7th Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin

October 28-30, 2016

Fairhope, Alabama

WELCOME

Welcome to the 7th Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin! With this meeting, we continue the important work of coming together as a community of diamondback terrapin researchers, managers, and enthusiasts started by Whit Gibbons and Rich Siegel at the first Workshop on the Ecology, Status, and Conservation of the Diamondback Terrapin in 1994. Since then, Roger Wood, Joe Butler, Willem Roosenburg, Russ Burke, and Mike Dorcas have continued to foster our improved understanding of terrapins and the threats they face range wide, hosting five additional Symposia over the last 20 years. Our community has continued to grow and mature with the formation of the Diamondback Terrapin Working Group in 2004, joining a handful of other organizations dedicated to improving the status of a single wild turtle species and its habitat.

We're here because we are enamored with terrapins. We are fortunate to work with such a charismatic and unique species – one that challenges us to work harder to improve our scientific understanding of the species as a whole and the conservation needs of individual populations. We are also fortunate to work in a community that is large enough to take on the work of terrapin research, conservation, management, and education, but small enough that most of us know each other (or will soon). I feel fortunate to work with all of you – people who are passionate about terrapins, generous with your time and talent, supportive of your colleagues and students, and fun, friendly people all around.

This Symposium is a time to reflect on the work we've done, celebrate our accomplishments over the last three years, and plan for the future of diamondback terrapins. As we all know, they continue to need all the help they can get. I hope you meet someone new, learn something you didn't know about terrapins, take home with something fun from the auction, and relax a little while enjoying your time on the beautiful Gulf Coast. Go back to your work invigorated and ready to plan for the next 20 years of terrapin research and conservation ahead.

Warm Regards,

Christina Mohrman
2016 Meeting Organizer, DTWG Co-Chair

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Program at a glance

Friday, October 28

Baytreat, Point Clear

4:00 – 5:30pm DTWG Business Meeting

Chaufee's Catering and Courtyard, Fairhope

6:00 – 9:00pm Welcome Social

Saturday, October 29

Fairhope Civic Center, Fairhope

8:00 – 9:00am Registration and Continental Breakfast

9:00 – 12:00pm Morning Presentation Sessions

12:00 – 1:00pm Lunch

1:00 – 3:30pm Afternoon Presentation Sessions

3:30 – 5:00pm Poster Session

Baytreat, Point Clear

6:00 – 10:00pm Social and Reception

Sunday, October 30

Fairhope Civic Center, Fairhope

8:00 – 8:30am Continental Breakfast

8:30 – 12:00pm Morning Presentation Sessions and Discussion

12:00 – 1:00pm Boxed Lunch and Depart

DETAILED PROGRAM

FRIDAY, OCTOBER 28

Baytreat, Point Clear

4:00 – 5:30PM DTWG BUSINESS MEETING

Chaufee's Catering and Courtyard, Fairhope

6:00 – 9:00PM WELCOME SOCIAL

SATURDAY, OCTOBER 29

Fairhope Civic Center, Fairhope

8:00 – 9:00AM REGISTRATION AND CONTINENTAL BREAKFAST

9:00 – 12:00PM WELCOME AND MORNING PRESENTATIONS

9:00 **Welcome**
Christina Mohrman, Co-Chair, Diamondback Terrapin Working Group

9:15 **Updating the IUCN Red List assessment of the Diamondback Terrapin**
Peter Paul van Dijk, Turtle Conservation Program Director, Global Wildlife Conservation

Presentation Session I – Research I
Moderator: Russell Burke, Past Co-Chair

*Student Presenter

9:45 **Identifying diamondback terrapin nesting habitat in the Nueces Estuary, Texas**
Aaron S. Baxter, Center for Coastal Studies at Texas A&M University

10:00 **Testing roadside barrier effectiveness to decrease diamondback terrapin (*Malaclemys terrapin*) mortality on a southern New Jersey causeway**
*Kimberly B. Lull, Green Mountain College

10:15 **Using a surrogate species to assess diamondback terrapin nesting beach quality in Alabama**
*Taylor M. Roberge, University of Alabama at Birmingham

10:30 Break

Presentation Session II – Research II
Moderator: Amanda Willard, Junior Co-Chair

*Student Presenter

10:45 **Reproductive ecology of Mississippi diamondback terrapins (*Malaclemys terrapin pileata*) in the northern Gulf of Mexico**
Andrew T. Coleman, Birmingham Audubon Society

11:00 **Tarmac terrapins: comparing two populations of diamondback terrapins (*Malaclemys terrapin*) in New York City's Jamaica Bay**
*Melissa E. Zostant, Hofstra University, Port Authority of NY & NJ

11:15 **Geographic variation in hatchling *Malaclemys* freeze tolerance**
*Arthur M. Calichio, Hofstra University

11:30 **Evolutionary history and aleontological record of the diamondback terrapin (Emydidae: *Malaclemys terrapin*)**
Dana Ehret, Alabama Museum of Natural History

11:45 **The use of recreational GPS logger and drone technology to study diamondback terrapins near Jekyll Island, GA**
*Davide M. Zailo, University of Georgia

12:00 – 1:00PM LUNCH

1:00 – 3:30PM AFTERNOON PRESENTATION SESSIONS

Presentation Session III – Management
Moderator: Thomas Mohrman, Gulf Coast Regional Representative

1:00 **The Northern diamondback terrapin (*Malaclemys terrapin terrapin*) in the northeastern United States: a regional conservation strategy**
Stephanie Egger, formerly Conserve Wildlife Foundation of New Jersey

1:15 **Encouraging fisheries cooperation in conservation of the diamondback terrapin in Mississippi**
Harron Q. Wise, Mississippi Department of Marine Resources

1:30 **Toward a better bycatch reduction device: BRD modifications enhance terrapin exclusion without reducing blue crab catch rates in South Carolina**
Jeffrey A. Schwenter, Marine Resources Division, South Carolina Department of Natural Resources

1:45 **Identification and retrieval of derelict crab pots to reduce bycatch in Barnegat Bay**
Stephanie Egger, formerly Conserve Wildlife Foundation of New Jersey and John Wnek, Marine Academy of Technology and Environmental Science

2:00 **Terrapin restoration at Poplar Island**
Willem Roosenburg, Ohio University

2:15 Break

Presentation Session IV – Conservation and Education
Moderator: Willem Roosenburg, Past Co-Chair

2:30 **Factors associated with historical trends in the occurrence of Texas diamondback terrapin (*Malaclemys terrapin*)**
George J. Guillen, Environmental Institute of Houston, University of Houston Clear Lake

2:45 **Establishing partnerships to conduct preliminary sightings of diamondback terrapins in Florida's Central Indian River Lagoon**
Nancy K.P. Ho, Coastal Biology, Inc.

3:00 **Combining citizen science and traditional research reveals regional trends in northeastern diamondback terrapin populations**
Russell Burke, Hofrstra University

3:15 **Expanding understanding of diamondback terrapin populations using citizen science and smartphones: a proposal for working together**
Sarah A. Finn, North Carolina Wildlife Resources Commission

3:30 – 5:00PM POSTER SESSION

*Student Presenter

Fighting the turtle extinction crisis with state laws: the diamondback terrapin's bright future
Elise P. Bennett, Center for Biological Diversity

Decomposition rate of the diamondback terrapin (*Malaclemys terrapin*) in crab pots
*Olivia Brooks, Ohio University

Effect of rainfall on predation of diamondback terrapin (*Malaclemys terrapin*) nests
*Rebecca Czaja, Northeastern University Marine Science Center

The telltale of turtles: cues used by raccoons to find diamondback terrapin nests
*Sarah Edmunds, Miami University, Wildlife Conservation Society

Detecting movements of northern diamondback terrapins (*Malaclemys t. terrapin*) in a southern New Jersey salt marsh using sonic telemetry
Lisa M. Ferguson, The Wetlands Institute

Dietary study of Ornate diamondback terrapins (*Malaclemys terrapin macrospilota*) inhabiting the Cedar Keys, Florida
Cypres R. Ferran, Department of Natural Sciences, Flagler College

Predator deterrent fences in MDMR's Hancock County Marshes Coastal Preserve
Jennifer Frey, Mississippi Department of Marine Resources

To BRD or not to BRD
S. Patrick Grubbs, College of William and Mary

Survey of diamondback terrapin (*Malaclemys terrapin*) populations and nesting sites in Georgia - 2015 and 2016
*T.A. Heckman, Biology Department, University of North Florida

Turtles rocking on the half shell: presence of diamondback terrapin nesting in the Rockaways
Alexandra Kanonik, WildMetro

Approaches to increase awareness of diamondback terrapins through education and outreach efforts in a southern New Jersey community
*Kimberly B. Lull, Green Mountain College

Why did the terrapin cross the road and what can you do about it? Advances in road management for diamondback terrapin conservation
John C. Maerz, University of Georgia

An American terrapin in Bermuda: Flagler College Expedition 2016
Madeline L. Musante, Department of Natural Sciences, Flagler College

Monitoring the status of diamondback terrapins in the Florida panhandle
Lawrence R. O'Connor, Florida Sea Grant, University of Florida/IFAS Extension

Evaluation of maternal investment in offspring of the diamondback terrapin (*Malaclemys terrapin pileata*): Egg size and Growth
Tandy Dolin Petrov, Department of Biology, University of Alabama at Birmingham

Does elevated salinity induce a physiological response in Texas diamondback terrapin (*Malaclemys terrapin littoralis*)?
*Lindsey C. Ramirez, Texas A&M University-Corpus Christi

Mississippi Derelict Crab Trap Program
Bill Richardson, Mississippi Department of Marine Resources

Demographics, distribution, and genetic variation in the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) within the Corpus Christi and Aransas Bay systems
*Shantel L. Swierc, Texas A&M University-Corpus Christi

Within and among year variation in reproductive output from two populations of the diamondback terrapin, *Malaclemys terrapin*
*Alayna F. Tokash, Ohio University

Effects of buoyancy on diving performance of juvenile northern diamondback terrapins (*Malaclemys t. terrapin*)
*Wolfgang N. Trumbauer, Widener University

Estimating hatchling sex ratios in northern diamondback terrapins (*Malaclemys t. terrapin*) from nest cavity temperature
*Wolfgang N. Trumbauer, Widener University and The Wetlands Institute

Evaluating population characteristics of northern diamondback terrapins (*Malaclemys t. terrapin*) within two neighboring saltmarsh creeks in southern New Jersey
*Charles P. Williams, Jr., Stockton University and The Wetlands Institute

Barnegat Bay turtle gardens: supporting shorelines to safeguard terrapins for sea-level rise
John P. Wnek, Marine Academy of Technology and Environmental Science

New Jersey's Terrapins: Two Pathways to Protection
John P. Wnek, Marine Academy of Technology and Environmental Science

Baytreat, Point Clear

6:00 – 10:00PM SOCIAL AND RECEPTION

2016 TERRAPIN CONSERVATION AWARD
BEST STUDENT ORAL AND POSTER PRESENTATION AWARDS
SILENT AUCTION TO SUPPORT DTWG GRANTS PROGRAM

SUNDAY, OCTOBER 30

Fairhope Civic Center, Fairhope

8:00 – 8:30AM CONTINENTAL BREAKFAST

8:30 – 12:00PM MORNING PRESENTATION SESSIONS AND DISCUSSION

Presentation Session V – Research III
Christina Mohrman, Senior Co-Chair

8:30 **Insights into the population ecology of Ornate diamondback terrapins (*Malaclemys terrapin macrospilota*) in the Cedar Keys, Florida**
Benjamin K. Atkinson, Flagler College

8:45 **Nesting activity and survival in a marked population of adult and head-started northern diamondback terrapins (*Malaclemys t. terrapin*) in southern New Jersey**
Brian Williamson, The Wetlands Institute

9:00 **Low hatching success appears to be a consistent feature for Bermuda's diamondback terrapins**
Mark E. Outerbridge, Department of Environment and Natural Resources, Bermuda Government

9:15 **Evaluation of diamondback terrapin (*Malaclemys terrapin*) nesting ecology throughout coastal Louisiana**
Steven H. Pearson, Louisiana Department of Wildlife and Fisheries

9:30 **Concentrations and nest requirements of Carolina diamondback terrapins in northeast Florida**
Joseph A. Butler, Biology Department, University of North Florida

9:45 **Assessing sea level rise and future habitat availability for diamondback terrapins in Maryland**
Christopher L. Rowe, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory

10:00 Break

10:15 **Discussion of IUCN Red List Update**
Moderator: Peter Paul van Dijk

11:00 **Next Steps and Final Wrap-up**
Moderator: Christina Mohrman

12:00 – 1:00PM BOXED LUNCH AND DEPART

Insights into the population ecology of Ornate diamondback terrapins (*Malaclemys terrapin macrospilota*) in the Cedar Keys, Florida

Atkinson, Benjamin K. (BAtkinson@flagler.edu), Flagler College

Coleman M. Sheehy III, Department of Biology and Seahorse Key Marine Laboratory, University of Florida; Steven A. Johnson, Department of Wildlife Ecology and Conservation, University of Florida; and Edward J. McGinley, Department of Natural Sciences, Flagler College

The ornate diamondback terrapin (*Malaclemys terrapin macrospilota*) is endemic to coastal salt marsh and estuarine habitats of Florida's Gulf coast. In 2013, *Malaclemys* was added to CITES Appendix II due to concern over extensive habitat loss, road mortality, incidental drowning in fishing gear, and trade for food and pets. Following a distributional survey completed by colleagues in 2009, we initiated an ecological investigation of *M. t. macrospilota* in Florida's "Big Bend" region. The Big Bend covers roughly 350 kilometers along Florida's least developed stretch of coastline. Prior to our study, little was known about the population of this species in the region. We are conducting our study within the Cedar Keys National Wildlife Refuge (CKNWR), located south of the Suwannee River mouth on Florida's Gulf Coast. We have permanently marked terrapins with PIT tags, and are collecting data on population size and demographic structure, habitat use, and dietary preferences. Preliminary results suggest that these terrapins exhibit considerable site fidelity, recruitment, and heterogeneity in habitat use within the region. Due in part to our ongoing study, the CKNWR population was deemed one of three statewide "Sentinel Populations" by the Florida Fish and Wildlife Conservation Commission, which is reviewing diamondback terrapins for state listing. Herein, we present a current overview on reproductive phenology, demographic structure, and estimated population size for our initial area of focus. Our longer-term goals include using genetic and mark-recapture methods to investigate metapopulation dynamics, inter-island movements and to determine significant threats to terrapin survival in the Big Bend.

Oral Student Presentation: No

Identifying diamondback terrapin nesting habitat in the Nueces Estuary, TX

Baxter, Aaron S. (aaron.baxter@tamucc.edu), Center for Coastal Studies at Texas A&M University-Corpus Christi

It is imperative to identify nesting sites so that they can be preserved as functional habitat. Bulk heading and other forms of hardened shorelines associated with coastal development restrict access to nesting areas. Wind and wave driven erosion can reduce the area available for nesting. Terrapins exhibit nest site fidelity, meaning they return to the same

nesting beaches each year. If these areas are altered or made unavailable, recruitment becomes limited and the population may eventually become extirpated. Several methods were used to locate nesting beaches in the Nueces Estuary including the use of trail cameras, radio and acoustic telemetry, and walking surveys. All methods contributed to the eventual discovery of terrapin nesting sites. Results of this study showed that diamondback terrapins utilize elevated areas of vegetated shell hash as nesting sites in the Nueces Estuary. These areas exist as narrow bands of substrate sandwiched between the open bay and tidal marsh. Because of the scarcity of this habitat type in the Nueces Estuary it is suggested that these areas first be protected from erosive wave action and then enhanced to provide larger areas of suitable nesting habitat. The creation of additional nesting sites could also provide more appropriate nesting habitat. Predator removal/relocation during the nesting season may also prove to increase nesting success for this species. It is also recommended that the nesting habitat characterization described in this report, be applied to other Texas estuaries to identify diamondback terrapin nesting sites throughout the state.

Oral Student Presenter: No

Fighting the turtle extinction crisis with state laws: the diamondback terrapin's bright future

Bennett, Elise P. (ebennett@biologicaldiversity.org), Center for Biological Diversity

Turtle populations in the United States are declining in the face of varied threats, and the diamondback terrapin (*Malaclemys terrapin*) is no exception. Terrapins face generalized threats from climate change, sea-level rise, and habitat destruction; as well as acute impacts from unrestrained harvest and crab-pot mortality. The impacts from unchecked overharvest and bycatch have caused abrupt, conspicuous declines in terrapin populations, indicating a pressing need for regulatory intervention. Though state laws may not be well-suited to address certain large scale threats like climate change, they have proven to be excellent tools to curb the localized impacts of overharvest in the absence of federal protection. Virtually every state in the U.S. has adopted a "wildlife trust doctrine" into its state statutes, which endows the state with powers and duties to protect wildlife for the benefit of the people. Over the last decade, some states within the terrapins' range have banned its commercial harvest using this power, resulting in a conservation benefit to the species. Like overharvest, crab-pot mortality is a significant threat with localized effect; however, bycatch reduction devices (BRDs) can significantly reduce the level of terrapin mortalities in crab pots with minimal effect on the number of crabs captured. States can and should implement state regulations requiring BRDs to address the impacts of crab-pot mortality. This poster provides a nationwide survey of existing state laws pertaining to diamondback terrapins, the legal rationale for wildlife laws in every state, and model language for a rule requiring BRDs on crab pots.

Poster Student Presenter: No

Decomposition rate of the diamondback terrapin (*Malaclemys terrapin*) in crab pots

Brooks, Olivia L. (ob969413@ohio.edu), Ohio University

Alayna Tokash, Ohio University and Willem Roosenburg, Ohio University

Commercial crabbers in the Maryland waters of the Chesapeake Bay fish with crab pots annually from 1 April to 15 December. Efforts to recover abandoned crab pots and record their contents while the fishery is closed have rarely documented the remains of diamondback terrapins (*Malaclemys terrapin*) despite well-established high rates of terrapin crab pot captures. This study provides one explanation why *M. terrapin* remains are rarely recorded during crab pot roundups. To avoid catching additional terrapins, we placed deceased terrapins inside crab pots containing bycatch reduction devices (BRDs) and recorded daily their decomposition rate on a scale of one to six: fresh (1), odor present (2), decomposition of flesh (3), decomposition of shell (4), deossification (5), and degradation of scutes (6). We conducted our study in July with water temperatures of 27°C and above. Our results show that younger *M. terrapin* individuals (< five years) decompose completely within four to five days while older individuals (> four years) decompose within five to seven days. These results suggest that the finding of *M. terrapin* carcasses is rare due to their high decomposition rate, which is much higher than expected given the apparent perception of the durable nature of the turtles' shells. A second experiment replicating our methods will be conducted in the early fall as water temperatures begin to decline. These results will be included.

Poster Student Presenter: Yes

Combining citizen science and traditional research reveals regional trends in northeastern diamondback terrapin populations

Burke, Russell L. (Russell.L.Burke@hofstra.edu), Hofstra University

Stephanie Egger, formerly Conserve Wildlife Foundation of New Jersey; A. Brett Bragin, New Jersey Sports and Exposition Authority; Barbara Brennessel, Wheaton College; Michael Farina, Marine Nature Study Area, Department of Conservation and Waterways, Town of Hempstead, NY; Alexandra Kanonik, WildMetro; Drew P. McQuade, New Jersey Sports and Exposition Authority; Noga Neeman, Department of Biology, Hofstra University; Charlotte B. Sornborger, Barrington Land Conservation Trust; John Wnek, Marine Academy of Technology and Environmental Science

Conservation of wide-ranging species is especially difficult because the necessary population trend data are usually very difficult to collect in a robust manner. Thus, it is possible for species to undergo dramatic declines before region-wide or range-wide changes are detected. The diamondback terrapin (*Malaclemys terrapin*) inhabits ca. 6000 km of U.S. Atlantic and Gulf salt marshes and mangrove ecosystems from Massachusetts to

Texas. Despite increased scientific and conservation interest in this species, terrapin population trend data are only available from a few small scale analyses and from qualitative surveys. Here we combine long term mark-recapture data collected by citizen science and more traditional academically-based projects from six terrapin populations in the northern portion of the terrapin range, spanning 16% of the species' range. The sites differ in terms of conservation issues, primarily nest protection and local habitat loss. We detected significant declines in two populations and more moderate declines at two more. There were overall significant increases in the number of nesting adults at two sites, but even these experienced dramatic declines in the last decade. We conclude that diamondback terrapins are extremely vulnerable in the northern portion of their range.

Oral Student Presenter: No

Concentrations and nest requirements of Carolina diamondback terrapins in northeast Florida

Butler, Joseph A. (jbutler@unf.edu), Biology Department, University of North Florida

Daniel P. Murphy and J. David Lambert, University of North Florida

The major objective of this study was to locate population concentrations and nesting areas of Carolina diamondback terrapins in the four northeastern-most counties of Florida (Nassau, Duval, St. Johns, and Flagler). We used head counts from the boat and walking surveys of shorelines and high spots that could possibly support nesting in order to establish terrapin presence. During the walking surveys we searched for crawls, intact and raided nests, live terrapins, dead terrapins, and terrapin bones. In an effort to evaluate whether woody plant presence affected nest site choices, we recorded the occurrence of 10 common woody species during each walking survey and compared areas where nesting did and did not occur. Further, to determine if soil characteristics influenced nesting we analyzed soil samples from most places we stopped. We collected 410 terrapin records in 2013 and 2014. Most were from Nassau County (281) and only two are from Flagler County. Most records were in the form of depredated nests (213) and we captured only four live terrapins. The woody plant data suggested that significantly more nesting occurred when Christmas Berry (*Lycium carolinianum*) was present, and nesting was less likely when either Wax Myrtle (*Myrica cerifera*) or Oak (*Quercus* spp.) were present. In the soils, those with high levels of potassium were more frequently used for nesting than those with low levels, however concentrations of sodium and phosphorus and pH levels did not differ between nesting and non-nesting samples. Data for soil grain size is still being evaluated.

Oral Student Presenter: No

Geographic variation in hatchling *Malaclemys* freeze tolerance

Calichio, Arthur M. (acalichio@optonline.net), Hofstra University

Russel L. Burke, Hofstra University

Hatchlings of some turtles are known to overwinter terrestrially, thus exposing themselves to harsh environmental temperatures. Diamondback terrapins (*Malaclemys terrapin*) display a full range of overwintering behavior; some overwinter in the nest, some overwinter terrestrially outside the nest, and some overwinter in the water. This species spans a wide range of winter conditions from latitude 41.67° to 27.80° N. Hatchlings from one northern population are known to be freeze tolerant; however freeze tolerance along the north-south gradient is unexplored. To determine if freeze tolerance differs in relation to geographic variations within this species, freshly laid eggs were collected from populations from New York to Florida. Following hatching specimens were cooled in a dark incubator for four months, then tested for freeze tolerance in a separate incubator, and checked for mortality. Freeze tolerance at subzero temperatures was demonstrated in the southern *M. terrapin* populations to a degree that was comparable to the northern populations. All represented populations had a significant majority of specimens that demonstrated freeze tolerance, with specimens from the New Jersey and Florida populations experiencing no mortality. It was demonstrated that freeze tolerance does subsist in warmer southern populations throughout the geographic gradient. Further studies will be needed to determine if freeze tolerance subsists in populations that were unexplored, with an emphasis on the Gulf Coast populations.

Oral Student Presenter: Yes

Reproductive ecology of Mississippi diamondback terrapins (*Malaclemys terrapin pileata*) in the northern Gulf of Mexico

Coleman, Andrew T. (andycoleman@birminghamaudubon.org), Birmingham Audubon Society

Taylor Roberge, University of Alabama at Birmingham; Thane Wibbels, University of Alabama at Birmingham; Ken Marion, University of Alabama at Birmingham; and Jonathan L. Pitchford, Mississippi Department of Marine Resources, Grand Bay NERR

A long-term conservation study of Mississippi diamondback terrapins in Alabama provided an opportunity to study the reproductive ecology of this Gulf of Mexico subspecies. A head-start project was initiated in 2007, and adult females were trapped while accessing the nesting beach. Oxytocin was administered to gravid females to induce egg deposition. Additional data from a Mississippi population of *M. t. pileata* were included in the present study to allow for comparison. Clutch sizes of gravid females from Mississippi were assessed using X-radiography. Average clutch size observed in the Alabama population (n = 95) was smaller ($\bar{X}$ = 7.6 ± 2.1 eggs, 1–12) than that observed in the Mississippi population (n = 8, $\bar{X}$ =

10.4 ± 2.5 eggs, 7–14). The observed difference could have been from the obvious disparity of sample sizes between the two populations; however, the sampled Mississippi females ($\bar{X}$ = 1443.6 ± 274.6 g) were larger than those from the Alabama population ($\bar{X}$ = 1158.1 ± 196.1 g). Clutch sizes were more strongly correlated to female size in the Mississippi population (R^2 = 0.70) than in the Alabama population (R^2 = 0.04). The absence of larger adult females in Alabama is most likely the result of unnatural mortality and has negative impacts on the total reproductive potential of this population.

Oral Student Presenter: No

Effect of rainfall on predation of diamondback terrapin (*Malaclemys terrapin*) nests

Czaja, Rebecca A. (raczaja@gmail.com), Northeastern University Marine Science Center

Alexandra Kanonik, WildMetro and Russell L. Burke, Hofstra University

Some turtle species, including diamondback terrapins (*Malaclemys terrapin*), often nest before and during rainstorms. We tested the hypothesis that rain may reduce the chemical and/or visual cues that predators use to locate turtle nests, decreasing the likelihood nests will be depredated by analyzing the impact of rainfall on predation rates of terrapin nests in the Jamaica Bay Wildlife Refuge, NY from June - August, 2016. Real and artificial nests built on days with varying amounts of rain were observed for 5 days. Rain on the night of oviposition significantly decreased the rate of depredation on real nests but not on artificial nests made with plain sand or terrapin-scented sand. However, there was a significant inverse correlation between the amount of rain and predation rates on both real nests and artificial nests constructed with plain sand. Nests laid or constructed on days when there was heavy rain were less likely to be depredated after five days than nests built on days with light or no rain. Only four out of 93 artificial nests made with terrapin-scented sand remained intact. These results show that nesting on the day of heavy rainfall events may decrease predation on terrapin nests.

Poster Student Presenter: Yes

The telltale of turtles: cues used by raccoons to find diamondback terrapin nests

Edmunds, Sarah E. (Edmundse@miamioh.edu), Miami University, Wildlife Conservation Society

Christine Kasparov, Department of Biology, Hofstra University; Alexandra Kanonik, WildMetro; and Russell L. Burke, Department of Biology, Hofstra University

Nest predation by raccoons (*Procyon lotor*) is the primary cause of mortality of diamondback terrapins (*Malaclemys terrapin*) in New York's Jamaica Bay Wildlife Refuge. We replicated the methods of Burke et al. (2005) to test whether a decade of conservation efforts had resulted in a change in raccoon predation behavior. We created artificial diamondback terrapin

nests in the sand and mixed grassland habitats of Ruler's Bar Hassock during the 2016 nesting season. We mimicked the nine types of artificial nest designs as described by Burke et al. and added a new treatment type for further investigative purposes, creating at least sixteen nests for each treatment. The various treatments were designed to test the effects of moisture, human scent, terrapin scent, ocean water scent, fresh water scent, soil disturbance, and flag markers on nest predation. Artificial nests were monitored for signs of raccoon digging for four days following construction, and were considered "depredated" if raccoon digging was noted anywhere between the flags. Supporting Burke et al.'s findings, we found that marking nests with flags did not affect predation rates. However, contrary to their findings that human scent decreased predation rates, we found that nests with human scent had high predation rates, similar to other treatments in which a hole was dug. We conclude that after a decade of conservation work at this site, raccoons seem to no longer be repelled by human scent, and continue to locate nests primarily based on soil disturbance, not visual markers, moisture, or olfactory cues.

Poster Student Presenter: Yes

The Northern diamondback terrapin (*Malaclemys terrapin terrapin*) in the northeastern United States: a regional conservation strategy

Egger, Stephanie (stephanie.egger@gmail.com), formerly Conserve Wildlife Foundation of New Jersey

The development of a regional, landscape level, multi-partner conservation strategy that focuses on the conservation, management, and protection of the Northern diamondback terrapin and its habitat in the Northeast has just been completed. The Strategy will help achieve long-term sustainability of the terrapin from Massachusetts to Virginia. We identified species occurrence and data gaps, locations for regional and individual state management, ranked threats, and reviewed the regulatory status in each state. The final report describes a strategic initiative for implementation of conservation actions across the region. We generated the first regional scale distribution model for the northern diamondback terrapin by synthesizing disparate, wide-ranging occurrence data gathered from over 50 sources. The model serves as a foundation from which conservation questions can be asked and management actions can be developed and implemented. One use of the regional model is the ability to identify and evaluate poorly documented areas, which may have fallen outside the jurisdictions of local conservation efforts. Other data gaps, such as the lack of confirmed terrapin occurrences in areas predicted suitable by the model, may become candidate locations for additional field investigations that would allow for more refined delineations of suitable habitat and provide explanations for these unoccupied areas. Conservation applications can be derived from the model at multiple scale levels (e.g. county, state, regional) depending on management goals. Among the topics that can be investigated using this model are evaluation of priority areas for conservation, threat assessments of anthropogenic stressors, and the effects of sea level rise.

Oral Student Presenter: No

Identification and retrieval of derelict crab pots to reduce bycatch in Barnegat Bay

Egger, Stephanie (stephanie.egger@gmail.com), formerly Conserve Wildlife Foundation of New Jersey

John Wnek, Marine Academy of Technology and Environmental Science

The Conserve Wildlife Foundation of New Jersey (CWFNJ) and partners received a NOAA Marine Debris Program Community-Based Marine Debris Removal Grant to conduct derelict crab pot removal in Barnegat Bay, N.J. to benefit diamondback terrapins (*Malaclemys terrapin terrapin*), blue crabs (*Callinectes sapidus*) and other NOAA trust resources. Over two years, CWFNJ and partners - the Marine Academy of Technology and Environmental Science, Monmouth University, Stockton University, ReClam the Bay, and the local recreational and commercial fishing community will identify, retrieve, and inventory more than 1,000 derelict crab pots from Barnegat Bay. After Year 1, there were 79 commercial-style traps retrieved (as denoted by rebar and pieces with tags) out of the 363 crab pots collected (this includes all recognizable objects considered crab pots). Seventy-four of the pots contained bycatch. Rock crabs (*Cancer irroratus*), followed by American eel (*Anguilla rostrata*) and oyster toadfish (*Opsanus tau*) were the most commonly caught live bycatch. Spider crabs (*Libinia emarginata*) and blue crabs were the most commonly caught dead bycatch. Eight diamondback terrapins were found dead in crab pots adjacent to the salt marsh. The project includes outreach and education components such as decals, a targeted brochure to reach the recreational fishing community, school presentations, a lesson plan and a specialized marine debris program for students. The project will also survey the commercial and recreational fishing community to gather information on the percentage of pots lost annually to help develop a long-term reporting system for derelict pots and bycatch observed.

Oral Student Presenter: No

Evolutionary history and aleontological record of the diamondback terrapin (Emydidae: *Malaclemys terrapin*)

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Diamondback terrapins (*Malaclemys terrapin*) are not well represented in the fossil record. The paucity of material is likely the result of the terrapin's narrow ecological distribution to coastal salt marshes, estuaries, tidal creeks, and mangroves along the Atlantic and Gulf shorelines of the United States. Shorelines have shifted dramatically over time, which

diminishes the likelihood of terrapin fossil recovery. Pleistocene glacial/interglacial cycles can deposit fossils of near shore organisms offshore under oceanic waters, or inshore up freshwater rivers and streams flowing out toward brackish habitats. Further, additional material undoubtedly remains unidentified, or misidentified in natural history collections. The recent appearance of known terrapin fossils (Late Pleistocene [Rancholabrean] and Holocene) limits our knowledge of the evolutionary and paleontological history of the genus. No earlier records of *Malaclemys* or *Malaclemys*-like taxa have been recovered. Here we discuss and describe materials recovered from Edisto Beach, South Carolina, Andrews Island/ South Brunswick River, Georgia, the Aucilla and Wekiva Rivers, Florida, Orleans County, Louisiana, and a Holocene shell and postcranial elements from Bermuda. Stateside specimens represent isolated carapacial bones from a number of different individuals. The Bermudian fossil represents a more complete skeleton, including some appendicular material. The fossils are identified as *Malaclemys* based on the features of scute sulci and the presence of annuli scars on most specimens. This report presents an established range for the genus in the southeastern United States during the Late Pleistocene, and suggests the types of localities where new material is likely to be encountered.

Oral Student Presenter: No

Detecting movements of northern diamondback terrapins (*Malaclemys t. terrapin*) in a southern New Jersey salt marsh using sonic telemetry

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Steven Wesolowski, George Mason University; Homer Wesolowski, The Wetlands Institute; Brian Williamson, The Wetlands Institute; Ralph Boerner, The Wetlands Institute; and Roger Wood, Stockton University and The Wetlands Institute

Behavior and movements of northern diamondback terrapins in salt marshes are notably challenging to study. From 2005-2009, sonic telemetry transmitters were deployed on terrapins to facilitate exploration of individual movements and habitat use in the salt marshes of southern New Jersey. Detections were recorded from April-December by 11 receivers distributed in 25 locations within a network of creeks, covering approximately 450 ha of salt marsh. Telemetry devices were affixed to 67 terrapins during the project, including 64 females (adult=56, juvenile=2, head-started juvenile=6), one adult male, and two unsexed terrapins. Detections were recorded in all study months and at all hours of the day, peaking in August and in the early morning hours across all years. Altogether, over 300,000 detections were recorded (median=1,004 detections/individual). Consecutive detections were converted into movements, either directional (i.e. between receivers) or stationary (i.e. at the same receiver), resulting in over 17,300 total moves. A visualization program was developed to display individual terrapin movements and explore a number of explanatory variables. Terrapins moved widely within the study area, though individual variation in habitat use was apparent. Direction of movement appeared to be influenced by tidal cycle, with more

movements in the direction of current during flow and ebb tides, and also by time of day. For example, upstream movements peaked in the morning hours (05:00-10:00), possibly as terrapins moved to foraging and basking locations. Though underlying factors are not yet clear, early results confirm the value of understanding individual movements and habitat use.

Poster Student Presenter: No

Dietary study of Ornate diamondback terrapins (*Malaclemys terrapin macrospilota*) inhabiting the Cedar Keys, Florida

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Diamondback terrapins consume a variety of estuarine and marine gastropods, bivalves, and crustaceans throughout their range. However, relatively little is known about the diet of this subspecies in the Gulf of Mexico. The goal of this study is to elucidate which taxa juvenile and adult ornate diamondback terrapins in this region preferentially exploit as prey. We studied an insular population inhabiting the Big Bend region of Florida's Gulf Coast within Cedar Keys National Wildlife Refuge. Forty-two fecal samples were passively obtained from different individuals of both sexes as well as various size classes to observe dietary preferences. Terrapins were placed individually into bins of fresh water to soak, which generally stimulated defecation. Fecal samples were strained, stored individually in 95 % EtOH, and analyzed using a dissecting microscope. We used a volumetric displacement method to characterize the relative abundance of various prey items per individual terrapin and to determine which food sources terrapins are selectively exploiting. Terrapins consumed relatively large numbers of crustaceans (e.g., decapods and barnacles) and marine gastropods, and prey size tended to increase with increased size of terrapins, with large females occasionally consuming mature Atlantic blue crabs (*Callinectes sapidus*). We also observed evidence of incidental consumption of submerged aquatic vegetation, presumably linked to secondary consumption of prey attached to plant surfaces. We are currently exploring whether dietary preferences shift ontogenetically – and how sexual size dimorphism plays a role in differential selection of prey items.

Poster Student Presenter: No

Expanding understanding of diamondback terrapin populations using citizen science and smartphones: a proposal for working together

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Hope Sutton, NC Coastal Reserve and National Estuarine Research Reserve; and Marie Davis, NC Coastal Reserve and National Estuarine Research Reserve

Diamondback terrapins (*Malaclemys terrapin*) are listed as a state species of concern in North Carolina, yet distribution throughout the state's large estuarine systems is not well known. In an effort to identify areas of terrapin presence and relative abundance around the Masonboro Island Reserve, a citizen-science project was launched in 2014. The "Terrapin Tally" project is a snapshot approach, using trained volunteers to conduct head-count surveys by kayaking along pre-mapped routes on specific dates and times. In its first three years, the Terrapin Tally engaged over 230 volunteers contributing over 1200 hours of volunteer effort to record over 230 terrapin observations around Masonboro Island. Data collected during these surveys has provided resource managers with an early indication of a potential drop in relative terrapin numbers that may be related to increased blue crab fishing in the area. Observations are recorded using a smartphone application developed by Murdoch University in Western Australia. While not developed specifically for our purposes, the Coastal Walkabout mobile application allowed citizens to record time and location of terrapin observations, as well as track effort. We present a summary of the data collected during the Terrapin Tally from 2014-2016 and suggest that this approach is an effective way to gather data to understand relative abundance of terrapins while also engaging citizens. With cooperation and resources from Diamondback Terrapin Working Group members, we propose developing a dedicated Terrapin Tally mobile application to aid in data collection throughout the species' range.

Oral Student Presenter: No

Predator deterrent fences in MDMR's Hancock County Marshes Coastal Preserve

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Ali Leggett, MS Department of Marine Resources

The Mississippi Department of Marine Resources Coastal Preserves Program is charged with protecting natural resources, preserving, restoring and enhancing native species and habitats. Bayou Caddy is part of the Hancock County marsh system and is the largest Coastal Preserve. Bayou Caddy has the most productive population of *Malaclemys terrapin*, diamondback terrapins, in the state. It also has a greater amount of predation than some of the island nesting sites due to predator access including wild hogs. We proposed using trail cameras to test a proof of concept that hogs would not be able to destroy elongated nest protectors. We proposed that the longer stripping is more effective in deterring predators

than the smaller square protectors used for sea turtles. We deployed cameras for two months during the 2016 nesting season. Cameras were checked every two to three weeks. Nest predation surveys were also completed for Hancock County Marshes Coastal Preserve resulting in over 150 predated nests between May and August 2016. We encountered two main predators on the fence cameras, *Sus scrofa* and *Canis latrans*. No *Procyon lotor* were identified on cameras but were identified by tracks on beaches. The fences remained intact for the entirety of the test. No juveniles were encountered during surveys here or upon removal of the fences in September. Next year nest fences will be deployed earlier and one week will be spent tracking crawls to locate potential nests for protection. A second site will be included to test these strip nest protectors.

Poster Student Presenter: No

To BRD or not to BRD

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Holly Funkhouser, College of William and Mary; Randy Chambers, College of William and Mary; Mike Arendt, South Carolina Department of Natural Resources; and Jeff Schwenter, South Carolina Department of Natural Resources

Terrapins are unintentional victims of the extensive blue crab fishery. We compared two models of Bycatch Reduction Devices (BRDs), designed to maintain the catch of commercially harvestable crabs while excluding terrapins. The "Virginia BRD" model was a thick plastic, 2"x6" rectangular frame painted with two colors: red on the outside facing the open water, and white on the inside facing the trap interior. Prior research suggests that more male than female blue crabs are attracted to red BRDs, and that fewer terrapins are captured in traps fitted with red BRDs. The "South Carolina BRD" model was a thin plastic, 2"x2.5" rectangular frame colored red. Prior research indicates this much smaller BRD model still allows large crabs to enter traps while excluding most terrapins. Twelve crab traps were placed in groups of three (control, VA BRD, SC BRD) at each of two different field sites in Virginia. Traps were checked every day, and baited every other day for a total of 25 days during June/July 2016. We found no significant difference among treatments in the numerical catch of over 2300 crabs; crabs from VA and SC BRD traps, however, were on average two mm smaller than crabs from control traps. Terrapin bycatch was 23 for control traps (average carapace length CL=12.7 cm), and three each for VA and SC BRD traps (CL=11.5 and 11.3, respectively). BRDs effectively reduce terrapin bycatch without a dramatic impact on crab catch, an important outcome to encourage legislators to mandate BRDs for crabbing in terrapin habitat.

Poster Student Presenter: No

Factors associated with historical trends in the occurrence of Texas diamondback terrapin (*Malaclemys terrapin*)

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The Texas diamondback terrapin, *Malaclemys terrapin littoralis*, is found in Texas estuaries from Sabine Lake to Nueces Bay. The primary objective of our study was to determine trends in the relative abundance of terrapin and identify possible factors affecting their abundance. We examined historical data and collected new data from interviews with bay user groups and additional field studies. We found little information on terrapin or their potential use by Native Americans or early settlers. Large numbers of terrapin were first reported in 1841 in Galveston Bay near oyster reefs and adjacent islands. Declines in terrapin were reported from 1841 to 1920 when it was commercially harvested. During 1912 through 1975 the shell dredging industry mined large amounts of oyster shell, while at the same time the oyster fishery harvested numerous oysters from adjacent reefs. These two industries eliminated numerous islands and shell beaches where terrapin nest. Today terrapin are most frequently observed foraging and nesting in Nueces Bay, West Bay, and Moses Lake where small isolated islands with shell hash beaches still exist. We conclude that the two primary factors causing major declines in terrapin before the 1970's were overharvesting and loss of nesting habitat due to shell dredging, channelization, and oyster harvest. Today the major sources of anthropogenic mortality appear to be bycatch associated with the blue crab fishery and boat collisions. Due to a small home range, loss of nesting habitat, and projected sea level rise, the terrapin will continue to face an increased risk of extirpation.

Oral Student Presenter: No

Survey of diamondback terrapin (*Malaclemys terrapin*) populations and nesting sites in Georgia - 2015 and 2016

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During a series of four to five day trips from May through July in 2015 and 2016, we surveyed for evidence of diamondback terrapin populations in parts of the brackish rivers and creeks of Bryan, Chatham, Liberty, and McIntosh counties in Georgia. Our hypothesis was that

terrapin presence would be affected by variations in the following factors: water quality, salinity, and the presence of woody vegetation. Working from a boat we searched for terrapin heads surfacing for air. We also did walking surveys of all shorelines and high spots searching for depredated terrapin nests, live terrapins, crawls, and dead terrapins or terrapin bones. In an effort to better characterize terrapin habitat requirements we collected water and salinity samples from creeks throughout the study area and tested for heavy metals and other water quality parameters to determine if water quality impacted terrapin ecology. Further, we recorded woody vegetation species at most places we searched to determine if their presence could have predictive value in terrapin nesting preferences. We created maps to display our route along with the data concerning terrapin evidence, water quality, salinity, and woody vegetation.

Poster Student Presenter: Yes

Establishing partnerships to conduct preliminary sightings of diamondback terrapins in Florida's Central Indian River Lagoon

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Laura Herren, Coastal Biology Inc.; Melisa Blasky, Coastal Biology Inc.; and Richard Herren, Coastal Biology Inc.

Florida Fish and Wildlife Commission currently lists diamondback terrapins as a Species of Greatest Conservation Need because of the lack of knowledge in terrapin distribution and genetic connectivity. By building from existing terrapin outreach monitoring efforts in the northern Indian River Lagoon (IRL) and extending the work to the central IRL geographical data gap for the subspecies, we conducted a population assessment (mark-recapture) along a mosquito impoundment where occupancy is known, but never evaluated. Individuals were captured using modified crab traps, deployed in areas where terrapins have been sighted, and surveyed by local youth volunteers. The traps were monitored from May-August 2016, during which 14 terrapins were captured. Morphometric measurements were taken from each individual to determine mass, carapace length and width, and plastron length. Additionally, 3-4 mm biopsy tissue samples were collected for genetic analysis. These preliminary monitoring efforts and our terrapin ambassador educated the public and garnered citizen scientist support for future surveys. In 2017, we hope to include a state-wide collaboration of obtaining tissue samples for restriction site associated DNA sequencing to examine population structure, connectivity, and genetic variation.

Oral Student Presenter: No

Turtles rocking on the half shell: presence of diamondback terrapin nesting in the Rockaways

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Zahir Shadick, Rockaway Waterfront Alliance; Louis Torres, Rockaway Waterfront Alliance; and Russell L. Burke, Department of Biology, Hofstra University

Jamaica Bay is home to New York City's second largest studied population of diamondback terrapins *Malaclemys Terrapin* on Ruler's Bar Hassock (RBH), second only to JFK. Recently, terrapin populations have declined over time likely due in part to high depredation of nests by raccoons *Procyon lotor*. Surveys were conducted during summer 2016 along the Rockaway peninsula for terrapin nesting sign. Surveys included Bayswater Park, the Rockaway Coastal Front, Dubos Point and Edgemere landfill. Nesting sign was based on presence of depredated nests as well as test digs according to previously used methods. We found a potentially large and relatively new terrapin nesting site on Edgemere landfill. Edgemere is a 78 year old superfund site which was decommissioned in 1991. Historically, this site was marshland prior to the landfills construction, it currently contains 70 ha of restored land. We found 65 predated nests and 111 test digs along the main gravel access road spanning the perimeter of the landfill. Tracks and sign indicated raccoons as the main predator here. The average distance terrapins traveled to nesting habitat at Edgemere averaged from 100 to over 35 meters, which is a greater distance compared to RBH where terrapins routinely travel less than 30 meters to available nesting habitat. Surveys at Dubos Point indicated much lower densities of nesting; only 3 depredated nests were found in accessible areas. No signs of nesting were identified other sites. Edgemere landfill may indicate the presence of a terrapin population comparable in size to the population at RBH.

Poster Student Presenter: No

Testing roadside barrier effectiveness to decrease diamondback terrapin (*Malaclemys terrapin*) mortality on a southern New Jersey causeway

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In southern New Jersey, diamondback terrapin (*Malaclemys terrapin*) populations have suffered extensive habitat loss, drowning in crab pots, and road mortality. Vehicle collisions disproportionately affect female turtles. Terrapin nesting season coincides with seasonally high traffic leading to many terrapin fatalities. In an effort to reduce road mortality, various types of roadside barriers were installed over eight years along the Northfield-Margate Boulevard, also known as the Margate Causeway. This privately owned four km causeway traverses vital terrapin habitat. The intent of this investigation was to test and compare the effectiveness of a new type of roadside barrier with existing barriers for reduction of terrapin fatalities. In association with the Margate Terrapin Rescue Project, a grassroots organization,

a new type of 25.4 cm split, high-density polyethylene (HDPE) corrugated tubing barrier was installed in trenches along an isolated section of the causeway. Daily patrols of the causeway were performed and terrapin fatality locations were recorded. In addition, nest counts on the marsh side and road side of barriers were conducted to serve as an indication of barrier effectiveness. Measured correlative variables included weather conditions and vegetation height. These were analyzed via Chi-Square tests. Using a combination of Chi-Square tests and one-proportion z-test in conjunction with nest count data, we observed that split corrugated tubing was significantly more effective ($p=0.0078$) at reducing terrapin fatalities than whole corrugated tubing. Effective terrapin barriers are essential to conservation efforts in southern New Jersey, and beyond, where road mortality brings significant pressure to nesting female diamondback terrapins.

Oral Student Presenter: Yes

Approaches to increase awareness of diamondback terrapins through education and outreach efforts in a southern New Jersey community

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Environmental education can motivate communities to make strides toward natural resource protection. Curricula focused on local conservation issues can increase positive attitudes and overall environmental awareness. In association with a grassroots organization, the Margate Terrapin Rescue Project, efforts were undertaken to increase public awareness about diamondback terrapins. Approaches to increase public awareness and knowledge of diamondback terrapins included social media and internet-based methods as well as in-person, hands-on interactions. Social media and website data were collected using Facebook Page Manager, SurveyMonkey, GoogleAnalytics and Twitter Analytics. Over time, Facebook "likes" significantly increased, Twitter followers increased and the Margate Terrapin Rescue Project website had a significant increase in page views. A crowdfunding campaign was created to fundraise for new roadside barriers along a high terrapin mortality roadway resulting in donations totaling $7,500. To engage the school-aged public, in-classroom lessons were taught to various grades. Lesson plans consisted of a presentation, hands-on activity, and interaction with a live terrapin. Post-lesson reviews were administered and scored. Scores indicated short-term retention of information, however additional studies are needed to measure long-term changes in attitude and awareness. In addition to classroom lessons and social media, various outreach efforts were undertaken including community meetings with open discussions, a citizen science program, and presentations at local events such as Terrapin Day at the Marine Mammal Stranding Center. The results of these efforts to date are largely qualitative rather than quantitative. However, as conservation efforts continue, outreach and assessment should also evolve to ensure terrapin population viability.

Poster Student Presenter: Yes

Why did the terrapin cross the road and what can you do about it? Advances in road management for diamondback terrapin conservation

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Roads are a pervasive threat known to diamondback terrapin populations. Roads directly increase female terrapin mortality and indirectly reduce nest success. Building off of our advances in identifying hot spots and moments of road mortality, we present data on additional patterns of terrapin road crossing behavior, and the success of three intervention strategies: focal hybrid barrier systems, flashing road signage, and roadside vegetation management. Using seven years of capture-recapture data along the causeway to Jekyll Island, we show that roadside hedges increased road-crossing behavior at 25 m and 50 m scales, and inter-capture distance and road crossing behavior decreased with female age [or head width]. The latter results suggests that a portion of road crossing behavior is the result of less precise nest site selection among younger females. Hybrid barriers placed at nesting hotspots reduced road mortality by 57%, and the installation of flashing signage increased survival of females crossing the road by 150%. Finally, we confirmed that the predation on terrapin nests was lower in areas without preexisting shrub rows compared to areas with shrubs, but areas where shrubs were removed had only nominal reductions in nest predation. Our ongoing studies demonstrate the benefits of long-term monitoring to identify finer-scale patterns of road and nest mortality and to measure the effectiveness of management efforts.

Poster Student Presenter: No

An American terrapin in Bermuda: Flagler College Expedition 2016

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In August 2016, our "Tortuga Crew" (Flagler College students and faculty) flew to Bermuda to collaborate with Dr. Mark Outerbridge, Senior Biodiversity Officer for the Government of Bermuda's Department of Environment and Natural Resources. Our aim was to investigate the resident native diamondback terrapin (*Malaclemys terrapin*) population. The study site was the Mid-Ocean Club golf course located on the east end of the main island, near

Tucker's Town. The focal habitats and surrounding landscape matrix are unique among diamondback terrapin localities described in the literature. Feeding behavior, nesting ecology, and sex ratios also appear to be unique in Bermuda. A mark/recapture study was conducted, supporting Outerbridge's long-term research. Baited modified collapsible fish traps were set in three bodies of water with wide-ranging vegetation and salinities on the property: Mangrove Lake, Trott's Pond, and South Pond. This effort totaled 40 trap-nights. These water features represent three of the four known spots where terrapins reside in Bermuda. The fourth pond is occupied seasonally. Each turtle was photographed and standard morphometric data were collected. In addition, scute anomalies were characterized and tissue samples were obtained for population genetics. Other highlights included release of artificially incubated hatchlings and excavation of nests located in the sand bunkers, to study hatching success. Additionally, necropsies were conducted on unhatched eggs. Moribund embryos with physical deformities were observed - likely due to environmental contamination from prior land use. More detail and study results on the aforementioned topics will be presented and post-trip perspectives shared from this incredible opportunity.

Poster Student Presenter: No

Monitoring the status of diamondback terrapins in the Florida panhandle

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The population status of diamondback terrapins (*Malaclemys terrapin*) in the Florida panhandle is unknown. Rick and Molly O'Connor were asked by the Florida Turtle Conservation Trust and the Florida Diamondback Terrapin Working Group if they would conduct surveys of panhandle counties to determine if terrapins still exist in the area and, if so, where their nesting beaches are located. Beginning in 2007, we conducted surveys in the six counties between the Alabama state line and the Apalachicola River. At least one visual confirmation of a terrapin was logged in each of the six counties and five nesting beaches were identified in Escambia and Santa Rosa counties. Between 2008 and 2010, the nesting beach at Indian Bayou (Santa Rosa County) was monitored for relative abundance. The number of tracks, depredated nests, active nests, heads/minute, and nesting females were logged. The relative abundance was estimated between 35-50 individuals. In 2008 and 2009, mark-recapture surveys were conducted at Indian Bayou and Big Lagoon State Park (Escambia County) using six modified crab pots. Seven terrapins were captured and marked using a triangle file on the marginal scutes. Only one terrapin was recaptured. In 2015, we trained 24 Florida Master Naturalists to assist in surveying potential nesting beaches in Escambia and Santa Rosa counties. Two new nesting locations have been identified. Results indicated that terrapins are present in the western Florida panhandle in isolated aggregations; however, the relative sizes of these aggregations and their demographic characteristics need to be further studied.

Poster Student Presenter: No

Low hatching success appears to be a consistent feature for Bermuda's diamondback terrapins

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Bermuda's diamondback terrapins appear to be the only wild breeding population outside the North American range and nest almost exclusively within a limited number of sand bunkers on a private golf course. Despite no records of nest depredation for this species on Bermuda, hatching success has been consistently very low since studies began. Between 2009 and 2016 the mean annual hatching success rate in the wild was determined to be 14.7% (range 3.4-32.3%). For terrapin eggs collected in the wild and artificially incubated at constant temperatures and humidities, the mean annual hatching success was 26.2% (range 15.2-44.6%). The majority of nests monitored during this period did not produce any hatchlings and there was no visible evidence of embryonic development upon examination of the failed eggs. The terrapin population living on Bermuda contains adequate (albeit low) numbers of males so it is unlikely that eggs were unfertilized. Lethal incubation temperatures may be partially responsible for the observed low hatching rates but recent toxicological investigations have shown that high levels of pollutants (petroleum hydrocarbons, trace metals and polycyclic aromatic hydrocarbons) may also be a contributing factor. Terrapin nesting was observed to be primarily diurnal, typically commenced in late March or early April and ended in late August. Peak oviposition was observed in May and June. The average clutch size was 5.1 (range 0-10 eggs) and the average incubation period was 61.8 days (range 49-83 days). Delayed hatchling emergence was documented, with as many as 43.8% of the hatchlings remaining in their natal nests over the winter months (2011).

Oral Student Presenter: No

Evaluation of diamondback terrapin (*Malaclemys terrapin*) nesting ecology throughout coastal Louisiana

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Jon J. Wiebe, Louisiana Department of Wildlife and Fisheries

The Louisiana Department of Wildlife and Fisheries (LDWF) implemented a multi-year (2013-2015) project which evaluated diamondback terrapin (*Malaclemys terrapin*) nesting ecology. Diamondback terrapins are coastally distributed between south central Texas in the Gulf of Mexico along the Gulf and Atlantic Coast north through Massachusetts. Throughout their range many different biotic and abiotic factors have been shown to influence terrapin abundance, distribution and nesting success. In Louisiana our research has been principally

focused on determining nest site locations, nest predators, nest surface characteristics, nest depth, clutch size, egg morphometrics, nest depredation rates and nest survivorship. Our results indicate that terrapin nesting occurs statewide in locations where suitable nesting substrates exist. Nests are laid in open areas and beneath dense vegetative cover with surface slopes in all orientations. Average nest ceiling height is 7.7 cm and average nest floor is 11.8 cm. Clutch Size averages 5.5 eggs and varies between 1 and 13 eggs. Statewide, average egg morphometrics are: mass 11.8 g, length 38.1 mm and width 24.5 mm. Depredation rates are between 50 and 100 percent depending on location. In 2015 we implemented a detailed study within a single nesting site at which 92 nests were surveyed. Within these nests 43% of eggs were depredated, 31% successfully hatched and the fate of 26% of eggs was not determined. At the nest level 76% of all nests surveyed were fully or partially depredated while 43% of nests successfully hatched at least 1 egg. Collectively, these data are considered paramount in determining the overall conservation status of diamondback terrapins within Louisiana.

Oral Student Presenter: No

Evaluation of maternal investment in offspring of the diamondback terrapin (*Malaclemys terrapin pileata*): Egg size and Growth

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Marlee Hayes, University of Alabama at Birmingham; Taylor Roberge, University of Alabama at Birmingham; Andrew T. Coleman, University of Alabama at Birmingham; Ken Marion, University of Alabama at Birmingham; and Thane Wibbels, University of Alabama at Birmingham

Maternal investment and hatchling growth were investigated in the diamondback terrapin. Adult female terrapins were captured on a nesting beach at Cedar Point Marsh, Alabama. Females were induced to lay their eggs in the laboratory. The number of eggs per clutch, size of eggs and hatchlings, and growth rates of hatchlings and post-hatchlings were examined in approximately 11-19 clutches per nesting season over four years of study. The number of eggs per clutch did not vary significantly between females. The size of eggs and hatchlings varied significantly by clutch with larger females tending to produce larger eggs. The results are not consistent with the optimal egg size theory, but in contrast appear more consistent with the developmental plasticity hypothesis. The results also indicated clutch-specific and sex-specific growth patterns in the hatchling and post-hatchling terrapins. The results of this study provide insight on the strategy for maternal investment and its potential long term effects on the fitness and growth of the diamondback terrapin.

Poster Student Presenter: No

Does elevated salinity induce a physiological response in Texas diamondback terrapin (*Malaclemys terrapin littoralis*)?

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This study evaluated the physiological effects of elevated salinity on blood chemistry in the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) within the Nueces and Mission-Aransas Estuaries. Terrapins (n = 105) were captured during April 2015-November 2015 from Nueces Bay, Oso Bay, and Goose Island State Park. Water parameters were recorded for each sampling event. A blood sample was drawn from the subcarapacial sinus vein; initial blood glucose concentrations and morphometric data were recorded for each individual captured. First time captures were scute notched and PIT-tagged as part of an ongoing mark-recapture study. Plasma samples were analyzed using an electrolyte panel (Na+, Cl-, K+, and CO2). There were significant differences between the three bay systems for glucose ($F = 4.45$; $p = 0.0147$), potassium ($F = 22.57$; $p = <.0001$), and CO2 ($F = 4.06$; $p = 0.0209$). There were also significant differences in salinity ($F = 9.14$; $p = 0.0003$) between the three bay systems. Males and females within Oso Bay had significant differences in glucose ($F = 7.53$; $p = 0.0116$) and potassium ($F = 7.64$; $p = 0.0106$), while males and females within Nueces Bay had significant differences in CO2 ($F = 4.27$; $p = 0.0450$). Further analyses of plasma samples include blood chemistry panels and ELISA tests for stress hormone production. The results of this research provide the first physiological assessment of Texas diamondback terrapins under elevated salinity conditions utilizing hormones as indicators.

Poster Student Presenter: Yes

Mississippi Derelict Crab Trap Program

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Beginning in the winter of 1999, the Mississippi Department of Marine Resources (MDMR) incorporated a derelict crab trap removal and recycling program into the regular duties of the Shrimp and Crab Bureau. A derelict crab trap is defined as any trap, which is un-buoyed, unmarked, and not actively fished. These traps may become derelict for several reasons: including but not limited to high tidal surge from storms, the inadvertent clipping of float lines by vessel propellers, traps unintentionally caught in shrimp trawls and crab trap theft. Once lost, derelict traps are marine litter that can continue to catch various marine species (ghost fishing), cause hazards to boaters and fishermen by impeding public access and contribute to user group conflicts. To date, the Mississippi Derelict Crab Trap Removal Program has removed 21,546 derelict traps from approximately 1,500 miles of the Mississippi shoreline. Derelict traps pose a greater threat to the Mississippi diamondback terrapin than do actively run traps, as they can continue to ghost fish until they are removed from the environment. A

total of 14,951 of these traps were retrieved by commercial and recreational crab fishermen, who have been instrumental in the success of this program and have contributed to the conservation of the Mississippi diamondback terrapin.

Poster Student Presenter: No

Using a surrogate species to assess diamondback terrapin nesting beach quality in Alabama

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The diamondback terrapin is considered a species of "highest conservation concern" in the state of Alabama in addition to other locations throughout its range. Nesting beach utilization in Alabama seems to be non-random, with one beach in particular, located at Cedar Point Marsh, hosting the highest nest abundance. The ability to assess nesting beach quality in an ecologically relevant way is important for the identification of nesting beaches that are crucial to the ecology and recovery of the diamondback terrapin in Alabama. Hatchling phenotype (e.g. size, mass) in reptiles has been shown to be affected by both genetic and environmental factors which could ultimately impact the fitness of the individual. Due to the conservation status of the diamondback terrapin, a surrogate species with similar sex determination characteristics, *Trachemys scripta elegans*, was used to experimentally assess hatchling phenotypes produced on known diamondback terrapin nesting beaches. Thirty two artificial nests of ten eggs and a temperature datalogger were distributed across seven beaches. Eggs were recovered just before hatching and hatchlings were subsequently measured, and sexed. In general, nest temperatures showed relatively large daily fluctuations. The majority of nesting beaches produced female-biased sex ratios; however, some beaches produced mixed sex ratios and others male-biased sex ratios. The heterogeneity of sex ratios produced among beaches suggests that the overall hatchling sex ratio may be a composite of sex ratios produced on multiple nesting beaches in an area. These results have implications for the conservation of the diamondback terrapin.

Oral Student Presenter: Yes

Terrapin restoration at Poplar Island

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The Paul S. Sarbanes Environmental Restoration Project at Poplar Island is the world's largest tidal wetland restoration project. Dredge material from Chesapeake Bay is being used to rebuild Poplar Island that once comprised more than 450 ha in Chesapeake Bay. Subsidence and erosion reduced the island to <4 ha by 1998. In 1998, the Army Corps of Engineers began to rebuild the island with a focus on creating estuarine wetland habitat and nesting environment for colonial shorebirds. When the perimeter dike was completed in 2002 diamondback terrapins began nesting in open, accessible shoreline on the island. As the restoration project has progressed, the island has changed due to progress of construction and succession of the habitat that provides nesting and wetland, juvenile, habitat that has led to growth in the terrapin population. Furthermore, the absence of nest predators and a headstart program on the island has resulted in a serendipitous and feasible model for terrapin restoration. My talk will present 14 years of terrapin monitoring data from Poplar Island revealing how we can effectively manage for the future of terrapin populations.

Oral Student Presenter: No

Assessing sea level rise and future habitat availability for diamondback terrapins in Maryland

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We used existing data on nesting site use by diamondback terrapins and projections from a model of future coastal habitat distributions ("SLAMM") to evaluate potential effects of sea level rise (SLR) on habitat availability for terrapins in the Maryland portion of the Chesapeake Bay, and in Maryland's coastal bays. We examined three scenarios for SLR in the Chesapeake Bay, consisting of projected increases of 39, 69, or 100 cm by year 2100 (SLR39, SLR69, and SLR100). The models suggest that most observed nesting sites (82-92 %) will be inundated by year 2100. The models predict a loss of brackish marsh, a critical feeding habitat, of ~ 30 (SLR39) to ~ 50 % (SLR100) on the Western Shore and ~ 300 (SLR39) to ~ 600 % (SLR100) on the Eastern Shore by 2100. Coastal bays will also experience a reduction of up to ~ 60 % (SLR100) in salt marsh over this period. Nesting habitats (beach and undeveloped coastal dry land) responded differently to SLR. Beach area increased or remained relatively constant in all regions, whereas undeveloped dry land declined in all regions, being most pronounced on the Eastern Shore where a ~ 400 to ~ 600 % decline is projected. Empirical data indicate that habitat changes consistent with the model predictions are already occurring. The future terrapin population in the Chesapeake Bay will encounter a different

abundance and distribution of critical habitat types, perhaps affecting the capacity of the system to support the population at its current level.

Oral Student Presenter: No

Toward a better bycatch reduction device: BRD modifications enhance terrapin exclusion without reducing blue crab catch rates in South Carolina

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Reducing diamondback terrapin (*Malaclemys terrapin*) mortality in crab traps remains a conservation priority. Crab trap bycatch reduction devices (BRDs) limit terrapin entry through trap funnels, but widespread BRD use has not occurred due to (1) indications that BRD use decreases catch of legal-size crabs, and (2) considerable entry of small to medium-sized terrapins through the commonly available 2" x 6" BRD design. During 2014 and 2015, SCDNR researchers devised several modifications to this design, with emphasis on decreasing both horizontal and vertical BRD dimensions. Field testing during 2014-2015 (>650 trap sets, ~3,000 hours) revealed similar crab size distributions (>3,100 crabs) between control and most BRD traps; however, a 20-26% decrease in legal crab catch was observed with the best-performing modified BRDs. Continued refinement in 2016 included rounded BRD edges to better accommodate large crab entry and installation of the BRD as far forward (within the trap funnel) as possible to achieve a shallower funnel slope, which in turn should reduce crab escapement. During 159 trap sets (775 hrs) between April and August 2016, catch of legal-sized crabs (n = 244, 40% of all crabs) per soak hour was not different between traps with (0.31) and without (0.32) BRDs. Only seven (22% overall) terrapins (mean = 7.9 cm SCL) were captured in BRD traps, whereas 25 terrapins (mean = 8.6 cm SCLmin) were captured in control traps. Based on these encouraging results, testing of this excluder design by recreational and commercial crabbers in South Carolina will commence in fall 2016.

Oral Student Presenter: No

Demographics, distribution, and genetic variation in the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) within the Corpus Christi and Aransas Bay systems

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The goals of this research are to determine the population genetics and population dynamics of the Texas diamondback terrapin (*Malaclemys terrapin littoralis*) within the Nueces/Corpus Christi Bay and Aransas Bay estuaries on the central Texas coast. The genetic data produced by this study can be integrated with previous DNA analyses on Nueces Bay populations and provide needed information for development of management strategies. It will also provide the first genetic data on populations located within Oso Bay (Nueces/Corpus Christi Bay estuary) and Aransas Bay. An understanding of the population genetics from these terrapins will help answer various questions for conservation management in an underrepresented region from bays that are relatively isolated from one another. Terrapins were captured between April 2015 and December 2015. Sex was determined based on morphological characteristics and females were checked for gravidity. Photographs, standard measurements, body condition score, age estimates, physical abnormalities, scute notches and PIT tags were all performed and applied for each individual. Blood samples were drawn from all captured individuals to genetically compare individuals within, and across, these bay systems using microsatellite DNA analysis. Preliminary captures, sex ratios, and standard measurement data for individual males and females are currently being analyzed, providing insight on the demographics of Texas diamondback terrapins in the study sites. DNA analysis will be performed on a ABI 3730xl DNA Analyzer, utilizing a multiplex PCR strategy involving M13 fluorescent labeled forward primers and the same 12 SSR primers that multiple previous studies have used for this species.

Poster Student Presenter: Yes

Within and among year variation in reproductive output from two populations of the diamondback terrapin, *Malaclemys terrapin*

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Optimal egg size theory predicts that selection should favor a single egg size that simultaneously maximizes female and offspring fitness. Deviations from optimal egg size theory exist and suggest that external factors influence reproductive output in many taxa. We investigated variation in reproductive output between two populations of the diamondback terrapin, *Malaclemys terrapin*, in Maryland over a multi-year period. For the

Patuxent River we used both excavated nests and female x-ray data, from Poplar Island we used only excavated nests. In both populations females lay multiple clutches within a nesting season, and egg size within clutches varies little early on. But as the nesting season progresses, within clutch egg size variation increases. The increase in egg size variation within clutches late in the nesting season suggests that resource availability and environmental stochasticity during the inter-clutch interval results in a "sloppy" allocation strategy that optimizes female over offspring fitness as females switch from "capital" to "income" breeding between first and subsequent clutches respectively. From our Patuxent River x-ray data, female size and pelvic aperture width correlated weakly with egg width; this comparison was not available from Poplar Island. However, we were able to compare egg and hatchling metrics among years on Poplar Island. There is a strong relationship between egg and hatchling size that varies among years. Additionally, within clutch variation in egg size was mirrored in variation in hatchling size. These data are the first to confirm hatchling size and variation is affected by egg size and variation.

Poster Student Presenter: Yes

Effects of buoyancy on diving performance of juvenile northern diamondback terrapins (*Malaclemys t. terrapin*)

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Over the past two years, we investigated the diving patterns of two cohorts of juvenile diamondback terrapins (N=20 each year). In both years we recorded the total time each terrapin spent above and below the water, and total number of dives over a two-hour experimental period. During the second year, we conducted a second experiment in which we lowered their specific gravity by attaching small balsa wood disks to their plastrons. Lowering the specific gravity of the terrapins resulted in more attempts to dive to the bottom of the tank (P=0.049), as well as shorter periods of time spent under water (P=0.041). These data suggest that juvenile diamondback terrapins have limited capacity for adjusting their specific gravity physiologically, and altering their specific gravity interferes with their ability to dive.

Poster Student Presenter: Yes

Estimating hatchling sex ratios in northern diamondback terrapins (*Malaclemys t. terrapin*) from nest cavity temperature

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Diamondback terrapins undergo temperature dependent sex determination during embryonic development. Males develop at incubation temperatures below 28°C, whereas females develop around or above 30°C. Incubation temperature may be influenced by factors such as nest depth, plant cover, shade, and substrate type. Using this information, we inferred the sex of clutches of eggs based on incubation temperature during the temperature sensitive period of embryonic development. We measured the temperature and relative humidity of a stratified sample of naturally occurring terrapin nests (N=13) with iButton temperature loggers at upper and lower nest cavity depths. Temperature and humidity of seven paired nest and control locations were also measured. We measured the temperatures of the nest cavity for a seven-day period (during days 8-11 of incubation) to capture the temperature sensitive period for sex determination of the developing embryo. We predicted the predominant sex of hatchlings in each nest by examining upper and lower nest temperatures. A chi-squared analysis determined no significant difference from the expected 1:1 sex ratio. Additionally, we found that nests in man-made substrates (shell and mulch) were significantly cooler than nests in naturally occurring substrates (sand and vegetation, $P<0.01$). These results suggest that changes in nesting habitat availability and use may have implications for the sex ratio of a local population. Though sample size was small, relative humidity in the nest cavity was significantly lower than in paired locations approximately 25cm away at comparable depth ($P<0.01$). Our results enhance understanding of terrapin nesting ecology in mosaic habitats.

Poster Student Presenter: Yes

Evaluating population characteristics of northern diamondback terrapins (*Malaclemys t. terrapin*) within two neighboring saltmarsh creeks in southern New Jersey

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Knowledge of diamondback terrapin population characteristics can allow impacts from road mortality, habitat loss and drowning in crab traps to be better understood.

Demographics and distribution of terrapins were examined in 2016 by deploying modified commercial-style crab traps in neighboring Josh and Charles Creeks, sites previously sampled for an ongoing mark-recapture study. Creeks were surveyed four times June 26-July 22. Upon capture, terrapins were scanned for microchips, measured, sexed, and microchipped if needed before release. Video of terrapins within traps was also recorded. Seventy-one terrapins were captured (Charles: N=22, Josh: N=49), and sex ratios did not differ significantly from 1:1 (Charles: $p=0.12$, Josh: $p=0.77$). When additional survey years (2002, 2003 for Charles Creek only, 2007, 2008, 2016) were considered, the Charles Creek population was female skewed ($p<0.01$), with a stronger female bias in 2002 and 2003. Within-creek differences in carapace length were detected across survey years for males for both creeks ($p<0.05$) but not females ($p\geq0.12$). Based on carapace length, male terrapins in Charles Creek were larger in 2016 compared to 2003, while males in Josh Creek were smaller in 2016 compared to 2002. However, when comparing between creeks, terrapins of both sexes were smaller in Charles Creek compared to Josh Creek ($p<0.01$). The over-representation of smaller terrapins in Charles Creek may indicate that terrapins leave the creek or are impacted by local threats as they mature. While these creeks are similar in location, vegetation, and salinity, environmental characteristics need further investigation.

Poster Student Presenter: Yes

Nesting activity and survival in a marked population of adult and head-started northern diamondback terrapins (*Malaclemys t. terrapin*) in southern New Jersey

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In southern New Jersey, northern diamondback terrapins face threats including road mortality, habitat loss, unsustainable harvest, and drowning in crab pots. As part of a multifaceted effort to study and conserve terrapins, scientists at The Wetlands Institute (TWI) have conducted a long-term mark-recapture study of the terrapin population since 1997 to better understand local demographics and population trends. For this preliminary analysis, we examined adult females that were captured near TWI or nesting on the property, and head-started female terrapins released into the local marsh. All individuals were marked using PIT tags. Over all nesting seasons, we recaptured by hand or recovered dead 393 of 492 marked females (79.8%) and 23 of 1,449 (1.6%) marked head-starters on TWI property or local roads. The high recapture rate for adult females demonstrates strong site fidelity, further supported by multiple recaptures of individuals within and among years. The lower rate for head-starters could be due to dispersal or low survival and capture probability for juvenile terrapins. However, some head-starters returned to nest, suggesting head-starting may benefit the local population. On average, 7.9 years lapsed between release and hand

recapture of head-starters, and several have been recaptured nesting multiple years. An initial analysis of survival probability for females nesting at TWI from 2002-2015 suggested high annual survivorship of adult terrapins (90.1%) which did not vary among years despite persisting threats. Work to estimate population parameters is ongoing. These results will help evaluate the local terrapin population's status and management needs.

Oral Student Presenter: No

Encouraging fisheries cooperation in conservation of the diamondback terrapin in Mississippi

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The Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) is classified by the Mississippi Department of Wildlife, Fisheries, and Parks as a "non-game species in need of management due to rarity or other factors making it vulnerable to extirpation." Terrapin mortality rates have been identified to nest predation, habitat loss through increased coastal development, and bycatch within the Blue Crab fishery. Derelict crab traps lost by fishermen also pose a threat to terrapins through ghost fishing. The Mississippi Department of Marine Resources, Office of Marine Fisheries has been actively promoting terrapin conservation through a variety of different approaches such as encouraging the use of Terrapin Excluder Devices (TEDs) in the Blue Crab fishery, increasing public awareness about the potential threats Mississippi's terrapin population face, and through the removal of derelict crab traps in Mississippi's marine waters. The Mississippi Derelict Crab Trap Removal Program, the most successful terrapin conservation initiative, through the help of Mississippi's commercial crab fishermen, has removed and recycled over 21,500 derelict traps from Mississippi waters since its inception of the program in 1999. The Mississippi Crab Trap Bycatch Reduction Device/TED Program has also been highly effective in distributing over 12,000 TEDs (3,000 traps) to both commercial and recreational Blue Crab fishermen.

Oral Student Presenter: No

Barnegat Bay turtle gardens: supporting shorelines to safeguard terrapins for sea-level rise

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MATES Project Terrapin in partnership with the Conserve Wildlife Foundation of New Jersey is conducting diamondback terrapin nest site development project along the Barnegat Bay shoreline areas. The project is funded by the Barnegat Bay Partnership and is an extension of

the "Turtle Gardens" established at Wellfleet, Massachusetts. Over the past two nesting seasons, we installed two new nesting sites on Long Beach Island, one at the Long Beach Island Foundation (LBIF) of the Arts and Science, and the other at a private residence. Sand was purchased from a local supplier with a minimum of 90% sand composition (mostly medium particle size) and < 1% organic composition. In the first year at the LBIF, 2015, five terrapins nested in the newly designated area, resulting in less female terrapins found nesting at the LBIF parking lot area. In 2015, we had an 83% hatch success rate at the LBIF Turtle Garden. In 2016, fourteen nests were dug in the LBIF Turtle Garden and there was only one terrapin encounter in the LBIF parking lot area. The "Turtle Garden" established at the private residence in 2016 supported thirteen terrapin nests. In both cases, large predator exclusion cages were installed on all nests to project eggs. The openings in the cage mesh were adequate in size (~4 cm) to allow for emerging hatchlings to escape. As part of the project, we developed educational materials, conducted outreach programs to schools, and conducted a sea-level rise, shoreline assessment survey that reached over 1000 responses.

Poster Student Presenter: No

New Jersey's Terrapins: Two Pathways to Protection

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On July 15, 2016, N.J. Governor Chris Christie signed into legislation Assembly Bill A2949 which makes the diamondback terrapin a non-game species. Terrapins were allowed to be harvested in the state from November 1 through March 31 each year. During the designated terrapin harvest season, terrapins with a plastron length of five inches or greater could be taken without the use of nets, dredges, or trawls. No license or reporting of catch was required by the New Jersey Fish and Wildlife Marine Fisheries Council (NJFWFC) that managed terrapin capture in the state. This action was in response to harvest activity in which 3,522 terrapins were legally sold to an aquaculture facility in Maryland in December 2013, and a second harvest of 800 terrapins occurred during the winter of 2014-2015, of which 500 were found to be taken illegally. At the time, N.J. had an open harvest season and no reporting requirements. The aquaculture facility in Maryland that the terrapins from N.J. were sold, applied to the U.S. Fish and Wildlife Service for a permit to sell over 14,000 terrapins overseas since they are protected under the CITES agreement. As a result of the harvest, NJ Department of Environmental Protection Commissioner Bob Martin signed two Administrative Orders (in 2015 and 2016) to close the terrapin harvest season. The NJDEP was working on an indefinite moratorium on harvesting terrapins at the time the legislation was signed into law. Thanks to the efforts of conservation groups, public support and student involvement, terrapins have gained non-game status in N.J.

Poster Student Presenter: No

The use of recreational GPS logger and drone technology to study diamondback terrapins near Jekyll Island, GA

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The vast majority of turtle species worldwide have been negatively impacted by anthropogenic disturbances such as habitat fragmentation, development, harvest, and road mortality. Many of these species exhibit complex life histories characterized by a slow rate of development to reproductive maturity, low recruitment, and longevity. Due to these traits, landscape and population-level disturbances can be detrimental and contribute to localized and regional population declines. One species facing these plethora of issues, the diamondback terrapin (*Malaclemys terrapin*), suffers from deleterious levels of road mortality along the Downing-Musgrove Causeway connecting Jekyll Island to mainland Georgia. The advent of small-scale biotelemetry devices allows for researchers to gather spatial data at previously unprecedented rates. To examine the spatial ecology of individual female terrapins utilizing both causeway and Jekyll Island habitats for nesting we modified cheap, easily-obtainable GPS loggers to fit our research needs and applied them to turtles captured during road cruising and seining events. We developed methods for GPS logger modification, stationary field testing, and application onto target animals. Additionally, we began to use a UAV drone to develop survey methods and examine capabilities of this technology to inform best practice methods. The varied movement and habitat use data will be used to inform local roadside management and development while our techniques and methods can be adapted to suit individual research, conservation, and management goals.

Oral Student Presenter: Yes

Tarmac terrapins: comparing two populations of diamondback terrapins (*Malaclemys terrapin*) in New York City's Jamaica Bay

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In 2009 hundreds of nesting *Malaclemys terrapin* (diamondback terrapin) emerged onto the runways at John F. Kennedy Airport in New York City, where previously only a few terrapins had been observed each year. Historically, the primary nesting site for the terrapins in Jamaica Bay was the central island of Rulers Bar, in Jamaica Bay Wildlife Refuge. At JFK, approximately 2,400 individuals have been uniquely and permanently marked in an 8-year period (2009-2016) compared to approximately 3000 individuals marked 1998-2016 at Rulers Bar, indicating a larger population nesting at JFK. No terrapin yet at either site has been

identified with a tag from the other site, suggesting two separate populations. Scute castings made from alginate and plaster have been used for aging studies of growth rings at both locations. Results thus far show that the JFK population is much younger than the population at Rulers Bar. Diet analysis has not yet been completed. The number of nests, clutch sizes, and egg sizes have been observed since 1998 at Rulers Bar and since then the number of nests has decreased, but the clutch sizes have increased. These observations began at JFK Airport in 2015 and will be compared to the nesting behavior at Rulers Bar. By observing nesting behavior, diet, and size, and age of the terrapins at JFK we hope to have gained better insight into the causes of the differences in population size, and the very rapid increase in size of the JFK population.

Oral Student Presenter: Yes

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