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**U.S. Fish & Wildlife Service Susquehanna River American  
Shad (*Alosa sapidissima*) Restoration: Potomac River Egg  
Collection, 2015**

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**Abstract**

During April and May 2015, monofilament gill nets were used to collect spawning ready American Shad (*Alosa sapidissima*) from the Potomac River, Maryland. Mature adults were strip-spawned on the river and fertilized eggs were provided to Pennsylvania's Van Dyke American Shad Hatchery in support of Susquehanna River American Shad restoration. Sampling consisted of 18 days, during which 2,828 adult American Shad were collected, with 1,077 of those adults used for spawning. A total of 170.6 L of American Shad eggs (~8.85 million) with a 23.1% fertilization rate resulted in ~2.04 million viable eggs that were used for stocking into the Susquehanna River.

## **Introduction**

American Shad (*Alosa sapidissima*) are an anadromous, pelagic fish species that range along the Atlantic coast from Labrador, Canada to Florida, United States of America (U.S. Fish and Wildlife Service 2006). American Shad are the largest of the clupeids native to North America (Stier and Crance 1985) and an important planktivore and prey species for Bluefish (*Pomatomus saltatrix*) and Striped Bass (*Morone saxatilis*; U.S. Fish and Wildlife Service 2006). American Shad return to their natal river to spawn after four to six years maturing at sea. Spawning movements follow a latitudinal cline and, although variable, generally peak at water temperatures of 14 to 21 °C (Stier and Crance 1985). Generally, April is the peak spawning month for American Shad in the Potomac River, Maryland.

Shad were once a valuable resource for Native Americans and have been economically important since European colonization of North America. In Pennsylvania, American Shad are said to have once ruled the waters of the Susquehanna River and its tributaries (The Native Fish Conservancy 2005). However, over the past century, American Shad populations have declined for a number of reasons. Initial population declines resulted from increased commercial harvest coinciding with increases in human population and gear efficiency. Habitat loss (impoundments) and degradation (pollution) followed and remain today as significant challenges to restoration. Attempts to mitigate impoundment effects on American Shad and other Susquehanna River species began in 1866. In that year Pennsylvania enacted the Act of March 30, 1866, which formed what is today the Pennsylvania Fish and Boat Commission (PFBC), and began over a century of fish passage efforts on the Susquehanna River (The Native Fish Conservancy 2005).

The U.S. Fish and Wildlife Service (Service) is partnered with state, Federal, and hydro-power companies, through the Susquehanna River Anadromous Fish Restoration Cooperative to restore American Shad to the Susquehanna River watershed. The Service's current Potomac River egg harvest operation is part of this, nearly forty year, multi-agency restoration effort. The Service's Maryland Fishery Resources Office's (MFRO) role is to deliver viable American Shad eggs to the Van Dyke American Shad Hatchery near Thompsettown, Pennsylvania. There, the eggs are incubated until hatching and fry are grown and marked before stocking into the Susquehanna River drainage.

#### Study Area

The Potomac River is approximately 1.5 km wide at Marshall Hall, Maryland (rkm 150), where American Shad gill netting occurs. The collection site is bounded by Dogue Creek (North) and Gunston Cove (South) and has long been linked to Shad harvest and culture. The river is tidal within this area, but remains freshwater throughout the spring. Bottom habitat is characterized by an abrupt transition from the deep channel ( $\approx 18.3$  m) area to relatively shallow depths ( $\leq 3.5$  m). Channel substrate consists of firm, sandy, mud with intermittent shell. Sand increases in the shoal area forming a comparatively harder substrate.

#### **Materials and Methods**

Two Service boats with a crew of three each fished for American Shad nightly. Three different sized, monofilament, floating gill nets were used in 2015. A 14.0 cm (5.5 in) stretch mesh net was used to target ripe females and was 6.1 m deep by 91.4 m long (female net). The net used to target males was 11.7 cm (4.6 in) stretch mesh and 5.2 m deep by 91.4 m long (male net). A third type of net was used to target males and smaller

females. This net had 12.7 cm (5.0 in) stretch mesh and was 5.5 m deep by 91.4 m long (unisex net). Each boat set up to five nets, with at least one net of each type per boat. Nets were joined in series and drifted parallel to shore in water depths ranging from approximately 6.1 to 12.2 m. Gill nets were set shortly before the evening's slack tide and fished approximately 45 minutes. Fishing was timed so that the nets' drift stalled parallel to a sharply defined shoal area where depth abruptly decreased to less than 4.0 m.

Tidal condition (transitioning high or low) was noted and surface temperature (°C), dissolved oxygen (mg/L), conductivity (microsiemens/cm;  $\mu\text{s}/\text{cm}$ ), and salinity (ppt) were recorded (Yellow Springs Instruments Model Pro 2030) each night (Figure 1). The number of running, green, or spent female American Shad, ripe male American Shad, and bycatch was recorded (Table 1; Figure 2). Gill net effort (minutes fished) was recorded but varied since the goal was to maximize catch during each sampling event. American Shad catch per unit effort (CPUE) was calculated by sex (male, ripe female, green female) and net type fished (male, female, unisex) per total net square footage and time fished ( $\text{CPUE} = [n/\text{hr}/\text{m}^2]$ ). For ease of interpretation, all CPUE values were multiplied by a scalar of 1,000 for the report. A sub-sample of American Shad (at least 5% of fish kept for spawning) were measured for total length (nearest mm) and weight (nearest 0.01 kg), and otoliths were extracted for aging, as a permit requirement of the Potomac River Fisheries Commission (PRFC). In addition, we stocked 14.6% (25 L) of all eggs stripped from American Shad back into the Potomac River, as another permit requirement by PRFC.

## Results

During spring 2015, the Potomac River was sampled a total of 18 days from 12 April through 8 May. From early to mid-April, surface water temperature remained

fairly consistent, until temperatures dropped in late April, mainly due to a cold front that passed through (Figure 1). Surface water temperatures ranged from 13.3 to 21.3 °C ( $\bar{x}$  = 16.6 °C) while dissolved oxygen ranged from 8.1 to 10.8 mg/L ( $\bar{x}$  = 9.5 mg/L; Figure 1). Water conductivity was fairly stable, ranging from 178 to 298  $\mu\text{s}/\text{cm}$  ( $\bar{x}$  = 244  $\mu\text{s}/\text{cm}$ ).

During the sampling timeframe  $\geq 5.0$  L of eggs were collected 12 times (66% of sampling days). A total of 170.6 L (range = 5.7–38.4 L,  $\bar{x}$  = 14.2 L/shipment) of eggs were shipped from the Potomac River (J. Tryninewski, PFBC, personal communication). The overall egg viability was 23.1%, although daily shipments had a range of 0.0–66.2%. This resulted in the production of ~2.044 million fry that were stocked into selected tributaries of the Susquehanna River (J. Tryninewski, PFBC, personal communication).

Gill netting captured 9,117 fish from the Potomac River, representing fourteen fish species (Table 1). Gizzard Shad comprised 60.4% of all fish caught, with American Shad the next largest portion of the catch (31.0%). Green female American Shad were more common than ripe females with a ratio of 2.1:1, but ripe females were more common than ripe males with a ratio of 2.79:1 (Figure 2; Table 2).

Catch per-unit-effort was generally highest in our unisex (12.7 cm stretch mesh) net. These nets had the highest CPUE's for both ripe and green females compared to all other net types (Table 3). However, males were better targeted by our male nets, which have the smallest mesh (11.7 cm). Values for male CPUE from both male and unisex nets were at least an order of magnitude higher than CPUE for males from our female net (Table 3).

**Discussion**

American Shad harvest in numbers sufficient enough to yield egg shipments was variable this year on the Potomac River. In past years, egg shipments have not typically been made at temperatures below 15 °C; however, in 2015 there was a sharp decline in water temperature in the middle of the spawning run. This year, temperatures were moderate to begin the season, with water temperatures ranging from 14.4–17.3 °C from 12 April–22 April. However, during this timeframe significant numbers of spawning-ready fish were not captured, and only three eggs shipments were made to Van Dyke Hatchery. The greatest numbers of ripe/running male and female American Shad were caught between 23 April and 4 May, when surface water temperatures were between 13.9–18.1 °C. During this timeframe, seven shipments were made, totaling over 118 liters; this accounted for more than two-thirds of all eggs shipped for the year. After 4 May, water temperatures rose nearly a degree Celsius per day, from 18.1 to 21.2 by 8 May. Only two egg shipments were made during this period, and both were of poor quality, with one shipment having 0% viability and the other 0.5%.

As in recent years, males were caught continuously throughout the spawning season (Table 2), which is likely attributed to the continued use of smaller mesh gill nets during the 2015 season. In the Potomac River, males are substantially smaller than females. To collect a greater number of males, at least one smaller mesh gill net (11.7 cm or 12.7 cm) was set, along with up to four larger mesh gill nets (14 cm). The smaller mesh nets were used in an effort to keep the sex ratio consistent with at least one male to three females throughout the entire season. Constant availability of sperm was expected to increase overall egg viability, resulting in more fry stocked into the Susquehanna River watershed.

## Conclusion

The Service provided Pennsylvania with 170.6 L of eggs, with an overall viability of 23.1% (~2.044 million viable eggs; see Project Summary results from previous years). The 2015 overall viability of 23.1% was well below the ten year average (37.4%) and was the second lowest viability in the history of the program; 2013 was the lowest at 21%. This is likely due, in part, to the sharp decline in water temperatures just as spawning-ready fish were being caught, and the subsequent quick rise in water temperature, well beyond ideal spawning temperature.

## Project Summary

Over the past ten years the USFWS has provided Pennsylvania with over 1,985 liters of eggs with an average viability of 37.4%, resulting in the production of nearly 35 million viable Shad eggs.

Year	Volume (L)	Viable Eggs (N)	Viability (%)
2015	170.6	2,044,013	23%
2014	316.7	5,671,992	39%
2013	118.1	1,603,498	21%
2012	258.0	5,664,920	51%
2011	137.4	2,714,435	44%
2010	375.0	6,874,712	39%
2009	132.2	1,885,500	30%
2008	194.4	3,491,069	41%
2007	183.9	2,875,455	42%
2006	99.3	2,003,222	44%

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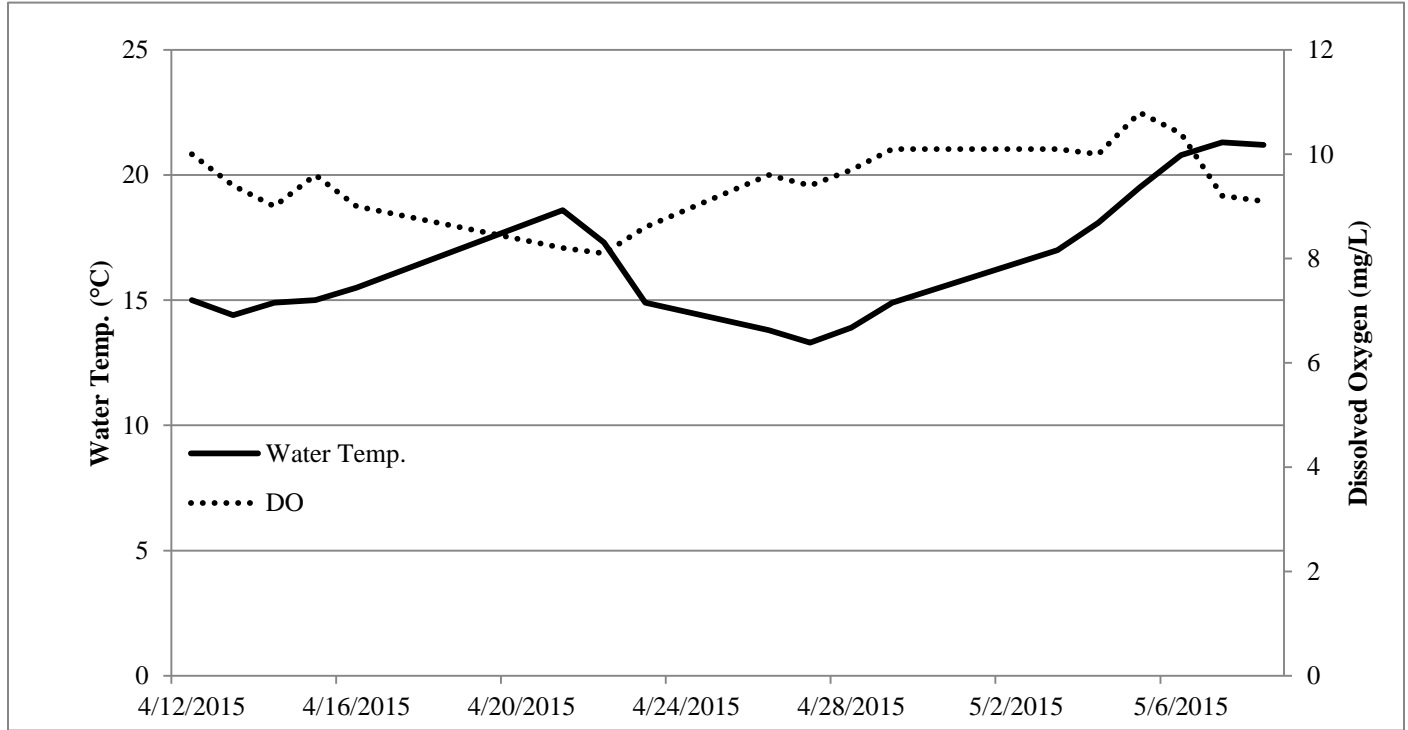


Figure 1. Spring 2015 Potomac River, Maryland surface water temperature (°C ) and dissolved oxygen (mg/L) measurements taken during American Shad (*Alosa sapidissima*) gill netting.

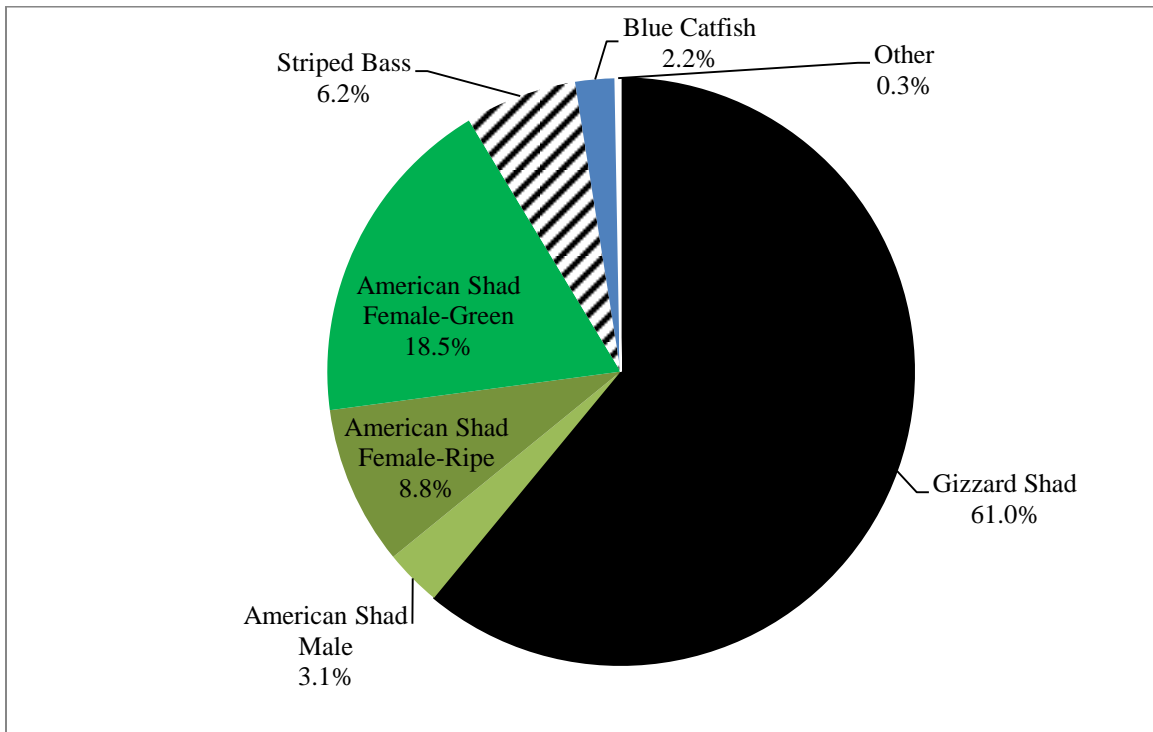


Figure 2. Spring 2015 species composition from Potomac River, MD gill net sampling. Other species, scientific names, and counts are listed in Table 1.

Table 1. List of species and number sampled (count) in gill nets from the Potomac River, MD during spring 2015.

<b>Common Name</b>	<b>Scientific Name</b>	<b>Count</b>
American Shad	<i>Alosa sapidissima</i>	2,828
Blue Catfish	<i>Ictalurus furcatus</i>	199
Blueback Herring	<i>Alosa aestivalis</i>	2
Channel Catfish	<i>Ictalurus punctatus</i>	6
Common Carp	<i>Cyprinus carpio</i>	1
Gizzard Shad	<i>Dorosoma cepedianum</i>	5,508
Hickory Shad	<i>Alosa mediocris</i>	2
Largemouth Bass	<i>Micropterus salmoides</i>	1
Longnose Gar	<i>Lepisosteus osseus</i>	8
Northern Snakehead	<i>Channa argus</i>	1
Quillback	<i>Carpionodes cyprinus</i>	3
Sea Lamprey	<i>Petromyzon marinus</i>	1
Striped Bass	<i>Morone saxatilis</i>	556
Walleye	<i>Sander vitreus</i>	1

Table 2. Daily American Shad (*Alosa sapidissima*) catch totals, with number of liters stocked/shipped to Van Dyke Hatchery and the associated viability of the shipment for spring 2015 (Note: Viability is only for eggs shipped to hatchery, for eggs stocked the viability is unknown).

Date	Males	Ripe Females	Green Females	Liters Stocked	Liters Shipped	Viability
4/12/2015	13	3	47	0.5		
4/13/2015	9	7	28	1		
4/14/2015	12	33	64		7.1	0.0
4/15/2015	8	7	27	2.5		
4/16/2015	12	41	77		8.1	21.2
4/21/2015	0	7	16			
4/22/2015	7	14	35		5.7	66.2
4/23/2015	19	32	46		10.6	0.0
4/26/2015	28	29	57		7.0	60.0
4/27/2015	3	29	35		7.4	5.0
4/28/2015	21	102	113		37.5	50.9
4/29/2015	26	102	99		38.4	33.0
5/3/2015	16	62	233	4	10.0	0.0
5/4/2015	13	51	171	4	8.0	63.0
5/5/2015	12	15	125	5		
5/6/2015	14	67	167	3	8.0	0.0
5/7/2015	69	189	322	5	22.8	0.5
5/8/2015	2	3	5			
<b>Total</b>	<b>284</b>	<b>793</b>	<b>1,667</b>	<b>25</b>	<b>170.6</b>	

Table 3. Average daily catch per unit effort (CPUE; fish/hour/m<sup>2</sup>) for spawning condition American Shad caught during Potomac River, MD gillnetting in spring 2015. Note: all values were multiplied by a scalar of 1,000.

<b>CPUE</b>		
Males	Male Net	10.64
	Unisex Net	2.16
	Female Net	0.26
Ripe Females	Male Net	4.71
	Unisex Net	9.81
	Female Net	4.35
Green Females	Male Net	12.02
	Unisex Net	17.93
	Female Net	11.04