Doctoral Students Using Advanced Technology to Study Forests

LiDAR data covers 80,000 acres of the Santa Catalina Mountains in southern Arizona

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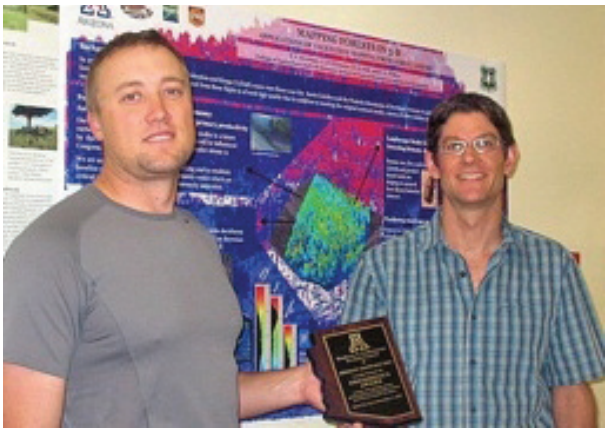
SCHOOL OF NATURAL RESOURCES AND THE ENVIRONMENT



Tyson Swetnam and Christopher "Kit" O'Connor, both doctoral degree candidates in the UA's School of Natural Resources and the Environment, earned a UA President's Award for their investigation of two area mountain ranges using LiDAR data.

Tyson Swetnam is using advanced technology to conduct an investigation that draws on 400 gigabytes of information gathered from an 80,000-acre stretch of the Santa Catalina Mountains to better understand the historical cycles of the range.

Swetnam is among a number of researchers at the University of Arizona who the Coronado National Forest has enlisted to investigate mountain ranges in southern Arizona using Light Detection and Ranging, or LiDAR, data.

For a number of reasons, the investigation is highly complex.

"LiDAR is so powerful. And this is the first time that we've been able to measure nearly every tree," said Swetnam, a doctoral degree candidate in the UA's School of Natural Resources and the Environment.

He is working alongside Christopher "Kit" O'Connor, another doctoral student in the same school, who is studying the top 85,000 acres of the Pinaleño Mountains near Safford, Arizona.

Where scientists have long conducted land surveys, collecting random samples and data to measure the height, density and biomass of forest trees, Swetnam and O'Connor are combining these traditional methods with LiDAR data.

Collectively covering about 150,000 acres of land, their investigation could answer critical questions necessary to aid forest managers who need to know when and where not to set controlled burns while also leading to advancements in the ways forests are studied.

Swetnam also noted that potential for biomass-reduction, or thinning projects, exists in both the Santa Catalina and the Pinaleño mountain ranges and that while no logging contracts exist in either range, their work could have implications for the nation's timber industry.

The LiDAR database is quite immense—involving measurements of nearly every tree, bush, trail, roadway and other dimples in the earth.

"It's more ecological information than we have had on any computer," Swetnam said.

He and O'Connor are using LiDAR data that was collected during flights over the Santa Catalina Mountains in 2007—which Swetnam is focusing on—and over the Pinaleño Mountains in 2008.

Law enforcement agencies, military organizations, coastal managers and astronomers are among those who have begun using data from LiDAR, advanced aerial photography that offers enormous and extraordinary amounts of high resolution topographical data.

Swetnam and O'Connor are using the data to visually plot the location of individual trees and other vegetation, and also structures. Eventually, they want to be able to use the data—which which appears as uniform speckles of varying colors and degrees—to

identify plant and tree species.

"It allows us to begin to answer questions we have never been able to answer," said O'Connor, also a graduate research associate at the Laboratory of Tree-Ring Research.

Swetnam and O'Connor also noted that LiDAR has applications that can address a variety of other natural resource management questions, such as identifying suitable habitat for threatened and endangered species—the Mount Graham Red Squirrel and Mexican Spotted Owl being among them—and charting the extent and severity of historic and contemporary fires, insect outbreaks and other landscape-scale disturbances.

But, for now, their investigations have just begun.

Both are advised by Don Falk, a UA adjunct associate professor of dendrochronology in the School of Natural Resources and the Environment, whose research group melds fire history, fire ecology, dendrochronology and restoration ecology to understand the nature of forest fires.

Their interrelated work involves investigating the structure of vegetation in both mountain ranges. The two back up the LiDAR imagery with field studies, collecting samples of the cores of living trees as well as felled trees. They also are taking both natural and human-caused events into consideration.

In addition to studying the history of logging on both mountains, they are attentive to the 1685 fire in the Pinaleño Mountains, along with outbreaks of beetles that occurred during the 1950s and 1990s. As for the Santa Catalina Mountains, the Aspen fire of 2002, the Bullock fire of 2003 and the Nuttall-Gibson fire of 2004 are among the key occurrences, along with the Clark Peak fire in the Pinaleño Mountains.

Likewise, the two are considering the history of programs and initiatives launched by the U.S. Forest Service, the logging industry and others and what effects such efforts have had on forest preservation, growth or decline.

O'Connor, who is interested in the age and demography of the forest, is also conducting a traditional dendrochronology project.

"Which are the teenagers and which are the old timers? And how have these dynamics changed with human land uses," O'Connor said.

Part of his findings will inform Swetnam's research, which is centered on quantifying the biomass of trees. Chiefly, Swetnam is studying carbon cycling.

"Trees are like bank accounts. Every year they grow a little bit, so that is carbon being taken out of the atmosphere and placed in the Earth," he said. "I think of a forest like a bank account. Every fire is like a debit on the account."

He and O'Connor already have had one presentation of their work.

During the annual Student Showcase, which is run by the UA's Graduate and Professional Student Council, they presented "Mapping Forests in 3-D Application of Vegetation Mapping from Aerial Lasers."

The project earned them the agriculture and environmental sciences first place award and the President's Award, which is donated by the office of UA President Robert N. Shelton and goes to student researchers who "exemplify outstanding academic research and community service," according to the UA council.

Swetnam and O'Connor's work is funded by the U.S. Forest Service, Rocky Mountain Research Station and their school. The UA's Laboratory of Tree-Ring Research and the Missoula Fire Sciences Laboratory in Montana are also partners on O'Connor's part of the project.

"Ultimately, we'll be able to use LiDAR to explain a lot of classical ecology that people came up with 100 years ago, both quantitatively and spatially," Swetnam said. "This is something that has never been done before." ✪

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