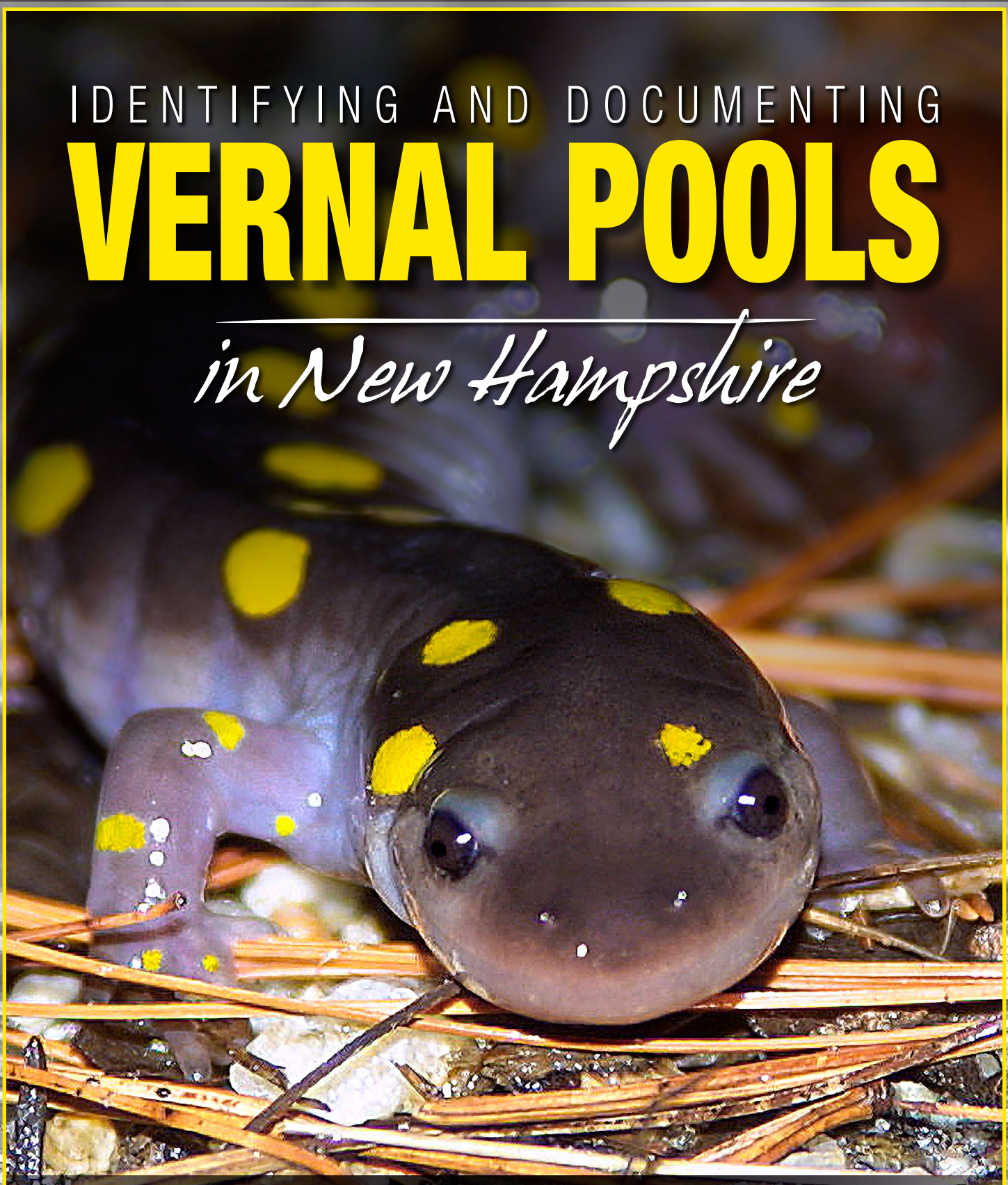
IDENTIFYING AND DOCUMENTING

# VERNAL POOLS

## *in New Hampshire*



THIRD EDITION

EDITED BY MICHAEL MARCHAND

*Published by*
New Hampshire Fish and Game Department • Nongame and Endangered Wildlife Program

IDENTIFYING AND DOCUMENTING

# VERNAL POOLS

## *in New Hampshire*

THIRD EDITION

EDITED BY MICHAEL MARCHAND


*Published by*
New Hampshire Fish and Game Department
Nongame and Endangered Wildlife Program

# ACKNOWLEDGMENTS

This is the third edition of the *The Identification and Documentation of Vernal Pools in New Hampshire,* and many people have assisted in the development and improvement of this publication over the years. All editions have been published by the New Hampshire Fish and Game Department's Nongame and Endangered Wildlife Program, in conjunction with the Public Affairs Division.

Funds for the development of the third edition came from the Nongame and Endangered Wildlife Program, N.H. Fish and Game Department, including Conservation License Plate (Moose Plate) funds and a grant from the U.S. Environmental Protection Agency.

The third edition was edited by Michael Marchand, wildlife biologist for the N.H. Fish and Game Department's Nongame Program. The following individuals provided text, thoughtful comments, and edits to the manual:

Loren Valliere, N.H. Fish and Game Department, Nongame and Endangered Wildlife Program; Sandy Crystal, Sandi Mattfeldt and Mary Ann Tilton, N.H. Department of Environmental Services, Wetlands Bureau; and Brett Thelen, Harris Center for Conservation Education. Pamela Riel, N.H. Fish and Game Publications Manager (Public Affairs Division), did the layout. Graphic Designer Victor Young, also of Fish and Game's Public Affairs Division, formatted images for publication, provided artwork and designed the cover. Additional credits are provided with photographs and figures throughout the manual.

This updated version of the manual builds on the work of previous contributors. The second edition (2004) was edited by Michael Marchand with contributions from Celine Goulet, Alina Pyzikiewicz, and Rita Boisvert. The original publication (1997) was edited by Anne Tappan, with contributions from John Kanter, Richard Cook, Sarah Allen, Paul Dest, Marian Baker, David Carroll, Laura Deming, Liz Garlo, Margaret Liszka, Jed Merrow, Jeff Osgood, Cathy Pedevillano, Lori Sommer, Rebecca Suomala, James Taylor, and Sheila Tuttle.

***Funding provided by:***



# Contents

*Contents, continued*

# Chapter One

## INTRODUCTION

### VERNAL POOLS: UNIQUE HABITAT, UNIQUE WILDLIFE

A vernal pool is a temporary body of water (wetland) that provides essential breeding habitat for certain amphibians – such as wood frogs, and spotted salamanders – and invertebrates – such as fairy shrimp. These unique wetlands typically cycle annually from flooded to dry. Vernal pools vary in size, shape, and location. Some are as small as several square feet in area; others extend to several acres during maximum flooding. The pools appear year after year in the same spots, except during exceptionally dry years. Pools occur in a variety of sites, including small depressions in the woods, kettle holes, and oxbows on river floodplains. Many occur in isolated depressions in areas far away from rivers and streams, lakes, and wetland areas. These differences are of little significance to the wildlife that depend on vernal pools for habitat; for them, the important considerations are water, food, cover (concealment) and lack of some predators.

Vernal pools are important as wildlife habitat because of the wide range of species that use them, including turtles, frogs, salamanders, fairy shrimp, clam shrimp, fingernail (or "pill" or "pea") clams, caddis flies and other aquatic insects. Some of these species (certain invertebrates, salamanders and frogs) are rarely found outside of areas containing vernal pools.



*A vernal pool surrounded by forest.*

© SANDY CRYSTALL

*A dried up vernal pool in the summer.*

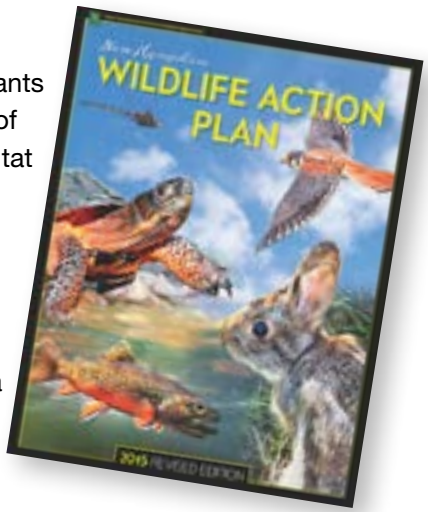
Vernal pools provide a safer breeding ground for these species than permanent waters because there are no fish to eat the eggs or larvae. In addition to the species specially adapted to vernal pools, these wetlands may serve as local watering holes for nearby animals; a feeding ground for birds, snakes, turtles and some mammals; or a hibernation site for turtles. A profusion of plant life may grow in and around the depression where the pools form, providing food and cover for other species. Vernal pools, used as breeding sites, provide a critical element in the life cycle of certain amphibians and invertebrates. The aquatic larval stage of vernal pool inhabitants is a race against time to complete development before the pool dries up. For salamanders, the time between hatch and metamorphosis is highly variable. These species are able to metamorphose earlier and at a smaller size when a pool is drying earlier than usual, or metamorphose later and at a larger size if the pool holds water for a longer amount of time than usual. Adult salamanders emerge from their subterranean habitat on the first relatively warm rainy nights of early spring. Spotted salamanders (which are black with large yellow dots and are up to eight inches long) and the smaller Jefferson and blue-spotted salamanders (which are grey-black with finely speckled blue spots) often find their way back to the pools in which they were born. Wood frogs are among the early arrivals, their chorus of duck-like quacks punctuating the night. Fairy shrimp, if present, are likely already swimming in the pool. Their eggs survive in the mud of dried pools and hatch early the next spring, when the pool is full of water.

Male salamanders arrive first and wait for the females, which generally follow soon after. In the pool, males and females participate in a mass courtship ritual known as congressing. Males deposit gelatinous capsules, usually about a half inch long, on the bottom of the pool. Females then take these sperm-filled packets, known as spermatophores, into their vents (cloacae) and fertilization occurs internally at the time of egg deposition. Then the eggs are laid in gelatinous masses in the water.

MIKE MARCHAND ©NHFG

*An adult Spotted salamander.*

The adults leave the pool after breeding, normally awaiting a rainy or wet night before returning to their cavities in the forest floor, hence they are sometimes called “mole salamanders.” The eggs hatch in four to eight weeks. The tadpole-like larvae are entirely aquatic and breathe with external gills. They gradually develop legs and jaws during their time in the pool. After two or three months (usually between July and September), they transform into young adults. When they have lost the last traces of their gills, they leave the pool to begin the next phase of their lives in the surrounding upland forest.




In addition to being vital as small, individual habitats for local plants and animals, vernal pools fill another important role. If we think of them as specialized aquatic stepping stones within a larger habitat type, we see that groups of pools form "corridors" of wetland habitat along which wildlife may travel. If the corridors do not exist, these creatures will be isolated and more vulnerable to drastic changes in their surroundings. These factors make the pools and surrounding uplands important habitat for the wildlife of New England. Because of the importance of vernal pools to a variety of wildlife species, they are included as a critical habitat type in the *New Hampshire Wildlife Action Plan*.

## USING THIS MANUAL

The goal of this manual is to train the public to identify and document vernal pool habitat. Although concerned about vernal pools, many people are not well acquainted with this particular wetland type. Awareness of vernal pools – their occurrence and importance – is the first step to their protection. Identification and documentation of vernal pool habitat is a key step. This manual will show you how to locate, identify and document vernal pools and indicator species.

© RUSS COBB

Vernal pools are especially vulnerable to human disturbance. The same characteristics that make vernal pools important breeding sites for certain species increases the possibility of disturbance or destruction. The ephemeral nature of this habitat makes vernal pools difficult to notice during much of the year. Many vernal pools are small and isolated, also making them difficult to notice. Identifying and documenting vernal pools before land use changes are considered, is vital to their protection.

**The definition and documentation criteria in this manual provide a standardized approach to evaluate and document the location and condition of vernal pool habitat. This information will enable citizens, conservation commissions, land managers and state agencies to take steps to protect this unique habitat.**

Once you have become involved with making field observations, you may discover that identifying and monitoring pools becomes an annual event for you! For those wishing to pursue their interests further, a bibliography in this manual provides listings of field guides and other references. Contact information for organizations and agencies interested in vernal pools and their protection are provided in the Appendix and on several websites focused on this resource.

## DOCUMENTATION VS. PROTECTION

Vernal pool protection is a two-step process. The first step involves identification of a pool as important wildlife habitat. The second step involves obtaining protection from disturbance. Protection of vernal pools is discussed in Chapter 9, but any landowner can help protect vernal pools and the species that depend on them by incorporating considerations for this important habitat type into management plans or management decisions.

Documenting vernal pools can accomplish the following:

- Contribute to scientific investigations about vernal pools and the wildlife that depend on them. Much remains to be discovered about the ecology of vernal pools and the organisms that depend on them. By being part of a statewide network of vernal pool observers, and providing your observations to NH's web-based reporting system: NH Wildlife Sightings (link to: *http://nhwildlifesightings.unh.edu/*), you will be enhancing the understanding and conservation of New Hampshire wildlife.
- Help landowners learn about and appreciate the importance of vernal pools on their properties and apply protective measures. Individual landowners have the most control over what is done on their properties. Many people, if they know they have something unique or valuable, will act to protect it. Actions can range from not dumping lawn clippings in a vernal pool to making changes in management or development plans or even placing permanent conservation restrictions on the area of the property where the vernal pool is located.
- Provide a basis for protection at the local level. Some municipalities have local wetland protection ordinances. You may wish to work to have your local ordinances amended to include protection for vernal pool habitat (pool and adjacent upland areas) or to draft such an ordinance for your city or town that will be considered when properties are subject to site plan and subdivision regulations.

## TERMS USED TO DESCRIBE VERNAL POOLS

For the purposes of this manual, a vernal pool typically:

- is a temporary body of water (surface water or wetland),
- provides essential breeding habitat for certain amphibians and invertebrates, and
- does not support viable population of fish.

Vernal pool habitat is characterized by extremes, each year flooding in spring and typically drying in late summer. Characteristics of a vernal pool are influenced by topography, surrounding vegetation and rainfall.

The size and duration of a particular pool may be quite different year to year due to local snow and rainfall conditions. Vernal pools are found in a variety of landscapes and surrounded by various types of habitat. A pool may be in an upland site, bottomland isolated site or associated with floodplain wetlands. Surrounding habitat may be forest (hardwood, softwood or mixed), field, shrub swamp, marsh, gravel pit or other. Size, depth and cover (branches or vegetation in the pool) also vary.

Vernal pools may be known by a variety of rather non-standard names. These additional names and characteristics provide a broader description of these wetlands. The major variables are duration of wet-dry cycles, season of filling, and pool size. All of the following waterbodies may be vernal pools.


© SANDY CRYSTALL

**Vernal pool or pond** is a term used to describe temporary ponds that fill up with water in the spring as a result of snowmelt, spring rains, and/or elevated groundwater tables. (Vernal comes from the Latin word for spring.) This term is also used to describe pools that reach their maximum size in springtime and has come to be used broadly as a synonym for "temporary pond." As noted above, in New Hampshire the term has been given a specific definition, with particular criteria for documentation as important wildlife habitat.

**Temporary or ephemeral pool or pond** is commonly used to describe aquatic habitats that are periodically flooded, then dry up. It is applied to a wide variety of aquatic habitats, ranging from short-lived puddles that form in low areas after rainstorms and remain only for one to two weeks, to kettle hole basins that contain some water most of the year and usually dry up only for a month or two in midsummer.


© SANDY CRYSTALL

**Seasonal isolated wetland** is often used to describe this habitat type. (See the Partners in Amphibian and Reptile Conservation (PARC) *Habitat Management Guidelines for Amphibians and Reptiles of the Northeastern United States* publication.)

**Autumnal pool or pond** fills in fall or early winter. Purists reserve the term "vernal pool" for spring-filled ponds that stay dry in fall and winter. Many of the temporary ponds in the state, although often referred to as vernal pools, fill in fall as groundwater tables rise and remain flooded until summer and are thus autumnal ponds.

© RUSS COBB

*Spring (March through May) is the easiest time of year in which to locate and document vernal pools.*

# Chapter Two

## LOCATING VERNAL POOLS

### WHEN TO SURVEY: START ANYTIME, BUT SPRING IS BEST

Spring (March through May) is the easiest time of year in which to locate and document pools. In early spring, salamanders are migrating, frogs are calling, courtship, mating and egg laying are occurring. In mid to late-spring, egg masses remain visible; larval salamanders and frogs (tadpoles) appear late spring into summer. Documentation is possible at other times of the year as well, but it can be more difficult. Preparing for field visits by networking and examining maps for potential survey locations can be done anytime.

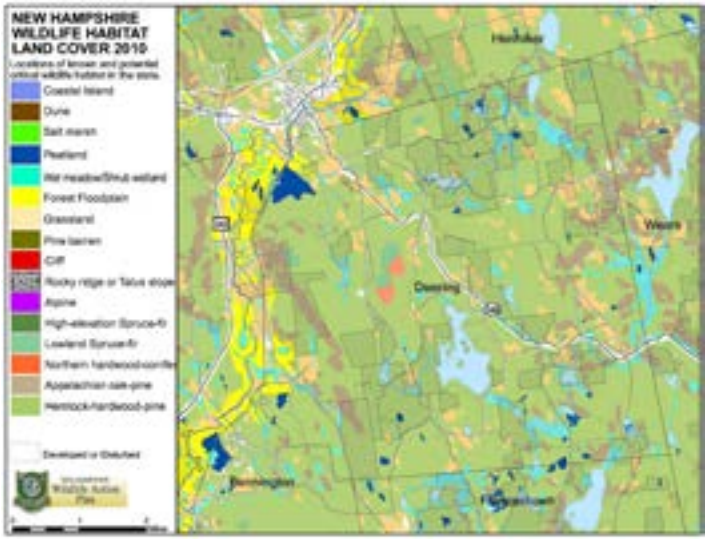
#### Networking to Generate Interest and Identify Potential Vernal Pools

Others in your community may be interested in helping document vernal pools as well including:

- **Town conservation commissions** are in an excellent position to spearhead a community effort to locate, document and verify vernal pools on town owned lands or other lands with landowner permission. A systematic search of the town for vernal pools is highly recommended. If this is not feasible, pursue vernal pool documentation on any level, perhaps starting with one town property. Talk to the town conservation commission to find out if they are involved in vernal pool documentation. The town website or town clerk will have a list of members. Attend one of the commission's meetings (contact the commission first to be placed on the agenda). If you are working on your own, share your findings with the commission. Information you have collected is very useful.
- **Organized Clubs.** Contact scout troops, school groups (such as high school environmental clubs), garden clubs, sporting organizations, watershed associations or university biology departments.
- **Citizen science programs.** There may already be a coordinated effort in your region such as those provided through the Harris Center (*http://www.harriscenter.org/conservation-research/citizen-science*).
- **Neighbors.** Many neighbors know of "spring pools" or "places with salamanders" and may be interested in joining the search.
- **Press.** To get help and build a network of "pool scouts" consider putting an announcement in your local newspaper or town newsletter or website asking for volunteers to identify vernal pools. Citizens may enjoy the opportunity to learn about this unique aspect of nature. Those who are unable to do the work themselves should be encouraged to call in to suggest likely locations. Ask a local paper or town newsletter to run a public service announcement or a story about vernal pools. Submit such a story yourself; the local paper will probably print it. Include a request for information or partners to help you identify some pools for documentation.

## USING MAPS TO IDENTIFY POTENTIAL VERNAL POOLS

In recent years, wildlife biologists and other scientists have investigated various methods for locating potential vernal pools in the landscape. With the availability of computer mapping – geographic information systems (GIS) – and data for soils, topography, and water resources, as well as aerial imagery, much has been done to analyze spatial data to identify certain habitats. *The maps produced for the New Hampshire Wildlife Action Plan* demonstrate this approach (shown at left). However, the ability to locate potential vernal pools has been less successful. The use of high resolution Lidar (a remote sensing technology that uses a laser to measure distance by reflected light) in generating predictive vernal pool maps shows promise based on initial attempts in other areas, but Lidar is not available statewide in New Hampshire as of 2014.




Reviews of **desk top** or **computer-based maps** and **aerial imagery** are the first step in an organized effort to locate vernal pools. Many types of maps and aerial photographs or imagery, are available in town and regional offices, libraries and on the internet. Depending on the purpose of the map and level of landscape detail, they may be useful in locating actual pools or, more likely, suggest areas to explore for vernal pools.

On **topographic maps**, look for contours designating depressions, wetland symbols and small water bodies. Look for concentrations of these features, as well as floodplains, oxbows, remnants of old riverbeds, wetland areas associated with rivers and streams, and low-lying depressions that may collect spring runoff, snowmelt or seepage. Although the USGS 7.5-minute topographic maps are good for showing landscape contours, they are more than 20 years old in some areas of the state, and lack many roads and developed areas. Also, contour intervals may not be sensitive enough to identify all vernal pools.

When examining **aerial imagery**, look closely at forested areas. Pools can be any size, but are usually small and round or elliptical shaped and may occur in clusters. A well-defined basin in an upland area may indicate a vernal pool; however, pools may occur at any elevation.

Features on aerial imagery that make vernal pools more visible:

- Leaves off of deciduous trees and shrubs (imagery obtained in early spring or late fall)
- No ice or snow cover
- Spring time (pools full)
- Large scale (1" = 400' to 1" = 1,000')
- Color infrared images often work well (available for the entire state of NH as are true color). Black and white images will work too.

**Map limitations:** Be aware of limitations of maps and aerial photographs/imagery. Certain features will be highlighted, or conversely, less likely to show up, depending on the original purpose of the map or imagery. Since vernal pools are often small and isolated, they can be obscured by the forest canopy and may not be visible on aerial photographs or topographic maps. Clusters of conifers may show up as a dark spot which looks like a pool and shadows of conifers can look similar to pools. Know the scale of your map. Start with maps of an area that is familiar to you; it is helpful to be able to match the map with what you know of the land. Use maps to target areas or sites to field check in addition to your recollections of small pools you may have observed or places you may have heard chorusing wood frogs.

## MAP TYPES AND SOURCES

**Town Wetland Maps** may be useful to survey for potential vernal pools, although generally they do not depict all wetlands.

**Aerial Photographs/Imagery** are often taken in the spring or late fall and may show locations of larger vernal pools. New Hampshire had aerial photographs of the entire state during "leaf-off" in 2010-2011.

**U.S. Geological Survey (USGS) Topographic Maps.** Though it may be difficult to locate new pools on unfamiliar land using these maps, they do show the lay of the land, and may indicate areas to explore.

**USDA - Natural Resources Conservation Service (NRCS) – Web Soil Survey.** Soil data are available for most counties. To locate potential vernal pool sites, look for peat and "muck" soil types that indicate the presence of wetlands, the soils that are identified as hydric, and for symbols for wetlands and isolated depressions. NRCS was formerly known as the Soil Conservation Service (SCS).


**U.S. Fish and Wildlife Service - National Wetlands Inventory (NWI) Maps.** NWI maps will not identify many small vernal pools; some larger pools will appear. Wetland classes that are most likely to be associated with vernal pools include PUB (palustrine, unconsolidated bottom), PSS (shrub wetland), PFO (forested wetland) and PEM (emergent marsh). Can be viewed online at: *http://www.fws.gov/wetlands/Data/Mapper.html*

**Federal Emergency Management Agency (FEMA) 100-year Floodplain Maps**

## TOOLS FOR VIEWING DATA

**GRANITVIEW.** General purpose mapping tool for New Hampshire that provides public access to many core database layers such as aerial photographs, topographic maps, and NWI wetlands (*http://granitview.unh.edu/*).

**NH Wetlands Mapper.** Provides access to similar data as GRANITVIEW. Used to help assess wetland functions and values. *http://nhwetlandsmapper.unh.edu*

**Geographic Information Systems (GIS).** If you have access to a geographic information system (e.g., ArcMap, QGIS), additional sources of information are available as spatial data layers. These layers can be downloaded from the University of New Hampshire Complex Systems GRANIT webpage (*http://www.granit.unh.edu/*). For a complete listing of available data layers, see the GRANIT catalog. Several layers available include topographic maps (digital raster graphics), digital aerial photographs (digital orthophoto quads), and NWI data layers.

**Internet Mapping Sites.** There are several free website such as Google (google.com) and Bing (bing.com) that can be used to view aerial photographs, some topography, and other features such as roads. These sites are valuable for quick views of imagery, but the user has less ability to change layers (provide additional information) compared to other tools mentioned here.

| TYPE OF MAP OR DATA SOURCE | TOWN | GRANITView | WETLANDS MAPPER | GOOGLE/BING MAPS |
|---|---|---|---|---|
| Parcel maps | Y | | | |
| Topography | | Y | Y | Y |
| Soils | | Y | Y | |
| Flood plains | Y | Y | Y | |
| Wetlands (NWI) | | Y | Y | |
| Wildlife Action Plan | | Y | Y | |
| Conservation lands | Y | Y | Y | |
| Land cover/land use | Y | Y | Y | |
| Aerial imagery | | Y | Y | Y |

## SEARCHING FOR VERNAL POOLS IN THE FIELD

### Targeted Searches of Vernal Pools

© NHFG/MICHAEL MARCHAND

*Nearly dry vernal pool.*

#### LOCATING ACTIVE VERNAL POOLS

Using information gathered from networking and evaluating maps and other tools, searches can begin to document whether pools are present and whether they meet the criteria of a vernal pool (see *Chapter 7*).

#### LOCATING DRY VERNAL POOLS

Field surveys may be conducted to locate pools during the non-breeding season. Dry pools may be found in late summer, fall and winter (in the absence of snow cover). Dry pools are more difficult to locate than flooded pools. Documentation relies on evidence of certain secondary vernal pool indicators – invertebrates, and thus can be very difficult *(see Figure 4-2)*. If you find a potential vernal pool in the dry season, look closely for any evidence of secondary vernal pool indicators and note the location for follow-up the next spring.

The following characteristics may help you to notice dry pools:

- Flat topography with variability, especially depressions in the landscape. Areas with several or a chain of, depressions have increased value as vernal pool habitat.
- Evidence of vernal pool hydrology:
  (1) Leaves darkened by water stains or a film of sediment. You may need to brush away recently fallen leaves to reveal the stained layer
  (2) Siltation marks or water stains on surrounding trees or vegetation
  (3) Trees with buttressed trunks or stilt roots
  (4) Sphagnum moss around the edge of a depression
  (5) Wetland plants growing in a dry depression

Some pools refill in fall or early winter from groundwater or rainfall. Pools may be evident from a distance in the leafless landscape. Look for pools in late fall and into winter prior to significant snowfall. The silvery sheen of a frozen pool surface may indicate a vernal pool. Note the location of these pools for a spring follow-up visit.

## Incidental Encounters of Vernal Pools

Pools (with or without water) may be encountered while walking on town lands, hiking with family or on other outings. Make note of these pools to investigate later.

## Road Cruising

Car cruising can be a very productive way to look for migrating salamanders and frogs on the first few warm rainy nights of early spring when migration to breeding pools is taking place. Dusk and nighttime are best. The basic idea is to drive slowly (10-15 mph) on roads that cut through likely habitat. Take a passenger who can pay more attention to the non-road areas, and record locations on a map where salamanders and frogs may be crossing or wood frogs are chorusing. Observe the general direction in which they are headed.

*Keep a sharp lookout for frogs or salamanders crossing the road and note the direction they are headed in.*

*Wood Frog* calls may not carry very far, so this method may locate only those breeding pools close to the road. *Spring peepers*, more widespread and easier to hear, are not vernal pool indicator species because they can use wetlands other than vernal pools, but may indeed be calling from a vernal pool. Explore that area for possible breeding pools. You can cover a lot of territory and then can return to the hot spots for more thorough searching. This method is best done with one or more spotters accompanying the driver – for safety reasons and to avoid running over salamanders and frogs. Don't allow the excitement of seeing amphibians in the road detract from traffic safety. If you are able, pull off to the shoulder to stop. Look for oncoming vehicles before getting out of the car.

Record the location of species observed, the number of individuals observed, and take a clear photograph (if possible) of any species observed. Submit your observations to N.H. Wildlife Sightings (*http://nhwildlifesightings.unh.edu/*). Reporting animals crossing roads can also help identify road crossing hotspots and to identify wildlife corridors worthy of protection.

## GETTING STARTED: PICK A POOL

Investigate your favorite pool (if you have one) first – it will be the easiest because you know it already, and the process will provide the experience and incentive to do more. Public lands – particularly those with recreation, school, or other facilities – can undergo environmental degradation as a result of heavy visitation or facility expansion, so it is a good place to inventory the areas for vernal pools. Conservation lands are probably least susceptible to potential development, but should be considered for vernal pools surveys as well. Identification of vernal pools can ensure that these areas will be protected in the event of forestry activity or trail construction on conservation land. Remember, even if the pool is small and isolated, documentation is valuable. Also, surveys of vernal pools in conservation areas can provide good reference data for comparing the condition of vernal pools.



*Try to determine if the land you want to enter is private or public.*

### Get Permission to Look for Vernal Pools on Private Land

You may not enter any posted private land without first getting permission from the owners of the property. It is recommended that you obtain permission to enter non-posted land as well. Conservation commissions, its members, or designee shall first obtain permission of the property owner or agent.

If you wish to obtain permission to look for vernal pools on a piece of property, but do not know who owns the land, you can find out through the tax assessor's office or town tax maps. Call or write to the owner, or knock on the door, and ask for permission to walk on the land. Tell the landowner who you are and explain your interest in observing pools on the property. Be sensitive to the fact that some owners may not appreciate your efforts to document pools on their land.

### Find Out About Access to Public Land

Don't assume that permission to observe pools on public land is automatic. Some public lands are restricted – such as areas for public wells and water supply protection, for example, as well as public developed lands like hospitals, airports, and prison properties. Wildlife refuges and parks may have restricted areas to protect wildlife from human disturbance. If you are unsure whether public access is permitted on public property where you wish to look for vernal pools, obtain permission from the department or organization that administers the lands on which you plan to walk.

### Notify the Authorities

In many parts of the state, people routinely walk in woods and open areas; in other, more populated areas, the local police may view such activities suspiciously. Depending on the conditions in your area, you may find it useful to notify the local police of the areas where you will be parking or walking. This is particularly sensible if you will be walking in the woods at night. Notifying the police ahead of time will prevent your having to make awkward explanations to an officer some rainy night. It may be useful to put a note in your car window explaining who and where you are.

# Chapter Three

## TIMING OF USE – VERNAL POOL ANIMALS

Because vernal pools are isolated and variable habitats with widely fluctuating temperature and oxygen levels accompanying the seasonal appearance and disappearance of water, specialized strategies for survival are found in salamanders, frogs and invertebrates that inhabit vernal pools. Three to five months is typical for the completion of the amphibian cycle, from egg laying through metamorphosis. Invertebrates inhabiting vernal pools may complete their life cycle in less time.

**Strategies of amphibians and invertebrates include:**

1. Rapid growth, so eggs and larvae can complete development before the pool dries up. When metamorphosis is completed, frogs and salamanders transform from aquatic larvae into terrestrial juveniles and migrate away; adult insects fly away.
2. Certain invertebrates "wait it out" in a dormant state until the pool floods again. Fairy shrimp eggs can rest in the sediments for years until conditions are right for hatching. Fingernail clams and snails *aestivate* – the summer equivalent of hibernation – in the mud. Caddis flies lay their eggs in dry pool depressions in fall. The eggs withstand drying and cold until the pool floods later in the fall or in spring from snowmelt and showers. Remarkably, the young caddis flies in spring-flooded pools catch up with those in fall-filling depressions and are ready to emerge at the same time, before the pool dries up in summer.


© BRETT AMY THELEN
*Woodfrog egg mass*


© SANDY CRYSTALL
*Tadpoles in a drying pool*


MIKE MARCHAND ©NHFG
*Adult woodfrog*

Many species associated with vernal pool habitat, notably certain salamanders and frogs, require both aquatic and terrestrial "upland" habitat to complete their life cycle. These two habitats must be located to allow these species to move freely between them. Jefferson and spotted salamanders travel an average of 150 m (500 feet) to breeding pools. Although migration distances of almost a mile have been noted, an increase in migration distance increases the risk of predation. The aquatic habitat provided by vernal pools, though temporary, is needed for breeding and development of larvae. On completion of breeding, adults leave the pools to feed and winter in nearby terrestrial habitat, followed by metamorphosed juveniles. Although these species actually spend a majority of their lives in a terrestrial environment, vernal pools provide a critical component of their life cycle.

## CONDITIONS AFFECTING AMPHIBIAN MIGRATION

Amphibian movement to spring breeding pools are strongly correlated with periods of high humidity or rainfall. Local conditions of temperature, precipitation, humidity and soil moisture all offer clues about when spring amphibian movements will take place in your locale.

- Look for amphibian migrations when early spring air temperatures are above 40° F (4°C).
- Arousal from hibernation is triggered by the first warm rain or substantial snow melt.
- Frogs and salamanders will migrate without rain and wet ground if temperatures (above 50° F, 10 °C) and humidity (83 - 87%) are high enough.

Amphibians can most readily be located and observed within 24 hours after rains. Migration and breeding begins earlier in the south and east part of the state and later in the west and northern regions of the state. Early April is typically the time of amphibian movement, though it may occur as early as mid-March. Males often travel to breeding sites first, followed by females a few days later. Open water may not be a prerequisite for the courtship. Spotted salamanders have been seen swimming under a thin film of ice, and wood frogs may be heard calling from pools rimmed with ice.

Conditions that bring a vast number of salamanders together at the same time and place are not present every year. Such assemblages have taken place during prolonged rains, allowing many individuals to reach the breeding ponds at essentially the same time. Consider yourself fortunate if you witness such a spectacle.

MIKE MARCHAND ©NHFG

*A young marbled salamander ventures into the forest surrounding a vernal pool*

Migration of adult salamanders to the breeding ponds normally occurs at night, beginning soon after dark and sometimes continuing until dawn, if suitable conditions are maintained. Salamanders within a short distance of the pool may reach it the first night of travel. Those moving greater distances may take several nights (even under favorable conditions) or as much as two weeks if cold weather interrupts. Favorable periods of migration may occur sporadically, often widely separated by intervals of resumed wintery conditions. If the night temperature falls below freezing, salamander movement is halted.

Most salamanders are nocturnal or at least avoid direct light. During the breeding season, however, usually secretive species may be found out and about during the day. *Jefferson Salamanders* – and likely other salamanders – rest during the day under leaves and other submerged objects in the breeding pool.

## SEASONAL "ARRIVAL" OF INDICATOR SPECIES

*Spotted salamanders*, the most conspicuous of the spring salamanders often are not the earliest to arrive at vernal pools. They are usually preceded by Jefferson/blue-spotted salamanders by 2 to 3 days and sometimes as much as a week. The earliest Jefferson salamanders arrive well in advance of frog activity. *Blue-spotted salamanders* appear about the time wood frogs emerge from hibernation. Males normally migrate 1 to 2 days before the females.

Approximately 50% of the spotted salamanders arrive at pools within the first 5 nights of migration; that 50% of the population will have completed their courtship activities in 7 to 10 days. The courtship of nearly the entire population will have been completed within 2 to 3 weeks. The adults then disperse from the pond and resume their fossorial (underground) lives.

MIKE MARCHAND ©NHFG

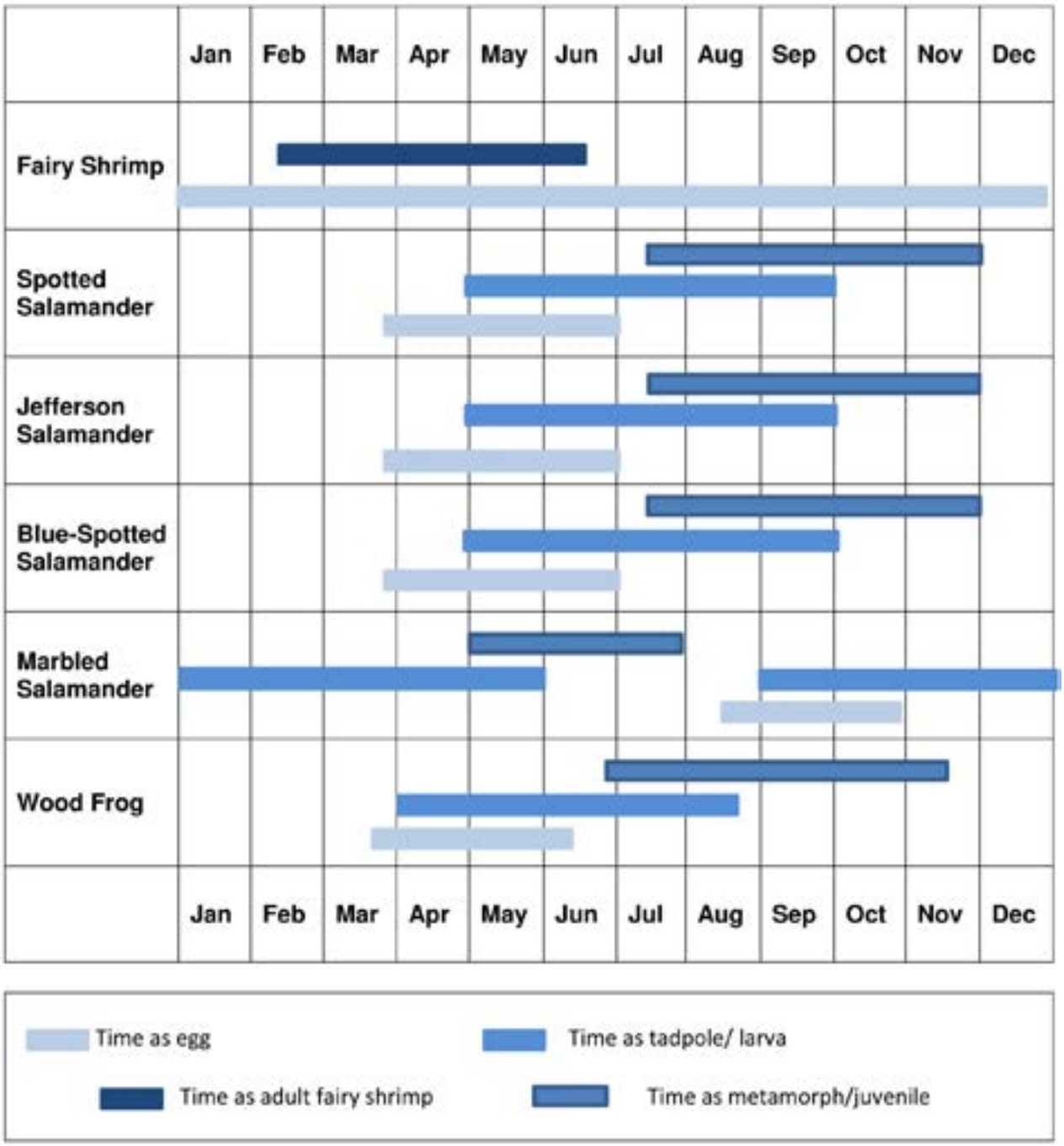
*An adult spotted salamander swimming in a vernal pool.*

Wood frogs emerge from hibernation and begin their annual migration to breeding ponds when melting snow and spring rains saturate the ground. Although spring peepers are more familiar as harbingers of spring, wood frogs actually appear first. Although the onset of the breeding cycle is weather related and variable for wood frogs, its duration is relatively constant. Wood frogs are "explosive" breeders – the entire sequence of arriving, mating, egg laying and returning to the terrestrial habitat is accomplished in a very brief time. This may be as short as a week in some pools. Wood frog calling, mating and egg-laying occur mainly in the early night hours and gradually diminish toward dawn. Calling and breeding activity often occurs during the day in undisturbed locations. Though spring peepers use vernal pools, this vocally conspicuous amphibian breeds in a wide range of wetland types. *The spring peeper is not a vernal pool indicator species, like the wood frog.*

© SANDY CRYSTALL

Fairy shrimp appear soon after spring thaw. Following breeding, the egg sacs are carried by the female. The adults live for only a short time thereafter, usually dying simultaneously with the drying of the pool. At death, the drought-resistant eggs are freed from the parent and remain on the pond bottom. Flooding of the pool the following year stimulates emergence from the egg.

*Figure 3-1.* ***TIMING OF USE BY VERNAL POOL PRIMARY INDICATOR SPECIES.***



# Chapter Four

## VERNAL POOL SPECIES

### INDICATOR SPECIES


MIKE MARCHAND ©NHFG

*Spotted salamander*

**Vernal Pool Indicator Species are those animal species that depend on, and indeed may require, vernal pool habitat for all or a portion of their life cycle.** Though some indicator species may be found in other types of wetlands or in permanent water, the vernal pool habitat provides the greatest chance for successful reproduction. The invertebrates and amphibians considered to be vernal pool indicator species in New Hampshire are listed in Fig. 4-1.

*See page 22-23 for the Key to New Hampshire Vernal Pool Indicator Species (during the breeding period) (Fig. 4-1) or Key to New Hampshire Vernal Pool Indicator Species (dry pools) (Fig. 4-5) on page 26.*

### Primary Vernal Pool Indicators

#### CRUSTACEANS

Fairy shrimp (Order *Anostraca* – the most common species are in Genus *Eubranchipus*)

#### AMPHIBIANS

Spotted salamander (*Ambystoma maculatum*)
Blue-spotted salamander (*Ambystoma laterale*)
Jefferson salamander (*Ambystoma jeffersonianum*)
Marbled salamander (*Ambystoma opacum*)
Wood frog (*Lithobates sylvaticus* – formerly *Rana sylvatica*)

### Secondary Vernal Pool Indicators

**These species that use vernal pools, may be found in habitats with similar conditions – they are not dependent upon vernal pools alone for breeding.** These organisms are capable of successfully reproducing and completing their life cycles in various permanent aquatic habitats. The species considered to be secondary vernal pool indicators in New Hampshire are listed below.

#### CRUSTACEANS

Clam shrimp or shells (Orders: *Spinicaudata and Laevicaudata*)

#### MOLLUSCS

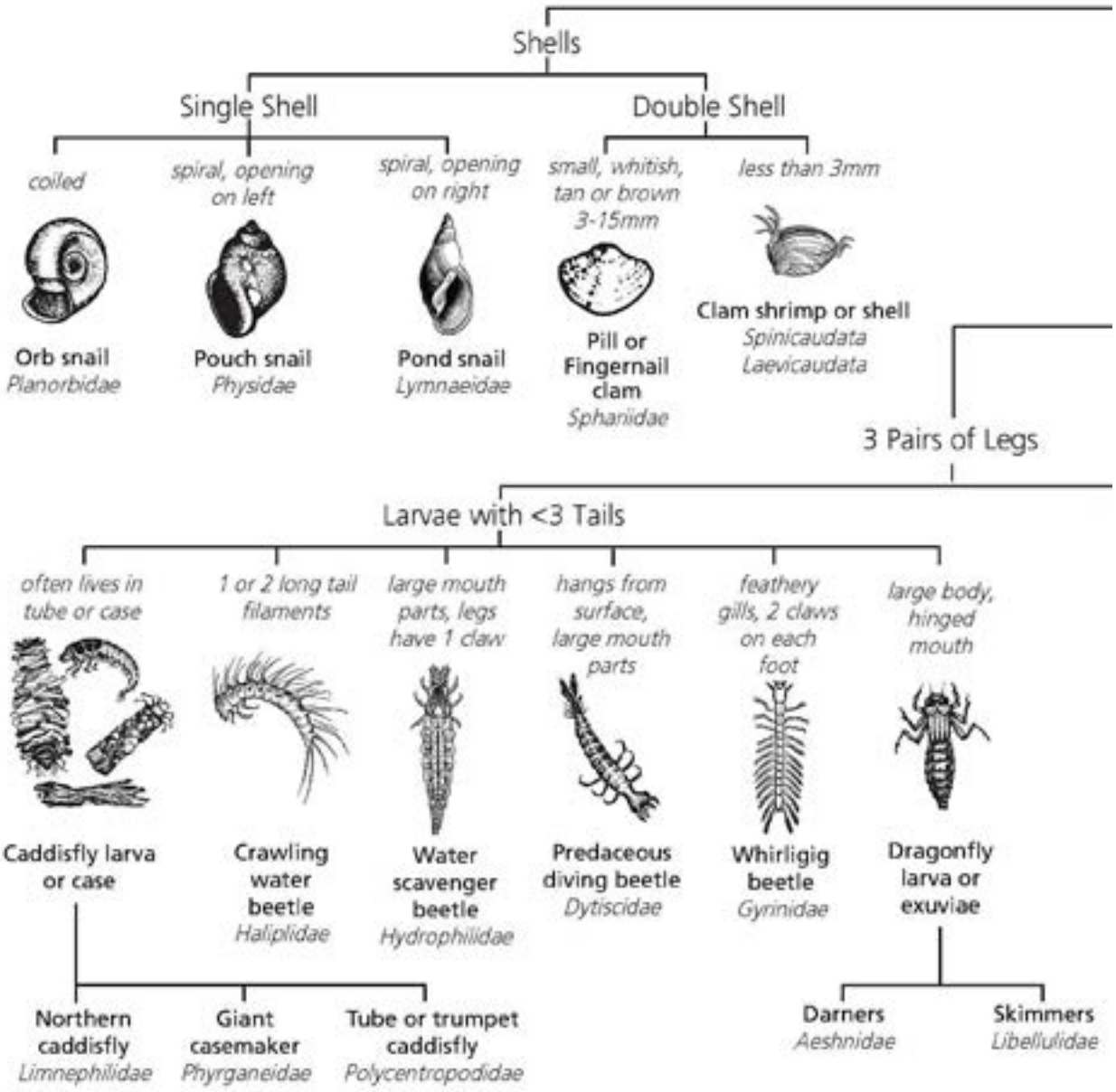
Fingernail clams or shells (Family: *Sphaeriidae*)
Spire-shaped snails or shells (Families: *Physidae and Lymnaeidae*)

*continued on page 24*

*Figure 4-1.* ***KEY TO NEW HAMPSHIRE VERNAL POOL INDICATOR SPECIES (during the breeding period)***

# Key to New Hampshire

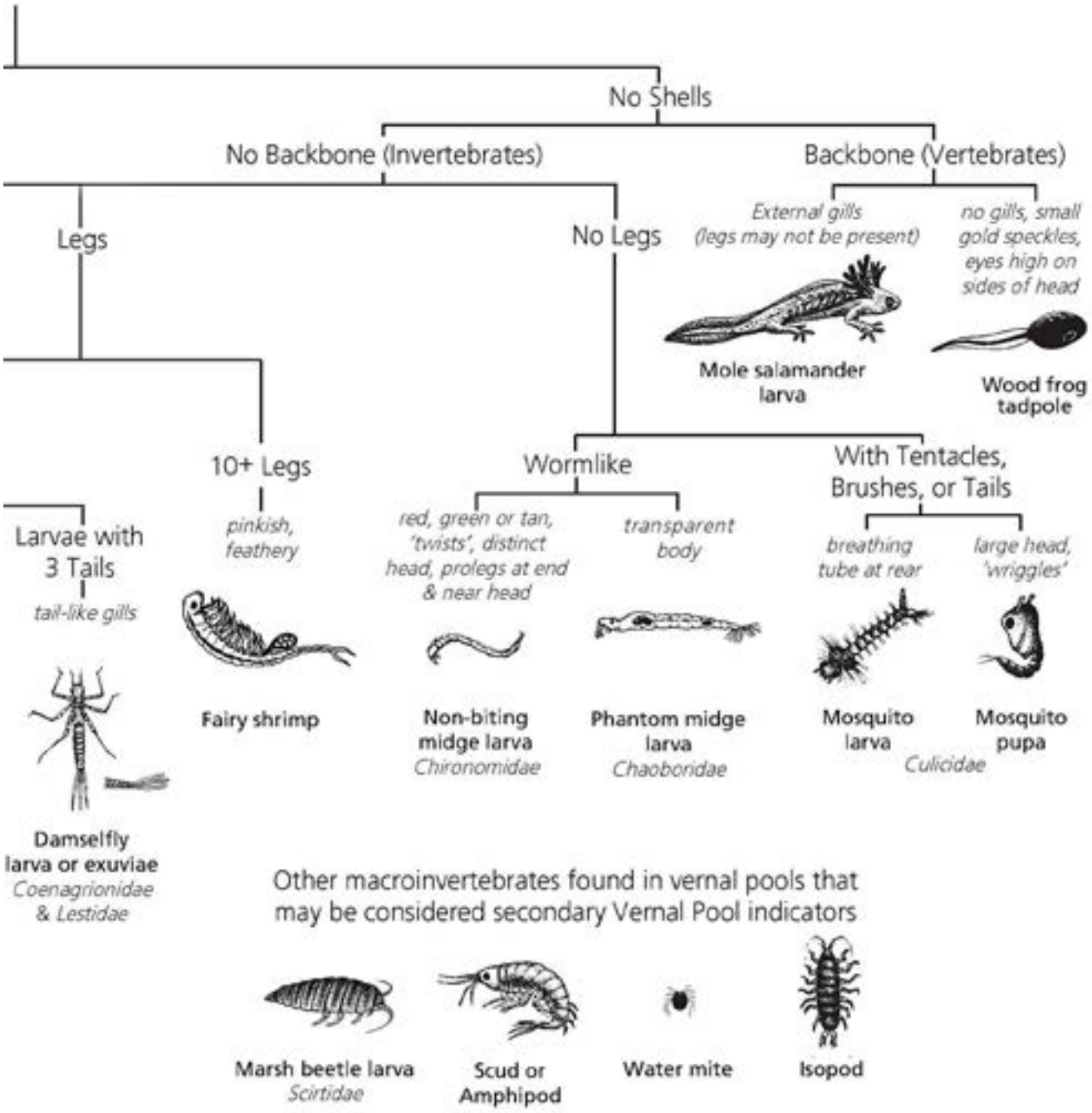
AQUATIC




- Additional field guides or other resosurces may be necessary to confirm or more specifically identify the intertebrates.
- For more information about vernal pools and identification of amphibian egg masses, check the NH DES website at: www.nhdes.nh.gov
- Images are not to scale.

# Vernal Pool Indicator Species

FORMS




*Key based on the work of the University of Wisconsin - Extension and the Riveredge Nature Center, Wisconsin. Whirligig beetle larva and pond snail images courtesy of ClipArtETC - Florida Center for Instructional Technology. All other images courtesy of University of Wisconsin - Extension Environmental Resources Center. May be reproduced with this credit for educational, non-profit purposes.*

2014

Flat-spire snails or shells (Family: *Planorbidae*)

### INSECTS

Aquatic beetle larvae (Families: *Dytiscidae, Gyrinidae, Haliplidae, Hydrophilidae*)
Caddisfly larvae or cases (Families: *Limnephilidae, Phryganeidae, Polycentropodidae*)
Clam shrimp or shells (Orders: *Laevicaudata and Spinicaudata*)
Damselfly larvae or exuviae (Families: *Coenagrionidae and Lestidae*)
Dragonfly larvae or exuviae (Families: *Aeshnidae and Libellulidae*)
True fly larvae or pupae (Families: *Culicidae, Chaoboridae, Chironomidae*)

## OTHER VERNAL POOL VISITORS

**These other species may visit pools and feed on various food sources and/or lay eggs there, but are not considered indicator species.**

*Spring peeper*

### *AMPHIBIANS*

Four-toed salamander (*Hemidactylium scutatum*)
Eastern newt (*Notophthalmus viridescens*)
Spring peeper (*Pseudacris crucifer*)
American toad (*Anaxyrus americanus* –
formerly *Bufo americanus*)
Gray treefrog (*Hyla versicolor*)
Green frog (*Lithobates clamitans* –
formerly *Rana clamitans*)
Fowler's toad (*Anaxyrus fowlerii* –
formerly *Bufo fowlerii*) –
N.H. SPECIAL CONCERN

*Painted turtle*

### *REPTILES*

Painted turtle (*Chrysemys picta*)
Snapping turtle (*Chelydra serpentina*)
Spotted turtle (*Clemmys guttata*) –
N.H. THREATENED
Blanding's turtle (*Emydoidea blandingii*) –
N.H. ENDANGERED
Wood turtle (*Glyptemys insculpta*) –
N.H. SPECIAL CONCERN
Ribbon snake (*Thamnophis sauritus*)
Eastern garter snake (*Thamnophis sirtalis*)
Northern water snake (*Nerodia sipedon*)

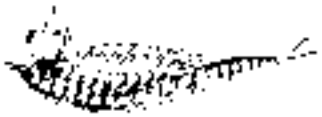
## VERNAL POOL SPECIES PROFILES

Indicator species are completely dependent on vernal pools during the aquatic phase of their life cycles, typically during the egg or larval stages. These pools also may be utilized by other less specialized species. A brief description of each organism, including its current known distribution and status in New Hampshire is included as well. Data on distribution are constantly being collected and updated through the Reptile and Amphibian Reporting Program (RAARP)/ N.H. Wildlife Sightings and other various sources. Check the *N.H. Fish and Game Nongame and Endangered Species Program webpage* for updates.

### CRUSTACEANS

#### FAIRY SHRIMP
**Primary Indicator**


© SANDY CRYSTALL



**Description:** Free-swimming filter feeders. They are omnivorous, eating such things as particles of algae and small crustaceans. To optimize food consumption, fairy shrimp feed while on their backs, rhythmically filtering the water with their legs as they swim. The different species of fairy shrimp vary somewhat in size, color, and shape. Observable characteristics include: appear delicate, transparent, elongated body; no carapace (shell-like covering); swim with their legs up; 11 pairs of leaf-shaped swimming legs; pair of compound eyes on stalks; long tail, sometimes with "neon" spots near the tip; generally brown, orange, or red in color.

**Size:** Range in length from 1.25-2.5 cm (0.5 to 1.0 in). Large compared with many other swimming invertebrates.

**Distribution and Status:** The common fairy shrimp (*Eubranchipus vernalis*) is locally abundant. Though widespread geographically, fairy shrimp are generally restricted to vernal pools on a seasonal basis. Their temperature tolerance is limited to about 4° to 15° C (40° to 60° F). Other factors potentially affecting their distribution include water chemistry, hydrology, and presence of algae in the spring.

**General Habitat:** Inhabit small, often temporary ponds, particularly in cold water. They are among the most characteristic inhabitants of vernal pools, especially in spring and early summer.

**Life History:** Fairy shrimp appear soon after spring thaw. Following breeding, the egg sacs are carried by the female. The adults live for only a short time thereafter, usually dying simultaneously with the drying of the pool. At death, the drought-resistant eggs are freed from the parent and remain on the pond bottom. Flooding of the pool the following year stimulates emergence from the egg.

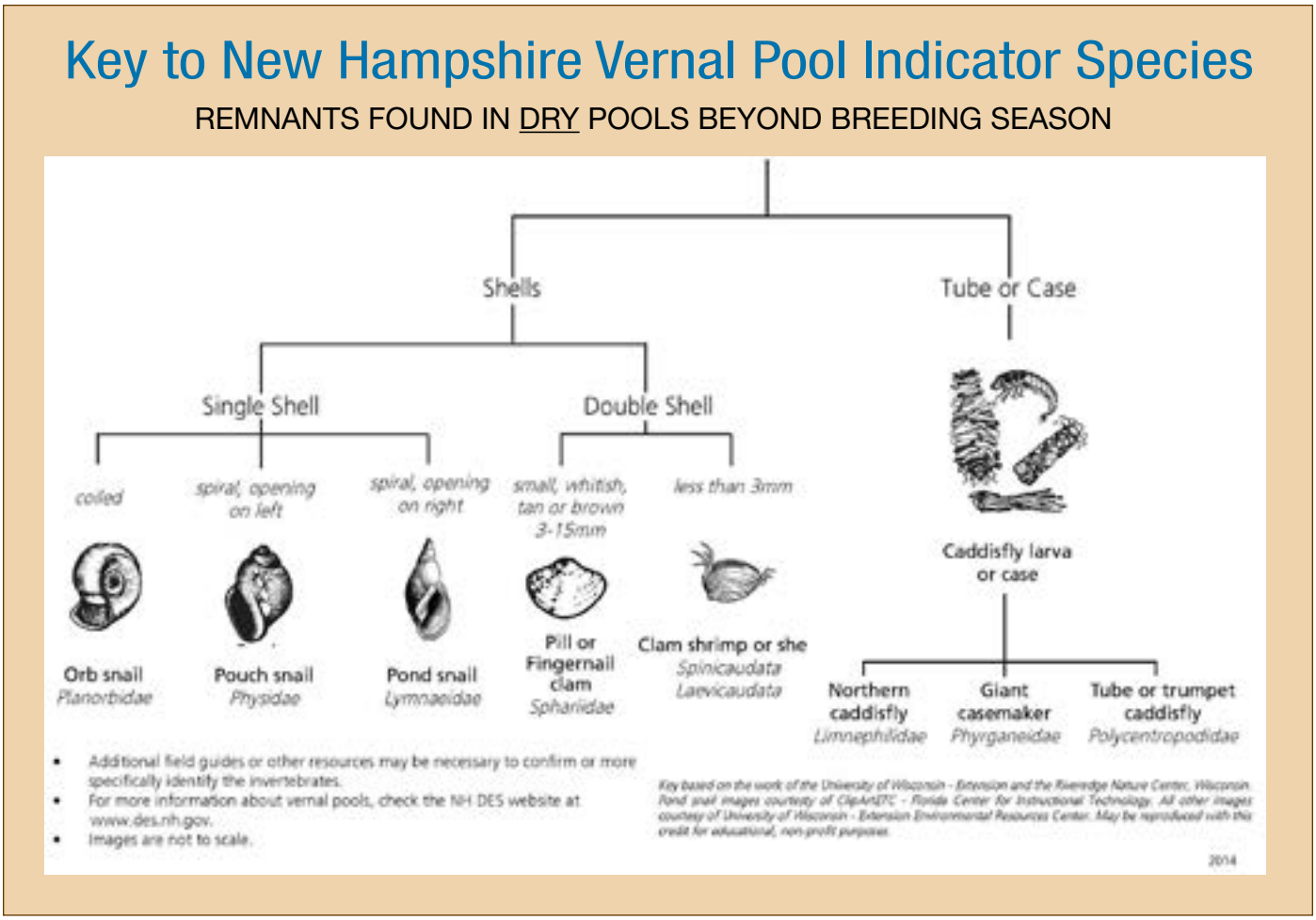
#### CLAM SHRIMP (Orders: *Laevicaudata and Spinicaudata*)
**Secondary Indicator**

**Description:** Bivalve carapace which consists of two articulated parts joined by either a fold (*Limnadia spp.*) or a true hinge (*Lynceus spp.*). The carapace is semi-translucent allowing for a slightly obscured internal view. In the *Limnadia* species of clam shrimp, external rings are visible on the carapace, but are absent in *Lynceus* species.

**Size:** Carapace approximately 10 mm (3/8 in).

**Distribution and Status:** Little is known about the occurrence and distribution of clam shrimp in New Hampshire.

*Figure 4-2.* ***KEY TO NEW HAMPSHIRE VERNAL POOL INDICATOR SPECIES (dry pools)***




**General Habitat:** Limited to ephemeral waters. Certain species (*Limnadia*) are typically found in ephemeral waters that are merely tiny pools in grassy depressions or rock crevices. Other species (*Lynceus*) are more likely found in large pools in upland woodland areas or in river flood plains.

## ISOPODS

**Description:** Isopods can be described as aquatic sow bugs (pill bugs). Often confused with fairy shrimp, but can be distinguished by their distinctive dorso-ventrally compressed (flattened) appearance (narrow when viewed from the side). Their brown to light gray bodies have numerous segments, with both first and last segments being the largest. They are poor swimmers, preferring to use their seven pairs of legs to crawl among the decaying vegetation on the pool bottom.

**Size:** Extremely small, rarely exceeding 15 mm (1/2 in).

**General Habitat:** Found in virtually every type of aquatic habitat.

**Life History:** Isopods feed on such things as dead and dying leaves and other aquatic vegetation. These tiny detritivores are a crucial part of vernal pool

ecology. Not only do they remove dead animal and plant material, but also, by processing large plant material into smaller particles, they increase colonization of algae and fungus thereby providing nutritious food for developing frogs.

### AMPHIPODS

**Description:** Commonly known as scuds or side-swimmers. Often confused with fairy shrimp, but can be distinguished by their distinctive laterally compressed appearance (narrow when viewed from the top).
**Size:** Extremely small, ranging in size 5 to 15 mm (less than 1/4 to 1/2 in).
**General Habitat:** Found in virtually every type of aquatic habitat.
**Life History:** These omnivore-detritivores spend much of their time among the decaying leaves and vegetation on the bottom of vernal pools.

## MOLLUSCS

### FINGERNAIL CLAMS
Secondary Indicator

**Description:** These small bivalve molluscs also are referred to as pea or pill clams. The different species of fingernail clams are difficult to identify.
**Size:** Less than 2.5 cm (1 in) in length.
**Distribution and Status:** Occur in a variety of aquatic habitats, including lakes, ponds, streams, and vernal pools. *Sphaerium occidentale*, is the primary inhabitant of woodland pools. It is found in Massachusetts and likely in New Hampshire.
**Life History:** Bear live young that are miniature versions of the adult. Certain species are highly adapted to living in vernal pools, capable of surviving in essentially dry pool beds for several months without apparent loss of viability.
**Verification:** Empty shells found in dry pool beds can be collected and submitted along with other information on the pool being documented.

### SPIRE-SHAPED OR FLAT SPIRE SNAILS
Secondary Indicator

**Description:** The snail shells come in a variety of shapes that are usually brown in color. They breathe air and are typically seen hanging upside down at the surface of pools with their “lung” opening exposed to the atmosphere. Adults graze on algae as well as decaying plant and animal matter.
**Size:** Range from 0.5 to 5 cm (0.25 to 2 in).
**General Habitat:** Occur in vernal pools, ponds, streams, and floodplains.
**Life History:** The snails emerge from the mud when flooding occurs. Small clusters of jelly-like eggs are laid on vegetation and other materials in the pools. When the pool dries up, the snails burrow into the mud on the pool bottom and emerge when the pool refills.
**Verification:** Empty shells found in dry pool beds can be collected and submitted along with other information on the pool being documented.

## INSECTS

### AQUATIC BEETLE LARVAE (Families: *Dytiscidae, Gyrinidae, Haliplidae, Hydrophilidae*)

**Secondary indicator**

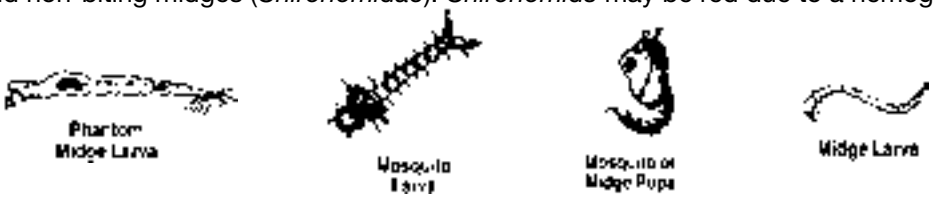
**Description:** *Hydrophilids* generally prefer standing water. Most larvae are predaceous, feeding avidly on invertebrate prey.

**Verification:** Photos of aquatic beetle larvae can help you identify the invertebrates you don't know, as well as document their presence. If you cannot obtain a clear photo that captures the characteristics suitable for identification, it may be useful to collect the invertebrate for preservation in a small container of rubbing alcohol (70%) if ethanol is not available. It can then be identified and considered for documentation.

### TRUE FLY LARVAE OR PUPAE (Families: *Culicidae, Chaoboridae, Chironomidae*)

**Secondary indicator**

**Description:** This group includes mosquitoes (*Culicidae*), phantom midges (*Chaoboridae*), and non-biting midges (*Chironomidae*). *Chironomids* may be red due to a hemoglobin-like




pigment.

**Distribution and Status:** Widespread with diversity distributions and ecology.

**Life History:** Most of these species can undergo long egg diapause during the dry period and hatch a few days after the vernal pool is hydrated.

**Verification:** Photos of larvae and pupae can help you identify the invertebrates, as well as document their presence. If you cannot obtain a clear photo that captures the characteristics suitable for identification, it may be useful to collect the invertebrate for preservation in a small container of rubbing alcohol (70%) if ethanol is not available. It can then be identified and considered for documentation.

### DAMSELFLY LARVAE (*Coenagrionidae* - Pond damselfiles and *Lestidae* - Spreadwings)

**Secondary indicator**

© DIRK ERCKEN_DREAMSTIME.COM

**Description:** Damselfly nymphs have three plate-like gills extending from the end of the abdomen (looking like a tail). They are predatory on insects and other small invertebrates.

**Distribution and Status:** Damselflies of the genus *Lestes* are one of the more commonly associated odonate species with vernal pools.

**Life History:** Spreadwings (*Lestidae*) have rapid growth rates and eggs that require diapause and remain dormant for the winter, thus many species are found in vernal pools. Adult spreadwings insert their eggs into the stems of emergent plants or on the water near aquatic vegetation in the summer. The eggs hatch in response to longer photoperiod, higher water temperatures, and adequate water levels. The larvae quickly mature and are often ready to emerge in as little as 50 to 60 days.

**Verification:** Photos of larvae and samples of exuviae can help you identify the invertebrates, as well as document their presence. If you cannot obtain a clear photo that captures the characteristics suitable for identification, it may be useful to collect the invertebrate for preservation in a small container of rubbing alcohol (70%) if ethanol is not available. It can then be identified and considered for documentation. Exuviae do not require ethanol for preservation.

### DRAGONFLY LARVAE (Families: *Aeshnidae* - Darners and *Libellulidae* - Skimmers)

**Secondary indicator**

VICTOR YOUNG ©NHFG

**Description:** Darner larvae have a streamlined shape and can grow up to more than 4 cm. Skimmer larvae are squat and have notably long spindly legs and cryptic coloration. Camouflage helps them hide in the leaves as they wait for prey. Large eyes provide excellent vision for these predators.

**Distribution and Status:** Found statewide, mostly in pools with a longer hydroperiod or that may be semi-permanently flooded.

**Life History:** Skimmers - For some skimmer, females deposit eggs on the dry surface of pools in the fall. After the eggs hatch, the nymphs grow rapidly and adults emerge in late spring or summer. Darners - Some darners may be found in long-cycle vernal pools that remain flooded into August or September. Migrants populations are adapted to longer cycle pools, and after the eggs are laid on aquatic plants or the pool bottom, and hatch, the nymphs mature. Dragonfly nymphs are predatory on pool animals including amphibian larvae and insects.

**Verification:** Photos of larvae and exuviae can help you identify the invertebrates, as well as document their presence. If you cannot obtain a clear photo that captures the characteristics suitable for identification, it may be useful to collect the exuviae.

### CADDISFLY LARVAE (Families: *Limnephilidae, Phryganeidae, Polycentropodidae*)

**Secondary indicator**

VICTOR YOUNG ©NHFG

**Description:** Larvae look similar to a white caterpillar with three pairs of legs. Their heads range in color from plain brown to a black-striped pattern. The larvae construct tubular cases out of grass, dead leaves, or twigs. These cases look like small sticks or miniature log cabins crawling along the pool bottom.

**Distribution and Status:** Found statewide in lakes, ponds, streams, rivers, and vernal pools.

**Life History:** Adult caddis flies lay their eggs in dry depressions of vernal pools or on overhanging vegetation during the fall months. When the pool is flooded in early spring, the larvae emerge from the egg mass. The larvae graze on algae, vegetation, and decaying plant and animal matter. However, some species are predaceous and consume salamander eggs. In the early stages, larval cases are less than 0.5 cm (0.25 in) long. But as the larvae proceed through their five molts, the cases can reach lengths of 1-4 cm (0.5 -1.5 in). After the fifth molt, the larvae glue their cases to vegetation and pupate. At the end of pupation, the metamorphosed adults leave their cases and fly away. As summer approaches, adult caddis flies settle into tree holes or caves where they then enter a state of inactivity.

**Verification:** Empty cases found in dry pool beds can be collected and submitted along with other information on the pool being documented.

## AMPHIBIANS (Salamanders)

### SPOTTED SALAMANDER
**Primary indicator**


VICTOR YOUNG ©NHFG

**Description:** Black or gray with up to 50 conspicuous yellow spots arranged in an irregular row on each side of its back. Undersides are lighter, typically slate gray in color.
**Size:** The largest of our mole salamanders, reaching lengths exceeding 20 cm (8 in).
**Distribution and Status:** Found throughout the state, but distribution appears sparse due to lack of occurrence information.
**Terrestrial Habitat:** Most abundant in deciduous and mixed forests, but occasionally utilize pools in open fields. The majority of their time is spent below ground, seeking refuge under leaf-litter, coarse woody debris, or in small mammal burrows. Do not appear to persist in highly disturbed, cleared regions. Spotted salamanders probably travel an average of 120 m (400 ft) from breeding areas to uplands, but may travel over 250 m (800 ft).
**Hibernation:** In upland forests, most commonly below ground in small mammal burrows or holes created by tree roots.
**Breeding Pool:** Prefer to breed in temporary to semi-permanent vernal pools free of fish populations, but will utilize such aquatic habitats as beaver flowages and anthropogenic pools. Pools used exclusively by spotted salamanders tend to warmer, less turbid waters located in more open sites than those used exclusively by blue-spotted/Jefferson salamanders.
*http://www.wildlife.state.nh.us/wildlife/profiles/spotted-salamander.html*

### BLUE-SPOTTED SALAMANDER – N.H. SPECIAL CONCERN
**Primary indicator**


© JAMES DEBOER_DREAMSTIME.COM

**Description:** Dark blue or blue-gray in color, with distinct bluish spots and black vents. The head is narrow and tapers to a rounded snout.
**Size:** Ranges in size from 10 to 12.7 cm (4 to 5 in).
**Distribution and Status:** Recorded in southeastern part of the state, with one record in northern New Hampshire. Hybridizes with Jefferson salamander.
**Terrestrial Habitat:** Generally associated with hardwoods with ample canopy cover, deep uncompacted leaf litter, and coarse woody debris. Will also utilize abandoned beaver flowages, anthropogenic (man-made) pools, and ponds in fields. Blue-spotted salamanders tend to be more tolerant of open habitat than Jefferson salamanders.
**Hibernation:** Seek winter cover in mammal burrows.
**Breeding Pool:** Favor pools with overhanging bushes and grass, sphagnum moss along the edges, and leafy bottoms. Water depth seldom reaches greater than 40 cm (15 in).
*http://www.wildlife.state.nh.us/wildlife/profiles/blue-spotted-salamander.html*


MIKE MARCHAND ©NHFG

### JEFFERSON SALAMANDER – N.H. SPECIAL CONCERN
**Primary indicator**

**Description:** Dark brown or gray-brown body flecked with white or pale blue and gray vents. Jefferson salamanders are difficult to distinguish from blue-spotted salamanders and hybrids of the two.
**Size:** Typically 10-18 cm (4-7 in).
**Distribution and Status:** In New Hampshire, the Jefferson salamander is

confirmed only from the Keene-Winchester area. Therefore, it is assumed that salamanders with blue spots are most likely to be either blue-spotted salamanders or hybrids of the two. Jefferson salamanders are listed as a Species of Special Concern in New Hampshire.
**Terrestrial Habitat:** Inhabitant of deciduous woods, favoring pools in comparatively undisturbed, well-drained upland woods. When not breeding, spend most of their time underground. May move up to 625 m (2,050 ft) from breeding areas, but travels of 130 m (450 ft) are probably more common.
**Breeding Pool:** Breeds in late March or April in pools.
**Special Note:** The Jefferson/blue-spotted salamander complex is a group that includes the Jefferson salamander, the blue-spotted salamander, and some very unusual hybrids. Distinguishing between hybrids and pure species usually requires special laboratory techniques. Due to this difficulty, it is recommended that you identify salamanders with blue spots as belonging to the Jefferson/blue-spotted salamander complex.
*http://www.wildlife.state.nh.us/wildlife/profiles/jefferson-salamander.html*

## MARBLED SALAMANDER – N.H. ENDANGERED

**Primary indicator**


© LLOYD GAMBLE/U MASS

**Description:** Relatively chunky salamander with dark body and silver or white crossbands along the back. Markings are gray in females and white in males.
**Size:** 9 to 12 cm (3.5 to 5 in).
**Distribution and Status:** Marbled salamanders are restricted to southern New Hampshire. Documented towns include Hinsdale, Brookline, Hollis, and Milford.
**Terrestrial Habitat:** Utilize a variety of habitats ranging from floodplain forests to mixed deciduous woodlands with well-drained sandy soils. In the summer can be found under rocks and logs. May move up to 200 m (650 ft) from breeding areas.
**Hibernation:** Deep burrows.
**Breeding Pool:** Marbled salamanders are unusual in that they lay their eggs during the fall, in a hollow of a dried-up spring pond under a log or leaves. The female will remain with the eggs until rains fill the pool and the larvae hatch.
*http://www.wildlife.state.nh.us/wildlife/profiles/marbled-salamander.html*

## FOUR-TOED SALAMANDER


© JEFF BEANE

**Description:** Brown or chestnut back and is easily identified by three distinguishing features: 1) four toes on their hind feet; most salamanders have five; 2) the tail has a distinct constriction at the base; and 3) the belly is bright white speckled with black spots.
**Size:** Males reach 5 to 7 cm (2 to 3 in) in total length, females slightly larger.
**Distribution and Status:** Likely to be found throughout the state south of the White Mountains where appropriate habitat is found. May be underreported due to its secretive habits.
**Terrestrial Habitat:** Adults are terrestrial, residing in undisturbed or mature deciduous forests adjacent to peatlands or moss-dominated depressions.
**Hibernation:** In decaying roots of trees.
**Breeding Pool:** Utilizes small ponds and slow-moving streams where abundant *Sphagnum*

or other mosses are present. Pools with islets of moss and associated logs are most often used as nesting sites. Their nests are situated so larvae will fall directly into the water upon hatching.

**Special Note:** The conspicuous constriction at the base of the tail marks a specialization that allows the tail to easily detach when snared by a predator. The tail will continue to twitch for several minutes after breaking off.

*http://www.wildlife.state.nh.us/wildlife/profiles/four-toed-salamander.html*

### EASTERN NEWT

VICTOR YOUNG ©NHFG

**Description:** Aquatic adults have red spots encircled with black on a greenish or olive back and have a yellow belly. The immature terrestrial stage is known as the "red eft" commonly seen on the forest floor.

**Size:** 7 to 10 cm (3 to 4 in)

**Distribution and Status:** Most common salamander found in lakes, streams, ponds, and marshes throughout the state.

**Terrestrial Habitat:** Associated with ponds in woodlands, field, orchards and mountains. Occasionally found in gravel pits, quiet areas of streams and shallow areas of lakes.

**Hibernation:** Adults may overwinter on land or in permanent ponds.

**Breeding Pool:** Utilizes permanent water including lakes, ponds, marshes, and slow-moving streams as well as vernal pools. Aquatic adults can be a serious predator on eggs and larvae of many salamanders and other amphibians. Typically associated with deeper pools in open areas.

**Special Note:** Larval, eft, and adult stages of eastern newts produce noxious skin secretions which help deter most predators.

*http://www.wildlife.state.nh.us/wildlife/profiles/red-spotted-newt.html*

## AMPHIBIANS (Frogs)

### WOOD FROG

**Primary indicator**

VICTOR YOUNG ©NHFG

**Description:** Light tan to dark brown body. It has a conspicuous dark "mask" extending from each eye back to the tympanum. A dark line of the same color typically runs from the front of each eye to the snout.

**Size:** Medium sized, ranging from 3.7 to 7 cm (1.5 to 3 in). Females are larger than males.

**Distribution and Status:** Widespread throughout the state.

**Terrestrial Habitat:** During the non-breeding season, Wood frogs inhabit deciduous or softwood forests, wooded wetlands, bogs, and along vegetated pond and lakeshores. Terrestrial habitats utilized may be a considerable distance from breeding pools, more than 1000 m (3,280 ft) in some instances.

**Hibernation:** Under leaf litter or shallow burrows near the surface of the ground.

**Breeding Pool:** Pools usually in or near wooded areas are used as breeding sites. Breeding may also take place in grassy ditches, cattail marshes, old gravel pits, or hollows in alder thickets flooded by spring rains.

**Special Note:** The call of the wood frog sounds remarkably like many ducks quacking.

*http://www.wildlife.state.nh.us/wildlife/profiles/wood-frog.html*

## SPRING PEEPER


© BRIAN LASENBY_DREAMSTIME.COM

**Description:** Color-variable from dark to light brown. A darker "**X**" usually appears on its back. Toes have round disks on their tips.
**Size:** Smallest of New Hampshire's tree frogs, reaching 1 to 3 cm (0.75 to 1.25 in).
**Distribution and Status:** Widespread throughout the state.
**Terrestrial Habitat:** Found in deciduous, coniferous, and mixed woodlands, with some preference for brushy, second-growth areas.
**Hibernation:** On land under moss and leaves during late November until January or early spring.
**Breeding Pool:** Utilize a variety of ponds, pools, marshes and swamps as breeding sites.
**Special Note:** The peep of the spring peeper is one of the loudest known animal sounds. It is equivalent to the roar of a motorcycle 25 feet away.
*http://www.wildlife.state.nh.us/wildlife/profiles/peeper-frog.html*

## AMERICAN TOAD


© STEVEN RUSSEL SMITH PHOTOS_DREAMSTIME.COM

**Description:** Dry, warty skin in varying shades of browns, grays, and greens. Dark, irregular patches of black mark their backs with one or two warts occurring within these patches. Chest and bellies are mottled black.
**Size:** Lengths of 6 to 11 cm (2 to 5 in).
**Distribution and Status:** Widespread throughout the state.
**Terrestrial Habitat:** Occur in a variety of forested and open habitats, uplands, and wetlands.
**Hibernation:** In burrows underground 30 cm (12 in) deep.
**Breeding Pool:** Open shallow waters including vernal pools, ditches, old beaver flowages, constructed ponds with sparse vegetation, and coves of large lakes.
**Special Note:** The large parotoid gland behind the eye produces noxious toxins that help deter any potential predators.
*http://www.wildlife.state.nh.us/wildlife/profiles/american-toad.html*

## FOWLER'S TOAD – N.H. SPECIAL CONCERN


©NHFG/ MICHAEL MARCHAND

**Description:** Body is usually brown or gray. The back and sides spotted, typically with 3 or more warts in each of the darkest large spots. The chest and belly are mostly unspotted.
**Size:** Medium to large sized, adults ranging from 5-7.6 cm (2-3 in).
**Distribution and Status:** Rare species of conservation concern. Found in uplands and wetlands associated with the Merrimack and Connecticut Rivers.
**Terrestrial Habitat:** Found in sandy areas such as river valleys, floodplains, lakeshores, and agricultural areas. Also may be found in pine forests, fields, and lawns.
**Hibernation:** In deep sandy soils.
**Breeding Pool:** Breeding sites are usually near semi-permanent pools with aquatic vegetation.
**Special Note:** The call of the Fowler's toad is a nasal, bleating w-a-a-a-a-h, similar to the sound of a sheep, lasting 1-4 seconds.
*http://www.wildlife.state.nh.us/wildlife/profiles/fowlers-toad.html*

### GRAY TREE FROG

VICTOR YOUNG ©NHFG

**Description:** Skin glandular, almost warty. Color is extremely variable, ranging from off white to green, gray, or brown. Bright patches of orange or yellow are hidden on the underside of the hind legs. Recently metamorphosed juveniles are an emerald green. Tips of their toes are modified into suction disks for climbing.
**Size:** 3 to 5 cm (1.5 to 2 in).
**Distribution and Status:** Found throughout the state except in the far north.
**Terrestrial Habitat:** Appear in forested areas near shallow water.
**Hibernation:** Under tree roots or leaves.
**Breeding Pool:** Vernal pools, permanent water, and swamps are used as breeding sites.
**Special Note:** Gray tree frogs have the ability to change color from light gray to pale green.
*http://www.wildlife.state.nh.us/wildlife/profiles/tree-frog.html*

### GREEN FROG

© MIRCEA COSTINA_DREAMSTIME.COM

**Description:** Range in color from green to brown and may have dark spots or mottling. A feature that distinguishes it from the bullfrog is a pair of prominent dorso-lateral ridges extending from the tympanum along the back, which bullfrogs lack.
**Size:** 5.5 to 12.5 cm (2.5 to 4 in) in length.
**Distribution and Status:** Common throughout New England.
**Terrestrial Habitat:** Adults live either in or adjacent to waterbodies. They are associated with moist woodlands and a variety of wetlands from shores of ponds, streams, and lakes.
**Hibernation:** Underground or under the water from October through March.
**Breeding Pool:** Shallow waters of ponds and lakes as well as permanent streamside pools are the preferred nesting sites. Although vernal pools are not used as breeding sites, they are often frequented throughout the season.
*http://www.wildlife.state.nh.us/wildlife/profiles/green-frog.html*

## REPTILES (Turtles)

### SPOTTED TURTLE – N.H. THREATENED

© GAIL COFFEY

**Description:** Primarily aquatic, but are often seen basking on floating matter or on shore. They have smooth dark shells with yellow spots. Number and arrangement of spots varies considerably among turtles and may be lacking all together.
**Size:** Small turtles that range in length from 8.75 to 11.25 cm (3.5 to 5 in).
**Distribution and Status:** Seems to be largely limited to southeastern New Hampshire. Spotted turtles are listed as threatened in New Hampshire.
**General Habitat:** Inhabit small shallow wetlands surrounded by dense vegetation. These wetlands may include slow streams, ponds, vernal pools, bog ponds, and wet meadows. Shrub swamps and tussock marshes associated with red maple swamps appear to be preferred habitat.
**Hibernation:** Under tree root balls in vernal pools, forested wetlands, scrub-shrub wetlands, or emergent wetlands.

**Special Note:** Vernal pools are important to spotted turtles and in some areas this species may be dependent on them. Pools serve as centers in which adults congregate, feed and breed. They may be of especially important to gravid (pregnant) females, providing a source of refuge and concentrated food.
*http://www.wildlife.state.nh.us/wildlife/profiles/spotted-turtle.html*

## BLANDING'S TURTLE – N.H. ENDANGERED


© DENNIS DONAHUE_DREAMSTIME.COM

**Description:** Distinct bright yellow chin and throat. Their dark, high-domed shells are flecked with small yellow markings.
**Size:** Length 17.5 to 22.5 cm (7 to 9 in).
**Distribution and Status:** Documented in most towns in southeastern New Hampshire; Blanding's turtles are listed as endangered in New Hampshire.
**General Habitat:** Semi-aquatic, utilizing intermittent woodland pools and acidic bogs. They appear to favor black (dark) waters found in close proximity (within several hundred meters) to buttonbush pools. Often makes extensive travels among wetland and upland habitats, up to several kilometers.
**Vernal Pool Usage:** If a vernal pool occurs within the activity range of a Blanding's turtle, it may be heavily used, even as a hibernation site. Vernal pools appear especially important to sub-adults who prefer their characteristically shallower, more vegetated waters. Males and females can be found in vernal pools together during courtship and mating seasons, generally April, May, and early June. Mating has been documented in emergent marshes within scrub-shrub and forested wetlands. Gravid females also may use vernal pools as 'stepping-stones' to reach distant nesting grounds.
*http://www.wildlife.state.nh.us/wildlife/profiles/blandings-turtle.html*

## WOOD TURTLE – N.H. SPECIAL CONCERN


MIKE MARCHAND ©NHFG

**Description:** Brown upper shells (carapaces) which appear sculptured or rough. Plastrons are yellow with black blotches and the skin on neck and foreleg is a reddish orange.
**Size:** Length 13 to 23 cm (5 to 9 in).
**Distribution and Status:** Found throughout the state, but not common in any one location. Wood turtles are listed as species of Special Concern in New Hampshire.
**General Habitat:** Associated with sandy-bottomed streams and rivers, dense thickets in riparian areas, and adjacent meadows.
**Hibernation:** Occurs at the bottoms of streams or rivers.
**Vernal Pool Usage:** Vernal pools are used during the spring and summer months for feeding.
*http://www.wildlife.state.nh.us/wildlife/profiles/wood-turtle.html*

### PAINTED TURTLE


© DAVERIG_STOCKFREEIMAGES.COM

**Description:** Distinguished by a smooth black or olive carapace, a colorful red margin where the carapace and plastron meet, and a red and yellow striped head and neck. The plastron has no markings and is pale yellow or orange.
**Size:** Generally 11 to 15 cm (4 to 6 in) in length.
**Distribution and Status:** Common throughout the state, especially south of the White Mountains.
**General Habitat:** Utilize shallow, muddy-bottomed ponds, marshes, woodland pools, river, lakeshores, wet meadows, bogs, slow-moving streams, and vernal pools. Often bask on hummocks, logs or rocks.
**Hibernation:** Burrows into mud or decayed vegetation of pond bottoms.
*http://www.wildlife.state.nh.us/wildlife/profiles/painted-turtle.html*

### SNAPPING TURTLE


© DAVE WILLMAN_DREAMSTIME.COM

**Description:** Shell is deeply serrated and ranges from light gray to black in color, but may appear green due to a dense growth of algae. Their heads are large with a strongly hooked beak. Their tails are long and strongly saw-toothed.
**Size:** New Hampshire's largest freshwater turtle, reaching lengths of up to 20 inches, but typically 20 to 30 cm (8 to 12 in).
**Distribution and Status:** Common throughout the state, especially south of the White Mountains.
**General Habitat:** Adults are almost wholly aquatic, commonly found in lakes, swamps, marshes, and vernal pools. Often bury themselves in leaves or mud bottoms, waiting for prey.
**Hibernation:** In mud or debris in lake bottoms, banks, and muskrat holes.
*http://www.wildlife.state.nh.us/wildlife/profiles/snapping-turtle.html*

## REPTILES (Snakes)

### RIBBON SNAKE


VICTOR YOUNG ©NHFG

**Description:** A very slender snake measuring 16-35 inches. Has 3 yellow or greenish stripes running down the surface on scale rows 3 and 4. The tail (starting at the cloaca and ending at the tip) is long and thin and measures 1/3 the length of the body. Commonly confused with garter snakes.
**Distribution and Status:** Throughout New Hampshire, except far north. Listed as a species in greatest conservation need in N.H. Wildlife Action Plan (2015).
**General Habitat:** Found in and near aquatic habitats such as ponds, swamps, bogs, and stream edges. May be found in wet woodlands, but seldom stray far from water. Uses brushy areas on the edges of water for concealment.
**Hibernation:** Underground on higher ground.
*http://www.wildlife.state.nh.us/wildlife/profiles/ribbon-snake.html*

### GARTER SNAKE

© TEEKAYGEE_DREAMSTIME.COM

**Description:** A small striped snake measuring 18-26 inches. Has variable color patterns, but typically has 2-3 yellow, brownish, or greenish stripes running vertically down the top and sides of the snake. May also have variable black spots between the stripes.
**Distribution and Status:** Common throughout N.H.
**General Habitat:** Found in a variety of habitats including woodlands, hillsides, wetlands, backyards, and even urban areas. Will use a variety of cover objects for shelter including rocks, logs, stumps and other debris such as trash piles and sheet metal.
**Hibernation:** May be solitary or communal in rock crevices, holes, stumps, or foundations.
*http://www.wildlife.state.nh.us/wildlife/profiles/garter-snake.html*

### NORTHERN WATER SNAKE

MIKE MARCHAND ©NHFG

**Description:** A dark, heavily blotched snake measuring 24-42 inches. Has a brown or grayish base color with numerous brown or black blotches or bands. The belly has black or red half-moon shapes that vary in pattern and arrangement.
**Distribution and Status:** Throughout New Hampshire, except far north.
**General Habitat:** Found in aquatic and semi-aquatic habitats such as streams, ponds, swamps, and marshes. Often uses logs or branches overhanging the water for basking. Rarely found far from water.
**Hibernation:** Underwater or in holes near water
*http://www.wildlife.state.nh.us/wildlife/profiles/water-snake.html*

## STATE PROTECTED SPECIES

**All native reptiles and amphibians have some protection under state law, including eggs and larvae.** State law prohibits any taking, possession and importation of Blanding's, spotted, Eastern box, and wood turtle (RSA 212-A, FIS 800, 1400). Marbled salamanders are listed as State Endangered in New Hampshire and therefore protected from export, sale, possession, and take (N.H.FG Rules – FIS 1000). Possession is also prohibited for blue-spotted salamanders and Jefferson salamanders. If these species are observed, a photograph should be submitted with the vernal pool documentation forms. However, you should not attempt to capture these species.

Limited possession is allowed for species not listed above such as spotted salamander and wood frog. However, we recommend possession only as necessary for photo documenting the species and/or assisting animals across roadways.

NHFG Chapter 800 Rules (Possession)
*http://www.gencourt.state.nh.us/rules/state_agencies/fis800.html*

NHFG Chapter 1400 Rules (Nongame Rules)
*http://www.gencourt.state.nh.us/rules/state_agencies/fis1300-1400.html*

© SANDY CRYSTALL

*Wood frog egg masses are visible in this early spring vernal pool.*

# Chapter Five

## EGGS AND LARVAE OF AMPHIBIAN VERNAL POOL SPECIES

### AMPHIBIAN EGGS

*Salamander eggs*

*Wood frog eggs*

Egg masses of salamanders and wood frogs can be readily distinguished from one another, differing in form and size. Salamander eggs are surrounded by a common gelatinous envelope, with individual eggs visible inside the envelope. Wood frog eggs lack a surrounding gelatinous capsule; they have an unconsolidated shapeless form.

Egg masses of salamanders and wood frogs are laid in the water and are often associated with shrubs, or submerged sticks or logs in a pool. Eggs may be attached to a vertical or horizontal support or hung from the drooping leaves of grasses, sedges or cattails.

When looking for egg masses in early spring, remember they should be far enough into the pool to remain covered by water for a couple of months; they will not usually be found at the very edge of the pool. Generally, salamander egg masses will be within 10 feet of shore and less than two feet below the water surface. The color of the jelly matrix of salamander eggs varies from clear to milky white, or green from symbiotic algae. Each of these color variations is normal. The egg mass has a consistency similar to gelatin.

You may find: clear egg masses, where the dark embryos are clearly visible through the jelly matrix; intermediate or grey egg masses where embryos are faintly discernible in a cloudy or grey jelly matrix; or white egg masses where the outer egg jelly is so opaque that embryos are barely discernible, at least during the early stages of development. This polymorphism is caused by the presence or absence of white crystal in the outer jelly layer. (White embryos are not viable).

As the eggs develop the mass may become greenish. In both salamander and wood frog eggs an algae (*Oophilia ambystomatis*) is found within the inner jelly capsules of egg masses. During development, the embryos are supplied with oxygen by the alga. The alga draws nourishment from the embryo and gives the egg mass a pale greenish color. The

approximate time since laying can be judged by the superficial appearance of the egg mass – small masses, where little swelling has occurred and where the embryos are close together, are younger.

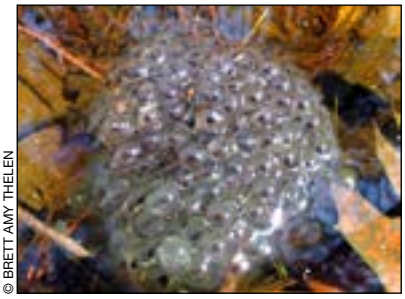
Water temperature is a prime factor in determining hatching period of amphibian eggs. One to two months is typical in the northeast when temperatures are 50° F (10° C) or above.

Salamander eggs hatch a few at a time, as the outer ones develop more rapidly, probably because they receive more light. After escaping the individual egg jellies, the hatchling larvae swim for a few hours within the outer jelly of the mass. In frog egg masses, eggs in the center of the mass tend to hatch first. Frog eggs are darker than salamander eggs, so the mass absorbs heat better, with the eggs in the middle of the mass being the warmest.

Egg masses may be subjected to intense predation by larval caddis flies. At night, predators such as adult eastern newts may be found on salamander egg masses, walking on the surface of the mass and snapping at the eggs. Salamander eggs tolerate a pH range of 6 to 10 with best hatching success at pH 7 to 9. High embryo mortality has been noted in temporary pools with pH below 6.

## WOOD FROG EGGS

- Breed in cold water, have compact submerged egg masses which provide protection from cold, desiccation and freezing.


© BRETT AMY THELEN

- The clear jelly capsules surrounding the eggs expand by water absorption and the globular clutch soon attains several times its initial size. An average individual clutch measures 6 to 10 cm (2.5 to 4 in) in diameter and contains about 1,750 eggs.
- Individual egg masses are tennis-ball sized and shaped. They are attached to twigs that are just below the surface of the pond.
- Isolated individual clutches are occasionally seen, but most are deposited in large communal masses, which are often confined to a single area of the pool and may consist of more than 100 clutches. Communal deposits look like a lumpy sheet.

## DIFFERENCES IN MOLE SALAMANDER EGGS

- Spotted, Jefferson and blue-spotted salamanders are known as mole salamanders.
- It may be difficult to distinguish Jefferson and blue-spotted salamander eggs.
- Eggs of the spotted salamander are more closely aggregated than those of the Jefferson salamander and the average number to the mass much larger.
- The outermost jelly covering spotted salamander eggs is much thicker and denser than that of the Jefferson salamander, and the outer surface is smoother, as it does not follow the contour of the individual eggs.
- Because blue-spotted and Jefferson salamanders frequently hybridize and are impossible to identify without a genetic assessment, they will be treated as a Blue-spotted/Jefferson salamander complex for reporting using this manual.

## SPOTTED SALAMANDER EGGS

- The egg mass is attached to sticks, weeds, grass, stems or reeds in quiet or slowly running water. Usually within 20 to 25 cm (8 to 10 in) of the surface, occasionally much deeper.

MIKE MARCHAND ©NHFG

- Each mass may contain 250 eggs, but 100 to 150 is typical. Immediately after deposition, the mass is 6 to 7.5 cm (2.5 to 3 in) in diameter, but it quickly absorbs water and expands to over 10 cm (4 in).
- Total complement may be deposited in several small masses or limited to one to two large ones.
- Individual eggs are 2.5 to 3 mm (1/10 in) in diameter, with the upper pole dark brown or grey and lower pole dirty white or dull yellow.
- Consistency of the outer jelly sheath is firm.
- Incubation period is 4-8 weeks, depending on the water temperature.

## JEFFERSON SALAMANDER EGGS

- One to 2 days after mating, females deposit eggs at night (during the day if conditions are cloudy and rainy) on submerged branches, aquatic plants or tree limbs dipping into the water.

© RUSS COBB

- Eggs are deposited in small masses (average number of 16, vary from 1 to 60) in an amber or clear matrix.
- Egg mass is an elongated sausage-shaped mass that is attached to underwater twigs, fern fronds, grasses, sedges or submerged leaves.
- Egg masses are generally concentrated toward the outer perimeter in sunny location of pool.
- Consistency of the egg mass jelly is less firm than the spotted salamander mass.
- Eggs hatch in 3-5 weeks.

## BLUE-SPOTTED SALAMANDER EGGS (see Jefferson salamander eggs above)

- Number of eggs per mass highly variable, normal range 6 to 30. Attached to stems and twigs or to leaves on pool bottoms. Consistency of matrix looser than gelatin.
- Eggs are only slightly adhesive, they fall to the bottom singly or cling lightly to vegetation in loose groups of 2 to 8. The large, clear, jelly capsule makes them virtually invisible in the water.
- Females lay eggs in a series of gelatinous masses at the bottom of the pond.

## MARBLED SALAMANDER EGGS

- Lay 50-200 eggs in dry pool during fall. Eggs are guarded by female until water inundates eggs and larvae hatch.

*Table 5-1.* ***CHARACTERISTICS OF EGGS OF AMPHIBIANS USING VERNAL POOLS***

| INDICATOR SPECIES | | | |
|---|---|---|---|
| | **WOOD FROG** | **SPOTTED SALAMANDER** | **BLUE-SPOTTED/ JEFFERSON SALAMANDER COMPLEX** |
| **Size of mass** | 6-10 cm (2.5-4 in) often deposited communally | variable in size, to 10 cm (1 in to over 4 in) | variable size |
| **Number of eggs per mass** | approx. 1,000 eggs per mass | 50-125, average 125 | highly variable, 6-30 (blue spot.)/1-60, average 16 (Jeff.) |
| **Shape of mass** | individual mass, ball shaped communal deposits like a lumpy sheet | globular to oval | small, loose, scattered groups. May be cylindrical or sausage-shaped |
| **Color of mass** | clear, becoming green | clear, milky or green | clear or clouded with sediment film |
| **Attachment** | twigs and stems | usually sticks and stems, also sedges | submerged branches, stems and leaves |
| **Depth** | just below the surface | 20-25 cm (8-10 in) or more below surface | 20-25 cm (8-10 in) below surface to on or near bottom |
| **Incubation period** | about 3 weeks | 4-8 weeks | 3-5 weeks |

| OTHER SPECIES | | | | | |
|---|---|---|---|---|---|
| | **EASTERN NEWT** | **FOUR-TOED SALAMANDER** | **SPRING PEEPER** | **GREY TREEFROG** | **AMERICAN TOAD** |
| **Size of mass** | single eggs deposited | variable | single eggs deposited | up to 10x12 cm (4 in x 5 in) | up to 1 m (3 ft) long |
| **Number of eggs per mass** | 80-450 per female | 22-64, average 50. may nest communally | 900 per female | 10-40 | thousands |
| **Shape of mass** | n/a | irregular | n/a | flattish mass or surface film | long parallel spiraling strings |
| **Color of mass** | n/a | -- | n/a | -- | transparent, later cloudy as silt and algae adhere |
| **Attachment** | aquatic vegetation | in cavities on underside of logs or within clumps of moss or grass | submerged vegetation | loosely attached to vegetation at surface | sometimes threaded through vegetation |
| **Depth** | -- | directly over a pool | -- | at or near surface | on open bottom |
| **Incubation period** | about 4 weeks | 6-8 weeks | about 6 days | 3-5 days | 3-12 days |

### FOUR-TOED SALAMANDER EGGS (not an indicator species)

- This salamander does not lay its eggs in the water. Egg clusters are deposited directly over a pool, in cavities on the underside of logs or within clumps of grass, *Sphagnum* or other mosses.
- Size of egg mass is variable, averaging 50 eggs.

**Characteristics of Eggs of Amphibians Using Vernal Pools** *(Table 5-1)* provides additional information about eggs of indicator species and other amphibians which may be encountered in vernal pools.

## LARVAL AMPHIBIANS

Larval amphibians inhabiting vernal pools are in a race against time – a race against drying of the pool. In dry years, many larvae may not grow fast enough to metamorphose before the pool dries. In drought years no larvae may survive. To overcome this, vernal pool amphibians have an early breeding season, prolonged embryo development and rapid larval growth

*Figure 5-1.* **CHARACTERISTICS OF FROG AND SALAMANDER LARVAE**

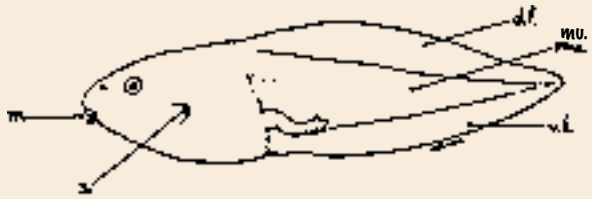



Fig. 5-1a. Frog tadpole; ***m.***–mouth; ***s.***–spiracle; ***d.f.***–dorsal fin; ***v.f.***– ventral fin; ***mu.***–muscular part of tail.

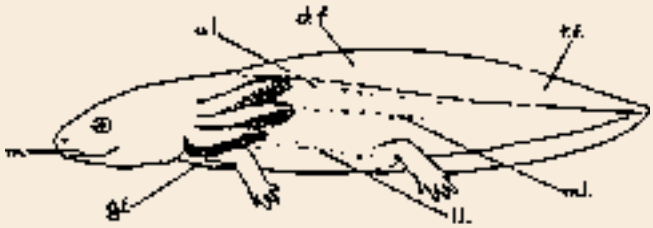



Fig. 5-1b. Salamander larva; ***m.***–mouth; ***g.f.***–gill filaments; ***t.f.***–*tail fin;* ***d.f.***–dorsal fin; ***u.l.***–upper row of lateral line organs; ***m.l.***–middle row of lateral line organs; ***l.l.***–lower row of lateral line organs.

Used by permission: Biological Survey of the Connecticut Watershed. 1939. Survey Report #4. N.H. Fish and Game Dept.

## FROG LARVAE

Frog larvae are commonly known as tadpoles or polliwogs. When first hatched, tadpoles hang from their eggs or nearby vegetation by an adhesive disk appendage on their head. Within a few days the gills cover over and the head and body swell. A tadpole uses its tail to propel itself through the water. The hind legs grow first, then front legs. (Fig. 5-1a)
A tadpole spends most of its active time feeding. Tadpoles are omnivores and suspension feeders, eating suspended algae, dead and living animals, and detritus. Food is ingested as the tadpoles swim or root around on leaf litter to dislodge debris.

### WOOD FROG LARVAE (Tadpoles)

Newly hatched larvae or tadpoles measure 7 to 9 mm (less than 1/2 in) in length. As they grow, their color lightens from velvety black to a mottled olive-brown. Newly hatched tadpoles hang motionless alongside the rapidly deteriorating egg mass. Within a few days they are capable of rapid escape movement. When disturbed, they disappear into the leaf litter or underwater vegetation.

Metamorphosis occurs from late May to mid-August. Transforming juveniles are faithful miniatures of the adults regarding color and marking. Large numbers of tiny frogs – less than 10 to 12 mm (1/2 in) – congregate under shore litter and vegetation before dispersing into surrounding terrain.

### AMERICAN TOAD LARVAE (Tadpoles)

Toad larvae or tadpoles are oval (broader near the vent than near the eyes). There is a rounded end to the tail. Toad tadpoles often congregate in schools – which confuses predators and stirs up bottom detritus to suspend food particles in the water.

## SALAMANDER LARVAE

Salamander larvae have bushy gills; a caudal (tail) fin which continues on to the back as a dorsal fin; and tiny legs. The prominent ruff of gills readily distinguish salamander larvae from frog larvae. The different species of salamanders have confusingly similar larvae. Many of the physical characteristics overlap. **Some salamander larvae may not be identifiable to species, especially blue-spotted, Jefferson and their hybrids.** Also, recently hatched larvae of many salamander species differ markedly from older larvae.

The size at which salamander larvae transform varies from year to year, depending on the conditions in the breeding ponds – such as whether or not the ponds are drying, the abundance of food and water temperature. Competitive interactions within the pool may affect metamorphosis. They transform at a smaller size where there is increased competition and density.

On rainy nights in late summer, large numbers of newly transformed juvenile salamanders may journey from pools to terrestrial habitat. Though they can be found crossing roads in wooded areas during this migration, they often escape notice because of their small size 5 to 6.5 cm (2 to 2.5 in) and dark color.

### SPOTTED SALAMANDER LARVAE

At hatch, spotted salamander larvae are 12 to 13 mm (1/2 in.) long. The background color is dull greenish yellow, with darker areas of olive on the head and small rounded black spots scattered over the dorsal surfaces, forming an indistinct band on either side of the mid-dorsal line. There are no large paired dark spots as in the Jefferson salamander. Gills and slender appendages known as balancers are present at hatching, the forelegs represented by elongate buds. The broad tail fin is continuous with the dorsal fin, which extends to a point opposite the forelegs.

The larval period is 70-100 days. Larvae transform into miniature adults at around 75 mm (3 in). Transforming young are found August to September (rarely to October in colder

*Table 5-2.* ***CHARACTERISTICS OF LARVAL AMPHIBIANS USING VERNAL POOLS***

| AMPHIBIAN INDICATOR SPECIES | | | |
|---|---|---|---|
| | **WOOD FROG** | **SPOTTED SALAMANDER** | **BLUE-SPOTTED/ JEFFERSON SALAMANDER COMPLEX** |
| **Bushy gills** | no | yes. prominent ruff of gills | yes. prominent ruff of gills. |
| **Size** | at hatch, 7-9mm (.3-.4 in). at metamorphosis, 10-12mm (.4-.5 in). | at hatch, 12-13mm (.5 in). at metamorphosis, 40-75mm (2-3.5 in). | at hatch 8-10mm (.3-.4 in) (blue spot.)/at hatch 11-14mm (.4-.6 in) (Jeff.), at metamorphosis about 50mm (2 in). |
| **Color, pattern** | at hatch, velvety black, then lightening to mottled olive-brown. | dull greenish-yellow | color and pattern variable, species probably indistinguishable. Blue-spotted – dark brown with yellow blotches dorsally. Indistinct light lateral band. Underside unpigmented. Jeff. - yellowish with indistinct blotches; underside unpigmented. |
| **Tail** | -- | tail fin extends forward onto the back. | tail fin extends well forward on to body, nearly to the head. Blue-spot – fins broad, clouded with black. |
| **Larval period** | 60-70 days | variable, 70-100 days | variable, 60-80 days |
| **Other** | when viewed from above, eyes seen on top of head. Transform late May to mid-August. | more slender in appearance than blue-spotted/ Jefferson salamanders. Transforms August - September, rarely into October. | big-headed appearance |

| OTHER AMPHIBIAN SPECIES | | | | | |
|---|---|---|---|---|---|
| | **EASTERN NEWT** | **FOUR-TOED SALAMANDER** | **SPRING PEEPER** | **GREY TREEFROG** | **AMERICAN TOAD** |
| **Bushy gills** | yes | yes | no | no | no |
| **Size** | -- | at hatch, 11-14mm (.4-.6 in) at metamorphosis 18-24mm (.75-1.0 in). | at metamorphosis 33mm (1.3 in). | at metamorphosis, 45-50mm (1.7-1.9 in). | at metamorphosis, tiny new toads, 8-10mm (.3-.4 in). |
| **Color, pattern** | light yellow to green-yellow with grey or brown flecks or bands above. Belly pale yellow without bands or spots. | yellow-green with dark spots. Spots make a Y on the back of the head. | beige, tan or orangish dorsum, with dark spots and greenish tone. Iridescent creamy venter. | light brown to dark green to black | black |
| **Tail** | -- | dorsal keel forward only to rear legs. Ventral keel to base of tail. | tan to brown to orange tinge with black spots on outer edge. Fin extends along back. | orangish to wine to scarlet tail fins, extend along back. | relatively short tail |
| **Larval period** | -- | around 6 weeks | 60-90 days | around 60 days | 50-60 days |
| **Other** | unusual life history with 3 distinct stages. Larvae and adults are aquatic. Juveniles are terrestrial (red efts). | -- | when viewed from above, pop-eyed appearance, eyes bulge to sides. | when viewed from above, pop-eyed appearance, eyes bulge to sides. | congregate in schools |

waters). When they leave the pool, the young salamanders may be completely dark. Yellow or orange spots are sometimes acquired within one week of transformation. Recently transformed young linger on the edge of the drying pool, hidden under logs, fallen bark or stones. Eventually they move on to find an underground retreat.

## BLUE-SPOTTED and JEFFERSON SALAMANDER LARVAE

The larvae of blue-spotted salamanders, Jefferson salamanders and hybrids are not readily identifiable. Jefferson/blue-spotted larvae have a big-headed appearance in comparison to the more slender spotted salamander larvae. The free-swimming, limbless phase of blue-spotted salamander larvae is brief, ending when forelegs develop and become functional. The hind legs soon appear and larvae become bottom dwellers.

The diet of small blue-spotted salamander larvae includes various invertebrates. As larvae grow larger, their diet includes vertebrates. The size of Jefferson salamander larvae at metamorphosis is variable, 48-75 mm (2-3 in.). This allows the larvae to escape from drying pools when small, or remain in the water for further growth if conditions are favorable. The length of the larval period may be 66-80 days. Transformed juveniles undergo further growth on land. Metamorphosis or transformation is signaled by degeneration of gill branches and frequent excursions to the surface to gulp air. Newly transformed larvae are 50-65 mm (2-2.5 in) in total length. Newly transformed juveniles retain noticeable blackened gill stubs for several days, but acquire adult colors and spot patterns within 24 hours of leaving the water.

MIKE MARCHAND ©NHFG

*Marbled salamander larva*

## MARBLED SALAMANDER LARVAE

Marbled salamander larvae are very similar in appearance to other 'mole' salamanders. Some differences include a pigmented chin and a row of light spots on the side of larvae. Because marbled salamanders begin development in the Fall, they are typically considerably larger than the other mole salamander larvae during spring surveys.

## FOUR-TOED SALAMANDER LARVAE (not a vernal pool indicator species)

Newly hatched gilled larvae are less than 11-14 mm (1 in) long, with a broad head, prominent eyes and a strongly compressed body and tail. The tail fin extends forward only to the rear legs, in contrast to the dorsal fin of mole salamanders, which extends well forward on to the back, nearly to the head. Toes of salamanders develop sequentially, so the number of toes is not diagnostic. At transformation, the tail is conspicuously short compared to a mature salamander; the tail constriction is barely visible; and a black patch marking the gill closure is visible.

## LOCATING LARVAL SALAMANDERS

By day, larval salamanders are typically hidden among vegetation and under debris. At night they move into the water column, where they remain suspended near the surface where they feed. Nocturnal stratification is noted in several species of mole salamander larvae. Stratification of larvae is best seen on dark nights following clear sunny days. Overcast days, bright moonlight, heavy winds, and rainfall disrupt the above pattern.

Young salamander larvae feed to some degree at all times, dining on planktonic invertebrates. However, the intensity of feeding behavior is elevated by a decrease in light intensity (onset of dusk). It has been noted that the concentration of plankton in the top 15 cm (6 in) of water is higher after dark. Some studies found that larval activity decreased or stopped 3-4 hours after dark.

Salamanders in all life stages are carnivorous. The size of the prey is determined by the size of the salamander. Older larvae may be seen stalking over open bottom in search of prey. When larvae first emerge in the evening, they are very dark. As they move and stratify, larvae become pale, almost translucent. The change is due to expansion and contraction of melanophores (skin pigment).



*If you need to handle a wood frog, do it carefully, with moist hands.*

# Chapter Six

## FINDING AND HANDLING VERNAL POOL AMPHIBIANS

© NHFG

*Biologist Mike Marchand dipnetting for amphibian larvae.*

This section describes a variety of techniques for investigating vernal pools for documentation. You do not need to use all of them to adequately investigate a pool. Use methods appropriate to the specific site, which enable you to collect required information while causing the least disturbance to the pool and its surroundings. If you are not experienced at exploring aquatic habitats, see "Equipment for Vernal Pool Search and Documentation" in the Appendix.

### CAUTION: PROCEED WITH CARE

- Wear protective clothing to ward off mosquitoes and other hungry insects. You want to minimize your use of repellent or apply it at home so you can wash your hands and avoid exposing any amphibians to the chemicals that can harm them. Remember, they breathe through their skin!

During investigation and documentation of vernal pool habitat, some disturbance is inevitable. Move slowly and carefully and minimize handling of animals. **Strive for only minor and temporary disruption of the pool.**

- Leave your dog at home. A dog romping through a pool can damage egg masses and make the water turbid.
- Youngsters make great field companions! Nevertheless, impress upon them the need for minimal disruption to the pool.
- Handle vernal pool animals and egg masses only when it is necessary for identification, either visually or by photographing the specimen. Do not remove egg masses from the pool or detach them from sticks or other substrates to which they are attached. It is important that the egg masses remain suspended above the pool bottom – otherwise they are subject to siltation and predation and are unlikely to hatch successfully.


© BRETT AMY THELEN

- Amphibians have moist bodies and can desiccate (dry out) quickly. Also, most amphibians absorb oxygen and other gases through their skin. Keep your hands moist – dip them into water or pick up moist moss or leaf litter before handling an amphibian. Do not handle them if you have insect repellant or sunscreen on your hands.
- Wearing polarized sunglasses will aid in seeing into the water.

## FINDING AMPHIBIANS: VISUALS

A variety of techniques used under a variety of conditions are needed to develop an accurate picture of the fauna of a given area. A quick survey performed when conditions are not favorable may turn up very little. Take your time! Most of the animals that live in vernal pools are small and secretive. A minimum of TWO visits per site is recommended – one in early spring, the second about a month later.

At many pools it is possible to gather documentation without going into the pool. Observations from the edge cause the least disturbance to pool inhabitants. Generally, searches when there is daylight are recommended. A greater range of amphibian life stages (eggs, larvae, juveniles and adults) and invertebrates are likely to be observed. There is potentially less disturbance to pool inhabitants since you can see the pool and adjacent area, and it is safer than stumbling around in the dark, especially if you are in an unfamiliar area.

Approach the pool slowly and quietly. Look for larger animals that may be resting on the surface, especially turtles. Walk carefully and stop often, scanning with or without binoculars. If you startle an unsuspecting animal, sit and wait a few minutes – it may reappear. Also, look carefully where it started from, to see if there may be another individual nearby.

Walk around the pool slowly, looking in the water for salamanders, frogs, egg masses and spermatophores. Be careful not to disturb the shoreline by excessive trampling. Bend down and get close to the water surface. This is greatly enhanced by a clear bottom bucket. Try to remain in one spot for a while (take a seat and start listening), alternately scanning and observing closely.

Turn over rocks, logs or other debris on or near the edge of the pool to look for salamander adults or juveniles. Do this gently; restore anything you move to its original position and condition.

You may need to walk into the pool in waders or paddle into a large flooded area in a canoe. Be careful not to stir up the bottom or dislodge egg masses if you walk or paddle out into the pool. Egg masses are often attached to submerged twigs. Take special care when moving near woody branches and twigs.



*Biologist Brendan Clifford uses a flashlight to search for amphibian larvae at night.*

**At night:**
Evening searches, during appropriate weather conditions, can reveal salamander courtship. Frog vocalizations may lead you to previously unknown pools.

A head lamp or flashlight greatly enhances nocturnal observations. In most cases light disturbs amphibians only if kept focused on an individual. Salamanders foraging in temporary ponds may be disturbed by movements outside the pond during the day, but typically resume feeding after less than 5 to 15 minutes. At night salamanders are typically not disturbed by movement and often tolerate direct light.

## FINDING FROGS: LISTEN!

Vocalizations of frogs may be the reason you have found your way to this pool, just as the frogs find their way to mates. Some species call during the day, but activity increases at dusk. Calling activity will be particularly low on cold or windy nights.

Movement in or around a pool is likely to disturb calling frogs. When disturbed, a few individuals may cease calling, followed by the entire chorus shutting down simultaneously. If this happens, and the area of the pool you are standing in is silent, remain still. Calling will usually resume in a few minutes. The disturbance and your presence may shut down the chorus for longer periods if the night is cool or the density of calling frogs is low.



*Wood frog calling.*

Wood frogs call in late March and early April. Wood frog calls have limited carrying power and can seldom be heard far from the pool. The sound is remarkably like the quacking of ducks. Large choruses can create the impression of a continuous rattling sound. Calling often continues during the day in undisturbed locations.

High-pitched jingle bell-like calls of spring peepers are heard from March through May. Peepers may breed in vernal pools, but are not particular about the type of wetland habitat used.

Check the resources in the Bibliography for recordings of frog calls online *(http://www.wildlife.state.nh.us/nongame/frogs.html)*.

## CATCHING AND HANDLING AMPHIBIANS IN THE WATER

If you can't identify an animal adequately while it is in the pool, try to catch it so you can more readily observe or photograph it. A long-handled dip net works best.

Always keep animals and egg masses covered with water and handle gently. Small animals can be transferred directly from the net to a container filled with pool water. A light colored plastic or enamel pan is recommended. Avoid glass containers.

For clearer inspection and for taking photos, you may wish to lift egg masses slightly above the water surface by sliding a pan underneath. Egg masses lifted above the water should be replaced gently without unnecessary agitation.



*Wood frog egg mass.*

Plunge trays are particularly useful where aquatic vegetation is dense and the animals are concealed. Try a plastic storage tray, approximately 20 x 20 x 5 cm (8 in x 8 in x 2 in). Plunge the tray into the water every few steps and quickly pull it out. The water sucked into the tray will likely contain invertebrates – such as fairy

shrimp,, tadpoles, salamander larvae or occasionally an adult amphibian. To further examine animals, gently pour the water from the tray through a fine-mesh dip net, separate the animals from vegetation and debris and transfer the animals to a tray or container for identification and/or photography.

Don't pour them back into the pool. Instead, submerge the holding container in the water and tip it gently.

## CATCHING AND HANDLING AMPHIBIANS ON LAND

On land, most amphibians can be caught by quickly bringing a cupped hand down over them. Be careful not to come down too hard. The captive must then be carefully extricated from beneath your hand. Be careful of the tails of salamanders; they easily detach.

Some individuals will likely have to be held briefly so they can be identified and/or photographed.



*Adult Eastern newt.*

Remember to handle frogs and salamanders with moist hands. Transfer the animal as quickly as possible to a clear plastic jar or container with a screw top. A clear plastic bag perforated with small holes and with damp moss or leaves inside will also work. Now you can carefully identify your catch or photograph it through the container. Keep amphibians cool. They should be kept in shade and out of the sun. Release them as soon as possible. It is best to handle only a single animal at a time.

Salamanders can be held for examination by gently grasping a rear leg while supporting the body with the other hand. The animal should have something to hold on to for security. Large salamanders can be held by encircling the trunk of the body with your fingers and letting the head protrude. *Do not hold a salamander by its tail.*

## RELEASING AMPHIBIANS

If you do catch a frog or salamander, let it go where it was captured. This is important: releasing an amphibian outside an area with which it is familiar may decrease its survival chances and moving amphibians can also aid in the spread of diseases.

This vernal pool documentation process has no requirements for collecting specimens of live animals.

## MINIMIZING THE RISK OF SPREADING AMPHIBIAN DISEASES.

Diseases such as ranavirus and chytrid fungus (Bd), have been associated with significant die-offs of amphibians. To avoid transporting and introducing amphibian diseases we recommend that you take simple disinfection measures when moving between vernal pools. See Northeast PARC for more details and current accepted protocols for disinfection. If your gear (e.g. sampling equipment, clothing, footwear) enters the wetland these steps are recommended:

1. Between vernal pools remove mud, aquatic vegetation, algae and other debris from your gear. A long handled brush can be helpful.
2. Place your gear in, or generously spray with, a decontamination solution. Current guidance is to expose your gear for 5 minutes to 4% bleach. Disinfect your gear away from the wetland as bleach is toxic to aquatic organisms. Bleach may lose its potency, so only dilute what you will need.
3. At the end of the day disinfect your gear and let it air dry.

Wear rubber soled boots or waders instead of felt-soled ones. The felt soles can trap and hold mud, vegetation and moisture, as well as invasive seeds and spores. This is a good practice to prevent the spread of other potentially invasive species from one location to another.



*At least two visits are usually needed to document the wet (top) and dry (bottom) cycle of a vernal pool. Photographs can help locate the pool in the future; note date and time of photo, as well as location.*

# Chapter Seven

## DOCUMENTING AND REPORTING VERNAL POOLS

- Documentation Overview
- Documenting the Pool Location
- Indicator Species Documentation
- Documentation Form
- Documentation Form Instructions
- Reporting Your Observations

### DOCUMENTATION OVERVIEW

This chapter provides information about the documentation of vernal pools during the breeding and non-breeding seasons and how the collected information is reported. To document the presence of a vernal pool, you must adequately demonstrate that the pool meets certain physical criteria and certain biological criteria. This can be done with photos, audio recording (of frog calls), detailed written observations (of the physical and biological criteria), or identified invertebrate specimens. Though complete information is preferred, incomplete reporting is better than no record at all and may be sufficient to document a vernal pool.

New Hampshire's wetland rules (administered by the N.H. Department of Environmental Services) provide a definition of vernal pool and the primary and secondary vernal pool indicators (the species that require or use vernal pools for part of their life cycle, respectively).

### PHYSICAL CHARACTERISTICS

A vernal pool may occupy a shallow depression or basin (typically standing water with no permanently flowing outlet) or may be part of a wetland complex or floodplain. The pool may have an intermittent stream flowing out of it at high water, but typically is isolated some of the time.

In order for a pool to provide suitable habitat for the various primary indicator species, a vernal pool typically holds water for at least two continuous months following spring ice-out, but cycles annually from flooded to dry conditions. The hydroperiod, size, and shape of the pool might vary from year to year.

At least two visits are usually needed to document the wet-dry cycle of a pool.

## BIOLOGICAL CHARACTERISTICS

By definition (in the NHDES rules), a vernal pool supports at least one primary vernal pool indicator, or at least three secondary vernal pool indicators and lacks a viable fish population.

1. **Primary vernal pool indicators** – presence or physical evidence of amphibian breeding (wood frog, marbled salamander, spotted salamander, Jefferson-blue spotted salamander complex) or presence of fairy shrimp
2. **Secondary Vernal Pool Indicators** – include but are not limited to, caddisfly larvae and cases (*Limnephilidae, Phryganeidae, or Polycentropodidae*), clam shrimp and their shells (*Laevicaudata, Spinicaudata*), fingernail clams and their shells (*Sphaeriidae*), aquatic beetle larvae (*Dytiscidae, Gyrinidae, Haliplidae, and Hydrophilidae*), dragonfly larvae and exuviae (*Aeshnidae, Libellulidae*), spire-shaped snails and their shells (*Physidae, Lymnaeidae*), flat-spire snails and their shells (*Planorbidae*), damselfly larvae and exuviae (*Coenagrionidae, Lestidae*), and true fly larvae and pupae (*Culicidae, Chaoboridae, and Chironomidae*).

## DOCUMENTING THE POOL LOCATION

Precise mapping of the vernal pool location is essential for its documentation and protection. Maps and descriptive information should enable others, unfamiliar with the area, to locate the pool for verification, follow-up observations or protection. Before you go "in the field" to survey vernal pools, obtain the maps you need for documentation (see *Chapter 2*). The following information will help you pinpoint the vernal pool:

1) **GPS Coordinates:** Coordinates can be obtained from a GPS unit, location-enabled smart phone, some digital cameras or from online sources such as Google Maps or Google Earth. Geographic coordinates for the pool location can be provided in latitude and longitude (degrees, minutes seconds.) or decimal degrees with information about the datum – NAD 83 or WGS 84. Recording coordinates from a GPS unit will be the easiest and often most accurate means to report precise vernal pool locations using either the N.H. Wildlife Sightings website or hard copy reporting forms.
2) Written directions to the pool (*Fig. 7-1*).
3) Map of vernal pool (see *Chapter 2*)
    - photocopy of map (e.g., USGS topographic map) or aerial photograph showing the location of the pool (*Fig. 7-2*);
    - a tax assessor's map, or other map showing property lines and ownership, with the location of the pool drawn on it;
4) A field or sketch map that you prepare at the site, showing the features of the pool and its position relative to local landmarks. Any other depressions or small pools in the general area should also be indicated to avoid confusion as to which pool has been documented (*Fig. 7-3*).

## WRITING DIRECTIONS TO THE POOL

Provide clear, precise written directions on how someone can find their way to your pool. Written directions can provide one of the easiest means for people to locate your pool at a later time for verification or protection.

*Figure 7-1.* **WRITTEN DIRECTIONS**

> *Pool is .7 mi. west of Rte. 125 on Steppingstone Road, Lee, near Barrington town line. Telephone pole # 1468/25, 872/16 is near culvert. Pool is located at the roadside, with a light screening of vegetation. Pool is about 15' wide and 20' long. Surrounded by grass & shrubs, grading into hardwood forest.*

A good written description should include:

a) a precise description of a logical starting point for a person walking to the pool, (e.g., "Start at the intersection of Mill Rd. and Spring Lane, 1.2 miles north of Brookfield Town line...");

b) the distance from the starting point to the pool, in feet;

c) the direction of travel, including compass bearing;

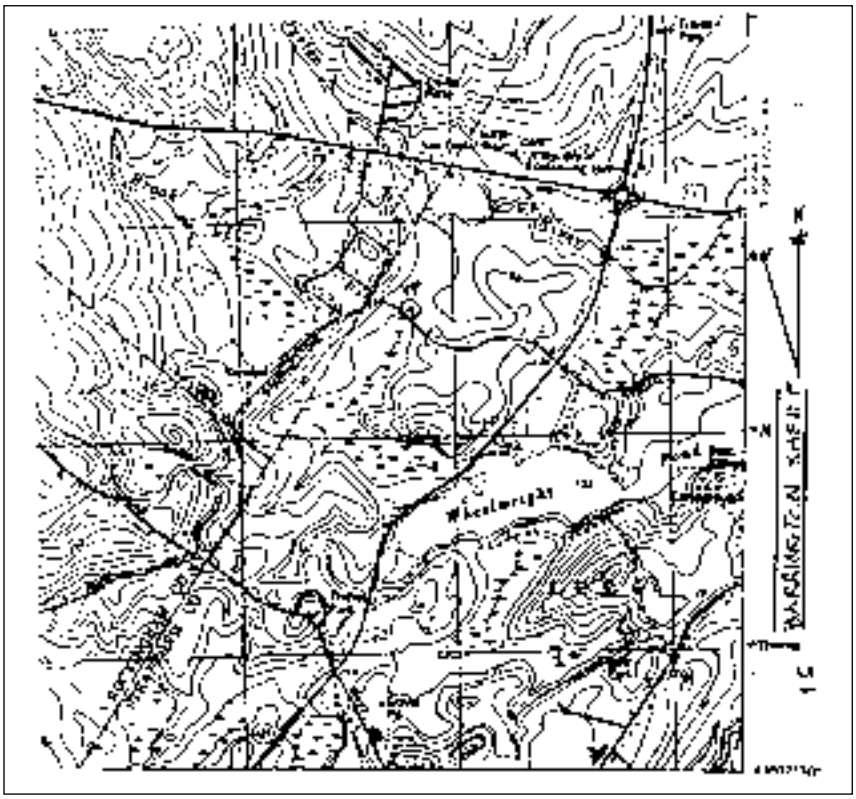
d) distinctive permanent landmarks along the path of travel and/or at the pool.

**Detailed Location Information** – this information should show the relationship of the pool to at least two permanent landmarks, preferably within 1,000 feet of the pool. The landmarks may either already appear on the map or be drawn in by you. The necessary information may be provided in one of the following ways:

a) You may sketch onto the tax map the locations of two permanent landmarks. It is helpful to provide:

- compass bearings from landmarks to pool;
- measured distances from landmarks to pool;
- a written description of the landmarks.

*Figure 7-2.* ***USGS TOPOGRAPHIC MAP***



b) You may submit an aerial photograph on which you have marked the location of the vernal pool and permanent landmarks, as well as other pools in the area.

## THE SKETCH MAP

**The Field or Sketch Map** – should include the following information:

a) the bearing and distance to the pool from a logical, specific starting point (such as the road or trail you walked to get there);

b) distances and bearings from at least two permanent landmarks within 1,000 feet of the pool. Show on your map the point from where you took your bearings;

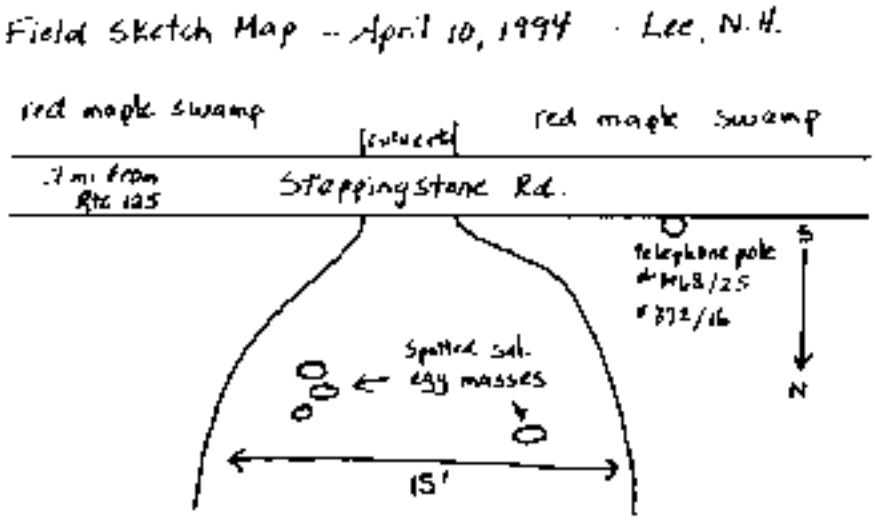
c) the approximate size and shape of the pool, including compass orientation;

d) locations of sightings of indicator species, such as salamander egg masses;

e) any other significant identifying features, such as fallen trees in the water, rock outcrops, distinctive stands of trees (e.g., Atlantic white cedar), etc.;

f) the point location(s) from which you took general photographs of the pool.

*Figure 7-3.* ***FIELD SKETCH MAP***




## USING PHOTOGRAPHS TO LOCATE THE POOL AT A LATER TIME

Taking a photograph of a general view of the pool will make it easier for others to locate it in the future. To be usable, a photograph should include identifiable permanent landmarks, if at all possible. In addition, you should note the following information in your field notebook for later transfer to a printed photograph or file name:

- photo number;
- day/time of the photo;
- the location of the pool (town, parcel)
- your name and/or the name of the photographer.

## INDICATOR SPECIES DOCUMENTATION

There are particular species that use vernal pools during specific life stages only or most of the time and they are considered indicator species. In New Hampshire, this includes certain amphibians and macroinvertebrates.

Although most of the vernal pool documentation has been and will be obtained during the breeding season, the vernal pool definition provide for indicator species whose larval cases or shells may be located in the dry vernal pool depressions. At the end of this section information is provided about documenting dry vernal pools.

## EVIDENCE OF AMPHIBIAN BREEDING

To adequately document a vernal pool, you need to look for specific life stages of indicator amphibians and other evidence of breeding. Refer to Chapter 3 for the indicator species list and information. The following are considered to be evidence of reproduction. Any one is sufficient for documentation. You are encouraged to record all species and life stages you observe.

### BREEDING ADULT AMPHIBIANS

**Wood frogs** – "chorusing," groups of males calling in unison, or mated pairs (amplexus).

**Courting behavior of salamanders** or presence of spermatophores

**Spermatophores** (photo right) – small (approx. 1/2 inch) vase- or stump-shaped white packets of sperm deposited by male salamanders on leaves, sticks or other debris on the pool bottom.

© NHFG/MIKE MARCHAND

*Spermatophores attached to a stick.*

### AMPHIBIAN EGGS

Wood frog and salamander egg masses differ in shape and size and are often deposited at different times.

**Wood frog eggs** lack a surrounding gelatinous capsule and have an unconsolidated shapeless form.

**Salamander eggs** are surrounded by a common gelatinous envelope, within which individual eggs are visible

### AMPHIBIAN LARVAE

Frog and salamander larvae can be differentiated by visual observation.

**Frog larvae**, commonly known as tadpoles or polliwogs, have no external gills. It is most important to ensure that the tadpoles you observe are wood frogs and not other (non-indicator) species.

**Salamander larvae** have bushy external gills. With close, detailed examination, it may be possible, but not necessary for documentation, to identify the salamander species

### TRANSFORMING JUVENILES

Transforming juveniles are those amphibians that are between the larval and adult stage. Frogs show some remnant of a tail and transforming salamanders look like adults, but have gill remnants.

## EVIDENCE OF INVERTEBRATES

The presence of fairy shrimp in a pool provides documentation of a vernal pool. Fairy shrimp are primary vernal pool indicators.

### OTHER INVERTEBRATES

The following table provides a list of the secondary vernal pool indicators, including the common name of the group or the families to which they belong and the common names used for species within the family.

***SECONDARY VERNAL POOL INDICATORS***

| Common name of macroinvertebrate group and evidence as indicator | Macroinvertebrate family | Common name of family members |
|---|---|---|
| Caddisfly larvae or cases | *Limnephilidae* | Northern caddisflies |
| | *Phryganeidae* | Giant case makers |
| | *Polycentropodidae* | Tube or trumpet caddisflies |
| Clam shrimp or shells | *Laevicaudata* | Clam shrimp |
| | *Spinicaudata* | Clam shrimp |
| Fingernail clams or shells | *Sphaeriidae* | Fingernail clams |
| Aquatic beetle larvae | *Dytiscidae* | Diving beetle |
| | *Gyrinidae* | Whirligig beetle |
| | *Haliplidae* | Crawling water beetle |
| | *Hydrophilidae* | Water scavenger beetle |
| Dragonfly larvae or exuviae | *Aeshnidae* | Darners |
| | *Libellulidae* | Skimmers |
| Damselfly larvae or exuviae | *Coenagrionidae* | Narrow-winged damselflies |
| | *Lestidae* | Spread-winged dragonflies |
| True fly larvae or pupae | *Culicidae* | Mosquitoes |
| | *Chaoboridae* | Phantom midges |
| | *Chironomidae* | Non-biting midges |
| Spire-shaped snails or shells | *Physidae* | Tadpole snails or pouch snails |
| | *Lymnaeidae* | Pond snails or limpets |
| Flat-spire snails or shells | *Planorbidae* | Wheel snails, orb snail, or ram's horn snails |

Document all macroinvertebrates present to the extent possible, as additional invertebrates may also be considered secondary vernal pool indicators. Unidentified macroinvertebrates may be collected for subsequent identification (*Figure 4-1* and *Figure 4-2*). Record observations on the Vernal Pool Documentation Form. If invertebrates are observed, but the types (Families) are not known, identify 'unknown' on datasheet.

### DRY POOL IDENTIFICATION

Surveys for vernal pools can be conducted outside of the breeding season. Invertebrates such as dragonfly and damselfly larvae leave behind exuviae – the larval cases – as they metamorphose into the adult stage. Exuviae are usually attached to nearby vegetation. Caddis fly cases may be located at the bottom of the dried pool or in the leaf litter. Shells of fingernail clams and clam shrimp may be present in the leaf litter as well. These remnants may be used to document the presence of a vernal pool under New Hampshire vernal pool definition *(Figure 4-2)*.

## IDENTIFICATION DETAILS FOR DOCUMENTING PRESENCE OF VERNAL POOL INDICATOR SPECIES

**Adult amphibians:** Identify adult amphibians to the species level, where possible

**Amphibian eggs:** At a minimum, distinguish between frog eggs and salamander eggs. Documenting the presence of salamander egg masses regardless of species, or wood frog eggs, is sufficient evidence for documentation. Identification of salamander eggs to species is optional.

**Larval salamanders:** Larval salamanders do not need to be identified to species – it can be challenging. Presence of a larva with bushy gills is sufficient.

**Larval frogs:** Species of frog other than the wood frog may use vernal pools. Since the wood frog is the only frog which is a vernal pool indicator species, tadpoles need to be identified to species, or rely on another life stage.

**Invertebrates:** Fairy shrimp and other invertebrates need only be identified to the group level (family or order), i.e., “caddis fly” or “fairy shrimp”. If you have the skill, resources and patience to make more detailed identification of invertebrates, your efforts will provide an even greater level of vernal pool information. Additional identification resources are provided in the bibliography. If invertebrates are observed, but the types (Families) are not known, identify ‘unknown’ on datasheet.

### VERIFICATION

All reports and records of observations of species using a vernal pool are encouraged and should be submitted. The documentation form provides a place to record data and how your sampling was conducted. The three levels of verification, described below, reflect decreasing levels of confidence in a record.

(1) A recognizable photograph is submitted.

Photos are the preferred method of recording specimens. or a specimen was collected and preserved. For amphibians this is not justified, for macroinvertebrates, it may be the only way that you will be able to take the time to identify the animal

(2) A specimen was handled, examined for identification, then released.

(3) A specimen was seen or heard but not captured. An auditory recording can aid in the verification of frogs.

It is important to distinguish on what basis information is reported: photo/collected specimens, positive identification through handling, but without photo or collection, or speculation of species presence/distribution.

### PHOTOGRAPHIC DOCUMENTATION

Photographs of animals provide the highest level of verification. Take two or three photos and send the one(s) that provide the best picture of characteristics observed.

Know the limitations of your camera. If you use a fixed-focus or “point and shoot” cameras, it may not be able to focus closer than 3 to 4 feet. Read your instruction manual.

With digital cameras, you can check immediately to see if the image you captured is sharp enough to identify the characteristic (or animal) of interest. A flash may be necessary, even during the day. If you have a polarized lens for your camera, that can help you capture images of egg masses and animals beneath the water's surface without the reflected light obscuring the resulting image.

## NEGATIVE RECORDS

To a certain extent, information about where a species does not occur can be useful in determining species ranges, habitat preference and documenting annual variation, although it is more difficult to be certain about a species' absence. If you locate a pool or dry basin that looks like it has outstanding potential for vernal pool indicator species, but none are present during your survey, report the physical pool information (size of pool and depression) and any species that are present. Perhaps next year the pool will be used by amphibians or other species, or a visit at an earlier or later time may result in species present that were not previously observed. There is significant variation in the use and degree of use of some vernal pools.

Version: March 2015

# New Hampshire Vernal Pool Documentation Form

**Purpose:** This form is to provide a way to collect appropriate information necessary to document the presence of a vernal pool or potential vernal pool in New Hampshire. It is also appropriate to use this form to document the *absence* of certain physical and, especially, biological characteristics to describe a pool or depression within a wetland that may not meet the definition of a vernal pool.

## I. Observer Contact information

| | |
|---|---|
| **Observer name** | |
| **Observer phone #:** | |
| **Observer email** | |
| **Observer Mailing address:** | |

## II. Location and Owner Identification

| | |
|---|---|
| Town: | |
| Property name (if applicable): | |
| Location Description/ Property street address: | |
| **Vernal Pool Coordinates**<br>*Coordinates obtained by GPS or other means. Report in degrees minutes seconds or decimal degrees: Latitude 43.2164 Longitude -71.5192. Datum: Use NAD83 or WGS84 for all coordinates* | Latitude:<br><br>Longitude: |
| **Source of coordinates**: (circle one):<br>GPS unit, Google Maps/Google Earth, Topo map, other | Tax map and lot # (if known): |
| Is observation on public land? Yes / No | Landowner permission obtained? Yes / No |
| Landowner name (if known) | |
| Landowner address<br>(if different than property address) | |
| Landowner phone or email | |

**Note: Provide a map that shows property and location of vernal pool (tax map/ USGS)**

**Vernal Pool Site Name:** _____

**Project affiliation**

- ☐ None
- ☐ Harris Center/AVEO
- ☐ Town _____
- ☐ Consultant
- ☐ Other _____

## III. Survey Information

| | | | |
|---|---|---|---|
| **Date of survey:** | | **Visit # (for season):** | **1 2 3 4 ___** |
| **Survey start time:** | **: am /pm** | **Survey end time:** | **: am /pm** |
| **Air temperature (F):** | | | |

**Weather/Other Comments:** provide any information about precipitation, cloud cover, wind, humidity, ice cover, etc here:

## IV. Vernal Pool Description

**Photos:** 1-3 photographs of vernal pool taken and provided with datasheet Yes / No

### Pool characteristics

**Vernal pool type (choose most appropriate description)**

- ☐ Upland-isolated pool (not associated with a larger wetland)
- ☐ Wetland complex (pool within or associated with a larger wetland habitat, such as red maple swamp, marsh pond edge.
- ☐ Floodplain pool

**Origin of pool (select one)**

- ☐ Unknown
- ☐ Natural depression
- ☐ Natural, but altered
- ☐ Small pond / constructed pond
- ☐ Quarry/sand pit excavation
- ☐ Ditch along road or rut from vehicle
- ☐ Created wetland/ pool (such as for wetland mitigation purposes)
- ☐ Other: _____

**Pool size (dimensions):** _____feet X _____feet (Area of open water in the pool depression )

*If round, measure diameter; if long and narrow, provide length and width dimensions.*

(check one): ☐Measured ☐Paced ☐Estimated ☐Other: _____

**How long does the vernal pool hold water? (Hydroperiod)**

- ☐ Seasonal (drying out entirely in most years)
- ☐ Semi-permanent (drying partially in most years)
- ☐ Permanent (Typically maintains water)
- ☐ Unknown

**Maximum water depth on survey date**

- ☐ < 6 inches (ankle deep)
- ☐ 6 inches – 1 foot (shin deep)
- ☐ 1 - 2 feet (knee deep)
- ☐ 2 - 3 feet (hip deep)
- ☐ 3 - 4 feet (chest deep)
- ☐ > 4 feet

**Pool Outlet:** Did you observe water flowing out of the pool on this date? **Y / N**

**Overstory/Shading of vernal pool depression**

*(Overstory is trees, shrubs, and associated limbs and leaves that block sunlight from penetrating the pool surface)*

- ☐ Mostly shaded by trees (> 50%)
- ☐ Less shaded by trees (< 50%)
- ☐ Shaded only by vegetation **in** the pool (such as shrubs)

**Vegetation in Pool (vernal pool depression)**
*Check (X) Vegetation type and proportion of vegetation in the pool (percent coverage) that can provide egg attachment or offer concealment to aquatic or developing larvae.*

| Vegetation type | Percent coverage of pool by vegetation *in the pool* | | |
|---|---|---|---|
| | <10% | 10-50% | >50% |
| Shrubs | | | |
| Emergent vegetation (Grasses, sedges, rushes, cattails) | | | |
| Submergent vegetation | | | |

Are **dead branches and downed woody material** (branches/twigs) available in pool for egg attachment?
(Select one category) ☐**None** ☐**1 - 10** ☐**greater than 10**

**Pool substrate** (select all that apply)
- ☐ Leaf litter
- ☐ Sand/gravel
- ☐ Muck
- ☐ Bedrock
- ☐ Other: _____

**Disturbance to vernal pool observed (select all that apply)**
Observe any disturbance to the pool (direct or indirect by siltation, for example)
- ☐ Dumping
- ☐ Ditching/draining
- ☐ Ruts from wheeled vehicles
- ☐ Runoff /siltation from human sources
- ☐ Other: _____
- ☐ None

**Surrounding habitat** (within 100 feet of the pool)

Check habitat type and select/circle appropriate percentage

- ☐ Forest (< 10%, 10-50%, > 50%)
- ☐ Open (shrublands, agriculture, grassland, etc.) (< 10%, 10-50%, > 50%)
- ☐ Wetlands (< 10%, 10-50%, > 50%)
- ☐ Open water (lakes/ponds, rivers/streams) (< 10%, 10-50%, > 50%)
- ☐ Residential (lawn, little amount of pavement/structures) (< 10%, 10-50%, > 50%)
- ☐ Industrial/Urban (mostly pavement and structures)(< 10%, 10-50%, > 50%)
- ☐ Paved Roads/driveways (< 10%, 10-50%, > 50%)
- ☐ Unpaved roads/driveways (< 10%, 10-50%, > 50%)

Describe any disturbance observed in the 100 foot area around the pool: _____

## V. Survey for vernal pool fauna (amphibians and macroinvertebrates)

**NOTE**: Provide photographs when possible.

### Species information - Primary Vernal Pool Indicators

| Species observed | Adults | | | Egg masses (#) | | Tadpoles, Salamander Larvae and Transforming Juveniles | |
|---|---|---|---|---|---|---|---|
| | Seen # | Courtship/ amplexus (Y/N) | Heard Y/N | Counted | Estimated | Tadpole/ Larvae estimated | #Transforming juveniles (#) |
| Wood frog | | | | | | | |
| Spotted salamander | | | NA | | | | |
| Marbled salamander | | | NA | | | | |
| Blue spotted/ Jefferson salamander | | | NA | | | | |
| Mole salamander (unknown species) | | | NA | | | | |
| Fairy shrimp | | NA | NA | NA | NA | NA | NA |

Record **other amphibian and reptile species** observed (such as spring peepers, etc.):

| Species observed | Adults | | | Egg masses (#) | | Tadpoles, Salamander Larvae and Transforming Juveniles | |
|---|---|---|---|---|---|---|---|
| | Seen # | Courtship/ amplexus (Y/N) | Heard Y/N | Counted) | Estimated | Tadpole/ Larvae estimated | #Transforming juveniles (#) |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Was entire pool surveyed for egg masses? Yes/ No If Yes, what percent of the pool? _____

(If the entire pool was not surveyed, is any part of the pool on an adjacent property? (Y/N)

**Sampling methods used during your survey (check all that apply):**

- ☐ Visual search
- ☐ Audible detection (Recorded: : Yes / No)
- ☐ Dip net
- ☐ Trapping
- ☐ None (incidental observation)

Were **spermatophores** observed (see photo right) ? Yes / No

Were **fish** observed in the pool? Yes / No

## Secondary vernal pool indicators - Invertebrates

During or after amphibian breeding season, there are other organisms whose presence or remains (larval cases, exuviae, or shells) indicate the presence of a vernal pool. These organisms are considered secondary vernal pool indicators.

The families or groups listed in the following table are among those **secondary vernal pool indicators** under the New Hampshire wetlands rules (Env-Wt 100). Additional species (family or groups) may qualify as secondary vernal pool indicators, hence blank spaces are provided to enter other species you observe.

| Macroinvertebrate Common name of group | Common name of family members | Macroinvertebrate family | Observed? (X) | Photo? |
|---|---|---|---|---|
| Caddisfly larvae or cases | Unknown type | Unknown type | | |
| | Northern caddisflies | Limnephilidae | | |
| | Giant case makers | Phryganeidae | | |
| | Tube or trumpet caddisflies | Polycentropodidae | | |
| Clam shrimp or shells | Unknown type | Unknown type | | |
| | Clam shrimp | Laevicaudata | | |
| | Clam shrimp | Spinicaudata | | |
| Fingernail clams or shells | Fingernail clams | Sphaeriidae | | |
| Aquatic beetle larvae | Unknown type | Unknown type | | |
| | Diving beetle | Dytiscidae | | |
| | Whirligig beetle | Gyrinidae | | |
| | Crawling water beetle | Haliplidae | | |
| | Water scavenger beetle | Hydrophilidae | | |
| Dragonfly larvae or exuviae | Unknown type | Unknown type | | |
| | Darners | Aeshnidae | | |
| | Skimmers | Libellulidae | | |
| Damselfly larvae or exuviae | Unknown type | Unknown type | | |
| | Narrow-winged damselflies | Coenagrionidae | | |
| | Spread-winged dragonflies | Lestidae | | |
| True fly larvae or pupae | Unknown type | Unknown type | | |
| | Mosquitoes | Culicidae | | |
| | Phantom midges | Chaoboridae | | |
| | Non-biting midges | Chironomidae | | |
| Spire-shaped snails or shells | Unknown type | Unknown type | | |
| | Tadpole snails or pouch snails | Physidae | | |
| | Pond snails or limpets | Lymnaeidae | | |
| Flat-spire snails or shells | Wheel snails, orb snail, or ram's horn snails | Planorbidae | | |
| Other*: | | | | |
| Other*: | | | | |

**Completed datasheets can be submitted to NH Wildlife Sightings at: http://nhwildlifesightings.unh.edu/ or mailed to NH Fish & Game Department, Nongame & Endangered Wildlife Program, 11 Hazen Drive, Concord NH 03301.**

# N.H. VERNAL POOL DOCUMENTATION INSTRUCTIONS

## SECTIONS:

I. Observer Contact Information
II. Location and Owner Identification
III. Survey Information
IV. Vernal Pool Description
V. Survey for Vernal Pool Fauna (amphibians and macroinvertebrates)

**The Vernal Pool Documentation Form** is used to record observations made during visits to a vernal pool or potential vernal pool. Your data can be submitted to NH Fish and Game, entered in the Wildlife Sightings online system, as well as used locally to inform your town's conservation efforts.

A minimum of two visits to a site are recommended -- one in the spring during breeding periods of amphibian indicator species (late March – early May) and a second visit a month or more later as the pool is drying. If you find a pool late in the season or are unable to make more than one visit, document the results of your survey at that time. Larval cases, exuviae, or shells of some secondary vernal pool indicators can be found when the pool is dry and used to document the presence of the indicator species and the vernal pool.

We encourage observers to fill in as many fields as they have information for. However, data may still be valuable if data sheets are only partially filled out. For example, if you didn't measure water depth or pool size but recorded the presence of fairy shrimp, this is valuable information.

### I. OBSERVER CONTACT INFORMATION

- Provide your **name** (as the observer) and contact information, including email address, in the appropriate spaces.

### II. LOCATION AND OWNER IDENTIFICATION

- In the **Location** section, provide basic information about the location of the vernal pool – town, street address (if possible), tax map and lot number of the property. If you are not the landowner, indicate if the landowner is known and whether permission was obtained.
- In addition to location descriptions and maps, location-specific data (such as a point location) is valuable. If a GPS unit is available, your location can be recorded as latitude and longitude in various formats (degrees, minutes, seconds, decimal degrees). The **datum of the GPS** unit should be set to NAD83, or record the datum (such as WGS 84). If a GPS unit is not available, latitude/longitude coordinates can be obtained from some online map services, such as Google Maps or Google Earth. If you have a smart phone with location capabilities enabled, record your location and indicate what phone and software was used to obtain the location. If you are taking photos with your smart phone (or some digital cameras), the location information may be captured with each photo you take. Indicate if that is the source of the location information.
- **Vernal Pool Site Name** – This is used for reference; use unique name for every pool

identified. Exact pools previously identified on a different date should use same Site Name.

- If you are conducting the survey as part of a project sponsored by the town or another organization, provide that information. If the vernal pool has been assigned an ID number or name by another organization, enter that information as the site name.
- Provide a sketch/field map of the pool in addition to other maps to illustrate the pool location.
- Photos of the pool, surrounding habitat and animals found are encouraged. Indicate if photos are being provided or available.

## III. SURVEY INFORMATION

- Provide the **date** of your visit and the **Survey Start Time** and **Survey End Time** of your search at the pool.
- Note whether this is your **first or a subsequent visit (Visit #)** documenting the resources of the pool this season. More than one visit to a pool is recommended to observe the pool from its high water to its drying stage.
- Record **weather** information such as **air temperature**, precipitation, humidity, cloud cover, wind, ice cover.

## IV. VERNAL POOL DESCRIPTION

**Pool characteristics**

- Identify the **vernal pool type**. Is the pool isolated and in an upland, part of a wetland complex or within a floodplain? Choose the best option.
- Identify the **origin of the pool**, if it is known. Options include “unknown” and “other” (with explanation).
- Determine **pool size** (area of open water) by measuring the pool, pacing the perimeter or estimating the size (at each visit). Indicate if size is estimated or measured. If you are using a GPS unit, you may be able to record your tracks around the pool (if that is possible), or you could take point measurements and connect them to determine size. The accuracy of your GPS may not be appropriate to measure smaller pools, so estimating the size would be good backup information for any GPS-based distance measurements you collect.
- Provide information about the **hydroperiod of the vernal pool**. If this is the first time you are visiting the pool, can select ‘unknown’ and report on the hydroperiod after your next visit to the pool.
- Measure and record the **maximum water depth** during each visit, according to the increments and descriptions provided.
- Identify whether or not there is an **outlet** to the pool, and if present, did you observe water flowing out of it during today’s visit?
- Identify to what extent the pool is shaded by **overstory** vegetation (more than 50% or less than 50%).
- Observe and estimate the type of **vegetation** (shrub, emergent, etc.) and proportion of the pool covered by vegetation. This is limited to the vegetation in the pool that

can provide surfaces for egg attachment or conceal developing aquatic larvae.

- Observe and estimate the amount of **dead and downed woody material** (branches/twigs) available in pool for egg attachment? Select one category, none, 1-10, or greater than 10.
- Identify the **pool substrate** (choose more than one, as necessary).
- As you approach the pool, observe and record the type(s) of **surrounding habitat** and land use that surround the pool – within 100 feet of the pool. Select more than one type as appropriate. For example, if half of the pool is within a forested area and the other half is within 100 feet of a residential lot with managed lawn select the 10-50% category for both of those habitat/land use types.
- Note if you observe any **disturbance to the pool**, or if no disturbance was observed.

## V. SURVEY FOR VERNAL POOL FAUNA (AMPHIBIANS AND MACROINVERTEBRATES)

In addition to breeding amphibians that use vernal pools, you will be looking for aquatic macroinvertebrates.

**Primary Vernal Pool Indicators – Amphibians and Fairy Shrimp**

- During the breeding season you will be looking for and recording information about species that require the habitat of vernal pools as part of their life cycle. These species are referred to as **primary vernal pool indicators**. Record your observations about the type and number of these animals that you hear or see – whether in egg, larval or adult form – in the table.
- If you observe other amphibian and reptiles, record them in the table that follows the primary vernal pool indicators.
- If you hear chorusing wood frogs, you may obtain an audio recording and submit a digital audio file of the full chorus – where calls are constant, continuous and overlapping – as evidence of breeding.
- Indicate how much of the vernal pool was surveyed for egg masses. If you were not able to survey the entire pool, indicate if it is the result of the pool occupying an adjacent property when no landowner permission was obtained.
- Identify the sampling methods that you used during your survey.
- Indicate if you observed spermatophores (sperm packets deposited by male mole salamanders)
- Indicate if you observed any fish.

**Secondary Vernal Pool Indicators – Invertebrates Only**

There are additional macroinvertebrates, other than **fairy shrimp**, that use vernal pools. By definition in the NH Department of Environmental Services wetland rules, without the presence of a primary vernal pool indicator, at least **three** of these secondary vernal pool indicators need to be identified to consider a pool a “vernal pool.” Note that some of these may also be identified outside of the amphibian breeding season, and even after a pool has dried. Document whatever you observe. You may find that additional resources may be needed to identify the macroinvertebrates you find. Collect a macroinvertebrate specimen in vernal pool water. Long term preservation may be done in 70% rubbing alcohol.

You may observe other species that are not listed in the table on the form but are in the vernal pools, and record them on the form.

- Record species observed, both primary and secondary vernal pool indicator species.
- Record the species and indicate whether what was observed was living larvae or "remnants" were present (shells or exuviae).

### VI. DOCUMENTATION - PHOTOGRAPHIC AND OTHERWISE

As you observe the habitat pool characteristics and animal species, take photos to document your observations. Depending on when your survey(s) occur(s), you may observe empty shells (of fingernail clams and clam shrimp), exuviae (of damsel and dragonfly larvae), or larval cases (caddisfly) -- all of them document the vernal pool's wetter stage. Photographing these secondary invertebrate indicators is important and collecting them for further identification may be considered. As many amphibians and reptiles, and their egg and larval stages can be easily misidentified, it is important to provide photographs whenever possible.

## REPORTING YOUR OBSERVATIONS

You have collected valuable information. Your vernal pool data may be entered directly into NH Wildlife Sightings, an online tool for capturing observations at vernal pool and of other wildlife (*http://nhwildlifesightings.unh.edu*). If you are not using ***N.H. Wildlife Sightings***, submit data forms, maps, photos and associated information to the Nongame and Endangered Wildlife Program at the **N.H. Fish and Game Department** and your **town Conservation Commission**, if appropriate.

*Thank you for taking the time identify these valuable natural resources of New Hampshire!*

**New Hampshire Fish and Game Department**
11 Hazen Drive, Concord, NH 03301
*http://www.wildlife.state.nh.us*

**New Hampshire Department of Environmental Services – Wetlands Bureau**
PO Box 95, 29 Hazen Drive, Concord, NH 03301
*http://des.nh.gov*

© NHFG/MICHAEL MARCHAND

# Chapter Eight

## VERNAL POOL PROTECTION

### REGULATORY STATUS

There are state or federal regulations which specifically mention vernal pools and provide clear definitions and requirements.

#### N.H DES Wetlands Bureau

Vernal pools have been protected as wetlands or surface waters under the wetlands dredge and fill law, RSA 482-A. In 2008 the Department of Environmental Services adopted rules (NH Administrative Rules Env-Wt) regarding vernal pools. The rules require that any standard application for a minor or major state wetlands permit, locate and delineate vernal pools and consider the impact of the proposed project on vernal pools. The rules provide a definition of vernal pools, primary vernal pool indicators, and secondary vernal pool indicators. The protection of an upland buffer may be included in a wetlands permit approval, however at this time there is no rule specifically defining a standard buffer width. The N.H. Administrative Rules that specifically reference vernal pools are provided herein:

**Env-Wt 101.75** "Primary vernal pool indicators" means the presence or physical evidence of breeding by marbled salamander, wood frog, spotted salamander, Jefferson-blue spotted salamander complex, or fairy shrimp.

**Env- Wt 101.86** "Secondary vernal pool indicators" means physical evidence used by wildlife biologists or certified wetlands scientists who are familiar with vernal pool habitats as evidence of the presence of a vernal pool, if primary vernal pool indicators are absent and other vernal pool characteristics suggest vernal pool habitat. Secondary vernal pool indicators include, but are not limited to, caddisfly larvae and cases (Limnephilidae, Phryganeidae, or Polycentropodidae), clam shrimp and their shells (Laevicaudata, Spinicaudata), fingernail clams and their shells (Sphaeriidae), aquatic beetle larvae (Dytiscidae, Gyrinidae, Haliplidae, and Hydrophilidae), dragonfly larvae and exuviae (Aeshnidae, Libellulidae), spire-shaped snails and their shells (Physidae, Lymnaeidae), flat-spire snails and their shells (Planorbidae), damselfly larvae and exuviae (Coenagrionidae, Lestidae), and true fly larvae and pupae (Culicidae, Chaoboridae, and Chironomidae).

**Env- Wt 101.106** "Vernal pool" means a surface water or wetland, including an area intentionally created for purposes of compensatory mitigation, which provides breeding habitat for amphibians and invertebrates that have adapted to the unique environments provided by such pools and which:

(a) Is not the result of on-going anthropogenic activities that are not intended to provide compensatory mitigation, including but not limited to:
- (1) Gravel pit operations in a pit that has been mined at least every other year; and
- (2) Logging and agricultural operations conducted in accordance with all applicable New Hampshire statutes and rules; and

(b) Typically has the following characteristics:
- 1) Cycles annually from flooded to dry conditions, although the hydroperiod, size, and shape of the pool might vary from year to year;
- (2) Forms in a shallow depression or basin;
- (3) Has no permanently flowing outlet;
- (4) Holds water for at least 2 continuous months following spring ice-out;
- (5) Lacks a viable fish population; and
- (6) Supports one or more primary vernal pool indicators, or 3 or more secondary vernal pool indicators.

**Env-Wt 301.01** (f) Delineations of vernal pools shall be based on the characteristics listed in the definition of "vernal pool" in Env-Wt 100. To assist in the delineation, individuals may use "Identification and Documentation of Vernal Pools in New Hampshire", 2nd Ed., 2004, published by the New Hampshire fish and game department.

**Env-Wt 302.04** Requirements for Application Evaluation. (a) For any major or minor project, the applicant shall demonstrate by plan and example that the following factors have been considered in the project's design in assessing the impact of the proposed project to areas and environments under the department's jurisdiction:

(7) The impact on plants, fish and wildlife including, but not limited to:
- a. Rare, special concern species;
- b. State and federally listed threatened and endangered species;
- c. Species at the extremities of their ranges;
- d. Migratory fish and wildlife;
- e. Exemplary natural communities identified by the DRED-NHB; and
- f. Vernal pools.

## U.S. Army Corps of Engineers (ACOE)

The ACOE Programmatic General Permit for the State of New Hampshire (effective date August 03, 2012) classifies vernal pools as a type of Special Wetland, requiring that the applicant must minimize surrounding upland impacts to the greatest extent practicable, with the effort to minimize impacts being commensurate with the value of the vernal pool. Furthermore the ACOE requires that impact minimization should be in accordance with *Best Development Practices: Conserving pool-breeding amphibians in residential and commercial development in the northeastern U.S., 2002*; Calhoun and Klemens. For example, site clearing, grading and construction activities should be limited to <25% of the seasonal pool terrestrial habitat (750 ft. radius from the vernal pool edge), and roads and driveways should be excluded from the VP envelope (100 ft. radius from the vernal pool edge).

## Municipal Involvement

Although the State has permitting requirements to protect wetlands and surface waters, protection of vernal pool resources, including the upland areas adjacent to the pools, may best be accomplished at the municipal level by the combined efforts of the town conservation commission and planning board. Town conservation commissions have statutory responsibility to advise state and municipal officials on the protection of all natural resources. They provide a local source of information and assistance to the N.H. DES Wetlands Bureau and municipal officials. A proactive approach by conservation commissions is recommended, including a systematic search for and mapping of vernal pools and involvement with the planning board in directing future land use.

Possible methods of incorporating vernal pool protection into current municipal activities include the following:

- A municipal Master Plan sets the best and most appropriate future development of the area under the jurisdiction of the planning board, to aid the board in designing ordinances that result in preserving and enhancing the unique quality of life and culture of New Hampshire, and to guide the board in the performance of its other duties in a manner that achieves the principles of smart growth, sound planning, and wise resource protection" (RSA 674:2). Conservation commissions should be intimately involved in the development of the natural resource portions of the plan. Vernal pools should be identified as important wildlife habitat and wetlands of significance. Goals developed for future natural resource protection should include the documentation of important vernal pools and the protection of these natural resources to help ensure the biodiversity of the area.

For more information on master planning and other local planning options contact the New Hampshire Office of Energy and Planning (http://www.nh.gov/oep/).

- Conservation commissions are encouraged to work with the local planning board to develop mechanisms that will ensure the consideration of vernal pools and other significant wildlife habitats in projects such as site plan reviews and subdivision regulations. Many times small isolated wetlands are considered – inappropriately -- low value wetlands.

  The identification and mapping of vernal pools on site plans and subdivision plans will provide an opportunity to reduce potential impacts and ensure any impacts that cannot be avoided will result in appropriate mitigation that protects these unique and sensitive resources.

- The Innovative Land Use Controls authorized in the Zoning section of New Hampshire's Local Land Use Planning and Regulatory Powers (RSA 674:21) allows the development of standards that are consistent with the master plan, and guides the planning board or its designee. This statute empowers town planning boards to delegate responsibilities. Zoning ordinances, including Environmental Characteristics Zoning, such as establishment of a "Wetlands Protection Ordinance" can be adopted.
- Conservation commissions, in cooperation with other local officials responsible for the management of town lands, should map all vernal pools on town-owned property and integrate the protection of these areas into management plans.
- Conservation commissions are encouraged to work with landowners interested in managing their land for wildlife habitat to locate and document vernal pools and integrate protection of these areas into management plans.

## Awareness is Key

Most importantly, vernal pools cannot be protected unless their locations are known and documented. Once members of the community and/or landowners know where vernal pools are located, as well as their importance to wildlife, it will be a giant step forward in their protection.

This manual is intended to aid individuals in the identification and documentation of vernal pools. It does not specifically address the conservation strategies needed to maintain these pools and the species that require them to live. **It is important to remember that although vernal pools provide crucial breeding and foraging habitat for a variety of species, populations of these species will NOT be maintained without adequate protection of surrounding uplands.** To successfully conserve wildlife associated with vernal pool habitats, conservation efforts will need to include vernal pools, as well as the terrestrial habitat surrounding the pool, and undeveloped landscape connections to other vernal pools and other wetlands.

For more details on conserving vernal pools, please see the Bibliography and especially *Best Development Practices – Conserving Pool-breeding Amphibians in Residential and Commercial Developments in the Northeastern United States* (Calhoun and Klemens 2002).

*Vernal Pools - Habitat Stewardship Series*
Provides information on recognizing vernal pools, why vernal pools are important, and stewardship guidelines for vernal pools.
http://www.wildlife.state.nh.us/habitat/brochures.html

*Habitat Management Guidelines for Amphibian and Reptiles of the Northeastern United States.*
Includes numerous management guidelines for 'seasonal isolated wetlands'.
http://northeastparc.org/wp-content/uploads/2015/08/Final-NE-HMG.pdf

# Appendix

## GLOSSARY

**Amplexus:** The position assumed by male and female frogs during egg laying and external fertilization; the male is on the female's back, clasping her body.

**Balancer:** A slender, rod-like appendage which projects from each side of the head of newly-hatched larvae in some species of salamanders.

**Carapace:** The top shell of a turtle, or the hard, shell-like covering of an invertebrate.

**Cloaca:** The chamber into which the intestinal, urinary and reproductive tracts open.

**Compressed:** Flattened; laterally compressed: flattened from side to side.

**Digit:** Finger or toe.

**Diurnal:** Active by day.

**Dorsal/dorsum/dorso:** The upper surface of an animal, the "back."

**Fossorial:** An animal that lives beneath the surface of the ground.

**Gill:** A feathery or filamentous aquatic respiratory organ, external in larval salamanders.

**Hydric soil:** Soil that is saturated or flooded during a sufficient portion of the growing season to develop anaerobic conditions in the upper soil layers.

**Juvenile:** Refers to the stage following metamorphosis when larval characteristics have been replaced by adult characteristics, but the animal has not reached reproductive maturity. See also transforming juvenile.

**Keel:** In salamanders, usually refers to the raised edge along the dorsal surface of the tail in certain species.

**Larva** (larvae, pl.): A gilled, free-living, post-hatching stage capable of acquiring its own nourishment. The larval stage begins at hatching and ends at metamorphosis.

**Lateral:** Referring to the side of an animal.

**Metamorphosis:** A change or transformation; in salamanders refers to the transition from a gilled larval stage to a juvenile stage lacking gills. In frogs transition from tadpole to juvenile frog

**Mole salamander:** Stout-bodied salamanders, genus *Ambystoma*. These salamanders spend most of their lives underground, entering temporary pools in early spring to breed.

**Nocturnal:** Active at night.

**Plankton:** Minute floating organisms; phytoplankton are tiny floating plants, usually algae; zooplankton are animal plankton.

**Plastron:** The bottom shell of a turtle.

**Pond larvae:** A type of salamander larva characterized by a deep dorsal fin that extends well forward onto the body, long feathery gills, slender toes and often the presence of balancers during its early stages.

**Primary vernal pool indicators:** The presence or physical evidence of breeding by marbled salamander, wood frog, spotted salamander, Jefferson-blue spotted salamander complex, or fairy shrimp.

**Secondary vernal pool indicators:** Physical evidence used by wildlife biologists or certified wetlands scientists who are familiar with vernal pool habitats as evidence of the presence of a vernal pool, if primary vernal pool indicators are absent and other vernal pool characteristics suggest vernal pool habitat. Secondary vernal pool indicators include, but are not limited to, caddisfly larvae and cases (*Limnephilidae, Phryganeidae*, or *Polycentropodidae*), clam shrimp and their shells (*Laevicaudata, Spinicaudata*), fingernail clams and their shells (*Sphaeriidae*), aquatic beetle larvae (*Dytiscidae, Gyrinidae, Haliplidae,* and *Hydrophilidae*), dragonfly larvae and exuviae (*Aeshnidae, Libellulidae*), spire-shaped snails and their shells (*Physidae, Lymnaeidae*), flat-spire snails and their shells (*Planorbidae*), damselfly larvae and exuviae (*Coenagrionidae, Lestidae*), and true fly larvae and pupae (*Culicidae, Chaoboridae*, and *Chironomidae*).

**Spermatophore:** A structure produced in the cloaca of a male salamander and then attached to the substrate; consists of a gelatinous base and stalk, capped with sperm; sperm transfer occurs when the female salamander removes the sperm packet with her cloaca.

**Transforming juvenile:** Those amphibians that are between the larval and adult stage. Frogs show some remnant of a tail and transforming salamanders look like adults but have gill remnants.

**Ventral/venter:** The lower surface of an animal; the belly or abdomen.

**Vernal pool:** a surface water or wetland, which provides breeding habitat for amphibians and invertebrates that have adapted to the unique environments provided by such pools, and which typically has the following characteristics:

(1) Cycles annually from flooded to dry conditions, although the hydroperiod, size, and shape of the pool might vary from year to year:

(2) Forms in a shallow depression or basin;

(3) Has no permanently flowing outlet;

(4) Holds water for at least 2 continuous months following spring ice-out;

(5) Lacks a viable fish population; and

(6) Supports one or more primary vernal pool indicators, or 3 or more secondary vernal pool indicators.

For the regulatory definition of ‘vernal pool’ used by N.H. DES, see *Chapter 8*.

## EQUIPMENT FOR VERNAL POOL SURVEYS AND DOCUMENTATION

Be prepared, dressed and equipped so you will be able to effectively search pools and identify and document what you find. Check through the list of suggested equipment. After some field sessions you will settle on a combination of gear and techniques which best suit you. Everyone has preferences on what to take to the field. Don't overburden yourself.

### OBSERVATION AIDS

At many pools it will be possible to gather documentation without going into the pool. Observations made from the edge create the least disturbance to pool inhabitants.

- A head lamp or waterproof flashlight for nocturnal forays. The advantage of a headlamp is that both hands are free.
- Dip nets of various sizes. A kitchen strainer will work for larger animals. The local bait shop or outdoor sports store is likely to carry a variety of hand nets, or you can make one from an old nylon stocking and a clothes hanger. Several companies online sell biological supplies and can be a source for nets and other equipment.
- Clear plastic jars and/or light-colored enamel baking pan or plastic dishpan for holding specimens while you identify or photograph them. A plastic tray can double as a plunge tray. A white Frisbee works well as a shallow tray. You may be able to obtain some clear deli containers that can hold a small sample for observation. By placing a white paper underneath the container you can view the contents easily. Glass containers are not recommended.
- Waterproof boots are imperative when visiting vernal pools early in the season or when it is cool weather. Hip- or chest-waders are recommended. As the weather warms you may choose to wear old sneakers that can get soaked.
- Magnifying glass (7X - 10X is recommended).
- A clear-bottom bucket greatly improves the view into the water. Cut the bottom out of a 5-gallon plastic bucket, leaving a 1/2 inch rim around the edge. Glue a piece of plexiglass to the outside of the bottom, using marine sealant or waterproof silicone. Use a waterproof flashlight to enhance viewing in dim conditions.
- Binoculars, especially those that focus closer than 15 feet, are very useful in making observations from a distance.

If you have an invertebrate that you need to identify, collect it in a small container with vernal pool water. If you are not able to identify it immediately following its collection, preserve it in a leak-proof container filled with isopropyl alcohol (rubbing alcohol) or 70% Ethyl alcohol (ethanol). Before you place it in the alcohol, note any colors on the specimen. Often preservation in alcohol will change the color of the specimen.

*Note: Do not take the rubbing alcohol into the field. Only use it in a controlled environment (your house or a lab).*

See Chapter Six for a discussion of minimizing the risk of spreading amphibian diseases (page. 52).

## DOCUMENTATION AIDS

- A field notebook - for recording observations and notes in field.
- Appropriate maps
- GPS unit
- Compass
- Field forms
- Clipboard
- Pencils
- Field guides (if necessary).
- Camera with flash, capable of close focus.
- Yard/meter stick to measure water depth (or mark various depths on the handle of a dip net that you are using)
- Thermometer to measure air and water temperature.
- 100 foot (or more) plastic tape to measure pool size.
- A small knapsack to carry a notepad, guides, camera, containers etc. This keeps everything organized and ready to go.

## DETERMINING DISTANCES

Pacing is a simple but effective method for estimating how far it is from one point to another without any special equipment. Pacing is the practice of calculating a distance based on the number of steps you have taken. There are generally two types of pacing, namely single and double pacing. Single pacing is counting every single step you take, while double pacing counts only on right or left foot steps. With pacing, you can measure the pool's dimension and find the distance from the road to your pool or from a permanent landmark to your pool.

Measure your pace (single or double, whichever you find easier to use) on a course – such as on your local high school track. For these purposes, this should be accurate enough for certification purposes. For tall people, one double pace will be closer to six feet; for shorter folks, four to five feet.

If you would like to more accurately determine the length of your pace, measure a course, 200 feet long, in terrain similar to that you'll be working in. Walk it twice and divide the number of paces it took into 400 feet. Memorize this number (the length of your pace).

With practice, you should be able to estimate distances with sufficient accuracy, even in uneven terrain.

**Hint:** when walking uphill, your pace will be shorter; compensate by subtracting a few paces from your total. When walking downhill, your pace will be longer; compensate by adding a few paces to your total.

Many outdoors people (such as hunters, golfers), use a laser rangefinder to estimate the distance to a certain object. These can be useful in estimating distances across larger vernal pools.

## HOW TO PHOTOGRAPH AMPHIBIANS AND REPTILES

These guidelines are provided to help you take photographs of amphibians and reptiles that can use used to identify the species, where possible. Although snakes and turtles are not vernal pool indicator species, they may be encountered. Photographs of any amphibian or reptile you observe are encouraged.

**Know the limitations of your camera.** The use of digital cameras has made photography easier by allowing you to see your photo before you leave the area. It doesn't make things easier when the animal is only around for a couple of seconds!

Many fixed focus (point and shoot) cameras cannot focus closer than three or four feet. Read your instruction manual to be sure. Make sure you know how to focus your camera on closer objects. Even some smart phone cameras can take excellent close-up photos. A flash can greatly increase your chances of getting a useful photograph, except that the flash will reflect off of any wet surfaces and eliminate some of your intended subjects. Take multiple photos and submit the best.

To get a good, recognizable photograph you might need to handle a specimen. Pictures of an animal in the hand are perfectly acceptable. Handle animals carefully; keep your hands moist, keep the animal cool, be careful of a salamander's tail – it can easily detach. Work quickly, do not detain the animal longer than necessary. (Do not handle animals if you have used insect repellent on your hands or body!)

**FROGS:** Virtually all frogs can be identified by a three-quarter view, where you are slightly above and off to one side of the animal. This view will show most identifying features, such as a mask, spots, warts and dorso-lateral folds.

**SALAMANDERS:** Most salamanders are easily identified from a photograph that is taken directly above them. Since most species are small, try to get as close as your lens will allow. Try to show all legs. It is best to place the salamander on a neutral colored background (a leaf, light bark or backpack) for contrast. A picture of the underside is helpful for identification of some species.

**TURTLES:** Most of the time a good picture of the top shell (carapace) will suffice. The young of some species of turtles have a different pattern from the adults, so be sure to get a clear shot. A picture of the bottom shell (plastron) is also recommended.

**SNAKES:** As a group, snakes have a wide variation in colors and patterns, even within members of the same species. Hatchling and juvenile snakes can be dramatically different from adults in color and pattern, and some species have various color morphs as adults. It is best to photograph from above from as close (and safe) a position as possible.

*Be sure to include in your field notes the date, location and comments regarding any photographs you take.*

# NEW HAMPSHIRE AGENCIES AND ORGANIZATIONS TO CONTACT FOR MORE INFORMATION ON VERNAL POOLS

| AGENCIES AND ORGANIZATIONS | TYPE OF INFORMATION |
|---|---|
| **Nongame and Endangered Wildlife Program**<br>**NH Fish and Game Department**<br>11 Hazen Drive<br>Concord, NH 03301<br>(603) 271-2462<br>*http://www.wildlife.state.nh.us/nongame/index.html* | Information about documenting vernal pools.<br>Amphibian and Reptile Species Profiles and reporting information.<br>Link to NH Wildlife Sightings.<br>NH Wildlife Action Plan. |
| **Audubon Society of New Hampshire**<br>**Conservation Department**<br>84 Silk Farm Road<br>Concord, NH 03301-8200<br>(603) 224-9909<br>*www.nhaudubon.org* | Conservation opportunities, workshops, presentations. |
| **N.H. Department of Environmental Services**<br>**Wetlands Bureau**<br>PO Box 95<br>29 Hazen Drive<br>Concord, NH 03302-0095<br>(603) 271-2147<br>*www.des.nh.gov/organization/divisions/water/wetlands/index.htm* | Vernal pool identification resources.<br>Wetlands rules about vernal pools.<br>Wetland permitting process. |
| **N.H. Office of Energy and Planning Program**<br>Governor Hugh J. Gallen State Office Park<br>Johnson Hall, 3rd Floor<br>107 Pleasant Street<br>Concord, NH 03301<br>(603) 271-2155<br>*www.nh.gov/oep/* | Zoning ordinances to protect water resources and vernal pools. |
| **UNH Cooperative Extension**<br>**State Office**<br>Taylor Hall<br>59 College Rd.<br>Durham, NH 03824<br>(603) 862-1520<br>*www.extension.unh.edu/Natural-Resources*<br><br>UNH Cooperative Extension has one office in each county, and the Education Center in Manchester. | Provides wildlife and habitat-focused technical assistance, property visits, educational programs, field trips, volunteer opportunities, and helps coordinate financial assistance to landowners and others interested in wildlife conservation and stewardship. |
| **Harris Center for Conservation Education**<br>Ashuelot Valley Environmental Observatory<br>83 Kings Highway<br>Hancock, NH 03449<br>(603) 525-3394<br>*www.aveo.org/citizen-science/vernal-pools/* | Ashuelot Valley Environmental Observatory (AVEO) is the citizen science arm of the Harris Center, linking citizens with professional scientists to gather ecological data aimed at protecting and restoring the environment of southwest New Hampshire. |
| **NH Association of Natural Resource Scientists**<br>PO Box 110<br>Concord, NH 03302<br>info@nhanrs.org<br>*www.nhanrs.org* | Organization's members include wetland scientists and wildlife biologists who have experience in documenting vernal pools. |

# BIBLIOGRAPHY

## TECHNICAL PUBLICATIONS


**Brooks, R. T.** and **E. A. Colburn**. 2012. *Island" Attributes and Benthic Macroinvertebrates of Seasonal Forest Pools*. NORTHEASTERN NATURALIST 19(4):559–578

**Babbitt, K.J.**, and **R. Jenkins**. 2003. *Developing a conservation strategy to protect land habitat functions for New Hampshire's reptiles and amphibians using the Blanding's turtle (Emydoidea blandingii) as a flagship species.* Final report for N.H. Fish and Game. University of New Hampshire, Durham, NH.

**Babbitt, K.J.**, **M.J. Baber**, and **T.L. Tarr**. 2003. P*atterns of larval amphibian distribution along a wetland hydroperiod gradient*. Canadian Journal of Zoology. 81:1539-1552.

**Babbitt, K.J.** 2005. *The relative importance of wetland size and hydroperiod for amphibians in southern New Hampshire*, USA. Wetland Ecology and Management 13: 269-279.

**Burne, M.R.** 2001. *Massachusetts Aerial Photo Survey of Potential Vernal Pools. Natural Heritage and Endangered Species Program*, Department of Fisheries and Wildlife. Westborough, MA.

**Calhoun. A.**, **Miller, N.** and **Klemens, M.** *Conserving Pool-Breeding Amphibians in Human-Dominated Landscapes through local implementation of Best Development Practices*. Wetlands Ecology & Management; May 2005, Vol. 13, Issue 3, p291.

**Cutko, A, and T.J. Rawinski.** 2008. *Flora of northeastern vernal pools, in Science and Conservation of Vernal Pools in Northeastern North America*. CRC Press, Boca Raton, FL.

**deMaynadier, P.G.** and **M.L. Hunter, Jr.** 2000. *Road effects on amphibian movements in a forested landscape*. Natural Areas Journal 20:56-65.

**deMaynadier, P.G.**, and **M.L. Hunter, Jr.** 1995. *The relationship between forest management and amphibian ecology; a review of the North American literature*. Environmental Reviews 3:230-261.

**deMaynadier, P.G.**, and **M.L. Hunter, Jr.** 1999. *Forest canopy closure and juvenile emigration by pool-breeding amphibians in Maine*. Journal of Wildlife Management 63:441-450.

**Gibbs, J.** and **W.G. Shriver** 2005. *Can road mortality limit populations of pool-breeding amphibians?* Wetlands Ecology and Management 13: 281-289.

**Gibbs, J.P.** 1993. *Importance of small wetlands for the persistence of local populations of wetland-associated animals.* Wetlands 13:25-31.

**Gibbs, J.P.** 2000. *Wetland loss and biodiversity conservation.* Conservation Biology 14:314-317.

**Herrmann, H. L., K .J. Babbitt, M. J. Baber,** and **R. G. Congalton**. 2005. *Effects of landscape characteristics on amphibian distributions in a forest-dominated landscape*. Biological Conservation 123: 139-149.

**Karraker, N.**, **J. Gibbs**, and **J. Vonesh** 2008. *Impacts of road de-icing salt on the demography of vernal pool-breeding amphibians.* Ecological Applications 18:724–734.

**Oliver, J.A.** and **J.R. Bailey** 1939. *Amphibians and Reptiles of New Hampshire in Biological Survey of the Connecticut River Watershed*, pp 195-222. N.H. Fish and Game Commission, Concord. 256 pp.

**Oscarson, D.** and **A.J.K. Calhoun**. 2007. *Developing vernal pool conservation plans at the local level using citizen scientists.* Wetlands 27:80-95.

**Paton, P.W.C.**, and **W.B. Couch, III**. 2002. *Using phenology of pond-breeding amphibians to develop conservation strategies*. Conservation Biology 16: 194-204.

**Patrick, D. A., C. M. Schalk, J. P. Gibbs,** and **H. W. Woltz**. 2010. *Effective culvert placement and design to facilitate passage of amphibians across roads*. Journal of Herpetology 44: 618-626.

**Patrick, D. A., J. P. Gibbs, V. D. Popescu,** and **D. A. Nelson**. 2012. *Multi-scale habitat-resistance models for predicting road mortality "hotspots" for turtles and amphibians*. Herpetological Conservation and Biology 7: 407-426.

**Patrick, D.A., M.L. Hunter, Jr.,** and **A.J.K. Calhoun**. 2006. *Effects of experimental forestry treatments on a Maine amphibian community*. Forest Ecology and Management 234(2006): 323-332.

**Pechmann, J.H.K., R.A. Estes, D.E. Scott,** and **J.W. Gibbons.** 2001. **Amphibian colonization and use of ponds created for trial mitigation of wetland loss**. Wetlands 21(1): 93-111.

**Preisser, E.L.**, **J.Y. Kefer**, **J.D. Lawrence**, and **T.W. Clark**. 2001. *Vernal pool conservation in Connecticut: An assessment and recommendations.* Environmental Management 26:503-513.

**Regosin, J.V.**, **B.S. Windmiller**, **R.N. Homan**, and **J.M. Reed**. V*ariation in terrestrial habitat use by four pool-breeding amphibian species*. Journal of Wildlife Management, 69(4):1481-1493. 2005

**Semlitsch, R.D**. and **J.R. Bodie**. 2003. *Biological criteria for buffer zones around wetlands and riparian habitats for amphibians and reptiles*. Conservation Biology 17:1219-1228.

**Semlitsch, R.D.** 1998. *Biological delineation of terrestrial buffer zones for pond breeding salamanders*. Conservation Biology 12:1113-1119.

**Semlitsch, R.D.** 2000. *Principles for management of aquatic-breeding amphibians*. Journal of Wildlife Management 64: 615-631.

**Semlitsch, R.D.,** and **J.R. Bodie**. 1998. *Are small, isolated wetlands expendable?* Conservation Biology. 12: 1129-1133.

**Semlitsch, R.D., D.E. Scott, J.H.K. Pechmann** and **J.W. Gibbons**. 1993. *Phenotypic variation in the arrival time of breeding salamanders: individual repeatability and environmental influence*. Journal of Animal Ecology 62: 334-340.

**Skelly, D.K.** 1997. *Pond permanence and predation are powerful forces shaping the structure of tadpole assemblages*. American Scientist 85: 36-45.

**Snodgrass, J.W., M.J. Komoroski, A.L Bryan, Jr.,** and **J. Burger**. 2000. *Relationships among isolated wetland size, hydroperiod, and amphibian species richness: implications for wetland regulations*. Conservation Biology 14: 414-419.

**Stone, J.S.** 1992. *Vernal Pools in Massachusetts: Aerial Photographic Identification, Biological and Physiographic Characteristics, and State Certification Criteria*. M.S. Thesis, University of Massachusetts, Amherst, MA.

**Tarr, M.** and **K. Babbitt**. *The Importance of Hydroperiod in Wetland Assessment: A guide for community officials, planners, and natural resource professionals.*

**Turtle, S.L.** 2000. *Embryonic survival of the spotted salamander (Ambystoma maculatum) in roadside and woodland vernal pools in southeastern New Hampshire*. Journal of Herpetology. 34: 60-67.

**Brooks.** 2004. *Weather-related effects on woodland vernal pool hydrology and hydroperiod.* WETLANDS, Vol. 24, No. 1.

**Windmiller, B.** and **A.J.K. Calhoun**. 2007. *Conserving Vernal Pool Wildlife in Urbanizing Landscapes, in Science and Conservation of Vernal Pools in Northeastern North America*. CRC Press, Boca Raton, FL.

**Windmiller, B.**, **R.N. Homan**, **J.V. Regosin**, **L.A. Willitts**, **D.L. Wells**, and **J.M. Reed**. 2008. *Breeding amphibian population declines following loss of upland forest habitat around vernal pools in Massachusetts, USA*. In: Mitchell, R.E., J. Brown, and B. Bartholomew (eds). Urban Herpetology. Herpetological Conservation.

## OTHER PUBLICATIONS

**Behler, J.L.** and **F.W. King**. 1979. *The Audubon Society Field Guide to North American Reptiles and Amphibians*. Alfred A. Knopf, Inc., Inc. New York. 718 pp. **A**

**Bergum, C. R.** 2009. *Under the Snow*. Melissa Stewart. Peachtree Publishers.

**Biebighauser, T.** 2002. *A guide to creating vernal ponds.* USDA Forest Service in cooperation with the Izaak Walton League of America. Morehead, Kentucky. 33 pp. **G, L**

**Brown, L. J.** and **R. E. Jung. 2005**. *An Introduction to Mid-Atlantic Seasonal Pools*. EPA/903/B-05/001. U.S. Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Fort Meade, MD. **G, A**
http://www.dnrec.delaware.gov/fw/dplap/information/Documents/Mid-Atlantic%20Seasonal%20Ponds%20-%20EPA.pdf

**Calhoun, A.J.K.** and **P. deMaynadier**. *Science and Conservation of Vernal Pools in Northeastern North America*. **G, C**

**Calhoun, A.J.K.** 2003. *Maine Citizen's Guide to Locating and Documenting Vernal Pools*. Main Audubon Society, Falmouth, ME. 96 pp. G

**Calhoun, A.J.K.** and **P. deMaynadier**. 2003. *Forestry Habitat Management Guidelines for Vernal Pool Wildlife in Maine*. U.S. Environmental Protection Agency, Boston, MA. **L**

**Calhoun, A.J.K.** and **M.W. Klemens**. 2002. *Best Development Practices: Conserving Pool-breeding Amphibians in Residential and Commercial Developments in the Northeastern United States*. MCA Technical Paper No. 5, Wildlife Conservation Society, Bronx, NY. 57 pp. **A, L**
http://maineaudubon.org/wp-content/uploads/2012/08/Best-Development-Practices-Conserving-Pool-breeding-Amph.pdf

**Chase, V.**, **L.S. Deming**, and **F. Latawiec**. 1995. *Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities*. Audubon Society of New Hampshire. 80 pp. **L**
http://www.nh.gov/oep/planning/resources/documents/buffers.pdf

**Colburn, E.** 2004. *Vernal Pools: Natural History and Conservation*. The McDonald and Woodward Publishing Company. Blacksburg, Virginia. **G, A, I, L**

**Collins, J.T.**, **R. Conant**, **R.T. Peterson**. 1998. *A Field Guide to Reptiles and Amphibians: Eastern and Central North America (Peterson Field Guides)*. Houghton Mifflin Harcourt; Fourth edition. **F, A, R**

**Cornell Laboratory of Ornithology**, 1982. *Voices of the Night*. 1982. The Calls of the Frogs and Toads of Eastern North America. Cornell Laboratory of Ornithology, Ithaca, NY. **A**

**Cowardin, L.M.**, **V. Carter**, **F.C. Golet**, and **E.T. LaRoe**. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. USDI Fish and Wildlife Service, Office of Biological Services. FWS/OBS-79/31. **W**

**DeGraaf, R.M.** and **M. Yamasaki**. 2001. *New England Wildlife: Habitat, Natural History, and Distribution*. University Press of New England, Hanover, NH. 482 pp. **G**

**DeGraaf, R. M.** and **D.D. Rudis**. 1983. *Amphibians and Reptiles of New England*. University of Massachusetts Press, Amherst. 85 pp. (out of print) **A**

**Donahue, D.F.** 1996. **A Guide to the Identification and Protection of Vernal Pool Wetlands of Connecticut**. University of Connecticut Cooperative Extension Program. **G, C**

**KEY** – Focus of reference

**G**: General vernal pool
**A**: Amphibians
**C**: Conservation
**P**: Plants
**W**: focus on Wetlands
**R**: Reptiles
**L**: Land Use
**F**: Field guide
**I**: Invertebrates
**K**: Kids/teachers and grades/ages as noted

**Elliott, L.** 2004. *The Calls of Frogs and Toads*. Book and CD. 2004. **A**

**Gibbs, J. P.**, **A.R. Breisch**, **P.K. Ducey**, **G. Johnson**, and **J. Behler**. 2007. *The Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation*. Oxford University Press. **A**

**Fassett, N.C.** 1975. *A Manual of Aquatic Plants*. The University of Wisconsin Press, Madison. 405 pp. **P**

**FitzSimmons, D.S.** and **G. Meszaros.** 2011. *Animals of Ohio's Ponds and Vernal Pools*. Kent State University Press, Ohio. **G**

**Harley, B.** 2008. Night of the Spadefoot Toads. (fiction). **A, K**

**Himmelman, J.** 1998. *A Salamander's Life.* (Nature Upclose) Children's Press (CT). **K**: age 5+ (gr: K+)

**Himmelman, J.** 1999. *A Wood Frog's Life*. Children's Press (CT). **K**: age 5+ (gr: K+)

**Hotchkiss, N.** 1972. *Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada*. Dover Publications, Inc., New York. 124 pp. **P**

**Hunter, M.L.**, **A.J.K. Calhoun**, and **M. McCollough**, eds. 1999. *Maine Amphibians and Reptiles*. University of Maine Press, Orono, Maine. 252. **A**

**Kenney, L.P.** and **M.R. Burne**. 2000. *A Field Guide to the Animals of Vernal Pools.* Massachusetts Division of Fisheries and Wildlife and the Vernal Pool Association, Reading, MA. 77 pp. **F, A, I**

**Kenney, L.P.** 2008. *Wicked Big Puddles*. Vernal Pool Association, PO Box 2295, Peabody, MA. **G**

**Klemens, M.W**. 2000. Amphibians and Reptiles in Connecticut. Connecticut Department of Environmental Protection, DEP Bulletin No. 32, Hartford, CT. A
*http://www.ct.gov/deep/cwp/view.asp?a=2723&q=325856*

**Knobel, E.** 1977. *Field Guide to the Grasses, Sedges and Rushes of the United States*. Dover Publications, Inc., New York. 83 pp. **P**

**Lamstein, S.M.** 2010. *Big Night for Salamanders*. Boyds Mills Press. **K:** gr: 3-7 (age 8-12)

**Lichvar, R.W.** 2013. *National Wetland Plants List.* The National Wetland Plant List: 2013 wetland ratings. Phytoneuron 2013-49: 1-241. **W**

**Magee, D.** 1981. *Freshwater Wetlands: A Guide to Common Indicator Plants of the Northeast*. University of Massachusetts Press, Amherst. **P**

**Massachusetts Audubon Society**. 1995. *Pond Watchers Guide to Ponds and Vernal Pool of Eastern North America*. Lincoln, Mass. 8 pp. (Highly recommended, excellent illustrations and laminated for field use). **G, F, K**

**Mazer, Anne**. 1994. *The Salamander Room*. Dragonfly Books; 1st Dragonfly Books Ed edition. 1994.

**McCafferty, W.P.** 1999. *Aquatic Entomology, The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives*. Jones and Bartlett Publishers, Sudbury, Massachusetts. (This book focuses more on flowing water habitats, but it has great illustrations.) **I**

**Mitchell, J.C.**, **A.R. Breisch**, and **K.A. Buhlmann**, 2006. *Habitat Management Guidelines for Amphibians and Reptiles of the Northeastern United States*. Partners in Amphibian and Reptile Conservation, Technical Publication HMG-3, Montgomery, Alabama. 108 pp. **A, R, L**
*http://northeastparc.org/wp-content/uploads/2015/08/Final-NE-HMG.pdf*

**KEY** – Focus of reference

| | | |
|---|---|---|
| **G**: General vernal pool | **W**: focus on Wetlands | **F**: Field guide |
| **A**: Amphibians | **R**: Reptiles | **I**: Invertebrates |
| **C**: Conservation | **L**: Land Use | **K**: Kids/teachers and grades/ages as noted |
| **P**: Plants | | |

**Morgan, D.E.** and **A.J.K. Calhoun**. 2012. **The Maine Municipal Guide to Mapping and Conserving Vernal Pools**. University of Maine, Sustainability Solutions Initiative, Orono, ME. **G, C, LU**
*http://umaine.edu/mitchellcenter/files/2013/07/Maine-Municipal-Guide-to-Mapping-and-Conserving-Vernal-Pool.pdf*

**NEPARC**. 2010. *Summary of Vernal Pool Regulations in the Northeast*. Northeast Partners in Amphibian and reptile Conservation (NEPARC). Publication 2010-2 (available online). **G, L**

*N.H. Wildlife Action Plan,* Habitats section. 2015. New Hampshire Fish and Game Department. (online) **G, C**
*http://www.wildlife.state.nh.us/wildlife/documents/wap/appendixb-habitats.pdf*

**Peckarsky, B.L.**, **P.R. Fraissinet**, **M.A. Penton**, and **D.J. Conklin**, Jr. 1990. *Freshwater Macroinvertebrates of Northeastern North America*. Cornell University Press, Ithaca, N.Y. 442 pp. **I**

**Petranka, J.W.** 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C. 587 pp. **A**

**Pfingsten, R.A.** and **F.L. Downs**, eds. 1989. *Salamanders of Ohio*. Bulletin of the Ohio Biological Survey 7(2). College of Biological Sciences, Ohio State University, Columbus. 315 pp. **A**

**Reid, G.K.** 1987. *Pond Life*, 2nd ed. Golden Guide Series. Golden Press, New York. 160 pp. **A, I**

**Semlitsch, R.D.** and **D.B. Wake**. 2003. *Amphibian Conservation*. **A**

**Smith, D.G.**, 2001. *Pennak's Freshwater Invertebrates of the United States: Porifera to Crustacea*, 4th Edition. August 2001. **I**

**Sperduto, D.**, and **B. Kimball**. 2011. *The Nature of New Hampshire. Natural Communities of the Granite State*. University of New Hampshire. N.H. Natural Heritage Bureau (Great information about plant communities and N.H.'s landscape. Little information specifically on vernal pools. **G**

**Tiner, R.W.** 2005. *In Search of Swampland: A Wetland Sourcebook and Field Guide by Rutgers University Press*. Second Edition. **W**

**Tiner, R.W., Jr.** 1988. *Field Guide to Nontidal Wetland Identification*. Maryland Dept. of Natural Resources, Annapolis and U.S. Fish and Wildlife Service, Newton Corner, MA. 283 pp. **W**

**Thorp, J. A.** and **D. C. Rogers**. 2010. *Field Guide to Freshwater Invertebrates of North America*. Academic Press, 2010. **I**

**Tyning, T.F.** 1990. *A Guide to Amphibians and Reptiles*. (Stokes Nature Guides) Little, Brown and Co., Boston. 400 pp. **A**

**Voshell, Jr., J. R.** 2002. *A Guide to Common Freshwater Invertebrates of North America*. The McDonald and Woodward Publishing Company. Blacksburg. **I**

**Wechsler, D.** 2006. *Frog Heaven: Ecology of a Vernal Pool*. Boyds Mills Press. **K:** gr 3-7 (age 8-12)

**KEY** – Focus of reference

**G**: General vernal pool
**A**: Amphibians
**C**: Conservation
**P**: Plants
**W**: focus on Wetlands
**R**: Reptiles
**L**: Land Use
**F**: Field guide
**I**: Invertebrates
**K**: Kids/teachers and grades/ages as noted

# About New Hampshire's Nongame and Endangered Wildlife Program

As the steward of New Hampshire's wildlife resource, the New Hampshire Fish and Game Department is responsible for the conservation of over 500 wildlife species. About 75 percent are nongame wildlife – species not hunted, fished or trapped. Twenty-seven species are endangered and thirteen are threatened. The Nongame and Endangered Wildlife Program was established in 1988 to develop and implement a program to protect and enhance this diverse group of wildlife.

The Program protects endangered, threatened and common species, connects wildlife to special habitats and restores landscapes that make it possible for wildlife to thrive. Most field projects are carried out in cooperation with other New Hampshire wildlife agencies and organizations.

The Nongame and Endangered Wildlife Program receives no funds from sporting licenses or related fees. Traditionally, funds have been raised annually from private sources, and are matched by the state.

**New Hampshire**
**Fish and Game Department**
**11 Hazen Drive**
**Concord, NH 03301**
**wildnh.com/nongame**