

**REPORT ON HORMONE-INDUCED SPAWNING TESTS  
WITH AMERICAN SHAD AT  
CONOWINGO DAM, SPRING 2010**

**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 has 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 to 10,000 adult American shad. The majority 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 the stress associated with lengthy transport times.

In addition to American shad spawning tests, hormone induced hickory shad spawning tests began at the Conowingo West Fish lift in 2003 and were conducted annually through 2008.

Hickory shad spawning tests in 2009 were conducted without the use of hormones. Hickory shad spawning tests were not conducted in 2010

## **METHODS AND MATERIALS**

The methods used to conduct the hormone induced spawning tests at the Conowingo West Fish lift in 2010 were generally similar to those used in the past ten years. Beginning with the 2008 tests and continuing for the 2010 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 2010 approved American shad study plan was assigned Study Number 11-375-10-7. 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. and the inclusion of control fish in the testing schedule. The smallest dose of sGnRHa available from Syndel was 75ug per pellet and all treatment fish received this dose in the 2010 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.

Total length and a sub-sample of weights was collected from all shad prior to placement into the spawning tanks. A 3:2 (M/F) sex ratio was utilized for all tests. Spawning tests 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 fish lasted 2 to 3 days and were terminated following the first large pulse of eggs. Control fish were held for 7 to 10 days and removed from the tanks when egg production declined or ended. Oxygen and water 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 48 hours after hormone injection) the eggs were washed out of the sock into a 10 gal plastic bucket. The eggs were then sieved with 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 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 was prohibited under the INAD agreement that was in effect.

The Conowingo West Fish Lift was the source of all 1075 pre-spawned American shad utilized for the 17 spawning tests conducted at Conowingo Dam in 2010. All fish were measured for total

length and a sub-sample (312) 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 while a sufficient number of shad needed to stock a spawning tank was collected. American shad spawning tests began on 4/22 and ended on 6/3. During this interval, 14 treatment and 3 control groups were tested. Test group size (50 adults in 10 ft tank and 75 adults in 12 ft tank) was adjusted to achieve a similar density of 1 fish per 125 liters of water. A sex ratio of 3 males to 2 females was achieved for all test groups.

## **RESULTS**

A total of 17 on-site spawning trials with 1075 American shad from April 22nd to June 3rd produced 122.2 liters of eggs (Table 1 and Appendix Table A-1). Over 115 liters of eggs were shipped to the Van Dyke Hatchery and the remaining 6.9 liters were released into the river below Conowingo Dam. The overall estimated viability of the eggs shipped to Van Dyke was 18.2 % (Mike Hendricks, personal communication). The total volume of eggs produced per female in 2010 (0.318 liters) was slightly below the average of 0.325 liter observed for the previous nine years (Figure 2). When adjusted for viability, the volume of viable eggs produced per female in the 2010 tests averaged 0.074 liters (Figure 2). There was a noticeable difference in the average volume of eggs produced between the treatment and control test groups. Test groups that received the hormone treatment produced an average of 8.2 liters of eggs while control groups produced 0 to 2.7 liters (average, 1.5 liters) per group. Control groups typically didn't produce any eggs until 72 hrs after the fish were placed in the spawning tank and daily egg production was usually less than 2 liters. Treatment fish usually produced the first and largest pulse of eggs after 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 15.7 to 27.1°C and 4.0 to 10.8 ppm. The overall mortality rate for adult American shad during the 2010 tests was 10 %. Mortality rates have ranged from 2 to 15% in previous years (Table 2). The mortality rate for individual

control groups in 2010 ranged from 6 to 32%. The higher control mortalities were probably due to the prolonged holding times (up to 10 days) for the last two control groups.

## **SUMMARY**

This was the 10th year of hormone induced American shad spawning tests at the Conowingo West Fish Lift. The overall viability (18.2%) of the 2010 American shad eggs was lower than the 23% viability recorded last year, but near the nine year average of 18.7%. During the last week of May, when river temperature reached 22.0°C, many of the American shad caught at the West Lift were spent, partially spent or in poor physical condition.

## **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, 2010.**

<b>Test Group</b>	<b>Treatment/Control</b>	<b>Start/Stop Date</b>	<b>M/F</b>	<b>Liters Collected</b>	<b>River Release</b>	<b>Total Liters Shipped</b>	<b>Date Shipped</b>
1	Control	4-22/4-28	30/20				
2	Treatment	4-23/4-25	45/30	16.2		16.2	25-Apr
3	Treatment	4-26/4-28	45/30	9.6		9.6	28-Apr
4&5	Treatment	4-29/5-2	75/50	16.2	2.1	14.1	1-May
6&7	Treatment	5-4/5-6	75/50	11.3		11.3	6-May
8&9	Treatment	5-6/5-9	75/50	16.1		16.1	8-May
10&11	Treatment	5-10/5-12	75/50	17.1		17.1	12-May
12&13	Treatment	5-14/5-17	75/50	15.6	0.2	15.4	16-May
14&15	Treatment	5-19/5-21	75/50	15.5		15.5	21-May
16	Control	5-25/6/4	45/30	1.9	1.9		
17	Control	5-25/6/4	30/20	2.7	2.7		
<b>Totals</b>			<b>645/430</b>	<b>122.2</b>	<b>6.9</b>	<b>115.3</b>	

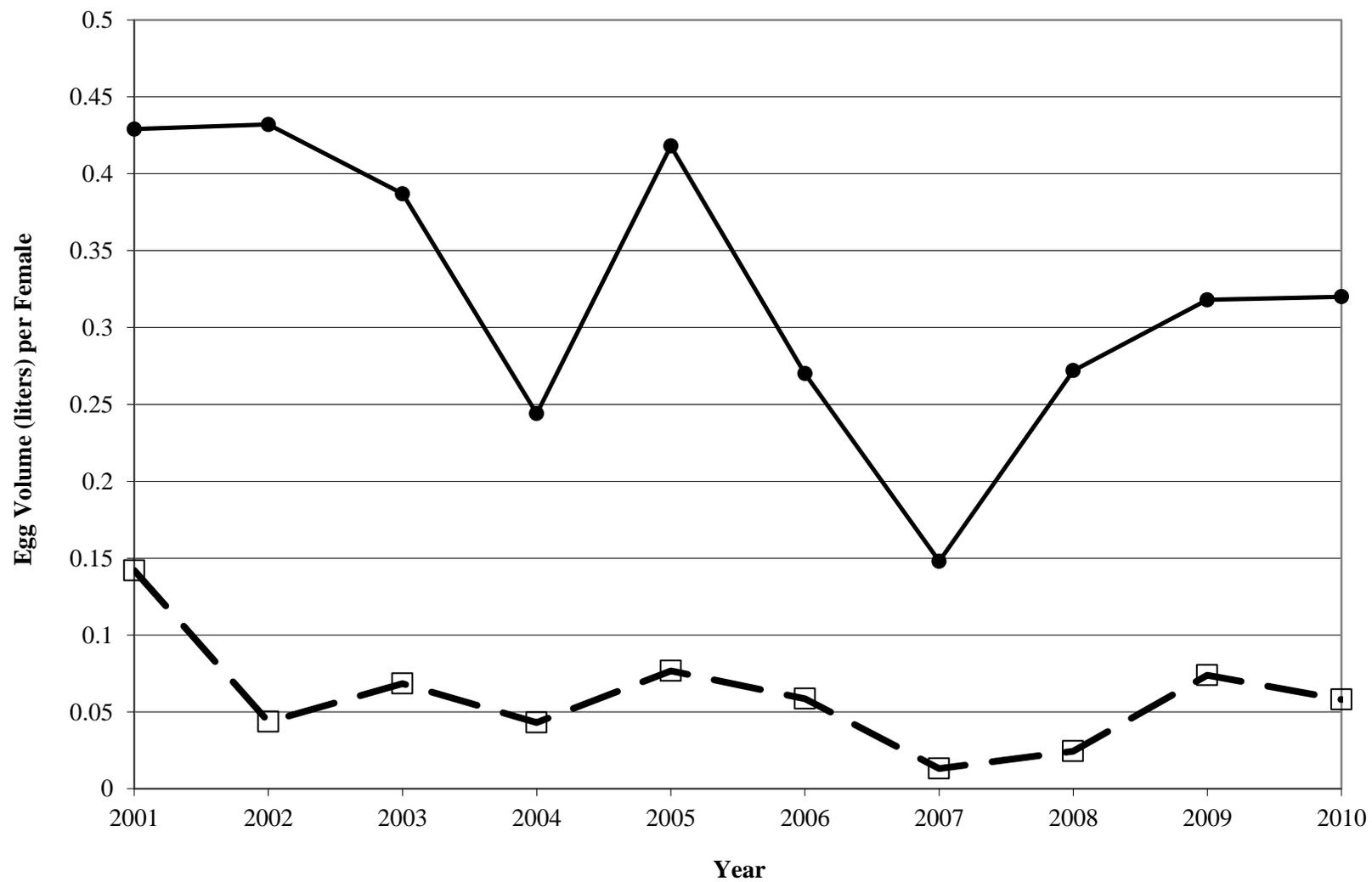
<b>Shipping Date</b>	<b>Liters Shipped</b>	<b>No. eggs</b>	<b>No. Viable</b>	<b>Viabil.(%)</b>
25-Apr	16.2	637,702	227,501	35.7
28-Apr	9.6	477,837	71,797	15.0
1-May	14.1	900,598	77,070	8.6
6-May	11.3	899,169	30,810	3.4
8-May	16.1	1,190,836	211,474	17.8
12-May	17.1	1,309,110	273,517	20.9
16-May	15.4	837,397	75,576	9.0
21-May	15.5	1,091,853	155,486	14.2
<b>Totals</b>	<b>115.3</b>	<b>7,344,503</b>	<b>1,334,705</b>	<b>18.2</b>

	<b>Treatment</b>	<b>Control</b>
Total Males	540	105
Total Females	360	70
Total Fish	900	175
Mean vol.(liters) / test group	8.2	1.5
Mean No. of Eggs / Liter	63,699	N/A
Mean No. of Eggs/Female	20,401	N/A
Mean No. of Viable Eggs/ Female	3,708	N/A

**Table 2****Summary of hormone induced spawning trials with American shad at Conowingo Dam, 2001-2010.**

<i>Year:</i>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
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	4-22/6-3
Tank diameter (ft)	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
Number of test groups	10	10	12	10	11	20	14	16*	16*	17*
Total fish	599	1,000	1,504	1,055	1,135	1,557	1,504	1010	994	1075
Males/Females per trial	36/24	66/34	75/50	75/50	75/50	47/31	75/50	38/25	37/25	38/25
Stocking density (fish/liters)	1/153	1/156	1/125	1/125	1/125	1/124	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
Hormone injected	LHRHa	sGnRHa	LHRHa	LHRHa	LHRHa	LHRHa	LHRHa	sGnRHa	sGnRHa	sGnRHa
Liquid, Pellet	P	P	L+P	L+P	L+P	L+P	L+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
Eggs collected (liters)	103	146.8	234	90.4	160.5	169.25	89.6	110.5	98.7	122.2
Liters of eggs /Female	0.429	0.432	0.387	0.244	0.418	0.270	0.148	0.272	0.245	0.279
No. eggs/liter	63,140	51,235	51,187	59,775	53,828	60,747	80,638	58,429	60,864	63,699
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
Viability (%)	33.2	10.1	17.7	20	23.9	21.7	8.9	9.8	23.2	18.2
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
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
Adult mortality rate (%)	6.0	3.6	2.0	11.5	3.3	3.5	8.3	10.3	15.0	10

\*Includes 3-4 control groups



**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, 2001-2010.**

## **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 2010.**

<b>Test Group 1 (control)</b>							
M/F	30/20	10 ft tank					
Start Date	4/22/10	1015		Dose/fish 0 ug sGnRH $\alpha$ (pellet implant)			
End Date	4/28/10	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/22/10	1540	17.3	7.7				
4/25/10	0930	16.1	8.9				2m
4/26/10	1715	17.1	8.6				
4/27/10	0830	17.2	7.4				1f
4/27/10	1720	17.1	8.8				
4/28/10	0945	16.3	9.2	trace			

<b>Test Group 2</b>							
M/F	45/30	12 ft tank					
Start Date	4/23/10	1015		Dose/fish 75 ug sGnRH $\alpha$ (pellet implant)			
End Date	4/25/10	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/23/10	1015	16.5	9.5				
4/23/10	1435	17.5	8.4				
4/25/10	0930	16.1	7.1	16.2	16.2		2m,6f

<b>Test Group 3</b>							
M/F	45/30	12 ft tank					
Start Date	4/26/10	1015		Dose/fish 75 ug sGnRH $\alpha$ (pellet implant)			
End Date	4/28/10	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/26/10	1330	17.1	7.8				
4/27/10	0830	17.2	3.5				
4/27/10	0930	17.2	9.5				
4/27/10	1720	17.1	8.8				
4/28/10	0945	16.2	8.8	9.6	9.6		5m,13f

**Appendix Table A-1.**

**Continued.**

<b>Test Group 4</b>							
M/F	30/20	10ft tank					
Start Date	4/29/10	1000		Dose/fish 75 ug sGnRH <sub>a</sub> (pellet implant)			
End Date	5/2/10	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/29/10	1700	16.8	8.5				
4/30/10	0915	16	9.2				
4/30/10	1645	16.7	10.8				
5/1/10	0900	15.7	10.6				
5/1/10	1030			5.9	5.9		
5/2/10	0845	15.9	10.7				
5/2/2010	1500	16.5	11.2				4f

<b>Test Group 5</b>							
M/F	45/30	12 ft tank					
Start Date	4/29/10	1100		Dose/fish 75 ug sGnRH <sub>a</sub> (pellet implant)			
End Date	5/2/10	1530					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
4/29/10	1700	16.8	8.8				
4/30/10	0915	16	9.6				
4/30/10	1645	16.7	10.2				
5/1/10	0905	15.7	10				
5/1/10	1000			8.2	8.2		
5/2/10	0840	15.9	10	2.1		2.1	
5/2/10	1530						2m, 2f

<b>Test Group 6</b>							
M/F	30/20	10 ft tank					
Start Date	5/4/10	945		Dose/fish 75 ug sGnRH <sub>a</sub>			
End Date	5/6/10	0900					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/4/10	1230	19.8	9.8				
5/4/10	1650	20.6	10.3				
5/5/10	1000	19.2	7.8				
5/5/10	1710	20.6	8.9				
5/6/10	0745	20.3	8.4	3.2	3.2		2m, 7f

**Appendix Table A-1.****Continued.**

<b>Test Group 7</b>							
M/F	45/30	12 ft tank					
Start Date	5/4/10	1030		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/6/10	930					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/4/10	1230	19.1	9.1				
5/4/10	1650	20.6	9.7				
5/5/10	1000	19.2	7.2				
5/5/10	1715	20.7	7.8				
5/6/10	0743	20.3	7.6	8.1	8.1		1m, 5f

<b>Test Group 8</b>							
M/F	30/20	10 ft tank					
Start Date	5/6/10	1130		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/9/10						
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/6/10	1430	21.5	8.3				
5/6/10	1800	22.1	9.0				
5/7/10	0915	21.4	7.0				
5/7/10	1710	21.3	7.0				
5/8/10	0730	21.2	6.4	7.4	7.4		
5/9/2010	0910	20.6	6.6				3f

<b>Test Group 9</b>							
M/F	45/30	12 ft tank					
Start Date	5/6/10	1230		Dose/fish 75 ug sGnRHa (pellet implant)			
End Date	5/9/10	1500					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/6/10	1430	21.5	7.2				
5/6/10	1800	22.2	7.8				
5/7/10	0918	21.3	5.5				
5/7/10	1710	21.4	7.0				
5/8/10	0800	21.1	6.4	8.7	8.7		
5/8/2010	0910	20.6	6.8				1m, 3f

**Appendix Table A-1.****Continued.**

<b>Test Group 10</b>							
M/F	30/20	10 ft tank					
Start Date	5/10/10	1145		Dose/fish 75 ug sGnRH <sub>a</sub> (pellet implant)			
End Date	5/12/10	1230					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/10/10	1420	20.2	6.8				
5/10/10	1710	20	6.0				
5/11/10	0910	19.2	6.2				
5/11/10	1722	19	6.1				
5/12/10	0830	18.6	7.0	7.9	7.9		1m, 1f

<b>Test Group 11</b>							
M/F	45/30	12 ft tank					
Start Date	5/10/10	1230		Dose/fish 75 ug sGnRH <sub>a</sub>			
End Date	5/12/10	1300					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/10/10	1425	20.2	5.8				
5/10/10	1712	20	5.9				
5/11/10	0912	19.2	5.8				
5/11/10	1723	19	5.2				
5/12/10	0832	18.6	6.0				
5/12/10	1130			9.2	9.2		1f

<b>Test Group 12</b>							
M/F	45/30	12 ft tank					
Start Date	5/14/10	1115		Dose/fish 75 ug sGnRH <sub>a</sub> (pellet implant)			
End Date	5/17/10	1100					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/14/10	1315	18.5	6.3				
5/14/10	1640	18.7	7.1				
5/15/10	0935	18	7.4				
5/16/10	0900	16.8	7.8	10.0	10.0		
5/17/10	0830	17.2	8.1	0.2		0.2	2f

**Appendix Table A-1.****Continued.**

<b>Test Group 13</b>							
M/F	30/20	10 ft tank					
Start Date	5/14/10	1230		Dose/fish 75 ug sGnRH $\alpha$ (pellet implant)			
End Date	5/17/10	900					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/14/10	1315	18.2	7.8				
5/14/10	1640	18.5	8.2				
5/15/10	0932	18	7.0				
5/16/10	0930	16.8	8.3	5.4	5.4		
5/17/2010	0830	17.2	8.8				2f

<b>Test Group 14</b>							
M/F	30/20	10 ft tank					
Start Date	5/19/10	1000		Dose/fish 75 ug sGnRH $\alpha$ (pellet implant)			
End Date	5/21/10	1000					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/19/10	1455	18.1	8.2				
5/19/10	1635	18.2	8.6				
5/20/10	0830	18.1	7.6				
5/20/10	1630	19.8	8.3				
5/21/10	0900	18.9	8.0	5.9	5.9		3f

<b>Test Group 15</b>							
M/F	45/30	12 ft tank					
Start Date	5/19/10	1100		Dose/fish 75 ug sGnRH $\alpha$			
End Date	5/21/10	1030					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/19/10	1455	18.2	7.4				
5/19/10	1635	18.3	7.7				
5/20/10	0832	18.2	6.6				
5/20/10	1632	19.8	6.6				
5/21/10	0900	19	7.0	9.6	9.6		1f

**Appendix Table A-1.**

**Continued.**

<b>Test Group 16 (control)</b>							
M/F	45/30	12 ft tank					
Start Date	5/25/10	1000	Dose/fish 0 ug sGnRHa				
End Date	6/4/10	9000					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/25/10	1500	20.3	6.6				
5/25/10	1720	21.7	7.2				
5/26/10	0740	21	5.8				
5/26/10	1515	22.8	6.0				
5/27/10	900	22.1	4.8	0.2		0.2	
5/27/10	1550	23.7	11.6				2f
5/28/10	812	22.2	8.5				
5/28/10	1455	23	8.5				
5/29/10	730	22.6	9.6				1m, 1f
5/29/10	1554	23.4	7.8				1m, 1f
5/30/10	715	23	7.8				1m, 1f
5/30/10	1545	24.3	8.0				2m
5/31/2010	0718	23.7	5.8				1m
5/31/2010	1524	24.9	7.6				1f
6/1/10	0725	24.5	6.6	0.5		0.5	
6/1/10	1424	26	7.2				2f
6/2/10	0725	25.3	6.7	0.5		0.5	3f
6/2/10	1430	26.9	6.8				1f
6/3/10	0730	26.2	8.3	0.2		0.2	1f
6/3/10	1450	27.1	5.7				1m
6/4/10	0730	26.1	4.0	0.5		0.5	1m, 1f

<b>Test Group 17 (control)</b>							
M/F	30/20	10 ft tank					
Start Date	5/25/10	1200	Dose/fish 0 ug sGnRHa				
End Date	6/4/10	1000					
Date	Time	Temp. (°C)	Oxygen (ppm)	Eggs (Liters) Collected	Eggs Shipped	River Releases	Morts Removed
5/25/2010	1720	21.6	7.9				
5/26/2010	735	21	6.6	trace		< 0.1	
5/26/2010	1515	22.8	7.1				
5/27/10	900	22.1	6.1	1.5		1.5	
5/27/10	1550	23.7	6.3				
5/28/10	810	22.2	7.4				
5/28/10	1455	22.9	8.0				
5/29/10	730	22.6	7.6				2f
5/29/10	1552	23.4	7.8				1f

**Appendix Table A-1.**

**Continued.**

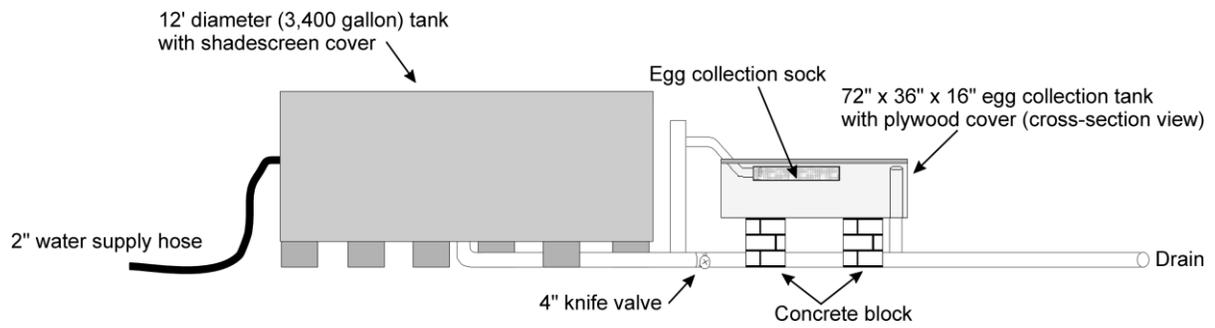
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<b>Test Group 17 (control) continued</b>						
5/30/10	715	23	8.2	0.5	0.5	
5/30/10	1545	24.2	8.2			
5/31/10	720	23.8	9.5			1f
5/31/10	1522	24.8	8.2			1m
6/1/10	725	24.5	8.4			1f
6/1/10	1424	26	7.7			2m
6/2/10	727	25.3	7.2	0.5	0.5	
6/2/10	1430	26.8	6.6			1m
6/3/10	727	26.2	7.0	0.2	0.2	3m
6/3/10	1448	27.1	6.0			1m
6/4/10	730	26.1	5.5			1m, 2f

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**MISCELLANEOUS  
TABLES AND FIGURES**



**Figure 1**

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