

Delaware River

Monroe County

American Shad Monitoring, 2023

American Shad represents a highly desirable fishery in the Delaware River during their spring spawning run. This fishery is collaboratively managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the Delaware River Basin Fish and Wildlife Management Cooperative (Co-op), the Pennsylvania Fish and Boat Commission (PFBC) engages management of American Shad through its membership in both entities. A suite of long-term monitoring time-series data sets, with associated management benchmarks, including relative abundance of juvenile and adult life stages and commercial exploitation, are employed to assess sustainability of the population as identified by Co-op members and outlined within the [2022 American Shad Sustainable Fisheries Management Plan \(SFMP\)](#). American Shad fisheries are judged sustainable if indices of stock condition remain within the defined benchmarks. Each of these time-series are annually updated and evaluated relative to the exceedance of defined benchmark criteria. The SFMP itself is revised on a five-year cycle, with the 2023 SFMP tenure effective from 2022 to 2026. All benchmarks are updated upon the initiation of each future five-year SFMP cycle.

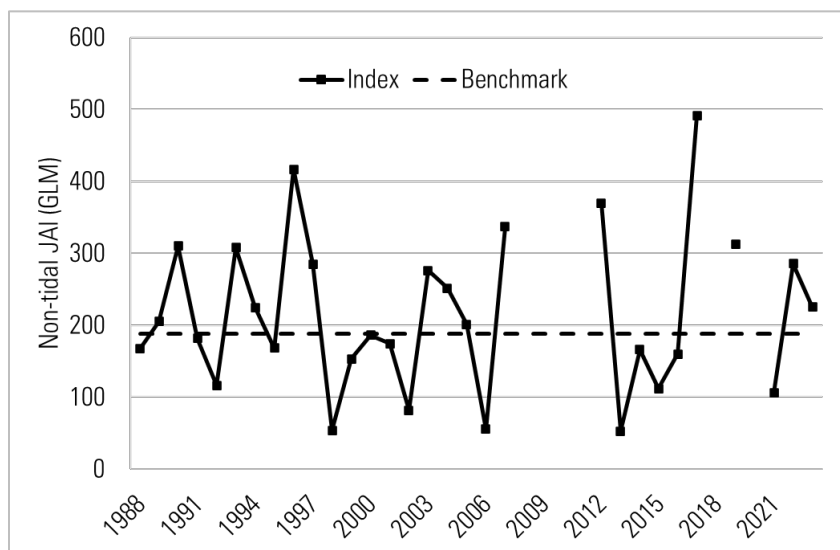
The Co-op proposes six benchmarks for defining American Shad sustainability. Identified benchmarks have been set to respond to any potential decline in stock due to increased exploitation. All benchmarks are viewed as conservative measures. The severity of management action is commensurate with the number of benchmarks exceeded.

Non-tidal Juvenile Annual Production Index (JAI)

Reinitiated by Co-op members in 2012, this juvenile production index (JAI) was derived from the historical New Jersey Division of Fish and Wildlife (NJDFW) monitoring program, 1988 to 2007. The survey consists of a series of fixed beach seining sites in the Delaware River main stem at Phillipsburg, NJ, Water Gap, NJ, and Milford, PA. with sampling conducted once-a-month, from August to October, representing the Delaware Basin JAI above head-of-tide. Essentially this survey tracks the relative abundance of young-of-the-year (YOY) fishes derived from the springtime adult spawning run. The non-tidal JAI is standardized with respect to environmental covariates using generalized linear model (GLM) methodology. The benchmark is based on data from 1988 to 2007 and 2012 to 2023. Sampling was suspended, from 2008 to 2011, 2018 (extreme high flows) and 2020 (COVID-19). Failure to meet the benchmark is defined as the occurrence of JAI values during three-out-of-the-five most recent years in the time-series, which are less than a value of 188 (i.e., the 50th percentile of the historical data, 1988 - 2019). In other words, higher values are indicative of sustainability.

A total of 10,787 YOY American Shad were collected during the 2023 season. The standardized total catch (i.e., 225.6) ranked 12th highest out of the 30-year time-series (Figure 1). With respect to the management benchmark, data gaps occurred during 2020 and the 2021 JAI (i.e., 106.4) failed the benchmark (i.e., less than 188) within the most recent five-years (i.e., 2019 to 2023). However, the 2019 (312.6; 5th highest in the time-series), 2022 (285.7) and 2023 (225.6) JAIs were greater than the benchmark. Given the missing data and the high rankings of the 2019, 2022 and 2023 JAIs, this index was judged as indicative of sustainability for the 2023 season.

Figure 1. Standardized (GLM) annual YOY American Shad total catch within the Delaware River, 1988 to 2023.

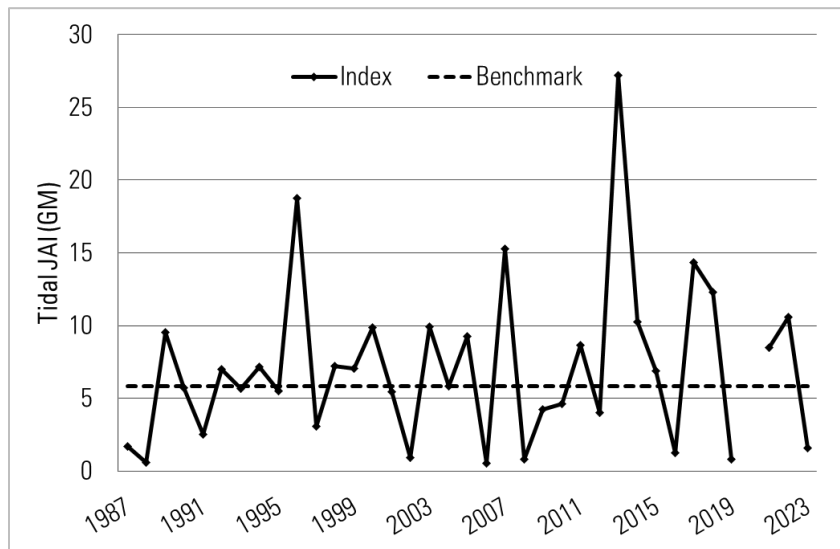


Tidal Juvenile Annual Production Index (JAI)

This index is derived from the NJDFW annual YOY Striped Bass beach seining, which also consistently catches YOY American Shad that occupy similar nursery ground habitats, within the upper Delaware Estuary. Only those fixed-sites from Newbold Island to the Delaware Memorial Bridge are included. The JAI index is represented as the annual geometric mean of the catch data. A benchmark was based on data from 1987 to 2019. Failure to meet the tidal benchmark is defined as the occurrence of JAI values in three-out-of-five-years, which were less than 5.81 (i.e., the 50th percentile of the historical data). Like the non-tidal JAI, higher values for the tidal JAI are indicative of sustainability.

The 2023 estimate of the tidal JAI was 1.6 ranking 30th in the 37-year time-series (Figure 2). Within the most recent five years, a data gap was introduced for 2020 (i.e., COVID-19); however, the 2019 (0.79) JAI was the only occurrence less than the benchmark until 2023. This index was judged as indicative of sustainability for the 2023 season but another low year in 2024 may trigger consideration for management action.

Figure 2. Geometric means (GM) of annual YOY American Shad total catch within the Delaware Estuary, 1987 to 2023.

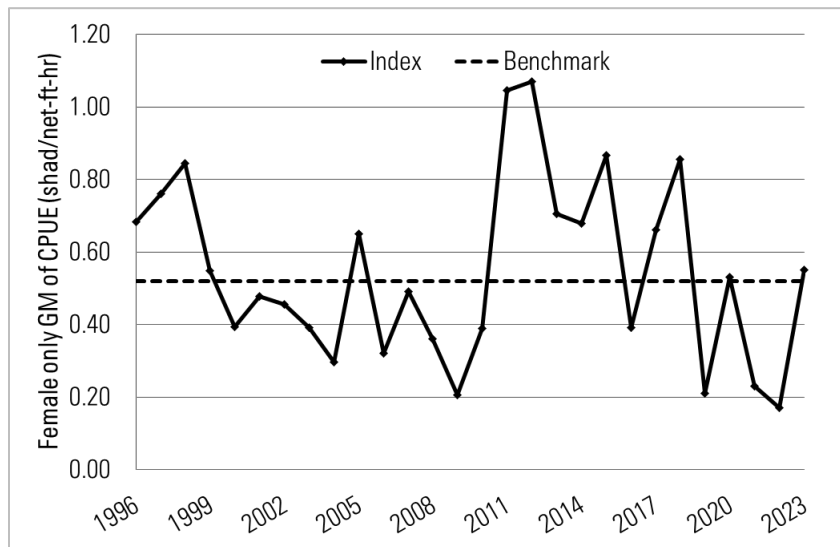


Spawning Run Relative Abundance

Annual estimates of adult relative abundance are derived from gill netting at Smithfield Beach (RM 218), by PFBC within the Delaware River main stem during the spring spawning run. This index is calculated as the annual geometric mean of female catch-per-unit-of-effort (CPUE: shad/net-ft-h). The benchmark was based on sampling from 1996 to 2019, with adult benchmark failure defined as the occurrence of three-out-of-five-years where index values were less than 0.52 (i.e., the 50th percentile of the historical data). Higher values are indicative of sustainability for this index.

A total of 755 American Shad (females: N = 674; males: N = 81) were captured during the 2023 season. Sizes varied from 18-inches to 23-inches total length for females and 16-inches to 21-inches total length for males. Unfortunately, within the most recent five-years (i.e., 2019 to 2023), three annual values (2019: 0.21 shad/net-ft-h; 2021: 0.23 shad/net-ft-h; 2022: 0.17 shad/net-ft-h) were less than the benchmark. The 2023 sample was slightly over the benchmark value at 0.54 shad/net-ft-h, ranking 13th in the time-series high (Figure 3). Prolonged high river flows experienced during the 2019 season, unduly influenced catchability of adult shad, introducing poor confidence in the spawning run index for that year. Due to catchability issues in 2019, this index was judged as sustaining the management benchmark for the 2023 season.

Figure 3. Annual geometric means of catch-per-unit-of-effort for adult female American Shad spawning run at Smithfield Beach (RM 218), Delaware River main stem, 1996 to 2023.

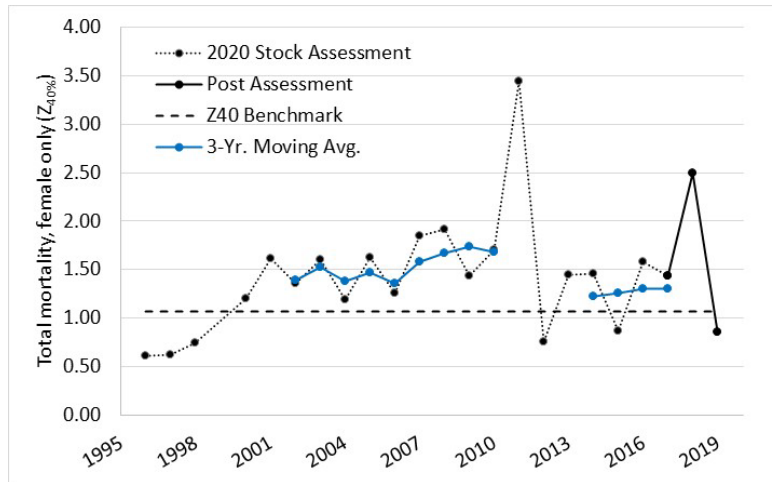


Total Mortality

This index represents the loss of females from the adult spawning population. It is calculated as the adult female total mortality (i.e., $Z_{40\%}$) from the spawning population age distribution. Ages are determined via otolith microstructure of shad collected at Smithfield Beach during the springtime spawning run. The total mortality benchmark is based on data from 2005 to 2017 and failure is defined as the three-year rolling average above a value of 1.07 (i.e., $Z_{40\%}$). Lower mortality values are indicative of sustainability for this index.

This index was demonstrated to be unsustainable within the Delaware Basin in the ASMFC 2020 stock assessment (Figure 4). In response, Co-op members implemented restrictions by 33% for both commercial landings and recreational harvest beginning for 2023 season. [Specifically, within Pennsylvania, the Delaware River daily creel limit was reduced to two shad per day \(see page 13 in Summary of Rules\).](#) The Lehigh and Schuylkill rivers remain catch-and-release only. Co-op members are hopeful this restriction will aid the reversal of female loss to the population. Annual estimates for 2021, 2022 and 2023 are pending age estimation of collected otoliths.

Figure 4. Total adult female mortality for American Shad captured at Smithfield Beach, Delaware River, 1996 to 2023.

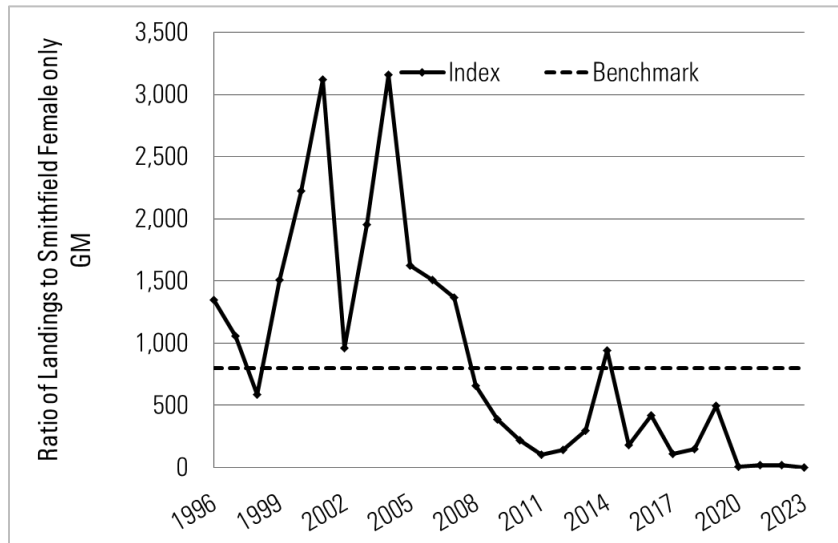


Ratio Commercial harvest to Spawning Run Relative Abundance

Commercial fisheries exist within the Delaware Bay that are known to harvest adult American Shad during the springtime as they return to their natal waters. The intent of this index is to address the relative loss of shad from the Delaware River population due to commercial fisheries relative to the Pennsylvania escapement index catch described above. It is expressed as the ratio of total combined pounds of adult shad reported to have landed within the states of New Jersey and Delaware, relative to the adult female only spawning run relative abundance as characterized by the Smithfield Beach index, divided by 100. The benchmark is based on data from 1996 to 2019. Failure is defined as the occurrence of three-out-of-five-years where values are above a value of 799 (i.e., the 50th percentile of historical data). Lower values are best for this index in maintaining sustainability.

Approximately, a combined total of 156-pounds of shad were reported being landed for the 2023 season to the states of New Jersey and Delaware. Half (i.e., 50%) of the total landings (i.e., 78-pounds) are attributed as representative of the Delaware River stock. The 2023 estimate was 1.4, ranking the lowest ever in the 28-year time-series (Figure 5). Within the most recent five-years (i.e., 2019 to 2023), index values for all years has remained well below the benchmark. This index was judged not in exceedance for the 2023 season.

Figure 5. Ratio of combined commercial landings from the Delaware Bay and lower Delaware Estuary to Smithfield Beach index, 1996 to 2023.

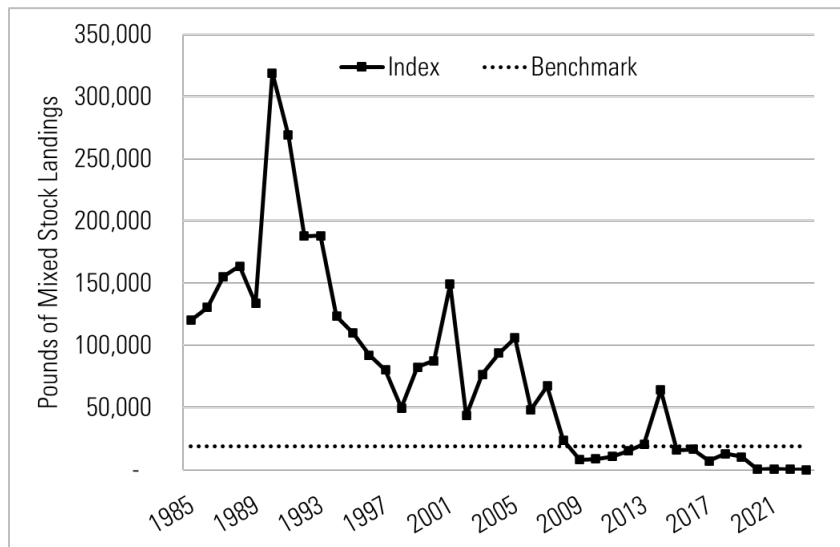


Mixed Stock Landings

American Shad occurring in the Delaware Basin are represented by both Delaware River origin fish as well as fish from multiple other coastal river stocks. The commercial fisheries operating within the Delaware Bay and Delaware Estuary land shad from these mixed stocks in addition to the Delaware River stock. The Co-op is sensitive to the potential impacts on East Coast shad stocks from those commercial fisheries. Assignment of 50% (i.e., half) of all commercial landings reported to the states of New Jersey and Delaware are attributed as representative of the mixed stock component, based on updated genetic findings. Thus, the other half of the combined total landings are considered Delaware River stock. The 39-year time-series encompasses 1985 to 2023 with the benchmark based on data from 1985 to 2019. Failure is defined as the occurrence of two (2) consecutive years with values above 18,505-pounds (i.e., the 25th percentile of historical data).

A combined total of 156-pounds of shad were landed from the Delaware Bay and Delaware Estuary, with 78-pounds considered as the mixed stock during 2023 (Figure 6). Within the most recent last two years, both the 2021 (i.e., 488-pounds) and the 2022 (i.e., 294-pounds) landings were well below the benchmark. This index was judged not in exceedance for the 2023 season.

Figure 6. Mixed stock landings of American Shad landings from the Delaware Bay and Delaware Estuary, 1996 to 2023.



Assessment of Delaware River American Shad Sustainability

Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring defines a sustainable fishery as one that will not diminish potential future stock reproduction and recruitment. Indices of female total mortality remains in exceedance of its benchmark. Corrective management action was enacted for the 2023 season by Co-op members in response to the failed female total mortality index. Given the newness of this measure, coupled with all other indices considered sustainable, further potential management action was not implemented for the 2024 season. Careful monitoring of all indices will continue in 2024 and into the future, with recommendations for management actions as benchmark interpretations require.

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