THE BOX TURTLE CONNECTION

A Passageway into the Natural World

Ann Berry Somers and Catherine E. Matthews

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Photographs by Ann Somers unless otherwise indicated

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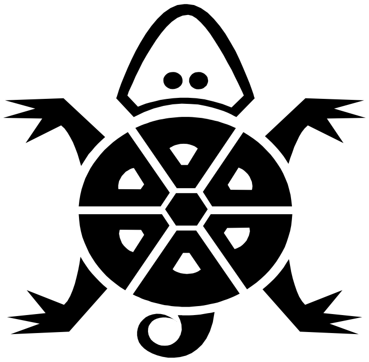
“To the amateur, I say learn about nature, but do it carefully and with commitment . . . Amateur naturalists have much to offer the scientific community in understanding the ways of box turtles. To the professional, I say get outdoors and observe nature . . . Natural history should be celebrated. After all, we are dealing with life in all its complexity. A study of box turtles is the perfect place to begin.”

– Ken Dodd (2001)



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Preface

It has been many decades or perhaps more than a century since natural history held a preeminent status in science, and it is clear that natural history is losing in the competition with cellular, molecular, and developmental biology at all levels of education and research. Most students see no future in natural history and truly believe that, like its namesake, natural history is history. Yet, there's still much to be discovered. "Keeping common animals common" (Gibbons and Stangel, 1999) will depend somewhat on our ability to make discoveries through research.

We assume some animals, like box turtles (genus *Terrapene*), are common because of our personal sightings, distribution maps which indicate they are widespread, and because they hold no special distinction of being at risk. Yet some of these familiar species may not be as common as we think. Since most of us see the occasional box turtle or two crossing a road, even in urban areas, we tend to think that box turtles are okay. That somehow, despite the fragmentation of their territories, they successfully negotiate the highways to find mates and lay eggs. Is it possible that because most of us have been lucky enough to see box turtles, wild and free (and Henry David Thoreau said, "All good things are wild and free."), that we have failed to notice the gradual decline in the numbers of our sightings? Recall the *boiling frog syndrome* which is described as a situation that occurs when a frog does not jump out of a pot of water that is gradually warmed, but hops out immediately if plunged into boiling water. Are we like the frogs that do not notice the subtle changes in the environment because they are gradual? We must take careful note of abiotic and biotic factors in our environment, such as the box turtles, which are sending clear messages that the ability of the environment to support diverse forms of life is diminishing.

Actually, there is still more at risk, more than not noticing the changes in the natural world, as serious as these are. There is the risk of disconnection with nature. Richard Louv calls this Nature Deficit Disorder and has identified a number of consequences of this detachment in his highly acclaimed book *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder* (2005). While there are many ways to address Nature Deficit Disorder, box turtles can play an important role in helping reconnect children with the joy and mystery of the natural world. Gentle by nature, box turtles are favorites of adults as well as children and are, or at least have been, common and familiar animals.

Many scientists believe that box turtle populations are now in decline. *The Box Turtle Connection: A Passageway into the Natural World* is for those who want to connect others with the natural world and at the same time contribute to our scientific understanding of these animals. It is about how to conduct research as well as how to create a curriculum based on research. We want curators, naturalists, educators, and students to be encouraged to engage in carefully designed box turtle research with a commitment to scientific validity.

We both teach at the University of North Carolina at Greensboro (UNCG) and have spent considerable time with turtles. Ann Berry Somers, a UNCG faculty member in the Biology Department, is a bog turtle researcher, one of the directors of Project Bog Turtle, and teaches a course on sea turtles that engages students in sea turtle recovery projects in North Carolina and

Costa Rica. Catherine Matthews, a UNCG faculty member in Science Education, has been an active member of herpetological organizations in Kansas, Idaho, and North Carolina, and has shared her love of turtles, as well as other reptiles and amphibians, with K-12 students and their teachers in each state. Drawing on the bog turtle research work with UNCG students, we designed the pilot box turtle study at Bethany Community Middle School (BCMS) in accordance with one already underway at Davidson College under the leadership of Biology Professor Dr. Mike Dorcas.

The BCMS Box Turtle Project, initiated in 2001, involved middle school students, their teachers, UNCG faculty and graduate students, and interested individuals in the Bethany community studying box turtles on the school grounds and adjacent property. The radio-tracking phase of the project was completed in 2004, but the mark-recapture study continues due to the dedication of Sarah Seymour, the BCMS science teacher. This project is described in detail in an article published in *Science Scope*, which is included as Appendix A. Please note that many of the tools and techniques described herein for studying box turtles can be applied to the study of other reptiles and amphibians (herpetofauna).

Plan and conduct your research carefully. Ken Dodd (2001) calls box turtles “homebodies” for good reason. They have a strong sense of place and for the most part stay at home and want to be left alone. Do not move them around casually or allow others in your study to do so. Do not allow your field study site to become a dumping site for turtles that are displaced by well meaning but misinformed participants. Do not hesitate to seek help from professionals. Sources in the *Bibliography* and *Additional Resources* should allow you to find professional help in developing research questions appropriate to your study and study site. As far as conservation decisions are concerned, remember, veterinarians are normally trained in companion (pet) or farm animal medicine and may not have any knowledge of the habitat requirements or behavior of wild reptiles. Look for people working in the field of conservation biology.

Our philosophy revolves around Luther Burbank’s (1907) thought from many years ago:

> "Every child should have mud pies, grasshoppers, waterbugs, tadpoles, frogs, mud turtles, elderberries, wild strawberries, acorns, chestnuts, trees to climb, brooks to wade in, water lilies, woodchucks, bats, bees, butterflies, various animals to pet, hay fields, pine cones, rocks to roll, sand, snakes, huckleberries and hornets, and any child who has been deprived of these has been deprived of the best part of their education.”

Let’s add box turtles to the list!

Ann Berry Somers
Catherine Matthews

Acknowledgements

The box turtle study conducted at Bethany Community Middle School (BCMS) was made possible because of the support of administrators at both BCMS and the University of North Carolina at Greensboro (UNCG). The enthusiasm and commitment of the faculty and students at BCMS and the professors, graduate, and undergraduate students from UNCG allowed this project to develop over a period of several years. This book is a spin off of that effort. The enthusiasm, commitment, and support also spread to BCMS parents, staff, and other members of the community. We are deeply grateful for their involvement and assistance.

Chris Swarth, Mike Quinlin, Heather Soja, Cathy Scott, Gary Stock, Thomas Berry, and others contributed sections to this book. Heather Soja and Cathy Scott helped write the Lesson Plans. Mike Quinlin and Chris Swarth contributed the chapter and worksheets on How to Conduct a Box Turtle Census. Gary Stock allowed us to include the chapter What Box Turtles Need from his website *With the Grain*. Thomas Berry granted permission to include his widely admired poem *It Takes a Universe*. Mary Hall-Brown provided cartographic expertise and home range maps. The Davidson College Herpetology Students compiled the Turtle Identification Codes. Elizabeth M. Walton's *Field Techniques for Bog Turtle Research in North Carolina* (2002), based on Somers' bog turtle research at UNCG, served as a model for this work. Walton also contributed to an early version of this manuscript.

The turtle illustrations are included courtesy of the Boy Scouts of America and appear in the BSA Reptile and Amphibian Study 1993 merit badge handbook. Additional drawings are by UNCG student, Jenny Kimmel. The turtle skeleton is reprinted with permission of the National Science Teachers Association Press and comes from their publication, *Hands-on Herpetology: Exploring Ecology and Conservation* (2001). The human skeleton is located at <http://www.eskeletons.org> and was created at the University of Texas at Austin under the direction of John Kappelman, PhD.

To each of the following individuals we give very special thanks for their support and assistance:

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It Takes a Universe

The child awakens to a Universe.
The mind of the child to a world of wonder.
Imagination to a world of beauty.
Emotions to a world of intimacy.

It takes a Universe to make a child
both in outer form and inner spirit.
It takes a Universe to educate a child.
A Universe to fulfill a child.

Each generation presides over the meeting of
these two in the succeeding generation.

So that the child is fulfilled
in the Universe and
the Universe is fulfilled in the child.

While the stars ring out in the heavens!

~ Thomas William Berry

1. The Turtle Connection

by Ann Somers

There on the path was a box turtle. She paused and looked at me curiously. I squatted down, fascinated by the subtle colors that moments earlier had so easily concealed the splendid creature in the leaves. I remember the joy of the unexpected discovery and the warm feeling I experienced when I picked her up. We made eye contact, each checking out the other through the window to the soul. It was as if the turtle and I shared a private experience, some intimacy, some connection. For me, it was like getting a present. I now recognize that others feel it too and that it never goes away no matter how many box turtles you might meet . . . or sea turtles . . . or bog turtles for that matter. I knew about looking turtles in the eye before my friend Jean Beasley told me to connect with sea turtles that way. I learned that from a box turtle as a child.

I appreciated that turtle immensely for allowing me to hold her. No flight or fight here. Some box turtles simply clam up and hope for the best when confronted by humans. Others take their situation into account and boldly ask to be left alone by means of urinating or walking on air as you hold them in your hand. But they are docile, gentle beasts for the most part. Only once did a box turtle really nail me. It was a feisty youngster that did not appreciate my fingers dangling before its face as I spoke to a small group of middle school students. It answered my insult by chomping down decisively on the fleshy part of my finger and holding on and on and on. It was all I could do to resist the urge to curse and throw the turtle off. This was not exactly the human-turtle connection I meant to demonstrate. Running water over the turtle finally solved the problem, but not before the students laughed hilariously at my predicament. Those students are older now and have forgotten many of the turtle facts I shared with them, but they always remember the day the turtle bit my finger in front of the class, and never fail to mention it when we meet. And we get to laugh again.

Children and adults alike respond to the gentle nature of the turtles and come to see life through their eyes. The turtle connection can be a key that unlocks the door to a new relationship with the natural world, one of wonder, beauty, and intimacy.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Are human beings *a part of* or *outside of* nature? Where are humans in the great cosmic order? Investigate human attitudes towards nature and the impact of those attitudes on wildlife. Have students research and compare the American Indian view of the human place in nature with the Western view.

Do we have an obligation towards other life forms? An activity to help students investigate their own attitudes and feelings towards nature, called “Do the duck walk” developed by the Wildfowl and Wetland Trust, can be found along with other valuable exercises at <www.wwtlearn.org.uk/worksheets/worksheet-duck_walk.pdf>.

2. Range and Habitat

North American box turtles, genus *Terrapene*, (Figure 1) are found over a wide geographic range (Figure 2). Within that range, their variety of colors and patterns (Figure 3) allows box turtles to utilize many different habitats. Microhabitats are small areas that may be distinguished from other areas in the surrounding area by humidity, temperature, cover or other physical characters that change daily and seasonally. These are especially important for box turtles since they are ectothermic (also known as "cold blooded" but see Glossary) meaning their body temperature changes with the environment. Turtles may control their body temperature by occupying open meadows in the cooler morning or evening hours, and withdrawing to woodlands during the hotter hours of the day where the humidity is higher and the temperature lower. Another way of controlling body temperature is to change microhabitats, such as moving into or out of sunlit spaces.

Box turtles may spend nights or periods of aestivation in a shallow depression called a *form* (Figure 4). The front legs are used to dig and the back legs are used to push out loose material, then the turtle maneuvers into the depression for a secure, protective fit (Stickel, 1950). When settling in for the winter, the turtle gradually digs a chamber until the carapace is completely hidden. In mild winters, the carapace may remain visible throughout the season. Some turtles may dig into root tunnels or old tree stumps; some bury themselves along slopes, under blackberry thickets, or in briar patches. We have observed box turtles over-wintering along side fallen logs and among root masses in floodplains. The same over-wintering sites may be used in subsequent years, and box turtles may share the same chambers with other box turtles, though this is rare (Dodd, 2001). Interestingly, our radiotelemetry studies have allowed us to observe what other researchers have found, that turtles sometimes move short distances during warm spells in winter.

Jennifer Mansfield-Jones

Figure 1. A juvenile eastern box turtle (*Terrapene carolina carolina*).

Some turtles move outside their characteristic home ranges to over-winter, mate or lay eggs, though many do not. Radiotelemetry studies are greatly increasing our understanding of turtle behavior (Chapter 17).

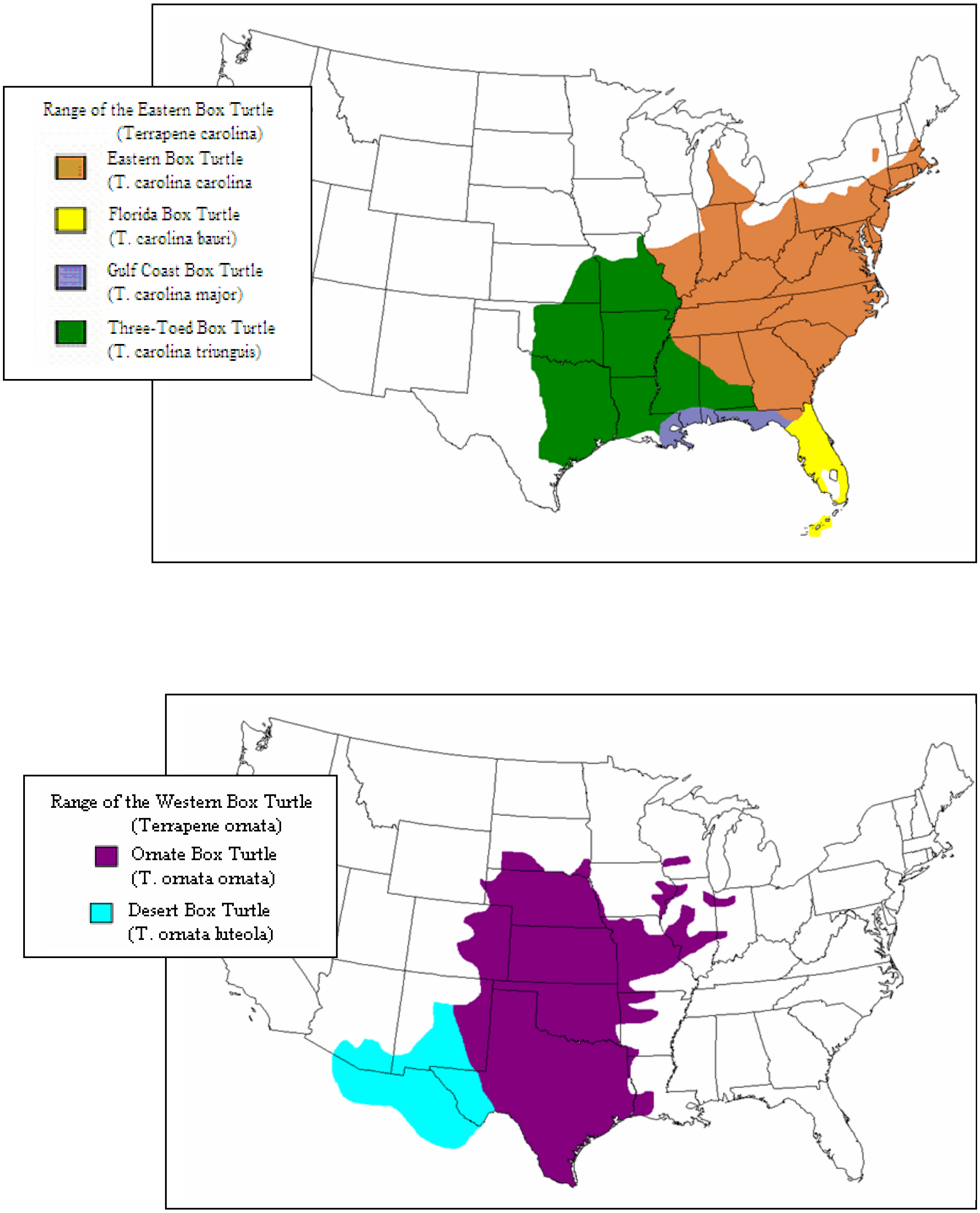

Figure 2. Box turtle range maps. Range of the eastern box turtles, *Terrapene carolina* (top), and the western box turtles *Terrapene ornata* (bottom). Various subspecies are represented by different colors. Maps courtesy of J. D. Willson.

Figure 3. Box turtles come in a variety of colors and patterns.

Habitat Problems for Box Turtles

The landscape throughout the range of the box turtle has changed drastically over the last few centuries. Habitats are fragmented and the microclimates are altered when roads, telephone and power lines transect them or when they are closely mowed or clear-cut. Cell phone towers now dot the landscape every two miles in our region, a swift change with unknown impact on turtle populations. Such changes allow more sunlight and wind to penetrate an area, which results in higher temperatures in warm weather, lower temperatures in cold weather, and the potential for stronger winds. Because box turtles are generalists, they can benefit from early successional habitats such as weedy fields and blackberry thickets that grow under electrical and telephone lines. However, such habitats may be deadly when it puts turtles into contact with road traffic, tractors, and mowers. Additionally, mowed roadsides, lawns, and cell tower fields offer turtles (and many other species) nothing in the way of food or shelter.

Figure 4. Box turtles create shallow depressions called *forms*.

Habitat fragmentation can also increase the chance of fire and allow penetration of non-native species such as honeysuckle and Japanese grass. Mid-sized predators such as domestic cats, dogs, and raccoons may increase in number. We suspect that this results in increased predation and may be a factor in the decline of some box turtle populations.

3. What Box Turtles Need

by Gary Stock

The following information describing the needs of box turtles was taken from the Internet site *With the Grain* at <http://www.wtgrain.org>, which is dedicated to educating people about their effects on the environment, and motivating them to make informed, responsible decisions. The website focuses on conservation issues, specifically documenting significant populations of the Eastern box turtle and offering techniques for effective stewardship of this species. In a section called *Habitat from Humanity*, the editor offers practical steps to support the habitat requirements of the Eastern box turtle.

“I need everything to be close to my home. A box turtle may live longer than a human, all within a few acres… Provide complete and diverse habitat as close together as possible, with no intervening roads, lawns, or houses.

I need wet soils to remain moist and open. Eastern box turtles require variety. However, changes in their water regime are unhealthy. Moist soils provide rest on hot days, a variety of foods, and water. Any wet space--a swamp, marsh, or damp forest depression--may be absolutely essential to survival in that locality.

I need a sunny spot to bask and reproduce. Eastern box turtles seek the sun, both seasonally and by the hour. Successful nesting demands clear patches of warm sand, under an open sky. Keep large, isolated clearings, or sun-seekers may end up in a deadly roadway.

I need living space that will last a lifetime and beyond. Given a chance, turtles will outlive you. However, today's healthy box turtle habitat may not persist. Natural processes often turn sunny clearings into thin, unhealthy woods. Consider ways to keep habitat intact, functioning, and legally protected for future generations.

I need privacy, security, and stability. Site conditions dictate survival for individuals and the species. If you are blessed to see box turtles on your land, their physical isolation is your utmost priority. Limit roads and traffic, educate neighbors, and exclude humans and other predators.

I need protection from people--all kinds. Land stewards, pet lovers, and even casual hikers can do unintended harm. Good intentions don't help a dead turtle. Enforce a few simple rules, including all your grade school lessons: be careful, be clean, be cautious.

I need a tremendous variety of native foods. Box turtles may eat anything organic, tasty to you or not. If flora or fauna are involved, it might be food. Leave places for insects and fungi to flourish. In the sun, encourage dense clusters of brambles, and let the rotted fruit fall.

I need a safe place to settle for the winter. Cold weather forces box turtles under cover or underground. Preserve areas with mature trees and soft, loose soil. Remove weedy plants, and reduce human activities. Let leafy boughs lie where they fall, and expand brush piles during the growing season (see below).”

“Build a Brush Pile for Turtles and Other Wildlife

A box turtle may reuse the same wintering spot year after year. It saved their life before; they'll be back. Human activities that compact the soil must be minimized in these life-saving winter yards. Stop leaf raking or burning, wood hauling--even foot traffic. The only reasonable activity is removal of seedlings and weeds that may themselves pose a threat.

You can easily build a great wintering brush pile yourself. Site selection is at least as important as the pile itself. Think Goldilocks: not too much, not too little--but just right. The list of criteria is detailed, but find any two or three together and you have a good site. If all these criteria co-exist, odds are box turtles already frequent the site in winter.

Start along the north side of a clearing, or, if necessary, the east side (late fall afternoon sun is a welcome treat). Work especially where large trees line the clearing edge (which tends to regulate both temperature and humidity). If no clearings exist, create some for future years. In the meantime, build piles beneath a large woodland tree or very large shrub. Their shade will have reduced grasses and woody stems that hamper burrowing.

Choose a spot with moderate air drainage--neither an exposed hilltop nor a low pocket. The soil must be relatively dry. Available water encourages ice formation, which can kill. However, exploit natural barriers of shrubs or tree trunks by selecting the moist side, away from prevailing winds. Wind-induced drying also is stressful. Remember Goldilocks.

This location will feel like a good spot to hunker down for the winter, even to you. Scope several sites 80 to 100 feet apart, perhaps further, so all the locals will have a chance. If time or resource constraints limit the number of piles, distribute them evenly over as large an area as the turtles seem to use. They will seek out the piles over some distance, especially when visible across a clearing.

For the pile, start with moderately large sticks several feet long, crisscrossed to permit some air movement. If possible, lean one in the notch of a scrub tree a few inches above ground. The pile should not be held off the ground, just a bit open here and there. Keep in mind that snow is your friend. Your goal is to provide as many places for snow to catch as possible, while providing alternative insulation if the snow fails.

Add layers of branches, especially with leaves attached, until you're tired of cutting. (If you have only bare branches, alternate with layers of grass or weeds you've pulled.) Seriously, keep cutting until you run out of energy. Two foot deep is good, four feet deep seems better. Five feet across is OK, ten feet across is great. Just keep the layers loose and random: no stacking. The more opportunity to get lost under that pile, the greater their survival rate.

By the way, don't be surprised to find turtles chilling out in the abandoned den of a badger, fox, coyote, or groundhog. Some will choose a cockeyed woodpile, where mice and moles have loosened underlying soil and moist leaves have accumulated. Long-moldering, humus-covered piles of very large rocks may serve the same purpose.”

4. The Box Turtle: A Species in Decline

Turtles are important to people and their decline is of concern for many reasons. They are, or have been, symbols in religion, mythology, art, writing, and medicine. Indigenous people of most temperate and tropical regions have always connected with turtles in many different ways. For example, North American Indians used turtles for food and ritual as well as made practical objects from their shells. Additionally, they are members of natural ecological communities and perform important ecological services such as seed dispersal (Braun and Brooks, 1987).

Box turtles are gradually disappearing from landscapes all across eastern North America (Swarth, 2005). Although these turtles are not facing imminent global extinction, most box turtle researchers believe that populations are in serious decline and that mortality from human activity is significant and increasing (Swarth and Hagood, 2004). Local extinctions, called extirpations, appear to be increasing. Extinction, at a low rate, is a natural and important aspect of evolution. However, the vast, vast majority of extinctions today result from human activity and are occurring at an accelerated rate so great that it is comparable to the mass extinction which eliminated the dinosaurs and other plants and animals 65 million years ago. Species like box turtles, which have few offspring, and are slow moving and late maturing, are particularly susceptible to human related extinction.

Neil Wagner

Figure 5. Box turtles can survive cool fires without going underground or hotter fires if cover is available. This burned turtle was quite healthy and active.

Habitat loss and overexploitation are the primary threats to reptile species threatened with extinction (Primack, 1998) and this appears to be the case for box turtles as well (Dodd, 2001), although long-term studies describing these trends are not available. Box turtles have little or no protection from loss of habitat, but they are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES), which regulates box turtle trade to other member nations (Dodd, 2001).

Injury and mortality from roads, railroads, and other transportation infrastructures are evident throughout the range of the turtles. Although turtles are equipped to deal with some types of physical injuries (Figure 5), they cannot withstand most car strikes and mower injuries, or being trapped between railroad tracks (Kornilev et al. 2006). Over-collection for the pet trade (Figure 6) also constitutes a serious threat. Such pressures are likely causing a decline in numbers of populations and numbers of turtles within populations.

Trade in wild caught turtles has escalated world-wide for the pet industry and Asian food markets, both domestically and abroad. The North Carolina Nongame Wildlife Advisory Committee became alarmed when commercial collection of various aquatic turtles had accelerated from 460 individual turtles in 2001 to over 23,000 in 2002 and worked with state legislators to enact new legislation limiting the numbers of turtles that a person may have in their possession to less than five total. Although legislation may help reduce additional turtles (including box turtles) from being removed from the wild, the loss of those already taken may have detrimental effects on population numbers for generations.

Box turtles are often characterized as the longest-lived vertebrates in North America. Although they may have the ability to live more than 100 years, it is unlikely that a large percentage actually do. As is the case with all wild populations, more offspring are born than live to reproductive age due to natural causes of mortality such as high levels of predation of eggs, hatchlings, and juveniles. This is one reason why turtles marked as hatchlings are rarely seen as adults.

Male box turtles may begin to reproduce around the age of 5 to 6 while females mature when they are closer to 7 or 8 years old, though this may vary with latitude. Females will lay from 1 to 7 eggs, and in some populations produce more than one clutch per year. Not all wild box turtles reproduce every year, probably due to inconsistent availability of foods and fluctuating environmental conditions (Dodd, 2001). Some years are just better than others.

Due to the small number of long-term studies, much remains to be learned about box turtles. Studies of short duration are important, but may not provide sufficient data to inform conservation decision-making. Long-term studies are rare, but very important.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Use maps to plot box turtle capture sites, to navigate on the study site, and to compute distances traveled by the box turtles. If you have historical maps, you can compare land use patterns over the past 100 years. Map lesson plan ideas can be found easily with online searches and topographic maps are available from the U.S. Geological Survey at <http://www.usgs.gov>.

Figure 6. Box turtles in Alaska? Most turtles in pet stores are wild-caught and some are shipped great distances. While having a pet turtle is a great way to learn about them, buying them from a reputable breeder is the best way to ensure that wild populations are not harmed. The vast majority of pet store turtles die in their first year of captivity (Williams, 1999). These photos were taken in Anchorage in 2003.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Have students read *The Terrible Turtle Trade* by Ted Williams available on the website <http://nytts.org/asia/twilliams.htm> (Williams, 1999). Generate a list of questions a parent should ask before allowing a child to get a pet starting with "*What is the lifespan of this animal?*" The answers may discourage impulsive buying. Ask students for ideas on what parents should do with a pet once the child loses interest in it or goes off to college.

5. Box Turtles in the Road

Many people who move box turtles across roads already know that they must take the turtle to the side of the road to which they were heading. There are other, well-intentioned individuals who move them to distant areas that they consider to be safer or more suitable.

Turtles of all species cross roads for many reasons. The road may transect their home range. They may be moving to or from a specific spot where they lay eggs or over-winter. Moving a turtle to a new location may mean hindering its ability to successfully find a mate, food, or find a suitable site for egg laying. Moving turtles outside their home territory may very well be dooming them to a long, slow death.

So, what is a responsible action when encountering a turtle in the road? Place the turtle on the side of the road in the direction in which they were heading. While this will not solve fragmented habitat problems, it may be best for the turtle. Box turtles can and do survive in some urban environments. Do not take turtles to a park as most parks prohibit the unauthorized release of wild or domestic animals.

Learn more about how roadways and walkways can be built or modified to help protect wildlife from harm. The website *KEEPING IT SIMPLE: Easy Ways to Help Wildlife Along Roads* at <http://www.fhwa.dot.gov/environment/wildlifeprotection/index.cfm> was created by the Federal Highway Administration's Natural and Human Environment Office. The purpose of the site is to highlight easy ways of reducing highway impacts on wildlife for the transportation community and for the traveling public.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Investigate why animal rights activists and conservation biologists sometimes disagree about the treatment of animals. The story of the feral pigs on lands owned by The Nature Conservancy (TNC) in Hawaii is a good example of these differences. What was the response of the People for the Ethical Treatment of Animals (PETA) when The Nature Conservancy decided to set snares for the pigs?

- Have the students learn more about these two organizations and present arguments from both viewpoints.
- Contrast what's best for the natural population, community, and ecosystem with what is best for the individual animal.

6. Planning Field Research

This section provides tips for creating effective field research methods and analyzing data collected. Science centers, museums, and schools can conduct box turtle research that, if carefully planned, will generate information of conservation value. If box turtle numbers are declining, as many scientists suspect, then sound scientific data are needed to develop successful conservation strategies. The following pages will offer information on how to conduct your study in a way that will allow you to compare your data with those collected by other researchers.

Before you begin, consider the following: What will be the length of this study? Am I really interested in activities that involve working outdoors? Am I dedicated to following the methods of sound science? If you use radiotelemetry (Chapter 17), are you prepared to track turtles throughout the year, even during seasons of uncomfortable weather?

Ideally, research on any long-lived species, including turtles, would last years since animal activity and environmental conditions vary over time and trends are difficult to detect with short-term studies. However, even short-term studies have value, especially for educational purposes.

Before deciding whether box turtle research is for you, answer the following questions. What are your goals? What are your research questions? What types of data will help you answer your research questions? Will radiotelemetry be valuable in meeting your goals? Will you involve the local community? Are you willing to insist that turtles be returned to their point of capture as soon as possible? Can you provide safe, secure, clean accommodations for turtles that cannot be processed right away?

Consult your state wildlife agency *before* you begin planning and seek advice regarding permits. They may know of other turtle researchers that can also advise you. Collaborating with other researchers and supporters will help the principal investigator determine the purpose and the scope of the study. Use this support to interest your science center, museum, or school administrators in your research ideas. Include other curators, instructors, or investigators in planning.

Engage students or junior curators by soliciting ideas from them as well as parents, administrators, and faculty in all disciplines. These may involve field trips or summer activities, as well as events to increase community awareness and involvement. Investigate forming relationships with local institutions of higher learning or organizations such as the local herpetological or natural history society.

Once you have determined what information you intend to collect, develop data sheets or modify the samples provided in Appendices B through E. Compile a list of the needed materials, supplies, and equipment. Develop a budget and identify potential sources of funding. If your institution receives federal funds, you must be aware of the *Guidelines for the Use of Live Amphibian and Reptiles in Field Research* (see Chapter 8).

Contacting the local television, radio stations, and newspapers will help advertise the citizen science aspect of your research and will inform the community about your initiative and the project needs. The Bethany Community Middle School (BCMS) study experienced a generous amount of community support that resulted in several newspaper articles as will as a statewide broadcast on public radio. Joy Hester et al. (in press) give an excellent description of the Davidson College study led by Mike Dorcas, which depends on locals as well as students to find turtles. The study was enhanced substantially by citizen involvement and provided substantial benefits for the local urban community.

Determine the geographic parameters of your study. The Davidson College study collects data on all turtles found within a 10-mile radius of the college. Your museum or school may have suitable habitat, however if you are working on private or government property you will need to obtain permission. Seek advice from knowledgeable legal sources to decide if you need to use release of liability or informed consent forms (see Appendix F for a sample permission form used in the BCMS study).

How will you analyze your data? How will the results from your study be used? At BCMS, our research team generated a poster, gave presentations at local secondary and elementary schools, were featured guests at the local Kiwanis Club meeting, and set up a booth at a local fall festival. We also gave a presentation at the state Science Teacher's Association's annual conference, presented a poster at a national Partners in Amphibian and Reptile Conservation (PARC) education meeting, and published an article in the National Science Teacher's Association magazine, *Science Scope* (see Appendix A).

Remember how important it is to have contacts with research scientists who can provide expertise and help lay the groundwork. Plan on analyzing your data and publishing your results. There are many possible venues, from peer-reviewed publications to a museum newsletter; just get it in print.

It should be obvious that conducting a box turtle study requires attention to many details as well as careful planning and commitment. However, such a unique educational opportunity can provide lots of fun and rewards for everyone involved.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Have students write an imaginative essay about a child's encounter with a turtle of any species. Later, have them write about their own most interesting turtle encounter. A good follow up would be for them to try and find a friend or relative with a turtle story and write it up with some embellishments. Read the turtle stories of indigenous peoples from around the world.

7. Participant Safety

Before you allow participants to join your turtle study, be sure that they each complete a medical form so you will be informed of any health issues such as allergies, asthma, or seizures. Be prepared for any such events. Even though the safety concerns encountered in box turtle research are normally few, incidents do occur.

Insect pests, spiders, and snakes may be encountered as well as briars and poison ivy. Be aware of hunting seasons, particularly in the fall. Know when and if hunting is allowed on the land where your study is being conducted, or if it is allowed on surrounding properties. You may want participants to wear orange safety vests and be noisy. An alternative is to avoid days when hunting is allowed.

Avoid having your fingers pinched when the turtle closes up by holding it tightly by the upper shell. Avoid dangling your fingers in front of their heads . . . yes, box turtles can bite, although this is unusual.

Avoiding Salmonella Contamination

Salmonella refers to a group of bacteria that can cause diarrhea in humans. *Salmonella* live in the intestinal tracts of humans and other animals, including turtles and birds. Such infections usually last 5-7 days or less and usually do not require medical treatment unless the patient becomes severely dehydrated or the infection spreads from the intestines. In rare cases, serious health problems may result. The most common means of infection is by mouth, but can also occur through open cuts or sores (Regional Centers of Excellence for Biodefence and Emerging Infectious Diseases, 2005). To avoid *Salmonella* when working with turtles,

- use antibacterial soap and wash with warm water. Carry disinfectant hand wipes or sprays in your backpack and a plastic bag to hold the discards.
- do not eat, drink, wipe your mouth, or rub your eyes until you have washed your hands.
- use plastic gloves to avoid exposure through an open cut or sore. Use fresh gloves with each turtle encounter to prevent possible cross-contamination between turtles.

Photographer unknown

Figure 7. Having landowner permission to access property can be important for participant safety.

8. Guidelines for Use of Live Amphibians and Reptiles in Field Research

> *"The humane treatment of wild vertebrates in field research is both an ethical and a scientific necessity. Traumatized animals may exhibit abnormal physiological, behavioral and ecological responses that defeat the purposes of the investigation. It is of particular importance that animals which are captured and marked be returned to the wild without impairment to resuming their normal activities, and that habitats essential for these activities not be rendered unsuitable in the course of capture efforts."*
>
> – ASIH, HL and SSAR 2001

There are expectations regarding use of live specimens in research which have been set forth by herpetological organizations and the federal government. The *Guidelines for Use of Live Amphibians and Reptiles in Field Research* (2001) will help you make good decisions about animal welfare. This joint publication of the American Society of Ichthyologists and Herpetologists (ASIH), the Herpetologists' League (HL), and the Society for the Study of Amphibians and Reptiles (SSAR) is available online (www.aish.org/pubs/herpcoll.html).

Federal regulations require that institutions receiving federal funding establish an Institutional Animal Care and Use Committee (IACUC) to assure that all animal related activities comply with the Animal Welfare Act. Most research compliance officers at colleges and universities are familiar with the requirements of the Act and may be willing to advise you in establishing research and teaching protocols that adhere to the established standards. Even if you are not required to abide by federal standards, set a good example by demonstrating concern for individual box turtles as well as their populations. Do not move them to new locations casually or allow others in your study to do so. Return turtles to the point of capture without delay.

Possession and collection of box turtles are regulated by some state agencies. Violation of these regulations is a serious offense. As mentioned in Chapter 6, Planning Field Research, you should contact your state wildlife agency to see which activities are allowed *before* you begin planning and obtain all necessary permits.

9. Visual Surveys

Wild box turtles are difficult to find on demand but, using the methods described here, your chances of finding box turtles should increase. It is not uncommon to find box turtles on roads, in the garden, or the woods, but finding a box turtle when you want to find one can be challenging. The search method we find most effective is to form a line and have all participants stand with outstretched arms touching, then move through the search area keeping the arm's length distance (also see next chapter). Look around large tree trunks, fallen logs, in stumps, and in brush. Try not to disturb habitats any more than necessary.

Box turtles are diurnal (active during the day) and most active during the spring and fall. A good time to search is just after a rain in late spring or early summer. Deep in the summer months, you may find box turtles are more active in the mornings or later in the afternoons; during the hottest hours they may hunker down under leaves or vegetation.

Collect all data while you are in the field so you do not have to remove the turtles from their habitat unnecessarily. Carefully pack your field bag so that you will have all the equipment necessary for data collection on site (Chapter 11). If you must remove a turtle from the wild, return it to the location of capture as soon as possible so that it may pursue its own agenda. A good guideline is to return the turtle by the next day, if not immediately.

Sheets of tin or plywood, called coverboards, may be found lying on the ground particularly near old home sites. These provide excellent habitat for turtles, other reptiles (especially snakes), and amphibians and can be used to deliberately attract them. Be careful when you look under coverboards, since what you find may surprise you. Copperheads are found over much of the range of box turtles and may take refuge under tin or plywood. These snakes are venomous, but are not deadly, as many people believe. If you find one, simply replace the coverboards and move quietly away from the area. Most people have a fascination with snakes, be it in awe or fear. Snake encounters provide an opportunity to educate participants about their value since they are one of the most misunderstood animals in nature.

ABC

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Your backpack can include beginner field guides for common reptiles, amphibians, birds, insects, spiders, and plants. This will allow participants to look up species they encounter without having to remove them from the wild. Quiz participants about which characteristics are important for identification.

10. How to Conduct a Box Turtle Census

by Mike Quinlan and Chris Swarth

Many field ecologists conduct censuses of animals in order to monitor population size and status. A census is a standardized count. When censuses are conducted frequently or for several years, they can provide accurate information on the numbers of animals in a given area. This technique has been used for many years to estimate the size of bird populations. A fairly accurate estimate of numbers and density (for example, the number of box turtles per hectare) can be determined if a census is conducted in a measured study plot.

Censuses are a good way to introduce students and adults to ecological monitoring, population ecology and to turtle behavior, and can be conducted by novices after they have been given some training. If censuses are conducted regularly, the resulting data can be used to track population trends and can even be used for comparative purposes by researchers elsewhere.

Setting-up the Census Plot

First you must select an area or habitat that you would like to census. Be sure to seek permission from landowners before you begin. Conduct a preliminary reconnaissance survey to make certain that the area is safe and that the terrain is not too difficult to traverse easily on foot.

A reasonably sized census plot is one or two hectares (a hectare is 10,000 m^2 or 2.47 acres). Your census plot will need to be marked well on the ground. The easiest way to do this is to use a GPS unit and a 100m tape. Mark each corner with a white, 3-inch diameter, 8-foot tall PVC pole and paint the top of the pole a bright color. If your census area is heavily vegetated you will need to place poles or colored plastic flags along the periphery and in the interior of the plot at 25m intervals. Interior flags or poles are useful for marking turtle locations within the plot and for helping searchers know where they are within the plot. Pipes or poles should be conspicuous enough that they can be seen from 10 to 15 meters away. If the plot has many deciduous trees it will be easiest to mark the plot in late winter before trees and shrubs have fully leafed out. It may take half a day to mark a plot, so you will want to do this well before you begin doing the censuses.

Make a data sheet with a plot map on an 81/2 by 11-inch piece of paper (see Appendix E). Use a fresh map and data sheet for every census. Include space on the data sheet to record the date, time, weather, names of searchers, and include a census plot map so that the exact location of each turtle can be plotted on the map.

Conducting the Census

Censuses should begin in the spring when turtles are emerging from hibernation. A weekly census is a useful frequency. Censuses should be done at the same time each day and should not be done before 10 am or after 4 pm. Strive for consistency. The census crew should consist of at least 4 or 5 competent searchers, but not more than 12. We recommend 45 minutes to one hour to conduct the census, depending on plot size and the number of searchers. Try to keep the duration of each census consistent.

Start the census by lining up the searchers, evenly spaced, along one edge of the plot. Walk slowly through the plot staying within sight of one another and everyone should walk in the same general direction (for example, from east to west). Each searcher should cover a swath of ground that is about 20m wide and runs the length of the plot. It is desirable to have some overlap of coverage between adjacent searchers to avoid overlooking turtles. Searchers should scan the entire plot looking for turtles that are on the surface or partially buried. Pay particular attention to fallen logs, the base of large trees, and to shrubby tangles; places where turtles are more likely to be found. Occasionally scan back in the direction that you walked for turtles that might be partially covered by leaves or under the edge of a log or shrub. Do not turn over logs or dig through the leaf litter, as this will disturb the turtles and their habitat. Searchers should move deliberately and slowly. Don’t be rushed!

Not all of the turtles in your census plot will be detected on a census. Box turtles can blend in very well and may simply be overlooked, even by seasoned box turtle experts. Other turtles will be hidden under leaves or logs. Based on experiments we conducted using old turtle shells placed in a small plot, we determined that experienced searchers could miss one third of the turtles in a plot. The fact that not every turtle will be spotted during a census is not a large problem and is partially offset if censuses are conducted the same way each time. The more censuses you conduct the better your estimate of density becomes.

Searchers should carry a map and compass to help the group stay oriented as they move through the plot. This also ensures more complete coverage and helps prevent searchers from wandering outside the plot. In dense vegetation, a map and compass may be crucial. The interior plot markers also help to keep searchers properly oriented.

When You Find a Turtle…

It is always exciting when a turtle is encountered on a census. When this happens, stop and call out so that the census leader can walk to you to examine the turtle and to plot its location on the data sheet. The turtle should not be handled at this point (unless it tries to walk away), but should be left on the ground where it is discovered. The sex of each turtle and any other pertinent information should be noted by the census leader and recorded on the data sheet. The time of each census along with weather conditions, and the names of all searchers should be recorded each time a census is made.

If you are also doing a mark-recapture study, you will want to confirm the identity of any turtle that you find and you will want to mark new turtles so they can be recognized when they are encountered again.

With time, your censuses will provide an accurate estimate of the number of turtles using the plot, the fidelity of turtles to the plot and even the numbers of turtles that pass through the plot but that may not actually live in the plot. If turtles are marked, you can begin to create individual home range maps. If you conduct censuses over several years you may even be able to estimate population fluctuations.

11. Equipment

Below is a list of recommended equipment for a field study of box turtles. Field equipment is usually carried in a backpack or a shoulder bag. Include plastic non-latex, disposable gloves and antibacterial hand wipes to prevent transmission of pathogens to or from animals (see Chapter 7, Participant Safety). In addition, carry a holding sack suitable for turtles or a 5-gallon bucket to hold turtles if there are delays between the time you catch them and the time they undergo data collection. For transportation in a car, use a plastic or cardboard box. A cooler is also useful for this purpose, but avoid styrofoam.

Use the following as a check list before you head out into the field:

- digital or Pesola scale
- 1/8” size slim (xx or xxx) triangular file
- data sheets (see Appendices C, D, and E)
- list of available identification codes (see Appendix F)
- calipers
- thermometer
- flagging tape
- fine tip permanent marker (black) for writing on tape
- disposable, non-latex gloves
- pencil or indelible ink pen– not standard ink pen
- disinfectant hand wipes, soap or lotion

Also consider the following items:

- first aid kit
- cell phone
- hat
- water bottle
- camera
- sulfur powder for chiggers (Dust around the opening of your pants, socks, and boots.)
- insect repellant (Deet is not recommended for animal handlers.)
- zipper type baggies for interesting things to look at in the classroom
- sun screen and rain gear

12. Data Collection

One of the purposes of the book is to describe some common methods of measuring turtles and collecting environmental data. This section establishes guidelines for collecting and recording box turtle data.

The value of any research effort is greater if the results can be compared with results from other studies. When similar research efforts in different areas collect data in a consistent manner it is possible to compare results. If research findings are to be pooled or compared with other studies, this is essential. Methods used in various studies can differ and still generate sound scientific conclusions; however, inconsistent methodology rules out the possibility of pooling data across sites, which limits sample size and the potential for generalization and transferability of conclusions and recommendations.

Each study should have the research questions described prior to initiation of field work, as this defines the information to be collected on the data sheets. Once the data sheets are constructed, participants should undergo field training with the research director. This should include practice measuring, notching, and filling out the forms. Rain repellant paper can be used but is not necessary. Forms must be filled out in dark pencil or black indelible ink, as standard ink will smear when it gets wet and light pencil and ink do not copy well. Design an electronic spreadsheet that will accommodate your data and have a responsible person enter the data as it becomes available. With help, junior curators or students can learn to do this. As always, each entry should be double-checked. Hard copies of the data sheets should be copied and kept on file at a different location. This allows researchers to examine questionable entries or findings in the spreadsheet database. Having hard copies at different locations means that the information is protected against disasters like fire or water damage.

When it comes to statistical analysis, missing data on key variables can result in the exclusion of other data that are available. This is true regarding data from turtles or sites. Complete each blank on the sheet, even if the information has been recorded elsewhere. If the solicited information is “not applicable” then enter “N/A”; if the information is not known, enter “N/K” in the space provided. Complete the data sheets while in the field as trying to remember the information at a later time can and does lead to inaccurate data.

Protocol for handling of the data sheets must be discussed with the participants. This includes the need for checking the forms for accuracy and legibility since legibility is *always* an issue. Data collectors often use inappropriate writing instruments or fail to take the time to write legibly. Write words and numbers clearly. Make sure 4s, 7s, and 9s are distinguishable. If one person collects the data, and another writes it down, have the person writing repeat the measurements to avoid miscommunication. Take time to train data collectors in these important techniques.

Once analyzed, consider publishing your results in your museum or school newsletter, state herpetological society bulletin, or a professional journal.

13. Marking System for Box Turtles

A widely accepted method of marking box turtles is described below. This system is used by the Davidson College Herpetology Lab (Dorcas, 2006), researchers at the Savannah River Ecology Lab, and many others around the world.

Figure 8. Marginal scute notches are made with a triangular file.

Most box turtles have 12 marginal scutes on each side of the carapace, though some may have more and some fewer. Turtles can be marked permanently by using a slim triangular file to make small v-shaped notches (Figures 8 and 9) in the marginals. On each side there are four marginal scutes that contribute to the bridge between the carapace and the plastron. These are not used for marking because the vascular connections between the plastron and carapace may be damaged. Use the remaining eight marginal scutes per side for any notching. The two top (anterior most) marginals on either side of the cervical scute will always be “A” and “X” respectively. The two marginal scutes at the posterior end of the carapace will always be “L” and “M” respectively. Turtles are marked with three notches representing a unique three-letter code. A digital image of the plastron can be used as an important double check on the notched code since notching errors can and do occur. Each plastron is unique and the digital photos can be stored with the data sheets. Images of the carapace and any injuries will also provide useful documentation.

Sherry Kelly

Figure 9. Researchers vary on preferred notch depth. This photo illustrates our preferred notch size.

Notch depth varies according to the preferences of the researcher (Figure 8). We use a small size (1/8” or less) triangular file so the notches are not too deep. Notching too deep can lead to infection, and notches too shallow can be mistaken for injuries. Dipping the file in ethanol between uses will reduce the risk of infection.

Researchers disagree about the advisability of marking hatchlings. We follow the advice of Bern Tryon of the Knoxville Zoo, who does not recommend it for most studies. He offers two compelling reasons: 1) the younger the age at marking, the less likely the markings will be retained as the turtle ages, and 2) considering the low rate of hatchling survival in any given population, to mark them and then count them as part of the population will likely give a very unrealistic estimate of the population size. If marking hatchlings is deemed necessary, use small fingernail scissors rather than a triangular file because the carapace of hatchlings is soft and flexible. Notches on the marginal scutes of hatchlings will migrate backward as the turtle grows.

The turtle in the figure below has been notched "BKO." The Dorcas lab at Davidson College uses an additional, temporary mark, made with a paint pen, to indicate that the turtle has been recently weighed and measured and need not be processed again that season. Use a minimal amount of fingernail polish or dull colored spray paint on the carapace scute corresponding to the month it was last processed (Figure 10). The paint will wear off in a few months. For more information on the research protocol used by the Davidson Herpetology Lab refer to Guidelines for Herpetology Laboratory Protocol and Guidelines (Dorcas, 2005).

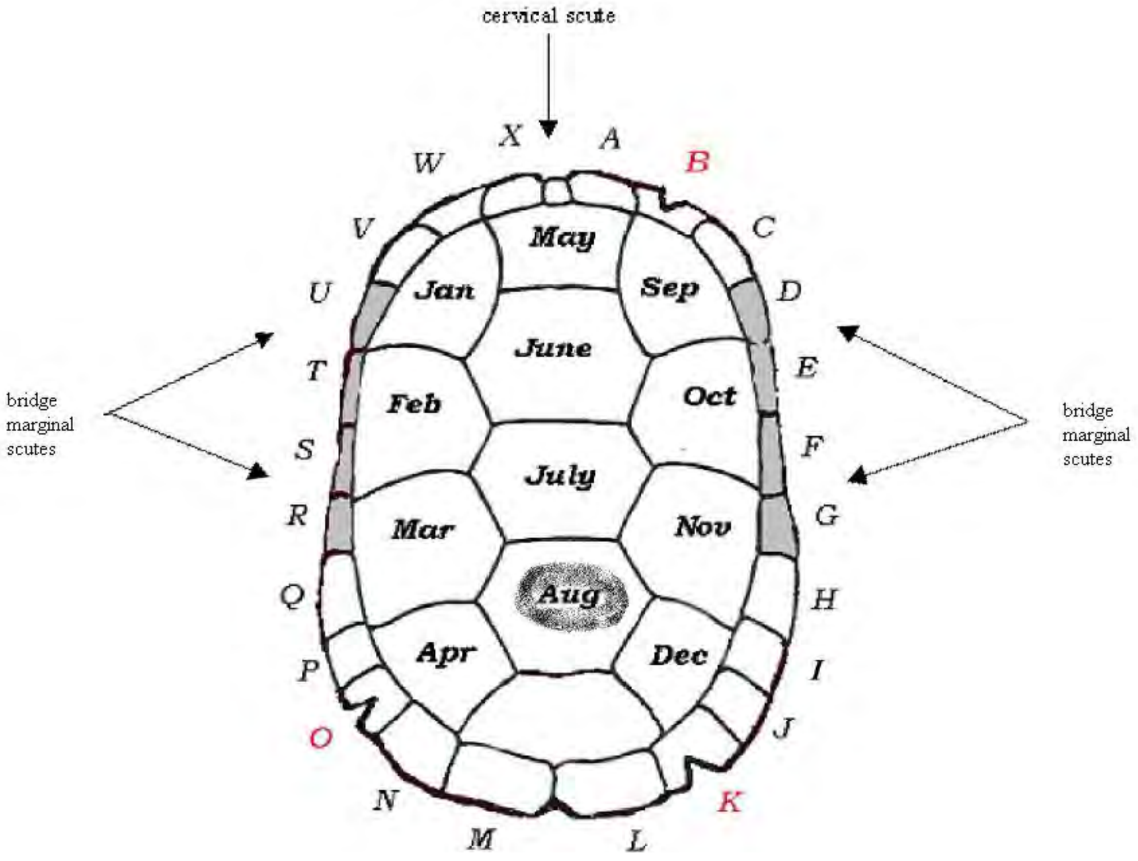

Figure 10. Carapace marked as "BKO," last processed in August. Bridge marginal scutes (D, E, F, G and R, S, T, U) are not marked.

For all possible letter combinations, see Appendix F *Turtle Identification Codes.* Recall that the bridge marginal scutes are not used. You may use the same system for marking other turtle species and the same codes can be used. Keep the next available identification codes with you while in the field so you are prepared to process the next new turtle. Count carefully because scute numbers can vary.

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Displaying a large poster about your research in the science center hallway, school cafeteria, or public library might generate increased interest in the study. You can also incorporate mapping as a good way to practice math skills such as measuring, interpolating, and calculating angles. In our poster (below) we incorporated a map and two graphs.

BCMS:

Bethany Community Middle School is a small charter school in rural Rockingham County, North Carolina. The wolf is the school mascot.

Project Goals:

- To form a science teaching and conservation partnership among a charter middle school, the university, and the surrounding community
- To expose students to conservation issues using the box turtle as a focus
- To integrate middle school curriculum including reading, mathematics, and writing around authentic science field experiences
- To study the habitat use, individual variation, and seasonal activities of the local box turtle population by using radio telemetry

Middle School Student Learning Activities:

- Searching visually for box turtles
- Using radio telemetry to track box turtles
- Identifying box turtles and other terrestrial turtles using visual characteristics, classification keys, and field guides
- Sexing and aging box turtles using various morphometric characteristics
- Marking box turtles using triangular files
- Weighing and measuring box turtles with spring scales, digital scales and various calipers and rulers
- Competing against Boykin spaniels trained to find and catch box turtles
- Measuring and recording abiotic parameters in box turtle habitats
- Reading both fictional and non-fictional literature about turtles
- Completing artwork and writing projects
- Searching the web for information about turtles and using a variety of microcomputer applications to prepare presentations and reports
- Public speaking events for younger children, middle school peers and adults to share their experiences in the Wolves Tracking Turtles Project
  - Fall 2002 Meeting of the North Carolina Herpetological Society
  - Fall 2002 Presentation to the North Carolina Science Teachers Association
  - Winter 2002-2003 Presentation to peers at Greensboro Day School
  - Winter 2002-2003 Presentation to the Madison Civitan Club

ELOB:

Expeditionary Learning Outward Bound is a model for comprehensive school reform for elementary, middle and high schools. It emphasizes learning by doing, with a particular focus on character growth, teamwork, reflection and literacy. Teachers connect high quality academic learning to adventure, service and character development through a variety of student experiences including interdisciplinary, project based learning expeditions. For more information see http://www.elob.org.

Catherine Matthews[1], Ann Berry Somers[2], Jennifer Mansfield-Jones[3], Mary Hall-Brown[1], Sarah Seymour[4], John Rucker[4], Hannah Epperson[4] and Corrie Tetterton[4]

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[4] Bethany Community Middle School

Catherine Matthews, Ann Berry Somers, Jennifer Mansfield-Jones, Mary Hall Brown,
Sarah Seymour, John Rucker, Hannah Epperson, Corrie Tetterton

14. Gender Determination

The turtle lives 'twixt plated decks
Which practically conceal its sex
I think it clever of the turtle
In such a fix to be so fertile. -Ogden Nash

The gender of turtles is determined by looking at several different characteristics. Adult males have a concaved plastron, a depression that allows more stability when mounting females. Females have a flat or slightly concaved plastron as in Figure 11. Since no one characteristic is 100% diagnostic for gender, examine the tail, color of head and legs, as well as the shape of the carapace to help you decide on gender.

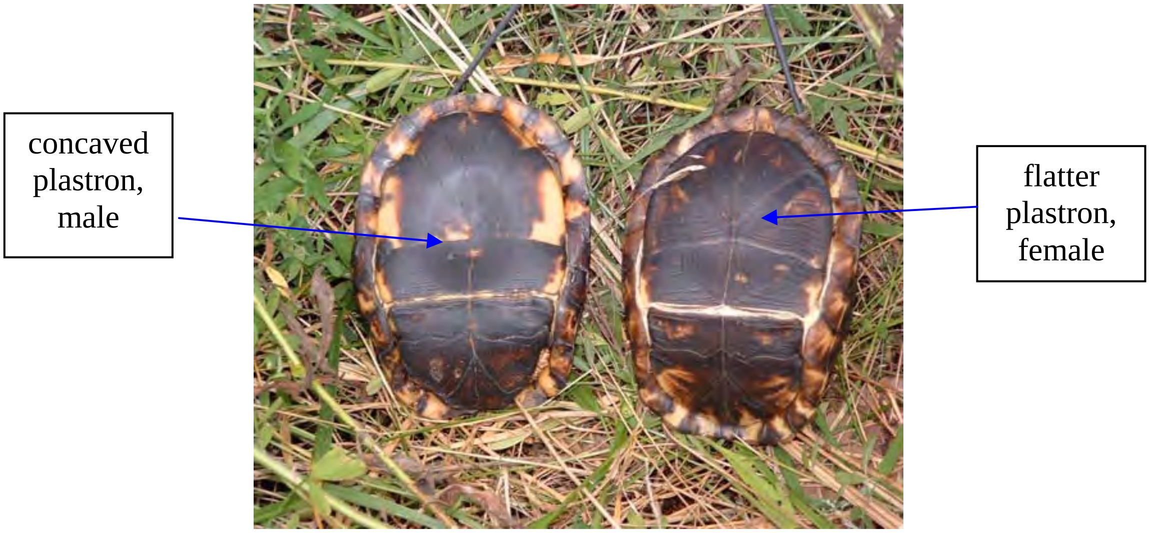


Figure 11. Plastrons of males are concave (left); females normally have flatter plastrons.

Figure 12. Males often have bright red eyes, though there are exceptions, such as in Florida.

Males have a more posterior placed anus than females and a longer tail, though observing these features on box turtles can be difficult since they close up with the tail inside. Many males also have a more colorful head and legs than females. Older males often exhibit flanged posterior marginals. Females have deeper, domed shells, which can be observed from a side view. The longer tail and concave plastron of males are not generally conspicuous until they reach a straight carapace length (SCL) of about 60 mm. Male box turtles in many populations have bright red eyes (Figure 12), with the notable exception of those found in Florida. Eye color in females is often brown, but may be yellow or dull red.

Gender characteristics are not observable in hatchlings and young juveniles (Figure 13) so determining the gender of a turtle at this stage is almost impossible. Use "UK" (unknown) in the "gender" field for very young turtles. Determining the presence of eggs in turtles is often done by inserting the little finger into the cavity behind the bridge in front of the hind legs and feeling for the distinctive lumps. This is not recommended for female box turtles, however, because box turtles have a hinged shell, which permits them to close the plastron tight against the carapace putting the researcher at risk of getting a finger caught. X-rays of gravid females will clearly show eggs, but in-field radiography is normally reserved for advanced levels of research. In such cases, researchers should consult Hinton et al. (1997). Although little information is available on the long-term effects of radiographs on hatchling health, their data suggest that radiation from standard shoulder x-ray doses (for humans) should not harm hatchlings or adults.

Marty K. Manuele

Figure 13. Hatchlings don't show gender characteristics.

15. Age Determination

Age determination is difficult if not impossible for most box turtles over the age of 20, but there are exceptions. For younger turtles annuli (rings representing arrested growth on the scutes of the carapace and plastron) can be counted, which roughly measure one per year. In the figure below, “0” is assigned to the natal scute, which is formed prior to hatching and is not used when determining age. Each successive ring is counted as one year, as shown in Figure 14. The drawing below represents a turtle estimated to be 6 years old. Note that the carapace and plastron are compared before making the estimate.

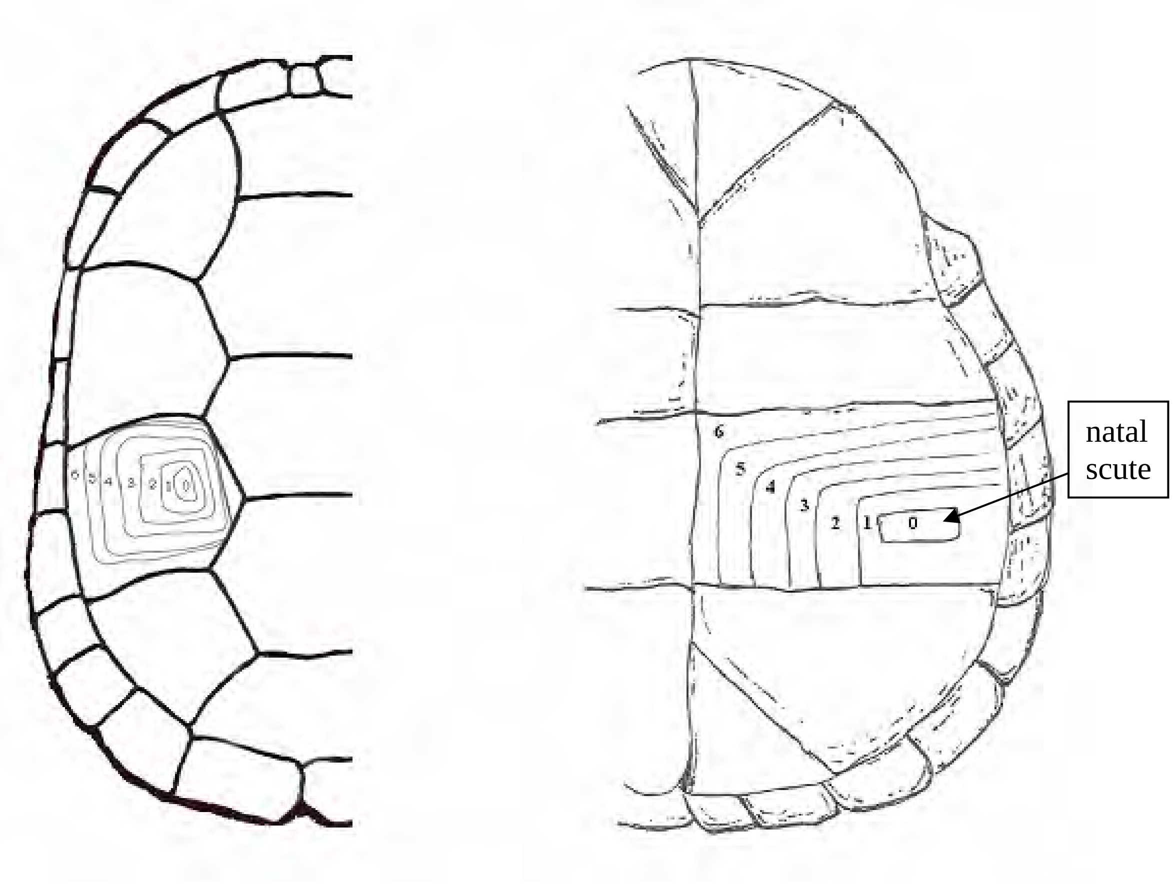


Figure 14. Annuli on carapace (left) and plastron (right).
Plastron drawing by Jenny Kimmel.

Counting annuli is clearly an inexact technique at best, even when done by meticulous and seasoned researchers (Wilson et al., 2003). Growth rings can form within as well as between years and can generate a false count, even in young turtles. Additionally, turtles may lose annuli demarcation as they age. If the shell is smooth or if annuli are crowded at the edges of the scute record the age as “20+”, even though some of these turtles may be younger than 20.

16. Weighing and Measuring

The following pages include diagrams and instructions for weighing and measuring box turtles. Project leaders are strongly encouraged to limit the number of measurements taken on the turtles in their study. Taking too many measurements increases the chances for error, consumes lots of field time, and can take the fun out of the outing. The purpose of including additional measurements in this book is to standardize different measurements that are being used by researchers. Most studies should limit data collection to the following: weight, maximum carapace length, total plastron length, shell height (depth) at hinge or maximum shell depth, and overall width at hinge or maximum width.

Weight. Use a digital scale with a platform to weigh box turtles. Lightweight and compact digital scales are available and, if handled carefully, will survive being carried in a backpack. Some field researchers use Pesola spring scales to measure box turtles (Figure 15), but larger, heavier box turtles can fall from spring scales unless they are first placed in a cloth bag. The weight of the bag must then be subtracted from the total weight of bag and turtle to get the weight of the turtle. If you use the spring scale method, carry extra bags since they become wet and turtles defecate in them.

Length, width, and shell height. For length, width, and height measurements, some researchers use 150-mm dial calipers, but the jaws are not really long enough for adult box turtles. For calipers with longer jaws try Haglof Mantax aluminum calipers (catalog number 59727) or Fowler for lightweight calipers. Forestry Suppliers, Inc. sells custom-made calipers.

Many box turtles show evidence of damage to marginal scutes from deformities in shell development or injury resulting from encounters with predators, hence producing a bias in the straight carapace length measurement. we recommend taking the maximum carapace length if only one measurement is taken.

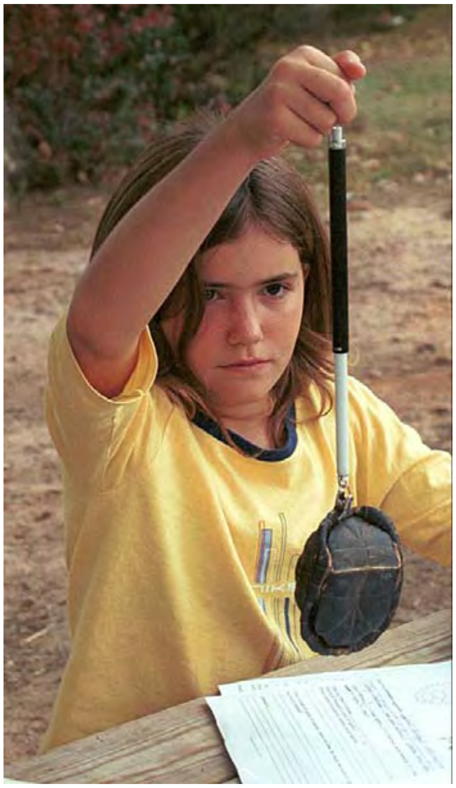


Figure 15. The Pesola scales shown here are not preferred for weighing heavy turtles, unless a weighing bag is used (not shown). Be sure to hang turtles where they will not fall far and risk injury if you weigh in this manner. A good alternative is to use digital scales with a weighing platform, which work quite nicely.

Straight-line Carapace Length (mm) – Measure straight, from the top of the cervical scute (midline) down across the vertebral scutes to the notch between the posterior marginal scutes, ignoring the curvature of the shell, as shown in Figure 16.

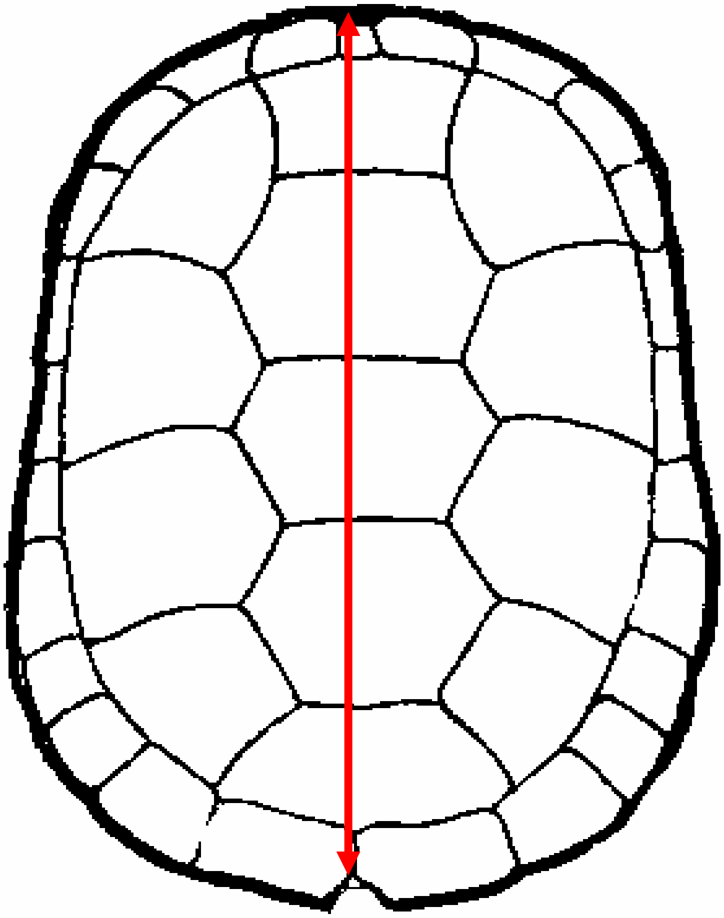


Figure 16. Measuring straight-line carapace length (SCL). Shell damage along the anterior or posterior marginals will distort SCL; therefore maximum carapace length (Figure 17) is the preferred measurement for length if only one measurement is taken.

Maximum Carapace Length (mm) – Measure by fitting the carapace between the caliper jaws from front to rear as shown in Figure 17.

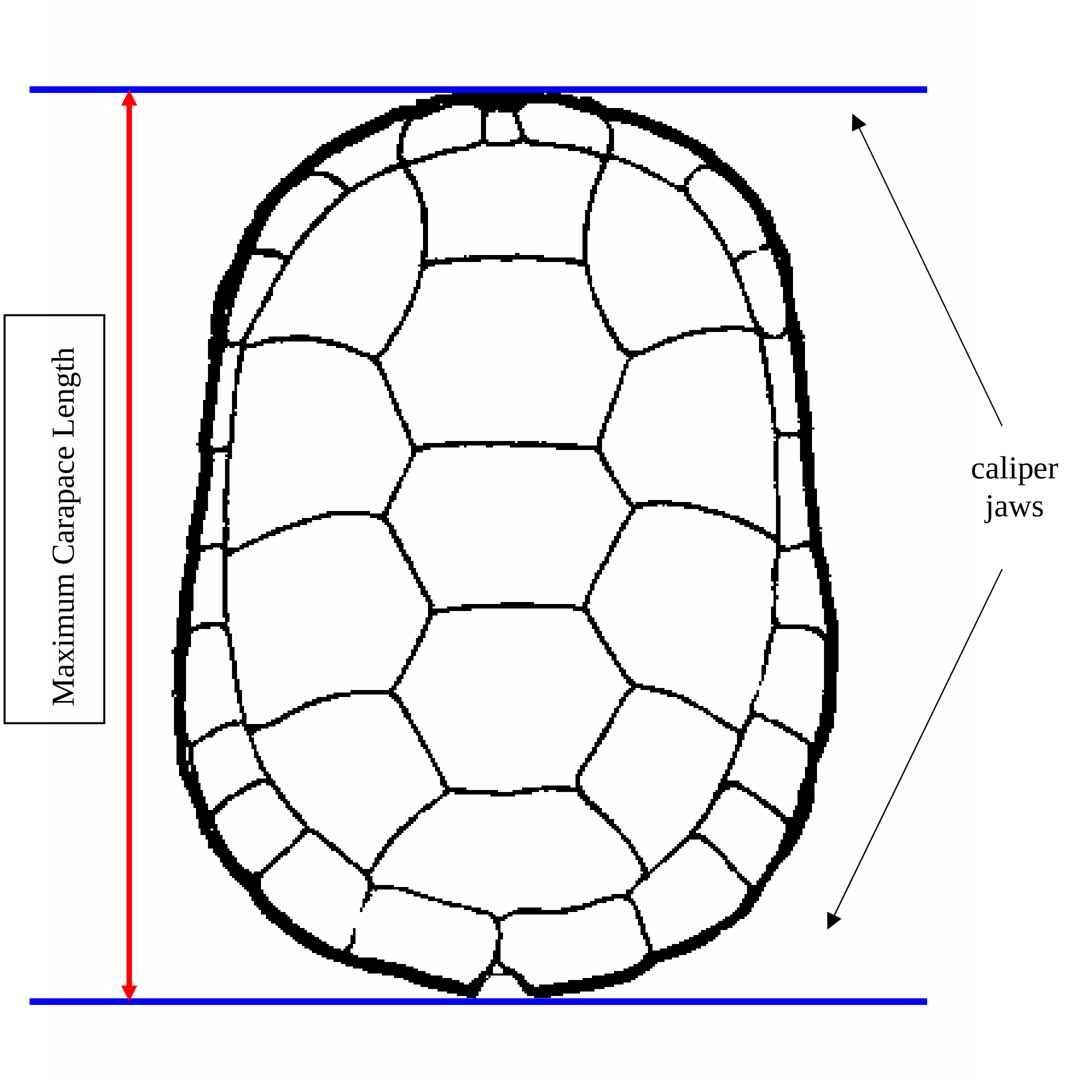


Figure 17. Measuring maximum carapace length.

Scute Counts (Figure 18):

Vertebrals – Count the scutes that are located down the turtle's spine.

Left Pleurals – Count the scutes just left of the vertebral scutes.

Left Marginals – Marginal scutes counted counterclockwise from the cervical scute to the midline at the rear of the turtle.

Right Pleurals – Scutes on the turtle's side, right of the vertebral scutes.

Right Marginals – Marginal scutes counted clockwise from the cervical scute to the midline at the rear of the turtle. (Right and left marginals do not overlap.)

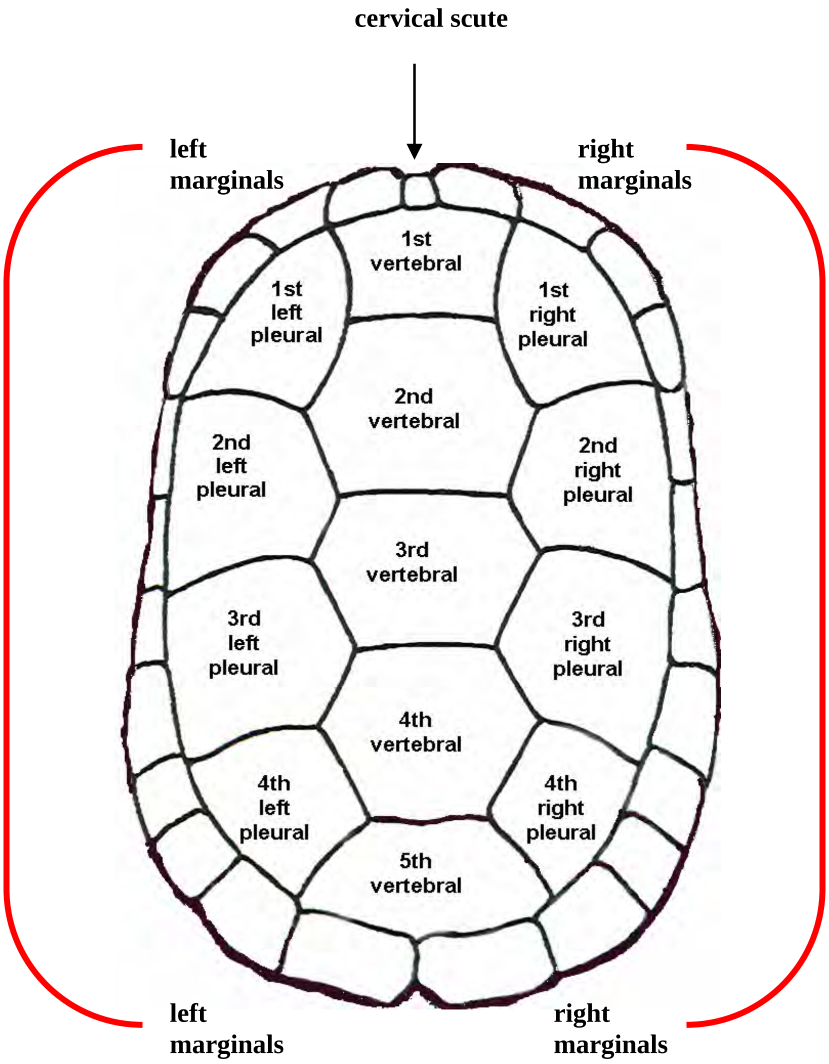


Figure 18. Names of scutes on carapace.

Shell Height at Hinge (mm) – The shell height at hinge measurement is obtained by measuring the shell between the hinge of the plastron and the top of the carapace.

Shell Height Maximum (mm) – The maximum shell height is obtained by measuring the shell with calipers at the greatest shell height, regardless of where that occurs (Figure 19).

Figure 19. Measuring maximum shell height. The shell height is obtained by sandwiching the turtle with calipers at the greatest shell height. *Drawing by Jenny Kimmel.*

Plastron Length (PL) Anterior to Hinge (mm) – This is a measurement made on the plastron from the longest anterior edge to the hinge. The caliper jaws are parallel with the plastron (in the same plane) and the curvature is ignored.

Plastron Length (PL) Posterior to Hinge (mm) – This is a measurement made on the plastron from the longest posterior edge to the hinge. The caliper jaws are parallel with the plastron (in the same plane) and the curvature is ignored.

Total Plastron Length (mm) – This measurement is obtained by adding together the plastron length anterior to hinge and the plastron length posterior to hinge.

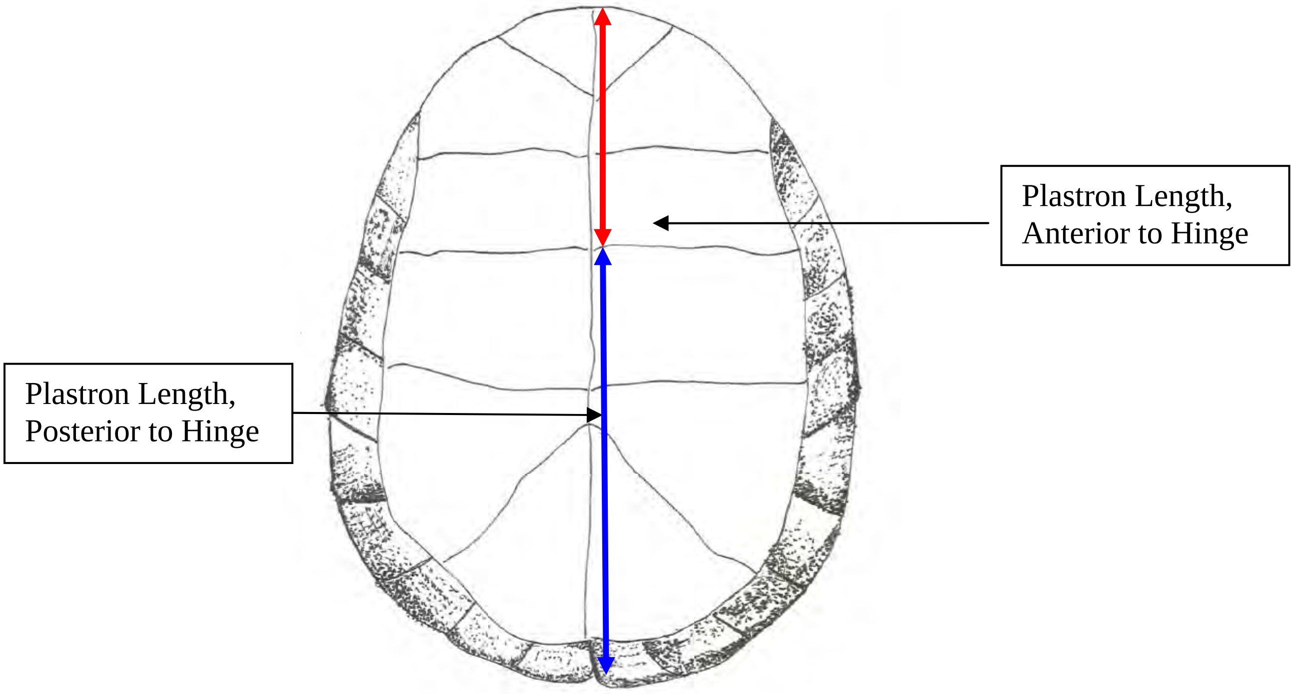


Figure 20. Plastron length (total) is measured by adding the two measurements shown above. *Drawing by Jenny Kimmel.*

Overall Width at Hinge (mm) – The width of the carapace is measured at the hinge.

Maximum Width (mm) – Measure the widest point of the carapace to determine maximum width. Note: The location of the widest point varies with individuals and subspecies.

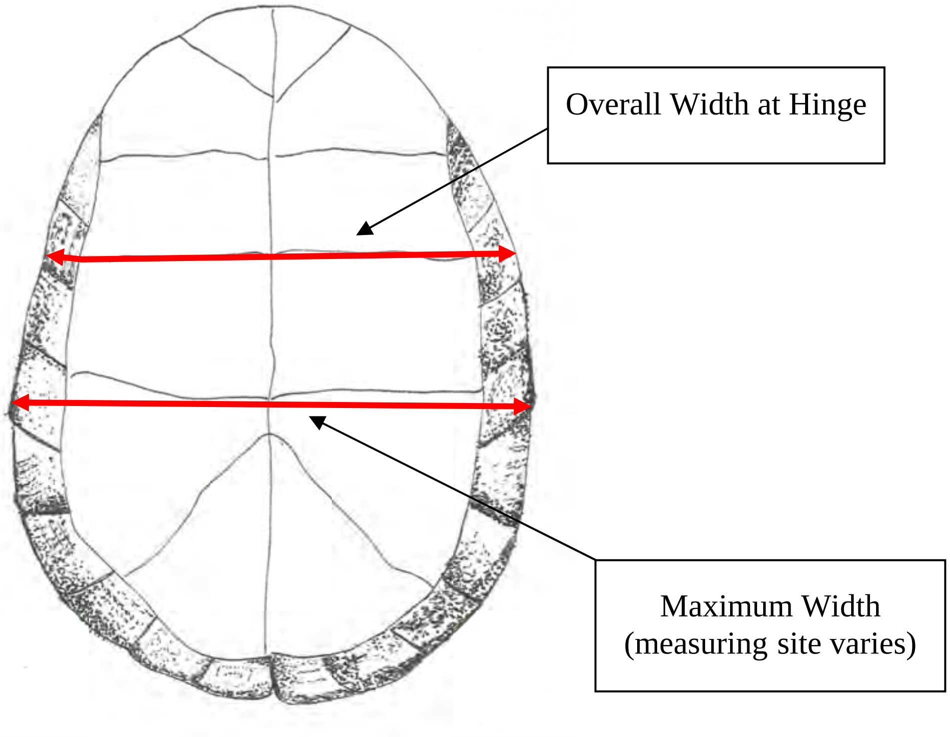


Figure 21. Carapace widths measured from ventral aspect.
Drawing by Jenny Kimmel.

17. Radiotelemetry

Sarah Seymour

Figure 22. Secure the transmitter near the 4th plural scute.

Radiotelemetry helps researchers understand the habits, movements, home range, and habitat preferences of box turtles. Radiotelemetry will require battery-powered transmitters and a hand-held receiver with an antenna (see Appendix H for equipment vendors). The BCMS study used receivers made by Wildlife Materials (Model TRX-1000s) and Telonics (TR-4) and found both to be outstanding units. We have used both a "rubber ducky" and the rigid antenna (Yagi F150-3FB) and have been pleased with both.

Miniature radio transmitters come with batteries encased in a coating of surgical wax and dental acrylic for waterproofing. The transmitter package varies in size depending on the battery used (long-lived batteries are larger and heavier). The supplier will advise you about battery life and size. When choosing a site for placing the transmitter, be sure to attach the transmitter to one of the pleural scutes, and avoid the rear vertebrals (see diagrams in Chapter 16, Weighing and Measuring) as placement there may interfere with mating. We secure transmitters in the vicinity of the 4th pleural scute, with the antenna placed toward the posterior of the specimen (Figure 22) but not everyone does it this way. Some researchers find that gluing a small piece of aquarium tubing over the site where the antenna attaches to the transmitter can minimize antenna breakage, but we have not had a problem with antenna breakage. Be sure to order the transmitters during the winter in order to receive them by spring.

Transmitters are fastened onto the shell with quick dry waterproof epoxy. First use aquarium sealant (Wilson et al. 2003) or quick-stick epoxy (Eckler et al. 1990) on the base of the transmitter to stabilize it while you prepare and apply the epoxy that will cover the transmitter completely. Transmitter plus glue should not add more than 7% of body weight (Schubauer 1981, Eckler et al. 1990), though size, shape, and placement of the transmitter may be more important than its weight (M. Dorcas, pers. comm.). This process takes less than a half hour and the animal can then be released.

Not all researchers agree about equipment and materials. Researchers at Jug Bay Wetlands Sanctuary (Maryland) find PC-7 epoxy to be a superior product, but a long drying time necessitates the turtle being held overnight. In this case, the transmitter is taped temporarily so the epoxy will harden adequately before the release.

Transmitters applied in this manner do not appear to impact the breeding or movement behavior of the turtles. In one study, individuals were successfully re-fitted with radio transmitters as many as six times during a four-year study period. Turtles carrying transmitters were observed carrying out normal activities such as foraging, mating and nesting, and migrating (Eckler et al.

1990). Remove or replace the transmitter before the battery dies, or you may never see it again. Dislodge transmitters from the carapace by gently prying with a knife.

Each transmitter emits a different frequency which can be picked up by the receiver once it is adjusted to that specific frequency. Only one signal is picked up by the receiver at a time. When receiving a signal, a "chirp" sound is produced which becomes louder as the receiver gets closer to the transmitter. Some trackers find earphones helpful. Allow time for team members to get acquainted with care and use of the equipment and practice detecting signals (Figure 23).

Figure 23. Tracking turtles takes practice!

Turtle locations can be marked with surveyors flagging tape. Record the turtle code, date and time on the tape with a permanent marker. If possible, record locations with a GPS unit. Although consumer grade GPS units do not provide turtle locations exactly (to within centimeters) they are often accurate enough for this type of study (often accurate within a few meters). Record microhabitat information on the data sheets.

Mapping the locations is very important. Some states have aerial photos that can be helpful or use a USGS topographic map or a hand drawn map. Use measuring tape and a compass to establish exact locations if you don't have a GPS unit (Figure 24). Photocopy a map of the research site onto the back of data sheets so locations can be mapped while on site. Generate a comprehensive map at the end of the season that will tell the story of the turtle's activity. The maps will illustrate each turtle's area of activity and its preferred habitat type and allows you to calculate the size of the activity range (Figure 25).

ABC

(**A**pplications of **B**ox turtle studies in the **C**lassroom)

Participants need time to familiarize themselves with the radiotelemetry tracking equipment. You can develop a game where students must locate specific transmitters and read clues located with the transmitters to understand next steps. Place each transmitter on dead turtle shells or in a small container and hide them. Without knowing where the containers are hidden or which transmitter is in each, students can improve their ability to locate the source of the signal. Let the students experiment with different types of equipment if you have more than one type of antenna, receiver, or headphones available. Really knowing how to use the equipment makes fieldwork much easier and makes the team more efficient.

Figure 24. Mark turtle locations with flagging tape.

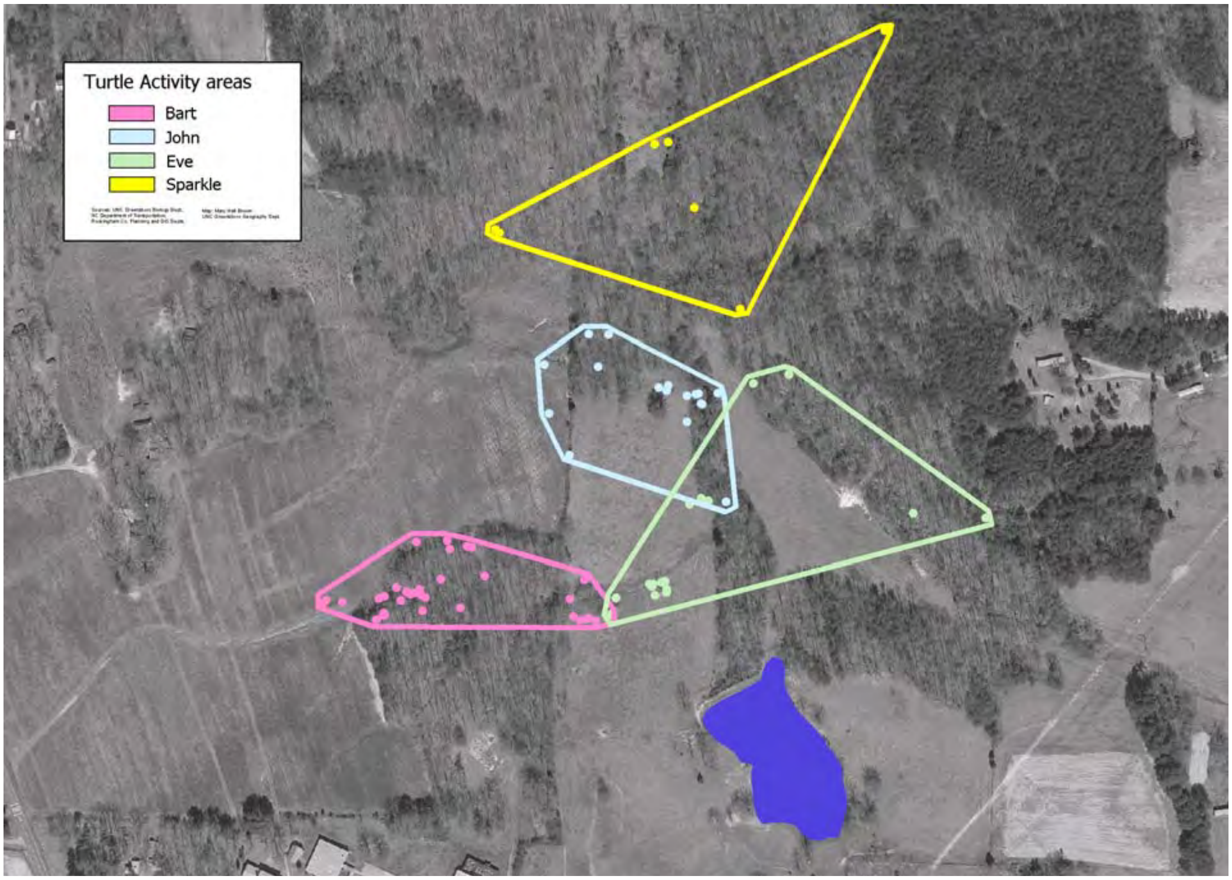


Figure 25. Area of activity of four box turtles over a one-year period. Source of base map: NC Department of Transportation, Rockingham Co. Planning and GIS Departments. Overlay by Mary Hall-Brown.

18. Turtle Care

There are many reasons why you will need temporary turtle housing. Junior curators, students, or interested locals may bring in turtles that cannot be processed immediately. Turtles may need transmitter replacement or you may be using a method of transmitter attachment that requires drying overnight. You may have a sick or injured turtle awaiting a veterinary visit. In any case, it is important to have suitable temporary housing prepared. When preparing to release turtles, remember to return them to the point of capture.

Terrariums make suitable temporary housing, but are not suitable for long-term care. A plastic storage container with high sides can also make safe housing for a turtle overnight, as long as it is not airtight. Box turtles are notorious for the ability to escape by climbing, so care must be taken to secure the breathable lid. Add water, as moisture and humidity are important to keep turtles comfortable. One end of the container may be slightly elevated so that the turtle may access or escape the wet end. Turtles do not need feeding if kept for only for a short time. The Minnesota Branch of the American Association of Laboratory Animal Science, Inc. has an excellent webpage at http://www.ahc.umn.edu/rar/MNAALAS/Boxtrt.html, which covers health and care of box turtles.

Clean the housing containers after each turtle so that it is always ready for the next occupant. Disinfect with a 1:20 bleach/water solution, rinse well with water, and allow to air dry completely before introducing another turtle. Protect yourself by wearing gloves and safety glasses during cleaning. Bacterial and viral respiratory infections can spread easily from one turtle to another.

Infestations of fly larvae on box turtles are not unusual. The mucus membranes and soft skin of turtles provide a perfect surface for bot flies and other flies to posit eggs, so that the newly hatched larvae may easily penetrate the skin, forming abscess-like lumps. Open wounds also provide easy access for egg deposition. A veterinarian should see box turtles with runny or swollen eyes or ears, nasal discharge, or large lumps. Before you begin your study, establish which veterinarian you will use and be clear about who will be responsible for paying the bill.

Inspect each turtle you encounter carefully and note any abnormalities in the appropriate place on the data sheet. Most researchers have seen turtles that have healed from injuries, some of them quite serious.

Transportation

If the need arises to transport a box turtle in a vehicle, place the animal into a box or a cooler with smooth sides and breathable lid. Do not use styrofoam as pieces may tear loose if the turtle claws at the sides. Be mindful that excessive handling, loud music, or a bumpy ride may be stressful. Covering the turtle with a wet towel will provide moisture and some privacy. Pay close attention to the temperature, and don’t allow direct exposure to sunlight or air conditioning vents.

Injured and Sick Turtles

Injuries from cars, tractors, lawn mowers, and dogs are not uncommon. Some injuries are fatal and some are not. Although most turtle researchers have encountered turtles that show signs of having healed from major trauma, most have also encountered sick or injured turtles that could benefit from health care. If you encounter a turtle that seems like it needs professional care, it probably does. Interview a few veterinarians in the initial stages of setting up your study to determine if they have had any professional training in reptile care. Most veterinarians are trained and experienced in treating dogs, cats, and farm animals but few are knowledgeable about treating turtles. Once you decide on a veterinarian, be sure you know who will be responsible for the bill.

You may encounter a dead turtle that still has soft tissue or an empty shell. Document the condition of the specimen and complete the fields on the data sheets just as you would for a live turtle. Include any information that might explain how the death occurred. With data, shells of dead turtles may be offered to a museum, or you may use them as part of your teaching collection. Information about how shells may be used in lesson plans is included in Chapter 20, Classroom Connections.

19. Field Etiquette and Landowner Relations

Public land is generally owned by a county, city, state, or federal agency and access is regulated by that agency. Citizens or corporations have ownership of private land and access is generally restricted. Before you begin to conduct fieldwork with wildlife on any property, you must obtain permission from the owners, public or private. In some cases you will need a wildlife permit from the state to do your study. On private property, you must have permission to be on the property too.

Developing a good relationship with the landowner, public or private, is essential for the success of the study. Neighboring landowners will discuss your study with one another and attitudes tend to be contagious. If some key landowners support your study, others may follow. The following guidelines may prove useful with any type of field research on private property. *Do not underestimate the importance of good landowner relations.*

Good field etiquette means treating landowners, land, and property with respect. Minimize any human impact on the environment. Recall the saying that goes: “Take only pictures; leave only footprints.” Remove plastic flagging marking significant locations once your data have been recorded. Once you have checked for critters under coverboards or logs put them back in place carefully, without harming any animals or habitats underneath. Remind the participants that all organisms deserve respect, including insects, plants, and snakes.

Be respectful of the privacy of the landowners. Remember that you are a visitor and dependent on them for permission to use this property for research. Share some time with the landowner over a glass of tea or snack if asked. Many landowners enjoy the social aspects of your visits so don’t cut this short. If possible get written permission to study turtles, though some landowners are fearful of any document that looks like a contract. Not all family members may be knowledgeable about an agreement you had with one family member, so try to determine who is considered the head of household. Discuss the issue of liability. It may be prudent to use liability release forms. Discuss whether the landowners want to be called before each visit, or if you may come and go as you please. Be sure to park in the spot designated by the landowner. Make sure you have a crib sheet for each site that includes the phone number and names of family members and pets. Do not assume that junior curators, students, or volunteers are knowledgeable about the importance of this aspect of the study and make it a priority in training.

John Lindsay

Figure 26. Involving children is a good way to interest parents and grandparents.

Involve Landowners

Landowner sightings and observations can be valuable. Provide interested landowners with data sheets to record their observations. Allow them to submit them in any format, such as email, hard copy, or phone.

Share the results of your study with interested landowners and be sure to acknowledge their assistance in your reports or presentations. When talking to the media, be sure to put in a thank you to participating landowners.

Consider the following as priorities:

- Allocating time for "chewing the fat" with landowners. Give them pictures of the students or their children or grandchildren working with the turtles. Many people love the idea of making contributions to education, even if they are not really interested in wildlife conservation. Involve children whenever possible.
- Explaining the value of the research.
- Knowing the boundaries of the property. Remember to close every gate you open as soon as you pass through.
- Writing letters of thanks and sending holiday greeting cards. Art or computer classes can help create an official *Certificate of Thanks*.

Avoid the following:

- Climbing over barbed wire fences or gates, as this can necessitate repairs. Use gates or crawl under, not over, fences.
- Wearing T-shirts with political messages or the like.

20. Classroom Connections

by Heather Soja, Catherine Scott, and Catherine E. Matthews

Teachers could easily spend an extended period of time on the study of box turtles. Many lessons could be taught not only in science, but also in social studies, English and mathematics. Whenever possible, we suggest that students be involved with interdisciplinary activities focused on field work (Figure 27). The following sample lesson plans are written for the teacher with student handouts provided. Seven lesson plans for the elementary school teacher are followed by five lesson plans for middle and secondary science teachers. The formatting of the lessons is different for the two sets of lessons but consistent within grade level ranges.

Turtle Connections in the Elementary School

by Catherine Scott and Catherine E. Matthews

The following seven lessons are designed for elementary school students. These include the following: language arts lessons (*Reading About Box Turtles* and *Writing About Reptiles: Box Turtle Poetry*), science lessons (*Box Turtle Classification: Reptile or Amphibian?* and *Box Turtles & Food Chains*), mathematics lessons (*Box Turtle Statistics: Mean, Mode, Range, and Median* and *Graphing Data about Box Turtles: Line Graphs and Bar Graphs*), and one social studies lesson (*Mapping Box Turtle Locations*). Each lesson has an informational lesson plan for the teacher followed by a handout(s) when applicable for the students. A WebQuest for 5th graders can be found at <www.uncg.edu/soe/herpetology>.

Lesson #1 Reading About Box Turtles

Objectives

Students will be able to list and describe characteristics of the Eastern Box Turtle, including habitat, diet, predator-prey relationships, and reproductive behaviors.

Background Information for the Teacher

Prior to completing this activity, students should read the Box Turtle E-Book located at www.uncg.edu/soe/herpetology. The E-Book provides general information about the box turtle and is a good opening lesson as it provides basic knowledge to build on as lessons progress.

Key words are underlined and defined in the E-Book to assist students with understanding important concepts. Students are asked questions throughout the book to help them make connections with their own lives. Students are given the opportunity to self-check their comprehension upon completion of the book by answering questions that are included in the E-Book.

Student activities include using both Venn Diagrams and Double Bubble Maps to compare and contrast information about the box turtle with information about humans.

Student Information

Students need to read the E-Book and answer accompanying questions. For extensions, students can design an informational page or brochure about the Eastern Box Turtle. They could also create their own E-Book with more information about the box turtle or information about another reptile of their choice. Students may design a board game or Memory game using facts that they have learned about the box turtle.

Student Handout for Lesson #1

Name: ________________________ Date: _________________________

Complete these activities on a separate sheet of paper. Staple this page to the top before handing it in.

1. Complete the attached Venn Diagram comparing your habitat to the box turtle's habitat.

2. Pick two of the vocabulary words below and write your own definition of each word.

    a. Predator
    b. Prey
    c. Habitat
    d. Omnivore

3. Complete the Double-Bubble Map comparing the similarities and differences between humans and box turtles.

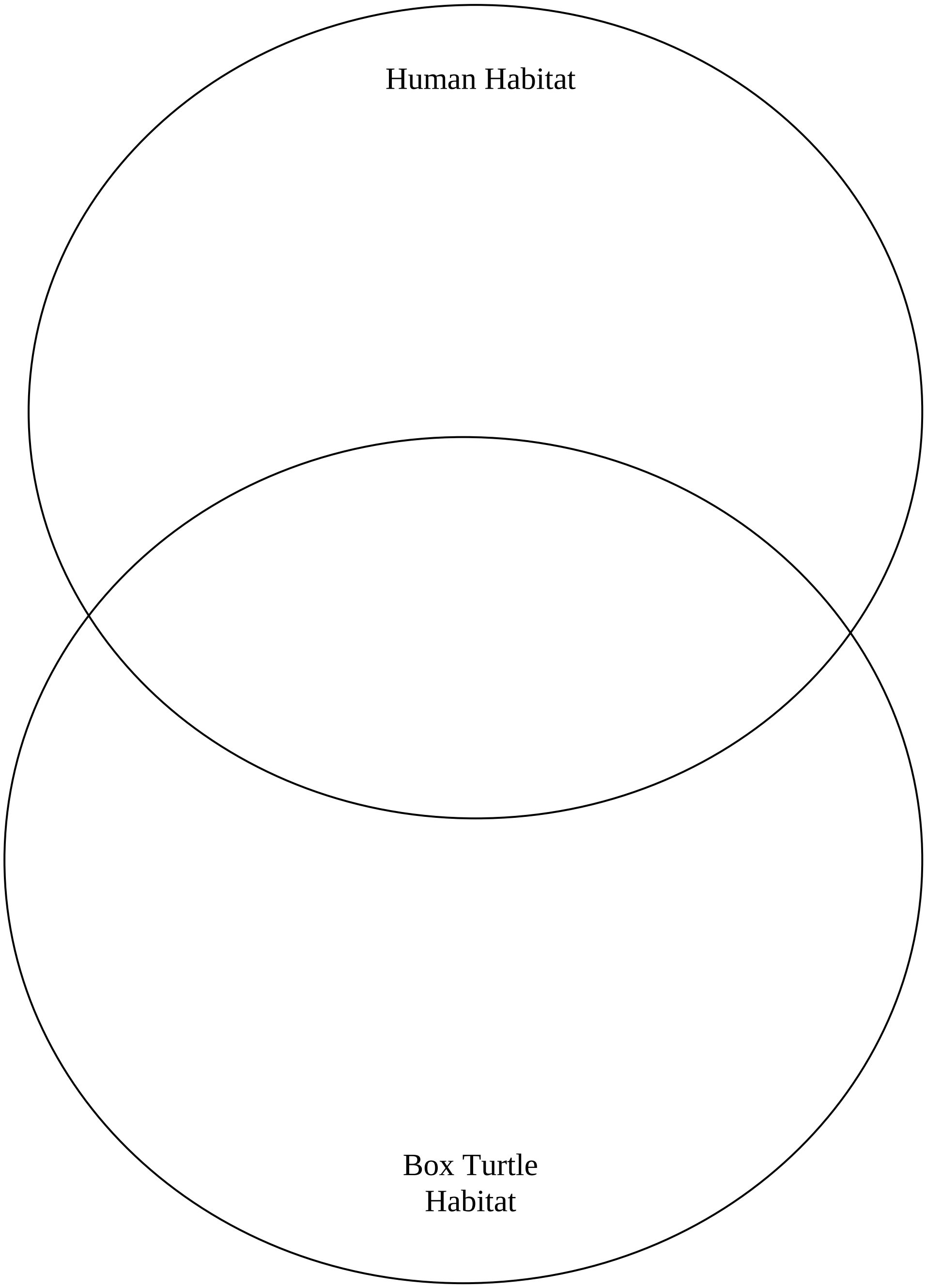
4. Using the box turtle range map of the United States, tell if turtles would be **likely** or **unlikely** to live near these cities:

    a. Los Angeles, CA
    b. Lawrence, KS
    c. Austin, TX
    d. Portland, OR
    e. Greensboro, NC

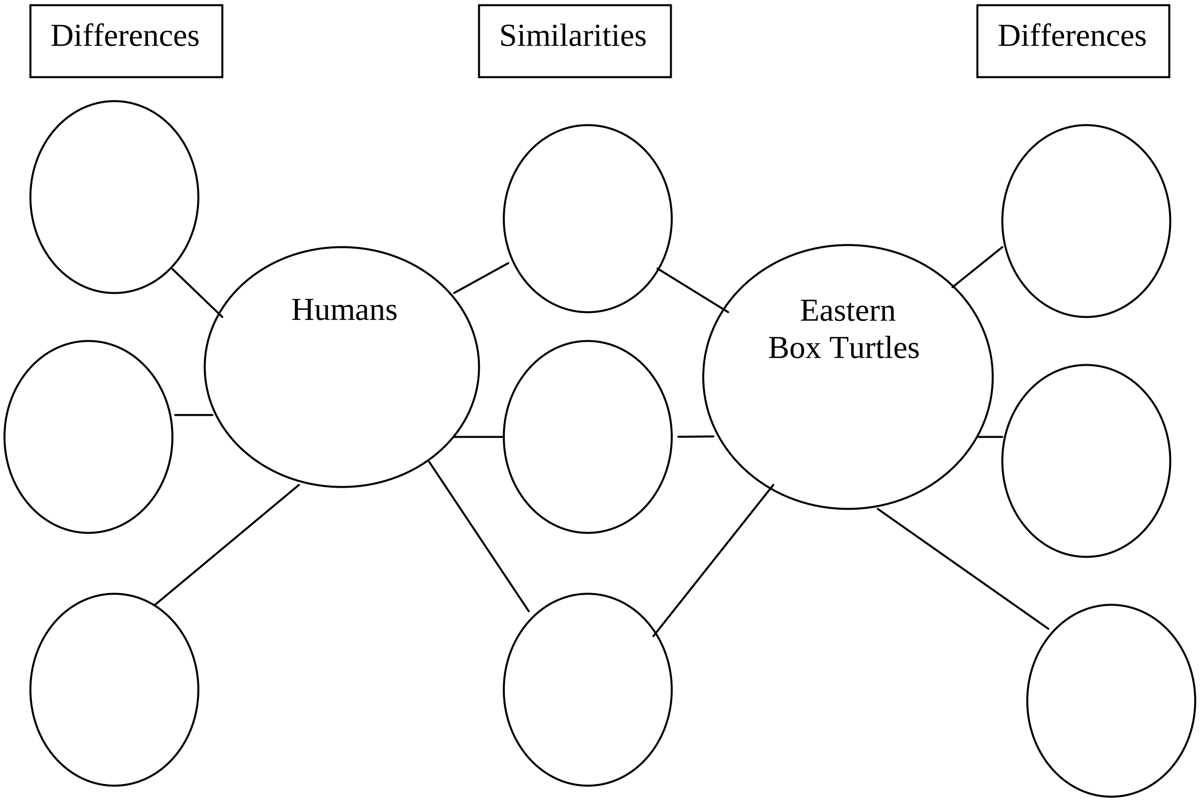
5. What is one new thing that you learned about the box turtle that you did not know before? Why did you find this information interesting?

6. What is one question that you still have or would like to know about box turtles that you did not learn?

Venn Diagram comparing Human Habitat and Box Turtle Habitat



Double Bubble Map comparing Humans and Eastern Box Turtles



Lesson #2 Box Turtle Classification: Reptile or Amphibian?

Objectives
Students will be able to list the differences between reptiles and amphibians.
Students will recognize that turtles are reptiles.

Background Information for the Teacher
Students often have a hard time distinguishing between reptiles and amphibians and may believe that turtles are amphibians because of their ability to swim underwater for long periods of time. This lesson is designed to help students learn the differences between reptiles and amphibians, and learn to classify animals accurately as reptiles or amphibians.

Student Information
Students will read about reptiles and amphibians on the following websites. They will determine whether the box turtle is a reptile or an amphibian.

Sites to use for information:

http://reptilis.net/herp-faq.html
http://www.anapsid.org/myths.html
en.wikipedia.org/wiki/Reptile
en.wikipedia.org/wiki/Amphibian

Student Handout for Lesson #2

Name: ___________________________________ Date: ___________________________

Are turtles reptiles or amphibians? Your job is to do some text-based research and determine whether box turtles are reptiles or amphibians.

1. First, write down everything you know about turtles that might give you clues as to whether box turtles are reptiles or amphibians.

2. Check out the websites provided by your teacher on reptiles and amphibians: http://reptilis.net/herp-faq.html, http://www.anapsid.org/myths.html, en.wikipedia.org/wiki/Reptile and en.wikipedia.org/wiki/Amphibian.

   Create a Venn Diagram on the back of this page comparing reptiles to amphibians. Do any of the websites tell you if box turtle are amphibians or reptiles?

3. The box turtle is a ________________________________.

Lesson #3 Mapping Box Turtle Locations

Objectives

Students will be able to identify the cardinal directions N, S, E, and W on a map.
Students will be able to identify the range of the Eastern Box Turtle on a map.

Background Information for the Teacher

Although students recognize the concepts of N, S, E, and W for directions, they sometimes have difficulty applying these concepts to map reading. This activity will help them to recognize the four compass coordinates, as well as examine the range of different species of box turtles in the United States.

Student Information

Each student needs a color copy of the maps page from *The Turtle Connection*: *A Passageway into the Natural World*.

Student Practice

1. Draw a compass on the board. Have students label the four directions on the compass.

2. Which turtle has the most westerly range?

3. Which turtle's range is east of the range of the Three-Toed Box Turtle?

Student Handout for Lesson #3

Name: ___________________________________ Date:___________________________

Use the Maps provided to answer the following questions about box turtles.

1. How many types of box turtles are there in the United States? What are their names?

2. Which turtle lives the farthest north?

3. Is the Eastern Box Turtles' range north or South of the Gulf Coast Box Turtle?

4. How many different species of box turtles can you find in North Carolina? Write the name(s) of the species below. What about Texas? Again, write the name of the species below.

5. Notice that box turtles are not found in the western United States. Why do you think this is?

Bonus: List the states where you can find the Eastern Box Turtle!

Lesson #4 Box Turtle Statistics: Mean, Mode, Range, and Median

Objectives

Students will be able to compute the mean, mode, range, and median of a set of numbers.
Students will be able to state the average number of eggs laid by a box turtle at a given time.

Background Information for the Teacher

Mean – Mean is the same as "average." To find the mean, you add up a set of numbers and then divide by the total number you added. For example, the mean of 95, 100, and 97 is 97.3
[(95 + 97 + 100) = 292/3 = 97.3]

Mode – Mode is the same as the "most." Which number occurs most frequently in a set of numbers? For example, the mode of 76, 67, 87, 34, and 87 is 87, because it shows up the most. There can be no mode, or there can be more than one mode in any given set of numbers.

Range – Range is the biggest number minus the smallest number. For example, the range of 65, 35, 12, and 98 is 86, because 98 -12 = 86.

Median – Median is the same as "middle." The median is the middle number when a set of numbers is placed in order from least to greatest. For example, the median of the set 23, 33, 34, 55, 65, 76, and 87 is 55. If there is no middle number, take the two middle numbers and find their mean or average. This will be your median.

Student Practice

Have students practice finding the mean, mode, range, and median using the following set of numbers. Explain steps to students and have them practice and explain how they got their answers. Allow time for questions if necessary. Should students get decimals in their answers, have them round to the nearest tenth.

Practice Problems

1. During a one-week period, box turtle locations were recorded each day and the distance from the previous day's location was recorded. The daily distance measurements were: 7 m, 13 m, 53 m, 22 m, 16 m, 13 m, and 12 m. Find the mean, mode, range, and median for this set of data. (Mean = 19.4 m; Mode = 13 m; Range = 46 m; and Median =13 m)

2. Pam kept track of how much her pet turtle weighed each summer for six summers. The weights were 320 g, 345 g, 360 g, 370 g, 370 g, and 380 g. What are the mean, mode, range, and median of these data? (Mean = 357.5 g; Mode = 370 g; Range = 60 g; and Median = 365 g)

Independent Practice for Students

Have students complete the following page for Independent Practice. If you prefer, they may work as partners to solve the problems. The table on the following page comes from H. Allard's "The eastern box turtle and its behavior," from the *Journal of the Tennessee Academy of Science*, 1948.

Student Handout for Lesson #4

Name: ___________________________________ Date:___________________________

The table below describes the weight and length of eggs laid in three different clutches, one with three eggs, one with six eggs and one with seven eggs. Fill in the mean (or average) for each column in the missing boxes:

Number of Eggs Laid in One Clutch	Weight per egg in Grams (g)	Length per egg in Millimeters (mm)
3	9.7 10.9 10.1	37 40 36.5
Average =		
6	8.6 8.4 8.3 8.5 8.3 8.3	34 34 32 34 33.5 33.5
Average =		
7	6.8 7.0 7.2 6.7 7.1 7.2 6.2	30 29.5 32 29.5 29.5 30.5 28
Average =		

1. What is the range for the weight of the first clutch of eggs (9.7 g, 10.9 g, 10.1 g)? What about the median and mode?

2. What are the range, median, and mode for the length of the third clutch of eggs (30 mm, 29.5 mm, 32 mm, 29.5 mm, 29.5 mm, 30.5 mm, and 28 mm)?

3. Which clutch of eggs has the greatest range for weight, Clutch 1, 2, or 3?

Lesson #5 Graphing Data about Box Turtles: Line Graphs and Bar Graphs

Objective

Students will be able to identify the type of graph (line graph or bar graph) that will best illustrate specific data sets.

Background Information for the Teacher

Graphs are important visual tools for displaying data because they make data easier to read and understand. There are many types of graphs that you can use to display data. Here, students will learn when to use line graphs and when to use bar graphs to display data about box turtles.
A *line graph* is used to show change over time. For example, if you were interested in determining weight gain of a turtle over its first years of life, you would use a line graph to display that data. A *bar graph* is used to show one-time measurements of different components. For example, if you were interested in how many hours a day a turtle spent eating, sleeping and walking then you would use a bar graph to show that data.

All graphs should be properly labeled with a title and x-axis (horizontal line) and y-axis (vertical line) labels. You will likely need to tell students to be sure to mark their axes with equal intervals. Sample line and bar graphs are on the following page.

Student Practice

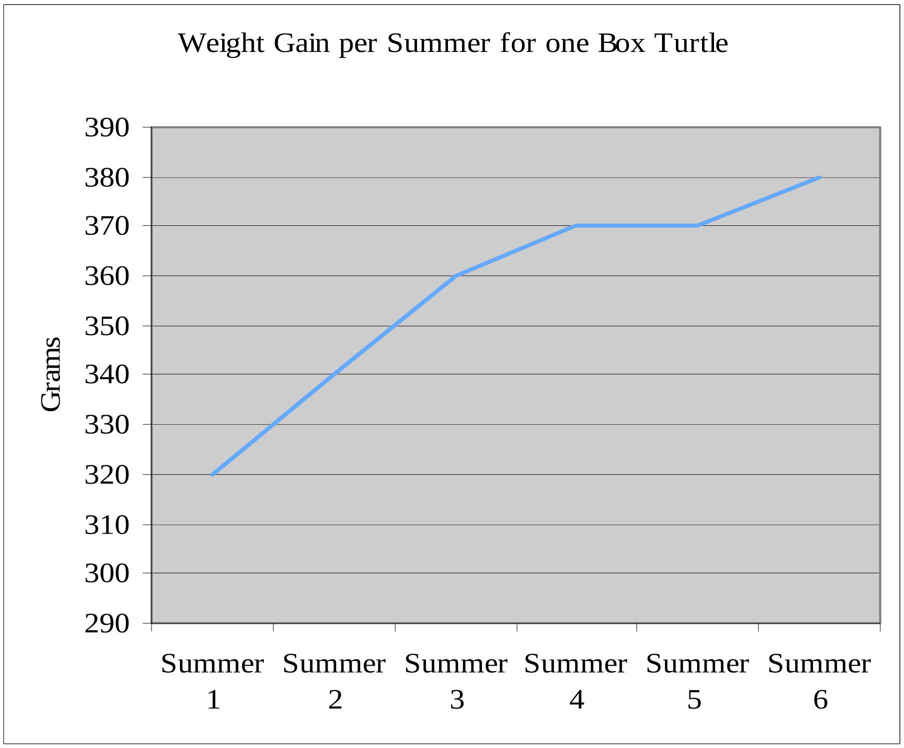
1. If Pam wanted to chart how much her turtle grew each year for six years, which graph would be best and why? [*A line graph, because it shows change over time*] Draw the correct graph for the data.

2. If Pam wanted to chart which food her turtle ate more of snails, earthworms, or berries, which graph would be best and why? [*A bar graph, because it shows single events]* Imagine that Pam's turtle was offered equal amounts of snails, earthworms, and berries but ate the following: 5 g of snails, 7 g of earthworms, and 3 g of berries. Draw the correct graph on your paper.

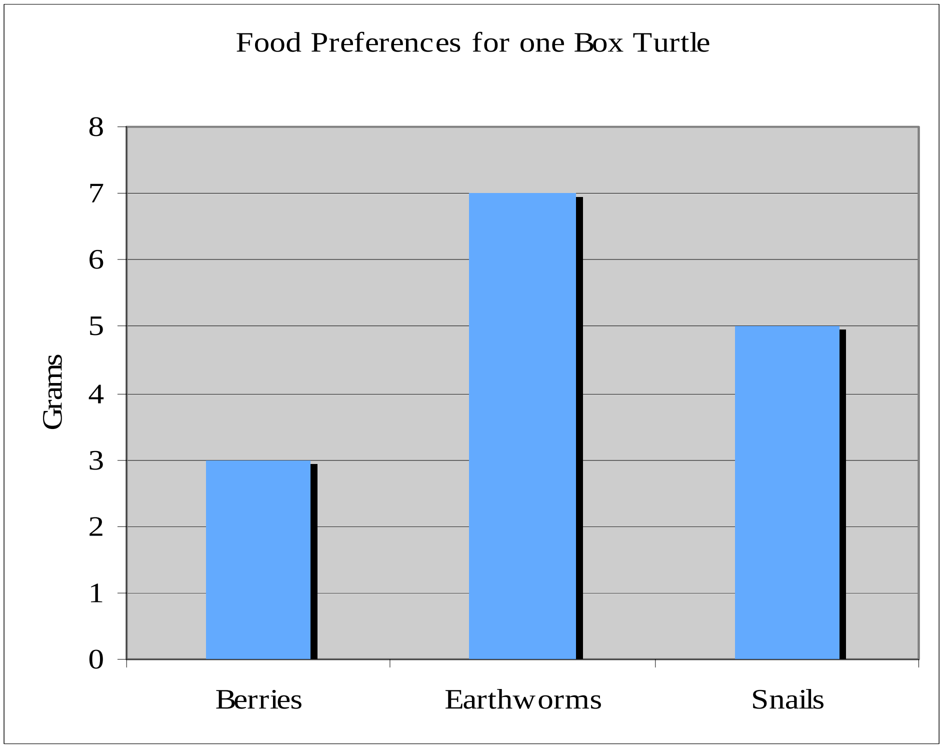
Independent Practice

Have students complete the following page for Independent Practice. If you prefer, they may work as partners to solve the problems.

Sample Line Graph



Sample Bar Graph



Student Handout for Lesson #5

Name: ___________________________________ Date:___________________________

1. Dr. Allard is well known for his work with turtles. While he was out in the field he collected data on how much turtles' eggs weighed. For one clutch of eggs, the weights were 6.8 g, 7 g, 7.2 g, 6.7 g, 7.1 g, 7.2 g, and 6.2 g.

    a) Which graph would best show this information? Why?

    b) Draw the appropriate graph below, or on another sheet of paper. Make sure to label each axis!

2. Dr. Allard found one turtle, Sally that he decided to bring home and study. Each day he charted how much food Sally ate. In order of the days (Sunday-Saturday), Sally ate 5 g, 3 g, 6 g, 4 g, 3 g, 2 g, and 4 g of food.

    a) Which graph would best show this information? Why?

    b) Draw the appropriate graph below, or on another sheet of paper. Make sure to label each axis!

Lesson #6 Box Turtles & Food Chains

Objectives

Students will be able to define the terms predator and prey
Students will be able to identify predator and prey relationships
Students will be able to sketch the different levels of various food chains

Background Information for the Teacher

In this lesson, students will examine the role of the box turtle in the food chain, as well as learn more about predators of the turtle and the prey of the box turtle. Although the shell serves as protection for the box turtle, the turtle is still a target of wildlife looking for a good meal, usually raccoons. Other animals that like to eat turtles include wolves, dogs, and snakes (turtle hatchlings and young juveniles). The turtle, on the other hand, is ready to make a meal out of a juicy earthworm or snail!

Hierarchy can be established in the food chain by establishing top predators and common prey. At the top of the food chain you can find animals that have few predators. The animals near the bottom of the food chain or food pyramid are animals that are commonly used as food for other organisms. Green plants always form the base of all food webs because plants make their own food through the process of photosynthesis.

Classroom Discussion

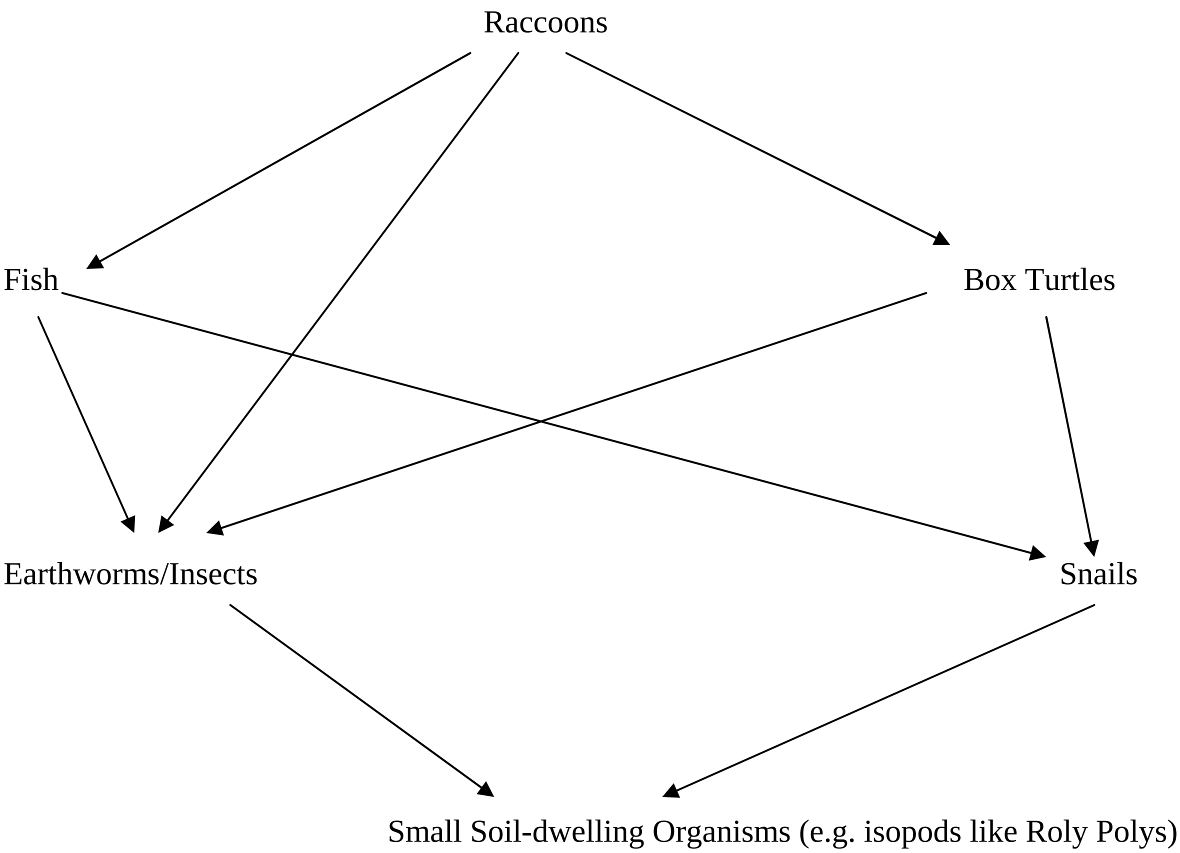
I like to ask my students what they know about predators and prey. I usually have them give some examples, to make sure that they do not have any misconceptions. Together we come up with our own definitions of “predator” and “prey”. After we have agreed on definitions, students brainstorm, in groups, the animals that might consider the box turtle to be prey, and the animals that might consider the box turtle to be a predator.

After a brainstorming session, have students share their thoughts and ideas with the class. Write ideas on the board to compare. Once everyone has contributed to the discussion, go through each animal suggested as predator or prey to get a class consensus. Then, have students create a food web to show the predator and prey relationships of the box turtle. If students need more support, show how to make a simple food chain with one predator and one prey for the box turtle. Encourage students to draw the animals in the food chain/web and color them. You might want to provide construction paper for the food webs. Examples of both a food chain and food web are on the following page.

Basic Food Chain (raccoons eat box turtles which eat snails)

Snails ⇨ Box Turtles ⇨ Raccoons

Basic Food Web



Lesson #7 Writing About Reptiles: Box Turtle Poetry

Objective

Based on what students have learned about the Eastern Box Turtle, they will create a poem about the species.

Background Information for the Teacher

Upon completing their study of box turtles, students should have a good idea of the characteristics of the box turtle. Students can take this information and write a poem based on what they know. Some types of poems to consider include:

Acrostic: Using the letters of a word (e.g., BOX TURTLE), students create a poem where each line begins with that letter. For example:
Bog-living
Ornate or Eastern
Xtremely hard to find!

Haiku: A three-lined poem generally about nature, with the following syllabic pattern:
Line 1: 5 syllables/Line 2: 7 syllables/Line 3: 5 syllables

Cinquain: A five-lined poem with the following syllabic pattern:
Line 1: 2 syllables
Line 2: 4 syllables
Line 3: 6 syllables
Line 4: 8 syllables
Line 5: 2 syllables

Example:
Turtle
Sitting, quiet
Enjoying the sunshine
Waiting for a good snack to come
Turtle

I enjoy teaching my students how to write all three kinds of poems, and then letting them create the poem of their choice. Students can design an illustration and complete their poem on construction paper. Encourage students to incorporate information that they have learned about the box turtle into their poem.

Turtle Connections in the Middle and Secondary School

by Heather Soja and Catherine E. Matthews

The following five formal lesson plans include *A Day in the Life of a Box Turtle,* activities on constructing a food web and playing a game that focuses on predators and box turtle survival; *The Turtle and Me,* comparing turtle and human skeletal structures; *If a Turtle Shell could Speak,* determining the age of turtles; *Let's Build a Box Turtle Nest,* where students build nesting sites and study gender determination; and *The Future of Turtles,* for investigating the biological status of turtles. Following these five formal lesson plans are additional ideas for incorporating lessons in different curricular areas.

Figure 27. Taking measurements, filling out data sheets, and doing art projects are good ways to encourage young people to look at turtles in detail.

Lesson #1   A Day in the Life of a Box Turtle

Background

Box turtles are terrestrial animals that live in several types of habitats. They may be found in forests or fields, under leaf litter, or simply crossing the road. The movement of a box turtle is related to its specific needs at a particular time. Turtles may roam in search of food, cover, mates, or a place to over-winter.

Box turtles are omnivores because they feed on both plant and animal matter. Scientists in the field have observed box turtles feeding on the following: mosses, fungi, berries, leaves, roots, earthworms, snails, slugs, grasshoppers, moths, and beetles. Little is known about box turtles' food preferences, but box turtles are opportunists and they eat what they can find or catch.

While box turtles have a well balanced diet and seem to enjoy a variety of foods, they too may become food for other organisms. Box turtles are most susceptible to predation when they are developing in the egg. Burrowing snakes and ground dwelling insects feed upon the eggs in the nest. Raccoons, skunks, dogs, and foxes prey on box turtles at all life stages from eggs to adults. Some snakes, crows, and vultures feed on box turtle hatchlings and juveniles.

Activity #1: Constructing a food web

In this activity, students should construct a food web that includes the box turtle along with the prey that it feeds upon as well as its common predators. The food web should include arrows that point from the prey item to the predator to show the organism that is eating. The food web should include 10 organisms including plants and animals. Students may draw, print, or cut out pictures to depict the organisms in the food web. The food webs may be displayed in the form of a mobile, as a poster, using a PowerPoint presentation, or having volunteers role-play their organism in a food web.

Students should share their food webs with the class and discuss the relationships between different organisms in the example. As an extension, students may lead a class discussion about the implications of removing one or more of the organisms from the food web and how that change could affect that ecosystem.

Activity #2: Box Turtle Predators

Students will participate in an activity that emphasizes the most essential things that animals need in order to survive. This role-playing activity will help students understand that a variety of factors affect the ability of turtles to maintain their health and successfully reproduce.

The teacher should mark off a playing field, which is 100' by 100'. The corners of the area should be clearly marked with stakes. Use flags or flagging to mark off sections of the field that represent the following: 1.) the nesting location (6% of the total area), 2.) a field that borders a forested area (edge) (47% of the total area), and 3.) a forested area with leaf litter (47% of the total area).

Introduce the game to the students by showing them pictures of raccoons, dogs, foxes, vultures, and humans. Briefly discuss how turtles might emerge from the nest and try to find shelter or cover for safety from predators.

Select four students as predators, while other students role-play hatchling box turtles.

Have each of the four students select a predator to mimic and have that student physically attempt to move as that predator. For example, raccoons should walk on all fours (arms and legs) while the crows could squat and utilize their arms as wings.

Hatchling students will move around on their knees and use their arms as the front legs of the box turtle hatchlings.

The hatchlings should begin their journey on the side of the playing field/area that is labeled as the nesting location and successfully find their way to the leaf litter without being eaten (tagged) by a predator. When the hatchlings reach the forested leaf litter they are considered to be in the safe zone and must remain there until the game has ended. If a turtle is tagged, it is “dead” and must stay where it was tagged until the end of the game.

Predators must begin the game on the leaf litter side of the area, while hatchlings begin the game in the nesting area. The teacher should blow a whistle to start the game and then blow the whistle a second time to end the game when all hatchlings are safe or dead.

Play the game four or five times and record the time it takes for the hatchlings to meet their fate. Alter the number and types of predators during each game and allow hatchlings to plan strategies if possible. Teachers may ask predators or hatchlings to role-play an injury to simulate factors that may affect the survival of a box turtle.

Record the number of survivors for each round and use this data to graph relative to the number of predators introduced in each game.

Discuss trends and observations made from the simulation as it relates to predator/prey relationships in an ecosystem. Discuss the role of humans in the life of the box turtle and explain how they might interrupt natural relationships between organisms in this and other ecosystems.

Name: ___________________________________ Date: ___________________________

Box Turtle Predators Game

Game #	# Box Turtles	# Predators	Length of Game	# Survivors/ % Survivors	# Dead/ % Dead
1	24	4			
2	20	8			
3	16	12			
4	12	16			
5	8	20			

Graph of Survival Rates
(Graph your independent variable, which is number of predators on the X-axis. Graph your number of box turtles, which is your dependent variable on the Y-axis.)

(On the back of this page graph the number of box turtles versus length of the game.)

Lesson #2 The Turtle and Me

Student Name ______________________

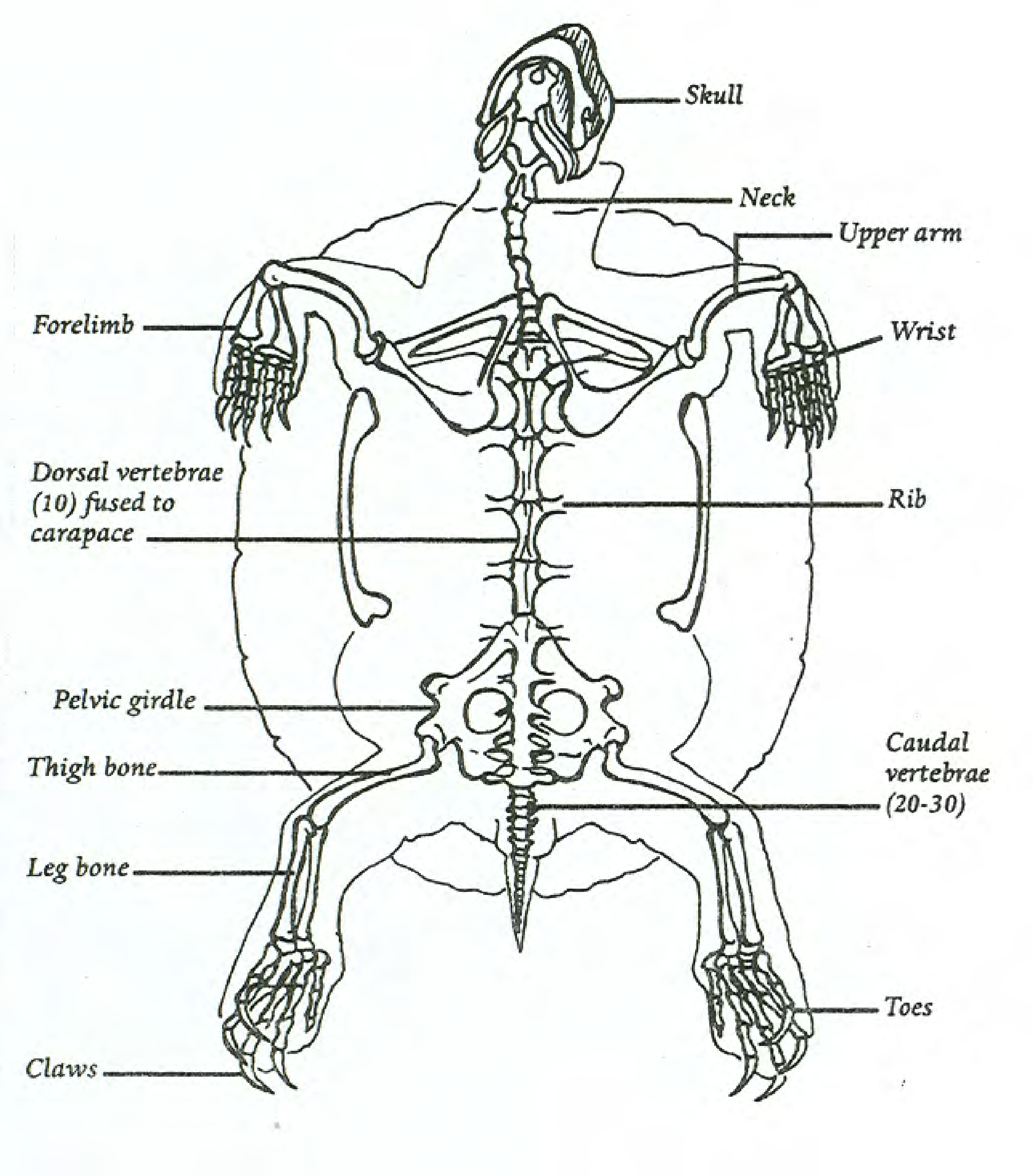
Background

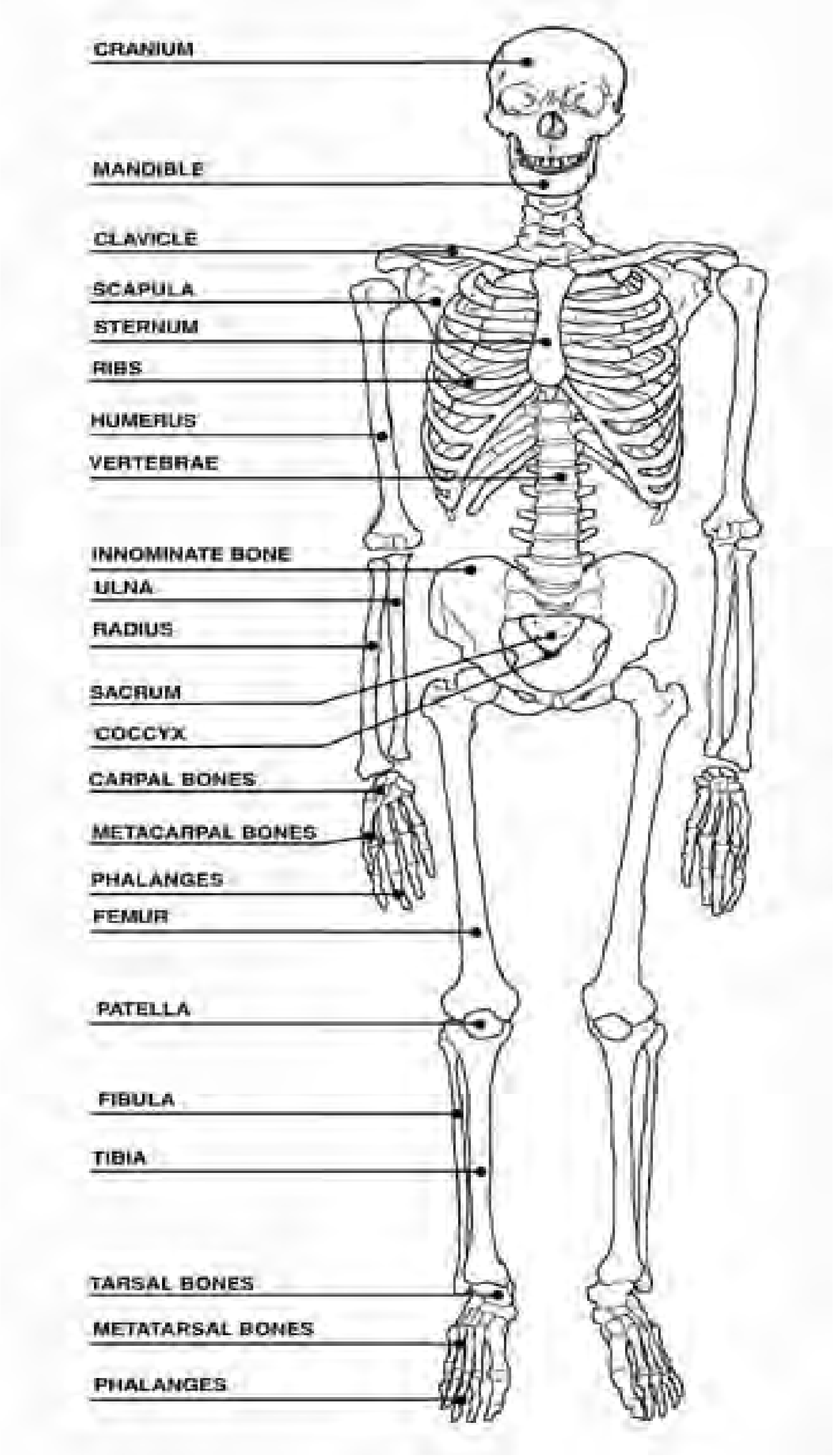
Charles Darwin was one of the first naturalists to document the similarities in adaptations between two different species of organisms. His theory of evolution by natural selection focused on the adaptations of species in relation to their natural environment.

Evolutionary relationships can be determined by comparing anatomical structures of different species. When two species share common anatomical structures that have different functions or purposes, these structures are called **HOMOLOGOUS STRUCTURES**. For example, the bones in a bat’s wing and the bones in the human hand are anatomically similar but have different functions for each organism. When two species share adaptations with similar functions but different anatomical structures, they are said to be **ANALOGOUS STRUCTURES**. For example, a bird's wing and a butterfly's wing have the same function, but their structures are different. Therefore, the wing of a bird and the wing of a butterfly are analogous structures.

Activity #1: Comparing turtle and human skeletons

Turtles and human beings actually share some similarities in their skeletal structures. Observe the diagrams on the next two pages for HOMOLOGOUS STRUCTURES shared between the turtle skeleton and the human skeleton, Identify and color four homologous structures on each skeleton. Color each pair of homologous structures a different color. Using a red pencil, label the common names of turtle bones with scientific names. Using a green pencil label the scientific names of human bones with common names.


Skull
Neck
Upper arm
Forelimb
Wrist
Dorsal vertebrae (10) fused to carapace
Rib
Pelvic girdle
Caudal vertebrae (20-30)
Thigh bone
Leg bone
Toes
Claws


CRANIUM
MANDIBLE
CLAVICLE
SCAPULA
STERNUM
RIBS
HUMERUS
VERTEBRAE
INNOMINATE BONE
ULNA
RADIUS
SACRUM
COCCYX
CARPAL BONES
METACARPAL BONES
PHALANGES
FEMUR
PATELLA
FIBULA
TIBIA
TARSAL BONES
METATARSAL BONES
PHALANGES

Homologous Structures Table

Referring to the diagrams in this lesson, describe the homologous structures shared between the turtle and human skeletons. Use the table below to list the structures that may be homologous structures shared between the two species. Below the structures you list, give a reason (in the same space) for why they would be considered homologous structures.

Box turtle	**Human being**
Structure: Reason:	Structure: Reason:
Structure: Reason:	Structure: Reason:
Structure: Reason:	Structure: Reason:
Structure: Reason:	Structure: Reason:

Short Answer Questions:

1. While there are similarities between the two skeletons, notable differences also exist between them. Describe differences observed between the skeletons of the turtle and the human.

2. Explain how the turtle and the human have similar adaptations and describe the similarities in each species.

3. Explain the similarities and differences of the phalanges (toes and fingers) in the turtle and human skeleton. How do their functions compare?

Extra Credit: Read and think more about the specific anatomy of the box turtle and include adaptations that make it unique from other turtle species. Discuss the role of these adaptations relative to the evolutionary success of the species.

Lesson #3 If a Turtle Shell Could Speak

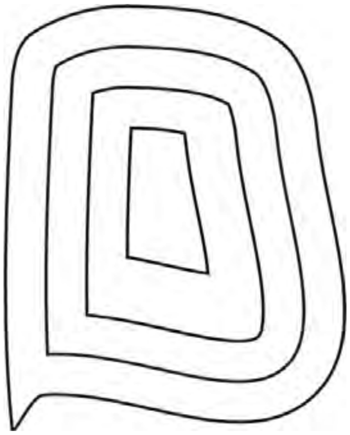
Background Activity #1

A turtle's shell is not only useful for protection from predators; it also represents a record of the turtle's life in a sense. For example, the rings (annuli) appearing on the scutes (scales) of a turtle shell can be used to estimate a turtle's age if the turtle is still younger than 10 or 12 years old and sometimes is accurate up to 20 years of age. This process is similar to counting the rings of a tree to determine the age of the tree, but dozens and even hundreds of tree rings can be counted accurately. In a box turtle, the rings are found on the scutes of the carapace (top shell) and on the scutes of the plastron (bottom shell). This method of estimating the age of young turtles is acceptable but not always accurate due to shell wearing in natural conditions and the lack of definition between annuli as the turtle ages.

Activity #1: Aging turtle shells

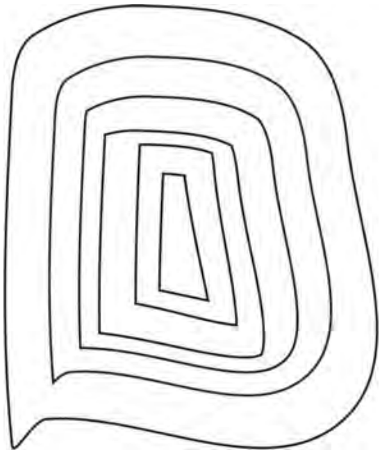
Below you will find three diagrams of one scute from the shell of 3 different young turtles. Look at the scute and estimate the age of the turtle and write your estimate in the space provided.

Diagram I



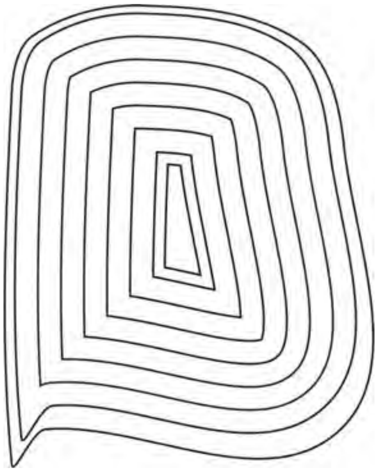
Age estimate: _____

Diagram II



Age estimate: _____

Diagram III



Age estimate: _____

Background Activity #2

Mark and recapture describes a method that allows scientists to learn about the lives of individual turtles. The shell of a turtle is marked in a pattern that is correlated to a specific code that represents one individual turtle. When the turtle is first captured, it is marked and data are collected. This turtle is immediately released in the same place it was found but with markings on its carapace. Most often the markings are created using a triangular file on specified scutes bordering the carapace (marginal scutes).

If the turtle is young, the age can be estimated at the time of the initial capture by counting annuli. If the turtle is recaptured at a later time, scientists can re-age the turtle using the ring method and compare the new estimate to the age data collected during the earlier capture.

During a mark and recapture study, other measurements are taken so that the growth of the turtle may be monitored and recorded. Some of these measurements include: weight, maximum carapace length, shell height at hinge, carapace width at hinge, and total plastron length (hinge to anterior + hinge to posterior = total plastron length).

Activity #2: Measuring turtle shells

Using the information below, take proper measurements of the turtle shells provided by your teacher. (Note: If using real shells, handle them with care and do not drop them.) Record the maximum carapace length, shell height at hinge, total plastron length (see above), and carapace width at hinge. Use the techniques described in earlier chapters. Record your measurements below.

Maximum carapace length ______

Carapace width at hinge ______

Shell height at hinge ______

Hinge to anterior margin ______

Hinge to posterior margin ______

Total plastron length ______

Short Answer Questions:

1. How do the turtle shells differ in their measurements?

2. What factors in their natural habitat may affect the growth of a turtle's shell?

3. How has the hinge of the box turtle shell contributed to the box turtle's success as a species?

Lesson #4 Let's Build a Box Turtle Nest

Background

Like many reptiles, box turtles lay eggs on land in a nest that the female prepares by digging a hole. The act of digging a nest is called nest excavation. Nest site selection is important because it may determine the temperature at which box turtle eggs develop. The temperature in the egg chamber affects developmental rate, gender of the offspring, and possibly the viability of the offspring in terms of size and growth rate.

Female box turtles have been observed in their natural habitat scratching the surface of the soil, presumably testing substrate content for a desirable nesting location (Legler, 1960). After a site has been selected, the female begins digging the egg chamber using her rear claws and angling her body. Using alternating movements of the back feet, the turtle curls the toes of the feet and uses the foot as a scoop (Dodd, 2001). It is suspected that some species of turtle, like the painted turtle, eliminate waste during the nesting procedure to soften the substrate and make excavation easier (Conant, 1938). Whether this behavior occurs in box turtles is unknown and is still under study.

After the eggs are deposited, the female covers the nest with substrate surrounding the excavation site using the hind legs. Temperature-dependent sex determination is a phenomenon that exists in box turtle species (Dodd, 2001). Typically, hatchlings from warm nests become females, whereas cool nests produce males.

Activity #1: Turtle Nest Temperature and Turtle Gender Relationships

Examine and discuss the table below:

Temperature-Dependent Sex Determination Study In Controlled Laboratory Conditions*

Temperature	Male turtles hatched	Female box turtles hatched
22.5 ^{O}C	73 %	27 %
25.0 ^{O}C	96 %	4 %
27.0 ^{O}C	81 %	19 %
29.0 ^{O}C	0 %	100 %
30.0 ^{O}C	0%	100 %

---

* Controlled laboratory study performed by scientists Ewert and Nelson in 1991. The Eastern box turtle typically shares the pattern as seen above but the exact pivotal period has not yet been determined (Dodd, C.K., 2001).

Short Answer Questions: Using Table 1, answer the following questions.

1. How does the temperature of the nest determine the number of males and females hatched?

2. According to the data in Table 1, what is the optimal temperature range for eggs developing into male turtles? Female turtles?

3. How might the percentage of female box turtles produced differ between nests laid in the woods and those laid in fields?

4. During one nesting season in Georgia, the temperatures dropped below normal and remained low for two consecutive weeks. How could these abnormal temperatures affect the box turtle population of Georgia during that reproductive season? Explain your answer.

Activity #2: An Ideal Nesting Location

During this activity, students will mimic nest excavation by turtles, as they prepare "model nests" using a soil sampler to extract soil substrate to a specific depth. Small groups of students will be assigned a nest depth by their teacher and will excavate a hole to that depth. The students will then take temperature readings of the soil at different levels within the "nest" and record those temperatures in their data tables.

Materials:
3 to 4 soil samplers/ small shovel or trowel
soil thermometers
measuring tapes
small marshmallows (to represent eggs)
Flags or labeled popsicle sticks

Student Procedures:

1. Each group should select a nesting site in an area approved by their teacher.

2. Students should begin excavating their nest according to the teacher's directions. Each group should be assigned a specific depth below the soil surface (let the surface soil equal 0 cm), so group members should use the available measuring tape to measure to their assigned soil depth.

3. Once the desired depth has been reached, have the nest checked by the instructor.

4. Label a flag or wooden craft stick with the group name, date, and specific depth.

5. On day one, fill the hole with small marshmallows (do not stuff them in) to about 2cm below the top of the nest. The marshmallows will represent small turtle eggs similar to those of the eastern box turtle.

6. Using the soil thermometer, take four temperatures from within the nest site. One temperature reading should come from the bottom of the nest and one from the top of the nest. The other two temperatures may be taken anywhere between the top and bottom and must have their depth recorded also. If time allows, it is best to repeat this data collection procedure 3 times and record the average values. Collect temperature data for the number of days indicated by the instructor. Record your findings. Cover the nests with soil when you are not taking measurements.

7. Using the temperature data you have collected, predict the number of eggs (marshmallows) that you believe will develop into males and the number of eggs that will develop into females. Report these numbers as percentages.

8. Use the data table below to collect the temperature data or develop a data table with your group to share with the rest of the class.

Temperatures Within Excavated Nest

Depths of Nest (cm)	Day 1	Day 2	Day 3	Day 4	Day 5
Surface (Top)					
2nd Reading __cm					
3rd Reading __cm					
Bottom Depth Assigned ___cm					

Short Answer Questions:

1. Describe the area where your nest is located. Include in your description any specific vegetation, leaf litter, signs of animals, and proximity to forest, buildings, and fields. What type of soil substrate is found in your nesting site?

2. Why did your group select this nesting site?

3. Would you predict that more males or more females would hatch from your nest? Explain.

4. How can temperatures vary in the nest of a box turtle? Support your answer with your data.

5. What other factors might contribute to the success of a turtle nest in a natural environment?

Extensions

• Continue collecting data over several months and keep a research journal about your findings.

• Create an informative tri-fold display board about the different nesting habits of various species of turtles throughout the world. Discuss how temperature affects sex determination in each species.

• Find an active turtle nesting area and record observations over an extended time period. Take soil temperature readings and try to predict the ratio of males to females expected to hatch from that nesting site.

Lesson #5 The Future of Turtles

Background

The Endangered Species Act (ESA) was passed by the U.S. Congress in 1973. This act was established to protect organisms, both plants and animals, from becoming extinct. According to the U.S. Fish and Wildlife Service, no turtle species in the U.S. has become extinct since the European settlements in the Americas, but population declines in many species have been regularly observed and recorded. Sources from the National Biological Service indicate that 45% of the species of turtles in the United States are protected in some way under endangered species legislation.

The Endangered Species Act offers several levels of protection to turtles depending upon their population status and future threats. Endangered or threatened status may be applied to specific turtle species.

Activity: Going, Going, Gone

Using the Internet, research the list of turtle species of the United States below to determine their species status. Prior to your research, make a prediction about their status based upon your own current knowledge and then compare it to your findings on the Internet.

Consider the list of turtles in the United States and predict their protection status using the letters **E= endangered, T= threatened, C= candidate for protection, or N= not protected by the ESA**, beside the common name of each turtle. Discuss your predictions with the class. Compare your prediction with the actual condition of turtles listed.

Common Name	Scientific Name	Predicted Status	Actual Status
1. Loggerhead sea turtle	*Caretta caretta*	____	___
2. Eastern box turtle	*Terrapene carolina*	____	___
3. Green sea turtle	*Chelonia mydas*	____	___
4. Bog turtle	*Glyptemys muhlenbergii*	____	____
5. Alligator snapping turtle	*Macroclemys temmincki*	____	____
6. Western pond turtle	*Actinemys marmorata*	____	____

Now, prepare an informative poster. Choose a turtle from the list above or another turtle species of the United States not mentioned and prepare an informative poster about the characteristics, life style (eating, reproduction, and location), species status, threats to the species, and “ways to help” that specific species.

Each student (may be completed in pairs) should present and share their information with the class. Students should provide a reference page to the instructor to reveal the sources of the information being provided to the class. When using the Internet to research a topic, be sure that the information is accurate and is provided by a reputable organization (.edu or .gov). Always cite your sources.

Additional Lesson Plan Ideas

The following ideas are based on a chapter by Matthews and Somers for *Curriculum Integration K-12: Theory and Practice* (2005) titled, "Using the Environment as a Context for Integrating the Middle School Curriculum."

English: A classic work of American literature that you might want to use with your students is John Steinbeck's *The Grapes of Wrath*. We would suggest using excerpts from the book, especially Chapter 3, which focuses on a land turtle. Steinbeck describes the travels and travails of a land turtle as it lumbers across a field, to a roadside embankment and climbs to the road where it is nearly hit by a car. A truck swerves to hit the turtle, but its wheel strikes only the edge of the shell and spins it off the highway. The turtle lies on its back, but finally pulls itself over and moves forward.

Literary critics suggest that the turtle is a metaphor for the migrant farmers whose stories and struggles are recounted in *The Grapes of Wrath*. The turtle, like the migrant farmers, carries its home on its back wherever it travels. The turtle plods along but is consistently confronted with danger and setbacks, specifically those of modernity and business. Critics say that Steinbeck made it clear through the symbol of the tenacious turtle that the migrants would be successful in establishing a new life in California.

Another well-known writer, Ogden Nash (1902 – 1971), a poet of numerous short rhymes had this to say about turtles in general:

The Turtle
The turtle lives 'twixt plated decks
Which practically conceal its sex.
I think it clever of the turtle
In such a fix to be so fertile.

Students could read more about Nash or write poems about specific turtle species using Nash's rhyming patterns. Read Nash's verses online at http://www.aenet.org/poems/ognash4.htm.

Using technical reference sources is a desirable language arts skill. The most highly acclaimed book on box turtles is Dodd's (2001) *North American Box Turtles*. It is easily readable and students can use it as a resource to compare and contrast information they locate about box turtles from other resources in order to judge the value and reliability of the information they find. Distinguishing between valid and invalid sources of information, including information online as well as text materials, is an important skill for students to develop.

Many cultures celebrate turtles as symbols of wisdom and longevity. Some American Indian tribes have used turtle shells as instruments and decorations. There are many legends about turtles in American Indian literature. Students find it fascinating to determine the source and wisdom of some of these legends.

Another popular activity for students we have worked with is having them write and then share children's books about turtles with students in elementary schools. All of these language arts activities have the potential to contribute significantly to your studies of the box turtle.

Mathematics: Mathematics is easily integrated into the box turtle study providing multiple examples of need-to-know mathematics with applications directly related to the study. Box turtle studies allow students to learn to use numbers to support their position statements in persuasive writing pieces, to draw conclusions about data sets, and to gain information about habitat and abiotic conditions in box turtle habitat.

Working with box turtles and box turtle habitat offers multiple opportunities to have students work with real mathematical ideas and science concepts that depend on an understanding of mathematics. For example, students can count rings on scutes and estimate the age of box turtles. Students can follow nests and count eggs laid and eggs hatched and calculate a hatching percentage. Students can compute simple descriptive statistics such as the average home range area of each turtle, the ratio of males to females in the population captured, sexed and marked, and the ratio of home range to age of turtles captured.

Students can graph data from various sources from the box turtle study including time of day activity is observed, date (month and day) of matings observed, date of first movement above ground in the spring, and last movement above ground in the late fall. Our students established informational databases by collecting data, inputting it, organizing it and searching and sorting files to use in the box turtle study.

Students mark box turtles by filing a pattern on their outer scutes with a triangular file, which allows subsequent positive identification of each turtle located. Students also take a number of measurements of each box turtle captured.

The study of perimeter, area and surface area and relationships among length, perimeter, area, and volume are included. Students can draw objects to scale and use scale drawings to solve problems.

As graphing is an integral part of box turtle research, the following objectives are easily met:

- Collect, organize, analyze, and display data (including box plots and histograms) to solve problems.
- Calculate, use, and interpret the mean, median, mode, range and frequency distribution for a set of data.

Social Studies: A social studies curriculum typically recommends that teachers and students utilize community-related resources such as field trips, and use map reading skills, interpret charts and graphs, and describe factors that determine changes in distribution of populations, resources and climates and then evaluate effects on the environment.

In the box turtle study, students describe the environmental impact of events such as fragmentation and loss of habitat on environments and subsequent populations of box turtles. Studying distribution maps of different species of box turtles is an excellent way to include geography in the curriculum. Range Maps offer yet another way of integrating map studies with your local investigations of herps.

U.S. populations of box turtles can be compared with other box turtles around the world. The Asian Turtle Crisis can be explored in great detail and compared with other issues that threaten turtles in other areas of the world.

A study of the legal system, at both the federal and state levels, is easy to incorporate in the Box Turtle Study. A very appropriate investigation would be to determine how bills become laws at both federal and state levels. In North Carolina our state legislature recently approved a bill to protect certain turtle species from exploitation. For more information on this bill use the "Bill Look-Up" feature and enter the number of the bill: S825 (*Protect Certain Reptiles and Amphibians)* on the N.C. Wildlife Resources Commission's web site at www.ncwildlife.org.

Visual Arts: The visual arts can be used throughout the box turtle study. Students can illustrate the books that they write for children on turtles. They can use art to illustrate their papers and projects and homework. The students we worked with on the box turtle study designed logos and T-shirts for our Turtle Team members. Art projects focus on art as a means of communication and persuasion including interpreting the environment.

Technology Integration: Many technology objectives can be met by the box turtle study. Students definitely learn to identify uses of technology in the workplace using GIS units to gather data about turtle locations, using radiotelemetry to track turtles, using digital scales to weigh turtles, using computers to maintain a database of information collected about turtles and using keyboarding and word processing and desk top publishing skills to prepare programs to share their knowledge with others. Students also learn to use simple graphing programs to display data. Technology integration is easily integrated into the box turtle study.

21. Notable Box Turtle Researchers

These people are among the many notable herpetologists who have contributed to box turtle research. Herpetology, the study of reptiles and amphibians, is a subset of biology, zoology, and even ecology. Many individuals and organizations have contributed to the study of herpetology, of which box turtle studies is a small part.

C. Kenneth Dodd, Jr. is author of the recent natural history classic, *North American Box Turtles: A Natural History*. This volume should be in every library within the range of the turtle and in every school or classroom where box turtle studies are being conducted. Dodd's fascination with box turtles began as a child and continues today with his long-term study of the Florida Box turtles on Egmont Key. His contributions are not confined to box turtles, however, as he has over 100 publications including journal articles, monographs, book chapters and reviews, symposium proceedings, and invited articles on many aspects of herpetology. His outstanding service and performance in the field of herpetology has been widely recognized with a number of awards and honors.

Charles and Elizabeth Schwartz of the Missouri Department of Conservation studied box turtles on their own property from 1965-1983. They perfected the use of dogs in box turtle research by using their Labradors to find turtles (Dodd, 2001). Results of their work with the three-toed box turtles (Schwartz and Schwartz, 1974; Schwartz et al., 1984) include findings on home range, population characteristics, and habitat use.

Lucille Stickel is considered by many to be the *Grand Dame* of box turtle research (Riedel, pers. comm.) Her studies of box turtles began in 1944 at the Patuxent Wildlife Research Center near Laurel, Maryland and continued until her retirement. Stickel (1950) provides the foundation for ecological studies of box turtles in eastern deciduous forests. She introduced the word *form* to describe the depression turtles make in the ground for resting. She also published papers on morphology, growth, home range, and population trends. Turtles she marked still roam the forests of Patuxent!

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Appendix A

Science Scope Article on BCMS Turtle Project

Outdoor Adventures: Tracking Eastern Box Turtles

Modified from the article printed in *Science Scope*, November, 2003 (Used by permission)

By Ann B. Somers, Catherine E. Matthews, Kristin R. Bennett, Sarah Seymour, and John Rucker

Ann Somers is a lecturer in the Department of Biology and Catherine Matthews is an associate professor in the Department of Curriculum and Instruction at the University of North Carolina at Greensboro. Kristin Bennett is an adjunct professor in the Department of Curriculum and Instruction at the University of North Carolina in Greensboro. Sarah Seymour is the science teacher and John Rucker an English teacher at Bethany Community Middle School (BCMS) in Reidsville, North Carolina.

Figure 28. The Turtle Research Team at Bethany Community Middle School

A thematic and hands-on approach to learning insures that students learn deeper and retain information longer. Bouillion and Gomez (2001) argue that real-world problems and school community partnerships help disengaged students connect with school science. When the activities of school science are not connected with children's lived experiences, there are both cognitive and affective consequences. According to the experiential learning theorist John Dewey:

> Dewey and others have long advocated situating learning in real world contexts and the use of 'authentic' tasks or realistic problems has become a common practice in project based science activities... The task before us is to help children…feel that the practice and knowledge of schools can have an impact on the world they live in and care about…At least part of that task will be accomplished when science curricula are connected directly to expertise and lived experience…building bridges to communities beyond school (Bouillion and Gomez 2001).

Our project was designed to engage middle grades students in an "authentic" task by involving them in a study of the Eastern box turtle (*Terrapene carolina carolina*), a species in decline. It emphasizes learning by doing and promotes character growth, teamwork, reflection, and literacy. Its goals are to:

• bring together the middle school, university, and local community to learn about the environment and the importance of stewardship of the natural world.

• integrate math, science, reading, computer literacy, and scientific field techniques in a science classroom through an interdisciplinary project.

• produce documents that will provide a model for other schools interested in establishing hands-on science with conservation implications.

The Concept

Eastern box turtles are long-lived reptiles that are late to mature and have few offspring. Habitat loss and fragmentation, road kill, and the international pet trade are a few of the issues that concerned scientists believe may threaten this species' long-term survival. Comprehensive studies describing long term population trends are rare, but there is strong commitment among researchers that mortality from human activity is significant and increasing. Box turtles have little protection from loss of habitat, but they are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES) which regulates box turtle trade to other member nations (Dodd, 2001). It is the belief of many respected scientists that continued pressures on this species will be detrimental to their survival given their particular biological characteristics (Howe 1996).

The idea for a box turtle mark-and-recapture project grew from successful turtle projects at the University of North Carolina at Greensboro (UNCG). Ann Somers, a turtle researcher, had used sea turtles and bog turtles (*Glyptemys muhlenbergii*) to interest students in conservation issues for many years with considerable success. She decided to try to interest her son's middle school, Bethany Community Middle School (BCMS), in a box turtle project after seeing the old fields and woods on the property. Initially, the reaction of the administrators and teachers at the middle school was lukewarm but soon metamorphosed into true enthusiasm when the students reacted favorably to the interaction with turtles. Catherine Matthews provided expertise in middle school science education and the box turtle study moved from a good idea into a true educational project. The adjacent landowners were amenable to the idea and the University-School-Community partnership was born.

After deciding on the basic goals of the project (as described previously), we performed several turtle tracking trials prior to seeking and receiving two $5,000 grants from the University-School Teacher Education Partnership (USTEP) at UNCG and one $5,000 Environmental Protection Agency (EPA) grant. Funds allowed us to purchase the needed equipment and supplies, although it is possible to conduct a low-tech version of this project with very little funding. Funds also allowed us to place UNCG graduate students, including Kristin Bennett, in BCMS classrooms to assist Sarah Seymour, the middle school science teacher.

Locating, marking, and tracking the box turtles on the school grounds and adjacent property served as the foundation from which all of the other activities evolved. In this ongoing project, students weigh, measure, and identify the gender of the turtles. They record information about landscape features and identify plants that live in the habitat where the turtles are found. Students also complete handwritten data sheets, enter data in a computer-based spreadsheet, and use the same electronic equipment that professional researchers use to learn about wild animals. This technology is integrated in the field through the radiotelemetry and GPS study and in the classroom when the advanced computer classes input tracking data into Excel worksheets.

Habitat preferences and threats to survival provide material for many interesting discussions. From these experiences, teachers and students practiced field techniques, studied turtle morphology, and discovered the flaws and frustrations of aging live turtles. From this they learned how to determine home ranges and the importance of population monitoring.

Methods of Finding Turtles

Most people are familiar with box turtles, also known as terrapins, because they see them on roads and in their yards. These terrestrial turtles move in search of food, mates, or (if a female) a place to lay eggs; they are likely to be seen on roadsides because roads have transected many of their home ranges. However, finding a box turtle when you want to find one is a different matter altogether.

Initially, we tried to locate turtles by simply walking the school property on favorable weather days (warm and humid). The eighth grade class, with teachers and university faculty in tow, headed out into the field but quickly realized that visual searches for box turtles, conducted during class periods, would not be productive enough in our area to carry the project forward.

We found only one box turtle by looking during class time and decided that searching for box turtles by sight and trying to keep the attention of an entire class of middle school students was problematic. To solve our problem of too few turtles, we contacted the owner of highly disciplined hunting dogs (two Boykin spaniels) that were trained to catch box turtles unharmed.

Although many types of dogs will find box turtles occasionally, even breeds such as Pekinese, the Boykins and Labradors that have been used in scientific studies are typically highly trained and well disciplined and are worked with daily by professional trainers and handlers. No turtle in this study has ever suffered an injury from either a dog or a human working on this project.

Most box turtle studies use visual searches only. Project personnel simply measure, mark, and release turtles that students or local citizens bring in to be included in the study. In some cases, one may spend a lot of time looking and not much time locating box turtles; however, box turtle densities vary enormously from region to region within the range of the turtle. Rockingham County, North Carolina has been heavily farmed for several hundred years without respite and we suspect that this is one of the reasons for lower densities of turtles. Besides impacting the habitat of box turtles, agriculture has a negative effect on turtles for other reasons. Almost all farmers in our region have tales of hitting turtles with tractors or other farm implements or of disturbing turtle nests. Our experience has been that counties that include protected areas such as national or state parks or forests, or counties that are currently less impacted by agriculture and heavy traffic can have much denser populations of box turtles than we have in Rockingham County, North Carolina. This suggests that school groups in rural, but non-agricultural areas, may have success finding box turtles by searching visually.

There are several other methods of finding box turtles that we have not tried yet in the BCMS project. Coverboards and feeding stations are two examples. Coverboards are structures like plywood sheets or pieces of old tin roofing that are placed strategically in the environment to attract reptiles. There is no bait involved. The boards are simply placed on the ground (or elevated slightly) in a shaded or semi-shaded area after raking fallen leaves and other debris away. Although we did not use this method at BCMS, Somers has found turtles using coverboards on other projects. Be careful: Snakes are also attracted to these structures so be prepared to instruct students about the importance of protecting snakes and leaving them alone. Carry a snake identification guide so you can make the most of the experience if you are lucky enough to attract a serpent. Students in our projects are taught to respect all species, venomous and non-venomous. We also considered putting out preferred food items at feeding stations, such as tomatoes, but have not tried this method yet. Once turtles are measured, they are always returned to the exact location where they were found.


Sarah Seymour

Figure 29. Turtle Day is a great way to expose students to environmental values and involve a large number of people.

If you don't want to spend time looking for box turtles, then you may want to consider a study of other more easily located reptile and amphibian species. It is important that you decide on a species to study that will yield successful data for students to analyze. In our projects, even students who weren't too excited about box turtles often truly enjoyed being outdoors or learning about other organisms encountered in the field.

If you are in an urban area and feel like you are unable to conduct fieldwork (which we highly recommend), or if you are looking for other case studies, the *Looking at our Environment* project offers an excellent case study of the gopher tortoise in Florida. You can access materials to teach this case study in your classroom at <www.late.worldwatcher.org> (GEODE, 2004).

Radio-tracking

We are currently tracking six box turtles using radiotelemetry. This activity requires the purchase of telemetry equipment (receiver and antenna) and battery powered transmitters. Small thumb-sized transmitters are anchored to the back of the turtle's upper shell with epoxy (Schubauer 1981; Eckler et a1.1990). We use both a Telonics TR4 and Wildlife Materials TRX-1000S receivers. With one receiver we use a flexible antenna called a "rubber ducky" and with the other a rigid antenna. Cost of both receiver and antenna is roughly $900-$1200. We prefer RI-2B transmitters from Holohil Systems, Ltd., which cost about $180 each and must be ordered weeks or months in advance, especially if the transmitters are needed in spring.

Student trackers, guided by their science teacher, met regularly after school to track the turtles' movements. Training in the use of this tracking device takes several hours including practice sessions to get the hang of listening to 'chirps,' locating the correct frequency (each turtle's transmitter is set to a different frequency), and then locating the turtle. However, once a turtle's relative location is known it takes just a few minutes of training for students to find them.

Student Involvement

Initially, student involvement was limited to volunteer students who worked after school, on weekends or occasionally during a sixth period elective class. These students joined either a tracking team or a public speaking team at BCMS. About 15 students played significant roles in the box turtle project over its first two years at BCMS. During the second year of the project we incorporated several 'turtle days' that involved whole classes tracking turtles. This typically involved grouping students into three groups (5-8 students per group) that rotated among three activities: (1) observing the dogs capturing turtles, (2) hands-on tracking of turtles with receivers, and (3) classroom based environmental activities. Several strategies were used to curtail potential management issues during these large group turtle tracking days. First, in the days leading up to the field experience, teachers reviewed fieldwork protocols and acceptable behavior in the field. Using small pre-determined groups allowed teachers to distribute students in such a way as to thwart potential pairs of unruly students. Finally, the very engaging, hands-on, out-of-door nature of these activities kept students eagerly involved. Due to the success of the project, the headmaster of the school decided to make the turtle project an elective class during sixth period for the 2003-2004 school year.

Recording the Data

Turtle behavior and measurements were recorded on two data sheets. One focused on collection of physical data from the turtle itself (Morphometric Data) and the other on habitat choice and characteristics (Locality Data). The morphometric data is a good way to organize science concepts that need to be taught to middle school students such as how to use scales and calipers and record data accurately, skills which are also important in many enterprises besides science. The site data is important for learning about habitat needs and preferences. Studying activity ranges for each turtle demonstrates that individual turtles prefer a particular area and allows students to speculate about how a turtle might meet its basic needs for food, water, mates, nesting, and hibernation within that limited range. Dodd (2001) calls box turtles “homebodies” and our findings clearly concur with his conclusion. These data are most important in stressing the conservation theme of the project. Roads, habitat destruction, and people taking turtles away from their home ranges threaten turtle populations all over the world. Students in this project can visualize why moving turtles is a problem since they know exactly the ranges of the turtles that they are tracking.

Once turtles were captured, the following student activities formed the basis for recording data: <u>Determining gender and aging</u>—Students learned to identify the gender of a box turtle by looking at the eyes: males generally (not always) have bright red eyes, while females have brown, yellow or dull red eyes. Students also learned to sex turtles by the shape of the shell. Male box turtles have a concave depression on their bottom shell (plastron) that allows them to stabilize when mounting a female to mate. Students also learned to age box turtles by counting the rings on the scutes, which are called annuli. They learn that this method provides only a rough estimate, but currently is the only way to estimate the age of a living turtle. Rings are difficult to count if there are more than 20, so the older the turtle, the more difficult it is to estimate age.


Sarah Seymour

Figure 30. Students learn to use spreadsheets by entering turtle data collected by other students.

<u>Weighing, marking, and measuring turtles</u>—All turtles are weighed using a digital scale and weight is recorded in grams. Pesola spring scales also work well in the field. Numerous length and width measurements are made with calipers and the data recorded in millimeters on the Morphometric Data Sheet. All turtles are marked by filing a number pattern on their marginal scutes (Gibbons 1988) and then released at the point of capture. Recaptured turtles are re-measured only if one year has lapsed since the last measurements were taken.

<u>Abiotic factors: The box turtle's habitat</u>—Site, temperature, and weather data are collected for every capture. Other important information includes time spent searching (a.k.a. search effort), method of collection (human or dog), substrate (soil) temperature, weather data (air temperature 2 cm above the surface and relative humidity), and habitat characteristics (dominant vegetation

type, height, and distance the turtle is located from the edge of habitat). Thus, we have a fairly complete record of habitat preferences for each turtle. Our turtles thus far indicate a definite preference for edge habitat spending most of their time at the junction or edge of the forest and an old field. Students can search for any reptile or amphibian on their school grounds using these techniques and data collection methods.

Using GPS units to record box turtles' positions and maps and mapping— Students learn to use handheld Global Positioning System (GPS) units to read elevation, latitude, and longitude when box turtles are located. Elevation is not accurate enough or relevant to our project, and thus is not recorded. These data are recorded on the Locality Data Sheet. If your school does not have access to a GPS unit, you can get a topographic map of your school site and read elevation, latitude, and longitude measurements from the map. We plan to do several lessons on using topographic maps in the classroom as a part of this continuing project.

Suggested Equipment Used in Our Study

The following items are kept in a couple of backpacks at BCMS so that the instruments needed in this fieldwork are handy. The list includes the items as well as approximate costs.

Hydrometer & Thermometer (relative humidity & air and soil temp.) $40
Flagging tape (to mark location) $3
Scales (spring or digital) $60-$100
Triangular file (to mark turtles) $6
Pencil or inedible ink pen (no standard ink pens) $3
Receiver and antenna (if radio-tracking) $ 900- $1200
Data sheets (morphometric and locality)
Global Positioning System (GPS) unit $ 180
List of codes that will be used on next turtles
Map of property to mark location
Wrist Watch (to record times of location and release)

Sharing the Results of Our Study

In addition to students who volunteered to be on a turtle tracking team, a number of students volunteered to be on a public speaking team to share results of our study with students at other middle schools in nearby counties, with middle school teachers at the North Carolina Science Teachers Association (NCSTA) Annual Meeting, with members of the North Carolina Herpetological Society, with members of Partners in Reptile and Amphibian Conservation (PARC) and with members of the USTEP board. In the fall, students will be going into local elementary school classes to share their knowledge of box turtles with younger children.

Interested in this project? Want to know how to get started? It is easy with a project like this. First, decide on your species of concern. If you decide to study box turtles, make sure that they are found in your study site. Box turtles are easy to catch. They are slow moving creatures and there are only five safety concerns with their capture:

1. When you pick up a box turtle hold it firmly by the upper shell. Don’t let your fingers get caught in a hinge should the turtle decide to close its shell.

2. Wash your hands after handling turtles and before you eat or rub your face. Turtles and all other reptiles can carry salmonella but if you follow careful hand-washing procedures then the risk of contracting *Salmonella* is minimal.
3. Avoid dangling your fingers in front of their heads …yes, box turtles can bite, although this is unusual.
4. The biggest safety concerns are incidental and to be expected in fieldwork. Box turtles enjoy briar patches and poison ivy (at least that's where we often find them) and of course other pests such as ticks and stinging insects are likely to be in the out-of-doors. When working near roads, exercise particular caution with respect to cars.
5. And, most importantly for the safety of the turtles: Do not move them around casually or allow others in your project to do so. Do not allow your field study site to become a dumping site for turtles that are displaced by well meaning but misinformed participants. Almost without exception, turtles should be returned to a place of safety at the place they were captured.

Conclusions

Tracking turtles has been a high profile project because of the gentle and charismatic nature of the turtles and the University-School-Community partnership. We have generated interest in box turtles in the BCMS students and teachers, and members of the community have volunteered to participate in this project. BCMS students have become aware of the interdisciplinary nature of curriculum and have learned specific information from the sciences, mathematics and language arts, as detailed earlier in this article, and as applied to real world conservation issues.

BCMS students have had opportunities to give public presentations to elementary school students, other middle school students, professional herpetologists, and science teachers in North Carolina. Two BCMS students had an opportunity to attend and present at the first national meeting of Partners in Amphibian and Reptile Conservation's (PARC) education group. Educators and students have produced a number of documents such as a poster, several presentations, and a science curriculum integration notebook based upon our research project. We look forward to our continuing collaboration and to the contributions that we may make to the conservation of box turtles.

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Appendix B

Turtle Drop-off Form

Instructions for Completing the Turtle Drop-off Form

Anyone leaving a turtle in your care should be required to provide pertinent information regarding locality and collector data as described below. Each turtle should be returned to the exact location where it was found within a day or so, if not the same day. Do not allow your study location to become a dumping site for turtles that are displaced by well-meaning, but misinformed participants. If the donor cannot return it, it is best not to accept the turtle unless you are willing to get the turtle back to the point of capture in a timely manner. See the following pages for a sample and a completed *Turtle Drop-off Form.* The instructions below explain how to complete the *Turtle Drop-off Form* used in the Bethany Community Middle School (BCMS) project. Use the sample form as a model to create your own drop-off form.

Will you be able to return this turtle today or in the next few days? If the answer is no, describe the importance of turtles being returned to the point of capture and that responsible research of wild animals means that the subjects are not displaced or held in captivity for long. If they or someone else are not available to return the turtle in the next day or so, politely decline the turtle.

Name – Get the name of the donor as well as the person responsible for returning the turtle to the location where it was captured.

Date – Enter the date that the box turtle was captured and also the date that the turtle was brought into the facility for data collection.

Address and phone numbers – Addresses and phone numbers will allow you to contact the responsible party when the turtle is ready to be released or when you need additional information. A database can be generated with names that can be used to acknowledge support for the project, such as thank you notes or holiday cards.

Name and phone number of the person who found the turtle, if different from above – Occasionally a relative or friend of the collector will bring the turtle into your facility. This field will allow you to record their contact information also.

County where turtle was found – Record the name of the county where the turtle was found. The BCMS campus is located near a four-county intersection so we were receiving turtles from all four counties. Although the ecosystems where the turtles were found are quite similar, biological data are often recorded in statewide databases based on county of occurrence so this information is important.

Time – Time of day may be important in determining the activity patterns of turtles and how they change over time. Also, when time of day is recorded you may discover an observer bias in the data if the researchers are out at the same time each day. This provides an excellent opportunity to discuss observer bias and similar phenomena with the participants.

Address or exact location where the turtle was found – Locality data are important for many reasons. Such data help researchers sort out important biological information and is one way of verifying the existence of box turtle populations. Part of your research or lesson plans may include mapping turtle locations.

UTM Coordinates and Map Datum: Geographic coordinates can be added to the form after the donor has left. They should be recorded in the Universal Transverse Mercator (UTM) grid system or in latitude/longitude, including minutes and seconds; UTM is used by UNCG researchers. Use a GPS unit or find the coordinates using the easy-to-use UTM finder available in the lower left corner of Mike Dorcas' Davidson College Herpetology homepage at <http://www.bio.davidson.edu/people/midorcas/dorcas_home.htm>. Any GPS information must include the map datum used such as North American Datum of 1927 (NAD27) or World Geodetic System of 1984 (WGS84). World Geodetic System of 1984 (WGS84) is the default datum for the UTM finder on the Dorcas website.

Describe habitat – Characterize the habitat generally and specifically if possible. Box turtles use a variety of natural habitats and many are discovered while crossing roads, eating in our gardens, inactive under blackberry thickets, or crossing driveways and lawns. Natural habitats may include forests, a meadow, brushy sedges, or maples. Include the dominant vegetation type like "long leaf pine forest" if not found on a road.

Describe weather – General descriptions of the weather can include whether it is cloudy, clear and sunny, hot and hazy, or cool and windy. Include the approximate ambient temperature at the time the turtle was captured.

Turtle's activity when found – Upon discovery, some box turtles will "run" or they may close up to wait out apparent danger. Common turtle activities include basking in the sun; crossing the road (AOR = alive on road); mating; eating blackberries, tomatoes, or earthworms; hiding beneath leaf litter; or laying eggs (Figure 31).

Any other information that will be helpful – Include anything here that you or the donor noticed, even if it seems irrelevant at the time.

Marty K. Manuele

Figure 31. A female turtle laying eggs.

Turtle Drop-off Form

Sample

Thank you for your interest in helping with our student box turtle study! We can only accept turtles in this study that will be returned to the exact location where they were found.

Will you be able to return this turtle today or in the next few days? Yes No
If yes, please fill out the form. If not, we cannot include your turtle in our study.

Name ____ Date ____________________

Address ____

Phone _____________________________________ Phone (other) _________________________

Name of person who found the turtle, if different from above _____________________________

Home phone of person who found the turtle, if different from above ________________________

County where turtle was found _________________ Time __________ A.M. or P.M. (circle one)

Address or exact location where the turtle was found ____________________________________

____

UTM and Map Datum____

Describe habitat ____

Describe weather, including temperature____

Turtle's activity when found ____

Any other information will be helpful! ____

____

____

____

____

Turtle Drop-off Form

Completed Sample

Thank you for your interest in helping with our student box turtle study! We can only accept turtles in this study that will be returned to the exact location where they were found.

Will you be able to return this turtle today or in the next few days? [✓ Yes] No
If yes, please fill out the form. If not, we cannot include your turtle in our study.

Name *Banna Lathan* Date *24 September 2004*

Address *8628 Church Street, Reidsville, NC*

Phone *336-951-4561 (home)* Phone (other) *cell 336-951-2500*

Name of person who found the turtle, if different from above *Kathy Moore*

Home phone of person who found the turtle, if different from above *336-581-7894*

County where turtle was found *Rockingham* Time *4:40* A.M. or [✓ P.M.] (circle one)

Address or exact location where the turtle was found *Turtle was found in thicket behind Kathy Moore's house at 458 Sunset Lane, Bethany NC.*

UTM and Map Datum *UTM E: 0602498 UTM N: 4018915UTM Zone: 17, Datum WGS84*

Describe habitat *Turtle was on the edge of blackberry thicket.*

Describe weather *Partly cloudy, temperature 21.4 ° C*

Turtle's activity *walking, head out*

Any other information will be helpful *Kathy Moore believes the same turtle had been in their tomato patch behind the house earlier this month.*

Appendix C

Turtle Morphometric Data Sheet

Instructions for Completing the Turtle Morphometric Data Sheet

A Turtle Morphometric Data Sheet should be completed for each turtle discovered. A blank sample and a completed sample of the Turtle Morphometric Data Sheet are included on the following pages. Design your own data sheet so that you collect information that will help you answer your research questions. Release the turtle at the point of capture after data collection.

Site name – If a name does not already exist for the property where the turtle was found, invent one. Examples: The Matthews Home Place, Cunningham Farm near the Haw River Access, or Camp Chestnut.

Turtle species – Record the species of turtle you are collecting data on such as Box, Mud, Snapping, or Other. If you listed "Other," write an explanation in the "Comments" section at the bottom of the page.

Turtle # – For new turtles, refer to Chapter 12, *Marking System for Box Turtles*, or if previously marked enter the turtle number.

Date – Enter the date you are collecting data.

Day of week – Enter the day of the week you are collecting data for this turtle.

Time – Record the time this turtle was discovered and indicate whether it was found in the A.M. or P.M.

Recapture – Circle "Y" for yes or "N" for no. Don't be too hasty. Carefully inspect the marginal scutes to determine if the turtle was previously marked. Filed notches often fill in with dirt, so run the tip of your fingernail along the edge of the marginals to feel for previously filed marks.

Observer(s) – List the complete names of all people present at the site on this date.

Name, address and phone number of collector (if turtle is brought into the lab) – Enter the name of the person who collected the turtle.

Is this individual willing to return this turtle to the site of capture? Enter "Yes" or "No."

Exact location of capture – Enter the city, county, and state where this turtle was found. Use road numbers, mileage, and directions from intersections, landmarks, or towns to denote the precise point where the turtle was encountered. Geographic coordinates should be recorded in the Universal Transverse Mercator (UTM) grid system or latitude/longitude, including minutes and seconds (UTM is preferred). An easy to use UTM finder is available on Mike Dorcas' Davidson Herpetology homepage in the lower left corner at <http://www.bio.davidson.edu/people/midorcas/dorcas_home.htm>. GPS information must include the map datum used, such as North American Datum of 1927 (NAD27) or World Geodetic System of 1984 (WGS84). World Geodetic System of 1984 (WGS84) is the default datum for the UTM finder on the Dorcas website.

Gender – Refer to Chapter 14, *Gender Determination*.

Age – Refer to Chapter 15, *Age Determination*.

Confidence rate: Rate your confidence in your ability to age the turtle on a scale of 0-3. A low rating can be because of inexperience or because the annuli are not clear.

Weight and measurements – Refer to Chapter 16, *Measuring and Weighing*.

Were digital photographs taken of the carapace and plastron? – Circle yes or no.

Turtle's activity/behavior – Activities may include basking, burrowing, or walking. Behavior may include information such as turtle is active, sluggish, or shy.

Weather conditions and **approximate temperature –** This should correspond to the "Weather" section of the Locality Data sheet described in Appendix D, *Locality Data – Turtle Survey Sheet*. Be sure to indicate whether Celsius or Fahrenheit measurement is used by including a "C" or "F."

Did you observe this turtle eating? – Circle "Yes" or "No."

What? – Enter what you saw the turtle eating such as tomatoes, blackberries, or an earthworm.

Anything identifiable in scat? – Enter anything you can identify in the turtle's feces, such as tomato or blackberry seeds.

Habitat – Enter the type of habitat in which the turtle was found as described on the data sheet.

Injuries/Defects/Parasites – Briefly describe any abnormalities observed. This could include any healed injuries noted on the carapace or plastron, missing appendages, or discharge from eyes or nose.

Indicate below where injuries, fire scars, unusual scute patterns or defects occur: – Indicate the location of the injury, anomaly or defect on the drawing(s) provided. Describe and illustrate these if possible.

Describe dominant vegetation – List the most prevalent type of vegetation found at the site of capture.

Capture method – Enter the number that represents the way this turtle was observed: 1 = Road Capture; 2 = Observed While Mowing; 3 = Visual Search (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle); 6 = Other (give a complete explanation of any method that doesn't fit into the previous categories).

Date and time of release – A turtle may be taken in for an educational program, transmitter attachment or a health assessment. In all cases, the date this turtle is returned to the wild should be entered here. If turtle is released the same day immediately after data collection, enter “same.”

Was turtle released at point of capture? – Circle “Yes” or “No.”

If not released at point of capture, please explain – Give a brief explanation.

If not released at point of capture, where and how far from the point of capture was the turtle released? – Give a brief, but thorough explanation.

Comments – List anything that seems noteworthy, such as unusual scute patterns (Figure 32), color, or markings, damaged shell (be specific), or bite marks.

Gil Grant

Dan Smith

Figure 32. Box turtles normally have 4 pleural scutes (top photo), but some have more or less. The turtle in the bottom photo has 3 pleural scutes on the left and 5 on the right (not shown).

Turtle Morphometric Data Sheet

Sample

Fill out a separate sheet for each turtle. Use only pencil or indelible ink.

Site name: ____________________ Turtle species:__________Turtle #________________

Date:_____________Day of week: ______ Time: __________ Recapture? Y or N

Observer(s):____

____

Name, address, and phone # of collector (if turtle is brought into the lab):_______________________

____

____

Is the collector willing to return this turtle to the site of capture? ___________________________

Exact location of capture (county, nearest town, road no. and distance to nearest intersection, name of landowner, UTM and map datum):

____

____

Gender: M or F **Mass in grams (weight):** (g):_____________________

Age: ______ **Confidence rate:** ___________(0 = can't age, 3 = sure of age as recorded)

Shell measurements:

___________Plastron Length: Anterior margin to hinge (mm)

\+ ___________Plastron Length: Hinge to posterior margin (mm)

=___________ Plastron Length: Total

Maximum Carapace Length (mm): ____________

Overall Width at Hinge (mm):____________

Shell Height at Hinge (mm):____________

Scute counts: Vertebrals _______; Right Pleurals_____ ; Left Pleurals________;

Right Marginals_________; Left Marginals _________

Digital photo taken of carapace? Y N **Digital photo taken of plastron?** Y N

Turtle's activity/behavior:____

____

Weather conditions:____

____

Approx. Temp.:______________ **Did you observe this turtle eating?** Y N **What?** ___________

Anything identifiable in scat? What?____

Habitat:___________________ (1 = road, 2 = edge of field or forest (within 6m of edge), 3 = field, 4 = pine/hardwood, 5 = stream or stream bank, 6 = open wetland, 7 = forested wetland, 8 = other)

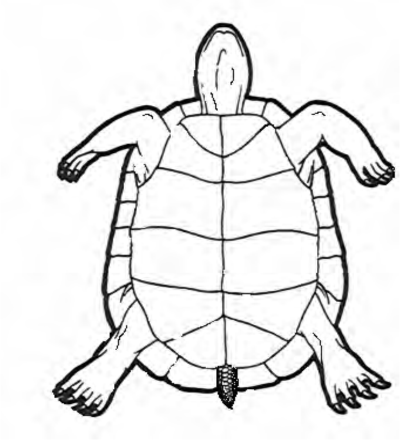
Describe dominant vegetation:____

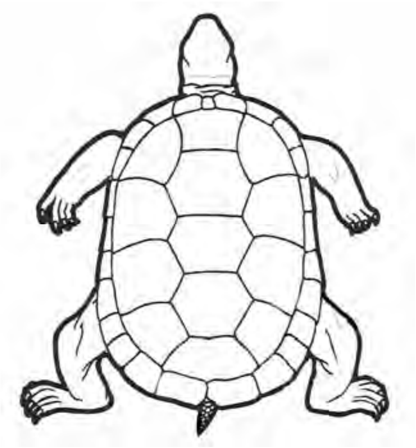
____

Injuries/Defects/Parasites:____

____

Indicate Below Any Injuries, Fire Scars, Unusual Scute Patterns or Defects:





Capture method:_______ 1 = Road Capture; 2 = Observed While Mowing; 3 = Visual Search (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle); 6 = Other (give a complete explanation of any method that doesn't fit into the previous categories).____________________

____

Date and time of release:____

____

Was turtle released at point of capture? *Y* *N*

If not released at point of capture, please explain:____

____

If not released at point of capture, **where** and **how far** from the point of capture was turtle released?

____

____

Comments:____

____

Turtle Morphometric Data Sheet

Completed Sample

Fill out a separate sheet for each turtle. Use only pencil or indelible ink.

Site name: *BCMS* **Turtle species:** *BOX* **Turtle #** *NOP "Bart"*

Date: *10 August 2005* **Day of week:** *Tuesday* **Time:** *10:15 am* **Recapture?** [✓ Y] or N

Observer(s): *Sarah Seymour, Troy Moore, Cody Lathan*

Name, address, and phone number of collector (if turtle is brought into the lab): *Timmy Potts found in front of his house at 321 Simpson Road, Reidsville, NC 336-681-5588*

Is the collector willing to return this turtle to the site of capture? *yes*

Exact location of capture (county, nearest town, road no. and distance to nearest intersection, name of landowner, UTM and map datum):

AOR *NC: Rockingham Co.: Hwy. 65, approx. 0.5 mi W of intersection SR 1001*

GPS reading: UTM Easting 601787, Northing 4024142 Datum NAD27

Gender: [✓ M] or F **Mass in grams (weight):** 435 g

Age: 15 + Confidence Rate: 3 (0 = can't age, 3 = sure of age as recorded)

50.8 Plastron Length: Anterior margin to hinge (mm)

\+ *75.8* Plastron Length: Hinge to posterior margin (mm)

= *126.6* Plastron Length Total

Maximum Carapace Length (mm) *134.5*

Overall Width at Hinge (mm) *94.6*

Shell Height at Hinge (mm) *55.8*

Scute counts: Vertebrals 5; Right Pleurals *4*; Left Pleurals *4*;

Right Marginals *12*; Left Marginals *12*

Digital photo taken of carapace? [✓ Y] N **Digital photo taken of plastron?** [✓ Y] N

Turtle's activity/behavior: *AOR* (alive on road) *turtle was crossing driveway*

Weather conditions: *Sunny, clouds breaking up from morning rain*

Approx. Temp.: *72° F* **Did you observe this turtle eating?** [✓ Y] N **What?** *a slug*

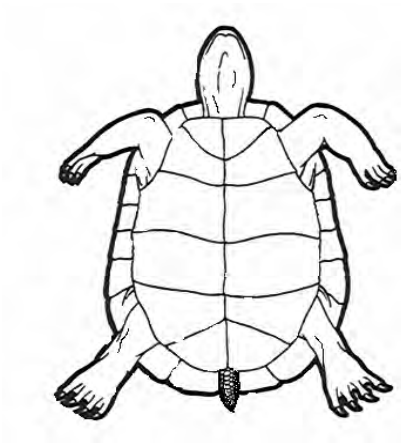
Anything identifiable in scat? What? *Seeds of some sort, not sure of type*

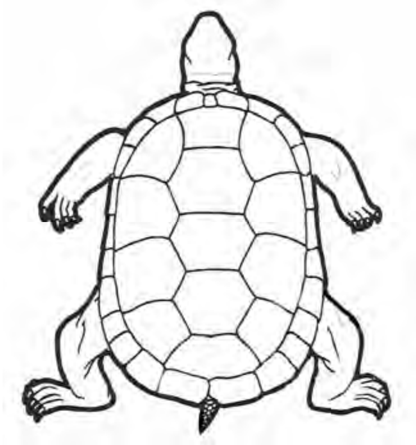
Habitat: *1* (1 = road, 2 = edge of field or forest (within 6m of edge), 3 = field, 4 = pine/hardwood, 5 = stream or stream bank, 6 = open wetland, 7 = forested wetland, 8 = other)

Describe dominant vegetation: *Turtle was found on the road, vegetation on the south side of the road was mixed hardwood-pine, on the north side of road was ditch and soccer field.*

Injuries/Defects/Parasites: *turtle seems to be in respiratory distress because he is blowing bubbles from his nose and is very bloated (or extremely overweight, which seems unlikely unless he has been in captivity somewhere and has been released).*

Indicate Below Any Injuries, Fire Scars, Unusual Scute Patterns or Defects:





Capture method: *1* 1 = Road Capture; 2 = Observed While Mowing; 3 = Visual Search (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle); 6 = Other (give a complete explanation of any method that doesn't fit into the previous categories).

Date and time of release: *released approx. 5 pm same day as capture. Since turtle was heading south, he was released at edge of forest along side the road, with head away from the road*

Was turtle released at point of capture? [✓ *Y*] *N*

If not released at point of capture, please explain: *N/A*

If not released at point of capture, **where** and **how far** from the point of capture was turtle released?

N/A

Comments: *none*

Appendix D

Locality Data Sheet

Instructions for Completing the Locality Data Sheet

Collecting locality data is an important part of box turtle research (Figure 33). You can use a GPS unit or mark turtle locations with flagging tape. These can be used to determine box turtle habitat preferences and spatial ranges. Don't feel disadvantaged if you don't have access to GPS units, aerial photographs, and mapping programs. A hand-drawn or photocopied map marked with location data will work nicely.

Figure 34 illustrates how easily turtle locations can be mapped using only a compass and a tape measure. Each fencepost was given a number. The tape measure was used to measure from turtle #7's location to the two closest fence posts. Using the following 3 pieces of information an accurate map was generated: 1) the number of the fencepost, 2) the distance from the post to the turtle's location, and 3) the compass bearing of the location from the fencepost.

Use a separate Locality Data sheet each time a turtle is discovered or reencountered. Collectively illustrating locations of turtles on maps made at the end of the season or after several years can provide sound scientific evidence of habitat preferences and areas of activity. Examples of sample and completed Locality Data sheets are included on the following pages. If you encounter a turtle that has recently been processed, simply observe the animal quietly since handling is not necessary.

Figure 33. Troy Moore tracks Bart at Bethany Community Middle School. Habitat data are collected at each locality.

Site name – Enter the name of the site where the turtle was found. Examples: Lawrence McCollum Place or Camp Chestnut.

Turtle name and/or ID# – Refer to Chapter 12, *Marking System for Box Turtles*, or enter the turtle's name or number if previously marked.

Date – Enter the date you are collecting data.

Day of week – Enter the day of the week you are collecting data.

Scribe – The scribe is the person doing the writing.

Party leader – Enter the name of the person who is in charge.

Time turtle was located – Note the time this turtle was encountered and indicate whether it was found in the A.M. or P.M.

Total number in party – Enter the total number of people who are present.

Names – Write the names of the individuals who are present.

How was the turtle located? – Indicate the means by which this turtle was found: 1 = Road Capture; 2 = Observed While Mowing; 3 = Visual Search (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle); 6 = Other (give a complete explanation of any method that doesn't fit into the previous categories).

GPS information – If using a hand-held GPS (Global Positioning System) unit, enter the geographic coordinates for Latitude, Longitude (including minutes and seconds) or enter units if using Universal Transverse Mercator (UTM). We prefer UTM because it is secant (tangent to two meridians) and thus reduces overall distortion. An easy to use UTM finder is available on Mike Dorcas' Davidson Herpetology homepage in the lower left corner at <http://www.bio.davidson.edu/people/midorcas/dorcas_home.htm>. GPS information must include the map datum used, such as North American Datum of 1927 (NAD27) or World Geodetic System of 1984 (WGS84). World Geodetic System of 1984 (WGS84) is the default datum for the UTM finder on the Dorcas website.

Turtle's activity – Circle the number with the best description of the turtle's activity: 1 = inactive, in view (perhaps basking or resting); 2 = inactive and covered (buried in leaf litter or mud); 3 = walking; 4 = over-wintering (the turtle is buried or partially beneath the surface during cold weather); 5 = turtle deep in brush (radiotelemetry indicates the turtle is located in a deep thicket or brush, but you can't visually confirm it); 6 = dog capture (unsure of the turtle's original location because it was retrieved by a dog): 7 = other (explain with a brief description).

Was the turtle touched? – Indicate yes or no.

Head – Indicate whether the turtle's head was in (1), out (2), or that you don't know (3), perhaps because it was retrieved by a dog or was buried in brush.

Habitat – Circle the type of habitat in which the turtle was found: 1 = road (the turtle was on the road); 2 = edge (within 6 meters of a habitat boundary such as the edge of a field, forest, or wetland); 3 = field (weedy field with no canopy); 4 = forest (wooded area with canopy); 5 = stream or stream bank; 6 = open wetland (wet area with no canopy); 7 = forested wetland (wet area with canopy): 8 = other.

Dominant vegetation – Enter the type(s) of vegetation that dominates the area where the turtle was discovered such as a multiflora rose thicket, long leaf pine forest, or grassy lawn.

Approximate height of vegetation – Enter the approximate height of dominant vegetation.

Tree canopy above turtle? – Circle yes or no.

Approximate distance from edge in meters – Approximate the distance from the point the turtle was discovered to the edge of the nearest different habitat type such as a forest, field, or wetland.

Soil temperature – The temperature at 1cm below the surface in Celsius as determined with a digital thermometer.

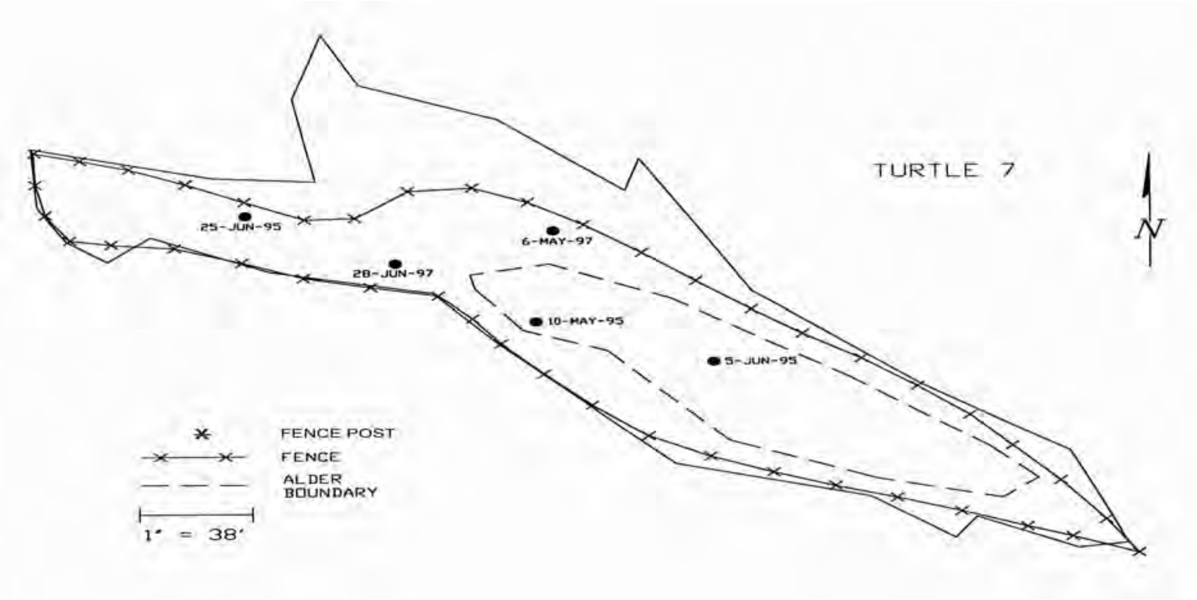


Figure 34. Structures in the habitat can be used to map turtle localities. This map illustrates a bog turtle research site where fenceposts and tree boundaries are used as landmarks to map locations of turtles (Somers, 2000). Hand drawn or computer-generated maps can be used to illustrate box turtle locations. Include different habitat types if possible.

Weather conditions – Briefly describe the weather conditions, such as sunny, cloudy, humid, rainy, or windy.

Relative humidity – Use a hydrometer to determine the humidity at the exact location of the turtle.

Air temperature – Use a digital thermometer to determine the air temperature 2 cm above the surface in Celsius. Use the same thermometer or the same type of thermometer for each recording.

Did it rain within the last 24 hours? – Circle yes or no.

How much rain? – Record number of centimeters or indicate if there was a light sprinkle.

Date and time of release – Record the date and time the turtle was released.

Other observations – List other species you noticed on this visit such as skunks, voles, deer, rabbits, green frogs calling, adult king snake, interesting plants, or substrate conditions. Note any tracks or scat observed.

See back? – Circle yes to indicate that you have additional notes on the backside of the Locality Data sheet.

ABC

(**A**pplications of **B**ox turtles studies in the **C**lassroom)

Create your own interdisciplinary exercises. Use mathematics to obtain distances and location data. In geography, study the different uses of topographic maps. Social studies classes can map historical land use and land cover changes for the turtle research site.

Locality Data Sheet

Sample

Site name: ____________________**Turtle ID**:_____________**Date:**____________**Day of wk:**______

Scribe:____________________**Party leader**:_________________**Time turtle was located:** ______

Total number in party ______________ **Names:**

How was the turtle located? (circle one)1 = Road Capture; 2 = Observed While Mowing;
3 = Visual Search (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle);
6 = Other (give a complete explanation of any method that doesn't fit into the previous categories).

GPS info: UTM Easting Northing **Map datum:**

Turtle's activity: 1 = inactive, in view; 2 = inactive and covered; 3 = walking, 4 = over-wintering;
Unable to determine because: 5 = turtle deep in brush; 6 = dog capture; 7 = other_____________

Was the turtle touched? yes no **Head:** 1 = in 2= out 3 = not known

Habitat: 1 = road; 2 = edge (within 6m of habitat boundary); 3 = field, 4 = forest;

5 = stream or stream bank; 6 = open wetland; 7 = forested wetland; 8 = other

Dominant vegetation: ____

Approximate height of vegetation: _________________**Tree canopy above turtle?** 1 = yes 2 = no

Approximate distance from edge, in meters:____

Soil temperature 1cm below surface (ºC): _____________ **Weather conditions:** _________________
____

Relative humidity at exact location of turtle:__________ **Air temperature** 2 cm above surface (ºC): ____*° C*

Did it rain within the last 24 hours? Y N **How much rain?**

Date and Time of Release:__________________**Was turtle released at point of capture?** *Y N*

If not released at point of capture, please explain why:_______________________________________
____

If not released at point of capture, **where** and **how far** from the point of capture was turtle released?
____

Other observations (butterflies, toads, lizards, snakes, mammals, interesting plants, substrate conditions, anything):

See back of sheet? Y or N

Locality Data Sheet

Completed Sample

Site: *Somers Berry Farm* **Turtle ID**: *ABX "Eve"* **Date:** *12 May 2004* **Day of wk:** *Wed.*

Scribe: *Corrie Tetterton "CT"* **Party leader**: *John Rucker "JR"* **Time turtle located:** *10:10 am*

Total number in party: 6 **Names:** *JR, CT, Hannah Epperson, Dalton Lathan, Dale Moore, Troy Moore*

How was the turtle located(circle one): 1 = Road Capture; 2 = Observed While Mowing; [✓ 3 = Visual Search] (you found the turtle by looking); 4 = Radio Signal; 5 = Dog (a dog located the turtle); 6 = Other (give a complete explanation of any method that doesn't fit into the previous categories.

GPS info: *UTM Easting: 601787, Northing: 4024142* **Map datum:** *NAD 27*

Turtle's activity: [✓ 1 = inactive, in view]; 2 = inactive and covered; 3 = walking: 4 = over-wintering;

Unable to determine because: 5 = turtle deep in brush; 6 = dog capture; 7 = other _____

Was the turtle touched? [✓ T = yes] F = no **Head (circle one):** 1 = in [✓ 2= out] 3 = not known

Habitat: 1 = road; [✓ 2 = edge] (within 6m of habitat boundary); 3 = field, 4 = forest;

5 = stream or stream bank; 6 = open wetland; 7 = forested wetland; 8 = other

Dominant vegetation: *Poison ivy, just inside woods of young hardwoods*

Approximate height of vegetation: *full canopy* **Tree canopy above turtle?** [✓ 1 = yes] 2 = no

Approximate distance from edge, in meters: *3 meters*

Soil temperature 1cm below surface (ºC): *20.6 ° C* **Weather conditions:** *cloudy, slight rain*

Relative humidity at exact location of turtle: *89%* **Air temperature** 2 cm above surface (ºC): *21.4 ° C*

Did it rain within the last 24 hours? [✓ Y] N **How much rain?** *About 1 cm in gauge*

Date and Time of Release: *12:20 pm* **Was turtle released at point of capture?** [✓ *Y*] *N*

If not released at point of capture, please explain why: *N/A*

If not released at point of capture, **where** and **how far** from the point of capture was turtle released?

Other observations (butterflies, toads, lizards, snakes, mammals, interesting plants, substrate conditions, anything!): *one adult eastern king snake and calling bullfrogs*

See back of sheet? Y or [✓ N]

Appendix E

Turtle Census Data Sheet

Instructions for Completing the Turtle Census Data Sheet

A separate Box Turtle Census Data sheet should be used for each census. Each turtle discovered will be recorded on that census' sheet. A blank sample and a completed sample of the Box Turtle Census Data Sheet are included on the following pages. Design your own data sheet to fit your study. All turtles should be released at the point of capture after data are collected.

Turtle Plot # – Enter the number assigned to the plot where you are conducting the census.

Date – Enter the date you are conducting the census.

Searchers – Enter the names of all persons participating in the census, if possible. If not, enter the number of participants.

Start – Enter the time you actually begin the census.

Finish – Enter the time you finish the census.

Temp – Enter the temperature (note Fahrenheit or Celsius) when you begin the census.

Wind – Enter the wind speed at the time you begin the census, using the appropriate code from the table below.

0 - Calm (smoke rises vertically, <1 mph)
1 - Light air (smoke drifts, 1-3 mph)
2 - Light breeze (feel wind on face, leaves rustle, 4-7 mph)
3 - Gentle breeze (leaves and small twigs in constant motion, 8-12 mph)
4 - Moderate breeze (blows dust and loose paper, 13-18 mph)
5 - Fresh breeze (trees swaying, >18 mph)

Sky/Weather – Enter the prevailing sky cover and weather conditions at the time you begin the census, using the appropriate code from the table below.

0 - Clear or few clouds
1 - Partly cloudy (scattered or variable)
2 - Cloudy (broken) or overcast
3- Fog or smoke
4 - Dry
5 - Drizzle or light rain
6 - Rain

Turtles Found – Enter the appropriate data on each turtle found during the census. Record the notches on the marginals and look up the identification code later, or just use the code. A number, corresponding to the line number for each turtle's entry, should be placed on the map, in the location where the turtle was found.

Search Technique

The four corners of your census plot should be marked in some way; three foot tall PVC or metal pipes or wooden stakes, in combination with plastic flagging work well. It is helpful to mark intermediate points around the perimeter and inside the plot at 25m or 50m intervals. This aids searchers in staying on line and making sure the whole plot is thoroughly covered. It may be useful to provide searchers with maps of the plot and magnetic compasses. Binoculars might also come in handy.

Searchers spread out along one side of the plot. At the signal to start, they move into and slowly through the plot, staying roughly abreast and heading toward the opposite side; e.g. east to west, north to south.

Searchers follow a generally straight course through the plot, but wander back and forth of the center line of their direction of travel. Each searcher should overlap slightly with the person on the right and left. In this manner, the group is more likely to cover the whole plot.

Searchers should stop periodically and scan the ground all around them, including to the rear. Carefully check in thickets, under shrubs, around the base of larger trees, inside tree hollows at ground level, in vernal pools, and alongside fallen logs and branches.

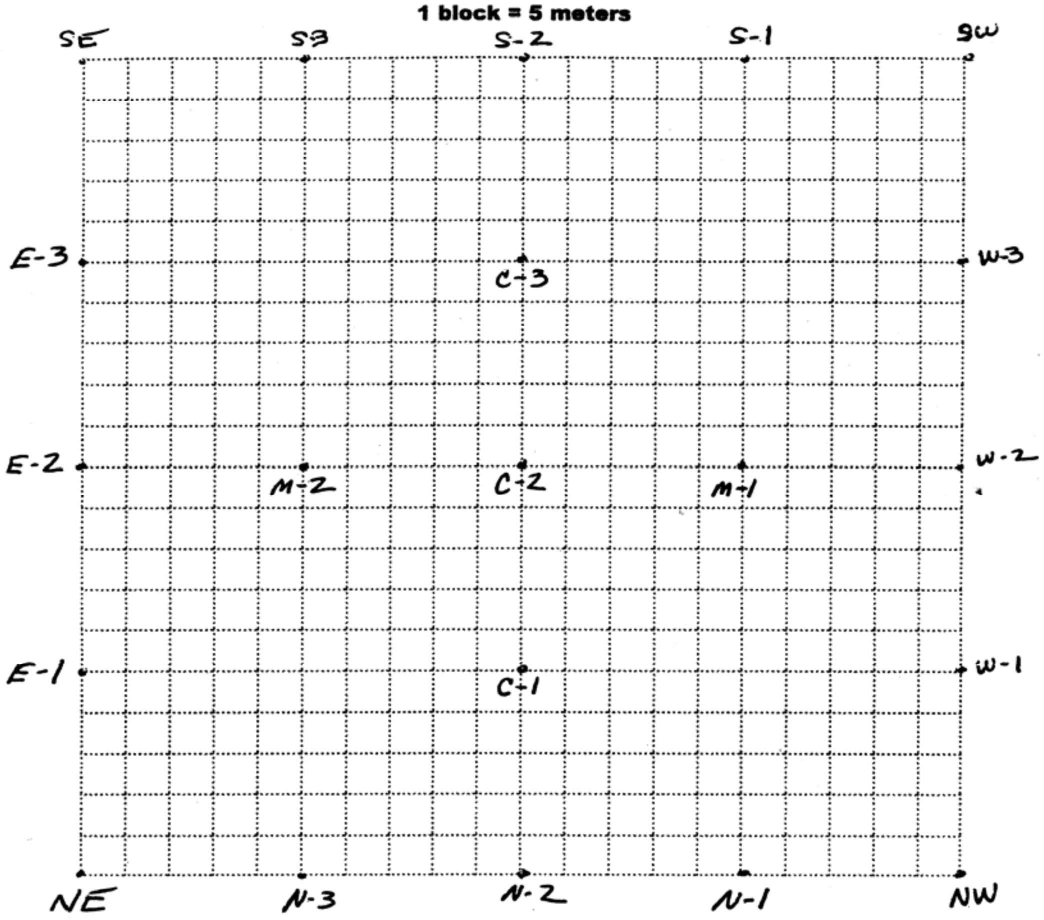
One person should be designated as the recorder. It helps if this person is very familiar with the census plot, as he or she will be the one plotting the location of each turtle found on the map. This person can also be searching for turtles, but is best positioned in the center of the line of searchers.

When a turtle is discovered, the person finding it shouts out “turtle” and remains in place, waiting for the recorder. After desired data is collected and the location plotted, the turtle is released at the site of capture.

Usually, a thorough census conducted by four to six people, in moderate terrain and vegetation, will take 45 minutes to one hour.

Turtle Census Data Sheet

Sample



TURTLE PLOT # ____________________

DATE____________________ **SEARCHERS**____________________

START__________ **FINISH**__________ ____________________

TEMP__________**WIND**__________ ____________________

SKY/WEATHER____________________ ____________________

TURTLES FOUND (notches on marginals, gender)

1. ____________________ **5.**____________________

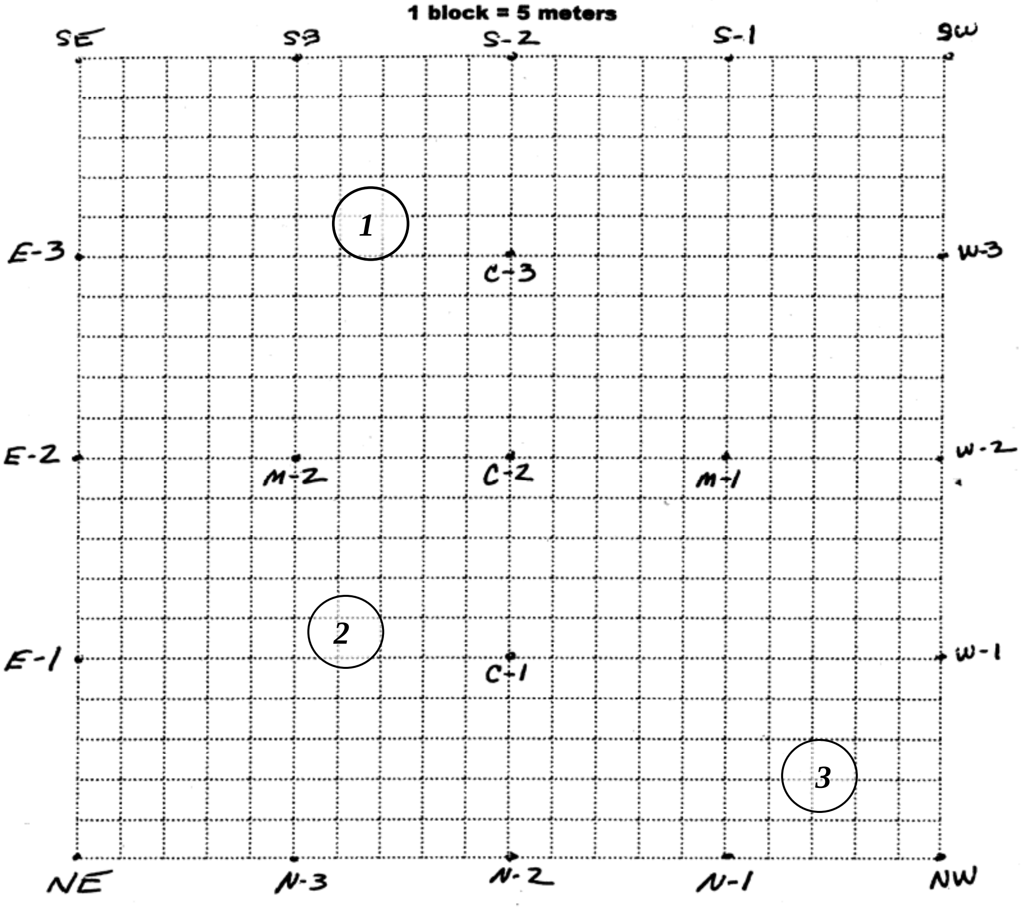
2. ____________________ **6.**____________________

3. ____________________ **7.**____________________

4. ____________________ **8.**____________________

Turtle Census Data Sheet

Completed Sample



TURTLE PLOT # *2 — Forest Trail*

DATE *24 July 2005*

SEARCHERS *Chris Swarth, Mike Quinlan, Joe Sage, Crista Kapps, Elaine Friehele*

START *1:00 p* **FINISH** *1:50 p*

TEMP *25° C* **WIND** *0 = calm*

SKY/WEATHER *0 = clear*

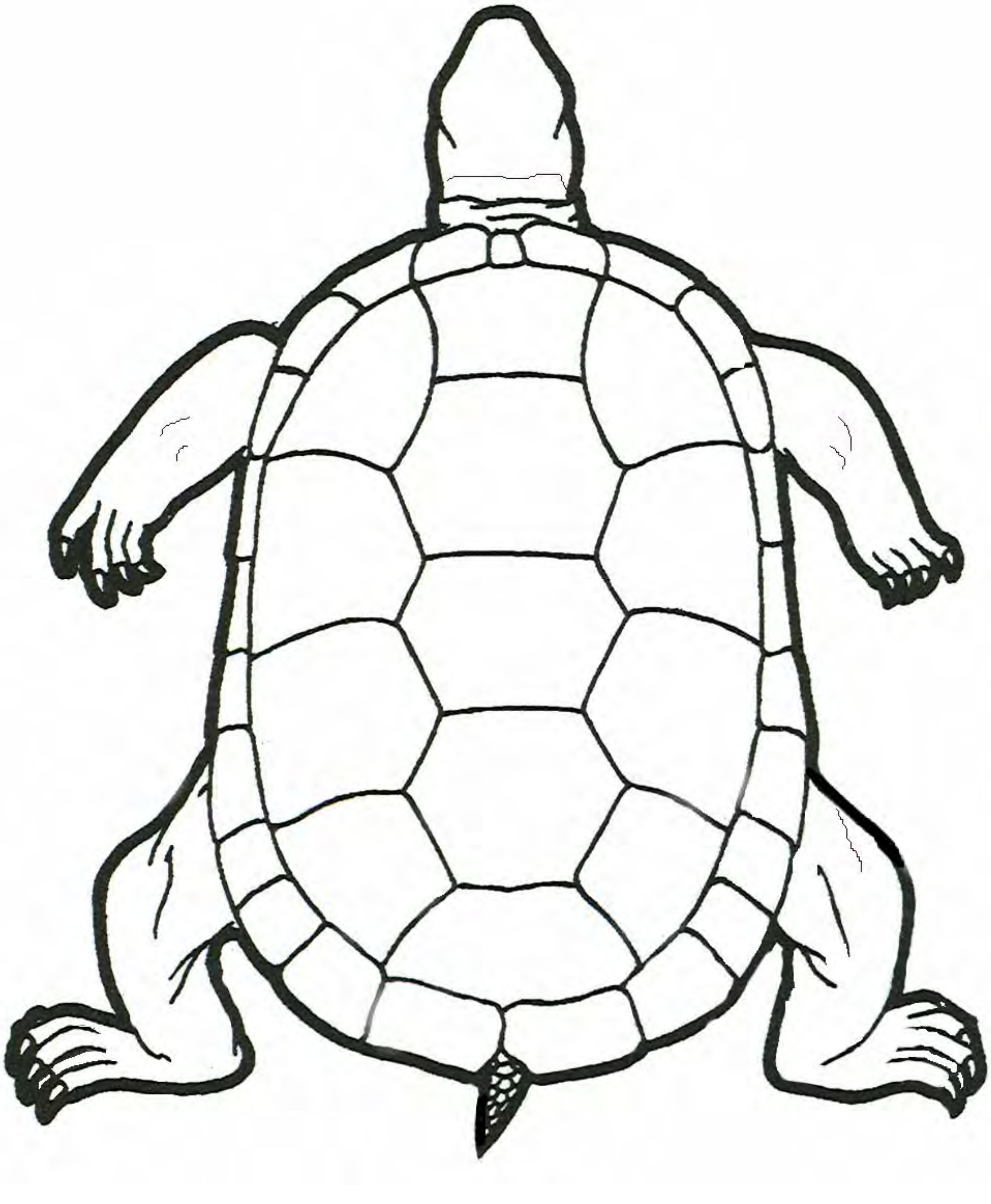
TURTLE (notches on marginals) / gender

1. *BKO (R 2, R 11, L 10) / ♀*
2. *New / ♂*
3. *JNV (R 10, L 11, L 3) / ♂*
4.
5.
6.
7.
8.

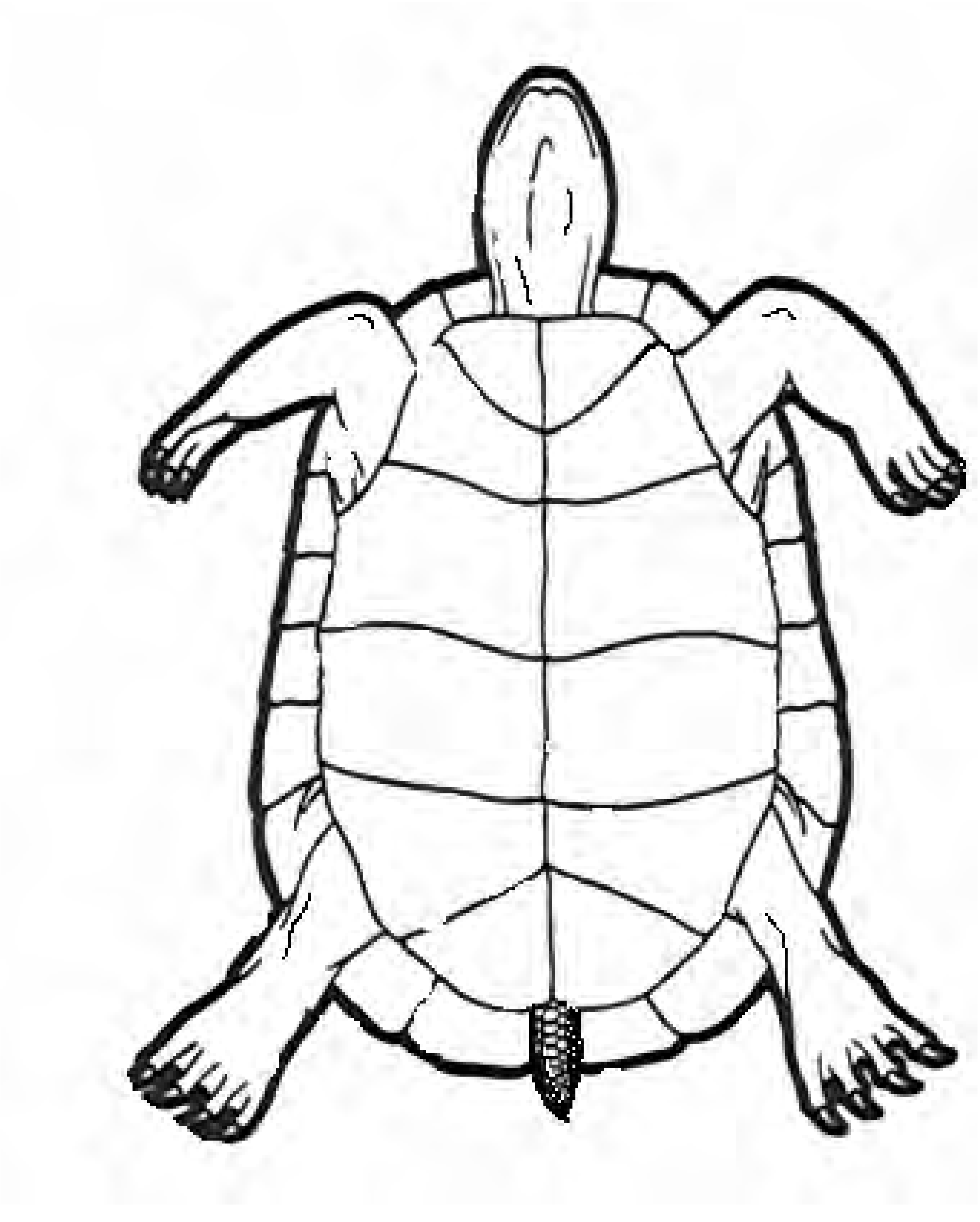
Appendix F

Diagrams and Handouts

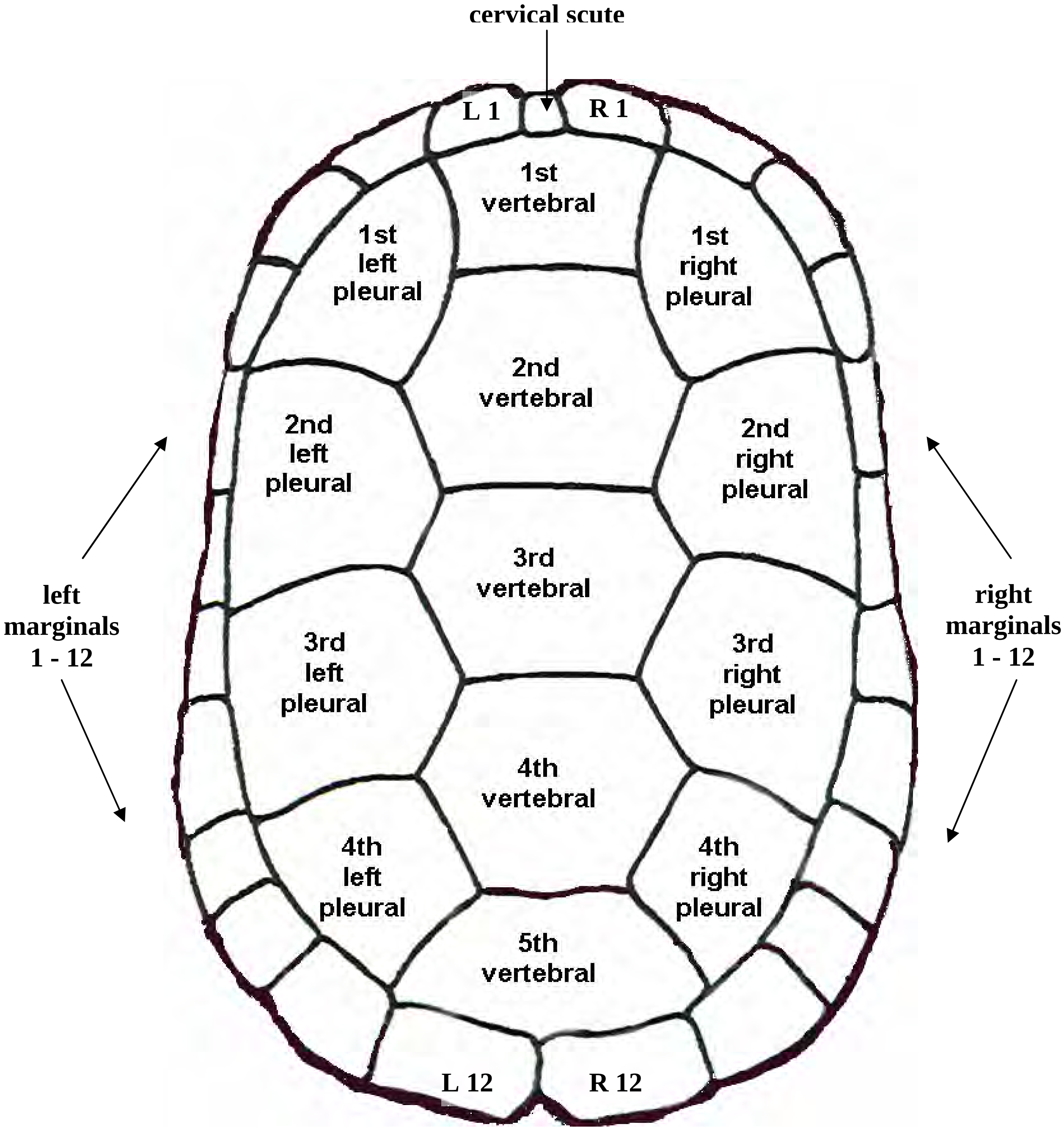
Turtle from Dorsal Aspect



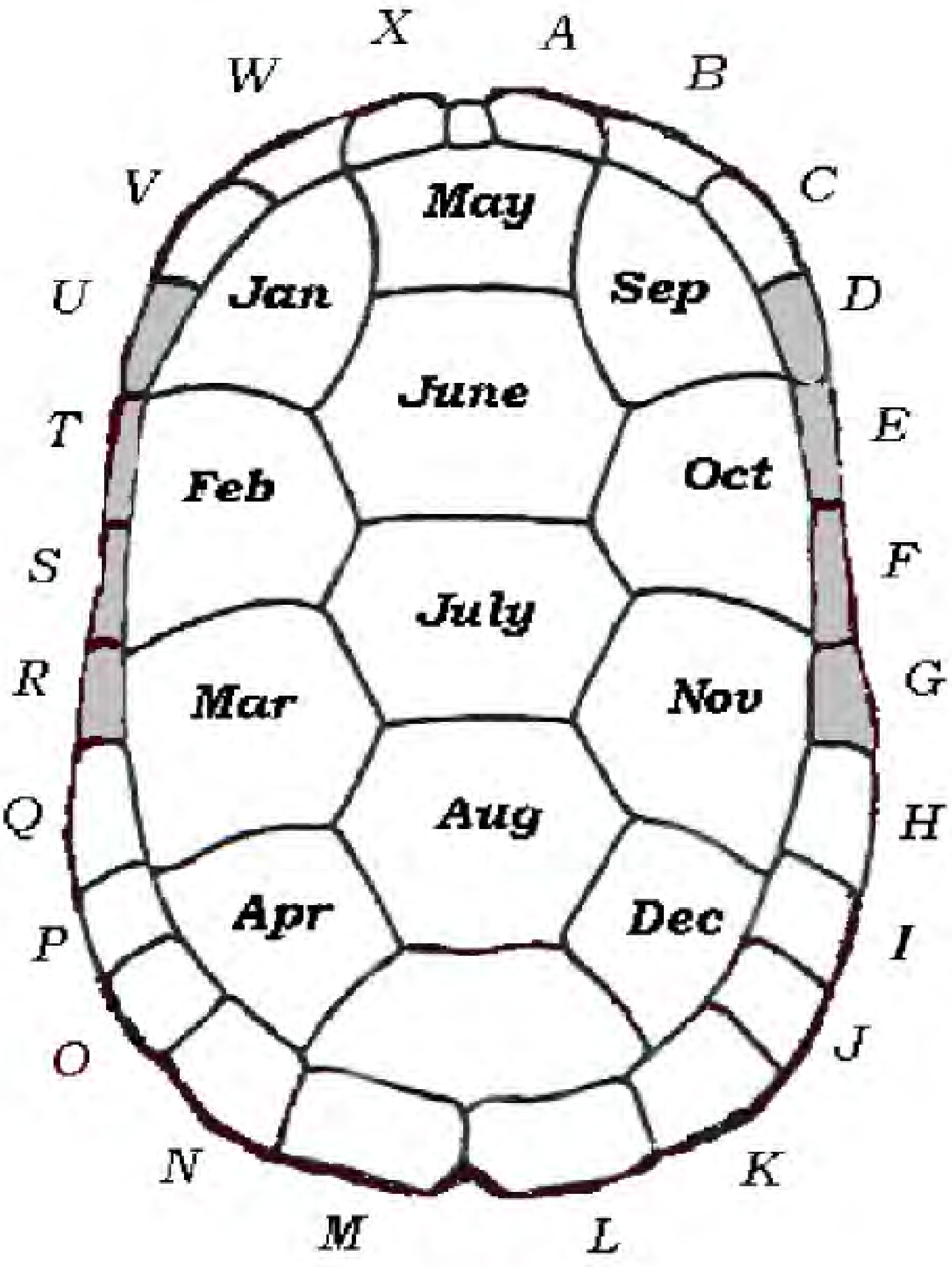
Turtle from Ventral Aspect



Names of Carapace Scutes



Carapace Labeled for Identification Codes



Turtle Identification Codes*

Complied by Davidson College Herpetology Students

ABC	AHN	AKO	AOW	BHL
ABH	AHO	AKP	AOX	BHM
ABI	AHP	AKQ		BHN
ABJ	AHQ	AKV	APQ	BHO
ABR	AHV	AKW	APV	BHP
ABL	AHW	AKX	APW	BHQ
ABM	AHX		APX	BHV
ABN		ALM		BHW
ABO	AIJ	ALN	AQV	BHX
ABP	AIK	ALO	AQW	
ABQ	AIL	ALP	AQX	BIJ
ABV	AIM	ALQ		BIK
ABW	AIN	ALV	AVW	BIL
ABX	AIO	ALW	AVX	BIM
	AIP	ALX		BIN
ACH	AIQ		AWX	BIO
ACI	AIV	AMN		BIP
ACJ	AIW	AMO	BCH	BIQ
ACK	AIX	AMP	BCI	BIV
ACL		AMQ	BCJ	BIW
ACM	AJK	AMV	BCK	BIX
ACN	AJL	AMW	BCL	
ACO	AJM	AMX	BCM	BJK
ACP	AJN		BCN	BJL
ACQ	AJO	ANO	BCO	BJM
ACV	AJP	ANP	BCP	BJN
ACW	AJQ	ANQ	BCQ	BJO
ACX	AJV	ANV	BCV	BJP
	AJW	ANW	BCW	BJQ
AHI	AJX	ANX	BCX	BJV
AHJ				BJW
AHK	AKL	AOP	BHI	BJX
AHL	AKM	AOQ	BHJ	
AHM	AKN	AOV	BHK	

** Cross off codes once they are used to avoid duplications. Put date used in space beside code.*

Turtle Identification Codes Continued

Cross off codes once they are used to avoid duplications. Put date used in space beside code.

BKL	BOP	CIJ	CLM	CQV
BKM	BOQ	CIK	CLN	CQW
BKN	BOV	CIL	CLO	CQX
BKO	BOW	CIM	CLP	
BKP	BOX	CIN	CLQ	CVW
BKQ		CIO	CLV	CVX
BKV	BPQ	CIP	CLW	
BKW	BPV	CIQ	CLX	CWX
BKX	BPW	CIV		
	BPX	CIW	CMN	HIJ
BLM		CIX	CMO	HIK
BLN	BQV		CMP	HIL
BLO	BQW	CJK	CMQ	HIM
BLP	BQX	CJL	CMV	HIN
BLQ		CJM	CMW	HIO
BLV	BVW	CJN	CMX	HIP
BLW	BVX	CJO		HIQ
BLX		CJP	CNO	HIV
	BWX	CJQ	CNP	HIW
BMN		CJV	CNQ	HIX
BMO	CHI	CJW	CNV	
BMP	CHJ	CJX	CNW	HJK
BMQ	CHK		CNX	HJL
BMV	CHL	CKL		HJM
BMW	CHM	CKM	COP	HJN
BMX	CHN	CKN	COQ	HJO
	CHO	CKO	COV	HJP
BNO	CHP	CKP	COW	HJQ
BNP	CHQ	CKQ	COX	HJV
BNQ	CHV	CKV		HJW
BNV	CHW	CKW	CPQ	HJX
BNW	CHX	CKX	CPV	
BNX			CPW	HKL
			CPX	HKM

Turtle Identification Codes Continued

Cross off codes once they are used to avoid duplications. Put date used in space beside code.

HKN	HOV	IKV	IPQ	JMO
HKO	HOW	IKW	IPV	JMP
HKP	HOX	IKX	IPW	JMQ
HKQ			IPX	JMV
HKV	HPQ	ILM		JMW
HKW	HPV	ILN	IQV	JMX
HKX	HPW	ILO	IQW	
	HPX	ILP	IQX	JNO
HLM		ILQ		JNP
HLN	HQV	ILV	IVW	JNQ
HLO	HQW	ILW	IVX	JNV
HLP	HQX	ILX		JNW
HLQ			IWX	JNX
HLV	HVW	IMN		
HLW	HVX	IMO	JKL	JOP
HLX		IMP	JKM	JOQ
	HWX	IMQ	JKN	JOV
HMN		IMV	JKO	JOW
HMO	IJK	IMW	JKP	JOX
HMP	IJL	IMX	JKQ	
HMQ	IJM		JKV	JPQ
HMV	IJO	INO	JKW	JPV
HMW	IJP	INP	JKX	JPW
HMX	IJQ	INQ		JPX
	IJV	INV	JLM	
HNO	IJW	INW	JLN	JQV
HNP	IJX	INX	JLO	JQW
HNQ			JLP	JQX
HNV	IKL	IOP	JLQ	
HNW	IKM	IOQ	JLV	JVW
HNX	IKN	IOV	JLW	JVX
	IKO	IOW	JLX	
HOP	IKP	IOX		JWX
HOQ	IKQ		JMN	

Turtle Identification Codes Continued

Cross off codes once they are used to avoid duplications. Put date used in space beside code.

KLM		LPX	MWX	PQV
KLN	KQV	LQV		
KLO	KQW	LQW	NOP	PQW
KLP	KQX	LQX	NOQ	PQX
KLQ			NOV	
KLV	KVW	LVW	NOW	PVW
KLW	KVX	LVX	NOX	PVX
KLX				
	KWX	LWX	NPQ	PWX
KMN			NPV	
KMO	LMN	MNO	NPW	QVW
KMP	LMO	MNP	NPX	QVX
KMQ	LMP	MNQ		
KMV	LMQ	MNV	NQV	QWX
KMW	LMV	MNW	NQW	
KMX	LMW	MNX	NQX	VWX
	LMX			
KNO		MOP	NVW	
KNP	LNO	MOQ	NVX	
KNQ	LNP	MOV		
KNV	LNQ	MOW	NWX	
KNW	LNV	MOX		
KNX	LNW		OPQ	
	LNX	MPQ	OPV	
KOP		MPV	OPW	
KOQ	LOP	MPW	OPX	
KOV	LOQ	MPX		
KOW	LOV		OQV	
	LOW	MQV	OQW	
KOX		MQW	OQX	
	LOX	MQX		
KPQ			OVW	
KPV	LPQ	MVW	OVX	
KPW	LPV	MVX		
KPX	LPW		OWX	

Student Permission Form

Sample

Bethany Community Middle School Science Project
Student Permission

*Eastern box turtle (*Terrapene carolina*) populations are in decline due to habitat loss and road kill as well as pet trade demands. It is the belief of many respected scientists and conservation biologists that continued pressures on this species will be detrimental to their survival, given their particular biological characteristics.*

This project will enable Bethany Community Middle School students to collect data as part of a school project that will educate them on field techniques, box turtle biology, and habitat threats. Size, age, gender, and habitat preference data will be collected on the turtles. Some turtles may be followed using radio-tracking devices.

A known risk, although small to researchers and students, is the transmission of Salmonella*. Many reptiles show no symptoms, but are carriers of* Salmonella*. Transmission of* Salmonella *to humans can cause serious health problems resulting in infections, enteritis (diarrhea), septicemia (infection in the blood), abortion, and a combination of other syndromes (medical problems). The most common route of infection is through the mouth, but infection can also occur through open cuts or sores on the skin.*

Students will be instructed on methods to avoid pathogens including the following:

- Wash hands thoroughly with an antibacterial soap and warm water after handling any reptile. Disinfectant hand wipes, lotions or sprays are available and will be carried whenever reptiles are handled in the field.
- Do not put your hands near your face until you have disinfected them (i.e. don't wipe your mouth, rub your eyes, or ingest food or water until you have washed your hands).
- Non-latex gloves should be used when handling turtles and be properly disposed of after each encounter with a turtle.

Students participating in this project will do so at their own risk, and parents agree to hold harmless Bethany Community Middle School and the University of North Carolina at Greensboro as well as all persons acting as the School or University's officers, employees, or agents from tort liability for bodily injury, property damage, and death consequent to claims of negligence arising from participation in the activities described above.

My signature below indicates that I have read and agree to the terms and conditions of allowing my child, _________________________________ (PRINT your child's name here), to participate in a box turtle study at Bethany Community Middle School. Furthermore, I agree to hold harmless Bethany Community Middle School and the University of North Carolina at Greensboro as well as all persons acting as the School or University's officers, employees, or agents from tort liability for bodily injury, property damage, and death consequent to claims of negligence arising from participation in the activities described above.

_____________________________________ ___________________

Parent or Guardian's Signature Date

Appendix G

Additional Resources

Eastern Box Turtles: Disappearing Gems of the Forest *by Sandra Barnett*. Power Point Presentation on CD. Copyright Mid-Atlantic Turtle and Tortoise Society, 2006.

These superbly researched and illustrated presentations should be included in any program of study involving box turtles. The CD includes two slide show presentations about the eastern box turtle, *Terrapene carolina carolina.* The presentations begin with a description of the species and its distribution, then take the audience through a year in the life of these fascinating little turtles. The presentations also discuss natural predators of box turtles, and the reasons why these turtles, which have successfully inhabited North America for millions of years, are now disappearing from our forests. The slide shows end with a host of suggestions as to what people of all ages can do to help save this animal.

One presentation is aimed at a middle school audience (grades 6 though 8) and runs about 25 minutes. The other is for a general audience, ranging from high school age on up and runs about 35 minutes. Included with each presentation is a script that can be printed and is meant to be read aloud by a teacher as the images are shown. To obtain a copy, send your snail mail address, email address, and $2.00 per copy to Sandy Barnett, 335 Stafford Drive, Baltimore, MD 21228.

Davidson Herpetology, Partners in Amphibian and Reptile Conservation (PARC), Central Carolina Reptile and Amphibian Initiative (CCAR),* and *Amphibians and Reptiles of North Carolina can be found on these excellent websites:

1.) http://www.bio.davidson.edu/people/midorcas/dorcas_home.htm;
2.) http://www.parcplace.org/PARCregions/Southeast/CCARI.htm;
3.) http://www.ccari.org/; and
4.) http://www.herpsofnc.org/

Dr. Mike Dorcas, Biology faculty member at Davidson College, is web master for all of these websites. The last site contains an online snake ID section and a segment on herps for kids, including adventures with Bobby the Biologist such as “Bobby the Biologist loves the Drift Fence.” Kids actually follow a drift fence and check the buckets to see what organisms they’ve captured. Guess what’s in one bucket? A box turtle! These sites include great information with frequent additions and modifications by Dr. Dorcas and his students.

Looking at Our Environment*:* If you are located in an urban area and feel like you are unable to conduct fieldwork, or if you are looking for other case studies, the *Looking at our Environment* project offers an excellent case study of the gopher tortoise in Florida. You can access materials to teach this case study at <http://www.late.worldwatcher.org>.

With the Grain: A website at http://www.wtgrain.org, *With the Grain* is dedicated to educating people about their effect on the environment, and motivating them to make informed, responsible decisions. The website focuses on conservation issues, specifically documenting significant populations of the Eastern box turtle and offering techniques for effective stewardship of this species. In a section called *Habitat from Humanity* (http://www.wtgrain.org/w1turtle.htm), editor Gary Stock offers practical steps to support the habitat requirements of the Eastern box turtle.

***A Working Guide to the Literature on Box Turtles (Terrapene*)**: Covers life history, evolution, fossil record, external morphology, and conservation. Compiled by Ken Dodd. If you want to create a rigorous, scientific study suitable for advanced students, or simply want to learn more, this is an excellent source to find literature and scientific papers written about box turtles. <http://cars.er.usgs.gov/Center_Publications/box_turtle_bib1/box_turtle_bib1.html>.

Partners in Amphibian and Reptile Conservation (PARC): An extensive web site at <http://www.parcplace.org/> has information on herpetology jobs, educational information ("learn about reptiles and amphibians"), an on-line herpetology art show, information on herpetology-related grant programs, plus a list of recommended books and other educational products and papers. Information on SPARC, Student Partners in Amphibian and Reptile Conservation, is also available on the web site The site includes references to box turtles including an eastern box turtle fact sheet and a story for children called *A Turtle Tale and Teacher's Guide*. There is also a link to a box turtle bibliography at
<http://www.fcsc.usgs.gov/Center_Publications/box_turtle_bib1/box_turtle_bib1.html>.

Society for the Study of Amphibians and Reptiles (SSAR): The world's largest international herpetological organization promotes research, conservation, and education for amphibians and reptiles. This is a great source for international publications, an extensive list of available grants, the journal *Herpetological Review*, and other SSAR publications that often include research topics pertaining to box turtles. Look for more information at <http://www.ssarherps.org/>.

A few of the many good turtle books

DeSpain, P. 1994. *Eleven Turtle Tales*. Little Rock, AK: August House. 106 pp.

De Vosjoli, P. and R. Klingenberg. 1995. *The Box Turtle Manual*. Lakeside, CA: Advanced Vivarium Systems. 102 pp.

Dodd, C. K., Jr. 2001. *North American Box Turtles, A Natural History*. Norman, OK: University of Oklahoma Press. 256 pp.

George, W. 1989. *Box Turtle at Long Pond*. New York City, NY: Greenwillow Books. 32 p.

Korman, S. 2000. *Box Turtle at Silver Pond Lane*. Norwalk, CT: Soundprints and the Smithsonian Institution. 32 pp.

Matthews, C.E., and A.B. Somers. 2005. Using the Environment as a Context for Integrating the Middle School Curriculum. Pp.149-166 in Etim, J.S. (ed.), *Curriculum Integration K-12*. Latham, MD: University Press of America, Inc.

Palika, L. 2001. *Turtles and Tortoises for Dummies*. New York City, NY: Hungry Minds, Inc. 312 pp.

Palmer, W.M., and A.L. Braswell. 1995. *Reptiles of North Carolina*. Chapel Hill, NC: The University of North Carolina Press. 412 pp.

Patterson, J. 1994. *The Guide to Owning a Box Turtle*. Neptune City, NJ: T. F. H. Publications. 64 pp.

Schneider, R., M. Krasny and S. Morreale. 2001. *Hands on Herpetology*. Arlington, VA: NSTA Press. 146 pp.

Wilke, H., G. Jankovics, and U. Anders. 2000. *Tortoises and Box Turtles: A Complete Owner's Manual*. Hauppauge, NY: Barron's Educational Series. 64 pp.

Appendix H

Contacts

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Michael E. Dorcas	Davidson College Department of Biology Davidson, NC 28035 www.bio.davidson.edu/Dorcas	704.894.2727 Office 704.894.2512 FAX midorcas@davidson.edu
Sarah Seymour	Bethany Community Middle School 181 Bethany Road Reidsville, NC 27320	336.951.2500
Chris Swarth Mike Quinlan	Jug Bay Wetlands Sanctuary 1361 Wrighton Rd. Lothian, MD 20711	410.741.9330 jugbay@toad.net
Radiotelemetry Equipment	Holohil Systems, Ltd 112 John Cavanagh Road Carp, Ontario, Canada KOA 1LO http://www.holohil.com	613.839.0676 info@holohil.com
	AVM Instrument Company LTD 2356 Research Drive Livermore, California 94550 USA http://cccweb.com/avm	510.449.2286 510.449.3980 AVMTELEM@ix.netcom.com

Appendix I

Glossary

abiotic – Non-living factors in an environment such as soil type and temperature.

annuli – Growth rings found on scutes located on the plastron and carapace of many species of turtles, including box turtles.

anthropogenic – Of or caused by humankind.

AOR – Alive on the road.

Appendix II – A list generated by Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) of species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. International trade in specimens of Appendix II species may be authorized by the granting of an export permit or re-export certificate; no import permit is necessary. (See Article IV of the Convention). *From CITES webpage* <http://www.cites.org/eng/append/index.shtml>.

biosphere – All the areas on the planet combined that contain living forms. This extends from the deepest parts of the oceans to the upper parts of the atmosphere where insects, birds, or bacteria can be found.

bridge – The bony connection between the carapace and the plastron.

caliper – An instrument with two adjustable arms (jaws) used to measure diameter or thickness.

canopy – The “roof” or top layer of the forest formed by the highest reaching branches.

carapace – The upper shell of a turtle or tortoise.

cartography – The art or technique of making maps or charts.

cervical – Of the neck. The scute overlying the nuchal bone is called the cervical scute.

chelonian – A collective term pertaining to turtles. Refers to the classification of turtle in the Order Chelonia.

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) – An international agreement between sovereign governments. Its purpose is to ensure that international trade in wild animals and plants does not threaten their survival.

cold-blooded – Outdated term used to describe species with body temperatures that reflect temperatures of the environment. Since the environment is not always “cold”, neither is the body temperature of such creatures. Today we understand there are a variety of mechanisms for an animal to control its body temperature. The term “cold-blooded” has fallen out of favor with scientists, and the term ectotherm is preferred.

costal – Refers to the bones of a turtle’s carapace that cover the ribs.

cloaca –A chamber into which an animal’s digestive, urinary and reproductive systems empty. The anus is the external opening of the cloaca.

clutch – The group of eggs produced at one time by a single female.

DOR – Dead on the road.

dorsal – Of, near, on, or toward the back of an organism.

drainage – The specific region of land drained into a river or other body of water. A watershed.

ectotherm – A “cold-blooded” animal, having a body temperature that is largely determined by the temperature of the environment. Most reptiles are ectotherms. Also see “cold-blooded” above.

endangered species – A species of animal or plant in danger of becoming extinct.

estivation *also* **aestivation –** A period of inactivity, usually during the summer, in response to very hot or dry conditions.

extinct – No longer in existence; having no living descendant.

extirpated – Extinct within a region.

fecundity – The total number of eggs produced by a female.

form – A depression in the ground that a turtle makes for rest and camouflage.

GPS – Global positioning system.

gravid – A female animal carrying eggs or embryos.

hatchling – A recently hatched turtle.

herps – Reptiles and amphibians; the animals studied by herpetologists.

hibernacula – An overwintering place used by hibernating animals.

hibernation – A type of cold-weather dormancy when normal rates of metabolic activity are depressed and need for food and water decreased. Also called overwintering.

homologous – Similarity resulting from common ancestry. Body parts are homologous if they have the same basic structure, the same relationship to other body parts, and develop in a similar manner in the embryo.

human encroachment – The expansion of human activity which intrudes into the natural habitats and communities of other species.

hydrology – The study and/or the behavior of water including precipitation, evaporation, and volume.

indigenous – A species that naturally occurs within a region; native.

morphology – The size and shape of a structure.

morphometric – Measurable structural characters.

neonate – A newborn in the first few months.

non-indigenous – A non-native species. A species in an area that it does not naturally inhabit.

nuchal – Of the neck. In turtles, it refers to the bone of the carapace overlying the neck.

overexploitation – Includes non-sustainable commercial, sport, and subsistence hunting as well as live animal capture for any purpose.

palpate – To examine by touching or feeling.

plastron – The bottom part of the shell on the underside of a turtle.

pleural scute – Scute overlying costal bone on the carapace of a turtle.

posterior – Pertaining to the rear or back part.

salmonella – Rod-shaped bacteria of the genus *Salmonella* that may be pathogenic (can cause food poisoning and other diseases in humans) and can be transmitted by reptiles.

scutes – The plates or scales that cover the bones of the turtle’s shell.

sedges – Grass-like plants with edges on the blades, usually found on wet ground or in water.

topography –Surface features, relative positions and elevations of land areas.

transpiration – The evaporative loss of water from a plant.

UTM – Universal Transverse Mercator Geographic Coordinate System used in mapping. Many topographic maps published in recent years use UTM coordinate system as the primary grids on the map. For more information see the USGS webpage <http://erg.usgs.gov/isb/pubs/factsheets/fs07701.html>.

vascular – Containing blood vessels or ducts for carrying lymph.

ventral – The underside or the lower surface; the belly not the back.