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Mapping a Redwood Forest with LIDAR

For the past several months, a twin-engine plane has slowly soared over Redwood National Park in search of the world's tallest trees. Five government agencies and conservation groups have pitched in to pay the Sanborn Mapping Company about $183,000 for an extremely detailed 3D image of the rugged wilderness area.

The plane is equipped with LIDAR, light detection and ranging, a new type of equipment that can be used to create digital maps that contain far more information than an aerial photograph.

"The LIDAR measurements will give us a highly accurate depiction of the forest floor and tree heights," said Dan Porter, of the Save-the-Redwoods League. "This application of LIDAR is fairly new. It's pretty cutting edge."

Porter said that the map will be used for far more than a search for tall trees. It will reveal all sorts of information that will be useful to conservationists. When it rains, a mudslide can choke up a river and kill endangered salmon. Scientists can use the maps to identify areas that are particularly vulnerable and then plant trees or take other measures to retain looming hillsides.

Forestry officials will also be able to identify young forest canopies that are too dense or otherwise in danger of not maturing into the majestic redwood groves that once stood there.

"We can learn more about old growth and the biodiversity that is there. Forest restoration takes the second growth forest to old growth (characteristics) by actively manipulating it," said Porter.

I was invited by Landis Communications to fly along on one of the last days of aerial mapping. Landis is a public relations firm that was hired to represent Save-the-Redwoods. After a few phone calls to the mapping company, I booked a flight to the northwest corner of California.

When my flight arrived in Crescent City, California, the weather was beautiful. The skies were clear and the air was still; the perfect conditions to slowly fly back and forth over a redwood forest at an altitude of only 800 meters. It was dusk, and two mapping experts picked me up from Jack Mc Namara Field, the same airport where their plane was tied down. They took me to the beach and we built a campfire from driftwood.

As we sat on the sand and talked, it became apparent that neither of the two geographers knew what would become of the massive amount of digital map data they were generating. What they were able to explain is how LIDAR mapping works and tell me all about their personal experiences.

Saralyn Durheim had been working as a LIDAR operator for over a year. During a project, her job is to sit in the back of a light airplane, navigate, and control the equipment while the pilot maneuvers back and forth in a pattern similar to that of mowing a lawn. Since she began working for Sanborn, the Oregon native has flown over locations as varied as suburban New Jersey and the hills of rural Texas.

While mapping New Jersey, her plane would turn around over New York City. "We were making our turns over New York City and since we were not flying too high off the ground, we were able to see all of the attractions in good detail."

My other companion at the campfire was Matt Aschbrenner, the newest member of the team. He takes turns with Saralyn between flying in the plane and babysitting locater beacons on the ground. Those beacons help orient the plane and give the LIDAR equipment some additional spatial information. The onboard system already has a GPS receiver.

While flying over the redwood forests, he spotted a beautiful mountaintop covered with wildflowers.

"We decided to go check it out," said Aschbrenner. "It is one of those things you would never have found by car."

Aschbrenner also mentioned the abrupt change they would often see from old growth forest to an area that had been logged and replanted. New trees, planted in a wasteland ruined by logging, are dwarfed by the older trees that surround them.

As my luck would have it, the clear skies had become thick with fog as I slept. On that morning, I would not be able to catch a ride in the 1968 Aero Commander that was decked out with Leica LIDAR equipment. I was however, able to meet up with the pilot and get a good look at his fancy ride.

"The airplane itself is cheaper than the Leica," said Cady Daniels IV, a commercial pilot and flight instructor turned mapping guru. "I don't exactly know how much the Leica costs, but I know it's a lot. If I had to save the airframe or the equipment, I would save the equipment."

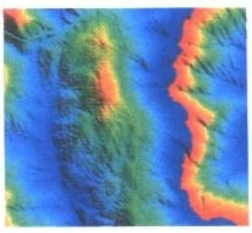
I was thrilled to have the undivided attention of a seasoned pilot, who could satiate my morbid curiosity about engine failures and other things that might lead to a small plane crash. He claims that their Aero Commander could easily be kept aloft if one of the two engines cut out and jokes that they could even keep mapping. Daniels said that there will soon be a shortage of the Commander style aircraft, which are ideal for the kind flying required for mapping. It has a huge rudder that gives it tremendous stability in the air and twin piston engines that get the best fuel economy when flying low and slow. Planes like that are no longer in production. Despite the relative fuel efficiency of their plane, it still gets seven miles to the gallon and they had already flown over 13,500 miles. You can do the math. I no longer feel all that bad about the 45 dollars it costs to fill the tank on my car.

A hole cut in the bottom of their plane allows a laser beam to sweep across the terrain below. The laser records the exact position of 85,000 points on the ground each second. That data is then used to construct an extremely rich 3D map.

Since some of the narrow laser beams can pass between the branches of trees and strike the ground below, it is possible to see a picture of the forest floor as well a separate map of the treetops. This will allow environmental scientists and forestry officials to accurately calculate the heights of individual trees. Before the advent of LIDAR, cartographers could use a technique called photogrammetry to estimate the heights of trees. This meant that they would examine aerial photographs and then calculate the actual size of a stand of trees. LIDAR measurements are almost a hundred times more accurate, recording the dimensions of each tree within one or two feet. Sometimes it is even possible to identify the type of tree with the LIDAR data.

Save-the-Redwoods is only one of the four organizations that sponsor the mapping project. Porter had initially intended to raise funds for mapping Mill Creek, one of the most successful restoration areas in the country. Short of his goal by $10,000, he decided to start looking for collaborators.

"The interest was overwhelming. Partners jumped on left and right," said Porter.
The other sponsors, including the Nature Conservancy, National Parks Service, Bureau of Land Management, and California State Parks Foundation, each have their own intentions for the geographic data.



Currently, the tallest known tree in Redwood National Park is called Hyperion and stands over 379 feet tall. "There's verbal accounts of taller trees," said Porter.

Once the mapping flights have been completed, the raw data will be put in the public domain and given to Steven C. Sillett, a professor of forestry at Humboldt State University. Then, sort of digital treasure hunt for those giants can begin.

LIDAR data is very hard to look at. When one off these is loaded into graphical software without any processing, it looks like a psychedelic moonscape. For that reason, playing with the unprocessed files will be great fun for forestry students and hobbyists but not the general public.

"Steve will look at this depiction of tree heights across the landscape and pick out hotspots," said Porter. Professor Sillett will then send his students or venture out into the forest himself to measure the heights of the trees in those areas, with the hope that a new giant can be found.

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