Altitude key to mapping mesquite, bluestem growth

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Yellow bluestem. Credit: Texas Tech University

In Texas, mesquite trees are as common as football, thunderstorms and hot summer nights. It is a staple of outdoor cooking and prevalent in

almost every part of the state.

But, for land managers, the spread of honey mesquite, a native and prevalent species, is an issue, as is the non-native yellow bluestem, a grass species native to eastern Europe and Asia that has been spreading throughout the southern U.S. over the last few decades. Together, these two species are a threat to maintaining rangeland diversity and productivity.

Controlling these two species, however, has been difficult. Hopefully, thanks to research by a team from Texas Tech University's Department of Natural Resources Management (NRM), rangeland managers may now have a method to get a leg up on controlling the spread of honey mesquite and yellow bluestem.

"Rangeland managers are interested in eradicating both species in order to maintain rangeland diversity and productivity," said Carlos Portillo-Quintero, NRM associate professor. "However, their suppression is a site-level process implemented by the rangeland manager that involves regular mechanical or chemical treatments."

Former master's student Matthew Jackson, who now serves as the Geographic Information System/Remote Sensing Manager for the Memorial Park Conservatory in Houston, led a project along with Portillo-Quintero and Robert Cox, NRM associate professor and President's Excellence in Teaching Professor, using unmanned aerial vehicles (UAV) to study the effects of and the ability to detect and map mesquite and bluestem growth. The results could help rangeland managers better control the spread and effectiveness of eradication techniques.

"At Texas Tech's Geospatial Technologies Laboratory, we have been using low-cost commercial UAVs to inspect and map ecological features

in different types of landscapes around Texas," Portillo-Quintero said. "The objective was to generate knowledge on the best practices that rangeland managers and contractors can apply when using this type of mapping technology."

Joining Jackson, Portillo-Quintero and Cox on the project were Department of Plant and Soil Science Chairman and associate professor Glen Ritchie, NRM graduate students Mark Johnson and Mukti Subedi, and State University of New York-Potsdam geology assistant professor Kamal Humagain. The research was conducted at the College of Agricultural Sciences & Natural Resources (CASNR) native rangeland site in Lubbock County, designed for studies in ecological and range management research.

Honey Mesquite. Credit: Texas Tech University

Identifying the issue

According to Portillo-Quintero, yellow bluestem is a clump-forming grass species that was introduced in the U.S. as an experimental grazing grass due to its massive seed productivity and easy establishment. As it was promoted on Conservation Reserve Program (CRP) lands throughout Oklahoma and Texas, it began to take over native grasslands with deleterious effects on the diversity of native plants, small animals and birds.

Currently, yellow bluestem can be found in about 60 of Texas' 254 counties, while honey mesquite is found in every corner of the state and everywhere in between. A native species, honey mesquite was limited mostly to low-lying drainage areas with sandy soils prior to European settlement. Since the 1800s, Portillo-Quintero said, intense livestock grazing and fire suppression have allowed honey mesquite to cover vast territories.

Controlling the spread of both species is a point of focus for rangeland managers throughout the state. Finding a novel way to control this spread is goal of rangeland managers, and the research findings from the Texas Tech team could be what they are looking for.

UAV mapping

In order to best determine how widely and quickly the honey mesquite and yellow bluestem spread, the Texas Tech researchers utilized a DJI Phantom 3 Pro UAV equipped with a 12-megapixel camera. The UAV would conduct one-hour flights using the Pix 4-D Capture mobile application on an iPhone to create flight plans and automatically fly the UAV.

Portillo-Quintero said this setup was used because of its popularity and low cost so that land managers could affordably use the same setup if they wanted to conduct the same flights.

An example of the unmanned aerial vehicle used to document honey mesquite an yellow bluesteam spread. Credit: Texas Tech University

Flights were conducted and data collected at altitudes of 30, 60 and 100 meters. The UAV and camera were able to capture high-resolution imagery and elevations over the entire rangeland site, and an image classification process using artificial intelligence algorithms and other classifiers were used to detect the honey mesquite and yellow bluestem plants.

"In order to be detectable, mesquite shrubs would have to be juveniles or adult plants," Portillo-Quintero said. "Yellow bluestem would have to be adults. The influence of the soil background and its similarity to other

species of grasses makes it more difficult to accurately detect."

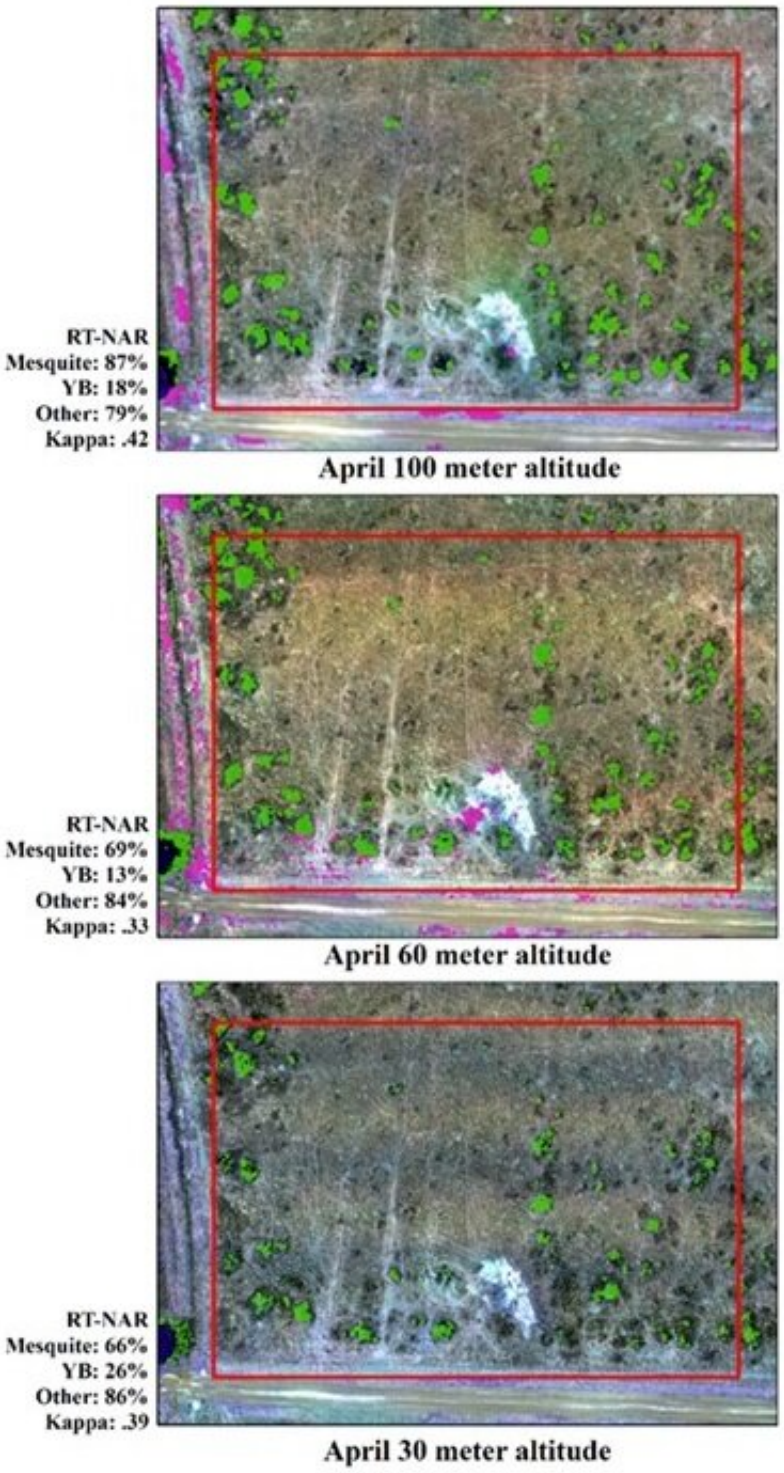
Flights were conducted seasonally from the summer of 2017 to the fall of 2018 due to rainfall and temperature factors that affect detectability of vegetation from above.

"Most plants in the rangeland, including mesquite shrubs and bluestem in the winter, have reduced or no photosynthetic activity, which means everything looks brown or dead," Portillo-Quintero said. "During the summer, it's the other way around, all plant species are in their peak of greenness."

"We found that both winter and summer seasons are problematic because plants look so similar it is hard to clearly distinguish between them. The work by Matthew showed how collecting data in the spring, where mesquite and bluestem are discernable from other grass and shrub species, greatly improves our ability to map them using image classification software and algorithms."

Altitude matters

Of all the flights made by the UAV over all types of seasons, it was determined the flights at 100 meters conducted during the spring were the most effective—with more than 80% accuracy—for mapping mesquite canopies based on reflection values and image segmentation information. However, for yellow bluestem, the mapping accuracy at 100 meters was extremely low, less than 20%.



This series of photos shows how well the growth of yellow bluestem and honey mesquite can be detected at higher elevations. Credit: Texas Tech University

"At the 100-meter altitude, the spectral information is collected at coarser pixel sizes," Portillo-Quintero said "This allows for a mixed spectral response that tends to mix branches with the leaves and soil background, forming a more uniform and distinct spectral signature of the plant species. At lower altitudes, the pixel is so small, it introduces more noise into the image, which makes it challenging for species to be accurately mapped."

The research also involved the use of Support Vector Machine classification algorithms, which can go deeper into the patterns of spectral response and canopy shapes of the specific species. They are able to learn which factors are more important in detecting and mapping individual species and are essential to detecting individual plants using UAV imagery.

The results of the research should give land mangers a leg up on detecting and controlling the spread of honey mesquite and yellow bluestem.

"Using the recommendations from our work, it is possible to map the distribution of the mesquite trees and plan ahead for their removal with high accuracy," Portillo-Quintero said "It is now much easier for technicians and investigators to perform such assessment with less cost and effort in a shorter time. Contractors in charge of managing a mesquite invasion, for example, can rely on UAV-based measurements to have a better sense of the amount of materials and equipment needed for its removal. A before-and after-assessment also can show the effectiveness of their removal techniques to the landowner."

Given the success of this project, Portillo-Quintero said the next step would be continuing this line of research using UAVs and multispectral cameras, potentially investigating other remotely sensed data such as light detection and ranging (lidar), or using laser light to illuminate and

measure the reflection off an object. Portillo-Quintero said Jackson has begun implementing these techniques for tree-cover mapping and urban ecology research in his position at the Memorial Park Conservatory.

"Identifying and monitoring juvenile and adult plants while they colonize new areas across the landscape helps prioritize locations for treatment," Portillo-Quintero said, "These are all money- and time-consuming activities."

Provided by Texas Tech University

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