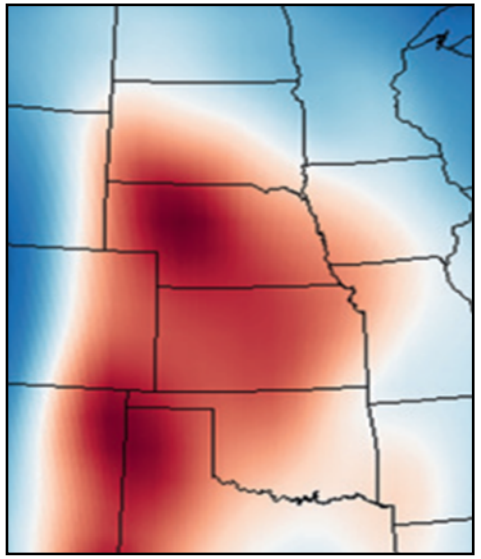
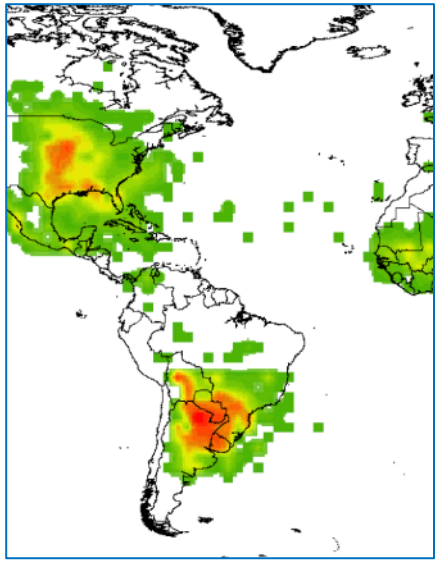
Climate Change and Ecological Impacts





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OKLAHOMA BIOLOGICAL SURVEY
The UNIVERSITY *of* OKLAHOMA

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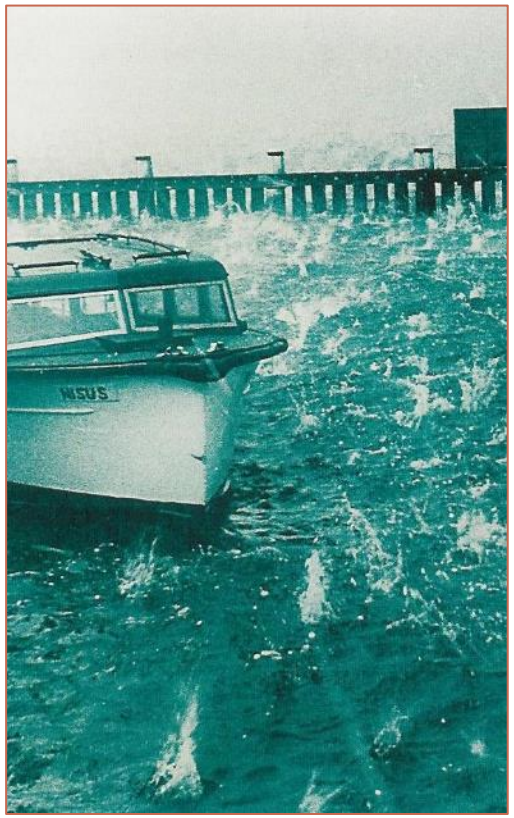
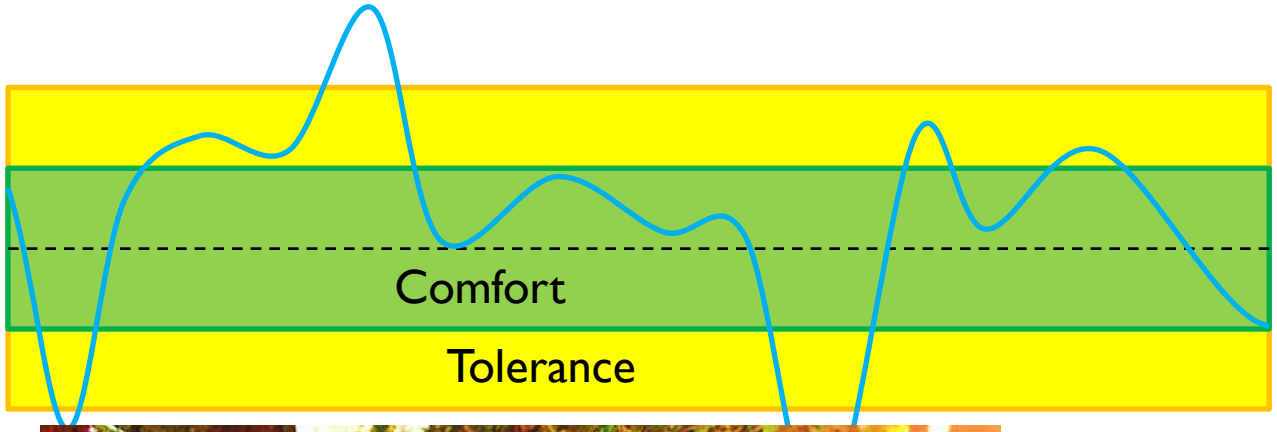
George Miksch Sutton Scholarship (OU)
Wilson Ornithological Society Paul A. Stewart Grants
OU Graduate Student Senate Research Grants
Oklahoma Ornithological Society

Severe Weather

- Transient climate extremes linked to wider atmospheric processes



Weather Effects on Populations



B. Strick

Weather Effects on Populations

University of Tulsa

Brown & Brown (1998, 2000)

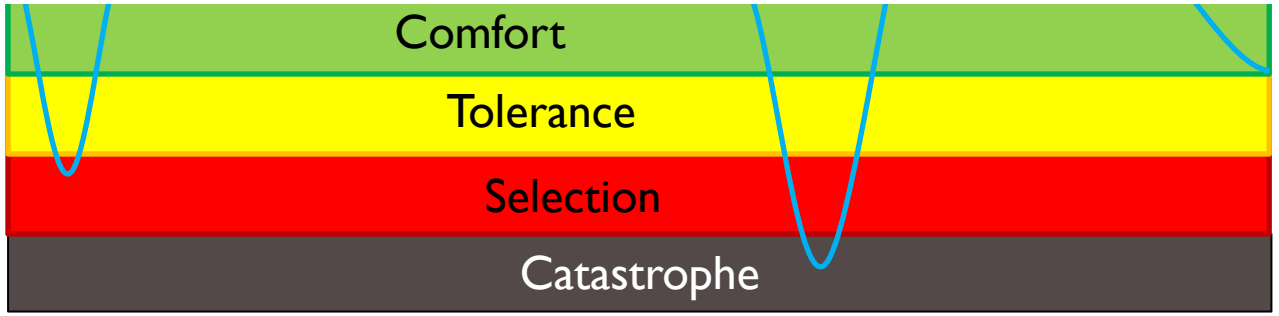
Weather Effects on Populations

Unidirectional impacts:

Hailstorms

Hurricanes

Ice Storm

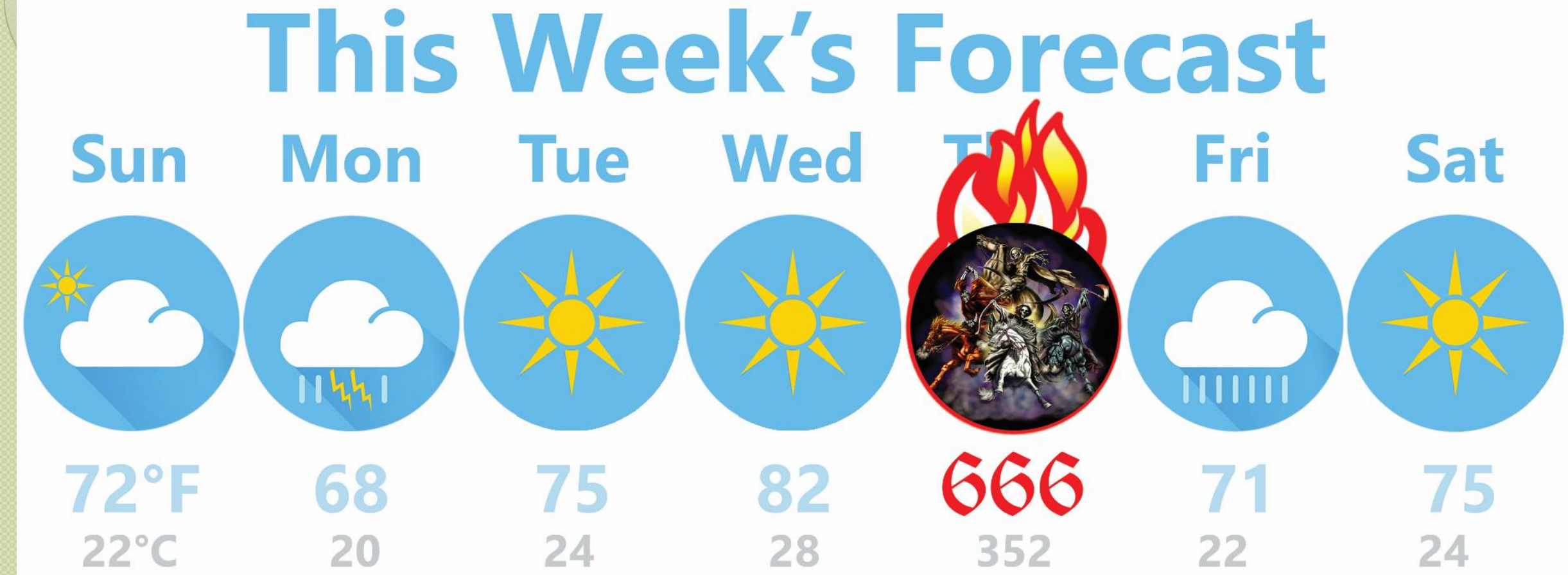


Bi-directional conditions:

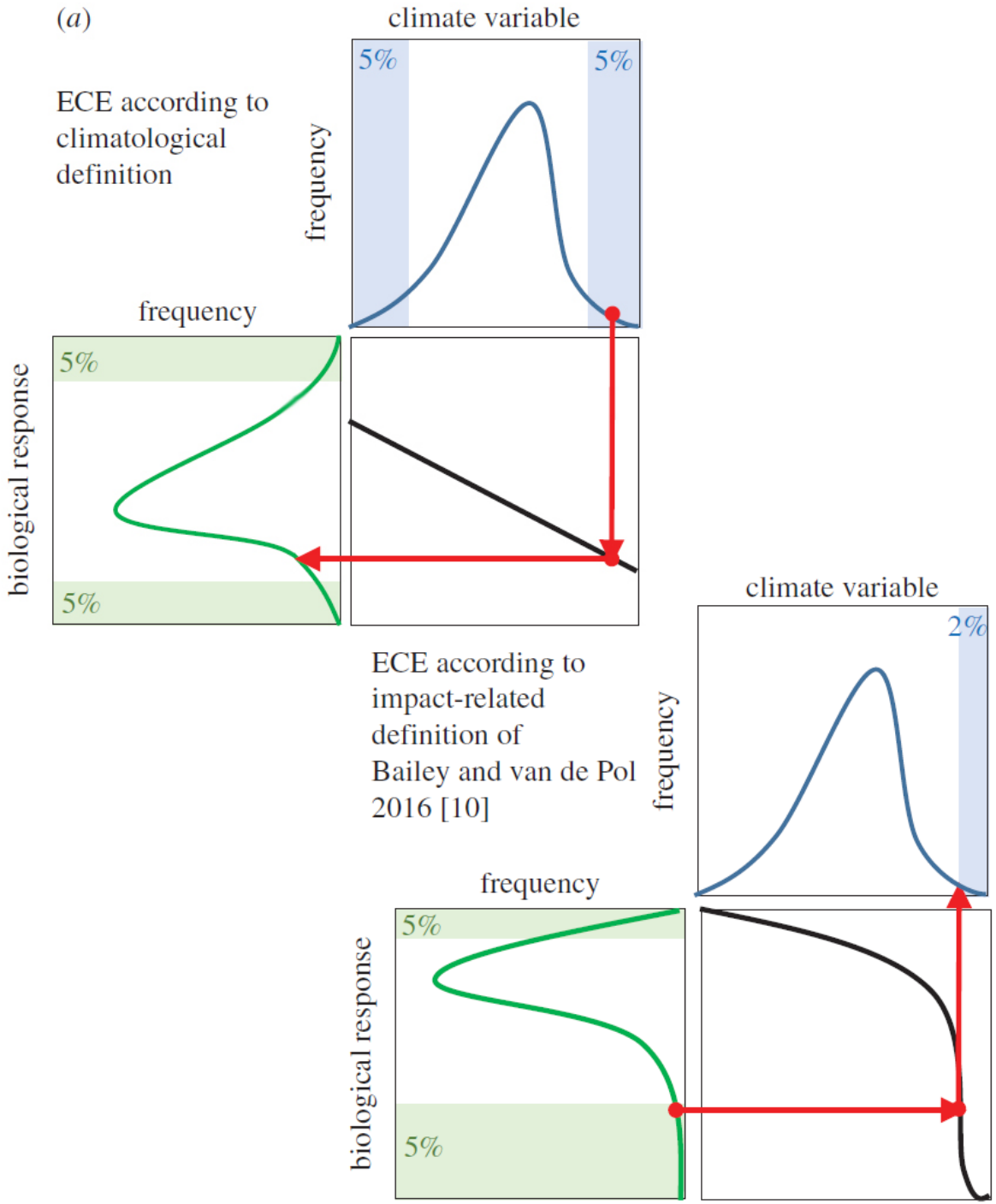
Temperature

Precipitation

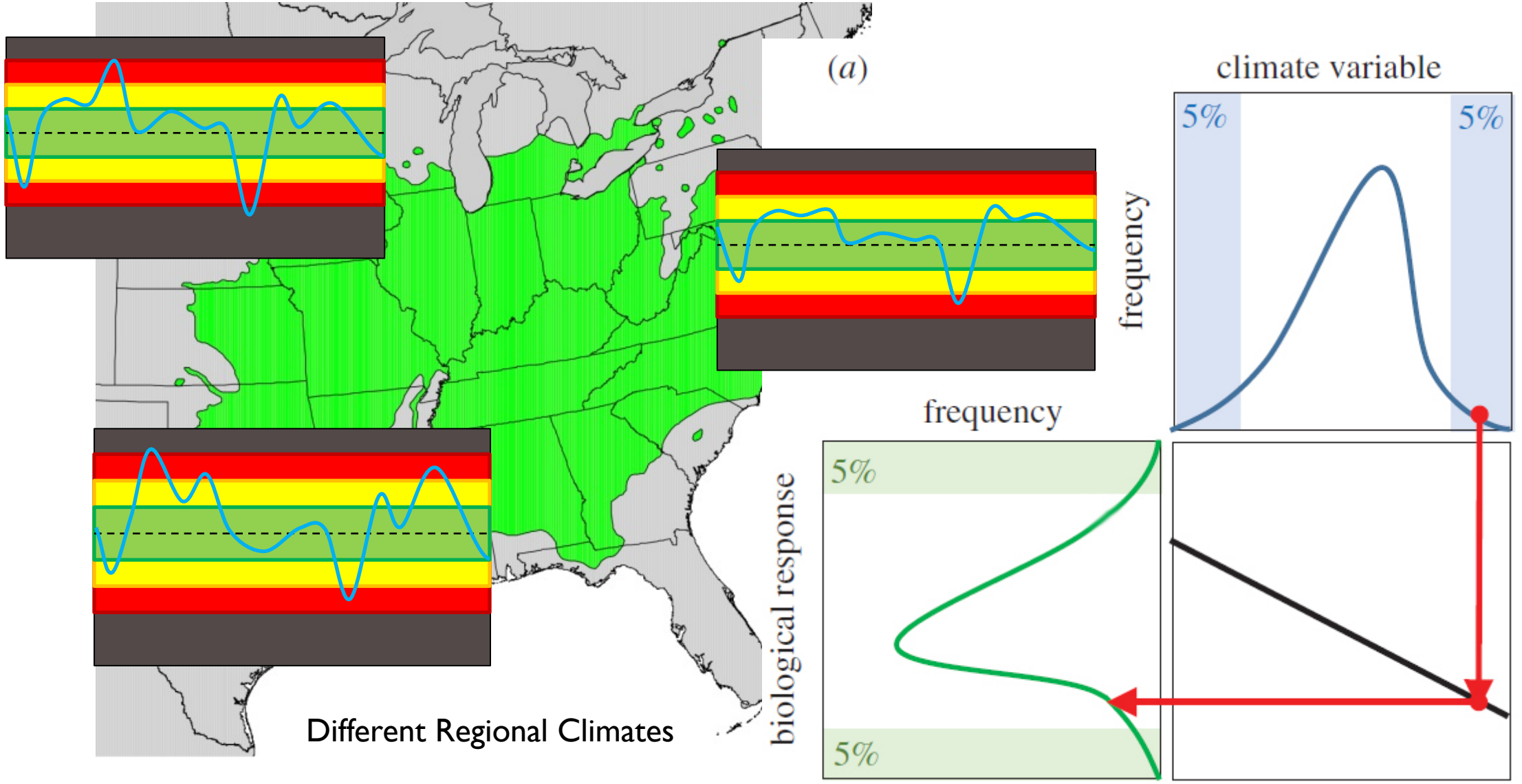
Catastrophes are game-changers



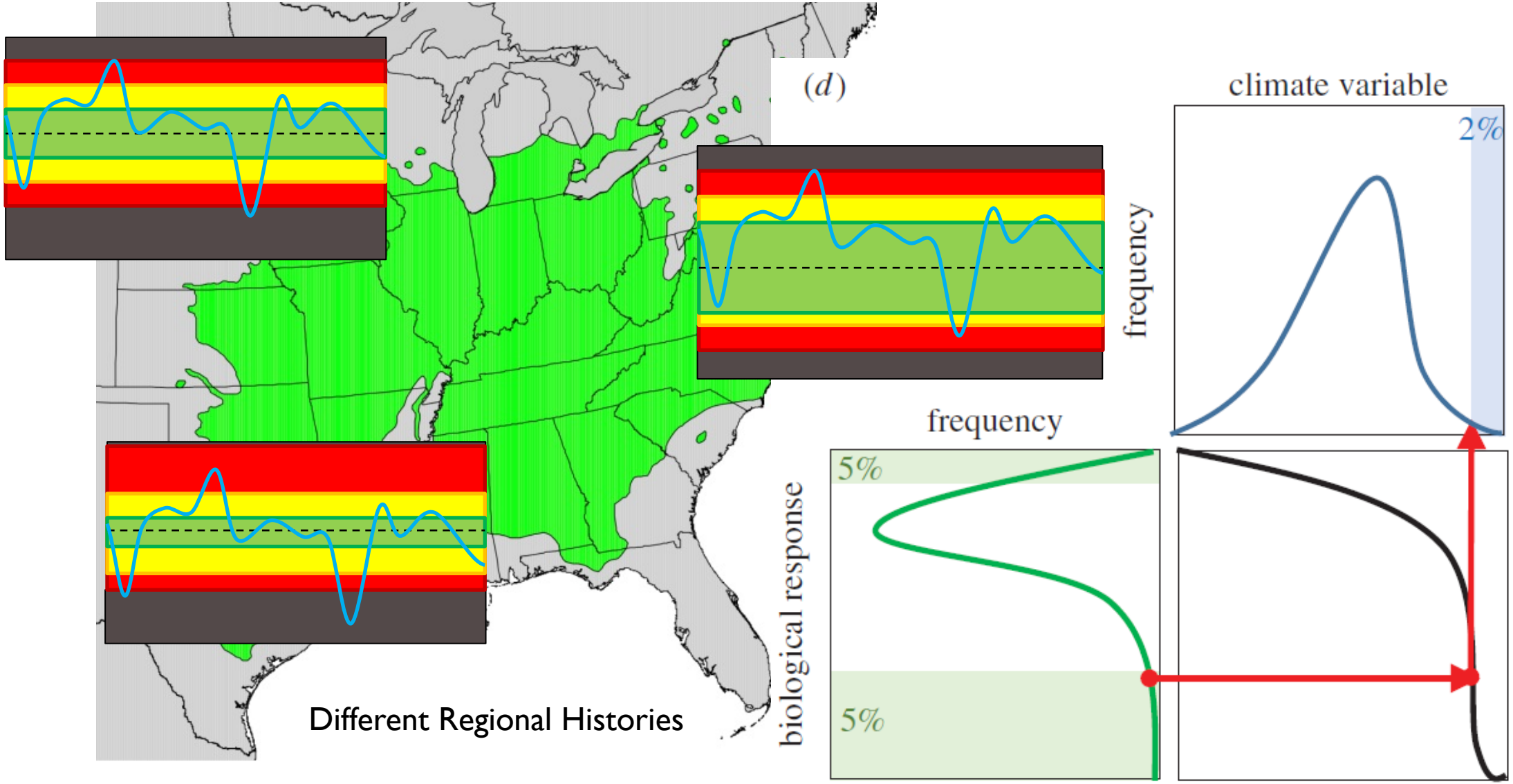
What is an extreme climatic event (ECE)?



Defining "extreme" *climatologically*



Defining "extreme" by *Impact*



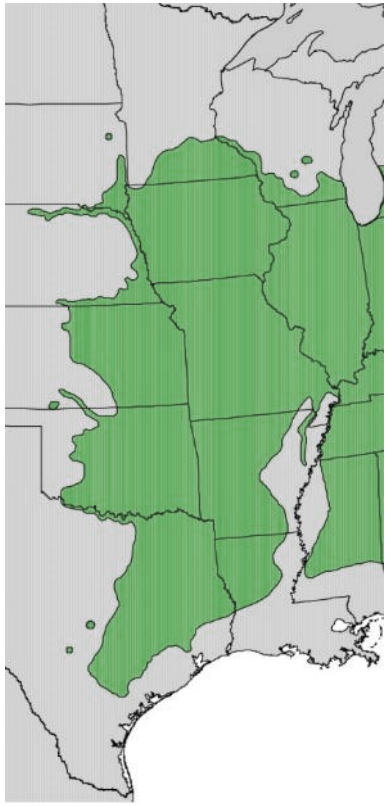
Understanding Severe Weather Ecology Impacts

1. How do we study such locally-unpredictable and transient events?

2. What can managers do to prevent and mitigate impacts?

Weather Ecology at Scales

How do patterns of climate relate to patterns of impact?



Spatial

- Interact with landscape & habitat variables
  - Non-linear thresholds
- Feedback with vegetation
- Connectivity impacts

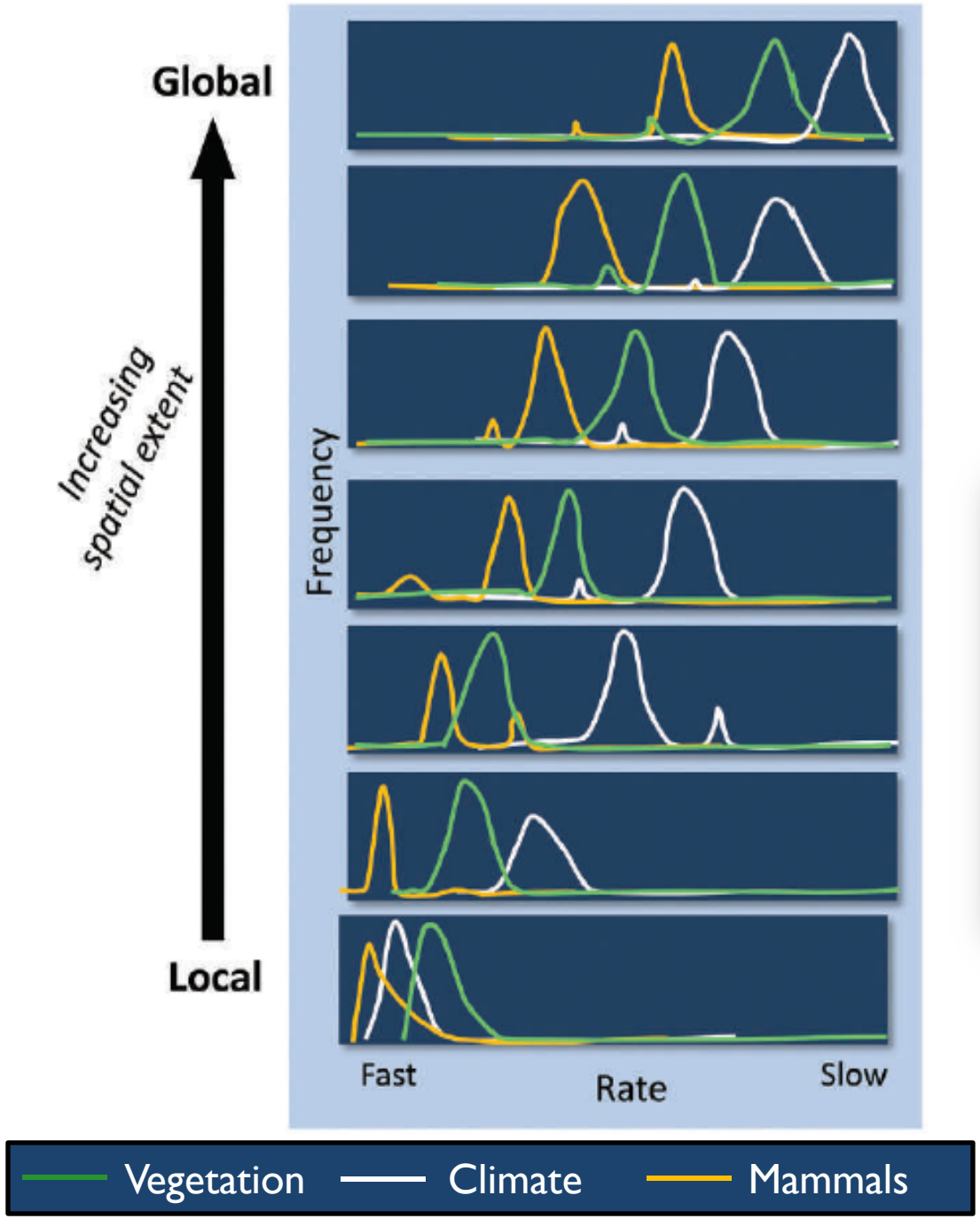
- **Mechanistic**

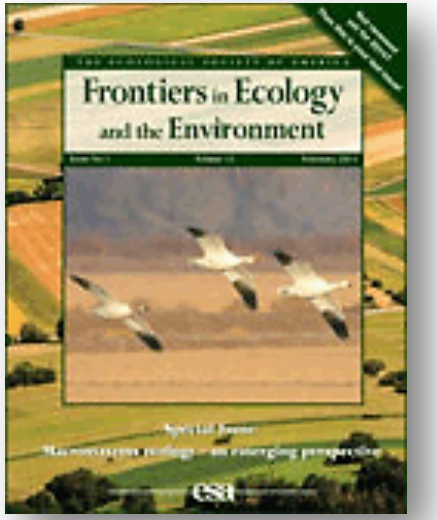
Temporal

- Limit species & habitat occupancy
- Non-independence of events (severity of impact depends upon prior events)

- **Dynamic**

Weather Ecology at Scales





Heffernan et al. 2014. *Frontiers in Ecology and the Environment* **12**:5-14

Attributing Impacts at Short & Local Scales

- Studies of **disaster** impacts limited by:
  - After-the-fact data collection
  - Site access constraints
  - Unreplicable
  - Confounding covariates (e.g., debris, scavenging)
  - Non-randomization
  - Risks of pseudoreplication

Accidental Ecological Impacts: Methodological Approaches

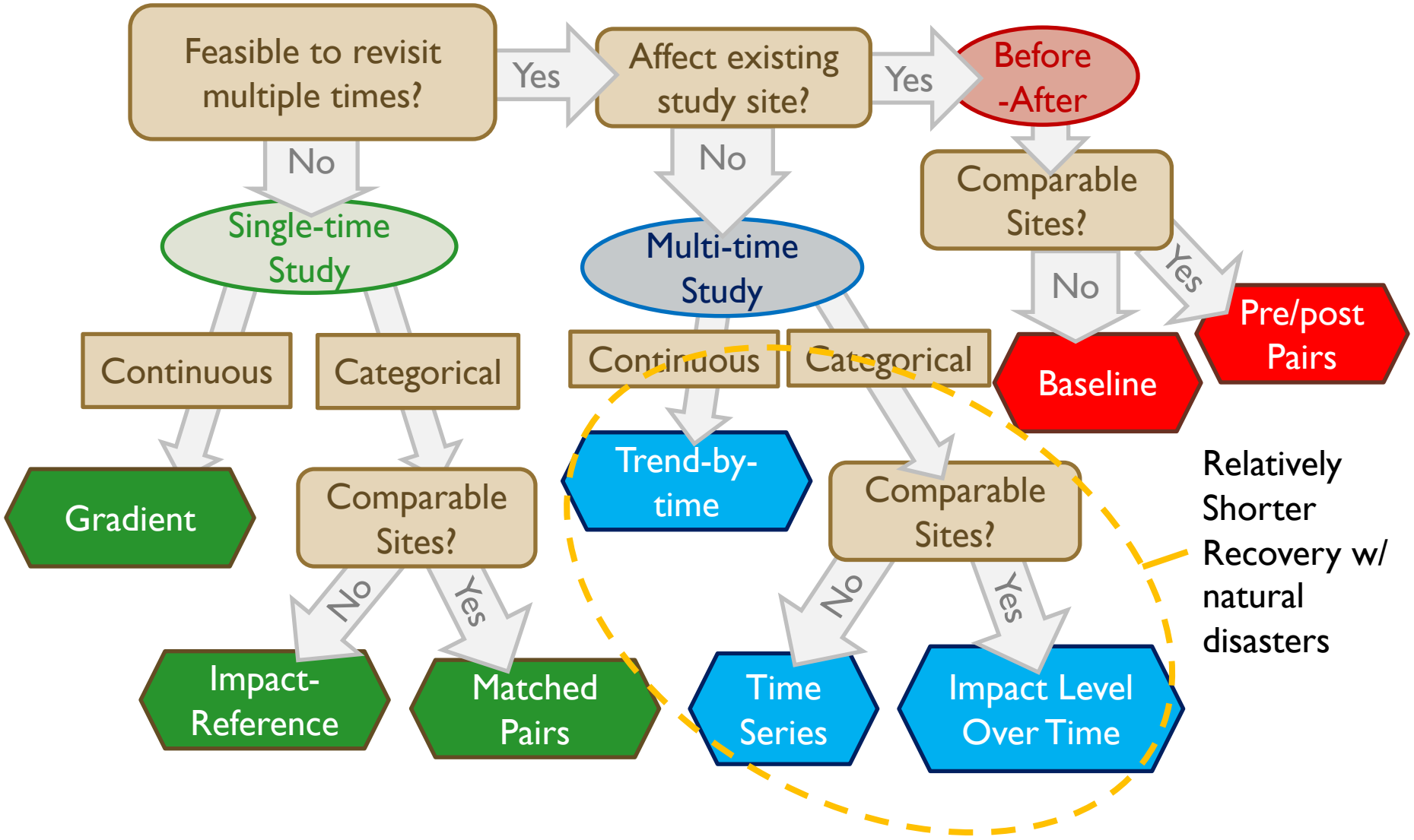
Analyzing the Effects of Accidental Environmental Impacts: Approaches and Assumptions

John A. Wiens; Keith R. Parker

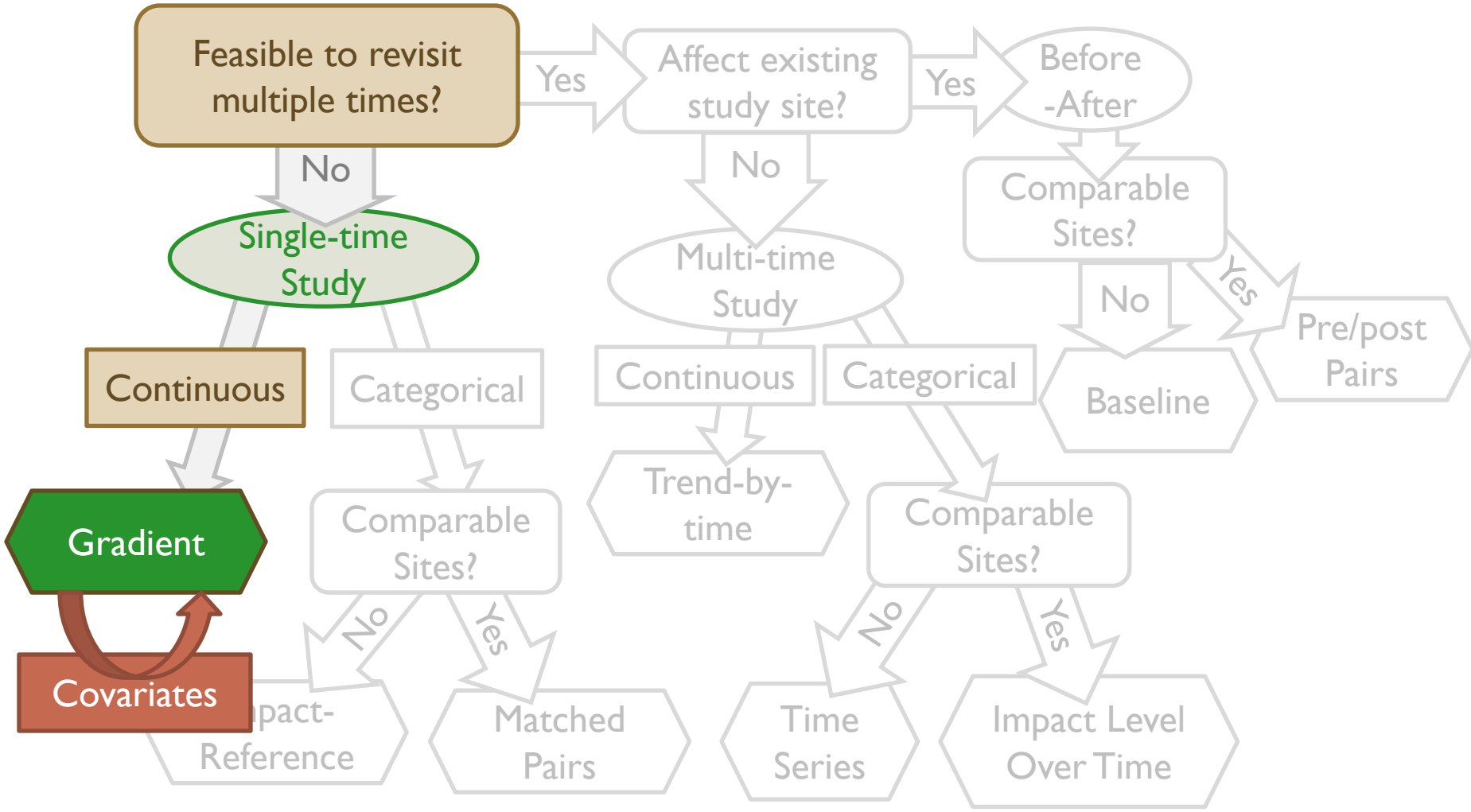
Ecological Applications, Vol. 5, No. 4 (Nov., 1995), 1069-1083.

Study design		Assessment of		Exposure variable		Reference	
		Initial impact	Recovery process	Categorical	Continuous	Spatial	Temporal
Before–after	Baseline	×		×			×
	Pre/post pairs	×		×		×	×
Single-time	Impact–reference	×		×		×	
	Matched-pairs	×		×		×	
	Gradient	×			×	×	
Multiple-time	Time-series	×	×	×			×
	Level-by-time	×	×	×		×	×
	Trend-by-time	×	×		×	×	×

Post-event Methods Flowchart

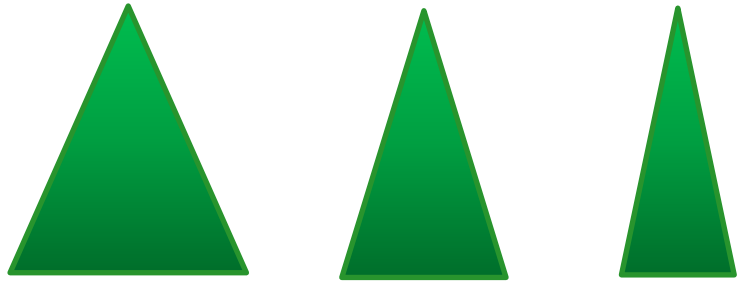


Post-event Methods Flowchart



Individual Effects of Severe Weather

Tree form
- taper
- density
- crown shape
- rooting depth



Courtesy of H. McCarthy

Flexibility vs. strength

Individual Effects of Severe Weather

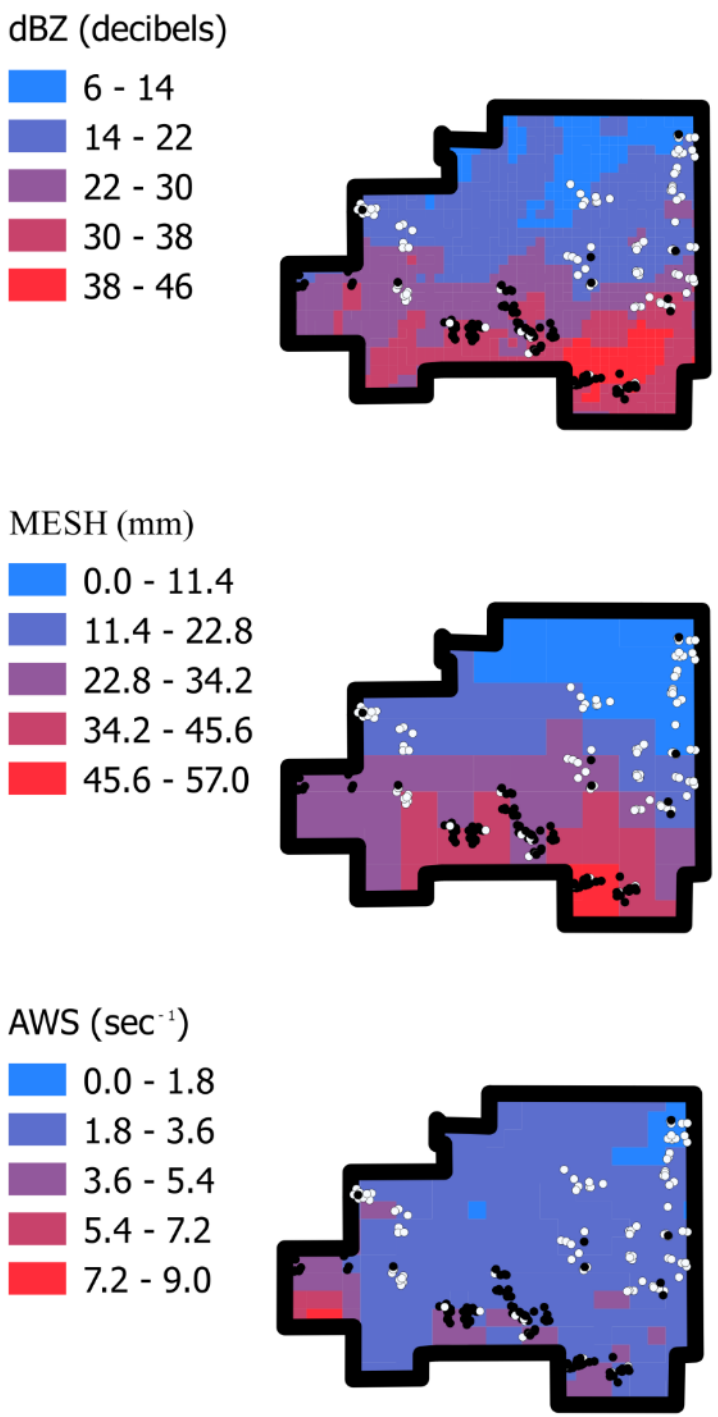
Post-event reports of animals …

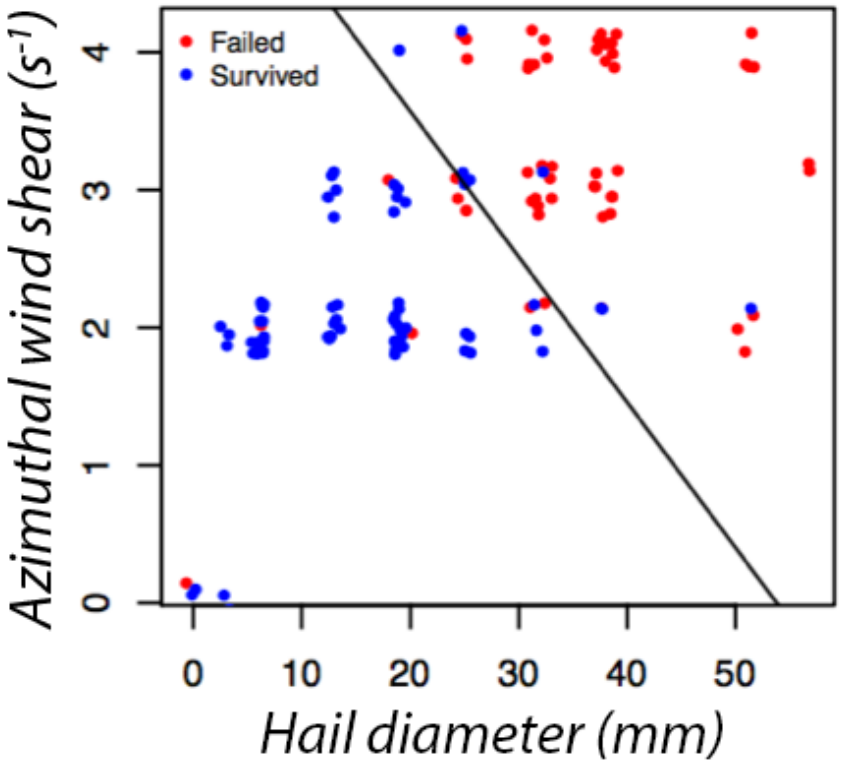
- Taxed
- Injured
- Lost nests
- Killed

Severe Weather Exposure

- Can occur throughout life-cycle
- Potentially high-risk periods
  - Nesting
    - e.g., hailstorm impacts on grassland birds

High Plains Hailstorm 6/22/14





Carver et al. (in prep)

Journal of Wildlife Management 75(2):458–462; 2011; DOI: 10.1002/jwmg.56

Note

Effect of Great-Horned Owl Trapping on Chick Survival in Piping Plovers

DANIEL H. CATLIN,[1] *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA*
JOY H. FELIO, *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA*
JAMES D. FRASER, *Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, USA*

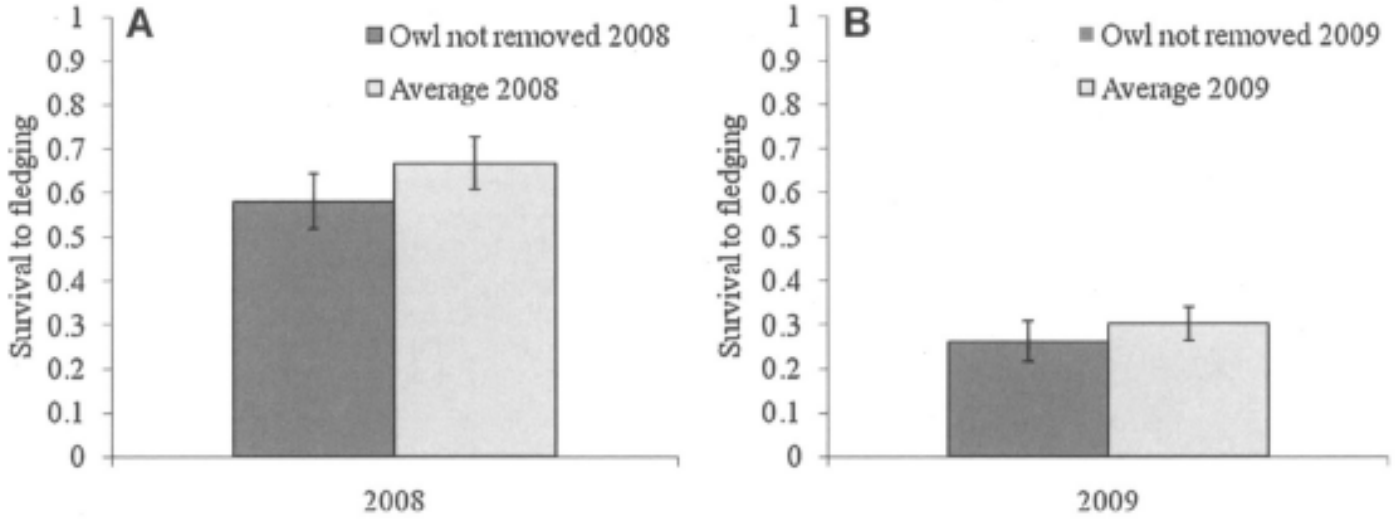


Figure 2. Probability of survival to fledging (approx. 25 days) of piping plover chicks on the Missouri River with average owl removal and without owl removal in (A) 2008 and (B) 2009. We calculated these values for the mean hatch date for a given year. Error bars represent 1 standard error.

2007). There were several hailstorms during the 2009 breeding season that affected our study site, potentially contributing to the differences between 2008 and 2009. In addition,

Severe Weather Exposure

- Can occur throughout life-cycle
- Potentially high-risk periods
  - Nesting
  - Molting
  - Migratory stopover

Stopover Hotspot – Great Salt Lake

Minimum count of 7,370 Red-necked Phalarope (*Phalaropus lobatus)* 3-days after hailstorm

Photos: John Neill, Utah DWR

Severe Weather Exposure

- Can occur throughout life-cycle
- Potentially high-risk periods
  - Nesting
  - Molting
  - Migratory stopover
  - Roosting or other aggregations

Increasing recognition of the importance of winter extremes for bird populations

Diversity and Distributions

A Journal of Conservation Biogeography

Biodiversity Research

Recent population declines in Afro-Palaearctic migratory birds: the influence of breeding and non-breeding seasons

Catriona A. Morrison, Robert A. Robinson, Jacquie A. Clark, Kate Risely, Jennifer A. Gill

nature COMMUNICATIONS

ARTICLE

Received 2 Sep 2016 | Accepted 1 Feb 2017 | Published 20 Mar 2017

DOI: 10.1038/ncomms14812 OPEN

Winter temperatures limit population growth rate of a migratory songbird

Bradley K. Woodworth[1], Nathaniel T. Wheelwright[2], Amy E. Newman[1], Michael Schaub[3] & D. Ryan Norris[1]

Journal of Field Ornit

Original Article

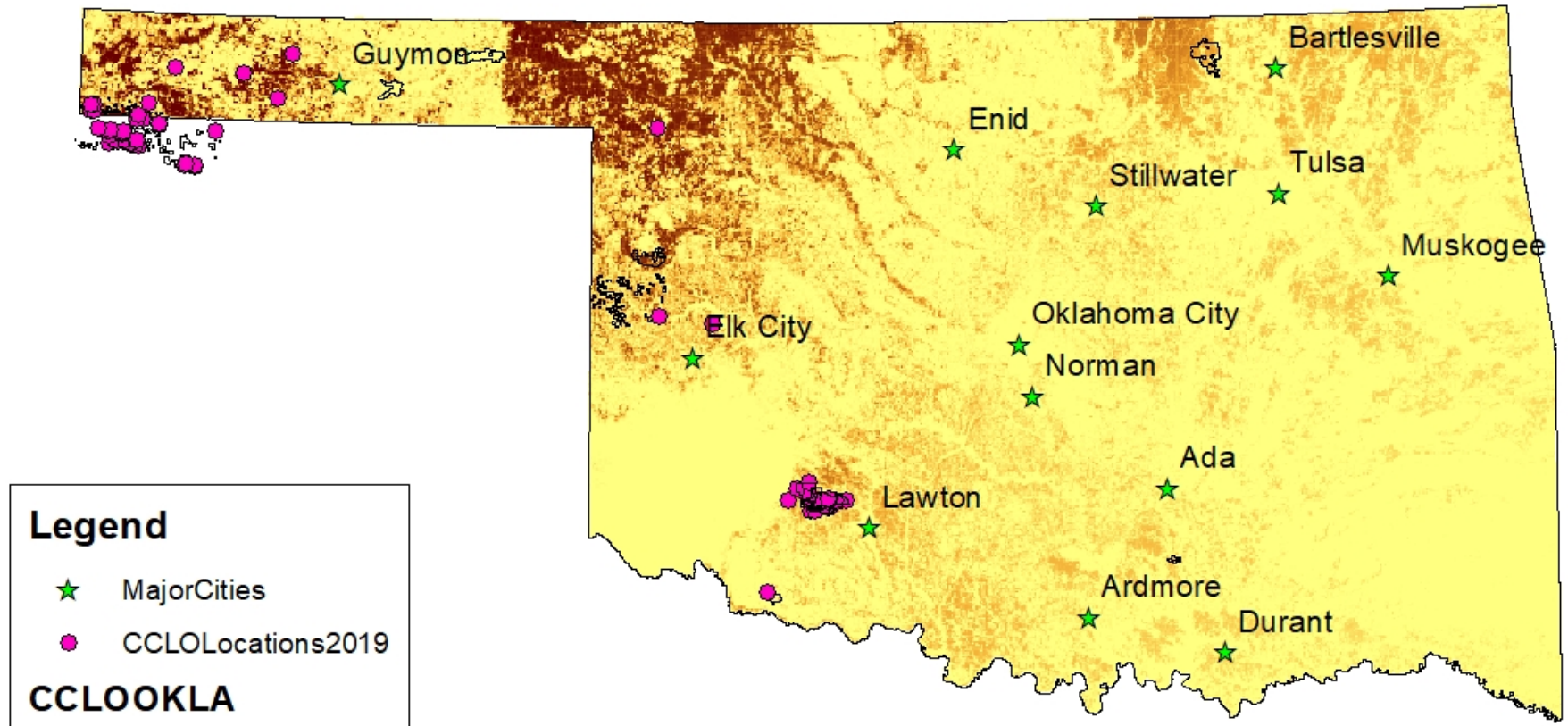
Winter survival of North American grassland birds is driven by weather and grassland condition in the Chihuahuan Desert

Alberto Macías-Duarte, Arvind O. Panjabi, Erin H. Strasser, Greg J. Levandoski, Irene Ruvalcaba-Ortega, Paul F. Doherty, Carmen I. Ortega-Rosas

Chestnut-collared Longspur

- 89% decline since 1960's
- Oklahoma at heart of winter distribution

Chestnut-collared Longspur Distribution in Oklahoma

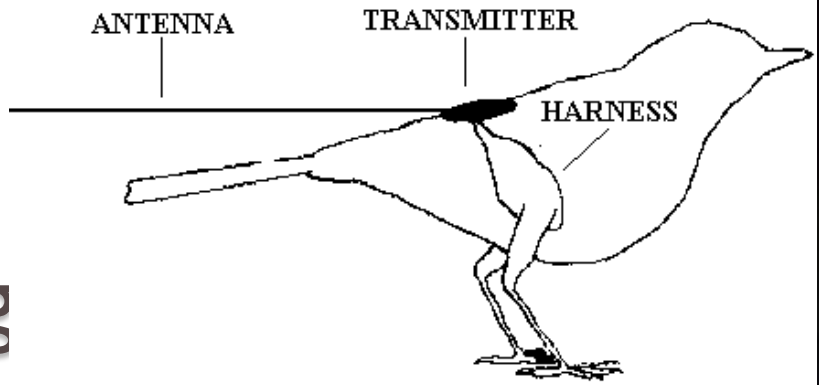


Chestnut-collared Longspur Habitat

Smith's
Longspur Habitat

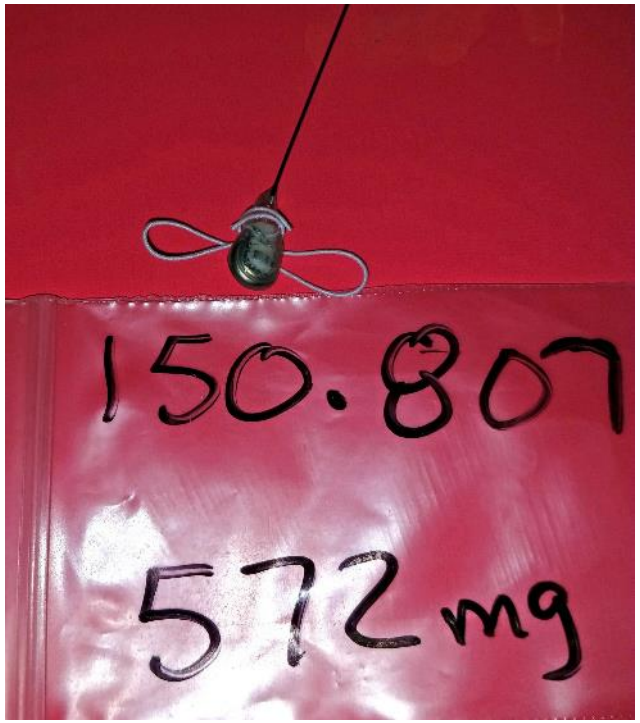
Not Longspur Habitat

VHF Radio Tracking

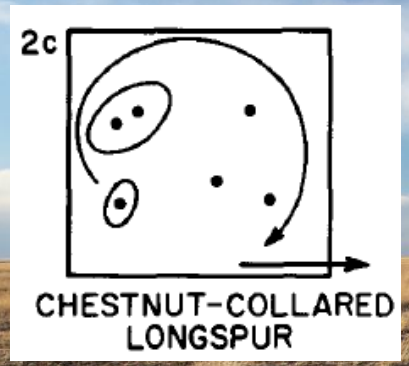


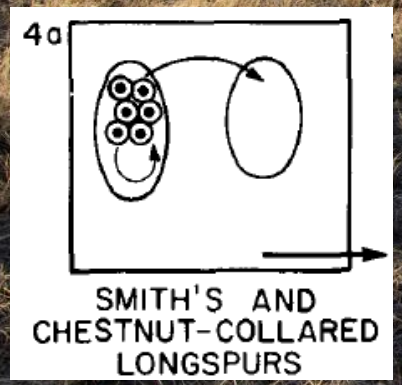
Individual movements:

- Around home range
- Among habitats
- In association with other marked birds
- Changes with weather or progress of season



Longspur flocking behaviors





Solitary, wandering movements

Wilson Bull., 95(4), 1983, pp. 591–602

PATTERNS OF SPACE USE IN GRASSLAND BIRD COMMUNITIES DURING WINTER

JOSEPH A. GRZYBOWSKI

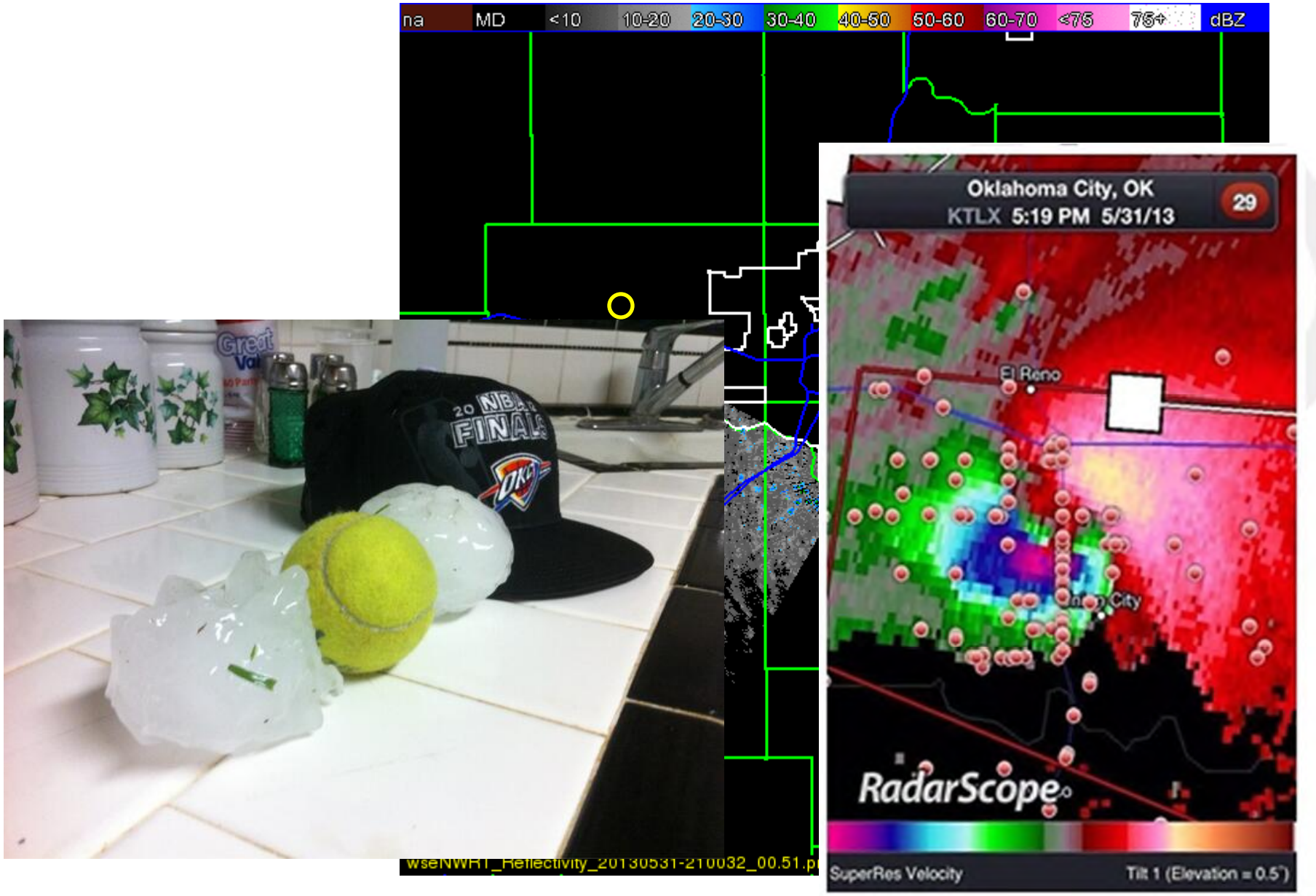
Gregarious, resource tracking

Depends on resource needs, availability, and risks of accessing

Severe Weather Exposure

- Can occur throughout life-cycle
- Potentially high-risk periods
- Sub-lethal impacts
  - Developmental

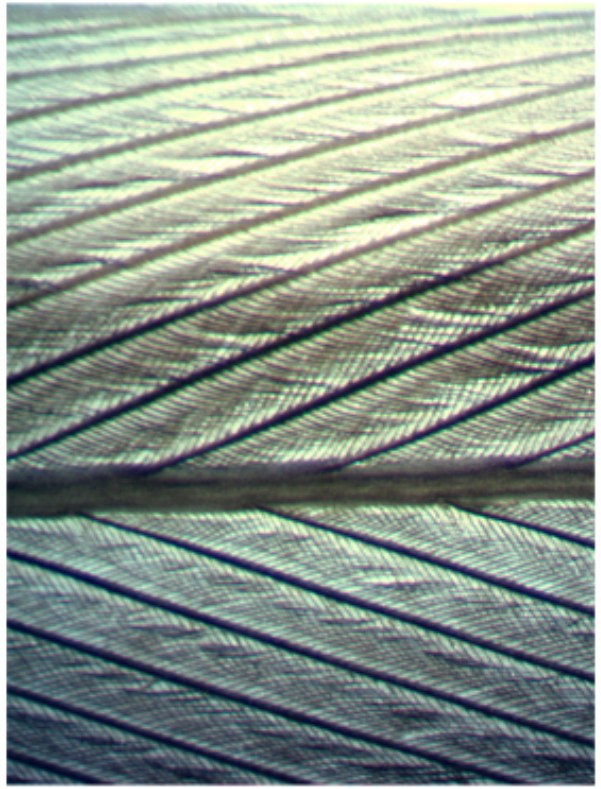
May 31, 2013 El Reno Severe Storm



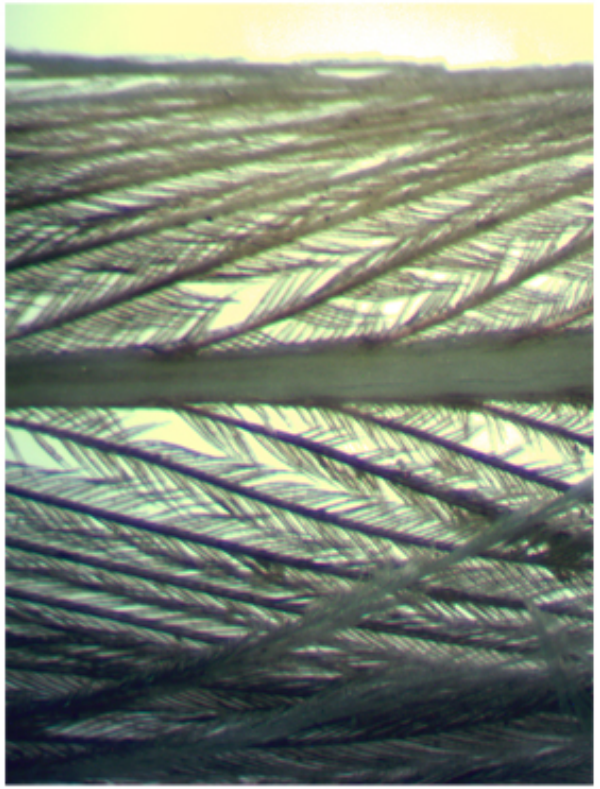
Prevalence of Fault Bars in GRSP-HY

- Fault bars found in 12 of 18 (66.7%) juvenile Grasshopper Sparrows captured in same field
- Nearly double the highest prevalence rate previously reported for any bird species (38.5%; Møller et al. 2009)

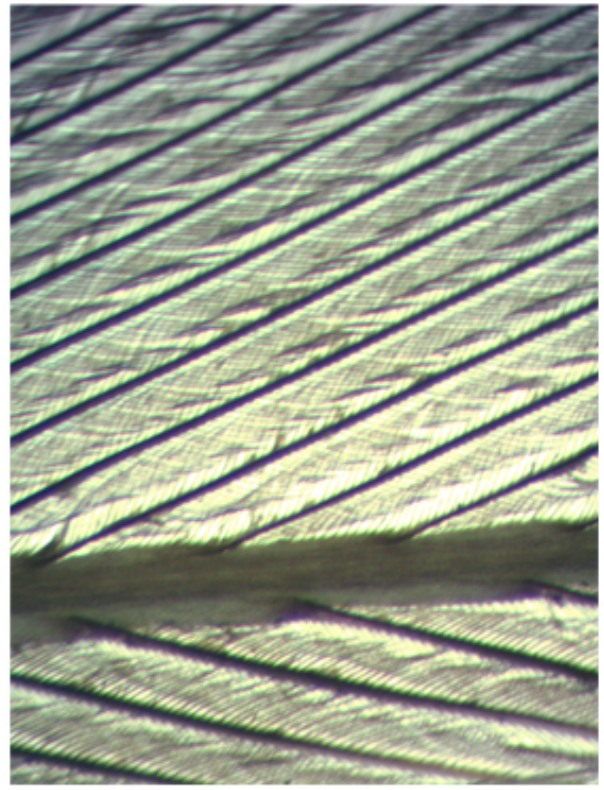
Feather Structure in Fault Bars



Fresh Rectrix

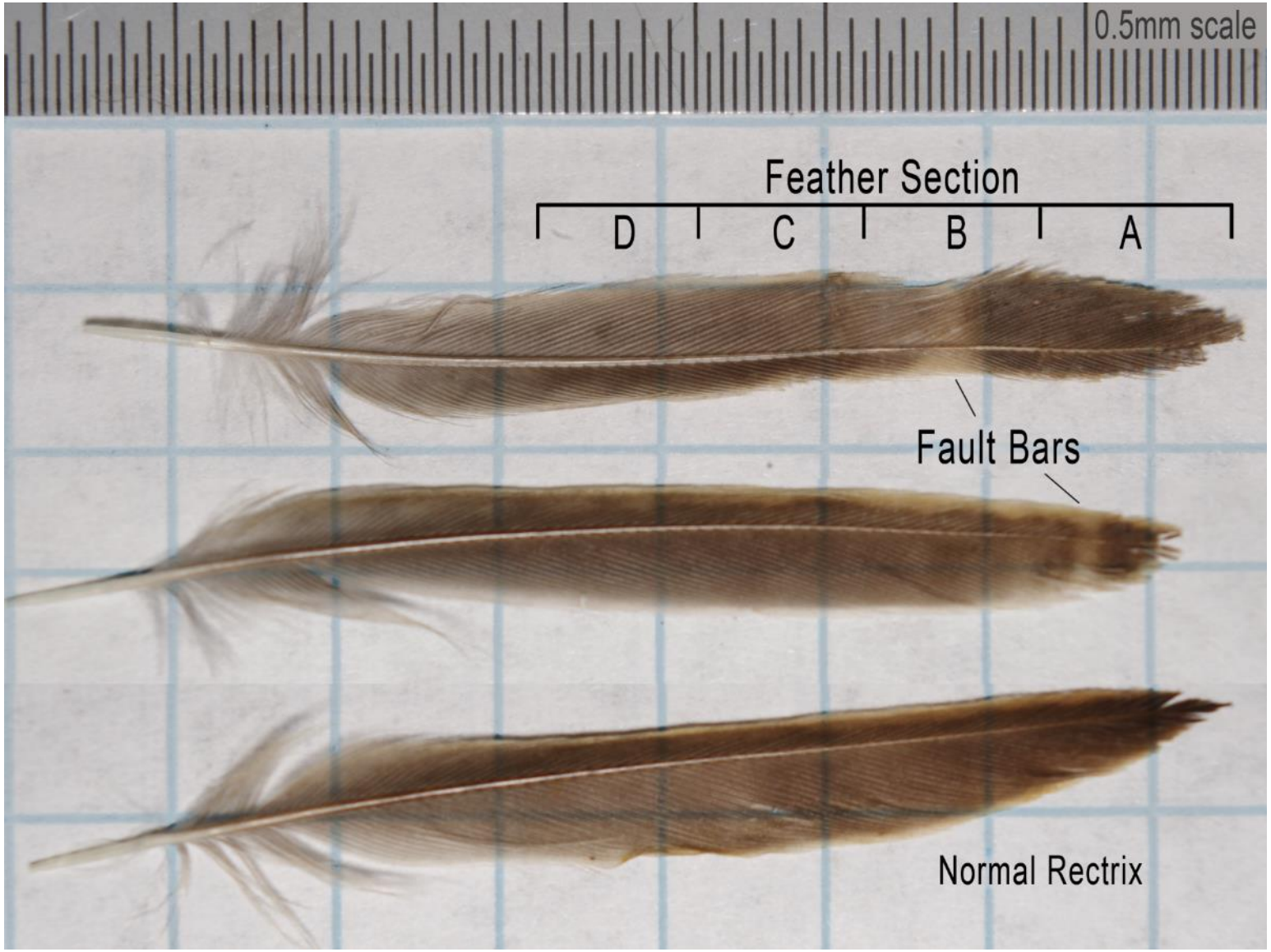


Fault Bar



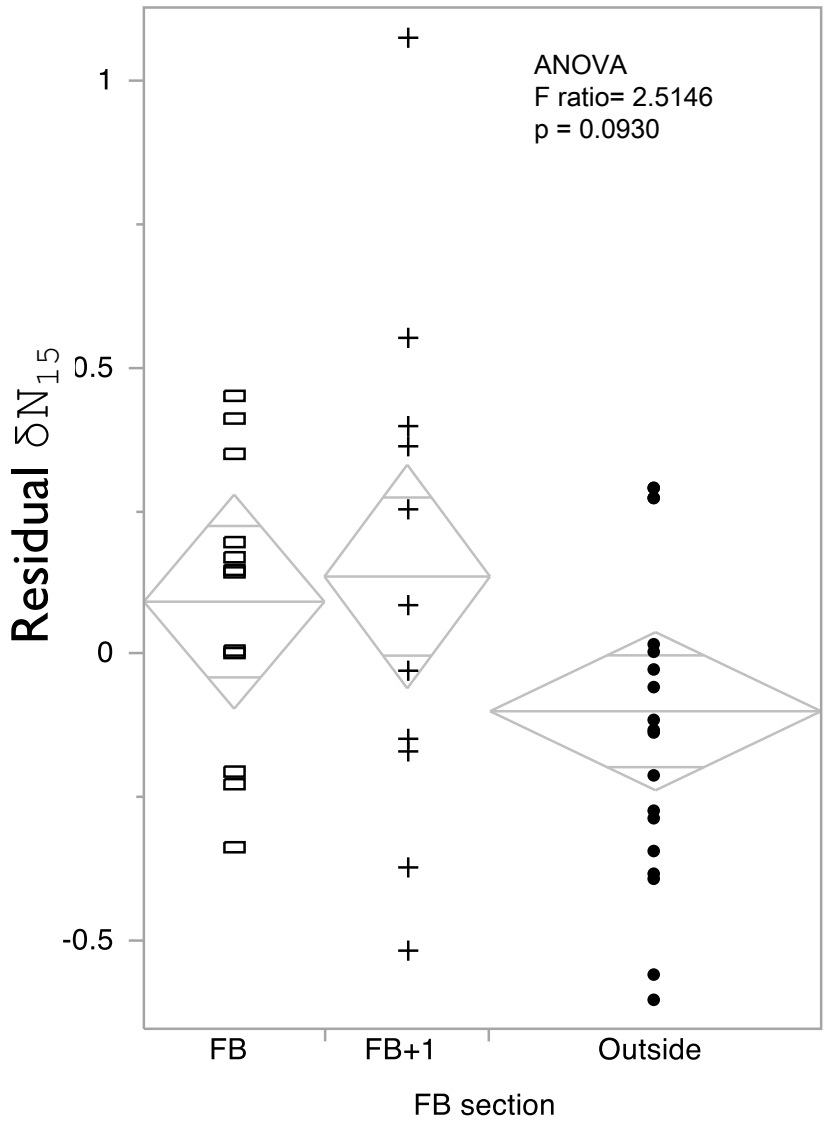
Old Rectrix (no FB)

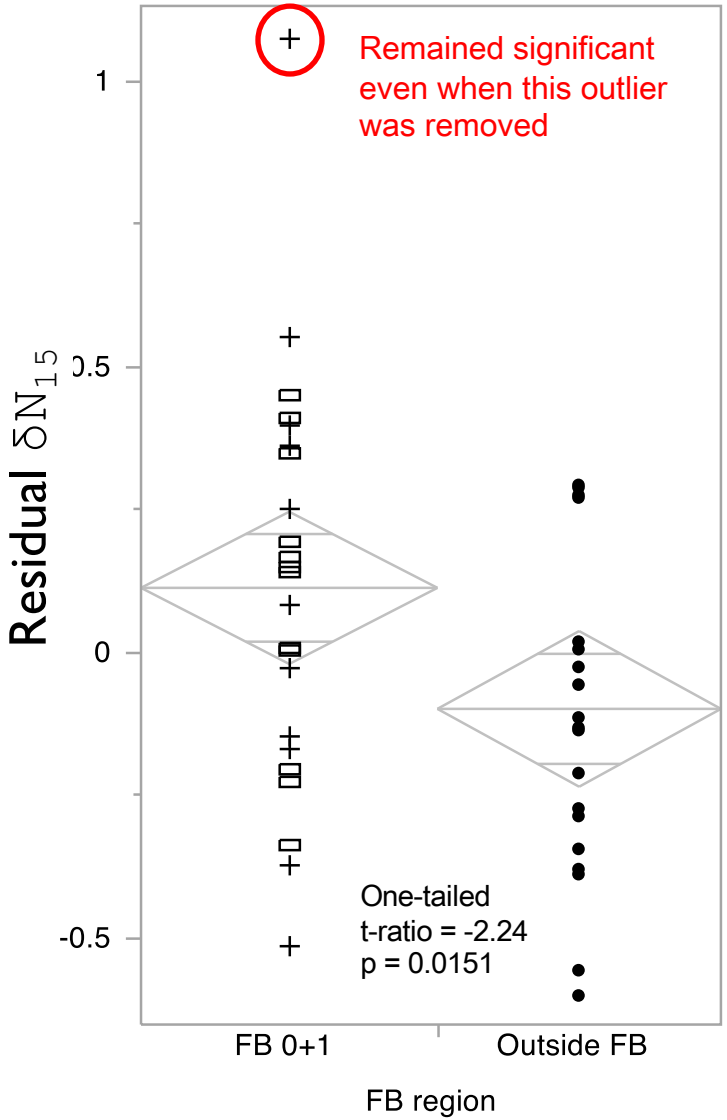
Section Analysis of Feather Stable Isotopes



Sections 0.25-0.40mg each

Corrected δN_{15} within FB Feathers





Severe Weather Exposure

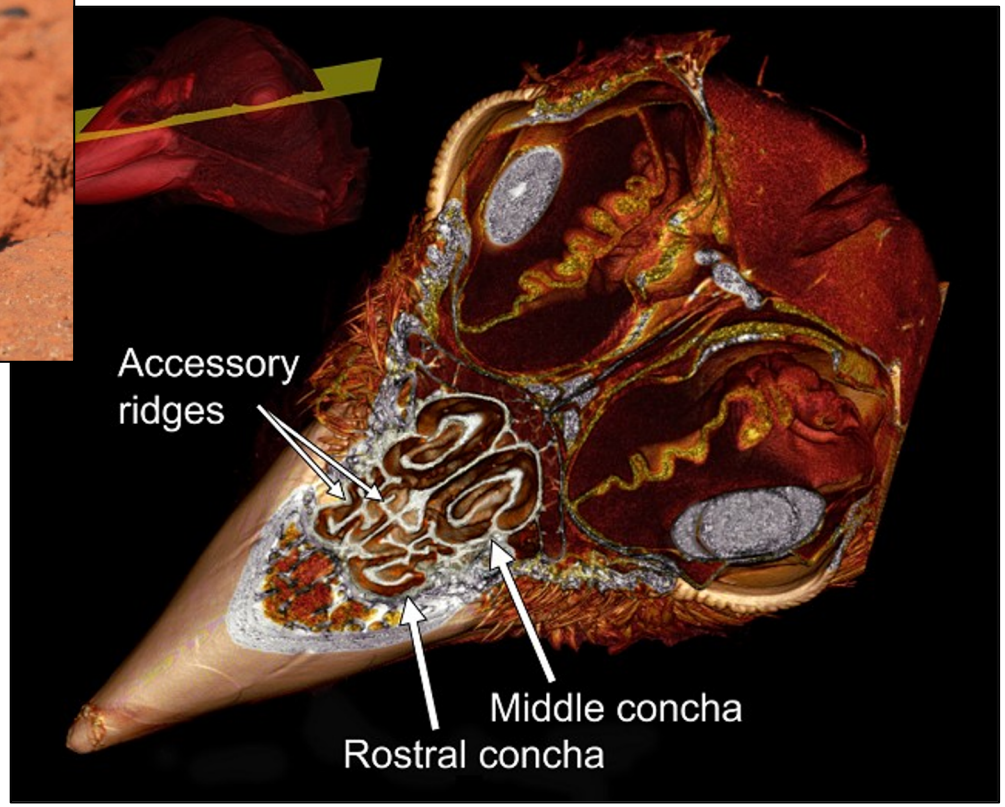
- Can occur throughout life-cycle
- Potentially high-risk periods
- Sub-lethal impacts
  - Developmental
  - Behavioral

Avian adaptations to increasing aridity

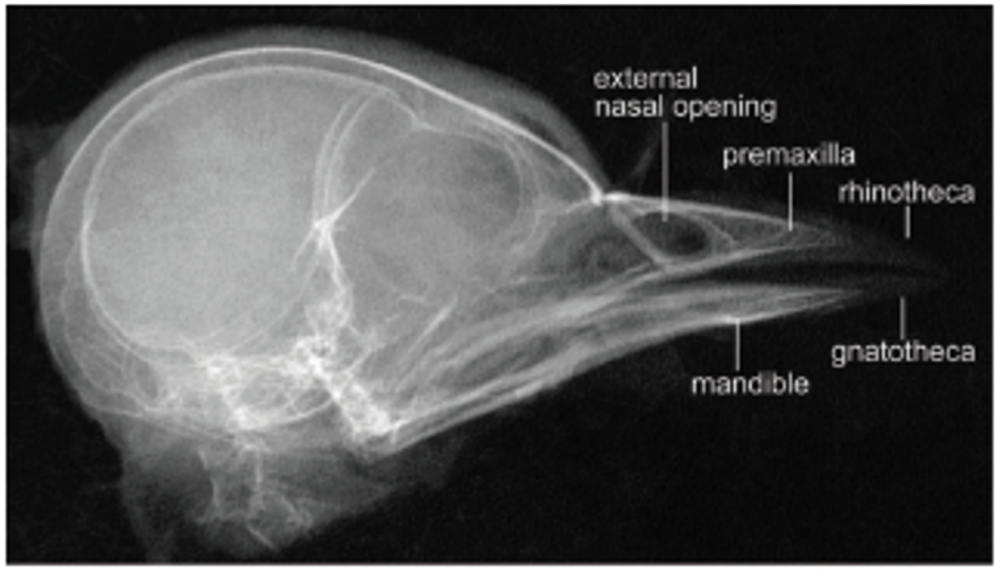
Panting and shade use

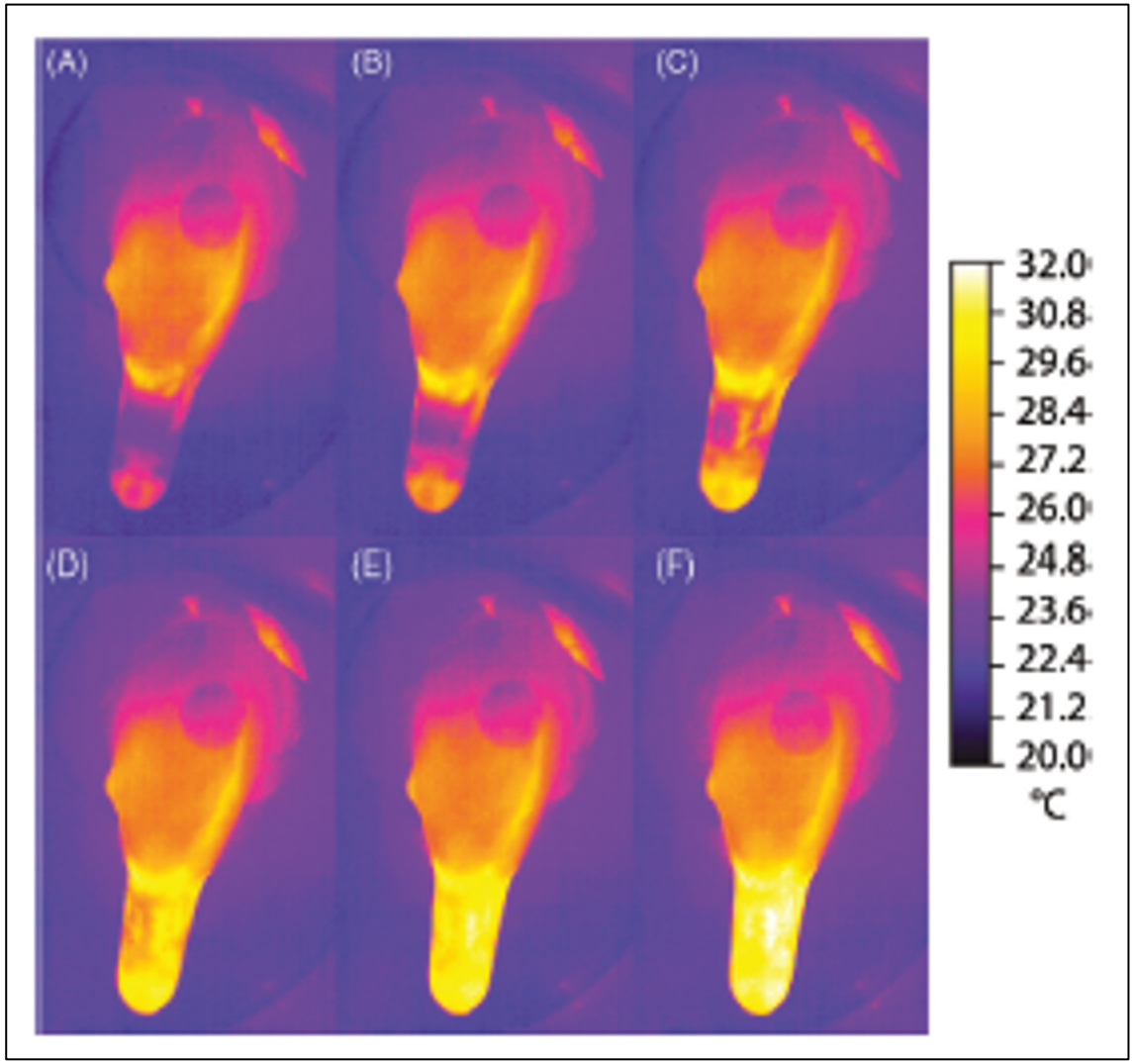
Radiative heat loss

Larger beaks with vascularization



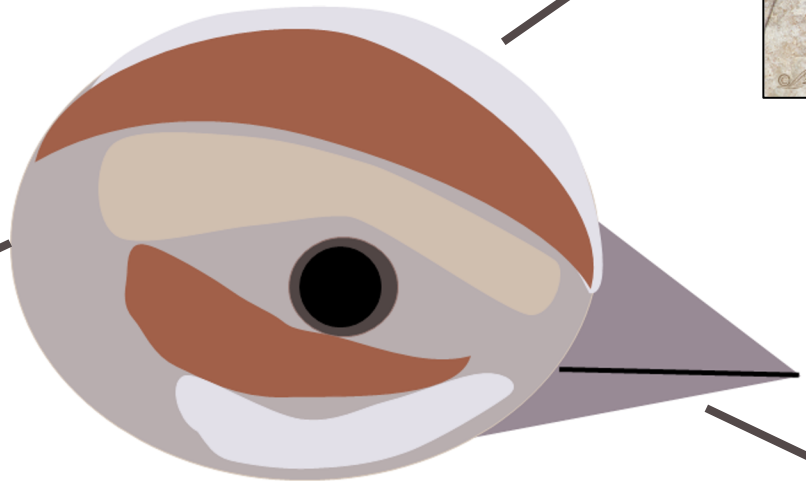
Beak morphology and thermoregulation (Tattersal et al. 2017)



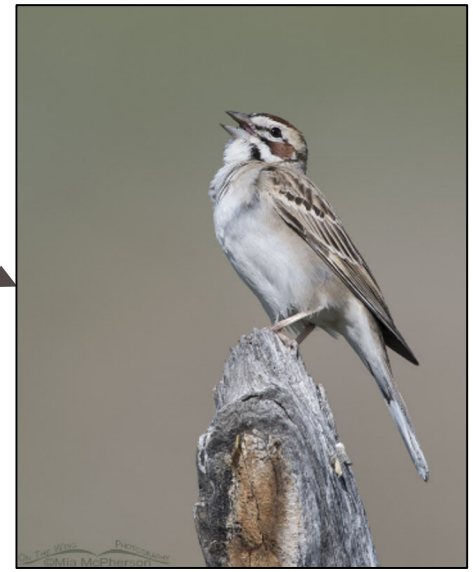


The beak is a multi-tool!

Thermoregulation



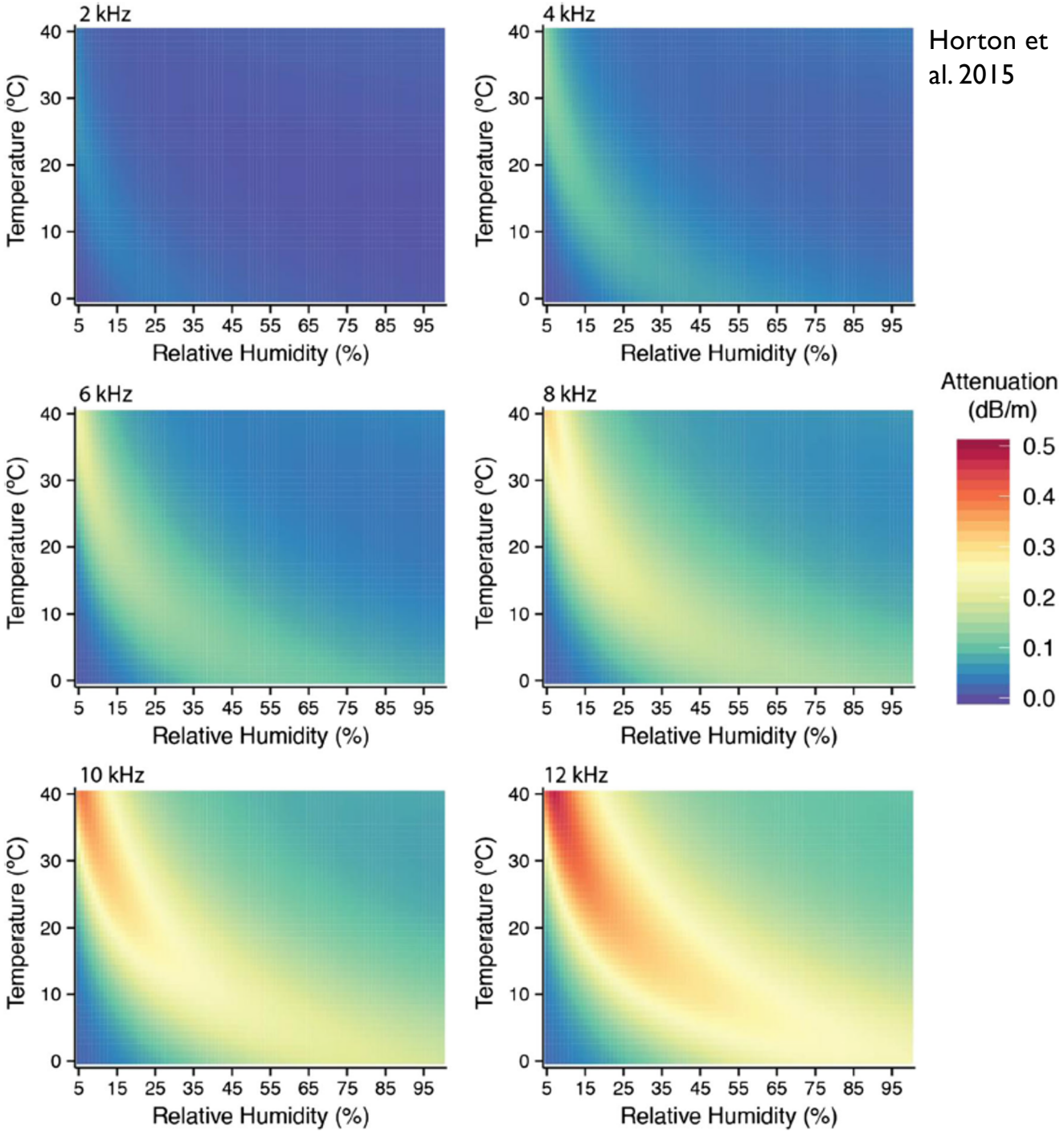
Foraging



Singing

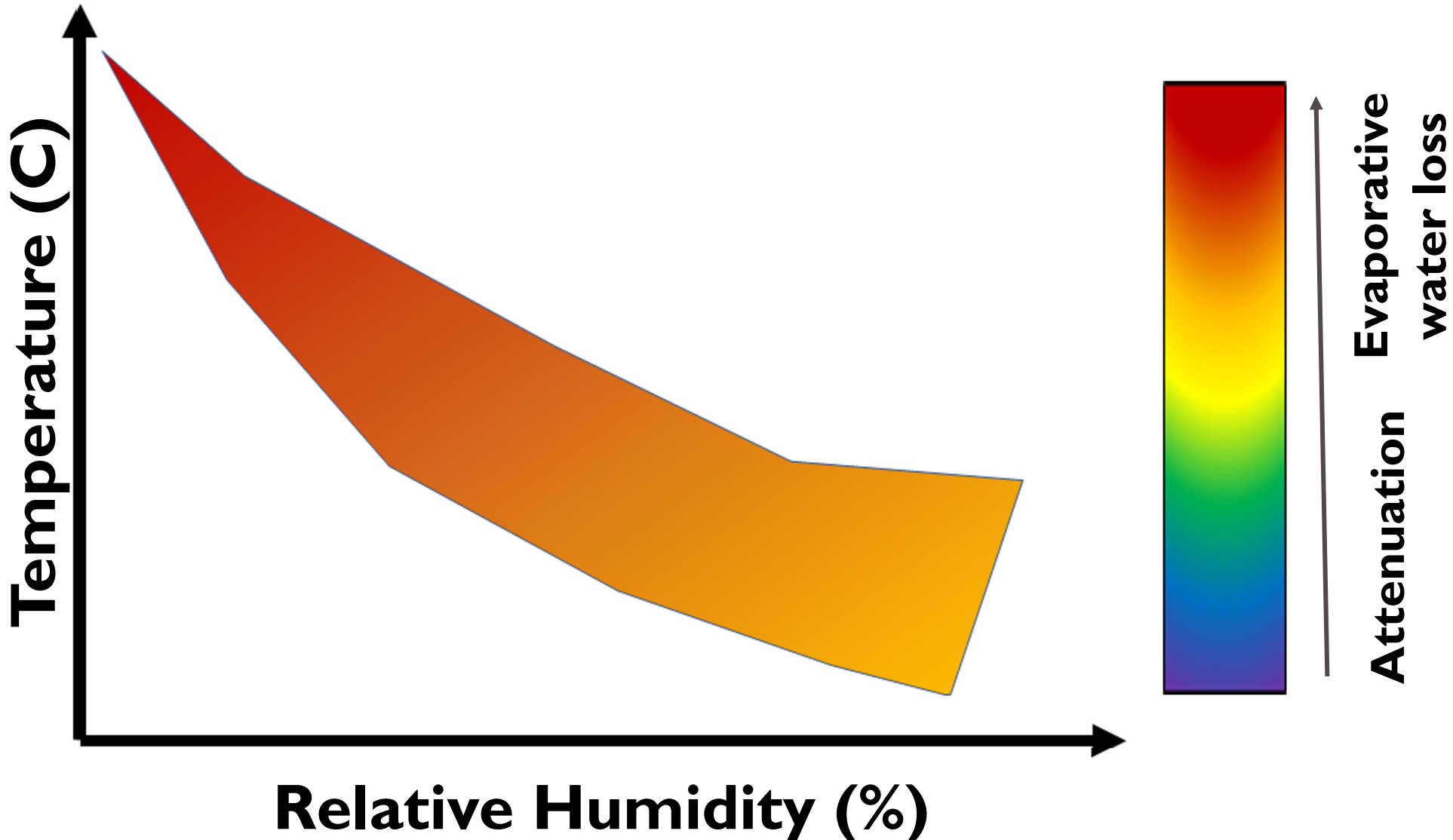
Bird song in arid environments

- High pitch songs attenuate at hot and dry environments (Horton et al. 2015)
- Singing more costly due to evaporative water loss (Ward and Slater 2005)



Horton et al. 2015

More aridity, more water loss, poorer sound transmission



How?

Relate daily song activity to:

- Weather conditions
- Supplemental water use

Impacts (and our ability to detect those) are likely to vary across species and individuals

Depending on:	For example …
◦ Adaptive anatomy or physiology →	Thermal tolerance
◦ Adaptive behaviors →	Escape or shielding behaviors
◦ Habitat usage →	Nest / refugia location
◦ Age & Sex →	Migratory arrival Vulnerable anatomy

Weather Ecology in Management

Why is this important and what can we do about it?

(aka, "so what?")

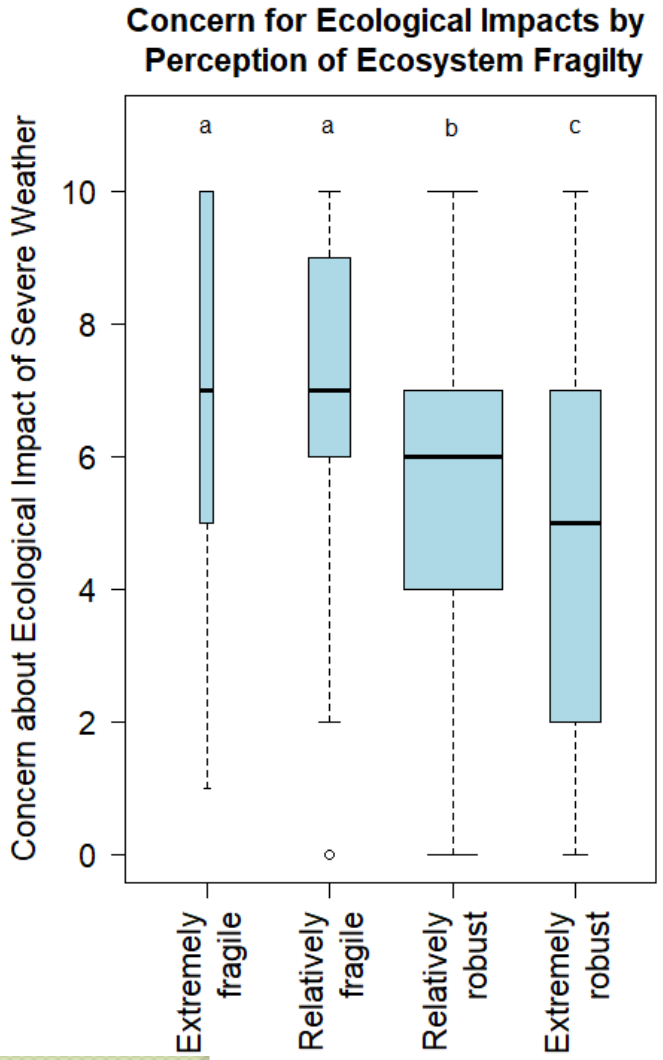
Understanding Resiliency and Recovery Potential of Species and Systems

- Evolutionary predisposition to deal with periodic disasters
  - How has this potentially been undermined by changes in climate regime and land-use?
- Effective mitigative approaches for particularly vulnerable species or processes

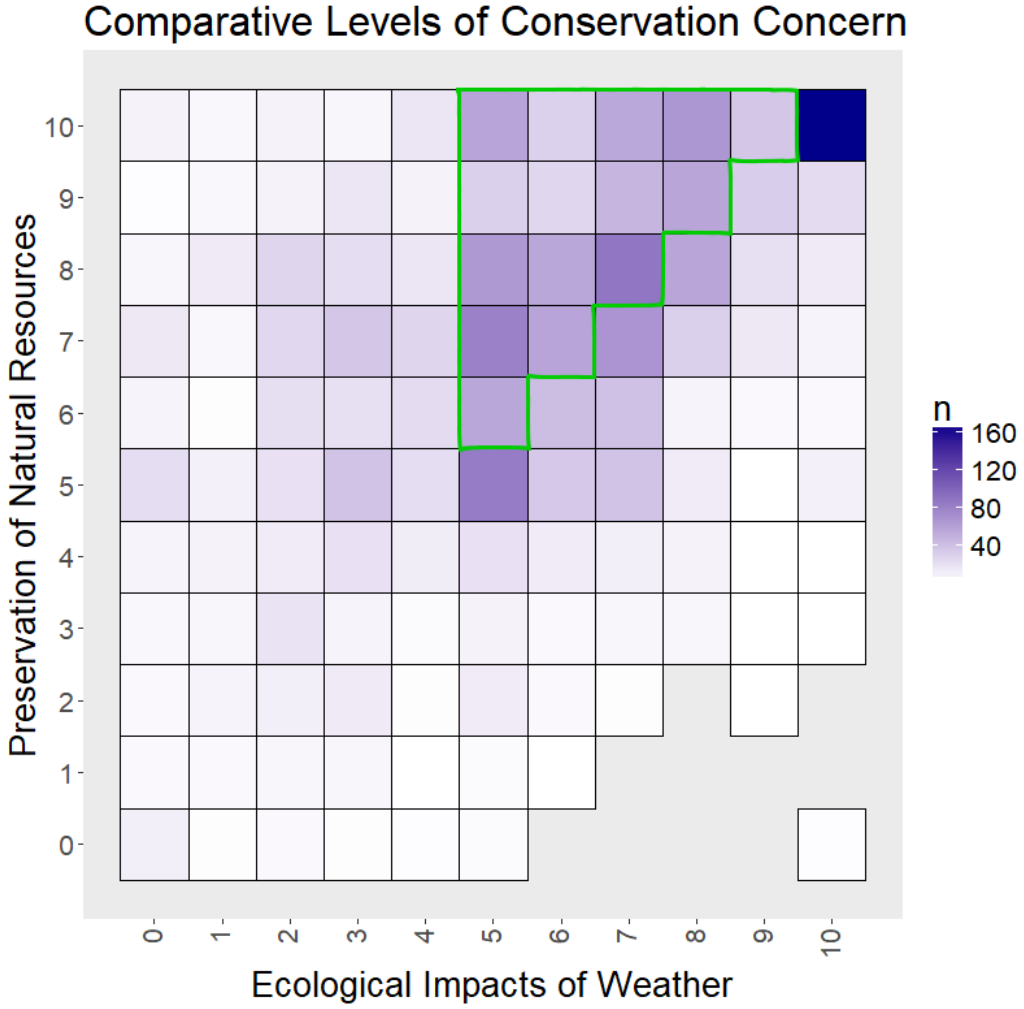
Planning for Resilience and Recovery

- Habitat management must consider all life-history needs of component species
  - More than bedrooms, nurseries, and bathrooms
  - Emergency plans not separate from core mission
- Plan for the catastrophic:
  - How will they escape a disaster and thereafter return?
  - Could elements of the habitat become hazards during an ECE?

Equating mitigation of Severe Weather Impacts to Preservation of Natural Resources



Questions about Oklahoman's concerns about impacts of weather versus preservation of natural resources integrated into the Meso-Scale Integrated Socio-Geographic Network (M-SISNet) quarterly survey



Conclusions

- Individual impacts of severe weather can have broad spatial and temporal impacts, especially within fragmented ecosystems
- Emergency habitats and mitigation actions are important parts of management plans
- An informed public will support you