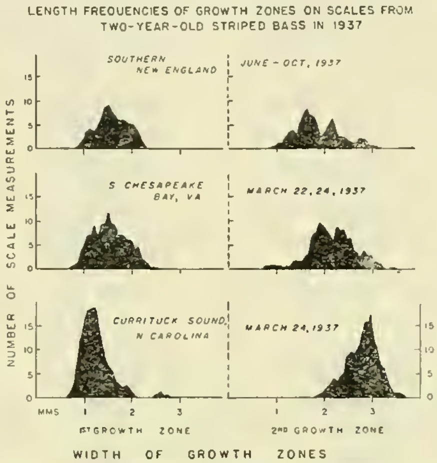

FIGURE 33.—The length-frequencies of the growth zones on scales from 2-year-old striped bass taken in southern New England southern Chesapeake Bay, and Currituck Sound (repeated from Figure 32 for comparative purposes), in 1937. The measurements making up each curve have been smoothed by a moving average of threes throughout.

However, it does not compare well with the similar curve for bass of the same year-class known to be of North Carolina origin. (See lower set of curves, figs. 32 and 33.) There is somewhat of an overlap between the curves of the widths of the second growth zones on scales from fish of the 1935 year-class of known origin from Chesapeake Bay and North Carolina, so that scales from fish of the same age-group but of unknown origin that show a second growth zone measuring from about 2.0–3.0 mm. might have been born in either of the above-mentioned areas. It is apparent that the majority of the widths of the second growth zones on the scales from fish taken in northern waters in the summer of 1937 fall below 2.0 mm. Judging from these measurements, it is possible to say that the North Carolina fish (assuming the Currituck Sound sampling to be representative of that area) contributed at an absolute maximum about 20 percent of the 2-year-olds summering in northern waters in 1937. The percentage that North Carolina contributed to the northern population at this time was probably much less. In fact, a comparison of the widths of the second growth zones of the scales from fish of the same year-class from Chesapeake Bay and from northern waters in 1937 (see fig. 33) shows that it is possible that North Carolina did not contribute anything directly to the population of 2-year-olds summering in the north in 1937, and that this population came entirely from the Chesapeake Bay area or north of it. The latter, however, is undoubtedly an extreme view.

It is thus apparent that in 1937 North Carolina contributed directly not more than a small fraction of the 2-year-old striped bass summering in northern waters, and that the 2-year-old bass in northern areas in that summer came mainly from the Chesapeake Bay latitudes and perhaps from the Delaware Bay region. There is, however, a possibility that the fish born in North Carolina contribute indirectly to the population summering in northern waters—that is, that they move up into Chesapeake Bay in the spring as 2-year-olds (e. g., see under the last part of the section on migrations) and then migrate to northern waters a year or more later. This is added evidence that the dominant 1934 year-class, which first appeared as 2-year-olds in northern waters in 1936, came from the general area of Chesapeake and perhaps Delaware Bays, although evidence of the above type should be obtained for several successive years before it can be considered conclusive proof of the fact that the contribution to northern waters in the spring and summer comes essentially from the latitudes of Chesapeake and Delaware Bays each year.

Measurements of the growth zones of scales from striped bass born in 1936 in the Delaware Bay and Albemarle Sound regions are shown in figure 34. It will be noted that the widths of the second growth zones of the scales from the fish of Delaware Bay origin born in 1936 are slightly below those for the growth zones on the scales from the fish of Chesapeake Bay origin born in 1935. (Compare upper set of curves in fig. 34 with middle set of curves in fig. 33.) It is probable that this difference is at least in part due to the fact that the second growth zones on the scales from the Delaware Bay fish were not yet quite complete (the fish were taken on November 8, 1937) because the annuli on scales do not appear until spring, although the growth from November to March is almost negligible. Whether or not there is a constant difference in the widths of the second growth zones of scales from fish of Delaware

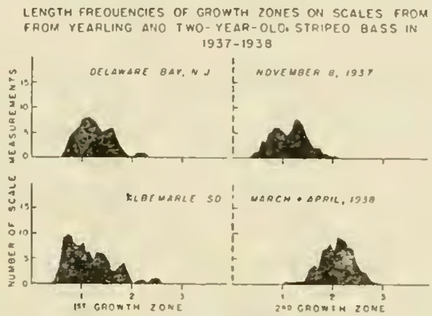

FIGURE 34.—The length-frequencies of the growth zones on scales from yearling and 2-year-old striped bass taken in Delaware Bay and Albemarle Sound in 1937 and 1938. The measurements making up these curves have been smoothed by threes throughout.

and Chesapeake Bay origin remains to be seen from sampling over a period of years. It is probable that this method will not provide a good means of distinguishing between bass born in these two regions, as the environmental differences are apparently insufficient to cause any constant difference in growth rate during the second year.

The widths of the second growth zones of scales from fish born in 1936 in Albemarle Sound (see lower set of curves in fig. 34) are interesting because although they are quite great, they are not so distinctively different from the others as those from North Carolina collected in 1937 (see bottom set of curves, figs. 32 and 33). They indicate, in other words, that although a wide second growth zone is apparently a characteristic of North Carolina fish from the general region of Albemarle Sound, this characteristic varies from year to year sufficiently so that it can only be used as a means of distinguishing fish of North Carolina origin from fish of Chesapeake Bay origin when the scales from fair samplings of bass that are just becoming 2 years old in the spring, before any coastal migrations have been undertaken, are available from both areas during any one year.

In conclusion it should be emphasized once more that the available evidence from general observation, scale analysis, and tagging experiments, gives every indication that the dominant 1934 year-class originated chiefly in the latitude of Chesapeake and Delaware Bays; that those fish produced in North Carolina contribute directly only a relatively small fraction to the population summering in northern waters; and that the main body of the northern summer population of striped bass comes from the area bounded on the south by Virginia and on the north by New Jersey. Further proof that Chesapeake Bay in general contributes a large proportion of the stock summering in northern waters is seen in figure 35, where the catches in New York and Maryland are compared in certain years from 1887 to 1935. (The material for this figure is taken from the U. S. Bureau of Fisheries canvass, and is not an annual comparison because the data are incomplete.) It will be noted that the trends of the catches in these two localities over this entire period show a remarkable correspondence—an agreement that could not reasonably be expected to occur unless the supply for both areas came mainly from the same source. In view of the evidence already presented, there can be little doubt that this source is the Chesapeake Bay area. In figure 35 the Maryland catch has been plotted at one-tenth its actual value throughout, a reduction which brings the annual catch in that State

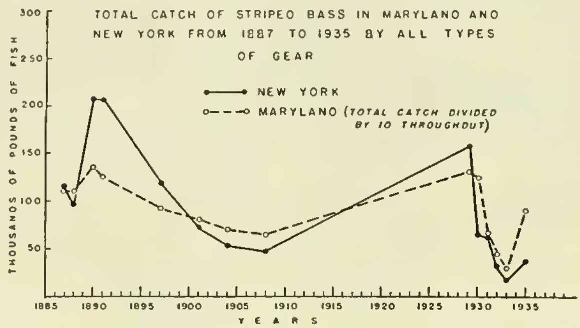

FIGURE 35.—Total catch of striped bass in certain years by all types of gear in Maryland and New York from 1887 to 1935 (from U. S. Bureau of Fisheries canvass). Maryland catch reduced to one-tenth throughout.

down to the same proportions as that of New York. Assuming the fishing intensity to be about the same in New York and Maryland, it is therefore reasonable to expect that this means that about one-tenth of each year's production of young in Chesapeake Bay reach New York. However, since immigrants from Chesapeake Bay are also taken in New Jersey and southern New England (unpublished material of V. D. Vladykov, p. 46), it is probable that somewhat more than one-tenth of the annual production of young leave Chesapeake Bay near the time that they become 2 years old, at the beginning of their third summer, and before they are old enough to be of any great value to the Chesapeake Bay fishery.

FOOD OF THE STRIPED BASS

The stomach contents of over 550 striped bass ranging in size from 6.5 to 115 cm. have been examined during the course of this investigation. These fish were all taken from April to November 1936 and 1937. Most of them were caught in Connecticut waters, although a few came from the Massachusetts coast and others from Long Island and New Jersey. Of the total number of fish examined, the majority were caught on rod and line; the others were taken by net. Over 75 percent of the stomachs studied came from bass that ranged in size from 30 to 50 cm.

The rugose lining of the stomach of the striped bass probably indicates a rapid rate of digestion. It is apparently not a steady feeder, but may gorge itself over comparatively short periods of time and then stop feeding until its stomach is completely empty again. Stomach-content analyses of individuals taken in the same seine hauls often showed the food to be in similar states of digestion, thus providing evidence that the members of a single school of striped bass feed simultaneously and then digest their food over essentially the same period of time. Often a high percentage of the bass in one haul would be filled with recently eaten fish such as menhaden (*Brevoortia tyrannus*) or silversides (*Menidia menidia notata*). Stomach-content analysis of the bass taken in another haul would reveal partially or well-digested food. At other times most of the fish taken together would be entirely empty. Approximately 52 percent of all the stomachs examined were completely empty. This high percentage may be explained, at least in part, by the fact that a large portion of the total number of stomachs examined were from rod-and-line caught fish, which are commonly empty because bass are more likely to be taken by anglers at the start of a feeding period when they usually have nothing in their stomachs, and also because bass taken on hook and line are often seen to regurgitate recently swallowed food.

Studies of the food of juvenile and yearling striped bass ranging from 3–11 cm. in standard length, seined on gravelly shoals of the Hudson River at Dennings Point, near Beacon, N. Y., have been made by Townes (1937) in connection with the biological survey of the Lower Hudson Watershed carried out in 1936 by the State of New York Conservation Department. The majority of these fish ranged from 3.0–5.5 cm. in length. It was found that the fresh-water shrimp (*Gammarus fasciatus*) formed about 60 percent of the food, with chironomid larvae the next most important item. Small fish remains (not identified, save for one eel, *Anguilla rostrata*), leptocerid larvae, and planktonic Crustacea such as *Latona*, *Cyclops*, and *Eurytemora*, formed a small percentage of the food. Hildebrand and Schroeder (1928) examined the stomach contents of small striped bass from the salt and brackish waters of Chesapeake Bay, and found that ". . . the young had fed on *Mysis*, *Gammarus*, annelids, and insects." The stomach-content analysis of small bass has been confined in the present study to 3 juveniles ranging from 6.0–7.5 cm. in standard length taken in the Parker River, Mass., on August 4, 1937, and 30 juvenile and yearling individuals from 11–23 cm. long taken in the Delaware River, near Pennsville, N. J., on November 8, 1937. Those from the Parker River all had their stomachs filled with the shrimp, *Crago septemspinosus*.[14] Those from the Delaware River were large enough to have become more voracious in their feeding habits, as is evidenced by the fact that 19 of the 30 examined contained the remains of fish of different species; the others were empty. A clupeoid species (probably menhaden, *Brevoortia tyrannus*) formed the main diet, while white perch, *Morone americana*, and shiners, *Notropis hudsonius amarus*, were also commonly eaten. It is of some interest that one bass 16.5 cm. (6½ inches) long contained a 7.5 cm. (2.95 inches) *Morone americana*, and examination of the stomach of an 18.5 cm. (7.28 inches) bass revealed the presence of a 10 cm. (3.94 inches) *Notropis* sp.

The examination of stomach contents of larger striped bass (above 25 cm.) has confirmed the commonly held view that this species is voracious in its feeding habits, and fairly general in its choice of food. It has also made it clear that bass often feed off the bottom, and blind individuals that were frequently taken in the Thames River, Conn. (see under section on parasites and abnormalities of the striped bass), appeared to manage well by feeding only on bottom-dwelling forms such as those included in the list below.

The most common form of food in Connecticut waters is the shiner, or silversides (*Menidia menidia notata*). This is a species which spawns in the spring (Hildebrand, 1922), and the young of each year stay so close to shore and are of such small size that they do not become available to the striped bass as food until August. At this time they reach 2 cm. in length and often stray farther offshore. The growth rate of juvenile *Menidia* is shown in figure 36. The length-frequency curves making up this graph are from random samples of the population seined at biweekly intervals from July to September 1937 in the Niantic River, Conn. It is apparent from a glance at the modes of these curves that in 1937 a peak of 2.0 cm. was attained shortly after the middle of August. Stomach-content analysis of striped bass 30–50 cm. long in this area in 1936 and 1937 showed that adult *Menidia* and the common prawn (*Palaemonetes vulgaris*) formed the main food from April to August, but that in August and September the bass fed on juvenile *Menidia* to a large extent. Shortly after this change in diet in 1936 there was a decided increase in the growth rate of the 2-year-old striped bass (see p. 28), which, despite the drop in water temperature (see fig. 30), was greatest in October. The presence of what was apparently an unusually great number of juvenile menhaden (*Brevoortia tyrannus*) in 1936 may also have played a part in this increased growth rate, for from August on striped bass commonly fed

[14] Identified by Dr. Charles J. Fish, Director of the Marine Laboratory at Narragansett, Rhode Island State College, Kingston, R. I.

heavily on this species during this year. However, juvenile menhaden were not as abundant in 1937 in this area, yet the growth rate of striped bass in September and October continued much as it had throughout the summer in spite of the drop in temperature (see fig. 18). It therefore appears that the increased food supply of striped bass resulting from the availability of juvenile *Menidia* after the middle of August may be correlated with the maintenance or increase of the growth rate in the early fall when the water temperature falls rapidly, and when the normal expectation

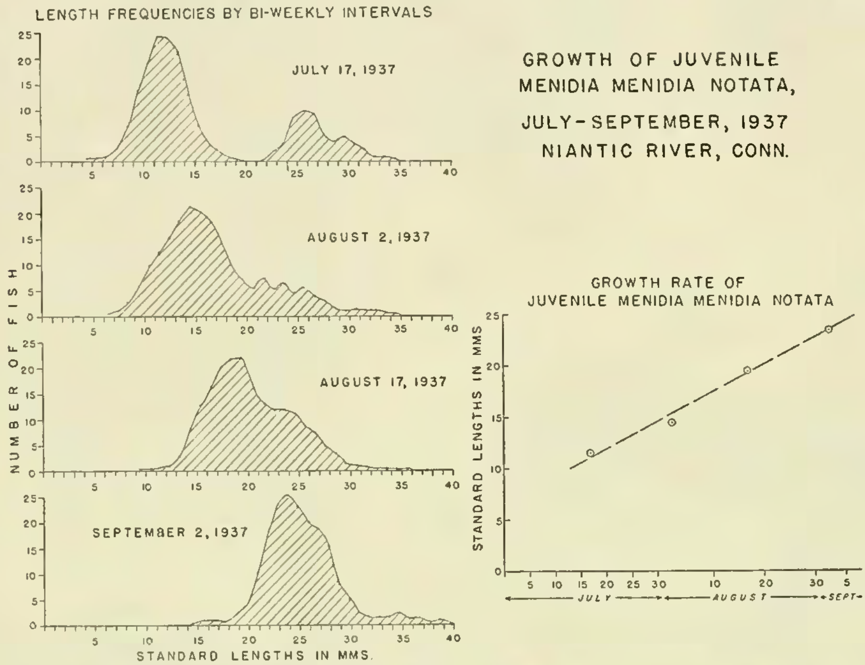

FIGURE 36.—The growth of *Menidia menidia notata*, from July to September 1937, in the Niantic River, Conn. The length-frequencies have been smoothed by a moving average of threes throughout (see Table 23 for original data).

would be that the growth rate would slow down. Other possible explanations of this apparently faster growth rate of striped bass in the late summer and early fall, such as faulty sampling and "compensatory growth," have been discussed in the section on the age and rate of growth of striped bass.

The following comprise all the forms of food found in the stomachs of the 550 striped bass examined in 1936 and 1937:

Common types:
- Shiners, or silversides (*Menidia menidia notata*).
- Menhaden (*Brevoortia tyrannus*).
- Shrimp, or prawns (*Palaemonetes vulgaris*).
- Mummichogs, or killifish (*Fundulus heteroclitus* and *majalis*).

Uncommon types:
- Sand Launces (*Ammodytes americanus*).
- Herring (*Clupea harengus*).
- Squid (*Loligo pealei*).
- Sandworms (*Nereis virens*).[15]
- Bloodworms (*Glycera dibranchiata*).[15]

Rare types:
- Flounders (*Pseudopleuronectes americanus*).
- Eels (*Anguilla rostrata*).
- Tomcod (*Microgadus tomcod*)—one 20 cm. specimen in a 40-cm. striped bass.
- Clams (*Mya arenaria*)—of small size.
- Crabs (*Callinectes sapidus* and *Ovalipes ocellatus*)—of small size.
- Snails (*Littorina*, sp. ?).
- Mussels (*Mytilus edulis*).
- White perch (*Morone americana*).
- Mullet (*Mugil cephalus*).
- Shiners (*Notropis hudsonius amarus*).
- Blennies (*Pholis gunellus*).
- Amphipods.
- Isopods.

[15] These 2 marine annelids are generally used for bait, thus pieces of them are often found in bass that were caught on rod and line. However, whole individuals also have been observed in the stomachs of striped bass.

It is apparent from a glance at this list that bass feed on a wide variety of animals, and it is likely that a study of stomach contents in other localities would yield as many more species as are common in the coastal waters inhabited by striped bass. In this connection, the examination of the stomach contents of 101 striped bass (yearling to 3-year-olds from the Albemarle Sound region and Manteo, N. C., in April 1938 yielded the following definitely identified forms, to say nothing of those that were too well digested to be identified: Teleosts.—Striped killifish (*Fundulus majalis*); sea trout, or spotted squeteague (*Cynoscion nebulosus*); silver perch (*Bairdiella chrysura*); croaker (*Micropogon undulatus*); gizzard shad (*Dorosoma cepedianum*); spotted ling, or hake, or codling (*Phycis regius*); anchovy (*Anchoviella mitchilli*); eel (*Anguilla rostrata*); white perch (*Morone americana*); glut herring (*Pomolobus aestivalis*); and minnow, or shiner (*Notropis*, sp.?). Crustacea[16].—Three species of shrimp (*Peneus brasiliensis*, *Palaemonetes carolinus*, *Crago septemspinosus*); young blue crab (*Callinectes sapidus*); and isopod (*Aegathoa oculata*).[17]

PARASITES AND ABNORMALITIES OF THE STRIPED BASS [18]

Parasites of the striped bass have been collected whenever they were observed from 1936 to 1938.

Two species of nematodes have been found that are endoparasitic on the striped bass. The first, *Goezia annulata* (syn.: *Lecanocephalus annulatus* Molin), was found in a single specimen in the stomach mucosa, and has been reported and described by Linton (1901) and MacCallum (1921). The second, *Dicheilonema rubrum* (syn.: *Filaria rubra* Linton), has been observed in innumerable striped bass. It was found in the peritoneal cavity, usually in the posterior end in close association with the gonads, but it never appeared to do any serious harm to its host. This species has been reported for the striped bass by Railliet (1918), and is described by Linton (1901).

Among the forms that are ectoparasitic on the striped bass are two species of copepods which have been found on various occasions. *Caligus rapax*, which occurs on many species of marine fish, and described by Wilson (1905 and 1932), is not uncommon. *Argulus alosae* Gould was taken on three striped bass in the Niantic River, Conn., in August and September, 1936, thus constituting a new host record for this species; it was described by Wilson (1903). It is also of interest that in the collection of juvenile bass taken from the western end of Albemarle Sound on May 11, 1938, a high percentage of the fish were parasitized by glochidia. It is supposed that these glochidia attached themselves to the fish in the fresh water at or near the mouth of the Roanoke River, and it is not known whether or not they can complete their normal encystment and development after being carried into the brackish waters of Albemarle Sound.

A review of the literature indicates that many other parasites have been reported for the striped bass. The monogenetic trematodes include *Lepidotes collinsi* (Mueller, 1936), *Aristocleidus hastatus* (Mueller, loc. cit.), *Epibdella melleni* (Nigrelli and Breder, 1934), *Microcotyle acanthophallus*, *M. cueides*, and *M. macroura*. Digenetic trematodes that have been reported on striped bass are *Distoma rufoviride* (syn.: *D. tenue*) (Linton, 1898), *D. tornatum* (Linton, 1901), and *D. galactosomum*. Two cestodes, *Rhynchobothrium bulbifer* and *R. speciosum*, have been reported by Linton (1901 and 1924), the former as plerocercoids in the intestine (adults in Selachians), the latter in cysts in the viscera. Besides the nematodes already mentioned, an *Ascaris* sp. has also been reported by Linton (1901). Two acanthocephalans, *Echinorhynchus gadi* (syn.: *E. aeus*) (Linton, 1901) and *Pomphorhynchus laevis* (syn.: *E. proteus*), have been taken from striped bass. Two other copepods besides those found by the author are the Lernaeopodid, *Achtheres lacae* (Wilson, 1915), and the Ergasilid, *Ergasilus labracis* (Wilson, 1911 and 1932).

In regard to the general well-being of the striped bass, there is no evidence that any of the parasites that are associated with it are of any great importance. *Dicheilonema rubrum*, which is so commonly found in the peritoneal cavity, shows a tendency

[16] Identified by Dr. Charles J. Fish, Director of the Marine Laboratory at Narragansett, Rhode Island State College, Kingston, R. I.

[17] The isopod, *A. oculata*, is normally found parasitic on squid (*Loligo pealei*) and young mullet (*Mugil* sp.), but since neither of these forms was seen in the stomachs of these bass, it is probable that *A. oculata* was taken by the bass while it was free-swiming during the breeding season.

[18] The author wishes to express his gratitude to Dr. John S. Rankin, of the Department of Biology at Amherst College, for his assistance in the preparation of the material on the parasites of the striped bass, and for his identifications of the nematodes and copepods.

to become partially embedded in the mesenteries, but the infection never appears to be serious. *Goezia annulata*, although comparatively rare, is probably a much more serious pest. MacCallum (1921: 261) says:

> Its mode of living is calculated to interfere very materially with the function of the stomach, inasmuch as it burrows under the mucous membrane, in fact excavating in some cases quite a space where several worms cohabit. . . . There are often several of these nests in the stomach, each nest may be 30 mm. to 40 mm. across, and as they cause a good deal of swelling and irritation, they may and do in some cases so restrict the cavity of the host's stomach that its food cannot be taken in any quantity sufficient to keep it alive. Thus the worms are a very serious menace to the fish.

This species is not common in striped bass, however, and according to reports is quite cosmopolitan in its choice of host, having been recorded from many other species of fish. Trematode infections are probably sufficiently rare in striped bass in their natural habitat to be of small importance. Nigrelli and Breder (1934) have shown that many of the Serranid fishes have developed a resistance to *Epibdella melleni*, while Jahn and Kuhn (1932) noted that " . . . the possibility of the development of immunity seems to be more strongly suggested in this family" (*Serranidae*). Copepod parasites are also apparently of small consequence to the striped bass.

It is worth mention that a surprising number of striped bass were encountered in the Thames and Niantic Rivers, Conn., that had cataracts of the eye. These were found commonly only in the Thames River, where they sometimes reached above 10 percent of the catch by seine. This opacity of the lens was encountered in all degrees from a slightly cloudy to a dead-white condition. It was almost universally bilateral, was rare in 2-year-old bass, and more common in the larger sizes. It was equally common in all months from April to October. A number of dissections under low-power magnification failed to reveal any parasites, such as larval digenetic trematodes, which might reasonably be expected to cause such blindness. Hess (1937) has recently shown that bilateral cataracts are common in trout in New York State, both in hatchery and wild stock, and he has proved with rainbow trout (*Salmo irideus*) ". . . that cataract in these fish is due to an unbalanced diet." He has been able to demonstrate that contagious infection, light, and hereditary factors, are not in any way connected with the production of such cataracts, and that the feeding of trout exclusively on pig spleen caused a high incidence of cataract; while trout fed with beef liver and heart never showed any trace of cataract. It seems likely, therefore, that a dietary deficiency may perhaps account for the high percentage of blind striped bass in the Thames River. It is interesting in this connection that the extraction of carotene by acetone from the liver and fatty tissue of blind and normal bass has tended to show less carotene per gram of tissue in the blind than in the normal individuals, and it is thus possible that a lack of vitamin A is associated with the dietary deficiency causing cataracts.

It is also of interest that Schultz (1931) has recorded a case of what gave every appearance of being completely functional hermaphroditism in the striped bass. This fish was taken in Oregon in May, and the eggs in one half of the gonads measured about 1 mm. in diameter, close to the size at the time of spawning (see p. 19), while the male half of the gonads was apparently developing normally.

DISCUSSION

It has been pointed out that there has been a striking decline in the numbers of striped bass along the Atlantic coast over long-term periods. (See under section on fluctuations in abundance of the striped bass, p. 8, and figs. 3 and 4.) The records show that this decline has been fairly steady from at least as far back as the middle of the nineteenth century, and perhaps before. They also indicate that it has been interrupted only by the occasional appearance of dominant year-classes—groups of striped bass that were produced in such huge amounts in certain years that they caused a marked increase in the numbers caught for short periods (see p. 8, et seq.). It is apparent from the available catch records (see fig. 4), however, that these dominant year-classes did not bolster the stock for more than a few years, and that their effects invariably have been short lived. In other words, the surplus created by them was soon removed, no permanent increase in abundance—and a consequent permanent increase in catch—resulted, and the decline in numbers of striped bass, although temporarily interrupted, soon resumed its normal trend.

Of especial importance in this respect is the dominant year-class of 1934, probably the largest production of striped bass in a single year in the past half century, whose members appeared along the Atlantic coast as 2-year-olds in 1936 and were at once subjected to the highly intensive fishery that confronts this migratory species over the greater part of its range. Information gathered in the course of this investigation makes it possible to demonstrate that this dominant year-class was directly responsible for a greatly increased catch, and also to make a rough estimate of the approximate rate at which this surplus was removed. Such an estimate is based on the percentage of tag returns from 2- and 3-year-old striped bass of the dominant 1934 year-class. (See pp. 36–41 and tables 17–20.) It includes all the factors which show that the percentage of tag returns on this age-group was far lower than the actual percentage removed by the fishery from 1936 to 1938. (See pp. 15 and 36.) Using this method, the most reasonable approximations show that about 40 percent of the members of this year-class were removed as 2-year-olds, and that at least 25–30 percent of the remaining 3-year-olds were taken by the fishery in 1937 and 1938. If these estimates are correct it means that over 50 percent of the 2-year-olds entering the fishery in the spring of 1936 had been removed by the spring of 1938, neglecting the effect of natural mortality, which is taken up below (see p. 59, et seq.), and which is an important factor in the rate of removal of the members of any population. Even though these estimates are only rough approximations, it is plainly evident that the enormous surplus created by the production of the dominant 1934 year-class, resulting in the largest catch of many years in 1936 (see figs. 4 and 6), is rapidly being removed, and that the members of this age-group will soon have been depleted to such an extent that they will no longer bolster the annual catch.

Granting, then, that there has been a sharp decline in the numbers of striped bass along the Atlantic coast despite the occasional appearance of dominant year-classes that bolstered the stock temporarily, it is of interest to know what has caused this decline. Two factors appear to have been responsible—first, the destruction of spawning areas by pollution and dams, and second, overfishing. Let us now consider these two factors in some detail.

There can be little doubt that striped bass formerly entered and spawned in nearly every river that was suitable along the better part of the Atlantic coast. As civilization advanced, dams were built, many of the streams were polluted, and the number of spawning areas that were available became less and less. It has been pointed out under the section on spawning habits and early life history, and elsewhere in this paper, that the majority of the spawning areas for striped bass are now confined to the coastal rivers from New Jersey south. There remain, however, a few isolated localities to the north that are still suitable—probably but a fraction of the areas that were once available. Yet it is clear from the production of the dominant 1934 year-class that there are still a sufficient number of good spawning areas left along the whole Atlantic coast to produce a large supply under the proper conditions. It should not be necessary to emphasize the fact that these remaining localities should be carefully protected against anything that might damage them, and other areas should be restored if it is possible.

Further investigations on the striped bass should continue the study of spawning areas along the Atlantic coast and determine the necessary requirements for the normal production, fertilization, and development of the eggs and larvae. In the case of some of the isolated spawning areas in northern waters, where the stock appears to have been maintained by a more or less self-supporting and partially resident population, there is some evidence that intensive winter and spring fisheries on the supply in the spawning localities have practically exhausted the stock. Under normal conditions the populations north of Cape Cod are probably not increased to any great extent by migrants from outside—especially from the south. This only occurs under exceptional cases, although it may occur more commonly in the future now that the Cape Cod canal provides an easy means of access to the north (see p. 41). Thus an intensive fishery in the winter and early spring when the members of such an isolated self-supporting stock are dormant and inactive, and hence more easily available for capture, may come close to entirely depleting a population of this sort.

Turning to the other factor, overfishing, which in conjunction with the destruction of spawning areas by dams and pollution has been responsible for the decline in abundance of striped bass, the problem is to see how overfishing affects the stock. Theoretically this factor may act in two ways—first, by the removal of too high a proportion of undersized and immature fish so that there are too few spawning individuals, and second, by failing to take the members of the available population at the most efficient size.

In regard to the removal of too great a number of striped bass before they have been given a single chance to spawn, evidence has already been presented to show that the fishery for the smaller size-categories of bass, 2- and 3-year-olds, is highly intensive, and that a large percentage of each successive year-class is caught before its members attain maturity. Yet there is no reason to believe that an additional supply of spawning individuals would result in an increased production, with the one possible exception noted below. Thus it has been emphasized in the section on fluctuations in abundance of the striped bass that the dominant 1934 year-class was apparently produced by as small a parental stock as there has ever been. This means that in southern waters the production of dominant year-classes is not completely dependent—at least down to a certain limit—on the quantity of spawning individuals. In other words, there appears to be no need for concern over the size of the spawning population in the south as long as it is at least as large as it was in 1934. If such a hypothesis be granted, there can be little good in raising the legal-length limit solely for the purpose of increasing the number of spawning fish—especially since we know that under the conditions of the present fishery the number of striped bass along the Atlantic coast is sufficient to produce a year-class of enormous proportions, such as the one that originated in 1934.

There is, however, one way in which an increased number of spawning adults may possibly bolster the supply in northern waters, for this supply has apparently declined in some cases to such an extent that the population has been practically wiped out. It has been shown before that in certain years striped bass from the south migrate north of Cape Cod. Since it has been well established that some of these migratory fish remain in northern waters through the winter, it is a reasonable expectation, if they were mature fish, that they would repopulate some of those areas which formerly supported small populations in northern waters and are still suitable for spawning purposes. Thus the striped bass has been virtually an unknown quantity north of Cape Cod for the past 30 years or more; that is, until the members of the dominant 1934 year-class came north of Cape Cod in huge quantities in 1936 and 1937 and provided a renewed sporting and commercial fishery of considerable size in those waters. It is certainly not unreasonable to predict that if a sufficient number of mature fish repopulate the spawning areas that still remain north of Cape Cod, the stock in northern waters can be replenished and the supply increased and maintained if the fish are given the proper protection.

It may therefore be said that measures designed to increase the supply of striped bass along the Atlantic coast by providing a greater number of spawning fish might quite possibly prove ineffective in the more southern waters of the Middle Atlantic Bight, for it is known that there are now a sufficient number of mature individuals to produce huge quantities of fish if the environmental factors are right; witness the dominant 1934 year-class. On the other hand, such measures would probably renew, at least partially, the supply north of Cape Cod where the stocks have been practically exhausted in many instances.

The other aspect of overfishing to be considered is whether or not the present fishery along the Atlantic coast takes the available members of the population at the most efficient size, or, whether or not the fishery makes the best possible use of the supply each year. Thompson and Bell (1934), Graham (1935), Thompson (1937), and others, have all discussed the theory of the effect of fishing on various stocks of fish, and have studied the problem of the most efficient utilization of the stock in different species. These papers have laid the foundation for future studies along this line, and it is possible to apply many of the principles set forth in them to the striped bass fishery of the Atlantic coast. Those who are critically interested in this whole subject should refer to the work of these authors.

The first problem in connection with the striped bass is to get some measure of the yield from the stock under the existing conditions of the fishery at the present time. Having attained this, it is possible to compare it with the yield from the stock under different conditions of the fishery and thus determine which is the most advantageous, not only from the point of view of profit to the fisherman, but also in the light of what is known about the life history of this species. In other words, it is desirable to discover at what age (or length) it is most advantageous to start the fishery for striped bass; i.e., whether the fishery gets the most profit out of taking the fish for the first time when they are 2-year-olds (averaging roughly three-quarters of a pound and 12 inches in length) as it does at present, or whether it would benefit by allowing the fish one or two more growing seasons before catching them.

In order to find the answers to these questions it is essential that the fishing mortality at different ages—the percentage of fish of each age taken by the fishery—and the natural mortality, be known. This can only be done accurately by careful studies and the collection of detailed statistics on the annual catches of striped bass over long-term periods, although the present work has given some information along these lines. Considering the dominant 1934 year-class, it has been assumed from the percentage of tag returns (see p. 57) that approximately 40 percent of its members were taken by the fishery as 2-year-olds in 1936 and 1937, and that about 25 percent of the 3-year-olds of 1937 and 1938 were also taken by the fishery. It is known from various catch records from Virginia to Rhode Island that only about one-quarter as many 3-year-old striped bass were caught in 1937 as the 2-year-olds that were taken in 1936. This is demonstrated in figure 4, where the catches of a pound-net fisherman at Fort Pond Bay, Long Island, N. Y., were approximately four times as great by number in 1936 as they were in 1937, and where the catch was over 90 percent 2-year-olds in 1936 and 3-year-olds in 1937. Given this information it is possible to estimate the natural mortality in 1936 by the following equation:

$$NM = S_1 - (FM_1 + S_2),$$

wherein NM is the natural mortality in 1936, S_1 the stock available in 1936, FM_1 the fishing mortality in 1936, and S_2 the stock available in 1937. S_1 can be given any arbitrary value, for example, 1,000. If FM_1 is assumed to be 40 percent of S_1 (see above), FM_1 is 400. S_2 is equal to approximately $4 \times FM_2$, where FM_2 is the fishing mortality in 1937, for tagging experiments indicate that roughly 25 percent of the 3-year-olds were taken in 1937. FM_2 is known to be ¼ FM_1, as only one-quarter as many 3-year-olds were taken in 1937 as there were 2-year-olds taken in 1936. Under these conditions FM_2 therefore becomes 100, and in the equation above, where S_1 was assumed to be 1,000, S_2 becomes 400. Substituting these values in the equation, the natural mortality in 1936 attains a value of 200. Thus of the original 1,000 fish in 1936, 400 were caught as 2-year-olds, and of the remaining 600 fish, 200 were lost through natural mortality. It is therefore apparent that if the estimates on which the figures making up this equation are based are correct, natural mortality accounted for about one-third of the 2-year-olds in 1936 which were not taken by the fishery. It should be pointed out, however, that slight variations in the percentages assigned to FM_1 and FM_2, which are only rough approximations, can materially change the value obtained for NM.

Taking the figures in the equation above, since they seem to be the best available, it is possible to get some estimate of the yield from the stock under the existing conditions of the fishery. Table 1 is a theoretical treatment of 1,000 striped bass of the 1934 year-class to show the rate of removal by the fishery and natural mortality, the numbers and poundage caught, and the market value, when the fish of this age group were caught over a 5-year period from 1936–40 (as 2-, 3-, 4-, 5-, and 6-year-olds). This treatment, in other words, considers the value when the fishery starts catching striped bass for the first time as 2-year-olds, which is exactly what occurred in 1936 along the Atlantic coast. The natural mortality is figured at one-third of the population, excluding those taken by the fishery. The fishing mortality was estimated to be 40 percent in 1936, 25 percent in 1937, 15 percent in 1938 (when the members of the 1934 year-class were 4-year-olds), 10 percent in 1939 (5-year-olds), and 5 percent in 1940 (6-year-olds)—a declining fishing mortality that undoubtedly represents as sharp a decrease in the percentage of fish of any year-class caught each year as could possibly exist, and probably over-estimates the decline in the percentage taken by the fishery as the members of a year-class become older. It will also be noted in table 1 that the price per pound varies with the different size categories under consideration. Thus the 2-year-olds averaging three-quarters of a pound each are listed as bringing 6.5 cents a pound, the 3-year-olds averaging 2 pounds each as 9.5 cents a pound, and the 4-, 5-, and 6-year-olds as bringing 10 cents a pound throughout. These prices were determined from information collected by the Bureau of Fisheries from an important dealer on the Atlantic coast. The average price per pound for the different size categories was determined by dividing the total dollar volume for each month by the total number of pounds of striped bass purchased each month from March through November 1937. The prices for each of these months were then averaged, giving the average price for the different size categories for the entire period. Since this dealer handled a total of approximately 200,000 pounds during this period, the prices for the different size categories should be accurate estimates.

TABLE 1.—*Theoretical treatment of 1,000 striped bass of the 1934 year-class to show the rate of removal by the fishery and natural mortality, the numbers and poundage caught, and the market value, when the fish were caught over a 5-year period from 1936–40. Note that in this treatment fish were caught for the first time when they were 2-year-olds*

	Age	Average length	Average weight	Total weight	Average price per lb.	Market value
	Years		*Pounds*	*Pounds*	*Cents*	
Assumiug 1,000 bass were available in 1936, of which 400 would be caught in 1936 (fishing mortality, 40 percent); 200 would die in 1936 (natural mortality, 33 percent of those not caught), leaving	2	31 cm. (12.2 inches).	0.75	300.0	6.5	$19.5
400 bass available in 1937, of which 100 would be caught in 1937 (fishing mortality, 25 percent); 100 would die in 1937 (natural mortality, 33 percent of those not caught), leaving	3	41 cm. (16.1 inches).	2.0	200.0	9.5	19.00
200 bass available in 1938, of which 30 would be caught in 1938 (fishing mortality, 15 percent); 57 would die in 1938 (natural mortality, 33 percent of those not caught), leaving	4	50 cm. (19.7 inches.)	3.5	105.0	10.0	10.50
113 bass available in 1939, of which 11 would be caught iu 1939 (fishing mortality, 10 percent); 34 would die in 1939 (natural mortality, 33 percent of those not caught), leaving	5	58 cm. (22.8 inches).	5.5	60.5	10.0	6.05
68 bass available in 1940, of which 3 would be caught in 1940 (fishing mortality, 5 percent).	6	66 cm. (26.0 inches).	8.0	24.0	10.0	2.40
Total number of striped bass caught during 1936–40, 544.	Total			689.5		57.45

In table 1 it will be seen that the total market value derived from 1,000 bass of the 1934 year-class over the 5-year period 1936–40 was $57.45, the total number of individuals caught was 544, and the total weight taken was 689.5 pounds. These figures represent the yield to the fishery when striped bass are caught for the first time as 2-year-olds (12 inches in length).

Table 2 gives similar information for the same number of bass of the 1934 year-class when the fishery did not catch them as 2-year-olds in 1936 but took them for the first time as 3-year-olds in 1937, and caught them over the 4-year period 1937–40. It will be noted that the total market value under these conditions was $64.48, the total number of individuals caught was 242, and the total weight taken was 661.5 pounds. Thus, less than half as many individuals were taken when the fishery first caught bass as 3-year-olds, yet the gross profit was substantially more. It is, therefore, plainly evident that if the figures upon which these calculations are based are reasonably accurate, the fishery is not utilizing the available supply of striped bass in the most efficient manner when it first takes them as 2-year-olds.

Since it has been shown that it is apparently more efficient for the striped bass fishery of the Atlantic coast to start taking the fish as 3-year-olds rather than as 2-year-olds, it is of interest to consider what the yield would be if the fishery waited still another year and did not begin to remove the members of the bass population until they became 4-year-olds. Treating the same 1,000 fish of the 1934 year-class in the same manner as shown in tables 1 and 2, with the sole difference that the fishery only operates over a 3-year period from 1938–40, the total market value drops to $43.60, and there appears to be an inefficient utilization of the available stock from every point of view. This striking drop in the gross profit under these conditions is due to the high value estimated for natural mortality each year, for the amount added in total growth by allowing the fish to live until they are 4 years old does not compensate for the numbers lost through natural mortality under these conditions.

TABLE 2.—*Theoretical treatment of 1,000 striped bass of the 1934 year-class to show the rate of removal by the fishery and natural mortality, the numbers and poundage caught, and the market value, when the fish were caught over a 4-year period from 1937–40. Note that in this treatment the fish were caught for the first time when they were 3-year-olds*

	Age	Average length	Average weight	Total weight	Average price per pound	Market value
	Years		*Pounds*	*Pounds*	*Cents*	
Assuming 1,000 bass were available in 1936, of which 333 would die in 1936 (natural mortality, 33 percent), leaving	2	----------	--------	--------	--------	--------
667 bass available in 1937, of which 167 would be caught in 1937 (fishing mortality, 25 percent); 167 would die in 1937 (natural mortality, 33 percent of those not caught), leaving	3	41 cm. (16.1 inches).	2.0	334.0	9.5	$31.73
333 bas available in 1938, of which 50 would be caught in 1938 (fishing mortality, 15 percent); 94 would die in 1938 (natural mortality, 33 percent of those not caught), leaving	4	50 cm. (19.7 inches).	3.5	175.0	10.0	17.50
189 bass available in 1939, of which 19 would be caught in 1939 (fishing mortality, 10 percent); 57 would die in 1939 (natural mortality, 33 percent of those not caught), leaving	5	58 cm. (22.8 inches).	5.5	104.5	10.0	10.45
113 bass available in 1940, of which 6 would be caught in 1940 (fishing mortality, 5 percent).	6	66 cm. (26.0 inches).	8.0	48.0	10.0	4.80
Total number of striped bass caught during 1937–40, 242.	Total			661.5	--------	64.48

In tables 1 and 2 it was shown that the total market value of striped bass taken from the available stock of 1,000 fish of the 1934 year-class from 1936–40 (bass caught for the first time as 2-year-olds) was $57.45, as compared with $64.48 when this same stock was utilized by taking its members for the first time when they were 3-year-olds over the period from 1937–40. It should be pointed out that the gain from allowing the fish to become 3 years old before being caught has been figured in these examples as the least that can result. In the first place, the fishing mortality on the members of the 1934 year-class was estimated from tagging experiments as 40 percent in 1936 and 25 percent in 1937. It has been arbitrarily placed at 15 percent in 1938, 10 percent in 1939, and 5 percent in 1940, because they are considered the lowest values possible. Whether or not this annual decline in the percentage taken is as steep as indicated above and in tables 1 and 2 is extremely questionable. It is obvious that if this decline is less sharp, the gain from allowing the fish to become 3 years old before being caught is relatively greater. Further than this, the natural mortality of the bass of the 1934 year-class is estimated to be 33 percent of the population (neglecting fishing mortality) in 1936, and it has been arbitrarily placed at 33 percent for the years from 1937 to 1940. Actually, it is extremely unlikely that it remains as high as 33 percent over this period, for it is reasonable to assume that as bass become older than 2 years of age they are less likely to be killed through natural causes. It is possible that when bass become much older the death rate increases, but in the examples in tables 1 and 2 that stage is probably not reached. Thus it is likely that the annual natural mortality of 33 percent from 1937 to 1940 is far too high. If this be so, the gain from allowing the fish to become 3 years old before being caught is again relatively greater than is shown by the total market value in the examples given above. It is evident therefore that the gain from catching striped bass for the first time as 3-year-olds is far more than is shown in tables 1 and 2. Nor should it be necessary to point out that the figures used in the examples in tables 1 and 2 represent only gross values, and that the net values would be far greater.

It is also of importance that if the fishery first starts to operate on the striped bass population when its members are 3 years old, a greater proportion of the stock is given a chance to spawn. It has already been shown (see p. 22) that female striped bass first mature at 4 years of age. If the stocks available at this age are compared in tables 1 and 2, it will be seen that of the 1,000 original fish of the 1934 year-class only 200 were left by 1938 when the fishery started taking the fish for the first time as 2 year-olds, while 333 were left by 1938 when the fishery started to operate on 3-year-olds. In other words, on the basis of these calculations about 1⅝ times as many female striped bass would be given a chance to spawn if the fishery were to allow the 2-year-olds to remain in the water and first started to catch them as 3-year-olds. It has previously been pointed out that although a conservation measure designed to increase the stock by adding to the number of spawners in the south has no evidence to prove that it is not a fallacious policy, an increase in the number of mature fish in northern waters should repopulate this area to a certain extent and revive the fishery in this region There are, of course, many spawning areas in northern waters that have been ruined by pollution and dams so that they could not be repopulated, but it is widely believed that depletion in northern waters is in part due to insufficient numbers of spawners. Thus Bigelow and Welsh (1925) say:

> Since striped bass have dwindled as nearly to the vanishing point in the St. John (which still sees a bountiful yearly run of salmon) as in the estuaries of rivers that have been dammed and fouled by manufacturing wastes, the chief blame for its present scarcity can not be laid to obstruction of the rivers; and as this is a very vulnerable fish, easily caught, always close inshore, always in shallow water, and with no offshore reservoir to draw on when the local stock of any particular locality is depleted by such wholesale methods of destruction as the early settlers employed—overfishing must be held responsible.

Probably one of the reasons why the depletion in northern waters has been so great is that bass which remain north in the winter become dormant and inactive (see p. 42), and hence far more easily available for capture, so that it is not impossible to wipe out an entire population. Under these circumstances there is good reason to believe that an added number of mature fish in northern waters would assist materially in renewing the supply in these areas, and that this supply could be maintained by affording the population adequate protection.

It should be mentioned at this point that the abundance of striped bass in California, where the present fishery arose as a result of two small original plantings (see p. 5), has been successfully maintained by protecting this species up to the time they become 4 years old, at which time they are about 20 inches in length. Thus Craig (1930) and Clark (1932 and 1933) have studied the fluctuations in abundance of the striped bass in California, and both of these authors came to the conclusion that "the striped bass population could support a commercial fishery as well as a sport fishery"—a conclusion to which, however, the California State legislature apparently paid scant attention, since commercial netting was prohibited by law after August 14, 1931.

In consideration of all the foregoing evidence, even though it is based on assumptions that need further corroboration by continued investigation of this species, it seems highly advisable to try the experiment of allowing striped bass to become 3 years old before they are caught in large quantities along the Atlantic coast. Both sportsmen and commercial fishermen should benefit by this apparently more efficient utilization of the available stock, the former by having an increased number of large bass to fish for, and the latter by making a definitely higher profit than they do under the present conditions. An addition to the spawning stock in northern waters, where the supply has been depleted to such an extent that an added number of mature individuals is badly needed, should also result from protecting this species up to the time it becomes 3 years old.

RECOMMENDATIONS

The preceding section has dealt with a theoretical discussion of the striped bass population of the Atlantic coast. The causes for its decline in numbers over long-term periods, its fluctuations, and the effects of different fishing intensities and natural mortality on the stock under the existing conditions have been considered. Also, an attempt has been made, on the basis of the limited information at hand, to determine how the available supply of striped bass can be utilized most efficiently from every point of view. The data tend to show that the way in which the fishery for striped bass along the Atlantic coast can make the best possible use of the available supply is to start taking the fish as 3-year-olds, when they average 41 cm. (16 inches) to the fork of the tail and weigh roughly from 1¾ to 2 pounds each. There is apparently more profit when the fishery first starts to take the bass as 3-year-olds than there is when the fishery starts to take the bass as 2-year-olds, because the greatest increment in growth in the entire life of the striped bass takes place during the third year of life—when the fish are 2 years old. This growth in the third year is sufficient to more than compensate for the losses due to natural mortality, and its advantages are missed when the fish are caught for the first time as 2-year-olds.

It is therefore recommended, on the basis of existing knowledge and as a practical experiment in conservation, that striped bass on the Atlantic coast less than 16 inches in length be protected.

The problem is, then, how striped bass should be protected up to the time they become 3 years old. Unfortunately the commercial fishery is not one which exists for the purpose of catching this species alone; rather, striped bass are taken in association with many other forms by different types of gear along the whole coast. It is impossible to make any limitation on the size of mesh to be used, since this would affect the capture of other species that do not need to be protected up to as large a size as do striped bass. Further than this, the striped bass is highly migratory and should be protected along the entire length of its range. It is only feasible, on this account, to suggest a universal length limit (or at least a commercial sale limit) for the entire Atlantic coast, and let the individual States determine by appropriate investigation whether additional restrictions on the gear employed in the striped bass fishery, and on the seasons when the fishery shall operate, would be profitable. It is no great hardship for commercial fisheries to return undersized bass to the water, and it is to their ultimate advantage to do so—not only from the point of view of the increased return it should bring them, but also in order to eliminate any legitimate objection by anglers to their fishing methods. That the mortality of these undersized bass from being caught in a net and handled before being released would be small under normal conditions is abundantly illustrated by the fact that some of the most successful tagging experiments that have been carried on during this investigation have been made on fish that were caught in seines and pound-nets.

It is apparent that there is nothing to be lost and much to be gained by allowing the striped bass of the Atlantic coast one more growing season than they have under existing conditions in the fishery—that is, by allowing them to become 3-year-olds before they are taken in large quantities. However, the gains from such an experimental measure will depend directly upon its universal acceptance along the entire Atlantic coast, and on the complete cooperation of those engaged in the fishery. The adoption of measures designed to protect striped bass of less than 16 inches in length should result in greater profit to the commercial fishermen, an increased supply of larger fish for the sportsmen, and a larger number that reach maturity—of which a certain number should spawn in northern waters and possibly replenish stocks which have been badly depleted.

It is also apparent that there is need for much more study on the striped bass of the Atlantic coast. This is especially true since the specific recommendations as to the size limit of the striped bass made in this paper are suggested on an experimental basis. It is therefore essential that more detailed and more accurate catch records be made available, and further biological studies be undertaken in order to trace the results of the recommendation if adopted, to make possible a suitable revision of the size limit if the results indicate that modification would be desirable, and to amplify the results of the present investigation.

SUMMARY AND CONCLUSIONS

(1) The foregoing report is concerned with the results of an investigation of the striped bass (*Roccus saxatilis*) of the Atlantic coast, from April 1, 1936, to June 30, 1938.

(2) The general morphology and systematic characters of the species are described in detail on the basis of the literature and material afforded by fin-ray, scale, and vertebral counts, and measurements on more than 350 individuals.

(3) The striped bass is strictly coastal in its distribution from the Gulf of St. Lawrence to the Gulf of Mexico. Those most commonly taken at present range from less than 1 pound to 10 pounds in weight; but larger individuals are by no means rare. The largest striped bass of which there is authentic record weighed 125 pounds.

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(4) Studies of the fluctuations in abundance of the species over long-term periods show that there has been a sharp decline in numbers. Dominant year-classes have at times temporarily raised the level of abundance, but the intensity of the fishery is such that their effects have been short-lived. The dominant year-class of 1934 was the largest to be produced in the past half century, although the parental stock at this time was probably as small as it ever has been. Evidence is presented to show that there is a good correlation between the production of dominant year-classes of striped bass and below-the-mean temperatures during the period before and immediately after the main spawning season.

(5) The striped bass is anadromous, spawning from April through June, the exact time depending on the latitude and temperature. The majority of spawning takes place from New Jersey south, although there are a few isolated spawning areas in northern waters. The development of the eggs and larvae is pictured, and the size of the juveniles at different times of the year is discussed.

(6) Sex determinations of striped bass in Long Island and New England waters show that the number of males in this northern range of the species seldom reaches much over 10 percent of the population; the percentage of males apparently decreases in the age-categories above the 2-year-olds. In waters farther south the sex ratios are not so disproportionate. Studies of the age at maturity show that approximately 25 percent of the female striped bass first spawn just as they are becoming 4 years of age, that about 75 percent are mature as they reach 5 years of age, and that 95 percent have attained maturity by the time they become 6 years old. A large percentage of the male striped bass are mature at the time they become 2 years old, and probably close to 100 percent are mature by the time they become 3 years old. This difference in the age at maturity of male and female striped bass may well account for the small percentage of males in northern waters, for the time of the spawning season in the south coincides with the time of the spring coastal migration to the north, which is made up mainly of immature females. (See under migrations, p. 44.)

(7) The age and rate of growth have been studied by scale analysis and by the average sizes of different age groups. The scale method and its applicability to the striped bass is discussed in full. Striped bass are roughly 12 cm. long when they become 1 year old, 24 cm. when they become 2 years old, 38 cm. when they become 3 years old, and 45 cm. when they become 4 years old. Thereafter the annual increment in length is about 7–8 cm. up to the tenth year. The growth rate of striped bass in the summer months in 1937 was much greater just north of Cape Cod than it was slightly south of Cape Cod. The growth rate of 2-year-old striped bass in Connecticut waters was approximately the same from June through October 1937, and increased in September and October 1936, despite the drop in water temperature. This maintenance of or increase in the growth rate in the fall was probably due to increased food supply at this time. The growth and availability of juvenile silversides (*Menidia menidia notata*) are shown to be of direct consequence in this relation. The members of the 1934 dominant year-class averaged 2 cm. smaller than the members of the 1933 and 1935 year-classes, neither of which were large, at similar ages. This difference in size developed before these fish became 2 years old.

(8) A total of 3,937 striped bass have been marked by either external disc tags or internal belly tags. Returns from these tagged fish, and the examination of commercial catch records, show that there is a mass migration to the north in the spring and to the south in the fall, and that the population in northern waters is stationary in the summer. These migrations have their greatest intensity along the southern New England and Long Island shores. They take place chiefly between Massachusetts and Virginia, although bass north and south of these areas play some part in the migrations. The Middle Atlantic Bight is undoubtedly the center of abundance for the striped bass over its entire range, and tagging experiments indicate that there is little encroachment by this stock on the populations to the north and south. Temperature undoubtedly plays some part in the migrations, for in Connecticut waters they have been observed to occur on each occasion when the water reached 7°–8° C. The migrations of the striped bass, however, are not universal, for this species is caught through the summer in southern waters and in northern waters in the winter. Those fish that stay north

in the winter often become dormant and inactive. The evidence is strong that the maximum tolerance limit for the species is 25°–26° C., which is about as high a temperature as coastal waters ever reach in the North and Middle Atlantic. Coastal migrations are not undertaken by bass less than 2 years old. Tagging experiments conducted in North Carolina in the springs of 1937 and 1938 tend to show that bass from this region contribute directly only a small percentage to the population summering in northern waters.

(9) The available evidence from general observation and scale analysis points to the conclusion that the dominant 1934 year-class originated chiefly in the latitude of Chesapeake and Delaware Bays, and confirms the results of the tagging experiments in North Carolina in the springs of 1937 and 1938 mentioned above.

(10) Stomach-content analyses on over 550 striped bass from northern waters, and on over 100 individuals from the south, show that bass are general in their choice of food—a large variety of fishes and crustacea forming the most common diet.

(11) Various nematodes and copepods have been found parasitic on the striped bass, and a number of trematodes, cestodes, and acanthocephalans have also been listed by other authors. Glochidia were found on small juveniles from the western end of Albemarle Sound. Several of the parasites listed constitute new host records. None of these parasites are of any great consequence to the general well-being of the striped bass population. A high percentage of bass in the Thames River, Conn., were found to have bilateral cataract. It is suggested that this is the result of a dietary deficiency.

(12) The decline in abundance of the striped bass of the Atlantic coast over long-term periods and its causes are discussed, and it is pointed out that the present practice of taking such a large proportion of the 2-year-olds annually is apparently not an efficient utilization of the supply, and that both the fishery and the stock should benefit by protecting this species until it is 3 years old, at which time it is approximately 41 cm. (16 inches) long to the fork of the tail and weighs 1¾ to 2 pounds. The adoption of such experimental measures designed to protect striped bass up to the time they become 3 years old should result in a greater profit for the commercial fishermen, an increased supply of larger fish for the sportsmen, and an added number of individuals that reach maturity, some of which may possibly spawn in northern waters and thus replenish the stocks in these areas where in many instances the populations have been exhausted. The need for further studies on the striped bass is emphasized in order that the results of the recommendation, if adopted, may be traced, so that suitable revision of the size limit may be made if the results indicate that modifications would be desirable, and in order to amplify the results of the present investigation.

TABLE 3.—*Record of striped bass taken by members of Cuttyhunk Club, Cuttyhunk, Mass., 1865–1907*

Year	Number of fish	Average weight	Largest fish	Year	Number of fish	Average weight	Largest fish
1865	1,174	----------	28	1887	235	12	42
1866	659	6.75	24.50	1888	29	16.50	56
1867	906	6.25	55	1889	4	22.50	41
1868	942	6.75	57	1890	154	14	41.50
1869	887	6.50	48	1891	43	11.75	24.25
1870	615	7.25	47	1892	18	16.50	38.50
1871	804	8.50	42	1893	39	16.25	35.50
1872	681	8	39	1894	80	9	35.25
1873	592	6.75	37	1895	21	17.25	36.75
1874	500	8.25	55	1896	25	14.25	27
1875	724	9.25	50.25	1897	69	11.25	33.50
1876	835	7	61	1898	45	9	23.75
1877	321	10.25	51.50	1899	21	13	35
1878	648	8.25	51	1900	14	18	54
1879	499	9.75	49	1901	13	14	29
1880	403	9	50.25	1902	2	17	26
1881	184	9.25	44	1903	4	10.75	15.75
1882	200	10.25	64	1904	5	15	35
1883	154	8.25	31.75	1905	7	16	40
1884	124	9	43	1906	1	9.25	9.25
1885	46	9	29.50	1907	5	19	23.50
1886	3	22	27.25				

NOTE.—See fig. 3.

TABLE 4.—*Number of striped bass taken each year in pound-nets at Fort Pond Bay, Long Island, N. Y., 1884–1937*

Date	Number of striped bass	Number of pound-nets in operation	Date	Number of striped bass	Number of pound-nets in operation
1884	3,630	6	1911	221	9
1885	1,872	6	1912	702	9
1886	4,354	6	1913	378	9
1887	2,688	6	1914	1,579	10
1888	2,046	6	1915	236	10
1889	915	6	1916	804	9
1890	720	7	1917	197	8
1891	636	7	1918	1,310	7
1892	455	7	1919	157	7
1893	1,953	7	1920	463	7
1894	3,643	8	1921	240	7
1895	3,689	8	1922	1,976	7
1896	35	9	1923	401	7
1897	895	9	1924	878	7
1898	708	9	1925	389	7
1899	189	9	1926	321	7
1900	1,551	9	1927	121	7
1901	1,310	9	1928	184	6 ?
1902	348	9	1929	100	8–12
1903	1,107	9	1930	325	8–12
1904	219	9	1931	500	8–12
1905	64	9	1932	35	8–12
1906	3,374	9	1933	50	8–12
1907	926	9	1934	100	8–12
1908	425	9	1935	400	8–12
1909	300	9	1936	15,600	12
1910	496	9	1937	4,200	12

NOTE.—See figs. 4 and 24.

TABLE 5.—*Length-frequency distribution of striped bass making up the random samplings of the commercial catch in Cape Cod Bay, at Newport, R. I., and at Montauk, Long Island, N. Y., in 1937*

Length (cm.)	Number of individuals			Length (cm.)	Number of individuals		
	Cape Cod Bay	Newport, R. I.	Montauk, Long Island, N. Y.		Cape Cod Bay	Newport, R. I.	Montauk, Long Island, N. Y.
20	1			57	4		
22	1			58	2	3	
28	1			59	3	1	1
32			1	60	2		
34	1			61	4		
35	2		1	62	3	1	
36	6		2	63	2	1	
37	3		5	64	2		
38	16	2	9	65	3		
39	22	1	12	66	2		
40	17	4	24	67	3		
41	31	8	21	68	2		
42	21	22	40	70	2		
43	21	28	56	71	1		
44	19	29	61	73	2		
45	19	44	34	77	1		
46	17	39	39	78	1		
47	20	44	26	80	1		
48	12	25	31	81	1		
49	23	21	12	84	1		
50	16	17	18	90	2		
51	15	14	6	96	1		
52	11	24	6	102			1
53	9	21	4	108	2		
54	7	12	2				
55	5	7		Total	366	378	413
56	3	10	1				

NOTE.—See fig. 5 for length-frequency curves smoothed by threes made up from this material.

TABLE 6.—*Total catch of striped bass by seine at Point Judith, R. I., 1928–37*

Date	Number	Pounds	Number of days fishing (equalizing factor)	Average weight (pounds)	Date	Number	Pounds	Number of days fishing (equalizing factor)	Average weight (pounds)
1928	225	1,925	19 (×4.4)	8.5	1933	1,513	9,625	66 (×1.3)	6.2
1929	1,050	5,700	83 (×1.0)	5.4	1934	234	1,300	31 (×2.7)	5.5
1930	600	4,825	70 (×1.2)	8.0	1935	1,250	7,000	58 (×1.4)	5.6
1931	775	5,200	48 (×1.7)	6.6	1936	7,500	18,000	49 (×1.7)	2.4
1932	1,375	8,800	60 (×1.4)	6.4	1937	4,500	12,000	44 (×1.8)	2.7

NOTE.—See figs. 6 and 7.

TABLE 7.—*Length-frequency distribution of juvenile striped bass from the Hudson River, July 3–Sept. 1, 1936*

Length (mm.)	Number of individuals at each millimeter	Length (mm.)	Number of individuals at each millimeter	Length (mm.)	Number of individuals at each millimeter	Length (mm.)	Number of individuals at each millimeter
20	1	49	16	70	18	91	2
		50	14	71	12	92	1
30		51	16	72	11	93	3
31		52	23	73	10	94	
32		53	15	74	12	95	4
33	1	54	17	75	7	96	
34	1	55	19	76	5	97	1
35	2	56	22	77	13	98	
36	4	57	18	78	7	99	
37	2	58	17	79	11	100	
38		59	19	80	8	101	
39	2	60	28	81	5	102	1
40	2	61	17	82	8	103	
41	4	62	17	83	6	104	1
42	8	63	19	84	5	105	1
43	7	64	13	85	1	106	
44	8	65	10	86	3	107	1
45	10	66	17	87	6		
46	15	67	10	88	8	Total	628
47	10	68	18	89	4		
48	16	69	12	90	3		

NOTE.—See fig. 10 for length-frequency curve of this material smoothed by threes.

TABLE 8.—*Length-frequency distribution of juvenile and yearling striped bass taken in the Delaware River, near Pennsville, N. J., Nov. 8, 1937*

Length (cm.)	Number of individuals
10	1
11	4
12	4
13	3
14	5
15	6
16	6
17	13
18	19
19	4
20	11
21	11
22	10
23	4
24	2
25	1
Total	104

NOTE.—See fig. 11 for length-frequency curve of this material smoothed by threes.

TABLE 9.—*Length-frequency distribution of juvenile striped bass taken in Albemarle Sound, N. C., on May 11, 1938*

Length (mm.)	Number of individuals
20	1
21	1
22	3
23	7
24	10
25	9
26	12
27	21
28	12
29	9
Total	85

NOTE.—See fig. 14 for length-frequency curves of this material smoothed by threes.

TABLE 10.—*Age at maturity of 109 female striped bass of known length*

Centimeters	2-year-olds (number of fish)		3-year-olds (number of fish)		4-year-olds (number of fish)		5-year-olds (number of fish)		6-year-olds and over (number of fish)	
	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature	Immature	Mature
28	1									
31	2									
32	1									
33	2									
34	2									
35	3									
36	1									
37	2									
38	3									
39	1		1							
40	2		2							
41	1		1							
42	1		2							
43			2	1						
44				1						
45			3							
46			2	1						
47				2	3					
48					2					
49						3				
50			1		1	6				
51					2	3				
52						5				
53					1	7		1		
55						1		1		
56								1		
57							1	5		
58								1		
59								1		
60								1		
61								2		
62								1		1
63										1
65										1
66										2
67										1
68										1
69										1
72										1
74										1
76										1
78										2
83										4
97										1
113										1
Total	22		14	5	9	25	1	14		19
	100%			26.6%		73.5%		93.3%		100%

NOTE.—Those individuals were listed as mature if their ova had attained sufficient size to indicate that spawning would occur the following season. See text (p. 21).

TABLE 11.—*Length-frequency distribution of all striped bass measured in Connecticut waters from April through October, 1936 and 1937*

Length (cm.)	Number of individuals		Length (cm.)	Number of individuals		Length (cm.)	Number of individuals	
	1936	1937		1936	1937		1936	1937
23	3		49	11	16	75	3	
24	4		50	13	17	76	4	
25	8		51	12	9	77	3	3
26	16	1	52	5	6	78	1	
27	21	2	53	7	7	79	1	
28	43	6	54	11	7	80		
29	61	22	55	5	8	81	2	
30	83	50	56	7	6	82	3	
31	121	62	57	8	5	83	1	
32	138	85	58	6	2	84	2	
33	190	127	59	7	2	85	2	
34	174	111	60	9		86	1	
35	198	111	61	5	2	87		
36	162	118	62	2		88	2	
37	136	102	63	6	2	89		
38	81	100	64	4	2	90	1	
39	35	81	65	5	1	91	2	
40	53	72	66	10	2	92		2
41	35	70	67	6		93	1	
42	35	57	68	7		94		
43	28	43	69	6		95	1	
44	16	40	70	4		96		
45	27	30	71	4		97	1	
46	15	25	72	4	1			
47	25	24	73	4		Total	1,933	1,460
48	23	20	74	3	1			

NOTE.—See fig. 17 for length-frequency curves of this material smoothed by threes.

TABLE 12.—*Length-frequency distribution of 2- and 3-year-old striped bass seined in Connecticut waters during 1936 and 1937, grouped by months*

Length in centimeters	Number of Individuals																			
	2-year-olds, 1936					3-year-olds, 1936					2-year-olds, 1937					3-year-olds, 1937				
	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
25		1																		
26	1	6									1									
27	9	8									2									
28	15	12	1	1							4	2								
29	11	17	6	7							16	2	2							
30	20	23	10	9	1						25	11	4							
31	12	25	27	25							22	14	11	1						
32	10	17	23	44	6						26	21	17	1		1				
33	10	15	34	68	7						23	22	32	2	6	1	3			
34	9	4	19	69	18						9	21	22	7	6	6	5			
35	8	3	26	80	17						11	21	24	8	5	11	5			
36	5	4	8	54	24	1					6	17	24	14	11	5	4	2	2	1
37	2	4	10	35	38	2	1				7	9	32	11	9	12	5	2	3	1
38	1	1	6	16	24	5					2	6	13	13	15	16	7	1	4	
39	2	1	4	7	26	4	2					3	11	7	14	14	5	3	4	
40	1	3	7	7	8	12	2	1			1	3	8	7	16	6	7	1	6	3
41			11	8	6	4	1					1	3	3	12	10	7	6	10	4
42		1	4	7	10	6	1	1			1	1	2		6	8	10	8	10	2
43			3	4	4		1	5	2			2	1		11	6	7	2	3	5
44			1	4		1	1	3					2	1	2	7	5	2	5	11
45			1	3	3	2	1	6							2	1	8	1	2	11
46				3		2		2							1	4	7	2	3	4
47							1	7	4	1					2		6	1	4	6
48							1	5	2	4							6		3	7
49								2	1								2	1	3	9
50								1		1							3	1	2	5
51																			1	3
52								1	1	1										2
53																			1	3
54										1										
55																				4
56																				3
57																				4
Total	116	145	201	451	192	39	12	34	10	8	156	156	208	75	118	108	102	33	66	88

NOTE.—See fig. 18 for length-frequency curves smoothed by threes to show growth from June to October each year.

TABLE 13.—*Length-frequency distribution of 2- and 3-year old striped bass taken north and south of Cape Cod, June to September 1937*

Length (cm.)	2-year-olds (number of individuals)		Length (cm.)	3-year-olds (number of individuals)	
	North of Cape Cod	South of Cape Cod		North of Cape Cod	South of Cape Cod
25			30		
26			31		
27			32		1
28			33		6
29	1		34		7
30		4	35		7
31	1	8	36	2	12
32	3	6	37		8
33	3	13	38	3	11
34	1	7	39	4	14
35	2	8	40	9	10
36	5	8	41	16	10
37		3	42	7	6
38	9	4	43	15	8
39	9	2	44	14	7
40	17	1	45	28	3
41	8		46	3	3
42	9	1	47	22	4
43	9	1	48	11	3
44	4		49	11	1
45	6		50	19	3
46			51	4	
47	1		52	4	
48			53	11	
49			54	8	
50			55	5	
			56	1	
Total	88	66	57	5	
			58	2	
			59	1	
			60		
			Total	205	124

NOTE.—See fig. 19 for length-frequency curves of this material smoothed by threes.

TABLE 14.—*Average lengths of striped bass at the time they become 1 year old, 2 years old, etc., to 9 years old*

Age	Average length		Age	Average length	
	Centimeters	Inches		Centimeters	Inches
1 year old	12.5	4.92	6 years old	61.0	24.02
2 years old	23.5	9.25	7 years old	68.5	26.97
3 years old	36.5	14.37	8 years old	75.0	29.53
4 years old	45.0	17.72	9 years old	82.0	32.28
5 years old	53.0	20.87			

NOTE.—See fig. 20.

TABLE 15.—*Original measurements of the radii of scales from 153 striped bass of measured length from 10.5–67 centimeters long*

Length (cm.)	Scale radius (mm.)	Length (cm.)	Scale radius (mm.)
10.5	1.22.	32.0	3.76.
11.0	1.37, 1.37.	32.5	4.16, 4.56.
11.5	1.52, 1.59.	33.0	4.12.
12.5	1.95, 1.59.	34.5	4.48, 4.30, 4.19, 4.09, 4.02.
13.5	1.81.	35.0	4.05, 4.26, 4.48, 4.26.
14.5	1.79, 1.70, 1.86.	35.5	4.38, 4.26, 5.03, 4.84, 4.48.
15.0	1.92, 1.85.	36.0	4.55, 4.84, 4.34.
15.5	2.02, 2.09.	36.5	4.52, 4.56, 4.30.
16.0	1.95.	37.0	5.10, 4.78, 4.38.
16.5	2.09, 2.24, 2.24.	37.5	4.67, 4.41, 4.56.
17.5	2.24, 2.09.	38.0	4.84, 4.84, 4.91, 4.39, 4.70, 6.06.
18.0	2.24, 2.39, 2.31, 2.09, 2.24, 2.37, 2.31.	39.6	4.88, 4.42, 5.27.
		40.0	5.24, 5.24.
18.5	2.24, 2.53, 2.46.	40.5	5.20, 5.24, 4.91.
19.5	2.35, 2.35.	41.0	5.35, 4.70, 4.91.
20.0	2.60, 2.39, 2.53.	42.0	5.13, 5.49, 5.28.
20.5	2.65, 2.67, 2.53.	43.0	5.67.
21.0	2.89, 2.74, 2.43, 2.67.	43.5	5.56, 6.11.
21.5	2.67, 2.69, 2.77, 3.10.	45.0	5.75.
22.0	3.03, 2.82.	45.5	6.43.
22.5	2.89.	46.0	6.18.
23.0	2.70, 2.86.	46.5	5.99.
24.0	3.14.	47.0	5.71.
24.5	3.40.	47.5	6.40, 6.00, 6.43.
25.0	3.03.	48.0	6.40, 6.28, 5.85.
26.0	3.62.	48.5	6.35.
26.5	3.36.	50.0	6.57, 6.36, 6.71.
27.0	3.32, 3.58.	51.0	6.07, 6.14.
27.5	3.83.	52.0	6.36.
28.0	3.99.	53.5	7.00.
29.0	3.90, 3.69.	54.0	6.79.
29.5	3.52, 4.12.	55.0	6.93.
30.0	3.62.	62.0	7.87.
30.5	4.12, 4.12.	63.0	8.73.
31.0	4.19, 3.83.	67.0	9.17.
31.5	4.19, 4.34, 4.56, 4.05.		

NOTE.—See fig. 21 for graph of relationship of scale growth to body growth in the striped bass, plotted from data in this table

TABLE 16.—*Annual increment in the length of the striped bass*

Age	Increment	
	Centimeters	Inches
First year	12.5	4.92
Second year	11.0	4.33
Third year	13.0	5.12
Fourth year	8.5	3.35
Fifth year	8.0	3.15
Sixth year	8.0	3.15
Seventh year	7.5	2.95
Eighth year	6.5	2.56

NOTE.—See fig. 22.

TABLE 17.—*Returns from 1,397 striped bass tagged in Connecticut, Apr. 23 to Oct. 27, 1936*

Date of return	Total number tagged by the end of each month	Original point of release	Number of returns each month	Locality of recapture	Total number of returns each month
May 1936	121	Niantic River, Conn	2	Niantic River, Conn	
		do	2	Thames River, Conn	
		do	6	Point Judith, R. I	
		do	2	Newport, R. I	12
June 1936	331	do	17	Niantic River, Conn	
		do	3	Thames River, Conn	20
July 1936	483	do	10	Niantic River, Conn	
		do	1	Thames River, Conn	11
August 1936	792	do	3	Niantic River, Conn	
		Thames River, Conn	2	Thames River, Conn	5
September 1936	1, 217	Niantic River, Conn	70	Niantic River, Conn	
		Thames River, Conn	3	Thames River, Conn	73
October 1936	1, 397	Niantic River, Conn	30	Niantic River, Conn	
		Thames River, Conn	2	do	
		do	1	Thames River, Conn	
		Niantic and Thames Rivers, Conn.	34	Montauk, Long Island, N. Y	
			10	South shore of Long Island, N. Y	77
November 1936	1, 397	Niantic River, Conn	4	Niantic River, Conn	
		Thames River, Conn	4	do	
		Niantic and Thames Rivers, Conn.	59	Montauk, Long Island, N. Y	
			7	South shore Long Island, N. Y	74
December 1936	1, 397	do	1	Manasquan River, N. J	
			1	Bradley Beach, N. J	
			2	Rehoboth Beach, Del	
			2	Cape Charles, Va	
			1	Manns Harbor, N. C	7
January 1937	1, 397	do	3	Toms River, N. J	
			1	Columbia, N. C	
			1	Manns Harbor, N. C	5
February 1937	1, 397	do	2	Toms River, N. J	
			1	Rehoboth Beach, Del	3
March 1937	1, 397	Niantic River, Conn	1	Wicomico River, Md	1
April 1937	1, 397	do	2	Niantic River, Conn	
		do	1	Hudson River, N. Y	
		Thames River, Conn	1	Oyster Bay, Long Island, N. Y	4
May 1937	1, 397	Niantic River, Conn	8	Niantic River, Conn	
		do	1	Thames River, Conn	
		do	1	Wye River, Md	
		do	1	Cape Charles, Va	
		Thames River, Conn	5	Niantic River, Conn	
		do	1	Thames River, Conn	
		do	1	Connecticut River, Conn	18
June 1937	1, 397	Niantic River, Conn	12	Niantic River, Conn	
		Thames River, Conn	3	Thames River, Conn	
		do	1	Niantic River, Conn	16
July 1937	1, 397	Niantic River, Conn	5	do	
		Thames River, Conn	1	Thames River, Conn	6
August 1937	1, 397	Niantic River, Conn	1	Niantic River, Conn	
		do	1	Thames River, Conn	2
September 1937	1, 397	do	1	do	
		Thames River, Conn	1	do	2
May 1938	1, 397	Niantic River, Conn	1	Hudson River, N. Y	1
Total recaptures.					337
Total percentage recaptured.					24. 1

TABLE 18.—*Returns from 103 striped bass tagged and released at Fort Pond Bay, Montauk, Long Island, N. Y., May 15–19, 1937*

Date of return	Number of returns each month	Locality of recapture	Total number of returns each month
May 1937	1	Montauk, Long Island, N. Y.	
	1	Shelter Island, Long Island, N. Y.	
	1	Point Judith, R. I.	3
June 1937	1	Connecticut River, Conn.	1
July 1937	2	Peconic Bay, Long Island, N. Y.	
	1	Oyster Bay, Long Island, N. Y.	3
August 1937	1	Montauk, Long Island, N. Y.	
	1	Peconic Bay, Long Island, N. Y.	
	1	Smithtown, Long Island, N. Y.	
	1	Cohasset, Mass.	
	1	Cape Cod Bay, Mass.	5
October 1937	1	Narragansett Pier, R. I.	1
May 1938	1	Connecticut River, Conn.	1
Total recaptures			14
Total percentage recaptured.			13.6

TABLE 19.—*Returns from 303 striped bass tagged and released at Fort Pond Bay, Montauk, L. I., N. Y., Oct. 25, 26, and 27, 1937*

Date of return	Number of returns each month	Locality of recapture	Total number of returns each month
October 1937	2	Gardiners Bay, Long Island, N. Y.	
	23	Montauk, Long Island, N. Y.	25
November 1937	1	Gardiners Bay, Long Island, N. Y.	
	5	Montauk, Long Island, N. Y.	
	27	South shore of Long Island, N. Y.	
	1	Monmouth Beach, N. J.	
	1	Barnegat Bay, N. J.	35
December 1937	4	South shore of Long Island, N. Y.	
	1	Mullica River, N. J.	
	1	Indian River, Del.	
	1	Rappahannock River, Va.	
	1	Great Choptank River, Md.	
	1	Cape Charles, Va.	
	1	Croatan Sound, N. C.	
	1	Stumpy Point, N. C.	
	1	Pamlico Sound, N. C.	12
January 1938	1	Barnegat Bay, N. J.	
	1	Mullica River, N. J.	
	1	Egg Harbor, N. J.	
	1	Synapuxent Bay, Md.	4
February 1938	3	South shore of Long Island, N. Y.	
	1	Barnegat Bay, N. J.	
	1	Great Egg Harbor River, N. J.	
	1	Rappahannock River, Va.	6
March 1938	2	Hudson River, N. J.	
	2	Barnegat Bay, N. J.	
	1	Great Egg Harbor River, N. J.	
	2	Rappahannock River, Va.	
	1	New Point, Va.	
	1	Kitty Hawk, N. C.	9
April 1938	1	Great Bay, N. J.	
	1	York River, Va.	
	1	Potomac River, Va.	
	1	Rappahannock River, Va.	4
May 1938	1	Plymouth, Mass.	
	1	Point Judith, R. I.	
	1	Asbury Park, N. J.	3
June 1938	1	Oak Bluffs, Mass.	
	1	Chatham, Mass.	2
Total recaptures			100
Total percentage recaptured.			33.0

TABLE 20.—*Returns from 770 striped bass tagged in Connecticut, Apr. 19–Oct. 30, 1937*

Date of return	Total number tagged by the end of each month	Original point of release	Number of returns each month	Locality of recapture	Total number of returns each month
June 1937	182	Niantic River, Conn	3	Niantic River, Conn	
		do	1	Thames River, Conn	4
July 1937	434	do	4	Niantic River, Conn	
		Thames River, Conn	11	Thames River, Conn	15
August 1937	614	Niantic River, Conn	9	Niantic River, Conn	
		Thames River, Conn	2	Thames River, Conn	
		do	2	Harkness Point, Conn	13
September 1937	628	Niantic River, Conn	2	Niantic River, Conn	
		do	1	Harkness Point, Conn	
		Thames River, Conn	1	New London Light, Conn	
		do	2	Harkness Point, Conn	
		do	1	Milford, Conn	7
October 1937	770	Niantic River, Conn	11	Niantic River, Conn	
		do	1	Harkness Point, Conn	
		do	1	Gardiners Bay, Long Island, N. Y	
		do	1	Montauk, Long Island, N. Y	
		do	1	South shore of Long Island, N. Y	
		Thames River, Conn	4	Niantic River, Conn	
		do	1	Harkness Point, Conn	
		do	1	Montauk, Long Island, N. Y	21
November 1937	770	Niantic River, Conn	1	Niantic River, Conn	
		do	1	South shore of Long Island, N. Y	
		Thames River, Conn	3	Gardiners Bay, Long Island, N. Y	
		do	4	South shore of Long Island, N. Y	9
December 1937	770	Niantic River, Conn	1	do	
		do	1	Hampton, Va	
		Thames River, Conn	1	Barnegat Bay, N. J	3
January 1938	770	Niantic River, Conn	1	South shore of Long Island, N. Y	
		do	1	Broadkill River, Del	2
March 1938	770	do	1	Delaware Bay, N. J	
		Thames River, Conn	1	Hudson River, N. Y	
		do	1	Toms River, N. J	3
April 1938	770	Niantic River, Conn	1	Delaware Bay, N. J	
		do	2	Niantic River, Conn	
		Thames River, Conn	2	do	5
May 1938	770	Niantic River, Conn	6	do	
		do	1	Connecticut River, Conn	
		Thames River, Conn	1	Niantic River, Conn	3
June 1938	770	Niantic River, Conn	3	do	8
Total recaptures					93
Total precentage recaptured					12.1

TABLE 21.—*Chemical analysis of the water at 2 stations in the Thames River, Conn., in the summer of 1937* [1]

Locality	Date	pH	Dissolved oxygen, parts per million	Chloride, parts per million	Sulfate, parts per million	Calcium, parts per million	Phosphates, parts per million
Off the submarine base, 1 mile above New London on the east side of the Thames River	June 2	7.70	7.76	13,350	1,834	316	0.30
	July 1	7.64	6.30	14,250	2,027	364	.52
	Sept. 15	7.59	5.11	15,350	2,176	254	.69
Off the State pier at New London, on the west side of the Thames River	June 2	7.82	8.80	15,100	2,133	314	.20
	July 1	7.74	7.10	15,600	2,279	346	.52
	Sept. 15	7.69	6.07	16,400	2,279	400	1.38

[1] These water analyses were supplied by the Connecticut State Water Commission. The samples were taken as catch samples, and therefore in no way represent a complete tidal cycle. The 2 localities listed above are both places where striped bass are commonly caught, and where a good number of bass were found dead in late August and early September 1937.

TABLE 22A.—*Returns from 52 striped bass tagged and released at extreme west end of Albemarle Sound, N. C., Mar. 26, Apr. 9, and 21, 1937*

Date of return	Number of returns each month	Locality of recapture	Total number of returns each month
March 1937	6	Mackeys, N. C	
	5	Edenton, N. C	
	1	Columbia, N. C	12
April 1937	1	Pasquotank River, N. C.	
	4	Mackeys, N. C	
	1	Edenton, N. C	
	1	Hertford, N. C	7
Total recaptures.			19
Total percentage recaptured.			36.5

TABLE 22B.—*Returns from 17 striped bass tagged and released off Coinjock, Currituck Sound, N. C., Mar. 27, 1937*

Date of return	Number of returns each month	Locality of recapture	Total number of returns each month
October 1937	1	Currituck Sound, N. C.	1
November 1937	1	Kitty Hawk, N. C	
	1	Currituck Sound, N. C.	2
December 1937	1	Currituck Sound, N. C.	1
Total recaptures.			4
Total percentage recaptured.			23.5

TABLE 22C.—*Returns from 8 striped bass tagged and released at Kitty Hawk, N. C. (outer coast), Apr. 29 and May 10, 1937*

Date of return	Number of returns each month	Locality of recapture	Total number of returns each month
January 1938	1	Pasquotank River, N. C	1
Total recaptures			1
Total percentage recaptured			12.5

TABLE 23.—*Original measurements of* Menidia menidia notata *to show growth of juveniles from July through September 1937 in the Niantic River, Conn.*

Standard length in millimeters	Number of individuals at each length				Standard length in millimeters	Number of individuals at each length			
	July 17	Aug. 2	Aug. 17	Sept. 2		July 17	Aug. 2	Aug. 17	Sept. 2
5	2				24	5	7	11	24
6					25	16	3	10	20
7	1	1			26	9	6	5	16
8	7	2			27	3	2	7	21
9	13	5			28	4		2	10
10	22	10	1		29	5	2	1	3
11	23	13			30	6	1	1	3
12	29	13	1		31		1	1	2
13	21	19	2		32	1	1		
14	14	22	6		33	2	1		3
15	5	22	17	1	34			1	2
16	3	16	16	2	35				2
17	2	16	16		36				
18	1	10	29	1	37				2
19		3	20	5	38				
20		8	17	8	39				1
21		5	11	18					
22	1	8	12	27	Total	200	200	200	197
23	5	3	13	26					

NOTE.—See fig. 36 for length-frequency curves of this material smoothed by threes.

LITERATURE CITED

BEAN, T. H.

1884. On the occurrence of the striped bass in the Lower Mississippi Valley. Proc. U. S. Nat. Mus., vol. 7, pp. 242–244. Washington.

BIGELOW, H. B. and W. W. WELSH.

1925. Fishes of the Gulf of Maine. Bull. U. S. Bur. Fish., vol. XL, pt. I, 1924 (1925), pp. 201, 251–256. Washington.

CAULKINS, F. M.

1852. History of New London, Connecticut. p. 610. Published by the author, New London, Conn.

CLARK, G. H.

1932. The striped bass supply, past and present. Calif. Fish and Game, vol. 18, No. 4, pp. 297–298. Sacramento.

1933. Fluctuations in the abundance of striped bass (*Roccus lineatus*) in California. Div. Fish and Game Calif., Fish Bull., vol. 39, pp. 1–18. Sacramento.

1936. A second report on striped bass tagging. Calif. Fish and Game, vol. 22, No. 4, pp. 272–283. Sacramento.

1938. Weight and age determination of striped bass. Calif. Fish and Game, vol. 24, No. 2, pp. 176–177. Sacramento.

COLEMAN, G. A. and N. B. SCOFIELD.

1910. Notes on spawning and hatching of striped bass eggs at Bouldin Island Hatchery. 21st Bienn. Rept., Calif. Board of Fish and Game Comm., 1909–1910, p. 109. Sacramento.

CRAIG, J. A.

1930. An analysis of the catch statistics of the striped bass (*Roccus lineatus*) fishery of California. Div. Fish and Game Calif., Fish Bull. No. 24, pp. 1–41. Sacramento.

CREASER, C. W.

1926. The structure and growth of the scales of fishes in relation to the interpretation of their life-history, with special reference to the sunfish *Eupomotis gibbosus*. Mus. of Zool., Univ. of Mich., Misc. Pub. No. 17, pp. 1–80. Ann Arbor.

CURRAN, H. W. and D. T. RIES.

1937. Fisheries investigations in the Lower Hudson River. Biological Survey (1936) No. XI, pp. 124–128. State of N. Y. Cons. Dept. J. B. Lyon Co. Albany.

DAHL, K.

1907. The scales of the herring as a means of determining age, growth and migration. Rept. Norweg. Fish. and Mar. Inv., vol. 2, pt. 2, No. 6. 36 pp.

GOODE, G. B. and associates.

1884. The fisheries and fishery industries of the United States, vol. 1, Sec. III, pp. 425–428. Washington.

GOWANLOCH, J. N.

1933. Fishes and fishing in Louisiana. State of La. Dept. of Cons., Bull. No. 23, pp. 208–213. New Orleans.

GRAHAM, M.

1935. Modern theory of exploiting a fishery, etc. Jour. du Conseil Internat. pour l'Exploration de la Mer, vol. 10, No. 3, pp. 264–274.

HERRINGTON, W. C.

1935. Modifications in gear to curtail the destruction of undersized fish in otter trawling. U. S. Bur. Fish., Inv. Rept. No. 24., vol. 1, 48 pp. Washington.

HESS, W. N.

1937. Production of nutritional cataract in trout. Proc. Soc. Exp. Biol. and Med., vol. 37, pp. 306–309.

HILDEBRAND, S. F.

1922. Notes on habits and development of eggs and larvae of the silversides, *Menidia menidia* and *Menidia beryllina*. Bull. U. S. Bur. Fish., vol. XXXVIII (Doc. No. 918), pp. 113–120. Washington.

——— and W. C. SCHROEDER.

1928. Fishes of Chesapeake Bay. Bull. U. S. Bur. Fish., vol. XLIII, pt. 1, 1927, pp. 247–250. Washington.

HUBBS, C. L.

1922. Variations in the number of vertebrae and other meristic characters of fishes correlated with the temperature of water during development. Am. Nat., vol. 56, pt. 645, pp. 360–372.

——— and R. M. BAILEY.

1938. The small-mouthed bass. Cranbrook Institute of Science, Bull. No. 10, pp. 1–92.

JAHN, T. L. and L. R. KUHN.
1932. The life history of *Epibdella melleni* MacCallum, 1927, a monogenetic trematode parasitic on marine fishes. Biol. Bull., vol. 62, pp. 89–111.

JENSEN, A. J. C.
1932. The effect of the plaice fishery on the stock of undersized plaice and its influence on the yield of the plaice fishery in the North Sea. Rapp. et Proc. Verb. des Réunions (Cons. Perm. Internat. pour l'Exploration de la Mer), vol. 80.

JORDAN, D. S.
1884. Manual of the vertebrates of the Northern United States. p. 231. Jansen, McClurg and Co. Chicago.
1929. Manual of the vertebrate animals of the Northeastern United States. 13th Ed., p. 172. World Book Co. Yonkers-on-Hudson, N. Y.

——— and B. W. EVERMANN.
1905. American food and game fishes. pp. 373–375. Doubleday, Page and Co. New York.

———, B. W. EVERMANN and H. W. CLARK.
1930. Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. Rept. U. S. Comm. Fish., 1928, pt. 2, p. 307. Washington.

LEA, E.
1918. Report on the age and growth of the herring in Canadian waters. Canadian Fisheries Expedition, 1914–1915. Ottawa.

——— and A. E. WENT.
1936. Plastic copies of microscopical reliefs, especially of fish scales. Hvalrådets Skrifter, Nr. 13, pp. 1–18. Oslo.

LINTON, E.
1898. Notes on trematode parasites of fishes. Proc. U. S. Nat. Mus., vol. 20, pp. 507–548. Washington.
1901. Parasites of fishes of the Woods Hole region. Bull. U. S. Fish. Comm., vol. XIX, pp. 405–492. Washington.
1924. Notes on cestode parasites of sharks and skates. Proc. U. S. Nat. Mus., vol. 64, Art. 21, pp. 1–114. Washington.

MACCALLUM, G. A.
1921. Studies in helminthology. Pt. 3, Nematodes. Zoopathologica, vol. 1, No. 6, pp. 255–284.

MASON, H. W.
1882. Report of operations on the Navesink River, New Jersey, in 1879, in collecting living striped bass for transportation to California. Rept. U. S. Comm. Fish and Fish., 1879, pp. 663–666. Washington.

MASTERMAN, A. T.
1913. Report on investigations upon the salmon. Bd. of Agric. and Fish., Fish. Inv., vol. 1.

MERRIMAN, D.
1937a. Notes on the life history of the striped bass (*Roccus lineatus*). Copeia, No. 1, pp. 15–36. Ann Arbor.
1937b. Notes on the life history of the striped bass. Trans. Sec. N. Am. Wildlife Conf., pp. 639–648. American Wildlife Institute, Investment Bldg., Washington.
1938. A report of progress on the striped bass investigation along the Atlantic coast. Trans. 3d N. Am. Wildlife Conf., pp. 478–485. American Wildlife Institute, Investment Bldg., Washington.

MOORE, E., et al.
1937. A biological survey of the Lower Hudson Watershed. Biological Survey (1936), No. XI, pp. 16, 62, 76, 127–128, 225–226, and 260–261. State of N. Y. Cons. Dept. J. B. Lyon Co. Albany.

MUELLER, J. F.
1936. New gyrodactyloid trematodes from North American fishes. Trans. Am. Fish. Soc., vol. 55, pp. 457–464. Washington.

NESBIT, R. A.
1934a. A convenient method for preparing celluloid impressions of fish scales. Jour. du Conseil Internat. pour l'Exploration de la Mer, vol. 9, No. 3, pp. 373–376.
1934b. A new method of marking fish by means of internal tags. Trans. Am. Fish. Soc., vol. 63, pp. 306–307. Washington.

NIGRELLI, R. F. and C. M. BREDER.
1934. The susceptibility and immunity of certain marine fishes to *Epibdella melleni*, a monogenetic trematode. Jour. Parasitol., vol. 20, pp. 259–269.

NORNY, E. R.
1882. On the propagation of the striped bass. Bull. U. S. Fish Comm., vol. I, 1881, pp. 67–68. Washington.

PARR, A. E.
1933. A geographic-ecological analysis of the seasonal changes in temperature conditions in shallow water along the Atlantic coast of the United States. Bull. Bingham Oceanographic Collection, vol. 4, No. 3, pp. 1–90.
1937. On self-recognition and social reaction in relation to biomechanics, with a note on terminology. Ecology, vol. 18, No. 2, p. 321–323.

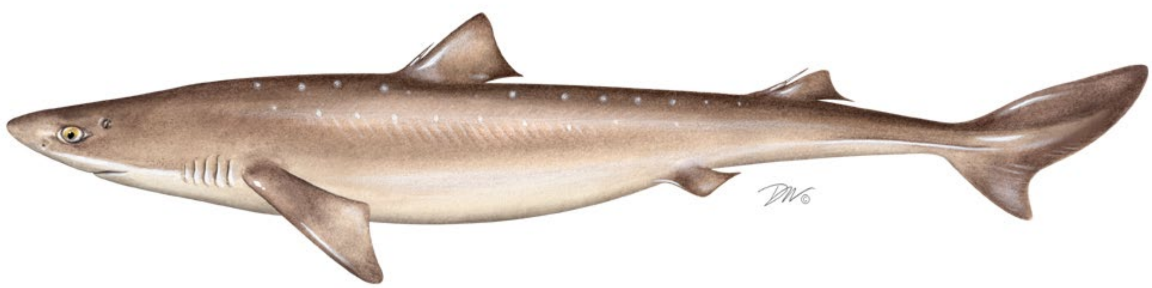
PEARSON, J. C.
1933. Movements of striped bass in Chesapeake Bay. Maryland Fisheries, No. 22, pp. 15–17.
1938. The life history of the striped bass, or rockfish, *Roccus saxatilis* (Walbaum). Bull. U. S. Bur. Fish., vol. XLIX, No. 28, pp. 825–851. Washington.

RAILLIET, A.
1918. Le genre *Dicheilonema* Diesing, 1861 (Nematoda, Filarioidea). Bull. Soc. Zool. de France, vol. 43, pp. 104–109.
RUSSELL, E. S.
1932. Fishery research: its contribution to ecology. The Journal of Ecology (edited for the British Ecological Society by A. G. Tansley), vol. 20, pp. 128–151.
SCHULTZ, L. P.
1931. Hermaphroditism in the striped bass. Copeia, No. 2, p. 64. Ann Arbor.
——— and A. D. WELANDER.
1935. A review of the cods of the Northeastern Pacific with comparative notes on related species. Copeia, No. 3, pp. 127–139. Ann Arbor.
SCOFIELD, E. C.
1931. The striped bass of California (*Roccus lineatus*). Div. Fish and Game Calif., Fish. Bull. No. 29, pp. 1–82. Sacramento.
SMITH, H. M.
1907. The fishes of North Carolina. N. Car. Geol. and Econ. Surv., vol. 2, pp. 271–273. Raleigh.
THOMPSON, W. F.
1937. Theory of the effect of fishing on the stock of halibut. Rept. Internat. Fish Comm., No. 12, pp. 1–22. Seattle.
——— and F. H. BELL.
1934. Biological statistics of the Pacific halibut fishery. (2) Effect of changes in intensity upon total yield and yield per unit of gear. Rept. Internat. Fish. Comm., No. 8, pp. 1–49. Seattle.
——— and W. C. HERRINGTON.
1930. Life history of the Pacific halibut. (1) Marking experiments. Rept. Internat. Fish. Comm., No. 2, pp. 1–137. Seattle.
THROCKMORTON, S. R.
1882. The introduction of striped bass into California. Bull. U. S. Fish Comm., vol. I (1881), pp. 61–62. Washington.
TOWNES, H. K., JR.
1937. Studies on the food organisms of fish. Biological Survey (1936), No. XI, pp. 225–226. State of N. Y. Cons. Dept. J. B. Lyon Co. Albany.
TRUITT, R. V. and V. D. VLADYKOV.
1937. Striped bass investigations in the Chesapeake Bay. Trans. Am. Fish. Soc., vol. 66 (1936), pp. 225–226.
VAN OOSTEN, J.
1929. Life history of the lake herring (*Leucichthys artedi* Le Sueur) of Lake Huron as revealed by its scales, with a critique of the scale method. Bull. U. S. Bur. Fish., vol. XLIV, 1928, pp. 265–428. Washington.
VLADYKOV, V. D. and D. H. WALLACE.
1938. Is the striped bass (*Roccus lineatus*) of Chesapeake Bay a migratory fish? Trans. Am. Fish. Soc., vol. 67 (1937), pp. 67–86.
WALFORD, LIONEL A.
1937. Marine game fishes of the Pacific coast from Alaska to the equator. Univ. of Calif. Press, pp. 93–97. Berkeley.
WATKIN, E. E.
1927. Investigations on Cardigan Bay herring. Rept. Mar. and Fresh Water Inv., vol. 2, pt. 5, Dept. Zool., Univ. Coll., Wales.
WILSON, C. B.
1903. North American parasitic copepods of the family *Argulidae*, etc. Proc. U. S. Nat. Mus., vol. 25, pp. 635–742. Washington.
1905. North American parasitic copepods belonging to the family *Caligidae*. Proc. U. S. Nat. Mus., vol. 28, pp. 479–672. Washington.
1911. North American parasitic copepods belonging to the family *Ergasilidae* Proc. U. S. Nat. Mus., vol. 39, pp. 263–400. Washington.
1915. North American parasitic copepods belonging to the *Lernaeopodidae*, with a revision of the entire family. Proc. U. S. Nat. Mus., vol. 47, pp. 565–729. Washington.
1932. The copepods of the Woods Hole region, Massachusetts. Bull. U. S. Nat. Mus., vol. 158, pp. 1–635. Washington.
WILSON, H. V.
1891. The embryology of the sea bass (*Serranus atrarius*). Bull. U. S. Fish Comm., vol. IX, 1889, pp. 209–277. Washington.
WOOD, W.
1635. New England's Prospect. Tho. Coates for John Bellamie, 83 pp. London.
WORTH, S. G.
1903. Striped bass hatching in North Carolina. Trans. Am. Fish. Soc., vol. 32 (1902), pp. 98–102.
1904. The recent hatching of striped bass, etc. Trans. Am. Fish. Soc., vol. 33 (1903), pp. 223–230.
1910. Progress in hatching striped bass. Trans. Am. Fish. Soc., vol. 39 (1909), pp. 155–159.
1912. Fresh-water angling grounds for the striped bass. Trans. Am. Fish. Soc. vol. 41 (1911), pp. 115–126.

Atlantic States Marine Fisheries Commission

DRAFT ADDENDUM VII TO THE SPINY DOGFISH INTERSTATE FISHERY MANAGEMENT PLAN FOR BOARD REVIEW

Commercial Management: Atlantic Sturgeon Bycatch



This draft document was developed for Board review and discussion at the October 2024 meeting week. This document is not intended to solicit public comment as part of the Commission/State formal public input process. However, comments on this draft document may be given at the appropriate time on the agenda during the scheduled meeting. Also, if approved, a public comment period will be established to solicit input on the issues contained in the document.

October 2024

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

Atlantic States Marine Fisheries Commission Seeks Your Input on
Spiny Dogfish Management

The public is encouraged to submit comments regarding this document during the public comment period. Comments will be accepted until 5:00 p.m. EST on **DAY, MONTH 2024**. Regardless of when they were sent, comments received after that time will not be included in the official record.

You may submit public comment in one or more of the following ways:

1. Attend public hearings pertinent to your state or jurisdiction.
2. Refer comments to your state's members on the Spiny Dogfish Board or Spiny Dogfish Advisory Panel, if applicable.
3. Mail, fax, or email written comments to the following address:

James Boyle
Fishery Management Plan Coordinator
Atlantic States Marine Fisheries Commission
1050 North Highland St., Suite 200 A-N
Arlington, VA 22201
Fax: (703) 842-0741
comments@asmfc.org (subject line: Spiny Dogfish Draft Addendum VII)

If you have any questions, please contact James Boyle at jbopyle@asmfc.org or 703.842.0740.

Commission's Process and Timeline	
August 2024	Spiny Dogfish Board Tasks Staff to Develop Draft Addendum VII
August – October 2024	Staff Develops Draft Addendum VII for Board Review
October 2024	**Spiny Dogfish Board Reviews Draft Addendum VII and Considers Its Approval for Public Comment**
November 2024 – January 2025	Board Solicits Public Comment and States Conduct Public Hearings
February 2025	Board Reviews Public Comment, Selects Management Options and Considers Final Approval of Addendum VII
TBD	Provisions of Addendum VII are Implemented

1. INTRODUCTION

The Atlantic States Marine Fisheries Commission (ASMFC) is responsible for managing spiny dogfish (*Squalus acanthias*) in state waters (0–3 miles from shore) under the authority of the Atlantic Coastal Fisheries Cooperative Management Act, and has done so through an interstate fishery management plan (FMP) since 2003. The states of Maine through North Carolina have a declared interest in the fishery and are responsible for implementing management measures consistent with the interstate FMP.

Spiny dogfish is managed in federal waters (3–200 miles from shore) through a joint FMP of the Mid-Atlantic Fishery Management Council (MAFMC) and the New England Fishery Management Council (NEFMC), with the MAFMFC taking the lead for federal management. These two councils make recommendations on management to the National Oceanographic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), which is responsible for implementing management based on the input from the two councils and per the requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

At its August 2024 meeting, ASMFC's Spiny Dogfish Management Board approved the following motion:

Move to initiate an addendum to maintain consistency between the Spiny Dogfish FMP and the recommended alternatives of Spiny Dogfish Framework Adjustment 6.

As a result, the Addendum proposes options to establish equivalent overnight soak restrictions proposed in Spiny Dogfish Framework Adjustment 6 for harvesters that possess state spiny dogfish permits but do not possess a federal spiny dogfish permit.

2. OVERVIEW

2.1 Statement of the Problem

In August 2024, NOAA Fisheries published a proposed rule (*Federal Register* notice 89 FR 65576; August 12, 2024) to approve and implement Spiny Dogfish Framework Adjustment 6, as recommended by the MAFMC and NEFMC. If approved, the rule would implement area-based gear requirements in the spiny dogfish gillnet fishery to reduce bycatch of Atlantic sturgeon for harvesters that possess a federal spiny dogfish permit. However, harvesters that do not possess a federal spiny dogfish permit and only fish in states waters would not be captured by the action. Because the specific areas proposed for additional management span state and federal waters, action is needed to implement corresponding measures for state-only permit holders to maintain consistency between the federal and interstate FMPs.

2.2 Background

2.2.1 Spiny Dogfish Framework Adjustment 6

The coastwide Atlantic sturgeon population is made up of five distinct population segments, all of which are listed as threatened or endangered under the Endangered Species Act (ESA). Section 9 of the ESA prohibits the take, including incidental, of endangered species, which is defined as "to harass, harm, pursue, hunt, shoot, capture, or collect, or to attempt to engage in any such conduct." However, exceptions may be granted to incidental take through an Incidental Take Statement (ITS) or an incidental take permit. An ITS provides the maximum permissible level of incidental take, reasonable and prudent measures to reduce takes, and other terms and conditions, all of which are required to maintain compliance with the ESA.

In response to a Biological Opinion from May 2021 that found potential adverse effects on Atlantic sturgeon through the authorization of several FMPs, including spiny dogfish, NOAA Fisheries developed an Action Plan with recommendations to reduce Atlantic sturgeon bycatch in federal large-mesh gillnet fisheries by 2024. The Councils used the Action Plan recommendations to develop Spiny Dogfish Framework Adjustment 6, which recommended prohibiting overnight gillnet soaks within certain spatial and temporal hotspots of sturgeon bycatch.

The hotspots were determined through observer bycatch data from 2017-2019 and 2021-2022, excluding 2020 due to low observer coverage. Three areas were identified to have the greatest incidence of interactions: one off of the coast of New Jersey (Figure 1) and two off the coasts of Delaware, Maryland and Virginia (Figure 2).

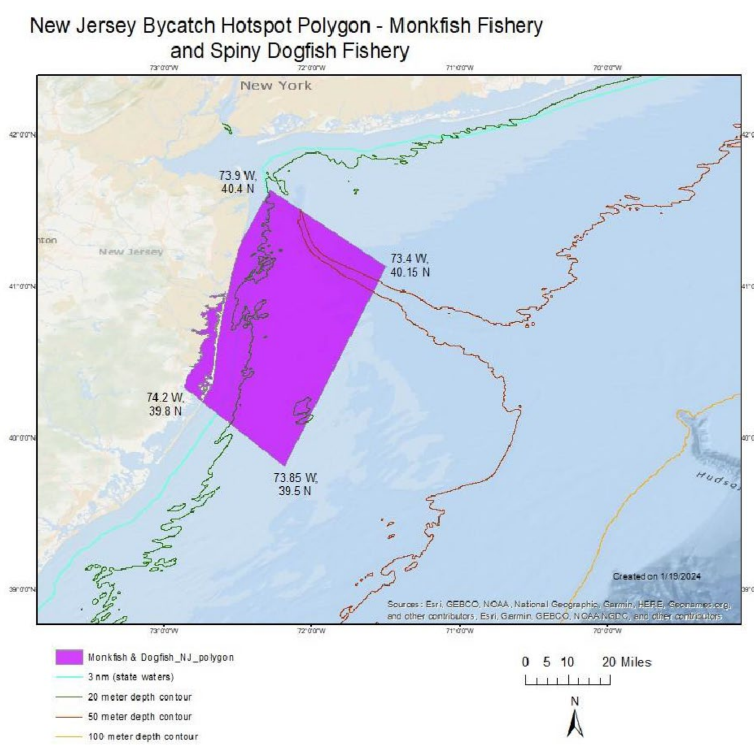


Figure 1. New Jersey Atlantic Sturgeon Bycatch Reduction Area from Spiny Dogfish Framework Adjustment 6.

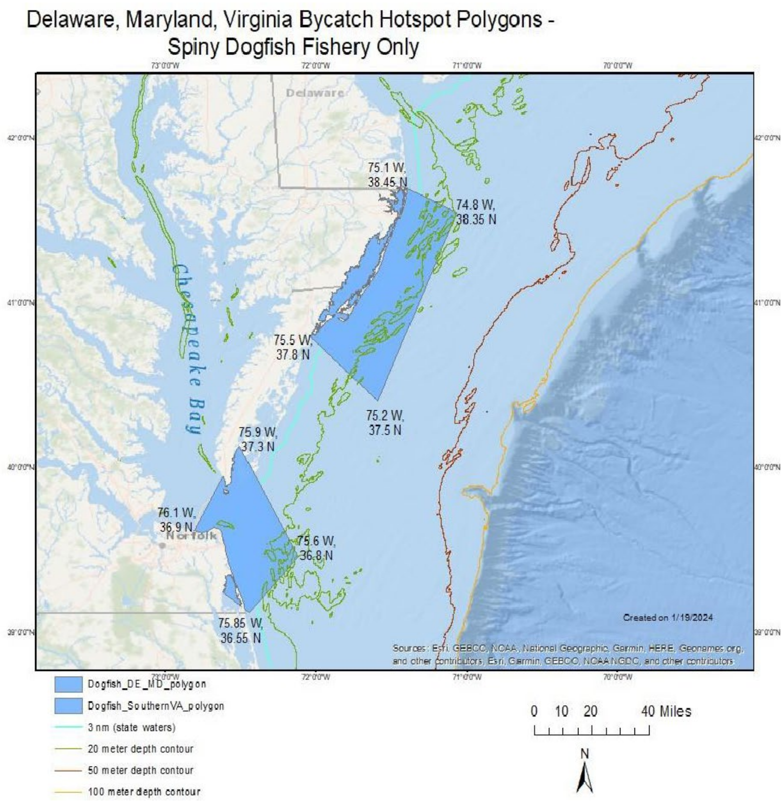


Figure 2. Delaware, Maryland, and Virginia Atlantic Sturgeon Bycatch Reduction Areas from Spiny Dogfish Framework Adjustment 6.

The New Jersey, Delaware and Maryland, and Virginia Atlantic Sturgeon Bycatch Reduction Areas would be delineated as all waters bounded by straight lines connecting the following coordinates in the order stated:

New Jersey Atlantic Sturgeon Bycatch Reduction Area	40°24′N, 73°54′ W
	40°9′N, 73°24′ W
	39°30′N, 73°51′ W
	39°48′N, 74°12′ W
	40°24′N, 73°54′ W
Delaware and Maryland Atlantic Sturgeon Bycatch Reduction Area	38°27′N, 75°60′ W
	38°21′N, 74°48′ W
	37°30′N, 75°12′ W
	37°48′N, 75°30′ W
	38°27′N, 75°60′ W
	37°18′N, 75°54′ W
	36°48′N, 75°36′ W

Virginia Atlantic Sturgeon Bycatch Reduction Area	36°33′N, 75°51′ W
	36°54′N, 76°6′ W
	37°18′N, 75°54′ W

Note that the Delaware and Maryland Atlantic Sturgeon Bycatch Reduction Area does not overlap with Delaware state waters.

New Jersey Atlantic Sturgeon Bycatch Reduction Area
Within the New Jersey Atlantic Sturgeon Bycatch Reduction Area, the NOAA Fisheries' proposed rule would require federally permitted spiny dogfish vessels using roundfish gillnets (i.e., not tie-down gillnets) with a mesh size between 5 and 10 inches (12.7 to 25.4 cm) to remove nets from the water by 8:00 p.m. Eastern Time (ET) each day until 5:00 a.m. ET the following day from May 1 through May 31 and November 1 through November 30 of each year.

Delaware, Maryland, and Virginia Atlantic Sturgeon Bycatch Reduction Areas
Within the Delaware and Maryland and the Virginia Atlantic Sturgeon Bycatch Reduction Areas, the NOAA Fisheries' proposed rule would require federally permitted spiny dogfish vessels using roundfish gillnets (i.e., not tie-down gillnets) with a mesh size between 5.25 and 10 inches (13.34 to 25.4 cm) would need to remove nets from the water by 8:00 p.m. ET each day until 5:00 a.m. ET the following day from November 1 through March 31 each year.

The proposed rule notes that implementation will occur 30 days after publication of the Final Rule, and the 2021 Biological Opinion requires bycatch reduction measures to be implemented before 2025.

2.2.2 State Permitting Approaches for Spiny Dogfish
Unlike federal management, states each use different permitting structures and some do not issue species-specific permits for spiny dogfish. Table 1 provides a summary of the permitting structures for New Jersey, Maryland, and Virginia. While New Jersey does not issue permits for spiny dogfish, the state does require a person or vessel to possess a federal spiny dogfish permit to possess spiny dogfish for sale, sell, or attempt to sell spiny dogfish (N.J.A.C. 7:25-18.12(g)1).

Table 1. Summary of permitting structure for affected states.

State	Permits that May Land Spiny Dogfish	Number of Permittees that use Gillnets	Other Gillnet Species in Permit
NJ	Gillnet	585	Shark, Large Skate, Smooth Dogfish, Bluefish
MD	Finfish (1,000 lb trip limit)	Unknown	Bluefish
	Striped Bass (2,500 lb trip limit)	52	Striped Bass
	Spiny Dogfish (10,000 lb trip limit)	25	N/A
VA	Spiny Dogfish	75	N/A

3. PROPOSED MANAGEMENT PROGRAM

Consider Sturgeon Bycatch Reduction Measures

Option 1: Status Quo
All gillnet harvesters of spiny dogfish that do not possess a federal spiny dogfish permit and only harvest in state waters may continue to soak nets overnight in the state waters portion of the bycatch reduction areas.

Option 2: Prohibit Overnight Soaks for Specified Times and Areas for State Spiny Dogfish Permits
Under this option, states would take action to apply complementary measures to holders of species-specific Spiny Dogfish Permits, where applicable. This option is consistent with Framework Adjustment 6 in that it applies new measures according to permit held; however, because of differences in how states permit their harvesters, there will be some allowances for spiny dogfish to be harvested in the state waters portion of the bycatch reduction areas that is inconsistent with the federal rules, as identified herein.

New Jersey Atlantic Sturgeon Bycatch Reduction Area
New Jersey would not have to take action because it does not have a species-specific permit for spiny dogfish. However, due to New Jersey's permitting rules, any person or vessel selling spiny dogfish in the state would have to have a federal permit and follow the regulations in the bycatch reduction area, including state waters of the area.[1]

[1] "A person or vessel shall not possess for sale any spiny dogfish nor shall a person sell or attempt to sell spiny dogfish without a valid annual vessel permit for spiny dogfish issued by the National Marine Fisheries Service" (N.J.A.C. 7:25-18.12(g)1.).

Delaware, Maryland, and Virginia Atlantic Sturgeon Bycatch Reduction Areas
Harvesters that possess a Maryland Spiny Dogfish Permit or Virginia Spiny Dogfish Permit using roundfish gillnets (i.e., not tie-down gillnets) with a mesh size between 5.25 and 10 inches (13.34 to 25.4 cm) would be required to remove nets from the water by 8:00 p.m. ET each day until 5:00 a.m. ET the following day from November 1 through March 31 each year within the state waters portion of the Delaware and Maryland and the Virginia Sturgeon Bycatch Reduction Areas. No action would be required by Delaware because the bycatch reduction area does not overlap with its state waters. Note that Maryland allows the commercial harvest of spiny dogfish with reduced trip limits by holders of their Striped Bass Permit and Finfish Permit. Under this option, those permit holders would not be subject to the provisions of the bycatch reduction areas without also possessing a Spiny Dogfish Permit.

Option 3: Prohibit Spiny Dogfish Harvest via Overnight Soaks for Specified Times and Areas
Note: This option was not reviewed by the full Spiny Dogfish Plan Development Team.

Under this option, states would take action to apply complementary measures to all spiny dogfish harvested from the bycatch reduction times/areas by the specified gillnet mesh sizes, regardless of the permit possessed by the harvester. This option is distinct from Option 2 in that it would not result in any allowances for spiny dogfish to be harvested in the state waters portion of the bycatch reduction areas that is inconsistent with the federal rules. However, enforcement may be more challenging under this option due to the need to identify when and where individual spiny dogfish were caught.

New Jersey Atlantic Sturgeon Bycatch Reduction Area
It would be prohibited to harvest or possess spiny dogfish caught using roundfish gillnets (i.e., not tie-down gillnets) with a mesh size between 5 and 10 inches (12.7 to 25.4 cm) that were left in the water for any portion of the time period between 8:00 p.m. ET each day and 5:00 a.m. ET the following day from May 1 through May 31 and November 1 through November 30 of each year within the New Jersey Atlantic Sturgeon Bycatch Reduction Area.

Delaware, Maryland, and Virginia Atlantic Sturgeon Bycatch Reduction Areas
It would be prohibited to harvest or possess spiny dogfish caught using roundfish gillnets (i.e., not tie-down gillnets) with a mesh size between 5.25 and 10 inches (13.34 to 25.4 cm) that were left in the water for any portion of the time period between 8:00 p.m. ET each day and 5:00 a.m. ET the following day from November 1 through March 31 each year within the Delaware and Maryland and the Virginia Atlantic Sturgeon Bycatch Reduction Areas. No action would be required by Delaware because the bycatch reduction area does not overlap with its state waters.

4. COMPLIANCE SCHEDULE
The Spiny Dogfish Management Board would need to determine a compliance schedule when considering approval of the draft Addendum.

5. LITERATURE CITED

Atlantic States Marine Fisheries Commission (ASMFC). 2002. Interstate Fishery Management Plan for Spiny Dogfish. 107p.

Fisheries of the Northeastern United States; Framework Adjustment 15 to the Monkfish Fishery Management Plan; Framework Adjustment 6 to the Spiny Dogfish Fishery Management Plan, 89 FR 65576 (August 12, 2024).

Mid-Atlantic Fishery Management Council (MAFMC) and New England Fishery Management Council (NEFMC). 2024. Joint Framework Action to Reduce Sturgeon Bycatch in Monkfish and Spiny Dogfish Fisheries. 209 pp.

Mid-Atlantic Fishery Management Council (MAFMC) and New England Fishery Management Council (NEFMC). 1999. Spiny Dogfish Fishery Management Plan. NOAA Award No. NA57 FC0002. 292 pp.

Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: **Interstate Fishery Management Program Policy Board and Mid-Atlantic Fishery Management Council**

FROM: **Chelsea Tuohy and Tracey Bauer, FMP Coordinators and Julia Beaty, Fishery Management Specialist**

DATE: **October 16, 2024**

SUBJECT: **Recreational Measures Setting Process Framework/Addenda Option Development**

On October 24, 2024, the Atlantic States Marine Fisheries Commission's (Commission) Interstate Fishery Management Program Policy Board (Policy Board) will meet with the Mid-Atlantic Fishery Management Council (Council) to consider the Summer Flounder, Scup, Black Sea Bass, and Bluefish Recreational Measures Setting Process Framework/Addenda. Under the Commission process for addenda, the Policy Board will consider approval of the Draft Addenda for public comment. Under the Council process for framework actions, the Council will consider approval of a final range of alternatives.

The Policy Board and Council last met to discuss this action on August 13, 2024. Since August, the Fishery Management Action Team/Plan Development Team (FMAT/PDT) have made a number of changes to the options, which are incorporated into the Draft Addenda provided in the briefing materials. These changes include the addition of Option D, further development of options C and E, addition of language regarding management uncertainty, and clarification of the accountability measures (AMs) under all options. A full summary is below. The options under consideration for this action are:

A. No Action
B. Percent Change Approach as adopted by the Harvest Control Rule Framework/Addenda
C. Modified Percent Change Approach Using RHL and Harvest
D. Modified Percent Change Approach Using the Recreational ACT and Catch
E. Biomass and Fishing Mortality Matrix Approach

In addition to refining the options under consideration, the FMAT/PDT discussed potential impacts of this action on the commercial sector, a topic also reviewed by the Council's Scientific and Statistical Committee (SSC) in a July 2024 report. While the Recreational Measures Setting Process Framework/Addenda only considers modifications to the process for setting recreational measures, this topic was reviewed by the FMAT/PDT and the SSC per the Policy Board and Council's direction in June 2022.

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Modified Percent Change Approaches (Options C-D) and Associated Accountability Measures
Since the Policy Board and Council last reviewed this action, an additional Modified Percent Change Approach option has been added to use the Recreational Annual Catch Target (ACT) and catch rather than the RHL and harvest (Option D). The FMAT/PDT recommended including this option as it will allow for greater consideration of how recreational measures impact discards compared to Options B and C because it uses the ACT, which accounts for total recreational removals. The ACT was selected to be included in the approach rather than the Recreational Annual Catch Limit (ACL) in the event that management uncertainty buffers are used in the future.

Under both Modified Percent Change Approaches (Options C and D), two sub-options for AMs have been included for consideration. The first sub-option would modify the current AMs to align with the biomass categories used in these options (described in Section 3.1 of the Draft Addenda). The second sub-option would make additional modifications to give greater consideration to if overfishing is occurring based on the most recent information. Please refer to Sections 3.3 and 3.4 of the Draft Addenda for more details.

Biomass and Fishing Mortality Matrix Approach and Associated Accountability Measures (Option E)
The option formerly known as the Biomass Based Matrix Approach was modified and is now referred to as the Biomass and Fishing Mortality Matrix Approach (Option E).This this approach was refined to:

- Remove the "Biomass Trend" column and replace it with fishing mortality (F) compared to F_{MSY}
- Use the recreational ACT instead of the ACL to account for management uncertainty buffers when setting measures
- Incorporate AMs directly into the approach

The FMAT/PDT concluded biomass trend is not a useful metric in this alternative as it is partially redundant with the biomass level categories. For example, when biomass is above 110% of the target, it could be appropriate to allow a 10% liberalization regardless of whether biomass is increasing, decreasing, or stable. If biomass declines, a more conservative approach would be used when it reaches a lower biomass category. Similarly, when biomass is around the target, status quo may be most appropriate regardless of biomass trend, with liberalizations or restrictions required in future years if biomass changes to the extent that it is categorized differently in the next cycle. When biomass is low (60-90% of the target), near overfished (50-60% of the target), or overfished (below 50% of the target), it may be most appropriate to always require restrictions, regardless of biomass trend. The SSC's report also raised concerns about how to most appropriately define a trend.

Instead, the FMAT/PDT agreed to replace biomass trend with an overfishing metric. By incorporating overfishing status into the revised table, this would allow for a clearer illustration of how overfishing status would be treated compared to the previous version of this alternative. The outcome now varies based on the biomass category and the fishing mortality rate.

Because specific responses to ACL overages and overfishing have been incorporated directly into this option, additional AMs are not needed.

Management Uncertainty

None of the options in the framework/addenda would change the process for setting the ACT less than or equal to the ACL to account for management uncertainty. Additional text has been added to the Draft Addenda to clarify that under all options, the Board and Council may choose to implement more restrictive recreational measures than would otherwise be required in order to address management uncertainty or concerns about the long-term sustainability of the stock. The intent of this addition is to allow the Board and Council to make adjustments, if desired, when setting recreational measures, which typically takes place after the ACT has been set. This can also allow for potentially finer-scale adjustments than may result from setting the ACT less than the ACL.

Impacts to the Commercial Sector

Although this action only considers the process for setting recreational measures, the Council and Policy Board agreed to further evaluate potential indirect impacts to the commercial sector. This action does not consider any changes to commercial management and it does not consider transferring quota between the commercial and recreational sectors. This action does not change the process for setting the commercial and recreational ACLs, ACTs, and landings limits (i.e., commercial quotas and Recreational Harvest Limits). This action does not modify the commercial/recreational allocations. Nothing in this action is intended to set the stage for future revisions to the commercial/recreational allocations for these species. Case law from other regions and NOAA Fisheries input provided during development of Amendment 22 to the Summer Flounder, Scup, and Black Sea Bass FMP indicate recreational ACL or RHL overages cannot be used to justify increasing the recreational allocation in the future.

The reporting of commercial and recreational fishery catch and landings are inherently very different. For example, due to required harvester and dealer reporting, landings data for the commercial fishery have low uncertainty. There is also a limited time lag in the availability of dealer data (e.g., weekly required reporting for federally-permitted dealers), which allows for timely monitoring and in-season closures, when needed, to prevent notable overages of the commercial quota. In addition, the commercial fisheries are mostly limited access, which controls the number of participants.

In contrast, recreational fishery data are provided by the Marine Recreational Information Program (MRIP). MRIP uses a statistical survey design to generate estimates for the entire fishery based on information collected from a subset of recreational anglers. MRIP also incorporates Vessel Trip Report data from federally-permitted for-hire vessels. As the MRIP data are based on a statistical survey design rather than a comprehensive record of landings data, the recreational estimates are more uncertain than the commercial landings estimates. MRIP estimates are produced in two-month “wave” increments. Preliminary estimates are typically available around 45 days after the end of each wave. Final estimates for the year are provided in the spring of the following year. Due to this notable time lag in the availability of MRIP data, in-season closures cannot be used for the recreational fisheries. In addition, the recreational fisheries for these species are open-access. The number of recreational participants is much higher than the number of commercial participants and can vary from year-to-year. For these reasons, it is more challenging to closely monitor and predict recreational landings compared to commercial landings.

This action intends to better account for these fundamental challenges in managing recreational fisheries. This action is not intended to allow the recreational fishery to exceed the recreational ACL, recreational ACT, or RHL.

The Council tasked the Scientific and Statistical Committee (SSC) with reviewing several aspects of this management action, including potential indirect impacts to the commercial sector. The outcome of the SSC's review is summarized in a July 2024 report. Since the time of the SSC review, the options under consideration have been modified to remove options (Biological Reference Point Approach), add options, and modify existing options based on SSC comments and further FMAT/PDT discussion and analysis.

One of the primary roles of the SSC is to provide recommendations to the Council on the annual acceptable biological catch (ABC) limits for each managed stock. The SSC's ABC recommendations are binding under the Magnuson-Stevens Fishery Conservation and Management Act; the Council cannot set catch limits that exceed the ABCs recommended by the SSC.

The SSC concluded in their July 2024 review that the setting of recreational bag, size, and season limits does not directly affect their ABC recommendations. However, if any of the management approaches considered through this action increase the frequency with which the ABCs are exceeded, the SSC may assume ABC overages in the projections that inform future ABCs. This could have the effect of reducing the ABCs, which would in turn reduce the catch and landings limits for both the commercial and recreational sectors. Due to the Council's risk policy, this has a greater impact for stocks below 150% of their biomass target than for stocks at or above 150% of the biomass target.

If the process in place for determining management measures results in a recreational ACL overage, recreational AMs can be triggered, which can help prevent the recreational sector's catch from deviating greatly from its ACL over time. The SSC report raised concerns about repeated ABC overages, but did not explicitly consider the role of AMs in this process. The SSC did not consider AMs in their review as the AMs for each option were not fully developed at that time.

Summer Flounder, Scup, and Black Sea Bass
Advisory Panel Meeting Summary

October 3, 2024

The Mid-Atlantic Fishery Management Council's (Council's) Summer Flounder, Scup, and Black Sea Bass Advisory Panel (AP) met jointly with the Atlantic States Marine Fisheries Commission's (Commission's) Summer Flounder, Scup, and Black Sea Bass AP on October 3, 2024 via webinar. The objectives of this meeting were to review and provide comments on the draft Summer Flounder Commercial Mesh Size Exemptions Framework/Addendum. This action considers modifications to the exemptions to the commercial summer flounder minimum mesh size, including options for modifying the Small Mesh Exemption Program (SMEP) area boundary, the SMEP annual review methodology, and the gear definition for the flynet exemption.

Council Advisory Panel members present: Katie Almeida, Frank Blount, Greg DiDomenico, James Fletcher, Jameson Gregg, Victor Hartley, Robert Pride, Philip Simon, Michael Waine, Charles Witek

Commission Advisory Panel members present: Frank Blount, Greg DiDomenico, Ken Neill

Others present: Chris Batsavage, Kiley Dancy, Laura Deighan, Corrin Flora, Hannah Hart, Emily Keiley, Elise Koob, Savannah Lewis, Nichola Meserve, Eric Reid, Matt Rigdon, Chelsea Tuohy, Angel Willey, Unknown number

Advisory Panel Comments

Following the staff presentation, one recreational advisor asked about the main benefits and drivers of this action, and requested more information on how the proposed options may impact the stock and the commercial industry. He noted that it did not seem like the options would have a negative impact on the stock or a major economic impact on the commercial sector aside from some increases in efficiency. Another advisor asked whether this action would benefit the average commercial fisherman, stating that he did not oppose the actions, but thought it may be more beneficial to law enforcement than to fishermen.

Staff and several commercial representatives provided perspectives on how the proposed action is intended to benefit the commercial industry by increasing flexibility for the commercial sector while possibly reducing regulatory discards. Staff summarized previous comments noting that even adding relatively minor regulatory flexibilities can incrementally increase economic benefits to the commercial sector. Previous comments have also noted the lack of flexibility to fish west of the SMEP line while vessels hold an active SMEP LOA. This can create inefficiencies as it does not allow them to switch gear and target fish just west of the current line while holding the LOA. The proposed SMEP expansion will help with this since it incorporates most of the area where they regularly catch the species they are targeting on these trips (i.e., squid, scup, whiting).

A commercial advisor agreed with these explanations for how this action creates additional flexibilities, efficiencies, and stability for industry.

One advisor wondered whether the proposed actions would have an impact on the number of trips taken, specifically, if efficiencies would increase to the point of having a negative impact on fishermen due fewer trips taken. Staff responded that it is not expected that there would be a notable impact on the number of trips taken; however, expected changes in effort have not been specifically estimated for this action. One advisor responded that in many cases crew pay is based on the amount of catch as opposed to the number of trips. As such, the proposed actions shouldn't impact the pay of fishermen if the number of trips were to change. A Board member agreed that the proposed actions should not impact the number of trips.

This Board member also noted that in 2017, the southern scup Gear Restricted Area (GRA) was modified to allow additional access to the squid fishery to important squid grounds, while having minimal impacts on scup. The proposed SMEP area modifications would have a similar effect, allowing commercial vessels to increase efficiency in the expanded area and reduce summer flounder regulatory discards. He also noted that the proposed changes in the flynet definition are intended to modernize the definition to describe nets that are currently in use.

At the conclusion of the meeting, participants discussed that the lack of public comments received at the two public hearings was primarily due to people being out fishing, given that the squid industry has not had a good year and needed to take advantage of squid availability on those days. A Board member noted talking to fishermen who stated their lack of comment is not due to lack of interest, but due to the need to prioritize fishing, as well as providing many previous comments on these issues. Another advisor agreed with this assessment.

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P. Weston Townsend, Chairman | Michael P. Luisi, Vice Chairman
Christopher M. Moore, Ph.D., Executive Director

MEMORANDUM

Date: October 10, 2024

To: Chris Moore, Executive Director

From: Kiley Dancy and Hannah Hart, Staff

Subject: Council Staff Recommendations on Summer Flounder Commercial Minimum Mesh Exemption Framework/Addendum

On Thursday, October 24, 2024 the Mid-Atlantic Fishery Management Council (Council) and the Atlantic States Marine Fisheries Commission's Summer Flounder, Scup, and Black Sea Bass Management Board (Board) will consider final action on the Summer Flounder Commercial Minimum Mesh Exemption Framework/Addendum.

Meeting materials for this agenda item are posted on the Commission's website at: https://www.asmfc.org/home/2024-annual-meeting and also to the Council's website at: https://www.mafmc.org/council-events/2024/council-asmfc-meeting-oct24. Previous documents for this action can be found on the action page for this Framework/Addendum, at: https://www.mafmc.org/actions/summer-flounder-commercial-mesh-exemptions.

Council Staff Recommendations

Council staff recommendations for final action are summarized below, based on review of information included in the draft addendum document and previous analyses, and considering public comments and Advisory Panel comments.

1. SMEP Area Boundaries

Staff recommend adopting option B, expanded SMEP exemption area. As noted in the hearing document, the expanded area represents a relatively modest expansion after considering the restrictions on bottom tending gear associated with the overlapping deep sea coral protection zone. Public comments indicated that this expanded area would provide the commercial industry with additional flexibility to retain summer flounder when fishing in this area using small mesh, potentially reducing regulatory discards of summer flounder.

Median discards per trip in the SMEP are low at 30 pounds of summer flounder from 2013 through 2022. Discards in weight, the percentage of trips with discards at various poundage thresholds, and the average percent of summer flounder discarded per trip are all very similar between observed LOA trips compared to all observed trawl trips during November through April.

Because of the smaller mesh sizes used by vessels holding SMEP LOAs, the proportion of summer flounder discards below the legal minimum size (14 inches) tends to be somewhat higher for LOA trips vs. non-LOA trips (see Appendix A in the draft Addendum for public comment). However, expanding the SMEP area would not necessarily increase fishing effort in this area, given that the intent is to reduce regulatory discards of legal sized summer flounder when they are encountered in this area by vessels primarily targeting other species. Assuming effort in the expansion area remains relatively stable, discards of undersized summer flounder with small mesh are likely to remain similar to current levels.

However, changes in fishing behavior are somewhat uncertain, and these aspects of the exemption program should continue to be closely monitored using improved methodologies applied in the development of this action. The Regional Administrator will retain authority to rescind the exemption will remain regardless of the option selected under alternative set 2 (see below). Information on the length frequency of discards, discard reasons, and targeting rates of summer flounder among LOA holders should be considered for regular monitoring where possible to ensure this expansion does not cause increases in discards of undersized fish.

2. SMEP Evaluation Criteria

Staff recommend adopting option C, tiered discard monitoring approach. The intent of this exemption program is to reduce regulatory discards. As described in the document, this trigger represents a more realistic percent of summer flounder expected to be discarded based on a revised and more accurate methodology for evaluating discards on LOA trips, which uses observer data from trips known to be actively holding an SMEP LOA. This type of monitoring and analysis was not possible at the time this exemption was originally put into place. In addition, many of the regulatory constraints impacting discards today were not present in the years used to evaluate the original 10% threshold. Most LOA trips do not catch large amounts of summer flounder; therefore, it is fairly easy for trips with small summer flounder catch to reach the 10% average discards of summer flounder per trip.

Rescinding the exemption could have unintended consequences of increasing regulatory discards, as vessels would continue to fish for other species using smaller mesh but would not be able to retain more than 200 pounds of summer flounder. Expected changes in regulatory discards would depend on the drivers of discards in the area in a given year, which can vary based on the interaction of various biological factors (e.g., stock size, size distribution), market factors (e.g., price trends, market demand), or regulations (e.g., total quota, state possession limits).

Staff recommend option C as it would allow for an increased understanding of circumstances leading to changes in discard rates and quantities, and allow managers to better predict the consequences of rescinding the exemption. Work that has been conducted through this action could serve as a starting point for this evaluation in years where it is needed. While option C does have a longer timeline for responding to data suggesting changes in discard rates, it allows the Regional Administrator greater flexibility in determining a management response that is most appropriate for the circumstances.

3. Flynet Definition

Staff recommend adopting option B, revised flynet definition. Previous comments on this issue have indicated that the existing definition is creating compliance and enforcement issues as operators use similar net types that do not meet the regulatory definition.

Public comments and observer data indicate that the types of nets under consideration for an expanded definition are not designed to catch flatfish and generally have very low catch of summer flounder due to their design.

Summer flounder represents a very small proportion (0.7% from 2007-2022) of the total observed catch by weight in these gear types, including 0.6% of observed landings and 0.9% of observed discards. Average total catch of summer flounder in these gear types is about 455 pounds per trip, with discards averaging about 100 pounds per trip. About 30% of these observed trips had summer flounder catch over 200 pounds, and 46% had catch over 100 pounds. Therefore, the majority of trips using these gear types would not require an exemption, but there appears to be some benefit to operators using these gear types who sometimes encounter more than 200 pounds of summer flounder November through April or 100 pounds May through October.

As with the SMEP, this exemption should continue to be closely monitored for any issues. Going forward, with the understanding that North Carolina data is no longer sufficient to monitor the exemption, evaluations will rely on observer and VTR data (once the previously recommended additional gear type field is added to the VTR forms).