# U.S. Fish & Wildlife Service Susquehanna River American Shad (*Alosa sapidissima*) Restoration: Potomac River Egg Collection, 2007

Ian Park*, Steve Minkkinen, Mike Mangold

To: Mr. Mike Hendricks
Chief, Fish Production Services
PABFC
1735 Shiloh Road
State College, PA 16801

From: U.S. Fish and Wildlife Service
Maryland Fishery Resources Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

15, April 2007

Ian_Park@fws.gov, (410) 573-4503

**Abstract**

During April and May, 2007 we used monofilament gill nets to collect 787 American shad from the Potomac River (rkm 150). The purpose of sampling was to supply viable eggs to the Pennsylvania Van Dyke American Shad Hatchery in support of ongoing Susquehanna River American shad restoration efforts. Sampling took place over a total of 19 days and supplied a total of 183.9 L of American shad eggs (7.5 million) with 42% fertilized for 2.9 million viable eggs. Ripe and green female American shad were equally represented (25.6% ripe, 26.4% green) and proportionally twice that of males (13.5%). The U.S. Fish and Wildlife Service's second attempt to deliver eggs for Susquehanna River American shad restoration resulted in slightly higher numbers of viable eggs despite the reduction of fishing time and collection location. Results from the Potomac River nearly equaled the combined effort from the Delaware and Susquehanna Rivers (3.2 million eggs).

**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 $C^o$ (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. Shad have undergone population fluctuations as a result of anthropogenic effects. In Pennsylvania, American shad are said to have once ruled the waters of the Susquehanna River and its tributaries (The Native Fish Conservancy 2005). 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 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 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 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**

We used 6.1 m deep by 91.4 m long floating monofilament gill nets with 14.0 cm stretch mesh panels on the Potomac River. Multiple nets were joined in series and drifted parallel to shore in depths ranging from approximately 7.6 to 16.8 m. Two small (6.7 m) boats consisting of three to four crew members set as many as three interconnected nets each. 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 ($C^o$), dissolved oxygen (mg/L), conductivity (micromos) and salinity (ppt) were recorded (Yellow Springs Instruments Model 85) each night gill nets were set (Figure 1). The number of running, green, or spent female American shad, ripe male American shad, and bycatch were recorded (Table 1, Figures 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= ($n/hr/ft^2$)). All CPUE values were multiplied by 1000 as a scalar for data display (Figure 1). American shad otolith samples were taken along with total length (nearest mm) and weight (nearest 0.1 gram) from 5% (n=40) of American shad captured. The samples taken were a permit requirement of the Potomac River Fisheries Commission.

**Results**

During spring 2007 we sampled the Potomac River a total of 19 days over a 40 day timeframe. During the 19 days of fishing we collected ≥ 5.0 L of eggs 11 times (57%). We shipped a total of 183.9 L (Range = 3.8 – 40.8 L, $\bar{x}$ = 16.7 L/shipment) of eggs from the Potomac River (M. Hendricks, pers. comm.). The egg viability averaged 42% with a range of 2 – 66% (M. Hendricks, pers. comm.).

Gill net sampling produced 2,009 fish from the Potomac River, nine fish species from six families were represented (Table 1). Ripe and green female American shad were equally represented (25.6% ripe, 26.4% green) and proportionally twice that of

males (13.5%) (Figure 2). Bycatch of striped bass and blue catfish was reduced in comparison to 2006 because nets were set further from shore in deeper waters. Reducing bycatch increased efficiency of spawning operations.

From early April to mid-May, surface water temperature gradually increased and dissolved oxygen displayed a generally descending trend on the Potomac River. However the second week of sampling on the Potomac the surface water temperature dropped drastically before gradually ascending to the minimum spawning temperature (Figure 1). Furthermore the final week of sampling, the dissolved oxygen steadily increased. The Potomac River surface temperatures ranged from 10.2 to 22.4 $C^o$ ($\bar{x}$ = 17.7 $C^o$) while dissolved oxygen ranged from 6.3 to 8.9 ($\bar{x}$ = 7.5 mg/L) (Figure 1). As time progressed CPUE for shad was variable and there was no apparent relation to which tide was fished or lunar cycle. The CPUE was the highest on the first day (4/4/07) of sampling (0.006/hr/$ft^2$) and the lowest on the fourteenth day (5/3/07) of sampling (0.000/hr/$ft^2$). Generally speaking the best trend of CPUE was between the fifth (4/23/07) and eleventh (4/30/07) day of sampling. At this point the CPUE ranged from 0.0015/hr/$ft^2$ to 0.0055/hr/$ft^2$ with an average of 0.0034/hr/$ft^2$.

**Discussion**

American shad harvest in numbers sufficient to yield egg shipments was variable on the Potomac River. The greatest numbers of ripe/running male and female American shad were caught between surface temperatures of 16.2-18.8. Overall the ratio of ripe male to running female was 2:1; however most of the ripe males were caught early in the sampling period when few running females were present. As the spawning season continued and more running females arrived at the spawning ground, the number of ripe

males decreased significantly (Table 2). Had the sex ratio been consistent with one male to two females through the entire season, the overall egg viability may have been substantially higher resulting in more fry to be stocked into the Susquehanna River watershed. On some evenings when male American shad catches were very low male American shad were often shared between Service boats, DC Fisheries, and Maryland Department of Natural Resources (MDDNR) and occasionally re-used. Using sperm extenders to preserve milt for use later in the spawning season, or collecting ripe male American shad from the Conowingo Dam fish lift, in the future should be considered as a way to sustain the high male to female ratio.

The 2007 Potomac River American shad collection provided Pennsylvania with 183.9 L of eggs, with an overall production of 2,875,455 viable eggs (42%) (Table 3 M. Hendricks, pers. comm.). In 2006 the Service provided 99.3 L of eggs from the Potomac River, with an overall production of 2,003,222 viable eggs (44%) ((M. Hendricks, pers. comm.). The 2007 sampling season consisted of 19 days of sampling with an average CPUE of 0.0020/hr/ft$^2$, whereas the 2006 sampling season consisted of 16 days of sampling with an average CPUE of 0.0010/hr/ft$^2$.

**Conclusion**

The Service's second attempt to harvest eggs from the Potomac River for delivery to the Van Dyke American shad hatchery, in support of Susquehanna River restoration, was successful. This year's sampling was hindered by the New York Department of Environmental Conservation decision to not allow American shad collection from the Hudson River. However this years sampling on the Potomac River nearly equaled results

from the Potomac and Hudson River during 2006 and Delaware and Susquehanna Rivers during 2007.

**Acknowledgements**

The Maryland Fishery Resources Office thanks those who participated in this years sampling, Jose Barrios, Sarah Bitter, Gioia Blix, Matthew Breece, Shiela Eyler, Eric Ferree, Emily Loose, Tina McCrobie, and Gretchen Murphy. We would also like to thank Matthew Baldwin from MDDNR.

**References Cited**

Stier, D.J., and J.H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.88). 34 pp.

*The Native Fish Conservancy Home Page*. 2005. Migratory fish restoration and passage on the Susquehanna River. <http://www.nativefish.org/ articles/Migratory_Fish_ Restoration.php>. January 9, 2006.

*U.S. Fish and Wildlife Service Chesapeake Bay Field Office Home Page.* 2006. American shad *Alosa sapidissima*. <http://www.fws.gov/chesapeakebay/SHAD .HTM>. August 8, 2006.

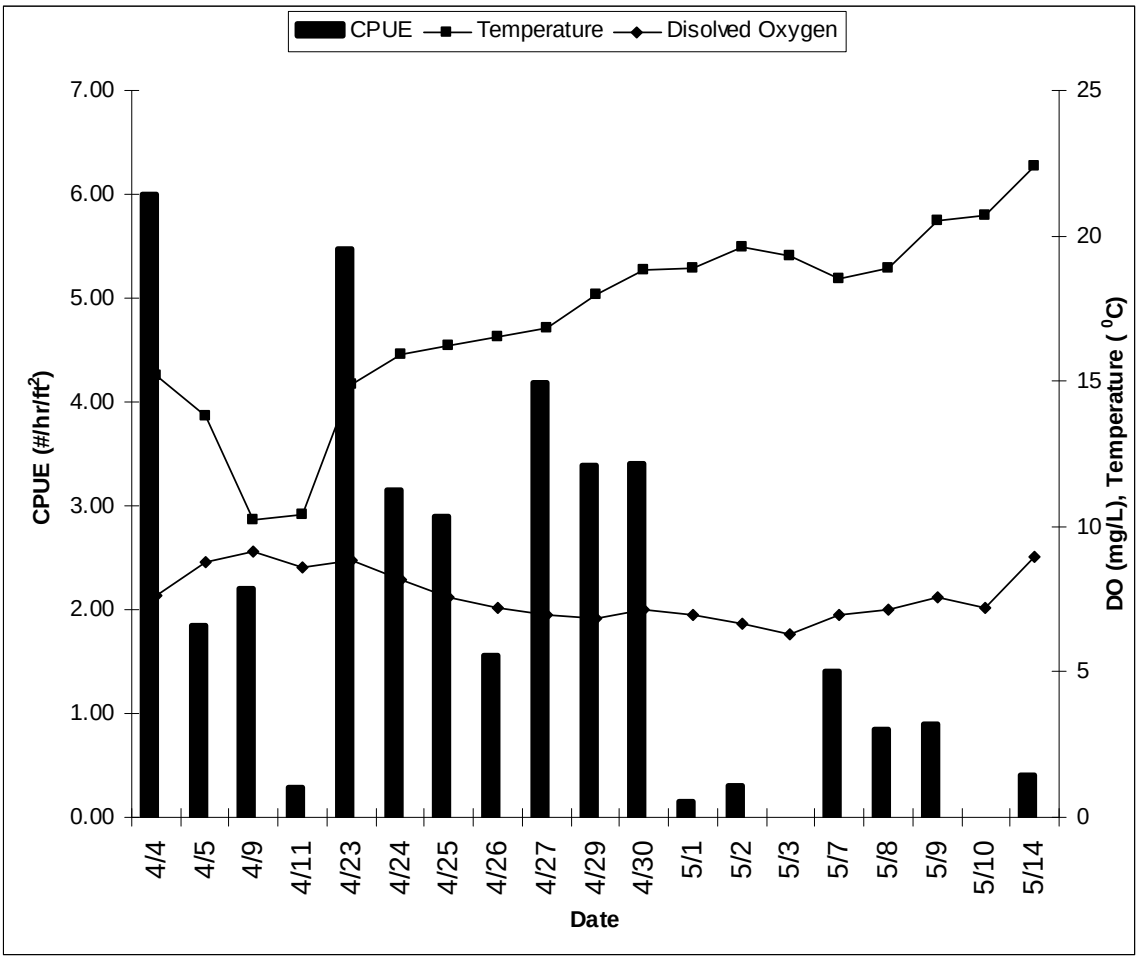


Figure 1. Spring 2007 American shad catch per unit effort, surface dissolved oxygen, and surface temperature, by sample date, for the Potomac River at Marshall Hall, MD. Surface salinity (not depicted) was always ≤ 0.10 ppt.

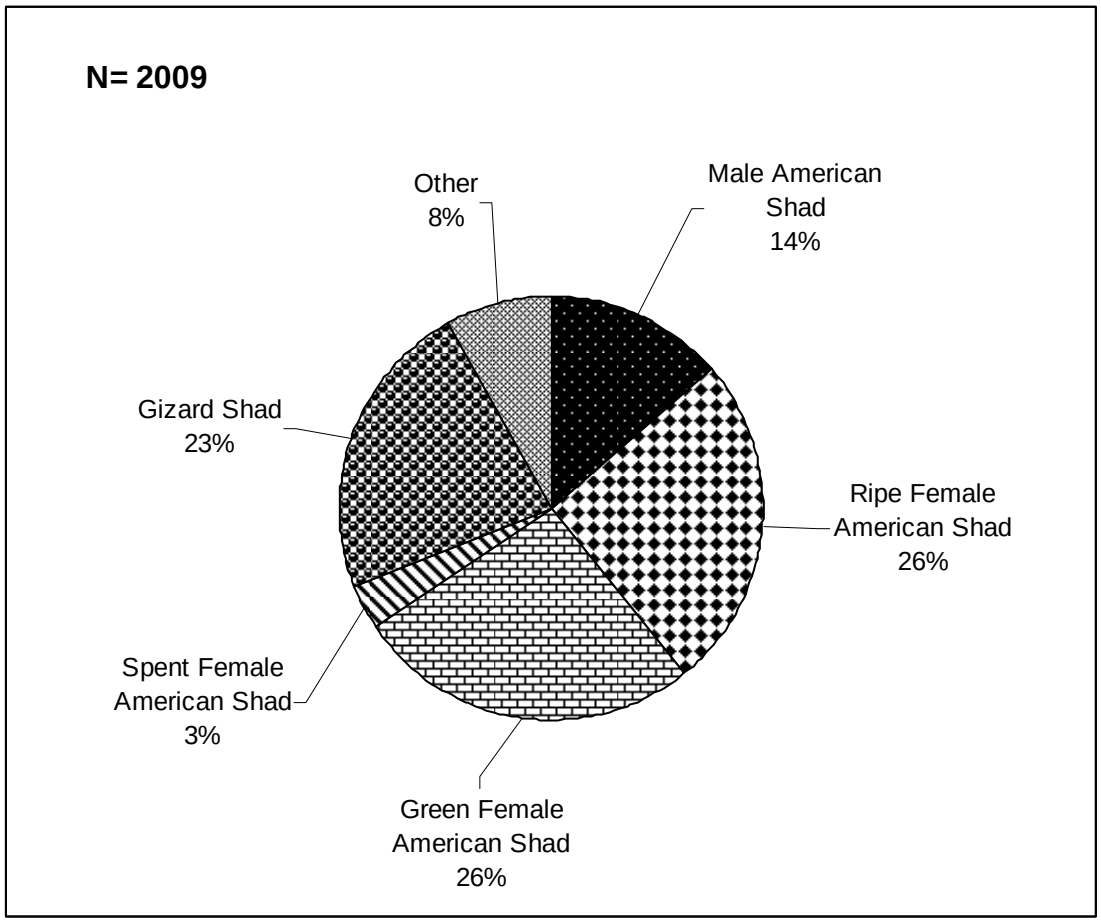


Figure 2. Spring 2007 species composition from Potomac River gill net sampling at Marshall Hall, MD. Other species and number caught listed in Table 1.

Table 1. List of species and number collected in gill nets from the Potomac River during spring, 2007.

| Family | Scientific Name | Common Name | Number Captured |
|---|---|---|---|
| Centrarchidae | *Micropterus salmoide* | largemouth bass | 1 |
| Clupeidae | *Alosa sapidissima* | American shad | 798 |
| | *Dorosoma cepedianum* | gizzard shad | 467 |
| Cyprinidae | *Cyprinus carpio* | common carp | 52 |
| | *Lepisosteus osseus* | longnose gar | 14 |
| Ictaluridae | *Ictalurus punctatus* | channel catfish | 8 |
| Lepisosteidae | *Morone saxatilis* | striped bass | 53 |
| Moronidae | *Ameiurus nebulosus* | brown bullhead | 2 |
| | *Ictalurus furcatus* | blue catfish | 30 |

Table 2. American shad catch totals with respect to male and female ratio and the associated viability and liters of eggs produced during spring, 2007.

| | Ripe Male | Running Female | Ratio Male:Female | Viability | Liters |
|---|---|---|---|---|---|
| 4/4/07 | 15 | 39 | 3:1 | 55% | 12.4 |
| 4/5/07 | 7 | 18 | 3:1 | 16% | 6.2 |
| 4/9/07 | 19 | 3 | 6:1 | 0 | 0 |
| 4/11/07 | 1 | 0 | 1:0 | 0 | 0 |
| 4/23/07 | 119 | 29 | 4:1 | 34% | 11.4 |
| 4/24/07 | 44 | 13 | 3:1 | 0 | 0 |
| 4/25/07 | 14 | 60 | 1:4 | 47% | 25.5 |
| 4/26/07 | 3 | 39 | 1:13 | 47% | 13.8 |
| 4/27/07 | 16 | 97 | 1:6 | 43% | 40.8 |
| 4/29/07 | 3 | 74 | 1:24 | 2% | 21.5 |
| 4/30/07 | 12 | 80 | 1:7 | 49% | 33.8 |
| 5/1/07 | 2 | 2 | 1:1 | 0 | 0 |
| 5/2/07 | 2 | 6 | 1:3 | 0 | 0 |
| 5/3/07 | 0 | 0 | 0 | 0 | 0 |
| 5/7/07 | 9 | 10 | 1:1 | 66% | 3 |
| 5/8/07 | 0 | 16 | 1:16 | 33% | 7 |
| 5/9/07 | 5 | 19 | 1:4 | 13% | 7.8 |
| 5/10/07 | 0 | 0 | 0 | 0 | 0 |
| 5/14/07 | 1 | 10 | 1:10 | 0 | 0 |

Table 3. 2007 American shad egg shipment and viability summary from collection sites delivered to the Van Dyke American Shad Hatchery near Thompsontown, PA (Hendricks 2007, unpublished).

| Site | Shipments (N) | Volume (L) | Eggs (N) | Viable Eggs (N) | Viability (%) |
|---|---|---|---|---|---|
| Potomac R. | 11 | 183.9 | 7,488,716 | 2,875,455 | 42% |
| Delaware R. | 15 | 135.8 | 6,457,563 | 2,337,598 | 39% |
| Susquehanna R. | 12 | 84 | 6,773,594 | 603,345 | 9% |
| **Total** | 38 | 403.7 | 20,719,874 | 5,816,398 | 28% |