

AMERICAN SHAD SPAWNING TESTS CONDUCTED AT CONOWINGO DAM, SPRING 2015

INTRODUCTION

The Conowingo Dam West Fish Lift was built in 1972 and has been operated annually during the months of April, May and early June. Initially it was an integral part of the anadromous fish restoration effort, which combined the operation of the West Fish Lift, hand sorting of target species and a fleet of transport trucks to carry American shad and other Alosids to upriver release sites. Since the completion of permanent fish lifts at Conowingo Dam (1991), Holtwood and Safe Harbor Dam (1997), and a fish ladder at York Haven Dam (2000), the role of the Conowingo West Fish Lift changed. Beginning in 2001, the Conowingo West Fish Lift has operated under contract as (1) a source of fishes for special on-site spawning studies to provide the PA Fish and Boat Commission Van Dyke Shad Hatchery with a source of fertilized American shad eggs, (2) provide adult shad for studies conducted by the Maryland Department of Natural Resources at the Manning Hatchery and (3) a source of otoliths and scales from adult American shad to analyze the age structure and origin of returning adult shad. The West Fish Lift operated 6-8 hours per day and six days per week from late April through early June typically captures 3,000 to 10,000 adult American shad. Most of these fish are in a pre-spawn condition and based on studies at the USFWS Lamar facility many of these fish could be induced to spawn within several days after injection of hormone implants. The advantage of conducting spawning studies on site at Conowingo Dam rather than at a distant hatchery is the elimination of stress associated with lengthy transport times.

Hormone induced hickory shad spawning tests began at the Conowingo West Fish lift in 2003 and were conducted annually through 2008. In 2009 and 2011, hickory shad spawning tests were successfully conducted without the use of hormones. No hickory shad spawning tests were

conducted in 2010 or 2012 through 2015 by Normandeau Associates, Inc. In 2013, Maryland Department of Natural Resources (MDDNR) utilized one of our spawning tanks at Conowingo Dam for two late season hickory shad trials using no hormones because of issues they were having at the Manning Hatchery.

METHODS AND MATERIALS

The methods used to conduct the hormone induced spawning tests at the Conowingo West Fish Lift in 2015 were generally similar to those used in the past fifteen years. Beginning with the 2008 tests and continuing for the 2015 tests, the study plan for the American shad spawning tests was submitted to the U.S. Department of Interior Fish and Wildlife Service Aquatic Animal Drug Approval Partnership Program, Bozeman MT, for approval. The approved American shad study plan for 2015 was assigned Study Number 11-375-15-004. The study protocols for the use of Salmon Gonadotropin-Releasing Hormone Analog (sGnRHa) under the investigational new animal drug (INAD) #11-375 required the use of hormone pellets manufactured solely by Syndel Industries Inc. The smallest dose of sGnRHa available from Syndel is 75ug per pellet and all treatment fish except eight males from the last spawning trial received this dose in the 2015 tests. Other requirements under this INAD included keeping detailed records of hormone inventory, collecting length and weight data on test fish and reporting results to Bozeman MT. Hormone injected fish that survive the spawning tests also cannot be released back into the river and must be euthanized. In the 2008 spawning tests with hickory and American shad, both species received hormone injections and each species received a separate Study number. Since the 2009 and 2011 spawning tests with hickory shad did not include hormone injections, those tests were not subject to the same INAD protocols which applied to the American shad tests. Spawning tests for American shad were conducted in a 10 ft diameter or 12 ft diameter fiberglass tank. These two tanks were assembled on-site at the West Fish Lift in early April and plumbed in a configuration identical to that used since 2001 (Figure 1). Both tanks were supplied with

approximately 40 gallons per minute of river water through a wall mounted 2-inch fitting. A screened 4-inch PVC drainpipe in the bottom of each tank provided the only exit for the demersal shad eggs and water from the tank. The water level in both spawning tanks was maintained by an external standpipe that also provided a source of water for the rectangular 72 by 36 by 16 inch raised egg collection tank. The calculated volumes for the 10 ft and 12 ft tanks were 6,400 and 9,200 liters, respectively. An egg sock fastened to the discharge from the spawning tank prevented the eggs from exiting the egg tank via the standpipe drain that maintained the water level in the egg tank.

Individual tests with hormone treated American shad lasted 2 to 3 days and were usually terminated following the first large pulse of eggs. With the approval of the Bozeman Montana office, no control fish were utilized in 2015. This request to eliminate controls was prompted by the anticipation of an abbreviated testing/spawning season.

Oxygen and temperature were monitored daily in the spawning tanks during each test. The egg sock was examined daily during each spawning test. Following the initial pulse of egg production (usually the second morning after hormone injection) the eggs were removed from the sock and placed into a 10 gal plastic bucket. The eggs were then sieved using a colander with 0.25 in holes to remove scales and other debris. After sieving, the eggs were transferred to a framed nylon net suspended in the egg tank. A No. 20 standard testing sieve was used to transfer the washed eggs from the nylon net into a graduated 2 liter measuring cup. Volume measurements in the field were approximations. The final volume and viability determinations for all shipments were made at the PFBC Van Dyke Hatchery. The packaging of eggs for shipment followed well-established techniques. Up to five liters of water hardened eggs were mixed with 5 liters of river water in double plastic bags. Pure oxygen was introduced into the inner bag before being sealed with tape or rubber band. The bags were placed into marked

insulated shipping containers and driven to the Van Dyke Hatchery by PFBC or Normandeau personnel; eggs were always driven to the hatchery on the same day they were collected.

No attempts were made to hand strip American shad following their removal from the spawning tanks. Hormone injected fish that survived to the end of each test were disposed of in an offsite pit. River release of hormone laden fish is prohibited under the INAD agreement that is in effect.

The Conowingo West Fish Lift was the source of all 558 pre-spawned American shad used in this year's spawning tests. All fish were measured for total length and a sub-sample (182) of weights was taken prior to placement of fish into the spawning tanks. Some American shad were kept in oxygenated holding tanks for up to 2 days until a sufficient number of shad needed to stock a spawning tank was collected.

RESULTS

A total of ten on-site spawning tests with 558 American shad from 29 April to 27 May produced 58.2 liters of eggs (Table 1 and Appendix Table A-1). A total of 58.2 liters of eggs were shipped to the Van Dyke Hatchery and no eggs were released into the river below Conowingo Dam. The overall estimated viability of the eggs shipped to Van Dyke was 7.9% (Table 1). The total volume of eggs produced per female in 2015 (0.266 liters) was slightly below the average of 0.287 liter observed for the previous ten years (Figure 2). The volume of viable eggs produced per female in the 2015 tests averaged 0.021 liters (Figure 2) and was the second lowest volume since 2001. Injected fish usually produced the first and largest pulse of eggs within 48 hrs followed by little or no egg production past 72 hrs. Water temperatures and dissolved oxygen levels in the spawning tanks were monitored daily and ranged from 15.0 to 24.5°C and 4.5 to 10.1 ppm, respectively. The overall mortality rate for adult American shad during the 2015 tests was 8.1%. Mortality rates have ranged from 2 to 15% in previous years (Table 2).

SUMMARY

This was the 15th year of hormone induced American shad spawning tests at the Conowingo West Fish Lift. The overall viability (7.9%) of the 2015 American shad eggs was below the ten year average of 18.0% (Table 2). Ten spawning test groups were completed at the Conowingo West Fish Lift and the entire supply of hormone pellets on-hand was utilized. After using all the hormone pellets, an effort was made to collect American shad to conduct a control spawning trial. After operating for two days and not collecting enough American shad in good condition, the control spawning trial was aborted. Due to low river flows in May 2015 and warm air temperatures, ambient river water temperature rose above 21.0°C as early as 9 May and may have affected viable egg production this season. Nearing the end of May, river temperature reached 23.0°C and many of the American shad caught at the West Lift were spent, partially spent or in poor physical condition. This combination of conditions, along with the partially spent and spent American shad, resulted in termination of the Conowingo West Fish Lift operations and American shad spawning trials.

TABLES AND FIGURES

Table 1.

Summary of egg production data for hormone(sGnRHa) induced spawning tests conducted with American shad at Conowingo Dam and shipped to the Van Dyke Shad Hatchery, Spring, 2015.

Test Group	Start/Stop Date	Male/Female	Liters Collected	River Release	Release Date	Total Liters Shipped	Date Shipped
1	5-3/5-6	36/18	4.9			4.9	6-May
2	5-9/5-11	30/20	4.0			4.0	11-May
3	5-9/5-12	32/18	2.2			2.2	11-May
			3.5			3.5	12-May
4	5-12/5-15	30/24	7.5			7.5	15-May
5	5-13/5-17	45/30	7.2			7.2	15-May
			2.0			2.0	17-May
6	5-15/5-17	30/20	5.8			5.8	17-May
7	5-17/5-19	45/30	6.2			6.2	19-May
8	5-17/5-19	30/20	5.0			5.0	19-May
9	5-19/5-21	30/20	5.7			5.7	21-May
10	5-21/5-23	31*/19	4.2			4.2	23-May
Totals		339/219	58.2			58.2	

* 23 of the 31 males were injected with the hormone; 8 males received no hormone injection

Shipping Date	Liters Shipped	No. eggs	No. Viable	Viabil.(%)
6-May	4.9	217,394	0	0.0
11-May	6.2	317,392	36,743	11.6
12-May	3.5	246,237	97,959	39.8
15-May	14.7	878,118	8,534	1.0
17-May	7.8	414,366	1,539	0.4
19-May	11.2	686,962	111,524	16.2
21-May	5.7	425,001	0	0.0
23-May	4.2	259,877	17,063	6.6
Totals	58.2	3,445,347	273,362	7.9

Total Males	339
Total Females	219
Total Fish	558
Mean egg vol.(liters) / test group	5.8
Mean No. of Eggs / Liter	59,198
Mean No. of Eggs / Female	15,732
Mean No. of Viable Eggs / Female	1,248

Table 2.

Summary of hormone induced spawning trials with American shad at Conowingo Dam, 2001-2015.

<i>Year:</i>	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Start/Finish date	4-30/6-4	4-24/6-6	4-28/6-5	4-27/5-27	4-27/6-6	4-20/6-3	5-4/5-30	4-25/6-6	4-30/5-29	4-30/5-29	5-12/6-7	4/24/5-31	4-24/5-28	4-22/5-30	4-29/5-27
Tank diameter (ft)	12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12	10,12
Tank volume (liters)	9,200	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
Number of test groups	10	10	12	10	11	20	14	16*	16*	17*	15	8	16	4	10
Total fish	599	1,000	1,504	1,055	1,135	1,557	1,504	1010	994	1,075	936	481	968	266	558
Males/Females per trial	36/24	66/34	75/50	75/50	75/50	47/31	75/50	38/25	37/25	37/25	36/26	36/24	36/24	39/27	34/22
Stocking density (fish/liters)	1/153	1/156	1/125	1/125	1/125	1/124	1/125	1/125	1/125	1/125	1/125	1/125	1/125	1/125	1/125
Male:Female ratio	3:2	2:1	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2	3:2
Hormone injected	LHRHa	sGnRHa	LHRHa	LHRHa	LHRHa	LHRHa	LHRHa	sGnRHa							
Liquid, Pellet	P	P	L+P	L+P	L+P	L+P	L+P	P	P	P	P	P	P	P	P
Dose (ug) Male/Female	75/150	150/150	150/150	150/150	150/150	150/150	25-45/75-95	75/75	75/75	75/75	75/75	75/75	75/75	75/75	75/75
Eggs collected (liters)	103	146.8	234	90.4	160.5	169.25	89.6	110.5	98.7	122.2	116.9	64.5	131.8	20.4	58.2
Liters of eggs /Female	0.429	0.432	0.387	0.244	0.418	0.270	0.148	0.272	0.318	0.279	0.3	0.338	0.341	0.185	0.266
No. eggs/liter	63,140	51,235	51,187	59,775	53,828	60,747	80,638	58,429	60,864	63,699	69,179	63,054	57,172	55,244	59,198
Total number of eggs shipped	6,503,420	7,521,346	11,970,764	5,403,660	7,998,778	10,281,444	6,773,594	5,749,467	5,885,504	7,344,503	7,362,613	3,827,377	7,186,492	1,126,974	3,445,347
Viability (%)	33.2	10.1	17.7	20	23.9	21.7	8.9	9.8	23.2	18.2	15.7	24.6	21.3	12.2	7.9
Total number of viable eggs	2,159,135	760,935	2,118,852	1,080,732	1,913,801	2,232,459	603,345	526,816	1,366,478	1,334,705	1,156,430	941,595	1,528,559	137,021	273,362
Total liters of viable eggs	34.20	14.85	41.42	18.1	35.6	36.75	7.97	9.64	22.45	20.95	16.72	14.93	26.74	2.48	4.62
Adult mortality rate (%)	6.0	3.6	2.0	11.5	3.3	3.5	8.3	10.3	15.0	10	9.4	10.7	5.7	9.4	8.1

*Includes 3-4 control groups

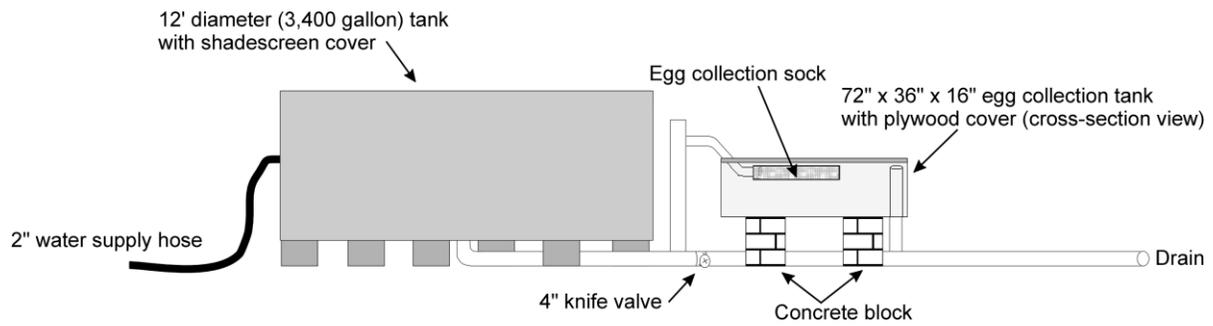


Figure 1

Schematic of tank spawning system used at Conowingo Dam West Fish Lift.

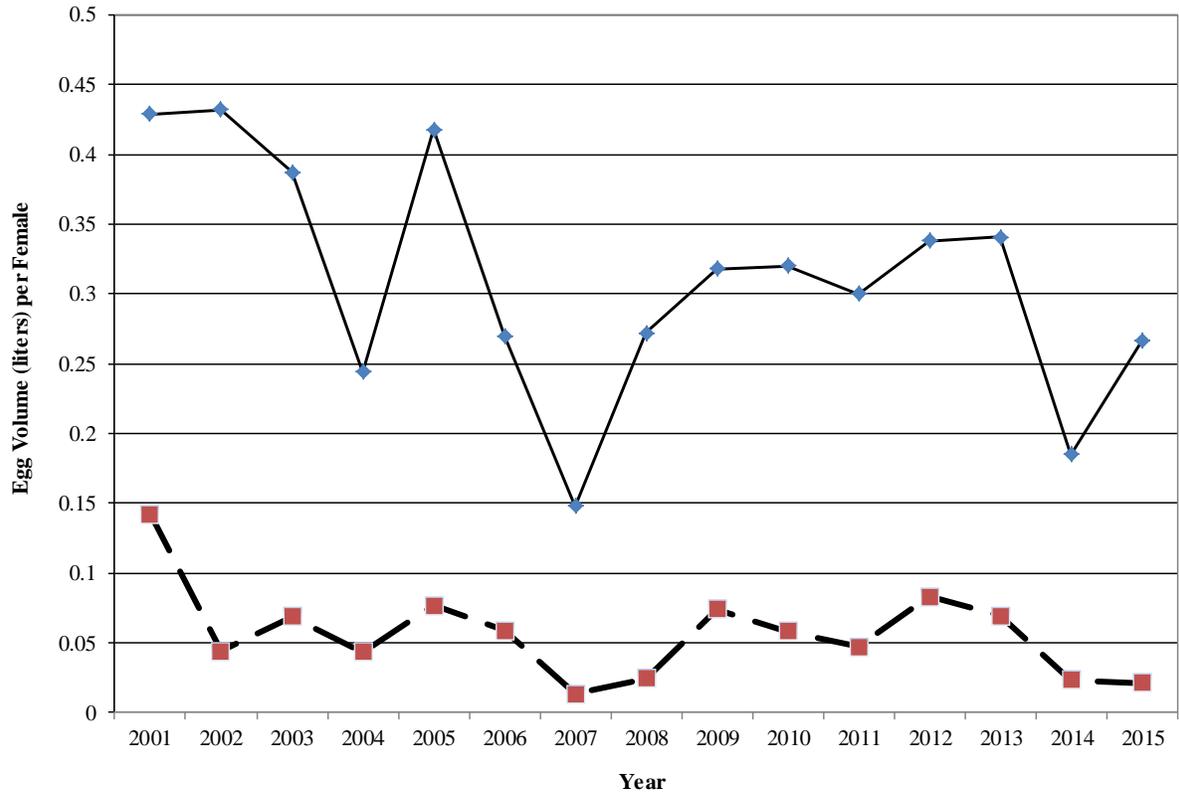


Figure 2. Comparison of total American shad egg volume (solid line) and viable egg volume (broken line) per female for the spawning tests conducted at Conowingo Dam, 2001-2015.

APPENDIX A

Appendix Table A-1.

Individual test group data for hormone induced American shad spawning tests conducted at Conowingo Dam West Fish Lift, Spring 2015.

Test Group 1							
M/F	36/18	10 ft tank					
Start Date	5/3/15			Dose/fish 75 ug sGnRH _a (pellet implant)			
End Date	5/6/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/3/15	1700	15.0	9.4				0
5/4/15	0815	15.0	9.3				0
5/4/15	1920	16.2	9.0				0
5/5/15	0900	16.0	9.3				0
5/5/15	1815	17.4	10.1				0
5/6/15	0800	18.0	10.0	5.0	5.0	0	5M; 6F

Test Group 2							
M/F	30/20	10 ft tank					
Start Date	5/9/15			Dose/fish 75 ug sGnRH _a (pellet implant)			
End Date	5/11/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/9/15	1300	20.2	8.0				0
	1800	20.2	8.0				0
5/10/15	0800	20.0	7.6				0
	1830	20.9	7.2				0
5/11/15	0900	21.2	6.8	4.0	4.0	0	3F; 1M

Test Group 3							
M/F	32/18	12 ft tank					
Start Date	5/9/15			Dose/fish 75 ug sGnRH _a (pellet implant)			
End Date	5/12/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/9/15	1800	20.8	7.6				0
5/10/15	0800	20.0	7.7				0
	1830	20.9	7.1				0
5/11/15	0900	21.2	7.5	2.5	2.5	0	0
	1745	22.8	6.1				0

5/12/15	0900	22.5	6.4	3.9	3.9	0	4F; 5M
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Appendix Table A-1.
Continued.

Test Group 4							
M/F	30/24	10 ft tank					
Start Date	5/12/15	Dose/fish 75 ug sGnRH _a (pellet implant)					
End Date	5/15/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/12/15	1715	23.2	5.0				0
5/13/15	0900	23.0	7.1				1M
	1645	23.5	7.0				0
5/14/15	0900	22.2	7.9				2F
	1530	23.0	7.3				0
5/15/2015	900	21.5	8.2	8.0	8.0	0	1M

Test Group 5							
M/F	45/30	12 ft tank					
Start Date	5/13/15	Dose/fish 75 ug sGnRH _a (pellet implant)					
End Date	5/17/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/13/15	1645	23.2	6.0				0
5/14/15	0900	22.2	6.6				0
	1530	23.0	6.4				0
5/15/15	0900	21.5	6.8	7.4	7.4	0	1M
	1650	21.9	4.6				0
5/16/15	0845	22.0	6.5				1M
	1400	23.0	5.3				0
5/17/2015	0800	22.5	5.8	2.4	2.4	0	0

Test Group 6							
M/F	30/20	10 ft tank					
Start Date	5/15/15	Dose/fish 75 ug sGnRH _a (pellet implant)					
End Date	5/17/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/15/15	1645	22.0	5.8				0
5/16/15	0845	22.2	7.2				0
	1400	23.0	6.6				0

5/17/15	0800	22.5	7.4	6.5	6.5	0	1M; 1F
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**Appendix Table A-1.
Continued.**

Test Group 7							
M/F	45/30	12 ft tank					
Start Date	5/17/15			Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/19/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/17/15	1600	23.2	5.2				0
5/18/15	0900	23.0	5.5				0
	1600	24.5	4.5				0
5/19/15	0800	23.0	6.0	6.2	6.2	0	6F; 1M

Test Group 8							
M/F	30/20	10 ft tank					
Start Date	5/17/15			Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/19/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/17/15	1600	23.2	6.3				0
5/18/15	0900	23.0	7.0				0
	1600	24.5	6.4				0
5/19/15	0800	23.0	7.5	5.0	5.0	0	0

Test Group 9							
M/F	30/20	10 ft tank					
Start Date	5/19/15			Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/21/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/19/15	1715	23.5	6.7				0
5/20/15	1100	23.5	8.3				1F
	1830	24.0	8.2				0
5/21/15	0830	22.0	9.3	5.9	5.9	0	2M; 2F

Appendix Table A-1.
Continued.

Test Group 10							
M/F	31/19	10 ft tank	Injected w/ hormone 23M and 19F, 8 males no hormone.				
Start Date	5/21/15		Dose/fish 75 ug sGnRHa (pellet implant)				
End Date	5/23/15						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/21/15	1300	22.2	8.3				0
5/22/15	0830	21.8	8.9				0
	1845	22.3	8.5				0
5/23/15	0815	21.5	9.6	4.5	4.5	0	1M