

Part of the *Science in North Carolina Series*

# Amphibians and Reptiles

Conservation of our Natural Heritage



**Michael E. Dorcas**



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This learning guide addresses the following goals and objectives in the North Carolina Standard Course of Study:

✧ 6<sup>th</sup> Grade

- Goal 1 (1.01, 1.05, 1.10)
- Goal 7 (7.01, 7.02, 7.03, 7.04)

✧ 7<sup>th</sup> Grade

- Goal 1 (1.01, 1.05, 1.10)

✧ 8<sup>th</sup> Grade

- Goal 1 (1.01, 1.05, 1.10)
- Goal 3 (3.08)

✧ High School Biology

- Goal 1 (1.01, 1.05)
- Goal 4 (4.02)
- Goal 5 (5.01, 5.03)

# Introduction

Science in North Carolina helps us in many ways. Science allows us to better understand how drugs affect our health. Science provides us the knowledge required to manage natural resources such as timber and fish stocks. And science helps us to better understand and appreciate the animals and plants that live around us and which make up an important part of our natural heritage.

Amphibians and reptiles (collectively known as “herpetofauna”) are important parts of our natural heritage. Unfortunately, however, they are often underappreciated and are disappearing from many parts of our state. Research focusing on the ecology and conservation of amphibians, reptiles, and other animals is now helping us to understand the problems these animals face and how we can help to correct those problems.

In this learning guide, I explain why amphibians and reptiles are important, the problems amphibians and reptiles face in North Carolina, and how scientific research is helping us to better manage these important components of our natural heritage.



Coral snake (*Micrurus fulvius*)

# About Amphibians and Reptiles

Amphibians and reptiles are vertebrates (animals with backbones) that represent important, but often overlooked components of North Carolina’s natural heritage. Amphibians include the familiar frogs, toads, salamanders, and the lesser-known caecilians, which are worm-like animals that live primarily underground in tropical regions. Amphibians are typically characterized by their moist skin and complex life cycles.

Most amphibians live in close association with aquatic areas that they use for breeding and egg laying. The eggs hatch into aquatic larvae, which eventually transform into adult amphibians. Some salamanders, however, do not rely on aquatic habitats and instead lay their eggs in moist places on land. When the eggs hatch, the babies look like miniature versions of their parents. Other species of salamanders actually have the ability to reproduce while still in the larval body form.



Red Salamander  
(*Pseudotriton ruber*)

Reptiles, which are more closely related to birds and mammals than they are to amphibians, consist of turtles, crocodilians, snakes, lizards, and a very rare lizard-like animal from New Zealand known as the tuatara. Reptiles’ bodies are generally covered by scales, which offer protection from water loss and in some cases, protection from predators. Most reptiles lay eggs that closely resemble those of birds. Some reptiles, like rattlesnakes, give birth to live young.

# Why Amphibians and Reptiles Are Important

Amphibians and reptiles are ectotherms (cold-blooded) and thus do not have to use energy to maintain the high metabolic rates of birds and mammals. Therefore, they are able to convert much of their acquired energy into growth and reproduction.<sup>1</sup> Because they are energetically efficient, amphibians and reptiles can often be so numerous that they exceed the biomass of all other vertebrates within an ecosystem.<sup>2-4</sup> However, because many species are secretive, they are rarely seen.

Amphibians and reptiles are important in nearly all ecosystems because they serve as predators of some animals and as prey for others.<sup>5,6</sup> Thus, amphibians and reptiles represent important parts of the food chain in many ecosystems. Many species of amphibians and reptiles live in both terrestrial and aquatic habitats and therefore serve as important transporters of biomass (i.e., energy and nutrients) between habitat types.<sup>7</sup>

Because amphibians and reptiles are so important, the diversity and status of amphibian and reptile populations is likely to reflect the ecological integrity of an area as well as the consequences of human-caused habitat modifications.<sup>8-11</sup> Amphibians in particular have been proposed as sentinels of environmental integrity, often referred to as “bioindicators.” Because they live in both aquatic and terrestrial ecosystems and because of their permeable skin, many amphibians may suffer from detrimental impacts in the environment before other species. Thus, amphibians may be able to function as our “canary in the coal mine” and warn us of environmental dangers that have yet to be detected by humans. For example, streams that contain healthy and robust salamander populations may indicate excellent water quality whereas the presence of only a

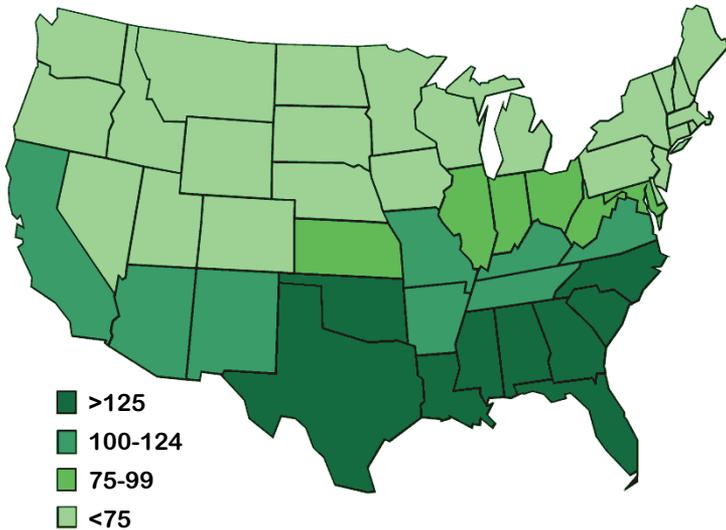
few salamanders in a stream may indicate poor water quality. Not many people would want to drink water with a salamander living in it, but, if you really think about it, would you want to drink water in which a salamander could not live?



# Amphibians and Reptiles in North Carolina

In the southeastern United States, amphibians and reptiles represent especially important groups of animals. More than half of the nearly 500 species of amphibians and reptiles found in the United States occur in the Southeast and nearly 100 of these are endemic (found nowhere else on earth). In the figure below, diversity is measured as the number of species per state.

### Amphibian and Reptile Biodiversity



North Carolina is home to an amazingly diverse assemblage of amphibians and reptiles including 30 species of frogs and toads, 58 species of salamanders, 20 species of turtles, 12 species of lizards, 37 species of snakes, and a single crocodilian, the American alligator (*Alligator mississippiensis*).

Some North Carolina amphibians and reptiles, such as bullfrogs (*Rana catesbeiana*) and garter snakes (*Thamnophis sirtalis*), can be found in a variety of habitat types and range across the entire state. Others are found only in very specific habitat types. For example, the diamondback terrapin (*Malaclemys terrapin*) is a species of turtle found only in salt marshes along the coast. Some species of amphibians and reptiles reach the limits of their geographic range in the state. For example, the magnificent eastern diamondback rattlesnake (*Crotalus adamanteus*), the largest rattlesnake in the world, reaches the northern limit of its range in North Carolina and one salamander, the Neuse river waterdog (*Necturus lewisi*), is found only North Carolina.



American Toad  
(*Bufo americanus*)

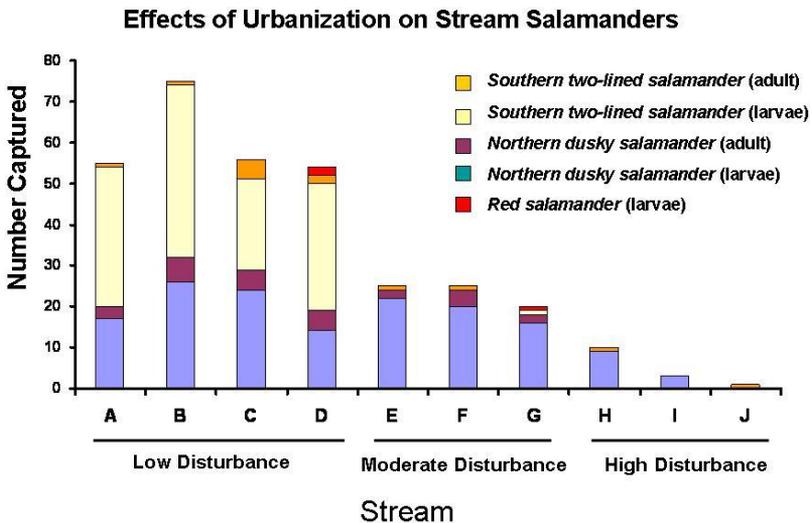
## **Problems for Amphibians and Reptiles in N.C.**

Like many other animals, populations of most species of amphibians and reptiles are declining in North Carolina and around the world at least partly due to human impacts. Various factors contribute to these declines, but for most species, loss of habitat due to development by humans continues to be a major threat. This process is generally known as “urbanization.” North Carolina is home to some of the fastest developing metropolitan areas in the country and when forests are converted to subdivisions and strip malls, animals are either displaced or killed. Additionally, the impacts of urbanization on nearby amphibian and reptile populations can be very detrimental. Impacts from urbanization include threats such as pollution of water bodies, road mortality, and fragmentation of populations into smaller, less viable ones.

Research is desperately needed before we can begin to understand the human impacts on animal populations. Compared to mammals and birds, amphibians and reptiles have been the focus of limited conservation research in North Carolina. Unfortunately, North Carolina risks losing some species of amphibians and reptiles in the very near future. For example, the beautiful coral snake (*Micrurus fulvius*) is a venomous species that has apparently disappeared from most of its historical range in North Carolina and is now only infrequently found in extreme southeastern parts of the state. For many species in the state, the current statuses of their populations are unknown, and some may disappear before measures can be taken to reverse population declines.

# Research on Amphibians and Reptiles in N.C.

Research examining the effects of urbanization on amphibian and reptile populations in North Carolina demonstrates the detrimental impacts we have on animals. For example, a published study examining stream salamander populations near Davidson, North Carolina, found that there was a strong, negative correlation between the amount of urbanization within the watershed of small streams and the number of salamanders inhabiting those streams.<sup>12</sup>



In this study, investigators used a geographical information system (GIS; a computer mapping program) to examine the amount of urbanization within the watersheds of 10 streams. They sampled these streams with equal effort using standard techniques and found significantly fewer salamanders in streams with high levels of urbanization. They also found that

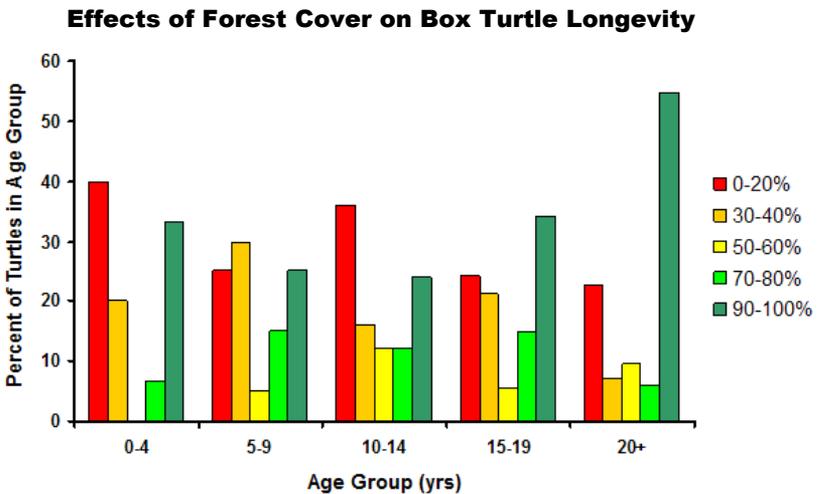
various characteristics of the streams, such as conductivity (a measure of the substances dissolved in the water), amount of leaf litter, diversity of invertebrates, and swelling of the streams during rain events were all correlated with levels of urbanization. Whether these factors directly influence the salamanders living in the streams warrants further investigation.

Stream salamanders can be extremely abundant in some streams and thus, represent organisms vital for stream ecosystem function. Because the water in which these salamanders are found is the same water many North Carolinians drink, it is important to investigate the causes of these negative impacts.



J. D. Willson, a former Davidson College student, sampling salamanders.

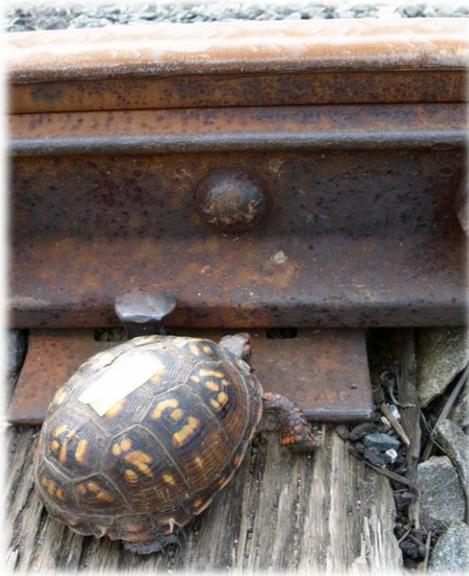
The eastern box turtle (*Terrapene carolina*) is the state reptile of North Carolina and a species of which many people are particularly fond. Box turtles are found throughout the state but may be disappearing from many localities for numerous reasons. Road mortality is certainly a problem for this species and, fortunately, many North Carolinians help box turtles survive by assisting them when found on roads. One research study showed that although box turtles can persist in some developed neighborhoods, there were fewer older box turtles in neighborhoods when compared to undeveloped forests.<sup>13</sup>



This finding is likely the result of increased mortality due to vehicular traffic, introduced predators such as dogs and cats, or even removal by people for pets.

Another apparent source of mortality for this species is railroads. Turtles are infrequently killed by trains but the structure of the railroad itself poses a significant hazard for these unique animals. Although it has never been the subject of an actual research study, anecdotal evidence based on the discovery

of numerous turtle carcasses suggests that box turtles can become trapped between railroad rails and then die of overheating in the sun or become susceptible to predation.<sup>14</sup> A recent study showed that if a box turtle does manage to become trapped, it is nearly impossible for that animal to escape unless it happens upon a railroad crossing.<sup>15</sup> Thus, in contrast to direct mortality on roads due to automobiles, mortality due to railroads is caused by the structure rather than the actual vehicles.



Once a box turtle is trapped on a railroad track, it becomes very difficult to escape before it overheats.

Because many railroads traverse forested areas, which are the natural habitat for box turtles in North Carolina, mortality as a result of railroads may be substantial. Perhaps an even more detrimental effect of railroads on box turtles is habitat fragmentation. Because a railroad rail represents a significant barrier to a box turtle, railroads likely separate historical

populations of these animals into smaller, isolated populations that are more prone to extinction. Future research should document the actual impacts that railroads have on this species. Likewise, methods that reduce negative impacts of railroads should be developed so that future generations will still be able to enjoy encounters with box turtles in North Carolina.



# **The Future of North Carolina's Amphibians and Reptiles**

The future of North Carolina's amphibians and reptiles rests in our hands. We have the opportunity and responsibility to reverse our detrimental impacts on our natural environments and the animals that inhabit them. Losing species from our state represents a partial loss of our natural heritage. Fortunately, many people are beginning to appreciate amphibians and reptiles as important parts of our natural ecosystems and as organisms deserving of our appreciation.

Through a combination of responsible planning, habitat preservation and restoration, and research to examine the impacts of human activities on animals, we can hopefully find ways to minimize the effects of our activities on our amphibian and reptile neighbors. Organizations such as North Carolina's Partners in Amphibian and Reptile Conservation (NCPARC; [www.ncparc.org](http://www.ncparc.org)) support these activities and bring people from various sectors together to work toward more effective amphibian and reptile conservation. However, education remains the key to conserving our environment and the animals that depend upon it. When we begin to educate adults and children about the animals that live around them, people begin to appreciate these animals more. It is this fundamental appreciation of amphibians and reptiles that represents the only real hope for their future.

Find out more about North Carolina's amphibians and reptiles at [www.herpsofnc.org](http://www.herpsofnc.org).

## Literature Cited

1. POUGH, F. H. 1980. The advantages of ectothermy for tetrapods. *The American Naturalist* 115:92-112.
2. BURTON, T. M., and G. E. LIKENS. 1975. Salamander populations and biomass in the Hubbard Brooks Experimental Forest, New Hampshire. *Copeia* 1975:511-546.
3. CONGDON, J. D., and J. W. GIBBONS. 1989. Biomass productivity of turtles in freshwater wetlands: a geographic comparison. p. 583-592 in *Freshwater and Wetlands and Wildlife*. R. R. Sharitz and J. W. Gibbons, editors. Office of Scientific and Technical Information, U.S. Department of Energy. Oak Ridge, TN.
4. PETRANKA, J., and S. MURRAY. 2001. Effectiveness of removal sampling for determining salamander density and biomass: a case study in an Appalachian streamside community. *Journal of Herpetology* 35:36-44
5. GIBBONS, J. W. and M. E. DORCAS. 2004. *North American Watersnakes: A Natural History*. University of Oklahoma Press, Norman, OK.
6. TAYLOR, B. E., R. A. ESTES, J. H. K. PECHMANN, and R. D. SEMLITSCH. 1988. Trophic relations in a temporary pond: larval salamanders and their microinvertebrate prey. *Canadian Journal of Zoology* 66:2191-2198.
7. GIBBONS, J. W., C. T. WINNE, D. E. SCOTT, J. D. WILLSON, X. GLAUDAS, K. M. ANDREWS, B. D. TODD, L. A. FEDEWA, L. WILKINSON, R. N. TSALIAGOS, S. J. HARPER, J. L. GREENE, T. D. TUBERVILLE, B. S. METTS, M. E. DORCAS, J. P. NESTOR, P. MASON, C. A. YOUNG, T. AKRE, R. N. REED, S. POPPY, T. MILLS, K. A. BUHLMANN, J. NORMAN, D. A. CROSHAW, C. HAGEN, E. E. CLARK, G. J. GRAETER, and B. B. ROTHERMEL. 2006. How productive can an isolated wetland be? Remarkable amphibian biomass and abundance. *Conservation Biology* 20: 1457-1465.
8. GIBBONS, J. W. 1988. The management of amphibians, reptiles, and small mammals in North America: the need for an

- environmental attitude adjustment. p. 4-10 in Management of Amphibians, Reptiles, and Small Mammals in North America. Flagstaff, AZ, July 19-21, 1988.
9. GIBBONS, J. W., D. E. SCOTT, T. J. RYAN, K. A. BUHLMANN, T. D. TUBERVILLE, B. S. METTS, J. L. GREENE, T. MILLS, Y. LEIDEN, S. POPPY, and C. T. WINNE. 2000. The global decline of reptiles, Deja Vu amphibians. *BioScience* 50:653-666.
  10. KNUTSON, M. G., J. R. SAUER, D. A. OLSEN, M. J. MOSSMAN, L. M. HEMESATH, and M. J. LANNOO. 1999. Effects of landscape composition and wetland fragmentation on frog and toad abundance and species richness in Iowa and Wisconsin, U.S.A. *Conservation Biology* 13:1437-1446.
  11. VITT, L.J., J. P. CALDWELL, H. M. WILBUR, and D. C. SMITH. 1990. Amphibian as harbingers of decay. *BioScience* 40:418.
  12. WILLSON, J.D. and M.E. DORCAS. 2003. Effects of habitat disturbance on stream salamanders: implications for buffer zones and watershed management. *Conservation Biology* 17:763-771.
  13. BUDISCHAK, S. A., J. M. HESTER, S. J. PRICE, and M. E. DORCAS. 2006. Natural history of box turtles, *Terrapene carolina*, in an urbanized landscape. *Southeastern Naturalist* 5: 191-204.
  14. PALMER W. M., and A. L. BRASWELL. 1995. Reptiles of North Carolina. The University of North Carolina Press, Chapel Hill, NC. 412 pp.
  15. KORNILEV, Y. V., S. J. PRICE, and M. E. DORCAS. 2006. Between a rock and a hard place: responses of eastern box turtles (*Terrapene carolina*) when trapped between railroad tracks. *Herpetological Review* 37: 145-148.

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Mike Dorcas is an Associate Professor in the Department of Biology at Davidson College, Davidson, NC. He received a B.S. and M.S. from the University of Texas at Arlington and a Ph.D. from Idaho State University. Mike has received numerous awards, including the Senior Research Award from the Association of Southeastern Biologists. Mike's research program focuses on the physiology, ecology, and conservation of amphibians and reptiles. Mike has published several book chapters and over 85 articles on the biology of amphibians and reptiles. His recent books include *A Guide to the Snakes of North Carolina* (Davidson College) and *Snakes of the Southeast* (University of Georgia Press).





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