Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: Atlantic Striped Bass Management Board

FROM: Atlantic Striped Bass Stock Assessment Committee

DATE: January 22, 2026

SUBJECT: Request for Board Guidance on Biological Reference Points and Spatial Management

Term of Reference #6 for the 2027 Atlantic striped bass benchmark stock assessment is:

Update or redefine biological reference points (BRPs; point estimates or proxies for BMSY, SSBMSY, FMSY, MSY). Define stock status based on BRPs by stock component where possible.

As the Stock Assessment Subcommittee (SAS) continues work on the assessment, they request guidance from the Board in order to develop biological reference points (BRPs) if the Board is looking for alternatives to the current BRPs.

This memo describes the history and rationale for the current BRPs and lays out the two areas that the SAS is looking for guidance on from the Board.

History of Current BRPs

The current spawning stock biomass (SSB) threshold for Atlantic striped bass is the estimate of female SSB in 1995, and the current SSB target is 125% of that value. The stock is declared overfished when SSB drops below the threshold. The current fishing mortality (*F*) target and threshold are the *F* rates that will maintain the population at the SSB target and threshold, respectively, in the long term. Overfishing occurs when *F* exceeds the *F* threshold. Because the Amendment 7 recruitment trigger was tripped prior to the most recent assessment update, the current values for the *F* target and *F* threshold are calculated using the current low recruitment regime (2008-2023) (Figure 1). This results in a lower *F* target and threshold than would be estimated from the longer time-series of recruitment used when the recruitment trigger has not been tripped.

The 1995 value of SSB was chosen as the threshold because the stock was declared rebuilt in 1995 based on 1) an increasing proportion of age-8+ (mature) female fish in the spawning population as a sign of an expanding age structure and a more productive, resilient spawning stock; and 2) a projection model that used life history information and *F* rates from tagging and catch curves to estimate SSB from the MD young-of-year (YOY) index over time. The MD YOY index extends back to the mid-1950s, so the estimates of SSB after the moratorium in the late 1980s were compared to estimates of SSB pre-collapse (1960-1972) to determine whether the

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stock had recovered. The projection model indicated that in 1995, SSB was at the 1960-1972 reference level, so the stock was considered re-built to pre-collapse levels.

The threshold was set on the basis of empirical/historical metrics, including managers' and stakeholders' satisfaction with the stock condition in the 1960s. The target was a somewhat arbitrary level (25%) above the 1995 value. Since the stock is managed based on the target, it is important to have sufficient board input as to the values which should be reflected in the target level so that it is no longer based on a somewhat arbitrary decision.

From 2003 to 2013, the *F* threshold was defined as F_{MSY}, but during the 2013 assessment, projections indicated that the population would stabilize below the SSB threshold if it was fished at F_{MSY}. Therefore, the definition of the *F* target and threshold were changed to align with the definition of the SSB target and threshold. The decision to maintain the SSB target and threshold definitions and change the *F* target and threshold was based on the FMP objectives around SSB and population structure as well as concerns about the reliability of F_{MSY} estimates, given the uncertainty in the stock-recruitment relationship used to derive it. During the 2019 benchmark, SPR-based reference points were explored, but the estimates of $F_{40\%SPR}$ and $F_{30\%SPR}$ from the single-stock model were lower than the empirical *F* values and resulted in an SSB target and threshold that were much higher than the 1995-based target and threshold.

Although SSB exceeded the target in the early 2000s for four years and was close to the target (i.e., the confidence intervals on the estimates of SSB included the target) for 11 years (Figure 1), some Board members have voiced concerns that the SSB reference points are too high and are biologically unattainable, especially during the current period of very low recruitment.

Request for Board Guidance

The SAS is planning to explore both empirical BRPs and model-based BRPs (e.g., SPR-based reference points), including spatial BRPs through the 2027 benchmark. The SAS has identified two major questions that would benefit from Board guidance as the assessment progresses.

1. How does the Board want to balance preserving SSB and allowing fishing?
2. What does the Board want from a spatial management framework?

The SAS is not asking the Board to select a specific BRP definition or come to consensus on these questions at this time, but understanding the range of opinions and the factors the Board considers important will help the SAS develop BRP options that best address different management objectives.

Balancing SSB and F

There is a trade-off between preserving SSB and allowing fishing, and determining the best balance between these two parameters requires management input. If the Board wanted to establish a lower SSB target and threshold – for example, setting the target to the 1995 estimate of SSB and the threshold to some lower percentage of that value – then the *F* target and *F* threshold values could increase, depending on the assumptions about future recruitment. Or the Board could set higher *F* target and threshold values based on a stable period in the fishery and calculate the SSB target and threshold values associated with those *F* rates in the long term, which would be lower than the current values.

A lower SSB would mean lower availability of larger fish. Even if the *F* target is increased, that may not translate into a higher harvest or yield, since that *F* rate is applied to a smaller population. In addition, lower availability of larger fish means lower encounter rates overall, particularly for the ocean region.

If the Board is interested in considering options for a set of BRPs with a higher *F* and lower SSB targets and thresholds, it would be helpful to receive input on things like:

- the preferred balance between SSB and *F*
- the relative importance of maximizing yield vs. maximizing catch rates or the availability of trophy size fish
- acceptable level of risk when it comes to preventing stock collapse
- alternative metrics for stock health such as total abundance or abundance of specific size or age classes instead of female SSB
- a preferred historical time-period for *F* reference points (i.e., when was the Board satisfied with fishery performance?)
- a preferred historical time-period for SSB reference points
- a lower limit on acceptable SSB levels, relative to 1995 levels or based on the preferred historical time-period

These items represent a range of possible management objectives and are not necessarily mutually exclusive of one another. The SAS could explore methods to evaluate tradeoffs between objectives and estimate optimal reference points to achieve multiple objectives. What is needed by the SAS is direction from the Board as to what is most valued from the fishery.

BRPs in a Spatial Management Framework

Currently, striped bass are assessed with a single set of BRPs for the entire stock-complex with region-specific management regimes to account for differences in availability of fish and other spatial dynamics. The SAS is exploring a new spatial, stock-specific model for this assessment and is seeking guidance on what the Board wants from a spatial management framework and how the Board would like to handle regions like Delaware Bay and the Hudson River.

Delaware Bay removals are part of the “ocean” fleet in the current single-stock model. The Delaware Bay stock was grouped with the Hudson River stock to form an “ocean” stock in the previous two-stock spatial model that did not pass peer review in 2019. If the Delaware Bay cannot be modeled as a separate region, due to data limitations, it could be grouped with either the Chesapeake Bay region/stock or with the “ocean” region again. Grouping Delaware Bay with the Chesapeake Bay would better align with recent research on the genetic similarity of fish from these areas and the frequent movement of both adult and juvenile fish between Bays through the C&D canal, but it would mean any stock- or region-specific BRPs would represent a joint Chesapeake Bay-Delaware Bay region/stock.

It would be helpful to receive input from the Board on their objectives for spatial management, such as:

- Is the Board interested in spatial BRPs – that is, having specific targets and thresholds by region to evaluate stock status against – or would the Board prefer to keep coastwide reference points and use spatial management regimes to attempt to achieve those targets?
- Would a Chesapeake/Delaware Bay region be acceptable to the Board, or would the Board prefer to keep Chesapeake Bay distinct from other regions?
- Is the Board interested in developing BRPs for the Hudson River as a distinct region if the data supported that, or would the Board prefer to keep the Hudson River with the "ocean" region?

The SAS notes that, similar to the current management framework, having coastwide or broader spatial BRPs would not prevent the use of finer scale regional management regimes.

The SAS noted that researchers at Virginia Tech have been working on a spatial management strategy evaluation for striped bass. The SAS will consider any available results from that project, as well as recent public comments on FMP objectives, that could inform potential biological reference point development and stakeholder priorities.

Timeline

If the Board is able to provide guidance to the SAS by the May 2026 Board Meeting, prior to the Assessment Workshop in August 2026, the SAS will be better able to develop options for BRPs that reflect the Board's management direction. The SAS intends to have the BRPs or BRP methodologies peer reviewed along with the assessment models through the 2027 Northeast (NRCC) Research Track, making them available for management consideration as soon as the assessment and review process is complete.

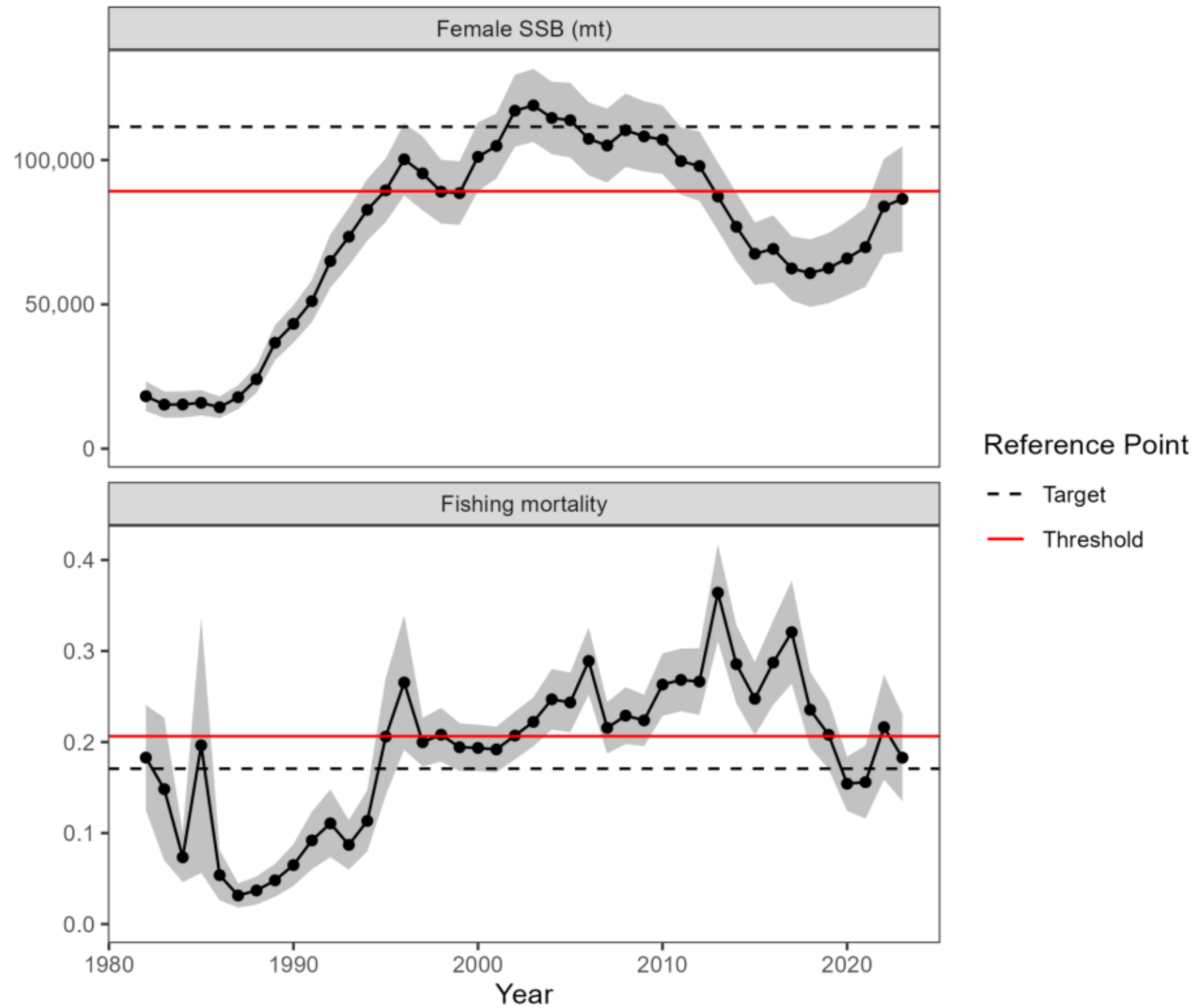

Figure 1. Female SSB (top) and total F estimates (bottom) plotted with their respective targets and thresholds. Shaded area indicates 95% confidence intervals of the estimates. Source: 2024 Stock Assessment Update.

Appendix 1: FMP Goal and Objectives in Amendment 7 Sections 2.3 and 2.4

The goal of Amendment 7 to the Interstate Fishery Management Plan for Atlantic Striped Bass is to perpetuate, through cooperative interstate fishery management, migratory stocks of striped bass; to allow commercial and recreational fisheries consistent with the long-term maintenance of a broad age structure, a self-sustaining spawning stock; and also to provide for the restoration and maintenance of their essential habitat.

In support of this goal, the following objectives are specified:

1. Manage striped bass fisheries under a control rule designed to maintain stock size at or above the target female spawning stock biomass level and a level of fishing mortality at or below the target exploitation rate.
2. Manage fishing mortality to maintain an age structure that provides adequate spawning potential to sustain long-term abundance of striped bass populations.
3. Provide a management plan that strives, to the extent practical, to maintain coastwide consistency of implemented measures, while allowing the states defined flexibility to implement alternative strategies that accomplish the objectives of the FMP.
4. Foster quality and economically-viable recreational, for-hire, and commercial fisheries.
5. Maximize cost effectiveness of current information gathering and prioritize state obligations in order to minimize costs of monitoring and management.
6. Adopt a long-term management regime that minimizes or eliminates the need to make annual changes or modifications to management measures.
7. Establish a fishing mortality target that will result in a net increase in the abundance (pounds) of age 15 and older striped bass in the population, relative to the 2000 estimate.

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Charting A Course for Striped Bass: Science and Regulatory Innovation for Offshore Aquaculture

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-F/OAQ-001
FEBRUARY 2026

Charting A Course for Striped Bass: Science and Regulatory Innovation for Offshore Aquaculture

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1 Executive Summary

Striped bass (*Morone saxatilis*) is one of the most valued fish species along the Atlantic coast of the United States (U.S.), noted for its ecological, cultural, and economic importance. Recreational and commercial fisheries have long depended on this species, but harvest in federal waters of the Exclusive Economic Zone (EEZ) along the East Coast has been prohibited since 1990. While the moratorium was vital for rebuilding wild stocks, it also blocks the potential to develop striped bass aquaculture offshore, despite major advances in science, technology, and management that now make such development both feasible and promising. Balancing aquaculture development with protection of wild striped bass populations and the fisheries they support is essential for ensuring the resilience of this iconic species. Over the past three decades, substantial progress has been made in aquaculture biology, offshore engineering, disease management, and regulatory oversight. Controlled breeding, biosecurity protocols, site selection tools, and environmental monitoring now allow offshore aquaculture systems to reduce risks of escapement, disease transmission, and ecosystem impacts. At the same time, governance frameworks have evolved to better integrate aquaculture with other ocean uses and conservation objectives. These advances suggest that offshore production of pure-strain striped bass could be feasible under a carefully designed regulatory structure that distinguishes aquaculture from wild harvest and ensures accountability, traceability, and environmental safeguards.

The purpose of this discussion paper is to identify the legal, policy, and scientific constraints on the production of cultured pure-strain striped bass in federal waters and outline the economic and environmental topics raised by the Atlantic States Marine Fisheries Commission (ASMFC). At the 2024 Winter Meeting of the ASMFC, Danielle Blacklock, Director of the NOAA Fisheries Office of Aquaculture, led the Interstate Fisheries Management Program (ISFMP) Policy Board in a discussion on the future of aquaculture and the potential role of Atlantic Striped Bass in U.S. seafood production. The Board raised longstanding concerns, describing issues on escapement, ecosystem impacts, enforcement related to the existing moratorium in the EEZ and illegal harvest, competition with wild-caught markets, economic feasibility, and the challenges of managing aquaculture alongside other ocean uses.

Building on this exchange, this Technical Memorandum provides historical context, summarizes the Commission’s concerns, and identifies potential pathways forward. It examines the biological foundations, regulatory history, technological readiness, environmental considerations, market dynamics, and governance needs for striped bass aquaculture. The memo highlights how coordinated science, policy, and industry innovation could support sustainable offshore farming of this species in a way that complements wild stock conservation and contributes to U.S. seafood supply and coastal economies.

NOAA Fisheries, in coordination with ASMFC, could amend the relevant regulatory provisions to allow aquaculture as an explicit exception to the EEZ moratorium on the fishing, harvest, possession, and retention of striped bass. The sections that follow summarize the key regulatory and scientific issues and outline proposed next steps.

Summary of Key Regulatory and Science Issues

1.1 Enforcement Considerations

Fishery managers have expressed a need for strong, enforceable assurances that the development of an aquaculture market for pure-strain striped bass will not create incentives for illegal harvest or lead to negative impacts on wild stocks and the fisheries they support. The ASMFC (through its Law Enforcement Committee), state agencies, and NOAA Fisheries' Office of Law Enforcement (OLE) collaborate extensively on interjurisdictional fisheries enforcement. State precedents for labeling and tagging farmed product offer models for ensuring consumer confidence and preventing substitution of wild fish into aquaculture supply chains. Product differentiation and proper enforcement mitigate these challenges by providing better accountability on the water and enabling law enforcement to track a fish from its origin. Strategies could be developed for regulatory frameworks to ensure that aquaculture-raised striped bass are accurately labeled and traceable throughout the supply chain.

1.2 Economic Contributions

Market demand strongly supports the development of a domestic striped bass aquaculture sector. U.S. seafood consumption continues to outpace supply, with the majority of products imported. The development of a robust striped bass aquaculture industry has the potential to generate similar spillover benefits, particularly for coastal communities. Recent economic research suggests that striped bass aquaculture is most profitable in offshore net-pen systems, with breakeven prices comparable to those of commercially farmed red drum (*Sciaenops ocellatus*). Demand-side conditions are favorable, yet production cost challenges and regulatory inconsistencies, especially in states with gamefish designations, may be addressed. Interstate transport and sale of pure-strain farmed striped bass could present barriers for market development that will require synergies between state and federal regulations to avoid enforcement challenges and ensure transparency. A complete understanding of the impacts that a farmed striped bass industry will have on existing imports and wild-caught alternatives will require further analysis on potential production volumes and targeted markets. However, introducing farmed striped bass into non-traditional retail and food-service channels could expand consumer exposure to the species, increasing overall demand for both farmed and wild-caught products.

1.3 Managing Ocean User Conflicts

The identification of suitable areas for aquaculture development, coupled with careful site selection and management, is fundamental to ensuring the long-term success and sustainability of offshore aquaculture. In the U.S., where competition for nearshore space is intense, expansion into the EEZ provides opportunities for larger sites with fewer nearshore user conflicts and greater social acceptance among commercial and recreational fishing communities. As part of NOAA's National Ocean Service, the National Centers for Coastal Ocean Science (NCCOS) plays a central role by developing science-based inclusive decision tools to inform precision siting for aquaculture and other sectors of the ocean economy.

1.4 Environmental Concerns

In the context of striped bass aquaculture, potential environmental effects can be grouped into several categories: (1) water quality, (2) benthic and sedimentary processes, (3) interactions with marine life and habitats, (4) cumulative and landscape-scale effects, and (5) mitigation strategies, including novel approaches such as integrated multi-trophic aquaculture (IMTA). Modern production technologies, standardized operating procedures, and best management practices reduce risks of degradation to water quality, benthic habitats, and marine life. All of these issues are managed by the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE), in coordination with NOAA through consultations under existing federal law. EPA generally applies water quality models to characterize interactions between effluent and the receiving environment. Further, the NOAA NCCOS has ongoing collaborations with the EPA to provide depositional and water quality modeling products and science advice to support agency permitting and associated environmental reviews and consultations for finfish aquaculture projects proposed for federal waters.

1.5 Escapement and Genetic Concerns

Escape events are among the most widely recognized ecological risks associated with marine finfish aquaculture. Recent advances in genomic technologies now enable high-resolution monitoring of striped bass population structure. These tools have been applied to striped bass, where they have clarified stock composition and informed management across the species' range. Decades of hatchery experience, the success of the hybrid striped bass industry, and advances in selective breeding and fish health management have established a strong technical foundation for farming pure-strain striped bass. Offshore net-pen systems, which have been successfully demonstrated internationally, provide suitable growing conditions while reducing many environmental pressures on coastal ecosystems. Emerging tools in genetics, automation, and biosecurity further strengthen the case for expansion into offshore environments. Additionally, NOAA and partners have developed models to evaluate genetic and ecological risks associated with aquaculture escape events. The intent of these tools are to support risk-based assessments of offshore aquaculture operations and to inform the development of management and engineering strategies that reduce the potential adverse effects of escape events on wild populations.

1.6 Disease

Equally important to environmental performance is maintenance of aquatic animal health. Disease represents one of the most significant operational risks in striped bass aquaculture and requires continuous, proactive management. Striped bass are susceptible to a range of pathogens and parasites, with recent research improving understanding of disease dynamics in both wild and farmed populations. Even well-managed farms may periodically require therapeutic intervention to control outbreaks, limit mortality, and protect animal welfare.

The Food and Drug Administration (FDA) provides centralized oversight of aquaculture therapeutants, ensuring that their use is scientifically justified and environmentally protective. At present, no antibiotics are approved for striped bass or most marine finfish species, reinforcing the importance of preventative health strategies. For striped bass aquaculture, disease prevention is therefore the primary line of defense, relying on vaccination where available, rigorous biosecurity protocols, water quality management, and structured health-monitoring programs to enable early detection and response. By integrating science-based biosecurity, judicious therapeutic use, and informed site selection, offshore aquaculture operations can reduce pathogen pressure, safeguard stock health, and minimize both economic losses and environmental risks. Comprehensive health-management frameworks that emphasize prevention, surveillance, and targeted intervention are thus essential for the sustainable development of offshore striped bass aquaculture.

1.7 Summary of Next Steps

Production of striped bass is already occurring abroad, with farmed product entering U.S. markets and competing with domestic seafood. The commercial appeal of cultivating pure-strain striped bass is therefore grounded in the existence of an established and recognized market opportunity. While demand in many regions remains seasonal, a key opportunity lies in expanding striped bass into a stable, year-round product that can complement and relieve pressure on wild fisheries while increasing total supply.

Realizing this opportunity will require coordinated progress across science, industry, and governance. Priority research needs include continued broodstock and selective-breeding programs, deployment of genetic safeguards, offshore production trials, fish health management, and development of sustainable feed strategies. At the same time, policy modernization will be essential, including reforms to regulatory frameworks in the EEZ, strengthened interagency coordination of federal permitting, expansion of marine spatial planning tools, and supporting workforce development and stakeholder engagement.

Striped bass aquaculture represents a strategic opportunity to expand domestic seafood production, strengthen coastal economies, and reinforce conservation of wild stocks. When science, governance, and markets are aligned, offshore farming of this species can move from technical feasibility to commercial reality, helping the United States advance national goals for seafood security, economic growth, and resilient coastal communities while coexisting with and supporting the long-term sustainability of commercial and recreational fisheries.

2 Overview

2.1 Biology and Distribution of Striped Bass

The striped bass (*Morone saxatilis*) is one of the most important sport fish and commercial fisheries along the Atlantic coast of North America. It is an all-time favorite for anglers. It belongs to the family Moronidae, which comprises both freshwater and anadromous taxa. In North America, the genus *Morone* is represented by four species: striped bass, white perch (*M. americana*), white bass (*M. chrysops*), and yellow bass (*M. mississippiensis*). Striped bass is the largest and longest-lived member of the group, with individuals documented to live more than 30 years and reach weights exceeding 100 pounds, although fish over 75 pounds are rare (Bowers, 1900; Smith, 1907).

Striped bass populations display regionally distinct migratory behaviors along the U.S. Atlantic coast. North of Cape Hatteras, North Carolina, adults are anadromous, ascending freshwater or brackish rivers in spring to spawn before returning to the coastal ocean (Rulifson & Dadswell, 1995; Morris et al. 2003). Major spawning grounds on the U.S. Atlantic coast includes the Chesapeake Bay (Virginia and Maryland), the Hudson River, and the Delaware River, although smaller spawning populations exist in several other bays and rivers as well, including the Albemarle Sound-Roanoke River (North Carolina) and the Kennebec River (Maine). Larval and juvenile recruitment occurs in estuaries, where young fish typically reside for one to two years before dispersing offshore. Seasonal migrations extend northward to Nova Scotia during summer and southward to Virginia and North Carolina during winter, where spawning occurs in spring (Greene et al., 2009). In the Chesapeake Bay, migration patterns differ by age and sex, reflecting ontogenetic variation in maturity (Kohlenstein, 1981). The Hudson River stock shows similar dynamics, with both resident and ocean-migratory contingents (McLaren et al., 1981). In the Bay of Fundy, adults migrate downstream after spawning, while juveniles either remain in rivers or disperse along the coast (Rulifson & Dadswell, 1995).

In contrast, striped bass populations south of Cape Hatteras, extending to the St. John's River in northern Florida and into the Gulf of America, are primarily riverine and potamodromous, lacking consistent oceanic migrations (Setzler-Hamilton 1980; McIlwain, 1980). Historically, the Gulf range extended from the Suwannee River, Florida, westward to rivers of the Lake Pontchartrain basin in Louisiana (Pearson, 1938; Merriman, 1941; Barkuloo, 1961, 1967; GSMFC, 2006). Today, the only remnant population persists in the Apalachicola–Chattahoochee–Flint (ACF) river system spanning northwest Florida, Georgia, and Alabama. No records exist of Gulf specimens captured in open ocean habitats, although telemetry studies indicate that ACF striped bass occasionally enter the Gulf and migrate along the coastline (McIlwain, 1980; Fruge, 2006; Long et al., 2013).

Commercial landings of striped bass in the Gulf ended in the 1960s, however, coastal stock enhancement and contributions from reservoir escapement have created recreational fisheries in some areas. Although not native to Texas, striped bass are occasionally reported in estuaries and rivers as escapees from stocked reservoirs. These reports, documented by Texas Parks and Wildlife through gill net and creel surveys, occur mostly in Sabine, Galveston, and Matagorda Bays (Texas Parks and Wildlife, n.d.).

Beyond their native range along the Atlantic and Gulf coasts, striped bass were successfully introduced to the Pacific coast in the late nineteenth century (ca. 1879). Within a decade, they supported vibrant recreational and commercial fisheries from southern California to the Columbia River, Oregon (Nichols, 1966). An introduction to Kauai, Hawaii, in 1920 was unsuccessful, as the transplanted California fish failed to survive (Randall, 1987).

2.2 Striped Bass Fisheries Management

Management of Atlantic striped bass is coordinated through the Atlantic States Marine Fisheries Commission (ASMFC), which works in partnership with state and federal agencies to assess population status and implement regulatory measures across the species' range (ASMFC, 2022a). The management unit includes all coastal migratory striped bass stocks from Maine through North Carolina. ASMFC has primary authority for striped bass management within state waters, while NOAA Fisheries (NMFS) has management authority in federal waters. Federal waters under the Magnuson-Stevens Fishery Conservation and Management Act are defined as the Exclusive Economic Zone (EEZ), which extends from the seaward boundary of state waters out to 200 nautical miles offshore.

Stock assessments have consistently documented the species' natural population variability and periods of overexploitation. Severe overfishing during the late 1970s and early 1980s led to a coastwide collapse, prompting the adoption of a moratorium and strict harvest controls in the mid-1980s (Richards & Rago, 1999; ASMFC, 1990). These actions facilitated recovery, and by the mid-1990s the stock was declared rebuilt (ASMFC, 1997).

Since recovery, striped bass have remained among the most intensively managed fisheries along the Atlantic coast. Regulatory tools have included size and slot limits, seasonal closures, quotas, and gear restrictions, with measures adjusted adaptively in response to new scientific assessments (ASMFC, 2022a). Despite these efforts, the 2018 benchmark stock assessment concluded that the stock was overfished and that overfishing was occurring (NEFSC, 2019). In response, the ASMFC enacted harvest reductions in 2020 to curb fishing mortality and initiate rebuilding (ASMFC, 2020).

Total removals in 2021, including commercial harvest, commercial discards, and recreational harvest and release mortality, were estimated at 5.1 million fish, similar to

2020 levels (ASMFC, 2022b). Recreational removals accounted for approximately 86% of this total, reflecting the dominance of the recreational sector. The commercial fishery, managed under state-specific quotas, has maintained relatively stable landings since 2004, while the recreational fishery is managed through bag limits, size restrictions, and seasonal closures in some jurisdictions (ASMFC, 2022b).

Broader management reforms were codified in Amendment 7 to the Interstate Fishery Management Plan (FMP), approved in 2022. Amendment 7 introduced more precautionary recruitment triggers, clarified conservation equivalency standards, enhanced measures to reduce recreational release mortality, and reaffirmed the requirement to rebuild the stock by 2029 (ASMFC, 2022a). Addendum I, approved in May 2023, further allowed for voluntary transfers of commercial quota in the ocean region, contingent on stock status (ASMFC, 2023).

Following the 2024 Stock Assessment Update, which determined the stock remained overfished though not experiencing overfishing, the ASMFC initiated Draft Addendum III in December 2024. This addendum, currently under development, is intended to provide new recreational and commercial measures for implementation in 2026 to ensure rebuilding by 2029 (ASMFC, 2024a). The Board is expected to finalize the addendum following public comment in late 2025, with implementation planned for early 2026 (ASMFC, 2025).

This evolving management framework illustrates the dynamic and adaptive nature of striped bass governance. The challenge remains to balance sustainable harvest opportunities with long-term conservation goals for a species that holds ecological, cultural, and economic importance along the U.S. Atlantic seaboard.

2.3 Legal History of Striped Bass Management

2.3.1 Atlantic States Marine Fisheries Commission and the Striped Bass Conservation Act of 1984

The ASMFC, established in 1942 through an interstate compact, was created to coordinate management of interjurisdictional fisheries along the Atlantic seaboard, including striped bass (ASMFC, 2022a). The Commission is composed of representatives from 15 states, the District of Columbia, the Potomac River Fisheries Commission, and federal agencies including NMFS and the USFWS. Collectively, these entities hold primary management authority and adopt regulations consistent with the Interstate FMP (ASMFC, 1990).

By the mid-1970s, striped bass populations had declined to historic lows. In 1979, Congress directed NMFS and USFWS to conduct a comprehensive study of the causes of this decline, examining environmental change, predation, competition, and fishing mortality (U.S. Congress, 1979)[1]. In response, ASMFC adopted the first Atlantic Striped Bass FMP in 1981 (ASMFC, 1981). To strengthen implementation, Congress enacted the Atlantic Striped Bass Conservation Act of 1984 (Pub. L. 98-613), which required states to implement ASMFC's striped bass regulations and established a federal enforcement backstop (U.S. Congress, 1984).

The Striped Bass Act empowered ASMFC to notify the Secretaries of Commerce and the Interior if a state failed to comply with the interstate FMP. Upon such notification, the Secretaries could jointly impose a moratorium on striped bass fishing in that state's waters (ASMFC, 1990). This enforcement authority, unique among the interstate marine fishery commissions, has proven effective in ensuring state compliance with ASMFC management actions (NMFS, 2020a).[2]

Congress strengthened the Striped Bass Act through amendments in 1988, authorizing the Secretary of Commerce acting through NMFS to regulate striped bass within the federal waters of the EEZ (U.S. Congress, 1988). Using this authority, the Secretary may develop offshore regulations, but any regulations are required to be consistent with the Magnuson–Stevens Fishery Conservation and Management Act (16 U.S.C. §1851 et seq.) and compatible with the ASMFC striped bass FMP. The 1988 and subsequent amendments also authorized NMFS and USFWS to carry out annual studies and population assessments of striped bass. The amendments also mandated biennial stock assessment and management reports from the Secretaries to ASMFC and Congress, expanded requirements for public participation in preparation of management plans, and provided dedicated annual funding for striped bass research and assessment (NMFS & USFWS, 1990).

In November 1990, NMFS implemented a moratorium on the harvest and possession of striped bass in the EEZ under the Striped Bass Act (55 Fed. Reg. 40184, 1990). This action was designed to reinforce ASMFC's rebuilding program, provide additional protection for striped bass thereby reducing fishing mortality, and ensure the effectiveness of state regulations. The moratorium remains in effect today (NMFS, 2020b). Amendment 4 to the Striped Bass Plan, adopted in 1989, allowed for limited increases in harvest. Amendment 4 relaxed the measures, and as states reopened fisheries, NMFS closed federal waters of the EEZ to ensure effectiveness of state

[1] "Reauthorization of the Atlantic Striped Bass Conservation Act", U.S. House of Representatives Report, 106-698.

[2] The Atlantic Coastal Fishery Cooperative Management Act (1993) generally mirrors the Striped Bass Act in giving the Secretary of Commerce the authority to impose moratoria in State waters, albeit for other Atlantic fisheries managed under ASMFC-approved fishery management plans.1988 Amendments and the Federal Moratorium.

measures (ASMFC, 1989). Although reopening of the EEZ has been periodically evaluated, including under Amendment 6 in 2003, both managers and stakeholders have consistently supported its continued closure, citing the predominance of mature, spawning-capable females offshore and the risk of increased fishing mortality if federal waters of the EEZ were reopened (ASMFC, 2003).

2.3.2 Executive Order 13449

In 2007, Executive Order 13449 affirmed federal policy to conserve striped bass and red drum, while clarifying that aquaculture production of these species was not restricted (Bush, 2007). The order declared that it is "the policy of the U.S. to conserve striped bass and red drum for the recreational, economic, and environmental benefit of the present and future generations of Americans" (Bush, 2007). The E.O. notes, importantly, that the order must be implemented in a manner consistent with applicable law. The E.O. essentially directed NOAA to promulgate regulations that restrict the sale of EEZ striped bass if it could do so consistent with the law. NOAA already had regulations on the books (i.e., closure of federal waters of the EEZ) that achieved the policies of the E.O.

2.3.3 Federal Jurisdiction and Regulations (Current Legal Constraints)

Management authority for Atlantic striped bass within state waters resides with the coastal states, coordinated through the ASMFC's Striped Bass FMP (ASMFC, 2022a). Federal authority in the EEZ is derived from the Magnuson Stevens Act, which predates the Atlantic Striped Bass Conservation Act and which requires NMFS to ensure that any regulations implemented for striped bass in the EEZ: (1) are consistent with the national standards under Section 301 of the MSA (16 U.S.C. §1851 et seq.); (2) are compatible with the ASMFC Striped Bass FMP and any federal moratoria authorized by statute; (3) ensure the effectiveness of state regulations within coastal waters; and (4) achieve long-term conservation and management objectives for the Atlantic striped bass resource (U.S. Congress, 1984; NMFS, 2020). In other words, NMFS or the Councils could develop a federal FMP for striped bass under the MSA if it so chooses. Alternatively, NMFS may implement regulations for striped bass under the ACA instead, which is the scheme we have today.

Federal regulations in the EEZ can be developed to complement ASMFC's Striped Bass FMP. Currently, federal regulations prohibit fishing for, harvesting, possessing, or retaining Atlantic striped bass in the EEZ (50 C.F.R. §697.7). Limited exceptions exist in Block Island Sound, where possession is permitted during continuous transit provided no fishing occurs in EEZ waters (NMFS, 1990).

In 1995, following ASMFC's declaration that striped bass stocks were rebuilt, NMFS considered lifting the EEZ ban or revising it to align with state size limits, as recommended by the Commission (ASMFC, 1997). After reviewing public comment and updated mortality estimates indicating fishing pressure was higher than previously believed, NMFS elected to maintain the EEZ moratorium (NMFS, 1995). Further, Amendment 6 included a recommendation to NMFS to consider reopening the EEZ (ASMFC, 2003). Following public review and consideration of updated stock assessments, NMFS concluded in 2006 that reopening the EEZ posed unacceptable risks because effort levels and associated fishing mortality could not be reliably controlled (NMFS, 2006).

Currently, implementing regulations (50 CFR 697.7(b)) state that it is unlawful for any person to do any of the following:

(1) Fish for Atlantic striped bass in the EEZ.

(2) Harvest any Atlantic striped bass from the EEZ.

(3) Possess any Atlantic striped bass in or from the EEZ, except in the following area: The EEZ within Block Island Sound, north of a line connecting Montauk Light, Montauk Point, NY, and Block Island Southeast Light, Block Island, RI; and west of a line connecting Point Judith Light, Point Judith, RI, and Block Island Southeast Light, Block Island, RI. Within this area, possession of Atlantic striped bass is permitted, provided no fishing takes place from the vessel while in the EEZ and the vessel is in continuous transit.

(4) Retain any Atlantic striped bass taken in or from the EEZ.

2.4 Solutions and Recommendations

A regulatory pathway that allows for offshore aquaculture of striped bass in the U.S. EEZ could be achieved without undermining the conservation achievements of the Striped Bass Conservation Act or ASMFC's management program. The following solutions are recommended:

2.4.1 Regulatory Carve-Out for Aquaculture

NMFS could lead an effort to amend existing regulations to explicitly recognize aquaculture operations as an exception to the EEZ moratorium. Permitting criteria may be established specific to aquaculture while reaffirming the prohibition on wild harvest in the EEZ. The language would have to be specific about who, when, and where the exemption would apply. This amendment would be subject to public comment and could include commentary by the ASMFC. While straightforward textually, NMFS intent is to work with the ASMFC to address any possible concerns before such action is considered.

2.4.2 Enforcement and Monitoring Framework

Federal and state enforcement agencies may adopt a robust compliance and monitoring program for aquaculture operations. This may include reporting requirements, periodic inspections, and integration of vessel monitoring systems or remote electronic monitoring to ensure no illegal harvest of wild striped bass occurs under the guise of aquaculture.

2.4.3 Traceability and Supply Chain Integrity

A comprehensive traceability system ("farm-to-market") is essential to differentiate cultured striped bass from wild-caught products. Tools could include genetic certification, tagging, or electronic product tracking. Such measures would prevent substitution of illegally harvested wild fish into aquaculture supply chains, thereby preserving confidence among regulators, markets, and consumers. Importantly, this approach would align with existing wild striped bass tagging programs used by coastal states, creating a seamless framework for distinguishing wild and farmed fish in commerce.

2.4.4 Alignment with Fisheries Management Measures

Complimentary aquaculture regulations could be developed by the States in consideration of existing striped bass fisheries management tools such as bag limits, size limits, and possession limits. While these limits may not apply directly to aquaculture, aligning aquaculture rules with conservation objectives will minimize regulatory conflicts and reinforce stock protection.

2.4.5 Certification of Pure-Strain Cultured Striped Bass

To ensure that aquaculture production supports conservation, cultured fish could be certified as pure-strain and non-interbreeding with wild stocks. Hatchery protocols, broodstock management, and genetic testing would safeguard against introgression and maintain the integrity of wild striped bass populations. Non-interbreeding status can be achieved through strict physical containment measures, siting farms away from migratory stocks, or by applying genetic control approaches such as triploidy, sterility induction, or technologies to prevent successful interbreeding with wild fish.

2.4.6 Preventing Market Leakage of Wild Harvest

Clear rules, coupled with enforcement and traceability, must ensure that wild-caught striped bass do not enter markets under the label of cultured product. This will protect both the conservation gains achieved under ASMFC management and the credibility of aquaculture enterprises. Such safeguards are not new; they already exist within the current hybrid striped bass and pond-farmed striped bass industries, where farmed product is clearly distinguished from wild harvest through tagging, documentation, and distribution controls. Building on this established framework, similar approaches can be extended to offshore aquaculture operations to provide regulators, markets, and consumers with confidence that aquaculture production remains separate from wild harvest.

3 Striped Bass Aquaculture in the EEZ: Jurisdiction, Enforcement, and ASMFC's Potential Role

The governance landscape for striped bass in federal waters remains shaped by moratoria and ASMFC oversight, yet opportunities exist to adapt these frameworks for aquaculture without undermining wild stock protections. Traceability systems, tagging protocols, and strong enforcement provisions can close loopholes that otherwise risk illegal harvest. With proactive engagement, ASMFC and federal agencies can ensure that aquaculture complements conservation rather than conflicts with it.

3.1 Jurisdictional Context

As outlined in Section 2.3, harvest within the U.S. East Coast EEZ is prohibited. This section explores how the ASMFC could consider adapting existing authorities for oversight of striped bass aquaculture. These restrictions do not apply in the Gulf of America, where applications are actively being explored to farm Atlantic striped bass, not hybrid varieties, and commercial activity is already occurring, for the purpose of human consumption. Pond-based farms are operating in North Carolina, South Carolina, and Texas. North Carolina and Ohio are pursuing commercial-scale recirculating aquaculture following successful research trials. To have a meaningful role in the development of this industry, the ASMFC could consider using existing authority to establish monitoring and enforcement programs for striped bass aquaculture as the market expands and interest grows for production in the Atlantic.

Permitting for most aquaculture operations in the U.S. EEZ currently falls under the authority of federal agencies, specifically the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (ACE). Under the Magnuson-Stevens Act, the Regional Fishery Management Councils (RFMC) are consulted by NMFS in relation to impacts to Essential Fish Habitat (EFH) regarding the regulatory actions taken by either the EPA or the ACE. The ASMFC has representation on some regional fisheries management councils, but does not currently have a direct regulatory or enforcement role in EEZ aquaculture.

To clearly outline the current situation: permitting within the EEZ primarily falls under the jurisdiction of the EPA and the ACE. The RFMCs are typically not involved beyond Essential Fish Habitat (EFH) consultations, or to the extent a Council has taken actions on policies concerning aquaculture.

A complicating exception to the general rule above is that the management of Atlantic striped bass in state waters is primarily the responsibility of the coastal states, and is promulgated through the ASMFC’s Striped Bass FMP. The management unit includes all coastal migratory striped bass stocks on the East Coast of the U.S., excluding the EEZ, which is managed separately by NMFS. Under the Atlantic Striped Bass Act, Section 5158 requires NMFS to ensure that any regulations implemented in the EEZ for striped bass:

1) Are consistent with the national standards in Section 301 of the MSA (16 U.S.C. 1801 et seq.).
2) Are compatible with the Striped Bass FMP and each federal moratorium in effect, as authorized by statute.
3) Ensure the effectiveness of State regulations within the coastal waters of a state.
4) Achieve long term conservation and management goals for the Atlantic striped bass resource. Federal regulations in the EEZ can be developed to complement ASMFC's Striped Bass FMP.

In November 1990, NMFS implemented a moratorium on the harvest and possession of striped bass in the EEZ under the Striped Bass Act to support the ASMFC Striped Bass Plan, provide additional protection for striped bass, and ensure the effectiveness of state regulations. This moratorium remains in effect today and current federal regulations ban the fishing, harvesting, possession and retention of Atlantic striped bass in the EEZ. As interest grows in the commercial culture of pure-strain striped bass in federal waters both in the Gulf of America and along the Atlantic, it is essential to recognize the regulatory gap that exists and the opportunity for ASMFC to step into a more proactive and protective role.

If the ASMFC wishes to have a meaningful role in this process, it could implement enforcement provisions specific to striped bass aquaculture, an authority that it currently possesses. It is also important to note that the ASMFC may be compelled to act regardless, given the potential expansion of pure-strain striped bass aquaculture in the Gulf of America and the potential of that product entering markets along the Atlantic.

This represents a timely opportunity for the ASMFC to actively engage with its stakeholders and ensure its voice is heard in shaping policy.

3.2 Scenarios for ASMFC Involvement

The expansion of pure-strain striped bass aquaculture presents both economic opportunity and ecological risk. The ASMFC is uniquely positioned to provide oversight of this industry, in conjunction with their protection of the wild striped bass stock. While it does not control permitting in the EEZ, the Commission establishes fishery management provisions and compliance standards that apply to its member jurisdictions, and thus influence the actions taken by Federal agencies working in the EEZ. If the ASMFC wishes to ensure that aquaculture development walks in parallel with decades of conservation work, it can consider exercising its authority to define and enforce compliance expectations related to striped bass aquaculture. The emergence of pure-strain production in regions like the Gulf of America underscores the urgency of this engagement.

Core Enforcement and Compliance Issues

Ultimately, fishery managers need strong, enforceable assurances that the development of an aquaculture market for pure-strain striped bass will not create incentives for illegal harvest, not undermine the commercial fishery or cause negative impacts on wild stocks. The primary enforcement concern appears to be illegal harvest, direct illegal sales of striped bass to consumers and restaurants. Strategies such as product differentiation and proper enforcement mitigate these challenges by improving accountability on the water and enabling law enforcement to track fish back to their origin. Effective regulation may include:

1. **Traceability and Product Differentiation**

Consistent labeling protocols across the supply chain, from production through market, are critical to preventing product misrepresentation. Effective approaches include physical identifiers, documentation procedures, and standardized processing requirements. Regulatory frameworks vary by jurisdiction, with some states tagging fish at the point of landing and others at the point of sale. The ASMFC has considered mandating dockside landing tags for all states, citing concerns that point-of-sale systems create greater opportunities for illegal harvest. A uniform dockside landing requirement could strengthen enforcement by reducing the risk of unrecorded landings, particularly in states with individual quotas where incentives for illegal sales are high. By ensuring traceability from the time fish are landed, tagging provides enforcement agencies with a critical tool to safeguard quota integrity and deter unlawful market activity.

Harvest of aquaculture striped bass from large offshore farms presents unique challenges for product tagging. Unlike small-scale operations, tagging at the point of capture, during loading to a well boat, or aboard a harvest vessel is impractical when tens of thousands of fish may be collected in a single event. Although gill- or tail-tagging systems can process up to approximately 200 fish per minute, they require individual handling, may adversely affect product quality, and can raise animal welfare concerns.

Dockside tagging reduces the risk of illegal mislabeling between aquaculture and wild-caught fish and is generally supported by enforcement agencies as a means of enhancing oversight, reducing opportunities for unlawful practices, and strengthening accountability across the seafood supply chain. Implementation considerations include enforcement logistics, operational safety, and consistency across fisheries with differing management structures. In particular, fisheries operating under individual quota systems are especially vulnerable to quota evasion, making rigorous dockside tagging a critical tool for compliance and traceability.

2. Monitoring and Market Controls

Reporting and tracking mechanisms must be adopted to monitor volumes of production, sales, and distribution of cultured striped bass. Rules concerning possession limits, vessel traffic, and size regulations may be considered, where appropriate, to ensure that aquaculture harvests are not masking illegal wild harvests.

3. Enforcement and Penalties

Penalty structures can deter violations, including fraudulent substitution between wild-caught and aquaculture products. Penalties should be calibrated to serve as effective deterrents and implemented through a clearly articulated enforcement framework that coordinates federal, state, and interstate authorities. Enforcement records show persistent convictions for the illegal possession or sale of fish by recreational fishers, underscoring the need for robust accountability measures (ASMFC, 2025). While the direct risk of recreational fish being misrepresented as aquaculture products may be relatively low, traceability systems and tagging requirements strengthen oversight and help address illicit market activity. There may also be value in exploring tagging protocols for recreational harvest, which could support traceability efforts and help deter unauthorized sales. In addition, consideration could be given to consistent size restrictions across recreational and commercial sectors.

4. Enforcement Burden and Legal Authorizations

The ASMFC and NOAA (specifically NMFS Office of Law Enforcement, OLE) collaborate extensively on fisheries enforcement. Their partnership blends federal oversight with regional/state-level enforcement, sharing burdens via multi-agency agreements and funding mechanisms tied to the Magnuson-Stevens Act and the Atlantic Coastal Fisheries Cooperative Management Act.

Under the Atlantic Coastal Fisheries Cooperative Management Act, NOAA provides funding to the states, in part, to support law enforcement capacity, including for Joint Enforcement Agreements (JEAs). NOAA’s OLE maintains formal agreements with a wide list of states (e.g., MD, MA, FL, GA, etc.) to ensure nationwide coverage. ASMFC’s Law Enforcement Committee (LEC) includes representatives from each member state plus NOAA, U.S. Coast Guard (USCG), and U.S. Fish and Wildlife Service (USFWS). Its tasks include reviewing enforcement plans, coordinating cross-jurisdictional efforts, and advising on regulation enforceability.

5. Law Enforcement Considerations

When reviewing investigation and criminal provisions, the following may be considered by the Law Enforcement Committee of the Atlantic States Marine Fisheries Commission:

- Consider a uniform regional traceability system for all seafood products harvested or produced for commercial sale, clearly distinguishing aquaculture from wild-caught sources.
- Standardize labels by year, type (aquaculture vs. wild-caught), color, and inscriptions for easy identification and traceability.
- Issue time-limited tags or labels (valid for a single calendar or fishing year) to ensure currency and prevent reuse or fraud.
- Include essential information on each tag, such as year, state or facility of origin, source type (aquaculture/wild), size limits (if applicable), and a unique identifier.
- Use tamper-evident and traceable tags that cannot be transferred between fish or altered without detection.
- Consider immediate tagging at the point of harvest or harvest-equivalent (e.g., at aquaculture facility dispatch or wild harvest landing).
- Require aquaculture operations to report production volumes and verify tag use based on certified harvest quantities.
- Enforce annual or seasonal return of all unused tags or labels, and prohibit federal permit renewal for non-compliance.
- Integrate tag tracking into dealer reports or electronic trip tickets, including identification of whether the product is farmed or wild-caught.
- Apply meaningful penalties, including license suspension or revocation, for mislabeling, misuse of tags, or other violations at the state or federal level.
- Ensure real-time, centralized access to tag issuance and use data for authorized enforcement personnel to facilitate on-the-ground inspections and audits.

Existing Models and Precedents

States have already taken action to regulate striped bass aquaculture in ways that promote transparency and accountability. Some states require a tagging program for commercially harvested striped bass. It is unlawful to sell or purchase commercially caught striped bass without a commercial tag. The intent is to prevent the sale or purchase of untagged striped bass in a state or jurisdiction where there is currently no commercial fishery program. Notably, Virginia had previously administered a detailed regulatory framework for culture of pure-strain striped bass. These efforts provide a valuable foundation for broader regional and federal collaboration.

A strong regulatory framework with effective enforcement and monitoring is essential to maintaining the integrity of the seafood supply chain. Clear differentiation between aquaculture-raised striped bass and wild-caught striped bass is critical to ensure consumer transparency and market fairness. To address these concerns, several Atlantic coastal states, including Massachusetts, Maine, New Hampshire, and Virginia (prior to repeal) have taken steps to regulate the labeling, handling, and marketing of aquaculture-raised hybrid striped bass. These state efforts promote transparency and accountability and provide a valuable foundation for broader regional and federal collaboration.

1. Maine and New Hampshire

Maine and New Hampshire have adopted similar regulatory frameworks to ensure that aquaculture-raised striped bass are accurately labeled and traceable throughout the supply chain. This alignment reflects a broader regional effort to promote consistency in labeling and enforcement standards across jurisdictions.

The sale of wild striped bass caught for personal use or by commercial fisheries in other states or jurisdictions is prohibited in the State of Maine. Striped bass sold in Maine markets and restaurants is therefore a cultured product and is primarily hybrid striped bass. In Maine, regulations under 13 DMR § 188-42-02 require containers of aquaculture-raised hybrid striped bass, whether whole or filleted, to be labeled as "Hybrid Striped Bass" and include the state of origin; the names, permit numbers, and addresses of shipping and receiving dealers; the date of shipment; and the net weight of the container. Fillets must retain their skin, and like in Massachusetts, the use of the term "striped bass" for marketing hybrid products is prohibited. Possession exemptions already exist in Maine; chiefly the exemption applies to aquaculture products that do not meet the legal size or season requirements for wild-caught marine organisms of the same species.

New Hampshire enforces nearly identical standards through N.H Admin. Code § Fis 807.14. The regulation cites the potential for hybrid striped bass markets to be used as outlets for undersized striped bass and emphasizes the importance of regulatory consistency across states. Like Maine and Massachusetts, New Hampshire mandates clear product labeling, skin-on requirements for fillets, and restricts the use of the term "striped bass" in marketing or sales for hybrid striped bass.

2. Virginia

Regulations for the commercial striped bass fishery in Virginia include minimum sizes, possession limits, gear restrictions, seasons, and quotas. Virginia previously administered a detailed regulatory framework for the lawful propagation, sale, and transport of aquaculture-raised striped bass and hybrid striped bass under 4VAC20-252.

Under this system, anyone seeking to operate an aquaculture facility to raise striped bass or hybrid striped bass in Virginia was required to obtain a permit from the Virginia Marine Resources Commission. The permit authorized and defined the limits for the purchase, possession, sale, transfer, and transport of striped bass and hybrid striped bass for aquaculture purposes. Permits were issued annually on a non-transferable basis, and were automatically renewed by the Commission provided the facility had been adequately maintained and remained structurally unchanged and in compliance with all permit conditions.

Permitted facilities were only allowed to acquire eggs, fry, and fingerlings from state-permitted, disease-free dealers. Each acquisition required documentation with receipts detailing the species, quantity, date, source, and destination. Harvesting striped bass from Virginia's tidal waters for the purpose of artificial spawning in aquaculture facilities remained subject to applicable state fishing laws, such as size limits and seasonal closures. Under the previous section, 4VAC20-252-210(C), striped bass or hybrid striped bass produced at a permitted aquaculture facility in another state may be imported for sale in Virginia, provided that all standards outlined in the regulation are met. Section 252-210 was repealed in April 2024 as an attempt to streamline regulations by the Commonwealth.

All market-ready fish had to be labeled with the name, address, and permit number of the producing facility. In addition, all sales and resales needed to be accompanied by a receipt documenting the species, seller, purchaser, date of sale, and production facility information. Copies of receipts were required to be kept by both parties and made available to enforcement authorities upon request. Permitted facilities were also required to maintain a chronological file of transactions for inspection by the Department of Wildlife Resources or agents of the Marine Resources Commission.

3. Massachusetts

Though Massachusetts does not have a legal framework addressing the aquaculture of pure strain striped bass, it does have an analogous legal framework for product differentiation of aquaculture vs wild caught product. Massachusetts enforces robust standards under 322 CMR 14.00 for the sale, transport, and distribution of aquaculture-raised finfish, with specific provisions for aquaculture-raised hybrid striped bass. Under Section 14.01, the state requires that all containers of aquaculture-raised striped bass, whether whole or filleted, are clearly labeled as "Hybrid Striped Bass". The labels must also include information on the state of origin, the names, and addresses of shipping and receiving dealers, the permit numbers of the shipping and receiving dealers, the date of shipment, and the net container weight. Aquaculture-raised hybrid striped bass fillets are also required to have the skin attached. Additionally, 322 CMR 14.01(5) makes it unlawful to promote, market, sell, or advertise hybrid striped bass products as "striped bass". Massachusetts extends these labeling requirements to all aquacultured finfish species that are wild caught and landed in the state. It also prohibits any sale, promotion, or transport of aquaculture-raised finfish unless they are properly labeled and clearly identified as being an aquaculture product.

4. North Carolina

Finally, while not directed toward aquaculture, an analogous legal framework for product differentiation exists in North Carolina. The state governs the possession and sale of wild-caught striped bass through a permitting and tagging system under 15A NCAC 030. 0503. Fish dealers must obtain a Striped Bass Dealer Permit for a specific harvest area- the Atlantic Ocean, the Albemarle Sound Management Area, or the Joint and Coastal Fishing Waters of the Central/Southern Management Area. Sale, purchase, or possession of striped bass without a validated dealer permit is unlawful. Striped bass taken from open harvest proclamation areas must have a tag attached to the mouth and gill cover. Tags are issued by the North Carolina Division of Marine Fisheries and must not be bought, sold, or transferred. These regulations support accountability and traceability and are designed to separate legally harvested wild-caught fish from illegal or misrepresented products in the market. Farmed striped bass in North Carolina are not subject to tagging requirements for transport or retail sale but must be accompanied by documentation identifying their cultured origin throughout shipment and distribution. The production of farmed striped bass requires appropriate permits or licenses from the North Carolina Department of Agriculture and Consumer Services, with additional regulatory oversight by the North Carolina Division of Marine Fisheries.

Without clear and consistent standards for traceability, aquaculture markets could unintentionally become an outlet for illegally harvested or undersized wild-caught striped bass. This not only undermines fishery management goals, but also erodes consumer confidence. Together, these state-level regulations demonstrate a coordinated approach to strengthen transparency, traceability, and compliance in the seafood supply chain. Additionally, they provide a valuable foundation for coordinated regional strategies or future federal policies aimed at ensuring product integrity and building consumer trust in the growing domestic aquaculture sector.

4 Marine Spatial Planning and Siting

The identification of suitable areas for aquaculture development, coupled with careful site selection and management, is fundamental to ensuring the success and long-term sustainability of offshore aquaculture. Forecasting environmental interactions represents a critical first step, providing the foundation for coastal and ocean-use planning while helping to equitably address points of resistance to aquaculture expansion.

This section highlights the challenges associated with unplanned or poorly coordinated aquaculture development and emphasizes the benefits of structured marine spatial planning (MSP) approaches. Spatial planning tools ranging from geographic information systems (GIS) and remote sensing to coupled biophysical and socioeconomic models offer science-based frameworks to guide aquaculture expansion in both coastal and offshore environments (Froehlich et al., 2017; Lester et al., 2018). Integrated approaches, such as the ecosystem approach to aquaculture (EAA), explicitly account for ecological carrying capacity, stakeholder interests, and governance structures (Morris et al., 2025; Theuerkauf et al., 2019). Increasingly, these tools are being adopted by regulatory agencies and decision-makers to address environmental, economic, social, and governance considerations, including biosecurity, climate change, and competition among ocean users.

Recent advances in MSP have yielded a suite of decision-support tools that foster coordinated, participatory, and integrated approaches to aquaculture management (Kapetsky et al., 2013; Gentry et al., 2017). Such tools not only help protect natural resources but also provide mechanisms to balance multiple, and often conflicting, uses of marine space. Drawing on case studies, this section identifies both successful examples of MSP implementation and common pitfalls or barriers that may hinder practical application.

Planning for aquaculture operations in U.S. federal waters requires a particularly high level of spatial analysis, given the diversity of existing ocean uses and the complex siting criteria required for offshore fish farms. Suitable sites must balance biophysical parameters (e.g., water depth, current speed, wave exposure, distance to port) with regulatory requirements, ecological sustainability, and social acceptance. Effective planning also necessitates consideration of cumulative impacts across time and space, as well as harmonization of aquaculture siting with broader sustainability goals and regulatory frameworks.

Recent planning and permitting efforts in the Gulf of America and Southern California highlight the necessity of multi-agency collaboration in evaluating candidate farm areas (Riley et al., 2021; Morris et al., 2021; Wickliffe et al., 2024). These processes incorporated assessments of navigation corridors, military operations, industrial activities, commercial and recreational fisheries, protected species, and sensitive habitats to minimize conflicts across ocean sectors. In both cases, spatial analysis tools proved essential at different stages of decision-making. For example, automatic identification system (AIS) vessel-tracking data, which record ship position, course, and speed, were used to evaluate potential navigational conflicts during planning. These analyses highlighted when specific data layers (e.g., vessel traffic, habitat mapping, socioeconomic information) were most informative—some being critical during the early planning phase to guide siting alternatives, and others later in permitting phases to refine project footprints and mitigate conflicts.

Together, the Gulf of America and Southern California case studies represent the most significant federal step yet to support offshore aquaculture development and underscore the importance of structured spatial planning in advancing offshore aquaculture for species such as striped bass along the U.S. coastline. By integrating ecological, economic, and social dimensions, MSP provides a transparent and adaptive framework capable of facilitating industry growth while safeguarding ecosystem health and compatibility among multiple oceanic uses.

As part of NOAA's National Ocean Service, the National Centers for Coastal Ocean Science (NCCOS) plays a central role in advancing MSP by developing science-based inclusive decision tools to inform precision siting for aquaculture and other sectors of the ocean economy. NCCOS integrates GIS technologies with ecological and ocean-use data to support planning, scoping, authorizing, and mitigating activities. These robust quantitative tools are paired with community and stakeholder engagement methods to bring in social-cultural considerations into the analysis. This approach provides strategies for siting aquaculture operations that account for regulatory and management priorities as well as stakeholder concerns. By reducing user conflicts and enabling coordination among regulators, operators, and stakeholders, spatial planning supports responsible aquaculture development in U.S. federal waters.

4.1 Siting Considerations for Atlantic Striped Bass

NOAA's NCCOS conducted a preliminary spatial analysis to identify thermally suitable areas for striped bass aquaculture along the U.S. Atlantic coast. The analysis evaluated both state and federal waters from Maine through Florida by quantifying how often water temperatures fell within defined biological production thresholds.

The suitable temperature range is defined as the range of water temperatures over which striped bass can maintain normal physiological function, survive, feed, and grow at commercially viable rates. Recent work conducted with industry partners indicates that temperatures from 15 to 30 °C support commercial production of striped bass from approximately 50 g to 2.5 kg (Andersen et al., 2021). Within this broader suitable range, the optimal temperature range represents the narrower thermal window that maximizes growth, feed conversion, and production efficiency. Laboratory studies of juvenile striped bass have identified optimal temperatures ranging from 24 to 28 °C (Cox & Coutant, 1981; Secor et al., 2000), while grow-out performance in production settings is generally reported optimal between 22 and 26 °C (R. Borski, North Carolina State University, pers. comm.). This framework aligns with bioenergetic growth models developed for striped bass, where the suitable thermal range represents conditions that sustain survival and growth (Hartman & Brandt, 1995), while the optimal range for aquaculture identifies the temperatures that maximize growth, production efficiency, and profitability (Klinger et al., 2017; Mengual et al., 2021).

Temperatures below 15 °C or above 30 °C are expected to reduce physiological performance, slow growth, and lower economic returns. Because striped bass in offshore systems are fully submerged, the assessment used modeled temperatures between 6-10 m depth to represent cage conditions. The siting analysis also limited candidate areas to water depths of 50 to 150 m to support cage infrastructure and to locations within 30 nautical miles of shore, since greater distances are likely to reduce economic viability.

The Naval Research Laboratory Global Ocean Forecasting System 3.1: 41-layer HYCOM + NCODA Global 1/12° Analysis dataset was used to estimate temperatures at depth as it provided the high spatial and temporal range and resolution needed for this analysis. The dataset provides modeled temperatures at 40 depth levels throughout the global ocean, at eight times throughout the day to inform daily temperature ranges. For each grid cell, minimum and maximum daily temperatures were extracted, and a location was considered to fall within the thermal range only if both values were within the defined threshold range. The number of qualifying days was then tallied across the study period. Cage culture constraints, as outlined previously, were applied to further isolate areas with appropriate thermal conditions, sufficient depth for viable cage deployment, and distances from shore that are economically realistic. Depth estimates were sourced from the NOAA National Centers for Environmental Information Earth Topography (ETOPO) Global Relief Model (NOAA NCEI, 2022). Data from 2020–2023 were used to calculate the mean number of days within suitable and optimal ranges per year.

Large areas of thermal suitability were identified throughout the mid-Atlantic and southern Atlantic regions, with many locations remaining within the suitable range for nearly an entire year (Figure 1). When cage culture siting criteria were applied (i.e., depth and distance to shore) the extent of available areas decreased substantially; however, regions off Florida and North Carolina continued to provide broad areas of suitable conditions. Optimal temperatures were less common than the broader suitable range, as expected, but conditions exceeding 100 days per year at optimal temperatures were observed along the mid-Atlantic and southern coast. Despite the prevalence of wild striped bass populations in the northeast, areas north of Cape Hatteras, North Carolina, frequently experienced temperatures below the suitable range, often for weeks at a time and more than 100–200 days annually. Elevated temperatures were less problematic, as the Gulf Stream remains offshore of the 30 nm distance from shore constraint that was applied.

During our study period, an average of 68.2 million ha of state and federal waters along the Atlantic coast met the suitable temperature range for striped bass aquaculture ≥ 250 days annually. Within this area, an average of 27.1 million ha was within the optimal temperature range for at least 150 days. When depth and distance from shore criteria were applied to the areas that experienced optimal temperatures on average ≥ 180 days the area decreased to 429,000 ha, located off the coasts of North Carolina and Florida.

Although the physiological performance, growth, and bioenergetics of striped bass is comparatively well studied (e.g., Anweiler et al., 2019; Penny & Pavey, 2021; 2023), important uncertainties remain regarding the thermal tolerances of different populations and life history stages. Laboratory studies are required to clarify how thermal thresholds vary across developmental stages and genetics, thereby informing more precise bioenergetic modeling. Additional physiological thresholds should also be quantified and integrated into future analyses to better characterize the species' aquaculture potential.

Expanding this analysis to other regions of the U.S. EEZ would provide a broader perspective on feasibility. Moreover, as ocean conditions continue to shift, evaluating bioenergetic thresholds under forecasted climate and thermal regimes will be essential to assessing the opportunity and longevity of aquaculture potential. Such analyses should also consider the adaptive capacity of both the industry and the species itself when estimating long-term temperature changes. Finally, extending this framework to other candidate species would help identify opportunities for advancing offshore aquaculture in U.S. waters.

Climate Change and Ocean Warming

Projected warming of the northwest Atlantic is expected to alter thermal suitability for striped bass. Offshore sites in North Carolina and Florida already approach the upper tolerance threshold of 30°C during summer months, potentially increasing risks of thermal stress (Friedland et al., 2025). Conversely, northern sites may become more viable under warming scenarios.

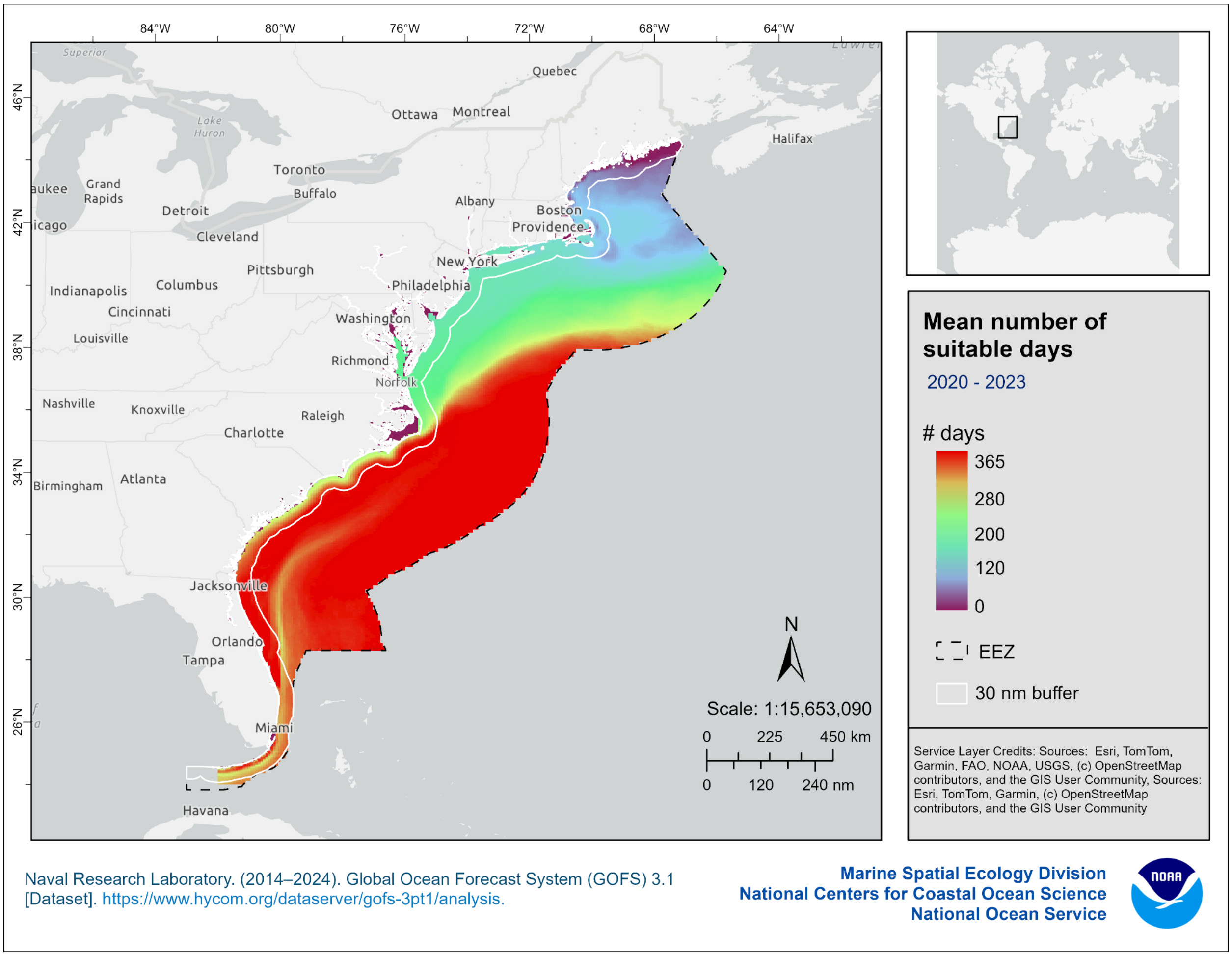

Figure 1. Number of days at suitable temperatures (15–30 °C) for striped bass, *Morone saxatilis*, in 2023. Water temperatures are presented for coastal and offshore waters through the extent of the Atlantic Coast U.S. EEZ (200 nm).

5 Consumer Awareness and Markets

Market conditions strongly favor the development of a domestic pure strain striped bass aquaculture sector (Andersen et al., 2021). Demand for sustainable, locally produced seafood is high, while wild harvests remain limited and imports of striped bass dominate supply. Pure-strain striped bass is well positioned to fill this gap, offering a recognizable and desirable product with strong consumer appeal and broad market potential.

When assessing the economic viability and sustainability of any new aquaculture industry, understanding market conditions, including supply and demand dynamics, is fundamental. These data inform pricing strategies, consumer behavior, and resource planning, while also guiding regulators and legislators on how to maximize economic benefits and minimize conflicts with existing enterprises.

Commercial hybrid striped bass aquaculture has been established in the U.S. since the late 1980s, complementing centuries of commercial capture fisheries. Despite these markets, interest from both producers and buyers is growing for pure-strain striped bass to meet rising demand for white-fleshed marine fish. Recent research and stakeholder engagement have also identified striped bass as a top candidate species for marine aquaculture expansion in the U.S. (Rexroad et al., 2021; Andersen et al., 2021; StriperHub, https://ncseagrant.ncsu.edu/striperhub/). These developments underscore the importance of evaluating the species' economic characteristics as commercialization advances.

5.1 Supply

A critical component of any economic analysis is the characterization of current market supply. For domestic aquaculture, evaluating the supply of wild-caught and imported alternatives provides insight into existing demand for a species and reveals trends in market strength over time. A comprehensive supply analysis for striped bass and other marine finfish species was previously conducted by Engle, van Senten, and Schwarz (2023); a similar methodology will be applied here using updated statistics to reflect current market conditions. This analysis will also incorporate the supply of farmed hybrid striped bass, given its relevance and similarity to the striped bass market.

According to the FAO (2025a), the only two regions where pure strain striped bass has been farmed since 1950 are Mexico and the Palestinian Territories. In 2023, Mexico had not reported any production (1,406 metric tons; 2022) and the Palestinian Territories had produced only 4 metric tons (FAO 2025a). Seven countries have produced farmed hybrid striped bass since 1950, however only four (Denmark, Israel, Italy, and the U.S.) reported production in 2024. The U.S. produced nearly 80% of the total supply of farmed hybrid striped bass in 2023 reaching 2,404 metric tons (FAO 2025a). Although the 2023 USDA Census of Aquaculture did not individually report statistics on food fish striped bass farms, 51 operations were identified as producing pure striped bass for "conservation, recreation, enhancement, or restoration purposes" in 2023 (USDA-NASS 2024).

Several states along the Atlantic coast allow for variable scales of commercial striped bass harvest, including Massachusetts, Rhode Island, New York, Delaware, Maryland, Virginia, and North Carolina. Commercial landings of striped bass reached 1,788 metric tons in 2023 while recreational landings were more than six times that (10,961 metric tons) in the same period (NOAA 2025b). While commercial landings remained relatively flat from the prior year, recreational landings fell by 33% in 2023 compared to 2022 (NOAA 2025b). Overall, the current supply of striped bass products in the U.S. is limited, fragmented, and unable to keep pace with demand. Wild harvests are strictly regulated and hybrid aquaculture production, though established, has not scaled to meet broader seafood market needs. These constraints on supply highlight the opportunity for pure-strain striped bass aquaculture to expand domestic availability. With this supply gap established, the following section considers consumer demand and market drivers that make striped bass a compelling candidate for offshore aquaculture development.

5.2 Demand

The U.S. per capita consumption of seafood has remained relatively stable for the last 20 years, reaching 22.1 kg of consumption in 2022 similar to other “high-income countries” (FAO 2024). However, demand for imported seafood in the U.S. still remains the highest in the world, purchasing $26.6 billion in 2024 which was $4 billion more than the next country, China (FAO 2025b). In fact, 70-90% of the total seafood that is consumed in the U.S. is imported, with more than half of that volume coming from farmed sources (NMFS 2024). In recent years, the American consumer has shown an affinity for farmed products and is willing to pay more for locally produced seafood (Fonner & Sylvia 2015; Brayden et al., 2018; Quagrainie 2019; Bouchard et al., 2021; Asche et al., 2022; Athnos et al., 2023). A domestic farmed striped bass industry has the potential to tap into these markets and take advantage of these US demand characteristics.

The primary market for striped bass extends across much of the U.S. eastern seaboard and Gulf States, where the species is well recognized and valued due to its long-standing fisheries. Additional, though smaller, markets exist in inland states. Wild-caught striped bass are harvested commercially under strict state-specific seasonal quotas and size limits and are typically landed at larger sizes (greater than 8–10 lbs.), making them well suited for fillet markets and high-end restaurants. In contrast, hybrid striped bass supply a different niche, commonly marketed at smaller sizes (1.5–2.0 lb.) and sold whole or live, particularly to urban ethnic markets. Farmed striped bass could enter channels similar to those of wild-caught fish while offering the advantage of year-round availability. As a highly recognizable product with versatile applications (e.g., whole fish, fillets, sushi), farmed striped bass would be positioned to complement, rather than replace, existing market segments.

Consumer preferences for several aquaculture species highlighted in the southeastern U.S. have been evaluated to better understand consumption habits (Agyeman et al. 2025; Rexroad et al. 2021). Respondents who rated the “source” of their striped bass as an important attribute, consumed it seasonally, and preferred to purchase it in restaurants or grocery stores were more likely to express strong demand (Agyeman et al. 2025). These findings suggest that future producers could successfully market striped bass through restaurants and grocery stores to seasonal consumers already familiar with the product.

Interestingly, price was not a statistically significant factor influencing the likelihood of purchase (Agyeman et al. 2025). Further work on consumer perceptions specific to striped bass is currently being conducted by StriperHub.

The extent to which farmed striped bass will substitute for imported or wild-caught striped bass in domestic markets remains uncertain and will require further study once production facilities are established. Market impacts will depend on factors such as relative price and availability of alternatives, product quality, production volumes, and the specific market channels targeted. Importantly, the introduction of a farmed product could also stimulate overall demand by increasing consumer exposure to striped bass in different seasons and product forms not traditionally available.

5.3 Harvest, Transport, and Processing

Hybrid striped bass are typically harvested at a size of 1.5-2.5 lbs., which is attained after 16-20 months of growout depending on the culture practices and environmental conditions. Fish are harvested using seines, lift nets, or pumping systems, and are either immediately placed in ice slurries to maintain product quality or live-hauled to urban ethnic markets which often provide the highest prices. Regardless of the sales channel, hybrid striped bass are sold almost exclusively as whole fish, with limited processing into fillets or other value-added products. At typical harvest sizes, hybrid striped bass yield only 30–35% fillet recovery, which is comparatively low and provides little incentive for processors to pursue fillet production.

Pure striped bass are produced in much smaller volumes, largely for regional markets. In the U.S., their proposed market size is 3–7 lbs., which can be attained in 24–36 months under favorable culture conditions. Unlike hybrids, pure striped bass are envisioned for harvest and processing into fillets and other value-added products, following a model more typical of marine finfish such as salmon. At these larger harvest sizes (≥3 lbs.), striped bass can achieve fillet yields closer to 40%, producing thicker cuts that resemble their wild-caught counterparts, a characteristic that enhances consumer familiarity and market appeal.

Efficient harvest and processing logistics are critical to resource use in offshore striped bass aquaculture. Variables such as harvest frequency, size uniformity, and stocking density directly influence costs and product quality (Engle et al., 2024). Uniform fish size simplifies grading and increases processing efficiency, though variability at scale can complicate operations. Optimizing stocking densities and harvest timing improves yields and reduces waste (Andersen et al., 2021).

Cold-chain management is important for striped bass, a high-value product requiring rapid chilling and continuous refrigeration to maintain freshness. Offshore distance complicates logistics, often necessitating insulated containers or onboard chilling systems (Srikanth et al., 2018). Efficient harvest and processing capacity will be critical for maintaining product quality, securing consistent supply, and enabling striped bass to penetrate broader domestic seafood markets.

5.4 Production Costs and Economic Contribution

Although no published studies have directly measured the cost of production for striped bass aquaculture in the U.S., several analyses have drawn on data from related species and production systems. Engle et al. (2024) estimated production costs for striped bass under three scenarios in the southern U.S.: coastal ponds modeled after red drum farms, offshore net pens modeled after greater amberjack (*Seriola dumerili*) and salmon farms, and recirculating aquaculture systems (RAS) modeled after salmon and rainbow trout facilities. Capital investments, production costs, and equipment requirements were adapted from these established industries, while biological performance assumptions for striped bass were derived from scientific literature and expert consultation. The analysis indicated that striped bass aquaculture was only profitable in offshore net pens, with breakeven prices comparable to those of commercially farmed red drum. Breakeven yields were similar to those of black drum, but higher than those required for species such as spotted seatrout and Florida pompano. Additional commercial research is needed to refine these estimates, and profitability in pond or RAS culture may be achievable with further technological and management improvements.

Economic contribution analyses provide broader insight into the linkages between aquaculture and other sectors of local, state, and national economies. A recent study by Kumar et al. (2024) found that U.S. aquaculture contributed $3.8 billion to the national economy and supported more than 22,000 jobs. Foodfish farms exhibited an economic multiplier of 1.79, while marine aquaculture had a multiplier of 1.78, meaning that each dollar spent generated an additional $0.79 and $0.78, respectively, in related economic activity. The development of a robust striped bass aquaculture industry has the potential to generate similar spillover benefits, particularly for coastal communities. Such growth could stimulate investment in marine infrastructure and logistics networks, creating shared benefits across multiple industries.

5.5 Conclusion

While the true economic and marketing characteristics of striped bass aquaculture cannot be fully assessed until a commercial industry is established in the U.S., potential can be estimated from current science, existing literature, and comparable industry sectors. Hybrid striped bass has been cultured successfully at commercial scale since the 1980s.

There is momentum and a growing shift toward pure-strain striped bass culture, with several farms in North Carolina, Florida, and Texas already pursuing this transition. In contrast, the supply of wild striped bass in the U.S. remains limited relative to other fisheries, and the long-term sustainability of both commercial and recreational harvest is increasingly uncertain.

Demand for seafood in the U.S. remains strong with the majority of products being imported. While commercial-scale striped bass aquaculture is still in the early stages, economic indicators suggest the species has viable market potential, particularly in the context of growing consumer demand for domestic, sustainably produced seafood. Demand-side conditions are favorable, yet production cost challenges and regulatory inconsistencies—especially in states with gamefish designations—must be addressed. Interstate transport and sale of pure-strain farmed striped bass could present barriers for market development that will require synergies between state and federal regulations to avoid enforcement challenges and ensure transparency.

6 Striped Bass Aquaculture History

The history of striped bass aquaculture has been detailed extensively in the literature, with Andersen et al. (2021) offering the most current account. The culture of striped bass was first described in the late nineteenth century by managers with an interest in stock enhancement to improve production of fish for enhancing commercial and recreational fisheries for tributaries of Albemarle Sound, Chesapeake Bay, Delaware Bay, and New York Bay (Worth 1884a; Bowers 1900). The first published report of a successful hatch of striped bass eggs under artificial conditions was made in 1874 by Spencer Baird, the first commissioner of the U.S. Commission of Fish and Fisheries (Baird, 1874). In 1879, the U.S. Fish and Wildlife Service (USFWS) hatched striped bass fry at a site located along the Abermarle Sound in North Carolina that had been used as an American shad (*Alosa sapidissima*) hatchery (USFWS, 1882). The U.S. Fish Commission established the first dedicated hatchery for the propagation of striped bass in Weldon, NC (Worth 1884b). The Edenton National Fish Hatchery was then established in North Carolina in 1898 by the USFWS with a similar purpose to Weldon (Woodroffe, 2012).

In the early twentieth century, the USFWS published technical manuals detailing procedures for spawning, hatching, and fry release of various cultured fishes, including striped bass (Piper, 1982). By 1910, the foundational methods for striped bass propagation were already established; however, the U.S. Bureau of Fisheries, formerly U.S. Fish Commission, abandoned plans for marine stock enhancement (Worth, 1910). Interest in hatchery-based programs was revived in the 1950s, following the discovery of a naturally reproducing striped bass population in the Santee–Cooper Reservoir system of South Carolina (Scruggs Jr., 1957). This development stimulated a large-scale augmentation program aimed at creating self-sustaining populations in freshwater rivers and reservoirs across the southeastern U.S., including Kentucky, Alabama, Georgia, and South Carolina (Geiger & Parker, 1985; Kinman, 1988; Stevens, 1975). By the 1980s, striped bass had been successfully stocked into hundreds of reservoirs across at least 36 states (Stevens, 1984; Kinman, 1988). Despite much success advancing culture and stocking practices, striped bass remained a challenging species.

A range of biological and operational constraints historically limited the development of striped bass culture. Key challenges included: (1) high sensitivity to handling and confinement stress; (2) inconsistent spawning success and unreliable hatchery production; (3) cannibalism during larval and juvenile stages, particularly under high stocking densities; (4) susceptibility to bacterial, parasitic, and viral diseases; and (5) elevated mortality during harvest, grading, and transport. Collectively, these constraints hindered large-scale adoption of striped bass aquaculture and shifted industry emphasis toward the culture of hybrid striped bass, which demonstrate improved tolerance to handling and environmental variability, more consistent performance on formulated feeds, and greater overall resilience to health management challenges. While history shows technical challenges, the hybrid industry demonstrates scalable solutions that inform pure-strain development.

6.1 Striped Bass Aquaculture: Lessons from the Hybrid Industry and Pathways for Expansion

Beginning in the 1960s, hybrid crosses between striped bass and other Moronids were produced because preliminary findings indicated that hybrids exhibited greater tolerance to extremes in temperature and dissolved oxygen than either parental species so were better suited in many aquaculture systems (Logan 1968). The most common cross made was between striped bass males and white bass (*M. chrysops*) females (i.e., sunshine bass) because many producers found that spawning smaller white bass females required less expertise than spawning striped bass females (Smith 1988). It was not until emergency fishing moratoriums were imposed (Maryland 1985–90; Virginia 1989–90) following the collapse of the striped bass fishery in the 1980s that the path for commercial hybrid striped bass aquaculture as a means of supplying a valuable seafood product emerged (Hodson & Hayes, 1990).

Today, the hybrid striped bass industry is fourth in value among finfish species in the U.S., behind only channel catfish, Atlantic salmon, and rainbow trout. Hybrid striped bass are currently cultured in about 19 different states, particularly in the South and Midwest, in constructed, inland freshwater ponds. The fish are usually grown for about 16 months, and are marketed whole at approximately 680 g (1.5 lbs.; D'Abramo et al., 2002). In coastal states, consumers are accustomed to, and often prefer, pure-strain wild striped bass harvested from marine environments. Pure strain striped bass, rather than hybrids, are also highly preferred in lucrative ethnic markets, seafood restaurants and sushi bars, and unlike hybrids, these pure strain striped bass can be grown in “open” systems (e.g., coastal areas) with reduced risk of genetic contamination of wild stocks. Marine striped bass culture was even initiated to meet this demand, and for these purposes, fish are generally grown to larger sizes (2.2 kg) for whole, gutted, or filleted market forms.

Although hybrids have successfully established their niche in the US aquaculture landscape, they have struggled to penetrate mainstream markets where pure striped bass have an advantage. Nonetheless, they offer a close industry comparable in terms of production planning discussions and have helped lay the foundational research for pure striped bass aquaculture. The remaining sections of this chapter will provide an overview of the current understanding of production planning and intensive culture systems for striped bass by drawing upon strategies from the closely related and established U.S. hybrid industry.

6.2 Hatchery and Nursery Systems

Hatcheries typically maintain broodstock, which are induced to spawn using temperature and photoperiod manipulation, behavioral cues, and hormone induction when necessary (Hodson and Sullivan 1993; Clark et al., 2005; Andersen et al., 2021). Once spawned, fertilized eggs are incubated in McDonald-type hatching jars or tanks until they hatch, usually within 2-3 days at water temperatures of 18-22°C. After hatching, the larvae are either transferred directly into fertilized ponds or maintained in indoor nursery tanks where they are fed a diet of live zooplankton such as rotifers and brine shrimp nauplii (i.e., *Artemia*). As the larvae grow, they are weaned onto commercially prepared diets.

Once juvenile striped bass reach a size of approximately 1–2 g, they are typically transferred to outdoor nursery ponds or larger tanks for further grow-out. Earthen ponds, ranging from 0.1 to 1.0 ha, are fertilized to enhance natural productivity and supplemented with commercial feeds. Juveniles are commonly stocked at densities of 50,000–100,000 fish per hectare and grown to 10–50 g over a period of 3–4 months.

Indoor RAS systems represent an alternative nursery method, particularly in regions where temperatures are unsuitable for pond culture (e.g., colder latitudes). RAS facilities produce juveniles for transfer to larger land-based farms. Outdoor ponds and climate-controlled RAS present viable opportunities to produce large numbers of fingerlings required for offshore aquaculture operations. A parallel model exists in the Atlantic salmon industry in Norway, where smolt are reared in freshwater hatcheries and nursery systems before transfer to coastal and offshore marine cages. Over the past decade, conventional flow-through hatcheries have increasingly been replaced by RAS, which offer advantages in water use efficiency, environmental control, and siting flexibility (Brown et al., 2025).

6.3 Transport and Stocking

When juvenile striped bass reach the target size, they are harvested from nursery systems and transferred to grow-out facilities. Harvesting is commonly conducted using seines or by draining ponds, after which fish are loaded into transport tanks equipped with aeration or oxygenation systems to maintain water quality during transit. Upon arrival, fish are acclimated to the receiving water before being stocked into production units.

Stocking densities in grow-out systems vary with production intensity and facility design, typically ranging from 10 to 50 kg/m³. In pond or net-pen systems, densities are generally maintained at the lower end of this range due to limited environmental control, whereas RAS can support higher densities under carefully managed conditions with systems for management of water quality, dissolved gases, and disinfection. In these open-water and pond environments, densities are also moderated by the larger volume of production systems and the space afforded allowing individuals to swim more freely.

6.4 Growout Systems

Although most U.S. production of hybrid and pure striped bass occurs in ponds, tanks, and raceways, there is increasing interest in offshore culture systems to meet growing demand for marine foodfish. Offshore aquaculture involves rearing fish in marine cages or net pens located in coastal or offshore waters. These systems offer potential advantages over land-based production, including reduced land use, lower energy requirements, and in some cases, improved economic feasibility. At the same time, offshore operations face unique challenges such as exposure to severe weather, predation, and logistical constraints associated with remote locations.

Net pens used for culture are commonly constructed of high-density polyethylene (HDPE) or steel and range in volume from 100 to 1,000 m³. Stocking densities typically range from 10 to 25 kg/m³, with fish fed commercial diets through automated feeding systems. Offshore environments are generally characterized by high water exchange, stable temperatures, and elevated dissolved oxygen, conditions that support favorable growth. However, the open nature of these systems increases risks of escapement and disease transmission to wild stocks compared with land-based facilities.

Land-based indoor systems (i.e., RAS technology) provide an alternative grow-out strategy, offering controlled culture conditions, robust biosecurity and disease management, flexible siting to enhance market access, and reduced risks to marine ecosystems (Brown et al., 2025). Despite these advantages, widespread adoption of RAS for striped bass and other marine finfish has been limited by high capital and operating costs and the challenges of maintaining stable production. Continued research is needed to address economic feasibility, product quality, feed formulation, and control of early maturation in culture systems.

7 Offshore Aquaculture Technology

Technological innovation has made it increasingly feasible to culture marine finfish in coastal and open-ocean environments, including the U.S. EEZ. Offshore aquaculture is generally defined as taking place in open ocean waters, in highly exposed environments subject to strong currents, waves, and storm events, requiring more robust and complex infrastructure than inshore or nearshore systems (Price & Morris, 2013; Drumm, 2010; Kapetsky et al., 2013). While offshore aquaculture represents only a small fraction of U.S. production today, demonstration projects and deployments in deep water have demonstrated that innovation in gear, materials, and monitoring systems can unlock substantial potential for growth (Froehlich et al., 2017; Buck et al., 2025). This sector currently consists of an offshore fish farm in Hawaii state waters and a small number of open ocean shellfish and seaweed farms around the nation.

7.1 NOAA's Role in Offshore Aquaculture Development

As one of the federal agencies responsible for stewardship of the nation's marine resources, NOAA is fostering the growth of a robust domestic aquaculture industry while ensuring that offshore development remains consistent with its environmental stewardship mandates. These efforts include developing tools to evaluate the ecological benefits and risks of marine aquaculture, implementing science-based regulations to safeguard ecosystems, and advancing production designs and operational practices that are compatible with sustainable fisheries and ocean use (Nicolls et al., 2020; NOAA OCM, 2023; BEA, 2021). Multi-agency work groups are also developing regionally tailored permitting frameworks to improve the efficiency and transparency of decision-making while maintaining compliance with environmental law. In support of these initiatives, Feldman et al. (2025) published a *Technical Guide to Marine Aquaculture Gear*, providing detailed guidance on cage and net-pen systems, mooring and anchoring technologies, and other essential components required for offshore aquaculture. These roles ensure that technological innovation is paired with regulatory oversight to support sustainable striped bass farming.

7.2 Marine Cages and Net-Pen Systems

Marine cage and net-pen aquaculture require large, durable enclosures designed to withstand offshore wave energy and the strong swimming behavior of cultured species. Striped bass, in particular, require high water flow for oxygenation, ample space to support growth, and robust containment systems to prevent escapes or structural damage. Successful offshore operations also depend on high-quality formulated feeds, continuous monitoring of fish health, and strict biosecurity measures to minimize the risk of disease. Site selection is critical to avoid harmful algal blooms, ensure dispersal of organic waste, and maintain thermal regimes within the species' tolerance limits.

For striped bass, offshore production would likely use large-volume submersible or semi-submersible cages engineered for high-energy environments. Submersible cages can be lowered below the wave zone during storm events, while semi-submersible pens and large circular HDPE cages provide surface stability with reduced wave exposure (Langan & Horton, 2003; Price et al., 2017). Cage volumes on the scale of tens of thousands of cubic meters afford fish the ability to swim freely, which not only supports welfare but also reduces effective stocking densities allowing for optimal growth and production of striped bass.

7.3 Nets and Predator Exclusion

Net design is central to containment and welfare. Offshore nets are typically constructed from abrasion-resistant, high-strength materials such as knotless nylon or high-density polyethylene (HDPE), designed to withstand constant pressure from fish and environmental forces. Mesh sizes are selected to retain the smallest stocked fish while minimizing drag and maximizing water exchange. Predator exclusion is achieved through reinforced predator nets or double-net systems that deter sharks, seals, and other large marine animals. These barriers are tensioned with spacers or standoff frames to prevent collapse into stock nets, reducing the risk of escapes or entanglement. Overhead bird nets or canopy structures are commonly installed to prevent depredation by seabirds, reducing stock stress and feed loss. Routine inspection and net cleaning are essential to maintain mesh integrity, prevent fouling that diminishes water exchange, and ensure both containment and predator deterrence. Increasingly, copper-alloy mesh is being adopted despite its higher cost, as it provides superior resistance to biofouling, reduces the frequency of net cleaning, and offers enhanced durability and predator protection relative to traditional synthetic materials.

7.4 Innovation and Future Directions

Technological advances are rapidly enhancing the sustainability and profitability of offshore aquaculture. Innovations include co-location with existing offshore infrastructure, autonomous feeding barges, ship-based aquaculture, real-time environmental monitoring platforms, and novel antifouling materials. In the U.S., there is competition for nearshore space and expansion into federal waters provides opportunities for larger sites with fewer user conflicts and greater social acceptance among commercial and recreational fishing communities (Kapetsky et al., 2013; Buck et al., 2025). With one of the largest EEZs in the world, the U.S. has significant potential to expand striped bass production offshore, provided that engineering, logistical, and environmental stewardship challenges are addressed through continued research, innovation, and regulatory collaboration.

8 Environmental and Ecosystems

Evidence from modern offshore systems shows that environmental impacts of net pen aquaculture can be limited and manageable when best practices are applied (Price & Morris, 2013). Strong currents, deeper waters, and advanced feeds reduce risks of nutrient buildup and habitat degradation, and with appropriate siting and monitoring, offshore striped bass farming can align with ecological sustainability goals while avoiding significant long-term ecosystem harm.

Despite these opportunities, public perception and regulatory concern remain among the largest barriers to starting new offshore aquaculture ventures in the U.S., particularly given the large ocean areas that could support development and the potential number of farms. The environmental effects of marine aquaculture vary widely depending on species selection, production methods, siting, and scale of operations (Belle & Nash, 2008; Price & Morris, 2013). Modern production technologies, standardized operating procedures, and best management practices (BMPs) reduce risks to water quality, benthic habitats, and marine life. Offshore farming, in particular, provides opportunities to minimize impacts due to deeper waters, stronger currents, and greater dilution potential compared to nearshore settings (Buck et al., 2025). At the same time, offshore development requires careful evaluation of ecological interactions, cumulative effects, and regulatory safeguards to ensure sustainable growth.

In the context of striped bass aquaculture, potential environmental effects can be grouped into several categories: (1) water quality, (2) benthic and sedimentary processes, (3) interactions with marine life and habitats, (4) cumulative and landscape-scale effects, and (5) mitigation strategies, including novel approaches such as integrated multi-trophic aquaculture (IMTA). This section synthesizes current knowledge, with a focus on offshore relevance, and highlights management and monitoring frameworks that can safeguard essential fish habitats (EFH) while supporting the expansion of a domestic striped bass aquaculture industry.

8.1 Water Quality and Nutrient Enrichment

Discharges such as solid wastes, nutrients, ammonia, fish waste, feed waste, pharmaceuticals, and chemicals from aquaculture operations are primarily governed by the implementing regulations of the Clean Water Act (CWA) Sections 402 and 403 (EPA, 2021). Section 402 requires that a National Pollution Discharge Elimination System (NPDES) permit for discharge into federal waters be issued in compliance with the U.S. Environmental Protection Agency's (EPA) ocean discharge criteria under Section 403, which aim to prevent unreasonable degradation of receiving waters (NOAA, 2022; EPA, 2025). In preparation of an NPDES permit, EPA generally applies water quality models to characterize interactions between effluent and the receiving environment. These models can address effluent dispersion within the water column and particulate deposition in near- and far-field zones, thereby informing monitoring plans to ensure environmental compliance and performance (Cromey et al., 2002; Stucchi et al., 2005).

Three-dimensional (3D) modeling tools have been developed to refine these assessments by predicting the transport and fate of aquaculture-derived wastes under site-specific conditions. By incorporating hydrodynamics, bathymetry, stocking densities, and feed inputs, these models simulate the dispersion of dissolved nutrients and the deposition of solid wastes, enabling forecasts of benthic organic enrichment, nutrient concentrations, and dissolved oxygen dynamics (Cromey et al., 2002; OSPAR, 2005; Newell & Richardson, 2014). Their predictive capability provides a science-based framework to evaluate farm-scale and cumulative impacts, guide siting decisions, establish thresholds for sustainable production, and reduce ecological risks. When integrated into regulatory processes, such modeling approaches strengthen the environmental safeguards of aquaculture permitting while supporting industry growth in a precautionary and adaptive management framework.

Organic Loading

The primary water quality concerns from finfish cage culture are nutrient enrichment (nitrogen and phosphorus), suspended particulates, lipids, and fluctuations in dissolved oxygen (Belle & Nash, 2008; Holmer, 2010). Waste from feed and fish excretion contributes organic matter and nutrients to surrounding waters. In offshore environments, strong currents and high flushing rates typically enhance dispersal, reducing localized benthic accumulation compared to nearshore systems (Chamberlain & Stucchi, 2007). Nonetheless, large-scale striped bass production could elevate nitrogen and phosphorus inputs, particularly if stocking densities are not matched with site-specific hydrodynamics.

Studies across the U.S. and Europe indicate that when farms are sited in deep, well-circulated waters, measurable nutrient effects are typically limited to within 30 m of cages, and persistent long-term impacts are rare (Price & Morris, 2013). Improvements in feed formulation, feeding efficiency, and digestibility have also substantially reduced nutrient loading compared to historical operations (Naylor et al., 2009). Nutrient spikes and transient oxygen declines may occur during feeding events but generally recover quickly in offshore sites with strong flushing (Troell et al., 2009).

In contrast, farms located in shallow or semi-enclosed nearshore systems are at higher risk of causing localized eutrophication. Here, aquaculture impacts may be difficult to distinguish from terrestrial nutrient inputs or municipal discharges (Shumway, 2011). For striped bass offshore culture, siting in high-energy environments such as off the continental shelf of North Carolina or Florida may reduce these risks. Maintaining high water exchange rates and adopting BMPs such as optimized feeding regimes, precision monitoring of feed delivery, and selection of formulated diets are critical for protecting water quality.

Dissolved Oxygen Dynamics

Respiration of fish and decomposition of organic waste can reduce dissolved oxygen (DO) levels, potentially affecting both cultured stocks and wild organisms. Offshore siting criteria, particularly depth (>50 m) and current speed (>5 cm s^{-1}), help mitigate these risks by ensuring sufficient oxygen replenishment. Seasonal stratification along the Atlantic coast, particularly in the mid- and south-Atlantic Bight, may constrain vertical mixing and should be carefully considered in site selection and hydrodynamic models (Friedland et al., 2025).

Hydrodynamics and Waste Dispersal

Modeling current velocities, flushing rates, and vertical mixing is central to evaluating carrying capacity. Offshore aquaculture has an advantage of greater dispersion compared to coastal farms, but cumulative impacts across multiple farms could overwhelm assimilative capacity if not spatially managed. Advanced models such as coupled hydrodynamic-biogeochemical frameworks (e.g., FVCOM, HYCOM, ROMS) can predict dispersal of nutrients and organic matter.

8.2 Benthic Habitats

Sedimentation Impacts

Deposition of waste feed and fecal matter can alter benthic community structure beneath cages. In coastal salmon farms, shifts toward opportunistic polychaetes and hypoxia-sensitive taxa have been observed (Hargrave, 2010). The extent of benthic impact offshore is expected to be more diffuse due to deeper water and higher energy conditions, though localized organic enrichment remains possible. For example, at well-managed offshore farms, these effects are typically confined to within 100 m of cages and benthic recovery between harvest and re-stocking is often rapid (Keeley et al., 2014). Anaerobic conditions may develop under heavily impacted sites, particularly in depositional environments with limited flushing or soft sediments (Kutti et al., 2007). To minimize risk, site selection should prioritize erosional seafloors, adequate depth, and high current velocity to disperse organic matter (Belle & Nash, 2008).

Emerging monitoring tools, including stable isotope tracers, acoustic imaging, and automated image analysis, provide cost-effective methods for assessing benthic impacts and far-field dispersal (Callier et al., 2018). Regulatory protocols often require sediment monitoring of indicator parameters such as redox potential, total organic carbon, and sulfide concentrations. Adaptive management frameworks, wherein farm management practices are modified in response to monitoring outcomes, represent a best practice for ensuring benthic protection.

Essential Fish Habitat

Offshore aquaculture operations may occur within or adjacent to designated Essential Fish Habitat (EFH). To the extent practicable, siting should minimize interactions with sensitive benthic features, including deep-water corals and hard-bottom reef systems. Along the Atlantic coast, these habitats are frequently associated with shelf breaks and submarine canyon systems (NOAA, 2021). Early consultation with relevant management agencies, combined with baseline environmental surveys, can inform site selection and help reduce the risk of habitat disturbance or degradation.

In the South Atlantic region, proposed offshore aquaculture sites may also overlap with habitats that support diadromous fish species, coral reef systems, and estuarine waters that are hydrologically connected to EFH (SAFMC, 2014). Mandatory consultation processes and site-specific environmental review can help identify these sensitivities and guide placement decisions. While poorly sited operations have the potential to affect benthic communities and water quality, locating facilities in deeper, well-flushed offshore waters is generally associated with a lower likelihood of significant environmental impacts.

The NOAA NCCOS has ongoing collaborations with the EPA to provide depositional and water quality modeling products (see Figure 2) and science advice to support agency permitting and associated environmental reviews and consultations for finfish aquaculture projects proposed for U.S. federal waters.

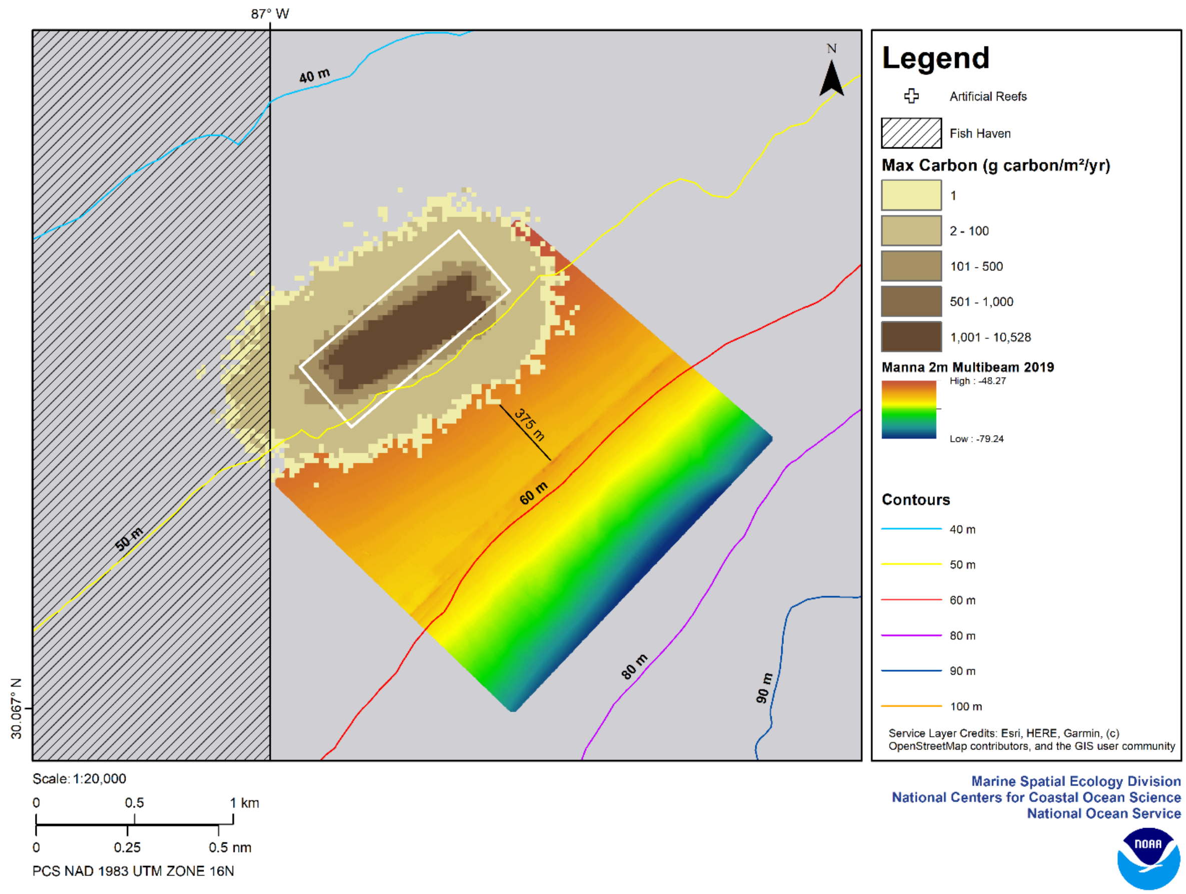

Figure 2. NOAA's National Centers for Coastal Ocean Science applied high-resolution depositional modeling to estimate maximum carbon deposition from a commercial-scale offshore finfish farm in the Gulf of America. Bathymetric data were collected during the baseline environmental survey and are represented at 2-m spatial resolution. The depositional model was run over a five-year period under maximum biomass conditions for an 18-cage configuration. Hydrodynamic forcing was derived from 2018 current fields produced by the Gulf of America HYCOM model. Model results demonstrate the importance of precision siting in identifying locations where solid waste and carbon deposition are sufficiently dispersed, thereby minimizing localized accumulation and supporting environmentally appropriate farm placement.

8.3 Protected Species and Habitat Interactions

The introduction of offshore aquaculture structures into Atlantic waters requires careful evaluation of potential interactions with protected resources, including marine mammals governed by the Marine Mammal Protection Act (MMPA) and species and habitats protected under the Endangered Species Act (ESA) (NOAA Fisheries, 2023a; NOAA

Fisheries, 2023b). Interactions between aquaculture gear and marine mammals, sea turtles, and seabirds remain an active concern but have been well documented both globally and domestically (Price & Morris 2013; NMFS 2015; Price et al. 2016; NMFS 2019; Bath et al. 2023). Recently, the NOAA Technical Guide to Offshore Aquaculture Gear and Protected Species Interactions indicates that entanglement risk is generally low for most offshore cage designs but not negligible, particularly for large whale species and protected turtles (Feldman et al., 2025). Gear modifications such as tensioned mooring lines, weak links, minimized slack, and the use of stiff or coated materials are essential to reduce entanglement hazards. In addition, strategic siting that avoids migratory corridors and ecologically sensitive habitats further lowers the likelihood of interactions.

Adequate risk assessment requires a baseline understanding of offshore aquaculture system design, mooring and net-pen configurations, feed inputs, and operational practices proposed for striped bass culture (Price & Morris, 2013). Potential pathways of interaction include entanglement with nets or mooring lines, attraction of predators such as seals and dolphins to farm sites, displacement or alteration of migratory routes, and changes in prey availability for ESA-listed fish, sea turtles, and marine mammals (Nelson et al., 2021; Read, 2008). The proximity of farms to designated critical habitats requires precautionary siting to avoid overlap (NOAA Fisheries, 2016; NMFS, 2021a; 2021b).

Emerging best management practices and technological innovations provide pathways to further reduce risks. These include predator-resistant and tensioned netting, siting analyses that explicitly exclude sensitive habitats and migratory routes, and adaptive monitoring programs that integrate acoustic, visual, and satellite data (Rust et al., 2014). Taken together, these measures highlight the importance of coupling aquaculture science with regulatory frameworks to ensure that striped bass offshore aquaculture develops in a manner consistent with the long-term protection and recovery goals of the MMPA and ESA.

NOAA's NCCOS is advancing a physics-based 3-D entanglement simulator in collaboration with partners (Bureau of Ocean Energy Management and BelleQuant Engineering) to support risk assessments for marine mammal entanglements with new and existing ocean industries including aquaculture. The simulator combines digital models of large whales and other protected species and underwater structures (moorings, rope, chain, and other structures) to mathematically and physically characterize the interactions between animal and gear. Potential entanglement scenarios, gear re-design can be tested to better understand risk and likelihood of adverse interactions between the gear and animal. This tool supports science-based risk assessments for regulators and industry, helping to inform engineering design, siting decisions, and mitigation strategies, thereby reducing one of the principal environmental concerns associated with offshore aquaculture expansion and facilitating efficient permitting and consultations for commercial-scale farms. By enabling proactive evaluation of entanglement risk and alternative design solutions, the entanglement simulator is intended to lower ecological impact uncertainty around offshore farm operations, support environmental compliance, and ultimately de-risk farm deployment in federal waters as part of broader marine spatial planning and protected species interaction research.

8.4 Ecosystem-Level Considerations

Food Web Dynamics

Offshore striped bass aquaculture introduces an artificial biomass of piscivores into marine ecosystems. While contained, the farms may act as fish aggregating devices, altering local species distributions. Evidence from salmon and tuna net pens suggests farms attract pelagic species, including forage fish, invertebrates, and predators (Dempster et al., 2002). Such aggregations may increase predation pressure or alter trophic pathways, though they can also enhance foraging opportunities for wild species (Callier et al., 2018).

Harmful Algal Blooms

Naturally occurring harmful algal blooms (HABs) pose a direct risk to striped bass aquaculture through mechanisms including gill irritation and damage, toxin exposure, hypoxia, and acute mortality events. As a result, understanding whether offshore cage culture contributes to HAB dynamics is a critical consideration for siting and management in the EEZ. Synthesis of the global literature indicates that marine net pen aquaculture does not exhibit a consistent or causal relationship with HABs when farms are appropriately sited and managed (Price & Morris, 2013). While dissolved nutrient releases from cage culture can produce localized and transient increases in phytoplankton biomass, particularly within tens to hundreds of meters of net pens, these responses have not been linked to the initiation or persistence of toxic or nuisance algal blooms (Price et al., 2015). In offshore and well-flushed environments characteristic of the EEZ, hydrodynamic dispersion and biological assimilation rapidly dilute dissolved nutrients, rendering aquaculture-derived inputs minor relative to background nutrient variability and watershed-driven sources. Evidence suggests that HAB risk is primarily governed by site-specific factors such as flushing, stratification, and existing nutrient loads rather than cage culture itself. Consequently, precision siting in dispersive offshore waters, combined with modern feed formulations and efficient feeding practices, is expected to minimize eutrophication risk and decouple offshore striped bass aquaculture from HAB dynamics in the EEZ.

9 Escapement Risks and Genetic Considerations for Offshore Striped Bass Aquaculture

Escape events pose real risks for genetic introgression, but decades of selective breeding, coupled with new genomic tools, provide safeguards to manage those risks. Domesticated strains, sterility technologies, and rigorous monitoring can ensure that aquaculture operations do not compromise wild population integrity. When paired with robust containment systems, striped bass aquaculture can proceed without undermining the genetic resilience of wild stocks.

For offshore operations, it is useful to distinguish between chronic, low-level seepage of escapees and rare, high magnitude catastrophic releases, because these pathways differ in detectability, dispersal potential, and the timing of exposure that drives genetic risk. Seepage most often results from small holes, net abrasion, predator related tearing, and routine activities such as handling and lifting, creating a persistent trickle of escapees that can be difficult to detect directly yet still sustain contact with wild conspecifics (Jensen et al., 2010; Holmen et al., 2021). Catastrophic events are more commonly linked to structural failure or mooring failure, collisions, and extreme weather, and they can release large numbers of fish over short periods, overwhelming recapture capacity and increasing the likelihood that mature escapees enter migratory corridors or spawning habitats during sensitive windows (Jackson et al., 2015; Thorvaldsen et al., 2015).

Escape events are among the most widely recognized ecological risks associated with marine finfish aquaculture, with outcomes shaped by species behavior, farm design and durability, siting and hydrodynamic conditions, operational practices, and interactions with predators such as sharks, marine mammals, and seabirds. Ecological consequences have been well documented across freshwater, estuarine, and marine systems, including competition with wild conspecifics, habitat displacement, disease and parasite transmission, and genetic introgression (Naylor et al., 2005; Hutchings & Fraser, 2008). Although domesticated fish often show reduced individual fitness and survival compared to wild stocks (Glover et al., 2017), even limited interbreeding can erode local adaptation, homogenize genetic structure, and reduce the long-term resilience of wild populations (Bourret et al., 2011).

For offshore aquaculture of native striped bass, these risks warrant particular attention. Striped bass are highly mobile and migratory, with populations ranging from the Gulf of St. Lawrence (Canada) to the St. John’s River (Florida) (Waldman et al., 2012). Resident populations occur in southern systems such as Albemarle Sound, North Carolina, while northern populations migrate extensively along the Atlantic coast (Boreman & Lewis, 1987; Overton et al., 2008). Escaped individuals could therefore disperse widely, interact with multiple genetically distinct subpopulations, and introduce risks of maladaptation or loss of genetic structure. Given the cultural, recreational, and commercial importance of striped bass, and their complex genetic composition, safeguarding wild populations is a priority for both fisheries and aquaculture management (ASMFC, 2019).

9.1 Historical Stocking and Genetic Legacy

The striped bass has a long history of hatchery propagation and stock enhancement. Beginning in 1884, striped bass from the Roanoke River were widely distributed for research and restoration purposes (Geddings, 1971). By the mid-20th century, federal and state hatcheries were producing and transporting striped bass throughout the U.S. and abroad. These efforts expanded during the 1970s and 1980s, when more than 20 hatcheries collectively released millions of fish annually to support restoration following severe population declines caused by overfishing, habitat degradation, and recruitment failure (Boreman & Austin, 1985; Rulifson & Laney, 1999). Although stocking programs contributed to recovery, widespread “cross-stocking” introduced non-native genetic material into multiple watersheds, altering natural genetic structure and raising long-term conservation concerns (Waldman et al., 2012). For example, while remnant native Gulf populations persist in the Apalachicola–Chattahoochee–Flint (ACF) river system in Florida, genetic analyses reveal substantial introgression (52%) from Atlantic stocks used in enhancement programs across the Gulf (Wirgin et al., 1997; Wirgin et al., 2010; GSMFC, 2006). The legacy of these programs underscores the importance of preventing further anthropogenic genetic alteration through aquaculture escapes.

9.2 Advances in Genomic Tools

Modern genomic approaches now allow high-resolution monitoring of striped bass population structure. Methods such as RADseq and genome-wide SNP genotyping enable the detection of fine-scale differentiation, even among weakly structured marine populations (Vendrami et al., 2017; Drinan et al., 2018; Jenkins et al., 2019). Analytical advances, including identification of outlier loci, provide insights into adaptive divergence and improve assignment accuracy in mixed-stock analyses (Gagnaire et al., 2015). These tools have been applied to striped bass, where they have clarified stock composition and informed management (LeBlanc et al., 2020; Wojtusik et al., 2023, 2025). Applications extend to monitoring genetic introgression, detecting illegal harvest, and assessing risks associated with aquaculture escapes (Ackerman et al., 2011; Martinsohn & Ogden, 2009).

9.3 Domesticated Strains and Aquaculture Applications

In parallel with restoration programs, a domesticated striped bass broodstock line has been developed through more than 30 years of selective breeding for aquaculture performance. The National Program for Genetic Improvement and Selective Breeding, based at North Carolina State University’s Pamlico Aquaculture Field Laboratory, created this line from multiple founder strains including the Roanoke River, Chesapeake Bay, Santee-Cooper Reservoir, Florida–Gulf of America, Canadian, and Pacific populations (Harrell et al., 1990; Kenter et al., 2018; 2023). Selection has emphasized growth, stress tolerance, and disease resistance, resulting in a strain phenotypically and genetically divergent from wild populations. This divergence may reduce the likelihood that escapees would survive or reproduce successfully in the wild, potentially lowering ecological risk compared to more recently domesticated or wild-derived stocks. However, if interbreeding occurs, maladaptive traits from the cultured line could still introgress into wild populations, compromising local adaptation and resilience (Ignatz et al., 2024; San Roman et al., 2025).

9.4 Risk Assessment and Mitigation

Effective escape risk management for offshore striped bass aquaculture requires a precautionary, multi-layered approach. Risk assessments incorporated into siting and permitting typically evaluate both the probability of escape and the ecological consequences of farm–wild interactions. Engineering strategies including robust mooring systems, regular inspection of nets and cages, predator deterrence, and contingency planning are critical for preventing escapes (Jackson et al., 2015). Genetic management measures such as broodstock traceability, use of sterile lines, and long-term genomic monitoring of both farmed and wild populations provide complementary safeguards (Glover et al., 2017; Karlsson et al., 2011).

Life-history traits of striped bass further inform risk analysis. For example, escaped males should reach maturity earlier and thus are more likely to contribute to wild spawning than females, which typically require two additional years to mature (Waldman et al., 2012). This suggests a moderate but non-negligible risk of introgression.

9.5 Reproductive Control and Genetic Containment

A practical operational safeguard is mandatory harvest before maturation, implemented through production schedules and, where appropriate, permit conditions that require complete cohort removal before fish are capable of spawning. This approach is widely treated in the aquaculture escape literature as a risk reduction measure because it limits the chance that escapees can contribute to reproduction, including scenarios where spawning can occur in or near net pens, or where mature escapees reach spawning habitats following an escape (Baskett et al., 2013).

One of the most effective strategies to minimize ecological and genetic risks from aquaculture escape events is the use of reproductively sterile fish. By eliminating or reducing the potential for interbreeding with wild populations, reproductive control technologies provide a biological safeguard that complements physical containment measures. Several approaches are currently available or under development in finfish aquaculture and could be applied to striped bass (Xu et al., 2023).

NOAA has developed the Offshore Mariculture Escape Genetic Assessment (OMEGA) model to evaluate genetic and ecological risks associated with aquaculture escape events. OMEGA simulates the probability of fish escaping from offshore farm systems, their survival and dispersal in the marine environment, and the likelihood of encountering and interacting with wild conspecifics. The model is intended to support risk-based assessments of offshore aquaculture operations and to inform the development of management and engineering strategies that reduce the potential adverse effects of escape events on wild populations (Purcell et al., 2025).

Triploidy

Induction of triploidy, producing fish with three sets of chromosomes, has been successfully applied in numerous aquaculture species, including salmonids, carp, and catfish, to create sterile or functionally sterile individuals (Piferrer et al., 2009; Benfey, 2016). While triploid performance varies by species, triploid striped bass have been produced experimentally and show promise for use in commercial systems (Okomoda et al., 2020). Incorporation of triploid technology into offshore striped bass culture could provide a near-term strategy for genetic containment, though further research is required to ensure consistent induction rates, animal welfare, and commercial performance.

Genetic Knockdown Approaches

Emerging biotechnologies offer more targeted methods of inducing sterility through gene knockdown or knockout of key reproductive pathways (Houston & Macqueen, 2019; Gutasi et al., 2023; Xu et al., 2023). For example, suppression of genes involved in germ cell development or meiosis can yield sterile phenotypes without altering somatic growth. While these methods are not yet commercially applied in striped bass, they are commercially available technologies for other marine fish species and the technology represents a potential long-term avenue for highly reliable reproductive control.

Monosex or Sex-ratio Control

Manipulation of sex ratios, such as producing all-male or all-female populations, can reduce reproductive capacity if only one sex is cultured. For striped bass, male fish reach sexual maturity earlier and could present a higher risk of genetic introgression following escapes, whereas all-female populations may reduce this risk (Waldman et al., 2012). Sex control has been applied in other aquaculture species through hormonal or genetic methods (Beardmore et al., 2001; Luckenbach et al., 2017; Berlinsky et al., 2020), but further research is needed to assess its feasibility in striped bass.

Research and Development

Development of sterility induction methods for striped bass aquaculture remains a critical research need. While the domesticated broodstock line developed at North Carolina State University provides a stable genetic foundation for offshore farming, it has not yet been systematically adapted for sterility. Developing robust and commercially viable sterility methods, whether through triploidy, gene knockdown, or sex-ratio control, would likely require 4–5 years of focused research to optimize protocols compatible with domesticated strains and evaluate fish performance in a commercial setting. Investment in this research would provide regulators and producers with a powerful tool to minimize ecological risk and ensure the sustainability of offshore striped bass aquaculture.

10 Aquatic Animal Health Considerations for Offshore Aquaculture

Disease is a primary operational risk for striped bass aquaculture and a recurring constraint on economic performance. Offshore net pens can support healthy production, but only when farms prevent pathogen introduction, detect problems early, and respond quickly under a regulated framework (Rhodes et al., 2023).

Open water pens continuously exchange water with surrounding ecosystems. That exchange improves flushing, but it also allows microbes and parasites to move between cultured fish and wild fish. Stocking densities needed for commercial production can amplify outbreaks and increase losses if farms do not maintain strong health controls (Rhodes et al., 2023).

Offshore striped bass aquaculture can maintain high animal health standards when farms treat disease as an operational risk that must be managed continuously. The priority is prevention, early detection, and targeted response. Site selection, biosecurity, surveillance, and compliance with therapeutic regulations together reduce disease incidence and limit potential effects on nearby wild fish populations (Rhodes et al., 2023).

10.1 Main pathways for disease and parasite pressure

Several conditions elevate risk in offshore culture, and each point to a specific management response.

1. **Proximity to wild fish**
   Pens located near migratory or resident striped bass can support two-way

movement of pathogens, which raises concerns for both farmed and wild fish (Rhodes et al., 2023).

2. **High connectivity through water exchange**
   Pathogens and parasites can disperse beyond farm boundaries, so surveillance and response planning must account for the broader site area, not only the cage footprint (Rhodes et al., 2023).

3. **Stress and suppressed immune function**
   Handling, fluctuating environmental conditions, and periods of suboptimal water quality can increase susceptibility to infection (Virginia Cooperative Extension, 2023).

4. **Biofouling and infrastructure condition**
   Fouling can reduce water circulation and degrade local water quality inside and around cages. Farms can reduce this risk through routine cleaning and appropriate materials, including copper alloy mesh where feasible (Rhodes et al., 2023).

Once aquatic pathogens establish in natural systems, eradication becomes difficult. Experience and modeling show that farms can increase pathogen abundance in surrounding waters if controls fail, which can affect farm productivity and nearby wild populations (Rhodes et al., 2023).

10.2 Striped bass pathogens and treatment considerations

Striped bass culture faces a recognizable set of bacterial and parasitic hazards, with risk shaped by environment, husbandry, and baseline pathogen presence.

In the Chesapeake Bay, mycobacteriosis caused by *Mycobacterium shottsii* and *M. pseudoshottsii* is endemic among juvenile wild striped bass, particularly in nutrient enriched estuaries. Mycobacteria also occur in cultured striped bass and hybrid striped bass, most often in recirculating systems, broodstock settings, or facilities experiencing chronic stress and poor water quality. Relative to other bacterial diseases, mycobacteriosis is not typically a leading driver of commercial losses. Columnaris disease, caused by *Flavobacterium covae*, remains a concern for net pen production. Additional pathogens and parasites documented for striped bass include the following (Paperna and Zwerner, 1976; Rhodes et al., 2023; MD DNR, 2024).

- *Ichthyophthirius multifiliis*, a protozoan that causes ich, or white spot disease, in freshwater fish (Rhodes et al., 2023).

- *Edwardsiella tarda*, which can cause systemic infection and mortality (Lee Herman and Bullock, 1986).

- *Streptococcus iniae*, documented in hybrid striped bass with systemic impacts (Evans et al., 2006).

Parasites can cause meaningful health impacts when infestation intensity is high, increasing stress and weakening fish condition (Rhodes et al., 2023).

10.3 Prevention focused management

For striped bass aquaculture, prevention carries the most weight. Farms typically rely on vaccination where available, strict biosecurity, careful water quality management, and structured health monitoring to detect emerging problems before mortalities escalate (Evans et al., 2006).

Several actions consistently support better health outcomes:

Area of Focus	Key Practice/Goal
Optimal Water Quality	Maintaining stable, high-quality water conditions to reduce stress and disease susceptibility.
Nutrition	Proper nutrition is critical for supporting the immune system and overall health of cultured striped bass.
Robust Biosecurity	Preventing pathogen introduction through controlled stock movements, disinfection protocols, and equipment sanitation.
Appropriate Stocking Densities	Avoiding overcrowding to limit stress and disease transmission.
Regular Health Monitoring	Early detection of pathogens or parasites through systematic surveillance, diagnostics, and record keeping.
Strategic Site Selection	Well-sited net pens in areas with adequate current flow help disperse waste, excess nutrients, and potential pathogens. Good water exchange reduces the concentration of organic matter and microbial loads, limiting the accumulation of disease agents. Sites must also allow for practical access and regular monitoring.

10.4 Therapeutants, antibiotics, and U.S. regulatory oversight

Even well managed farms sometimes require therapeutic intervention to address mortalities, infestations, or infections (FDA, 2022). In U.S. marine aquaculture, the set of approved options remains limited compared to other animal production sectors (FDA, 2022). Therapeutant use is governed by a regulatory system designed to protect animal health, the environment, and food safety (FDA, 2020). Treatments, including extra label use where applicable, require veterinary supervision and must follow federal rules. Current constraints include the lack of therapeutants explicitly approved for offshore marine aquaculture systems in the United States, which increases the importance of prevention and careful case management (FDA, 2020).

FDA provides central oversight for aquaculture therapeutics, and this oversight helps limit ecological risk associated with medication use (Scott, 2004). Management approaches that reduce parasite pressure, such as adjusting stocking densities and timing stocking events, can reduce reliance on drugs. Antibiotic use has declined substantially in salmon aquaculture, including a reported drop of roughly 90 percent around the turn of the century with continued reductions thereafter (Tveterås 2002). In Maine, antimicrobial medicated feeds such as oxytetracycline were reported in 8 percent of salmon production cycles from 2003 to 2017, with no reported use from 2009 to 2017 (Love et al. 2020). Despite declining use, antibiotic persistence in sediments can range from days to years depending on light, oxygen, pH, temperature, and sediment characteristics (Adenaya et al. 2023; Coyne et al. 2001; Rigos and Troisi 2005). This persistence can contribute to selection for antibiotic resistant bacteria near aquaculture sites, so any use should remain limited and carefully controlled.

At present, no antibiotics are approved for striped bass and other marine aquatic species. Some broad-spectrum antibiotics and feed additives, including florfenicol and oxytetracycline, may be available under the National Investigational New Animal Drug Program as permitted by the U.S. Fish and Wildlife Service. Use should remain sparing, under veterinary oversight, and consistent with approved protocols to limit environmental accumulation and ecological disruption.

10.5 Vaccines and alternatives

Vaccines have been under development in aquaculture for more than 50 years and now represent a rapidly expanding disease prevention tool. Adoption varies because cultured species, production conditions, and delivery methods differ widely across aquaculture systems. Even so, vaccine development and use increasingly supports production practices that reduce antibiotic dependence while improving fish welfare.

11 Resource Use and Operational Efficiency in Offshore Striped Bass Aquaculture

Striped bass aquaculture is resource-intensive, but innovations in feed efficiency, automation, and renewable energy offer pathways to reduce costs and environmental impacts. Studies suggest offshore production can be profitable when efficiency is prioritized at scale. With continued improvements, striped bass farms could achieve both economic competitiveness and operational sustainability in U.S. waters.

11.1 Feeds and Feed Efficiency

Feed represents the single largest input cost in striped bass aquaculture and is the most significant driver of environmental performance. Research has focused on reducing reliance on fishmeal and fish oil while maintaining growth and health outcomes. Alternative ingredients such as soybean meal, corn gluten meal, and poultry by-product meal show promise, though digestibility and nutrient availability remain ongoing challenges (Fujita et al., 2023). Novel sources, including insect meals, bacterial biomass, fish silage, and single-cell proteins, are also being tested as viable replacements for traditional marine-derived proteins (Turchini et al., 2019; Glencross et al., 2007). Advances in formulation now allow diets to be tailored to species-specific needs, improving feed conversion ratios (FCR) and nutrient retention (Price & Beck-Stimpert, 2014; Hua et al., 2019).

Aquaculture has historically relied on forage fish (e.g., anchovy, sardine, menhaden) due to their high-quality protein and omega-3 fatty acids, with roughly 20 million metric tons (≈20% of the global marine harvest) processed annually for fishmeal and oil (FAO, 2018). However, supply has plateaued, and their proportional use in aquafeeds has declined for two decades (Naylor et al., 2021). Despite these trends, fishmeal and fish oil remain critical for some marine species requiring highly digestible proteins and long-chain polyunsaturated fatty acids (Hua et al., 2019). Studies have shown that alternative protein sources can replace much of the fishmeal in aquaculture diets without compromising performance (Rust et al., 2011; Gatlin et al., 2007). Plant proteins (soy, corn, algae, seaweed) and microbial or insect meals offer scalable solutions, with ongoing USDA and NOAA-supported research aimed at reducing environmental impacts and improving adoption (Rexroad et al., 2021).

Striped bass have demonstrated efficient feed conversion and can grow well on formulated diets with reduced reliance on fishmeal and fish oil (Rexroad et al., 2021; Andersen et al., 2021). This flexibility distinguishes them from other marine carnivorous species and helps limit pressure on forage fish resources. Continued refinement of striped bass-specific feeds will further strengthen the species' sustainability profile while supporting offshore aquaculture development.

11.2 Energy Use

Energy use is a major determinant of both cost and environmental footprint in offshore striped bass farming. Operations require energy for feeding, monitoring, cage maintenance, harvesting, and transport (Price & Beck-Stimpert, 2014). Lacking grid connectivity, farms rely on fossil fuels or renewable systems to power infrastructure (Fujita et al., 2023).

Harvesting is especially energy-intensive, with vessels consuming fuel for propulsion, refrigeration, and lifting equipment. Long-distance logistics amplify these demands, raising operational costs and carbon emissions (Sardar et al., 2025; Basurko et al. 2013). Optimizing vessel routing and adopting hybrid or alternative-fuel vessels can reduce energy use.

Renewable energy technologies such as floating solar, wave, and hybrid wind-solar systems are increasingly evaluated as alternatives for offshore aquaculture infrastructure (Rubino, 2008; Soto & Wurmann, 2019). Coupled with energy storage, these systems can provide reliable low-carbon power for feeding, sensors, and communications (Haider et al., 2024). Strategic siting also plays a role: proximity to shore reduces vessel fuel use and enables more efficient logistics (FAO, 2024).

As offshore aquaculture expands, energy management will become central to economic viability and environmental performance. Reducing fossil fuel dependence and integrating renewables will support both industry competitiveness and broader carbon-reduction goals. Integrating renewable energy and efficiency technologies can lower operating costs while reinforcing the sustainability profile of offshore striped bass aquaculture, strengthening its alignment with U.S. climate and seafood goals.

12 Historical Review of Research Initiatives and Commercial Projects

Past research and pilot projects in the U.S. and abroad show that striped bass aquaculture is biologically feasible but historically hampered by regulatory uncertainty, infrastructure challenges, and limited market development. Recent advances in genetics, production systems, and consumer demand now address many of these barriers. These lessons confirm that the current moment offers the strongest opportunity yet for offshore striped bass aquaculture to succeed.

12.1 Research Initiatives

StriperHub, a coordinated NOAA Sea Grant initiative led by North Carolina Sea Grant and North Carolina State University, is advancing striped bass aquaculture in the U.S. by integrating genetics, production research, and industry outreach. Long-term selective breeding programs at NC State's Pamlico Aquaculture Field Laboratory have produced domesticated lines with improved growth, feed efficiency, stress tolerance, and disease resistance, now capable of reaching 1.8 kg within 18 months. By coupling these advances with seed production, grow-out demonstrations, and market development, StriperHub is positioning pure-line striped bass to compete directly in both premium and commodity markets, creating new opportunities for expansion of U.S. aquaculture.

The USDA has played a pivotal role in advancing striped bass and hybrid striped bass aquaculture through strategic research funding and breeding programs. Notably, USDA-supported initiatives, such as the National Research Support Project 8 (NRSP-8), NIFA projects, and Agricultural Research Service (ARS) collaborations, have fostered genetic improvement and selective breeding efforts, enabling enhanced growth, disease resistance, and performance in RAS and pond systems. These investments, combined with targeted SBIR grants focused on pedigree tracking, semen preservation, and broodstock development, have strengthened the industry's capacity for commercial diffusion of superior striped bass genetics

12.2 Marine Cage Culture

United States

Over the past five decades, several experimental and pilot-scale commercial attempts have been made to culture striped bass in marine net pens or cages, particularly in New York waters. These projects demonstrated the biological feasibility of cage culture but also underscored the environmental and operational challenges. The earliest documented trial occurred in 1974–1975, when researchers deployed floating cages in a seawater lagoon off Shelter Island, New York. Fingerlings stocked in the fall suffered from mortality events when water temperatures dropped to 1 °C, necessitating onshore overwintering. Restocked fish grew during the following summer, but survival and retention were poor due to escapes, and only 14% were harvestable by fall (Harrell et al., 1976). A second pilot project in 2011 stocked 15,000–20,000 striped bass into net pens in New York State waters (University of Vermont Sea Grant, 2022). This effort was short-lived after a vessel strike damaged infrastructure and Hurricane Sandy further disrupted operations, ultimately forcing removal of the pens. Finally, in 2012, a private venture launched in Gardiners Bay at the northern end of Long Island. Striped bass raised in net pens exhibited strong growth and survived the impacts of Hurricane Sandy. Fish were later transferred to an onshore facility and marketed through restaurants and seafood retailers in Long Island and Manhattan, demonstrating small-scale biological and commercial feasibility. However, broader challenges related to permitting, scalability, and storm resilience remain unresolved (Multi Aquaculture Systems, 2012).

Collectively, these U.S. case studies highlight both the opportunities and risks of striped bass aquaculture in marine cages. While growth performance can be strong, success depends heavily on site selection, infrastructure resilience, and regulatory clarity. Despite these challenges, multiple offshore aquaculture initiatives have identified striped bass as a promising candidate for the U.S. EEZ in recent years. These include Pacific Ocean AquaFarms, with proposed sites off San Diego and Long Beach, California, and Manna Fish Farms, with proposed sites off Pensacola, Florida, and Long Island, New York.

International

Pacifico Aquaculture, founded in 2010 in Ensenada, Baja California, was the first and only commercial-scale offshore striped bass farm in North America. Situated 8 miles offshore near Isla Todos Santos, the operation utilized marine net pens supported by a hatchery and nursery RAS at Playa Tres Emes, where juveniles were reared to approximately 80 g before transfer offshore. The company achieved four-star Best Aquaculture Practices (BAP) certification, encompassing hatchery, grow-out, processing, and feed, and was recognized by Monterey Bay Aquarium's Seafood Watch with a "Good Alternative" rating. At its peak, Pacifico consistently produced up to 3,200 metric tons annually, with ambitions to scale toward 20,000 metric tons per year. Their product was marketed to "conscientious consumers" and premium channels across North America. Its striped bass entered retail and foodservice markets through distribution partnerships with Whole Foods, Amazon Fresh, Fresh Direct, Earth Fare, and through Santa Monica Seafood in California and the U.S. Southwest. Nationwide distribution extended through wholesalers such as Profish, Seattle Fish Company's Chef's Fresh Fish, Samuels Seafood, and Wulf's Fish, while restaurant chains including Pacific Catch prominently featured the product. Pacifico was also a regular exhibitor at the Seafood Expo North America, where it promoted its brand and product lines to domestic and international buyers.

For more than a decade, Pacifico represented the sole commercial example of offshore striped bass aquaculture in the region. In June 2025, the company ceased operations, marking the closure of North America's only offshore striped bass producer and concluding a pioneering commercial effort (Fiorillo, 2025; Mayer, 2025).

Several co-authors of this report conducted site visits to the Pacifico operation during commercial development, peak production, hatchery construction, and following its closure, providing important lessons for future striped bass aquaculture development. Despite strong market demand, the operation experienced persistent production challenges, largely attributed to suboptimal siting relative to suitable thermal regimes. Temperature variability negatively affected growth rates and feed conversion efficiency, resulting in inconsistent production performance and difficulty in reliably supplying product to market. These observations underscore the critical importance of precision siting to ensure thermal suitability, production reliability, and long-term commercial viability for offshore striped bass aquaculture.

12.3 Recirculating Aquaculture Systems

Feasibility of land-based culture has been researched in depth for pure striped bass (Engle et al., 2024), but commercial scale comparables only exist for their hybrids in the U.S. and Asia. The U.S. companies included AquaFuture Inc., founded in 1990 (Turners Falls, Massachusetts) and Kent SeaTech founded in 1972 (Mecca, California). Both operations experienced years of technical successes with the species but economic challenges (e.g., feed cost, energy demand, stagnant fish prices) caused them to pivot to barramundi (*Lates calcarifer*) and biofuel respectively. Operations in China continue to demonstrate successful production in RAS for their domestic premium markets. Although the biological and technical potential exists to produce pure striped bass at scale in RAS, concerns about operating costs and market price remain when raising fish to marketable size.

12.4 Pond Aquaculture

Most commercial striped bass and hybrid striped bass production occurs in the southeastern and midwestern states (notably North Carolina, Arkansas, Mississippi, and Texas) where earthen ponds are used for fingerling and grow-out phases. Hybrid striped bass have historically been preferred due to superior hardiness and growth. The typical production system is a two-phase model: fry are first reared in hatcheries, then stocked into fertilized ponds to grow into fingerlings or market-size fish. Pond culture benefits from relatively low infrastructure costs and established feed-based management, though it requires substantial land, warm water, and aeration. The 2023 USDA Census of Aquaculture reports there were 57 farms producing hybrid striped bass in the U.S., with 32 of those marketing food-size fish.

13 Conclusions

Striped bass is among the most iconic and economically valuable fishes of the U.S. Atlantic coast. Decades of hatchery propagation, hybrid striped bass aquaculture development, and scientific advances have laid the foundation for farming pure striped bass in offshore environments. This report demonstrates that offshore striped bass aquaculture is biologically feasible, economically competitive, and aligned with national goals of expanding domestic seafood production. Yet, current federal rulemaking prohibits possession of striped bass in the EEZ, creating a de facto ban on offshore striped bass farming along the eastern Atlantic. To advance sustainable aquaculture, this prohibition could be reconsidered. Updating federal and state regulations to explicitly allow striped bass aquaculture in the EEZ would unlock opportunities for economic growth, seafood security, and coastal community development while safeguarding wild stocks through modern genetic, ecological, and regulatory safeguards.

The pathway forward requires targeted investment in science and deliberate policy reform. Offshore striped bass aquaculture should proceed within a precautionary, adaptive management framework that emphasizes ecological compatibility, environmental responsibility, and stakeholder trust. With appropriate research, policy innovation, and regulatory clarity, the U.S. can establish a robust offshore striped bass aquaculture sector that complements conservation of wild fisheries and strengthens the resilience of the seafood supply chain.

13.1 Priority Research Needs

- Offshore production trials: Conduct large-scale demonstration farms to test performance under high-energy offshore conditions.
- Broodstock improvement: Expand selective breeding programs to enhance growth, feed efficiency, and disease resistance in domesticated lines.
- Feeds and nutrition: Optimize sustainable diets using alternative proteins, oils, and functional ingredients tailored to striped bass.
- Genetic containment tools: Develop and validate methods to ensure reproductive sterility of farmed striped bass.
- Fish health management: Advance vaccines and biosecurity protocols for aquatic animal health management in offshore settings.
- Farm economics: Model the production costs and business feasibility of striped bass aquaculture to determine profitability timelines and financial risk.
- Market research: Assess consumer preferences, willingness to pay, and branding strategies for farmed pure-strain striped bass.

- Reproductive control for striped bass aquaculture remains a critical research need.

13.2 Policy and Management Needs

- Regulatory reform: Amend 50 C.F.R. §697.7 to permit aquaculture of striped bass in the EEZ, while maintaining the ban on wild harvest.
- Permitting frameworks: Develop clear, streamlined, and science-based offshore aquaculture permitting pathways that integrate NOAA, EPA, and USACE authority.
- Traceability and labeling: Establish traceability standards to distinguish cultured striped bass from wild harvest, ensuring market integrity.
- Compliance and enforcement: Implement monitoring systems to verify containment, environmental compliance, and genetic safeguards.
- Biosecurity regulations: Update aquatic animal health frameworks to address offshore net-pen systems, including rapid response protocols for disease events.
- Stakeholder engagement: Facilitate public and industry input into striped bass aquaculture planning to build social license and reduce conflict.
- Workforce development: Support training programs to transition maritime workers into skilled aquaculture careers.

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From:	Info (ASMFC)
To:	Comments; Emilie Franke
Subject:	FW: [New] [External] Atlantic striped bass fishery
Date:	Thursday, December 18, 2025 4:54:42 PM

-----Original Message-----
From: Eric Warner <eric.warner03@gmail.com>
Sent: Wednesday, December 17, 2025 11:00 AM
To: Info (ASMFC) <info@ASMFC.ORG>
Subject: [New] [External] Atlantic striped bass fishery

Recreational guys get blamed but commercial guys are raping the fishery. The fall run this year was awful for shore based anglers. Less fish year after year. Quit procrastinating! The commercial guys are just as responsible, and probably a hell of a lot more, for the downfall of this fishery. The fact that you guys continue to do nothing is absolutely disgusting and disgraceful. I am a catch and release recreational angler and would like to see this fishery thriving for future generations (my two sons).

E

Eric Warner