

Title: Nesting Ecology of Diamondback Terrapins: Predation and Recruitment

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Investigator:

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Abstract:

Diamondback terrapins (*Malaclemys terrapin*) are found in coastal waters of eastern United States and are the only completely estuarine turtles in North America.. They are relatively common in the Hudson River Bight, and in fragmented populations along the coastlines of Long Island. They inhabit cordgrass (*Spartina*) marshes and tidal creeks, where they feed on mollusks, crustaceans and other invertebrates. Recent research suggests that terrapins are ecologically critical species for maintenance of natural nutrient and energy pathways in their ecosystems.

Terrapins are easily the most abundant reptiles in Jamaica Bay Wildlife Refuge. With the combination of high visitation rates and additional millions of potential visitors within easy driving distance, there is an excellent opportunity to use terrapins within JBWR as a vehicle for environmental education.

Terrapin populations range-wide appear to be decreasing due to a variety of factors, and thus it is important that effective conservation measures be implemented. Despite their ecological importance and rare status, no detailed information is available about population size or survivorship. This lack of data is of particular concern because our recent work suggests that recruitment may have dropped dramatically in the last decade, since raccoons were introduced to JBWR. We seek to learn more about the impact of raccoons and other predators on the terrapin population of JBWR, and, if appropriate, assist in the development of conservation efforts needed to ensure the persistence of this population.

Background:

Statement of Issue-

The diamondback terrapin, *Malaclemys terrapin*, can be found in salt marshes and tidal creeks of the Atlantic and Gulf coasts of North America. Their ability to tolerate salt water is due to salt-excreting orbital salt glands; these have been found to be so efficient that the terrapins can tolerate full sea water for months (Davenport et al. 1990). Despite their unusually high tolerance of salt water, terrapins are not sea turtles. They have clawed feet rather than flippers, and belong to the same family (Emydidae) as other common New York species, such as painted turtles (*Chrysemys picta*) and eastern box turtles (*Terrapene carolina*). However, both sea turtles, especially juveniles, and diamondback terrapins feed in nearshore salt-water habitats and in some ecosystems members of the two species may be found together.

Previous work has shown that terrapins are responsible for a significant amount of cropping of crustaceans, crabs, molluscs, and other invertebrates (Tucker et al. 1995). For example, terrapin predation has been shown to dramatically reduce the abundance of periwinkles (*Littorina*) (Levesque and Fauth 1999). In addition, terrapins move enormous

quantities of nutrients and calories from water to land in the form of eggs. Terrapin eggs, as well as emerging hatchlings, are preyed upon by a variety of predators, including foxes, mink, crows, gulls, and raccoons. For example, recent work in Jamaica Bay Wildlife Refuge suggest that eggs equivalent to 300,000 Kcal were eaten by raccoons in one small beach in a single year (Feinberg and Burke, in press). Adults, especially nesting females, are also vulnerable to predation, especially to raccoons (Feinberg and Burke, in press, Ernst et al. 1994).

Terrapin populations, historically large but unmeasured throughout estuarine habitats of New York (Morreale 1992), suffered a precipitous decline in numbers around the turn of the century as they were harvested in huge numbers, primarily for the New York City soup market. Terrapin populations recovered somewhat in some areas subsequent to the collapse of the soup industry in the 1930's. In addition to the animals originally present in the area, a large number of terrapins, not necessarily from northern populations, were released in the Hudson Bight area around time of the collapse of the market for soup animals (Spagnoli and Marganoff 1975). Currently, there is no information available on population sizes or movements of terrapins in New York, other than presence/absence data (e.g., Morreale 1992). It appears that the populations in New York have recovered somewhat. *Malaclemys terrapin* is currently considered a "Species of Special Concern," in New York State. This status is used to designate species that are extremely uncommon in an area and/or have specific habitat requirements and thus must be carefully monitored. The New Jersey National Heritage Program describes the species as "believed to be in peril but the degree of rarity [is] uncertain"; this is largely due to uncertainty about the impact of accidental drownings in crab traps.

The Jamaica Bay terrapin population is undoubtedly the largest in New York State, and probably the largest in the entire northeastern U.S. The size of this population is likely due mostly to the large size and productivity of the wetlands of Gateway National Recreational Area. The sparsely vegetated, sandy shorelines of Gateway also provide ideal nesting beaches for terrapins. For example, well in excess of 1800 terrapin nests are laid annually in the Jamaica Bay unit of Gateway alone (Feinberg and Burke, in press). In addition, the entire Gateway National Recreational Area receives complete, year round protection from commercial and recreational harvest, which prevents removal of terrapins. Not surprisingly, terrapins are the most abundant reptile found in Gateway, and are often observed in shallow tidal creeks and flats in many areas of the park (Anonymous 1989). As such, they are a well-known and popular wildlife component of Jamaica Bay Wildlife Refuge. However, the species is under threat by increased urbanization, as well as the recent introduction of raccoons into the area (Feinberg and Burke, in press).

Although it is obvious even from just the sheer number of terrapins nesting at Jamaica Bay Wildlife Refuge, numerous observations of terrapins throughout Gateway National Recreational Area, and sightings of terrapins on the Hudson River that a large population of terrapins is currently utilizing the Hudson River Bight, the size and status of this population is unknown. This uncertainty is particularly risky because Jamaica Bay Wildlife Refuge has come under threat recently due to the increased presence of raccoons (as major predators) and the urbanization of the area around the Refuge. Cook (1989) reported essentially no predation on terrapin nests in the 1980's. This is not surprising because raccoons, which are important egg predators in many turtle populations, did not

historically inhabit Jamaica Bay Wildlife Refuge (O'Connell 1980). It was not until 1990 that raccoons first reached the Refuge, and it was then considered extremely rare to find even a single dead raccoon per year on Cross Bay Boulevard, the road leading to the Refuge. These low predation levels may have been responsible, at least in part, for the buildup of a large terrapin population in the Bight. However, Feinberg and Burke (in press) observed large numbers of raccoons foraging in turtle nesting areas during the nesting season, found turtle egg shell fragments in hundreds of raccoon scats, and documented nearly 100% nest predation levels in 1998 and 1999. In addition, small numbers of adult female terrapins were found killed in a manner typical of raccoon predation elsewhere, suggesting that the raccoons are not only greatly reducing terrapin recruitment now but also affecting the adult population. Without an accurate estimate of the effects of the new rate of predation on terrapin population size, it is impossible to know how it may impact the future of terrapins. It is quite difficult to census adult populations directly, thus studies of nesting ecology and year-to-year measures of the numbers of nesting females provide a good estimate of population status.

Relevant literature-

Anonymous. 1989. Gateway National Recreation Area: Pamphlet to Amphibians and Reptiles.

Cook, R. 1989. A natural history of the diamondback terrapin. *Underwater Naturalist* 18: 25-31.

Davenport, J. and E.A. Macedo. 1990. Behavioural osmotic control in the euryhaline diamondback terrapin *Malaclemys terrapin*: responses to low salinity and rainfall. *J. Zool., Lond.* 220: 487-496.

Ernst, C.H., R.W. Barbour and J.E. Lovich. 1994. *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington.

Feinberg, J.A. and R.L. Burke. 2003. In press. Nesting ecology and depredation of diamondback terrapins, *Malaclemys terrapin*, at Gateway National Recreation Area, New York, U.S.A. *Journal of Herpetology*.

Morreale, S.J. 1992. The status and population ecology of the diamondback terrapin, *Malaclemys terrapin*, in New York. Okeanos Ocean Research Foundation, Inc. Hampton Bays. 73 pp

Levesque, E.M. and J.E. Fauth. 1999. Effect of diamondback terrapin *Malaclemys terrapin* on the size and density of the salt water periwinkle, *Littorina irrorata*. Paper presented at the Annual Meeting of the American Society of Ichthyologists and Herpetologists, State College PA.

O'Connell, A. 1980. The relationships of mammals to the major vegetation communities in Gateway National Recreation Area (Jamaica Bay Wildlife Refuge, Breezy Point, and Sandy Hook) including a soil analysis of selected areas. Gateway Institute for Natural Resource Sciences, National Park Service, U.S. Dept. of Interior. Gate-N-012-11.

Spagnoli, J.J. and B.I. Marganoff. 1975. New York's marine turtle. *The Conservationist*. June-July 17-19.

Scope of study-

I intend to carry out this work within the Jamaica Bay/Breezy Point Unit of Gateway National Recreational Area, primarily on the island of Ruler's Bar Hassock.

Intended use of results-

The outcome of this work will be a better understanding of the factors affecting the reproduction and survivorship of diamondback terrapins at GNRA. This better understanding should facilitate data-based management. Undergraduate research projects, master's thesis, and peer-reviewed publications will be prepared on the basis of this research.

Objectives:

The objective of my research is to determine whether raccoons and/or other predators are having a significant impact on recruitment into the diamondback terrapin population at Jamaica Bay Wildlife Refuge.

Methods:

Description of study area-

The primary study area will be the island known as Ruler's Bar Hassock in what is sometimes called the "Tern Nesting Area." However, terrapins nest in many places on Ruler's Bar Hassock, so these areas will be studied as well.

Procedures-

Teams of volunteers and students will search through the various places on Ruler's Bar Hassock where terrapins nest throughout the nesting season, approximately late May through the beginning of August each year. Adult turtles encountered will be observed inconspicuously if they are nesting or appear about to do so. When nesting is complete, the nest site will be marked and the female turtle will be weighed, measured, marked, and released. Adult turtles that are encountered either after nesting or too disturbed to nest at that time will be weighed, measured, marked and released. Blood samples (ca. 0.5ml) will be taken from some adult females. Marked nests will be checked daily until predated. Some nests will be protected from above-ground predators so that egg viability and below-ground predation can be measured. Regularly, throughout the nesting season, the entire nesting area will be surveyed for the remains of predated nests and terrapin carcasses.

Some females encountered while too disturbed to nest will be taken temporarily to the Animal Facility at Hofstra University. There they will be induced to lay their eggs, via injections of the natural and safe hormone oxytocin. This procedure takes about two hours, while the turtles behave as if nesting normally. After this time, the turtles can be returned to the place of capture and released. Some eggs will be incubated for tests of egg viability and to measure the impacts of substrate moisture and incubation temperature on hatchling sex and other characteristics. Other eggs and resulting hatchlings will be used for paternity tests.

Raccoons will be trapped using Tomahawk live traps. Each raccoon will be tranquilized, weighed and measured, uniquely marked, and released.

Collections-

Blood samples will be taken from some adult female terrapins. As many as 100-300 eggs/year may be collected from gravid female terrapins at Hofstra University for experiments there. When these experiments result in hatchlings that may be released,

released will be coordinated with JBWR personnel. Carcasses of terrapins and raccoons found at JBWR will be kept at Hofstra University until research is complete.

Analysis-

Standard statistical tests will be utilized to analyze the data using SPSS.

Schedule-

Nesting terrapins will be studied throughout the nesting season, from late May until early August. Nests will be monitored until predation or hatchling emergence. Hatchlings will be monitored from emergence until they enter water. Raccoons will be live-trapped and released from once to three times/year, depending on the frequency needed for population estimation.

Budget-

This project is funded by the New York City Environmental Fund, the Hudson River Foundation, and funds from Hofstra University.

Products:

Publications and reports-

See "intended use of results" section above.

Collections-

See "collections" section above. Nearly all specimens collected during this project will be consumed during analysis, the remainder will be released. Any remaining specimens designated as permanent voucher collections will be fixed and deposited in a repository acceptable to the National Park Service and documented using NPS standards.

Data and other materials-

n/a

Literature cited:

See 'relevant literature' above.

Qualifications:

The P.I. has considerable experience with all the methods, techniques, and equipment described here. See attached curriculum vitae for more information.

Supporting documentation and special concerns:

Safety-

n/a

Access to study sites-

All sites are accessible from main roads and the main trail of JBWR. Permission to work off designated trails and on the "terrapin trail" while closed will be necessary.

Use of other equipment-

Inconspicuous temporary blinds may be used at JBWR.

Chemical use-

Telazol, a regulated substance, is used to sedate trapped raccoons. This use is under the supervision of a veterinarian who is a member of Hofstra University's Institutional Animal Care and Use Committee.

Ground disturbance-

Little or none

Animal welfare-

This research has been approved by Hofstra University's Institutional Animal Care and Use Committee.

NPS assistance-

None needed, except that the "Terrapin Trail" should be closed from the last week of May through the first week of August.

Wilderness 'minimum requirement' protocols-

n/a

VITA

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Education

Ph.D. (Biology) 1994, University of Michigan.

M.S. (Wildlife Ecology) 1987, University of Florida.

B.S. (Zoology) 1981, Ohio State University.

Teaching Appointments

Associate Professor (2002-present), **Assistant Professor**, 1996 to 2002. Department of Biology, Hofstra University, Hempstead NY. Evolution, Ecology, Conservation Biology, Human Biology, Field Ecology, Behavior.

Lecturer, State University of New York at Stony Brook, NY. Summer 1999. Herpetology.

Lecturer, School of Natural Resources & Ecology, University of Michigan, Ann Arbor, MI. 1995. Waterfowl and Wildlife Management.

Lecturer, Department of Biology, Eastern Michigan University, Ypsilanti, MI. 1994-1995. Principles of Genetics, Conservation Biology, Herpetology.

Teaching Assistant, Department of Biology, University of Michigan, Ann Arbor, MI. 1988-1990, 1991-1994. Ecology, Introduction to Biology I & II, Genetics and Society, Honors Biology Discussion, Biology and Human Affairs.

Research Experiences

Assistant (Associate, 2002) Professor, Department of Biology, Hofstra University, Hempstead, NY. 1996 to present.

Research Scientist, School of Natural Resources & Environment, University of Michigan, Ann Arbor, MI. 1994-1996.

Research Assistant, Herpetology Division, Museum of Zoology, University of Michigan, Ann Arbor, MI. 1990-1991.

Research Associate, Tall Timbers Research Station, Tallahassee, FL. 1987-1988.

Research Assistant, Florida State Museum, University of Florida. 1985-1987.

Biological Aid (Wildlife), U.S. Fish and Wildlife Service, Denver Research Station, Gainesville, FL. 1986.

Research Biologist Assistant, Florida Game and Fresh Water Fish Commission, Wildlife Research Laboratory, Gainesville, FL. 1983-1985.

Grants

New York City Environmental Fund, Hudson River Foundation. "Environmental Education: Exposing the public to management issues at Jamaica Bay Wildlife Refuge". \$15,218. 2001.

National Park Service, with George Frame. "Inventory of the mammals, reptiles, and amphibians at 14 sites in Jamaica Bay, NY". \$30,000. 2000.

Hudson River Foundation, with Jamina Oomen. "Movement, Population Size, and Habitat Use of Diamondback Terrapins (*Malaclemys terrapin*) in the Hudson River" \$89,949. 1999.

New York City Environmental Fund, Hudson River Foundation. "Conservation and Management of Diamondback Terrapins in Jamaica Bay Wildlife Refuge". \$11,755. 1998.

Presidential Research Award, Hofstra University. \$200 (1998), \$500 (1999), \$500 (2000), \$500 (2001), \$500 (2002).

Faculty Research and Development Grant, Hofstra University. \$1,863 (1997); \$760 (1998), \$700 (1999), \$700 (2000), \$700 (2001), \$800 (2002).

One With Nature Program Grant, Zoological Society of Philadelphia. For research on natural history of wood turtles, bog turtles and spotted turtles. Received \$6,700 (1996), \$2,300 (1997), \$2700 (1998), \$2,000 (1999), \$2200 (2000).

Norcross Foundation Grant. For research on natural history of wood turtles, bog turtles and spotted turtles. Received \$5,000. 1997.

Conservation and Research Foundation Grant. For research on natural history of wood turtles, bog turtles and spotted turtles. Received \$3,600. 1997.

Rackham Pre-Doctoral Fellowship, University of Michigan. For research on the effects of egg size and incubation temperature on hatchling geckos. Received \$12,000. 1992.

Chicago Herpetological Society Research Grant. For research on optimal techniques for head starting gopher tortoises. Received \$1000. 1992.

Hinsdale-Walker Scholarship, The University of Michigan Museum of Zoology. For research on egg size variation in snapping turtles. Received \$1000. 1991.

E.S. George Reserve Scholarship, The University of Michigan Museum of Zoology. For research on egg size variation in snapping turtles. Received \$1000. 1990.

Peter Olaus Okkelberg Award, Department of Biology, The University of Michigan. For research on egg size variation in snapping turtles. Received \$1000. 1990.

Rackham Block Grants, Department of Biology, The University of Michigan. For research on egg size variation and sex determination in snapping turtles and geckos. Received \$750 each. 1990, 1991, 1992, 1993.

The Bankers Land Company Research Grant, MacArthur Foundation, Chicago IL. For evaluation of turtle relocation as a mitigation technique on land to be developed. Received \$25,000. 1985-1986.

Refereed Publications

Burke, R.L. and S. Ner. In review. Seasonal and Daily Activity Patterns of the Italian Wall Lizard, *Podarcis sicula*, in New York, USA. Journal of Herpetology.

Feinberg, J.A. and R.L. Burke. In press. Nesting ecology and depredation of diamondback terrapins, Malaclemys terrapin, at Gateway National Recreation Area, New York, U.S.A. Journal of Herpetology.

- Starkey, D.E., Burke, R.L., Forstner, M.R.J., Iverson, J.B., Janzen, F.J., Rhodin, A.G.J., Ultsch, G.R., and H. B. Shaffer. 2003. Molecular Systematics and Phylogeography of the Painted Turtle (*Chrysemys picta*) Complex". Evolution. 57: 119-128.
- Burke, R.L., A. A. Hussain, J. M. Storey, and K. B. Storey. 2002. Freeze tolerance and supercooling ability in the Italian wall lizard, *Podarcis sicula*, introduced to Long Island NY. Copeia. 2002: 836-842.
- Burke, R.L. and Mercurio, R. 2002. Food habits of a New York population of Italian wall lizards, *Podarcis sicula* (Reptilia, Lacertidae). American Midland Naturalist. 147: 368-375.
- Oliverio, M., Burke, R.L., Bologna, M.A., Wirz, A., and P. Mariottini. 2001. "Molecular identification of native (Italy) and introduced (USA) *Podarcis sicula* populations (Reptilia, Lacertidae)". Italian Journal of Zoology. 68:121-124.
- Burke, R.L., T.E. Leuteritz and A.E. Wolf. 1996. Phylogeny of the turtle subfamily Emydinae. Herpetologica. 52:572-584.
- Burke, R.L., M.E. Ewert, J.B. McLemore and D.R. Jackson. 1996. Temperature-dependent sex determination and hatching success in the gopher tortoise (*Gopherus polyphemus*). Chelonian Conservation and Biology. 2:86-88.
- Burke, R.L. and J. Birch. 1996. White-tail deer adaptively skew offspring sex ratio. Ecological Research 10:351-357.
- Burke, R.L. and L. Little. 1995. *Drosophila* do not skew offspring sex ratio as predicted by Trivers-Willard. Journal of Insect Behavior 8:231-239.
- Burke, R.L. 1994. Diurnal aggregation of banded geckos under field conditions. Southwest Naturalist 39:297-298.
- Burke, R.L., E.J. Jacobson, M. Degayner, and L.J. Guillette. 1994. Non-invasive sex identification of juvenile gopher and desert tortoises (Genus: *Gopherus*). Amphibia-Reptilia 15:183-189.
- Burke, R.L. 1993. Adaptive value of sex determination mode and offspring sex ratio bias in reptiles. Copeia 1993:854-859.
- Burke, R.L. 1991. Relocations, repatriations, and translocations of amphibians and reptiles: Taking a broader view. Herpetologica 47:350-357.
- Burke, R.L., J. Tasse, C. Badgley, S.R. Jones, N. Fishbein, S. Phillips and M.E. Soulé. 1991. Conservation of the Stephens' Kangaroo rat (*Dipodomys stephensi*):

Planning for persistence. Bulletin of the Southern California Academy of Sciences 90:10-40.

Burke, R.L. 1989. Florida gopher tortoise relocation: Overview and case study. Biological Conservation 48:295-309.

Burke, R.L. 1989. Burrow to tortoise conversion factors: Comparison of three gopher tortoise survey techniques. Herpetological Review 20:92-94.

Burke, R.L. and J. Cox. 1989. Evaluation and review of field techniques used to study and manage gopher tortoises. P. 205-215 *In*: Management of amphibians, reptiles and small mammals in North America. USDA Forest Service General Technical Report RM-166.

Burke, R.L. and S.R. Humphrey. 1987. Rarity as a criterion for endangerment in Florida fauna. Oryx 21:97-102.

Book and book reviews

Burke, R.L. 2003. Invited Book Review: Box Turtles: A Natural History. The Quarterly Review of Biology. In press.

Burke, R.L. 1997. Invited Book Review: Ecological Studies of Crocodilians in Suriname. The Quarterly Review of Biology 72: 348-349.

King, F.W. and R.L. Burke. 1989. Crocodilian, tuatara and turtle species of the world: A taxonomic and geographic reference. Association of Systematic Collections, Washington D.C. 216 p.

Manuscripts in preparation

Burke, R.L., McKernan, B.A., C. Kutzman, and M. Jordan. Manuscript nearly complete. "Distribution, abundance, and soil ecology of three weed species in the Hempstead Plains, New York" for Restoration Ecology.

Burke, R.L. Manuscript in prep. "Sexual dimorphism, reproduction and fat body cycles of the Italian wall lizard, *Podarcis sicula*, introduced to New York", for Canadian Journal of Zoology.

Burke, R.L., M. J. Sebetich, and J.H. Kaufmann. Manuscript in prep. "Home range size variation in wood turtles, *Clemmys insculpta*", for Herpetologica.

Ashton, K. and R. L. Burke. Manuscript in prep. "Florida gopher tortoise relocation: 16 years later", for Biological Conservation.

Published Abstracts

Burke, R.L. and S. Ner. 2001. Seasonal and diel activity patterns of Italian wall lizards, *Podarcis sicula*, on Long Island, New York. Paper presented at the meeting of the Ecological Society of America, Madison, WI.

Burke, R.L. and M. Sebetich. 2001. Home range and seasonal movements of wood turtles in northern New Jersey. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, State College, PA.

Ner, S. and R.L. Burke. 2001. Diamondback terrapins: Predators and predation rates at Jamaica Bay Wildlife Refuge, New York. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, State College, PA.

Capitano, W. and R.L. Burke. 2001. Analysis of home range and reproduction in a Long Island population of box turtles. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, State College, PA.

Feinberg, J. and R.L. Burke. 1999. Terrapin nest predation at Gateway National Recreational Area. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, State College, PA.

Feinberg, J. and R.L. Burke. 1998. A new database available for herpetological research. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, Guelph, Ontario.

Patel, N. and R.L. Burke. 1998. Food habits of the European wall lizard, *Podarcis sicula*, introduced to Long Island, New York. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, Guelph, Ontario.

Hussain, A.A. and R.L. Burke. 1998. Supercooling and freeze tolerance in the lizard *Podarcis sicula*. Paper presented at the meeting of the American Society of Ichthyologists and Herpetologists, Guelph, Ontario.

Burke, R.L. and T.E. Leuteritz. 1993. Phylogenetic analysis of the subfamily Emydinae based on morphological, behavioral, and life history characters. Paper presented at the meeting of the Society for the Study of Amphibians and Reptiles. Bloomington, IN.

Burke, R.L. and K.L. Yurewicz. 1993. Predation risk of the Western banded gecko, *Coleonyx variegatus* (Gekkonidae), with regard to body size, tailness, and sprint speed. Paper presented at the meeting of the Society for the Study of Amphibians and Reptiles. Bloomington, IN.

Burke, R.L. 1990. Turtle population sex ratios: comparing observations to predictions. Paper presented at the meeting of the Society for the Study of Amphibians and Reptiles/Herpetologist's League. New Orleans, LA.

Invited Presentations

Burke, R.L. 2002. "The Ecology of Italian wall lizards, *Podarcis sicula*, in Long Island, New York." Paper presented at Exotic Species Symposium, American Society of Ichthyologists and Herpetologists meeting, Kansas City, MO.

Burke, R.L. 2000. "Conservation Lessons from Introductions and Re-introductions of Reptiles", "Inventory and Monitoring Programs for Reptiles", and "The Ecology of Terrapins at Gateway National Recreational Area" at "Conservation Strategies for Amphibians and Reptiles in Zoos" November 16-22, 2000, at the Taipei Zoo (Taiwan).

Burke, R.L. 2000. "Terrapin Research At Gateway National Recreational Area" at the 2nd Workshop on the Ecology, Status and Conservation of Diamondback Terrapins" in Stone Harbor, NJ, October 6-8, 2000.

Burke, R.L. 1999. "Conservation biology of diamondback terrapins at Gateway National Recreational Area". Department of Biology, Queens College, Flushing, NY.

Burke, R.L. 1999. "Overwintering Behavior of New Jersey Wood Turtles". Paper presented at the Forum on the Biology and Conservation of North American Turtles of the Genus *Clemmys*, American Society of Ichthyologists and Herpetologists meeting, State College, PA.

Burke, R.L. 1998. "To Freeze or Not to Freeze: Amphibians and Reptiles in the Cold". Symposium at the meeting of the American Society of Ichthyologists and Herpetologists, the Society for the Study of Reptiles and Amphibians, and the Herpetologists' League. Guelph, Ontario.

Professional Service

Long Island Frog Call Survey Coordinator, North American Amphibian Monitoring Program, National Biological Service, 1996-present.

Manuscript review for Journal of Herpetology, Copeia, American Midland Naturalist, Northeastern Naturalist, Journal of Zoology, Herpetological Applications, Animal Biology, and Ecology.

Board of Directors for Seatuck Environmental Association 1999-present.

Masters Students

Razzano, Pasquale, M.S. 1999. A phylogeographic study of *Cnemidophorus sexlineatus* using mitochondrial DNA sequence analysis.

Feinberg, Jeremy, M.S. 2000. Nesting ecology of diamondback terrapins (*Malaclemys terrapin*) at Gateway National Recreational Area.

Giambanco, Maria, M.S. 2002. Comparison of fertility rates, hatchling survivorship and sex ratios of field and laboratory incubated nests of the estuarine turtle *Malaclemys terrapin*.

Ner, Sylwia, M.S. 2003. Depredation rates of diamondback terrapin nests at seven upland islands in Jamaica Bay, NY.

Capitano, William, M.S. Defense expected in summer 2003. Box turtle (*Terrapene carolina*) nesting ecology and hatchling survivorship at Wertheim National Wildlife Refuge.

Broadwater, Katrina, M.S. Defense expected fall 2003. Raccoon (*Procyon lotor*) population size and movements at Jamaica Bay Wildlife Refuge.

Sclafani, Sharon, M.S. Defense expected spring 2004. Nest site selection in diamondback terrapins; a test of Roosenberg's maternal condition-dependent nest choice hypothesis.

Lee, Sam, M.S. expected fall 2003. Repatriation success and health assessment of eastern box turtles (*Terrapene c. carolina*) at Caumsett State Park.

McIntyre, Annie, M.S. expected spring 2004. Evaluation of mitigation techniques for the creation of nesting and foraging habitats for piping plovers (*Charadrius melodus*).

