



ECOSYSTEM-BASED FISHERIES MANAGEMENT IN CHESAPEAKE BAY

Striped Bass

Striped bass have recently been hailed as one of the greatest success stories of fisheries management in Chesapeake Bay. The Atlantic coast striped bass fishery collapsed in the 1970s and early 1980s and in response Maryland and Virginia imposed a harvest moratorium on the species. The fishery was re-opened in 1990 to commercial watermen after recruitment levels rebounded. The population was considered fully restored in 1995. The recovery was likely a result of both successful management and environmental conditions favorable for early life survival. Precautionary management since that period has allowed the population to support a large commercial and recreational fishery in Chesapeake Bay. Currently the stock is actively managed through a Baywide quota, which covers the three jurisdictions in the Chesapeake Bay (Maryland, Potomac River, and Virginia waters) for both the recreational and commercial fisheries. The Chesapeake Bay hosts a year-round adult striped bass population and is an important spawning and nursery habitat for both the Bay stock and the larger Atlantic Coast population. Striped bass are long lived — reaching ages of 30-plus years and weights in excess of 100 pounds. They are considered excellent recre-



Figure 1. Striped bass (*Morone saxatilis*). Credit: Duane Raver, U.S. Fish & Wildlife Service.

ational sport fish and are targeted by commercial watermen for consumption sale. In 1965 the striped bass was designated Maryland's state fish by the Maryland General Assembly. Although the current population level is estimated to be well above target (148% in 2008), high rates of disease and recruitment fluctuations continue to cause concern.

Striped bass was selected as the pilot species for this EBFM project. Maryland Sea Grant assembled a team of scientists and managers to consider an ecosystem approach for management. The team laid the groundwork for the project by implementing a new systematic approach to fishery management — identification of ecosystem issues impacting the species in Chesapeake Bay and recommendations for indicators and reference points that managers may use to address the issues. The striped bass team identified ecosystem issues within four critical areas: habitat suitability, stock dynamics, foodwebs, and socioeconomics. We summarize their findings below.

Habitat Issues and Drivers

Climate Change and Warming

The Chesapeake Bay has experienced nearly a 2° C rise in mean surface water temperature over the past 70 years and a rise of similar magnitude is predicted by 2090. Striped bass are dependent upon favorable recruitment conditions. Disruption in the match between the timing of spawning and conditions favorable to recruitment may be caused by future winter and spring warming and may negatively impact the population. Similarly, a mismatch among seasonal fisheries regulations, migration patterns, and population distributions may occur due to warming. These may

cause fishing to occur during sensitive periods for the population. Winter warming could also promote year-round residency, and reduce overwinter juvenile mortality leading to increased pressure on the forage species targeted by striped bass. Alternatively, warming summers could substantially depress habitat suitability for older resident striped bass. It is conceivable that by maintaining diverse spawning behaviors, striped bass may retain stability in recruitment in the face of warmer water temperatures and/or more variable future winter and spring climate conditions.

Flow

Striped bass spawning and nursery habitats are impacted by disruptions in the natural freshwater flow regimes in Chesapeake Bay. Such variations in freshwater river flow influence hypoxic volume and area, which then limit the availability of striped bass habitat. The primary causes of flow variation are dam operations and construction, water withdrawals, harbor maintenance, agriculture, power generation, and public utilities.

Hypoxia

Hypoxic volume has expanded in Chesapeake Bay over the past 50 years and represents an increasing loss of summer habitat for adult and juvenile striped bass. The impacts are most significant during the summer months when striped bass habitat is vulnerable to hypoxia. Studies in other regions indicate that fish avoid hypoxic areas and that this behavior taxes their growth and increases their energy demands. Initial avoidance of hypoxic areas may also lead to habitat crowding and increased competition. Long-term effects of persistent hypoxia include depletion of prey resources, decreases in reproductive success, and immune suppression. In the Chesapeake Bay watershed, increases in impervious surface and the transition from rural to suburban landscapes may amplify hypoxia in the Bay.

Contaminants and Pollution

Contaminants were implicated in the decline of Chesapeake Bay striped bass recruitment in the 1970s, but their effects were largely indistinguishable from other factors such as high fishing rates and an unfavorable climate regime. Contaminants may depress productivity and consumption advisories related to contaminant loads may lower the desirability of striped bass as table-fare, impacting both commercial sales and recreational fishing. Risk management strate-

gies may assist in predicting the effects of suspected contaminant-related problems.

Watershed Development

Increasing urban sprawl has been identified as a major threat to the Chesapeake Bay watershed. Sprawl impacts water supply and water quality, affecting striped bass larvae, juveniles, and adults through sedimentation, flow alteration,

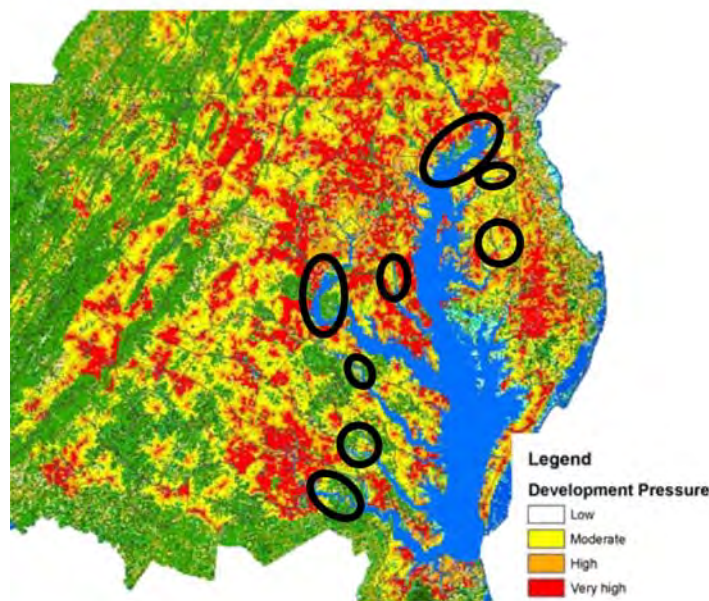


Figure 2. Projections of development pressure with ovals indicating striped bass spawning areas. Two lower Eastern Shore ovals may contain multiple spawning areas. Source: U.S. Geological Survey (prepared for the Chesapeake Bay Program).

nutrient enrichment, contaminants, and thermal pollution. When striped bass spawning areas are overlaid onto a U.S. Geological Survey map of estimated development pressure, the data indicate that all striped bass spawning watersheds appear to be under moderate to very high development pressure (Figure 2). The implication of this pressure on the striped bass population in Chesapeake Bay should be considered.

Foodweb Issues and Drivers

Forage and Predation

Striped bass management actions have produced greater abundance and larger fish. Consequently, prey consumption by this population has been potentially high enough to seri-

ously impact other fisheries and the abundance of forage fishes, although the magnitude of this impact is largely unknown. High forage demand has coincided with a deterioration of indicators of striped bass nutritional state, an outbreak of disease, and rising natural mortality rate estimates, although striped bass survival appears to remain high.

Invasive Species

Blue and flathead catfish were introduced to Chesapeake Bay tributaries in the 1970s with the intent of establishing new recreational fisheries. Both have founded robust populations in the Bay and likely compete with juveniles for invertebrate prey and with adult striped bass for forage fish species. Blue catfish also prey on young striped bass. Further investigation is needed into the impact of catfish predation and efforts are underway to characterize blue catfish diet, population size, and spatial distribution to gain a better understanding of their potential impacts on striped bass in Chesapeake Bay.

Stock Dynamics Issues and Drivers

Recruitment Variability

Striped bass recruitments in the Maryland and Virginia portions of Chesapeake Bay vary more than twentyfold over the past fifty years. The marked collapse of the Atlantic coast fishery in the 1970s resulted in low juvenile recruitment although the population recovered in the early 1990s in response to management regulations. High inter-annual recruitment variability is still a conspicuous characteristic of post-recovery striped bass population dynamics.

Exploitation

Failure of strong year-classes in Chesapeake Bay after 1970 and an alarming decline in landings provided the basis for harvest moratoria in the Bay region (starting with Maryland in 1985) and much more restrictive management elsewhere. The criterion for recovery and reopening fisheries was met in 1989 and a new era of more conservative harvest management began in 1990. In most recent years annual landings in the Chesapeake Bay area stabilized around nine million pounds. It appears that maintaining the fishing mortality rate at or below the current target yields a sustainable population and robust spawning stock. However, removals due to recreational and commercial discards are poorly understood and may be significant enough to impact the population. Further, while bycatch is known to occur in the striped bass fishery, there is no accurate characterization of the species caught during different seasons by various gear types. Further investigation into bycatch patterns may yield insight into larger ecosystem impacts.

Disease

Striped bass are known to be susceptible to a variety of common fish pathogens and disease-related mortality events have occurred in Chesapeake Bay. Recent attention has largely centered on bacterial infections caused by the genus *Mycobacterium* spp. *Mycobacterium* is a chronic disease common in wild and captive fishes. It causes lesions and impairs liver, kidney, and spleen function (Figure 3). Current stock assessments indicate that non-fishing mortality in striped bass has increased since 1999. Modeling efforts suggest that disease may be associated with the increased striped bass population size recently seen in

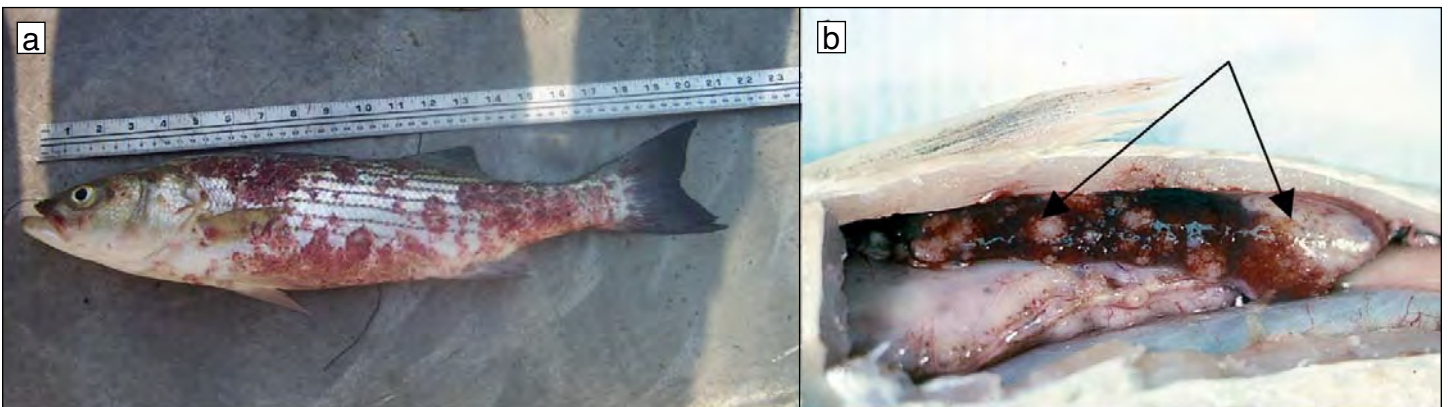


Figure 3. Gross signs of mycobacteriosis in Chesapeake Bay striped bass: (a) severe ulcerative dermatitis and (b) multi-focal gray nodules (arrows) within the spleen. Credit: Virginia Institute of Marine Science.

Chesapeake Bay and may be linked to the increased mortality. Disease negatively impacts consumption of striped bass and may, in turn, impact the recreational and commercial fisheries in Chesapeake Bay.

Connectivity

The health and persistence of the Chesapeake Bay striped bass population depends upon several key factors linked to connectivity. The spawning units associated with each major Chesapeake Bay sub-estuary must be conserved; the nurseries connected to these spawning units must be functional; and connectivity between the spawning units and their associated nurseries must remain intact. Exploitation, habitat degradation, and climate change may all impact future spawning units and nursery areas.

Socioeconomics Issues and Drivers

Livelihoods

Striped bass are the most important economic finfish species in Chesapeake Bay and they contribute to the livelihoods that watermen (including charter boat captains) earn from the Bay. In 2009, watermen earned \$8.5 million from striped bass harvest. Additionally, there were 145,000 angler trips on charter boats in Maryland and Virginia in 2010. Striped bass is the species most frequently targeted on these trips.

Valuation of Water Quality

Striped bass is more sensitive to low oxygen conditions than most other finfish species. The value of improvement (or degradation) in water quality for recreational fishermen targeting striped bass has been investigated. The researchers found that a degradation in water quality to 3 mg/l dissolved oxygen across the Bay resulted in a \$8.84 (1998 dollars) decrease in the value of a striped bass trip or \$7.3 million a year.

Consumption/Demand

Striped bass are the most frequently targeted recreational sport fish in Chesapeake Bay and they also support a large

commercial fishery. Striped bass yield the highest price per pound for finfish caught in Chesapeake Bay. The average price paid to watermen in 2009 was \$1.74 per pound. This was the lowest price, in real dollars, since the moratorium on fishing lifted in 1989, and probably reflects the impacts of the economic recession on demand and seafood prices in general.

Economic Impacts of Management

Maryland and Virginia employ different management strategies for striped bass in Chesapeake Bay. Maryland employs traditional fishery management regulations including limited entry and effort controls, while Virginia has recently moved towards a catch share or quota-based management program. Although both strategies appear to be effective in promoting the striped bass population, there have been differing economic impacts on fishermen within the two states. Specifically, from the period following the implementation of catch shares in Virginia to 2007, the mean price per pound was five percent higher in Virginia than Maryland and in 2007, Virginia received 33% more per pound compared to Maryland. This phenomenon may be a result of catch shares allowing Virginia fishermen to be more flexible and efficient, resulting in higher compliance and revenues per boat.

Summary

Striped bass appear to be recovered following management strategies designed to rebuild the population in Chesapeake Bay. However, there is concern that the recovered population may be impacting forage fish populations, exceeding the available prey base, and demonstrating signs of deteriorating health conditions. Further, future climate change and unchecked watershed development may threaten the striped bass population in Chesapeake Bay. From an ecosystem perspective, the interconnections between striped bass and its habitat, stock dynamics, foodweb, and associated socioeconomics should be considered in a shift to EBFM. This shift will require prioritization of management goals for the five key species and ultimately a balance between ecological phenomena and human activities.

Table 1. Critical ecosystem considerations for striped bass in Chesapeake Bay.

Ecosystem Stressor		Issues/Drivers/Stressors
1. Habitat	a. Climate Change and Warming	<ul style="list-style-type: none"> Warmer temperatures may degrade striped bass nursery habitat and decrease availability of suitable adult habitat. Higher seasonal temperatures may decrease larval survival. Because of the warmer temperatures in the Bay, striped bass may not immigrate out to the coastal stock, increasing competition for prey in the Bay.
	b. Flow	<ul style="list-style-type: none"> Freshwater flow variations may influence survival of striped bass eggs and larvae.
	c. Hypoxia	<ul style="list-style-type: none"> Avoidance of low dissolved oxygen areas yields net habitat loss and potential crowding. Persistent hypoxia decreases fish yields and abundances, as well as suppresses striped bass immune response leading to increased disease.
	d. Contaminants	<ul style="list-style-type: none"> Contaminants may depress striped bass productivity. Required consumption advisories about contaminants negatively impact commercial sales and recreational participation.
	e. Watershed Development	<ul style="list-style-type: none"> Greater watershed development over time increases impervious surfaces, erosion, and sedimentation resulting in habitat instability and potentially impaired reproductive success. Urban sprawl near the Bay may deteriorate water quality and water supply required for all striped bass life stages.
2. Foodwebs	a. Forage and Predation	<ul style="list-style-type: none"> Current striped bass population numbers have the potential to significantly impact forage fish abundance in the Bay.
	b. Invasive Species	<ul style="list-style-type: none"> Invasive blue and flathead catfish compete with juvenile and adult striped bass for prey. Blue catfish prey on striped bass; the degree of impact on the striped bass population is unknown.
3. Stock Dynamics	a. Recruitment Variability	<ul style="list-style-type: none"> Alterations in temperature and freshwater flow in the Bay due to human activities and environmental changes may impact recruitment and population stability. Juvenile striped bass abundance is largely dependent upon favorable environmental conditions and processes.
	b. Exploitation	<ul style="list-style-type: none"> Maintaining fishing mortality at or below the management target is required to promote a sustainable fishery and robust spawning stock. Recreational and commercial discards may significantly impact the striped bass population.
	c. Disease	<ul style="list-style-type: none"> Mortality associated with disease in Chesapeake Bay is not well understood. Hypoxia and habitat degradation may promote disease such as mycobacteriosis.
	d. Connectivity	<ul style="list-style-type: none"> Striped bass yield, stability, resilience, and persistence in the Bay depend upon conservation of spawning units attached to major sub-estuaries, maintaining connectivity between functioning spawning units and their associated nurseries.
4. Socioeconomics	a. Livelihoods	<ul style="list-style-type: none"> Watermen (including charter boat captains) rely on striped bass more than any other targeted species to support their livelihoods.
	b. Management Considerations	<ul style="list-style-type: none"> Different management strategies in Maryland and Virginia may contribute to higher value and greater compliance with regulations.
	c. Valuation of Water Quality	<ul style="list-style-type: none"> Decreased water quality directly correlates with diminished value of the striped bass fishery.
	d. Consumption/Demand	<ul style="list-style-type: none"> While striped bass has the highest price per pound of finfish caught in Chesapeake Bay, since 2009 they sold for the lowest price since the moratorium, likely a reflection of the current economic climate.

THE ECOSYSTEM-BASED FISHERIES MANAGEMENT (EBFM) PROJECT FOR CHESAPEAKE BAY has been developed and coordinated by Maryland Sea Grant, working in partnership with the scientific community and the region's state and federal agencies (the Virginia Marine Resources Commission, Maryland Department of Natural Resources, Potomac River Fisheries Commission, Atlantic States Marine Fisheries Commission, District of Columbia Department of the Environment, NOAA, and EPA). The EBFM Project targets five key species identified in the Ecosystem Planning for Chesapeake Bay document, including striped bass, menhaden, blue crab, alosines, and oysters. The goals of the EBFM project are to build a sustainable mechanism for addressing ecosystem issues for fisheries within Chesapeake Bay and to develop ecosystem tools for use in ecosystem-based fishery management plans for the five key species (or group of species in the case of alosines). Currently the project involves 85 scientists, managers, and stakeholders from within and beyond the Chesapeake Bay region. For more information on Maryland Sea Grant's Ecosystem-Based Fishery Management Project please visit: www.mdsg.umd.edu/ebfm.

Authors and Editors

The information in this summary brief was adapted from the EBFM for Chesapeake Bay Striped Bass Background and Issue Briefs authored by the Striped Bass Species Team members: Jim Uphoff (MD DNR, Chair), Joe Cimino (VIMS), Kate Culzoni (EDF), Mary Fabrizio (VIMS), David Gauthier (VIMS), John Jacobs (NOAA Oxford), Mike Johnson (VMRC), Ed Martino (NOAA Oxford), Nichola Meserva (ASMFC), David Secor (UMCES-CBL), Alexei Sharov (MD DNR), Wolfgang Vogelbein (VIMS), Marek Topolski (MD DNR), and Doug Lipton (Chair of the Socioeconomic Quantitative Ecosystem Team). Alesia Read, Jonathan Kramer, Shannon Green, and Jessica Smits served as editors.

For More Information and References

Please visit our website for more information on the Striped Bass Species Team and all other information related to the Ecosystem-Based Fisheries Management Program at Maryland Sea Grant: www.mdsg.umd.edu/programs/policy/ebfm/

Further information and all references for primary literature can be found within the species briefs here: www.mdsg.umd.edu/programs/policy/ebfm/bioteam/stripedbass/

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