Predicting the impact of climate change on animal distributions
A test of the range-shift capacity in two butterfly species

Shannon Pelini
University of Notre Dame

Advisor: Jessica Hellmann, UND

GREF Mentor: Aimée Classen, UT
Climate change moves species poleward

- **Systematic migration**
  - Individuals move to newly suitable locations
  - Problems: dispersal barriers; habitat availability

- **In situ change in population dynamics and local colonization**
  - Populations build up at range edge and lead range expansion
  - Problems: dispersal barriers; habitat; Specialization, adaptation
Study System

**“Skipper”**

- Small specialist
- Oak spp.
- Erynnis propertius
- 4 cm

I. Will warming increase edge populations?

II. Will host plant transitions limit shifts in the skipper?

**“Swallowtail”**

- Large generalist
- Parsley Family
- Papilio zelicaon
- 8 cm
A test of periphery enhancement to reveal limitations to climate-driven range shifts

Periphery Enhancement Hypothesis
Fitness optimal in core conditions

Core

Periphery

Adaptation to periph. temp.?
Specialization to non-temp.?

Core Conditions = Periphery Enhancement?
(Oregon) (Vancouver Island)

Translocation experiments
Field experiment

Survivorship
Body Size/Fecundity
Results

Proportion surviving +/- 95% CI

<table>
<thead>
<tr>
<th>Rearing region</th>
<th>C Source</th>
<th>P Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.15</td>
<td>0.3</td>
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Mass (g) +/- 95% CI

<table>
<thead>
<tr>
<th>Rearing region</th>
<th>C Source</th>
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<tbody>
<tr>
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<td>0.1</td>
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p = 0.004
Results

Proportion surviving +/- 95% CI

<table>
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<th>P</th>
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<td>0.4</td>
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Pupal Mass (g) +/- 95% CI

<table>
<thead>
<tr>
<th>Rearing region</th>
<th>C</th>
<th>P</th>
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</thead>
<tbody>
<tr>
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<td>0.5</td>
<td>1</td>
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</table>

- *p = 0.004
- **p = 0.041
- **p = 0.018
## Field Experiment Summary

<table>
<thead>
<tr>
<th>Core = Periphery Enhancement?</th>
<th>Survivorship</th>
<th>Body Size</th>
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</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>No</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

![Butterfly images](image)
Chamber Experiment

Temperature (degC)

Date


5/27 6/10 6/24 7/29 8/12 8/26 9/9 9/23 10/7

0.0 10.0 20.0 30.0 40.0

Temperatur e
## Experimental Design

<table>
<thead>
<tr>
<th>Source</th>
<th>Temperature</th>
<th>Host Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Core</td>
<td>Q. <em>garryana</em>&lt;sub&gt;core&lt;/sub&gt;</td>
</tr>
<tr>
<td>Periphery</td>
<td>Periphery</td>
<td>Q. <em>garryana</em>&lt;sub&gt;periphery&lt;/sub&gt;</td>
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<tbody>
<tr>
<td>Core</td>
<td>Core</td>
<td><em>Lomatium utriculatum</em>&lt;sup&gt;(LU)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Periphery</td>
<td>Periphery</td>
<td><em>L. nudicaule</em>&lt;sup&gt;(LN)&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>P. crispum</em>&lt;sup&gt;(Parsley)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Results

C survival in C conditions

P survival in C conditions

P conditions

Odds Ratio +/- 95% Cl

Body size (mm) +/- 95% Cl

Temperature treatment

* p<.001
Results

Odds Ratio +/- 95% CI

P temp; parsley

Field analog

p<0.001

C  P

Temperature

Pupal mass (g) +/- SE
## Chamber Experiment Summary

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<tbody>
<tr>
<td>Mixed</td>
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<td><img src="image" alt="Body Size" /></td>
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<tr>
<td>No</td>
<td><img src="image" alt="Survivorship" /></td>
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* Indicates additional data or a note.
## Synthesis

<table>
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<tr>
<th>Evidence</th>
<th>Northern Range Shift?</th>
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<tbody>
<tr>
<td>• Temperature primary determinant of performance</td>
<td>YES, if host plants moved</td>
</tr>
</tbody>
</table>
| • Reduced performance in C field conditions-extreme  
• Performance host plant-dependent | ? |
The role of transition zones in host plants for a specialist butterfly species
Q. garryana (Garry oak)
White oak
Deciduous
slopes, valleys: 1,000-4,000 ft.

Q. kelloggii (Black oak)
Red oak
Deciduous
mountain: 2,000-6,000 ft.

Q. agrifolia (Coast live oak)
Red oak
Evergreen
Coastal: < 5,000 ft.
Are populations adapted to local hosts?
Results

Survivorship +/- SE

Garry skippers

Coast skippers

p=0.27

p<0.001
Summary

Garry skippers

Latitude shift

Altitude shift

Coast skippers

Latitude shift

*
Barriers to successful range shifts

- Dispersal ability
- Physical barriers
- Abiotic constraints
- Adaptation
- Availability and quality of resources

Changes in community composition and function
Acknowledgements

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• Land Owners
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THANK YOU!

sgray2@nd.edu

Poleward