Study seeks to help southwestern white pine navigate climate change, disease

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A new collaborative project involving Virginia Commonwealth University seeks to understand the ecology and evolutionary history of the southwestern white pine tree – found in the mountains of the

southwestern United States and Mexico – so as to help predict the tree species' response to climate change and infestations of an exotic fungal pathogen known as white pine blister rust.

Andrew Eckert, Ph.D., an evolutionary geneticist and an assistant professor in VCU's Department of Biology in the College of Humanities and Sciences, is the principal investigator at VCU on the five-year study, "Blending Ecology and Evolution using Emerging Technologies to Determine Species Distributions with a Non-native Pathogen in a Changing Climate," which is funded by a $528,066 grant by the National Science Foundation. His work is part of a larger grant from the National Science Foundation totaling more than $4 million.

Eckert and his collaborators – Kristen Waring, Amy Whipple and Lluvia Flores-Renteria from Northern Arizona University, Heather Lintz, Christopher Still and Michael Wing from Oregon State University and Sam Cushman and Richard Sniezko from the U.S. Department of Agriculture's Forest Service – chose to focus on the southwestern white pine because of its ecological importance in the mountains of the desert in the southwestern United States and Mexico.

"It is a foundational species in montane forests—high-elevation forests—where it provides food and nesting sites for numerous birds and mammals," Eckert said. "In addition, southwestern white pine has a distribution across the landscape that is conducive to using it as a natural experiment to test hypotheses about how species come to be distributed across diverse environments."

The research may help scientists better understand the genetic basis of local adaptation, how patterns of pollen and seed movement allow populations to persist, and how to use that data to make better predictions to inform forest management practices.

"We are using a mixture of next-generation technologies to generate enormous datasets comprising information about genetic polymorphisms, physiological responses in controlled and natural environments and geospatial and climate data on unprecedented scales outside of model organisms," Eckert said.

The data will be used to explain the current distribution of southwestern white pine, including how it has adapted to local climate conditions in the past, thereby allowing researchers to use that information to build and assess models about how the species' distribution will change as climate changes and pathogens invade its native range.

Climate, Eckert said, is one of the most important environmental influences on the distribution and growth of tree species, and researchers know that climate is changing. This research project, he said, is novel because it will incorporate genetic information about how the southwestern white pine has adapted evolutionarily to climate in the past.

"Information such as this can then make predictive models more precise and hopefully more accurate, because we know that populations of organisms such as trees adapt to their local environments," he said.

The project is also unusual in that its sampling design crosses the border between the U.S. and Mexico.

"Since the bulk of the continuous distribution of southwestern white pine is in the mountains of northern Mexico, we enlisted the help of several Mexican colleagues," Eckert said. "These colleagues will be heavily involved with the collection and analysis of the data, including publications resulting from this work. This reflects the commitment of our research team to bring the highest level of rigor to this project, as logistically it would have been much easier to restrict sampling to the United States."

The project will involve educational and outreach activities, including exhibits and garden plantings at Flagstaff Arboretum in Arizona and the U.S. Forest Service Dorena Genetic Resource Center in Cottage Grove, Oregon.

Postdoctoral, graduate and undergraduate students will participate in the project and will be trained in interdisciplinary science that bridges genomics, tree disease resistance testing, landscape ecology, modeling, engineering, remote sensing and spatial analysis.

It will also involve an outreach website, in both English and Spanish, that will provide results to the public, as well as several workshops for conferences in the Southwest, one of which will be a cross-border meeting between Mexican and U.S. foresters.

The project, according to its abstract, will "strengthen cross-border research, management efforts in forest conservation and our understanding of how genetics shape life on Earth."

More information: "Collaborative Research: Blending Ecology and Evolution using Emerging Technologies to Determine Species Distributions with a Non-native Pathogen in a Changing Climate." nsf.gov/awardsearch/showAward?AWD_ID=1442486

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