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September 5, 2012

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**BELL BEND NUCLEAR POWER PLANT
MUSSEL SURVEY REPORT
BNP-2012-200 Docket No. 52-039**

Enclosed is the Normandeau Associates, Inc. Mussel Survey report for the presence/absence of two target species, the Green floater and Brook floater mussels, in the North Branch Susquehanna River downstream of the proposed Bell Bend project.

Of the target species, no Brook floater were found. Fourteen Green floater were found at one location between Swan and Heron Islands. As explained in the report Green floater population density in this area is considered to be very small and approaches 0.0 mussels per m² of river bottom.

Should you have questions or need additional information regarding these revisions, please feel free to contact me.

Respectfully,


Gary Petrewski

GP/kw

Enclosure: Normandeau Associates, Inc., "Mussel Survey in the Susquehanna River near the proposed Bell Bend Project at Berwick, PA", Report 21665.001-MS, Rev 0, August 2012.

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Enclosure

Normandeau Associates, Inc.,
"Mussel Survey in the Susquehanna River near the proposed Bell Bend Project at
Berwick, PA",
Report 21665.001-MS, Rev 0,
August 2012.

Mussel Survey in the Susquehanna River near the proposed Bell Bend Project at Berwick, PA

Proposed Bell Bend Nuclear Power Plant Site,
Luzerne County, Pennsylvania



Prepared for

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August 2012

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ABBREVIATIONS

Abbreviation	Meaning
BBNPP	Bell Bend Nuclear Power Plant
cfs	Cubic feet per second; 1 cfs = 0.646 mgd
NRC	Nuclear Regulatory Commission
PADEP	Pennsylvania Department of Environmental Protection
PFBC	Pennsylvania Fish & Boat Commission
PPL	PPL Bell Bend, LLC; sponsor of the BBNPP project
SRBC	Susquehanna River Basin Commission
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1. SUMMARY

A mussel survey to document the presence or absence of green floater (*Lasmigona subviridis*) and brook floater (*Alasmidonta varicosa*) was conducted in part of the Susquehanna River that may be impacted by consumptive water use of a new nuclear plant (the Bell Bend Project) at Berwick, PA. The survey was conducted in accordance to an approved study plan¹ on June 27-30, 2012, a period of low and decreasing river discharge. Provisional river discharge measured by the U.S. Geological Survey (USGS) at Wilkes-Barre, PA on June 30 was 2,830 cfs.

The mussel survey consisted of search for the sandy habitat in which both target species are known to live, followed by semi-quantitative survey for these species in the sandy habitat, and subsequent quantitative sampling to determine population density in areas where the target species were observed. Habitat containing sand as a principal component in a range of proportions relative to other substrate particle sizes was semi-quantitatively surveyed for freshwater mussels at 15 locations around five islands in the Susquehanna River below the Bell Bend Project discharge downstream to the area of the Nescopeck Bridge.

A total of seven mussel species was identified in the semi-quantitative mussel survey, including green floater, which was observed at only one location – the Green Floater Study Compartment, located in the upstream end of the channel that separates Heron Island from Swan Island. Brook floater was not observed at any location. Aside from the absence of green floater from the other semi-quantitative survey locations, the only other difference in species identity between these locations and the Green Floater Study Compartment was the absence of eastern floater from the latter location. This absence may be due to the apparent absence of silt in the substrate in the Green Floater Study Compartment, noting that eastern floater is known to thrive in silt and mud.

Yellow lampmussel, elktoe, and eastern floater were among the most frequently observed mussels in the semi-quantitative survey. A small (juvenile) yellow lampmussel indicated recruitment in the Green Floater Study Compartment.

Eleven green floater were observed in the Green Floater Study Compartment during 10.2 search hours of the semi-quantitative survey. An additional three green floater were observed on the substrate surface during quantitative sampling in the Green Floater Study Compartment, but outside the quantitative sampling grids.

Water depth ranged from 0.1 to 1.7 feet at the 14 points where green floater were observed. Twelve green floater were observed where water depth ranged from 0.7 to 1.7 feet. Current velocities ranged from 0.0 to 1.7 ft/sec at the 14 points where green floater were observed, with 12 green floater observed where current velocity ranged from 0.6 to 1.7 ft/sec.

¹ Study Plan submitted and approved by the SRBC in August 2011.

The two green floater observed in shallow water (0.1 feet depth) with no measurable current velocity were lying flat on the river substrate, whereas the other green floater were seen partially buried in the substrate siphoning water. The two green floater lying flat on the substrate could be interpreted as a response to decreasing water level, perhaps an attempt to move across the substrate to deeper water.

The Green Floater Study Compartment encompassed approximately 20,700 square feet of river bottom characterized by a substrate comprised of a mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand. No silt appeared to be present. The green floater appeared to be clustered in the upstream end of the Green Floater Study Compartment, with no cause apparent in the habitat.

The large size of the Green Floater Study Compartment suggested that collection of only nine quantitative samples as described in the study plan would be inadequate to characterize its mussel resources. Therefore, a total of 102 0.25 m² quadrat samples were collected in six quantitative sampling grids, each 5 m x 10 m, established in the Green Floater Study Compartment. This effort increased the quantitative sample size from 9 to 102 samples and distributed the samples across the large area. Each quadrat sample was surface collected and excavated to 10 cm depth. A total of 11 mussels were observed, representing three species. Elktoe was most frequently observed, with triangle floater and yellow lampmussel observed in smaller numbers. Elktoe were observed in all but one quantitative sampling grid. Small (<30 mm shell length) individuals of each species were observed, indicating recruitment in the Green Floater Study Compartment.

No green floater were observed in the quantitative samples. However, three green floater were observed on the surface of the substrate during the quantitative sampling, but outside the quantitative sampling grids.

Green floater were not observed in the quantitative sampling conducted in the Green Floater Study Compartment, leading to a population density estimate of 0.0 per m² of river bottom. However, the observation of green floater in the semi-quantitative survey indicates that the true density for this species is somewhat higher than 0.0 per m². Nevertheless, the true density cannot be much higher than 0.0 per m², noting the large sample size (n = 102) in which no green floater were observed in the quantitative sampling.

2. INTRODUCTION

The Bell Bend Project (Project), a new nuclear plant, is proposed for construction along the Susquehanna River at Berwick, PA. The Susquehanna River Basin Commission (SRBC) requested that certain studies be performed to evaluate the potential impacts that Project operations might have on the aquatic biota and water quality in the Susquehanna River. Among these requested studies is an evaluation of the presence of two rare mussel species and as appropriate an analysis of potential impacts to these mussels due to the Project's consumptive water use. This report describes a mussel survey conducted to document the presence or absence of these rare species in areas of the Susquehanna River that may be impacted by Project consumptive water use. The mussel survey was conducted on June 27-30, 2012.

The study plan, which formed the basis for the survey, is included in this report's Appendix A. It is the result of discussions held in Berwick on February 23, 2011, and subsequent SRBC comments on initial drafts. The SRBC, the PFBC, USFWS, USGS, PPL, and PPL's consultants (Normandeau Associates and Ecology III) participated in the February 23, 2011 discussions. Mussel biologists Dr. William Lellis (USGS) and Dr. Robert Anderson (USFWS) as well as Dr. Brian Mangan (Kings College in Wilkes-Barre), who has local knowledge of the river and its mussels, participated.

Consumptive water use (43 cfs) at low river discharge at Berwick (800 cfs) is predicted to reduce the river water surface elevation by 0.5 inch or less. Discussion at the Berwick meeting centered on how to evaluate the impact on mussels from the predicted reduction in water surface elevation. Dr. Lellis suggested that attention should be directed toward two rare mussels (green floater – *Lasmigona subviridis* and brook floater – *Alasmidonta varicosa*) that may occur in the river at Berwick. He said that these two species (the target species) live in sandy habitat and that such habitat is likely to be found near several islands located just upstream of the Nescopeck Bridge. Dr. Lellis suggested that a mussel survey should be conducted that included search for sandy habitat at the islands, followed by determination if the target species are present in the sandy habitat, and if so, in what density. Locality information in terms of field-acquired GPS coordinates, would be used with hydrologic modeling to determine if areas where the target species were found would be dewatered or otherwise subject to potential impact by a change in river water surface elevation due to consumptive water use at low river discharge. The details of the survey were discussed at the Berwick meeting and in a subsequent telephone conference call held on May 20, 2011.

The study plan was prepared with the approval of Normandeau's Donald Mason. Mr. Mason appears on the PFBC's and USFWS's list of Qualified Mussel Surveyors (Susquehanna, Delaware, and Potomac Drainages)². Mr. Mason led the field survey effort and oversaw all mussel identification. Normandeau's William Ettinger prepared this report with the approval of

² List revised March 14, 2011.

Mr. Mason. Mr. Ettinger is an aquatic biologist with experience conducting and reporting on at least 20 mussel surveys. Mr. Ettinger participated in the field component of the survey with Mr. Mason and Normandeau's Alan Frizzell and Bryan Lees. Resumes for Mr. Mason, Mr. Ettinger, Mr. Frizzell, and Mr. Lees are included in this report's Appendix B.

3. *STUDY OBJECTIVES*

The objective of this study was to determine whether green floater and brook floater are present in areas of the Susquehanna River (near several islands located just upstream of the Nescopeck Bridge) that may be impacted by consumptive water use at the proposed Bell Bend Nuclear Power Plant and if so, in what density. It was not the objective of this study to determine or quantify potential impacts. Impact analysis is the subject of a subsequent study.

4. **THE TARGET SPECIES**

4.1. **GREEN FLOATER (LASMIGONA SUBVIRIDIS)**

The following description is taken from the species account available on the Pennsylvania Natural Heritage Program website (www.naturalheritage.state.pa.us/factsheets). The species account is included in Appendix C of this report.

The green floater is a small mussel, usually less than 55 mm in shell length, with color varying from a dull yellow to green with many dark green rays visible, especially in young individuals. It is often found in small creeks and large rivers and sometimes canals. The preferred substrate is gravel and sand in pools and other calm water areas where strong currents are absent. Green floater is more likely to be found in hydrologically stable streams, not those prone to flooding and drying. The fish host species is unknown.

The green floater is predominantly an Atlantic drainage species, found from New York south to Georgia, but also is present in river systems west to Tennessee. Green floater is not very common in Pennsylvania, but has been found in the Susquehanna, Delaware, and Ohio River drainages. The state status in Pennsylvania is imperiled (S2), as it is not frequently encountered in its expected range in the state.

4.2. **BROOK FLOATER (ALASMIDONTA VARICOSA)**

The following description is taken from the species account available on the Pennsylvania Natural Heritage Program website (www.naturalheritage.state.pa.us/factsheets). The species account is included in Appendix C of this report.

The brook floater is a small mussel, usually less than 70 mm in shell length, with color varying from yellowish green to greenish brown with dark green rays. It is found in flowing water - small streams to large rivers, not in ponds or lakes. The preferred substrate is sand and gravel or gravel. Identified fish host species include blacknose dace, longnose dace, golden shiner, pumpkinseed, slimy sculpin, yellow perch, and margined madtom.

The brook floater is an Atlantic drainage species, sporadically distributed from Nova Scotia to South Carolina. The state status in Pennsylvania is imperiled (S2), due to the few individuals found during surveys throughout most of its range in the state.

5. *THE SURVEY REACH*

The mussel survey reach encompasses the river around the five islands located just upstream of the Nescopeck Bridge (PA Route 93) to approximately 3.5 miles upstream. The river is approximately 600 feet wide at the Nescopeck Bridge, but expands markedly to approximately 1,400 to 1,600 feet wide at the islands. Water depth is relatively shallow in the survey reach, making use of outboard motor-driven boats difficult at low river flow.

The river bottom is rugged throughout most of the survey reach, dominated by exposed cobble, rubble, boulder, and exposed bedrock in many areas. Areas of silty sand and gravel can be found along the island's perimeters and between Hess Island and the river's north shoreline. Extensive gravel and cobble bars associated with the islands are obvious at low river flow.

Prominent in the river bottom at several locations are v-shaped weirs constructed for fish capture in the past. These weirs contain rubble and boulder-sized rocks and can increase water depth and current velocity appreciably in the immediate area.

The mussel survey reach may be characterized as a mosaic of riffle-run-pool-glide macrohabitat types dominant in the upper Susquehanna River (PFBC 2011). Very little submerged aquatic vegetation was observed in the mussel survey reach during the mussel survey.

6. METHODS

The mussel survey was conducted along the shorelines of islands located in the Susquehanna River reach extending approximately 3.5 miles upstream from the Nescopeck Bridge (Figure 6.0-1). These islands are Swan Island, Heron Island, Hess Island, Rocky Island, and Goose Island. The entire perimeters of these islands were surveyed, including the short length of the river's north shoreline adjacent to Hess Island.

The survey was conducted by a team of four biologists from Normandeau, supported by a biologist from Ecology III. An invitation to participate was extended to Dr. Heather Galbraith (USGS), in lieu of Dr. Lellis, who had moved to another position within the USGS. Invitations also were extended to Dr. Anderson, the PFBC's mussel biologist - Nevin Welte, Pat Naugle (SRBC), and Mark Hartle (PFBC). Mr. Naugle observed semi-quantitative survey in part of the survey reach and examined several mussel species.

Proper identification of target species is important. William Ettinger, Normandeau Associates, met with Dr. Galbraith at the USGS facility in Wellsboro, PA to refresh identification skills in the species that could be observed in the survey reach, including the two target species. One brook floater shell was borrowed for reference use in the field. In addition, Mr. Ettinger also examined shells in the collections of the Delaware Museum of Natural History in Wilmington, DE. Several green floater shells were borrowed from the museum for reference use in the field. Lastly, all surveyors reviewed the borrowed reference shells as well as shells in their own personal reference collections immediately before the survey. All questionable mussel identifications were decided by Mr. Mason. Representative mussels were photographed in the field.

6.1. SURVEY OF HABITAT AT RISK TO BE DEWATERED

It was critical to the study to ensure that habitat suitable to support the target mussel species was not overlooked in the field survey. Search for sandy habitat (and subsequently, the target species in sandy habitat) was conducted to a distance of approximately 200 feet from the island's shorelines, which corresponded to approximately 2 to 3 feet in water depth at most locations on the dates of survey. In effect, this was a search for sandy habitat and subsequent survey for mussels in a band around each island extending to 200 feet offshore. No sandy habitat observed within the 200 feet offshore search area was determined to extend beyond 200 feet offshore.

6.2. SEMI-QUANTITATIVE SURVEY (TIMED SEARCH)

Noting that Dr. Lellis advised that the target species will be found in sandy habitat, the survey team searched for sandy habitat around the island perimeters to the prescribed distance offshore. This was accomplished in several ways, including members of the survey team using masks and snorkels and lying prone in the water while moving in the downstream direction in order to take advantage of river current, as suggested by Dr. Lellis. In other instances, shallow water and

water clarity favored standing in the water and viewing the river bottom through the water surface.

In order not to overlook green floater or brook floater in sandy habitat that may be marginal for either species, a range of habitats containing less or more sand in a mixture of other substrate particle sizes (e.g., silt, gravel, cobble, rubble, boulder, or bedrock) was surveyed. These habitats included silty sand, sandy gravel with/without cobble, rubble, or boulder, and sandy deposits on bedrock or behind boulders.

Timed searches for mussels were conducted using masks and snorkels in locations where sandy substrate was found. With one exception, each sandy habitat location was searched for mussels up to a targeted total of 3.0 search hours, an amount of time that is generally considered to be sufficient to locate rare mussel species in a semi-quantitative survey. Distinct sandy habitat substrate locations that likely would have taken longer than 3.0 search hours for survey in entirety were “subsurveyed” – partially surveyed with the coverage distributed over the compartment’s entire area.

The one exception to the total of 3.0 search hours noted in the previous paragraph was a large area of habitat (the Green Floater Study Compartment – see Section 7.1) that was determined to contain green floater. The large size of this area (approximately 300 feet x 69 feet = approximately 20,700 ft²) suggested that 3.0 search hours of semi-quantitative survey would be inadequate to characterize its mussel resources. Therefore, 10.2 search hours of semi-quantitative survey were expended in this area.

A uniform search pattern, parallel transects at least 6 feet apart followed by up to four individual surveyors, was used as allowed by bottom conditions. For example, fallen timber and boulders necessitated changes in search pattern direction. The surveyors searched the substrate surface, including use of the hands in “grubbing through” the sand for buried mussels. Live mussels, regardless of species, were identified, shell length measured, and returned live to the river bottom. Representative individual mussels were photographed.

The limits of locations containing sandy substrate were defined and a GPS field instrument with sub-meter accuracy was used to log mapping coordinates. GPS coordinates were logged and water depth and flow velocity were measured where the target species were found. A brief written description was prepared, supported by photographs. This description included characterization of substrate conditions using the same particle size classification employed in the hydrological modeling.

No empty (dead) shells of the target species were observed.

6.3. QUANTITATIVE SURVEY

The study plan stated that a limited quantitative survey was to be conducted in locations where either of the target species was found. Because the survey reach is rocky and patches of sandy substrate that might contain the target species were anticipated to be small (e.g., ≤ 500 ft²), the study plan called for collection of nine quantitative samples using a 0.25 m² quadrat following a

systematic sampling design with three random starts as per *A Guide to Sampling Freshwater Mussel Populations* (Strayer and Smith 2003). These nine samples were to be collected within a 4.5 m (14.8 ft) x 4.5 m (14.8 ft) grid established in the center, or what was reasonably considered to be the center, of each area where target species were found. The locations of the nine samples within the grid were randomly selected *a priori* from the 81 possible locations through use of the USGS' Mussel Estimation Program.

However, the only location where a target species was found was a large area of habitat (the Green Floater Study Compartment – see Section 7.1). The large size of this area (approximately 300 feet x 69 feet = approximately 20,700 ft²) suggested that collection of only nine quantitative samples as described in the study plan would be inadequate to characterize its mussel resources. Therefore, a larger grid size, 5 m (16.4 ft) x 10 m (32.8 ft) defining 17 samples, was employed and six of these grids were established at different locations in the area in order to increase the quantitative sample size (from 9 to 102 samples) and to better distribute the samples across the large area. It should be noted that the locations of the 17 samples within the grid were randomly selected *a priori* from the 200 possible locations through use of the U.S. Geological Survey's Mussel Estimation Program. Four of the sampling grids were located approximately equally distant from each other along the waterline where most of the green floater were observed in the semi-quantitative sampling. Two grids were located further offshore, approximately between pairs of grids located along the shoreline. The location of the grids was adjusted slightly to prevent inclusion of known locations of green floater determined in the semi-quantitative survey and, therefore, to prevent potential observation of these individuals in the quantitative sampling. By doing so, density estimates would not be biased³.

The use of 0.25 m² quadrats in quantitative sampling following a systematic sampling design with multiple random starts is a standard method employed in many mussel surveys, including Smith, et al. (2001), a USGS study of two Federally-listed mussel species in the Allegheny River in Pennsylvania. This publication is often recommended for its methodology by Federal and state agency personnel. It should be noted that in Smith, et al. (2001), the quantitative sampling encompassed 0.75% of a large habitat compartment, whereas 1.33% of the Green Floater Study Compartment was sampled, nearly twice the Allegheny River coverage.

Each quadrat sample consisted of a surface collection, followed by excavation to a depth of 10 cms and subsequent sieving of the excavated substrate with 6 mm mesh. Surface-collected and excavated mussels were kept separate in order to determine what proportion of mussels were present at the substrate surface and what proportion was buried. All observed mussels were treated as described in Section 6.2.

The study plan called for computation of density estimates through use of the U.S. Geological Survey's Mussel Estimation Program available on the Survey's website. Unfortunately, this

³ Subsequent to conduct of the study, in a conference call dated July 26, 2012, the resource agencies expressed concern over the field-selected quantification procedure. However, due to the near zero mussel density found, no resurvey of the area was felt to be warranted.

Program has been taken down from the website. Therefore, density estimates (mean no. per m² and standard deviation) were computed using Excel spreadsheets.

7. **RESULTS AND DISCUSSION**

The mussel survey was conducted on June 27-30, 2012, a period of weather conditions favorable to the effort. No precipitation occurred during the period and air temperatures were considered warm to hot. River discharge was low and decreased through the period. Water clarity was excellent and the river bottom could be viewed easily in several feet of water. Provisional mean daily discharge measured by the USGS at Wilkes-Barre was as follows:

<u>Date</u>	<u>River Discharge (cfs)</u>
June 27	3,250
June 28	3,050
June 29	2,950
June 30	2,830

7.1. **SEMI-QUANTITATIVE SURVEY (TIMED SEARCH)**

River bottom substrate considered to contain sufficient sand to conduct semi-quantitative survey was identified at 15 locations near the islands. These locations were characterized as containing almost entirely sand with some silt; almost entirely sand with some gravel; silty sand; sand interstitially in a mixture of gravel, cobble, rubble, and boulder; sand deposits behind boulders; and sand deposits on bedrock. These locations were observed near all of the islands.

The results of the semi-quantitative survey are summarized in Tables 7.1-1 through 7.1-4. The mussel data and other information for each survey location are included in Appendix D.

A total of seven species was identified in the semi-quantitative mussel survey, including green floater, which was observed at only one location – the Green Floater Study Compartment, located in the upstream end of the channel that separates the downstream end of Heron Island from the upstream end of Swan Island (Figure 7.1-1). Brook floater, the other target species, was not observed at any location. Photographs of representative individuals of the seven identified species are included as Figures 7.1-2 through 7.1-7.

Identity of the species observed in the Green Floater Study Compartment (Table 7.1-1) was identical to that observed at the 14 other semi-quantitative survey locations (Table 7.1-2), with two exceptions. As stated above, green floater was not observed at the 14 other survey locations. The second exception is the presence of eastern floater (*Pyganodon cataracta*) at 7 of the 14 other locations, but not in the Green Floater Study Compartment. Eastern floater is known for its “ability to thrive in silt and mud” (Nedeau 2008) and silt was present in the substrate at a number of the 14 other survey locations, but not in the Green Floater Study Compartment.

Yellow lampmussel (*Lampsilis cariosa*) was observed most frequently in the Green Floater Study Compartment and at the 14 other semi-quantitative survey locations (Tables 7.1-1 and 7.1-2). Elktoe (*Alasmidonta marginata*) also was frequently observed in the Green Floater Study Compartment and elktoe and eastern floater also were frequently observed at the 14 other survey locations. One eastern elliptio (*Elliptio complanata*) was observed in the Green Floater Study Compartment and at one of the 14 other survey locations.

Shell length frequencies observed in the Green Floater Study Compartment (Table 7.1-3) and at the other 14 semi-quantitative survey locations (Table 7.1-4) were relatively similar for all species. Most notable was observation of one yellow lampmussel with only 13 mm shell length in the Green Floater Study Compartment. This individual is a juvenile, indicating recruitment in the Green Floater Study Compartment.

Eleven green floater (GF1 through GF11 in Figure 7.1-1) were observed in the Green Floater Study Compartment during 10.2 search hours of the semi-quantitative survey. An additional three green floater (GF11, GF13, and GF14) were observed on the surface of the substrate during the quantitative sampling, but outside the quantitative sampling grids.

Water depth and current velocity measured at the point where each green floater was observed are shown in Table 7.1-5. The water depths ranged from 0.1 to 1.7 feet with 12 green floater observed where water depth ranged from 0.7 to 1.7 feet. The current velocities ranged from 0.0 to 1.7 ft/sec, with 12 green floater observed where current velocity ranged from 0.6 to 1.7 ft/sec.

Green floater GF13 and GF14 were observed lying flat on the substrate in shallow water (0.1 feet depth) with no measureable current velocity (Table 7.1-5). The other green floater were observed partially buried in the substrate siphoning water, in what should be considered the species' preferred orientation (Figure 7.1-2). The orientation of green floater GF13 and GF14 could be interpreted as a response to decreasing water level, perhaps an attempt to move across the substrate to deeper water.

The Green Floater Study Compartment extended approximately 69 feet offshore from the water line along approximately 300 feet of the shoreline of the downstream end of Heron Island – approximately 20,700 square feet (Figure 7.1-1). The substrate was a mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand (Figure 7.1-2). There appeared to be no silt present in the substrate and the substrate appeared relatively uniform in composition throughout the Green Floater Study Compartment. The boundaries were established where more cobble and rubble and less gravel became obvious in the substrate.

The green floater appeared to be clustered in the upstream end of the Green Floater Study Compartment, with no cause apparent in the habitat. Several discarded automobile tires were present in the shallow water along the nearby shoreline, but there was no obvious relationship to where the green floater were observed.

7.2. *QUANTITATIVE SURVEY*

Seventeen 0.25 m² quadrat samples were collected in each of six quantitative sampling grids established in the Green Floater Study Compartment (Figure 7.1-1) for a total of 102 samples collected. Each sample consisted of surface collection and excavation (to 10 cm) collection components. More details are present in Section 6.3.

A total of 11 mussels were observed, representing three species (Table 7.2-1A). Most of the mussels were elktoe (8), with triangle floater (1) and yellow lampmussel (2) in lesser and nearly equal numbers. Densities were less than 1 mussel per m² of river bottom in all species.

No green floater were observed in the quantitative samples. However, three green floater were observed on the surface of the substrate during the quantitative sampling, but outside the quantitative sampling grids.

Elktoe were observed in nearly all quantitative sampling grids (Table 7.2-1B). Mussels were absent only from Sampling Grid SG4, located in the downstream end of the Green Floater Study Compartment.

Shell length frequency data indicate that small (<30 mm) individuals of each species were collected (Table 7.2-1C). These mussels are likely juveniles, indicating recruitment in the Green Floater Study Compartment.

Most of the mussel observed in the quantitative sampling appeared in the excavation component (Table 7.2-1D). However, the elktoe, observed in greatest number, were evenly distributed between the surface and excavation components.

Green floater were not observed in the quantitative sampling conducted in the Green Floater Study Compartment, leading to a population density estimate of 0.0 per m² of river bottom. However, the observation of green floater in the semi-quantitative survey indicates that the true density for this species is somewhat higher than 0.0 per m². Nevertheless, the true density cannot be much higher than 0.0 per m², noting the large sample size (n = 102) in which no green floater were observed in the quantitative sampling.

8. *FINDINGS*

The findings of the mussel survey are as follows:

1. Habitat containing sand as a principal component in a range of proportions relative to other substrate particle sizes was semi-quantitatively surveyed for freshwater mussels at 15 locations, leading to the observation of seven species.
2. One of the target species (brook floater) was not observed.
3. The second target species (green floater) was observed at only one location, an area of approximately 20,700 feet² of river bottom in the upstream end of the channel between Heron and Swan Islands. The substrate in this area (the Green Floater Study Compartment), was a mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand. There appeared to be no silt present in the substrate.
4. Eleven green floater were observed in 10.2 search hours of semi-quantitative sampling in the Green Floater Study Compartment. An additional three green floater were observed on the surface of the substrate during the quantitative sampling, but outside the quantitative sampling grids.
5. Three mussel species were observed in the quantitative sampling in the Green Floater Study Compartment. Green floater was not observed, leading to a population density estimate of 0.0 per m² of river bottom. Of course, observation of the species in the semi-quantitative sampling indicates that the true density is somewhat higher than 0.0 per m² of river bottom. But, the true density cannot be much higher, noting the large sample size (n = 102) in which no green floater were observed in the quantitative sampling.

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FIGURES

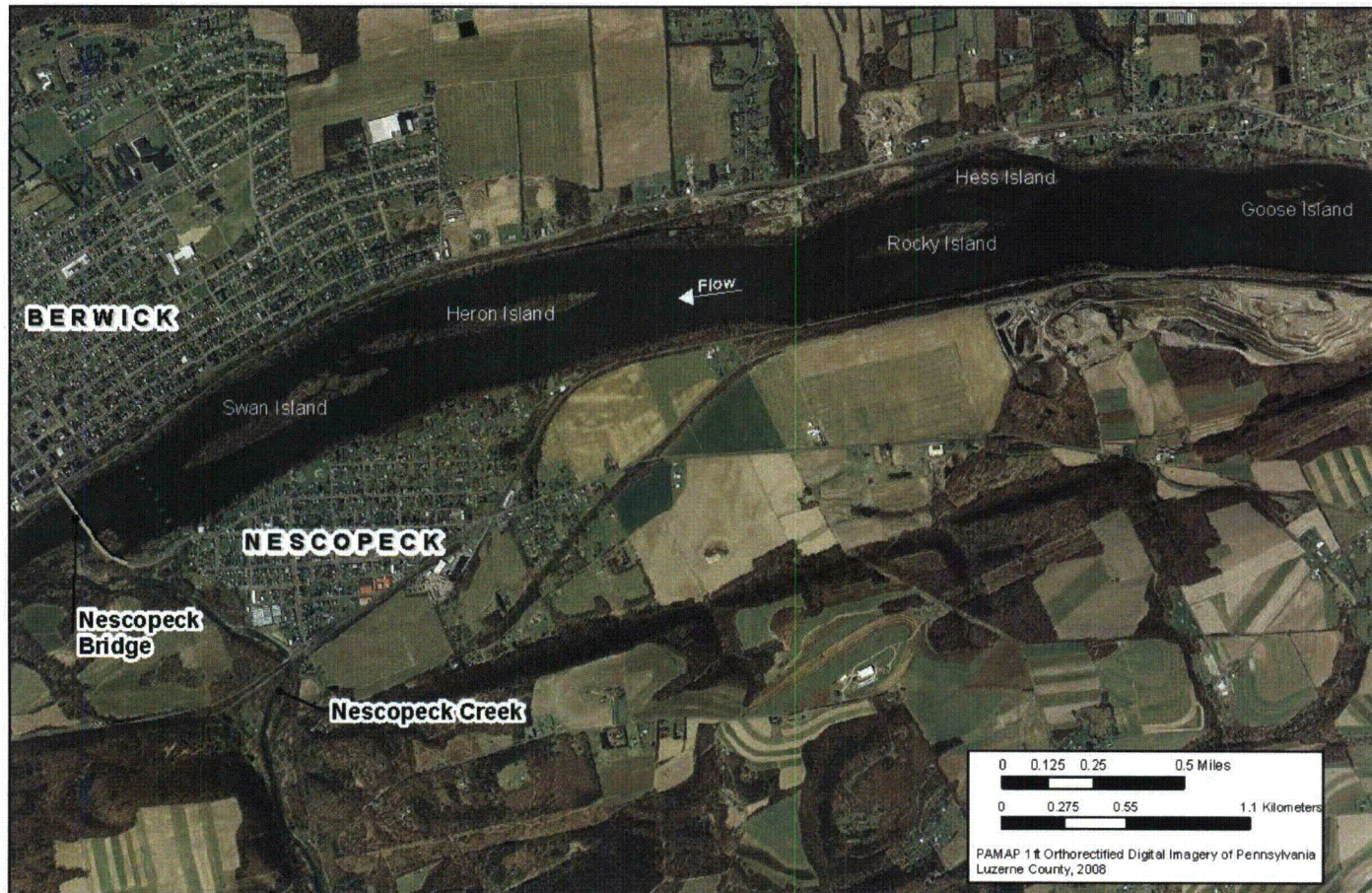


Figure 6.0-1.
Susquehanna River Mussel Survey Reach at Berwick, PA.



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project: 21665.001 file name: Figure6.01_MusselSurvey

Path: J:\CAD\Stowe_Jobs\21065.001_Susquehanna_Mussel\MXD\Figure6.01_MusselSurvey_SusquehannaRiver.mxd

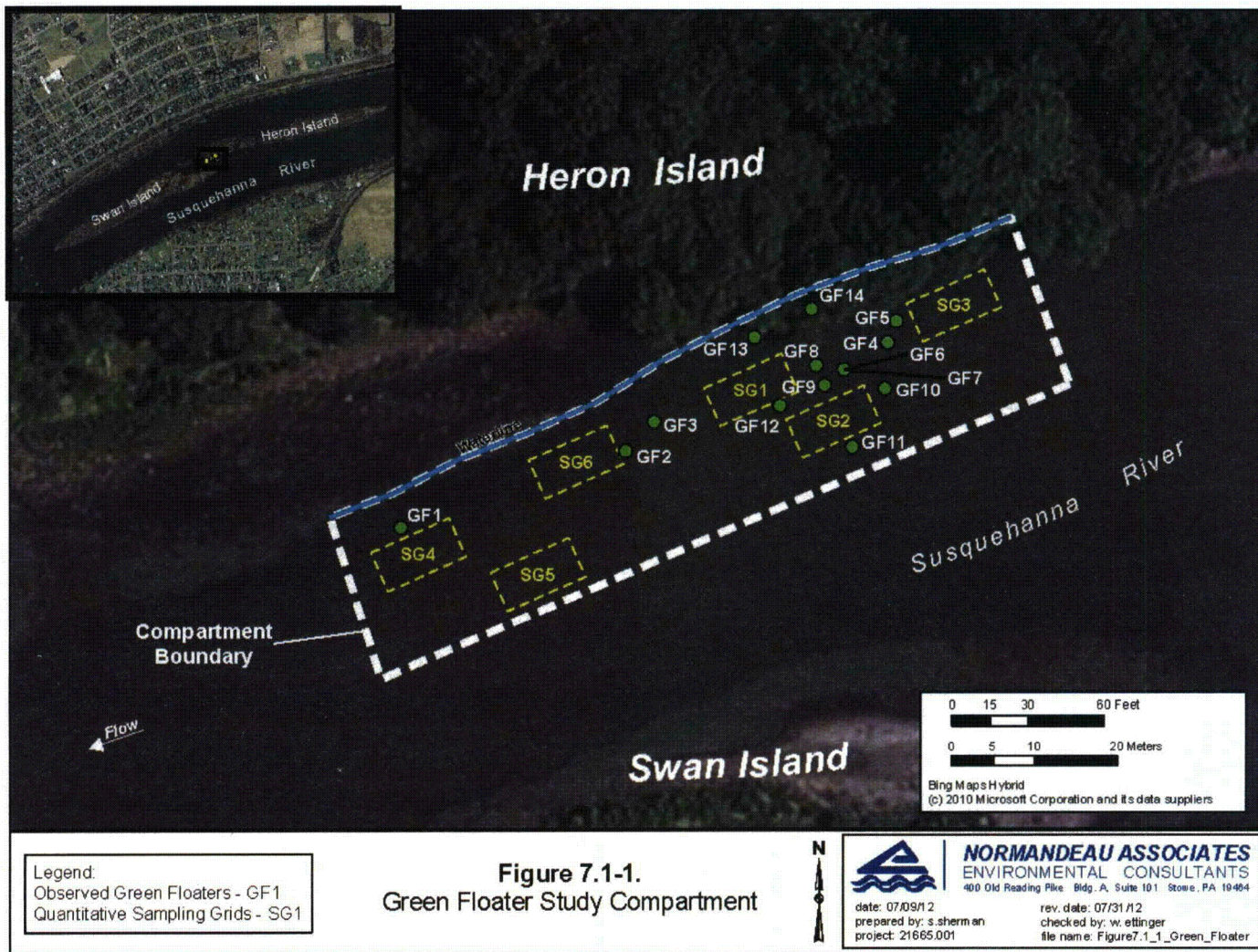




Figure 7.1-2. Green floater in substrate between Heron Island and Swan Island.

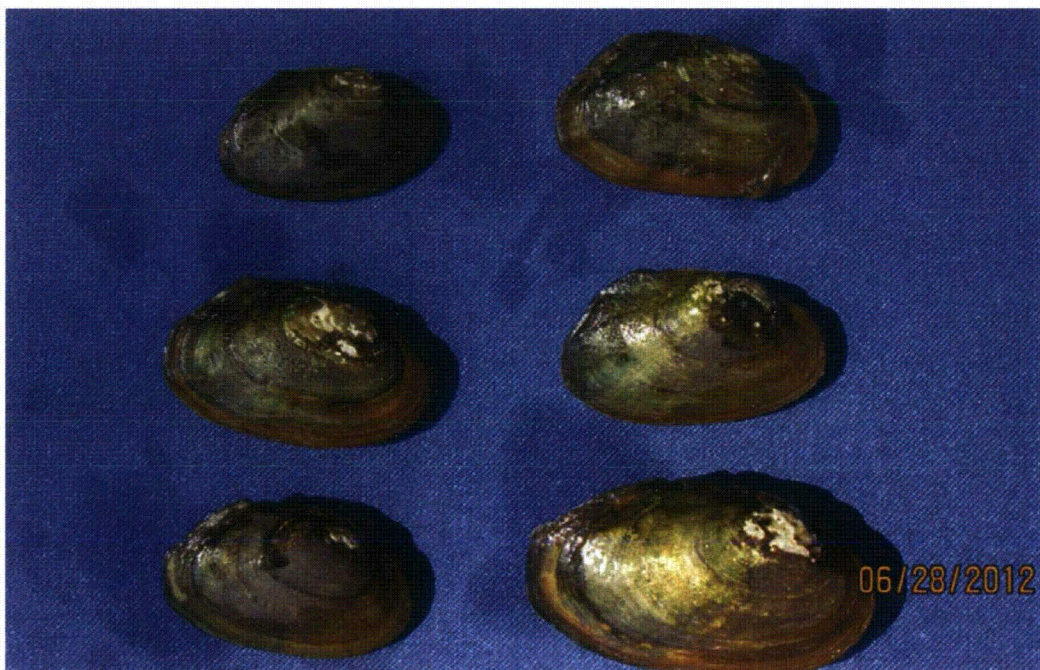


Figure 7.1-3. Six green floater observed between Heron Island and Swan Island.



Figure 7.1-4. Top to bottom: elktoe, yellow lampmussel, and triangle floater observed near Goose Island.



Figure 7.1-5. Five elktoe observed near Goose Island.



Figure 7.1-6. Left to right and top to bottom: four creeper, one yellow lampmussel, one eastern elliptio, and two eastern floater observed near Hess Island.



Figure 7.1-7. Triangle floater observed near Goose Island.

TABLES

TABLE 7.1-1: SUMMARY OF SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS IN THE GREEN FLOATER STUDY COMPARTMENT.

Common Name	Species	Total	Percent Composition	Mean No. of Mussels per Search Hour
Creeper	<i>Strophitus undulatus</i>	7	7.2	0.7
Eastern elliptio	<i>Elliptio complanata</i>	1	1.0	0.1
Elktoe	<i>Alasmidonta marginata</i>	31	32.0	3.1
Green floater	<i>Lasmigona subviridis</i>	11	11.3	1.1
Triangle floater	<i>Alasmidonta undulata</i>	10	10.3	1.0
Yellow lampmussel	<i>Lampsilis cariosa</i>	37	38.1	3.6
Total Number of Mussels		97		
Total Mussel Search Hours		10.2		
Total Mussels Per Search Hour		9.5		

TABLE 7.1-2: SUMMARY OF ALL SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS WITH EXCEPTION OF THE GREEN FLOATER STUDY COMPARTMENT.

Common Name	Species	Total	Percent Composition	Mean No. of Mussels per Search Hour
Creeper	<i>Strophitus undulatus</i>	10	6.0	0.7
Eastern elliptio	<i>Elliptio complanata</i>	1	0.6	0.1
Eastern floater	<i>Pyganodon cataracta</i>	32	19.2	2.3
Elktoe	<i>Alasmidonta marginata</i>	34	20.4	2.4
Triangle floater	<i>Alasmidonta undulata</i>	8	4.8	0.6
Yellow lampmussel	<i>Lampsilis cariosa</i>	82	49.1	5.8
Total Number of Mussels		167		
Total Mussel Search Hours		14.2		
Total Mussels Per Search Hour		11.8		

TABLE 7.1-3: SHELL LENGTH FREQUENCY DISTRIBUTION OF MUSSELS OBSERVED DURING THE SEMI-QUANTITATIVE SURVEY, IN THE GREEN FLOATER STUDY COMPARTMENT ONLY.

creeper (<i>Strophitus undulatus</i>)		eastern elliptio (<i>Elliptio complanata</i>)		elktoe (<i>Alasmidonta marginata</i>)		green floater (<i>Lasmigona subviridis</i>)		triangle floater (<i>Alasmidonta undulata</i>)		yellow lampmussel (<i>Lampsilis cariosa</i>)	
Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.
46	1	100	1	48	1	25	1	41	1	13	1
60	1			51	1	26	1	43	1	48	1
66	1			52	1	27	1	45	2	51	1
69	1			55	1	29	1	47	3	55	1
70	2			57	1	30	1	48	1	60	2
72	1			58	1	31	1	51	1	61	1
				59	1	32	1	52	1	62	2
				61	4	33	1			63	1
				62	1	35	1			65	3
				63	2	38	1			66	1
				64	1	48	1			68	1
				67	3					71	4
				69	2					72	1
				71	2					73	3
				72	2					78	1
				73	1					79	1
				76	1					80	1
				77	1					81	2
				80	2					83	2
				81	1					84	2
				92	1					88	1
										89	1
										92	1
										95	1
										100	1
Total Measured	7		1		31		11		10		37
Total Observed	7		1		31		11		10		37

TABLE 7.1-4: SHELL LENGTH FREQUENCY DISTRIBUTION OF MUSSELS OBSERVED DURING THE SEMI-QUANTITATIVE SURVEY, WITH EXCEPTION OF THE GREEN FLOATER STUDY COMPARTMENT - CONTINUED.

elktoe (<i>Alasmidonta marginata</i>)		triangle floater (<i>Alasmidonta undulata</i>)		yellow lampmussel (<i>Lampsilis cariosa</i>)	
Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.
34	1	46	1	30	1
52	1	48	2	55	1
54	2	49	1	56	1
55	1	52	1	57	1
56	1	53	1	61	1
57	1	54	1	62	1
58	1	58	1	64	4
59	1			65	1
60	2			67	1
61	2			69	2
62	1			70	1
64	1			71	3
65	2			72	1
68	2			73	1
69	2			76	1
70	3			78	2
71	3			79	1
74	1			80	2
76	1			81	1
77	2			82	1
78	2			83	2
84	1			89	1
				90	2
				95	1
				100	2
Total Measured	34		8		36
Total Observed	34		8		82 ²

² Includes 46 individuals observed at Rocky-4 in the range of 81 to 120 mm shell length.

TABLE 7.1-5. GREEN FLOATER (*LASMIGONA SUBVIRIDIS*) LOCALITY INFORMATION.

Green Floater No.	Latitude	Longitude	Water Depth ¹ (feet)	Current Velocity ¹ (feet/second)
GF1	N41°3.5438'	W76°12.9765'	0.9	0.8
GF2	N41°3.5485'	W76°12.9570'	0.8	0.6
GF3	N41°3.5504'	W76°12.9545'	0.7	0.7
GF4	N41°3.5553'	W76°12.9342'	1.3	1.0
GF5	N41°3.5567'	W76°12.9334'	1.0	0.9
GF6 ²	N41°3.5536'	W76°12.9380'	1.7	1.7
GF7 ²	N41°3.5536'	W76°12.9380'	1.6	1.4
GF8	N41°3.5539'	W76°12.9404'	1.4	1.5
GF9	N41°3.5526'	W76°12.9397'	1.7	1.2
GF10	N41°3.5523'	W76°12.9345'	1.3	1.3
GF11	N41°3.5485'	W76°12.9374'	1.7	1.6
GF12	N41°3.5513'	W76°12.9436'	1.5	1.4
GF13	N41°3.5558'	W76°12.9457'	0.1	0.0
GF14	N41°3.5576'	W76°12.9407'	0.1	0.0

¹ Measured using a Marsh McBirney flow meter and top-setting wading rod at 60% of the depth below the water surface (= 40% of the depth above the riverbed). All of these measurements were made at 6:00 PM on June 30, 2012. Provisional mean daily discharge measured at the USGS gage at Wilkes-Barre, PA was 2,830 cfs on this date.

² These green floater were observed together within one foot of each other.

TABLE 7.2-1. SUMMARY OF QUANTITATIVE SAMPLING RESULTS

A. Number and Density in the Entire Green Floater Study Compartment

Common Name	Total No. Observed	Mean No. per m ²	Standard Deviation
Elktoe (<i>Alasmidonta marginata</i>)	8	0.32	1.08
Triangle floater (<i>Alasmidonta undulata</i>)	1	0.04	0.40
Yellow lampmussel (<i>Lampsilis cariosa</i>)	2	0.08	0.56
Total	11	0.44	1.24

B. Numbers by Quantitative Sampling Grid

Name	Quantitative Sampling Grid						Total
	SG1	SG2	SG3	SG4	SG5	SG6	
Elktoe (<i>Alasmidonta marginata</i>)	2	1	2	0	2	1	8
Triangle floater (<i>Alasmidonta undulata</i>)	1	0	0	0	0	0	1
Yellow lampmussel (<i>Lampsilis cariosa</i>)	1	0	0	0	0	1	2
Total	4	1	2	0	2	2	11

TABLE 7.2-1. SUMMARY OF QUANTITATIVE SAMPLING RESULTS – CONTINUED.

C. Shell Length Frequency

elktoe (<i>Alasmidonta marginata</i>)		triangle floater (<i>Alasmidonta undulata</i>)		yellow lampmussel (<i>Lampsilis cariosa</i>)	
Shell Length (mm)	No.	Shell Length (mm)	No.	Shell Length (mm)	No.
22	1	28	1	21	1
58	1			77	1
63	1				
65	1				
67	2				
75	1				
86	1				
Total Measured	8		1		2
Total Observed	8		1		2

D. Surface Collection Versus Excavation

Common Name	Species	Surface	Excavation	Total
elktoe	<i>Alasmidonta marginata</i>	4	4	8
triangle floater	<i>Alasmidonta undulata</i>	0	1	1
yellow lampmussel	<i>Lampsilis cariosa</i>	0	2	2
TOTAL		4	7	11

APPENDIX A – THE STUDY PLAN

Study Plan for a Mussel Survey in the Susquehanna River
Near the Proposed Bell Bend Project at Berwick, PA

Prepared for

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Prepared by

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Final

AUGUST 2011

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FIGURES

Figure 1 Susquehanna River Mussel Survey Reach at Berwick, Pa

APPENDIX

Resume of Donald Mason

1.0 INTRODUCTION

The Bell Bend Project (Project), a new nuclear plant, is proposed for construction along the Susquehanna River at Berwick, PA. The Susquehanna River Basin Commission (SRBC) has requested that certain studies be performed to evaluate the potential impacts that Project operations might have on the aquatic biota and water quality in the Susquehanna River. Among these requested studies is an evaluation of the presence of certain mussel species of concern and as appropriate an analysis of potential impacts to these mussels due to the Project's consumptive water use. This study describes a proposed mussel survey to document the presence or absence of certain rare mussel species in areas of the Susquehanna River that may be impacted by Project consumptive water use. It does not address potential impacts from construction of Project intake or discharge structures. This study plan is prepared for submission to the PA Fish and Boat Commission's (PFBC) Natural Diversity Section.

This study plan is the result of discussions held in Berwick on February 23, 2011, and subsequent SRBC comments on initial drafts of this study plan. The SRBC, the PFBC, PPL, and PPL's consultants (Normandeau Associates and Ecology III) participated in the February 23, 2011 discussions. Mussel biologists Dr. William Lellis (USGS) and Dr. Robert Anderson (U.S. Fish and Wildlife Service - USFWS) as well as Dr. Brian Mangan (Kings College in Wilkes-Barre), who has local knowledge of the river and its mussels, participated.

Consumptive water use (43 cfs) at low river discharge at Berwick (800 cfs) is predicted to reduce the river water surface elevation by 0.5 inch or less. Discussion at the Berwick meeting centered on how to evaluate the impact on mussels from the predicted reduction in water surface elevation. Dr. Lellis suggested that attention should be directed toward two rare mussels (green floater - *Lasmigona subviridis* and brook floater - *Alasmidonta varicosa*) that may occur in the river at Berwick. He said that these two species (the target species) live in sandy habitat and that such habitat is likely to be found near several islands located just upstream of the Nescopeck Bridge. Dr. Lellis suggested that a mussel survey should be conducted that included search for sandy habitat at the islands, followed by determination if the target species are present in the sandy habitat, and if so, in what density. Locality information in terms of field-acquired GPS coordinates, would be used with hydrologic modeling to determine if areas where the target species were found would be dewatered or otherwise subject to potential impact by a change in river water surface elevation due to consumptive water use at low river discharge. The details of the survey were discussed at the Berwick meeting and in a subsequent telephone conference call held on May 20.

This study plan describes only the mussel survey. It does not include details concerning how the data will be used in determination of impacts due to consumptive water use.

This study plan has been prepared with the approval of Normandeau's Donald Mason. Mr. Mason appears on the PFBC's and USFWS's list of Qualified Mussel Surveyors (Susquehanna, Delaware, and Potomac Drainages). Mr. Mason will lead the field survey effort and oversee all mussel identification. Mr. Mason's resume is attached.

2.0 STUDY OBJECTIVES

The objective of this study is to determine whether two rare mussel species of interest (green floater – *Lasmigona subviridis* and brook floater – *Alasmidonta varicosa*) are present in areas of the Susquehanna River (near several islands located just upstream of the Nescopeck Bridge) that may be impacted by consumptive water use at the proposed Bell Bend Nuclear Power Plant. The study will determine if the target species are present in areas subject to potential impact as a result of the BBNPP consumptive use, and if so, in what density.

It is not the objective of this study to determine or quantify potential impacts. If the rare mussel species are found in areas subject to potential impact due to the proposed project consumptive use, then additional consultation with the SRBC and resource agencies will be required to consider appropriate methods of impact analyses.

3.0 METHODS

The mussel survey will be conducted along the shorelines of islands located in the Susquehanna River reach extending approximately 3.5 miles upstream from the Nescopeck Bridge (Figure 1). These islands are Swan Island, Heron Island, Hess Island, and Goose Island. The entire perimeters of these islands will be surveyed, including the short length of the river's north shoreline adjacent to Hess Island. In addition, the perimeter of Rocky Island will be included in the survey, but it is not likely that the sandy habitat preferred by the two target species will be found there.

It is planned to conduct the survey during the period August through September when river and meteorological conditions are favorable – relatively low river discharge with little turbidity and little precipitation forecast for at least five to seven days, the anticipated length of the effort.

The survey will be conducted by a team of four biologists from Normandeau. It is anticipated that others will participate, including Dr. Mangan and a student, for a total of five biologists. An invitation has been extended to Dr. Lellis and invitations will be extended to Dr. Anderson and to the PFBC's mussel biologist, Nevin Welte.

Proper identification of target species is important. Therefore, the Normandeau mussel surveyors will be experienced in mussel survey techniques and in mussel identification. The surveyors will meet with Dr. Lellis at the USGS facility in Wellsboro, PA to refresh identification skills and to borrow reference shells for use in the field. All surveyors will examine the reference shells at the time of the survey. All questionable mussel identifications will be decided by Mr. Mason. Representative mussels will be photographed.

3.1 ENSURING SURVEY OF HABITAT AT RISK TO BE DEWATERED

It is critical to the study to ensure that habitat suitable to support the target mussel species is not overlooked in the field survey. The habitat necessary for survey will be identified by range of water depth on the dates of survey. Search for sandy habitat (and subsequently, the target species in sandy habitat) will be conducted to a distance of approximately 200 feet from the island's shorelines, which should correspond to approximately 2 to 2.5 feet in water depth on the dates of survey. In effect, this is a search for sandy habitat and subsequent survey for mussels in a band around each island extending to 200 feet offshore. Distinct sandy habitat substrate locations that extend further offshore than 200 feet will be searched to no further than 300 feet offshore if either of the target species is found within the original 200-foot boundary.

3.2 SEMI-QUANTITATIVE SURVEY (TIMED SEARCH)

Noting that Dr. Lellis has advised that the target species will be found in sandy habitat, the survey team will search for sandy habitat around the island perimeters to the prescribed distance offshore. This may be accomplished by the members of the survey team using masks and snorkels and lying prone in the water while moving in the downstream direction in order to take advantage of river current, as suggested by Dr. Lellis. However, it may be that shallow water and water clarity may favor standing in the water, viewing the river bottom through the water surface with or without a clear-bottomed bucket (depending

on surface water conditions), and moving upstream to minimize turbidity in front of the surveyors. Therefore, the survey team will use one or the other of these search techniques as river conditions dictate.

A preliminary view of the habitat along the perimeter of Rocky Island will be conducted by boat before searching for sandy habitat as described in the previous paragraph. This preliminary effort is warranted because it is unlikely that sandy habitat is present along the island.

A timed search for mussels will be conducted using masks and snorkels in locations where sandy substrate is found. Each sandy habitat location will be searched for mussels in entirety up to a targeted total of 3.0 biologist hours, an amount of time that is generally considered to be sufficient to locate rare mussel species in a semi-quantitative survey. Distinct sandy habitat substrate locations that likely will take longer than 3.0 biologist hours for survey in entirety will be “subsurveyed” – partially surveyed with the coverage distributed over the compartment’s entire area. Simply put, a maximum of 3.0 biologist hours will be spent in mussel survey at each distinct sandy habitat location where physical size warrants the effort. Less time will be spent in small areas of sandy habitat.

A uniform search pattern, parallel transects at least 6 feet apart followed by up to four individual surveyors, will be used as allowed by bottom conditions. For example, fallen timber may necessitate changes in search pattern direction. The surveyors will search the substrate surface, including use of the hands in “grubbing through” the sand for buried mussels. All live mussels, regardless of species, will be identified, shell length measured, and returned live to the river bottom. Representative individual mussels will be photographed.

The limits of locations containing sandy substrate will be defined and a GPS field instrument with sub-meter accuracy will be used to log mapping coordinates. Water depth will be measured at each point where mapping coordinates are logged. GPS coordinates will be logged and water depth and flow velocity will be measured where the target species are found. A brief written description will be prepared, supported by photographs. This description will include characterization of substrate conditions using the same particle size classification employed in the hydrological modeling.

Empty (dead) shells of the target species will be collected as encountered.

3.3 QUANTITATIVE SURVEY

In locations where either of the target species is found, a limited quantitative survey effort will be conducted in order to determine population density. A systematic sampling design with three random starts as per *A Guide to Sampling Freshwater Mussel Populations* (Strayer and Smith 2003) will be used. Because the survey reach is known to be rocky and any patches of sandy substrate are likely to be small, it is anticipated that a total of 9 samples will be collected (3 samples per random start) at each location. A 9 unit x 9 unit grid will be established in the center, or what is reasonably considered to be the center, of each location. A 0.25m² quadrat (0.5 m on each side) will define each sampling unit. Therefore, the 9 unit x 9 unit grid will be 4.5 m x 4.5 m in dimension (81 0.5m x 0.5m units). Collection of 9 samples out of the possible 81 sample units will result in sampling 11.1% of the total surface area of the grid. Each quadrat sample will consist of a surface collection, followed by excavation to a depth of 10 cm and seining the excavated substrate with 6 mm mesh. Surface-collected and excavated mussels will be kept separate. All live mussels will be treated as described in Section 3.2, above.

The mapping coordinates of each quantitative sample station will be logged using a GPS instrument with sub-meter accuracy. Water depth and current velocity will be measured in each quadrat sample. A brief written description will be prepared, supported by photographs. This description will include characterization of substrate conditions.

3.4 REPORTING

A report will be prepared that includes the results of all field work. Maps with locations, transects sampled, and survey limits and representative photographs will be included. River stage and discharge data will be included.

All methodology will be described, including how water depth was determined for survey. Any decisions made in the field relative to sampling effort will be described.

The mussel data will be summarized to include identity and numbers observed, size range measured, and locations where they were found. Semi-quantitative survey data will be expressed as numbers of live mussels per search hour. The quantitative data will be expressed as density estimates (mean number per $m^2 \pm 1$ standard error) as determined through use of the U.S. Geological Survey's Mussel Estimation Program.

All habitat information (substrate description, water depth, and water velocity) will be reported. The locality data (GPS-logged coordinates) will be delivered for determination of dewatering potential via use of GIS and hydrological modeling.

4.0 REFERENCES

Strayer, D.L. and D.R. Smith. 2003. *A Guide to Sampling Freshwater Mussel Populations*. American Fisheries Society Monograph 8. American Fisheries Society, Bethesda, Maryland. 103 pp.

FIGURES

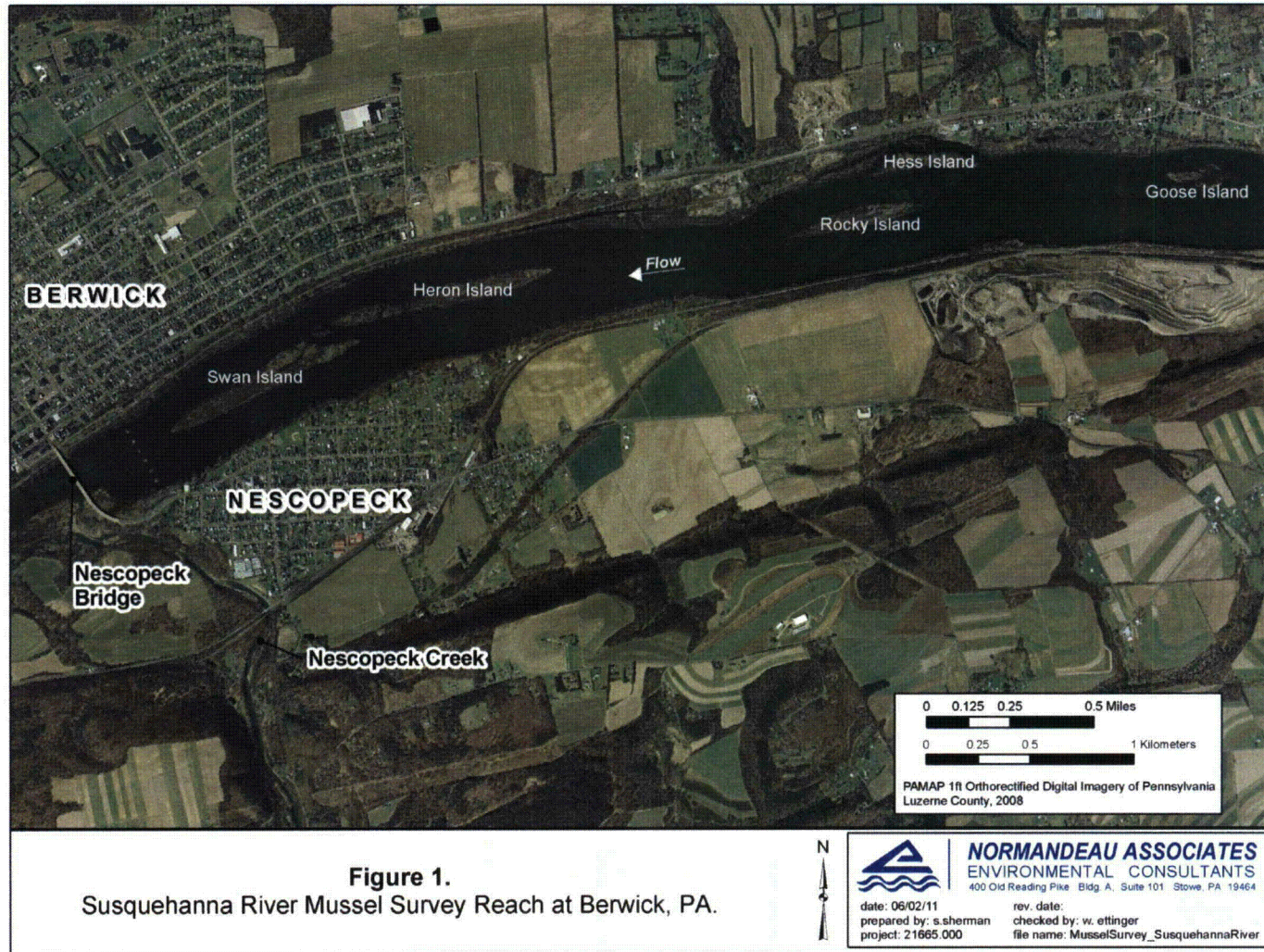


Figure 1 Susquehanna River Mussel Survey Reach at Berwick, Pa.

APPENDIX

DONALD P. MASON Aquatic Ecologist

Mr. Mason has over 25 years' experience assessing the effects of habitat alteration on aquatic ecosystems. His specialties include evaluating the effects of hazardous substances, hydropower, and commercial development on fish and benthic macroinvertebrate communities. Mr. Mason has conducted and managed studies using freshwater macroinvertebrates as pollution indicators, assessed the impacts of road and highway construction on aquatic communities, and searched for rare, threatened, or endangered mussels and other aquatic species.

SELECTED PROJECT EXPERIENCE

Delaware River Joint Toll Bridge Commission (2010-Present) – Delaware River (PA/NJ) Scour Remediation Mussel Survey; Led a team of SCUBA divers to search for Rare, Threatened and Endangered (RTE) freshwater mussels near bridges that were scheduled for scour remediation. Since scour remediation efforts may adversely affect freshwater mussels near the rehabilitated piers, state-listed RTE mussel species were relocated to suitable habitat outside of the areas of impact. Responsible for obtaining and collecting permits; conducting the mussel search; relocating listed species to unaffected areas; and submitting reports to the PA Fish and Boat Commission and to the NJ Department of Environmental Protection, all on an expedited two month schedule.

Environmental Solutions and Innovations, Inc. (2010) – Delaware River Dwarf Wedgemussel Survey (PA/NJ); Provided technical expertise for a dwarf wedgemussel (*Alasmidonta heterodon*) survey for a proposed pipeline crossing over the Delaware River. The client was required by Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service New Jersey Field Office to have a certified dwarf wedgemussel surveyor on the survey crew. Responsible for providing certified dwarf wedgemussel surveyor expertise.

Exelon (2010) – Susquehanna River Mussel Survey (MD); Provided freshwater mussel survey expertise for a survey downstream of Conowingo Dam on the Susquehanna River for the Conowingo Hydroelectric Relicensing Project. Field Biologist.

Florida Power and Light (2008-Present) – Fort Halifax Dam Removal Fish and Mussel Relocation Project (ME); Led a crew of 20 staff and volunteers to search for yellow lampmussel (*Lampsilis cariosa*) and tidewater mucket (*Leptodea ochracea*) as the Fort Halifax Dam was removed and the upstream impoundment was dewatered. Both of these species are threatened in the State of Maine. A total of 10,221 threatened mussels were relocated with less than one percent mortality. Project Manager.

Massena Electric Department (2007-2010) – Grasse River Benthic Macroinvertebrate and Mussel Survey (NY); Conducted seasonal benthic macroinvertebrate sampling throughout the Grasse River from Louisville to Massena, NY using kick nets (qualitative) and Ponar grabs (quantitative). Also, worked with SCUBA divers to qualitatively and quantitatively survey freshwater mussels (Unionidae) throughout the Grasse River during 2007, 2008, and 2009. A total of nine mussel species were identified. Technical Director.

EDUCATION

M.S. 1982, Entomology, University of New Hampshire
B.A. 1976, Biology, Plymouth State College

PROFESSIONAL EXPERIENCE

1985-Present Normandeau Associates
1983-1985 Battelle New England
Marine Research Laboratory
1982-1983 Normandeau Associates
1982 Charles T. Main, Inc.

PROFESSIONAL AFFILIATIONS

North American Benthological Society

New England Association of Environmental Biologists

PPL Resources, Inc. (2006) – Assessment of fly ash spill impacts to the mussel and periphyton communities in the Delaware River at Martins Creek Generating Station. The survey included search for mussels in shallow wadeable habitats and in deep pools with SCUBA at locations upstream and downstream of the fly ash entry point. Field Biologist.

Secor International Incorporated (2005-2006) - Baseline Investigation of the Little Mississinewa River (IN); Sediment in the Little Mississinewa River, Randolph County, IN is contaminated with PCBs from a former electrical manufacturer. Sediments at several locations along seven miles of the river will be dredged and replaced with clean material as remediation. Fish tissue and benthic macroinvertebrate community data were collected to establish baseline conditions prior to remediation. Principal Investigator.

South Shore Tri-Town Development Corporation (2001-Present) - Tri-Town Wildlife Surveys; This site, located on the former South Weymouth Naval Air Station property (MA), has areas contaminated with petrochemicals and demolition debris. Sampled the west branch of French's Stream to search for three species included on the Massachusetts Natural Heritage and Endangered Species Program list, the Mystic Valley Amphipod (*Crangonyx aberrans*), the Spatterdock (or Spring Blue) Darner (*Aeshna mutata*), and the Mocha Emerald (*Somatochlora linearis*). Specimens of the Mystic Valley Amphipod were collected on site, however neither of the dragonflies was found. Responsible for data collection and report preparation. Principal Investigator.

Beazer Homes Corp. (2006) - Andover Junction Brook Habitat Assessment and Mussel Survey (NJ); Assessed the aquatic habitat and conducted a freshwater mussel survey along 3,000 feet of streambed in Andover Junction Brook and an unnamed tributary stream, both located on a proposed planned unit development property in Andover Borough, NJ. This study was conducted to determine the species composition and relative abundance of the on-site mussel community and to determine whether Dwarf Wedge Mussel (*Alasmidonta heterodon*), a freshwater mussel included on the Federal List of Endangered Species, was present on the property. Project Manager.

Fryeburg Aquifer Resource Committee. (2006) - Baseline Investigation of Aquatic Biota in Wards Brook and Lovewell Pond (ME); Potential impacts associated with proposed additional water withdrawals from the Wards Brook aquifer, for commercial bottling, on the ecology of Wards Brook and Lovewell Pond was studied. Two of the primary ecological concerns addressed in this study included 1) the paucity of baseline information on the aquatic biota (fish, mussels, invertebrates) in Wards Brook and Lovewell Pond and, 2) impacts of groundwater withdrawal on these biota and water quality. Principal Investigator.

Upper Peninsula Power Company (2004) – Assessment of the Silver Lake Dam Breach on Downstream Mussel Fauna (MI); Led a crew of six investigators to assess the effects of the Silver Lake Dam breach on downstream mussel fauna. The survey was conducted along 32 miles of the river from Silver Lake to the river mouth at Lake Superior and included assessments of mussel habitat quality, species composition, and population density. A total of five mussel species were found throughout the study area, including cylindrical papershell (*Anodontoides ferussacianus*), giant floater (*Pyganodon grandis*), fatmucket (*Lampsilis siliquoidea*), eastern elliptio (*Elliptio complanata*), and white heelsplitter (*Lasmigona complanata*). Project Manager.

Vanasse Hangen Brustlin, Inc. (2003-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT) Freshwater Mussel Survey and Relocation; Surveyed and relocated Vermont state-listed threatened and endangered freshwater mussels that would potentially be impacted during construction of a bridge to

replace the Route 78 causeway/bridge. A total of 418 mussels, including two Vermont state-listed endangered species, the Fragile Papershell (*Leptodea fragilis*) and the Pink Heelsplitter (*Potamilus alatus*), and one state-listed threatened species, the Giant Floater (*Pyganodon grandis*), were relocated using SCUBA divers to areas outside of the influence of construction activities. Responsible for leading the field crew and report preparation. Program Manager.

Vanasse Hangen Brustlin, Inc. (2000-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT); This multi-faceted study included studies on the movements of the state threatened spiny-soft shell turtle (*Trionyx spiniferus*) using radiotelemetry, a fish habitat and creel survey, and a state-listed freshwater mussel survey and relocation (see above) in relation to an existing causeway and a proposed new bridge. Responsible for data collection and report preparation. Crew Leader/Program Manager.

Public Service Company of New Hampshire (2003) - Merrimack River (NH) Brook Floater Survey; Surveyed 24 river miles using SCUBA divers, to search for populations of Brook Floater mussels (*Alasmidonta varicosa*), a NH state-listed endangered species. This study was conducted to evaluate the susceptibility of this species to impacts associated with hydroelectric generation and was the most extensive survey ever conducted for this species in the New Hampshire portion of the Merrimack River. This survey established several new records on the extent and location of brook floater populations in the Merrimack River. Responsible for leading the field crew and preparing the final report. Project Manager.

City of Manchester (CT) (1994, 1996, 1998) - A bioassessment of the fish and benthic macroinvertebrate communities in the Hockanum River was conducted as part of the discharge permit application for the Manchester, CT Sanitary Landfill and sewage treatment plant. Benthic communities were sampled using artificial substrate (rock basket) samples and kick samples, then analyzed separately using EPA's Rapid Bioassessment Protocol level 3 (RBP III). Fish data were analyzed using RBP level 5. Responsible for data collection, analysis, and report preparation. Aquatic Communities Technical Director.

Dexter Corporation (CT) (1997) - Surveyed 300 ft of streambed in Stony Brook (CT), near an aqueduct proposed for reconstruction, to look for Dwarf Wedge Mussels (*Alasmidonta heterodon*). *A. heterodon* is a federally listed endangered species that is sensitive to sedimentation and would have been adversely affected by construction activities. Responsible for conducting the field survey and report preparation. Project Manager.

New Hampshire DOT (1997) - Supervised a dive team that searched a section of the Johns River (NH), crossed by a bridge proposed for reconstruction, to look for Dwarf Wedge Mussels (*Alasmidonta heterodon*). *A. heterodon* is a federally listed endangered species which would have been adversely affected by construction activities. Responsible for project management, field data collection, and report preparation. Project Manager.

Smith College (1997) - Paradise Pond (MA) Dredging Mitigation Project; Worked closely with the client as well as State and Federal regulatory personnel to develop mitigation plans to alleviate impacts of dredging operations on a downstream population of Dwarf Wedge Mussel (*Alasmidonta heterodon*), a federally-listed endangered species. Technical Director.

City of Brockton (MA) (1997) - Supervised a dive team that surveyed the shoreline of Silver Lake, MA in search of two freshwater mussels included in the Massachusetts list of species of special concern, Eastern Pond Mussel (*Ligumia nasuta*) and Tidewater Mucket (*Leptodea ochracea*). Responsible for supervising the field crew and report preparation. Project Manager.

Northeast Maritime (1997) - Conducted a freshwater mussel search and evaluated mussel habitats in several streams that would be crossed by a gas pipeline in central Maine. The main purpose of this study was to identify habitats and populations of state and Federally listed rare, threatened, and endangered mussel species, primarily Dwarf Wedge Mussel (*Alasmidonta heterodon*), Brook Floater Mussel (*A. varicosa*), Yellow Lamp Mussel (*Lampsilis cariosa*) and Tidewater Mucket (*Leptodea ochracea*). Project Biologist.

SE Technologies, Inc. (1997) - Collected benthic macroinvertebrate data using EPA's Rapid Bioassessment Protocols level 2 (RBP II) and conducted an endangered aquatic species search near a closed electroplating facility to determine whether groundwater or surface runoff from the site was adversely affecting the aquatic biological community in Fivemile River (CT). Responsible for data collection, analysis, and report preparation. Project Manager.

SPECIAL TRAINING

- OSHA 40-Hour Safety Certification
- OSHA 8-Hour Safety Certification Refresher (Current)
- Rapid Bioassessment Protocols (RBP)
- Hazardous Material Supervisors Training (OSHA 29 CFR 1910.120)
- First Aid and CPR
- Habitat Evaluation Procedures (HEP)

SELECTED PRESENTATIONS

Mason, D.P. Survey for the Presence of Dwarf Wedge Mussels (*Alasmidonta heterodon*) in the Paulins Kill River, NJ. Presented to the 24th Annual Meeting of the New England Association of Environmental Biologists, March 2000, Jackson, NH.

Mason, D.P. and W.E. Hearn. Effects of fluctuating flows on benthic communities. Presented to the 37th Annual Meeting of the North American Benthological Society, May 1989, Guelph, Ontario, Canada.

Mason, D.P., S.L. Radke, K.T. Tracewski, and P.C. Johnson. Eclosion of gypsy moth (Lepidoptera: Lymantriidae) egg masses held under constant conditions as a function of sampling date. Presented to the 52nd Annual Meeting of the Eastern Branch of the Entomological Society of America, September 1980, Baltimore, MD.

SELECTED PEER-REVIEWED ARTICLES AND PUBLICATIONS

Haney, J.F., T.R. Beaulieu, R.P. Berry, D.P. Mason, C.R. Miner, E.S. McLean, K.L. Price, M.A. Trout, R.A. Vinton, and S.J. Weiss. 1983. Light intensity and relative light change as factors regulating stream drift. *Archiv fur Hydrobiologie* 97(1):73-88.

Mason, D.P. 1982. Physical and hydrochemical effects on stream insect communities in the White Mountain National Forest of New Hampshire. M.S. Thesis, University of New Hampshire, Durham, New Hampshire. 106 pp.

APPENDIX B – RESUMES

DONALD P. MASON

Aquatic Ecologist

Mr. Mason has over 25 years' experience assessing the effects of habitat alteration on aquatic ecosystems. His specialties include evaluating the effects of hazardous substances, hydropower, and commercial development on fish and benthic macroinvertebrate communities. Mr. Mason has conducted and managed studies using freshwater macroinvertebrates as pollution indicators, assessed the impacts of road and highway construction on aquatic communities, and searched for rare, threatened, or endangered mussels and other aquatic species.

SELECTED PROJECT EXPERIENCE

Delaware River Joint Toll Bridge Commission (2010-2011) – Delaware River (PA/NJ) Scour Remediation Mussel Survey; Led a team of SCUBA divers to search for Rare, Threatened and Endangered (RTE) freshwater mussels near bridges that were scheduled for scour remediation. Since scour remediation efforts may adversely affect freshwater mussels near the rehabilitated piers, state-listed RTE mussel species were relocated to suitable habitat outside of the areas of impact. Responsible for obtaining and collecting permits; conducting the mussel search; relocating listed species to unaffected areas; and submitting reports to the PA Fish and Boat Commission and to the NJ Department of Environmental Protection, all on an expedited two month schedule.

Shawnee Inn and Golf Resort (2011) – Bridge Replacement Mussel Survey; Led a team of SCUBA divers to search for Rare, Threatened, and Endangered (RTE) freshwater mussels at the location in the Delaware River where a bridge would be constructed. The bridge would grant year-round access to an island that is part of the Shawnee golf course. Five mussel species were identified. Project Manager.

Environmental Solutions and Innovations, Inc. (2010) – Delaware River Dwarf Wedgemussel Survey (PA/NJ); Provided technical expertise for a dwarf wedgemussel (*Alasmidonta heterodon*) survey for a proposed pipeline crossing over the Delaware River. The client was required by Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service New Jersey Field Office to have a certified dwarf wedgemussel surveyor on the survey crew. Responsible for providing certified dwarf wedgemussel surveyor expertise.

Exelon (2010) – Susquehanna River Mussel Survey (MD); Provided freshwater mussel survey expertise for a survey downstream of Conowingo Dam on the Susquehanna River for the Conowingo Hydroelectric Relicensing Project. Field Biologist.

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EDUCATION

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B.A. 1976, Biology, Plymouth State College

PROFESSIONAL EXPERIENCE

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1983-1985 Battelle New England Marine Research Laboratory
1982-1983 Normandeau Associates
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Fryeburg Aquifer Resource Committee. (2006) - Baseline Investigation of Aquatic Biota in Wards Brook and Lovewell Pond (ME); Potential impacts associated with proposed additional water withdrawals from the Wards Brook aquifer, for commercial bottling, on the ecology of Wards Brook and Lovewell Pond was studied. Two of the primary ecological concerns addressed in this study included 1) the paucity of baseline information on the aquatic biota (fish, mussels, invertebrates) in Wards Brook and Lovewell Pond and, 2) impacts of groundwater withdrawal on these biota and water quality. Principal Investigator.

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Vanasse Hangen Brustlin, Inc. (2003-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT) Freshwater Mussel Survey and Relocation; Surveyed and relocated Vermont state-listed threatened and endangered

freshwater mussels that would potentially be impacted during construction of a bridge to replace the Route 78 causeway/bridge. A total of 418 mussels, including two Vermont state-listed endangered species, the Fragile Papershell (*Leptodea fragilis*) and the Pink Heelsplitter (*Potamilus alatus*), and one state-listed threatened species, the Giant Floater (*Pyganodon grandis*), were relocated using SCUBA divers to areas outside of the influence of construction activities. Responsible for leading the field crew and report preparation. Program Manager.

Vanasse Hangen Brustlin, Inc. (2000-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT); This multi-faceted study included studies on the movements of the state threatened spiny-soft shell turtle (*Trionyx spiniferus*) using radiotelemetry, a fish habitat and creel survey, and a state-listed freshwater mussel survey and relocation (see above) in relation to an existing causeway and a proposed new bridge. Responsible for data collection and report preparation. Crew Leader/Program Manager.

Public Service Company of New Hampshire (2003) - Merrimack River (NH) Brook Floater Survey; Surveyed 24 river miles using SCUBA divers, to search for populations of Brook Floater mussels (*Alasmidonta varicosa*), a NH state-listed endangered species. This study was conducted to evaluate the susceptibility of this species to impacts associated with hydroelectric generation and was the most extensive survey ever conducted for this species in the New Hampshire portion of the Merrimack River. This survey established several new records on the extent and location of brook floater populations in the Merrimack River. Responsible for leading the field crew and preparing the final report. Project Manager.

City of Manchester (CT) (1994, 1996, 1998) - A bioassessment of the fish and benthic macroinvertebrate communities in the Hockanum River was conducted as part of the discharge permit application for the Manchester, CT Sanitary Landfill and sewage treatment plant. Benthic communities were sampled using artificial substrate (rock basket) samples and kick samples, then analyzed separately using EPA's Rapid Bioassessment Protocol level 3 (RBP III). Fish data were analyzed using RBP level 5. Responsible for data collection, analysis, and report preparation. Aquatic Communities Technical Director.

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New Hampshire DOT (1997) - Supervised a dive team that searched a section of the Johns River (NH), crossed by a bridge proposed for reconstruction, to look for Dwarf Wedge Mussels (*Alasmidonta heterodon*). *A. heterodon* is a federally listed endangered species which would have been adversely affected by construction activities. Responsible for project management, field data collection, and report preparation. Project Manager.

Smith College (1997) - Paradise Pond (MA) Dredging Mitigation Project; Worked closely with the client as well as State and Federal regulatory personnel to develop mitigation plans to alleviate impacts of dredging operations on a downstream population of Dwarf Wedge Mussel (*Alasmidonta heterodon*), a federally-listed endangered species. Technical Director.

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Dwarf Wedge Mussel (*Alasmidonta heterodon*), Brook Floater Mussel (*A. varicosa*), Yellow Lamp Mussel (*Lampsilis cariosa*) and Tidewater Mucket (*Leptodea ochracea*). Project Biologist.

SE Technologies, Inc. (1997) - Collected benthic macroinvertebrate data using EPA's Rapid Bioassessment Protocols level 2 (RBP II) and conducted an endangered aquatic species search near a closed electroplating facility to determine whether groundwater or surface runoff from the site was adversely affecting the aquatic biological community in Fivemile River (CT). Responsible for data collection, analysis, and report preparation. Project Manager.

SPECIAL TRAINING

OSHA 40-Hour Safety Certification

OSHA 8-Hour Safety Certification Refresher (Current)

Rapid Bioassessment Protocols (RBP)

Hazardous Material Supervisors Training (OSHA 29 CFR 1910.120)

First Aid and CPR

Habitat Evaluation Procedures (HEP)

SELECTED PRESENTATIONS

Mason, D.P. Survey for the Presence of Dwarf Wedge Mussels (*Alasmidonta heterodon*) in the Paulins Kill River, NJ. Presented to the 24th Annual Meeting of the New England Association of Environmental Biologists, March 2000, Jackson, NH.

Mason, D.P. and W.E. Hearn. Effects of fluctuating flows on benthic communities. Presented to the 37th Annual Meeting of the North American Benthological Society, May 1989, Guelph, Ontario, Canada.

Mason, D.P., S.L. Radke, K.T. Tracewski, and P.C. Johnson. Eclosion of gypsy moth (Lepidoptera: Lymantriidae) egg masses held under constant conditions as a function of sampling date. Presented to the 52nd Annual Meeting of the Eastern Branch of the Entomological Society of America, September 1980, Baltimore, MD.

SELECTED PEER-REVIEWED ARTICLES AND PUBLICATIONS

Haney, J.F., T.R. Beaulieu, R.P. Berry, D.P. Mason, C.R. Miner, E.S. McLean, K.L. Price, M.A. Trout, R.A. Vinton, and S.J. Weiss. 1983. Light intensity and relative light change as factors regulating stream drift. *Archiv fur Hydrobiologie* 97(1):73-88.

Mason, D.P. 1982. Physical and hydrochemical effects on stream insect communities in the White Mountain National Forest of New Hampshire. M.S. Thesis, University of New Hampshire, Durham, New Hampshire. 106 pp.

WILLIAM S. ETTINGER
Branch Office Manager
Principal Aquatic Ecologist

Mr. Ettinger manages Normandeau's Lewes, DE office. His education and expertise are in aquatic, estuarine, and marine ecology, specializing in macroinvertebrates, physical habitat, hydrology, and water quality. He has wide experience in diverse areas of natural resource impact assessments and is currently responsible for evaluation of effects of acid mine drainage, dredging, industrial effluents, water diversion, and power plant operations on aquatic biota, particularly benthic macroinvertebrates. His experience includes freshwater mussel surveys (including federal and state-listed species), bathymetric data acquisition in several states, characterization of river bottom substrates using side-scan sonar, and survey of aquatic resources in support of waterfront redevelopment permitting. Mr. Ettinger is recognized as a qualified dwarf wedgemussel surveyor by the US Fish and Wildlife Service's New Jersey Field Office.

SELECTED PROJECT EXPERIENCE

Warren County, NJ Engineer's Office (2012) – Survey for dwarf wedgemussel (*Alasmidonta herterodon*) in the Paulins Kill River at the Station Road Bridge near Hainesburg, NJ. This survey was conducted as a permitting requirement in support of a bridge replacement project. Project Manager/Principal Investigator.

NJ Department of Environmental Protection-Endangered and Nongame Species Program (2012) – Survey for dwarf wedgemussel (*Alasmidonta heterodon*) in the Pequest River at Great Meadows, NJ. The objective was to determine if a historic population still inhabits approximately 2 kilometers of the Pequest River. Project Biologist.

Hatch Mott MacDonald, Inc. (2012) – Survey for mussel habitat in Bluestone Creek in Doddridge County, WV. The objective was to determine if habitat suitable to support mussels is present at a proposed gas pipeline crossing. Project Manager/Principal Investigator.

Exelon Energy, Inc. (2010-Present) – Survey of freshwater mussels in the Susquehanna River downstream of Conowingo Dam in Maryland in support of hydroelectric relicensing. This effort included semi-quantitative survey in a 4.5-mile river reach, followed by quantitative sampling in five selected areas within that reach. Search methodology included use of SCUBA in deeper water. Project Manager/Principal Investigator.

Confidential Client (2010) – Survey for dwarf wedgemussel (*Alasmidonta heterodon*) in the Delaware River at a proposed pipeline crossing near Port Jervis, NY. Normandeau provided survey personnel and expertise in identification of dwarf wedgemussel to another consultant. Project Manager.

Hunt Engineers, Architects & Land Surveyors, Inc. (2010) – Survey of freshwater mussels in the Chemung River at the Madison Avenue Bridge in Elmira, NY. The bridge project involved placement of scour protection around the piers. Project Manager/Principal Investigator.

Fisher Associates (2010) – Survey of freshwater mussels in the Chemung River at the Centerway Arch Bridge in Corning, NY. Part of the bridge project involved concrete repairs to the piers. Project Manager/Principal Investigator.

EDUCATION

- M.S. 1974, Entomology, Pennsylvania State University
- B.S. 1972, Fundamental Sciences, Lehigh University

PROFESSIONAL EXPERIENCE

- 1983-Present Normandeau Associates
- 1979-1983 Skelly and Loy
- 1974-1979 Ichthyological Associates, Inc.

PROFESSIONAL AFFILIATIONS

- American Entomological Society
- American Fisheries Society
- Freshwater Mollusk Conservation Society
- North American Benthological Society
- Pennsylvania Academy of Science

Aqua Pennsylvania, Inc. (2010) – Survey of freshwater mussels downstream of a lowhead dam in the Shenango River in Sharon, PA. The dam project involved repair of general deficiencies. Project Manager/Principal Investigator.

National Park Service (2009) – Survey of freshwater mussels and submerged aquatic vegetation at the Chesapeake and Ohio Canal National Historical Park in Pool 4 of the Potomac River. The project involved repair to an historic retaining wall along the river's one shoreline. Project Manager/Principal Investigator.

Matrix New World Engineering (2009) – Survey for dwarf wedgemussel (*Alasmidonta heterodon*) habitat in an unnamed tributary to the Paulins Kill, near Sparta, NJ. Project Manager/Principal Investigator.

Kleinschmidt Associates, Inc. (2008) – Survey for dwarf wedgemussel (*Alasmidonta heterodon*) habitat in Yards Creek, tributary to the Paulins Kill, near Blairstown, NJ, in support of hydroelectric relicensing. Project Manager/Principal Investigator.

AREVA NP, Inc. (2007) – Preliminary survey of mussels present in the Susquehanna River at Berwick, PA. This survey was conducted as part of electric utility intake and discharge structure siting. Principal Investigator.

Gannett Fleming, Inc. (2004-2008) – Survey of the fish and mussels present in the Susquehanna River at Wilkes-Barre, PA. This river reach would be affected by proposed construction of an inflatable dam. Project Manager/Principal Investigator

PPL Resources, Inc. (2006-2010) – Assessment of fly ash spill impacts to the mussel and periphyton communities in the Delaware River at Martins Creek Generating Station. The survey included search for mussels in shallow wadeable habitats and in deep pools with SCUBA at locations upstream and downstream of the fly ash entry point. Principal Investigator.

Hunt Engineers, Architects, & Land Surveyors, Inc. (2006) – Survey of freshwater mussels present in the Susquehanna River at Oneonta, NY. This survey was conducted on short notice in order to support NYS DOT's emergency stabilization of a riverbank below NYS Route 23. Water depth required use of SCUBA. Project Manager/Principal Investigator.

Kleinschmidt Associates, Inc. (2005) – Survey of mussels present in the Susquehanna River at Holtwood Dam as part of a hydroelectric relicensing effort. This survey was conducted in the impoundment (Lake Aldred) upstream of the dam and in the tailrace and free-flowing river downstream. Principal Investigator.

Skelly and Loy, Inc. (2003-2005) – Survey of freshwater mussels in the Susquehanna River in the vicinity of planned construction of a sewer force main river crossing. The effort was focused on search for two state species of concern, the green floater (*Lasmigona subviridis*) and the yellow lampmussel (*Lampsilis cariosa*) and, subsequently, relocation of these species from the project area. Because of waters in excess of 5 feet depth, SCUBA was required. Project Manager/Principal Investigator.

McFarland-Johnson, Inc. (2003) – Survey of freshwater mussels in the Chenango River in the vicinity of the I-81/NYS Route 17 interchange project in Binghamton, NY. The effort was focused on search for the NYS threatened species, the green floater (*Lasmigona subviridis*), and one federal species of concern, the yellow lampmussel (*Lampsilis cariosa*). Because of varied physical conditions, SCUBA as well as snorkeling was required. Project Manager/Principal Investigator.

STV, Inc. (2004-2010) – Survey of freshwater mussels and characterization of the fish community present in the Delaware River at the I-95 Bridge, West Trenton, NJ. Water depth required use of SCUBA. In addition, Section 7 Consultation on the federally-listed shortnose sturgeon. Project Manager/Principal Investigator.

Amy S. Greene Environmental Consultants, Inc. (2003) – Survey of freshwater mussels at several highway bridge crossings over the Paulins Kill and Wall Kill Rivers in Sussex County, New Jersey. The target species included the federally- and state-listed dwarf wedgemussel (*Alasmidonta heterodon*) and the state-listed triangle floater (*Alasmidonta undulata*). Project Manager/Principal Investigator.

Amy S. Greene Environmental Consultants, Inc. (2003) – Survey of freshwater mussels in the Raritan River at Raritan, Manville, and Somerville, New Jersey. Five prospective impact areas from sanitary sewer construction were searched, primarily for the state endangered species, the brook floater (*Alasmidonta varicosa*). Project Manager/Principal Investigator.

C&S Engineers, Inc. (2001) – Survey of a marina and the nearby Niagara River for three Federally-listed endangered mussel species – the clubshell (*Pleurobema clava*), the pink mucket (*Lampsilis abrupta*), and the fat pocketbook (*Potamilus capax*). The effort involved search by SCUBA divers as well as wading. Project Manager/Principal Investigator.

Allegheny Energy (2000) – Survey of mussels present in portions of Pools 4 and 5 of the Potomac River near Hagerstown, MD. This effort confirmed the presence of a state-listed endangered species (green floater – *Lasmigona subviridis*), which had not been observed for over 20 years. Principal Investigator.

SPECIAL TRAINING

Attended 1991 and 1992 Workshops on Freshwater Bivalves of Pennsylvania, presented by Dr. Arthur E. Bogan at the Carnegie Museum of Natural History, Pittsburgh, PA.

Attended 2008 workshop entitled Freshwater Mussels: Problems, Resources, and Taxonomy, presented by Dr. Arthur E. Bogan at the 2008 Association of Mid-Atlantic Aquatic Biologists meeting at Cacapon State Park, Berkeley Springs, WV, 2-3 April 2008.

Attended 2011 workshop entitled Identification and Taxonomy of Mussels, presented by Dr. Arthur E. Bogan at the 2011 Association of Mid-Atlantic Aquatic Biologists meeting at Cacapon State Park, Berkeley Springs, WV, 7-8 April 2011.

ALAN FRIZZELL

Dive Operation Manager/Biologist

Mr. Frizzell is Dive Operation Manager overseeing all dive projects performed by Normandeau Associates. Coordinates dive safety, education and equipment maintenance. Professional scientific diver since 1987, logging over 4,000 dives.

Mr. Frizzell is also Biologist/Field Technician with experience in the collection of finfish, benthic macroinvertebrates, plankton, and water quality data in marine, estuarine, and freshwater habitats; microscopic and gross identification of marine flora and fauna; data processing and compilation of lobster larvae annual report; and captaining up to 42-foot boats. Mr. Frizzell also has conducted surveys for endangered freshwater mussels.

EDUCATION

B.S. 1980, Biology, minor in Chemistry,
Keene State College

PROFESSIONAL EXPERIENCE

1986-Present Normandeau Associates

PROFESSIONAL AFFILIATIONS

American Academy of Underwater Sciences
Diver Alert Network

SELECTED PROJECT EXPERIENCE

Exelon Energy, Inc. (2010-Present) – Survey of freshwater mussels in the Susquehanna River downstream of Conowingo Dam in Maryland in support of hydroelectric relicensing. This effort included semi-quantitative survey in a 4.5-mile river reach, followed by quantitative sampling in five selected areas within that reach. Search methodology included use of SCUBA in deeper water. Dive Operation Manager/Biologist.

Delaware River Joint Toll Bridge Commission (2010-Present) – SCUBA survey for mussels near the piers of multiple bridges in support of environmental permitting for river scour remediation measures. Dive Operation Manager/Biologist.

Seabrook Nuclear Generating Station, NH (1999-Present) - Underwater video Inspection and Cleaning of offshore Intake Structures. On-line biofouling removal. Field Technician/ Diver.

Bowline Generating Plant Hudson River, NY (1994-Present) - Barrier net placement around intake. Dive Operation Manager.

Florida Power and Light, Seabrook Nuclear Generating Station, NH (1986-Present) - Environmental monitoring studies including off-shore and on-site samples; finfish collection using trawl, beach seine and impingement methods; ichthyoplankton collection with boat-towed hoop nets and entrainment sampling on-site; intertidal and subtidal studies of flora and fauna through non-destructive methods of transect and quadrant, destructive methods of air-lifting and artificial settling stones; *Mya* larvae collection with hoop nets; lobster larvae collection using Neuston nets and counting/identification of Stages I through V; water quality profile collections through YSI water temperature collection with onset probes and downloading information into computers; crustacean collection and measurement of green and *Cancer* crabs; *Mya arenaria* random plotting through aerial view of flats which are later sampled; underwater videotaping. Dive Operation Manager.

Massena Electric Department (2007-2009) – Grasse River Benthic Macroinvertebrate and Mussel Survey (NY); SCUBA survey of the mussels in the Grasse River from Louisville to Massena, NY. A total of 9 mussel species was identified. Dive Operations Manager/Biologist.

PPL Resources, Inc. (2006) – Assessment of fly ash spill impacts to the mussel and periphyton communities in the Delaware River at Martins Creek Generating Station. The survey included search for mussels in shallow wadeable habitats and in deep pools with SCUBA at locations upstream and downstream of the fly ash entry point. Dive Operation Manager/Biologist.

Hunt Engineers, Architects, & Land Surveyors, Inc. (2006) – Survey of freshwater mussels present in the Susquehanna River at Oneonta, NY. This survey was conducted on short notice in order to support NYSDOT's emergency stabilization of a riverbank below NYS Route 23. Water depth required use of SCUBA. Dive Operation Manager/Biologist.

Enercon: Fitzpatrick Nuclear Plant, Oswego, NY (2006) – Installation and dismantling of hydro-acoustics around intakes of the plant to monitor fish movements. Dive Operation Manager.

FPL Wyman Station, Cousin's Island, ME (2006) – Pre-construction dredge permitting. Videotaping transect of proposed dredge site using SCUBA. Dive Operation Manager.

Rowe Nuclear Plant, Rowe, MA (2006) - Decommission of power plant. SCUBA diving to collect sediment samples to be tested for PCB's and radiological contamination. Depths of 10-70 ft. Dive Operation Manager.

Quoddy Bay, Eastport ME (2006) - Eelgrass survey for proposed LNG terminal located in Quoddy Bay. Mapping of eelgrass beds using SCUBA. Benthic grab sample for polychaetes. Dive Operation Manager/Field Technician.

Haley and Aldrich Engineering, Laconia NH (2006) – Post construction monitoring of coal tar dredging and removal. Sediment samples were collected for fauna analysis. Samples were located by GPS and collected by SCUBA. Dive Operation Manager/Field Technician.

STV, Inc. (2004-2010) – Survey of freshwater mussels and characterization of the fish community present in the Delaware River at the I-95 Bridge, West Trenton, NJ. Water depth required use of SCUBA. In addition, Section 7 Consultation on the federally-listed shortnose sturgeon. Dive Operation Manager/Biologist.

Skelly and Loy, Inc. (2003-2005) – Survey of freshwater mussels in the Susquehanna River in the vicinity of planned construction of a sewer force main river crossing. The effort was focused on search for two state species of concern, the green floater (*Lasmigona subviridis*) and the yellow lampmussel (*Lampsilis cariosa*) and, subsequently, relocation of these species from the project area. Because of waters in excess of 5 feet depth, SCUBA was required. Dive Operation Manager/Biologist.

McFarland-Johnson, Inc. (2003) – Survey of freshwater mussels in the Chenango River in the vicinity of the I-81/NYS Route 17 interchange project in Binghamton, NY. The effort was focused on search for the NYS threatened species, the green floater (*Lasmigona subviridis*), and one federal species of concern, the yellow lampmussel (*Lampsilis cariosa*). Because of varied physical conditions, SCUBA as well as snorkeling was required. Dive Operation Manager/Biologist.

Nantucket Electric, Cape Cod/Nantucket, MA (2003/2006) - Impact study of the installation of an underwater power cable from Cape Cod to Nantucket. Transects of eelgrass beds and videotaping performed. Field Technician/ Diver.

Hubline. Duke Energy, Massachusetts Bay, MA (2003-2006) – Monitoring post-construction of Hubline pipeline from Salem Harbor to Weymouth Harbor. Annual analysis of scallop beds, juvenile lobsters (via suction sampling), flora and fauna development (via underwater photography) and rugosity. Dive Operation Manager/Field Biologist.

D.A. Collins, Bass River, Beverly, MA (2005) – Underwater videotaping of impacted dredge area, presence of undredged coal tar, and inspection of cloth sediment cover. Dive Operation Manager/Field Biologist.

Haley and Aldrich, Ferry Landing, Tarrytown, NY (2004-2005) – Dredging site used barrier net to exclude sturgeon and other fish from area. SCUBA was used to inspect net for proper deployment and damage. Dive Operation Manager/Field Biologist.

Merrimack River (NH) Brook Floater Survey (2003) - Surveyed 24 river miles using SCUBA divers, to search for populations of Brook Floater mussels (*Alasmidonta varicosa*), a NH state-listed endangered species. This study was conducted to evaluate the susceptibility of this species to impacts associated with hydroelectric generation and was the most extensive survey ever conducted for this species in the New Hampshire portion of the Merrimack River. This survey established several new records on the extent and location of brook floater populations in the Merrimack River. Responsible for leading the field crew and preparing the final report. Field Technician/ Diver.

Missisquoi Bay Bridge Project, Lake Champlain (VT) Freshwater Mussel Survey and Relocation (2003) - Surveyed and relocated Vermont state-listed threatened and endangered freshwater mussels that would potentially be impacted during construction of a bridge to replace the Route 78 causeway/bridge. A total of 418 mussels, including two Vermont state-listed endangered species, the Fragile Papershell (*Leptodea fragilis*) and the Pink Heelsplitter (*Potamilus alatus*), and one state-listed threatened species, the Giant Floater (*Pyganodon grandis*), were relocated using SCUBA divers to areas outside of the influence of construction activities. Field Technician/Diver.

United States Navy, McAllister Point, RI (2003) Set transects on artificial reefs to determine percent cover of flora and fauna. Took pictures of reefs. Set fish traps to get measurements of fish living on reef. Outlined eelgrass bed to determine how far the bed had moved over time. Field Technician/Diver

Duke Energy, Boston Harbor, MA (2002-2003) - Collected core samples from contaminated sediments near the Hubline pipeline. Field Technician/Diver.

Massachusetts Central Artery, Boston Harbor, MA (2002) - Monitoring of artificial reef including transects, underwater videotaping, and general visual assessments. Field Technician/Diver.

C&S Engineers, Inc. (2001) – Survey of a marina and the nearby Niagara River for three Federally-listed endangered mussel species – the clubshell (*Pleurobema clava*), the pink mucket (*Lampsilis abrupta*), and the fat pocketbook (*Potamilus capax*). The effort involved search by SCUBA divers as well as wading. Dive Operation Manager/Biologist.

Bath Iron Works, Bath (ME) (1997-2000) - Environmental studies conducted prior to and during shipyard expansion. A primary dive survey was done for subtidal sediments and identification of the flora and fauna. Monthly/Bimonthly finfish collections using various methods (trawl, beach seine, Fyke nets) targeting endangered species shortnose sturgeon (*Acipenser brevirostrum*). Dive Operation Manager/Field Biologist.

Massachusetts Coastal Zone Management (1998-1999) - Monthly/bimonthly finfish collection using trawls and beach seines in New Bedford and Gloucester Harbors. Field Leader.

Massachusetts Coastal Zone Management (1998-1999) - Quahog population study of New Bedford and Fall River Harbors. Hydraulic dredging of varied substrate to assess population. Efficiency of dredge checked by divers. Dive Operation Manager/Diver.

Quonset Point Associates, Quonset Point (RI) (1998) - Impact study of the development of Quonset Point. Visual identification and videotaping of benthic organisms and quahog population study by one meter quadrant extraction. Dive Operation Manager/Diver.

Portland (ME) Water District, Water Supply of Sebago Lake (1998) - Impact study on the effects of lowering water levels and beach erosion. Collection of sediment cores at varying depths by divers. Field Leader/Dive Operations Manager/Diver.

Johns River Dwarf Wedge Mussel Survey (NH) (1997) - Conducted a dive survey in a section of the Johns River crossed by a bridge proposed for reconstruction, to look for dwarf wedge mussels (*Alasmidonta heterodon*). A.

heterodon is a federally listed endangered species which would have been adversely affected by construction activities. Responsible for conducting the search and locating previously identified dwarf wedge mussel beds. Dive Operation Manager/Diver.

Brocton (MA) Water Supply of Silver Lake, Pembroke (MA) (1997) - A dive survey in search of two freshwater mussel species, eastern pond mussel (*Ligumia nasuta*) and tidewater mucket (*Leptodea ochracea*) which are included in MA Natural Heritage Program's list of Species of Special Concern. Dive Operation Manager/Diver.

Northeast Maritime (ME) (1997) - Conducted a freshwater mussel search and evaluated mussel habitats in streams in central Maine, where a gas pipeline would be crossing. The study was to identify habitats and populations of all mussel, with concerns of rare, threatened, and endangered mussel species, primarily dwarf wedge mussel (*Alasmidonta heterodon*), brookfloater mussel (*A. varicosa*), tidewater mucket (*Leptodea ochracea*), and yellow lampmussel (*Lampsilis cariosa*). Field biologist.

Ransom Environmental, Troy (NH) (1997) - Quarry dive to locate and photograph submerged paint drums. Dive Operation Manager/Diver.

Coastal Water of Searsport, ME - *Zostera* bed location. Field Manager and Dive Operation Manager.

Boston Harbor Navigation Improvement Project - Environmental assessment for U.S. Army Corps of Engineers dredging project. Crew Leader.

Boston Harbor - Site assessment in placement of artificial reef. Dive Operation Manager.

Cogeneration Plant on Penobscot River, Bucksport, ME - Environmental assessment of a proposed cogeneration plant. Crew Leader.

Wisconsin Public Service - IFIM studies on Peshtigo River. Field Technician.

Fitzpatrick Nuclear Generating Station, Oswego, NY - Fish telemetry studies. Project Dive Supervisor.

Yankee Rowe Nuclear Generating Plant, Rowe, MA - Environmental studies. Water quality data and fisheries. Field Leader.

New York Power Authority, Verplank, NY - Fish survival studies. Field Technician/Diver.

Seabrook Station Offsite Chlorine Minimization Study, Hampton, NH - Construction and laboratory assessment. Crew Leader.

SPECIAL TRAINING

1983 – NAUI Open Water SCUBA Diver

1984 – NAUI Sport Diver

1996 - Present – Red Cross CPR certification

1987 - Present – NSC First Aid certification

1991 - Present – DAN Oxygen First Aid

2004 – Nitrox certification

BRYAN W. LEES Aquatic Ecologist

Mr. Lees has over 10 years experience in a wide array of aquatic ecological studies including fisheries, macroinvertebrates, and water quality. Mr. Lees' duties include sampling fish and macroinvertebrates, providing fish and macroinvertebrate identification in the field, and identification of macroinvertebrates in the laboratory. His other responsibilities include data compilation and analysis and report preparation.

SELECTED PROJECT EXPERIENCE

Exelon Energy, Inc. (2010-Present) – Survey of freshwater mussels in the Susquehanna River downstream of Conowingo Dam in Maryland in support of hydroelectric relicensing. This effort included semi-quantitative survey in a 4.5-mile river reach, followed by quantitative sampling in five selected areas within that reach. Search methodology included use of SCUBA in deeper water. Biologist.

AREVA NP (2008-Present) – BBNPP ER and Studies Project. Wrote Aquatic Ecological Source Reports to support the COLA Environmental Report. Authored Chapters 4, 5, and 6 of the COLA Environmental Report for Bell Bend Nuclear Power Plant, Salem Township, Luzerne County, PA. Also was lead biologist for aquatic ecological field studies required under NRC and other regulatory guidance from July 2007 through September 2010. Supported NRC site meetings, responses to NRC requests for additional information, and revisions of the COLA Environmental Report.

AREVA/UniStar Bell Bend Nuclear Power Plant (2008) - Project manager for Impingement and Entrainment Studies at PPL's Susquehanna Steam Electric Station. Wrote Impingement and Entrainment Sampling Report.

Pulte Homes of PA, LLC (2007-Present) – Assessment of construction impacts on a stream macroinvertebrate community near a large golf course/housing development in Chester County, PA. This work is a PA Department of Environmental Protection permitting requirement.

Woodard & Curran (2006–Present) - Aquatic benthic macroinvertebrate sample analysis for Pound Ridge Golf Club, Stamford (CT).

Mactec Engineering and Consulting (2006-Present) – Aquatic benthic macroinvertebrate sample analysis for Honeywell-Ironton (OH) Wetlands Assessment Study.

Exelon Power (2006-Present) – Assisted with the monitoring of aquatic conditions during reactor outages at Oyster Creek Nuclear Generating Station. During the events, field teams of biologists monitored the facilities discharge canal looking for any stressed or dying fish or marine organisms, conducted water temperature surveys, and collected target fish species for analytical and beneficial use purposes.

EDUCATION

- M.S. 2005, Wildlife and Fisheries Science, The Pennsylvania State University
B.S. 1999, Wildlife and Fisheries Science, The Pennsylvania State University
B.S. 1999, Environmental Resource Management, The Pennsylvania State University

PROFESSIONAL EXPERIENCE

- 2005-Present Normandeau Associates
2003-2005 The Pennsylvania State University
2000-2003 Stroud Water Research Center
2000 Pennfield Farms Inc.
1999 Pennsylvania Fish and Boat Commission
1999 The Pennsylvania State University
1998 Envircon Associates Inc.
1997 The Pennsylvania State University

PROFESSIONAL AFFILIATIONS

- American Fisheries Society
North American Benthological Society

SAIC, William Dick Lagoon Project (2006-Present) - Assessed the benthic macroinvertebrate communities and habitat of two streams, one of which will receive discharge of treated effluent from a Superfund site.

Exelon Power (2005-Present) - The Limerick Generating Station Water Supply Modification Demonstration Project and Wadesville Mine Pool Withdrawal and Stream Flow Augmentation Demonstration Project – Data analysis, report writing, and fish and macroinvertebrate sampling.

Exelon Energy (2005-Present) – Fish and macroinvertebrate sampling in the East Branch Perkiomen Creek, part of the Point Pleasant Water Diversion Project, Bucks and Montgomery Counties, PA.

Sanofi Pasteur (2005-Present) – Ecological studies of impact of discharge from a pharmaceutical plant on Swiftwater Creek in the Pocono Mountains in northeast Pennsylvania.

Drumore Crossing, LP (2009) – Assessment of macroinvertebrate community structure in Fishing Creek in Lancaster County, PA. This effort was conducted to determine if an upgrade to Exceptional Value stream status was warranted.

Waste Management, Inc. (2009) – Assessment of macroinvertebrate community structure to determine impact of landfill leachate treatment plant discharge to the Delaware River. This effort was a Delaware River Basin Commission permitting requirement.

Independence Construction Materials, Inc. (2007-2009) – Assessment of quarry discharge impacts on the macroinvertebrate community in Octoraro Creek, Lancaster County, PA. This work was a PA Department of Environmental Protection NPDES permitting requirement.

Reliant Energy (2005-2009) – Seward Station 316(a) Study; Conducted ecological fieldwork for a thermal variance study on the Conemaugh River, PA.

Exelon Power/BBL (2005-2008) – Aquatic ecologist on a team of economists, engineers and biologists to provide 316(b) Phase II compliance services at seven fossil-fuel generating stations in PA, TX, and MA. The team provided Phase II applicability analysis, strategy recommendations, PIC documents and Compliance Demonstration Studies (CDS).

NJ Dept. of Environmental Protection (2005-2008) – Water quality and biological productivity studies in Round Valley Reservoir, Hunterdon County, NJ. Studies focused on improving the forage fishery supporting black bass and trout fisheries.

Exelon Power (2007) – Conducted fisheries studies on the Schuylkill River in support of a 316(a) thermal variance renewal for Cromby Generating Station. This work included fish collection, data analysis, and report preparation.

Mactec Engineering and Consultants (2007) – Aquatic benthic macroinvertebrate sample analysis for Nuclear Metals Superfund Site, Concord (MA) Aquatic

Geryville Materials, Inc. (2006) - Assisted in macroinvertebrate assessment related to a proposed rock quarry discharge into Hosensack Creek.

Merrill Creek Reservoir (2006) – Assisted in fisheries studies for a pumped-storage reservoir in New Jersey.

Exelon Power (2005-2006) – Impingement and entrainment sampling at four fossil-fuel generating stations in Pennsylvania.

New York City Department of Environmental Protection (2005) – Fish and macroinvertebrate survey in Schoharie Creek downstream of Gilboa Dam (NY).

Reading Site Contractors (2005) – Age and growth analysis of largemouth bass and bluegills in two ponds in Chester County, PA.

School of Forest Resources at The Pennsylvania State University (2003-2005) – Graduate Research/Teaching Assistant.

- Designed and conducted study of the relationship of macroinvertebrate and fish assemblages to watershed and riparian condition measures
- Collected, processed, and identified macroinvertebrates
- Surveyed fish communities using backpack, towboat, and boat electrofishing gear
- Used ArcGIS to determine watershed land cover, watershed area, and attributes of streams
- Instructed in Fisheries Science class highlighting collection of fish and macroinvertebrates, fish identification, fish aging using scales and otoliths, using gastric lavage to collect stomach contents, water chemistry analysis, Index of Biotic Integrity, and Rapid Bioassessment Protocol
- Supervised three undergraduate research assistants in completion of laboratory projects

Stroud Water Research Center (2000-2003) – Aquatic Entomology Staff Scientist.

- Collected aquatic macroinvertebrates from a variety of watersheds in PA, DE, NY, NC, and GA
- Processed and identified macroinvertebrates to genus and species levels, including Chironomidae
- Analyzed biological data and calculated metrics and water quality indices
- Selected stream sampling locations and coordinated field sampling activities
- Additional duties included: a) training student interns; b) leading field crews; c) conducting field and laboratory chemistry and, d) surveying larval and adult stream salamanders

Pennfield Farms Inc. (2000) – Wastewater Treatment Technician.

- Managed wastewater treatment facility
- Monitored treatment plant function and performed tasks vital to daily operations

Pennsylvania Fish and Boat Commission (1999) – Fisheries Biologist Aide.

- Collected and identified macroinvertebrates and fishes
- Participated in acid mine drainage biomonitoring, wetlands delineation, and highway construction permitting

School of Forest Resources at The Pennsylvania State University (1999) – Research Assistant.

- Sorted benthic macroinvertebrate samples
- Identified benthic macroinvertebrates

Envircon Associates Incorporated (1998) – Environmental Assistant.

- Sampled wastewater and completed water quality analysis for various constituents
- Administered mechanical and biological controls to treatment systems

School of Forest Resources at The Pennsylvania State University (1997) – Research Assistant.

- Studied the preferred substrate of darters in an artificial stream

SPECIAL TRAINING

EPT2 Taxonomic Certification

FWS-FIS2C01 Principles & Techniques of Electrofishing

OSHA 40-Hour Safety Certification

OSHA 8-Hour Safety Certification Refresher (Current)

Pennsylvania Chapter of the American Fisheries Society's Cyprinidae and Catostomidae Identification Workshop

Pennsylvania Department of Environmental Protection's Fish of the French Creek Drainage Identification Course

PA/WV Chapter of AFS Continuing Education Workshop for Mid-Atlantic Fish Identification

AMAAB Decapoda, Oligochaeta, and Plecoptera Identification Workshops

SELECTED PRESENTATIONS

Blye, R.W., P.L. Harmon, and B.W. Lees, Normandeau Associates and Kinnel, J., Veritas Economic Consulting, Matty, R., Exelon Power. 2006. Comparison of Entrainment at Adjacent Intakes on a Tidal river With and Without Large Slot-width Wedge-wire Screens: A Case for Partial Compliance with 316(b) Phase II Performance Standards for Reduction in Entrainment. UWAG EPRI meeting: Atlanta, September 6-7, 2006.

Whaley, J., J. Kinnel, and M. Bingham, Veritas Economic Consulting, R.W. R.W. Blye and B.W. Lees, Normandeau Associates. 2006. Approaches for Estimating Annual Impingement from Sample Counts. UWAG EPRI meeting: Atlanta, September 6-7, 2006.

Comparison of GIS and "on the ground" Assessments of Riparian Area Condition. Presented at North East Fish and Wildlife Conference. April 2005.

Linking riparian area condition and characteristics of fish and benthic macroinvertebrate assemblages. 135th Meeting of the American Fisheries Society, Anchorage, AK. September 2005.

APPENDIX C - SPECIES ACCOUNTS

Green Floater (*Lasmigona subviridis*) and Brook Floater (*Alasmidonta varicosa*).

Green Floater (*Lasmigona subviridis*)

Freshwater Mussel Species of Concern

State Rank: S2 (imperiled), Global Rank: G3 (vulnerable)

Identification

The green floater (*Lasmigona subviridis*) is a small mussel, usually less than 55 mm in length. The shell is thin and the mussel has a subovate or trapezoidal shape. The color varies from a dull yellow to green with many dark green rays visible, especially in young individuals. This species may be confused with the creek heelsplitter (*Lasmigona compressa*) (NatureServe 2005; Strayer and Jirka 1997). The creek heelsplitter is larger, thicker shelled, and less ovate. Also, the creek heelsplitter has only been found in the Ohio River Drainage in Pennsylvania while the green floater is also present in the Susquehanna and Delaware River Drainages.

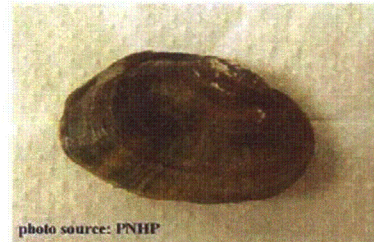


photo source: PNHP

Habitat

The green floater is often found in small creeks and large rivers and sometimes canals. This species is intolerant of strong currents and occurs in pools and other calm water areas (NatureServe 2005, North Carolina Mussel Atlas, Strayer and Jirka 1997). Preferred substrate is gravel and sand in water depths of one to four feet. This species is more likely to be found in hydrologically stable streams, not those prone to flooding and drying. Good water quality is also important for this mussel species (North Carolina Mussel Atlas).

Host Fish

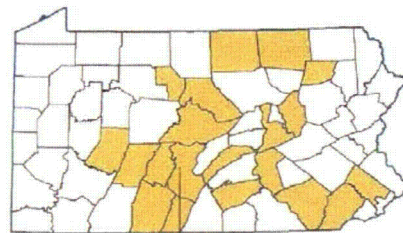
Glochidial (larval) hosts for the green floater are not known (NatureServe 2005, Strayer and Jirka 1997).

Status

From New York south to Georgia and west to Tennessee the green floater is found. This species is not very common in Pennsylvania, but has been found in the Susquehanna, Delaware, and Ohio River Drainages (NatureServe 2005). The state status of the green floater is imperiled (S2), as it is not frequently encountered within its expected range (www.naturalheritage.state.pa.us/invertebrates.aspx). The small size of this species may make it difficult to locate live animals during surveys. Shells of dead green floaters tend to get buried in the surrounding habitat. More extensive surveys are necessary to determine the current status of this species in Pennsylvania and the United States.

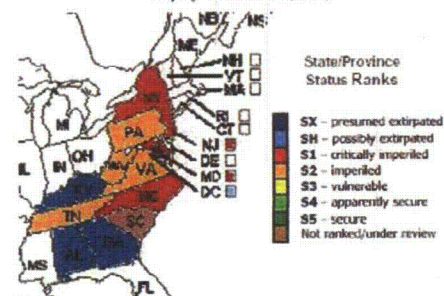
The green floater was listed as threatened in an assessment of the conservation status of the freshwater mussels of the United States by the American Fisheries Society (Williams et al. 1993). The green floater has been historically widespread in the Susquehanna River drainage in New York; however, populations have declined since the early 1990s, probably due to pollution (Strayer and Jirka 1997). Decline in the abundance of this species in other places could be due to stream transport of their preferred habitat, as well as increases in pollutants. The introductions of zebra mussels and Asian clams have also negatively impacted abundance of this species in surveys. However, since this mussel species is hermaphroditic, small populations might survive slightly better than other mussel species in less than ideal conditions (NatureServe 2005).

Pennsylvania Distribution by County



Pennsylvania Natural Heritage Program data 2007

North American State/Province Conservation Status Map by NatureServe (2007)



References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.2. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: September 4, 2007).
- North Carolina Mussel Atlas, Species Information and Status. Website: www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg2b1a1_9.htm
- Pennsylvania Natural Heritage Program. Biota of Concern In Pennsylvania (BOCIP) Lists. Website: www.naturalheritage.state.pa.us/invertebrates.aspx
- Strayer, D.L. and K.J. Jirka. 1997. The Pearly Mussels of New York State. The New York State Education Dept., Albany, NY. 113pp and plates Williams, J.D., M.L. Warren, K.S. Cummins, J.L. Harris, and R.J. Neves. 1993. Conservation Status of Freshwater Mussels. Fisheries 18(9): 6-22.



Brook Floater

Alasmidonta varicosa

Freshwater Mussel Species of Concern

State Rank: S2 (imperiled), Global Rank: G3 (vulnerable)

Identification

The brook floater (*Alasmidonta varicosa*) is a small mussel, usually less than 70 mm in length. The shell is thinner towards the posterior margin and the mussel has a subovate or subtrapezoidal shape (Strayer and Jirka 1997). The ventral margin is slightly indented and the anterior end is abruptly curved. The valves are laterally inflated, giving the mussel a swollen appearance in cross section (Connecticut DEP 2003; Bogan 2002; Nedeau 2000). The posterior ridge is broad and rounded with well-defined ridges crossing the growth lines on the posterior slope. The periostracum (outer covering) is commonly yellowish-green (juveniles) to greenish-brown (adults) and usually has radiating dark green rays across the surface. This species possesses a cantaloupe colored foot (Bogan 2002; Connecticut DEP 2003; Nedeau 2000; Strayer and Jirka 1997).



Photo:

http://www.mass.gov/dfwele/dfw/nhesp/images/al_varicosa.jpg

Habitat

The brook floater is only found in habitats that have consistently flowing water – from small streams to large rivers. It is not found in water bodies that have static water flow such as ponds or lakes (Connecticut DEP 2003; Nedeau 2000). This species favors clean water in gravel or sand and gravel substrates in riffles of creeks and small rivers (Nedeau 2000; www.natureserve.org/explorer; www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg7b1a1_8.htm; <http://research.amnh.org/biodiversity/mussel/alasmidontagenusframeset.html>).

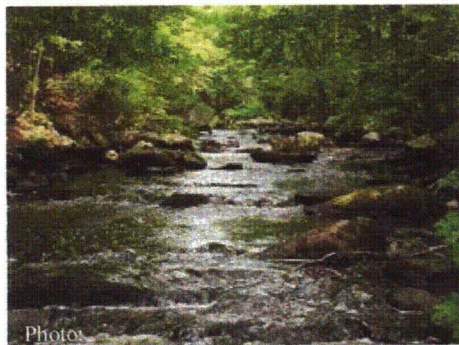


Photo:

<http://research.amnh.org/biodiversity/mussel/alasmidontagenusframeset.html>



Photo:

<http://www.mass.gov/dfwele/dfw/nhesp/images/bioimgback.jpg>

Host Fish

Identified potential fish hosts for the brook floater include: blacknose dace, longnose dace, golden shiner, pumpkinseed, slimy sculpin, yellow perch, and margined madtom (Bogan 2002; Nedeau 2000; www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg7b1a1_8.htm; <http://research.amnh.org/biodiversity/mussel/alasmidontagenusframeset.html>).

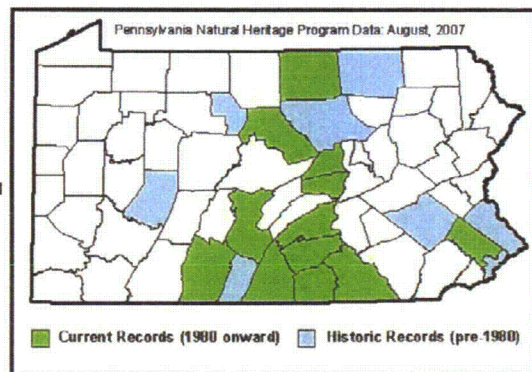
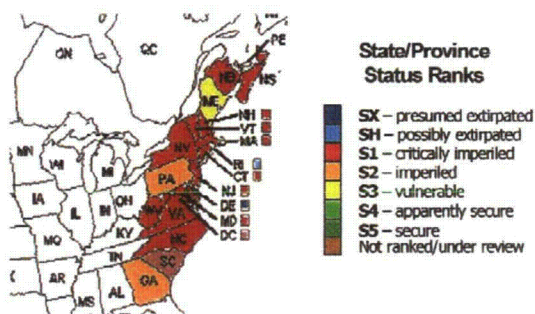
Status

Alasmidonta varicosa is sporadically distributed in Atlantic drainages from Nova Scotia to South Carolina. It appears to be extant from most of the sites it was previously reported in along the Atlantic coast in Maine. This species is observed frequently in Maine; however, when found, populations consist of only a few individuals (Nedeau 2000). In an assessment of the conservation status of the freshwater mussels of the United States by the American Fisheries Society (Williams et al. 1993), the brook floater was listed as threatened. The Pennsylvania status of the brook floater is imperiled (S2) due to a lack of individuals found during surveys throughout most of its range within state boundaries (www.naturalheritage.state.pa.us/invertebrates.aspx). More surveys are required to determine the status of this species and other freshwater mussels in Pennsylvania.

The brook floater has experienced significant declines in population size throughout most of its range. This species has been affected by general pollution, siltation, wastewater runoff, impoundments, and biological collection. Additionally, introductions of the zebra mussel and Asiatic clam have had negative impacts on the distribution of this species. The brook floater is extremely sensitive to hypoxia, pollution, and silt (Nedeau 2000; www.natureserve.org/explorer/).

North American State/Province Conservation Status

Map by NatureServe (2007)



References

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APPENDIX D - Semi-Quantitative Survey Location Data

APPENDIX TABLE D-1: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS AT GOOSE ISLAND

Common Name	Species	GOOSE-1	GOOSE-2	GOOSE-3	Total
Eastern floater	<i>Pyganodon cataracta</i>	6	3		9
Elktoe	<i>Alasmidonta marginata</i>	6	1	1	8
Triangle floater	<i>Alasmidonta undulata</i>	1		1	2
Yellow lampmussel	<i>Lampsilis cariosa</i>	3	1	1	5
Total Number of Mussels		16	5	3	24
Total Mussel Search Hours		1.0	1.0	0.25	2.25
Total Mussels Per Search Hour		16.0	5.0	12.0	10.7

For Goose Island Semi-Quantitative Survey Locations, See Appendix Figure D-1

GOOSE-1

1. Silty sand extending along the south side of Goose Island approximately 200 feet to the island's downstream end and approximately 40 feet offshore from the waterline.
2. Latitude and longitude:
Upstream end – N41°3.8926'; W76°10.1233'
Downstream end – N41°3.9090'; W76°10.1631'

GOOSE-2

1. Silty sand extending approximately 225 feet along the north side of Goose Island and approximately 10 feet offshore from the waterline. This location is near the middle of Goose Island.
2. Latitude and longitude:
Upstream end – N41°3.9396'; W76°9.9960'
Downstream end – N41°3.9246'; W76°10.0731'

GOOSE-3

1. Silty sand extending approximately 30 feet along the north side of Goose Island and approximately 10 feet offshore from the waterline. This location is near the downstream end of Goose Island. There is less silt at this location than at the other Goose Island stations.
2. Latitude and longitude:
Mid-point – N41°3.9221'; W76°10.1247'

APPENDIX TABLE D-2: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS AT ROCKY ISLAND

Common Name	Species	ROCKY-1	ROCKY-2	ROCKY-3	ROCKY-4	Total
Creeper	<i>Strophitus undulatus</i>				1	1
Eastern floater	<i>Pyganodon cataracta</i>	1		1		2
Elktoe	<i>Alasmidonta marginata</i>	1			9	10
Triangle floater	<i>Alasmidonta undulata</i>				2	2
Yellow lampmussel	<i>Lampsilis cariosa</i>	2	2	1	46	51
Total Number of Mussels		4	2	2	58	66
Total Mussel Search Hours		0.5	0.33	0.13	2.5	3.46
Total Mussels Per Search Hour		8.0	6.0	15.4	23.2	19.1

For Rocky Island Semi-Quantitative Survey Locations, See Appendix Figure D-2

ROCKY-1

1. Bedrock with shallow sand and gravel in “corrugations” approximately 100 feet offshore of the waterline along the north side of Rocky Island. Approximately 100 feet (upstream to downstream) of river in a strip approximately 10 feet wide was surveyed.
2. Latitude and longitude:
Mid-point – N41°3.8687’; W76°11.0397’

ROCKY-2

1. Sand (little to no silt) with gravel, cobble, and rubble located at the downstream end of Rocky Island. This habitat is approximately 10 feet by 30 feet.
2. Latitude and longitude:
Mid-point – N41°3.7644; W76°11.4897’

ROCKY-3

1. Almost all sand (some gravel) in a break in water willow beds along the south shoreline of Rocky Island. This habitat is approximately 15 feet x 15 feet.
2. Latitude and longitude:
Mid-point – N41°3.7633’; W76°11.3906’

ROCKY-4

1. Gravel with some interstitial sand extending approximately 1,000 feet along the south side of Rocky Island and from approximately 15 feet to approximately 75 feet offshore.
2. Latitude and longitude:
Upstream end – N41°3.7756’; W76°11.2895’
Downstream end – N41°3.7633’; W76°11.3906’

APPENDIX TABLE D-3: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS AT HESS ISLAND

Common Name	Species	HESS-1	HESS-2	Total
Creeper	<i>Strophitus undulatus</i>	4	1	5
Eastern elliptio	<i>Elliptio complanata</i>	1		1
Eastern floater	<i>Pyganodon cataracta</i>	17	3	20
Elktoe	<i>Alasmidonta marginata</i>	2		2
Yellow lampmussel	<i>Lampsilis cariosa</i>	2	2	4
Total Number of Mussels		26	6	32
Total Mussel Search Hours		0.75	1.0	1.75
Total Mussels Per Search Hour		34.7	6.0	18.3

For Hess Island Semi-Quantitative Survey Locations, See Appendix Figure D-2

HESS-1

1. Silty sand grading to sandy gravel and extending along the secondary channel behind Hess Island approximately 100 feet to the island's downstream end and approximately 25 feet offshore from the waterline.
2. Latitude and longitude:
 Upstream end - N41°3.9411'; W76°11.1471'
 Downstream end– N41°3.9225'; W76°11.1665'

HESS-2

1. Sandy gravel extending along the south side of Hess Island approximately 60 feet to the island's downstream end and approximately 15 feet offshore from the waterline.
2. Latitude and longitude:
 Upstream end – N41°3.9200'; W76°11.1528'
 Downstream end– N41°3.9225'; W76°11.1665'

APPENDIX TABLE D-4: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS AT HERON ISLAND

Common Name	Species	HERON-1	HERON-2	Total
Creeper	<i>Strophitus undulatus</i>	2		2
Eastern floater	<i>Pyganodon cataracta</i>	1		1
Elktoe	<i>Alasmidonta marginata</i>	1	2	3
Yellow lampmussel	<i>Lampsilis cariosa</i>	10	1	11
Total Number of Mussels		14	3	17
Total Mussel Search Hours		2.0	0.5	2.5
Total Mussels Per Search Hour		7.0	6.0	6.8

For Heron Island Semi-Quantitative Survey Locations, See Appendix Figure D-3

HERON-1

1. Gravel, cobble, and rubble on bedrock with a few boulders extending downstream approximately 1,000 feet along the north side of Heron Island from the island's upstream end and from approximately 25 feet to approximately 100 feet offshore. The occasional boulder had 1 to 3 square feet of sand downstream and the survey was restricted to this sand located downstream of the boulders.
2. Latitude and longitude:
Upstream end – N41°3.6971; W76°12.2508'
Downstream end – N41°3.6889'; W76°12.4639'

HERON-2

1. Gravel and cobble with some sand extending along the north side of Heron Island approximately 150 feet to the downstream end of the island and approximately 50 feet offshore from the waterline.
2. Latitude and longitude:
Upstream end – N41°3.5465'; W76°13.0814'
Downstream end – N41°3.5355'; W76°13.1116'

APPENDIX TABLE D-5: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS AT SWAN ISLAND

Common Name	Species	SWAN-1	SWAN-2	SWAN-3	Total
Creeper	<i>Strophitus undulatus</i>		1	1	2
Elktoe	<i>Alasmidonta marginata</i>	1	4	6	11
Triangle floater	<i>Alasmidonta undulata</i>	1	2	1	4
Yellow lampmussel	<i>Lampsilis cariosa</i>		3	8	11
Total Number of Mussels		2	10	16	28
Total Mussel Search Hours		1.0	2.0	1.25	4.25
Total Mussels Per Search Hour		2.0	5.0	12.8	6.6

For Swan Island Semi-Quantitative Survey Locations, See Appendix Figure D-3

SWAN-1

1. Cobble and rubble with some gravel and sand extending to approximately 15 feet offshore of the downstream end of the channel between Heron and Swan Islands.
2. Latitude and longitude:
Mid-point – N41°3.5289'; W76°13.1235'

SWAN-2

1. Gravel, cobble, rubble, and boulders with some sand offshore extending the entire length of the north side of Swan Island and from approximately 25 feet to 100 feet offshore.
2. Latitude and longitude:
Upstream end – N41°3.5289'; W76°13.1235'
Downstream end – N41°3.2874'; W76°13.6017'

SWAN-3

1. Loose, sandy gravel extending approximately 50 feet downstream from the downstream end of Swan Island. Habitat is teardrop-shaped and approximately 50 feet at its widest.
2. Latitude and longitude:
Mid-point – N41°3.2857'; w76°13.6054'

**APPENDIX TABLE D-6: SEMI-QUANTITATIVE MUSSEL SURVEY RESULTS
IN THE GREEN FLOATER STUDY COMPARTMENT IN THE HERON/SWAN
ISLAND CHANNEL**

Common Name	Species	GFSC-1	GFSC-2	GFSC-3	GFSC-4	GFSC-5	Total
Creeper	<i>Strophitus undulatus</i>	2		1		4	7
Eastern elliptio	<i>Elliptio complanata</i>		1				1
Elktoe	<i>Alasmidonta marginata</i>	11	3	5	2	10	31
Green floater	<i>Lasmigona subviridis</i>	6		1	1	3	11
Triangle floater	<i>Alasmidonta undulata</i>	4	3			3	10
Yellow lampmussel	<i>Lampsilis cariosa</i>	11	1	3	8	14	37
Total Number of Mussels		34	8	10	11	34	97
Total Mussel Search Hours		3.0	1.5	1.17	0.75	3.75	10.2
Total Mussels Per Search Hour		11.3	5.3	8.5	14.7	9.1	9.5

For the Green Floater Study Compartment Survey Routes, See Appendix Figure D-4

Green Floater Study Compartment Corner Coordinates

Corner	Latitude	Longitude
Northeast	N41°3.5624'	W76°12.9230'
Southeast	N41°3.5524'	W76°12.9186'
Northwest	N41°3.5434'	W76°12.9822'
Southwest	N41°3.5340'	W76°12.9785'

GFSC-1

1. Mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand with no silt.
2. Approximately 150 feet along the Heron island shoreline approximately 5-20 feet offshore of the waterline in the upstream end of the compartment.

GFSC-2

1. Mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand with no silt.
2. Approximately 175 feet along the mid-channel side of the compartment in the upstream end of the compartment.

GFSC-3

1. Mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand with no silt.
2. Approximately 100 feet from the mid-channel side of the compartment along the downstream side of the compartment and then turning upstream along the Heron Island shoreline.

GFSC-4

1. Mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand with no silt.
2. Approximately 100 feet along the Heron Island shoreline in the middle of the compartment.

GFSC-5

1. Mixture of gravel, cobble, rubble, and the occasional small boulder in a matrix of interstitial sand with no silt.
2. Approximately 200 feet along the middle of the compartment between GFSC-1 and GFSC-2.

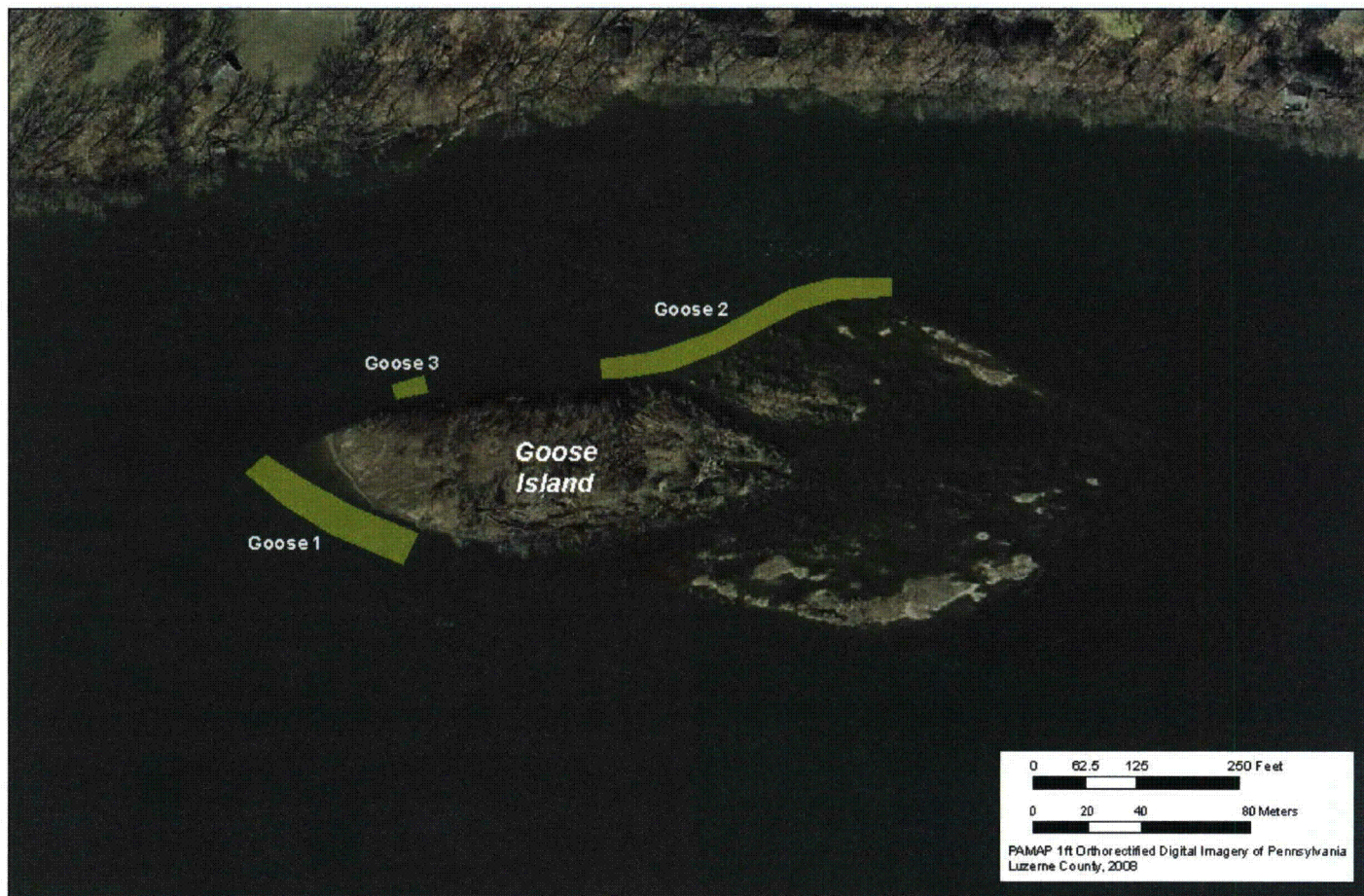


Figure D-1.
Semi-Quantitative Survey Locations
Goose Island



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project: 21665.001

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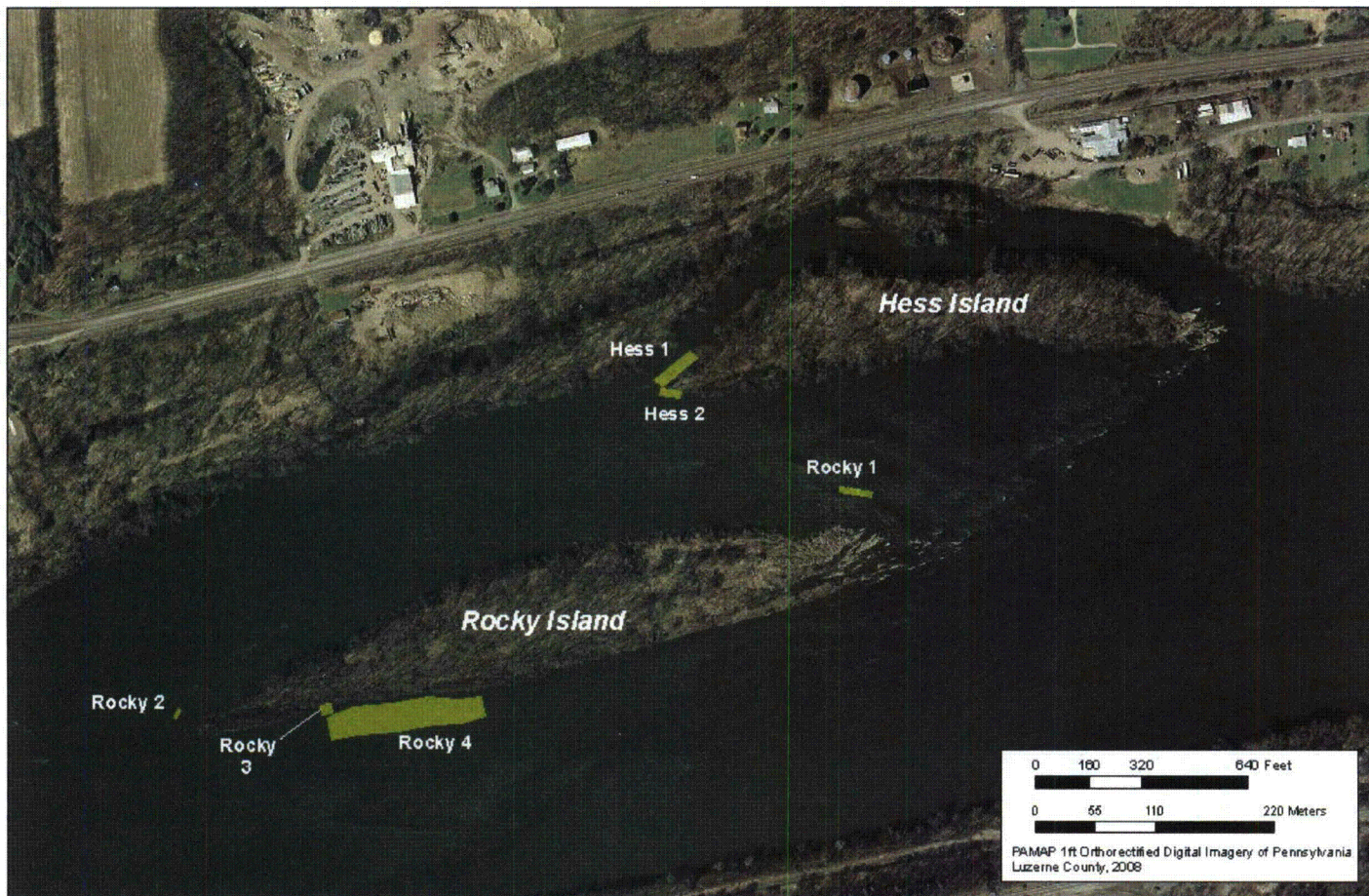


Figure D-2.
Semi-Quantitative Survey Locations
Hess Island and Rocky Island



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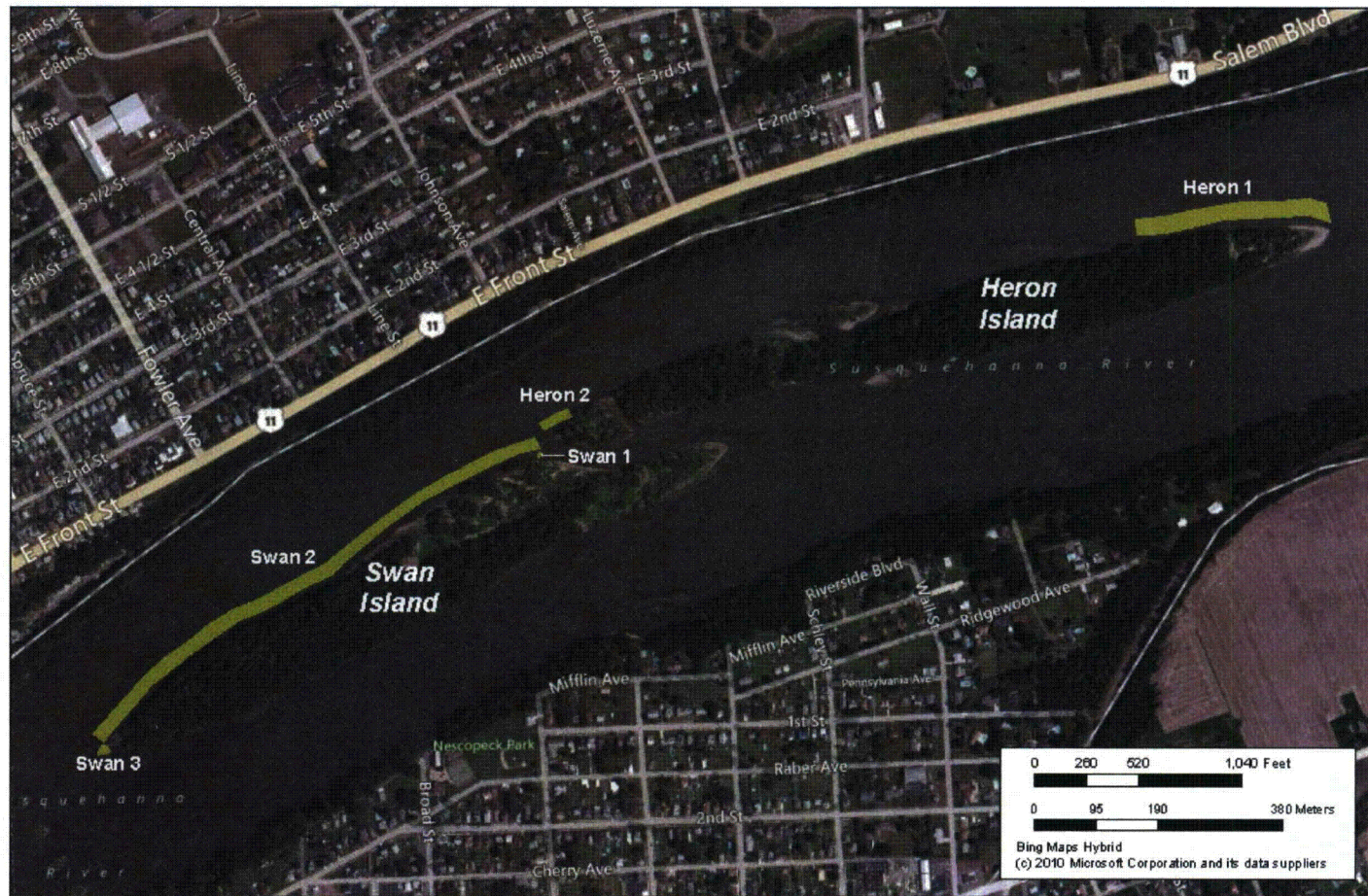


Figure D-3.
Semi-Quantitative Survey Locations
Heron Island and Swan Island

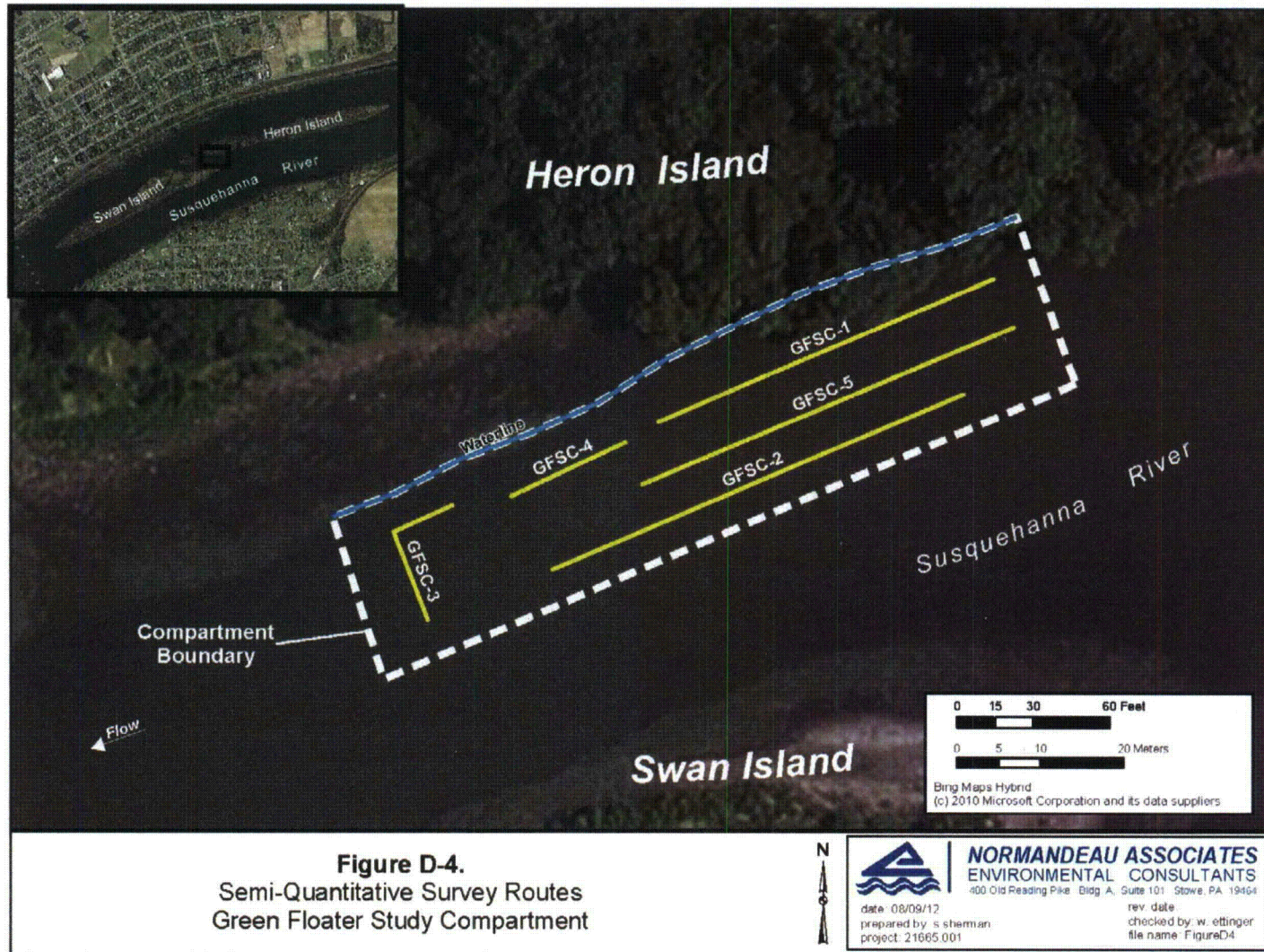


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