Fish Habitat of Concern Designations for Fish and Shellfish Species

Managed by the
Atlantic States Marine Fisheries Commission

January 2024

Prepared by the

ASMFC Habitat Committee and
Habitat Program Coordinator



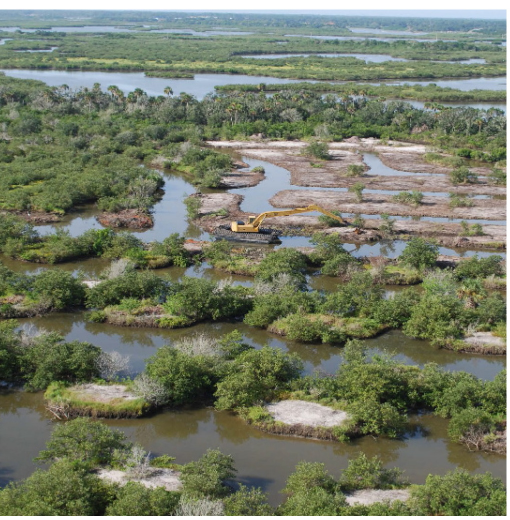
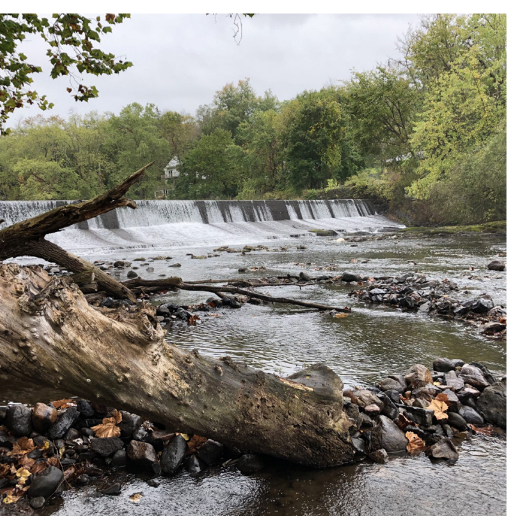

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PHOTO ACKNOWLEDGEMENTS
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Table of Contents Page, top to bottom: Salt marsh © Matt Poole, USFWS; River herring in riverine bottom habitat © Onne Vanderwal; Photo taken from Volusia County Mosquito Control helicopter © L. Walters, UCF; Paulina Dam, Paulins Kill, NJ © The Nature Conservancy

Introduction

The Atlantic States Marine Fisheries Commission (Commission or ASMFC) serves as a deliberative body that coordinates the conservation and management of the Atlantic coastal states' shared fishery resources for protection and sustainable use. The Commission's Habitat Committee functions to promote and support cooperative interstate conservation, restoration, and protection of vital habitats for Commission-managed species. One of these functions includes the development of recommendations for Habitat Areas of Particular Concern (HAPC) for each species. The Commission renamed HAPC to Fish Habitat of Concern (FHOC) in October 2017 to distinguish the Commission term from the federal term defined by the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). FHOCs are a subset of fish habitat that are particularly ecologically important, sensitive, vulnerable to development threats, and/or rare. FHOCs are defined based on the same criteria as federally designated HAPCs, but since species managed only by the Commission do not fall under the Magnuson-Stevens Act, their habitats are not afforded federal legal protection and no consultation with the National Marine Fisheries Service (NMFS) is required. Defining HAPCs and FHOCs for federally- and Commission-managed species, respectively, is intended to focus conservation efforts on specific habitats that are most ecologically important, vulnerable, and/or necessary to support each life stage of a species.

Goals

This report has two primary goals:

1. To describe the regulatory and policy context for habitat descriptions in Commission Fishery Management Plans;
2. To draft text descriptions of FHOC for species managed only by the Commission, plus Atlantic sturgeon. Atlantic sturgeon management will become the responsibility of the Commission once it is declared recovered. Given that the Commission wishes to affirm NMFS's designation of Critical Habitat (CH) for the species, the Habitat Committee elected to include the species in this document.

Commission Policy on Habitat Descriptions in Fishery Management Plans

The Commission recognizes the importance of habitat conservation as a critical component of fisheries management and that thriving habitats produce abundant fish populations. While the Atlantic Coastal Fisheries Cooperative Management Act does not grant the Commission regulatory authority over habitat of Commission-managed species, the Commission does require habitat descriptions be included as part of each Commission Fishery Management Plan (FMP) in recognition of the critical role habitat plays in fisheries production and ecosystem function.

Guidance and process for the development of habitat sections to be included in FMPs is outlined in the ASMFC's Habitat Committee Guidance Document (2013).

The basic elements of an FMP's habitat section include:

1. Description of the Habitat;
2. Identification and Distribution of Habitat and HAPC (since re-named FHOC);
3. Present Condition of Habitats and FHOCs;
4. Recommendations and/or Requirements for Fish Habitat Conservation/Restoration; and Information Needs/Recommendations for Future Habitat Research.

This document focuses on designations under Section 2: Identification and Distribution of Habitat and FHOC, and under Section 3: Present Condition of Habitats and HAPCs (*since re-named FHOC*) where appropriate.

Commission-managed species are not subject to requirements imposed by the Magnuson-Stevens Act which mandate designation of Essential Fish Habitat (EFH) and evaluation of federally-permitted projects that may impact that habitat[1]. However, the NMFS and U.S Fish and Wildlife Service (USFWS) do have obligations to consult on a broader array of trust resources under the Fish and Wildlife Coordination Act, which includes Commission-managed species.

Guidelines for Identifying Fish Habitats of Concern

The Commission's guidelines for identifying FHOCs (formerly HAPCs) in FMPs are stated in the box below. The subsections were combined to create the current designations.

The text is taken from Appendix 3 to the Habitat Committee Guidance (2013, pp. 30-31). Note: *"Habitat Area of Particular Concern"* has been changed to *"Fish Habitats of Concern"* in the text below where appropriate.

> *1.4.1.2: Identification and Distribution of Fish Habitats of Concern*
>
> *The intent of this subsection is to identify habitat areas or [fish] habitat area of concern that are unequivocally essential to the species in all their life stages, since all used habitats have already been identified in Subsection 1.4.1.1.*
>
> *Habitat Areas of Particular Concern, or HAPCs, are areas within EFH that may be designated according to the Essential Fish Habitat Final Rule (2002) based on one or more of the following considerations: (i) the importance of the ecological function provided by the habitat, (ii) the extent to which the habitat is sensitive to human-induced environmental degradation, (iii) whether, and to what extent, development activities are, or will be, stressing the habitat type, or (iv) the rarity of the habitat type. Descriptions of EFH are not currently being included in FMPs prepared for species solely under Commission management. The definition of FHOC is therefore modified to be areas within the species' habitat that satisfy one or more of the aforementioned criteria.* ***When an FHOC is described for a species solely under the management of the Commission, the designation does not have any regulatory authority. Please refer to the ASMFC HAPC document for a list of species under Commission management only and description of the corresponding HAPC (ASMFC 2013b)[2].***
>
> *A FHOC is a subset of the "habitats" described in Subsection 1.4.1.1, and could include spawning habitat (e.g., particular river miles or river reaches for striped bass populations), nursery habitat for larvae, juveniles and subadults, and/or some amount of foraging habitat for mature adults. FHOC are geographic locations which are particularly critical to the survival of a species. Determination of the amount of habitats (spawning, nursery, subadult, adult residence, and adult migration routes) described in Subsection 1.4.1.1 that should be classified as FHOC may be difficult.*
>
> *Examples of FHOC include: any habitat necessary for the species during the developmental stage at which the production of the species is most directly affected; spawning sites for anadromous species; benthic areas where herring eggs are deposited; primary nursery areas; submerged aquatic vegetation*

1 Federal agencies proposing or authorizing projects within EFH areas are required to consult with NMFS to determine the impact of those projects on EFH. This EFH consultation is required only for federally managed species, not for species solely under the management authority of the Commissions. Regulatory guidelines for EFH consultations can be found at 50 C.F.R. §600.905 2015.

2 The referenced document is referring to this current document (ASMFC 2022).

in instances when species are determined to be "dependent" upon it; and inlets such as those located between the Atlantic Ocean and bays or sounds, which are the only areas available for providing ingress by larvae spawned offshore to their estuarine nursery areas.

The extent of habitats or FHOC for a species may depend on factors such as habitat bottlenecks, the current stock size and/or the stock size for which a species Management Board and Technical Committee establishes targets, etc. Given the current state of knowledge with regard to the relationship between habitat and production of individual species, this information may not be available for many species.

If known, the historical extent of FHOC should also be included in this subsection, in order to establish a basis for Subsection 1.4.1.3. Use of GIS is encouraged to depict the historical and current extent of HAPCs, and determine the amount of loss/degradation, which will assist in targeting areas for potential restoration.

1.4.1.3: Present Condition of Habitats and Fish Habitats of Concern

This subsection should include, to the extent the information is available, quantitative information on the amount of habitat and FHOC that are presently available for the species, and information on current habitat quality. Reasons for reduction in areal extent (either current or historical), should be addressed, for example, "dam construction has eliminated twenty percent of historical spawning habitat" (ASMFC, 2008), "forage habitat bottleneck has reduced the young-of-year populations by thirty percent", or "fishing gear continues to disturb fifty percent of the forage habitat", etc.

Any habitats or FHOC that have diminished over time due to habitat bottlenecks should be incorporated to the extent information is available. Habitat bottlenecks can occur due to natural disasters, fishing disturbance, impacts of development, or other complex processes that can cause habitat shifts. This subsection can further address options to reverse or restore current known habitat bottlenecks. All current threats to the species' habitat should be discussed in this subsection. If known, relative impacts from these activities should be identified and prioritized. For example, addressing hydrological alterations and their impacts are a high priority for anadromous species. These may include freshwater inflow/diversions; changes in flows due to hydropower, flood control, channel modifications, or surface/aquifer withdrawals; and saltwater flow or salinity changes due to reductions in freshwater inflows or deepening of navigation channels, which facilitate upstream salinity increases. Threats should also be assessed for their effect on the ability to recreationally and commercially harvest, consume, and market the species (e.g., heavy metals or chemical contamination which results in the posting of consumption advisories, or prohibition of commercial fisheries for a species, e.g., striped bass in the Hudson River, NY).

This subsection will serve as a basis for the development of recommended or required actions to protect the species' habitat, which will be outlined in Section 4.4. For example, the effectiveness of water quality standards should be reviewed in this subsection. If they are ineffective or inappropriate at protecting water quality at a level appropriate to assure the productivity and health of the species, then a recommendation should be included under the recommendations section (Section 4.4) for improvement of water quality standards.

Purpose of this Report

Although habitat information is required for each FMP, the amount of information compiled for each species varies, as does the extent of the underlying habitat-related science. Also, FMPs are written and amended as management needs arise, and the frequency of updates is not consistent between plans. Consequently, FHOC designations range from non-existent to specific and recent. This report was initiated to assess the current FHOC designations and make updates, clarifications, and improvements where possible.

The Habitat Committee drafted text descriptions of FHOC for each Commission-managed species drawing on information from the current description of FHOC in the FMPs, species fact sheets, other ASMFC publications, and current literature. Descriptions were reviewed and modified by the species technical committees for accuracy and approval.

FHOC will not be designated for species managed jointly with the Councils, instead deferring to federal designations for EFH and HAPCs. FHOC designations in this document are <u>underlined</u> and are to be designated on a case-by-case basis for ASMFC species which may be listed under the Endangered Species Act (the presumption being that ASMFC would still be responsible for management of the species, once it is declared recovered).

As FMPs and other Commission documents are updated, 'Habitat Areas of Particular Concern (HAPC)' will be replaced with 'Fish Habitats of Concern (FHOC)' as appropriate.

Fish Habitats of Concern for Commission Managed Species

AMERICAN EEL

Although no current anthropogenic threats to the functional health of the Sargasso Sea have been reported (aside from climate change), it is a FHOC for spawning adults and their eggs. Reproduction for the panmictic population exclusively occurs in this region. The drift of leptocephalus larvae from the Sargasso Sea towards the Atlantic coast may be affected by climate change-induced alterations in ocean currents (Knights 2003; Caesar et al. 2018; Thornalley et al. 2018; Peng et al. 2022). The impact of these changes on larval drift dynamics is currently unknown, but the predicted weakening and shifting of the Gulf Stream (Ezer 2015, Rypina et al. 2016) may reduce larval transport to coastal and fresh waters. Currents, primary production, and the transfer of toxins from adults to eggs all influence the success of hatching, larval migration, feeding, and growth.

Sargassum seaweed was previously harvested in US waters through surface trawling, primarily by one company. However, such harvesting has now ceased. The harvesting of Sargassum began in 1976 but was limited to the Sargasso Sea starting from 1987. Approximately 44,800 dry pounds of Sargassum were harvested since 1976, with 33,500 pounds coming from the Sargasso Sea (SAFMC 1998). It is unknown whether this harvest directly or indirectly influenced American eel mortality as the extent of eel bycatch in these operations was not documented. The South Atlantic Fishery Management Council adopted a management plan in 2001, which led to the elimination of Sargassum harvesting in the South Atlantic exclusive economic zone and state waters (SAFMC 1998).

The survival and abundance of glass eels along the continental shelf are likely influenced by various human activities. Channel dredging, shoreline alterations, and the disposal of dredged material overboard are common practices along the Atlantic coast, but their effects on glass eels are currently unknown. Furthermore, these activities, along with the impact of mobile fishing gear, may damage the benthic habitat of American eels. However, the significance of these impacts also remains unknown. Changes in salinity within embayments resulting from dredging projects could potentially alter the distribution of American eels.

Tributary headwaters are another FHOC for American Eel. Nearshore areas, embayments, and tributaries provide vital nursery and feeding habitats to support the growth and recruitment of all elver, yellow, and silver eel life stages. The availability of these habitats influences eel density and may also impact sex determination. Therefore, it is crucial to protect and restore the quantity and quality of these habitats, including providing upstream access. Fish that successfully reach upstream areas may also face significant challenges during downstream migration. For example, if eels have to pass through turbines, mortality rates can vary drastically.

The abundance of elver and yellow eel stages is affected by physical changes in these coastal tributary habitats. Dams that block or restrict upstream migration reduce access to and availability of the habitat necessary for eel distribution and growth. The direct loss of wetlands or access to wetlands, as well as restricted access to the upper reaches of tributaries, has significantly reduced the availability of these important habitats. Wetland loss is estimated at 54% (Tiner 1984), and access to Atlantic coastal tributaries for American eel nursery habitats is estimated to have decreased or been restricted by 84% (Busch et al. 1998).

AMERICAN LOBSTER

There have been widespread increases in the area and duration of stressful water temperatures (>20°C) throughout inshore waters of Southern New England (ASMFC 2010, ASMFC 2020). This loss of optimal thermal habitat in the region has caused the American Lobster stock to contract into deeper waters. Additionally, young-of-year recruitment in historically productive inshore areas has shown dramatic declines over the past two decades, reaching sustained low levels. Consequently, much of the Southern New England fishery has moved to deeper offshore areas. The reduction of optimal thermal habitat due to rising ocean temperatures in Southern New England is a major concern for this species.

Although the Gulf of Maine still falls within the optimal temperature range for American lobsters, it is warming at unprecedented rates, and recent years have seen declines in young-of-year recruitment and older juvenile indices (ASMFC 2015, ASMFC 2020). While the Gulf of Maine/Georges Bank stock remains at a relatively high level of reference abundance, the declines in recruitment and other indices of older life stages has prompted ASMFC to consider management changes to protect spawning stock biomass. Close monitoring of the Gulf of Maine population will be crucial in detecting population changes in the coming years, but overall, it is currently in generally good condition. In contrast, the Southern New England population of American Lobsters is at historic low levels, and the lack of optimal thermal habitat for all life stages is a major concern.

Other FHOCs for American lobsters include gravel, cobble, boulder, and embedded rock for young-of-year, juvenile, and adult life stages. Areas where these habitats are limited and in close proximity to offshore shoals are susceptible to various types of anthropogenic impact. Research has shown that American lobsters undergo metamorphosis through four larval stages before settling to the bottom, and they require shelter to protect them from predators during this vulnerable time (Wahle and Steneck 1991, Wahle and Incze 1997). It is critical to protect these shallow water cobble/boulder areas from coastal development. Furthermore, egg-bearing female lobsters tend to aggregate in offshore and nearshore shoal areas (Campbell 1990, Carloni and Watson 2018, Jury et al. 2019). These areas likely provide access to warm water for brooding eggs and close proximity to deep offshore areas for releasing larvae. Areas such as Grand Manan, Canada; Monhegan Island, Maine; Isles of Shoals, Maine/New Hampshire; and Georges Bank have all documented large aggregations of female reproductive lobsters. Therefore, these areas need to be taken into consideration when planning any coastal development.

ATLANTIC CROAKER

FHOCs for juvenile Atlantic croaker include low salinity estuarine habitats along the Atlantic coast in early spring to higher salinity estuarine habitats in summer and early fall. These habitats feature mud and detrital bottoms that are rich in benthic prey and maintain dissolved oxygen (DO) levels higher than 2.0 mg/L. Estuaries such as Pamlico Sound and Chesapeake Bay serve as important nursery and spawning areas for Atlantic Croaker (Schloesser and Fabrizio 2018). Adult Atlantic croaker also depend on estuarine habitats during spring through fall, in areas with salinities ranging from 3-27 ppt and DO greater than 2.0 mg/L. However, unlike juveniles, adults are less restricted by bottom substrate type due to an ontogenetic diet shift.

Along the Atlantic coast, juvenile Atlantic croaker are typically found in estuaries. Young-of-year individuals less than 50 mm total length (TL) inhabit low salinity or upriver areas (Haven 1957; Dahlberg, 1972; Chao and Musick 1977; White and Chittenden 1977; Miller et al. 2003). Juveniles show a positive correlation with mud bottoms that contain abundant detritus and benthic prey (Cowan and Birdsong 1985). As they develop, juveniles migrate downstream, and by late fall, most of them move out of the estuaries and into coastal ocean habitats (Miglarese et al. 1982). From spring (after spending winter in the coastal ocean) through fall, adult Atlantic croaker can be found in estuaries over muddy and sandy substrates, seagrass beds, and near oyster, coral, and sponge reefs (White and Chittenden 1977; TSNL 1982).

Studies have indicated that Atlantic croaker are virtually absent from waters with DO levels below 2.0 mg/L, suggesting they are very sensitive to DO concentrations (Eby and Crowder 2002). This sensitivity to DO levels can limit the quantity and quality of habitat during the warmer summer months in estuarine systems experiencing nutrient enrichment and eutrophication issues. Additionally, the use of bottom-tending fishing gear can impact FHOCs for Atlantic croaker (Able et al. 2017, Odell et al. 2017).

ATLANTIC MENHADEN

Estuarine-subtidal and riverine-tidal systems are FHOCs for the larval and early juvenile life stages of Atlantic menhaden. Atlantic menhaden production relies heavily on these systems, specifically within the upstream limit of the tidal zone. However, the water quality of these systems is threatened by various factors such as climate change, toxicants, nutrient pollution, and altered freshwater flows. Climate change, in particular, contributes to lower dissolved oxygen (DO) levels in estuarine waters due to increasing average annual temperatures. Both the Neuse River Estuary and Chesapeake Bay have experienced hypoxic or anoxic conditions during the summer (Cooper and Brush 1991), leading to significant episodic mortality of juvenile Atlantic menhaden, particularly in the Neuse (Carpenter and Dubbs 2012). These adverse conditions are detrimental to the survival of young Atlantic menhaden. Therefore, it is crucial to address the threats to estuarine water quality in order to protect the habitat and ensure the sustainability of Atlantic menhaden populations.

ATLANTIC STRIPED BASS

Striped bass spawning and larval nursery habitats (which overlap) are concentrated in fresh-low salinity tidal reaches of tributaries, where the estuarine turbidity maximum is particularly important (Hollis 1967; Dey 1981; Grant and Olney 1991; Schaaf et al. 1993; North and Houde 2003; Uphoff 2008; Maryland Sea Grant 2009; Martino and Houde 2010; Boyd 2011). Atlantic Coast striped bass fisheries rely on strong, environmentally influenced year-classes produced in Chesapeake Bay tributaries (which contributes approximately 80 percent of the coastal migratory striped bass stock), the Hudson River, the Delaware River, and to a lesser extent the Roanoke River (Callihan et al. 2015). These strong year-classes, when not subject to heavy fishing pressure, will reproduce over many years, mitigating the impacts of environmental variation (Florence 1980; Rago and Goodyear 1987; Rago 1992; Richards and Rago 1999; Secor 2000; 2007; Maryland Sea Grant 2009). Year-class success of Chesapeake Bay striped bass is largely determined within the first three weeks of life in early spring and is a product of egg abundance and the highly variable survival of eggs and larvae (Ulanowicz and Polgar 1980; Uphoff 1989; 1993; Houde 1996; Maryland Sea Grant 2009). As such, spawning and larval habitats within tidal reaches of tributaries are considered FHOC for Atlantic striped bass.

Water temperature and river discharge during the late winter and spring significantly influence year-class success. Cooler and wetter conditions due to winter-spring climate variability are important drivers for striped bass recruitment (Wood and Austin 2009; Maryland Sea Grant 2009; Martino and Houde 2010; Millette et al. 2020). Water temperature directly impacts recruitment by causing egg and early larvae mortality at lethally low or high temperatures, and indirectly via its influence on the timing of zooplankton blooms for first-feeding larvae. River flow, on the other hand, is associated with zooplankton dynamics, nursery volume, advection, water quality, and contaminant toxicity (Hollis 1967; Dey 1981; Uphoff 1989; 1992; Secor and Houde 1995; Limburg et al. 1999; Maryland Sea Grant 2009; Martino and Houde 2010; Shideler and Houde 2014; Secor et al. 2017; Millette et al. 2020).

Striped bass spawning in Chesapeake Bay rivers, the Hudson River, and Roanoke River occurs between 12˚C and 23˚C (Peer and Miller 2014; Nack et al. 2019; Greene et al. 2009), with temperatures exceeding 21˚C considered unsuitable (Uphoff 1993). Spring water temperature is the dominant factor influencing the timing of striped bass spawning in the Chesapeake Bay (Peer and Miller 2014), with peak egg production in the Pamunkey and Rappahannock rivers occurring between 15°C and 18°C (Grant and Olney et al. 1991). Temperature oscillations also have an important influence on egg production (Secor and Houde 1995); episodic mortalities of eggs and newly hatched larvae occurs when temperatures fall below 12˚C (Uphoff 1989; Rutherford and Houde 1995; Peer and Miller 2014). In the Nanticoke and Choptank rivers, nearly all eggs are collected before water temperatures reach 20°C or 21°C (Uphoff et al. 2022). Larval catches increase significantly between 14°C and 17°C and continue at a slower rate up to 20°C due to larval growth, which influences mobility, catchability, and mortality (Uphoff et al. 2022). Cohort-specific mortality rates for early striped bass larvae in the Patuxent River are greatly affected by water temperature, with both early (<14°C) and late (>21°C) cohorts experiencing higher mortality (Secor and Houde 1995).

During the past 70 years the Chesapeake Bay has experienced a near 2˚C rise in mean surface water temperature, a trend that could alter the timing of spawning and survival of eggs and early larvae (Maryland Sea Grant 2009; Peer and Miller 2014, Giuliano in press). Warming in this region has recently been observed to occur at a more rapid rate from May-October than November-April, and this seasonal split coincides with striped bass spawning and larval development (Hinson et al. 2022). In the Hudson River, earlier spawning has been reported due to the earlier onset of suitable water temperatures, although changes in spawning duration vary spatially (Pan et al. 2023). Modeling temperature-increase scenarios from 2010 to the 2090s suggest that warming may lead to earlier and shorter spawning events (Nack et al. 2019). Long-term climate patterns and warming, along with changes in acidic deposition, increased freshwater salinization, and shifts in agriculture and watershed management in the Chesapeake Bay watershed, indicates larval habitat suitability may shift (Uphoff 2023).

Chesapeake Bay tributary flow exhibits positive and negative relationships and associations to striped bass early life stage survival and year-class success (Kernehan et al. 1981; Uphoff 1989; 1992; Rutherford et al. 1997; Martino and Houde 2010; Millette et al. 2020; Gross et al. 2022). Poor recruitment of age-0 Chesapeake Bay striped bass is more likely when flows are below average (Gross et al. 2022). Alterations in natural river flow due to dam operations, water withdrawal, and harbor maintenance have been attributed to declines in various regions, including the Roanoke River (Rulifson and Manooch 1990), the Santee-Cooper System (Bulak et al. 1997), and Savannah River (Reinert et al. 2005). In some cases, the restoration of "natural" salinity has led to increased captures of wild larvae and juveniles (Reinert et al. 2005). The Hudson River's size appears to provide more stabilization of physical factors like temperature and flow compared to smaller Chesapeake Bay tributaries (Limburg et al. 1999).

Episodic mortalities of striped bass larvae in some Chesapeake Bay tributaries during the 1980s and 1990s were attributed to poor water quality (Uphoff 1989; 1992; Hall et al. 1993; Richards and Rago 1999). Low survival rates in the Choptank River during the 1980's was associated with low pH, alkalinity, and conductivity, which influences the toxicity of metals (Uphoff 1989; 1992; Hall et al. 1993; Richards and Rago 1999). Improvements in water quality, including increased pH and alkalinity, coincided with regulatory actions that reduced rainfall acidity, the deposition of toxic metals in acid rain, and enhanced conservation agriculture that reduced the use of inorganic fertilizers and pesticides (potential sources of toxic metals), and reduced erosion (Uphoff 2023). The installation of secondary wastewater treatment in the Philadelphia area led to improved water quality and the re-establishment of striped bass spawning in the Delaware River after decades of poor water quality (Weisberg and Burton 1993; Kaufman 2010). Many striped bass spawning areas receive runoff from agricultural operations, but also from large urban and suburban areas (Uphoff 2008; 2023). Watershed urbanization increases runoff volume and intensity in streams, resulting in greater physical instability, erosion, sedimentation, thermal pollution, contaminant loads, and nutrient influx (Beach 2002; Wheeler et al. 2005; NRC 2009: Hughes et al. 2014a; 2014b). Urbanization also introduces additional industrial wastes, contaminants, endocrine disruptors, stormwater runoff, and road salt, that are all ecological stressors (Brown 2000; NRC 2009; Benejam et al. 2010; McBryan et al. 2013; Branco et al. 2016; Kaushal et al. 2018; Baker et al. 2019).

In summary, striped bass concentration in specific tidal reaches at various life stages, the impact of temperature and river discharge on egg and larval survival and age-0 recruitment, and the influence of watershed activities (i.e., agriculture and urbanization) play pivotal roles in the dynamics of striped bass year-class success and population health. These factors, combined with long-term climate patterns and human activities will impact their spawning and nursery habitats, thereby necessitating continued monitoring and conservation efforts to support striped bass populations in Atlantic coastal waters.

The management of Striped Bass FHOC and the factors influencing them, such as water quality and watershed land use patterns, typically falls outside the jurisdiction of state agencies responsible for fishery management. Instead, these agencies often play an advisory role in local, state, and federal decision-making processes that directly affect water quality and the condition of Striped Bass FHOC. However, the inclusion of fish habitat considerations in these decisions varies widely among jurisdictions, and while individual choices may have a limited impact, the cumulative effect of numerous decisions significantly affects the condition of Striped Bass FHOC.

Although we are not proposing at this time to designate striped bass Atlantic Ocean habitats as FHOC, we note for the record that the offshore habitats used by the coastal migratory stock during winter are very important to the health, sustainability, and production of the stock. During their winter residency in the ocean, sexually mature adult striped bass feed heavily upon schooling prey species (i.e., especially Atlantic herring, Atlantic menhaden, bay anchovy; see Nelson et al. 2006; Overton et al. 2008), which influence striped bass condition and spawning. Lipids are the source of metabolic energy for growth, reproduction, and swimming for fish, and these energy reserves relate strongly to foraging success, reproductive success, potential prey density, habitat conditions, environmental stressors, and subsequent fish health and survival (Tocher 2003; Jacobs et al. 2013). There is also evidence to indicate that striped bass infected with mycobacteriosis likely experience some degree of recovery due to winter residency and prey consumption in the ocean (see Jacobs et al. 2009). Striped bass schools overwintering offshore are vulnerable to recreational fishing pressure, from which they are protected when they are in the exclusive economic zone (EEZ) due to the current moratorium. These striped bass schools are also subject to bycatch in commercial large-mesh gill net fisheries (i.e., for monkfish, spiny dogfish, and other species; see Gearhart 1998). We believe that the criteria for designating FHOC in these offshore winter habitats are likely met; however, the distribution of striped bass during winter varies widely across a broad area (see Newhard 2023), making it challenging to designate any particular area as FHOC.

ATLANTIC STURGEON

The FHOCs for Atlantic sturgeon include the NMFS designations for the five discrete population segments (DPS) comprising the species range. The designations can be found here: *https://www.fisheries.noaa.gov/action/critical-habitat-designation-atlantic-sturgeon*. They include the reaches of Atlantic Coast rivers where spawning migrations, egg deposition, and larval and early juvenile nursery habitats occur. Threats to these habitats are multiple and include altered river flows and thermal regimes due to hydropower operations, water withdrawals, and increased incidence of storms owing to climate change; low dissolved oxygen (DO), ocean acidification, altered salinity due to navigational dredging, and ship strikes, among others.

Information regarding Atlantic sturgeon use of spawning reaches at a finer scale has increased since the CH designation in 2017, as a result of ongoing long-term studies using acoustic telemetry of sexually mature Atlantic sturgeon (e.g., see Breece et al. 2021 for the Hudson River population; Hager et al. 2020 for the York River population in Virginia; and additional information is currently being gathered for North Carolina rivers under an NMFS Section 6 grant, see McCargo et al. 2019). These studies may allow further refinement of Atlantic sturgeon FHOCs beyond what is presently designated as CH by NMFS.

When the initial CH designations were made, NMFS indicated that inadequate data prevented the designation of estuarine or offshore habitats where sturgeon aggregations occurred as CH, mainly because there were no specific physical or biological features unequivocally associated with these areas. However, the Atlantic States Marine Fisheries Commission (ASMFC) believes that there is now sufficient justification and data available to designate certain habitats as FHOC for ASMFC purposes. This is especially relevant to Atlantic sturgeon nursery habitats within estuaries that fall outside the current NMFS CH designations, where consistent fishery-independent sampling has shown the presence of juvenile sturgeon. Recommendations are based in large measure on the comprehensive review of Atlantic sturgeon life history by Hilton et al. (2016) and supplemented by additional published information.

Most rivers serving as natal habitats discharge into estuaries, making these areas highly important in the migratory pathway for juvenile sturgeon as they journey from their birthplaces to the ocean. In many cases, NMFS CH designations already encompass the estuarine portions of these rivers. For instance, Haverstraw Bay, recognized as a significant Atlantic sturgeon nursery area (Pendleton and Adams 2021), and the Delaware River estuary (Hale et al. 2016) are already included in NMFS CH designations. However, we propose that additional estuarine areas downstream also deserve FHOC status. This recommendation is based on the persistent and documented presence of juvenile Atlantic sturgeon within these estuaries and their vital role in the migratory pathway from local rivers and other spawning populations (Waldman et al. 2013).

Specifically, these estuarine FHOC areas, moving from north to south, encompass:

1. Long Island Sound (Dunton et al. 2010, citing Bain et al. 2000 and Savoy and Pacileo 2003).
2. Delaware Bay (Dunton et al. 2010; Brundage and O'Herron 2009; Breece et al. 2018).
3. Chesapeake Bay, including the Nanticoke River-Marshyhope Creek estuary (Musick 2005; Greenlee et al. 2017; Secor et al. 2022).
4. Western Albemarle Sound, supported by a decades-long time series documenting young-of-year production and subadult habitat use (Armstrong 2003; ASMFC 2017).
5. Pamlico Sound, where Atlantic sturgeon use has been documented through various sources (ASSRT 2007; Oakley and Hightower 2007; McConnaughey et al. 2019; Boyd 2015-2018; Byrd and Pensinger 2022).
6. Brunswick River (tributary to the Cape Fear River, NC, Post et al. 2014).
7. Winyah Bay (Collins et al. 2000; Simpson et al. 2015; Crane 2021).

Furthermore, long-term fishery-independent data time series (Laney et al. 2007 and unpublished data; Dunton et al. 2010) and analysis of fishery-dependent data derived from the observation of Atlantic sturgeon bycatch (e.g., Stein et al. 2004; ASMFC 2007; NMFS 2022) have consistently documented aggregation sites for subadult and adult Atlantic sturgeon in the nearshore marine environment. These offshore aggregation sites meet one or more of the criteria for FHOC as stated in the introduction to this document.

These sites are relatively few in number, yet they are of great importance for winter aggregation and foraging. They are, however, subject to multiple anthropogenic threats, including activities such as sand mining, depositions of olivine sand for carbon sequestration, oil and gas exploration, and shipping (with concerns regarding oil spills and ship strikes).

Specific nearshore FHOC sites include:

1. Rockaway (Dunton et al. 2010, Figure 9B, p. 460).
2. Sandy Hook (Dunton et al. 2010, Figure 9B, p. 460).
3. Kennebec River delta (Dunton et al. 2010, Figure 9A, p. 460).
4. Areas off Duck, mapped in dark red with sturgeon counts ranging from 25-46/km2, as described in Wickliffe et al. 2019 (p. 126).

Notably, during the spring and fall, juveniles are found off Rockaway, Sandy Hook, and off the Kennebec River delta (Dunton et al. 2010, 2015, and unpublished acoustic data). Stein et al. (2004) mapped multiple areas from Cape Hatteras northward, and Dunton et al. (2010) also identified multiple sites. Analysis of the complete time series (1988-2016) of data from Atlantic sturgeon captures during the Cooperative Winter Tagging Cruises (see Laney et al. 2007) by Wickliffe et al. (2019) further documents the Atlantic sturgeon 'hot spot' in the nearshore Atlantic Ocean off North Carolina, near Duck. These aggregation sites are not only used by sturgeon from nearby natal rivers but are also frequented by sturgeon from other Distinct Population Segments (DPSs) as well (Wirgin et al. 2015; Kazyak et al. 2021). In reference to the sites documented and mapped by Dunton et al. (2010), they emphasized, "Specifically, Sandy Hook (NJ), Rockaway (NY), and Kennebec (ME), which are hotspots of Atlantic sturgeon captures, as identified by this study, should be protected." They further emphasized that the Kennebec 'hotspot' is particularly important because Atlantic sturgeon captured in Maine river systems have been shown to represent a separate DPS (Grunwald et al. 2008).

More recently, acoustic telemetry has been conducted on the New York Wind Energy Lease area (see Frisk et al. 2019, and Ingram et al. 2019). The study documented the presence of juvenile, subadult and adult Atlantic Sturgeon within the wind lease area throughout much of the year (during the period November 2016 through early February, 2018). While the study successfully demonstrated the high utility of acoustic telemetry for determining the abundance and distribution of Atlantic Sturgeon within the study area, its temporal duration was shorter than the studies which are cited above that employed longer observer or survey time series and identified persistent aggregations across years. Therefore, we are not recommending at this time that the habitat within the NY Wind Lease Area be designated as FHOC for Atlantic Sturgeon.

BLACK DRUM

Black drum are habitat generalists, so no FHOCs are designated at this time. They can be found at various life stages in the following habitats: tidal freshwater, estuarine emergent vegetated wetlands (flooded salt marshes, brackish marshes, and tidal creeks), estuarine scrub/shrub (mangrove fringe), submerged rooted vascular plants (seagrasses), oyster reefs and shell banks, unconsolidated bottom (soft sediments), ocean high salinity surf zones, and artificial reefs. The estuarine system as a whole serves as the species' primary nursery area. In the future, we may elect to specify documented spawning sites as FHOC for black drum, should acoustic surveys be able to accurately pinpoint such habitats (e.g., see Rice et al. 2016).

COBIA

Important habitats for cobia include estuarine and nearshore spawning areas, as well as live reefs and artificial structure. Good water quality is critical for the sub-population of cobia that spawn inshore, particularly in high salinity sounds in South Carolina and Virginia where spawning aggregations occur, and where eggs and larvae develop. Oceanic spawning sites off Virginia to Georgia may extend from just outside inlets and sounds to the Gulf Stream (Brown-Peterson et al. 2001). Although the exact locations of offshore spawning sites are unknown, cobia are often associate with structures provided by live reefs, artificial reefs, oil platforms, and navigation markers.

Port Royal Sound, St. Helena Sound, Beaufort Inlet, Barden's Inlet, Hatteras Inlet, Pamlico Sound, and the mouth and lower portion of the Chesapeake Bay are designated as FHOC, especially during the months of April through June, when extensive eggs and larvae have been documented (Lefebvre and Denson 2012). Movement data show that cobia can exhibit site fidelity to spawning areas, returning to the same sites across multiple years. There are four genetically distinct groups of cobia found along the Atlantic coast, with two of these groups associated with inshore spawning in South Carolina and Virginia/North Carolina (Darden et al. 2018), which further supports the aforementioned areas. As research on cobia spawning habitat and movements expands, additional locations may be considered as potential FHOCs in the future.

As for many species, protection of spawning habitat can help to ensure population viability. Seasonal cobia migrations along coasts and between inshore and offshore waters are driven by water temperature; thus, interannual variation in water temperature and climate change could potentially affect the timing of spawning and recruitment (Crear 2021). Protection of spawning habitat is warranted in areas that are subject to urbanization, eutrophication, and dredging. In the Chesapeake Bay, one of the cobia spawning sites, the combination of excess nutrient loading and warmer water has led to more frequent and severe hypoxic events (e.g., Hagy et al. 2004).

Along the Atlantic coast, cobia are divided into two stocks at the Florida/Georgia border (GMFMC 2014), with a mixing zone from southern Georgia to Cape Canaveral, FL (Darden et al. 2014, Perkinson et al. 2019). The east coast of Florida is considered a migratory zone and is managed by the Gulf of Mexico Fishery Management Council. Hence, Florida is not considered in the habitats of concern for the Atlantic States Marine Fisheries Commission (ASFMC).

HORSESHOE CRAB

Habitat requirements for horseshoe crab change throughout their life cycle. They extend from intertidal beach fronts and tidal flats in coastal embayments for eggs and larvae to the edge of the continental shelf for adults. The distribution of high-quality spawning beaches, which are minimal affected by human disturbance, presents a potential bottleneck to reproductive success for this species. Beach areas that provide spawning habitat are FHOC for adult horseshoe crabs. Spawning adults prefer sandy beaches in low wave energy areas, usually within bays and coves. The ideal beach habitat for spawning horseshoe crabs includes a sufficient depth of porous, well-oxygenated sediments that provide a suitable environment for egg survival and development. However, nest depth and location on the beach vary among the Atlantic states depending on local spawning habitats available. Spawning beach characteristics can vary along the coast, with beaches in Florida typically having a finer grain size and larger area of tidal inundation and saturated zones. As a result, the sediment holds more water, although these beaches have also shown to hold oxygen farther from the water line than in Delaware (Penn and Brockman 1994).

Juvenile horseshoe crabs utilize nearshore shallow waters and intertidal flats as they develop. Larger juveniles and adults utilize deep water habitats for foraging but these are not considered Fish Habitats of Concern. Among these habitats, beaches are the most critical (Shuster 1996). Optimal spawning beaches may limit the reproductive success of the horseshoe crab population.

In New Jersey, the highest concentrations of horseshoe crabs occur on small sandy beaches surrounded by salt marshes or bulkheaded areas (Loveland et al. 1996). The spawning beaches within Delaware Bay are critical habitats as they support the highest density of spawning horseshoe crabs along the U.S. Atlantic Coast. Prime spawning beaches within Delaware Bay consist of sand beaches between the Maurice River and the Cape May Canal in New Jersey, and between Bowers Beach and Lewes in Delaware (Shuster 1996). Horseshoe crab eggs play an important ecological role in the food web for migrating shorebirds, and the Delaware Bay is an important stopover location for the threatened red knot. Good spawning habitat is widely distributed throughout Maryland's Chesapeake and coastal bays, including tributaries. In South Carolina and Georgia, horseshoe crabs spawn in substantial numbers on various substrates, including sandy beaches, salt marshes, and coarse-grained oyster shells. These sites are also known stopover locations for red knots. While the viability of eggs deposited in salt marshes is slightly reduced compared to sandy beaches, horseshoe crabs apparently use these habitats frequently for spawning in South Carolina (Kendrick et al. 2021). Florida has less dense concentrations of horseshoe crabs, but there are still prominent spawning populations on both the Atlantic and Gulf Coasts. The Indian River Lagoon has the highest densities of horseshoe crabs in Florida.

JONAH CRAB

Currently there is not enough information available to designate Jonah crab FHOC.

NORTHERN SHRIMP

<u>Deep, muddy basins (generally 90-180 m, but found down to 300 m) in the southwestern region of the Gulf of Maine</u> act as cold-water refuges (4-6°C) for adult shrimp during periods when most water in the Gulf reaches sub-optimal temperatures. These basins are therefore designated as a FHOC. Sub-optimal temperatures are considered to be over 8°C, with temperatures over 12°C being highly stressful for northern shrimp and potentially causing mortality if exposed to these temperatures for longer periods (ASMFC 2017, Richards and Hunter 2021). Temperature serves as a habitat bottleneck for this species (Apollonio 1986).

Nearshore water provides habitat for the larval and juvenile stages of northern shrimp, but their specific habitat requirements and spatial distribution are not well known (ASMFC 2017). For more details, please refer to Figure 10 in Amendment 3 of the northern shrimp Fishery Management Plan (ASMFC 2017) and Figure 6 in Richards and Hunter 2021, which show temperature regimes and shrimp populations, respectively, beyond 10 miles from the shore. Additionally, you can find a general discussion on "Offshore Habitat Preferences" in Apollonio et al. 1986, page 18.

RED DRUM

FHOCs for Red drum vary based on life stage. For ***early juveniles*** FHOCs include <u>protected marshes</u> (tidal fresh, brackish, and salt water) and <u>tidal creek habitat</u> (Peters and McMichael 1987; Wenner, 1992; FWCC 2008). ***Subadults***, while they can use a wide range of estuary habitats, exhibit the highest abundances and apparent productivity in association with <u>submerged aquatic vegetation, oyster reef, tidal creeks, and marsh</u> (tidally fresh, brackish, and salt) habitats (Pafford et al. 1990; Wenner 1992; Adams and Tremain 2000). The highest concentrations tend to be found in areas with dense reefs and/or shell hash in association with tidally flooded marsh habitats where these habitats exist. FHOCs for ***adults*** include <u>inlets, channels, sounds, outer bars, and within estuaries</u> in some areas (e.g., Indian River Lagoon, FL) due to their importance for red drum spawning activity (Murphy and Taylor 1990; Johnson and Funicelli 1991; Reyier et al. 2011).

Nursery areas, essential for the continuing existence of a species, can be found throughout estuaries for red drum. Larvae and early juveniles prefer shallow waters of varying salinities that offer a certain degree of protection. These areas include coastal marshes, shallow tidal creeks, bays, tidal flats of varying substrate, tidal impoundments, and seagrass beds (Pattillo et al. 1997; Holt et al. 1983; Rooker and Holt 1997, Rooker et al. 1998; Levin et al. 2001). Since red drum larvae and juveniles are ubiquitous in such environments, it is impossible to designate specific areas as deserving more protection than others. Moreover, these areas serve as nursery habitats not only for red drum but also for numerous other resident and estuarine-dependent species of fish and invertebrates, especially other sciaenids. Similarly, subadult red drum habitat extends over a broad geographic range and adheres to the criteria that define HAPCs and FHOCs. Subadult red drum are found throughout tidal creeks and channels of southeastern estuaries. They utilize submerged aquatic vegetation, tidal creeks, oyster reefs, as well as tidally fresh, brackish, and salt marshes (Pafford et al. 1990; Wenner 1992; Adams and Tremain 2000). The entire estuarine system, from the lower salinity reaches of rivers to the mouth of inlets, is vital to the continuing existence of this species.

While there is currently no supporting evidence to suggest that a particular habitat type limits red drum populations, it should be noted again that seagrass beds are vitally important for newly settled individuals, and oyster reefs, tidal creeks, and coastal rivers are of critical importance to red drum during the juvenile and subadult life stages. Data from Georgia's Marine Sportfish Health Survey indicate that over 80% of juvenile red drum in Georgia waters are associated with shell habitats. Changes in water flow and conditions due to watershed activities may also limit the recruitment of larvae at a local scale.

RIVER HERRING AND SHAD
ALEWIFE (*Alosa aestivalis*)
BLUEBACK HERRING (*Alosa pseudoharengus*)
AMERICAN SHAD (*Alosa sapidissima*)
HICKORY SHAD (*Alosa mediocris*)

NOTE: Due to the dearth of information on FHOCs for alosine species, this information is applicable to American shad, hickory shad, alewife, and blueback herring combined. Information about one alosine species may be applicable to other alosine species and is offered for comparison purposes only.

Metapopulation structure, meaning groups of the same species that are spatially separate, but may interact at some level, is evident in river herring. Metapopulation structure is important because individuals may be locally adapted. Adults frequently return to their natal rivers for spawning but some limited straying occurs between rivers (Jones 2006, ASMFC 2009). Critical life history stages for American shad, hickory shad, alewife, and blueback herring, are the egg, prolarva (yolk-sac or pre-feeding larva), post-larva (feeding larva), and early juvenile (through the first month after transformation) (Klauda et al. 1991a, b). Thus FHOC for these species are spawning grounds and nursery habitat where these critical life stages grow and mature. This broadly includes freshwater ponds, rivers, tributaries, and inlets. The substrate preferred for spawning varies greatly and can include gravel, detritus, and submerged aquatic vegetation. Blueback herring prefer swifter moving waters than alewives do (ASMFC 2009). Nursery areas include freshwater and semi-brackish waters. Access to these spawning and nursery habitats may be blocked or impeded by dams or other barriers. Juvenile alosines, which leave the coastal bays and estuaries prior to reaching adulthood, also use the nearshore Atlantic Ocean as a nursery area (ASMFC 1999). See Greene et al. 2009 for tables that detail environmental, temporal, and spatial values/factors affecting the distribution of alewife, blueback herring, American shad, and hickory shad.

Habitat quantity

Thousands of kilometers of historic anadromous alosine habitat have been lost due to development of dams and other obstructions to migration. In the 19th century, organic pollution from factories created zones of hypoxia or anoxia near large cities (Burdick 1954, Talbot 1954, Chittenden 1969). Gradual loss of spawning and nursery habitat quantity and quality and overharvesting are thought to be the major causative factors for population declines of American shad, hickory shad, alewife, and blueback herring (ASMFC 1999).

It is likely that American shad spawned in all rivers and tributaries throughout the species' range on the Atlantic coast prior to dam construction in this country (Colette and Klein-MacPhee 2002). While precise estimates are not possible, it is speculated that at least 130 rivers supported historical runs; now there are fewer than

70 systems that support spawning. Individual spawning runs may have numbered in the hundreds of thousands. It is estimated that runs have been reduced to less than 10% of historic sizes. The 2020 American Shad Benchmark Stock Assessment Summary reported that the percentage of historic riverine habitat that is currently unobstructed varies from 4-100% in 23 river systems from Maine to Florida, with 12 systems at 75% or less unobstructed and seven river systems at 50% or less unobstructed (see table in ASMFC 2020a). One recent estimate of river kilometers unavailable for spawning is 4,360 km compared to the original extent of the runs. This is an increase in available habitat as compared with estimates from earlier years, with losses estimated at 5,280 km in 1898 and 4,490 km in 1960. The increase in available habitat has largely been due to restoration efforts and enforcement of pollutant abatement laws (Limburg et al. 2003).

Some states have general characterizations of the degree of habitat loss, but few studies have actually quantified impacts in terms of the area of habitat lost or degraded (ASMFC 1999). It has been noted that dams built during the 1800's and early to mid-1900's on several major tributaries to the Chesapeake Bay have substantially reduced the amount of spawning habitat available to American shad (Atran et al. 1983, CEC 1988), and likely contributed to long-term stock declines (Mansueti and Kolb 1953). North Carolina characterized river herring habitat loss as "considerable" from wetland drainage, stream channelization, stream blockage, and oxygen-consuming stream effluent (NCDENR 2000). Sixteen state and cooperative river basin habitat plans that provide greater local detail on American shad habitat and are available at *http://www.asmfc.org/species/shad-river-herring*.

Some attempts have been made to quantify existing or historical areas of anadromous alosine habitat, including spawning reaches. Most recently, the American shad benchmark assessed and compared the amount of currently available habitat for American shad in Atlantic coast rivers to historic habitat availability (ASMFC 2020b). See section 2.7.2 for a description of this analysis. Results are presented for individual systems in each system stock section (Section 3), and overall coastwide results are provided in section 4.4.2. Previously, Maine estimated that the American shad habitat area in the Androscoggin River is 2,111 acres. In the Kennebec River, Maine, from Augusta to the lower dam in Madison, including the Sebasticook and Sandy rivers, and Seven Mile and Wesserunsett streams, there is an estimated 6,510 acres of American shad habitat and 24,606 acres of river herring habitat. Lary (1999) identified an estimated 1,877 acres of suitable habitat for American shad and 6,133 acres for alewife between Jetty and the Hiram Dam along the Saco River, Maine. Above the Boshers Dam on the James River, Virginia, habitat availability was estimated in terms of the number of spawning fish that the main-stem area could support annually, which was estimated at 1,000,000 shad and 10,000,000 river herring (Weaver et al. 2003).

Although many stock sizes of alosine species are decreasing or remain at historically low levels, some stock sizes are increasing. It has not been determined if adequate spawning, nursery, and adult habitat presently exist to sustain stocks at recovered levels (ASMFC 1999).

Habitat quality

Concern that the decline in anadromous alosine populations is related to habitat degradation has been alluded to in past evaluations of these stocks (Mansueti and Kolb 1953, Walburg and Nichols 1967). This degradation of alosine habitat is largely the result of human activities. However, it has not been possible to rigorously quantify the magnitude of degradation or its contribution to impacting populations (ASMFC 1999).

Of the habitats used by American shad, spawning habitat has been most affected. Loss due to water quality degradation is evident in the northeast Atlantic coast estuaries. In most alosine spawning and nursery areas, water quality problems have been gradual and poorly defined; it has not been possible to link those declines to changes in alosine stock size. In cases where there have been drastic declines in alosine stocks, such as in the Chesapeake Bay in Maryland, water quality problems have been implicated, but not conclusively demonstrated to have been the single or major causative factor (ASMFC 1999).

Toxic materials, such as heavy metals and various organic chemicals (i.e., insecticides, solvents, herbicides), occur in anadromous alosine spawning and nursery areas and are believed to be potentially harmful to aquatic life, but have been poorly monitored. Similarly, pollution in nearly all of the estuarine waters along the East Coast has certainly increased over the past 30 years, due to industrial, residential, and agricultural development in the watersheds (ASMFC 1999).

SPOT

FHOCs for ***larval spot*** include brackish and saltwater marsh as well as submerged aquatic vegetation in mesohaline and polyhaline waters. From Delaware to Florida, primary nursery habitat for ***juveniles*** includes low salinity bays and tidal marsh creeks with mud and detrital bottoms that contain their epifaunal and infaunal prey. Seagrass habitats, where present, appear to be most important for young-of-year spot in early spring. In the Chesapeake Bay and North Carolina, juveniles can be found in eelgrass. FHOCs for ***adult spot*** include tidal creeks and estuarine bays with mud and detrital substrates which support abundant prey (epifauna and benthic infauna). Bottom-tending fishing gear may impact spot FHOCs (Odell et al. 2017).

SPOTTED SEATROUT

Submerged aquatic vegetation, salt marsh, and oyster reefs, especially where submerged aquatic vegetation is not available, are FHOCs for spotted seatrout. Seagrass beds provide important habitat for both juvenile and adult spotted seatrout, but are in decline along much of the Atlantic coast (Orth et al. 2006; Waycott et al. 2009; Adams et al. 2019; Morris et al. 2022). Salt marsh and oyster reef habitats provide FHOCs for juvenile and adult spotted seatrout, particularly in areas where submerged aquatic vegetation naturally does not occur. These habitats are also in decline, and are under continuing threats due to coastal development, sea level rise, and ocean acidification. Spawning takes place on or near seagrass beds, as well as sandy banks, natural sand, shell reefs, near the mouths of inlets, and off the beach (Daniel 1988; Brown-Peterson and Warren 2002). Environmental conditions in spawning areas may affect growth and mortality of egg and larvae, as sudden salinity reductions cause spotted seatrout eggs to sink, thus reducing dispersal and survival (Holt and Holt 2002).

TAUTOG

All structured habitats that are used by juvenile and adult tautog (e.g., outcrops, rock piles, boulders, shells, reef, hard and soft corals, and sea whips), as well as inlets adjacent to estuaries serving as important refuge and spawning sites are FHOCs (Dorf and Powell 1997; Arendt and Lucy 2001; ASMFC 2002, 2017). Submerged aquatic vegetation is a FHOC for larvae, young-of-year, and juveniles (Steimle and Shaheen 1999; Wong 2001).

WEAKFISH

Important habitats for weakfish include estuarine and oceanic nursery and spawning areas distributed along the coast from Maine through Florida. The principal spawning area is from North Carolina to Montauk, NY (Hogarth et al. 1995). Additionally, extensive spawning and presence of juveniles have been observed in the bays and inlets of Georgia and South Carolina (D. Whitaker, South Carolina Department of Natural Resources, personal communication), as well as in nearshore areas off North Carolina and Virginia (ASMFC and USFWS, unpublished data; Osborne 2018).

Spawning sites include coastal bays, sounds, and the nearshore Atlantic Ocean, while nursery areas include the upper and lower portions of the rivers and their associated bays and estuaries, as well as nearshore areas in the Atlantic Ocean. Disturbance to a nursery area will affect the overall coastal weakfish population, but it would have the greatest impact on the specific sub-population and the local fisheries that depend on it. Notably, weakfish have been found to engage in natal homing (Thorrold et al. 2001). Their spawning site fidelity ranges from 60 to 81%, similar to estimates of natal homing in birds and anadromous fishes (Thorrold et al. 2001). As a result, estuaries with significant concentrations of weakfish juveniles are designated as FHOCs (i.e., Pamlico Sound in North Carolina; see Barbieri 2016). Egg and larval habitats include the nearshore waters, bays, estuaries, and sounds where they are transported by currents or in which they hatch.

Juvenile weakfish inhabit the deeper waters of bays, estuaries, and sounds, including their tributary rivers. They also use the nearshore Atlantic Ocean as a nursery area (Osborne 2018). In states like North Carolina, they are associated with sand or sand/seagrass bottom. In Chesapeake and Delaware Bays, they migrate to the Atlantic Ocean by December.

Adult weakfish inhabit both estuarine and nearshore Atlantic Ocean habitats. Warming coastal waters in spring trigger their migration inshore and northward from wintering grounds to bays, estuaries, and sounds. Larger fish are the first to migrate inshore and tend to congregate in the northern part of their range. Commercial fisheries data from Chesapeake and Delaware Bays and Pamlico Sound indicate that smaller weakfish follow larger ones later in summer. After their initial spring appearance, weakfish return to the larger bays and nearshore habitats for spawning. In northern areas, a greater portion of adults spend the summer in the ocean rather than estuaries. Weakfish form aggregations and migrate offshore as temperatures decline in the fall, generally moving southward. The Continental Shelf from Chesapeake Bay to Cape Lookout, North Carolina, serves as the major wintering ground. Winter trawl data show that most weakfish are caught between Ocracoke Inlet and Bodie Island, NC, at depths of 18-55 m (59-180 ft). Some weakfish may remain in inshore waters from North Carolina southward.

The quality of weakfish habitats has been significantly compromised by human activities, with estuarine habitats experiencing varying degrees of loss and degradation. While it is generally acknowledged that estuarine weakfish habitats have undergone deterioration, few studies quantify the impacts in terms of the area of habitat lost or degraded. Estuarine nursery habitat, crucial for weakfish, is particularly impacted by bottom-tending gear (Odell et al. 2017).

Evidence of water quality degradation is apparent in northeast Atlantic coast estuaries, such as the New York Bight, which regularly receives deposits of contaminated dredged material, sewage sludge, and industrial wastes. This has led to oxygen depletion, creating large masses of anoxic waters during the summer months, often referred to as "dead zones."

Habitat losses, likely stemming from intense coastal development over the past few decades, lack quantification. Dredging and filling activities, coastal wetland conversion for agriculture, and water quality degradation from various discharges contribute to the potential loss or degradation of weakfish nursery habitat. Changes in water discharge patterns due to withdrawals or flow regulation may also facilitate functional losses in riverine and estuarine areas important for weakfish.

Power plant cooling facilities pose a continuous threat to weakfish populations. Recent EPA rules estimate over 2.2 million weakfish age 1 equivalents lost due to entrainment at cooling water intake structures in the Delaware Bay. Ongoing alterations to freshwater flows and discharge patterns in rivers and estuaries further threaten weakfish habitats. Increased mortality is anticipated from additional municipal water intakes in spawning and nursery areas, although proper screening measures may partially mitigate these impacts (Environmental Protection Agency).

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