A Framework for the Recovery of American Shad (*Alosa sapidissima*) in the James River, Virginia

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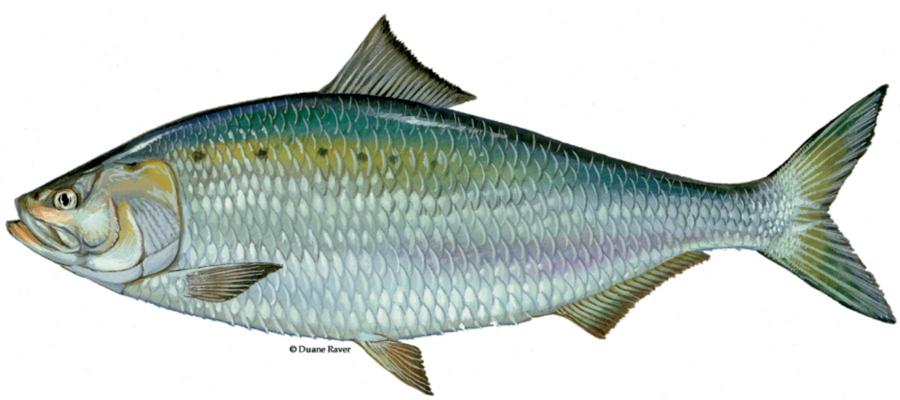

Submitted
November 2023

VIMS | William & Mary
Virginia Institute of Marine Science

Acknowledgments

Financial support for activities described herein were provided through a budget appropriation to the Virginia Institute of Marine Science (VIMS) included in the 2021-2023 Executive Biennial Budget following a request made by the James River Association (JRA). Mark Luckenbach (VIMS) and Cecilia Lewis (VIMS) offered critical guidance and support for the organization and success of the two workshops and the development of this report. Elizabeth Andrews (formerly VCPC, now UVA Environmental Institute), Hunter Hoffler (VCPC) and Katherine Priegues (VCPC) contributed to the law and policy analysis. We thank Lyle Varnell (VIMS) and the workshop participants for their thoughtful and constructive contributions to and review of this report. In particular, Mike Bednarski (DWR), Tom Dunlap (JRA), Greg Garman (VCU), Jim Gartland (VIMS), Patrick Geer (VMRC), Grace Massey (VIMS), Jan McDowell (VIMS), Patrick McGrath (VIMS), Jian Shen (VIMS), Troy Tuckey (VIMS), and Alan Weaver (DWR) contributed information, data, and/or graphics included in this report. Mary Beth Armstrong (VIMS), Kaite Cisz (VIMS), and Miguel Montalvo (VIMS) served as workshop rapporteurs. Rebecca Latourell (VIMS) assisted with report formatting.

Please cite this report as:
Hilton, E.J. 2023. A Framework for the Recovery of American Shad (*Alosa sapidissima*) in the James River, Virginia. Report submitted to the Virginia General Assembly and the Secretary of Natural and Historic Resources by the Virginia Institute of Marine Science, William & Mary, Gloucester Point, VA.

Author's note: Scientific citations in the body of the report follow the style (Author[s], publication year) and the full citation is provided in the references section at end. Legal and policy citations, which often provide code sections in federal and state laws and regulations or point to a government website, are indicated by footnotes in the body of the text.

EXECUTIVE SUMMARY

American Shad (*Alosa sapidissima*) once supported one of the largest commercial fisheries along the Atlantic coast. American Shad historically held significant economic and cultural value in the Commonwealth, in addition to filling a critical ecological niche in Virginia's rivers and the Chesapeake Bay. The most recent American Shad stock assessment found that coastwide populations of American Shad were depleted, with overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change indicated as possible causes

In the fall of 2021, the James River Association petitioned the Governor's Office for an appropriation to be included in the 2022-2024 Executive Biennial Budget to provide "funding for VIMS to complete an emergency American shad recovery plan to address the population of shad in the James River." The goal of this effort was to guide future management decisions for the species and establish a road map for Virginia to restore American Shad in the James River and elsewhere in the Commonwealth. This was to be accomplished by reviewing the historical and current conditions of American Shad and evaluating threats to the species in the James River, including water quality and habitat limitations, water withdrawals, predation, migratory barriers, and bycatch among other potential management or policy areas.

Two meetings were held that brought together experts on American Shad, environmental policy, and fisheries biology and management, as well as other stakeholders and partners. This report documents the results of those meetings and the other efforts to provide a framework for recovery of American Shad in the James River. The following recommendations, together with identified lead agencies and collaborators, and estimated time frames and costs were identified by the group. The Virginia Coastal Policy Center (VCPC) at William & Mary was contracted to identify legal authorities and opportunities for Virginia's agencies, tribes or other stakeholders to implement varying management alternatives for American Shad and these recommendations are listed below and are incorporated into this report.

Recommendations for recovery of American Shad (Alosa sapidissima) in the James River, VA

- Continue annual sampling by VIMS, and the Department of Wildlife Resources (DWR), and other relevant surveys to monitor relative adult and juvenile abundance of American Shad and its phenology.
- Revisit or develop benchmarks for the VIMS Alosine Monitoring Program, the DWR Electroshocking Survey, and the DWR Boshers Dam Fish Passage Survey to evaluate progress toward recovery.
- Conduct genetic monitoring and anlysis for American Shad in the James River.
- Expand sampling through DWR electrofishing surveys to include the Appomattox River to assess habitat use of these portions of the James River watershed by American Shad.
- Fund a study of the early life history of American Shad, including an inventory of the historical spawning habitat.

- Evaluate potential for restoration and/or enhancement of habitats in the James River that are critical for successful American Shad spawning, including benthic habitats below the fall line and prioritize funding for restoration of the most important habitats.
- Promote the use of the Governor's Blue Catfish Processing, Flash Freezing & Infrastructure Grant Program to cover the additional costs incurred by catfish processors.
- Seek reversion to the FDA regulation for catfish processing rather than the USDA regulation.
- Determine bycatch of American Shad in fisheries in the Menhaden fishery in the Chesapeake Bay.
- Determine the impact on American Shad caught as bycatch in commercial fisheries in the James River, and the mortality of American Shad caught in targeted catch and release recreational fisheries of American Shad.
- Provide funding for a study to assess the individual and cumulative impacts of grandfathered water intake facilities on the population of American Shad in the James River and consider actions to mitigate any impacts.
- Require all unpermitted water intake facilities to submit data regarding actual withdrawal volume of intakes annually or even seasonally.
- Require new cooling water intake facilities to adopt additional technology and require additional monitoring to protect American Shad as a "fragile species".
- Evaluate the impact of permitted and proposed surface water withdrawal intakes within the James River on early life history stages of American Shad to determine cumulative effects and, if needed, enforce mitigation for large scale withdrawals.
- Determine the potential impact of small scale surface water removals on American Shad (e.g., agricultural and golf course irrigation systems), including collecting data on the number and distribution of pumps and the potential scale of losses through mesocosm experiments.
- Develop regional partnerships, including with tribal communities, in support of hatchery propagation of American Shad and other alosine fishes (e.g., river herring).
- Evaluate the temporal shifts in phenology, early life history, age and growth dynamics, and body condition of American Shad to determine if there are predictable trends related to its spawning stock abundance and recruitment.
- Evaluate the correlation between the abundance and body condition of American Shad during the coastal marine phase of their lives and those of fish that have returned to rivers to spawn.
- Explore potential shifts in abundance and timing of zooplankton by developing a multi-year zooplankton monitoring program within the Chesapeake Bay and coastal environments to determine the relationship between zooplankton and variation in American Shad stock abundance, structure, and/or condition.
- Determine predation on American Shad and their diet requirements in marine environments to clarify measures the could be undertaken to alleviate pressure on the population.

Abbreviations and acronyms

ASMFC	Atlantic States Marine Fisheries Commission
BTA	Best technology available
CFR	Code of Federal Regulation
ChesMMAP	Chesapeake Bay Multispecies Monitoring and Assessment Program
CTD	Conductivity, temperature, and depth
DEQ	Virginia Department of Environmental Quality
DWR	Virginia Department of Wildlife Resources
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FMIA	Federal Meat Inspection Act
FSIS	Food Safety and Inspection Service
JRA	James River Association
MBES	Multibeam Echosounder
NEAMAP	North East Area Monitoring and Assessment Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
SLAF	Stormwater Local Assistance Fund
TOYR	Time of year restriction
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VCPC	Virginia Coastal Policy Center
VCU	Virginia Commonwealth University
VDEQ	Virginia Department of Environmental Quality
VDWR	Virginia Department of Wildlife Resources
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollutant Discharge Elimination System
VWP	Virginia Water Protection Permit Program

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INTRODUCTION

American Shad (*Alosa sapidissima*) were once one of the largest commercial fisheries along the Atlantic coast. American Shad historically held significant economic and cultural value in the Commonwealth, in addition to filling a critical ecological niche in Virginia's rivers and the Chesapeake Bay. The most recent American Shad stock assessment found that coastwide populations of the species were depleted and noted that "multiple factors are likely responsible for shad decline such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change" (ASMFC 2020; Fig. 1). Among the major conclusions drawn from available data and observations during the 2020 assessment are that American Shad, like other fishes when stocks are at low levels, are particularly sensitive to both biotic and abiotic perturbations that truncate their age structure, thereby reducing population resilience. Recovery of American Shad stocks will need to address multiple factors (e.g., fish passage, predation, water quality, climate change, etc.) in addition to any level of mortality. American Shad have been particularly impacted by these factors in the James River watershed, where annually monitored abundance levels have reached an all-time low.

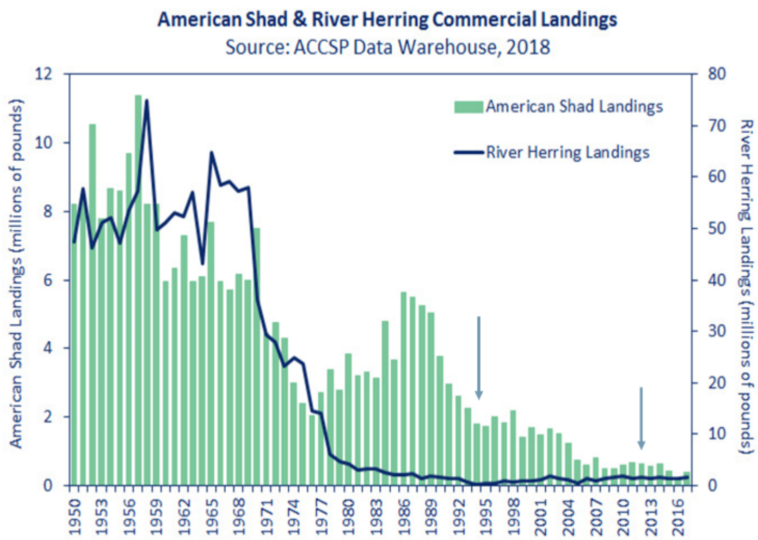

Fig.1. Landings of American Shad and River Herring from 1950 to 2017, Source: ASMFC.

In the fall of 2021, the James River Association petitioned the Governor's Office for an appropriation to be included in the 2022-2024 Executive Biennial Budget to provide "funding for VIMS to complete an emergency American Shad recovery plan to address the population of shad in the James River." The goal of this effort was to guide future management decisions for the species and establish a road map for Virginia to restore American Shad in the James River and elsewhere in the Commonwealth. This was to be accomplished by reviewing the historical and current conditions of American Shad and evaluating threats to the species in the James River, including water quality and habitat limitations, water withdrawals, predation, migratory barriers, and bycatch among other potential management or policy areas. Using this information, this plan outlines data gaps needed to support a recovery plan and recommends a series of recovery actions, including estimates of time and costs associated with each. The Virginia Coastal Policy Center (VCPC) at William & Mary was contracted to identify legal authorities and opportunities for Virginia's agencies, tribes, or other stakeholders to implement varying management alternatives for American Shad, and these recommendations have been incorporated into this report.

HABITAT, DISTRIBUTION, AND LIFE HISTORY

American Shad is an anadromous fish species that ranges from northern Labrador to Florida along the East Coast of North America (Munroe 2002). In the marine phase of their lives, American Shad form large schools along the coast from the surface to about 220 m depth, and depending on the part of their range, up to 175 km (109 miles) from the coastline (Munroe 2002); they tend to be shallower and closer to shore in spring, summer, and fall, and move to deeper waters during the winter. As anadromous fishes, American Shad use rivers to spawn from the St. Lawrence River in Canada to the St. John's River in Florida. In Virginia, American Shad is found in the Chesapeake Bay and its major tributaries, including the Potomac, Rappahannock, York, and James rivers, as well as smaller tributaries and other coastal habitats (e.g., along the Delmarva peninsula). Additionally, American Shad are found in certain rivers in Virginia that drain to North Carolina (Desfosse et al., 1994).

The James River forms at the junction of the Cowpasture and Jackson rivers (river kilometer [rkm] 580; river mile [rm] 933), and its drainage is the largest watershed in Virginia, totaling 26,164 km^2 (16,258 $miles^2$; Jenkins and Burkhead, 1994). Prior to damming, which began in the colonial period, American Shad were reported to reach these headwaters and far into the major tributaries of the James River (Loesch and Atran, 1994). Boshers Dam in Richmond, which was constructed in 1823, is at the upper end of the fall zone at rkm 182 (rm 113). The two primary tributaries of the James River below the fall line at Richmond are the Appomattox River, which joins at the city of Hopewell (rkm 112; rm 69.6), and the Chickahominy River, which joins at rkm 65 (rm 40.4). The average annual spring discharge on the James River is 294.2 m^3/s (965^3ft/s; Tuckey 2009). The extent of salt water is variable, but brackish conditions are observed as far up as the mouth of the Chickahominy River on a seasonal basis. Tidal water reaches the City of Richmond at approximately rkm 167 (rm 103.8) at the lower end of the fall zone.

American Shad spawn in the spring and early summer, displaying a latitudinal timing of their runs (i.e., earlier in the year in the southern portion of the range, becoming progressively later in the year farther north). Water temperature is the primary cue for initiating spawning runs in the river, with initiation of spawning migration into the rivers occurring in waters as cold as 5°C (41°F), with peak spawning in Virginia rivers between 10°-13°C (50°-55°F; VIMS data). Spawning of American Shad generally occurs in shallow (<6 m; <20 ft) stretches of river over a range of bottom types, including clean sand, gravel, cobble, and bedrock (but not mud or silt); see Munroe (2002) and references therein. Successful spawning and rearing of larval and juvenile American Shad also are affected by dissolved oxygen levels, with adults showing stress at 4 mg/l, with sublethal effects at 3.5 mg/l and high mortality at 2 mg/l.

In the James River, Aunins & Olney (2009) determined the principle spawning grounds of American Shad to be located from rkm 124.5 to rkm 158 (rm 77.4 to 98.2). This was based on eggs being collected from rkm 124.5 to rkm 154.5 (rm 77.4-96.0; with peak density at rkm 137.5 and rkm 145.5, rm 85.1 and 90.4, respectively) and yolk-sac larvae being collected from rkms 124.5 to 158 (rm 77.4 to 98.2; with peak densities at rkm 135.5 to rkm 149.5, or rm 84.2 to 92.9, respectively). A spawning habitat suitability model for American Shad (including data from the York River system; Bilkovic et al. 2002) was developed by Hightower et al. (2012; updated from the work of Stier and Crance, 1985), and found the following parameters to maximize their habitat suitability curve: temperature near 19.6°C (67.3°F); velocity greater than or equal to approximately

0.8 m/s (2.6 ft/s); 2.5 m (8.2 ft) depth (with the index dropping steeply at greater depths); and substrate of cobble (with gravel and bedrock also significant; unlike Stier and Crance (1985), sand was not found to be significant in the habitat suitability model (Hightower et al., 2012).

The semi-buoyant eggs of American Shad drift downstream from the spawning grounds for a variable distance (1.6-6.4 km, 1-4 miles; Munroe 2002, and references therein), where they sink to the bottom until hatching. In the Connecticut River, eggs and larvae were found to have an LC_{50}

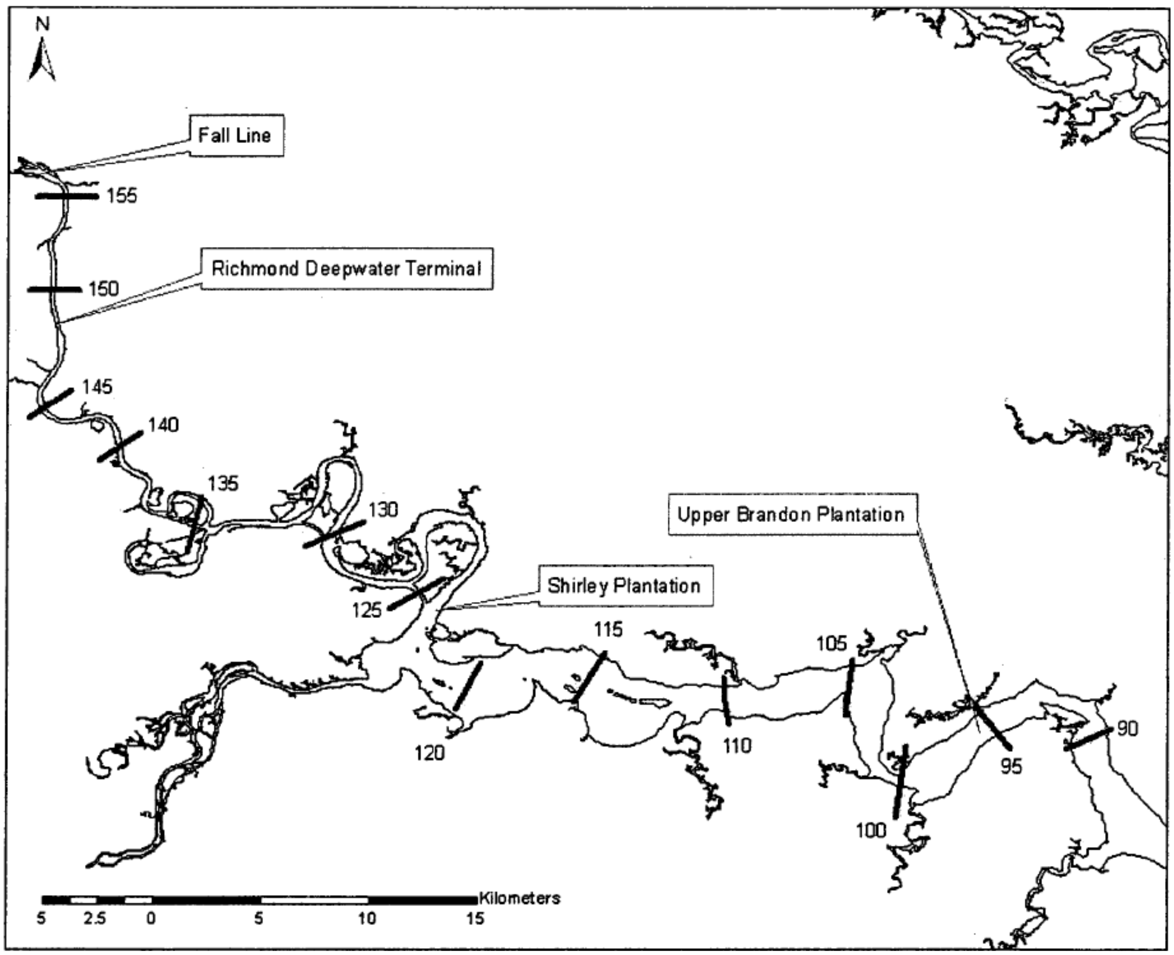

Fig. 2. Portion of the James River that was determined to be the principle spawning grounds of American Shad (upstream of Shirley Plantation to just above the fall line). From Aunins (2006: fig. 1).

of 2.0-2.5 ppm for dissolved oxygen (Carlson 1968), grow best at pH of 6.0-7.0 (Crecco and Savoy, 1987) and have the strongest larval development in salinities of 7.5 ppt (Liem, 1924).

American Shad eggs hatch in 12-15 days at 12°C (54°F) and 6-8 days at 17°C (63°F; Munroe, 2002). Nursery grounds and habitat use of young-of-the-year American Shad during their residency in the James River have not been fully described and are generally poorly known. Juvenile American Shad have been collected by DWR pushnet and electrofishing sampling above Boshers Dam, though typically at low frequency and not in every year (DWR unpublished data).

They have also been observed and collected in tidal freshwater reaches of the James River in DWR sampling (DWR unpublished data). Young-of-the-year American Shad move from in-river freshwater habitats of the Virginia tributaries to the Chesapeake Bay in November and December, and then emigrate to the coastal marine environment in February and March (Hoffman 2006; York River Estuary as the representative system).

CURRENT STOCK STATUS

In 1998, states were required to develop and submit restoration targets for stocks under moratorium. Virginia presented preliminary targets to the Plan Review Team of the ASMFC Shad and River Herring Management Board, with the provision that these targets would be revised as appropriate historical data became available. Criteria to achieve restoration targets were proposed as either: (1) a three-year period during which the catch index remains at or above the target level in the staked gillnet monitoring of the spawning run; (2) a three-year period during which the average catch index is above the target level and the target level is exceeded in two of the years; or (3) a significant increasing trend over a five-year period with the target exceeded in the last two years. Using the information presented above and additional analysis, the ASMFC stock assessment subcommittee developed benchmarks for restoration of Virginia's stock of American Shad (ASMFC 2007a). These benchmarks were reviewed and accepted by the ASMFC American Shad stock assessment peer review panel in 2007 (ASMFC 2007b) and were upheld with the adoption of Amendment 3 to the Interstate Fishery Management Plan for American Shad (ASMFC 2010).

For the James River, the available target index is 6.40, which is the geometric mean of the catch index values observed in 1980-1992. However, it needs to be noted that American Shad abundance in the 1980s was insufficient to support the fishery. On the James River, the seasonal catch index was 0.07 in 2022, which is below the geometric mean of the current monitoring data (2.25). This value is also well below the peak catch index observed in the 1980s (29.20). Prevalence of hatchery fish on the James River reached an all-time high of 60.5% in 2013 and has been demonstrated to be correlated with spawning stock size (McGrath et al., 2023). The James River stock has been dependent on hatchery inputs and there is strong evidence of persistent recruitment failure of wild stocks. Due to budget constraints and absence of brood stock, stocking efforts of American Shad on the James River were reduced in the mid-2010s, and in 2018 the stocking effort ceased operation. The overall assessment based on the VIMS alosine monitoring program for the James River is that the stock remains at historically low levels and was dependent on hatchery inputs (Hilton et al., 2023).

CAUSES OF DECLINE AND IMPEDIMENTS TO RECOVERY

Rulifson (1994) identified several potential impacts and causes for the decline of American Shad in the James River system (inclusive of the James, Nansemond, Chickahominy, Appomattox, and Pagan rivers). Within the James River itself, channelization, dredge and fill, dams, industrial water intakes, industrial discharge, overfishing, chemical pollution, thermal effluents, turbidity, and sewage outfalls were included as factors for decline. Within the Nansemond, Chickahominy, and Appomattox, dams were cited as factors, with industrial discharge and overfishing also at play in the Chickahominy and turbidity and sewage outfalls in the Pagan River. Impediments to recovery were largely common throughout James River drainage (e.g., inadequate fishways, reduced freshwater input to estuaries, reduced spawning habitat) but also included water withdrawal in the Nansemond River, reduced freshwater input to estuaries, reduced spawning habitat, fishing on spawning area, and water withdrawals in the Chickahominy River, inadequate fishways, water releases from dams, reduced spawning habitat, and water withdrawal on the Appomattox River, and turbidity and poor water quality on the Pagan River.

Hilton et al. (2021) indicated the following as primary threats to American Shad in the James River: barriers to migration; pressures from land use associated with population growth; in-river construction blocking migration; and surface water withdrawal and discharge. These and other threats were discussed at an interagency James River American Shad Recovery Plan meeting held in October 2022 at William & Mary. At that meeting, additional threats such as invasive species and climate change were discussed. These are outlined below.

Barriers to Migration. Numerous dams on the James River and its tributaries have historically blocked migration of fishes. Between 1989 and 1993 three dams in the fall zone in Richmond were breached or notched, extending available habitat to the base of Boshers Dam. A vertical slot fishway was installed on the north side of Boshers Dam (built in 1823) in 1999, reopening 221 km (137 miles) of the upper James River and 322 km (200 miles) of its tributaries to American Shad and other anadromous fishes; the next dam of the mainstem is at Lynchburg, VA (Weaver et al., 2003). A total of 7,564 upstream functional network kilometers (4,700 miles) were reopened by the Boshers fishway (Martin, 2019). American Shad began using the Boshers fishway during the inaugural season and the early three-year trend of passage was increasing (also Weaver et al., 2003). Since then, the numbers of American Shad passing annually has fluctuated and is generally correlated with the trend of the VIMS Alosine Monitoring Program index taken farther downriver. According to DWR's annual fishway monitoring American Shad and at least 29 other fish species pass through the fishway each spring. A rigorous fishway efficiency study has not been conducted at Boshers for any of the species (and now not enough American Shad are getting to Richmond to accommodate a study). However, DWR does not see large numbers of American Shad stacking up below the dam during weekly spring boat electrofishing (Alan Weaver, DWR, unpublished data).

For the purposes of population modeling in the context of the most recent American Shad stock assessment (ASMFC 2020), the current available American Shad habitat was estimated as a proportion of total historical habitat extent. Current unobstructed habitat was defined as the habitat area below the first impoundment, while the historical habitat extent includes all American Shad habitat historically accessible in the absence of impoundments. For the James River system, current unobstructed habitat area represents 72.77% of the historical habitat extent (71.9 of 98.8 km^2; 44.7 of 61.4 m^2). This estimate, however, does not include habitat utilized by fishes utilizing the fish passage systems noted above. Following the development of the Chesapeake Bay Fish Passage Prioritization Tool (Martin 2019), DWR considers the habitat upstream of Boshers Dam as currently available to American Shad because it is known that at least some individuals are utilizing the fish passage system and that some juvenile production is occurring above the dam (Alan Weaver, DWR, pers. comm., 2023).

Approximately 204 km (126 miles) of the main stem of the Appomattox River is accessible to American Shad. Harvell Dam (rkm 17, rm 10.6) in Petersburg, VA had a Denil fishway (1998) and then the dam was removed in 2014. Brasfield Dam (rkm 28; rm 17.4) that forms Lake Chesdin near Matoaca, VA has a fish lift that completes passage through the Appomattox fall zone resulting in access to 4,759 upstream functional network kilometers (2,957 miles).

The first dam on the Chickahominy is Walkers Dam at rkm 35 (rm 21.7) that has a functioning double Denil fishway built in 2015 that reopens 48 mainstem river kilometers (29.8 miles), or 818 upstream functional network kilometers (508 miles). American Shad are known to use the Walkers fishway (DWR, unpublished trapping data) and have been found over 40 km (24.8 miles) upstream (Michael Odom, USFWS personal communication 2020).

A number of additional dam removal and fishway construction projects have occurred in the past on several smaller creeks and streams in the James River drainage as well (http://www.dwr.virginia.gov/fishing/fish-passage/). In the James River, seven dams remain spaced over 34 km (21.1 miles) beginning with Scott's Mill Dam in Lynchburg, VA. The owner of Scott's Mill Dam has applied to FERC for a hydropower license, and DWR and USFWS are requiring American Eel and Sea Lamprey passage as part of the licensing process, with a clause that passage for American Shad must be accommodated in the future should the species ever start reaching Scotts Mill Dam (Alan Weaver, DWR, pers. comm. 2023). Removal of these barriers or passageway installation would open a significant amount of habitat.

Federal grant programs may present a viable avenue for funding projects to remove obstructions and improve fish passage to upstream spawning areas. The U.S. Fish and Wildlife Service's National Fish Passage Program[1] "provide[s] financial and technical assistance to support projects that improve fish passage" and "may be initiated by any individual, organization, government, or agency, in cooperation with their local Fish and Wildlife Conservation Office."[2] As part of the Bipartisan Infrastructure Law, the National Oceanic and Atmospheric Administration (NOAA) has received funding for fish passage programs as well, totaling $400 million over the next five years.[3] In 2023, NOAA awarded funding to four projects that will improve fish passage for American Shad and other species in four East Coast states, including in North Carolina.[4] Virginia also could choose to seek some of this funding for additional fish passage projects.

Habitat availability and suitability. Further study of freshwater habitat use by American Shad in Virginia is needed. Specifically, quantification and analysis of specific reaches of riverine habitats used by American Shad during residency (adults during the spawning run, larvae, and juveniles) is needed to better manage and address habitat concerns of the species.

It is difficult to identify specific actions to be taken in land use management that will affect American Shad population status (Waldman and Gephard, 2011). In-river construction projects

[1] *National Fish Passage Program*, U.S. FISH & WILDLIFE SERV., https://www.fws.gov/program/national-fish-passage/what-we-do (last visited May 24, 2023).

[2] *Id*.

[3] *Infrastructure Law: Fisheries & Protected Resources*, NOAA, https://www.noaa.gov/infrastructure-law/infrastructure-law-fisheries-protected-resources/fish-passage (last visited May 23, 2023).

[4] *Fish Passage Projects Recommended for Funding*, NOAAA, https://www.fisheries.noaa.gov/national/habitat-conservation/fish-passage-projects-recommended-funding (last visited May 24, 2023).

such as bridge and tunnel construction and maintenance, dredging, and others, have the potential for disruption of American Shad migration (as well as that of other anadromous fishes) from both direct (e.g., acoustic interference) and indirect (e.g., habitat alteration) factors. Time-of-year restrictions (TOYR) for American Shad are currently enforced between February 15 and June 30 of any year. There may be case-by-case relaxation of this TOYR exceptions based on where the work is proposed. For example, upstream of Boshers Dam on the James River, DWR recommend the TOYR to be March 15 to June 30 because American Shad do not reach this point in the river until mid-March. Also case-by-case consideration of appropriate mitigation measures for individual projects (e.g., bubble curtains, coffer dams, etc.). Overboard disposal of dredged material from federally-mantained channels in the James River and other regions in Virginia pose a potential threat to American Shad eggs, larvae, and juveniles as they move down river from spawninig grounds.

Land-use changes. Many of the non-barrier threats identified by Rulifson (1994) can be collectively viewed as the results of changes in land use associated with population growth. The human population surrounding the three primary Virginia rivers is centered in Richmond (James River), with another significant population center in Fredericksburg (Rappahannock River); the remaining areas are rural. According to the Chesapeake Bay Program, within Virginia land-use pressure is highest along the James River at Richmond, with other significantly high vulnerability levels at the James River near the confluence of the Chickahominy River, and the peninsula separating the James River from the York River. Land use surrounding rivers within the Chesapeake Bay watershed in Virginia likely is associated with contamination (significant levels throughout, principally PCBs, but also metals within the York River system), sediment load (High in the Rappahannock, Low in the York River system, Chickahominy and Appomattox rivers, and Medium in the Upper James River), and phosphorus yields (High in the Rappahannock, Medium in the Upper James River, and Low in the other rivers); nitrogen yields are low in all three river systems. Low summertime dissolved oxygen levels remain a threat in all portions of the three rivers, except the upper Mattaponi and upper Pamunkey rivers (York River System), and the upper James River.

Surface Water Withdrawal and Discharge. Surface water is removed for power generation (nuclear and fossil fuel), manufacturing, and agriculture, and may be categorized as either consumptive (irrigation) or non-consumptive (e.g., power generation). Surface water withdrawals in Virginia include significant removal of water from reservoirs, ponds and other impoundments, springs, rivers, and streams, and in 2019 accounted for 89% of total (=surface + ground) water withdrawals within the Commonwealth (1.1 billion gallons per day); this was 1% lower than the five-year average due to decrease in manufacturing (VDEQ 2020). The surface waters used by American Shad are subject to significant withdrawals, with the largest volumes removed occurring in the waters surrounding Richmond, Hampton Roads, and Washington D.C. (as well as Giles County, which lies outside of the range of American Shad).

Water intake structures can impact all life stages (eggs, larvae, and adults) of fishes, including American Shad, that cannot swim away from currents generated by water intakes. Aquatic organisms are directly impacted by water intakes in two distinct ways: by impingement and entrainment. Impingement is when aquatic organisms are physically pinned against the outer part of intake structures or mesh screens during periods of intake water withdrawal due to water intake velocities which are too high to allow the fish to escape. Organisms that lack the ability to escape the cooling water intake system are subject to inevitable mortality. Entrainment happens when aquatic organisms are pulled through a water intake and into a cooling water system due to there being no screen surrounding the intake or a screen with a mesh size that is too large.

Rates of entrainment and impingement mortality can be lowered by installing intake structures with smaller screen pore sizes[5] and by limiting intake water velocity.[6] Several federal and state agencies have developed entrainment and impingement prevention guidelines which set maximum approach velocities for water and maximum screen pore size. [7] In 2021 the DWR, which reviews and provides input on many applications for surface water intakes, updated its recommended Intake Design and Operation Standards, which "serve to minimize impingement and entrainment and are considered reasonably protective of aquatic resources given the currently available knowledge base."[8] The Standards recommend that an intake be fitted with a screen with openings no larger than 1 millimeter; that the intake velocity not exceed 0.25 feet per second; and that the intake not withdraw more than 10% of instantaneous flow (90% flow by) to ensure continued access to instream habitats by resident aquatic species.[9]

The U.S. Environmental Protection Agency (EPA) regulates cooling water systems and thermal discharges under Sections 316 and 402 of the Clean Water Act (CWA).[10] Section 316(a)[11] addresses thermal discharges that are regulated in National Pollutant Discharge Elimination System (NPDES) permits, which are covered by Section 402 of the CWA.[12] Section 316(b) of the CWA requires EPA to establish regulations that minimize the adverse environmental impacts of cooling water intake structures at industrial facilities that are subject to NPDES permitting.[13] Such adverse effects include entrainment and impingement of fish species.

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[5] *Best Management Practices for Entrainment and Impingement Prevention*, W. VA. DEP'T OF ENV'T PROTECTION, https://dep.wv.gov/oil-and-gas/Water%20Management/Documents/Entrainment%20and%20Impingement%20Prevention%20BMPs_Final.pdf (last visited May 23, 2023).

[6] *Id*. ("Screen pore size should be limited to the extent that fish above a certain size would be physically unable to pass through. Additionally, the screened-in area should be large enough such that the approach velocity of water into the intake is sufficiently low that a fish may swim to avoid the screen.").

[7] *Id.* (table summarizing various agency approaches).

[8] Surface Water Intake Working Group, *Surface Water Withdrawal Intake Design and Operation Standards*, VA. DEPT. OF WILDLIFE RES. (May 19, 2021), https://dwr.virginia.gov/wp-content/uploads/media/Surface-Water-Intake-Design-Operation-Standards.pdf.

[9] *Id.*

[10] The Clean Water Act, 33 U.S.C. §1251 et seq. (1972).

[11] 33 U.S.C. § 1326(a); 40 C.F.R. 125(H) (regulations implementing § 316(a)).

[12] 33 U.S.C. § 1342.

[13] 40 C.F.R. §§ 122.10-122.64, 125.80-125.99, 125.130-125.139 (2014) (regulating the cooling water intake requirements for existing power generating facilities and existing manufacturing and industrial facilities that are designed to withdraw more than 2 million gallons per day (mgd) of water and use at least 25 percent of the water they withdraw exclusively for cooling purposes; if a facility has an NPDES permit but does not withdraw more than 2 mgd, it is subject to permit conditions developed by the NPDES Permit Director on a case-by-case basis using best professional judgment); *see also Cooling Water Intakes*, EPA (June 16, 2022), https://www.epa.gov/cooling-water-intakes ("The rule regulates the mortality rates for fish and aquatic life that encounter cooling water intake structures at existing power plants, industrial sites, and manufacturing facilities."); *see also How to Maintain Fish Friendly Water Intake Solutions*, WASTEWATER DIGEST (Mar. 8, 2021), https://www.wwdmag.com/wastewater-treatment/screens/article/10939454/how-to-maintain-fish-friendly-water-intake-solutions.

Section 316(b) requires that an intake structure's location, design, construction and cooling capacity reflect the best technology available (BTA) for minimizing adverse environmental impacts. [14] EPA regulations, which became effective in 2014, specify how to reduce impingement[15] and entrainment. However, regarding entrainment, the regulation allows for site-specific determination of the BTA for fish protection.[16] Thus, regulators have some flexibility in selecting fish protection technologies.

In Virginia, the withdrawal of volumes greater than the average of 10,000 gallons per day during a month, or 1 million gallons per month for non-tidal waters (60,000 gpm for tidal waters) for irrigation are required to be reported through the Water Withdrawal Reporting Regulation (VDEQ 2020). However, because of the permitting thresholds, the withdrawal of surface water for most agricultural purposes is exempt from permitting requirements but have the potential to directly impact American Shad through impingement and entrainment.

The VDEQ is the permitting authority for surface water withdrawals in Virginia: "Projects involving surface water withdrawals from state waters and related permanent structures require permits under the Virginia Water Protection (VWP) Permit Program Regulations as directed by Article 2.2 of the State Water Control Law."[17] A new cooling water intake facility requiring a Virginia Pollutant Discharge Elimination System (VPDES) permit must comply with impingement and entrainment avoidance requirements that echo the federal requirements set forth in 40 CFR Parts 122 and 125.[18] Existing facilities that are not subject to cooling water intake requirements under 9VAC25-31-165 must meet requirements under section 316(b) of the Clean Water Act as determined by VDEQ on a case-by-case, best professional judgment basis.[19]

VDEQ coordinates its VWP permit review with the VMRC when the application for a VWP individual permit for a surface water withdrawal also requires a VMRC permit.[20] As part of its

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[14] 33 U.S.C. § 1326(b); 79 Fed. Reg. 48300-439 (Aug. 15, 2014); *see* Memorandum from Deborah G. Nagle, Water Permits Division Director & Robert K. Wood, Engineering and Analysis Division Director, Off. of Water, to Water Division Directors, Regions I - X (Dec. 11, 2014), https://www.epa.gov/sites/default/files/2015-04/documents/cooling-water_esa-instructional-memo_12-11-2014.pdf.

[15] OFF. OF WATER, U.S. EPA, EPA-821-R-14-002, TECHNICAL DEVELOPMENT DOCUMENT FOR THE FINAL SECTION 316(B) EXISTING FACILITIES RULE, (May 2014), https://www.epa.gov/sites/default/files/2015-04/documents/cooling-water_phase-4_tdd_2014.pdf ("The final rule requires that all existing facilities must meet impingement mortality requirements…The permit must include conditions, management practices and operational measures necessary to ensure proper operation of any technology used to comply with the impingement mortality standard at § 125.94(c) and the entrainment standard at § 125.94(d).").

[16] *See id.* at 7-1 ("EPA's national BTA [Best Technology Available] entrainment standard puts in place a framework for establishing entrainment requirements on a site-specific basis. The framework includes the factors that must be considered in the Director's determination of the appropriate BTA controls as well as the standard for determining when an otherwise affordable control technology may be rejected as the basis for the BTA standard. . . . The rule does not prescribe a single nationally applicable entrainment performance standard but instead requires that the Director must establish the BTA entrainment requirement for a facility on a site-specific basis.").

[17] *Water Withdrawal*, Va. Dept. of Env't Quality, https://www.deq.virginia.gov/permits-regulations/permits/water/water-withdrawal; *see* VA. CODE ANN. §§ 62.1-44.15:20 to 22.

[18] *See* 9 VA. ADMIN. CODE § 25-31-165.

[19] 9 VA. ADMIN. CODE § 25-31-165(C).

[20] VA. CODE ANN. § 62.1-44.15:5.01; 9 VA. ADMIN. CODE § 25-210-330.

review, VDEQ and VMRC determine the potential impacts the intake may have on instream flow, aquatic life, water quality, recreation, and downstream impacts.[21] To assist them in determining aquatic life impacts, the two agencies are increasingly requiring the use of a Particle Tracking Model developed by the VIMS that simulates tidal flow and larval transport processes.[22] For all VWP permit applications, DEQ undertakes a 45-day agency coordination period when VMRC and the VDWR), as well as other relevant state agencies, may provide input on the permit.[23] As noted above, in 2021 the VDWR updated its recommendations for design and operation of water intakes to minimize impacts upon resident aquatic fauna.[24] However, these recommended standards are not binding on all facilities; grate guidelines will only be applied if there are new water intake permits sought.

Invasive Species. Introduced predatory fishes may be a significant factor in recovery of imperiled populations. It is recognized that introduced predators may have a disproportionate impact on young age classes in already depleted populations (ASMFC 2020). In combination with other recovery actions, reduction in the density of invasive predatory fishes has been shown to have a positive effect on populations of fishes of conservation concern. For example, a population of Bonneville Cutthroat Trout (*Oncorhynchus clarkia utah*), an imperiled species that has been petitioned for listing under the Endangered Species Act, was shown to increase in numbers in a tributary of the Logan River in northern Utah following the mechanical removal of the invasive brown trout (*Salmo trutta*) and subsequent stocking of cutthroat trout (Budy et al. 2021). Invasive species in the James River represent a significant potential limitation for American Shad recovery.

The fish fauna and aquatic communities of the lower James River are far from pristine. Within the lower James River and its tributaries, several species of non-native fishes are well established, including naturalized species such as Channel Catfish (*Ictalurus punctatus*), Smallmouth Bass (*Micropterus dolomieu*), and Bluegill (*Lepomis macrochirus).* These naturalized species can have significant impact on as predators of American Shad. For example, Hopler (2008) found that following introduction of a hatchery program stocking American Shad larvae upstream of Boshers Dam, American Shad juveniles were the second most common species in the diets of Smallmouth Bass following these restoration efforts.

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[21] 9 VA. ADMIN. CODE § 25-210-340(B)(5).

[22] *See, e.g.,* Issue Analysis Form, Prince George Raw Water Intake Modeling (Nov. 24, 2020), https://cms1files.revize.com/princegeorgeva/20201120104813.pdf.

[23] *See* VA. CODE ANN. § 62.1-44.15:20 ("(B) The Board shall, after providing an opportunity for public comment, issue a Virginia Water Protection Permit if it has determined that the proposed activity is consistent with the provisions of the Clean Water Act and the State Water Control Law and will protect instream beneficial uses. (C) Prior to the issuance of a Virginia Water Protection Permit, the Board shall consult with and give full consideration to any relevant information contained in the state water supply plan described in subsection A of § 62.1-44.38:1 as well as to the written recommendations of the following agencies: the Department of Wildlife Resources, the Department of Conservation and Recreation, the Virginia Marine Resources Commission, the Department of Health, the Department of Agriculture and Consumer Services, and any other interested and affected agencies. . . . Agencies may submit written comments on proposed permits within 45 days after notification by the Board.").

[24] Surface Water Intake Working Group, *supra* note 24.

Predatory fish species that have been more recently introduced and have become well established in the James River include the Flathead Catfish (*Pylodictis olivaris*, a piscivore introduced in the 1960s) and Blue Catfish (*Ictalurus furcatus*, an omnivore introduced in the 1970s). Even more recent introductions in the James River watershed have been made of species that are (still) not as widespread. These include species such as Northern Snakehead (*Channa argus*) and Alabama Bass (*Micropterus henshalli*), with the former having been collected in the Lakeview Reservoir of the Appomattox River near Petersburg in 2018, and the latter having been confirmed recently in the fall-zone of the James River and in the Chickahominy River.

The ubiquitous presence of Blue Catfish in the lower James River is widely considered to be a major impediment for management of native species (Schloesser et al. 2011, Fabrizio et al. 2018, Schmitt et al. 2017). Fabrizio et al. (2018) estimated a population of 1.2 million Blue Catfish in a 12-km reach in the tidal portion of the James River. Such population sizes can have a profound effect on prey species. For example, Fabrizio et al. (2021) estimated that more than 2 million Blue Crab (*Callinectes sapidus*) were removed annually from their study area (c. 200 km^2 of the tidal portion of the James River) through predation by Blue Catfish. Schmitt et al. (2017) suggested that Flathead Catfish may have a greater impact as predators on American Shad than does Blue Catfish (occurring in 1.47% of stomachs sampled for Flathead Catfish vs. <1% of Blue Catfish stomachs sampled). However, given such extreme population sizes of this generalist predator, Blue Catfish in the James River and other tributaries of the Chesapeake Bay is likely an important limiting factor on the recovery of American Shad through predation on juvenile fishes.

The vast abundance of Blue Catfish has created a recreational fishery with an estimated economic impact of $2.5 million in the James River system.[25] Conversely, the estimated value of Virginia's entire commercial catfish fishery is roughly $1.5 million, assuming maximum landings of 2.5 million pounds of catfish at $0.60 per pound.[26] Currently, the United States Department of Agriculture (USDA) sets inspection requirements for catfish fisheries in the United States, a departure from other aquaculture regulation, which is almost exclusively controlled by the United States Food and Drug Administration (FDA).[27] The 2014 Farm Bill (Agricultural Act of 2014)[28] specifies that the USDA – which gained authority over catfish inspection in the 2008 Farm Bill[29] – must inspect the conditions in which catfish were raised (or in this case caught) and transported before being brought to market. These requirements create a bottleneck effect in the processing phase of commercial catfishing, which negatively impacts the economics of catfish as a viable,

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[25] *Invasive Catfish Management Strategy,* CHESAPEAKE BAY PROGRAM at 3, https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/Invasive_Catfish_Management_Strategy_Aug_2020_final.pdf (last visited May 25, 2023).

[26] *Id*.

[27] *Id*. at 14. ("The USDA inspection requirements for wild-caught Chesapeake Bay catfishes need to be addressed because current requirements appear to limit processing capabilities and, consequently, removal of biomass in the region.").

[28] Agricultural Act of 2014, Pub. L. No. 113-79, 128 Stat. 649 (2014), https://www.govinfo.gov/content/pkg/PLAW-113publ79/pdf/PLAW-113publ79.pdf.

[29] Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, 122 Stat. 1651 (2008), https://www.congress.gov/110/plaws/publ246/PLAW-110publ246.pdf.

commercially targeted species in Virginia.[30] When Congress adopted the 2008 and 2014 Farm Bills, domestic catfish processors worried that USDA regulation of the commercial catfish market would alter the economics of operating a processing facility.[31] The United States Government Accountability Office found in their investigation of proposed USDA regulatory oversight of catfish processing that the FDA and National Marine Fisheries Service felt continuous inspection (required under USDA regulation) is unnecessary, duplicative and expensive.[32]

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[30] *Invasive Catfish Management Strategy, supra* note 92, at 4 ("Despite recent advances in marketing and harvest techniques, United States Department of Agriculture (USDA) inspection requirements mandated by the 2014 Farm Bill have reduced processing capabilities and, according to the processors, have created a bottleneck in the market.").

[31] 9 C.F.R. pts. 300, 441, 530, 531, 532, 561.

[32] U.S. Gov't Accountability Off., GAO-12-411, Seafood Safety: Responsibility for Inspecting Catfish Should Not Be Assigned to USDA (2012) ("Both FDA and NMFS officials stated that continuous inspection will not improve catfish safety and is counter to the use of FDA's hazard analysis requirements, in which systems are most efficiently monitored periodically rather than daily.").

Climate Change. It has been demonstrated that the rise in ocean temperatures is having a negative effect on growth (Audzijonyte et al. 2016) and physiology (Hittle et al. 2021) for many North Atlantic marine and anadromous species of fishes. Gilligan-Lunda et al. (2021) used Bayesian hierarchical models to predict a reduction in growth and an increase in instantaneous natural mortality under two different climate scenarios. Other factors such as timing of migration have also been affected by changing environmental conditions (Staudinger et al. 2019; Nack et al. 2021).

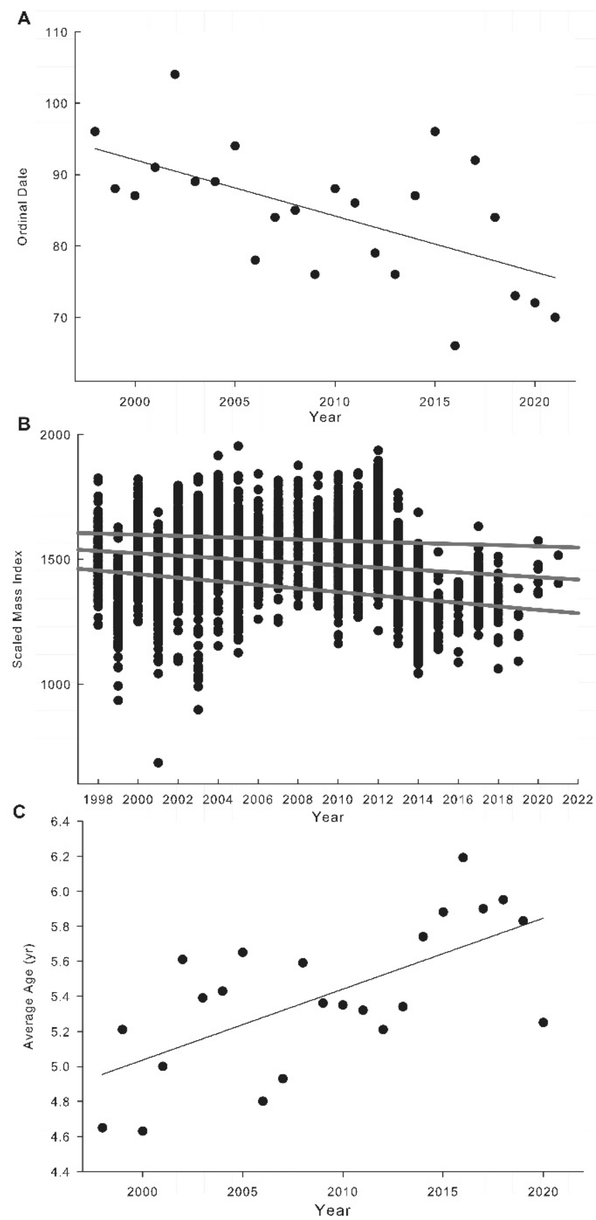

Fig. 3. Preliminary analyses of data from VIMS Alosine Monitoring Program. A, Trend in the day-of-year (ordinal date) of the peak of the spawning run over time. B, Relationship between mass (i.e., body condition) of spawning individuals over time; circle indicating absence of heavier fish. C, Trend in age of returning fish over time.

Based on results of the VIMS Alosine Monitoring Program, American Shad are migrating into the tributaries of the Chesapeake Bay earlier in recent years compared to early in the time-series, with peak catch-per-unit-effort occurring 2 to 3 weeks earlier (Fig. 3). Preliminary analyses also suggest that there has been a shift in body condition and age structure of the spawning stock of American Shad across this time-series. Between 1998 and 2015, age-5 fish were always the most abundant; age-5 is the age at which American Shad first recruit to the gear used in this program. From these results, it can be concluded that the increase in the average age was due to an increase in the number of older individuals. Although the average age of the catch increased from 2016 to 2019, this was not due to the presence of a greater number of older individuals. Instead, it was due to the decrease in the number of age-5 fish such that age-6 was the most abundant in the catch. During this time, there were still mature age-4 and age-5 fish in the sample (albeit fewer), so the maturity schedules do not appear to have changed. Fulton's body condition factor K (length/weight) was calculated for every running ripe female American Shad caught from 1998-2019, with the hypothesis that if the body condition had decreased, it would help to explain the decrease in age-5 fish. To address this, a quantile regression (0.25, 0.5, and 0.75) was used to determine if change in body condition was significant across the time series. All the quantile regression lines were significant ($p<0.001$) and had a negative slope, and the negative trend in body condition was still apparent for each age when examined separately.

Therefore, we can preliminarily conclude that fish-at-age are getting smaller, which decreases the catchability of those individuals. Notably, there is an absence of fish with Fulton K values above the 75% quantile in the years from 2014-2019. This could have impacts on the reproductive success in that smaller fish produce fewer eggs. The correlation of these shifts with environmental changes within the Chesapeake Bay ecosystem and beyond (e.g., coastal regions in which these anadromous fishes grow) has not yet been made.

EXISTING MONITORING PROGRAMS

In this section, a brief description of ongoing monitoring programs that encounter American Shad in or from the Chesapeake Bay generally, and the James River specifically. Relevant data from these time series of American Shad abundance are provided in the form of graphs showing trends over time.

NORTH EAST AREA MONITORING AND ASSESSMENT PROGRAM (NEAMAP). This trawl survey, which has been ongoing annually since 2008 (Latour et al., 2022), complements other coastal surveys conducted by other state and federal fisheries agencies, and collects data on juvenile and adult fishes. Spring and fall sampling occur from Cape Cod, Massachusetts to Cape Hatteras, North Carolina. Approximately 150 stations are sampled in daylight hours using a bottom trawl (depths to 60 feet, and to 120 feet in Long Island Sound), with GPS, vessel speed, duration of tow, engine speed, water depth, and tidal stage recorded. The trawl net that is used for sampling is a 4 seam, 3 bridle, 400 x 12 cm net with a cookie sweep and 2.54 cm knotless liner in the cod end, with Thyboron Type IV 66" doors. Atmospheric and ocean condition data, water quality, and other data are collected. Catch at each station is sorted by species and size, with aggregate weights, counts, and individual lengths recorded for each species. Subsamples (n=5) for each species are taken (five at each station) and length, weight, sex, and maturity data are recorded. Stomachs and otoliths are removed and preserved for later analysis.

CHESAPEAKE BAY MULTISPECIES MONITORING AND ASSESSMENT PROGRAM (CHESMMAP). Since 2002 (Bonzek et al., 2022), ChesMMAP has sampled recreationally and commercially important fishes in the mainstem of the Bay from the mouth just outside the Chesapeake Bay Bridge Tunnel to Poole's Island, Maryland. There are four cruises per year (March, June, September, and November) that sample 35 stations in March, 80 stations in June and September, and 45 stations in November. Station data include GPS locations, vessel speed, duration of tow, engine speed, water depth, and tidal stage.

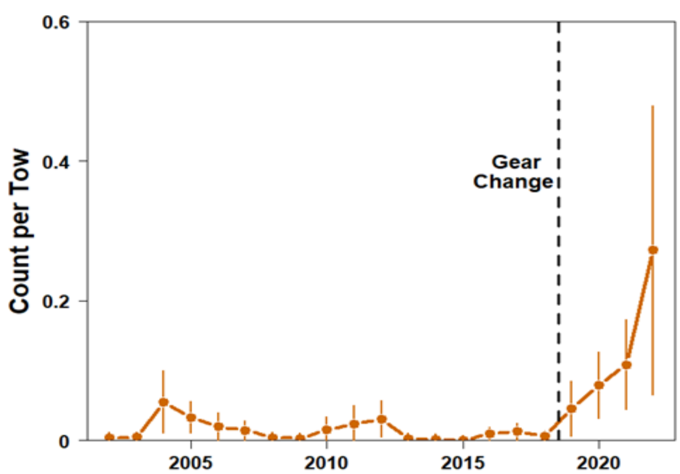

Fig. 4. Relative abundance of American Shad from the VIMS ChesMMAP survey. Note that the increase of catches in 2019 reflects increased gear efficiency rather than increased abundance.

The trawl net that is used (since 2019) for sampling is a 200 x12cm, 4 seam, 3 bridle bottom trawl with a 5cm flat sweep fitted with Thyboron Type IV 44", trawl doors. Atmospheric and ocean condition data, water quality, and other data are collected. Catch at each station is sorted by species and size, with aggregate weights, counts, and individual lengths recorded for each species. Subsamples (n=5) for each species are taken (five at each station) and length, weight, sex, and maturity data are recorded. Stomachs and otoliths are removed and preserved for later analysis. Results are shown in Fig. 4.

JUVENILE FISH AND BLUE CRAB SURVEY. This survey has been conducted since 1955, with some modification of sampling design (Tuckey and Fabrizio, 2022). A trawl net with a 5.8-m head line, 40 mm stretch-mesh body, and a 6.4-mm liner is towed along the bottom for 5 minutes during daylight hours. Sampling occurs monthly except January and March, when few target species are available. Sampling in the tributaries occurs monthly, at both the random stratified and historical fixed (mid-channel) stations. Fixed stations were sampled monthly (nearly continuously) since 1980 with sites in each tributary spaced at approximately 5-mile intervals from the river mouth up to the freshwater interface. From the mid-1950s (York River) and early-1960s (James and Rappahannock rivers) to 1972, fixed stations were sampled monthly using an unlined 30' trawl. During 1973-79, semi-annual random stratified sampling was performed by the VIMS Ichthyology Department, while the VIMS Crustaceology Department continued monitoring the fixed tributary stations on a limited monthly basis (May-November). Since 1996, all three tributaries have been sampled with a random stratified design. The current design (combined fixed and random stations) provides greater spatial coverage and a long-term historical reference (Tuckey and Fabrizio, 2022). At the completion of each tow, all fishes are identified to species, counted, and measured to the nearest millimeter fork length (FL) and total length (TL); Species that have varying size ranges were measured and counted by size class and large catches of a particular species were randomly subsampled, measured, and the remaining unmeasured catch was counted. Results are shown in Fig. 5.

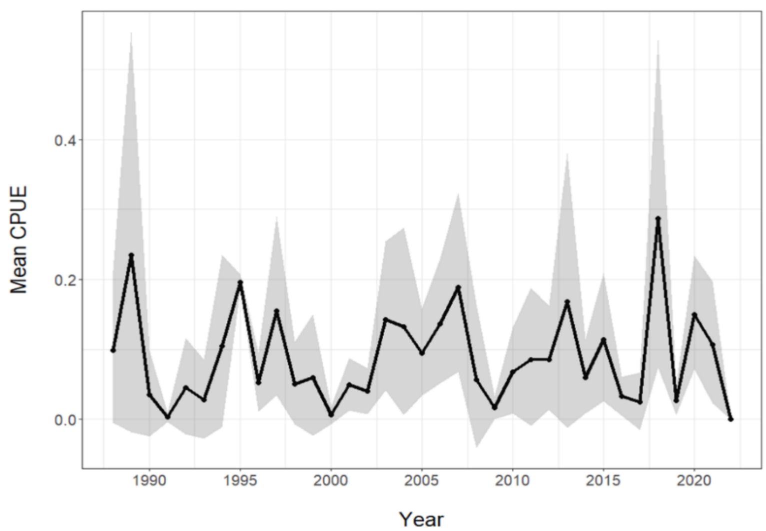

Fig. 5. Relative abundance of American shad from VIMS Juvenile Fish Trawl Survey from 1988-2022.

VIMS JUVENILE FISH SEINE SURVEY. Field sampling is conducted during five biweekly periods from June or July through August (Fig. 6). During each round, seine hauls are conducted at 18 index stations and 21 auxiliary stations in the James, York and Rappahannock river systems. The Index stations have been sampled annually from 1967 to 1973, and from 1980 to the present. Auxiliary sites were added to the survey in 1989 to provide better geographic coverage and increase sample sizes within each river system. Collections are made by deploying a 30.5 m long, 1.2 m deep, and 6.4 mm mesh minnow seine perpendicular to the shoreline until either the net was fully extended or a depth of approximately 1.2 m is encountered and then pulling the offshore end down-current and back to the shore. A single haul was completed at each auxiliary station, and duplicate hauls, with an interlude of at least 30 minutes, were completed at each index station. Even with a 30-minute interlude between hauls at index stations, second hauls cannot be considered independent samples and their use violates a key assumption necessary for making inferences from a sample mean (Rago et al. 1995); only the first haul at each index station is used to calculate the annual index of American Shad. A sub-sample of American Shad of up to 25 individuals is measured to the nearest millimeter fork length. Sampling time, tidal stage, and weather conditions are recorded at each sampling location. Salinity, water temperature, and dissolved oxygen concentrations are measured after the first haul using a handheld YSI water quality sampler.

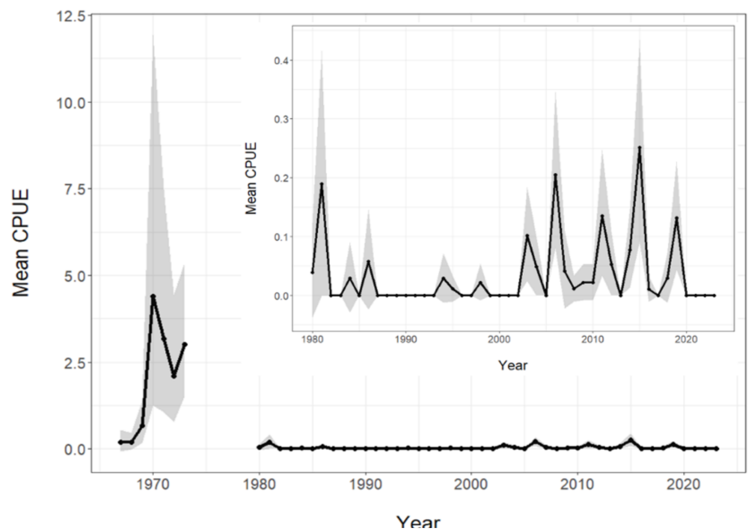

Fig. 6. Relative abundance of American shad from VIMS Striped Bass Seine Survey from 1967 – 2023 and 1980 – 2023 (inset).

VIMS Alosine Monitoring Program. One staked gill-net, approximately 274 m in length, is set on the James River. James River sets are located in the lower James River near the James River Bridge at river mile 10 (36° 50.0' N, 76° 28.8' W). To ensure that catch rates in the current monitoring program are comparable to logbook records, nets on the James River are constructed of 12.4 cm stretched-mesh monofilament netting. Panel lengths are consistent with historical records (9.14 m each). Each week between February and May, nets are fished for one day (i.e., a 24-h set) and then hung in a non-fishing position until the next sampling episode. Occasionally, weather or other circumstances prevent the regularly scheduled sampling on Sunday, and sampling was postponed, canceled or re-scheduled for another day. Individual American Shad collected from the monitoring sites are measured and weighed on an electronic fish measuring board interfaced with an electronic balance. The board recorded measurements (fork length and total length) to the nearest mm, received weight input to the nearest g from the balance, and allowed manual input of additional data (such as field data and comments) or subsample designations (such as gonad tissue and otoliths) into a data file for subsequent analysis. Results are shown in Fig. 7.

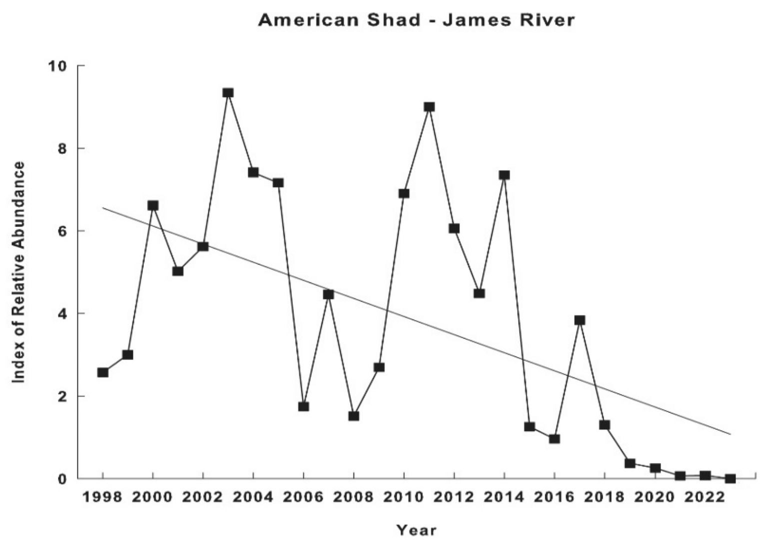

Fig. 7. Relative abundance of spawning female American Shad over time. Data from VIMS Alosine Monitoring Program.

DWR Electroshocking survey. Weekly boat electrofishing for adult anadromous fishes is conducted from March to June (Fig. 8). The James River is sampled in the tidal/non-tidal interface area at the lower end of the fall zone and other fall zone areas such as just below Boshers Dam. The Chickahominy River is sampled above and below Walkers Dam. Each river reach contains several sampling stations to cover the area. The inter-annual trend of catch per unit effort (CPUE) is used as a measure of relative run strength. At each station, sex, fork and total lengths, and weight are recorded for a subsample of 25 American Shad.

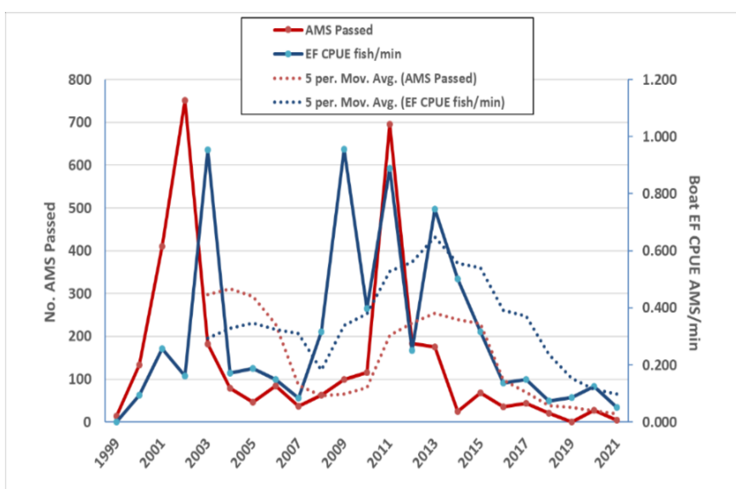

Fig. 8. Catch-per-unit-effort of American Shad over time. Data from DWR Anadromous Fish Electroshocking Survey.

BOSHERS DAM FISH PASSAGE SURVEY. The vertical slot fishway at Boshers Dam on the James River (rm 113) near Richmond, Virginia, was completed in early 1999 and first operated and monitored in the spring of 1999. Videos are collected during the entire spring spawning run at the fishway viewing window. During 1999, live counts were obtained during six-hour periods on three to four randomly selected days. In 2000, mostly live counts were obtained, and the use of VHS recordings was first employed. All usable video was reviewed. In 2001 and 2002 all counting was been done by reviewing time-lapse VHS recordings. Starting in 2003 all counting has been done by reviewing digital video collected during the migration season. The digital equipment has evolved over time and currently a surveillance DVR and digital camera is used to collect passage video. All useable video is reviewed and all fish species are counted. Beginning in 2010, a 15-minute portion of every hour of video has been randomly selected and reviewed, and all observed American Shad are counted. Hourly estimates are made by multiplying by four and then tallied for daily and full season results. Prior to switching to subsampling, from 2005 to 2010, 15-minute increments were recorded to simulate subsampled estimates for comparing to the full hour/day/season counts; statistical analyses were conducted, and the estimation method accurately reflects the full hour counts. From 2010-2015, the first 15 minutes for each hour of video were analyzed. In 2016 the 15 minute per hour sub-sampling approach was modified to randomly select the 15-minute increment. The total number of a given species is estimated by multiplying the 15-minute count by four to arrive at an hourly estimate. An average of 839 daytime hours and 222 nighttime hours (1058 hours total) are reviewed annually by DWR to count all species of fishes, including American Shad, and calculate an estimated rate of passage for each species. Results are shown in Fig. 9.

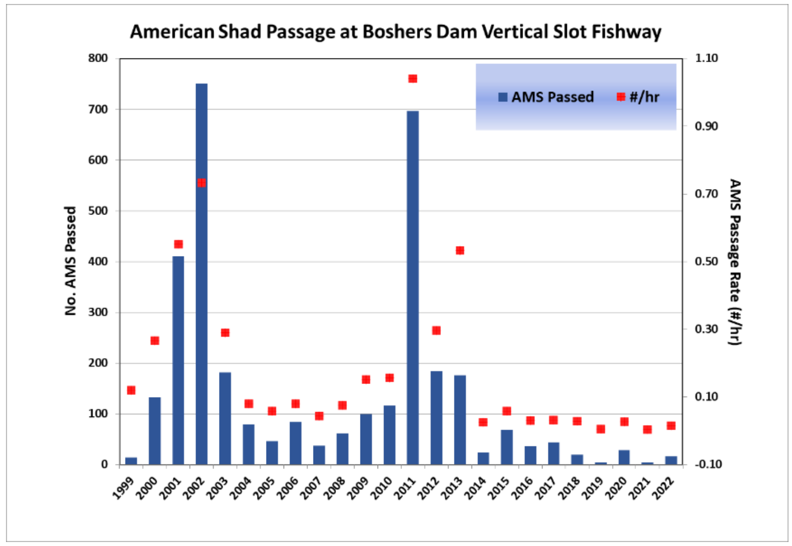

Fig. 9. Number of American Shad over time counted passing through the Boshers Dam Fish Passage and the estimated rate of passage. Data from DWR.

DWR JUVENILE ALOSINE PUSH NET SURVEY. The DWR Fish Passage Program has been conducting summer and fall push net sampling on the tidal James and the Boshers Dam pool (James) since 1999. The DWR push net sampling season typically ranges from late May through October or occasionally early November. River stations are sampled either weekly or on a roughly biweekly rotational basis. Because the targeted fish are negatively phototropic the work is conducted at night to increase the probability of encountering juvenile alosines. A bow mounted net on a sturdy frame attached to a 17' boat with a 60hp outboard motor. The net is lowered into the water on the frame to start a sample and then raised using an electric winch mounted near the stern. The net is 0.76 m in diameter and mesh size ranges from 3.2 mm early in the season up to 6.35 mm later in the season. In the James River drainage, sample stations are currently located in Chickahominy Lake in the first two miles upstream of Walkers Dam (which has a Denil fishway), in the tidal Chickahominy River within the first two miles downstream of Walkers Dam, and in the tidal James below Richmond; Boshers Dam pool and the tidal Appomattox River were also sampled historically but were discontinued due to budget and staff constraints. Typically, six pushes ranging from 2.5 minutes to 10 minutes in duration are conducted on sampling nights. The volume of water sampled during push netting is determined by using a flow meter and the CPUE is expressed as the number of fish per 100m^3 of water sampled. CPUE is used as a way to measure and compare the density of juvenile alosines both spatially and temporally. Length and weight are taken from a subsample of each alsoine species as well as pooled length and weight for all alosines collected.

HABITAT DATA GAPS

Key data gaps that directly pertain to American Shad recovery and that require focused evaluation include characterization of American Shad spawning and nursery habitats of the James River. In the summer of 2023, preliminary survey of the current condition of the river bottom for American Shad was conducted by VIMS. A Sonic 2026 Multibeam Echosounder (MBES) was employed to

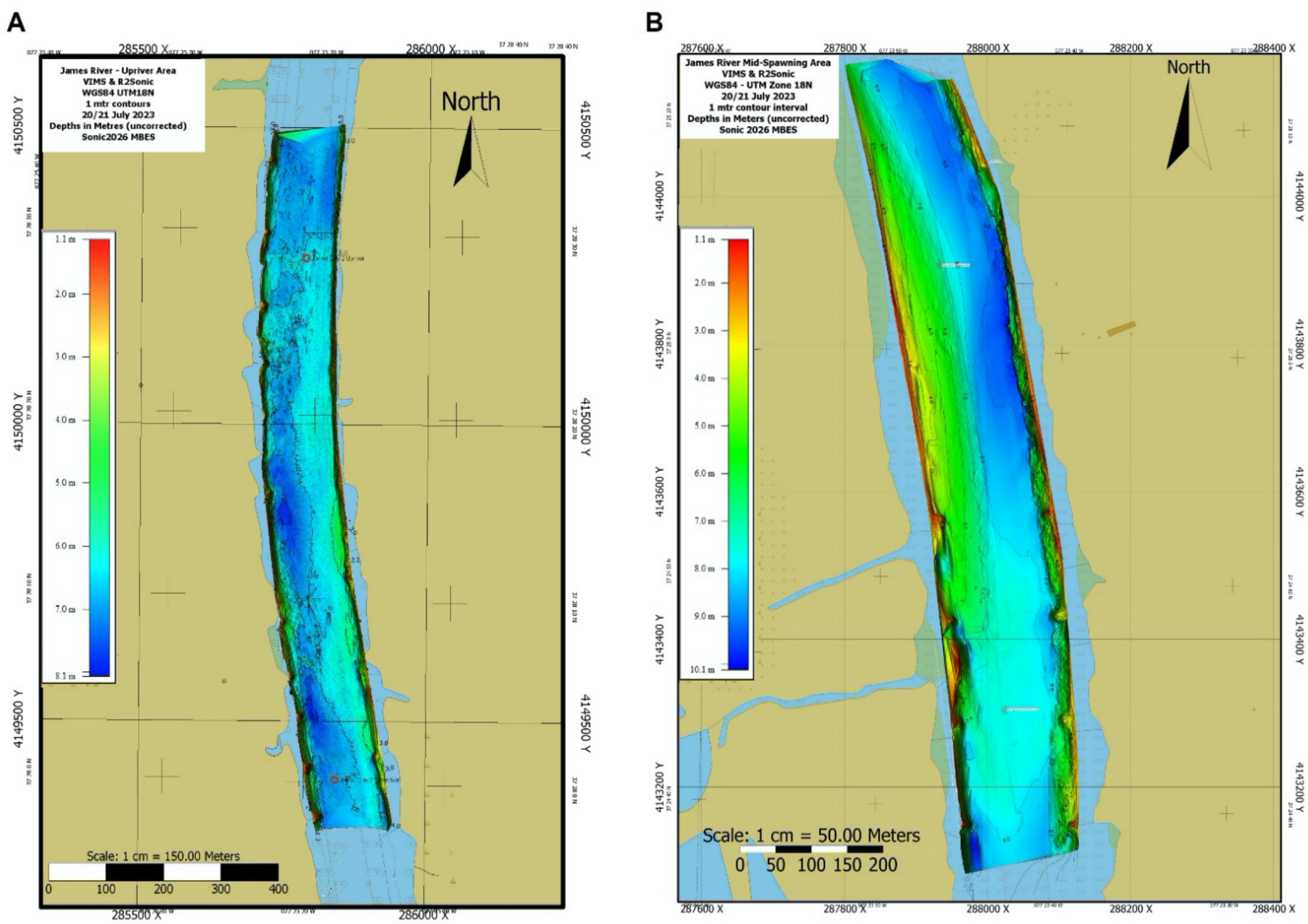

Fig. 10. High-resolution bathymetric survey with Castaway CTD profile and sediment grab locations marked at the A, upriver and B, mid-spawning sites.

map two sampling sites within the principal Shad spawning grounds in the James River as determined by Aunins and Olney (2009). The first site, identified as the upriver site is a 1-km stretch of river located above the Richmond Deepwater Terminal (at rkm 149). The second site, identified as the mid-Spawning site, is a 1-km stretch of river located near the center of the spawning ground (rkm 141). At each site, a high-resolution bathymetric survey was collected using a frequency of 450 kHz. Figure 10 shows the survey for the spawning-zone covering as much of the width as possible for a 1 km stretch of the river. A similar survey was collected at the upriver site as well. Debris and old dock pilings prevented moving any closer to the shores at both sites. A Sontek Castaway CTD was used to collect temperature and salinity profiles as well as speed of sound profiles, at two locations identified to correct the acoustic signals from the MBES. A YSI6600 CTD equipped with a turbidity meter was used to collect a representative turbidity profile from each site. Five surface sediment grab samples were also collected for each site, two on each shore in approximately 2-3 meters of water, as well as one in the middle of the channel at the location of one of the Castaway profiles.

In addition to the high resolution bathymetric surveys, low frequency transects were also collected using the multifrequency mode of the Sonic 2026. The intensity of the acoustic response for each frequency used, 90, 170 and 250 kHz, is different depending on the type of sediment. By comparing these different responses with sediment samples taken at each site, bottom characterization can be inferred. Because of time constraints, only three multifrequency bathymetry transects were collected at each site, one along each bank and one down the center. Future surveys such as these should provide 200% coverage of the river to allow complete coverage.

The results of this preliminary analysis are shown in Figure 10, which shows the results of the high resolution bathymetry survey, and Figure 11, which shows the multi-frequency composite scans at the upriver site and at the mid-spawning site and the bottom sediment variation along each of

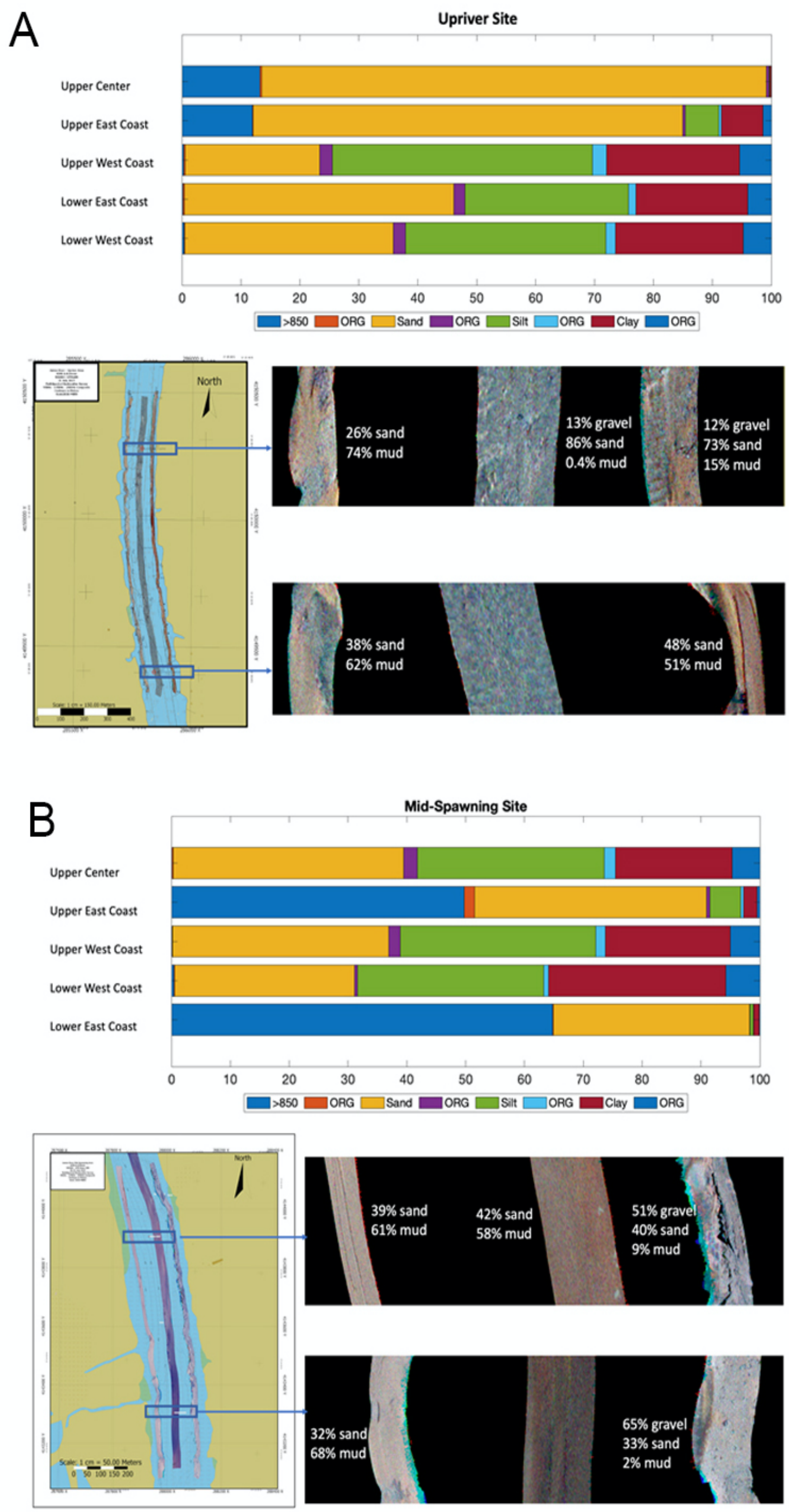

Fig. 11. Sediment analysis from the A, upriver site and B, mid-spawning sites. For each site, the top panel shows the grainsize distribution from the sediment grabs taken during the bathymetric survey, the bottom left panel shows the three low-frequency multi-frequency composite scans to show the bottom sediment variation along each scan and the bottom right panel shows the grainsize of the sediment grab samples collected at the upper and lower ends of the survey site.

three scans for the sites (one along the west bank, one down the center and one along the east bank). The scan for the center of the mid-spawning site channel (Fig. 10B) has color changes indicative of a complex benthic structure, whereas in the upriver site the center appears to be more homogenous and more reflective, indicative of a much coarser bottom sediment type. Conversely, the river edges in the mid-spawning site are more homogenous along each bank with the east bank being much more reflective. The upriver banks, by contrast, are very complex, especially the eastern side. From the multifrequency scans and bottom sediment grabs (Fig. 11), the upriver bank portions of the sampling stretch is shown to be greater percentage hard bottom (sand and gravel), whereas the mid-spawning sampling area has large components of mud, which is poor spawning substrate for American Shad. This preliminary high-resolution bathymetry survey comprised only 2% of the identified American Shad spawning range. For the multi-frequency composite scans of this region there was no overlap between the three transects, which is necessary to fully characterize the bottom type of the river. Therefore, further scans with the multifrequency sonar would allow a better determination of the true complexity of the bottom, and allow a better assessment of the spawning habitat condition.

STOCK RECOVERY GOAL

The primary goal of the James River American Shad Recovery Plan is to take actions that will restore the species to historical levels. In the short term, the abundances observed in the 1980s can provide a suitable benchmark for recovery. For the purposes of management, the criteria to achieve restoration targets that were accepted by the ASMFC are: (1) a three-year period during which the catch index remains at or above the target level in the staked gillnet monitoring of the spawning run; (2) a three-year period during which the average catch index is above the target level and the target level is exceeded in two of the years; or (3) a significant increasing trend over a five-year period with the target exceeded in the last two years. For the James River, the available target index (based on the VIMS Alosine Monitoring index) is 6.40, which is the geometric mean of the catch index values observed in 1980-1992; it is important to note that the level of abundance in the 1980s was not sufficient to support a fishery (Hilton et al. 2023). Therefore, long-term stock abundance must be substantially above this level to be able to withstand perturbations (anthropogenic or natural).

STAKEHOLDERS AND PARTNERS

There are many potential stakeholders with an interest in restoring American Shad to the rivers of Virginia. These include recreational anglers, commercial fishermen, non-governmental organizations, academic scientists, and state and federal management agencies. In addition to these potential stakeholders, partners in conservation, including the Sovereign Nations of Virginia, need to be incorporated into any discussions focusing on the restoration and usage of American Shad. The objectives of stakeholders and partners need to be considered as management options continue to be developed and, ultimately, prioritized and implemented. Initial consultations with stakeholders and partners are a crucial first step in this framework.

STOCK RECOVERY RECOMMENDATIONS

The following recommendations outline areas of need and actions that can be taken to address the recovery of American Shad in the James River. These were discussed and the actions were prioritized (within broad categories as listed below) by participants at the September 2023 workshop. Some actions build on the results of others, and therefore cost estimates will be unknown until preceding actions and efforts are completed.

CONTINUATION AND EXPANSION OF EXISTING MONITORING PROGRAMS

It is critical to maintain and strategically enhance all existing monitoring programs that encounter American Shad to be able to assess the effects of the recovery actions for this species. Due to budgetary constraints, some programs (e.g., the VIMS Alosine Monitoring Program) have experienced constriction in the temporal scope of sampling, while others need further support to effectively complement currently available data.

1. **Continue annual sampling by VIMS, DWR, and other relevant surveys to monitor relative adult and juvenile abundance of American Shad and its phenology.** Costs for the current surveys are supported by a combination of grants, contracts, and agency and institutional funding instruments. As noted above, the VIMS Alosine Monitoring Program has experience temporal constriction in recent years due to the reduced budgets. The funds estimated here would allow the sampling of four months (currently limited to 3 months) to better evaluate shifts in the migratory behavior of American Shad in the James River and Chesapeake Bay.

   Agency lead: Virginia Institute of Marine Science

   Timeline: Ongoing

   Cost: $40,000, ongoing.

2. **Revisit or develop benchmarks for the VIMS Alosine Monitoring Program, the DWR Electroshocking Survey, and the DWR Boshers Dam Fish Passage Survey to evaluate progress toward recovery.** Current monitoring data from the surveys described above will be reviewed and evaluated in the context of historical abundance data and changes in the landscape that affects American Shad in the James River watershed. Key factors that may be considered in revising or establishing benchmarks are the passage rates of American Shad at migratory blockages, amount and quality of spawning habitat (from the published estimate of 1 acre^2 supporting 50 spawning adults). An interagency workshop will be held following data collection to develop benchmarks to mark progress toward population restoration.

   Agency leads: Virginia Institute of Marine Science; Virginia Department of Wildlife Resources

   Collaborators: Atlantic States Marine Fisheries Commission; VA Alosine Task Force

   Timeline: 1 year

   Cost: $15,000

3. **Genetic monitoring and analysis for American Shad in the James River.** One of the key factors necessary for effective management and recovery of a species is an understanding of its genetic diversity within a population. This project will develop an estimate for the number of breeding individuals in James River American Shad population, as well as evaluate the genetic diversity within this population relative to other spawning populations within the Chesapeake Bay. These are important metrics that will inform downstream conservation and management actions. Samples will include archived material from the VIMS Alosine Monitoring program (including otoliths and scales). In addition, collection of genetic samples from all individuals from the James River and samples from other Chesapeake Bay rivers in Virginia, will be initiated during the 2024 sampling season, utilizing resources already available. This will establish an archival base for genetic samples of American Shad in the James River and will contribute to the sample base for evaluating genetic diversity of American Shad in the Chesapeake Bay. Costs for this project will include sample processing and sequencing for microsatellite and/or single nucleotide polymorphism loci (from an estimated 800 individuals over the 25-year time series) and staff time for data collection and analysis.

   Agency lead: Virginia Institute of Marine Science

   Timeline: 1 year

   Cost: $101,500

4. **Expand sampling through DWR electrofishing surveys to include the Appomattox River to assess habitat use of these portions of the James River watershed by American Shad.** The Appomattox River historically was surveyed for American Shad, but this has been discontinued due to funding shortages. For restarting this component of the survey, which would allow better determination of habitat use and distribution of American Shad in the James River drainage, cost estimates include an additional electrofishing boat and trailering capabilities, and ongoing staff time.

   Agency lead: Virginia Department of Wildlife Resources

   Timeline: Ongoing

   Cost: $146,000 in Year 1, $50,000 annually after Year 1.

IMPROVE AMERICAN SHAD HABITAT

Shad require specific substrate for spawning habitat, specifically sandy loam or gravel substrate. Contamination in American Shad habitat, especially sediment pollution, is a considerable impediment to Shad access to spawning substrate. The Chesapeake Bay Program has noted that "further study of freshwater habitat use by American Shad in Virginia is needed. Specifically, quantification and analysis of specific reaches of riverine habitats used by American Shad during residency (adults during the spawning run, larvae, and juveniles) is needed to better manage and address habitat concerns of the species." [33]

With better understanding of the requirements for and existence of prime American Shad habitat in the James River watershed, VIMS could suggest targeted areas for habitat restoration and protection efforts, including general wetland and stream restoration. Suggestions for stream improvement for fish habitat and health appear in the Virginia Stream Restoration and Stabilization Best Management Practices Guide developed by the Virginia Department of Conservation and Recreation.[34] These include aquatic habitat and fish passage considerations.[35] The Guide could be amended to specifically discuss practices to foster and protect prime American Shad habitat. In addition, the Commonwealth could modify its Stormwater Local Assistance Fund[36] (SLAF) Guidelines to prioritize wetland and stream restoration funding from the SLAF for those targeted areas.

The James River has experienced substantial anthropogenic changes that have impacted the aquatic organisms. Study and mitigation of habitat degradation and change is critical for the successful recovery of American Shad in the James River. In addition to the actions described below, state agencies currently have the authority to require monitoring for species interactions as part of the permitting process for projects likely to interact with managed or protected species. These actions encourage relevant agencies, including the Virginia Department of Environmental Quality, the Virginia Marine Resources Commission, and the Virginia Department of Wildlife Resources, with support and input from the Virginia Institute of Marine Science, to place more scrutiny on applications for projects in the James River that are likely to negatively interact with American Shad. These include, but are not limited to, construction, dredging, and water withdrawals.

1. **Study of early life history of American Shad, including an inventory of the historical spawning habitat.** This analysis will include (but not be limited to), identification of critical portions of the James River being used for spawning through intense ichthyoplankton sampling during the spawning season (for three years), the development of high-resolution bathymetry maps of currently used spawning grounds (two years), and identification of changes to benthic habitats by comparison to historical data. Bathymetric and multifrequency bottom sediment type surveys will be completed to cover the full 26-km historic spawning range identified in the James River with the R2Sonic 2026 sonar (to be purchased). Sediment grab samples will be collected and analyzed for grain size to ground truth the multifrequency surveys. The surveys will be completed in the first year with resampling selected locations during the spawning period to explore if there are any changes to the bottom sediment type as

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[33] *Shad*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/issues/whats-at-risk/shad (last visited May 25, 2023).

[34] *The Virginia Stream Restoration and Stabilization Best Practices Guide,* DEPT. OF CONSERVATION AND RECREATION, DIVISION OF SOIL AND WATER CONSERVATION (2004), https://www.deq.virginia.gov/home/showpublisheddocument/7085/637521938606770000.

[35] *Id*. at ch. 2.11.

[36] VA. CODE ANN. § 62.1-44.15:29.1.

compared to the rest of the year. The second year will be used for data processing and completion of report. In addition, comparisons to historical data from published literature and unpublished records at VIMS, VCU, NOAA and other institutions and agencies will serve as the basis for future mitigation efforts. Costs for this project include staff time (including a graduate student), vessel usage, bathymetry mapping equipment and analysis, and ichthyoplankton sampling.

Agency lead: Virginia Institute of Marine Science

Collaborators: Virginia Commonwealth University, Virginia Department of Wildlife Resources

Timeline: 3 years

Cost: $825,100

2. **Evaluate potential for restoration and/or enhancement of habitats in the James River that are critical for successful American Shad spawning, including benthic habitats below the fall line.** This action builds on the results of the study of spawning and early life history of American Shad described above, which will work to delineate portions of the river that are used for spawning and larval development, and therefore need protection through management, as well as identify portions of the river that are should be targeted for habitat restoration efforts and funding. **The timeline and cost of this action can not be estimated at this time because the scope of work is entirely dependent on the outcomes of Action 1.**

   Agency lead: Virginia Department of Wildlife Resources

   Collaborators: Virginia Marine Resources Commission, Virginia Institute of Marine Science, Virginia Commonwealth University,

Reduce Mortality of American Shad

Mortality, including both fishing and natural mortality, is a direct limitation on the recovery of American Shad. Although fishing mortality has been reduced to the extent easily feasible (i.e., a moratorium on commercial fishing and restriction to catch-and-release recreational fishing for American Shad), there are other sources of fishing mortality that need to be better understood (e.g., bycatch mortality). A small permitted bycatch fishery exists in Virginia (see Hilton et al. 2023), and in recent years has been a source of biological information on American Shad in the James River; it is unlikely this source of mortality is significantly impacting recovery. Instead, other policy, biological research, and resources management actions are recommended to reduce predation pressure and water withdrawal impacts on Americean Shad in the James River.

Reduction of Predation Pressure

Policy Actions.

1. **Promote the use of the Blue Catfish Processing, Flash Freezing, and Infrastructure grant funds to cover additional infrastructure costs associated with Blue Catfish processing.** To promote catfish as a viable commercial fishery, even amid industry frustration over USDA regulation, in 2023 the Virginia General Assembly created the

Governor's Blue Catfish Processing, Flash Freezing, and Infrastructure Grant Program (Virginia catfish processing program).[37] Under the legislation, the Secretary of Agriculture and Forestry will disperse the funds made available by the program through grants of no more than $250,000 per political subdivision to support blue catfish processing, flash freezing, and infrastructure projects.[38] The General Assembly intended these funds to support commercial fishing for Blue Catfish in the James River and other Virginia river systems by increasing the capacity for processing them, especially for small-scale watermen.[39]

As of July 1, 2023, the Code of Virginia Title 3.2, Chapter 3.1 will include the Virginia catfish processing program in § 3.2-312, which among other things presents guidelines for awarding such grants. The individual responsible for formulating these guidelines is the Secretary of Agriculture and Forestry.[40] These guidelines and grants are intended to assist the catfish commercial fishery, but they do not change the fact that catfish processing is still subject to USDA regulations.[41] Under current USDA authority, infrastructure for a federal inspector and separate processing facilities for all meat products covered under the jurisdiction of the USDA is required by the Federal Meat Inspection Act (FMIA).[42] Specifically, FMIA requires that:

> The Secretary [of Agriculture] shall cause to be made, by experts in sanitation or by other competent inspectors, such inspection of all slaughtering, meat canning, salting, packing, rendering, or similar establishments in which amenable species are slaughtered and the meat and meat food products thereof are prepared for commerce as may be necessary to inform himself concerning the sanitary conditions of the same, and to prescribe the rules and regulations of sanitation under which such establishments shall be maintained…."[43]

Therefore, the Secretary of Agriculture and Forestry could state broadly in the guidelines for distributing funds from the Virginia catfish processing grant program that the grants may be used to assist with paying for any additional infrastructure needed to accommodate the required federal inspections at processing facilities. Providing state funding to cover the additional costs incurred by catfish processors under the USDA's Food Safety and Inspection Service (FSIS) regime hopefully will reduce the bottleneck in processing for the Virginia commercial catfish fishery, although it will not entirely remove the extra burden imposed by USDA oversight.

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[37] Va. Code Ann. § 3.2-312 (2023) (adopted as Chapter 133 of 2023 Acts of Assembly).

[38] *Id*.

[39] *Id*. at § 3.2-312(C) (*"*[T]he Governor will . . . favor projects that create processing, flash freezing, and infrastructure capacity in proximity to small-scale blue catfish watermen.").

[40] *Id*. ("The Secretary of Agriculture and Forestry shall develop guidelines for the Blue Catfish Processing, Flash Freezing, and Infrastructure Grant Program and administer the Blue Catfish Processing, Flash Freezing, and Infrastructure Grant Program on behalf of the Governor.")

[41] Federal Meat Inspection Act of 1906, Pub. L. 59-382, 34 Stat. 669; Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, 122 Stat. 1651 (2008), https://www.congress.gov/110/plaws/publ246/PLAW-110publ246.pdf.

[42] Federal Meat Inspection Act of 1906, Pub. L. 59-382, 34 Stat. 669.

[43] 21 U.S.C. § 608 (2005).

2. **Seek Reversion to FDA Regulation of Catfish Processing Rather Than USDA Regulation.** As an alternative to covering additional processing costs with the new state grant funds, Virginia lawmakers could advocate for a return to FDA oversight of catfish processing procedures by following in the footsteps of Maryland state lawmakers who passed a joint resolution urging the United States Congress to amend U.S.C. § 601(w)(2)[44] (which codified inclusion of catfish within the purview of USDA regulatory oversight) and "return federal oversight responsibilities related to the processing and inspection of wild invasive catfish caught in the Chesapeake Bay [and its watersheds] to the U.S Food and Drug Administration."[45]

   The less onerous FDA oversight procedures could eliminate processing bottlenecks and additional costs currently imposed by the USDA regulation. Other entities, such as the James River Association, the Chesapeake Bay Foundation, and the Chesapeake Bay Commission also could engage with Congressional representatives to lobby for this change in support of the restoration of the Shad fishery. Aquatic species harvested under FDA regulation are subject to much less burdensome and stringent processing requirements than USDA's requirements. Most notably, FDA regulations do not require an on-site federal food inspector or a separate processing space (as catfish currently require under USDA's FSIS regulation).[46] If Congress were to choose to revert to FDA oversight of the catfish processing industry, assuming it remains the same as the pre-2008 Farm Bill regulation of commercial catfish fisheries, it would only require processors to adhere to food safety standards outlined in 21 CFR 123.11[47] – standards that are common throughout the seafood processing industry. In addition, reverting to FDA oversight in conjunction with the Virginia catfish processing program (assuming the program has auxiliary benefits beyond addressing USDA regulatory burdens on commercial catfish fishermen) could rapidly expand the commercial catfish fishery in the James River, thereby decreasing predation on American Shad. Although some processors have noted benefits associated with marketing USDA-inspected product, processing capacity would likely increase if the inspection requirements for Blue Catfish matched those for other seafood products (Andrew Scheld, VIMS, pers. comm. 2023).

<u>**Biological Actions**</u>

1. **Determine bycatch of American Shad in the Menhaden fishery in the Chesapeake Bay.** The most recent bycatch study of the Menhaden fishery in the Chesapeake Bay is more than 30 years old (Austin et al., 1994). This Action would provide an update to this report through the development of a fisheries observer program for the Menhaden fishery (an extension of the current VMRC fisheries observer program). The fishing season for the Chesapeake Bay is 29 weeks (May 1 – Nov 17 in 2023) while the ocean season is 34 weeks (May 1 – Dec 22 in 2023). To ensure appropriate temporal coverage weekly sampling

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[44] Md. S.J. Res. 4, Natural Resources – Fishing – Wild–Caught Blue Catfish (2021), https://mgaleg.maryland.gov/mgawebsite/Legislation/Details/SJ0004?ys=2021RS (cross-filed bill with Md. H.J. Res. 1).

[45] *Id.*

[46] 21 C.F.R. § 123.11 (2015).

[47] *Id.*

during the season is proposed (5-10% observer coverage). Costs for this Action include fisheries observers, travel to and from port, and data entry, management, and analysis.

Agency lead: Virginia Marine Resources Commission

Collaborator: Virginia Institute of Marine Science

Timeline: 3 years

Cost: $525,000

2. **Determine the impact on American Shad caught as bycatch in commercial fisheries in the James River, and the mortality of American Shad caught in targeted catch and release recreational fisheries of American Shad.** VIMS currently interacts with commercial fishers to collect samples and data from American Shad that are landed as part of the limited bycatch fishery for American Shad in the Virginia tributaries of the Chesapeake Bay. Data from this survey contribute to annual compliance reports to the ASMFC, but have not been formally analyzed. Further, the impact of the catch and release recreational fishery for American Shad is unknown. Specifically, post-release mortality is potentially a source of mortality that is currently not considered in estimates of impact. Based on the 2020-2021 DWR Angler Survey (Valdez and White, 2021), 6.7% of respondents indicated they targeted shad or herring. By partnering with community anglers, this project will develop estimates of post-release mortality of American Shad by employing acoustic telemetry (i.e., tagging fishes caught as part of the fishery and analyzing their survival and movements post release). Costs for these projects include tags and staff time for tagging, vessel usage to download acoustic receiver data, and data analysis; receivers are already available and therefore not included in the cost estimate.

   Agency lead: Virginia Institute of Marine Science

   Collaborators: Virginia Department of Wildlife Resources, Virginia Marine Resources Commission

   Timeline: 1 year

   Cost: $35,000

Impacts of water withdrawals

<u>**Policy Actions**</u>

1. **Provide funding for a study to assess the individual and cumulative impact of grandfathered water intake facilities on the population of American Shad in the James River and consider requiring actions to mitigate and impacts.** The Commonwealth has developed standards and an inter-agency consultation process for new industrial water intakes to avoid impacts to aquatic life.[48] These standards come into effect when new water intakes are proposed, or when old, unpermitted facilities are required to obtain permits due to changes in their intakes. However, Virginia has created categories of "grandfathered" industrial water intake facilities that do not have to obtain Virginia Water

[48] VA. CODE ANN. § 62.1-44.15:20.

Protection (VWP) permit coverage, as set forth in statute[49] and the VWP regulations (referenced below):

- 9VAC25-210-310(A)(1): Any surface water withdrawal established on or before July 1, 1989 is not required to have a VWP permit; however, a permit is required if a new Clean Water Act § 401 certification is required to increase the withdrawal.[50]

- 9VAC25-210-310(A)(2): Any surface water withdrawal not in existence on July 1, 1989 is not required to get a VWP permit if the person proposing to make the withdrawal received a § 401 certification before January 1, 1989 that authorized the installation of any necessary withdrawal structures; but a permit is required before such withdrawal is increased beyond the amount authorized by the certification.[51]

- 9VAC25-210-310(A)(3): Any existing lawful unpermitted surface water withdrawal initiated between July 1, 1989, and July 25, 2007, that has complied with the Water Withdrawal Reporting regulations (9VAC25-200) and that is not subject to other exclusions contained in 9VAC25-210-310,[52] is also not required to have a VWP permit.

Notably, withdrawals qualifying for 9VAC25-210-310(A)(1) exclusions from VWP permit coverage are required to submit certain information to DEQ, but "the information is not used to set a limit on grandfathered users, unless a proposal is made which otherwise triggers the need for a VWP permit."[53] For instance, a permit is required if a new § 401 certification is required to increase a withdrawal.[54]

The VWP regulations at 9VAC25-210-310 also provide a trigger clause for certain facilities excluded from permitting requirements which allows DEQ to require that the operator of a system cease withdrawal and seek a permit if DEQ finds that the withdrawal, individually or in combination with other existing or proposed projects, adversely impacts

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[49] VA. CODE ANN. § 62.1-44.15:22(B).

[50] 9 VA. ADMIN. CODE § 25-210-310(A)(1) ("This exemption applies even in cases where there is an interruption in service, a change in ownership, or a change in purpose, unless the intake is abandoned. . .").

[51] 9 VA. ADMIN. CODE § 25-210-210(A)(2).

[52] 9 VA. ADMIN. CODE § 25-210-310A(3)(b) ("Examples of activities that would increase a withdrawal and then require a Section 401 Certificate include, but are not limited to, moving an intake to deeper water, usually to better utilize low flows; replacing a dam or weir due to severe leakage; elevating a dam spillway to increase storage capacity in the impounded pool; constructing a larger intake to replace an existing smaller intake; and constructing a new intake to supplement withdrawals at an existing intake. Municipal water supply, agricultural, and commercial intakes and impoundments are examples of users that often meet this exclusion until water supply demands increase."); Guidance Memorandum No. 11-2004 from Ellen Gilinsky, Water Division Director, Va. Dept. of Env't Quality, to Regional Directors, Regional VWPP/Water Permit Managers, VWPP Staff & Enforcement Staff 8, (Mar. 17, 2011), https://townhall.virginia.gov/L/GetFile.cfm?File=C:%5CTownHall%5Cdocroot%5CGuidanceDocs%5C440%5CGDoc_DEQ_4411_v1.pdf.

[53] Guidance Memorandum No. 11-2004, *supra* note 45.

[54] VA. CODE ANN., § 62.1-44.15:22 (B).

state waters or fish and wildlife resources.[55] However, the trigger clause does not include the "grandfathered" intakes covered in 9VAC25-210-310(A)(1).[56]

These "grandfathered" facilities do not require VWP permits, and are thus not subject to permit requirements. Thus, many older facilities that take water from the James River for power generation or manufacturing do not currently meet Virginia's best practice standards to minimize impacts on aquatic life.[57] However, they are not required to upgrade to best technology available unless they are augmenting their intake systems or applying for a new permit. Where these re-permitting cycles are not happening, grandfathered facilities are left exempt from those permit standards which protect American Shad. The individual and cumulative impact of grandfathered water intake facilities on the American Shad populations in the James is unclear and requires more research.

To address this issue, policymakers should consider providing funding to assess the individual and cumulative impacts of grandfathered water intake facilities on the American Shad population in the James River. If these facilities are found to have a significant impact on American Shad, then the General Assembly could consider requiring actions to mitigate those impacts, such as requiring certain protective measures to reduce entrainment for intakes in prime habitat areas or requiring VWP permits for grandfathered intakes above a certain size and/or water intake velocity in habitat areas. In studying these issues, the Commonwealth should consult with the Tribes in Virginia who have historically raised or relied upon American Shad as a food source to obtain input on implementation best practices in support of James River American Shad restoration.

2. **Require all unpermitted water intake facilities to submit data regarding actual withdrawal volume of intakes annually or even seasonally.** Closely tied to the concept of grandfathered intakes is the lack of sufficient reporting requirements to enable the Commonwealth to best manage American Shad. As DEQ Guidance notes, "The users who qualify for one or more of the [VWP permit] exclusions may or may not be required to report their surface water use under the Water Withdrawal Reporting Regulation 9VAC25-200, depending upon the purpose and rate of surface water withdrawal."[58] This impacts the Commonwealth's ability to assess the full impacts of intakes on American Shad.

The State Water Control Board regulations[59] require certain entities[60] to report water withdrawal information to the Board for its use in preparing plans and programs for the management of water resources pursuant to § 62.1-44.38 of the Code of Virginia. These

[55] 9 VA. ADMIN. CODE § 25-210-310 (B).

[56] 9 VA. ADMIN. CODE § 25-210-310(B) (DEQ may only require ceasing of withdrawal for entities exempted under subdivisions (A)(3) through (A)(11) of the Code, which does not include the grandfathered intake exemption located at (A)(1)).

[57] *Saving American Shad - the Founding Fish*, *supra* note 15.

[58] Guidance Memorandum No. 11-2004 at 8, *supra* note 45.

[59] 9 VA. ADMIN. CODE § 25-200.

[60] 9 VA. ADMIN. CODE § 25-200-30(A)(1) ("Reportable withdrawals include, but are not limited to, those for public water supply, manufacturing, mining, commercial, institutional, livestock watering, artificial fish culture, and steam-electric power generation uses.").

reporting requirements apply to some unpermitted intakes if they withdraw enough water. The withdrawal of volumes greater than the average of 10,000 gallons per day during a single month, or more than 1 million gallons per month for the purpose of irrigating crops, is required to be reported through the Water Withdrawal Reporting Regulation [61], whether or not the withdrawal is permitted. This thus could include 9VAC25-210-310(A)(1)-(3) grandfathered facilities, but it is limited to unpermitted intakes that withdraw a significant amount of water. The Water Withdrawal Reporting Regulation also requires, under Exemptions, that Industrial VPDES permittees annually report to the State Water Control Board simply the source and location of water withdrawals and the use information required by the regulation.[62]

The reporting requirements should generate sufficient data for VIMS to provide informed recommendations on intakes' cumulative impacts on American Shad. With sufficient information, VIMS could conduct scientific modeling of American Shad populations in the James River, and this information could inform assessments of new permitting requests. However, required reporting data is limited, and unpermitted, unregulated water withdrawals that do not reach the threshold for reporting requirements have unknown impact. This matters for American Shad because with this additional information, VIMS, VMRC, and VDEQ could make more informed recommendations regarding permit reviews.

One way policy makers could address this issue is to consider requiring all unpermitted water intake facilities to submit data regarding actual withdrawal volume of intakes annually or even seasonally. Currently, 9VAC25-210-310(A)(1)(b) requires grandfathered, unpermitted intakes in existence as of July 1, 1989 to provide to DEQ "the estimated maximum capacity of the intake structure, the location of the existing intake structure, and any other information that may be required by the department" and, for agricultural withdrawals, to provide to DEQ the maximum annual surface water withdrawal over the last 10 years. In addition, 9VAC25-210-310(A)(3) requires grandfathered, unpermitted surface water withdrawals initiated between July 1, 1989 and July 25, 2007 that have complied with the Water Withdrawal Reporting regulations to annually report withdrawals as required by those regulations. Provision of additional data by all grandfathered withdrawers would help to inform the need for further legislative or regulatory requirements to help protect the American Shad.

3. **Require new cooling water intake facilities to adopt additional technology and require additional monitoring to protect American Shad as a "fragile species"**. NPDES permits issued after July 14, 2018 must include conditions to implement and ensure compliance with the impingement mortality standard at 40 CFR § 125.94(c) and the entrainment standard at 40 CFR 125.94(d), including measures designed to minimize detrimental effects to federally-listed species and designated critical habitat.[63]

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[61] *Id.*

[62] 9 VA. ADMIN. CODE § 25-200-30(B)(3).

[63] 40 C.F.R. § 125.98(b)(2) ("Pursuant to § 125.94(g), the permit may include additional control measures, monitoring requirements, and reporting requirements that are designed to minimize incidental take, reduce or

State NPDES Directors (i.e., DEQ) may also require additional technologies for protection of "fragile species" pursuant to 40 CFR §125.98(d), and may require additional monitoring of species of fish and shellfish not already required under 40 CFR § 125.95(c).[64] "Fragile species" is defined in the federal regulation to include American Shad.[65] Thus, VDEQ could require new cooling water intake facilities to adopt additional technology and require additional monitoring to protect American Shad from impingement, as part of the VPDES permit process.[66]

Biological Actions

1. **Evaluate the impact of permitted and proposed surface water withdrawal intakes within the James River on early life history stages of American Shad to determine cumulative effects and enforce mitigation for large scale withdrawals.** Within the James River watershed there are numerous permitted surface water intakes, with more than 20 in the portion of the river downstream of Boshers Dam that was identified as the peak spawning grounds for American Shad (see Fig. 11; Aunins and Olney, 2009). Costs for this study include two years of salary for a postdoctoral researcher and one month of a VIMS faculty's time in each year, travel (for collaborating with DEQ partners) to conduct the Particle Tracking Model analysis for predicting the effect of surface water intakes on American Shad.

   Agency lead: Virginia Institute of Marine Science

   Collaborators: Virginia Department of Environmental Quality

   Timeline: 2 Years

   Cost: $370,000

remove more than minor detrimental effects to Federally-listed species and designated critical habitat, or avoid jeopardizing Federally-listed species or destroying or adversely modifying designated critical habitat (e.g. prey base). … The Director may include additional permit requirements if: (i) Based on information submitted to the Director by any fishery management agency or other relevant information, there are migratory or sport or commercial species subject to entrainment that may be directly or indirectly affected by the cooling water intake structure; or (ii) It is determined by the Director, based on information submitted by any fishery management agencies or other relevant information, that operation of the facility, after meeting the entrainment standard of this section, would still result in undesirable cumulative stressors to Federally-listed and proposed, threatened and endangered species, and designated and proposed critical habitat.").

[64] 40 CFR § 125.98(d).

[65] 40 CFR § 125.92(m) ("Fragile species means those species of fish and shellfish that are least likely to survive any form of impingement. For purposes of this subpart, fragile species are defined as those with an impingement survival rate of less than 30 percent, including but not limited to … American Shad ….").

[66] *See* 9 VA. ADMIN. CODE § 25-31-165.

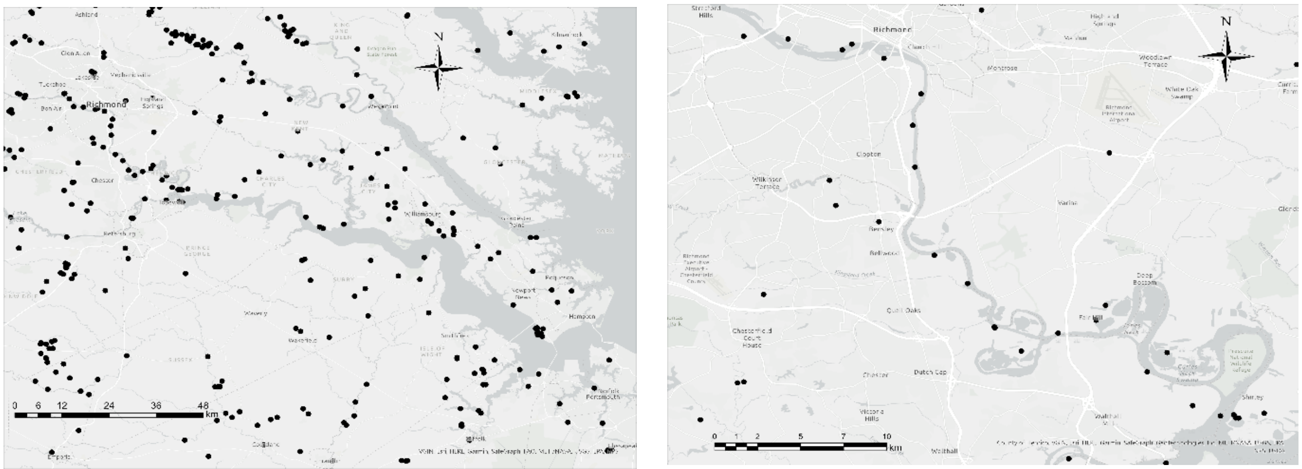

Fig. 11. Permitted surface-water withdrawals. Left, all surface-water withdrawals. Right, withdrawals within the American Shad spawning reach in the James River. Withdrawal location data from DEQ.

2. **Determine the potential impact of small-scale surface water removals on American Shad** (e.g., agricultural and golf course irrigation systems), including collecting data on number and distribution of pumps and the potential scale of losses through mesocosm experiments. This project would complement both the modeling efforts described above for Action 1, as well as involve the hatchery activities described below. Costs include staff time (including a graduate student) for data collection and analysis.

   Agency leads: Virginia Institute of Marine Science and Virginia Commonwealth University in partnership with USFWS (Harrison Lake Hatchery)

   Collaborators: Virginia Department of Environmental Quality, Virginia Department Wildlife Resources

   Timeline: 3 years

   Cost: $99,200

INCORPORATE HATCHERY PROPAGATION IN AMERICAN SHAD RECOVERY

In conjunction with the U.S. Fish and Wildlife Service, the VDWR and the Interstate Commission on the Potomac River Basin created a stocking program for American Shad. This project used state and federal hatcheries to reintroduce 'tagged' American Shad fry, releasing 3.3 million American Shad in the James River and 4.7 million in the Rappahannock River. Due to the high financial burden and other factors limiting American Shad's progress toward recovery in its native range, the stocking program was ended in 2017. Given that there is strong evidence of persistent recruitment failure of wild stock in the James River, hatchery inputs of American Shad may present an important mitigation effort to consider for recovery.

The workshop participants discussed at length the value of restarting a stocking program for American Shad in the James River to support restoration of habitat and other mitigation efforts for recovery of wild stock. The workshop participants expressed reluctance to establish a production scale hatchery for American Shad for the purposes of maintaining a stocking program for the river. Concerns for this as a restoration strategy include the availability of appropriate brood stock. Although the James River stock is no longer genetically distinct, there may be unknown factors such as imprinting on natal habitats that necessitate brood stock to be James River origin. Although propagation of American Shad larvae for stocking is not the goal of hatchery operations, the workshop participants also considered the importance of the continuation of hatchery operations for a variety of reasons beyond stock enhancement, including experimental manipulation of larval American Shad (e.g., for experiments related to larval behavior in relation to water intakes), refinement of best practices of aquaculture of American Shad and related species, and to support education and outreach efforts related to American Shad. Renewed funding for hatcheries, coupled with research on other conservation pressures, could be an effective tool to support restoration of American Shad in the James River. The Pamunkey and Mattaponi tribal governments have traditionally raised young American Shad in hatcheries and stocked them in rivers across the region.[67] The Pamunkey Tribe have a long history with operating a hatchery, as a hatchery was first established on their land in 1918 to raise and release young American Shad into the Pamunkey River.[68] The Mattaponi Tribe also have operated a hatchery on the Mattaponi River for years.[69] If the General Assembly decides to renew funding for Shad hatchery programs, it should consult with them and all Tribes in Virginia who have land or traditional territory on the James River who could potentially desire to be involved in future hatcheries and stocking programs.

1. **Develop regional partnerships, including with tribal communities, in support of hatchery propagation of American Shad and other alosine fishes (e.g., river herring).**

   Agency lead: Virginia Commonwealth University in partnership with USFWS (Harrison Lake Hatchery) and Virginia Institute of Marine Science

   Collaborators: Virginia Tribal Communities, VA Department of Wildlife Resources

   Timeline: 3 years

   Cost: $150,000

DETERMINE EFFECTS OF CLIMATE CHANGE ON AMERICAN SHAD IN VIRGINIA

Although mitigation of the effects of climate change on American Shad populations cannot be directly addressed, acknowledgment and better understanding of these factors is important for

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[67] https://www.chesapeakebay.net/issues/whats-at-risk/shad *Shad, supra* note 73; Ben Swenson, *The Pamunkey Indian Reservation Shad Hatchery; A Lesson in Conservation and Community*, ABANDONED COUNTRY (Apr. 15, 2013), https://www.abandonedcountry.com/2013/04/15/the-pamunkey-indian-reservation-shad-hatchery-a-lesson-in-conservation-and-community/.

[68] *Natural Resource*, PAMUNKEY INDIAN TRIBE, https://pamunkey.org/natural-resource (last visited May 25, 2023); Rachel Felver, *Virginia's Original Inhabitants Help to Restore Shad*, CHESAPEAKE BAY PROGRAM, https://www.chesapeakebay.net/news/blog/virginias-original-inhabitants-help-to-restore-shad (last visited May 25, 2023).

[69] *Meet the Mattaponi*, VIRGINIA WATER TRAILS, https://virginiawatertrails.org/meet-the-mattaponi/ (last visited May 25, 2023); *Shad, supra* note 73.

effective management and potential recovery of this species. Four interrelated actions were discussed by workshop participants and are outlined below.

1. **Evaluate the temporal shifts in phenology, early life history, age and growth dynamics, and body condition of American Shad to determine if there are predictable trends related to its spawning stock abundance and recruitment.** This series of studies build from preliminary analyses based on the VIMS Alosine Monitoring Program (presented above) that shows the spawning season has shifted at least three weeks earlier in the year and that there has been a demonstrable shift in the age and body condition of American Shad utilizing the James River. Similar data available from DWR and VCU also show a shift in the timing of riverine residency of American Shad. These analyses will be applied to management actions designed to protect American Shad (e.g., adjustment of time of year restrictions for in-river construction projects). Costs include staff time to assemble and analyze data.

   Agency lead: Virginia Institute of Marine Science

   Collaborators: Virginia Department of Wildlife Resources, Virginia Commonwealth University

   Timeline: 1 year

   Cost: $35,000

2. **Evaluate the correlation between the abundance and body condition of American Shad during the coastal marine phase of their lives and those of fish that have returned to rivers to spawn.** This project leverages historical and current data that are available from ongoing survey programs based at VIMS that have collected the necessary data (abundance, age, length, and weight) from individuals collected in both freshwater and marine environments. Costs include staff time to analyze and report on the data.

   Agency lead: Virginia Institute of Marine Science

   Timeline: 2 years

   Cost: $41,300

3. **Explore potential shifts in abundance and timing of zooplankton** by developing a multi-year zooplankton monitoring program within the Chesapeake Bay and within the coastal environments to determine the relationship between zooplankton to variation in American Shad stock abundance, structure, and/or condition. Sampling for this would be based from ongoing surveys completed as part of the VIMS Multispecies Research Group, including ChesMMAP and NEAMAP, and cost estimates include costs of gear, supplies, vessel costs, sample processing, and data analysis.

   Agency lead: Virginia Institute of Marine Science

   Timeline: 3 years

   Cost: $248,000

4. **Determine the level of predation on American Shad and diet of American Shad during the marine phase of life.** There is little data available related to the level of predation that American Shad experience while in the marine environment. Similarly, there is little information available on the diet of American Shad while in marine environments (most studies of the diet of American Shad focus on their freshwater residency during spawning, indicating that they only incidentally feed during their spawning migration). This proposed project would address this knowledge gap by leveraging the ongoing monitoring programs that encounter American Shad in the Bay and in coastal habitats. Costs include staff time for sample processing and analyzing these data.

   Agency lead: Virginia Institute of Marine Science

   Timeline: 3 years

   Cost: $30,000

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APPENDIX 1

WORKSHOP #1 PARTICIPANT LIST AND AGENDA

October 12, 2022

Workshop #1 – Participant List

*virtual participant

Participant	Agency/Organization
Alan Weaver	VA Department of Wildlife Resources
Alexa Galvan	VA Marine Resources Commission
Ashleigh Magee	Virginia Institute of Marine Science
Cecilia Lewis	Virginia Institute of Marine Science
*Chas Gowan	Randolph Macon College
Dave Hopler	Virginia Commonwealth University
DEQ Representative	VA Department of Environmental Quality
Elizabeth Andrews	William & Mary
Eric Brittle	VA Department of Wildlife Resources
Eric Hilton	Virginia Institute of Marine Science
Erin Reilly	James River Association
Jamie Brunkow	James River Association
Jessica Kraus	William & Mary
Jian Shen	Virginia Institute of Marine Science
Jim Gartland	Virginia Institute of Marine Science
Lane Eubank	Upper Mattaponi Tribe
Lisa Moss	U.S. Fish and Wildlife Service
Mark Luckenbach	Virginia Institute of Marine Science
Mary Fabrizio	Virginia Institute of Marine Science
Patrick McGrath	Virginia Institute of Marine Science
Rachel Mair	U.S. Fish and Wildlife Service
Randy Owen	VA Marine Resources Commission
Robert Latour	Virginia Institute of Marine Science
Tim Owen	VA Department of Wildlife Resources
Troy Tuckey	Virginia Institute of Marine Science

American Shad Recovery Plan for the James River, Virginia – Workshop #1

October 12, 2022, 9:30 am to 3:30 pm
Sadler Center, Chesapeake B (3rd Floor)
William & Mary
Williamsburg, VA

Time	Topic
9:30 am – 9:45 am	Welcome, logistics, and attendee introductions (Eric Hilton)
9:45 am – 9:55 am	Introduction, scope, and background (Eric Hilton)
10:00 am – 11:00 am	Overview of on-going programs and available data (10 minutes each) • Monitoring – VIMS Alosine Program (Eric Hilton) • Monitoring – Offshore (Jim Gartland) • Monitoring – DWR (Eric Brittle) • Fish Passage (Alan Weaver) • Habitat Quality (Eric Hilton)
11:00 am – 11:15 am	Break (15 minutes)
11:15 am – 12:00 pm	Overview of on-going programs and available data (10 minutes each) • Water Intakes (Troy Tuckey) • Invasive Species (Troy Tuckey) • Hatchery (Pat McGrath) • Climate Change (Eric Hilton)
12:00 pm – 1:00 pm	Lunch (Chesapeake A)
1:00 pm - 2:00 pm	Breakout groups: Where are the gaps, and what are the needs for a recovery plan? • Monitoring – Eric Hilton (Chesapeake A) • Habitat – Troy Tuckey (Chesapeake BC) • Policy – Elizabeth Andrews (Room #381)
2:00 pm – 2:10 pm	Break
2:10 pm –3:00 pm	Discussion and next steps (Chesapeake BC) • Monitoring needs (15 min) • Data needs (bycatch, fish passage, water intakes, habitat restoration, invasive species, climate change) (20 min) • Modeling needs (15 min)
3:00 pm – 3:30 pm	General discussion of a "final product" (15 min) Tentative timelines and due dates (15 min)
3:30 pm	Adjourn

APPENDIX 2

WORKSHOP #2 PARTICIPANT LIST AND AGENDA

September 27, 2023

Workshop #2 – Participant List

*virtual participant

Participants	Agency/Organization
Alan Weaver	VA Department of Wildlife Resources
Alexa Galvan	Virginia Marine Resources Commission
Ashleigh Magee	Virginia Institute of Marine Science
Brady Donovan	U.S. Fish and Wildlife Service
Brycen Boettcher	VA Commonwealth University
Cecilia Lewis	Virginia Institute of Marine Science
Chad Boyce	VA Department of Wildlife Resources
Chas Gowan	Randolph Macon College
Frank Adams, Chief	Upper Mattaponi Tribe
Clint Morgeson	VA Department of Wildlife Resources
Dave Hopler	VA Commonwealth University
Doug Nemeth	U.S. Fish and Wildlife Service
Eric Hilton	Virginia Institute of Marine Science
Gregg Garman	VA Commonwealth University
Jamie Brunkow	James River Association
Katie Cisz	Virginia Institute of Marine Science
Lisa Moss	U.S. Fish and Wildlife Service
*Mark Custalow, Chief	Mattaponi Indian Reservation
Mark Luckenbach	Virginia Institute of Marine Science
Mary Beth Armstrong	Virginia Institute of Marine Science
Miguel Montalvo	Virginia Institute of Marine Science
Mike Bednarski	VA Department of Wildlife Resources
*Pat Geer	Virginia Marine Resources Commission
Patrick McGrath	Virginia Institute of Marine Science
Rachel Mair	U.S. Fish and Wildlife Service
Robert Burgholzer	VA Department of Environmental Quality
Robert Gray, Chief	Pamunkey Indian Tribe
Tim Hoyt	Virginia Institute of Marine Science
Tom Dunlap	James River Association
Troy Tuckey	Virginia Institute of Marine Science

James River American Shad (*Alosa sapidissima*) Recovery Framework – Workshop #2

September 27, 2023, 9:00 am to 3:05 pm

Virginia Commonwealth University, Rice Rivers Center
3701 John Tyler Memorial Hwy
Charles City, VA 23030

Agenda

9:00 am – 9:15 am	Meet and greet
9:15 am – 9:30 am	Introductions, agenda review and logistics (Eric Hilton)
9:30 am – 9:45 am	Federal Appropriation for Alosine Research (Greg Garman)

9:45 am – 10:15 am	Overview of progress to-date:
	• Mapping water intakes along the James River
	  o Available water withdrawals data
	  o Modeling the cumulative impacts of water intakes
	• Acoustic survey of spawning habitat
	  o Preliminary mapping results
	  o Mapping additional sites
	• Policy analysis by Virginia Coastal Policy Center (VCPC)

10:15 am – 10:30 am	Discussion • Any additional (known) data gaps
10:30 am – 10:45 am	Break
10:45 am – 12:00 pm	Recovery Plan recommendations #1 – 3 (Eric Hilton) • Rcmd. #1 - Continuation of existing monitoring programs • Rcmd. #2 – Improve American shad habitat • Rcmd. #3 – Reduce mortality of American shad
12:00 pm – 01:00 pm	Lunch
01:00 pm – 02:00 pm	Recovery Plan recommendations #3 – 5 (Eric Hilton) • Rcmd. #4 – Role of hatcheries in American shad recovery • Rcmd. #5 – Determining the effects of climate change and it's impacts
02:00 pm – 02:30 pm	Prioritize recovery actions (Eric Hilton)
02:30 pm – 02:45 pm	Break
02:45 pm – 03:00 pm	Next steps (Mark Luckenbach) • Action items and assignments • Timeline and reporting to the General Assembly
03:00 pm – 03:05 pm	Adjourn