FINAL REPORT FOR THE FOURTH SYMPOSIUM ON THE ECOLOGY STATUS AND CONSERVATION OF THE DIAMONDBACK TERRAPIN

10-12 August 2007

Hosted by
Arlington Echo Outdoor Education Center
Millersville, Maryland

Sponsored by
Ohio University, ORSP
Ohio University, Department of Biological Sciences
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The National Aquarium in Baltimore
Zoo-med Laboratories, Inc.
Chesapeake Bay Trust

Report written by Willem M. Roosenburg
Symposium Organizer

Group Photo of the attendees of the IVth Symposium on the ecology status and Conservation of the diamondback terrapin, 12 August 2007 at Arlington Echo Outdoor Education Center. Photo by Natalie Boydston

Preface

In August of 1994, Drs. Rich Siegel and Whit Gibbons organized the first Workshop on the Ecology Status and Conservation of the Diamondback Terrapin at the Savannah River Ecology Laboratory in Aiken, South Carolina. Subsequent workshops were held at the Wetlands Institute in Stone Harbor New Jersey in 2000 and in Jacksonville, Florida in 2004. The 2004 Jacksonville workshop attendees initiated the Diamondback Terrapin Working Group as a national organization representing those interested in terrapin research, conservation, and education. Approximately 30 people attended the first one day workshop in 1994 and there were less than 10 presentations. This symposium has over 100 attendees, 26 presentations, and 16 posters. Part of the establishment of the working group recognized that the growing interest and concern for terrapins warranted meeting meet every three years. This brings us to the Fourth Symposium in Millersville, Maryland here in Arlington Echo.

Since 1994, this group has expanded and we continue to grow. The working group provides the infrastructure that brings those interested in terrapin conservation, research, and education together regularly. Five regional groups meet annually to discuss progress and identify new threats and initiatives to improve terrapin conservation and management. The regional groups help to identify local issues in which the working group can provide support at a national level. For example, since we last met the working group has played a role in closing terrapin fisheries in South Carolina and Maryland. Conservation and management groups are recognizing that we are an organization that can lend expertise, but more importantly specific data to conservation and management issues.

The working group maintains a website that provides information, regional meeting minutes, and a bibliography of terrapin publications. As we look to the future, we hope that we can provide greater opportunity for those involved in terrapin research and conservation by providing technical expertise, research funding, and a continued regular meeting schedule. We, as an organization, are committed to the appropriate conservation and management of terrapin populations throughout their range. We also recognize that the charismatic nature of terrapins make them an excellent tool for environmental education. We recognize the value of these programs but also encourage that they incorporate a scientific component to gain greater knowledge about terrapins.

This symposium provides the opportunity for those that are involved in terrapin research, conservation, and education to learn from the experiences and successes of others working with terrapins. We look forward to the dialogue, exchange, and the future collaborations that the symposium will initiate.

The organizers of the workshop are grateful to Ohio University Office of Research and Sponsored Programs, Ohio University Department of Biological Sciences, Arlington Echo Outdoor Education Center, Maryland Department of Natural Resources, Maryland Sea Grant, the Chesapeake Bay Foundation, the DC and Maryland Chapter of the Nature Conservancy, Zoomed Laboratories Inc, the National Aquarium in Baltimore, The Chesapeake Bay Trust, the University of Maryland's Fear the Turtle Program, the Chelonian Research Foundation and the IUCN Tortoise and Freshwater Turtle Specialist Group. We also thank Steve Barry and Will Williams and the staff of Arlington Echo for their enthusiasm and logistical support for the symposium.

Willem M. Roosenburg and Joseph Butler – Co-directors of the Diamondback Terrapin Working Group

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Workshop organizer – **Willem Roosenburg**, Ohio Center of Ecology and Evolutionary Studies and the Department of Biological Sciences

Workshop Hosts – **Steve Barry and Will Williams**, Arlington Echo Outdoor Education Center

Silent Auction Coordinator – **Patrick Baker**, Swathmore College, Department of Biology

Student Volunteers: **Leah Graham, Melanie Heckman, Brooks Kohli, Scott Clark, Alanna Silva, and Natalie Boydston**

The Diamondback Terrapin Working Group logo was developed by Barbara Kemp of Kemp Design Services from a photo of a northern diamondback terrapin (*Malaclemys terrapin terrapin*) from the Patuxent River in Maryland waters of Chesapeake Bay.

Summary

The Diamondback Terrapin Working Group (DTWG) hosted the IVth Symposium on the Ecology, Status and Conservation for the Diamondback Terrapin from 10-12 August 2007. Ninety-two scientists, students, educators, and resource managers met at Arlington Echo Outdoor Education for the three-day conference. Participants heard 27 oral presentations and viewed 16 posters at the symposium. Individuals from 16 states and three foreign countries were present; Connecticut and Louisiana were the only states in the terrapin's range that were not represented at the meeting. The meeting started Friday with the DTWG business meeting and a social held in nearby Millersville. Research presentations dominated the talks Saturday and Sunday morning. Sunday's late morning session presented educational programs. Sunday afternoon began with recaps from the regional representatives of the DTWG followed by a discussion led by Rich Seigel that focused on the progress, changes in the status of terrapin populations throughout their range, and new emerging concerns relating to terrapin conservation. Finally, Anders Rhodin, head of the IUCN Tortoise and Freshwater Turtle Specialist Group, closed the symposium.

Sunday morning's second session focused on educational programs that used terrapins or were focused around terrapin research. Talks by Will Williams from Arlington Echo featured the Terrapin Connection Program at Arlington Echo that uses the terrapin as an outreach tool to capture the interest of young students about environmental issue. John Wnek from New Jersey talked about their terrapin education program that allows students and individuals to participate in field research. We also heard a talk about an education-outreach program in South Carolina that informed the public about terrapins and their plight in crab pots. This program offered free bycatch reduction devices to individuals interested in making their crab pots terrapin safe. All of these talks exemplified that the terrapin is a charismatic species that readily captures ones attention and thus provides a compelling hook for environmental outreach.

Research talks presented findings from a variety of terrapin investigators throughout the terrapin's range. Talks were presented on population studies, toxicological research, conservation, hatchling over wintering, nesting biology, and the impact of crab pots. One of the more interesting conservation studies used molecular genetics to determine that animals confiscated from the markets in New York originated from several states and several populations in Chesapeake Bay. Many research programs identified crab pots as a continuing threat to terrapins throughout their range. Wherever there is an overlap between terrapin populations and either a commercial or recreational crab pot fisheries, there is a decline in the terrapin population. This was iterated several times as researchers presented photographic evidence of "death pots" in which many terrapins were killed in a single pot. Interestingly, these death pots seem to be very site specific and pots separate by as little as 100 m vary by as much as two orders of magnitude in the number of turtles they catch. Additional evidence was presented from Virginia that there were differences in population structure between areas with and without crab pots. Attendees also presented evidence of the effects of habitat loss throughout the range of terrapins. The primary concern was the loss of suitable nesting habitat as shoreline development continues throughout the range. Researchers working on Cape Cod, Rhode Island, Chesapeake Bay and South Carolina raised concerns that where waterfront real estate is at a premium, terrapin habitat is under constant threat and frequently eludes recognition in development planning and permitting processes. Finally, data from South Carolina pointed to an increase in shell damage and limb loss that can be attributed to recreational boating. Although the harvest pressures on terrapins have been reduced tremendously new threats emerge with the increased use and encroachment of their habitat.

Saturday afternoon featured a special session on terrapin research in Maryland. The session led off with two presentations that reviewed the regulatory history of terrapin and the process that led to the new law closing the commercial fishery in Maryland. Interesting reports followed on winter dredging as a harvest/survey technique and the terrapin populations in Tangier's Sound. The last two presentations of the day discussed hatchling over wintering biology at Poplar Island and the lack of compliance with the BRD regulations in Maryland. Although considerable progress has been made in terrapin conservation and management, it is clear that work remains to be done to ensure the sustainability of terrapins in Chesapeake Bay and elsewhere.

With the closure of the commercial terrapin harvest in Maryland in 2007, the number one conservation issue reflected at the meeting was the mortality of terrapins in crab pots. The loss of wetland habitat also concerned researchers because wetlands play a critical role in the completion in the terrapin's life cycle. At the conclusion of the meeting, Anders Rhodin, head of the IUCN Tortoise and Freshwater Turtle Specialist Group suggested that a proposal be put forth that would put the terrapin in CITES Appendix III. Based on the terrapins life history that make it vulnerable to increased mortality of adults and juveniles combined with its similar appearance with other species that currently are on the CITES appendices indicate that it is a good candidate species for appendix III. The advantage of the appendix III designation is that it would require federal monitoring of trade and commerce of the terrapin. The appendix III listing would provide better data on the continued trade and exploitation of terrapins in the US.

One overarching concern that was expressed both in the business meeting and was reflected in the presentations and attendance was a lack of research initiatives in the gulf coast regions. While the eastern seaboard in the US is active with terrapin research, only two studies were ongoing in the gulf region, one in Mississippi, and another in Alabama. Additionally, some of the attendees are poised to begin work in Galveston Bay of Texas. Louisiana remains a black hole with regard to both knowledge of terrapin life history and their status within the state. To help promote terrapin research in the gulf region, DTWG officers agreed that the Vth Symposium on the Ecology, Status, and Conservation of the Diamondback Terrapin be held in the gulf region and Russ Burke from Hofstra University has accepted the task of meeting organizer.

This report documents the activities of the symposium including the schedule of talks and events, abstracts of the presentations and posters, list of attendees and presenters, and notes of the business meeting and regional representative reports. If you would like more information about the symposium or the Diamondback Terrapin Working Group please go to www.dtwg.org or email Willem Roosenburg at roosenbu@ohio.edu.

Meeting Schedule

Friday 10 August

15:00 - 21:00 – Registration – Field Hall

15:00 – 17:00 – Diamondback Terrapin Working Group Business Meeting – Sensory Room

17:00 – 22:00 – Welcome beer and wine mixer and social – Historic Baldwin Hall – Millersville, MD

Saturday, 11 August 2007

8:30 Introduction – Willem M. Roosenburg, Co-Director DTWG – Field Hall

8:35 Welcome to Arlington Echo – Steve Barry, Director

Session I – Chair Joe Butler – Field Hall

8:40 ' Environmental correlates of emergence from the nest for hatchling *M. terrapin*. Patrick J. Baker[1], M. L. Perry[1], H. Chmura[1], Ros Herlands[2], and Roger C. Wood[2] [1]Department of Biology, Swarthmore College; and [2]Department of Biology, The Richard Stockton College of New Jersey.

9:00 Overwintering in hatchling diamondback terrapins. Matthew Draud and Marc Bossert, Department of Biology, C.W. Post – Long Island University.

9:20 Nesting Ecology of the Diamondback Terrapin (*Malaclemys terrapin*): A Comparison of Nesting Conditions at Barnegat Bay, New Jersey. John P. Wnek, Harold W. Avery, James R. Spotila, and Walter F. Bien, Department of Bioscience and Biotechnology, Drexel University.

9:40 Increased Nest Success for the Carolina Diamondback Terrapin (*Malaclemys terrapin centrata*) following Raccoon (*Procyon lotor*) Removal from a Nesting Beach in Northeastern Florida. Eric C. Munscher, Candace Cox, and Joseph A. Butler, Biology Department, University of North Florida.

10:00 Coffee Break

Session II - Chair Meg Hoyle – Field Hall

10:20 Current Status and Future Survival of Diamondback Terrapin, *Malaclemmys terrapin pileata*, populations in the salt marshes in Alabama. Andrew T. Coleman[1], Thane Wibbels[1], Ken Marion[1], David Nelson[2], Joel Borden[2], Gabriel Langford[2], and John Dindo[3] [1]Department of Biology, University of Alabama at Birmingham [2]Department of Biology, University of South Alabama and [3]Dauphin Island Sea.

10:40 Mississippi Diamondback Terrapin (*Malaclemys terrapin pileata*) Population Surveys at Grand Bay National Estuarine Research Reserve, Mississippi . Christina F. Watters[1], Christopher A. May[1] and Mark S. Woodrey[1,2]. Grand Bay National Estuarine Research Reserve and [2]Coastal Research and Extension Center, Mississippi State University.

11:00 Preliminary Results of a Survey of the Distribution and Population Status of the Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) in the Big Bend Region of Florida. Joseph A. Butler[1] and George L. Heinrich[2] [1]Biology Department, University of North Florida; [2]Heinrich Ecological Services.

11:20 Population biology of diamondback terrapins: lessons learned from a dissertation. Kristen M. Hart, US Geological Survey, Florida Integrated Science Center.

11:40 Status of Diamondback Terrapins at the Northern Fringe. Barbara Brennessel, Wheaton College.

12:00 Lunch - Arlington Echo Dining Hall - Treasures of Echo, Steve Barry Arlington Echo Outdoor Education

Center.

Saturday, 11 August 2007

Session III - Chair Russ Burke – Field Hall

13:00 Population Pressures on Diamondback Terrapins in Lower Chesapeake Bay, Randy Chambers, Matthew Wolak, Victoria Ruzicka, and George Gilchrist, Keck Laboratory, College of William and Mary.

13:20 Assessment of the Effects of Roads and Crabbing Pressures on Diamondback Terrapins on Georgia's Coast. Andrew M. Grosse and **John C. Maerz.** D. B. Warnell School of Forestry and Natural Resources, The University of Georgia.

13:40 Use of Roadway Fencing as a Means of Preventing Diamondback Terrapin (*Malaclemys terrapin terrapin*) Mortality from Vehicle Strikes in New Jersey. I.S. Eberly and Roger C. Wood, The Wetlands Institute.

14:00 Mercury and the diamondback terrapin: A synthesis of field and laboratory studies investigating *Malaclemys terrapin* as an indicator of mercury contamination in estuaries. Courtney Arthur, Grice Marine Lab.

14:20 Patterns and ecological effects of limb loss and major shell injury in diamondback terrapins (*Malaclemys terrapin*). Michael E. Dorcas[1], Kristen K. Cecala[1], and J. Whitfield Gibbons[2] [1]Department of Biology, Davidson College; [2]Savannah River Ecology Laboratory.

14:40 Tracking terrapins through genetic analysis: Multilocus assignment tests shed light on origin of turtles sold in markets. Lori A. Lester[1], Kristen M. Hart[2], Russell Burke[3], Tim L. King[4], and Larry B. Crowder[1] [1]Duke University, Nicholas School of the Environment and Earth Sciences Marine Laboratory, [2]USGS Florida Integrated Science Center; [3]Hofstra University, Biology Program, [4]USGS, Aquatic Ecology Branch, Leetown Science Center.

15:00 Coffee Break

Session IV - Chair Willem Roosenburg – Field Hall

15:20 The Role of Demography in the Management of Maryland Terrapins: A four Act Play, Willem M. Roosenburg, Center for Ecology and Evolutionary Studies, Ohio University.

15:40 How Maryland's Commercial Terrapin Fishery was Closed Through Legislative Process. Richard Stanley[1], Alexandra Seiss[2], Jack Cover[3], Vicky Poole[3] Jeff Topping[3], Willem Roosenburg[4], Peter Paul van Dijk[5]. [1]Chesapeake Terrapin Alliance, National Aquarium in Baltimore, Ohio University Center for Ecology and Evolutionary Studies, Athens OH, Conservation International.

16:00 Use of a Traditional Harvest Method to Capture and Document Diamondback Terrapins in Winter Hibernacula in Chesapeake Bay. G. M. Haramis, P. F. Henry, D. D. Day, and D. W. Marshall, USGS - Patuxent Wildlife Research Center.

16:20 Diamondback terrapins in the Maryland Tangiers area of the Chesapeake Bay. Paula. F. Henry, D. D. Day, and G. M. Haramis, - USGS - Patuxent Wildlife Research Center.

16:40 Diamondback Terrapin Nesting Ecology at the Poplar Island Environmental Restoration Project Leah Graham[1] and Willem Roosenburg[2], [1] Environmental Studies Program, Ohio University and [2]Center for Ecology and Evolutionary Studies, Ohio University.

17:00 Compliance with BRD Regulations in a Maryland Recreational Crab Pot Fishery. Tom Radzio[1], Jaclyn Smolinsky[1] and Willem Roosenburg[2] [1]Innovative Technology Solutions, [2]Ohio Center for Ecology and Evolutionary Studies.

18:00 Banquet - Hella's Resturant Millersville Maryland: Keynote address - Live Long to Prosper– What Life Histories and Demography Tell us About the Harvest of Long-lived Organisms. Justin Congdon Sa-

vannah River Ecology Laboratory

Sunday, 12 August 2007

Session V – Chair Brian Mealey – Field Hall

9:00 Demonstration – How to get blood from a terrapin – Willem Roosenburg and others.

9:20 Impacts of nest site choice and nest characteristics on hatchling success of Diamondback Terrapins of Jamaica Bay, New York Amanda Scholz Department of Biology, Hofstra University.

9:40 Diamond-backed Terrapin Nesting Habitat Enhancement Project in Delaware Seashore State Park, Delaware. Holly Niederriter[1] and Chris Bennett[2], [1]Delaware Division of Fish and Wildlife; [2]Delaware Division of Parks and Recreation.

10:00 Coffee Break

Session VI – Chair George Heinrich – Field Hall

10:20 The South Carolina Aquarium's Diamondback Terrapin Preservation Project. Shelley Dearhart, South Carolina Aquarium, Charleston, SC.

10:40 Education Using Diamondback Terrapins: Developing Grade Appropriate Lessons for the Classroom. John P. Wnek, Harold W. Avery, James R. Spotila, and Walter F. Bien, Department of Bioscience and Biotechnology, Drexel University.

11:00 Terrapin Connection, Engaging Students with Environmental Education that Leads to Stewardship. Stephen Barry[1]**, Will Williams[1],** and Willem Roosenburg[2]**.** [1]Arlington Echo Outdoor Environmental Education Center and [2]Center for Ecology and Evolutionary Studies, Ohio University.

11:30 Ecology and Behavior of the Mangrove Terrapin (*Malaclemys terrapin rhizophorarum*) in Key West National Wildlife Refuge, FL (USA) Roger Wood and Daniel Hernandez. The Wetlands Institute, The Richard Stockton College of New Jersey.

11:20 – 13:00 Lunch Arlington Echo Dining Hall

Session VII - Chair Rich Seigel – Field Hall

13:00 - 14:40 Update and initiatives from the regional representatives. Discussion of the direction and goals of the DTWG for the next three years. Led by Rich Seigel—Towson State University

14:40 Concluding Remarks, Anders Rhodin – The Chelonian Research Foundation and IUCN Tortoise and Freshwater Turtle Specialist Group.

15:00 End of Symposium

Paper Abstracts

Courtney Arthur. Grice Marine Lab, Charleston, SC.

Mercury and the diamondback terrapin: A synthesis of field and laboratory studies investigating *Malaclemys terrapin* as an indicator of mercury contamination in estuaries.

Mercury contamination has become an increasingly important global issue over the past century, especially in susceptible aquatic environments where inorganic mercury is biotransformed to the toxic methylmercury form. Several years ago the Owens lab began an investigation into using the diamondback terrapin, *Malaclemys terrapin*, as an indicator of mercury (Hg) contamination in estuaries along the eastern coast of the United States. This comprehensive study includes (1) a preliminary field assessment of mercury levels in *M. terrapin* and the marsh periwinkle, *Littoraria irrorata*, a primary prey source, spanning 2004-2005; (2) a toxicokinetic model of mercury uptake and storage in *M. terrapin*, as derived from short and long-term captive exposure studies spanning 2004-2006; and (3) an assessment of mercury levels in *M. terrapin* on both a regional scale that spans the gradient of atmospheric Hg deposition along the eastern coast of the United States, and on a microscale in Charleston Harbor spanning summer 2006. Terrapin blood and scute matrices have been investigated, and results show these compartments to be reflective of short and long term storage, respectively. Importantly, blood and scute collection involve non-lethal sampling techniques and have proven useful compartments for toxicological analyses throughout the study.

Preliminary results of the field studies indicate the diamondback terrapin may be useful as an indicator of extreme mercury contamination. One superfund site along Purvis Creek in Brunswick, GA showed significantly higher ($\overline{x}$ = 3810.2 ng/g) scute Hg levels than all other sites sampled in 2004 ($\overline{x}$ = 309.5 ng/g). Higher levels of mercury were detected in the larger *L. irrorata* that are primarily consumed by adult females, suggesting the possibility that niche partitioning between adults explains higher levels of mercury in female scute tissue (female $\overline{x}$ = 287.1 ng/g, male $\overline{x}$ = 217.0 ng/g, $p < 0.05$). A half-life of 428 h was determined from the short-term captive methylmercury dosing experiment, with complete elimination from the body extremely unlikely. Analyses are underway to complete the toxicokinetic model with data from the long-term feeding protocol. Lastly, the microscale sampling in Charleston Harbor did not detect differences in female scute Hg levels when comparing two mercury contaminated sites and two pristine sites ($F_{3,15}$=0.66, P=0.59). Female scute mercury levels did vary along a regional gradient, with one site along the York River significantly higher than all other sites tested and one site in the far western Florida Keys with significantly lower scute mercury levels ($F_{4,25}$=22.58, P<0.0001). The York River site is directly adjacent to a coal-fired power plant, which is likely a point-source of mercury pollution that is influencing terrapin Hg levels. Analysis of prey and sediment samples collected as part of the summer 2006 protocols will aid in answering questions of mercury availability to *M. terrapin* in its local estuaries. Results from this study will determine the usefulness of using *Malaclemys terrapin*, with its long life span, high site fidelity, and ease of capture, as an indicator of mercury contamination in estuarine environments.

Patrick J. Baker[1], M. L. Perry[1], H. Chmura[1], Ros Herlands[2], and Roger C. Wood[2]. [1]Department of Biology, Swarthmore College, Swarthmore, PA and [2]Department of Biology; The Richard Stockton College of New Jersey, Pomona**,** NJ.

Environmental correlates of emergence from the nest for hatchling *M. terrapin*.

Little is known about the factors that determine emergence timing for hatchlings of *Malaclemys terrapin terrapin.* We examined the influence of environmental conditions on the timing of hatchling emergence from the nest for *M. t. terrapin* in southern New Jersey. The nesting season at our field site is constrained to spring and early summer and neonates typically emerge from the nest in late summer or early fall of the same year. However, some hatchlings overwinter in the nest and, despite intermittent frost exposure during hibernation, emerge the following spring. We will discuss the influence of rainfall, air temperature, and other environmental factors on emergence activity.

Stephen Barry[1], Will Williams[1], and Willem Roosenburg[2]. [1]Arlington Echo Outdoor Environmental Education Center, Millersville, MD; [2]Center for Ecology and Evolutionary Studies, Ohio University, Athens OH

Terrapin Connection – Engaging Students with Environmental Education that Leads to Stewardship.

Diamondback terrapins possess the appearance and appeal to captivate the attention of individuals of all ages. Because of their charismatic nature they are an excellent motivator to introduce and teach environmental ethos and stewardship. In Anne Arundel County, Maryland Public Schools, we use the terrapin as a model to introduce and teach environmental impacts and responsibility, and basic scientific principles. The environmental curriculum uses the terrapin as a focal point to lead into other topics such as habitat quality, water quality, and habitat restoration. The curriculum teaches an ecosystem approach to conservation and restoration that uses classroom terrapins as a "window" for learning about the Chesapeake Bay watershed. Our turtles originate from natural nests on Poplar Island Maryland, are delivered to the classroom, and are raised by the students. The students monitor growth and health of the turtles and raise them to a size that they can be sexed using laparoscopic endoscopy. Turtles are returned to Arlington Echo in the spring for sexing and the implantation of PIT tags. Approximately two weeks after this procedure students release their terrapins at Poplar Island. This experiential learning approach reinforces the tools of science and the need for scientifically –based approaches to environmental stewardship.

Barbara Brennessel, Wheaton College, Norton, MA

Status of Diamondback Terrapins at the Northern Fringe

Since the late 1970s and early 1980s, conservation organizations, state agencies and individual researchers have been observing the population of *Malaclemys terrapin terrapin* on Cape Cod, at the northernmost range of the species. During this time period, specific clusters of terrapins have markedly declined or have become extirpated, while others appear to be stable. I will introduce you to our Cape Cod terrapins and the individuals and organizations that conduct research, devise educational programs and design conservation strategies.

I will also describe some of our ongoing projects and conservation efforts in Wellfleet, MA. Mark/recapture studies, radio tagging, nest monitoring and other research has led to the identification of habitats that are required to support the life and activity stages of diamondback terrapins in our northern marshes and estuaries. Recent observations suggest that some of our relatively stable populations may be undergoing declines in nesting activity in specific areas, even in those that are under conservation protection. The Northeast Diamondback Terrapin Working Group has identified threats to the species, including loss and/or degradation of coastal, marsh and nesting habitat, road mortality, drowning in crab pots and dredging activities. We have produced and distributed conservation guidelines that have been shared with town planners, conservation commissions and environmental groups to highlight some of the strategies that can be used to ensure the survival of this species.

Joseph A. Butler[1] and George L. Heinrich[2]. [1]Biology Department, University of North Florida, Jacksonville, FL; [2]Heinrich Ecological Services, St. Petersburg, FL

Preliminary Results of a Survey of the Distribution and Population Status of the Ornate Diamondback Terrapin (*Malaclemys terrapin macrospilota*) in the Big Bend Region of Florida

We were awarded a Nongame Wildlife Grant (NG06-021) from the Florida Fish and Wildlife Conservation Commission to assess the distribution and population status of the ornate diamondback terrapin (*Malaclemys terrapin macrospilota*) in the Big Bend region of Florida. This region comprises four counties and includes at least 150 miles of shoreline, a majority of which is included in the Big Bend Seagrasses Aquatic Preserve. A search of 20 of the most likely museums located only 12 specimens from this area. We believe the paucity of terrapin data from this region is due to the relative inaccessibility of the coastline, a circumstance that could prove beneficial to this species. Our plan is to identify populations of diamondback terrapins from the St. Marks River south to the Suwannee River. Concomitantly, we will locate terrapin nesting sites and characterize biotic and abiotic aspects of both aquatic and nesting habitats. We will do this in a series of 10 five-day trips to the area over a three-year period, each to a different section of the Big Bend region. During each trip we will deploy six crab pots modified to a height that will allow captured terrapins to breathe at high tide. Pots will be baited with fish and checked for three days. Secondly, when

terrapins are present in creeks they frequently surface for air, so we will search as many tidal creeks as possible by boat and do "head counts." We will also search beaches and shorelines for eggshells left by nest-raiding raccoons and for terrapin skeletal remains. At the time of this writing, we have completed two field trips and have confirmed the presence of terrapins at two sites near Horseshoe Beach and three sites near Shired Island. We will have data from a third trip by the time of the symposium. We will present an ArcView map depicting our 10 launch sites and the results from this summer's fieldwork.

Randy Chambers, Matthew Wolak, Victoria Ruzicka, and George Gilchrist. College of William and Mary, Keck Lab, Williamsburg, VA.

Population Pressures on Diamondback Terrapins in Lower Chesapeake Bay

In the York River sub-estuary of Chesapeake Bay, nest predation and drowning in crab traps appear to be the factors most influential on terrapin population size and structure. Daily surveys of nesting on a complex of three small islands demonstrated high rates of nest predation by raccoons, with 99%, 92%, and 63% predation, respectively, of all eggs laid per island. A matrix model of population dynamics for terrapins from the island complex indicated the current population size was unsustainable with the high rate of nest predation. From sensitivity analysis, the intrinsic growth rate of the population was most responsive to increased survivorship of the 4-7 year age class. The blue crab fishery in southern Chesapeake Bay, however, is selectively removing a by-catch of smaller adult male and immature female terrapins in this age class. Female terrapins from the lower Chesapeake Bay population are significantly larger than females from a Connecticut population where crabbing pressure is non-existent, in a trend opposite of what would be predicted from Bergmann's rule. Further, the age-size relationship for extant Chesapeake Bay females is skewed toward larger females, relative to museum specimens collected from Chesapeake Bay before commercial crab traps were used. We hypothesize that selection against males and slower-growing females yields a surviving population of fewer males and female terrapins that have grown faster than terrapins from areas without crab traps. Sexual dimorphism in terrapins increases if females invest more energy into somatic growth than into sexual reproduction. Selection at the threshold of reproduction in the 4-7 year age class appears to be forcing a rapid evolutionary response of faster-growing female diamondback terrapins in lower Chesapeake Bay.

Andrew T. Coleman[1], Thane Wibbels[1], Ken Marion[1], David Nelson[2], Joel Borden[2], Gabriel Langford[2], and John Dindo[3]. [1]Department of Biology, University of Alabama at Birmingham; [2]Department of Biology, University of South Alabama and [3]Dauphin Island Sea.

Current Status and Future Survival of Diamondback Terrapin, *Malaclemmys terrapin pileata*, populations in the salt marshes in Alabama

Historic data and anecdotes indicate that the diamondback terrapin was once abundant in coastal waters of Alabama. Although, based on recent surveys, these populations appear to have declined in Alabama salt marshes, estuaries and bays. This is despite the fact that there is abundant salt marsh habitat for terrapin in coastal areas of Alabama and state protection for this species. The current study obtained basic demographic and ecological data of terrapins in Alabama to better understand the survival status of these populations. A variety of methodologies were utilized including head surveys and modified crab traps in salt marshes and depredated nest surveys and drift fences with pitfall traps on nesting beaches. Blood samples obtained from captured terrapins were used in both a population genetic and hormone analysis. Of all of the locations sampled, Cedar Point Marsh seems to contain the largest nesting aggregation. However, the commercial crab fishery is well established in Alabama, further prompting the examination of threats to terrapin in this area. The efficacy of bycatch reduction devices (BRD's) at preventing terrapin capture yet allowing marketable crab capture was studied in Cedar Point Marsh. In addition, area nesting beaches were examined using several physical parameters to determine which characteristics are necessary for an important terrapin nesting location. These results provide baseline data that is essential for developing effective management strategy for enhancing the survival of the diamondback terrapin in Alabama.

Shelley Dearhart. South Carolina Aquarium, Charleston, SC.

The South Carolina Aquarium's Diamondback Terrapin Preservation Project

The South Carolina Aquarium has partnered with North Inlet-Winyah Bay National Estuarine Research Reserve to work on a grant-funded education and outreach project for the summer of 2007, focusing on the preservation of South Carolina's diamondback terrapins (*Malaclemys terrapin)*. This species faces a number of threats, both natural and anthropogenic, that could potentially affect their population status if ignored. One of these threats is mortality in crab traps. Interested terrapins will enter traps which contain bait, captured crabs, or other turtles. Small rectangular devices, called excluders or by-catch reduction devices (BRDs), have been developed to modify crab trap openings and aid in decreasing the number of terrapins caught as by-catch. The South Carolina Aquarium is working to educate recreational crabbers and the general public about crab trap mortality, as well as raise awareness of and distribute BRDs to recreational crabbers throughout the state. The Aquarium is conducting educational workshops along the coast at various nature preserves and state parks informing the public about terrapins, as well as offering suggestions to aid in the species' survival. Displays are exhibited at a variety of coastal festivals, supply stores, marinas and fishing piers teaching fishermen about the ecosystem they may be affecting and giving BRDs to any recreational crabber willing to use them.

Michael E. Dorcas[1], Kristen K. Cecala[1], and J. Whitfield Gibbons[2]. [1]Department of Biology, Davidson College, Davidson, NC; [2]Savannah River Ecology Laboratory, Aiken, SC.

Patterns and ecological effects of limb loss and major shell injury in diamondback terrapins (*Malaclemys terrapin*)

Major injuries occur frequently in many turtle species as a result of attempted predation or anthropogenic factors. In declining diamondback terrapin (*Malaclemys terrapin*) populations, learning more about causes and results of injuries can be helpful in developing sound management plans. By examining patterns of limb loss and other major injuries, inferences can be made about the causes of injuries and about predators on terrapins. We examined patterns of limb loss and major shell injuries in a population of terrapins studied for 24 years at Kiawah Island, SC. The frequency of terrapins captured exhibiting limb loss declined over time, but the rate of shell injuries appears to have increased, possibly as a result of increased watercraft activity around Kiawah Island. Limb loss frequency was higher in the Kiawah River than in smaller tidal creeks. Because no differences in rates of limb loss were found between males and females, we conclude that limb loss is likely due to aquatic predators (i.e., limb loss does not appear to be the result of terrestrial predation during nesting). Analysis using Program MARK showed that terrapins with a major injury (limb loss or shell injury) have lower survivorship than uninjured terrapins. We conclude that, in addition to protection of nesting habitats, measures to protect terrapins from watercraft may increase the survivorship of adult terrapins.

Matthew Draud and Marc Bossert. Department of Biology, C.W. Post – Long Island University Brookville, NY.

Overwintering in hatchling diamondback terrapins

We studied overwintering in hatchling diamondback terrapins over three consecutive years in Oyster Bay, located along the north shore of Long Island, New York. Each year we studied hatchlings that naturally emerged from nests in August and September. We employed both mark-recapture and radio telemetry to track the movements of the hatchlings. The hatchlings spent from several weeks to two months foraging in the high marsh before moving upland into overwintering areas in October. Radio telemetry data revealed that the movement from high marsh to final hibernacula typically involved several moves over 3-8 days and covered as many as 270 meters walking distance. We found that hatchlings buried themselves in the sand above the highest high tide line in terrestrial habitat, often near the roots of clumps of grass or herbaceous plants. It was also common for hatchlings to hibernate beneath trees, especially throughout the drip zone. Hatchlings tended to move deeper into the sand until all movements ceased after soil temperatures dropped below 10-12^{o}c. Overwintering survivorship varied dramatically among years and was strongly related to minimum soil temperature in the hibernacula. Hatchlings that experienced soil temperatures below 4^{o}c for at least 12 hours all died. Some hatchlings that experienced soil temperatures less than 2^{o}c for extended lengths of time had problems with motor coordination upon emerging in the spring. These included the in-

ability to walk in a straight line and the tendency to flip over without being able to right themselves. In several animals the lack of motor coordination resolved on its own, but others died within a week of emerging. The significance of the findings will be discussed in terms of habitat requirements for the species.

I.S. Eberly and Roger C. Wood. The Wetlands Institute, Stone Harbor, NJ.

Use of Roadway Fencing as a Means of Preventing Diamondback Terrapin (*Malaclemys terrapin terrapin*) Mortality from Vehicle Strikes in New Jersey.

Every summer along the Atlantic coast of southern New Jersey, hundreds of gravid diamondback terrapins (*Malaclemys terrapin terrapin*) are run over and killed by motor vehicles as they cross roadways in search of nest sites. In view of encouraging preliminary results from a pilot study conducted in 2004, a large-scale barrier fencing project was developed during the summer of 2005. Silt fencing was installed along either side of Stone Harbor Blvd. (approximately 0.9 km = 1.77 km total) to provide an effective barrier that prevents terrapins from wandering onto heavily-trafficked roads. In addition, GPS data of terrapin road kills indicated that certain stretches of coastal roads are "hot spots" of unusually heavy terrapin mortality. From 2005-2006, the barrier fence was installed along a section of Stone Harbor Blvd. reducing the number of terrapin road kills by approximately 85% - 83%, from 46 (in 2004) to only 6 (in 2005) and 7 (in 2006). In 2006, a 0.3 km section of a promising new fencing material, “Tenax” (a thick, mesh material), was installed to determine its durability in harsh coastal conditions over the course of a year. In the summer of 2007, the fencing project was expanded to include an additional “hotspot” along a 2.28 km section of Avalon Blvd. We expect that the newly fenced roadways will further reduce terrapin mortality as was seen along Stone Harbor Blvd.

Leah Graham[1] **and Willem Roosenburg**[2]**.** [1] Environmental Studies Program, Ohio University, Athens, OH and [2]Center for Ecology and Evolutionary Studies, Ohio University, Athens, OH.

Diamondback Terrapin Nesting Ecology at the Poplar Island Environmental Restoration Project

The Poplar Island Environmental Restoration Project (PIERP) is a 475 hectare reconstruction of Poplar Island which had eroded into Chesapeake Bay. The goal of the PIERP is to use dredged material to rebuild the island and provide suitable wildlife habitat for both wetland and upland species. After the completion of the perimeter dike in 2002, diamondback terrapins (*Malaclemys terrapin*) began nesting on the PIERP and we initiated monitoring of terrapin nesting and nest success. Nesting activity and recruitment has increased from 69 nests in 2002 to a peak of 282 in 2005. Nest success on the PIERP is high compared to mainland nesting areas because the primary nest predators, raccoons and foxes, are removed. The high nest success on the PIERP has resulted in a better understanding of the proportion of nests over-wintering in the Chesapeake region allowing us to compare nest survivorship and hatchling energetics of fall and spring emerging hatchlings. Furthermore, we have marked over 3000 hatchlings and released them into the PIERP wetlands in anticipation of determining younger age class survivorship. We summarize our monitoring trends and discuss how the PIERP may serve as an example for future restoration of terrapin habitat.

Andrew M. Grosse and John C. Maerz. D. B. Warnell School of Forestry and Natural Resources, The University of Georgia, Athens, GA

Assessment of the Effects of Roads and Crabbing Pressures on Diamondback Terrapins on Georgia’s Coast

Commercial and residential development of coastal habitats places significant pressure on wildlife. The diamondback terrapin, *Maleclemys terrapin*, is one of Georgia’s “high-priority” species for conservation attention in coastal habitats. In Georgia, vehicle induced mortality has been proposed as a potentially important factor contributing to terrapin population declines; however, studies in other states suggest that bycatch mortality from neglected or abandoned crab pots may explain the declines in terrapin populations in coastal environments. The objective of our project is to assess whether road density or historic crabbing pressure is correlated with the current abundance of terrapins in tidal creeks along Georgia’s coast. We used GIS to characterize road density and crabbing effort in all of Georgia’s tidal creeks, grouped creeks into one of four classes (no roads:no crabbing, high roads:no crabbing, low roads:high crabbing, and high roads:high crabbing), and then selected 24 creeks for study using a stratified random design. We seined each creek 5 times over a 100 d period between April and June, and all terrapins captured were aged, measured, and marked uniquely. We will use general linear models and standard regression techniques to examine the relationships between road density and crabbing pressure on closed population estimates of terrapin

abundance. Results presented in the poster will be based on the first of two years of sampling effort.
G. M. Haramis, P. F. Henry, D. D. Day, and D. W. Marshall. USGS - Patuxent Wildlife Research Center Beltsville, MD.

Use of a Traditional Harvest Method to Capture and Document Diamondback Terrapins in Winter Hibernacula in Chesapeake Bay

We used a traditional harvest method of Chesapeake Bay watermen to capture and document northern diamondback terrapins (*Malaclemys terrapin terrapin*) from estuarine bay hibernacula. During winters 2003-2005, we captured 1,213 terrapins at 7 estuarine bay sites, 6 of which were located in the Tangier Sound region of Chesapeake Bay. Terrapins were captured using a modified scrape, or dredge, originally developed for commercial harvest of blue crabs (*Callinectes sapidus*). The scrape did not injure terrapins and proved an efficient capture method capable of landing as many as 160 terrapins/hr. We found terrapins aggregated at specific sites in mud-bottomed, semi-protected estuarine bays in close proximity to salt marsh. Locations had good tidal circulation and were deep enough (1.5-3.5 m) to offer little risk of dewatering even during unusually low storm tides. Cold winters (water temperatures <7ºC) produced well populated hibernacula of mostly adult terrapins with sex ratios favoring females at 6 of 7 sites. Absence of terrapins <5 years of age suggested these young age classes were hibernating at interior marsh locations. In contrast, good representation of 5 to 10 year-old females (19.0% of total female captures) indicated healthy recruitment success in the region. Observed decline in yearly captures at one site resulted from recent harvest activity, and at a second site, from the appearance of dense bottom cover of submerged aquatic vegetation. Results of an ad hoc experiment with 24 adult terrapins found removal and return to hibernacula to have no outward deleterious effects at 3 weeks post capture. Recently prohibited in Maryland, it is apparent how winter scrape harvesting of large numbers of breeding-age females from estuarine bay hibernacula could severely depopulate and suppress recruitment of local terrapin populations. In contrast, this traditional harvest method holds promise as an effective tool for scientific study and monitoring of Chesapeake Bay terrapin populations.

Kristen M. Hart. Ph.D. US Geological Survey, Florida Integrated Science Center, St. Petersburg, FL.

Population biology of diamondback terrapins: lessons learned from a dissertation.

Diamondback terrapins (Malaclemys terrapin) are distributed along the US east coast from Massachusetts to Texas in brackish water habitats. Until now, no clear population definition had been established for this continuously-distributed species, so effective conservation efforts to mitigate population-level threats have not been realized. To determine ecologically and evolutionarily relevant management units, I used molecular techniques (i.e., microsatellite DNA) to test the hypothesis that *M. terrapin* comprise one single, homogeneous population. Secondly, to assess the magnitude of the threat that actively-fished commercial crab pots pose for terrapins, I conducted experimental fishing studies with crab fishers in North Carolina and tested the ability of several bycatch reduction devices (BRDs) to exclude terrapins but retain valuable blue crabs. Finally, to estimate adult survival rate, capture probability, and abundance for the less-studied mangrove terrapin, I conducted a mark-recapture study in the Big Sable Creek (BSC) complex of the Florida Everglades and analyzed individual encounter histories. Results indicate that *M. terrapin* exists as distinct metapopulations or regional management units (MUs), which do not exactly coincide with previous morphologically-based subspecies designations. Additionally, microsatellite analysis revealed that male-biased dispersal exists in *M. terrapin*. Field studies conducted in NC revealed that terrapin interaction with blue crab fishery activity primarily occurs in the early spring, close (i.e., < 250m) to shore. Terrapin bycatch in crab pots can be mitigated by using BRDs, although some BRDs still allow adult males to enter. Larger (i.e., 5.0 cm) BRDs did not significantly affect catch rates of economically valuable crabs, but smaller (i.e., 4.5 and 4.0 cm) BRDs did ($p < 0.001$). Finally, I established the first adult survival rate ($\varphi = 0.79$) and population estimate (mean N = 1545 individuals) for mangrove terrapins, and I determined that their distribution within Big Sable Creek lies largely in unsurveyed habitat.

Paula. F. Henry, D. D. Day, and G. M. Haramis. USGS - Patuxent Wildlife Research Center, Beltsville, MD.

Diamondback terrapins in the Maryland Tangiers area of the Chesapeake Bay.

The USGS Patuxent Wildlife Research Center conducted a multi-year study to assess the population structure of the Northern Diamondback terrapin within the Maryland Chesapeake Bay. One of our study sites, Martin National Wildlife Refuge located in the lower Chesapeake Bay, is an offshore island comprised of >1600 hectares of highly pro-

ductive, nearly pristine, salt marsh vegetation interconnected by an extensive array of tidal guts. The island is abundant with high quality terrapin nesting and foraging habitat, but has few mammalian predators. Our initial efforts to capture terrapins using fyke nets situated near shore and adjacent to known nesting beaches, resulted in trapping over 1000 terrapins, 88% of which were females. To better characterize the overall population structure within this complex island environment, we designed an alternative sampling device, a baited box trap, to catch terrapins within the interior of the marsh. Box traps were distributed across 3 habitat types within the Refuge: open water, channel, and tidal pool.
Using both trapping methods, data on population structure, habitat partitioning, and seasonal distribution were collected from 3005 individuals over a 3-year period. Sampling bias and relative differences in population information obtained by comparing capture rates from three distinct trapping methods used in this research project, the fyke nets, the baited box traps, and hibernacula dredging, are discussed.

This is a preliminary report of USGS research. It has not yet been peer-reviewed and may not be cited.

Lori A. Lester[1], Kristen M. Hart[2], Russell Burke[3], Tim L. King[4], and Larry B. Crowder[1] [1]Duke University, Nicholas School of the Environment and Earth Sciences Marine Laboratory, Beaufort, NC; [2]USGS Florida Integrated Science Center, St. Petersburg, FL; [3]Hofstra University, Biology Program, Hempstead, NY; [4]USGS, Aquatic Ecology Branch, Leetown Science Center, Kearneysville, WV

Tracking terrapins through genetic analysis: Multilocus assignment tests shed light on origin of turtles sold in markets

Diamondback terrapins (*Malaclemys terrapin*) are currently sold for human consumption in many large cities in the United States. Some Asian cultural groups utilize large numbers of terrapins, both regionally and world-wide, as a protein source. Terrapin populations face many prevalent problems including predation by both native and non-native predators, and anthropogenic disturbances (such as habitat destruction, roadkill, and bycatch in blue crab traps). The additional anthropogenic dilemma of terrapins sold in fish markets is particularly troubling when added to the long list of widespread disturbances. Terrapin harvesting is restricted in each state throughout the Atlantic and Gulf coastal range of the species; however, enforcement of these restrictions is weak. The objective of our study was to determine the origin of terrapins sold in New York City's Fulton Fish Market. In 2004, we collected blood samples from 63 individual terrapins confiscated from illegal sellers in the Market. Some of these terrapins were released off the coast of Maryland, based on the belief that the terrapins were originally harvested in the Chesapeake Bay. In this study, we used microsatellite DNA variation to test the hypothesis that *M. terrapin* collected in the Market are from the Coastal Mid-Atlantic terrapin metapopulation. We extracted DNA from blood samples, performed PCR, and screened each turtle at 12 polymorphic microsatellite DNA loci developed for bog turtles (*Glyptemys muhlenbergii*). Statistical analyses relied on assignment tests to determine the most likely region of origin for each terrapin to the metapopulation and subpopulation level. Many of the terrapins were assigned to the Chesapeake Bay metapopulation (or subpopulations in Maryland); however, some terrapins were assigned to the Coastal Mid-Atlantic or the Coastal Carolina region. Rules and regulations (and the enforcement of these rules) need to be improved to adequately protect terrapins from direct harvest.

Eric C. Munscher, Candace Cox, and Joseph A. Butler, Biology Department, University of North Florida, Jacksonville, FL.

Increased Nest Success for the Carolina Diamondback Terrapin (*Malaclemys terrapin centrata*) following Raccoon (*Procyon lotor*) Removal from a Nesting Beach in Northeastern Florida.

Raccoons have been shown to depredate up to 100% of diamondback terrapin (*Malaclemys terrapin*) nests on some beaches. Previous predator removal programs have demonstrated significant decreases in depredation on turtle nests with accompanying increases in nest success. In 2005 a raccoon (*Procyon lotor*) removal program was implemented on a known diamondback terrapin nesting beach in northeast Florida to determine if this was a viable option for predator control. Terrapin nesting at this site had been monitored in 1997 and 2000 with no such predator removal program in place, and nest predation rates were 82.0% and 86.5%, respectively. Twenty-nine raccoons were trapped and lethally removed between 13 February 2005 and 31 October 2005. Terrapin nesting was monitored from 1 May 2005 until 31 October 2005. With the removal of the primary nest predator nest predation rate dropped to 24.5%, representing a 57.5-62.0% increase in nest success.

Holly Niederriter[1] and Chris Bennett[2]. [1]Delaware Division of Fish and Wildlife, Smyrna, DE; [2]Delaware Division of Parks and Recreation, Dover, DE.

Diamond-backed Terrapin Nesting Habitat Enhancement Project in Delaware Seashore State Park, Delaware

Diamondback terrapins (*Malaclemys terrapin*) have been documented attempting to cross a 4-lane 55-mph highway separating Rehoboth Bay from ocean dune habitat in Delaware Seashore State Park. Fencing was erected in recent years that appeared to deter most females from crossing the road. However, some still tried to make the trek and much of the nesting habitat previously used was no longer accessible. In an attempt to mitigate for the loss of the nesting habitat as well as keep females from attempting to cross the road, two new nesting habitats were added on the bay side of the road.

Monitoring was conducted in 2005 and 2006 to determine 1) if females would find and use the sites and 2) if the nests would be as successful as other bayside nesting habitats. The two new sites and five known nesting sites were visited daily during the nesting and emergence seasons. Data collection included approximately one hour of observation at each site at least 5 days/week (to observe nesting directly and document nest locations) and recording number of live and depredated nests. Hatch season data collection included number and location of apparent hatches as well as number of depredated nests.

Preliminary results indicate that females found and used the nesting areas. Predation appears to be low in the first year of use but may escalate as predators find the habitats and nests. Structure of habitat and amount/type of vegetation may affect amount of nest depredation.

Tom Radzio[1], Jaclyn Smolinsky[1] and Willem Roosenburg[2]. [1] Innovative Technology Solutions, Victorville, CA; [2]Ohio Center for Ecology and Evolutionary Studies, Athens OH.

Compliance with BRD Regulations in a Maryland Recreational Crab Pot Fishery

Mortality in crab pots is thought to be the leading threat to diamondback terrapins in many parts of the species' range. In 1992, Dr. Rodger Wood developed a simple by-catch reduction device (BRD) that has the potential to dramatically reduce terrapin mortality in crab pots. Over the past 15 years, a number of states have adopted regulations designed to implement BRD use in recreational, and to a lesser extent, commercial crab pot fisheries. As in other fisheries, reducing terrapin by-catch in crab pots will depend greatly on compliance levels with BRD regulations. In summer-fall 2005, we surveyed crab pots for the presence or absence of BRDs in 6 creek tributaries of the Patuxent River, Maryland. Our findings suggest that, 6 years after Maryland mandated BRD use in its recreational fishery, most recreational fishers continue to fish pots without BRDs. We suggest that requiring pots sold to recreational crabbers to already have BRDs installed would dramatically increase BRD use and decrease unnecessary terrapin mortality in the recreational fishery.

Willem M. Roosenburg. Center for Ecology and Evolutionary Studies, Ohio University, Athens, OH.

Demography of the Patuxent River Terrapin Population

I have been conducting a mark-recapture study of a population of diamondback terrapins since 1987. Population size was stable from 1987 to 1996, but declined by approximately 75% since that time. Herein, I show that this population decline is linked to several extrinsic factors that reduced adult survivorship and contributed to the decline in the population. These extrinsic factors include an oil spill, illegal and poor fishing practices, and a possible commercial harvest. These results when applied to a feasible demography modeling approach indicate that the decline in terrapin population was predictable based on the changes in survivorship experienced in this population. The findings of this research combined with modeling of other commercial species in Chesapeake Bay contributed to the closure of the terrapin fishery in Maryland.

Amanda Scholz Department of Biology, Hofstra University, Hempstead, NY

Impacts of nest site choice and nest characteristics on hatchling success of Diamondback Terrapins of Jamaica Bay, New York

Nest site choice and nest construction has the potential to play a highly significant role in the reproductive fitness of organisms. I observed diamondback terrapins (*Malaclemys terrapin*) nesting at the Jamaica Bay Wildlife Refuge in Queens, New York in 2004 (1306 hatchlings emerged from 144 nests) and 2005 (1086 hatchings emerged from 136 nests). Nest sites had significantly less overhead cover than random sites. Nest temperature, measured in critical thermal units, was affected by the percent grass cover surrounding the nest, by nest depth, and by % dicotyledonous plant cover around the nest site. The average nest temperature during the thermosensitive period was also strongly influenced by the % grass cover. Nest depth was not correlated with female size, oviposition month, average egg weight or clutch size for either year. In 2004, warmer, shallower nests were significantly more successful and in 2005 deeper, cooler nests were significantly more successful. These differences were due to the very dissimilar climate patterns in 2004 and 2005. Hatchling success was negatively correlated with the occurrence of grass for both years, although nest depth appeared to be most important for determining hatchling success in 2005 and grass cover was most important in 2004. This study suggests shifting climatic patterns may alter selective pressures on nesting turtles. However, avoidance of grass may be more consistent, because grasses are important predators of terrapin eggs.

Richard Stanley[1], Alexandra Siess[1,2,3], Jack Cover[4,1], Vicky Poole[4,1], Jeff Topping[4,1], Willem Roosenburg[5,1], Peter Paul van Dijk[6]. [1]Chesapeake Terrapin Alliance, Manchester MD; [2]The Tortoise Reserve, White Lake, NC; [3]George Washington University, Washington D. C.; [4]National Aquarium in Baltimore, Baltimore, MD; [5]Ohio University Center for Ecology and Evolutionary Studies, Athens OH; [6]Conservation International, Arlington, VA.

How Maryland's Commercial Terrapin Fishery was Closed Through Legislative Process

We present the regulatory and legislative process in Maryland resulting in the passage of House Bill 760 and Senate Bill 532 (2007). These laws permanently close the commercial take of diamondback terrapin in the State, as well as, requiring Maryland DNR to promulgate regulations for the conservation of Maryland's diamondback terrapins. A well-organized, multifaceted campaign combined public outreach, sound scientifically based findings, political lobbying and poignant testimony to develop a convincing argument to close the harvest. The Chesapeake Terrapin Alliance reveals the inside story on how we successfully organized and implemented a campaign to close Maryland's commercial terrapin fishery.

Christina F. Watters[1], Christopher A. May[1] and Mark S. Woodrey[1,2]. Grand Bay National Estuarine Research Reserve, Moss Point, MS and [2]Mississippi State University, Coastal Research and Extension Center, Biloxi, MS.

Mississippi Diamondback Terrapin (*Malaclemys terrapin pileata*) Population Surveys at Grand Bay National Estuarine Research Reserve, Mississippi

Mississippi diamondback terrapins (*Malclemys terrapin pileata*) are found along the Gulf Coast from the Florida panhandle to western Louisiana. The Grand Bay National Estuarine Research Reserve (Grand Bay NERR) is located in extreme southeastern Mississippi, near the center of the Mississippi diamondback terrapin's range. In Mississippi, the terrapin is listed as "imperiled because of rarity or factor(s) making it vulnerable to extirpation". While populations of some terrapin subspecies are well studied, little is known about the Mississippi diamondback terrapin. The last coastwide surveys for diamondback terrapins in Mississippi were completed over ten years ago. At that time, some of the largest estimated populations of diamondback terrapins were located within the Grand Bay NERR. Since then, local terrapin populations may have been impacted by nearby landfall of several major hurricanes and tropical storms, erosion of nesting beaches, and bycatch mortality in commercial crab traps. We are currently employing several methods to estimate current population status and to assess changes that may have occurred in the Grand Bay NERR terrapin populations. Techniques include nesting beach surveys, mark-recapture, genetic analysis, and sonic telemetry tracking of individuals.

John P. Wnek, Harold W. Avery, James R. Spotila, and Walter F. Bien. Department of Bioscience and Biotechnology, Drexel University, PA.

Education Using Diamondback Terrapins: Developing Grade Appropriate Lessons for the Classroom

Diamondback terrapins are found along coastal areas of the East and Gulf Coasts of the United States. A majority of the United States population can be found along coastal areas which pose a threat to terrapin habitat. Providing educational material about diamondback terrapins is an effective way to promote conservation of this species. Curricula that could be used in both formal and informal education venues will facilitate the protection of this species. Specifically, tailoring lessons to grade-specific learners including lower elementary, upper elementary, middle and high school students will provide educators with a meaningful way to engage students in terrapin classroom activities. The Marine Academy of Technology and Environmental Science, in conjunction with Drexel University, is developing terrapin lessons and learning materials that could be used in both the school and informal education settings. We are soliciting the help of the National Diamondback Terrapin Working Group for input into the development of new curricula and final review prior to publication.

John P. Wnek, Harold W. Avery, James R. Spotila, and Walter F. Bien. Department of Bioscience and Biotechnology, Drexel University, PA.

Nesting Ecology of the Diamondback Terrapin (*Malaclemys terrapin*): A Comparison of Nesting Conditions at Barnegat Bay, New Jersey

Terrestrial and aquatic habitats are critical to the survival and reproductive success of turtle species. Coastal habitats located in the United States are impacted by development, dredging, and pollution. In estuarine systems, diamondback terrapins, *Malaclemys terrapin*, are adversely affected by these anthropogenic impacts. Because natural nesting areas have been fragmented or destroyed, terrapins use such areas as roadsides and dredge islands for nesting. In the Barnegat Bay Estuary, New Jersey, a mosaic of natural and degraded ecosystems exists for terrapins to use. Marshes are often filled with sediments dredged from the bay floor and are used as nest sites by terrapins. During the 2006 field season (June – September), terrapin nests were monitored at one such site at North Sedge Island, Barnegat Bay where we determined clutch size (12.5), conducted morphometric egg measurements (length, width, mass), and relocated eggs to a hatchery on the island. Entire clutches were randomly placed in one of three 2.25 m^2 plots consisting of 1) sand, 2) sand-loam, or 3) one year removed dredge material. Each plot was further divided into a shaded and non-shaded region to determine potential effects of vegetation shading on embryo development and survivorship. Nest incubation temperatures were recorded regularly throughout incubation. The greatest hatching success and hatchling emergence occurred in the sand-loam plot with 4 out of 5 nests in the open area producing hatchlings. The one-year removed dredge material produced no hatchlings in both the open and shaded areas. There was a significant difference between hatching and emergence in the sand loam open plot versus all other treatments except for the sand loam shaded plot. There was no significant difference in mean nest temperatures between experiments plot types. Our findings suggest that although dredge islands are used by nesting female terrapins, the chemical and/or physical composition of recently dredged soil may cause hatching success of terrapins to be significantly reduced, and can have important consequences for viability of terrapin populations.

Roger Wood and Daniel Hernandez. The Wetlands Institute, Stone Harbor, NJ and The Richard Stockton College of New Jersey, Pomona, NJ.

Ecology and behavior of the mangrove terrapin (*Malaclemys terrapin rhizophorarum*) in Key West National Wildlife Refuge, FL (USA)

Mangrove terrapins (*Malaclemys terrapin rhizophorarum*) have by far the smallest range of any of the seven described subspecies of diamondback terrapin. This subspecies was first described by H.W. Fowler in 1906 on the basis of a single adult female discovered on the island of Boca Grande (now part of Key West National Wildlife Refuge) in the southwesternmost Florida Keys. No further scientific studies were undertaken until the early 1980's, when a comprehensive survey of islands in the lower Florida Keys provided the first reliable information about the distribution and abundance of mangrove terrapins. Hundreds of terrapins were marked during the surveys of the early 1980's, especially at the eastern end of Barracouta Key, which supports the densest population in the lower Keys. Field work has since continued on an intermittent basis. The region took a direct hit from Hurricane Georges in

1998, and then again by Hurricanes Katrina, Rita and Wilma in 2005. For the past three years, a team from the Wetlands Institute has returned to Key West National Wildlife Refuge to revisit all the islands where terrapins had previously been discovered. Hurricane damage has been severe on the islands (Barracouta and Boca Grande) where the greatest numbers of mangrove terrapins have been found. Nonetheless, the population of mangrove terrapins in the lower Keys does not appear to have been significantly altered since the early 1980's. Terrapins originally marked then have continued to be recovered, thus establishing the best longevity data for any population of diamondback terrapins rangewide

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Poster Abstracts

Phil Allman and Willem Roosenburg. Ohio University, Dept of Biology, Athens, OH.

Understanding the Evolution of Egg Size in the Diamondback Terrapin, *Malaclemys terrapin*

Egg size in oviparous reptiles can significantly influence life history traits such as offspring size, growth, sex, survivorship, and ultimately individual fitness. For this reason, understanding the co-evolution of egg size and clutch size is central to life history theory. The diamondback terrapin is an emydid turtle that inhabits brackish water from the coastal region of New England through Texas in the United States. Females in northern populations lay relatively small eggs in large clutches whereas females in southern populations deposit large eggs in small clutches. Neutral-lipid extractions indicate that eggs from southern populations contain a higher proportion of yolk-lipids than eggs from northern populations. Under similar incubation conditions, eggs from southern populations produce larger hatchlings that have a proportionally higher lipid stores, a higher mass-specific metabolic rate, and a faster growth rate. A common garden design experiment indicates that larger hatchlings have a growth and survivorship advantage in warmer growth treatments. These data suggest an increased metabolic demand in the warmer climates of southern populations select for larger offspring in southern populations. This constraint is released in northern populations where metabolic demands decrease during hibernation. In northern populations, females can allocate less energy to each offspring allowing for higher clutch sizes and increased fecundity.

Gaëlle Blanvillain[1], Jeffrey A. Schwenter[1], Rusty D. Day[2], Margie M. Peden-Adams[3], Steven J. Christopher[1] and David Wm. Owens[1]. [1] Grice Marine Laboratory, College of Charleston, Charleston, SC; [2] National Institute of Standards and Technology at the Hollings Marine Laboratory, Charleston, SC; [3] Marine Biomedicine and Environmental Science Center, Medical University of South Carolina, Charleston, SC.

Health impairment of a diamondback terrapin (*Malaclemys terrapin*) population at a superfund site in Brunswick, GA, USA.

Diamondback terrapins were collected from four sites in South Carolina and compared to one site in Brunswick, Georgia, which had been heavily contaminated with inorganic mercury in the past. We looked at physiological impacts of mercury on the reproductive capacity and immune function of the diamondback terrapins. Blood mercury concentrations were measured and revealed much higher concentrations in animals collected at Purvis Creek, GA compared to all other sites (mean = 746.2 ng/g and 43.2 ng/g respectively, $p < 0.001$). Testosterone levels were measured as an indicator of endocrine disruption, and were not significantly different between males. However, testosterone levels were significantly lower in females collected at Purvis Creek ($p < 0.05$), possibly due to a higher number of immature turtles in this creek, as shown by the significantly lower female body mass at this site compared to all other sites (mean weight = 516.7 g, and 865.5 g respectively, $p = 0.0018$). Lysozyme activity was measured as an indicator of immune capabilities, and revealed a significant negative correlation with blood mercury concentrations ($r_s = -0.56$, $p < 0.001$). Terrapins collected at Purvis Creek had significantly lower lysozyme activity levels than at all other sites ($p < 0.001$), which suggests terrapins at Purvis Creek might be vulnerable to bacterial infections. Indeed, we noticed a heavy infection level shown by black necrosis marks on the plastron of terrapins from Purvis Creek. This has never been seen elsewhere in our terrapin studies in four Southeastern States.

Russel Burke and Amanda Widrig. Hofstra University, Biology Program, Hempstead, NY.

Results from a public survey of range-wide trends in diamondback terrapin numbers

We created both paper and online versions of a survey to assess public perceptions of the status, distribution, and conservation concerns of diamondback terrapins (*Malaclemys terrapin*). The survey asked both closed and open-ended questions about observations of terrapins in the field. The paper copies of the survey were mailed to 300 nature centers, natural history museums, zoos, as well as to herpetologists, ichthyologists, marine patrol and wildlife conservation officers throughout the 16 states where terrapins occur. The online version was heavily publicized through professional and amateur herpetology listserves, state and regional kayakers clubs, articles in the state wildlife magazines of each state and a popular herpetoculture magazine. 614 surveys were completed, which included numerous people from each state in the terrapin range. Responders were associated with a wide variety of non-governmental organizations and numerous levels of government. Most of responders (67%) reported seeing terrapins at least once per year, so we considered these people fairly familiar with terrapins. The most commonly observed terrapin behaviors were swimming and basking. Just over half of the responders who expressed an opinion thought that terrapin populations in their areas were decreasing, and very few know of either new terrapin populations or terrapin populations that were increasing. Over 20% of the responders knew of a terrapin population that had significantly declined or gone extinct. Responders identified habitat destruction, nest predators, and by-catch in crab traps as the most serious threats to terrapin populations in their area. This survey suggests although most research on terrapins is focused on nesting ecology, most people see terrapins performing other activities. Also, although many terrapin researchers believe terrapin numbers are decreasing, respondents to this survey were more evenly split.

C. M. Coleman, H.W. Avery, W.F. Bien, and J.R. Spotila. Department of Bioscience and Biotechnology, Drexel University Philadelphia, PA.

Impacts of Habitat Fragmentation on the Mating System of the Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*) in the Barnegat Bay Estuary

Estuaries are among the most productive ecosystems in the world and provide critical resources and habitat for birds, fish, marine invertebrates, and other wildlife. Barnegat Bay is a 70 km estuary located along the central coast of New Jersey and is ecologically threatened by changes in water quality, habitat alteration, fisheries decline, and other human activities. The Barnegat Bay National Estuary Program has outlined priority problems and solutions needed to restore and protect the ecological functions of the estuary. Approximately 45 percent of the shoreline is bulkheaded by man-made walls to prevent beach erosion. In addition, 70 percent of the shoreline is altered by development and 35 percent of the submerged aquatic vegetation has been lost. Furthermore, 60 percent of marshes are ditched to enable access for fish to control mosquito populations. We propose to use the diamondback terrapin as an indicator of estuary function because this turtle species is a habitat generalist, utilizing both land and aquatic habitats within the estuary. Anthropogenic changes in the estuary may reduce terrestrial nesting areas and aquatic feeding habitat. This loss of habitat may cause population declines and reduction of movements of terrapins between preferred habitats. By reducing effective population size (i.e., number of breeding individuals in a population, denoted as N_e) and dispersal of individuals, the mating system of terrapins (e.g., monogamy, polyandry, polygyny) may also be altered. Because terrapins exhibit both general habitat and nest site fidelity, mechanisms that reduce inbreeding may be important for increasing N_e . The N_e affects the rate of genetic drift, rate of loss of genetic diversity, and the rate of inbreeding within a population. Mating systems and kin avoidance (i.e., avoidance of mating with siblings), are mechanisms that reduce inbreeding, however these mechanisms may be impaired with increased habitat fragmentation. We propose to characterize the genetic structure of the diamondback terrapin within Barnegat Bay and to study kin avoidance and mating systems in five study sites throughout the Bay with different levels of habitat fragmentation. We will determine whether terrapins avoid inbreeding depression while maintaining N_e sufficient for the long-term viability of the diamondback terrapin population of Barnegat Bay.

Candace Cox, Eric Munscher and Joseph A. Butler. Department of Biology, University of North Florida, Jacksonville, FL.

Home Range of the Carolina Diamondback Terrapin (*Malaclemys terrapin centrata*) in Northeastern Florida

The diamondback terrapin is a brackish water turtle with seven subspecies and a range along the Atlantic coastline from Cape Cod, Massachusetts to the southern tip of Florida and along the Gulf Coast to Texas. In various populations throughout their range terrapins have been found to return to nesting areas in subsequent years and also to exhibit site fidelity. Other than this, little is known concerning their movements throughout the year. One North Carolina study presented home ranges for 29 adult terrapins over two years in several artificial ditches in Davis Marsh, but this is the only such information presently in print. We followed nine female Carolina diamondback terrapins (*Malaclemys terrapin centrata*) with radio telemetry for periods ranging from two to ten months in northeastern Florida. In 1997-1998, we tracked two terrapins captured in Deep Creek, which is a tidal creek off the Intracoastal Waterway located about 3.7 k north of the St. Johns River; and three terrapins captured at a nesting beach adjacent to the Nassau River. In 2000-2001, we tracked four terrapins, all from Deep Creek. We attached a transmitter to the rear of the carapace of each terrapin using marine epoxy. Each transmitter was situated such that the 25 cm whip antenna broke the surface when terrapins surfaced for air or if they were buried in shallow mud. We attempted to locate all terrapins at least twice during each week of the study. When terrapins were located, GPS coordinates were recorded, and, with these GPS points, home range was determined using ESRI ArcMap 9.2 and Hawths Analysis Tools for ArcGIS9. Both the adaptive and fixed kernel methods and the minimum convex polygon method will be presented and the results will be compared to those of the North Carolina study.

Andrew K. Davis[1], Aaliyah D. Green[2] and John C. Maerz[1]. D. B. Warnell School of Forestry and Natural Resources, The University of Georgia, Athens, GA and University of Georgia Savannah River Ecology Laboratory, Aiken, SC.

Plastron melanization and levels of mercury are related in diamondback terrapins

Melanin is best known as a pigment that produces dark color in the skin, feathers and scales of vertebrates. Dark coloration protects against UV rays, can be important in social or interspecific interactions, and among reptiles aids in the absorption of light during basking. Melanin also has a lesser known function in the detoxification of heavy metals such as mercury. Mercury is a pervasive industrial pollutant in estuaries of the eastern United States, and has been a focal contaminant in numerous studies of coastal fauna including diamondback terrapins (*Malaclemys terrapin*). As part of a larger study, we used digital image analysis to evaluate levels of shell asymmetry and pigmentation in relation to mercury levels among 32 hatchling terrapins. Mercury level among terrapins was not correlated with the amount of shell asymmetry; however, mercury level among terrapins was negatively correlated with the darkness of a terrapin's plastron [an indication of melanin production]. In other words, terrapin hatchlings with darker plastrons had lower mercury levels. There are two possible explanations for this pattern. First, terrapins with high melanin levels have a higher detoxification capacity and, therefore, do not accumulate mercury as readily as conspecifics with low melanin levels. Alternatively, terrapins exposed to higher mercury levels must divert more melanin to metal detoxification and away from shell pigmentation. Our results suggest that shell coloration may be a reliable field indicator of mercury loads among individual terrapins. In addition, our results suggest that individuals may vary in their capacity to handle mercury contamination, which may be important for understanding human-driven evolutionary changes to this species.

J. M. Fekete, H.W. Avery, W.F. Bien, and J.R. Spotila. Department of Bioscience and Biotechnology, Drexel University Philadelphia, PA 19104.

The Impacts of Estuarine Development on Nesting Success of Diamondback Terrapins (*Malaclemys terrapin*) in Barnegat Bay, NJ.

Anthropogenic degradation of estuaries results in alteration and destruction of some of the world's most productive ecosystems. Our research focuses on direct and indirect effects that coastal development has on a model estuarine vertebrate, the diamondback terrapin (*Malaclemys terrapin*). The diamondback terrapin is an estuarine turtle and is an integral part of the salt marsh food web. The terrapin faces multiple threats from anthropogenic activities. Direct threats include incidental mortality by cars, boats and crab traps and habitat loss due to shoreline devel-

opment. Indirect effects, or ecological interactions resulting indirectly from a change in the ecosystem, are difficult to detect but can have profound impacts. With increasing coastline development a reduction in available nesting habitats may force terrapins to nest in closer proximity to home ranges of predators of their eggs and hatchlings. Predation is often the primary cause of terrapin nest failure. An increasing human population may cause an increase in the populations of opportunistic predator species by providing predators with abundant food sources. These predator species in turn affect the abundance of terrapins by predating on terrapin nests. Barnegat Bay may contain high densities of opportunistic predators within close proximity to terrapin nesting beaches due to high human population density. Dredging, another major anthropogenic impact to estuaries, has occurred along the U.S. coast for over a century. Sediment from dredging is used to create artificial islands and to fill in or "enhance" shorelines. Islands made from dredged sediments, or dredge spoil islands, serve as nesting habitat for terrapins, with the potential benefit that they are isolated from areas with high densities of mammalian predators. Our research will determine terrapin nesting success on beaches that vary in distance from human development. We will also identify predator species and determine predation rates of terrapin nests on natural islands, dredge spoil islands and mainland beaches. We will statistically compare hatching success rates and predation rates at all types of nesting areas. Our findings will help identify nesting beaches that are critical for the nesting ecology of the terrapin, and will help determine management actions necessary to increase the nesting success and population viability of this model estuarine vertebrate.

Megan A. First. Keck Environmental Lab, College of William and Mary, Williamsburg, VA.

Effects of Nest Predation and Crabpot Mortality on the Age and Size Structure of a Diamondback Terrapin Population in Virginia

The diamondback terrapin has been subjected to numerous anthropogenic threats for over a century. In several parts of its range the terrapin has been listed as threatened or a species of special concern. The reasons for the most recent declines appear to be heavily attributed to nest predation by subsidized predators and drowning in commercial crabpots. The present work aims to determine the impacts of nest predation and drowning in crabpots on a population of terrapins inhabiting the Goodwin Islands complex in the Chesapeake Bay National Estuarine Research Reserve in Virginia. The first phase will determine whether the age structure of nesting females is skewed toward older age classes on the three islands where observed nest predation rates are known to exceed 85% and recruitment is expected to be low. The average age of nesting females on each island will be determined and compared to levels of predation pressure for each island. During the nesting season, beaches are monitored daily for female terrapins that are aged, measured, and weighed prior to release. The island-specific number of eggs per clutch will also be used a proxy for differences in fitness among islands. The second phase of the research will determine the impact of crabpot mortality on growth and reproduction. We have hypothesized that if crabpots are selecting for fast-growing females, then reduced energy for reproduction may be a necessary trade-off. Age specific clutch size, egg mass, and size of females nesting on the Goodwin Islands, where crabpot mortality is extensive, will be measured. The same measurements will be made for females nesting on a small sub-estuary upstream from the Goodwin Islands where crabpot mortality is non-existent. Age-specific averages will be compared to determine if females do in fact grow more quickly when crabpots are present and so respond with reduced reproductive output.

Leigh Anne Harden[1], Shannon E. Pittman[1], J. Whitfield Gibbons[2], and Michael E. Dorcas[1]. [1]Department of Biology, Davidson College, Davidson, NC and [2]Savannah River Ecology Laboratory, Aiken, SC.

Two heads are better than one: development of a rapid assessment technique for diamondback terrapin (*Malaclemys terrapin*) populations using headcounts

Although diamondback terrapins appear to be declining throughout much of their geographic range, more information is required to evaluate population trends. Unfortunately, sampling terrapin populations is both time and labor intensive. We have initiated studies to examine the efficacy of using headcounts in tidal creeks as a rapid-assessment technique for monitoring terrapin populations. In 2005, as part of a 24-year study of terrapins at Kiawah Island, SC, we began headcount surveys in conjunction with regular aquatic sampling. Headcount surveys consisted of recording the number of terrapin heads we observed from a boat going up (run 1) and down (run 2) tidal creeks. These surveys were conducted before aquatic sampling (i.e., low tide) as well as other times (e.g., high tide). We found a significant relationship between the number of heads seen and the number of terrapins cap-

tured (R^2 = 0.543). The number of heads seen in run 1 combined with run 2 provided the strongest correlation with the number of terrapins captured. We also examined the effect of other variables such as day of year, time of day, cloud cover, and creek location on the number of heads seen. We plan to refine our model by including other locations along the east coast. The development of a refined model will allow rapid assessment of terrapin populations and effective monitoring of population trends, thereby improving implementation of appropriate conservation measures.

Leigh Anne Harden[1], Nicholas A. DiLuzio[1], J. Whitfield Gibbons[2], and Michael E. Dorcas[1]. [1]Department of Biology, Davidson College, Davidson, NC and [2]Savannah River Ecology Laboratory, Aiken, SC.

Spatial and Thermal Ecology of Diamondback terrapins (*Malaclemys terrapin*) in a South Carolina Salt Marsh

East coast barrier islands, such as Kiawah Island, South Carolina, have experienced rapid urbanization resulting in alteration of their salt marsh ecosystems. These estuarine ecosystems serve as critical habitat for numerous endemic wildlife species, such as diamondback terrapins (*Malaclemys terrapin*), which are particularly vulnerable to anthropogenic disturbances. To better understand the interactions between terrapins and their environment, we initiated an intensive six-day radiotelemetric study to investigate the daily movements and habitat use of five terrapins within a tidal creek. In conjunction with radiotelemetry, we used micro-dataloggers to continuously monitor both terrapin and environmental temperatures. We found that during high tides, low tides, and ebbing tides, terrapins spent more time in the marsh (*Spartina* sp., mud, and occasional shallow water) than in the open water of the creek channel. Terrapins remained within the same tidal creek system and moved a mean total distance of 750 m with individual total distances moved ranging from 440 to 1159 m. From 13 May until 1 June 2006, carapace temperatures of two male terrapins varied from 16.0 to 41.0 C. Comparing these temperatures to environmental temperatures allowed us to make detailed inferences about basking behavior. Our short radiotelemetric study provides new insight to understanding diamondback terrapin habitat use and site fidelity, which will assist in making management decisions and in developing predictive models to estimate population sizes.

Daniel Hernandez & Roger Wood. The Richard Stockton College of New Jersey, Pomona, NJ and The Wetlands Institute, Stone Harbor, NJ.

Preliminary results of radio telemetry to analyze movement patterns of mangrove terrapins (*Malaclemys terrapin rhizophorarum*) in Key West National Wildlife Refuge, FL (USA)

We conducted a pilot radio telemetry study using eight adult female mangrove terrapins (*Malaclemys terrapin rhizophorarum*) on Barracouta Key in Key West National Wildlife Refuge, FL, from 9 March 2007 to 15 March 2007. Additionally, we collected spatial data using GPS from other recaptured mangrove terrapins not fitted with transmitters. Data obtained from this study suggest that mangrove terrapins can move significant distances from day-to-day (and even within a single day) throughout the island interior. We relocated mangrove terrapins in both red mangroves (*Rhizophora mangle*) fringing the island and black mangrove (*Avicennia germinans*) forests in the interior of the island. It has generally been thought that mangrove terrapins do not move much while in island interiors and that black mangrove forests are their preferred habitat. Our initial findings do not support those assumptions. Our data suggest that mangrove terrapins may travel between the island's edge and its interior on a regular basis. Our results indicate that mangrove terrapins may seek shelter in the forested interiors of islands and feed in the waters surrounding the island.

Erin Horn. Department of Biological Sciences, Hofstra University, Hempsted NY.

Patterns of Diamondback Terrapin Activity at an Urban National Park Over a 14 Year Period As Revealed by Park Ranger Field Notes

Many ecological studies are short term; this is particularly problematic when dealing with phenomena that change year to year and that involve species that are very long-lived. One way to extend the time span of a study is to make use of old records from previous researchers. Since 1999, we have been studying the diamondback terrapins of Jamaica Bay Wildlife Refuge, part of Gateway National Recreation Area. This urban park spans the mouth of the Hudson River, and has been a major recreational area for the people of New York City since its creation in 1972.

The Park Ranger staff began keeping records on terrapin sightings in 1979 and continued until 1992, with a total of 338 records of separate sightings. These records reveal patterns of terrapin behaviour that we have not seen in our more recent work.

Park Ranger records show that hatchling terrapins were found on land every month from April through December, with peaks in May-June and September-October. Hatchling records from very early in the spring indicate hatchlings that either overwintered in the nest or overwintered in surface terrestrial environments. Hatchling records in the middle of the summer probably indicate hatchlings that spent considerable amounts of time on land after emerging. The number of hatchlings seen per year has stayed fairly constant, with a high of 21 and an average of nine hatchlings per year.

Park rangers observed large breeding congregations (up to 220 terrapins) in the bay; recently, we have not seen any more than 30 at one time. There were also large numbers of terrapins sighted in June and July, the time in which females come ashore to lay eggs. The park records have provided us with valuable information about past population numbers and behavioral patterns that may be useful in our future work.

Kerry Muldoon. Dept. of Biological Science, Hofstra University, Hempstead, NY.

Terrestrial movements of Diamondback Terrapin hatchlings (*Malaclemys terrapin)* on Long Island, New York

Terrestrial movements of hatchling diamondback terrapins, *Malaclemys terrapin*, are poorly known. Literature suggests hatchlings may migrate either to the water or towards vegetation, but there is little documentation supporting either claim. There have been no in-depth or long-term studies to determine why terrapins behave so differently from other aquatic turtle hatchlings. Aquatic environments can offer hatchlings predator protection and a freeze-proof overwintering location. Vegetated upland locations could also offer predator protection or food availability. My research focuses on determining the terrestrial movements of hatchlings and why they may choose terrestrial locations over aquatic habitats. Eleven drift fences were installed in four areas of Jamaica Bay Wildlife Refuge (JBWR), part of Gateway National Recreation Area on Long Island, New York. Each area had at least two drift fences. Small pitfall traps were placed one meter apart along the fence line, parallel to the fence and submerged up to the top under sand or dirt. I monitored each container daily before dusk between August 6, 2006 and October 29, 2006. Each captured hatchling was marked, measured, photographed, and placed on the opposite side of the fence under vegetation. Forty-seven hatchlings were found and six were later recaptured. The majority of the hatchlings were moving upland towards vegetation. This study will continue Spring and Fall 2007.

Jacob R. Owens[1] and Roger C. Wood[1,2] . [1]The Wetlands Institute, 1075 Stone Harbor Blvd, Stone Harbor, NJ and[2]The Richard Stockton College of NJ, Pomona, NJ.

Tracking northern diamondback terrapins (*Malaclemys terrapin terrapin)* in a southern New Jersey (USA) salt marsh using sonic telemetry.

Except for information about nesting activities, relatively little is known about the behavior or ecology of wild populations of northern diamondback terrapins. Diamondback terrapins are a cryptic species. Only females are seen on land during the early summer nesting season. Males never emerge onto land. What these turtles spend most of their time doing out in their salt marsh habitat is largely unknown. In order to gain more knowledge about their detailed movements, a sonic telemetry program was initiated at the Wetlands Institute during the summer of 2005. So far more than 40 female diamondback terrapins found in the vicinity of the Wetlands Institute in Stone Harbor, NJ, have been equipped with mobile transmitters (Vemco V9-2L-R04K coded pingers) and released back into the salt marsh. Nine stationary receivers (Vemco VR2), strategically placed throughout the marsh, pick up signals sent by the terrapin transmitters, allowing us to record their movements. Results so far show that there is considerable individual variation in the movements of different terrapins.

Margaret Perry and Patrick Baker. Department of Biology, Swarthmore College, Swarthmore, PA.

Differences in scute anomaly type and frequency in male and female diamondback terrapins

Previous research has suggested a positive correlation between incubation temperature and frequency of scute

anomalies in the diamondback terrapin (Malaclemys terrapin). Since diamondback terrapins have temperature-dependent sex determination, with higher incubation temperatures producing females, it seems likely that female terrapins would have more scute anomalies than males. Male and female diamondback terrapins were trapped in two salt marsh creeks in southern New Jersey during June and July 2007. The type and frequency of scute anomalies in these turtles were recorded and compared between the sexes. Split cervical scutes occur with equal frequency in males and females, while some other anomalies show more variation with sex. It appears that incubation temperature may influence different types of anomalies to different degrees, perhaps because some anomalies are genetically determined while others are developmental in origin.

Sara Petrochic and Matthew Draud. Department of Biology, C.W. Post – Long Island University, Brookville, NY.

Analyses of bite force, head shape, and prey preference in the diamondback terrapin.

Diamondback Terrapins are one of a few emydid turtle species that are specialized to crush mollusk and crustacean prey. The ability to crush prey that posses calcareous and chitinous exoskeletons presumably requires a skull design that allows forceful jaw closing. We directly measured bite force in terrapins ranging in carapace length from approximately 30 mm to 220 mm using a gnathodynamometer. We quantified differences in head shape through skull and mandible measurements and by conducting shape analyses on digitized photographs. We found significant differences in the head shapes of males and females and a great deal of variation within the sexes. Female terrapins produced significantly greater bite force than similarly sized males, and overall attributes of head shape strongly influence bite force. The best correlates with bite force were measurements of the lower jaw length. Terrapins had significantly greater bite forces compared to those of a closely related emydid species, the red eared slider, which does not specialize in crushing prey with hard shelled exoskeletons. Prey preference from feeding choice experiments and fecal analyses will also be presented.

Fourth Symposium on the Ecology, Status and Conservation of the Diamondback Terrapin 10-12 August 2007, Arlington Echo Outdoor Education Center, Annapolis, MD

Regional Reports
Presented 12 August 2007

Russell Burke, Northeast

15 members of the NE group met Sept 06
- talked about census techniques, applicable averages – broad areas, looking for user friendly way to expand knowledge of terrapin populations
- CNET – use them to collect information on mortality
- Ocean kayaking group very interested in working with the NE region. They know a lot about where populations of terrapins are, and could be an untapped resource
- Management guidelines for homeowners

Chuck Landry will take the Regional Rep position from Russ.
Next meeting will be in the Spring (TBD)

Paula Henry, Mid-Atlantic

- Three annual meetings
  - 30 members met in 2005 at the Wetland Institute
  - 2 conference calls in 2006, one on nesting surveys, and one on marking techniques
    - There was some discussion on writing up methods to make them easily available to students and resource biologists. Also proposal to hold future conference call on education.
  - ~25 members last met in March of 2007, at the Biden Center in DE.

At all meetings and conference calls, Maryland DNR representatives have willingly participated, and presented

information and updates regarding the commercial harvest and regulations

Areas of focus in the Mid Atlantic meetings:

Map out the specific locations and summaries of ongoing and historic research and monitoring activities in the Mid Atlantic Region.

To assess what information is available on specific populations

To identify areas of data/information gaps

To identify potential resource for future monitoring or management strategies

To identify PI and facilitate exchange of what techniques have been tried and what works etc.

Offer to add the same information for other Regions if there is an interest – contact co-chairs of Mid Atlantic with summary and specific locations to be added to map. Chris Bennett of the DE DNR is willing to update the map information

Develop a series of position papers on critical issues and risk factors concerning diamondback terrapins.. The target audience is primarily State legislators and resource managers.

Position papers focus on 1 issue, summarizing any relevant data related to historical, biological, and legislative issues. Includes references and is based on the science.

One page fact sheet on the issue – drawn from the position paper but summarized in 1 page.

At this time the first position paper has been produced on the issues of terrapins in the pet trade and is being circulated for review.

Next MidAtlantic Regional Meeting is planned for February 9th, at VIMS in Wachapreague, VA.

Regional co-chairs are Ruth Boettcher and Holly Niederriter, but Holly can't start until Aug '08.

Paula will stay on until that time.

Meg Hoyle, Southeast

Road mortality in South Carolina

Ghost trap problems in SC & GA

Targeted stake holders and invited them to a regional meeting

- National Estuarine Research Reserve System has been a good partner in every state with terrapins;

Met with GA transportation officials, who agreed to delay program a year to study turtle crossing problem

SC removed the terrapin as a game species, and legislation passed to start crab pot cleanup

BRD survey – working with crabbers on this one

- GA DNR statewide terrapin survey
- Teacher workshop now includes terrapins
- Meg has been a speaker at numerous outreach venues
- Upcoming goals:

Causeway project that will be an example of how things should be done

Move the BRD research forward

George Heinrich, Florida

Florida is a single state region, since it includes both Atlantic and Gulf of Mexico

Coastline of Florida represents approximately 20% of the species' entire range

Three subspecies are endemic, with a total of 5 of the 7 formally described subspecies present

Consequently, FL is an important state for terrapin conservation

Florida region has met annually since 2004

minutes of the 2005 and 2006 meetings are posted on the DTWG website

majority of each meeting consists of presentations on Florida-based research projects

also discussions regarding research needs, conservation concerns and actions needed

The number of Florida terrapin researchers and projects has grown over the past ten years

- Crab pots and habitat loss continue to be major concerns

Initiation of field studies, crab pot regulations and distributional surveys rank high as conservation actions needed

Our region has not agreed on any specific DTWG projects to date, but has discussed conservation needs with both FWC and DEP staff

FWC was exploring the development of an issues team (current status unknown)

Regulatory change requiring BRDs has been proposed by Butler and Heinrich
Several groups in the state have initiated ghost pot cleanup efforts

Kristen Hart has agreed to serve as the new regional rep

- next regional meeting will likely be in Cedar Key in early 2008

Christina Watters, Gulf Coast

most Gulf Coast regional members were unable to attend the 2004 meeting because of Hurricane Ivan
met in 2004 at the University of MS
another meeting in 2005 was cancelled due to a visit by Katrina
meeting in 2006 in MS was well attended
regional issues include TED's and ghost pot retrieval
no meeting since 2006 – hoping to restart with a Gulf symposium in 2008 to generate some studies
DTWG will help provide some expertise

Fourth Symposium on the Ecology, Status and Conservation of the Diamondback Terrapin 10-12 August 2007, Arlington Echo Outdoor Education Center, Annapolis, MD

Discussion Session 12 August 2007

Four areas of concern/discussion that were raised at the last triennial meeting:

1: Are terrapin populations more of less secure/stable?
2: Have any threats increased or decrease since the last meeting?
3: Are 2004 conservation methods still valid?
4: Shat have we learned about terrapin ecology since2004?

1: Are terrapin populations more secure?

In the Chesapeake, more secure thanks to the ban on harvest, but there are still serious negative impacts due to habitat & nesting loss (increased coastal development; more and more recreational crab pots; less natural beach areas, etc.)

Do we have an agreed upon population status assessment method that can be used across the board?
Are there stable populations, and what differentiates these areas?

2: Increased or decreased threats?

Identified in 2004: Crab pots – habitat – nest alteration – predation –cars – propeller hits

Climate Change models show dramatic losses of salt marshes and nesting habitat
Crab pots are a matter of education and enforcement, so may be declining in importance relative to the others items on the list, but will always be a problem for juveniles and males
Some progress made on pots and cars

3: 2004 conservation methods still valid?

Crabbing regulations – Habitat protection – Population studies – Trap removal – Field Studies – Distribution surveys – Habitat identification

Need to determine what the population stability is and label it so we have something to work with

CITES deals with international trading issues, and would not effect how we study the species; IUCN is biology based, and would be more pertinent and helpful to the DTWG focus

CITES deals with international trading issues, and would not effect how we study the species; IUCN is biology based, and would be more pertinent and helpful to the DTWG focus
Add Education

4: What have we learned since 2004?

We don't need any more studies on clutch size, frequency, nesting patterns or seasonal activity
In 2004, needed more data on :
adult survival - juvenile survival - long term population viability - multi-matings – paternity

Still don't really know enough about clutch frequency. We don't know how many *don't* nest, and can't do fecundity estimates without this information
Some progress on adult survivorship
Genetic data sets – phylogeny of terrapins is a mess. Might find that subspecies are actually a separate species, which could effect our status of populations studies, if they are not really the same

Fourth Symposium of the Ecology, Status & Conservation of the Diamondback Terrapin
Diamondback Terrapin Working Group

Minutes - Business Meeting
10 August 2007

Present:
Joe Butler, Co-chair
Willem Roosenburg, Co-chair
George Heinrich, FL Regional Representative
Meg Hoyle, SE Regional Representative
Roger Wood
Dan Day
Christina Watters
Tom Radzio
Russell Burke, NE Regional Representative
Paula Henry, Mid-Atlantic Regional Representative
Mary Hollinger, Secretary
Justin Congdon

Reviewed **Treasurer's report**, submitted by Brian Mealy. For reasons unknown, the account, originally opened in NY, incurred exorbitant bank fees ($488.90 over a 2 year period) Brian moved the account to a FL bank, and the fees should no longer be an issue. Willem noted that there will probably be an additional ~$5000 by the end of the symposium, bringing the balance to something near $10,000. Over 80 people have registered for this symposium.

Currently only the DTWG Treasurer has signature authority. Brian suggested that the Board consider authorizing another signer. This was agreed, and that responsibility will go to the Senior Chair.

It was also suggested that the Treasurer collect the money, but that someone else keep track of the membership. Rather than set up a Membership Secretary, this will fall to the Secretary. An online membership application will be put online. Due to costs incurred when using credit cards or Paypal, we will accept checks only. Forms will be mailed the Secretary, who will record the membership information and forward the checks to the Treasurer. The Secretary will be responsible for maintaining a mailing list and sending dues reminders.

It's election time. Joe & Willem will continue on as Senior co-chairs. Russell Burke is the only candidate on the ballot for Junior co-chair. Elections will be held at the end of the sessions on Saturday afternoon, 11 August 2007. Only

members may vote, and are so designated by green dots on their meeting badges.
It was also noted that the Bylaws require an elections committee.
What do the dues get members? A suggestion that a newsletter should be sent out periodically; the DTWG literature site needs to be pass-worded to avoid copyright infringements, and that would be members only; other??

Accomplishments over the last three years:

The DTWG logo has been designed and approved and is in use
The By-laws have been approved by the Board, and are now official
The Solicitation of Contributions (SOC) and 501(c)(3) status is in the works
We're incorporated as a Not For Profit in the State of Florida
The Maryland terrapin fishery was closed down
The terrapin was removed as a game species in South Carolina
The DTWG website was set up, and the literature section was especially appreciated
The listserve is up and running

DTWG brochure:

Discussions on what we want in terms of content, format and purpose. The general sentiment was the simpler, the better. Bookmarks and postcards have proven very popular for several groups. Paula noted that the Mid-Atlantic representatives (Paula, Ruth and Holly) had begun work a series of position papers. They are nearly finished with the first one on terrapins as pets. These papers will be submitted to the membership at large for comments, but final approval will be voted on by the Board. General education materials including power point slide presentations and .PDF brochures will be solicited from members by Russ, and compiled and put online. There was also support for generating a canned presentation which could be used by anyone at meetings which might be good targets for the Working Group.

It was suggested that the DTWG might try to get corporate sponsors to help publish and distribute printed materials. The graphic designers that helped us with the logo offered to work on a brochure. The Board agreed to pay them up front for the work they did on the logo, rather than the longer process of giving them a cut of any product sales.

There are some changes in the (not elected) regional officer levels.
Holly Niederriter and Ruth Boettcher have agreed to take over as regional reps for the Mid-Atlantic area, but neither can do so until 2008. Willem suggested that perhaps Patrick Baker might be willing to step in.
Kristen Hart is willing to take the Florida region.
Chuck Landry is the most likely to chair the NE and has said he would do it.
Gulf region? Christina Watters is willing to assist there if Tom Mohrman needs help.
Discussion ensued about how the DTWG can best help the Gulf region. There aren't a lot of researchers in that area, and there hasn't been a regional meeting there since 2006. Meg suggested tapping the National Estuarine Research Reserve (NERR) for help - both money and coordination - in setting up a regional meeting. DTWG would help provide expertise and would help the region formulate questions about the terrapin populations and what needs to be done there. Christina will spearhead that effort.

Goals for the next three years:

Set up a regional Gulf Coast meeting
Do the brochures/postcard outreach items
Put together a generic presentation
Generate the range maps - who's doing what, where
Set up a clearinghouse for pit tags users
Write position papers on terrapin issues for state managers and regulators

List of Attendees and Participants

Phil Allman
Department of Biological Sciences
Florida Gulf Coast University
Ft Meyers, FL 33965
pa508701@ohiou.edu

Andrew Agyekumhene
University of Ghana
Ghana, Africa

Courtney Arthur
Grice Marine Lab
205 Fort Johnson Rd.
Charleston, SC 29412
cdarth@gmail.com

Harold W. Avery
Department of Bioscience and Biotechnology,
Drexel University
Philadephia, PA 19104

Patrick J. Baker
Department of Biology
Swarthmore College
Swarthmore, PA 19081
bakerpj@muohio.edu

Sarah Barlow
Tybee Island Marine Science Center
PO Box 1879
Tybee Island, GA 31328
sbarlow@tybeemsc.org

Sandy Barnett
Chesapeake Terrapin Alliance
355 Stafford Drive
Catonsville, MD 21228
sandybarnett@comcast.net

Steve Barry
Arlington Echo Outdoor Education Center
Millersville, MD 21108
sbarry@aacps.org

Chris Bennett
Delaware Division of Parks and Recreation
89 Kings Highway
Dover, DE 19901

Walter F. Bien
Department of Bioscience and Biotechnology
Drexel University,
Philadelphia, PA 19104

Gaëlle Blanvillain
Grice Marine Laboratory
College of Charleston
205 Fort Johnson Road
Charleston, SC 29412

Ruth Boettcher
VA Department of Game and Inland Fisheries
PO Box 476
Painter, VA 23420
ruth.boettcher@dgif.virginia.gov

Joel Borden
Department of Biology
University of South Alabama
Mobile, Alabama 36688

Marc Bossert
Department of Biology
C.W. Post – Long Island University
720 Northern Blvd
Brookville, NY 11548
marcnys@yahoo.com

Natalie Boydston
Department of Biological Sciences
Ohio University
Athens, OH 45701

Barbara Brennessel
Wheaton College
26E. Main Street
Norton, MA 02766
bbrennes@wheatonma.edu

Russell Burke
Hofstra University
Biology Program
Hempstead, NY 11549
biorlb@hofstra.edu

Joseph A. Butler
Biology Department
University of North Florida Jacksonville, FL 32224 jbutler@unf.edu

Kristen K. Cecala
Department of Biology
Davidson College
Davidson, NC 28035-7118

Randy Chambers
College of William and Mary
Keck Lab, Rm 101
Wake Drive
Williamsburg, VA 23187
rmcham@wm.edu

H. Chmura
Department of Biology
Swarthmore College
Swarthmore, PA 19081

Steven J. Christopher
National Institute of Standards and Technology at the Hollings Marine Laboratory
331 Fort Johnson Road
Charleston, SC 29412

Scott Clark
Department of Biological Sciences
Ohio University
Athens, OH 45701

Andrew Coleman
Campbell Hall 255
Dept. of Biology
1300 University Blvd.
University of Alabama at Birmingham
Birmingham, AL 35294
colemana@uab.edu

Claire Coleman
Department of Bioscience and Biotechnology
Drexel University
3141 Chestnut St.
Philadelphia, PA 19104
cmc76@drexel.edu

Justin Congdon
Savannah River Ecology Laboratory
Bar Boot Ranch
Box 1128
Douglas, AZ
congdon@vtc.net

Jack Cover
National Aquarium in Baltimore
501E. Pratt Street/Peir 3
Baltimore MD 21202
jcover@aqua.org

Candace Cox
Department of Biology
University of North Florida, Jacksonville, FL 32224
coxc0006@unf.edu

Larry B. Crowder
Duke University
Nicholas School of the Environment and Earth Sciences Marine Laboratory
Beaufort, NC 28516

Andrew K. Davis
D. B. Warnell School of Forestry and Natural Resources,
The University of Georgia
Athens, GA 30602

Dan D. Day
USGS Patuxent Wildlife Research Center
c/o BARC-EAST Bldg 308 Rm 114
10300 Baltimore Avenue
Beltsville, MD 20705
dday@usgs.gov

Rusty D. Day
National Institute of Standards and Technology at the Hollings Marine Laboratory
331 Fort Johnson Road
Charleston, SC 29412

Shelley Dearhart
South Carolina Aquarium
100 Aquarium Wharf
Charleston, SC 29401
Phone: 843 579-8565
sdearhart@scaquarium.org

Nicholas A. DiLuzio
Department of Biology
Davidson College
Davidson, NC 28035-7118
nidiluzio@davidson.edu

John Dindo
Dauphin Island Sea Laboratory
101 Bienville Blvd
Dauphin Island, AL 36528

Michael E. Dorcas
Department of Biology
Davidson College
Davidson, NC 28035-7118
midorcas@davidson.edu

Matthew Draud
Department of Biology
C.W. Post – Long Island University
720 Northern Blvd
Brookville, NY 11548
mdraud@liu.edu
Ilene "Bean" S. Eberly
The Wetlands Institute
1075 Stone Harbor Boulvard
Stone Harbor, NJ 08247
research@wetlandsinstitute.org

Julie Fekete
Department of Bioscience and Biotechnology
3141 Chestnut St.
Philadelphia, PA 19104
Jf82@drexel.edu

Megan A. First
Keck Environmental Lab
College of William and Mary
Williamsburg, VA 23187
mafirs@wm.edu

J. Whitfield Gibbons
Savannah River Ecology Laboratory
Drawer E
Aiken, SC 29803
gibbons@srel.edu

George Gilchrist
College of William and Mary
Keck Lab, Rm 101
Wake Drive
Williamsburg, VA 23187

Leah Graham
Environmental Studies Program
Ohio University
Athens, OH 45701
lg370206@ohio.edu

Jordan Gray
Armstrong Atlantic State University
10012 White Bluff RD APT 105
Savannah, GA 31406
jg7217@students.armstrong.edu

Aaliyah D. Green
D. B. Warnell School of Forestry and Natural Resources
University of Georgia
Savannah River Ecology Laboratory
Drawer E
Aiken, SC 29802

Paul Gritis
Gritis Books
PO Box 283
Coopersburg, PA 18036
pgritis@yahoo.com

Andrew M. Grosse
D. B. Warnell School of Forestry and Natural Resources
The University of Georgia
Athens, GA 30602
grossea@warnell.uga.edu

Anna-May Hansen
CBEC and Montgomery County Schools
20136Timber Oak Lane
Germantown, MD 20874
Turningthetide1@aol.com

Mike Haramis
USGS Patuxent Wildlife Research Center
c/o BARC-EAST Bldg 308 Rm 114
10300 Baltimore Avenue,
Beltsville, MD 20705
mharamis@usgs.gov

Leigh Anne Harden
Department of Biology
Davidson College
Davidson, NC 28035-7118
leharden@davidson.edu

Kristen M. Hart
US Geological Survey
Florida Integrated Science Center
600 Fourth Street South
St. Petersburg, FL 33701
kristen_hart@usgs.gov

Kelly Haskett
University of Huston, Clear Lake
126 Whiston WQay S.
Alvin, TX 77511
kellihaskett@yahoo.com

Melanie Heckman
Department of Biological Sciences
Ohio University
Athens, OH 45701

George L. Heinrich
Heinrich Ecological Services
1213 Alhambra Way S.
St. Petersburg, FL 33705-4620,
george@heinrichecologicalservices.com

Paula F. Henry
USGS - Patuxent Wildlife Research Center
Beltsville Lab
c/o BARC-East, Building 308
10300 Baltimore Avenue
Beltsville, Maryland 20705
paula_henry@usgs.gov

Ros Herlands
Department of Biology
The Richard Stockton College of New Jersey
Pomona, NJ 08247
rherlands@stockton.edu

Daniel Hernandez
The Richard Stockton College of New Jersey
Pomona, NJ 08247
daniel.hernandez@stockton.edu

Mary Hollinger
NOAA
PO Box 965
Huntingtown, MD 20639
canoe2@chesapeake.net

Erin Horn
Hofstra University
2338 Lefferts Pl.
Bellmore, NY 11710
erinehorn@yahoo.com

Meg Hoyle
3002 Myrtle Street
Edisto Island, SC 29843
megcoastal@aol.com

Gina Hunt
MD Department of Natural Resources
Tawes State office Building - B2, 580 Taylor Ave.
Annapolis, MD 21401
ghunt@dnr.state.md.gov

Brian Kelley
The Wetlands Institute
1075 Stone Harbor Boulvard
Stone Harbor, NJ 08247
bmkelley@udel.edu

Tricia Kimmel
Maryland Department of Natural Resources Cooperative Oxford Lab, 904 S. Morns St.
Oxford, MD 21654
tkimmel@dnr.state.md.us

Peter King
Francis Marion College
PO Box 100547
Florence, SC 29501
pking@fmarion.edu

Brooks Kohli
Department of Biological Sciences
Ohio University
Athens, OH 45701

Lori A. Lester
Duke University
Nicholas School of the Environment and Earth Sciences Marine Laboratory
Beaufort, NC 28516
lorilester@gmail.com

Ken Marion
Campbell Hall 255
Dept. of Biology
1300 University Blvd.
University of Alabama at Birmingham
Birmingham, AL 35294

John C. Maerz.
D. B. Warnell School of Forestry and Natural Resources
The University of Georgia
Athens, GA 30602
jmaerz@warnell.uga.edu

Dwight. W. Marshall
Smith Island, MD 21824

Kaitlin Mattos
8269 Hammond Branch Way
Laurel, MD 20733
kjmattos@wustl.edu

Christopher A. May
Grand Bay National Estuarine Research Reserve
6005 Bayou Heron Road
Moss Point, MS 39562

Jeff Morgen
University of Maryland Science tech Program
701 East Pratt Street, Suite 200
Baltimore, MD 21202
morgen@umbi.umd.edu

Rick Morin
MD Department of Natural Resources
Tawes State office Building - B2, 580 Taylor Ave.
Annapolis, MD 21401
RMorin@dnr.state.md.us

Kerry Muldoon
Dept. of Biological Science
Hofstra University
Hempstead, NY, 11549
Kerry.Muldoon@yahoo.com

Eric Munscher
Department of Biology
University of North Florida, Jacksonville, FL 32224;
mune0001@unf.edu

Holly Niederriter
Delaware Division of Fish and Wildlife
4876 Hay Point Landing Road,
Smyrna, DE 19709
Holly.Niederriter@state.de.us

Mark Outerbridge
Bermuda Zoological Society
PO Box FL 145
Flatt's FLBX
Bermuda
mouterbridge@gov.bm

David Nelson
Department of Biology
University of South Alabama
Mobile, Alabama 36688

Margie M. Peden-Adams
Marine Biomedicine and Environmental Science Center
Medical University of South Carolina
Charleston, SC 29412

David Wm. Owens
Grice Marine Laboratory
College of Charleston
205 Fort Johnson Road, Charleston, SC 29412
owensd@cofc.edu

Jacob R. Owens
The Wetlands Institute
1075 Stone Harbor Blvd
Stone Harbor, NJ, 08247

Alexander Patterson
Barrington Land Trust
16 Sweetbriar Drive
Cranston, RI 02920
alex2525@mail.uri.edu

Sara Petrochic
Department of Biology, C.W. Post – Long Island University
720 Northern Blvd.
Brookville, NY 11548
spetrochic@gmail.com

M. L. Perry
Department of Biology
Swarthmore College
Swarthmore, PA 19081

Shannon E. Pittman
Department of Biology
Davidson College
Davidson, NC 28035-7118
shpittman@davidson.edu

Vicky Poole
National Aquarium in Baltimore
501E. Pratt Street/Peir 3
Baltimore MD 21202
vpoole@aqua.org

Tom Radzio
Innovative Technology Solutions
7686 SVL Box 13233 Sea Gull Dr.
Victorville, CA 92395
tomradzio@hotmail.com

Dianna Ramirez
University of Huston Clear Lake
1506 Goliad Avenue
LeMarque TX 77568
diannaLramirez@hotmail.com

Bill Richardson
Mississippi Department of Marine Resources
1141 Bayview Avenue
Bilon, MS 39530
bill.richardson@dmr.ms.gov

Anders Rhodin
Chelonian Research Foundation
168 Goodrich Street
Lunenburg, MA 01462
RhodinCRF@aol.com

Willem M. Roosenburg
Ohio Center for Ecology and Evolutionary Studies
Department of Biological Sciences
107 Irvine Hall
Ohio University
Athens Ohio, 45701
roosenbu@ohio.edu

Eric Rulison
Hofstra University
2771 Mayfield Place
North Belmont, NY 11710
elrulison@gmail.com

Victoria Ruzicka
College of William and Mary
Keck Lab, Rm 101
Wake Drive
Williamsburg, VA 23187

Amanda Scholtz
Department of Biology
Hofstra University
Hempstead, NY 11549
aw_star@hotmail.com

Jeffrey A. Schwenter
Grice Marine Laboratory
College of Charleston
205 Fort Johnson Road Charleston,SC 29412
jeffrey@schwanks.com

Rich Seigel
Department of Biology
Towson University
8000 York Road
Towson, MD 21252
rseigel@towson.edu

Alexandra Seiss
Chesapeake Terrapin Alliance
turtles@toast.net

Alanna Silva
Socio-environmental and Water Resources Institute
Federal Rural University of Amazonia - UFRA
Belém, Pará, Brazil

Phillip Skipwith
The Wetlands Institute
1075 Stone Harbor Boulvard
Stone Harbor, NJ 08247
stk28675@loki.stockton.edu

Charlotte Sornborger
Barrington land Conservation Trust
1 Wildacrs Lane
Barrington, R! 02806
c_sornborger@hotmail.com

Jaclyn Smolinsky
Innovative Technology Solutions
7686 SVL Box 13233
Sea Gull Dr. Victorville, CA 92395

James R. Spotila
Department of Bioscience and Biotechnology
Drexel University, PA 19104

Rick Stanley
Chesapeake Terrapin Alliance
Manchester, MD 21102

Kaci Thompson
University of Maryland
Fear the Turtle Program
1313 Symons Hall
College Park, MD 20742
kaci@umd.edu

Jeffery Topping
National Aquarium in Baltimore
501E. Pratt Street/Peir 3
Baltimore MD 21202

Tony Tucker
Mote Marine Laboratory
1600 Ken Thompson Parkway
Sarasota, FL 34236
tucker@mote.org

Diane Tulipani
Virginia Institute of Marine Science
PO Box 1346
Glouster Point, VA 23062
dctulip@vims.edu

Peter Paul van Dijk
Conservation International
2011 Crystal Drive, Suite 500
Arlington, VA 22202
p.vandijk@conservation.org

Christina Watters
Grand Bay National Estuarine Research Reserve
6005 Bayou Heron Road
Moss Point, MS 39562
christina.watters@dmr.ms.gov

Thane Wibbels
Campbell Hall 255
Dept. of Biology
1300 University Blvd.
University of Alabama at Birmingham
Birmingham, AL 35294
twibbels@uab.edu

Amanda Widrig
Hofstra University
Biology Program
Hempstead, NY
Will Williams
Arlington Echo Outdoor Education Center
Millersville, MD 21108
wrwilliams1@aacps.org

John P. Wnek
Department of Bioscience and Biotechnology
Drexel University, PA 19104
jwnek@mail.ocvts.org

Matthew Wolak
College of William and Mary
Keck Lab, Rm 101
Wake Drive
Williamsburg, VA 23187

Roger C. Wood
Department of Biology
The Richard Stockton College of New Jersey,
Pomona, NJ 08247
research@wetlandsinstitute.org

Mark S. Woodrey
Grand Bay National Estuarine Research Reserve
6005 Bayou Heron Road
Moss Point, MS 39562
Drexel University, PA 19104
jwnek@mail.ocvts.org

Summary of Revenues and Expenditures for Symposium

Revenues	
Grants and Awards	
Chelonian Research Foundation	$1,000.00
MD DNR	$500.00
MD Sea Grant	$500.00
OU ORSP	$800.00
OU Biological Sciences	$500.00
Nature Conservancy	$1,000.00
Chesapeake Bay Foundation	$1,000.00
Fear the Turtle	$1,000.00
Chesapeake Bay Trust	$2,115.00
Funds raised through registration, Membership Fees and Silent Auction	$8,464.00
Total Revenues	**$16,879.00**
Expenses	
Nick's of Clinton	$281.18
Hellas Lounge and Resturant	$3,378.41
Hellas Lounge and Resturant	$100.00
Wawa	$23.55
Precision Imprints	$939.50
Precision Imprints	$1,057.50
Precision Imprints	$349.00
Staples	$118.17
Arlington Echo	$1,500.00
American Airlines	$382.59
Arlington Echo	$1,748.59
Arlington Echo	$2,417.59
Total Expenses	**$12,296.08**

Top Left: Claire Coleman demonstrating drawing blood from a terrapin. Top Right: Willem Roosenburg drawing blood from a terrapin. Below: Attendees listening to presented papers. Left: Justin Congdon delivers his keynote presentation at the banquet.