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 U.S. and are critically important for providing a wide range of resources for humans and habitat for plants and animals, including numerous endemic and imperiled species such as the pinyon jay. Despite their importance, pinyon and juniper trees have experienced recent dieback events due to drought, aridification, and insect outbreaks (Fig. 1). For example, the 2002 – 2003 drought that covered much of the southwestern U.S. resulted in widespread pinyon mortality, and more recently the 2017 – 2018 drought caused juniper dieback on the Colorado Plateau, including SEUG parks. We used protocols jointly developed by the USGS and NPS SEUG to assess tree structure and condition in the field, and then scaled up evaluation of dieback using satellite imagery within a limited area of Arches National Park. Funding from CNHA was provided to broaden the survey of stands of pinyon and juniper trees where we are now working towards mapping wider reaches of the Colorado Plateau and making a larger assessment of dieback.

Funds from the CNHA 2024 Discovery Pool helped cover the costs of field work and outreach, including classroom field trips, as well as field data collection and using imagery to detect dieback at larger scales. The primary field work was completed involving undergraduate students from Utah Valley University and Co-PI Bishop's Natural Resources Management class. Protocol refinement, training and data collection occurred during fall 2024. Training was accomplished in and around Utah County then in SEUG parks with Armin Howell (NPS SEUG). The training in southeastern Utah also provided an opportunity for students to meet and network with Armin Howell and USGS technicians collecting data. USGS trained staff from the Colorado National Monument and Dr. Deborah Kennard from Colorado Mesa University on the protocol and are currently conducting surveys in the monument to expand assessment of regional dieback in parks. Additional training of USGS technicians will occur spring 2025 to expand field-based sampling.

Methods Overview and Accomplishments

To expand our sampling approach, we generated random locations in pinyon-juniper dominated NPS Inventory and Monitoring map units. We restricted locations to within 1.6 km of roads that were not designated for four-wheel drive vehicles. We also did not sample areas with greater than 26 degree slope or where the path from the nearest road would cross a cliff (>45 degree slope). Additionally, we stratified the available sampling areas by an aridity index to ensure distributed samples across environmental gradients. We worked with Dr. Mickey Campbell at the University of Utah to refine a method of using aerial and satellite imagery to detect dieback in Grand Co. Utah (Campbell et al. 2020) to develop a preliminary pinyon-juniper dieback raster

for SEUG parks to ensure that our sampling covered potentially highly impacted areas and removed locations with 0% tree canopy cover according to RCMAP fractional land cover.

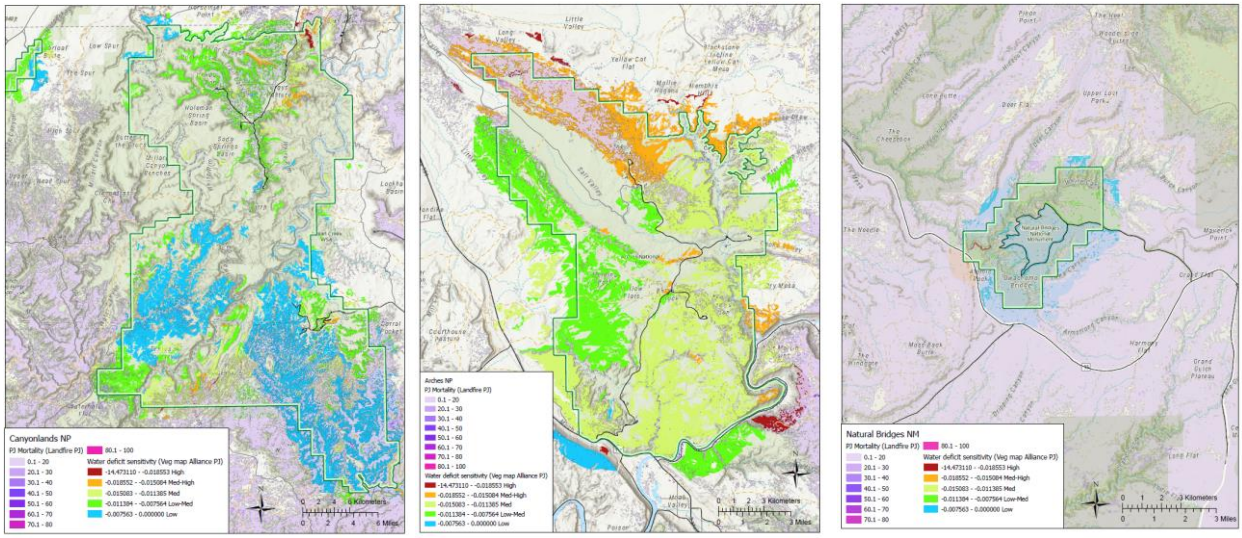

Figure 1. Preliminary pinyon-juniper dieback map used for sampling areas where highly tree dieback may have occurred in SEUG parks. These maps will be updated with field-based validation and additional analysis using aerial and satellite imagery.

New protocols were established from a collaborative group involving the PIs and NPS employees based on the previous USGS-NPS data collection. Prior to any field work, we worked with Heidi Wainer, the SEUG research permit coordinator, to attain permits for working in the four SEUG parks. Data collected included identifying locations with alive and dead pinyon and juniper trees, establishing a 30 m diameter circular plot and temporarily marking 10 trees in each plot. Trees were then measured for root collar diameter, height, and stem count (on multi-stem juniper trees). Root collar diameter was collected for each stem and then using the square root of the sum of squares (USDA Forest Service Nationwide Inventory Field Guide). Each of the 10 trees were assessed in different stages of tree development from living to final decomposition (adapted from Bartels et al 1985). Canopy cover to use for imagery model validation was calculated by measuring the longest length of the individual tree canopy cover and the perpendicular to the longest length. Height was collected using a rangefinder and clinometer. Other plot measurements included outlining the sampling plot on a map including all vegetation and areas of bedrock exposure for further imagery validation of tree condition, percent cover of pinyon and juniper trees, shrubs, and other vegetation by functional group, and percent exposed bedrock. Photographs were taken at cardinal directions of all the sampled plots and high-precision (< 1) GPS location data were saved for each sampled tree. T. Bishop and her class visited 21 plots total over the span of two trips in November 2024 with a total of 17 different students split into two groups (9 students per trip +

Bishop). The plots were in Canyonlands National Park Island in the Sky District (9 plots), Needles District (10 plots) and 2 plots in Arches National Park. Data has been entered and shared with other PIs for data analysis and modeling work. The field trips provided opportunity for the student

Figure 2: Top left – Dr. Bishop with students from ENVT 3770 Natural Resources Management class finishing their last plot of the trip; *Top right* – Student Hali Lukacs providing direction to Risa Nelson on how to use a clinometer to measure the angle for estimating tree height*; Bottom left* – Students Brittany Lade and Adam Memmott measuring diameter of root collar (DRC) for a juniper tree in Arches National Park*; Bottom right* – Student Mark Jeffs works with partner Bryce Peterson (not pictured) to estimate DRC for a particularly difficult dead juniper tree in Canyonlands National Park

participants to learn the ecology of SEUG parks, how to conduct vegetation sampling, navigate and work with maps, and build connections with NPS and USGS staff on the natural resource management and science of pinyon-juniper woodlands.

Future Work

We will focus at least one more class field trip this spring to sample Natural Bridges NM given the high amount of dieback in the area. Coordination with NABR archeologist and USGS field crew will occur prior to sampling. We will have a small field crew of USGS technicians conduct more extensive surveys in SEUG parks using our updated protocols to understand where dieback has occurred across a larger gradient of environmental conditions. All this field-based data will be entered, quality checked and used to train imagery of where dieback has occurred across the region.

We will align the locations of the field-based measurements with 4-band, 0.6-m resolution National Agriculture Imagery Program (NAIP) imagery in GIS. We will then use a combination of image segmentation and machine learning methods to model tree dieback as a function of image spectra (and derived metrics like the normalized difference vegetation index) and climate and soil characteristics, including precipitation and soil depth and texture. The model will then be used to

predict tree mortality and dieback throughout the parks. After initial imagery modeling, we will determine whether more ground plot data is needed where we will work with NPS, USGS, and UVU collaborators and technicians to collect. That data would then be incorporated into the modeling to increase robustness and accuracy of the mapping and interpretation efforts. Once modeling, interpretation is complete we will prepare maps and reports to share directly with NPS staff and other land management agencies, Science Moab in addition to a USGS data release.

References

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