

Larry Hogan, *Governor*
Boyd Rutherford, *Lt. Governor*



Pete K. Rahn, *Secretary*

STATE HIGHWAY ADMINISTRATION

RESEARCH REPORT

EFFECTIVENESS OF NEST SITE RESTORATION FOR THE ENDANGERED NORTHERN MAP TURTLE

REPORT NO. 1: NEST SITE SELECTION AND NEST SUCCESS FROM 2013-2014 AND ESTABLISHMENT OF ENVIRONMENTAL CENTER

**RICHARD A. SEIGEL, KAITE ANDERSON, BRIAN DURKIN, AND
TEAL RICHARDS-DIMITRIE**

TOWSON UNIVERSITY

FINAL REPORT

MAY 2015

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Technical Report Documentation Page

1. Report No. MD-15-SHA-TU-1-01	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Effectiveness of Nest Site Restoration for the Endangered Northern Map Turtle Report No. 1: Nest Site Selection and Nest Success From 2013-2014 and Establishment Of Environmental Center		5. Report Date May 2015	
		6. Performing Organization Code	
7. Author/s Richard A Seigel, Kaite Anderson, Brian Durkin, and Teal Richards-Dimitrie		8. Performing Organization Report No.	
9. Performing Organization Name and Address Towson University 8000 York Road Towson, MD 21252		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. SP309B4N	
12. Sponsoring Organization Name and Address Maryland State Highway Administration Office of Policy & Research 707 North Calvert Street Baltimore MD 21202		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code (7120) STMD - MDOT/SHA	
15. Supplementary Notes			
16. Abstract The Northern Map Turtle, <i>Graptemys geographica</i> , is a Maryland state Endangered Species, found only in the lower Susquehanna River in Maryland. The only area where nests of this species are not heavily impacted by predators occurs in the town of Port Deposit. However, turtles in Port Deposit must often cross a gravel parking lot with constant vehicular traffic to reach the nesting sites, and turtles may become disoriented by human disturbance and move away from the river, towards the roadway, Maryland Route 222. In addition, the soil in which the turtles are nesting is heavily compacted and turtles often abandon nest sites after unsuccessful nesting attempts. The objectives of this project were to (a) to rehabilitate the existing nesting areas in Port Deposit to enhance nesting success, (b) find ways to avoid disturbance by humans during nesting, and (c) work with town officials in establishing an environmental education center about the Susquehanna River and the Northern Map Turtle. Data from 2013-2014 showed that nesting in Port Deposit occurred from late May to late July. Numbers of nests varied from 7-8 per year and no nests were attacked by predators. Most nests were found adjacent to the Tomes Landing Marina, but a few were found upstream near condominiums. Distance from water ranged from 1-60 meters and no differences were found between years. Hatching of this species generally overwinter in the nest, with emergence in April and May of the following year. TU staff worked with officials from SHA and Port Deposit to design the interpretive signs for the education center and the text of these signs is largely complete. Installation will occur in 2015 as part of Phase II of this project. Rehabilitation of the nesting areas has also been designed and installation will occur in 2015 as part of Phase II of this project.			
17. Key Words Turtles, endangered species, nesting, human disturbance		18. Distribution Statement: No restrictions This document is available from the Research Division upon request.	
19. Security Classification (of this report) None	20. Security Classification (of this page) None	21. No. Of Pages 42	22. Price

Form DOT F 1700.7 (8-72) Reproduction of form and completed page is authorized.

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EXECUTIVE SUMMARY

The Northern Map Turtle, *Graptemys geographica*, is a Maryland state Endangered Species, found only in the lower Susquehanna River in Maryland. Like many riverine turtle species, populations of map turtles in the US are threatened by commercial harvesting for the pet trade and by human recreational activities. Impacts from habitat modification and human recreation are of special concern for Northern Map Turtles in Maryland; flows of the lower Susquehanna River are influenced by generation from the Conowingo Hydroelectric Dam and the river below the dam is heavily used for recreational activities such as hiking, fishing, and boating during the spring, summer, and fall.

Studies funded by the Maryland Department of Natural Resources and Exelon Corporation from 2008-2012 showed that (1) there is a reproductively-active population of Northern Map Turtles in the lower Susquehanna River, both below and above the Conowingo Hydroelectric Dam, with most turtles concentrated in a 1.9 km linear area from the upriver end of Roberts Island to the down river end of Spencer Island across from Susquehanna State Park; and (2) nesting occurs along relatively open areas on both in-river islands, along the banks of Octoraro Creek and Deer Creek, and in the town of Port Deposit from May-July, but most nesting areas are heavily disturbed by humans and most nests (up to 100% in some years) are destroyed by predators.

The 2008-2012 study indicated that the only known site with consistently successful nesting in Maryland is in the town of Port Deposit, especially in the area surrounding Tomes Landing Marina. However, the Tomes Landing nesting site is far from optimal; turtles nesting at this site must often cross through a gravel parking lot with constant vehicular traffic to reach the actual nesting sites, and adult and hatchling turtles may become disoriented by human disturbance and move away from the river, towards Maryland Route 222. In addition, the soil in which the turtles are nesting is heavily compacted and turtles often abandon nest sites after unsuccessful nesting attempts.

Because of the high importance of the Tomes Landing nesting sites, SHA, the town of Port Deposit, the Maryland Department of Natural Resources, and Towson University (TU) formed a joint effort in 2011 to seek funding to rehabilitate the current nesting sites with more appropriate soil and an exclusion barrier to keep turtles away from areas with high foot and vehicular traffic. In addition, these agencies collaborated on the development of a plan to renovate the historic Gas House in Port Deposit as a combined research station and environmental education center.

To better inform the rehabilitation project and increase its chances for success, TU conducted studies of the nesting ecology of Northern Map Turtles from 2013-2014. The primary objective of this project was to determine whether rehabilitation of the historic nesting areas in the immediate vicinity of the Tomes Landing Marina will result in enhanced utilization by nesting Northern Map Turtles and whether this nesting success of these turtles is also increased as a result of the rehabilitation project. Specific project objectives also included assessing how foot traffic along the Susquehanna River “Greenway” impacts turtles and to establish interpretive displays regarding the Map Turtle and its use of the Tomes Landing nesting site. These data will be useful in establishing a set of “Best Practices” for future management of areas where road or foot traffic impact threatened or endangered species.

Research Findings

Nesting of Northern Map Turtles in Port Deposit occurs in May, June, and July, with most nesting occurring between early June and early July. A total of 15 nests were found in Port Deposit in these two years and nesting effort was approximately the same in each year, with 8 nests in 2013 and 7 nests in 2014. Nesting occurred in two primary areas in Port Deposit, in the immediate vicinity of the Gas House (12 nests in 2013 and 2014 combined) and three nests found upstream of the Gas House near the developed condominiums. Nests were found at sites from immediately adjacent to the river to > 60 meters inland. All nests constructed in 2014 were marked with flagging to ensure that they will not be disturbed during the on-going construction at the Gas House.

No nests in Port Deposit were destroyed or attacked by predators during this study. This contrasts with the near 100% nest predation seen in “natural” areas such as Octoraro Creek. With one exception, all hatchlings from these nests emerged in the spring of the following year after nests were dug, i.e., hatchlings from nests built in June 2013 emerged from the nest in the spring of 2014. A total of 93 hatchlings were captured emerging from nests during this study. Mean sizes of these hatchlings differed significantly between years, although the reasons for these differences are not apparent. Since the rehabilitation of the nesting areas had just been initiated during the late fall of 2014 and winter of 2015, conclusions for this objective will be made during Phase II of this project in 2015.

Working closely with SHA and representatives from Port Deposit, TU staff drafted the interpretive display language and vision for outdoor signage, indoor installations, and a take-home pamphlet text of a series of interpretive displays for visitors to the Tomes Landing site regarding the Northern Map Turtle. Installation of these displays will be done during Phase II of the project.

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List of Acronyms and Abbreviations

- 1) **CITES**: the Convention on International Trade in Endangered Species of Wild Fauna and Flora
- 2) **GPS**: Global Positioning System
- 3) **iButtons**: Miniature temperature-sensitive data loggers used to record nest temperatures of turtles
- 4) **JMP**: Statistical software used for data analysis
- 5) **MD-DNR**: Maryland Department of Natural Resources
- 6) **R**: Statistical software used for data analysis
- 7) **SHA**: State Highway Administration
- 8) **SYSTAT**: Statistical software used for data analysis
- 9) **TU**: Towson University
- 10) **VIE tagging**: Method of marking hatchling turtles using injectable dye under the skin's surface

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

The Northern Map Turtle, *Graptemys geographica*, is a Maryland state Endangered Species, found only in the lower Susquehanna River in Maryland. Like many riverine turtle species, populations of map turtles in the US are threatened by commercial harvesting for the pet trade (Klemens and Thorbjarnarson, 1995; Schlaepfer et al., 2005), habitat modifications (Moll, 1980; Pluto and Bellis, 1986; Jones, 1996; Mitchell and Klemens, 2000; Moll and Moll 2004, Bennett et al., 2009), and by human recreational activities (Moore and Seigel, 2006; Bulte et al., 2010). All populations in the US are listed under Appendix II of CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). Impacts from habitat modification and human recreation are of special concern for Northern Map Turtles in Maryland; flows of the lower Susquehanna River are influenced by generation from the Conowingo Hydroelectric Dam and the river below the dam is heavily used for recreational activities such as hiking, fishing, and boating during the spring, summer, and fall (summarized in Smith et al., 2008, 2009, 2010).

Given the potential impacts of the Conowingo Hydroelectric Dam and associated human recreational use of the river, the Maryland Department of Natural Resources (hereafter, MD-DNR) and Exelon Corporation funded a study by Towson University on the status and ecology of Northern Map Turtles in Maryland starting in 2008. These data showed that (1) there is a reproductively-active population of Northern Map Turtles in the lower Susquehanna River, both below and above the Conowingo Hydroelectric Dam, with most turtles concentrated in a 1.9 km linear area from the upriver end of Roberts Island to the down river end of Spencer Island across from Susquehanna State Park; and (2) nesting occurs along relatively open areas on both in-river islands, along the banks of Octoraro Creek and Deer Creek, and in the town of Port Deposit from May-July, but most nesting areas are heavily disturbed by humans and most nests (up to 100% in some years) are destroyed by predators.

The 2008-2012 study indicated that the only known site with consistently successful nesting in Maryland is in the town of Port Deposit, especially in the area surrounding Tomes Landing Marina. All five nests found in this area in 2011 were successful, compared with a virtual 100% predation or failure rate for nests found at Octoraro Creek and on islands in the river (Seigel et al., 2011). However, the Tomes Landing nesting site is far from optimal; turtles nesting at this site must often cross through a gravel parking lot with constant vehicular traffic to reach the actual nesting sites, and adult and hatchling turtles may become disoriented by human disturbance and move away from the river, towards the roadway, Maryland Route 222. In addition, the soil in which the turtles are nesting is heavily compacted and turtles often abandon nest sites after unsuccessful nesting attempts.

Because of the high importance of the Tomes Landing nesting sites, SHA, the town of Port Deposit, the MD-DNR, and TU formed a joint effort in 2011 to seek funding to rehabilitate the current nesting sites with more appropriate soil and an exclusion barrier to keep turtles away from areas with high foot and vehicular traffic. In addition, these agencies collaborated on the development of a plan to renovate the historic Gas House in Port Deposit as a combined research station and environmental education center.

To better inform the rehabilitation project and increase its chances for success, Towson University conducted studies of the nesting ecology of Northern Map Turtles from 2013-2014. The primary objective of this project was to determine whether rehabilitation of the historic nesting areas in the immediate vicinity of the Tomes Landing Marina will result in enhanced utilization by nesting Northern Map Turtles and whether this nesting success of these turtles is also increased as a result of the rehabilitation project. Specific project objectives also included assessing how foot traffic along the Susquehanna River “Greenway” impacts turtles and to establish interpretive displays regarding the Map Turtle and its use of the Tomes Landing nesting site. These data will be useful in establishing a set of “Best Practices” for future management of areas where road or foot traffic impact threatened or endangered species.

CHAPTER 2: RESEARCH OBJECTIVES

2.1 Determine the timing, duration, and behaviors of Northern Map Turtles during nesting at Port Deposit

These data will indicate whether vehicular or foot traffic are impacting use of the nesting site and nest success and will indicate whether the exclusion fencing has been successful in maintaining nest success at the town's marina site. Information from nesting prior to rehabilitation of the nest sites is reported here.

2.2 Determine the spatial distribution of nests at the Tomes Landing site both before and after the rehabilitation of the nesting areas.

Specifically, these data will be used to compare site utilization between pre- rehabilitation and post-rehabilitation time periods. Information from nesting prior to rehabilitation of the nest sites is reported here.

2.3 Determine nest success at the Tomes Landing site both before and after the rehabilitation of the nesting areas

This objective is designed to determine if habitat modifications of existing nesting areas results in changes in nesting success and, consequently, population viability. Information from nesting prior to rehabilitation of the nest sites is reported here.

2.4 Determine the incubation period and timing of nest emergence both before and after the rehabilitation of the nesting areas.

Baseline data from pre-rehabilitation nests will be used to see if habitat modifications resulted in changes in incubation time, temperature, and timing of emergence of hatchlings. Information from nesting prior to rehabilitation of the nest sites is reported here.

2.5 Conduct a mark-recapture study on newly-released hatchlings.

Once hatchlings emerge from their nests, information on their short-term survival growth and movements is critical to understanding the viability of this population. Information from nesting prior to rehabilitation of the nest sites is reported here.

2.6 Establish a series of interpretive displays for visitors

TU staff are collaborating with SHA and officials from Port Deposit to help engage and inform visitors to the Tomes Landing site regarding the Northern Map Turtle, the role played by the Tomes Landing site in maintaining this population, and how rehabilitation of the nesting areas and the establishment of the boundary fences helps maintain viable populations of the state's endangered species.

2.7 Ensure that all construction activity occurring during the study period is informed of all locations of extant nests to avoid any disturbance to nests

Because of on-going construction at the Tomes Landing site, all nest locations need to be made available to SHA and Port Deposit officials and the actual nest site marked in such a way to avoid their disturbance during incubation.

CHAPTER 3: METHODOLOGY

3.1 Determine the timing, duration, and behaviors of Northern Map Turtles during nesting at Port Deposit

In 2013-2014, TU staff made observations on timing and behaviors during nesting via direct observation, by walking a standard route from the Gas House to the upstream end of Port Deposit. Time of day, duration of the nesting foray, exact nest location, and environmental conditions (air temperature, relative humidity, cloud cover, wind speed and direction) were recorded for all turtles seen nesting. If a female was disturbed while nesting, the source and timing of the disturbance was recorded. Once nesting was completed, the female was captured, processed as indicated below, and released at the site of capture.

All adult turtles were measured for carapace and plastron length using a tape measure or tree calipers, accurate to ± 5 millimeters. Mass was recorded with a portable spring balance, accurate to ± 5 grams. Gender was determined based on the size of the tail and the position of the vent in relation to the rear edge of the plastron. All unmarked turtles were given an individual mark by notching or drilling marginal scutes (Ernst et al., 1974). All adults were released at the site of capture within one hour of capture. All procedures were approved by the Animal Care Committee at TU.

3.2 Determine the spatial distribution of nests at the Tomes Landing site both before and after the rehabilitation of the nesting areas.

The primary reason for the rehabilitation of the nesting sites in Port Deposit is to determine if habitat modifications of existing nesting areas can potentially enhance nesting success and, consequently, population viability. It is especially important to know if nest site selection is random or non-random with respect to newly established soil plots and whether successful nests are concentrated spatially. These data will be essential to informing the rehabilitation program planned by local and state agencies.

In 2013-2014, TU staff collected data on nest site selection prior to rehabilitation of the nesting area. Once females completed nesting (see above), the nest was located and the nest site marked with a flag about 0.5 meters from the nest site (to avoid predators using the flag as an indicator of nest site location). All predated and intact nest localities were recorded using a hand-held GPS with post-processing accuracy of 1-11 meters (> 90% localities at < 3 meter accuracy).

Once rehabilitation of the nesting area has been completed in 2015, the numbers and spatial distribution of nests in 2013-2014 (pre-rehabilitation) will be compared with those in 2015 to determine how females responded to modification of the nesting area. Because females have been marked in previous years, we will also be able to identify any females using the Jacob's Gas House that have not been previously captured at that site.

3.3 Determine nest success at the Tomes Landing site both before and after the rehabilitation of the nesting areas.

As with spatial distribution of nests, it is critical to understand whether the proposed rehabilitation of the nesting areas results in greater recruitment to the population, as measured by nest site success (the proportion of nests that hatch successfully). After recording the locations of nests as noted above, nests were monitored daily for signs of predation (e.g., a dug up nest chamber with egg shells scattered at the nest site). After approximately 60 days, each intact nest was surrounded by a close-topped wire screen mesh cage that will allowed hatchlings to emerge but not leave the vicinity of the nest. TU staff monitored the fate of each nest 3-5 times per week until late fall (early November) and then every two weeks from November through March, then twice weekly from April until hatching. If nests had not emerged by mid-May, they were carefully excavated by hand to determine the fate of the eggs and release any hatchlings that had become entombed.

3.4 Determine the incubation period and timing of nest emergence both before and after the rehabilitation of the nesting areas

Most (but not all) nests of Northern Map Turtles “overwinter in the nest”, i.e., the hatchlings actually emerge from their eggs after about 60-80 days of incubation, then remain quiescent in the underground nest chamber until the following spring (Nagle et al., 2004). Data collected by TU from 2009-2011 suggested that spring emergence is the rule in the Susquehanna River population, with most emergence occurring from late April through mid-May. The factors that determine how long hatchlings remain in the nest and what triggers hatchling emergence remains poorly understood. Since the timing of emergence may have important correlation with hatchling survival, a better understanding of the environmental factors regulating incubation periods and hatchling emergence is important to the viability of this population

Using the same nests monitored for survival noted above, TU staff placed temperature-sensitive data loggers (“iButtons”) on selected nests to monitor incubation temperatures every 30 minutes from egg-laying through hatchling emergence. These data will be compared with data from nests constructed after rehabilitation of the nesting areas, to see if nests constructed in 2015 have a different thermal profile from nests constructed in prior years.

3.5 Conduct a mark-recapture study on newly-released hatchlings.

Until recently, hatchling turtles have been very difficult subjects for mark-recapture studies, due to the issues involved in marking such small animals in a way that is both identifiable and does not interfere with their movements or behaviors. In 2012, TU staff conducted a trial study using visual implant elastomer tagging (VIE tagging). VIE tagging involves the use of a colored liquid polymer which is injected under the plastron in very small quantities, leaving a bright mark that fluoresces under UV light (Davy et al., 2010). This method has been shown to be both long-lasting and have little or no effect on the turtle, making it ideal for our purpose (see Fig 3-1).

Tests with this method in 2012 allowed the marking of 24 hatchlings in an individual manner, with no apparent harm to the animals (Anderson et al., 2015).

The method was approved by the MD-DNR, and was implemented on a broader scale in 2013-2014 to conduct a mark-recapture study of hatchlings from the Tomes Landing site. Each hatchling found in nests at the Tomes Landing site was measured for carapace and plastron length to the nearest 0.1 millimeter using digital calipers and weighed to the nearest 0.1 gram using a digital balance. Hatchlings were then given an individual VIE mark and released at the Tomes Landing site in a way that allows the turtles to move to the water in a way that mimics their natural behaviors. Daily survey trips, in a kayak, were made along the edge of the river to recapture these hatchlings with a long-handled net. Recaptured turtles were checked for their VIE mark, and individuals that had not been processed for over 30 days were measured as above, then released at the point of capture. This allowed for the measurement of growth rates and movements of individual hatchling turtles, being done for the first time for Maryland populations of this species.

3.6 Establish a series of interpretive displays for visitors.

The conversion of the Jacob's Gas House into an environmental education center and the rehabilitation of the nearby nesting areas provide a unique opportunity to inform visitors to Port Deposit about the Susquehanna River ecosystem in general and the Northern Map Turtle in particular. Although discussions with experts in environmental education will be helpful in planning the final products, TU staff plan to use four approaches to inform visitors about the Northern Map Turtle:

- “Built in” (permanent) displays in the Jacobs Gas House and along the nearby walkways that show photos of the turtle, maps of where the turtle nests and hibernates, and text that shows how rehabilitation of the nesting areas and the establishment of the boundary fences helps maintain viable populations of the state Endangered species.
- Short pamphlets that visitors can take with them that provide much of the same information as above, but with a map of Port Deposit and nearby areas that has numbered codes showing where visitors can observe the Map Turtle from the shoreline
- A short video documentary about the Northern Map Turtle, the Susquehanna River ecosystem, with emphasis on how rehabilitation of the nesting areas and the establishment of the boundary fences helps maintain viable populations of the state Endangered species. This will be available on the TU website, on the Facebook page for the Northern Map Turtle, and on the website planned for the Visitor's Center
- Use of modern “social media” to reach a broader audience. This will include expansion of the current Facebook page devoted to the turtle and the use of “QR” codes impeded in the displays noted above that will allow visitors to the Gas House to download information directly into cell phones and tablets.

3.7 Ensure that all construction activity occurring during the study period is informed of all locations of extant nests to avoid any disturbance to nests.

The current plan for the construction activity near the Jacob's Gas House, including rehabilitation of the nesting sites, is planned to begin in the mid-summer of 2015, after the end of the nesting season for Northern Map Turtles. This is a substantial delay in the original timing of this project. TU staff worked with officials from the town of Port Deposit and representatives from SHA to insure that (a) the construction does not begin until after the end of the nesting season and to locate and clearly mark all active nests in the vicinity of the construction zone so that they are not disturbed by these activities. To that end, all nests were surrounded with fluorescent flagging attached to small posts that create at least a one meter buffer zone around each nest.

3.8 Statistical Analysis.

The collected data were analyzed using JMP for Windows, SYSTAT (ver. 13) or R. Data for morphometric and distance comparisons. All data were first tested for assumptions of normality using a Kolmogorov-Smirnov one-sample test of the residuals of the analyzed data. Equality of variances was tested using a Levene's test. If violations of assumptions were found, data were first transformed to natural logs and then re-tested. If violations were still found, a non-parametric test was used for further analysis. Frequency data were tested using a contingency table analysis.

CHAPTER 4: RESEARCH FINDINGS AND DISCUSSION

4.1 Determine the timing, duration, and behaviors of Northern Map Turtles during nesting at Port Deposit.

Over the two years reported here as part of the SHA-funded study, nesting activity was recorded between May 31st and July 26th. Dates for 2013 were May 31st - July 15th (46 days duration) and dates for 2014 were June 3rd - July 26th (54 days duration). We observed ten (10) individual Northern Map Turtles nesting in Port Deposit in 2013 and found eight completed nests, compared with six females found nesting and seven completed nests in 2014. The number of females nesting in 2014 is slightly higher than that seen in Port Deposit in 2012 (work not funded by SHA), when we observed seven females nesting in town but only four completed nests. Since we cannot sample the nesting sites seven days a week, the differences in these values among years could represent a combination of sampling error and stochastic variation. Thus, no conclusion as to possible increases in nesting activity over time can be drawn from these data.

The daily timing of nesting attempts at Port Deposit in 2014 is shown in Fig. 4-1. Nesting attempts were recorded as early as 0600 and as late as 1300 hours. The peak of nesting attempts was between 0800-0900 hours.

4.2 Determine the spatial distribution of nests at the Tomes Landing site both before and after the rehabilitation of the nesting areas.

Nesting occurred in two primary areas in Port Deposit with one occurring in the immediate vicinity of the Gas House and another occurring upstream of the Gas House near the developed condominiums (see Figs. 4-2a and 4-2b). Overall, ten (10) nests were found in the immediate vicinity of the Gas House and three nests upstream near the condominiums. Nests were found at sites from immediately adjacent to the river (1 meter) to areas further inland, as far as 60 meters from the river (Table 4-1). There were no differences in mean distance from water for constructed nests between the two years for which data are available (Table 4-1). The spatial distribution of nests in 2013 and 2014 (pre-rehabilitation) will be compared with the distribution of nests in 2015 (post-rehabilitation) during Phase II of this research.

Just before the onset of nesting in 2014, Maryland DNR completed basic work on the shoreline restoration, leveling the area, removing invasive vegetation, and placing a cobble substrate (see Fig. 4-3). Three turtles made use of this area to come up out of the river, but, as expected, no turtles have attempted to nest at this site. Unfortunately, the clearing of the area made the site considerably more attractive to local residents and town visitors and disturbance to turtles while nesting remains an ongoing issue. At least two turtles found their way onto land immediately downstream of the fishing pier, and did not use the beach. Whether this was a result of the disturbance noted above or another reason cannot be determined at this time.

4.3 Determine nest success at the Tomes Landing site both before and after the rehabilitation of the nesting areas.

All nests that were constructed in summer 2012 emerged successfully in the spring of 2013 and the same was true for all nests constructed in the summer of 2013. Nests constructed in 2014 are still being monitored as of this writing and these data will be reported in the Phase II reporting. Data on differences (if any) in nesting success between pre- and post-rehabilitation will be made during Phase II of this research.

4.4 Determine the incubation period and timing of nest emergence both before and after the rehabilitation of the nesting areas.

With one exception, all nests of Northern Map Turtles in this population overwintered in the nest, i.e., hatchlings in nests constructed in summer 2013 emerged in spring 2014. The first documented occurrence of same-year hatchling emergence for this population was observed on August 29, 2013. This clutch was laid on June 8, 2013 and contained nine hatchlings; the nest exhibited 100% survivorship. Although the evidence is not definitive, the early emergence of hatchlings in this nest may have been caused by human disturbance. Until other nests emerge in the same year as construction, this population should be considered to have obligatory overwintering (*sensu* Ultsch, 2006).

The incubation period for the overwintering nests in this population ranged from 291-337 days for nests constructed in 2013 and emerging in 2014 compared with 334-343 days for nests constructed in 2012 and emerging in 2013. The overall mean for both years was 327 ± 15.7 days. Data on differences (if any) in incubation times between pre- and post-rehabilitation will be made during Phase II of this research.

The temperature profile data collected for iButtons are available for nests constructed in 2013 and 2014. No differences were seen between these two years, although sample sizes are small. These data will be compared with data from nests constructed after rehabilitation of the nesting areas, to see if nests constructed in 2015 have a different thermal profile from nests constructed in prior years. These data will be analyzed as part of the Phase II research report.

4.5 Conduct a mark-recapture study on newly-released hatchlings.

A total of 93 hatchlings were captured, measured, and marked during Phase I of this study, 53 in 2013 (from nests constructed in 2012) and 40 in 2014 (from 2013 nests). Table 4-2 shows the mean sizes of these hatchlings, broken down by year. There are strongly significant differences in body sizes of these hatchlings between these two years of the study, with hatchlings from 2013 being much larger than those from 2014 (Table 4-2). The reasons for these differences are not clear; possible explanations include (a) different females of different sizes constructing nests in 2013 compared with 2014 and (b) differences in incubation times and conditions, which can influence size at emergence. These data (combined with hatchlings that emerge from 2014 nests in 2015) will be used as a baseline to determine whether hatchlings emerging from nests

constructed in rehabilitated nest sites differ in body size from hatchlings from earlier nests.

During 2013, 16 of the 53 hatchlings (30.2%) emerging from nests that year were recaptured at least once in the Susquehanna River adjacent to the Tomes Landing and Condo marinas and three of those were recaptured multiple times. During 2014, nine of 40 hatchlings (22.5%) were recaptured at least once in the same areas. These recapture rates did not differ significantly between years (contingency table analysis, Chi-square = 0.35, df = 1, P = 0.55). These data (combined with hatchlings that emerge from 2014 nests in 2015) will be used as a baseline to determine whether recapture rates of hatchlings emerging from nests constructed in rehabilitated nest sites differ from earlier nests.

4.6 Establish a series of interpretive displays for visitors.

4.6.1 Interpretive Displays

A draft of the interpretive display language and vision for outdoor signage, indoor installations, and a take-home pamphlet are attached as Appendix I to this report. With some minor changes, this language is expected to be that used for the interpretive displays. Officials at Port Deposit have contracted with an outside vendor to fabricate the design for these displays, but then decided that using Towson University staff is a better solution. Discussion on how to produce these displays is currently underway.

4.6.2. Social Media

In April of 2012, the ‘Northern Map Turtles in Maryland’ Facebook page (<https://www.facebook.com/marylandmapturtles>) was created as a public outreach tool. Through this page, TU is able to share interesting photos and videos with the public, address questions and comments about research on Map Turtles from interested parties, and assess public interest in the different aspects of the project (e.g. nesting behavior versus basking behavior vs population size). Many local residents have discovered that this population exists solely through the Facebook page, validating the need for a supplementary outreach tool in addition to the face-to-face communication that is the traditional primary method of public relations and outreach. Researchers are most active on the Facebook page during the active season for the Northern Map Turtle (April-November). However an effort is made to post updates throughout the winter to keep in touch with the public.

Since its creation, the page has received 273 ‘likes’ on Facebook, as well as numerous comments posted on the site. Examples of some of the illustrative materials posted on the Facebook site are provided in Figures 4.4-4.7

4.7 Ensure that all construction activity occurring during the study period is informed of all locations of extant nests to avoid any disturbance to nests

Nests from 2014 have been well-marked with flags and stakes to help prevent any disturbance by construction equipment. Most or all nests are expected to hatch completely before the onset of construction in July. Installation of a temporary wildlife exclusion fence should prevent nests constructed in 2015 from any disturbance, but these nests will be marked and flagged as in previous years.

CHAPTER 54: CONCLUSION

The basis of this study was to compare data on the nesting ecology of Northern Map Turtles from before and after rehabilitation of the nesting grounds. Since that rehabilitation did not commence until after the end of the 2014 nesting period, most conclusions must be deferred until Phase II of this project, when these comparative data will be available. That being said, certain conclusions can be drawn at this time:

- 1) The nesting period for this population varies only slightly among years, commencing in late May or very early June and ending from mid to late July. A “safe” period when construction or other human activities should be curtailed or eliminated would be May 20th - July 25th
- 2) The number of nests at Port Deposit also varies only slightly each year, from a low of four to a high of 10 nests per year. There is a slight trend for larger numbers of nests in later years, but this could easily be a result of sampling error.
- 3) All nests constructed in Port Deposit hatched successfully and no predation was seen in any year. With one exception, all hatchlings in this population overwinter in the nest.
- 4) A successful mark-recapture program has resulted in a recapture rate of 22-31% per year and no differences have been found among years. Most hatchlings spend the first few weeks of their life in the vicinity of Port Deposit and some have been found to move upstream at least limited distances.

ACKNOWLEDGEMENTS

Thanks go to the Maryland State Highway Administration (SHA) and the town of Port Deposit for arranging funding and granting permission to conduct this study. Not many state agencies and municipalities are willing to spend their limited funds and time to better understand how to protect wildlife, and TU is most grateful to SHA and Port Deposit for their willingness to support our work. Special thanks go to Linda and David Read, Vicky Rinkerman, and Rod Heinze (Port Deposit) and Eric Beckett, Allison Hardt, Cheryl Jordon, and Sharon Hawkins (SHA). Deep gratitude also goes to Scott Smith of Maryland DNR, who has been a constant source of support during our work on Map Turtles, helping to arrange the funding for the work from 2008-2011 and for providing advice and guidance for many portions of this study. This work would not have been possible without his support and that of MD-DNR.

Many other individuals help make this study a success. TU would especially thank Scott McDaniel of the Susquehannock Wildlife Society and Kevin Smith of Maryland DNR. A very large number of individuals assisted us with field work or other aspects of the study. Among those providing field help, special thanks goes to Nathan Byer, Scott Martin, Caitlin Principe, Nicole Eller, Kristen Kolenda, Ryan McGehee, and Ben Seigel.

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Table 4-1: Distance (in meters) between nest sites and the closest entrance to the Susquehanna River for Northern Map Turtles at Port Deposit in 2013 and 2014.

2013	2014
1.06	62.4
31.6	7.6
47.9	14.7
50.4	41.9
59.7	59.7
53.8	40.5
57.4	60.3
52.9	
Mean = 44.3 ± 6.88 m	Mean = 41.0 ± 8.43 m

Means shown + 1 SE. There were no differences between the two years (Kruskal-Wallis test = 0.030, P = 0.862).

Table 4-2: Mean sizes of Northern Map Turtle hatchlings at Port Deposit in 2013 and 2014.

Year	Body Mass	Carapace Length	Min Plastron Length	Max Plastron Length
2013 N = 53	6.99 ± 0.232	32.22 ± 0.371	28.7 ± 0.271	29.48 ± 0.229
2014 N = 40	6.18 ± 0.192	30.49 ± 0.303	27.33 ± 0.288	27.93 ± 0.293
Kruskal- Wallis Test	7.838; P = 0.005	13.370; P < 0.001	11.250; P = 0.001	13.682; P < 0.001

Lengths in millimeters, mass in grams. Means are shown ± 1 SE. Differences between years tested using a non-parametric Kruskal-Wallis test due to severe non-normality of the data (uncorrected by log-transformations).

Figure 3.1: Illustration of VIE marking of a hatchling Northern Map Turtle. This is also an example of illustrative materials posted on social media.



Figure 4-1: The cumulative number of female Northern Map Turtles (*Graptemys geographica*) completing (dark bars) and attempting (light bars) nesting at Port Deposit by time of day.

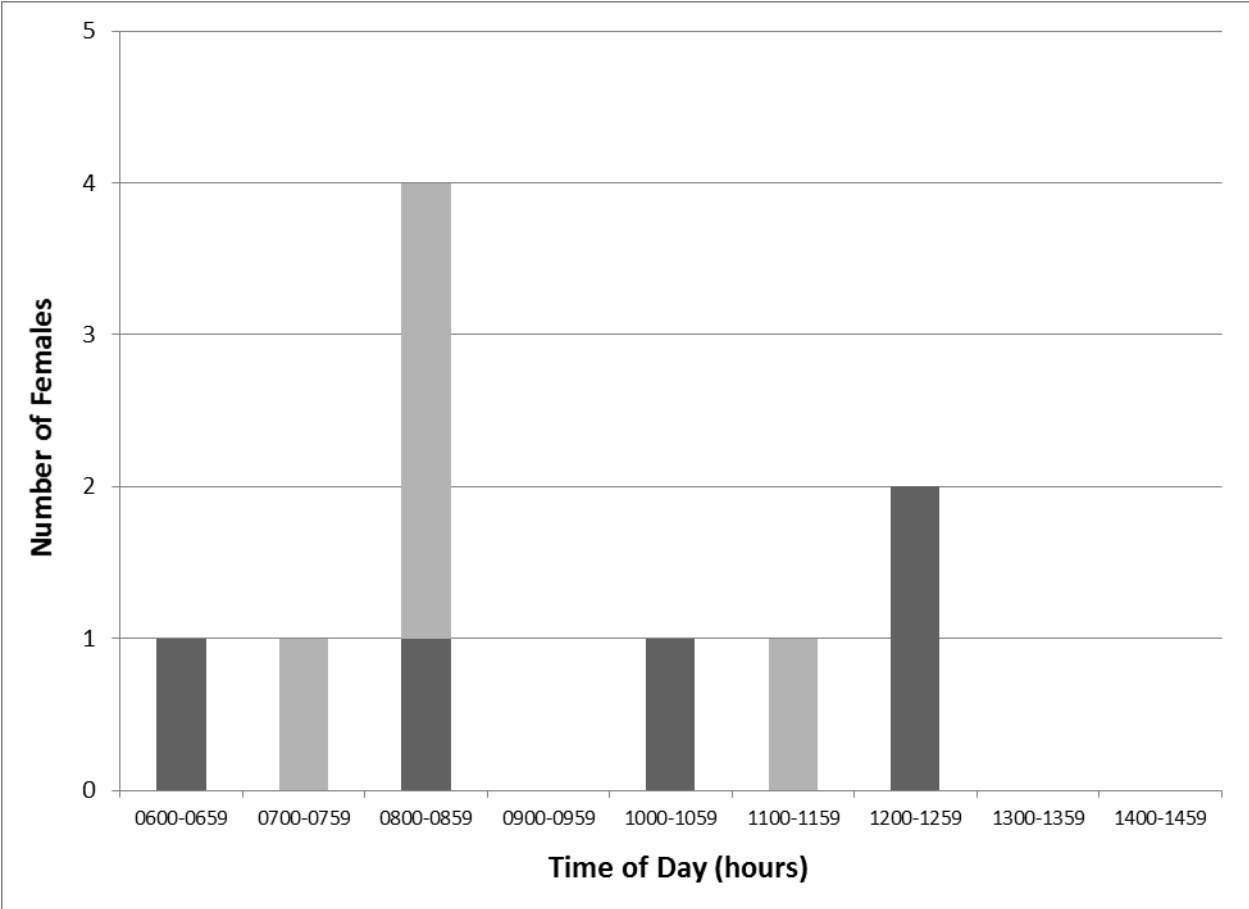


Figure 4.2a: Spatial distribution of Northern Map Turtle nests at the Tome Gas gashouse in Port Deposit in 2013 (blue markers) and 2014 (pink markers).



Figure 4.2b: Spatial distribution of Northern Map Turtle nests at the upstream condos in Port Deposit (pink markers).



Figure 4.3: Photograph of nesting beach at Port Deposit before (above) and following (below) restoration work by Maryland DNR in spring 2014.

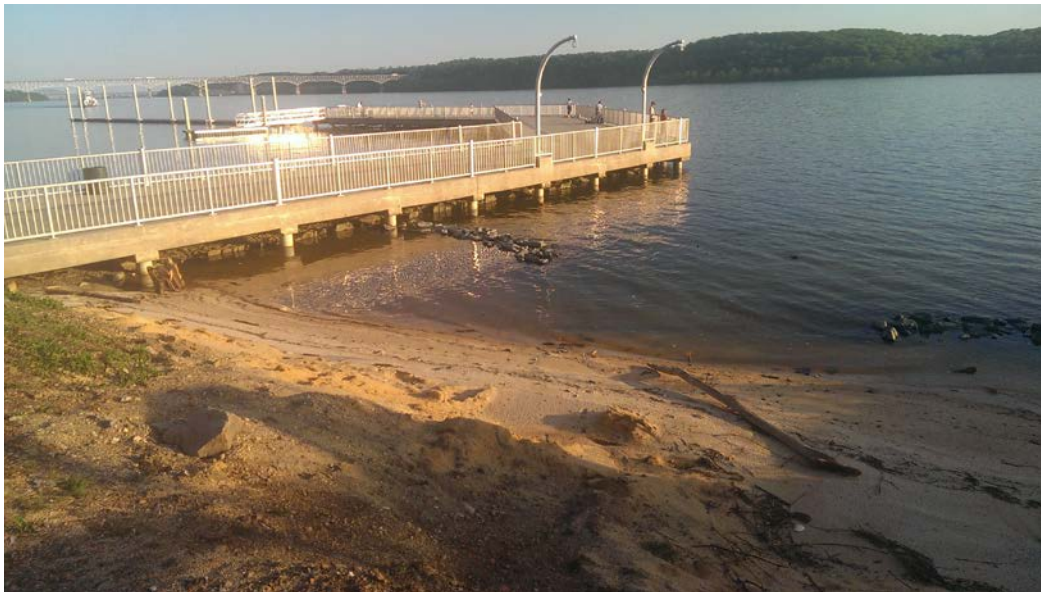


Figure 4.4: SHA site visit to Northern Map Turtle research site as an example of illustrative materials posted on social media



SHA site visit to Northern Map Turtle research site



SHA site visit to Northern Map Turtle nesting site

Figure 4.5: Predated nest of a Northern Map Turtle as an example of illustrative materials posted on social media



Predated nest of a Northern Map Turtle



Turtles in land environment



Turtles on basking platform



Clutch of turtle eggs

Figure 4.6: Newly-emerged hatchling Northern Map Turtle as an example of illustrative materials posted on social media



Newly-emerged hatchling Northern Map Turtle

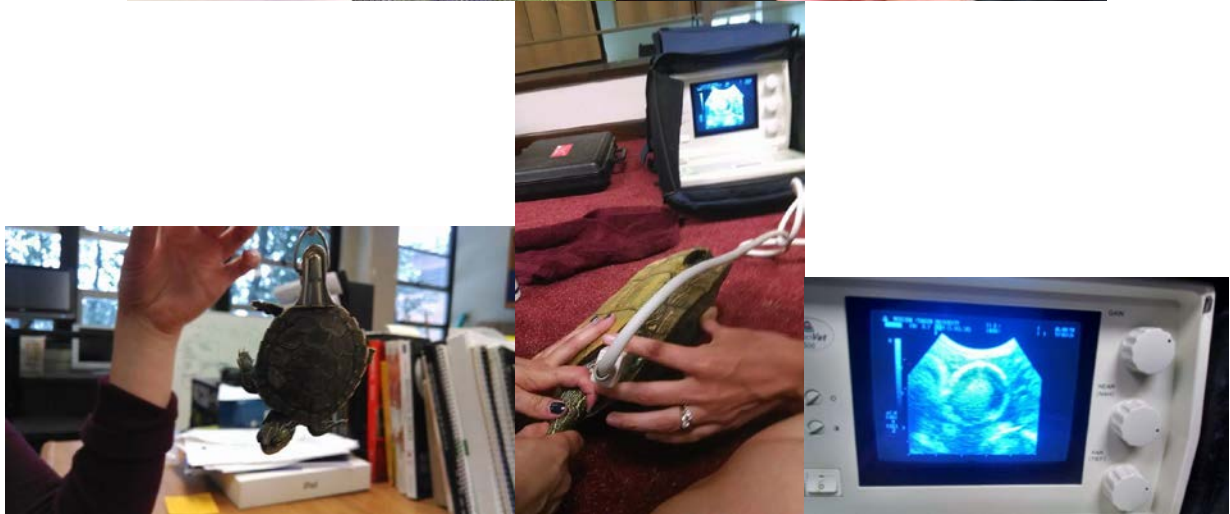


Newly-emerged hatchlings to be identified

Figure 4.7: TU student conducting VIE marking of hatchling Northern Map Turtle as an example of illustrative materials posted on social media



TU student conducting VIE marking of Northern Map Turtle hatchling



Marked, Measured, Weighed, and Sonogram

APPENDIX A

Draft of interpretive displays for visitors to the Tomes Landing site regarding the Northern Map Turtle

Outdoor signs along Greenway (suggested text in italics)

These will be displayed like typical park interpretive signage. They have been ordered in such a way that no matter which direction the pedestrian is walking there will be a logical flow. The QR code leading to the Facebook page should be displayed in one of the bottom corners of each sign.

1. Life of the Lower Susquehanna

This sign will face the river on the up-river start of the walk around the Gas House, to the left of the Gas Station ramp when facing the river. It will be the start or end of the signage. It should include an artistic depiction (field guide like drawing) of a cross-section of the river. Organisms to include: 1-2 important SAV species, 1-3 aquatic invertebrates (Elliptio, Elima, Trichoptera), 1-4 Fish (American Shad, Striped Bass, Yellow Perch, American Eel), Northern Map Turtle, 1-4 Birds (Bald Eagle, Great Blue Heron, waterfowl, Barn swallow), and 1-3 Mammals (Beaver, Raccoon, Fox).

QR code to Greenways site

2. Northern Map Turtles in Maryland

This sign will be facing the river as the Greenway turns the corner to the gas house and will explain the status, range, and why Northern Map Turtles are special to MD. It should include a good photograph of a basking aggregation with obvious Susquehanna habitat in the background. A range map with the Maryland portion highlighted should be depicted in a callout box in a corner.

Suggested Text:

Northern Map Turtles (Graptemys geographica) are one of the Lower Susquehanna's most charming residents. They are listed as State Endangered due to their restricted range in the state. Though there are historic records of Northern Map Turtles from the Elk and Bush rivers they are currently only known in Maryland from the Susquehanna and its tributaries, above and below the Conowingo Hydroelectric Dam. They are the state's only truly riverine turtle, making them a special inhabitant of the largest freshwater input to the Chesapeake Bay. In the U.S. there are few turtles that inhabit riverine systems for all or part of their life histories. All human alterations to rivers make species in these habitats especially vulnerable. In addition to habitat loss some map turtles species are heavily collected for the pet trade--which has led the Convention on

International Trade in Endangered Species to list the entire map turtle genus in 2005 to prevent unsustainable or illegal exploitation.

QR code to MDDNR

3. Northern Map Turtle Characteristics

This sign will be at the inland end of “Gas House Cove” facing down river and include three images over a habitat shot in the background depicting Northern Map Turtle sexual dimorphism, their crushing palate for eating mollusks, and a good basking photo. Each image will be accompanied by brief text.

Suggested Text:

Northern Map Turtles are highly sexually dimorphic in both body size and head size. Females reach up to 10.6 inches and have much wider heads than do males. Males reach up to 6.3 inches and average only 20% of the mass of females.

*It has been well documented that larger female head size is an adaptation for crushing mollusks. The females in this population are primarily feeding on Piedmont Elimia (*Elimia virginica*), a snail that covers the rocks and logs on the Lower Susquehanna. With the smaller body and head sizes the males eat smaller mollusks (tiny clams and snails) and incorporate aquatic insects into their diet.*

Northern Map Turtles are avid baskers and otherwise, only leave the water to nest. They are ectothermic (cold blooded) and basking in the sun is a behavior that allows them to regulate their body temperature. They may form aggregations of up to 30 turtles. Basking Northern Map Turtles are extremely wary and all will dive into the water at the slightest sound or movement, even from many yards away. Even the splashing of another individual into the water may cause a disturbance.

4. Northern Map Turtle Gas House Partnership

This sign will face down river at the upriver side of the Gas House and should include logos of the “key players” involved in the project. A callout box briefly showing how radiotelemetry works would be a good addition.

Suggested Text:

In 2008, Towson University was asked by the Maryland Department of Natural Resources to do a status assessment of Northern Map Turtles in Maryland, because they had not be formally recorded in the state since 1990. A pilot study quickly revealed basking aggregations both above and below the Conowingo Dam. At the time, there was virtually no ecological information on the species in the state. A population level study followed

to begin to discover how Northern Map Turtles were using the habitat and potential threats to their viability. By outfitting a portion of the population with radio-transmitters, we began to understand the way the population was using the river, including key hibernacula and nest sites. One of the most surprising discoveries was that a portion of the females in the population use the town of Port Deposit for nesting!

After this discovery, researchers began to build relationships with members of Tomes Landing Marina, the Chamber of Commerce, Town Council, and other interested citizens. It was clear to all that the turtles choosing the town for nesting was a great opportunity for a conservation partnership. Multiple threats to the females coming to town were identified, including difficult access through the “rip-rapped” shoreline, potential mortality from vehicles, unnatural soil conditions, and disturbance from foot traffic. Where you are standing today is the product of an effort to rehabilitate this area for the good of the turtle. In turn, making this historic town a great example of how research and education, a lot of great hearts and just hard work can be beneficial for both the turtles and the town.

See this partnership featured on National Geographic Online Freshwater Species of the week

QR code to National Geographic article

5. Nest Site Rehabilitation: Protective fencing and nest mounds

This sign will be facing down river near the gashouse entrance.

Language will need to be drafted as details are hammered out.

QR code to video of Rhonda in the Tomes parking lot

6. Nest Site Rehabilitation: Living Shoreline

This sign will be facing the greenway looking up river and into “Gas House Cove” that will be restored to a Living Shoreline. From this sign the reader will be able to look at the Gas House and see at least one experimental nesting mound in front of the Gas House and most likely a second on the downriver side of the Gas House.

Language will need to be drafted as details are finalized.

QR code to Living Shoreline page (Chesapeake Bay Trust or DNR)

7. Rich History of the Lower Susquehanna

This sign should be at the edge of the town jetty facing the river and will be the start or end of the signage. The same artist from the natural history sign should design a drawing with a hodgepodge images of the sharp shooters, maybe what the Tomes complex used to look like, old schooners, Susquehannok artifacts, Bainbridge etc.

Suggested Text:

Not only does the Lower Susquehanna River have an impressive natural history, but a rich cultural history as well. From where you stand the famous explorer John Smith made it only a little farther up the river in his schooner. A fascinating group of humans from the native, Susquehannock to European settlers that where the foundation what this country is today, have called Port Deposit their home. One such settler was Jacob Tome, who came to Port Deposit penniless and ended up one of the richest men in the US, leaving a huge legacy to this town. The building that stands behind you is what is left of the Tome Mansion,, which has been restored to Maryland Historical Society standards while being converted in to a town information center and research station for the continued studies on Northern Map Turtles and other Lower Susquehanna River wildlife.

QR code to town site of choosing

Indoor Installations

The vision for these is permanent backlit displays with models of animals from the river, combined with associated interactive activities on one wall of the gas house devoted to Northern Map Turtle information. Presumably there will also be historical/cultural displays in the gas house as well. Plans for these are less detailed, as we are a ways out from completion of the gas house restoration and will have ample time to flesh them out further as the opportunity to complete them arises.

Major points to be made regarding Map Turtles include: Sexual size dimorphism, Diet, Habitat use, Nesting ecology and management, and impacts of the Conowingo Dam and mitigation

Other public education products include:

- Color pamphlets that visitors can take with them that provide much of the same information as above, but with a map of Port Deposit and nearby areas that has numbered codes showing where visitors can observe the Map Turtle from the shoreline
- A short video documentary about the Northern Map Turtle, the Susquehanna River ecosystem, with emphasis on how rehabilitation of the nesting areas and the establishment of the boundary fences helps maintain viable populations of the state Endangered species.
- “Turtle Cams”, i.e., a video feed of a remote camera focused on areas where Map Turtles aggregate for basking. This could be both at the Gas House exhibit and made available on-line via Facebook.