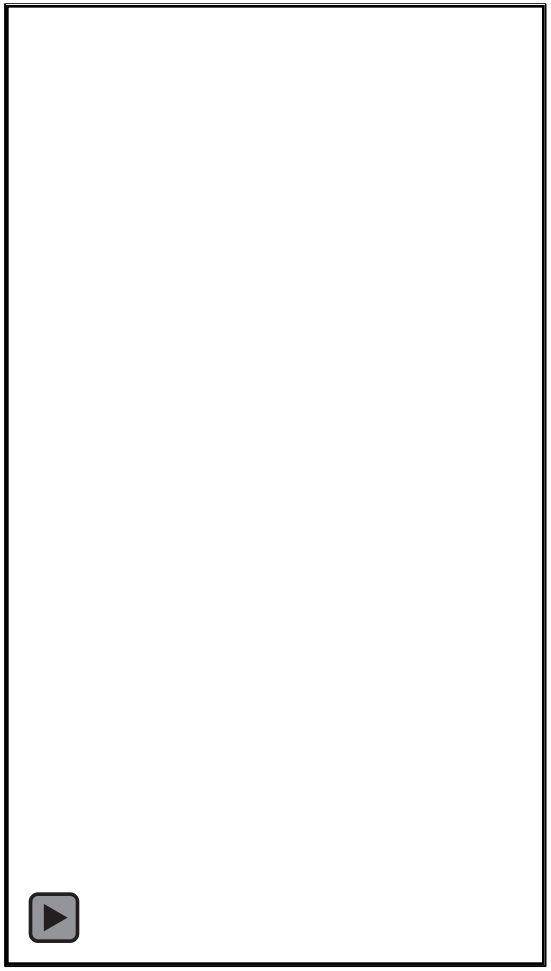
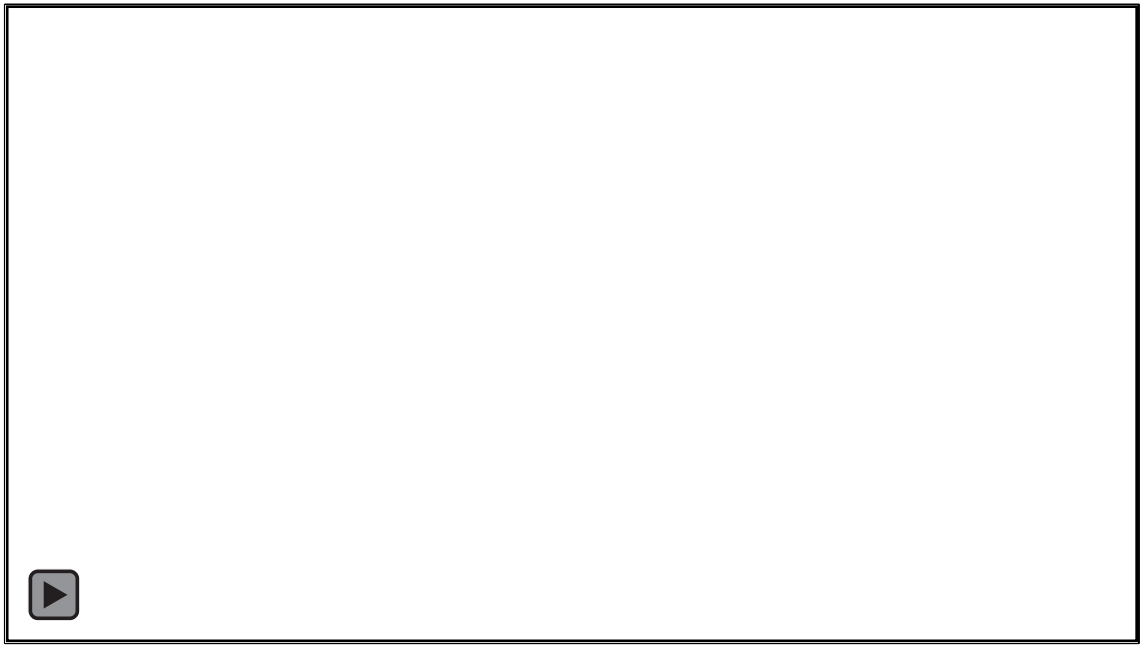
Citizen science: A symbiotic future for research and education using biological collections

Emily K. Meineke, Steven D. Frank,

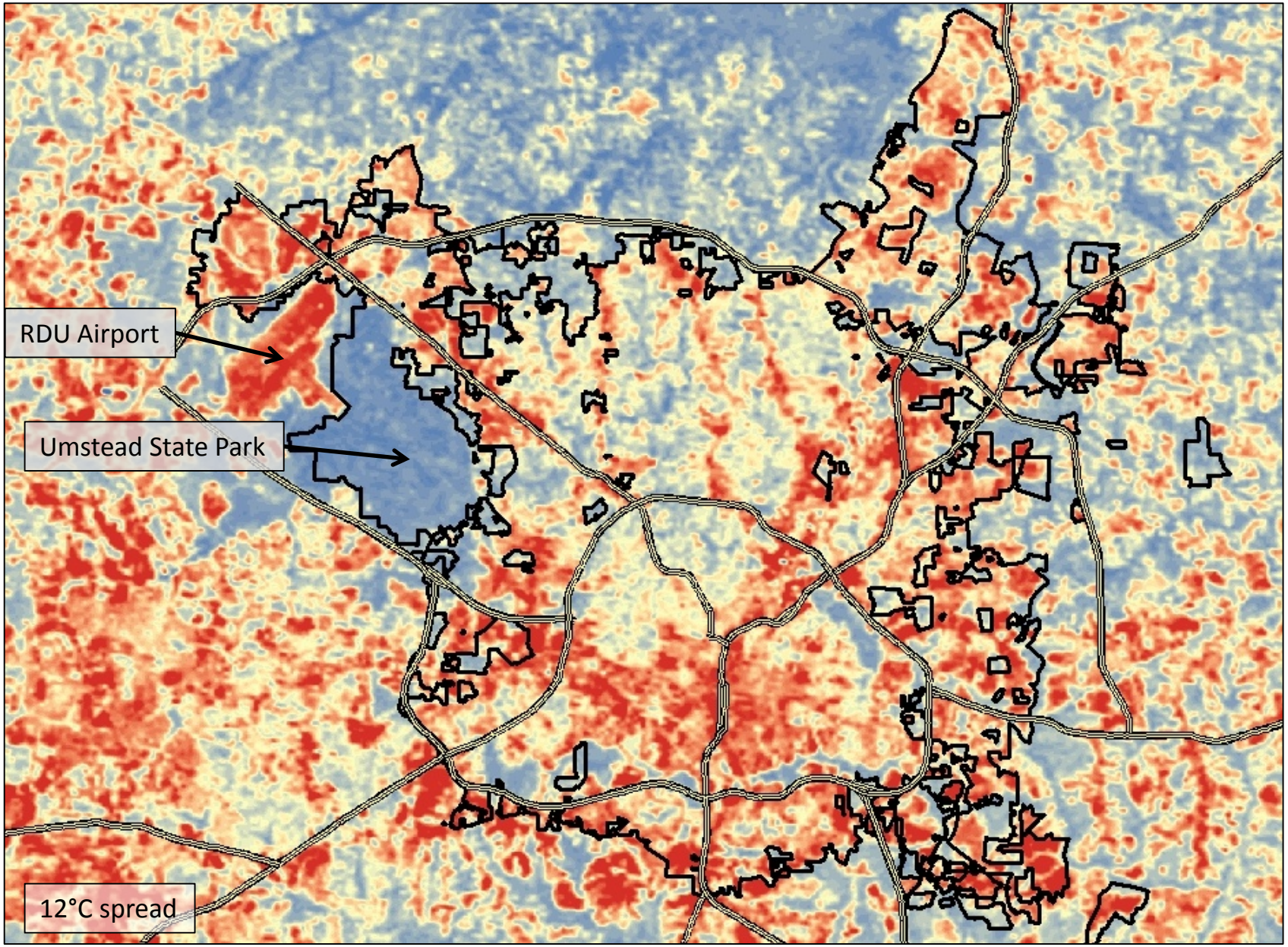
Robert R. Dunn

In 2011, I was introduced to scale insects.





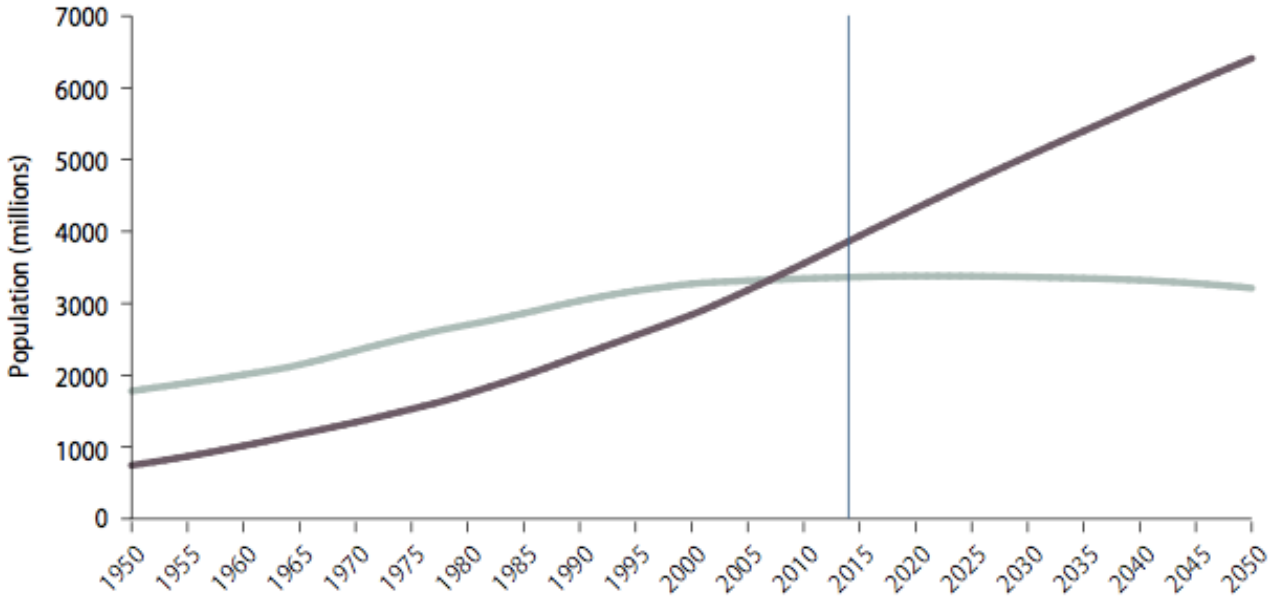
For the last ~5 years, I've studied herbivorous arthropod communities in urban heat islands.



Herbivores like urban heat. They're bad for trees. Heat is also bad for trees. Trees are getting hotter.

Figure 2.

Urban and rural population of the world, 1950–2050



A majority of the world's population lives in urban areas

The public is increasingly disengaged with natural history.

Source: gamesphere.com

suburban fifth-grader who memorably told nature advocate Richard Louv, “I like to play indoors better 'cause that's where the electrical outlets are.”

LA Times, Dec. 2014

Small collections offer unique opportunities to connect people to natural history of their immediate environments.

Source: naturalsciences.org

Our projects explore natural history on, in, and around humans.

Photos by Lauren Nichols

SCHOOL OF ANTS

A YourWildLife.org Project

World Map

The (Ant) World as Revealed by Public Science

Here we have a map showing off the places in which citizens have sampled ants as part of the School of Ants project. We're constantly updating the map as new shipments of ants come in.

Crematogaster cerasi

From Dr. Eleanor's Book of Common Ants

Species name: *Crematogaster ashmeidi*, *Crematogaster lineolata*, and *Crematogaster cerasi*

A.K.A.: Acrobat ants

Size: 0.1-0.18 inches

Where it lives: Most often, you will find acrobat ants nesting under bark in trees, the forest floor, or rotting wood, but sometimes they wander into our homes, snuggling their nests in tight spots like between shingles and in the walls.

What it eats: Primarily sugar lovers, acrobat ants sometimes take a break from lapping honeydew off aphids' rear ends to forage on protein like dead insects.

What's the big deal?

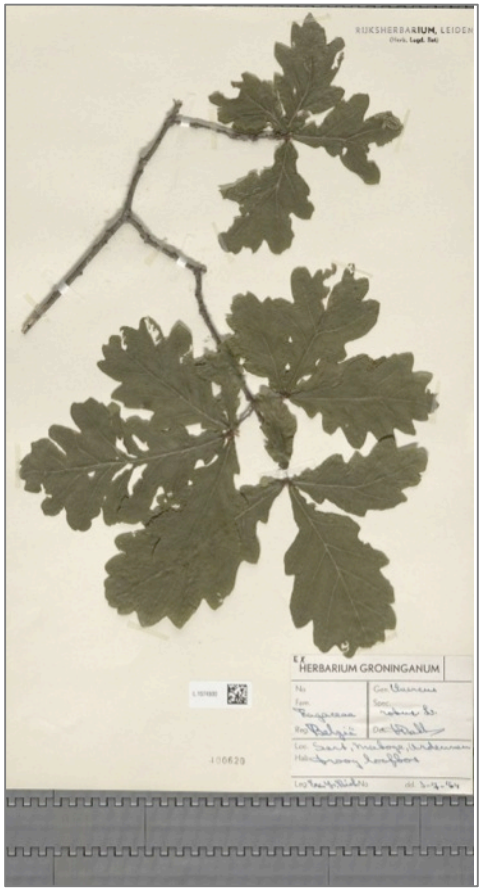
One summer, I traveled to a remote North Carolina island for a research project. The project required that I crawl under and around people's homes looking for ants.

While walking to one home, I accumulated a following of local ducks that waddled behind me waggling their bills in hopes of food and quacking reproachfully when they found none. I hate to disappoint, so I snuck into a local's backyard and dumped out my supplies, looking for a duck-suitable snack. As I rifled through my bug-collecting equipment, a man came out of the house.

Arthropods of Our Homes

New Project:

Using herbaria to track global change effects on chronic herbivory and herbivore evolution



Warming can help ectothermic herbivores

Youngsteadt et al. 2014

ELSA'S FIGURE

However, predicting the effects of global change can be complicated . . .

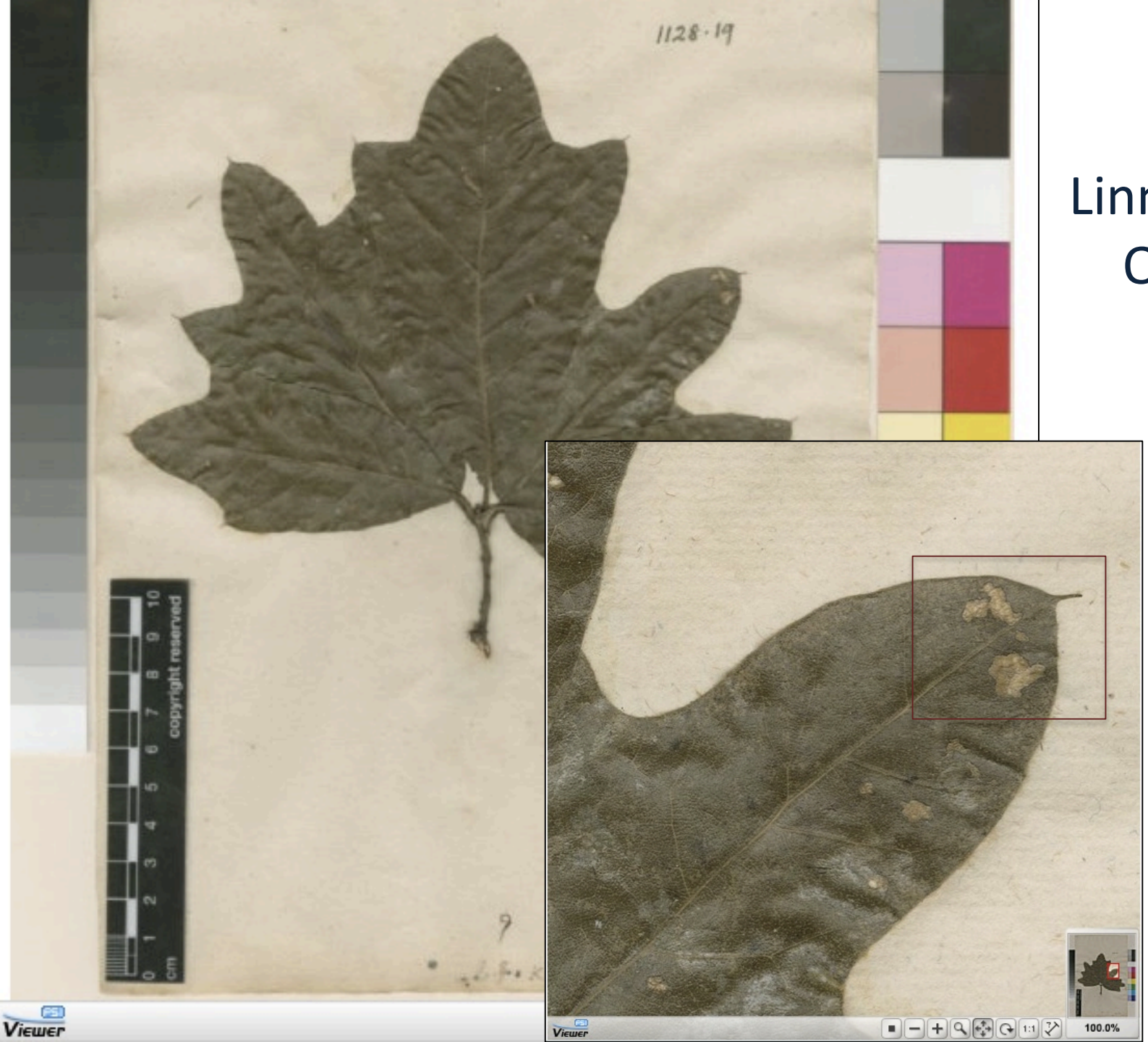
Overall goal: **Understand how/whether climate affects herbivory and herbivore evolution over several centuries**

Leaf mines

Chewing damage

Galls

Linnaeus' Oaks



http://linnean-online.org

Linnaeus' Oaks

http://linnean-online.org

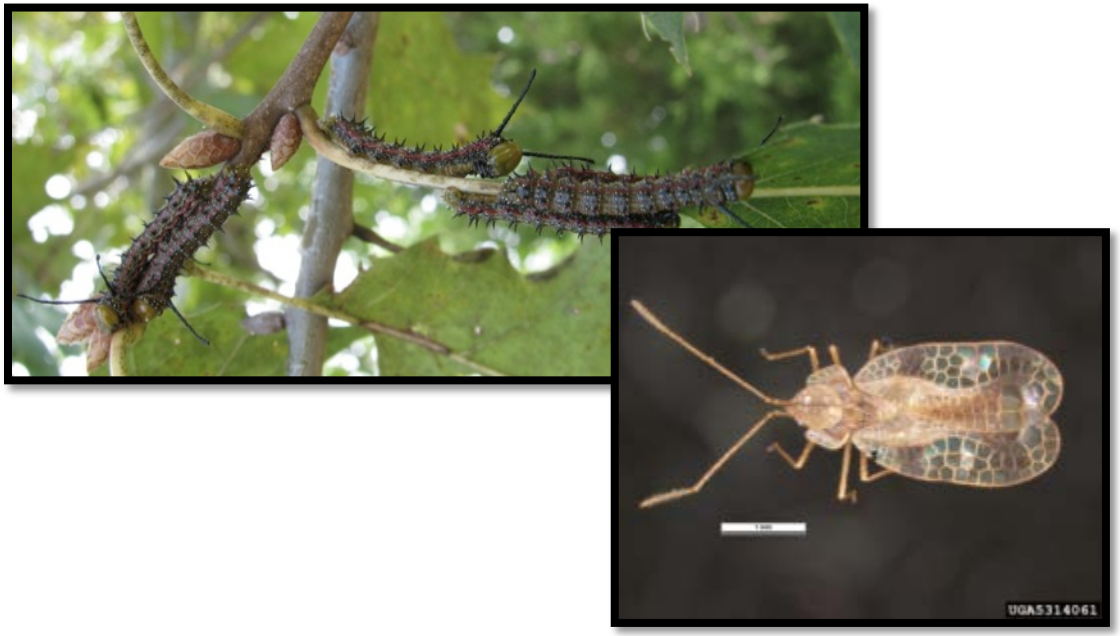
Source: bladmineerders.nl

NSF Postdoc Fellowship application- Research Using Biological Collections

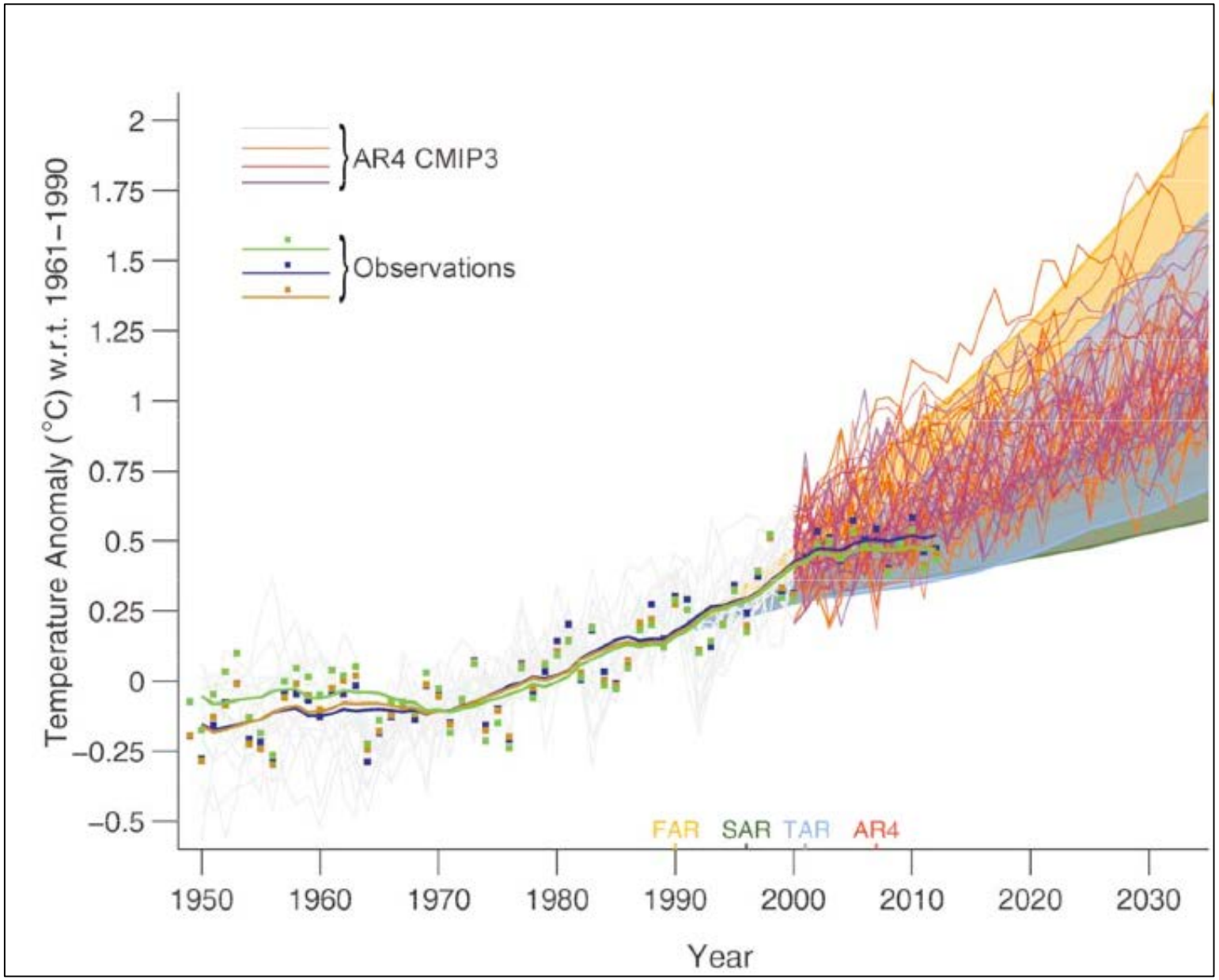
Affiliations

- University of Copenhagen (Aimee Classen, Nate Sanders, Thomas Gilbert)
- North Carolina State University (Rob Dunn, Steve Frank)
- Natural History Museum of Denmark
- National Herbarium of the Netherlands

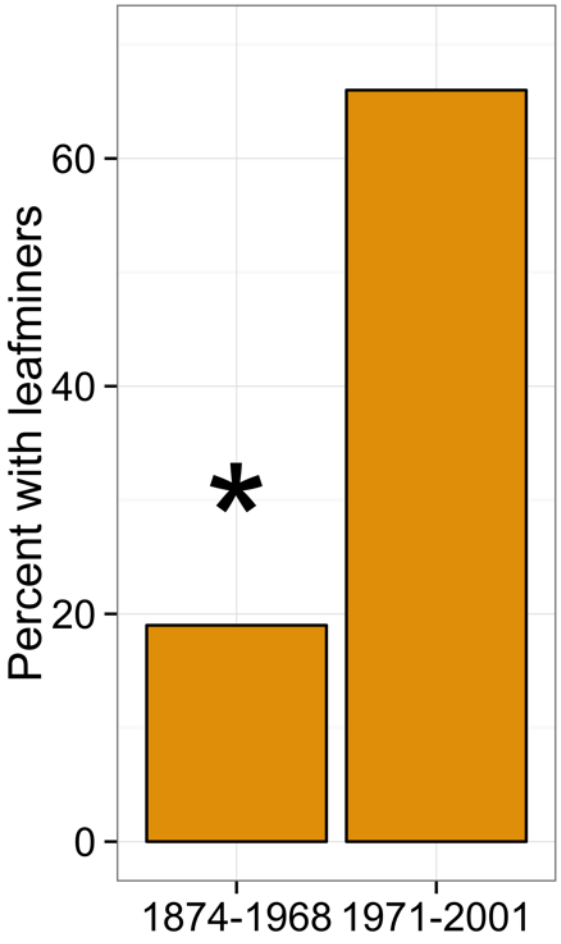
Objective 1: **Use collections to understand how herbivore communities have changed over centuries**

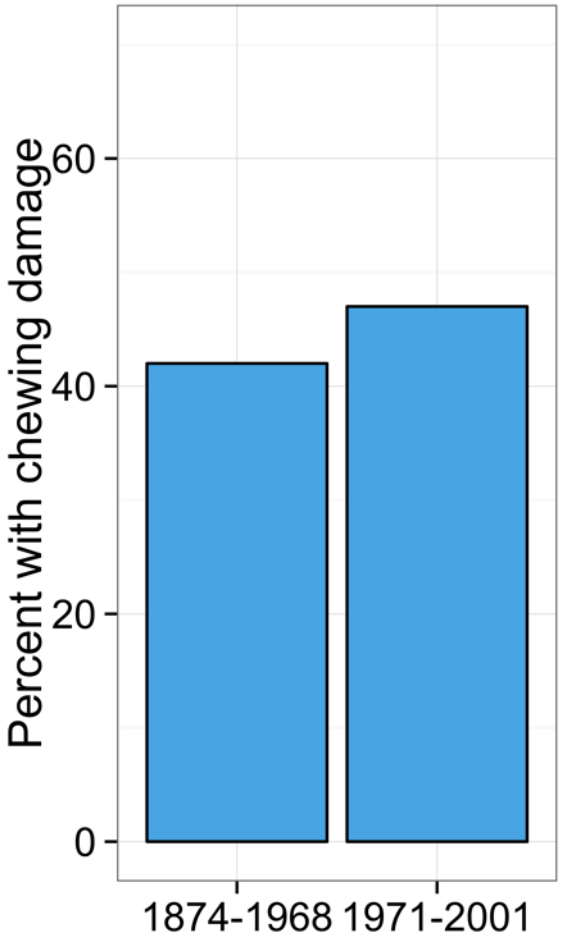


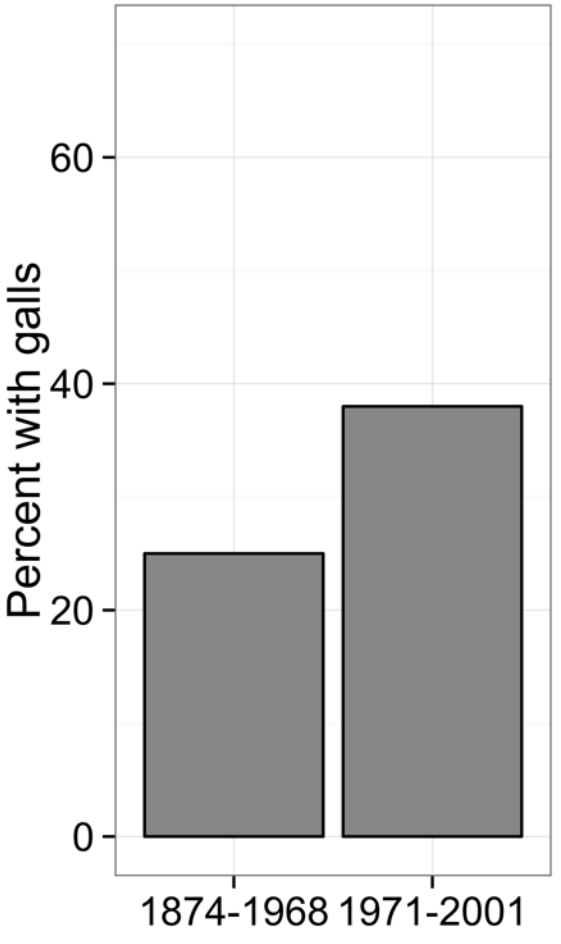
1. How has herbivore abundance, diversity, and community composition changed over time?
2. To what extent are these changes driven by climate or urbanization?


AR4 CMIP3
Observations
Temperature Anomaly (°C) w.r.t. 1961–1990
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
−0.25
−0.5
FAR
SAR
TAR
AR4
1950
1960
1970
1980
1990
2000
2010
2020
2030
Year

IPCC 2013


Percent with leafminers
60
40
20
0
*
1874-1968
1971-2001


Percent with chewing damage
60
40
20
0
1874-1968
1971-2001


Percent with galls
60
40
20
0
1874-1968
1971-2001

Objective 2: **Develop molecular methods to ask evolutionary questions**

Lees et al. 2011

Objective 3: **Develop into research opportunities in university classrooms**

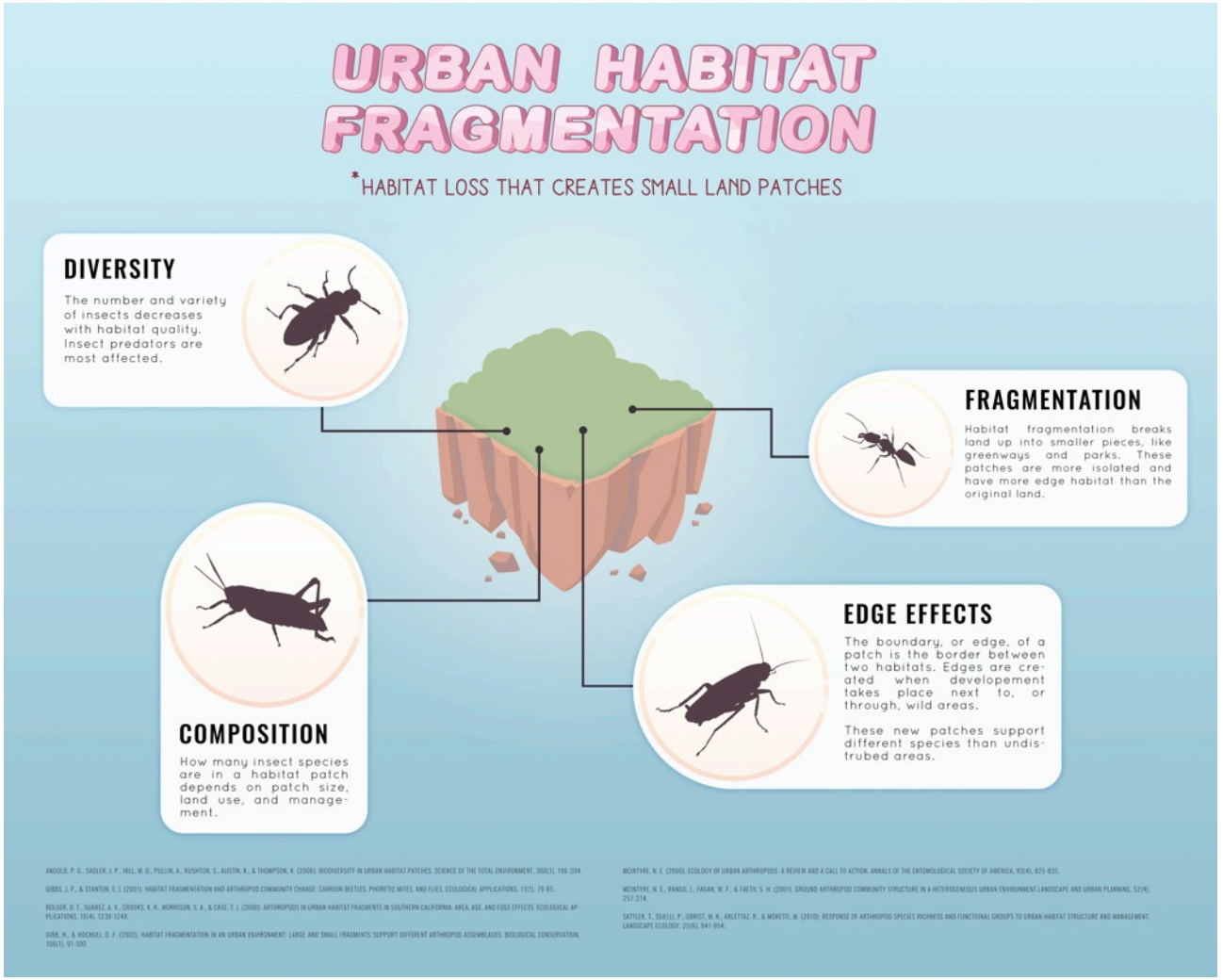
Outreach goals:

- Develop learning objectives
- Develop materials
- Connect students to local flora/arthropods
- Allow students to design their own projects

Research goals

- Build bigger collections
- Using existing collections

. . . and an opportunity to learn scientific communication



By Jackie Fitzgerald

Objective 4: **Develop citizen science projects**

Outreach goals:

New data

- Create a worldwide herbivory monitoring network in K-12 schools
- Develop urban collections
- **The Raleigh City Herbarium**

Historical data

- Collaborate with public to augment databases with herbivory metadata

Research goals:

- Build larger collections
- Regular monitoring
- Big data

Conclusions

- Small collections offer a unique view into natural history and global change.
- They can be used to educate the public and to study ecology.
- We need to survey urban biodiversity, and the public can help.

Acknowledgements

Special thanks to:

Margarita Lopez-Uribe & Elsa Youngsteadt for proposal review

EPA STAR Fellowship Program

NCSU Department of Entomology

USGS Southeast Regional Climate Science Center

NASA Biodiversity Grant

NSF