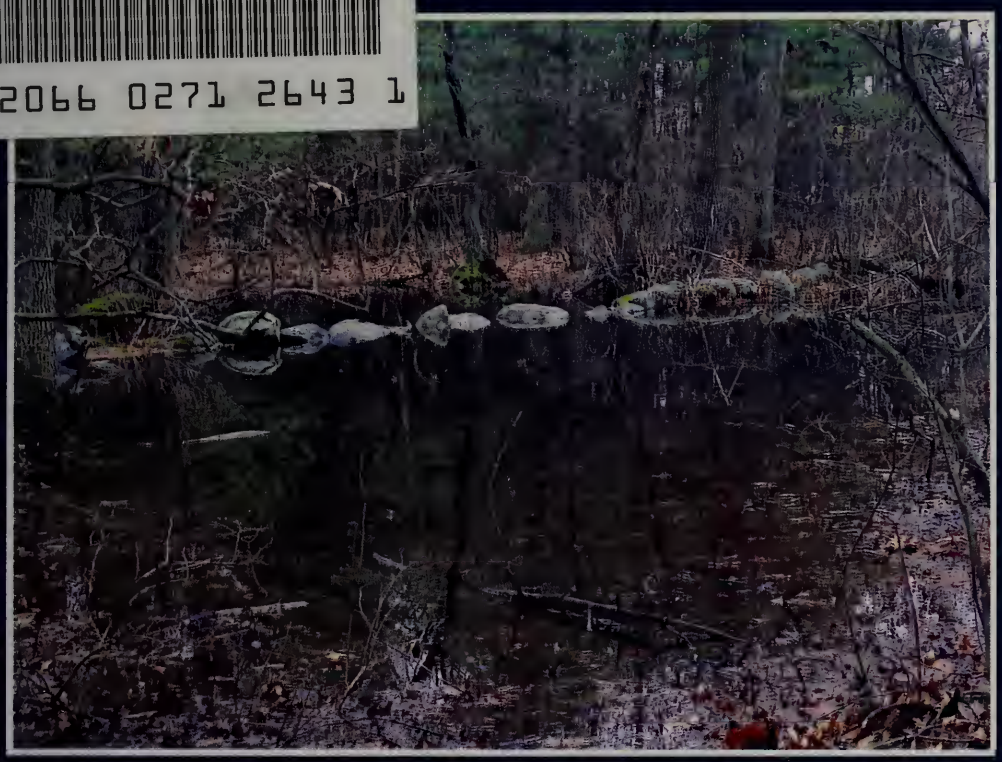
A Field Guide to the animals of Vernal Pools



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Massachusetts Division of Fisheries & Wildlife
Natural Heritage & Endangered Species Program
&
Vernal Pool Association
May 2000

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Vernal pools are critical habitats that support unique and valuable wildlife communities. As Environmental Affairs Secretary, one of my top priorities is to help citizens reconnect with the natural world. I believe that this field guide will be a wonderful aid in discovering and exploring the treasures of our vernal pools, and will be helpful in efforts to preserve them.

- Bob Durand, Secretary
Executive Office of Environmental Affairs
Commonwealth of Massachusetts

Over many years, there have been individuals and groups, intentionally or not, whose unflagging support, periodic inspiration, valued criticism, invitations to visit, access to properties, companionship on uncountable field trips, love of nature, support for education, or generous funding have ultimately made this book possible. We sincerely thank: Carolyn Asbury, Kyla Bennett, Collette Blais, Jack Buckley, Alan and Janet Burne, Eric Chaisson and the Wright Center for Innovative Science Education, Betsy Colburn, Paul Colombo, Lisa Dennehy, Nancy Eaton, Peggy Emslie, the EnTrust Fund, Mark Erelli, Essex County Greenbelt Association, Suzanne Fowle, Dave Gorrill, Harry Harutunian, Mike Harney, Mike Hayslett, Anna Hicks, April Hobart, Pat Huckery, Scott Jackson, David King, Gary Kreamer, Rob and Karen Loomis, Mary Kenney, Joe Martinez, Jim and Stina MacDougall, Stafford Madison, Mark Maguire, Mike McCarthy, Joseph "Mick" McLaughlin, Steve Metz & Governor Dummer Academy, Steve Meyer, Joan Milam, Frank Orlando, Judy Parker, Susan Pike, Peter Ranney, RMHS field biology students, Rick Roth & the Cape Ann Vernal Pond Team, Scott Shumway, Jim Starr, the Sweet Water Trust, Karen Talentino, Laura Timmerman, Sarah Turtle, Tom Tyning, James White, Alison Whitlock, Brian Windmiller, and Henry Woolsey.

As you walk through the New England woods in winter and peer between the branches of the leafless trees, you might discover a small frozen pond formed in a shallow depression. Return to this area in early spring when the soil has thawed and you might hear the quacking chorus of wood frogs or observe spotted salamanders as they plod to the water in a thousands-year-old mating ritual. Visit the pool in late spring after the plants leaf out and you could be entertained by dragonflies darting above the surface and swooping to catch a meal, wading birds probing the water for the abundant tadpoles, or green frogs yelping as they leap away at your approach. Within the clear water beyond the schooling amphibian larvae may be abundant fairy shrimp, insect larvae, small crustaceans, fingernail clams, planaria and other invertebrates. Return again in the sticky heat of summer and this woodland oasis will likely be an open area of damp mud or dried, crinkled leaves. The water will be gone and with it the visible animal life which erupted a few months earlier. You will have observed the cycle of life in a New England vernal pool. We present this guide to aid your personal explorations and study of this wonder of the New England landscape. Enjoy your visits.

Leo Kenney and Matt Burne, May 2000

Vernal pool wildlife communities are variable. Physical factors such as sunlight, water temperature, acidity, and duration of flooding all affect the type of pool life. Whether the pool is very small (1) or surprisingly large (2), surrounded by deciduous trees (3) or hidden by coniferous vegetation (4) will partially determine the organisms in the pool.

Why this book?

The public's interest in vernal pools and vernal pool ecology has increased tremendously in recent years. While the initial surge may be attributable to efforts to encourage vernal pool certification in Massachusetts, the sustained interest stems from a genuine fascination with the ecology of organisms whose existence revolves around these temporary puddles in the forest. Hundreds of teachers now integrate vernal pool studies into their curricula. Citizens organize road closings and information programs on amphibian migration nights. Nature sanctuaries, state parks, national parks, elder hostels, Conservation Commissions, youth groups, garden clubs, land trusts, museums, zoos and aquariums are all scheduling vernal pool programs and exhibits. With all of this interest in vernal pool ecology, there was a clamor for a simple introductory field guide such as this book.

In an effort to produce a useful and portable field guide including examples of organisms found in both temporary and persistent pools, many compromises have been made. Organisms easily found in other guides (plants, birds and mammals) are not included. Identification of organisms is only to a level achievable with a hand lens and the observation of a live specimen to be returned to the pool unharmed. Thus, we do not include keys to amphibian larvae which would require a dead specimen. Identification of many invertebrates is only to phylum level, while others are identified to the species level. Some organisms are not included because of difficulty in field identification or space limitations. Yet, this guide will bring most people to a comfortable level of familiarity with vernal pool organisms.

All measurements are given in the English system. To save space, we use these abbreviations: NE=New England, MA=Massachusetts, P=phylum, C=class, O=order, SO=suborder, and F=family.

What is a vernal pool?

Vernal pools are ephemeral wetlands which fill annually from precipitation, runoff, and rising groundwater. Most years they become completely dry, losing water through evaporation and transpiration. The wet-dry cycle prevents fish from becoming established, yet presents a rich, albeit temporary, habitat for many species. Beneath the still waters of these woodland pools is a staggering array of life.

In this guide, we consider vernal pools to be wetlands that are or become isolated while containing water, are utilized by indicator species, and have wet-dry cycles that preclude permanent populations of fish. This definition may not coincide with definitions used for regulatory purposes in Massachusetts and other states nor with usage by some scientists in professional papers.

Vernal pools are variable in appearance, water source, time of filling, surrounding habitat, plant and animal content, and many other factors. In all cases, they share two characteristics: they do not hold water permanently and they are free of breeding populations of fish. In New England, the term "vernal pool" is used to refer to a wide variety of temporary, fish-free wetlands. In the narrow sense, a vernal pool is a temporary wetland which fills each spring (vernal means spring) and dries annually. Few of our pools meet this standard; most fill in the fall or winter and many of our larger vernal pools persist for several years before drying. The popular use of "vernal pool" refers to temporary wetlands regardless of when they fill or dry as long as they support certain animal communities.

Scientists and regulators, on the other hand, may use "vernal pool" with overlapping but still differing meanings. Scientists are concerned with the variable animal communities which result from the differing seasons of pool filling and the duration of the water in the pool. A short-lived spring pool will have a far different

The upland habitat near the pool is home for most vernal pool breeding amphibians and helps determine the species which use the pool. A hardwood forest pool (1) might have blue-spotted salamanders; an interdunal swale (2) Fowler's toads; an open field pool (3) spadefoot toads; a red maple swamp (4) four-toed salamanders.

Pools which are semipermanent are likely to have wetland vegetation. A forested wetland might contain red maple and highbush blueberry (1). Open areas of pools might have emergent herbaceous vegetation (2). Coastal plain ponds form rings of vegetation as they dry (3).

community than a fall-filling pool or one which lasts for several years. Scientists often distinguish between the ephemeral "vernal pool" and longer duration "semipermanent ponds." Regulators may define "vernal pool" based on a number of criteria including its location, the regulations involved, and the species present.

This guide will continue the popular usage of "vernal pool" in its broadest sense. Vernal pools are any fish-free, temporary wetland that supports indicator species.

Indicator species

Because of low oxygen levels and periodic drying, vernal pools are free from breeding populations of fish. Numerous amphibian and invertebrate species have evolved life cycles adapted to the exploitation of a temporary wetland without the predation of fish. Some species are completely dependent upon ephemeral wetlands for parts of their life cycle. Such animals are the "obligate" or "direct indicator" species of vernal pools. "Facultative" vernal pool species ("indirect indicators") are those which use both vernal pools and other wetland habitats for their various life activities. They have physical or behavioral adaptations to deal with the wet-dry cycle of a vernal pool and require a pool which holds water for 2-3 months, but are also found in other wetlands.

In Massachusetts, the vernal pool obligate species are: the wood frog, the spadefoot toad, four species of mole salamander (the spotted salamander, the blue-spotted salamander, the Jefferson salamander, and the marbled salamander), and two species of fairy shrimp. Facultative species include most of our remaining frogs, a few reptiles, numerous insect larvae, fingernail clams, amphibious snails and leeches.

Vernal pool protection in Massachusetts

In Massachusetts, vernal pools are afforded some protection through several regulations, chief among these being the Wetlands Protection Act Regulations and local bylaws. Other regulations which include vernal pool protection are the Surface Water Quality Standards, Title V of the Massachusetts Environmental Code, and the Forest Cutting Practices Act Regulations. Many, but not all, of these regulations require that the pool be "certified" by the Natural Heritage and Endangered Species

Program (NHESP). Certification is a documentation process where a citizen collects evidence of the presence of a vernal pool and its biological indicators and submits this evidence and location maps to the NHESP. The NHESP reviews the submission and subsequently may certify the pool. Certification only establishes that a vernal pool exists. Any protection arises from the application of the various regulations during permit reviews. For complete information on certification and protection in Massachusetts, consult the references on page 70.

Life in a vernal pool

A vernal pool is a productive hatchery for terrestrial amphibians. Its short period of intensive growth cycles the nutrients and energy of fallen leaves on the pool bottom into the frogs and salamanders of the adjacent woodlands; these animals make up a significant portion of the wildlife of a forest. Due to our own inattention and the secretive nature of these animals, we do not realize their overall significance. For example, a moderate sized vernal pool might have several thousand wood frogs entering to breed and then returning to the forest. Yet most people, even those who spend extensive time in the woods, never encounter even one of these woodland creatures. Mole salamanders are seldom observed except on rainy migration nights when hundreds might be moving to or from a vernal pool. Yet these animals live out their 20 years of life within a few hundred feet of that pool. How many have you ever seen?

A pool represents the cumulative evolution of a number of species adapted to and exploiting a productive, although temporary, habitat. Activity in the pool is seemingly choreographed so that each species maximizes its own chances for survival. Organisms feed upon one another, yet sufficient numbers survive to maintain the population in future years. Years of drought or other adverse

Certification in Massachusetts

A vernal pool may be documented for certification by the MA Natural Heritage & Endangered Species Program by any of three methods.

Obligate species method

Submit a photograph of the pool holding water and evidence (photo/tape) of any of the following from the pool:

breeding activity of wood frogs, spadefoot toad, spotted salamander, blue-spotted salamander, Jefferson salamander, or marbled salamander; presence of fairy shrimp.

Facultative species method

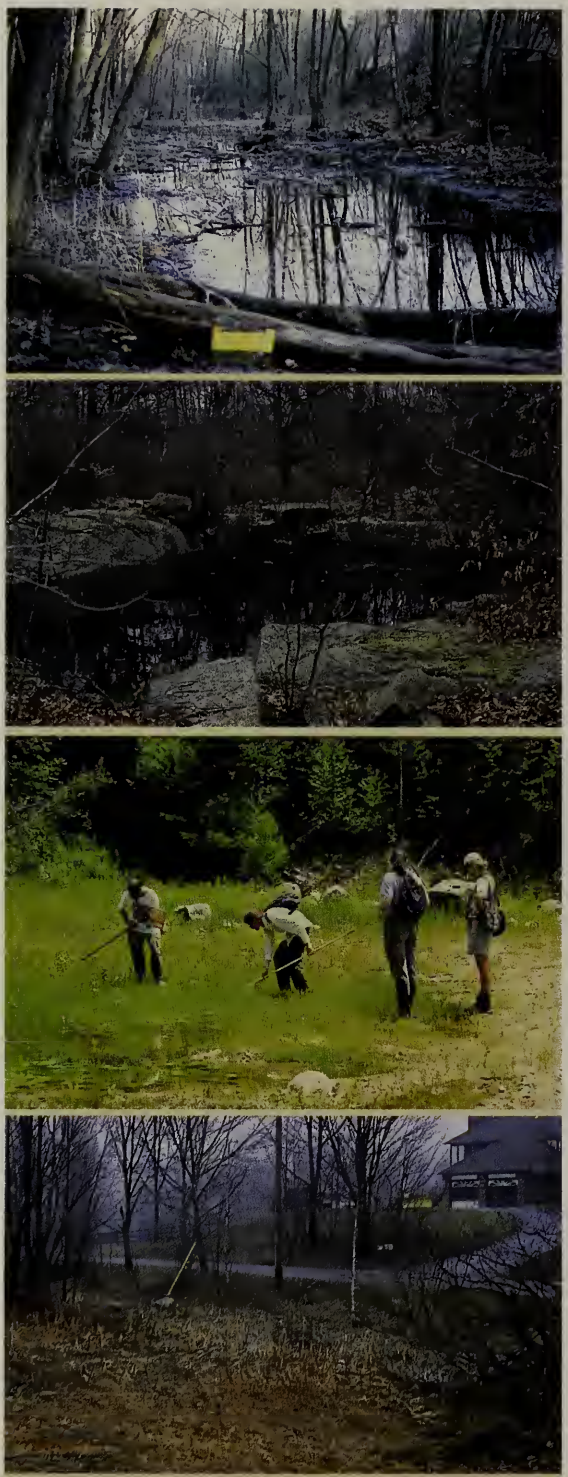
Submit photographs of the pool holding water and the pool dry (or other proof of no fish) and evidence (photo/tape) of any two of the following from the pool:

breeding activity of spring peepers, gray treefrogs, green frogs, leopard frogs, pickerel frogs, American toads, Fowler's toads, four-toed salamanders; *presence* of red-spotted newt adults, spotted turtles, wood turtles, Blanding's turtles, painted turtles, snapping turtles, predaceous diving beetle larvae, water scorpions, dragonfly nymphs, damselfly nymphs, dobsonfly larvae, whirligig beetle larvae, caddisfly larvae, leeches, fingernail clams, or amphibious air-breathing snails.

Dry pool method

Submit photograph of a dry pool (or other proof of no fish) and evidence (photographs/specimens) in the dried pool bed of any one of the following:

the shells of fingernail clams or amphibious air-breathing snails, the cases of caddisfly larvae, or the exuvia (shed exoskeleton) of dragonflies and damselflies.



Pools filled by river and stream flooding (1) might contain fish for a period but eventual drying prevents these from being permanent populations. Human activities produce areas which sometimes function as vernal pools. This small quarry (2), abandoned gravel pit (3) and roadside area (4) are fishless and have obligate vernal pool species.

conditions resulting in low survival rates might be followed by exceptional years of population survival.

The food chain within the vernal pool begins with forest leaves dropping or blowing into the pool in fall. Bacteria and fungi begin the decay process and then themselves become food for slightly larger zooplankton such as daphnia, copepods, and rotifers. A variety of insect larvae feed on leaves, shredding them as they forage. The caddisfly larvae both shred leaves and utilize leaf fragments or small sticks to build cryptic cases within which they reside. Other insects, such as the water boatman, amphibious snails and various small crustaceans, feed on leaves and other plant material, reproduce, and become abundant. When the frog tadpoles hatch, they become continual feeders of leaves, other plant material, and algae of the pool. The prolific herbivorous animals are hunted by the developing forms of the predaceous diving beetle, fishfly, dragonfly, damselfly, water scorpion, as well as the adults of some of these and other species. These predators also hunt each other.

Salamander larvae also are carnivorous. When small, they feed on daphnia and similarly sized creatures. As they grow, their diet consists of whatever they can cram into their large mouths, including larger invertebrates and frog tadpoles. Many salamander larvae consume other salamander larvae, usually of different species. Marbled larvae are large enough in mid-spring, when the Jefferson, blue-spotted and spotted larvae hatch, that they can devour considerable numbers of the these smaller salamanders. In turn, the Jefferson and blue-spotteds are usually larger than the spotteds because of earlier egg deposition or faster development. They feed on the larvae of the spotted salamander. Even the spotted larvae can be cannibalistic and feed on other spotted larvae in times of overcrowding, such as when the pool is drying.

The food web continues to become increasingly raveled. Turtles and snakes

go to the pool to feed on the developing species. Spotted turtles eat the egg masses of spotted salamanders, as well as insects and larvae of amphibians. Ribbon snakes catch amphibian larvae or emerging adults in the shallow vegetation at the pool edge. Nocturnal owls swoop on amphibians traveling to and from the pool. Wading birds eat whatever is available. Raccoons grab tadpoles, large insects, adult frogs and anything else within their reach.

The developing organisms of a vernal pool race to end their dependence on the pool before the water disappears. Whether they win or not, many still become food for others and pass the energy and nutrients from the pool back into the forest. Those that leave the pool alive might survive in the forest ecosystem to return to the pool another year, or they might be eaten by owls, raccoons, or shrews. Those that die in the overheated shallows of a disappearing pool are scavenged by birds, mammals, reptiles, and insects, and enter the forest ecosystem as units of energy. The abundance of amphibians and invertebrates which leave the pool, on their own or in the bellies of others, becomes a substantial amount of the animal tissue found in the adjacent forest and a significant food resource for other upland species, as well as a future nutrient source for forest vegetation.

Importance of Vernal Pools

Vernal pools are essential habitat for portions of the life cycles of many species. They are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and feeding in an area of reduced predation. They are also important as water sources for other wildlife, both for drinking on a hot summer day as well as irreplaceable links in the overland passage of various amphibians and reptiles as they travel from one wetland to another.

Vernal pools are indispensable to biodiversity, both locally and globally. For a species with a wide distribution,

Leaves (1), algae and phytoplankton are the food base for life in a vernal pool. Frog larvae (2) turn a considerable amount of leaf material into animal tissue. Many of these amphibians are eaten by predators while in the pool or when they leave as they mature (3). Those that die when the pool dries (4) are consumed by scavengers.

individual vernal pools are essential to the local population. Eliminate those pools and the population of that animal will die out in that area. For a species with a narrow distribution, a specific vernal pool might be the only place on earth that animal is found. If the pool is destroyed, that species will be extinct. Examples exist in the scientific literature of a species identified from one vernal pool, but not found again since the destruction of that pool. In Massachusetts, the Intricate Fairy Shrimp is known from only 10 pools. Spadefoot toads are known from only 40 sites in the entire state. Destruction of only a few pools would jeopardize the existence of these animals in Massachusetts.

Human impacts on vernal pools

The increasing population density in New England and resultant sprawl of housing, roads, shopping malls, and recreational ball fields continues to impact vernal pools and vernal pool species. Pools have been filled to create upland or have been used as road drainage detention ponds, both of which are allowable under certain regulations. Critical surrounding habitat is cleared for homes, lawns, fields and parking. Irrigation wells lower the water table and hasten pool drying. Overuse of fertilizers and pesticides threatens the water quality of pools which are highly dependent on runoff as a water source. Mosquito control efforts both drain vernal pools and chemically or biologically affect species in the pools, other than just mosquitoes. Roads constructed near pools contribute to high mortality. Vehicle traffic is a significant problem for slow moving migratory amphibians where almost the entire local population will move on the same night. Highways with multiple travel lanes and concrete center dividers fragment the habitat, prevent migration and range expansion, and restrict gene flow in a population.

(1) Vernal pools are basins which naturally collect water. This makes them attractive as water detention structures in subdivision construction. Such use is legal under some conditions although it destroys the biotic function of the pool. (2) Some towns enforce road closings on amphibian migration nights in an effort to minimize damage caused by automobile traffic.

Solutions to these problems, if there are any, are beyond the scope of this guide. If you are concerned about vernal pool species and the human impact on them, become knowledgeable about these species and vernal pools. Then become involved in your local government. The Conservation Commission, Planning Board, Open Space Committee and similar regulatory groups all make decisions which affect land use and vernal pools. Regional organizations involved in environmental issues, species protection and land use issues would include your local watershed association, the Massachusetts Audubon Society, the Nature Conservancy, local land trusts and nature centers. Become proactive now. Don't wait for the vernal pool you know to be threatened.

Visiting a vernal pool

The first step to studying a vernal pool is to find one. Considering the abundance of vernal pools, the search should not be difficult. Check with the local conservation commission for information about known pools which might be on public land. Or simply visit conservation property, state parks and forests, and other public open space and look for isolated bodies of water fitting the description of a vernal pool. You could use topographic maps, hiking maps, soil conservation maps and aerial photography to aid your search. As an aid to the identification of vernal pools, the NHESP initiated a program in the fall of 1999 to identify Potential Vernal Pools (PVP) from aerial photography. As of this writing, Bristol and Plymouth Counties have been completed. The remainder of the state should be photo-interpreted for PVPs by the fall of 2001. For information on PVP maps, contact NHESP or MassGIS.

In Massachusetts, a visit to a vernal pool could be for the purposes of documenting biotic communities for official state certification. You would need to photograph the pool and evidence of specific organisms which use the pool. This evidence and maps which pinpoint the pool location would then be sent to NHESP. For more information, see page 5.

The Executive Office of Environmental Affairs (EOEA) urges citizens to take an interest in vernal pool appreciation, study and protection. However, EOEA strongly recommends that anyone interested in field verification of potential vernal pools or vernal pool certification obtain landowner permission prior to conducting surveys and gathering data. No one pursuing official vernal pool certification should trespass on legally posted property. Teachers should always seek landowner permission before bringing students onto private property for activities.

The actual study of a vernal pool requires little in the way of specialized equipment. At most, you might want a small net, hand lens, shallow container and boots or water socks. Egg masses can be found by looking for them at the water surface or attached to vegetation below the surface. Polarized glasses or casting a shadow on the surface help to eliminate reflections. The net is used to capture invertebrate or amphibian larvae. Run the net through the water randomly and dump the contents into some water in your container. Netting at the water surface or in the leaf litter will result in different collections of animals. After observing your specimens, return them to the pool.

When visiting a vernal pool, consider both your personal safety and the long-term protection of that pool. Be careful of deep water, drop-offs, submerged objects, and the grasping mud of a pool bottom. Recognize and avoid both poison ivy and poison sumac. Children should be properly supervised. In and around the pool, minimize your impact. Do not collect vertebrate specimens. Do not remove egg masses from their attachment sites. Do not transfer animals between pools. Consider and minimize the impact of large groups or multiple visits at a pool.

Visiting a vernal pool and observing the specialized life that utilizes this type of wetland can be a rewarding experience. Find a pool and get to know it. Visit it frequently and observe the changes throughout the year. Share your findings with others in your family, school, and community.

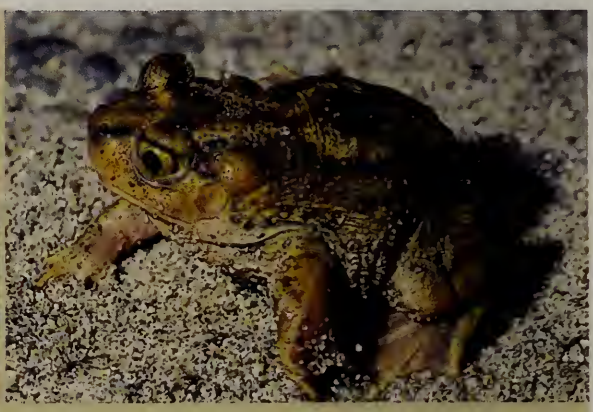
Pictorial guide to the adult amphibians and reptiles of MA

The following section is a pictorial guide to all of the frogs, salamanders, snakes and turtles of Massachusetts. We have included all amphibians and reptiles in this guide since any of these animals might be encountered as you search the New England landscape for vernal pools. Many of these animals have no direct association with vernal pools. Vernal pool indicators have a page reference listed at the end of their description directing you to their species account. Also included in this section is a pictorial guide to the egg masses of the wood frog and the New England mole salamanders. These guides are useful throughout New England as they include the majority of reptiles and amphibians in this region.

Massachusetts state-listed rare species are followed by **E** for endangered, **T** for threatened and **SC** for special concern.

Adult Frogs of Massachusetts

Wood frog. 1.5-2.5"; light tan (almost pink) to dark brown; dark brown to black "mask" across the eyes; white upper lip. (p. 20)



Spadefoot toad. 1.8-2.5"; dark to gray-brown; two pale, irregular lines on back; vertical pupil; hind foot with black, hardened projection. (p. 28) **T**

Bullfrog. 4-8"; pale green to dark olive color, often with scattered brown spots; ridge around top and back of ear; throat yellow in males. (p. 22)

Green frog. 2-4"; green to brown body color; dorsolateral ridge extends from eye along side of body; throat yellow in males. (p. 23)

In frogs and toads, the tympanum is the external ear, located just behind the eye; the raised fold running from the eye along the side of the body is the dorsolateral ridge. Body length is measured from snout to base of body.

Leopard frog. 2-5"; dark rounded spots surrounded by light colored ring on brown to green background; inner thighs white. (p. 24)

Pickerel frog. 1.7-3"; dark angular spots on light cream to pale brown background; inner thighs bright yellow. (p. 25)

Gray treefrog. 1.3-2.3"; ash to dark brown with irregular light or dark patches outlined in black; conspicuous toe pads; orange inner thighs. (p. 26)

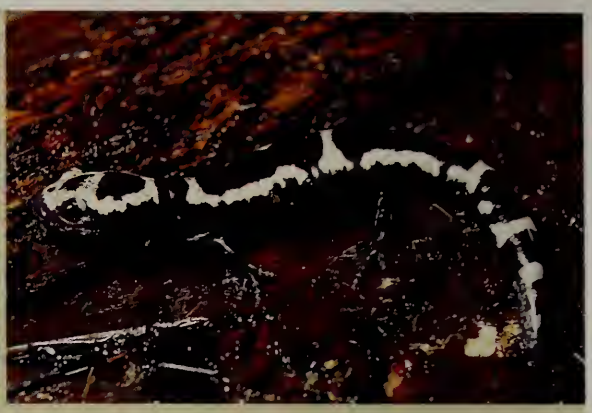
Spring peeper. .7-1.3"; light tan to brown color with irregular darker "X" on back; toe pads. (p. 27)

American toad. 2-4.3"; warty skin; color highly variable with dark spotting; 1-2 warts in larger spots; belly white with black mottling. (p. 30)

Fowler's toad. 2-3.7"; warty skin; color highly variable with dark irregular spots; 3 or more warts in larger spots, unmarked white belly (p. 31)

Adult Salamanders of Massachusetts

Spotted salamander. 4.5-8"; bluish-black to brownish-black with bright yellow spots. (p. 32)



Marbled salamander. 3-5"; black to purplish-black with white or grayish markings which may connect to form bars across the back. (p. 34) T

Blue-spotted salamander. 3-5.5"; grayish-black to dark gray with blue spots on body, tail and legs; 13 costal grooves. (p. 36) SC

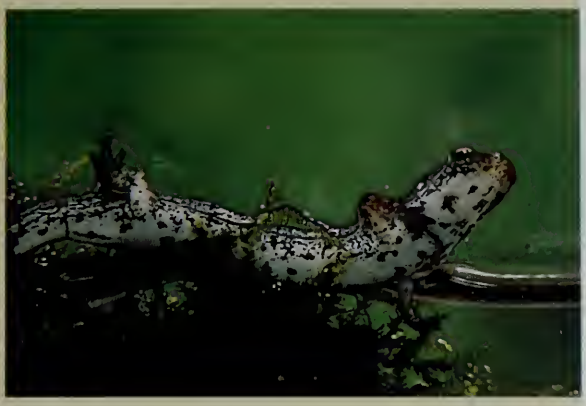
Jefferson salamander. 5-7.5"; chocolate-brown to gray with light bluish flecks along side; 12 or 13 costal grooves. (p. 38) SC

Hybrid of the Jefferson (above) and blue-spotted (below) salamanders. Grayish-black with light flecking on sides. (p. 38) SC

Red-spotted newt. 3-5"; adult has olive body, juvenile is red-orange; both have row of black-ringed, bright orange spots along each side. (p. 40)

In salamanders, costal grooves are the indents on the side of the body along the ribs.

Dusky salamander. 2.5-4.5"; dark brown to olive with translucent underside; light flecking on lower sides. Light line behind eye to jaw. (p. 41)



Four-toed salamander. 2-3.5"; reddish-brown body color; white underside with black flecks; obvious constriction at base of tail. (p. 42) **SC**

Redback salamander. 2.2-4"; bluish-black body with or without a red dorsal stripe; light blue flecking on side; 18-20 costal grooves. (p. 43)

Spring salamander. 4.5-7.5"; dark-orange to reddish-brown with fine dark patterning; groove from nostril to upper lip, slight lateral flattening of tail. **SC**

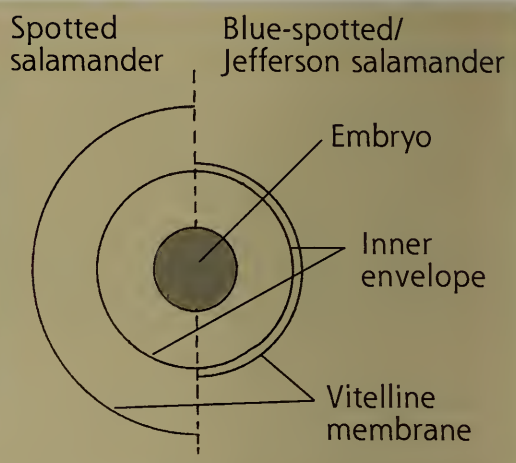
Two-lined salamander. 2.5-3.5"; variable greenish-yellow to orange body with a wide dark stripe on each side.

Mudpuppy. 8-16"; brownish body with blackish spots; completely aquatic with three red external gills on each side of the head throughout life.

Egg masses of the wood frog and NE mole salamanders

Wood frogs and the mole salamanders (pages 20 and 32-39) require vernal pools for breeding. In MA, they are considered direct indicators of vernal pools and termed "obligate species."

Wood frogs lay fist-sized, spherical egg masses attached to vegetation at the water's surface; 500-1500 eggs; no outer, surrounding matrix.



Terminology used in distinguishing salamander eggs.

If held out of water, the mass flattens out and has a very bumpy surface, each ova produces a .25-.5" bump with a black embryo at its center.

Masses are oval, elongate or kidney-shaped, have 30-250 eggs, and are either clear or opaque white; masses are very firm, like set gelatin.

The masses become green with algae; following hatching, remnant egg masses may be found for several days floating at the surface.

The vitelline membrane surrounding spotted salamander embryos (center) is much further from the embryo than in blue-spotted eggs (sides).

Though similar, the egg masses of obligate species can be distinguished with practice. These pages will help you identify the egg masses of the "obligate" vernal pool amphibians. Shape, firmness, and characteristics of the various envelopes surrounding the embryos (vitelline membrane especially) are key in identifying egg masses.

Blue-spotted Salamander Eggs

Blue-spotted salamanders lay eggs singly, in sheets on the pool floor or in very loose masses; surrounding matrix is like unset gelatin.

Jefferson Salamander Eggs

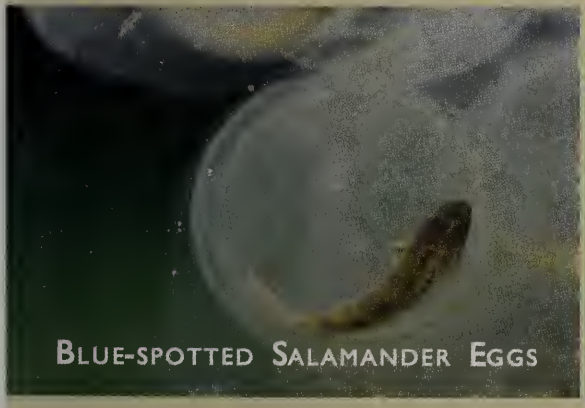
Jefferson salamanders lay long egg masses attached to vegetation; masses are relatively firm, typically with a bumpy outer surface.

Blue-spotted Salamander Eggs

Masses contain 1-30 eggs and are extremely loose; nonliving embryos are common, appearing as cloudy white eggs.

Jefferson Salamander Eggs

The vitelline membrane (cloudy halo) is close to the inner envelope of the ova as in blue-spotted salamander eggs; here the outer matrix is visible.



Blue-spotted Salamander Eggs

The vitelline membrane is very close to the inner envelope of the ova, unlike eggs of spotted salamander; the outer matrix is not seen here.

Salamander Hatchling

Larvae of the mole salamanders all hatch with bushy external gills and balancers under the chin. They are very difficult to tell from one another in the field.

Adult Snakes of Massachusetts

Sizes of snakes are for lengths typical in MA, based on the NE literature. However, it is not uncommon to find specimens that are significantly larger than average. Maximum recorded lengths of snakes found in the region are in parentheses. Snakes are individually variable and color patterns may not match those pictured. Caution: although poisonous snakes are rare in Massachusetts, we do have populations of Timber Rattlesnake and Northern Copperhead.

Redbelly snake. 8-12" (16"); black or brown back with red belly; three light spots at neck.

Northern brown snake. 9-15" (20"); light to dark brown keeled scales on back; two rows of dark spots on back; pale, unmarked belly.

Milk snake. 24-36" (52"); back blotched with maroon, black and brown; belly black and white checkered; light colored "Y" spot on head.

Northern ringneck snake. 9-16" (27"); dark gray to black unkeeled scales on back; yellow belly and ring at neck.

Smooth green snake. 12-20" (26"); bright green unkeeled scales on back; white or pale yellow belly.

Eastern worm snake. 7-11" (13"); brown back: belly and lower sides pink; pointed head. T

In snakes, keeled scales have a distinct raised line in the center of the scale; scales are in lengthwise rows which are counted from the base of the side upward.

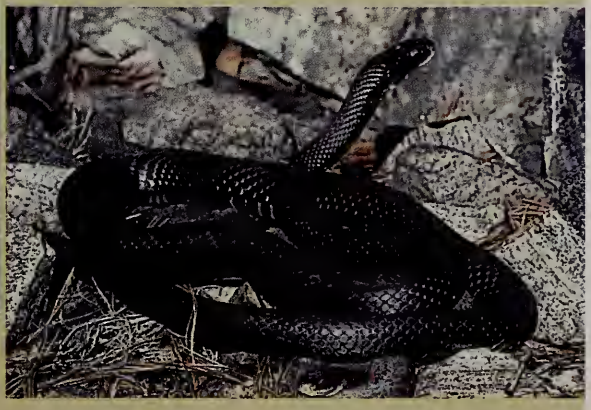
Eastern garter snake. 18-30" (48"); brown-green to black body with 3 light stripes; area between mid and side stripes often checkered; side stripes on scale rows 2 and 3. (p. 45)

Northern water snake. 18-42" (55"); dorsal pattern of alternating bands of blue-gray and brown to almost black with no pattern; strongly keeled scales. (p. 44)

Ribbon snake. 18-26" (38"); black to brown body with three bright yellow stripes; side stripes located on scale rows 3 and 4. (p. 45)

Black rat snake. 42-72" (101"); black, weakly keeled dorsal scales; white and black checkered belly; thin neck. E

Hognose snake. 20-33" (45"); body black, gray, or variously patterned; keeled scales; pointed, upturned snout; neck and head-flattening behavior when disturbed.



Black racer. 35-60" (73"); black unkeeled dorsal scales; underside blue-black; chin white.

Adult Snakes & Turtles of Massachusetts

Northern copperhead. 24-36" (53"); wide unmarked, coppery head; reddish-brown hourglass bands on copper body; vertical pupil. **E**

Eastern timber rattlesnake. 36-60" (74"); black or dark brown bands on yellow or brown body; rattle on tail; wide head; vertical pupil. **E**

Blanding's turtle. 7-10"; bright yellow throat and chin; high-domed carapace; black to gray with yellow or tan flecking. (p. 46) **T**

Eastern box turtle. 4.5-6"; highly domed carapace; hinged plastron; brown to black with variable, irregular orange or yellow markings. (p. 48) **SC**

Wood turtle. 5.5-8"; orange throat and front limbs; highly sculpted brown carapace often with yellow or orange flecking or vertical stripes. (p. 47) **SC**

Spotted turtle. 3.5-5.5"; variable number of yellow dots on head, neck and carapace; pale plastron with variable black markings. (p. 46) **SC**

In turtles, the upper shell is called the carapace and the bottom shell is called the plastron. Each division on the carapace and plastron is called a scute.

Plymouth redbelly turtle. 10-12.5"; gray to black carapace with vertical red striping in largest scutes; red belly and marginal scutes. **E**

Painted turtle. 4.5-6"; black, gray or olive carapace with 2-3 broad pale bands; large yellow spots behind eyes; yellow and red stripes on neck. (p 48)

Snapping turtle (juvenile shown). 8-18"; relatively flattened carapace with deeply serrated hind margin; very small plastron; large head and claws. (p 47)

Musk turtle. 3-4.5"; smooth, high-domed carapace; uniform black to pale gray color, algae on shell common; greatly reduced plastron.

Diamondback terrapin. 4-9"; pale gray to black with concentric rings, groves or ridges; pale head, neck, limbs with spots; pale plastron. **T**

Bog turtle. 3-4"; chestnut to black carapace, sometimes sculpted with growth rings; bright yellow to orange patches behind each eye. **E**

Wood frog

Rana sylvatica

Adult female wood frogs in breeding condition (note abdomens swollen with eggs) on migration night in spring.

Adults

The adult wood frog is a medium sized (1.5-2.5"), light tan to dark brown, terrestrial frog found in moist woodlands. It is easily recognized by the dark "mask" extending from each eye back through the tympanum. The adults are seldom associated with water other than during the breeding season of early spring when wood frogs migrate en masse to vernal pools. Males then commence a raucous, quacking, breeding chorus. Mating and egg laying follow and are completed within a few weeks, upon which adults leave the vernal pool to return to nearby uplands. The adults sometimes overwinter partially frozen under the leaf litter of the forest floor.

Listen for wood frog choruses at vernal pools in March and early April. Frogs will call at night and on warm days. Adults are secretive during daylight and seek cover when disturbed. At night, chorusing adults can usually be observed by flashlight. Other than the breeding season, look for wood frogs in woodlands and adjacent habitat. Encounters will be by chance since they are very difficult to see among the leaves of the forest floor, but may may be seen hopping away when disturbed.

Eggs

An egg mass is a gelatinous fist-sized blob consisting of up to 1,500 individual eggs. Individual eggs are .25-.5" spheres containing a black embryo. There is no outer matrix unifying the mass. While in amplexus, females attach their eggs to vegetation in shallow water near or at the water surface. Egg masses are attached to tussock sedges and woody stems in sunny locations of a vernal pool, particularly in the

Recently deposited wood frog egg masses. Eggs are still spherical and show no development. Matrix has not been colonized by algae yet.

Communal cluster of wood frog egg masses. Such clusters may number hundreds of masses and serve to trap solar heat and accelerate development.

northwest section. If the pool is dominated by emergent vegetation such as buttonbush, eggs are often found in clearings or other locations which receive maximum sunlight. Often, many females lay eggs in the same area in large communal clusters. Within a few days of deposition, growth is obvious and embryo development can be observed. Larvae hatch in about 28 days. Egg masses quickly become colonized by a symbiotic algae (*Oophila amblystomatis*). Green egg masses floating at the water surface might easily be mistaken for clumps of algae.

Recently hatched tadpoles resting on egg mass. The green color is from symbiotic algae growing in the egg mass which produces oxygen.

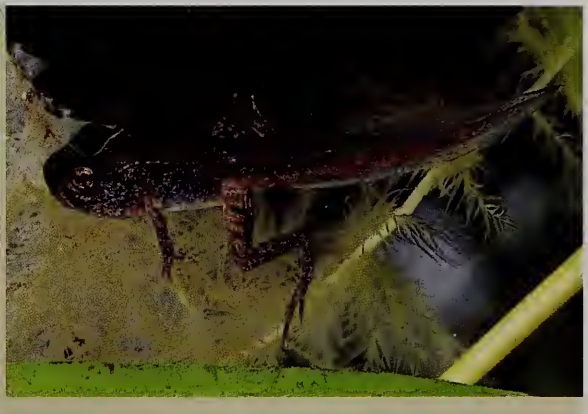
Larvae

Wood frog larvae are dark brown to blackish tadpoles. Immediately after hatching the tadpoles are black, about .25" long and found on or near the egg mass. They remain with the egg mass for a few days grazing on the symbiotic algae before swimming throughout the pool. As they grow, the dorsal color becomes brown and the venter develops gold flecking. The tail fin ends near the base of the tail.

They feed on algae and leaf material on the pool bottom and grow rapidly so as to undergo metamorphosis before the pool dries. By June, these tadpoles will have developed legs and begun their emergence onto land. Tadpoles are preyed upon by various aquatic insects (diving beetle adults & larvae, giant water bugs, etc.) as well as northern water snakes, ribbon snakes, turtles and various wading birds.

Tadpoles hatch from egg masses in April. Spent egg masses appear as green blobs in the water but have the gelatinous feel and appearance of eggs. Tadpoles often school in shallow areas of the pool or float near the surface. Both activities provide solar heat to warm them in the relatively cool waters of a vernal pool. Running a net through the water is sure to capture some of these tadpoles if they are present, since they are usually in abundance. Toad eggs are laid a few weeks after wood frog eggs and toad tadpoles will be smaller than wood frog larvae when both are present.

Wood frog tadpole in close-up side view and clustered in hands held in the water (inset). A coppery flecking over the belly and sides develops.



Developed wood frog larva near metamorphosis. The froglet is an air-breather and will be found within vegetation and at pool edge.

Bullfrog

Rana catesbeiana

Adult bullfrogs have no dorsolateral ridge. Males have a bright yellow throat. The ear is larger than eye.

Eggs are laid in a frothy raft on the water surface, up to 2' in diameter.

Tadpoles get quite large and have creamy white or tan bellies. They are typically dark green with black spots.

This bullfrog is approaching metamorphosis and has almost lost its tail.

Adults

The adult bullfrog at 4-8 inches body length is the largest frog east of the Mississippi River. Smaller adults and juveniles may be confused with the green frog in MA. However, the bullfrog has a smooth back with no dorsolateral ridges (folds of skin), unlike the green frog, and no other adult frog gets as large. Adults and juveniles vary in color from bright green to dark olive. Males have a yellow throat and an eardrum which is larger than the eye. Bullfrogs are typical of permanent and semipermanent water bodies where they breed. They may use temporary vernal pools during migrations and for feeding throughout the spring and summer. Bullfrogs eat almost anything that moves and which they can cram into their mouths, including other frogs and tadpoles.

Male bullfrogs have a deep "jug-o-rum" breeding call that can be heard throughout the summer months. Captured bullfrogs sometimes give a loud open-mouthed scream in an attempt to get a predator to release them.

Eggs

Eggs are laid in frothy mats that may be as large as 2 feet in diameter. They float at the water's surface at first, but may sink to the bottom before they have completely hatched. The larvae hatch within 2 weeks and begin a long development that may last up to 3 years.

Larvae

Bullfrog larvae typically take 2 years to reach metamorphosis. They grow to very large sizes, are light green to dark olive and have variable black or brown spots. Their bellies are creamy white or pale yellow. Larvae can often be seen sitting motionless in shallow water basking in warm sunlight.

Green frog

Rana clamitans melanota

Adults

Adult green frogs are quite variable in color but always have a pair of dorsolateral ridges down the back.

The green frog (2-4") is a common frog of all types of wetlands in NE. It varies from green to olive to brown in color. It is similar in appearance to the bullfrog but is distinguished from that species by having a pair of dorsolateral ridges extending from the tympanum along the back. The bullfrog lacks dorsolateral ridges and has a smooth back. Green frogs move about on wet nights and can show up in almost any body of fresh water. Adults feed on all manner of invertebrates (beetles, caterpillars, earthworms, etc.) and small vertebrates (small frogs, fish, small mice). In turn, they are preyed upon by larger frogs, wading birds, turtles, etc. The adult male above has a leech attached just above the front leg.

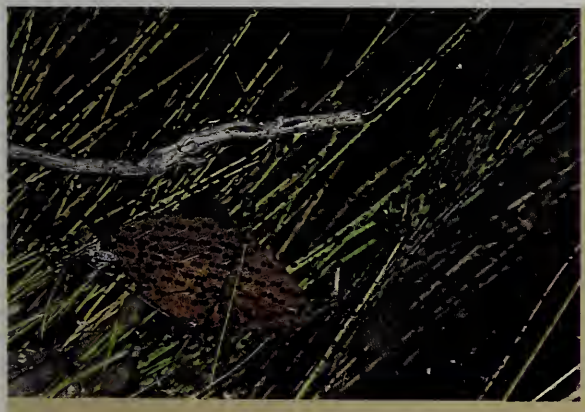
Listen for the alarm-call yelp of green frogs as they leap into a pool at your approach. As the weather warms in late spring, you can hear the single note , banjo-like "g'lunk" of male green frogs at vernal pools and other wetlands.

Eggs

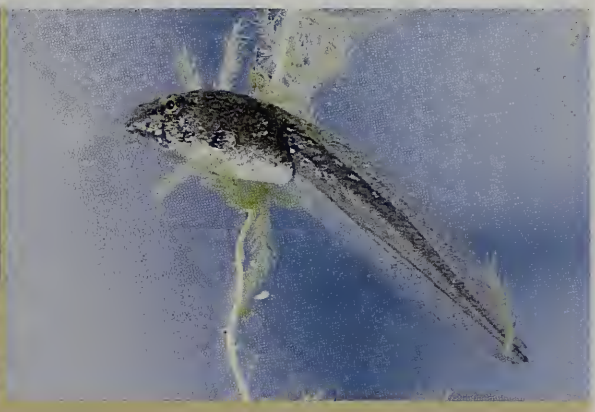
Up to 5000 small black eggs are laid in a filmy jelly on the surface of the water during June-August. The mass may be attached to vegetation or float freely. The eggs hatch within a few days.

Larvae

Tadpole (2-2.5") are olive above, cream below, with a relatively long, slender tail having a uniform spot pattern. Tadpoles overwinter and metamorphose the following summer. Overwintering tadpoles can be seen under the ice throughout winter. In the summer, tadpoles in various stages of development might be found. Between June and August, transforming frogs with only tail remnants can be seen.



Eggs are laid in large mats loosely attached to vegetation or simply floating at the water's surface.



Tadpoles are difficult to distinguish from other frog tadpoles. They have a creamy white belly and get quite large.

Northern leopard frog

Rana pipiens

Adult leopard frogs are greenish or light brown with round, dark spots. The inner thigh is white.

Adults

The northern leopard frog (2-5") is a beautiful, sleek, spotted frog of meadows, floodplain forests and wetlands. The leopard frog has a pattern of irregular rounded spots on a background of green or brown (see p. 11). Each spot is outlined with a light-colored ring. The dorsolateral ridges often contrast sharply with the body color. Their large, powerful hind legs are spotted, though the spots may blend toward bars on the extremities. Leopard frogs can be easily confused with pickerel frogs which have almost rectangular spots on a light brown background. However, leopard frogs have creamy white or pale yellow inner thighs, whereas pickerel frogs have bright yellow inner thighs.

The northern leopard frog may be abundant in some localized areas but is uncommon throughout much of its range. It is found in scattered areas of eastern MA and in the major drainage basins of central and western MA. Its present status in MA is not well known, but this species is believed by many scientists to be in decline.

Leopard frogs will make 2-3 quick leaps when disturbed and then disappear into vegetation. It is a fast animal which provides a challenge for those who pride themselves as accomplished bare-hand frog-catchers.

Eggs & Larvae

Egg masses are produced in a flattened sphere up to 6" wide and 3" thick. They look much like the egg masses of other frogs in that there is no thick outer gelatin matrix. Each mass has between 4000 and 6000 eggs which hatch within 2-3 weeks. Larvae become fairly large (to 3.4") and have olive or tan to brown bodies, tails speckled with fine black markings, and creamy white bellies.

Juvenile northern leopard frog. Many are seen on wet nights as they mature and leave wetlands.

Tadpoles are difficult to distinguish from other frog larvae. They have a creamy white belly and speckled tail.

Pickerel frog

Rana palustris

Adults

The pickerel frog (1.7-3") is a dramatically spotted frog. It is more common in New England than the northern leopard frog with which it is often confused. The pickerel frog has dark, rectangular spots on a lighter brown to greenish background. Yellow or orange coloration on the underside of the rear thighs positively distinguishes this frog from the leopard frog, but requires that you catch it first.

Adult pickerel frogs have angular brown spots organized in 2 rows down the back and bright yellow or orange inner thighs.

Pickerel frogs can be found at a variety of wetland habitats but seem to favor shallow water and a shoreline with herbaceous vegetation. They are frequently encountered in damp woods, meadows, and similar moist areas.

Adults feed on a variety of small terrestrial invertebrates including insects, arachnids, and sowbugs, as well as some aquatic invertebrates such as snails, amphipods and isopods. Pickerel frogs produce a noxious skin secretion which makes them distasteful to some predators. Snakes seem to avoid them, yet bullfrogs and green frogs do not seem to be bothered by their defenses.

Eggs & Larvae

Eggs are laid in tight round clumps attached to vegetation under the water surface some time from late April to mid-May. About 2000-3000 light brown to yellow embryos are in each mass. In most cases, they hatch in about a week. Larvae are difficult to distinguish from most other frog tadpoles in the field. However, their light brown to pale greenish bodies are irregularly spotted with brown, and their sharply pointed tail tends to have little pigmentation. The creamy white belly has a gold iridescent hue, and the gut coil is not clearly visible.

The yellow or gold-colored embryos of pickerel frogs are quite striking and can not be confused with other frogs.

Tadpoles have a largely unmarked tail with a sharp point but identification is difficult in the field.

Gray treefrog

Hyla versicolor

The adult's color changes from ash to dark brown and even green in response to environmental stimuli.

Juveniles are approximately 1/2" long and a brilliant green color. Note the toe pads. Eggs masses are loose and filmy and hatch within a few days.

Gray treefrog tadpoles may have a red tail if under environmental stress. When legs develop, each toe has a tiny toepad.

Adults

The gray treefrog (1.3-2.3") is the larger of the two New England treefrogs. Its color varies from a light green to ash to dark brown. The insides of the hind legs are a bright orange, visible when the frog climbs or leaps. There is a distinct light spot outlined in black below each eye. Recently metamorphosed juveniles are an emerald green. Each toe has a disk-like toepad used for clinging to branches, vegetation and even windows. Adults are often found near suburban homes where they feed on insects attracted to lights at night. They are sometimes found in flower boxes and hanging plants where they spend the day.

When nights warm to 60°F, males produce a trilling call from trees as they make their way to pools and other wetlands to breed. They often call just before rain and also on warm days.

Eggs

Eggs are laid from late April through August in small filmy masses of 10-40 eggs (brown above, cream below) which are attached to aquatic vegetation. Each female is capable of laying up to 2000 eggs. Eggs hatch within a few days.

Larvae

Larvae (.25-2") develop rapidly, feeding on algae and aquatic vegetation. The large tail fin, patterned with black spots, reaches nearly to the top of the head. Under stress (predation, pool drying, etc.), the tail may become almost brick red. The red color provides a distraction for predators which might grab the expendable tail rather than the animal's torso. Transformation into a terrestrial frog occurs after one to two months. The small (.6"), bright-green emergents can be found on shoreline vegetation by mid-July.

Spring peeper

Pseudacris crucifer

Adults

The spring peeper (.7-1.3") is probably best known by its sharp peeping call heard in choruses from wetlands in early spring. Though familiar by its voice, this diminutive treefrog is not easy to see. Most are surprised to learn that the familiar sound of spring which can carry for a quarter of a mile is produced by a frog of about an inch in size. Each animal is color-variable from dark to light brown. An "X" is generally visible on the back.

The adult spring peeper calls from pools and other wetlands during breeding season, lays eggs, and then returns to the surrounding forests. Adults are often heard but seldom seen.

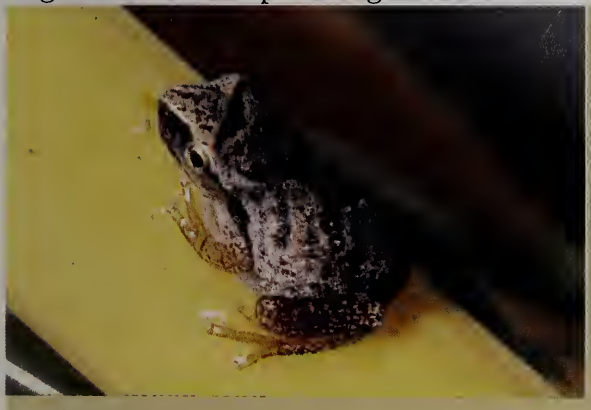
Finding a spring peeper at night with a flashlight is quite a challenge. Peepers are notoriously difficult to see even when nearby and peeping loudly! They are usually sitting on the ground or on low vegetation. Each male is calling for females and defending his tiny territory. The familiar single peep is the advertisement call. If a male's territory is invaded by a rival male, he will make a short trilling aggressive call. Try to distinguish the two calls.

Eggs

Eggs (egg and envelope combined) are about .06" in diameter and may be laid singularly or in clusters attached to vegetation or on the pool bottom. A female may produce up to 800 eggs. Egg laying takes place from early spring into summer.

Larvae

Larvae hatch in 7-10 days at <.25" long and grow over the next 5-8 weeks up to 1.3". The underside is metallic bronze and the dorsal side is dark tan. Larvae are preyed upon by all pool predators, from insects to salamander larvae to turtles (see p. 39 and p. 51) Larvae emerge with a tail remnant and can be seen on vegetation at the pool edge in this condition.



The characteristic "X" is visible on the back of this recent metamorph, shown perched on a cattail stalk.

Tiny peeper eggs may be deposited in small clusters or as single eggs attached to aquatic vegetation.

Spadefoot Toad

Scaphiopus holbrookii holbrookii

Massachusetts
Threatened Species

Adult spadefoot toads are unique in having a vertical pupil. Their name is derived from the hardened tubercle on the hind foot which they use for digging.

Adults

The spadefoot toad (1.8-2.5") is a most secretive animal seldom encountered other than during brief, unpredictable breeding bouts after rain events. It is a lightly warted toad with two wavy yellow lines on a dark brown to gray body. Unlike any other frog or toad in MA, the pupil is vertical. It is most obvious when viewed in bright light. On each hind foot is the sharp, black tubercle used for digging, from which this uncommon species derives its name.

Adults are superior diggers and inhabit burrows from which they venture out on rainy nights to feed. It is on these wet nights that they might be seen crossing roads or in fields and woodlands. Otherwise, the spadefoot is seldom observed except for the few days when they are at temporary pools for breeding. The species is adapted to dry conditions and may remain underground for weeks at a time. During drought periods, the spadefoot encapsulates itself in an underground mud chamber to prevent moisture loss and remains there until conditions improve. Typical habitat for the toad is sandy or loose loamy soil. They have been found in scattered areas of the coastal plain of eastern MA from Plum Island (Newburyport) through the southeastern part of the state and on to Cape Cod and the Islands. However, the northeastern population of spadefoot toad has become entirely isolated from southeastern populations. None currently is known from any of the towns between Newburyport and Bristol County. They are also known from areas in the Connecticut River valley.

Spadefoot toad habitat is typically quite ephemeral. Slight depressions that are filled after torrential rains and dry within a couple of weeks are preferred.

Eggs are laid in loose masses clinging to the stems of grasses or other vegetation in the pool. As many as 2000 eggs are laid by each female in their occasional breeding bouts.

Eggs

Embryo development is obvious by the day following egg laying. The embryos hatch in a matter of days.

Breeding seems to be in response to very heavy rains rather than being seasonal. The exact conditions required are not well understood and populations may go several years between breeding events. Following heavy rains sometime from mid-April to July, spadefoots emerge from their burrows and go to nearby pools. These breeding pools might be typical vernal pools or more temporary pools formed in fields and low areas as a result of the rain. The males chorus with repetitive, short, low-pitched trailing calls of "Errrr." When a female approaches, the male clasps her just above the hind legs. In amplexus, together they swim underwater where the female attaches her eggs to plant stems as they are released and fertilized. Over 2,000 eggs are laid in sticky bands among those of other spadefoots. Emergence, chorusing, and egg-laying take place on a single night. By the following day, the adults have returned to their burrows.

Larvae

Eggs hatch within only a few days. The tadpoles feed on algae and carrion and develop rapidly. Metamorphosis into a toadlet may take place in as little as 2-3 weeks if conditions are appropriate. Toadlets move away from the temporary pool, construct their own burrows, and begin the secretive life of the spadefoot toad.

Conservation Note

Spadefoot toad larvae go through an incredibly fast development. From hatching to metamorphosis can take as little as 2 weeks.

Little is known about the actual distribution of spadefoot toads in MA. The NHESP database lists fewer than 50 occurrences of the spadefoot in the entire state, making it our rarest amphibian. Their secretive nature, rapid breeding and development, and overall rarity make them difficult for researchers to document. Many of the listed occurrences are for an individual toad and do not represent a known breeding population. For example, a dried, flattened spadefoot roadkill was found on Plum Island in the early 1970's. It was only in 1998 that a breeding population was confirmed on Plum Island when a breeding chorus was heard and recorded. If you find a spadefoot toad or breeding site, photograph the animal, record the mating call, take good notes as to the animal's location and notify the NHESP immediately. The spadefoot toad is a Threatened Species in MA.

American toad

Bufo americanus

The American toad is known to most everyone as the common toad of gardens and woods where they eat insects and other invertebrates.

Adults

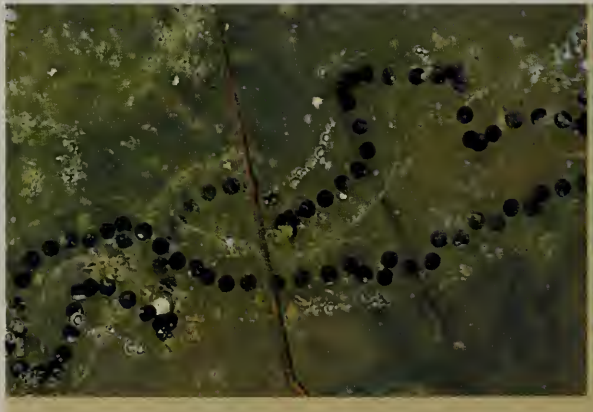
The American toad (2-4.3") is the familiar "hoptoad" of gardens and woodlands. It has dry, warty skin in varying shades of brown, red-brown, gray, or olive with dark spots of brown or black. The body color may vary with temperature, time of day and the animal's activities. The American toad has a white belly mottled with black, one or two warts within the large dorsal spots, and typically has no middorsal stripe. The large paratoid gland behind the eye produces a noxious toxin as an effective deterrent to predation by most mammals, including cats and dogs, although skunks and raccoons cause some predation. Toads are eaten by various snakes including the hognose, garter, and water snakes. American toads are active at night and cooler portions of the day, feeding on a wide variety of invertebrates, such as ants, moth caterpillars and adults, beetles, earthworms and wasps.

Eggs

Toads mate from mid-March to mid-April, moving on rainy nights to wet areas such as vernal pools, marshes, swamps, the shallows of rivers and lakes and even water-filled ditches and ruts. Males call with a melodious trill lasting up to 30 seconds. Thousands of eggs are laid in two gelatinous strands that are tangled in the vegetation as the amplexing pair moves about.

Larvae

Eggs hatch in about a week. The black tadpoles often swim in schools as they feed on suspended matter, algae, plants and carrion. After 4 weeks of development, they emerge on land as dark toadlets less than a half inch in size and disperse into woodlands and across suburban lawns.



American toad eggs are in laid in paired gelatinous strands many feet long.

Tadpoles are black with an unpigmented tail fin rounded at the tip.

Fowler's toad

Bufo woodhousii fowleri

The Fowler's toad has a distinctive dorsal stripe, 3 or more warts per large dorsal spot, and an unmarked white belly.

Adults

The Fowler's toad (2-3.7") is similar in appearance to the American toad, with which it is often confused. Generally, the Fowler's toad is lighter in color tending toward green, gray and white with dark spots. Each of the large dorsal spots contains three or more warts. A middorsal stripe is distinct and the belly is white without any black mottling. The American toad and Fowler's toad may be difficult to distinguish from one another because individuals may be found with a combination of characteristics of both species.

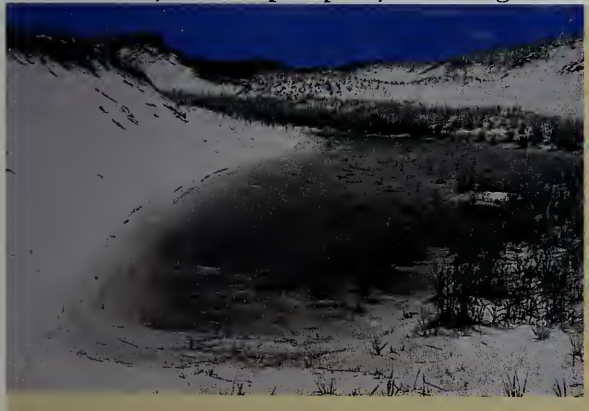
The Fowler's toad is found throughout the coastal plain area of eastern MA, including Cape Cod and the Islands, and the Connecticut River valley. The Fowler's toad prefers a drier habitat than the American toad. If both are found in the same locale, the Fowler's is likely to be in a dry, rocky area, whereas the American would be where the soil is more moist. The Fowler's toad is active on rainy nights as well as sunny days.

Eggs

Fowler's toads breed from late April through June, which is somewhat later in the season than the American toad. The male's call is a harsh "waaah." Eggs are laid in the shallow waters of various wetlands and are similar to those of the American toad, but may be in double rows within each gelatinous strand. As the eggs develop, the double rows become less distinct. Strands may be as long as ten feet and be tangled in aquatic plants.

Larvae

Tadpoles are black and virtually indistinguishable from those of the American toad. They develop rapidly and begin emerging as toadlets as early as mid-May.



In coastal areas, Fowler's toads may breed in interdunal swales such as this one in Barnstable, MA.

As many as 8000 eggs are laid in double strands, each of which might have paired files of eggs.

Spotted salamander

Ambystoma maculatum

Adult spotted salamanders are secretive and seldom seen.

Adults

The adult spotted salamander is a large (4.5-8") amphibian appropriately named for its obvious yellow spots on a blackish body. This animal is unmistakable, though not often encountered other than when accidently discovered under logs or when migrating to vernal pools on rainy nights in spring for breeding. Adults spend their lives in forested areas within a half mile of a vernal pool. They frequent small mammal burrows, crevices in rock walls and tunnels beneath logs in soft soil, seldom venturing in the open except to feed at night. Though unfamiliar to most because of their habits, the spotted salamander is probably abundant where suitable habitat still exists. Populations will often persist in diminished numbers where habitat has been disturbed. Adults eat various invertebrates including worms, centipedes, crickets, spiders, etc.

Spotted salamanders can be found on rainy nights in early spring as they cross roads migrating to vernal pools to breed. In some towns, roads are closed and interested individuals gather to view mass migrations. Often the animals migrate on several rainy nights. At vernal pools, the salamanders gather in a "congress" where males court females in an aquatic swarm of salamanders.

Eggs

On breeding nights, males produce many spermatophores in the area of congressing. A female picks up sperm from several spermatophores and her eggs are internally fertilized. Within a few days the female produces a single large or several smaller egg masses which she will attach to vegetation near the water surface. Many salamanders may use the same attachment site and produce communal egg mass clusters. Egg masses consist of 30 to 250 individual eggs surrounded by a stiff gelatinous matrix.

Spermatophores on leaves on pool bottom. Inset: close-up. Sperm are at the spermatophore's platform top.

Spotted salamander egg mass (~80 eggs) attached to twig. The matrix has enlarged by absorbing water.

The masses range in diameter from 1 to 6 inches. The entire mass may be clear or white. As the eggs develop over several weeks, masses become green from the alga *Oophila amblystomatis*.

Egg masses may be distinguished from other salamander species by their firm texture, similar to set gelatin. Individual eggs have a relatively large space between the vitelline membrane and the outer edge of the egg (see p. 14). Eggs are preyed upon by spotted turtles, caddisfly larvae (Phryganeidae) and other predators.

Egg masses are attached to vegetation in sunny locations in vernal pools and can be found anytime from early spring (mid-March) through May. The gelatinous matrix will protect the embryos from temporary stranding if water levels recede for short periods. Look for egg hatching from mid-May onward.

Communal egg deposition site with both opaque white and clear masses.

Developing egg masses quickly become green due to a symbiotic alga.

Larvae

The .5" larvae hatch about 6-8 weeks after egg deposition. Larvae have feathery external gills just behind the head and below these, a pair of "balancers" which keep them upright. Balancers are lost after a couple of days. Larvae grow quickly, feeding on daphnia, small insect larvae (chironomid midge, etc.), oligochaete worms, and other small invertebrates. At maturity, they are 2-3". They are eaten by predatory insects (predaceous diving beetles, their larvae, and giant water bugs), other ambystomatid larvae, as well as turtles.

Sweeping a fine net along the leaves on the pool bottom will often capture larvae. The external gills can be easily observed if the larvae is placed in water. As pools dry, larval development accelerates. The external gills disappear as the metamorph becomes a land-dwelling animal. Look for emerging metamorphs in and under vegetation and debris at the pool edge.

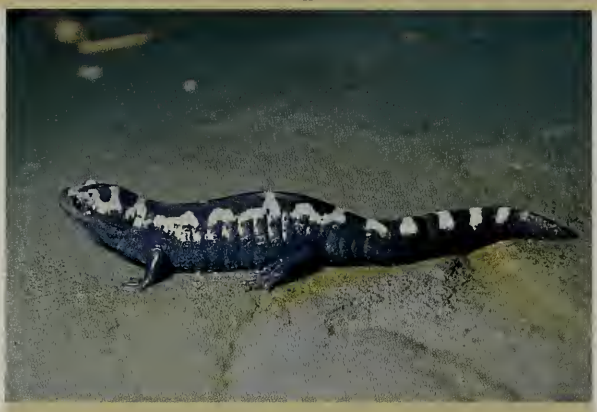
Spotted salamander larvae have distinctive bushy external gills, a large head. Older larvae have all four legs.

Emergent spotted salamanders often have unorganized spots, sometimes just light flecking, which can make them difficult to distinguish.

Marbled salamander

Ambystoma opacum

Massachusetts
Threatened Species



The marbled salamander is a stocky animal with white or grayish patterns on a dark body.

Adults

The marbled salamander (3-5") has a distinctive pattern of white or grayish spots and bars on a black, purplish-black, or grayish body. The animal is not large but has a stout, pudgy appearance. The patterning on the male is white, while that of the females tends to be more grayish. These salamanders are fossorial, utilizing animal burrows most of the time. They are occasionally found under logs and rocks in their deciduous forest habitat, but are rarely seen above ground except on rainy nights in late summer and early fall. Their diet consists of invertebrates, including earthworms, crickets, ants, snails, slugs, and various types of beetles.

Eggs

Marbled salamanders are late summer breeders. Both males and females migrate to the area surrounding a dry vernal pool in late August -September, perhaps as late as October. Males court females and produce spermatophores from which the females obtain sperm. The female constructs a nest under moss, leaves or cover objects in a dry area of the pool basin and deposits between 50-200 small transparent eggs. The eggs quickly become darkened with soil and leaf particles. She remains with the eggs until hatched, warding off predators such as small mammals (e.g. shrews), newts, and insects. The eggs hatch when covered with water as the pool fills. If flooding does not take place before winter, the female will abandon the nest to seek cover for hibernation.

The elevation at which the nest is built in the pool is particularly important to hatching and larval development. If the eggs are in the deepest area of the pool, they might be flooded with just a light rain, hatch, and then die if the water evaporates. Eggs at too high an elevation might not be flooded during the fall but have to await spring rains, while enduring the ravages of predation and winter temperatures. Most nests are constructed at a median location, but the best area varies with each year's weather patterns.

Adult female marbled salamander with clutch of eggs in nest on dry pool bottom.

Larvae

Larvae develop within the egg and hatch when the eggs are flooded. Because of this fall hatching, the marbled larvae are likely to be the only salamander larvae that would be found

under pool ice in the winter or in a pool when it thaws in the early spring. Rarely, spotted salamander larvae will overwinter and be seen under the ice or in early spring. A marbled larva can be distinguished from the occasional spotted larva by a row of light spots on its sides and by the pattern of uniform black stippling on its white throat.

Marbled larvae are carnivorous and feed throughout the winter, under the ice, on zooplankton and available macroinvertebrates. As they grow, they feed on larger prey, eventually consuming most any moving creature they can get in their mouths, including dytiscid and haliplid beetles, snails, mayfly nymphs and damselfly nymphs. By spring, they are able to feed on the hatching larvae of wood frogs and other species of mole salamander. Because they hatch in the fall, marbled larvae eat a different size class of food in the spring than consumed by hatching spotted, Jefferson or blue-spotted larvae. There is little real competition for food among these species in the spring. However, there is a certain amount of predation by the marbled on the other mole salamander larvae. Marbled larvae transform to the land-dwelling form in May and June. Upon metamorphosis, they have a grayish-blue spotted pattern on a purplish-black body. Within a few weeks, the spots come together to form the characteristic adult pattern.

Marbled salamander larvae will be the only or largest salamander larvae in a pool in spring. Distinctive features are the row of light spots on the side and the white throat mottled with black.

Larvae can be positively distinguished from other mole salamanders by their pigmented chin.

Recently transformed larvae have a grayish spotted pattern on their body for few weeks before developing the adult coloration.

Conservation Note

The marbled salamander is at the northern limit of its range in MA and is therefore quite uncommon. They have been found in the Connecticut River valley, central Worcester County north to Princeton, and in southeastern MA excluding Cape Cod. Historic populations in Lynnfield, Wakefield, and Boxford all seem to be gone. Recently, populations have been reported in both Dighton and Princeton by elementary school classes studying vernal pools. There are records for 70 sightings of marbled salamanders in MA with only 38 known breeding sites.

Blue-spotted salamander

Ambystoma laterale

Massachusetts
Species of Special Concern

Adult blue-spotted salamander with coloration reminiscent of old-time "enamel ware."

Adults vary tremendously in coloration and patterning. Their bodies range from black to purplish-brown and blue spots may contrast sharply or be rather muted.

Adults

Blue-spotted salamanders (3-5.5") have a pattern of bright blue spots scattered over a black or grayish-black body. The blue-spotted salamander has 12-13 costal grooves on each side of the body. This positively distinguishes them from lead phase redback salamanders (p. 43), with which they are sometimes confused, which have 18-22 costal groves. Hybrids of the blue-spotted salamander (see Jefferson salamander account, p. 38) tend to be more brownish to gray-black in body color with less prominent blue spotting, most obvious on the sides.

Adults are fossorial and secretive. They are usually seen when crossing roads on migration nights, although they might also be encountered under cover objects in forested areas around vernal pools and forested wetlands. Be sure to replace any logs or other cover objects you might move exactly as you found them. These items provide important habitat for numerous organisms. They are found throughout eastern MA to the Connecticut River, but none has been reported from Cape Cod and the Islands. Adults feed, usually nocturnally, on earthworms,

Eggs are often laid in sheets on the pool floor. Pearly-white eggs are dead and are being consumed by a fungus.

Blue-spotted salamander egg mass. The vitelline membrane is very close to the inner envelope of the freshly-laid eggs.

slugs, isopods, and various other arthropods. Like all mole salamanders, they exude a sticky, white, noxious substance which is distasteful to some predators.

Eggs

Mating takes place in early spring at vernal pools when adults migrate from woodland burrows to their natal pool. A male will court a female, produce spermatophores and the female collects sperm from these in her cloaca. Between 100-500 eggs are strewn about the pool as either individual eggs, small clusters attached to vegetation, or sheets on the pool bottom. Individual eggs measure about .2" in diameter, are brown, have a vitelline membrane <.05" from the inner envelope of the egg, and are surrounded by a loose, clear gelatinous material. Individual masses may contain from 1-30 eggs. Masses in hybrid populations (see p. 39) are seldom laid in sheets, and tend to have a high percentage of gray to whitish eggs that have not been successfully fertilized scattered throughout the mass. Blue spotted egg masses do not have the "set gelatin" firmness of spotted salamander masses. Because the matrix of the mass is clear and the eggs are scattered throughout the pool, they can be very difficult to find.

Eggs consist of (from the center) the embryo, the inner envelope, and vitelline membrane all of which are embedded in the clear matrix of the mass. Blue-spotted eggs can be distinguished from spotted eggs by the very small distance between the vitelline membrane and inner envelope in the blue-spotted egg.

Larvae

Larvae develop in the egg for about 3-4 weeks. Upon hatching, they have external gills just behind the head and a pair of balancers just forward of the gills. The balancers help to keep them upright until they develop legs shortly after hatching. Like other mole salamanders, blue-spotted salamander larvae develop for 2-4 months before they metamorphose into terrestrial juveniles. Larvae might be netted in a vernal pool, but mole salamanders are extremely difficult to distinguish from one another in the field.

Blue-spotted larvae are very difficult to distinguish from larvae of other mole salamanders in the field.

Recent metamorph showing the indistinct juvenile patterning and "scar" where the gills were resorbed.

Jefferson salamander

Ambystoma jeffersonianum

Massachusetts
Species of Special Concern

The Jefferson salamander is probably the most secretive of the mole salamanders. They are seldom seen except on breeding nights.

Adults

The Jefferson salamander (5-7.5") is a chocolate brown to blue-black animal with light blue flecking on its lower sides, legs and tail. They are secretive, living underground in the forest up to one-half mile from their breeding pool. They might be found when looking under logs and other cover objects but, generally, finding a Jefferson salamander is a rare event except for breeding nights in early spring. Migration to the breeding pools is the earliest for any of the mole salamanders, sometimes taking place on rainy nights with ground only partially thawed and ice still on the pools. At the pools, males and females locate each other by chemical cues and the male courts the female with snout rubbing, clasping, mutual swimming and tail waving. If the female is receptive, the male drops spermatophores and the female picks up sperm from them in her cloaca.

Eggs

A few days after mating, the female lays up to 250 eggs in small clusters of 12-75 eggs attached to vegetation near the water surface. The masses are clear, have a loose consistency and are difficult to see. They are tubular when attached to twigs and irregular when attached to soft vegetation. They may become greenish from algal growth. Embryos develop quickly and hatch within 4-6 weeks, usually before the eggs of the spotted salamander which might be using the same pool.

Larvae

Young larvae hide within the leaf litter and are fiercely predatory on all manner of invertebrates and even other salamanders. As they grow, they feed in the open water

Jefferson salamander eggs are deposited in small tubular clusters when attached to twigs. The mass is filmy, transparent and cryptic.

Larvae are dark pigmented, have a broad head and white throat like the spotted and blue-spotted salamander larvae.

of the pool where they may be observed at night and on sunny days hunting near the water surface. They are preyed upon primarily by predatory insects. Larvae complete development in 2-4 months and leave the pool for small mammal burrows in the forest. Sexual maturity is reached in 3 years. Life span may be another three years in nature.

Hybrids

Throughout Massachusetts are found hybrid salamanders which have physical characteristics intermediate between Jefferson and blue-spotted salamanders. These hybrid animals are the result of historic crosses between the two parent species as long ago as the end of the last glaciation. Neither the origin of these hybrids nor the methods of their reproduction is fully understood. Most all of the hybrids are female and have extra sets of chromosomes making them polyploid animals. However, some of the hybrids are diploid having one set each of Jefferson and blue-spotted chromosomes.

Experienced researchers can sometimes identify the diploid hybrids as Jefferson or blue-spotted by the relatively wide head of the Jefferson or by the wider blue spots of the blue-spotted as well as other equally subtle characteristics. The polyploid specimens can only be accurately identified by blood analysis or karyotyping. The hybrids are assigned as either Jefferson or blue-spotted based on the parent species from which they have more sets of chromosomes or, if the values are equal, to coincide with the prevalent local species.

For field study, if the hybrid is found west of the Connecticut River, it should be considered a Jefferson salamander. If it is found east of the Connecticut River, it should be considered a blue-spotted salamander.

For a complete discussion on hybridization, consult *Salamanders of the United States* by James Petranka.

Jefferson larvae are carnivorous and will feed upon most any invertebrate or small vertebrate it can capture. This larva has captured a spring peeper tadpole.

A recently transformed Jefferson salamander juvenile has a bluish-gray spotted pattern for a few weeks.

Hybrids of blue-spotted and Jefferson salamanders have features intermediate between the two species. This blue-spotted from Reading, MA (a) and Jefferson (b) from Pittsfield, MA would be difficult to distinguish without chromosome testing.

Red-spotted newt

Notophthalmus viridescens viridescens

Adult newts are aquatic and may be found in vernal pools, particularly semipermanent ones. They are aggressive predators in vernal pools.

Adults

Adult red-spotted newts (3-5") are completely aquatic and are found in a variety of wetlands, including some vernal pools. Upper body color is an olive green to yellowish brown with a row of bright red spots encircled in black along each side. The underside is yellow. The tail is keeled to aid in swimming. The keel is prominent in males, especially during the breeding season. Males also have black, hardened growths on their legs and feet during the breeding season.

Newts have a complex life cycle which includes four stages: the egg, larva, eft, and adult. Newts are carnivorous and opportunistic and eat insect larvae, worms, fingernail clams, amphibian eggs and larvae, leeches, and cladocerans. Adults are fully aquatic and rely on semipermanent or permanent water bodies. They are able to become terrestrial and move to alternate habitat in the event that their pond dries. Larval, eft, and adult stages produce noxious skin secretions that deter predation by most organisms.

Eggs

Breeding is a spring event in which the male courts the female, grabs her from above with his hind legs and fans his cloacal scents toward her head with his tail. He dismounts and drops a spermatophore in front of her. She picks up sperm in her cloaca and fertilizes the eggs. Between 100-400 eggs (.06") are laid singularly, attached to aquatic vegetation over the next few weeks. Females often hide eggs by wrapping parts of the vegetation around them. Eggs are laid between April and June and hatching occurs in 20-30 days, depending upon temperature.

The larvae have a black stripe extending from the snout through the eye and a yellow underbelly. These characteristics help distinguish them from mole salamander (*Ambystoma* sp.) larvae.

Larvae

Larvae are yellowish green with a mottled pattern on the back and a distinctive yellow underside. They have a blunt snout with a black stripe extending from the tip through the eye. Larvae feed on ostracods, copepods, snails, fingernail clams, chironomid midge larvae, and appropriately sized insect larvae. Both larvae and adults feed on mosquito larvae. They forage mainly at night and hide during the day. Larval development takes about 2-3 months with emergence in MA during July and August.

Eft

The eft can be a brilliant vermilion to a green-brown and has rows of orange-red spots bordered in black. Efts are terrestrial and spend 4-5 years wandering before reaching sexual maturity and seeking a wetland for permanent residence. Although they may return to their natal pond, the eft is the dispersal stage for the newt, responsible for colonizing new habitats.

The color of the terrestrial red eft stage ranges from brilliant orange-red to a green-brown. Efts are active in daylight, particularly if rainy.

Efts are brightly colored, abundant in many areas, and active during the day. They actively disperse during spring rain events, but are often encountered throughout much of the year in dry, upland areas. They feed on a variety of invertebrates, including Collembola, mites, fly larvae and spiders. Their skin secretions are considerably more toxic than those of the adult or larvae. The eft's almost neon color is considered a "warning coloration" to signal their toxicity and prevent predation. The combination of toxicity and warning seems to work, as efts have only occasional predators. Their toxins cause severe reactions in many amphibians and reptiles, including death, but are not harmful to humans through contact. Still, it would be folly to eat a red eft.

Dusky salamander

Desmognathus fuscus fuscus

The dusky salamander is found in streams and wet forested areas. It is not a vernal pool animal but is sometimes misidentified as a Jefferson salamander because of its dark color and light spotting.

Dusky salamanders (2.5-4.5") are brown to black in color when viewed in their poorly lit natural surroundings. In bright light, they appear to have a mottled rather than a uniform dark pattern, but markings are extremely variable. As with other members of its family (Plethodontidae), there is a conspicuous groove that runs from the nostril to the upper lip called a nasolabial groove. There is also a light line that runs diagonally from the eye to the corner of the mouth.

The dusky is an animal of streams, seeps and springs. It is not a vernal pool creature. It is included in this book in the event that someone looking under cover objects near streams or rivers uncovers a dusky salamander and thinks it might be a Jefferson salamander. Dusky salamanders can be quickly distinguished from mole salamanders like the Jefferson by their habit of jumping to escape capture. Mole salamanders can move quickly, but are not able to leap as the dusky can.

Four-toed salamander

Hemidactylium scutatum

Massachusetts
Species of Special Concern

Four-toed salamanders are the smallest salamanders in Massachusetts.

Adults

The four-toed salamander (2-3.5") is a small reddish-brown salamander easily identified by: a) its having four toes on each of its feet, b) its white belly speckled with black (p. 13), c) costal groves that meet along the spine in a herringbone pattern, and d) the distinctive constriction at the base of its tail. This small salamander breeds in various types of wetlands, but requires mounds of sphagnum moss for nest building. Vernal pools and other wetlands (such as red maple swamps) with dense hummocks of sphagnum moss are used. The animal is active at night; by day it seeks cover under logs and other objects. It feeds on spiders, springtails and various small insects. The tail of the four-toed salamander will break off at the base-constriction if the animal is handled roughly or seized by a predator. The tail wiggles about and distracts the predator while the salamander escapes.

Eggs & Larvae

It is believed that mating takes place in the late summer and early fall with the male producing spermatophores from which the female picks up sperm in her cloaca. The following spring, when the animals emerge from hibernation, the female migrates to a vernal pool about the same time that spotted salamanders migrate. The female constructs a nest above the water within sphagnum moss. She produces between 20-40 eggs and generally remains with them until hatching. Larvae hatch about 5 weeks after deposition. The larvae wiggle from the nest and drop down into the pooled water. They develop for about six weeks before absorbing their gills and emerging as a juvenile on land. The young four-toed salamanders disperse into the forest surrounding the breeding habitat.

Four-toed salamanders lay eggs in nests constructed in clumps of sphagnum moss overhanging the water of woodland vernal pools.

Female four-toed salamander with nest of eggs within sphagnum moss clump. Females remain with the nest until the eggs hatch.

Redback salamander

Plethodon cinereus cinereus

The redback salamander commonly has a red dorsal stripe (a). It may also be found as the unstriped "lead phase" form (b) or, rarely, as entirely red (c).

Eggs are laid in clumps under logs and other cover. The larvae develop completely within the egg.

Adults

The redback salamander (2.2-4") is a terrestrial salamander found most everywhere in MA. The body is blue-black with an obvious red dorsal stripe or is blue-black without any red stripe, called the lead phase redback. The lower sides have bluish flecks. In some rare cases, the body may be entirely red. Redback salamanders forage at night for food, hunting small invertebrates on the forest floor and even climbing into shrubbery in pursuit of prey. They may be seen hunting on rainy nights when other amphibians are migrating. As vernal pools dry and shrink in size, this animal might venture into the previously wet area to hunt, but otherwise has no real association with vernal pools. They do not breed in vernal pools.

Redback salamanders are included in this guide for two reasons. They are our most common and abundant salamander and often come to mind when vernal pools and salamanders are mentioned to someone new to vernal pool ecology. Of greater importance, the unstriped form of redback salamander is sometimes mistaken for blue-spotted or Jefferson salamander, particularly by someone who wishes to find a "rare species." Jefferson and blue-spotted salamanders, no matter their overall length, have a wide head and stout body and should not be confused with the narrow-bodied redback. To be really sure, count the costal grooves on the side of the animal. The redback has 18-20 costal grooves on each side while the blue-spotted and Jefferson have 13 costal grooves.

Eggs & Larvae

Reproduction is entirely terrestrial. Males produce spermatophores from which females collect sperm in their cloaca. Up to 14 eggs are laid in a clump attached to the underside of logs or other cover. The female remains with the eggs through a two month development. The larval stage is entirely within the egg from which young, miniature redbacks finally emerge.

The habitat provided by a drying vernal pool is suitable foraging area for many of our terrestrial snakes. Look for these animals as you visit vernal pools

Snakes

Few snakes are regularly found at vernal pools. Three of our species, for which accounts follow, are more aquatic in their habits than the others and may actually be found hunting in the water of a vernal pool. Other more terrestrial species might come to feed at or near a vernal pool, particularly as the pool begins to dry and metamorphosing amphibians are abundant under the debris of the pool bottom and around the pool margins. We have found ringneck snakes, red-bellied snakes and northern brown snakes under logs in a partially dry pool. Green snakes have been found in shrubs at a pool's edge catching insects. Hognose snakes are regularly found at the margins of coastal plain ponds. Black racers inhabit forested areas and might be found near a vernal pool. In summary, snakes are where you find them. For most people, finding them is a rare occurrence as the observer has to be attuned to looking for snakes. The snake species you are most likely to encounter while exploring vernal pools are on these two pages. Identification photographs of the other species found in Massachusetts are in the Pictorial Guide on pages 16-18. For further information on snakes, consult some of the publications listed in the reference section on page 70.

Northern water snake

Nerodia sipedon sipedon

Northern water snakes are often observed basking coiled among vegetation at the water's edge. Older specimens may be completely black.

Northern water snakes are extremely variable in color and pattern. Older individuals may be entirely black or dusky gray, but they typically have saddles and blotches ranging from crimson to black on a lighter field of brown or gray. Patterns on the belly scales are highly variable, but usually consist of dark reddish to black half-moons and variable spotting. They reach lengths of 18-42". The dorsal scales have keels.

They are common around most any water body in much of MA, but seem to be uncommon or absent in middle and northern Berkshire County. They will typically be seen basking on open sedge hummocks, rocks, and logs in vernal pools. These snakes will defend themselves by biting mercilessly if picked up. Though their powerful jaws impart a painful bite, they are not poisonous. They should be left alone and not handled. Water snakes are important predators in vernal pools, actively hunting for frogs and tadpoles, salamanders and their larvae, and invertebrates.

Eastern garter snake

Thamnophis sirtalis sirtalis

Garter snakes have 3 pale stripes down their length, often with a checkerboard pattern between.

The eastern garter snake (18-30") is one of the most common snakes in MA. Semiaquatic in its habits, it is often encountered in or near vernal pools. Garter snakes have 3 longitudinal stripes down the length of the body ranging from bright yellow to tan to greenish. The middorsal stripe may be faint. The body is black, brown, or dark green and variably marked with an alternating dark and light brown checker board pattern between the light stripes. The belly is variable, though typically light yellow, and has quite variable markings in 2 rows down its length. It is easily confused with the similar-appearing ribbon snake, but its longitudinal stripes are always confined to the 2nd and 3rd scale rows, counting up from the belly scales. Dorsal scales are keeled, making the snake look and feel somewhat rough.

Eastern garter snakes eat a wide variety of organisms, including invertebrates, amphibians and small mammals, and may be important predators of newly metamorphosing frogs, toads and salamanders at the edge of a vernal pool.

Ribbon snake

Thamnophis sauritus sauritus

Long and slender, the ribbon snake has 3 bright yellow stripes down its length and an exceptionally long tail.

Ribbon snakes (18-26") are easily confused with the eastern garter snake (described above). They have a black to dark olive body with 3 bright yellow to greenish longitudinal stripes down their length. Unlike the garter snake, the 2 lateral stripes are always on scale rows 3 and 4, counting up the side from the belly scales. The belly is yellow to greenish and unmarked. Ribbon snakes have a particularly slender head and body, and though the scales are keeled, the scales do not impart the very rough appearance typical of garter snakes. Ribbon snakes have very long tails, often accounting for more than 1/3 of the entire body length. The tail is the portion of the body beyond the vent on the underside of the snake.

Ribbon snakes are especially fond of frogs, which make up a large part of their diets. They are often found near or in water, and are strong swimmers.

Spotted turtle

Clemmys guttata

Massachusetts
Species of Special Concern

The spot patterns the shells of spotted turtles vary considerably, but distinguish them from other species.

Spotted turtles rely heavily on vernal pools early in the spring as an important source of food after coming out of hibernation. The spotted turtle is a small (3.5-5.5"), primarily aquatic turtle with a smooth black shell and obvious bright yellow spots on its carapace, legs, head, and tail. The number and arrangement of spots vary considerably among turtles and can actually be used to identify individuals. Some may lack spots altogether on the carapace, but they will have the characteristic spots on the head and neck. Males can be distinguished from females by their concave plastron (bottom shell), a brown or black jaw and brown eyes. Females have a flat or convex plastron, orange chin, red eyes and a yellow beak.

Early in the spring, spotted turtles spend considerable amounts of time in vernal pools feeding on amphibian eggs, invertebrates, and other food items. They are state-listed as a species of "Special Concern" and should be reported to the NHESP.

Wood turtle

Clemmys insculpta

Massachusetts
Species of Special Concern

The bright orange skin of the neck and fore limbs and deep sculpting of the shell identify wood turtles.

A bright orange throat and front legs help distinguish the wood turtle (5.5-8") from any other turtle in MA. Each of the large scutes on the carapace is highly sculpted, roughly into pyramid shapes, that have obvious growth rings. The shell may range from a very light brown to chestnut to almost black ground color and may have contrasting light rays of yellow, gold or orange. The plastron is yellow with variable black markings which may cover large portions of the plastral scutes. Males have a deeply concave plastron, long front claws and tail.

Wood turtles are typically associated with streams and slow rivers but range widely across the terrestrial landscape. They use vernal pools heavily during the early spring where they feed on a variety of foods including amphibian eggs, larvae and invertebrates. They are a state-listed species of "Special Concern" and when found should be photographed and recorded with the NHESP.

Blanding's turtle

Emydoidea blandingii

Massachusetts
Threatened Species

Blanding's turtles can be readily identified by their unique, lemon-yellow jaws and high-domed shells.

Blanding's turtles can be identified from quite a distance by their bright yellow throat that is often exposed as these large turtles hold their heads high while basking. Their large (7-10"), highly domed shells are dull gray to black and often flecked with small yellow or buff markings. Their flecking may be largely absent or run together to form streaks on some individuals. Their plastrons are pale yellow with variable black markings, often covering large portions of each plastral scute. The plastron has a hinge at the front which allows the turtle to completely close its shell for protection after pulling in its head and legs.

Blanding's turtles are semiaquatic, found in a variety of wetlands including marshes, swamps and flood plain wetlands. However, they will travel over land considerable distances to reach vernal pools where they feast on amphibian egg masses, larval amphibians, crustaceans, and other organisms and plants throughout the spring.

Snapping turtle

Chelydra serpentina

Even hatchling snapping turtles have large heads, deeply serrated shells, and saw-toothed tails.

The largest freshwater turtle in MA, snapping turtles may grow to be as large as 20" in shell length. Their long neck and tail may add as much to their length, making these animals attain tremendous overall size. Their shells are typically light gray to black but may have a green cast due to dense growths of algae. The back margin of the carapace is deeply serrated, and the center scutes are weakly keeled. Quite often, especially in older turtles, the center of the shell becomes depressed and actually makes the upper shell concave. They have a strongly serrated, or "saw-toothed" tail, and may have huge, curved claws. Given the size of the animal, their plastron is extremely small, covering little of their body.

Despite their reputation, they are hard to rouse if they are in the water, even when stepped on. They eat a tremendous variety of foods, including plants, adult frogs and other animals, and can often be found in vernal pools throughout the year.

Eastern painted turtle

Chrysemys picta picta

Commonly seen basking, the dark shell with light lines and markings on the head identify the painted turtle.

Common to almost any pond, lake or river, painted turtles are one of the most familiar turtles in MA. Often seen basking on logs or rocks just above the water's surface, their smooth black or dark olive carapace (4.5-6"), red markings along the sides where the carapace and plastron meet, and red and yellow stripes on the head and neck make identifying these turtles easy. Wide, light lines cross the carapace where the lead edges of the large scutes line up, further distinguishing the eastern painted turtle. The plastron has no markings and is pale yellow or cream colored. Males have long, thick tails and very long claws on the front feet. In the western part of MA, another subspecies of the painted turtle, the midland painted turtle, is found. It looks very much like the eastern painted in coloration, but the large scutes on the carapace do not line up across the shell, and the broad light stripes do not exist.

Though not dependent upon vernal pools, painted turtles will sometimes be found during the spring and summer in these habitats. They perch above the water sunning themselves but flush easily upon approach. They are good at disappearing, and are often very difficult to catch once they have leapt into the water.

Eastern box turtle

Terrapene carolina carolina

Massachusetts
Species of Special Concern

A box turtle will draw in its head and limbs and tightly close the shell when disturbed.

The eastern box turtle has a small (4.5-6"), highly domed carapace and a plastron that is hinged across the front and back, allowing the animal to clamp itself shut in an almost impenetrable package. Highly variable, the coloration of the carapace ranges from pale yellow-brown to almost black, with light yellow to orange blocky markings that may be so reduced as to look like polka dots. Males have a highly concave plastron and distinctive orange-red eyes, while females have a convex plastron and brown eyes.

A state-listed rare species, eastern box turtles are essentially terrestrial. However, they can be found in the habitat surrounding vernal pools, and have been known to travel through vernal pools and other wetlands, stopping to soak and feed.

Caddisfly

c: INSECTA o: TRICHOPTERA

Larvae of Limnephilidae family. The style of case construction leads to the common name, log-cabin caddisfly.

Caddisfly larvae construct protective cases from vegetation and other materials found in the water. Cases protect the soft abdomen of the larvae and provide both camouflage and ballast. The larvae are able to retreat into their case in order to avoid threats from predators. The larval movements within the case also create a current through the case which helps aerate the gills in oxygen-deficient vernal pools.

The style of construction and materials used for the case can be a rough guide to family, although there is some variability in material choice. The larvae of the log-cabin caddisflies Limnephilidae) use stems and woody material to make cases up to 1.25" long. They eat plant material and detritus and are important in the vernal pool because they shred large leaves into small pieces usable by other organisms. The cigar-tube or leaf-roller caddisflies (Phryganeidae) construct cases of leaf material up to 3" long. They often have conspicuous stripes on the head and thorax. Their diet is variable, depending upon species, and includes plant material, detritus, and some predation. Leaf-rollers may occasionally be observed with their body extended into a salamander egg mass as they feed on the developing embryos.

Larvae use their legs and mouth parts to pull and crawl their way over the pool bottom and along vegetation. Larvae pupate in the water and adults emerge before the pool dries. Adults are small, mothlike, terrestrial insects which fold their wings tent-like over the body when at rest. They lay gelatinous egg masses in the water, on vegetation, and on the moist bottom of dry vernal pools. Eggs may overwinter in dry pools.

Cases of caddisflies can be found on the bed of dry vernal pools. These can be used to prove the dry wetland is a vernal pool.

Larva of Phryganeidae family. The cases of the "cigar-tube caddisfly" are made of leaves and leaf pieces.

Very young caddisflies do not use the same materials as adults to make cases; sand grains are often used.

Aquatic Coleoptera

c: INSECTA o: COLEOPTERA

Aquatic beetles, including the predaceous diving beetles (Dytiscidae) and many other families within the order Coleoptera, are a diverse and varied group of insects. Aquatic beetles are common in vernal pools and other wetlands and range significantly in size, color, and patterning. Adult beetles use vernal pools for breeding and feeding, and the larvae rely on the fish-free waters for relatively safe habitat in which to develop. The larvae and adults of many different families, genera and species are often present in a vernal pool at the same time. As many as 20 species of aquatic beetles have been identified from a single vernal pool.

Identifying these animals to genus and species, and even distinguishing the families, requires specialized keys and equipment and is not a field activity. We make no attempt in this key to distinguish individual genera or species. The aquatic Coleoptera are such a large group that many species have not been closely studied and quite often are simply refered to as aquatic beetles.

Predaceous diving beetle

o: COLEOPTERA f: DYTISCIDAE

Dozens of species occur in vernal pools. Some species typical of semipermanent pools may be as large as 2 inches while others may be as small as .1".

Adults

Both larval and adult predaceous diving beetles are fiercely predatory and feed on invertebrate and vertebrate organisms. Adults range in size from .1-1.75" in body length and vary in color from plain brown or black to very highly patterned with spots or stripes. Their body shape is oval, with the head generally streamlined to fit the body contour. The swimming hairs on the hind legs form a paddle-like surface which propels this deft swimmer. Dytiscids can be distinguished from some similar-appearing beetles in that both hind legs are moved in unison when swimming.

Adults breathe from a bubble of air held under their elytra (hard outer wings). They periodically replenish the oxygen supply in the bubble by poking the tip of their abdomen through the water surface. Some species that use annually-drying vernal pools remain in the pool year-round, overwintering in the dry basin.

Growing to over 3", Dytiscid larvae are sometimes called toe-biters.

Dytiscid larvae are voracious predators, earning the name "water tigers."

Larvae

The Dytiscidae is a tremendously large and diverse group of beetles. There is a variety of shapes, sizes, and behaviors including hunting habits that make identifying species quite challenging. Larvae have an obvious head, distinct from the thorax, with a pair of large, sickle-shaped, piercing mandibles used to grab prey and inject a digestive enzyme. They are generally poor swimmers and use their legs to walk on the substrate, among vegetation, or to dog-paddle in the water while hunting for prey. Many dytiscid beetle larvae are visual predators that grab any animal in which they sense motion. This behavior affects the ecology of vernal pools because amphibian larvae must remain active to complete their growth before the pool disappears. When they move, tadpoles increase their likelihood of being attacked.

Dytiscids are much more commonly found in vernal pools that hold water for extended periods. Very ephemeral pools may have adult beetles that have flown in to feed, but are less likely to have many larval predaceous diving beetles in them.

Crawling water beetle

O: COLEOPTERA F: HALIPLIDAE

The crawling water beetle swims and walks through the water and vegetation of a vernal pool.

The crawling water beetle is very small (.1-.25"), yellow or orange, and typically spotted or patterned. They can be seen swimming in the water or crawling on submerged vegetation and on the bottom of vernal pools. They are often confused with small predaceous diving beetles. However, the head of the crawling water beetle protrudes distinctly beyond the smooth arc defined by its body and the hind end is more narrowed. It has enlarged hind coxal plates (rear-most pair of plates on ventral surface) which no other beetle has. The elytra (hard outer wings) often have rows of tiny holes. The hind legs have swimming hairs. Like other aquatic beetles, the crawling water beetle breathes air carried under the elytra and enlarged coxal plates. Adults and larvae are herbivores.

Water scavenger beetle

O: COLEOPTERA F: HYDROPHILIDAE

Both adults and larvae of this diverse group are difficult to distinguish from other beetles.

Adults

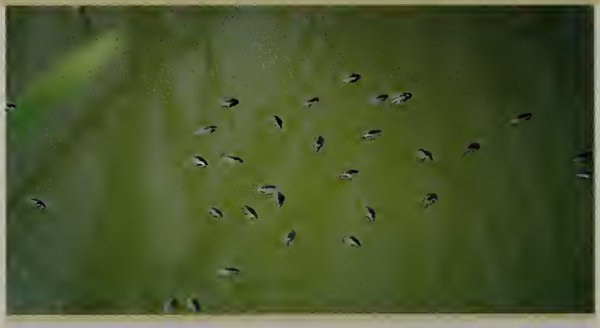
The water scavenger beetles (.1-.5") are an abundant group second only to the dytiscids in diversity. Adults are oval and elongate with a pronounced convex shape, as opposed to the more flattened dytiscids. They have distinctive clubbed antennae, often hidden under the head. They are nearly indistinguishable from other aquatic beetles without specialized keys and a microscope. However, unlike dytiscids, water scavenger beetles surface head first and swim by moving their hind legs alternately. Adults are omnivores.

Larvae

Larvae grow as large as 1.5". They are poor swimmers and will hang from the water surface (where they obtain oxygen) or hide in vegetation to await prey.

Whirligig beetle

O: COLEOPTERA F: GYRINIDAE



Whirligig beetle adults dart about on the water surface. Larvae, with feathery gills, remain below.

Adults

Adults are easily recognized as bluish-black, oval, flattened beetles swimming in schools on the water surface. Their specialized eyes, divided so they can see both above and below the water surface, help them avoid predators. When disturbed, they swim erratically and dive. They are scavengers and will feed on insects trapped in the surface tension of the water.

Larvae

Larvae grow to 1.5". They have feathery lateral gills on their abdomen, and do not surface for air. They can be easily confused with other invertebrate larvae, but their abdomen terminates in 4 hooks, unlike any others. Whirligig beetle larvae are predaceous.

Damselfly

o: ODONATA s.o.: ZYGOPTERA

Amber-winged spreadwing, *Lestes eurinus*, are typically found in vernal pools that dry annually.

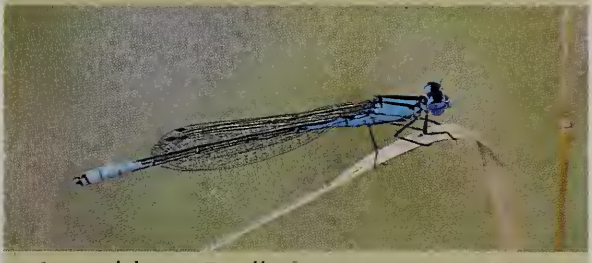
A pair of Northern bluets, *Enallagma cyathigerum*, in the mating "cartwheel." The male is above.

Adults

Damselflies (1" to 2") are delicate bodied insects. They have very slender, elongated abdomens and a broad head much wider than the body. Four long, slender wings, very similar to one another in size and shape, are folded over the abdomen or held out to the sides when at rest. The coloration, patterns on the abdomen and thorax, and especially the anal appendages, are important in distinguishing the species.

Many damselflies require semi-permanent pools to successfully complete their life cycles. However, there are a number of species in MA that are able to use more temporary pools that dry every year. These tend to deposit eggs in the stems of emergent vegetation where the eggs overwinter.

Spotted spreadwing, *Lestes congener*.



Azure bluet, *Enallagma aspersum*. Note wings folded over the abdomen.

Larvae

Larvae look much like the adult, but wings are present only as wing pads, and there are 3 large, feather-shaped gills at the end of the abdomen. The head is quite broad relative to the rest of the body, with large eyes.

Larvae in vernal pools are fairly good swimmers and can be found swimming through the water column where they prey on invertebrates and small vertebrate animals.

Damselfly nymph with 3 feather-shaped gills at the end of the abdomen.

Dragonfly

o: ODONATA s.o.: ANISOPTERA

Twelve-spotted Skimmers (*Libellula pulchella*) vigorously defend territories.

The Common Green Darner (*Anax junius*) is fast and a challenge to catch.

The Black-tipped Darner (*Aeshna tuberculifera*).

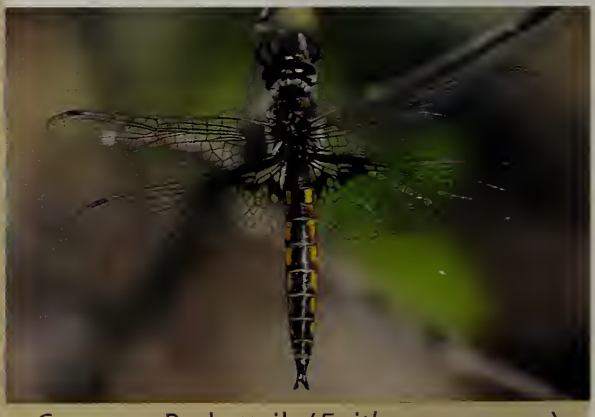
The Yellow-legged Meadowhawk (*Sympetrum vicinum*) is common.

Adults

Dragonflies are a common site around many New England wetlands and are a favorite sign of summer for many. They are difficult to confuse with any other flying insects because of their large, broad wings that are always held straight out to the sides, extremely large eyes and their often brightly colored and patterned abdomens. Dragonflies will be present in greater numbers and diversity at vernal pools which do not dry every year, though some may be found in annually-drying pools.

The 2 families that are most commonly encountered in vernal pools are the darners (Aeshnidae) and the skimmers (Libellulidae). Darners are large and tend to have very highly-patterned abdomens with dramatic black bars and spots and bright blue, green or red coloration. Many skimmers have more uniformly colored abdomens but may have interestingly patterned wings.

Dragonflies are quite active. The darners are particularly strong fliers and seldom seen at rest. Dragonflies have a voracious appetite for small flying insects. They are often called mosquito-hawks because mosquitos make up an important part of their diet during the summer. They are quite territorial and



Common Baskettails (*Epitheca cynosura*) have a hairy thorax and yellow spots.

Frosted Whiteface (*Leucorrhinia frigida*) at rest. Wings are tipped down to help regulate body temperature.

The Four-spotted Skimmer (*Libellula quadrimaculata*).

can be watched defending small aerial territories from other adult dragonflies that compete for mates and food.

Many dragonflies deposit eggs in water. During egg laying, the male clasps the female behind the head in flight with appendages at the end of the abdomen. The female deposits eggs by repeatedly dipping the tip of her abdomen below the water surface in a hand-stitching motion. Some species, however, deposit eggs in plant stems.

The Slaty Skimmer (*Libellula incesta*) can be found flying in June and August.

Larvae

Dragonflies that use vernal pools have developed various strategies that allow them to survive in these ephemeral habitats. The eggs of many species go through a resting stage after being laid in vegetation. Hatching is triggered by the return of water. Some have life cycles of less than a year and the larvae are therefore able to develop in temporary pools. The larvae of some dragonflies that breed in vernal pools are able to complete the aquatic phase of their life cycle before the pool dries completely because their rate of development increases as the water temperature warms.

Darner larvae clasp and crawl along plant stems while stalking prey and are important predators in vernal pools.

Larvae of the skimmers have broad abdomens and spindly legs. They hide in debris, waiting for prey.

Backswimmer

O: HEMIPTERA F: NOTONECTIDAE

Backswimmers hang upside down from the water surface and dart through the water column.

Backswimmer nymphs have white backs and indistinct developing wing pads.

The backswimmers have long, slender bodies (.2" to .6") that are patterned with black and yellow mottling. Dense hairs covering their backs hold a thin layer of air which imparts a silvery sheen to the insects. True to their name, backswimmers swim "upside down" with their ventral side facing the surface, their hind legs with stiff swimming hairs working oar-like to move them through the water. Their forelegs are nearly as long as the middle legs. At rest, they often hang from the water surface, the tip of their abdomen protruding into the air. They are adept hunters and subdue other insects, crustaceans, and snails with their long, piercing beaks.

Nymphs look very similar to the adult throughout their development but lack the well-developed wings and color patterns of the adults.

Water boatman

O: HEMIPTERA F: CORIXIDAE

The water boatman has distinctive yellow and black tiger stripes and long, oar-like hind legs.

Water boatmen are small (.2" to .5"), somewhat flattened aquatic bugs. They are easy to confuse with backswimmers because of their long, oar-like hind legs with stiff swimming hairs and their general shape. However, their dramatic yellow and black tiger stripe patterns and short triangular beaks set these bugs apart. Their forelegs are also much shorter than the middle pair. Water boatmen overwinter in permanent water and fly to vernal pools in midsummer.

Like most aquatic insects, the water boatmen are air breathers. Adults carry a store of air on the ventral surface as a thin film. It is renewed by frequent trips to the surface where they can often be found resting. While most Hemiptera are restricted to a liquid diet by their piercing, sucking mouthparts, the water boatmen have a modified beak that allows them to grind their food items. Different species are predators, scavengers, herbivore-detritivores, or omnivores.

Water scorpion

O: HEMIPTERA F: NEPIDAE

Slender raptorial forelegs are used in capturing prey. Note red mite nymphs attached to legs.

Water scorpions are an important invertebrate predator found in vernal pools. There are 2 genera found in MA. The majority are long and extremely narrow (pictured), but one species is broad and oval-shaped. They range from .6" to nearly 2.5". Their abdomens end in a pair of long (up to .75") breathing tubes which help distinguish them from the closely related giant water bug. They are poor swimmers and tend to hide within aquatic vegetation, hanging from the water's surface with breathing tubes poking into the air, lying in wait for invertebrates and small vertebrate animals. They have raptorial forelimbs that are used to capture prey, and piercing, sucking mouthparts.

As adults, water scorpions overwinter in deep ponds, lakes or rivers, and migrate to breeding habitats in the spring time. While not often found in very ephemeral pools, they will use vernal pools with dense emergent vegetation.

Giant water bug

O: HEMIPTERA F: BELOSTOMATIDAE

Females deposit their eggs on the backs of the adult males who carry them until they hatch.

Giant water bugs are medium to large sized (up to 2.5") insects that are oval-shaped and greatly flattened. They are important top predators that use their stout, raptorial forelimbs to capture and kill anything that they can. They spend much of their time hanging from the water's surface with their short, strap-like breathing tubes poking into the air, waiting for a potential meal. Giant water bugs have earned the names "fishkiller" and "toe-biter." Great care should be taken in handling these insects.

In one genera of giant water bug (*Belostoma*), the female deposits her eggs on the back of the male. The eggs are brooded by the male, who fans them with his hind legs to help keep them aerated. He provides protection to the developing eggs, yet will actually eat the eggs if they are dislodged from his back prior to hatching. In the other genera of giant water bug (*Lethocerus*), eggs are laid in masses above the water surface on vegetation.

Water Strider

O: HEMIPTERA F: GERRIDAE

Water striders skate along the water surface hunting for small invertebrate prey.

Adults

Water striders (.25-.5") are semi-aquatic insects that walk on the water surface of vernal pools and other water bodies. Water striders contact the water with all of their legs. You might first notice them by the unique 4-ringed shadow they cast on the pool bottom when at rest with the forelegs held ready to capture prey. Their legs end in tufts of dense hairs that prevent them from breaking the surface tension, keeping them afloat. Their slender bodies, and water walking habits make them distinctive and unmistakable.

They hunt small surface-dwelling invertebrates and are important predators of adult mosquitos and other insects that rest on the water surface just after emergence from their aquatic larval stage. While they spend most of their time striding along the water surface, they are good fliers and can disperse widely.

Fishfly

O: MEGALOPTERA F: CORYDALIDAE

Fishflies have long, stout bodies with a pair of gills (lateral filaments) on each segment.

Larvae

Fishfly larvae (to 2") have a dark, shiny head with stout, pinching mandibles used to capture and subdue aquatic insects and other invertebrate prey. Their long, relatively stout bodies are distinctive in having 8 paired lateral gills. The gills look much like a single spine on either side of each segment. The lateral gills, and a pair of terminal siphons characteristic of species most often found in vernal pools, allow these insect larvae to obtain oxygen in vernal pools that often have quite low oxygen content. Some species, particularly those found in streams, also have dense tufts of gills at the base of the lateral gills for pulling oxygen out of flowing water.

Fishfly larvae tend to be found in vernal pools that hold water for most of the summer and that have deep mucky soils. Occasionally, the larvae can be found by looking under logs and stones in the deeper portions of a dry vernal pool, where they may be waiting for the return of water. By burying into the wet mud under cover of a rotting log, they may be able to survive a short dry period.

Mayfly

c: INSECTA o: EPHEMEROPTERA

Larvae

Mayflies are a diverse group of insects, all of which have aquatic larvae. Though most commonly found in rivers, mayfly larvae can often be found in vernal pools. They are small (.25-.75"), delicate larvae that have a set of 3 (rarely 2) "caudal filaments" that look like flexible spines at the end of their abdomen. Thin, fanlike gills are paired along the abdomen on each segment, giving the larvae a somewhat ragged appearance. Mayfly larvae are detritivores, feeding on a wide variety of plant and decaying animal matter.

Mayflies have very slender legs, paired lateral gills and typically 3 filaments on the tip of the abdomen.

Mayflies go through a synchronous emergence where many nymphs hatch at the same time, in some cases flooding the night with newly-emerged adults. The adults emerge with only one task, to mate and produce the eggs that will hatch the following year. They emerge with no mouth parts, and only live for a couple of days after metamorphosis. Their ephemeral adult stage gives rise to their scientific name.

Chironomid midge

o: DIPTERA f: CHIRONOMIDAE

Larvae

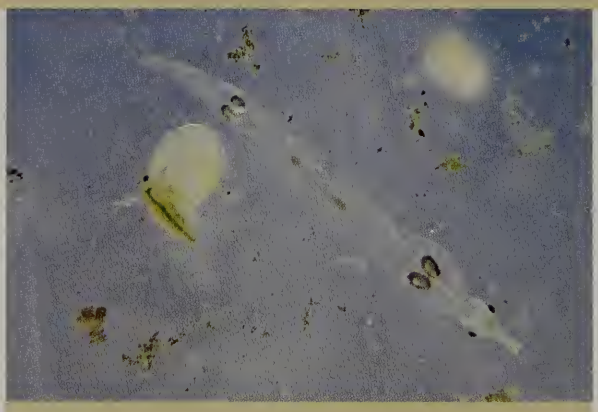
The chironomid midges constitute the largest family of aquatic insects. Their larvae (.1-.8") are very commonly found in vernal pools and are an important food source for numerous vertebrate and invertebrate predators. The larvae are basically worm-shaped, slender and cylindrical, though they have pairs of fleshy prolegs at both ends of their bodies. Many chironomid midge larvae are blood red due to a hemoglobin-like pigment that helps them retain oxygen. This pigment allows the larvae to survive in water that is very low in dissolved oxygen, as is common in vernal pools as drying proceeds through the seasons.

Chironomid midge larvae are blood-red, wormlike larvae that wriggle through the water column.

Chironomid larvae tend to be predatory, but may also graze on fine detritus particles on the substrate. They can be found in the pool bottom debris or wiggling wildly in open water as they use body contortions for movement.

Phantom midge

O: DIPTERA F: CHAOBORIDAE



Phantom midges, sometimes in dense clouds, may only be visible at first because of their hydrostatic organs.

Larvae

Phantom midge larvae are transparent and nearly invisible to the casual observer. The larvae are long (typically <1") and narrow with a distinct head and are often first noticed because of small air sacs at both ends of their bodies. They are predatory and have an enlarged pair of antennae modified to function in capturing prey which includes small insects, crustaceans, and other invertebrates.

They move with a jerking motion, though usually simply float within the water column waiting for prey. The air sacs, or hydrostatic organs, act as ballast and enable them to maintain their position in the water column without rising or sinking. In late spring and early summer, extremely dense clouds of phantom midges may fill the water of vernal pools. They are an important food source for developing salamander larvae and other predators that are in the annual race against pond drying.

Mosquito

O: DIPTERA F: CULICIDAE

Mosquito "wrigglers" hang from the water surface. Pupae or "tumblers" may somersault through the water.

Larvae

Larval mosquitoes (.3-.5") are often called "wrigglers" because of the body gyrations used for movement. They hang head down at the water surface with their breathing siphons poking into the air. Ten genera are found in MA, with some species being vernal pool breeders. Most wrigglers feed on detritus and microorganisms, although two of the genera have members which are predatory on other mosquito larvae. They are eaten by predatory insects and salamander larvae.

Adult mosquitoes feed on plant juices. Females feed on blood (mostly nonhuman) before breeding. Eggs of some species are laid on moist soil and may remain dormant until flooded. Others lay eggs on the water surface, often in rafts. Mosquitos of temporary pools may develop from egg to adult in as little as a week in warm weather; several broods are possible in a season. Mosquitoes are eaten by a variety of amphibians, insects, birds and bats.

Springtails

c: INSECTA o: COLLEMBOLA

Adults

The Collembola, or springtails, are tiny (<.2"), wingless insect-like arthropods. There is quite a bit of diversity among this group of minute organisms, but most have a unique jumping structure called a furcula on the underside of their bodies near the end of the abdomen. The furcula is held against the abdomen at rest, and is released like a tightened spring, launching the animal considerable distances (for their size). Also called snow fleas, they are often found in dense congregations very early in the spring on remnant patches of snow.

Springtails are tiny primitive insects that are often found in great numbers on a pool's surface.

Some springtails are truly aquatic or semiaquatic and found on the water surface, but most live in the soil, litter, and moist vegetation. They feed primarily on algae, microorganisms including bacteria, detritus, and other organic material. Careful observation of water scooped from a vernal pool will often reveal hundreds of these creatures.

Water mites

c: HYDRACHNIDIA o: ACARIFORMES

Adults

The water mites comprise a tremendously diverse group of small, spider-like organisms. Seldom reaching sizes greater than .2", they can often be found scurrying through a sample of vernal pool water. They are most commonly brilliant red or green, but may be tan, brown, yellow, or even blue. Their soft bodies are spherical or egg-shaped. Identifying mites to family, genus and species requires a microscope and the use of complicated keys.

Bright red, brown, yellow and sometimes even blue, the aquatic mites are extremely diverse.

Mites go through an incredibly complex life cycle beginning as eggs laid in gelatinous masses that hatch within a couple of weeks. Upon hatching, the larva is parasitic on an aquatic insect (see water scorpion image, p. 57) and goes through 3 nymphal stages, alternately active and inactive, before finally metamorphosing into a swimming adult. As adults, water mites may be omnivorous, but most are carnivorous or parasitic.

Amphipod

One species is a Massachusetts Species of Special Concern

c: MALACOSTRACA o: AMPHIPODA

Amphipods may be abundant in the leaf litter of a vernal pool.

Adults

Amphipods are small crustaceans (.2" to .4") also known as "sideswimmers" or scuds. They are very narrow-bodied, gray to whitish animals. When seen darting through the water, they often appear to be trailing their threadlike limbs behind them. Amphipods are omnivore-detritivores, and are often found among the decaying leaves and vegetation on the bottom of a vernal pool, but may spend time slightly buried into the soft substrate. Amphipods may survive dry periods in vernal pools by burying themselves in the mud. The Mystic Valley Amphipod (*Crangonyx aberrans*), occasionally found in eastern MA, is a state listed rare species.

Isopod

c: MALACOSTRACA o: ISOPODA

Isopods, or aquatic sow bugs, are important scavengers and detritivores in vernal pools.

Adults

Isopods (<.7") are flattened, broad-bodied crustaceans that live among the leaf litter and bottom detritus of vernal pools. Their bodies have numerous segments, but both the first and last segments are much larger than the others. They are poor swimmers and their 7 pairs of legs are used for crawling about the pool bottom. Isopods are typically brown to light gray, providing important camouflage from the predators found in vernal pools.

Mature females have an opaque white brood pouch (marsupium) on the bottom of the last body segment where the eggs develop and hatch. They have no specialized adaptations, such as drought-resistant eggs or a diapause phase, to survive the dry periods characteristic of vernal pools.

Isopods are scavengers and detritivores, feeding on dead and dying aquatic animals, live and decaying leaves and aquatic vegetation. Along with other detritivores, isopods play a crucial role in vernal pool ecology. They help break down and remove dead animal and plant material and process large plant material in the pool into ever smaller pieces. As particle sizes decrease, the surface area which is colonized by algae and fungus increases. This enhances the nutritional value of detritus as it is fed upon by developing frogs, as well as other detritivores and filter feeders.

Fairy shrimp

One species is a Massachusetts Species of Special Concern

c: BRANCHIOPODA o: ANOSTRACA

Adult male fairy shrimp, *E. vernalis*, with claspers used in mating evident.

Fairy shrimp are small (.5-1.5"), orange to green, delicate-bodied crustaceans that live only in vernal pools. They swim "upside down" through the water, rhythmically beating their abdominal appendages which also serve as respiratory structures. When viewed from above, their sometimes white forked tail may make them noticeable. They may move slowly, dart quickly, or even remain stationary as they filter bacteria, phytoplankton, protozoans and detritus. Mature females have a brood pouch evident at the base of the abdomen, while males appear to have an enlarged head due to claspers used in mating.

E. intricatus, on the left, has much longer antennal appendages.

Two species of fairy shrimp are confirmed from MA. *Eubranchipus vernalis* is common and widespread, while the intricate fairy shrimp, *E. intricatus*, is a state-listed rare species known from only a few sites. They can be differentiated by examining the heads of mature males under a hand lens. *E. intricatus* has a pair of long, often curled, antennal appendages which reach to the end of the claspers. The antennal appendages of *E. vernalis* are quite small and inconspicuous (see diagram).

Female fairy shrimp produce several broods of encysted eggs which must dry and be re-submerged before they will hatch. Hatched larvae develop quickly into mature adults which reproduce several times. The drought and cold resistant cysts withstand ingestion by animals, may be blown by wind from a dry pool, or carried along with mud or plant matter. The rapid development and reproduction of fairy shrimp places their activity period in a vernal pool at a time (winter and early spring) when there are few predators present.

Maturing female. Encysted eggs are developing in the brood pouch, and the head is much smaller than a male's.

Fairy shrimp are camouflaged by the surrounding leaves. The white forked tail gives this female away.

Clam shrimp

Two species are Massachusetts State Listed Species

c: BRANCHIOPODA o: LAEVICAUDATA

The carapace of clam shrimp is held agape, exposing the antennae and ends of their many legs.

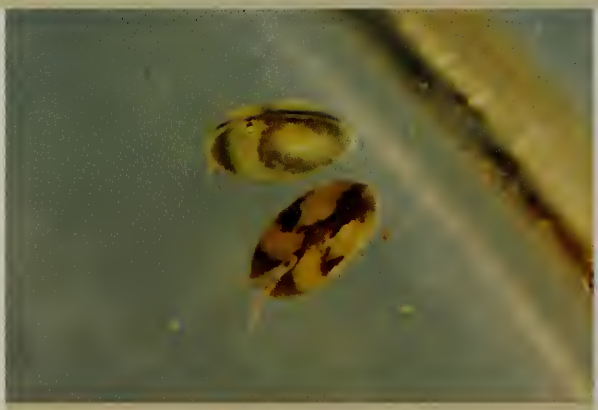
Clam shrimp are small (<.3") crustaceans that have a clam-like bivalve carapace (shell) covering their head and body. The carapace is semi-translucent, allowing a slightly obscured view of the body. *Lynceus brachyurus*, the only species in the order Laevicaudata, does not have any growth rings on the carapace. Two species of clam shrimp in the order Spinicaudata, *Limnadia lenticularis* and *Eulimnadia agassizii*, which are both quite rare in MA, have visible growth rings that serve as a record of their molts.

Adults die shortly before their pools dry, or may be stranded by the receding water. Eggs collect in the female underneath the carapace and are shed with each molt. The eggs of clam shrimp are resistant to desiccation, allowing them to persist in the temporary habitat of vernal pools year after year, and also facilitate their transport among potential habitats. These animals develop extremely quickly, reaching sexual maturity in a matter of days after hatching from the egg.

Clam shrimp live near the bottom of the pool, moving along the substrate. They feed on algae, bacteria, and detritus by straining water passed over their branched limbs under the carapace.

Ostracod

p: CRUSTACEA c: OSTRACODA



Ostracods are easily overlooked in a vernal pool because of their tiny size and cryptic coloration.

The ostracods, or "seed shrimp," are tiny crustaceans that can be seen darting around a sample of pool water. They rarely exceed .1". Their bivalve carapace (shell) gives them an appearance similar to that of a tiny oblong clam with little swimming legs. There are no growth rings on the carapace. Their color is quite variable, but the larger ostracods often have a dark banded pattern on the shell which, in addition to their relatively larger size, helps draw attention to them. Fine setae cover the carapace, giving them a slightly "hairy" appearance when viewed under a microscope or hand lens. Their drought-resistant eggs are capable of passing through the intestines of birds and remaining viable which makes it easy to colonize new sites.

Daphnia

c: BRANCHIOPODA "CLADOCERA"

Daphnia may fill the water column in the summer time and are important prey for many animals.

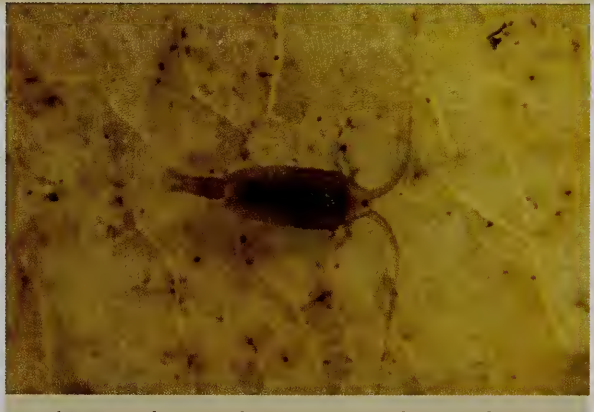
Cladocerans, often called daphnia after the largest family (Daphniidae), are small crustaceans that are extremely important food items in vernal pools. Their small size (<.2"), abundance, and lack of any defenses make them important prey for predaceous invertebrates, amphibian larvae, and other organisms. They have a thin carapace that encloses the body, but not the head and large modified antennae. Antennae are used in locomotion and they move about the water column in a "hopping" motion.

Daphnia eat organic detritus, algae, and bacteria. The multiple legs are used to generate a water current between the 2 valves of the carapace where food particles are filtered and collected in a tract that leads to the mouth. Filtered material is ground by mouth parts.

Daphnia go through a complex and unique life cycle in temporary waters. Early spring reproduction is by parthenogenesis, resulting in all female eggs. As water temperature and competition increase, males are produced. Sexual reproduction then produces encapsulated, drought resistant eggs that overwinter.

Copepod

p: CRUSTACEA c: COPEPODA



The Calanoida, an order of the Copepoda, have very long antennae which aid in swimming.

Copepods are an important component of the food base for predatory invertebrates and growing salamander larvae in vernal pools. Their bodies are clearly segmented and cylindrical. Most are silvery-gray in color and rarely grow larger than .2". There are 3 orders that comprise this class of microcrustaceans. All are similar in appearance but are varied in life-style. The Harpactacoida graze bottom detritus, the Calanoida filter plankton, and the Cyclopoida are predatory.

Just as the copepods have varied feeding strategies, they have multiple strategies for surviving the dry periods typical of vernal pool habitats. Adults may form cocoons or encyst themselves, entering a state of estivation during drought. Many species form a thick walled resting egg which is resistant to drying and freezing.

AMPHIBIOUS SNAILS

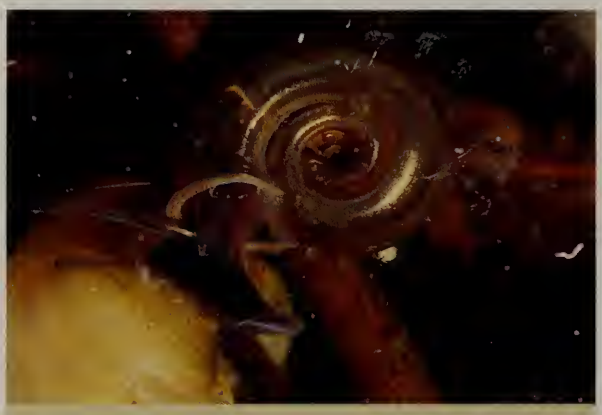
P: MOLLUSCA C: GASTROPODA

A spire snail showing the elongated spiral shell. If the tip of the spiral is held upward with the opening facing you, the Lymnaeidae (shown) have the opening on the right side, the Physidae have the opening on the left.

Several families of amphibious, air breathing snails are found in vernal pools. Snails have hard, calcified shells that help protect them from many predators and also help them survive dry periods in vernal pools. The three families of amphibious snails found in MA vernal pools can be separated from one another by the general shape of the shell. Two of the families, called "spire-shaped" snails, have elongated spiral shells (see caption). The third family, the Planorbidae, has a spiralling shell which is flat, or in one plane. The colors of amphibious snail shells are generally dull browns and light grays, but some species have muted stripes or other markings. The fleshy bodies of planorbid snails tend to have a red or pink cast due to hemoglobin, a respiratory pigment.

Amphibious (or pulmonate) snails breathe atmospheric air obtained at the surface. While some have developed gills that allow them to remain under water indefinitely, most rely on lungs, as did their terrestrial ancestors. Dry periods are dealt with in a variety of ways. Some species are strictly annual, living just one year. The eggs they produce in the spring hatch the following year. Many species spend the summer or winter burrowed into mud and detritus of the dry or frozen pool. One genus is able to form a hardened "epiphragm" that encases the body and helps protect them from drying and freezing. The juveniles of this genus leave the pond and estivate for 3-4 months buried in the detritus on the shore. They return with rising water levels.

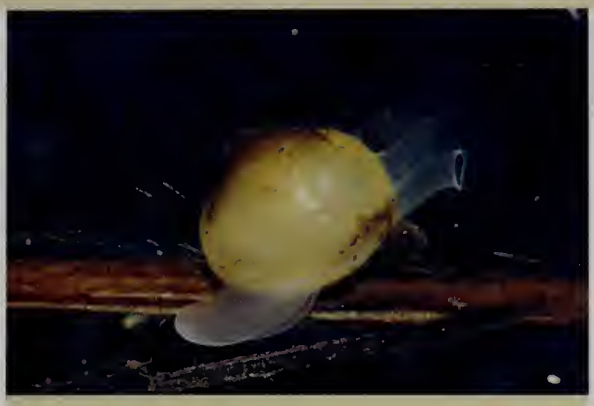
Snails can be observed moving slowly along the bottom litter of a pool where they feed on leaf litter, decaying vegetation and algae. Most feed by scraping with a tongue-like structure called the radula. It is a muscular organ with hard teeth used to scrape particles of food which are then ingested. Their feeding activity fills an important role in vernal pool ecology by breaking down large organic matter into increasingly smaller pieces. Snails are preyed upon by waterfowl, leeches, beetle larvae and other aquatic invertebrate predators, turtles, and sometimes by amphibians. They may be transported passively by ducks and wading birds that leave a pool with mud or vegetation containing snails or their eggs attached to their bodies.



Planorbid snails are spiralled but are flat when looked at from the side, without an elongated spire.

FINGERNAIL CLAM

P: MOLLUSCA C: BIVALVIA



Fingernail clams have a muscular ambulatory "foot" and a pair of tubular siphons.

Fingernail clams (<.5") are also known as pea or pill clams because of their very small size and uniform cream to light brown color. There is seldom any distinctive patterning on the shell, although some species may exhibit some darker colored bands following the arc of the shell. There are no annual rings or large ridges on the shell surface, but there are microscopic ridges (striae). Their shells are hardened like freshwater and marine clams and mussels, but in some species the shell is quite thin and sometimes brittle. Careful handling is required to avoid crushing them. They have a muscular foot used to dig and to move about the substrate of a pool and a pair of tubular siphons used in respiration and feeding. One family (Sphaeriidae) containing three genera and 21 species occurs in MA. Separating them is difficult and requires a microscope and specialized keys.

Fingernail clams are filter feeders that rely on detritus and leaf litter that has been broken down into very small pieces by other organisms. All fingernail clams are hermaphroditic, and young are brooded in the inner gill of the parent. Tiny free-living clams are expelled when development is completed.

Fingernail clams typically live for one or 2 years, though some may live as long as 3 years. Some species survive dry periods by burrowing into sediments or going into an estivation (resting) state prior to the pool drying. In some species, only the recently hatched juveniles survive the dry periods, while adults die. The species *Sphaerium occidentale* is amphibious and able to breath atmospheric oxygen. When fingernail clams die, their shell is left on the pool bottom. Finding their shells in a dry depression is an excellent indicator that a vernal pool exists.

Free living juvenile clams (left) are expelled from the parent's mantle after being brooded in the inner gill.

Searching a dry vernal pool will often turn up hundreds of clam and snail shells with very little effort.

Gordian (horsehair) worm

P: NEMATOMORPHA O: GORDIOIDA

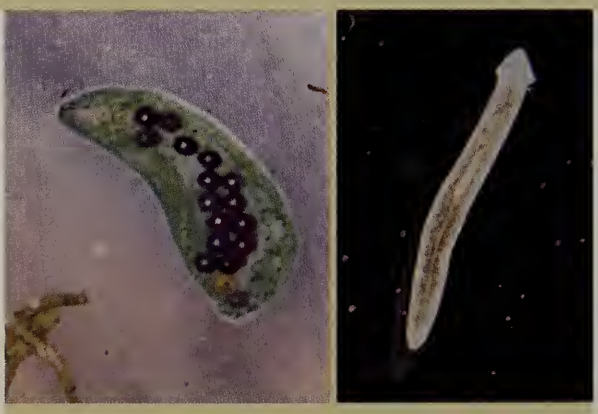
Gordian worms may reach up to 3 feet in length. They twist and coil into impossible-looking knots.

Gordian or horsehair worms were once thought to be the hairs of a horse's mane that had come to life by some act of magic. However, the truth about their life histories is more like the plot of a horror movie. Long (from 1-2" to over 3') and never more than about .2" in diameter, these worms are plain, unsegmented, and may be yellow, brown or black. They form impossible-looking tangles with other worms during mating, yet effortlessly seem to extract themselves from one another.

In temporary pools, eggs hatch into preparasitic larvae which become encysted on the leaves and detritus of the drying pool. They are thus able to survive dry periods. A terrestrial insect host becomes infected by the larvae as the cysts are eaten along with the vegetation or detritus they have come to rest on. The worm grows, ultimately filling the body cavity of its host. Though the mechanism is not known, when the worm is prepared to emerge, the host is brought to water where the worm bursts from the host's body cavity and metamorphoses into an aquatic adult. Horsehair worms die shortly after breeding, which may not occur for up to a year after becoming an adult.

Planaria

P: PLATYHELMINTHES C: TURBELLARIA



Encysted eggs are visible in the tiny, uncommon green planaria; the common grayish planaria can be found in many pools.

Planaria are small (.2-1.2"), unsegmented flat worms. The group is large and diverse (17 species are found in MA), and exhibits a wide variety of life history traits and habitat preferences. Several planaria are commonly found in vernal pools. However, when scooped up in a net or jar, they often roll into an indiscrete blob. Though you may not notice them immediately, looking at a jar of pool water and leaf litter after a day or so will typically reveal many planaria crawling about the sides of the jar.

They live for a year or less, but some are able to encyst themselves, extending their life cycles. This also allows some species to survive dry periods in vernal pools. The green planaria, *Dalyellia viridis*, has a symbiotic zoochlorellae that imparts its color.

Leech

P: ANNELIDA C: HIRUNDINAE

One species is a Massachusetts Species of Special Concern

Turtle leeches have a distinct balloon shaped body considerably wider at the hind end when at rest.

Finding a leech in your net, or worse, on your leg, can cause a great panic despite the fact that they rarely feed on the blood of warmblooded animals. Leeches are flattened dorsoventrally. Turtle leeches have distinctive balloon shaped bodies, while others you might find have a uniform width and gently taper to the head. There is a powerful suction pad on the posterior end used to anchor the animal, and some have another suction pad surrounding the mouth at the anterior end. Leeches are annelids, or segmented worms. They have 34 body segments, but each segment has from 3-16 "annuli" which give the appearance of a highly segmented body. They may be strikingly patterned, have brightly colored venters, or be unpatterned and dark.

Leeches are chiefly predatory, feeding on amphibian eggs and small invertebrates.

Leeches are generally scavengers, feeding on dead or dying animals that they encounter, but some are predatory. Most predatory leeches feed upon the larvae of aquatic invertebrates or on amphibian embryos developing in egg masses.

Some produce eggs, and others cocoons, that are drought resistent. This characteristic helps leeches persist despite the dry periods of vernal pools. Mature leeches may also tolerate drought by burrowing into the mud to avoid desiccation. There are more than 30 species in the northeast.

Aquatic oligochaete worms

P: ANNELIDA C: OLIGOCHAETA

Oligochaete worms may be transported overland by unwitting birds and other animals.

Aquatic worms can be found, sometimes in great numbers, among the detritus and mud in vernal pools. They are up to 1.5" long, very slender, and their bodies have many segments. Like earth worms, they feed on detritus and mud, helping to break down leaf litter and mix the soil. Oligochaetes survive in vernal pools by producing cocoons in the summer or autumn which may withstand short dry periods and are important in overland transport.

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About this Guide

Once thought to be just puddles in the forest, vernal pools are now recognized as rich but temporary ecosystems. This guide provides for the first time an introductory reference to the specialized creatures that depend upon vernal pools. Beautiful full-color photographs and descriptive text are combined to aid in the identification and study of amphibians, reptiles and many invertebrates.

In this guide you will find:

- Discussion about vernal pools and their importance to the ecology of New England
- Photographic guide to all of the adult salamanders, frogs, toads, turtles and snakes found in Massachusetts and much of New England
- Photographic guide to the egg masses of the New England mole salamanders and the wood frog
- Species accounts with full-color photographs, key diagnostic features and natural history notes for the amphibians, reptiles, and invertebrates which utilize vernal pools for portions of their life
- Lists of resources to help further your study of vernal pools and their organisms.

This guide is an important tool for environmental education and for individuals documenting vernal pools for certification in Massachusetts or for inventory programs in other states. For information about certification, including field documentation forms, contact the Massachusetts Natural Heritage & Endangered Species Program.