Lesson 3 & 4 Article

Climate change will leave Edith's checkerspot butterflies out of sync

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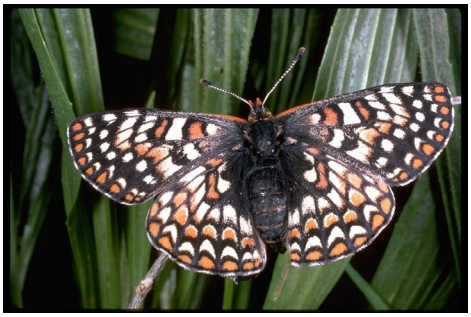
By Steve Toub

As part of our continuing series examining the impacts of climate change on endangered species, we'll now address how the rapid, disruptive climate change impacts the Edith's checkerspot butterfly. The butterfly is so sensitive to climate that the National Academy of Sciences (NAS) study on the Ecological Impacts of Climate Change says it acts as an "early warning indicator of climate change in North America."



Bay checkerspot butterfly – T.W.Davies (c), California Academy of Sciences

Two subspecies of the Edith's checkerspot butterfly are listed under the Endangered Species Act, the Bay checkerspot in the San Francisco Bay area, which was listed as threatened in 1987 and recommended to be "uplisted" to endangered last month, and southern California's Quino checkerspot, listed as endangered in 1997. Habitat destruction due to human development is the primary cause in declining populations of both subspecies, but the NAS reports that the Quino "is the first endangered species for which climate change is officially listed as both a current threat and a factor to be considered in the plan for its recovery" since the habitat in Baja California that is least developed is becoming too warm and arid to support the population.

Known for their delicate nature, butterflies' unique life cycle is part of their cultural appeal. Caterpillars need enough to eat during their larval stage to be able to go dormant during the pupa stage and emerge as adult butterflies. Unlike the migratory monarch, whose caterpillars can live on any number of milkweed species, the Edith's checkerspot butterfly spends its entire life in an extremely small habitat. Both the Bay and Quino checkerspots have only one primary host plant species during its larval stage, the dwarf plantain (Plantago erecta).

This habitat sensitivity makes them more susceptible to environmental changes than other butterflies: when the dwarf plantain ages earlier as a result of climate change, it becomes less available to checkerspot caterpillars. This lack of synchronicity between checkerspots and the resources on which they depend has been proven to lead to declines in their population and local extinctions, negatively impacting the likelihood of their recovery.

By looking at historical records in combination with 1994-1996 field studies of the Edith's checkerspot butterfly, Camille Parmesan has found that "population extinctions were four times as high along the southern range boundary (in Baja, Mexico) than along the northern range boundary (in Canada), and nearly three times as high at lower elevations (from 8,000 to 12,5000 feet)." This shift northward (92km) and upward (124m) in elevation corresponds to the warming trend in this region over this time period (105km northward and 105m upward), making this one of the first studies to make the claim that decline of a species is most likely due to warming trends.

While rapid climate change may force the checkerspot to migrate northward and to higher elevations, the host plants and nectar sources they depend upon may not always be available there or be able to migrate as quickly as the checkerspot, creating resource mismatches. Stanford University researchers also report that since the temperature and precipitation changes are expected to increase in variability, it is less likely that butterfly and its larval hosts could adapt than if the changes followed a consistent pattern from year to year.

In response to increased climate change, the traditional options of protecting habitat in the northern and higher-elevation areas of the existing range of these two subspecies may not be enough. Some conservation biologists such as Parmesan are now proposing that species like the Bay and Quino checkerspot butterflies be forcibly moved into areas in which they've never been. This "managed relocation" strategy, isn't without controversy; critics have labeled it as "tantamount to ecological roulette."

To learn more about the impact of climate change on endangered species, visit the Endangered Species Coalition website at stopextinction.org and see previous posts on polar bears, pikas, birds, and reptiles.

Categories: climate change, adaptation, Global Climate Change Impacts in the United States, checkerspot butterfly

National Wildlife Federation | http://www.nwf.org/News-and-Magazines/National-Wildlife/News-and-Views/Archives/2007/Walden-Warming.aspx

Lesson 3 & 4 Article

Walden Warming

Following in Thoreau's footsteps, Massachusetts researchers are creating the most complete picture yet of global warming's impact on the biology of a U.S. region

10-01-2007 // T. Edward Nickens By Steve Toub

MAY 10, 1853, was a warm day outside Concord, Massachusetts--an early spring day when a New Englander outdoors would "begin to think of thin coats," noted Henry David Thoreau. Walking from Concord towards Saw Mill Brook, Thoreau jotted down what he saw. "The deciduous woods were in their hoary youth," he wrote, "every expanding bud swaddled with downy webs." Nodding trillium had flower buds, and hornbeam was about to bloom. Pear trees had blossomed, and the butternut buds were the most pronounced of all the woods' hickories. He heard the spring's first veery. "It is remarkable," wrote Thoreau, "that I saw this morning for the first time the bobolink, gold robin [most likely a northern oriole], and kingbird."

Remarkable, too, that he kept such meticulous records. In fact, on almost every spring morning between 1851 and 1858, long after his private tenure at Walden Pond, Thoreau explored the ponds and shady woods around Concord, observing nature. For day after day, year after year, he searched for the first blooms of more than 300 plant species and watched for the first arrivals of migrating birds.

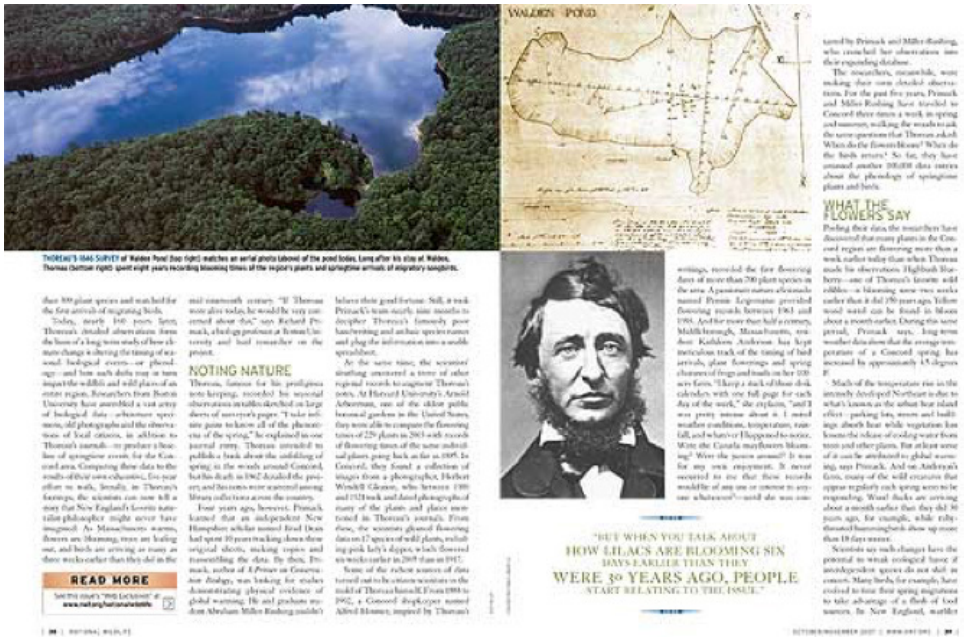
Today, nearly 160 years later, Thoreau's detailed observations form the basis of a long-term study of how climate change is altering the timing of seasonal biological events--or phenology--and how such shifts may in turn impact the wildlife and wild places of an entire region. Researchers from Boston University have assembled a vast array of biological data--arboretum specimens, old photographs and the observations of local citizens, in addition to Thoreau's journals--to produce a baseline of springtime events for the Concord area. Comparing these data to the results of their own exhaustive, five-year effort to walk, literally, in Thoreau's footsteps, the scientists can now tell a story that New England's favorite naturalist-philosopher might never have imagined: As Massachusetts warms, flowers are blooming, trees are leafing out, and birds are arriving as many as three weeks earlier than they did in the mid-nineteenth century. "If Thoreau were alive today, he would be very concerned about this," says Richard Primack, a biology professor at Boston University and lead researcher on the project.

NOTING NATURE

Thoreau, famous for his prodigious note-keeping, recorded his seasonal observations in tables sketched on large sheets of surveyor's paper. "I take infinite pains to know all of

the phenomena of the spring," he explained in one journal entry. Thoreau intended to publish a book about the unfolding of spring in the woods around Concord, but his death in 1862 derailed the project, and his notes were scattered among library collections across the country.

Four years ago, however, Primack learned that an independent New Hampshire scholar named Brad Dean had spent 10 years tracking down these original sheets, making copies and reassembling the data. By then, Primack, author of *A Primer on Conservation Biology*, was looking for studies demonstrating physical evidence of global warming. He and graduate student Abraham Miller-Rushing couldn't believe their good fortune. Still, it took Primack's team nearly nine months to decipher Thoreau's famously poor handwriting and archaic species names and plug the information into a usable spreadsheet.



HISTORICAL IMAGES FROM CONCORD FREE PUBLIC LIBRARY

At the same time, the scientists' sleuthing uncovered a trove of other regional records to augment Thoreau's notes. At Harvard University's Arnold Arboretum, one of the oldest public botanical gardens in the United States, they were able to compare the flowering times of 229 plants in 2003 with records of flowering times of the same individual plants going back as far as 1885. In Concord, they found a collection of images from a photographer, Herbert Wendell Gleason, who between 1900 and 1921 took and dated photographs of many of the plants and places mentioned in Thoreau's journals. From these, the scientists gleaned flowering data on 17 species of wild plants, including pink lady's slipper, which flowered six weeks earlier in 2005 than in 1917.

Some of the richest sources of data turned out to be citizen-scientists in the mold of Thoreau himself. From 1888 to 1902, a Concord shopkeeper named Alfred Hosmer, inspired by Thoreau's writings, recorded the first flowering dates of more than 700 plant species in the area. A passionate nature aficionado named Pennie Logemann

provided flowering records between 1963 and 1993. And for more than half a century, Middleborough, Massachusetts, resident Kathleen Anderson has kept meticulous track of the timing of bird arrivals, plant flowerings and spring choruses of frogs and toads on her 100-acre farm. "I keep a stack of those desk calendars with one full page for each day of the week," she explains, "and I was pretty intense about it. I noted weather conditions, temperature, rainfall, and whatever I happened to notice. Were the Canada mayflowers blooming? Were the juncos around? It was for my own enjoyment. It never occurred to me that these records would be of any use or interest to anyone whatsoever"--until she was contacted by Primack and Miller-Rushing, who crunched her observations into their expanding database.

The researchers, meanwhile, were making their own detailed observations. For the past five years, Primack and Miller-Rushing have traveled to Concord three times a week in spring and summer, walking the woods to ask the same questions that Thoreau asked: When do the flowers bloom? When do the birds return? So far, they have amassed another 100,000 data entries about the phenology of springtime plants and birds.

WHAT THE FLOWERS SAY

Pooling their data, the researchers have discovered that many plants in the Concord region are flowering more than a week earlier today than when Thoreau made his observations. Highbush blueberry--one of Thoreau's favorite wild edibles--is blooming some two weeks earlier than it did 150 years ago. Yellow wood sorrel can be found in bloom about a month earlier. During this same period, Primack says, long-term weather data show that the average temperature of a Concord spring has increased by approximately 4.5 degrees F.

Much of the temperature rise in the intensely developed Northeast is due to what's known as the urban heat island effect--parking lots, streets and buildings absorb heat while vegetation loss lessens the release of cooling water from trees and other plants. But at least some of it can be attributed to global warming, says Primack. And on Anderson's farm, many of the wild creatures that appear regularly each spring seem to be responding. Wood ducks are arriving about a month earlier than they did 30 years ago, for example, while ruby-throated hummingbirds show up more than 18 days sooner.

Scientists say such changes have the potential to wreak ecological havoc if interdependent species do not shift in concert. Many birds, for example, have evolved to time their spring migrations to take advantage of a flush of food sources. In New England, warbler species such as the black-throated blue warbler and American redstart feed heavily on leaf-eating caterpillars, which peak in abundance after leaf out and before leaves mature and grow tough.

In northern Europe, biologists already have found troubling evidence that one migratory bird, the pied flycatcher, has suffered from getting out of sync with its springtime food source. In the past, flycatchers arrived from their West African wintering grounds just as winter moth caterpillars were hatching. But warmer springs have pushed the caterpillar's

emergence date two weeks earlier--unbeknownst to flycatchers that are still 2,800 miles away. In regions where the timing of caterpillar abundance has shifted the most, researchers have documented a 90 percent decline in flycatcher numbers. In the United States, a similar "potential for mistimed relationships is very real," says Primack, "but it is understudied."

A COLD HARD LOOK

To increase much needed data on global warming's impact on U.S. species, some scientists propose identifying and training a network of modern-day Thoreaus. According to Primack, Miller-Rushing and other researchers, there is the potential for a rich interaction between scientists and members of the general public interested in gathering observations on natural phenomena such as plant flowering and the arrival of migratory birds. Countries such as England, Belgium and Canada have long embraced monitoring programs that rely, in part, on observations of nonscientists. Recently, a consortium of U.S. government agencies and academic institutions, with funding from the National Science Foundation, launched just such an effort, the National Phenological Network, to help researchers collect and disseminate information about seasonal changes.

"We desperately need a wall-to-wall, coast-to-coast network of phenological observation points--literally thousands of points on par with what is being done with meteorological observations," explains Julio Betancourt, a biologist with the U.S. Geological Survey's Desert Laboratory in Tucson, Arizona, and one of the network's founders. Volunteer observers are an important part of the process. The group's Project BudBurst, begun as a pilot program in spring 2007, will launch nationally in January 2008. Volunteers from across the country are asked to choose from a long list of plants to watch for signs of a particular phenophase, such as budburst, first leaf or first flower, and to report observations online.

"So much of the discussion about global climate change has centered on numbers--fractions and degrees of fractions," says biologist Mark D. Schwartz of the University of Wisconsin–Madison, who is helping to coordinate the network's startup. "But when you talk about how lilacs are blooming six days earlier than they were 30 years ago, people

start relating to the issue. And tell them that they can involve themselves in the process of documenting these changes, and that makes it very real.

"That's something Kathleen Anderson understands well. "This kind of work should inspire more people to be more observant," she says. At the age of 84, she still keeps notebooks handy at home, in the car and in the kitchen. "And it really doesn't matter where you live. If you look closely, you'll find enough things to interest you in the little bit of land that is around you."

After all, as Thoreau told his friend and sometime walking companion, Ellery Channing, in 1859, "There is nothing but the seasons." By which he might have meant that the seasons will tell all, to those who wish to hear.

Writer T. Edward Nickens is based in North Carolina. To find out how to participate in the National Phenological Network, go to www.usanpn.org.

Lesson 3 & 4 Article

Why is Phenology Important?

How plants react to seasonal change has a big impact on the natural environment.

Because plants are at the base of the food chain, anything that affects plants can impact other parts of the ecosystem. Phenology is important because it affects whether plants and animals thrive or survive in their environments. It is important because our food supply depends on the timing of phenological events. And, to scientists, changes in the timing of phenological events can be used an as indicator of changing climates.

Pine warbler at John Heinz National Wildlife Refuge, Photo: USFWS

Phenological observations have been used for centuries by farmers to maximize crop production, nature-lovers to anticipate optimal wildflower viewing conditions, and by almost all of us to prepare for seasonal allergies.

From a cultural viewpoint, we time festivals and events around specific phenological events. For example, a Cherry Blossom Festival happens during the first two weeks in April in Washington, D.C., whether or not there are cherry blossoms. The festival traditionally ends with a parade through blooming trees, but over the past few decades the cherry trees have been blooming earlier and now the parade happens after the peak bloom. The flowers bloom in response to warming temperatures, so if climate change is causing it to be warmer earlier in the year, the flowers will bloom earlier as well.

Having a parade for cherry blossoms while the blooms are fading is bad timing, but it is perhaps not quite as dire as some cases of bad timing that affect entire ecosystems. For example, in most ecosystems, there are insects and plants that need each other. Hungry insects searching for nectar from flowers inadvertently transport pollen from flower to flower. The pollen grains hitch a ride, often by sticking to an insect's legs. By distributing pollen, the insects, called pollinators, are fertilizing the flowers, allowing the plant to grow seeds and fruit.

But it takes time for insects to develop from egg to larva to adult, and the timing of their growth can't be sped up just because the flowers are blooming earlier. As the climate warms, plants may become out of sync with the insects that pollinate them. If an insect is still a larva when the flowers blossom, for example, it will not be able to fly from flower to flower to transport pollen. Without pollination, the flowers will not be fertilized and will not produce fruit.

Cotton mouse found in the southeastern United States, Photo: Wikipedia

Mammals in the ecosystem can be affected too. For example, consider mice. Some mice eat insects and seeds. If plants bloom too early for insects to pollinate them, then the seeds won't grow. And if the insects are too late to gather food from the flowers, they will not survive either. Without seeds or insects to eat, the mice may not survive. And animals that eat mice, like snakes and hawks, will also go hungry.

Changes in phenological events can also have a significant impact on how we humans live our lives and interact with our environment on a daily basis.

Changes in phenological events can also have a significant impact on how we humans live our lives and interact with our environment on a daily basis. For example, the timing of when plants flower and fruit can affect our food supply and therefore our health. Pollen allergies can also be exacerbated by changes in growing conditions. People who are allergic to plant pollen will experience reactions to the changes in flowering times and the lengthening of the growing season.

From historical records and observations, we know that phenological events can vary from year to year. Ecosystems can recover from variation between years, but when these changes happen consistently over many years, the timing of events such as flowering, leafing, insect emergence, and allergies can impact how plants, animals, and humans are able to thrive in their environments.