Butterfly and plant responses to climate change in montane meadows of Grand Teton National Park

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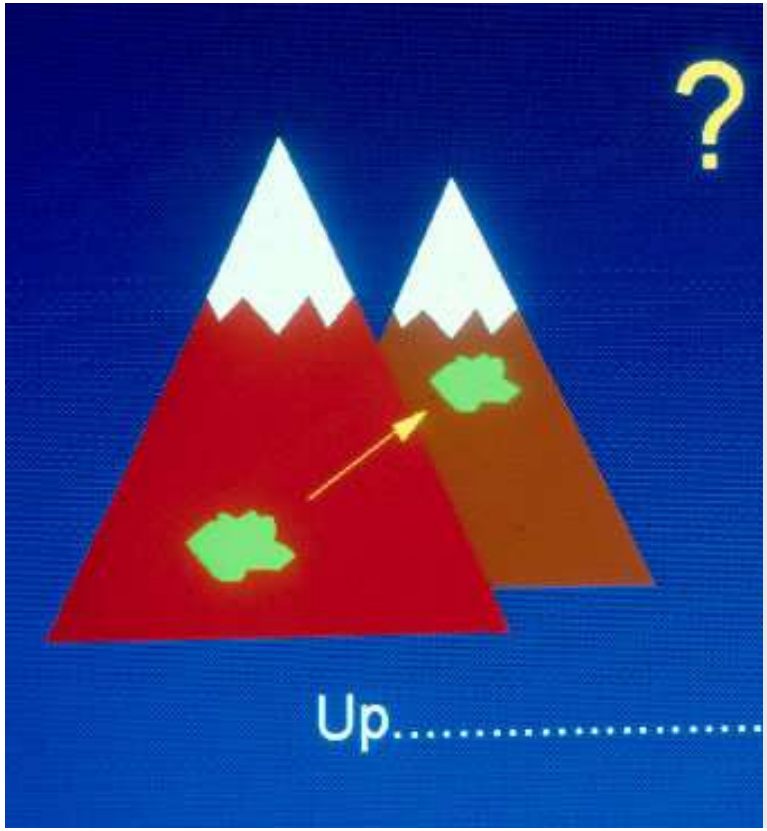
Mountains & Minds

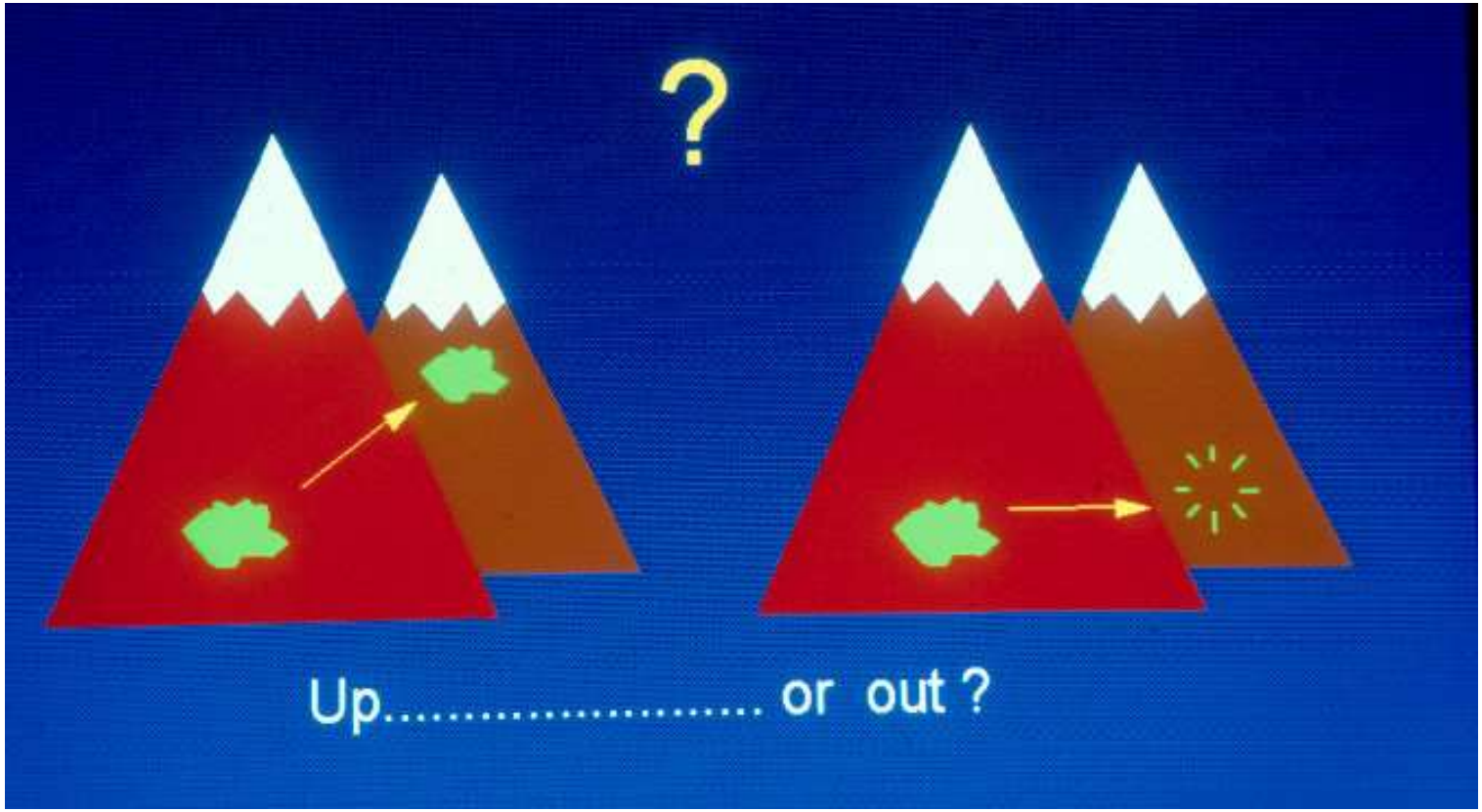
The complexity of climate responses

Diagram courtesy of Jay Fitzsimmons

Climate Change Change Responses in Mountain Systems



Climate Change Change Responses in Mountain Systems



Parnassius Butterflies as an Indicator Group

- *Parnassius apollo*

  (European species)

  - Renowned Eurasian montane butterfly
  - Red Book listing; decreasing in 12/28 countries, extinct in 3

- *Parnassius clodius* and *smintheus*

  (N. American species)

  - Well-studied species in U.S. and Canada
  - Caterpillars emerge at time of snowmelt
  - Experiencing tree encroachment into alpine meadows in Canada

Parnassian Butterfly Species: Global Indicators of Climate Change

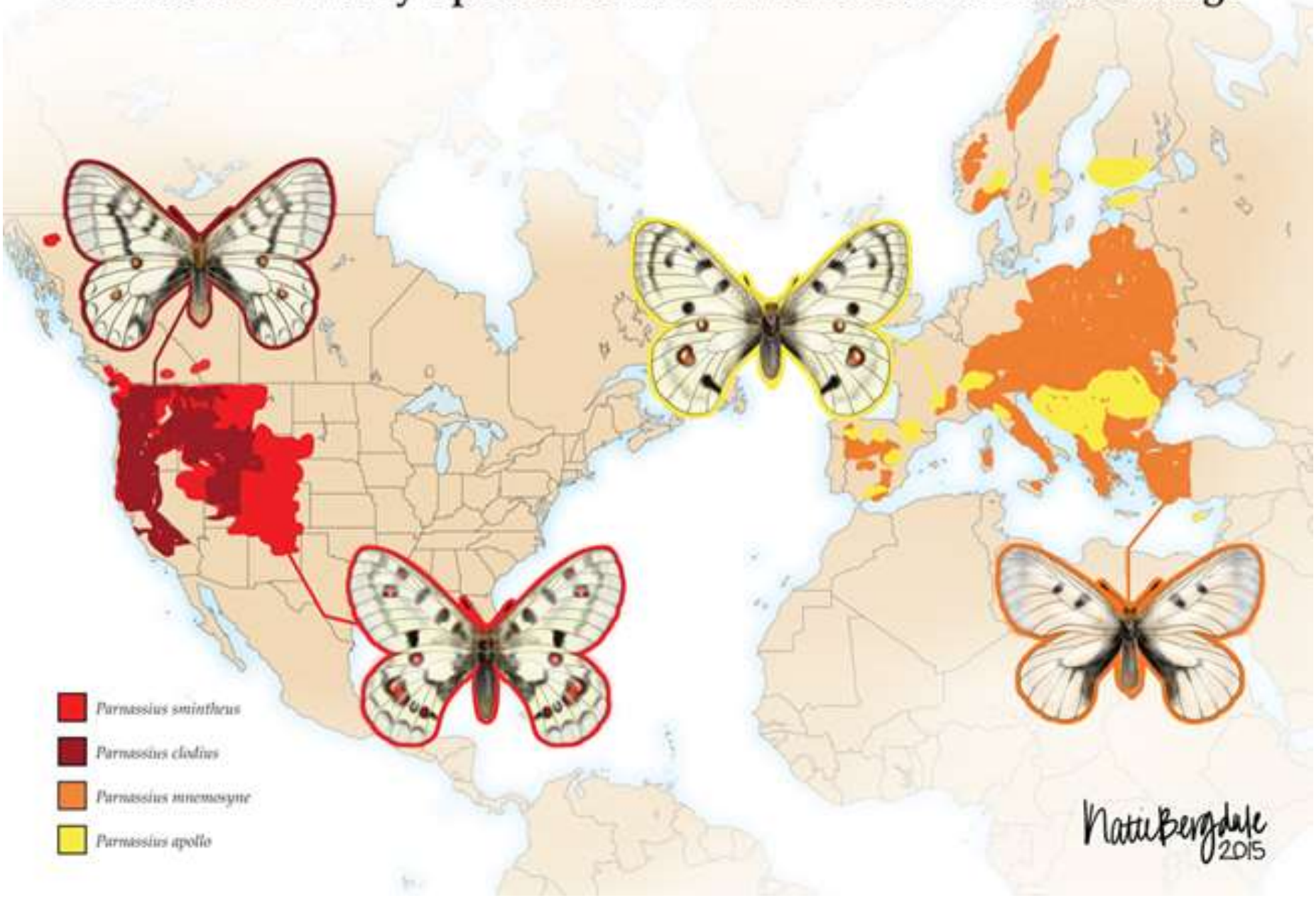
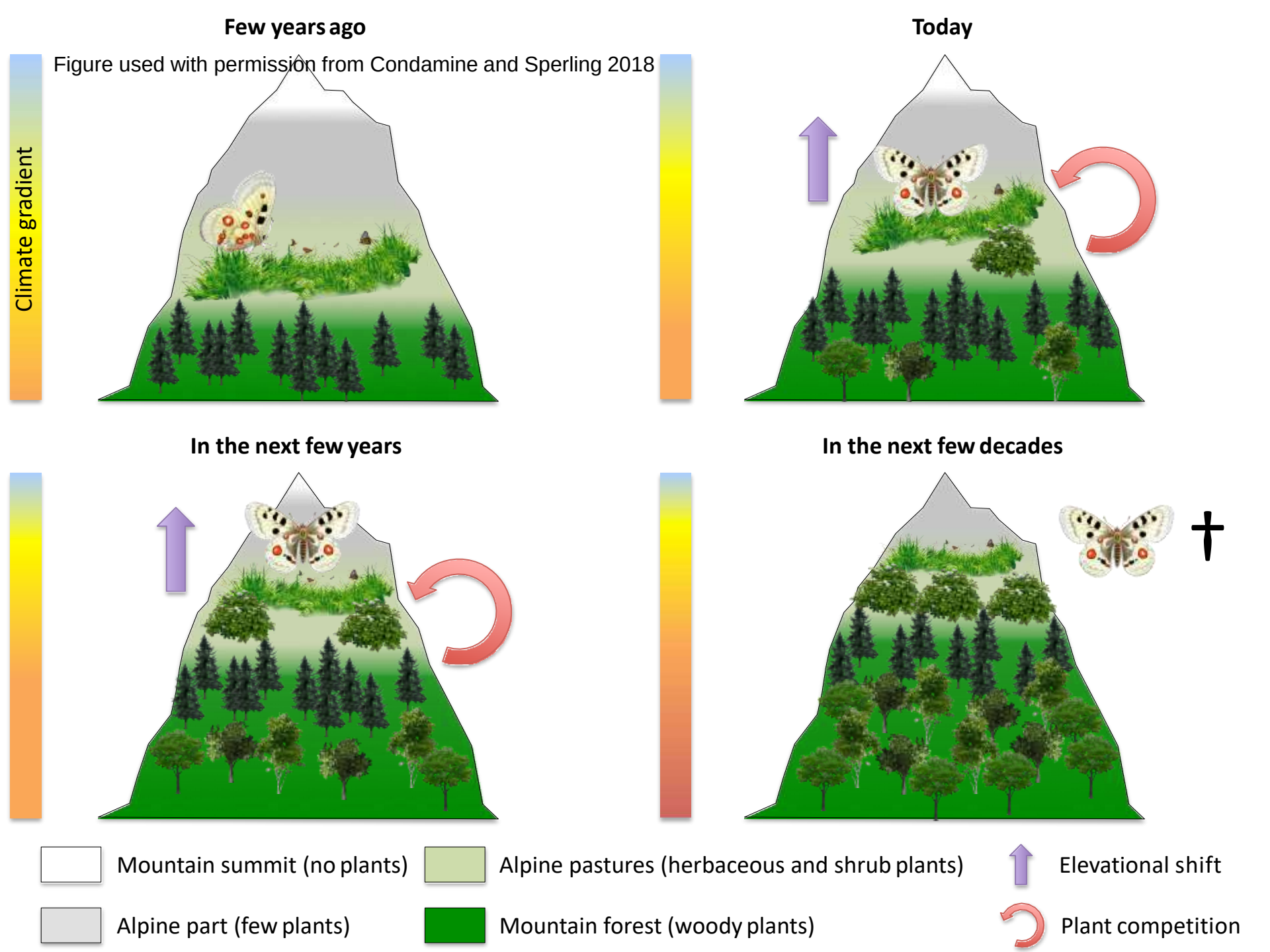


Figure used with permission from Condamine and Sperling 2018



Encroaching forests decouple alpine butterfly population dynamics

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Communicated by David W. Schindler, University of Alberta, Edmondton, AB, Canada, June 12, 2007 (received for review March 19, 2007)

Over the past 50 years, the rising tree line along Jumpingpound Ridge in the Rocky Mountains of Alberta, Canada, has reduced the area of alpine meadows and isolated populations that reside within them. By analyzing an 11-year data set of butterfly population sizes for 17 subpopulations along the ridge, we show that forest habitat separating alpine meadows decouples the dynamics of populations of the alpine butterfly *Parnassius smintheus*. Although the distance between populations is often negatively correlated with synchrony of dynamics, here we show that distance through forest, not Euclidean distance, determines the degree of synchrony. This effect is consistent with previous results demonstrating that encroaching forest reduces dispersal among populations and reduces gene flow. Decoupling dynamics produces more smaller independent populations, each with greater

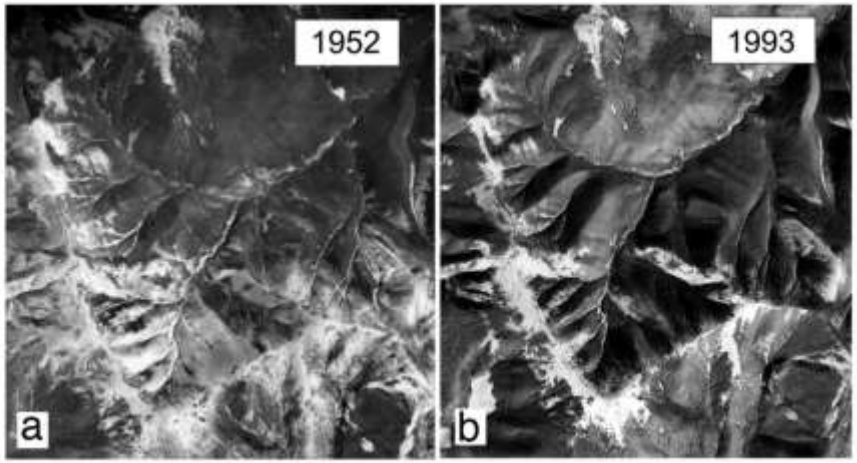

PLATE 1. Late spring snow in meadow "M" on Jumpingpound Ridge, Alberta, Canada. Photo credit: David Z. Roth.

Ecology, 94(1), 2013, pp. 190–199

Variability in winter climate and winter extremes reduces population growth of an alpine butterfly

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[2]*Department of Biological Sciences, University of Cincinnati, Cincinnati, Ohio 45221-0006 USA*

PROCEEDINGS OF THE ROYAL SOCIETY B

Proc. R. Soc. B (2005) **272**, 553–560
doi:10.1098/rspb.2004.2976
Published online 7 March 2005

Among- and within-patch components of genetic diversity respond at different rates to habitat fragmentation: an empirical demonstration

Nusha Keyghobadi[1]*, Jens Roland[2], Stephen F. Matter[3] and Curtis Strobeck[2]

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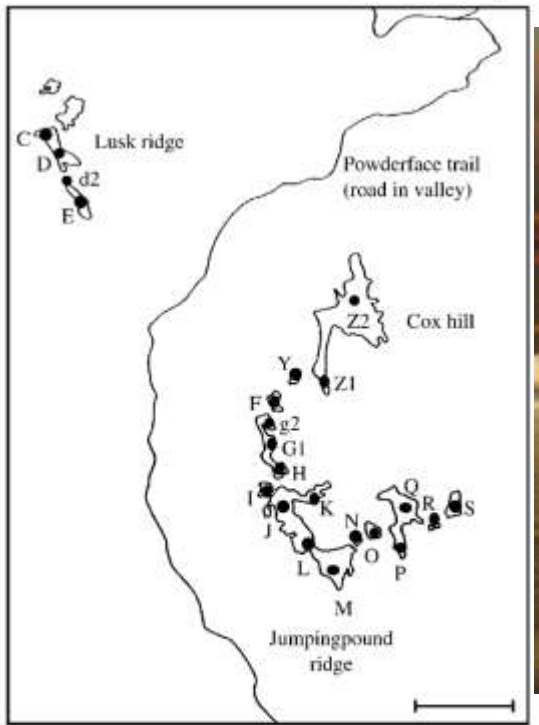
[2]*Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9*
[3]*Department of Biological Sciences, University of Cincinnati, Cincinnati, OH 45221-0006, USA*



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Apollo Butterfly (*Parnassius apollo* L.) in Europe – its History, Decline and Perspectives of Conservation

Mirosław Nakonieczny* • Andrzej Kędziorski • Katarzyna Michalczyk

University of Silesia, Department of Animal Physiology and Ecotoxicology, Bankowa 9, PL 40-007 Katowice, Poland

Corresponding author: * **miroslaw.nakonieczny@us.edu.pl**

HOME TOURISM NATURE HISTORY ENVIRONMENTAL EDUCATION WEATHER CONTACT

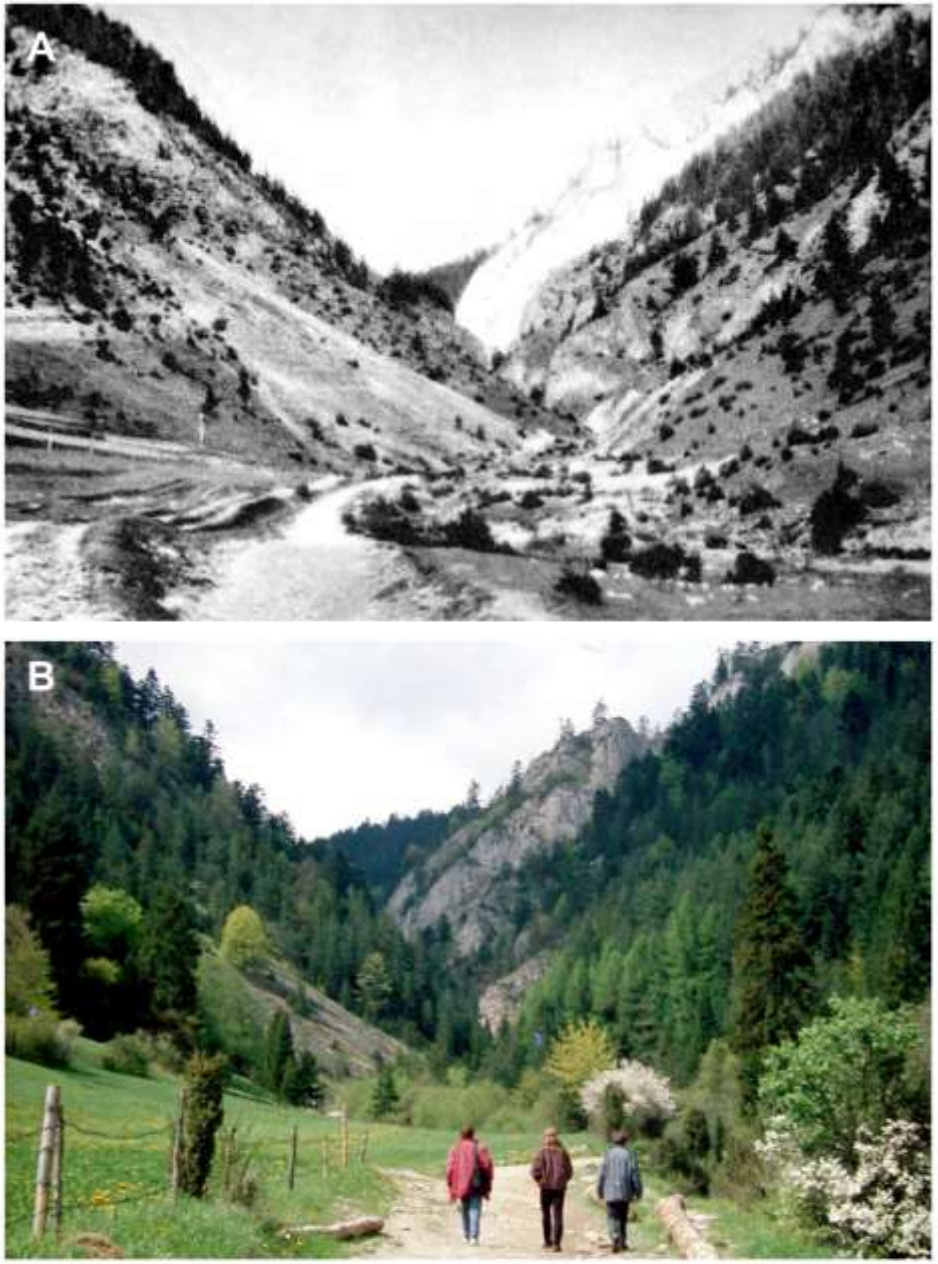


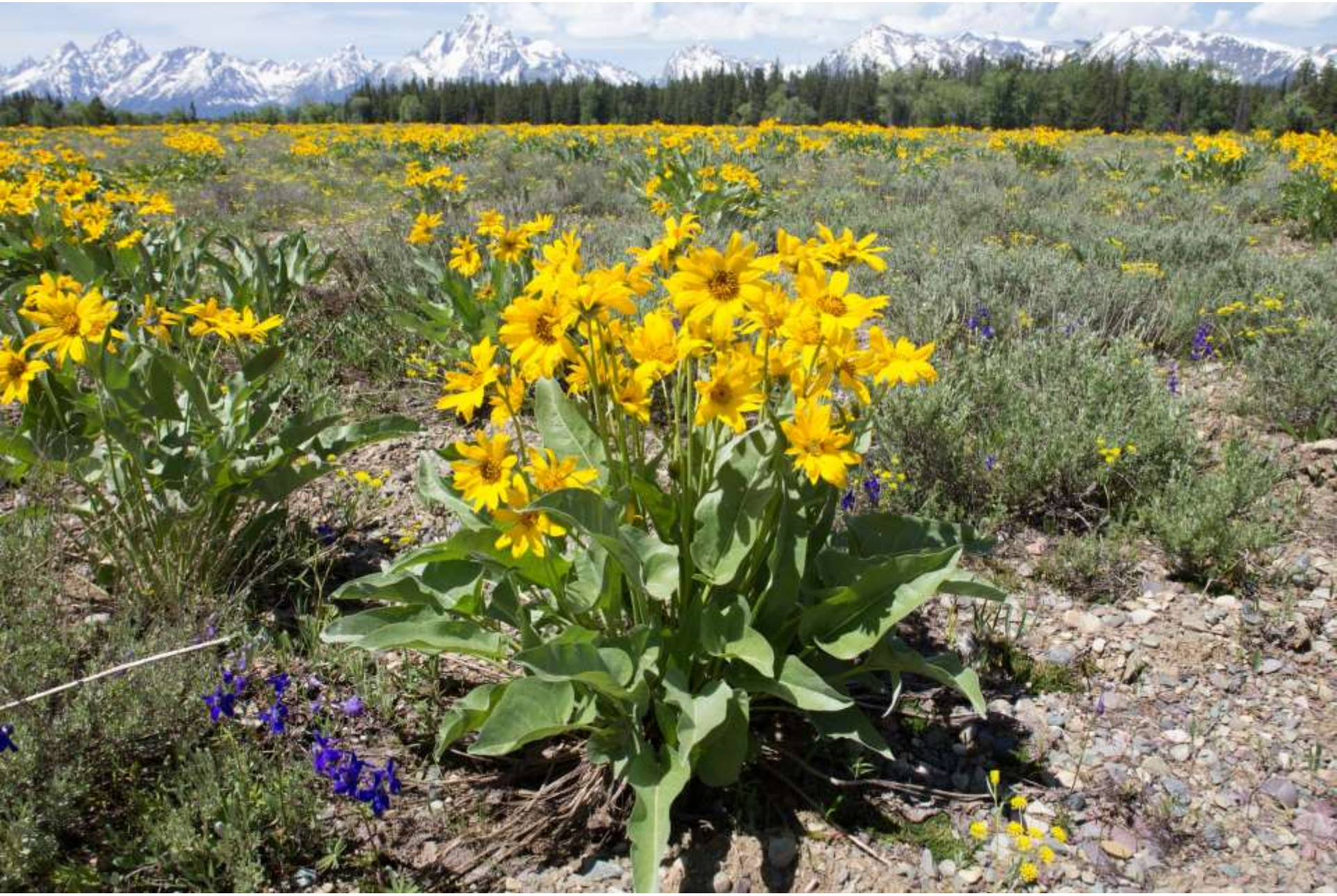
Fig. 6 Sobczański Gorge at Trzy Korony foothils (the Pieniny Mts). (**A**) Past view (the 1920s) (courtesy of K. Karwowski and Pieniny National Park archive); (**B**) Recent view (1995) from the same perspective as in A (photo: M. Nakonieczny).

M.S. Fred & J.E. Brommer / Conservation Evidence (2015) **12**, 8-13

Translocation of the endangered apollo butterfly *Parnassius apollo* in southern Finland

Marianne S. Fred[1] & Jon E. Brommer[2]*

[1] *Aronia Research and Development Institute, Novia University of Applied Sciences, Finland*
[2] *Department of Biology, University of Turku, Finland.*



Logan Crees

Ecological Entomology (2004) **29**, 139–149

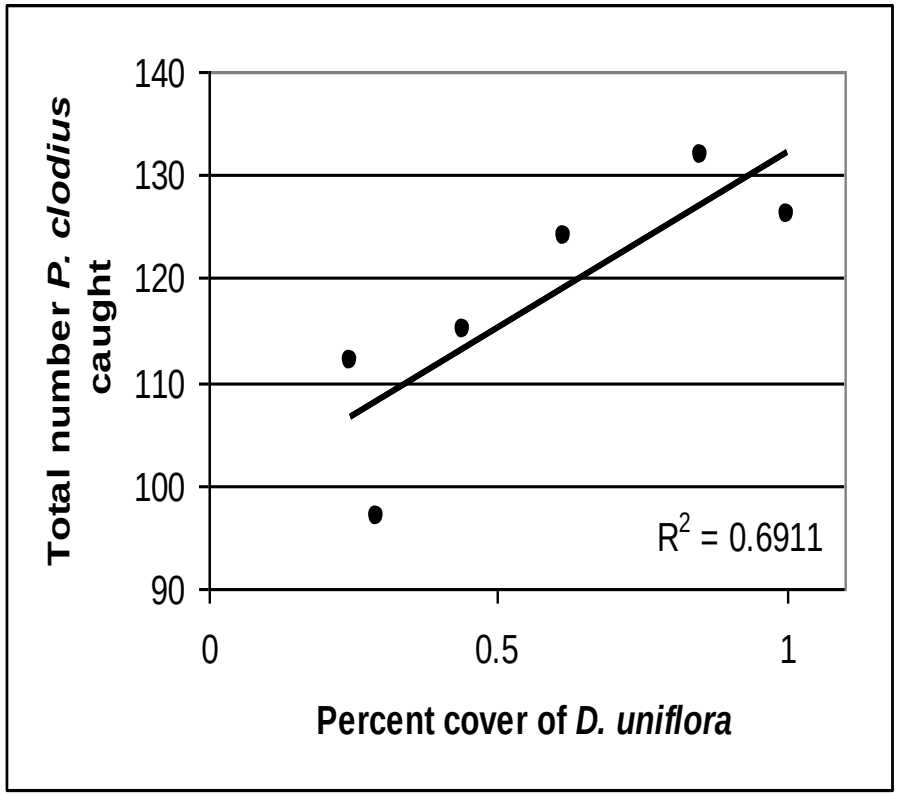
Survival, movement, and resource use of the butterfly *Parnassius clodius*

JULIA N. AUCKLAND, DIANE M. DEBINSKI and WILLIAM R. CLARK Department of Ecology, Evolution, and Organismal Biology, Iowa State University, U.S.A.

- Large population, conducive to mark-recapture study
- Population in Pilgrim creek has ranged from 200-800 individuals marked per year
- Males come out first and are much more numerous
- Percent recapture up to 25%

K. Szcodrons

Host Plant Relationship



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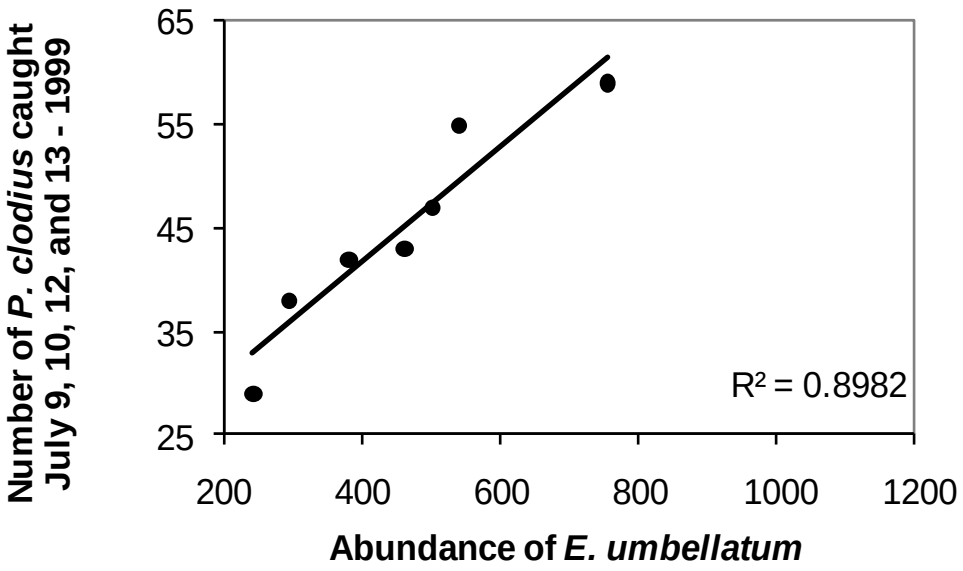
*Dicentra uniflora (*Fumariaceae)

F=8.95, df=5, P<0.0403

Auckland, Debinski and Clark, 2004 *Ecological Entomology*

Nectar Plant Relationship

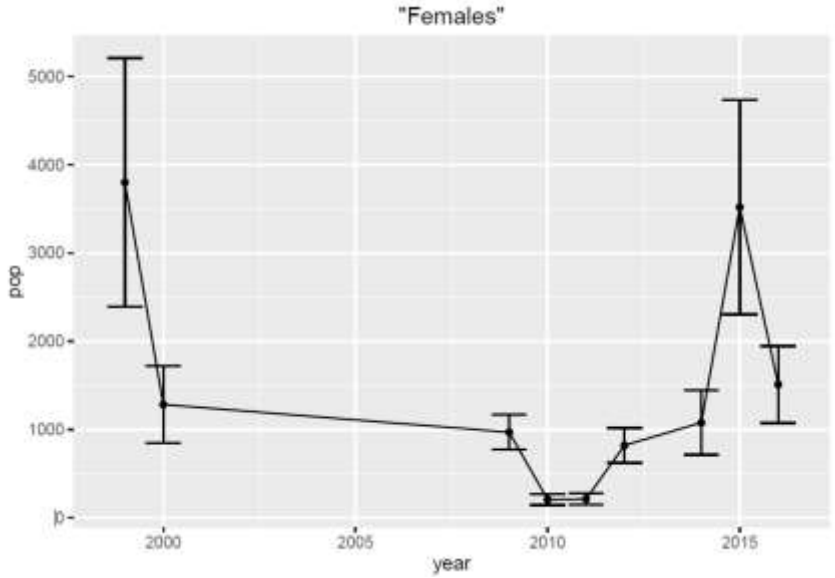


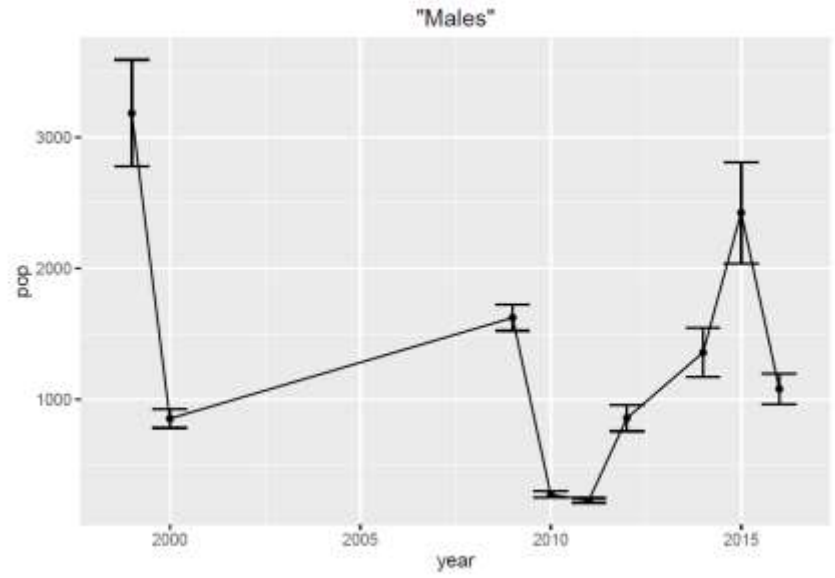
F=0.38, d.f.=6, P<0.01

Auckland, Debinski and Clark, 2004 *Ecological Entomology*

Connecting Plant and Insect Responses

Pilgrim Creek Population Size over Time



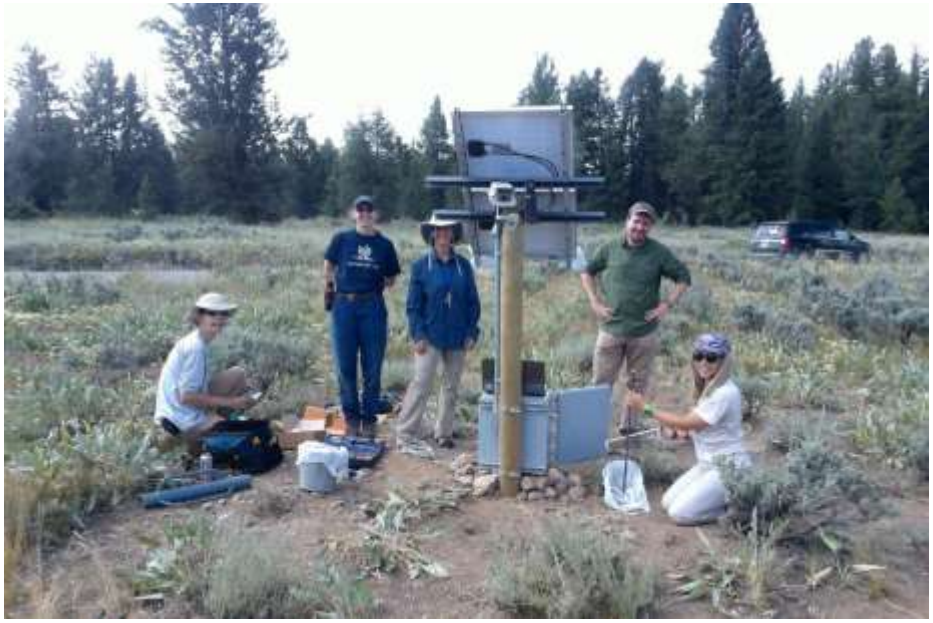


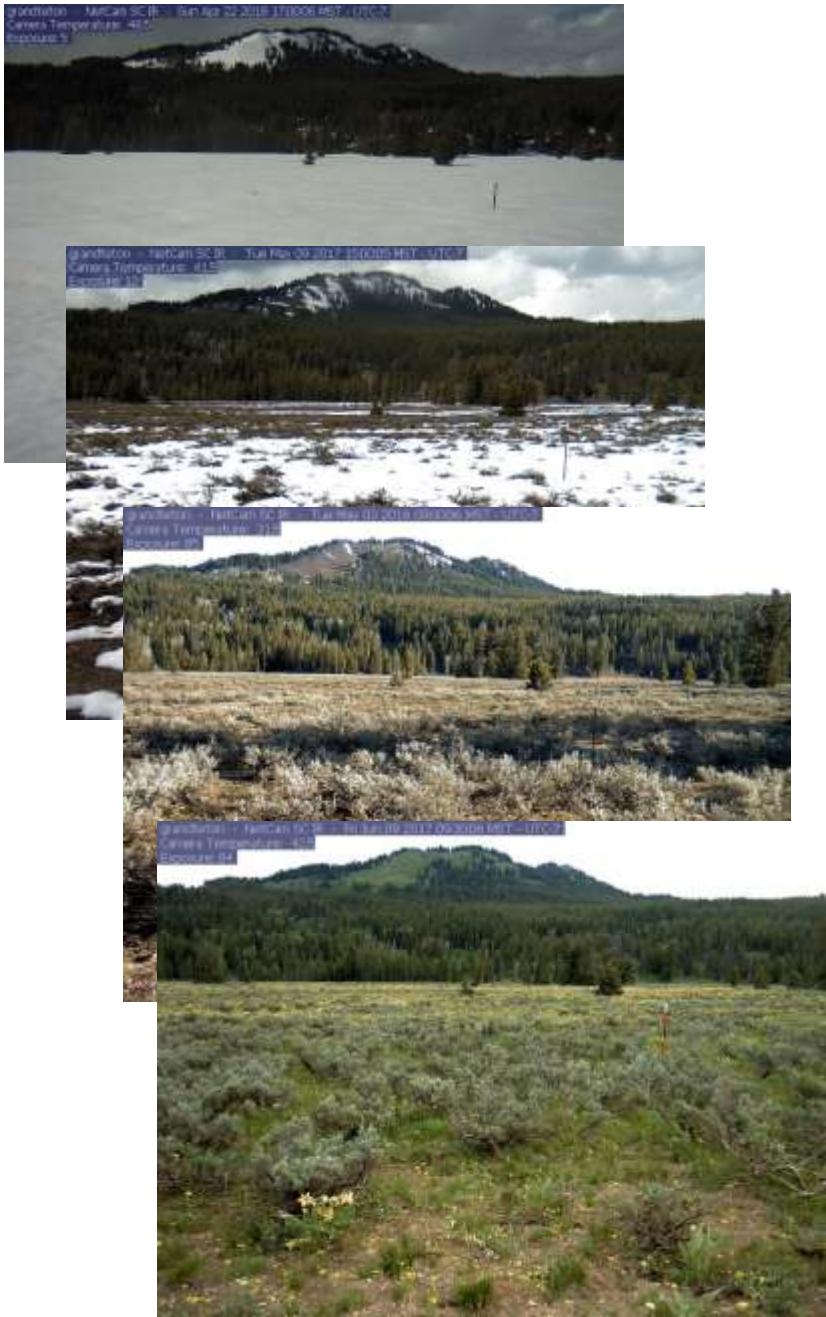
McCombs and Debinski, unpublished data

Zoe Pritchard

Zoe Pritchard

AmericaView Phenocams





http://www.americaview.org/
http://phenocam.sr.unh.edu/webcam/gallery/

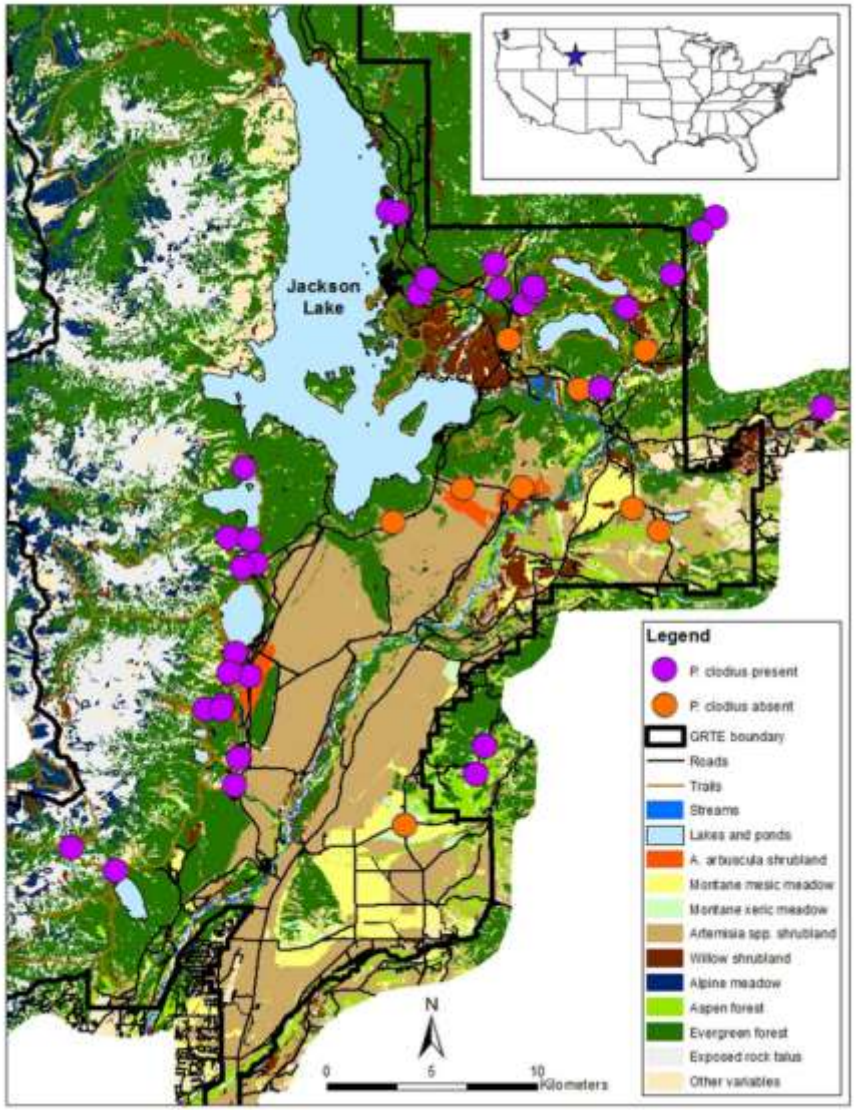
Journal of Insect Conservation
https://doi.org/10.1007/s10841-018-0060-1

ORIGINAL PAPER

Occupancy modeling of *Parnassius clodius* butterfly populations in Grand Teton National Park, Wyoming

Kimberly E. Szcodronski[1,2] · Diane M. Debinski[1,3] · Robert W. Klaver[4]

Received: 17 August 2017 / Accepted: 20 April 2018



esa

ECOSPHERE

Effects of experimentally reduced snowpack and passive warming on montane meadow plant phenology and floral resources

J. A. SHERWOOD,[1] D. M. DEBINSKI,[1,†] P. C. CARAGEA,[2] AND M. J. GERMINO[3]

[1]*Department of Ecology, Evolution, and Organismal Biology, Iowa State University, Ames, Iowa 50011 USA*
[2]*Department of Statistics, Iowa State University, Ames, Iowa 50011 USA*
[3]*US Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, Idaho 83706 USA*

- Experimental snow removal and temperature modification

Experimental Design

Control: No Treatment

Snow Removal

Passive Warming

Passive Warming and Snow Removal

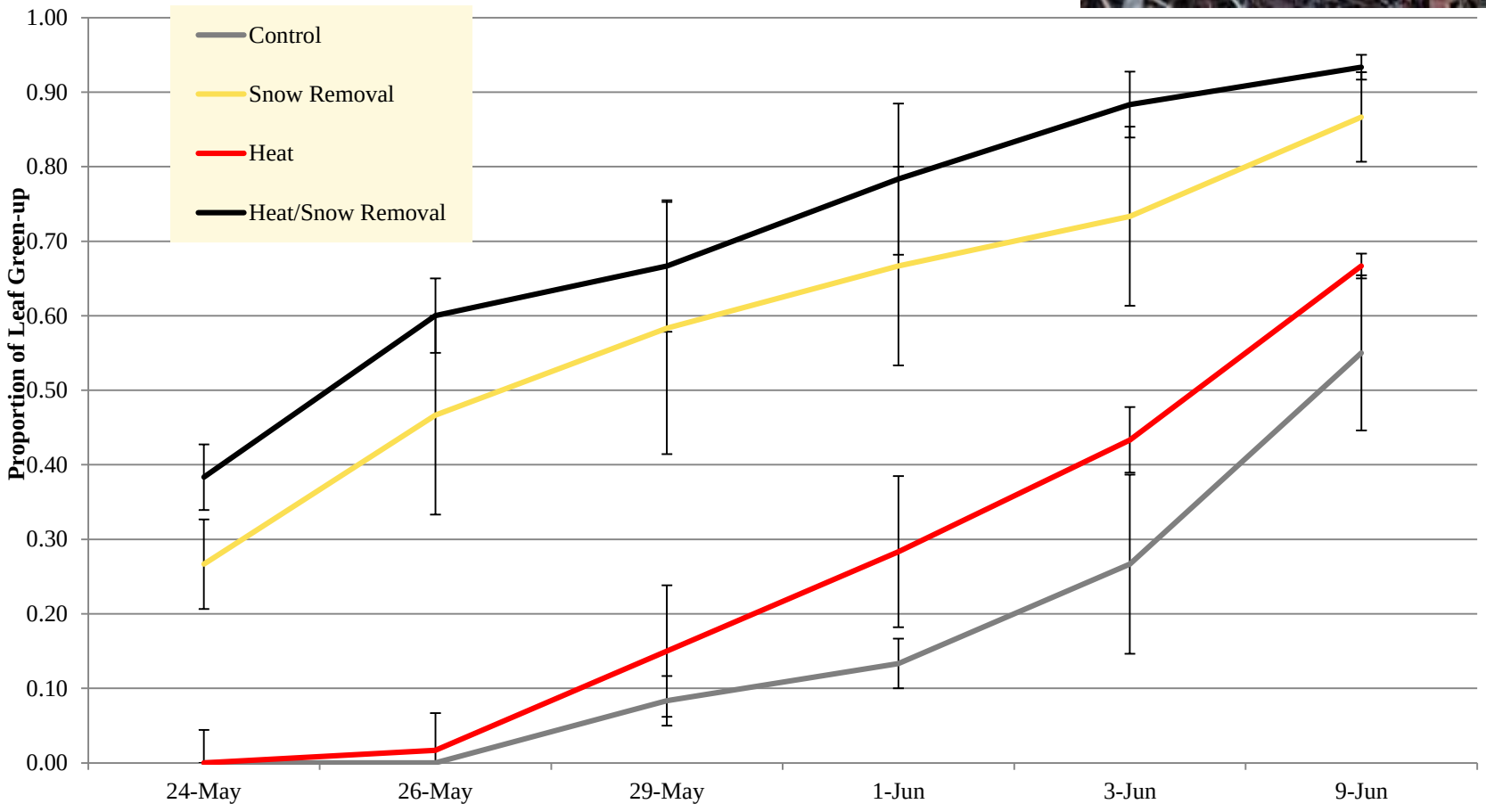
Study Site at Pilgrim Creek, May 12, 2011

Study Site at Pilgrim Creek, July 18, 2011

Plant Growth & Phenology Assessment

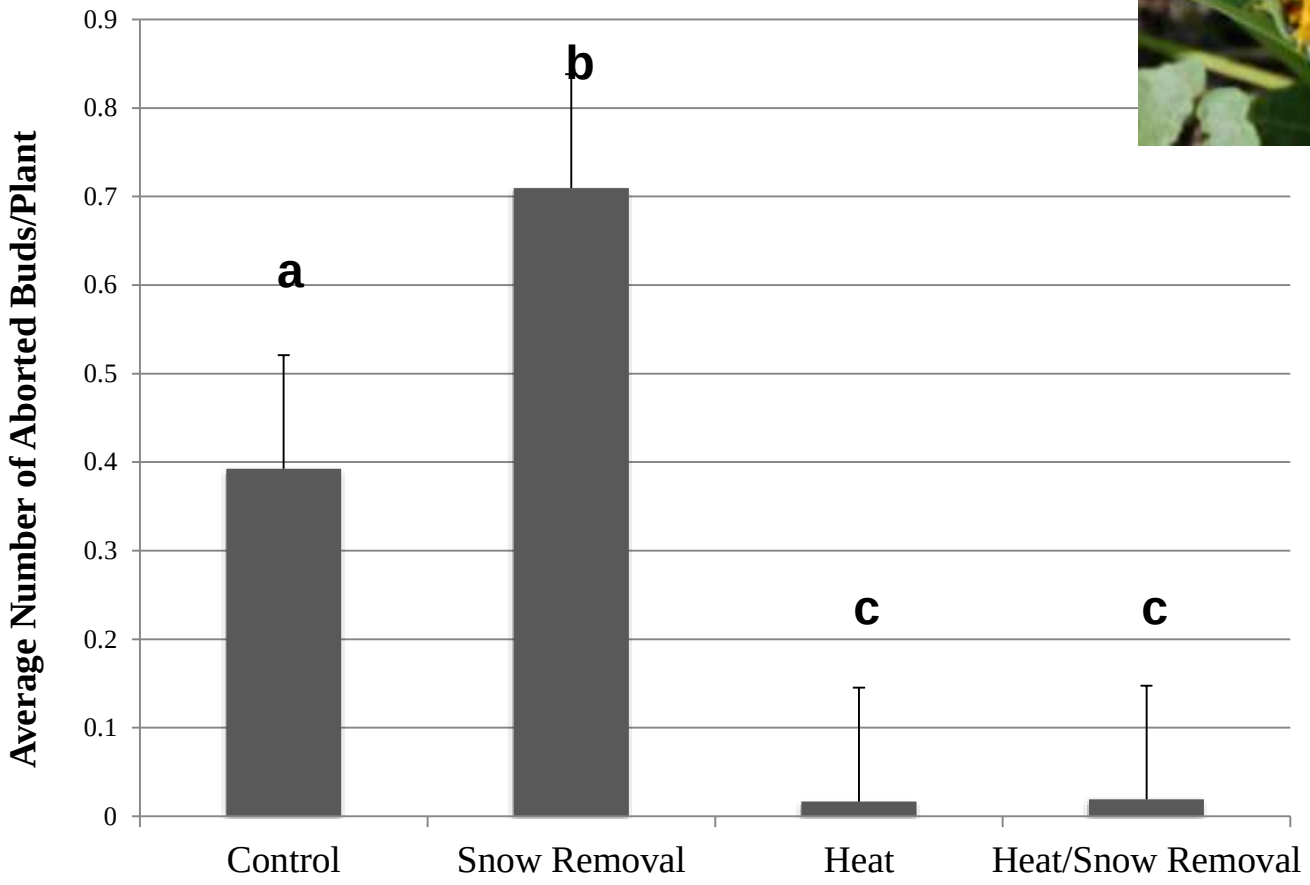
Green-up Date

Average *Eriogonum umbellatum* Green-up Date



(Sherwood, Debinski, Caragea, and Germino 2017 *Ecosphere*)

Frost damage
Balsamorhiza sagittata



(Sherwood, Debinski, Caragea, and Germino 2017 *Ecosphere*)

Nectar Response of Sulphurflower buckwheat (*Eriogonum umbellatum)*

Snow removal

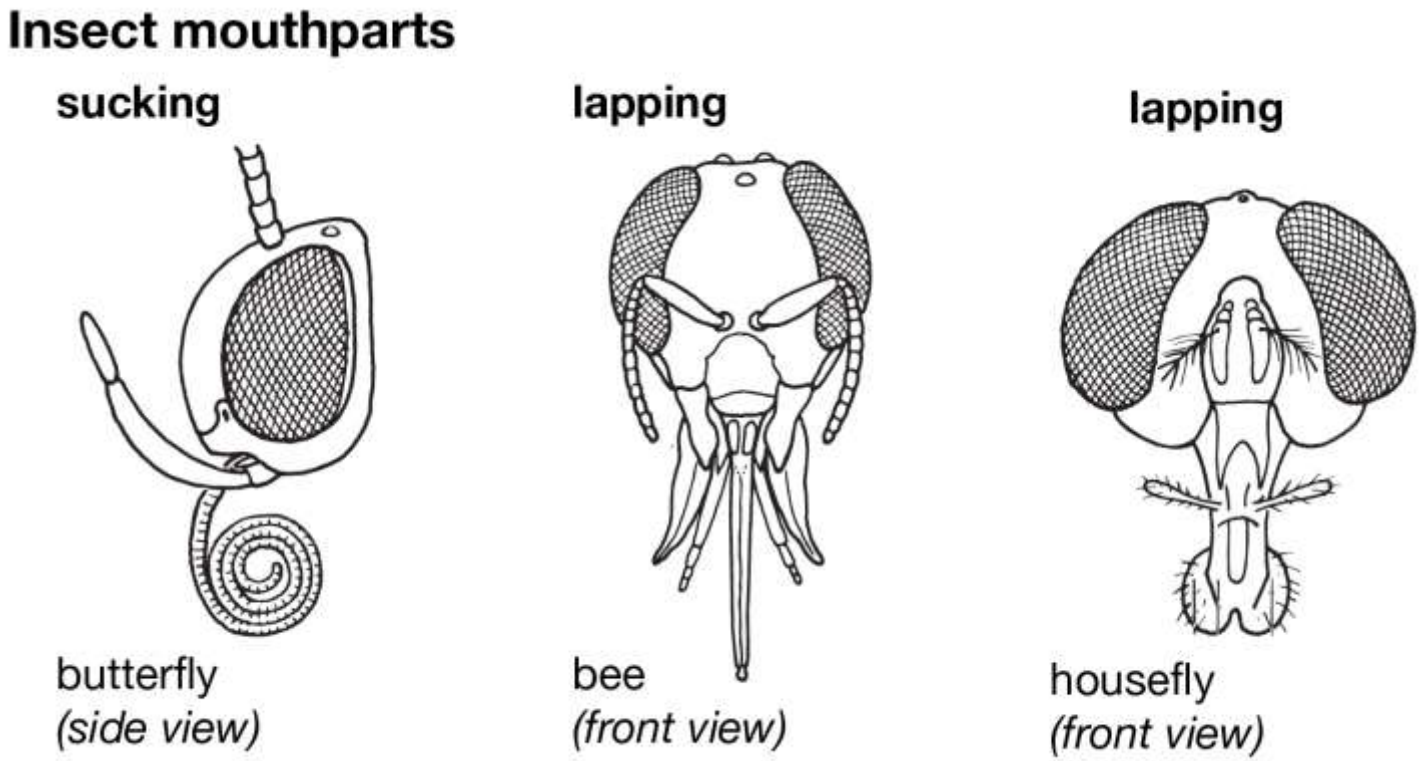
- Concentration (↔)
- Volume (↔)
- Sugar mass (↑ a little)

Heat

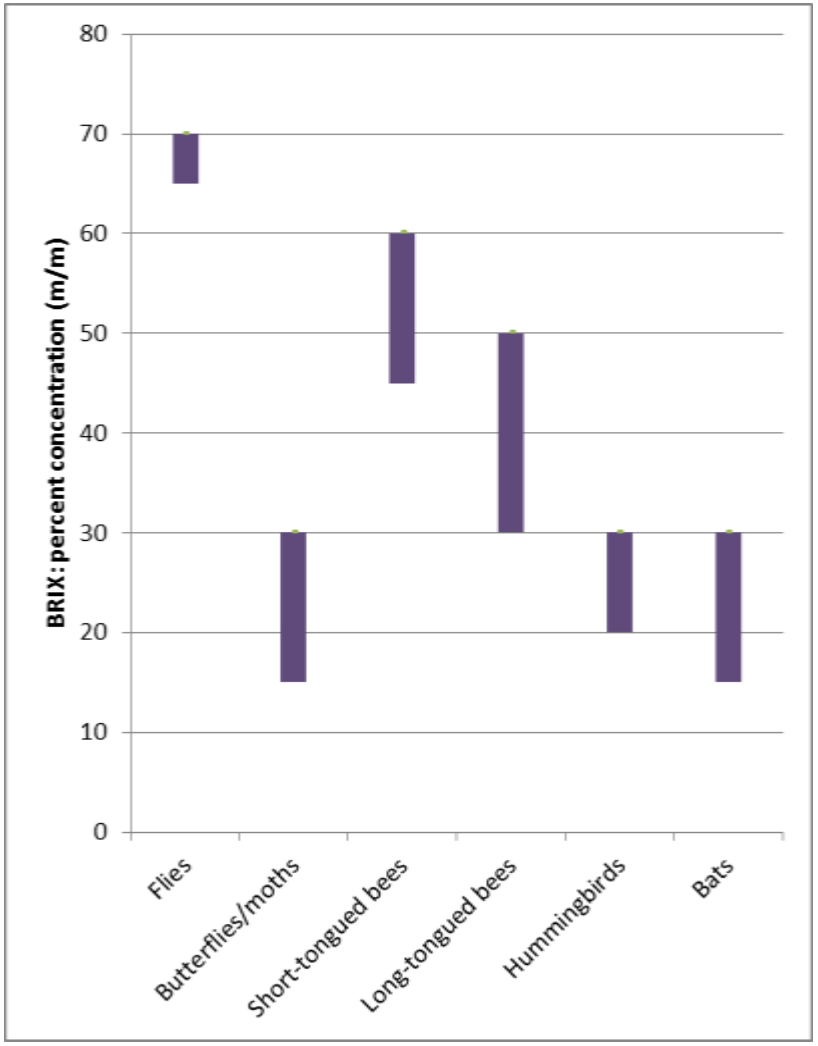
- Concentration (↑ a lot)
- Volume (↓ a little)
- Sugar mass (↔)

McCombs and Debinski (in prep.)

Nectar and Pollinators



Nectar Concentration



Nectar concentration preferences for pollinators

Adapted from Willmer, 2011

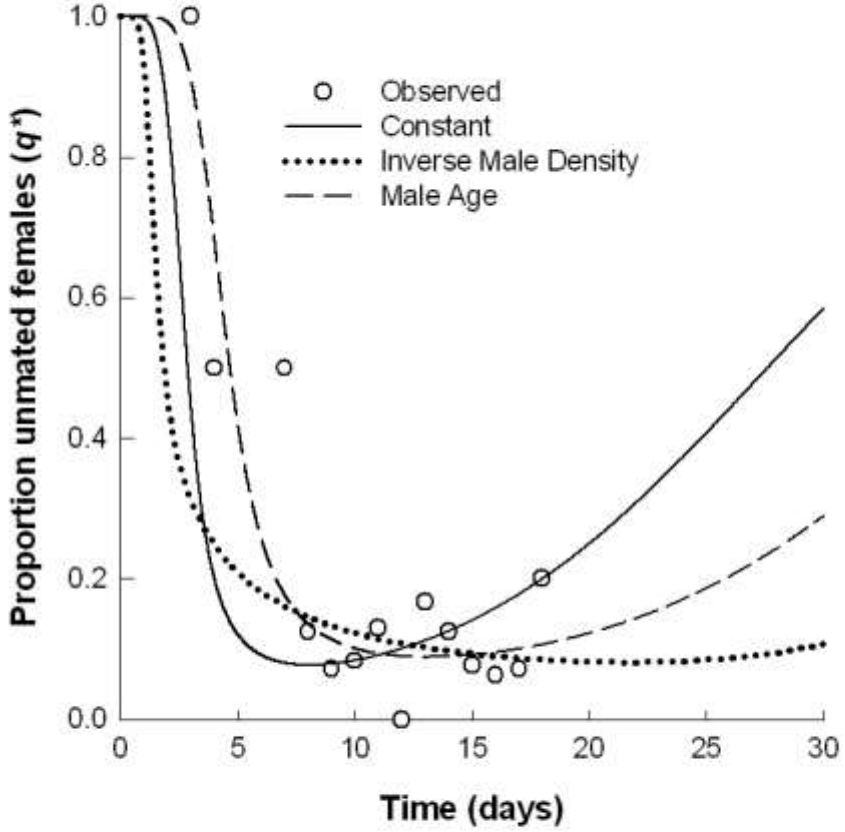
Journal of Animal Ecology

British Ecological Society

Journal of Animal Ecology 2008, **77**, 746–756 doi: 10.1111/j.1365-2656.2008.01385.x

Reproductive asynchrony in natural butterfly populations and its consequences for female matelessness

Justin M. Calabrese[1]*, Leslie Ries[2,6], Stephen F. Matter[3], Diane M. Debinski[4,7], Julia N. Auckland[4,8], Jens Roland[5] and William F. Fagan[2,9]



K. Szcodronski

J Chem Ecol (2012) 38:525–537
DOI 10.1007/s10886-012-0114-x

Occurrence of Sarmentosin and Other Hydroxynitrile Glucosides in Parnassius (Papilionidae) Butterflies and Their Food Plants

Nanna Bjarnholt · Mirosław Nakonieczny · Andrzej Kędziorski · Diane M. Debinski · Stephen F. Matter · Carl Erik Olsen · Mika Zagrobelny

Received: 23 December 2011 / Revised: 28 March 2012 / Accepted: 30 March 2012 / Published online: 25 April 2012

Logan Crees

Journal of the Lepidopterists' Society
72(3), 2018, xx–xx

OBSERVATIONS OF MELOE (COLEOPTERA) LARVAE HITCHHIKING ON *PARNASSIUS CLODIUS* (PAPILIONIDAE) IN GRAND TETON NATIONAL PARK

Additional key words: Triungulin

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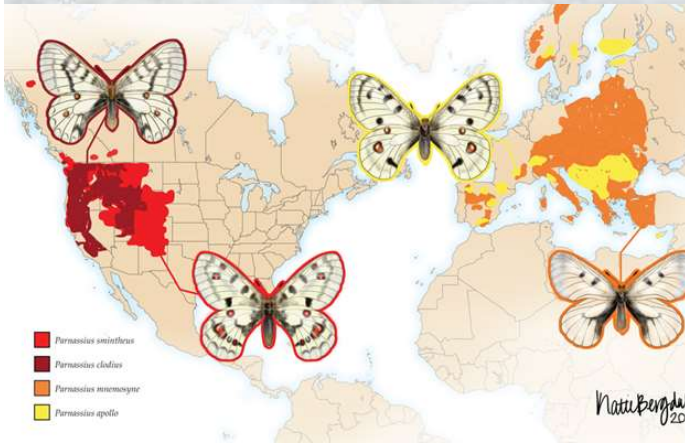
Logan Crees

Kim Szcodronski

Take Home Messages?

Summary

- Mark-recapture studies show high interannual variation in population size – snowmelt conditions may be key.
- Not all sagebrush meadows are equally valuable as Parnassius habitat.
- Warming and decreased snow could affect number of nectar flowers & nectar characteristics.
- Parnassius allow for cross-continental comparisons of environmental response – concept of sister parks.
- There is always more to learn…



Acknowledgements









Acknowledgements

- EPA STAR Grant R825155
- NSF LTREB Grant DEB 0518150
- University of Wyoming- NPS Research Station
- Univ. of Ottawa Distinguished Visiting Researcher Pgm.
- North Central Climate Science Center
- AmericaView
- Grand Teton Natural History Association
- Yellowstone National Park
- Grand Teton National Park
- U.S. Forest Service
- Big Sky Institute
- Iowa State University Experiment Station
- Denver Zoological Foundation
- Iowa Space Grant Consortium
- NASA
- Xerces Society
- Decagon Instruments
- Center for Global and Regional Environmental Research
- Montana State University

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