The HERP Project, Herpetology Education in Rural Places and Spaces

In Awe of Nature: Surveying Stream Amphibians

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Surveying Stream Amphibians

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 salamanders, frogs, turtles, and snakes, all of which may be caught in minnow traps) and what kinds of permits you may need to handle the animals that live in or near stream ecosystems.

I. Project Description

This curriculum project focuses on the study of amphibians that live in small North Carolina streams in the Piedmont and Inner Coastal Plain. It also investigates other organisms that are denizens of such streams and the food chains that are formed by the interactions of these creatures. This study was conceived and developed by The HERP (Herpetology Education in Rural Places and Spaces) Project staff. The following curriculum is meant to support your efforts to develop your own educational program about small-order North Carolina streams or similar ecosystems. We provide information about the animals and food chains that are commonly found in such streams, the materials and methods we used to study them, and data collection and reporting.

We begin our stream amphibian studies with a very open-ended inquiry question: "What organisms (salamanders, frogs, and macroinvertebrates) are found in this stream?" From this starting point, learners may develop other questions. For example:

What parts of the stream do each of these kinds of organisms prefer?

Who eats whom?

How do the various species (for example, frogs and salamanders) partition the habitat so that each gets what they need?

Who is active during the day (diurnal) and who is active at night (nocturnal)?

Next, we ask a procedural question: "How can we find out what kinds of animals are in this stream?" We introduce participants to minnow traps and leaf packs (see Materials). From here, we encourage students to ask and seek answers to questions specific to each stream or stream site investigated.

II. Philosophical Teaching Points

Small streams in the Piedmont are common natural resources and have ecological value at many levels. They feed water to larger rivers and streams. They are associated with wetland vegetation and provide habitat for animals that require moist soil or access to water. Streams and associated wetlands provide topographic variety, enhancing plant and animal diversity at a regional level. In North Carolina, the Piedmont is the most heavily populated area of the state, and such habitats are increasingly altered into urban watercourses that feed into sewage/stormwater systems. Small streams may become part of neighborhood or agricultural landscapes where they are exposed to excessive sunlight and heat. Pollution and/or environmental degradation of such areas will affect not only the immediate site, but downstream waters and ecosystems as well. Our Piedmont streams contain an abundance of life that is overlooked by most people and are among the ecosystems that are most in need of conservation.

We viewed the various stream sampling sites, called stations, as ecosystems. Once all stations were surveyed, the group could retreat to a comfortable spot to review data collected. We found it useful to discuss these ecosystems from a food chain/energy flow perspective as well as interpreting sources of environmental degradation for each ecosystem.

III. Learning Objectives for the Stream Amphibian 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 and handle stream amphibians
3. Demonstrate and explain appropriate use of equipment (traps (leaf packs and minnow traps) and nets) and measurement tools
4. Explain the trapping methods that are used in this project (**leaf packs** and **minnow traps**)
5. Describe and discuss the threats to small streams and their inhabitants in the geographical region where the streams are located
6. List characteristics of salamanders
7. Identify salamanders to family (and, with adults, to species)
8. Compare and contrast the life cycles of salamanders and frogs
9. Define the term **macroinvertebrate** and list and identify several common macroinvertebrates in streams (e.g. dragonfly nymphs, damselfly nymphs, water striders, and water scorpions)

IV. Instructor Background Needed to Conduct Project

Previous experience in biology fieldwork is helpful but not mandatory. If you are comfortable in the out-of-doors and in aquatic environments, you can conduct this project. It is important, however, for the instructor to fully prepare before starting an investigation with participants. Reading this document and visiting the stream site and dip netting to sample organisms in the water at the study site should provide information about the organisms present.

The following paragraphs explain the main points that instructors will want to emphasize about stream amphibians. Remember this curriculum is an inquiry investigation; instructors should elicit as much information as possible from participants about main points rather than telling the participants information before they have a chance to think about what they are seeing and experiencing and the science behind it. Given the opportunity, participants will probably mention what instructors would have lectured about anyway, and if they do not mention everything, instructors can add to the conversation after participants have had a chance to think and share information. It is important to try to understand participants' thinking to help correct any misconceptions. It is also important for instructors to admit to participants what they do not know, and to think and discuss how the group can find answers. The following background information may be helpful for instructors.

Small streams that are wide enough to jump over are very common in North Carolina and contain a surprising number and diversity of animals that form food chains of remarkable complexity. Amphibians are often dominant members of such communities. They were the first major group of vertebrates (animals with backbones) to exist on land. For that reason, their bodies and life cycles are in many cases transitional between fully aquatic fish and fully terrestrial reptiles, birds, and mammals. Listed below are some important characteristics of modern amphibians:

- Glandular, moist skin that is susceptible to drying and the absorption of noxious or toxic substances (in contrast, reptiles have scales)
- Lack of an external earhole (present in reptiles)
- Lack of nails/claws (found in reptiles)
- A **vent** (excretory and reproductive opening) that is oriented longitudinally with the body (as opposed to transversely, as in reptiles)
- Most amphibians in North Carolina have four limbs, but these may be reduced or partially absent in aquatic forms
- Soft gelatinous eggs with no hard protective covering such as an eggshell; amphibian eggs are laid in water or moist terrestrial environments

• Life cycles with or without an aquatic larval stage

Many people confuse salamanders and lizards. The five-lined skink, the lizard (with an external ear hole, claws, scales, etc.) in the photograph below on left, and the three-lined salamander, photograph below on right, are often confused.

In the Piedmont streams we have studied, we often catch frogs and salamanders. The "herps" (reptiles and amphibians) below are commonly found and you can get additional information about each animal, as well as listen to the frog calls, by going to the Herps of North Carolina website.

- Bullfrog (*Lithobates catesbeiana*)
- Green Frog (*Lithobates clamitans*)
- Pickerel Frog (*Lithobates palustris*)
- Southern Leopard Frog (*Lithobates sphenocephala*)
- Northern Dusky Salamander (*Desmognathus fuscus*)
- Mud Salamander (*Pseudotriton montanus*)
- Red Salamander (*Pseudotriton ruber*)
- Three-lined Salamander (*Eurycea guttolineata*)
- Southern Two-lined Salamander (*Eurycea cirrigera*)

In streams in the Inner Coastal Plain, a few additional species of salamanders can be found:

- Amphiuma (*Amphiuma means*)
- Siren (Greater Siren [*Siren lacertian*] and Lesser Siren [*Siren intermedia*])

Among other organisms, crayfish and many species of adult and **larval insects** can be found in streams. Finfish are not overly common in our streams, but they may be very common in slightly larger watercourses. Unfortunately, small watercourses can be fragile, and often are easily polluted by chemicals, **siltation**, light, or heat. A lack of any or all of the organisms mentioned above is a good indicator that stream conditions are not optimal. The exact species

encountered will depend on location and on the size and environmental quality of the stream being used as a study site.

V. Materials

- GPS or Smart Phones with a GPS app (such as Easy GPS)
- Smart Phones with an appropriate data collection app (our app is The HERP Project app, available as a free download at theherproject.uncg.edu)
- Paper datasheets (see Appendix A)
- Metric rulers
- Metric thermometers
- A humidity gauge
- Calipers (0–6 in [0-150 mm])
- pH paper
- Several five-gallon industrial food containers
- Sorting trays–white porcelain shallow pans are excellent
- Wildlife meshing of approximately 1-inch net gauge (bird netting; orange bags or onion bags could work as long as the mesh gauge is about 1 square inch to let in adult salamanders)
- Twist ties
- Local leaves and twigs
- Surveyor's pins (steel arrows)
- Minnow traps (Funnel-type)
- Bait for minnow traps (we use waterp-packed sardines in cans)
- Empty plastic bottles with lids (to keep the minnow traps afloat)
- Marking flags (to indicate location of leaf packs)
- A pictorial key to aquatic insects (we use printed and laminated copies of North Carolina macroinvertebrate keys). These are included after The Herp Project Data Sheet, in Appendix B, and are available for free
- A field guide to the local amphibians (we use *Amphibians & Reptiles of the Carolinas and Virginia*, 2010). Good field guides are indispensable to this stream study project

VI. Participant Safety in the Field

While doing fieldwork in North Carolina, participants may encounter chiggers, yellow jackets, ticks, and spiders. Using insect repellant (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 repellant (such as Permethrin) instead of applying insect repellant 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 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. Look before you step. 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.

Care should be taken when working around water if learners are inexperienced swimmers. Leaders should also be mindful of the dangers associated with aquatic reptiles and amphibians. Certain amphibians and invertebrates can deliver a healthy bite or pinch; first-timers not familiar with these organisms may choose to wear heavy gloves. Upon return from the field, all individuals should wash their hands immediately. In the unusual event of a serious bite or sting, medical assistance should be sought immediately even if it means termination of the activity. If participants are new to fieldwork, they may be more comfortable wearing boots, waders, and gloves to handle animals from the streams.

Instruct participants in the safe use of materials. If participants are wearing waders (waterproof overalls with boots connected), make sure to explain that they should never enter water deeper than the top of the overalls, so the overalls do not fill with water to weigh them down and make them sink. The safe and proper use of equipment protects participants and organisms.

VII. Animal Handling Guidelines

When handling any live animal, it is important to keep two safety issues in mind: the safety of the person who is holding the animal and the safety and welfare of the animal itself. The humane treatment of any animal in field research is an ethical and a scientific necessity. Amphibians are especially susceptible to injury from any noxious chemical (poisons, insecticides, strong household cleansers, and the like) and/or living organisms (bacteria, fungi, or other microbes) due to their moist, permeable skin. Any person intending to handle amphibians should wash and rinse their hands thoroughly with antibacterial soap and clean water, making sure to wash each time before picking up a new animal so as to avoid cross-contamination. Amphibians must be kept hydrated at all times. If their skin becomes sticky or dry, it is time to release the animal or irrigate it with natural water (i.e., water from its habitat). This is especially true of small or larval amphibians that do not carry a large reserve of water in their bodies and can desiccate quickly. Tap water from city reservoirs, often called "city water," or other chemically treated water (including bottled water) should never be used to hydrate amphibians. Additionally, amphibians can have lightly ossified skeletons that are not resistant to strong pressures or forces, so they must be handled with care.

Trapping

This section describes how to properly handle a trapped animal. The interval between setting traps and checking traps (active traps such as minnow traps, from which animals cannot escape) should be as short as possible, never more than 24 hours. A trap is a potential death sentence for the animal and it is the researcher's ethical imperative to check traps in a timely manner. Lead instructors/investigators must make every effort to prevent trap deaths from exposure or drowning. The traps should be positioned using some type of flotation device so that captured amphibians without gills have access to air. We make sure that each of our traps floats before we leave our study site.

Although most amphibians in North Carolina cannot deliver a harmful bite, there are one or two, such as **amphiumas** in the coastal plain, that can. Additionally, stream invertebrates such as crayfish or insects with piercing mouthparts can deliver a painful pinch or bite, and may draw blood. All participants, both instructors and students, should be prepared for the possibility of being bitten or pinched by animals that seek to defend themselves. Keep fingers and hands out of the range of pincers and mouth parts at all times. Crayfish, for instance, can be safely handled by grasping them with thumb and pointer finger on their **thorax** directly behind their pincers.

Holding and NOT Holding Amphibians and Invertebrates

These animals must always be handled gingerly. This can be a problem with frogs, since they have strong muscular legs that allow them escape a captor's hands. A good way to hold a frog without damage is to extend the legs and hold them gently but firmly while supporting the body of the frog with the other hand. As long as the frog cannot cock its legs, it will have a hard time jumping.

Video Holding and Identifying a Frog: http://vimeo.com/109028047

Adult salamanders can be held with thumb and pointer finger (image following page); the thumb should be placed on their pectoral region between and just posterior to the front legs, with the pointer finger under the body, opposite the thumb.

These suggestions do not apply to eel-like aquatic salamanders such as amphiumas and **sirens**. We do not handle these organisms during our lessons, and only an experienced professional should handle them. **Larval amphibians** are delicate creatures; we do not handle them, and suggest that they not be handled. Instead, we place them in buckets of stream water for inspection and identification. Likewise, we do not handle aquatic insects; rather we place them in buckets for close examination.

The two photographs above show how to restrain the rear legs of the frog so it is unable to escape a captor's hands.

Video Two-Toed Amphiuma: http://vimeo.com/109853551

VIII. Student Activities

During the introductory period, students will notice general environmental conditions (rain, cloud cover, wind, air temperature, and relative humidity). There are some questions to think about when introducing the project:

- Why do amphibians need water in their environment?
- What factors determine who eats whom in a stream food chain?
- What is a life cycle?
- Why are streams important to many species of larval and adult amphibians?

Our Piedmont stream amphibian exercise utilized six sampling stations spread along approximately 200 meters of streambed. The sites were deliberately set up to examine the impact of sunlight and heat on the first two stations. The number and positioning of the stations should reflect the environmental issues being addressed and the personnel available. The total **sampling time** for our six stations is approximately three hours, which includes 20 minutes of general introduction and another 30 minutes of debriefing, summary, and data transfer. The project is designed such that data can be recorded on hard copy datasheets, which are supplied to each student, and entered into The HERP Project's data collecting app (theherpproject.uncg.edu/apps-collecting-data/) that can upload information via the Internet.

Preparing Traps

When ready, students should be introduced to the general sampling scheme at each station. We had three traps of two different kinds at each station. One trap was a leaf pack and the other two were minnow traps. Leaf pack traps were made by us and the minnow traps (the funnel type) are commonly available at fishing or outdoor supply stores. The photograph below shows a leaf pack trap in a **sorting tray**.

Leaf pack traps

Leaf pack traps should be installed four to eight days before sampling. Animals may come and go as they please in leaf pack traps after they are set because they are passive traps. This condition is in contrast to minnow traps, which are active traps and must be checked daily. Set up enough leaf packs so that each small group of 4-6 students can examine a leaf pack at each site each day. Examining leaf packs works best if the leaf packs are disassembled. Leaves may be discarded on the forest floor and the meshing placed in a garbage bag for later disposal. To create the leaf pack traps, obtain several garbage bags full of hardwood leaf litter from the forest near your stream. Wrap a double handful of leaves in an 18-inch square of wildlife meshing. Finally, close bundle with a twist tie.

To hold them in place and under the water's surface, we use long red and white surveyors' pins threaded through the leaf packs. Because the species, including amphibians, that are attracted to the leaf packs do not breathe air exclusively (they can obtain oxygen from the water) and can escape if necessary, no harm can come from their prolonged submersion. We have caught a variety of insects and both larval and adult salamanders in such packs, and they were unharmed by the capture method.

The photograph above shows a student carefully starting to sort a recently removed leaf pack. Note the white sorting trays and how they provide contrast against the dark leaf matter the student will be sifting through to locate stream amphibians and macroinvertebrates. A thin layer of water has been poured into the sorting dish to keep the organisms moist while the students process the trap.

Examining tadpoles and a crayfish from the leaf pack

Identifying organisms from leaf packs

Minnow Traps

We conducted experiments to determine what attracted stream amphibians to the minnow traps. To test fish bait, one minnow trap should be baited with a smelly food item; we used water-packed sardines. The can of sardines was punctured so that the fluids escaped but the sardines stayed in the can. The other trap should remain unbaited to serve as a control. To test light as an attraction, one trap included a light source (a glowstick) while the paired trap had no glowstick. This gave instructors the opportunity to discuss the necessity and value of controlled experiments in science.

Minnow traps should be baited and placed in the stream the afternoon before the survey. If surveys are to occur on successive days, traps can be inspected, re-baited, and immediately placed back in the water, thus allowing a maximal trapping period for the next day. Minnow traps should be placed so at least one entrance hole is under water; however, the trap should protrude into the air at some point along its length to allow trapped animals access to air. Unlike the leaf pack trap, the minnow traps may capture amphibians or other species that must have access to atmospheric oxygen. If the stream is too deep, empty plastic bottles with a lid can be used as air-filled floats to keep at least some of the trap above water.

Video Traps and Experimental Design: http://vimeo.com/109027230

Video Minnow Traps: http://vimeo.com/109854296

These photographs are examples of minnow traps. Notice the plastic bottles in the traps. These are used to float the trap to ensure that trapped organisms do not drown before the trap is checked.

Recording animals and collecting data

Keep all amphibians out of the direct sun so they will not dry out or overheat. Amphibians are **ectotherms**, animals that derive body heat from external sources. Usually they avoid overheating in their natural environments by immersing themselves in water, burrowing in the soil, or seeking refuge under leaf litter. Try not to hold them for too long. As mentioned above, amphibians must remain hydrated during recording.

Return all amphibians and insects to their natural habitats as soon as possible. Excessive handling and confinement stresses these animals in many ways. It is important to return each animal to the exact place where it was found. When examining nature, a cardinal rule is to leave the system exactly as you found it, to the greatest extent possible. In general, keep the following guidelines in mind:

- All animals must be released at the point of capture
- Animals should be processed for data collection quickly and efficiently with minimal handling
- Almost all animals can bite. Some rarely do, and some do so without hesitation. Know what species is being handled
- Hands should be washed both before and after handling animals

Data Collection

At each station, students will collect air and water temperature and pH of the water. Once this is done, a leaf pack will be extracted from the stream and carefully inspected for insects, other invertebrates, and vertebrates like salamanders and frogs. We use white sorting trays filled with enough stream water to cover the bottom. The sorting trays provide good contrast for the darker organisms. Numbers of insects of various orders and the species of amphibians (adults and larvae) should be recorded if identification is possible. Length of adult salamanders should be recorded from the tip of the snout to the posterior terminus (end) of the vent (this is called a **Snout Vent Length** measure or SVL) in mm. SVL is used because salamanders can lose their tails to predators and regenerate them, so SVL provides a more consistent indicator of animal size. The drawing on the right indicates where the vent is located on salamander.


The arrow is pointing to an adult salamander’s vent

Careful recordkeeping will assure results are accurate. Be sure to note if minnow traps are baited or unbaited and if and when they have been inspected for amphibians and other animal life. Captured individuals should be identified to species if possible and measured as above. Crayfish are commonly caught in minnow traps, and they can be quickly discussed and released.. Finfish should be treated in the same manner as crayfish. For all organisms captured, numbers of individuals should be counted, with larval forms being a separate category.

Data Reporting to The HERP Project and HerpMapper

Through use of the free Herp Project data collecting app (theherpproject.uncg.edu/apps-collecting-data/), HRE participants recorded data and uploaded it to an open source database found on the Herp Project website (http://nc-herps.appspot.com/). This enabled us to compare our data with previous years, and we can download data sets for further analysis. Data can be uploaded to share with the public and scientists worldwide on the HerpMapper citizen science site (www.herpmapper.org).

IX. Resources

Books and articles

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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	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.
Core Ideas: Adaptation Biodiversity Bio indicators Biomes Biotic parameters 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	**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 evidenc -Obtaining, evaluating, and communicating information **Crosscutting Concepts:** -Cause and Effect -Scale, Proportion, and Quantity -Stability and Change *Real, not a simulation or model.	**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. 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

The Herp Project Curriculum	Next Generation Science Standards	International Society for Technology in Education Student Standards
Weather and climate		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. HERP Data Sheet

MONITORING

STREAM AMPHIBIANS DATA SHEET

Date:	Time:	Water Temperature: ____ °C
Relative Humidity ______%	Weather Conditions: Sky Code (0-4): ______ Wind Code (0-3): ______	Air Temperature: ____ °C
Station Number (1-5):	Team:	

Insects	Number of Individuals		
Insect order	Leaf Pack	Minnow Trap	Notes
Amphibians and Other Animals	Number of Individuals		
Species	Leaf Pack	Minnow Trap	Notes

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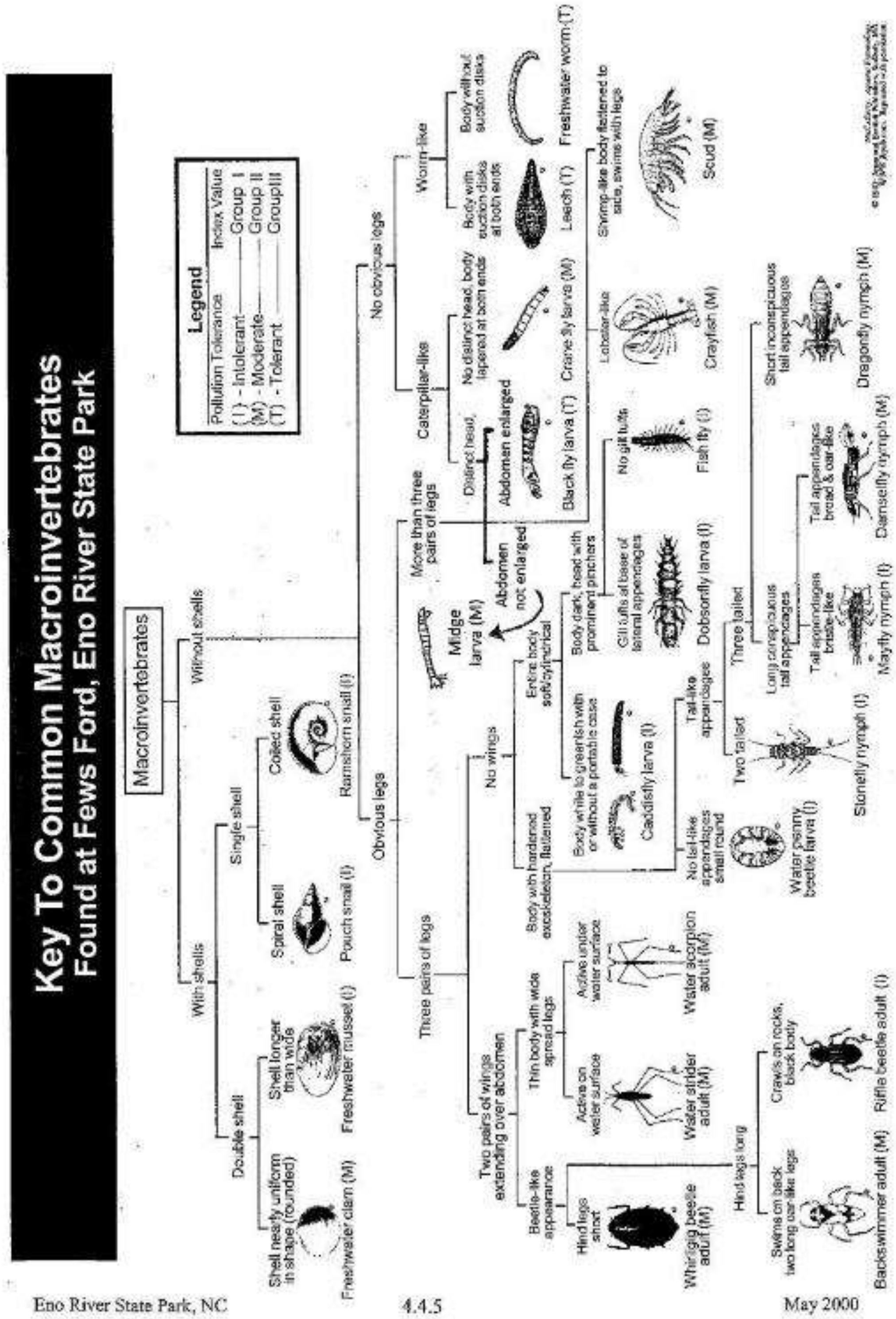
Appendix B. Macroinvertebrate Key



Appendix C. Transcript of Holding and Identifying a Frog

Andy – Ok, as I've said before, I find the easiest way to hold frogs is by the very end of their rear, or hind, legs so that they can't cock to jump. So, what we want to do is identify this so everybody get their field guides out and we're going to look for the characters that we discussed earlier and y'all are going to tell me what I'm looking at here.

Participant – Well, you've got that lateral, or ridge, what's it called again?

Andy – Lateral line, lateral fold.

Participant – That goes down behind its ears.

Andy – Behind its ears. There's one clue.

Erika – Do you remember what it's called?

Participant – Tympanum?

Erika – Tympanum, yes!

Andy – Ok, so, do we see any brightish or neon green up under its eye. So what do you think, a frog this big, what do you think our two choices are?

Participant – Green frog or Bullfrog.

Andy – Green frog or Bull so do we see that neon green under the eyes that Green frogs have? Now Bulls can sometimes look like that too.

Participant – Not really.

Andy – I don't really see that. It's kinda green but not really neon green.

Participant – Um, 145 and 146.

Andy – So, the real key in this case is what that fold does. And what have we decided it does?

Participant – Curves back around behind the ear so I say it's an American Bullfrog.

Andy – There you go. And let's look at his stomach. So you see the splotching, the darker splotching on the venter, right? Ok, so that pretty much tells us. Ok, so now let's look at the size of the tympanum and y'all tell me whether we're looking at a young man or a young lady here.

Participant – Female. They're small in size.

Andy – Yeah, smaller tympanum. Ok, so, anyone want to hold the frog?

Erika – Let's show them the eyeball. Ok, look at his eyes, guys. See, I can push it back, see how I can just push it down in?

Participant – Does that…

Andy – Oh they have muscles that can actually pull their eyeballs in and out. So why would you want your eyeballs up like that?

Participant – So you can see above the water?

Andy – Yeah, so you can stay in the water but see what's above the water. But why would you want to be able to pull them down?

Participant – So predators don't see you.

Andy – Predator… let's think about some other things. How do you reckon frogs find a lot of their food?

Participant – Under the water… Oh so they can sneak up on them.

Andy – Well, they're gonna be nosing around in litter right? Pushing through leaves and sticks and twigs. Do you want your eyes up where they can be damaged doin that kind of thing?

Participant – Uh uh.

Andy – No, you want to pull them down. And most amphibians depend on their sense of smell as their primary sense. Ah, I work on salamanders and I had a salamander physiologist from Germany once tell me that salamanders are just giant noses. They can see but they don't use their eyes much. And salamanders can do the exact same thing, they have telescope eyes that they can pull down when they're foraging under leaves or under rocks in streams and things like that.

Participant – May I hold him?

Andy – Sure, so just grab right there at the end. There you go.

Participant – Oh, ok. I thought he would be more jumpy.

Andy – No, you see, if he can't cock his legs, there's not much he can do. Or she, excuse me, that's a young lady.

Participant – There were three tadpoles, correct?

Participant – Four. Four small ones.

Erika – You want to try picking one up and you can see what it is?

Participant – Any of them have legs?

Andy – Do you think Green frog adults would eat Bullfrog tadpoles?

Participant – Sure.

Andy – Sure. Would an adult Bullfrog eat a Green frog or a Green frog tadpole? Sure.

Appendix D. Transcript of Two-Toed Amphiuma

Erika – So what does it look like to you guys?

Participants – Eels.

Erika – It looks like an eel?

Participant – Uh huh.

Erika – But what is it really?

Participant – Salamander.

Erika – It's a salamander. So these are the largest salamanders in North America.

Leader – They can reach sizes of up to 48 inches. This is a pretty good guy here. As you can see, well, I don't know if you can see, but right here, see that little appendage right there?

Participant – Yeah.

Leader – With two little itty bitty toes? Can y'all see that?

Participant – Yeah.

Leader – Can everybody see that?

Erika – He's got two back here and two up front.

Leader – See that little foot right there? That little itty bitty foot?

Erika – And this guys called a two-toed amphiuma. So like I was saying earlier, he's got six rows of teeth and they're all segmented so they're broken up, so he may have two on this side, two on this side, and two in the middle but they're all broken up.

Leader – So what would you think that these guys eat?

Participant – Small fish.

Leader – Small fish, yeah. What else would live back in this area that they might like to eat?

Participant – Frogs.

Leader – Frogs? Yeah. With six rows of teeth they can pretty much eat anything, right? Their main forage is usually crayfish. You know, crayfish have shells but it's nothing for them to crunch through those shells with six rows of teeth.

Erika – These guys are mostly active at night. When there's heavy, when there's a lot of heavy rain they can cross over roads to the other side and they'll go to, like, a ditch or something.

Leader – How do you think these guys breath?

Participant – Lungs.

Leader – Lungs? Maybe, anybody else got an idea?

Participant – Skin.

Leader – Skin… What do you think, Emily?

Emily – I don't know.

Leader – You don't know?

Emily – No.

Leader – These guys can actually breathe all three ways: they can breathe through their skin, they also have a lung so they can gulp air and breathe like we do, and they also have internal gills. So they're kinda the ultimate survivor, they can survive in just about any kind of environment.

Erika – So not a lot is known about their early stages of life because not a lot of people catch these things. They're really abundant in areas but they're just not caught a lot. So a lot isn't known about their early stages of life. We do know they can lay anywhere from 10 up to 200 eggs and they usually lay in, like, damp places.

Appendix E. Transcript of Traps and Experimental Design

Andy – So, at each site in this particular project, we have three different kinds of traps. One of them is a leaf-pack trap and that's pretty much a passive trap where we put the packs in the water and macroinvertebrates and certain kinds of salamanders and amphibians will crawl in there for cover during times of the day when they're not active. And then they can hide in there and so then we can pull those little packs out and see what we've got. In addition, at each site, we have two minnow traps, one of which we bait and we bait with sardines, but you're free to try whatever you'd like, and the other minnow trap is unbaited. We can attract a variety of different kinds of things in those baited and unbaited traps. We regularly get crayfish, we get adult and tadpole frogs, we get adult and larval salamanders in those sorts of traps. So we can talk a little bit about food chains and who eats who and energy processing and stuff like that. Mostly we try to emphasize the numbers of animals that you can find in streams of this size that you can jump across. We can then talk about experimental design, controlled experiments and why controls are important. Then we let the students think a little about which of our minnow traps has a manipulative variable and which of it has a control, why those work the way they do.

And the interesting thing about it is we get varied results on that, our results are not necessarily clear cut. The main conclusion that I have come to over three or four years is that frog tadpoles seem to be attracted to baited traps and I can't tell much difference between any of the other animals. They seem to go into the other two kinds of traps almost equally. Ok, so that's a little bit about experimental design.

Appendix F. Transcript of Minnow Traps

Erika – You've seen them? So you guys know what they look like?

Participant – Yeah.

Erika – So who wants to give me a brief description? Go ahead Emily.

Emily – I don't know, they can swim into it but they can get out.

Erika – What shape does it tend to be?

Participant – Like a cone.

Erika – Like a cone? Ok, so, why can they swim in and not out?

Emily – The shape of it…

Participant – It kinda funnels them in.

Erika – It funnels in, that's right. So this is what your basic minnow trap is gonna look like. I know that they have different sizes for these, you can get ones with bigger holes and ones with smaller holes. What do you notice that we put in all our traps that you've seen?

Participant – A bottle so it floats.

Erika – We put a bottle so it floats. Why do we want it to float?

Emily – So that they can get air.

Erika – So they can get air? Ok.

Participant – So it's not sitting on the bottom.

Erika – So it's not sitting on the bottom, ok. And we don't want anything in here that needs air to drown, right? Ok so when you set a trap like this, how often do you want to check it?

Participant – Every day.

Erika – Everyday, how many times a day do you think?

Participant – Probably twice.

Erika – Once or twice a day, why do we want to do that?

Participant – To make sure that, if you do have something in there that you take it out.

Erika – Ok, that's right. Ok, what sorts of things do you think we would catch in this? What kind of amphibians? Or maybe not even amphibians, other things too.

Participant – Salamanders.

Erika – Salamanders, ok.

Participant – Amphiumas.

Erika – Amphiumas, ok. Anybody else? What do we hear calling every night?

Participants – Frogs.

Erika – Frogs, ok. And then what is this thing, it would normally be alive?

Participant – Fish.

Erika – A fish. So fish, what other kinds of things could we find in here?

Participant – Snakes.

Erika – Ok, snakes. And what is this thing here?

Emily – A spider.

Erika – Spiders, ok, so we can find bugs. So there's a variety of things you can find in here and there are a bunch of different ways that you could bait your traps. You can put sardines like we did, we stole your idea Christine. So you can put sardines or you can put chicken, we put chicken in one. Last year we did glow sticks. So you can use a bunch of different kinds of things to try…

Participant – Glow sticks?

Erika – Mm hmm, we were trying to see if the light attracted…So this is going to be what your basic minnow trap will look like so, when you're done, and you don't see anything in it. You normally wanna roll it around like this, make sure you look at it from all sides and you're not missing anything. And you'll just throw it back in the water like this.

Appendix G. Glossary

amphiuma: a large, eel-like salamander that lives in black water areas of North Carolina

ectotherms: animals that derive body heat from external sources

larval amphibians: tadpoles and salamanders generally undergo metamorphosis. The larval stage is the stage that follows the egg stage. Larval amphibians breathe with gills.

larval insects: six legged, three body part animals that are sub-adults; Larva are the second stage of the insect, following the egg and preceding the chrysalis or cocoon and adult stages

leaf packs: passive traps constructed of leaves and other debris from forested habitats that surround streams or other bodies of water. A handful or two of debris is surrounded by a cage of garden netting. Leaf packs allow animals to move freely in or out but provide substrates for animals.

macroinvertebrate: small animals without backbones that can be seen with the naked eye like dragonfly nymphs and diving beetles and caddis fly larvae

minnow traps: active traps that capture minnows, frogs, tadpoles, salamander and salamander larvae. They sit or float in bodies of water and animals swim in but cannot get out do the funnel-shaped openings at either end of the trap

sampling time: the amount of time that one spends collecting data in a specific place at a specific time

siltation: the process of silt (fine particles of sand, clay, or other materials) moving from the land into a body of water. Too much silt causes problems with light penetration and is generally not healthy for the habitat or the animals that live and breathe there

sirens: large salamanders that have greatly reduced limbs

Snout Vent Length: length of adult salamanders should be recorded from the tip of the snout to the posterior terminus (end) of the vent

sorting tray: a white pan that makes it easy to see aquatic organisms

thorax: the middle part or chest part of the body (for insects, the three body parts are head, thorax and abdomen)

vent: excretory and reproductive opening