Poster Abstracts

GIS Analysis of Nesting Habitat Preferences in *Malaclemys terrapin* along the Patuxent River, Maryland

Phil Allman, Meghan Holcombe and Willem Roosenburg, Department of Biological Sciences, Ohio University, Athens, OH 45701; PA: pa508701@ohio.edu

GIS-based spatial analysis generates predictive geographical nesting distribution models based on the presence of suitable habitat. These models provide details of animal-habitat relationships that can be used to improve the current conservation and species management plan. During the 2000 and 2001 nesting seasons, the Patuxent River, Maryland was extensively surveyed for *Malaclemys terrapin* nesting activity as well as habitat characteristics describing each nest. All habitat characteristics were ranked and mapped for each nest using GIS software. Terrapins nested primarily in sunny habitats but showed no preference for, or against, vegetation cover. Higher nesting densities were observed on sandy beaches adjacent to pocket-marshes, whereas sandy beaches at a larger distance to marshes had lower nesting densities. Sea walls function as barriers to reach the nesting habitat above the tidal zone. Other erosion control methods, such as T-groins and offshore, segmented rip-rap, have the potential for maintaining, and even creating, nesting habitat while simultaneously providing shoreline stability. These data maps can be used to locate suitable nesting habitat so that erosion control methods and other landscape modifications can be performed in a way that minimizes the impact on habitats.

Activity of the Mississippi Diamondback Terrapin (*Malaclemys terrapin pileata*) along the Alabama Coast

Joel A. Borden, Gabriel J. Langford and David H. Nelson, University of South Alabama, Department of Biology, LSCB RM 124, Mobile, AL 36688; GJL: gjl302@jaguar1.usouthal.edu

Diamondback terrapins were sampled from April to August 2004, along the western coast of Alabama from Bayou Heron to Mon Louis Island. Several trapping techniques were utilized, including the following: nesting pitfall traps, modified crab traps and visual transects. Terrapins were individually marked (notching marginal scutes), weighed and measured (carapace length, carapace width, shell height, plastron length, tail length, and head width). Females were palpated for eggs, anomalies (predation marks, prop scars, barnacle and oyster fouling) were noted, and all individuals were digitally photographed. Our study attempted to systematically document the abundance and distribution of terrapins in Alabama coastal waters. There are no population data available on the terrapin in Alabama. The terrapin is currently listed as a high conservation risk by the state of Alabama. Further research is needed to help identify current threats to terrapin populations in Alabama and to allow for the conservation of the species in its natural habitat.

The Status and Demography of Two Populations of Ornate Diamondback Terrapins (*Malaclemys terrapin macrospilota*) on the West Coast of Florida

Christopher S. Boykin, Biscayne Bay Aquatic Preserve, 1275A NE 79th Street, Miami, FL 33138; christopher.boykin@dep.state.fl.us

Three sampling methods were utilized to capture *Malaclemys terrapin macrospilota* at Tarpon Key in Pinellas County, Florida and in the Saint Martins Keys (SMK) in Citrus County, Florida. During the months of September through January from 1998 through 2004, 149 terrapins were marked at TK. In October through December of 2003 and May through June of 2004, 369 terrapins were marked at SMK. Recapture rates for TK and SMK were 60% and 37% respectively.

Catch per unit effort (CPUE) was calculated for each of the three sampling methods. Five modified blue crab traps (1.6 m tall) and five standard blue crab traps with floatation devices were baited with 3.2 kg of ground menhaden chum and deployed in the waters surrounding TK and SMK. CPUE for the trapping method were found to be 0.56/trap day at TK and 1.5/trap day at SMK. Mangrove surveys were conducted by walking the islands' interior black mangrove forest. CPUE for mangrove surveys were found to be 0.5/hour at TK and 2.2/hour at SMK. Lagoon surveys were conducted at TK by wading through the interior lagoon during extreme low tides in January. CPUE for lagoon surveys at TK were 2.5/hour.

Sex ratios were female-biased (2.5:1 at TK and 1.1:1 at SMK). Mean mass for females was 994 g for TK and 1,184 g at SMK. Mean mass for males was 306 g at TK and 354 g at SMK. Mean straight plastron length (SPL) for females was 16.5 cm at TK and 17.5 cm at SMK. Mean SPL for males was 11.0 cm at TK and 11.8 cm at SMK. Morphological variations, barnacle loads, predation rates, and population estimates are also compared.

Predator Excluders Improve Survival of Hatchlings Without Altering Nest Temperatures

Barbara Brennessel[1] and Don Lewis[2]; [1]Department of Biology, Wheaton College, Norton, MA 02766; [2]Massachusetts Audubon Society, Wellfleet Bay Wildlife Sanctuary, P.O. Box 1054, South Wellfleet, MA 02663; BB: bbrennes@wheatonma.edu

Variable rates of nesting as well as nest depredation occur in diamondback terrapin nesting areas in Wellfleet, Massachusetts. In some locations, predators destroy 30-40% of the nests, while in other nesting areas over 90% of the nests are depredated. Most nests are destroyed within a few days after egg deposition. Beginning with pilot projects in 2001, we have employed predator excluders, made from hardware cloth, to protect diamondback terrapin nests. The viability of hatchlings in protected nests is very high. Of 27 protected nests in 2001, only one was destroyed. In 2002, only one of 56 protected nests was depredated. To ensure that predator excluders do not alter nest temperatures, and thus hatchling gender ratios and/or time for hatchlings to develop and emerge, we conducted field studies of soil and nest temperatures in protected and control nests. Our studies indicate that our nest protectors do not alter soil or nest temperatures. The excluder devices affected neither the 2-7^{o} C diel temperature variation nor the times of daily high and daily low temperatures. There is more temperature variation due to nest location than to any effects that can be attributed to the excluders.

Effects of Pollution on the Life History of the Diamondback Terrapin

Dawn Ford and Willem Roosenburg, Department of Biological Sciences, Ohio University, Athens, OH 45701; DF: df362190@ohiou.edu

Turtle conservation typically focuses on habitat loss, head starting programs and human-induced mortality from fisheries practices. Although these data are crucial to the persistence of chelonian populations, turtles are also impacted by a myriad of other anthropogenic factors. Turtles, and especially terrapins, inhabit highly industrialized areas replete with numerous chemical contaminants. Environmental pollutants can directly affect organisms by decreasing survival or indirectly by altering factors that influence life history traits and ultimately affect fitness. Here we report some results from two studies; first, we present data suggesting terrapin exposure to oil spills decreases hatching and survival and then, we provide causative evidence about the effects of PCBs on terrapin growth. Terrapins exposed to even our lowest sublethal dose of PCB 126 were significantly smaller in mass and length. Turtles may seem very resilient to pollutants based on the high tissue contamination levels reported in the literature, however, the effects of contaminants can be somewhat cryptic and long term. If we are going to effectively conserve and manage turtle populations, we must do so with breadth, considering ecological, physiological and toxicological parameters.

Use of a Traditional Harvest Method to Sample Diamondback Terrapins in Winter in Chesapeake Bay

Michael Haramis[1], Paula F. P. Henry[1], Daniel D. Day[1], and Dwight W. Marshall[2]; [1]U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, MD 20708; [2]P.O. Box 665, Tylerton, MD 21866; MH: michael_haramis@usgs.gov

Harvest of diamondback terrapins (*Malaclemys terrapin)* in Chesapeake Bay historically took place in the winter months using dredges of various configurations. We worked with Dwight W. Marshall, an experienced terrapin harvester from Smith Island to document these methods first-hand, to assess the effects of commercial harvest on local populations, and potentially adapt the methods for scientific study. In the winters of 2003 and 2004, we used a modified crab scrape to dredge 766 terrapins at seven hibernacula, six of which were located in the Tangier Sound area. The scrape was framed from cold-rolled steel stock, was 1.7 m wide and trailed an 8 cm mesh nylon bag to retain terrapins. The scraping bar was equipped with 30 downward facing teeth (15 cm long) to help remove terrapins from soft bottom sediments. Hibernacula were located in semi-protected estuarine bays normally within 300 m from nearby marsh. These sites were characterized by water depths of 2 to 4 m and bottoms of moderately soft mud. These conditions provided for good tidal circulation, even under ice cover, while at the same time protecting against dewatering at extreme low storm tides. The cold winters of 2003 and 2004 ($<7^{o}$ C February water temperatures) produced well-populated hibernacula of primarily adult terrapins. The dredge did not injure terrapins and proved to be an efficient capture method capable of landing 100 terrapins/hour in some circumstances. We found terrapins abundant at most sites and site-specific sex ratios to vary widely. Most importantly, our sampling revealed the relative ease of harvest of large numbers of adult females from estuarine bay hibernacula. Removal of large numbers of breeding-age females could have long-term effects on local terrapin populations.

Population Study of the Diamondback Terrapin in the Maryland Chesapeake Bay

Paula F. P. Henry, Daniel D. Day and Michael Haramis, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, MD 20708; PFPH: paula_henry@usgs.gov

The USGS Patuxent Wildlife Research Center is conducting an extensive study to address the distribution and population viability of the northern diamondback terrapin (*Malaclemys terrapin terrapin*) within the Chesapeake Bay. The current status of the bay's terrapin population is unknown but like many aquatic species within the bay, terrapins may be adversely affected by factors such as degradation of their critical habitat and continued commercial exploitation. In 2003, focal population studies were initiated at two sites along the Maryland eastern shore: the first is an upper bay site at Eastern Neck National Wildlife Refuge, characterized by extensive agricultural and residential development; and the second is a lower bay site at Glenn L. Martin National Wildlife Refuge, characterized as a remote, pristine salt marsh. Site specific demography and population estimates are based on mark-recapture data collected throughout the year. During the 2003 and 2004 nesting seasons, fyke nets and baited box traps yielded greater than 3,300 terrapins, including more than 600 recaptures. Differences in relative occupancy rates within marsh habitat types are presented. Ultimately, information on resource needs, population size, structure, and age-class specific survivorship estimates generated by this study will assist resource managers in their efforts to preserve diamondback terrapin populations and their habitats in the Chesapeake Bay.

Conservation of Northern Diamondback Terrapins (*Malaclemys terrapin terrapin*) in Southern New Jersey: Comparison of Artificial Incubation with Natural Incubation

Rosalind L. Herlands and Roger C. Wood, Richard Stockton College of New Jersey, Pomona, NJ 08240 and The Wetlands Institute, 1075 Stone Harbor Boulevard, Stone Harbor, NJ 08247; RLH: rherlands@stockton.edu

For the past 15 years, we have recovered potentially viable eggs from roadkilled diamondback terrapins during the nesting season in June and July. These eggs are then placed in artificial nests (clean plastic storage boxes containing sterile, moist vermiculite), which are incubated under controlled conditions in the laboratory. In a typical year we will incubate 750 to 1,000 eggs with an average hatching success of 40%. The resultant hatchlings are headstarted for nine to ten months and then returned to the wild population in the local salt marsh from which their mothers emerged the previous year. We have established the critical temperatures for producing female and male hatchlings. Because these efforts are part of a larger conservation project, we intentionally produce mostly females to replace those lost on the local salt marsh roads. However, the replacement is only partial because each year we return far fewer hatchlings than the number of adult females killed. We are currently tagging the hatchlings with microchips just before release in an effort to determine their long-term survival in the wild. We have recently started to compare artificial incubation with natural incubation. Nests laid along the nature trail at The Wetlands Institute have been protected with predator exclosures (21 nests in 2001, 30 nests in 2002, 98 nests in 2003, and 38 nests in 2004). Temperature probes were placed in several of the nests. We have documented the emergence of hatchlings from these natural nests, as well as the number of eggs in each nest that hatch and the location of these nests (in shade or full sun) versus the length of the incubation period. Preliminary data from our first three years of observations show: 1) unlike the eggs in our artificial incubated nests, most of the eggs in these protected nests did complete development, 2) hatchlings in several of the nests overwintered, and 3) hatchlings from the same nest do not emerge simultaneously. During the summers of 2002 and 2003, we also placed potentially viable eggs from roadkills into "simulated" nest sites near the exclosures of natural nests in order to compare the hatching success and the size of the hatchlings with those from our artificially incubated nests.

Use of Ultrasound, Laparoscopy, and Testosterone Levels in Determining the Reproductive Biology of the Diamondback Terrapin, *Malaclemys terrapin*, in the Estuaries of Charleston, South Carolina

A. Michelle Lee[1], David W. Owens[2] and William A. Roumillat[3]; [1]Medical University of South Carolina, CCEHBR, 219 Ft. Johnson Road, Room 248, Charleston, SC 29412; [2]College of Charleston, Grice Marine Laboratory, 205 Ft. Johnson Road, Charleston, SC 29412; [3]South Carolina Department of Natural Resources, Marine Resources Division, P.O. Box 12559, Charleston, SC 29422; AML: leea@musc.edu

Five hundred seventy-five diamondback terrapins (210 females, 365 males) were sampled from Charleston Harbor and the Ashley, Cooper and Wando Rivers. *Malaclemys terrapin* exhibited a reproductive cycle described as post-nuptial, in which gonadal recrudescence occurs in the late summer and fall prior to winter hibernation. The probable mating season subsequently occurred in the spring upon emergence from winter hibernacula.

Based on oviducal egg presence, the nesting season of the Charleston Harbor estuarine system's *Malaclemys terrapin* populations occurred from 25 April to 2 August. Follicular diameters were minimal after the nesting season, with ovarian growth occurring throughout the late summer and fall. Female testosterone showed significant temporal variation (χ^2= 91.1, 9 df, P<0.0001). Testicular development was minimal in the spring and summer, and peak spermatogenesis occurred in the fall. Likewise, testes were easily visible with ultrasound in the fall when testes were turgid and active, as the epididymides began to fill with spermatozoa. There was significant temporal variation in male testosterone (χ^2= 142.0, 9 df, P<0.0001). There was no significant spatial variation in testosterone for males or females among the four sampling areas (χ^2 < 6.19, 3 df, P< 0.178).

This baseline information regarding the seasonal reproductive activity of the diamondback terrapin may be used in the future to reduce anthropogenic threats, such as human activity on and near the terrapin nesting beaches and breeding waters during the nesting season. Timing of coastal development projects should be altered to avoid nesting and mating seasons.

A Short History of the Illustration and Related Literature of *Malaclemys terrapin* (Schoepff)

Chuck Schaffer, 13811 Tortuga Point Drive, Jacksonville, FL 32225; chelonian1@aol.com

Schoepff's biological investigation of *Malaclemys* incorporated illustration as an integral element, important for reasons more complex than appearances would warrant. Zoological illustration has evolved through a complex development of various styles and techniques from cave art to modern photography. Initially appearing in paper form on manuscripts, it advanced from woodcuts, to engravings on steel or copper plates as in Shaw's *Testudo concentra* (1802) and Boulenger's *Malacoclemmys terrapin* (1889). A major turning point in zoological illustration came with the 1800s when the scientific method's influence was coupled with vivid hand-colored realism in works such as Latreille's *Testudo centrata* (1801), Holbrook's *Emys terrapin* (1842) and Wied's *Emys pileata* (1865). This period also witnessed increasing numbers of works written for public appeal with common animals like the diamondback terrapin seen in new and different ways. Early images, rather than documenting scientific fact, were often exaggerated or enhanced, seeking appeal with symmetrical unrealistic poses or stylized designs, often the result of social or religious pressure. Others were copied from earlier works, with detail deteriorating in subsequent appearances, or drawn from descriptions rather than life, giving credence to inaccuracies, myths and errors. Eventually, chromolithography, the first true color printing, appeared and was augmented with monochrome photography in Hay (1905). With photography, fewer illustrations are drawn; yet these illustrations remain an important teaching/documentation tool, more reproducible than

photographs. Images may also serve, not only to document or teach, but even as type specimens (neotypes), the case with Gray's *Chitra indica*, and Schoepff's *Malaclemys (Testudo) terrapin*.

Mercury… It's What's For Dinner?

Jeffrey A. Schwenter[1], Gaëlle Blanvillain[1], Russell Day[2], and David W. Owens[1]; [1]College of Charleston, Grice Marine Laboratory, Charleston, SC 29412; [2]National Institutes of Standards and Technology, Hollings Marine Laboratory, 331 Fort Johnson Road, Charleston, SC 29412; JAS: jeffrey@schwanks.com

The unique conditions existing in estuaries make these habitats a major repository for mercury pollution in the southeast U.S. They serve as important sites for the microbial transformation of inorganic mercury into the more toxic and bioavailable methylmercury. As a relatively abundant, long-lived estuarine species, the diamondback terrapin (*Malaclemys terrapin*) may serve as a sentinel species for methylmercury pollution in Atlantic and Gulf Coast estuaries. Blood, keratin and marsh periwinkle (*Littorina irrorata*) methylmercury concentrations are being used to establish baseline mercury contamination levels in male and female terrapins and their prey species in four South Carolina estuaries (Winyah Bay, Charleston Harbor, Cape Romain, and ACE Basin) and one Georgia estuary (Brunswick/Purvis Creek). A kinetics experiment is investigating short-term temporal changes in blood $^{201}Hg/^{202}Hg$ ratios as the result of a non-natural isotopic dietary methylmercury exposure. Subsequent long-term feeding studies are investigating bioaccumulation of mercury in various tissue compartments. Keratin deposition is being monitored by alternating control and treatment doses and periodically administering isotopically enriched diets. Blood and keratin should reflect mercury deposition on different time scales and may, therefore, be used to develop an Index of Recent Exposure (IRE). Laser ablation depth profiling will allow for additional examination of chronological scute mercury deposition. These experiments allow for the determination of mercury levels along a major portion of southeastern coastline and have implications for the health of terrapin populations and estuaries as a whole. Terrapins may serve as an important indicator of mercury pollution in these estuaries and the large number of commercially important species they contain.

Strategies for Protecting a Colony of State-endangered Diamondback Terrapins in Rhode Island

Charlotte B. Sornborger, Barrington Land Conservation Trust, 1 Wildacre Lane, Barrington, RI 02806; c_sornborger@hotmail.com

Discovery of the last substantial population of diamondback terrapins in Rhode Island has led to actions taken by the Barrington Land Conservation Trust to protect the terrapins' foraging/basking/nesting habitats. Actions include: 1) a fifteen-year population study by local volunteers*, a student intern program, amplified by investigations of several Master's and Ph.D. candidates, 2) participation in the development of the Town Comprehensive Plan to establish the nesting area as a wildlife refuge, 3) securing a town ordinance to restrict the speed of motorboats in certain areas of the estuary and placement of appropriate buoys, 4) assignment of the Land Trust as managers of the refuge by the Town Council, 5) development of a management plan with the principal goal of protection of diamondback terrapin nesting habitat, 6) ongoing implementation of the tenets of the management plan by volunteers, scouts and the town department of public works, 7) conducting and supporting nature walks and educational programs on-site for adults and youth (future guardians), 8) supporting the testing of sediment samples in the estuary for possible toxins, and 9) taking the preliminary steps, appraisals and meetings with landowners, to secure conservation easements on adjacent privately-held land.

*Over 300 female terrapins nesting in the Nockum Hill area have been marked and their histories recorded. Twenty nests per year are protected by relocation to a predator-free enclosure. These studies have led to the listing of the diamondback terrapin as endangered in Rhode Island.

Road Mortality of the Northern Diamondback Terrapin (*Malaclemys terrapin terrapin)* on Access Roads Due to Traffic Volume and the Effectiveness of PIT Tags to Evaluate Road Return During the Nesting Season (Preliminary Data)

Stephanie Szerlag, Biology Department, Saint Joseph's University, 5600 City Ave., Philadelphia, PA 19131; ss298823@sju.edu

Road mortality of the northern diamondback terrapin, *Malaclemys terrapin terrapin,* in the Jacques Cousteau National Estuarine Research Reserve was examined as a direct result of traffic volume on Great Bay Boulevard (Tuckerton, New Jersey) during the nesting season from May-July 2004. Traffic volume and speed measuring devices were stationed on four transect sections of the road mapped out by previous terrapin studies. Transect sections were divided by bridges that crossed the subtidal creeks and were surveyed for approximately ten weeks. A total of 600 adult female terrapin occurrences were recorded on the road, with 53 of those being road mortalities (8.83%). We attempted to identify any relationships between traffic volume and road mortality for each transect section. It was found that a greater percentage of roadkills were observed in the transect section with the highest traffic volume. A majority of the roadkills were noted between 8:00-9:00 am (N=24). One hundred terrapins were tagged during the first week of the nesting season with PIT tags in order to observe their effectiveness in a mark-recapture study of road reoccurrence on Great Bay Boulevard. Of the 100 tagged, 16 were recaptured (25 total recaptures). Of those, six were long-term recaptures (19-45 days after initial tagging date). It should also be noted that greater terrapin occurrence was observed on or around the full and new moons.

Revised Survival Estimates for Diamondback Terrapins at Kiawah Island, South Carolina

Anton D. Tucker[1], J. Whitfield Gibbons[2] and Judith L. Greene[2]; [1]Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236; [2]University of Georgia, Savannah River Ecology Laboratory, Drawer E, Building 737-A, Aiken, SC 29802; ADT: tucker@mote.org

We analyze a case study for an extirpation within a metapopulation of diamondback terrapins (*Malaclemys terrapin*) in salt marshes bounding Kiawah Island, South Carolina, followed from 1983-2003. The survival and migration probabilities were estimated by a multi-strata approach in Cormack-Jolly-Seber mark-recapture models to obtain transition probabilities among four tidal creeks adjoining a river. Terrapins showed high fidelity to each sub-population and the low migration rates were insufficient to recolonize a creek that suffered extirpation. Annual survival rates of adult female terrapins averaged 0.84 across all creeks, ranging from 0.748 to 0.971. Survival rates were converted to instantaneous mortality rates (M) for the purpose of calculating the mean lifespan as 1/M. When re-expressed in terms of mean lifespan, the results confirmed that the average female terrapin did not survive to its estimated age at maturity, as might be predicted if additional mortality of females was implicated from mortality from crab pots.

Recent surveys still support earlier published findings that incidental mortality of terrapins in crab pots is a conservation concern. New data suggest that apparent survival of both sexes declined by 8% in Oyster Creek (to 0.66-0.7), and by 4% in Fiddler Creek (to 0.76-0.78). Apparent survival in Sandy Creek was up by 4% for males in Sandy Creek (0.94), but declined by 16% for females (0.81). The extirpated

population in Terrapin Creek, which experienced a sudden decline during the early 1990s, has not recolonized.

A Review of Rangewide Regulations Pertaining to Diamondback Terrapins

Christina F. Watters, The Wetlands Institute, 1075 Stone Harbor Boulevard, Stone Harbor, NJ 08247; research@wetlandsinstitute.org

In 1988, Donnelly compiled a summary of regulations pertaining to diamondback terrapins throughout their range. This compilation was never formally published but was widely circulated within the relatively small community of individuals interested in terrapin conservation. A number of states have modified their terrapin regulations since then, and an updated, more comprehensive survey of terrapin regulations seems in order. Existing state regulations reflect a widely varying degree of concern about diamondback terrapin conservation. The regulatory status of terrapins varies greatly (state endangered, state threatened, special concern, game animal, no listing). On a federal level, terrapins are not afforded any formal listing or protection. Adjacent states within the range of a specific subspecies sometimes give terrapins different regulatory status listings and manage terrapins with significantly different regulations. It would make sense to coordinate regulatory efforts at least on a regional basis in order to provide more effective protection for this species.