U.S. Fish & Wildlife Service Susquehanna River American Shad (*Alosa sapidissima*) Restoration: Potomac River Egg Collection, 2013

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Abstract

During March and April, 2013 we used monofilament gill nets to collect 805 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. This year we sampled 25 days and supplied a total of 118 L of American shad eggs (7.5 million) with a 21% fertilization rate resulting in 1.6 million viable eggs. The U.S. Fish and Wildlife Service's eighth season delivering eggs for Susquehanna River American shad restoration resulted in a lower number of viable eggs as in previous years.

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 ^{o}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 in to 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 2013 egg collections. One net size targeted ripe females and the other 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 five 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 (^{o}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 (CPUE= (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 2013 the Potomac River was sampled a total of 24 days from April 8th through May 14th. During the sampling timeframe ≥ 5.0 L of eggs were collected 10 times (41%). MFRO shipped a total of 118 L (Range = 4.7 – 18.1 L, $\bar{x}$ = 11.8 L/shipment) of eggs from the Potomac River (M. Hendricks, pers. comm.). The overall egg viability was 21%, although daily shipments had a range of 0 – 67.4% (J. Tryninewski, pers. comm.).

Gill netting produced 5,111 fish from the Potomac River, representing thirteen fish species from eight families (Table 1). In 2013, green females were more common than ripe females with a 2.21:1 ratio, but ripe females were more common than ripe males with a 2.02:1 ratio (Figure 2).

From early April through mid May, surface water temperature and dissolved oxygen remained fairly consistent.(Figure 1). Surface water temperatures ranged from 12.4 to 19.3 ^{o}C ($\bar{x}$ = 17.1 ^{o}C) while dissolved oxygen ranged from 8.4 to 12.1 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 fourteenth day (4/28/2013) of sampling (0.028/hr/m^2) and lowest on the last day (5/14/2013) of sampling (0.0007/hr/m^2). The highest CPUE values were between the tenth day (4/21/2013) and eighteenth day (5/1/2013) of sampling. During this time the CPUE ranged from 0.012/hr/m^2 to 0.028/hr/ft^2 with an average of 0.015/hr/m^2 (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 16.5-18.2 ^{o}C as opposed to 2012 sampling when the greatest numbers of ripe/running male and female American shad were collected between water temperatures of 15.9-16.9 ^{o}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 2013 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 118 L of eggs, with an overall viability of 21.3% (1,603,498 viable eggs) (Table 3). An unusual increase in water temperature early in the year allowed for fishing consistently throughout the American Shad spawning season. On two occasions his year, fishing did not occur due to high winds and the associated wave heights. The 2013 overall viability of 21% is the lowest viability to date and lower than the eight year average (39%) since Potomac River egg collection began in 2006.

One reason this year's low viability may have occurred is the eggs collected this year were significantly smaller than in years past. In 2012 we averaged 43,346 per liter and had an overall viability of 51%, in 2011 we averaged 45,375 eggs per liter and had an overall viability of 44%. This year we had an average of 63,667 eggs per liter. This leads us to believe that a lot of the eggs that were taken from the females were not viable.

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 (%)
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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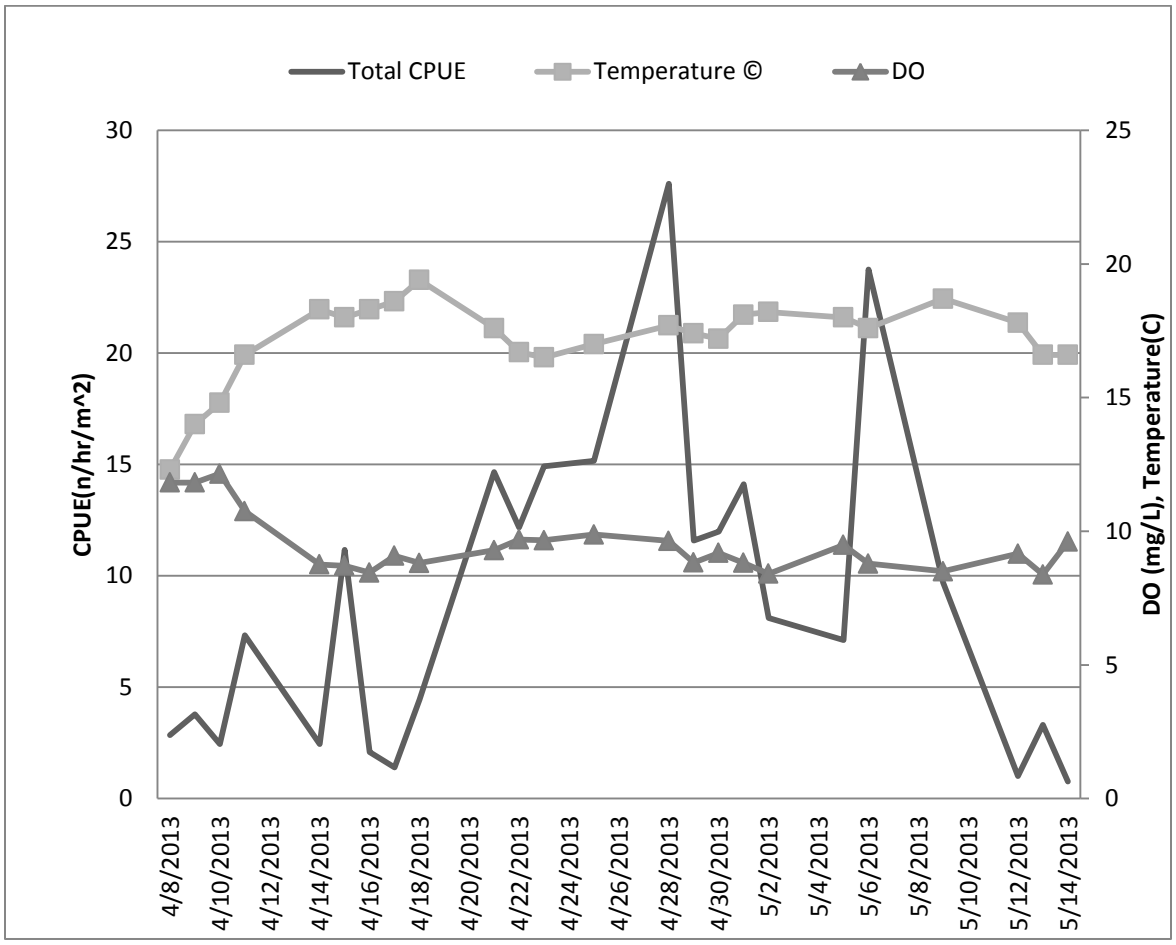

Figure 1. Spring 2013 American shad catch per unit effort, surface dissolved oxygen, and surface temperature, by sample date, for the Potomac River at Marshall Hall, MD. Surface salinity (not depicted) was always ≤ 0.2 ppt.

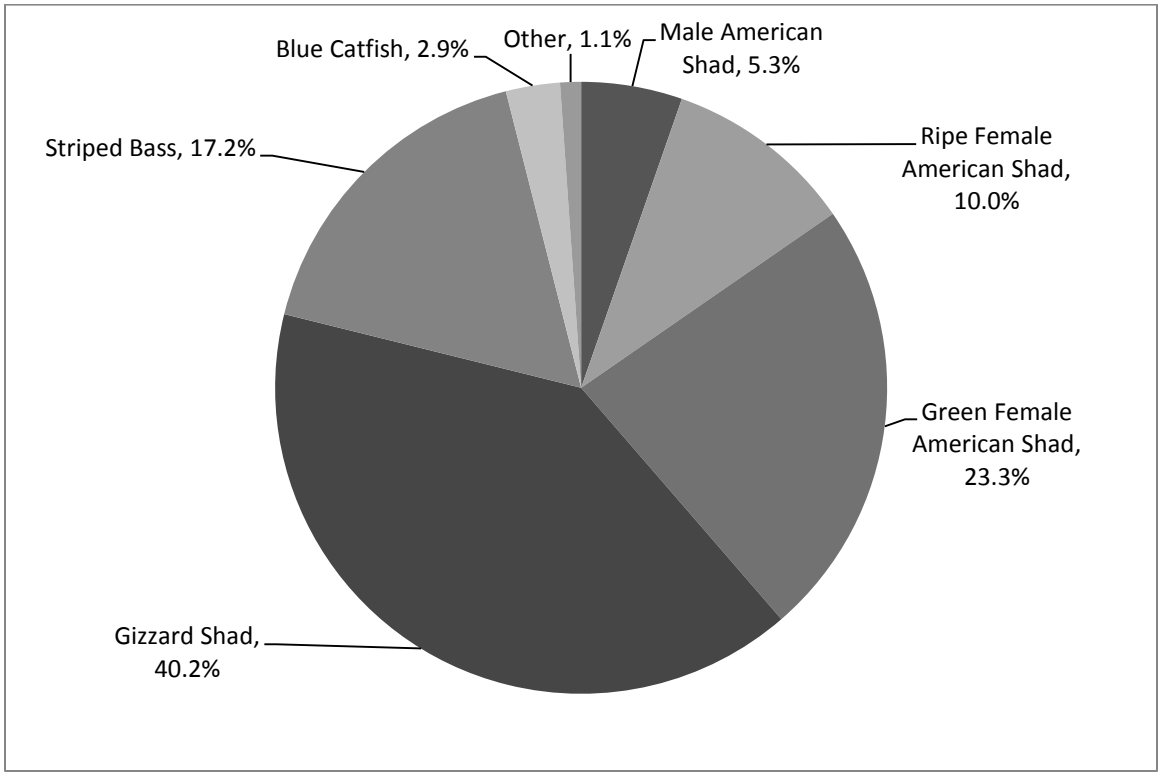

Figure 2. Spring 2013 species composition from Potomac River gill net sampling at Marshall Hall, MD. Other species and number caught listed in Table 1.

Table 1. List of species and number collected in gill nets from the Potomac River during spring, 2013.

Family	Scientific Name	Common Name	Number Captured
Catostomidae	*Carpiodes cyprinus*	quilback sucker	4
Centrarchidae	*Micropterus salmoides*	largemouth bass	2
Channidae	*Channa argus*	northern snakehead	2
Clupeidae	*Alosa mediocris*	hickory shad	4
	Alosa sapidissima	American shad	1972
	Dorosoma cepedianum	gizzard shad	2041
Cyprinidae	*Carassius auratus*	goldfish	2
	Cyprinus carpio	common carp	1
Ictaluridae	*Ameiurus catus*	white catfish	1
	Ictalurus furcatus	blue catfish	145
	Ictalurus punctatus	channel catfish	5
Lepisosteidae	*Lepisosteus osseus*	longnose gar	24
Moronidae	*Morone saxatilis*	striped bass	871

Table 2. American shad catch totals with respect to male and female ratio, the associated viability and liters of eggs produced during spring, 2013. * represents eggs stocked into river, the viability for these eggs is unknown

Date	Ripe Male	Running Female	Ratio Male:Female	Liters	Viability
4/8/2013	8	2	4:01	0	0
4/9/2013	9	3	3:1	1*	
4/10/2013	4	3	1.33:1	1.5*	
4/11/2013	16	5	3.2:1	0	0
4/14/2013	2	5	.4:1	3*	
4/15/2013	10	22	.45:1	3*	
4/16/2013	2	4	.5:1	0	0
4/17/2013	0	4	0:1	0	0
4/18/2013	5	12	.41:1	0	0
4/21/2013	18	24	.75:1	9.5	28%
4/22/2013	6	25	.24:1	10	24%
4/23/2013	9	48	.19:1	15.6	19%
4/25/2013	43	39	1.1:1	15.6	61%
4/28/2013	21	91	.23:1	18.1+2*	0
4/29/2013	6	41	.14:1	11.4	22%
4/30/2013	20	40	.5:1	10.8	12%
5/1/2013	28	25	1.12:1	4*	
5/2/2013	14	25	.56:1	7.6	67%
5/5/2013	12	16	.75/1	4.7	67%
5/6/2013	14	71	.19/1	14.8	7%
5/9/2013	10	23	.43/1	4*	
5/12/2013	1	3	.33:1	0	0
5/13/2013	7	6	1.16/1	1.5*	
5/14/2013	1	2	.5:1	0	0

Table 3. 2013 Shipment and viability summary for American shad eggs, delivered to the Van Dyke Hatchery from various collection sites (Hendricks 2013, unpublished).

Site	Shipments (N)	Volume (L)	Eggs (N)	Viable Eggs (N)	Viability (%)
Potomac R.	10	118.1	7,512,761	1,603,497	21.34
Delaware R.	12	155.7	7,487,618	1,442,990	19.27
Susq.Conowingo	12	125.65	7,186,492	1,528,558	21.27
Grand total	34	399.45	24002789	7301277	20.62