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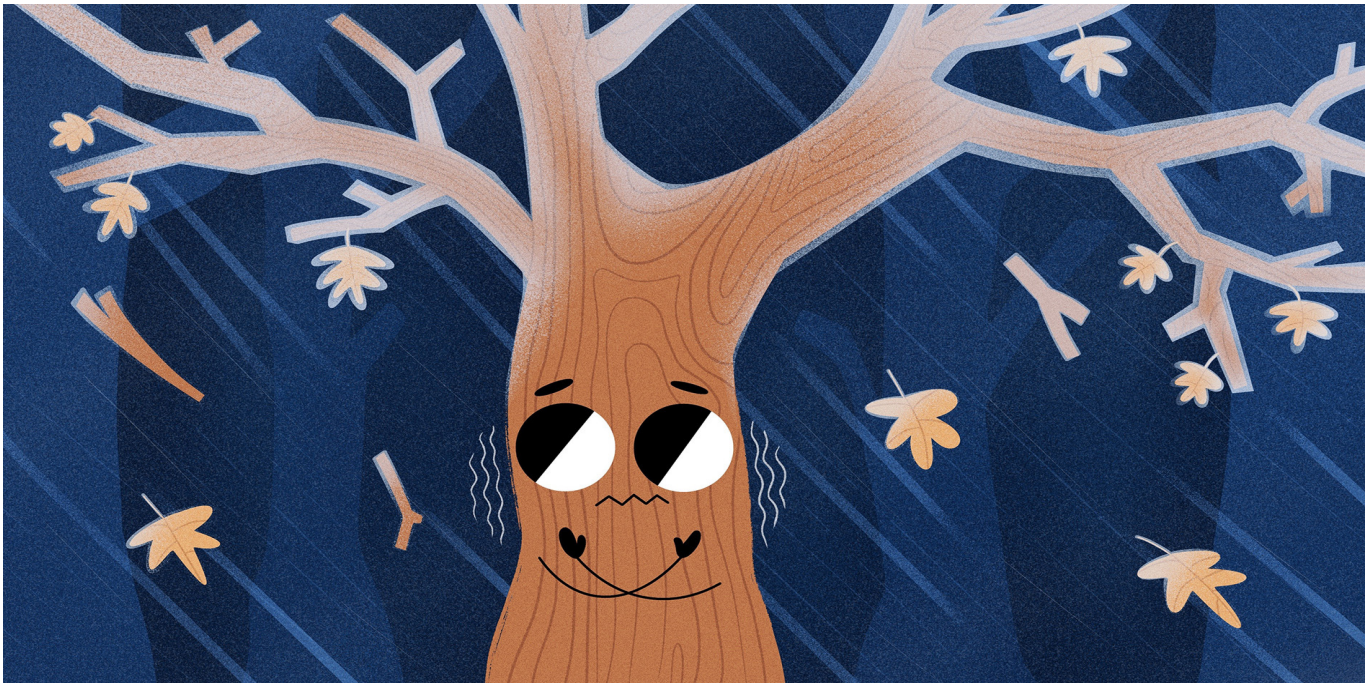

# ICE STORMS: NOT AS COOL AS THEY SEEM

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YOUNG REVIEWERS:


AYAT
AGE: 12


CALEB
AGE: 11


JENDAYI
AGE: 13


KATHERINE
AGE: 12

Ice storms might sound fascinating, but for forests, they are not as cool as they seem! Ice storms happen when freezing rain coats trees, branches, and the forest floor in a shiny, frozen glaze. These storms can be a big deal because they can affect our forests and the things we care about, like, wood, wildlife, and places for recreation. Despite this, we do not know very much about how ice storms affect forests. Scientists at the Hubbard Brook Experimental Forest, New Hampshire (USA), decided to learn more. They used fire-fighting pumps and hoses to create experimental ice storms in the forest during the winters of 2016 and 2017. They found that these experimental storms caused a lot of short- and long-term damage to trees, including breaking of twigs and branches. In a nutshell, ice storms are not just about frozen beauty—they have real consequences for our forests and species that are not used to ice!

## HAVE YOU EVER SEEN AN ICE STORM?

Ice storms are one of the most beautiful yet frightening winter weather events. They happen when rain falls through freezing air and turns to ice as it hits trees, roads, powerlines, or the ground. At first, this creates a shiny, sparkling layer on everything, making it seem like a winter wonderland. Early in the storm it can sound almost musical, like tiny glasses clinking in the treetops as ice-coated twigs gently rub together.

But if the storm continues, the beauty can shift to danger. As ice builds up, it can make surfaces like roads and walkways slippery. The weight of the ice can snap power lines and knock out electricity. It can also break tree branches or even cause whole trees to topple over. The air fills with sounds of loud cracking and crashing as branches and trees come falling down.

## ICE STORMS AND OUR CHANGING CLIMATE

**ICE STORM BELT**

A geographic area from northeastern Texas to New England that has experienced many ice storms in the past.

As our planet's climate changes, scientists believe that large ice storms might happen more often [1, 2]. Scientists also think that the places where these storms now occur most frequently—an area called the **Ice Storm Belt**, which stretches from northeastern Texas to New England—might shift north. This means that places that have not seen many ice storms before may experience more of them in the future. More ice storms mean more frozen trees, property damage, and accidents because of slippery conditions and falling trees [3].

Despite their impact, we do not know much about ice storms. It is hard to predict when and where an ice storm will happen. And during a big ice storm, even the bravest of scientists need to seek safety and stay in their homes. Most of what we know is based on observing what happens in the aftermath of a big storm, like after the Northeast Ice Storm of 1998 [4].

## CREATING ICE STORMS: A NOVEL EXPERIMENT

**SCIENTIFIC METHOD**

A process for testing ideas to discover facts about the world. It involves observing, questioning, predicting, experimenting, and concluding.

In New Hampshire, scientists had an idea: instead of waiting for the next big ice storm, they decided to create their own icy winter weather in a controlled setting [5]! This allowed them to use the **scientific method** to better understand how ice storms affect forest ecosystems. They had already observed the damage caused by natural ice storms. Now they asked questions about what these storms do to forests, like how do different amounts of ice accumulation (the amount of ice building up on branches) damage different types of trees? The scientists also wanted to know how long it takes for forests to recover from the damage caused by these extreme winter weather events.

They formed hypotheses, made predictions, and then set out to test their predictions.

## HUBBARD BROOK EXPERIMENTAL FOREST: AN OUTDOOR LABORATORY

They chose Hubbard Brook Experimental Forest in New Hampshire for their experiment. The USDA Forest Service put this 7,800-acre area in the White Mountain National Forest aside as an outdoor laboratory in 1955, to study the water cycle. Back then, the Forest Service scientists wanted to know how forests in the mountains kept downstream towns and cities from flooding. Since then, scientists have been studying the trees, streams, wildlife, and climate in this forest. The forest has years of background data and was even the site of a major natural ice storm in 1998! It was perfect for this new experiment!

## CONDUCTING THE ICE STORM EXPERIMENT

In the spring of 2015, scientists set up 10 large plots within Hubbard Brook Experimental Forest. Each plot was 20 × 30 m, or about the size of a basketball court. The plots would receive five treatments, with two replicate plots for each treatment. The treatments included: control (0 mm ice), light (6 mm ice), moderate (13 mm ice), moderate x2 (13 mm ice in two back-to-back winters), and heavy (19 mm ice). Ice accumulation is measured as the *radius* of ice on a twig, so the *diameter* of ice would be twice those measurements, or up to an 38 mm inches of ice! The plots were located near the Hubbard Brook for water, and next to a road so scientists could get there easily on snowmobiles and all-terrain vehicles. During the summer, they took detailed measurements of the forest, from the tops of the trees to the bottom of the roots. This was their "pretreatment" data. Pretreatment data was important so the scientist's knew what the forest was like before they added the ice. The scientists also practiced making storms. They needed to be able to make these storms perfectly under the best of conditions in summer, so they would be ready for the worst weather in winter!

Then they waited. They needed the perfect night, with freezing temperatures and no wind. In mid-January 2016, the weather cooperated and they set to work. Over 4 dark, cold nights, a team of 40 scientists, working in shifts, used firefighting pumps and hoses to spray water from Hubbard Brook up and over the trees (Figures 1, 2). The water came down on the trees as a fine mist and froze on contact, creating a realistic layer of ice. Scientists watched the forest change as the ice formed. Tree limbs curved downwards as the ice got heavier and heavier. Everyone cheered when the first tree limb fell because it showed that the experiment was working. It was awe-inspiring to watch entire trees topple over with heavy loads of ice on every twig.

Working carefully, the scientists successfully created ice storms of varying intensities, including light, moderate, and heavy icing. But that was not all. In February of 2017, they went back and iced two of the moderate plots with another coat of ice, to see what might happen to the forest if it was hit by moderate ice storms for two winters in a row.

**Figure 1**

A scientist spraying water over the forest canopy to make an experimental ice storm.

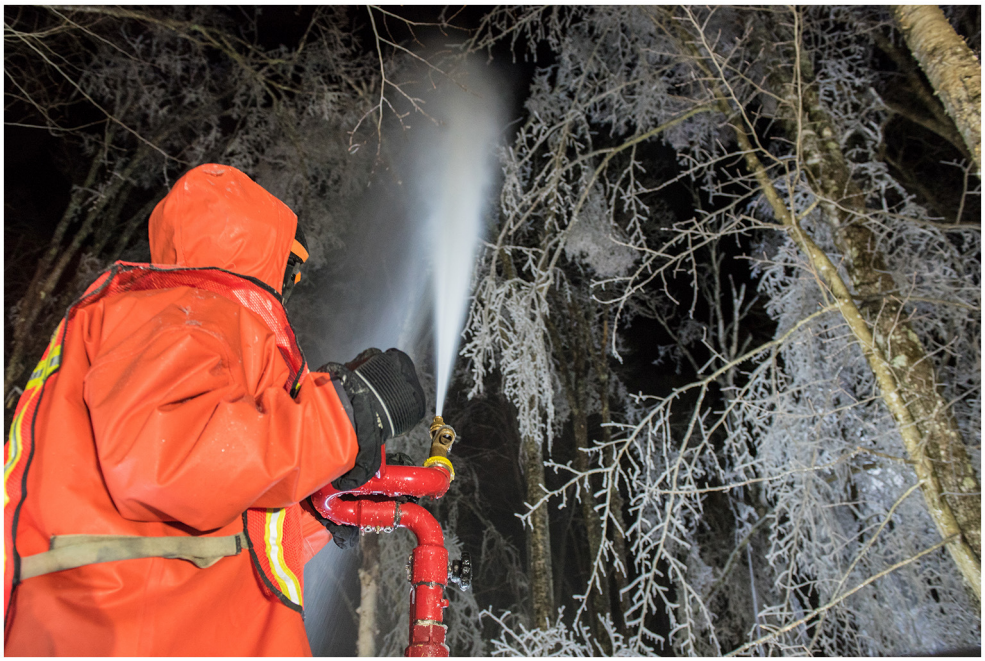

Figure 1

**Figure 2**

A scientist looking on as crews make an experimental ice storm.

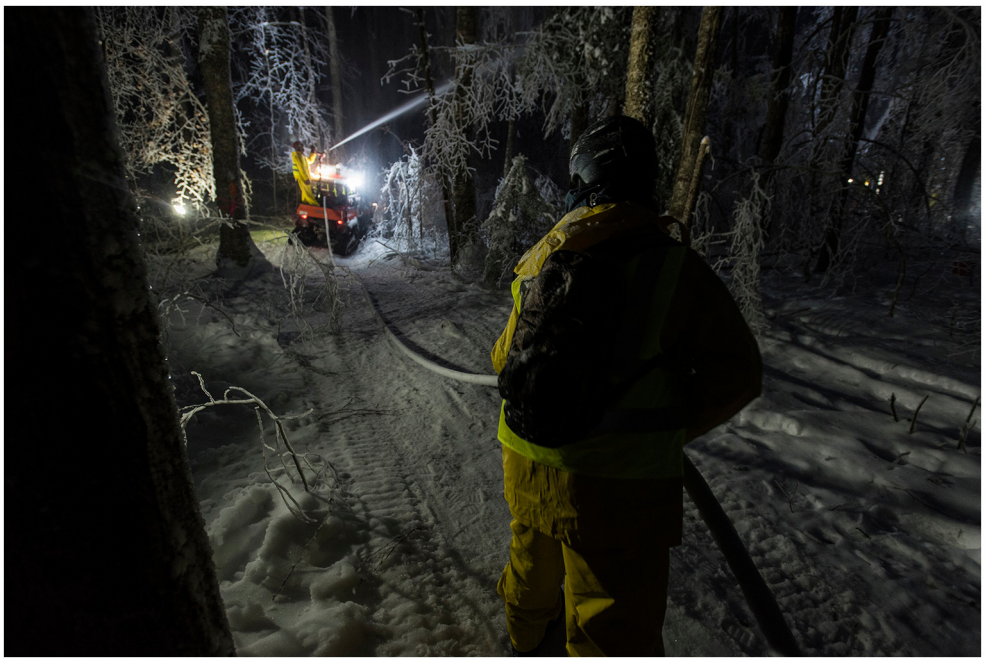

Figure 2

## OBSERVATIONS AND DISCOVERIES

Then it was time to collect the data (Figure 3)! First, the scientists measured the amount of ice on the branches, to make sure the experiment worked. Then they measured the amount of fallen twigs and branches, the changes in light coming through the damaged **canopy**, the overall health of the forest, and how it recovered over time. The experiment revealed some cool insights.

**CANOPY**

The top layer of a forest, where the trees leaves and branches meet. It forms the "roof" of the forest.

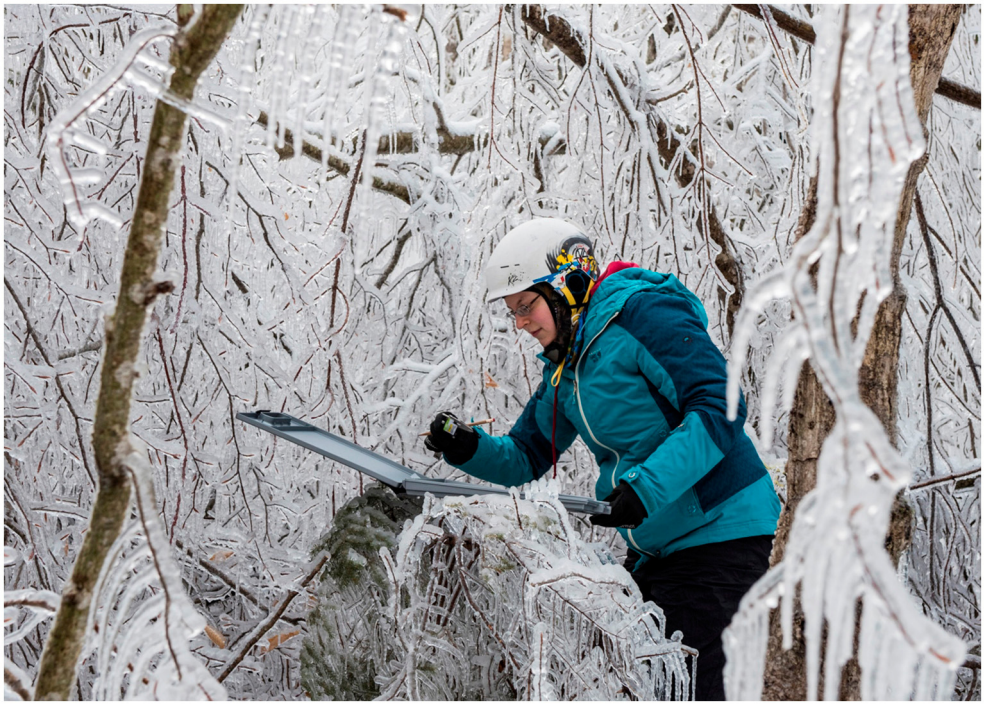

**Figure 3**

Scientist and co-author, Wendy Leuenberger, measuring ice accumulation after an experimental ice storm was created.

### The Experiment Worked

Careful measurements of ice in the forest showed that the scientists successfully recreated, light, moderate, and heavy ice storms.

### Trees Are Tough but They All Have a Breaking Point

The experiment showed that light icing caused minimal harm, but moderate and heavy icing resulted in a lot of broken branches and even toppled trees. Some trees, because of the properties of their wood, were more likely to break than others. For example, branches on broad-leaved **deciduous trees**, like red maples, frequently snapped and broke. But the branches on needle-leaved **coniferous trees**, like red spruce, were more likely to bend than break. The branches on these trees curved down toward the tree trunks like folded umbrellas under ice. They popped back up when the ice melted.

**DECIDUOUS TREES**

Trees with broad leaves that drop off each year.

**CONIFEROUS TREES**

Trees with needle-like leaves that bear cones.

### A Lot of Wood Moved From the Trees to the Ground

One of the most noticeable things after an ice storm is the amount of wood on the ground. In this experiment, the amount of wood falling

to the ground in 2016 was 55 g/m$^2$ in the control plots where there was no ice, and 183, 420, and 1,660 g/m$^2$ in the light, moderate, and heavy treatment plots. Scientists also compared these numbers to the average amount of wood that falls to the ground at Hubbard Brook in a typical year. This comparison showed that a single moderate ice storm would break off the same amount of branches (>1-inch diameter) as would typically fall in an entire year. A heavy ice storm would break off almost 5 times the amount of branches than would fall in a typical year.

### One Ice Storm Is Bad, but Two Ice Storms Are Worse

Two of the moderate plots (the moderate x2 treatment) were iced twice: once in 2016 and again in 2017. The amount of branches that came down in the 2nd year of icing was 2 times greater than what came down in the 1st year. This suggests that some branches that were damaged in the 1st year's storm stayed on the trees but fell to the ground in the 2nd year.

### The Loss of Branches Lets More Light Into the Forest

The loss of branches and treetops in the moderate and heavy icing treatments created gaps in the canopy that let from 2 to 3 times more light into the forest compared to the non-iced plots or the pretreatment data.

### Canopy Damage Gets Worse Over Time

Damage to the trees did not occur just during or immediately after the storm, but progressed over time, especially for moderate or heavy icing treatments. For example, some trees went from healthy to weakened, and others went from weakened to dead over the course of a couple years. Scientists will need to continue to monitor these trees to see what happens to them over longer periods of time.

## WHY THIS RESEARCH MATTERS

Forests are not only beautiful places, but they are vital for the health of the planet. They provide clean air, water, wood, food sources like nuts and maple syrup, homes for animals, and places to play and explore. They are also important for absorbing carbon dioxide through the process of **photosynthesis**, which helps to store carbon in plant tissue and slow global **climate change**. Knowing how ice storms affect our forests helps us take better care of these important places. It also helps people be more prepared to face these icy winter weather makers.

**PHOTOSYNTHESIS**

The process by which plants use sunlight, water, and carbon dioxide to make their own food and release oxygen.

**CLIMATE CHANGE**

The long-term shift in weather patterns and temperatures on Earth, largely caused by human activities like burning fossil fuels and cutting down forests.

## CONCLUDING THOUGHTS

From the Hubbard Brook Ice Storm experiment, scientists have learned a lot about how ice storms affect forests. They will continue to study

these forested plots for the coming decades, to see how long it takes the trees to fully recover from their icy treatments. They will also wait to see if the icing makes them more likely to suffer from other stresses, like insect infestations or fire. Only time—and more research—will tell.

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## ORIGINAL SOURCE ARTICLE

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## YOUNG REVIEWERS

**AYAT, AGE: 12**
I am 12 years old and an elementary school student. I love sketching, painting, playing chess, and reading books. My favorite books include "Amari" and "The Magicians of Paris", and anything and everything about fantasy books. I like nature, cycling, badminton, and frequently go out hiking to observe the beauty of nature, take notes, and make sketches in my notebook.

**CALEB, AGE: 11**
Caleb enjoys all things science, animals, reading, exploring the outdoors, playing the violin, and curling. When he grows up, Caleb wants to be an architect focusing on eco-friendly and animal oriented buildings. He has tried four sports and is always up for trying something new. Caleb's favorite foods are macaroni and cheese or lasagna. He enjoys traveling and would like to go to an animal reserve.

**JENDAYI, AGE: 13**
Hi! I am Jendayi. I play the oboe and a little bit of piano. I like hanging with my best friend, Kat. We normally walk around my town and eat ice cream together. When I grow up, I want to be a Children's therapist. I feel it is important to be a child's therapist because kids should also have the ability to be heard by adults. My favorite subjects in school are science and English. Those are my favorite subjects because I love conversation and I love finding new things with evidence.

**KATHERINE, AGE: 12**
Hi, my name is Katherine! My friends call me Kat and Kathy. I like to play cello and piano. My favorite thing to do in my free time is hang out with my best friend, Jen, and draw. When I grow up, I want to be a vet because I like animals, so I am going to own a lot of dogs and cats. My favorite subject in school is English because I like reading with my peers and having discussions.

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