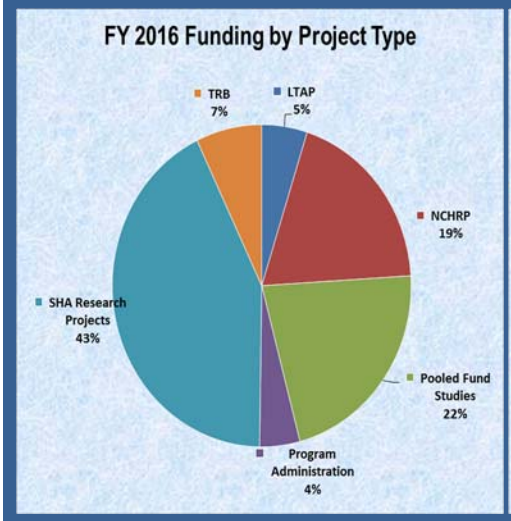
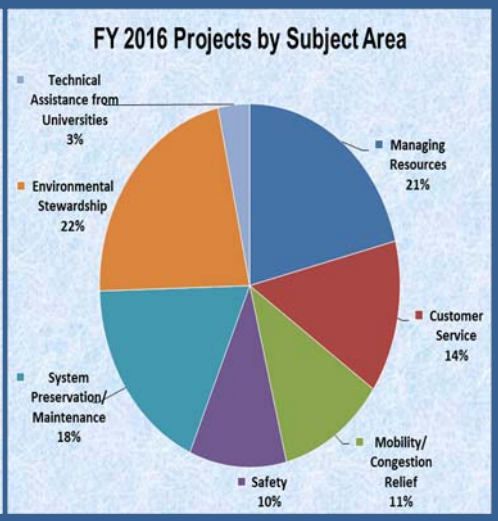
Research Annual Report

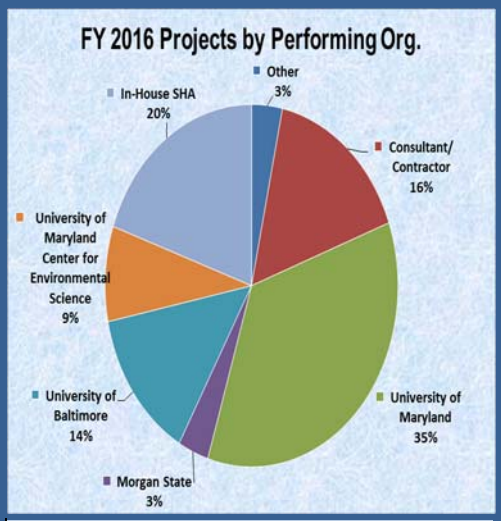
STATE PLANNING & RESEARCH PART II

2016 At-A-Glance JANUARY 1, 2016 – DECEMBER 31, 2016

This report presents a summary of the Maryland Department of Transportation State Highway Administration's (SHA) State Planning & Research (SPR) Part II Program. The funding statistics are provided for the FY 2016 Research Work Program in the following charts. The tables on pages 2 through 5 list all SHA-funded research projects by subject area that were active or completed during 2016. Two of the completed projects are highlighted starting on page 6.







LTAP	$ 170,000
NCHRP	$ 658,909
Pooled Fund Studies	$ 755,000
Program Administration	$ 150,000
SHA Research Projects	$ 1,472,258
TRB	$ 245,870
Total	**$ 3,452,037**

Managing Resources	$ 310,000
Customer Service	$ 200,000
Mobility/ Congestion Relief	$ 168,343
Safety	$ 153,915
System Preservation/ Maintenance	$ 265,000
Environmental Stewardship	$ 325,000
Technical Assistance from Universities	$ 50,000
Total	**$ 1,472,258**

Other	$ 50,000
Consultant/ Contractor	$ 235,000
University of Maryland	$ 522,258
Morgan State	$ 50,000
University of Baltimore	$ 200,000
University of Maryland Center for Envi	$ 125,000
In-House SHA	$ 290,000
Total	**$ 1,472,258**

In addition to administering the annual Research Work Program, in 2016 the Research Division focused on providing access to research results from other states and transportation organizations through email announcements. The announcements are posted on the Research Division's Intranet page and then routed to an email group of employees who signed up to receive information on certain topic areas. Over 180 information announcements were sent out in 2016.

Maryland SHA 2016 Research

TABLES ARE ORGANIZED BY SUBJECT AREAS:

ABBREVIATIONS:

SHA	Maryland State Highway Administration
FHWA	Federal Highway Administration
MSU	Morgan State University
TU	Towson University
UB	University of Baltimore
UMBC	University of Maryland, Baltimore County
UMCP	University of Maryland, College Park
UMCES	University of Maryland Center for Environmental Science

Cancelled research projects

Research projects that are still active

Completed research projects

Safety

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP409B4K	Validation and Guideline Development of Dilemma Zone Protection Systems	UMCP	Hua	FY 2014	$140,000	50%	$ 18,110.84	X
SP409B4N	Development of Local Calibration Factors for Implementing the Highway Safety Manual Phase II study for Freeway and Ramp Applications	MSU	Hua	FY 2014	$100,000	100%	$ 32,148.21	
SP609B4F	Fatigue Resistant Design Criteria for MD SHA cantilevered Mast Arm Signal Structures	UMCP	Sharon	FY 2016	$153,915	32%	$ 48,932.48	

Mobility/Congestion Relief

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP309B4C	Work Zone Performance Monitoring and Assessment through RITIS	UMCP	Hua	FY 2013	$100,000	100%	$ 9,999.61	
SP609B4E	Development of Traffic Management Decision Support Tool for Freeway Incident Traffic Management (FITM) Plan Deployment	UMCP	Sharon	FY 2016	$168,343	9%	$ 15,255.00	

Administrative

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP609B42	Research Program Development and Implementation	In-House SHA	Allison	FY 2016	$150,000	100%	$ 158,541.84	

System Preservation/Maintenance

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP409B4F	Validation of Source approval of HMA Surface Mix Aggregates using Spectrometer	MSU	Sharon	FY 2014	$110,000	100%	$ 49,258.32	
SP409B4G	Stormwater Infiltration Potential (SIP)/Site Characterization using NASA Public Domain Imagery	MSU	Sharon	FY 2014	$110,000	100%	$ 29,877.31	
SP409B4J	Precision monitoring of bridge deck curvature change during replacement	UMCP	Sharon	FY 2014	$100,000	100%	$ 22,140.76	
SP509B4F	Recycled Material Availability in Maryland—A Synthesis Study	UMCP	Hua	FY 2015	$120,000	100%	$ 63,671.82	
SP509B4J	Determination of Asphalt Millings Properties as Related to Stormwater Management Concerns	UMCP	Sharon	FY 2016	$170,520	60%	$ 50,225.31	
SP509B4K	Effective Implementation of Ground Penetrating Radar (GPR) - Phase II	UMCP	Hua	FY 2015	$155,000	100%	$ 128,237.60	
SP609B45	LTPP Maryland Performance Data Collection/Monitoring	In-House SHA	Allison	FY 2016	$30,000	100%	$ 36,490.87	
SP609B4J	Phase II Use of Spectrometer Technology at HMA Plants and Project Sites to Validate and Track Performance of Aggregates	MSU	Sharon	FY 2016	$110,000	Project Cancelled	$ -	

Environmental Stewardship

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP209B4S	Sustainable Landscaping Practices for Enhancing Vegetation	UMBC	Sharon	FY 2012	$100,000	100%	$ 20,106.81	
SP309B4J	Evaluation of Reclaimed (Recycle) Concrete Aggregate (RCA) Road Materials for Use in Oyster Aquaculture: Phase 2 - Field Testing	MSU	Hua	FY 2013	$56,000	100%	$ 66,620.02	
SP409B4E	Evaluation of Waste Concrete Road Materials For Use In Oyster Aquaculture Phase III: Restoration Scale Applications	MSU	Hua	FY 2014	$97,000	100%	$ 19,978.82	
SP409B4H	Evaluating Channel Degradation of Maryland Streams (Phase III- Part	Consultant/ Contractor	Hua	FY 2014	$100,000	100%	$ 13,968.69	
SP509B4C	Literature Review and Synthesis of Compost Properties, Sources, Availability and Findings	Consultant/ Contractor	Hua	FY 2015	$120,000	100%	$ 19,469.03	
SP509B4E	Identification of Low Growing, Salt Tolerant Turfgrass Species Suitable for Use Along Highway Right of Way	UMCES	Hua	FY 2015	$100,651	100%	$ 25,701.28	
SP509B4M	Effectiveness of Nest Site Restoration for the Endangered Northern Map Turtle – Phase II	TU	Sharon	FY 2015	$70,000	100%	$ 6,266.53	X
SP509B4N	Are outbreaks of emerging pathogens correlated with construction of wetlands? Phase II surveys	TU	Sharon	FY 2015	$63,502	100%	$ 11,890.76	
SP609B4C	Use of Compost Blankets to Establish Permanent Vegetation	UMCP	Hua	FY 2016	$200,000	18%	$ 36,231.95	
SP609B4G	Evaluating the Success of Meeting Design Objectives on Previously Constructed OOS Stream Stability Projects	Penn State University	Hua	FY 2016	$125,000	34%	$ 41,815.50	
SP609B4H	Long Term Bed Degradation in Western Coastal Plain Streams	Consultant/ Contractor	Hua	FY 2016	$110,000	27%	$ 29,679.23	

Managing Resources

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP509B4G	Efficient and Effective Implementation of Alternative Project Delivery	UMCP	Sharon	FY 2015	$164,060	79%	$ 125,430.37	
SP509B4H	Safe Accommodation of Bicyclists on High Speed Roadways in Maryland	UMCP	Hua	FY 2015	$120,000	90%	$ 43,509.28	
SP609B44	Evaluation of Experimental Features	In-House SHA	Allison	FY 2016	$80,000	67%	$ 55,334.74	
SP609B47	New Products Evaluation	In-House SHA	Allison	FY 2016	$80,000	97%	$ 72,283.98	

Technical Assistance from Universities

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
SP509B4A	Analyzing the Impact of Median Treatment Safety Countermeasures on Bicycle and Pedestrian Safety	UMCP	Allison	FY 2015	$100,000	7%	$ 6,592.27	
SP609B49	Morgan State Summer Internship Program	MSU	Sharon	FY 2016	$50,000	100%	$ 28,407.22	

National Initiatives

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2016	FY 2016 Expenditures	Spotlight
NCHRP	National Cooperative Highway Research Program	Other	Allison	FY 2016	$658,909	100%	$ 658,909.00	
SP609C41	Local Technical Assistance Program (LTAP)	UMCP	Allison	FY 2016	$150,000	46%	$ 68,364.76	
SP609B43	TRB Technical Activities Service	Other	Allison	FY 2016	$125,870	100%	$ 123,315.00	
SP609B4B	AASHTO Technical Services Programs	Other	Allison	FY 2016	$120,000	100%	$ 119,200.00	

Transportation Pooled Fund Studies

Project Number	Project Title	Lead Agency	Research Manager	Work Program	Funding	Transfer Completed?	FY 2016 Expenditures	Spotlight
TPF-5(054)	Maintenance Decision Support System (MDSS)	SD	Sharon	FY 2016	$25,000	Y	$25,000	
TPF-5(065)	Traffic Control Device (participation revisited on annual basis)	FHWA	Sharon	FY 2016	$10,000	Y	$10,000	
TPF-5(099)	Evaluation of Low Cost Safety Improvements (participation revisited on an annual basis)	FHWA	Sharon	FY 2016	$30,000	Y	$30,000	
TPF-5(176)	Traffic Simulaton & Analysis - FFY 2016	FHWA		FY 2016	$35,000	Y	$35,000	
TPF-5(198)	Urban Mobility Study	TX	Sharon	FY 2016	$25,000	Y	$50,000	
TPF-5(267)	Accelerated Performance Testing for the NCAT Pavement Test Track	AL	Sharon	FY 2016	$360,000	Y	$360,000	
TPF-5(279)	High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics (2nd year of a 3-year commitment)	FHWA	Sharon	FY 2016	$15,000	Y	$15,000	
TPF-5(285)	Standardizing the Lightweight Deflectometer (LWD) equipment for measuring the Modulus/Stiffness of Unbounded Soils and Aggregate tool as Compaction Quality Assurance Measures (QA)	MD	Sharon	FY 2016	$25,000	Y	$70,307	
TPF-5(299)	Improving the Quality of Pavement Surface Distress and Transverse Profile Data Collection and Analysis	FHWA	Sharon	FY 2016	$15,000	Y	$15,000	
TPF-5(305)	Regional and National Implementation and Coordination of ME Design	FHWA	Sharon	FY 2016	$10,000	Y	$10,000	
TPF-5(315)	National Accessibility Evaluation - Added 2/10/16	MN	Sharon	FY 2016	$200,000	Y	$200,000	
TPF-5(326)	Develop and Support Transportation Performance Management Capacity Development Needs for State DOTs - Added 2/10/16	RI	Sharon	FY 2016	$30,000	Y	$30,000	

2016 Research Highlights

SP409B4K – Intelligent Dilemma Zone Protection System at High-Speed Intersections

The objective of this project is to design, deploy, and evaluate an Intelligent Dilemma Zone Protection System (I-DZPS) that is capable of improving intersection safety by reducing side-angle crashes and rear-end collisions. These two types of crashes, plaguing many high-speed intersections, are likely due to drivers' decisions when they are trapped in their respective "dilemma zone," defined by the Institute of Transportation Engineers (ITE) as the space between two points on an approach to a signalized intersection, beginning at a point where approaching drivers—when shown a yellow display—will stop at the stop line of the intersection and ending where drivers—again, when shown a yellow display—will proceed through the intersection before the light turns red. Between these two points, drivers are faced with the dilemma of deciding whether to stop or proceed through the intersection. This is a dilemma because they may not be able to stop comfortably at the stop line, nor pass the intersection before the light turns red. Dilemma zones for drivers vary in location and length with vehicle approaching speeds, reaction times, and vehicle deceleration or acceleration constraints.

The I-DPZS was developed by the University of Maryland and deployed by SHA at US 40 and Red Toad Road in Cecil County, Maryland in 2012. The system can dynamically extend the all-red phase (every signal in all directions of the intersection is red, to provide additional clearance time, ranging from 0.5 to 3.0 seconds) when it detects a potential red-light running vehicle. It can also alert approaching drivers to reduce speeds with roadside sensors or variable message signs.

In this project, the improved version of I-DPZS was deployed at two high-speed rural intersections (US 40@Western Maryland Parkway and MD 213@Williams/Locust Point Road), and included the following principal components: (1) two wide-range sensors to track the speeds and locations of all vehicles within the identified dilemma zones; (2) software to predict the response of drivers during the yellow phase and to activate the all-red extension function if needed; and (3) a web-based module to monitor the system's performance from a control center or a designated remote location.

The intersection of US 40 and Western Maryland Parkway in Washington County, Maryland, is highlighted in this summary. The three-leg intersection is located where Western Maryland Parkway (three approaching lanes, two for left-turn and one for right-turn vehicles) ends at US 40, a four-lane divided highway with a posted speed limit of 55 mph. The neighboring intersections are about 1,400 feet and 4,500 feet away on either side along US 40 and the target approach has an on-ramp to I-81 700 feet upstream. There were 15 crashes recorded at this intersection between 2010 and 2012, and 12 of them were potentially related to the responses of drivers in the dilemma zone. This intersection's I-DZPS, activated in October 2016, includes one web-based monitoring module, two sensors on the eastbound US 40 for vehicle detection and all-red activation, and one sensor on westbound US 40 for green extension under actuated control (see Figure-1).

Results

Field evaluation of the deployed I-DZPS was conducted about one month after the system activation date, and real-time system monitoring and performance analysis was carried out with respect to the traffic flow characteristics impacts and the all-red extension activations.

Impact on the traffic flow characteristics-1: A comparison of the before-and-after distribution of the dilemma zones, varying mainly with each individual vehicle's approaching speed and accelerate/deceleration rate, is shown in Figure 1, where its maximum length was reduced from 960 feet to 670 feet, a 30% reduction. Total length of the dilemma zones weighted by traffic volume in each speed bin also showed a 40% reduction from 73 feet to 44 feet.

Impact on the traffic flow characteristics-2: The percentage of vehicles approaching the target intersection at a speed over 55 mph dropped from 29 to 16 percent. This could be due to the deployment of roadside wide-range sensors that are visible to approaching drivers.

Impact on the traffic flow characteristics-3: More drivers were observed making the conservative decision to "stop" during a yellow phase, compared with the driver decisions observed in the before-deployment period. For example, the percentage of drivers deciding to "pass" through the intersection during yellow phases at the speed of 45-55 mph and 300-400 feet from the stop line, were observed to decrease from 50 percent in the before-deployment period to 43 percent in the after-deployment period (see Figure 2).

Impact on the traffic flow characteristics-4: The deployment of the I-DZPS did not have an impact on aggressive drivers, often driving at speeds over the posted speed limit (see Figure 2). This seems to justify the need for all-red extensions which, would help prevent crashes between aggressive red-light running vehicles and vehicles entering from the cross street.

Detection rate for all-red extension: In the preliminary observation period of 312 signal cycles, the I-DZPS initiated extension calls in 99 cycles. 30% of those calls were false-positive, i.e., predicting that a passing vehicle would not clear the intersection when it actually did before the light turned red; perhaps because the driver accelerated. More importantly, the video taken at the target approach demonstrated that the I-DZPS successfully provided all-red extensions to the five observed red-light running instances, demonstrating the potential safety benefits to this type of system.

Long-term performance analysis to assess the impacts on traffic flow characteristics and safety will be completed in 2017.

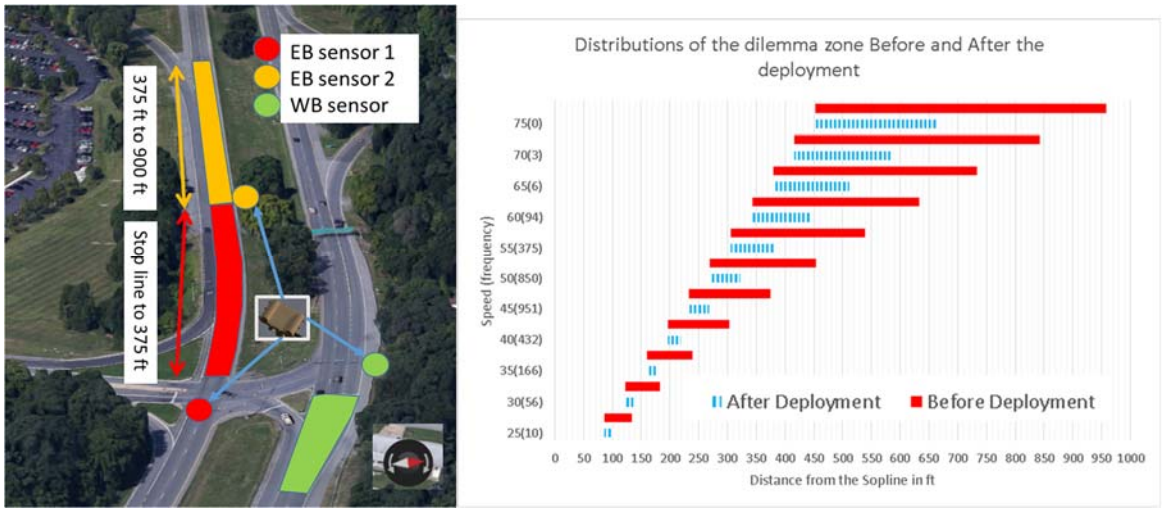


Figure 1: The intersection of US 40 and Western Maryland Parkway

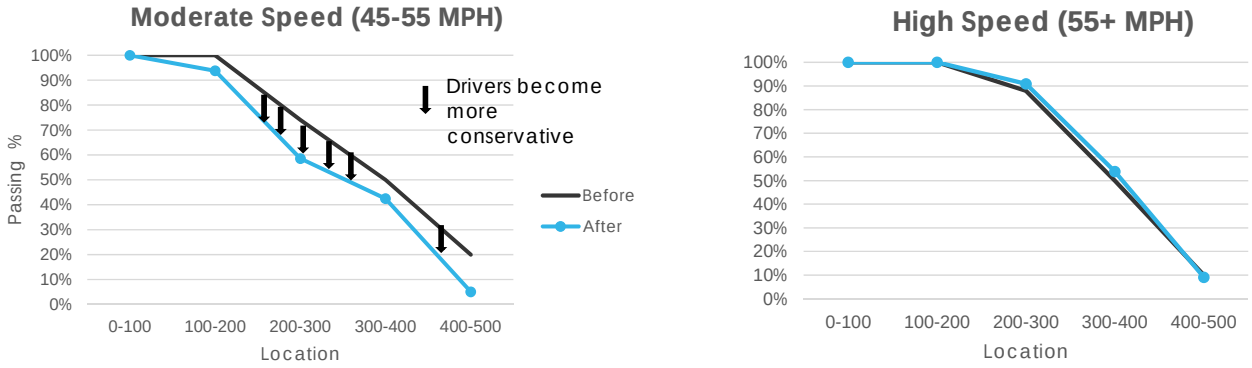


Figure 2: "before-and-after" comparison of % drivers deciding to pass

SP509B4M – Effectiveness of Nest Site Restoration for the Endangered Northern Map Turtle Report 2: Use of Artificial Nesting Sites and Wildlife Exclusion Fence to Enhance Nesting Success

The Northern Map Turtle is a 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 is in the town of Port Deposit. Turtles nesting in Port Deposit often cross a gravel parking lot with constant vehicular traffic to reach their nesting sites. Turtles may become disoriented by human disturbance and move away from the river, towards Maryland Route 222, the main roadway through the town. In addition, the soil in which the turtles are nesting is heavily compacted and turtles often abandon nest sites after unsuccessful nesting attempts.

The Port Deposit nesting site is the location for a new environmental education center dedicated to the Susquehanna River and its animal and plant life, including the Northern Map Turtle. The plans for the center call for establishment of a secured nesting area for Map Turtles that will be surrounded by a wildlife exclusion fence to prevent disturbance of female Map Turtles while they are nesting and protect the turtles from vehicle traffic and human interaction.

How Map Turtles will react to these rehabilitated sites and to restriction to their nesting sites is unknown. Turtles could seek to evade the wildlife fence, ignore the better soil types, or abandon the area entirely. Thus, the objectives of this project were to (a) test how female Map Turtles reacted to a wildlife exclusion fence, (b) whether females would make use of a series of artificial nesting mounds to improve soil conditions, and (c) whether confining females to a limited area resulted in higher levels of human disturbance. Figure 3 below shows the rehabilitated nesting sites and temporary wildlife fence. These data will be useful in establishing a set of “Best Practices” for future management of areas where human visitation via foot traffic impact threatened or endangered species.

Figure 3: Site photo showing rehabilitated nesting grounds at the Jacob Tome Gas House, along with the temporary wildlife fence.

Figure 4: Site photo of wildlife blind (at red arrow) at top right corner of Gas House

Observations from a wildlife blind (i.e. concealed shelter for viewing wildlife; see Figure 4) located adjacent to the wildlife fence indicated that some turtles attempted nesting outside the fence perimeter, especially early in the nesting season. Some females were observed entering the enclosed site and abandoning their attempt after walking along the perimeter of the fence and not being able to move beyond it. Although some females evaded the fence early in the season, most nests were dug within the fence perimeter and disturbance by visitors was minimal. Nest success was not quite as high as in previous years, possibly a result of poor drainage conditions around the fence. Data collected after the rehabilitation of the nesting grounds and the installation of the temporary drift fence in 2015 was compared with data collected from 2013-2014, specifically for (a) timing of nesting, (b) spatial distribution of nests, (c) timing of emergence of hatchlings, and (d) success of nests.

A total of 12 females were found attempting to nest during 2015, of which four nested successfully. The total of eight nests at Port Deposit in 2015 was comparable to the numbers seen in 2013 (eight nests) and 2014 (seven nests). Some turtles attempted nesting outside the wildlife fence, especially early in the nesting season. Some females were observed entering the enclosed site and abandoning their attempt after walking along the perimeter of the fence and not being able to move beyond it. Of the five nests constructed within the fence perimeter, three were built on or just adjacent to the nesting mounds that were placed to attract females to nest in better soil conditions, but two nests were built along the fence barrier itself. One of the five nests at the Gas House site was attacked and destroyed by a dog or a coyote in September 2015. This was the first recorded instance of a predator destroying a nest at Port Deposit. Of the remaining four nests at the Gas House site, two had high hatching success, producing 8 and 11 hatchlings, respectively.

Although sample sizes for post-rehabilitation nesting are small, certain conclusions can be drawn at this time:

- 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.
- 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.
- Female Map Turtles did successfully complete five nests within the perimeter of the temporary wildlife fence, although use of the rehabilitated soil types was limited.
- Despite the limited area available for nesting and considerable foot traffic in the vicinity of the nesting site, the research team found limited examples of human disturbance of nesting females. Additional public education would be valuable.

Recommendations of Best Practices

1) The total area of rehabilitated soils provided for nesting by female Map Turtles should represent a higher proportion of the total available nesting area. At least 25% of the total area available should consist of rehabilitated soils and such soils should be placed along the wildlife exclusion fence to a depth of at least 24” and extending at least 36” inside the fence line.
2) The nesting mounds provided in 2015 all were colonized by weeds during the 2015 nesting season. While some vegetative growth may be beneficial, control of this vegetation will be needed in future years to prevent excessive shading of the nest sites and to prevent root masses from destroying viable nests.
3) Careful attention needs to be paid to the drainage of water from storms at the nesting areas. Pooling of water at the wildlife exclusion fence could be responsible for destruction of nests by erosion or drowning of eggs.

The M**ap Turtle gets its name from the pattern on its shell that resembles the contour lines on a map.**

Figure 5: Map Turtle hatchlings

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