The HERP Project, Herpetology Education in Rural Places and Spaces

In Awe of Nature: Looking at Lizards

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Looking at Lizards

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 animals such as wild-caught lizards and what kinds of permits you may need to handle lizards.

I. Project Description

This curriculum focuses on a lizard project that we conducted with high school participants and teachers as a part of The HERP (Herpetology Education in Rural Places and Spaces) Project's Herpetological Research Experience (HRE). HREs are residential summer programs that provide opportunities for high school students and teachers to participate in studies of frogs, turtles, snakes, lizards, and salamanders. This curriculum provides ideas for conducting an educational program on lizards. We provide information about lizards, describe how we conduct **mark/recapture studies** of **anoles**, and explain how we catch anoles and other lizard species that live in the North Carolina Piedmont and the North Carolina Inner Coastal Plain. Sampling methods and techniques, data collection, and reporting procedures are also described.

II. Philosophical Teaching Points

Lizards are the largest group of living reptiles and come in many sizes, shapes, patterns, and colors. There are 155 species of lizards in North America. Lizards are ideal model organisms for study because they are found in many habitats (forests, deserts, marshes, and prairies). Lizards live in all but a few states, making lizards perfect organisms for scientific investigations. While lizards are numerous and we know a great deal about the ecologies of lizards in North American deserts, we do not know as much about their ecologies in other regions of the continent. Lizards act as both predators and prey in food chains, and different species of lizards may compete for the same habitat in an ecosystem. Lizards also act as pollinators and seed dispersers. Lizards are generally diurnal, courtship is brief, and fertilization is internal. Most lizards are egg layers, but occasionally young are born alive. All North Carolina native lizards are egg layers (**oviparous**). Many lizards are insectivorous and play important roles in food webs, helping to control insect populations.

Lizards are common and widespread in North America, and therefore are excellent

organisms to track as our climate changes. Because we do not know much about their ecology outside their North American desert habitats, our observations can be useful to understanding their behaviors and life histories. As the presence and or abundance of specific lizard species change, lizards may become harbingers of future environmental degradation. In North Carolina, one threat to native lizards is invasive species of lizards. Invasive species may have no natural predators, they may destroy habitat, and they exploit the resources of the native species.

III. Learning Objectives for The Lizard Project

After completing this project, participants will be able to:

1. Engage in inquiry investigations that demonstrate an understanding of the nature of science
2. Demonstrate techniques to safely catch, handle, house, and release lizards
3. Demonstrate appropriate use of equipment (lizard lassoes) and measurement tools (scales to determine mass and calipers to determine total length [TL] and snout-vent length [SVL])
4. Explain the trapping methods that are used in this project
5. Describe threats that lizards face in general (e.g. loss of habitat) and locally (e.g. competition with invasive species)
6. List the characteristics of lizards
7. Use a field guide to identify local species of lizards
8. Compare and contrast the biology and ecology of two lizard species that occupy the same habitat
9. Explain that lizards can be found in nearly every state, are a critical creature in food webs, and serve, like all animals, an important role in ecosystems where they are abundant
10. Demonstrate an understanding of how to study lizard populations and population structure by using temporary mark/recapture methods

IV. Instructor Background Needed to Conduct Project

The willingness to learn is the most important quality of a Lizard Project Leader. Previous experiences in biology fieldwork are very helpful but not mandatory as long as someone involved with the project is comfortable in the out-of-doors, especially in overgrown natural areas. It is however important for the instructor to do some preparation before starting a lizard investigation with participants. Observing lizards at the study site beforehand will provide information about

the organisms present. Different capture methods are used for different kinds of lizards; practicing catching lizards at the study site is important so techniques can be properly demonstrated to participants.

Remember, as this curriculum is an inquiry investigation, elicit as much information as possible from participants about the main points rather than telling them information before they have a chance to think about what they are experiencing. Add information to the conversation after participants have had a chance to think and share information. It is important to try to understand participants' thinking in order to help correct any misconceptions. It is also important to discuss what is unknown, and to think about how the group could find answers.

Lizard Project Leaders make connections with HRE participants by asking questions such as :

- Does anyone have a pet lizard? (If participants do, the leaders can ask them to share about their pet lizard)
- Has anyone ever caught lizards before? (If participants have, the leaders can ask them to share their experiences)

Using Pet Lizards (typically non-native species) to Learn Lizard Anatomy

A live animal is beneficial for engaging students in this project, but realistic models or even lizard cards can be used to teach content. To teach students the basic anatomy of lizards, as well as proper handling methods, our Lizard Project Leaders use a bearded dragon, a large non-native pet lizard. As the leaders introduce the bearded dragon, they ask the students questions. Students' comments and questions can be used to teach general information about lizards. Examples of leading questions include:

- What do you notice?
- Is this the same or different than salamanders you have seen?
- Does anyone know what it is?

Asking leading questions allows the discussion to be based on the questions the HRE participants ask and the comments they make.

Examples of student questions about the Bearded Dragon include (answers are in italics):

- Where are these found? (*Bearded Dragons are found in the wild in Australia)*
- Are they more aggressive in the wild? *(Yes, adult bearded dragons are territorial and establish social* ***hierarchies*** *in which aggressive displays are a normal part of their social interactions. The beard is used for both mating and aggression displays.)*
- Are they territorial? (*Yes, males have a 2-3 meter territory.)*

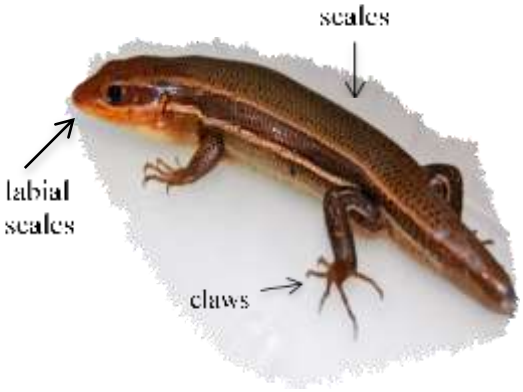
- What does it eat? (*It eats a 70% vegetarian/30% animal [crickets, mealworms, and other small invertebrates] diet.)*
- Is that an eardrum? (*These are external ear holes. This is one way you know it is a lizard. If we see a legless 'snake' with ear holes, we know it is really a lizard, even if someone calls it a "glass snake.")*

After several student questions, the leaders guide the participants with more direct questions. The overall goal is for participants to understand the differences between reptiles and amphibians and the differences between snakes and lizards. Examples of the guided questions

Figure XX. The photo on the left is a smooth earth snake; notice there is no ear hole. The photo on the right is an Eastern glass lizard, also called a glass snake. Notice the ear hole, above the black arrow. Photo on left from http://www.fieldherpforum.com. Photo on right from www.herpsofnc.org

include (answers are in italics):

- What do we call this rough looking skin? (*Scales. All reptiles have scales. Salamanders do not have scales.)*
- Do animals have lips? (*On reptiles, like snakes and lizards, we call them* ***labial scales****.)*
- What do you notice about its feet? (*Lizards have claws, unlike salamanders, which do not have claws on their toes).*
- What do you notice about its eyes? *(Its eyes are to the side so it doesn't see straight in front.)*



This is a photo of a Broad-head skink. The skink lost its tail at some point prior to capture.

It is important to know this information because these are the distinguishing features of lizards. Knowing the characteristics of lizards helps students learn more about animals that

people sometimes mistakenly identify as lizards, such as snakes and salamanders. These features are also used to distinguish different lizard species from one another.

Project leader holding a bearded dragon video: http://vimeo.com/109472770

V. Materials

- Aquariums, branches for lizards
- Store bought lizards (e.g. anoles)
- Crickets and cricket housing
- Bamboo poles
- Dental floss
- Tape
- Ruler
- Caliper
- Ziploc bags
- Magnifying glass
- Sharpie permanent marker
- GPS (or a smartphone app)
- Spring or digital scales
- Data sheets

VI. Participant Safety in the Field

While doing fieldwork in North Carolina, participants may encounter including chiggers, yellow jackets, ticks, and spiders. Using insect repellant (but not on hands if participants plan to handle 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 repellant (such as Permethrin) instead of applying insect repellant to the skin. Pulling crew 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 engage in safe fieldwork practices. They should wear sunscreen and carry drinking water. In hot weather, make sure participants are well hydrated; ask them to stop and drink water at regular intervals to help prevent heat stroke or other complications. Sturdy boots are useful when hiking in rough or overgrown terrain. If an area may contain snakes, know that feet and ankles are the most common bite locations, followed by hands. Wear protective footwear (such as rubber work boots to cover calves), long pants, gloves (such as leather gloves), and look before placing hands down or around a tree. Always hike with a partner and let someone else know the itinerary.

When looking for lizards, there are only two venomous lizard species in the US: the Gila monster and Mexican beaded lizard (reverse these or names since Gila comes first here but in the photos Beaded is first), both in the Southwest. (can't edit the photo captions below –

but would delete the captions except the citation and put a text book on the map or image of the animal with the name)

To the left is a Mexican beaded lizard, which is found in Southwest US, as the range map, right, shows.
Photo and range map: http://nylearns.org/module/content/search/item/1004/viewdetail.ashx#sthash.MK0Igwuj.dpbs

To the left is a Gila monster. These lizards are found in the Southwest US, as depicted by the range map on the right.
Photo and range map: http://animals.nationalgeographic.com/animals/reptiles/gila-monster/

VII. Animal Handling Guidelines and Animal Care

Regardless of the size of the lizard, the animal will not feel secure unless all of its limbs are supported. Small lizards can usually be grasped in one hand, with their forelegs resting on the index (pointer) finger, their body lying across the palm, and their hind feet gently gripped.

Calm individuals will usually be content to rest in this position with little or no restraint. Feistier lizards may require applying gentle pressure with the thumb across the animal's back. In most cases, the animal is not held. Instead, it is just sitting on the hand. The thumb may be resting on the animal's back without exerting pressure, but this point of contact is generally enough to keep the lizard still. Turning them over gently on the palm and rubbing their undersides can make some lizards, such as the Eastern Fence Lizard, lie still.

NOTE: Skinks and glass lizards break their tails easily. Anyone handling skinks or glass lizards should be especially careful, because they lose an important energy reserve when they lose their tails, and life will likely be more difficult as their tails regenerate.

Releasing Animals

Release animals where they were caught and where they can quickly find cover. Allow animals to crawl under rocks, logs, or coverboards instead of putting the cover pieces on top of them, as this can potentially harm the lizard.

Animal Care/Pet Care

Many captive-bred reptiles, such as Bearded Dragons, live a long time, so owners need to make a long-term commitment to take care of them and keep them healthy. Captive-bred anoles only live a couple of years, so they make good starter pets. Never release a captive-bred lizard into the wild; for information on why this is so important, consult the Partners in Amphibian and Reptile brochure called "Don't Turn it Loose."

VIII. Student Activities

Identifying Lizards

To facilitate lizard identification in the classroom, project leaders should catch several lizards of different lizard species prior to the HRE and keep them in the classroom throughout the week. These lizards can be used to teach participants how to identify different species. These organisms should be released at the point of capture at the conclusion of the HRE. Note: If individuals will not eat or drink in captivity then release them and catch new individuals. If wild-caught lizards are kept for a few days, we recommend having several different sized crickets on hand to feed them, as small lizards, like ground skinks, need smaller crickets than larger lizards, like broadhead skinks.

Using a field guide, identify lizards in the classroom. We use *Amphibians and Reptiles of the Carolinas and Virginia 2nd Edition*. The field guide provides detailed information about the natural history of each species as well as range maps. Educators could also create a dichotomous key to use to identify the lizards in their area; there may already be one available online. One activity that Lizard Project leaders can do involves a set of lizard identification cards (photographs right), which the Lizard Project leaders created. They use these cards in the classroom and in the field. Each participant wears a card necklace with a photograph of one lizard on the front and a description of the characteristics of the lizard on the back. This aids in identification of lizards in the field and helps students familiarize themselves with the local species. We call this a walking field guide.

The first lizards students are introduced to are captive-bred green anoles, which are easy to identify and relatively easy to hold. Students are often eager to hold the animals, but they must first identify the animal by using their field guides. Students are instructed not to "just use the pictures" for identification but also to read the descriptions carefully and look at range maps. To help students do this, the leaders use the "Give Me Three" ID rule, which requires students to identify at least three characteristics of the organism (e.g. size, range, coloration, stripes, spots, or habitat) in order to confirm a positive identification. In North Carolina, only anoles have colored dewlaps. However, during mating seasons, coloration variations are also seen in eastern fence lizards (males will have bright blue markings on their throats and bellies) and broadhead skinks (males will have reddish orange heads). Following the Carolina anole identification, students are given three different skinks (broadhead, five-lined, and southeastern five-lined) to identify because they are easily confused.

Common Species of Lizards in Our NC Project Areas

The following table should help identify North Carolina lizards that look similar at first glance. We also use the field guide to help with identification.

Scientific Name	**Common Name**	**Distinguishing Characteristics**
Anolis carolinensis  Photo by Drumguy8800	Green anole or Carolina anole	Green or brown. Males have large, red **dewlap**.
Cnemidophorus sexlineatus 	Six-lined race runner	6 lines on body and very fast! Has easily seen **femoral** pores, even on juveniles.
Eumeces fasciatus	Five-lined skink	5 to 8 inches long with wider **subventral** (**median subcaudal**) scale row. 5 stripes on back, usually 4 labial scales, and **dorsal** cranium lines usually converge.

 Photo by Patrick Coin		
Eumeces inexpectatus 	Southeastern five-lined skink	5.5 to 8.5 inches long with narrow **midventral** (median subcaudal) scale row. 7 stripes on back, usually 5 labial scales, and dorsal cranium lines do not converge.
Eumeces laticeps  Photo by Ryan Somma	Broadhead skink	6.5 to 12.75 inches long with wider subventral (median subcaudal) scale row. 7 stripes on back, usually 5 labial scales, dorsal cranium lines do converge. Males tend to lose their stripes and have bright red/orange heads during mating season.
Sceloporus undulates 	Eastern fence lizard	Has keeled scales. Males have blue color on throat and belly.
Scinecella lateralis 	Ground skink	3 to 5 inches long, yellow belly and dark stripe on sides; prefers woodland habitat with pines.

Capturing Lizards

First, learn everything possible about the lizards being caught by reading about and observing them. Find the most likely places for lizards which are usually associated with basking, food supply, or hiding places. Enter the area they frequent in a stealthy manner to get as close as possible.

Lizards will be wary, so use a slow, careful, non-threatening posture when approaching. Sudden movements will cause the lizards to seek safety, making it unlikely that they will emerge again for some time.

While stalking their prey, lizards move slowly back and forth, as though they were waving in a breeze. If participants do this same back and forth motion, they may be able to move right up to a lizard and possibly touch it. Have participants move slowly back and forth, until their hand is positioned where they want it. Then make the grab with a flat hand. This ensures that the lizards are not at risk of being injuried.

Methods for Various Lizard Locations

Tree trunks. When a lizard moves to the backside of a tree, memorize where the lizard is and make a flat-handed grab, not too hard, in that spot even if the animal isn't visible (see below for details).

Under cover. Turn over anything lizards can hide under, including boards, boxes, firewood, or other items in cool, moist places in the yard where they can hide undisturbed. Make sure to flip the items away from you as other animals might also be using this cover as a hiding spot. They will scurry away, but, if participants are prepared, lizards are not too fast.

Methods for Lizard Capture

Using hands. Lizards, such as anoles or fence lizards on tree trunks or skinks in leaf litter, can be caught by hand. Use a quick, flat hand whenever possible to cover the lizard in order to avoid harming the animal. Don't grab the lizard by its tail because the tail can detach and the lizard then escapes. Don't grab the lizard's head or neck because it might get hurt.

Using a net. For faster varieties of lizards like skinks, participants may want to use a deep net, which is easily made. This may be a simple bag made from cheesecloth or other open weave fabric stretched onto a stiff wire loop made from a clothes hanger. Make the shape similar to the letter D, so there is a square edge that can be placed on the ground. The net will allow participants to capture lizards without harming them when they are grabbed. Deeper nets mean lizards can be guided into the bottom and the middle or top of the net under the hanger can be grabbed so the lizard can't get away.

Trapping. A simple trap can be constructed and baited (with food such as small crickets). Lizards (especially skinks) can be caught by simply scooping them up with leaf litter into a small plastic trashcan. Sorting through the leaf litter can also yield other terrestrial invertebrates, which can provide material for discussion about food webs and invertebrates' roles in the environment. Some lizards can be caught by cutting an 18" long section of PVC pipe and closing one opening with duct tape (make sure the sticky side does not come in contact with the lizard). Lizards see this as a hole and run right in.

Photo from: http://alpha.cartercole.com/2010/10/how-to-make-simple-lizard-trap.html

Using a Lizard Lasso. Using a lasso on the end of a bamboo stick is a great strategy for catching lizards with broader heads and thinner necks, such as anoles and fence lizards. More streamlined lizards, such as skinks, are hard to catch with lassos. Lassoing rarely hurts a lizard. To ensure students are comfortable using lizard lassos, they can practice on plastic lizards. Making a lasso is easy; you only need to know how to tie a slipknot.

The best way to lasso is to work the loop over the lizard's head completely before tightening. Take the animal off the lasso as quickly as possible. If the lizard has spun around, allow it to spin back (or spin the pole) so that the line does not get twisted; taking a lizard off before allowing it to untangle will often ruin a lasso.

Practice how to safely remove lizards from the lassos. Take a lizard off by simply pulling on the "handle" which opens the lasso. Having two or three people remove a lassoed lizard is helpful. The lizard can rest on the bamboo pole (one person holds the pole) while another person releases the lasso. The third person can gently but securely hold the lizard as described above.

Lasso used on a real lizard video: http://vimeo.com/109472935

How to use a lasso video: https://www.youtube.com/watch?v=dnhh9xx9aB0

How to make a lizard lasso video: **http://vimeo.com/109472357**

The pictures on the following page demonstrate one method of lizard lasso construction. For small lizards, a 10 or 20 lb. monofilament fishing line is recommended.

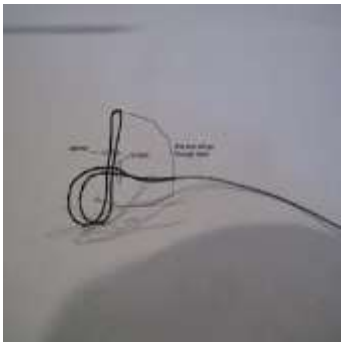
1.

Cut fishing line about 1’ long

2.

Fold one end of the fishing line (about 3”) toward the unfolded end

3.



Form the doubled portion into a circle

4.

Pass the doubled end through the circle

5.

Pull doubled end through circle to form knot

6.

Leave looped portion extended above knot

7.

Leave ¼” loop above knot

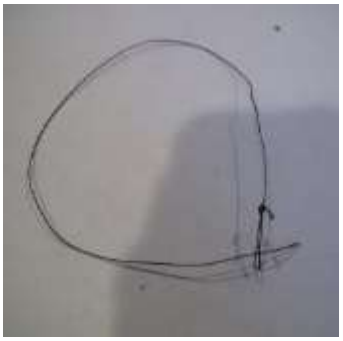
8.

Cut short string below knot

9.

Put single end of string…

10.



…through the loop above the knot

11.

Form a 1”-2” diameter lasso

12.

Attach single strand end of fishing line to tip of a pole

Several questions can be asked about the lizard lassos. For example,

- How does the bamboo pole's length affect the rate of lizard capture?
- How does the lasso's length affect the rate of lizard capture?

A recently lassoed anole, resting on a bamboo pole.

Data Collection

Students should collect the following data on each lizard: sex, total length, snout to vent length and mass. The table below gives tips to help you determine the values that you should enter on the datasheets for your measurements.

<table>
<tr><th>Data</th><th>Sex
(F or M)</th><th>Total Length (mm)</th><th>Snout to Vent Length
(SVL) (mm)</th><th>Mass
(g)</th></tr>
<tr><td rowspan="2">Tips</td><td rowspan="2">Size of the femoral pores, which are secretory glands on the inside thighs

Size and color of the dewlap

Dimorphic Color characteristics (e.g. Fence Lizards)</td><td>Use calipers to measure

Measure from the tip of the snout to the end of the tail</td><td>Use calipers

Measure from the tip of the snout to the posterior end of the vent</td><td rowspan="2">Place the lizard in a plastic bag

Use a spring or digital scale to weigh the empty bag. Then place the lizard in the plastic bag and weigh the lizard and the bag.

Subtract the bag's mass from the mass with the lizard to get the lizard's mass</td></tr>
<tr><td colspan="2">These two lengths are important as lizards can lose and regenerate their tails.

Find the ratio of the two lengths by dividing the SVL by the total length.</td></tr>
</table>

Identifying eastern fence lizard video: http://vimeo.com/109472550

Identifying scales video: http://vimeo.com/109472178

Identifying green anole video: http://vimeo.com/109471430

Collecting these data allows for generalizations about a population of lizards. For example, what could be extrapolated about a population where lots of lizards have lost their tails?

A student gently pulls the dewlap on an anole to determine the sex of the anole. The large bright dewlap indicates that the anole is a male.

Measuring a lizard with calipers. A plastic bag keeps the lizard still and straight.

Mark/Recapture Study of Anoles (*Anolis carolinesis*).

We work for short-term periods in many of our study sites, and therefore conduct only a few mark/recapture studies. After we complete data collection as described above, we mark the anole on its side with a non-toxic permanent marker. We release the anole exactly where it was captured and then, as our program progresses, we look for these marked anoles each day as well as new anoles. Anoles shed (but do not eat) their skins about every four weeks, so marking these lizards in this way does minimal harm to the animal while allowing us to look broadly at habitat use and calculate estimated population numbers of green anoles.

A recently marked anole, which had lost its tail prior to being captured.

Additional Data Collection Possibilities

Fluorescent tracking powder can be used to analyze the terrestrial movements of lizards at night. Simply dip the lizard's feet in the powder and release it at the point of capture, being careful not to get any of the powder in the lizard's mouth or eyes. Return in the evening with a black light to follow its path. Identifying where the lizard was first spotted and measuring how far up the tree or from a bush the lizard was can provide further data for analysis.

Making observations of lizard behavior in a science notebook enhances students' observation skills. Examples of observational data students can collect include:

- Observing when lizards seek sun and how they orient their bodies towards the sun
- Measuring, describing, and collecting GPS coordinates and photographing areas associated with lizard activity
- Describing, drawing, and/or photographing lizards' sunning sites and measuring the distance from cover (e.g. tree, bush, or leaf litter) or distance up tree
- Mating or territorial display behaviors such as displays of dewlaps
- Observing and recording insects in lizard activity area

The following questions help students use their lizard data to better understand the animals:

- Is there a relationship between SVL and mass?
- Does time and position in the sun aid in thermoregulation?
- Do larger lizards sun longer than smaller ones?
- Do different species sun for different times?
- Are there differences in the areas of activity for different species of lizards?
- Are there differences in the insects associated with each lizard activity site?

A student carefully records the location for the captured anole. The student will record the GPS coordinates on the data sheet and use flagging tape to mark the capture location. GPS coordinates will also be written on the flagging tape.

Invasive Lizards

One threat to native lizards is invasive species of lizards. Invasive species may have no natural predators, they may destroy habitat, and they exploit the resources of the native species. One example of an invasive species is the brown anole, *Anolis sagrei*, a native of Cuba and the Bahamas now abundant in Florida and expanding its range up the Eastern seaboard. Where populations of *A. sagrei* and the native green anole, *A. carolinensis*, occur together, *A. carolinensis* lizards shift their spatial niche upward to occupy arboreal perches from trunk to tree canopy, abandoning the ground perches they typically utilize when *A. sagrei* are absent. This spatial shift may lead to a change in the number and types of prey available to native *A. carolinensis* populations (Campbell, 2000). Green anoles are common in the Southern Coastal Plain and

Piedmont of North Carolina, so scientists are monitoring the northward march of the brown anole very carefully to assess its effect on the native lizards. Since green anoles are endemic to North Carolina, students can help closely monitor these populations. It is easy to distinguish between the two species: the green anole has a pink dewlap while the more aggressive brown anole has an orange dewlap.

North Carolina is host to at least two other invasive species: Mediterranean house geckos, *Hemidactylus turcicus*, and Texas horned lizards, *Phrynosoma cornutum*. A good article to use, which chronicles the various non-native lizards in NC is "Lizard Invaders," in the March-April 2015 issue of *Wildlife in North Carolina*.

Data Reporting to The HERP Project and HerpMapper

Through use of the Herp Project app (available for FREE download at 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. A new international citizen science herp database, Herp Mapper (www.herpmapper.org) has been developed and we recommend its use too.

IX. Resources

Web Resources

Anole Annals: http://www.anoleannals.org
Carolina Biological Supply: http://www.carolina.com/
Carolina Herp Atlas: http://www.carolinaherpatlas.org
"Frog plays ipad the ant crusher" video: http://www.youtube.com/watch?v=AbKGrtpgBtA
Herpedia: http://www.herpedia.com
Reptile Supplies: http://www.lllreptile.com
Handling Reptiles: http://lllreptile.com/info/library/care-and-husbandry-articles/-/handling-reptiles/
Partners in Amphibian and Reptile Conservation: http://www.parcplace.org
The HERP Project: http://theherpproject.uncg.edu
The Lizard Lab: http://whitinglab.com/
World Wide Science: http://www.wideworldscience.blogspot.com
Partners in Amphibian and Reptile Conservation brochure "Don't Turn it Loose": http://www.parcplace.org/images/stories/pdfs/DontTurn.pdf
Research Techniques: http://www.uvm.edu/~jschall/techniques.html

Books and Articles

Beane, J. C., Braswell, A. L., Mitchell, J.C., Palmer, W. C., & Harrison III, J.R. (2010). *Amphibians & reptiles of the Carolinas and Virginia*. Chapel Hill: University of North Carolina Press.

Campbell, T.S. (2000). Analyses of the effects of an exotic lizard (*Anolis sagrei*) on a native lizard (*Anolis carolinensis*) in Florida, using islands as experimental units. Unpubl. Ph.D. dissert. University of Tennessee, Knoxville.

International Society for Technology in Education (ISTE). (2007) Student Standards https://www.iste.org/docs/pdfs/20-14_ISTE_Standards-S_PDF.pdf

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By State*s. Washington, DC: The National Academies Press.

Palmer, W.M. and Braswell A.L. (1995). *Reptiles of North Carolina*. Chapel Hill: University of North Carolina 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/

X. Especially for Teachers

The Herp Project Curriculum	Next Generation Science Standards	International Society for Technology in Education Student Standards
Practices/skills: Research design Hypothesis building/testing Data collection Measurement skills Taxonomy Data analysis Presentations/videos Citizen Science digital data upload	**HS-LS2-1.** **ESTS1-1** **Science and engineering practices:** -Using mathematical and computational thinking -Constructing explanations and designing solutions	**1. Creativity and innovation:** a. Apply existing knowledge to generate new ideas and processes in research design. **2. Communication and collaboration**: b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats to share findings from scientific investigations. **3. Research and information fluency**: a. Plan strategies to guide inquiry using apps in the field for scientific investigations. **4. Critical thinking, problem solving, and decision-making:** 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. **5.** Digital citizenship: a. Advocate and practice safe, legal, and responsible use of information and technology. **6. Technology operations and concepts**: 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.
Energy flows Food energy pyramids Food webs Genetic hybridity Habitat/Niches Human impacts Interdependence Interactions Invasive species study Natural selection	**HS-LS1-2** **HS-LS2-1, 2, 6, 8** **HS-LS3-1, 2, 3** **HS-LS4-1, 4, 5, 6*** **HS-ESS2-2, 4*, 5, 6, 7** **HS-ESS3-1, 3*, 4, 5, 6*** **Science and engineering practices:** -Engaging in argument from evidence	**2. Communication and collaboration**: d. Identify trends and forecast possibilities. **3. Research and information fluency**: b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media. c.

The Herp Project Curriculum	Next Generation Science Standards	International Society for Technology in Education Student Standards
Population studies Predator/prey Species diversity Weather and climate	-Obtaining, evaluating, and communicating information **Crosscutting Concepts:** -Cause and Effect -Scale, Proportion, and Quantity -Stability and Change *Real, not a simulation or model.	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. **4. Critical thinking, problem solving, and decision-making**: 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. **5. Digital citizenship:** b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity. **6. Technology operations and concepts**: Understanding technology concepts, systems, and operations. b. Select and use applications effectively and productively. c. Troubleshoot systems and application.
Extension Activity: Reduce human impact on the ecosystem.	**HS-LS2-7** **HS-LS4-6** **HS-ETS1-2, 3, 4** **Science and engineering practices:** -Developing and using models -Developing possible solutions -Optimizing design solution **Crosscutting concepts:** Influence of science, engineering, and technology on natural world	**1. Creativity and innovation**: a. Apply existing knowledge to generate new ideas, products, or processes. b. Use *models and simulations to explore complex systems and issues. **4. Critical thinking, problem solving, and decision-making**: 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. The HERP Project Data Sheet

Lizard Population Survey

Group Number: _____ Scribe:_____
Date (dd/mm/yyyy): _____ Number in party: _____
Exact location of study: County_____, NC, Site Name_____ Beginning Time _____AM/PM
Environmental Parameters
Current Air Temp_____F/C Max Air Temp for past 24 hours_____F/C Min Air Temp for past 24 hours____F/C
Relative Humidity _____% Rain amt. w/in last 24 hrs _____mm Number of Days since last rainfall _____

Capture Location (GPS Coordinates)	Species	Capture Method (Lasso or Hand)	Sex	Mass (g)	SVL (mm)	Tail Length (mm)

Additional Information related to this day of data collection:

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Appendix B. Transcript of Project Leader Holding Bearded Dragon

Lacey – See his scales, ok. This guy does have some spikes (motions to sides of lizard) so we gotta be careful how we hold him. He doesn't mean to hurt you but, you know, they do poke. Ok, he has what?

Participant – Sharp claws

Lacey – So do you guys notice the claws? That's another characteristic, ok? (Points to back feet) Notice anything else?

Participant – He's tiny but his skin is really big and hanging off. (Motions around his own neck.)

Lacey – (Laughs) Ok.

Appendix C. Transcript of Lasso Used on a Real Lizard

(Participant holds lasso on the end of a stick over a lizard. He quickly lassos the lizard and picks it up.)

Lacey – Oh nice, there you go.

Participant – Oh it's a stick, I got you with a stick.

Lacey – Good job, yeah, perfect.

(Lacey removes the lasso from the lizard's neck.)

Lacey – There you go.

Appendix D. Transcript of How to Make a Lizard Lasso

Lacey – So, we're going to practice with our big string and then we're going to go to our fishing line because that's what we really use. If you're a Boy Scout or a Girl Scout or have done any type of adventure training, this is really a slip knot that we're making so if you know how to do that…

Participant – I know how to make a slip knot.

Lacey – Good. If you know how to make a slip knot, then you can help teach others after we go through our basic instructions. But I want one end to be short so you see I have my short end here, (holds up string with short end pinched) and see when I put them together it gives me a double string?

Appendix E. Transcript of Identifying Eastern Fence Lizard

Lacey – So, what do we have here?

Participant – Lizards.

Lacey – Hold on, you're saying these are the same?

Participant – Mm Hmm

Lacey – So what type of lizard is this?

Participant – Eastern Fence

Lacey – Eastern Fence Lizard, good. Now which one's male and which one's female?

Participant – This one's… this one's male.

Lacey – How do you know that one's a male?

Participant – Black, on the bottom.

Lacey – Ok, so right there? (points to bottom of one lizard) Good! And notice how that one? (points to other lizard) Now if we look, see how her head is also smaller? And her body's smaller?

Appendix F. Transcript of Identifying Scales

Haley – So the sub-caudal are the ones along the tail and so in the one that you're describing there, the midline, the ones right down the middle, would be a lot thicker than the rows next to them. And so, on these ones, the scales are pretty much the same width across the tail.

Participant – Ok.

Haley – So that kinda helps us rule out the one you were just describing so keep looking.

Participant – Ok, so, this one is not a five-line skink?

Haley – It shouldn't be, if you look at the rows on the tails, probably. But, is there anything else that we could use to rule it out?

Appendix G. Transcript of Identifying Green Anole

Lacey – So if they don't live here, it's probably not that species.

Participant #1 – She said it's a native to here.

Lacey – These are all caught here. In fact, you guys get to release all of these today except our three that say "captive" on the top. We have to go take these back to their homes.

Participant #2 – (to participant #3) You've got this one, do you want me to pick it up?

Participant #3 – Yeah.

Participant #2 – (Reaches into the carrier) His tail is…

Participant #3 – Oh, I found him! (Points to field guide) He's that one.

Lacey – How do you know?

Participant #3 – Because of the legs.

Lacey – So, explain to me. What do you mean, because of the legs?

Appendix H. Glossary

anoles: small lizards in the *Iguanidae* family

dewlap: fold of loose skin hanging from the neck of the animal, sometimes brightly colored

dorsal: of or relating to the upper side or back side of an animal

femoral: having to do with the thigh or femur of an animal

hierarchies: ranking or level of authority in an animal community

labial scales: scales on the lips of lizards and snakes

mark/recapture studies: involve marking a number of individuals in a natural population, and returning them to that population, and then recapturing some of them in order to estimate the size of the population at the time of mark and release--the number of recaptures relative to the total of individuals marked initially should be the same as the total number marked relative to the total population

median subcaudal: the middle row of scales on the underside of the base of the tail

midventral: middle of the belly or underside, the ventral side of the animal

oviparous: egg laying

subventral: under the ventral (belly) side of the animal