Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

October 19, 2021
9:00 – 10:30 a.m.
Webinar

Draft Agenda

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

1.	Welcome/Call to Order *(J. Davis)*	9:00 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from May 2021	9:00 a.m.
3.	Public Comment	9:05 a.m.
4.	Consider American Shad Habitat Plans/Updates *(B. Neilan)* **Action**	9:15 a.m.
5.	Consider Technical Committee Report on Methods for Evaluating Mixed-stock Catch *(B. Neilan)* **Possible Action**	9:40 a.m.
6.	Progress Report on Prioritizing Systems for Shad Recovery and Developing Inventory of Available Data to Support Development of Fish Passage Criteria *(B. Neilan)*	10:05 a.m.
7.	Update from USGS Eastern Ecological Science Center on Alosine Science in Support of Interstate Management *(T. O'Connell)*	10:15 a.m
8.	Elect Vice Chair *(J. Davis)* **Action**	10:25 a.m.
9.	Other Business/Adjourn	10:30 a.m.

MEETING OVERVIEW

Shad and River Herring Management Board
October 19, 2021
9:00 a.m. – 10:30 a.m.
Webinar

Chair: Justin Davis (CT) Assumed Chairmanship: 2/21	Technical Committee Chair: Brian Neilan (NJ)	Law Enforcement Committee Representative: Warner (PA)
Vice Chair: VACANT	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: May 5, 2021
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from May 5, 2021

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

4. Consider American Shad Habitat Plans/Updates (9:15-9:40 a.m.) Action
Background
• Amendment 3 to the Shad and River Herring FMP requires all states and jurisdictions to submit a habitat plan for American shad. A majority of the habitat plans were approved by the Board in February 2014, and it was anticipated that they would be updated every five years. • The states began the process of reviewing their American shad habitat plans and making updates in 2020, however, many states encountered delays due to COVID-19. The Board has approved the following habitat plan updates: ME, NH, MA, RI, CT, Delaware River, MD, NC, SC, Savannah River, GA and FL. • The following plans were submitted for TC review and Board consideration at the October 2021 meeting: VA, DC, NY (**Briefing Materials**). • The Technical Committee reviewed these habitat plan updates via email and recommends Board approval (**Supplemental Materials**). The remaining states will provide their updated plans to the TC for review before the next Board meeting.
Presentations
• Shad Habitat Plan Updates for Board Consideration by B. Neilan
Board actions for consideration at this meeting
• Consider approval of updated shad habitat plans for VA and DC, and new habitat plan for NY

5. Consider Technical Committee Report on Methods for Evaluating Mixed-stock Catch (9:40-10:05 a.m.) Possible Action

Background

- The American Shad 2020 Benchmark Stock Assessment and Peer Review Report was accepted for management use in August 2020. The assessment found that American shad remain depleted on a coastwide basis, likely due to multiple factors, such as fishing mortality, inadequate fish passage at dams, predation, pollution, habitat degradation, and climate change. At the February 2020 meeting, based on the TC recommendation the Board tasked the TC with "developing methods to evaluate bycatch removals in directed mixed-stock fisheries in state waters in order to understand and reduce impacts to stocks outside the area where directed catch occurs."
- The TC formed a work group to address this task. Relevant data were collected from the states to identify possible methods for evaluating the impacts of mixed-stock removals in directed mixed-stock fisheries in state waters in order to understand and reduce impacts to stocks outside the area where directed catch occurs (**Supplemental Materials**).

Presentations

- Technical Committee Report and Recommendations on Methods for Evaluating Mixed-stock Catch by B. Neilan

Board actions for consideration at this meeting

- Consider recommending the TC recommendations be incorporated into the Delaware River Basin Coop Sustainable Fishery Management Plan.

6. Progress Report on Prioritizing Systems for Shad Recovery and Developing Inventory of Available Data to Support Development of Fish Passage Criteria (10:05-10:15 a.m.)

Background

- In light of the 2020 American shad stock assessment results, which showed that barriers to fish migration are significantly limiting access to habitat for American shad, in May 2021 the TC recommended actions to address fish passage impacts on population recovery, including that dam removal and the use of fish passage performance criteria be prioritized by state and federal agencies with fish passage prescription authority. The Board sent letters to the U.S. Fish and Wildlife Service and NOAA Fisheries to support their efforts to review dam passage. Additionally, the Board tasked the TC with prioritizing systems for shad recovery and developing an inventory of available data that would support development of fish passage criteria.
- The TC has made progress on this task by identifying Federal Energy Regulatory Commission (FERC) hydropower projects that are a priority for shad recovery efforts. Additionally the TC is gathering information on the types of data available for developing fish passage criteria for these priority projects. The TC expects to deliver a final report on this task at the next Board meeting.

Presentations

- Progress Report on Prioritizing Systems for Shad Recovery and Developing Inventory of Available Data to Support Development of Fish Passage Criteria by B. Neilan

7. Update from USGS Eastern Ecological Science Center on Alosine Science in Support of Interstate Management (10:15-10:25 a.m.)
Background • The U.S. Geological Survey (USGS) is the primary science agency within the Department of Interior and uniquely positioned to deliver ASMFC the actionable science required by the Atlantic Coastal Fisheries Cooperative Management Act of 1993. • USGS's Eastern Ecological Science Center is conducting over 20 research projects in support of ASMFC-managed species. For shad and river herring, these include a genetic stock identification and tissue repository, innovative passage technologies, and disease research **(Supplemental Materials).**
Presentations • Update on Alosine Science in Support of Interstate Management by T. O'Connell

8. Elect Vice-Chair

9. Other Business/Adjourn

Atlantic States Marine Fisheries Commission

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MEMORANDUM

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

FROM: **Shad and River Herring Technical Committee**

DATE: **October 8, 2021**

SUBJECT: **Technical Committee Recommendations on American Shad Habitat Plan Updates**

Amendment 3 to the Shad and River Herring FMP requires all states and jurisdictions to submit a habitat plan for American shad. A majority of the habitat plans were approved by the Shad and River Herring Management Board (Board) in February 2014, and it was anticipated that they would be updated every five years. The states began the process of reviewing their American shad habitat plans and making updates in 2020, however, many states encountered delays due to COVID-19. To date the Board has approved the following habitat plan updates: ME, NH, MA, RI, CT, Delaware River, MD, NC, SC, Savannah River, GA and FL.

For the October 2021 Board meeting, two additional habitat plan updates have been submitted for Board consideration from VA and DC, and the state of NY submitted a new habitat plan for the Hudson River. The updates that were made to each plan and the new plan for the Hudson River are summarized in the sections below. <u>The TC reviewed these plans via webinar on September 27, 2021, and recommends Board approval of all three plans.</u>

Virginia Shad Habitat Plan Update

The scope of this report and its updates are limited to the three primary tributaries of the Chesapeake Bay within Virginia (James, York, and Rappahannock rivers). This 2021 report includes additional information or progress on existing threats recorded within the 2014 report, but also includes documentation of additional threats considered to impact American Shad habitat including:

In river construction and blockage to migration

- In-river construction projects such as bridge and tunnel construction and maintenance, dredging, and others, have the potential for disruption of American Shad migration from both direct (e.g., acoustic interference) and indirect (e.g., habitat alteration) factors.
- This threat will be addressed through the enforcement of time of year restrictions on in-water development and case-by-case consideration of appropriate mitigation measures for individual projects

M21-114

Agricultural/Industrial Water Intakes and Discharge

- 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.
- Recommended actions in the plan to address this threat include developing a better understanding of the amount of water intakes for agriculture, particularly in tidal streams and rivers that support American Shad spawning and nursery grounds, as the effects (e.g., temperature and chemical differences) of discharge in non-consumptive water withdrawals on American Shad (particularly on early life history stages) is unknown.

District of Columbia Shad Habitat Plan Update

The updated plan included information on dredging projects within the District and invasive species monitoring since the last plan submission.

- Since the previous plan the dredging/channelization project associated with the runway extension at Reagan National Airport has been completed. There are no known channelization or dredging projects located within the District of Columbia at this time.
- The Department of Energy and Environment has an ongoing study examining stomach contents of the invasive blue and flathead catfish. To date, more than 1000 blue and flathead catfish digestive tracts have been examined with no American shad observed. The opportunistic nature of these catfish still poses a potential impact to American shad populations within the District of Columbia.

Hudson River Shad Habitat Plan

This is a new plan being submitted by the state of New York. The plan details the historically and currently available American shad spawning and nursery habitat within the tidally influenced portion of the Hudson River, current threats to these habitats, and ongoing projects geared toward better understanding and mitigating the impacts of these threats.

Habitat Assessment

- American shad currently have access to 91% of historical mainstem Hudson River habitat but conversion of habitat during the dredging and channelization of the upper portion of the estuary from preferred habitat to habitats not preferred by shad has been significant.

Threats Assessment

- The Plan identifies threats to American shad spawning and nursery habitat including:
    - Barriers to migration
        - Migration barriers represent a relatively minor threat to shad habitat availability as the Hudson stock has lost access to just 9% of historic habitat
    - Water Withdrawals

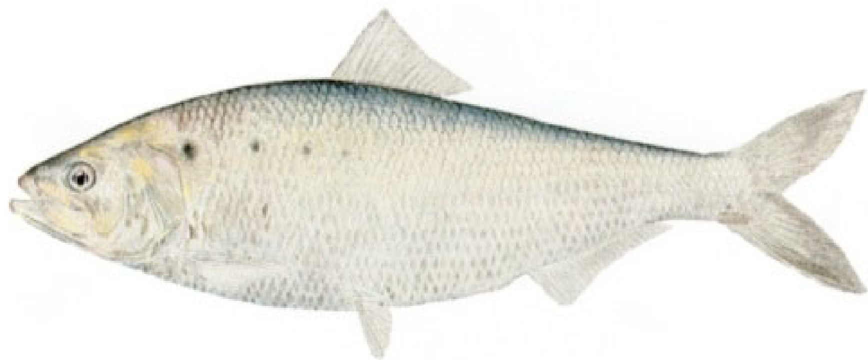
    - Modeling efforts have shown that impingement and entrainment mortality of American shad at various power generating facilities have resulted in year class reductions ranging from 16 to 52% during the period of 1974 to 1997
  - Anthropogenic Habitat Changes
    - Dredging/channelization of the mainstem Hudson River and adjacent land use changes over the past century have resulted in the change and degradation of preferred habitat used by American shad including the loss of 57% of the intertidal shallow water habitat (1,821 hectares) found north of the City of Hudson (km 190) during the middle of the 19th century.
  - Climate Change
    - The Hudson River stock will be vulnerable to climate change due, in part, to changes in water temperatures, water quality, and lost nursery habitat as storm intensity and frequency carry sediments that hinders the growth of submerged aquatic vegetation
  - Invasive Species
    - Over the past century invasive species have entered the Hudson River that threaten the American shad recruitment through predation from invasive fish species and loss of nursery habitat as a result of invasive plant species such as water chestnut

Habitat Restoration Programs

- Within the Hudson River system there are significant and ongoing efforts to understand and reduce the impacts of threats to American shad and shad spawning and nursery habitats identified in the Plan
- Restoration efforts include:
  - The removal of 9 dams within the Hudson River estuary since 2016
  - Managing water intakes to reduce entrainment and impingement mortality of shad eggs and larval American shad
  - Restoring vegetated shallow water and intertidal habitats including a side channel restoration project completed in July 2018 at Gay's Point (km 196), near Coxsackie, NY
  - Invasive species monitoring and management
  - Monitoring climate change impacts to the Hudson River and American Shad to identify and implement opportunities to adaptively manage and minimize adverse impact

Commonwealth of Virginia American Shad Habitat Plan

2021 Update



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Introduction

The Virginia American Shad Habitat Plan for the ASMFC is a joint effort between staff of the Virginia Institute of Marine Science, Virginia Department of Wildlife Resources, and the Virginia Marine Resources Commission. This 2021 report includes additional information or progress on existing threats recorded within the 2014 report, but also includes documentation of three additional threats considered to impact American Shad habitat: 1) In-river construction and blockage to migration; 2) Agricultural water intakes; and 3) Industrial water intakes and discharge. The scope of this report is limited to the three primary tributaries of the Chesapeake Bay within Virginia (James, York, and Rappahannock rivers. We thank Emily Hein (VIMS), Eric Brittle (VDWR), and Randy Owen and Tiffany Birge (VMRC) for information.

Agencies within the Commonwealth of Virginia with Regulatory Ability Related to American Shad or American Shad Habitat Management

Virginia Marine Resources Commission (VMRC). The VMRC is divided into three divisions: 1) Fisheries Management, which is charged with regulation of fisheries resources in tidal and marine environments, including collection of fisheries statistics, development of management plans, and promotion and development of recreational fishing activities; 2) Habitat Management, which manages and regulates the submerged bottom lands, tidal wetlands, sand dunes, and beaches; and 3) Law Enforcement, which enforces state and federal fisheries laws and regulations.

Virginia Department of Wildlife Resources (VDWR). The Department of Game and Inland Fisheries became the Department of Wildlife Resources on July 1, 2020. The VDWR manages and regulates inland fisheries, wildlife, and recreational boating for the Commonwealth of Virginia, and is responsible for enforcement of laws pertaining to wildlife and inland fisheries management.

Virginia Department of Environmental Quality (VDEQ). The VDEQ is charged with monitoring and regulating the quality of air and water resources in Virginia. VDEQ is organized into many programs, including Air, Water, Land Protection and Revitalization, Renewable Energy, Coastal Zone Management, Enforcement, Environmental Impact Review, Environmental Information, and Pollution Prevention.

In addition to state agencies, the Army Corps also regulates all of these areas from the federal perspective (with input and/or official consultation with other federal agencies such as NOAA-Fisheries and Fish and Wildlife Service).

Habitat Assessment

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) (Fig. 1). Additionally, American Shad are found in certain rivers in Virginia that drain to North Carolina (Desfosse et al., 1994). We include description of the habitat of these systems in Virginia, but there are no regular surveys of the status of these stocks in Virginia's portion of these systems beyond their presence in the systems. We focus discussion on the major western tributaries of the Chesapeake Bay as these are the primary stocks in Virginia waters. Although certain spawning/rearing reaches are known for American Shad for individual rivers (Bilkovic et al. 2002), the amount of habitat used by American Shad for these life history stages at a river-wide scale is unknown for Virginia tributaries of the Chesapeake Bay. Several tidal portions of the three major Virginia tributaries of the Chesapeake Bay have been designated as high priority areas for living resources, and migratory fishes in particular (Figs. 2, 3).

James River

The James River forms at the junction of the Cowpasture and Jackson rivers (rkm 580), and its drainage is the largest watershed in Virginia, totaling 26,164 km^2 (Jenkins and Burkhead, 1994). Average annual spring discharge on the James River is 294.2 m^3/s (Tuckey 2009). Prior to damming, which began in the colonial period, shad and river herring were reported to reach these headwaters and far into the major tributaries of the James River (Loesch and Atran, 1994). 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), and the Chickahominy River, which joins at rkm 65. 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 at the lower end of the fall zone. Boshers Dam is at the upper end of the fall zone at rkm 182.

York River System

The York River system includes the Mattaponi and Pamunkey rivers, which merge at West Point, VA, to form the York River (53 rkm). This is the smallest of the three western tributary systems, with a watershed of 6,892 km^2 (Jenkins and Burkhead, 1994); the Pamunkey drainage is larger and has greater average spring discharge than that of the Mattaponi (3,768 km^2 and 47.5 m^3/s vs. 2,274 km^2; 27.2 m^3/s, Bilkovic 2000). Tidal propagation extends to approximately 67 rkm in the Mattaponi and 97 rkm in the Pamunkey (i.e., approximately 120 km and 150 km, respectively, from the mouth of the York River; Lin and Kuo, 2001). The extent of the salt intrusion varies by season, but moderate salinity values (>2 ppt) are often observed in lower portions of these rivers.

Rappahannock River

The Rappahannock River, which is approximately 314 km in length (172 km is tidal; 118 km is salt water), has its headwaters in the Piedmont and is fed by the Rapidan River. The Rappahannock watershed encompasses a total of 7,032 km^2 (Jenkins and Burkhead, 1994), and the average annual discharge at the fall line is 45 m^3/s (O'Connell and Angermeier 1997). An estimated 125 tributaries of the Rappahannock River are potentially used by alosines (O'Connell and Angermeier 1997).

Other systems

American Shad are known from the Chowan River drainage, which in Virginia comprises the Meherrin River, and the Nottoway and Blackwater rivers (the latter two form the Chowan River in North Carolina). Collectively, the watershed of these rivers forming Virginia's portion of the Chowan River drainage is 10,518 km^2 (Jenkins and Burkhead, 1994). The Nottoway and Blackwater rivers support American Shad, which were collected in the mainstems of the rivers in 2020 (Brittle, 2020a, b). There are no dams that impede American Shad migrations on either river (E. Brittle, VDWR, pers. comm. Sept. 2021).

The Meherrin River, which originates in Virginia, joins the Chowan River in eastern Hertford County, North Carolina. The Meherrin is largely blocked for migration by fishes by a dam at Emporia, VA (E. Brittle, VWDR, pers. comm. Sept. 2021), although American Shad have been collected within the Meherrin at the base of the Emporia Dam. A fish lift is present at the dam, and based on surveys conducted up river, there is at least historical (1990s) use of the lift by migrating American Shad. There is currently little directed sampling above the dam and the hydropower operator is not required by FERC to monitor the lift, so the current usage of upstream portion of the river by American Shad is unknown. The downstream portion of this river has not been surveyed for anadromous fishes since 2006 (E. Brittle, VDWR, pers. comm. Sept. 2021).

Threats Assessment and Habitat Restoration Programs

Rulifson (1994) identified the following river specific factors potentially involved in the decline of migratory alosines in Virginia, including American Shad:

<u>Rappahannock River:</u> dams, overfishing, turbidity, low oxygen

<u>York River System:</u>

- York River: industrial water intakes, industrial discharge locations, overfishing, chemical pollution, thermal effluents, low oxygen, sewage outfalls
- Mattaponi River: industrial discharge locations, overfishing, thermal effluents
- Pamunkey River: industrial discharge locations, overfishing, thermal effluents

<u>James River System:</u>

- James River: channelization, dredge and fill, dams, industrial water intakes, industrial discharge locations, overfishing, chemical pollution, thermal effluents, turbidity, sewage outfalls
- Nansemond River: dams
- Chickahominy River: dams, industrial discharge locations, overfishing.
- Appomattox River: dams
- Pagan River: turbidity, sewage outfalls

Further Rulifson (1994) identified the potential habitat management practices, or rather their effects, involved in the decline of migratory alosines in Virginia, including American Shad:

Rappahannock River: inadequate fishways, reduced spawning habitat

York River System:
- York River: poor water quality
- Mattaponi River: poor water quality
- Pamunkey River: poor water quality

James River System:
- James River: inadequate fishways, reduced freshwater input to estuaries, reduced spawning habitat, poor water quality, water withdrawal
- Nansemond River: inadequate fishways, reduced freshwater input to estuaries, reduced spawning habitat, water withdrawal
- Chickahominy River: reduced freshwater input to estuaries, reduced spawning habitat, fishing on spawning area, water withdrawal
- Appomattox River: inadequate fishways, water releases from dams, reduced spawning habitat, water withdrawal
- Pagan River: turbidity, poor water quality

From the above threats assessment, several primary classes of threats and their associated repercussions are identified here in relation to American Shad habitat needs and restoration in Virginia. These are discussed below.

Threat: Barrier to Migration (Dams). As an anadromous fish, American Shad are negatively impacted by obstructions to migration from marine and estuarine habitats to the upstream freshwater spawning and rearing habitats. Here we provide a review of the primary obstructions found on the three Virginia tributaries of the Chesapeake Bay.

Rappahannock River: The main stem of the Rappahannock River was dammed until 2004-2005 when the submerged Crib Dam (built in 1854) and the Embrey Dam (built in 1910) at Fredericksburg (rkm 179) were removed. Removal of the dam reopened 170 km of potential habitat on the Rappahannock and Rapidan rivers for migratory fishes, such as American Shad and river herring (American Shad and Blueback Herring have been collected 45 km upstream of dam). Over 2,200 miles of Upstream Functional Network miles were reopened by the removal of Embrey Dam, which was the last remaining dam on the Rappahannock main stem. Upstream Functional Network miles are all miles accessible on the barrier stream plus all accessible tributary miles above the passage project (Martin, 2019). There are dams in place on tributaries of the Rappahannock (e.g., the Rapidan River) that may impede migration of American Shad (although it is unknown if American Shad used these reaches prior to dam installation). A fish passage was installed on the Orange Dam on the Rapidan River, a tributary of the Rappahannock (http://www.dwr.virginia.gov/fishing/fish-passage/) 16 km upstream of Rapidan Mill Dam, which remains as a migration barrier.

York River System: The Mattaponi, Pamunkey, and York rivers are all completely undammed. There are few dams in place on some tributaries of these rivers (e.g., the Ashland Mill Dam on the South Anna River, a tributary of the Pamunkey, which is known to block American Shad migration).

James River: 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 fish passage was installed in Boshers Dam (built in 1823) in 1999, reopening 221 km of the upper James River and 322 km 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 4,700 upstream functional network miles were reopened by the Boshers fishway (Martin, 2019). Approximately 204 km of the main stem of the Appomattox River is accessible to American Shad. Harvell Dam (rkm 17) in Petersburg, VA had a Denil fishway (1998) and then the dam was removed in 2014. Brasfield Dam (rkm 28) that forms Lake Chesdin near Matoaca, VA has a fish lift that completes passage through the Appomattox fall zone resulting in access to 2,957 upstream functional network miles. The first dam on the Chickahominy is Walkers Dam at rkm 35 that has a functioning double Denil fishway built in 2015 that reopens 48 mainstem river kilometers (508 upstream functional network miles). American Shad are known to use the Walkers fishway (2021 DWR trapping data) and have been found over 40 km 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/).

Recommended Actions: Installation of fish passage systems, breaching and removal of dams as appropriate (see Fig. 4 for recent activities in Virginia and the Chesapeake Bay watershed generally). Continued monitoring of fish passage systems currently in place for effectiveness for American Shad passage.

The remaining significant American Shad habitat that is yet to be reopened in Virginia includes the South Anna River, a tributary of the Pamunkey River, upstream of the Ashland Mill Dam (this would open 59.5 km of shad habitat on the mainstem plus any suitable tributary miles). American Shad were routinely collected during sampling for several years below Ashland Mill Dam at Rt. 1 and continue to be caught by anglers below the dam. Discussion of removal of this dam was proposed as mitigation for the King William Reservoir and there have been recent discussions of removal being done for mitigation credits, but the dam is still in place. Ashland Mill Dam is a Tier 1 (top 5% priority) barrier in the Chesapeake Bay Fish Passage Prioritization Tool (https://maps.freshwaternetwork.org/chesapeake/#) . In the James River, there remain seven dams spaced over 34 km beginning with Scott's Mill Dam in Lynchburg, VA (removal of these barriers or passageway installation would open a significant amount of habitat). Within the Rappahannock River system, removal or fish passage at the Rapidan Mill Dam (on the Rapidan River, a tributary of the Rappahannock; also a Tier 1 priority) would open 53.1 km of habitat because there is a Denil fishway on a water supply dam (Orange, VA) 16 km upstream of Rapidan Mill Dam. Passage options are currently being explored including removal for mitigation credits.

Agency or Agencies with Regulatory Authority: Licensing and relicensing of dams is regulated by FERC. Within Virginia, VDWR oversees the Fish Passage Program. VMRC, VDWR, and VDEQ all may be involved with the permitting process, regulations and monitoring of aspects of fish passage systems, dam removals, and other environmental factors associated with these activities depending on position of the dam. VDWR consults with fish passage engineers from the USFWS throughout fish passage projects.

Goal: "The importance of migratory fish species was recognized in the 1987 Chesapeake Bay Agreement and re-affirmed in Chesapeake 2000. A commitment was endorsed to 'provide for fish passage at dams and remove stream blockages whenever necessary to restore natural passage for migratory and resident fish.' The Fish Passage Work Group of the Bay Program's Living Resource Subcommittee developed strategies (1988) and implemented plans (1989) to fulfill this commitment. In 2004, the original Fish Passage Goal of 1,357 miles (established in 1987) was exceeded. Chesapeake 2000 led to the establishment of a new Fish Passage Goal, set in 2004, committing signatory jurisdictions to the completion of 100 fish passage/dam removal projects," to re-open an additional 1,000 miles of high-quality habitat to migratory and resident fishes. This increased the overall goal to 2,807 total miles for which Virginia is responsible for roughly one-third of the miles to be reopened. [from VDWR (https://dwr.virginia.gov/fishing/fish-passage/#background; accessed June 28, 2021)].

Progress: Through 2013 partners reopened a total of 2,690.75 miles based on the original method of counting miles (mainstem miles only on barrier stream). Starting with 2014, the method for counting miles reopened was modified to begin counting all accessible miles above a barrier on the barrier stream and its tributaries. This method calculates what is known as "upstream functional network miles" in order to provide a more realistic picture of habitat restoration and accessibility (Martin, 2019). Using this GIS based method over 12,000 miles have been reopened by dam removal and over 19,000 miles have been reopened by fish passage installation for a grand total of 31,313.4 upstream functional network miles. Because American Shad tend to spawn in larger streams not all of the upstream functional network miles are necessarily available to shad spawning. The current Long-term Target in the Chesapeake Bay Fish Passage Logic and Action Plan is as follows: Continually increase access to habitat to support sustainable migratory fish populations in the Chesapeake Bay watershed's freshwater rivers and streams. By 2025, restore historical fish migration routes by opening an additional 132 miles every two years to fish passage. Restoration success will be indicated by the consistent presence of Alewife, Blueback Herring, **American Shad**, Hickory Shad, American Eel and Brook Trout, to be monitored in accordance with available agency resources and collaboratively developed methods.

Cost: N/A

Timeline: N/A. Other than continuing to contribute to the overall Bay passage goal target dates there is no Virginia specific timeline set for dam removal and fish passage installation in Virginia. While not set for individual species (i.e., specific to American Shad), the next phase in prioritizing will use the prioritization tools and other existing information to create a Virginia plan that could include breaking down habitat total goals and accomplishments per anadromous species, including American Shad.

Threat: Pressures from Land Use Associated with Population Growth

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 a significant population center in Fredericksburg (Rappahannock River); the remaining areas are rural (Fig. 5). 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 (Fig. 6). 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; Fig. 7), sediment load (High in the Rappahannock, Low in the York River system, Chickahominy and Appomattox rivers, and Medium in the Upper James River; Fig. 8), and phosphorus yields (High in the Rappahannock, Medium in the Upper James River, and Low in the other rivers; Fig. 9); nitrogen yields are low in all three river systems (Fig. 10). Low summertime dissolved oxygen levels remains a threat in all portions of three rivers, except the upper Mattaponi and upper Pamunkey rivers (York River System), and the upper James River (Fig. 11).

Recommended Action: No specific actions can be identified related to mitigation against land use in Virginia as it relates to American Shad habitat use. Indeed, 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). However, 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. As a first step toward addressing decline of American Shad in Virginia, in part due to habitat alteration, a hatchery stocking program ran from 1994 to 2017 in the James River and 2003 to 2014 in the Rappahannock River.

Agency or Agencies with Regulatory Authority: Land use regulations associated with water quality primarily are under the authority of VDEQ, although both VMRC and VDWR may be involved in the permitting process and other aspects of regulation for certain activities that will affect water quality.

Goal: No specific goals are identified for protecting American Shad from pressures associated with habitat alteration and other land use changes. Enforcement of a moratorium on fisheries of American Shad (VMRC; VDWR) is aimed at curbing further declines.

Progress: The moratorium for American Shad has been in place in Virginia since 1994. Stocking of hatchery fishes (VDWR) ceased on the Rappahannock after the 2014 season and on the James after the 2017 season.

Cost: N/A

Timeline: N/A

Threat: In-River Construction Blocking Migration

In-river construction projects 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.

Recommended Action: Enforcement of time-of-year restrictions (TOYR). Current TOYR for American Shad are between February 15 and June 30 of any year (https://dwr.virginia.gov/wp-content/uploads/media/Time-of-Year-Restrictions.pdf). 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, VDWR recommend the TOYR to be March 15 to June 30 because American Shad do not reach this point in the river until mid-March. Case-by-case consideration of appropriate mitigation measures for individual projects (e.g., bubble curtains, coffer dams, etc.).

Agency or Agencies with Regulatory Authority: VMRC regulates any structures on, over, or under subaqueous bottom, the local wetlands board (or VMRC if a locality has not adopted the Wetlands Ordinance) regulates anything on, under, or over tidal wetlands (between mean low water and mean high water for non-vegetated areas and between mean low water and 1.5 x the tide range above mean high water for vegetated wetlands). VMRC distributes permit applications to other regulating agencies and other agencies (e.g., DWR, VIMS) that do not issue permits themselves to provide input to the permit process during the public interest review.

Goal: No specific goal is set for this threat, as the projects are sporadic and change year to year. However, with each application, measures of how the project will affect habitat are assessed and considered during the application process. Any request for TOY suspension for a specific project is vetted by inter-agency discussions.

Progress: Using the most recent five-year average (2016-2020), approximately 1,789 permit applications are estimated to be submitted per year for projects in Tidewater Virginia that have the potential to impact American Shad habitat. Within the same five-year time window, an estimated average of 346 permit applications per year for the non-tidal reaches of Virginia are received. An unknown number of these projects have the potential to adversely affect this species' habitat. Project scope ranges from small developments with minor impacts, if at all (e.g., dock construction and repair) to major infrastructure improvements (e.g., construction of a new tunnel across the mainstem of the James River).

Cost: N/A

Timeline: N/A

Threat: 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).

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). The VDWR recently updated its recommendations for design and operation of stream intakes (https://dwr.virginia.gov/wp-content/uploads/media/Surface-Water-Intake-Design-Operation-Standards.pdf), with the following requirements: intake is fitted with a screen with openings no larger than 1 mm, the intake velocity does not exceed 0.25 feet per second, and the intake does not withdraw more than 10% of the instantaneous flow. 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.

Recommended Action: Develop a better understanding of the amount of water intakes for agriculture, particularly in tidal streams and rivers that support American Shad spawning and nursery grounds. Further, the effects (e.g., temperature and chemical differences) of discharge in non-consumptive water withdrawals on American Shad (particularly on early life history stages) is unknown.

Agency or Agencies with Regulatory Authority: VDEQ regulates water withdrawals and discharges. The VDEQ reports annually (October) to the VA Governor and General Assembly on the status of Water Resources in the Commonwealth. In-stream work is permitted by VMRC. VDEQ regulates water withdrawals, although water intakes for agricultural use (i.e., irrigation) are exempt (see 9VAC25-210-310; https://www.deq.virginia.gov/permits-regulations/permits/water/water-withdrawal).

Surface water withdrawal permits are applied for through the VDEQ, with input from VMRC and the U.S. Army Corps of Engineers (USACE) with VDEQ determining the potential impact on aquatic life, water quality, recreation, and downstream impacts.

Goal: Although by law the withdrawal of surface water for agricultural purposes is unregulated, (i.e., exempt from permit requirements), these withdrawals, given their position within the watersheds, are undoubtedly a potential source of loss of early life history stages through impingement and entrainment. Data on the prevalence of agricultural intakes within specific river systems would allow for estimation of potential losses of larval American Shad. This is a recognized concern by the VDEQ (2020). VDEQ has "tentatively been approved for federal funding from the USGS Water Use Data Research Program to support a project to improve estimates of agricultural water use." This and other VDEQ studies, including habitat and water quality and ecological modeling, are steps to fill these information gaps.

Progress: Nothing yet to report.

Cost: N/A

Timeline: N/A

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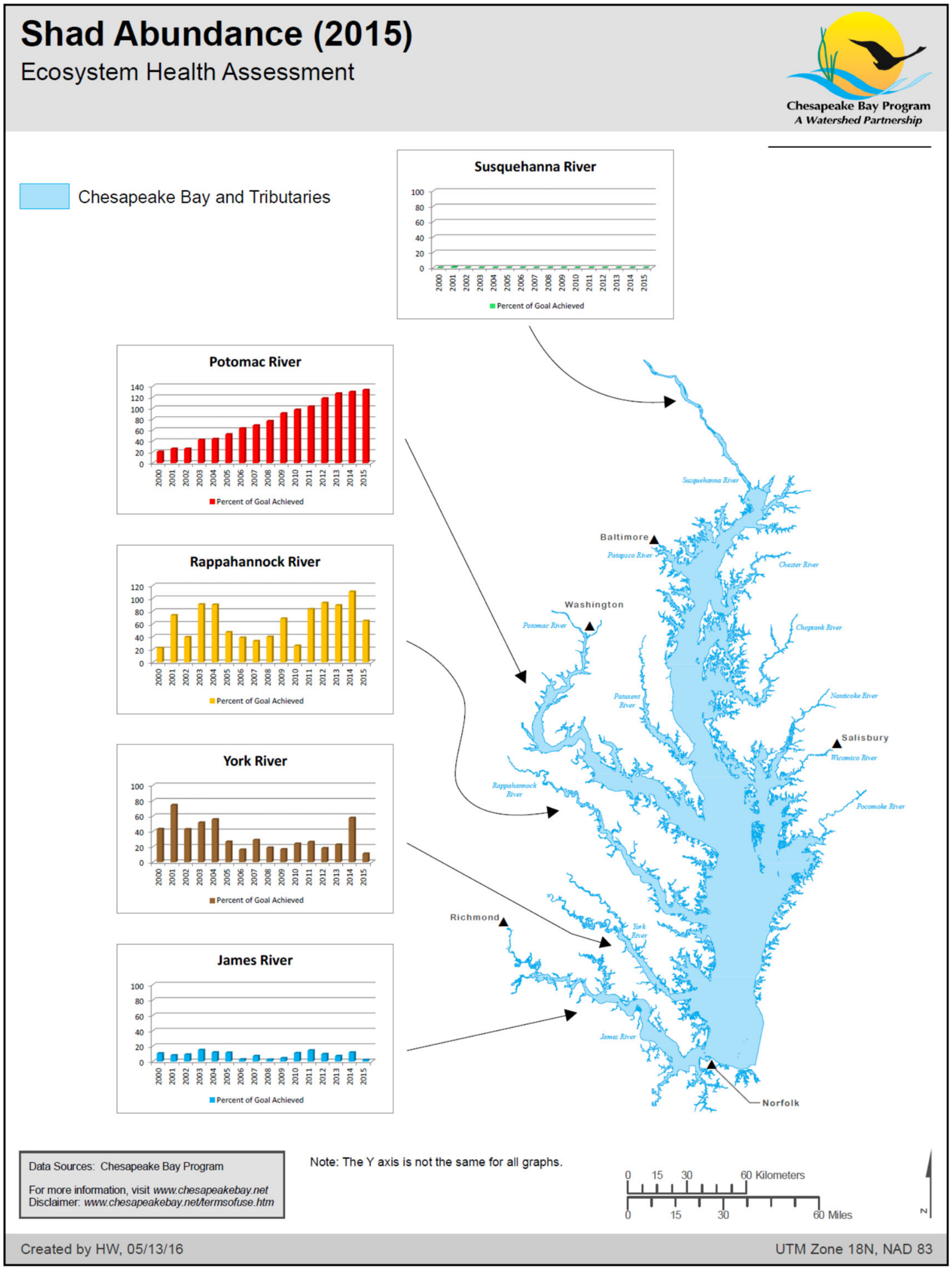

Figure 1. Shad distribution and abundance in the Chesapeake Bay. (Source: Chesapeake Bay Program)

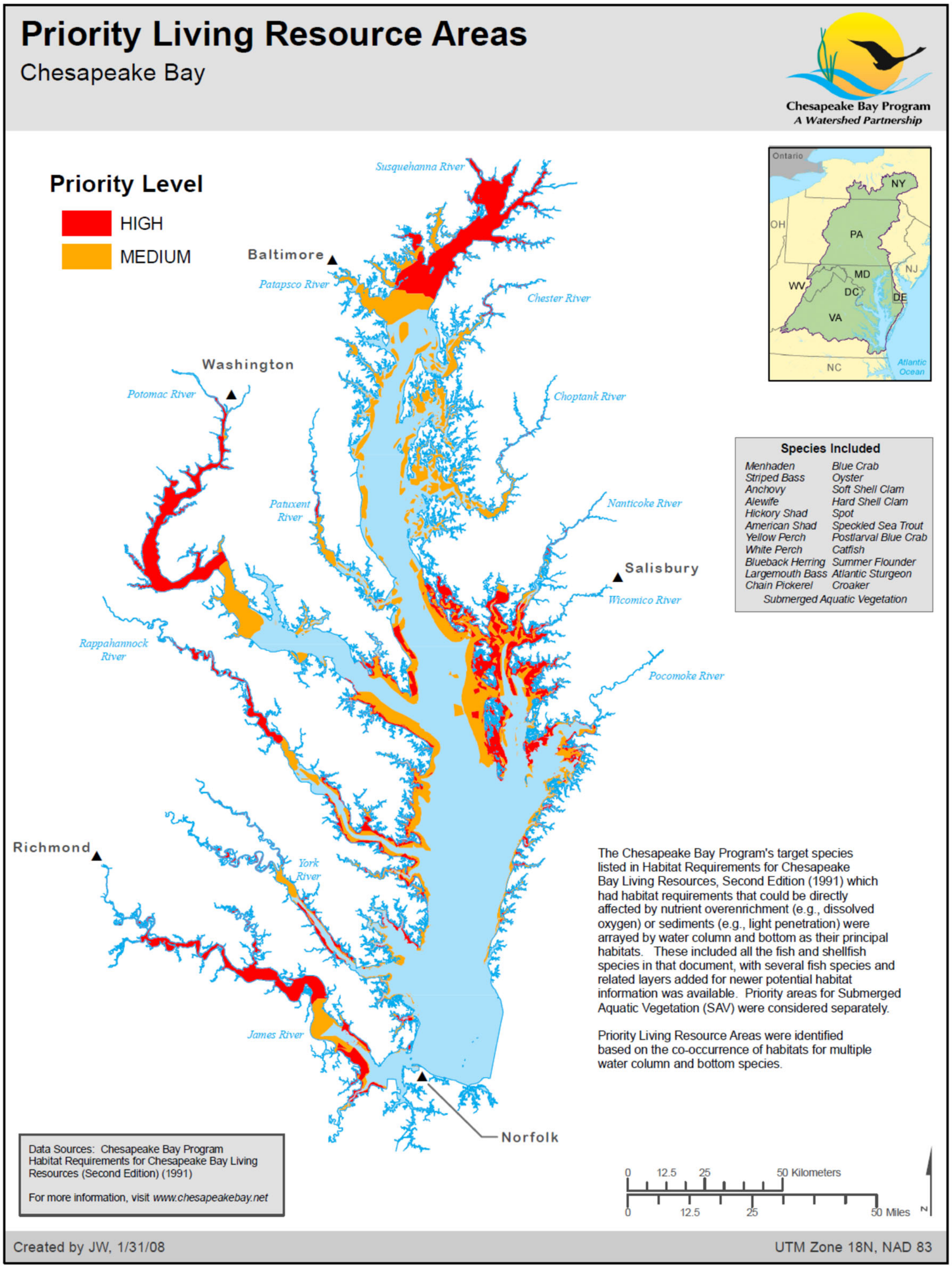

Figure 2. Priority living resource areas of the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

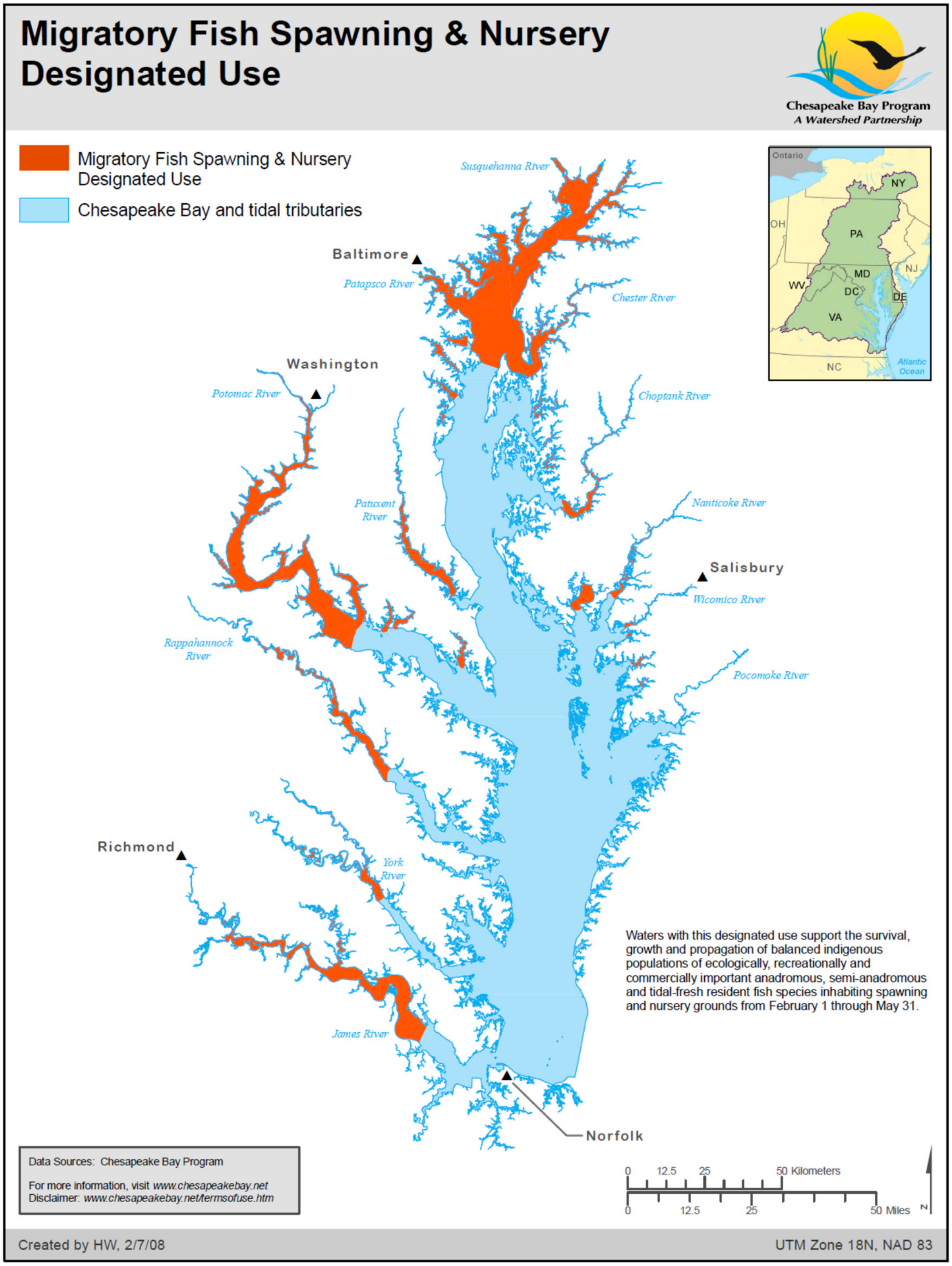

Figure 3. Migratory fish use of the Chesapeake Bay watershed (Source: Chesapeake Bay Program)

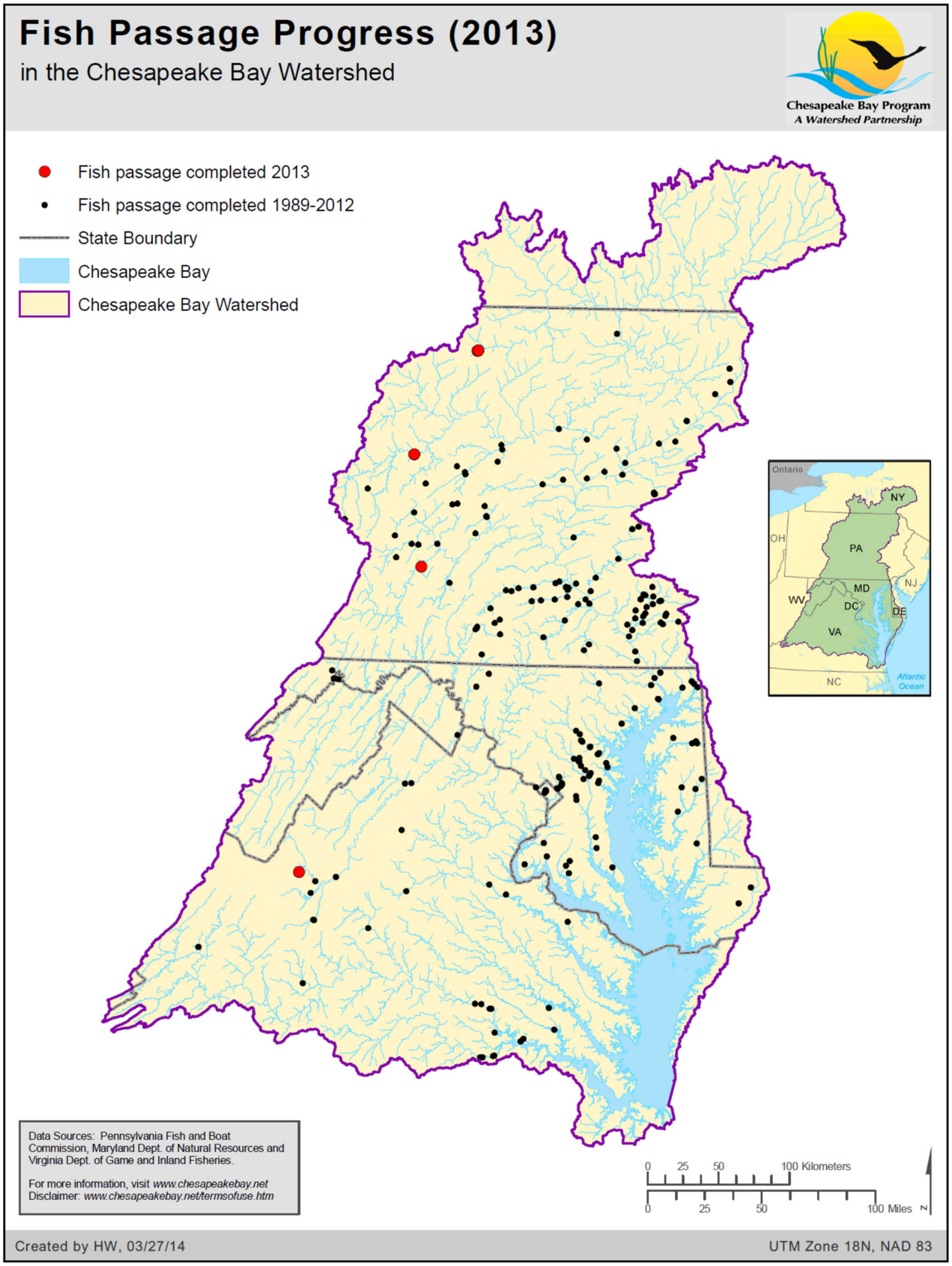

Figure 4. Fish passage projects in the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

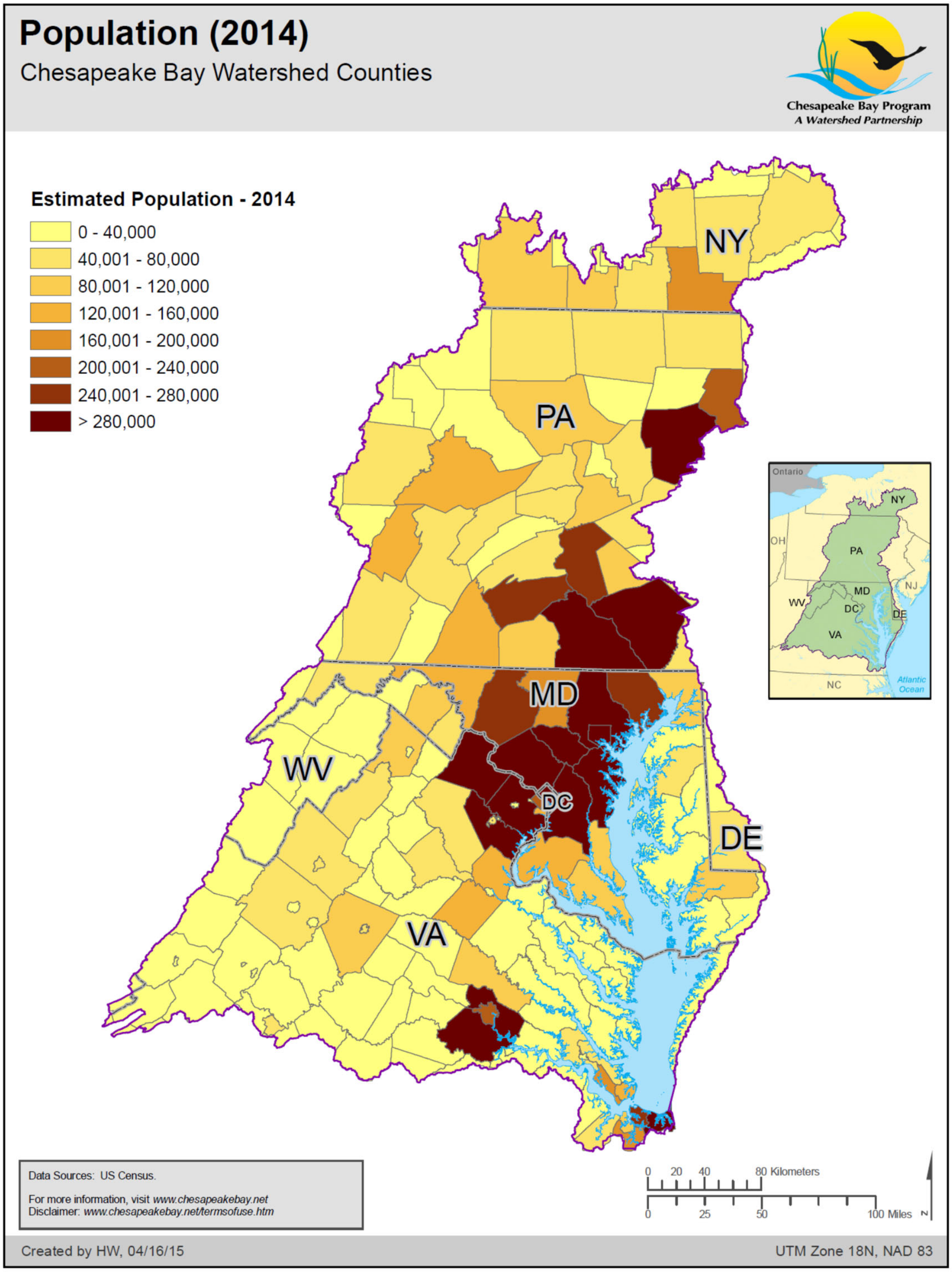

Figure 5. Population levels of the Chesapeake Bay region. (Source: Chesapeake Bay Program)

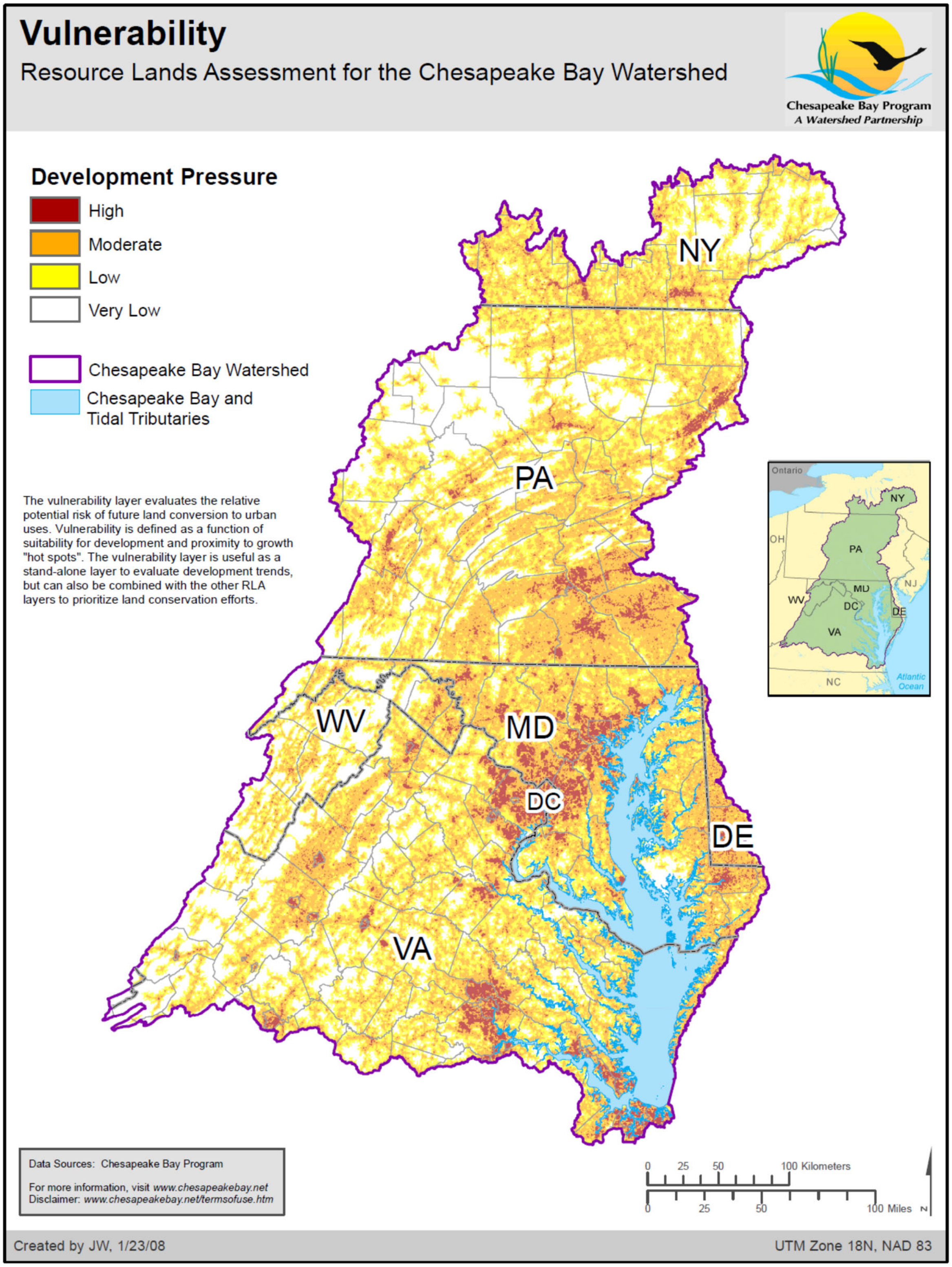

Figure 6. Potential for lands to become urban, representing significant land use changes and impacts. (Source: Chesapeake Bay Program)

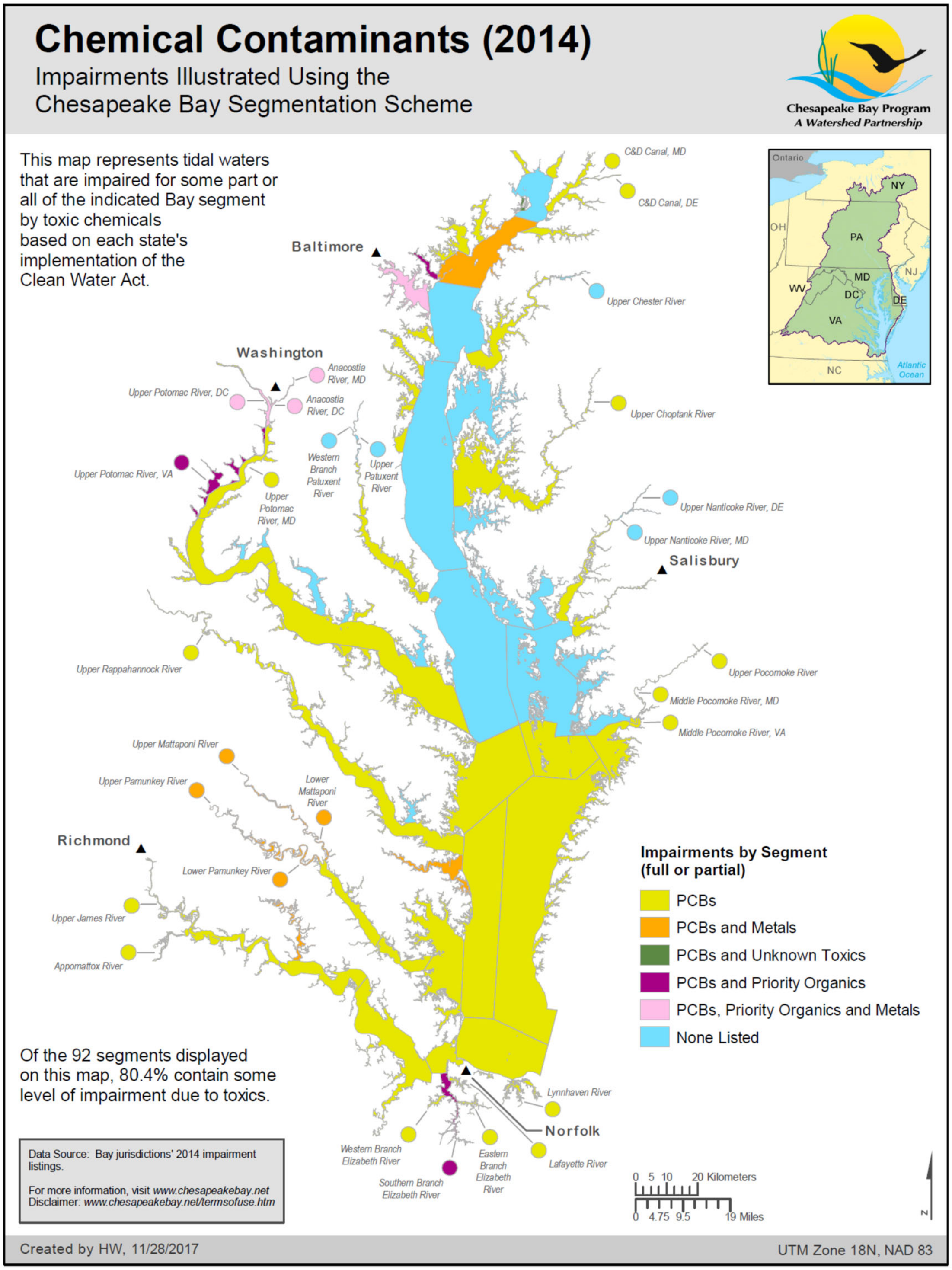

Figure 7. Chemical contaminants in the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

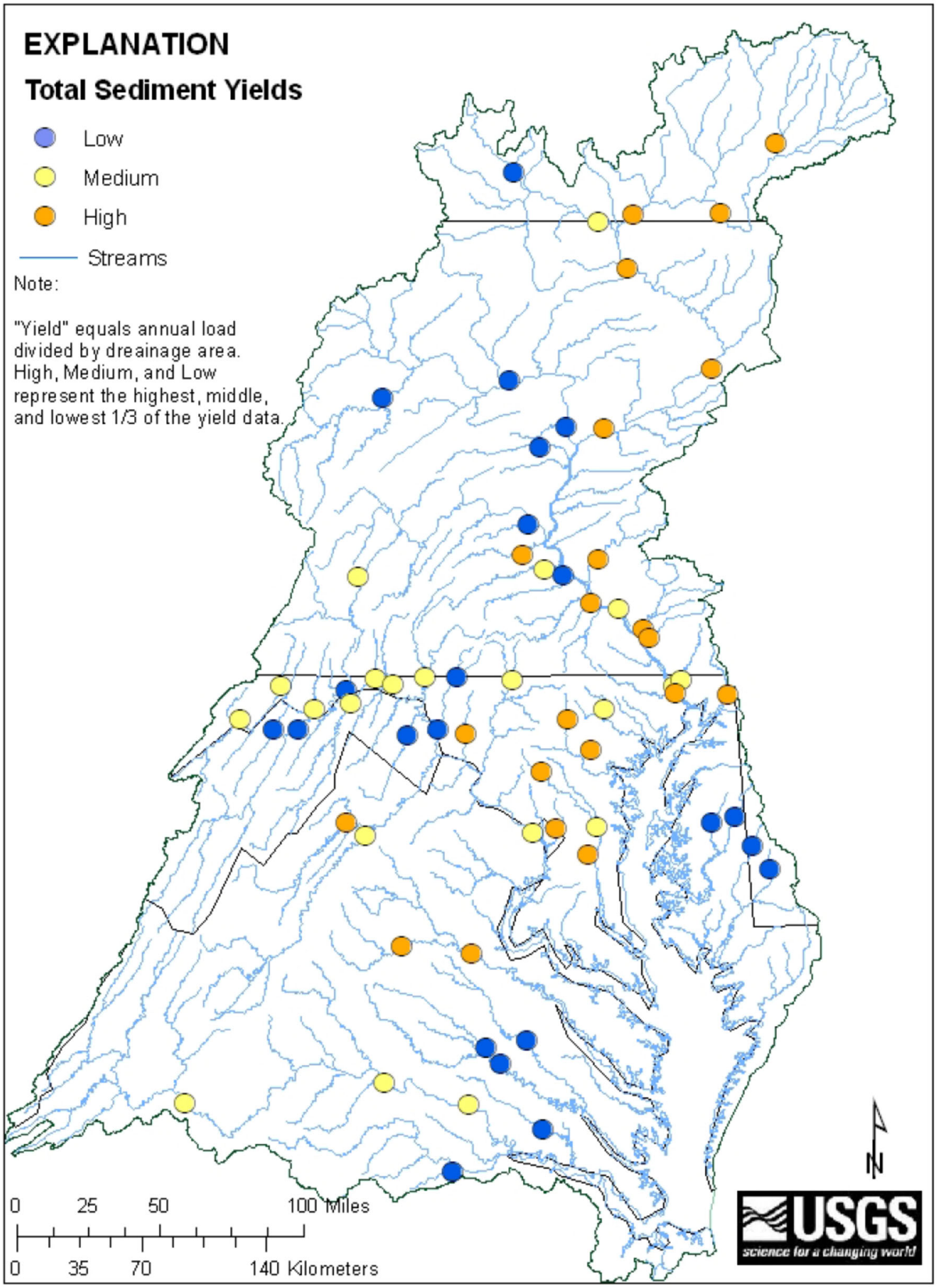

Figure 8. Sedimentation yields in the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

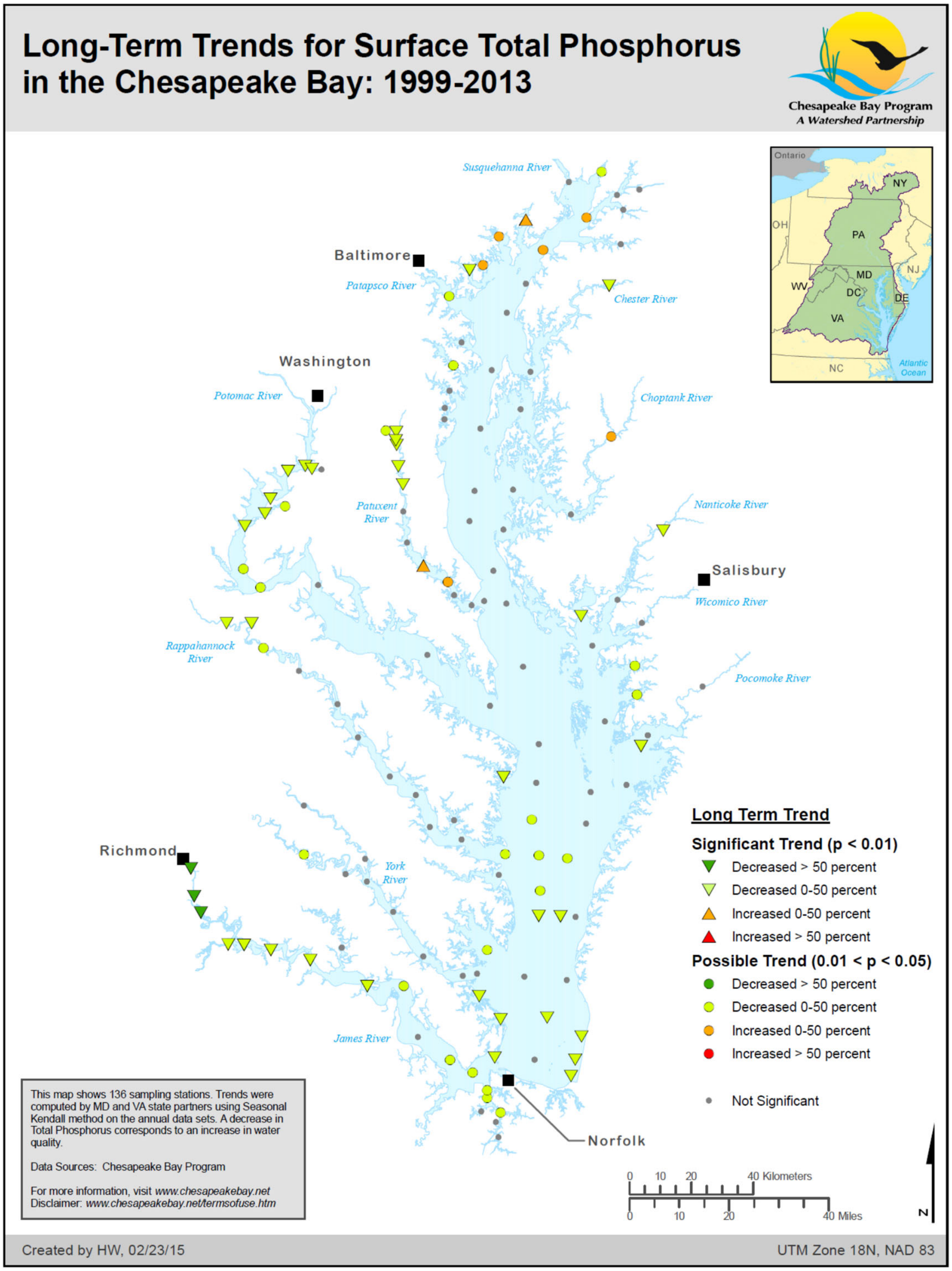

Figure 9. Total phosphorus yields in the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

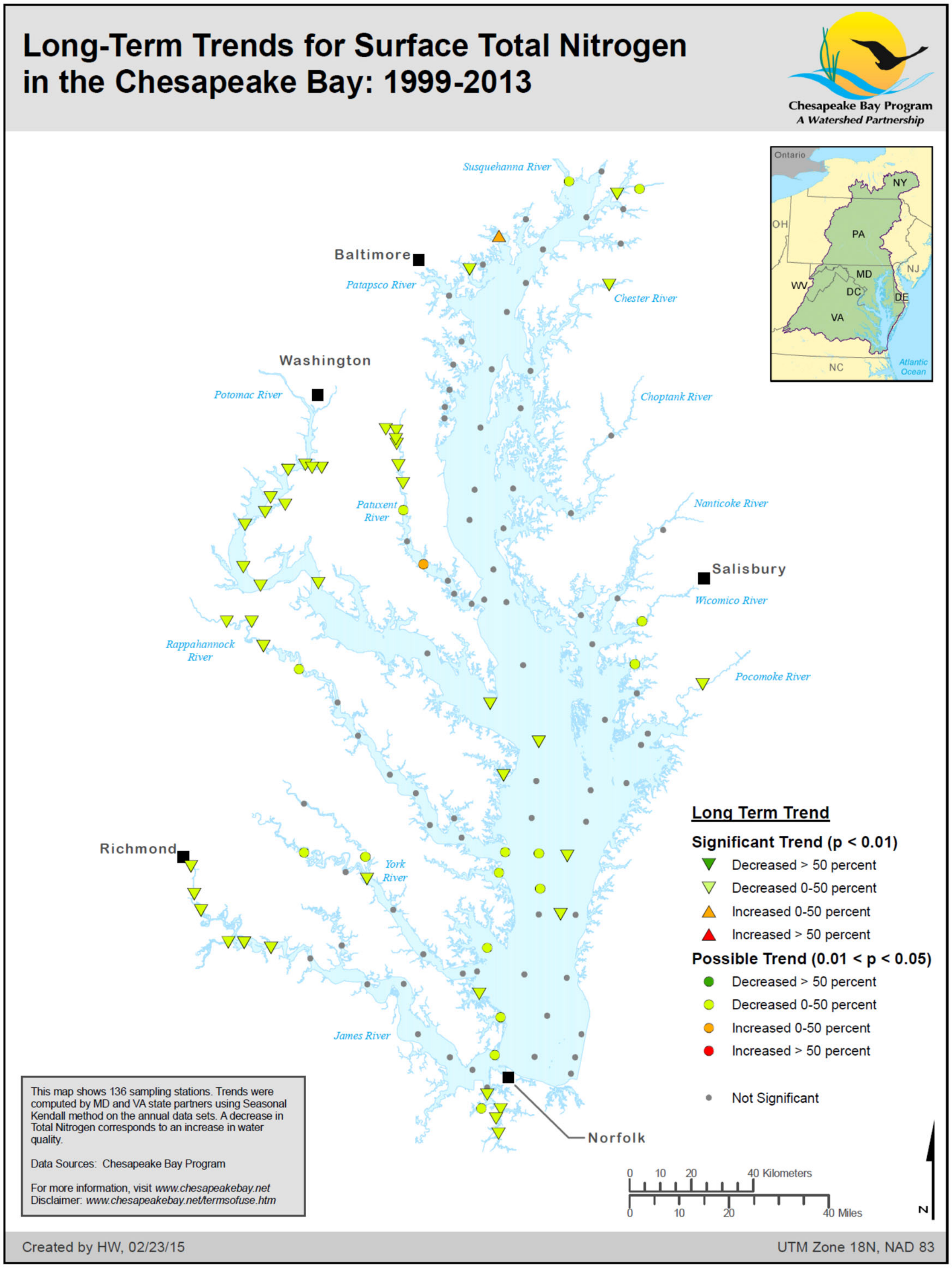

Figure 10. Total nitrogen yields in the Chesapeake Bay watershed (Source: Chesapeake Bay Program)

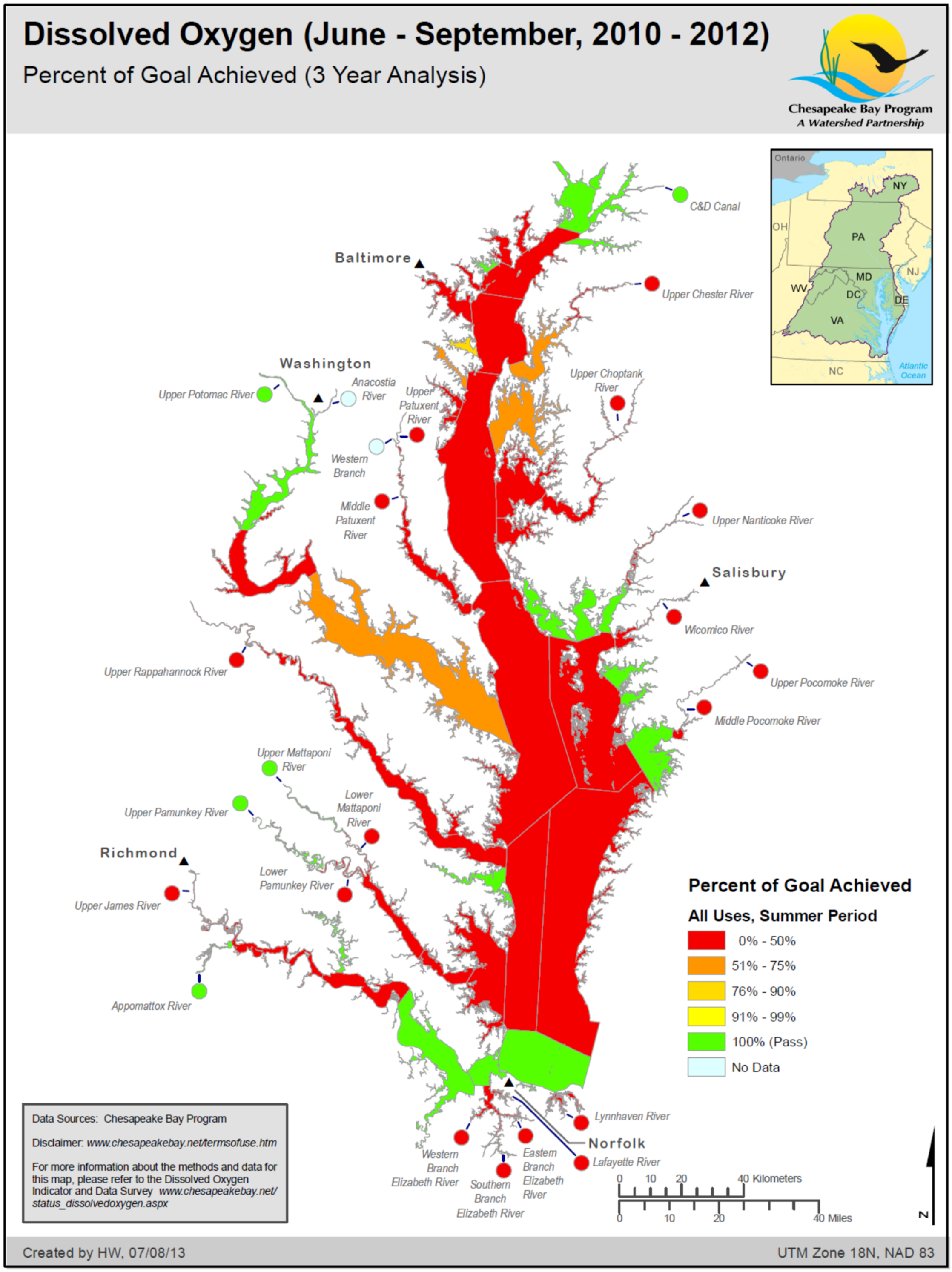

Figure 11. Dissolved oxygen in the Chesapeake Bay watershed. (Source: Chesapeake Bay Program)

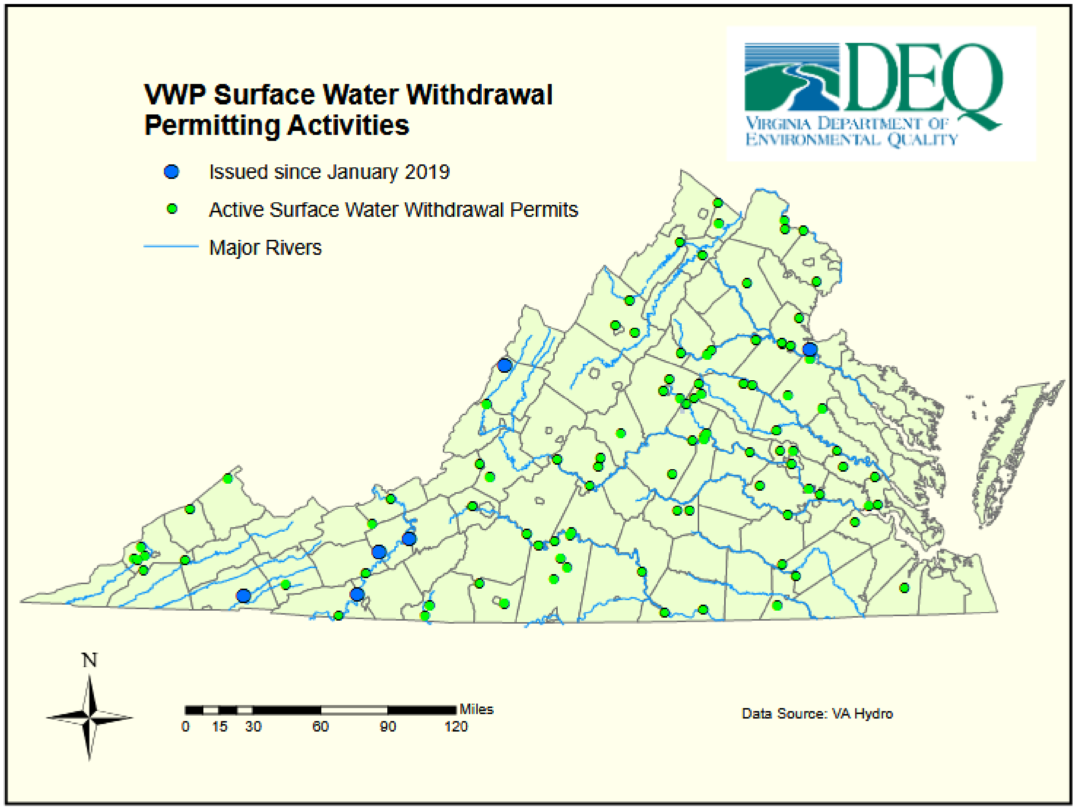

Figure 12. Surface water withdrawal permitting activities. Source: VDEQ (2020: fig. 4).

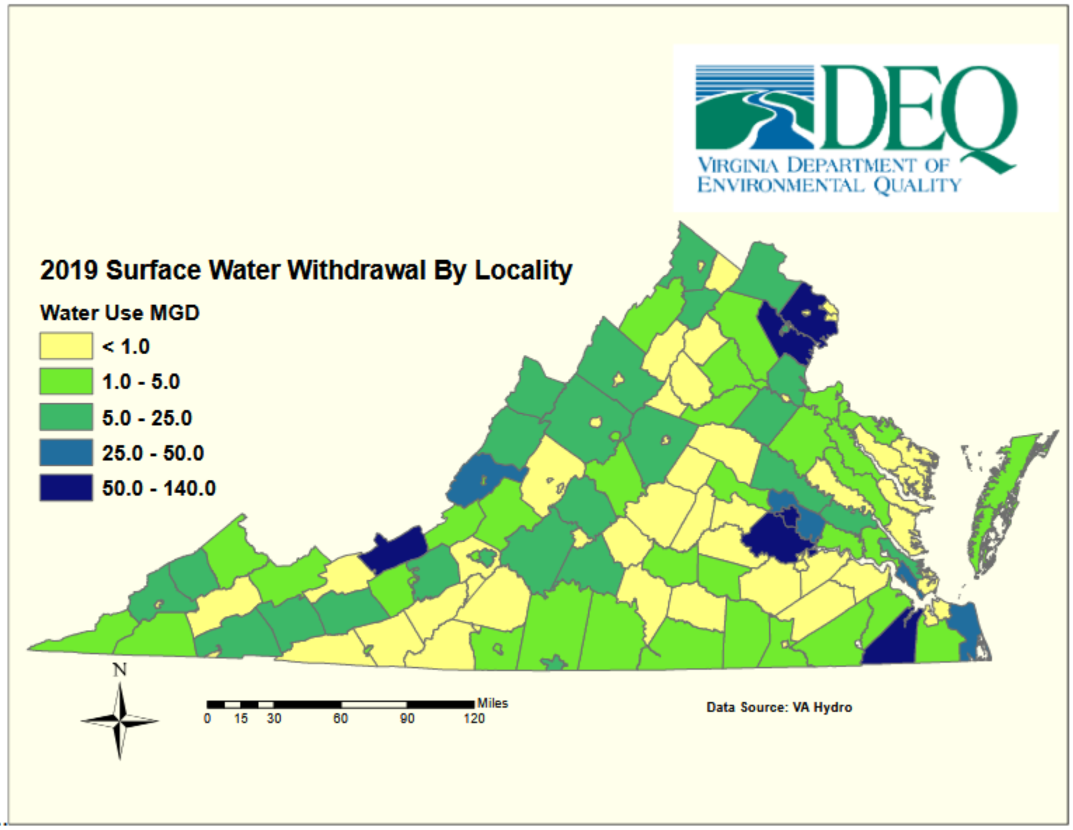

Figure 13. Surface water withdrawals. Source: VDEQ (2020: fig. 8).

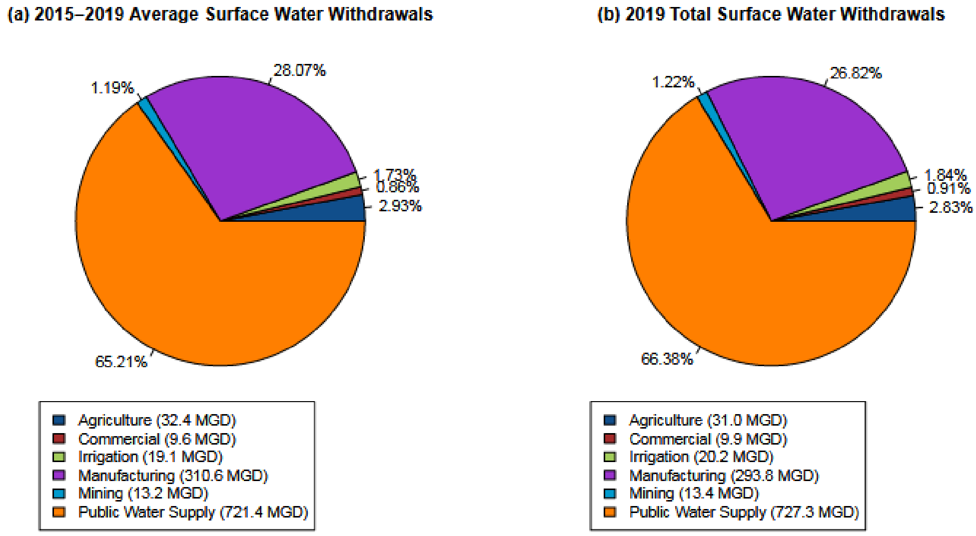

Figure 14. Surface water withdrawals by type. Source: VDEQ (2020: fig. 11).

Shad and River Herring Technical Committee Report: Recommendations for Evaluating Bycatch Removals in Directed Mixed-stock Fisheries in State Waters

October 2021

1 INTRODUCTION

The American Shad 2020 Benchmark Stock Assessment and Peer Review Report was accepted for management use in August 2020. The assessment found that American shad remain depleted on a coastwide basis, likely due to multiple factors, such as fishing mortality, inadequate fish passage at dams, predation, pollution, habitat degradation, and climate change. One of the priority research recommendations identified in the stock assessment and highlighted by the Technical Committee (TC) was to "conduct annual stock composition sampling through existing and new observer programs from all mixed-stock fisheries (bycatch and directed). Potential methods include tagging (conventional external tags or acoustic tags) of discarded catch and genetic sampling of retained and discarded catch. Mortality rates of juvenile fish in all systems remain unknown and improvement in advice from future stock assessments is not possible without this monitoring. Known fisheries include the Delaware Bay mixed-stock fishery and all fisheries operating in the Atlantic Ocean (U.S. and Canada) that encounter American shad (see Section 4.1.4 in the stock assessment report)."

To address this recommendation, the TC recommended that the Board task them to consider methods that could be used to understand and reduce impacts of mixed-stock catch on stocks outside the area where directed catch occurs. Therefore, at the February 2021 meeting the Board tasked the TC with "developing methods to evaluate bycatch removals in directed mixed-stock fisheries in state waters in order to understand and reduce impacts to stocks outside the area where directed catch occurs." The TC formed a task group to focus on this work. The task group produced the following report, and recommendations were developed by the full TC.

2 IDENTIFICATION OF MIXED-STOCK SHAD FISHERIES AND AVAILABLE DATA

After initial discussions, the task group requested that the full TC submit any data that could be used to identify where mixed stock shad fisheries may be taking place in state waters as well as data that might be useful in evaluating the impacts of these mixed stock fisheries on the individual stocks being harvested. The task group received a number of fishery dependent and independent data sets including data from tagging studies, by-catch genetic analysis, commercial landings, and long-term general abundance surveys (Table 1). The tagging studies and genetic analysis provided proved useful for identifying mixed stock shad fisheries within the Delaware Bay and Winyah Bay. Given the quantity of relevant data available from the Delaware Bay, this system was used as a test case for developing methods to evaluate the potential impacts of mixed stock harvest on individual stocks which could be applied to the other mixed stock fisheries that were identified.

The table below details the data sets submitted to the task group and used to identify or rule out potential mixed stock fisheries along the coast. From these submitted data, the task group was ultimately able to identify mixed stock fisheries in the Delaware Bay and Winyah Bay systems. These data were used to explore the potential effects of mixed stock fisheries on out of basin stocks and identify management strategies that may be useful for limiting these potential effects.

Table 1. Available Data Pertaining to Mixed-stock Shad Catch on the Atlantic Coast

Data Set	*System*	*Time Series*
New Jersey Adult Shad Tagging Survey	Delaware Bay	1995-2019
New Jersey Commercial Landings Reports	Delaware Bay	1980-2019
Delaware Commercial Landings Reports	Delaware Bay	1980-2019
Waldmen et al., Genetic Study, 2014	Delaware Bay	2009-2010
Bartron & Prasko, Genetic Study, 2021	Delaware Bay	2017-2019
Hudson River Adult Haul Seine Index	Hudson River	1988-2017
North Carolina, Acoustic Tagging Study	Albemarle Sound	2017-2018
South Carolina Adult Tagging Survey	Winyah Bay	2003-2005, 2010-2020
Maryland Adult Shad Tagging Survey	Susquehanna River	1987-2019

2.1 Mixed-stock bycatch in state waters

2.1.1 Delaware Bay

The shad fishery within the Delaware Bay is generally considered the most significant source of mixed stock harvest within states' waters. Commercial fisheries in the bay and upper estuary are carried out by fisherman from the states of New Jersey and Delaware. The New Jersey fishery is a directed gill net fishery, typically harvesting between 10,000 to 20,000 pounds of shad per year. The shad harvested in Delaware are typically caught as bycatch in the directed striped bass gill net fishery. Landings from Delaware fluctuate significantly, averaging around 16,000 pounds per year over the past decade, with larger yearly shad catches being seen when the fishermen switch to smaller mesh sizes when targeting smaller striped bass.

A variety of studies have been completed using both tag recapture data and DNA analysis to determine stock origin of American shad within the Delaware Bay. New Jersey's Bureau of Marine Fisheries has been tagging shad in the lower bay continually since 1995 with recapture data showing about 40% of American shad recaptures occurring within the Delaware Basin. The remaining 60% being reported from the ocean and within river systems spanning from the St. Lawrence River in the north and as far south at the Santee River in South Carolina with the Hudson River making up the largest proportion (17.5% - 34.4%) of out of basin recaptures. DNA analysis by Waldmen et al., 2014, found varying proportions of stock representation from the commercial harvest depending on the analysis method used with Delaware Basin fish representing between 24% and 53% of the harvest and Hudson River fish making up the largest proportion of out of basin harvest. A more recent study by M. Bartron and L. Prasko with the USFWS Northeast Fishery Center using similar methods to Waldmen et al., 2014, found similar varying proportions of Delaware Basin versus out of basin stock compositions. The Hudson River stock represented the largest proportion of out of basin fish in this study as well. As a result of these high proportions of out of basin American shad that are caught in the commercial fisheries in Delaware Bay, a Mixed Stock Fishery Benchmark has been implemented as part of the Sustainable Fishery Plan to minimize the impact of the Delaware Bay fishery on out of basin stocks.

2.1.2 Winyah Bay System, SC

The Winyah Bay System is made up of five main rivers and encompasses parts of North Carolina and South Carolina. Historically, American shad inhabited all of the Great Pee Dee River 280 kilometers (km) and had access to all main stem tributaries throughout the 22,258 km^2 watershed within South Carolina, including Little Pee Dee River (187 km), Lynches River (225 km), Black River (243 km), and Waccamaw River (225 km) in both South Carolina and North Carolina. The South Carolina commercial shad fishery is a directed gill net fishery, with the bulk of the catch occurring in the lower Pee Dee and Waccamaw Rivers. Landings fluctuate due to river discharge, but average around 24,000 – 35,000 pounds per year.

Since 2010, fishery-independent monitoring occurs annually in the lower Waccamaw River, prior sampling occurred on a rotational basis and included years 2003-2005. Sampling consists of using drift gill nets along a stretch of river in the Intra-coastal Waterway (ICW) where all captured shad are tagged with dart tags and released to estimate fishing mortality rates in this system. Tag return rates varied based on fishers' participation and with recent changes to regulations to demonstrate sustainability, have decreased significantly. Return rates during early years in the time series indicated a straying rate of ~25% (those returns from other rivers within the System). However, the majority of these occurred in the Great Pee River, a major high flow tributary river connected to the Waccamaw River and known spawning area for American shad. Therefore, tagging information alone cannot be used to distinguish stock composition.

Beginning in 2020 and continuing annually, fin clips were taken from captured shad in the lower portions of the Waccamaw and Great Pee Dee Rivers to better understand genetic mix stock composition of returning shad in the Winyah Bay System. In a similar effort as described above for Delaware Bay, results of genetic analysis for these samples should provide some missing information regarding number of stocks and composition of those stocks. If warranted, this information can then be used to update Sustainable Fishery Management Plans for the Winyah Bay System.

3 METHODS FOR EVALUATING BYCATCH REMOVALS IN DIRECTED MIXED-STOCK FISHERIES

The task group chose to take a tiered approach evaluating available data and potential methods for addressing this task, with the Delaware Bay mixed stock fishery serving as an example. Three tiers were developed based on (1) methods applicable with the quantity and quality of data currently available (first-tier), (2) methods applicable with data that could reasonably be collected without significant changes in near term data collection efforts (second-tier), and (3) advanced methods that would provide the most robust information but also would require significant changes in data collection efforts (third-tier). This tiered approach was used in order to allow the Board to consider several management approaches for addressing the effects of mixed stock fisheries while also considering the availability of information and associated timelines for each tier.

3.1 **First-Tier Methods**

The first-tier represents the evaluation method that can currently be undertaken given the quantity and quality of fishery dependent and independent data available from existing data collection efforts.

Relative F with static stock composition

Age data and mortality estimates for American shad have been collected and calculated relatively inconsistently in regards to the stocks associated with the mixed stock fisheries. As a result, modeling efforts using these data as applied to evaluating impacts of mixed stock fisheries on out of basin stocks have not yielded useful results.

Data that have been consistently collected over appreciable time series include commercial landings reports and fishery independent relative abundance indices which can be used to develop a relative fishing mortality (*F*). When evaluated in conjunction with stock composition data (e.g., tag recapture data, genetic data), it is possible to generate stock specific relative *F*s for American shad harvested in mixed stock fisheries.

The task group determined all required data are currently available to evaluate the impact of the commercial American shad fishery in the lower Delaware Bay on Hudson River stock American shad using this relative *F* method. Hudson River stock shad represent the largest proportion of out basin shad harvested in this fishery. For this method, the proportion of Hudson River shad in the Delaware Bay mixed stock fishery, (24.5% derived from tag recapture data), can be applied to the yearly total mixed stock landings to derive an estimate of Hudson River stock removals (average of 4,443 lbs per year, 2003-2019). The yearly Hudson River stock removals can then be divided by the yearly index value generated from the New York Hudson River Adult Shad Haul Seine Survey to generate a yearly and time series average relative *F*.

Hudson River stock proportions have also been generated for the Delaware Bay using genetic analysis in several studies with varying proportions that could be used to generate alternative total Hudson River stock removals and subsequent relative *F* estimates. The caveat to using the proportions of Hudson River stock generated with the genetic analyses is that these represent proportions based on 1 to 4 year snapshots versus the tagging data which yields an average proportion over the entire time series being analyzed. The relative *F* method explored here for the Delaware Bay mixed stock fishery could readily be applied to other known mixed stock fisheries where the appropriate data (commercial landings, FI relative abundance index, and stock proportions) are available.

Management Approaches

Options to address the impacts of mixed stock harvest on out of basin stocks, as evaluated using stock specific relative *F*s, include establishing a relative *F* benchmark and associated management triggers based on a time series when rates of harvest were deemed acceptable.

Alternatively, catch caps can be developed to keep the harvest of out of basin stocks of American shad to an acceptable level and/or area restrictions can be implemented to reduce or eliminate fishing effort within areas where mixed stock fisheries are known to occur.

Timing of Analysis

Data are available to support this analysis in the Delaware Bay mixed stock fishery immediately. These data are not immediately available for a similar analysis in the Winyah Bay system.

3.2 **Second-Tier Methods**

The second-tier includes a method that offers improvements to the first-tier method with minor changes to existing data collection efforts.

Relative F with time-varying stock composition

The relative *F* method with static stock composition assumptions informed by existing snapshot sampling described in the first-tier could be improved with increased frequency of stock composition monitoring. Uncertainty in estimates would decrease with increased frequency of sampling (e.g., annual sampling) due to interannual variation in stock composition driven by factors like spatial and temporal variation of fishing and abundance changes of stocks encountered.

Three high priority research recommendations focused on collection of stock composition data (storage infrastructure, population baseline data, and mixed stock data) were included in the 2020 stock assessment and would address current limited and opportunistic sampling that would support the first-tier method. These recommendations led to the development of an alosine genetic sample repository at the Leetown Research Laboratory of the United States Geological Survey Eastern Ecological Science Center (USGS EESC). This effort aims to collect tissues from spawning rivers to create population baselines. Probabilistic genetic analysis would be used to assign individuals from the mixed stock fisheries to their respective populations. Hence, it will be possible to partition bycatch into its component stocks and identify populations that are potentially more affected. Researchers at the USGS EESC are working in collaboration with researchers at Cornell University to develop a panel of single nucleotide polymorphisms (SNPs) for higher resolution stock assignment. The principal advantage of these markers over microsatellites is their repeatability and accuracy. The repository addresses infrastructure needs, improved population baseline data, and mixed stock data from fisheries occurring in federal oceanic mixed stock fisheries, but additional support is necessary to sample mixed stock fisheries in state waters including the Delaware Bay mixed stock fishery.

Management Approaches

Management approaches would be the same as for the first-tier method, but would informed by estimates with greater certainty.

Timing of Analysis

This method could be applicable after as little as one year of stock composition data sampling and analysis in the Delaware Bay fishery. Updated estimates could then be provided each year new stock composition data are collected. These data are not immediately available for a similar analysis in the Winyah Bay system.

3.3 **Third-Tier Methods**

Catch Impact Analysis

A catch impact analysis would use an adult equivalents model as described by Ianelli and Stram (2015). This analysis divides mixed stock fishery removals of potential spawners, both from the current fishing year and previous fishing years (i.e., removals of immature or repeat spawning fish from previous years), by the sum of bycatch removals and spawning escapement. This impact estimate ranges from zero to one, with zero indicating no impact from the fishery, one indicating complete removal of an annual spawning run by the fishery, and an increasing impact as the estimate increases from zero to one. A feature of these estimates that offers an improvement to the first- and second-tier methods is that they can be interpreted as absolute exploitation estimates as opposed to relative exploitation estimates. Absolute exploitation estimates can more readily be compared to biological reference points.

This method would quantify any mixed stock fishery impacts and, if generated in a time series, provide trends of these impacts through time. However, the method does not provide reference point estimates, requiring the need for ad hoc reference points developed through additional simulation analyses or other methods (e.g., per-recruit analyses) if used for management.

This method may be the better suited of the third-tier methods for stocks that are under moratorium or have very limited in-river removals, as removal data from established and directed fisheries improve utility of traditional stock assessment models like statistical catch-at-age models.

Data Requirements

Total Mixed Stock Fishery Removals

Total removals of shad by the mixed stock fishery are necessary, including both fish retained for harvest and fish discarded that die due to interaction with the fishery. Total discards, both discarded dead and released alive, and a discard mortality rate are needed to estimate total dead discards.

- Delaware Bay Mixed Stock Fishery: Total harvest data are reported for the Delaware Bay mixed stock fishery. Complete harvest data are available back to 2002 and incomplete data (NJ harvest only) are available back to 1985. Delaware harvest data prior to 2002 were reported without spatial information and would require assumptions to delineate into mixed stock harvest (lower bay) and harvest of the Delaware River stock only (upper bay). However, data limitations (see below) would preclude applying this method retrospectively to these earlier years. Anecdotal information indicates that discards of American shad in this fishery are negligible.

Biological sampling of mixed stock catch is necessary to determine the number of spawners that would have been repeat spawners had they not been removed by the fishery. This would require length, age, and repeat spawn mark sampling. If the mixed stock fishery encounters immature shad, maturity ogives would also be necessary.

- Delaware Bay Mixed Stock Fishery: Biological sampling data are not regularly collected from the Delaware Bay mixed stock fishery. It can be assumed the fishery is only encountering mature shad returning to spawn, precluding the need for maturity ogives. There were several research recommendations in the 2020 stock assessment to further evaluate error in spawn mark determinations which would help understand utility of these data for this type analysis.

Stock composition monitoring in the mixed stock fishery would also be required. Snapshot sampling (i.e., sampling less frequently than annual intervals) could be used. However, as with the relative *F* method, uncertainty in estimates would likely decrease with increased frequency of sampling due to interannual variation in stock composition driven by factors like spatial and temporal variation of fishing and abundance changes of stocks encountered.

- Delaware Bay Mixed Stock Fishery: There are stock composition estimates available for 2009-2010 (Waldman et al. 2014). There are additional, recent stock composition estimates from 2017-2020 (Bartron and Prasko 2021), but additional estimates (i.e., stock composition estimates across baseline groups for the lower Delaware Bay sampling region only) would be necessary to support a catch impact analysis. The USGS EESC alosine repository does provide a pathway for improved stock composition data, but, again, additional support is necessary to sample the Delaware Bay mixed stock fishery.

A study (or assumptions) is needed to determine migration patterns of the stocks impacted relative to the timing of the mixed stock fishery and spawning. If the mixed stock fishery occurs following the spawning run for a given stock, the fishery impacts the stock the following year and beyond (i.e., removal of potential repeat spawners). If the mixed stock fishery occurs prior to the spawning run, the fishery impacts the stock in the same year and beyond.

- Delaware Bay Mixed Stock Fishery: Based on the timing of this fishery and concurrent sampling by a fishery-independent survey that encounters unripe fish, it can be assumed that all fishing occurs pre-spawn.

Spawning Escapement Counts

The analysis requires escapement count data (absolute abundance of fish as they return to their spawning grounds). Escapement counts could be observed counts at a choke point (e.g., fishway count) or extrapolations of relative abundance measured by a fishery-independent survey.

- Delaware Bay Mixed Stock Fishery: There are fishway counts for three stocks that account for at least 1% of the Delaware Bay mixed stock fishery, according to 2010 stock composition estimates (Waldman et al. 2014), that were considered reflective of interannual abundance changes during the 2020 stock assessment: the Essex Dam fishway count on the Merrimack River, the Holyoke Dam fishway count on the Connecticut River, and the Boshers Dam fishway count on the James River. Unfortunately, these are considered indicators of relative abundance, not absolute spawning escapement, because of their locations above some American shad spawning grounds and river flow impacts to fishway operation throughout the spawning season.

Marine Survival

Estimates of marine survival-at-age are needed to correctly account for removals of potential repeat spawners. Marine survival data are used to decrement removals of potential spawners in previous years that would have experienced mortality from other causes. Assumptions could be made in the analysis, but any information on marine survival and how it changes through time would reduce uncertainty of estimates.

- Delaware Bay Mixed Stock Fishery: These estimates remain a primary limitation in assessment of all American shad stocks. The 2020 stock assessment provides estimates of baseline natural mortality based on the life history of the species that could be used for this component of total mortality. Fishing mortality due ocean bycatch has not been quantified. Ocean bycatch has been declining in recent years and assumptions about this mortality may become less impactful if this declining trend continues, but current contribution to total mortality is unknown.

Statistical Catch-at-Age Model

Statistical catch-at-age models could be used to estimate fishing mortality and exploitation rates of fisheries that remove portions of the stock abundance, including mixed stock fisheries. Statistical catch-at-age models are forward-projecting, age-structured models that track total stock abundance and exploitation rates through time according to data collected on changes in abundance-at-age and fishery removals-at-age. Fishing mortality and exploitation rates could be compared to those of other fisheries (e.g., in-river, stock-specific fisheries) and reference points to determine bycatch fishery impacts. To estimate mixed stock catch impacts, these models would be applied to individual stocks. For example, a model would need to be applied to Hudson River stock data sets, including mixed stock fishery removals of Hudson-origin fish, to estimate mixed stock catch impacts to the Hudson River stock. Therefore, the stock of interest would need all data sets required for these models. These models were applied to two stocks in the 2020 stock assessment that were negligible components of the Delaware Bay mixed stock fishery, according to Waldman et al. (2014), but data limitations precluded application to other stocks. Reference points would likely need to be estimated with coupled per-recruit analyses. This method would be less applicable to stocks under moratorium, which are likely to remain in data limited situations and be at low abundances that are encountered with high variability by mixed stock fisheries.

Data Needs

These models would require similar data sets as the catch impact analysis, with a few exceptions discussed below.

Relative Abundance

Total escapement counts required for the catch impact analysis are not required for statistical catch-at-age model, as these are estimated with these models using relative abundance data.

- Delaware Bay Mixed Stock Fishery: Relative abundance data are available for many of the stocks occurring in the Delaware Bay mixed stock fishery (see tables 13-20 in the 2020 stock assessment).

Total Fishery Removals

This method also requires total removals along with age composition data from biological sampling for all fisheries, whereas the catch impact analysis is still applicable if data from some removal sources (e.g., ocean bycatch) are unavailable.

- Delaware Bay Mixed Stock Fishery: As noted for the catch impact analysis, stock-specific ocean bycatch removals remain a major data limitation in assessment of American shad stocks. Recreational fishery removals are also a data limitation in some stocks impacted by the Delaware Bay mixed stock fishery inducing the Delaware River stock and Connecticut River stock.

Management Approaches

These methods could provide mixed stock catch impacts relative to established reference points, which could be used to trigger management responses (e.g., effort controls, catch reductions). However, this would not be real-time information and would only inform reactive management responses in subsequent fishing seasons.

Timing of Analyses

The catch impact analysis would be most applicable after at least a time series of data equal to the age structure in the population impacted by the fishery. This would be approximately nine and six years for mixed stock fisheries that remove all age classes and just mature age classes, respectively. Statistical catch-at-age models would require longer time series of data than the catch impact analysis that are dependent on contrast in the population over the time series. This analysis focused on the Delaware Bay mixed stock fishery, but the data requirements, timing of analyses, and management approaches would apply to the Winyah Bay system as well.

4 TECHNICAL COMMITTEE RECOMMENDATIONS

4.1 Recommended Path Forward

The TC reviewed the methods considered by the task group for evaluating bycatch removals in directed mixed-stock fisheries in state waters in order to understand and reduce impacts to stocks outside the area where directed catch occurs. Each tier was assessed based on the current data available and the required change in data collection efforts that would be necessary to successfully conduct each given method of analysis. The pros and cons of each tier were weighed with special attention being paid to increases in data sampling and analysis required to complete more robust analysis methods. The TC chose to prioritize considered methods based upon robustness of analysis used while also considering whether data requirements for each method could be practically achieved.

4.2 **Management Recommendations**

After considering all of the options available, the TC recommends the second-tier method be used for evaluating bycatch removals in directed mixed-stock fisheries. Based on these methods, the TC recommends management strategies also be developed to reduce impacts of out of basin harvest in these fisheries. This tier involves developing a Relative F index based on increased genetic sampling and/or tagging efforts which could potentially provide annual stock composition of mixed stock landings. This method is preferable to the current first-tier methods of applying a historical average to stock assignment based on past tagging and DNA studies as regular DNA analysis can account for yearly fluctuations in stock composition of the harvest. While the TC acknowledges that the third tier methods would provide the most robust analysis of mixed stock fishery impacts, the required increase in data collection and sampling efforts could not practically be completed by agencies involved in mixed stock fisheries without a significant increase in staff time and resources. The TC feels that the minor increase in sampling and analysis required under the recommended second-tier methods could easily be achieved and could provide a meaningful increase in assessment quality over the status quo (first-tier) methods.

Whether the Board agrees with the TC recommendation or prefers an alternative approach, the preferred method should be incorporated into the appropriate Sustainable Fishery Management Plans through the development of management strategies, benchmarks, and triggers for addressing the impacts of mixed-stock catch. The Delaware River Basin Fish and Wildlife Management Cooperative is currently in the process of updating the American Shad Sustainable Fishery Management Plan for 2022; if desired, this update could potentially include a new mixed-stock benchmark based on the methods evaluated by the TC and recommended by the Board.

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TOM O'CONNELL, EASTERN ECOLOGICAL SCIENCE CENTER DIRECTOR
PRESENTATION TO THE ASMFC SHAD & RIVER HERRING MANAGEMENT BOARD
OCTOBER 19, 2021

BACKGROUND

USGS is the primary science agency within the Department of Interior and uniquely positioned to deliver ASMFC the actionable science required by the Atlantic Coastal Fisheries Cooperative Management Act of 1993.

The Eastern Ecological Science Center (EESC) is aligning USGS investments with ASMFC management needs to produce actionable science. To that end, EESC has amplified its fisheries science support to ASMFC, USFWS, and NOAA Fisheries. In each of the past three years, the USGS Ecosystem Mission Area has provided $100,000 to EESC to conduct science in support of ASMFC-managed species. EESC has leveraged this funding into more than $2 million and over 20 research projects. The projects are developed in support of actionable science that covers a range of ASMFC species management and science needs.

The 2020 American Shad Benchmark Stock Assessment indicated coastwide populations are depleted. Restricted access to spawning habitat is significantly hindering recovery and may equate to a loss of more than a third of spawning adults. The 2017 River Herring Stock Assessment Update indicates coastwide populations remain depleted at near historic lows on a coastwide basis. However, total mortality estimates over the final three years of the data time series (2013-2015) are generally high and exceed region-specific reference points for some rivers. The "depleted" determinations were used instead of "overfished" because the impact of fishing cannot be separated from the impacts of all other factors responsible for changes in abundance.

EESC PROJECT HIGHLIGHTS FOR SHAD & RIVER HERRING

1. ALOSINE GENETIC STOCK IDENTIFICATION AND TISSUE REPOSITORY

Distinguishing among alosine populations is a critical component of ASMFC's Shad and River Herring Fishery Management Plan, which requires states to develop sustainable fishery management plans to maintain commercial and recreational fisheries. Sustainable fishery management plans must demonstrate that a stock can support a commercial and/or recreational fishery that will not diminish future stock reproduction and recruitment.

Alosines spend much of their life history in estuarine and marine environments, where they may form mixed stock aggregations and are captured as bycatch in other fisheries. An enhanced understanding of stock composition provides critical information on the status and trends of specific populations and offers insight into how offshore fisheries bycatch may be impacting recovery efforts.

EESC biologists are using genomic markers to build baseline information for American Shad (*Alosa sapidissima*) and expand existing data for Blueback Herring (*Alosa aestivalis*) and Alewife (*Alosa pseudoharengus*). The use of single-nucleotide polymorphisms (SNPs) will provide enhanced resolution of stock structure, greater repeatability, and cost savings when compared to previous genetic analyses using microsatellite markers.

EESC is seeking collaborators to assist with sample collection of American shad, blueback herring, and alewife throughout their ranges. If you have the opportunity to collect tissue samples and would like to support the project, please contact Dr. Miluska Olivera Hyde at mhyde@contractor.usgs.gov.
Primary Investigator: Dr. David Kazyak, dkazyak@usgs.gov

2. Passage Projects

Applied Research on Fish Lift Entrances for Alosines

EESC's Conte Anadromous Fish Research Laboratory in Turners Falls, Massachusetts has a unique fish passage research facility where biologists, hydraulic and civil engineers design and test fish passageways tailored to specific species and river systems. EESC scientists are improving fishway designs to increase the percentage of migrating alosines that are able to find passage, reduce the amount of time it takes for a fish to pass a fish ladder, and increase survival of upstream and downstream migration.
Primary Investigator: Dr. Kevin Mulligan, kmulligan@usgs.gov

Development of a novel D-cylinder fish ladder for multiple species including shad and river herring

Fish ladder designs have, for the most part, not been developed in many decades. Moreover, fish ladders that were installed on the Atlantic Coast tend to be ones that were designed for Pacific salmonids. On the Atlantic and Gulf Coasts, target species include alosines (shad and herring) as well as anguilliform swimmers (eel and lamprey) which have much different swimming capabilities and kinematics. The objective of this project is to develop a new fish ladder design that will pass a multitude of target species and incorporates contemporary knowledge of fish swimming performance and behavior, targeted for fish of the Atlantic Coast. The fishway experiments will be performed at the EESC Conte Research Laboratory located in Turners Falls, Massachusetts.
Primary Investigator: Kevin Mulligan, kmulligan@usgs.gov

Passage of Anadromous Shad and River Herring at Barriers

EESC is improving historic habitat access for alosines through better upstream and downstream fish passage. The project is focused on greater understanding of clupeid biology (primarily shad and river herring), including physiology, energetics, behavior, ecology, and life-history, and then relating these data to migratory movements and passage performance at barriers such as fishways, culverts, and tidegates. Statistical modeling methods are advanced that inform and serve as standards for passage evaluations, often forming the foundation for Federal Energy Regulatory Commission licensing requirements. These methods are now being applied to improve conservation of migratory fishes globally.
Primary Investigator: Dr. Ted Castro-Santos, tcastrosantos@usgs.gov

Development of an East Coast Fish Passage Structure Database

EESC biologists are integrating revised fishway data and standardized metrics into a geographic information system (GIS) database as well as the American Eel GIS Habitat Assessment Database. An online mapping tool for querying fishway data and metrics is under development.
Primary Investigator: Dr. Alex Haro, aharo@usgs.gov

3. Investigating Novel Hepatitis B Virus in River Herring

EESC scientists have responded to a technical assistance request by the New Jersey Department of Fish & Wildlife regarding evidence of a novel virus associated with alewife (*Alosa pseudoharangus*). This assistance led to the identification and complete genome sequencing of a novel hepatitis B-like virus collected from the Maurice River in New Jersey. Molecular diagnostic tools were developed to screen for this virus and next generation sequencing methods have been utilized to evaluate viral diversity. At present the involvement of this virus in overt alewife disease is not well understood. Similarly, the prevalence of this virus in alewife populations is unknown. This technical assistance research simply adds a viral pathogen to the list of disease agents that may be associated with alewife population health. This work established precedent virus biosurveillance in migratory alewife stocks.

Primary Investigator: Dr. Luke Iwanowicz, liwanowicz@usgs.gov