

Findlay-Robinson, Rachel, Deecke, Volker B. ORCID: <https://orcid.org/0000-0003-2781-5915> , Weatherall, Andrew ORCID: <https://orcid.org/0000-0002-8413-1539> and Hill, Davina ORCID: <https://orcid.org/0000-0001-9085-6192> (2019) Climatic effects on life-history in hazel dormice. In: National Dormouse Conference, 16 November 2019, Reading, UK. (Unpublished)

Downloaded from: <http://insight.cumbria.ac.uk/id/eprint/6817/>

Usage of any items from the University of Cumbria's institutional repository 'Insight' must conform to the following fair usage guidelines.

Any item and its associated metadata held in the University of Cumbria's institutional repository Insight (unless stated otherwise on the metadata record) may be copied, displayed or performed, and stored in line with the JISC fair dealing guidelines (available [here](#)) for educational and not-for-profit activities

provided that

- the authors, title and full bibliographic details of the item are cited clearly when any part of the work is referred to verbally or in the written form
 - a hyperlink/URL to the original Insight record of that item is included in any citations of the work
- the content is not changed in any way
- all files required for usage of the item are kept together with the main item file.

You may not

- sell any part of an item
- refer to any part of an item without citation
- amend any item or contextualise it in a way that will impugn the creator's reputation
- remove or alter the copyright statement on an item.

The full policy can be found [here](#).

Alternatively contact the University of Cumbria Repository Editor by emailing insight@cumbria.ac.uk.

Climatic effects on life history in the hazel dormouse

Rachel Findlay-Robinson

Supervised by

Dr. Davina Hill, Dr. Volker Deecke & Dr. Andrew Weatherall



@RachFinRob



Rachel.Findlay-robinson@uni.cumbria.ac.uk

people's
trust for
endangered
species


University of
Cumbria


WOODLAND
TRUST


Suffolk
Wildlife
Trust

CHESTER
ZOO

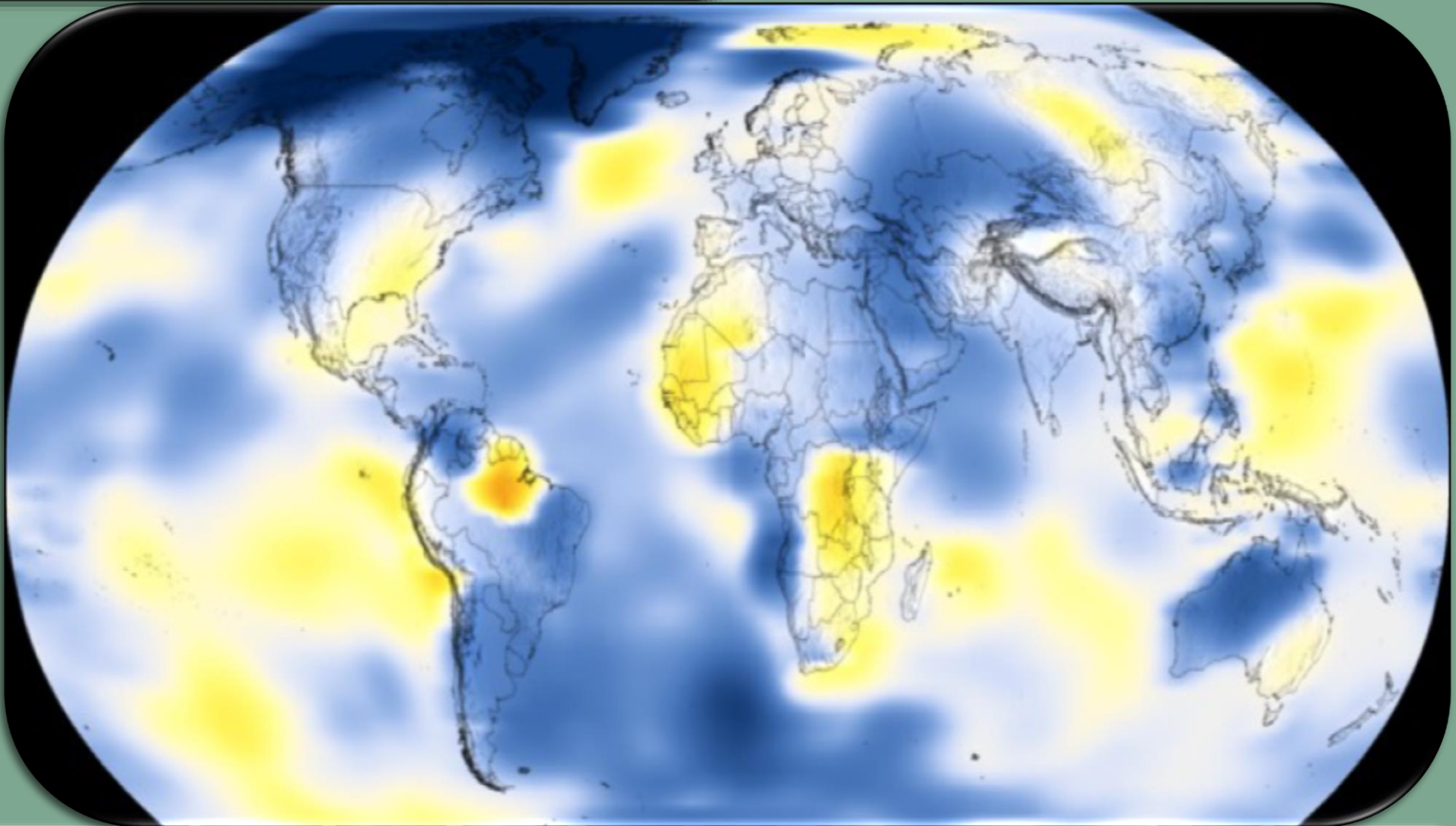
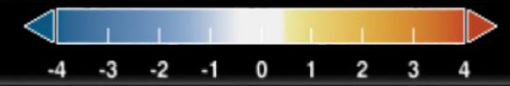


Woodland Trust/WTML

Global Climate Change




1888

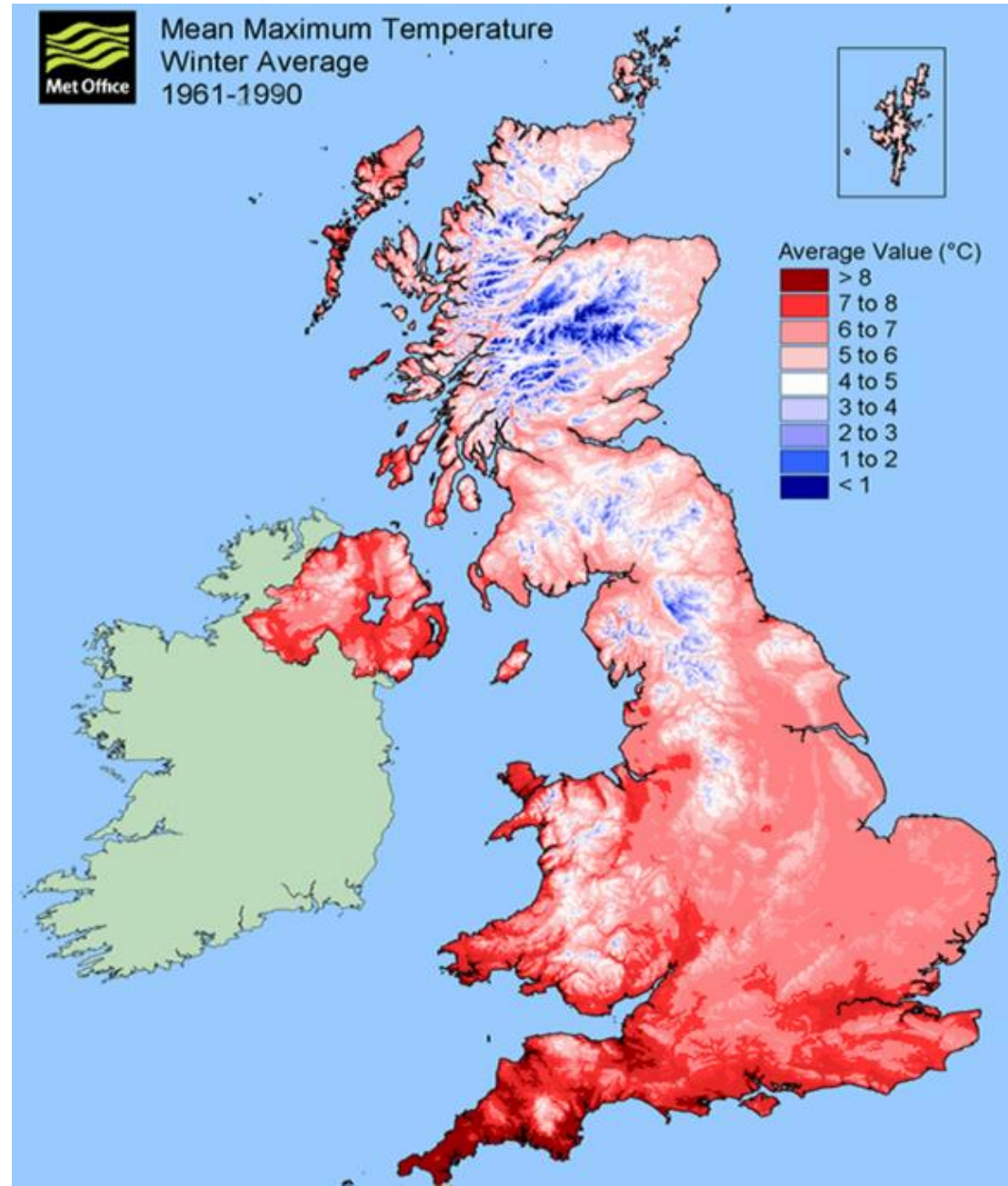
Temperature Difference (Fahrenheit)



NASA's Climate Time Machine <https://climate.nasa.gov/interactives/climate-time-machine>

UK Climate change

-  Dormice present
-  Dormice common
-  Reintroduction site



Climate change and hibernators

Functional Ecology

Functional Ecology 2016

doi:10.1111/1365-2435.12620

Thermal climate-linked variation in annual survival rate of hibernating rodents: shorter winter dormancy and lower survival in warmer climates

Christopher Turbill¹ and Samantha Prior¹

Hawkesbury Institute for the Environment, Western Sydney University, Locked Bag 1707, Penrith 2751, New South Wales, Australia

Summary

1. In seasonal climates, many animals, including a wide range of small mammals, are physiologically capable of prolonged dormancy ('hibernation'), when foraging-related activity ceases entirely for part of the year. Low metabolic rates while dormant minimise energy and wear requirements, but the behavioural state of inactivity also reduces exposure to mortality risk, especially predation.

2. Thermal effects on activity underlie spatial patterns in annual survival rate of ectotherms. We hypothesised that, because local thermal conditions affect the duration of hibernation, positive effects of dormancy on survival could also underlie a relationship between hibernation, spatial variation in thermal climate and annual survival rate among populations of hibernating rodents.

3. We tested for effects of local thermal climate on hibernation rate among populations of collared lemmings.

Chapter 8 Impact of Climatic Variation on the Hibernation Physiology of *Muscardinus avellanarius*

Iris Pretzlaff and Kathrin H. Dausmann

Abstract Climate change will not only directly affect climatic parameters, such as temperature and precipitation, but ultimately also ecological and physiological parameters of animal species. Our study investigates the effects of variation in climatic conditions, as experienced by climate change, on hibernation physiology and energy balance of a small hibernating mammal, the hazel dormouse

Ecology and Evolution

Fitness implications of seasonal climate on Columbian ground squirrels

F. Stephen Dobson¹, Jeffrey E. Lane², Matthew Low³ & Jan O. Stenseth⁴

¹Department of Biological Sciences, Auburn University, Auburn, Alabama 36849

²Department of Biology, University of Idaho, Moscow, Idaho 83843

³Department of Biology, University of Idaho, Moscow, Idaho 83843

⁴Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2G6, Canada

Keywords: climate, fitness, ground squirrel, survival, winter hibernation

Correspondence: F. Stephen Dobson, Department of Biological Sciences, Auburn University, Auburn, AL 36849-5400. Tel: 014-844-1690; Fax: 014-844-9234; Email: fstephen@auburn.edu

Funding information: National Science Foundation (Grant Number DIB-0084273), National Science Foundation (Grant Number DIB-0084273), National Science Foundation (Grant Number DIB-0084273), National Science Foundation (Grant Number DIB-0084273), National Science Foundation (Grant Number DIB-0084273)

Received: 10 May 2016; Accepted: 31 May 2016

doi:10.1002/ece.2279

Introduction

The relationship between climate and fitness is a fundamental biological process that influences population dynamics and regulation (Schwartz 2000; Miller et al. 2008). Due to the overwhelming evidence of anthropogenic influence on global climate (IPCC 2014), there has been a renewed emphasis on the relationship between climate change and fitness, and how anthropogenic climate change will affect the fitness and population viability of wild animals (e.g. Both et al. 2006, 2009; Miller et al. 2008; Moyes et al. 2011; Tack et al. 2015). This is

the case for many species, including hibernating mammals. Hibernation is a survival strategy that allows animals to survive in harsh winter conditions by reducing their metabolic rate and energy requirements. Hibernating mammals typically enter a state of dormancy during the winter months, during which they consume very little food and have a significantly lower metabolic rate than during the active season. This strategy is particularly important for small mammals, which have a high surface area to volume ratio and therefore lose heat rapidly. Hibernation allows them to conserve energy and survive through the winter months when food is scarce and temperatures are low.

Climate change is affecting altitudinal migrants and hibernating species

David W. Inouye¹*, Billy Barr¹, Kenneth B. Armitage¹, and Brian D. Inouye²

¹Department of Biology, University of Maryland, College Park, MD 20742; ²Rocky Mountain Biological Laboratory, P.O. Box 519, Crested Butte, CO 81624

³Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS 66045-2106; and ⁴Center for Population Biology, One Shields Boulevard, University of California, Davis, CA 95616

Edited by Harold M. Mooney, Stanford University, Stanford, CA, and approved December 17, 1999 (received for review October 8, 1999)

Calendar data of the beginning of the growing season at high altitude in the Colorado Rocky Mountains is variable but has not changed significantly over the past 25 years. This result differs from growing evidence from low altitudes that climate change is resulting in a longer growing season, earlier migrations, and earlier reproduction in a variety of taxa. At our study site, the beginning of the growing season is controlled by melting of the previous winter's snowpack. Despite a trend for warmer spring temperatures the average date of snowmelt has not changed, perhaps because of the trend for increased winter precipitation. This juxtaposition between low and high altitudes may create problems for species, such as many birds, that migrate over altitudinal gradients. We present data indicating that this already may be true for a mountain robin, which are arriving 14 days earlier than they did in 1981: the interval between arrival dates and the first date of bare ground has grown by 18 days. We also report evidence for an effect of climate change on hibernation behavior: yellow-bellied marmots are emerging 38 days earlier than 23 years ago, apparently in response to warmer spring air temperatures. Migrants and hibernators may experience problems as a consequence of these changes in phenology, which may be exacerbated if climate models are correct in their predictions of increased winter snowfall in our study area. The trends we report for earlier formation of permanent snowpack and for a longer period of snow cover also have implications for hibernating species.

Introduction

In high mountains, such as the Colorado Rockies, there is a short, but active, growing season. Resources are abundant and competition is very low. In contrast, in low mountains, the growing season is long and active. Resources are scarce and competition is high. This juxtaposition of conditions may create problems for species that migrate over altitudinal gradients. We present data indicating that this already may be true for a mountain robin, which are arriving 14 days earlier than they did in 1981: the interval between arrival dates and the first date of bare ground has grown by 18 days. We also report evidence for an effect of climate change on hibernation behavior: yellow-bellied marmots are emerging 38 days earlier than 23 years ago, apparently in response to warmer spring air temperatures. Migrants and hibernators may experience problems as a consequence of these changes in phenology, which may be exacerbated if climate models are correct in their predictions of increased winter snowfall in our study area. The trends we report for earlier formation of permanent snowpack and for a longer period of snow cover also have implications for hibernating species.

Study Site and Methods

The Rocky Mountain Biological Laboratory (RMBL) in Gothic, CO at approximately 2,945-m elevation in the West Elk mountains. Since 1981, RMBL has recorded snowfall and snow pack daily. From 1975 to 1979 the permanent snow cover began on November 4 (range from November 24) and lasted until May 24 (range from June 19), for an average length of 202 days.

Body Mass and Winter Severity as Predictors of Overwinter Survival in Preble's Meadow Jumping Mouse

ROBERT A. SCHORK*, PAUL M. LUKACS, AND GREGORY L. FLORANT
Colorado Natural Heritage Program, Colorado State University, 254 General Services Building, Fort Collins, CO 80523, USA (PML)

Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80523, USA (GLF)

Department of Biology, Colorado State University, Fort Collins, CO 80523, USA (GLF)

Abstract Meadow jumping mice (*Zapus hudsonius*) reduce their metabolism substantially during hibernation and use stored fat reserves for overwinter energy needs. Preble's meadow jumping mouse (*Z. h. preblei*; PMJM) occurs along the Front Range of Colorado, north into southeastern Wyoming, and is listed as a threatened species under the Endangered Species Act because of the conversion and degradation of riparian habitats. To better understand the factors that affect overwinter survival, we conducted a mark-recapture study of PMJM in the Front Range of Colorado, El Paso County, Colorado. We used environmental data to predict survival. We found that survival of PMJM was lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures.

LETTER

Delayed phenology and reduced fitness associated with climate change in a wild hibernator

Jeffrey E. Lane^{1,2,3}, Loeske E. B. Kruskal¹, Anne Charmantier¹, Jan O. Murie¹ & F. Stephen Dobson^{1,4}

¹Department of Biology, University of Alberta, Edmonton, Alberta T6G 2G6, Canada; ²Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS 66045-2106; ³Center for Population Biology, One Shields Boulevard, University of California, Davis, CA 95616; ⁴Department of Biological Sciences, Auburn University, Auburn, AL 36849-5400

Abstract The most commonly reported ecological effects of climate change are shifts in phenologies, in particular of warmer spring temperatures leading to earlier timing of key events. Among animals, however, whereas we still know comparatively little about other seasonal adaptations, such as mammalian hibernation, here we show a significant delay (0.47 days per year, over a 20-year period) in the within-individual phenotypic plasticity, females emerged later to investigate the climatic conditions at our study location. Although there has not been a significant annual trend in spring temperature, the date of snowmelt has become progressively later over time, years of later emergence were also associated with lower survival. These results show that plastic responses to climate change may be associated with declines in individual fitness and hence, population viability.

Introduction

Over periodic events or phenologies, in wild animal species of rodents. As temporal resource life cycles rapidly owing to climate change, the extent to which individuals have important components of their life cycle that are not synchronized with the most often cited ecological changes from advances of 0.23 days (rd; Fig. 1c) per year, there is evidence that populations may be exhibiting ecological advance, or have exhibited ecological advance, or have exhibited ecological advance, or have exhibited ecological advance.

Body Mass and Winter Severity as Predictors of Overwinter Survival in Preble's Meadow Jumping Mouse

ROBERT A. SCHORK*, PAUL M. LUKACS, AND GREGORY L. FLORANT
Colorado Natural Heritage Program, Colorado State University, 254 General Services Building, Fort Collins, CO 80523, USA (PML)

Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80523, USA (GLF)

Department of Biology, Colorado State University, Fort Collins, CO 80523, USA (GLF)

Abstract Meadow jumping mice (*Zapus hudsonius*) reduce their metabolism substantially during hibernation and use stored fat reserves for overwinter energy needs. Preble's meadow jumping mouse (*Z. h. preblei*; PMJM) occurs along the Front Range of Colorado, north into southeastern Wyoming, and is listed as a threatened species under the Endangered Species Act because of the conversion and degradation of riparian habitats. To better understand the factors that affect overwinter survival, we conducted a mark-recapture study of PMJM in the Front Range of Colorado, El Paso County, Colorado. We used environmental data to predict survival. We found that survival of PMJM was lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures.

Introduction

In high mountains, such as the Colorado Rockies, there is a short, but active, growing season. Resources are abundant and competition is very low. In contrast, in low mountains, the growing season is long and active. Resources are scarce and competition is high. This juxtaposition of conditions may create problems for species that migrate over altitudinal gradients. We present data indicating that this already may be true for a mountain robin, which are arriving 14 days earlier than they did in 1981: the interval between arrival dates and the first date of bare ground has grown by 18 days. We also report evidence for an effect of climate change on hibernation behavior: yellow-bellied marmots are emerging 38 days earlier than 23 years ago, apparently in response to warmer spring air temperatures. Migrants and hibernators may experience problems as a consequence of these changes in phenology, which may be exacerbated if climate models are correct in their predictions of increased winter snowfall in our study area. The trends we report for earlier formation of permanent snowpack and for a longer period of snow cover also have implications for hibernating species.

Study Site and Methods

The Rocky Mountain Biological Laboratory (RMBL) in Gothic, CO at approximately 2,945-m elevation in the West Elk mountains. Since 1981, RMBL has recorded snowfall and snow pack daily. From 1975 to 1979 the permanent snow cover began on November 4 (range from November 24) and lasted until May 24 (range from June 19), for an average length of 202 days.

Body Mass and Winter Severity as Predictors of Overwinter Survival in Preble's Meadow Jumping Mouse

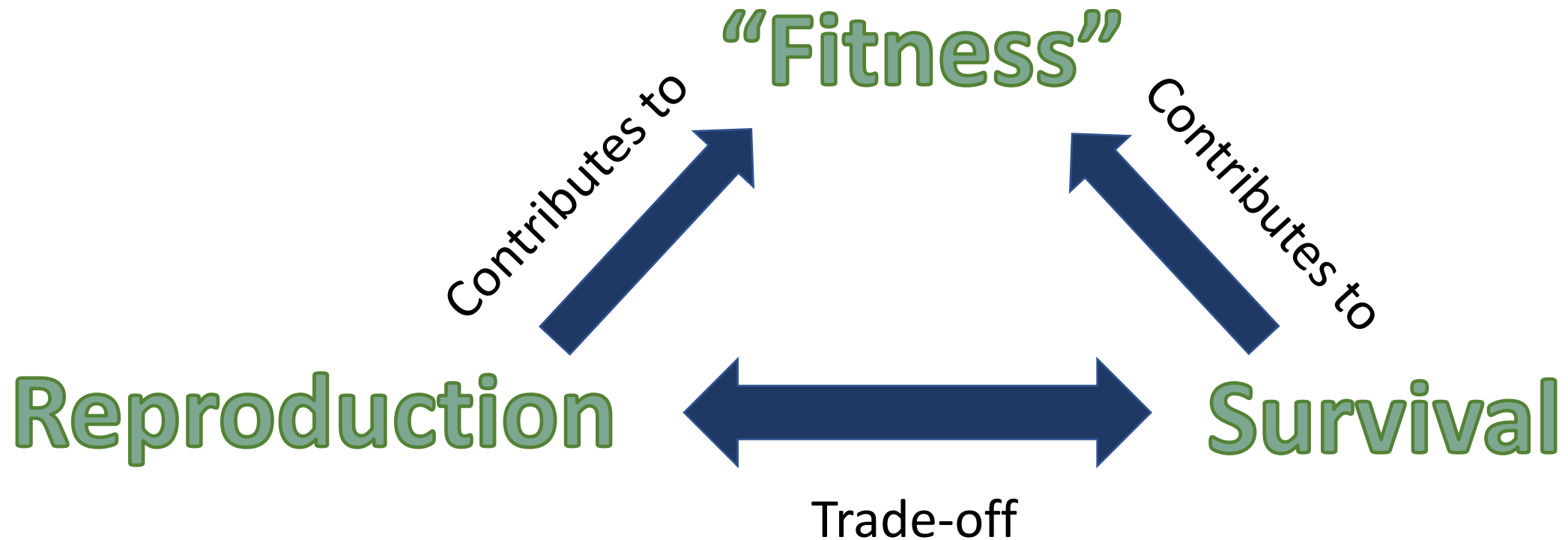
ROBERT A. SCHORK*, PAUL M. LUKACS, AND GREGORY L. FLORANT
Colorado Natural Heritage Program, Colorado State University, 254 General Services Building, Fort Collins, CO 80523, USA (PML)

Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80523, USA (GLF)

Department of Biology, Colorado State University, Fort Collins, CO 80523, USA (GLF)

Abstract Meadow jumping mice (*Zapus hudsonius*) reduce their metabolism substantially during hibernation and use stored fat reserves for overwinter energy needs. Preble's meadow jumping mouse (*Z. h. preblei*; PMJM) occurs along the Front Range of Colorado, north into southeastern Wyoming, and is listed as a threatened species under the Endangered Species Act because of the conversion and degradation of riparian habitats. To better understand the factors that affect overwinter survival, we conducted a mark-recapture study of PMJM in the Front Range of Colorado, El Paso County, Colorado. We used environmental data to predict survival. We found that survival of PMJM was lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures. Survival was also lower in years with higher winter precipitation and lower winter temperatures.

What is life history?

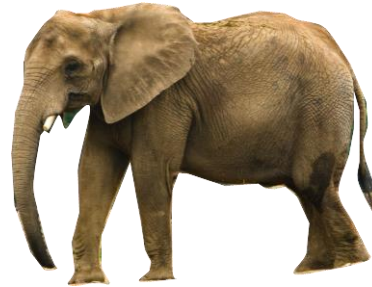


What is life history?

Units of
energy



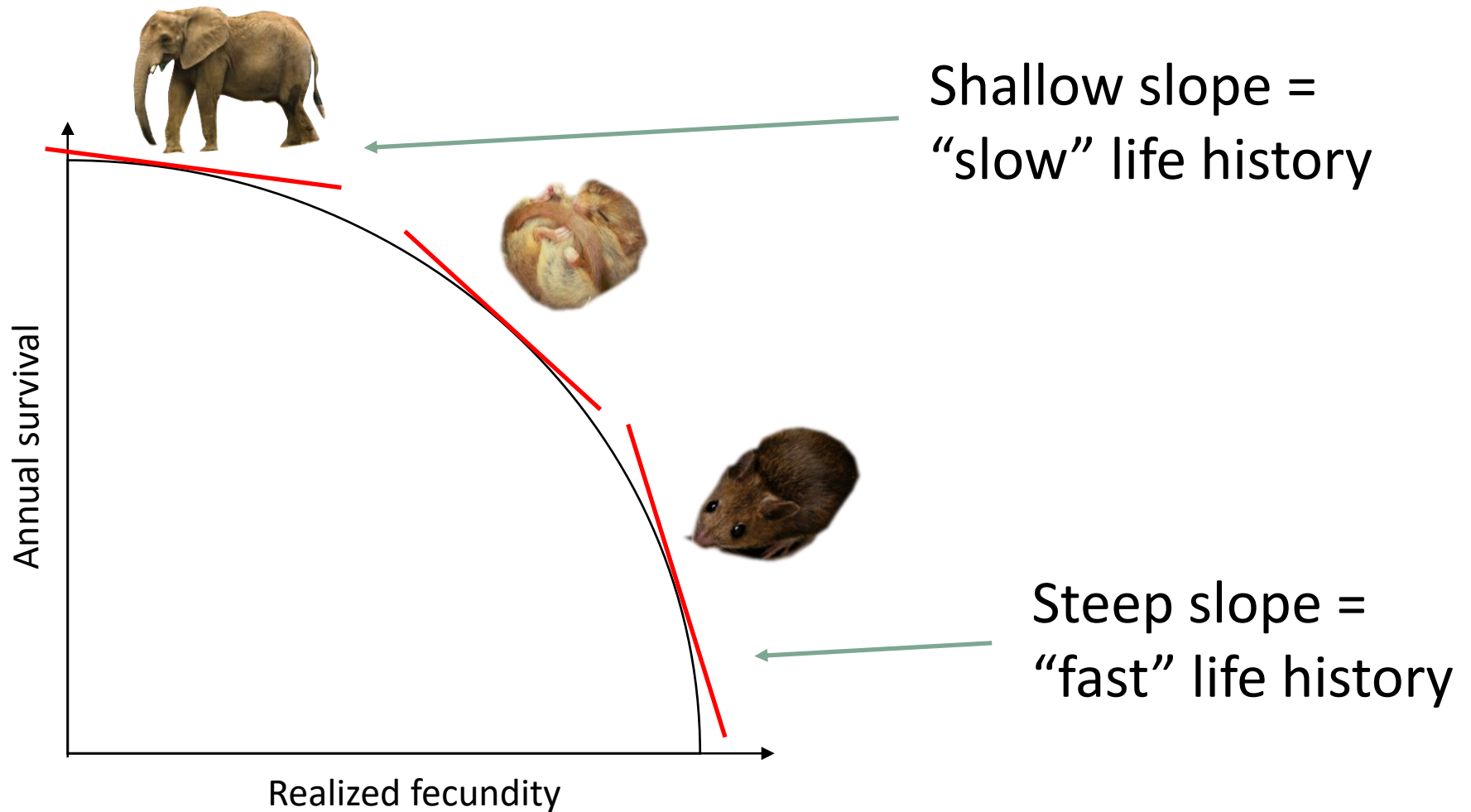
Reproduction



Survival



What is life history?



Life history

Fitness

Survival

Reproduction

Lifespan

No. litters

Life history

Growth rate

Litter size

Torpor

Mating

Activity levels

Hibernation

Foraging

Budding

Fruiting

Food availability

Flowering

Leafing

Summer

precipitation

Summer

temperature

Weather

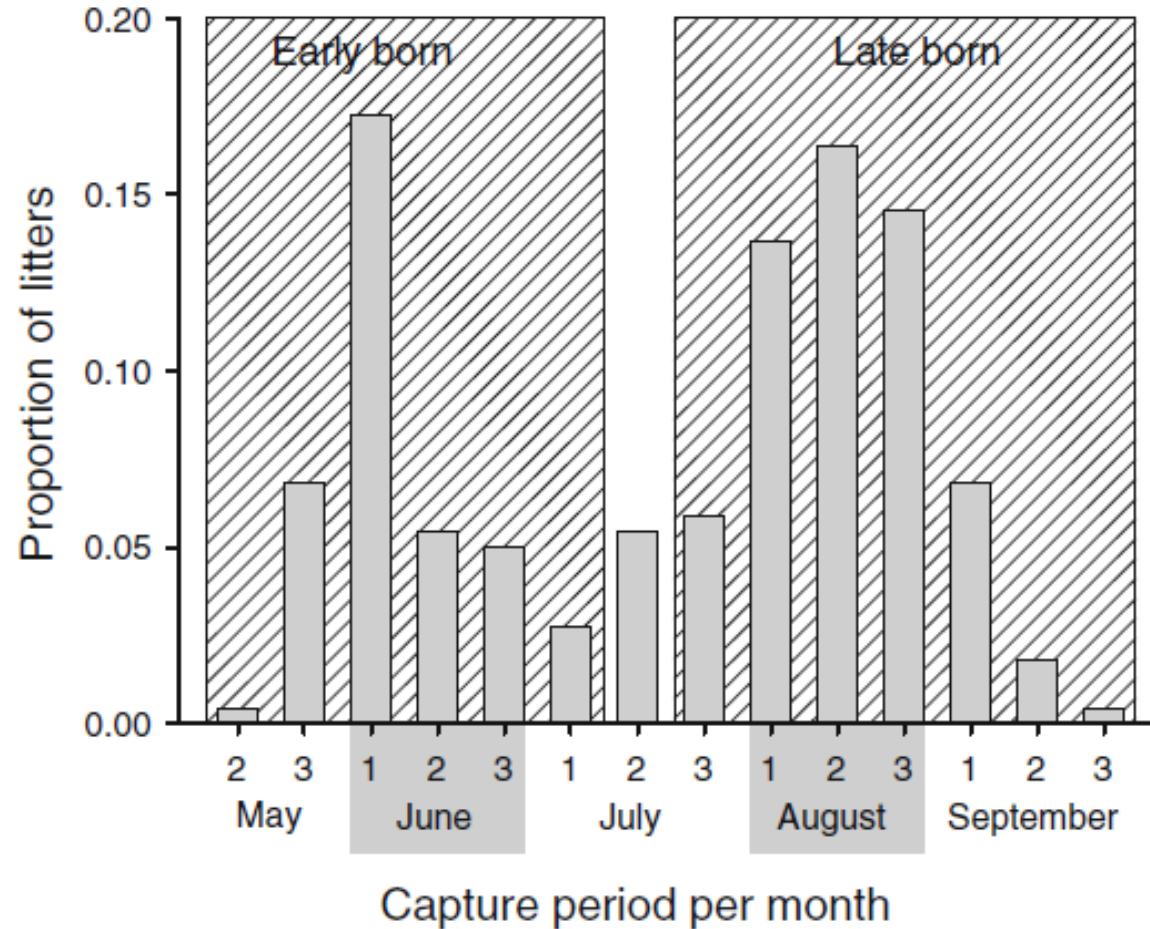
Winter

temperature

Winter

precipitation

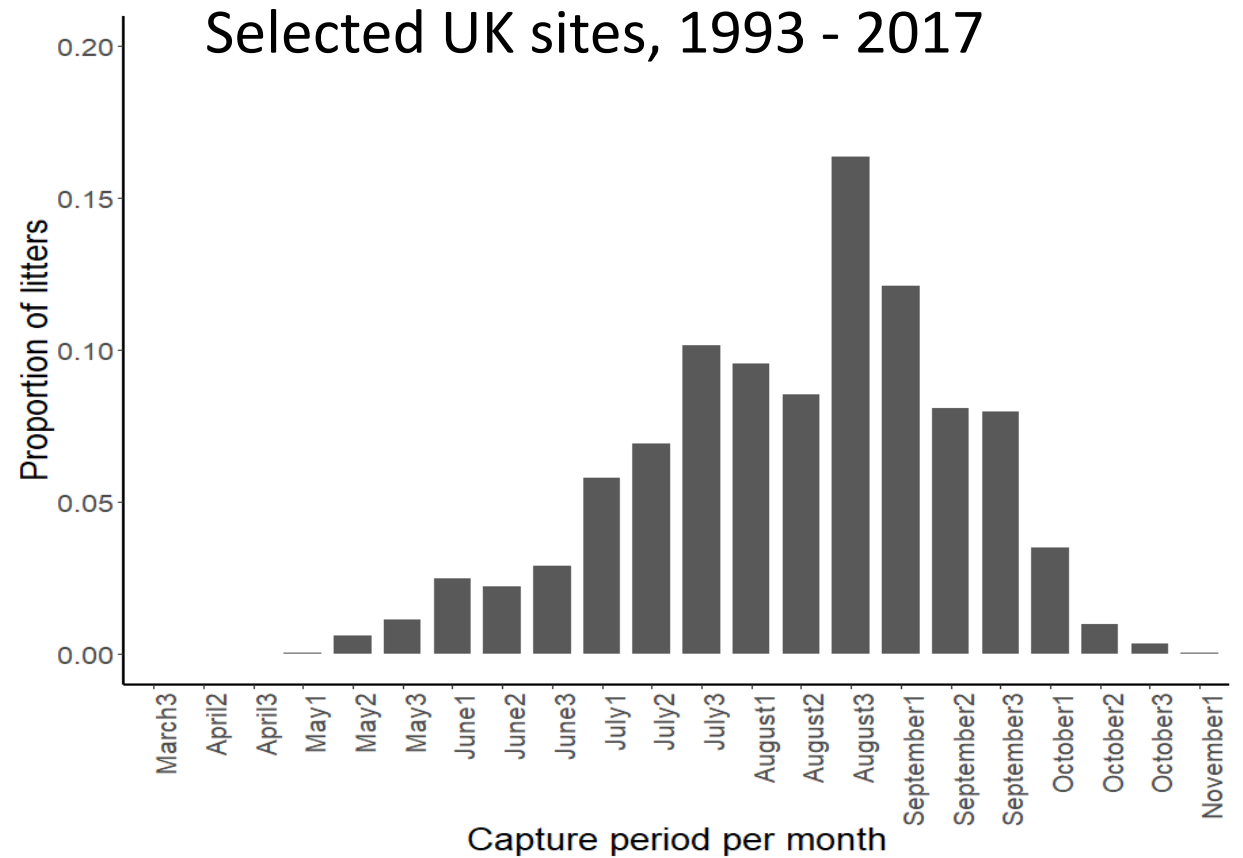
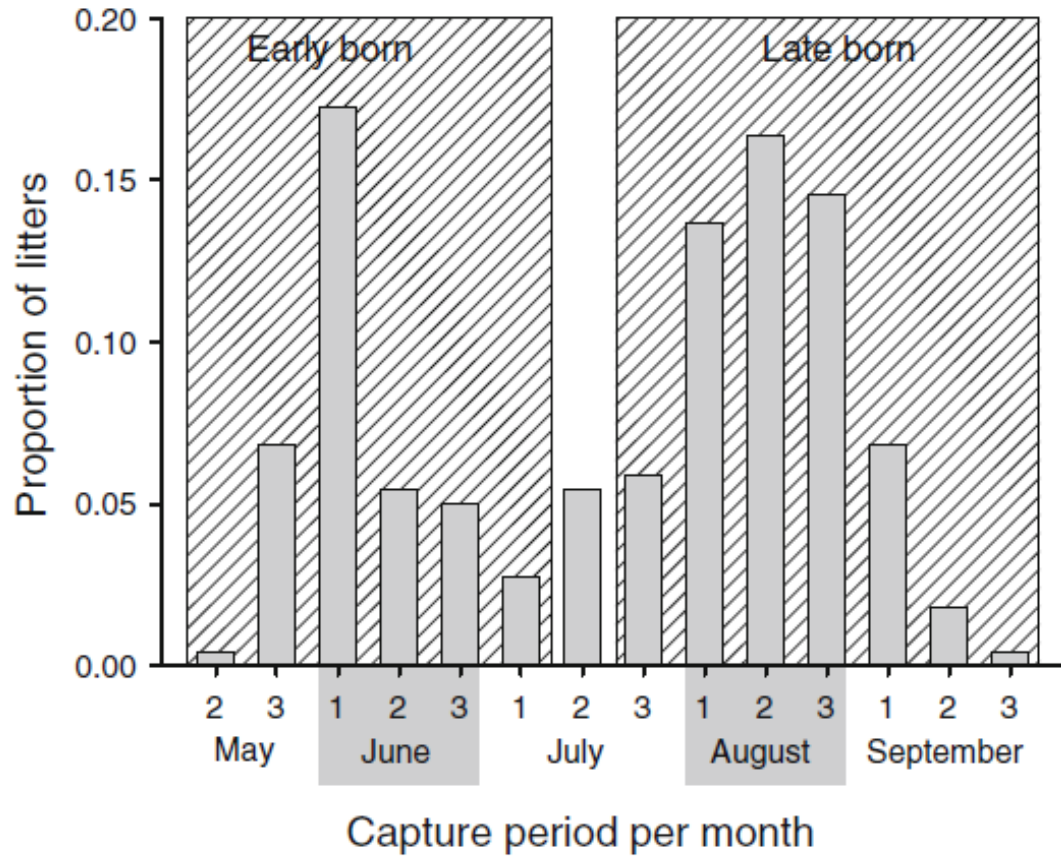
Reproduction



Šakiai district,
Lithuania

1981 - 2007

Reproduction



Life history

Fitness

Survival

Reproduction

Lifespan

No. litters

Life history

Growth rate

Litter size

Torpor

Mating

Activity levels

Hibernation

Foraging

Budding

Fruiting

Food availability

Flowering

Leafing

Summer

precipitation

Summer

temperature

Weather

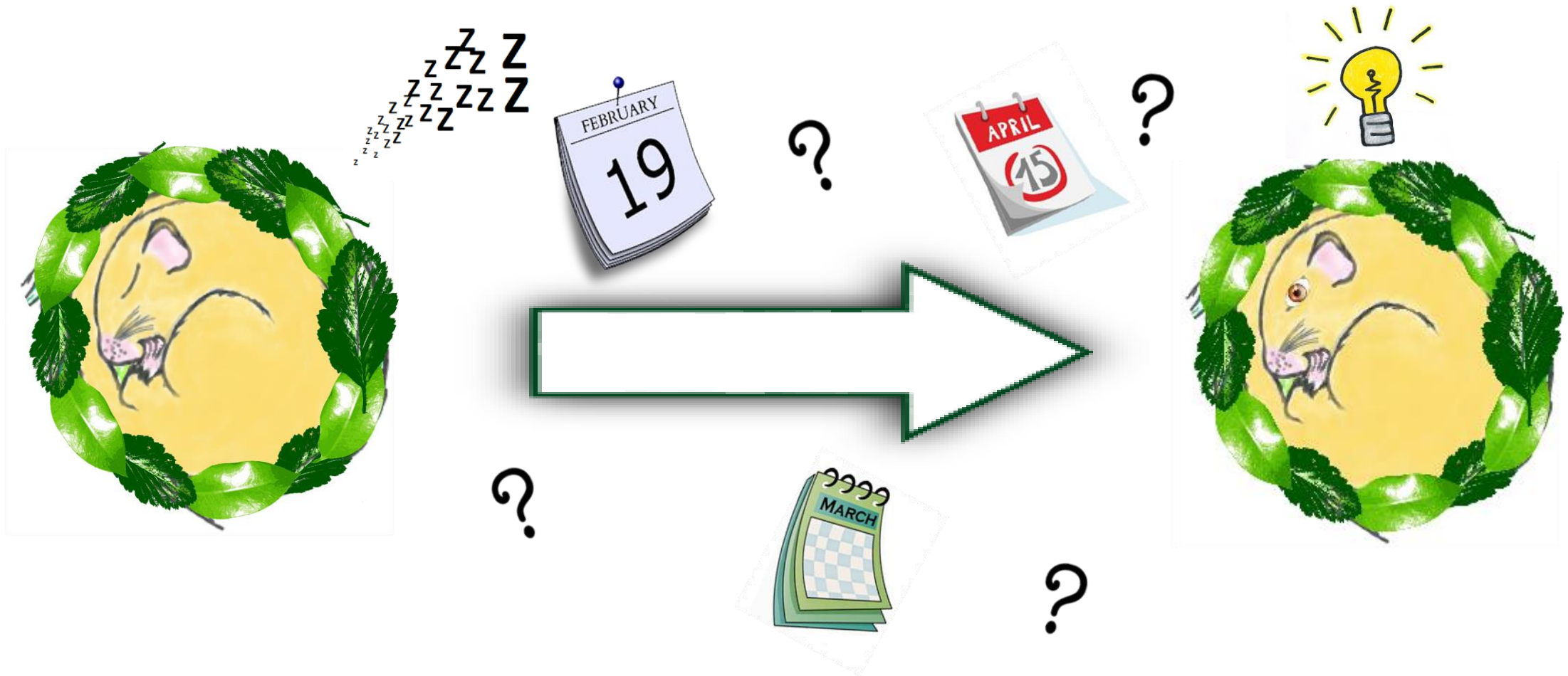
Winter

temperature

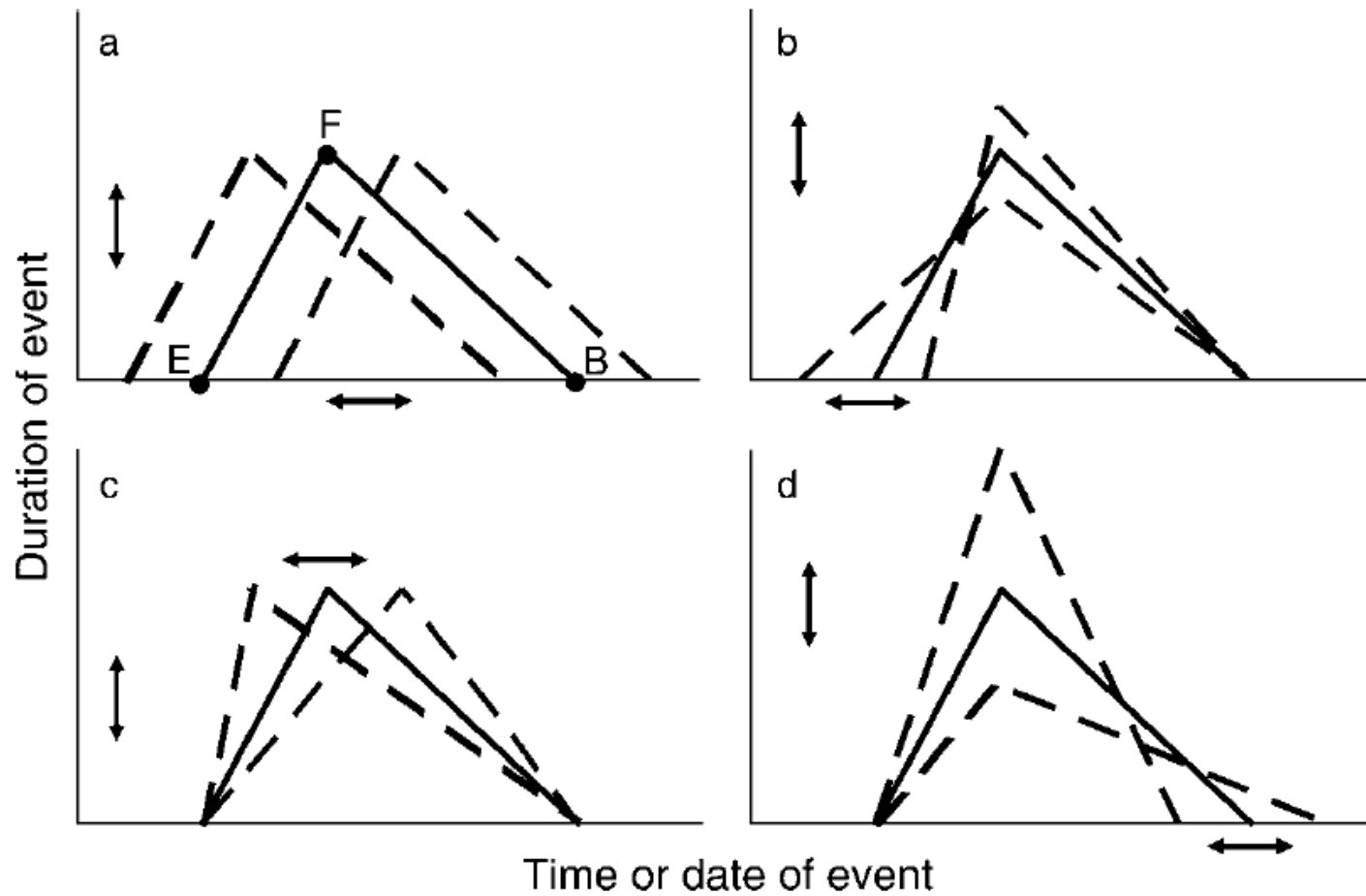
Winter

precipitation

Activity levels



Food availability



E - budding

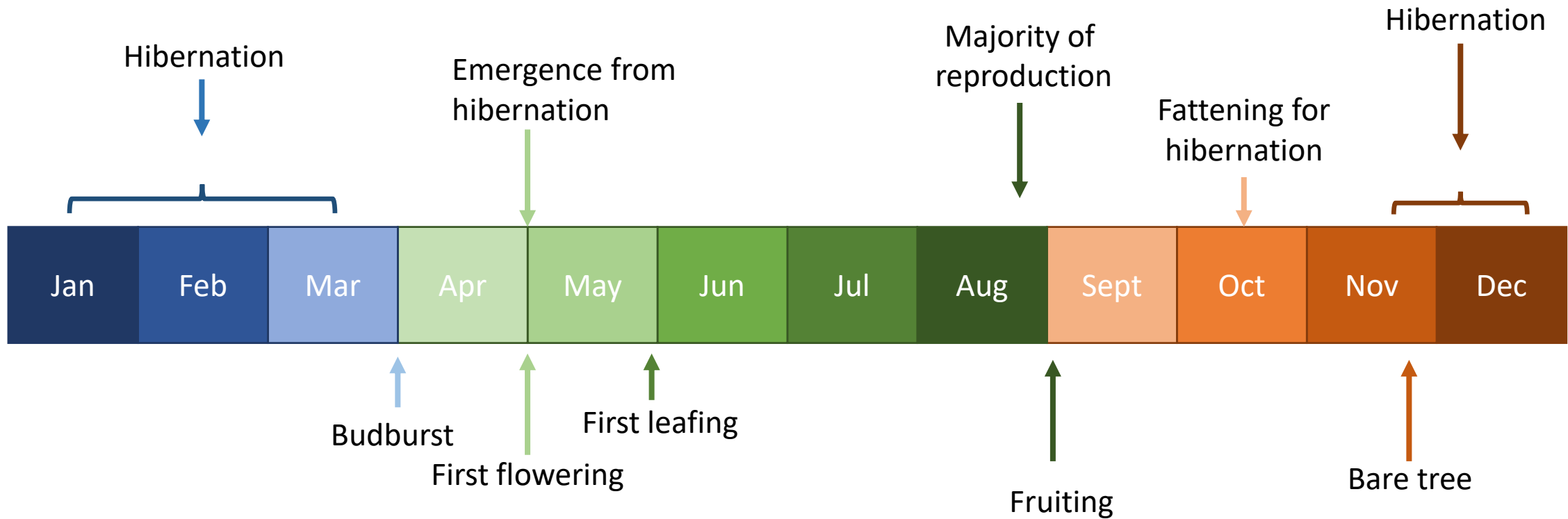


F - leafing

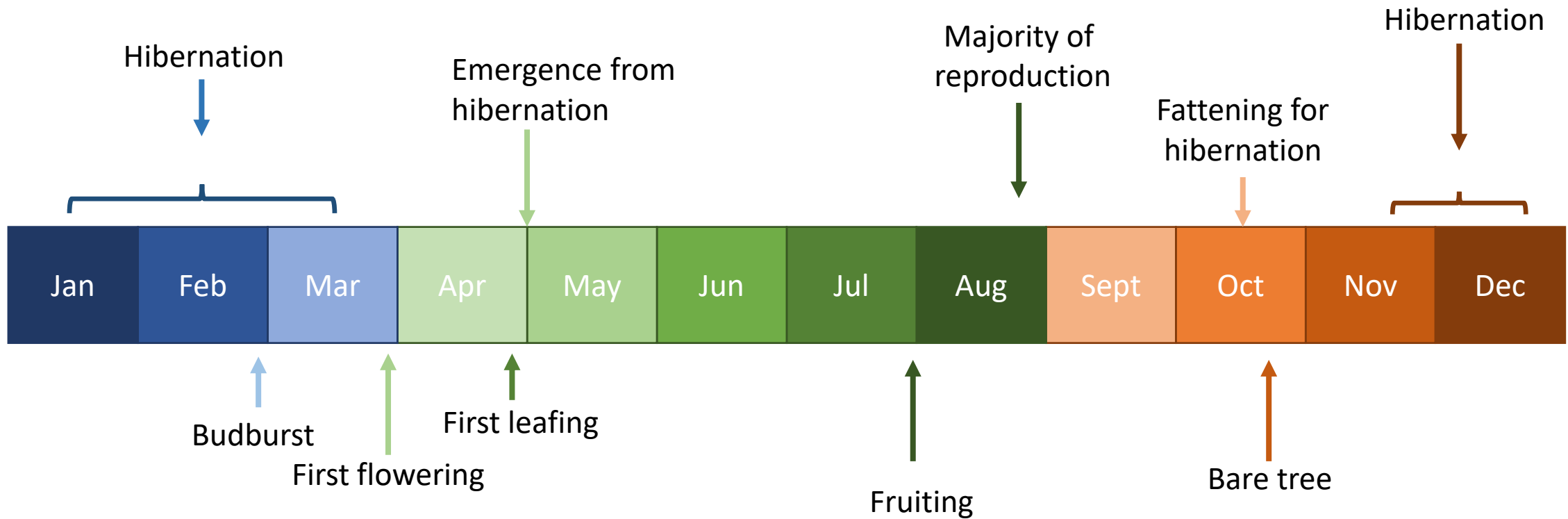


B - fruiting

Potential effects



Potential effects



Applications

Reintroductions

Long-term conservation

Woodland management



Acknowledgements

-  People's Trust for Endangered Species
-  Woodland Trust
-  Suffolk Wildlife Trust
-  Chester Zoo
-  Roger Trout
-  University of Cumbria
-  My supervisors, Drs. Davina Hill, Volker Deecke and Andrew Weatherall



YOU!