Assessing pinyon-juniper mortality across Southeast Utah Group National Parks
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Project Summary

Pinyon-Juniper (PJ) communities that include woodlands, savannas, and closed canopy forests, cover an extensive area of 100 million acres across the western United States and provide a wide range of resources for humans and habitat for plants and animals, including numerous endemic and imperiled species such as the pinyon jay (Hartsell et al. 2019). Despite their importance, pinyon and juniper trees have experienced recent dieback events due to drought, aridification, and insect outbreaks (Figure 1). For example, the 2002 – 2003 drought that covered much of the southwestern United States resulted in widespread pinyon mortality (Breshears et al. 2005), and more recently the 2017 – 2018 drought caused juniper dieback on the Colorado Plateau (Campbell et al. 2020), including Southeastern Utah Group parks. We used funding from the Canyonlands Natural History Association and protocols jointly developed by the U.S. Geological Survey and National Park Service to relate tree condition from field surveys to the amount of tree dieback estimated using aerial imagery across Arches and Canyonlands National Parks and Natural Bridges National Monument.



Figure 1. Dead pinyon pines at Arches National Park. Photo credit: Armin Howell, National Park Service

Methods

We focused our analyses on pinyon-juniper communities designated by National Park Service Inventory and Monitoring map units (https://www.nps.gov/im/ncpn/seug.htm). We applied a previously developed method that used aerial and satellite imagery (Campbell et al. 2020) to create a preliminary layer of potential tree dieback in Southeastern Utah Group parks. We used this layer to stratify our survey locations and removed locations with 0% tree canopy cover according to the Rangeland Condition Monitoring, Assessment, and Projection (https://www.usgs.gov/centers/eros/science/rangeland-condition-monitoring-assessment-and-projection-rcmap) fractional landcover. We surveyed low to high potential dieback from randomly selected areas represented in the preliminary layer by taking a high-precision (< 1 m) location of each tree and evaluating its structure and condition, and characterizing pinyon and juniper trees and other vegetation in the surrounding area (US Forest Service 2011, Figure 2). We aligned the tree location in a geographic information system using the most recently available imagery from the National Agriculture Imagery Program (NAIP, https://naip-usdaonline.hub.arcgis.com) at 0.6-m resolution (Figure 2). For each tree location, we added background points in and around the plots at locations that were not trees to account for soil, rocks, and non-tree vegetation. We calculated different vegetation indices and textural metrics to account for spatial patterns in the images. We then constructed a random forest model with these metrics to identify live trees, dead trees, and non-trees.

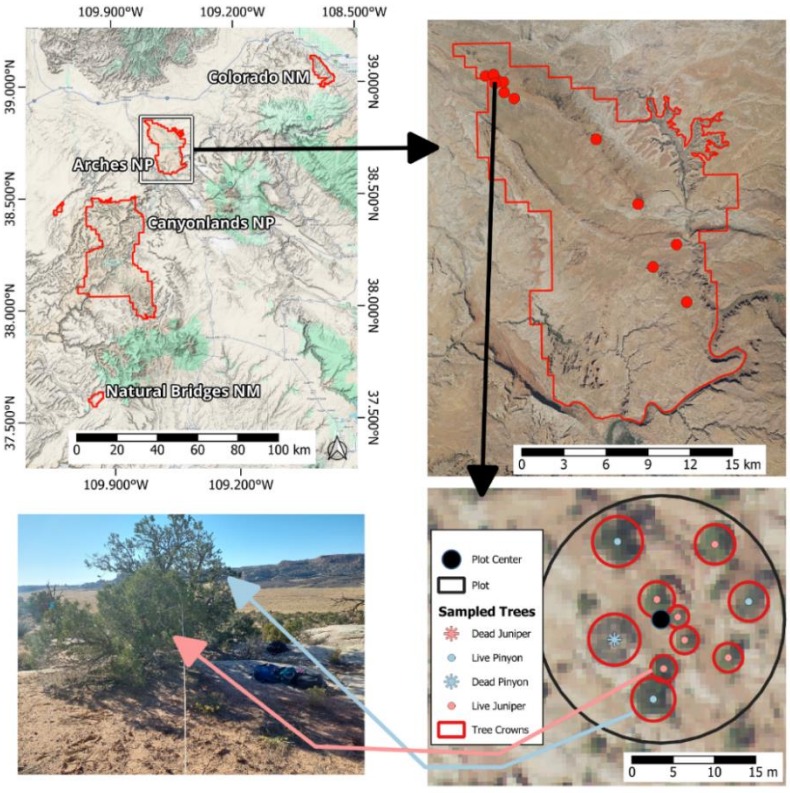


Figure 2. We surveyed Southeastern Utah Group parks (top left, basemap generated with Google terrain tiles) for pinyon and juniper dieback in plots (top right), then aligned tree locations with National Agriculture Imagery Program imagery (bottom right) to detect live and dead trees (bottom left) and scale-up dieback estimates across parks (https://naip-usdaonline.hub.arcgis.com). NP, national park; NM, national monument. =

Results

The surveys provided an opportunity for students at Utah Valley University to learn the ecology of Southeastern Utah Group parks, how to conduct vegetation sampling, navigate and work with maps, and build connections with National Park Service and USGS staff on the natural resource management and science of pinyon-juniper woodlands. Student surveys were incorporated into our assessment of pinyon and juniper dieback using aerial imagery. By integrating the survey with imagery, we demonstrated a method to scale-up estimates of pinyon and juniper mortality in the parks (Figure 3). These preliminary assessments can provide high-resolution understanding of the locations and amount of mortality that has occurred across the landscape. The method we piloted could be adopted as a decision-support tool for park management to help determine potential interventions to mitigate dieback or restore pinyon and juniper trees after dieback has occurred. Surveys coupled with new imagery acquisitions, can help park staff monitor the condition of pinyon-juniper ecosystems, including identifying where new dieback has occurred, and if there has been new tree growth.

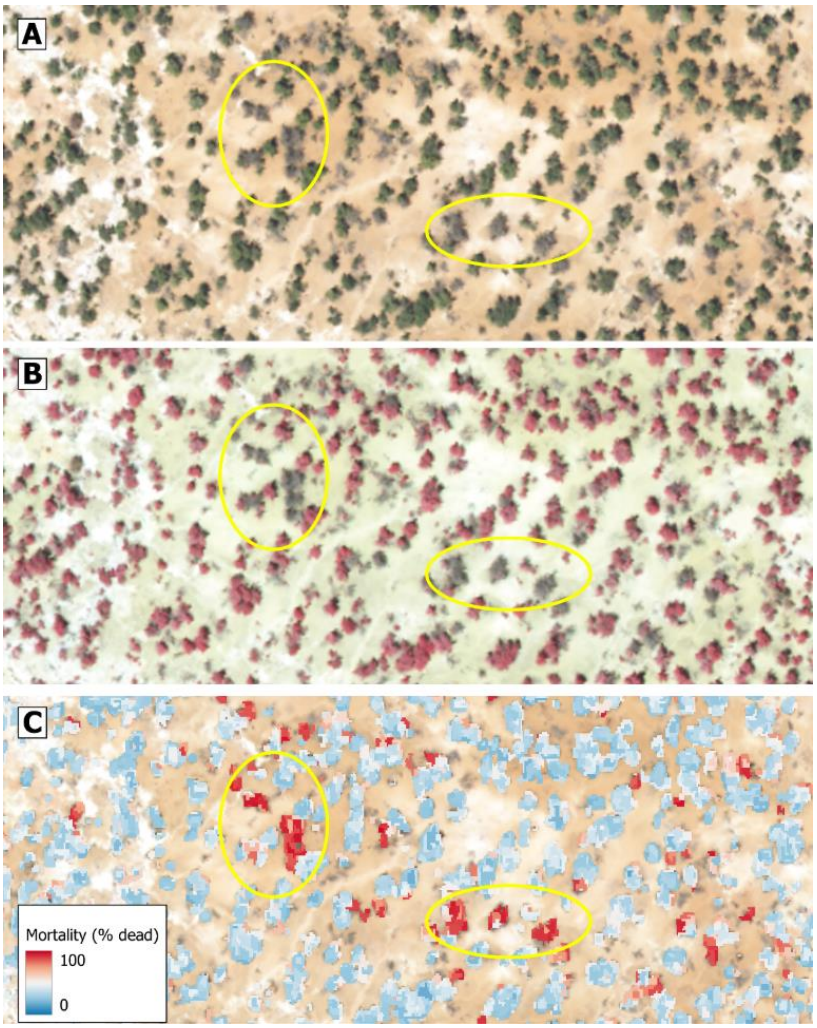


Figure 3. Estimates of pinyon-juniper mortality at Natural Bridges National Monument generated with A) true color National Agriculture Imagery Program (https://naip-usdaonline.hub.arcgis.com) image, and B) false color NAIP image (live trees are red; dead trees are gray/brown). C) Estimates of percent mortality ranging from completely alive (blue) to completely dead (red). Yellow ellipses show two groups of dead trees across all three images.

To more broadly communicate our project to a diverse audience, we provided a podcast of our project through Science Moab in September 2025 (Figure 4). As of December 2025, the podcast had been played over 250 times and features support from the Canyonlands Natural History Association. We rescheduled an October 2025 meeting (cancelled due to government shutdown) with National Park Service Southeastern Utah Group park staff to March 2026 to discuss project progress.

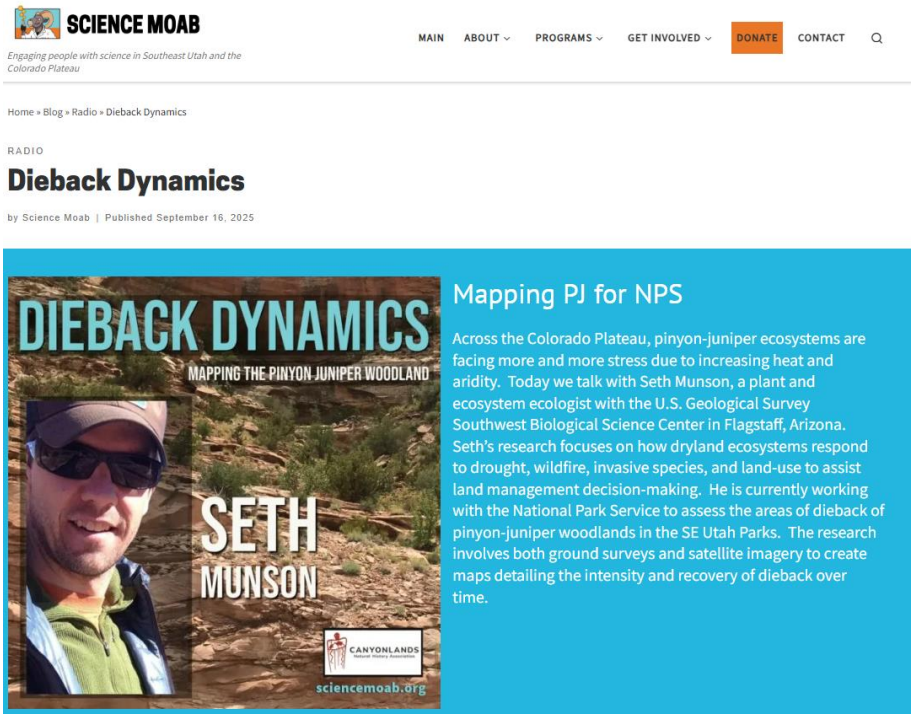


Figure 4. We discussed our pinyon-juniper dieback project on the Science Moab podcast in September 2025 (https://sciencemoab.org/dieback-dynamics).

References

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