Vermont Amphibians and Vernal Pools

Curriculum and Resources

*Some background and curriculum ideas are adapted from the Appalachian Mountain Club's "A Mountain Classroom" amphibian education program, originally compiled by Lindsay Watkins and Joslin Heyn.

A note on Vermon's Framework of Standards and Learning Opportunities

Learning about amphibians and vernal pools is a fun way for students to connect to natural creatures and places in the community, and many activities designed around a study of amphibians can be used to meet Vermont standards for the Vital Results, Science, Mathematics, and Technology, and even History and Social Science (geography, citizenship).

Background Information

Spring has arrived in Vermont and the signs are everywhere. Migratory birds are returning, black bears are waking from their winter dens in search of food, and frogs and salamanders are making their annual pilgrimage in the millions to breeding sites. Late March, April, and May are the months for spotting these beautiful amphibians in Vermont.

Wood Frogs and Spring Peepers are the first frogs to move and Spotted Salamanders are the first salamanders to get going. The first warm spring rain in will trigger a mass migration and for only a few weeks afterward, ponds, streams and shallow temporary pools (***vernal pools***) will be filled with these little critters. One only has to drive (carefully!) on a wet road during these weeks to see countless amphibians crossing roads en-route to their breeding sites.

What are amphibians?

Amphibians are ***vertebrates*** (have skeletons) and are ***poikilotherms***, which means that their body temperature varies quite a bit based on the surrounding environment. ("poikilo"= variable, "therm" refers to temperature. These animals are commonly known as "cold-blooded" and may also be referred to as "ectotherms.") Mammals are ***homeotherms*** ("homeo"= the same, like "homeostasis"; also known as "warm-blooded" or "endotherms"). Amphibian skin is extremely porous and moist, with a coating of mucous to allow for gas exchange and to minimize heat and water loss. Basking and burrowing are techniques used by amphibians to keep their body temperatures comfortable. While many amphibians are quite at home on land, most require a moist or aquatic environment for breeding; this is the basis for the word "amphibian" which comes from the Greek terms: amphi = both; and bios = mode of life. Because amphibians rely on their environment for thermoregulation (regulating body temperature) they are nearly absent from tundra, alpine, desert and marine environments (salt water dries them out) and prefer moisture-rich areas such as ponds, lakes, wetlands, and rivers. Many amphibians are also nocturnal to take advantage of the cooler moist night air. The four main characteristics that make amphibians amphibians are: 1) they are poikilotherms, 2) they

have three life phases (egg, larva, and adult) and go through metamorphosis, 3) they lay soft eggs with a gelatin-like coating and no shell in water or in very moist environments, and 4) they have permeable skin.

What is a vernal pool?

Kenney and Burne define vernal pools as "wetlands that are or become isolated while containing water, are utilized by indicator species, and have wet-dry cycles that preclude permanent populations of fish." They are temporary wetlands, which will fill annually from precipitation, run-off and rising ground water. Vernal pools will periodically dry-up, usually annually or every couple of years.

One quality that all vernal pools share is the lack of breeding populations of fish, a result of low oxygen levels and the pools drying out. The absence of fish as predators has allowed amphibians and invertebrates to adapt to a multi-phased life cycle that maximizes the resources available in temporary breeding pools.

A vernal pool can always be identified beyond a doubt by the presence of indicator species such as Fairy shrimp, a type of crustacean, that breed exclusively in these areas. These **obligate species** are completely dependent on ephemeral wetlands for parts of their life cycle. Examples of other obligate species in Vermont include the Wood Frog, three species of salamander (the Spotted Salamander, the Blue-Spotted Salamander, and the Jefferson Salamander) and two species of fairy shrimp. **Facultative species** are those that use both vernal pools and other wetland habitats for their various life cycles. These include most of our other frogs, Eastern Spotted Newts, a few reptiles, numerous insect larvae, fingernail clams, amphibious snails and leeches.

During breeding season, a vernal pool at just the right time will have hundreds, perhaps thousands of frogs and salamanders congregating and calling and with little regard for a human visitor.

Why are vernal pools important?

Vernal pools are essential habitat for many species. They are also the favored habitat for considerably more species, particularly amphibians, who use them to breed and eat in an area of reduced predation. Additionally they are an important water source for other wildlife both for drinking and as "stepping-stones" along overland corridors for various amphibians and reptiles as they move between permanent wetlands. Vernal pools are important to biodiversity as some species may only be found in specific vernal pools.

Which amphibians can you see in the spring?

The first amphibians to start moving to vernal pools in spring are the Wood Frogs. They are joined soon after by Spring peepers, Blue-Spotted and Yellow-Spotted Salamanders. The Eastern Newt can also be found in early spring. American toads, Northern leopard frogs and Gray treefrogs will move in the following 2-4 weeks. Other species, like the Northern Dusky

Salamander, Northern Two-Lined salamander, Green frog, Bullfrog and Mink frog breed from early summer into the fall.

What can be found in the vernal pools?

When visiting a vernal pool, you can see and hear many organisms. In particular, you can look and listen for amphibians in all stages of metamorphosis. Frogs go through complete metamorphosis: egg, larva (tadpole), and adult. Many insects, which you may also find in the pools, also go through complete metamorphosis. These include caddisflies, midges, and mosquitoes. Some invertebrates, such as mayflies, stoneflies, damselflies, and dragonflies go through less of a dramatic change (incomplete metamorphosis) and pass through a nymph stage rather than a larval stage.

For amphibians, the egg and larva stage are usually dependent on water, though there are some frogs that can lay eggs on the ground and are not dependent on water. A few frogs even go through incomplete metamorphosis; eggs hatch into little froglets rather than tadpoles.

What is the difference between a toad and a frog?

"Frog" is a term that includes all hopping or leaping amphibians, including toads. However, there are some general differences between the two. Frogs prefer moist habitats, have slim bodies, smooth skin, and long slender legs, they move quickly and leap great distances, and usually can be found with other frogs of the same species.

Toads can tolerate drier habitats, have thick plump bodies with bumpy skin and stubby legs, move more slowly, hop rather than leap, and are usually found alone. Toads also have prominent bony ridges on top of their heads (cranial crests) and conspicuous swollen glands behind their eyes (parotid glands).

What do they eat?

Most amphibians are carnivores (meat-eating) and prefer spiders, worms, caterpillars, flies, and other invertebrates. Larger amphibians like the Spring Salamander and the Bullfrog will eat insects, but also consume snakes, small turtles, baby birds and other amphibians. Young amphibians (called larvae for salamanders and tadpoles for frogs and toads) can be carnivores or herbivores. Some prefer diatoms and algae until they reach adulthood and turn into carnivores.

How can we identify them by sound?

Frogs make many different kinds of sounds, but most calls are produced by the males. The advertisement call is used to bring in the female frogs and define a territory, the aggressive call is used to warn off other males, and the courtship call is used once territories have been established and the female frogs have arrived. The call frogs are most easily identified by is the male's advertisement call.

Most frogs call by taking air into their lungs through their nostrils and pumping the air rapidly back and forth from the lungs to a resonating chamber called the vocal sac. As the air goes

back and forth, it passes over the vocal chords causing them to vibrate and make noise, without the frog even opening its mouth. Frogs primarily call in the spring, starting in April and going through May and into June; however, some species will call into the summer and sporadically even in the fall.

Amphibian Conservation and Threats

In the early 1980s, scientists studying amphibians began to notice sudden and dramatic drops in amphibian populations and in some cases, sudden extinctions. One famous example, the shiny, bright yellow, Golden Toad, was a popular symbol of Costa Rica's biodiversity in the 1970's, and the toads were abundant in Monteverde National Park throughout the 70's and 80's. In 1987, one researcher reported seeing 133 toads mating in a pool the size of a kitchen sink, but by 1989 researchers found only a single Golden Toad. Researchers searched extensively for any evidence of the species until 1994, when the IUCN officially listed it as extinct.

Since the 1980's, scientists have come to regard amphibian decline as one of the most critical threats to the earth's biodiversity; 427 amphibian species are currently listed as "critically endangered," and a species of amphibians is more than 200 times more likely to become extinct than a species from another group of organisms. Amphibian decline has been especially severe in North, Central, and South America, as well as Australia. Many scientists believe that amphibians serves as "indicator species" and reflect the overall health of ecosystems; they may not be the only species to go extinct from an area—just the first.

Scientists still disagree about the causes of amphibian declines around the world, but in many cases, populations and species are threatened by more than one factor, including some of the following (from *Hands on Herpetology,* Schneider, Krasny, & Morreale):

- ***Introduced Species-*** as a result of stocking ponds for fishing, and bullfrogs being introduced in many places in the western US where they are not native. Fish and bullfrogs may eat native amphibians or take over their habitat.
- ***Human Consumption-*** some species of frogs may be threatened as a result of the export of their legs to France, where they are eaten as a delicacy.
- ***Ultraviolet Radiation-*** some frogs and toads are damaged by UV radiation, and the radiation can help a disease-causing fungus to kill amphibian eggs.
- ***Acid rain/acid soil***- amphibian eggs and tadpoles cannot survive in water and soil with a pH below 4, and amphibians have disappeared in some regions that suffer from acid rain.
- ***Pesticides/Pollutants-*** frogs in some lakes sprayed with DDT have still shown high residual levels of DDT many years after DDT was banned, and frog populations have increased in areas where other pesticide use was stopped. Studies have shown various pesticides to have an effect on amphibians, in some cases causing neurological problem and in others in disrupting hormone balances (pesticides that mimic estrogen have caused an overwhelming number of amphibians to develop as females in some populations, changing the male-female balance). Pesticides are also thought to be responsible for malformation in some species, causing missing limbs or extra limbs that may make individuals less likely to survive.

- ***Disease-*** scientists in Australia, Costa Rica, and the United States have seen evidence of a pathogenic fungus that causes a disease called Chytridiomycosis, which interferes with a frog's skin function, making it hard for frogs to maintain their moisture balance and making them more susceptible to infections that can pass through the skin. The first case of Chytridiomycosis was found in a species of African frog that is commonly sold elsewhere as a pet and for laboratory use, so the fungus may have spread around the world from infected African frogs. Several other diseases have also been found to affect amphibians.
- ***Habitat Loss/Modification-*** because of amphibians' "double life" in water and on land, they are often more susceptible to the effects of habitat loss than organisms that need only one habitat type to survive. In some cases, vernal pools are drained for mosquito control, farming, or development. Because amphibians migrate from their upland habitat to breeding pools, they are also threatened by having to cross through modified habitat, such as farm fields and across roads. When populations shrink due to habitat loss or modification, the small populations that remain have a smaller gene pool, and as a population are less able to adapt over time to deal with small environmental changes.
- ***Climate Change-*** Climate change is confounding factor that magnifies the impact that other factors have on amphibian populations, and may by itself also impact survivorship of individuals and populations of amphibians. Climate change's impact on weather patterns has a major impact on amphibian populations. For example, climate change can lead to increased cloud cover in some tropical areas, and in turn, increased cloud cover facilitates the growth of the Chytrid fungus.

More information is available from the IUCN (International Union for the Conservation of Nature and Natural Resources) website:

> "The first comprehensive assessment of the conservation status of all amphibians was completed as the Global Amphibian Assessment (GAA) in 2004. Since then the data has been updated in 2006 and again in 2008 to include new information and newly described or revalidated species. Almost 650 experts from over 60 countries have so far contributed to the assessment. The study's results provide a baseline for global amphibian conservation, and are already being used to design strategies to save the world's rapidly declining amphibian populations." Among the key findings in the 2008 update of the Global Amphibian Assessment are:
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> - Nearly one-third (32 %) of the world's amphibian species are known to be threatened or extinct, 43 % are known to not be threatened, and 25 % have insufficient data to determine their threat status.
> - As many as 159 amphibian species may already be extinct. At least 38 amphibian species are known to be Extinct; one is Extinct in the Wild; while at least another 120 species have not been found in recent years and are possibly extinct.
> - At least 42 % of all species are declining in population, indicating that the number of threatened species can be expected to rise in the future. In contrast, less than one percent of species show population increases.
> - The largest numbers of threatened species occur in Latin American countries such as Colombia (214), Mexico (211), and Ecuador (171). However, the highest

levels of threat are in the Caribbean, where more than 80 % of amphibians are threatened or extinct in the Dominican Republic, Cuba, and Jamaica, and a staggering 92 % in Haiti.

- Although habitat loss clearly poses the greatest threat to amphibians, a newly recognized fungal disease is seriously affecting an increasing number of species. Perhaps most disturbing, many species are declining for unknown reasons, complicating efforts to design and implement effective conservation strategies.

Fortunately, the attention amphibians have received in recent years has led to more efforts to save and conserve amphibians. While amphibian decline may seem like an overwhelming problem, we can all help. Learning about and caring about amphibians is a great first step, and there are many ways to get involved in amphibian conservation efforts, from participating in citizen science programs to helping salamanders cross the road on rainy nights. See the activities and resources sections for more ideas.

In the Northeastern United States, amphibians fare somewhat better than in some other parts of the world. They have been spared from some of these threats such as the Chytrid fungus, which has yet to arrive, but still face many of the threats listed above. Some of the most prevalent in Vermont are habitat degradation due to development of particularly roads) and pollution from pesticides and other contaminants. In Vermont there is only one amphibian species listed by the state as endangered (The Boreal Chorus Frog), however, there are several more which are considered of special concern such as the Jefferson Salamander, Fowler's Toad, Four-toed Salamander, and the Mudpuppy.

List of amphibians found in Vermont, with their *Rank, **Status, and ***SGCN Priority

For more information on each species and its habitat, range, and life history, visit the Vermont Reptile and Amphibian Atlas: http://community.middlebury.edu/~herpatlas/herp_index.htm

Frogs and Toads:

American Toad, *Anaxyrus americanus,* S5
Fowler's Toad, *Anaxyrus fowleri,* S1, SC, High
Gray Treefrog, *Hyla veriscolor,* S5
Spring Peeper, *Pseudacris crucifer,* S5
Boreal Chorus Frog, *Pseudacris maculate,* S1, E, High
American Bullfrog, *Lithobates catesbeianus,* S5
Green Frog, *Lithobates clamitans,* S5
Pickerel Frog, *Lithobates palustris,* S5
Northern Leopard Frog, *Lithobates pipiens,* S4
Mink Frog, *Lithobates septentrionalis*, S3
Wood Frog, *Lithobates sylvaticus,* S5

Salamanders:

Jefferson Salamander, *Ambystoma jeffersonianum,* S2, SC, High
Blue-Spotted Salamander , *Ambystoma laterale,* S3, SC, Medium
Spotted Salamander, *Ambystoma maculatum,* S5, Medium
Northern Dusky Salamander, *Desmognathus fuscus,* S5
Northern Two-lined Salamander , *Eurycea bislineata,* S5
Spring Salamander, *Gyrinophilus porphyriticus,* S4
Four-toed Salamander, *Hemidactylium scutatum,* S2, SC, Medium
Mudpuppy, *Necturus maculosus,* S2, SC, High
Eastern Newt, *Notophthalmus viridescens,* S5
Eastern Redback Salamander , *Plethodon cinereus,* S5

State Status, as per the Vermont Endangered Species Law
E: Endangered—in immediate danger of becoming extirpated in the states
T: Threatened—high possibility of becoming endangered in the near future

Information Categories, not established by law
PE: Proposed for endangered.
PT: Proposed for threatened.
SC: Special Concern: rare; status should be watched.
SGCN: Species designated as having the Greatest Conservation Need (SGCN) in Vermont's Wildlife Action Plan. Listed as either high or medium priority conservation for funding through the State Wildlife Grants Program.

State Ranks of Plants, Animals, and Natural Communities
State ranks are assigned by the Nongame & Natural Heritage Program based on the best available information. They are not established by law. Ranks are reviewed annually.
S1: At very high risk due to extreme rarity (often 5 or fewer populations or occurrences in the state), very steep declines, or other factors.
S2: At high risk due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
S3: At moderate risk due to restricted range, relatively few populations, or occurrences (often 80 or fewer), recent and widespread declines, or other factors.
S4: Locally common or widely scattered to uncommon: not rare.
S5: Common: widespread and abundant.

<u>How Can We Monitor Amphibians?</u>
Amphibians are monitored by many different groups using many different methods.
There are national, regional, state, and local organizations that have been set up for the purpose of monitoring amphibian population. Many of these groups are glad to work with non-scientists such as school groups and amateur naturalists who may submit observations in a variety of ways. This way of collecting data is often referred to as "citizen science", and is a great way for scientists and the public to collaborate and gather information that would be impossible to get without working together. Several of these groups can be found in the list of resources at the end.

Methods for monitoring amphibians vary widely, and may include visual counts, auditory call surveys, or looking for tadpole, eggs, or other signs that amphibian are present. You will want to choose the organization you would like to submit data to ahead of time so that you can collect it in a way that will work for them. Most organizations have websites that include information such as background information, guides to data collection, and data sheets that should be used if you are hoping to submit data to an official organization for use. The organization we worked with was the Jericho Conservation Commission, but activities and data collection should be adapted to work with the organization of your choice.

Classroom and Field Activities

Frog calls game

Objective: To introduce students to the different frog and toad calls they may hear in the field.
Equipment/materials: CD player, Frog Call CD either *Voices of the Night: the Calls of the Frogs and Toads of Eastern North America* (Cornell Lab of Ornithology) or *Field Recordings of Maine Frogs and Toads* (included with *Maine Amphibians and Reptiles*, by Hunter, Calhoun, and McCollough), index cards with frog call descriptions, blindfolds (optional)

Introduce the activity by playing a mixed chorus of frog calls ("The Field Recording of Maine Frogs and Toads" track 28 works well.) Ask students if they know what they are listening to. Do they know any of the names of the frogs or toads we might find around here? How about any other amphibians?

Depending on student's prior knowledge, introduce amphibians. What are amphibians? What is the difference between a toad and a frog? What might the amphibians be eating out there? What are invertebrates? What is metamorphosis?

Have the students spread out around a large open area (field, gym, etc.), and tell them you're going to hand each person a card with a description of a sound on it. You can prepare these ahead of time on index cards using the calls list below. (Before you give out cards, it may be helpful to tell students what a "trill" is, as some might not know.) Students shouldn't let anyone else see their card, and you can collect them once everyone knows what sound they are supposed to make. When you say GO everyone should start making his or her sound and mingling around the room, trying to find the other "frogs" of their species. In a controlled space, blindfolding everyone to do this activity can be fun too.

After everyone has found the other frogs of their species, explain the different kinds of calls that frogs will make to communicate different messages: mating calls, warning calls, etc. Also mention that only the male frogs call, primarily to attract suitable mates in the springtime, and that by calling at different frequencies, amphibians can

Play the tracks for each frog species that the students were imitating, and see if each group can pick out their frog. Show pictures of toads and frogs they are listening to and then have each group use field guides or books to learn and share a few facts about their frog. You can also introduce any species that you didn't have students imitate.

Frog calls students can imitate:
Spring Peeper: Loud, high pitched "PEEP, PEEP, PEEP"
American Toad: Long, high pitched trill
Gray treefrog: Short trill
Green frog: "Nnn-gonk!"
Bullfrog: Low pitched "RUM, RUM, RUM"
Wood frog: Duck-like chuckle
Northern leopard frog: Snoring sounds
Fowler's toad (not generally found in Vermont, but lives in New England): Long, loud, high pitched "WAAAAA"

Clay Metamorphosis
Objective: For students to understand the process of metamorphosis and the structure and function of a frog's body
Equipment/materials: modeling clay

Hand out lumps of clay to everyone and ask them to an egg. Then tell everyone it's time for their egg to hatch, and have them sculpt tadpoles. Explain metamorphosis and ask everyone to "morph" his or her tadpole into a frog. Discuss what is involved in metamorphosis, what goes on that you cannot see, and how size changes during metamorphosis. Display pictures of tadpoles and frogs to use as models. Explain complete and incomplete metamorphosis as it pertains to insects and salamanders. Once all the tadpoles have morphed into frogs, discuss frogs' body structure. What unique adaptations do frogs have for getting around on land and it water? From here you can move onto the frog jump, a fun demo.

Frog Jump
Objective: To reinforce frogs unique adaptations for getting around.
Equipment/materials: Frog silhouettes; one 20cm long, one 12.5cm long, one 7.5cm long. 50-yard/meter tape measures. Picture or model of a frog skeleton.

Frogs are great jumpers! Many can jump farther than 10 times their body length. Here are the "leap lengths" for just a few frogs:

Frog	*Length of Frog*	*Maximum Jump*
Bullfrog	20.3 cm	213.5c cm (>10 x body length)
Northern Leopard frog	12.5 cm	162.5 cm (13 x body length)
South African Sharp-Nosed Frog*	7.6 cm	334.4 cm (44 x body length!)

*World Record Holder!

Ask students to leap as far as they can from a standing position. Record the distance. Explain how important it is for frogs to be able to jump quickly to get away from animals that might eat them. Have students demonstrate how far certain species of frogs can jump by having them measure out the maximum jump lengths (above) and compare them to the size of the frog using the silhouette cards. Have students compare the length of their own jumps to their body length. Take the average body length of the students in your class and calculate their "jump length" for 10 x, 13 x, and 44x their body length and measure it out!

Have students look at the picture of model of a frog skeleton, as well as photos of frogs. Why can frogs jump so well? Look at the hinged pelvis and huge rear leg bones and muscles. Also discuss frogs' use of camouflage as a defense and show some pictures (Gray Tree Frogs and Wood Frogs are great examples). Being able to jump long distances and immediately blend in after landing is a huge help for frogs. You can also discuss toads' defense mechanism, parotid glands that secrete a toxin.

If you have students that need to get some energy out, they can try the "Peep Leap". The greatest recorded number of consecutive jumps for a frog is 120 for a freshly caught adult spring peeper that was placed on a grassy lawn. Can any of your students beat the record?

Amphibian road crossings; vernal pool exploration, monitoring and documentation
Objective: To visit and explore a vernal pool; to assist migrating amphibians at dangerous road crossings; to help document and/or monitor a vernal pool.
Equipment/materials: Buckets and/or collection trays, nets (long- and short-handled), vernal pool field guides, tape measures, thermometers, pH probe or kit, dissolved oxygen kit, hand lenses.
One of the best ways to learn about amphibians and vernal pools is to actually visit a vernal pool. Beforehand, talk with students about what a vernal pool is, why they are important, and what might be found there. Emphasize that the group needs to be extremely respectful of this sensitive habitat and the creatures they find, and set clear boundaries and guidelines at the pool.

Amphibian catching ground rules:

- Be respectful of each other, the equipment, and the vernal pool. No running, and watch your step!
- When touching frogs, be sure hands are clean and wet (with pond water not faucet water) any contact with chemicals such as insect repellent, moisturizer, or sunscreen will hurt the frogs. Students should wash hands before going outside; NO BUGSPRAY ALLOWED!
- Handle amphibians gently and as little as possible

- Whenever possible use a long handled net to scoop up a frog. Place or drop it gently in a bucket with an inch of water on the bottom. A lot of frogs in one bucket is not stressful as long as their skin is kept moist.
- Do not put bullfrogs in a bucket with other frogs, including other bullfrogs. Bullfrogs eat other frogs.
- Cover loosely to keep them from jumping out.
- Frogs are delicate. Please hold firmly but don't squeeze them. A frog can be held gently and securely for observation by the two hind legs.
- Blades of grass can cut a frog's skin if the frog is dragged across a blade. Please be careful when catching frogs in the grass.
- Don't remove egg masses from their attachment sites.
- Don't transfer animals between pools or from site to site. Return them where you find them.
- When looking for amphibians under rocks and logs, roll the rock/log gently and replace it exactly as you found it. Put any frogs or salamanders that were underneath gently NEXT TO the log or rock so they can crawl back under on their own.

Approach vernal pools quietly and take a few moments to spread out sit for a couple of minutes silently. Listen and try to identify any frogs by their calls. Then go explore the vernal pool and find critters. Use field guides to identify what you find and discuss the adaptations of vernal pool species.

If documenting or inventorying a vernal pool, use the appropriate monitoring tools and data collection methods. Your town may have a conservation commission that maps and documents vernal pools, or contact the state of Vermont or Jim Andrews from the Vermont Herp Atlas (jandrews@middlebury.edu). You can also have students collect data to be submitted to Frogwatch USA (visit http://www.aza.org/frogwatch/ for more information).

Another great way to get students directly involved with amphibians is to help out with road crossings on wet nights in the early spring. For information on where to help and a free training, contact the North Branch Nature Center in Montpelier to learn about their Amphibian Monitoring Program
(http://www.northbranchnaturecenter.org/AMP.htm)

Amphibian migration tag
Objective: To help students understand the idea that amphibians migrate from their upland habitat to vernal pools to breed, and why conserving vernal pools and the surrounding area is important. To show students how large an area around a vernal pool or wetland may be needed for amphibians to have enough habitat.
Equipment/materials: Rope, hula hoops, a tarp (for the vernal pool), tape measures (there are other possibilities for items that could be used in the game; get creative)

This is a big group tag game that can help kids gain a better understanding of amphibian migration. You need a large field or a gym. About three-fourths of the students will be migrating amphibians, while the other fourth will be various predators (have students discuss what would eat amphibians). You need two "safe" areas, one to simulate amphibians' upland habitat and one for a vernal pool, and you can add some "safe zones" for the migrating amphibians (hula hoops to simulate rocks or logs they could hide under or small vernal pools, etc.) Have students "migrate" and see what happens. How many get eaten? Have students brainstorm what "obstacles" amphibians might face as they migrate to their breeding pools each year. For example, they may have to cross a road. For a road, lay a rope across the entire playing area and have several students act as "cars" driving up and down the road. What happens when habitat is lost and these cover objects and small stepping-stone pools are no longer available? What if a vernal pool gets drained for mosquito control, or polluted? You can get creative with this and discuss all sorts of different ways amphibians could be helped or harmed during their migration.

After being silly, discuss how far amphibians travel between their upland habitat and the pools where they breed. Have students measure the distance that various species will travel.

From the Vermont Department of Fish and Wildlife:

100-foot Zone — Within this zone, pool-breeding adults and juveniles emerging from the pool can occur at high densities at critical times of the year. This zone also protects water quality and habitat by providing shade to the forest floor and pool, filtering runoff, providing root tunnels, and supplying leaf litter and woody debris to the pool.

600-foot Zone — This zone represents the majority of the important terrestrial habitat needed by these species during most of the year (Semlitsch, 1998; Faccio, 2001). Recent studies indicate that at least this much area around the pool is needed to protect 95% of adults in mole salamander populations. Faccio found that females move farther than males and other studies indicate that *average* distances of movement for mole salamanders and juvenile wood frogs can go well beyond 600 feet from the pool.

Amphibian migration map

Objective: For students to learn that upland habitat, breeding pools, and a safe pathway between the two is critical for amphibians; similar objectives/outcomes as Amphibian Migration Tag above, but a low-key option.

Equipment/materials: large, long sheet of paper or several poster-sized sheets that can be lined up end-to-end, crayons, markers, pencils, field guides and other resources on amphibians

Roll out enough paper onto the floor so each student will have room to draw (at least 10 feet long for a class of 20). Tape down securely. Distribute crayons and markers. Ask for one volunteer to draw vernal pool in a central location. Talk about upland habitat and what types different amphibians might need. Assign each student an amphibian species and to learn about

using field guides and other resources. Each student should design a good upland habitat for their individual animals, including plants, trees, logs, tunnels for burrowing, leaf litter, rocks. Once most habitats are complete. Have students brainstorm obstacles amphibians may encounter when migrating to their breeding site and have everyone draw some obstacles into the mural. Encourage them to include things such as roads, stone walls, developments, and any naturally-occurring obstacles they can think of. Then each student should draw realistic routes (probably through other student's drawn obstacles) to the vernal pond for the animal to follow. Discuss how many of the individual animals will actually make it to the breeding pond, what positive things humans might do to help animals overcome man-made barriers, and what habitats need to be preserved for these animals to survive and reproduce?

Links and Resources

Ongoing Monitoring Programs

Association of Zoos and Aquariums - Frogwatch USA:
http://www.aza.org/frogwatch/index.html

North Branch Nature Center – Amphibian Monitoring Program:
http://www.northbranchnaturecenter.org/AMP.htm

USGS – North American Amphibian Monitoring Program
http://www.pwrc.usgs.gov/naamp/

Vermont Center for Ecostudies – Vernal Pool Mapping Project:
http://www.vtecostudies.org/VPMP/

Vermont Fish and Wildlife Department – Vernal Pool Form:
http://www.vtfishandwildlife.com/library/forms_and_applications/nongame_and_Natural_Heritage/Vernal_Pool/Vernal%20Pool%20Write-in%20Form.pdf

Vermont Reptile and Amphibian Atlas:
http://cat.middlebury.edu/herpatlas/

Wildlife Guides and Resources

Books

Halliday, Tim and Kraig Adler, editors. 2002. The Firefly Encyclopedia of Reptiles and Amphibians. Firefly Books, Inc. Buffalo, NY.

Heyer, W. Ronald (ed.) 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution, Washington, D.C.

Hunter Jr., Malcolm L., Aram J.K. Calhoun, and Mark McCollough. 1999. Maine Amphibians and

Reptiles. The University of Maine Press. Orono, ME.

Kenney, Leo P., and Mathew R. Blume. 2001. A Field Guide to the Animals of Vernal Pools. Massachusetts Division of Fisheries & Wildlife. Natural Heritage and Endangered Species Program & Vernal Pool Association. Westborough, MA.

Lang Elliot, Carl Gerhardt, and Carlos Davidson. 2009. The Frogs and Toads of North America. Houghton Mifflin Company. Boston, MA. (With Frog and Toad Sounds CD)

Schneider, Rebbeca L., Marianne E. Krasny, and Stephen J. Morreale. 2001. Hands-on Herpetology. National Science Teachers Association Press. Arlington, VA.

Stebbins, R. and N. Cohen. 1995. A natural history of amphibians. Princeton University Press, Princeton, NJ.

Websites

AmphibiaWeb – Worldwide Amphibian Declines:
http://amphibiaweb.org/declines/declines.html

Eek! Teacher Pages – Guide to Frog Egg Masses
http://www.dnr.state.wi.us/org/caer/ce/eek/teacher/frogeggs.htm

The IUCN Red List of Threatened Species – Amphibians:
http://www.iucnredlist.org/amphibians

USGS – Frog Call Quizzes:
http://www.pwrc.usgs.gov/frogquiz/

USGS – Tadpole Identification Guide:
http://fl.biology.usgs.gov/armi/Guide_to_Tadpoles/SEARMITadpoleGuide.pdf

Vermont Fish and Wildlife Department – Seeps and Vernal Pools
http://www.vtfishandwildlife.com/books/Wetland,Woodland,Wildland/__76_to_386_Part_4_A_Guide_to_the_Natural_Communities_of_Vermont/__237_to_386_Wetland_Communities/_244_to_308_Forested_Wetlands/302_to_308_Seeps_and_Vernal_Pools.pdf

VPIRG – The Fate of Frogs: A Closer Look at Frog Deformities:
http://www.teachertube.com/files/support/344.pdf

Curriculum Resources

ECOS - Ecologist Educators and Schools Partnerships in GK-12 Education – Inquiries:
http://www.bioed.org/ecos/inquiries/

Toronto Zoo Wetland Curriculum Resource:
http://www.torontozoo.com/adoptapond/curriculum/ab-intro.html

Vermont Public Interest Research Group - The Frog Project
http://www.vpirg.org/downloads/VPIRGFrogCuriclm.pdf

Other Citizen Science Opportunities

Vermont Center for Ecostudies – Citizen Science
http://www.vtecostudies.org/citsci.html

Cornell – Citizen Science Page
http://www.birds.cornell.edu/citsci/