

Can forests take the heat?

Managing Pests and Ecosystem Services In a Warming Climate

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Frank Lab Activities

Research:

- Determine how urbanization and global change affect arthropod pests, tree health, ecosystem services
- Develop environmentally sound management for tree pests

Extension:


- Train urban foresters, landscapers, others who manage tree and urban forest health
 - Presentations, articles, other resources

Outreach:

- Educate general public via presentations, writing

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RESEARCH ARTICLE

Urban Warming Drives Insect Pest Abundance on Street Trees

Emily K. Meineke , Robert R. Dunn, Joseph O. Sexton, Steven D. Frank

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Abstract

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Methods

Results

Discussion

Acknowledgments

Author Contributions

References

Reader Comments (1)

Figures

Abstract

Cities profoundly alter biological communities, favoring some species over others, though the mechanisms that govern these changes are largely unknown. Herbivorous arthropod pests are often more abundant in urban than in rural areas, and urban outbreaks have been attributed to reduced control by predators and parasitoids and to increased susceptibility of stressed urban plants. These hypotheses, however, leave many outbreaks unexplained and fail to predict variation in pest abundance within cities. Here we show that the abundance of a common insect pest is positively related to temperature even when controlling for other habitat characteristics. The scale insect *Parthenolecanium corni* was 13 times more abundant on willow oak trees in the hottest parts of Raleigh, NC, in the southeastern United States, than in cooler areas, though parasitism rates were similar. We further separated the effects of heat from those of natural enemies and plant quality in a greenhouse reciprocal transplant experiment. *P. corni* collected from hot urban trees became more abundant in hot

PEST MANAGEMENT

Reduced Risk Insecticides to Control Scale Insects and Protect Natural Enemies in the Production and Maintenance of Urban Landscape Plants

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Environ. Entomol. 41 (2): 377–386 (2012); DOI: <http://dx.doi.org/10.1603/EN11230>

ABSTRACT Armored scale insects are among the most difficult to manage and economically important arthropod pests in the production and maintenance of urban landscape plants. This is because of morphological traits that protect them from contact insecticides. I compared initial and season-long control of euonymus scale, *Unaspis euonymi* Comstock (Hemiptera: Diaspididae), by reduced-risk insecticides (insect growth regulators [IGRs], neonicotinoids, spirotetramat) to determine if they controlled scale as well as more toxic insecticides such as the organophosphate, acephate, and pyrethroid, bifenthrin. I also evaluated how these insecticides affected natural enemy abundance on experimental plants and survival when exposed to insecticide residue. All insecticides tested

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Another feature of their distribution is that they are of very rare occurrence in the country, while they become excessively abundant in cities and towns. I may further say I have never seen them upon the soft maple or any other tree while growing in a state of nature, with the possibility of finding them on a wild grape vine yet unknown. Its range extends from the west, to Minnesota, Iowa

NO

JOSEPH DUN

- I. PULVINARIA
- II. ASPIDIOTUS A

FROM PROCEEDINGS OF DAVENPORT AC

DAVENPORT, IOWA:
FEBRUARY, 1880.

GAZETTE COMPANY, PRINTERS.

53



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Ecology of Herbivorous Arthropods in Urban Landscapes

Michael J. Raupp,¹ Paula M. Shrewsbury,¹ and Daniel A. Herms²

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Key Words

urbanization, gra, biodiversity, eco.

Abstract

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THE GLOOMY SCALE, AN IMPORTANT ENEMY OF
SHADE TREES IN NORTH CAROLINA.

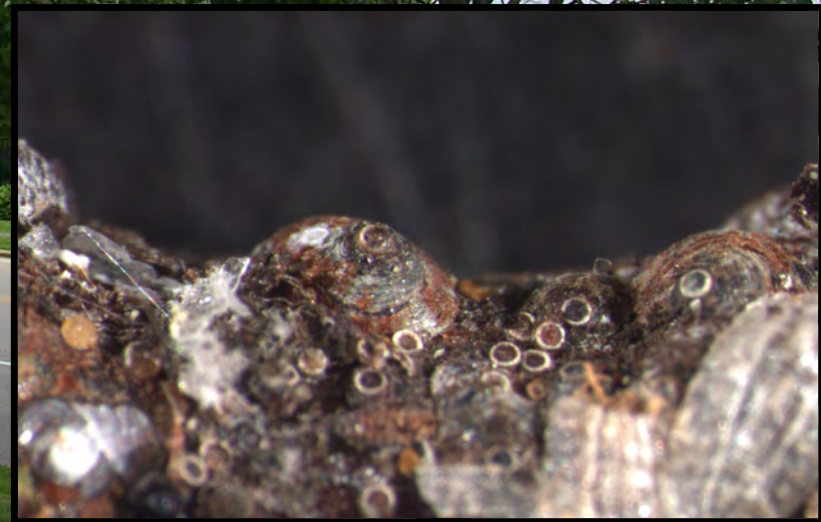
BY Z. P. METCALF.

The gloomy scale is the most important insect enemy of shade trees in North Carolina. We are led to make this statement for two reasons: First, because it increases far more rapidly than any other insect attacking shade trees, and in the second place it is all but confined to the maples which have been so largely used for shade purposes along the streets of our cities and towns. The gloomy scale is rather closely related to the famous San Jose scale, which is so destructive to our fruit trees. Unlike the San Jose scale it is a native insect. We are led to believe this because the gloomy scale is very heavily parasitized, indicating that it has been established in this country for a long period of time. Then the fact that the scale has been found on a willow along a stream in Lincoln County is another very strong indication of its nativity.

The gloomy scale differs from the San Jose scale in another very vital respect, and that is that it is very much more difficult to control. We believe that this is due to the fact that the gloomy scale lives over the winter as a mature insect, while the San Jose scale lives over the winter as a half grown young. The latter condition enables us to apply very caustic insecticides at a time when the insect is weakest, and at the same time the tree is in a dormant condition so that it is not injured in the least. Then, too, the dorsal scale of the gloomy scale is much thicker and more closely applied to the ventral scale than is the case with the San Jose scale, so that the gloomy scale is especially well protected against any contact insecticide.

These facts forced themselves upon our attention soon after we commenced experiments for the control of this insect four years ago. We soon discovered that the remedies usually recommended for the San Jose scale would be of little or no use against this insect. As a matter of fact the mortality of the scale on some unsprayed trees was less than that of some trees

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Oak lecanium scale

- *Parthenolecanium quercifex*
- Pest of oak trees



Clyde Sorenson



Emily Meineke

Hypothesis: Heat increases pest abundance on urban plants



Photo: E. Youngsteadt

Hypothesis: Heat increases pest abundance on urban plants



Adam Dale, PhD Student



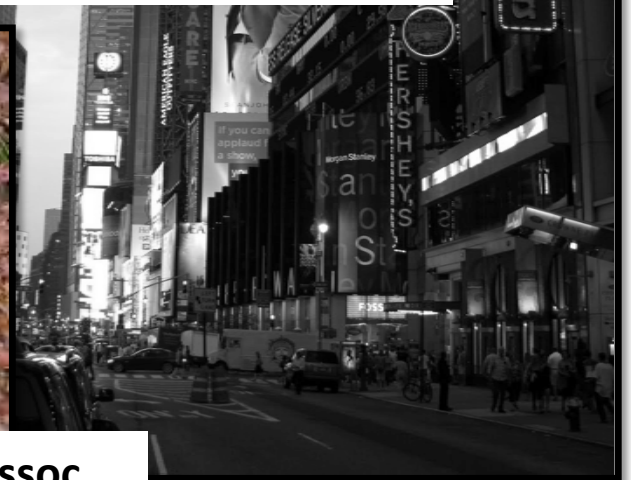
Emily Meineke, PhD student



Rob Dunn



Elsa Youngsteadt, Research Assoc.



Objectives

Determine how urban warming affects pest abundance and fitness

Determine if the effects of urban warming predict the effects of global warming

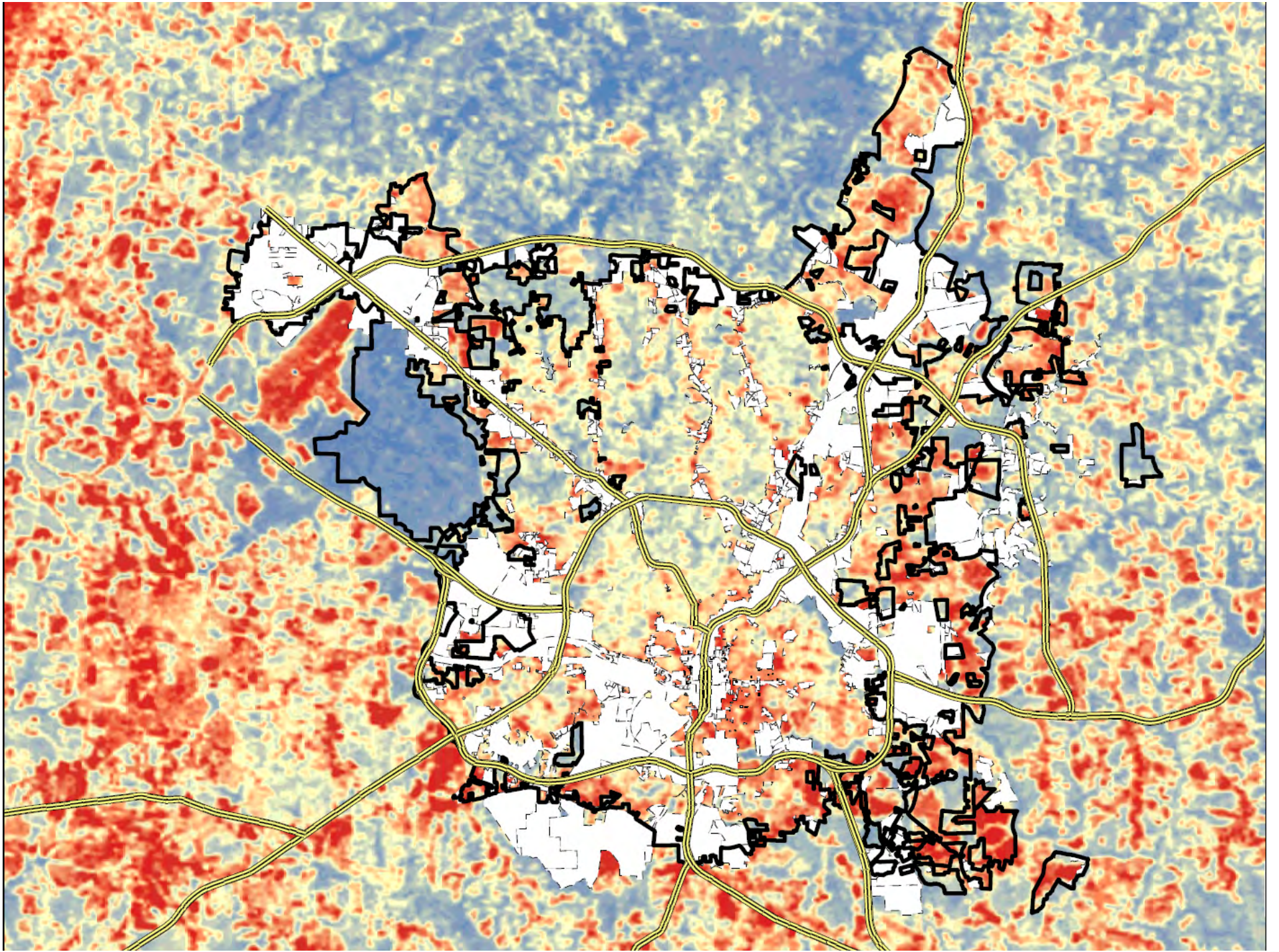
Determine how warming and pests interact to affect tree health and ecosystem services

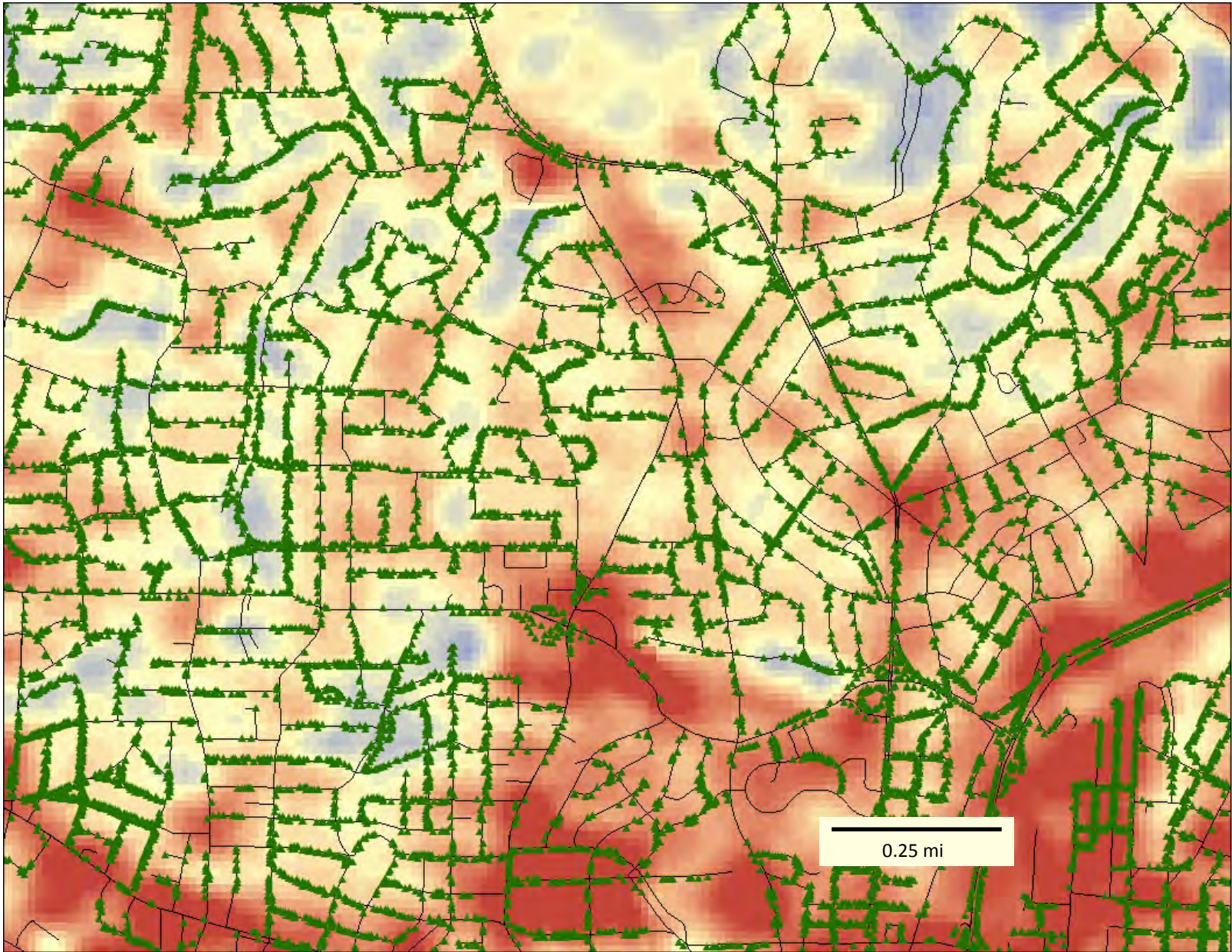
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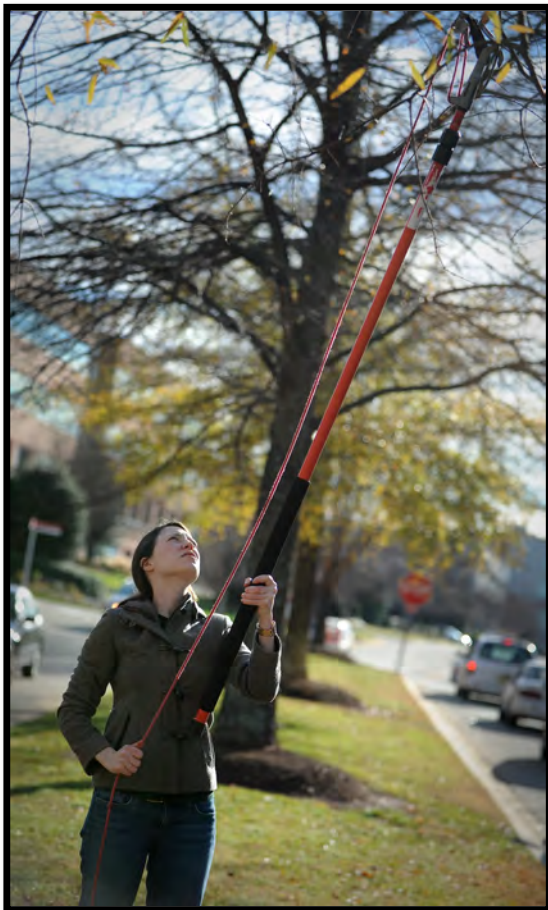


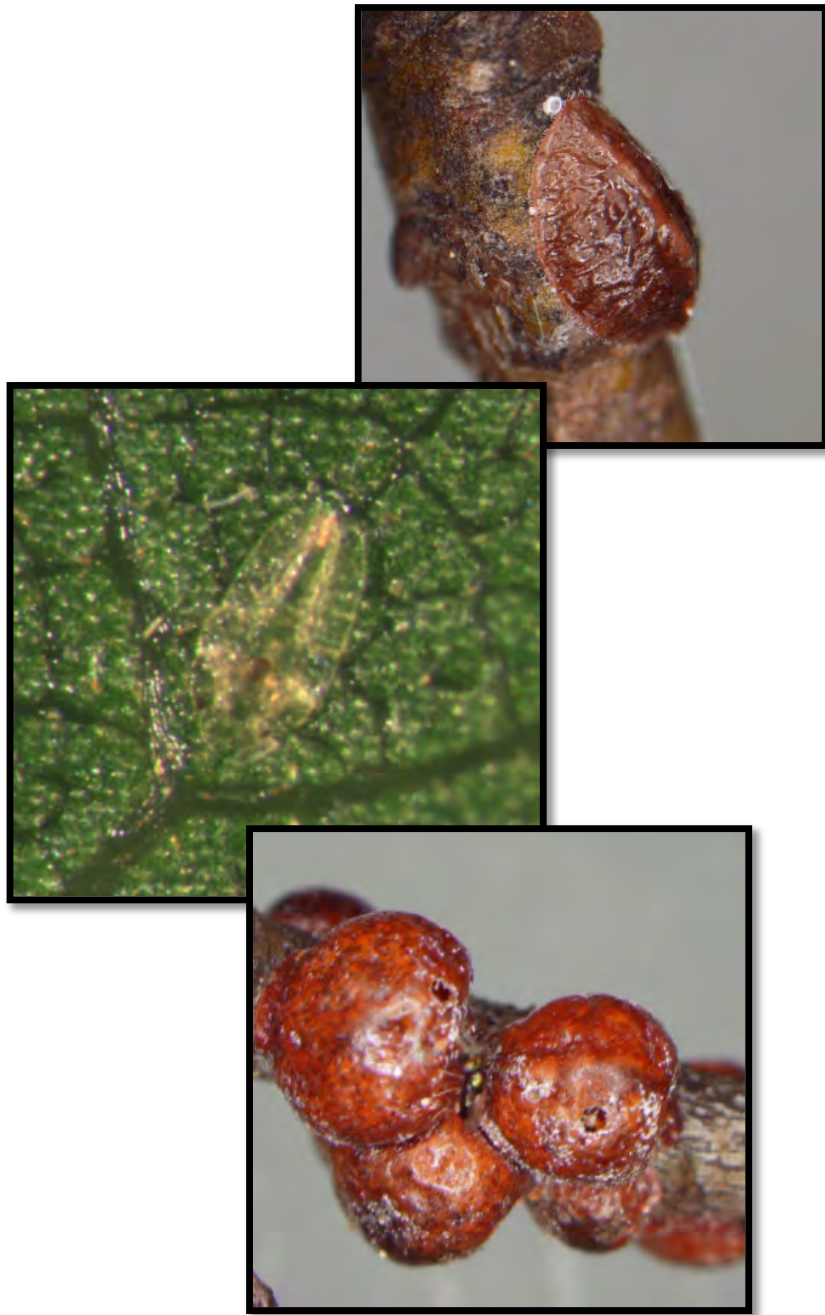
6.6 ° latitude

5°C difference in annual average temperature

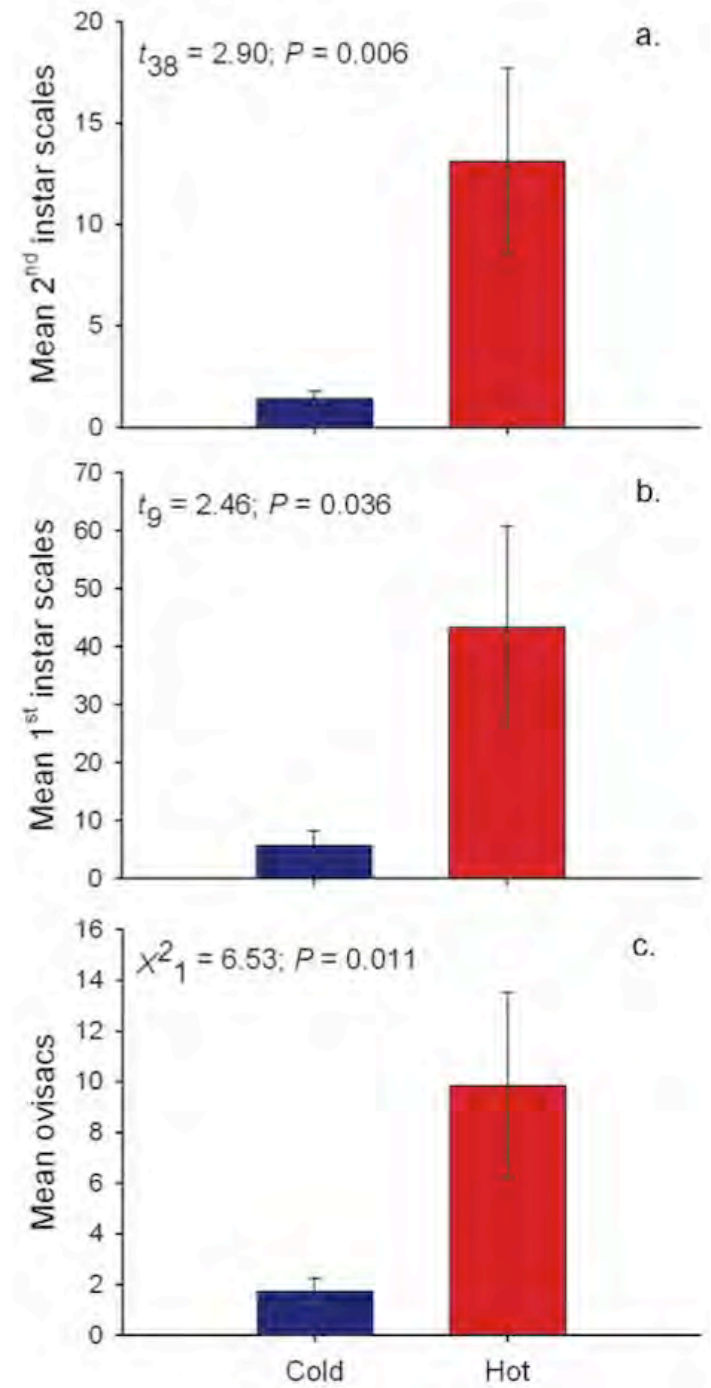
Warming increases scale insect abundance and fitness in cities

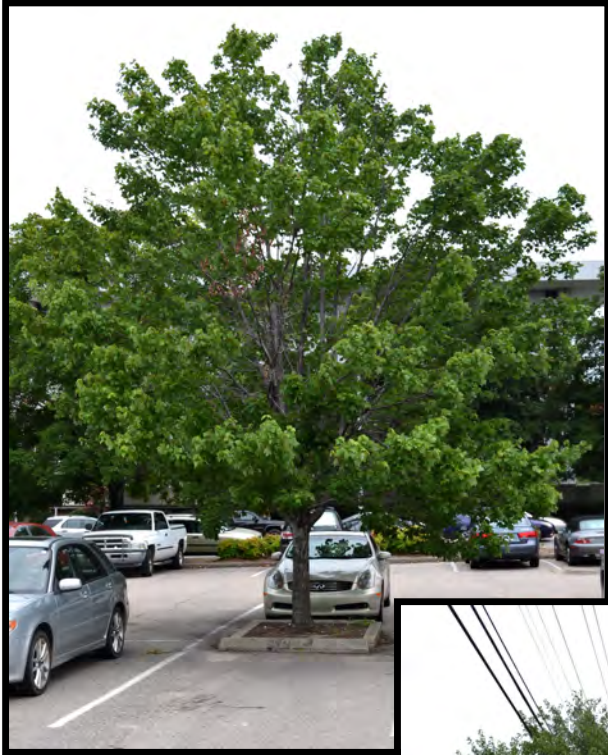
(Meineke et al. 2013. *PLoS One*; Dale and Frank Accepted. *Ecological Applications*)



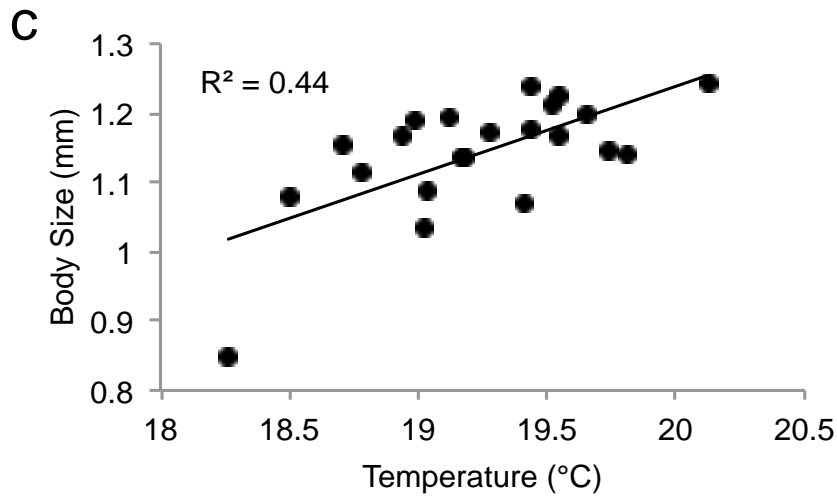
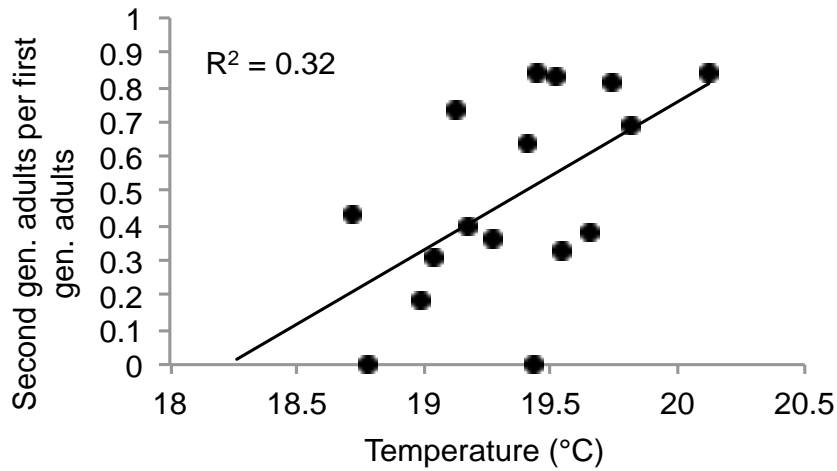


Meineke et al. 2013. *PLoS One*

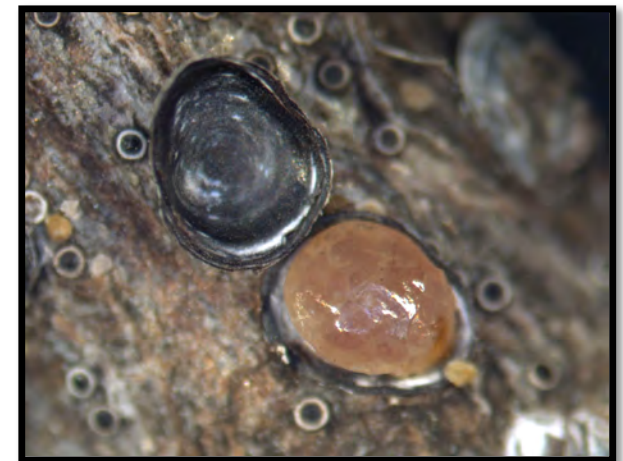
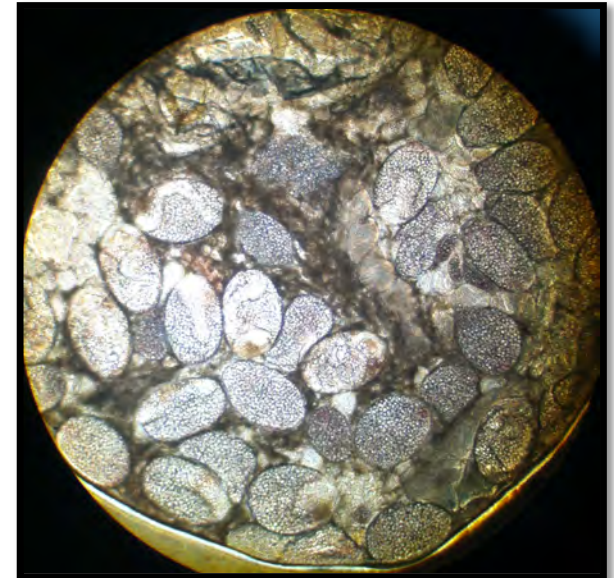
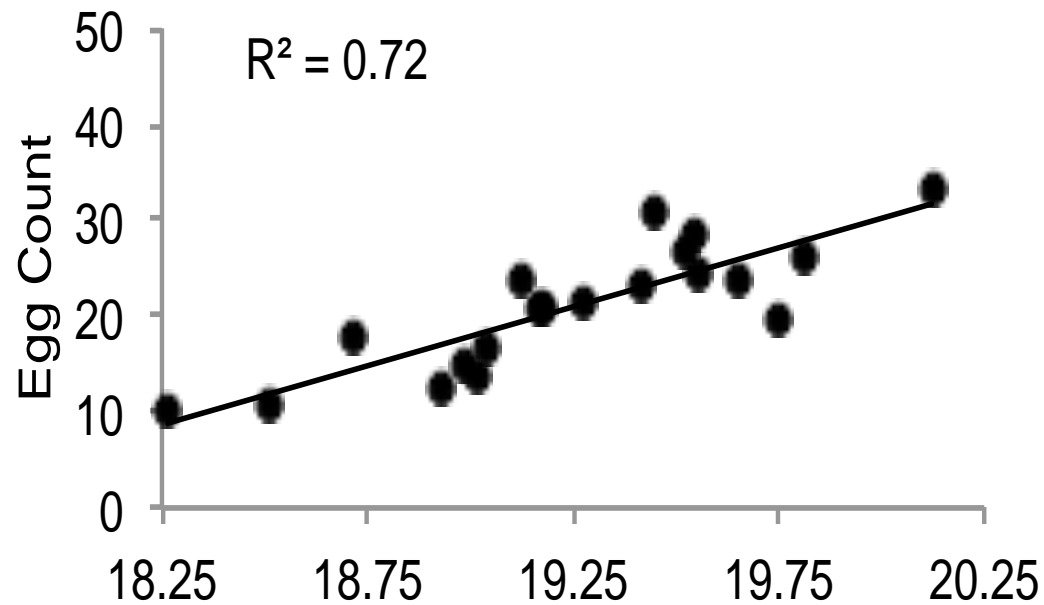




Gloomy scale size and survival increases at hotter sites

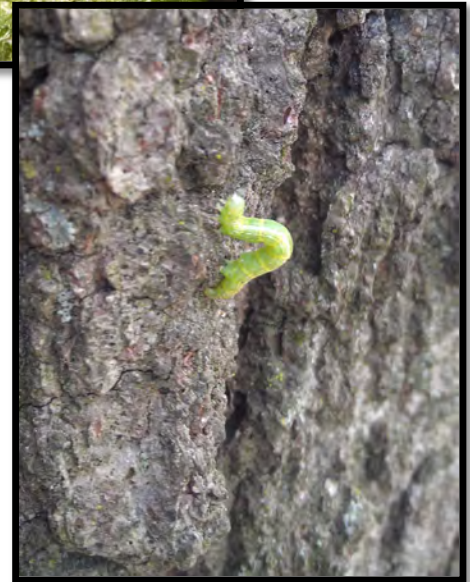


Gloomy scales are more fecund at hotter sites



Future research:

- Investigate other pest taxa that increase or decrease due to warming
- Investigate warming affects on interactions with predators and parasitoids
- Investigate evolution of scale populations to warmer environments



Objectives

Determine how urban warming affects pest abundance and fitness

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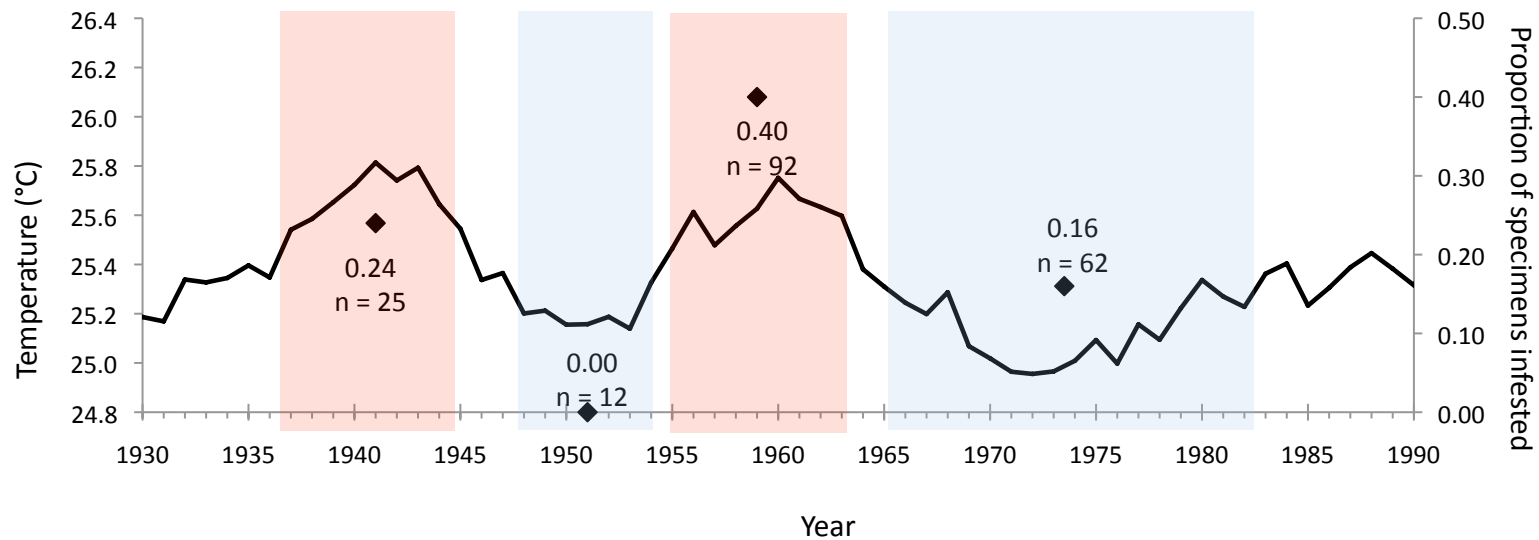
Determine how warming and pests interact to affect tree health and services

Climate change affects scale insect abundance in natural forests based on herbarium specimens and climate chambers

(Youngsteadt et al. draft for PNAS)



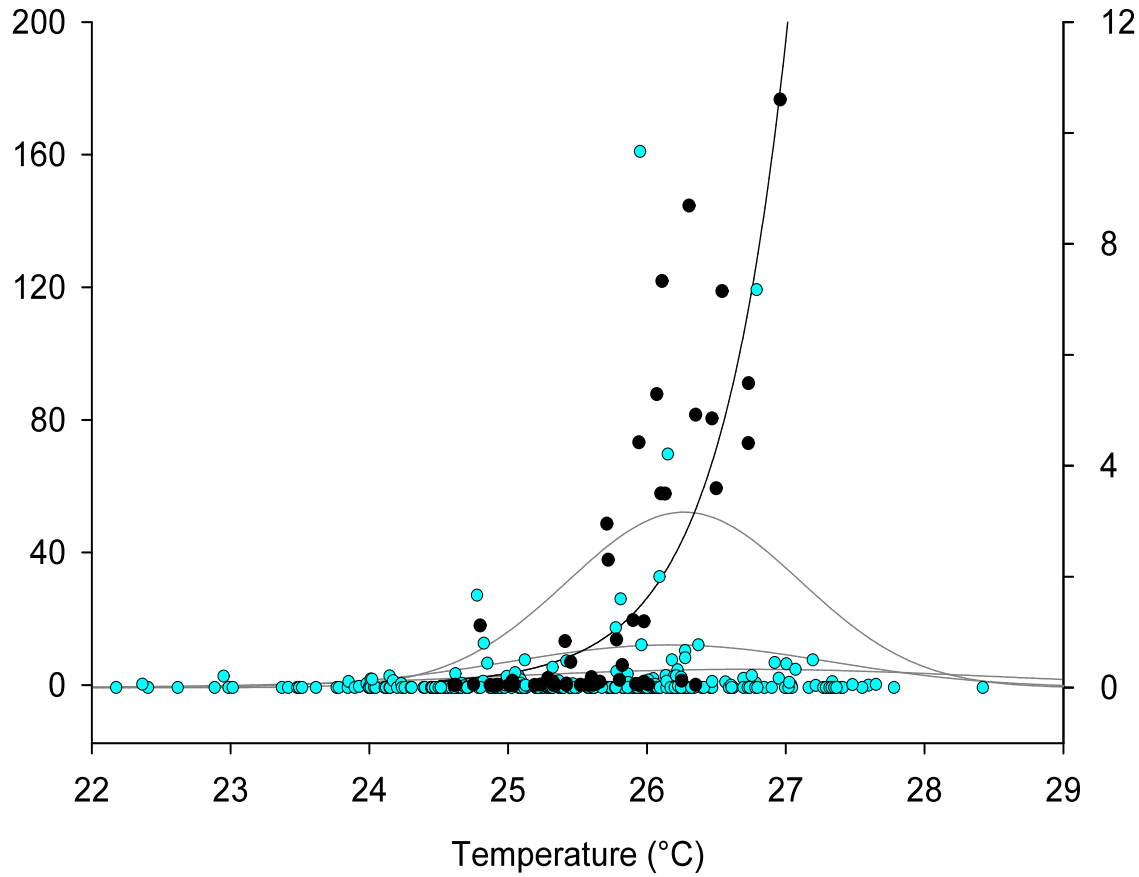
Gloomy scale abundance fluctuates with temperature trends over time



Black line is 10-year running average of August temp (left Y axis); diamonds are proportion of specimens that have gloomy scale (right Y axis); X axis is year



Gloomy scale response to warming is congruent across urban and historical datasets.



Future research:

- Determine if cities predict pest range and habitat expansion to warming

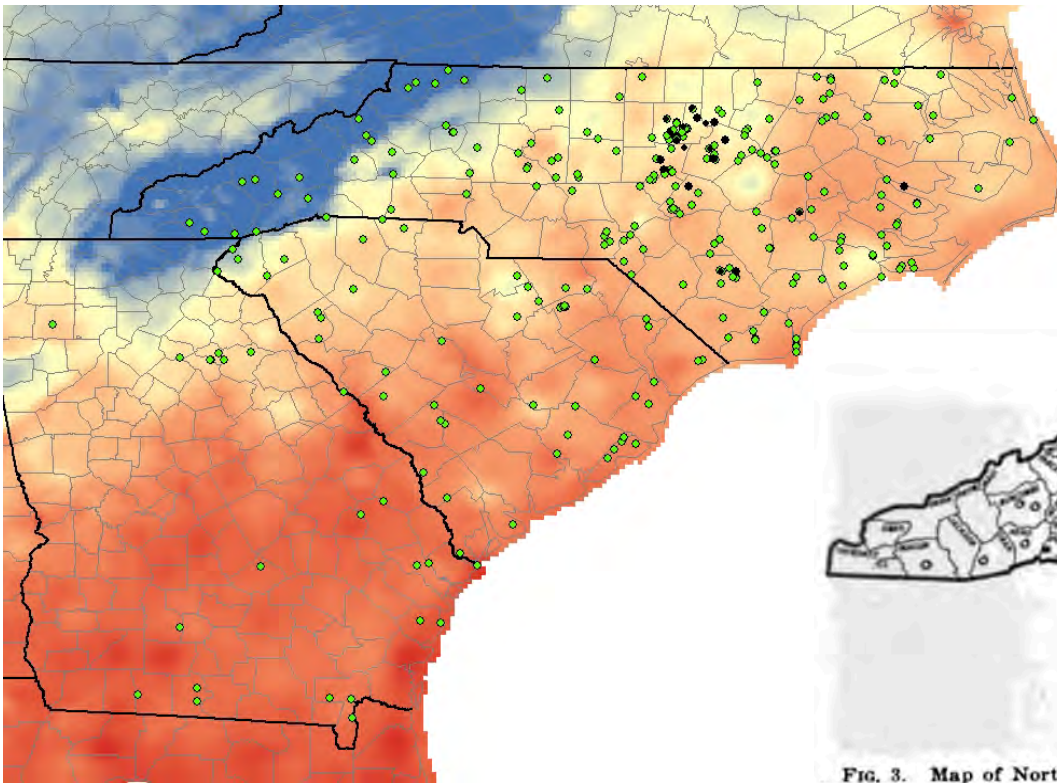


FIG. 3. Map of North Carolina. The solid dots indicate places where the gloomy scale has been found. The small rings indicate places inspected, but no scale found.

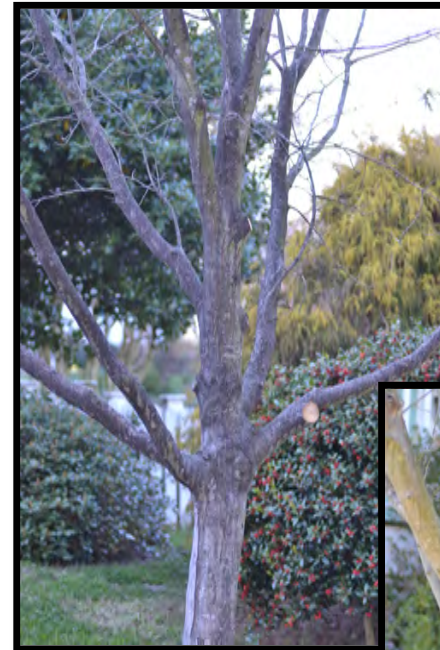
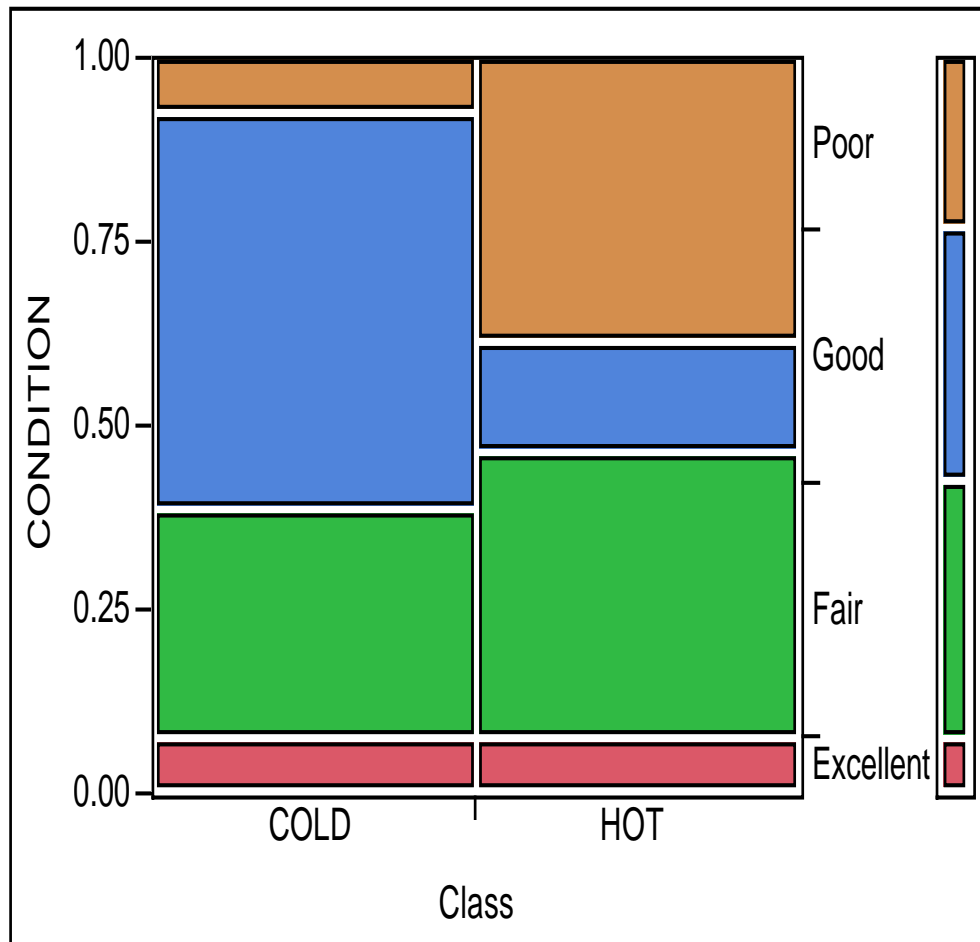
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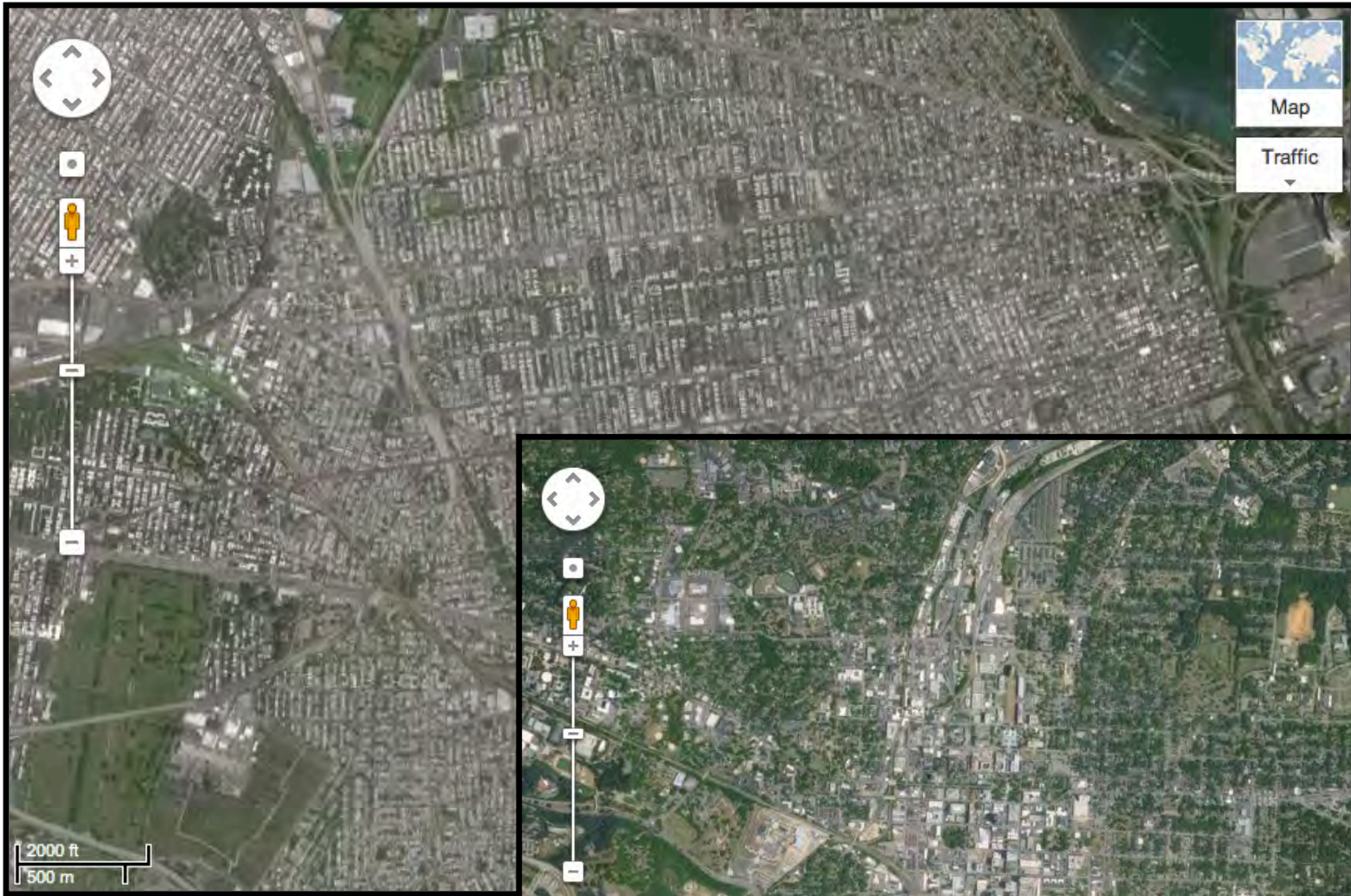
Hot trees are more likely to be in poor health



Forests are in trouble

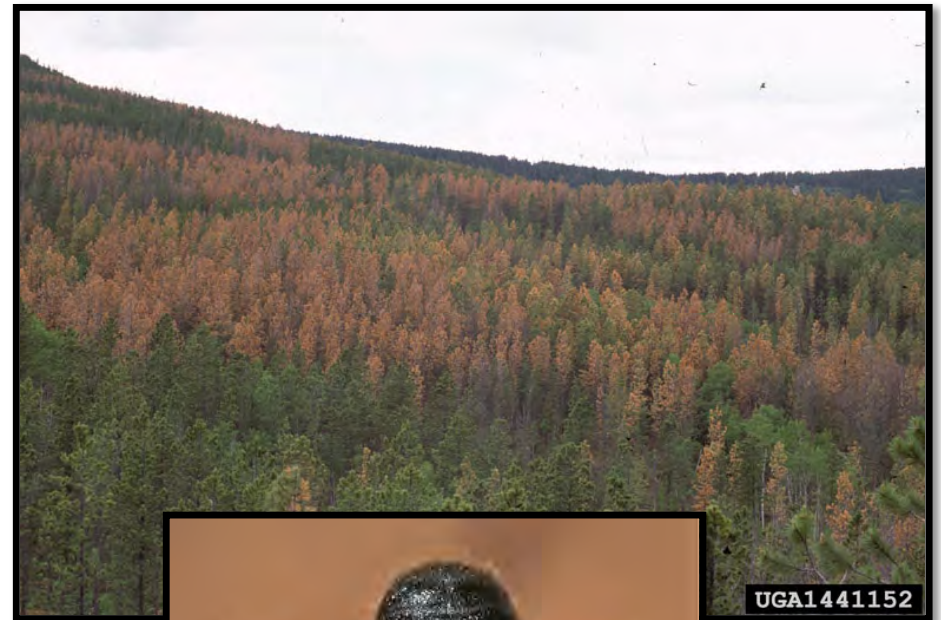
- Cities are getting bigger and hotter
- Urban forest canopy is declining
- Young tree survival is low





Forests are in trouble

- Climate change affects natural forests
- Alters insect physiology, behavior, interactions



- Contributors
 - Emily Meineke
 - Adam Dale
 - Elsa Youngsteadt
 - Kevin McCluney
 - Rob Dunn

- Collaborators and Cooperators

- Dean Urban
- Nadia Singh
- Sally Thigpen
- Sarah Widney
- Steve Bambara
- NY Rec & Parks
- Baltimore Rec & Parks
- Boston Rec & Parks

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- George Washburn
- Bobby Chanthammavong

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- NSF RAPID
- USDA AFRI
- EPA STAR



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WHERE DISCOVERIES BEGIN



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