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Goodbye to the Ice Pond of Old?

What the thawing and freezing of lakes can tell us about climate change.

By Ethan Nedeau

In these days of increasing societal demands on our time, urbanization and homogenization of natural landscapes, and electronic distractions from spring peepers and sunsets, we are becoming more and more detached from Earth's natural calendar that once guided us. Some people are still in tune with subtle seasonal changes, but most of us are too distracted—we blink and winter turns to summer; we blink again and the maple leaves are turning red. While growing up on a lake, I marked time based on where and what fish I could catch, the appearance of water lily blossoms, the congregation of cormorants in the river, or the "rum-rum-rum" of breeding bullfrogs. When alder leaves were the size of a mouse's ear, it was time to fish for brook trout. Spotted salamanders could be found crossing our wooded paths on the first warm rainy night after the spring snowmelt, and this meant that we could soon plant peas.

Once the Romans developed a calendar based on Earth's spin around its axis and the sun, most of us began to live by a standard set of 12 months, 52 weeks, and 365 days. But while Earth's tilt on its axis and orbit around the sun determine seasons, the specific timing of natural events depend on infinitely more factors, including the moon's gravitational pull, physical and chemical processes of Earth and its atmosphere, biological processes, and complex interactions among all of these things. Humans are the only species whose lives are scheduled according to a standard calendar; all other species respond to the environment.

When we compare natural events to our calendars, we see that they occur at different times from year to year, often as much as several weeks apart from their long-term average. Anomalies in either direction are usually offset over time, and the long-term average usually stays consistent. Yet, something has been happening in the last century—Earth's natural calendar is shifting away from the human calendar. Natural events are showing a consistent departure from their long-term average. The change may seem to some people to be imperceptibly slow, and is often shrouded among natural variability. But for those with long-term data—or a lifetime's worth of shrewd observation—the changes are profound.

Some of my fondest memories growing up near a lake are of watching the freeze and thaw of the ice. A lake does not go quietly when it succumbs to the cold—its protests are like sharp thunderclaps that reverberate across the skies and through the forests, or like an oak bent to its breaking point before it finally splinters. I used to lie in bed listening to the lake make ice, and wiggle my toes with thoughts of skating in the morning. My grandfather used to skate by Thanksgiving, but nowadays, my family feels blessed if we can skate by Christmas. A few years ago, the lake was still unfrozen in late January, and three years ago, two local fishing derbies were cancelled in February—for the first time ever—because of thin ice.

People have been recording ice-out dates on lakes for well over a century, providing insight into long-term trends in ice duration (the time between freezing and thawing of lake ice), which can indicate climate trends. Scientists at the U.S. Geological Survey in Maine examined 64-163 years of ice-out data for 29 New England lakes. They found that average ice-out dates had become 9 days earlier in northern/mountainous regions, and 16 days earlier in southern New England. Coupled with anecdotal observations of later freeze dates in the fall, average ice duration may have declined by over a month in some areas in New England over the last century. The scientists used the ice-out data to infer an average late winter and early spring temperature increase of 1.5°C (2.7°F) since 1850. There is similar evidence from elsewhere in North America:

- Between 1969-1988, average ice duration became 20 days shorter on an Ontario lake, mostly accounted for by earlier ice-out dates.
- Average ice-out dates became 15 days earlier from 1890-1991 on a Wisconsin lake, and the years 1980-1991 accounted for 8 of those days.
- Between the 1950s-1990s, average ice-out became 7 days earlier in 6 central and western Canadian lakes.
- Between 1846-1996, in lakes and rivers in the northern hemisphere, freeze dates became 5.8 days/

100 years later and ice-out dates became 6.5 days/ 100 years earlier.

These studies all suggest that springtime is arriving sooner and may mean that some lakes are becoming warmer. Ice-out, however, is not the only sign of spring that is arriving sooner—studies show numerous examples of plants and animals responding to warmer springs. In the latter half of the 20th century, dates of the last hard frost and lilac blooming have both become significantly earlier in New England. Scientists in Wisconsin studied 55 springtime events—from the appearance of pussywillows to robins to trillium blooms—and found that for all combined, these events occurred an average of 0.12 days earlier per year over 61 years (7.3 days). From one year to the next, 0.12 days might not seem important. But what is important is that over the long-term, the changes are consistent and headed in one direction. The climate is changing—and plants, animals, and ecosystems are responding.

Ice duration data for North American lakes is just the tip of the iceberg for compelling evidence of climate change. There is now an unprecedented melting of glaciers throughout the world, particularly in polar regions. Arctic permafrost is thawing and the Arctic growing season has gotten significantly longer. Russian rivers are discharging much more freshwater and threaten to upset global ocean circulation patterns. Arctic sea ice is melting fast—both in spatial extent and depth. Some models predict that the Northwest Passage will be ice-free in the summer within 75 years.

Why is it important that ice duration on local lakes is decreasing? What does this mean for natural ecosystems? The main concern is not ice duration per se, but that lakes may be getting warmer. In northeastern lakes, climate change is expected to cause a decrease of cold-water habitats, increase of warm-water habitats, reductions in dissolved oxygen, reduced lake levels, changes in lake mixing regimes, and altered nutrient cycles. This will affect nearly everything about our lakes—habitats, populations, communities, and ecosystem processes. These types of effects will also be evident in streams and rivers.

Using climate change models, scientists predicted changes in lake fish habitat throughout North America based on anticipated effects on temperature and dissolved oxygen. They predicted a 45% loss in cold-water habitat, with virtual disappearance of such habitats from many shallow and medium-depth lakes. Native brook trout, blueback trout, lake trout, and salmon will lose habitat because of climate change, as will non-native (but recreationally important) rainbow trout and brown trout. Many non-game species that are ecologically important—such as dace, chub, darters, and sculpin—will also lose habitat as waters warm.

Scientists predict a doubling of atmospheric carbon dioxide over pre-Industrial levels by 2100 caused by combustion of fossil fuels and biomass burning. Climate change models indicate that over the next hundred years Earth's temperatures will increase by 1.4-5.8°C (2.5-10.4°F) from 1990 levels. Wintertime temperatures in northern latitudes are expected to show the greatest warming. Between 1895-1999, average temperatures for the New England region (including northern New York) increased by 0.41°C (0.74°F), though some subregions showed higher increases (1.0°C [1.8°F] in New Hampshire, 1.28°C [2.3°F] in Rhode Island). The coastal zone warmed by 0.94°C (1.7°F). Wintertime temperatures increased by an average of 1.0°C (1.8°F) over the same period, including a 1.94°C (3.5°F) increase in New Hampshire and 1.67°C (3.0°F) increases in Rhode Island and Vermont. Despite a long-term trend toward a warmer climate, the Gulf of Maine region might actually experience a period of cooling in coming decades. Scientists believe that the Gulf Stream—which carries warm water northward from the tropics—might weaken or shift its course due to melting of arctic sea ice, possibly leading to a rapid cooling period with longer and harsher winters, similar or perhaps far more severe than the 2002/2003 winter in our region.

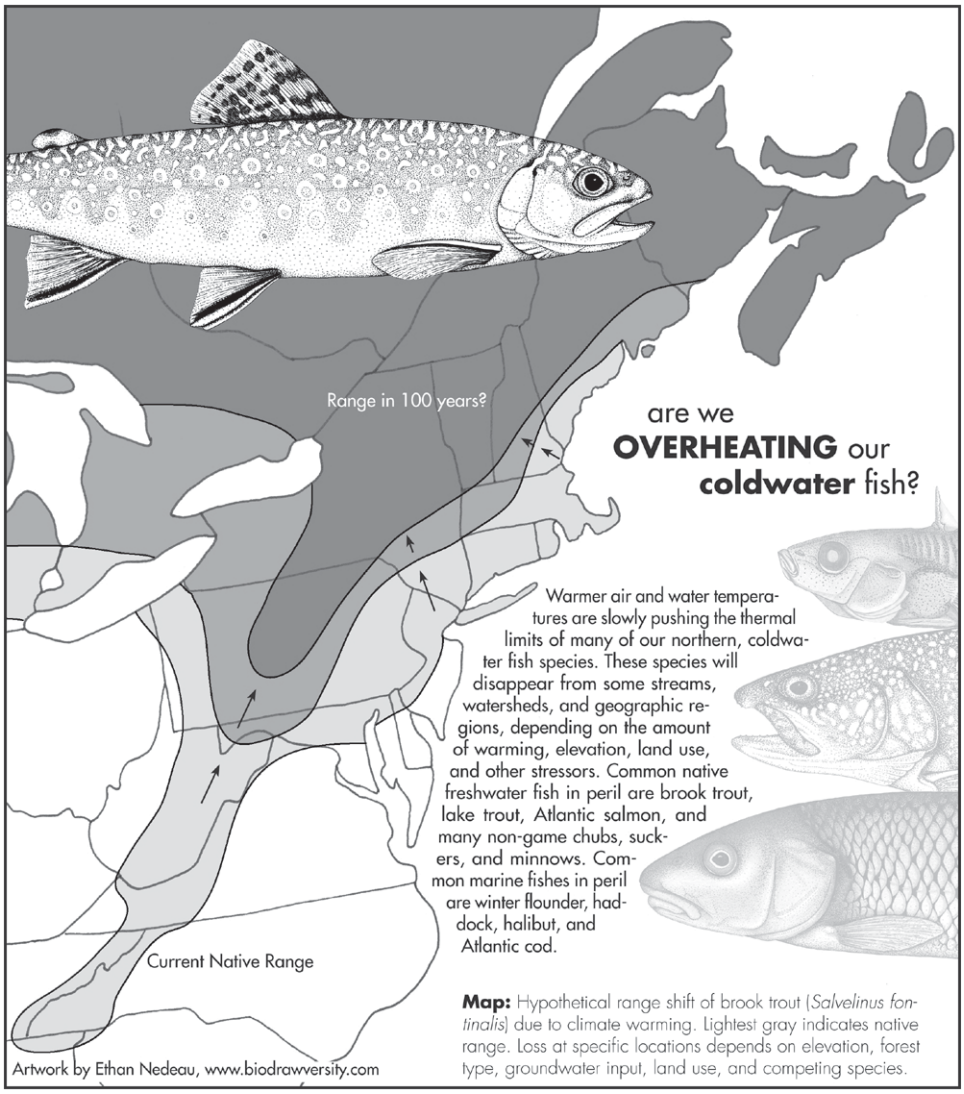
Scientists predict that warm-water habitats will increase, causing the "good growth period" of warm-water fishes to become several weeks longer. Warm-water fish, such as smallmouth bass, largemouth bass, and bluegill—will likely expand their habitats as previously cool habitats become more suitable. In the northeast, most of these warm-water fish are also non-native predators. Their competitive advantage over native species will increase as water temperatures rise.

A Few Extra Degrees?

When the woodpile is rapidly dwindling by early March, or wind-driven snow makes for a harrowing commute home, we are all tempted to think fondly of climate change. What are a few extra degrees? People might be more alarmed if we were facing "global cooling." Only 20,000 years ago, average global temperatures were 6-7°C (10-12°F) colder than they are now, and most of our region was covered with glaciers up to two miles thick. Native plants and animals were forced into refugia far out on the continental shelf or to the south. We are now facing the prospect of a warming period of nearly the same magnitude—except much faster—and the effects will be equally dramatic. The ten hottest years of the last

millennium have all occurred since 1983. If Boston's average annual temperature were to increase by 5.6°C (10°F), its climate would be similar to that of Atlanta, Georgia. In Nova Scotia, if Halifax's average annual temperature were to increase by the same amount, its climate would be similar to that of Philadelphia.

The Roman calendar will be the same in 100 years as it is today—in fact, it will take over 44,000 years for it to fall out of step with the sun by even a day. But perhaps in 100 years April will no longer signify wood frogs and spotted salamanders, June may no longer signify brook trout rising for caddisflies, July may no longer signify fireflies and painted turtles, and January may no longer signify ice skating and snow angels. Climate change threatens everything about the nature of New England and eastern Canada—the seasons that shape our lives, the woods and waters that have sustained us for centuries, and our cultural and economic prosperity. Whether we bicycle to work, or encourage our political leaders to support regional and global initiatives, it is important that we do all we can to address this global problem.



Map: Hypothetical range shift of brook trout (*Salvelinus fontinalis*) due to climate warming. Lightest gray indicates native range. Loss at specific locations depends on elevation, forest type, groundwater input, land use, and competing species.

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