CLIMATE AND FLORISTIC VARIATION IN THE GREAT BASIN AND MOJAVE DESERT

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Wesley E. Niles Herbarium, UNLV
Great Basin – Mojave Desert

- Premier location to study climate change
  - Paleoclimate proxy data sets:
    - Biological: fossil, pollen, woodrat midden
    - Geomorphological: pluvial lake shores and basins, sand dunes, glacial and periglacial features
Great Basin – Mojave Desert

- Presence of all major temperate life-zones except Humid Transition
- Understanding our flora requires the context of climate change, isolation of populations, and refugia
Physiographic Great Basin

Hunt 1967
Plant species have specific tolerances for conditions and resource availability (e.g., temperature, nutrients, water).

Vary one of the conditions (climate), and the distributions of the plants should change.
To detect changes in vegetation as it responds to changes in climate, we must first know where the vegetation is now. We don’t know very well how species are distributed. We must develop the baseline data.
<table>
<thead>
<tr>
<th>Charlet</th>
<th>Billings (1951)</th>
<th>Merriam (1898)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine</td>
<td>Alpine tundra MZS</td>
<td>Arctic-Alpine</td>
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<tr>
<td>Subalpine</td>
<td>Limber pine–bristlecone pine MZS</td>
<td>Hudsonian</td>
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<tr>
<td>Montane</td>
<td>Yellow pine–White fir MZS</td>
<td>Canadian</td>
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<tr>
<td>Pygmy Conifer</td>
<td>Pinyon–juniper MZS</td>
<td>Upper Sonoran</td>
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<tr>
<td>Sagebrush</td>
<td>Sagebrush–grass</td>
<td>Upper Sonoran</td>
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<tr>
<td>Blackbrush</td>
<td>Creosote–bush</td>
<td>Lower Sonoran</td>
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<tr>
<td>Creosotebush</td>
<td>Creosote–bush</td>
<td>Lower Sonoran</td>
</tr>
<tr>
<td>Saltbush</td>
<td>Shadscale</td>
<td>Lower Sonoran</td>
</tr>
</tbody>
</table>
Nevada Vegetation Zones: Great Basin Series

- Alpine
- Subalpine
- Montane
- Pygmy Conifer
- Sagebrush
- Saltbush
- Absolute desert

Not part of Mojave series

South Aspect - North Aspect
Nevada Vegetation Zones: Great Basin Series at Full Glacial

Nival

Alpine

Subalpine

Pluvial Lake / Montane?

South Aspect

North Aspect
Nevada Vegetation Zones: Great Basin Series at °T Max

Alpine
Subalpine
Montane
Pygmy Conifer
Sagebrush
Saltbush

Absolute desert

South Aspect  North Aspect
Great Basin Series: Hypotheses

Nival
Alpine
Subalpine
Pluvial Lake / Montane?

Full Glacial
$H_{A2}$

Subalpine
Montane
Pygmy Conifer
Sagebrush
Saltbush
Absolute desert / Pluvial Lake

Present Day
$H_0$

Alpine
Subalpine

Alpine
Montane
Pygmy Conifer
Sagebrush
Saltbush
Absolute desert

Thermal Max
$H_{A1}$
Mojave Series: Hypotheses

Full Glacial $H_{A2}$

Present Day $H_0$

Thermal Max $H_{A1}$
Climate Monitoring Infrastructure

- State of the art climate monitoring stations

[Image of an old structure with text annotations: Precipitation gauge, Radiation sensor, Passive solar design, High tensile strength supports]
Climate Monitoring Infrastructure

- State of the art climate monitoring stations
Montane Islands in a Desert Sea

Climate transects
The Data

Four types collected at each site

- Floristic
  - the plant species

- Vegetation
  - the arrangement and structure of plant species that dominate the site

- Physical
  - Location, elevation, aspect, slope, substrate

- Photographic
  - High resolution, geo-referenced, time-stamped
Distribution of samples ($n = 2007$)
Great Basin National Park, White Pine County, Nevada

Climate monitoring installations (7):

Vegetation samples \( (n = 316) \)
Floristic Data
Mojave matrix: 2,000 samples x 840 species
Vegetation Matrix:

2340 samples x 53 attributes
Climate monitoring installations (7):
Climate monitoring installations (5):
576 NVCS plots (266 in Great Basin transect, 310 in Mojave transect)

1770 “RACE” samples (1700 in Mojave transect, 70 in Great Basin transect)

Quantitative cover species data

Presence/absence species data

Useful for detailed analysis of species distributions in a single landscape feature

Useful for defining life zones in a single landscape feature or across a region
Coarse Scale

- Presence/Absence data of groups of trees and shrubs
- Useful for regional trends
Coniferae

Group characteristics
- Economically important
- Ecologically important
- $K$-selected species
- Long time to reproductive maturity, long-lived, slow to move
Great Basin – Mojave Desert Conifers

- Distance to "source" has small effect on diversity
- Size of "island" has large effect on diversity
“Montane relief” alone explained 65% of the variation in conifer diversity across the region.
Distribution pattern is extinction-driven, due largely to changing climate over past 2 million years.

Examining climate change in our lifetime requires a finer scale.
PRISM
(Parameter-elevation Regressions on Independent Slopes Model)
Fine Scale

- Quantitative cover species data
- Useful for detailed analysis of species distributions in a single landscape feature
- Irradiance values derived from 10m DEM and the highly complex topography of the Red Rock Canyon National Conservation Area
Surficial Geology

- Scale 1:150,000
- MMU 10 ha
- 47 Mapped Units
- Contains Generalized Bedrock Geology and surficial units
- Created by Kyle House and UNR Geo-Spatial Lab
Soils Maps

USDA NRCS mapping efforts in Clark County and White Pine County are complete.
To date, > 1000 unique vegetation Associations ($n = 2340$ samples)

Encountered 950 of 4400 taxa in the region
- sampling remains inadequate

Relating environmental variables to distribution of species
Side Benefit

- More than 1100 encounters with more than 50 sensitive rare species in 2340 samples

Photo by Pat Leary
New climate measurements

Future surveys can detect responses to change