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Spring Break

The reemergence of reptiles and amphibians

Invaluable Vernal Pools

If you are fortunate enough to live in an area where you can hear spring peepers, then you probably know what I mean when I say that my heart is filled with joy each spring when their unique trill sounds for the first time after a long winter.

Where I live that time usually comes toward the end of March and is sometimes followed by a cold snap that silences the peepers. And even though I know they have experienced such temperature fluctuations for millennia, I am always worried that they will "make a bad decision" (in the vernacular of those of us with teenagers) and stay out too late. After all, it is the male peepers that cause all the racket in hopes of attracting females. So I always wonder if the biology of breeding will trump the biology of survival.

I suppose the good news is that spring peepers can survive being (mostly) frozen—a trick that should get more attention from kids who seem to be wowed by many kinds of special effects in the *non*-natural world.

An important thing about spring peepers is they need the right habitat to carry out their life cycle. Adult peepers survive roughly three years, during which they must have a place to call home, ensuring that their young can survive year-to-year and, in the long-term, that their much-anticipated evening chorus will forever sound out in spring.

What peepers—and many other creatures you will read about in this issue of *Sanctuary*—need are vernal pools, which are shallow ponds subject to large seasonal water fluctuations. During the winter and spring, they fill with snow, rain, and high groundwater; but, during most of the summer and fall, they typically—but not always—are dry. The key thing is that vernal pools are devoid of fish because of their impermanent nature. That means that the tadpoles, eggs, and larvae of all the species in the early stages of their life cycle are not in danger of being eaten by fish.

Vernal pools are found in woodlands, meadows, and floodplains all across Massachusetts. Some animals live in vernal pools year-round while some rely on vernal pools just for breeding. Frog tadpoles and salamander larvae develop in the pools before migrating to adjacent uplands to live out most of their adult lives.

These temporary pools are extremely vulnerable to development and are often overlooked when wetlands are identified on construction sites because in many months they're dry and resemble the surrounding land. Even if a vernal pool itself is saved from destruction, changes in the adjacent upland may disrupt the habitat and life cycles of the resident species. Removal of the surrounding forest during building of houses, driveways, and lawns, for example, may degrade a nearby vernal pool to such an extent that the amphibian population is eliminated.

The first warm rainy night in the spring (at least 45 degrees) triggers a mass movement of salamanders from the forested uplands to the vernal pools, where they will lay thousands of eggs before reversing their migration. There are many Mass Audubon programs in the spring that both explain and observe this phenomenon. I hope that you will consider joining us to marvel at these amazing creatures and that you will also take steps to help protect these harbingers of spring.

Laura Johnson, President

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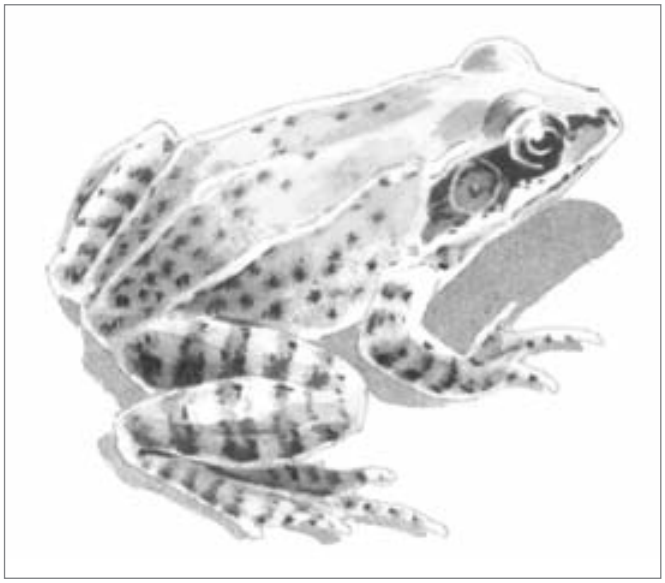
Twilight of the Frogs



Some years ago on Boston Common I met a man named Earl, whose "home," as he called it, was under one of the bridges of the Bowker Overpass, along the Charles River. Earl told me that one night in April, as he was headed home along the Fenway, he heard the sound of sleigh bells ringing in the empty sky.

Earl was not a man who was opposed to the occasional recreational use of controlled substances, and, as he admitted, he first thought he was hallucinating. This was, after all, April, and Santa Claus was busy elsewhere in the North. "I couldn't figure out what the hell it was," Earl said.

Having heard similar stories on other occasions, I told him that he was quite well grounded in reality, and what he had heard was the sound of spring peepers calling from one of the marshes along the Muddy River.

I heard a similar tale from a newly arrived urbanite in our semirural town about a flock of invisible ducks. Said ducks were residents of a shallow pond in back of my new neighbor's house. There were many of them, and they were calling loudly, but, when the neighbor snuck up on them, they fell silent. They also disappeared.

"No ducks anywhere" he explained. "Just quiet waters, as if they had all taken flight."

"Wood frogs," I told him.

Such stories and others like it are the stuff of the first warming days of spring. Wood frogs, the first frogs to call, begin singing (if you can call it that) as early as the beginning of March in some locations. One year I even heard them in February. Spring peepers will begin calling whenever the water of their breeding rises above 45 degrees; in fact, spring peepers have been recorded singing in every month of the year. I heard them once on an unusually warm day during the January thaw some years ago.

The spring voices of frogs, along with the hooting of great horned owls, and the spring songs of chickadees and titmice, are among the first sounds of spring. And in the case of frogs, the sounds must have been, in a sense, the first voices of the primordial earth.

For many, this first damp voice of life after the deathly silence of winter is a signature of hope, a sign of endurance and regeneration. Even though the songs sound out on the darkest rainiest nights of late winter, and even though there will be periods of cold, wet snow, and sleet and, in some years, even blizzards, frog song in spring offers hope.

Not everyone reads such a message in this first voice of the earth, however. The botanist Donald Culross Peattie, author of the once-popular daybook of nature *An Almanac for Moderns* (1935), read ominous warnings in the calling of spring peepers from the marshes of the Potomac, near his home. He foresaw in that ancient music the inhuman and irrepressible forces of reproduction, the benign indifference of the universe. It was his belief that long after human beings had "shattered and eaten and debauched" themselves by their folly, the cold-blooded voices of frogs would still ring out from the marshes of the world.

As we now know, he was right on one count. Human folly is threatening the very mechanics of the atmosphere, in the form of, among other devastating prospects, global climate change. But Peattie was wrong on another count. Frogs themselves are succumbing to a variety of ill-understood pressures that are causing their decline throughout the world.

Frogs evolved about 200 million years ago during the early Jurassic era. As Peattie writes, their voices must have been some of the first sounds heard on earth.

Frogs have endured massive continental shifts, worldwide droughts, long periods of volcanism, falling seas and rising seas, periods of global warming, and many seemingly endless ages of ice. But only now in the past four or five decades, to our knowledge, have their numbers suffered. The reasons for the decline are multiple: disease, pollution, a thinning of the ozone layer, habitat loss, and perhaps some other as-yet-undiscovered threat (see page 15).

Their spring call, as Peattie suggested, has a dark ring, a bell tolling for an empty planet. It appears that, unless some solution—or solutions in this case—can be found, the old biblical axiom that holds that the first shall be last will not be true.

JHM

Safe Passage

Early spring is salamander season.

by Michael J. Caduto

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Spotted salamander

What is it that moves some people to venture out on a cold, damp, spring night to watch slimy four-legged amphibians wriggle over roads and through woods to a shallow pool, there to intertwine in a dewy love dance? Why do some of us fall under the spell of the salamanders' vernal rite?

Perhaps we glimpse in these lithe creatures something of our own origins. Our distant past recalls an ancient teleost emerging from a primordial sea: no longer aquatic but not yet of the terrestrial realm. Salamanders reflect a shared phylogeny with human beings and in fact resemble a stage in the womb that we humans all pass through on our way to birth. Maybe we unconsciously sense a primal kinship with these fellow creatures, and just want to usher them along their plodding pathways to the relative safety of a living pool.

The vulnerability of these endearing soft-bodied sluggards is heightened by our knowledge that, in their drive to consummate rests the hope for a new generation. Few things are as poignant as the sight of a dead spotted salamander in the road. To find one such unfortunate creature is to see, embodied there, the death of a promise.

Whatever the reason, every spring people gather to help salamanders achieve safe passage.

Some years ago I participated in such a rite in Union Village, Vermont. Generally, the salamanders move during the first spring rain when the ground has thawed and the temperature is above freezing. When the first night of major migration arrived and the spotted salamanders began their outing, we gathered with rain gear and flashlights, and we put up sandwich-board signs to warn approaching motorists.

After several long cold hours of shepherding salamanders across the narrow rural road along which cars raced like Ferraris, we'd had so many close calls that gallows humor peppered our conversation. Nonetheless, attendance at this amphibians-versus-automobiles war zone became a popular annual event. The fervor of such dedicated souls seems boundless. In Massachusetts, there are even a bluegrass group and a lager named Salamander Crossing.

These endearing semiaquatic vertebrates are inaptly named for a Greek mythological fire lizard called Salamandra—a creature that, some believed, could walk through fire. Possibly, this association arose because travelers often came upon old campfires whose smoldering remains had been doused with water, only to roll aside the unburned logs to find salamanders beneath.

Most of these ostensible fire walkers, including the so-called mole salamanders, spend the winter hibernating under leaf litter, logs, and rocks. Some, such as the red-spotted newt, sluggishly loll about in the frigid world at the bottom of a pond.

When the late-winter sun arches higher, and temperatures begin to climb, the normally reclusive mole salamanders make a grand vernal entrance, including the Jefferson, spotted, and blue-spotted. (The marbled salamander, another member of this group, lays its eggs in autumn.)

As early as February and continuing through April—often before the ice has melted—Jefferson salamanders emerge from hibernation and are sometimes seen moving over snow and ice. They gather to reproduce amid thick mats of leaves at the bottom of vernal pools. These relatively streamlined, four- to seven-inch salamanders, with backs of grayish brown and patches of blue

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Red eft

on the sides and legs, are found mostly west of the Connecticut River.

Jefferson salamanders usually live year-round within no more than 800 feet of their breeding grounds: true vernal pools in undisturbed deciduous forests. After breeding, the females lay masses of roughly 30 eggs and attach them to underwater sticks and stems. Depending on the temperature and habitat conditions, eggs hatch in two to six weeks and the larval stage lasts 2 to 4 months.

In contrast to the Jefferson's discretion is the display of the spotted salamander—our salamandrine diva of spring. If Andy Warhol had been a naturalist, he might have had the spotted salamander in mind when he said that everyone will be famous for fifteen minutes. In the case of spotted salamanders, they get to have their fifteen minutes of fame every spring when their spectacular nocturnal mass migrations herald the demise of winter.

These salamanders live in moist environments throughout most of New England—quietly eating worms, insects, spiders, and snails as they creep under logs and leaf litter, along streambanks, and even through rodent tunnels. In March to mid-April—when the ground has thawed, the temperature has risen to about 45 degrees Fahrenheit, and we have our first evening of rain or high humidity—spotted salamanders appear en masse with their six- to eight-inch-long, shiny, bluish-black bodies and two striking rows of yellow-orange spots meandering down the back.

Spotted salamanders will travel up to a quarter-mile to breed in the same vernal pool each year. They often follow the same route and, in places, may even arrive at the pool in a similar order from one breeding season to the next. Some even return to the same burrow after breeding. This synchronized march to the breeding pools is even more impressive because spotted salamanders are mute—and devoid of a mating call, as are other species of salamanders. But their quiet routine breeds success: spotted salamanders have been known to live for up to twenty years.

Soon after they reach the breeding pool, males deposit sperm in capsules called spermatophores, which are then taken into the cloaca by the females. After the eggs are fertilized internally, within a week of reaching the breeding pool females lay 100 to 200 eggs in gelatinous masses about six inches below the surface. Eggs hatch in 30 to 60 days into quarter-inch larvae, which mature in about two to three months, growing faster in warmer water.

Many spotted salamanders reproduce in vernal pools, but they also gather in small ponds that do not harbor predators, such as fish and turtles. Vernal pools are the prime breeding grounds for roughly half of all salamanders found in Massachusetts.

At about the same time that spotted salamanders command the stage for the initial night of movement, the uncommon and reclusive blue-spotted salamander also puts in an appearance. They breed in shallow wetlands in and near rich deciduous woodlands, and also wet meadows and swamps in central and eastern Massachusetts. At 4 to 5 inches in length, this salamander is smaller than the other mole salamanders. If you're lucky, and vigilant, you might find them breeding in shallow wetlands where females lay loose clutches of about a half-dozen eggs in leaves along the bottom.

Although it's not one of the mole salamanders, at 5 to 7 inches long, the rare northern spring salamander is of a similar size. This richly hued salamander bears salmon-colored skin and darker markings that trail along the backs and sides in a pattern similar to that on the back of a brook trout. Seldom seen, even though their range includes all but southeastern Massachusetts, they are most abundant in northwestern Berkshire County. Spring salamanders require cold-water streams, springs, swamps, and lakeshores in mature hardwood forest of undeveloped areas, and have even been found in limestone caves. The females, which breed in autumn and early winter, begin to lay eggs in April, depositing a single layer under rocks and logs in seclud-

ed waters. Eggs hatch in late summer and autumn, and the young live as aquatic larvae for up to four to five years before becoming sexually mature.

The red-spotted newts have both an in-your-face character and eye-catching coloration. Newts emerge early because they remain active in the cold, especially if they live in a deep enough marsh or pond where the water doesn't freeze, or near a spring. Newts are found throughout New England and eastern North America.

Adult red-spotted newts are 3 to 4 inches long with green skin that is often tinged with yellow and brown. Both the adult newt, and the immature terrestrial stage, which is called a red eft, are covered with red spots. The efts' red spots are highlighted against bright orange-red skin that feels cool and dry to the touch. Colors tend to be brighter on efts that live in wetter habitats. Because of efts' feel, shape, and bright coloration, many people mistakenly think they are small lizards. The day-glo skin warns predators that they are extremely toxic to eat. Their skin contains ten times the dose of noxious secretions as that of the aquatic adult.

Because of efts' feel, shape, and bright coloration, many people mistakenly think they are small lizards. The day-glo skin warns predators that they are extremely toxic to eat.

Newts breed from April to June, then lay eggs singly on plant stems and leaves in shallow water. Each female may lay 300 or more eggs. After three to five weeks, the eggs hatch into gilled larvae that live in the water for 2 to 4 months, after which they lose their gills, grow lungs, and climb out onto the land as efts. During their roughly four- to five-year terrestrial lifetimes, efts hibernate during the winter under leaves, logs, and similar cover. Mature efts turn into the greenish adult newts, develop a finlike tail, and go back to the water to complete the life cycle.

If you wonder why many salamanders breed in pools without predators, then watch a local pond that is well populated with newts and in which amphibian eggs have been laid. I've seen newts ravage wood frog egg clusters, latching on and jerking their little bodies back-and-forth to tear off egg after egg. Newts can devour virtually an entire season's clutch of wood frog eggs as if it were their private stock of amphibious caviar, leaving behind eggless algae-coated masses of translucent jelly.

Newts eat just about anything that's small enough to catch and swallow, including caddisfly larvae, mayfly larvae, and spiders. They also eat their own skin after shedding it, and, like many salamanders, cannibalize their own larvae. Fortunately, they also consume lots of mosquito larvae.

Several other salamanders emerge each spring to reproduce in their own particular way. The common entirely terrestrial northern redback salamander, and its blackish gray lead-backed form, emerges from foot-deep hibernacula. Each female lays about eight eggs, hanging them in spaces under logs and in moist rock crevices. Redbacks are New England's most numerous terrestrial vertebrate. In one study, they were found to make up the largest biomass of any vertebrate animal in New Hampshire's northern forest.

The vernal pools and wetlands where many salamanders breed occur mostly in our diminishing, undisturbed places. Also, when compared with larger wetlands, vernal pools can go undetected and unprotected because they are only present for part of the year.

Water pollution also threatens salamanders, including toxins and hormonelike chemicals to which amphibians are particularly susceptible. Acid rain is a major problem for many species, especially in their breeding pools. Spotted salamanders are declining, in part because their developing eggs require water with a pH that ranges from 6 to 10—7 to 9 is ideal, in other words, neutral to slightly alkaline.

Despite the lack of current press coverage, acid rain is still falling, sometimes having a pH that reaches down to 4, which is forty times more acidic than normal. The acid water also leaches copper, aluminum, and other toxic elements into the water.

Of course, the quality of water in breeding pools is irrelevant if salamanders are run over on their way to their breeding pools. In addition to citizen groups that muster springtime road-crossing assistance to salamanders, some aficionados are thinking long term. Back in 1987, activists in Amherst moved beyond the bucket brigade and built tunnels under a popular salamander crossing along Henry Street. A study that was aided by a University of Massachusetts herpetologist revealed that 75 percent of the salamanders that found the tunnels made it safely to the other side.

Aiding the salamanders' yearly travel simply lets them exercise a 160-million-year-old right-of-way that predates automobiles, civilization, and even human existence. To satisfy the drive to procreate, these determined overlanders, the intrepid salamanders, will risk everything.

Michael J. Caduto is the author of 18 books, including Pond and Brook: A Guide to Nature in Freshwater Environments *and the* Keepers of the Earth® *series. He travels from his home in Vermont, presenting environmental programs and performances. His website is: www.p-e-a-c.e.net.*

The Pools of Spring

Those small ponds you see in the woods in March are critical to the survival of certain species of amphibians.

by Thomas Conuel

Vernal pool

For many years, the residents of Amherst, Massachusetts, as well as other towns throughout the state, organized "bucket brigades" to carry salamanders and frogs safely across roads during what was often called the "Big Night," a slightly confusing term for one of many early spring nights in New England, usually rainy, when the ground has thawed and salamanders and wood frogs begin their annual migration to vernal pools.

Vernal pools are shallow temporary ponds that appear in the woods and fields of New England in late winter and early spring. They are isolated, ephemeral links between the ice and snow of winter and the drying heat of summer and are veritable nurseries of life for many species of frogs and salamanders, as well as myriad forms of aquatic invertebrates that can endure the long drought between summer and the following spring. They are easily one of the most important ecological features in the New England landscape, and, while 5,000 have been certified by volunteers and local conservationists in Massachusetts, no one knows how many exist in the state and where they are all located.

In Amherst, the idea of helping the salamanders and frogs across the road spread to a program that included warning signs and construction of two underpasses to funnel the migrating amphibians toward their destination. Residents who formed the original bucket brigades knew when to expect the amphibian migrations, watching for a rainy night with the beginning of a thaw, with temperatures around 45 degrees Fahrenheit.

The so-called "Big Night" in early spring near a vernal pool actually involves thousands of amphibians moving on multiple nights, and often from a great distance, requiring more than a single night to reach their destination. After breeding, the salamanders and wood frogs return to the forest, at night in the rain, leaving behind egg masses that will hatch and bring new life to lands around the vernal pool.

Vernal means spring, and while many vernal pools fill with spring rains and snowmelt and then go dry for the

summer, others form with autumn rains and freeze over in winter. Most are small and shallow, though occasionally a pond of several acres will surprise us in the woods. The temporary pools are found all across New England, in deep woods, and also in meadows and floodplains—anywhere where a pond forms for more than two months in the spring with no permanent outlet. A vernal pool is not connected to a permanent body of water such as a lake or river, and is free of breeding populations of fish.

Life in a vernal pool begins with forest detritus. Dead leaves from the forest sink to the bottom of the pool where they decompose and are further shredded by caddisflies and isopod crustaceans. The plant debris hangs in the water and becomes food for fairy shrimp, tadpoles, and bottom-feeding insects, mollusks, worms, and crustaceans, which in turn are eaten by water beetles and salamander larvae. In March and April, the wood frogs, spring peepers, gray treefrogs, American toads, Fowler's toads, spotted salamanders, blue-spotted salamanders, Jefferson salamanders, and marbled salamanders live and breed in the pools before returning to the woods or fields, as do various turtles. By late March and early April, the pool is bejeweled with amphibian egg masses.

In late spring, dragonflies swoop above the pool, wood ducks paddle about, and a raccoon may come to drink. As summer approaches, the pool begins to dry out, and the frogs and salamanders have grown from eggs, larva, and tadpoles to young adults, and they crawl or hop off into the forest. Algae and duckweed spread over the surface, and then slowly the water vanishes, replaced by mud, worms, mollusks, and eggs that sink into the ooze.

The absence of fish is important to the life of the vernal pool. Because they have no inlets or outlets and change dramatically as they fill with water and then gradually dry up, vernal pools support a wide variety of amphibians. With no predatory fish in the pond, salamanders, frogs, and toads flourish. In season, these small ponds teem with life.

On a single night in a one-acre pool in Concord, observers counted several thousand wood frogs and spring peepers, and 500 spotted salamanders. Several state-listed species depend on vernal pools for survival, including the threatened marbled salamander and eastern spadefoot toad, as well as species of special concern, the blue-spotted salamander and Jefferson salamander.

There may be 100,000 vernal pools in Massachusetts, but then again there may be fewer—perhaps around 10,000. Nobody really knows, though recent mapping initiatives suggest a figure closer to the higher estimate. Because vernal pools are so important to frogs, salamanders, and fairy shrimp, the Massachusetts Natural Heritage and Endangered Species Program (NHESP) has undertaken an initiative to verify and then certify vernal ponds starting with a statewide aerial photo survey of potential sites. Vernal pools are everywhere, many on private property, some of which is posted with "No Trespassing" signs.

The guidelines for classifying and protecting vernal pools, revised in Massachusetts in March 2009, reduce the number of facultative species (those that breed in vernal pools and other locations) acceptable for certification to four amphibians (spring peeper, gray treefrog, American toad, and Fowler's toad)—and at least two must be proven breeders for the pool to qualify. The guidelines also eliminate the Dry Pool certification method, which allowed confined-basin depressions with no standing water that contained evidence of wetland invertebrates such as caddisfly larva cases, freshwater clam shells, or dragonfly and damselfly larva exuvia (i.e., shed skins). In addition, requirements for documenting the characteristics of a vernal pool were enhanced to require more comprehensive photographs of the pool and the egg masses of obligate (those that breed only in vernal pools) amphibians using the pool.

Some vernal pools are already protected under the Wetlands Protection Act, local bylaws, or federal regulations. Pools certified by the NHESP receive more protection under state regulations than those that are not certified. Citizens can gather the necessary documentation.

To certify a vernal pool and protect the habitat, you need to provide evidence that the pool exists and holds water and then becomes dry and is free of fish, as well as proof that the pool is used for breeding by obligate species, which depend on the pool for their existence, and/or by facultative species.

For more on vernal pool certification, visit: www.massaudubon.org/vernalpools and click on the Natural Heritage and Endangered Species Program link.

Thomas Conuel is a field editor for Sanctuary *magazine.*

The Ice Turtles

Spring is the season for turtle watching.

by Tom Tyning

For nearly a decade, I've been hoping to photograph one of the seemingly anomalous scenes of New England natural history—turtles basking on a shelf of ice. This typically occurs during a very short window in late winter and early spring when the thin frozen edges of lakes and ponds begin to thaw in the ever-increasing solar radiation. Near where I live, there is a road that divides a large lake from a small shallow pond. It is here that I see the ice turtles, but rarely do I have my camera in hand at the same time. Maybe this year will be different. But more likely I'll simply miss those precious few days when it occurs.

Based on the general information we profess to know about reptiles, this observational opportunity should not ever happen. Turtles are supposed to be reptiles, and everyone knows they can't stand the cold. Reptiles are sun-loving heat-absorbing ectotherms (commonly and incorrectly described as "cold-blooded) that become lethargic when temperatures drop and die when it falls below freezing. Yet, here are these turtles, climbing out onto the ice at the edge of springtime. It turns out that's just the beginning of a series of remarkable adaptations that make the shelled vertebrates of New England all the more fascinating.

The dozen native turtle species of the region have to deal with a lot of uncertainty in their universe. Some of these such as daily and seasonal temperature fluctuations, extended droughts, changes in predator populations, and many other aspects of their world have been solved through incredibly long evolutionary processes that make turtles one of the most successful groups of vertebrates ever to inhabit the planet. However, other changes, from toxic effluent and lake drawdowns to the vagaries of pet preferences and continued wetland alteration, occur too rapidly for turtles to adjust. The result is decreasing populations of virtually all species, here and around the world. It's amazing any turtles still survive today, but the contents of their evolutionary dowry certainly are still at work.

Take, for example, the relatively common encounter with tiny coin-sized turtles that may be found in a field or your newly turned garden in April and May. Most of these are snapping or painted turtles that just emerged from nests dug by their mothers the previous May or June.

Virtually all turtles' eggs hatch in the autumn, but in many cases the newly emerged hatchlings don't bother digging their way out. Instead, they remain below the surface and wait out the long and sometimes brutally cold winter. Housing codes require New England homeowners to put water pipes at least four feet below ground in order to avoid freezing. Yet, baby snapping turtles sit only three or four inches deep.

Research conducted in many parts of the country show that somehow, some individual turtles, in some populations, are able to survive freezing temperatures by avoiding ice-crystal formation in their tissues. Frozen plasma in cells expands to burst membranes, killing cells and their associated tissues. It is the basis for frostbite on exposed digits in ice climbers and the ragged appearance of opossum ears. We mammals are tender when it comes to cold. Take a peek at a turtle hatchling and imagine what it has just been through.

It seems likely that springtime emergence may have become a successful survival strategy for some species and some individuals. While virtually all our turtles hatch from mid-August to late September, they enter a world that has waning food stores and temperature, which severely limits their chances for growth. As any raccoon, weasel, bullfrog, or red-shouldered hawk knows, a baby turtle is just the right size morsel for an early autumn feast, and most hatchlings likely end up as food for these and plenty of others. However, by remaining in the nest until spring, hatchlings have more opportunities to feed and rapidly outgrow their predators one species at a time.

Not all New England turtles delay their emergence to spring. Though recorded in all of our species, it is an uncommon behavior in Blanding's, box, musk, and wood turtles, and in diamondback terrapins. However, virtually all of these are affected in a profound way while they are still embryos in the nest. Discovered initially by conservationists trying to stem the sickening and precipitous decline of sea turtle populations by incubating eggs in laboratory conditions: the sex of most turtles turns out to be determined by the temperature at which the embryos incubate and not by genetic determination as it is in humans and other mammals.

Still, two North American turtles break the rule—temperature sex determination is unknown in our state-listed wood turtle and the spiny softshell of Vermont. But, as far as is known, it is the rule in all other species. How the impending global climate change will impact future turtle populations is not clear, but the effects are unlikely to be positive.

Springtime is also the best time of year to get a glimpse of several native species that overwinter in water. Don Lewis, volunteer for Mass Audubon on Cape

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Wood turtle

Cod, has spent the last couple of decades scouring inner beaches and especially salt marshes for a turtle once thought to have been exterminated by New England colonists. The diamondback terrapin haunts tidal creeks and estuaries of eastern and southern coastal states. Tens of thousands of pounds of terrapins were taken annually to stock the finest eateries in Philadelphia, Boston, New York, London, and Paris.

It is almost unbelievable that terrapins didn't follow the fate of the great auk and heath hen. Miraculously, the few diamondbacks that survived to the twentieth century left offspring that have repopulated our region. From late winter to early spring, Lewis paddles his kayak or wades in on a slack tide to glimpse the subtle projections of terrapin beaks that break the surface and gulp atmospheric air for the first time in five months.

In April, Bob Prescott, director of Mass Audubon's Wellfleet Bay Wildlife Sanctuary, expects his resident box turtles to blink their eyes and back out from the pitch pine leaf litter that covered them through the end of winter. Ectotherms don't produce their own heat, but it is possible that the dome of pine needles and oak leaves holds a tiny bit of warmth from the soil. Yet, there's precious little of that this time of year, and box turtles respond to the columns of sun rays that zigzag through the tall pines and reach to the ground. Even a few minutes of sunlight on the carapace can lift a turtle's spirit, if not its body temperature. For a few tentative weeks, box turtles make short forays, sipping rainwater from curled oak leaves and refueling their digestive system by sampling slugs, earthworms, or even early wildflower blossoms.

Inland, turtle hunters walk the banks of small creeks and streams in hopes of discovering underwater a hand-sized animal with brilliant orange skin. Wood turtles have spent the winter beneath the debris captured by a winding meander, within root masses, or below submerged logs. Here, in deep water and provided with the cover of thousands of leaves, branches, and tree trunks, wood turtles wintered quietly, but with occasional forays to readjust their position. Now they are watching the sun rise higher in the sky and testing the air tempera-

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Eastern painted turtle

ture. When the air becomes warmer than the water, wood turtles are tempted to bask on the sunlit banks, often covered with six months of silt and sand that anchor to the richly sculpted shell plates—the hallmark of the species.

About the same time, an endearing picture of an animal and its habitat can be found. In the quiet wetlands throughout the state, March and April are perfect times to find our small spotted turtles. Basking next to a skunk cabbage blossom or simply sitting on the partially flooded haircap moss edges of a marsh, spotted turtles are small and easily overlooked, and it requires close attention to discover them. The only species more difficult to find is the endangered bog turtle, which is poorly named since it is found in alkaline fens as opposed to acid bogs. The four-inch adults barely poke out of their sedge- and fern-covered hummocks. All small turtles are especially vulnerable this time of year since they are slower than usual and become easy prey for many wetland predators, from mink and muskrats to raccoons and raptors.

Most of us become cognizant of springtime turtles when we first notice them basking on logs in our favorite wetlands. It can be a cold spring morning, but if the sun is strong look for turtles fully exposed, with head, neck, and limbs outstretched. Of course, they gain the benefit of thermal radiation and can quickly increase their internal body temperature in this fashion. But aerial basking has other benefits as well. Turtles are commonly host to a number of ectoparasites including such diverse organisms as leeches and algae. Exposing their shell and limbs to air effectively dries these parasites into oblivion. Another critical function of basking in air comes from the benefits derived from direct exposure to ultraviolet radiation. Through a series of chemical reactions, vitamin D is produced, and, among its several benefits, it makes the turtle shells strong and solid.

Basking sites may be especially important to turtles. In some wetlands, painted turtles can be stacked shell to shell, taking up every possible inch of tree trunks, boards, debris, emerging rocks, or other items that bring them in contact with unfiltered sunlight. There appears to be much competition for favored basking sites, and dominant individuals regularly outmaneuver others to gain the advantage.

On the other hand, it is not common to see snapping or musk turtles basking. It does occur, but much less frequently than with our other species. Instead of fully exposing themselves to air, they undergo a fascinating variation on the theme, known as aquatic basking, typically performed in shallow water. It is also possible to glimpse these turtles, nostrils breaking the surface, far from shore, floating at the very top of the pond. Whether or not these turtles need to bask as much as others is unknown, but, as anyone who has taken time to look at these animals closely knows, they regularly host large populations of leeches and algae. Some adult musk turtles positively look furry, with filamentous algae trailing behind their carapace. One wonders whether or not this provides better camouflage for a turtle that already looks like a stone. Presumably, when the parasite loads become massive, even these two species will crawl out and bask for hours at a time.

The change of seasons is a make-or-break time for turtles of all species and ages. Getting a head start on thermoregulation offers more opportunities to feed, grow, and reproduce. How individuals fare these few weeks of spring can spell success or failure for local populations. But it is clear that the turtles we do see these spring days have survived another, or maybe their first, New England winter.

And I for one will be looking for those that haul themselves onto the waning ice shelves at my local pond.

Tom Tyning is a professor of environmental science at Berkshire Community College and author of A Guide to Amphibians and Reptiles *in the Stokes Nature Guides series.*

The State of the Snake

Resulting from various threats to snakes' well-being, many species in Massachusetts are in decline.

by Karl Meyer

A black racer saved me once. Not to overglamorize the situation—the snake was dead. Still, it came between me and the fast-closing mongrel bent on ripping me from my bicycle on a lovely spring day. It was inches from my calf when it suddenly yelped, screeched to a halt, and circled back timidly—the fur raised on its neck. I too had noted the large snake looped along the pavement. But I knew something the canine didn't—I'd examined the beautiful gray-black scales of that mostly intact black racer corpse the previous afternoon.

Where snakes are concerned, I'm a lot like that dog. Our shared mammalian fear of snakes, *ophidiophobia*, appears to be a hardwired survival trait harkening back to an age when reptiles were far more prominent. "Fables about snakes far outmatch reality," herpetologist Tom Tyning will tell you. None of Massachusetts' fourteen species provoke much fear in Tyning. He has studied snakes for four decades and today is one of the Bay State's staunchest advocates for preserving populations and critical habitats for increasingly rare species. "Since Europeans arrived in North America, the general response to snakes can be summed up with one word: 'persecution.' "

DRAWING © LARS JONSSON

Tyning authored *A Guide to Amphibians and Reptiles*, his UMass graduate work included radiotelemetry tracking of timber rattlesnakes, and for the past decade he has been a professor of environmental science at Berkshire Community College. He also spent twenty-four years as a touted trip leader and master naturalist with Mass Audubon. Our inordinate snake fear is evident in the near extirpation of the state's two venomous species, copperheads and timber rattlesnakes, but all species suffer persecution, and "in encounters when snake identity comes into question the snakes always loose," says Tyning.

Common patterned species like northern water snakes and milk snakes are often misidentified and killed—yet the chances of someone happening across a venomous snake, even in their few remaining habitats, are minuscule. "There have only been two documented snake-bite deaths in Massachusetts in over two hundred years," Tyning notes. Curiously, venomous species are not even the rarest snakes in the Commonwealth.

Five native snakes are today protected by penalties of hefty fines and/or imprisonment—it's illegal to "harass, kill, collect, or possess" them. "Geographically challenged" is how Tom Tyning describes the state-threatened worm snake's predicament. At just 7 to 11 inches, these sandy-soil burrowers both prey on, and resemble, earthworms. The worm snake is a more southern and western species, whose biological footprint brushes just north into the metro-Springfield area.

As habitat and size go, black rat snakes are at the other end of the spectrum. With a few specimens measuring over six feet, they are the state's longest snake. Endangered rat snakes are noteworthy for their climbing ability. They even lay eggs in the rotting cores of trees. Black rat snakes are found in pockets of habitat in central Massachusetts and the Connecticut Valley. But most of us, even if we stare up into the sun-dappled May woods for the rest of our days, will never see one.

Researcher Peter Mirick is widely known for his nearly thirty years as editor of *Massachusetts Wildlife*, the Commonwealth's quarterly on natural history, conservation, hunting, and fishing from the Mass Division of Fisheries and Wildlife. But few know that his biology studies in graduate school focused on reptiles and amphibians. Today, Mirick's fieldwork continues—including an ongoing study of a population of endangered rat snakes in Sturbridge that began in 1997.

"In spring they are very arboreal, looking for birds and squirrels," he says. "They'll stick to a pine tree like Velcro. They have a whole different set of muscles. They're shaped like a loaf of bread in cross-section." Peter Mirick devoted nearly an entire issue of *Massachusetts Wildlife* to a guide describing the Commonwealth's snake species in 2009. Thanks to radio-tracking, he once witnessed the combat "dance" between two male rat snakes. "They intertwined

from end to end. They don't bite each other; they wrestle. The point seemed to be holding your opponent's head down." Once the loser skulked off, the winner went into a hollow log.

Peter Mirick says that common snakes like garter, ring-necked, and northern water snakes seem to be doing well, but populations of state-listed species, including the eastern hognose snake—which receives only minimum protection—all face challenges. He notes that decades of public and private land protection work has resulted in great strides to protect habitats, but this is a time when the Natural Heritage and Endangered Species Program (NHESP) and the state's ability to protect rare species have come under attack.

The attacks include both a private lawsuit and a legislative challenge to the state's powers. House Bill 4167, the Coakley-Rivera Bill, was backed by an unusually large and somewhat unlikely group of western Massachusetts state representatives. The bill is largely viewed as spearheaded by complaints about development rights raised by Springfield WWLP TV Channel 22 Vice President and General Manager William Pepin. Pepin objects to restrictions or changes that might be required through the Natural Heritage and Endangered Species Program considerations as he seeks to build a luxury retirement home—plus a second house on a smaller parcel, on 36 acres of land purchased with his wife in April 2009 in Hampden, Massachusetts. Parts of the tract turned out to be habitat of the increasingly rare eastern box turtle. Pepin is currently challenging NHESP powers in court.

Many business and development interests—and legislators in the Channel 22 viewing region—are rooting for the heavy-handed challenge to the state's species protections in Coakley-Rivera. But those worried about the viability of rare populations see the bill as a knee-jerk statutory response to problems that could be addressed via minor procedural changes.

If passed as written, House Bill 4167 would strip the state's NHESP of significant review powers—including long-held and rarely used fail-safe tools that are critical to ensuring that the Commonwealth's biological heritage will be protected for future generations. Peter Mirick describes today's species protection work in the face of developer demands as doing wildlife triage. "There's only so much habitat to go around—with them wanting everything."

Last September, Dave Small, the state's assistant regional director of the Ware River Watershed at Quabbin Reservoir, received a call and then an email about snakes. He was out the door in a heartbeat. The reason for the departure: baby eastern hognose snakes! Small zipped over to a sandy site in the Quabbin area where friends hovered over marvelously patterned hognoses, each barely six inches long. The snakes moved cryptically in grass and sand, just off the pavement's edge. The onlookers counted four in all, but one was dead—likely crushed by a pedestrian or passing cyclist.

Dave Small is president of the Athol Bird and Nature Club (since 1988) and also acting executive director of the Millers River Environmental Center. The observers stood vigil until the snakes retreated to sandy burrows with the day's setting sun, but worried that more would be lost if the baby snakes were using the pavement for warmth. The next morning, October 1, 2009, Small and a friend were back. Gingerly walking the pavement edge, they spotted three tiny hognoses; then another two—five in all. The snakes circled outward and returned: and five snakes had morphed into seven. What happened next is described in Small's blog.

"Almost immediately movement caught our attention as another snake appeared from below ground, then another and another. Fourteen in all!"

The tiny adult-look-alikes burrowed straight up through sand, moving "in fits and starts out into the undergrowth, shedding their skins along the way." Bulky-bodied hognose snakes rely on their fabulous coloration—ranging from mustard to gray, to black and brown, for protection. These snakes are harmless to humans and specialize in consuming toads in their sandy habitats. But if they're surprised or challenged, they will inflate an almost cobralike hood and hiss, feigning strikes to fool predators. If that doesn't work, they may simply roll over and play dead in a singularly unappetizing display.

Though the eastern hognose snake is mentioned along with our rare species in NHESP documents, "It's a snake that is, at the moment, totally unprotected," says Tom Tyning. He notes that UMass researchers are currently satellite tracking six hognose snakes. "They tend to be big fat snakes that people notice, and kill. They are truly uncommon." Peter Mirick says that he wouldn't be surprised if the hognose was proposed for listing as a species of special concern. "It is probably at that level," he says.

And Dave Small, who has been fascinated for decades by birds, butterflies, and all manner of reptiles and amphibians since he was growing up in Athol, agrees about the hognose. "Overall, there just aren't as many snakes around as there used to be," he says.

Tom Tyning's work on snakes is providing new information on timber rattlers, copperheads, and rat snakes—some of it through genetics. In some rugged habitats where populations still exist, he's finding distributions and combinations of cohabiting snakes that begin to look a little like the Galápagos Archipelago. "We don't know why they all coexist in some places together, but we get these oddball distribution maps that don't quite fit what we would have guessed." Without further habitat protection, it's unknown how increasingly small, genetically isolated populations can do. "Work in Sweden has shown that these populations can go fine for a while, and then crash," he says. "Last year's cool wet summer here resulted in lots of reports of dead females or partially developed young."

© LARS JONSSON

Timber rattler

Tyning will continue mapping genes on species that can live 20 to 30 years, but only breed every two years. Swedish biologists are making progress introducing new gene-mixing techniques in their rare populations of snakes. But Tyning also notes a troubling development in some rare species here: anecdotal reports of a disease similar to the white-nose syndrome that has decimated the Northeast's hibernating bat populations. "Some claim they are seeing a health issue with some species—a fungus or bacterium."

The worry again is that human visits and disturbance in these isolated habitats and hibernacula are possible vectors in distributing a catastrophic pathogen. Global warming could also prove to be part of the scenario. "If these diseases are a real factor," says Tyning, "we need to try and get a handle on this and inoculate or isolate populations."

One bedrock necessity is simple enough: habitat. Snakes need a livable environment where they can go about life cycles unmolested by ever-widening human consumptive patterns. Smaller less mobile populations like worm snakes may require just a few protected acres to remain viable. But, for sunning, hunting, breeding, and hibernating, the sometimes-intermixed populations of copperheads, timber rattlers, and rat snakes may require relatively untrammeled tracts of hundreds—or even thousands—of acres to continue into the future. That means an absence of ridgetop houses, ATVs, mountain bikes, and poorly chosen windmill sites with attendant road networks.

It may mean leaving the dog at home.

But what ultimately is most needed, perhaps, is a simple acknowledgement that snakes have a right to exist as a life-form that has co-evolved with humans across millions of years on earth.

"We fail to ask the right questions," Tyning insists. "Snakes have their own intrinsic value. These are creatures that live without arms and legs; they hunt animals and navigate in complete darkness. They are nothing short of miraculous. We are lucky to be alive with them at this time."

Karl Meyer lives in Greenfield and is the winner of a 2008 Teacher's Choice Award for his book Wild Animals of North America. *He can be contacted at: karlmeyerwriting.com.*

Spring Song

Counting frog calls

by Sandra Cofran

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American toad

It is a moonlit night in early April. There is still ice on the edges of ponds and steams, but for me, spring is arriving—not on the wings of the returning migrating birds with their burgeoning dawn chorus of mating songs, but with the bell-like night song of the spring peeper and the quacking bark of the wood frog.

For more than six years, I have been part of a citizen science project monitoring the numbers of New England frogs by listening for their mating songs. I joined this project because of a childhood fear of frogs and toads. But, as I've learned more, I've come to respect and even love these unassuming little living indicators of the planet's health. I understand their importance in the web of life and value them for the lessons they have to tell us.

Armed with a checklist of protocols, a thermometer, compass, clipboard, flashlight, and camera, the frog monitoring teams fan out at sites to specific points on a map and then become all ears to the music of the night.

And amazing music it is.

The strongest and fullest choruses with the most variety come in April and May. The season begins with the wood frog, a midsize beauty with a delicate black mask. These frogs are usually found in the forest, but spring brings them to the waterside for mating and egg laying. Theirs is an unusual song—a cross between a bark and a quack—and it is loud and in full chorus unmistakable.

The tiny heralds of spring known as peepers, which never gain more than an inch or so in size, in good number can also produce an enormous volume of music. Sitting in the midst of a large chorus can be almost overwhelming—at times as if the sound around you is enveloping you and you are becoming a part of all that wild singing. It is an experience not to be missed.

These two species are followed later in the season by calls of the American toad, which has the only true "song"—a long, connected, whistling melody that, in my estimation, makes him a Caruso compared with other frogs whose growls and croaks are second-rate. He is also rather noble in his presentation. I have held toads in the spotlight of my flashlight and watched them, unfazed, rear up on their front legs, stretch their mighty throats toward the moon, and sing out loud and clear, almost as if they enjoyed the audience.

On the roadside one evening, I had the privilege of watching a little gray treefrog belt out his trilling spring song. He'd shimmied up a reed and, clutching it with his hind and fore feet, was using the height to "throw" his sound. Tossing his head back, he inflated the air sac under his throat and added his song to the general cacophony of the night. He had the aspect of a crooner, clutching a microphone, serenading his swooning fans.

Pickerel and leopard frogs have vocalizations that sound like a grating *grr*ing noise. The calls (in this case you wouldn't want to call them songs) remind me of Edward G. Robinson's signature growl voiced in the mobster movies of the 1940s. Because of this, I always picture the "leps" and "pics" in pin-striped suits with little cigars clutched in their froggy lips. I can't help but think of them as the "bad boys" of the frog pond. Yet their anuran beauty, the lovely lemony-colored underside of the pickerel and the mosaic-like spotted pattern of the leopards, make them a joy to see as well as hear.

The classic frog songs that everyone recognizes come from the late-season breeders: the gulping, twanging sound of the green frog and the rolling *jug-o-rum* of the bullfrog. These two species are the heralds of the end of the anuran mating season.

And although you can still hear peepers and gray treefrogs fairly late into the summer, the majority of mating is over by July, and by September the ponds and marshes fall silent.

Sandra Cofran works at Mass Audubon headquarters and surveys frog song at Great Meadows National Wildlife Refuge in Concord.

The Fate of All Frogs

Two million years of evolutionary adaptions may not be enough.

by Gayle Goddard-Taylor

Anyone who lives or walks near a vernal pool in the spring is familiar with the sound of the wood frog, a widespread creature that is reliant on these ephemeral water bodies, which dry relatively rapidly, preventing the presence of predators such as fish. Heard as far north as the Arctic Circle, the wood frog's spring chorus sounds to the novice ear more like quacking ducks than croaking frogs.

Quick to develop, the tadpoles turned wood frogs soon leave their shrinking pool for the trees, blending well with the forest floor and tree bark. So adapted are they to cold that wood frogs can survive being completely frozen, exhibiting no breathing or heartbeat during this state thanks to the high glycogen level in their cells that acts as a sort of antifreeze. When they "defrost," they do so from the inside outward, thus reactivating critical life-support functions first.

Frogs (Order Anura in the Class Amphibia) are legion, with almost 5,000 species worldwide. But at the first Amphibian Mini Summit held at the Zoological Society of London last August, leading scientists noted that at least one in three amphibian species are facing extinction—a breathtaking statistic given that the earliest amphibians emerged 350 years ago. These first amphibians developed some pretty extraordinary adjustments to survive by crossing land when bodies of water they inhabited dried up.

Their singular adaptations make it even more distressing that animals with so ancient a pedigree are declining, victims of pollution, habitat loss, increased UV light from a thinning ozone layer, and a disease known as chytridiomycosis, caused by the chytrid fungus *(Batrachochytrium dendrobatidis)*.

Frogs in particular have evolved some unique responses to environmental challenges. Some species brood their young in their mouths or in hip pockets similar to marsupial pouches; others raise them in a frothy stew in an underground chamber. Some frogs have developed toxins and advertise the fact with bright colors. Others exude repellent secretions that deter mosquitoes and even kill the HIV virus.

Professor Alan Richmond, a herpetologist at the University of Massachusetts at Amherst, has increasingly focused on this worldwide frog decline in his classes, hoping to inspire a new generation of activist biologists. His enthusiasm for anurans bubbles over when he describes the extraordinary transformation each frog undergoes, from tadpole to adult.

"Think of a tadpole as a swimming head with special mouthparts for scraping algae off leaves and sticks, gills for breathing, and a great long gut for processing the algae," he says. "The eyes are adapted for seeing the movement of currents underwater, and they have special receptors for detecting electrical currents in the water."

At a certain point, though, they begin to change. They resorb their tails, develop legs, and replace their gills with lungs. Their guts shrink and their jaws enlarge

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Spring peeper

© MARK I. BROWN

Young bullfrog

because now they eat insects. They grow huge ears to detect predators. The entire suite of selective pressures they faced as tadpoles shifts to a whole new set of environmental pressures as adult frogs, and these changes help them cope.

"You have to just sit down and stare out the window and think about what an amazing and unfathomable transformation this is," Richmond says. "And it happens every spring."

Certainly, it occurs this way for New England's frogs, which include some eleven species of toads and true frogs, which fortunately seem to be holding their own in the face of all the threats that are claiming their brethren elsewhere—all of them except perhaps the eastern spadefoot, which is listed as threatened in Massachusetts.

A curious creature that lives in a burrow underground, the spadefoot may not leave its haven for weeks at a time and only comes out on damp nights to eat slugs and various insects. Adapted to live in deserts, it waits for an extended period of rain to emerge and then breeds in large congregations—in New England, that happens anytime from April to August.

"The spadefoot tadpole reaches maturity faster than any other frog, usually in four to six weeks," says Peter Mirick, a biologist with MassWildlife. "If the pool dries up faster, they metamorphose into smaller sizes and get out faster."

Among the most recognizable of New England's frogs—and the most common—is the American toad, the lumpy brown creature that many a parent has warned will give warts to anyone who picks it up. That, of course, is a myth—but knowing that it secretes a bufotoxin from its parotoid glands that wards off predators and irritates human skin doesn't make the toad any more palatable.

Unlike most frogs, the American toad is highly terrestrial, its tough skin being an adaptation to hold in moisture when it's away from the water. Because its tadpoles are highly toxic, just as the toad itself is, it doesn't require the safety of a vernal pool for its eggs to develop. The Fowler's toad has a similar survival adaptation—special glands behind its eyes produce a poisonous fluid resembling milkweed sap.

All toads have yet another survival strategy: when picked up, the males utter a loud chirp, perhaps meant to startle a predator, but Mirick says that it serves another purpose as well. "During breeding season, things get pretty chaotic in the pool," he says. "Sometimes, in their frenzy, a male will grab another male, and that male will make this 'release' call that announces in so many words: 'Hey, I'm not a female!'"

Another of the more familiar frogs is the American bullfrog, whose loud croaking can be heard over long distances. The bullfrog is certainly the largest frog, with some topping out at a pound in weight and a foot in

length. It gets that big because it isn't discriminating about what it eats, and in some parts of the world it has become an invasive species.

"Pound for pound, the bullfrog is the most voracious predator in North America," says Mirick. "It will eat anything that fits in its mouth, as long as it's alive, and that includes other frogs, snakes, and birds."

New England's most colorful frog is the leopard frog, largely a river dweller, with striking leopard-like spots on an almost-neon-green background. Extremely observant, the leopard frog is difficult for scientists to monitor simply because it is so hard to catch. Those who have tried have been led on a zigzag chase that usually ends in failure.

The pickerel frog, which sports brown spots on a lighter brown background, is thought to be a more abundant species than the leopard frog. The yellow color beneath its legs announces that it is toxic. All of these frogs are considered aquatic since they spend most of their time in or near permanent water bodies.

The chameleon-like gray treefrog actually ranges in color from gray to green depending on the substrate and is a mere two inches at maturity. True to its name, it is arboreal, with the large adhesive pads under its toes helping it to climb.

Also terrestrial, the spring peeper is another frog recognizable by its loud persistent calling. It's hard to fathom how such a small creature a mere one inch long can make such a large noise. It does so with a vocal sac that expands and contracts like a balloon, and the volume rises considerably when hundreds join in.

All these frogs require water to successfully reproduce. Reproduction occurs outside of the body, with the female depositing eggs in water and the male discharging sperm to fertilize them. Floating in masses or strings along the water's surface, these eggs increasingly have become victims of damage resulting from excessive exposure to UV light. This is caused by thinning of the ozone layer, which means that greater amounts of UV light reach the earth's surface, according to UMass' Richmond. Studies in which some frogs' eggs have been covered and others have been left uncovered show that exposed eggs have a far greater failure rate than those that are shielded.

Further, microscopic parasites hosted by snails are claiming frogs in greater numbers by attacking them during development and causing deformities that include too few or too many limbs. And pollutants are also affecting metamorphosis. "There's a whole huge suite of endocrine disrupters," says Richmond, "one of which is perchlorate, a compound used in fertilizer and rocket fuel, and it prevents tadpoles from metamorphosing into frogs."

But, by far, the biggest threat to frogs has been the spread of the chytrid fungus. One theory is that the outbreak originated with the African clawed frog, which coevolved to develop an immunity. This species has been shipped around the world as part of the pet trade, as well as for use in pregnancy tests. As happens, the frogs have been either intentionally or unintentionally released into the wild, bringing with them the fungus to populations of frogs with no immunity. Some of our frogs seem to be resistant to it," says Mirick. "The coastal plain frogs appear to have an immunity, but those up in the mountains or further inland don't."

Many of the Central American frogs, however, aren't immune and have been going extinct at a breathtaking rate as the fungus marches—about 50 miles a year—toward South America. Scientists in Central America, lacking weapons to fight the fungus in the wild, have been snatching up some species and placing them in refugia, waiting for answers. Now infections have been documented throughout the Americas, in Europe, and most recently in Southeast Asia.

A number of amphibian and frog protection efforts have been launched worldwide. In an effort to document the status of frogs, the North American Amphibian Monitoring Program has been training volunteers to conduct frog censuses by identifying the different frog vocalizations in their regions. "The trick," says Richmond, "is to put this data to use by defending frogs in a political way. But political will takes time, something many frogs don't have much of these days."

Recognizing that, Save the Frogs, an international nonprofit organization founded by Virginia-based Kerry Kriger, PhD, is taking a multipronged approach to living up to its name. Kriger lectures on the frog decline throughout the country and recently conducted a workshop for Panamanian scientists to help them detect the fungus. The organization also provides grant funding for researchers to work on frog issues, and he and his volunteers are lobbying for laws that require disease testing on imported frogs. They are also pushing for removal of non-native stocked trout at Sequoia and Kings Canyon National Park in California, where once-abundant yellow-legged frogs are threatened with extinction because the fish are consuming the tadpoles.

Outside the scientific community, the amphibian extinction crisis is all but invisible. Save the Frogs (www.savethefrogs.com) is trying to rectify that through lectures, information booths, and its annual Save the Frogs Day, this year scheduled for April 30.

For biologist Peter Mirick, the problem is symbolized by the disappearance of an Australian gastric-brooding frog, which turned off its digestive juices in order to raise its young in the safety of its own mouth. The frog, which may have provided a cure for ulcers, went extinct a mere three years after it was first discovered. It begs the question, how many frogs have gone undiscovered before slipping into oblivion, along with potential cures for untold diseases. And something less tangible—"Frogs are a part of our culture," says Mirick.

Gayle Goddard-Taylor is a field editor for Sanctuary *magazine.*

The Political Landscape

One Percent for Nature

by Jennifer Ryan

It's no secret that at all levels of government, and across the country, budget makers are staring down into black-bottomed coffers. The recession may technically be over, but as one-time props are pulled out, budget realities are front and center.

Massachusetts is no different. Funding for homeless shelters, veterans' homes, education, and public safety have all been cut. It's a regular sight to see public health and homeless advocates and others in front of the State House or clustered around the Governor's office saying, "Don't you know what these cuts mean?" And for the state environmental programs, it's a double-whammy—a perfect storm—right on the heels of the big budget cuts of a few years ago.

This is a story of numbers and competing interests.

The state budget: It's roughly $27 billion per year; 51 percent goes to health and human services; 21 percent to education; 11 percent to "independents" such as the state auditor, sheriffs, and board of library commissioners; and 8 percent to administration and finance. The remaining 9 percent makes up the rest, including 0.7 percent for environmental programs.

About 40 percent of the state budget goes to entitlement programs, meaning the state is obligated to pay. If cuts are needed, they come from the remaining 60 percent. Since 2001, state spending for health care has increased 61 percent, employee benefits 30 percent, and debt service 8 percent; education and local aid dropped 3 percent, human services were down 8 percent, higher education was down 37 percent, economic development down 38 percent, and noneducation local aid down 39 percent (Massachusetts Taxpayers Foundation).

Income and capital-gains tax revenue has shrunk—in fiscal-year 2008, the state brought in $20.9 billion, and in 2010, $18.9 billion (Massachusetts Taxpayers Foundation). The two-billion-dollar drop is coupled with declines in other agency funding sources such as permit fees. Declines go along with rising fixed costs; health care costs, in particular Medicaid payments (about 30 percent of the state budget), along with employee benefits, continue to increase. Pension obligations are looming on the horizon, ramping up around 2012. For the coming year, one-time sources like stimulus funds may not be there. The increased sales tax is projected to raise about $130 million annually. But, with a projected budget gap of two billion next year, $130 million only goes so far (Massachusetts Budget and Policy Center).

What does all this mean for our modest corner in the state budget? Over the past ten years, annual environmental spending dropped $58 million, from $245 million out of a $22 billion total annual budget in 2001 to $187 million in 2010—or a drop from 1.1 percent of total spending to 0.7 percent. So, for managing and protecting the 695,000 acres owned by the Commonwealth; for supporting the 3,000 total full-time staff across the Department of Environmental Protection (DEP), Department of Conservation and Recreation, Department of Fish and Game, and Department of Agricultural Resources, the state dedicates 0.7 percent of its resources.

Additional deep cuts are on the horizon. We have one of the largest state park systems in the country. The Department of Environmental Protection brings in about two-thirds of its budget in permit revenues, which are swept into the state's general fund and are not kept by the DEP. The Department of Fish and Game is largely funded by hunting and fishing licenses and federal sources, yet its small programs that need state funds are either cut, as with Riverways, or the state operating budget is eliminated, as with the Natural Heritage and Endangered Species Program.

In 2003, the last time The Environmental Council of the States crunched the numbers, Massachusetts ranked 49 out of 50 in the percentage of the state budget spent on environmental programs. Percentage points count here—they found that 1.4 percent across states was low; 1.9 percent in 1991 was the peak. We reached 0.86 percent in 2009, but are on a precipitous slide back down. Yes, we are a progressive state in terms of climate change legislation, rare species legislation, and on other fronts—but we are undoing good legislation by starving programs. A 1988 Senate Ways and Means report on the environmental budget found that without increasing funding for environmental programs, we could not meet the constitutional requirement of Article 97 that "the people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment." That was twenty-three years ago.

The programs that conduct biological research and inventories; restore and manage critical habitats; manage forests and parks; and implement environmental laws that protect public health and the environment are continually cut deeper and deeper. And they are a tiny portion of the state budget. Environmental programs are being left behind by Beacon Hill.

As a Commonwealth, our goal should be to restore environmental spending to at least 1 percent of the state budget. Core environmental programs support vital ecosystem services, and, as we cut beyond bare bone, we must recognize that these cuts will ultimately cost the state more in terms of increased pollution, degraded habitats, deferred maintenance, etc., and, ultimately, the damage can never be undone. Further cuts, which are certain to come, will cause irreversible harm to the environment, economy, and public health.

Jennifer Ryan is Mass Audubon's legislative director.

Families Afield

A Handsome Toad

by Ann Prince

Fowler's toad

It seems incongruous to me that toads are customarily considered ugly, when in truth they are unmistakably magnetic, invariably evoking such fascination. According to an old New England proverb: "If the spring's first hoptoad comes jumping your way, it will bring you many friends." Yet, I prefer to say that a handsome toad in your garden will bring you good fortune in any number of ways. Who needs a prince when you have a toad that loves to eat the grubs, mosquitoes, slugs, caterpillars, and ants in your yard?

Nothing can dampen my family's delight whenever we see a toad in the yard. It's easy to be riveted by a toad's winsome wide eyes and the ridiculous distances it can hop considering its size. The children's excitement can't be contained—whether it's a chunky rough-skinned adult camouflaged in the damp leaf litter or a tiny thumbnail-sized toadlet only recently transformed from a tadpole.

So we welcome toads to our outdoor living space not only for the enjoyment of observation but for their all-natural pest control. It makes good sense to provide our amphibian friends with a safe haven.

There are two commonly seen species of toad that live in the Northeast. One of these, the American toad, is quite abundant and widespread. The other, the Fowler's toad, is more adapted to sandy habitats, which would include our coastal location. Backyard birds are generally easy for the layperson to recognize, but how many non-herpetologists can tell one species of toad from another? Believe it or not, the best way to distinguish the two local toad species is to count the number of warts on each one of their spots. One to two warts per spot, it's an American toad; three or more warts per spot, it's a Fowler's.

There's a simple explanation for why we don't run into our dooryard toads more frequently. They are well camouflaged and nocturnal. It sometimes takes a child's sharp eyes to notice a toad; the toadlets are so tiny following metamorphosis that they're hard to discern from grasshoppers or crickets, and the mottled adults can sit so still and blend in so well with their background that they easily remain unnoticed. They can even darken and lighten slightly depending upon the substrate they're settled upon. Furthermore, toads like to hunker down in a darkened cool burrow or under thick vegetation during daylight hours to rest. Then, while we're sleeping, they come out to hunt for larval and adult insects in our dug-up flowerbeds, postage-stamp lawn, and detritus-filled woodland.

At night in spring, the toads' courtship calls sound out from deep in a soggy gully on the far side of my next door neighbors' house. Lying awake in the darkness, it's pleasant to listen for the prolonged bird-like trill of the American toads, which often sing in unison, or the sheeplike *baa* of the Fowler's toads, which seem to call back-and-forth to one another.

There are several key landscaping considerations that keep our garden and woods environmentally attractive for toads. A wholesome habitat ensures that the adults will remain year after year and that the new toadlets dispersing from wet areas in summer will thrive as well.

Toads' skin is permeable. They absorb the water they need through their skin, but they also absorb chemicals and pollutants, so an organic yard without herbicides and pesticides is essential. And since toads like to excavate

dens in soft soil and mulch, the ground litter should be free of chemicals if you want to keep toads around. It's important to avoid garish-colored mulches that have been dyed fake-looking hues such as shoe-polish black, harvest gold, or magma red. Some of these flashy mulches are made from chipped lumber that may contain toxins and heavy metals. Instead, we use untreated natural mulch, chipped-up limbs and leaves from our own property, or whatever stones, sticks, and debris happen to grace the ground.

Since toads require moisture, rain gardens can be dug for them. These shallow depressions, which include native plantings that tolerate wet conditions, hold rainwater until it's gradually absorbed into the ground. A broken terra cotta pot, strategically placed in the garden, can serve as a nice shelter for a toad that has decided to hang around. And be sure your amphibian friend can dig into the ground below.

I've learned never to take toads in my garden for granted. Their charisma is irresistible, their ecological benefits are undeniable, and, if you provide them with the right conditions, they'll become regulars. There are numerous other toad-friendly features that can be incorporated into a yard, but remember, the more natural, the better.

Ann Prince is associate editor of Sanctuary.

Sanctuary Salamander Surveys

© LARS JONSSON

Redback salamander

As part of Mass Audubon's Sanctuary Inventory and Monitoring Project, staff and volunteers are collecting baseline data on the presence and abundance of salamanders at many of our sanctuaries. Salamanders regularly seek refuge under rocks and old logs. In order to survey them, coverboards—which are one-foot-square pieces of wood—are arranged in a grid on the forest floor and checked periodically to find out what's underneath.

"Almost all of the salamanders we observe in these coverboard surveys are redback salamanders," says Southeast and Islands Region Conservation Scientist Robert Buchsbaum, who is coordinating the project for Mass Audubon. "This is perhaps the most abundant vertebrate in terms of biomass in our New England forests so its presence is a great indicator of forest health."

Dedicated volunteer monitors are doing fieldwork at Moose Hill in Sharon, something we hope to replicate at other sanctuaries. Two schools are also involved at their local sanctuaries: Greater New Bedford Regional Vocational and Technical High School at Allens Pond in Dartmouth and Bristol County Agricultural High School at Oak Knoll in Attleboro. Students have the chance to learn about hands-on research while contributing to a study that will provide important information on long-term trends.

In addition to finding redbacks, monitors have unearthed other intriguing creatures beneath the coverboards, including rare four-toed salamanders, spotted salamanders, and an occasional snake. There has been an assortment of invertebrates as well, such as centipedes, millipedes, beetles, ants, sowbugs, and slugs.

Sampling egg masses in vernal pools and surveying frog calls have also been initiated at some of the sanctuaries. "We try to go to each vernal pool three times each spring from late March through June," says Buchsbaum, "walking around the periphery and visually counting all the egg masses we can find. The two main things we sample for are egg masses of wood frogs, which spawn very soon after the snow melts, and spotted salamanders, which spawn a little later." By sampling three times, the monitors can track the developing eggs of the two species.

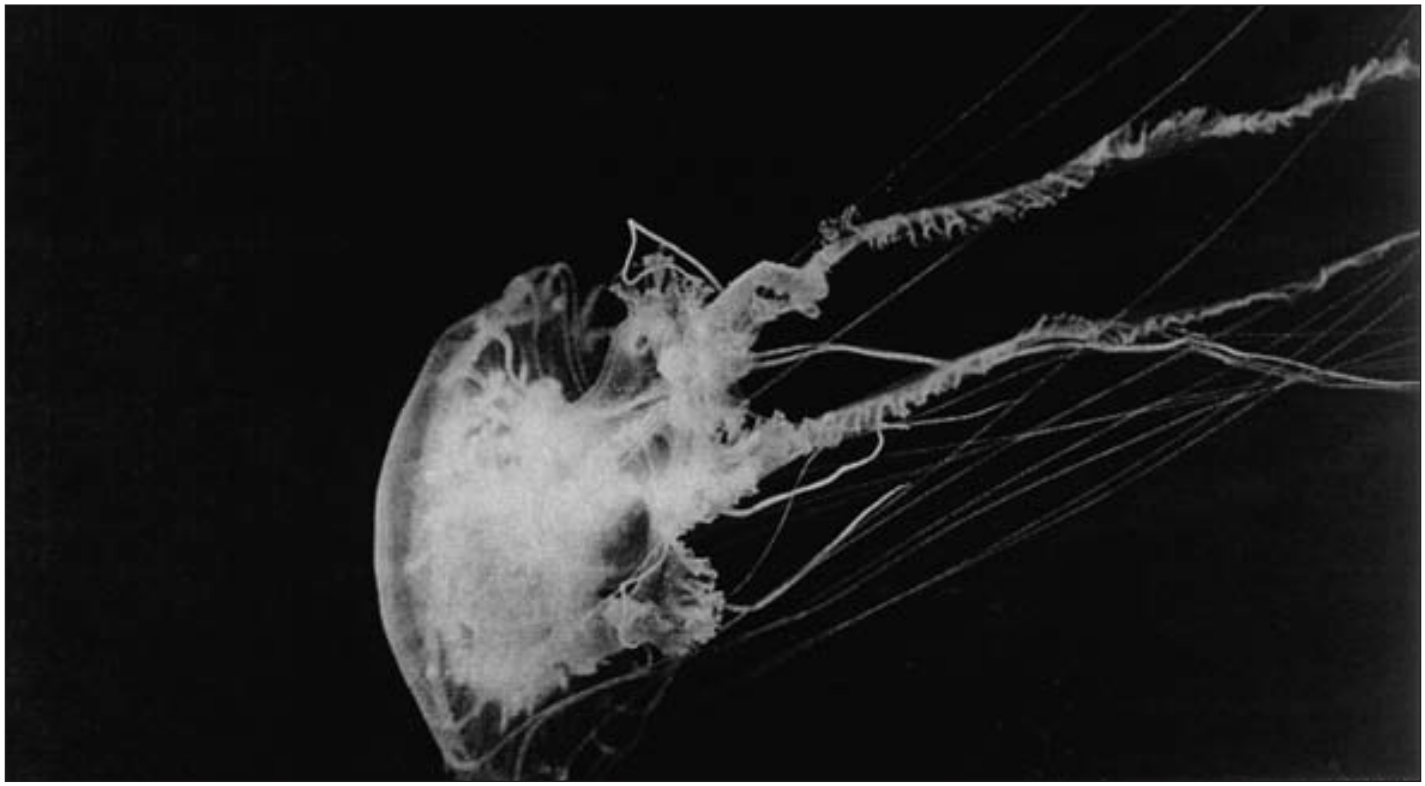
Most recently, frog calling surveys began in 2008, which, according to Buchsbaum, are easy for staff and volunteers, who simply visit a wet area on their local sanctuary and keep daily records on the intensity of the frog choruses—mainly of spring peepers and wood frogs. "We have the potential to contribute to a national effort to track trends in populations of salamanders and frogs through these surveys," says Buchsbaum. He stresses that, since amphibians have suffered declines in their populations all over the world, it's critical to continue these baseline studies on our own properties. AP

If you're interested in becoming a volunteer monitor to help survey amphibians for Mass Audubon, contact your local sanctuary.

Notes From the Real World

Seeing Green

by Chris Leahy



Sea nettle

For E.O. Wilson, it was a jellyfish—a sea nettle (*Chrysaora quinquecirrha*) to be precise. According to the eminent entomologist's autobiography, Wilson was seven at the time of the encounter and was wading in the warm subtropical shallows of the too-aptly-named Paradise Beach near Pensacola, Florida.

"The creature is astonishing," he writes. "It existed outside my previous imagination…. It came into my world abruptly from I knew not where, radiating what I cannot put into words except—*alien purpose and dark happenings in the kingdom of deep water* (author's italics). [It] still embodies, when I summon its image, all the mystery and tense malignity of the sea."

For the seven-year-old Vladimir Nabokov, it was a rare swallowtail feeding on honeysuckle nectar in a Russian garden, "…a splendid pale yellow creature with black blotches, blue crenels, and a cinnabar eyespot above each chrome-rimmed black tail. As it probed the inclined flower from which it hung, its powdery body slightly bent, it kept restlessly jerking its great wings, and my desire for it was one of the most intense I have ever experienced." (*Speak Memory*, 1955)

Call it the Awakening, this unexpected, incidental, yet life-changing stumble into a different universe is by no means reserved for great scientists or literary geniuses—though perhaps they express the experience with special eloquence. It is known to many people who are fortunate enough to live their lives consumed by a passion for some aspect of the natural world.

My casual study of the phenomenon has revealed certain commonalities. The "incident" always involves a particular species, whose appearance and behavior can be recalled decades after the event with uncanny detail. My own moment involved the discovery of a giant silk moth—a newly emerged male Promethea moth (*Callosamia promethea*) trapped in a drugstore window where I, age seven, had accompanied my father on some long-forgotten errand.

I was familiar with butterflies from my routine explorations of neighborhood fields and gardens. And I knew that the rather anonymous brown nocturnal replacements for butterflies were moths. But the Promethea drew my attention with what I am tempted (though

© JOHN SILL

Magnolia warbler

Share your *Awakening* experience…

If you've had an unexpected encounter with nature that made you "see green," we'd like to hear from you.

Email your Awakening anecdote to: sancmag@massaudubon.org.

Selections will appear on Mass Audubon's website later this spring.

embarrassed) to describe as supernatural force. My memory preserves not just the distinctive characteristics of a new curiosity but the very sensation of my mind working detail by detail to come to terms with something entirely other.

The blackish green bloom on the velvety scales of the freshly eclosed moth, the border pattern like inked designs on parchment, the lidless eyes staring from the wingtips, the soft flopping of the great wings when I disturbed the creature with my finger seemed not merely interesting, but thrilling, as if some strangeness in the moth had reset whatever mechanism it is that allows us to take the world's most remarkable details for granted or to fail to see them entirely.

The metaphors that people use to describe their Awakenings tend to have a transcendent quality. They speak of a veil falling or a door opening, revealing another world not previously imagined. The descriptions are reminiscent of those near-death experiences during which a trauma victim watches serenely from a perch on the ceiling while strangers attempt to revive her.

A middle-aged man I know, with "rather less than a normal curiosity about the natural world," was lying in a hammock in his yard on a May morning when a magnolia warbler in full nuptial regalia appeared on a branch above him.

"I feel foolish saying it, but it was like seeing an angel," he said. The atmosphere seemed suddenly clearer, and I realized that there was a dimension to the world that I had somehow overlooked and now urgently needed to explore."

A colleague who began her scientific career as a botanist had a "personal encounter" with a double-crested cormorant lasting a few minutes. "Pre-cormorant, birds weren't really on my screen; post-cormorant, I became obsessed with bird behavior. It was kind of as if you'd never been able to see the color purple before and now there were amazing purple things all around. Purple wonderland!"

Awakening anecdotes have the qualities of dreams, but the dreamer in this case doesn't return to the former reality. As in a fairy tale with a happy ending, the hero or heroine continues on a new path typically with new clarity and a positive trajectory. The experiences often seem to be, in pop-psych jargon, "life changing."

So do they represent actual brain changes? Are the Awakenings "caused" by some combination of physical factors? Why are they relatively rare?

The biophilia (literally "love of living things") hypothesis expounded by E.O Wilson, Steven Kellert, and others supposes that a deep-seated affinity for other life-forms and the living world as a whole is an inherent part of our biological evolution. Does this mean that everyone (Dick Cheney? Kim Jong-il?) has a dormant love of nature within himself, ready to be sparked into full realization by some stimulus? Or are only certain people unconsciously predisposed to awaken to nature in this way resulting from previous life experiences or genetic influence?

Given that many of the ills of modern life can be linked to humanity's increasing remoteness from nature, and that individual psyches seem to benefit from a personal connection with the natural world, it would seem that the world might benefit from a greater frequency of these events. Can Awakenings be induced?

David Morimoto is an associate professor of Natural Sciences and Mathematics at Lesley University in Cambridge, Massachusetts. He grew up in Jamaica Plain, and, though he remembers gray squirrels and other manifestations of nature from his urban neighborhood, a full-blown Awakening didn't happen until he was in graduate school. The scene was a winter beach on Plum Island, where his introductory ornithology class came upon a dead red-breasted merganser. It may seem odd that a biophilia seizure should occur in response to a dead duck, but in fact another common element in Awakening anecdotes is closeness—being near enough to see the creature in question in minute detail, perhaps to touch it, as if to confirm its remarkable physical reality. And, with its improbable metallic-green Mohawk; slender, bright-scarlet, un-duck-like bill; and intricate tracery of feather patterns, a drake red-breasted merganser is a perfect waker upper.

Morimoto recalls the usual symptoms—a rush of emo-

tion, incredulity at having lived twenty plus years without being aware of mergansers, followed by an obsessive desire to "catch up," to discover all the details of the new world. Unlike those who have the experience in childhood and may forget the sensation of seeing the world fresh with the veil removed, Morimoto remembers visiting his old Boston neighborhood—a place of which he had detailed mental imagery—after the merganser moment, to find that his home had changed for him. Familiar trees came into clearer focus. What kind of trees were they? Smudges of green in sidewalk cracks stood out as different species of plants: wildflowers—speedwells! What kind of speedwells?

Morimoto describes this transformation as "seeing green," and he believes that promoting this ability is arguably a more powerful conservation strategy than lecturing people about the value of biodiversity and lamenting the anthropogenic degradation of the biosphere (although he admits he does these too). People who, so to speak, have gone through the looking glass and can "see green," he believes, automatically become invested at the core of their beings in protecting nature.

Our neighborhood trees and even weedy lots join the family pets in our affection. Conservation ceases to be an abstraction and becomes basic good housekeeping practice for the ecosystem we all live in and share with other living things. This is especially true in urban ecosystems where we have long been encouraged to believe that nature does not exist: cities as the opposite of nature.

While science is just beginning to study the urban ecosystem and even give it some overdue respect, Morimoto has no trouble getting his students to appreciate the biodiversity in Cambridge. He does this using a wide spectrum of intellectual techniques. His own research involves the theory of networks and hierarchies through evolutionary space and time, and he teaches basic science by encouraging his students to compare the arthropod populations in different accumulations of urban leaf litter and the like. But he also spends a good deal of time simply taking to the streets with his students, documenting the city's natural history and creating favorable circumstances for the occurrence of Awakening moments.

His enthusiasm for his subject and apparent ability to induce biophilia in his charges allow us to hope for a new pandemic of awareness.

Chris Leahy holds the Gerard A. Bertrand Chair of Natural History and Field Ornithology at Mass Audubon.

Birding Programs

BERKSHIRE SANCTUARIES
Lenox, 413-637-0320
Canoe Meadows Bird Walks
April 2, 9, 16, 23, 30—8-10 a.m.
May 7, 14, 21, 28—7-9 a.m.

BOSTON NATURE CENTER
Mattapan, 617-983-8500
Birding for Kids
May 1—11 a.m.-12:30 p.m.

BROAD MEADOW BROOK
Worcester, 508-753-6087
Birding by Ear Workshops
Every Wednesday evening from March 24-April 21—7-8:30 p.m.

BROADMOOR
South Natick, 508-655-2296
Birds and Breakfast
May 9—6-10 a.m.

DRUMLIN FARM
Lincoln, 781-259-2206
Buff Up Your Birding
April 11—8:30 a.m.-12:30 p.m.
For children in grades 6-12
Putting the "Song" in Songbird
April 11—2-4:30 p.m.
For children ages 7-11

IPSWICH RIVER
Topsfield, 978-887-9264
Woodcock Walks
April 1, 6—7-8:30 p.m.
Plum Island Bird Walk
April 25—7-11 a.m.
Spring Migrants at Mount Auburn
May 7—6:15-11:30 a.m.

JOPPA FLATS
Newburyport, 978-462-9998
Wednesday-Morning Birding
Every Wednesday—9:30 a.m.-12:30 p.m.
Preregistration is not required

SOUTH SHORE
Marshfield, 781-837-9400
Birding at Mount Auburn
May 16—6-11:30 a.m.

WACHUSETT MEADOW
Princeton, 978-464-2712
All About Birds
May 1—1-4 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
Birding North Monomoy and Nauset Marsh
Regular tours start in late May.

Call the individual sanctuaries for more information, fees, and to register.
For a full listing of Mass Audubon programs and events, visit our online catalog at www.massaudubon.org/programs.

Mass Audubon Tours
supporting conservation here and abroad

Natural History Travel

Traveling with Mass Audubon supports conservation in Massachusetts and abroad. Join us!

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2010 International Birding and Nature Trips

Galapágos Islands Natural History Cruise:
April 2-11, with Sue MacCallum
Birding and Natural History in Northern Greece:
April 19-30, with Elissa Landre
Mongolia: May 22-June 7, with Chris Leahy
Montana's Prairie Spring: June 5-13, with Wayne Petersen
Birding in Guyana: October 1-10, with Elissa Landre
Kenya Birding and Big Game Safari:
October 30-November 13, with Chris Leahy
For detailed itineraries, email: travel@massaudubon.org or call 800-289-9504

2010 US TOURS

Mystic Seaport's Maritime and Natural History:
April 14-16, with John Galluzzo and Dennis Murley
For more information, contact Wellfleet Bay, 508-349-2615, or South Shore Sanctuaries, 781-837-9400
Cosponsored with South Shore and Wellfleet Bay Wildlife Sanctuaries
Birding in Big Bend National Park:
April 21-28, with Carol Decker and Scott Santino
For more information, contact Ipswich River, 978-887-9264
New Mexico—Rio Grande Lowlands to Rocky Mountain Highlands: April 21-29,
With René Laubach and Bob Prescott
For more information, contact Berkshire Sanctuaries, 413-637-0320
Cape Cod Birder's Weekend: May 21-23
For more information, contact Wellfleet Bay, 508-349-2615
Birding the Poconos: June 10-13
For more information, contact South Shore Sanctuaries, 781-837-9400
Connecticut Lakes Birding Weekend:
June 11-13, with Bill Gette
For more information, contact Joppa Flats, 978-462-9998
Puffins & Peatlands—Exploring the Maine Coast: June 18-21
For more information, contact Broad Meadow Brook, 508-753-6087
Machias Seal Island and Eastern Maine:
June 19-21, with David Larson
For more information, contact Joppa Flats, 978-462-9998
Puffins and Peatlands: July 15-18
For more information, contact Ipswich River, 978-887-9264, or South Shore Sanctuaries, 781-837-9400
Cosponsored by Ipswich River and South Shore Sanctuaries
Women's White Mountains Weekend: July 29-31
For more information, contact Ipswich River, 978-887-9264

SCHOOL VACATION WEEK PROGRAMS

BOSTON NATURE CENTER
Mattapan, 617-983-8500
Spring Has Sprung
April 20 -23

BROAD MEADOW BROOK
Worcester, 508-753-6087
April Vacation
April 19-23—9 a.m.-3 p.m.

BROADMOOR
South Natick, 508-655-2296
April School Vacation Week
April 20-23
Week or single days available

DRUMLIN FARM
Lincoln, 781-259-2206
April School Vacation Week
April 19-23
For children in grades 4-8

HABITAT
Belmont, 617-489-5050
April School Vacation Week
Pollination Party:
April 20—9 a.m.-3:30 p.m.
Animal Allies:
April 21—9 a.m.-3:30 p.m.
Endangered Species on the Brink:
April 22—9 a.m.-3:30 p.m.
Sensational Spring Pools:
April 23—9 a.m.-3:30 p.m.
For children in grades K-3
Adventurers:
April 20-23—9 a.m.-3:30 p.m.
For children in grades 4-6

IPSWICH RIVER
Topsfield, 978-887-9264
April Vacation Adventure Days
April 20-23—9 a.m.-3 p.m.

SOUTH SHORE
Marshfield, 781-837-9400
April School Vacation Week
April 20-23
For children ages 5-12; full- and half-day programs

WACHUSETT MEADOW
Princeton, 978-464-2712
April School Vacation Days
April 20-23—9 a.m.-3 p.m.
For children ages 5-11

WELLFLEET BAY
South Wellfleet, 508-349-2615
April Vacation Adventures
April 19–23—9 a.m.-3 p.m.
Peeps Group:
Half day—*9 a.m.-12:30 p.m.*
Full day—*9 a.m.-3 p.m.*
For children in preschool; must be age 4 by January 1, 2010
Mummichogs Group:
April 19-23—9 a.m.-3 p.m.
For children grades K-1
Bullfrogs Group:
April 19-23—9 a.m.-3 p.m.
For children in Grades 2-5

Call the individual sanctuaries for more information, fees, and to register.

Statewide Volunteer Day

Mark your calendar for our annual Mass Audubon Volunteer Day. Have fun while lending a helping hand with a variety of indoor and outdoor projects for all ages and abilities.

Bring your friends or family and a picnic lunch, and enjoy the sanctuary after the work is done.

April 24, 2010
9:00 am-noon

sign up online at
www.massaudubon.org/workforwildlife

Work for Wildlife at any one of these wildlife sanctuaries:

Central & Western
- Arcadia, Easthampton
- Pleasant Valley, Lenox
- Wachusett Meadow, Princeton

Greater Boston & North Shore
- Boston Nature Center, Mattapan
- Broadmoor, Natick
- Habitat, Belmont
- Ipswich River, Topsfield
- Visual Arts Center, Canton

Southeast, Cape, & Islands
- Attleboro Springs, Attleboro (opens in fall 2010)
- Felix Neck, Edgartown
- Long Pasture, Barnstable
- Moose Hill, Sharon
- North River, Marshfield

www.massaudubon.org/birdathon

SUSTAINABILITY PROGRAMS

BOSTON NATURE CENTER
Mattapan, 617-983-8500
Sustainability at the Workplace
March 20
Sustainable Art for Children
March 20

BROAD MEADOW BROOK
Worcester, 508-753-6087
Easy Composting for Healthy Landscapes
March 16
Greening Up Your Yard Naturally
April 1

IPSWICH RIVER
Topsfield, 978-887-9264
Design Your Own Nature Garden
April 17

JOPPA FLATS
Newburyport, 978-462-9998
Spring into Sustainability
March 27

LONG PASTURE
Cummaquid, 508-362-7475
Grazing Green
April 17

STONY BROOK
Norfolk, 508-528-3140
Sustainability in the Garden
Home Composting: *March 27*
Specialty Gardens: *April 17*

WELLFLEET BAY
South Wellfleet, 508-349-2615
Growing Green
March 19 and 26
Sustainable Sand Castles
April 17
Recycled Art
April 22

Call the individual sanctuaries for more information, fees, and to register.
For a full listing of Mass Audubon programs and events, visit our online catalog at www.massaudubon.org/programs.

Family Programs

BERKSHIRE SANCTUARIES
Lenox, 413-637-0320
Bat House Building Workshop
March 27—1:30-3 p.m.
Fish Tales
April 22—1-3 p.m.
Mother's Day Wildflower Walk
May 10—10 a.m.-12:30 p.m.

BLUE HILLS
Milton, 617-333-0690
Welcome Spring!
May 1—10-4:30 p.m.

BOSTON NATURE CENTER
Mattapan, 617-983-8500
Trail Detectives
April 9—4-5:30 p.m.

BROAD MEADOW BROOK
Worcester, 508-753-6087
Flying High with Worcester's Peregrine Falcons
April 25—2-3:30 p.m.

BROADMOOR
South Natick, 508-655-2296
Up Close and Personal with Reptiles
April 11—1-2:30 p.m.

DRUMLIN FARM
Lincoln, 781-259-2206
Spring Green Fest
April 17—10 a.m.-4 p.m.
Bringing Up Baby
April 30—3:30-5 p.m.
Dairy Day
June 5—10 a.m.-4 p.m.

HABITAT
Belmont, 617-489-5050
Summer Solstice Celebration
June 18—6:30-8:30 p.m.

IPSWICH RIVER
Topsfield, 978-887-9264
It's Big Night!
April 10—6-7 p.m.
Guided walks conducted every 10 minutes
Audubon Nature Festival
June 6—10 a.m.-4 p.m.

JOPPA FLATS
Newburyport, 978-462-9998
Imagine, Sing, and Learn at Joppa
Ducks in the Marsh: *April 29 and 30*
Investigate, Create, and Learn
In Search of Seals: *March 24*
Getting Down with Ducks: *April 28*
Homeschool Classes
Waterfowl Wardens Study Session: *April 2*
Destination Ducks and Geese Field Trip: *April 9*
Family Flyby at Joppa Flats
Good Earth Art: *April 3*
Check Out Nature's Library: *April 17*

SOUTH SHORE
Marshfield, 781-837-9400
Sunset Hayrides
April 10—6-7:15 p.m.
May 1—6:30-7:45 p.m.
June 5—7-8:15 p.m.
Walk for Wildlife
May 8

WACHUSETT MEADOW
Princeton, 978-464-2712
Wildlife Watch
April 17—1-3 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
15th Annual Cape Cod Natural History Conference
April 3
Afternoon Family Fun
April 19-23—2 p.m.
For families with children of all ages

WILDWOOD
Rindge, New Hampshire, 866-627-2267
Wildwood's Spring Alum Event
May 22
For more information visit our website www.wildwoodalum.org

© BOB SPEARE

Diamondback terrapin

Call the individual sanctuaries for more information, fees, and to register.
For a full listing of Mass Audubon programs and events, visit our online catalog at www.massaudubon.org/programs.

Spring 2010 Optics Sale

Members' special discount of 15%

April 3 to April 11

A great selection of binoculars, spotting scopes, and accessories

Audubon Shop
At Drumlin Farm Wildlife Sanctuary
Route 117, Lincoln, MA 01773
781-259-2214
Tuesday-Sunday, 10 a.m.-5 p.m.

Waterfront Cottage Available for Rent

Pierpont Meadow Wildlife Sanctuary in Dudley

Available mid-May through early October

Call 978-464-2712 for more information and availability.

Remember when?

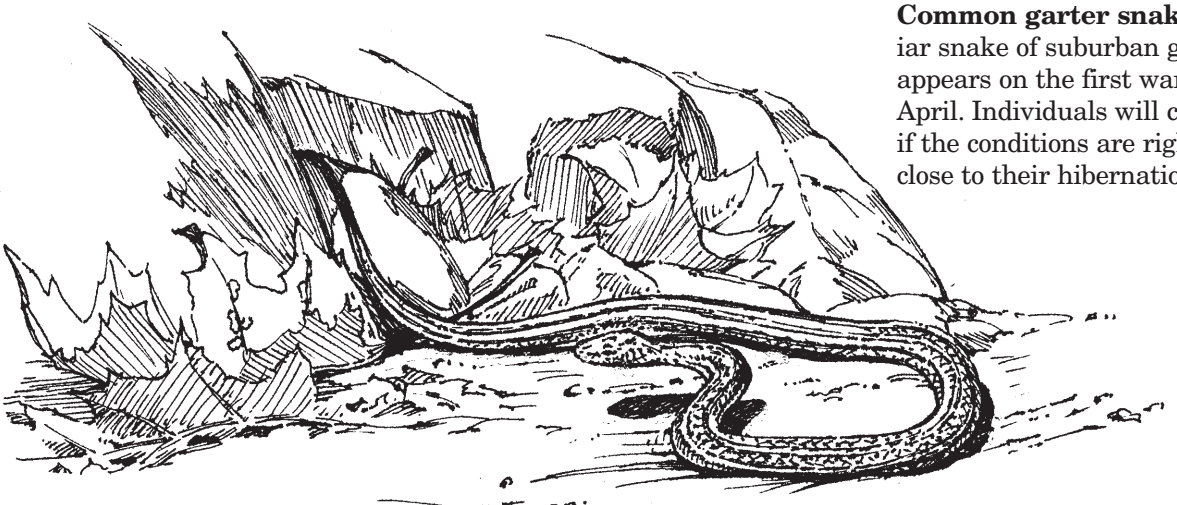
Join us for our spring alum event on May 22, 2010. Contact the Wildwood office at 866-627-2267, or visit our website www.wildwoodalum.org for more information.

Curious Naturalist

The Emergence

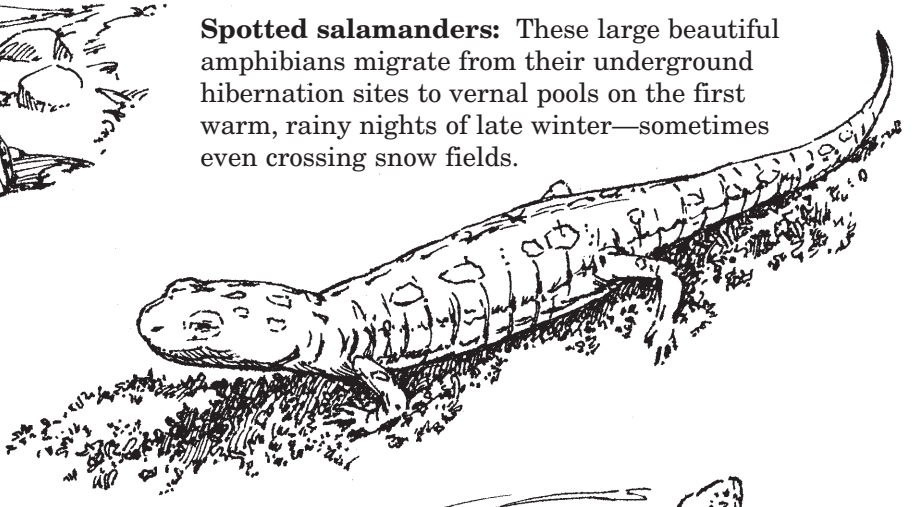
Illustrated by Gordon Morrison

Starting as early as late February in some areas, amphibians and reptiles slowly emerge from their long and sometimes perilous winter hibernation.

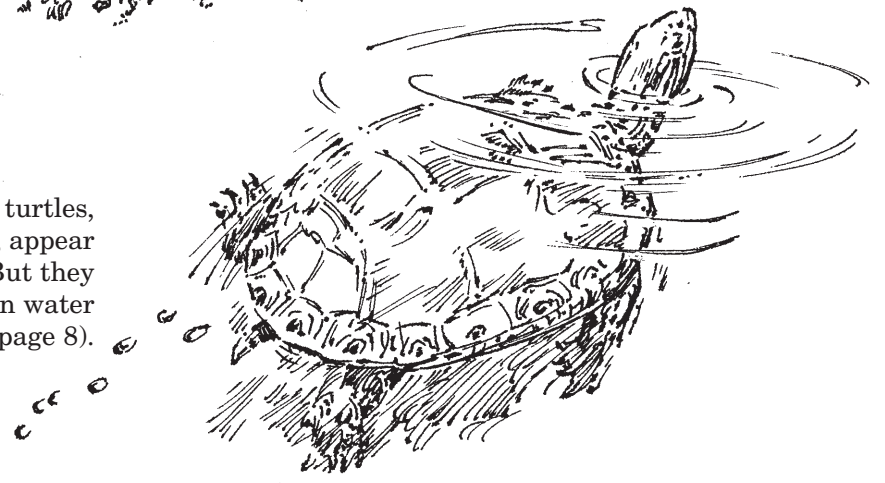


Common garter snakes: This familiar snake of suburban gardens usually appears on the first warm days of April. Individuals will come out earlier if the conditions are right, but remain close to their hibernation areas.

Spotted salamanders: These large beautiful amphibians migrate from their underground hibernation sites to vernal pools on the first warm, rainy nights of late winter—sometimes even crossing snow fields.



Wood frogs: Wood frogs are generally the first frogs to call, usually around early March when the ice melts back in the vernal pools. Their "song" sounds more like a duck than a frog (see page 2).



Painted turtles: These common turtles, like their fellow reptiles the snakes, appear when the sun is sufficiently warm. But they may appear as soon as there is open water on their ponds to bask on ice (see page 8).

Outdoor Almanac ▲ Spring 2010

March 2010

March 20 Vernal equinox, first day of spring. Days and nights are equal length.

March 23 Listen for the trill of song sparrows.

March 26 Phoebes and fox sparrows arrive about this time.

March 28 Listen for spring peepers about this date.

April 2010

April 7 Field sparrows come back.

April 13 Tree swallows have returned.

April 19 In wooded areas, listen for the muffled drum call of ruffed grouse.

April 21 Shadbush blooms; look for the white flowers against the brown, leafless trees.

April 24 Watch the wooded swamps for nesting wood ducks.

April 27 Listen for the trill of toads from nearby swamps and marshes.

April 29 Watch for returning towhees, brown thrashers, house wrens, barn swallows, and chimney swifts.

May 2010

May 6 Trout lilies, columbine, trillium, and other woodland wildflowers are still in bloom. Watch them now before the trees leaf out.

May 7 Northern orioles and catbirds come back. Watch for spring azure butterflies in the garden.

May 13 Bobolinks are active in hayfields and meadows.

May 15 This is generally the height of the spring warbler migration. Watch the treetops and shrubbery at dawn and dusk for migrating birds. Listen for the dawn chorus.

May 23 Watch for painted turtles and snapping turtles as they move onto dry land to lay their eggs.

May 25 Broad-winged hawks return, along with the scarlet tanagers and rose-breasted grosbeaks.

May 29 Dogwood flowers.

June 2010

June 6 Listen for the bullfrog chorus from freshwater marshes and ponds.

June 9 Field wildflowers begin to bloom around this date. Sulphur butterflies emerge.

June 11 Watch for fireflies in grassy areas.

June 19 Baby birds appear about this time; look for them on lawns and in shrubbery. Most seemingly lost babies are not orphans; parents are nearby.

June 21 Summer solstice.

July 2010

July 2 Daylilies bloom along roadsides.

July 6 Watch for monarch butterflies on milkweed blooms.

July 9 Listen for the bullfrog chorus from local ponds.

July 10 Field wildflowers begin to bloom.