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PREFACE

VERNAL POOLS, HARBINGERS OF SPRING

”Quack, quack, quack, ...“ could it be? As I bushwhack my way through the awakening forest over patches of slushy snow and soggy moss, I move ever closer to what I think must be a flock of black ducks sequestered in the trees. Have you ever done this...? All to find the wayward flock of ducks is instead a chorus of wood frogs singing the praises of spring? This is what I think of when I hear the term ”vernal pool.“ This manual is designed to help you identify, describe, and ultimately protect this unique wetland habitat.

An ecologist would describe a **vernal pool** as a wetland that is an ephemeral (temporary) pool that typically fills with snow melt and spring run-off (“vernal” = spring) and dries sometime during the summer. Many of these pools are essential breeding habitat for certain amphibians and invertebrates such as wood frogs, spotted and blue-spotted salamanders, and fairy shrimp. The key ecological feature is the seasonal nature of the pool that maintains a fishless environment conducive to the successful breeding of some amphibians. In addition to the species dependent upon these pools for successful reproduction, vernal pools are used for feeding and resting by a diversity of other animals, such as spring peepers and grey tree frogs, which can successfully reproduce in permanent waters or other aquatic habitats

In addition to being vital habitat for local plants and animals, vernal pools are important landscape features. If we think of them as wetland islands in a sea of upland forests, we see that groups of pools form stepping stones of hospitable habitat along which wetland-dependent wildlife may travel. Animals may leave meager resources at one pool and find more suitable habitat elsewhere. If the wetland mosaic of pools in an upland matrix is destroyed, wildlife populations may be isolated and more vulnerable to changes in their surroundings. Therefore, vernal pools are important habitat for local wildlife *and* they also form an important network of wetlands in the landscape.

PURPOSE OF THE MANUAL

Many people, though concerned about vernal pools, are not versed in vernal pool ecology. The primary goal of this manual is to provide you with the knowledge you need to locate, identify, and document vernal pool habitat

and vernal pool indicator species.

A second goal of this manual is to heighten public awareness of the ecological values of vernal pool habitats. Many pools are small, isolated and ephemeral in nature and they may be unnoticed at certain times of the year. Hence they are extremely vulnerable to human disturbance. Losses of many vernal pools in the same watershed can reduce available habitat for vernal pool animals.

Finally, the manual is designed to fill you with excitement about a unique habitat and its denizens. Part of the joy of living in New England is in finding the simple treasures that this recently glaciated landscape affords--glacial erratics, esker-bog complexes, kettle ponds, and vernal pools. As long as our forests are singing, we know they are healthy. Come join us in an effort to find, describe, and conserve the best singing pools in the forest.

For the vernal pool enthusiast smitten by the amphibian sirens of the forest, a list of field guides and other references is provided in the bibliography. Addresses and telephone numbers of organizations interested in vernal pools are provided in Appendix A.

CHAPTER I: An Introduction to Vernal Pools

WHAT IS THE DEFINITION OF A VERNAL POOL?

Seasonal or vernal pools are found worldwide and are known by many names. For example, in the mid-western United States they are referred to as prairie potholes while in the southeastern United States they are called seasonally ponded isolated wetlands. In New England, among ecologists, the term ”vernal pool“ has come to mean a very specific type of wetland primarily defined by its breeding animal community. For the purposes of this document, vernal pools (or temporary wetlands), are defined as naturally-occurring, seasonal bodies of water, free of predatory fish populations, that provide breeding habitat for 1 or more of Maine’s 4 vernal pool indicator species—spotted and blue-spotted salamanders (*Ambystoma maculatum* and *A. laterale*), wood frogs (*Rana sylvatica)*, and fairy shrimp (*Anostraca* spp.

Unvegetated pools, marshes, wet meadows, shrub swamps, and forested wetlands may all provide potential breeding habitat for vernal pool indicator species. Vernal pools occur in a variety of landscape settings including bottomlands associated with rivers, wetland complexes, and as isolated wetlands or depressions in an upland landscape. In some cases, these pools may be semi-permanent (never completely drying) or permanent. Permanent breeding pools tend to be shallow enough to exclude adult fish populations by becoming anoxic by summer's end and/or by completely freezing to the bottom in winter. These special features, particularly the lack of predatory fish, make vernal pools extremely important wildlife habitat.

Vernal pools typically hold water for three to five months beginning in early spring. However, characteristics of a vernal pool, such as size, duration of flooding, substrate, and vegetation are influenced by many factors including landscape setting, surficial geology, soil type, and surrounding vegetation. Furthermore, the size and duration of flooding for a particular pool may be quite different from year to year depending on local snow and rainfall patterns.

In some regions of the state, human-created pools and other wetlands, including beaver flowages and lake shores, may provide important breeding sites for the indicator species. We encourage landowners to protect these sites as well.

For the purposes of this manual, we are using the simple definition given above. However, you may have heard other terms describing vernal pools in the northeastern United States including ”astatic waters,“ ”seasonal ponds,“ ”temporary ponds,“ or ”ephemeral ponds“ and they are defined in the glossary.

THREE GOOD REASONS TO DOCUMENT AND CONSERVE VERNAL POOLS

1. SPECIAL BREEDING HABITAT

Fishless pools are optimal breeding habitat for vernal pool amphibian indicator species. Egg masses of wood frogs and the blue-spotted and spotted salamanders (known as "mole" salamanders because of their habit of living in small, underground burrows during the non-breeding season) do not have toxic compounds or the mechanical or physiological barriers to predation that characterize egg masses of many aquatic amphibians that regularly breed in permanent pools with fish (Brodie et al. 1987; Henrikson 1990; Crossland 1998). Even though the indicator species may be breeding in other wetlands, survival and recruitment of juveniles is problematic in wetlands with fish. Mole salamanders often return to breed in the pools where they were born (natal site fidelity) (Sinsch 1990, Duellman and Tureb 1986) and show little tendency to move away from disturbed sites (Petranka et al. 1994). At a minimum, protection of this specialized breeding habitat is a critical first step in conserving these species.

2. Habitat for increasingly threatened species

Worldwide declines in amphibian populations have focused attention on amphibian conservation. Many vernal pool species in northeastern North America are state-listed. For example, the blue-spotted salamander is listed as a Species of Special Concern in Vermont and Massachusetts and as threatened in Connecticut (Hunter et al. 1999). Blanding's (state-endangered) and spotted turtles (state-threatened) use vernal pools extensively in southern Maine. The ringed boghaunter and ebony boghaunter dragonflies (state-endangered) and four-toed salamander (state special concern) are also found in acidic, sphagnum-filled vernal pools. Wood turtles (state special concern) use vernal pools in riparian areas extensively for feeding. Feather foil, a rare aquatic plant, is exclusively found in vernal pools in southern Maine.

3. WETLAND STEPPING STONES IN AN UPLAND LANDSCAPE

Vernal pools and other small wetlands are important landscape features. The loss of small wetlands in a watershed may make it difficult for

amphibians to get from one pool to another. As more and more wetlands are lost, the distances between pools become greater (Gibbs 1993, Semlitsch and Brodie 1998).) These small wetlands also contribute to local biodiversity. Vernal pools support a myriad of plant, invertebrate, and vertebrate taxa (particularly amphibians) that would otherwise not occur in a local area.

THE VERNAL POOL HABITAT: THE VERNAL POOL AND THE UPLAND "LIFE ZONE."

The surrounding upland supports vernal pool amphibians during the 11.5 months in which they are not using the breeding pools (Semlitsch 1998). The 3 vernal pool amphibian indicator species depend on both aquatic and terrestrial habitats to complete their life cycle. Vernal pool breeding amphibians need areas of uncompacted deep litter, coarse woody debris, and patches of canopy shade for maintaining a suitable forest floor environment that enables dispersal, migration, foraging, and hibernation (deMaynadier and Hunter 1995. DiMauro, unpub data). This dependence on the habitat around the pool has prompted Semlitsch (1998) to refer to the "buffer zone" around pools as a "life zone." Juvenile wood frogs and adult mole may travel over half a mile from breeding pools (deMaynadier and Hunter 1996; and Semlitsch 1998). Salamanders, and to a lesser degree wood frogs, are especially sensitive to desiccation and temperature extremes (Shoop 1974; Stebbins and Cohen 1995). Conserving the upland area around the vernal pool is necessary for conserving wildlife values associated with vernal pools. In extreme instances, vernal pool amphibians have disappeared from pools after surrounding uplands were lost, even though the pool and a forested buffer were protected.

Vernal pools contribute a tremendous amount of amphibian and invertebrate biomass (and hence food) to the surrounding upland. After leaving the vernal pool, young and mature wood frogs and mole salamanders provide easy prey to a wide variety of forest animals including snakes, turtles, birds, predatory insects, and small mammals (Wilbur 1980; Pough 1983; Ernst and Barbour 1989). Salamanders and wood frogs in the forest may weigh more

than breeding birds and small mammals combined! (Windmiller 1996). You can see how amphibians are a powerful influence on the ecology of the surrounding forests. In fact, by feeding on insects, spiders, and other invertebrates, the influence rates of forest litter decomposition and nutrient cycling (Wyman 1998).

CHAPTER II: LOCATING VERNAL POOLS

ACCESS ISSUES

In many parts of the state, people routinely walk in woods and open areas; in other, more populated areas; the local police may look on such activities suspiciously. Depending on the conditions in your local area, you may find it useful to notify neighbors and/or the local police that you will be parking in and/or walking around the areas you have chosen. 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.

Public lands

Don't assume that permission to observe pools on public land is automatic. Some public lands are restricted, including public wells and watershed lands, solid waste disposal sites, hospitals, airports, and prison properties. Wildlife refuges and parks may have restricted areas to protect wildlife from human disturbance. Time of day may also be regulated. It is not uncommon for parks to have access from sunup to sundown for example. If you are unsure of access to public property, check with the department or organization that administers the lands. It also may be useful to put a note in your car window explaining whom you are, where you are, and why you are surveying the land.

Private land

In Maine, many privately owned open spaces have traditionally been open to public access. State law holds that individuals entering onto properties that have been subject to such public access are not guilty of trespassing. (Note, though, that it is illegal to enter on any private land in a motorized vehicle without permission from the owner.) It may be wise, however, and it is certainly courteous, to ask for permission of a landowner when you plan to enter property for the purpose of locating and describing vernal pools. You may not enter on any posted private land without first getting permission from the landowner. It is **strongly** recommended that you obtain permission to enter non-posted land as well.

If you wish to look for vernal pools on a piece of property but do not know the landowner, you can find out who the landowner is through the tax assessors' office or town tax maps. To gain access, call, write, or visit the owner.

Identify yourself and explain your interest in observing pools on the property. Be sensitive to the fact that some owners may not appreciate your efforts to locate and describe vernal pools on their land. If a landowner is not willing to cooperate and asks you to leave, do so immediately and politely. Do not stay and try to persuade or badger the owner into allowing you access.

WHEN?

Spring (March through May) is the easiest time of year to locate and describe pools. In early spring fairy shrimp are present, salamanders are migrating, frogs are calling, and courtship, mating, and egg laying have begun. In mid- to late spring, egg masses are highly visible. Larval salamanders and frogs (tadpoles) appear late spring into summer. Documentation of the presence of vernal pools is possible at other times of the year as well, but it can be more difficult.

Amphibian movements to spring breeding pools are strongly correlated with periods of high humidity or rainfall. Local weather conditions, including temperature, precipitation, and humidity, all offer clues about when spring amphibian movements will take place in your area. Expect amphibians to emerge from hibernation after the first warm spring rain or substantial snowmelt if air temperatures are above 40°F (4°C). Frogs and salamanders will migrate without rain and wet ground if temperatures are above 50°F (10°C) and humidity is greater than 80%. Amphibians can most readily be located and observed within 24 hours after rains. Wood frogs seem to be less tightly tied to weather conditions than salamanders and have been observed migrating during periods of drought and temperatures below 40°F. Their calls are infectious, so once a few males start calling, others will come to pools even in adverse conditions.

Migration from adjacent uplands to breeding pools occurs from mid-March to early April in southern Maine, the time of amphibian movement, though it may occur as early as mid-March. In central and northern Maine, mid- to late April or early May is more likely. Males head to breeding sites first, with females following 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 snow and ice.

Migration of adult mole salamanders (yellow and blue-spotted salamanders) to the breeding ponds normally takes place 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. Those traveling greater distances may take several nights, even under favorable conditions, or as much as two weeks if cold weather interrupts. Favorable periods of migration occur sporadically, often widely

separated by intervals of resumed wintry conditions. If night temperatures fall below freezing, salamander movement is halted. Conditions that bring a vast number of salamanders together (a ”congress“ of salamanders) at the same time and place are not present every year. Such assemblages take place during prolonged rains that permit many individuals to reach the breeding ponds at roughly the same time. Consider yourself fortunate if you witness such a spectacle.

WHERE? VERNAL POOLS IN THE LANDSCAPE

A wide variety of landscape settings have potential to support vernal pools in the northeastern forest. Commonly, vernal pools will be found in deep swales (low-lying linear depressions) in landscapes with impervious layers beneath the soil surface that perch or hold water. Pools may be a part of a larger wetland, commonly forested or scrub-shrub wetlands, associated with river floodplains, or may occur as isolated depressions (shallow depression or kettle hole) in upland landscapes. The pools may or may not have inlets and outlets; often these are very low-flow and/or functional only part of the year. 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, and the reduced predation characteristic of a fishless environment.

How?

A systematic search of your town for vernal pools is highly recommended. If this is not feasible, you may choose to locate vernal pools in a small portion of your town or on your own property. All information on vernal pools is valuable. Pools can be located by using one or any combination of the following methods:

1. Map work
2. Networking
3. Road surveys
4. Random encounters

Map work

Many types of maps or aerial photographs are available in state, regional, and town offices, outdoor sporting stores, and libraries. Depending on the type of map, the level of landscape detail or scale of aerial photographs, maps may be useful in locating actual pools, or more likely, suggesting potential areas to explore for vernal pools. Since vernal pools are often small and/or isolated they rarely show up on maps. Be aware of the limitations of maps. Know the scale of your map. Start with maps of an

area you are familiar with; it is helpful to be able to match the map with what you know of the land. Use maps to target areas to field check.

Aerial photographs

Interpretation of aerial photography takes some experience. If your group of volunteers has no experience, you may want to hire some help. However, below are some tips to help the novice.

When examining aerial photographs, pay close attention to forested areas as vernal pools are commonly found in forested habitats. Pools can be of any size and are variable in shape from round or elliptical to reticulated and irregular. They may occur in clusters. In upland settings (i.e. pool is not in a larger wetland system), pools will often stand out as well-defined basins. Vernal pool identification is easiest with photography taken under the following conditions:

- leaf off
- no ice or snow cover
- spring time (pools full)
- large scale (1" = 400' to 1" = 1,000')
- color infrared is the best (and the most expensive), black & white photos will work.
- stereoscopic sets will allow you to see the photos in three dimensions with a stereoscope; this is an invaluable aid for determining depressions and low-lying areas.

Some problems you may encounter searching aerial photos for vernal pools include:

- coverage of the town may be incomplete or out of date
- pools under dense coniferous or even mixed canopy cover may be difficult if not impossible to pick out
- clusters of conifers on black & white photos may show up as a dark spots which look like pools
- shadows can obscure pools or be mistaken for pools

U.S. Geological Survey 7.5 minute topographic maps

On topographic maps look for contours designating depressions, wet spot symbols and small ponds. Especially look for concentrations of these

features. Topographic maps may also provide evidence of floodplains, oxbows, remnants of old riverbeds, wetland areas associated with rivers and streams, and low-lying kettleholes that may collect spring runoff, snowmelt or seepage. Topographic maps can be purchased from many camping and outdoor equipment stores, bookstores, and the Maine Geological Survey in Augusta. It may be difficult to locate new pools on unfamiliar land using these maps; however, they do show the lay of the land, and may indicate areas to explore. They are particularly useful for areas of the town with which you are already familiar.

U.S. Fish & Wildlife Service National Wetland Inventory (NWI) Maps

The U.S. Fish and Wildlife Service has produced NWI maps for most of Maine. These maps can be used to identify wetland complexes. Look clusters of small wetlands as possible locations for searching for vernal pools. In general, look for:

- wetlands that are not connected to streams or lakes;
- PUB, PSS, and PFO-C wetland classes that are hydrologically isolated (these codes are explained on the bottom of the map),
- medium sized headwater PFO1/4E or F wetlands (may have an outlet stream). In some cases, large pools may even be mapped by NWI.

Be aware that NWI maps should serve only as a guide as they do not include all wetlands in the landscape and may misrepresent wetland types or classes. They are particularly helpful for picking out large areas of forested wetland (labeled PFO) or shrub wetland (labeled PSS) where vernal pools are likely to occur. Vernal pools are sometimes labeled PUB (palustrine, unconsolidated bottom). Most Maine towns will have copies of NWI maps you may borrow. They also can be ordered from the Maine Geological Survey in Augusta or the Map Store in Old Town (see addresses in Appendix A).

U.S.D.A. Natural Resources Conservation Service (NRCS) Soil Surveys

These soil maps are available for most counties at NRCS offices and possibly through your town office or library (note that NRCS was formerly the Soil

Conservation Service). It is not yet known if vernal pools are more commonly found in one soil type or another. Look for wetland soil complexes (peat, muck, very poorly drained, poorly drained, and somewhat poorly drained soils) when searching likely areas for pools. Any of the regional NRCS offices would gladly name the wetland soils (hydric soils) in your area to help you search the map. See Appendix B for a list of Maine hydric or wetland soils. Note however that vernal pools also occur in upland soils. To guide you in identifying upland landscapes and soil types likely to support pools, a description of landscapes and soil types is also given in Appendix B.

Maine Department of Environmental Protection Freshwater Wetland Maps

These maps may be of limited use as the minimum mapping unit is 10 acres and they exclude forested wetlands. These may only be useful in identifying complexes > 10 acres of nonforested wetland. These maps are also available through the Maine Geological Survey.

Town Wetland Maps or FEMA 100 Year Floodplain Maps

These may be available through the town conservation commission or planning board. FEMA (Federal Emergency Management Agency) governs building in floodplains and provides maps depicting low-lying areas adjacent to a stream or river.

Note: See addresses and phone numbers for resources in Appendix A.

2. Networking

Attract support and build a network of ”pool scouts“ by putting an announcement in your local newspaper or town newsletter asking for volunteers to identify vernal pools or information leading to pools. Submit such a story yourself; the local paper will probably print it. Citizens may enjoy the opportunity to learn about vernal pools. Those who are unable to do the work themselves should be encouraged to call in to suggest likely locations. Many neighbors know of ”spring pools“ or ”places with salamanders.“

People who work in the woods such as foresters, loggers, surveyors, and

naturalists may have invaluable local knowledge of breeding hot spots. Try to tap into this resource.

Contact scout troops, school groups, garden clubs, sporting organizations, watershed or lake associations, or university biology departments for information about vernal pools or to enlist volunteers.

Searching for vernal pools on foot in your own neighborhood may be more rewarding than road surveys. In any case, always be aware of private property issues and request permission from owners to check out potential pools. Public land in your neighborhood is always a good place to start!

3. Road Surveys

Auto cruising can be very productive for finding amphibians on the first warm, rainy spring nights when migration to breeding pools is taking place. (NOTE: Amphibians may move on cool nights if it is raining...it is not uncommon to see them move when temperatures are in the 40s.) You can cover a lot of territory by vehicle initially and then return to the hot spots for more thorough searching on foot.

Dusk and nighttime are best. Drive slowly (10-15 mph) on roads that pass through likely breeding habitat. When you spot amphibians, observe the general direction in which they are headed. Also listen for wood frog choruses. These calls do not carry very far, so a pool containing wood frogs would have to be located relatively close to the road in order to be detected. Spring peepers, more widespread and easier to hear, are not indicator species, but may indeed be calling from a vernal pool. Explore that area for possible breeding pools.

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 encounter a dead frog or salamander (or snake or turtle) and are willing to handle it: (1) identify it; (2) measure it; (3) photograph it; and (4) record the date and location of the find. This information can be sent in with the final vernal pool description forms.

4. Random Encounters

Pools may be encountered on your own property, while checking town lands, hiking with family or on other outings. Make note of these pools to investigate yourself or pass the information along to interested town officials or vernal pool enthusiasts.

LOCATING VERNAL POOLS IN OTHER SEASONS: RED FLAGS

Dry pools

Dry pools may be found in late summer, fall and winter (in the absence of snow cover) and are more difficult to identify than flooded pools. Documentation, which primarily relies on evidence of amphibian breeding and the presence of certain invertebrates, is very difficult. If you find a possible vernal pool in the dry season make note of the location on a map and then visit it again in spring. The following characteristics may help you to notice dry pools:

- Flat topography with depressions or ”pit-and-mound“ topography in the landscape. Areas with multiple depressions have increased value as potential vernal pool habitat.

- Fingernail clams, fairy shrimp eggs (these are positive proof of a vernal pool), or caddisfly cases just below the leaf litter, in the top duff layer.

- Evidence of temporary flooding. This includes:
- leaves darkened by water stains or a film of sediment. (You may need to brush away this season's leaves to reveal the stained layer)
- siltation marks or water stains on surrounding trees or vegetation
- trees with buttressed trunks or stilt roots
- sphagnum moss associated with a depression
- wetland plants growing in a dry depression
- presence of a wetland (hydric) soil

Fall Surveys

WEAR BLAZE ORANGE DURING HUNTING SEASON!

Most pools begin to refill in fall or early winter, from groundwater discharge or rainfall. Pools may be evident from a distance in the leafless landscape. Look for pools in late fall or early winter before significant snowfall. The silvery sheen of a frozen pool surface may indicate a vernal pool. Note the location of these pools on a map for a spring follow-up visit.

CHAPTER III: VERNAL POOL FAUNA

This chapter will introduce you to the most common vernal pool animals that you will encounter and provide you with natural history information for each. Evidence of breeding indicator species is required for a pool to be considered a vernal pool. A field guide for these animals as well as others that use vernal pools is provided below. You can copy these pages and laminate them for a field reference guide. The tables and figures included on the identification of egg masses and larvae and adults (Tables 1 and 2) would also be useful for carrying into the field.

Indicator vernal pool species are those that depend upon vernal pool habitat for successful reproduction. In Maine, there are only four vernal pool indicator species--three amphibians (spotted and blue-spotted salamanders and wood frogs) and one crustacean, the fairy shrimp.

Other species found in vernal pools are called **facultative**. These facultative organisms, although they are often found in vernal pools, are not dependent upon them; they can successfully reproduce and live elsewhere. Many animals are facultative vernal pool species including green frogs, spring peepers, turtles, and a variety of aquatic invertebrates. Most plant species associated with vernal pools are considered facultative because they are common in many wetland habitats. Therefore, plants are not used as a tool for identifying vernal pools in this manual.

LIFE HISTORY OF VERNAL POOL INDICATOR SPECIES

Because vernal pools are isolated and variable habitats, with temperature changes, oxygen stresses, and drought accompanying the seasonal appearance and disappearance of water, salamanders, frogs and invertebrates that inhabit vernal pools have developed specialized survival strategies. The aquatic stage of vernal pool inhabitants is a race against time. Three to five months is needed to complete the amphibian cycle, from egg laying through metamorphosis. However, the time between hatch and metamorphosis is highly variable. Salamanders are able to metamorphose more quickly and at a smaller size when a pool threatens to dry prematurely. Some invertebrates inhabiting vernal pools, such as fairy shrimp, may complete their life cycle in less than a month.

Key survival strategies for vernal pool animals include:

- Rapid growth, so that eggs and larvae can complete development during the short time that water is present;

- Departure from the pool when metamorphosis is completed (adult insects fly away and frogs and salamanders transform from aquatic larvae into terrestrial juveniles and migrate);

- Dormancy or a ”wait-it-out“ strategy until the pool floods again. Fairy shrimp eggs can rest in the dry sediments for years until conditions are right for hatching, while fingernail clams and snails estivate--the summer equivalent of hibernation--in the mud.

Both the salamanders that are listed as indicator vernal pool species are known as **mole salamanders**. This common name pertains to the burrowing habits of adults who live most of their lives underground in root cavities and the burrows of small mammals. They may live as deep as three feet below ground. The spotted and blue-spotted salamanders share a distinctive life history.

Adult salamanders emerge from their subterranean haunts on the first relatively warm rainy nights of early spring. It is estimated that up to 90% return to the pools from which they emerged. Male salamanders migrate to the breeding pool first and wait for the females to arrive. Adult salamanders will migrate up to one-half mile to reach breeding pools. In the pool, males and females participate in a mass courtship ritual known as congressing. Males deposit gelatinous capsules, known as spermatophores, up to one-half inch long, on the bottom of the pool. Females take these sperm-filled packets, into their vents (cloacae) and fertilization occurs internally at the time of egg deposition. The eggs are laid in gelatinous masses attached to vegetation in the water.

The adults leave the pool after breeding, normally awaiting a rainy or wet night before returning to their cavities in the forest floor. The eggs hatch in three 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. Larvae are carnivorous, eating insect larvae, small crustaceans, and aquatic worms. Under crowded conditions, larvae may become cannibalistic. 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. Salamanders may live up to 15 years.

Wood frogs rouse from their hibernation sites and begin their annual migration to breeding ponds when melting snow and spring rains saturate the ground (some males move closer to breeding pools to hibernate in the fall). They are able to hibernate at much shallower depths (under rotted logs/stumps, leaf litter, under stones and mats of moss) than the mole salamanders because within five minutes of freezing, wood frogs can accumulate high levels of glucose in the liver and leg muscles. Glucose is subsequently released into the bloodstream and tissues preventing freezing (Storey and Storey 1986). Although spring peepers are more familiar as harbingers of spring, wood frogs often appear first. Remarkably adapted to the cold, it is not unusual to find the earliest migrants swimming where ice remains in the water nearby. Wood frog calling, mating, and egg-laying occur mainly in the early night hours and gradually diminish toward dawn. Calling and breeding activity also occurs during the day in undisturbed locations.

Wood frogs are described as explosive breeders because the entire sequence of appearance, mating, egg laying and return to the terrestrial habitat is accomplished in a very brief time. This may be as short as a week in some pools but may extend up to 30 days. The emerging tadpoles transform into adults some 6 to 15 weeks later. Young tadpoles feed on algae and microorganisms scraped from aquatic vegetation. As they grow older, some other plant and animal matter is consumed. Adults' summer in cool, moist woods and consume a wide variety of invertebrates including slugs, spiders, and worms.

Little is known about the ecological role of wood frogs in upland forests. However, they are present in large numbers in northeastern woodlands. Windmiller (1996) estimated the biomass of wood frogs in 50 acres of forest adjacent to a breeding pool to be in excess of 150 pounds. Given their abundance and diet of forest invertebrates, it is likely that wood frogs influence decomposition rates and nutrient cycling in upland forests.

Fairy shrimp are small crustaceans restricted to vernal pools and are widely

distributed throughout the United States. Though widespread in spatial distribution, fairy shrimp are greatly restricted seasonally. Their temperature tolerance is limited to 40-60°F (4-15°C). They appear soon after spring thaw and disappear with the onset of warm, summer weather leaving behind resistant eggs that carry the species over to the next favorable period. The resting egg (actually a developing embryo) has a dark covering and is able to survive drying, extreme heat, freezing and ingestion by birds. Reflooding the following spring stimulates hatching. Adult fairy shrimp may persist into the summer season but are usually difficult to find after May. Fairy shrimp typically have one generation per wet episode.

Fairy shrimp do not occur in all vernal pools. Even within one pool, shrimp may occur with regularity for many years only to disappear in others, even under seemingly favorable the conditions. The habitat requirements for fairy shrimp are not well documented. Studies in Maine were not able to explain why fairy shrimp commonly occur in some pools and are absent from others. Potential factors affecting their distribution include water chemistry, hydrology, depth of unfrozen water in the winter, and presence of algae in the spring. Certain environmental conditions required by the eggs for maturation and hatching, including soil moisture conditions, precipitation patterns, and freezing, may be primary factors dictating habitat suitability (Colburn, in press). Dexter and Kuehnle (1951) studied vernal pools over a ten-year period and concluded that flooding history of a pool during the previous season and the precipitation during the winter and spring affected hatching of *Eubranchus* spp. *Eubranchus* spp. are known to be intolerant of pollution, siltation, salinity, high alkalinities, and temperatures in excess of 20 degrees C. Both *E. intricatus and E. bundyi* appear to be restricted to clear waters (Pennak 1978).

A FIELD GUIDE TO VERNAL POOL INDICATOR SPECIES

Some vernal pool indicator species appear to have habitat preferences; characteristics of the breeding pool and other general habitat are listed for indicator and other species where information on preferences is available. Tables 1 and 2 provide quick reference to major characteristics of amphibian egg masses and larval stages. Field guides that will aid in identification of vernal pool animals are listed in the bibliography. For details and finer points refer to these guides.

AMPHIBIANS

Spotted Salamander (*Ambystoma maculatum*)

Description: Gray brown to blue-black. Two irregular rows of bright yellow spots on each side. Under-sides are lighter, typically slate gray.
Size: The largest of our mole salamanders, adults are up to 6-8 inches (14-20 cm) long.
Distribution and status: Spotted salamanders occur throughout New England, the Great Lake States, the southeastern United States (excluding Florida), and Atlantic Canada. In Maine, the species has been reported most frequently in central Maine.
Terrestrial habitat and hibernation: Spotted salamanders are found in both deciduous, mixed, and softwood forests and on some occasions in open fields. The majority of time is spent below ground (hence the name "mole salamanders"), commonly in shrew or other small mammal burrows (Kleeberger and Warner 1983; Madison 1997). They also seek refuge under leaf-litter and coarse woody debris. Adults feed on forest-floor invertebrates including earthworms, snails, spiders, and insects. Home ranges vary from as little as 1 sq m to up to 40 sq. m (Colburn, 1999). Windmiller (1996) estimated adult densities within 200 m of a Massachusetts temporary pool to be 1-4 per 100-sq. m; juvenile densities within 55 m of the pool were 3-20 per 100-sq. m. Spotted salamanders hibernate in upland forests most commonly below ground (up to 3 feet) in small mammal burrows or burrows created by tree roots.
Breeding pool: Spotted salamanders preferentially breed in temporary to semi-permanent vernal pools free of fish populations. Although they may breed in beaver flowages, lake shores, and anthropogenic pools (roadside ditches, borrow pits, skidder ruts), reproductive success (measured in terms of recruitment of juveniles to the population), may be problematic. The presence of fish or short hydroperiods may render these sites biological sinks. Pools used exclusively by spotted salamanders tend to be warmer, less turbid, and in more open sites than those used exclusively by blue-spotted salamanders.

Egg masses: Number of eggs per mass usually between 100-150. Masses with fewer or more eggs do occur. They are normally attached to twigs or plant stems several inches below the surface of the water. The color of the jelly matrix varies from clear (colorless) to milky white, and is sometimes green from algae. Consistency of gelatinous envelope

surrounding entire egg mass likened to jello. Individual eggs are dark brown or gray above and lighter below.
Larvae: Dull greenish, chin and throat without markings, head broad and blunt, wider than body.

Blue-Spotted Salamander (*Ambystoma laterale*)

Blue-spotted (Ambystoma laterale) and Jefferson (Ambystoma jeffersonianum) salamanders interbreed producing polyploid hybrids formerly known as Tremblay's or silvery salamanders (depending on the number of chromosomes from the blue-spotted and Jefferson's). It is believed that the great majority of Maine's blue-spotted salamanders are hybrids (Knox 1999). For a complete discussion of the genetic complexities associated with these hybrids, refer to Petranka (1998) or Hunter (1999). For the purposes of this account, realize that variability in physical characteristics, egg mass morphology, and habitat preferences may stem from our inability to easily identify hybrids versus pure populations.

Description: Dark-colored salamander marked with irregular blue or bluish-white spots on the sides of the trunk and tail. The head is narrow and tapers to a rounded snout. Hybrids tend to be more brownish. Usually have flecks of the same color on its back. Coloration is reminiscent of old enamelware pots.
Size: Breeding adults range from 3.9-5 inches (9.8 to 12.7 cm). Hybrids may grow to

6.7" (17 cm)

Distribution and status: Blue-spotted or "Tremblay's" salamander (the most likely hybrid in Maine) probably occur throughout Maine however they are less commonly reported than the spotted salamander. To date, no genetically pure populations of blue-spotted salamanders have been reported in Maine. Blue-spotted salamanders are found throughout New England (with the exception of Rhode Island), the Great Lake States, and Atlantic Canada. The blue-spotted salamander is listed as a Species of Special Concern in Vermont and Massachusetts and is listed as Threatened in Connecticut (Hunter et al. 1999).
Terrestrial habitat and hibernation most likely mimics that described for the spotted salamander. Upland forests with ample canopy cover, deep, uncompacted leaf litter, and coarse woody debris to provide shading, cool refuge, and a moist environment are requisite. These mole salamanders also seek winter cover in burrows. Appear to favor sandy soils.
Breeding pool: Favor pools with overhanging bushes and grass, sphagnum moss margins or leafy bottoms. In Maine, blue-spotted salamander breeding habitat is similar to that described for spotted salamanders: temporary pools and a variety of artificial pools and beaver flowages. Preliminary surveys of pool-breeding amphibians throughout the state show that pools are either dominated by spotted or blue-spotted egg masses: rarely are pools equally shared by the two species. Reasons for this division are being investigated (Calhoun, unpub. data). Possible reasons may be differences in upland habitat requirements, or differences in tolerances to within-pool variables including temperature,

depth, hydrologic regime, and oxygen concentrations. There is evidence that blue-spotted salamanders are more sensitive than spotted salamanders to low pH and cannot reproduce successfully in highly acidic waters (Karns 1992; Sadinski and Dunson 1992). High sulfate, zinc, and aluminum concentrations have also been documented to exclude breeding populations (Freda and Dunson 1985; Horne and Dunson 1994). Researchers in New Hampshire and Vermont more commonly associate breeding blue-spotted salamanders with streamside pools and red maple forested wetlands.

Egg masses: Number of eggs per mass highly variable. Normal range appears to be between 6 and 30. They are found either attached to stems and twigs or to leaves on pool bottoms. Consistency of masses is somewhat looser than jello. Egg masses tend to be smaller than spotted salamanders. Morphology and numbers of eggs are variable between hybrids and pure populations.
Larvae: Mature larvae robust and nearly black; prominent ruff of external gills and a broad-finned tail; bottom dwellers; noticeable paired black spots on dorsum, on either side of tail fin.

Wood Frog (*Rana sylvatica*)

Description: Has a dark patch, the ”robber's mask,“ usually brown, extending back from each eye. Dark line of the same color usually runs from the front of the eye to the snout. Background color varies from light tan to dark brown. Two pronounced ridges are present on each side of the back.
Size: Range in size from 1.5 to 2.75 inches (3.75 to 7 cm). Females are larger than

males.

Distribution and status: Common in suitable woodland habitat throughout the state. Found throughout New England, the Great Lakes States, Atlantic Canada and Maine. They are not currently a state-listed species in New England although population declines have been noted in Rhode Island.
Terrestrial habitat and hibernation: During the non-breeding season, wood frogs live in deciduous or softwood forests, wooded wetlands, bogs, and along vegetated pond and lake shores. In some parts of their range, they are more commonly found in one forest-type over another. The terrestrial habitat of wood frogs may be a considerable distance from breeding pools (more than half a mile). Reported home ranges average 45 (Windmiller 1996) to 64 square meters (Bellis 1965). Hibernate under leaf litter or in shallow burrows near the surface of the ground.

Breeding pool: Pools usually in or near wooded areas. Also, breed in grassy ditches, cattail marshes, old gravel pits, or hollows in alder thickets flooded by spring rains. However, if fish are present in these habitats or if they dry early in the season, reproduction may be unsuccessful.
Egg masses: Eggs laid in large globular masses of, on average, 1,000. Found either attached to twigs and stems or lying on the bottom if pool very shallow. Like all frog eggs, they lack a surrounding gelatinous envelope and therefore have a lumpy appearance. Egg masses usually are spherical at first. As they develop they tend to have an unconsolidated, shapeless form. Wood frogs often lay communal egg masses, but it may be possible to differentiate individual masses if surveyed soon after deposition.
Larvae: Mottled olive brown sometimes appearing gold-flecked; venter with pinkish bronze iridescence; eyes just above sides, not bulging out as in spring peepers and gray tree frogs.
Voice: A hoarse, clucking sound reminiscent of a duck. They are explosive breeders and may only call for one week.
Note: A species highly palatable to predators, it survives in numbers only in vernal pools.

CRUSTACEANS

Fairy Shrimp (*Eubranchipus* species are most common)

Drawing by Mark C. Erelli of the Vernal Pool Association
Fairy shrimp, or anostracan crustaceans, are the only invertebrate indicators for vernal pools in Maine. There are seven families of anostracans in North America; species common in the glaciated northeastern United States belong to the family Chirocephalidae, genus Eubranchipus. Species of fairy shrimp found in the northern region are most commonly Eubranchipus bundyi; Eubranchipus vernalis is the dominant species replaces E. bundyi in southern New England. Fairy shrimp from the family Branchinectidae occur in eastern Atlantic Canada (Branchinecta paludosa) and may occur in northern Maine.

Description: The different species of fairy shrimp vary somewhat in size, color, and shape. All swim upside down, waving 10 pairs of leaf-shaped limbs, with which they feed. The two major eyes are on stalks. Most have a long tail, sometimes with ”neon“ spots near the tip. Colors generally white or brownish, with orange or reddish marks; egg sacs carried by females may be bright blue. Strikingly large among the swimming

invertebrates. From a distance may look like small fish.
Size: Length 0.5 - 1.0 inches (1.25-2.5 cm).

Distribution and status: Probably found in vernal pools throughout the state.
Eggs: Very small (pinhead size), brownish and laid in clumps.
Breeding pools: Fairy shrimp occur only in waters that are free of fish populations---primarily temporary and semi-permanent vernal pools. The habitat requirements for fairy shrimp are not well documented. *Eubranchus* spp. is known to be intolerant of pollution, siltation, salinity, high alkalinities, and temperatures in excess of 20 degrees C. Both *E. intricatus and E. bundyi* appear to be restricted to clear waters (Pennak 1978).
Move tables after text on eggs and larvae

EGGS AND LARVAE OF VERNAL POOL AMPHIBIAN INDICATOR SPECIES

Egg masses of salamanders and wood frogs may be attached to a vertical or horizontal support (including sticks, branches, or live plants) 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.

Egg masses of salamanders and wood frogs can be readily distinguished as they differ in form and size. However, an algae (*Oophilia ambystomatis*) forms a symbiotic association with both salamander and wood frog egg masses within the inner jelly capsules giving some egg masses a pale green cast. The embryos are supplied with oxygen by the algae. In turn, the algae draw nourishment from waste products from the embryo.

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.

Spotted and blue-spotted salamander egg masses

Salamander eggs are surrounded by a common gelatinous envelope with individual eggs visible inside the envelope. 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 of jello. You may find:

1. clear egg masses, where the embryos are clearly visible through the jelly matrix,
2. intermediate or gray egg masses where embryos are faintly discernible in a cloudy or grey jelly matrix, or
3. white egg masses where the outer egg jelly is so opaque that embryo 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. 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. Egg masses may be subjected to intense predation by larval caddisflies or leeches. At night predators such as adult Eastern newts may be found walking on the surface of salamander egg masses and snapping at the eggs.

In general, salamander eggs tolerate a pH range of 6-10 with best hatching success at pH 7. However in Maine, pH values of 4-6 are not unusual.

Spotted Salamander eggs

Mark C. Erelli

Where: The egg mass is attached to sticks, weeds, grass, stems, or reeds in quiet or slowly running water usually within 8-10 inches of the surface, occasionally much deeper.
Number of eggs: As many as 250 eggs, but 100-150 is typical.
Size: Immediately after deposition, the mass is 2.5-3 inches (6-7.5 cm) in diameter, but it quickly absorbs water and can expand to over 4 inches. The total complex may be deposited in several small masses or limited to 1-2 large ones. Individual eggs are 2.5-3 mm in diameter with the upper pole dark brown or gray and lower pole dirty white or dull yellow.
Consistency: Outer jelly sheath is firm.
Incubation period: 31-45 days or more depending on the water temperature.

Drawing by Adam Goodspeed

Blue-spotted Salamander eggs

Where: Eggs are only slightly adhesive -- they fall to the bottom singly or cling lightly to vegetation in loose groups of 2-8. Some masses are larger; up to 30 eggs forming loose cylindrical masses commonly deposited along sticks or horizontal vegetation
Number of eggs: *Number* of eggs per mass highly variable, normal ranges 1-30.
Size: Large clear jelly envelope makes them virtually invisible in the water; generally smaller than spotted salamander.
Consistency: Consistency of matrix looser than jello.

Note: Some tips for telling spotted from blue-spotted egg masses:

1. blue-spotted masses are generally smaller (size MAY overlap though),
2. blue-spotted eggs have a very small space between the egg and adjacent membrane of the egg (in the spotted the space is the width of the egg), and
3. blue-spotted egg masses are watery whereas spotted egg masses are firmly gelled.

Wood frog eggs

Mark C. Erelli

Wood frog egg masses lack a surrounding gelatinous envelope and are generally spherical when fresh, becoming flabbier with age. They have compact submerged egg masses, which provide protection from cold, desiccation and freezing. Frog eggs are darker than salamander eggs, so the mass absorbs heat better. The eggs in the middle of the mass are the warmest and hence hatch first. The clear jelly capsules surrounding the eggs expand by water absorption and the globular clutch soon attains several times its initial size.

Where: 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. As the eggs develop, communal deposits look like a lumpy sheet.

Number of eggs: Roughly 2000 eggs.

Size: Individual clutch measures 6-10cm (2.5-4 in) diameter; individual egg masses are tennis ball size and shape.

Frog and Toad Larvae

Frog and toad 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 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. A tadpole spends most of its active time feeding. Tadpoles are suspension feeders; they eat primarily plankton and bacteria. Food is ingested as the tadpoles swim or root around on leaf litter to dislodge debris.

Salamander Larvae

Salamander larvae have bushy gills; the caudal (tail) fin continues onto the back as a dorsal fin and tiny legs are present. The prominent ruff of gills readily distinguishes salamander larvae from frog larvae. Recently hatched larvae of many salamander species differ markedly from older ones. The size at which salamander larvae transform varies from year to year depending on the conditions in the breeding ponds such as water status, 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--2 to 2.5 inches (5-6.5cm) and dark color.

Locating Larval Salamanders

By day, larval salamanders are typically hidden among vegetation and under debris. Aquatic-stage juveniles rest under debris on the pond bottom during the day. At night they move into the water column where they remain suspended near the surface to feed. 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/liter in the top 6 inches (15-cm) of water is higher after dark. This migration from a hidden daytime strategy to open feeding on the surface is called nocturnal stratification. Stratification of larvae is best seen on dark nights following clear sunny days. Overcast days, bright moonlight, heavy winds, and rainfall disrupts the above pattern.

Salamanders in all life stages are carnivorous. The size of the prey is determined by the size of the salamander. Older juveniles 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).

SPECIES NOTES

Spotted Salamander Larvae

Mark C. Erelli

At hatch, spotted salamander larvae are ½ inch long (12-13mm). 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. Gills and balancers are present at hatching and 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 3 inches (75mm). Transforming young are found August to September and rarely to October in colder 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 Larvae

Blue-spotted larvae have a bigheaded 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 hindlegs soon appear and larvae become bottom dwellers. The diet of small larval blue-spotted salamander larvae consists of various invertebrates. Large larvae include vertebrates in their diet. 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 2-2.5 inches (50-65mm) 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.

Wood Frog Larvae (Tadpoles)

Mark C. Erelli

Newly hatched larvae or tadpoles measure 7-9mm in length. As they grow, their color lightens from velvety black to a mottled olive-brown. Newly hatched tadpoles hang motionless along side 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, less than ½ inch (10-12mm), frogs congregate under shore litter and vegetation before dispersing into surrounding terrain.

TABLE 1. **CHARACTERISTICS OF EGGS OF AMPHIBIANS USING VERNAL POOLS**

	Indicator Species			Other Amphibians Using Vernal Pools				
	Wood Frog	Spotted Salamander	Blue-spotted Salamander	Eastern Newt	Spring Peeper	Grey Treefrog	American Toad	Green Frog
Size of Mass	2.5" - 4" (6 - 10 cm) Often deposited communally	Variable size 1" to over 4" (6 - 10cm)	Variable size Generally smaller than spotted salamander egg masses	single eggs deposited	single eggs deposited	up to 4" x 5" flattish mass	up to 3 feet long	6" - 12" (15 - 30 cm)
# of Eggs Per Mass	(1,000 eggs per mass	50 - 250, avg. 125	highly variable, 1 - 30	80 - 450 per (	900 per (	10 - 40	thousands	1500 - 5000
Shape of Mass	Individual mass, ball-shaped; communal deposits like a lumpy sheet	globular to oval	small, loose scattered groups that may be cylindrical or sausage-shaped attached to vegetation or single eggs deposited on leaf litter	—	—	flattish mass or surface film	long, parallel spiraling strings	floating masses of jelly; no shape

Color of Mass	clear, becoming green	clear, milky or green	clear or clouded with sediment film	__	__		transparent, later cloudy as silt & algae adhere	__
Attachment	twigs and stems	usually sticks and stems, also sedges	submerged branches, stems & leaves	aquatic vegetation	submerged vegetation	loosely attached to vegetation at surface	sometimes threaded through vegetation	emergent floating vegetation
Depth	just below surface	8" - 10" or more below surface	8" - 10" below surface to on or near bottom			at or near surface	on open bottom	shallow water
Incubation Period	(3 weeks	4 - 8 weeks	3 - 5 weeks	(4 weeks	(6 days	3 - 5 days	3 - 12 days	3 - 5 days

TABLE 2. **CHARACTERISTICS OF LARVAL AMPHIBIANS USING VERNAL POOLS**

	Indicator Species			Other Amphibians Using Vernal P			
	Wood Frog	Spotted Salamander	Blue-spotted Salamander	Eastern Newt	Spring Peeper	Grey Treefrog	Americ Toa
Bushy Gills	No	Yes (3 per side) Prominent ruff of gills	Yes (3 per side) Prominent ruff of gills	Yes (4 per side)	No	No	No
Size	Hatch 7-9mm; metamorphosis 10-12 mm	Hatch 12-13mm (0.5"); metamorphosis 40-75mm (2-3.5")	Hatch 8-10mm; metamorphosis (50 mm (2")		Metamorphosis 9-14 mm	Metamorphosis 45-50 mm (1.7"-1.9")	Tiny n toads, 8 mm (0.3"-0
Color Pattern	At hatch, velvety black, then lightening to mottled olive-brown, sometimes appearing gold-flecked. Venter with pinkish bronze iridescence	Dull greenish-yellow; sides of head & upper jaw same color as top of head; head broad and blunt, wider than body; chin & throat without markings	Dark brown with yellow blotches dorsally; indistinct light lateral band; underside unpigmented; noticeable paired black spots on dorsum, on either side of tail fin	Light yellow to green-yellow with grey or brown flecks or bands above; belly pale yellow without bands or spots; Distinct dark stripe on sides of head from nostrils to gills, head narrow. Lower jaw somewhat pointed; upper jaw lighter than top of head.	Beige, tan or orangish dorsum, with dark spots and greenish tone. Iridescent creamy or bronze venter.	Light brown to dark green to black; venter white; intestinal coil visible.	Very da almost b even venter. somew flatten eyes sm and dor
Tail	Tail fin rounded dorsally, tapering to a	Tail fin extends forward onto back; fin heavily mottled with black,	Tail fin extends well forward on body, nearly to head. Fins broad,		Tan to brown to orange tinge with	Orangish to wine to scarlet tailfins, extends along back & heavily mottled	Relativ short with

	fine point. Faint, small markings on tail fin.	often giving hind area a dark appearance; gills reddish.	clouded with black.		black spots on outer edge. Fin extends along back.	with black. Tail fins end in well-developed flagellum.	round end. Ta low wit pigme
Larval Period	60 - 70 days	Variable; 70 - 100 days	Variable; 60 - 80 days	80 - 112 days	60 - 90 days	Around 60 days	50 - 6 days
Other	Transform late May- mid-August. Eyes are just above sides, not bulging out on sides like spring peepers or grey treefrogs. Intestinal coil partly visible.	More slender appearance than blue spotted salamander. Transform Aug.-Sept., rarely Oct.; may overwinter	Bigheaded appearance.	Unusual life history with 3 distinct stages. Larvae & adults are aquatic; juveniles are terrestrial red efts.	When viewed from above, pop-eyed appearance ; eyes bulge to side.	When viewed from above, pop-eyed appearance; eyes bulge to side.	Congrega schools. median other tad in vernal will have on right

A FIELD GUIDE TO FACULTATIVE VERNAL POOL FAUNA
(Animals found in vernal pools that are not specialized to breed in them)

AMPHIBIANS

Four-toed Salamander (*Hemidactylium scutalum*)

State species of special concern

Description: Easily identified by three distinctive characteristics: 1) only four, not five, toes on hind feet, 2) tail has distinct basal constriction, and 3) the belly is bright white speckled with black. Color reddish brown, fading to gray or almost black along the sides.
Size: Males 5-7.6 cm (2-3 in) in total length; females slightly larger.
Distribution and status: Three clusters of locations documented in Maine to date: both sides of the Penobscot River from Dedham north to Mattamiscontis; Mt. Desert Island, and in the southern part of Lincoln and Sagadahoc counties. Maine Species of Special Concern. May be under-reported owing to its secretive habits.
Terrestrial habitat: Associated with wet moss, usually sphagnum moss. Adults are terrestrial residing in forests adjacent to peatlands or forests with sphagnum depressions.
Breeding pool: Small ponds, slow moving streams. Aquatic larvae are found in small ponds and streams running through bogs or wet mossy areas. Eggs under moss around vernal pools have been recorded in central and southern Maine.
Eggs: Eggs laid in the spring following the late summer mating. Eggs laid singly (although may clump or is communal nest) in cavities within a clump

of moss or grass overhanging water.
Larvae: Keeled tail that is continuous with the back keel. A short, wide, dark bar on the side of the head joins the eye and gills.
Life history: Breeding season from late summer to early fall. Eggs laid the following spring. Incubation period form 38-60 days. Larvae wriggle from terrestrial nest until drop into the water; during the 6-week period in the water the larvae develop into adults and return to terrestrial haunts.
Four-toed salamanders have been observed eating a variety of insects, spiders, and snails.

Eastern Newt (*Notophthalmus viridescens*)

Description: Aquatic adults normally olive green, but coloration can vary from yellow-brown to dark greenish brown. One line of red spots on each side of the upper back. Undersides lighter, usually yellowish, and speckled.
Size: Length 3 - 4 inches (9-12 cm).
Distribution and status: Statewide with smaller reported population for the northern and western regions of the state.
General habitat: Adults are aquatic; juvenile red efts in woodland near pools.
Breeding pool: Typically associated with deeper pools, usually open areas. Uses permanent water including ponds in woodlands, fields, orchards, and mountains. Also gravel pits, quiet areas of streams and shallow areas of lakes.
Eggs: Laid in water and usually attached singly to aquatic vegetation.
Larvae: Keeled tail, external gills, light yellow to yellowish green with flecks or bands of gray and brown pigment above; distinct dark stripe on sides of head from nostrils to gills, head narrow.
Life history: Eggs usually hatch in early summer and the aquatic larval stage lasts 12 to 16 weeks. Some transformed juveniles stay in the pond or pool and gradually develop into adults. Others, known as red efts, migrate to woodland habitat and develop bright orange or red coloration. Mature adults breed in lakes and ponds, less commonly in vernal pools. Breeding usually in the spring.
Note: Aquatic adults can be an important predator on eggs and larvae of salamanders and other amphibians. Pond-breeding amphibians using small, shallow vernal pools for breeding would be essentially free from this predator.

Green Frog (*Rana clamitans*)

Description: Back varies from brown to green in color with dark brown or gray spots or splotches usually present. Undersides mostly white. A prominent ridge runs down each side of the back, ending on the body and not reaching to the groin.
Size: Length 2.25-5.0 inches (5.5-12.5cm).
Status and distribution: Common throughout the state.
General habitat: **Rarely** ventures far from water. Found on shores of ponds, streams, and lakes or in moist woodland.
Breeding pool: Occurs in many types of aquatic habitats: ponds, streams, marshes, vernal pools, springs and moist woods.
Egg masses: Large masses of several thousand eggs attached to stems and twigs. Much less common in vernal pools than wood frog eggs. Masses usually expand as a film of eggs on water surface.
Larvae: Tadpoles olive green with dark spots on dorsum an cream color on the venter; throat and sides are mottled with dark green and the tail is green mottled with brown. Grow to 6.4 cm (2.6") and metamorphose in a little over one year.
Voice: A fairly explosive sound, something like a loose banjo string. Can be a single note or a note repeated several times.
Life history: Adults live either in or adjacent to water bodies. Breeding usually occurs from May to August. Eggs hatch in less than one week. Tadpoles require one season to two years to transform. May be encountered under the frozen surface of pools or ponds. Often breeding in semi-permanent to permanent pools.
Note: Rarely use vernal pools for breeding. Eggs are deposited in shallow water of ponds and lakes and in streamside pools. However, adults and young frogs often frequent vernal pools.

American Toad (*Bufo americanus*)

Description: The common toad or ”hoptoad“ familiar to most people. Color variable; grays, browns and greens are common. Always with darker irregular blotches or patches on the back. Warts numerous on the back, but no more than one or two warts occur in the largest dark spots or patches. Chest and belly usually with dark spots.
Size: Length 2-4.5 inches (6-11.25 cm).
Status and distribution: Common throughout the state.
General habitat: **Toads** are generalists and occur in a variety of forested and open habitats, upland and wetland.
Breeding pool: Breed in open shallow water in vernal pools, ditches, old beaver flowages, flooded gravel pits, artificial ponds with sparse vegetation and coves of large lakes.
Eggs: From 4,000 to 12,000 eggs laid in pairs of long curling strings around aquatic vegetation.
Larvae: Very dark, almost black, even on venter; body somewhat flattened; eyes small and dorsal.
Voice: Long, fast musical trill, which can last 5 to 30 seconds.
Life history: Adults found everywhere from gardens to wet swampy areas to dry mountain forests. Breed in shallow water, usually in late April or May, traveling to the breeding pond at night in large numbers. Males call to females inflating a large throat pouch. The eggs hatch in 3 to 12 days and tadpoles transform into juveniles in 5 to 10 weeks.
Note: Explosive breeders--large numbers of individuals arrive at a breeding site within a short period. The breeding process is usually completed within two weeks.

Spring Peeper (*Pseudacris crucifer*)

Description: By far the smallest of our native frogs. Back is gray, brown, or olive with an often imperfect darker cross running across it.
Size: Length 0.75-1.25 inches (1.8-3cm).
Status and distribution: Common throughout the state.
General habitat: Deciduous, coniferous and mixed woodlands. There may be some preference for brushy, second growth areas.
Breeding pool: Breed in ponds, pools, marshes and swamps; grassy or muddy; permanent or temporary.
Eggs: From 800 - 1,000 eggs are laid singly and attached to aquatic vegetation near bottom of pools. They are very difficult to detect.
Larvae: Beige, tan or orangish dorsum with dark spots; iridescent or bronzy venter
Voice: High piping whistle that ends with a slur, repeated at intervals of about a second. Sometimes trilled.
Life history: Adults live in wet woods or brush near ponds, pools or swamps. Breeding males begin to sing, usually in choruses, during the first wet spring evenings. Breed in woodland pools or ponds. Eggs hatch in 6 to 12 days; tadpoles usually transform in July.

Gray Tree Frog (*Hyla versicolor*)

Description: Color very variable, off white, green, gray, or brown. Usually a light spot beneath each eye. Bright patches of orange or yellow hidden on the underside of the hind legs. Like all tree frogs, toes are modified into suction disks for climbing.
Status and distribution: Appears to be largely limited to the southern and central portions of the state, with few records in the east.
General habitat: Forested areas near shallow water.
Breeding pool: Breeds in vernal pools, permanent water and swamps.
Egg masses: Up to 2,000 eggs laid in packets of 4 to 40, usually attached to surface vegetation. Unlike salamander eggs, packets lack surrounding capsule and there are generally many packets in close proximity.
Larvae: Light brown to dark green/black; venter white; intestinal coil visible; tail fins of older larvae often reddish.
Voice: A rather slow, flutelike trill.
Life history: Inhabits the same types of habitat as the spring peeper. Breeding usually occurs between early May and July. Egg laying begins some 20 to 35 days after adults first appear at the pond or pool. Eggs hatch in 4 to 5 days.
Note: The gray tree frog has fast development--as fast as three weeks from egg to metamorphosis. Often uses vernal pools for breeding, avoiding predation associated with more permanent water.

Bullfrog (*Rana catesbeiana)*

Mark C. Erelli
Description: The dorsum of adults is generally uniform in color, ranging

from light green or olive to very dark green or brown. The venter is usually a pearly or creamy white. Mottles or spots may be present on venter or dorsum. The male tympanum is obviously larger then the eye diameter; it is the same in the female.
Size: The largest of all North American frogs, adults may reach a length of 8 inches (20 cm) from tip of nose to vent.
Status and distribution: Probably ranges throughout Maine, except perhaps from northern Oxford County through the U.S.-Canada border region in extreme northwestern Maine.
General habitat/breeding pool: The primary habitat requirement is a permanent water body with abundant emergent and shoreline vegetation.
Egg masses: Eggs are laid singly within a large, jelly envelope. The egg mass floats on the surface of the water, and unlike other frogs', occurs as a thin film
Voice: Deep throated "jug-o-rum."
Life history: Most wholly aquatic of Maine frogs. Bullfrogs are the last frogs to breed in Maine. Earliest dates for emergence by hibernating adults is May. Breeding occurs mid-to late June and July. The tadpole phase usually lasts two winters; transformation to adults requires a 10-20 day period. Subadult bullfrogs reach sexual maturity in four to five years. Bullfrog tadpoles are primarily vegetarian while adults are aggressive predators taking snakes, small fish, and even young waterfowl. Third season larvae show well-developed hind legs prior to actual transformation.

REPTILES

Painted Turtle (*Chrysemys picta*)

Description: Large scales or scutes on top of the shell. Lighter, often olive green, bands separate them. Top of carapace usually blackish or grayish with a colorful red margin. Undersides plain yellow or orange. Bright yellow spots on either side of the head behind the eye--can be seen at a distance with binoculars.
Size: Maximum length of carapace or top of shell 7.1" (18 cm).
Status and distribution: Largely restricted to areas within 40 miles of the coast.
Life history: Adults aquatic, live in many types of habitats such as bogs, vernal pools, marshes and even salt marshes. Often seen basking on sunny

days. Breeding occurs from March to June, sometimes later. Eggs laid between May and July, typically five or six. Nests are situated very close to water. Eggs hatch in late August or early September. Young sometimes overwinter in the nest.

Spotted Turtle (*Clemmys guttata*)

State-threatened

Description: Dark shell with yellow spots. Spots sometimes few in number.
Size: Length 3.5-4.5 inches (8.75-11.25 cm).
Status and distribution: Historically rare in Maine; widely dispersed populations in southern and central Maine; moderately common only in extreme southern York County. State Threatened.
Site: Small shallow wetlands (slow streams, ponds, vernal pools, bog ponds, roadside ditches, wet meadows) surrounded by dense vegetation. Shrub swamps and tussock marshes associated with red maple swamps are characteristic habitat.
Life history: Lives in unpolluted, small, shallow bodies of water. Often seen basking on floating matter or on shore. Breeds March to May. Eggs laid in well-drained soil June to July, usually three to five in number. Hatchlings emerge late August to September. Adults estivate in upland habitat in July and August. Vernal pools are important to spotted turtles. Vernal pools serve as centers in which adults congregate, feed and breed. Pools may be of special importance to gravid (egg-carrying) females, providing refuge and important foraging opportunities. Spotted turtles have been seen feeding on spotted salamander egg masses. Turtle activity in vernal pools may occur as early as March. In years during which water levels remain high, spotted turtles may keep to pools into early July.

Note: Vernal pools are important for feeding, courtship and mating.

Blanding's turtle (*Emydoidea blandingii*)

State-endangered

Description: Bright yellow chin and throat with yellow extending along the lower surface of the long neck. Indistinct pale yellow flecks on the dark high domed shell.
Size: Length 7-9 inches (17.5-22.5 cm).
Status and distribution: Widespread presence in York County; possibility of residence in Cumberland and Oxford counties. State Endangered.
Site: Use intermittent woodland pools and acidic bogs, especially if those habitats are within several hundred meters of buttonbush (*Cephalanthus occidentalis*) pools. They appear to favor black (dark) water pools.
Life history: Primarily aquatic, these turtles frequent marshes, shrub swamps, rivers, and streams. Shallow, dark, and heavily vegetated waters are preferred. Nest in well-drained settings, frequently those under agricultural use. Breeds May to July. Eggs laid in well-drained soil in mid June, usually twelve to thirteen in number. Hatchlings may emerge in August. Adults sometimes estivate in upland habitats in July and August. Blanding's turtles use many wetland habitats, but vernal pools are one of the most important. If Blanding's turtles are present, vernal pools will be heavily used, especially for feeding and hibernation sites. Sub-adults are particularly frequent visitors of vernal pools, using shallower more vegetated pools that dry by early July in most years. Adults use deeper black water pools. Presence of Blanding's turtles in vernal pools varies with water levels. These turtles may enter a vernal pool in late October in anticipation of fall refilling for use as an overwintering site. Individuals have been seen emerging from hibernation in a vernal pool while it still had abundant ice cover. Courtship and mating have been observed in vernal pools generally in April, May, and early June.

Note: Vernal pools are important feeding areas in spring and summer. May hibernate in vernal pools.

Snapping Turtle (*Chelydra serpentina*)

Description: Head is large, with a strong hooked beak. Tail long and saw-toothed on top surface. Rear margin of rough blackish or brownish shell is saw-toothed as well.
Size: Length 8-12 or more inches (20-30 cm); weight up to 35 lbs.
Status and distribution: Common in southeastern and central Maine, east into Washington County; in western and northwestern Maine distribution more spotty.
Life history: Adults almost wholly aquatic. Commonly found in lakes, swamps, ditches, water traps on golf courses, etc. Breed in the spring or summer, and usually lay their clutches of 20 to 80 eggs in mid-June. Nests usually in banks close to a water body. Eggs hatch between late August and early October. Young occasionally overwinter in the nest and emerge in spring.
Note: Vernal pools are sometimes used as feeding areas in spring and summer.

Wood Turtle (*Clemmys insculpta*)

State Special Concern

Description: Upper shell (carapace) brown and appears sculptured or rough. Plastron yellow with black blotches. Skin on neck and foreleg is a reddish orange.

Size: Generally 5-9 inches (13-23 cm).
Status and distribution: Statewide. State Special Concern.
Life history: This turtle is at home on the land and in the water. Overwinters in rivers and streams. Spends most of the summer (May-August) in riparian habitat: forested wetlands, marshy meadows, beaver flowages, and agricultural land up to several hundred meters from the stream or river. Breeds in summer or fall and usually lay clutches of 6 to 9 eggs in mid-June. Nests usually at gravel bars and riverbanks. Eggs hatch late August through early October.
Note: Vernal pools, especially old oxbows, within the floodplain are used extensively during the summer for feeding.

MOLLUSKS

Fingernail Clams (Family *Pisidiidae)* (Species of *Sphaerium*, *Musculium*, and *Pisidium*)

Mark C. Erelli

Description: Look like small clams, ranging from the size of a pinhead to as large as a dime. Shells may be tan or brown, most commonly whitish.
Size: Generally 0.125-0.5 inches (3.125-1.25 cm). None larger than 1.5 inches (3.75cm).
Status and distribution: Occur in vernal pools statewide, as well as in lakes, ponds, streams, floodplains and other wetland habitats.
Life history: Found on pool bottoms and on vegetation growing in flooded pools. Adults bear live young, release them from between their shells into pools. Adults and/or young burrow into the mud as pools dry and reemerge when the pool is again flooded.

Amphibious Snails (Order *Basommatophora*) (Species of *Physa*, *Lymnaea*, *Helisoma*, *Gyraulus*, and others)

Mark C. Erelli
Description: Snails with a variety of shell shapes, usually brown in color. Breathe air and are often seen at the surface of pools, hanging upside down on the surface film with the ”lung“ opening exposed to the atmosphere. Consult the field guides listed in the bibliography for more detailed information on description.
Size: Varies with species and life stage. Generally from 0.25 to 2 inches (0.625-5 cm).

Status and distribution: Floodplains, vernal pools, ponds, and streams throughout the state.
Life history: Emerge from muds when flooding occurs. Adults graze on algae and decaying plant and animal material. Eggs are laid in small clusters on vegetation, leaves, and other materials in the pools, and young snails hatch out. When the pool dries up, the snails burrow into the mud on the pool bottom and withstand drying until the pool refills.

INSECTS

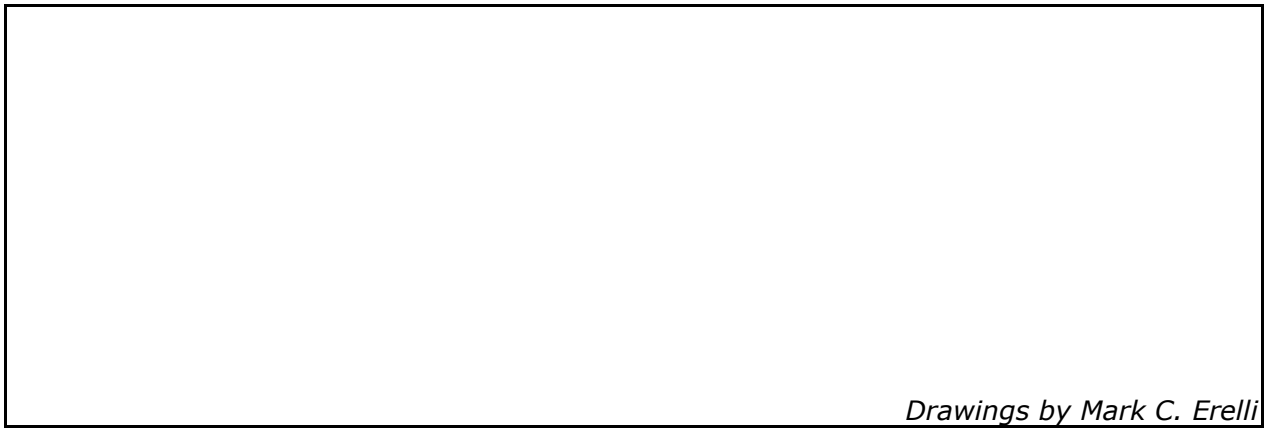
Caddisflies (Order *Trichoptera*) (Caddisflies from the families *Phryganeidae* and *Limnephilidae* are particularly common)

Mark C. Erelli

Description: Vernal pool caddisflies construct tubular cases out of vegetation (i.e. twigs, leaf particles conifer needles sometimes interwoven with coarse sand or pebbles.) The cases often look like small sticks crawling along the pool bottom or like miniature log cabins (genus *Limnephilus*). A common case observed in vernal pools in Maine resembles a cylindrical sea urchin about 3/8" long. The larva inside the case looks much like a white or tan caterpillar with a brownish head and three pairs of legs. Some vernal pool species have striking black stripes on their heads. Other cases are long, smooth tubes usually constructed of leaf material. These are members of the genus *Ptilostomus* and they may prey heavily on egg masses.
Size: In early stages less than 0.25 inches long. Cases of older larvae that are most easily seen in vernal pools, and empty cases left behind when the pools dry, are usually 0.5 to 1.5 inches long but may be much smaller.
Status and distribution: Caddisflies are found statewide in lakes, ponds, streams, rivers, and vernal pools.
Life history: Adult Caddisflies look like small brown moths and lay their eggs in the fall in the dry depressions of vernal pools or on overhanging vegetation. The eggs withstand drying and cold until the pool floods later in the fall, during a winter thaw, or from spring snowmelt and showers. When the pool is flooded, the larvae emerge from the egg mass. The larvae graze

on algae, vegetation, and decaying plant and animal matter. Some are predaceous; in vernal pools, some species are important predators on salamander eggs. At the end of pupation, the metamorphosed adults leave the cases and fly away. The adults remain in an inactive state during the summer, resting in tree holes or caves.

OTHER AQUATIC INSECTS:



Drawings by Mark C. Erelli

Many species common in ponds throughout the state, including dragonflies, damselflies, predacious diving beetles, giant water bugs, whirligig beetles, backswimmers, water boatmen, midges, phantom midges, mosquitoes, and others, can be found in vernal pools. Consult the guides listed in the bibliography if you are interested in identifying the aquatic insects you find in the vernal pools you are studying.

THREATENED AND ENDANGERED SPECIES

Report sightings of spotted, wood, and Blanding's turtles.

If you live in York County there may be Blanding's or spotted turtles using vernal pools. Turtles may use pools from a few days to months or the entire winter. Wood turtles also use vernal pools, especially pools in river floodplains. Watch for these turtles in vernal pools and be sure to report any observations (even if it is not in a vernal pool). The ringed boghaunter dragonfly (Williamsonia lintneri), associated with acidic vernal pools, is a Maine Endangered Species.

In Massachusetts and Connecticut, a number of fairy shrimp, clam shrimp, and amphipods are state-listed.

If you observe any animals listed as endangered, threatened, or of special concern (listed in Appendix H), you should report your sightings to the Department of Inland Fisheries and Wildlife's Endangered Species Program. Information submitted should include the species (give descriptive information to back up your description, preferably including photographic documentation); date and time of the observation; location where you saw the animal (with sufficient detail to allow someone to relocate the area); and your name, address, and telephone number.

CHAPTER IV: TECHNIQUES AND TIPS FOR FINDING AND DOCUMENTING VERNAL POOL INDICATOR SPECIES

This chapter describes a variety of techniques for finding and handling vernal pool animals. Detailed descriptions of what to look for are given in Chapter V - Assessing the Pool. **Please read this section carefully before proceeding to assess a vernal pool.** Preferred methods of documenting the presence of indicator species are photography and description in hand. Thus it is essential that you acquaint yourself with proper technique for handling vernal pool animals. Choose a method that is appropriate to the specific site, that will enable you to collect the desired information and that will cause the least disturbance to the pool and its surroundings. If you are not experienced at exploring aquatic habitats, see Appendix C, "Field Equipment for Vernal Pool Documentation."

CAUTION: PROCEED WITH EXTREME CARE

- Egg masses and amphibians are extremely sensitive to chemical residues. Do not put your hands in the pool if you have used bug repellent or any other chemical applications to your skin.

- While you are collecting information about the 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! However, impress upon them the need for minimal disruption of the pool.

- Handle vernal pool animals and egg masses only when it is necessary for description, 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 (if they become detached, try to reattach them at the same depth as they were through the same attachment channel if possible). 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.

- Seining is not recommended as a method of determining absence of fish in a pool because of the disturbance it causes and the difficulty of working in a pool crowded with submerged and emergent plants. It may be an option in large, permanent pools with little vegetation. In any case, seining should never be done during the spring breeding season.

Tip: Polarized sunglasses greatly aid in seeing into the water! Don't leave home without them!

FINDING FAIRY SHRIMP

It is difficult to predict the best time to search your pool for fairy shrimp. They are known to hatch before ice is off in semi-permanent pools. The best way to document fairy shrimp is to visit your pool a week or so after it fills with water. Use a dipnet to sample different areas of your pool. Sometimes you can see them swimming. We have scarce data on fairy shrimp distribution so we encourage you to make at least one visit before the egg masses are deposited to check for early-hatching fairy shrimp. Check again when you are counting egg masses. We desperately need your data on this species. If vegetation is very dense and dipnets are not working, try using plastic storage bins. Plunge the bin into the water every few steps and quickly pull it out. The water sucked into the tray will likely contain invertebrates, tadpoles, salamander larvae or occasionally an adult amphibian. To further examine animals, gently pour the water from the bin through a fine-mesh dip net, separate the animals from vegetation and debris and transfer the animals to a white enamel tray or jar for description and/or for a photograph. Release your catch as soon as you are finished with identifying and/or photographing them. Don't pour them back into the pool. A gentler method is to flood the holding container in the water and release the catch.
Warning: Be careful handling invertebrates. Some, like predacious diving beetles, bite!!

FINDING EGG MASSES

Again, polarized sunglasses are your first tool. Egg masses are not randomly distributed; they tend to be clustered in certain parts of the pool,

often northern exposures where ice may melt first. In most small pools, eggs can be found in less than 3 feet of water within the first 3-10 feet of shore. Search clumps of vegetation and fallen logs and sticks. If vegetation is scarce, eggs may rest on shallow bottoms. Depending on the weather, your indicator species may be laying at different times so if you can, make more than one visit. In dry and cool years, the wood frogs and blue-spotted salamanders may lay first. Spotted salamanders tend to be more dependent on warm and rainy conditions. Hence, they may lay 2-3 weeks later if conditions are not good. If water is very silted or murky, searching may be more difficult. Wade slowly trying not to stir up the bottom and gently lift vegetation to the water's surface to see if masses are present. In clear waters, you may not even need to wade into the pool.

FINDING AMPHIBIANS: VISUALS

WHEN?

Daytime is preferable as there is potentially less disturbance to pool inhabitants since you can see better. A greater range of amphibian life stages (eggs, larvae, juveniles, adults) and invertebrates are likely to be observed during daytime visits. However, night visits are the best times to observe adults, especially salamanders during the early breeding season. A variety of techniques at different time points are needed to develop an accurate picture of the fauna of a given area. A short-term survey performed when conditions are not favorable may be unproductive. Take your time! Most of the animals that live in vernal pools are small and secretive.

A minimum of <u>three</u> visits per site is recommended -- one in early spring when egg masses are present, the second in mid-summer when larvae are growing, and a final visit late summer to document pool dry down and potentially see emerging metamorphs. At many pools it may be possible to gather documentation without going into the pool. Visual observations are preferred as they create the least amount of disturbance.

Note: If you choose to venture out at night, be cautious, as it is easy to get disoriented in the woods at night -- even a very short distance from the road. Also, you are more likely to trip over things, stumble into holes, etc.

How?

Approach the pool slowly and quietly while looking for larger animals that may be resting on the surface, especially turtles. Look for basking sites on sunny, warm days. 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, determine where it was to see if there might be another individual nearby. Walk around the pool slowly looking in the water for salamanders, frogs, egg masses and spermatophores. 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, and restore anything you move to its original position and condition. (Be careful not to disturb the shoreline by excessive trampling.)

Bend down and get close to the water surface. This is greatly enhanced by looking through a clear bottom bucket. Salamanders foraging in vernal pools may be bothered by movements outside the pool during the day, but typically resume feeding after less than 5 to 15 minutes. Try to remain in one spot for a while, alternately scanning and studying a specific area. At many pools, it may be possible to gather the desired information without going into the pool.

If you do a night search, you will find that in most cases light disturbs amphibians only if kept focused on an individual. Wading slowly through a pool using a headlamp creates general disturbance in the area of the observer; a yard or more ahead, the disturbance is minimal. At night salamanders are typically not alarmed by movement and often tolerate direct light.

LISTENING TO VERNAL POOLS: FROG CALLS

(Tapes of Maine's singing amphibians are available to volunteers; a CD of Maine's singing amphibians is included in "The Amphibians and Reptiles of Maine")

Salamanders do not vocalize. High-pitched jingle bell-like calls of spring peepers are heard from March through May. Although peepers do not breed specifically in vernal pools, they may lead to vernal pools. Wood frogs call in March through May depending on location. Ice may still be on the pond. Wood frog calls have limited carrying power and can seldom be heard far from the pond. 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. 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 pond you are standing in is silent, remain still. Calling will usually begin in a few minutes. If not, you may be able to "jump start" the chorus by quacking yourself! If the night is cool or the density of calling frogs is low, your disturbance may shut down the chorus for longer periods.

CATCHING AND HANDLING AMPHIBIANS IN THE WATER

BE SURE YOUR HANDS ARE FREE OF CHEMICALS!

If you can't identify an animal adequately while it is in the pool, try to catch it so that you can more readily observe or photograph it. A long handled dip net works best, but an ordinary kitchen strainer will suffice. Always keep animals and egg masses covered with water and handle them gently. Small animals can be transferred directly from the net to a container filled with pond water. A light colored plastic or enamel pan is best. 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. You must be very careful not to dislodge the egg mass from its attachment

site.

CATCHING AND HANDLING AMPHIBIANS ON LAND

Note: Most adult animals do not need to be captured in order to be identified.

Most amphibians in a terrestrial setting can be caught by quickly bringing a cupped hand down over them. Be careful not to come down too hard. 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. Amphibians have moist skin and can desiccate quickly. Keep your hands moist. Dip them into water or pick up moist moss or leaf litter before handling an amphibian. Do not handle the amphibian if you have insect repellent or other chemicals on your hands because the chemicals will be absorbed through the animal's moist skin. Keep frogs and salamanders cool and out of the sun. Transfer the animal as quickly as possible to a clear plastic jar with a screw top riddled with holes to allow air to circulate in the jar. A clear plastic bag perforated with small holes and damp moss or leaves inside will also work. Now you can carefully identify your catch or possibly even photograph it through the container. It is best to handle only one animal at a time. Salamanders can be held 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. **Remember; do not hold a salamander by its tail.**

RELEASING AMPHIBIANS

All animals should be released as soon as possible. Release animals where they were captured. Releasing an amphibian outside an area with which it is familiar may decrease its survival chances. This vernal pool description process has no requirements for collecting specimens of live animals.

CHAPTER V: ASSESSING THE POOL - IS IT A VERNAL POOL?

In this chapter you will learn what information is required to call a pool a **vernal pool** and how to determine if vernal pool indicator animals are breeding in the pool. **The information you collect is extremely valuable.** Biologists have too little information on vernal pools and the animals that depend upon them. Your detailed account of species, including estimates of animal populations, egg masses, and different life stages (such as salamander larvae, tadpoles, juveniles, and adults), will be used by biologists at Maine Audubon Society and MDIFW to learn more about vernal pool ecology and how to conserve vernal pools.

PICK A POOL

Assess 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. If you choose a pool close to home or on your own property, it will be easier to make all three visits or more! Some find it useful to have a partner for note taking, safety, and companionship.

CRITERIA FOR VERNAL POOL STATUS

A pool meets the criteria for ”vernal pool“ in this manual if the following conditions are satisfied:

1. The pool is a temporary, seasonal, or semi-permanent fresh water body (and hence fishless) that remains flooded long enough to support the life-cycle of one or any combination of the vernal pool indicator species--spotted salamanders, blue-spotted salamanders, wood frogs, and fairy shrimp. Evidence of breeding of one or any combination of the vernal pool indicator species supports this criterion.

2. If the pool is a permanent water body and it supports one or any combination of the indicator species, it must be fishless. (This criterion would exclude most, if not all, beaver flowages unless there are isolated pools along the edges, which are hydrologically separated from the rest of the flowage.)

COLLECTING EVIDENCE FOR VERNAL POOL DESCRIPTION

1. Evidence of breeding indicator species

To adequately document a vernal pool, you need to look for specific life stages of indicator amphibians and other evidence of breeding.

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 even for animals that are not indicator species.

- **Breeding adults**

  Wood frogs

1. "chorusing," groups of males calling in unison
2. mated pairs (amplexus)

  Spotted and blue-spotted salamanders

1. Courting behavior (males and females congressing)
2. Spermatophores

  (Spermatophores are small (approx ½ inch) vase- or stump- shaped white packets of sperm deposited by male salamanders on leaves or other debris on the pond bottom.)

  Note: Identify adult indicator species to the species level. For example, "wood frog," "spotted salamander," NOT "frog" or "salamander."

- **Eggs**

  Note: At a minimum, distinguish between wood frog eggs and salamander eggs. Documenting the presence of salamander egg masses, regardless of species, or wood frog eggs, is sufficient evidence for documentation. Description of amphibian eggs of facultative species is optional.

See egg mass descriptions in Table 1 and Chapter III.

- **Larvae**

  Frog and salamander larvae can be readily distinguished by visual observation. With close detailed examination it may be possible to identify larvae to species. Refer to Table 2 or Chapter III for detailed descriptions.

  Note: Larval salamanders do not need to be identified to species; it can be challenging. Presence of a larvae with bushy gills is sufficient. Facultative species of frogs and toads may use vernal pools. Because the wood frog is the only frog that is a vernal pool indicator species, tadpoles need to be identified to species if used to document the presence of wood frogs.

- **Transforming juveniles**

  Metamorphosing frogs show some remnant of a tail. Transforming salamanders have gill remnants.

- **Presence of fairy shrimp**

  The presence of fairy shrimp in a flooded pool qualifies the pool as a vernal pool as defined in this manual. As they hatch out in the pool in spring from overwintering eggs, their presence is enough to document breeding activity the previous season.

  Note: Fairy shrimp and other invertebrates need only be identified to the group level (family or order), i.e. "a caddisfly" or "a fairy shrimp." If you have the skill, resources, and patience to make more detailed description of invertebrates, your efforts will provide an even greater level of vernal pool information. Additional resources for identifying invertebrates are provided in the bibliography.

2. The permanent pool with indicator species is fishless.

There are many ways to make this determination. The amount of effort involved will be dictated by the size and complexity of the pool.

If the pool is small, a visual assessment may be sufficient.

If the pool is larger or obscured by vegetation it may be necessary to set minnow traps, seine, or use nets.

Note: It may be necessary to make this determination after the breeding season so as not to disturb the spring breeders. Seining and netting could disturb and/or destroy egg masses. Trapping could kill amphibians, especially adults. Seining and trapping should be a last resort and only done after the spring breeding season in late August or September.

CHAPTER VII: FILLING OUT THE VERNAL POOL DOCUMENTATION FORM

THE FINAL PACKAGE--PUTTING IT ALL TOGETHER

The completed forms and maps should be sent to:

Aram Calhoun
Department of Plant, Soil, and Environmental Sciences
5722 Deering Hall
Orono, ME. 04461
207-581-3010
calhoun@maine.edu

The following is a checklist of items to be included in your package. If you check off these items, your package will be complete.

_____ a written description of vernal pool and how to find it

_____ a sketch map of the pool

_____ a map of the location (USGS, tax assessors, NWI)

_____ a completed vernal pool description form

_____ photographs (optional, but highly desirable) of indicator species and/or the site

Thank you for your enthusiasm and support.

CHAPTER VIII: VERNAL POOL PROTECTION AND CONSERVATION INITIATIVES

REGULATORY STATUS

Federal Level

Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to regulate certain activities within waters of the United States. The definition of "waters of the United States" includes wetlands. The Corps defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated conditions." They regulate the "discharge of dredged or fill material" into all waters. A discharge can include activities such as filling a wetland to make it into an upland area, draining a wetland, or mechanically clearing land that involves cutting trees and grubbing out the stumps.

In Maine, the Corps has traditionally regulated naturally occurring vernal pools either as wetlands or as other waters of the U.S. (i.e. "special aquatic sites"). Some vernal pools will occur within a larger area of forested or scrub-shrub wetland and will be regulated as a portion of the larger wetland system. In other instances, a vernal pool can occur as a distinct feature within an upland landscape, such as an Oak Forest. Because some vernal pools do not support wetland vegetation, they may not be regulated as a wetland, per se, but may still be regulated as a water of the United States. Vernal pools may not be afforded full protection under Section 404 for two reasons: 1) Due to the misconception that wetlands <1 acre are not regulated (they are) by the Corps and, 2) the fact that there is a programmatic general permit that allows impacts 1/10 acre and many pools may be smaller than this. Artificially created areas are regulated if they meet the definition of wetland. Specific exceptions are stormwater conveyance features or a pond created for a specific purpose, e.g., irrigation, farm, or fire pond.

As our knowledge of the ecological importance of vernal pools has increased in recent years, the Corps has paid increasing attention to these unique wildlife habitats in their review of project proposals. Through the input of the U.S. Fish and Wildlife Service and the U.S. Environmental Protection

Agency, the Corps has begun to consider project effects on not just the vernal pool itself, but also to non-breeding seasonal habitat and amphibian migration routes that occur in nearby wetland and upland habitats. The Corps can require protective buffer strips around vernal pools, even in upland areas. However, this occurs only if some wetland is being filled as the Corps regulates dredge and fill activity in wetlands. In Vermont, vernal pools are specifically mentioned as regulated wetlands in the State Programmatic General Permit. This may be included in other New England state permits in the future.

The key to vernal pools receiving regulatory attention, however, is having the pools identified either in the permit application or during a site visit by the Corps or other federal agency involved with the review of permit applications. An applicant may not be aware that a vernal pool occurs on a project site, or a field review during the wrong time of the year may result in a vernal pool being overlooked. Although the Corps regulates all waters of the U.S., regardless of how small an area, the level of review given to each permit application is generally dependent on the amount of impact proposed (e.g., wetland fill). Under the current Federal permit program, if a proposed project will impact less than 15,000 square feet of wetland it is a Category 1 impact and no permit application is required. Therefore, a small vernal pool could be completely destroyed without any regulatory scrutiny.

State Level

The Maine Department of Environmental Protection (DEP) also regulates wetlands under the authority of the Natural Resources Protection Act, which regulates a variety of ”protected‟ natural resources, in addition to wetlands. The DEP defines wetlands in the same fashion as the Corps of Engineers and regulates similar activities in wetlands, such as filling or draining.

The DEP began a modified wetland regulation program in September 1995 where, for the first time, they regulate all wetlands, regardless of size. Like the Corps, the DEP gives greater review to those permit applications that propose to affect larger amounts of wetlands or wetlands that are typically recognized as higher value wetlands (e.g. coastal wetland or emergent wetlands >20,000 square feet). Impacts less than 4300 square feet are exempt. For example, a vernal pool survey in southern Maine demonstrated that 58% and 80% of the vernal pools identified were less than 4300 and 15,000 sq. ft respectively. In central Maine, 93% of the pools were less

than 4300 sq. ft. Consequently, the same problems as exist at the federal level also hold true for Maine's wetland regulatory program. Vernal pools can "slip through the regulatory cracks" because the amount of wetland impact proposed by a particular project is relatively small, or the vernal pool(s) is never identified either in the permit application or during a site visit by regulatory agencies.

When Maine modified its wetland regulatory program in 1995, they added Significant Vernal Pools to the state's list of "Significant Wildlife Habitats," which are a special category of protected natural resources. The Maine Department of Inland Fisheries and Wildlife (MDIFW) is responsible for defining and mapping Significant Vernal Pools. MDIFW is currently developing a strategy for defining Significant Vernal Pools. Both definitions and maps would be required to go through the public rule-making process. Designation as a Significant Vernal Pool would provide regulatory jurisdiction for those pools that do currently receive protection and could also provide regulatory review by the DEP for smaller wetland impact projects that currently receive no review under the wetland program. However, in the interim, MDIFW is relying on a voluntary, cooperative strategy of protecting vernal pools.

In the unorganized towns and plantations, the Land Use Regulation Commission (LURC) regulates activities in wetlands (LURC's language on vernal pools is consistent with the statutory provisions in NRPA). However, LURC's regulatory authority over vernal pools is tied to MDIFW's ability to define and map vernal pools. In unorganized towns, MDIFW is relying on a voluntary, cooperative strategy for protecting vernal pools. In addition to potential identification of Significant Wildlife Habitats, LURC wetland protection rules regulate any wetlands shown on their zoning maps. The rules provide for an additional route to identify, and subsequently protect, Significant Wildlife Habitat when assessing development activities. Specifically, any applicant whose project will disturb 15,000 square feet of a mapped wetland or an acre or more of land (either upland or wetland) is required to provide a delineation of all wetlands in the project area. Therefore, if LURC learns about the existence of vernal pools via a wetland delineation associated with an application, LURC may consider impacts to the vernal pool in its evaluation of the application

Local Level

No specific protection at the local level exists for vernal pool habitat. Municipalities and towns have the option to create stricter protection for natural resources than are afforded by either federal or state regulations. Local protection can occur on a ”watchdog‟ level as well as at the regulatory level. Most destruction of important wildlife habitat is notably borne from ignorance, not malice. Thus, a heightened awareness of the ecological importance of vernal pool habitat by the citizenry could result in more protection. Private stewardship of vernal pools can be a very effective protection strategy. Evidence of draining of pools through ditching, filling of pools with earth or slash from forestry operations, or other physical disturbances can be investigated and hopefully corrected at the local level. As pointed out above, even though protection is afforded at the federal and state level, pools must first be identified in permit applications and site reviews. No one has more knowledge or vested interest in a town's resources than the local people. Grassroots stewardship of this critical wetland type is the key to protection.

AMPHIBIAN MONITORING PROGRAMS IN THE STATE OF MAINE.

MAMP (the Maine Amphibian Monitoring Program)

In 1996, Maine Audubon Society, MDIFW, and the University of Maine collaborated to participate in the North American Amphibian Monitoring Program (NAAMP), the North American component of the Declining Amphibians Task Force. The Maine Amphibian Monitoring Program (MAMP) is in its third year. Currently, 58 singing amphibian-monitoring routes have been established statewide. Volunteers monitor these routes three times per year recording at each stop species of singing amphibian and an abundance code based on number of individuals singing. After the 5th or 6th year, our data will be evaluated by NAAMP to assess population trends. In the short-term, these data are valuable in adding to our knowledge of the phenology, distribution, and yearly variability of singing amphibians including the wood frog. After the 5th or 6th year, our data will be evaluated to assess population trends. In the short-term, these data are valuable in adding to our knowledge of the phenology, distribution, and yearly variability of singing amphibians including the wood frog.

VIP's (Very Important Pools)

In Spring, 1999, a vernal pool volunteer monitoring program was initiated by Maine Audubon Society and the University of Maine. The goal of this project is to collect long-term (a minimum of three years) chemical and biological data on pools, to make this data accessible to the public through development of a web page database (see www.wetlandconnections.org), and to begin mapping vernal pools on a GIS database. Fifty to 100 pools will be monitored the first year of this project. Collection of data follows procedures outlined in this manual. Volunteers for 2000, the Century of the Amphibian (maybe?), are greatly needed from western, northern, and downeast Maine. For more information, contact Aram Calhoun, 581-3010 (UME) or calhoun@maine.edu.

CHAPTER IX. 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 under her forelegs.

astatic waters: Some ”temporary ponds“ or ”vernal pools“ don't dry up completely each year, but rather, fluctuate dramatically in size from large, seasonally flooded basins to small, permanent pools. Because the area of permanent water is small, it tends to be very low in oxygen in the summer and may dry up in exceptionally dry years. Fish and other animals that need permanent water cannot survive in these ponds. The ponds thus function like temporary waters despite the persistence of the permanent pool in most years. Wetland scientists, in attempting to bring more precision into the definition of these variable habitats, use the term ”astatic (nonstable) waters“ to emphasize the seasonally fluctuating water levels.

autumnal pond or pool: Purists note that ponds that fill in fall or early winter should be termed ”autumnal pools“ and reserve the term ”vernal pool“ for ponds that fill in the spring and stay dry in fall and winter. Many of the temporary ponds in Maine, although often referred to as vernal ponds, fill in during the fall as groundwater tables rise and remain flooded until summer and are thus autumnal ponds. In this manual we make no distinction between autumnal and vernal pools.

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 (vent): The chamber into which the intestinal, urinary and reproductive tracts open.

compressed: Flattened; e.g., laterally compressed indicates flattened from side to side.

digit: Finger or toe.

diurnal: Active by day.

dorsal/dorsum: The upper surface of an animal, the ”back.“

ephemeral pond or pool: Temporary ponds that retain water only from a day or two to a week. Most commonly, ephemeral pools form after rainstorms. They often contain highly specialized communities of crustaceans and aquatic insects whose life histories are specially modified to account for the long periods of drought between one filling and the next. Sometimes the term is used to describe longer-lived temporary ponds that dry seasonally but contain water for several months each year. This type of temporary pond could be considered a vernal pool in this manual.

facultative species: Refers to animals that may be found in vernal pools but which do not depend on them for successful reproduction. Green frogs, spring peepers, and turtles are examples.

fossorial: An animal that lives beneath the surface of the ground. Mole salamanders, including spotted and blue-spotted salamanders, are examples.

gill: A feathery or filamentous aquatic respiratory organ.

hydric soil: Refers to a soil that is saturated long enough during the growing season to develop characteristics that classify it as a wetland soil.

indicator species: Refers to animals that depend on vernal pool habitat for successful reproduction. In Maine there are four -- the spotted salamander, blue-spotted salamander, wood frog, and fairy shrimp.

intestinal coil: The intestines of a tadpole that are coiled up in the far ventral half of the body. For some species, the intestinal coil is wholly or partially visible. It looks like the coil or rings of a snail shell.

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

kettle/kettlehole: A depression in the landscape caused by ice blocks deposited during the last glaciation.

larva (larvae, pl.)**:** A gilled, free-living, post-hatching stage animal 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.

migration: Any movement by animals between two areas. As a rule, it is a response to changes in environmental conditions.

mole salamander: Any member of the Ambystomatidae family of salamanders. They are called mole salamanders after their habit of burrowing into the ground or using the burrows of other animals. The blue-spotted and spotted salamanders belong to this family.

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.

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.

temporary pond: This is the most common general term used to describe aquatic habitats that are periodically ponded and dry. It is used to describe 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 kettlehole basins that contain some water most of the year and usually dry up only for a month or two in midsummer. All of the terms listed below describe different kinds of temporary ponds. Many temporary ponds are important wildlife habitats for unique biological communities that include

fairy shrimp and fingernail (or ”pill“ or ”pea“) clams, caddisflies and other aquatic insects, turtles, frogs, toads, and salamanders. The pools appear year after year in the same spots, except during exceptionally dry years.

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

vernal pool: Strictly speaking, this 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.“

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