
**Susquehanna River American Shad (*Alosa sapidissima*)
Restoration
Potomac River Egg Collection, 2012**

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Abstract

During March and April, 2012 we used monofilament gill nets to collect 1,187 adult American shad from the Potomac River (rkm 150). The purpose of sampling was to supply fertilized eggs to Pennsylvania's Van Dyke American Shad Hatchery in support of Susquehanna River American shad restoration efforts. Sampling took place over 23 days and supplied a total of 258 L of American shad eggs (11.2 million) with a 51% fertilization rate resulting in 5.7 million viable eggs. This was the U.S. Fish and Wildlife Service's (Service) seventh year delivering eggs for Susquehanna River American shad restoration, resulting in the second highest number of viable eggs delivered.

Introduction

American shad (*Alosa sapidissima*) are an anadromous pelagic species ranging from Labrador to Florida, along the Atlantic coast (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 at sea. Spawning movements follow a latitudinal cline and although variable, spawning generally peaks from 14 to 21 °C (Stier and Crance 1985). Generally, April is the peak spawning month for American shad in the Potomac River.

Shad were 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, American shad have undergone population fluctuations as a result of anthropogenic effects. Initial population declines resulted from commercial harvest coinciding with increases in human population and gear efficiency. Habitat loss (damming) and degradation (pollution) followed and remain significant challenges to restoration. Attempts to mitigate dam effects on American shad and other Susquehanna River species began in 1866. In that year Pennsylvania drafted an Act, which directed dam owner/operators to maintain fish passage structures (The Native Fish Conservancy 2005). The Act established a commissioner's office that evolved into the Pennsylvania Boat and Fish Commission (The Native Fish Conservancy 2005).

The 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 and its tributaries. 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 Thompsontown, PA. Once there, the shad eggs are incubated until hatching and larvae 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, MD (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. Bottom habitat is characterized by an abrupt transition from the deep channel (≈ 18.3 m) area to relatively shallow depths (≤ 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. Two different types of net were used in 2012 egg collections. One net was for targeting ripe females and the other for targeting ripe males. The net used to target females was 6.1 m deep by 91.4 m long floating monofilament gill net with 14.0 cm stretch mesh panels. The net to target males was 5.2 m deep by 91.4 m long floating monofilament gill net with 11.7 cm stretch mesh. Up to four nets per boat were joined in series and

drifted parallel to shore in water depths ranging from approximately 7.6 to 16.8 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 ($^{\circ}\text{C}$), dissolved oxygen (mg/L), conductivity (microsiemens) and salinity (ppt) were recorded (Yellow Springs Instruments Model 85) each night (Figure 1). The number of running, green, or spent female American shad, ripe male American shad, and bycatch were recorded (Table 1, Figure 2). Gill net effort was recorded but varied since the goal was to maximize catch during each sampling event. Catch per unit effort (CPUE) was calculated as daily combined male and ripe female catch per total hours fished per total net square footage ($\text{CPUE} = (\text{n/hr/m}^2)$). All CPUE values were multiplied by 1000 as a scalar for data display (Figure 1). American shad were sub-sampled for otolith extraction, total length (nearest mm) and weight (nearest 0.25 kilogram). as a permit requirement of the Potomac River Fisheries Commission.

Results

During spring 2012, the Potomac River was sampled a total of 23 days from March 26- April 12. During the 23 days of fishing, ≥ 5.0 L of eggs were collected 17 times (74%). MFRO shipped a total of 258 L (Range = 5.0 – 25.7 L, $\bar{x} = 13.8$ L/shipment) of eggs from the Potomac River (M. Hendricks, pers. comm.). The overall egg viability was 51%, although daily shipments had a range of 6.1 – 69.5% (M. Hendricks, pers. comm.).

Gill netting produced 6,995 fish from the Potomac River, representing ten fish species from six families (Table 1). In 2012, green females were more common than ripe females with a 1.26:1 ratio, but females were more common than ripe males with a 1.50:1 ratio (Figure 2).

From late March to late April, surface water temperature displayed a rising trend while dissolved oxygen decreased (Figure 1). Surface water temperatures ranged from 14.3 to 17.8 °C ($\bar{x} = 16.1$ °C) while dissolved oxygen ranged from 10.3 to 14.1 mg/L ($\bar{x} = 12.3$ mg/L) (Figure 1). CPUE for shad was variable and there was no apparent relation to tide or lunar cycle. CPUE was the highest on the nineteenth day (4/19/2012) of sampling (0.0863/hr/m²) and lowest on the first day (3/26/2012) of sampling (0.019/hr/m²). The highest CPUE values were between the seventeenth day (4/18/2012) and nineteenth day (4/23/2012) of sampling. During this time the CPUE ranged from 0.027/hr/m² to 0.086/hr/ft² with an average of 0.051/hr/m² (Figure 1).

Discussion

American shad harvest in numbers sufficient enough to yield egg shipments was consistent on the Potomac River. The greatest numbers of ripe/running male and female American shad were caught between surface water temperatures of 15.9-16.9 °C as opposed to 2011 sampling when the greatest numbers of ripe/running male and female American shad were collected between water temperatures of 16.8-18.6 °C. As in past years, males were caught continuously throughout the spawning season (Table 2). Catching males throughout the entire sampling season can be directly attributed to continuing to use a smaller mesh gill net during the 2012 season. In the Potomac River males are substantially smaller than females. To collect a higher number of males, at least

one smaller mesh gill net (11.75 cm) was set, along with up to eight larger mesh gill nets (14 cm stretch mesh “female” nets). The smaller mesh nets were used in an effort to keep the sex ratio consistent with one male to two females throughout the entire season. Constant availability of sperm was expected to increase overall egg viability, thus resulting in more fry stocked into the Susquehanna River watershed.

Conclusion

The USFWS provided Pennsylvania with 258 L of eggs, with an overall viability of 51% (5,664,920 viable eggs) (Table 3). An early spring and an unusual increase in water temperature early in the year allowed for fishing consistently throughout the American Shad spawning temperatures. On three occasions this year, fishing did not occur due to high winds and the associated wave heights. The 2012 overall viability of 51% is the greatest viability to date and greater than the seven year average (42%) since Potomac River egg collection began in 2006.

Project Summary

Over the past six years the USFWS has provided Pennsylvania with almost 26 million viable shad eggs.

Year	Volume (L)	Viable Eggs (N)	Viability (%)
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%

Acknowledgements

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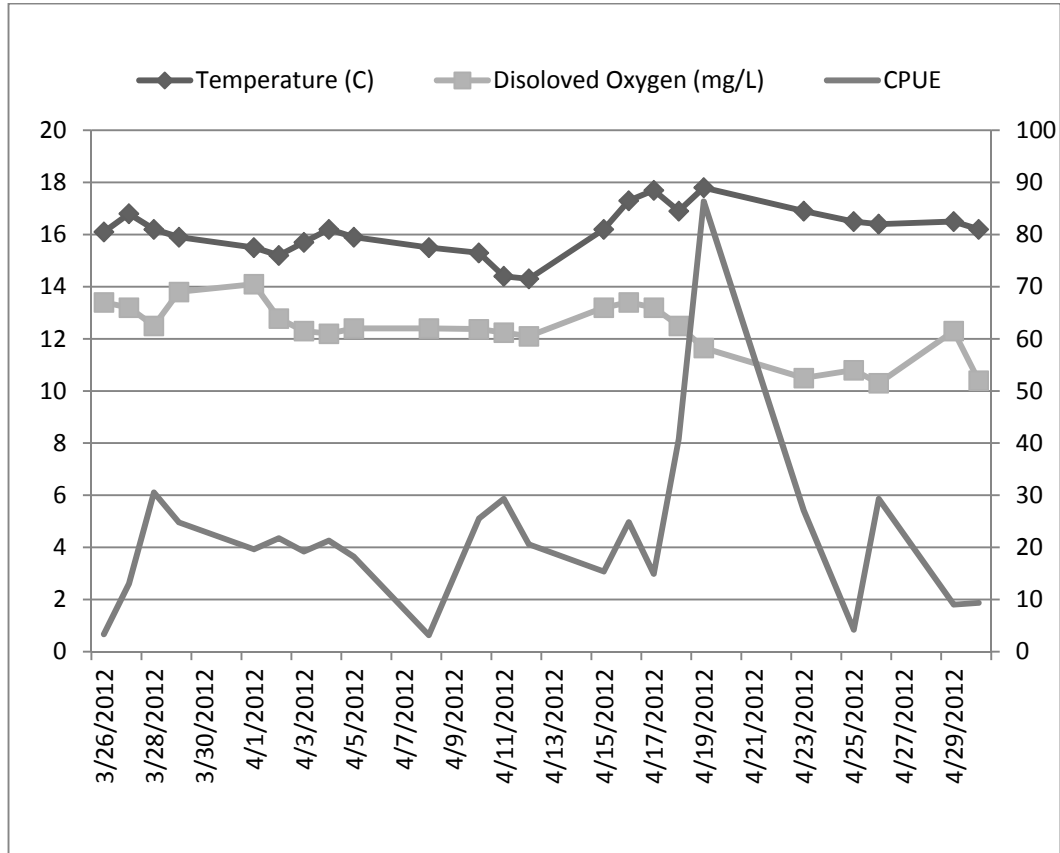


Figure 1. Spring 2012 American shad catch per unit effort, surface dissolved oxygen, and surface temperature, by sample date, for the Potomac River at Marshall Hall, MD. Surface salinity (not depicted) was always ≤ 0.2 ppt.

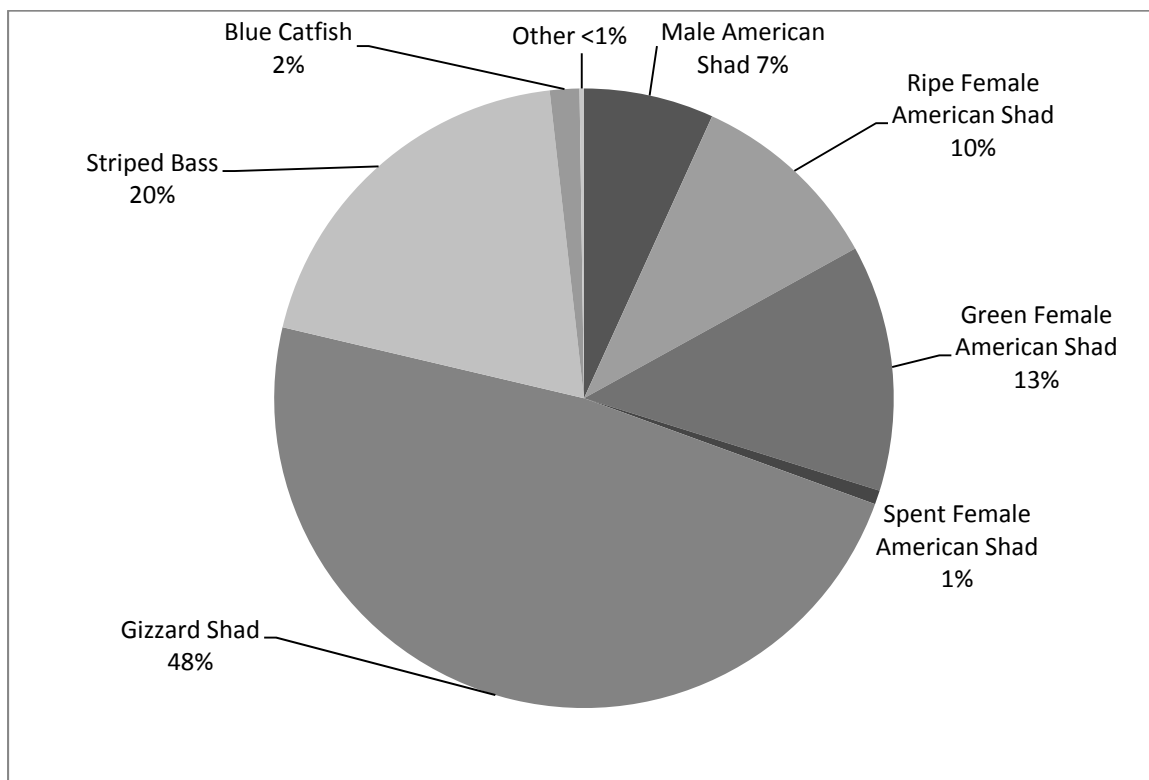


Figure 2. Spring 2012 species composition from Potomac River gill net sampling at Marshall Hall, MD. Other species and number caught listed in Table 1.

Table 1. List of species and number collected in gill nets from the Potomac River during spring, 2012.

Family	Scientific Name	Common Name	Number Captured
Catostomidae	<i>Carpionodes cyprinus</i>	quillback sucker	1
Clupeidae	<i>Alosa mediocris</i>	hickory shad	2
	<i>Alosa sapidissima</i>	American shad	1,187
	<i>Brevoortia tyrannus</i>	Atlantic menhaden	5
	<i>Dorosoma cepedianum</i>	gizzard shad	3,367
Cyprinidae	<i>Carassius auratus</i>	goldfish	2
Ictaluridae	<i>Ictalurus furcatus</i>	blue catfish	108
	<i>Ictalurus punctatus</i>	channel catfish	3
Lepisosteidae	<i>Lepisosteus osseus</i>	longnose gar	3
Moronidae	<i>Morone saxatilis</i>	striped bass	1,367

Table 2. American shad catch totals with respect to male and female ratio, the associated viability and liters of eggs produced during spring, 2012.

Date	Ripe Male	Running Female	Ratio Male:Female	Liters	Viability
3/26/2012	1	1	1:1	0.00	0.00
3/27/2012	17	23	1:1.35	9.00	0.49
3/28/2012	55	28	1.96:1	15.10	0.60
3/29/2012	26	24	1.08:1	13.70	0.70
4/1/2012	36	43	1:1.19	14.80	0.39
4/2/2012	39	60	1:1.53	17.05	0.56
4/3/2012	26	65	1:2.5	15.80	0.63
4/4/2012	49	47	1.04:1	19.40	0.64
4/5/2012	43	8	5.3:1	16.55	0.51
4/8/2012	3	69	1:23	0.00	0.00
4/10/2012	46	55	1.62:1	21.20	0.56
4/11/2012	42	31	1.35:1	16.55	0.59
4/12/2012	29	44	1.51:1	8.05	0.52
4/15/2012	29	81	1:2.79	8.80	0.59
4/16/2012	30	49	1:1.6	9.65	0.06
4/17/2012	22	24	1:1.09	10.20	0.55
4/18/2012	67	28	2.39:1	25.70	0.60
4/19/2012	16	9	1.77:1	0.00	0.00
4/23/2012	47	54	1:1.14	18.50	0.66
4/25/2012	8	36	1:4.5	0.00	0.00
4/26/2012	68	45	1.51:1	17.95	0.12
4/29/2012	6	47	1:7.83	0.00	0.00
4/30/2012	7	28	1:4	0.00	0.00

Table 3. 2012 Shipment and viability summary for American shad eggs, delivered to the Van Dyke Hatchery from various collection sites (Hendricks 2012, unpublished).

Site	Shipments (N)	Volume (L)	Eggs (N)	Viable Eggs (N)	Viability (%)
Potomac R.	17	258.0	11,183,457	5,664,920	51
Delaware R.	12	116.1	8,991,955	694,762	8
Susq.Conowingo	6	60.7	3,827,377	941,595	27
Grand total	35	434.8	24,002,789	7,301,277	30