SUMMER 2014

SANCTUARY

THE JOURNAL OF THE MASSACHUSETTS AUDUBON SOCIETY

The Rise of the South

Climate change and the northward spread of plants and animals

FINAL ISSUE: SEE INSIDE COVER

Issue 200—The Last *Sanctuary* Magazine

This issue of *Sanctuary* magazine marks the end of an era. It is the final edition of *Sanctuary*'s 34-year 200-issue publication run, and a significant moment in Mass Audubon's history. The editor, John Hanson Mitchell, and his staff will now turn their attention to production of an annual book-length publication that will be sent out to members at the beginning of the year.

I'm pleased and excited to report that the new yearly publication will retain many of the qualities that have made *Sanctuary* such a cherished institution among Mass Audubon members and supporters, as well as nonmember readers. The annual book will have the same combination of eloquent and informative writing, beautiful artwork, evocative poetry, and overall singularity. The magazine's most popular feature, *Outdoor Almanac,* will appear in another Mass Audubon publication.

A little history is in order. *Sanctuary* was launched in September 1980 and was the brainchild of John Mitchell, who created the journal by cobbling together ideas from earlier Mass Audubon publications and adding several elements of his own. Over the years, he assembled a devoted staff and a large stable of regular writers and illustrators. *Sanctuary* staff included production editors Betty Graham and Rose Murphy, designers Valerie Bessette and Lynne Foy, and associate editor Ann Prince. Many of the stories and columns from various *Sanctuary* issues were reprinted by other journals, magazines, and newspapers including *The New York Times*, *The Boston Globe*, *Utne Reader*, *National Geographic*, local journals, and British publications.

Some essays on critical contemporary issues were entered into the Congressional Record; others were used in schools and colleges. Some of the themes were decidedly controversial, but popular, such as an issue on hunting. Some issues enraged politicians. Many offered pointed comments on local land development controversies, proudly angering developers in the process. One or two generated threatened lawsuits. And one, the hunting issue, elicited a death threat against the president (glad that wasn't me!).

Sanctuary has won several awards in its time, for its design and for its unique single-themed approach. In 1998, Mitchell won the coveted John Burroughs Award for his *Sanctuary* essay "Of Time and the River." Some of the *Sanctuary* themes turned out to be best sellers and are still requested by various individuals and organizations. One issue, a mock trial of humanity by the animal kingdom, had an interesting aftermath. It was turned into a school play and was also used as a church service in Rochester, New York. Parishioners were given a tag with the name of an extinct animal written on it. The minister then read off a list of the animals and one by one the congregants rose and walked to the back of the church when their animal name was called. In the end, the church pews were empty.

Given this history it seems only fitting that this last issue of *Sanctuary* tackles the prominent environmental issue of our time, climate change. Mass Audubon has adopted climate change as one of the pillars of our current Five-Year Strategic Plan, and we've developed a four-part climate program that is both appropriately suited and scaled to our organization, and that can have a positive impact on this seemingly unmanageable challenge. As usual, the writers, artists, and editors of *Sanctuary* offer us their unique perspective on this issue, which, in turn, we trust will further engage our readers in the struggle.

We look forward to seeing John Mitchell's next publication. We know it will be very special.

Henry Tepper, President

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Cover: Prairie Garden Trust, Henry Domke, *Common Checkered Skipper*

FEATURES

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Monarch and empty chrysalis

DEPARTMENTS

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The Mockingbird

This story begins years ago on a snowy day in March when I had a call from a cousin telling me that a popular old uncle had died in his sleep. Uncle Justin was a favorite of mine, a rambling old dog with a host of tales from his youth; he was one of the few relatives who took notice of me, probably because I was the only one who would listen to his stories. He once told me he was the only survivor of Custer's Last Stand, a feat he accomplished by hiding in the belly of a dead horse. I was too young to know better. The funeral was to be held in Justin's hometown on the Eastern Shore of Maryland.

Mockingbird: things to come

The news of his death came at the end of one of the snowiest years on record. I was living at that time in a remote fairy tale cottage in the middle of an 11,000-acre forest in northwestern Connecticut. We were sometimes snowed in for days, and, having endured three and a half months of steely silence and snow, the only good thing I could draw from the news of Justin's death was the fact that we would get down to the old family lands on the Eastern Shore and that mockingbirds would probably be singing in the town graveyard.

As I had hoped it would be, the day of the funeral was warm, with a light overcast; you could smell the earth, the buds of oaks were swelling, and the boxwood and holly hedges were flush with green. All the old family members—those who were left at any rate—were there, none of them too surprised to hear that Justin had finally died; he was in his nineties at the time. The service was held in an old Norman-style church where my grandfather once served as minister, and after the service we all made our way down to the grave site. And sure enough, as they lowered the old man to his final resting place, I heard the familiar bubbling tripping-along quatrains of a mockingbird.

We drove back home to Connecticut through one of those traditional late March snowstorms and had to hike up our long unplowed driveway through foot-deep snow. I missed sadly the birdsong of the south. But to paraphrase the old proverb, if I could not go to the mockingbird, then the mockingbird would come to me.

This came to pass as a result of events that took place far away and long ago. Around 1710 an Englishman named Thomas Newcomen invented a commercial steam engine that was fired by coal, and since the Midlands had an apparently inexhaustible amount of coal beneath its grounds, by 1725 coal-fired mills, adapted from Newcomen's designs, were built around coal pit mines throughout the region. Newcomen's invention, and the abundance of cheap accessible fuel, encouraged what came to be known as the Industrial Revolution. As a result of the success of the use coal for both heating and industrial uses, one hundred years later, the infamous London fogs would sometimes block the sun for days on end.

Then, in 1896, a Swedish scientist named Svante Arrhenius published a scientific paper theorizing that extensive coal burning was adding carbon dioxide gas to the Earth's atmosphere. He predicted this would ultimately raise the planet's average temperature, a phenomenon that came to be termed the greenhouse effect.

That was the beginning. The end is yet to be seen.

Ten years after Uncle Justin died, the realities of Thomas Newcomen's coal-fired steam plant became dramatically apparent—at least to me. By that time I was living in a fast-developing farm town northwest of Concord, another cold place that got all the worst of any winter storms that came through. We had a plot of arable land there and a good garden, and one spring day, working in the vegetable plots, thinking of nothing in particular, I heard a familiar set of musical phrases. I paid no attention at first, and suddenly realized what I was hearing.

And it was there, thanks to Newcomen and coal and industrialization, that the mockingbird came to me.

JHM

New Plants in Town

Yet another effect of climate change—shifting plant communities

by Teri Dunn Chace

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Oriental bittersweet twining itself through a deciduous tree

There is a scene in Walt Disney's 1940 animated film *Fantasia* when a glowing fairy swings a sparkly wand over the world, conjuring plants and flowers and assigning them to designated spots as she flits around the screen. The background music is Tchaikovsky's *Waltz of the Flowers*, creating a mood of excitement and joy.

Recently, I was reminded of those scenes, ironically, while watching a TEDTalks program on global warming. Instead of a fairy, vegetation on a map was brought into view and moved by the sweep of a commentator's laser pointer. No music, no joy, just grim images of an inexorably changing landscape.

Climate change is already with us: in our region, in the state of Massachusetts, in our own woods and wildlands and yards and farms. The trends are discernible. Since about 1970, temperatures have risen nearly 2 degrees Fahrenheit in New England, according to the Northeast Climate Impact Assessment Team (NCIAT). A cascade of effects emanate from that change. This past winter notwithstanding, winter temperatures are rising faster than summer ones. Snow melts earlier. Spring comes earlier. We are experiencing hotter, more humid summer days, short-term droughts in summer and fall, and more intense storms during all seasons. More precipitation is falling as rain rather than snow. Growing seasons are longer—some plants are blooming earlier, pests are on the move, and water supplies are unstable.

One familiar plant in our part of the world is definitely being affected, the sugar maple. A neighbor's father, who works a large sugarbush in Vermont, confirms that the sap is flowing as much as two weeks sooner than it did just a decade ago—which is to say he is tapping

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Common reed

earlier and earlier. This effectively shortens the season and reduces production. He and others fear that there may come a day when sugar maples are no longer viable for this use. If this happens, not only will a major crop sputter out, but the vivid fall foliage of maples—such a delight to behold and, of course, also an iconic tourist attraction in Vermont as well as the rest of New England—will fade. With these changes and losses, longtime lifestyles and economies will falter.

Along with beeches and birches, maples are projected to shift northward in order to survive and prosper in the colder climates they are best suited to. Coniferous forests may move up (to higher altitudes where possible) and out of the region northward; spruces and firs, hemlocks and larches could follow.

What will fill the vacancies is unclear and undoubtedly depends on many factors. We may see more of what are now considered more southerly deciduous trees such as magnolias, dogwoods, and sweet gum. Or perhaps trees that prosper in warmer, drier conditions will take the stage and we'll see mainly more oaks and pines. At higher altitudes, the current plant residents—alpine and tundra species—may have nowhere to go and die out altogether.

One thing that has been thoroughly studied in the past is how gaps are filled in plant communities. Clearing out sections of forest trees—whether for development, farming, or harvesting of timber—has been a common practice in this part of the world for centuries. Plant succession, the process by which vegetation fills back in, and especially post-agricultural succession, has been well studied. Sun-loving herbaceous plants may have their day but eventually get shaded out as shrubs and trees return.

Climate change will affect whatever fills the gap in the landscape. Rising summer and winter temperatures favor certain plant pests, allowing them to move into and prosper in new areas or even to have population explosions. As the pests spread, the plants they favor will die off or retreat, with little prospect of resurgence in their now-altered habitat.

Particularly positioned to grab openings are non-native invasive plants, which grow and spread quickly. Oriental bittersweet and buckthorn in our forests and common reed in our wetlands are familiar examples. These aggressive plants elbow out the natives, multiplying unchecked by indigenous insects or grazing mammals or birds. Thus, succession as it has usually operated would not occur, and the result is that the composition of wild or uncultivated areas would be altered. Furthermore, as frost lines push ever northward, it is not impossible that we will see incursions from additional warm-climate invaders, such as the ominously named mile-a-minute vine and even the dreaded kudzu that has overwhelmed southern forests.

Tree species with similar needs tend to form regional plant communities such as the maple/beech/birch or oak/hickory forests. Also, certain understory shrubs and wildflowers and groundcovering plants associate with these communities. But in addition to temperature, individual species, both large and small, have their own requirements for soil, light, and moisture. Under changing climatic conditions, species are likely to react differently—in terms of migration rates, seed-dispersal mechanisms, and the speed and success of establishment. In the forests of the future, it may not be a simple matter of entire, familiar communities shifting northward or into higher elevations. It's conceivable that even minor shifts and losses will redefine the makeup of our landscapes, requiring a recalibration process by the plants.

Wetlands and marshes will likewise be impacted. As water levels rise, and/or the composition of the water changes, becoming more or less saline depending on the location, some plants may adjust. Sedges and cattails, for instance, are already adapted to seasonal changes including shifting water levels. Others such as buttonbush and pickerelweed may not fare as well. Animal species that are associated with various wetland plants stand to be affected as their traditional food and shelter alters. Already, non-natives such as common reed and purple loosestrife have encroached upon and even overtaken areas where openings occurred and the existing plants did not adapt or didn't adjust quickly enough. Resilient invaders are able to outcompete native flora, and are tenacious. The original native plants—without interven-

tion—may never regain a foothold.

Farmers and orchardists are also being affected, which in turn impacts what we eat and drink and how far things will have to travel to get to our kitchens. For example, in southeastern Massachusetts, cranberry bog owners are fretting about climate change's adverse effects on their livelihood. The CEO of a large cranberry business in Wareham that supplies Ocean Spray laments that "we're having warmer springs, we're having higher incidences of pests and fungus, and we're having warmer falls when we need to have cooler nights." Some cranberry production is moving north into New Brunswick, Canada, and investment in land in cooler areas of Chile is also being considered.

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Familiar forest species are shifting northward.

In recent years, erratic spring weather has been at best a nail-biter and at worst a fiasco for apple orchards in part of this region. An unseasonable warm spell in March a few years ago caused early blooms, but the insect pollinators were not yet active enough. Late-spring frosts followed, harming and killing buds. The result? A crop disaster. In the future northeastern apple growers may have to seek real estate in colder areas in an effort to meet demand and continue their livelihood. Tactics of this sort are likely not an option for small local producers.

The challenging growing conditions facing fruit producers in a time of climate change isn't just an agricultural or horticultural problem. It's also an economic and social problem and relates to the big picture. The growing popularity of local foods may be seriously challenged. Global warming is likely to compel us to change our buying and eating habits. Clinging to what we've always known could become quixotic, expensive, and eventually untenable.

Meanwhile, producers may have to adjust to new conditions. What will they grow? What will be in our markets and at farmstands in the future? Peaches? Peanuts? Avocadoes? Citrus? Don't laugh—if our region gets significantly warmer, such produce may be on the "eat-local" table.

The same goes for horticulture. Will we shift to planting and harvesting long-season crops like hot peppers and okra in our vegetable patches? Will we grow tropical plants outdoors? Will tulips falter and compel us to switch our affections to rain lilies? With the changing plant zones, gardeners are already contemplating these upcoming choices. Skepticism, indifference, denial, guilt, worry, disbelief may be the spectrum of lay responses to climate change's effects on the plants we know and love. But the upcoming generation of scientists will have a lot of work to do and limited time to do it in.

Data is already being collected. Researchers at the Arnold Arboretum spend early spring into summer checking the grounds weekly, noting what comes into bloom when. Some of us do this informally already; and there is even a web site, Project BudBurst, that collects observations from ordinary citizens at the national level. Participating will also make you hyperaware of what is happening right in your own corner of the world, in your town or yard or garden or favorite parks and nature preserves.

Another response is an attempt to preserve species before they are exterminated or their habitats are altered. New England Wild Flower Society in Framingham is a leader in this region with its seed bank and various ongoing scientific projects that study the coming changes. Research and modeling are also being undertaken by our state Natural Heritage and Endangered Species Program.

In the past the greatest detrimental human impact on natural systems and plant communities was from pollution and encroaching development. Now that we recognize climate change at the macro level, our culpability is arguably harder to rein in and more alarming. It's also harder to understand and to arrest at the local level. But this is where it will hit home.

The TEDTalks fellow spoke of earth's energy being "out of balance," referring to feedback loops and, hence, overall warming. Floods, droughts, monster storms, and polar vortexes are increasing. It's frightening that long-familiar patterns are unraveling. I miss the innocent days when we assumed things were stable.

Regular contributor Teri Dunn Chace divides her time between Cape Ann and Upstate New York. She is the author of The Anxious Gardener's Book of Answers *and* How to Eradicate Invasive Plants.

Earlier Birds

A changing calendar of avian arrivals

by Joe Choiniere

On April 2, 1914, Raymond Gregory recorded his first eastern phoebe of the spring in Princeton, Massachusetts, where he ran the local country store in the center of town. He recorded this common flycatcher's first arrival on April 1, 7, and 9, and March 31 in succeeding years. Here was a predictable natural phenomena that one might set a calendar by. Gregory was a skilled and dedicated bird observer; his bird journals, archived in the library of Wachusett Meadow Wildlife Sanctuary, continue his observations, more sporadically in the later years, until 1940. The phoebes arrived on March 31, April 1, 4, and 7 in his last four years of record keeping.

For twenty-five years, it appears that one could define the first week of April simply by the relatively unchanging arrival of these migrant flycatchers. Yet, a century later and scarcely a mile away from Gregory's store, on the grounds of Wachusett Meadow, something has changed; and the familiar gray birds pursue insects from rooftop and fence post more than a week earlier than Gregory's birds!

When I arrived on the sanctuary in 1983, phoebes quickly became the literal harbingers of spring for me—arriving around the vernal equinox (March 20 or 21), thus marking the beginning of a procession of natural happenings that filled the spring calendar for the sanctuary. Now the phoebes arrive in late winter. My own informal record keeping indicates that other birds are showing up at least a week earlier, including ruby-throated hummingbirds, ruby-crowned kinglets, and a favorite of sanctuary visitors, our two species of swallow.

Swallows are a revealing bird to look at as far as dates of arrivals and departures and blossoming flowers are concerned; their reputation for punctuality in spring perhaps stems from Capistrano's famous cliff swallow colony, now dwindled to nothing, with the birds' former arrival occurring on March 19, hailing the vernal equinox. Wachusett Meadow has sizable nesting colonies of tree and barn swallows; the graceful birds arrive roughly ten days apart and are immediately apparent for their numbers and aerial antics, so records are fairly complete and reliable. It is indeed a fine spring day, no matter the weather, no matter the calendar, when swallows greet your morning.

Gregory's notes document tree swallows arriving in the second week of April over the 1913 to 1940 period. In the 1980s, tree swallows generally arrived a week earlier. As cavity nesters, tree swallows proliferated with the arrival of beavers in the early 1990s, as natural nests in dead trees more than doubled the population, which had depended upon a couple dozen nest boxes in place since 1984. Tree swallows routinely arrived in the last week of March during the period 1991 to 2004.

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Carolina wren

I worry that there is a danger in these early arrivals. Vagaries of weather are especially common in March and are now predicted to be especially varied by climate change experts. This can lead to scarcity of the birds' flying insect food. Even now, in some years, swallows become trapped in nest boxes due to a torpor induced by the cold and many die.

Of all the birds, barn swallows affect me the most by their current earliness, perhaps because my birthday and wedding anniversary now coincide with their arrival the first week of May. Since 25 to 30 pairs of these birds nest in a specific barn at the sanctuary, it's easy to record the arrival of the resident birds each year by the commotion they create. Barn swallows were still a reliable first-week-of-May bird for my first few years at the sanctuary, but by 1989 their advent had crept back into April, and within fifteen years they began arriving as early as April 23.

Researchers Jessica Vitale and William Schlesinger, in "an examination of historical records maintained by a local bird club…," found that "44 springtime migrant bird species show evidence of an increasingly early first arrival date during a 123-year record (1885 to 2008) in Duchess County, New York. Ninety-one percent of the species showed a significant advance over this period, with the mean advance being 11.6 days per century." Most scientists who study these bird effects relate them to climate change.

Two rather striking avian visitors from southern climes have spent the summer around my own home in the past few years, a phenomenon mirrored at Wachusett Meadow. Now year-round residents, these species that are nesting farther and farther north. And they just so happen to be among the most obvious of birds: the Carolina wren, our

largest native wren and among the noisiest (and nosiest) of species with its loud *tea-kettle*, *tea-kettle* calls, and the red-bellied woodpecker, its rather startling plumage impossible to miss around the bird feeders.

They both take over the neighborhood. A Carolina wren will fly into my sheds and hang out, sometimes getting trapped inside so that I have to leave all the doors open at least until after dark to allow them to escape. The cavity-nesting red-bellies hold tree holes dear, and will send the gray squirrels packing. It's interesting to speculate on how they managed to fit into the already-replete woodpecker niche, with the downy, hairy, and pileated woodpeckers along with yellow-bellied sapsuckers and northern flickers all inhabiting the local woods.

Mass Audubon's *Massachusetts Breeding Bird Atlas 2* (BBA2) describes the red-bellied woodpecker as having "posted the third largest overall increase in new blocks occupied. This remarkable expansion, also witnessed in neighboring New York and throughout much of the Northeast, is thought to result from the species' suburban adaptability, combined with the trend toward warming winters."

There are other birds that have moved breeding ranges northward in the past. Wachusett Meadow's Forbush Breeding Bird Census shows that the tufted titmouse, formerly a more southerly species, arrived in the state in earnest during the 1960s and is now seen throughout the sanctuary. Another more southerly species, the turkey vulture, was regularly noted from 1976 onward, and the seemingly ubiquitous northern cardinal only became a regular in 1984. Although the cardinal began to nest routinely in Massachusetts in the 1960s, it was noticeably less common in the northern Worcester Plateau ecoregion when Mass Audubon's first bird atlas was conducted. Its arrival coincided with my own, with many sanctuary callers reporting cardinals in the early 1980s as they spread neighborhood to neighborhood.

Cardinals' expansion may have been aided by bird feeding, as suggested in the *Massachusetts Breeding Bird Atlas 2*. "The ability to make a living in human-altered landscapes has been at least partly responsible for the extraordinary spread of this species." Its earlier singing dates, moving backward from March into early February, and multibrooded behavior are other hallmarks of a successful expansioner.

Scientists are documenting nesting range expansions northward in many birds. Using the 1980 to 1985 and 2000 to 2005 *Atlas of Breeding Birds in New York State,* scientists reported that "the birds of New York State are moving polewards and up in elevation," and that birds "showed an average northward range shift in their mean latitude of 2.2 miles in 25 years. "The repeated pattern of a predicted northward shift in bird ranges in various geographic regions of the world provides compelling evidence that climate change is driving range shifts."

In the same New York study, researchers were surprised to find out that this effect was more pronounced than expected: "the southern range boundaries of northerly birds moved northward by 7 miles." One bird that begs this question at Wachusett Meadow is the white-throated sparrow, which once nested here. From about 1995 on, the white-throated sparrow pairs plummeted from a dozen to none. In the 1960s the bird was common, the Forbush Bird Club locating as many as 37 singing males on the sanctuary. Mass Audubon's BBA2 lists the bird as strongly declining, with conservation action urgent.

Purple finch

Habitat change at the sanctuary has been toward forest and away from early successional forests growing in on old agricultural lands, a trend that may have led to losses of this once common bird, along with its familiar melancholy song, *Poor Sam Pea-bo-dy, Pea-bo-dy, Pea-bo-dy*.

Scientists project that other birds will move north and out of Massachusetts with temperature shifts. The golden-crowned kinglet, a spruce-nesting species, is one, although planted spruce stands might not disappear as easily as native spruce as the earth warms. The purple finch is another; its decline is an enigma for ornithologists. The BBA2 states that the bird "shows a significant decreasing Breeding Bird Survey trend…in the Eastern US overall. To date there is little expectation of recovery for this species because there is little work being done to help the species."

In the end, whether global climate change induced the shifts or otherwise, it's not the fact of bird declines and changing seasons that affects me most—it's the *feel* of it. Something just isn't right.

I can perhaps best explain this in the activities of a favorite bird, part of a spring dance. In late April the dewy webs of early sheet weaver spiders adorn every shrub at dawn, while the audial webs of the song of the ruby-crowned kinglet awaken me gently with pianissimo, as it chases almost invisible insects in the red maple flowers. They go together—red maples, kinglets, and insects. But if it is birds that may be at stake, I wonder whether the kinglets must follow the procession of red maple bloom ever northward.

Joe Choiniere is property manager at Wachusett Meadow and Broad Meadow Brook wildlife sanctuaries.

Siege from the South

Newly arrived insect pests and what to do about them

by Gayle Goddard-Taylor

© RICK SARDINHA

Asian longhorn beetle

While scientists, economists, and policy makers continue to parse the scope and costs of a warming climate, there are others farther down the food chain that are resolving the matter their own way. Taking advantage of warmer winters to travel, they have arrived en masse in northeastern forests and backyards. They are insect pests.

Without a doubt, the presence or impending arrival of two insects in particular can be blamed on climate change. Currently topping the list of "the most unwanted" is the hemlock woolly adelgid (HWA), an aphid-like insect first noticed in Virginia in the 1950s. An exotic imported from Japan, it has since spread up the coastline, reaching Massachusetts about 20 years ago.

"There's no question that warmer winters help them spread," says Harvard Forest researcher David Orwig, who has studied HWA for the past 18 years. With no defense other than carefully timed spraying of individual hemlocks, a tactic impossible to implement in larger forests, researchers have been racing to find a way to stem the spread of HWA.

In Massachusetts, the adelgid is primarily ensconced in the east as well as in the Connecticut River valley. The Berkshires have largely been spared so far, according to Brian Hawthorne, a biologist with the Wildlife Habitat Incentive Program (WHIP) of MassWildlife. "The hemlock is not only a common tree in Massachusetts, but it's also a very important part of the forest," says Hawthorne. "It's shade tolerant and provides cover for deer in winter. It also provides food for wildlife, especially in early spring."

Just nibbling at the southern border of Vermont a decade ago, today HWA has chomped its way well up into that state and also into New Hampshire and Maine. The winters of 2004 and 2005 were cold enough to stall its northward march—but only fleetingly. In fact, researchers discovered that it would take a 91 percent winter mortality rate to stop adelgid expansion.

Researchers initially released an insect predator, *Laricobius nigrinus*, which proved too sensitive to the cold. Recently, researchers discovered a more cold-hardy *Laricobius nigrinus* in interior cold regions of the western US. Scientists hope that this beetle will eventually thrive and keep HWA in check.

"It's definitely showing some promise," says Harvard Forest's Orwig. "We've got to have at least this type of ability to overwinter and reproduce to even stand a chance."

Some researchers believe that insect predators and parasites aren't the only avenue of defense. A second front in the battle to stem the adelgid may be an entomopathogenic—insect-killing—fungus that researchers at the University of Vermont (UVM) have been studying for the past decade. "With HWA, one of the first things we did was to search all along the eastern seaboard to Virginia and North Carolina for insect-eating fungi that were impacting it," says UVM's Bruce L. Parker, PhD, who works in collaboration with colleague Margaret Skinner, PhD. Not only did Parker and Skinner find one; they found several. Research was begun but their real breakthrough occurred recently when a New Hampshire forestry official told them about a large infestation of HWA that had disappeared over the course of a year. "We investigated and discovered that it was an insect-killing fungus occurring naturally in our environment that was getting the job done," says Parker.

Parker and Skinner are currently testing the fungus in Vermont by isolating a highly infested hemlock branch and spraying the fungi on that branch alone, leaving others unsprayed. What they have found is that the fungus has not only killed adelgids on the sprayed branch but is somehow making its way to the unsprayed branches and doing its work there as well.

The second pest to take advantage of warming winters is the equally destructive southern pine beetle (SPB), which will soon be knocking at the doors on Long Island and ultimately in the pine forests of southeastern Massachusetts and Cape Cod. Originally found only in the southeastern states, the SPB most recently invaded New Jersey's beloved pine barrens where it has ravaged some 14,000 acres.

Like its cousin the western pine beetle (WPB), which has been taking advantage of warming temperatures to race eastward through commercially valuable jack pine forests,

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Emerald ash borer

the SPB reached epidemic mode in 2001. Matthew Ayres, PhD, a professor of biology at Dartmouth College, has been studying the SPB for at least 15 years and he sees its recent expansion as clearly tied to climate change. Research has shown that if the temperature of overwintering beetle larvae drops to around 5 degrees Fahrenheit, the cells in the larvae will suddenly crystallize and it will die.

"If it doesn't quite reach that temperature, even for several days' time, the beetle is fine," says Ayres. "On the other hand, if it drops below the supercooling point [crystallization temperature], it doesn't need to be a sustained temperature. Five minutes is enough to ensure death."

Historically, populations of the native SPB would rise and fall according to the abundance or scarcity of a checkered beetle that is a predator and a fungus that is an antagonist of another fungus upon which the beetle larvae depend for their nutrition. But climbing temperatures and pine forests that are weakened by overcrowding have upset that historical balance and allowed the SPB to reach outbreak mode.

"The coldest night of the winter has warmed by over 7 degrees Fahrenheit in the past 50 years over most of the US," says Ayres. "That's a tremendous change that is relaxing the northern distribution limits of the southern pine beetle."

A third highly destructive insect making inroads into the Northeast, the emerald ash borer (EAB), may be somewhat cold sensitive—but it is tolerant of even lower temperatures than those that affect HWA and SPB. In 2008, it had been discovered in 7 states and Ontario, Canada, but is now in 23 states.

The EAB was found on state forestland in Dalton, Massachusetts, in 2012 and has since invaded a handful of nearby communities. This year significant infestations were found in North Andover, Massachusetts, and Concord, New Hampshire. State agencies have not taken the invasions lightly—moratoriums on the movement of all ash products, firewood, and nursery stock have been enacted throughout Merrimack County in New Hampshire and Berkshire County in Massachusetts.

Entomologist Juli Gould works solely on EAB for the USDA's Animal and Plant Health Inspection Service (APHIS), where some researchers are taking a two-pronged approach—parasitic wasps are being tested while others are investigating tree resistance. One problem APHIS faces is that the borer kills trees rapidly. Another is that EAB larvae, safe beneath the bark, are difficult to find. Researchers must look for woodpecker damage as a sign that the larvae could be present.

"We also have to release the parasitoids when the EAB is at a low density, which is hard to do," says Gould. "If we release it in a high-density site, the trees die and the borer populations decline before the parasitoids have a chance to increase in number." That means finding a site with a low EAB population and lots of ash, preferably not large trees—one of the wasps cannot penetrate the bark of older trees to lay its eggs. A site with corridors of ash is also preferred because it allows the wasps to move as the borer does.

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Southern pine beetle

The winter of 2013/2014 may have knocked back the HWA, but it will surely rebound in a couple of years. There's more hope that the frigid temperatures will have exterminated enough SPB to push it out of epidemic mode and back to a level that trees can survive.

Whether or not the past winter impacts either pest, there certainly is no shortage of other destructive insects to keep forest managers busy. For example, the highly destructive Asian longhorn beetle (ALB), an exotic pest found in Worcester in 2008, targets hardwoods—maple, birch, and ash—to lay its eggs. The larvae bore into stems and branches, girdling the tree and blocking nutrients. The only defense against the ALB is to destroy affected trees.

The red pine scale (RPS), widespread in Massachusetts and recently confirmed in New Hampshire, is taking a toll in red pine plantations. As with the ALB, the only defense at this point is tree removal. Both states have authorized the removal of large patches of affected red pines on state-owned land. And, most recently, yet another pest, the cynipid gall wasp, was discovered in 2012. Little is known about this latest invasion, which caused damage to black oaks on Cape Cod and Martha's Vineyard, but University of Massachusetts entomologists have begun studying the wasp.

So where do forest managers go from here? Inspecting every shipment of wood to this country would be costly in the extreme and would grind commerce to a halt, according to Juli Gould. Moratoriums on the movement of wood products can be difficult to police. Tree removal and biocontrols remain that thin line of defense. But perhaps, in the long term, the forests of the Northeast may be looking at a new normal, with the new pests becoming the old pests—but at levels the trees can withstand.

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

Northward Wings

Caught in the winds of climate change

by Michael J. Caduto

For many naturalists, summer arrives on sheer silent wings that move with a flutter of color and lightness. Greeks once believed that a human soul came into the world every time a butterfly emerged from its chrysalis. In parts of Asia, butterflies symbolize happiness and joy. And there's a Celtic belief that a tiny faerie can change itself into a butterfly to avoid being discovered by human beings.

In recent times, Western culture has hatched its own butterfly lore. Back in the 1970s, the Butterfly Effect spun off from the Chaos Theory, which attempted to make sense of the apparent randomness of the universe. The Butterfly Effect held that the faintest movement of air caused when a butterfly flapped its wings in, say, Massachusetts, begins a series of interconnected events that can ultimately cause a hurricane in some distant place like Cuernavaca.

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Great spangled fritillary on common milkweed

Some decades hence, we seem to be experiencing a reverse Butterfly Effect, raising serious scientific questions: If climate change heats up the Gulf Stream and contributes to warmer weather in Massachusetts, and if it generates a greater number of hurricanes in the Gulf of Mexico, will some butterflies stop flapping their wings in Massachusetts?

In 2012 Elizabeth Crone, PhD, Associate professor at Tufts University, coauthored a pivotal article with Greg Breed, PhD, and Sharon Stichter, PhD, called Climate-driven Changes in Northeastern US Butterfly Communities, which was published in *Nature Climate Change* following research conducted through the Harvard Forest in Petersham.

"Climate is getting warmer," says Crone. "Mobile species move to new areas that suit their climate needs, if there is no other limiting factor. Species that are from the south are becoming more abundant, and species from the north are less abundant, on average. Many are increasing their range northward, but some species may not be able to move north due to habitat needs and geographic boundaries."

Between 1992 and 2010, shifts in population numbers and geographic ranges have been observed in 100 of the 116 species of butterflies studied in the field. With the advent of warmer average annual temperatures, the butterfly species for which Massachusetts had once formed the northern edge of their range are moving farther north, and their numbers are increasing. Prominent among these species are the zabulon skipper and the giant swallowtail with its striking yellow spots and bars highlighted against 7-inch-wide black wings.

But those species for which the state's climate has demarked the southern extreme of their range are also shifting northward, especially in the warmest regions such as the southeast and the Pioneer Valley. Of the 21 butterfly species that fall into this group, 17 are in decline, including the Atlantis and Aphrodite fritillaries. Within this group those that live at higher elevations are more stable, but species found in the lowlands are decreasing rapidly.

Research shows that these responses are specifically related to climate and are not tied to other changes in

the environment, such as habitat alteration. Findings have not made a correlation between these recent population declines and the availability of plants that are essential for food and reproduction.

Climate change is also affecting the timing of different behaviors among butterflies.

"In addition to shifts in geographic ranges," Crone points out, "as the average temperature rises, species emerge earlier on the whole."

Boston University researchers, including biology professor Richard Primack, PhD, and Caroline Polgar, PhD, are among members of a team studying the impact of climate change on the phenology of plants and animals, including the relationship between temperature and the timing of seasonal flight among elfin and hairstreak butterflies in Massachusetts. With the earlier onset of springtime and warmer overall summer temperatures, butterflies are flying earlier in warmer years.

"People hadn't noticed these changes until we gathered the data and pieced it together," says Crone. "We used the Massachusetts Butterfly Club's data to chronicle changes. Club members go out and record the species they see in the field on any given day at any given time. You can use the number of species seen on a particular trip to estimate how thoroughly an area was searched and to account for variation in things like weather conditions.

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Zabulon skipper

Climate change is the driving force behind dramatic shifts in the geographical ranges of many species. Researchers have used the latitude of Boston as the dividing line between species considered to be Northern or Southern. This is not just an arbitrary choice: It turns out that Massachusetts forms a zone of transition between the warmer climate to the south and the colder regime to the north. As climate change accelerated, the Bay State became a frontier for studying the responses of plants and animals over time. This critical location, along with its varied bioregions and elevations, makes Massachusetts a revealing barometer for gauging how climate change is affecting butterflies throughout New England.

Sharon Stichter, a retired sociology professor from UMass Boston, discovered a second calling as a butterfly researcher and author. "Butterflies are such a self-evidently beautiful form of life," says Stichter. "When I retired I bought some land on the North Shore, created habitat for birds and butterflies, and gradually became aware of the need for protecting butterflies. In the 1990s I met some folks who were just finishing work on the Massachusetts Butterfly Atlas and were starting the Massachusetts Butterfly Club."

Stichter is author of the online butterfly research and monitoring

© WILL COOK

Red-banded hairstreak

website, The Butterflies of Massachusetts (www.butterfliesofmassachusetts.net), as well the book, *The Massachusetts Butterfly Club Guide to Good Butterfly Sites*. She talks, with obvious delight, about the species that are on the rise: "The great spangled fritillary is increasing, as is the frosted elfin." Speaking of butterfly watching, Stichter says, "It's a wonderful avocation, which doesn't have to happen in faraway places or at the first crack of dawn. It can be done in your own backyard."

Other species whose numbers have increased during the past twenty years in response to rising temperatures include the giant swallowtail, gray comma, fiery skipper, sachem, Appalachian brown, white M hairstreak, red-banded hairstreak, and common checkered-skipper.

The zabulon skipper is one aptly named butterfly at the forefront of the rapid migration of previously southern species into Massachusetts. First sighted in Massachusetts in 1988 in Longmeadow near the southern Connecticut River at the Fannie Stebbins Wildlife Refuge and at Allens Pond in South Dartmouth, the zabulon skipper has now spread as far north as Whately and Topsfield, and east to Martha's Vineyard.

But climate change cuts both ways—a fact that has been especially detrimental to butterflies that live in the coldest parts of the state, such as the Berkshires and the Worcester Plateau. During the past two decades, the Atlantis fritillary is being overwhelmed by a tide of warmer weather, and its small island of preferred climate is now restricted to a few of the higher elevations in the Berkshires. This butterfly is joined by the Aphrodite fritillary, meadow fritillary, and silver-bordered fritillary among those species that have suffered climate-related declines in recent years.

The eyed-brown, Leonard's skipper, northern cloudywing, and Arctic skipper are at the forefront of butterflies in decline, as is the diminutive Acadian hairstreak, which sports a short tail on each hindwing, elegant gray underwings adorned with red and black markings, and a blue tail spot. The Harris' checkerspot has disappeared completely from southeastern Massachusetts.

"The Aphrodite fritillary and Atlantis fritillary are withdrawing to higher mountaintops, and there's not much that can be done," observes Stichter. "The regal fritillary was last sighted in 1980 on the mainland; the remaining island populations were wiped out by hurricanes, and it was last sighted on Nantucket in 1988."

A greater incidence of hurricanes and other severe tropical storms associated with climate change is also impacting monarch butterflies, the only species that makes extended, long-distance migrations to New England. Monarch butterflies from eastern North America overwinter in the mountains of southern Mexico. Each spring they journey north, laying eggs on milkweed along the way. These eggs hatch and produce the next generation, which then continues the migration north. Several generations are born during the course of a summer before monarchs reach New England. In 2013 there was a near-absence of monarch butterflies in New England, and their population in recent years has been about 1/18 of what it was less than twenty years ago.

Whether or not you ascribe to the Zuni belief that butterflies can predict the weather, there is no denying that they are harbingers of how our environment will evolve in an era of climate change. In Buddhism, butterfly metamorphosis symbolizes the human capacity for transformation—our ability to transcend self-centeredness and be guided by noble principles rooted in a sense of oneness with all beings. The true test plays out in the myriad decisions we make in our daily lives—choices that will determine the fate of these ephemeral denizens of the air.

Michael J. Caduto is an author, ecologist, and storyteller.

What you can do:

- **Subscribe to MassLep and report butterfly sightings online.**
- **Join the Massachusetts Butterfly Club, www.naba.org/chapters/nabambc.**
- **Make choices in energy use and lifestyle that are designed to reduce carbon emissions and slow climate change. Support similar changes at the societal level.**
- **Use native plants to create butterfly gardens, including varieties that provide sources of food and places to lay eggs, such as milkweed for monarchs.**
- **Don't use pesticides, herbicides, and other chemicals that are harmful to butterflies and other beneficial insects such as honeybees.**
- **Maintain open spaces for butterflies to feed, rest, and breed. For example, join Monarch Watch and plant a Monarch Waystation habitat, www.monarchwatch.org/waystations.**
- **Inform others about what is going on with butterfly populations and encourage them to get involved.**

Bring on the Butterfish

Climate change impacts on New England marine life

by Robert Buchsbaum

Beginning around 1886, the United States Bureau of Fisheries lab (now the Northeast Fisheries Science Center of the National Oceanic and Atmospheric Administration) began recording seawater temperatures from a dock in Woods Hole's Great Harbor. After a brief hiatus during World War II, the Woods Hole Oceanographic Institution took over the temperature measurements from its own dock in 1944. These data represent one of the longest time series of direct seawater temperature measurements known.

Analyzed by Scott Nixon and his colleagues from the University of Rhode Island (URI), the data show that recent Woods Hole seawater temperature since the 1990s is about 2.2 degrees Fahrenheit higher than it was from 1890 through 1970. In scientific slang, the data are "noisy," i.e., complex, due to annual variations and some atmospheric conditions that last several years. But the signal from climate change is unmistakable. Other long-term measurements show similar results. In sum, global climate change has slowly been warming our oceans.

The trend of ocean warming will continue for our lifetime and those of our children, grandchildren, and beyond. Models of ocean temperatures project an increase of about another 1 to 7 degrees Fahrenheit by late this century in the waters off New England. The range depends on the location (e.g., higher over the shallow waters of Georges Bank, less change in the eastern portion of the Gulf of Maine). It also depends upon how much effort humans make to control greenhouse gas emissions.

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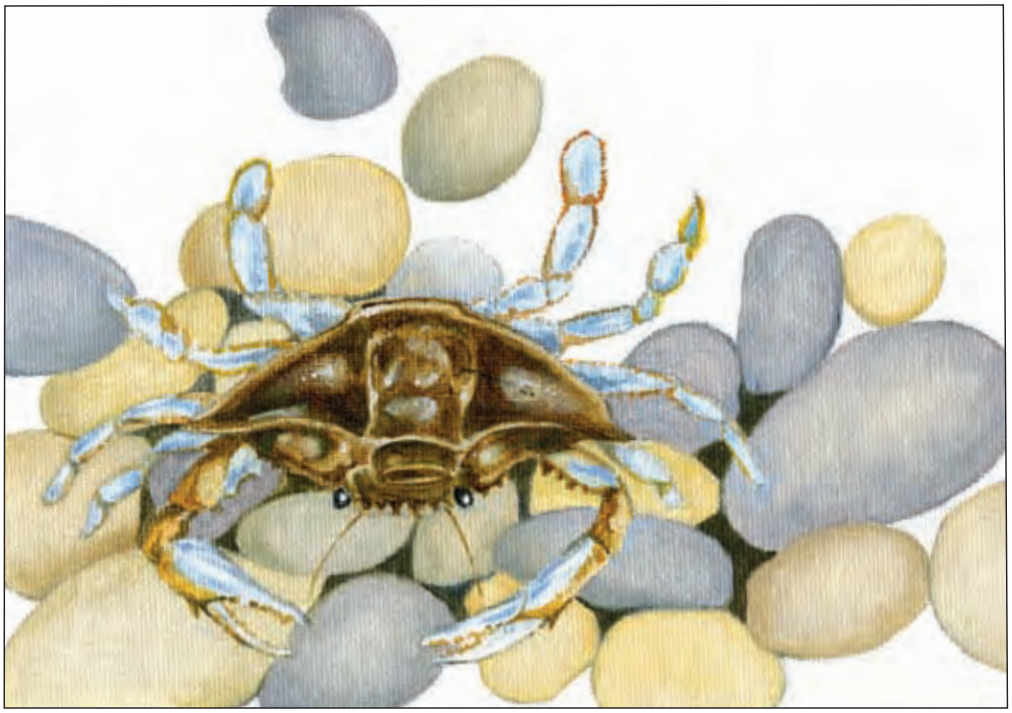
Scup are moving northward

What does this warming mean for our marine life? An examination of recent trends provides a hint of what is in store for the future of New England marine fish. A number of recent studies have shown that southern fish are moving into New England waters and some more northern cold-water species are declining. A recent analysis of 36 fish stocks by the Northeast Fisheries Science Center showed that two-thirds either shifted the center of their ranges to the north or moved into deeper waters or did both from 1968 through 2007. (A stock is the population of a species occupying a certain area, such as Atlantic cod on Georges Bank.) These movements are consistent with a response to warmer oceans. The fish on the move represented a variety of taxonomies (different families), habitats (bottom dwelling and open water), original geographic distributions (north and south), and different levels of fishing pressure (from none to heavily exploited).

The 17 species that moved north included two species of herring (alewives and Atlantic shad) that annually run up rivers in the spring to spawn and spend the rest of the year swimming in the pelagic (open ocean) zone feeding on plankton; southern New England yellowtail flounder, a bottom-dwelling commercially harvested flatfish of offshore sandy shoals; and blackbelly rosefish, a deep-water species that looks somewhat like a perch and is not targeted commercially in New England. The shifts north were on average 0.6 to 5 miles per year, a much higher rate of northern migration than has been



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Blue crabs, which are currently decreasing in number, feed on the square-backed marsh crab, which is expanding north and devouring cordgrass on Cape Cod.

observed for many terrestrial species (typically less than 0.5 miles per year).

Seventeen species moved to deeper water, eight of which also moved farther north. Pollock, cusk, and goosefish are species that sought out deeper water, presumably to remain within their preferred temperature ranges.

In addition to the movement north and to deeper water, 12 northern species that are at the southern edge experienced a contraction in their ranges. This suggests that they are declining as the habitat becomes less optimal for their survival. Atlantic cod from Georges Bank and southern New England yellowtail flounder are in this group. Some of the fish whose ranges contracted also shifted north. In contrast, a number of species whose original ranges were considered more southern, e.g., Atlantic herring and spotted hake, expanded their ranges.

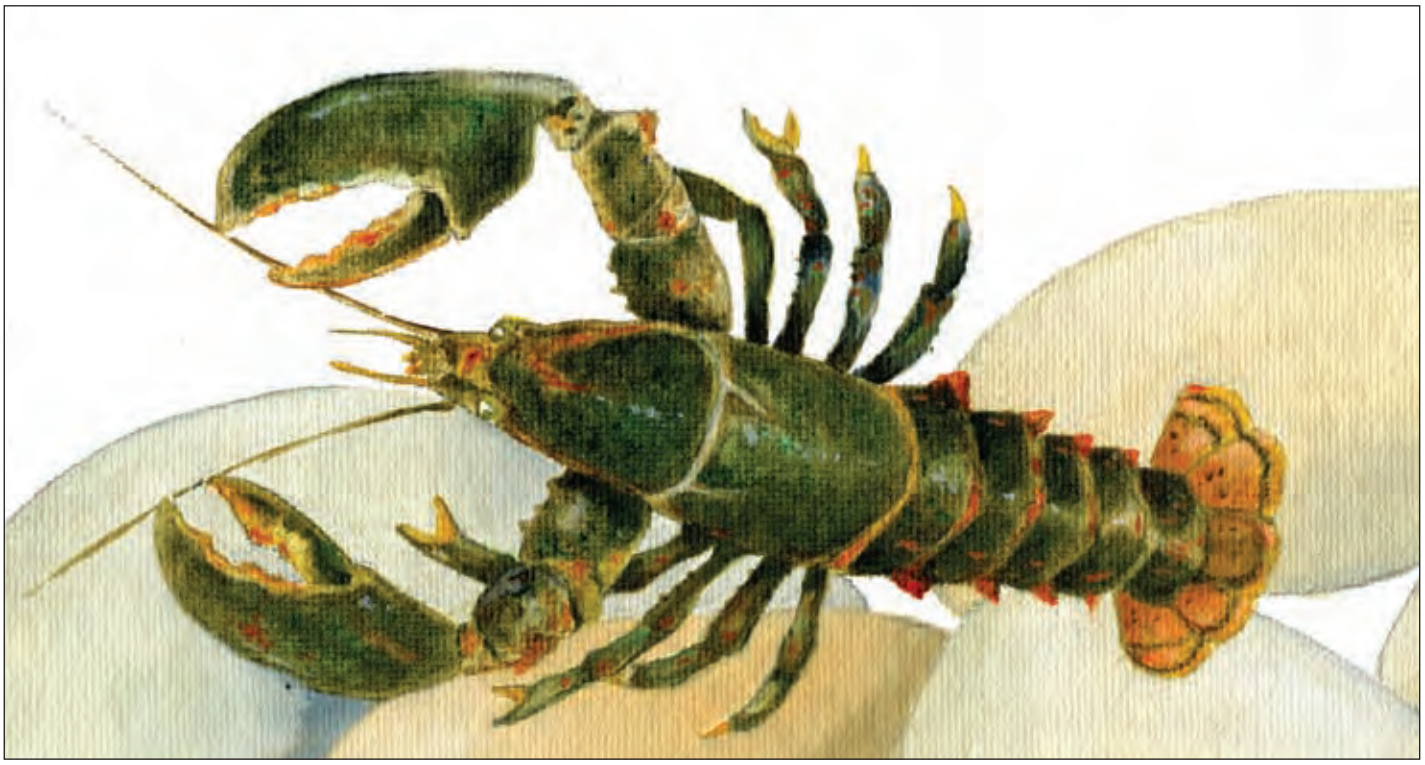
The future of cod, for years the mainstay of fishing in New England, is clouded by climate change. Cod populations are already at very low levels resulting from overfishing, and their ability to recover is likely to be exacerbated by warming sea temperatures. This bottom-dwelling, cold-water fish is now close to the southern limits of its range in southern New England. Cod thrive where the average ocean temperature does not exceed 47 degrees Fahrenheit; however, this temperature is currently regularly exceeded south of Cape Cod. Adults can tolerate somewhat warmer waters but the growth and survival of juveniles is inhibited above 47 degrees Fahrenheit. Cod are likely to disappear completely from much the southern part of the species' current range in the near future, but the problem does not stop there.

Future projections indicate that the rich fish grounds of Georges Bank will become marginal habitat for both adult and juvenile cod over the next 50 years. Georges Bank is a critical area for cod reproduction so the consequences of this loss may be experienced far beyond the immediate area. Eventually, the relatively cooler Gulf of Maine waters (Cape Cod through Nova Scotia) will become suboptimal habitat even under more optimistic climate change scenarios.

Unlike cod, the fishery for lobsters is still booming with record catches occurring in Maine. Their future in Maine looks relatively secure over the next 100 years, at least in terms of climate change. Warming projected for cooler sections of the Gulf of Maine may even expand the habitat that is optimum for lobsters. In contrast, lobsters' future in southern New England is bleak. Although Long Island Sound was never in the center of their range, lobsters were formerly abundant enough there to support a small commercial fishery. That no longer exists, and declines have also occurred off Rhode Island and in Buzzards Bay. The maximum bottom temperature tolerated by a lobster, 68 degrees Fahrenheit, is currently exceeded in summer and early fall in these locations.

Not only are the lobsters stressed by the heat, but warmer temperatures increase their sensitivity to low dissolved oxygen concentrations, an unfortunate consequence of excess nutrient loading to many of our coastal waters. This has led to lobster die-offs in Long Island Sound. Lobster shell disease, a bacterial infection possibly associated with warmer temperatures and certain pollutants, has also contributed to the decline of the commercial fishery for lobsters in southern New England.

Along with the decline in cod and other cool-water species, a number of species of marine fish of more southern ancestry will increase or expand into New England waters in response to climate change. These include Atlantic croaker, spot, black drum, butterfish, scup, and summer flounder. Some of these are already common south of Cape Cod; others will be familiar to anyone who had fished off Long Island, New York, or along the Jersey shore. Atlantic mackerel is a migratory species that is common in the summer in New England waters, but moves south and offshore in win-



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Lobsters' future in southern New England is bleak.

ter. Since 1968 to 2008, the wintering distribution of mackerel has shifted about 150 miles north, extending the season during which this fish is present here.

Changes in ranges are occurring in other groups of marine organisms with potential long-term implications for our coastal ecosystem. Scientists are concerned that invasive species such as the European green crab, Asian shore crab, and colonial tunicates will continue to spread north as our coastal waters warm. Several species of invasive colonial tunicates have become particularly problematic over the past 20 years. Related to solitary sea squirts, the colonial tunicates are filter-feeding marine invertebrates that form crusts on hard surfaces. They can cover extensive areas of the sea bottom, encrust eelgrass blades, and encumber aquaculture projects. Tunicates have a swimming larval stage with a primitive support structure akin to our backbone, hence they are distant relatives of vertebrates. Results of experiments on *Didemnum vexillum*, a bottom-dwelling colonial tunicate thought to originate from Japan, suggests that the successful dispersal and settling of its larvae in New England is enhanced by warmer temperatures. This species is now common on docks and piers and has even shown up on sea scallop beds at Georges Bank.

Another interesting northward movement is the square-backed marsh crab. Studies carried out by Brown University scientists showed that this voracious nocturnal omnivore is responsible for at least some of the loss of salt marsh cordgrasses on Cape Cod over the past 10 years, perhaps longer. It is a native to mid-Atlantic states and was not thought to occur in any numbers on the north side of Cape Cod until scientists started looking into the cause of the damage to the marsh plants. It will be interesting to see whether blue crabs, the major predator of square-backed marsh crabs in Narragansett Bay (and likely elsewhere), will follow it around Cape Cod and serve to eventually control its numbers.

Organisms are moving north at least partly to remain within a certain optimum climatic "envelope" that is best for each species. But they do not exist in a vacuum. There are ecological relationships between predator and prey that are affected by our changing climate. Juvenile cod, right whales, and many other marine organisms depend heavily on *Calanus finmarchicus*, a species of copepod that becomes abundant in the spring in places like Cape Cod Bay and Georges Bank. There is concern that warmer winter temperatures could lead to earlier blooms of this species. If the timing of cod spawning does not change, this copepod may no longer be present in sufficient numbers to feed juvenile cod.

Oceanographic processes related to climate change are occurring on a wide scale and are likely reverberating through marine food webs. The entire North Atlantic Ocean is now receiving more freshwater as the Greenland ice sheet melts. The plume of freshwater from Greenland is thought to be extending the period of plankton blooms, to the benefit of herring and other fish that feed on plankton.

Narragansett Bay has been the site for a number of

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Cod may disappear from the southern part of their range.

studies of how climate change might have effects that cascade through marine food webs. Scientists at URI have found that the gradual warming of seawater has changed some fundamental marine processes. First-year students of marine biology are taught that after a period of winter inactivity diatoms and other phytoplankton, the one-celled algae that are the foundation of the marine food web, start blooming in the late winter or early spring in response to increased light levels. This is followed by a bloom of zooplankton, such as copepods, which feast on the abundance of algae.

University of Rhode Island scientists have found that the annual spring phytoplankton bloom in Narragansett Bay is weaker and occurs earlier in the year than formerly. In some years it does not occur at all. They hypothesize that the warmer winter temperatures are allowing zooplankton to breed much more rapidly earlier in the season, so the phytoplankton populations are grazed down before they can build up. The effect filters down to the bottom (benthic) community. In the past, the uneaten phytoplankton used to sink to the bottom where they were consumed by worms and other benthic invertebrates, thus supporting the benthic food web. The loss of phytoplankton biomass combined with warmer temperatures has contributed to the decline of winter flounder and other bottom-dwelling fish that consume these benthic invertebrates. Overall, cold-water bottom-dwelling fish such as winter flounder, red hake, and longhorn sculpin have been replaced by opportunistic pelagic species such as butterfish, scup, and longfin squid. These latter marine organisms prefer warmer temperatures and feast on zooplankton.

Another climate-related mechanism contributing to the decline in winter flounder in Narragansett Bay is that the warmer winter temperatures are allowing sand shrimp to remain active throughout the year. As its name implies, winter flounder spawn in winter. Formerly, flounder larvae were too large to be consumed by sand shrimp when the sand shrimp became active in the spring. This is no longer the case. There are also now earlier blooms of comb jellies, which are voracious predators of fish food (copepods) and fish larvae. In the past, these did not appear until midsummer, but now they appear in the spring in Narragansett Bay and many other bays and estuaries along our coast.

It is sad to envision a future when our tide pools are covered with invasive tunicates, our bays are chock-full of comb jellies, and some of our most cherished fish, Atlantic cod and winter flounder, are in retreat. The potential for that to happen will hopefully be one more thing spurring us to take action to address climate change.

Robert Buchsbaum is Mass Audubon's conservation scientist in the Southeast and Islands Region.

Addressing Climate Change at Mass Audubon

by Loring Schwarz

Back in 1896, our intrepid founders Harriet Lawrence Hemenway and her cousin Minna B. Hall rallied to address the most frightening threat to nature in their time—the fashion industry's wanton extirpation of birds for their lovely plumage. Their willingness to address a crucial social problem and promote fashion alternatives led to passage of state and federal legislation to protect birds.

It is perhaps ironic that Harriet and Minna labored at the dawn of the 20th century—a transformative era in Boston. Automobiles were making an appearance on the streets, and street cars began to open up the suburbs to life outside the urban core. Could they have taken a peek into the future, what would Minna and Harriet have done about the unimaginable threat to nature that would eventually surface?

From our 21st-century vantage point, we now know that the phenomenon of climate change, caused by excessive carbon dioxide and other heat-trapping gases in our atmosphere, has been increasing global temperatures and changing the chemistry in our oceans. The excessive gases are primarily the result of human activity, evidenced mainly in the cumulative effect of the burning of fossil fuels and land use changes such as massive deforestation across the globe.

We are already observing changes in our ecosystems as a result of the effects of climate change. For years those of us working in land conservation have been trying to anticipate how this threat will play its hand in the local natural systems we are trying to protect. In planning our actions to protect nature, we have noticed the appearance of some concrete and sinister signs and are anticipating some worrisome trends.

There are a variety of impacts that will be made worse by climate change. These include water stress, pests and pathogens, extreme weather events, invasive species,

Climate Change Action

• Promotion of sustainable living

Mass Audubon has reduced its carbon footprint 50 percent through energy efficiency and green energy. Our sanctuaries across the state serve as solar, geothermal, and energy-efficiency demonstration sites. Our investments in alternatives and efficiency show the public that, through commitment and long-term planning, organizations that install green energy and energy-efficiency features can reduce carbon dioxide emissions, conserve water resources, and save money.

• Our policy toward progress

A strong Global Warming Solutions Act, Regional Greenhouse Gas Initiative, and Green Communities Act will form a framework for reducing our heat-trapping gases at the community and state levels. We will promote a comprehensive statewide adaptation plan and work with the Massachusetts legislature to gain passage and funding for a Comprehensive Adaptation Management Program (CAMP).

• Climate literacy through education

Creating climate literacy here in Massachusetts requires revealing the problem to each citizen and encouraging personal and political action. Sanctuaries statewide will be climate learning centers, educating diverse audiences in addressing climate change and revolutionizing the way we present this challenging topic.

• Climate adaptation resilience

The diverse ecological systems of Mass Audubon's 35,000 acres provide a bank that stores carbon in biomass and soil in perpetuity while insulating us from harsh climate impacts. Much of our land is in forest. On average every acre of forestland in Massachusetts stores 85 tons of carbon each year, with the rate and mass of carbon storage increasing over time as forests mature.

• Factoring climate change into land planning

Land restoration projects such as the Sackett River dam removal at Canoe Meadows Wildlife Sanctuary create water-storage capacity and flood protection while reconnecting severed river habitat and buffering it with newly created floodplain forest. At Rough Meadows Wildlife Sanctuary, we are working with several partners to design and protect what may be productive salt marsh of the future as the level of the sea rises and floods low-lying areas.

• A broader conversation

We hope to engage partners concerning land protection and management in an era of change. We are beginning to simplify regional and statewide climate change scientific planning tools and evaluate conservation practices that are site appropriate. Our work will help the state's land trusts, municipalities, and private landowners to better allocate land protection and management resources.

wildfire, and shoreline erosion, with multiple impacts occurring at a single site in some cases. Protecting the natural world must now include actions to arrest the progression of climate change and prepare for what will surely be a different environment.

Despite what is at stake, addressing climate change in the mainstream has been problematic, the science complex, and the politics thorny. We, as a broad conservation community, have struggled to find the best ways to confront these problems. Even among environmentalists, there have been debates as to which aspects of climate change deserve attention first, or even exclusively. For example, how much attention should be trained on avoiding the unimaginable (reducing heat-trapping emissions) versus managing the unavoidable (adaptation to inevitable changes)?

The truth is that, wittingly or not, Mass Audubon has been addressing climate change since its earliest days. Our philosophy of living lightly on the earth translates to practices such as recycling, using public transportation, and supporting locally grown food that we know reduces emissions. The act of protecting land and managing it sustainably, as we have on our 35,000 acres, provides insurance in a changed climate since naturally resilient landscapes store carbon and are better able to protect us from the vagaries of extreme weather.

Mass Audubon can continue to pioneer strategies in both emissions reduction and adaptation to climate change. There are many ways that the lens of climate change can refine our approach in operations, land protection and management, science planning and research, and ongoing advocacy, and there are also specific activities we must embark on by way of a unique Mass Audubon role.

Our new four-part climate change strategy taps our acknowledged expertise, with each activity addressing a specific method to move statewide progress along. Collectively, they provide a mix of actions, address climate change root causes, and promote strong adaptation responses to the inevitability of a changed climate. We believe that by modeling success in these four areas we can multiply our impact across the Commonwealth.

Loring Schwarz is director of the climate change program at Mass Audubon.

Climate Preparedness in the Commonwealth

by Karen Heymann

"…one second of time conveys to the mind a strange idea of insecurity, which hours of reflection could never create." – Charles Darwin

Any New England farmer, gardener, or birder can tell you that on average spring is arriving sooner, summers are getting hotter, and winters are becoming warmer and drier. Climate change is the greatest threat to the nature of Massachusetts, and even our best efforts to curb the concentration of heat-trapping gases in the atmosphere are projected to avoid only its worst impacts. In 2012 alone there were eleven different weather and climate disasters across the United States, with estimated losses exceeding $1 billion each.

Then Hurricane Sandy wrought more destruction than anyone previously thought possible; at more than a thousand miles wide, it claimed 159 lives and caused more than $68 billion in damage. Homes and businesses were damaged or destroyed, and communities were left to contend with massive cleanup and recovery efforts that are still going on today. Experts conclude that coastal areas are particularly vulnerable to the interacting effects of development, pollution, and climate change, and coastal communities are poorly prepared to respond to increasing risks imposed by climate change. Inland communities are by no means immune since more frequent intense storms and extended heat waves affect them as well.

Mass Audubon's Advocacy Department works to connect Massachusetts residents with the environment regardless of how "green" they are and bridges the gap for those with different perspectives on matters of the environment, public health, and the economy. Our twelve decades of conservation work and research are highly relevant to addressing modern-day climate issues in urban, suburban, and rural settings. The quality of the water we drink, the air we breathe, and the food we eat are dependent on the services that nature provides.

Modern climate strategies integrate natural systems into state municipal and local planning efforts. Over the last decade, accepted approaches include conservation and restoration of wetlands, marshes, seagrass beds, and oyster and coral reefs, powerful tools provided by Mother Nature, unmatched in their capability to absorb floodwater and buffer damaging wind. When a storm hits, these areas absorb storm surge and protect people and wildlife living farther inland. However, the rapid rate of development along our coast and in our floodplains has degraded these valuable resources and weakened our natural defenses.

Massachusetts has led the way on climate change solutions by partnering with ten Northeast and Mid-Atlantic States in the Regional Greenhouse Gas Initiative (RGGI). This "cap and trade" program reduces our regional global warming emissions from power plants and creates a revenue stream that can be used for energy-efficiency projects. In 2008 the state legislature passed the Global Warming Solutions Act, which requires Massachusetts to reduce emissions of heat-trapping gases to levels recommended by scientists to help us avoid the most dangerous effects of climate change over a specified time frame. This, along the Green Communities Act to encourage energy efficiency in cities and towns, as well as other science-based environmental laws, regulations, and policies, positions the Commonwealth as a leader and will encourage other states to adopt similar approaches to address climate change.

Natural disasters shouldn't be required to rally initiation of a comprehensive plan to prepare us for the projected impacts of climate change. Last summer, President Barack Obama stated: "Those who are already feeling the effects of climate change don't have time to deny it—they're busy dealing with it." Today, with 85 percent of Massachusetts' 6.7 million residents living within 50 miles of the coast, it could be our friends and neighbors recovering from a catastrophic hurricane. Mass Audubon is supporting recently filed legislation, An Act providing for the establishment of a comprehensive adaptation management plan in response to climate change (S2028), introduced by Senator Marc Pacheco (D-Taunton). This bill would require the state to adopt a plan to identify vulnerabilities in our electrical grid, buildings, roads, airports, dams, water supplies, and sewage treatment plants and then recommend how to strengthen them. We helped to draft language in the bill that requires this plan to consider the protective value of our beaches and wetlands, forests and rivers, and other natural systems. Call your legislator today and let him or her know that you support this bill.

Karen Heymann is Mass Audubon's Legislative Director. She worked previously on environmental and agricultural policy in the US House of Representatives and as a farmer in western Massachusetts.

Sketch from Zone 6b

Maryland and coastal Massachusetts have comparable weather, but their commonality—a shared minimum average temperature—appears to be edging northward.

by Ann Prince

The Maryland state tree, bird, and flower: white oak, Baltimore oriole, black-eyed Susan

As a resident of the South Shore, I've referred to the USDA plant hardiness zone designations often over the past 25 years to ascertain which specific plants will and will not make it through the winter. These zones are based upon the average minimum (coldest) yearly temperatures. One benefit of being close enough to smell the salt air and see the salt water is the relative mildness onshore, known as the maritime effect, with lagging ocean temperatures moderating the climate on land close to the sea.

Maintaining a suburban yard with wildlife-friendly flora is an extremely important way to sustain native animal species, and it requires thoughtful decisions. There's no point in planting something that won't survive, and it's good to make room for trees, shrubs, and herbaceous woodland plants while leaving space for sunlight to grow vegetables and flowers. Many of the trees and shrubs have already decided for themselves where they want to be, which of course pleases the migrating and year-round birds, and other winsome residents from chipmunks and flying squirrels to leafhoppers and jumping spiders.

A big plus in understanding the ecosystem is a lifelong familiarity with Zone 6b. Who could have imagined that the Maryland neighborhood where I grew up—a short bike ride from the Potomac River—would be in the same hardiness zone as a narrow strip that climbs north near the Atlantic shoreline through Delaware, New Jersey, New York, Connecticut, and Rhode Island and all the way up to my little Massachusetts town?

I love the familiar so I'm happy to abide among many of the same species: not nostalgia but lighthearted joyous memories from decades past are re-lived 350 miles north of my original hometown every day. The similarities in my yard as a kid outside DC and my current habitat just north of Plymouth far exceed the differences—if you overlook the fact that the iron-rich southern clay is red in contrast to the yellow clay/sand soil of our New England hillside.

Lo and behold, the Maryland state symbols are all represented in my yard, six states northward.

Three handsome specimens of the Maryland state tree, the white oak, characterized by light-colored shallow-furrowed bark and leaves with round lobes, greatly enhance the view outside my bedroom window. And the Maryland state flower, black-eyed Susan, and the state bird, the Baltimore oriole of course, are delights in summer. (Forgive me if I must still root for the Orioles despite being a Red Sox convert.)

Cottonwoods, various species of oak, and other oriole nesting trees can be found all through the neighborhood. The children's two little dogs, a Westie and Yorkie, have inadvertently donated hair they've shed as nesting material for the orioles, whose structurally superlative hanging woven nests are well hidden somewhere nearby.

The birds that I watched at my feeder as a preschooler and learned to identify before being able to pronounce them properly—namely cardinals and tufted titmice—began to extend their ranges well above the Mason-Dixon line at the outset of the Sixties, getting a head start on my move northward by 20 years or so. They

Common in Zone 6b: American dogwood, Carolina wren, spring azure butterfly

are once again my feeder birds, awakening anyone who wishes to listen in the early a.m. with their happily whistled *cheer, cheer, cheer* and *peter, peter, peter*. These vocals are ingrained in my consciousness like the voices of my children.

Oaks on the lot are ecosystems that support a multitude of species of moth and butterfly caterpillars, and also breeding and resident birds including wrens, woodpeckers, and nuthatches. The beech grove is a boon for wildlife since beechnuts are popular with small mammals and game birds such as wild turkeys. The grove reminds me of my favorite beech tree, which happened to be in my childhood yard in Maryland.

When my family moved to Carderock Springs when I was 7, the biggest of the beeches in my backyard, I discovered, was magically linked to some romantic event from decades ago. It had an old heart with two lovers' names carved into its smooth bark. The sweethearts' declaration of love obviously pre-dated division of the land into lots, and my house was built not 15 feet from the tall trunk. Since the construction so close must have taken some finesse, the builder surely noticed the tree's enchantment too.

Fifty years later, I visited the tree this winter thanks to the gracious current owners. Though the inscribed names have slowly faded into the trunk as it has broadened, they remain visible but not legible. But there is still no mistaking that heart! Whoever sited the home also left an oak in the center of the front yard. At least 200 years old, it is more magnificent than ever, its canopy spreading over the entire front yard like a green umbrella.

In our off-River-Road neighborhood, we had profusely blooming native dogwoods, which highlighted the woodland that the subdivision builder left as natural as possible. So in their honor I transplanted an American dogwood near my front doorstep in Duxbury. Fittingly, the caterpillars of my second favorite butterfly, the spring azure, love dogwood and munch on the buds, as well as on steeplebush, meadowsweet, blueberry, and viburnum, before they metamorphose and emerge as delicate blue winged angels.

With this surfeit of spectacular and heartwarming natural phenomena in Zone 6b, one might wonder why everything could be anything but all right with the world. Yet reminiscing can be bittersweet. And alas, change is happening. Regardless of the long-term predictions with respect to climate change and how on or off base they might be, the temperature is already rising—in Zone 6b and all over the map. In fact, according to the USDA all zones have moved upward a half-step (about 2 ½ degrees difference).

But rather than fretting, I'm going to accept the challenge and try to make a positive difference when I can. I continue to remove unwanted non-native plant pests that are trying to invade. And by contrast, since I didn't see a single monarch last year—unheard of in the flyway where my land is located—I'm going to plant more butterfly weed and milkweed for the monarch caterpillars, and not "weed" their food plants out of the lawn despite their height. Of course, my budding environmentalist son won't mow down the milkweed either.

And as for the Baltimore orioles, while widely distributed throughout the state, their numbers are decreasing overall. The *Massachusetts Breeding Bird Atlas 2* has therefore placed the oriole in the "whispering bird" category, meaning that it is currently "quietly" declining. While my beloved home state bird (just one of many avian species that can benefit from assistance) seems to be ubiquitous on our land presently, we will help in whatever way we can.

Orioles happen to love orange flowers for nectar and lengths of ribbon or twine for their nests so we'll definitely make sure to take that into account each year and provide them with the necessary materials. Maybe sometime in summer we'll catch sight of a work of art suspended from a tree—a nestful of multicolored yarn mixed with plant fiber, grapevine bark, even fishing line, woven by the female.

Most of all, more than ever, we will encourage our favorite native plants and animals in any way we can, consider their many needs during times of transition, and never never give up.

Ann Prince is associate editor of Sanctuary.

Integrating Satellite Remote Sensing and On-the-Ground Observation

by Ann Prince

How are ecosystems changing over time? This fundamental question is being asked at Mass Audubon sanctuaries statewide. With various factors threatening the stability and resilience of our native ecosystems, it is critical to track ecological changes that have occurred in past decades as a way to anticipate what further changes may occur at our sanctuaries in the next 50 years and counting.

For decades, researchers have been gathering information on changing ecosystems using both top-down and bottom-up approaches—from space-age land cover maps derived from satellite remote sensing to traditional field-based surveys of species location and identification. When combined, these complementary data sets enable scientists not only to assess what has changed so far but also, theoretically, to assist in forming models to make predictions moving forward.

Climate change will affect Mass Audubon's coastal sanctuaries in obvious ways as a result of sea-level rise, causing higher tides, flooding, and saltwater intrusion. But deviation over time regarding flora and fauna, and habitats in general, is inevitable at all of our properties. What makes Broadmoor—a 624-acre inland sanctuary in Natick, acquired in 1968—the perfect place for change-based research is the assemblage of data accumulated there over nearly five decades.

Boston University doctoral student Valerie Pasquarella, a young scientist working on her dissertation under the guidance of professors Suchi Gopal, Curtis Woodcock, and Les Kaufman, is taking on the challenge of understanding long-term ecological change both within and beyond the boundaries of Broadmoor. Historic data for her study comes from various sources including Breeding Bird Surveys conducted from 1974-1978 and 2007-2011, Christmas Bird

Circa 1980: View of Indian Brook from the trail beside the gristmill spillway at Broadmoor Wildlife Sanctuary

Counts spanning decades, broad ecological assessments carried out by Mass Audubon scientists, and more specialized research conducted by Boston University biology professors Robert Tamarin, Les Kaufman, Richard Primack, and their students on mammals, fish, salamanders, lady's slippers, and other flora and fauna at the sanctuary.

"Broadmoor has served as a field station for BU nearly since its establishment," says Sanctuary Director Elissa Landre. "We're continuing that tradition with more academic collaboration."

Also integral to Pasquarella's dissertation is her employment of remote sensing and other geospatial technologies in furthering our understanding of Broadmoor's habitats and their dynamic nature. Pasquarella uses a series of "views from space"—Landsat satellite imagery acquired approximately bimonthly over the past 30 years—to map and monitor changes in land cover.

Because different materials such as water, soil, and vegetation reflect visible and infrared light in distinguishable ways, Landsat's seven distinct spectral bands or "colors" can be used to discriminate among many different human-dominated and natural land cover types. While most prior research on change detection has focused on comparing two dates of imagery to identify locations that have changed, Pasquarella is making use of the complete archive of Landsat observations and applying a brand-new time-series-based analysis technique innovated by Professor Woodcock and his crew of researchers at BU.

This new approach allows Pasquarella to reconstruct a 30-year history of the Broadmoor landscape from Landsat data, using surface reflectance measurements and models to track both gradual habitat transitions such as increased wetland flooding following the advent of beaver populations and the occurrence of forest succession, and abrupt changes in ecosystem states, for example, habitat restoration projects and suburban development. Pasquarella unifies her top-down approach with bottom-up views of the Broadmoor landscape by comparing the models and maps she generates from Landsat time series data with empirical data collected by naturalists, researchers, and citizen scientists on the ground at Broadmoor.

While climate change is one factor affecting the ecology at the sanctuary, there are other variables that come into play: how continued pressure human development has transformed natural communities, how active the beavers have been in creating wetlands, which invasive plants are already making inroads, and how the Charles River rises and falls as a result of influences upstream. Whatever the reason for the evolving ecosystem, Pasquarella is charting it all and creating a new model for Broadmoor and other sanctuaries to use in making decisions about adaptive management far into the 21st century.

Ann Prince is associate editor of Sanctuary.

Spring 2014: the same location as the image to the left (page 22). Significant flooding has occured as a result of a beaver dam downstream.

Poetry

Edited by Wendy Drexler

© FRANCES ROSS

Magnolia blossoms

To the *Magnolia grandiflora* Migrating North

by Margaux Novak

I'm guilty
of calling you north
because I've come north—
you who lies down with the south
who stretches out
and hugs the curves of mountains
who whispers to the coastline
and sighs.

It's a long trek to here,
and the frost will not be kind.
Heat is heavier where you are.
I used to be southern, tea-sweet dirt.
I knew the egret's call, the firefly nights.
Stay there.
Ignore the heat. Root deeper.
Leaf more. Forget me.

Margaux Novak was raised in coastal North Carolina and received two degrees from NC State University. Her poems have recently appeared in Ink Seed *and* Satul. *She lives in Boston.*

Tree Peony Changes Her Mind

by Anna M. Warrock

When in June her red silken hair
piled in a bun began to untangle,
I blushed with gratitude.
But ten years on, she dallies elsewhere.
Now blooming in May,
she seems too pert, too eager
for Summer, which also rises early to urge her on.
The two, like movie stars in my backyard,
drift in a fraught glory,
too much, too soon,
that blinds us
to the why and wherefore.

Anna M. Warrock's poems have been set to music, installed in the Davis Square MBTA station, Somerville, and published in journals. Her chapbooks include Horizon *and* Smoke and Stone.

Disordered

by Denise Provost

The daffodils have thrust up from the ground
their optimistic stubs of green. It's now
the end of January. Tell me how
these premature arrivals will be found
in their proper season—with stems unwound,
exposed and spent? Likewise, the cherry tree
displays its pointed buds prominently—
will they, then, freeze, and fall? Red shoots abound
on our rose vine, coaxed from its dormancy
by spells of freakish heat. Some celebrate
these spring-like winter days, and do not see
disturbances. We underestimate
the earth's unexpected fragility,
a sweet abundance we cannot replace.

Denise Provost has published poetry in Bagel Bards #8, Ibbetson Street, Muddy River Poetry Review, qarrtsiluni, Quadrille, Sonnet Scroll, *and* Light Quarterly. *She lives in Somerville.*

Nobody cares to do anything about the weather

by Marge Piercy

A friend is growing a fig tree on Cape
Cod. I wonder how it will withstand
this winter of storms pressing hard
one on the other in frigid waves.

The storms grow bigger, hurricanes
more intense, nor'easters gnawing
the dunes, flooding inward. Weather
is simply more of everything.

We are suddenly zone seven here
so I no longer mulch tree peonies
and left some summer bulbs still
buried in six inches of earth.

A neighbor is having rare success
growing cantaloupes and lima beans.
Stink bugs are new invaders. Old
local garden adages are obsolete.

The experts say we can grow figs
here, but we are sailing on our spit
of sand into a new ocean. Nobody
knows what's coming down on us.

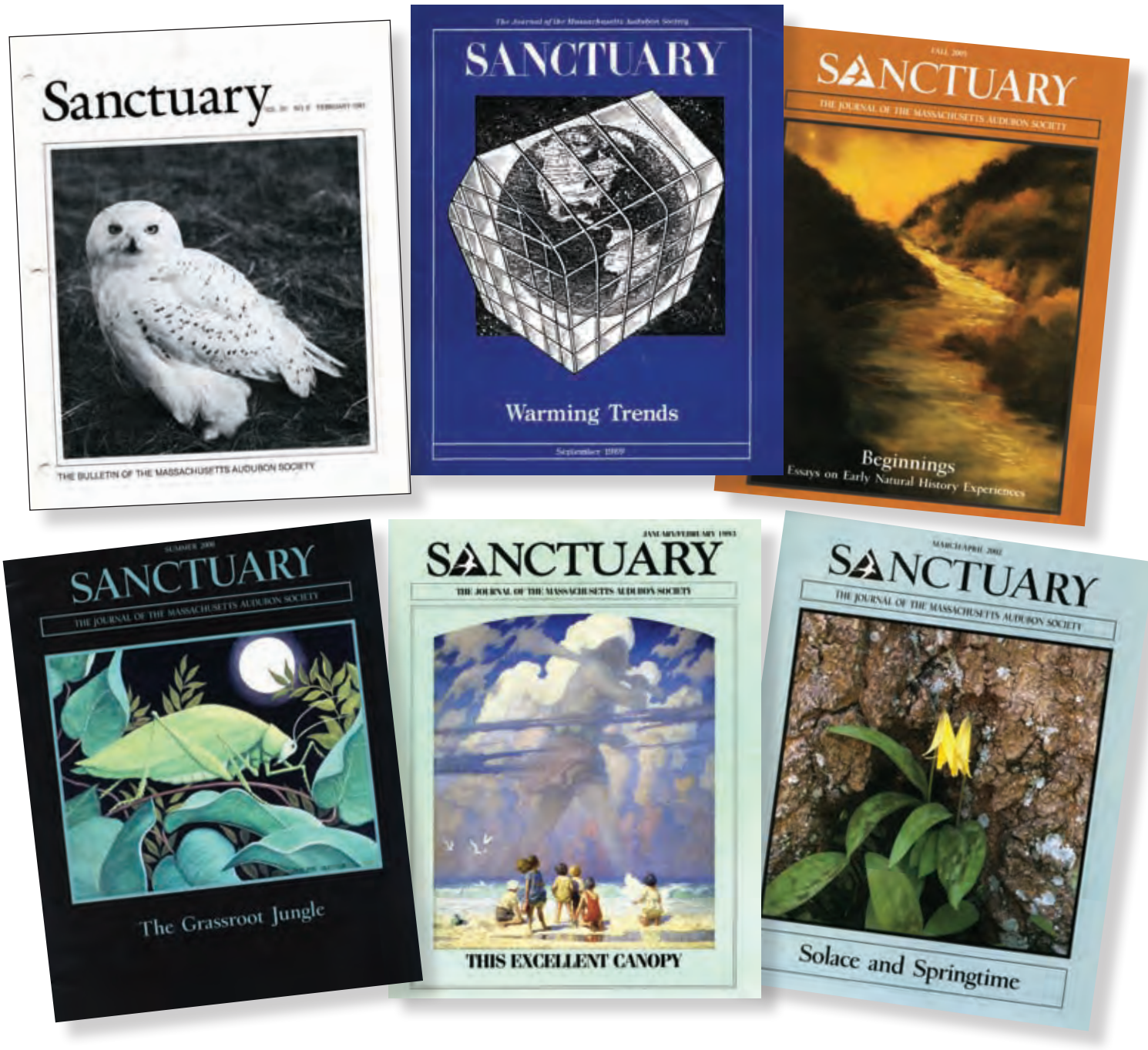
Marge Piercy has published 18 poetry collections, recently from Knopf The Hunger Moon: New & Selected Poems 1980–2010*; a memoir,* Sleeping with Cats, *from Harper Perennial; 17 novels; and a short story collection,* The Cost of Lunch, Etc., *from PM Press.*

Evidence

by Margot Wizansky

Summer, before spring this year,
even before winter is upon us.
Sweat without foliage. Seasons
harden, shatter. The sky, dark
threatening, yields no rain.
Wild turkeys take over
the town, a rafter of them
strutting down Cypress Street,
hungry and restless, jumping
the fence at the corner of Gorham,
menacing children and dogs,
scratching the powdery earth
for grubs. We cannot interfere
or risk arrest. Forsythia
is tentative, a little dull,
and quickly wilts. Crocuses
push up, go limp. Sap neglects
to run or boils down pale
and meager. Still standing, sage
broadcasts a new mustiness
to the air. Sea ransacks
the beach, a ragged greasy strip
where flies begin their pestering.
Leafless season sings a dirge at evensong.
How will we know when to plant,
atonement twisted upon itself,
and when to dance the harvest?

Margot Wizansky's poems are in journals and anthologies about Alzheimer's and cancer. She transcribed the oral history of Emerson Stamps, grandson of slaves: Don't Look Them In The Eye: Love, Life, and Jim Crow.



Sanctuary Back Issues Available

Climate change, the theme of this final issue and now a central focus for Mass Audubon, was first covered in the September 1989 *Sanctuary* entitled "Warming Trends," an entire edition devoted to problems and solutions related to the looming global challenge.

Themes of *Sanctuary*, always educational and timely, have run the gamut—covering each of the seasons individually; specific wildlife groups ranging from winged insects to birds, turtles to bears; habitat types such as pine barrens, vernal pools, forests, barrier beaches, wetlands, and oceans; and environmental problems including invading non-native species, acid rain, and proliferation of pesticides. Other editions featured ecological art, land conservation, literature, farming, migration, wind, the tropical connection, the urban environment, weather, geology, sustainable communities, wind, fisheries, the coast, green economics, nighttime, landscapes, literature, children and nature, and the list goes on.

All told, including this final issue, Mass Audubon published 200 editions of *Sanctuary*.

If you'd like to obtain back issues, call 781-259-2167 or 781-259-2168.

CANOE AND KAYAKING PROGRAMS

BERKSHIRE SANCTUARIES
Lenox, 413-637-0320
Canoe Trip on Buckley Dunton Lake
August 3 and 24—9 a.m.-noon
Canoe Trip on Goose Ponds
August 17 and September 13—8 a.m.-noon
Canoe Trip on the Housatonic
September 6—8:30 a.m.-12:30 p.m.

BROADMOOR
South Natick, 508-655-2296
Fall Foliage Canoes
September 27-October 19

CONNECTICUT RIVER VALLEY
Easthampton, 413-584-3009
Late-Summer Paddle
August 29—6:30-8:30 p.m.

FELIX NECK
Edgartown, 508-627-4850
Kayak Quest
Daily Monday-Friday—May 5-September 26
Call to reserve a boat: 508-627-4850
Moonrise Kayaks
August 10—7-9 p.m.
August 11—7:30-9:30 pm
September 8—6:15-8:15 p.m.
September 9—6:45-8:45 p.m.
Ages 11 and up with an adult in a tandem boat; preregistration required

IPSWICH RIVER
Topsfield, 978-887-9264
Essex River Wildlife Adventure by Kayak
July 26—10 a.m.-4 p.m.
Family Dusk Paddles
August 8 and 22—6-8 p.m.
Annisquam River Paddle
September 6—noon-5:30 p.m.

LONG PASTURE
Cummaquid, 508-362-7475
Barnstable Harbor Kayak Trips
June 7 and 21—6-8:30 p.m.
June 14—10:30 a.m.-1 p.m.

SOUTH SHORE
Marshfield, 781-837-9400
Deer Island Archipelago by Sea Kayak
September 21-27

WACHUSETT MEADOW
Princeton, 978-464-2712
Moonlight Canoe for Adults
September 13—6:30-8:30 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
Kayaking and Canoeing
Weekdays; times vary

FALL CELEBRATIONS

BLUE HILLS
Milton, 617-333-0690
Fall Festival and Yard Sale
October 11, 12, 13—10 a.m.-4 p.m.

BROAD MEADOW BROOK
Worcester, 508-753-6087
Boo Meadow Brook Halloween Hike
October 10, 11—6:30-8:30 p.m.

BROADMOOR
South Natick, 508-655-2296
Creepy Crawlies
October 26—1-2 p.m.

CONNECTICUT RIVER VALLEY
Easthampton, 413-584-3009
Changing Lands: An Exploration of Arcadia Wildlife Sanctuary in Celebration of 70 Years of Conservation
October 18—10 a.m.-2 p.m.

FELIX NECK
Edgartown, 508-627-4850
Fern and Feather at 50 Fest
October 12—11 a.m.-3 p.m.

IPSWICH RIVER
Topsfield, 978-887-9264
Halloween Happenings
October 24 and 25

MOOSE HILL
Sharon, 781-784-5691
Halloween Prowl
October 24, 25, 26
Preregistration required

SOUTH SHORE
Marshfield, 781-837-9400
Farm Day
October 18—10 a.m.-4 p.m.

WACHUSETT MEADOW
Princeton, 978-464-2712
Hey Day
October 4—11 a.m.-5 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
Sea Turtle Festival
October 11

Family Programs

BERKSHIRE SANCTUARIES
Lenox, 413-637-0320
Evening at the Beaver Ponds
August 6—6:30-8 p.m.
September 3—6-7:30 p.m.

BLUE HILLS
Milton, 617-333-0690
Timber Rattlesnakes
July 18—7-8 p.m.
Build a Bird Feeder Exhibit
August 16—11:30 a.m.-12:30 p.m. and 2:30-4:30 p.m.
Build a Toad Home Exhibit
September 14—10 a.m.-12:30 p.m.

BOSTON NATURE CENTER
Mattapan, 617-983-8500
Nature Photography Workshop—Precious Pollinators with Eduardo del Solar
August 2—8-10 a.m.
Giving a Hoot about Owls
September 19—7-8:30 p.m.
Nature Photography Workshop—Fall Foliage with Eduardo del Solar
October 18—8-10 a.m.

BROAD MEADOW BROOK
Worcester, 508-753-6087
A Home for Birds
July 19—10-11 a.m.
Introduction to Moths
July 22—8 p.m.-midnight
Barbara J. Walker Butterfly Festival
August 9—10 a.m.-4 p.m.

BROADMOOR
South Natick, 508-655-2296
Wild about Turtles
September 13—1-2:30 p.m.

CONNECTICUT RIVER VALLEY
Easthampton, 413-584-3009
First Child in the Woods
June 21, July 26, August 23—10-11 a.m.
For infants up to age 5 along with a caregiver
Forest Sensory Walk
August 16—10-11:30 a.m.

FELIX NECK
Edgartown, 508-627-4850
Seashore Discovery
June 16-August 29—10-11:30 a.m.
Creature Feature
June 17-August 28—10-11 a.m.
Marine Discovery Tour
June 24-August 26—5:30-7:30 p.m.

HABITAT
Belmont, 617-489-5050
Ice Cream and Insects
July 30—6-7:30 p.m.
A Night at the Pond
August 13—6:30-8 p.m.

JOPPA FLATS
Newburyport, 978-462-9998

LONG PASTURE
Cummaquid, 508-362-7475
Aquatic Explorations
Every Thursday from July 3-August 28—1:30-3:30 p.m.

MOOSE HILL
Sharon, 781-784-5691
Carve a Pumpkin
October 23—1 to 8 p.m.
Fall Family Campout
September 20—6 p.m.
Preregistration required

WACHUSETT MEADOW
Princeton, 978-464-2712
Helping Wildlife: Monarch Butterflies
August 30—1-3 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
Marine Life Cruise in Wellfleet Harbor
Weekdays; times vary
Nauset Marsh Cruises
Weekdays; times vary

Birding Programs

BERKSHIRE SANCTUARIES
Lenox, 413-637-0320

BROAD MEADOW BROOK
Worcester, 508-753-6087
Saturday-Morning Birdwalk for Adults
August 2, September 6—7-9:30 a.m.
Friday-Morning Birds
August 29 through October 24—7-9 a.m.

BROADMOOR
South Natick, 508-655-2296
Hawk Watch at Pack Monadnock
September 13 and 20—10 a.m.-3 p.m.

CONNECTICUT RIVER VALLEY
Easthampton, 413-584-3009
The American Kestrel
August 27—9:00 a.m.-noon

FELIX NECK
Edgartown, 508-627-4850
Early Birders
June 26-August 28—8-9 a.m.

IPSWICH RIVER
Topsfield, 978-887-9264
Shorebird Migration
July 26—7:30 a.m.-noon
Warm-Water Seabirds of Stellwagen Bank
August 8—8 a.m.-1:30 p.m.

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

SOUTH SHORE
Marshfield, 781-837-9400
Daniel Webster at Sunset
August 30—5-7 p.m.
Birding by Van
July 20 and August 17—9-11:30 a.m.
Witnessing Shorebird Migration on Duxbury Beach
August 29—4:30-6:30 p.m.
Friday-Morning Bird Walk
Every Friday morning—8:15-11:45 a.m.
Preregistration not required

WACHUSETT MEADOW
Princeton, 978-464-2712
Hawk Watching for Families
September 7—12:30-2:30 pm
Fall Hawk Migration for Adults
September 14—12:30-3:30 p.m.

WELLFLEET BAY
South Wellfleet, 508-349-2615
Trips to Monomoy National Wildlife Refuge
Weekdays; times vary

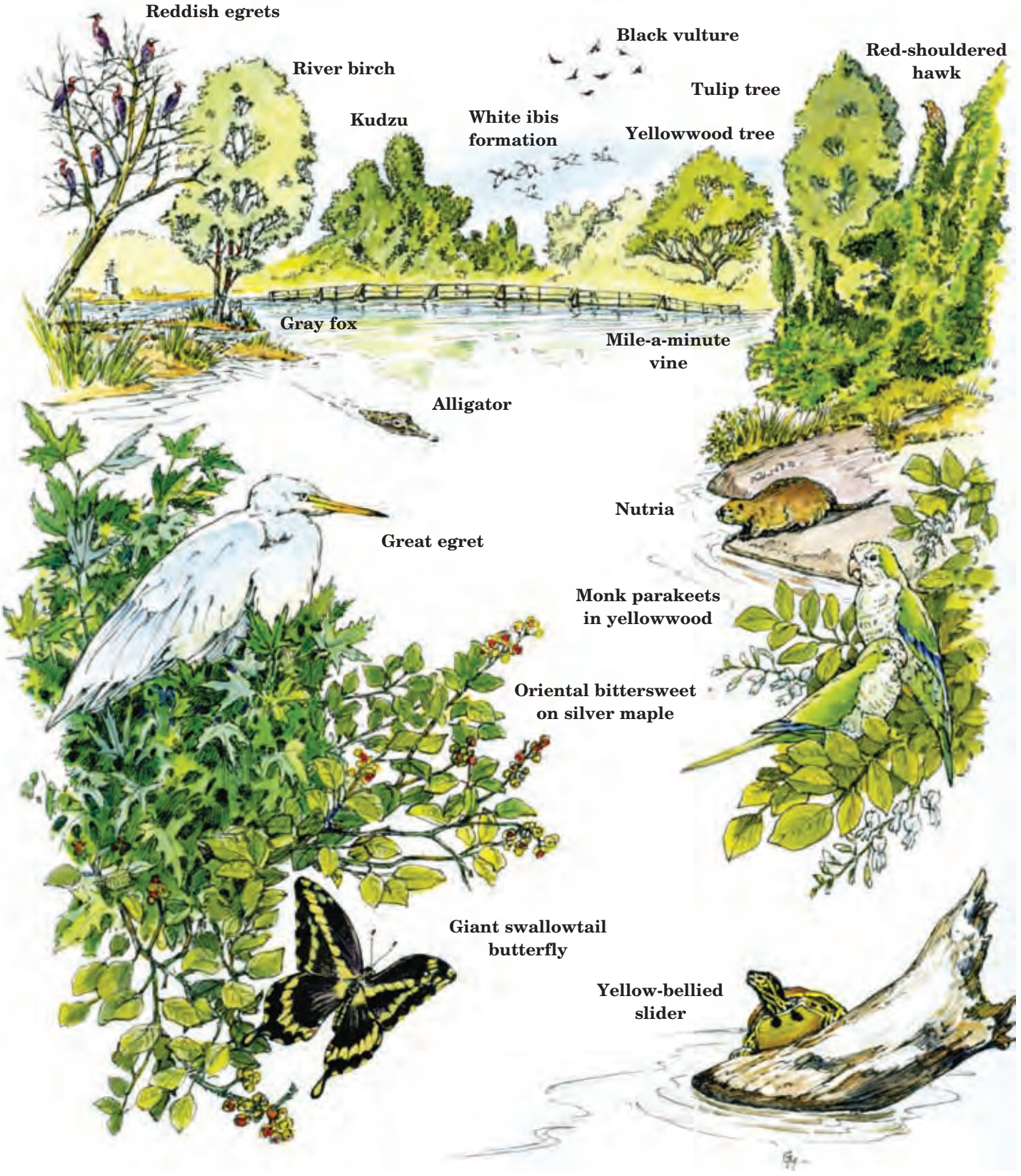
Call the individual sanctuaries for more information, fees, and to register.

For a full listing of Mass Audubon programs and events, visit our online catalog at www.massaudubon.org/programs.

Curious Naturalist

The North Bridge in Concord, July 2045?

Illustrated by Gordon Morrison



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Outdoor Almanac Summer 2014

July 2014

July 25 Shorebirds begin migrating southward. Watch for flocks along the coast.

July 27 Look for Indian pipes and beechdrops in forested areas.

August 2014

August 5 Yellow warblers and northern waterthrushes begin moving south.

August 9 Black fruits appear on the curving stems of Solomon's seal.

August 10 Full moon. The Summer Moon (Colonial American).

August 14 Goldfinches are nesting at this time. Watch for them in gardens and field edges.

August 16 Sweet pepperbush blooms near lakes and ponds about this time; sniff the air for its spicy odor.

August 18 Woodland asters begin blooming.

August 23 Cardinal flower blooms along clean freshwater streams.

August 26 Watch for migrating nighthawks overhead at dusk.

August 29 Fall webworms begin to appear; look for their nests at the tips of tree branches.

August 31 Chimney swifts and barn swallows form premigratory flocks.

September 2014

September 6 This is the peak of the fall warbler migration; watch for them in backyard shrubbery and treetops.

September 8 Full moon. The Chrysanthemum Moon (Chinese).

September 10 Broad-winged and sharp-shinned hawks migrate about this time of year.

September 23 Autumnal equinox; days and nights are of equal length.

September 26 Look for ripening wild grapes along old stone walls. Wild cherries, elderberries, and dogwood berries are ripe. Watch the thickets for feeding migratory birds.

October 2014

October 2 Green darner dragonflies migrate about this time. See them over sunny meadows.

October 5 First juncos arrive from the north.

October 6 Phoebes are still around.

October 8 Full moon. The Singing Moon (Celtic).

October 10 Watch for squirrel middens on stumps and rocks.

October 14 Yellow crab spiders may be seen inside goldenrod flowers.

October 17 Look for daddy longlegs in meadows.

October 19 Watch for large flocks of blackbirds.

October 21 Yellow-rumped warblers migrate. Listen for their *check* call as they perch in small trees and shrubs.

October 23 Oaks are still holding their leaves.

October 26 Once the leaves are off willows and elms, look for oriole nests at the ends of branches.

October 29 First hard frost around this date.

November 2014

November 4 Mushrooms are still coming up: look for the bright caps of yellow *Pholiota* growing on logs and vase-shaped clusters of oyster mushrooms on tree trunks.

November 6 Full Moon. The Trading Moon (Cherokee).

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