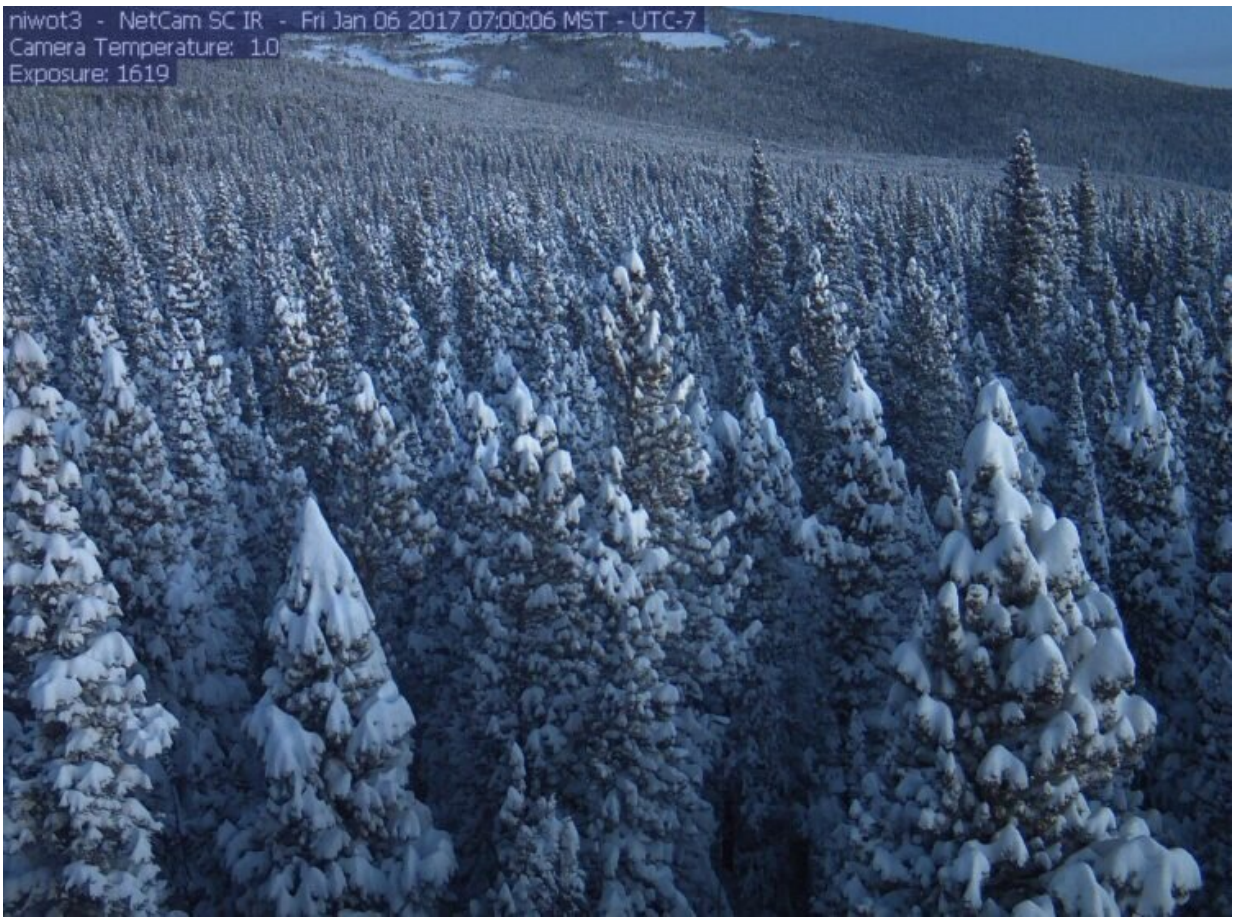
Is there snow in that tree? Citizen science helps unpack snow's effect on summer water supplies

June 13 2022, by Sarah McQuate



In a citizen science project created by UW researchers, participants viewed time-lapse photos from Colorado and Washington and labeled photos taken when trees had snow in their branches. Shown here is a time-lapse image from a camera on the AmeriFlux Tower in Niwot Ridge, Colorado. This image is

archived in the PhenoCam network and is one of the images citizen scientists analyzed in this project. Credit: AmeriFlux Tower

The snow that falls in the mountains is good for more than just skiing, snowshoeing and breathtaking vistas. The snowpack it creates will eventually melt, and that water can be used for hydropower, irrigation and drinking water.

Researchers want to predict how much water we will get later in the year based on the snowpack. But in forested regions, the trees impact the calculations. When falling snow is intercepted by trees, it sometimes never makes its way to the ground, and the current models struggle to predict what will happen.

To improve the models and investigate what happens to this intercepted snow, University of Washington researchers created a citizen science project called Snow Spotter. Participants viewed time-lapse photos from Colorado and Washington and labeled photos taken when trees had snow in their branches. This information provided the first glimpse of how snow-tree interactions could vary between climates and how that could affect predictions of summer water supplies.

The team published these findings May 18 in AGU *Water Resources Research*.

"We, as skiers or snow enthusiasts, know that the snow in Colorado compared to Washington is really different. But, until now, there hasn't been an easy way to observe how these differences play out in the tree canopy," said lead author Cassie Lumbrazo, a UW doctoral student studying civil and environmental engineering. "This project leverages volunteers to get some hard data on those differences. Another benefit is

that it introduces our volunteers to how research works and what snow hydrology is."

There are three possible scenarios for snow that's been caught by trees. It could fall to the ground as snow, adding to the current snowpack. It could be blown away and turn to water vapor, therefore not adding anything to the snowpack. Or the snow could melt and drip to the ground, which, depending on the conditions, may or may not add to the total amount of water in the snowpack.

One current issue with the mathematical models that describe these processes is that researchers don't know the timing—over the course of a year, how often is there snow in the trees, and what happens to it?—and how this timing varies in different climates.

But time-lapse cameras can record what's happening in remote locations by taking photos every hour, every day for years, creating a huge dataset of images.

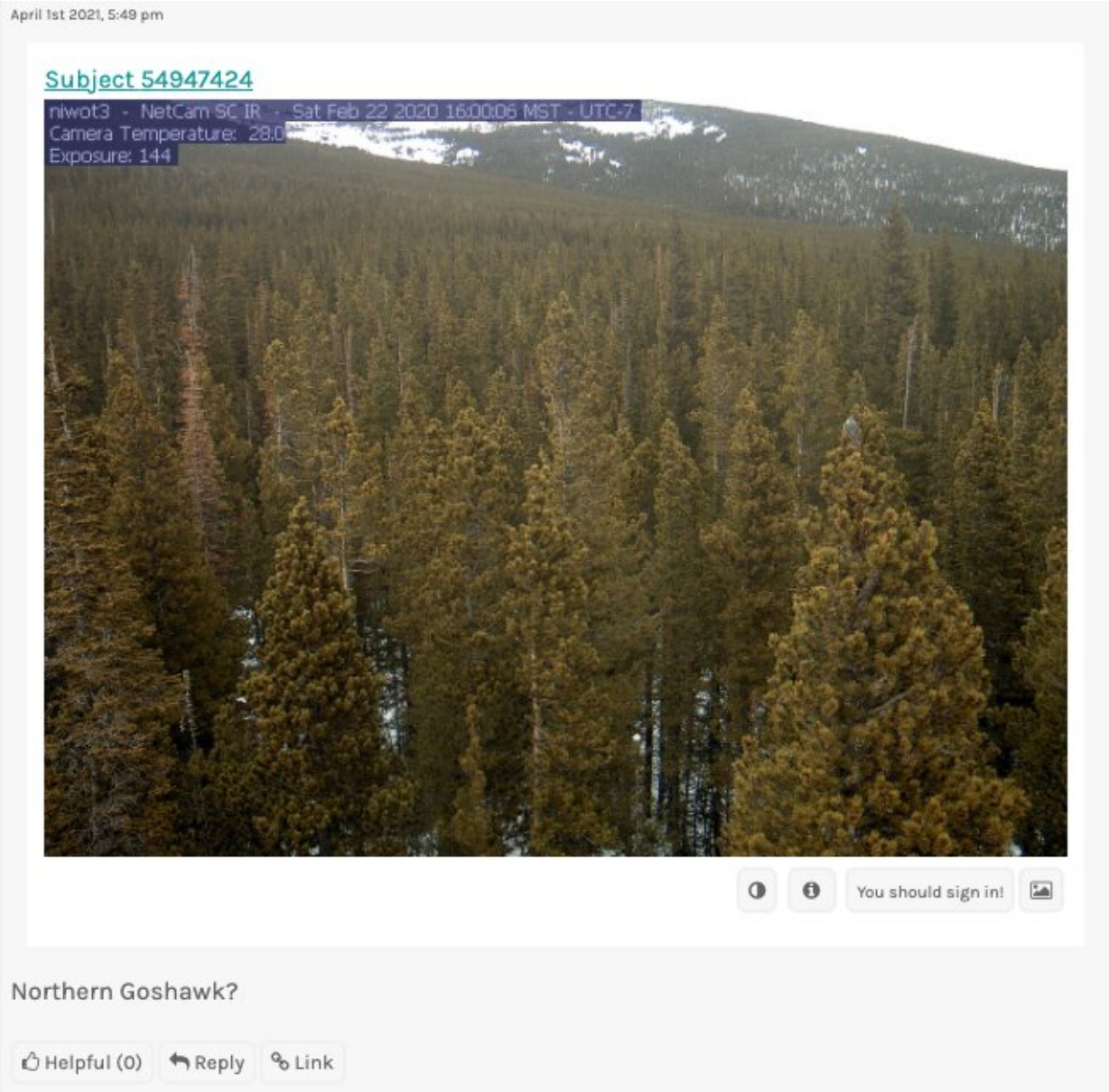
That's where the citizen scientists come in. Snow Spotter shows volunteers a photo, with the question: "Is there snow in the tree branches?" Volunteers then select "yes," "no," "unsure" or "it's dark" before moving on to the next photo.

Using Snow Spotter, a total of 6,700 citizen scientists scanned 13,600 images from a number of sites across the western United States. The team focused on four sites for this study: Mount Hopper, Washington; Niwot Ridge, Colorado; and two different sites in Grand Mesa, Colorado.

"When the project started, I don't think anybody really knew how successful it was going to be," said Lumbrazo, who is currently doing research in Norway as part of the Valle Scholarship & Scandinavian

Exchange Program. "But citizen scientists were processing it so fast that we kept running out of images for people to classify. We've received feedback that this task is really relaxing. Citizen scientists can pull up these photos in the Zooniverse app and they can just sit on the couch and click through really fast."

Each photo had between nine and 15 different volunteers classify it, and the volunteers agreed between 95% and 98% of the time. From there, the researchers could piece together what snow in the trees looked like over the course of the year for each site.



Citizen scientists often engaged with the photos they were classifying, for example, calling out animals that showed up in the frame. Shown here is a screenshot of a participant pointing out a bird in the lower right-hand corner of the image. Credit: University of Washington / AmeriFlux Tower

"Our data physically shows the difference in the snow," Lumbrazo said.

"You can see how the snow in Washington just becomes cemented in the canopy and never leaves, which is how it feels when you ski that snow. As opposed to the snow in Colorado where you get frequent snowfall, but it's blowing away. It's dry and dusty."

The researchers used this dataset to evaluate current snow models. One limitation, however, is that right now the team only knows when snow is present in the trees. This method doesn't say how much snow is in the trees, another component needed to make the models even better.

"But a limitation that does not exist is the number of citizen scientists who are willing to process these images," Lumbrazo said. "We've signed off on countless volunteer hours for students, and they even end up having some great discussions about certain images and it becomes more of a scientific conversation."

In addition, the dataset generated by these volunteers could be used to train a machine learning algorithm to classify images in the future, the team said.

The researchers are working to expand their image dataset to include photos from around the world so that they can continue learning about how different climates and precipitation patterns affect the snowpack, which will also help make the models more accurate.

Additional co-authors are Andrew Bennett and William "Ryan" Currier, both of whom completed this research as UW civil and environmental engineering doctoral students; and Bart Nijssen and Jessica Lundquist, both UW professors of civil and environmental engineering. Snow Spotter was created by Max Mozer, who started this project as a UW undergraduate student studying civil and environmental engineering.

More information: Cassie Lumbrazo et al, Evaluating Multiple

Canopy-Snow Unloading Parameterizations in SUMMA With Time-Lapse Photography Characterized by Citizen Scientists, *Water Resources Research* (2022). DOI: 10.1029/2021WR030852