

FINAL REPORT OF
INVESTIGATIONS OF SHORTNOSE STURGEON
EARLY LIFE STAGES IN THE
DELAWARE RIVER, SPRING 2007 AND 2008

Prepared For

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TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	MATERIALS AND METHODS.....	1
2.1	Collection of Shortnose Sturgeon Eggs and Larvae	1
2.2	Tracking of Acoustically-Tagged Adult Shortnose Sturgeon.....	2
3.0	STUDY AREA.....	2
4.0	RESULTS	3
2.1	2007 Survey	3
2.1.1	Acoustic Telemetry	3
2.1.2	Artificial Substrate Sampling.....	3
2.1.3	D-Frame Net Sampling	3
2.2	2008 Survey	4
2.1.1	Acoustic Telemetry	4
2.1.2	Artificial Substrate Sampling.....	5
2.1.3	D-Frame Net Sampling	5
5.0	DISCUSSION	6
5.1	Benefits of the Project.....	6
6.0	LITERATURE CITED	8

ACKNOWLEDGMENTS

LIST OF FIGURES

Figure 1.	Artificial substrate sampler	11
Figure 2.	D-frame net	11
Figure 3.	Daily mean river discharge, water temperature, and dissolved oxygen at the USGS Trenton gage, May 1-31, 2007.....	12
Figure 4.	Artificial substrate sampler locations, 2007.....	13
Figure 5.	D-frame net sample locations, 2007	14
Figure 6.	Lateral view of a 15.2 mm larval shortnose sturgeon collected on May 11, 2007	15
Figure 7.	Ventral view of a 15.2 mm larval shortnose sturgeon collected on May 11, 2007....	15
Figure 8.	Daily mean river discharge, water temperature, and dissolved oxygen at the USGS Trenton gage, March 27-May 31,2007	16

Figure 9. Number of acoustically-tagged adult shortnose sturgeon detected in the non-tidal Delaware River, March-May 2008	16
Figure 10. Locations of acoustically-tagged adult shortnose sturgeon, April 2008.....	17
Figure 11. Artificial substrate sampler locations, 2008.....	18
Figure 12. D-frame net sample locations, 2008	19
Figure 13. Density of shortnose sturgeon eggs and larvae in D-frame net samples, April-May 2008.....	20
Figure 14. Shortnose sturgeon egg collected by D-frame net on May 2, 2008.....	20
Figure 15. Larval shortnose sturgeon (13.0 mm) collected on April 25, 2008	21
Figure 16. Larval shortnose sturgeon (10.6 mm) collected on May 8, 2008	21.

LIST OF TABLES

Table 1. Collection information for acoustically-tagged adult shortnose sturgeon detected in the non-tidal Delaware River, Spring 2008	22
Table 2. Adult shortnose sturgeon detected by a passive acoustic receiver located in the non-tidal Delaware River near Yardley, PA, Spring 2008.	22
Table 3. Results of active acoustic tracking in the non-tidal Delaware River, Spring 2008. ...	23
Table 4. Density of shortnose sturgeon eggs and larvae in D-frame net samples by date, Spring 2008.	24
Table 5. Density of shortnose sturgeon eggs and larvae in D-frame net samples by sampling area, Spring 2008	24
Appendix Table 1. Daily mean river discharge, water temperature, dissolved oxygen, and specific conductance at the USGS Trenton gage, May 1-31, 2007.	
Appendix Table 2. Shortnose sturgeon eggs collected by artificial substrate sampler, Spring 2007.	

- Appendix Table 3. Shortnose sturgeon eggs and larvae collected by D-frame net, Spring 2007.
- Appendix Table 4. Daily mean river discharge, water temperature, dissolved oxygen, And specific conductance at the USGS Trenton gage, March 15-May 31, 2008.
- Appendix Table 5. Shortnose sturgeon eggs collected by artificial substrate sampler, Spring 2008.
- Appendix Table 6. Shortnose sturgeon eggs and larvae collected by D-frame net, Spring 2008.

1.0 INTRODUCTION

Considerable research has been performed on the biology of adult shortnose sturgeon (*Acipenser brevirostrum*) in the Delaware River, including studies of distribution (Hastings et al., 1987), abundance (Hastings et al., 1987; ERC, 2006b), and annual movements (Brundage, 1986; O'Herron et al., 1993; ERC, 2006a). Based on movement patterns and collection of ripe individuals, it has been inferred that shortnose sturgeon in the Delaware River spawn in early spring, primarily in the lower non-tidal river between the Trenton rapids and Scudders Falls (Brundage, 1986; O'Herron et al., 1993). However, the presence of early life stages in the presumed spawning area has never been confirmed, nor have specific habitat conditions on the spawning grounds been fully documented.

The New Jersey Division of Fish and Wildlife (NJDF&W) Endangered and Nongame Species Program (ENSP) received funding from the National Marine Fisheries Service (NMFS), through an Endangered Species Act (ESA) Section 6 Cooperative Agreement, to perform a two-year survey for shortnose sturgeon early life stages in the Delaware River. NJDF&W, in turn, contracted with Environmental Research and Consulting, Inc. (ERC) to conduct the field data collection for this study.

The objective of this project was to locate and document occurrences of early life stage shortnose sturgeon in the Delaware River. Specific goals included 1) documenting occurrences of shortnose sturgeon eggs and larvae and their specific habitats in the Delaware River, 2) incorporating occurrence information into the ENSP's Biotics database, and 3) identifying critical habitat(s) to pursue, if appropriate and supported by the data collected, a critical areas designation for shortnose sturgeon spawning and nursery areas.

This report presents the results of the shortnose sturgeon early life stage study performed under the Section 6 agreement during spring 2007 and 2008.

2.0 MATERIALS AND METHODS

2.1 *Collection of Shortnose Sturgeon Eggs and Larvae*

Sampling for shortnose sturgeon early life stages was performed using artificial substrates (McCabe and Beckman, 1990) and D-frame ichthyoplankton nets (Taubert, 1980; Auer and Baker 2002).

The artificial substrates consisted of floor buffing pads anchored to the river bottom using concrete pavers (Fig. 1) and marked with a float. Two pads were set approximately 6 m apart at each location. The natural substrate at each sampler location was characterized by visual observation or probing with a PVC rod. The artificial substrates were periodically examined in the field for shortnose sturgeon eggs, photographed, and returned to the river.

The D-frame ichthyoplankton nets were 76 cm across the base and 54 cm high, and were fitted with a knotless 1600 µm mesh nylon bag 317.5 cm long with a detachable cod end (Fig.

2). Each net was equipped with a General Oceanics (Model 2030 MK II) flow meter to measure the volume of water filtered. The D-frame nets were anchored to the bottom using a large grapnel and marked with a float. In 2007, the D-frame net samples were either examined in the field (if the detritus load allowed), or preserved with 10-percent formalin and processed in the laboratory. In 2008, all samples were preserved and processed in the laboratory.

The location of each artificial substrate and D-frame net sample was determined using a Geographic Positioning System (GPS). Water depth and current velocity (measured approximately 0.3 m below the surface with a Mead Instruments current meter) were measured at each sampling location. Water temperature and dissolved oxygen concentration were measured with a YSI Model 85 hand-held meter at least once during each sampling day.

Jones et al. (1978), Bath et al. (1981), Washburn & Gillis Associates (1981), and Snyder (1988) and were the principal taxonomic references used for identification of shortnose sturgeon eggs and larvae.

2.2 *Tracking of Acoustically-Tagged Adult Shortnose Sturgeon*

Information on the occurrence and distribution of adult, presumably spawning, shortnose sturgeon in the non-tidal Delaware River was obtained by tracking fish that had been tagged with VEMCO (VEMCO Ltd., Shad Bay, Nova Scotia) acoustic transmitters (see ERC (2006a) for a complete description of the telemetry equipment and tagging procedures). Acoustically-tagged shortnose sturgeon were located by active tracking (2007 and 2008) with a VEMCO V-60 receiver and hydrophone, and by passive monitoring (2008 only) with a VEMCO VR-2 receiver deployed near Yardley, PA, at rkm 222.8.

3.0 STUDY AREA

The study area for this study encompassed the lower non-tidal Delaware River from approximately the Trenton rapids to immediately upstream of a riffle area at rkm 231.8, locally known as the “Fife & Drum rapids”. The study area consists primarily of relatively shallow (depths typically <3 m at summer river flows) run habitat, with slow to moderate current velocities. Large areas of rapids with fast, turbulent flow occur at the fall line (Trenton rapids) (rkm 214.5) and immediately below a wing dam constructed atop a natural rock ledge at Scudders Falls (rkm 225.3). Smaller riffle areas occur near the upstream end of Rotary Island (rkm 220.7) and at the Fife & Drum rapids (rkm 231.8). Bottom substrates within the study area consist primarily of well-flushed cobble and gravel. Boulders and bedrock outcrops occur in some areas, particularly within the Trenton rapids and downstream of Scudders Falls.

4.0 RESULTS

4.1 2007 Survey

In 2007, field sampling was initiated on May 1, which was late in the typical shortnose sturgeon spawning period on the Delaware River, and continued through May 23. The late start of the project was necessitated by a delay in contract issuance. Daily mean river discharge, water temperature, and dissolved oxygen concentration measured at the U.S. Geological Survey (USGS) Trenton gage (No. 01463500) during the sampling period are presented in Appendix Table 1 and plotted in Figure 3.

4.1.1 Acoustic Telemetry

Two acoustically-tagged adult shortnose sturgeon (both males) that had been tagged in the upper tidal Delaware River near Bordentown, NJ, in November 2006 were detected in the non-tidal river on May 1, but not thereafter. One shortnose sturgeon (tag no. 1076) was detected near the railroad bridge at rkm 220.9, while the other (tag no. 1074) was located downstream of Blauguard Island at approximately rkm 217.

4.1.2 Artificial Substrate Sampling

Artificial substrate samplers were deployed on May 1 and removed from the river on May 14 (Appendix Table 2). Artificial substrates were set at four locations between Scudders Falls and the I-95 Bridge and at a fifth location near Rotary Island (Fig. 4). Cobble was the dominant substrate at all sampling locations.

One shortnose sturgeon egg was collected on a substrate set immediately downstream of Scudders Falls on the Pennsylvania side of the river on May 7, 2007. Water depth and current velocity at the time this egg was collected were 0.6 m and 0.79 m/sec, respectively (Appendix Table 2).

4.1.3 D-Frame Net Sampling

D-frame net sampling was initiated on May 4 and continued through May 23. Sampling was conducted downstream of Scudders Falls, downstream of the I-95 Bridge, and along a cross-river transect downstream of Blauguard Island (Fig. 5). Thirty-two collections, filtering a total of 84,344 m³ of water, were made (Appendix Table 3).

One shortnose sturgeon egg (sample density = 0.031/100m³) and three shortnose sturgeon larvae (sample density 0.093/100m³; 10.0 mm total length (TL), 11.0 mm TL, and unmeasurable (specimen curled)) were collected by a D-frame net set downstream of the I-95

Bridge on the Pennsylvania side of the river on May 4. Water depth and current velocity measured at the time of this sample were 1.5 m and 1.16 m/sec, respectively (Appendix Table 3).

One confirmed and one probable shortnose sturgeon larvae were collected in a D-frame net set downstream of Blauguard Island on the Pennsylvania side of the river on May 11 (sample density = 0.059/100m³). The confirmed larva was 15.2 mm TL (Figs. 6 and 7). The head of the second larvae was damaged, but its size, pigmentation, and fin morphology indicate that it was also a shortnose sturgeon. Water depth and current velocity measured at the time of collection were 0.9 m and 1.04 m/sec, respectively (Appendix Table 3).

4.2 2008 Survey

In 2008, field sampling was initiated on March 27 and continued through May 30. Daily mean river discharge, water temperature, and dissolved oxygen concentration measured at the USGS Trenton gage during the sampling period are presented in Appendix Table 4 and plotted in Figure 8.

4.2.1 Acoustic Telemetry

Seventeen adult shortnose sturgeon were detected in the lower non-tidal Delaware in spring 2008. Collection information for these fish is presented in Table 1; all were tagged in the upper tidal Delaware River between Bordentown and Trenton. The two shortnose sturgeon detected in the non-tidal river in 2007 (tag nos. 1074 and 1076) were again detected in 2008.

The passive receiver was deployed near Yardley on November 5, 2007 and removed on June 1, 2008. Thirteen adult shortnose sturgeon were detected by this receiver during March 30 through April 24 (Table 2). Daily mean water temperature at Trenton during this period ranged from 6.3-17.8°C. The duration that a given sturgeon was detected by the Yardley receiver ranged from 1-20 days and averaged 10.5 days. Six of the shortnose sturgeon detected by this receiver were male and seven were female; average detection duration was 8.7 days for males and 12.0 days for females. The greatest number of shortnose sturgeon ($n = 10$) were detected by the passive receiver on April 10 and 11 (Fig. 9). Daily mean water temperature on these dates was 11.5°C and 12.3°C, respectively.

Twelve shortnose sturgeon were detected by active tracking; 10 on April 14, seven on April 18, and one on April 22 (Table 3). Fish found during active tracking ranged from 0.4 km upstream of the Calhoun Street Bridge (rkm 216.5) to 0.6 km upstream of the Washington Crossing Bridge (rkm 228.8) (Fig. 10).

4.2.2 *Artificial Substrate Sampling*

Artificial substrate samplers were deployed on March 27 and removed from the river on May 30 (Appendix Table 5). Artificial substrates were set at three locations immediately downstream of the Fife & Drum rapids, two locations downstream of Scudders Falls, two locations downstream of the I-95 Bridge, two locations near Yardley, and one location near Rotary Island (Fig. 11). Cobble was the dominant substrate at all sampling locations.

A total of 12 shortnose sturgeon eggs were collected on the artificial substrates between April 14 and May 6. Five eggs were collected downstream of the Fife & Drum rapids, four were collected downstream of the I-95 Bridge, and three were collected near Yardley. Shortnose sturgeon eggs were collected by artificial substrate at water depths ranging from 1.2-3.3 m (\bar{x} = 2.33 m) and current velocities ranging from 0.88-1.49 m/sec (\bar{x} = 1.12 m/sec) (Appendix Table 5).

4.2.3 *D-Frame Net Sampling*

D-frame net sampling was initiated on April 18 and continued through May 22. Sampling was conducted along transects immediately upstream of the Fife & Drum rapids, downstream of the I-95 Bridge, and downstream of Blauguard Island (Fig. 12). Sixty-eight collections, filtering a total of 116,355 m³ of water, were made (Appendix Table 6).

The D-frame net samples yielded a total of 150 shortnose sturgeon eggs, collected during April 18 through May 22 (Figs. 13 and 14). Daily mean water temperature at Trenton during the period that eggs were collected ranged from 13.2-17.9°C. Egg density in individual samples ranged from 0.024-3.480/100m³ (Appendix Table 6). Average egg density over the entire sampling period was 0.129/100m³. The highest egg density (0.585/100m³) occurred on April 18 (Table 4). Mean water temperature in April 18 was 13.2°C. Egg density by sampling area was 0.012/100m³ upstream of the Fife & Drum rapids, 0.035/100m³ downstream of I-95, and 0.362/100m³ downstream of Blauguard Island (Table 5). Shortnose sturgeon eggs were collected by D-frame net at water depths ranging from 0.5-2.4 m (\bar{x} = 1.45 m) and current velocities ranging from 0.64-1.71 m/sec (\bar{x} = 1.22 m/sec) (Appendix Table 6).

Three shortnose sturgeon larvae were collected by D-frame net. One larva (sample density = 0.160/100m³; 13.0 mm TL) was collected downstream of the I-95 Bridge (PA side) on April 25 (Fig. 15). Water depth and current velocity measured at the time of this sample were 2.0 m and 0.94 m/sec, respectively. Two shortnose sturgeon larvae (sample density = 0.102/100m³; 10.6 and 14.0 mm TL) were collected downstream of the I-95 Bridge (NJ side) on May 8 (Fig. 16). Water depth and current velocity measured at the time of this sample were 1.8 m and 1.64 m/sec, respectively (Appendix Table 6).

5.0 DISCUSSION

This project documented the occurrence of shortnose sturgeon early life stages over an approximately 17 km reach of the lower non-tidal Delaware River from the Trenton rapids to immediately upstream of the Fife & Drum rapids. The collection of drifting shortnose sturgeon eggs in D-frame nets samples above the Fife & Drum rapids indicates that spawning is occurring further upstream. Based on river morphology and suitable substrates, it is likely that some shortnose sturgeon spawning occurs at least to Lambertville (approximate rkm 238) and, perhaps, further upstream. The rapids below the Lambertville wing dam, in particular, would appear to provide excellent spawning habitat for shortnose sturgeon. Adult shortnose sturgeon are known to occur in the New Hope-Lambertville reach of the river from both historic accounts (Cobb, 1900) and incidental captures in the 1970s and 1980s in the Lewis haul seine fishery for American shad (O'Herron et al., 1993).

In the present study, adult shortnose were first detected in the non-tidal river at the end of March. Peak spawning likely occurred in mid-April, based on the number of acoustically-tagged adults detected, egg density in D-frame net samples, and occurrence of eggs on artificial substrates. The collection of a shortnose sturgeon egg on May 22 suggests that some spawning activity in 2008 continued well into May. The temperature range for spawning-related activity suggested by present-study data is 6-17.9°C, with peak activity around 13.5°C. Shortnose sturgeon early life stages were collected at water depths ranging from 0.5-2.4 m and current velocities ranging from 0.64-1.71 m/sec, over well flushed cobble substrates. The timing and conditions of spawning documented in the present study were consistent with those inferred from past studies in the Delaware River (Brundage, 1986; O'Herron et al. 1993) and other rivers in the northeast (Dadswell, 1979; Taubert 1980; Washburn and Gillis Associates, 1981; Kieffer and Kynard, 1996).

5.1 Benefits of the Project

Occurrence information for early life stage shortnose sturgeon collected through this project was incorporated into the Endangered and Nongame Species Program's (ENSP) Biotics Database. The ENSP maintains rare animal occurrence data in an Oracle/GIS-based database called Biotics. Biotics was developed by NatureServe, a nonprofit organization representing a network of member programs comprising 74 independent centers that are the leading source of information on the precise locations and conditions of rare and threatened species and ecological communities in the Western Hemisphere. Consistent standards for collecting and managing data allow information from different programs to be shared and combined regionally, nationally, and internationally.

On a state level, the data housed within Biotics are the basis for the creation of ENSP's Landscape Project. In 1994, the ENSP adopted a landscape level approach to endangered, threatened, and other rare species conservation by developing the Landscape Project. Through geographic information system (GIS) technology, the Landscape Project uses species location and land-use/land cover as well as species life history information to produce maps that depict imperiled and rare wildlife habitat throughout the state.

The Landscape Project has been or is being written into many rules including: Highlands Water Protection and Planning Act Rules (N.J.A.C. 7:38), the Coastal Zone Management Rules (N.J.A.C. 7:7E), Flood Hazard Area Control Act Rules (N.J.A.C. 7:13), Freshwater Wetlands Protection Act rules (N.J.A.C. 7:7A), Endangered and Threatened Wildlife Species Habitat (N.J.A.C. 7:25B), and the Water Quality Management Planning rules (N.J.A.C. 7:15).

As a result of this study, the number of shortnose sturgeon early life stage occurrences in the Biotics database was greatly expanded. Occurrences of eggs and larvae for the species had previously been represented in the database solely through records of specific power plant impingement/entrainment events. Once entered into the database, early life stage sightings were assigned species occurrence areas (SOAs) based on feature labels developed for the Landscape Project. An SOA is defined as a species-specific polygon that is applied to all occurrences in the Biotics database that is used to value habitat for the Landscape Project. These SOAs are based on average home range/territory size, or other appropriate life-history parameters as reported in peer-reviewed scientific literature or through ENSP research.

All shortnose sturgeon SOAs will appear in the next version of the Landscape Project, currently scheduled for release in 2009. This new version will contain a stream layer not included in previous releases. Information on shortnose sturgeon critical areas in the Delaware River, including spawning and nursery areas, will be available to such agencies as NJDEP's Division of Land Use Regulation (LUR), who regularly reviews applications for permits to build or develop on environmentally sensitive land such as freshwater wetlands, coastal areas, and floodplains. Until then, SOA data for aquatic species, including shortnose sturgeon, are available to DEP permitting units for use during the environmental review process. Examples of projects that could potentially be impacted by information gathered through this study include dredging, waterfront development, bridge replacement (e.g. Scudders Falls Bridge), water withdrawal, and others.

In addition to use in the ENSP's Biotics database and Landscape Project, information on early life stage occurrences obtained during this project is being used in the Delaware River section of the Draft Status Review of Shortnose Sturgeon, a report prepared by the Shortnose Sturgeon Status Review Team (SRT) for the National Marine Fisheries Service (Shortnose Sturgeon Status Review Team, 2008). The status review report summarizes information gathered for an Endangered Species Act (ESA) status review, which was initiated by NMFS to update species information since the Final Recovery Plan for Shortnose Sturgeon (NMFS, 1998).

Finally, documenting early life stages adds to our overall knowledge base regarding behavior, movement patterns, and spawning habitats of the Delaware River shortnose sturgeon population. By confirming the spawning area boundaries and incorporating sightings of eggs and larvae into Landscape, we will have the capacity to more effectively protect these critical areas and ultimately contribute to the recovery of the species.

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FIGURE 1
Artificial substrate sampler



FIGURE 2
D-frame net

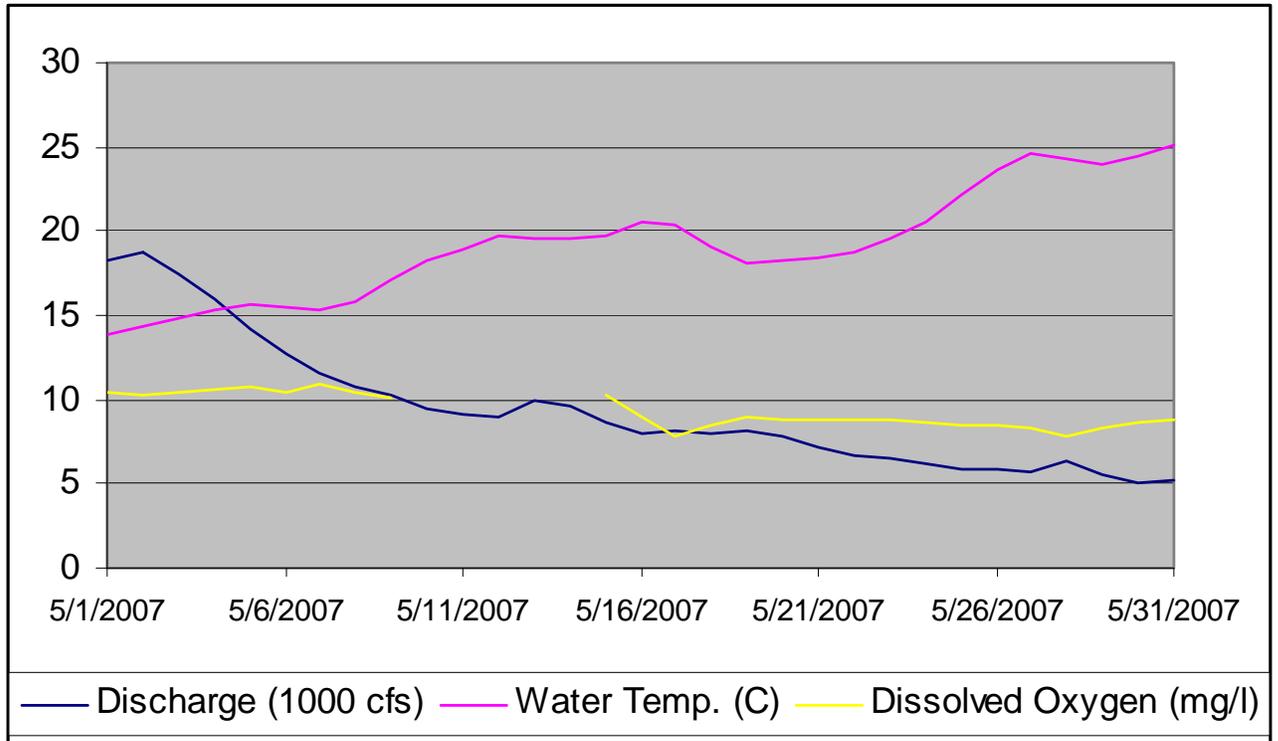
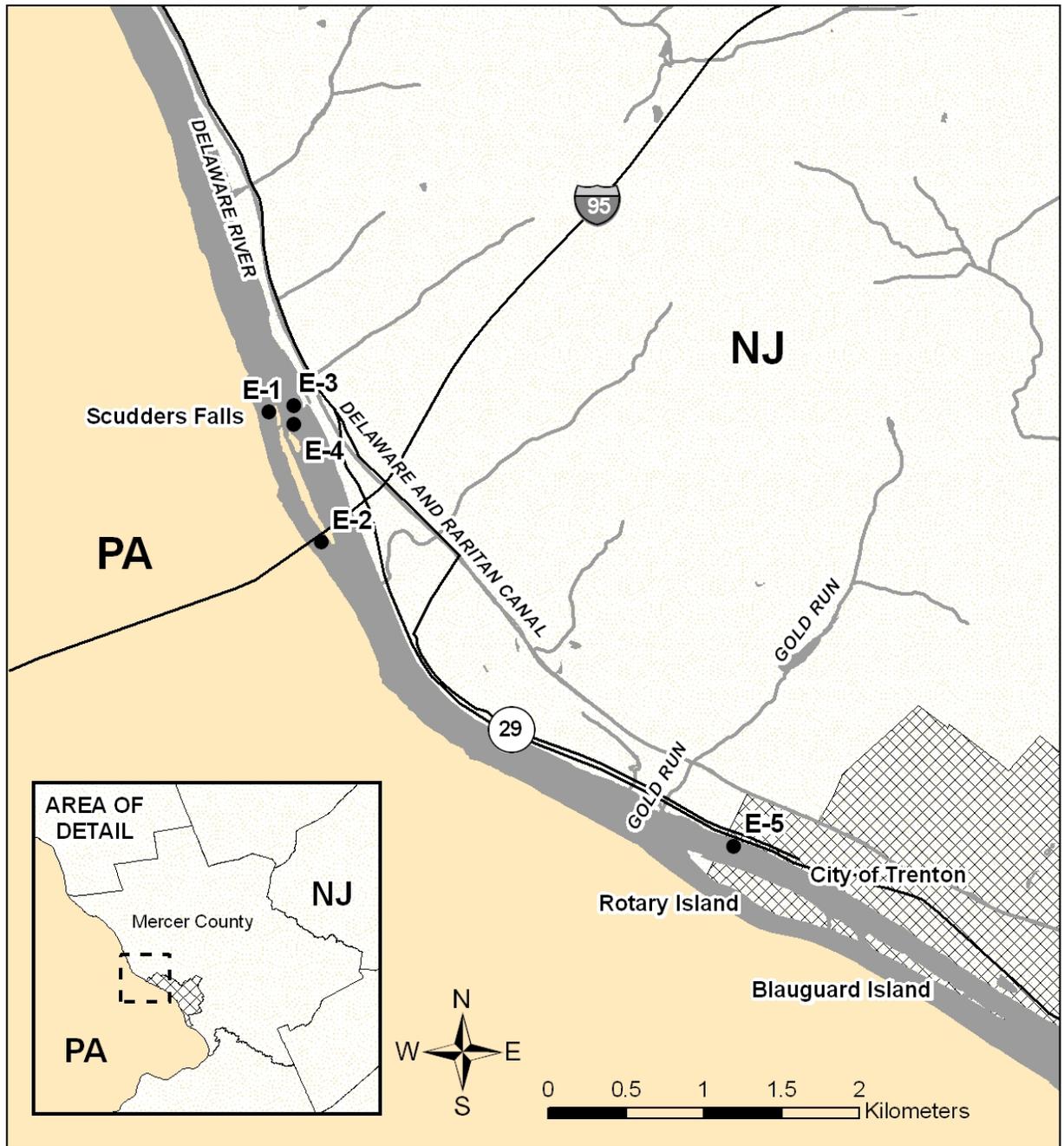
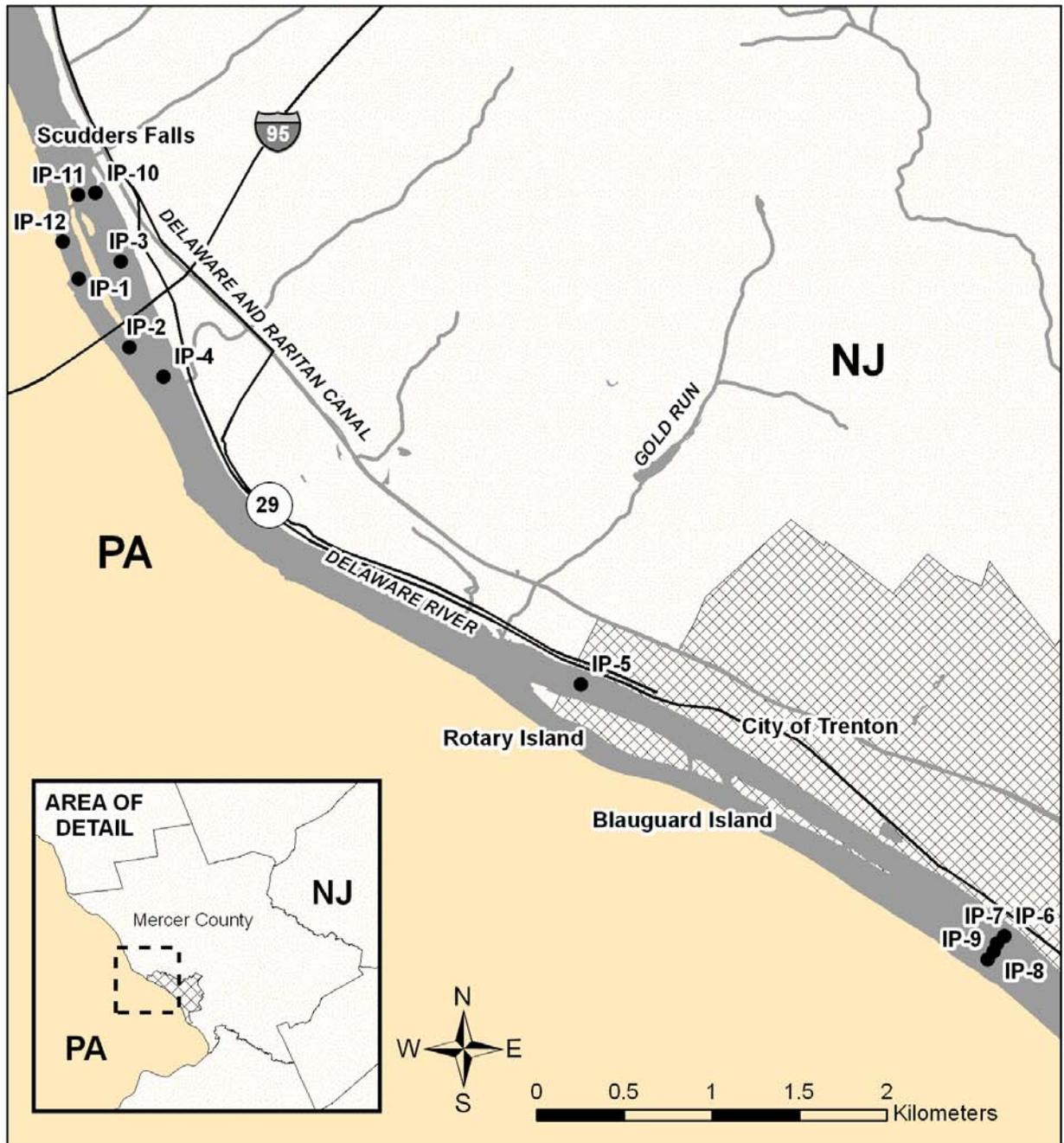


FIGURE 3
Daily mean river discharge, water temperature, and dissolved oxygen at the USGS Trenton gage, May 1-31, 2007



**FIGURE 4:
Artificial substrate sampler locations, 2007**



**FIGURE 5:
D-Frame net sample locations, 2007**



FIGURE 6
Lateral view of a 15.2 mm TL larval shortnose sturgeon collected on May 11, 2007



FIGURE 7
Ventral view of the head of a 15.2 mm TL larval shortnose sturgeon
collected on May 11, 2007

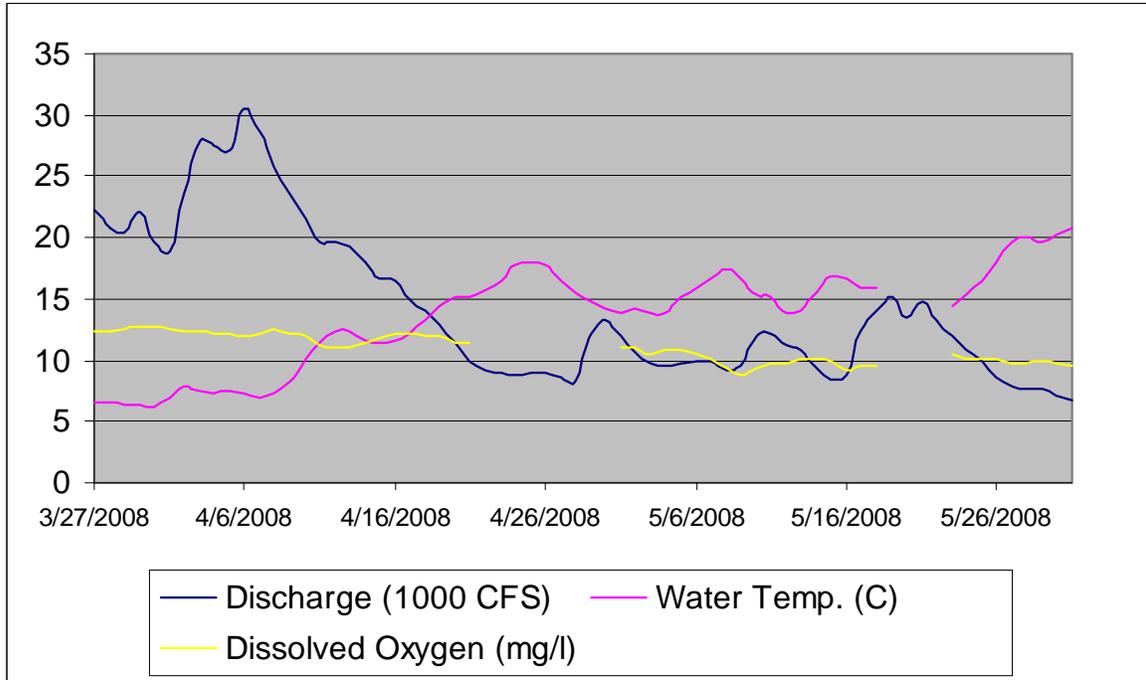


FIGURE 8
Daily mean river discharge, water temperature, and dissolved oxygen at the USGS Trenton gage, March 27-May 31, 2008

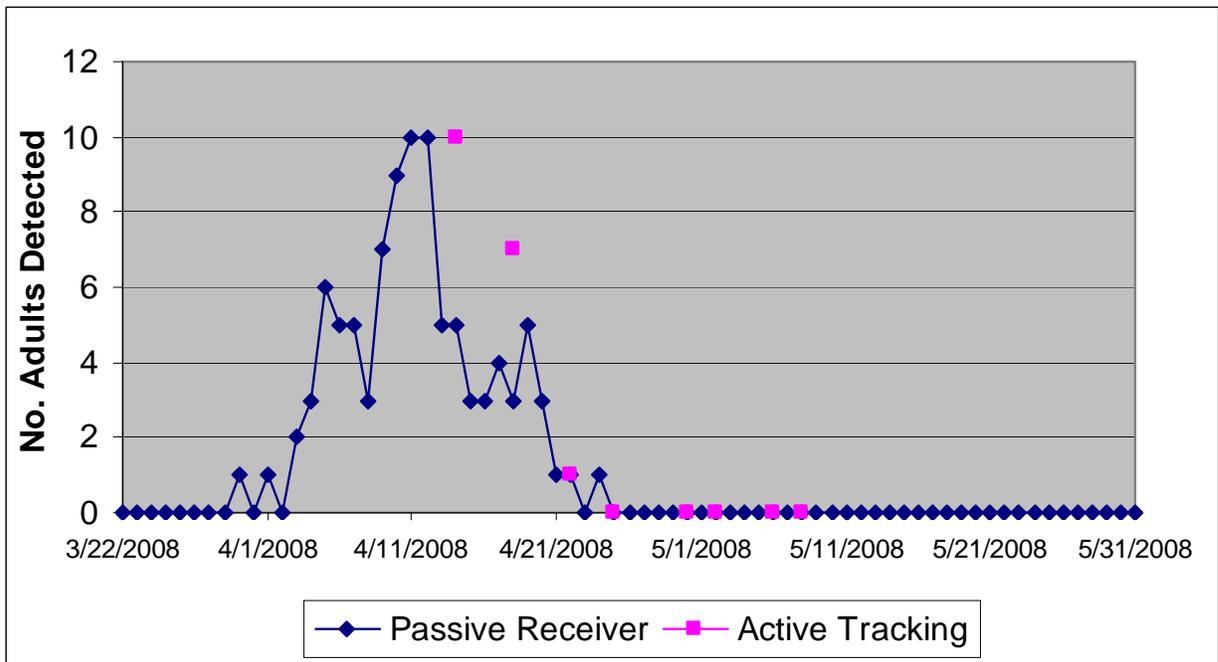
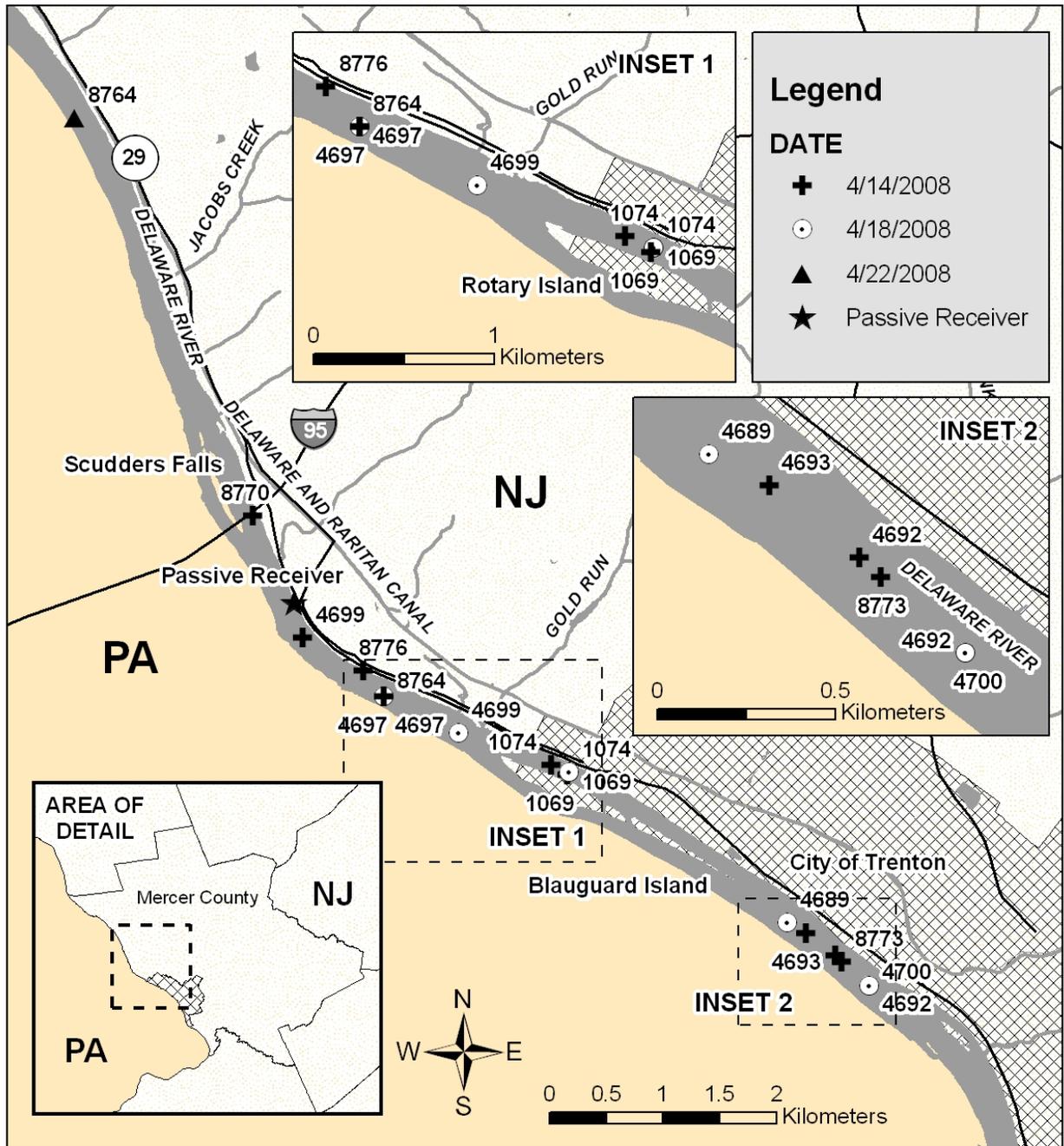
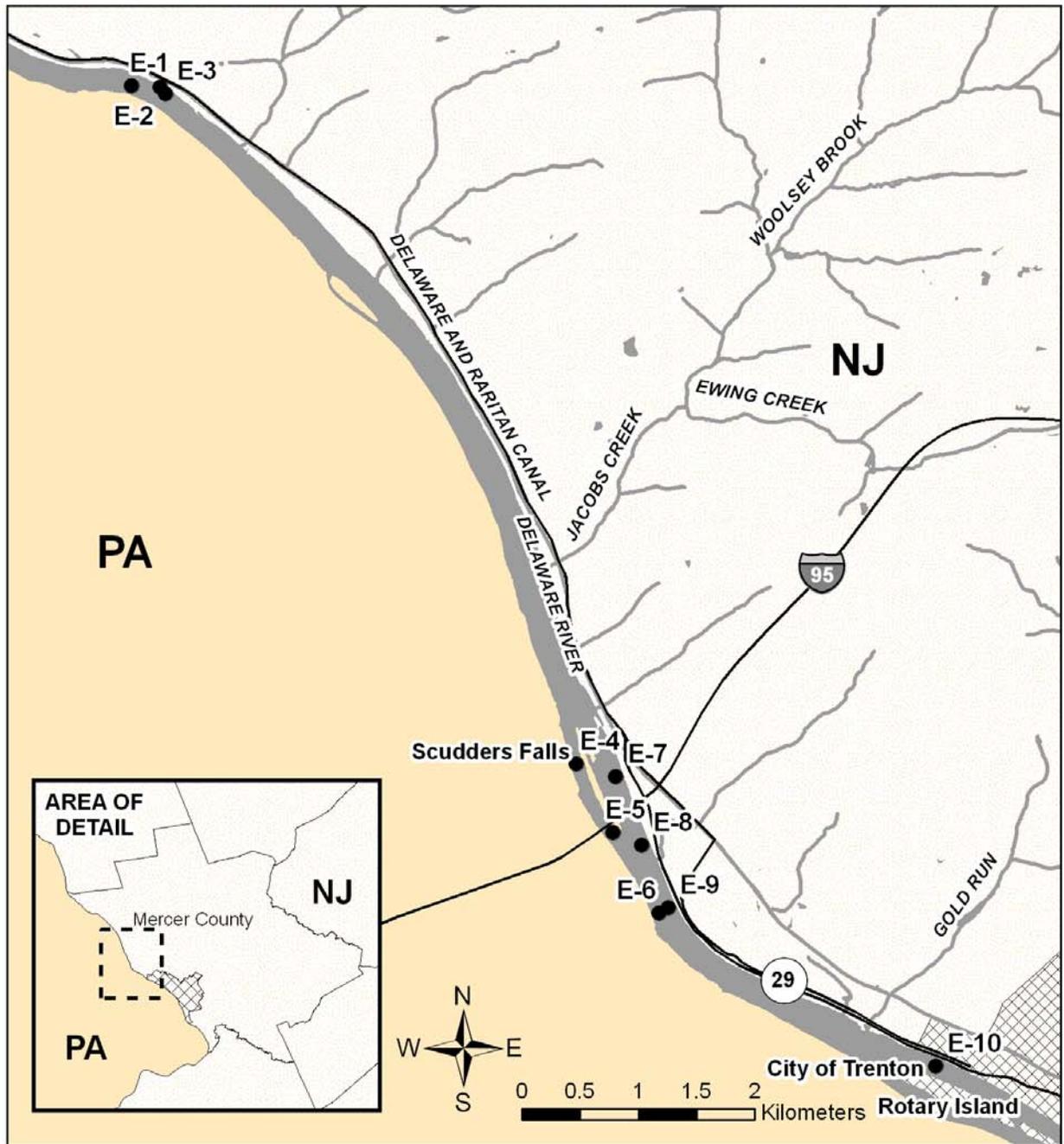


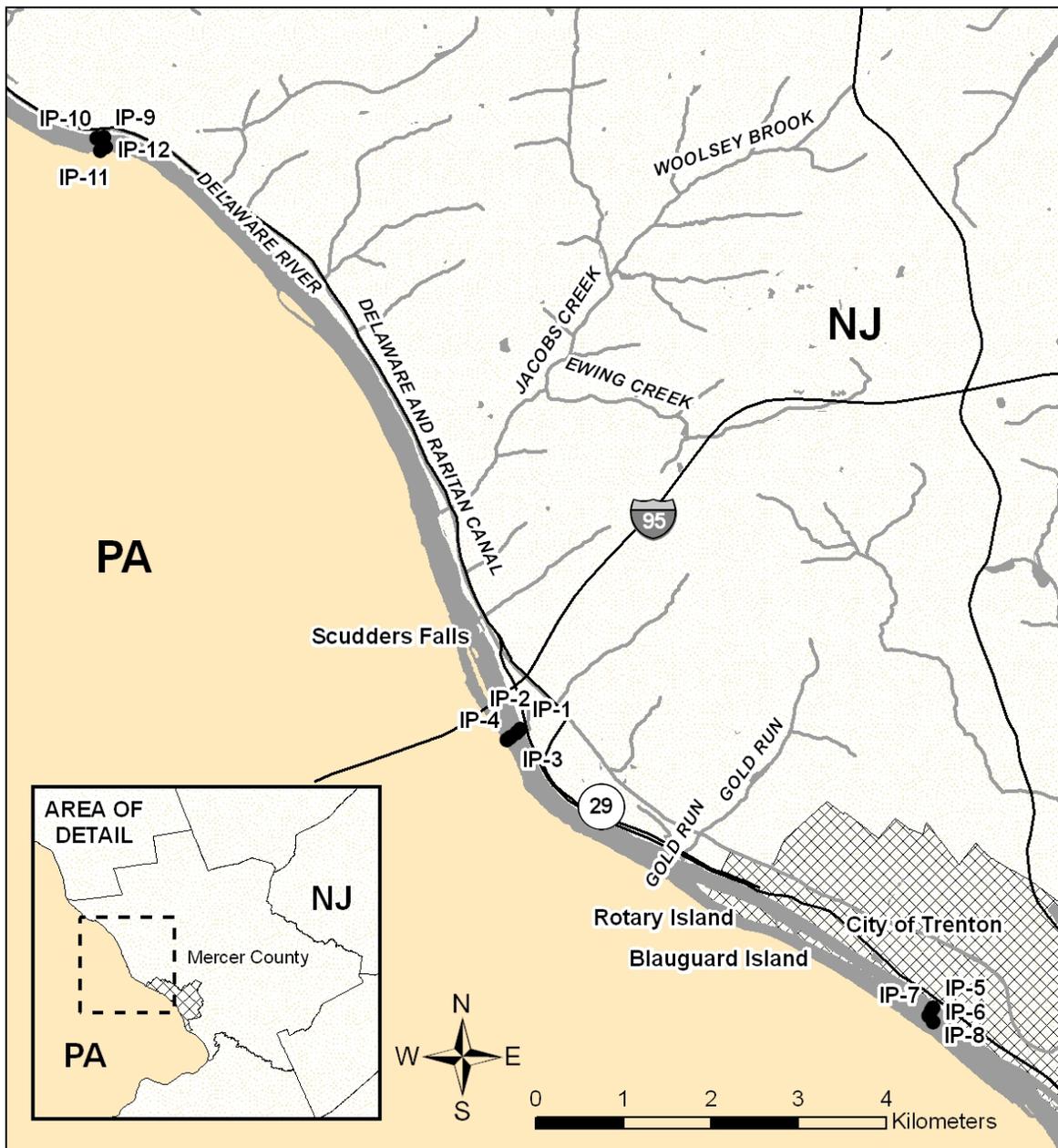
FIGURE 9
Number of acoustically-tagged adult shortnose sturgeon detected in the non-tidal Delaware River, March-May 2008



**FIGURE 10:
Locations of acoustically tagged
adult shortnose sturgeon, April 2008**



**FIGURE 11:
Artificial substrate sampler locations, 2008**



**FIGURE 12:
D-Frame net sample locations, 2008**

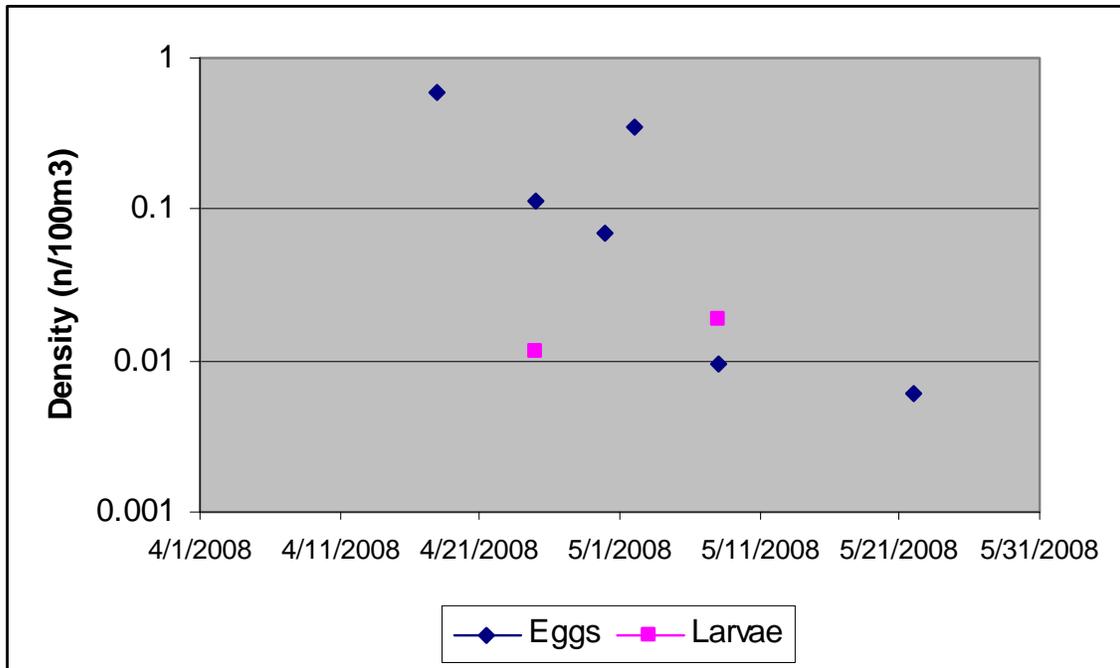


FIGURE 13
Density of shortnose sturgeon eggs and larvae in D-frame net samples, April-May 2008

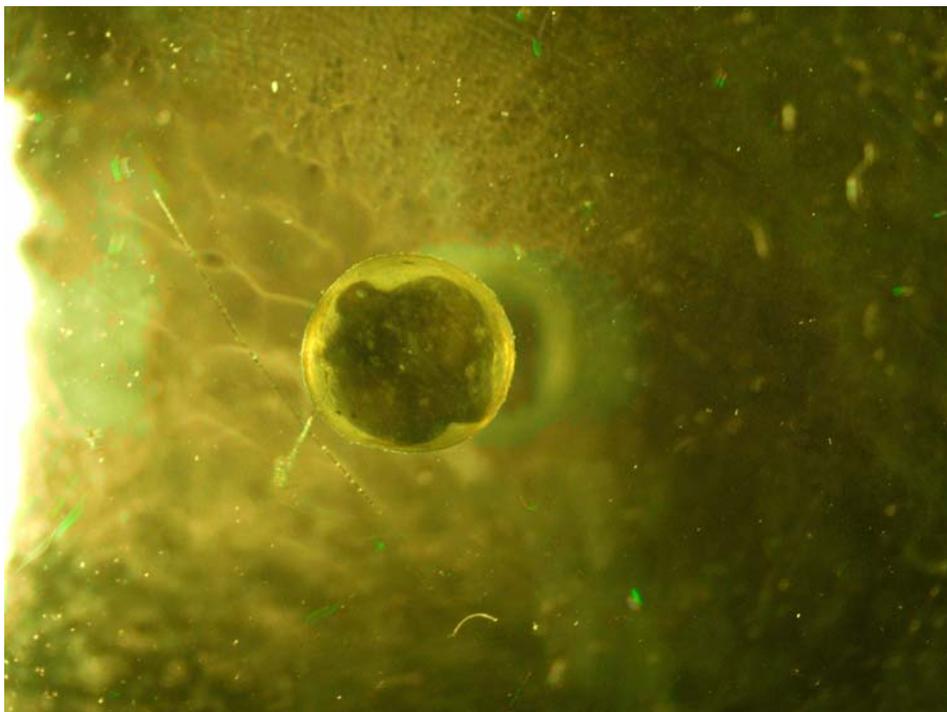


FIGURE 14
Shortnose sturgeon egg collected by D-frame net on May 2, 2008



FIGURE 15
Larval shortnose sturgeon (13.0 mm TL) collected on April 25, 2008



FIGURE 16
Larval shortnose sturgeon (10.6 mm TL) collected on May 8, 2008

TABLE 1
Collection information for acoustically tagged
adult shortnose sturgeon detected in the
non-tidal Delaware River, Spring 2008

Acoustic Tag No.	Tagging			
	Date	Fork Length (mm)	Weight (kg)	Sex
1069	11/14/2006	754	3.40	M
1074	11/14/2006	735	3.24	M
1076	11/14/2006	774	3.64	M
4689	6/5/2007	719	3.04	M
4692	6/5/2007	656	2.16	F
4693	6/5/2007	645	2.28	M
4697	6/5/2007	772	3.26	F
4698	6/5/2007	659	2.58	F
4699	6/5/2007	689	2.34	F
4700	6/5/2007	665	2.18	--
8764	11/8/2007	783	4.06	F
8768	11/7/2007	655	2.56	M
8770	11/8/2007	798	3.83	M
8772	11/8/2007	800	4.44	F
8773	11/8/2007	713	3.20	F
8775	11/8/2007	759	3.16	F
8776	11/8/2007	682	2.58	M

TABLE 2
Adult shortnose sturgeon detected by a passive
acoustic receiver located in the non-tidal
Delaware River near Yardley, PA, Spring 2008

Acoustic Tag No.	First Detection	Last Detection	No. of Days Detected	No. Detections
1074	4/10	4/12	3	192
1076	4/10	4/20	11	77
4689	4/12	4/12	1	73
4697	4/5	4/21	17	1697
4698	4/4	4/20	17	1183
4699	4/12	4/9	8	449
8764	4/5	4/24	20	2460
8768	3/30	4/11	13	985
8770	4/6	4/22	17	2325
8772	4/5	4/11	7	400

8773	4/10	4/12	3	923
8775	4/1	4/12	12	2172
8776	4/8	4/14	7	2062

TABLE 3
Results of active acoustic tracking in the non-tidal Delaware River, Spring 2008

Date	Start Location	End Location	Detections	
			Acoustic Tag No.	Location
4/14/2008	"Fife & Drum rapids"	Trenton rapids	8770	I-95 Bridge, NJ side
			4699	1.2 km D/S I-95 Bridge
			8776	1 km U/S RR Bridge
			1074	0.8 km U/S RR Bridge
			4697	0.8 km U/S RR Bridge
			8764	0.8 km U/S RR Bridge
			1069	0.4 km U/S of D/S end Rotary Isl., NJ side
			4693	0.8 km D/S Blauguard Island
			8773	1.2 km D/S Blauguard Island
			4692	0.8 km U/S Calhoun St. Bridge
4/18/2008	Scudders Falls	Trenton rapids	4697	0.8 km U/S RR Bridge
			4699	near RR Bridge
			1069	mid Rotary Island, NJ side
			1074	mid Rotary Island, NJ side
			4689	0.6 km D/S Blauguard Island
			4692	0.4 km U/S Calhoun St. Bridge
			4700	0.4 km U/S Calhoun St. Bridge
4/22/2008	"Fife & Drum rapids"	Yardley	8764	0.6 km U/S Washington Crossing Bridge
4/25/2008	Scudders Falls	Rotary Island		No Detections
4/30/2008	"Fife & Drum rapids"	Yardley		No Detections
5/2/2008	Scudders Falls	Trenton rapids		No Detections
5/6/2008	"Fife & Drum rapids"	Rotary Island		No Detections
5/8/2008	Scudders Falls	Trenton rapids		No Detections

TABLE 4
Density of shortnose sturgeon eggs and larvae in
D-frame net samples by date, Spring 2008

Date	Eggs		Larvae	
	No.	Density (n/100m ³)	No.	Density (n/100m ³)
4/18/2008	89	0.585	0	0.000
4/22/2008	0	0.000	0	0.000
4/25/2008	10	0.115	1	0.012
4/30/2008	5	0.069	0	0.000
5/2/2008	44	0.351	0	0.000
5/6/2008	0	0.000	0	0.000
5/8/2008	1	0.009	2	0.019
5/12/2008	0	0.000	0	0.000
5/16/2008	0	0.000	0	0.000
5/19/2008	0	0.000	0	0.000
5/22/2008	1	0.006	0	0.000

TABLE 5
Density of shortnose sturgeon eggs and larvae in
D-frame net samples by sampling area, Spring 2008

Sampling Area	Eggs		Larvae	
	No.	Density (n/100m ³)	No.	Density (n/100m ³)
U/S "Fife & Drum rapids"	5	0.012	0	0.000
D/S I-95 Bridge	14	0.035	3	0.008
	13			
D/S Blauguard Island	1	0.362	0	0.000

APPENDIX

APPENDIX TABLE 1
Daily mean river discharge, water temperature, dissolved oxygen
concentration, and specific conductance at the USGS Trenton
gage, May 1-31, 2007

Date	Discharge (thousand cfs)	Temp. (°C)	Diss. Oxy. (mg/l)	Spec. Cond. (umhos)
5/1/2007	18.20	13.8	10.4	146
5/2/2007	18.70	14.3	10.3	145
5/3/2007	17.50	14.9	10.5	150
5/4/2007	16.00	15.3	10.6	151
5/5/2007	14.20	15.6	10.7	153
5/6/2007	12.70	15.5	10.4	169
5/7/2007	11.50	15.3	10.9	179
5/8/2007	10.70	15.8	10.5	195
5/9/2007	10.20	17.1	10.1	195
5/10/2007	9.40	18.2		200
5/11/2007	9.05	18.9		207
5/12/2007	8.92	19.8		206
5/13/2007	10.00	19.6		215
5/14/2007	9.68	19.5		210
5/15/2007	8.61	19.7	10.3	207
5/16/2007	8.03	20.6	9.0	212
5/17/2007	8.11	20.3	7.9	224
5/18/2007	8.00	19.0	8.5	233
5/19/2007	8.17	18.1	8.9	231
5/20/2007	7.87	18.2	8.8	226
5/21/2007	7.21	18.5	8.8	227
5/22/2007	6.73	18.8	8.8	230
5/23/2007	6.49	19.5	8.8	233
5/24/2007	6.24	20.6	8.7	239
5/25/2007	5.85	22.2	8.5	242
5/26/2007	5.81	23.6	8.4	245
5/27/2007	5.76	24.6	8.3	244
5/28/2007	6.35	24.3	7.9	245
5/29/2007	5.62	24.0	8.3	249
5/30/2007	5.05	24.4	8.7	244
5/31/2007	5.14	25.1	8.8	244

APPENDIX TABLE 2
Shortnose sturgeon eggs collected by artificial substrate sampler, Spring 2007

Station	E-1	Date	5/1/2007	5/7/2007	5/14/2007
Location	ca. 100 m D/S Scudders	Depth (m)	1.0	0.6	0.8
	Falls, PA side	Current vel (m/sec)	1.49	0.79	1.22
Latitude	40°15.913'	No. eggs	---	1	0
Longitude	74°51.133'				

Station	E-2	Date	5/1/2007	5/7/2007	5/7/2007
Location	ca. 10 m D/S I-95 Bridge,	Depth (m)	1.5	1.0	1.0
	PA side	Current vel (m/sec)	1.22	1.23	1.16
Latitude	40°15.460'	No. eggs	---	0	0
Longitude	74°50.891'				

Station	E-3	Date	5/1/2007	5/14/2007
Location	ca. 200m D/S Scudders	Depth (m)	1.8	1.0
	Falls, NJ side	Current vel (m/sec)	1.16	---
Latitude	40°15.939'	No. eggs	---	0
Longitude	74°51.017'			

Station	E-4	Date	5/1/2007	5/7/2007	5/14/2007
Location	ca. 300 m D/S Scudders	Depth (m)	1.07	0.8	1.0
	Falls, NJ side	Current vel (m/sec)	1.89	1.52	1.46
Latitude	40°15.871'	No. eggs	---	0	0
Longitude	74°51.015'				

Station	E-5	Date	5/1/2007	5/7/2007	5/14/2007
Location	Rotary Island,	Depth (m)	1.7	0.8	0.8
	NJ side	Current vel (m/sec)	1.37	1.43	1.16
Latitude	40°14.415'	No. eggs	---	0	0
Longitude	74°49.015'				

APPENDIX TABLE 3
Shortnose sturgeon eggs and larvae collected by D-frame net, Spring 2007

Location No.	Date	Time	Location	Volume Filtered (m ³)	Depth (m)	Current Velocity (m/sec)	Eggs		Larvae	
							No.	Density (n/100m ³)	No.	Density (n/100m ³)
IP-1	5/4/2007	1015-1410	ca. 375 m U/S I-95 Bridge, PA side	5021	1.2	1.62	0	0.000	0	0.000
IP-2	5/4/2007	1040-1440	ca. 50 m D/S I-95 Bridge, PA side	3230	1.5	1.16	1	0.031	3	0.093
IP-3	5/4/2007	1110-1505	ca. 200 m U/S I-95 Bridge, NJ side	4113	1.2	1.50	0	0.000	0	0.000
IP-4	5/4/2007	1125-1345	ca. 300 m D/S I-95 Bridge, NJ side	2093	2.0	1.37	0	0.000	0	0.000
IP-5	5/7/2007	1205-1518	U/S end of Rotary Island, NJ side	3573	0.8	1.43	0	0.000	0	0.000
IP-6	5/7/2007	1252-1434	ca. 700 m D/S Blauguard Island, NJ side	1026	0.5	0.64	0	0.000	0	0.000
IP-7	5/7/2007	1302-1445	ca. 700 m D/S Blauguard Island, NJ side	1403	0.8	1.16	0	0.000	0	0.000
IP-8	5/7/2007	1309-1500	ca. 700 m D/S Blauguard Island, PA side	1701	0.8	1.31	0	0.000	0	0.000
IP-6	5/8/2007	0955-1500	ca. 700 m D/S Blauguard Island, NJ side	1381	0.7	0.61	0	0.000	0	0.000
IP-7	5/8/2007	1000-1445	ca. 700 m D/S Blauguard Island, NJ side	3631	1.0	1.22	0	0.000	0	0.000
IP-8	5/8/2007	1003-1435	ca. 700 m D/S Blauguard Island, PA side	3831	1.0	1.28	0	0.000	0	0.000
IP-9	5/8/2007	1007-1425	ca. 700 m D/S Blauguard Island, PA side	3397	0.8	0.91	0	0.000	0	0.000
IP-6	5/11/2007	0943-1507	ca. 700 m D/S Blauguard Island, NJ side	2037	0.5	0.52	0	0.000	0	0.000
IP-7	5/11/2007	0947-1455	ca. 700 m D/S Blauguard Island, NJ side	2984	0.6	0.91	0	0.000	0	0.000
IP-8	5/11/2007	0950-1445	ca. 700 m D/S Blauguard Island, PA side	4260	0.9	1.25	0	0.000	0	0.000
IP-9	5/11/2007	0955-1430	ca. 700 m D/S Blauguard Island, PA side	3365	0.9	1.04	0	0.000	2	0.059
IP-10	5/14/2007	1130-1332	ca. 150 m D/S Scudders Falls, NJ side	1808	1.2	1.52	0	0.000	0	0.000
IP-11	5/14/2007	1132-1357	ca. 150 m D/S Scudders Falls, NJ side	2038	0.7	1.46	0	0.000	0	0.000
IP-12	5/14/2007	1140-1421	ca. 600 m D/S Scudders Falls, PA side	2972	0.8	0.91	0	0.000	0	0.000
IP-2	5/14/2007	1210-1430	ca. 50 m D/S I-95 Bridge, PA side	1475	0.9	1.07	0	0.000	0	0.000
IP-6	5/16/2007	0951-1251	ca. 700 m D/S Blauguard Island, NJ side	1227	0.5	0.70	0	0.000	0	0.000
IP-7	5/16/2007	0958-1300	ca. 700 m D/S Blauguard Island, NJ side	1748	0.8	0.82	0	0.000	0	0.000
IP-8	5/16/2007	1002-1315	ca. 700 m D/S Blauguard Island, PA side	2307	0.9	1.13	0	0.000	0	0.000
IP-9	5/16/2007	1005-1331	ca. 700 m D/S Blauguard Island, PA side	2177	0.7	0.79	0	0.000	0	0.000

APPENDIX TABLE 3
Continued

Location No.	Date	Time	Location	Volume Filtered (m ³)	Depth (m)	Current Velocity (m/sec)	Eggs		Larvae	
							No.	Density (n/100m ³)	No.	Density (n/100m ³)
IP-6	5/18/2007	0945-1325	ca. 700 m D/S Blauguard Island, NJ side	1495	0.6	0.58	0	0.000	0	0.000
IP-7	5/18/2007	0950-1335	ca. 700 m D/S Blauguard Island, NJ side	2719	0.8	1.04	0	0.000	0	0.000
IP-8	5/18/2007	0956-1350	ca. 700 m D/S Blauguard Island, PA side	2802	1.0	0.98	0	0.000	0	0.000
IP-9	5/18/2007	0959-1403	ca. 700 m D/S Blauguard Island, PA side	2721	0.8	0.94	0	0.000	0	0.000
IP-6	5/23/2007	1115-1516	ca. 700 m D/S Blauguard Island, NJ side	1634	0.5	0.55	0	0.000	0	0.000
IP-7	5/23/2007	1120-1525	ca. 700 m D/S Blauguard Island, NJ side	2867	0.6	0.79	0	0.000	0	0.000
IP-8	5/23/2007	1124-1534	ca. 700 m D/S Blauguard Island, PA side	3836	0.9	1.04	0	0.000	0	0.000
IP-9	5/23/2007	1129-1545	ca. 700 m D/S Blauguard Island, PA side	3472	0.7	1.10	0	0.000	0	0.000
Total				84344			1	0.001	5	0.006

Appendix Table 4
Daily mean river discharge, water temperature, dissolved oxygen concentration, and specific conductance at the USGS Trenton gage, March 15-May 31, 2008

Date	Discharge (thousand cfs)	Temp. (°C)	Diss. Oxy. (mg/l)	Spec. Cond. (umhos)
3/15/2008	32.80	5.7	12.3	148
3/16/2008	32.50	6.2	12.3	152
3/17/2008	31.70	6	12.6	147
3/18/2008	29.10	5.5	12.7	147
3/19/2008	27.50	5.3	12.6	151
3/20/2008	38.90	6	12.1	158
3/21/2008	55.20	5.3	12.3	133
3/22/2008	48.00	4.8	12.7	113
3/23/2008	38.00	5	12.9	122
3/24/2008	32.10	5.2	12.8	133
3/25/2008	27.90	5.6	12.8	139
3/26/2008	24.40	6.2	12.7	147
3/27/2008	22.20	6.6	12.4	154
3/28/2008	20.80	6.5	12.3	159
3/29/2008	20.40	6.3	12.6	162
3/30/2008	22.00	6.3	12.8	154
3/31/2008	19.60	6.2	12.7	151
4/1/2008	18.90	7	12.5	157
4/2/2008	23.60	7.8	12.4	157
4/3/2008	27.80	7.5	12.4	139
4/4/2008	27.60	7.3	12.2	126
4/5/2008	27.10	7.4	12.2	131
4/6/2008	30.50	7.3	12	128
4/7/2008	28.70	7	12.2	124
4/8/2008	25.80	7.3	12.5	127
4/9/2008	23.60	8.3	12.2	130
4/10/2008	21.50	10.2	12	136
4/11/2008	19.70	11.5	11.3	141
4/12/2008	19.60	12.3	11	146
4/13/2008	19.20	12.4	11	153
4/14/2008	17.90	11.6	11.4	152
4/15/2008	16.70	11.4	11.8	154
4/16/2008	16.40	11.6	12.2	157
4/17/2008	15.00	12.2	12.1	159
4/18/2008	14.00	13.2	12	164
4/19/2008	13.00	14.5	11.9	169

Appendix Table 4
Continued

Date	Discharge (thousand cfs)	Temp. (°C)	Diss. Oxy. (mg/l)	Spec. Cond. (umhos)
4/20/2008	11.40	15.1	11.5	175
4/21/2008	9.96	15.1	11.4	186
4/22/2008	9.22	15.8		199
4/23/2008	8.92	16.5		211
4/24/2008	8.75	17.8		210
4/25/2008	8.98	17.9		212
4/26/2008	8.99	17.7		210
4/27/2008	8.54	16.4		216
4/28/2008	8.27	15.5		217
4/29/2008	12.20	14.8		220
4/30/2008	13.30	14.3		207
5/1/2008	12.00	13.9	11	196
5/2/2008	10.70	14.2	11	196
5/3/2008	9.67	13.9	10.5	199
5/4/2008	9.48	13.9	10.9	203
5/5/2008	9.72	15.2	10.9	206
5/6/2008	10.00	16	10.5	205
5/7/2008	9.89	16.7	10.1	196
5/8/2008	9.25	17.5	9.3	197
5/9/2008	9.47	16.6	8.8	200
5/10/2008	11.90	15.3	9.3	204
5/11/2008	12.10	15.1	9.7	206
5/12/2008	11.20	13.9	9.8	201
5/13/2008	10.80	14	10.2	195
5/14/2008	9.40	15.5	10.1	201
5/15/2008	8.49	16.8	9.9	205
5/16/2008	8.77	16.6	9.2	209
5/17/2008	12.30	15.9	9.5	208
5/18/2008	14.00	15.9	9.5	207
5/19/2008	15.20			
5/20/2008	13.50			
5/21/2008	14.80			
5/22/2008	13.30			
5/23/2008	12.00	14.4	10.4	181
5/24/2008	10.90	15.4	10.2	185
5/25/2008	10.00	16.4	10.2	187
5/26/2008	8.60	17.9	10.1	191
5/27/2008	7.80	19.6	9.7	200
5/28/2008	7.59	20	9.7	204
5/29/2008	7.72	19.7	9.9	215
5/30/2008	7.16	20.3	9.8	213
5/31/2008	6.73	20.7	9.5	212

APPENDIX TABLE 5
Shortnose sturgeon eggs collected by artificial substrate sampler, Spring 2008

Station	E-1	Date	3/27/2008	4/22/2008	4/30/2008	5/6/2008	5/12/2008	5/19/2008	5/30/2008		
Location	D/S "Fife & Drum rapids", mid river	Depth (m)	4.9	3.0	3.6	3.6	3.4	3.4	3.0		
		Current vel .(m/sec)	2.01	1.37	1.40	0.27	0.70	---	---		
Latitude	40°18.908'	No. eggs	---	0	0	0	0	0	0		
Longitude	74°53.811'										
Station	E-2	Date	3/27/2008	4/14/2008	4/22/2008	4/30/2008	5/6/2008	5/12/2008	5/19/2008	5/30/2008	
Location	D/S "Fife & Drum rapids", NJ side, upper	Depth (m)	2.1	2.1	3.3	3.3	3.0	3.0	2.1	2.0	
		Current vel (m/sec)	1.16	0.70	0.85	0.88	0.64	0.64	---	---	
Latitude	40°18.900'	No. eggs	---	0	0	1	4	0	0	0	
Longitude	74°53.635'										
Station	E-3	Date	3/27/2008	4/14/2008	4/22/2008	4/30/2008	5/6/2008	5/12/2008	5/19/2008	5/30/2008	
Location	D/S "Fife & Drum rapids", NJ side, lower	Depth (m)	2.4	2.4	3.0	2.4	2.4	2.7	2.7	2.6	
		Current vel .(m/sec)	1.16	0.60	1.40	0.55	0.85	0.98	---	---	
Latitude	40°18.872'	No. eggs	---	0	0	0	0	0	0	0	
Longitude	74°53.605'										
Station	E-4	Date	3/27/2008	4/14/2008	4/18/2008	4/22/2008	4/30/2008	5/6/2008	5/12/2008	5/19/2008	5/30/2008
Location	D/S Scudders Falls, PA side	Depth (m)	1.5	1.5	2.1	1.8	1.8	1.2	1.7	1.5	1.4
		Current vel .(m/sec)	2.74	2.13	2.07	1.86	1.82	1.77	---	---	---
Latitude	40°15.770'	No. eggs	---	0	0	0	0	0	0	0	0
Longitude	74°51.102'										
Station	E-5	Date	3/27/2008	4/14/2008	4/18/2008	4/22/2008	4/30/2008	5/6/2008	5/12/2008	5/19/2008	5/30/2008
Location	D/S I-95 Bridge, PA side	Depth (m)	1.8	1.8	1.5	1.2	1.2	1.2	1.7	1.8	1.7
		Current vel .(m/sec)	2.13	1.43	1.16	1.09	1.31	1.10	---	---	---
Latitude	40°15.452'	No. eggs	---	1	1	1	0	0	0	0	0
Longitude	74°50.881'										

APPENDIX TABLE 5

Continued

Station	E-6	Date	3/27/2008	4/14/2008	4/18/2008	4/22/2008	4/30/2008	5/6/2008	5/16/2008	5/19/2008	5/30/2008
Location	near Yardley, PA side	Depth (m)	2.4	2.1	1.8	2.4	2.4	1.8	1.8	2.4	1.8
		Current vel. (m/sec)	1.80	1.16	0.91	1.09	1.04	0.94	---	---	---
Latitude	40°15.076'	No. eggs	---	0	0	0	0	0	0	0	0
Longitude	74°50.598'										

Station	E-7	Date	3/27/2008	4/14/2008	4/18/2008	4/22/2008	4/30/2008	5/6/2008	5/16/2008	5/19/2008	5/30/2008
Location	D/S Scudders Falls, NJ side	Depth (m)	1.7	1.8	1.2	1.2	1.2	0.9	0.9	1.2	0.9
		Current vel. (m/sec)	2.29	1.28	1.28	1.58	1.34	1.25	---	---	---
Latitude	40°15.707'	No. eggs	---	0	0	0	0	0	0	0	0
Longitude	74°50.863'										

Station	E-8	Date	3/27/2008	4/14/2008	4/22/2008	4/30/2008	5/6/2008	5/16/2008	5/19/2008	5/30/2008
Location	D/S I-95 Bridge, NJ side	Depth (m)	2.4	2.4	1.8	1.8	1.8	1.5	1.8	1.8
		Current vel. (m/sec)	2.12	1.49	1.55	1.49	1.40	---	---	---
Latitude	40°15.391'	No. eggs	---	1	0	0	0	0	0	0
Longitude	74°50.707'									

Station	E-9	Date	3/27/2008	4/14/2008	4/18/2008	4/22/2008	4/30/2008	5/6/2008	5/16/2008	5/19/2008	5/30/2008
Location	near Yardley, NJ side	Depth (m)	3.4	3.0	2.4	2.4	2.4	2.4	2.4	2.7	2.6
		Current vel. (m/sec)	2.12	1.37	0.91	0.79	0.98	1.07	---	---	---
Latitude	40°15.100'	No. eggs	---	2	1	0	0	0	0	0	0
Longitude	74°50.545'										

Station	E-10	Date	3/27/2008	4/14/2008	4/18/2008	4/25/2008	5/2/2008	5/8/2008	5/16/2008	5/22/2008	5/30/2008
Location	adjacent to Rotary Isl., NJ side	Depth (m)	2.4	2.4	1.8	1.4	1.4	1.2	1.2	1.2	1.2
		Current vel. (m/sec)	1.83	1.34	0.88	0.64	0.64	0.56	---	---	---
Latitude	40°14.370'	No. eggs	---	0	0	0	0	0	0	0	0
Longitude	74°48.921'										

APPENDIX TABLE 6
Shortnose sturgeon eggs and larvae collected by D-frame net, Spring 2008

Location No.	Date	Time	Location	Volume Filtered (m ³)	Depth (m)	Current Velocity (m/sec)	Eggs		Larvae	
							No.	Density (n/100m ³)	No.	Density (n/100m ³)
IP-1	4/18/2008	1004-1249	ca. 425 m D/S I-95 Bridge, NJ side	2417	2.1	1.34	4	0.165	0	0.000
IP-2	4/18/2008	1015-1304	ca. 425 m D/S I-95 Bridge, NJ side	2774	2.0	1.71	2	0.072	0	0.000
IP-3	4/18/2008	1026-1313	ca. 425 m D/S I-95 Bridge, PA side	1390	1.2	0.91	0	0.000	0	0.000
IP-4	4/18/2008	1035-1322	ca. 425 m D/S I-95 Bridge, PA side	1453	2.4	1.04	1	0.069	0	0.000
IP-5	4/18/2008	1450-1709	ca. 700 m D/S Blauguard Island, NJ side	1309	1.0	0.85	0	0.000	0	0.000
IP-6	4/18/2008	1457-1720	ca. 700 m D/S Blauguard Island, NJ side	1667	1.2	0.98	1	0.060	0	0.000
IP-7	4/18/2008	1505-1728	ca. 700 m D/S Blauguard Island, PA side	2327	2.0	1.49	81	3.480	0	0.000
IP-8	4/18/2008	1514-1739	ca. 700 m D/S Blauguard Island, PA side	1876	1.2	1.19	0	0.000	0	0.000
IP-9	4/22/2008	1030-1340	Immediately U/S "Fife & Drum rapids", NJ side	3691	1.0	1.40	0	0.000	0	0.000
IP-11	4/22/2008	1056-1404	Immediately U/S "Fife & Drum rapids", PA side	2342	1.5	1.16	0	0.000	0	0.000
IP-12	4/22/2008	1050-1352	Immediately U/S "Fife & Drum rapids", PA side	2384	1.2	1.16	0	0.000	0	0.000
IP-10	4/22/2008	1105-1419	Immediately U/S "Fife & Drum rapids", NJ side	3308	1.2	1.37	0	0.000	0	0.000
IP-1	4/25/2008	0950-1149	ca. 425 m D/S I-95 Bridge, NJ side	1535	1.7	1.16	0	0.000	0	0.000
IP-2	4/25/2008	1000-1200	ca. 425 m D/S I-95 Bridge, NJ side	1685	1.5	1.25	0	0.000	0	0.000
IP-3	4/25/2008	1010-1218	ca. 425 m D/S I-95 Bridge, PA side	625	2.0	0.94	0	0.000	1	0.160
IP-4	4/25/2008	1019-1224	ca. 425 m D/S I-95 Bridge, PA side	673	1.7	0.70	0	0.000	0	0.000
IP-5	4/25/2008	1308-1424	ca. 700 m D/S Blauguard Island, NJ side	739	0.5	0.67	0	0.000	0	0.000
IP-6	4/25/2008	1314-1438	ca. 700 m D/S Blauguard Island, NJ side	674	0.5	0.64	1	0.148	0	0.000
IP-7	4/25/2008	1319-1452	ca. 700 m D/S Blauguard Island, PA side	1435	1.2	1.34	9	0.627	0	0.000
IP-8	4/25/2008	1326-1511	ca. 700 m D/S Blauguard Island, PA side	1304	0.8	1.10	0	0.000	0	0.000
IP-9	4/30/2008	1015-1222	Immediately U/S "Fife & Drum rapids", NJ side	1548	1.2	1.13	1	0.065	0	0.000
IP-10	4/30/2008	1022-1238	Immediately U/S "Fife & Drum rapids", NJ side	1903	0.8	1.25	1	0.053	0	0.000
IP-11	4/30/2008	1030-1254	Immediately U/S "Fife & Drum rapids", PA side	2018	0.8	1.01	2	0.099	0	0.000
IP-12	4/30/2008	1040-1315	Immediately U/S "Fife & Drum rapids", PA side	1743	0.8	1.16	1	0.057	0	0.000

APPENDIX TABLE 6

Continued

Location No.	Date	Time	Location	Volume Filtered (m ³)	Depth (m)	Current Velocity (m/sec)	Eggs		Larvae	
							No.	Density (n/100m ³)	No.	Density (n/100m ³)
IP-1	5/2/2008	0931-1142	ca. 425 m D/S I-95 Bridge, NJ side	1610	1.8	1.16	0	0.000	0	0.000
IP-2	5/2/2008	0940-1153	ca. 425 m D/S I-95 Bridge, NJ side	1949	1.8	1.46	1	0.051	0	0.000
IP-3	5/2/2008	0952-1206	ca. 425 m D/S I-95 Bridge, PA side	1256	1.8	0.85	5	0.398	0	0.000
IP-4	5/2/2008	0959-1214	ca. 425 m D/S I-95 Bridge, PA side	1146	1.8	0.98	0	0.000	0	0.000
IP-5	5/2/2008	1300-1620	ca. 700 m D/S Blauguard Island, NJ side	1139	1.0	1.04	0	0.000	0	0.000
IP-6	5/2/2008	1306-1536	ca. 700 m D/S Blauguard Island, NJ side	1538	1.2	1.40	4	0.260	0	0.000
IP-7	5/2/2008	1310-1548	ca. 700 m D/S Blauguard Island, PA side	2196	1.5	1.58	34	1.548	0	0.000
IP-8	5/2/2008	1317-1601	ca. 700 m D/S Blauguard Island, PA side	1711	1.0	0.98	0	0.000	0	0.000
IP-9	5/6/2008	1028-1242	Immediately U/S "Fife & Drum rapids", NJ side	2107	1.0	1.19	0	0.000	0	0.000
IP-10	5/6/2008	1036-1254	Immediately U/S "Fife & Drum rapids", NJ side	1840	1.2	0.91	0	0.000	0	0.000
IP-11	5/6/2008	1045-1307	Immediately U/S "Fife & Drum rapids", PA side	1879	1.5	1.16	0	0.000	0	0.000
IP-12	5/6/2008	1050-1314	Immediately U/S "Fife & Drum rapids", PA side	2015	1.2	1.07	0	0.000	0	0.000
IP-1	5/8/2008	1002-1204	ca. 425 m D/S I-95 Bridge, NJ side	1718	1.5	1.19	0	0.000	0	0.000
IP-2	5/8/2008	1008-1215	ca. 425 m D/S I-95 Bridge, NJ side	1966	1.8	1.64	0	0.000	2	0.102
IP-3	5/8/2008	1016-1223	ca. 425 m D/S I-95 Bridge, PA side	935	1.2	0.70	0	0.000	0	0.000
IP-4	5/8/2008	1022-1231	ca. 425 m D/S I-95 Bridge, PA side	792	1.8	0.82	0	0.000	0	0.000
IP-5	5/8/2008	1325-1526	ca. 700 m D/S Blauguard Island, NJ side	868	1.8	0.52	0	0.000	0	0.000
IP-6	5/8/2008	1330-1536	ca. 700 m D/S Blauguard Island, NJ side	1220	0.9	0.70	0	0.000	0	0.000
IP-7	5/8/2008	1335-1544	ca. 700 m D/S Blauguard Island, PA side	2032	1.2	1.16	1	0.049	0	0.000
IP-8	5/8/2008	1341-1557	ca. 700 m D/S Blauguard Island, PA side	1151	1.2	0.56	0	0.000	0	0.000
IP-9	5/12/2008	1030-1230	Immediately U/S "Fife & Drum rapids", NJ side	2029	1.5	1.13	0	0.000	0	0.000
IP-10	5/12/2008	1037-1244	Immediately U/S "Fife & Drum rapids", NJ side	1633	1.2	0.82	0	0.000	0	0.000
IP-11	5/12/2008	1045-1256	Immediately U/S "Fife & Drum rapids", PA side	1827	1.5	1.37	0	0.000	0	0.000
IP-12	5/12/2008	1051-1311	Immediately U/S "Fife & Drum rapids", PA side	1736	1.5	1.07	0	0.000	0	0.000

APPENDIX TABLE 6

Continued

Location No.	Date	Time	Location	Volume Filtered (m ³)	Depth (m)	Current Velocity (m/sec)	Eggs		Larvae	
							No.	Density (n/100m ³)	No.	Density (n/100m ³)
IP-1	5/16/2008	1052-1309	ca. 425 m D/S I-95 Bridge, NJ side	1986	1.5	1.13	0	0.000	0	0.000
IP-2	5/16/2008	1103-1321	ca. 425 m D/S I-95 Bridge, NJ side	1991	1.5	1.19	0	0.000	0	0.000
IP-3	5/16/2008	1116-1333	ca. 425 m D/S I-95 Bridge, PA side	1549	1.5	0.82	0	0.000	0	0.000
IP-4	5/16/2008	1131-1345	ca. 425 m D/S I-95 Bridge, PA side	856	1.7	0.85	0	0.000	0	0.000
IP-5	5/16/2008	1418-1621	ca. 700 m D/S Blauguard Island, NJ side	1110	0.6	0.91	0	0.000	0	0.000
IP-6	5/16/2008	1423-1634	ca. 700 m D/S Blauguard Island, NJ side	1383	0.9	0.91	0	0.000	0	0.000
IP-7	5/16/2008	1429-1648	ca. 700 m D/S Blauguard Island, PA side	1990	1.2	---	0	0.000	0	0.000
IP-8	5/16/2008	1433-1702	ca. 700 m D/S Blauguard Island, PA side	1485	1.2	---	0	0.000	0	0.000
IP-9	5/19/2008	1015-1216	Immediately U/S "Fife & Drum rapids", NJ side	1596	1.2	---	0	0.000	0	0.000
IP-10	5/19/2008	1026-1228	Immediately U/S "Fife & Drum rapids", NJ side	1789	1.2	---	0	0.000	0	0.000
IP-11	5/19/2008	1040-1245	Immediately U/S "Fife & Drum rapids", PA side	1559	1.2	---	0	0.000	0	0.000
IP-12	5/19/2008	1046-1255	Immediately U/S "Fife & Drum rapids", PA side	1431	1.2	---	0	0.000	0	0.000
IP-1	5/22/2008	0940-1142	ca. 425 m D/S I-95 Bridge, NJ side	1664	2.1	---	0	0.000	0	0.000
IP-2	5/22/2008	0950-1206	ca. 425 m D/S I-95 Bridge, NJ side	2120	2.4	---	0	0.000	0	0.000
IP-3	5/22/2008	0958-1221	ca. 425 m D/S I-95 Bridge, PA side	1620	1.8	---	0	0.000	0	0.000
IP-4	5/22/2008	1007-1239	ca. 425 m D/S I-95 Bridge, PA side	4082	2.1	---	1	0.024	0	0.000
IP-5	5/22/2008	1323-1524	ca. 700 m D/S Blauguard Island, NJ side	1516	0.9	---	0	0.000	0	0.000
IP-6	5/22/2008	1328-1536	ca. 700 m D/S Blauguard Island, NJ side	1660	1.2	---	0	0.000	0	0.000
IP-7	5/22/2008	1332-1550	ca. 700 m D/S Blauguard Island, PA side	1871	1.8	---	0	0.000	0	0.000
IP-8	5/22/2008	1338-1605	ca. 700 m D/S Blauguard Island, PA side	1987	1.6	---	0	0.000	0	0.000
Total				116355			150	0.129	3	0.003