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# Will this cold winter cause the demise of invasive forest pests?

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Everyone can probably agree that we've had an unusually cold winter. According to the Northeast Regional Climate Center here on the Cornell campus this winter is amongst the top 5 coldest on record in Ithaca if you count the number of days when the temperatures dipped below zero Fahrenheit. However, by this standard the last time we had a winter as harsh as this was 2003, only 10 years ago. When thinking about the impacts on insects we often reference extreme low temperatures. The coldest temperature ever recorded in Ithaca was -35°F in 1934. Since then the coldest was -24°F in 1994. The problem with using individual weather sites to get an idea of area-wide impact is that as everyone knows there are cold spots and warm spots on the landscape. Here in Ithaca the coldest reported temperature this winter was -13°F at the Game Farm Road weather station but the director of the Northeast Regional Climate Center reported that he had -22°F at his house, just 10 miles away.

Before going any further it's important to understand how insects deal with cold. Insects basically have two strategies for surviving extreme cold; they can avoid it by finding a warmer location to hide in, and they can physiologically tolerate the cold down to a certain lethal temperature. Cold temperatures kill insects by forming of ice crystals which then puncture cell walls. Ice crystal formation at sub-freezing temperatures is inhibited by the buildup of glycerol, basically antifreeze, in an insect's blood. The accumulation of glycerol is usually gradual in response to environmental triggers but can sometimes be rapid. The temperature at which ice crystals form in an insect is called its supercooling point and is determined by lab studies. Supercooling points vary between insect species and according to the season of the year. For example, the supercooling point will typically be highest in summer and decrease through fall and early winter to its lowest point in January and February, and then gradually increase again in spring. Thus, the same low temperature that would not harm an insect in the depths of winter might kill a substantial portion of the population in fall or spring when the concentration of glycerol in the blood is lower and the supercooling point is higher.

Let's consider what we know about two of the most important forest pests currently in New York, Hemlock Woolly Adelgid and Emerald Ash Borer, and how this winter may impact their populations.

The Hemlock Woolly Adelgid (HWA), *Adelges tsugae*, has been spreading through the state since the late 1980's, starting in the lower Hudson Valley (Figure 1). Its spread has increased in the past few years, perhaps aided by some mild winters. Cold temperatures have been documented as responsible for killing significant numbers of HWA and have been thought to be regulating its march northward in New England. HWA cannot avoid cold because once they settle on a twig and begin feeding they will not move for the rest of their life. However, they are protected somewhat from wind-chill by the woolly wax they produce that surrounds their body. A recent laboratory study demonstrated that HWA from the Berkshire Mountains suffered 97% mortality at -22°F (-30°C) and none survived -31°F (-35°C). These lowest temperatures are not common in most of New York (Figure 2), but lab studies don't always tell

the whole story when you get out in the woods. To get an idea what is going on outside the lab I recently sampled two sites that have been harboring HWA for a few years. At Taughannock State Park near Cayuga Lake, according to my instruments the temperature never got below -8°F (-22°C) yet we found HWA mortality to be about 88%. On the other hand, at Mine Kill State Park in the northern Catskills temperatures got to -24°F (-31°C) and we found only about 72% mortality. Wait a minute, there is more mortality where it is warmer? There are two things going on here: 1) HWA reproduce asexually and have a very high reproductive rate so all you need is a few to survive the cold and the population is off and growing; and 2) perhaps more troubling is that research indicates cold tolerance is a genetically linked trait so progeny of the survivors will also be cold tolerant. The Mine Kill SP data suggests HWA populations in colder areas are indeed becoming more cold tolerant than those in warmer locations like Taughannock SP. However, getting a high percentage kill will knock back the HWA population in an area for a couple years but they will rebound rapidly. Reduced density of HWA means there is less competition and the food quality of hemlock twigs will be degraded more slowly, basically giving the surviving HWA a fertile field for reproduction, and they can do that rapidly.

The Emerald Ash Borer (EAB), *Agrilus planipennis*, is established in a number of locations across New York and populations continue to build, although less than 5% of our forests are currently infested. The difference with EAB is that it is protected under the bark during the winter and they are found around the base of the trunk and even in upper roots, areas that are usually protected by snow. The important thing about this habitat is that the trunk of the tree acts like a large thermal mass that moderates temperature extremes. The few hours of extreme cold experienced in the early hours of a morning won't be felt under the bark of a tree. The trunk of the tree will also be heated by sunlight in even the coldest weather. So, even though your thermometer might indicate a temperature you think is extreme, EAB are experiencing something entirely different.

Work on cold tolerance of EAB has been conducted in Minnesota and Ontario. Lab research in Ontario indicated the supercooling point of EAB was between -9.4°F and -15.5°F (-23°C and -26°C) whereas in Minnesota another lab study found 5% mortality at 0°F (-18°C), 34% at -10°F (-23°C), 79% at -20°F (-29°C) and 98% at -30°F (-34°C). It might seem that -20°F was fairly common this winter but think about the warm periods between the cold snaps and how much time it would take to cool down a log to that temperature. Even if there was 80% mortality competition would be reduced and EAB populations would rebound quickly. EAB may even be developing cold tolerant populations but we don't have the research to clearly demonstrate this is happening. The researchers in Minnesota also evaluated mortality in logs placed outside and found that there were still a few survivors where temperatures measured in the logs where EAB are found reached -33°F (-36°C) in Grand Rapids, MN. Looking at the map of cold temperatures in NY (Figure 2), it appears the only place there might be an impact would be in the high Adirondacks where there is not much ash. Remember, EAB is successfully killing untold numbers of trees near Moscow, Russia and its much colder there!

The take home message is that cold temperatures are not a "silver bullet" for controlling our invasive forest pests. We might have bought another year or two of relief with HWA but due to their reproductive prowess they will be back soon and maybe even stronger than before. EAB will be hardly phased by low temperatures in NY this year and very likely no time in the future. We must prepare for the arrival of these insects in order to mitigate their impacts and lay plans to preserve the genome of our threatened native ash and hemlock through seed collection and treatment of seed trees to keep them alive. We need to use this time wisely to conserve what we can of our native forests.

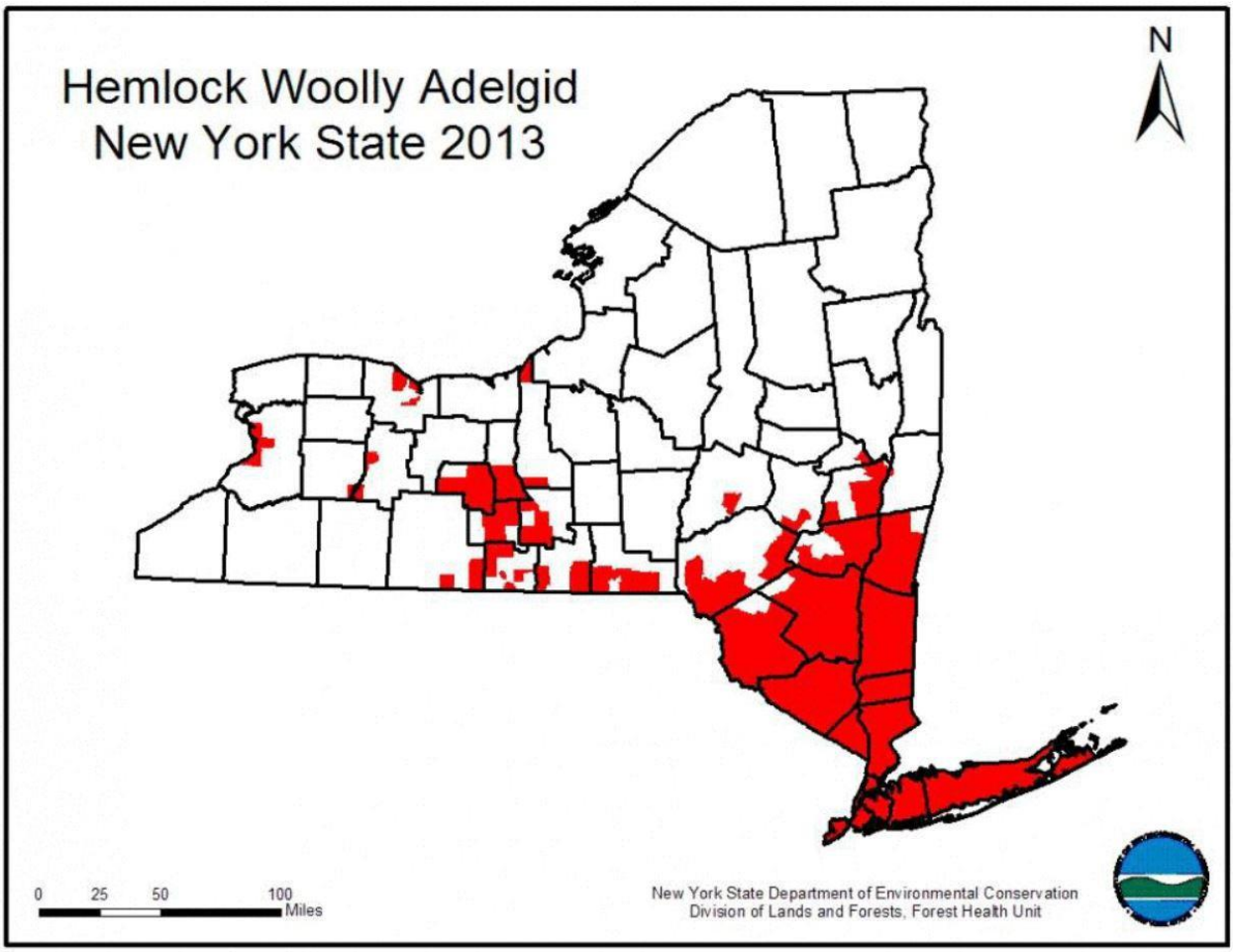


Figure 1. Current distribution of Hemlock Woolly Adelgid in New York State towns. Scott McDonnell, NYSDEC, Forest Health Unit.

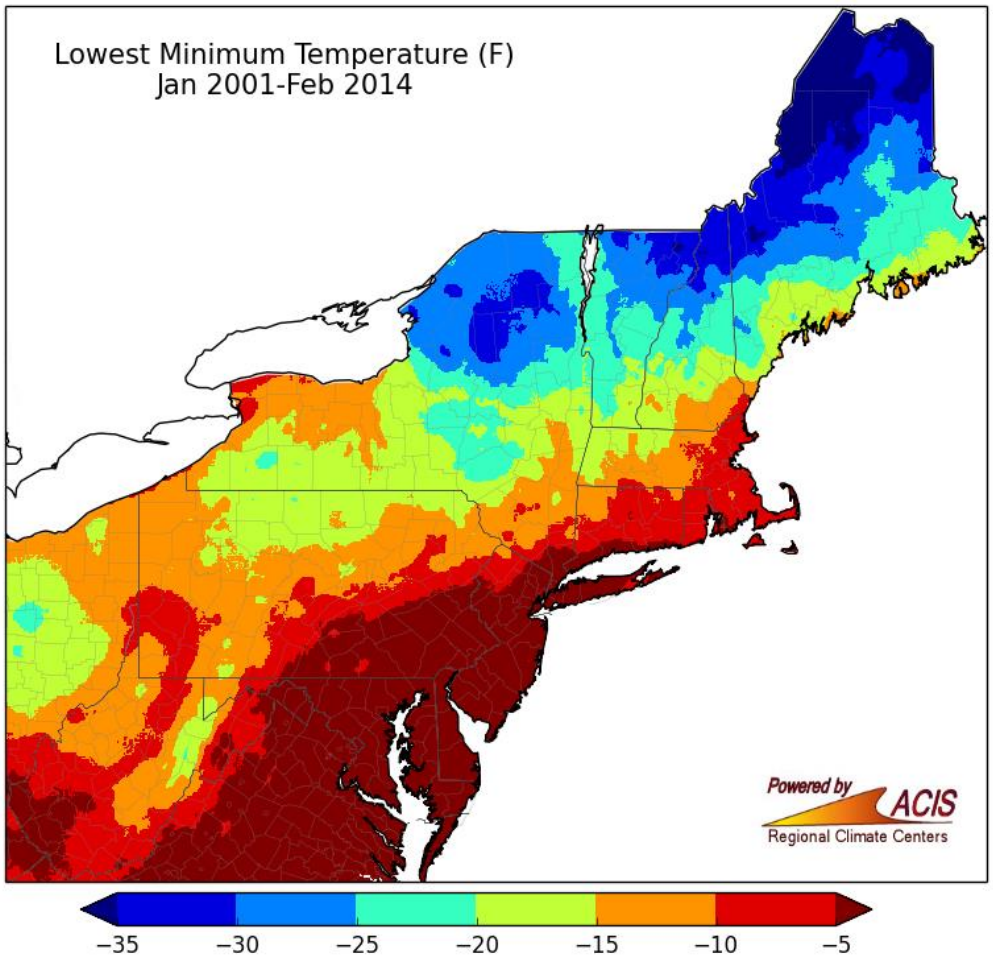


Figure 2. Lowest temperatures recorded in the Northeast from January 2001 to February 2014 in degrees Fahrenheit. Northeast Regional Climate Center, Cornell University, Feb 2014.