

# 2

## Ecology of Bog Turtles



Dennis W. Herman

Bog turtle eggs (*Clemmys muhlenbergii*).

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Scientifically known as *Clemmys muhlenbergii* and formerly called the “Muhlenberg’s” turtle, the bog turtle is North America’s smallest turtle species. Bog turtles are characterized by their small size, dark coloration, and large yellow to orange blotches on both sides of the head. Shell lengths of bog turtles average between 3 and 4 inches, and the largest bog turtle ever recorded was 4.5 inches.

The main identifying character of bog turtles is the brightly colored blotch located behind the eye on each side of the head. These blotches vary in coloration from yellow, yellow-orange, orange, and orange-red from population to population. Turtles with yellow or orange blotches may be found within the same population and in some sites the turtles’ head blotches may be only yellow or orange. The size and shape of the blotches also vary from population to population and are dependent on the turtle’s age. Juvenile and newly hatched bog turtles possess large blotches that are light in coloration, whereas older adults have brighter and more intensely colored blotches that are usually diffused with darker pigment and are often broken up and incomplete.

The upper shell or carapace is usually black to mahogany-brown and may be marked with lighter whitish to yellowish sunburst rays of color in the individual scutes. The lower shell, or plastron, is usually black with varying amounts of white or pale yellow patches. The neck, limbs, and tail are very dark brown or black, with or without streaks of red or orange. The top of the head is usually speckled with black and the lower jaw may be spotted with red or orange. The upper jaw is notched, creating two sharp points on the beak. Along the back is found a mid-dorsal keel or ridge and pronounced sculptured growth rings around the scutes are present on the carapace



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*The large blotch on each side of the head is characteristic of the species. The shape and color of the blotches may vary from region to region.*

in juveniles and middle-aged adults. Older adults usually possess smooth worn shells and lack mid-dorsal keels and distinct growth rings due to years of digging or burrowing in mucky soils and vegetation.

Sexual dimorphism is pronounced in this species. Unlike many other turtles the males are larger than females and possess larger, more robust heads. Carapace lengths average 3.5 to 4 inches in males, while females are slightly smaller with an average of 3 to 3.75 inches in length. Females have greater carapace width to length ratios and shell heights than males. The rear marginal scutes are usually flared in males giving them a more streamlined appearance from above, while female bog turtles appear more circular. The plastron is dished out or concave in males and is flat in females. Male bog turtles have long, thick tails with the anal (cloacal) opening extending past the edge of the plastron, and females have short tails with the cloacal opening inside the plastron edge.

## Protected Status

Bog turtles have been variously protected by every state in which they occur. The bog turtle is listed as "Threatened" in Georgia, North Carolina, South Carolina, and Tennessee, and "Endangered" in Virginia. Because of inconsistent state protection throughout the turtle's range, the U.S. Fish and Wildlife Service placed the bog turtle on the Endangered Species list in November 1997. The bog turtle is listed as "Threatened" for the northern population (CT, DE, MA, MD, NJ, NY, and PA) and "threatened due to similarity of appearance" for the southern population (GA, NC, SC, TN, and VA); this designation is based on the naturally occurring 250-mile gap between the population in southern Virginia and that of Maryland. The southern bog turtle population is not fully protected under the Endangered Species Act (ESA), but may not be possessed, sold, traded, or collected. Landowners in the southern states can continue to develop bog turtle habitat by any legal means available to them, as long as the proper permits are obtained beforehand. In the northern states, bog turtles are fully protected under the ESA. A summary of the ESA is included in the Example Handout in Appendix C.

## Population Dynamics

Little is known about the dispersal or movement patterns of bog turtles. Individual bog turtles have been found crossing roads more than a mile from their wetland home or other suitable habitats. These migratory movements take them into forested uplands, distant ridges, lowland valleys, and cultivated areas. Summer and early fall movements are sometimes long, bringing them into areas where their occurrence is unexpected. Males tend to move more frequently and over greater distances than females. Bog turtles may exist in moderate to high densities in suitable habitats. Mark-and-recapture studies in the southern part of the bog turtle's range indicate that suitable habitats have densities of 15 to 20 turtles per acre. Home ranges for bog turtles are estimated to be less than 0.5 acre (.23 ha) in area and are slightly larger for males than for

females. Sex ratios in the bog turtle's southern range average 1 male to 1.3 females per site.

The bog turtle is an ectothermic reptile (cold-blooded), and undergoes a definite annual cycle related to seasonal changes of temperatures in its environment. Bog turtles alternate seasonal warm-weather activity with cold-weather inactivity. Winter survival requires that bog turtles undergo a period of cold-weather dormancy through the winter. Winter dormancy is probably longer at higher elevations than in the Piedmont. Depending on the weather, bog turtles sometimes begin surface activity during mid-March in the South. The greatest bog turtle activities occur from mid-April through September. Elevation affects the timing and length of the major phases of the activity cycle. In the Piedmont, bog turtles have a longer active season than turtles in the higher Mountain sites.

The bog turtle's life span is estimated to be in excess of 40 years based on recapture studies. Female bog turtles reach sexual maturity at approximately 3 inches in carapace length or from 5 to 7 years of age. The secondary sexual dimorphic characters of males (longer tail and concave plastron) begin to appear at around 2 1/2 inches in carapace length. Bog turtles in the wild are capable of reproducing between 5-7 years of age under the most ideal conditions, but the actual age of first egg deposition is closer to 10 years. Reproduction may take place annually, but most likely occurs every second or third year. Female bog turtles may reproduce from 10 to 15 times over a 40 to 50 year life span. Egg clutch sizes range from 1-6 eggs with an average of 3 eggs per clutch.

## Distribution

Bog turtles are known from Georgia, North Carolina, South Carolina, Tennessee, and Virginia in the southern part of their range (Figure 2.1). The majority of records are known from the Blue Ridge Intermountain Plateau, but many have been found in the upper Piedmont along the base of the Blue Ridge Escarpment. Elevations of bog turtle sites range from 710 to 4500 feet, with the majority known from 2000 to 3000 feet elevation. Bog turtle populations

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**Figure 2.1** Range of bog turtles (*Clemmys muhlenbergii*) in the Southeast.

have been found along ten river basins in the Southeast in both the Mississippi-Ohio and Atlantic drainages.

### Habitat Dynamics

Wetlands preferred by bog turtles are spring-fed with saturated soils and modest amounts of running water. The sites do not have standing water of significant depth. Viable bog turtle populations occur in seepage slopes or terraces along headwaters of small to moderate size streams. Sites occupied by bog turtles are infrequently flooded, so they are not found on large, flat floodplains of major rivers or streams. Bog turtle habitat is characterized by being sedge-dominated, wet meadows with little or no canopy and are referred to as sedge meadows or Meadow Bogs.

Bog turtles are not found in true “bogs” in the Southeast. True bogs are typically

composed of vegetation mats that grow over small depressions, ponds, or small lakes. They are fed primarily by rain and water runoff. Peat moss (*Sphagnum* sp.) and other bog building plants along the shore grow out into water-filled depressions, eventually filling them with decomposed vegetation.

The common denominator of all bog turtle habitats in the South is that they are spring-fed. Technically speaking, the wetlands preferred by bog turtles are known as fens. To most ecologists a fen is a spring-fed wetland located over calcareous or mafic rock and enriched by nutrients, creating a wetland with great plant diversity. Only one such wetland has been described from the southern Mountains, although fens are common further north. Bog turtle habitats are, in fact, “poor or acidic” fens located over granite or metamorphic gneisses. These spring-fed wetlands are acidic with

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*Bog turtles are often found in grazed wetlands.*

many floral components common to both true bogs and nutrient rich fens. Sphagnum, usually associated with acidic bogs, can be the dominant ground cover in many bog turtle habitats. Because of the acidic nature of these nutrient-poor fens and plant assemblages linked to true bogs, some ecologists refer to them as bogs. In fact, one rare natural community, the Southern Appalachian Bog, is so named because of these characteristics. Sedge meadows (also known as Meadow Bogs) are a major component of these natural communities, and wetlands that have little or no sedge meadow habitat are inhabited by small populations of bog turtles or no turtles at all. The open nature of meadow bogs allows maximum sunlight to warm the herbaceous layer providing bog turtles with basking and nesting sites. One of the bog turtle's ultimate limitations is a closed canopy, which cuts off surface light and warmth.

Habitats in the upper Piedmont may or may not have floral components similar to those along the Blue Ridge. Most Mountain sites have peat moss (*Sphagnum* sp.) as ground cover; some exhibiting extensive mats, while others have only a few patchy areas.

Piedmont sites, on the other hand, vary greatly in the amount of peat moss growth with many having no peat moss at all. Needle rushes (*Juncus* sp.) appear to be more prevalent in Piedmont sites, while sedges dominate Mountain sites.

Meadow Bogs are defined as "impacted" natural areas, usually grazed by livestock or

located adjacent to pastures and are created and maintained by agriculture, livestock, beaver, and possibly fire. Today livestock have replaced the large herds of herbivores (bison, elk, and earlier the larger Pleistocene megafauna) that once seasonally migrated through and lived in the wetlands, grazing and browsing on low shrubs and sedges, maintaining the open wet meadows preferred by bog turtles and other species. The majority of bog turtle populations in the Southeast occur in sites that are currently grazed or formerly grazed by livestock. The turtle's dependence on livestock grazing and browsing has been well documented.

Beavers were once a major creator of ponds (see *Wetland Management by Beavers*, Chapter 6). These ponds filled in over time to become open wet meadows used by bog turtles. Today beavers have rebounded from near extinction and these industrious rodents may create short-term negative impacts to existing bog turtle habitats by flooding them. The beaver's importance in creating and maintaining bog turtle habitat may not be as evident today as it was in the past. As bog turtle sites are protected along common stream corridors, beavers may once again be beneficial to the bog turtle's long-term survival.

### Threats to Bog Turtles and Their Habitat

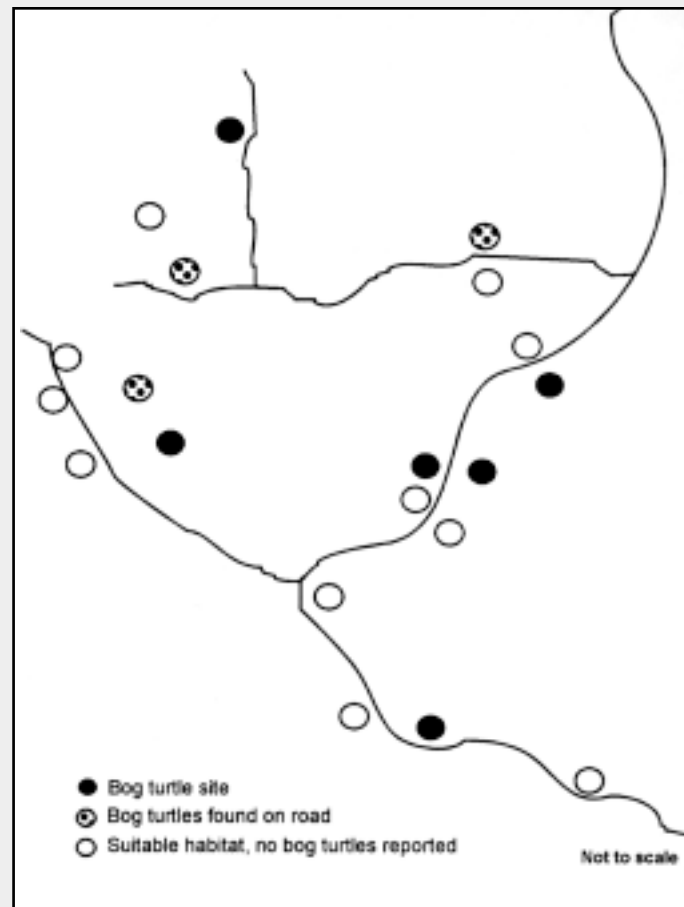
Wetlands inhabited by bog turtles are under constant threats from agricultural use, development, and natural succession. The illegal collecting of bog turtles for the pet trade, both domestic and international, directly threatens the turtle itself. These threats are having an adverse effect on bog turtle populations in the South, as well as throughout the turtle's range. Habitat loss has accelerated over the past 20 years from fragmentation due to human encroachment and natural succession. The decline in bog turtle populations can be attributed directly to these threats.

Prior to European colonization in the 1700s, the dynamic wetlands used by bog turtles were a complex of habitat units and potential habitats interconnected by a mosaic of dispersal routes. The long-term dynamic ecosystem could

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**Box 2.1 A Bog Turtle Metapopulation in North Carolina****By Dennis W. Herman**

The best known metapopulation in North Carolina, currently under study, is comprised of at least 20 wetlands ranging from 0.5 to 6 acres in size along a small stream with several tributaries. Bog turtles have been captured in six of these wetlands and found on roads at three locations within the drainage (see Figure 2.2). The first bog turtle site in this metapopulation was discovered in 1990. This site, which is located on a secondary tributary, has 35 marked turtles and is currently the largest turtle colony known in the metapopulation. Bog turtles were captured and marked in three other wetlands along the stream drainage during the early 1990s, the largest population with seven turtles recorded. Additional turtle captures have been made since the initial discovery of these wetlands. Searches in nine other wetlands have yet to produce bog turtles, for reasons yet unknown. This is a classic metapopulation with intact habitat units along the main corridor and four secondary tributaries, some with turtles and others without. The average distance between habitat units is roughly one mile, and the greatest distance between bog turtle sites is two miles. Currently, there are no impediments to dispersal, although a road does parallel the stream in some places and pasture is common in many areas. The entire stream drainage is under private ownership, with the exception of three small wetlands owned by the National Park Service (Blue



**Figure 2.2** Bog turtle metapopulation showing subpopulations. Roads not shown.

Ridge Parkway). Protection of the entire corridor and habitat units would preserve one of the best metapopulations known in North Carolina, but multiple ownership along the drainage makes it very difficult to do so using conventional purchase methods.

withstand the loss of a single habitat unit while providing bog turtles with other usable habitats. The biological need for individual bog turtles to disperse takes them out of their wetlands to explore and locate new sites to colonize. Individual turtles could move freely up or down the corridor, enriching the gene pool and helping to maintain genetically healthy population units. Bog turtle habitat units or single population sites interconnected along a common stream corridor are referred to as metapopulations (Box 2.1). Only a handful

of these metapopulations remain today because of habitat fragmentation. The most common types of fragmentation occur when streams are impounded to form lakes, highways are built across inhabited wetlands, and wetland habitat units are drained for agricultural use or development. Roads that bisect bog turtle wetlands are the single most detrimental threat to turtle populations. Highway mortality is high in areas where bog turtles must cross roads to get from one wetland to another. There is no doubt that roads and highways can

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be managed more effectively to reduce road mortality and some of these measures are discussed in Chapter 6 in the section on Managing Roadways.

Most of the metapopulations known today are fragmented, with great distances separating one population unit from the next. Bog turtles encounter impediments that make it difficult for dispersal to occur successfully. Some bog turtles have been found crossing ridges to locate wetlands in an adjacent valley. Overland dispersal may be more common than was previously thought, but it may also be a result

of habitat unit losses along the stream corridor that turtles used historically. As mentioned previously, very few metapopulations remain in the South today. Bog turtle populations are dynamic, fluctuating and shifting over long time periods. The survival of the bog turtle depends on connected habitat units along riparian corridors or habitat patches in adjacent valleys where dispersal into them is not impeded. A case study of the best metapopulation presently under investigation in North Carolina is presented in Box 2.1.

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### Bibliography

- Arndt, R.G. 1977. Notes on the natural history of the bog turtle, *Clemmys muhlenbergii* (Schoepff), in Delaware. *Chesapeake Scientist* 18(1):67-76. Some of the first natural history information ever reported on the species in Delaware.
- Barton, A.J. and J.W. Price. 1955. Our knowledge of the bog turtle, *Clemmys muhlenbergii*, surveyed and augmented. *Copeia* 1955(3):159-165. One of the earliest comprehensive studies on bog turtles.
- Bloomer, T.J. and R.J. Holub. 1977. The bog turtle, *Clemmys muhlenbergii*: A natural history. *Bulletin of the New York Herpetological Society* 13(2):9-23. This article presents information on movements, hibernation, and color variation in the species.
- Buhlmann, K.A., J.C. Mitchell, and M.G. Rollins. 1997. New approaches for the conservation of the bog turtle, *Clemmys muhlenbergii*, in Virginia. In: J. Van Abbema (Ed.), *Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles: An International Conference*, pp. 359-363. July 1993, State University of New York, Purchase. New York Turtle and Tortoise Society, New York. One of the first articles to discuss protection of bog turtles on a landscape scale, using watersheds as a basis for identifying metapopulations.
- Bury, R.B. 1979. Review of the ecology and conservation of the bog turtle, *Clemmys muhlenbergii*. USDI/FWS Special Scientific Report, Wildlife No. 219:1-9. A comprehensive review of then-current information on the bog turtle.
- Carter, S.L. 1997. Movements, home range, and habitat preference assessment of the bog turtle (*Clemmys muhlenbergii*) in southwestern Virginia. M.S. thesis, V.P.I. and State Univ., Blacksburg, VA. One of the most thorough studies conducted on the bog turtle in the Southeast.
- Carter, S.L., C.A. Haas, and J.C. Mitchell. 1999. Home range and habitat selection of bog turtles in southwestern Virginia. *Journal of Wildlife Management* 63(3): 853-860. Outlines a system to identify the important factors and partners when developing a conservation plan. This system includes physical, biological and human social systems both on-site and on adjacent lands that affect the target site, and consequent conservation success. A good model that can be adapted for use in any conservation planning effort.

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- Chase, J.D., K.R. Dixon, J.E. Gates, D. Jacob, and G.J. Taylor. 1989. Habitat characteristics, population size, and home range of the bog turtle, *Clemmys muhlenbergii*, in Maryland. *Journal of Herpetology* 23(4):356-362. This article presents important information on hibernacula, habitat, and home ranges of the species in Maryland.
- Copeyon, C. 1997. US Fish and Wildlife Service: Final rule to list the northern population of the bog turtle as threatened and the southern population as threatened due to similarity of appearance. *Federal Register* 62(213), Nov. 4, 1997. A review of the bog turtle range-wide with a comprehensive discussion of the reasons for its listing as a "threatened" species in the North and "threatened due to similarity of appearance" in the South.
- Earley, L.S. 1989. Wetlands in the highlands. *Wildlife in North Carolina* 53(10):11-16. A popular-press article on the types of rare wetlands found in the Mountains of North Carolina with excellent color photographs.
- Ernst, C.H. 1977. Biological notes on the bog turtle, *Clemmys muhlenbergii*. *Herpetologica* 33(2):241-246. One of the first and finest articles ever written on the biology of the bog turtle. Ernst reports important information on size, home range, and movements of the bog turtle in Pennsylvania.
- Fahey, K.M. 1992. Habitat survey and census of bog turtle, *Clemmys muhlenbergii* Schoepff, populations in Georgia: Final report for 1991-1992. Report submitted to Fish & Game Division, Georgia Department of Natural Resources. 14 pp. The results of the first field work conducted on the bog turtle in Georgia with a discussion of new sites.
- Fontenot, L.W. and S.G. Platt. 1993. A survey of the distribution and abundance of the bog turtle, *Clemmys muhlenbergii*, in South Carolina. Report submitted to S.C. Wildlife and Marine Resources Department, Heritage Trust Program. One of the first field studies on the bog turtle in South Carolina. The investigators' lack of success in locating new sites indicates the turtle's rarity in the state.
- Herman, D.W. 1989. Tracking the rare bog turtle. *Wildlife in North Carolina* 53(10):17-19. Updated existing information on the bog turtle in North Carolina with a discussion of the threats inherent to the species.
- Herman, D.W. 1994. The bog turtle, *Clemmys muhlenbergii*, in North Carolina: An action plan for its conservation and management. Report to North Carolina Wildlife Resources Commission. The first comprehensive report on the life history of the bog turtle in North Carolina. The report focuses on the need for a conservation and management plan for the species and identifies and prioritizes sites for their protection potential.
- Herman, D.W. 1999. The impacts of livestock grazing on bog turtle habitat in the Piedmont and Mountains of the Southeast. Report to U.S. Natural Resources Conservation Service, Wetlands Science Institute. This study is the first to focus on the impacts of livestock grazing on bog turtle habitat in the Southeast. The results of the study indicate that limited grazing is not only beneficial, but also necessary for the continued survival of the bog turtle and its habitat.



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## Ecology of Bog Turtles

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- Herman, D.W. and B.W. Tryon. 1997. Land use, development, and natural succession and their effects on bog turtle habitat in the southeastern United States. In: J. Van Abbema (Ed.), *Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles — An International Conference*, pp. 364-371. July 1993, State University of New York, Purchase. New York Turtle and Tortoise Society, New York. Provides a comprehensive review of the status of bog turtles in the Southeast and discusses the decline of turtle populations caused by land use, development, and natural succession.
- Kiviat, E. 1978. Bog turtle habitat ecology. *Bulletin of the Chicago Herpetological Society* 13(2):29-42. This was the first in-depth review of bog turtle habitat and the agents that help create and maintain it.
- Lee, D.S. and A.W. Norden. 1996. The distribution, ecology, and conservation needs of bog turtles, with special emphasis on Maryland. *Maryland Naturalist* 40(1-4):7-46. Features a comprehensive history of the bog turtle and descriptions of its habitat, and theorizes on the zoogeography of the species.
- Lovich, J.E., D.W. Herman, and K.M. Fahey. 1992. Seasonal activity and movements of bog turtles (*Clemmys muhlenbergii*) in North Carolina. *Copeia* 1992(4):1107-1111. This paper discusses the results of a nine-month radio telemetry study on the bog turtle—the first ever conducted in the Southeast. A comparison of frequencies and distances moved by male and female bog turtles indicated that bog turtles are more active during the hotter months than was previously thought.
- Mitchell, J.C. 1994. *The Reptiles of Virginia*. Smithsonian Institution Press, Washington, D.C. This is a comprehensive work of great importance. Most reptile species of Virginia are also found in surrounding states, so this book will be a worthy addition to the bookshelves of naturalists throughout Southeast. Dr. Mitchell includes a very fine species account of the bog turtle as he discusses the natural history of the species in Virginia.
- Mitchell, J.C. and K.A. Buhlmann. 1991. Distribution and status of the endangered bog turtle (*Clemmys muhlenbergii*) on the Blue Ridge Parkway in Virginia. Report to the National Park Service, Blue Ridge Parkway, Asheville, North Carolina. One of the first reports to focus on distribution of the bog turtle in Virginia along the Blue Ridge Parkway. Several new sites were discovered during this study.
- Mitchell, J.C., K.A. Buhlmann, and C.H. Ernst. 1991. Bog turtle. In: K. Terwilliger (Coord.), *Virginia's Endangered Species*, pp. 457-459. McDonald and Woodward Publishing Co., Inc., Blacksburg, Virginia. A fine species account and review of the bog turtle in Virginia.
- Nemuras, K.T. 1974a. The bog turtle. *Wildlife in North Carolina* 38(2):13-15. The first article to discuss the bog turtle in North Carolina and report on new county records.
- Nemuras, K.T. 1974b. The bog turtle - Profile of an endangered species. *Virginia Wildlife* 35(6):7-9. The first article to discuss the bog turtle in Virginia and report on new county records.

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## Ecology of Bog Turtles

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- Nemuras, K.T. and J.A. Weaver. 1974. The bog turtle — Synonym for extinction? *National Parks and Conservation Magazine* 48(6):17-20. One of the earliest articles to discuss threats to the bog turtle and its habitat.
- Palmer, W.M. and A.L. Braswell. 1995. *Reptiles of North Carolina*. The University of North Carolina Press, Chapel Hill. A superior work which contains information about variation, distribution, habits, and habitat of all reptile species in the state. The color photographs and line illustrations are of exceptional quality.
- Shafale, M.P. and A.S. Weakley. 1990. Classification of natural communities in North Carolina, third approximation. North Carolina Natural Heritage Program Report. A comprehensive discussion of the natural communities in North Carolina and the plants associated with them. One of the earliest reports to give names to the various wetland communities discussed in this manual.
- Somers, A.B. 2000. A population of bog turtles in the Piedmont of North Carolina: Habitat preferences, capture method efficacy, conservation initiatives, and site enhancement. Report to US Natural Resources Conservation Service, Wetland Science Institute. A detailed analysis of a small population of bog turtles studied over a 6-year period. Important implications for establishing guidelines to determine the presence of bog turtles in potential sites before they are destroyed (20-20 Rule).
- Tryon, B.W. 1988. The rare little turtle of east Tennessee. *Tennessee Wildlife* 11(4):6-9. One of the first articles to discuss the status and natural history of the bog turtle in Tennessee.
- Tryon, B.W. 1990. Bog turtles (*Clemmys muhlenbergii*) in the South: A question of survival. *Bulletin of the Chicago Herpetological Society* 25(4):57-66. A comprehensive discussion of the bog turtle's status in the Southeast and the various threats to its habitat.
- Tryon, B.W. and D.W. Herman. 1990. Status, conservation, and management of the bog turtle, *Clemmys muhlenbergii*, in the southeastern United States. In: K.R. Beaman, F. Caporaso, S. McKeown, and M. Graff (Eds.), *Proceedings of the First International Symposium on Turtles & Tortoises: Conservation and Captive Husbandry*, pp. 36-53. August 1990, Chapman University, Orange, California. California Turtle & Tortoise Club and Chapman University. The earliest paper on the status of bog turtles in the Southeast with a discussion of conservation and management actions needed to insure the turtle's future survival.
- Zappalorti, R.T. 1975. The status of the bog turtle *Clemmys muhlenbergii* in North Carolina. Report to the National Audubon Society, New York. The first status survey ever conducted in North Carolina is presented in this report. New county records are discussed, as well as mark and recapture information.
- Zappalorti, R.T. and E.W. Johnson. 1981. The ecology of the bog turtle, *Clemmys muhlenbergii* (Schoepff), (Reptilia, Testudines, Emydidae) in western North Carolina. Report to The Highlands Biological Station, University of North Carolina. Provides a more comprehensive presentation of the above status survey and bog turtle ecology.