2015 Maryland FMP Report (June 2016)
Section 2. Alosines: a) Shad, and b) Herring

a) American shad (*Alosa sapidissima*) and hickory shad (*Alosa mediocris)*

The American shad juvenile index from the Maryland portion of the Chesapeake Bay reached a record high in 2015, indicating a successful spawn. The Potomac River American shad juvenile index was greater than all other system indices and was the highest index observed for this species since the inception of the juvenile survey in 1954. Adult American shad abundance continued to increase in 2015 in all monitored Chesapeake Bay tributaries, but still remains well below historic values. Hickory shad populations on both the Patuxent River and Choptank River were deemed self-sustaining in 2014. The stocking program shifted focus in 2015, conducting exploratory surveys on the Pocomoke River, Marshyhope Creek, Chester River, Sassafras River, Elk River, Northeast River, and the Patapsco River for baseline hickory shad data in order to determine restoration need.

Fishery Management Plans (FMPs)

The Atlantic States Marine Fisheries Commission (ASMFC) adopted the Interstate Fishery Management Plan for Shad and River Herring in 1985. In response, Chesapeake Bay jurisdictions implemented the Chesapeake Bay Alosid [*sic*] Management Plan (CB Alosine FMP) in 1989 to coordinate shad and river herring management among Chesapeake Bay jurisdictions. The CB Alosine FMP identified declining abundance, over-fishing, insufficient research and monitoring, and habitat loss as problems. The plan set guidelines to continue the American shad moratorium in Maryland and reduce exploitation rates in Virginia; remove stream blockages and reopen historic habitat; and continue stocking hatchery-raised fish. The CB Alosine FMP Amendment 1 (1998) continued the shad moratorium, initiated review of criteria to reopen a shad fishery, and initiated development of measurable restoration targets.

The ASMFC implemented Amendment 1 to the Interstate Fishery Management Plan for Shad & River Herring in 1999. The amendment mandated a 40% reduction in the American shad ocean intercept fishery by 2003 and a closure by 2005. In-river commercial fisheries were also limited; not to exceed a fishing mortality rate of 30% of the maximum spawning potential of an unfished population (F_{30}). Technical Addendum I (2000) made adjustments to state fishery independent and dependent monitoring programs, but did not affect Maryland's obligations. Addendum I (2002) clarified hatchery-rearing requirements for Alosa species. Amendment 3 (2010) was enacted by ASMFC in response to the continued lack of improvement in American shad abundance. Amendment 3 established an instantaneous total mortality (fishing and natural) benchmark of Z_{30}, refined the juvenile recruitment failure definition to be more conservative, mandated states to monitor bycatch and discards, and required states with commercial and/or recreational (excluding catch and release) American shad fisheries to have approved fishing and habitat sustainability plans. Potomac River Fisheries Commission (PRFC) submitted a sustainable fishery management plan for American shad in 2012. Habitat restoration plans were approved by ASMFC for Maryland, District of Columbia, and Virginia in 2014 and can be found on the ASMFC website (http://www.asmfc.org/species/shad-river-herring). The ASMFC has scheduled a stock assessment update for American shad for 2018.

The adequacy of the CB Alosine FMP, including Amendment 1, was evaluated in 2012 to determine if the strategies and actions provided an appropriate management framework for addressing management changes implemented by ASMFC. The plan review team (PRT) determined that the CB Alosine FMP's strategies and actions were adequate to meet ASMFC compliance requirements and Chesapeake Bay management goals. Following input from the Maryland Sport Fisheries Advisory Commission and the Tidal Fisheries Advisory Commission, the PRT recommended no changes to the CB Alosine FMP. However, if and when the stock has adequately recovered and a limited fishery is ready to be opened, an amendment will need to be developed.

In 2006, the National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Fisheries Ecosystem Advisory Panel adopted a Fisheries Ecosystem Plan for Chesapeake Bay. In 2009, Maryland Sea Grant facilitated development of Ecosystem-based Fisheries Management for Chesapeake Bay Alosine Background and Issue Briefs (American shad, hickory shad, alewife herring, and blueback herring; (http://www.mdsg.umd.edu/sites/default/files/files/EBFM-Alosines-Briefs.pdf) in cooperation with state, federal, and academic representatives. The issues section examined four stressor categories: habitat (migratory barriers, flow and water quality, land-use ecology, and physical alteration), food web (forage, competition, predation, freshwater ecology, and vectors of biological material), stock dynamics (stock assessment history, anthropogenic mortality, life history, connectivity, and stock structure), and socioeconomic (cultural, economic, and environmental considerations, restoration, and management guidelines).

Stock Status

American shad harvest in Maryland declined in the late 1950s and reached historic low levels in the mid-1970s where it has remained [1] (Figure 1). The Maryland Department of Natural Resources (MD DNR) population estimates for the Conowingo Dam tailrace indicate that American shad abundance increased from 1998 to 2001, decreased after 2001 through 2007, and has remained relatively stable at low levels with a slight increase in recent years.[1, 2] The 2015 American shad population estimate for the Susquehanna River below Conowingo Dam was 139,973

fish [1, 2] (Figure 2). Unlike the abundance trend, the number of American shad passed over Conowingo Dam at the East Fish Lift has declined in recent years. In 2015, 8,341 American shad passed through the east fish lift, the lowest recorded passage since 1989. [3]

American shad abundance in the Potomac River is measured using an index based on the number of pounds per pound net day. The Potomac River restoration target is 31.1 lbs.; the mean commercial pound net landings during the 1950s. Abundance has steadily increased since 2000 and has exceeded the restoration target since 2011 (Figure 2; E. Cosby, PRFC, pers. comm.).

Abundance of wild (non-hatchery reared) and repeat (spawned in previous years) spawning American shad varies among river systems. Approximately 60% of American shad in the Conowingo Dam tailrace were of wild stock during 2015. Sixty-four percent of male and 68% of female American shad in the Potomac River were repeat spawners in 2015.[2] In the Choptank River, adult American shad are not frequently encountered by monitoring surveys and 92% of juveniles in 2014 were hatchery reared. Since there is evidence of natural reproduction in the Choptank River, the restoration program has expanded sampling in order to locate where staging and spawning occurs. [4]

Hickory shad populations in the Patuxent and Choptank rivers were determined to be self-sustaining in 2014 after 11 and 18 years, respectively, of stocking efforts. The proportion of wild, spawning adult hickory shad in the Patuxent River has been ≥ 80% in 8 of the last 10 years and was 91% in 2014.[5] The proportion of wild, spawning adult hickory shad in Choptank River from 2001 - 2013 has varied between 29% - 85%. In 2014, 74% of spawning adults were wild.[5] A stable population of spawning adult hickory shad has been present in the lower Susquehanna River since 1996[5] without any stocking. Sixty-one percent of female and 57% of male hickory shad in Deer Creek were repeat spawners during 2015.[1]

Current Management Measures

Harvest of American shad from the Chesapeake Bay has been prohibited by Maryland since 1980, by PRFC since 1982, and by Virginia since 1994. Maryland allows commercial fishermen a 2 fish per day bycatch of dead American shad for personal use. No sale of American shad bycatch is allowed in Maryland. Virginia maintains an American shad bycatch permit for the gillnet fishery. Bycatch permit holders are allowed up to 10 fish per vessel from permitted areas as long as a greater number of spot, croaker, bluefish, catfish, striped bass, or white perch are landed. PRFC allows a 2% bycatch of American shad by volume of the total catch, with a 2 bushel per day limit per licensed fishermen. Pennsylvania and New York also prohibit harvest of American shad in the Susquehanna River basin. All Atlantic coast states closed their American shad ocean intercept fisheries in 2005.

Maryland enacted a hickory shad moratorium in 1981. Virginia prohibited hickory shad harvest in 1994. The District of Columbia and PRFC prohibited hickory shad harvest in 1992 and 1995, respectively.

The National Marine Fisheries Service (NMFS) enacted the New England Fishery Management Council's (NEFMC) Amendment 5 to the Atlantic Herring FMP in 2014.[6] Amendment 5's objectives to improve monitoring and minimize bycatch of river herring catch are anticipated to also reduce at-sea mortality of shad.[6]

The Mid-Atlantic Fishery Management Council (MAFMC) adopted Amendment 14 (2014) to the Atlantic Mackerel, Squid, and Butterfish FMP to improve monitoring of these fisheries and to limit shad mortality in the Atlantic mackerel fishery. The MAFMC approved an incidental shad and river herring catch cap of 196,211 pounds for the Atlantic mackerel fishery for 2015.[7] The shad and river herring estimated incidental catch from the Atlantic mackerel fishery for 2015 was 28,373 pounds, combined, and comprised 14.46% of the incidental catch cap.[7] The shad and river herring incidental catch cap was set at 180,779 pounds for the 2016 Atlantic mackerel fishery. [7]

The National Marine Fisheries Service (NMFS) did not approve all measures in Amendment 14. An increase in observer coverage was disapproved.[8] The MAFMC and NEFMC hope to address the need for increased observer coverage in the Omnibus Industry-Funded Monitoring Amendment currently in development. NMFS has the final decision on what management recommendations will be adopted for fisheries in federal waters. The MAFMC has begun the process of re-assessing whether it is necessary to include shad and river herring as stocks in the Atlantic Mackerel, Squid, and Butterfish FMP. The current timeline requires a decision by October 2016.

The Fisheries

In Maryland, commercial bycatch mostly occurs during the spring pound net fishery. Pound nets are found in tributaries and the upper Chesapeake Bay.[1] Bycatch is limited to 2 dead American shad for personal use per day.

The Marine Recreational Information Program (formerly Marine Recreational Fisheries Statistics Survey, MRFSS) stopped collection of American shad and hickory shad recreational data in 2009. Recreational catch and release fisheries for American and hickory shad occur in the tailrace below Conowingo Dam. Catch and release fisheries – primarily hickory shad – also occur in Deer Creek and Octoraro Creek, tributaries to the lower Susquehanna River. Maryland DNR conducts a voluntary angler logbook survey and an annual creel survey of shoreline anglers along the Conowingo Dam tailrace.[2] Beginning in 2014, anglers can participate in

the logbook survey online through MD DNR's website (http://dnrweb.dnr.state.md.us/fisheries/surveys/login.asp). Data from the American shad logbook and angler surveys indicate a decrease in catch rate since 2000 (Figure 3).[1, 2] The trend mirrors the catch rate trend of the MD DNR tagging survey (Figure 3). An active catch and release recreational fishery for both shad species also occurs in the Potomac, Patuxent, and Choptank rivers.[4] Current shad release mortality in the recreational fishery is unknown. In 1998, catch and release mortality of 309 American shad at the Conowingo Dam tailrace was calculated to be 0.97%.[9] Mortality from the current recreational fishery is believed to be negligible.[1]

Issues/Concerns

Conowingo Dam is the most significant remaining blockage to American shad migrating up the Susquehanna River in Maryland even though there is a fish lift. Although American shad are captured in the lift, hickory shad have rarely been documented using the fish lift.[1, 3] Relicensing for the Conowingo hydroelectric project continues to be reviewed by the Federal Energy Regulatory Commission.[1] One of the primary issues of the relicensing process is effective fish passage at the dam. Exelon, the company that owns the dam, has agreed to improve fish passage. The specifics of the improvements are expected to be finalized when a new license is issued, possibly in 2018. It will then take several years to implement the fish passage improvements.

Comparisons between scale age and a fish's known age revealed a notable amount of bias and error.[10] Percent agreement among 13 biologists varied between 50% and 77%. Ageing accuracy was greatest for shad ages 3-6 (34% - 49%) but decreased significantly for age 7 fish (12%) and age 8 fish (4%). Otolith sampling is not a feasible option because of the depressed stock status. The accuracy of using scales to determine repeat spawning remains problematic.[10]

The effect of multiple mortality sources such as ocean bycatch, dam turbines, pollution, and predation on shad abundance is unknown. Additional data are required to estimate natural, anthropogenic, and fishery mortalities to develop appropriate biological benchmarks.

Currently, Maryland does not monitor commercial bycatch and discard of American shad as specified in ASMFC Amendment 3. Although the Maryland commercial finfish reporting forms have a designation for discards/bycatch, fishermen are not required to report bycatch or discards.

Figure 1. Time series of commercial landings of American shad, 1950-2014 in Maryland and Virginia.[11]

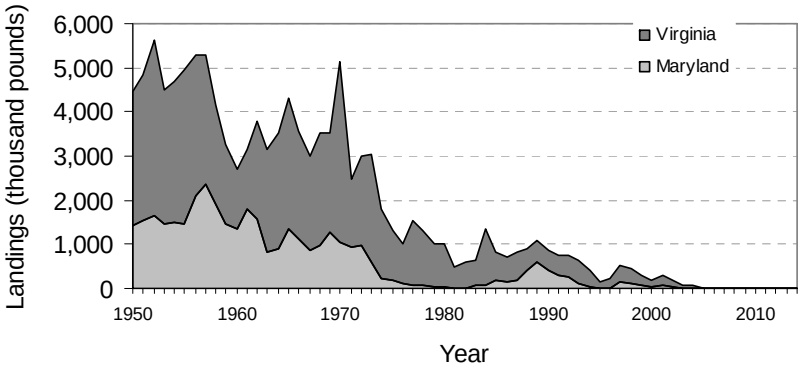


Figure 2. American shad passed at Conowingo Dam's east fish lift (1997-2015).[2] **American shad population estimate for the Conowingo Dam tailrace (1986-2015).**[3] **and the status of American shad restoration in the Potomac River (2000-2015; E. Cosby, PRFC, pers. comm.).**

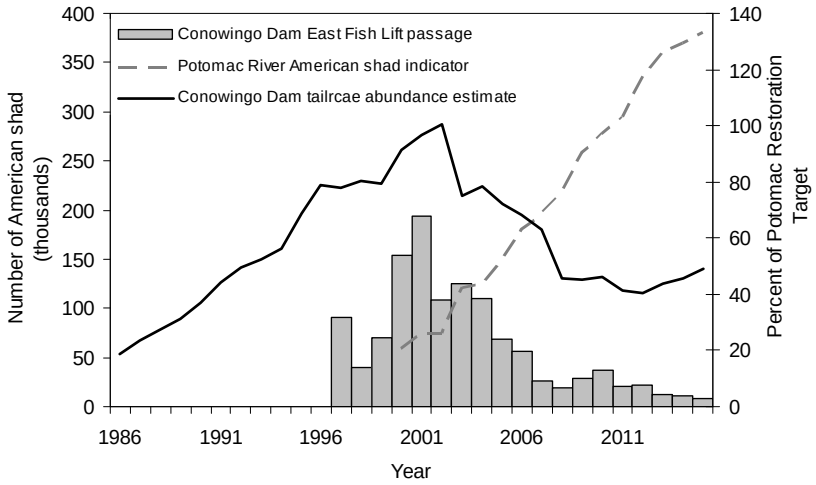
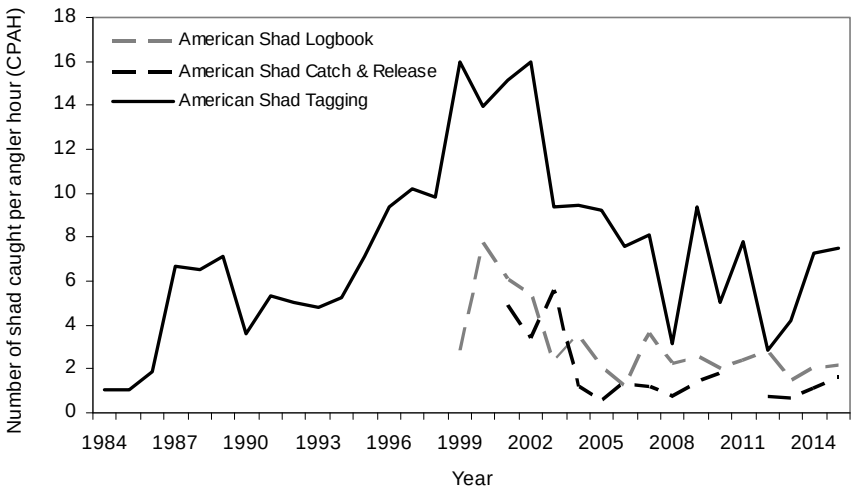


Figure 3. Average catch per angler hour from the MD DNR tagging study (1984-2015), the recreational angler logbook survey for American shad (1999-2014), and American shad catch and release fishery below Conowingo Dam (2001-2014, no data for 2011).[3]



References

[1] Lipkey, G. K. 2014. Maryland's 2015 compliance report: American shad (*Alosa sapidissima*) hickory shad (*Alosa mediocris*) alewife herring (*Alosa pseudoharengus*) blueback herring (*Alosa aestivalis*). Maryland Department of Natural Resources, Annapolis, Maryland.

[2] Maryland Department of Natural Resources. 2016. Chesapeake Bay Finfish Habitat Investigations. US FWS Federal Aid Project F-61-R-9 2012 – 2015. Maryland Department of Natural Resources, Annapolis, Maryland.

[3] Pennsylvania Fish and Boat Commission. 2014. Susquehanna River American shad. http://www.fish.state.pa.us/shad_susq.htm

[4] Stence, C. P., M. W. Baldwin, and M. Bowermaster. 2016. American shad restoration in three Maryland rivers. US FWS Federal Aid Project F-57-R Segment 16 Progress Report. Maryland Department of Natural Resources, Annapolis, Maryland.

[5] Stence, C. P., M. W. Baldwin, and M. Bowermaster. 2015. Hickory shad restoration in three Maryland rivers. US FWS Federal Aid Project F-57-R Segment 16 Progress Report. Maryland Department of Natural Resources, Annapolis, Maryland.

[6] Federal Register 79(30) February 13, 2014 Rules and Regulations. Final Rule. Fisheries of the Northeastern United States; Atlantic Herring Fishery; Amendment 5.

[7] Personal communication from the National Marine Fisheries Service, Greater Atlantic Region Fisheries Office. Northeast Region Quota Monitoring Report. July 2, 2015. http://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/reports_frame.htm

[8] Federal Register 79(36) February 24, 2014. Rules and Regulations. Final Rule. Fisheries of the Northeastern United States; Atlantic Mackerel, Squid and Butterfish Fisheries; Amendment 14.

[9] Lukacovic, R. 1998. Mortality of American shad caught and released by anglers below Conowingo Dam. Maryland Department of Natural Resources, Fisheries Service. Fisheries Technical Report Series, Number 21.

[10] McBride, R. S., M. L. Hendricks, and J. E. Olney. 2005. Testing the validity of Cating's (1953) method for age determination of American shad using scales. Fisheries, 30:10, 10-18.

[11] Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division. http://www.st.nmfs.noaa.gov/index

b) Alewife herring *(Alosa pseudoharengus)* and blueback herring *(Alosa aestivalis)*

Maryland's river herring spring spawning runs in the upper bay region have shown an increasing trend since 2013. In previous assessments, scientists have identified the need for a standardized approach to data collection for river herring. This need was addressed at the River Herring Data Collection Standardization Workshop held in 2015: a joint effort of the National Marine Fisheries Service (NMFS) and the Atlantic States Marine Fisheries Commission (ASMFC). The workshop report makes short term and long term recommendations for current and future river herring surveys (http://www.asmfc.org/uploads/file/56fc3c6dRH_DataCollectionStandardizaitionWorkshopSummary_March2016.pdf). In 2015, the NMFS and the ASMFC also published a coastwide conservation plan for river herring that utilizes input from experts throughout the range of the species, collectively called the River Herring Technical Expert Working Group (TEWG), on the NMFS website (http://www.greateratlantic.fisheries.noaa.gov/protected/riverherring/conserv/index.html).

Fishery Management Plans (FMPs)

ASMFC adopted the Interstate Fishery Management Plan for Shad and River Herring in 1985. In 1989, Chesapeake Bay States implemented the Chesapeake Bay Alosid [*sic*] Management Plan (CB Alosine FMP) to coordinate shad and river herring management. The CB Alosine FMP identified declining abundance, over-fishing, insufficient research and monitoring, and habitat loss as problems. The plan set guidelines to reduce river herring fishing mortality and remove impediments to access of historic habitat.

The ASMFC enacted Amendment 2 (2009) to address coastwide declines in alewife and blueback herring stocks and address the lack of fishery-dependent and independent monitoring for these species. Amendment 2 required states to have an ASMFC approved river herring sustainability plan by 2012 or close their river herring fisheries. Sustainability plans require development of a river herring juvenile index, a monitoring plan for spawning adults, and collection of commercial and recreational fisheries statistics including bycatch data. Maryland closed its river herring fisheries due to a decline and persistently low levels of river herring in Maryland. As required by ASMFC, Maryland submits an annual compliance report.

In 2006, the National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Fisheries Ecosystem Advisory Panel adopted a Fisheries Ecosystem Plan for Chesapeake Bay. In 2009, Maryland Sea Grant facilitated development of an Ecosystem-based Fisheries Management for Chesapeake Bay Alosine Background and Issue Briefs (American shad, hickory shad, alewife herring, and blueback herring) in cooperation with state, federal, and academic representatives (http://www.mdsg.umd.edu/sites/default/files/files/EBFM-Alosines-Briefs.pdf). The issue section examined four stressor categories: habitat (migratory barriers, flow and water quality, land-use ecology, and physical alteration), food web (forage, competition, predation, freshwater ecology, and vectors of biological material), stock dynamics (stock assessment history, anthropogenic mortality, life history, connectivity, and stock structure), and socioeconomic (cultural, economic, and environmental considerations, restoration, and management guidelines).
The NMFS and the ASMFC coastwide conservation plan (2015) is intended to be a dynamic web-based plan that can be easily updated and has the following goals: identify key research needs for assessment and conservation, increase coordination of river herring research and conservation, identify funding sources for river herring research and conservation, identify conservation actions to address threats, cultivate research groups to address key topics, improve information to be used in the next assessment, improve information used in conservation efforts, further conservation efforts to address threats, and increase outreach about river herring.

Stock Status

The ASMFC's 2012 river herring stock assessment determined that alewife and blueback herring populations are depleted coastwide.[1] Furthermore, mean age and maximum length have decreased in some systems. The next ASMFC river herring stock assessment update is scheduled for 2017.

Maryland Department of Natural Resources (MD DNR) conducted the third year of a fishery independent river herring gill net survey in the North East River, developed to assess the spawning stock of alewife and blueback in the upper bay region. In 2015, 1,200 river herring were sampled, an increase from the 722 encountered in 2014.[2] Forty-six percent of alewife herring were repeat spawners and 30% of blueback herring were repeat spawners in 2015. The total instantaneous mortality was 1.3 for alewife and 1.7 for blueback.[2] Seine surveys are used to calculate juvenile abundance indices (JAI) which have varied without trend since 1980.[2,3] The JAIs for alewife and blueback herring were above average in 2015 for the Chesapeake Bay region.[2]

Current Management Measures

Maryland, Virginia, and the Potomac River Fisheries Commission instituted a recreational and commercial river herring moratorium, January 1, 2012. All river herring and river herring products imported into Maryland must include a bill of sale from a state with an approved river herring fishery [3] (Maine, New Hampshire, New York, North Carolina, and South Carolina).

The NMFS enacted the New England Fishery Management Council's (NEFMC)

Amendment 5 to the Atlantic Herring FMP in 2014.[4] Amendment 5's objectives to improve monitoring and minimize bycatch of river herring catch are anticipated to also reduce at-sea mortality of shad.[4]

The MAFMC adopted Amendment 14 (2014) to the Atlantic Mackerel, Squid, and Butterfish FMP to improve monitoring of these fisheries and limit shad and river herring mortality in the Atlantic mackerel fishery. The MAFMC approved an incidental shad and river herring catch cap of 196,211 pounds for the Atlantic mackerel fishery for 2015. The shad and river herring estimated incidental catch from the Atlantic mackerel fishery for 2015 was 28,373 pounds: 14.46% of the incidental catch cap.[5] The shad and river herring incidental catch cap was set at 180,779 pounds for the 2016 Atlantic mackerel fishery.[5]

The NMFS did not approve all measures in Amendment 14. An increase in observer coverage was disapproved.[6] The MAFMC and NEFMC hope to address the need for increased observer coverage in the Omnibus Industry-Funded Monitoring Amendment currently in development. NMFS has the final decision on what management recommendations will be adopted for fisheries in federal waters. The MAFMC has begun the process of re-assessing whether it is necessary to include shad and river herring as stocks in the Atlantic Mackerel, Squid, and Butterfish FMP. The current timeline requires a decision by October 2016.

The Fisheries

Alewife and blueback herring recreational fishery data have not been available from the Marine Recreational Information Program since 2009. All commercial and recreational river herring fisheries in Maryland are under a moratorium. No river herring were reported landed by commercial harvesters in 2015.[3] When the fishery was open, commercial landings of river herring appeared to cycle from high to low approximately every 20 years (Figure 1). During that time, a decreasing trend in landings was evident. Commercial river herring landings were in decline around the mid-1900s and declined precipitously after 1968 (Figure 1). River herring landings have failed to rebound since 1976. Recreational catch and release angling is allowed. Limited data is available, but this recreational fishery is believed to be minimal.[3] Maryland DNR has monitored alewife and blueback herring from the Nanticoke River and other portions of Chesapeake Bay since 1980, and began monitoring the North East River spawning run in 2013.

Issues/Concerns

In 2013 a river herring ageing workshop[7] took place to compare age estimates and methodologies among Atlantic coast states. River herring age is determined from scales using the same methodology as for American shad (previously discussed), although some states also use otoliths for age determination. River herring of known age were not available to determine the accuracy of age estimates: obtaining accurate ageing is an imperative data gap. The workshop determined that age estimates of a fish tended to differ between labs, presumably due to different sample preparation and ageing methodologies. Otoliths were often aged younger than scales for young fish and aged older than scales for older fish. The extent of bias was affected by reader experience, species (alewife versus blueback), river system, and environmental conditions. Standardization of ageing methods and validation of scale ages are needed. At the Data Collection Standardization Workshop held in November 2015, it was recommended that paired otolith and scale samples should be collected from all fish sacrificed for biological sampling. [8]

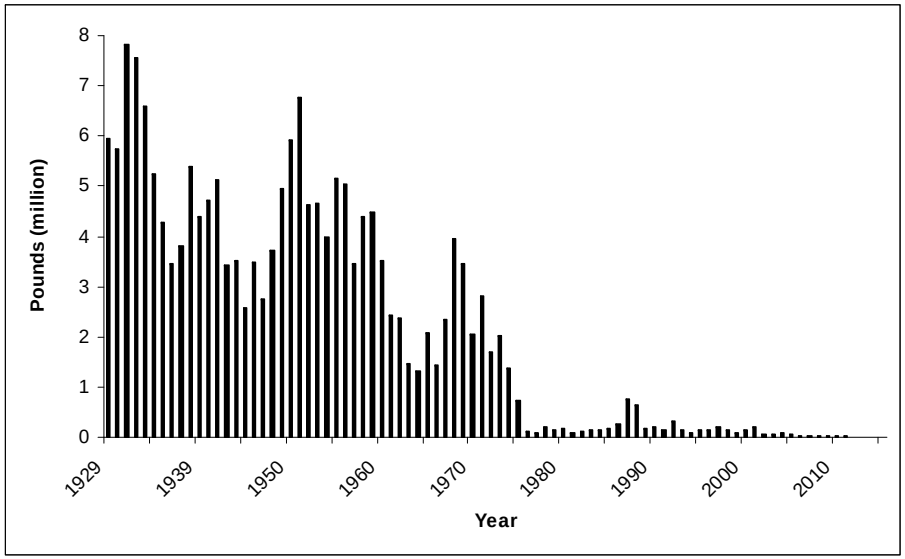
Misidentification of river herring species is relatively common. Alewife and blueback are easily confused and they have also been confused with young hickory shad and American shad. At the Data Collection Standardization Workshop held in November 2015, it was recommended that field identification should be validated, when possible, with a more rigorous laboratory-based method.[8]

River herring mortality sources include harvest, bycatch, discard, pollution, and predation. In Maryland, mortality from hydroelectric turbines is considered insignificant because they are rarely encountered in Conowingo Dam's fish lifts and passed upstream.[3] Ocean trawl bycatch of juvenile river herring in the Atlantic mackerel and Atlantic herring fisheries is of particular concern.[1] Genetic studies indicate 78% of blueback herring bycatch from the New England Atlantic Herring fishery is of Mid-Atlantic origin.[9] The NEFMC and MAFMC will continue to address river herring as bycatch and incentivize avoidance by fishermen. Additional at-sea observer data would improve development of management benchmarks.

Adult access to suitable spawning habitat has historically been impeded by blockages of various types and size. Dams are a common type of barrier. Although building fishways has been an option for moving fish upstream, these structures are not a hundred percent efficient at passing fish. Removal of blockages is the preferred method for reopening spawning habitat. Maryland's Fish Passage Program is responsible for working on projects to reopen spawning habitat for anadromous fish. Two large dams on the Patapsco River were removed (Union and Simkins - 2010), but two dams remain on the river's mainstem. Removal of Bloede Dam, the lower most dam on the river, requires relocating a 42" sewer line and retrenching a 13" sanitary line. The project partners have determined that a passive release of sediment (mostly sand and gravel) from the impoundment is the best management approach. Phase 1 of the project is scheduled to begin in spring 2017. Removal of the dam structure is expected to begin in winter 2017/2018. More detailed information can be found at: http://dnr2.maryland.gov/fisheries/Pages/fishpassage/bloede.aspx. The Fish Passage Program is also updating its online Fish Passage Prioritization Tool and working with partners to develop an incentive program to help make dam removal more attractive for private owners.

National Resources Defense Council petitioned the NMFS in 2011 to designate alewife and blueback herring as threatened species. In 2013, NMFS determined that designation of either species as threatened or endangered was not warranted. (http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/RiverHerringSOC.htm). Following the determination not to list alewife and blueback herring as endangered species, NMFS, partnering with ASMFC, began an initiative to proactively conserve the coastwide population of river herring. This initiative established the TEWG, composed of individual experts from state and federal agencies, academia, the fishing industry, federally recognized tribes, and conservation organizations from the East Coast of the United States and Canada to provide knowledge and guidance for a coastwide conservation plan. The NMFS promised to revisit the ESA listing of river herring in 2018.

Figure 1. Time series of commercial landings of shad river herring (alewife and blueback, 1929-2015) in Maryland.[3, 9]



References

[1] Atlantic States Marine Fisheries Commission. 2012. River herring benchmark stock assessment volume I. Stock Assessment Report No. 12-02 Atlantic States Marine Fisheries Commission. Arlington, Virginia.

[2] Maryland Department of Natural Resources. 2016. Chesapeake Bay finfish habitat investigations. US FWS Federal Aid Project F-61-R-9 2012 – 2015. Maryland Department of Natural Resources, Annapolis, Maryland.

[3] Lipkey, G. K. 2016. Maryland's 2015 compliance report: American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife herring (*Alosa pseudoharengus*) blueback herring (*Alosa aestivalis*). Maryland Department of Natural Resources, Annapolis, Maryland.

4 Federal Register 79(30) February 13, 2014 Rules and Regulations. Final Rule. Fisheries of the Northeastern United States; Atlantic Herring Fishery; Amendment 5

[5] Personal communication from the National Marine Fisheries Service, Greater Atlantic Region Fisheries Office. Northeast Region Quota Monitoring Report. July 2, 2015. http://www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/reports_frame.htm

[6] Federal Register 79(36) February 24, 2014. Rules and Regulations. Final Rule. Fisheries of the Northeastern United States; Atlantic Mackerel, Squid and Butterfish Fisheries; Amendment 14.

7 Atlantic States Marine Fisheries Commission. 2014. 2013 river herring ageing workshop report. Atlantic States Marine Fisheries Commission. Arlington, Virginia. http://www.asmfc.org/files/Science/RiverHerringAgeingWorkshopReport_August2014.pdf

8 Atlantic States Marine Fisheries Commission. 2016. Report on the River Herring Data Collection Standardization Workshop. Atlantic States Marine Fisheries Commission. Arlington, Virginia. http://www.asmfc.org/uploads/file/56fc3c6dRH_DataCollectionStandardizaitionWorkshopSummary_March2016.pdf

[9] Hasselman, D.J, E.C. Anderson, E.E. Argo, N.D. Bethoney, S.R. Gephard, D.M. Post, B.P Schondelmeier, T.F. Schultz, T.V. Willis, and E.P. Palkovacs. 2016. Genetic stock composition of marine bycatch reveals disproportional impacts on depleted river herring genetic stocks. Canadian Journal of Fisheries and Aquatic Sciences. 73:951-963.DOI: 10.1139/cjfas-2015-0402.

[9] Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division. http://www.st.nmfs.noaa.gov/index

1998 Amendment 1 to the 1989 Chesapeake Bay Alosid [*sic*]Management Plan Implementation Table (updated 6/2016)			
Strategy	Action	Date	Comments
1.1 1 The Bay jurisdictions will reevaluate the criteria for reopening a fishery in the Chesapeake Bay during the Alosid [*sic*] FMP revision process. Until new criteria are determined, the moratorium will remain in place for American and hickory shad in the Chesapeake Bay.	1.1 The Bay jurisdictions will continue the moratorium on American shad in Chesapeake Bay.	1989 On-going 2009 - 2011 On-going 2012 2014	The Bay jurisdiction will reevaluate the criteria for reopening a fishery in Chesapeake Bay once a need for a revision of the FMP is designated. The coastal intercept fishery was closed December 2004. The Bay moratorium remains in place for American and hickory shad. MD Sea Grant coordinated development of a Chesapeake Bay Ecosystem-based FMP. Chesapeake Bay jurisdictions continue to follow ASMFC requirements. http://www.asmfc.org/species/shad-river-herring PRFC developed an ASMFC approved sustainability plan for American shad. MD, DC, & VA developed ASMFC approved shad habitat plans. http://www.asmfc.org/files/ShadHabitatPlans/AmShadHabitatPlan_MD.pdf
1.2 A special target-setting task force was charged to "establish measurable restoration targets" for American shad in the Bay. Eight spawning/nursery areas that historically supported substantial recreational and commercial fisheries were used to develop tributary-specific, quantitative recovery targets. The task force recommended that the stock recovery targets proposed for American shad be incorporated into the Alosid [*sic*] management plan.	1.2 The bay jurisdictions will incorporate the shad restoration targets into the revised Alosine FMP	1999 2007 2008 On-going 2012 **2015**	River specific targets were proposed in 1997, but no action was taken. STAC held a 2007 workshop on Alosine targets. The white paper did not include targets. The CBP shad abundance index was expanded from the Susquehanna River to include the James, York, and Potomac Rivers. The index is based on fish passage on the Susquehanna and James Rivers, commercial bycatch CPUE on the Potomac River, and gill net CPUE on the York River. The CBP Sustainable Fisheries GIT revised the shad abundance indicator. The James River index was modified to include both lower James and Bashers Dam data. An index for the Rappahannock River was added. Indices for the York, Potomac, and Susquehanna rivers were not changed. **Between 2014 and 2015, shad abundance decreased from 44 to 30% of the goal**. For more

1998 Amendment 1 to the 1989 Chesapeake Bay Alosid [*sic*]Management Plan Implementation Table (updated 6/2016)			
Strategy	Action	Date	Comments
		2010	information: http://www.chesapeakebay.net/indicators/indicator/american_shad_abundance No relationship exists between adult and juvenile shad abundance limiting the usefulness of a JAI. Any relationship that may exist is masked by at-sea mortality.

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Strategy	Action	Date	Comments
1.1.1 Removing the moratorium on Maryland American shad will not occur until the stocks of American shad in the upper Bay are fully recovered. Reestablishing a fishery will occur when annual population estimates in the upper Bay increase for three consecutive years and stock size reaches at least 50% of historical levels (approximately 500,000 fish) during one of those three years. Regulations will be established to ensure that initial annual exploitation in the upper Bay does not exceed 10% when the fishery is opened. Stock levels will be determined from an annual stock estimation study and exploitation rates will be established based on recreational and commercial surveys.	1.1.1 American shad abundance in the upper Bay has improved but has not sufficiently recovered to warrant an open fishery. American shad abundance is also low in other Maryland river systems. Maryland will continue the moratorium on American shad in the Chesapeake Bay.	1980 On-going 1982 On-going 1992 On-going 1998 2013	Shad stocks have fluctuated since the moratorium began in 1980. Spawning adult population is estimated annually for the Conowingo Dam tailrace. Population estimates for shad in the Upper Bay ended due to the loss of commercial pound nets in the Susquehanna Flats. Criteria to reopen the fishery have not been determined. Limited hickory and American shad bycatch harvest is allowed from the Potomac River pound net and gill net fisheries. PRFC has had a moratorium on directed shad harvest in Potomac River since 1982. DCFM implemented a moratorium on shad harvest within District of Columbia waters of the Potomac River in 1992. CBAMP Amendment 1 supersedes Strategy 1.1.1 restoration criteria No stock allocation for Alosa species has been developed due to the moratorium. Resource allocation will be revisited when Alosa stocks are deemed recovered.
1.1.2 Virginia will follow ASMFC recommendations for a 25% exploitation rate for alosids [*sic*].	1.1.2 Virginia will utilize the Virginia Marine Resources Commission's Stock Assessment Program and the fishery surveys of the Virginia	1994	VA implemented a moratorium on the harvest of American and hickory shad from the Bay in 1994.

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Strategy	Action	Date	Comments
	Institute of Marine Science to assess current Alosid [*sic*] exploitation is above the 25% rate, Virginia will take the appropriate steps to limit fishing effort.	Continue 2010 On-going 2012 On-going	ASMFC allows a limited American shad commercial bycatch harvest in the James, York, and Rappahannock rivers for the anchored and staked gill net fisheries. VA has an allowable catch for Native American tribes. PRFC adopted a moratorium on directed harvest of river herring for the Potomac River. VA implemented a river herring moratorium January 1, 2012 as specified by ASMFC.
1.2 Maryland will recommend management of river herring on a system by system basis. Criterion for closing a system to river herring harvest will be based on juvenile indices from 1985 through 1989 and commercial harvests over the last 10 years. Maryland, Pennsylvania and Virginia will recommend that harvest from all systems slated for restoration be regulated or closed. Technical criterion will be submitted to ASMFC for reevaluation of the 0% exploitation rate for river herring in Maryland. In addition, Maryland will control the harvest of river herring by one or a combination of the following harvest limits; harvest season; areal closures; or gear restrictions. Virginia will use similar measures to control harvests of river herring, American shad and hickory shad.	1.2 River herring harvest will be controlled. Types of management actions which will be considered in the regulation of river herring are as follows: Harvest – Quotas would be a reasonable regulation if the size of the spawning stock in a given year was predictable Seasons – Setting a season during a segment of the "average" spawning period to regulate exploitation Areal closures – Restrict exploitation in those areas where the potential for harvest is greatest such as restricted portions of migratory routes or at migration barriers Gear restrictions – Restrict large-volume harvesting by pound nets and/or haul seines	2012 On-going 2012	Commercial harvest of river herring declined due to low market demand and uncertain stock status. Commercial and recreational river herring fisheries were closed on January 1, 2012. All river herring and river herring products imported into MD and VA must include a bill of sale. MD and VA do not have an ASMFC approved sustainable fishery plan for river herring. PA prohibited the harvest of river herring in the Susquehanna River watershed.
1.3 Maryland will continue the moratorium on the fishery for hickory shad and consider opening a recreational fishery when the American shad stocks have recovered.	1.3 Management actions and strategies for American shad and hickory shad will not be separated due to the paucity of information available for hickory shad and by nature their similar life history.	1981, 1992, 1995 On-going 1994 Continue 2010 Continue 2014	MD (1981) and DC (1992) and PRFC (1995) continue moratorium on hickory shad. Recent monitoring results suggest hickory shad are rebuilding in the Bay. Larval and juvenile hickory shad have been stocked in the Patapsco, Patuxent, Choptank, and Nanticoke rivers. Shad are no longer stocked in Marshyhope Creek (Nanticoke River). Stocking has been focused on the Choptank River. From 1994-2015, 44.5 million American shad and 111.6 million hickory shad have been stocked. Hickory shad are considered self-sustaining in the

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			Patuxent and Choptank rivers.
1.4 Pennsylvania will continue to prohibit the harvest of American shad in the Susquehanna River and its tributaries, and American and hickory shad in the Conowingo Reservoir while restoration efforts are in progress.	1.4 As restoration of alosids [*sic*] progresses over dams in the Susquehanna River, additional regulations in Pennsylvania will be promulgated to protect these species until a degree of restoration is achieved	On-going Continue	PA prohibits the harvest of American and hickory shad in the Susquehanna River watershed. Insufficient recreational catch data are available post-2008. There is a recreational catch and release fishery below Conowingo Dam.
2.1 Maryland, Pennsylvania and Virginia will continue to participate in the ongoing ASMFC-coordinated coastal fishery stock identification and ocean landing studies of alosids [*sic*].	2.1 Maryland, Pennsylvania and Virginia will participate in the ongoing ASMFC alosid [*sic*] management program, both in Board and Scientific and Statistical Committee activities, with the goal of providing adequate protection to the component of the coastal stock which returns to the Chesapeake Bay to spawn.	On-going 1997 1999 2007 2012 2012-2013 2014 ongoing	MD, VA, and PRFC participate in the ASMFC shad management board and technical committee. ASMFC conducted a stock assessment in 1997. Amendment 1 to the ASMFC shad plan adopted a strategy to keep fishing mortality below F_{30}. ASMFC Amendment 3 specified the American shad total mortality threshold to Z_{30} for the coastal stock. ASMFC completed a stock assessment in 2007. The ASMFC Review Panel recommended the development of population specific reference points. American shad and river herring mortality rates have increased. Alosa bycatch in ocean fisheries are contributors, but data is limited. Bycatch mortality in Chesapeake Bay has not been estimated. The ASMFC Management Board approved the 2012 river herring stock assessment. MAFMC adopted Amendment 14 which imposes a 520,000 lb. Alosa bycatch limit to the Atlantic mackerel fishery. NEFMC has adopted Amendment 5 to the Atlantic herring FMP. Both amendments will improve bycatch reporting. MD and VA participated in the TEWG for river herring coordinated by NMFS and ASMFC to inform and develop a coastwide conservation plan for river herring.
2.2 Virginia will follow ASMFC recommendations	2.2 A) Implement a coastal shad tagging program	1991	Tagging studies indicated that the coastal fishery is

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to reduce shad harvest to a 25% exploitation rate.	to determine which stocks are being exploited in the intercept fishery	Continue On-going	mixed and highly variable from year to year. Continuation of tagging programs is recommended. DNA data is used to identify populations within the mixed ocean stock. MD and VA obtain tissue samples for research upon request.
	2.2 B) Control the coastal intercept fishery through a combination of gear restrictions, seasonal and area closures, and harvest limits	1993 2005 On-going	ASMFC Amendment 1 required closure of the coastal intercept fishery by December 2004.
	2.2 C) Continue to monitor and document its territorial sea intercept fishery for American shad	1993 On-going	VA is required to monitor coastal commercial harvest.
2.3.1 Virginia will follow ASMFC recommendations to reduce river herring harvest to a 25% exploitation rate.	2.3.1 Virginia will control river herring harvest during spawning migrations through gear restrictions and spawning area closures.	1992 On-going 2012 Completed	The harvest of river herring has declined for a number of reasons including a loss of spawning habitat due to dams, commercial fishing, and as by-catch in the Atlantic herring and Atlantic mackerel ocean fisheries. Action 2.3.1 was superceded by the ASMFC's 2012 moratorium on river herring harvest.
2.3.2 Maryland and Virginia will ensure that river herring by-catch in the foreign and domestic mackerel fisheries is minimized.	2.3.2 Maryland and Virginia will monitor river herring by-catch through the mid-Atlantic Fishery Management Council and support the following recommendations: a) The foreign fishery will stay 20 miles offshore.	In effect On-going	River herring bycatch is monitored under Amendments 14 and 15 to the MAFMC Atlantic Mackerel/Squid/Butterfish FMP. NAFO monitors international fishing fleets.
	2.3.2 b) Maximum by-catch of 1% for river herring in the foreign and domestic mackerel fisheries with a cap on total allowable by-catch.	In effect On-going **2015**	River herring bycatch is monitored by the MAFMC, NEFMC, NMFS, and NAFO. **MAFMC approved an 180,779 pound incidental shad and river herring bycatch limit for the Atlantic mackerel fishery for 2016. The fishery will close early if the incidental bycatch limit is exceeded.**
	2.3.2 c) Intercept fisheries will be discouraged.	**2012-2015**	**MAFMC under Amendment 14, approved an 180,779 lb. Alosa bycatch limit to the Atlantic mackerel fishery for 2016. NMFS has approved NEFMC Amendment 5 to the Atlantic herring FMP. Both amendments will improve at-sea observer bycatch reporting and monitoring.**
3.1 The jurisdictions will collect specific data on alosid [*sic*] species to improve stock assessment	3.1 A) Maryland will continue the alosid [*sic*] juvenile survey and develop an index of stock	Continue	VIMS, MD DNR and DCFM have Alosine juvenile surveys and calculate indices for each species.

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databases.	abundance. Virginia will continue to collect shad and herring juvenile abundance data with the objective of developing a baywide index of abundance for these species. (Currently being implemented) The juvenile index will be used in conjunction with adult stock estimates to trigger regulatory changes and harvest rates.	2009 Continue 2010 Discontinued	The last several years indicate an increase in juvenile Alosines. ASMFC Amendment 2 requires river herring JAI surveys. VA & MD continue to provide data to coastal stock assessment Preliminary stock recruit indices for river herring were developed and presented to the ASMFC's Herring Stock Assessment Sub-committee (SAS). The effect of bycatch, environmental factors, and stock change on the relationship requires further study. No trends were detected for American shad and there was insufficient data for hickory shad. Initial stock-recruit analyses indicated that a river herring JAI was a predictor of future year class strength. The SAS decided not to pursue development of the indices.
	3.1 B) Maryland will continue research projects for American shad in the upper Bay and Nanticoke River which provide annual estimates of adult shad. (Currently being implemented)	Continue Discontinued 2009 Continue 2011 2013 Continue	Adult shad tagging project on the Nanticoke River was ended due to a lack of tag returns. ASMFC Amendment 2 requires adult river herring spawning/population assessment. The Nanticoke River commercial survey is the data source for the river herring spawning population assessment. The Nanticoke River commercial survey will continue during the moratorium. **In 2015, river ice conditions prevented this assessment, but it will resume in 2016.** A fishery independent gill net survey was conducted in the Northeast River to monitor spawning river herring.
	3.1 C) Virginia will improve assessment of current fishing rates on shad stocks in territorial waters and seek to improve catch and effort data through mandatory reporting. (1990)	1995 Continue	Commercial landing data have been improved on a coastwide basis with the establishment of ACCSP. Limited American shad bycatch fisheries exist.
	3.1 D) The VMRC Stock Assessment Program will provide additional fishery dependent data collection	On-going	Required by the ASMFC.

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	for Virginia's shad fisheries (on-going)		
	3.1 E) Virginia will initiate an ocean intercept tagging program to determine stock composition in the coastal shad fishery (1990)	1991-1992 Completed 2005	Tagging work completed in 1992. Results indicated coastal catch is mixed and highly variable. Ocean intercept shad fishery was closed.
	3.1 F) Maryland will examine the exploitation rates of alewife and blueback herring in selected tributaries of the Chesapeake Bay and improve the accuracy and utility of herring landings. (1990)	1990 On-going Continue	Mortality rates are calculated for river herring in the Nanticoke River. Exploitation rate estimation has not been a priority. MD began a moratorium on river herring in 2012.
	3.1 G) Virginia will cooperate with research institutes to implement a survey of selected shad and herring spawning grounds, compiling information on basic spawning stock characteristics including relative adult abundance, juvenile abundance, size, age and sex ratios. (Currently being implemented)	1990 Completed 2009 2009 On-going	A map of historic shad and herring spawning areas has been completed. Tributary-specific targets were considered. The FMPC and ad hoc Fish Passage workgroups met to discuss how to address the development of targets. No targets were adopted. CBSAC sponsored a workshop to evaluate different methodologies and recommended a multi-metric approach. ASMFC Amendment 2 requires adult river herring spawning/population assessment and Amendment 3 (2010) requires adult American shad spawning/population assessment.
	3.1 H) American shad abundance will be investigated in the Potomac River, a system of historic importance, through a joint effort by Maryland, Virginia, and District of Columbia. (1991)	 1991 On-going 2011	MD striped bass juvenile seine and gill net surveys collect American shad data. DCFM has been sampling the upper Potomac for shad and river herring since 1991. The juvenile survey on the Potomac indicates shad are increasing in abundance especially since 2000. Juvenile shad indices have ranged from 1.05 (2010) to 13.3 (2004). The 2011 JAI was 1.99 (GM). The abundance of juvenile Alosa spp is highly variable and involves density dependent processes that regulate year class strength.

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		2015	The PRFC American shad pound net survey indicates that CPUE in **the Potomac River is 133% of the ASMFC restoration target.**
4.1 The Chesapeake Bay Program's Fish Passage Workgroup has analyzed the problem of impediments to Alosid [*sic*] migration and presented its recommendations for acceptance in December 1988. Maryland will develop a multi-faceted program based on the program's recommendations to restore spawning habitat to migratory fishes by removing blockages. Virginia, through its Anadromous Fish Restoration Committee, will develop a comprehensive inventory of dams and other impediments restricting the migration of the shad and river herring to their historical spawning grounds and establish fish passage facilities. The Pennsylvania Fish Commission (PFC) will continue to refine its inventory of low head dams through SRAFRC and continue to promote fish passage at structures on the Susquehanna River tributaries having the potential for Alosid [*sic*] spawning and nursery habitat. Maryland, Virginia, District of Columbia, U.S. Fish and Wildlife Service and Corps of Engineers will continue its work for fish passage at Little Falls and Rock Creek.	4.1 The District of Columbia, Maryland, Pennsylvania and Virginia will implement the plan adopted by the Fish Passage Workgroup to remove barriers. Projects include: A) Permanent fish passage facilities are being designed and will be constructed at Conowingo Dam at a cost of $12.5 million. (1989)	Variable Completed 2010 2011 Continue 2012 2009 - 2012 2014 Ongoing	Actions 4.1A - 4.1C, 4.1E, and 4.1G - 4.1I have been completed. Actions 4.1D, 4.1F, and 4.1J – 4.1L are underway. Conowingo Dam East Fish Lift is operational. SRAFRC adopted the Migratory Fish Management and Restoration Plan for the Susquehanna River Basin in 2002, which was revised in 2010. This plan sets restoration goals for all Alosine species. The last significant blockage in MD for spawning American shad passage is the Conowingo Dam. Shad passage at Conowingo is being evaluated as part of the FERC relicensing process. Shad upstream passage efficiency at Conowingo was estimated in 2010 at 45% and in 2012 at 26%. American shad telemetry study detected fall-back behavior, where many fish enter the East Fish Lift, but leave without passage. Fish passage and habitat studies conducted as part of the FERC relicensing process are available at: http://www.exeloncorp.com/locations/ferc-license-renewals/Conowingo/Pages/Documents.aspx FERC has not renewed the license for the Conowingo Project. The project is currently operating on an annual license under the provisions of the old license. The current license expired on September 1, 2014. The federal and state agencies are still working out the details for balancing hydropower production with all the other uses of the lower Susquehanna River including environmental considerations. **Exelon has agreed to improve fish passage at**

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			Conowingo Dam. The details will be determined prior to the license renewal: tentatively scheduled for 2018.
	4.1 B) Design planning and implementation of fishways at Holtwood, Safe Harbor and York Haven dams on the Susquehanna River. (In progress)	1986 Completed 2010 Continue **2015**	Fishways have been constructed. Fishway improvements are periodically implemented to boost fish passage efficiency. Holtwood Dam fishway is being renovated to improve upstream passage of Alosa. **All improvements were completed by 2015.** **York Haven Power Company, LLC plans for a "nature-like" fishway were approved by Dauphin County commissioners and building is slated to begin in 2018-2020.**
	4.1 C) A comprehensive inventory of dams and other impediments restricting the migration of shad and river herring to their historical spawning grounds has been completed. (1989)	1990 2011/2012 Completed And On-going	Action completed. The Nature Conservancy in conjunction with NOAA, USFWS, MD DNR, PA FBC, VGIF, CBP, USACE, American Rivers, VCU, and Chesapeake Bay Trust completed a GIS based Chesapeake Fish Passage Prioritization tool to prioritize dam removal based on ecologically relevant metrics. The tool is currently being used and was updated in 2014/2015. Another update is slated for 2017/2018.
	4.1 D) Removal of stream blockages, re-stocking efforts, and construction of fish ladders at sites of barriers on priority streams and rivers will begin. (1990)	Continue 1989-2007 Ongoing 2009 2010	1,838 miles of Chesapeake Bay stream habitat was reopened in PA, VA, and MD for anadromous fish from 1988 through 2005. VA has removed 6 dams, breached 3, and built passage structures at 9 as of 2015. Several fish passage projects are being pursued. VA dam removal status is available at http://www.dgif.virginia.gov/fishing/fish-passage/ Between 1989 and 2013, approximately 2,576 miles of habitat were reopened to anadromous and resident fish. From 1986 to 2003, >340 million American shad fry and fingerlings were cultured and released in

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		Continue 2011	Susquehanna, James, Pamunky, Mattaponi, Rappahannock, Potomac & Choptank rivers. Rappahannock River stocking began in 2003. Patuxent River hickory shad have been restored and stocking discontinued. Limited monitoring will continue. Marshyhope stocking was discontinued after 2011. Choptank River hickory shad have been restored and stocking discontinued. American shad are only stocked in the Choptank River as of 2011.
		2011-2013 Completed	Additional wells were drilled at Manning hatchery and liners added to existing ponds to accommodate increased river herring culture.
		2010 on-going	Union Dam and Simkins Dam on Patapsco River were removed. Removal of Bloede Dam on the Patapsco River is scheduled for 2017.
		2013 Continue	Experimental stocking of American shad, hickory shad, and river herring in the Patapsco River began in 2013. **602,593 alewife, 310,000 American shad, 328,000 blueback, and 1,127,500 hickory shad were stocked in 2015. This was the terminal year of stocking for this project, but monitoring will continue for an additional 2 years. MD DNR is seeking additional funds for continued stocking.**
		2014 On-going	The 2014 CB Watershed Agreement (prompted by Executive Order 13508) included an outcome for opening 1,000 miles of migratory fish passage by 2025 (baseline mileage 2,041).
	4.1 E) A demonstration fish ladder project has been developed with the Chesapeake Bay Foundation and the town of Elkton as an example with public access. (1989)	Completed	Elkton dam fishway was built in 1993. Thousands of herring and resident fish have used the fishway to access 12 miles of upstream habitat for spawning, forage, and cover. Fish Passage staff documented over 7,000 alewife and blueback herring using the fishway in 1999. Town of Elkton created a bypass channel around the dam which increased from bank incision and erosion

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		2014	upstream. Sediment accumulation has increased at the entrance and exit of the fishway that has to be dredged roughly every 2 years. The number of herring using the fishway has significantly decreased since 2005, which corresponds with the time frame for the coast wide decline of both shad and herring. In 2009, there was some evidence of river herring spawning upstream of the Elkton Dam. In 2014, river herring were observed below the fish ladder but sediment deposits are inhibiting fish from using the ladder. The town of Elkton is responsible for maintaining the ladder and will make provisions for improving access when their MDE permit is renewed in 2016.
	4.1 F) A program to reduce turbine mortalities by implementing guidance and avoidance techniques, i.e., use of fish attraction or avoidance devices to guide shad away from turbines to "sluice gate".(1991)	1992 1994 1997 2001 2009-2013 Completed	YOY American shad survival from passage through a Kaplan turbine (Conowingo Dam) is 95%. YOY shad survival was 90% for a single runner Francis turbine at Holtwood Dam. YOY shad survival at double runner Francis turbines was 77% at York Haven Dam and 83% at Holtwood Dam. Exelon Generating Company LLC funded a study to estimate YOY American shad mortality from a single runner Francis turbine at Conowingo Dam during the FERC relicensing process. YOY survival was 90%. Entrainment of adult, out-migrating American shad is projected to be high. Adult shad survival is 80-90% at Francis turbines and 84% at Kaplan turbines.
	4.1 G) Fish passage facilities on the James and Rappahannock Rivers will be established. (Currently being implemented)	1999 Completed 2005 Completed	Vertical slot fishway completed at Boshers Dam on the James River, the last in the fall zone of Richmond. This reopened 137 miles of the mainstem James and over 150 miles of major tributaries. Embrey Dam was removed from the Rappahannock River reopening 106 miles of the Rappahannock and Rapidan rivers.
	4.1 H) The recently constructed passage facility on the Chickahominy River at Walker's Dam will be evaluated for its effectiveness. (1990)	1989 Completed	A double Denil fishway on Walkers Dam was rebuilt in 1989 by the City of Newport News to allow passage of migratory fish. Alosa, blueback herring,

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			alewife and American shad have been documented using the fishway.
	4.1 I) Fish passage facilities at Little Falls Dam on the Potomac River will restore about 10 miles of spawning habitat and at Rock Creek park will open an additional 5 miles of spawning habitat.	1999 - 2000 Completed	A hydraulic model and construction of Little Falls Dam fish passage has been completed. Fish passage effectiveness has been difficult to measure.
	4.1 In addition to the strategies detailed in the Fish Passage Plan, several aspects must be coordinated with the Fishery Management Plan: J) Sources of adult fish used for restocking areas will be coordinated with other states and agencies. (1990)	Continue Continue	Hatchery-rearing methods are standardized. MD, VA, and PA strip spawn. DE hatchery spawning is hormone free. Jurisdictional coordination is good. All American shad broodstock used by MD, VA, PA, and USFWS are from the Potomac River. MD stocks larval, early juvenile, and late juvenile stages to improve stocking success rate. PA stocks some American shad from the Delaware and Susquehanna Rivers.
	4.1 K) The reintroduction of alosid [*sic*] stocks will require specific regulatory measures to protect the newly-introduced fish until populations have been established.	Continue 2010 2011 2013	Moratorium in place for American and hickory shad. Hickory shad data is insufficient for most tributaries to determine population status. Juvenile downstream survival has to be improved at dams having Francis turbines: Holtwood and York Haven. Normandeau studies at Safe Harbor (2008) and Conowingo (2012) indicate ~86% survival of adult American shad during downstream passage. Moratorium is in place for river herring. Allocation of shad and herring resources among stakeholders has been deferred until the species stocks are declared restored.
	4.1 L) Monitoring is essential in gauging the impact of fish passage projects on restoration efforts.	1999 Continue Continue	ASMFC Amendment 2 encourages assessment of fishway passage efficiency/inefficiency for river herring. Boshers Dam vertical slot fishway is monitored for passage each spring. American shad plus 23 other species are known to use the passage.

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		Continue	Fishways are monitored on a limited basis as new ladders are constructed. A 10 year fish passage monitoring goal of 50% coverage is being considered. Fishway efficiency has been difficult to measure. Passage indices should be explored.
4.2 Restoration of shad and river herring to suitable unoccupied habitats will be accomplished by introducing hatchery-raised juveniles or transplanting gravid adults. Present policy fully supports the transplantation of adult shad using fish passage facilities at Conowingo Dam under the assumption of reasonable outmigration. However, if outmigration is not obtained, then the effects of transporting adults from the population below the dam needs to be reevaluated.	4.2.1) Maryland and Pennsylvania will continue to work within SRAFRC's ongoing programs as described in the annual work plan to evaluate methods for ensuring successful downstream passage for juveniles and adults. This will include spill, diversion devices, and bypass systems.	Continue 2002 2010 2014	SRAFRC adopted a new Alosine Management and Restoration Plan for the Susquehanna River Basin in 2002. Restoration Plan was revised in 2010 http://www.dec.ny.gov/docs/fish_marine_pdf/r7fsrafcfinal.pdf York Haven Power Company, LLC plans for a "nature-like" fishway were approved by Dauphin County commissioners and building is slated to begin in 2018-2020**.**
	4.2.2 A) Maryland, Pennsylvania, and Virginia working within SRAFRC, will promote using Susquehanna River brood stock for hatchery production.	Discontinued 2002 Continue Continue	Brood stock are no longer collected from the Susquehanna River. MD, VA, PA, and USFWS use American shad brood stock collected from the Potomac River. 10% of eggs collected from Potomac River brood stock must be returned to the Potomac as mitigation for egg removals. Susquehanna River American shad spawned at MD hatcheries have had poor fertilization rates. Funding is not available to determine the cause. Population level impact of poor fertilization rates in the wild stock [*in situ*] has not been determined. Normandeau Associates, Inc. spawns Susquehanna River American shad for experimental stocking in PA. The fish are collected at the Conowingo Dam's west fish lift.
	4.2.2 B) Virginia will expand funding to the recently constructed Pamunky/Mattaponi Indian Reservation shad hatcheries.	1993 Continue	Funding was from VMRC, but is now provided by VDGIF.
4.3.1 Technical issues concerning water quality standards for dissolved oxygen and minimum flows in the Susquehanna River below Conowingo Dam have been negotiated.	4.3.1 The following technical issues have been accepted. A) Adoption of Maryland water quality standard for dissolved oxygen of 5.0 mg/liter in the Susquehanna River below Conowingo Dam (1989)	Continue	Standards were implemented in 1989 and have been monitored ever since. New water quality criteria for living resources have been adopted. Water quality sampling protocols are being reviewed during the FERC relicensing process.

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	B) Installation of turbine venting systems and intake air injection capabilities (1991)	1988 – 1991 Completed	All 7 Francis turbines now have turbine venting systems and partial intake air injection system.
	C) Operation of turbines as necessary to meet the DO standard (1989)	Continue	Power generation is adjusted as needed.
	D) Monitored spills as necessary (1989)	Continue	Water releases are closely monitored to maximize pool volume.
	E) A schedule of minimum and continuous flows (1989)	Continue	The dam and reservoir are managed to meet required water flows. However, the minimum flow (cfs) is not continuously maintained, but rather allowed to fluctuate below the minimum within the management window. The minimum flow requirement is not daily but rather the average monthly flow. Flow requirements are being negotiated.
4.4 Maryland DNR has proposed new criteria for use in the revised water use classification and water quality standards system setting standards for temperature, dissolved oxygen, pH, amount of suspended solids and a number of "priority pollutants" in anadromous fish spawning areas.	4.4 Establish new categories in the water classification system to guide resource management based on the physical habitat and water quality characteristics. The revised system would define anadromous fish spawning areas as either Class II waters (fresh, nontidal warm water streams, creeks and rivers) or Class III waters (tidal estuarine waters and Chesapeake Bay).	2007 2011 2014 On-going	Maps delineating particular habitats of concern are used for developing water quality standards. Revised habitat prioritization maps have been completed by CBP. Jurisdictions adopted the Chesapeake Watershed Agreement (2014) to set specific restoration goals and timeframes. For more information: http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf
4.5 The District of Columbia, Maryland, Pennsylvania and Virginia will cooperatively evaluate the available scientific data on the effects of impaired water quality on alosids [*sic*] as a means of developing more effective water quality criteria for spawning and hatching areas and take action now to reduce pollution from several sources.	4.5) The first three action items are commitments under the 1987 Chesapeake Bay Agreement. Maryland DNR, PFC, DC and VMRC will not carry out the specific commitments, but are involved in setting the objectives of the programs to fulfill the commitments and reviewing the results of the action programs. The achievement of these commitments will lead to improved water quality and enhanced biological production. A) Develop and adopt a basinwide plan that will achieve a 40% reduction of nutrients entering the Chesapeake Bay by the year 2000. 1) Construct public and private sewage facilities.	On-going Variable	Chesapeake Bay Program develops, revises, and monitors goals and strategies for nutrients, wastewater, sediment, stormwater, agriculture, development, and chemical contaminants. For more information: http://www.chesapeakebay.net/issues/issue/nutrients http://www.chesapeakebay.net/issues/issue/wastewater http://www.chesapeakebay.net/issues/issue/sediment http://www.chesapeakebay.net/issues/issue/stormwater_runoff http://www.chesapeakebay.net/issues/issue/agriculture http://www.chesapeakebay.net/issues/issue/develop

1989 Chesapeake Bay Alosid [*sic*] Management Plan Implementation Table (updated 6/2016)			
Strategy	Action	Date	Comments
	2) Reduce the discharge of untreated or inadequately treated sewage. 3) Establish and enforce nutrient and conventional pollutant limitations in regulated discharges. 4) Reduce levels of nutrients and other conventional pollutants in runoff from agricultural and forested lands. 5) Reduce levels of nutrients and other conventional pollutants in urban runoff.	2000 2007 2009 2009 2010 2012 On-going 2014 On-going	ment New commitments were established in the Chesapeake 2000 Agreement. For Alosines, priority populations will be identified and tributary-specific targets developed. STAC sponsored a workshop during 2007 to develop restoration targets. Executive Order 13508 by President Barack Obama required federal agencies to increase cooperation and leadership, coordinate with state and local government, and enforcement of Clean Water Act. EPA is mandating restoration criteria and actions for Chesapeake Bay States. EPA developed a Chesapeake Bay watershed TMDL. States must have EPA approved plans with 2 year milestones or face fines and other sanctions. Various jurisdictions have filed legal challenges to the EPA TMDL. Jurisdictions submitted Phase I watershed implementation plans (WIP) in 2010 and Phase II WIPS in 2012 Jurisdictions adopted the Chesapeake Watershed Agreement (2014) to set specific restoration goals and timeframes. For more information: http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf
	4.5 B) Develop and adopt a basinwide plan for the reduction and control of toxic materials entering the Chesapeake Bay system from point and nonpoint sources and from bottom sediments. 1) Reduce discharge of metals and organic compounds from sewage treatment plants receiving industrial wastewater. 2) Reduce the discharge of metals and organic compounds from industrial sources. 3) Reduce levels of metals and organic compounds	On-going 2014 On-going	Chesapeake Bay Program develops, revises, and monitors goals and strategies for chemical contaminants. For more information: http://www.chesapeakebay.net/issues/issue/chemical_contaminants Jurisdictions adopted the Chesapeake Watershed Agreement (2014) to set specific restoration goals and timeframes. For more information: http://www.chesapeakebay.net/documents/FINAL_C

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Strategy	Action	Date	Comments
	in urban and agriculture runoff. 4) Reduce chlorine discharges to critical finfish areas.		hes_Bay_Watershed_Agreement.withsignatures-HIres.pdf
	4.5 C) Develop and adopt a basinwide plan for the management of conventional pollutants entering the Chesapeake Bay from point and nonpoint sources. 1) Manage sewage sludge, dredge spoil and hazardous wastes. 2) Improve dissolved oxygen concentrations in the Chesapeake Bay through the reduction of nutrients from both point and nonpoint sources. 3) Continue study of the impacts of acidic conditions on water quality. 4) Manage groundwater to protect the water quality of the Chesapeake Bay. 5) Continue research to refine strategies to reduce point and nonpoint sources of nutrient, toxic and conventional pollutants in the Chesapeake Bay.	2011 2008 On-going 2011 Continue	Some Alosa spawning reaches appear to be sand and gravel deficient and may impair egg survival. MD DNR and USACE are studying sand and gravel transport at the Simkins Dam removal site (Patapsco River) as well as possible negative effects of accumulated sand and gravel behind blockages. MD DNR Fisheries Service is studying spawning and hatching success with associated habitat and watershed conditions including land use. **Analyses indicate that urbanization is detrimental to Alosine spawning.** Sediment accumulation behind Conowingo Dam is nearing capacity. At capacity, the Dam will no longer reduce sediment, nutrient and other pollutant inputs to Chesapeake Bay. Options being considered for sediment removal and disposal include sediment bypass, quarry infill, use as landfill material, construction material, and Blackwater Wildlife Refuge marsh restoration. High flow events (storms) scour significant quantities of the stored sediment. 2014 On-going Jurisdictions adopted the Chesapeake Watershed Agreement (2014) to set specific restoration goals and timeframes. For more information: http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf
	4.5 D) Develop and adopt a plan for continued research and monitoring of the impacts and causes of acidic atmosphere deposition into the Chesapeake Bay. This plan is complimented by Maryland's research and monitoring program on the sources, effects, and control of acid deposition as defined by Natural Resources Article Title 3, Subtitle 3A, (Acid Deposition: Sections 3-3A-01 through 3-3A-04).	On-going 2014 On-going	Chesapeake Bay Program develops, revises, and monitors goals and strategies for air pollution. For more information: http://www.chesapeakebay.net/issues/issue/air_pollution Jurisdictions adopted the Chesapeake Watershed Agreement (2014) to set specific restoration goals and timeframes. For more information:

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Strategy	Action	Date	Comments
	1) Determine the relative contributions to acidic deposition from various sources of acid deposition precursor emissions and identify any regional variability. 2) Assess the consequences of the environmental impacts of acid deposition on water quality. 3) Identify and evaluate the effectiveness and economic costs of technologies and non-control mitigative techniques that are feasible to control acid deposition into the Bay.		http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf

Acronyms:
ACCSP – Atlantic Coastal Cooperative Statistics Program
ASMFC – Atlantic States Marine Fisheries Commission
CBAMP – Chesapeake Bay Alosa Management Plan
CBP - Chesapeake Bay Program
CBSAC – Chesapeake Bay Stock Assessment Committee
Cfs – Cubic feet per second
CPUE – Catch per unit effort
DCFM – District of Columbia Fisheries Management
DO – Dissolved oxygen
EPA – Environmental Protection Agency
FERC – Federal Energy Regulatory Commission
FMP - Fishery Management Plan
GIS – Geographic information system
GIT – Goal implementation team
GM – Geometric mean
JAI – Juvenile abundance index
MAFMC – Mid-Atlantic Fisheries Management Council
MD DNR – Maryland Department of Natural Resources
NAFO – Northwest Atlantic Fisheries Organization
NEFMC – New England Fishery Management Council
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
PA FBC – Pennsylvania Fish and Boat Commission
PFC – Pennsylvania Fish Commission
PRFC – Potomac River Fisheries Commission
SAS – Stock assessment sub-committee
SRAFRC – Susquehanna River Anadromous Fish Restoration Committee
STAC - Chesapeake Bay Program, Scientific and Technical Advisory Committee
TEWG – Technical Expert Working Group
TMDL – Total maximum daily load
USACE – United States Army Corps of Engineers
USFWS – United States Fish and Wildlife Service
VCU – Virginia Commonwealth University
VGIF – Virginia Game and Inland Fish
VIMS – Virginia Institute of Marine Science
VMRC – Virginia Marine Resource Commission
WIP – Watershed implementation plan
YOY – Young of year