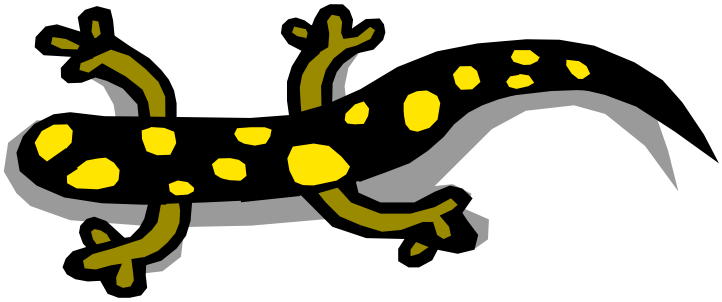
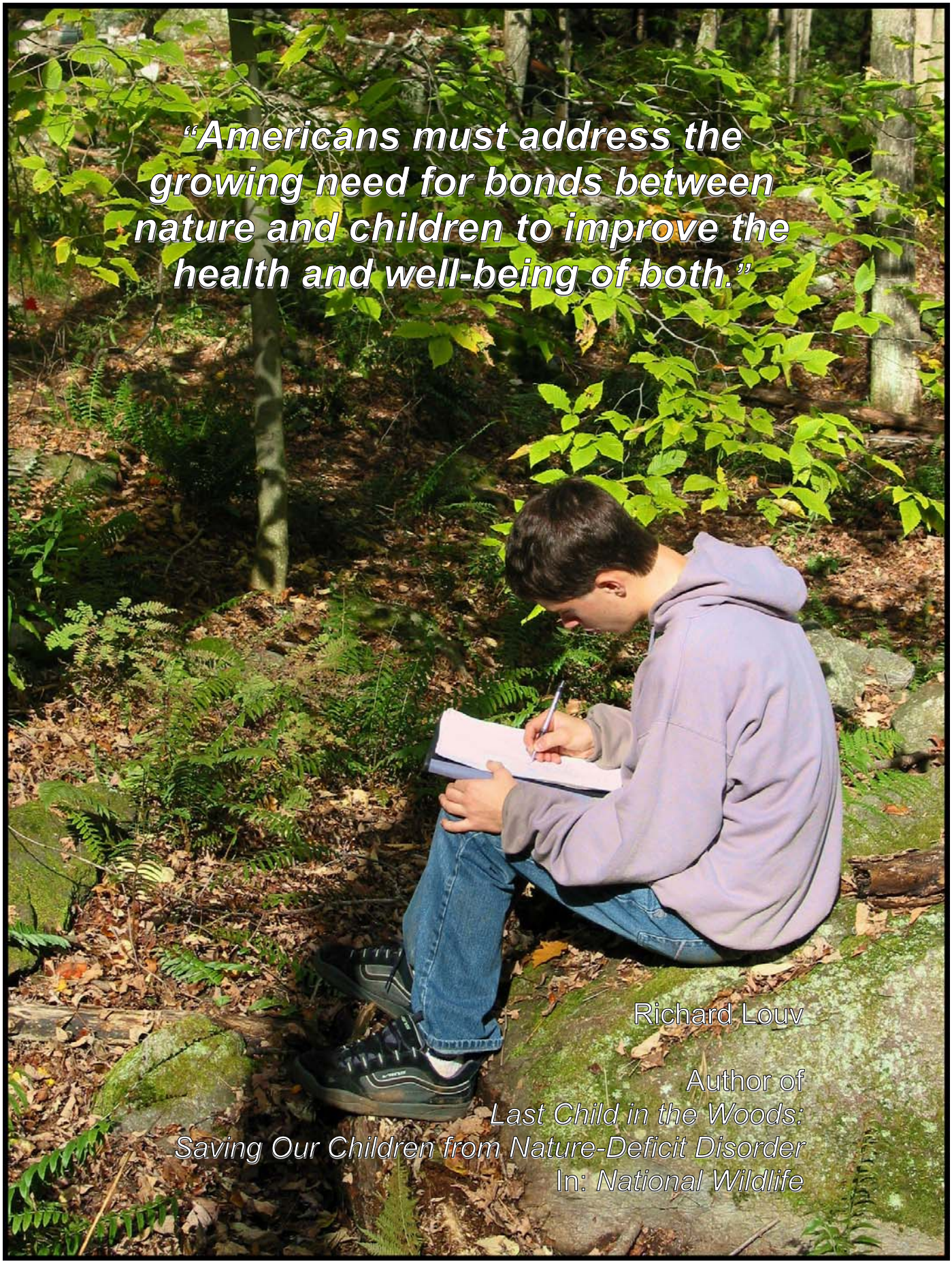
SEARCHING FOR SALAMANDERS

A MonitoringProgram



A Middle School (6-8) and High School Biology/Ecology Curriculum

This curriculum is designed to engage students in an ongoing salamander-monitoring program that will assist our local National Parks in tracking our environment's health.


"Americans must address the growing need for bonds between nature and children to improve the health and well-being of both."
Richard Louv
Author of
Last Child in the Woods:
Saving Our Children from Nature-Deficit Disorder
In: National Wildlife

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SEARCHING FOR SALAMANDERS

Project Overview and Rationale

The National Park Service's Inventory and Monitoring Program (I&M Program) is responsible for helping parks meet their mission of preserving park resources. The national program is divided into 32 networks that each work with a group of parks. The networks design and implement ecological monitoring programs that provide critical information to the National Parks and the public about the integrity of landscapes, ecosystems, and species. Because it is not possible to monitor all aspects of park natural resources, the I&M program focuses on identifying and tracking key indicators that provide reliable and useful information.

The Northeast Temperate Network (NETN) consists of a diverse group of parks, including Acadia National Park in coastal Maine, Morristown National Historical Park in New Jersey, and the Appalachian Trail, which crosses fourteen states. The majority of NETN parks were established for their cultural resources and are relatively small, but the natural resources in these parks are crucial to understanding their cultural value.

The Network parks are:

Acadia NP, Maine
Appalachian NST, Georgia, North Carolina, Tennessee, Virginia, Maryland, West Virginia, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Vermont, New Hampshire, and Maine
Boston Harbor Islands NPA, Massachusetts
Marsh-Billings-Rockefeller NHP, Vermont
Minute Man NHP, Massachusetts
Morristown NHP, New Jersey
Roosevelt-Vanderbilt NHS, New York
Saint-Gaudens NHS, New Hampshire
Saratoga NHP, New York
Saugus Iron Works NHS, Massachusetts
Weir Farm NHS, Connecticut

For more information go to http://www1.nature.nps.gov/im/units/netn/index.cfm.
See Appendix 1 for a map of these parks

What are Salamanders?

NOTE: The following material has been taken from the following sources:

Sustaining America's Aquatic Biodiversity: Salamander Biodiversity and Conservation
Authors: David Bishop and Carola Haas, Department of Fisheries and Wildlife Sciences, Virginia Tech
Publication Number 420-528, Posted October 2003

Michigan Department of Natural Resources
http://www.michigan.gov/dnr/0,1607,7-153-10370_12145_12201-61141--,00.html

The Terrestrial Salamander Monitoring Program (USGS)
http://www.pwrc.usgs.gov/Sally/. This program began on June 30, 1997. Most of the materials provided here were written by Dan Lantz (redeftboy@yahoo.com).

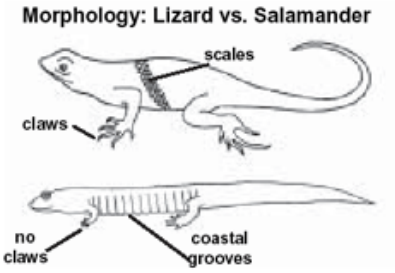
Often mistaken for lizards, these moist-skinned, secretive creatures play a very important role in nature, especially in woodland and wetland habitats. They are much more abundant than most people realize, but are still very sensitive to changes in their environment. As a fundamental part of our natural heritage, it is essential that we ensure their survival.

Salamanders, along with the closely related frogs and toads, belong to the group of animals called amphibians. Like fish, reptiles, birds, and mammals, amphibians have a bony skeleton. But unlike their vertebrate relatives, amphibians typically have moist, smooth (or bumpy) skins, lay unshelled eggs in water, and hatch out as gilled fish like larvae that eventually undergo metamorphosis into a lung breathing, land living or semi aquatic adult. (A few kinds keep their gills, and live underwater permanently.)

The conspicuous (and seasonally noisy) frogs and toads are familiar to most people, but the silent and secretive salamanders are largely creatures of mystery. When salamanders are seen during their rare above ground migrations, many people mistake them for lizards, which they vaguely resemble. However, the thin skinned, moisture loving salamanders are not at all closely related to the lizards, which are scaly-skinned, warmth loving reptiles that lay shelled eggs on land.

Most native salamanders spend the majority of their lives hidden under forest soils and leaf litter, or (in the case of Mudpuppies and Sirens) on the bottoms of ponds, lakes, or streams. Salamanders can absorb water, and even take in oxygen and release carbon dioxide ("breathe") through their thin skins. Most adult salamanders also breathe with lungs, though the little Red backed and Four toed Salamanders lack lungs completely, and do all their breathing through the skin. Salamanders require cool, moist habitats, and they soon die if exposed to the hot sun, or confined in dry places. In fact, when moving on the surface they can become dehydrated even when the air is saturated with moisture. Logging, insect defoliation, development, and canopy fires all can reduce population levels indirectly through loss of soil moisture, exposure to sun, or the compaction and disruption of soils. In direct contrast, salamanders achieve their highest densities in ancient or undisturbed forests.

At first glance, most salamanders look like lizards and sometimes are called "spring lizards." However, salamanders are amphibians, not reptiles, and, unlike lizards, they have moist skin with no scales, no ears, and no claws.



Here is a summary of a few key characteristics:

- Extremely long-lived (20+ years)
- Low reproductive rate (fecundity)
- Often guard their eggs
- Take 2 or more years to mature
- Some have eliminated the energetic costs of lungs and ventilating
- Respire directly through their skin
- Can go for months, if not years, without eating
- Body temperatures fluctuate with the local substrates
- Store fat in their tails

Salamanders in the United States range in size from 2 inches to over 2 feet in length. Most species have two pairs of legs, but some look more like eels than lizards and have reduced or only a single pair of legs.

The tails of aquatic salamanders are often compressed to aid in swimming, whereas those of terrestrial species are more rounded. Some salamanders have the ability to regenerate their tails if they are lost.

Salamanders continue to grow past sexual maturity and must periodically shed their skin. After shedding, they often eat the skin. Mucous-secreting glands help prevent their skin from drying out when they are out of the water. Other glands release toxins that protect them from predators. Some have glands that produce pheromones, chemicals that are used in courtship and mating.

Most aquatic larval salamanders have gills that are absorbed when they metamorphose to adults. Some salamanders, such as the mudpuppies and waterdogs, keep external gills throughout their lives. The gills, as in fish, are red in color due to the high blood concentration necessary for oxygen absorption from the water. Gill size may be related to the water quality. In warm, slow-moving, low-oxygen waters, salamanders often have larger gills than those found in cool, flowing, high-oxygen waters.

Salamanders do not have ears, but may be able to detect vibrations through their legs and jaws. In the water, vibrations are detected by the lateral line system, rows of sensors found on the head. Most species have well-developed eyes. The exceptions are the few cave-dwelling species that live in complete darkness where eyes are unnecessary. Salamanders, unlike frogs, are voiceless except for a slight squeaking noise made by a few species when disturbed or excited.

What do they eat?

Salamanders are predators. Most feed on insects, worms, and other small invertebrates. Salamanders are often the most the abundant vertebrate animal in the forest. They are an important link in the food web, preyed upon by larger amphibians, snakes, turtles, birds, predaceous insects, and fish. Salamanders are active foragers, moving through their environment searching for prey. They can use visual and chemical cues to detect prey items. Salamanders use their tongue (covered with sticky secretions) to capture prey. Aquatic salamanders use suction to capture prey. Immature (larval) salamanders, like adults, are predators and feed upon aquatic insects and other invertebrates.

How do they reproduce?

Salamanders have a variety of reproductive strategies. Most species have a two-part life cycle that, like frogs, includes a larval stage and an adult stage. Some species lack a larval stage, and newly hatched individuals look like miniature versions of the adult. Most salamanders hatch from eggs and spend several weeks to years growing as aquatic larvae before they undergo metamorphosis to become adults. When the adults reach sexual maturity, they often return to breed at the same site where they were born.

Although frogs typically reproduce by external fertilization, few (10 percent) salamanders exhibit external fertilization. In most salamanders, fertilization is internal. Male salamanders court females with species-specific behaviors. The male then deposits a packet of sperm (a spermatophore) on the ground and the female transfers it into her body. The eggs are fertilized internally, but laid **externally in a selected habitat.**

Where do they live?

Most salamanders are found in or near wetlands. Because they lack the scales of reptiles, salamanders are susceptible to drying out, and must live in moist environments. Some species have the ability to burrow underground; others use burrows created by other animals like crayfish.

Salamanders occupy a wide range of aquatic habitats, from temporary pools to large rivers (hellbenders) and from cold mountain streams (many dusky salamanders) to warm ponds (tiger salamanders). Salamanders are able to live in cool environments. Most salamanders are active at night and during rain events, which permit them to move around to feed or mate.

All species of salamanders in the United States lay eggs. Aquatic salamanders lay their eggs in water, and terrestrial species lay their eggs in moist areas under vegetation, rocks, or logs or underground. The female usually stays with the eggs for weeks or months until they hatch, defending them from predators and removing silt, debris, or fungal growth.

During the breeding season, males often develop secondary sexual characteristics such as pads on their hind limbs to help them hold onto slippery females when mating. Males of some lungless salamanders develop long teeth that are used to scratch the females' backs.

Some species can breed year round, but most salamanders have distinct breeding seasons, which vary depending on the species, location, and weather conditions. Those that breed in ponds and temporary wetlands are explosive breeders. Hundreds of individuals may migrate into a breeding pond, reproducing in mass on a single night when conditions are right. See Appendix 2 for a listing of the species known to exist in each park and Appendix 3 for their range maps.

How long do they live?

Some salamanders live more than 50 years. Most salamanders live for 8 to 20 years, but large aquatic salamanders, such as hellbenders, have been known to live between 25 and 55 years. Even the small streamside salamanders, such as the mountain dusky salamander, regularly live more than 10 years.

Many small salamanders need three to four years to become large enough to breed. The red-spotted newt, for example, may spend seven years in the immature red eft phase before undergoing a second metamorphosis, and returning to a pond to breed. Because of their long life span, loss of adult salamanders may have a larger effect on population survival than occasional reproductive failure.

Predation

Many predators will eat salamanders and their larvae, including fish, frogs, snakes, birds, and small mammals such as shrews, raccoons, and skunks. Large salamanders sometimes eat smaller ones even their own siblings! Most salamanders (once they become terrestrial adults) spend the vast majority of their time hidden in soil or forest debris, and are vulnerable to enemies only during the brief spring breeding season.

Our native salamanders are generally harmless creatures that appear to be almost defenseless, but they do have a number of defenses against predators. Many species have skin glands that produce distasteful or even poisonous substances to repel predators. The skin toxins of the terrestrial "eft" stage of the Eastern Newt are poisonous enough that small animals may be sickened or killed by eating them though few actually try, having been warned off by the eft's bright red or orange color. The red color phase of the Red backed Salamander (a relatively non-toxic species) may gain some protection by mimicking the eft's bright colors. The "mole" salamanders (genus Ambystoma) have concentrations of poison glands on their tails, which may be lashed at an attacking predator. Salamander skin glands also produce a protective mucus covering that can make the animals very difficult to hold on to. The aquatic Mudpuppy is a prime example trying to grasp this creature in hand has been likened to gripping a wet bar of soap!

If attacked by a predator, the smaller salamander species can drop portions of their tails. The lost tail piece will continue to wriggle, perhaps confusing the predator long enough to allow the salamander to escape. Later, they can re-grow a new tail. Some scientists are studying about the ability of the salamanders to regenerate new arms, legs, and tails.

Environment & Conservation

Despite being secretive and inconspicuous, salamanders play important roles in nature, especially in woodland and wetland habitats. They are predators on smaller creatures, such as insects, spiders, and worms, and in turn are eaten by a variety of larger animals, from songbirds to bears. Several studies in moist forests show that the numbers and biomass (living weight) of salamanders can equal or surpass that of other vertebrates, such as birds and mammals a strong indication of their ecological significance. Many human activities can harm salamander populations. Their eggs and larvae are threatened by the destruction of shallow ponds and wetlands. (Many people fail to realize the critical importance of wetlands that may be dry for half the year!). When forest trees are harvested by humans, the resulting higher ground temperatures and lowered humidity can quickly eliminate most or all of the resident salamanders. Contamination of habitats by pesticides, fertilizers, sewage, or industrial and farm wastes are additional threats.

Recent concerns about the decline of amphibian populations in many parts of the world have been mainly focused on frogs and toads that are often relatively easy to detect and survey, due to their distinctive breeding voices. Salamanders are affected by the same environmental factors as their noisier relatives, but are more challenging to find and study.

Rationale for Studying Salamander Populations

Despite salamander predominance in some ecosystems and their long co-evolution with forests, we know very little about the population health, cycles, and trends of these woodland species. Are populations of these terrestrial species declining, as populations of North American frogs and toads have, or are they comparatively stable? Are currently forestry practices and the recovery of mountain forests from industrial logging at the turn of the century increasing the number of salamanders? Data sets are few and scattered, focused on research rather than monitoring, and largely unpublished. Consequently, existing information provides almost no help in detailing regional status.

Our best knowledge about the population health of terrestrial salamanders comes almost entirely from the repeated field observations of herpetologists. There is now useful information on status, but the information is not nearly sensitive or systematic enough to do more than provide a post-mortem of any population collapse.

The long-term tenure of salamanders in forested ecosystems would suggest that their loss or decline might have consequences affecting many other plant and animal species. Numbers and biomass alone dictate that the effects of changes in their populations could cascade throughout the forest as their invertebrate prey and vertebrate predators adjust.

Consequently, the ability to track changes in salamanders, both declines and increases, would provide insights into forest ecosystems and perhaps a more realistic assessment of forest health than those based on the classical forestry measures of stocking and growth rates. Forest health must account for the communities of all plants and animals (such as salamanders) that exist under the defining umbrella of large woody plants. An increasing or stable number of salamanders would indicate that the forest's balance of invertebrates, leaf litter, moisture, pH, debris, burrows, and other habitat features were sufficient, while declines would signal environmental shifts counter to the needs of the species and increasing ecosystem impairment. Detection of salamander declines would hopefully provide adequate forewarning, allowing us to search for the root causes and take action to reverse the damage. Given their longevity and low fecundity, as well as the stability of the forest soil environment, changes in salamander population are much more likely to represent significant environmental changes than changes in other groups of North American amphibians.

Therefore, this monitoring program's primary functions are to warn of impending population problems, to direct conservation management (activities, monies), and to generate hypotheses for research. Without such a monitoring network, populations can collapse to the point that conservation and management options become limited and expensive, exactly the sort of situation which led to the endangered listing of several western frogs and toads. Salamanders' patterns of population change, when coupled with measurements of their surroundings, will permit the investigation of the effects of geographic location, land management, air quality, vegetation, and associations with other species on salamander population dynamics.

Other less tangible but equally important benefits will also accrue from the long-term monitoring of salamanders. As with bird and forestry trend data, ecological insights into species

biology and ecology come to both those who collect the data in the field and those who analyze them in the laboratory. As data and analyses accumulate, so too does the monitoring site's attraction to outside researchers. Monitoring with coverboards is attractive and appropriate for school participation. Because fall and spring are usually the best monitoring periods, this opens up many opportunities for schools to join while giving students real-life scientific experience.

Thus, the rationale for monitoring terrestrial salamanders is built on:

- Their key role and high densities in many forests
- The stability in their counts and populations
- Their vulnerability to air and water pollution
- Their sensitivity as a measure of change
- The threatened and endangered status of several species
- Their inherent beauty and appeal as a creature to study and conserve

SEARCHING FOR SALAMANDERS

Project Protocol

The following information was largely taken from:

Northeast Temperate Network and Marsh-Billings-Rockefeller NHP
Forest Amphibian Protocol

Version 1.01
May 29, 2006

This simplified protocol is intended to assist the parks (NTMP) in setting up the salamander survey. Ecologists have discovered that one of the best ways to monitor salamanders is with the use of artificial coverboards because they are

- Non-disruptive to the natural habitat
- Attract species that are difficult to trap in pitfall traps
- Providing a standardized sampling unit
- Minimize observer biases and errors

Locating Coverboards: Transects or arrays of coverboards can be installed anywhere there are terrestrial salamanders to crawl under them. Because the objective of the monitoring program is to look at patterns of changes of salamanders in relationship to local and regional habitat, climate, location, and landscape factors, all contributions are encouraged (that meet the general requirements listed below). That said, there are 2 situations for which we would particularly like to encourage parks to establish monitoring sites.

Ancient or Old Growth Sites: In particular those sites that have had little disturbance due to cutting, grazing, plowing, or other major anthropogenic disturbance. These sites act as reservoirs of plant and animal populations, and, while all are inescapably affected by the air, water, and landscape changes that occur around them, they represent something of a natural control for comparison with other sites. Also, if widespread declines are detected in these, the most optimal of salamander sites, then we have grounds for increased worry regarding global changes.

Disturbed Sites: At the other end of the spectrum are sites where salamander populations are or are likely to become stressed. Such sites could include fragmented woodlands, urban/suburban sites, forest management sites, grazed woodlands. Sites could be established prior to an impact, during the impact, or in the aftermath of these changes. As a rule, the situation with the most potential is one where the monitoring can begin well before a disturbance takes place.

Sampling arrays will be located near long-term **forest condition monitoring plots**. The arrays will not be at the long-term plots in order to reduce impacts on the forest plots; arrays will be placed 40 m away from the forest plots, and within the same stand whenever possible. NOTE: it is very important that classes avoid disturbing the forest monitoring plots. If you notice that you are in a plot where all of the trees have metal tags, please move your class outside of the area.

Scouting: Potential monitoring sites should be scouted to determine if populations of any of the target monitoring species are present.

Distance from Edge: Coverboards should be placed so they are more than 50 m from the edge of the forest.

Habitat: Each transect/array should traverse only one habitat, if possible.

Habitat Discontinuity: Transects can be divided into several subsections to avoid inappropriate habitat.

Pairing Boards: To minimize the potential effects of territoriality, coverboards (if using single boards) should be laid out in pairs, 0.5 m apart.

Distance Apart: Based on recapture distances for several species, distance between sets of coverboards should be a minimum of 6m.

Number of Coverboards in a Transect: The number of coverboards in a transect should be enough so that salamander counts average 10 or more per check (during the season of peak abundance of salamanders). A rough estimate of this number can be made by scouting a prospective area during the appropriate season and counting the proportion of natural cover objects with salamanders under them. Then, double this proportion and use that number to estimate the number of coverboards to put in place. For example, if you found that 1 out of 10 natural coverboards had a salamander under it in your scouting runs, then you would want 50 coverboards in your array. Another way to approach the problem is to put 100 objects out in a suspected low salamander density area, 50 at moderate densities, and 25 at high densities.

Transect Layout: The objects are best placed in a transect (to cover the greatest area) but can be curved to fit topography or put in a matrix to fit the limitations of the site. If the area being monitored has high relief, you may wish to run the transects perpendicular to the slope for ease in censusing and the .monitoring of students

The following is an example: A salamander-monitoring project might begin with two arrays of 50 stations each (a 5 x 10 array); stations would be 10 m apart, and each would have a pair of coverboards spaced one meter apart. The number of arrays and number of

coverboards per array can be adjusted as data is collected and the optimum level of participation is determined. It has been suggested that 15 coverboard stations per array or transect should be adequate, but using 50 stations will provide more of an opportunity for all students to participate in the different aspects of data collection.

Establishing each array will require 100 labeled white or red oak boards measuring 20 x 30 x 2.5 cm (approximately 8 x 12 x 1 inches), 4 rebars or other posts for marking corners, a GPS for locating plot boundaries, a compass (with declination set correctly), and a 100 m measuring tape. Locate and mark corners A and D, and run the tape between these corners as straight as possible. Place a cover board 0.25 m north and 0.25 m south of each corner, and 0.5 m north and south every 10 meters along the measuring tape (each pair of boards is one station. If a tree or other object is in the way, place the board as close as possible to the desired location.

After establishing the first row of stations, use the GPS to locate and mark corners B and C. Run the measuring tape between A and B, and establish stations at the corner and every 10 meters between the corners (at 10 m, 20 m, and 30 m). The coverboards should always be placed 0.25 m north and 0.25 m south of the station point. Repeat this process with corners C and D.

Next, run the tape between the stations that have been established 10 m north of corners A and D, and establish the stations between them. Continue with the stations 20 m north of the line between A and D, the 30 m stations, and then the stations between corners B and C.

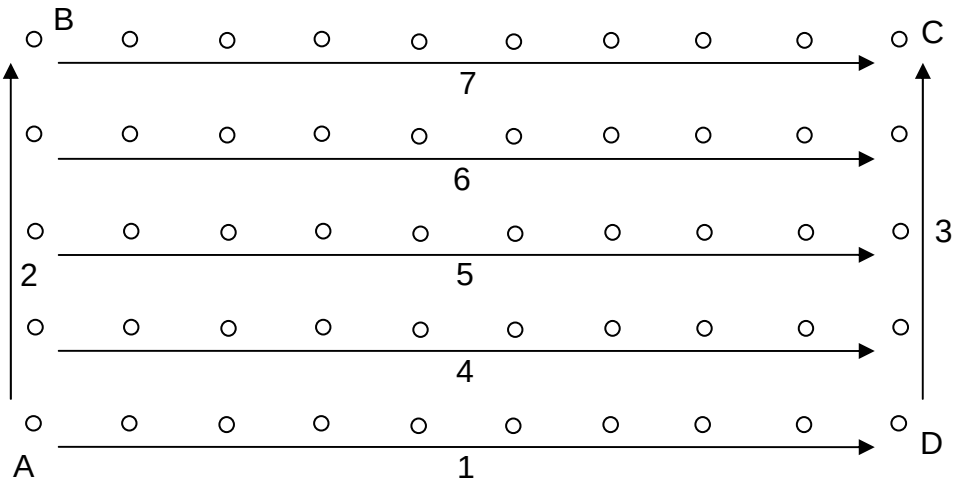


Diagram of stations in an array, with corners (letters) and suggested order of station establishment (numbers). Each station consists of two boards, 0.25 m north and south of the point indicated.

Installing a Board: When installing a coverboard the leaf litter should be removed, the mineral soil leveled, and the board placed so its entire surface is in contact with the earth.

Identifying Arrays and Stations: For clarity, each array should be designated with a letter and each station in the array should be assigned an individual number, starting with the number 1.

Crushing Salamanders: If you remove an animal from under a coverboard, or if it moves out under its own accord, it should be released immediately after measuring it next to the board so that it can crawl back under on its own without being crushed.

Continuity of Cover Materials: For the sake of repeatability and experimental value, coverboards should be the same size in each park, They must be maintained, *ad infinitum*. We strongly recommend labeled white or red oak boards measuring 20 x 30 x 2.5 cm (approximately 8 x 12 x 1 inches) See Appendix 6 for the suitability of various wood types.

What Time of Year to Check Under Coverboards: High air moisture, calm wind conditions, high soil and litter moisture, and low (but above freezing) temperatures are the physiologically optimal conditions that prompt salamanders to move out of their soil retreats and under coverboards. As many studies have shown early spring and very late fall (especially pronounced in Eastern populations) are when salamander numbers reach their highest surface densities, particularly the younger age classes that are the most vulnerable group to desiccation. The Fall peaks in counts tend to be compressed into the last few weeks prior to the first hard freeze, and often average higher than spring counts, probably due to courting activities. In fact, numbers can drop precipitously (even after it warms back up) following the first freeze.

General recommendations for the timing of taking counts (assuming no prior knowledge about the surface abundance patterns at a site) are as follows: The fall sampling period should begin 1 month prior to the average hard freeze data in the fall and ends with the first hard freeze. The spring sampling period starts following the complete thawing of the soil column, roughly when temperatures move into the upper 30s and low 40s. Sampling should stop about 2 months after that date or if daytime temperatures begin to regularly exceed the 50s.

General Setup Recommendation: If possible, have the coverboards in place and weathering at least 4 months prior to inventorying. This will allow the salamanders time to accept them as a normal, useful part of their environment.

Monitoring Steps

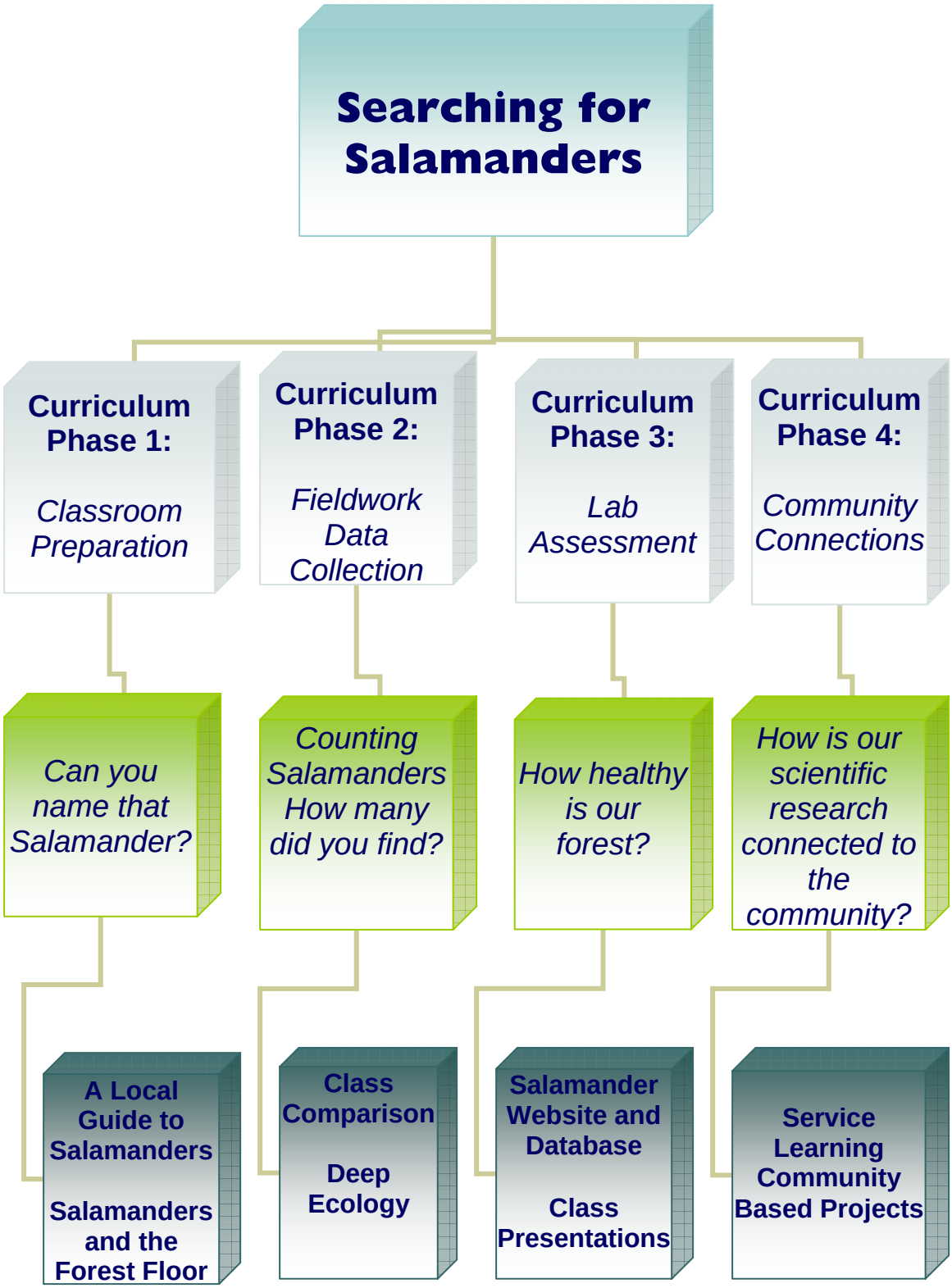
See the middle school and high school curricula for specifics.

Checking: Each coverboard is raised, and any salamanders found underneath should be placed in a moistened (not a lot of water, as they can drown) Ziploc bag. The simplest way to moisten the bag is with a couple of sprays from a plant mister.

Capturing: It is sometimes easier to grab a handful of litter/dirt along with the salamander than to try to capture the salamander by its "waist." Do NOT grab the creature by the tail, as their tails break easily as a defense mechanism. If the tail does break, it can seriously lessen the salamander's chance for survival.

Identifying: Each salamander should be identified according to species. This is why learning the species is necessary prior to monitoring. It should be mentioned that some species have color variations (i.e. the northern red-backed salamander has a red stripe as well as a "lead-back," speckled black variation) and this should be noted.

Measuring and Recording: Measure the salamanders using the provided metric ruler graduated in millimeters (mm). Enter all data required on the data sheets provided.


Searching for Salamanders
Curriculum Phase 1: Classroom Preparation
Curriculum Phase 2: Fieldwork Data Collection
Curriculum Phase 3: Lab Assessment
Curriculum Phase 4: Community Connections
Can you name that Salamander?
Counting Salamanders How many did you find?
How healthy is our forest?
How is our scientific research connected to the community?
A Local Guide to Salamanders
Salamanders and the Forest Floor
Class Comparison
Deep Ecology
Salamander Website and Database
Class Presentations
Service Learning Community Based Projects

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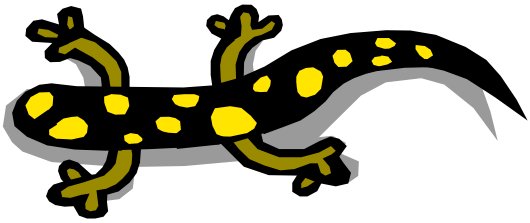
A Monitoring Program



Middle school grades curriculum (6-8) engaging students in an ongoing salamander monitoring program in our local National Parks

SEARCHING FOR SALAMANDERS

Middle School (6-8) Curriculum Overview

Objective

This is a general life science curriculum (Grades 6-8) designed to create civic engagement of students with their local National Parks in the Northeast Temperate Network by undertaking a monitoring program of salamander populations. The purpose of this curriculum, then, is to engage students in collecting meaningful scientific data about salamander populations. This data will be used by scientists as an indication of forest ecosystem health.

Essential Question

How can the presence or absence of salamanders help determine the health of our forest ecosystems?

Time

This curriculum will allow you to choose the length of time you would like to use to explore this topic within your classroom. A **minimum of three days** should be devoted in order for the monitoring process to be meaningful and accurate. This curriculum could extend to 2-4 weeks depending upon the integration of other life science units such as animal classification, ecosystem equilibrium, and forest ecology including food chains and webs.

This curriculum **requires at least 1 visit** to the park for data collection. **Preferably, there would be 3 visits** on a weekly basis in either the springtime (April/May) or fall (September/October/November) before the killing frost. (See Protocol)

SEARCHING FOR SALAMANDERS

Curriculum Phase I: Classroom Preparation 1-3 days

Can you name that Salamander?

Time
1½-hr block or two 45-minute class periods

Learning Objectives
- Students will understand the mission of the National Park Service and how it relates to the monitoring and inventory of salamander populations
- Students will understand their role as data collectors in the salamander monitoring/inventory program for their local National Park
- Students will be able to identify the unique characteristics of salamanders
- Students will understand how salamanders are bio-indicators of forest health
- Students will be able to identify species of salamanders that are specific to their local park

Background knowledge
- Students should understand the characteristics that make an animal an amphibian
- Students should understand how to identify organisms based on specific traits (classification).
- Students could have knowledge of food chains and ecosystem equilibrium prior to study but that could also be used as an extension to incorporate into the unit of study.
- Students should understand the process of the scientific method

SEARCHING FOR SALAMANDERS

Materials

Use of Internet- www.npwrc.usgs.gov/narcam/idguide/
http://yahooligans.yahoo.com/content/animals/amphibians/
Field guide to Northern Amphibians and Reptiles; 1 for every 3-4 students
Can you name that salamander? Handout; 1 copy per student
Chart paper with questions/ markers
Fun Facts about Salamanders
Laminated colored pictures of local salamander species (from resource kit)
Amazing Salamander Ad template

Key Vocabulary

Salamanders are amphibians. An **amphibian** is a vertebrate in the Animal Kingdom. **Vertebrates** are animals that have a backbone. Amphibians are **ectothermic** which is also known as cold-blooded. This means their body temperature changes with their surroundings. Amphibian literally means "double-life". Amphibians spend part of their life in water and part on land. Amphibians will lay their eggs in water, develop and move onto land as an adult. The forests of North America have several species of salamanders who have adapted to woodlands and are entirely **terrestrial** which means their complete life cycle is on land. Amphibians are often called **ecological indicators** because signs of unhealthy amphibians can be a warning sign of changes in the ecosystem. When large numbers of amphibians start to die, a problem with the environment may exist. The reason they are **bio-indicators** is due to their thin skin that can easily absorb any chemicals in the water or air. As **ectotherms,** climate change can also affect their populations.

Introduction

Before students begin learning about salamanders and collect data in the park, it is important for students to understand the importance of their own role in the collecting of this data now and in the future. Teachers should explain to students that they will be collecting data that will be used to determine the health of the ecosystem in the park based on the salamander populations. Teachers should inform students about National Parks and their mission.

Below is information taken from http://www.nps.gov/legacy/legacy.html about the legacy and mission of the National Park Service. Teachers could also research the local park they will be working with and give the students some background information about the park in which they will be collecting data.

When Did The NPS Begin?

Although Congress set aside Yellowstone National Park in 1872, there was no real system of national parks until a federal bureau, the National Park Service, was created on August 25, 1916 to manage those areas then assigned to the U.S. Department of the Interior. Following is a list of significant legislation which influenced the creation and growth of the National Park System.

Yellowstone National Park Act, 1872

The Yellowstone Act preserves the watershed of the Yellowstone River "*for the benefit and enjoyment of the people.*" For the first time, public lands were preserved for public enjoyment, to be administered by the federal government. Put under the "*exclusive control of the Secretary of the Interior,"* the land was *"reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground..."*

National Park Service Organic Act, 1916-

"There is created in the Department of the Interior a service to be called the National Park Service, which shall be under the charge of a director....The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified, except as are under the jurisdiction of the Secretary of the Army, as provided by law, by such means and measures as conform to **the fundamental purpose to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment for the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.**"

General Authorities Act, 1970 –

The purpose of this act is to include all areas administered by the National Park Service in one National Park System and to clarify the authorities applicable to the system. Areas of the National Park System, the act states, "though distinct in character, are united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage; that, individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all people of the United States..."

Redwoods Act, as amended 1978-

This act reasserted the system-wide standard of protection prescribed by Congress in the original Organic Act. It states, "Congress further reaffirms, declares, and directs the promotion and regulation of the various areas of the National Park System...shall be consistent with and founded in the purpose established by the first section of the Act of

August 25, 1916, to the common benefit of all the people of the United States. The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

The National Park Services' Mission states" ***to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Organic Act 1916.***

This curriculum is designed in order to help engage students in the continuation and further development of the NPS Inventory and Monitoring Program throughout the Northeast Temperate Network. It is equally important that students understand the mission of this specific program and their role within it while they are collecting important information that will help parks to analyze the health of each parks' ecosystem.

The National Park Service's Inventory and Monitoring Program (I&M Program) is responsible for helping parks meet their mission of preserving park resources. The national program is divided into 32 networks that each work with a group of parks. The networks design and implement ecological monitoring programs that provide critical information to the National Parks and the public about the integrity of landscapes, ecosystems, and species. Because it is not possible to monitor all aspects of park natural resources, the I&M program focuses on identifying and tracking key indicators that provide reliable and useful information.

The Northeast Temperate Network (NETN) consists of a diverse group of parks, including Acadia National Park in coastal Maine, Morristown National Historical Park in New Jersey, and the Appalachian Trail, which crosses fourteen states. The majority of NETN parks were established for their cultural resources and are relatively small in size, but the natural resources in these parks are crucial to understanding their cultural value.

The Network parks are:

Acadia NP, Maine
Appalachian NST, Georgia, North Carolina, Tennessee, Virginia, Maryland, West Virginia, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Vermont, New Hampshire, and Maine
Boston Harbor Islands NPA, Massachusetts
Marsh-Billings-Rockefeller NHP, Vermont
Minute Man NHP, Massachusetts

Morristown NHP, New Jersey
Roosevelt-Vanderbilt NHS, New York
Saint-Gaudens NHS, New Hampshire
Saratoga NHP, New York
Saugus Iron Works NHS, Massachusetts
Weir Farm NHS, Connecticut

You can find a map of these parks in Appendix 1

Park contact information is listed in Appendix 4.

For more information go to http://www1.nature.nps.gov/im/units/netn/index.cfm.
This website will allow you to contact the individual park websites and get more information about the park where students will be doing their inventorying and monitoring studies.

Classroom Activity

1. Assess students' prior knowledge about salamanders and data collecting by placing the following questions on chart paper that is hung at different places around the room. Break students into smaller groups of 3-4 students to brainstorm what they already know about each question and have them write responses on the paper.

- **Can you name any salamanders that live in our local forest?**
- **What characteristics would help us to identify a particular type of salamander?**
- **If we are going to see if the forest is healthy based on the population of salamanders, what types of data should we collect about the salamander populations and its habitat?**
- **Why do you think it would be important to know what type and how many salamanders live in our forest?**

Have groups spend a few minutes at each question and then rotate through each question to read what the other group wrote and add any new ideas.

Once they have traveled to each question, have the group share their question and the responses given by the class. Have a group member add to them as you discuss the key points below.

Key points that should be addressed for each question are:

#1: The names of salamanders that live in the local forest (see Appendix 2)

#2: Characteristics should be coloring, patterning on the top, sides and underneath, and size

#3: The data to be collected should be type of salamander, its length, habitat, weather—amount of rain in 24hr/week long period, date, time, temperature, wind speed, cloud cover, soil temperature, other organisms present

#4: If the population of salamanders were low, that could mean that other populations in their food chain are affected. It could indicate that other factors are disturbing the ecosystem and the health of the forest

2. After group discussion, have students remain in their small groups. Hand out fun facts about salamanders and have one person in the group read them aloud. Have the group choose the **top 3 facts** they think are most important to salamander populations that might help to determine the health of the forest. Have each group member share one fact they chose and explain why that fact is important to our data collection on salamanders.

Key points to address during the discussion:

- Salamanders breathe through their skin so they can easily take in pollutants from the air and water that could affect their population.
- Salamanders are ectothermic and since their bodies change with their surroundings, they can be affected by a change in the climate over time.
- We know that forests that have not been disturbed have historically high populations of salamanders. So, if our salamander population is low, it is probably somehow being disturbed.
- Salamanders are an important part of the food chain for other vertebrates and, if their population is low, other populations might be affected.
- Since they reproduce at a low rate but live for a long time, a change in their population could indicate a significant change in other amphibian populations.

3. Give each group a colored, laminated picture of a salamander that lives in the local park forest. (See Appendix 2 to find information about the salamander species that have been found in your park.) List the possible names of the salamander species they might identify on the board. This will help to narrow down the options due to the difficult task of identifying between species that look similar.

Give them the template for ***Amazing Salamander Ad*** and explain what data they will be collecting on their salamander species.

- name: common and scientific/ Latin
- habitat: specific environment and range
- adult size: length in cm
- identifying feature-coloring, patterning, other features
- other species it resembles

Give them a field guide to northern amphibians and reptiles. Show them how they can use the guidebook to determine the name of a species and learn more about it. Have them use the guidebook to identify the salamander in the photograph and fill in the necessary information on their ad.

If there is time, they can also use the web sites to add to the information about their salamander species.
www.npwrc.usgs.gov/narcam/idguide/
http://yahooligans.yahoo.com/content/animals/amphibians/

4. Hand out ***Can you name that salamander?*** As groups present, each student should fill in the appropriate information about each salamander. Let students know that this will be their key to use when they go to the park to count the number of salamander species that they see.

5. Have the group present their amazing salamander ad aloud to the other groups. Have each student responsible for presenting 1-2 pieces of information about the salamander. Display ads throughout the classroom.

Digging Deeper: Curriculum Extensions

A LOCAL GUIDE TO SALMANDERS

The research of a specific local salamander species could be done on an individual basis. Their "ad" could become part of a local salamander guide to the forest. Each student could be responsible for drawing and describing the food chain/web of their salamander and explain how it is important to the health of the entire forest ecosystem. The research pages could be laminated and bound together to be a classroom reference guide.

This website is a resource for food chains/webs.
http://library.thinkquest.org/2943/fchain.html

SALAMANDERS IN THE FOREST FLOOR CYCLE

Students could learn about the cycle of the forest floor and the role of the salamander as a consumer. This would be an appropriate time to introduce producers, consumers, and decomposers. Students could "act out" the forest floor cycle by giving each student a sign that indicates a role of a producer, consumer, and decomposer on the forest floor as well as signs that indicate arrows. They should then arrange themselves according to who eats whom and what role they play in the cycle.

Producers: Trees and plants grow and lose leaves → **decomposers:**

bacteria and fungi feed on plant matter → **small consumers; herbivores**:

insects feed on bacteria and fungi → **consumers; omnivores** :salamanders

feed on small insects → nutrients like nitrogen and phosphorous get recycled

back into the soil, air, and water → new plants grow and the cycle begins

anew

SEARCHING FOR SALAMANDERS

Curriculum Phase 2: Fieldwork and Data Collection
1-3 Field Visits

Counting Salamanders:
How many did you find?

Time

The recommendation for monitoring and doing an inventory of salamander populations suggests that 3 visits to the same site over the course of a year would provide the most accurate information and data. However, all data collected is important and one visit is much better than none at all. Visiting in the spring or fall at the same location would also be preferable.

Class preparation time: 20-30 minutes
On-site time: 1-2 hours depending upon how many arrays you sample and traveling time to the site location.

Learning Objectives

- Students will learn how to collect data in a systematic way in order to decrease the level of bias and variability
- Students will locate, identify and count the species of salamanders present under the coverboards set up at the park location
- Student's data will be utilized now and in the future to determine trends of forest health based on fluctuations or stability in salamander populations

Background knowledge

- Students should have an understanding of the scientific method and the necessary steps in the process: question, background information, hypothesis, observation/data collection, and drawing conclusions from data.
- Students should have a strong understanding of their significant role in the data collection of salamander species and numbers in the park.
- Students should be able to identify local salamander species correctly.
- Students should be able to identify the controls and variables that will be involved in their investigation.
- Students should know how to collect data that is accurate and consistent.

SEARCHING FOR SALAMANDERS

Materials

1 Lab Kit per group:

- Plastic bin
- Data collection folders; 1 per group
- Data collection spreadsheet inventory and monitoring; 1 per group
- Celsius thermometer
- Can you name that salamander guide in cover sheets; 1 for each group
- Salamander Identification booklet with laminated pictures and ruler
- Pencils
- Plastic baggie

Digital Camera (if possible)
1 Chaperone per group of 3-4 students
A Park staff scientist or employee (if available)

Key Vocabulary

The purpose of the **inventory** is for students to count accurate numbers of salamander species in the area they will be sampling. The purpose of the **monitoring** is to look at data that is collected in the same sampling region in the park year after year to draw conclusions about the health of the forest ecosystem in relation to the stability or fluctuation of the salamander populations. The students will be collecting data in an **array** that will be established by the individual park staff. The **array** will be an area that has been sectioned off and **coverboards** made of wood will be placed in an equidistant pattern. These **coverboards** act as artificial debris/habitat for salamanders to crawl under and use for shelter. Each array will be identified with a name and each coverboard will have an identification number on it.

Introduction

Explain to students that today they will be using their knowledge of salamander identification to collect valuable information for the National Park Service for an inventory and monitoring program that will continue many years into the future. Stress that it is extremely important to take this task seriously and do the best job they can while they are in the field collecting data. Inform students that the correct identification of each species and the total number that they find is the most important factor to focus on in their work. Warn students that handling the amphibians is not permitted because they can be crushed or harmed very easily but photographing them or drawing them is encouraged.

SEARCHING FOR SALAMANDERS

Classroom Activity

1. In order to remind kids of the importance of the identification of each species they find in the field, start the class by flashing laminated pictures of each species and have students try to give their names. If they are unsure, allow them to use their "*Can you name that salamander?"* sheet. Ask them to state an identifying feature that helped them to identify the species.

2. Post these pictures on the board and write the salamanders' names and major identifying features underneath them while you continue to teach them about how they will inventory and monitor the salamander population in the park.

3. Divide students into groups of 3-4, depending on class size, and place them with a chaperone. Have each group sit together. Handpicking the groups might be preferable due to the importance of the work they will be doing. Each group should receive a pocket folder that has their names, array name and coverboard #'s on it. This folder will be used to hold all of their sheets and information.

4. Hand each student a *Searching for Salamanders Scientific Investigation* sheet. Define the question, background information, hypothesis, materials, controls and variables, and data collection information for the field investigation.

Question: Is our National Park forest healthy according to the salamander populations found in the investigation?

Background information: Ask students to recall facts that were discussed in the previous class.

[Salamanders are ecological indicators within an ecosystem due to their highly sensitive skin, low reproduction rate, and long life. Large populations of salamanders are found in undisturbed forests. Salamanders are ectothermic and a change in temperature can affect their population size. The salamanders that are found in the local forest are (name species).]

Materials: List the items found in the lab kit

Control and Variables: The control in this investigation is the site location and the use and placement of the coverboards. The variables that could affect the investigation are weather, time of year, salamander identification accuracy, and accurate counting.

5. Hand each student a data collection spreadsheet. Tell them to put their name, date, group #, and array location on it. Go over the data they will be collecting once they get to their array and explain how they will collect the data.

Data Collection

Before taking the class to the site, have the groups assign the following roles they will perform at the array. Depending on group size, a person might have to perform more than one role

Field ecologist: This person should collect data on rainfall, air temperature, wind speed, cloud cover, soil temperature, and habitat once the group arrives at the site. In order to get information about rainfall in the area, go to the NOAA website http://www.weather.gov/forecasts/graphical/sectors/ and post rainfall information on the board. This person should also do field sketches of habitat and organisms in array.

Investigation Assistant: This person will responsible for removing the coverboard, aiding in the identification of the salamander and helping to count the numbers of salamanders. He or she should be recording the data on the spreadsheet as the sleuth identifies it: coverboard #, salamander name, number counted, time, and other organisms present.

Salamander Sleuths: At least 2 people should have this role. Once the coverboard has been removed, they should identify the type of salamander seen by using the key and guides, count how many are present and try to measure length(s). Salamanders tend to freeze in the first few moments of being exposed. If so, students can lay the laminated ruler on the ground and try to get a rough estimate of size. If the teacher feels confident in the chaperones, the chaperones may use a plastic baggie turned inside out to pick up the salamander very gently. Once the salamander stretches out, the students could then try to measure it. *Please note: students should not be allowed to handle the salamanders in any way.*

6. Once groups have been established and roles have been assigned, the fieldwork will begin at the site. Chaperones should have a good understanding of the work they will be doing with students and the importance of accurate data collection. Chaperones should aid in the identification and inventorying process.

7. Coordinate with scientists at the park to meet with your group and give a more detailed explanation about the work that the students will be doing and the long-term goals of this data collection. The scientist could describe to the students how the arrays were located and set up. The scientist could review identification of salamanders and aid students in their data collection by demonstrating the proper way to uncover boards and count salamanders.

8. At the site, groups will be assigned to a specific number of coverboards to check in their array. Students should systematically go to each one and record the necessary information on their data collection sheets.

9. Once they have collected all of their data at the site, students should place their data collection sheets in their group folder and place everything back in their lab kit.

Digging Deeper: Curriculum Extensions

CLASS COMPARISON

If students were only able to visit a site once, have other classes in the school, or at other schools, do the same investigation and compare the results among the different groups. The students should compare what they found in the same location in the arrays. They could swap data or compile their data and draw conclusions about the data found by the other groups depending on factors such as time of the year and weather.

DEEP ECOLOGY

If this monitoring investigation is a part of a forest ecology unit, students could extend their data collection to include tree identification and inventory, forest floor habitat description, and other forms of wildlife observed during their visits. Students could do soil pH testing, soil texture and types of soil as a barometer of forest floor health. They could use this data to make a comparison between salamander populations found in two different array habitats. They could then draw conclusions about habitat types and salamander populations.

FOREST CONDITION MONITORING

Students can compare their findings during the salamander monitoring and forest ecology units with the results of the Forest Condition Monitoring program the NETN is conducting in the parks of the network. Drawing comparisons between the additional information and the data the students have collected will allow more in depth conclusions to be drawn about habitat types and salamander populations.

The NETN Forest Condition Monitoring Protocol was developed for long-term monitoring of forest vegetation. The overall goal is to monitor status and trends in the structure, function and condition of NETN forested ecosystems in order to inform management decisions affecting those systems. Sites were randomly selected, and at each monitoring site a suite of measurements will be taken (see table below). The population being monitored is all upland forests and woodlands within park boundaries.

Salamander arrays have been established near one of the NETN Forest Condition Monitoring plots. Please contact the network if you would like information relevant to your array.

Metric		Objectives
Stand Metrics	Stand structural class	Determine status & trends in the distribution of structural classes. Compare the distribution of structural classes to that expected under natural disturbance regimes.
	Canopy closure	Determine status & trends in canopy closure by stand structural class. Examine correlation between canopy closure & climatic stress, storms, pest & pathogen outbreaks & other disturbances.
	Snag abundance	Estimate status & trends in snag abundance by size class.
	Coarse woody debris (CWD)	Determine status & trends in coarse woody debris volume & density by size class.
	Photopoint	Provide visual reference of plots for long-term qualitative comparison.
Tree Metrics	Tree condition	Qualitatively assess tree condition and estimate trends in tree condition by species.
	Tree growth and mortality rates	Determine growth & mortality rates by tree species & stand structure. Examine correlation between these rates & air pollution, pest or pathogen outbreaks, climatic stress or other known stressors.
	Tree regeneration	Determine status & trends in tree regeneration by species & size class.
Understory Metrics	Understory diversity	Determine status and trends in native understory plant species richness. Determine status and trends in exotic plant species cover. Determine change in cover or extent of species indicative of deer browse pressure, climate stress, or air pollution stress.
Soil Metrics	Forest floor condition	Qualitatively assess forest floor condition & estimate trends in spatial extent of invasive exotic earthworms, humus presence, and trampling impacts.
	Soil chemistry	Determine status & trends in soil Ca:Al and C:N ratios to assess the extent of base cation depletion, increased aluminum availability and/or nitrogen saturation are impacting NETN forest soils.
Landscape Metrics	Landscape context	Determine status & trends in interior forest patch size, & proportion of surrounding area in natural cover & in anthropogenic landuse.

Curriculum Phase 3: Lab Assessment

How healthy is our forest?

Time

1½-hour block or two 45-minute classes

Learning Objectives

- Students will use the data they collected in the park to help answer their original question and draw conclusions about their hypothesis.
- Students will graphically represent the important data collected during their field visit(s).
- Students will write a lab report that outlines the scientific method used for their scientific investigation of salamander populations in the local National Park.

Background Knowledge

- Students should have an understanding of using sets of data to create basic line/bar graphs that show amount found and/or change over time.
- Students should be able to look at data collected and draw conclusions from that data.
- Students should be familiar with the basic outline for writing a lab report.
- Students should be able to write a complete paragraph including a topic sentence, supporting details and a concluding sentence.

SEARCHING FOR SALAMANDERS

Materials

Let's get to graphing; 1 copy per student

- graph paper
- ruler
- *Lab Report Outline*; 1 copy per student
- *Lab Report Rubric*; 1 copy per student
- Students data collection sheets
- *Searching for Salamanders Scientific Investigation* sheet

Key Vocabulary

Students will be representing the data they collected through the making of a graph. Students should know that a graph is set up with an **X and Y-axis.** The **X-axis** represents the **independent (or manipulated) variable** and the **Y-axis** represents the **dependent (or responding) variable.** The independent variables are things such as forest cover type, time of year, soil pH, etc. The dependent variables are data like the number of organisms inventoried. The **intervals** on the graph need to be consistent in order to represent the data accurately (5, 10, 15, 20). **Bar graphs** are an excellent way to show results that are one time, that aren't continuous—especially samplings such as surveys, inventories, etc. **Line graph** shows change over time and can be used to compare salamander inventory data from year to year. Each graph should be labeled with a proper **title** that uses the labels of the X and Y-axis and appropriate units of measurement. (Ex: Number of red-backed salamanders found in array _____ under coverboards #____ to____.)

Introduction

The students will be working in their small groups but will be individually responsible for writing their own lab report for their Searching for Salamanders Scientific Investigation. Students will begin by determining the data they will be graphing for their group. This may include more than one graph. After the graphing has been completed, students will work individually on putting the scientific method that they used during their investigation into a written report. This report should help to both illustrate and assess their comprehension of the method used during their fieldwork investigation and to draw conclusions about the health of the forest based on the results of the salamander data collected.

Classroom Activity

1. Begin class by asking students what the original question was that they were trying to answer while collecting data on salamanders. Rewrite the original question on the board.

2. Ask students to share why this data is important to collect and how can this data be used by the park in the future. List their reasons on the board.

3. Ask students to share one thing they noticed or observed during their data collection at the site. List their observations on the board.

4. Prompt students by asking, "Now that we have collected this data, what do you think we should do with it in order to answer our original question and help the scientists in the park?" Student responses should include saying that they need to show the data graphically and draw accurate conclusions about what they found during their investigation.

5. Have students sit in their investigation groups. Groups should receive their folders that have their data collection and scientific investigation sheets.

6. Hand out ***Let's Get to Graphing*** sheets, graph paper, and a ruler to each student. Review how to set up a graph and where information should be located in the graph (X-axis, Y-axis, titles, scales, key). Talk about the difference between bar and line graphs and what each one represents.

7. Ask students to look at their data collection sheets and determine the information that they should show in their graph in order to answer the original question. Ask them which type of graph they should use to represent their data. The most basic graph students should complete is one that shows the type of salamander and numbers found in a bar graph. If students were able to visit the site more than once, the graphing could be expanded to include the 3 different visits. A line graph could be drawn to show the change in the salamander population over time.

8. Each student should use the data collected in their group to show the quantity of each salamander species found in their section of coverboards in the array. Students could choose a particular species to graph the results of, compare the results of different species, or create one graph that represents all of the species.

9. After groups have completed their graphs, share the results of each graph and make a compilation graph on the board together. Discuss with students what the results of the graph indicate in relation to forest health. Ask students "What are some things that could affect the population of salamanders in the forest? Make a t-chart that is titled natural or ecological disturbances and human disturbance. Brainstorm these disturbances.

9. Ask students to tell why it is important for scientists to write up the method and results of their investigation. Hand out the ***Lab Report Outline and Grading Rubric*** and review each component.

10. Students should write a rough draft of the lab report using the outline and their graphs. Once the rough draft is completed, students can peer-, or self-edit using the lab report outline as a checklist to make corrections to their draft.

11. Final reports should be typed and handed in.

Digging Deeper: Curriculum Extensions

SALAMANDER DATABASE OR WEBSITE

For students who have technological abilities, the data collected by the class and the reports that are written could become a part of a webpage. Students could include the salamander species and identification information, graphs and conclusions about the health of the forest in the webpage. Data could also be put into a larger database throughout the Northeast Temperate Forest Network of the National Park and could be added to each year the monitoring and inventory investigation is complete.

CLASS PRESENTATIONS

As a group, students could present the data they collected and what they found in their section of the array. The presentations could have a variety of graphs that give information about habitat conditions as well as salamander species. Students could use photographs from their fieldwork experience to create a visual presentation or a PowerPoint. Students should be responsible for presenting the necessary components of their report: introduction, methods and procedures, results, and conclusion. This presentation would allow other groups to make a comparison between their results and the results of others.

Curriculum Phase 4: Community Connections

How is our scientific research connected to our community?

Time

1½-hr block or two 45-minute periods to prepare presentation
10-15 minutes to practice presentation
20-30 minutes to present

Learning Objectives

- Students will publicly present their scientific investigation and data results to members of the local community who have a vested interest in this program
- Students will use oration and memorization skills to effectively communicate their learning
- Students data collection and presentation will be given meaning and relevance
- Students will be involved in a civic engagement project that will utilize a variety of skills

Background Information

- Students should have an understanding of who their audience is and why their research is important to them
- Students should have a clear understanding of the data they collected and how it relates to the health of the forest
- Students should have some knowledge of how to prepare and present an effective oral presentation

SEARCHING FOR SALAMANDERS

Materials

- Digital photos from investigation
- Salamander images
- *Presentation Planning* sheet; 1 copy per group
- Note cards
- Group Folders including all information collected during the unit
- Handmade or computer generated graphs of data from each group
- Access to a computer if students are creating a PowerPoint presentation
- Access to a variety of materials for creating a visual display

Introduction

Students will be asked to present their Searching for Salamanders Investigation to a minimum of park staff and scientists at the park. This is an opportunity for their data to have meaning and relevance. This presentation could be simply inviting the staff to the classroom or could extend into the greater community and be an evening presentation at school or in the park. This part of the curriculum is critical to civic engagement and the achievement of the learning throughout this unit of study.

Class Activity

1. Have students sit in their field study groups. Hand out the ***Presentation Planning*** sheet. Ask the groups to brainstorm 3-5 things that make a presentation great and 2-3 ways to present information effectively.

For example, they should note that presentations should be clear, concise, engaging, have good visuals, and be informative. Format possibilities are PowerPoint, poster board tri-fold, or any other unique ideas that will get their information across to the audience.

2. Inform students that they will be putting together one part of a larger presentation that will be given to the park staff and scientists. Smaller groups will present specific parts of the class presentation. Explain ***Presentation Group Roles*** to the entire class and then hand out their individual roles by group. Students could either choose the group they would like to work in or be assigned to a particular role prior to the beginning of class.

3. Have students fill in the title of their group role and list their responsibilities on their ***Presentation Planning*** sheet. Go over creating an outline for their presentation. Brainstorm an example on the board to help kids get started with their own outline.

Example:

Role 1: Introduction

I. Introducing the class and the project

a. Introduce yourselves
b. State background information about the class

II. Describe the types of things we learned during this unit of study

a. How to identify particular types of salamanders
b. Important facts about salamanders as eco-indicators of forest health
c. Collected data on array habitat conditions, types and amount of salamanders found under each cover board
d. Presented our investigation in a final lab report

III. Introduce the next presenters
a. Introduce the names of the next presenters and their topic

4. In the outline, they should determine which group member will be responsible for presenting which part of the outline. The group should then list the resources they will need and give a general description of what their presentation will look like.

5. Check each group's planning sheets. Once they have been approved, have the students begin to create their presentations. Each student should write up note cards that highlight the information he or she is responsible for during the presentation.

6. Once their proposed presentations have been completed, have the students practice by presenting their information in class before the final group presentation. Go over the key things to remember for a presentation:

1. **Dress appropriately**
2. **Speak clearly**
3. **Maintain eye contact**
4. **Know information well—memorize note cards**
5. **Make smooth transitions from one person to another**
6. **Always smile and answer any questions asked of you to the best of your ability**

Digging Deeper: Curriculum Extensions

As students are preparing their presentations for park staff and scientists, ask them who else would find these data useful. Work together to construct a list of interested parties. Develop targeted invitations to these groups, explaining the project and emphasizing why this group might find these particular data relevant and important. Groups might include:

- Conservation commission members
- Garden club members
- Local nature center staff and board
- Local environmental groups
- State Fish and Wildlife or Agency of Natural Resources staff
- The general community

Work with park personnel to identify service-learning projects that the students could do to help preserve the salamander habitat within the park.

Work with the local conservation commission, state and municipal parks departments or privately held publicly accessible lands such as nature center land to identify habitat improvement service-learning projects that the students could do.

Have students prepare a brochure summarizing their findings and outlining steps homeowners can take to protect salamander habitat. Distribute these brochures through local home and garden stores and through local conservation groups.

SEARCHING FOR SALAMANDERS

Chaperones' Field Notes

Students should <u>not be allowed to handle the salamanders</u> in any way. Chaperones may handle a salamander by using a plastic baggie over their hands. Kids and chaperones should wash their hands or use latex gloves when handling the coverboards. <u>No suntan lotion or bug spray should be used during the fieldwork.</u>

1. Today, you will be working with a small group to help collect data for the National Park Service Inventory and Monitoring Program. The purpose of this program is to use students to collect meaningful, accurate data about the salamander populations living in our park in order to determine forest ecosystem health. This data will be collected now and many years to come in order to chart fluctuations in salamander populations in the park.

2. Each student in your group will be assigned to a specific role. Each role has specific duties for which the student will be responsible. It is your job as chaperone to monitor their progress and help them to complete all of their fieldwork tasks.

Field ecologist: This person should collect data on rainfall, air temperature, wind speed, cloud cover, soil temperature, and habitat once the team arrives at the site. This person should also do field sketches of habitat and the organisms in the array.

Investigation Assistant: This person will be responsible for removing the coverboard, aiding in the identification of the salamander, and helping to tally the numbers of salamanders. He or she should be recording the following data on the spreadsheet: cover board #, salamander name, number(s) counted, time, as well as the other organisms present.

Salamander Sleuths: Once the coverboards have been gently removed and placed to the side, the sleuth should identify the types of salamanders seen by using the laminated field guide, count how many are present and try to measure their lengths. Salamanders tend to freeze in the first few moments of being exposed. If this is the case, students can use the ruler printed on one of the laminated sheets on the ground and try to get a rough estimate of size. Coverboards should then be carefully put back into their original position making sure that the salamanders are well protected.

3. Students will have a group binder and a lab kit in which to collect their data. It is important that all the data collected be complete and accurate. Help students to use the salamander identification cards in order to identify correctly the species they have discovered. All data sheets and materials need to be collected at the end. If available, use a digital camera to document salamanders that are found. This is especially helpful if there is a question as to correctly identifying the species. If possible, recommended photos would be of the top, bottom and side of the salamander.

Let's Get to Graphing: *Representing our Salamander Inventory Data*

In order to figure out what our data means, we need to show our data graphically. All graphs should be accurate and include the following information:

Title: This should state the labels of the x and y axis
Example: Amount and type of salamanders found in array #3 under coverboards #1-10 on (give date)

Y Axis:
Dependent variable
Label in units

Example:
Number of individuals

X Axis: Independent variable
Label in units
Example: Salamander species found in array Letter C under coverboards #1-10

Scales: Each axis must be labeled with consistent intervals of numbers (0,5,10,15,20)

Key: If you are doing a double bar graph to compare two sets of data you should use colors or patterns to represent the different sets of data. Make sure you create a key to show this.

Example: red backed salamanders = red bar
spotted salamanders=yellow bar

SEARCHING FOR SALAMANDERS

Lab Report Outline: Reporting on our Salamander Investigation

Name: _____ Date: _____ Class: _____

The report you will be writing about concerning our data collection on salamanders in the local National Park will be extremely important information for park scientists and staff. This report will tell the park the methods of your investigation and the conclusions from your data that help to predict the health of the forest.

INTRODUCTION

- Introduce the purpose of this report and investigation
- State the question of the investigation
- Give any background information learned prior to the investigation
- State your hypothesis

DATA COLLECTION METHODS AND PROCEDURES

- List the materials used during the investigation
- State the purpose of your role in the investigation (field ecologist, investigation assistant or salamander sleuth) and the data you collected
- Explain the control and the variables in the investigation

DATA COLLECTION RESULTS

- The name of your array and coverboard #'s investigated
- Habitat field notes: amount of rainfall, air temperature, wind speed, cloud cover, soil temperature and habitat description
- Salamander monitoring and inventory results: name and amount of species found

DRAWING CONCLUSIONS

- Discuss the proving or disproving your hypothesis
- Explain what you think the health of the forest is based on your data collection results
- Answer the following: If the salamander population is low due to disturbance, what could be done to improve the health of the ecosystem? OR, If the salamander population is high due to a healthy forest ecosystem, what could be done to keep it healthy?

SEARCHING FOR SALAMANDERS

Lab Report Grading Rubric

Grading Criteria	You are a Salamander Sleuth! 90-100	Good Work 80-89	Some Areas of Concern 70-79	Investigation Incomplete 69 or below
Introduction	Purpose and question of investigation was clear and concise, explained background information thoroughly, stated reasonable hypothesis	All necessary information was included. Language could have been more clear and concise or Lacked a few details or Hypothesis could have shown more insight	Some necessary information was missing or Language was unclear and sentences were incomplete or Lacked specific details or Hypothesis did not relate specifically to question	Several omissions, sentences incomplete, lacks detail and reason
Methods and Procedures	Explained the materials and procedure used to collect data in great detail, explained individual role, controls and variables	All necessary information was included Lacked specific details in materials, procedure, individual role or control/variables	Some necessary information was missing Materials used and procedure not clear or Control and variables not explained	Several omissions, does not clearly outline methods and procedures used during investigation
Results	Explained in great detail the data collected during the investigation	Explained all data collected in investigation. Lacks elaboration of specific details	Some data results were not explained or described in detail	Data was not explained in written form
Conclusion	Discussed proving or disproving hypothesis, determined health of the forest based on data results, made inferences about what could be done to protect the forest ecosystem	Drew reasonable conclusions but did not make original inferences or suggestions	Some necessary information was missing Did not discuss hypothesis or determine the health of the forest or make an inference about protecting the forest	Several omissions, does not draw reasonable conclusions about the data or include necessary details

SEARCHING FOR SALAMANDERS

Name: _____ Date: _____ Class: _____

Salamander Monitoring and Inventory Scientific Investigation

State the question of the investigation: _____

_____

_____

Describe what you have already learned about this question:

_____

_____

_____

_____

_____

_____

_____

_____

State a hypothesis that predicts what the answer to the question will be:

_____

_____

Materials used for data collection:

_____

_____

_____

Control and Variables in the investigation:

_____

_____

_____

_____

Procedure for collecting data on salamanders:

Field ecologist: collect habitat field notes and sketch habitat and organism observations

Name:_____

Investigation assistant: remove coverboards to gently reveal salamanders and record data collected by the salamander sleuths

Name: _____

Salamander sleuths: Identify, count, and measure salamanders found under coverboards

Name(s): _____

Presentation Planning

In small groups, you will be responsible for presenting a part of what we have learned in our Searching for Salamanders unit to park staff and scientists.

List 3-5 things that make a presentation great!

- _____
- _____
- _____
- _____
- _____

List 2-3 ways that information can be effectively presented

_____

- _____
- _____

Presentation Role your group is responsible for: _____

Information your group will be presenting: _____

_____

_____

_____

_____

_____

Presentation Outline

I. _____Name: _____

a. _____

_____

b. _____

_____

c. _____

_____

II. _____Name: _____

a. _____

_____

b. _____

_____

c. _____

_____

III. _____Name: _____

a. _____

_____

b. _____

_____

c. _____

_____

Describe the resources/materials you will need for creating your presentation and the type of presentation your group will be doing.

_____

_____

_____

Presentation Approval: _____

Role 1: Introduction

Information to be presented:

- Introduce yourselves and briefly explain what we have been learning about in our Searching for Salamanders unit
- Describe the activities we have done during class

Can you name that Salamander? Data Collection Fieldwork and Lab Report write up

- Introduce the next group and their topic—salamander identification

Role 2: Salamander Identification

Information to be presented:

- Briefly explain the activities we did to learn about salamanders
- Teach about the species of salamanders that we learned about and how they are identified: Use *Can You Name That Salamander?*
- Teach about why salamanders are eco-indicators of forest health: Use *Fun Facts About Salamanders*
- Introduce the next presenters and their topic—fieldwork and data collection

Role 3: Fieldwork and Data Collection

Information to be presented:

- Explain the purpose of collecting data during our fieldwork experience. State the question we were trying to answer
- Explain the materials and procedures we used to collect information about the types and numbers of salamanders in the park
- Explain the roles (field ecologist, investigation assistant, salamander sleuth) that people were responsible for during the fieldwork: Use *Scientific Investigation Sheet*
- Introduce the next group and their topic—results of data collection

Role 4: Data Collection Results

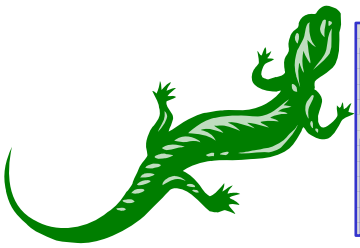
Information to be presented:

- Explain the general habitat conditions that were observed during our fieldwork investigation: *rainfall amount, air temperature, soil temperature, cloud cover, wind speed, general habitat description*
- Explain the results of what was found in each group for salamander types and numbers. Use the graphs of each group to make a graph that represents the entire array
- Introduce the next group and their topic—conclusion

Role 5: Drawing Conclusions

Information to be presented:

- Explain, based on our data, how healthy we have determined the forest to be: Use *Drawing Conclusions* part of *Lab Report*
- Explain what could be affecting the health of the forest ecosystem; natural and ecological disturbances
- Explain what could be done to improve or maintain the health of the forest ecosystem



Fun Facts About Salamanders

- Have a long life span- 20+ years
- Reproduce at a low rate
- Often guard their eggs
- Take 2 or more years to mature
- Breathe through their skin
- Can go for months, if not years, without eating
- Ectothermic- body temperature changes with their surroundings
- Store fat in their tails
- A source of food for other vertebrates
- Skin must remain moist or they lose their ability to obtain oxygen
- Nocturnal- Hunt and are active at night
- Adapted to living in woodlands and live their entire life cycle on the forest floor
- Complex social systems and tiny home ranges
- Extremely energy efficient
- Logging, insect defoliation, land development and forest fires can reduce populations of salamanders
- Large populations of salamanders found in undisturbed forests

Salamander Common Name: _____

Salamander Latin Name: _____

A colored sketch of salamander

Adult Length in cm

_____

Habitat and range:

_____

_____

_____

_____

Identifying Characteristics:

Coloring: _____

_____

Patterning: _____

_____

Other identifying features: _____

_____

_____

_____

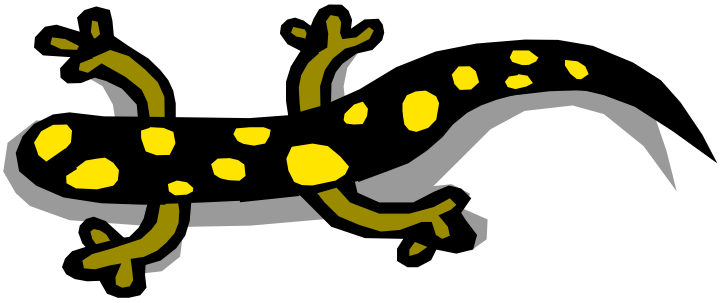
Be careful, this species also looks like _

_____

_____

SEARCHING FOR SALAMANDERS

A Monitoring
and
Inventory Program



A High School Biology/Ecology Curriculum

This curriculum is designed to engage students in an ongoing salamander-monitoring program that will assist our local National Parks in tracking our environment's health.

SEARCHING FOR SALAMANDERS

High School Curriculum Overview

Objective

This is a high school biology or ecology curriculum designed to create civic engagement of students with their local National Parks in the Northeast Temperate Network by undertaking a monitoring program of salamander populations. The purpose of this curriculum, then, is to engage students in collecting meaningful scientific data about salamander populations. This data will be used by scientists as an indication of forest ecosystem health.

Essential Question

How can the presence or absence of salamanders help determine the health of our forest ecosystems?

Time

Keeping in mind the pressures of time in a modern high school science class, this curriculum will allow you to choose the length of time that you would like to use to explore this topic within your classroom. A **minimum of three days** should be devoted in order for the monitoring process to be meaningful and accurate. However, this curriculum could extend to several weeks depending upon the integration of other units such as animal classification, ecosystem equilibrium, forest ecology, and/or environmental issues.

This curriculum **requires at least 1 visit** to the park for data collection. **Preferably, there would be 3 visits** on a weekly basis in either the springtime (April/May) or fall (September/October/November) before the killing frost. (See Protocol)

Please Note: Collaboration with other classes or schools is entirely possible—even encouraged.

Curriculum Phase I: Classroom Preparation

Knowing Our Salamanders

Time
1½-hr block or two 45-minute class periods

Learning Objectives
- Students will understand the mission of the National Park Service and how it relates to the monitoring and inventory of salamander populations
- Students will understand their role as data collectors in the salamander monitoring/inventory program for their local National Park
- Students will be able to identify the unique characteristics of salamanders
- Students will understand how salamanders are bio-indicators of forest health
- Students will be able to identify species of salamanders that are specific to their local park

Background knowledge
- Students should understand the characteristics that make an animal an amphibian
- Students should understand how to identify organisms based on specific traits (classification).
- Students could have knowledge of food chains and ecosystem equilibrium prior to study but that could also be used as an extension to incorporate into the unit of study.
- Students should understand the process of the scientific method

SEARCHING FOR SALAMANDERS

Materials

Use of Internet- www.npwrc.usgs.gov/narcam/idguide/
Field guide to Northern Amphibians and Reptiles; 1 for every 3-4 students
Laminated colored pictures of local salamander species (from resource kit)

Key Vocabulary

Salamanders are amphibians. An **amphibian** is a vertebrate in the Kingdom Animalia. **Vertebrates** are animals that have a backbone. Amphibians are **ectothermic** which is also known as cold-blooded. This means their body temperature changes with their surroundings. Amphibian literally means "double-life." A name given because amphibians spend part of their life in water and part on land. Amphibians, in general, will lay their eggs in water, develop there, and move onto land as adults. The forests of North America have several species of salamanders that have adapted to woodlands and are entirely **terrestrial** which means their complete life cycle is on land. Amphibians are often called **ecological indicators** because signs of unhealthy amphibians can be a warning sign of changes in the ecosystem. When large numbers of amphibians start to die, a problem with the environment may exist. The reason they are **bio-indicators** is due to their thin skin that can easily absorb any chemical contaminants in the water or air. As **ectotherms,** climate change can also affect their populations.

Introduction

Before students begin learning about salamanders and collect data in the park, it is important for students to understand the importance of their own role in the collecting of this data now and in the future. Teachers should explain to students that they will be collecting data that will be used to determine the health of the ecosystem in the park based on the park's salamander populations. Teachers should inform students about National Parks and their mission.

Below is some useful information about the legacy and mission of the National Park Service. (http://www.nps.gov/legacy/legacy.html.). Teachers could also research the local park they will be working with and give the students some background information about the park in which they will be collecting data.

When Did The NPS Begin?

Although Congress set aside Yellowstone National Park in 1872, there was no real system of national parks until a federal bureau, the National Park Service, was created on August 25, 1916 to manage those areas then assigned to the U.S. Department of the Interior. Following is a list of significant legislation which influenced the creation and growth of the National Park System.

Yellowstone National Park Act, 1872

The Yellowstone Act preserves the watershed of the Yellowstone River "*for the benefit and enjoyment of the people.*" For the first time, public lands were preserved for public enjoyment, to be administered by the federal government. Put under the "*exclusive control of the Secretary of the Interior,"* the land was *"reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground..."*

National Park Service Organic Act, 1916-

"There is created in the Department of the Interior a service to be called the National Park Service, which shall be under the charge of a director....The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified, except as are under the jurisdiction of the Secretary of the Army, as provided by law, by such means and measures as conform to **the fundamental purpose to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment for the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.**"

General Authorities Act, 1970 –

The purpose of this act is to include all areas administered by the National Park Service in one National Park System and to clarify the authorities applicable to the system. Areas of the National Park System, the act states, "though distinct in character, are united through their inter-related purposes and resources into one national park system as cumulative expressions of a single national heritage; that, individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all people of the United States..."

Redwoods Act, as amended 1978-

This act reasserted the system-wide standard of protection prescribed by Congress in the original Organic Act. It states, "Congress further reaffirms, declares, and directs the promotion and regulation of the various areas of the National Park System...shall be consistent with and founded in the purpose established by the first section of the Act of August 25, 1916, to the common benefit of all the people of the United States. The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress."

The National Park Services' Mission states" ***to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Organic Act 1916.***

This curriculum is designed in order to help engage students in the continuation and further development of the NPS Inventory and Monitoring Program throughout the Northeast Temperate Network. It is equally important that students understand the mission of this specific program and their role within it while they are collecting important information that will help parks to analyze the health of each parks' ecosystem.

The National Park Service's Inventory and Monitoring Program (I&M Program) is responsible for helping parks meet their mission of preserving park resources. The national program is divided into 32 networks that each work with a group of parks. The networks design and implement ecological monitoring programs that provide critical information to the National Parks and the public about the integrity of landscapes, ecosystems, and species. Because it is not possible to monitor all aspects of park natural resources, the I&M program focuses on identifying and tracking key indicators that provide reliable and useful information.

The Northeast Temperate Network (NETN) consists of a diverse group of parks, including Acadia National Park in coastal Maine, Morristown National Historical Park in New Jersey, and the Appalachian Trail, which crosses fourteen states. The majority of NETN parks were established for their cultural resources and are relatively small in size, but the natural resources in these parks are crucial to understanding their cultural value.

The Network parks are:

Acadia NP, Maine
Appalachian NST, Georgia, North Carolina, Tennessee, Virginia, Maryland, West Virginia, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Vermont, New Hampshire, and Maine
Boston Harbor Islands NPA, Massachusetts
Marsh-Billings-Rockefeller NHP, Vermont
Minute Man NHP, Massachusetts
Morristown NHP, New Jersey
Roosevelt-Vanderbilt NHS, New York
Saint-Gaudens NHS, New Hampshire
Saratoga NHP, New York
Saugus Iron Works NHS, Massachusetts
Weir Farm NHS, Connecticut

You can find a map of these parks in Appendix 1

Park contact information is listed in Appendix 4.

For more information go to http://www1.nature.nps.gov/im/units/netn/index.cfm.
This website will link to the individual park websites and where you can get more information about the park where your students will be doing their inventorying and monitoring studies.

Classroom Activity: Prior Knowledge Assessment

1. Assess students' prior knowledge about salamanders and data collecting by placing the following questions one to each sheet of chart paper that have been hung at different places around the room. Break students into smaller groups of 3-4 students to brainstorm what they already know about each question and have them write their responses on the papers.

A) Can you name any salamanders that live in our local forest?
B) What characteristics would help us to identify a particular type of salamander?
C) If we are going to see if the forest is healthy based on the population of salamanders, what types of data should we collect about the salamander populations and habitat?
D) Why do you think it would be important to know the types and numbers of salamanders that live in our forest?

As a class, consider and evaluate the entries and add any missing information. **Key points that should have been addressed for each question are:**

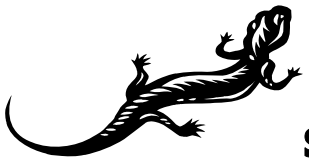
A) The names of salamanders that live in the local forest (see appendix 2)

B) The characteristics should be coloring, patterning on the top, sides and underneath, and size.

C) The data to be collected should be type of salamander, its length, habitat, weather—amount of rain in 24hr/week long period, date, time, temperature, wind speed, cloud cover, soil temperature, and other organisms present.

D) If the population of salamanders were low, that could mean that other populations in their food chain are affected. It could indicate that other factors are disturbing the ecosystem and the health of the forest.

2. After group discussion, have students remain in their small groups. Hand out the two-page salamander fact-sheet called "What Are We Searching For?" and choose individuals from each group to read it aloud. It is dense with information. Have the groups choose the **top 3 facts** they think are most important to salamander populations that might help us determine the health of the forest. Class discussion should follow. (Best with photos and/or illustrations)



SEARCHING FOR SALAMANDERS

What Are We Searching For?

Classification of Salamanders

Kingdom: Animalia
Phylum: Chordata
Class: Amphibia
Subclass: Lissamphibia
Order: Caudata (formerly Urodela)

There are about 500 species of salamanders and newts in the world. These may be the most abundant terrestrial vertebrates in much of North America. They are found throughout the world, especially in the northern hemisphere.

Life Cycle:

Egg → Larva → Juvenile → Adult

General Characteristics

- Adults use gas exchange through lungs, skin, and lining of mouth cavities (Some have no lungs at all!)
- They have a double loop circulatory system with three-chambered heart
  1st loop—oxygen poor blood from heart to lungs and skin, then oxygen rich to heart
  2nd loop—oxygen rich blood moves from hear through vessels to the body to diffuse into cells
- The aquatic larvae resemble adults but exchange gasses through skin and with gills
- They have thin, moist skin with no scales
- Moisture is an absolute necessity
- Long, slim bodies, necks and tails
- Most have four legs
- Found in moist areas: under logs or in leaf litter
- Range in size from 15-cm to 1.5-m long
- Extremely long-lived (20+ years)
- Low reproductive rate (fecundity)
- Often guard their eggs
- Take 2 or more years to mature
- Can go for months, if not years, without eating
- Some salamanders have the ability to regenerate their tails if they are lost.
- Salamanders do not have ears, but may be able to detect vibrations through their legs and jaws. In the water, vibrations are detected by the lateral line system, rows of sensors found on the head and similar to those found on the sides of fish.

Organ Systems

Feeding and the Digestive System

Salamander larvae and adults are **carnivores** (frog larvae are herbivores): they feed on a variety of invertebrates, especially worms and insects, and even small vertebrates. Some use jaws to capture prey; others can flick out a long, sticky tongue with speed and accuracy to catch flying prey. Food path: mouth—-esophagus—stomach—-small intestine (into bloodstream)—-large intestine—-cloaca. The c**loaca** serves as the one opening that receives digestive wastes, urinary waste, or eggs or sperm.

Excretory System

Wastes filtered from blood through kidneys excreted as **ammonia** (product of protein metabolism—excreted by water dwelling organisms) or **urea** (made from ammonia in liver and stored in urinary bladder—land organisms) as waste product of cellular metabolism

Nervous System

They have a very well developed nervous system with excellent vision used to locate and capture prey. They have a **nictitating membrane,** a third, transparent eyelid that can move across eye for protection under water and to maintain moisture up on land.

They are **ectothermic** meaning that they obtain their body heat from the external environment and cannot regulate their body temperatures through metabolism. So, they must sense the temperature in order to move to where they can heat or cool themselves as needed. Thus, they can be affected by a change in the climate over time.

Reproductive System

Salamanders have **internal fertilization** through the cloaca. The female picks up sperm from the males. After fertilization, the eggs are laid in masses, covered with a sticky, jelly-like substance that helps anchor them to vegetation. The embryos use the attached yolk for nourishment until hatching.

- Because salamanders breathe through their skin, they can easily take in pollutants from the air and water that could affect their populations.
- We know that forests that have not been disturbed have historically high populations of salamanders. (They were the most common vertebrates of the forest) So, if our salamander populations are low, it is probably because our forests are somehow being disturbed.
- Salamanders are an important part of the food chain for other vertebrates and, if their populations are low, other populations might be affected as well.
- Since they reproduce at a low rate but live for a long time, a change in their populations could indicate a significant change in other amphibian populations.

3. Give each group a copy of the colored, laminated folder called Field Identification of Northeastern Salamanders. Ahead of time, you should be sure that each includes photos of all of the salamanders that live in your local park forest. (See Appendix 2 to find information about those species) You may also wish to pass out copies of field guides. (Appendix 7) If the students have not yet had experience, show them how they can use the guidebooks to determine the identification of a species and to learn more about it. Give them time to familiarize themselves with the sources and with the animals.

4. Have them share their ideas about the most useful identifying traits for each species. In other words, "How will you know what you've found?"

5. Finally, with resources closed, test them with unlabeled photos, prepared overheads, or PowerPoint slides. If necessary, go back and repeat the process. Obviously, it is critical that students be able to ID successfully before heading out to collect data.

If there is time, they can also use the following website to add to the information about their salamander species.
www.npwrc.usgs.gov/narcam/idguide/

Other websites of value can be found in Appendix 8

Digging Deeper: Curriculum Extensions

The research of a specific local salamander species or of an unusual species, such as the giant salamanders of Japan and China, could be done on an individual basis for a research project or for extra credit.

Students could learn about the cycles occurring on the forest floor and the role of the salamander as a consumer.

Students could also research the concept of adaptation to habitat. What features allow these creatures to be successful where they are yet unsuccessful in others? Use the range maps found in Appendix 3 to stimulate discussion. Why does our park have the species that it does and not others?

SEARCHING FOR SALAMANDERS

Curriculum Phase 2: Fieldwork and Data Collection
1-3 Field Visits

Time

The protocol suggests that three visits to the same site over the course of a year would provide the most accurate data. However, all data collected is important and one visit is much better than none at all. Consistently visiting in either the spring or fall at the same location would also be preferable (fewer variables). Try to avoid inventorying directly after significant rainfalls when salamanders may be out foraging (not under coverboards for counting and more vulnerable to crushing). (See Protocol)

Class preparation time: 20-30 minutes
On-site time: 1-2 hours depending upon how many arrays you sample and the traveling time to the park's site location.

Learning Objectives

- Students will learn how to collect data in a systematic way in order to decrease the level of bias and variability
- Students will locate, identify and count the species of salamanders present under the coverboards set up at the park location
- Students will learn how their data will be utilized, both now and in the future, to determine trends of forest health based on the fluctuations or stability of these salamander populations

Background knowledge

- Students should have an understanding of the scientific method and the necessary steps in the process: question, background information, hypothesis, observation/data collection, and drawing conclusions from data.
- Students should have a strong understanding of their significant role in the data collection of salamander species and numbers in the park.
- Students should be able to identify local salamander species correctly.
- Students should be able to identify the controls and variables that will be involved in their investigation.
- Students should know how to collect data that is accurate and consistent.

SEARCHING FOR SALAMANDERS

Materials

1 Lab Kit per group:

- Data collection folders; 1 per group
- Data collection spreadsheet inventory and monitoring; 1 per group
- Celsius thermometer
- Salamander Identification booklet with laminated pictures and ruler
- Pencils
- Plastic Ziploc baggies
- Latex gloves

Digital Camera (if possible)
Wind meter (if available)

1 Chaperone per group of 3-4 students
A Park staff scientist or employee (if available)

Key Vocabulary

The purpose of the **inventory** is for students to count accurate numbers of salamander species in the area they will be sampling. The purpose of the **monitoring** is to look at data that is collected in the same sampling region in the park year after year to draw conclusions about the health of the forest ecosystem in relation to the stability or fluctuation of the salamander populations. The students will be collecting data in an **array** that will be established by the individual park staff. The **array** will be an area that has been sectioned off with **coverboards** made of wood will have been placed in an equidistant pattern. These **coverboards** act as artificial debris/habitat for salamanders to crawl under and use for shelter. Each array will be identified with a letter and each coverboard will have an identification number on it.

Introduction

Explain to students that today they will be using their knowledge of salamander identification to collect valuable information for the National Park Service for an inventory and monitoring program that will continue many years into the future. Stress that it is extremely important to take this task seriously and do the best job they can while they are in the field collecting data. Inform students that the correct identification of each species and the total number that they find is the most important factor to focus on in their work. Remind students of the proper methods for handling the amphibians because they can be crushed or harmed very easily. Encourage students to, instead, photograph them or drawing them.

SEARCHING FOR SALAMANDERS

Classroom/Onsite Inventorying Activity

1. In order to remind kids of the importance of the identification of each species they find in the field, start the class by flashing laminated pictures of each species and have students try to identify them. Ask them to state a key feature that helped them to identify the species.

2. Divide students into groups of 3. Have each group sit together. (Handpicking the groups might be preferable due to the importance of the work they will be doing). Each group should receive a pocket folder that has space for their names, array letter and the coverboard #'s to monitor. This folder will be used to hold all of their sheets and information.

3. Have the students look at the data collection sheets found inside. Describe the roles involved in the fieldwork.

A) The first role should collector of data on the abiotic factors such as rainfall, air temperature, wind speed, cloud cover, soil temperature, and general biotic factors about the habitat. In order to get information about rainfall in the area, you may need to visit the NOAA website http://www.weather.gov/forecasts/graphical/sectors/ or one similar found at Accuweather.com or Weather.com and post rainfall information on the board. This person should also do field sketches of habitat and organisms in array.

B) A second person will responsible for removing the coverboard, aiding in the identification of the salamander and helping to count the numbers of salamanders. He or she should be recording the following data on the spreadsheet: coverboard #, salamander species present, number counted, time, and other organisms present.

C) Once the coverboard has been removed, the third member should lead the identification process by using the key and guides, count numbers and measure length(s). Salamanders tend to freeze in the first few moments of being exposed. Under such circumstances, students can simply lay the laminated ruler on the ground and try to get a rough estimate of size. For active salamanders, this student will have been issued latex gloves and a moistened Ziploc bag for their brief, safe capture for the purpose of data collection. The plastic baggie, turned inside out, is worn over the gloved hand and used to pick up the salamander very gently. Once the salamander stretches out, it is much easier to measure. If available, use a digital camera to document salamanders that are found. This is especially helpful if there is a question as to correctly identifying the species. If possible, recommended photos would be of the top, bottom and side of the salamander.

4. Give the students a few moments to self-assign tasks within their groups. (Changing student roles later is possible and perhaps advisable). Explain the types of data that they will collect and, as needed, review the methods for doing so.

5. Hand each student a *Searching for Salamanders Scientific Investigation* sheet. Define the question, background information, hypothesis, materials, controls and variables, and data collection information for the field investigation.

Question: Is our National Park forest healthy according to the salamander populations found in the investigation?

Background information: Ask students to recall facts that were discussed in the previous class.

[Salamanders are ecological indicators within an ecosystem due to their highly sensitive skin, low reproduction rate, and long life. Large populations of salamanders are found in undisturbed forests. Salamanders are ectothermic and a change in temperature can affect their population size. The salamanders that are found in the local forest are (name species).]

Materials: List the items found in the lab kit

Control and Variables: The control in this investigation is the site location and the use and placement of the coverboards. The variables that could affect the investigation are weather (recent rainfall, frost, drought, etc) time of year, and any other changes that might have occurred (assuming that this is not the initial survey). Two potential experimental errors are miss-identification of salamanders and inaccurate counting.

6. Once groups have been established and roles have been assigned, the fieldwork will begin at the site. Introduce the chaperones. (Chaperones should have been given a copy of the handout "Chaperone Field Notes" so that they will have a good understanding of the work they will be doing with students and the importance of accurate data collection. Chaperones should aid in the identification and inventorying process.

7. Coordinate with scientists at the park to meet with your group and give a more detailed explanation about the work that the students will be doing and the long-term goals of this data collection. The scientist could describe to the students how the arrays were located and set up. The scientist could also review identification of salamanders and aid students in their data collection by demonstrating the proper way to uncover boards and count salamanders.

8. At the site, groups will be assigned to a specific number of coverboards to check in their array.

Students should systematically go to each one and record the necessary information on their data collection sheets. Once they have collected all of their data at the site, students should place their data collection sheets in their group folder and place everything back in their lab kit.

Digging Deeper: Curriculum Extensions

CLASS COMPARISON

If students were only able to visit a site once, have other classes in the school, or at other schools, do the same investigation and compare the results among the different groups. The students should compare what they found in the same location in the arrays. They could swap data or compile their data and draw conclusions about the data found by the other groups depending on factors such as time of the year and weather.

DEEP ECOLOGY

If this monitoring investigation is a part of a forest ecology unit, students could extend their data collection to include tree identification and inventory, forest floor habitat description, and other forms of wildlife observed during their visits. Students could do soil pH testing, soil texture and types of soil as a barometer of forest floor health. They could use this data to make a comparison between salamander populations found in two different array habitats. They could then draw conclusions about habitat types and salamander populations.

FOREST CONDITION MONITORING

Students can compare their findings during the salamander monitoring and forest ecology units with the results of the Forest Condition Monitoring program the NETN is conducting in the parks of the network. Drawing comparisons between the additional information and the data the students have collected will allow more in depth conclusions to be drawn about habitat types and salamander populations.

The NETN Forest Condition Monitoring Protocol was developed for long-term monitoring of forest vegetation. The overall goal is to monitor status and trends in the structure, function and condition of NETN forested ecosystems in order to inform management decisions affecting those systems. Sites were randomly selected, and at each monitoring site a suite of measurements will be taken (see table below). The population being monitored is all upland forests and woodlands within park boundaries.

Salamander arrays have been established near one of the NETN Forest Condition Monitoring plots. Please contact the network if you would like information relevant to your array.

Metric		Objectives
Stand Metrics	Stand structural class	Determine status & trends in the distribution of structural classes. Compare the distribution of structural classes to that expected under natural disturbance regimes.
	Canopy closure	Determine status & trends in canopy closure by stand structural class. Examine correlation between canopy closure & climatic stress, storms, pest & pathogen outbreaks & other disturbances.
	Snag abundance	Estimate status & trends in snag abundance by size class.
	Coarse woody debris (CWD)	Determine status & trends in coarse woody debris volume & density by size class.
	Photopoint	Provide visual reference of plots for long-term qualitative comparison.
Tree Metrics	Tree condition	Qualitatively assess tree condition and estimate trends in tree condition by species.
	Tree growth and mortality rates	Determine growth & mortality rates by tree species & stand structure. Examine correlation between these rates & air pollution, pest or pathogen outbreaks, climatic stress or other known stressors.
	Tree regeneration	Determine status & trends in tree regeneration by species & size class.
Understory Metrics	Understory diversity	Determine status and trends in native understory plant species richness. Determine status and trends in exotic plant species cover. Determine change in cover or extent of species indicative of deer browse pressure, climate stress, or air pollution stress.
Soil Metrics	Forest floor condition	Qualitatively assess forest floor condition & estimate trends in spatial extent of invasive exotic earthworms, humus presence, and trampling impacts.
	Soil chemistry	Determine status & trends in soil Ca:Al and C:N ratios to assess the extent of base cation depletion, increased aluminum availability and/or nitrogen saturation are impacting NETN forest soils.
Landscape Metrics	Landscape context	Determine status & trends in interior forest patch size, & proportion of surrounding area in natural cover & in anthropogenic landuse.

SEARCHING FOR SALAMANDERS

Curriculum Phase 3: Lab Assessment

How healthy is our forest?

Time

1½-hour block or two 45-minute classes

Learning Objectives

- Students will use the data they collected in the park to help answer their original question and draw conclusions about their hypothesis.
- Students will graphically represent the important data collected during their field visit(s).
- Students will write a lab report that outlines the scientific method used for their scientific investigation of salamander populations in the local National Park.

Background Knowledge

- Students should have an understanding of using sets of data to create basic line/bar graphs that show amount found and/or change over time.
- Students should be able to look at data collected and draw conclusions from that data.
- Students should be familiar with the basic outline for writing a lab report.
- Students should be able to write a complete paragraph including a topic sentence, supporting details and a concluding sentence.

Materials

Let's get to graphing; 1 copy per student

- graph paper
- ruler
- colored pencils
- *Lab Report Outline*; 1 copy per student
- *Lab Report Rubric*; 1 copy per student
- Students data collection sheets
- *Searching for Salamanders Scientific Investigation* sheet
- Alternately, access to computers with graphing programs and printers

Key Vocabulary

Students will be representing the data they collected through the making of a graph. Students should know that a graph is set up with an **X and Y-axis.** The **X-axis** represents the **independent (or manipulated) variable** and the **Y-axis** represents the **dependent (or responding) variable.** The independent variables are things such as forest cover type, time of year, soil pH, etc. The dependent variables are data like the number of organisms inventoried. The **intervals** on the graph need to be consistent in order to represent the data accurately (5, 10, 15, 20). **Bar graphs** are an excellent way to show results that are one time, that aren't continuous—especially samplings such as surveys, inventories, etc. **Line graph** shows change over time and can be used to compare salamander inventory data from year to year. Each graph should be labeled with a proper **title** that uses the labels of the X and Y-axis and appropriate units of measurement. (Ex: Number of red-backed salamanders found in array _____ under coverboards #____ to____.)

Introduction

The students will be working in their small groups but will be individually responsible for writing their own lab report for their Searching for Salamanders Scientific Investigation. Students will begin by determining the data they will be graphing for their group. This may include more than one graph. After the graphing has been completed, students will work individually on putting the scientific method that they used during their investigation into a written report. This report should help to both illustrate and assess their comprehension of the method used during their fieldwork investigation and to draw conclusions about the health of the forest based on the results of the salamander data collected.

Classroom Activity

1. Begin class by asking students what the original question was that they were trying to answer while collecting data on salamanders. Rewrite the original question on the board.

2. Ask students to share why this data is important to collect and how can this data be used by the park in the future. List their reasons on the board.

3. Ask students to share one thing they noticed or observed during their data collection at the site. List their observations on the board.

4. Prompt students by asking, "Now that we have collected this data, what do you think we should do with it in order to answer our original question and help the scientists in the park?" Student responses should include saying that they need to show the data graphically and draw accurate conclusions about what they found during their investigation.

5. Have students sit in their investigation groups. Groups should receive their folders that have their data collection and scientific investigation sheets.

6. Hand out ***Let's Get to Graphing*** sheets, graph paper, and a ruler to each student. Review how to set up a graph and where information should be located in the graph (X-axis, Y-axis, titles, scales, key). Talk about the difference between bar and line graphs and what each one represents.

7. Ask students to look at their data collection sheets and determine the information that they should show in their graph in order to answer the original question. Ask them which type of graph they should use to represent their data. The most basic graph students should complete is one that shows the type of salamander and numbers found in a bar graph. If students were able to visit the site more than once, the graphing could be expanded to include the 3 different visits. A line graph could be drawn to show the change in the salamander population over time.

8. Each student should use the data collected in their group to show the quantity of each salamander species found in their section of coverboards in the array. Students could choose a particular species to graph the results of, compare the results of different species, or create one graph that represents all of the species.

9. After groups have completed their graphs, share the results of each graph and make a compilation graph on the board together. Discuss with students what the results of the graph indicate in relation to forest health. Ask students "What are some things that could affect the population of salamanders in the forest? Make a t-chart that is titled

natural or ecological disturbances and human disturbance. Brainstorm these disturbances.

10. Ask students to tell why it is important for scientists to write up the method and results of their investigation. Hand out the ***Lab Report Outline and Grading Rubric*** and review each component.

11. Students should write a rough draft of the lab report using the outline and their graphs. Once the rough draft is completed, students can peer-, or self-edit using the lab report outline as a checklist to make corrections to their draft.

12. Final reports should be typed and handed in.

SEARCHING FOR SALAMANDERS

Lab Report Grading Rubric

Grading Criteria	You are a Salamander Sleuth! 90-100	Good Work 80-89	Some Areas of Concern 70-79	Investigation Incomplete 69 or below
Introduction	Purpose and question of investigation was clear and concise, explained background information thoroughly, stated reasonable hypothesis	All necessary information was included. Language could have been more clear and concise or Lacked a few details or Hypothesis could have shown more insight	Some necessary information was missing or Language was unclear and sentences were incomplete or Lacked specific details or Hypothesis did not relate specifically to question	Several omissions, sentences incomplete, lacks detail and reason
Methods and Procedures	Explained the materials and procedure used to collect data in great detail, explained individual role, controls and variables	All necessary information was included Lacked specific details in materials, procedure, individual role or control/variables	Some necessary information was missing Materials used and procedure not clear or Control and variables not explained	Several omissions, does not clearly outline methods and procedures used during investigation
Results	Explained in great detail the data collected during the investigation. Excellent graph	Explained all data collected in investigation. Lacks elaboration of specific details. Graph has all components but lacks a polished look.	Some data results were not explained or described in detail. Graph missing important data or components	Data was not explained in written form. No graph submitted
Conclusion	Discussed proving or disproving hypothesis, determined health of the forest based on data results, made inferences about what could be done to protect the forest ecosystem	Drew reasonable conclusions but did not make original inferences or suggestions	Some necessary information was missing Did not discuss hypothesis or determine the health of the forest or make an inference about protecting the forest	Several omissions, does not draw reasonable conclusions about the data or include necessary details

SALAMANDER DATABASE OR WEBSITE

For students who have technological abilities, the data collected by the class and the reports that are written could become a part of a webpage. Students could include the salamander species and identification information, graphs and conclusions about the health of the forest in the webpage. Data could also be put into a larger database throughout the Northeast Temperate Forest Network of the National Park and could be added to each year the monitoring and inventory investigation is complete.

CLASS PRESENTATIONS

As a group, students could present the data they collected and what they found in their section of the array. The presentations could have a variety of graphs that give information about habitat conditions as well as salamander species. Students could use photographs from their fieldwork experience to create a visual presentation or a PowerPoint. Students should be responsible for presenting the necessary components of their report: introduction, methods and procedures, results, and conclusion. This presentation would allow other groups to make a comparison between their results and the results of others.

Curriculum Phase 4: Community Connections

How is our scientific research connected to our community?

Time

1½-hr block or two 45-minute periods to prepare presentation
10-15 minutes to practice presentation
20-30 minutes to present

Learning Objectives

- Students will publicly present their scientific investigation and data results to members of the local community who have a vested interest in this program
- Students will use oration and memorization skills to effectively communicate their learning
- Students data collection and presentation will be given meaning and relevance
- Students will be involved in a civic engagement project that will utilize a variety of skills

Background Information

- Students should have an understanding of who their audience is and why their research is important to them
- Students should have a clear understanding of the data they collected and how it relates to the health of the forest
- Students should have some knowledge of how to prepare and present an effective oral presentation

Materials

- Digital photos from investigation
- Salamander images
- *Presentation Planning* sheet; 1 copy per group
- Note cards
- Group Folders including all information collected during the unit
- Handmade or computer generated graphs of data from each group
- Access to a computer if students are creating a PowerPoint presentation
- Access to a variety of materials for creating a visual display

Introduction

Students will be asked to present their Searching for Salamanders Investigation to a minimum of park staff and scientists at the park. This is an opportunity for their data to have meaning and relevance. This presentation could be simply inviting the staff to the classroom or could extend into the greater community and be an evening presentation at school or in the park. This part of the curriculum is critical to civic engagement and the achievement of the learning throughout this unit of study.

Class Activity

1. Have students sit in their field study groups. Hand out the ***Presentation Planning*** sheet. Ask the groups to brainstorm 3-5 things that make a presentation great and 2-3 ways to present information effectively.

For example, they should note that presentations should be clear, concise, engaging, have good visuals, and be informative. Format possibilities are PowerPoint, poster board tri-fold, or any other unique ideas that will get their information across to the audience.

2. Inform students that they will be putting together one part of a larger presentation that will be given to the park staff and scientists. Smaller groups will present specific parts of the class presentation. Explain ***Presentation Group Roles*** to the entire class and then hand out their individual roles by group. Students could either choose the group they would like to work in or be assigned to a particular role prior to the beginning of class.

3. Have students fill in the title of their group role and list their responsibilities on their ***Presentation Planning*** sheet. Go over creating an outline for their presentation. Brainstorm an example on the board to help kids get started with their own outline.

Example:

Role 1: Introduction

I. Introducing the class and the project

a. Introduce yourselves
b. State background information about the class

II. Describe the types of things we learned during this unit of study

a. How to identify particular types of salamanders
b. Important facts about salamanders as eco-indicators of forest health
c. Collected data on array habitat conditions, types and amount of salamanders found under each cover board
d. Presented our investigation in a final lab report

III. Introduce the next presenters
a. Introduce the names of the next presenters and their topic

4. In the outline, they should determine which group member will be responsible for presenting which part of the outline. The group should then list the resources they will need and give a general description of what their presentation will look like.

5. Check each group's planning sheets. Once they have been approved, have the students begin to create their presentations. Each student should write up note cards that highlight the information he or she is responsible for during the presentation.

6. Once their proposed presentations have been completed, have the students practice by presenting their information in class before the final group presentation. Go over the key things to remember for a presentation:

1. **Dress appropriately**
2. **Speak clearly**
3. **Maintain eye contact**
4. **Know information well—memorize note cards**
5. **Make smooth transitions from one person to another**
6. **Always smile and answer any questions asked of you to the best of your ability**

Presentation Group Roles

Role 1: Introduction

Information to be presented:

- Introduce yourselves and briefly explain what we have been learning about in our Searching for Salamanders unit
- Describe the purpose of our activities

Introduce the next group and their topic—salamander identification

Role 2: Salamander Identification

Information to be presented:

- Briefly explain the activities we did to learn about salamanders
- Teach about the species of salamanders that we learned about and how they are identified
- Teach about why salamanders are bio-indicators of forest health

Introduce the next presenters and their topic—fieldwork and data collection

Role 3: Fieldwork and Data Collection

Information to be presented:

- Explain the purpose of collecting data during our fieldwork experience. State the question we were trying to answer
- Explain the materials and procedures we used to collect information about the types and numbers of salamanders in the park
- Explain the student's roles

Introduce the next group and their topic—results of data collection

Role 4: Data Collection Results

Information to be presented:

- Explain the general habitat conditions that were observed during our fieldwork investigation: *rainfall amount, air temperature, soil temperature, cloud cover, wind speed, general habitat description*
- Explain the results of what was found in each group for salamander types and numbers. Use the class graphs

Introduce the next group and their topic—conclusion

Role 5: Drawing Conclusions

Information to be presented:

- Explain, based on our data and class discussions, how healthy we have determined the forest to be
- Explain what, if anything, could be affecting the health of the forest ecosystem (natural and ecological disturbances)
- Explain what could be done to improve or maintain the health of the forest ecosystem

Thank the audience for coming and open a period of questions and comments!

Digging Deeper: Curriculum Extensions

As students are preparing their presentations for park staff and scientists, ask them who else would find these data useful. Work together to construct a list of interested parties. Develop targeted invitations to these groups, explaining the project and emphasizing why this group might find these particular data relevant and important. Groups might include:

- Conservation commission members
- Garden club members
- Local nature center staff and board
- Local environmental groups
- State Fish and Wildlife or Agency of Natural Resources staff
- The general community

Work with park personnel to identify service-learning projects that the students could do to help preserve the salamander habitat within the park.

Work with the local conservation commission, state and municipal parks departments or privately held publicly accessible lands such as nature center land to identify habitat improvement service-learning projects that the students could do.

Have students prepare a brochure summarizing their findings and outlining steps homeowners can take to protect salamander habitat. Distribute these brochures through local home and garden stores and through local conservation groups.

SEARCHING FOR SALAMANDERS

Chaperones' Field Notes

Key Information: **No suntan lotion or bug spray should be used during the fieldwork**. Handling of salamanders should be kept to the minimum required to gather the necessary data. The animals should never be touched by uncovered hands.

Today, you will be working with a group, or groups, of students to help collect data for the National Park Service Inventory and Monitoring Program. The purpose of this program is to use students to collect meaningful, accurate data about the salamander populations living in our park in order to determine forest ecosystem health. This data will be collected now and for many years to come in order to chart fluctuations in salamander populations in the park.

The students will have been assigned to groups of three. Each group member has a specific role. It is your job as a chaperone to monitor their progress and help them to complete all of their fieldwork tasks.

1. One person in the group should collect data on rainfall, air temperature, wind speed, cloud cover, soil temperature, and habitat once the team arrives at the site. This person should also do field sketches of habitat and of the organisms in the array.

2. A second student will be responsible for removing the coverboard, aiding in the identification of the salamander, and helping to tally the numbers of salamanders. He or she should be recording the following data on the spreadsheet: cover board #, salamander name, number(s) counted, time, as well as the other organisms present.

3. Once the coverboards have been gently removed and placed to the side, the third student should identify the types of salamanders seen by using the laminated field guide, count how many are present and try to measure their lengths. Salamanders tend to freeze in the first few moments of being exposed. If this is the case, students can use the ruler printed on one of the laminated sheets to try to get a rough estimate of size. This student will have been issued latex gloves and a moistened Ziploc bag and given instructions for the proper handling and measuring of specimens.

Coverboards should then be carefully put back into their original position making sure that the salamanders are well protected. To minimize crushing, those animals that were removed for measuring should be allowed to crawl back under of their own accord.

Students will have a group binder and a lab kit in which to collect their data. It is important that all the data collected be complete and accurate. Help students to use the salamander identification cards in order to identify correctly the species they have discovered. Finally, help to make certain that all data sheets and materials have been collected at the end.

Thank you very much for your assistance

Appendix 1: Map of Northeast Temperate Network Parks

*Appendix 2: Salamander Species Information**

Acadia NP, Maine

Most likely to find:
Eastern red-backed salamander
Red-spotted newt

Least likely to find:
Four-toed salamander
Spotted salamander
Northern two-lined salamander

Marsh-Billings-Rockefeller NHP, Vermont

Most likely to find:
Eastern red-backed salamander
Red-spotted newt

Least likely to find:
Spring salamander
Spotted salamander
Northern two-lined salamander
Four-toed salamander
Jefferson salamander
Dusky salamander

Minute Man NHP, Massachusetts

Most likely to find:
Eastern red-backed salamander
Red-spotted newt

Least likely to find:
Spring salamander
Spotted salamander
Northern two-lined salamander

Morristown NHP, New Jersey

Most likely to find:
Eastern red-backed salamander
Red-spotted newt

Least likely to find:
Spring salamander
Spotted salamander
Northern two-lined salamander
Four-toed salamander
Northern slimy salamander
Northern dusky salamander
Northern red salamander

Saint-Gaudens NHS, New Hampshire

Most likely to find:
Eastern red-backed salamander
Red-spotted newt

Least likely to find:
Spotted salamander
Northern two-lined salamander
Northern dusky salamander
Spring salamander
Jefferson salamander
Four-toed salamander

Saratoga NHP, New York

Most likely to find:	*Least likely to find:*
Eastern red-backed salamander	Spotted salamander
Red-spotted newt	Northern two-lined salamander
	Jefferson/ blue spotted salamander
	Spring salamander
	Four-toed salamander
	Northern dusky salamander

Saugus Iron Works NHS, Massachusetts

Most likely to find:	*Least likely to find:*
Eastern red-backed salamander	Northern two-lined salamander
Red-spotted newt	Spring salamander
	Spotted salamander
	Northern two-lined salamander
	Four-toed salamander
	Northern dusky salamander

Weir Farm NHS, Connecticut

Most likely to find:	*Least likely to find:*
Eastern red-backed salamander	Spotted salamander
Red-spotted newt	Northern two-lined salamander
	Jefferson salamander
	Four-toed salamander
	Northern dusky salamander
	Northern slimy salamander

Roosevelt-Vanderbilt NHS, New York

Most likely to find:	*Least likely to find:*
Eastern red-backed salamander	Spotted salamander
Red-spotted newt	Northern two-lined salamander
	Spring salamander
	Jefferson salamander
	Northern slimy salamander
	Four-toed salamander
	Northern dusky salamander
	Northern red salamander

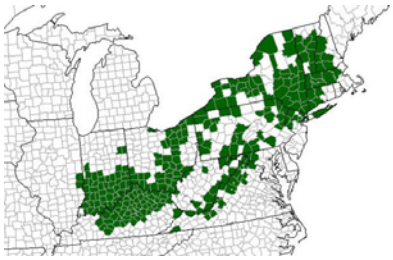
* Other amphibians that students may encounter while in the field are the wood frog, spring peeper, and American toad. In addition, students should be aware that snakes may also be found under the coverboards.

Appendix 3: Salamander Range Maps

Spotted salamander

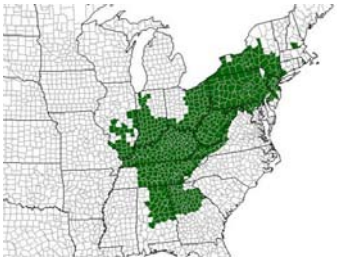
Eastern Red-backed salamander

Jefferson salamander



Northern two-lined salamander

Northern slimy salamander



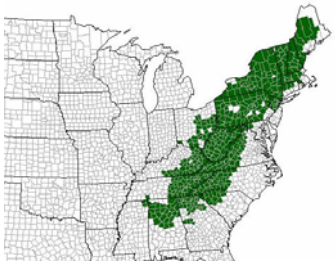
Four-toed salamander

Red-spotted newt

Northern dusky salamander

Northern red salamander

Spring salamander



Taken from ARMI National Atlas for Amphibian Distributions
http://www.pwrc.usgs.gov/armiatlas/

Appendix 4: National Park Contact Information

National Park	*Resource Manager Contact*	*Telephone number*	*Email address*
Acadia	David Manski	207-288-8720	David_Manski@nps.org
Appalachian Trail	Donald Owen	304-535-4003	Donald_Owen@nps.gov
Boston Harbor	Shelia Colwell	617-223-8566	Shelia_Colwell@nps.gov
Boston Harbor	Marc Albert	617-223-5170	Marc_Albert@nps.gov
Marsh Billings Rockefeller	Christina Marts	802-457-3368 ext.31	Christina_Marts@nps.gov
Minute Man	Chris Davis	978-318-7831	Christopher_Davis@nps.org
Morristown	Bob Masson	908-766-6841	Robert_Masson@nps.gov
Roosevelt-Vanderbilt	David Hayes	845-229-1521	David_Hayes@nps.gov
Saint-Gaudens	Steve Walasewicz	603-675-2175 ext. 110	Steve_Walasewicz@nps.gov
Saratoga	Chris Martin	518-664-9821 ext. 215	Chris_Martin@nps.gov
Weir Farm	Greg Waters	203-544-9829 ext 11	Greg_Waters@nps.gov

Appendix 5: Salamander Extensions and Service Learning Projects:

FrogwatchUSA™

A joint National Wildlife Federation (NWF)—U. S. Geological Survey project that uses volunteers to help track these amphibian populations across the country.

http://www.nwf.org/frogwatchUSA/

Project FeederWatch

Project FeederWatch is a winter-long survey of birds that visit feeders at backyards, nature centers, community areas, and other locales in North America. FeederWatchers periodically count the highest numbers of each species they see at their feeders from November through early April. FeederWatch helps scientists track broadscale movements of winter bird populations and long-term trends in bird distribution and abundance. It is administered by the Cornell Lab of Ornithology

http://www.birds.cornell.edu/pfw/

Birdhouse Network

Citizen scientists document the breeding habits of cavity-nesting birds. Gathering basic information about nest-box inhabitants, and then subjecting that information to scientific scrutiny, is the first step toward assessing the effect of nest boxes on the cavity-nesting birds that use them.

http://www.birds.cornell.edu/birdhouse/

VerMonitors

Monitors butterflies in Vermont. The Vermont Butterfly Survey (VBS) is a five-year (2002-2006) census to document the relative abundance and distribution of butterflies across Vermont. The results, in the form of data tables and general distribution maps for each species encountered in the project, will be published and available on the Internet. Fieldwork will rely heavily on volunteers. Participants need little experience to join the survey - only an interest in butterflies. Documenting the status of butterflies offers numerous benefits. The survey will make essential data available to landowners, land-use planners, municipalities, and other organizations

making conservation and management decisions. VBS will enhance our knowledge of distribution, relative abundance, flight times and favored nectar sources of Vermont's butterflies at the beginning of this century. The survey will allow Vermonters to contribute to a greater understanding of the nature of their state.

http://www.vinsweb.org/vbs/

Adopt Your Watershed: http://www.epa.gov/adopt/:

Learning Projects: http://www.epa.gov/teachers/community-svc-projects.htm

Save the Salamanders™: http://www.savethesalamanders.org/ salamander crossing rights

Appendix 6: Suitability of Wood Species for Coverboards

Species	Drying Time (days)	Rot Resistance (Low to High)
High Suitability		
Northern White Oak	80-250	H
Bur Oak		H
Chestnut Oak	120-320	H
Gambel Oak		H
Oregon White		H
Post White		H
Osage Orange		VH
Mesquite		H
Redwood (sinker)	200-365	H
Black Locust		VH
Moderate Suitability		
Bald Cypress	100-300	H-M
Sassafras		H
Redwood (light)	60-185	H
Red Cedar		H
Juniper		M
Tamarack		M
Western Larch		M
Low Suitability		
Tulip (Yellow) Poplar	40-150	L
Cottonwood	60-150	L
Pines	15-200	L
Spruces	20-150	L
Hemlocks	60-200	L
Maples	30-200	L
Red Oak		L

Appendix 7: Bibliographic Resources

Behler, John L. *The Audubon Society Pocket Guides: Familiar Reptiles and Amphibians*. New York: Knopf, 1988.

Biggs, Alton, Whitney C, Hagins, William G/ Hollidy, Chris L. Kapicka, Linda Lundgren, Ann H. Mac Kenzie, Willim D. Rogers, Marion B. Sewer, and Dina Zike. *Biology*. New York: McGraw Hill, 2007.

Bishop, David and Carola Haas. *Sustaining America's Aquatic Biodiversity: Salamander Biodiversity and Conservation.* Department of Fisheries and Wildlife Sciences, Virginia Tech. Publication Number 420-528, Posted October 2003

Conant, Roger and Collins, Joseph. *Petersons Field Guide: Reptiles and Amphibians; Eastern and Central North America*. Houghton Mifflin Company, 1998.

Edmonson, Hilary. "Hot on the Salamander's Trail: Researchers Struggle to Save Threatened Amphibian." *Guelph*. Oct. 17, 2003.

Holt, Reinhart and Winston. *Holt Science and Technology: Animals*. Holt, Reinhart and Winston, 2005.

Tyning, Thomas F. *A Guide to Amphibians and Reptiles*. Boston: Little, Brown and Co., 1990.

Appendix 8: Helpful Websites and Links

National Park Service:

http://www.nps.gov/legacy/legacy.html: NPS history
http://www1.nature.nps.gov/im/units/netn/index.cfm: NPS inventory/monitoring program
http://www.nps.gov/acad/ : Acadia
http://www.nps.gov/appa/: Appalachian Trail
http://www.nps.gov/boha/: Boston Harbor
http://www.nps.gov/mabi/: Marsh Billings Rockefeller
http://www.nps.gov/mima/: Minute Man
http://www.nps.gov/morr/: Morristown
http://www.nps.gov/rova/: Roosevelt-Vanderbilt
http://www.nps.gov/saga: Saratoga
http://www.nps.gov/wefa/: Weir Farm

Salamander Sites

Amphibiaweb, worldwide data base on amphibians:
http://elib.cs.berkeley.edu/aw/search/

Checklist of Amphibian Species and Identification Guide: An Online Guide for the Identification of Amphibians in North America north of Mexico:
http://www.npwrc.usgs.gov/narcam/idguide/index.htm

Frogs and Toads of Tennessee: http://www.state.tn.us/twra/frogs.html

Georgia Amphibians:
http://museum.nhm.uga.edu/gawildlife/amphibians/amphibians.html

Michigan Department of Natural Resources
http://www.michigan.gov/dnr/0,1607,7-153-10370_12145_12201-61141--,00.html

National Atlas for Amphibian Distributions
U.S. Department of the Interior | U.S. Geological Survey | Patuxent Wildlife Research Center
Amphibian Research and Monitoring Initiative (ARMI).
http://ww.pwrc.usgs.gov/armiatlas/species.cfm?recordID=173650

National Wildlife Federation: www.enature.com/fieldguides/

North American Amphibian Monitoring Program
http://www.mp2-pwrc.usgs.gov/naamp/

North Carolina's Amphibians and Reptiles:
http://www.bio.davidson.edu/Biology/herpcons/herpcons.html

Partners in Amphibian and Reptile Conservation
http://www.parcplace.org/education/index.htm

Reptiles and Amphibians of Virginia and Maryland: http://mysite.verizon.net/vze1m6wp/

Salamanders of Virginia
http://fwie.fw.vt.edu/VHS/salamanders_of_virginia.htm

South Carolina Reptiles and Amphibians: http://www.snakesandfrogs.com/index.htm

Yahooligans: http://yahooligans.yahoo.com/content/animals/amphibians/

Virginia Cooperative Extension: http://www.ext.vt.edu/index.html

Ecology:

Conservation International:
http://www.biodiversityscience.org/xp/CABS/research/repamp/rep_amp_cons.xml

FrogWeb: Amphibian Declines & Deformities: http://www.frogweb.gov/

San Francisco's Exploratorium Museum's Frog Exhibition:
http://www.exploratorium.edu/frogs/

Thinkquest
http://library.thinkquest.org/2943/fchain.html food chains/webs

Appendix 9: Northeast Temperate Network Vital Signs Monitoring Plan

Environmental Management Issues

The ecosystems of New England currently are subjected to a suite of man- induced stressors unlike anything encountered during their long history prior to European settlement. These stressors act as agents of change in a myriad of related and often interacting ways. While the effects of some stressors, like acidic deposition, have been extensively studied and are well understood (Driscoll et al. 2001a), the effects of other important stressors, like climate change, are complex and unpredictable enough to elude our understanding despite concerted and ongoing study (McNulty and Aber 2001). The impacts of many stressors will vary depending upon land use history (Foster et al. 2003), and the combined impact of this suite of interacting stressors is certain to yield unexpected results (Aber et al. 2001). In this section, we summarize knowledge about the effects of key stressors upon NETN systems.

Invasive Species:

The effects of invasive exotic species on the structure, composition, and function of natural systems have become a chief concern of ecologists and land managers over the last 20 years (Drake et al. 1989). Invasion of native habitats by non-indigenous species or by native species whose densities are becoming unnaturally inflated (e.g., white-tailed deer) is presently recognized as second only to direct habitat loss and fragmentation as a threat to biodiversity. Currently, northeastern terrestrial systems are being seriously impacted by several species of invasive exotic insect pests and pathogens. The hemlock wooly adelgid has caused widespread mortality of hemlock across the eastern U.S. since introduction here in the 1950s, and threatens to rapidly and substantially reduce or eliminate eastern hemlock throughout much of its range (Orwig et al. 2002) which could have substantial impacts on associated taxa such as forest birds. Invasive exotic earthworms are another important taxa currently spreading through northeastern forests causing “keystone” changes to soil structure and nutrient cycling (Hendrix 1995). Several species of invasive exotic terrestrial plants are also currently impacting northeastern terrestrial ecosystems, by competing with native flora, altering habitat, and altering ecosystem dynamics such as nutrient cycling and hydrology (Mack et al. 2000).

Invasive plants contribute to the channeling (narrowing and deepening) of streams and the eutrophication and depletion of dissolved oxygen of lakes and ponds. Invasive exotic species can also profoundly affect visitor experience, by changing the quality of water used for swimming, boating, fishing, and drinking. The most prolific invasive exotic flora within NETN freshwater aquatic habitats are common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and curly pondweed (*Potamogeton crispus*). Bass and bluegill are the primary invasive exotic fauna present in NETN systems (Mather et al. 2002); these species have the potential to displace native fish communities through habitat disruption, competition for resources, and/or predation. Other exotic invasive exotic species such as zebra mussels have the potential to become management issues if introduced into NETN parks.

Invasive exotic species are also widespread within New England intertidal systems. The native species composition of these systems was depleted by extinctions caused by Pleistocene glaciation (Stanley 1986), leaving these systems particularly vulnerable to invasion by exotic species. Historic and modern shipping practices have supplied a steady influx of invaders, including some of the most common species now encountered (Carlton 1985). These factors have drastically altered New England intertidal community composition over the last few hundred years and probably caused many local extinctions, but

we lack knowledge of intertidal community composition prior to European exploration and settlement. Within New England salt marshes, the exotic reed *Phragmites australis* has been particularly destructive, out-competing native marsh plants and altering habitat. New invasive exotic species continue to arrive and spread. The Asian shore crab (*Hemigrapsus sanguineus*), native to the coasts of southern Russia, Japan, Korea and China south to Hong Kong, has recently invaded the Atlantic coast. First detected in 1988 by a biology student on Cape May, New Jersey, the crustaceans have been moving north and south along the eastern seaboard. *Botrylloides violaceus*, a colonial tunicate native to the northwest Pacific, was probably introduced by fouling in the 1970s and is now abundant from Long Island Sound to Maine.

Deer Herbivory:

In many parts of the northeastern United States, deer populations have reached historic high levels due to a combination of habitat modification and the extirpation of natural predators (Augustine. White-tailed deer: Morristown NHP) White-tailed deer reduce forest regeneration rates and can aid in the introduction and expansion of invasive plants.

Land Management/Agriculture/Silviculture:

The national historic sites and parks within NETN are managed primarily to achieve cultural goals, such as maintaining historical landscapes or practices. In order to achieve this, these parks apply substantial land management to maintain open or early successional habitat, perpetuate agriculture within parks, or practice silviculture within parks. These activities can have significant ecological impacts due to direct habitat alteration, habitat fragmentation, and the application of herbicides, pesticides, and fertilizers. In addition, silviculture alters forest structure and composition, as well as ecological processes acting within affected forests.

Hydrologic Alterations and Beaver Engineering:

Hydrologic alterations have many causes, including land use history, increases in impervious surface area associated with development, installation of culverts, water withdrawals and discharges, the installation of water storage and release from impoundments, and straightening or confining a channel within an urban area. These alterations can directly affect the aquatic flow regime, sediment transport and water quality. Alterations can also affect geomorphology over the long term by dampening peak flows, changing patterns of aggradation and degradation, constricting a meandering channel, and causing local scour. Hydrologic alterations such as impoundments can restrict the movement of aquatic organisms.

Beaver engineering is one of the most pervasive hydrologic alterations to NETN parks. Water diversions of any kind can be viewed as potential agents of both positive and negative change to wetlands. Beaver can affect almost any wetland type but are especially common along streams and ponds where they build dams. Dam construction typically kills all woody vegetation, reduces the water velocity, and drastically changes plant species composition and structure (Thompson and Sorenson 2000). Beaver alteration of wetlands occurs in decadal cycles with an initial period of flooding after dam creation and impoundment followed by abandonment after the beavers deplete the local food source. Thus, beavers destroy habitat by flooding the unusual vegetation of bogs and fens, for example, but they conversely create many highly productive wetlands along streams formerly dominated by upland vegetation. Despite the many positive effects of beaver engineering, beavers create challenges for park managers when they occur at an excessive level. Beavers topple trees; flood roads, crops, and woodlands; create impoundments; flood riparian areas; and alter riparian vegetation.

Nearby Land use/Roads:

The landscape of New England has been profoundly altered by human activities over the last four hundred years (Foster et al. 2004). Widespread clearing for agriculture and logging for timber have left very few terrestrial systems in the northeastern United States untouched. In particular, the southern New England coast and adjacent areas of

New York and New Jersey are among the most densely settled areas within the United States, resulting in the elimination or drastic alteration of all of the central hardwood forests within this region.

Remaining areas are small, fragmented, and heavily impacted by human activities, and exist in a matrix of managed rural and suburban habitat. A large and growing body of scientific literature documents the negative impacts of habitat fragmentation on biodiversity in a wide variety of ecological systems (Fahrig 2003). The impacts of fragmentation have been especially well documented upon avian communities, and population declines of a variety of forest interior avian species are linked to habitat fragmentation (Rich et al. 1994, Austen et al. 2001).

A network of roads cuts through the northeast, reinforcing edges and introducing disturbance, pollutants, de-icing chemicals and facilitating invasion by exotic species (Brothers and Spingam 1992, Spellerberg 1998). Roads are among the most widespread forms of habitat modification and can have profound effects on wetland communities (Trombulack and Frissell 2000, DiMauro and Hunter Jr 2002, Gibbs and Shriver 2002, Forman et al. 2003). Road construction has been implicated in the significant loss of wetland biodiversity at both local and regional scales for birds, herptiles, and vascular plants (Findley and Houlahan 1997).

Land uses such as farming, forestry, development, and water management can all affect the magnitude and frequency of stream flow and thus a river's ability to erode the land. When streams are constrained from meandering by urban alterations, hydraulic instability can cause increased deposition, erosion, slumping, over-widening or the abandonment of existing channels for new ones (Dunne and Leopold 1978). As water body buffers expand or contract, sources and amounts of non-point source pollution and runoff to the water body can also change. Barriers between water bodies, such as impoundments, can inhibit the movement of species and thus affect the floral and faunal composition of a water body.

Visitor Use:

Visitor use may be one of the most important stressors acting within boundaries of NETN parks. As part of its mission, the NPS aims to preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. It is a complex task to balance the NPS mission of preserving resources unimpaired while also having the public enjoy, and be educated and inspired by those resources. Hikers can increase erosion on and around trails, trample nearby vegetation and cause soil compaction. Car traffic within parks can cause wildlife fatality and reinforce the fragmentation effects associated with roads. Horse riding can contribute to trampling, erosion, and aid in the spread of invasive exotic species. Snowmobiling can cause wintertime disturbance to wildlife.

Stressors to freshwater aquatic resources related to visitor use include the extraction of natural resources (such as fish), erosion stemming from multiple uses, road runoff and contamination stemming from the many roads that allow visitor access within the parks, and the introduction of invasive species carried in by visitors.

Rocky and sandy intertidal areas are frequently visited habitats and often the focus of park-led interpretive tours at both Acadia and Boston Harbor Islands.

Visitor use at both of these parks can cause substantial trampling and removal of resources. In order to truly understand biotic change within the intertidal zone, it will be important to monitor visitor use, and more specifically, visitor intensity, location, and activity, such as walking, boating, or recreational shell-fishing (Engle and Davis 1 996a, 1 996b). Trampling and other visitor use impacts are likely to be localized within areas accessible to parking or ferry.

Ozone:

Tropospheric (ground level) ozone is a damaging phytotoxin of significant concern within the northeastern United States (U.S. Environmental Protection Agency 1996). Ozone is formed by sunlight acting upon nitric oxides and simple hydrocarbons from industrial emissions and motor vehicles. Thus, tropospheric ozone levels vary rapidly in space and time, and are highest on sunny, still days in areas within and downwind of urban centers, industrial facilities, and transportation corridors. Elevated background levels of tropospheric ozone occur throughout the northeastern United States. In addition to harming human health, ozone damages sensitive plant species by causing a visible spotting or "stipple" on the upper surface of plant leaves. Ozone can cause reduced photosynthesis, reduced growth, premature aging, and leaf loss with or without the occurrence of foliar injury.

Atmospheric Deposition:

Acidic deposition, derived from nitrogen and sulfur emissions from electric utilities, manufacturing, agriculture and other sources, is deposited in precipitation (wet deposition), directly onto vegetation immersed in clouds and fog (occult deposition), and also by direct transfer of particles and gases (dry deposition). Deposition of sulfur and nitrogen in rain and snow can acidify soils and surface waters, negatively affecting fish, plants, and other biota.

Anthropogenic atmospheric deposition can dramatically affect water quality in wetland systems. Acidic deposition, in the form of nitrogen and sulfur oxides, can alter wetland structure and function (Morris 1992). Another significant component of anthropogenic air pollution is mercury. Although
Impacted visibility on the Appalachian National Scenic Trail: Great Smoky Mountains NP

Mercury is a naturally occurring element, studies show that human activities have more than tripled its concentration in the environment, which can cause negative impacts in wetland systems, such as direct toxicity and reduced fecundity of secondary consumers.

Atmospheric deposition is one of the largest sources of nitrogen to streams in the northeast. Measures of atmospheric deposition are critical for understanding water chemistry and stress (Likens and Bormann 1974). Fifty percent of total nitrogen entering New England rivers and streams in 1992-1993 was estimated to come from atmospheric deposition originating both inside and outside the region (Moore et al. 2004) Atmospheric deposition is particularly problematic in NETN parks for the surface water bodies with low acid neutralizing capacity (ANC). This parameter is a key indicator of recovery, determining the capacity of lakes and streams to buffer acidic inputs and prevent further acidification (U.S. Environmental Protection Agency 2004).

Contamination:

Anthropogenic sources of contaminants include industrial effluent, municipal wastewater, runoff from agricultural, urban, and forested areas, and atmospheric deposition. Human activity speeds the rate at which naturally occurring metals leach into the environment. Concentrations of lead, mercury and zinc within sediments were positively correlated with urban land use in the Hudson Connecticut, Housatonic and Thames River Basins from 1992-1994 (Breault and Harris 1997, Wall et al. 1998). Specific conductance and dissolved chloride concentrations have increased in rivers in New England over the 20th century (Bell 1993, Kulp and Bohr 1993, Strause 1993, Toppin 1993, Trench 1996). This is likely due to the increased use of de-icing salts on roads. Contamination of aquatic systems by road runoff and de-icing chemicals, such as rock salt and magnesium chloride, can substantially impair water quality and affect a variety of organisms.

Wetland contamination is typically associated with runoff from agricultural areas, residential and urban areas, wastewater treatment facilities, and atmospheric deposition. Heavy metals such as mercury, lead, zinc, and cadmium can be directly toxic to wetland fauna (Adamus et al. 2001). Contaminants, including trace metals such as copper, lead, mercury, zinc, cadmium, and nickel; organic chemicals such as PCBs; polynuclear aromatic hydrocarbons (PAHs); and pesticides all have been found to affect adversely the quality of surface water and sediments in the northeastern United States. (Maine Department of Environmental Protection, written communication, 1992). Contaminants accumulate in sediments, are consumed by bottom-feeding organisms, and then work their way up the food chain. Contaminants inhibit the growth, reproduction, and immune systems of aquatic organisms.

Taken from: Northeast Temperate Network Vital Signs Monitoring Plan—Identifying Vital Signs Using Conceptual Ecological Models
Chapter 2

Appendix 10: National Science Standards Addressed

Life Science (5-8)

CONTENT STANDARD C:

POPULATIONS AND ECOSYSTEMS

- A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers--they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Science as Inquiry

CONTENT STANDARD A:

As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

ABILITIES NECESSARY TO DO SCIENTIFIC INQUIRY

IDENTIFY QUESTIONS THAT CAN BE ANSWERED THROUGH SCIENTIFIC INVESTIGATIONS. Students should develop the ability to refine and refocus broad and ill-defined questions. An important aspect of this ability consists of students' ability to clarify questions and inquiries and direct them toward objects and phenomena that can be described, explained, or predicted by scientific investigations. Students should develop the ability to identify their questions with scientific ideas, concepts, and quantitative relationships that guide investigation.

DESIGN AND CONDUCT A SCIENTIFIC INVESTIGATION. Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables. They should also develop the ability to clarify their ideas that are influencing and guiding the inquiry, and to understand how those ideas compare with current scientific knowledge. Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

USE APPROPRIATE TOOLS AND TECHNIQUES TO GATHER, ANALYZE, AND INTERPRET DATA. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes.

DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

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USE APPROPRIATE TOOLS AND TECHNIQUES TO GATHER, ANALYZE, AND INTERPRET DATA. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collection, summary, and display of evidence is part of this standard. Students should be able to access, gather, store, retrieve, and organize data, using hardware and software designed for these purposes.

DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment. Students should begin to state some explanations in terms of the relationship between two or more variables.

Science in Personal and Social Perspectives

CONTENT STANDARD F:

As a result of activities in grades 5-8, all students should develop understanding of

- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

POPULATIONS, RESOURCES, AND ENVIRONMENTS

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion vary from region to region and from country to country.

NATURAL HAZARDS

- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans. Natural hazards include earthquakes, landslides, wildfires, volcanic eruptions, floods, storms, and even possible impacts of asteroids
- Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

Standards taken from http://fermat.nap.edu/html/nses/6d.html#csc58

National Science Standards Addressed
(9-12)

Life Science

CONTENT STANDARD C:

THE INTERDEPENDENCE OF ORGANISMS

- The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.
- Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.
- Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

THE BEHAVIOR OF ORGANISMS

- Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.
- Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes;

these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.

- Like other aspects of an organism's biology, behaviors have evolved through natural selection. Behaviors often have an adaptive logic when viewed in terms of evolutionary principles.
- Behavioral biology has implications for humans, as it provides links to psychology, sociology, and anthropology.

NATURAL RESOURCES

- Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.
- The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.
- Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

ENVIRONMENTAL QUALITY

- Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.
- Materials from human societies affect both physical and chemical cycles of the earth.
- Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, over consumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.

NATURAL AND HUMAN-INDUCED HAZARDS

- Normal adjustments of earth may be hazardous for humans. Humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in the earth's solid crust. As

societies have grown, become stable, and come to value aspects of the environment, vulnerability to natural processes of change has increased.

- Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.
- Some hazards, such as earthquakes, volcanic eruptions, and severe weather, are rapid and spectacular. But there are slow and progressive changes that also result in problems for individuals and societies. For example, change in stream channel position, erosion of bridge foundations, sedimentation in lakes and harbors, coastal erosions, and continuing erosion and wasting of soil and landscapes can all negatively affect society.
- Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards--ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

Science as Inquiry

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

ABILITIES NECESSARY TO DO SCIENTIFIC INQUIRY

IDENTIFY QUESTIONS AND CONCEPTS THAT GUIDE SCIENTIFIC INVESTIGATIONS. Students should formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations.

DESIGN AND CONDUCT SCIENTIFIC INVESTIGATIONS. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.

USE TECHNOLOGY AND MATHEMATICS TO IMPROVE INVESTIGATIONS AND COMMUNICATIONS. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this standard. Mathematics plays an essential role in all aspects of an inquiry. For example, measurement is used for posing questions, formulas are used for developing explanations, and charts and graphs are used for communicating results.

FORMULATE AND REVISE SCIENTIFIC EXPLANATIONS AND MODELS USING LOGIC AND EVIDENCE. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation.

RECOGNIZE AND ANALYZE ALTERNATIVE EXPLANATIONS AND MODELS. This aspect of the standard emphasizes the critical abilities of analyzing an argument by

reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.

COMMUNICATE AND DEFEND A SCIENTIFIC ARGUMENT. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.

UNDERSTANDINGS ABOUT SCIENTIFIC INQUIRY

- Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.
- Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.
- Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.
- Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.
- Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge.
- Results of scientific inquiry--new knowledge and methods--emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge. In addition, the methods and procedures that scientists used to obtain evidence must be clearly reported to enhance opportunities for further investigation.

Standards taken from http://fermat.nap.edu/html/nses/6d.html#csc58

National Science Teaching Standards Addressed

TEACHING STANDARD B:

Teachers of science guide and facilitate learning. In doing this, teachers

- Focus and support inquiries while interacting with students.
- Orchestrate discourse among students about scientific ideas.
- Challenge students to accept and share responsibility for their own learning.
- Recognize and respond to student diversity and encourage all students to participate fully in science learning.
- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

Coordinating people, ideas, materials, and the science classroom environment are difficult, continual tasks. This standard focuses on the work that teachers do as they implement the plans of Standard A in the classroom.

TEACHING STANDARD C:
Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers

- Use multiple methods and systematically gather data about student understanding and ability.
- Analyze assessment data to guide teaching.
- Guide students in self-assessment.
- Use student data, observations of teaching, and interactions with colleagues to reflect on and improve teaching practice.
- Use student data, observations of teaching, and interactions with colleagues to report student achievement and opportunities to learn to students, teachers, parents, policy makers, and the general public

MAKE THE AVAILABLE SCIENCE TOOLS, MATERIALS, MEDIA, AND TECHNOLOGICAL RESOURCES ACCESSIBLE TO STUDENTS. Effective science teaching depends on the availability and organization of materials, equipment, media,

and technology. An effective science-learning environment requires a broad range of basic scientific materials, as well as specific tools for particular topics and learning experiences. Teachers must be given the resources and authority to select the most appropriate materials and to make decisions about when, where, and how to make them accessible. Such decisions balance safety, proper use, and availability with the need for students to participate actively in designing experiments, selecting tools, and constructing apparatus, all of which are critical to the development of an understanding of inquiry.

It is also important for students to learn how to access scientific information from books, periodicals, videos, databases, electronic communication, and people with expert knowledge. Students are also taught to evaluate and interpret the information they have acquired through those resources. Teachers provide the opportunity for students to use contemporary technology as they develop their scientific understanding.

IDENTIFY AND USE RESOURCES OUTSIDE THE SCHOOL. The classroom is a limited environment. The school science program must extend beyond the walls of the school to the resources of the community. Our nation's communities have many specialists, including those in transportation, health-care delivery, communications, computer technologies, music, art, cooking, mechanics, and many other fields that have scientific aspects. Specialists often are available as resources for classes and for individual students. Many communities have access to science centers and museums, as well as to the science communities in higher education, national laboratories, and industry; these can contribute greatly to the understanding of science and encourage students to further their interests outside of school. In addition, the physical environment in and around the school can be used as a living laboratory for the study of natural phenomena. Whether the school is located in a densely populated urban area, a sprawling suburb, a small town, or a rural area, the environment can and should be used as a resource for science study. Working with others in their school and with the community, teachers build these resources into their work with students.

TEACHING STANDARD E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

- Display and demand respect for the diverse ideas, skills, and experiences of all students.
- Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.
- Nurture collaboration among students.
- Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.

- Model and emphasize the skills, attitudes, and values of scientific inquiry.

The focus of this standard is the social and intellectual environment that must be in place in the classroom if all students are to succeed in learning science and have the opportunity to develop the skills and dispositions for life-long learning. Elements of other standards are brought together by this standard to highlight the importance of the community of learners and what effective teachers do to foster its development. A community approach enhances learning: It helps to advance understanding, expand students' capabilities for investigation, enrich the questions that guide inquiry, and aid students in giving meaning to experiences.

TEACHING STANDARD F:
Teachers of science actively participate in the ongoing planning and development of the school science program. In doing this, teachers

- Plan and develop the school science program.
- Participate in decisions concerning the allocation of time and other resources to the science program.
- Participate fully in planning and implementing professional growth and development strategies for themselves and their colleagues.

PLAN AND DEVELOP THE SCHOOL SCIENCE PROGRAM. The teaching in individual science classrooms is part of a larger system that includes the school, district, state, and nation. Although some teachers might choose involvement at the district, state, and national levels, all teachers have a professional responsibility to be active in some way as members of a science learning community at the school level, working with colleagues and others to improve and maintain a quality science program for all students. Many teachers already assume these responsibilities within their schools. However, they usually do so under difficult circumstances. Time for such activities is minimal, and involvement often requires work after hours. Resources are likely to be scarce as well. Furthermore, the authority to plan and carry out necessary activities is not typically in the hands of teachers. Any improvement of science education will require that the structure and culture of schools change to support the collaboration of the entire school staff with resources in the community in planning, designing, and carrying out new practices for teaching and learning science.

Standards taken from http://fermat.nap.edu/html/nses/6d.html#csc58

SEARCHING FOR SALAMANDERS: Data Collection Sheet

Names: _____ **Date:** _____ **Group #** ____

Array: _____

Coverboard #'s: _____ **to** _____

Habitat Conditions: Field Notes

Fill in the following information about your sampling site.

Amount of Rainfall Last 24 Hr. (In cm.)	Amount of Rainfall Last Week (In cm.)	Air Temperature (Degrees C.)	Wind Speed (M/sec)	Cloud Cover Describe as overcast, cloudy, partly cloudy, clear skies	Soil Temperature (Degrees C.)	Habitat Description Types of trees, general description of landforms, presence of water and other organisms

SEARCHING FOR SALAMANDERS: Data Collection Sheet

Names: _____ **Date:** _____ **Group #** ____

Habitat Conditions: Field Sketches

Habitat Vegetation: Sketch a stand of trees or plants located in the array	Habitat Organisms: Sketch a salamander and/or any other organisms found in the array

SEARCHING FOR SALAMANDERS: Data Collection Sheet

Names: _____ **Date:** _____ **Group #** _____

Array: _____

Coverboard #'s: _____ **to** _____

Salamander Monitoring and Inventory

Be sure not to handle any salamanders. Be very quiet and gentle while you are collecting data.

Coverboard #	Salamander Species Name	Number counted	Length in cm (if measured)	Time	Other organisms present

Page 2

Coverboard #	Salamander Species Name	Number counted	Length in cm (if measured)	Time	Other organisms present

SEARCHING FOR SALAMANDERS:
Data Collection Folder

Data Collectors' Names:
_____
_____
_____

Array Number/Letter _____

Coverboard #s from _____ to _____

SEARCHING FOR SALAMANDERS:
Data Collection Folder

Data Collectors' Names:
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Array Number/Letter _____

Coverboard #s from _____ to _____

SEARCHING FOR SALAMANDERS:
Data Collection Folder

Data Collectors' Names:
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Coverboard #s from _____ to _____

SEARCHING FOR SALAMANDERS:
Data Collection Folder

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Data Collection Folder

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SEARCHING FOR SALAMANDERS:
Data Collection Folder

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Coverboard #s from _____ to _____to _____

SEARCHING FOR SALAMANDERS:
Data Collection Folder

Data Collectors' Names:
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Array Number/Letter _____

Coverboard #s from _____ to _____