Prepared for:
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2008 Wreck Pond River Herring Field Monitoring and Assessment Final Report

Wreck Pond, Monmouth County, New Jersey

October 2008

ENSR Corporation
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Document No.: 06352-003

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1.0 Introduction

1.1 PURPOSE AND NEED

As stated in the 2006/2007 Wreck Pond River Herring Field Monitoring and Assessment Final Report (Appendix E), the New Jersey Department of Environmental Protection (NJDEP) Bureau of Coastal Engineering (Bureau) extended the existing outfall pipe connecting Wreck Pond with the Atlantic Ocean an additional three hundred feet (300') seaward in 2006. To satisfy the conditions of NJDEP Permit 1300-04-0010.1 (WFD 040001), ENSR Corporation (ENSR) was contracted by the Bureau to monitor anadromous clupeid movement within Wreck Pond during spawning migration and to quantify herring usage of the extended outfall structure. Conditions of the permit are as follows:

1. River herring monitoring must be conducted prior to and concurrent with construction - annually for a three year period.
2. A qualified biologist must conduct monitoring during the anadromous spawning runs (November 1st to December 31st and March 15th to June 1st).
3. Monitoring will be performed to quantify the herring usage of the pipe.
4. A report documenting the results of the assessment must be submitted within 1 month of the annual assessment to the Program.
5. The results of the monitoring, including the monitoring methods used and the qualifications of the surveyor must be forwarded to the Program for review.

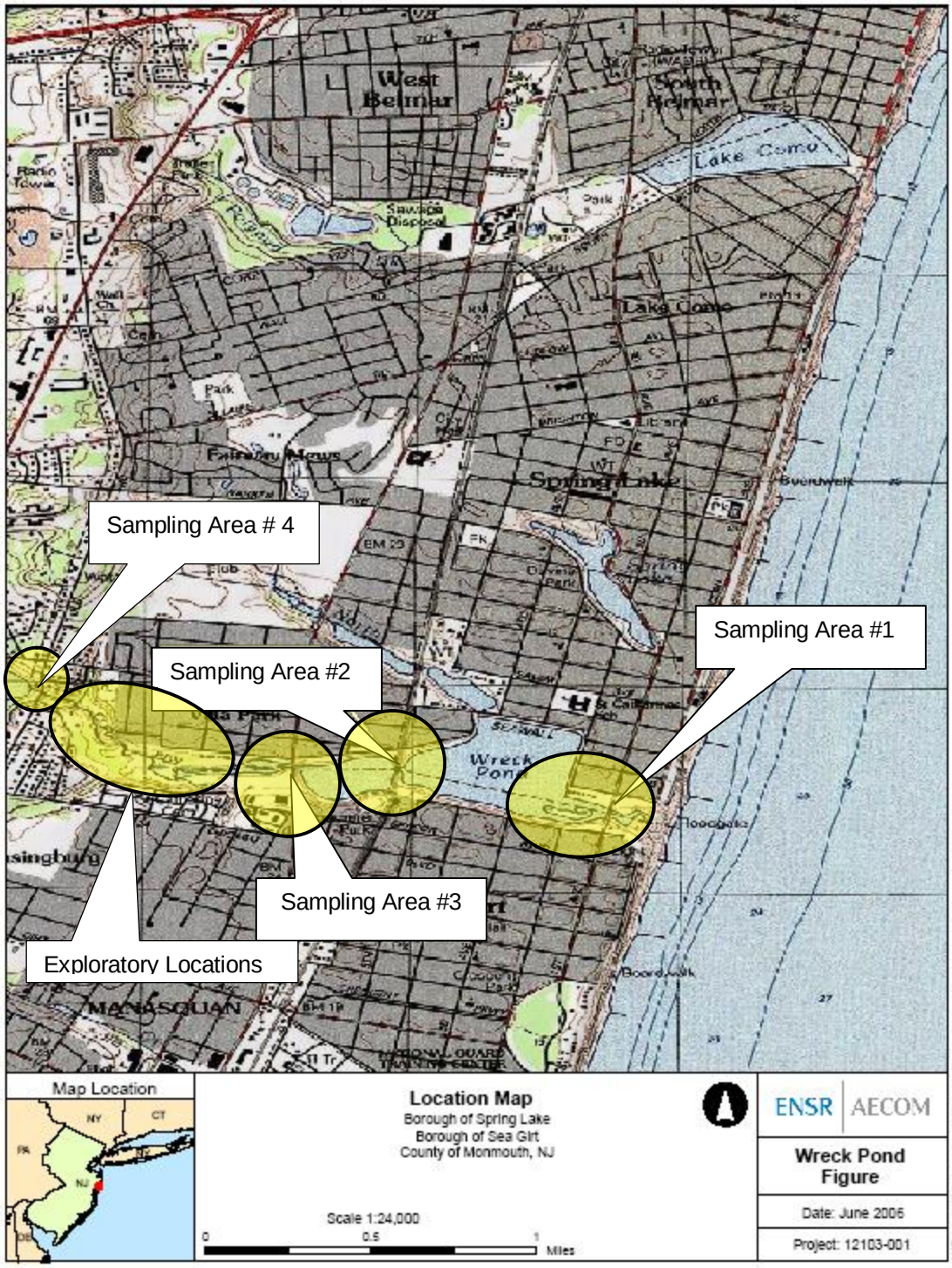
The three-year river herring presence/absence field monitoring assessment for blueback herring (*Alosa aestivalis)* and alewife (*Alosa pseudoharengus*) within Wreck Pond, Monmouth County, New Jersey was initiated in April 2006. Project location is given Figure 1. The collected data from 2006/2007 indicated an unhindered, viable run of alewife within Wreck Pond but was inconclusive in confirming if mass movements of blueback existed. This study is the final of three with emphasis on determining if a viable run of blueback exists within Wreck Pond or is hindered by the outfall extension. Results of each annual survey will be used to determine if further mitigation is necessary to promote anadromous passage within Wreck Pond.

1.2 SITE LOCATION AND HISTORY

Wreck Pond is located between the boroughs of Sea Girt and Spring Lake, Monmouth County, New Jersey (Figure 1) and is connected directly to the Atlantic Ocean by an 84", 800-foot intake/outfall structure (includes 300' extension completed in 2006). Depth of the basin is a function of tidal fluctuation and ranges between one to eight feet at mean low water (MLW). Watershed area is approximately 11.5 square miles and land use consists of a mix of wooded areas, agricultural areas, low to medium density residential areas, and mixed-use areas. Drainage into the system includes tributary streams and storm water runoff from storm drains located in surrounding residential areas and overflow from Old Mill Pond. Monmouth County University completed a microbial source tracking assessment of Wreck Pond in 2006 to develop management recommendations for the area and to identify sources contributing to pathogen contamination. Potential sources of bacterial contamination were attributed to storm water runoff, avifauna, domestic and feral pets, farm animals, and residential fertilizer use. This combination of stormwater runoff and nutrient loading within Wreck Pond can affect local near shore, coastal water quality via the outfall structure. The area near where Wreck Pond interacts with near shore waters is classified as "Prohibited for Shellfish Harvest".

Wreck Pond has been identified and documented as a confirmed anadromous spawning ground for alewife (*Alosa pseudoharengus)* and blueback herring (*Alosa aestivalis*) (NJDEP, 2000; Byrne, 1986; Zich, 1978). Further site history details are given in Appendix F, Section 1.2.

Figure 1 - Project Location and Sampling Areas -Wreck Pond 2008



2.0 RIVER HERRING LIFE HISTORY

2.1 DESCRIPTION

Blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*) are euryhaline, anadromous planktivores externally distinguished by eye diameter and color (when freshly caught) and internally by the color of their peritoneum and the number of gill rakers on the lower limb of the first arch. Further morphological description of each is given in Appendix F, Section 2.

2.2 LIFE HISTORY/SPAWNING CHARACTERISTICS

Juvenile, sub-adult, and adult alewife and blueback herring spend the majority of their life in the open ocean, although it has been documented that some alewife populations remain in freshwater.

Initiation of spawning runs for alewife and blueback is temperature dependent (Bigelow and Schroeder, 2002; Bozeman and Van Den Avyle, 1989; Loesch, 1977). Ordinarily in New Jersey, there is a three to four week difference between alewife and blueback spawning runs in sympatric areas (Don Byrne, NJDEP, pers. comm. November, 2005) with alewife beginning late March early April and blueback shortly thereafter. Detailed life history/spawning characteristics are located in Appendix F, Section 2.

3.0 SURVEY METHODOLOGY AND MATERIALS

Prior to initiating herring sampling, ENSR identified a team of qualified biologists and forwarded primary surveyor qualifications and monitoring methodology to the Bureau of Coastal Engineering as prescribed in the conditions of NJDEP Permit # 1300-04-0010.1 (WFD 040001) in 2006. In conjunction with the Bureau's review, ENSR submitted a scientific collections permit application in preparation for a May 5, 2008 sample start date. A New Jersey Scientific Collections Permit (Permit #0836) was issued on April 28, 2008 (Appendix A). Wreck Pond herring sampling was performed from May 5th to June 6th, 2008. Unlike the 2006 and 2007 passive sampling effort that used a stationary fyke net set underneath the railroad bridge during spring tides, the 2008 sampling effort incorporated active sampling using a 30 and 100-foot seine net at a number of locations every few days (Figure 1 and Appendix E). Sample event scheduling was based on the confirmed presence of clupeids in nearshore waters adjacent to Wreck Pond, known presence of species based on 2006/2007 results, attainment of inshore water temperatures optimal for herring spawning, and the increased probability of herring movement relative to lunar tide levels. The periodicity of sampling was designed to coincide with recommendations received from the NJDEP Bureau of Marine Fisheries.

The following describes the sampling location, equipment, and protocol used to sample for presence/absence of clupeid species (with emphasis on blueback herring) at Wreck Pond in 2008.

3.1 SAMPLING LOCATION

Active sampling was performed at four (4) general areas within the Wreck Pond Watershed and at a minimum of two (2) exploratory locations during each sampling event (Figure 1). Exploratory sampling locations were based on visual observations at time of collection, substrate type and water depth, anticipated fish movement, observed bird activity, and previous local knowledge of preferred habitat locations within Wreck Pond and Wreck Pond Brook. Site photographs are given in Appendix B. As recommended by the NJDEP Bureau of Marine Fisheries, each sampling area was seined twice weekly or every 3 to 4 days between sampling cycles, and sample locations within each area were rotated every other sampling event. ENSR sampled with either a 30 or 100-foot seine net (boat deployed) at each location. General and exploratory sampling areas identified within the Wreck Pond Watershed and Wreck Pond Brook included, but were not limited to, the following (Figure 1):

- Underneath and slightly west of the railroad bridge located directly west of the First Avenue Bridge and east of Route 71 in Spring Lake, NJ;
- Near the First Avenue Bridge that separates the first and second ponds in Spring Lake, NJ;
- The spill pools of the dam located by the Old Mill Inn Restaurant in Spring Lake Heights, NJ; and
- Wreck Pond Brook from the western edge of the James Burns Site located west of Route 71 in Spring Lake Heights, NJ upstream in the vicinity of Shore Road and Meadowbrook Road in Spring Lake Heights, NJ.

3.2 EQUIPMENT

Dependent on site accessibility and water depth, ENSR used either a 30-foot, ¼" nylon mesh bag seine with a 4'x 4'x 4' bag or a 100-foot ¼" nylon mesh bag seine with a 6'x6'x6' bag to actively search for and confirm presence of river herring (with emphasis on blueback). The 100-foot seine net was deployed from the shoreline with the help of a small aluminum 12' skiff (Registration #NJ 1385 FT) powered by a Minn Kota 36lb thrust electric trolling motor. Net mesh size was chosen in consultation with the Bureau of Marine Fisheries in 2007 and 2008 to ensure effective catch with minimal impact to collected fish. Water quality and depth at each

sampling area was obtained each sampling event with a multi-probed YSI 6920 Environmental Monitoring System and a 650 MDS data-logger. Parameters measured included depth of water from substrate to surface, conductivity, specific conductivity, salinity, dissolved oxygen, water temperature, pH, and turbidity.

3.3 SAMPLING METHODS

Prior to Bureau approval for sampling methodology, ENSR monitored the local water temperatures and tracked herring movement via Internet and through discussions with local anglers. Mobilization was initiated on May 4, 2008 as requested by the Bureau and surveys began on May 5, 2008. Photographs showing sampling methods are given in Appendix B.

Physical Herring Sampling and Processing

As previously mentioned, sampling methodology for the 2008 survey differed from the methodology used in 2006 and 2007. Fyke net sampling performed in 2006 and 2007 was designed to intercept migratory movement during flood tide at a stationary site and was limited by tidal fluctuation and lunar cycle. To better determine blueback presence, it was determined that active collection using seine rather than stationary net would be more effective and allow for a more intensive survey at a variety of locations. Initially, it was presumed that seine sampling would be limited to flood tide and performed the day before, the day of, and the day after each new or full moon. Though lunar cycles and spring tides were incorporated into the sampling schedule, sampling schedule was not strictly based on the tidal or lunar cycle. Through further correspondence with the Bureau of Marine Fisheries, it was determined that actively sampling by seine should be performed every few days or twice weekly during spawning season since herring would remain within the waterbody for several days after a lunar or spring tide cycle. Sampling was conducted twice a week every 3-4 days starting May 5, 2008, with the exception of May 20th when sampling was postponed until the following day due to lightning. Sampling concluded on June 6th, 2008. The sampling schedule is given below.

Table 1 Sample Dates

5-May
8-May
13-May
17-May
20-May
21-May
24-May
27-May
30-May
3-June
6-June

The sampling effort consisted of one to two seine hauls at each location during each event with net choice dependent on width, depth and openness/accessibility of waterbody. At open water sites, the 100-foot seine net was deployed from the beach with the help of a small aluminum 12' skiff (Registration #NJ 1285 FT) powered by a Minn Kota 36lb thrust electric trolling motor. One biologist remained onshore in a stationary position with one end of the net while the remainder of the net was deployed from the vessel's bow into the

current with vessel movement away from shore. When about three quarters of the net was deployed, the vessel returned shoreward, creating a semicircular net set that was then hauled ashore manually. In less accessible areas, where depth was usually less than 4 feet, seining was performed without boat assistance and the 30-foot seine net was used. The 30-foot seine net was pulled by two biologists, one at each end, for a predetermined distance (usually 50 to 300 feet in distance) and then hauled ashore upcurrent. In cases where overhanging vegetation, pools, and undercut banks provided retreat habitat outside of the main channel, a third biologist walked ahead of the seine and attempted to flush out any river herring occupying shoreline habitat. On average, sampling and processing took about one (1) hour at each site.

During net retrieval, measures were taken to limit stress to captured species, allow for sample accumulation within the bag at an even pace, and to ensure survivability of species collected. The net retrieval process consisted of hauling the seine net ashore and carefully monitoring the lead-line to ensure it stayed in contact with substrate to minimize catch escape. Once the bag was close to the shoreline, the lead-line and float-line of the bag were pulled ashore simultaneously to ensure that none of the captured species were lost. Species were then removed from the net and placed into buckets/baskets for processing. The net's wings and bag were re-inspected for any species that might have been missed during initial sorting. Species collected during re-inspection were processed with the original sample. During initial sorting, the bag remained partially submerged to increase survivability of collected species. Clupeids were removed from the bag first and transferred into partially submerged fish sorting baskets for immediate processing (Appendix B). Other species collected were identified to the lowest practical taxonomical level, counted, and batch weighed. Fish sorting gloves were worn by the primary fish handler to minimize damage to the fish and remaining specimens were sorted by species, placed in either fish baskets or buckets according to size, and processed accordingly.

The processing of all fish and invertebrate species collected included confirmation of taxonomic identification, enumeration, individual length determination and individual weight and/or batch weight. To assist in determining possible age class; fork length (FL) and total length (TL) were recorded for herring species and FL and/or TL were recorded for all other species. Since very few catches exceeded 25 individuals per species, length measurements to the nearest centimeter (cm) and individual weights to the nearest 0.1 gram (when applicable) were recorded for all processed species. In the event that species were batch weighed, sorting baskets or buckets were tared and weights were recorded in kilograms. In addition, species condition at time of release (i.e. live, fresh dead, or dead) was recorded. To minimize mortality, fish processing was expedient and did not require a significant amount of time per individual. Once individual processing was complete, live specimens were released downcurrent of the sample site. When necessary, individuals were revived by gently passing water through their gills. All data was recorded on updated ENSR data sheets (Appendix C).

4.0 RESULTS

A total of eleven sampling events lasting six to eight hours in duration were conducted in Wreck Pond from May 5th - June 6th 2008. Sample schedule was initially based on local tide tables for the open Atlantic Ocean in the nearshore waters of Belmar, New Jersey and sampling sequence followed the movement of the incoming tide. Due to the landward distance of the sampling sites from the outfall and the capacity of the eastern end of the pond to hold water before breaching the elevated riprap beneath the railroad bridge, the timing of the ebb and flood tides were found to lag considerably from the published local tide charts (approximately 3-4 hours). Tidal information for each event is given in Table 2. Species collected by sampling event are given in Table 3.

Table 2 - 2008 Tide Table for the Atlantic Ocean at Belmar , NJ from May 5 - June 6, 2008

Tide Table for Belmar, New Jersey May 5 – June 6									
Date	**High Tide**	**High Tide**	**Low Tide**	**Low Tide**	**Sunrise**	**Sunset**	**Moonrise**	**Moonset**	**Moon Phase**
5/5/08	7:38am 4.9	7:56pm 6.1	1:39am - 0.5	1:38pm - 0.5	5:50am	7:56pm	5:26am	8:43pm	New
5/8/08	10:23am 4.7	10:38pm 5.6	4:15am - 0.5	4:12pm - 0.1	5:46am	7:59pm	8:08am		
5/13/08	2:33am 4.6	3:17pm 4.6	9:09am 0.4	9:31pm 0.8	5:41am	8:04pm	2:03pm	2:28am	
5/17/08	6:06am 4.2	6:32pm 5.1	12:01am 0.4	12:04pm 0.4	5:37am	8:08pm	6:12pm	3:55am	
5/20/08	8:12am 4.2	8:23pm 5.1	2:09am 0.2	2:03pm 0.6	5:35am	8:11pm	9:16pm	5:25am	Full
5/21/08	8:51am 4.1	8:58pm 5.0	2:49am 0.2	2:42pm 0.7	5:34am	8:12pm	10:11pm	6:07am	
5/24/08	10:57am 3.8	10:56pm 4.6	4:42am 0.5	4:31pm 1.0	5:32am	8:14pm		8:55am	
5/27/08	12:33am 4.5	1:17pm 4.1	6:54am 0.7	7:11pm 1.2	5:30am	8:17pm	1:11am	12:10pm	
5/30/08	3:20am 4.4	3:58pm 5.0	9:43am 0.2	10:34pm 0.5	5:29am	8:19pm	2:21am	3:37pm	
6/3/08	7:21am 4.8	7:39pm 6.1	1:22am - 0.4	1:17pm - 0.3	5:27am	8:22pm	4:45am	8:50pm	New
6/6/08	10:09am 4.8	10:24pm 5.6	4:01am - 0.6	4:00pm - 0.1	5:26am	8:24pm	8:15am	11:31pm	

In total, the 100-foot seine net was deployed 35 times and the 30-foot seine was deployed 28 times for a total of 63 net deployments over 11 sampling periods. Seven (7) live alewife were collected and released over the 11 day sampling events. No blueback herring were collected. All seven (7) alewife collected were released in a live condition. Individual lengths and species conditions prior to release are given in Appendix C and D.

In addition to processing targeted clupeids, ENSR processed, enumerated, weighed (when applicable), measured, and identified all other collected species to the lowest practical taxonomical level (Appendix C and D, Table 3). A total of 29 other fish species were collected during the surveys and include the following: Banded Killifish (*Fundulus diaphanus*), Mummichog (*Fundulus heteroclitus*), Striped Killifish (*Fundulus majalis*), Atlantic Silverside (*Menidia menidia*), Inland Silverside (*Menidia beryllina*), Brown Bullhead (*Ameiurus nebulosus*), Windowpane Flounder (*Scophthalmus aquosus*), Summer Flounder (*Paralichthys dentatus*), Winter Flounder (*Pseudopleuronectes americanus*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis macrochirus*), Redbreast Sunfish (*Lepomis auritus*), White Sucker (*Catostomus commersoni*), Common Carp (*Cyprinus carpio*), White Perch (*Morone americana*), Yellow Perch (*Perca flavescens*), Gizzard Shad (*Dorosoma cepedianum*), Cutlips Minnow (*Exoglossum maxillingua*), Blacknose Dace (*Rhinichthys atratulus*), Rainwater Killifish (*Lucania parva*), Common Shiner (*Luxilus zonatus*), Golden Shiner (*Notemigonus crysoleucas)*, Chain Pickerel (*Esox niger)*, Threespine Stickleback (*Gasterosteus aculeatus*), Sheepshead Minnow (*Cyprinodon variegatus*), American Eel (*Anguilla rostrata*), Northern Pipefish (*Syngnathus fuscus.*), Seahorse (*Hippocampus sp*.), and Large Mouth Bass (*Micropterous salmoides)*. In addition to the above-listed species, one (1) Spider Crab (*Libinia emarginata*), seven (7) Blue Crab (*Callinectes sapidus*), one (1) Green Crab (*Carcinus maenas*), 1 Stone Crab (*Menippe mercenaria*), 152 Sand Shrimp (*Crangon septemspinosa*), 74 Grass Shrimp (*Palaemonetes sp.)*, one (1) Mantis Shrimp (*Lysiosquillina sp*.), and two (2) Musk Turtle (*Sternotherus odoratus*) were collected. Total species count per net retrieval and species list by common name are given in Table 3.

During each event, individual water quality measurements were taken with a YSI 6920 multi-probed water quality meter and a 650 MDS data logger. Water Quality Data for each individual sampling location is given in Table 4.

Table 3 - Summary of Species Collected by Sampling Event

Sample ID Number	Alewife	Blueback	Banded Killifish	Mummichug	Striped Killifish	Atlantic Silverside	Inland Silverside	Brown Bullhead Catfish	Windowpane Flounder	Summer Flounder	Winter Flounder	Pumpkinseed	Blue Gill	Redbreast Sunfish	Unkown Sunfish	White Sucker	Common Carp	White Perch	Yellow Perch	Gizzard Shad	Cutlips Minnow
WP050508	4								2			13			2	2	2	3	2		2
WP050808			172	231		43			3			30					4	1	4		
WP051308			2			2			1			8	1			1					
WP051708			13			106			1			6					4				
WP052008			1			3			1			6				2					
WP052108																					
WP052408						7				3	3	1				3		4		1	
WP052708			22	4			2			1		50		2			4	4	1		
WP053008				24			1					39		2		52	2	3	5	3	
WP060308	3		20	17		1	3	3			1	16		1		6					1
WP060608			14	4	13	8	14		1	4	1	40	4	3	2	7		1	5		
Total	***7***	***0***	***244***	***280***	***13***	***169***	***15***	***6***	***12***	***7***	***6***	***209***	***5***	***8***	***2***	***73***	***16***	***16***	***17***	***4***	***3***

Table 3- Summary of Species Collected per Sampling Event (cont.)

Sample ID Number	Blacknose Dace	Rainwater Killifish	Common Shiner	Golden Shiner	Chain Pickrel	Threespine Stickleback	Sheepshead Minnow	Large Mouth Bass	Unknown Minnow	American Eel	Pipefish	Spider Crab	Blue Crab	Green Crab	Stone Crab	Unknown Crab	Sand Shrimp	Grass Shrimp	Mantis Shrimp	Musk Turtle	Seahorse	
WP050508	1	2		24	2							1					11			2		
WP050808					1	2	4			2							2					
WP051308			1		4					1								15			1	
WP051708			1				2		1	1			1					19				
WP052008			25							3					1	1	47		1			
WP052108					2																	
WP052408					1								3				37					
WP052708				4	1	2		5	5		1		1		1		20					
WP053008					7	1		1		1			1				35					
WP060308				3	2	1				1								40				
WP060608	1			6	2			2	1		1		1	1								
Total	***2***	***2***	***27***	***37***	***22***	***6***	***6***	***8***	***7***	***9***	***2***	***1***	***7***	***1***	***1***	***1***	***152***	***74***	***1***	***2***	***1***	

Table 4 Wreck Pond Water Quality Data by Event and Sample Location

Date/Time	Site	Temp	SpCond	Cond	Salinity	DO Conc	DO %	pH	Turb	Comments
M/D/Y	Number	°C	ms/cm	ms/cm	ppt	mg/l	%		NTU	
5/05/2008 0908	1	-	38835	29948	24.71	14.85	164.4	7.79	-4.4	
5/05/2008 0954	2	13.60	37535	29363	23.82	13.09	145.9	7.82	-3.4	
5/05/2008 1040	3	16.91	6358	5376	3.49	12.37	130.4	8.14	5.5	
5/05/2008 1058	3b	-	-	-	-	-	-	-	-	Same as 3 above.
5/05/2008 1237	4	18.51	224	196	0.11	10.82	115.5	7.36	26.9	
5/05/2008 1500	5	20.55	216	198	0.10	11.27	125.4	7.91	2.4	
5/08/2008 0900	1	17.74	20415	17585	12.25	13.66	154.5	7.66	0.4	
5/08/2008 1107	2	19.33	3750	3344	1.99	12.11	132.9	8.26	65.7	
5/08/2008 1224	3	20.22	4323	3929	2.31	11.94	133.7	7.72	298.7	
5/08/2008 1323	4	20.06	229	207	0.11	11.49	126.6	8.36	2.5	
5/08/2008 1354	5	18.90	224	198	0.11	11.00	118.3	7.83	2.3	
5/08/2008 1405	6	-	-	-	-	-	-	-	-	Same as 5 above
5/13/2008 0830	1	9.83	8104	5755	4.51	18.41	167.2	7.94	3.7	
5/13/2008 0951	2	11.26	439	323	0.21	13.09	119.6	8.42	4.8	
5/13/2008 1051	3	12.24	188	142	0.09	12.46	116.3	8.08	6.1	
5/13/2008 1220	4	13.77	183	144	0.09	14.05	135.7	7.77	4.5	
5/13/2008 1255	5	13.91	183	144	0.09	13.86	134.3	7.64	9.5	
5/13/2008 1311	6	-	-	-	-	-	-	-	-	Same as 5 above
5/17/2008 0954	1	14.08	9188	7271	5.17	16.35	164.0	7.93	30.6	
5/17/2008 1032	2	14.96	20696	16729	12.43	11.98	128.1	7.33	1.9	
5/17/2008 1211	3	16.34	210	175	0.10	11.47	117.1	7.85	7.3	
5/17/2008 1256	4	-	-	-	-	-	-	-	-	YSI - broken
5/17/2008 1315	5	-	-	-	-	-	-	-	-	YSI - broken
5/17/2008 1457	6	-	-	-	-	-	-	-	-	YSI - broken
5/20/2008 0926	1	11.29	36536	26966	23.06	11.74	124.0	7.79	0.6	
5/20/2008 1020	2	13.45	801	624	0.39	11.62	116.6	8.45	2.8	
5/20/2008 1036	3	13.11	197	152	0.09	12.65	120.4	8.50	1.7	
5/21/2008 0836	4	12.57	188	143	0.09	14.01	131.8	8.86	-3.3	
5/21/2008 0836	5	-	-	-	-	-	-	-	-	Same as 4 above
5/21/2008 0923	6	12.98	193	149	0.09	12.30	116.8	8.06	10.1	
5/24/2008 0922	1	12.31	14529	12116	8.47	12.38	132.9	7.94	4.8	
5/24/2008 1015	2	16.71	1472	1239	0.74	11.60	120.5	8.25	4.5	
5/24/2008 1105	3	18.06	209	181	0.10	12.67	134.1	7.73	37.6	
5/24/2008 1130	4	16.87	203	171	0.10	12.51	129.2	7.62	2.1	
5/24/2008 1200	5	-	-	-	-	-	-	-	-	Same as 4 above
5/24/2008 1240	6	18.90	205	182	0.10	12.42	134.0	7.52	1.5	
5/27/2008 0913	1	19.19	15038	13370	8.78	9.86	112.4	8.10	1.8	
5/27/2008 1103	2	20.78	1370	1260	0.69	9.60	107.6	8.36	75.5	
5/27/2008 1142	3	19.27	213	189	0.10	11.09	120.3	8.40	10.4	
5/27/2008 1334	4	19.95	202	183	0.10	10.07	110.7	7.80	3.7	
5/27/2008 1352	5	20.06	201	183	0.09	10.36	114.6	7.54	1.8	
5/27/2008 1425	6	23.37	212	206	0.10	10.29	120.8	7.74	14.5	
5/30/2008 0908	1	18.58	7205	6359	3.98	11.44	125.9	7.97	0.6	
5/30/2008 1038	2	20.03	291	264	0.14	9.04	99.5	8.07	60.4	
5/30/2008 1150	3	22.64	193	184	0.09	12.63	146.3	7.92	2.0	
5/30/2008 1320	4	22.86	190	183	0.09	11.21	130.4	7.89	0.9	
5/30/2008 1337	5	22.73	191	182	0.09	10.69	124.0	7.70	2.9	
5/30/2008 1358	6	22.81	189	182	0.09	10.59	123.1	7.68	-69.3	
6/03/2008 0911	1	15.07	39376	32201	25.39	16.39	190.2	7.98	-0.2	
6/03/2008 0938	2	19.76	28536	25682	17.64	16.54	200.9	7.90	0.3	
6/03/2008 1023	3	21.80	2221	2085	1.14	14.82	169.9	8.31	25.2	
6/03/2008 1110	4	21.39	231	215	0.11	13.40	151.5	8.05	2.8	
6/03/2008 1235	5	23.91	228	223	0.11	11.24	133.4	7.68	34.4	
6/03/2008 1250	6	24.35	225	222	0.11	11.55	138.2	7.67	-3.6	
6/06/2008 0903	1	19.39	4010	3580	2.13	10.46	115.1	7.78	5.1	
6/06/2008 0927	2	-	-	-	-	-	-	-	-	Same as 1 above
6/06/2008 0943	3	-	-	-	-	-	-	-	-	Same as 4 below
6/06/2008 1044	4	15.06	35025	28377	22.09	12.34	140.3	7.36	1.5	
6/06/2008 1134	5	19.48	628	562	0.31	10.05	109.5	8.57	5.6	
6/06/2008 1306	6	19.21	165	147	0.08	11.07	119.9	8.25	4.0	
6/06/2008 1437	7	21.31	156	145	0.07	10.98	124.0	8.12	3.4	
6/06/2008 1451	8	22.01	156	147	0.07	11.03	126.2	7.69	17.1	
6/06/2008 1457	9	-	-	-	-	-	-	-	-	Same as 8 above

5.0 CONCLUSION

The objective for the 2008 Wreck Pond Herring survey was to determine presence/absence of alewife and blueback (with emphasis on blueback) through active sampling methods, compare results with the 2006 and 2007 surveys, and to determine if a viable run existed post-construction. The results of the 2006 and 2007 surveys suggested the extended outfall was not an obstacle or hindrance to alewife migration (Appendix F, Section 5.0). Results further indicated blueback presence (one fish each year) but, results did not confirm or deny if a viable run of blueback existed in the Wreck Pond Watershed. To increase catch probability for blueback, the 2008 survey increased the level of collection effort by incorporating seine netting at numerous locations within the entire watershed. The results of the 2008 sampling program verified a small presence and migration of alewife in Wreck Pond at the beginning of the sampling event, and some juvenile emigration towards the end of the program (June 3, 2008). Based on prior results for mid-May (all sampling efforts included a mid-May event), it appears that though collection effort had not changed in 2006 and 2007 numbers of alewife collected, 80 and 49 respectively, had decreased. In 2008, the level of catch effort was increased by actively searching and sampling preferred clupeid habitats. Regardless, four (4) adult alewife were collected in mid-May and no blueback were collected.

Possible reasons for the decrease in alewife numbers and the absence of collected bluebacks could be associated with the following:

1. Based on past results, it appears alewife are not hindered by the outfall structure. The low numbers collected in 2008 may be a function of timing since sampling was scheduled closer to estimated blueback movement, not alewife migration. Blueback herring, on the other hand, may be hindered by the extended outfall structure and are unable to access natal spawning grounds. As stated in the ENSR 2007 Wreck Pond Herring Monitoring Report, clupeids are affected by light. In North Carolina, an extensive gill net survey indicated that river herring (blueback herring and alewife) no longer exist in streams where bridges had been replaced by pipes or box culverts (Moser and Terra 1999). Herring are also reluctant to enter pipes due to shadowing (Hendricks, 2006). Even though alewife may access Wreck Pond and are subject to the same light limitations, blueback are known to be slightly more sensitive to light (Don Byrne, NJDEP, pers. comm. April, 2007) which may cause a low presence.

2. The decrease of alewife and the absence of blueback between 2006 and 2008 in the Wreck Pond Watershed could be associated with the decline of the fisheries as a whole. Currently, many Atlantic Coast populations of blueback herring (Alosa aestivalis) and alewife (Alosa pseudoharengus) are in decline or are at depressed levels (Crecco and Gibson 1990). Anthropogenic stresses associated with the decline include fishing (commercial and recreational) and habitat loss and degradation (e.g., dam construction, siltation, and pollution). Based on available landings records from the National Marine Fisheries Service (NMFS), commercial landings dropped from 13.6 million pounds in 1985 to 1.33 million pounds in 2004, a difference of 90% (ASMFC, 2007). Scarcity of large runs in local estuaries located near Wreck Pond were also evident in 2008 (Geiser, 2008 and App, 2008).Decrease in numbers collected could also be associated with and earlier or lack of a larger run.

3. A viable run of blueback has not existed in Wreck Pond for many years and can no longer be categorized as a confirmed spawning ground. Since designated as confirmed spawning for blueback, over time, stressors may have either diminished the population or caused the Wreck Pond spawning population to go elsewhere. Local newspaper articles in March through May 2008 described a large run in the Delaware River but not a very noticeable within smaller estuaries near Wreck Pond. Diminished populations may be attributed to overfishing, water quality degradation, and loss of

spawning habitat. Unlike alewife, blueback prefer to spawn in swifter waters. The lack of blueback in preferred, upstream habitat sampled in Wreck Pond in 2008 may be indicative of lack of spawning activity.

4. Other anthropogenic and chemical barriers are deterring blueback movement. It is a known fact that water quality in Wreck Pond has been in decline. In addition, development has been expanding. It is possible that natal qualities recognized historically no longer exist.

Overall, results of the 2008 survey are dissimilar to those of 2006 and 2007. The three surveys do show that there is inshore/offshore movement of clupeid species through the extended outfall. The surveys also indicate a decreasing trend in population size of migrating clupeids in Wreck Pond. Though catch effort was increased, the 2008 sampling effort collected 7 alewife and zero blueback, whereas 49 alewife and two (2) blueback were collected in 2007 and 229 alewife and one (1) blueback were collected in 2006. The collection of the several alewife late in the spring of 2008 is an indication that the extension still does not obstruct their passage, but perhaps the larger run occurred earlier than the sample start date. The earlier run is further confirmed by the larger size/growth rate of juveniles collected in June. The repetitive low number of blueback collected relatively at the same time from 2006 through 2008 does, however, indicate that either there was never a large spawning population that used Wreck Pond or movement of the species is hindered. Without historical data indicating if a viable blueback run did exist, there is still a possibility that the extended outfall would not hinder mass movement if it did exist, Additional annual studies are recommended to document more thoroughly the distribution, abundance, and migratory success of the clupeid that transit the extended outfall pipe and to provide baseline data for future comparison. The low number of alewife collected in 2008 is a possible indicator of the end of the alewife spawning run or a decline in either the Wreck Pond population or the Atlantic population, however, the low number of blueback was consistent with the 2006 and 2007 data and most likely a viable Wreck Pond population no longer exists.

Additionally, the collection, abundance, and presence of other estuarine/marine forage species within the watershed (i.e. Atlantic silversides and blue crab) are usually indicative to the presence of larger marine predatory species in the area (Froese and Pauly, 2001) and would further support the assumption that the extension does not hinder fish passage between the open Atlantic and Wreck Pond. Due to their limited salinity tolerance, presence and temporal distribution for marine predatory species in areas of variable salinities like those confirmed at the various sample sites, movement would be restricted by tidal fluctuation. The presence of an available forage base, in conjunction with variable salinities, would indicate that larger, salinity dependent species have accessibility to offshore waters. The presence of marine and euryhaline organisms further supports the conclusion that tidal flushing is consistent with that observed in 2006 and 2007 and that these species remain unhindered in transiting between Wreck Pond and nearshore waters.

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