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The Ins & Outs of Developing a Field-Based Science Project: Learning by Lassoing Lizards

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ABSTRACT

We describe a field-based lizard project we did with high school students as a part of our summer Herpetological Research Experiences. We describe data collection on lizards captured, identified, and marked as a part of our mark-recapture study. We also describe other lizard projects that are ongoing in the United States and provide resources for teachers to help them start their own field-based science projects. Our work with lizards focuses on fieldwork but also includes classroom components with captive-bred and wild-captured animals. Information on organizations that focus on lizards is provided, including several citizen science opportunities.

Key Words: Ecology; fieldwork; lizards; reptiles; herpetology.

Studying lizards can be an exciting and rewarding project for high school students, providing opportunities to engage in biology and contribute to scientific research. Lizards are ideal model organisms for classroom inquiry because they are found in many habitats (forests, deserts, marshes, and prairies) and in most states. Exceptions include Alaska, Maine, New Hampshire, and Rhode Island (J. Beane, personal communication).

Lizards are reptiles with scales, external ear openings, and claws at the ends of their toes. Many are insectivorous and play important roles in food webs, helping to control insect populations. Because of their superficial resemblance to salamanders, lizards are commonly mistaken for their amphibious relatives; however, salamanders have smooth, moist skin, no external ear openings, and no claws. Most salamanders are found only in or close to aquatic environments, whereas lizards are found in many ecosystems around the world. Herpetology, the study of reptiles and amphibians, groups these ectotherms together and commonly refers to both groups of organisms as “herps.” Herpetology is often field-based and provides opportunities for teachers and students to engage in field science.

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, including some invasive species. One example of an invasive species is the brown anole, *Anolis sagrei*, 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, individual *A. carolinensis* shift their spatial niche upward to occupy arboreal perches from trunk to tree canopy, abandoning the ground perches they otherwise utilize when populations occur in the absence of *A. sagrei*. 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. North Carolina is host to at least two invasive species: Mediterranean house geckos, *Hemidactylus turcicus*, and Texas horned lizards, *Phrynosoma cornutum*.

Males and females of the same lizard species often show color differences, and juveniles are frequently distinct from adults. Subspecies may differ also. An example of variance in a lizard that is found in North Carolina is the legless lizard, commonly mistaken for a snake. Unlike their serpent counterparts, legless lizards (sometimes referred to as “glass snakes”) have movable eyelids and external ear openings.

The sex of certain species of lizards can be distinguished by the size of the femoral pores, secretory glands on the inside thighs.

For example, male Texas horned lizards have enlarged femoral pores, whereas the femoral pores of females are barely visible. In other species, such as geckos, the females lack femoral pores.

Lizards have varied lifestyles but are generally diurnal. Lizard courtship is brief, and fertilization is internal. Most lizards are egg layers, but occasionally young are born alive. All North Carolina native lizards are oviparous (Palmer & Braswell, 1995). Only two species in the United States are venomous (Gila monster and Mexican beaded lizard). Both are located in the Southwest.

Lizards are reptiles with scales, external ear openings, and claws at the ends of their toes.

Lizards were designated as the 2012 Herp of the Year by the Partners for Amphibian and Reptile Conservation (PARC). PARC's initiative for The Year of Lizard was eloquently stated:

Why Lizards, and Why Now? The growth of human communities and our effects on natural habitats are having its toll on our lizards, as for so many other taxonomic groups. Habitat loss and fragmentation is the main threat to lizards, but other factors are being raised as issues as well: overexploitation, predation, and climate variation. The purpose of the ...Year of the Lizard ... is to raise awareness for lizard conservation. With place-based management, local populations can thrive. This is a taxonomic group that can benefit by Citizen Science actions.... We believe that citizens, natural resource managers, scientists, and the pet and food and related industries can work together to address issues and to help ensure long-term survival of lizard species and populations. (<http://www.parcplace.org>)



Figure 1. A Carolina green anole, *Anolis carolinensis*, captured with a lizard lasso.

The purpose of this article is twofold. First, we describe, in detail, the lizard project we developed as a part of the Herpetological Research Experiences (HREs) we offer to high school students. Second, we present lizards as an excellent study organism to introduce students to field science and to explore biological diversity because of their wide distribution, high population densities, and interest to students. Plus, they are safe to handle.

○ Lizard Lassoin' (Capturing Lizards... Well, Some Lizards)

With such widespread abundance, lizards make great study subjects for high school science classrooms. The first challenge in studying lizards, if you plan to weigh, measure, or mark them, is to capture them. Some lizards can be captured by hand with a quick grab, but one method that works for anoles and fence lizards is using a lasso that consists of a slipknot tied at the end of a pole (see Figure 1). See Web Resources (below), which include a website with instructions on how to make lizard lassos.

○ Our HRE Lizard Project

Our team of scientists, science educators, and graduate students has spent the past six summers running HREs for high school students (rising 9th- to 12th-graders). We have studied aquatic and terrestrial turtles, salamanders (in streams and temporary pools), snakes, and frogs. Our lizard project was developed for 2012's Year of the Lizard and was refined and offered again in 2013.

In North Carolina, we have 13 species of lizards, all relatively small and nonvenomous (Beane et al., 2010). During our HREs, we identified three lizard species at our first site in the central Piedmont area of North Carolina (CCR) and seven species at our second site in the upper coastal plain (Rockfish). All three species found in the Piedmont were also found in the upper coastal plain, so we have experience with seven different species of lizards. See Table 1 for a list of lizard species found in North Carolina and the lizard species identified at each of our HRE field sites.

Table 1. Lizard species in North Carolina, showing which species were captured and studied in our project.

Scientific Name	Common Name	Captured at CCR HRE	Captured at Rockfish HRE
<i>Anolis carolinensis</i>	Green anole		X
<i>Sceloporus undulatus</i>	Eastern fence lizard	X	X
<i>Scincella lateralis</i>	Ground skink		X
<i>Eumeces fasciatus</i>	Five-lined skink	X	X
<i>E. laticeps</i>	Broadhead skink	X	X
<i>E. inexpectatus</i>	Southeastern five-lined skink		X
<i>Cnemidophorus sexlineatus</i>	Six-lined racerunner		X
<i>Ophisaurus attenuatus</i>	Slender glass lizard		
<i>O. ventralis</i>	Eastern glass lizard		
<i>O. mimicus</i>	Mimic glass lizard		
<i>Phrynosoma cornutum</i>	Texas horned lizard		
<i>Hemidactylus turcicus</i>	Mediterranean gecko		
<i>Eumeces anthracinus</i>	Coal skink		

In our HRE lizard project, students looked for, captured, identified, and collected data on lizards. We determined sex and measured snout-to-vent length, total length, tail length, and mass. Our inquiry questions for the lizard project were (1) What kinds of lizards can be found? (2) What are the distribution patterns of the various lizards that are located and identified? (3) How do the lizards vary in length and weight? (4) What is the ratio of males to females in different lizard species? (For many of our lizard species, determination of sex would require internal probing, which we did not do; we also tried everting hemipenes, but with our small lizards this didn't work very well either.) Once we have sufficient data about the lizard populations that are present at our study sites, we will include some experimental questions in our studies, such as (1) Do male anoles adjust their home ranges based on ambient air temperatures? and (2) How do the food preferences of female anoles change seasonally?

Before going into the field to collect lizards, students were introduced to an adult male pet bearded dragon that is kept at the Environmental Education Center at Rockfish, North Carolina (<http://www.eenorthcarolina.org/ee-centers.html>). Bearded dragons are great introductory lizards for teaching external lizard anatomy because they are large and allow students to easily observe the anatomical features of lizards, such as ear openings, claws, scales, labial scales (scales on the mouth), and femoral pores. Once students were comfortable identifying the external anatomy of a lizard, they were given a live native lizard to identify using a field guide, *Amphibians & Reptiles of the Carolinas and Virginia* (Beane et al., 2010). Students soon discovered that three lizard species (broadhead skinks, five-lined skinks, and southeastern five-lined skinks) look almost identical when they are juveniles (Beane et al., 2010). To determine which of the three species they had, students used magnifying glasses to count the labial scales before the scale under the eye and looked at the midventral row of scales under the tail. The broadhead skink has five labial scales before the scale under the eye, whereas five-lined skinks usually have four labial scales. Southeastern five-lined skinks have a narrow midventral scale row, which distinguishes them from the broadhead and five-lined skinks that have a wide midventral scale row under the tail (see Table 2).

We did not know whether we would be able to capture lizards each day that we were in the field, so we purchased eight captive-bred anoles from Carolina Biological Supply and set up appropriate housing. Having these captive anoles allowed us to begin our project indoors, where students could learn the appropriate skills to conduct the field-based component. Students practiced locating the captive

Table 2. Identifying three similar juvenile North Carolina lizards.

Scientific Name	Common Name	Number of Labial Scales Before Scale under Eye	Width of Midventral Scale Row under Tail
<i>Eumeces fasciatus</i>	Five-lined skink	4	wide
<i>E. laticeps</i>	Broadhead skink	5	wide
<i>E. inexpectatus</i>	Southeastern five-lined skink	4	narrow

The HERP Project's 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, Hand, or Trap)	Sex	Mass (g)	SVL (mm)	Tail Length (mm)

Additional Information related to this day of data collection:



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Figure 2. Data sheet for The HERP Project's lizard study.

anolos in their tanks, which helped them develop a search image. Then they learned to weigh and measure these captive anoles. They were also able to distinguish males from females. They were able to look very closely at these lizards to develop an understanding of characteristics of lizards in general (claws and external ear openings) and field identification characteristics of green anoles in particular (color of skin and size and color of dewlap).

After the students became skilled at identifying and processing (sexing, weighing, measuring, and marking) anoles, we constructed

lizard lassos. The students made their own lassos and tested them on plastic lizards distributed throughout the room. Once they could demonstrate how to capture and then remove a plastic lizard from the lasso, they practiced lassoing a captive anole before heading out to the field.

In the field, students actively searched for lizards by walking trails and visually inspecting trees, fences, and buildings on site. When we successfully captured our lizards by hand or with lizard lassos (see Figure 1), we recorded the GPS coordinates and tagged the capture locations with flagging tape to ensure that our lizards would be returned to exactly where we captured them. After fieldwork, we went indoors to process these lizards and complete our data sheets (see Figure 2) on iPads using the Forms app (we created a Google form that mirrored the paper data sheet).

We used digital or Pesola scales to determine the mass of the lizards and calipers or plastic rulers to record their total lengths, snout-to-vent lengths, and tail lengths (see Figure 3). We also sexed our lizards by looking at dewlaps and other morphological characteristics but did not do any internal probing to determine sex (see Figure 4). Finally, we took a nontoxic permanent marker and wrote a number on each anole's side and then released it at the capture site (see Figure 5). Anoles periodically shed their skin and do not

eat their shed skin, so the marker does not harm the anole (Plummer & Ferner, 2012).

In addition, for a behavioral study of the captive-bred anoles, we uploaded various free “bug smashing” games, such as Ant Crusher, onto iPads. This idea came from a YouTube video showing a frog in front of a smart phone reacting to flies on the screen. Our study asked, “Would an anole react to ‘bugs’ on an iPad screen?” (see Web Resources and Figure 6). No discernable patterns in the anoles’ reactions were observed; HRE participants hypothesized that this was because the insects on the screen were not typical anole prey.

○ A Classroom Lizard Project

As we planned our lizard project, we became aware of research that had been conducted by a high school science class in inner-city Chicago with their teacher, Aaron Reedy, and an assistant professor from the University of Alabama at Birmingham. The results of this classroom study of brown anoles led to a peer-reviewed publication entitled “Maternally chosen nest sites positively affect multiple



Figure 3. Student measuring a lizard at Rockfish.



Figure 4. Male anole, *Anolis carolinensis*, found at Rockfish. Student shows the large, red dewlap (marked with arrow) that distinguishes male anoles from female anoles.



Figure 5. Marked female anole, *Anolis carolinensis*, with regenerating tail.



Figure 6. Testing anoles, *Anolis carolinensis*, on the Ant Crusher game.

components of offspring fitness in a lizard” (Reedy et al., 2013). The teacher, Aaron Reedy, said,

Our experiment asked the question, “How does the choice of an egg laying female’s nest site affect the survival of her offspring?”.... We moved 80 lizards into our classroom and started doing science. The data my students collected showed that female brown anoles are highly sensitive to moisture when choosing a nest site and that this choice of nest can have serious survival consequences for her hatchlings through the first 12 weeks of life. We found that a good choice of nest can lead to as much as a 22% increase in offspring size, when compared to a poor choice. (<http://blogs.scientificamerican.com/guest-blog/2012/08/31/the-lizard-project-5-reasons-why-scientists-and-science-teachers-should-work-together-for-a-new-brand-of-science-outreach/>)

Aaron’s class experiment was part of an ongoing collaboration with Dan Warner and other field biologists. These scientists, led by

Warner, are currently conducting an evolutionary study with brown anoles on several Florida spoil islands. Classrooms can get involved by following the Florida lizard project and by video conferencing with scientists in the field (<http://wideworldscience.blogspot.com>).

○ Next Generation Science Standards

The *National Science Education Standards* (National Research Council, 1996) noted that “the most powerful connections between science teaching and learning are made through thoughtful practice in field experiences” (p. 67). The *Framework for K–12 Science Education* (National Research Council, 2011) mentioned fieldwork as well. Many of the *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013) may be met through fieldwork and the study of live animals.

From molecules to ecosystems, lizards can bring science to life. For the specific study of heredity, inheritance, and traits (NGSS, HS-LS3), lizards from local natural areas show variations both within species as well as between species and using these live animals brings learning to life in a way that no single illustration in a book or a two-dimensional video can do. For the study of ecosystems (HS-LS2), the dynamics of identifying lizard species, studying their reproductive habits, and linking lizards to food webs and environmental parameters in their local habitat can bring first-hand awareness to students, especially students who need this hands-on approach as an entry into complex scientific concepts. Science learning for all is a goal of the NGSS and coincides with the goals of effective education using fieldwork to teach and enhance learning as a crosscutting concept.

○ Citizen Science Programs

Many lizards are little studied, and basic ecological information is lacking, including where they are located. In 2012, PARC launched a national effort to compile new and existing locality data for lizards. You can participate in this effort by submitting lizard localities on forms provided on the PARC website.

Another website that citizen scientists can contribute to is *Anole Annals*, “written and edited by scientists who study *Anolis* lizards ... to disseminate new scientific research, natural history anecdotes, and a wide range of other anole-related information” (<http://www.anoleannals.org>). This citizen science program allows individuals to upload anole sightings as observations.

In addition to *Anole Annals*, if you live or travel in the Carolinas and see lizards in either North Carolina or South Carolina, you can establish a free account on the Carolina Herp Atlas (<http://www.carolinaherpAtlas.org>) and log your lizard sightings.

All three of these resources can be used by classrooms to upload data about recent captures both in the schoolyard and in local areas. Students can document species found at home once they understand the process.

Tips for implementing a successful lizard project in your classroom and/or on your school grounds:

- (1) Find out about lizards that are located in your area of the country and the habitats they prefer.
- (2) Locate a state herpetological society and find members knowledgeable about lizards who will share information with you and your students.

- (3) Keep a captive-bred lizard in your classroom as a pet. Many small lizards are relatively short lived, and many books on pet care are readily available.
- (4) Schedule a guest speaker for your classes. Do not let schedules or lack of scientists nearby deter you. Video conferencing can be a useful and meaningful way to bring scientists into your classroom.
- (5) Survey your schoolyard and locate the most suitable lizard habitat. Establish a field-based lizard survey of your schoolyard or nearby natural area and contribute to citizen science.
- (6) Before taking students into the field, instruct them on how to collect and process lizards. Use live lizards, if possible, or plastic replicas for students to practice capture/release and handling methods (see Appendix). Students can also learn to identify, weigh, and measure snout-to-vent lengths and/or tail lengths in the classroom.
- (7) To prepare for fieldwork, containers will be needed if lizards are to be kept for any length of time. Plastic sandwich bags can be used to weigh and measure lizards, but do not keep the animals in the baggies for an extended period of time. Small plasticware works well for relatively longer periods. Rulers or calipers and small electronic or spring scales can be used to process the lizards. For a short-term mark-recapture study, nontoxic permanent markers can be used to mark lizards that do not consume their skins. If cameras or handheld devices are available, students can photograph the lizards.
- (8) Divide the students into small groups and have copies of the lizard data sheet for each group (see Figure 4) or use Google forms on iPads or other digital media.
- (9) Assign each group an area to survey. If students find a lizard, they can share with the other groups. Students work in groups to process the captured lizards.
- (10) Flag the area where each lizard was found if lizards are being taken back to the classroom to process. Also, indicate on the data sheet where each lizard was found. Release all lizards at their point of capture.
- (11) Back in the classroom, students can analyze data to determine population statistics such as sex ratios and size ratios as well as habitat preference and success rates of capture methods. Students can also correlate environmental parameters such as temperature and relative humidity to lizard capture. To continue to build on the lizard survey, lizards can be used as model organisms to discuss food webs, energy resources, biochemical processes, evolution, and taxonomy throughout the school year.
- (12) Create a blog or twitter account for students, parents, and community members to follow your classes' adventures. Aaron Reedy's website, Wide World Science, is an excellent example.
- (13) Get involved with a scientist, as Aaron Reedy did with his students.
- (14) Follow the Florida lizard project adventures with your class.
- (15) Recommend students for The Herp Project's HRE. HREs are funded by a National Science Foundation ISE Grant (DRL-1114558) in 2012–2014. Visit our website (theherpproject.uncg.edu) for additional information on these programs.

○ Conclusions

The lizard project has been very successful with students, who enjoyed the content, the field search, lassoing lizards, and even the data collection. In the future, we plan to expand our lizard project and track anoles using nontoxic powdered fluorescent dye or powdered chalk to learn more about their habitat use at night. We also plan to keep our eyes open and our minds alert to possible invading brown anoles. Students enjoy making scientific contributions to long-term studies, and our lizard project is designed to respond to the call from PARC – to assess our native lizard populations and the threats they face.

“Brave, knowledgeable, and excited” are just a few ways students described themselves after participating in our HREs. Within a short period, students became proficient with scientific tools and research procedures. We challenge you to start a lizard project in your classroom, on your school grounds, or in your local community. Ask new questions about lizards in your study and share them with “The Herp Project.”

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○ Web Resources

- Anole Annals: <http://www.anoleannals.org>
- Carolina Biological Supply: <http://www.carolina.com/>
- Carolina Herp Atlas: <http://www.carolinaherpatlas.org>
- Frog YouTube video: <http://www.youtube.com/watch?v=AbKGrtpgBtA>
- Herpedia: <http://www.Herpedia.com>
- How to make a lizard lasso: <https://plus.google.com/photos/104188908342332305503/albums/5745019895621301777?banner=pwa>
- LLL Reptile: <http://lllreptile.com/info/library/care-and-husbandry-articles/-/handling-reptiles>
- PARC: <http://www.parcplace.org>
- The Herp Project: <http://theherpproject.uncg.edu>
- World Wide Science: <http://www.wideworldscience.blogspot.com>

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Appendix. Animal handling and safety guidelines.

- (1) **Plan the catch.** Lizards will be wary, so use a slow, careful approach.
 - (a) Find the most likely place for locating the lizard.
 - (b) Decide on the capture method (hands, lasso, or net) you will use.
 - (i) **Using your hands.**
 - Use a quick, slightly cupped hand to cover the lizard.
 - Don't grab the lizard by its tail (it can detach its tail and get away).
 - Don't grab the lizard's head or neck, because you might hurt it.
 - (ii) **Using a lasso.** A lasso on the end of a bamboo pole is a great strategy.
 - Dental floss (transparent) or Tri-filament fishing line (36 or 45 pound) works well.
 - Monofilament line tends to open on its own (releasing the lizard) and also tends to cut into the skin of soft lizards such as *Anolis*.
 - Carry extra lassos into the field, but sometimes a single lasso can be used for months.
 - Take the animal off the lasso as quickly as possible. Take a lizard off by simply pulling on the "handle" which opens the lasso.
 - (iii) **Using a net.** For faster lizards, like skinks, you may want to use a net.
 - Deep nets allow you to shake the lizard into the bottom and grab the middle or top of the net under the hanger so it can't get away.
- (2) **Handling lizards.** Lizards can bite, so students need to be warned that this could occur. However, bites are not harmful or painful. Leather gloves can be offered if biting is a concern.
 - (a) The animal will not feel secure unless all of its limbs are supported.
 - (b) Small lizards can usually be grasped in one hand, with their forelegs resting on your pointer finger, their body lying across your palm, and their hind feet gently gripping your hand.
 - (c) More feisty animals may require you to use your thumb to apply gentle pressure across the animal's back.
- (3) **Releasing animals.** Release animals where they were captured and where they can quickly find cover. Allow animals to crawl under rocks or logs instead of putting the cover pieces on top of the animal.