AMERICAN SHAD SPAWNING TESTS CONDUCTED AT CONOWINGO DAM – 2012

NORMANDEAU ASSOCIATES, INC.
1921 River Road
Drumore, Pennsylvania 17518

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 when operated 6-8 hours per day and six days per week from late April through early June typically captures 3,000 to10,000 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.

METHODS AND MATERIALS

The methods used to conduct the hormone induced spawning tests at the Conowingo West Fish lift in 2012 were generally similar to those used in the past ten years. Beginning with the 2008 tests and continuing for the 2012 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 2012 was assigned Study Number 11-375-11-8. 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 was 75ug per pellet and all treatment fish received this dose in the 2012 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 gpm 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 2012. This request to eliminate controls was prompted by the anticipation of an abbreviated testing/spawning season. Because of additional Exelon Relicensing studies scheduled in 2012 requiring the use of adult shad, the demand for American shad was high. The Conowingo adult shad turbine survival study required 323 fish. The Conowingo EFL upstream fish passage effectiveness study required 35 adult shad from the WFL as angling for adult shad was not productive after early May, and the York Haven downstream fish passage study required 64 shad. Also, an additional 148 shad were utilized for the PPL Holtwood PIT-tag study.

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 481 pre-spawned American shad used in this year's spawning tests. All fish were measured for total length and a sub-sample (133) 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 eight on-site spawning tests with 481 American shad from 24 April to 29 May produced 64.5 liters of eggs (Table 1 and Appendix Table A-1). Over 60.7 liters of eggs were shipped to the Van Dyke Hatchery and the remaining 3.8 liters were released into the river below Conowingo Dam. The overall estimated viability of the eggs shipped to Van Dyke was 24.6% (Table 1). The total volume of eggs produced per female in 2012 (0.338 liters) was slightly above the average of 0.320 liter observed for the previous ten years (Figure 2). The volume of viable eggs produced per female in the 2012 tests averaged 0.083 liters (Figure 2) and was the highest 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 oxygen levels in the spawning tanks were monitored daily and ranged from 15.3 to 26.8°C and 5.4 to 10.8 ppm. The overall mortality rate for adult American shad during the 2012 tests was 6.9%. Mortality rates have ranged from 2 to 15% in previous years (Table 2).

SUMMARY

This was the 12th year of hormone induced American shad spawning tests at the Conowingo West Fish Lift. The overall viability (24.6%) of the 2012 American shad eggs was above the ten year average of 18.4% (Table 2). The demand for adult American shad for other studies and the unexpected difficulty of collecting sufficient numbers of shad on a regular basis were the reasons a full complement of 15± tests with 936 injected fish could not be completed before the end of the American shad run that typically ends in early June. The elimination of control tests enabled eight spawning test groups to be completed from the West Lift. During the end of May and the first day of June, river temperature reached 26.0°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 resulted in poor egg production for the last spawning test.

TABLES

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, 2012.

Test Group	Start/Stop Date	Male/Female	Liters Collected	River Release	Release Date	Total Liters Shipped	Date Shipped
1	4-24/4-26	45/30	12.5			12.5	26-Apr
2	4-24/4-26	30/11	2.1			2.1	26-Apr
3	4-27/4-29	45/30	10.3			10.3	29-Apr
4	5-1/5-3	30/20	7.1			7.1	3-May
5	5-4/5-6	45/30	14.9			14.9	6-May
6	5-21/5-23	30/20	8.2			8.2	23-May
7	5-24/5-26	45/30	5.6			5.6	26-May
8	5-29/5-31	20/20	3.8	3.8	31-May		
Totals		**290/191**	**64.5**	**3.8**		**60.7**	

Shipping Date	Liters Shipped	No. eggs	No. Viable	Viabil.(%)
26-Apr	12.5	639,385	124,831	19.5%
26-Apr	2.1	129,107	25,206	19.5%
29-Apr	10.3	929,657	236,061	25.4%
3-May	7.1	353,400	47,453	13.4%
6-May	14.9	921,945	358,954	38.9%
23-May	8.2	507,379	74,385	14.7%
26-May	5.6	346,503	74,705	21.6%
Totals	**60.7**	**3,827,376**	**941,595**	**24.6%**

Total Males	**290**
Total Females	**191**
Total Fish	**481**
Mean egg vol.(liters) / test group	**8.0625**
Mean No. of Eggs / Liter	**63,054**
Mean No. of Eggs/Female	**20,039**
Mean No. of Viable Eggs/ Female	**4,930**

Table 2.

Summary of hormone induced spawning trials with American shad at Conowingo Dam, 2001-2012.

Year:	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
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	4-23/6-1
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
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
Number of test groups	10	10	12	10	11	20	14	16*	16*	17*	15	8
Total fish	599	1,000	1,504	1,055	1,135	1,557	1,504	1010	994	1,075	936	481
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	36/23
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
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
Hormone injected	LHRHa	sGnRHa	LHRHa	LHRHa	LHRHa	LHRHa	LHRHa	sGnRHa	sGnRHa	sGnRHa	sGnRHa	sGnRHa
Liquid, Pellet	P	P	L+P	L+P	L+P	L+P	L+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
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
Liters of eggs /Female	0.429	0.432	0.387	0.244	0.418	0.270	0.148	0.272	0.318	0.279	0.298	0.338
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
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	3,827,376
Viability (%)	33.2	10.1	17.7	20	23.9	21.7	8.9	9.8	23.2	18.2	15.7	24.6
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
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
Adult mortality rate (%)	6.0	3.6	2.0	11.5	3.3	3.5	8.3	10.3	15.0	10	9.4	6.9

*Includes 3-4 control groups

FIGURES

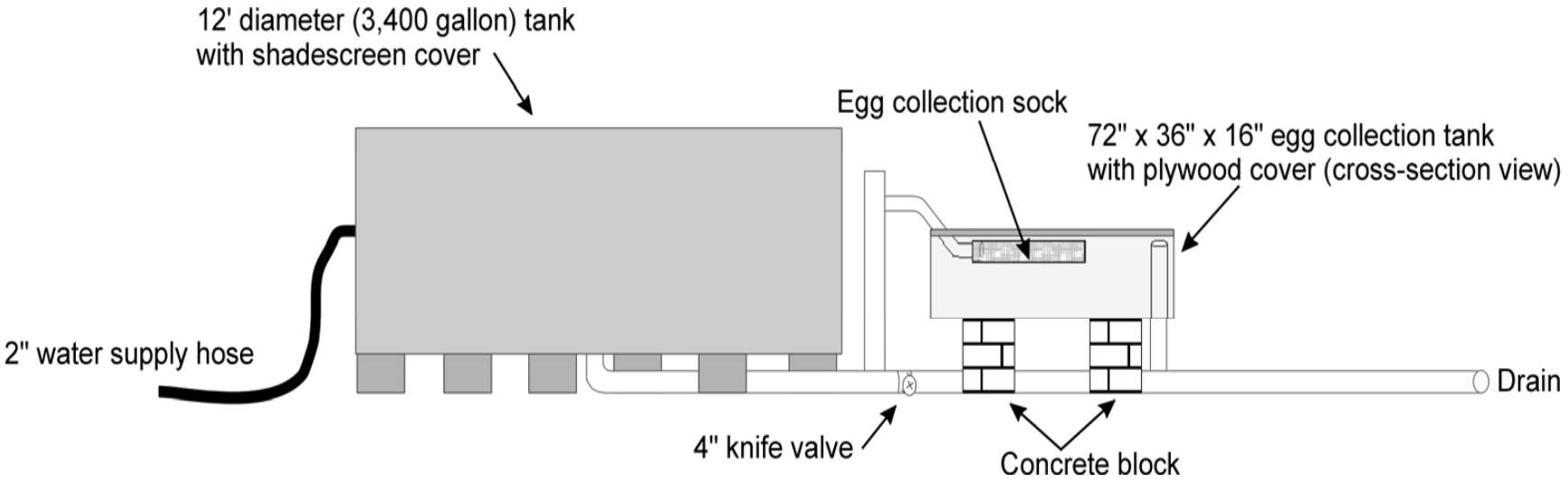

Figure 1

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

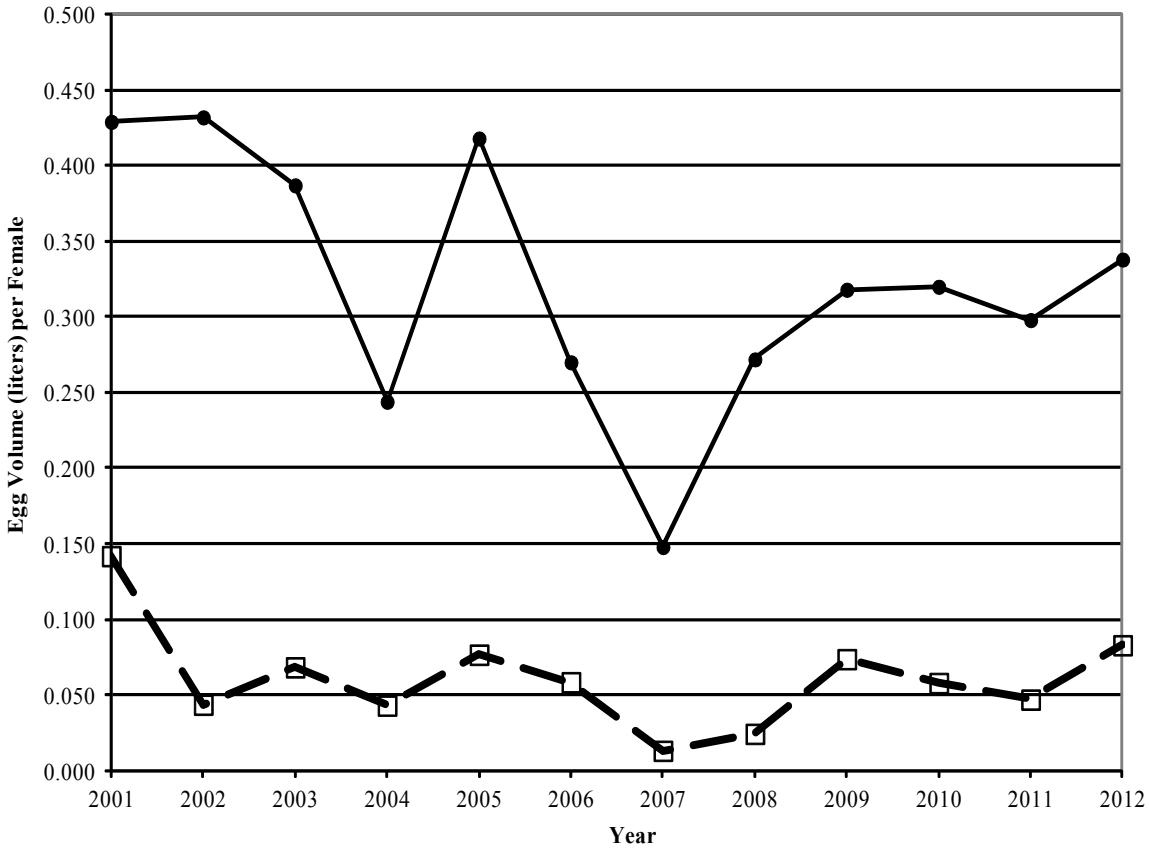

Figure 2. Comparison of total American shad egg volume (solid line) and viable egg volume (broken line) per female for the spawning tests conducted at Conowingo Dam, 2001-2012.

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 2012.

Test Group 1

M/F	45/30	12 ft tank					
Start Date	4/24/12	1100		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	4/26/12	1530					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/24/12	1325	18.3	5.8				
4/25/12	1045	17.4	5.4				
4/26/12	0840	18.2	9.4	12.0	12.0		4f

Test Group 2

M/F	30/11	10 ft tank					
Start Date	4/24/12	1045		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	4/26/12	1530					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/24/12	1326	18.2	8.4				
4/25/12	1426	17.9	6.5				
4/26/12	0845	18.2	7.6	2.0	2.0		3f

Appendix Table A-1.
Continued.

Test Group 3

M/F	45/30	12 ft tank					
Start Date	4/27/12	1015		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	4/29/12	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/27/12	1455	17.7	6.8				
4/28/12	1740	17.5	7.2				
4/29/12	0840	15.3	8.6	10.0	10.0		1f

Test Group 4

M/F	30/20	10ft tank					
Start Date	5/1/11	0920		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/3/11	1030					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/1/12	1130	15.3	9.6				
5/1/12	1436	15.6	10.8				
5/2/12	0015	15.3	10.0				
5/2/12	1630	15.4	10.6				
5/3/12	1000	15.6	10.5	7.0	7.0		1m, 4f

Appendix Table A-1.
Continued.

Test Group 5

M/F	45/30	12 ft tank					
Start Date	5/4/12	0950		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/6/12	1200					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/4/12	1400	17.0	9.7				
5/5/12	0825	17.1	9.2				
5/5/12	1710	17.8	8.4				
5/6/12	0900	17.6	8.0	14.0	14.0		1m, 1f

Test Group 6

M/F	30/20	10 ft tank					
Start Date	5/21/12	1215		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/23/12	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/21/12	1648	21.4	7.9				
5/22/12	0900	20.8	7.4				
5/22/12	1645	22.8	8.0				
5/23/12	0820	21.3	7.5				
5/23/12	0930			8.0	8.0		3m, 2f

Test Group 7

		12 ft tank					
M/F	45/30						
Start Date	5/24/12	1040	Dose/fish 75 ug sGnRHa (pellet implant)				
End Date	5/26/12	1000					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/24/12	1200	22.5	5.8				
5/24/12	1635	23.1	6.5				
5/25/12	0800	22.2	6.4				
5/25/12	1650	23.0	6.2				
5/26/12	1000	22.8	6.2	5.8	5.8		3f

Test Group 8

		10 ft tank					
M/F	30/20						
Start Date	5/29/12	1215	Dose/fish 75 ug sGnRHa (pellet implant)				
End Date	5/31/12	1630					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/29/12	1345	26.3	7.6				
5/30/12	1620	26.8	9.4				
5/31/12	1630			3.8		3.8	3m, 7f