Response of arthropod communities to shrub expansion in Western Alaska

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Introduction

Shrub expansion in the arctic
Questions

How might shrub expansion affect arthropod communities in the arctic?

1. Do the **phenological patterns** of arthropod abundance vary by habitat type? By ecosystem role?

2. Are **arthropod abundance** and **diversity** significantly different in shrubby and open habitats?
Photo credits: USGS Alaska Science Center, N. Paprocki, D.A. Walker, J. Beringer
Methods

1.2km² plot

30 randomly selected points

Insects collected 8 times from June 7th to July 26th
Methods: Analysis

1. Do the phenological patterns of arthropods vary by habitat type? By ecosystem role?

Poisson GLM (LRT to test significance of interaction terms)

Cumulative abundance ~ date * habitat type

MANOVA (Pillai’s trace)

Date25 + Date50 + Date75 ~ Guild + Guild2 + Abundance
Results

Phenology by Habitat Type

Pairwise comparisons to Tall Shrub

Not significantly different

Med/low  p=0.722
Tundra    p=0.000122
Alpine    p=0.000453
Results

MANOVA
Response: 25%, 50%, and 75% Day

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Pillai's trace</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guild</td>
<td>0.857</td>
<td>0.163</td>
</tr>
<tr>
<td>Guild2</td>
<td>0.21</td>
<td>0.151</td>
</tr>
<tr>
<td>Abundance</td>
<td>0.132</td>
<td>0.366</td>
</tr>
</tbody>
</table>
Discussion

1. Do the phenological patterns of arthropods vary by habitat type? By ecosystem role?

Most habitat types significantly different in phenology, except Tall Shrub and Med/Low Shrub. Contrary to expectation, Tundra and Alpine habitats appear to reach peak abundance later.

Guild a significant predictor of phenology in glm model, but contradictory results when tested with MANOVA - this may be due to small sample size or loss of information.

Weaknesses

Alpine and Tall Shrub habitats undersampled
Irregularities in sampling interval, had to throw out a whole week
One sampling method, biased towards canopy dwellers
Lack of taxonomic specificity made guild designations difficult or impossible in some cases
2. Are **arthropod abundance and diversity** significantly different in shrubby and open habitats?

Linear & Mixed-effects models

\[
\text{Abundance} \sim \text{Elevation} + \text{Aspect} + \log(\text{Heterogeneity}) + \text{PlantHeight} + \text{ShrubCover} + \text{Percent cover of many plant types}
\]

\[
\text{Plant Diversity} \sim \text{Elevation} + \text{Aspect} + \text{ShrubCover} + (1|\text{Observer})
\]

\[
\text{Arthropod Diversity} \sim \text{Elevation} + \log(\text{Heterogeneity}) + \text{HabitatClass} + \text{Plant Diversity} + \text{MaxHt}
\]

\[
\text{Arthropod Richness} \sim \text{Elevation} + \log(\text{Heterogeneity}) + \text{ShrubCover} + \text{Plant Diversity} + \text{MaxHt}
\]

Taxon accumulation curves to compare diversity between habitat types
Shrub cover most significant predictor of arthropod abundance (p = 6.4e-5)
## Results

### Arthropod Diversity (Shannon-Weaver)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>AIC</th>
<th>adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation + log(Heterogeneity) + HabitatClass + PlantH + MaxHt</td>
<td>2.97</td>
<td>0.32</td>
</tr>
<tr>
<td>Elevation + log(Heterogeneity) + ShrubCover + PlantH + MaxHt</td>
<td>0.16</td>
<td>0.36</td>
</tr>
<tr>
<td>Elevation + log(Heterogeneity) + ShrubCover + MaxHt</td>
<td>-1.83</td>
<td>0.40</td>
</tr>
<tr>
<td>Elevation + log(Heterogeneity) + MaxHt</td>
<td>-3.33</td>
<td>0.42</td>
</tr>
<tr>
<td><strong>Elevation + log(Heterogeneity)</strong></td>
<td>-4.49</td>
<td>0.43</td>
</tr>
<tr>
<td>log(Heterogeneity)</td>
<td>-3.29</td>
<td>0.37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficient(s) in best model</th>
<th>Est.</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation</td>
<td>-0.0034</td>
<td>0.0020</td>
<td>0.0995</td>
</tr>
<tr>
<td>log(Heterogeneity)</td>
<td>0.1717</td>
<td>0.0482</td>
<td>0.0020</td>
</tr>
</tbody>
</table>

### Arthropod Richness

<table>
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<tr>
<th>Predictors</th>
<th>AIC</th>
<th>adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation + log(Heterogeneity) + ShrubCover + HabitatClass</td>
<td>126.38</td>
<td>0.51</td>
</tr>
<tr>
<td>log(Heterogeneity) + ShrubCover + HabitatClass</td>
<td>124.40</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>log(Heterogeneity) + ShrubCover</strong></td>
<td><strong>120.39</strong></td>
<td><strong>0.58</strong></td>
</tr>
<tr>
<td>log(Heterogeneity)</td>
<td>120.95</td>
<td>0.55</td>
</tr>
</tbody>
</table>

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<th>Coefficient(s) in best model</th>
<th>Est.</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShrubCover</td>
<td>0.1192</td>
<td>0.0779</td>
<td>0.1426</td>
</tr>
<tr>
<td>log(Heterogeneity)</td>
<td>3.5597</td>
<td>1.0648</td>
<td>0.0034</td>
</tr>
</tbody>
</table>
Results

Taxon Accumulation Curves

Samples

Alpine
Tundra
Med/Low Shrub
Tall Shrub
Discussion

2. Is arthropod diversity significantly different in shrubby and open habitats?

*Arthropod abundance significantly predicted by shrub cover,* highest in tall shrub habitats

Plant species diversity
- negatively correlated with percent shrub cover
- **not a strong predictor of arthropod diversity**

Plant height heterogeneity
- **significant predictor of arthropod diversity and richness**
- increased in shrub habitats.

Weaknesses
- Alpine and Tall Shrub habitats undersampled
- Irregularities in sampling interval, had to throw out a whole week
- One sampling method, biased towards canopy dwellers
- Lack of taxonomic specificity underrepresents diversity
Next Steps
Thanks!

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References


Questions?

Photo credit: Derek Sikes, UAM