Assessing Biodiversity of Mojave Desert Springs using environmental DNA, botanical surveys, geology and ecoregion

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Background

Mojave Desert springs are fragile ecosystems, hosting endemic plants and animals, which are threatened by the growing demand for water and climate change. The remote, vast, and extreme nature of the Mojave Desert make assessments of biodiversity challenging. To develop management practices that will protect these groundwater dependent ecosystems, real-time, low cost biodiversity methods need to be implemented. Environmental DNA (eDNA) metabarcoding can capture a snapshot of biodiversity from any location based on DNA of any group of organisms (Fungi, Plants, Animals, etc.) present in the environment from water, soil, sediment, and air samples and does not require taxonomic expertise.

Objectives

- Assess biodiversity with eDNA metabarcoding
- Compare eDNA results to botanical surveys
- Compare community composition to geology & geography

Materials & Methods

- Water (Three 1 liter) and paired sediment (Three 1.5ml tubes) samples (3 one liter) were collected at 16 springs across the Mojave Desert in Spring of 2019 (Fig. 1). Samples were extracted and 3 markers amplified targeting plants and vertebrates. Libraries for each sample type with pooled markers were sequenced in Miseq. Sequencing reads were processed in Anacapa for taxonomic assignment and analyzed in R for alpha a beta diversity.
- Botanical surveys were carried out in Fall of 2018 or Spring of 2019, with samples taken and identified by characteristics. Tables of species were generated and compared to eDNA results.
- Geology was determined from previously published papers and springs were assigned to ecoregion. This data was explored to explain ecological community patterns.

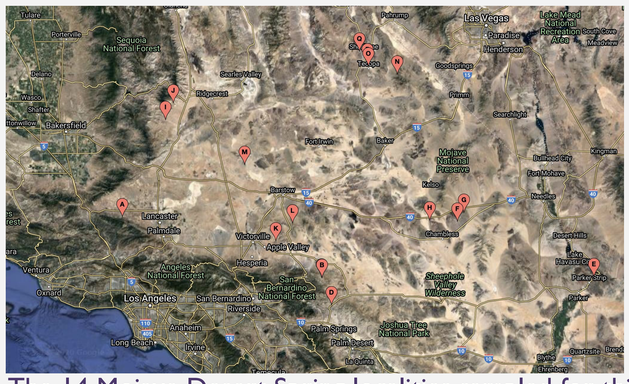

Fig.1 The 14 Mojave Desert Spring localities sampled for this study

Results

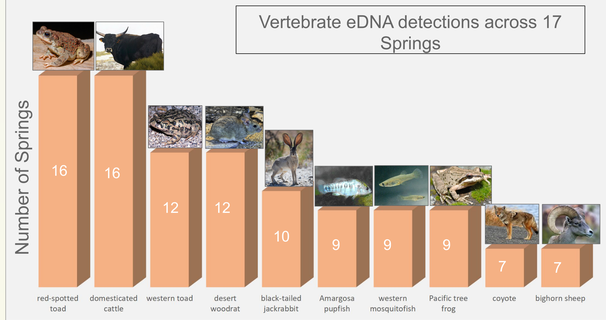

Fig 2. Top 10 vertebrates detected by eDNA across 17 springs.

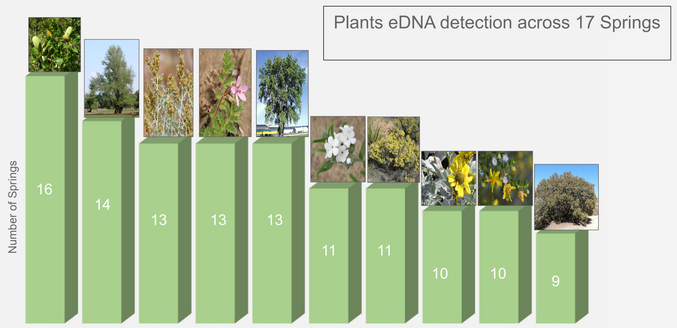

Fig 3. The top 10 plants detected by eDNA method, across 17 springs.

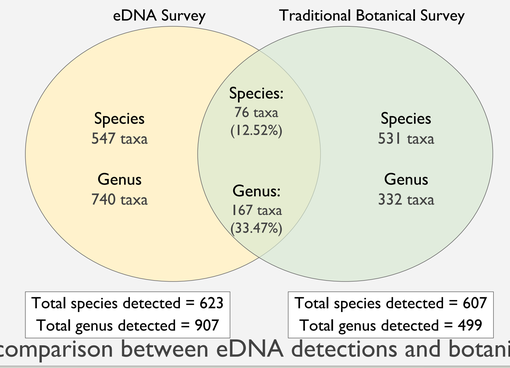

Fig 4. The comparison between eDNA detections and botanical surveys.

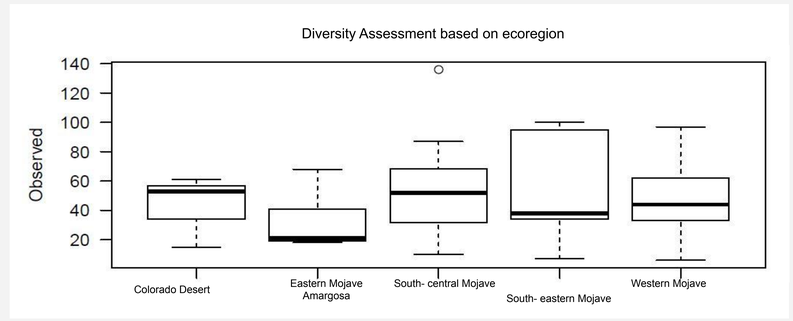

Fig 5. Alpha diversity of plants by ecoregions of the Mojave Desert

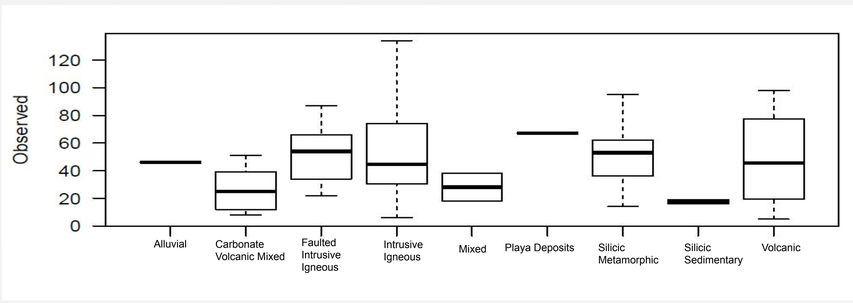

Fig 6. Alpha diversity of plants by vent lithology of Mojave Desert Springs

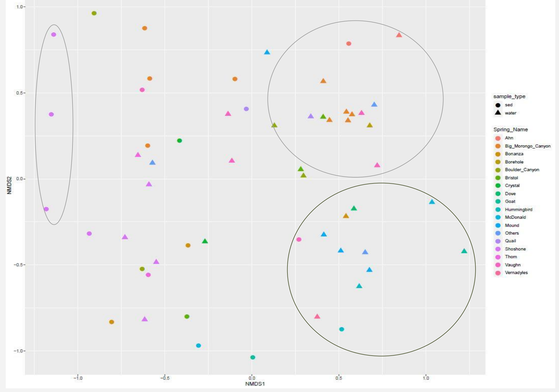

Fig 7. Beta diversity of Mojave Desert springs for plants

Discussion

- The diversity shared across springs included common species of the Mojave Desert but also non-native species like cows, mosquito fish, black poplars, and eastern cottonwoods. (Fig. 2 & 3).
- The comparison between the eDNA detections and botanical surveys had poor agreement (Fig. 4) and could be attributed to sampling in different seasons.
- The alpha diversity analyses for plants shows higher diversity observed in the South-Eastern Mojave Desert, a location where the Mojave and Sonoran Desert intermix (Fig. 5).
- The alpha diversity analyses for plants shows higher diversity in intrusive igneous and volcanic (Fig. 6) as result of the rich mineral content.
- The beta diversity results of plants demonstrate groupings by modified springs, geographic proximity, and sample types (Fig. 5).

Future Directions

- Combine with other methods like remote sensing to capture seasonal vegetation changes
- Apply methods for continual monitoring of biodiversity
- Creatively address locations where water sampling is an issue to increase sampling area
- Expand databases and improve/develop markers for major groups

Reference

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Acknowledgement

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