Predicting the impact of climate change on animal distributions

A test of the range-shift capacity in two butterfly species

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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”

4 cm

Small specialist

Oak spp.

Erynnis propertius

I. Will warming increase edge populations?

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

“Swallowtail”

8 cm

Papilio zelicaon

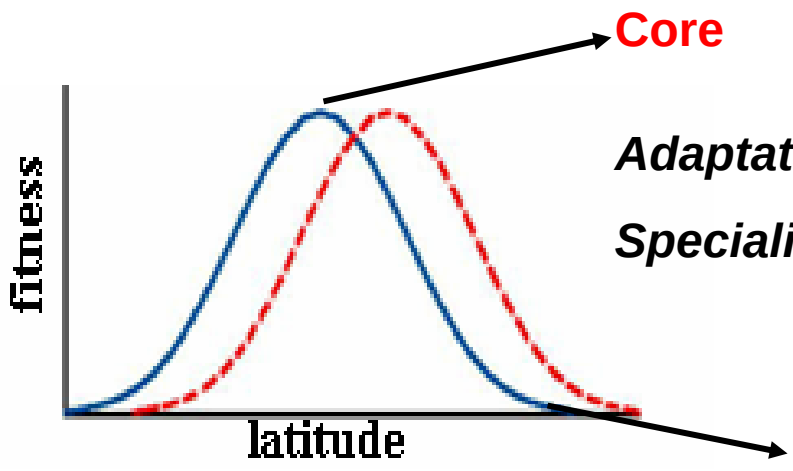
Large generalist

Parsley Family

A test of periphery enhancement to reveal limitations to climate-driven range shifts

Periphery Enhancement Hypothesis

Fitness optimal in core conditions



Adaptation to periph. temp.?

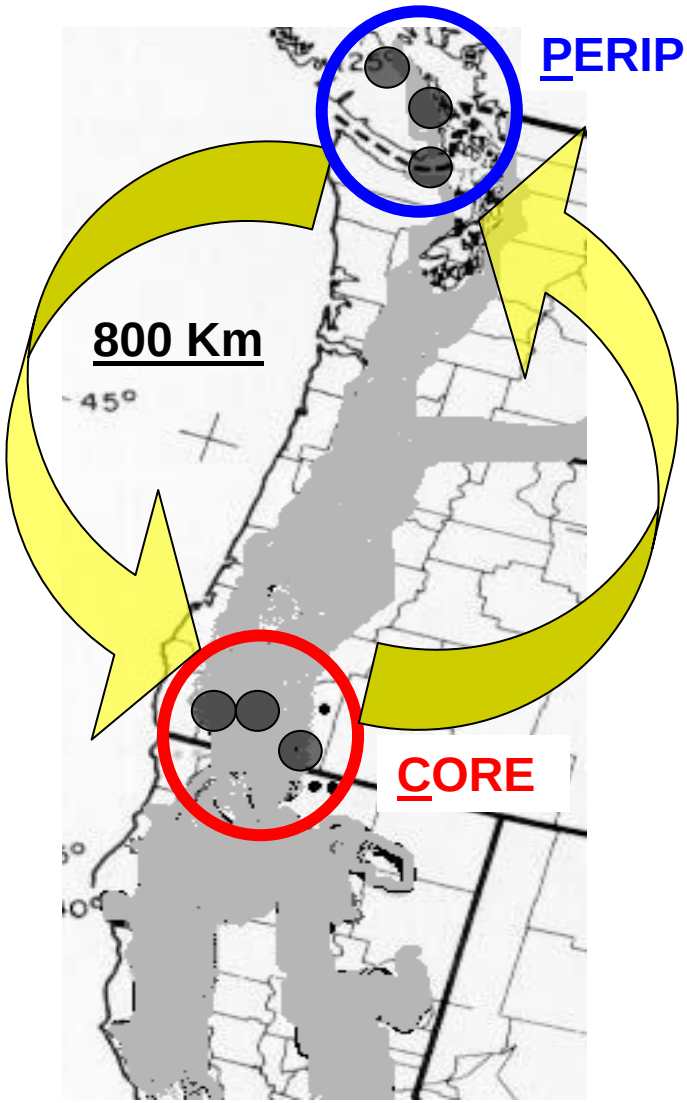
Specialization to non-temp.?

Core Conditions = Periphery Enhancement ?

(Oregon) (Vancouver Island)

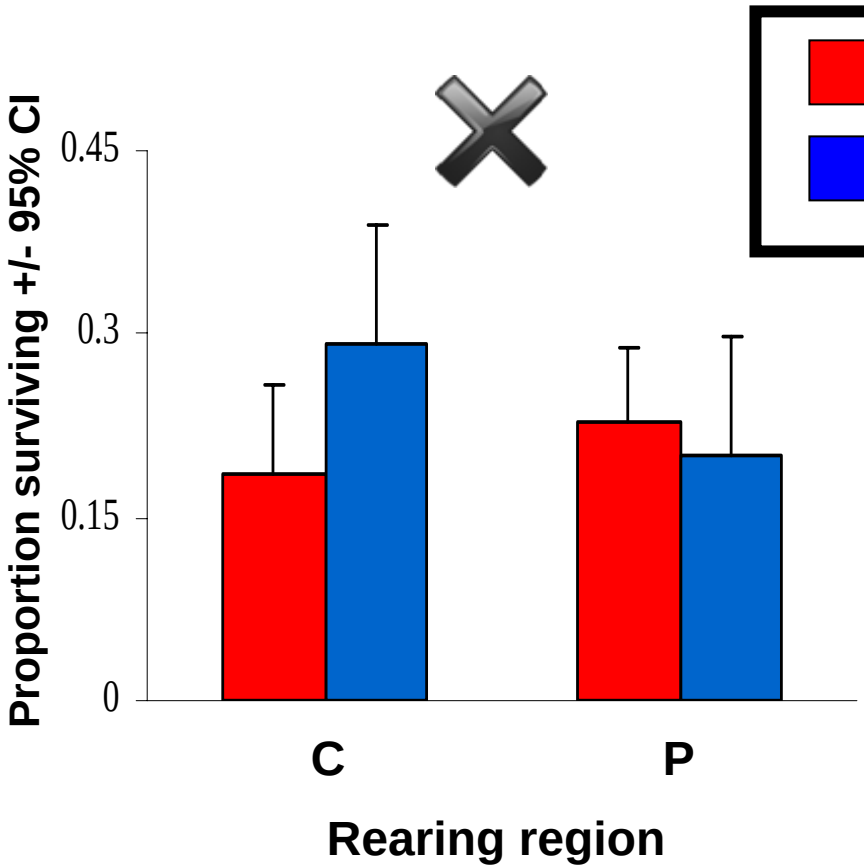
Translocation experiments

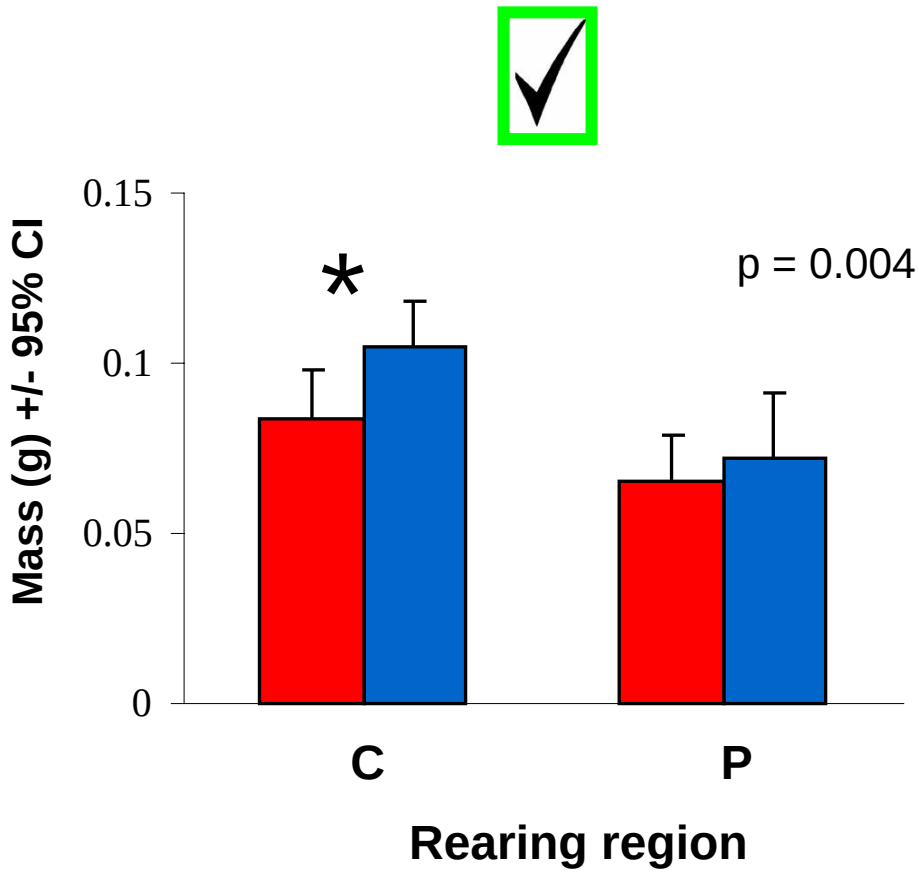
Field experiment



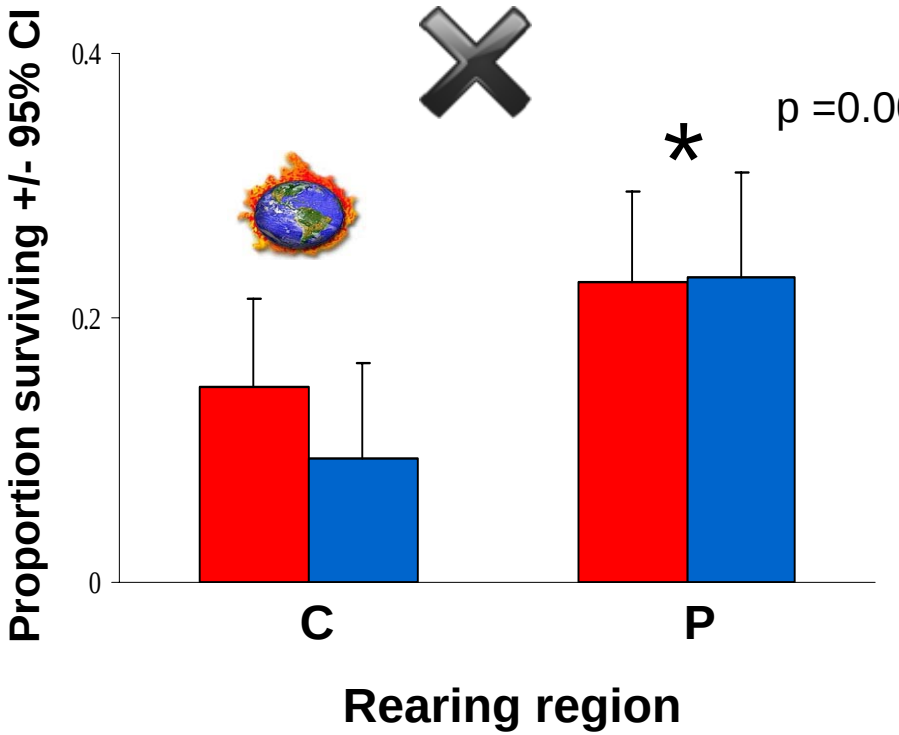
Survivorship
Body Size/Fecundity

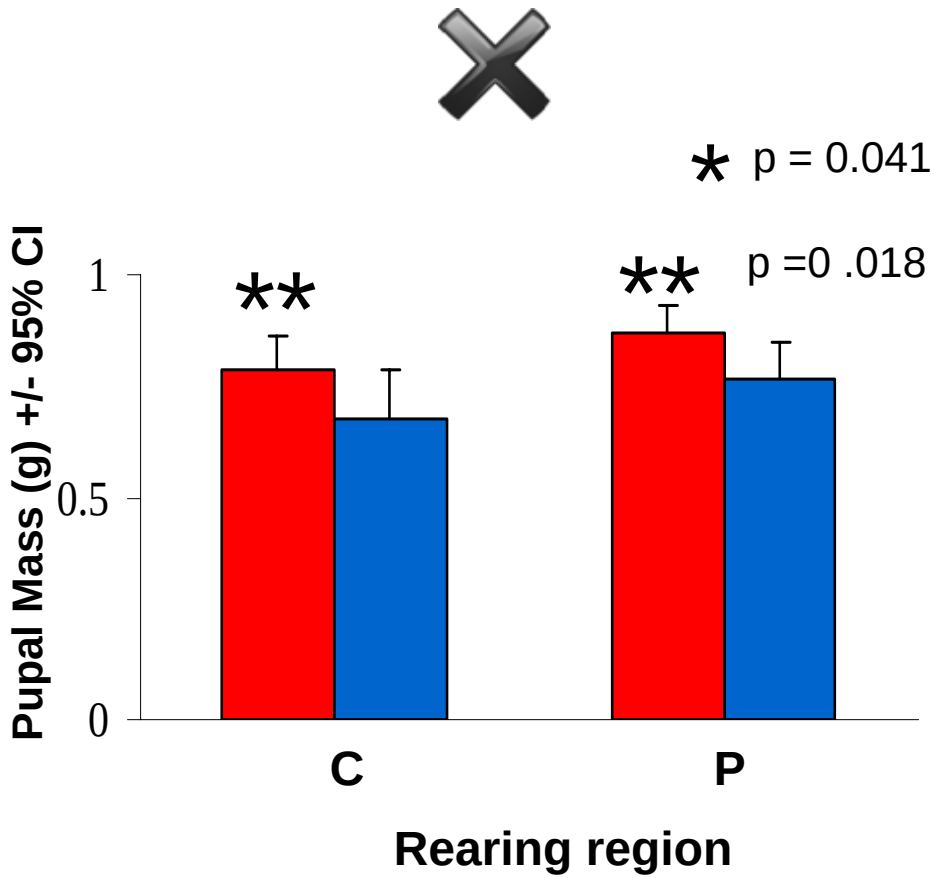
Results


C Source
P Source
Proportion surviving +/- 95% CI
0.45
0.3
0.15
0
C
P
Rearing region


Mass (g) +/- 95% CI
0.15
0.1
0.05
0
*
p = 0.004
C
P
Rearing region

Results

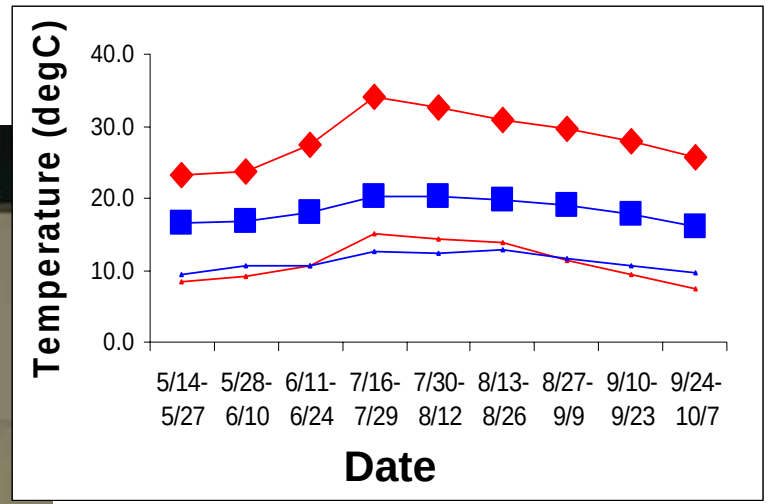

Proportion surviving +/- 95% CI
0.4
0.2
0
C
P
Rearing region
p =0.004
*


Pupal Mass (g) +/- 95% CI
1
0.5
0
**
**
C
P
Rearing region
* p = 0.041
p =0 .018

Field Experiment Summary

		Core = Periphery Enhancement?	
	Survivorship	✗	Mixed
	Body Size	✓	
	Survivorship	✗	No
	Body Size	✗	

Chamber Experiment



Experimental Design

Source	Temperature	Host Plant
Core	Core	Q. garryana$_{CORE}$
Periphery	Periphery	Q. garryana$_{PERIPHERY}$

Source	Temperature	Host Plant	
Core	Core	*Lomatium utriculatum*	(LU)
Periphery	Periphery	*L. nudicaule*	(LN)
		**P. crispum*	(Parsley)

Results

C survival in C conditions

P survival in C conditions

P conditions

Odds Ratio +/- 95% CI

18
16
14
12
10
8
6
4
2
0

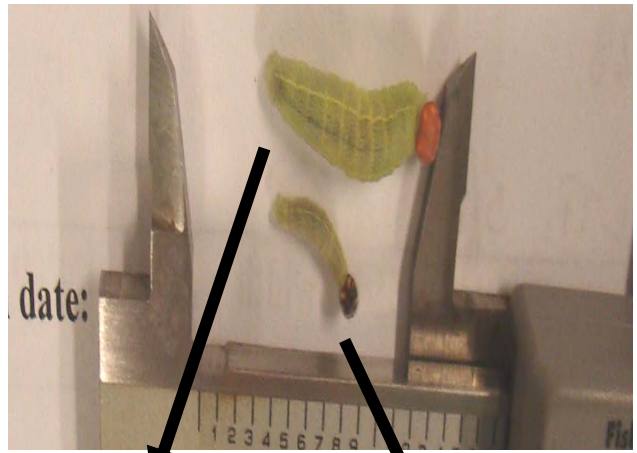
*

*

Temperature

Plant Source

Temperature x Plant Source



Body size (mm) +/- 95% CI

4
3
2
1
0

*

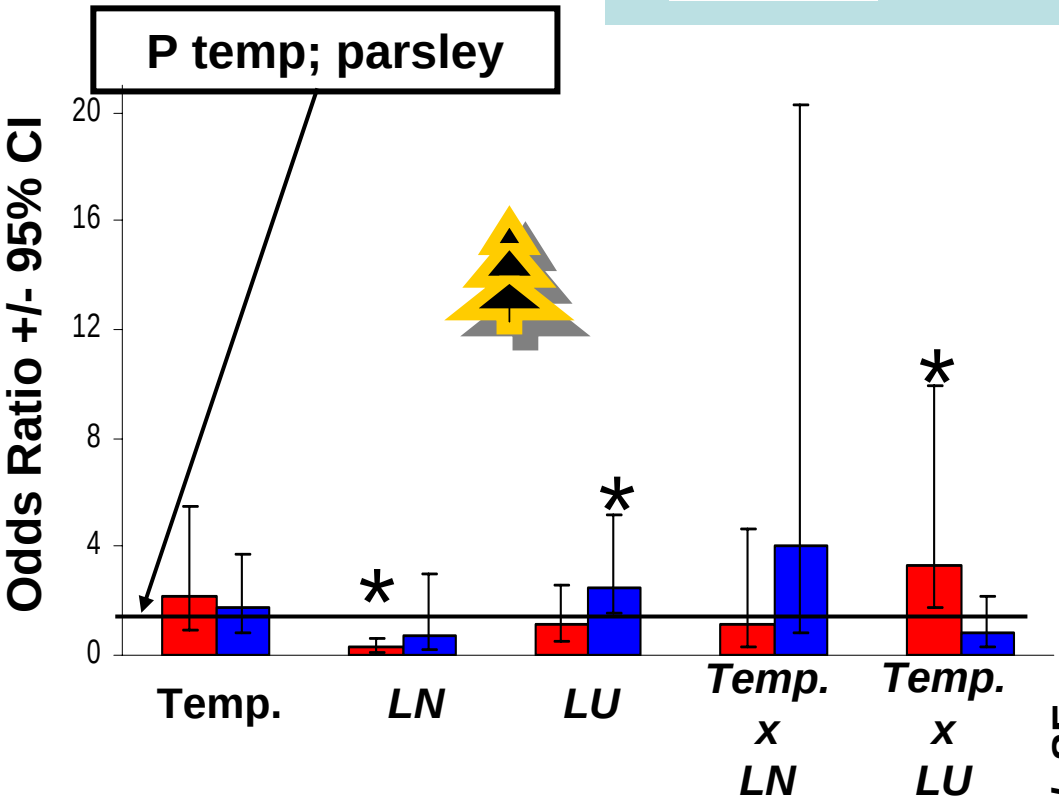
p<.001

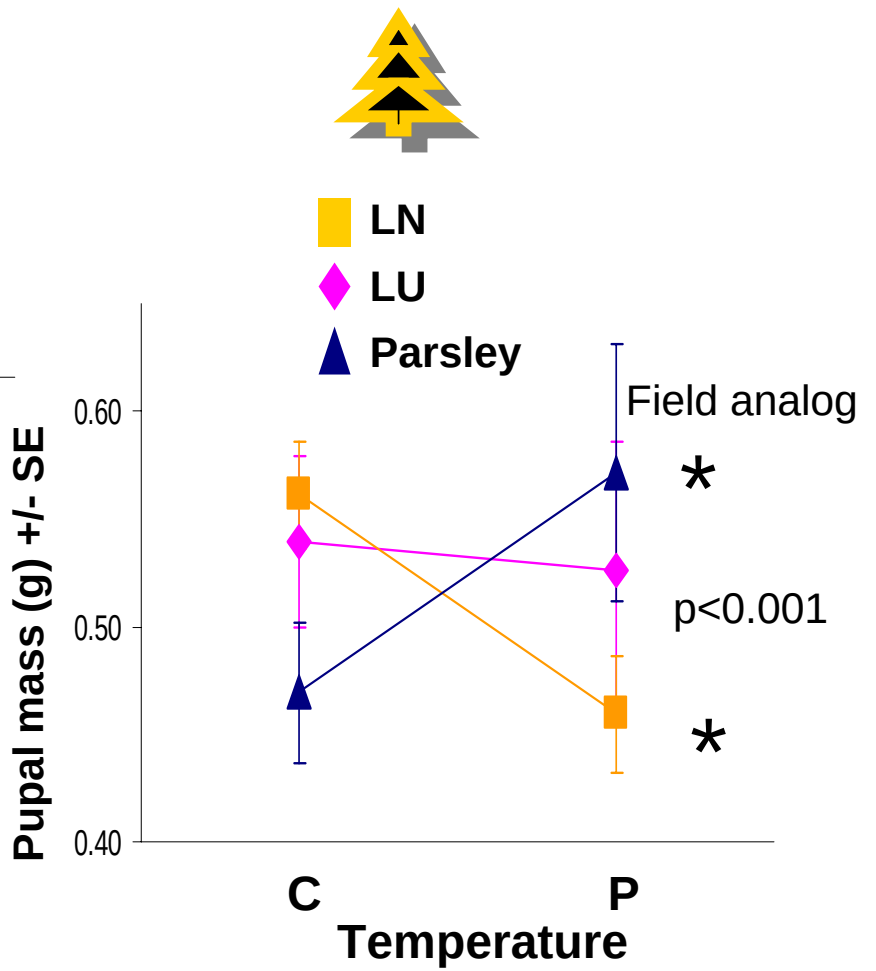
C

P

Temperature treatment

Results


P temp; parsley
Odds Ratio +/- 95% CI
20
16
12
8
4
0
*
*
*
Temp.
LN
LU
Temp. x LN
Temp. x LU


LN
LU
Parsley
Field analog
Pupal mass (g) +/- SE
0.60
0.50
0.40
*
p<0.001
*
C
P
Temperature

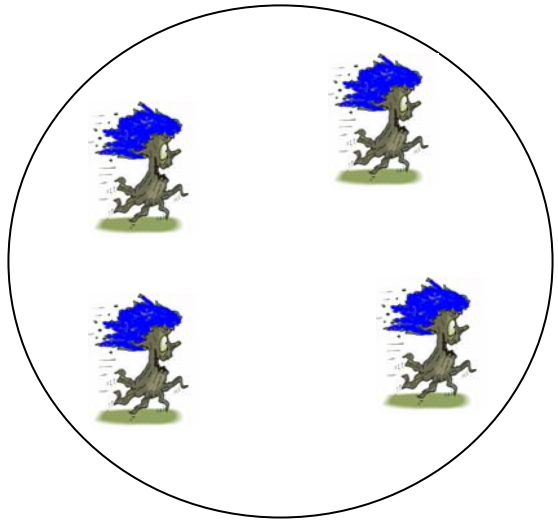
Chamber Experiment Summary

		Core = Periphery Enhancement?		
	Survivorship	✗	*	→ Mixed
	Body Size	✓	✓	
	Survivorship	✗		→ No
	Body Size	✗		

Synthesis

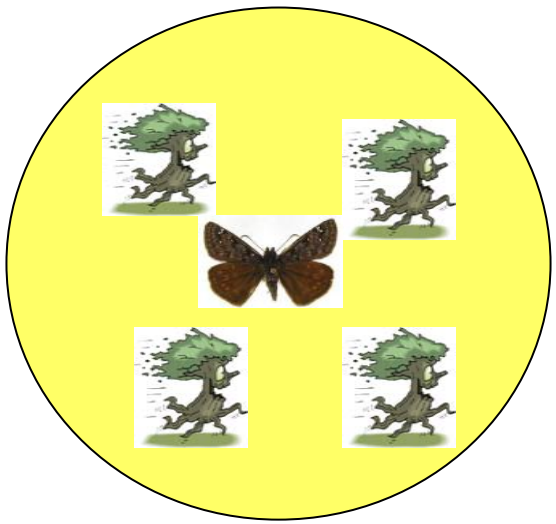
	Evidence	Northern Range Shift?
	•Temperature primary determinant of performance	YES, if host plants moved
	•Reduced performance in C field conditions-extreme •Performance host plant-dependent	?

The role of transition zones in host plants for a specialist butterfly species



Plant A

Plant B



Poleward

Study System

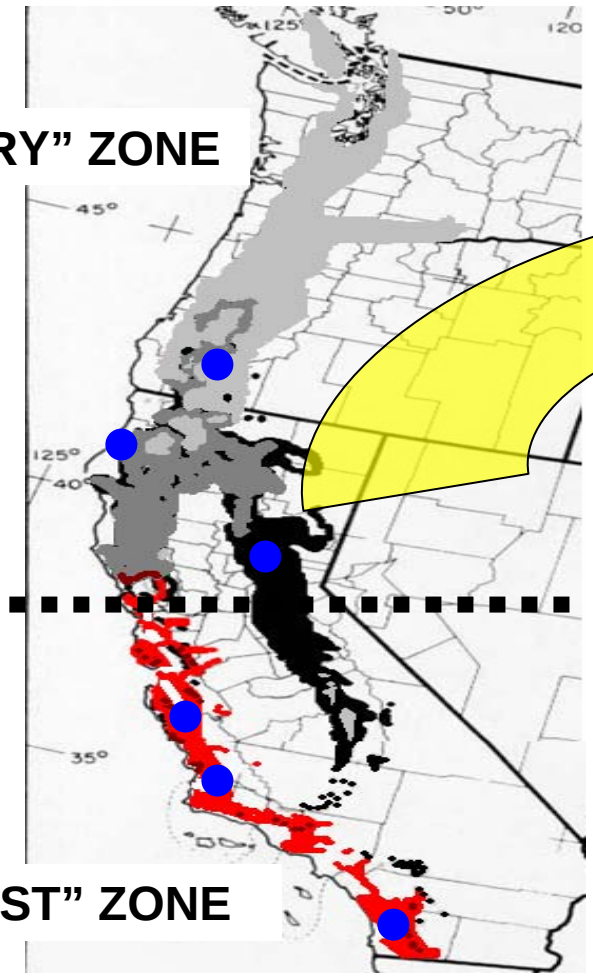
***Q. garryana* (Garry oak)**
White oak
Deciduous
slopes, valleys:1,000-4,000 ft.

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

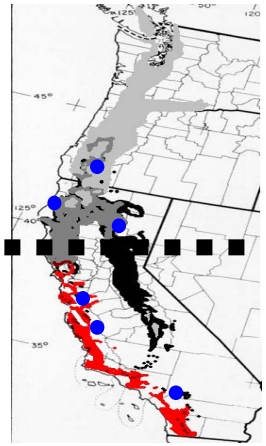
***Q. agrifolia* (Coast live oak)**
Red oak
Evergreen
Coastal: < 5,000 ft.

Methods

Are populations adapted to local hosts?



Results



p<0.001

*

Survivorship +/- SE

0.8
0.6
0.4
0.2
0

a
a
b
a'
b'
a'

Garry skippers

p=0.27

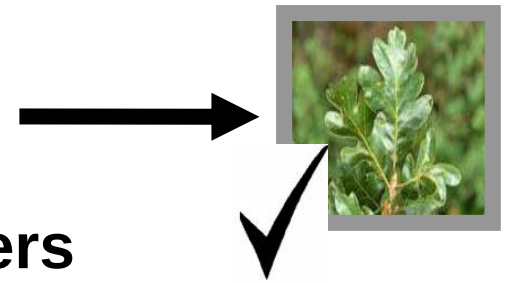
Coast skippers

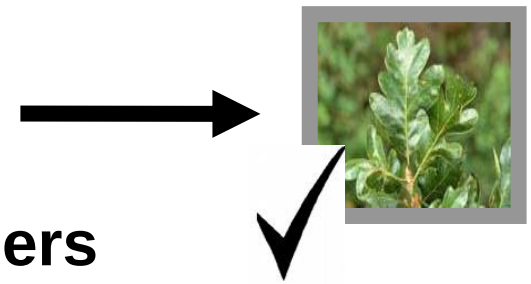
p<0.001

Summary

Garry skippers

Coast skippers





Latitude shift

*

Altitude shift

Barriers to successful range shifts

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

=

Changes in community composition and function

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THANK YOU!

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