Back to the Future: Using Historical Records to Assess Plant Community Shifts Along an Elevation Gradient in a New Mexico Sky Island

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Introduction: Sky island habitats – such as the Organ Mountains of southern NM – are model systems for understanding the impacts of climate change on biological communities[1]. The Organ Mountains' harsh elevation gradient (1,189 – 2,738 m) allows us to see in real time how species are responding to altered climatic conditions. Understanding these processes is critical for rangeland management[2], nevertheless, very little is known about individual species response to climate change in New Mexico and arid regions more generally[3]. To address this gap in knowledge, we leverage occurrence and ecological monitoring data to understand climate-induced biogeographical shifts among flora of the Organ Mountains of through space and time.

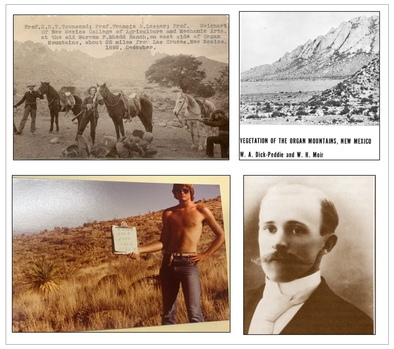
Hypothesis: Over the past 130 years of climate change, plant species will have shifted up in elevation in the Organ Mountains.

Objectives:

1. To establish a record of Organ Mountain plant species occurrences from the past 130 years.
2. To explore trends in species' distribution in space and time including landscape position (e.g., elevation, slope, aspect) and plant community dynamics (e.g., richness, abundance, diversity, ecosystem structure).
3. To design and start a monitoring program using Assessment Inventory and Monitoring (AIM) Core methods for future change detection.

Methods: Species occurrence and ecological data were compiled from three sources 1) archival materials, primary and secondary source documents 2) biodiversity databases and 3) Bureau of Land Management (AIM) data. Additionally, we collected abundance, species richness, and ecosystem structure data using AIM Core Methods along elevational strata.

Historical Records



Biodiversity Databases

Source	Occurences
Consortia of Intermountain Herbaria	24304
The Global Biodiversity Information Facility	28233
New Mexico State University Herbaria	2705
SEINET	23923
The Smithsonian Institute	794
University of Texas El Paso Herbarium	11207
Archival Historical Records	800
Total Records	91966

AIM - Ecological Monitoring Data

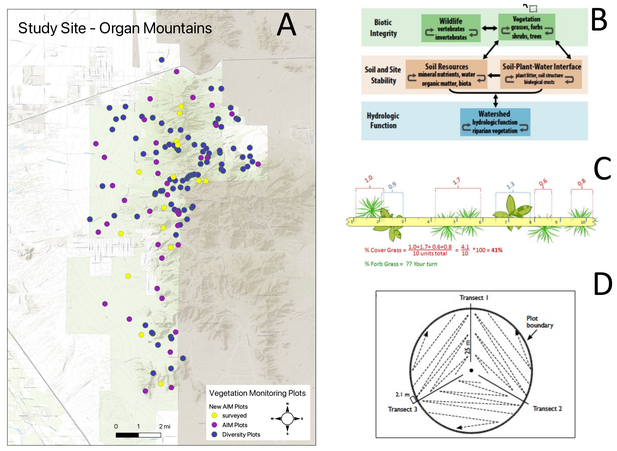


Figure 5. Elements contributed to this project by the Assessment Inventory Monitoring methods – species richness, ecosystem structure, and species' relative abundance. **A.** Map of AIM and Diversity plots in the Organ Mountains including additional plots from this project (in yellow). **B.** Relationship between metrics collected and ecosystem function. **C.** Illustration of a transect measuring canopy gap. **D.** Diagram of plot layout.

Preliminary Results

Organ Mountains plant biodiversity through time and elevational gradients: alpha, physiological and phylogenetic diversity

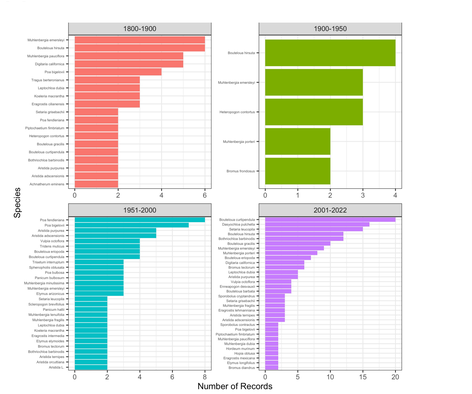


Figure 1. Poaceae alpha diversity in the organs Mountains, NM based on 100 years of recorded occurrence data. **A.** Occurrence data of representative species of Poaceae. **B.** Diversity of Poaceae based on C3 and C4 photosynthetic pathways

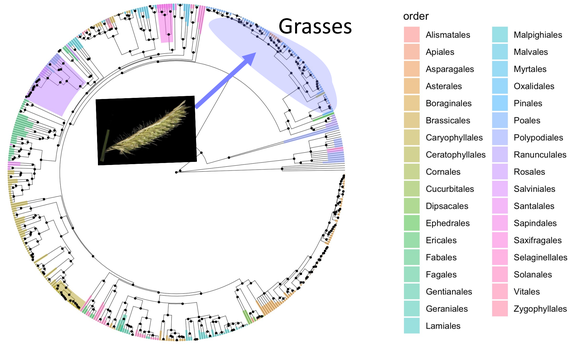


Figure 2. Vascular plant phylogenetic diversity in the Organs Mountains. Poaceae lineage marked in purple.

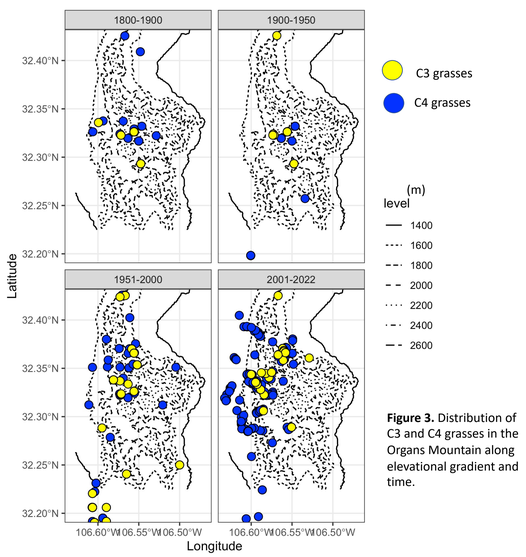


Figure 3. Distribution of C3 and C4 grasses in the Organs Mountain along elevational gradient and time.

Next Steps: Integrate environmental covariates, combine presence only and presence/absence data, and elucidate patterns species traits and plant communities through time and space.

Conclusions: Unifying data with temporal resolution, botanical precision, and standardized methods results in a dataset that is more than the sum of its parts – allowing insights into the past, present, and future. A quality that is crucial when managing ecosystems impacted by climate change.

Implications for Range Management

1. Identify fast-adapting species for restoration, translocation, and targeted demographic studies
2. Identified local extirpations, new invasions, sensitive taxa, and threatened populations
3. Protection of ecological, socio-ecological, and tourism-related resources
4. Supply models for plant community response to climate change in arid systems
5. Provide proof of concept for a long-term ecological monitoring of the Organ Mountains

References

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Acknowledgements: Undergraduate assistants: Justin Lopez, Charlene Juanico, Joshua Martinez. USDA NIFA ENHANCEMENT Enhancing Hispanic Access to Natural Resource and Agricultural Careers through Education, Mentorship, and Training, NMSU Herbaria Team, Bureau of Land Management.