



The HERP Project, Herpetology Education in Rural Places and Spaces  
**In Awe of Nature: Celebrating Snakes**



Written by Ann Somers, Catherine Matthews, Lacey Huffling, and Courtney Anderson



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The Herp Project is supported by the National Science Foundation, Grant No. DRL-1114558. Any opinions, findings, and conclusions or recommendations expressed in this manuscript are those of the authors and do not necessarily reflect the views of the National Science Foundation.

## Celebrating Snakes

Before starting a project similar to the one described in this curriculum, contact your state wildlife resources commission or state division of fish and game to see what kinds of permits you need to work with snakes.

### I. Project Description

This curriculum describes the Snakes Project developed by The HERP (Herpetology Education in Rural Places and Spaces) Project for the Herpetological Research Experience (HRE) program. These guidelines offer ideas to formal and informal science educators for running educational program on snakes.

Our investigations last about 3.5 hours, involve 5-7 participants, and are led by a Project Leader and an assistant. The first hour is spent outdoors, walking the local fields and woods, checking under logs, debris, and **coverboards**. While walking, everyone takes a turn telling stories from their own lives involving snakes. Using the inquiry method of investigation, the Project Leader promotes discussion about eco-regions, ecology, and the importance of predators. The remaining time is spent indoors in a large room where we examine live snakes and discuss anatomy, biology, identification, and behavior. Our goals are to have students learn about and appreciate snakes and, most importantly, develop empathy for snakes.

Because our intent is to help participants learn about their own environments and local fauna, our Snakes Project depends heavily on the use of wild animals captured and held for the duration of the HRE and then released at the point of capture. Captive bred or pet store snakes can be used, but should never be released into the wild. For more information on why captive bred or purchased snakes should never be released into the wild, consult the PARC (Partners in Amphibian and Reptile Conservation) pamphlet called "[Don't Turn It Loose](#)," available free online.

### II. Philosophical Teaching Points

Frequently, even in informal settings, educators rely on lecturing to educate students. It seems to work, so why not? An alternative is to ask questions rather than just telling students facts which is known as the inquiry method of teaching. Student centered investigations, where students respond to posed questions and have their responses taken seriously, are a much more powerful way to engage students in learning the concepts. Hands-on learning coupled with the inquiry-based

learning ignites curiosity and enhances student interest in the material. Project Leaders become facilitators, guides, and learning partners rather than lecturers. We offer examples of open-ended questions that are useful for this kind of teaching.

When introducing students to material on snakes, it is reasonable to expect that many of them will be uninformed about the importance and value of snakes. The leader may point out that we don't know how many total species exist in the world. The number is thought to be around 10 million species but could be many times that. This means there are quadrillions of ecological interactions every day. It takes all of these to make life as we know it possible. We don't take a breath without the workings of the natural world—so we should honor, respect, and appreciate all forms of life, including snakes, and their roles in the great community of existence. It is a mistake for us to think we can pick and choose which species deserve to live and which should be eliminated. In the words of the great thinker Aldo Leopold (1938),

The last word in ignorance is the man who says of an animal or plant: "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering. (p. 146-147)

### III. Learning Objectives

Students completing the Snakes Project should be able to:

1. Engage in inquiry investigations that demonstrate an understanding of the nature of science
2. Demonstrate techniques to safely catch (coverboards, traps, hand) and handle snakes
3. Demonstrate appropriate use of equipment and measurement tools
4. Explain the trapping methods that are used in this project (coverboards, traps, hand)
5. Describe and discuss threats to snakes
6. List characteristics of snakes
7. Identify at least three local snakes to species, giving at least three biological characteristics that describe the species
8. Explain the importance of snakes in ecosystems and the importance of snakes to humans
9. Describe aspects of a snake's biology (hearing, smell, and touch) and behavior, including how they respond to threats
10. Express empathy for snakes.

## IV. Instructor Background Needed to Conduct Project

Experience is important for leadership of the Snakes Project. Leaders should be able to identify the common snakes of the region, know how to care for different kinds of snakes in captivity, be calm around snakes (even those that are nervous or irritable), and be able to handle them confidently and safely. Snakes and people have a tendency to scare each other, so the person leading the project should be sensitive to student anxieties as well as the snake's fears. The leader should understand and use the inquiry method of teaching to best engage participants. Enthusiasm for this method is critical to the success of the program.

## V. Materials

### General Materials:

- Snake bags or pillow cases (queen and king size best, but standard sizes will work)
- Hand wipes
- Snake hook and bagger (available commercially or can be homemade from sturdy materials)
- Hoes or sturdy rakes to turn coverboards
- ~ 5-7 snakes or more (non-venomous, local, wild-caught and a few captive-bred (aka pet store snakes))
- Snake cages for each snake, temporary snake cages can be made from plastic containers with snapping lids such as shoe boxes with small holes added (make holes from inside, drilling out, so sharp edges are not on inside)
- Covers for snake cages such as old tablecloths, etc. and "DO NOT REMOVE COVER" signs.
- Field guides to local reptiles and amphibians and/or snake identification books, specific to your region if available (e.g. *A Guide to the Snakes of North Carolina* by Mike Dorcas, 2004)
- 5-20 shed snake skins, some from venomous species if available (obtain from local nature centers or local snake keepers)
- Snake and mammal skulls (if available)
- Models of local venomous snakes
- Magnifying glasses to look closely at snake scales

### Materials for Optional Measuring Activity using Squeeze Box:

- Packing foam at least one inch thick, any size (e.g. 8" x 8" for smaller snakes, etc.)
- Washable plastic covering for foam, to protect from snake musk
- Plexiglas, any thickness, cut to match size of foam
- String
- Measuring tape or meter stick

## VI. Participant Safety in the Field

While doing fieldwork in North Carolina, participants may encounter chiggers, yellow jackets, ticks, and spiders. Using insect repellent (but not on hands if handling herps) and wearing a hat and long pants are useful ways of preventing these animals from biting, stinging, or attaching. Clothes can be pre-treated with insect repellent such as permethrin, instead of applying insect repellent to the skin. Pulling socks over the bottoms of pants legs is an especially good way of preventing ticks, chiggers, and spiders from crawling up legs. Participants should also wear sunscreen and carry water. Sturdy boots are useful when hiking in rough terrain. Wear protective footwear and long pants or gaiters and look before placing hands down or around a tree. Look before you step. Always hike with a partner and let someone else know the itinerary. Never pick up a snake that you cannot identify.

### Snake Bites

Snake bites, from **venomous** or **non-venomous snakes**, are rare. Because there are many more non-venomous snakes than venomous snakes in our region. If bitten by a snake, the chances are that it is from a non-venomous snake. Indeed, this is true for all of North America. If you experience a non-venomous snake bite, wipe the area with antiseptic, as is done for insect bites, and cover it to prevent infection. Continue to watch the bite site and get medical help if the bite seems to be getting infected. In North Carolina, call the Carolinas Poison Center at 1-800-222-1222 if bitten by a potentially venomous snake.

Reduce the chances of venomous snake bites by stepping carefully. Do not catch or handle snakes unless the species can be identified. Don't try to catch and handle venomous snakes without proper training. Many venomous snake bites are from people attempting to catch or move them. Although snake bites are extremely rare, it is important to be clear on what is recommended in such cases. The following snake bite protocol is from the [Carolinas Poison Center's website](#):

Venomous snakes leave one or two puncture wounds.

If bitten by a snake, you **SHOULD**:

Sit down and stay calm.

Gently wash the area with warm, soapy water.

Remove any jewelry or tight clothing near the bite site.

Keep the bitten area still, if possible, and raise it to heart level.

Call the Carolinas Poison Center: 1-800-222-1222.

If bitten by a snake, you **SHOULD NOT**:

Cut the bitten area to try to drain the venom. This can worsen the injury.

Ice the area. Icing causes additional tissue damage.  
Make and apply a tourniquet or any tight bandage. It's better for the venom to flow through the body than for it to stay in one area.  
Suck or use a suction device to remove the venom.  
Attempt to catch or kill the snake.

If a snakebite victim is having chest pain, difficulty breathing, face swelling, or has lost consciousness, call 911 immediately.

## **VII. Animal Handling Guidelines**

### **Preparations for Catching Snakes**

Prior to the program, coverboards should be placed in quiet, protected areas in the general location where the program will occur. Coverboards are large pieces of roofing tin (new or used, 2' x 8' galvanized roofing tin; smaller sizes also work fine) and sheets of untreated plywood (4' x 8' and  $\frac{3}{4}$ " thickness is best) that are placed in field-forest edges, near brush piles, or at other places snakes may frequent. Coverboards provide shelter for snakes and sometimes attract ants, amphibians, rodents, or worms, which snakes eat. Coverboards are most effective if they have been in place for months or years, but may attract animals if they are put in place only days prior to the program. Animals found under coverboards can be caught, or observed without being caught. When ready to release a captured animal, put the coverboard back in place first, then let the animal crawl underneath it again. If the animal is put down before replacing the coverboard, it could be hurt.

### **Catching and Handling Snakes**

The following wild snake handling recommendations are the same techniques the participants will be shown in the student activities sessions. Please note, participants in The HERP Project never catch or handle snakes unsupervised and they never catch or handle venomous snakes in our program.

Collection permits may be required from the state wildlife agency, so be sure to contact the agency permit coordinator for accurate information. Catching and removing snakes from the wild, even temporarily, is normally disallowed in local, state, and national parks. Preferred places for observing snakes are state and local parks, on private property, or while snakes are crossing roads. Trespassing laws differ from state to state so know the laws in your state. Landowners must give permission if snakes are going to be caught on their private property. Be careful when stopping on

roads as it is easy to get rear-ended when stopping for a snake. Typically, snakes should not be removed from their own homes.

The first rule of catching snakes is never touch a snake unless the animal has been identified. Learn to identify local snake species and learn their habits, habitats, and behaviors. Some snake behavior is predictable and some is not. For example, some snakes bite and some do not. Be prepared to be bitten if snake species that normally bite are being caught. If being bit by a non-venomous snake seems scary, then don't catch snakes, as such fear is dangerous to humans and snakes alike. Being smart reduces the number of bites, but expect to be bitten occasionally when catching snakes.

### Small Snakes

Catching small species like worm snakes and ring-necked snakes is easy. Pick them up gently by the middle section, which typically won't harm the animals or the handlers. Many small species of snakes don't bite people; some have mouths that are too small and some just don't have the inclination to bite. Some snakes rely on escape, camouflage, or musking as their main defense and don't bite even if their mouths are large enough. Expect any snake to expel **musk** as a repellent. Musk is a foul substance emitted from the **vent** as a fear response and is meant to deter predators. It does, however, wash off easily. Young snakes (of larger species), such as neonates (newborns) and small juveniles, may display defensive behavior, such as biting, wiggling, or musking, and may bite more readily than their adult counterparts. If bitten, don't jerk away as this can easily damage the snake's delicate mouth. Sometimes it is best to admire the snake *in situ* (where it is found) and let it go on its way rather than trying to catch it.

### Large Snakes

Catching large snakes by hand is a skill that must be practiced. Catch a snake gently. When approaching a snake, be quiet and slow. Once a snake becomes aware of nearby humans, it may respond by fleeing, remaining frozen in position, or becoming agitated, all of which are signs of fear. Some snakes demonstrate fear or attempt to discourage pursuers by tail whipping, musking, coiling, tensing their muscles, curling their upper lip, or striking. Even when this occurs, the snake can still be caught without harming it by moving swiftly and calmly. If possible, approach the snake from behind and do not make sudden or jerky movements. Dropping a towel, pillowcase, or an empty snake bag over the head (**hooding**) will briefly distract the snake. Use this short-lived

advantage and gently grab the snake *without hesitation* by its middle and immediately support its body from underneath. Snakes typically tense up and jerk when first touched, so expect this to happen. If the snake begins to jerk or to strike, don't let go and don't squeeze tighter. Remain calm and bag the snake (see Bagging below) as quickly as possible, or release it carefully on the ground. If the snake bites, don't jerk away as this may damage its mouth. Bites are to be expected occasionally, even when handling non-venomous snakes.

Snake hooks can be used to catch larger non-venomous snakes or venomous snakes of any size, but they are rarely used otherwise (we don't use venomous snakes in our activities). Sometimes a hook is used to gently keep the head end of a large nervous snake away from the catcher. A second hook may be useful to support the bodies of larger specimens. Good balance and concentration are required. We demonstrate the use of snake hooks for students and let them practice using them with predictably gentle larger snakes like rat snakes and corn snakes that have been handled a number of times and are very tame. This is a very popular activity.

Tongs (sometimes called Pillstrom tongs) can be used to grasp snakes gently from the middle, but we don't recommend using them with non-venomous snakes. Tongs can harm the animal by breaking ribs or damaging soft tissue. They may cause scale abrasions unless the jaws of the device are padded with foam rubber. Grabbing snakes by the neck with either tongs or hands is discouraged. Lassos do not work well on snakes (but do on some species of lizards, see Lizards Curriculum of The HERP Project).

### Bagging (Sacking) Snakes

Bagging (sacking) snakes is a method that allows them to be transported safely. A typical snake sack is much longer than it is wide. The bags can be of various sizes and can be purchased or homemade. Pillowcases can be used effectively for purposes of bagging. Queen- or king-sized pillowcases are better than the standard size, but any size will work. Snake sacks can be used singly or doubly as a snake sacker system (see description below).

Small snakes can be carefully hand-placed in the bottom of a single bag. Shake the bag while holding it closed at the top to ensure that the snake is in the bottom. Before knotting the top, grasp the top of the bag with one hand and, with the other hand, squeeze the bag from the top moving downwards to be sure the snake is still at the bottom. Twist the top part of the bag before knotting the bag, using a tight overhand knot that can be undone quickly. Only one snake should



be in each bag.

Bagging large snakes can be more difficult than it appears on TV. Sometimes they can be coaxed into the snake sacker without being handled, but beware, as strikes and escapes can occur when getting them in and out of bags. Snake sackers are two-bag systems, which consists of one snake bag being loosely nested in another snake bag that is fixed to a circular or a D-ring on a long handle (see image below). While the top bag is held open on the ring, the snake is picked up with hooks or tongs and simply dropped in gently.

When the animal is in the bag, the neck of the bag is sealed by gripping it tightly and twisting it, then tying an overhand knot in the twisted part. Act quickly if a very fast snake is being bagged, and be certain that the animal is not climbing out when the sack is knotted. Their heads may need to be immobilized from outside the bag before it can be tied safely, but this must be done with great care since snakes are able to bite through bags. Knotted bags containing snakes should only be picked up by the cloth above the knot and always kept well away from the body.

When releasing a snake from a bag, simply untie the bag and then untwist the bag, as the snake is unable to escape until the twist in the bag has been removed. At that point, gently shake the snake out of the bag if it does not leave of its own accord. To release a nervous, wiggly, large snake from a bag, secure the snake gently near the front of the body from the outside of the bag. While keeping the snake secured (and its weight supported), untie and untwist the bag, before gently shaking the snake out. When releasing animals, allow animals to crawl under rocks, logs,



Lift the snake from the anterior half of the body, allowing it to balance itself on the hook, as this participant is doing.



Sliding a closed hand down the bag assures the snake is completely in the bottom of the bag. The knot can be tied with the other hand.

or coverboards instead of putting the cover pieces on top of the animal. Always return them to the place where they were found; otherwise, they could become lost.

### Walking Field Guides

A fun activity for adults and youth is to wear snake identification guides. Each participant puts a pre-made, laminated necklace with a picture of a snake that might be found on the walk. On the back is information describing some features that can be used for identification, such as size, **dorsal** color, **keeled** or not-keeled scales, and **ventral scute** colors.

## VIII. Student Activities

**Part 1: THINK HABITAT** (about 1 hour) is conducted outdoors. Activities include walking, storytelling, noticing eco-regions, and looking under logs and coverboards. Prior to gathering announce that:

- insect repellent may be used but participants must wash their hands prior to departing because repellent could harm the animals
- everyone is required to wear name tags, leaders included.

Once the group gathers, go around the circle for self-introductions. Then let participants know the expectations before embarking on the walk: the group will stay together while walking, everyone is invited tell a snake story, and, when a participant is talking, others listen. Everyone should have access to a field guide. Leaders are encouraged to call participants by name. Participants are invited to carry the snake bags or snake hooks.

### Storytelling

Everyone has a snake story they want to tell, so we begin our program taking turns telling stories as we walk the grounds checking coverboards. If a participant can't think of a snake story, we suggest that they tell about their favorite or most-feared snake or share a snake fact they find fascinating. Although most of the stories end badly for the snake, the Project Leader listens carefully, shows interest in the individual student, and is nonjudgmental. Storytelling provides a chance for the students to talk, to be heard,



Participants sharing stories of snake experiences



The “catchers” face the opening when the coverboard is lifted and are ready to swiftly catch animals. “Lifters” use tools to lift the boards, keeping them safe from any creatures that may strike or bite.

and to reveal a little about themselves. Most participants enjoy talking about themselves and learning about others and this activity is a great ice-breaker. Of course, stop to flip a good log if one is seen.

Ideas for questions to ask along the way:

- What would you call this type of habitat?
- Why do you think coverboards are attractive for animals?
- Do you think coverboards in sunshine or shade would be most attractive for snakes?
- Do you think two different kinds of snakes will use the same coverboard at the same time?
- What do you think snakes are eating in this area?
- Do any snakes eat plants?
- What do you think the ancestors of snakes looked like?

### Checking Coverboards

Flipping coverboards can be done solo, but having a group of at least four means two people can be designated as “catchers” and two people as “lifters.” Catchers agree to catch reptiles or amphibians found under the boards. It is not unusual, in our areas, for all of the coverboards to be checked in the summer and no snakes found (spring and fall are much better times for finding snakes under these types of cover). Lifters lift the coverboards, preferably using a tool such as a hoe, reaching across the board to lift the side farthest away so that any animals underneath will not see the lifters. The catchers are ready to spring into action, but stand perfectly still as the board is being lifted. If a lizard or snake is uncovered, the catchers quickly and gently snatch it. Even if surprised, the lifters DO NOT drop the coverboard as it could harm the creature below.

Scrape around underneath the coverboard if leaves and other debris are present. Several animals of different or the same species may be present. Don’t forget to look for animals of all types, especially invertebrates. Try to decide if the invertebrates are herbivores or carnivores.

Invertebrates can serve as food for various reptiles. When finished looking, gently place the



Handling snakes is the most rewarding and instructive aspect of the program. Besides generating empathy and understanding, the handler becomes self-confident and feels accomplished.

coverboard back on the ground. We don't often find vertebrates under the coverboards during our programs because we are normally checking them in the heat of the day. Coverboards can be highly productive when situated near brush piles and checked in favorable weather at various times of day.

### Snake-Watching

Although our programs do not include snake watching outdoors (unless a special opportunity presents itself), observing snakes from a comfortable distance can be a worthwhile and enjoyable activity. Watching for an extended period can teach one a lot about snake behaviors, fears, and needs, however some snakes stay perfectly still for hours limiting the number of behaviors that can be observed. Watching snakes in nature or in captivity will allow participants to begin thinking like a snake and to understand the motivations driving their behaviors. Not frightening the snake is important for both watching and catching. Of course, in order to watch snakes, one needs a suitable place where they are likely to find snakes moving about, basking, feeding, or swimming. Ask local park rangers about good spots to find wildlife. Roads and platforms overlooking swamps are particularly suitable for this type of activity. Using binoculars

can be a great help when looking for wildlife. Insects, frogs, turtles, and other herps are exciting subjects too!

**Part 2: THINKING LIKE A SNAKE** (1.5 to 2.5 hours) is our indoor activity. This section includes Preparation for Activities, Kinds of Snakes Used, Empathy for Snakes, Snake Identification, Looking Carefully at Live Snakes, Venomous and Non-Venomous Snakes, Snake Biology, Snake Senses, Snake Anatomy and Reproduction, Handling Snakes, and Measuring.

### Preparation for Activities

We house 18-20 native wild-caught snakes so that 5-7 of them will be available each day for our 5-day program, with 5-7 participants per day. Our snakes are caught specifically for this purpose and are released exactly where captured when the sessions are completed (see *Catching and Handling Snakes*, page 6). This seems to be a successful strategy, since we have caught some of the same snakes in successive years in the same locations.

Please note that caring for wild-caught snakes takes more experience than caring for captive bred snakes. Consult the state zoo or herpetological society for advice and use the considerable online resources that are available.



A student allows black racer to tongue-flick her hand. Neither the snake nor the student reacted with fear.

Why So Many Snakes? We house about three times as many snakes as we will use in any one day. We do this because

- Our programs are offered every day for five days. Programs offered less often would not need as many snakes.
- As a rule, we don't handle individual snakes two days in a row because snakes tire easily and the teaching sessions are more stressful for some species than others. Fatigued snakes are irritable and may strike at cage walls more readily.
- We don't normally handle snakes that are in-shed (preparing to shed skin as evidenced by opaque eye coverings), but we use them to show students how to recognize snakes in-shed,

sometimes called “in the blue.”

Hence, it takes about 19-20 snakes to be ready for a week of daily programs. We also use 1-2 captive bred snakes for level-one snakes (see Levels of Engagement). Programs utilizing more captive bred snakes (pet store snakes) may be able to house fewer captured snakes.

### Kinds of Snakes Used

We want students to become familiar with local snakes, so we use small, medium, and large species of non-venomous snakes that are common in our area. For example, we use worm snakes (*Carphophis amoenus*), brown snakes (*Storeria dekayi*), Eastern garter snakes (*Thamnophis sirtalis*), Eastern hognose snakes (*Herterdon platirhinos*), mole kingsnakes (*Lampropeltis calligaster*), racers (*Coluber constrictor*), and rat snakes (*Elaphe [Pantherophis] obsoleta*). A high-quality model of the venomous copperhead (*Agkistrodon contortrix*) is used for identification and comparison with other blotched snakes.

Captive snakes can also be used, but using primarily local wildlife supports our goals of engaging participants with the local fauna, ecology, and ecosystems. We use a few long-term captive snakes (captive bred) loaned by friends or staff members.

### Empathy for Snakes

Learning the biology of snakes is valuable and important, but to truly understand and appreciate snakes, one must learn what is important to them, how they manage to live successfully,



Actively engage participants in every way possible. This student was recording responses to the question, “How do snakes respond when they are afraid?”

what risks they face from humans, and why it is important for humans to understand them. It is also important to know what scares snakes. Observing snake body language while they are in the cages is an important first step to empathizing with them.

Begin by asking participants what they think the word “empathy” means then describe what it means to you. Use the sample questions below or come up with others. Ask the question, then give time for responses. Be affirming and positive when students respond (even with wrong

answers) and don't give your answers right away. Ask questions like, "How can you tell when a snake is afraid?" or "How do snakes respond to threats?" These questions are particularly important, so make time to discuss this subject in some depth. Let the student call out ideas and have one of them write the responses on board. Note that no single snake will exhibit all the responses mentioned.

Discuss the topics generated by the above conversation, as this is one of the best exercises to help students understand snakes. Answers should include the following: flight, increased respiration, kinking body (muscle contractions), jerking movements, striking, biting, musking, twisting when held, flattening head, hissing and spreading neck (e.g. hognose snake), thrashing, dropping from tree limbs in an attempt to escape, playing dead, coiling, shaking tail, increased alertness, etc. Some possible guiding questions are listed below, followed by answers.

- What does it mean when the muscles of the snake tense up? It means the snake is afraid for its life and may take action to defend itself.
- When a snake strikes at a person, what is it trying to accomplish? It is trying to get the person to leave it alone. It is not trying to eat the person.
- Describe snake body language not related to fear. These include tongue flicking (to pick up on environmental cues), ambush position (to prepare to strike if prey animals should come by), coiled in hiding (while resting or digesting), and actively moving about (searching for food or mates).
- What is important to a snake? Food, mates, water, privacy, safety, dens or rookeries for some species, ability to control temperature, finding safe places to lay eggs or stay warm until young are born (some species lay eggs, some have live young), etc.
- Why are snakes important? Are snakes predators or prey? Snakes are important as both prey and predators. This question can begin discussions about food chains and the importance of predators to the health of the ecosystem and to the species that they prey on (population control).
- Why are snakes important to humans? Snakes consume animals that we consider pests and protect our crops by consuming rodents. Snake venom is very important in the production and development of many medicines. Since snakes are important to their ecosystems, they



Shed skin study will allow students to see the differences between dorsal and ventral scales and keeled and unkeeled scales.

are also important to us. Stress that humans are a part of the local ecosystems.

- How do humans threaten snakes? Despite the low incidence of snake bites, many people see these animals as a serious concern. Because of this fear, snakes are readily killed. In truth, use of cell phones while walking or driving is much more dangerous. Some people may not kill snakes themselves, but acquiesce in their killing. Roads and construction are extremely damaging to snakes and wildlife. Free ranging housecats are also dangerous to snakes because snakes are not adapted to this predator. Adding a new predator, such as domestic cats, means that snake populations decline. If we want to retain biodiversity, it is important for educated people to help inform others about the importance of snakes. Encourage friends and family to tolerate snakes or even to build safe habitats for them, such as brush piles.
- Why is it important for people to understand snakes? Snakes are important elements in the landscape and the biological communities where they are found. Too often snakes are brutally killed because people needlessly fear them or their intentions. In our experience, most children do not naturally fear snakes but some do and many are taught to fear and hate snakes as they get older. Arguably, an individual's environmental awareness, education, and compassion is revealed by their attitudes towards snakes.



Rule of Threes: At least three characteristics are needed to support a species identification. Here, the participant used the ring around the neck, and the dorsal and ventral coloration to support the identification as a ringneck snake.

### Snake Identification

To help students learn to identify snakes, begin by asking how they would describe a snake to someone who had never seen one. Let the students call out ideas.

Have a student write the responses on the

board. Then have them look at characteristics of the skin using shed skins. Distribute shed skins among the participants and talk about the shedding process and why snakes shed their skin. Have them compare how humans shed skin (continually) to how a snake sheds its skin (all at once).

How often snakes shed their skins depends on how much they are eating and growing. Some fast growing snakes with a good food supply, especially young snakes, may shed several times a year.

If an opaque snake (about to shed) is available, it can be shown to the participants but should not be handled much. Ask students to find a shed skin with strongly **keeled** scales, one with



weakly keeled scales, and one with smooth scales. Keeled scales have ridges, weakly keeled scales have small ridges, and smooth scales have no ridges at all.

The answers to the following discussion questions will depend on the particular shed skin. Use your local field guide to determine which skin characteristics are typical of which species. The following questions will help students begin recognizing anatomical differences.

- Can this tell you anything about what kind of snake shed this skin?
- Are the scales smooth or keeled?
- Is the vent scale divided or not divided?
- Are the ventral tail scales divided or not divided?
- How do the dorsal scales differ from the ventral scales?

### Looking Carefully at Live Snakes

Snake cages should be covered when participants enter the room so neither the snakes nor the participants won't become alarmed. Only one snakes should be in a cage. Lightweight display cages with clear bottoms (such as deli containers) will enable participants to see the ventral colors and patterns. Once the room is quiet, the covers are removed and students may move around the room.

Using a field guide, have participants work with a partner or by themselves to determine the species of the snake. Focus on the coloration of **dorsal** (back) and **ventral** (belly) sides, **anterior** and **posterior**, shape of head, rough/keeled or smooth scales, typical species behaviors, and the range of occurrence as indicated by the range map in the identification book. It is recommended to have at least three identifying characteristics before confidently stating the species identification.

Using the copperhead model, ask students to give an elevator speech (a succinct speech given in the time it would take to ride an elevator) describing the differences between a copperhead and another blotched snake such as the mole kingsnake.

### Venomous and Non-Venomous

Discuss identifying venomous and non-venomous snakes. Ask a participant to write all answers on the board.

- Can you tell if a snake is venomous by looking at its head? Some snakes have facial pits near the nostrils. These are the venomous pit vipers. Some venomous snakes have triangular heads, and this can be of help in identifying venomous snakes, but beware. Some non-venomous snakes may appear to have triangular shaped heads because of the

positioning of their heads or for other reasons. Conversely, some venomous snakes, like coral snakes, have oblong heads that look a lot like non-venomous snakes. So using the shape of the head should not be the only feature used to determine if a snake is venomous or not.

- Does anyone know what percentage of NC snakes are venomous? Of the 37 species of snakes in NC, there are only six venomous snake species, which is about 16%. This means that 84% of our NC snake species are non-venomous. The six venomous snakes in NC include the copperhead, eastern diamondback rattlesnake, pigmy rattlesnake, timber rattlesnake, cottonmouth, and the eastern coral snake. Many non-venomous snakes have blotches rather than bands, but there are exceptions such as the northern watersnake in the figure above. Examples of non-venomous snakes with blotches are mole kingsnakes, juvenile rat snakes, and corn snakes.
- Do you die if you are bitten by a NC venomous snake? Venomous snakes may inject some, all, or none of their venom when biting. When no venom is injected, it is called a dry bite. It takes a large investment of energy to produce venom, so venom is sometimes conserved.



Venomous Copperhead, *Agkistrodon contortrix*, and the non-venomous Northern Watersnake, *Nerodia sipedon*, (right) are often confused.

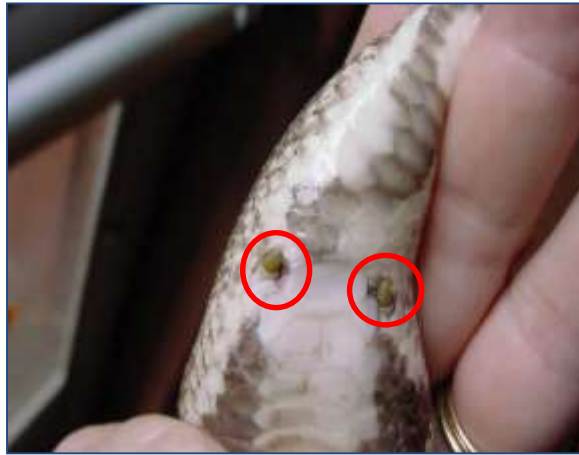
Most NC venomous snake bites are not fatal, but all should be considered serious if any venom at all is injected. A bite from any venomous snake is an emergency, especially an Eastern diamondback rattlesnake, though the likelihood of encountering one of these snakes is extremely low. Most cottonmouth and copperhead bites are not fatal for humans, but should be treated as serious injuries in need of immediate professional attention (see Snake Bites under Participant Safety).

- Mole kingsnakes, corn snakes, juvenile rat snakes, and indeed all blotched snakes are often mistaken for copperheads and killed. Look at coloration, shape of body, and shape of head to identify snakes. A good policy is to just leave them alone and admire them from a distance.

## Snake Biology

A leader can take any number of tracks when discussing snake biology. Some leaders

begin by pointing out that snakes require warmth like other animals. Snakes are reptiles and most reptiles are ectothermic (ecto = from the outside, thermic = temperature). This means that, unlike mammals who use food energy to keep their bodies warm, reptiles obtain body heat from their environment. Proper digestion, reproduction, and other biological processes require that the snake is at an adequate or optimum temperature. Ask students about different ways reptiles seek or retain body heat, and have one of the students create a list on the board. Other potential lines of questions regarding the biology of snakes are outlined below.



Spurs on either side of vent in pythons and boas are vestigial structures, which provide support for the theory that snake ancestors once had legs. M. Baumeister photo.

- Is a snake a vertebrate or an invertebrate? Which kind of animal is a snake? Vertebrate, reptile.
- What kind of animal are we? Vertebrate, mammal.
- What do you think snake ancestors looked and behaved like? Fossils suggest that snake ancestors were a type of burrowing lizard of the early Cretaceous. Snakes likely lost their legs by growing them more slowly or for a shorter period of time, resulting in shorter and shorter legs, until the legs eventually disappeared. Not having legs gave pre-snakes an advantage for life underground. Those with slower growing legs or shorter legs lived longer and had more offspring (babies), thereby increasing the numbers of legless individuals in the population until legs were lost altogether. However, a few snakes, like boas and pythons, still have remnants of leg bones inside their bodies and spurs which can be seen next to the vent.

### Snake Senses

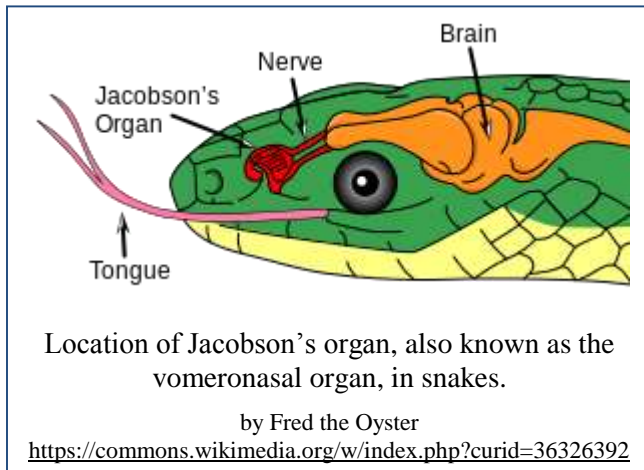
Snakes depend on different senses than humans. Some snakes have excellent eyesight while others do not. Like all animals, they depend on their senses to find food and mates and to escape danger. Snakes also need to find warm places to raise their temperature. All snakes are highly dependent on their tongues for gathering important information.

Possible questions about the tongue:

Have students observe tongue-flicking. The tongue is a sensory organ used to sample the

air for important information. Air is full of molecules that are invisible to the eye. Tips of the snakes' tongue grab samples of this information-laden air. The two tips of the tongue insert air into two openings in the roof of the mouth where Jacobson's organ is located.

Ask if anyone knows the name of that organ (show the students a diagram illustrating the locations of the openings to Jacobson's organ in the mouth). It is Jacobson's organ, which



distinguishes scents and sends messages to the brain. The scent molecules in the air may reveal there is food available nearby or water or mates. Neonate rattlesnakes read scent trails to find their way to the wintering den. The tongue is forked to increase the amount of molecules that are received and also to provide a directional component, comparable to our two ears. For example, if the right fork

of the tongue grabs air that has a more powerful signal than the left fork, this tells the snake that the source of the scent is to the right. Thus the snake may follow a scent without opening its mouth because they have a small opening between their lips. This allows a stealthy way for snakes to know what is going on in the world without drawing attention to themselves.

Students will be interested to learn about snakes' ears. Snakes don't have external ear openings but are very sensitive to vibration. Serpents evolved from a type of ancestral lizard and lizards have ear openings, but external ear openings may have been a disadvantage. They may have been prone to infection from debris entering the openings, so the ancestor burrowing lizards

with small ear openings or no ear openings may have lived longer. Living longer allowed them more years to lay clutches of eggs, producing more offspring and increasing the number of individuals in the population with small ear openings. Over time, snakes lost ear openings altogether. When they emerged from a subterranean existence and began living above ground, they came up without external ears.

Touch is a particularly important sense and snakes are very sensitive to touch. Along with their sense of smell, touch plays a very important role in their ability to survive and respond to threats. Snakes depend heavily on information that comes through their skins and are, at times, able to detect the size of prey and predators based on their vibrations. They are able to feel the slightest changes in their environments and are able to quickly respond to these changes.

### Snake Anatomy and Reproduction

Have students do an activity as they discuss snake teeth. Prepare by randomly placing mammal and snake skulls on the table. Without explanation, ask two students to separate the skulls into those with **heterodont** dentition and those with **homodont** dentition and write the words on the board. Students can often figure this out themselves. Ask questions about teeth and diet:

- How would you describe the teeth? What do you think the words heterodont and homodont mean?
- Why are snakes' teeth curved? Mammals, like us, have different kinds of teeth, some sharp, like our incisors, to bite into food, and some flat, like our molars, to grind food. Our teeth



are not all the same, which is called heterodont dentition. Snakes' teeth are all similar, so we would describe snakes as having homodont dentition.

- What do snakes eat? All snakes eat other animals. No snake eats plants.
- Which animals eat snakes? Who are their predators? Why is predation so important to life?
- Are you a predator?
- How do you tell where the tail of the snake starts? At the **vent**.
- How do you tell if a snake is male or female? It is hard to tell without one of each sex. Look at the first part of the tail, just posterior to the vent. In males, the first part of the tail will be thicker and does not taper immediately. In females, the tail will start to taper immediately posterior to the vent. This characteristic is highly variable among individuals and species. The best way to tell is to see snakes mating because they certainly know which are males and which are females! Another way to tell is by using specialized probes to insert into the **cloaca**, but we don't use them and don't recommend their use as it is very easy to harm a snake unintentionally using probes.
- How do snakes reproduce? Do all snakes lay eggs? Many of our local snakes do not lay eggs but are live-bearers. Little snakes called **neonates** emerge from the female's vent. Often live-bearing snakes make their living in or near water where lots of places are too wet to safely hatch eggs.
- What is unusual about a snake's penis? There are two of them, called **hemipenes**. Snakes can be identified to species from the **morphology** of the hemipenes. When mating, male snakes will insert only one hemipene into the cloaca of the female. For more information, see <http://www.sjonhauser.nl/hemipenes-amazing-copulatory-organs-of-snakes.html>

## Handling Snakes

The part of the program we enjoy most is handling the snakes. We have developed a system



Racers can be intimidating because they are large and somewhat nervous (prone to bite), but they tame quickly when handled daily. They are good choices for a Level Three snake, best when they are fresh-caught, but also good when they have tamed down a bit, just not quite as thrilling. Tom Harten photo.

that motivates students to rapidly overcome fears and engage with snakes in challenging ways. At the beginning of our program, students are asked to use the *Levels of Engaging with Snakes* poster developed by The HERP Project (see next page) to identify how comfortable they are with snakes. They then have the opportunity to see others handling snakes and to touch them if they wish. Almost without exception, hesitant students touch a snake before the program is over.

Our program is unlike a visit to a nature center where visitors may use two fingers to touch a captive-reared, docile snake or possibly hold one. Our program allows participants to engage with nonvenomous snakes as herpetologists do. For instance, students may, if they wish, pick up a snake from the cage or the floor or catch one outdoors. They may engage with challenging snakes or ones that react suddenly or that strike or bite. Each person climbs the ladder of engagement at their own rate, with the calm, professional support of the Project Leader and Assistant Leader.

**Picking up a snake for the first time video:** <http://vimeo.com/109046952>

**Picking up an adult snake from an aquarium video:** <http://vimeo.com/109035914>

**Picking up a snake from a box video:** <http://vimeo.com/109048663>

As the session progresses, students often become more engaged and begin climbing the ladder of engagement. Each day, we have a new group in the snake unit, but word gets out about the snakes and the engagement levels. By the end of the week, new participants are primed for advancement by gossip and other HRE programs that have helped them become accustomed to handling reptiles and amphibians. By the last two days, most students reach the highest level of engagement and joyfully discuss this during lunchtime reports. None of our snakes has ever been harmed, nor has any participant been hurt. Snake bites are uncommon, but when one occurs, the student involved tends to be quite proud of the marks left on their skin (if they are visible, but often they are not).

# Levels of Engaging with Snakes\*

*What level are you today?*

- 0 Do not like snakes; nervous when in the room with snakes
- 1 Will look at and admire the snakes, but don't want to touch one
- 2 Touch snake of your choice, with someone else holding snake
- 3 Hold a level-one snake of your choice, with someone carefully handing it to you
- 4 Pick up a level-one snake from cage, floor or outdoors
- 5 Hold a level-two snake of your choice, with someone carefully handing it to you
- 6 Pick up level-two snake from cage
- 7 Pick up level-two snake outdoors or from the floor
- 8 Hold a level-three snake of your choice, with someone carefully handing it to you
- 9 Pick up level-three snake from cage
- 10 Pick up level-three snake outdoors or from the floor



Level-one snakes (examples): worm snakes, ringneck snakes, brown snakes, earth snakes, redbelly snakes, juvenile hognose snakes, green snakes, most hatchlings of nonvenomous species and captive bred snakes and tamed snakes. Individuals of the same species may be ranked at different levels depending on disposition.

Level-two snakes (examples): adult corn snakes, rat snakes, mole kingsnakes, large untamed hognose snakes, most adult non-venomous

Level-three snakes (examples): racers, garter snakes, water snakes, other particularly nervous adult non-venomous snakes



Images by JC Beane

**Note:** Level four, five, and six snakes are large and especially nervous snakes, venomous snakes, and very excitable venomous snakes. We do not use or handle these snakes in our programs.

\*Levels of engagement and snake levels developed by The HERP Project, UNC Greensboro



## Measuring Snakes

Ask students to think of three different ways one might measure the length of a snake. Ask a student to write these methods on the board. Some possible responses include “stretch the snake,” “let it crawl along a wall,” “put it into a tube,” etc.

A person could try to stretch a snake but this could damage the vertebrae because the muscles will tense in response to stretching. Snakes will squeeze up and loosen up, shortening and lengthening the spinal column, making it impossible to get an accurate reading. Measuring a dead snake is not accurate either. Dead snakes measure considerably longer than live snakes because there are no muscle contractions to compress the spaces between the vertebrae. Snakes have over 200 synovial joints (moveable joints like our knees and backbones) in their skulls and backbones, which is why live snakes can stretch and shrink depending on muscle contractions and dead snakes with no muscle contractions are so much longer than live ones. My 9-year-old neighbor was fascinated by this news and was inspired to say, “That must be why snakes are so bendy!” Indeed it is, Jack. Indeed it is.

Since there really are no good ways to accurately measure live snakes, we use a squeeze box because it is the least stressful method we know. A squeeze box is a home-made unit that consists of a piece of foam, a clear piece of Plexiglas the same size as the foam, and a piece of plastic or vinyl that is also the same size. The video shows how it is assembled and used, and why the snakes remain calm, safe, and unharmed.

**Snake measuring video:** <http://vimeo.com/109815751>



Left: Apply gentle pressure on the plexiglass covering the snake, helping the animal remain calm and unharmed. Then, trace the spine with a dry erase marker; when done, release the snake. Right: The line is measured with a string, and the string is then measured with a meter stick.

A snake may be in the squeezebox for a minute or less. Simply place the snake between the Plexiglas and the covered foam and gently press down. The snake becomes immobilized without being harmed. Quickly use an erasable pen to draw a line on the Plexiglas from the head of the snake down the vertebral column to the tip of the tail. Then release the snake and return it to the cage. Take yarn or string and lay it along the line, then measure the length of the yarn or string with a meter stick to get the snake's measurement. In order to compare snake lengths, measure all of the snakes being compared with the same technique.

### Data Reporting to The HERP Project and HerpMapper

Through use of the free The HERP Project app (available for FREE download: <http://theherpproject.uncg.edu/apps-collecting-data>), HRE participants record data and upload it to an open source database found on The HERP Project website (<http://nc-herps.appspot.com>). This enables us to compare our data with previous years, and we can download data sets for further analysis. The same data may also be uploaded to Herpmapper (<https://www.herpmapper.org/>).

## IX. Resources

### Websites

The Davidson College Herpetology Laboratory: [http://www.herpsofnc.org/herps\\_of\\_NC/snakes/snakes.html](http://www.herpsofnc.org/herps_of_NC/snakes/snakes.html)

Savannah River Ecology Lab: <http://srelherp.uga.edu/snakes/index.htm>

The North Carolina Museum of Natural Sciences: <http://naturalsciences.org/>

### Books and articles

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University Press. 1966. p. 146-147

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DC: The National Academies Press.

### **Visual Learning Software**

VL HERPS is a free visual learning software program designed for learning reptiles and  
amphibians of the Southeast at home. [http://theherpproject.uncg.edu/visual-learning-  
software/](http://theherpproject.uncg.edu/visual-learning-software/)

## X. Especially for Teachers

<p style="text-align: center;"><b>The Herp Project Curriculum</b></p>	<p style="text-align: center;"><b>Next Generation Science Standards</b></p>	<p style="text-align: center;"><b>International Society for Technology in Education Student Standards</b></p>
<p><b>Practices/skills:</b>                      Research design                      Hypothesis building/testing                      Data collection                      Measurement skills                      Taxonomy                      Data analysis                      Presentations/videos                      Citizen Science digital data upload</p>	<p><b>HS-LS2-1.</b>  <b>ESTS1-1</b>  <b>Science and engineering practices:</b>                      -Using mathematical and computational thinking                      -Constructing explanations and designing solutions</p>	<p><b>1. Creativity and innovation:</b> a. Apply existing knowledge to generate new ideas and processes in research design.  <b>2. Communication and collaboration:</b>                      b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats to share findings from scientific investigations.  <b>3. Research and information fluency:</b> a. Plan strategies to guide inquiry using apps in the field for scientific investigations.  <b>4. Critical thinking, problem solving, and decision-making:</b> Use critical thinking skills to solve problems, plan, and conduct research using digital tools. a. Identify and define authentic problems and significant questions for investigation using digital tools in the field.  <b>5. Digital citizenship:</b> a. Advocate and practice safe, legal, and responsible use of information and technology.  <b>6. Technology operations and concepts:</b> Understand technology concepts, systems, and operations. a. Understand and use technology systems. b. Select and use applications effectively and productively. Transfer current knowledge to learning of new technologies.</p>
<p><b>Core Ideas:</b>                      Adaptation                      Biodiversity                      Bio indicators                      Biomes                      Biotic parameters</p>	<p><b>HS-LS1-2</b>  <b>HS-LS2-1, 2, 6, 8</b>  <b>HS-LS3-1, 2, 3</b>  <b>HS-LS4-1, 4, 5, 6*</b>  <b>HS-ESS2-2, 4*, 5, 6, 7</b>  <b>HS-ESS3-1, 3*, 4, 5, 6*</b></p>	<p><b>2. Communication and collaboration:</b>                      d. Identify trends and forecast possibilities.  <b>3. Research and information fluency:</b> b. Locate, organize,</p>

<b>The Herp Project Curriculum</b>	<b>Next Generation Science Standards</b>	<b>International Society for Technology in Education Student Standards</b>
Carrying capacity Climate change Ecosystem dynamics Energy flows Food energy pyramids Food webs Genetic hybridity Habitat/Niches Human impacts Interdependence Interactions Invasive species study Natural selection Population studies Predator/prey Species diversity Weather and climate	<b>Science and engineering practices:</b> -Engaging in argument from evidence <b>Crosscutting Concepts:</b> -Cause and Effect -Scale, Proportion, and Quantity -Stability and Change  *Real, not a simulation or model.	analyze, evaluate, synthesize, and ethically use information from a variety of sources and media. c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks. d. Use apps in the field to process data and report results. <b>4. Critical thinking, problem solving, and decision-making:</b> b. Plan and manage activities to develop a solution or complete a project. c. Collect and analyze data to identify solutions and/or make informed decisions. <b>5. Digital citizenship:</b> b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity. <b>6. Technology operations and concepts:</b> Understanding technology concepts, systems, and operations. b. Select and use applications effectively and productively. c. Troubleshoot systems and application.
<b>Extension Activity:</b> Reduce human impact on the ecosystem.	<b>HS-LS2-7</b> <b>HS-LS4-6</b> <b>HS-ETS1-2, 3, 4</b> <b>Science and engineering practices:</b> -Developing and using models -Developing possible solutions -Optimizing design solution <b>Crosscutting concepts:</b> Influence of science, engineering, and technology on natural world	<b>1. Creativity and innovation:</b> a. Apply existing knowledge to generate new ideas, products, or processes. b. Use *models and simulations to explore complex systems and issues. <b>4. Critical thinking, problem solving, and decision-making:</b> Using technology to help reduce impact. d. Use multiple processes and diverse perspectives to explore alternative solutions.  *Real, not a simulation or model



## Appendix A. HERP Data Sheet

### The HERP Project Snake Data Sheet

for wild caught snakes or to be used as practice with captive snakes

Date (mm/dd/yyyy): \_\_\_\_\_ Day of week: \_\_\_\_\_ Time: \_\_\_\_\_ am or pm

Observers: \_\_\_\_\_

Scribe: \_\_\_\_\_ Status: Alive Dead Recap? Y N UKN

Snake Species: \_\_\_\_\_ Scientific Name: \_\_\_\_\_

Confidence Level of species ID 1-4 (1 = certain, 2 = not positive, 3 = guessing) \_\_\_\_\_

Coordinates (UTM, WGS 84): N \_\_\_\_\_, E \_\_\_\_\_

Habitat (1-10): \_\_\_\_\_ Microhabitat (under a rock/coverboard, in a stump hole, rocks near dam of lake, etc.): \_\_\_\_\_

Days since last rain: \_\_\_\_\_ Air Temp: \_\_\_\_\_ F C Relative humidity: \_\_\_\_\_

Sky Code (0-6): \_\_\_\_\_ Wind Code (1-4): \_\_\_\_\_ Location Description (Where was the animal located?): \_\_\_\_\_

**Capture Method (1-17):** \_\_\_\_\_ **Weight (g):** \_\_\_\_\_ **Sex:** F M UKN **Gravid:** Y N UKN N/A

**Life Stage:** Egg Hatchling Sm. Juvenile Lg. Juvenile Adult Unknown

**Photo Record?** Y N

**Total Length measured by squeeze box method (mm):** \_\_\_\_\_

**Estimate of total length** \_\_\_\_\_ feet/inches or mm **Name of estimator:** \_\_\_\_\_

**Injuries/defects/parasites (include sketch if possible):**

**Notes (what was the animal doing when you found it/behavior, etc.):**

**Date reported to CHA (Carolina Herp Atlas):** \_\_\_\_\_

**Habitat codes:** 1 = Road; 2 = Edge of field or forest; 3 = Field; 4 = Pine/hardwood forest; 5 = Stream or stream bank; 6 = Open wetland; 7 = Forested wetland; 8 = Lake; 9 = Riparian; 10 = Other

**Capture Method codes:** 1 = Road; 2 = Visual search did not handle; 3 = Visual search hand capture; 4 = Coverboard plywood; 5 = Coverboard tin; 6 = Other

**Sky Codes:** 0 = Few clouds; 1 = Partly cloudy (scattered) or variable sky; 2 = Cloudy or overcast; 4 = Fog or smoke; 5 = Drizzle or light rain; 6 = rain

**Wind Codes:** 0 = Calm (< 1 mph); 1 = Light Air (1-3 mph); 2 = Light Breeze (4-7 mph), leaves rustle, can feel wind on face; 3 = Gentle Breeze (8 - 12 mph), leaves and twigs move around, small flag extends, 4 = Strong wind (more than 12 mph) cloudy (scattered) or variable sky; 2 = Cloudy or overcast; 4 = Fog or smoke; 5 = Drizzle or light rain; 6 = rain

## **Appendix B. Transcript of Picking Up a Snake for the First Time**

**Courtney** – Ok, so, picking up a snake for the first time is a little different than being handed one because they're not quite as ready for it. We do have a couple of snakes here, they're in tubs so there's the whole lid removal thing to deal with, they can try to come out when you take the lid off so you have to be ready for it. I'm here to help but, you're gonna, you're gonna do it. Well, this is a hatchling water snake. They can be a little snappier, this one has not been so that's an option if you want to. Or if you want to be a little on the safer side this is a worm snake, they have those teeny little mouths that we talked about so it can't really bite you even if it wanted to and they just don't. And then we have a ring neck snake which is my favorite. He's a little wigglier but they're not really bitey. So, we have like three levels here.

**Participant** – I'm gonna go for the ring neck. (Points at large aquarium)

**Courtney** – You wanna go for the ring neck? (Picks up aquarium) Ok, so, we've got the paper and he is all curled up which can be a defensive position but we're just going to, like you said, show him your hand and then let him, and then pick him up away from the head. And you're just going to support as much of the body as you can and he's tiny so that's most of him. (Participant reaches in aquarium and picks up snake) And these you have to grip them a teeny bit so that they don't wiggle away from you but you're not going to squeeze or put very much pressure. Perfect. See once they chill a little bit they'll get used to you and start kinda holdin on. They're like, "Fine, if I have to be here, I'll just stay." Yay.

**Ann** – (off camera) Can you put him back now?

**Courtney** – (participant leans over aquarium to lower snake back into it) Now you just gently let him go and he'll usually go hide by himself so you don't have to do much. But in the tubs, sometimes they do try to shoot out so you're ready with the lid.

## **Appendix C. Transcript of Picking up a Snake from a Box**

**Courtney** – See his tongue wiggling a little bit? He's probably just going to bump into you more than anything, his mouth may or may not be open... does that make sense?

**Participant** – Yeah.

**Courtney** – So, it's not traumatizing, I promise, it happens all the time. But you just casually reach in, grab it, and then you have it. (Participant reaches in the box and grabs the snake)

Perfect... perfect! You support the body, there you go! (snake begins to wiggle out of participant's hands) Oh, now he's wiggling out, make sure you have his head, perfect. And there's some loveliness that he dropped for you.

**Participant** – He did?

**Courtney** – Yeah, he just went to the bathroom.

#### **Appendix D. Transcript of Picking Up an Adult Snake from an Aquarium**

**Ann** – The first thing you want to do is you want the snake to know you're there, you don't wanna surprise it. So one of the things I usually do is I let the snake see my hand, and then I'm gonna come towards about halfway or a third of the way toward the head and then pick it up. Sometimes it's helpful, with this snake, is just to pick it all up as a glob, ok? So you're going to let the snake see you. Now, let's talk about one other thing, I know you know this but not everybody else does. Alright now sometimes you freak the snake out when you do that and snake jerks. What are you going to do then?

**Participants** – Stay calm.

**Ann** – You're going to stay calm. You're gonna stay calm. And you're going to just be calm because if you're calm, there's a better chance. Now, say the snake bites you, what do you do?

**Participant** – Stay calm.

**Ann** – Stay calm. You don't want to jerk your hand away. So, any snake can bite, not all snakes will bite. This snake has never bitten anyone, it doesn't mean that it won't since it still could. Alright? We've got a brave volunteer here and we're going to let him take the snake out. (Participant reaches in the aquarium) Notice how he lets the snake see him, you know the snake has seen him because it's moving, it's looking at him. Has it tongue-flicked yet?

**Participant** – Yeah.

**Ann** – Yes, it's tongue-flicking so that means it's trying to figure out what's going on in the world. Now it's taking its tongue and putting it in openings in its mouth and it's taking air to an organ. What's the name of that organ?

**Participants** – Jacobson Organ

**Ann** – Jacobson's Organ, good! Alright, now let's move it over...



## Appendix D. Transcript of Snake Measuring

**Courtney** – There's not good way to go down the entire snake without stretching her out which can hurt her cause if you stretch her out too much, it's kinda like stretching you out. You don't necessarily know you're doing it and she's gonna kind of fight because she doesn't know what's going on. So the easiest way to get a length on a snake is by using what we call a squeezebox. Now we have squishy goodness down here, so we're not going to hurt her. Something to go over it because she's probably going to make a mess, cause they do that. And then we have the plexiglass which we're going to draw on. So if you want to, put her down, and try to put her down so that she's not overlapping, if possible cause we don't want to squish her. And watch where her head goes cause she'll latch onto the table. (Participant places the snake on the covered foam and it begins to wiggle away)

**Ann** – (off screen) I think he may need some help, somebody jump in and help him.

**Courtney** – Perfect. Good job! (Places the plexiglass over the snake) Put a little light pressure, you don't have to put a lot and we're squishing her down into a pad so it's pretty safe for her. It just makes her feel nice and secure. (Participant steps up with a marker and begins to draw on the plexiglass) And we are going to draw a line all the way down her vertebral column all the way from the tip of the nose to the tip of the tail getting every curve... Which you are doing beautifully. (Participant continues to trace the snake) And you have that long skinny tail all the way to the tip of it. (Participant finishes the line)

**Ann** – (off screen) Nice!

**Courtney** – (lifts the plexiglass a little and holds snake) And now we have the outline of the snake so we can let her go. Somebody ready? (Lifts plexiglass all the way off) Got her? (Participants pick up snake again) So if this were a wild snake and we weren't too worried about taking multiple measurements, she could just go. And so she's free to go, she's not scared anymore, and we have her outline to do what we need to do. (Cut to plexiglass laying on table with snake outline) Step two, we're going to trace the string along this backbone, so we can get a measurement. We're going to do it very carefully and as accurately as possible, maybe needing a partner. You want to partner up? (Participants lay string along the line on the plexiglass) And again, we don't want to stretch the snake out too much because they have all those synovial joints and we don't want to stretch them too

much. And it's hard to get an accurate reading on them when they can flex that many joints. There's a lot of variability there.

**Participant** – It's not long enough.

**Courtney** – So we'll just hold a finger on the exact point where it was and now we don't need to hold the string on where the head was anymore. So we can let that go and just start over at this point. Does that make sense? (Participants move the string) Start from my finger and go down.

**Participant** – This way?

**Courtney** – (Turns string around for participants) There you go. And then go toward the tail like you were. (Participants finish the measurement) Perfect. So now we know we have one full length of string and then that much.

## Appendix E. Glossary

**anterior:** of, near, on, or toward the front of an organism

**cloaca:** an interior canal that provides a common passageway for fecal, urinary, and reproductive discharge in most fish, reptiles, amphibians and birds

**coverboards:** large pieces of roofing tin (new or used, 2' x 8' galvanized roofing tin; smaller sizes also work fine) and sheets of untreated plywood (4' x 8' and ½" or ¾" thick; ¾" thickness is best) that are placed in field-forest edges, near brush piles, or at other places herps may frequent

**dorsal:** of, near, on, or toward the back of an organism

**hemipene:** one of two paired penises (hemipenes), the copulatory organs of male snakes and lizards

**heterodont:** dentition (teeth) of an organism that are all shaped alike

**homodont:** dentition (teeth) of an organism that are not all shaped alike

**hooding:** a towel, pillowcase, or an empty snake bag placed over a snake's head

***in situ:*** where it is found

**keeled:** having a ridge

**morphology:** the size and shape of an organism

**musk:** a foul smelling liquid expelled from an animal's vent or anus

**neonates:** new born snakes that either emerge from a female snake's vent or hatched from an egg

**non-venomous snakes:** snakes that lack venom

**posterior:** pertaining to the rear or back part

**scutes:** the protective plates or scales that cover the faces and bodies of reptiles. In turtles, also the plates that cover the shell

**squeeze box:** a device for measuring lengths snakes and other animals. It consists of a piece of foam for the animal to rest on and a matching piece of Plexiglas to place gently over the animal holding it in place, temporarily immobilizing it for measuring purposes

**venomous snakes:** snakes that have the ability to inject venom when biting

**vent:** opening of the cloaca to the outside, the vent scale is conspicuous on the underside of reptile or amphibian

**ventral:** the underside or the lower surface; the belly not the back