Effects of elevation and heat load on the landscape-scale distribution of male and female trees in aspen (Populus tremuloides)

- Robert Bidner
Quaking Aspen (*Populus tremuloides*) – Flowers, Twig, and Seeds
Aspen on the Landscape

- Vegetative reproduction from root suckers\textsuperscript{1,2}
- Stand replacing disturbance\textsuperscript{3,4}
Aspen Decline and Future Range

- Grazing/browsing pressure\(^{5,6}\)
- Fire suppression\(^7\)
- Climate change related drought\(^{8,9}\)

Photo Credit – Rocky Mountain Research Station (Ft. Collins, CO)
Aspen Distribution Literature

- Described at local scale\textsuperscript{10,11,12}

- Genetic and geographic history\textsuperscript{13,14}

- Focus on large mortality events\textsuperscript{15,16}

Photo Credit – Rick Wicker
Aspen Sex Distribution – Grant/Mitton (1979)

<table>
<thead>
<tr>
<th>Elevation Range</th>
<th>1,700 – 2,450m</th>
<th>2,450 – 2,900m</th>
<th>2,900 – 3,100m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Female, Number of Sample Sites</td>
<td>56%, (52)</td>
<td>46%, (94)</td>
<td>36%, (52)</td>
</tr>
</tbody>
</table>

• Male/Female spatial segregation by elevation

• Individual sex recorded in the field

Data Credit – Grant and Mitton 1979
Research Question:

Do aspen sex ratios change with elevation and heat load index?
Hypothesis:
The overall sex ratio of aspen genets on the landscape will be male-biased, both at higher elevations and at sites with a greater heat load index.
Site Location and Field Collection

- 32 total sites
- 21-50 samples per site (1452 total)
- Broad elevation gradient
- Wet/dry moisture categories
Lab Portion – Determining Sex

- Using genetic markers
- Clear and easily interpreted results
## Data + Methods

- **Aspect and slope extracted with ArcMap 10.6.1**

- **Heat load index calculated from radian aspect, slope, and latitude\(^\text{18}\)**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Score_M1_F0</th>
<th>Aspect</th>
<th>Slope</th>
<th>Latitude (°)</th>
<th>Longitude (°)</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM1601</td>
<td>0</td>
<td>101.9689</td>
<td>21.70365</td>
<td>39.36802</td>
<td>-106.815</td>
<td>2348</td>
</tr>
<tr>
<td>COM1602</td>
<td>0</td>
<td>193.7849</td>
<td>18.61226</td>
<td>39.37673</td>
<td>-106.811</td>
<td>2449</td>
</tr>
<tr>
<td>COM1603</td>
<td>1</td>
<td>306.391</td>
<td>26.95446</td>
<td>39.38447</td>
<td>-106.804</td>
<td>2521</td>
</tr>
<tr>
<td>COM1604</td>
<td>0</td>
<td>145.5128</td>
<td>11.01114</td>
<td>39.38263</td>
<td>-106.795</td>
<td>2573</td>
</tr>
<tr>
<td>COM1605</td>
<td>1</td>
<td>271.7466</td>
<td>21.68808</td>
<td>39.37843</td>
<td>-106.785</td>
<td>2508</td>
</tr>
</tbody>
</table>
Bayesian Model

- **Binomial (Bernoulli) GLM**
- Elevation, heatload, site, latitude, interaction term
- Uninformative priors
Model Analysis

- Iterations = 10000
- # Chains = 2
- Thin = 4
- Gelman Diagnostic
- Effective Size

<table>
<thead>
<tr>
<th>2. Quantiles for each variable:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5%</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>beta[1]</td>
</tr>
<tr>
<td>beta[2]</td>
</tr>
<tr>
<td>beta[3]</td>
</tr>
<tr>
<td>beta[4]</td>
</tr>
<tr>
<td>beta[5]</td>
</tr>
<tr>
<td>beta[6]</td>
</tr>
</tbody>
</table>
Plotted Data and Analysis

- Nearly 2:1 Male ratio overall (923 M to 529 F)
- Model = No effect of elevation
1 Site with very low heat load values (ORS)
Model = No interaction
Plotted Data and Analysis
Discussion

- Effect of elevation ✗
- Effect of heat load ✗
- Effect of Latitude ✗
- Site Effect
- Interaction between elevation and heat load ✗
Future Work

• Create a hierarchical model by site
• Analyze different interaction terms
• Look into heat load outlier site
Thanks for Listening! Questions?

Photo Credit – Michigan Department of Natural Resources