

Pinelands Preservation Alliance
Pinelands Science Forum on Climate Change

**Climate and Microclimate:
Whither Local Species?**

Eastern Fence Lizard
Sceloporus undulatus

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Rutgers University**

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Pine Barrens tree frog
Hyla andersonii



Summary

1. Microclimate, especially temperature, affects all of life.
2. Relevant scale of microclimate depends on body size.
3. Amphibians: breeding phenology is constrained by thermal ecophysiology. Climate change may result in loss of breeding habitat and shifts in phenology, with possible changes in species assemblages in breeding ponds.
4. Lizards: Daily and seasonal activity, local distribution, and nest site selection are constrained by thermal ecophysiology. In near-term climate change, lizards may experience longer growth seasons, faster development, and shortened generation times. By the end of the century, local extinctions could occur.

New Jersey's climate has warmed over the past 125 years.

NJ Average Monthly Temperatures, 1895 – 2022

Blues: Coolest 10 years
Red and pink: warmest 10 years



1895

2022

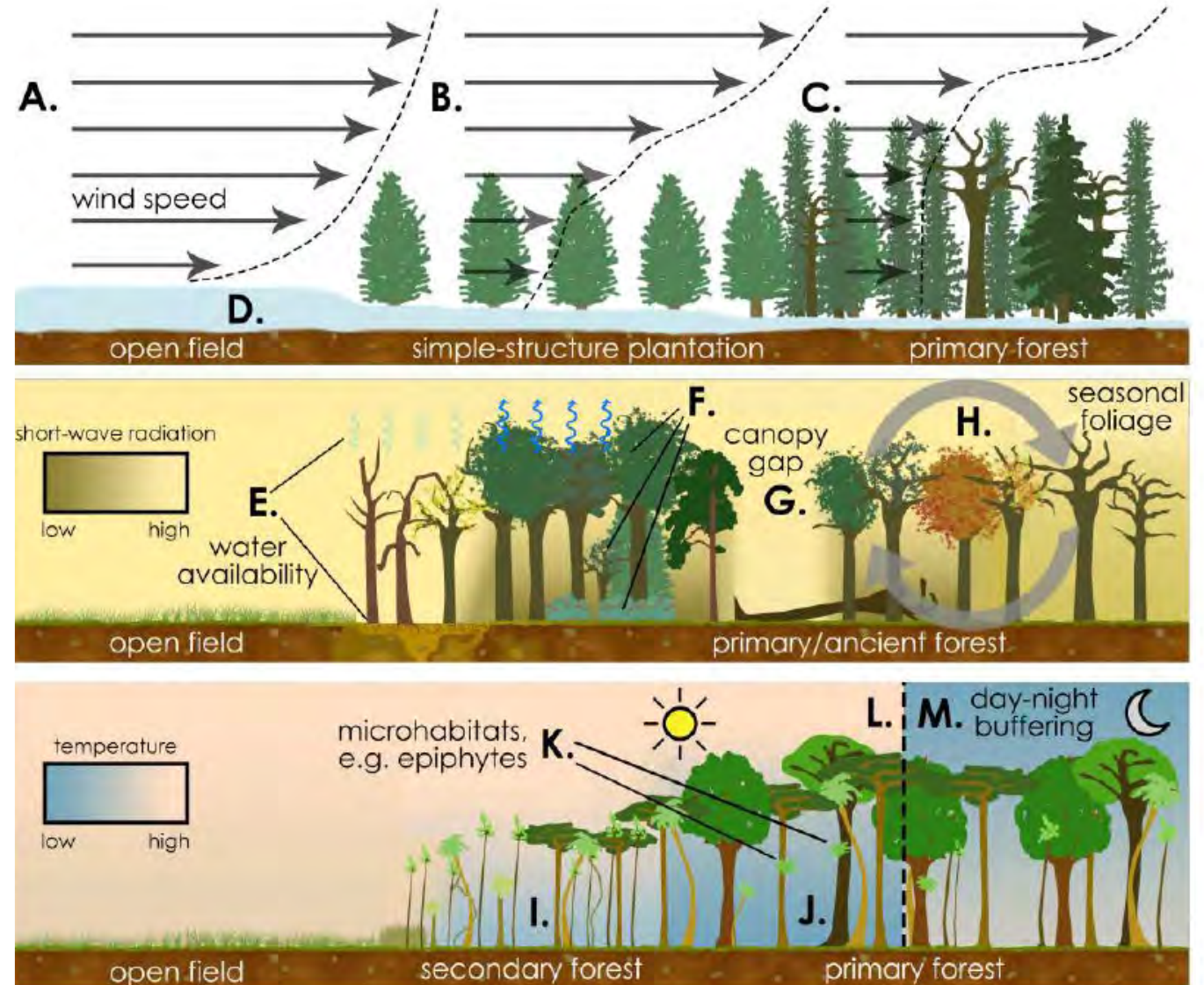
Microclimates are the thermal, hydric, and radiative conditions in the first meter or so above and below the earth's surface — **“the climate near the ground”**.

The topic encompasses a wide range of physical processes including the effects of terrain and vegetation on radiation, air temperature, wind speed, and humidity as well as the dynamics of soil temperature, soil moisture and snow. An understanding of microclimates is of fundamental importance in ecology because **it represents the physical conditions actually experienced by organisms.**

Vegetation Drivers of Microclimate are particularly important in the Pinelands.

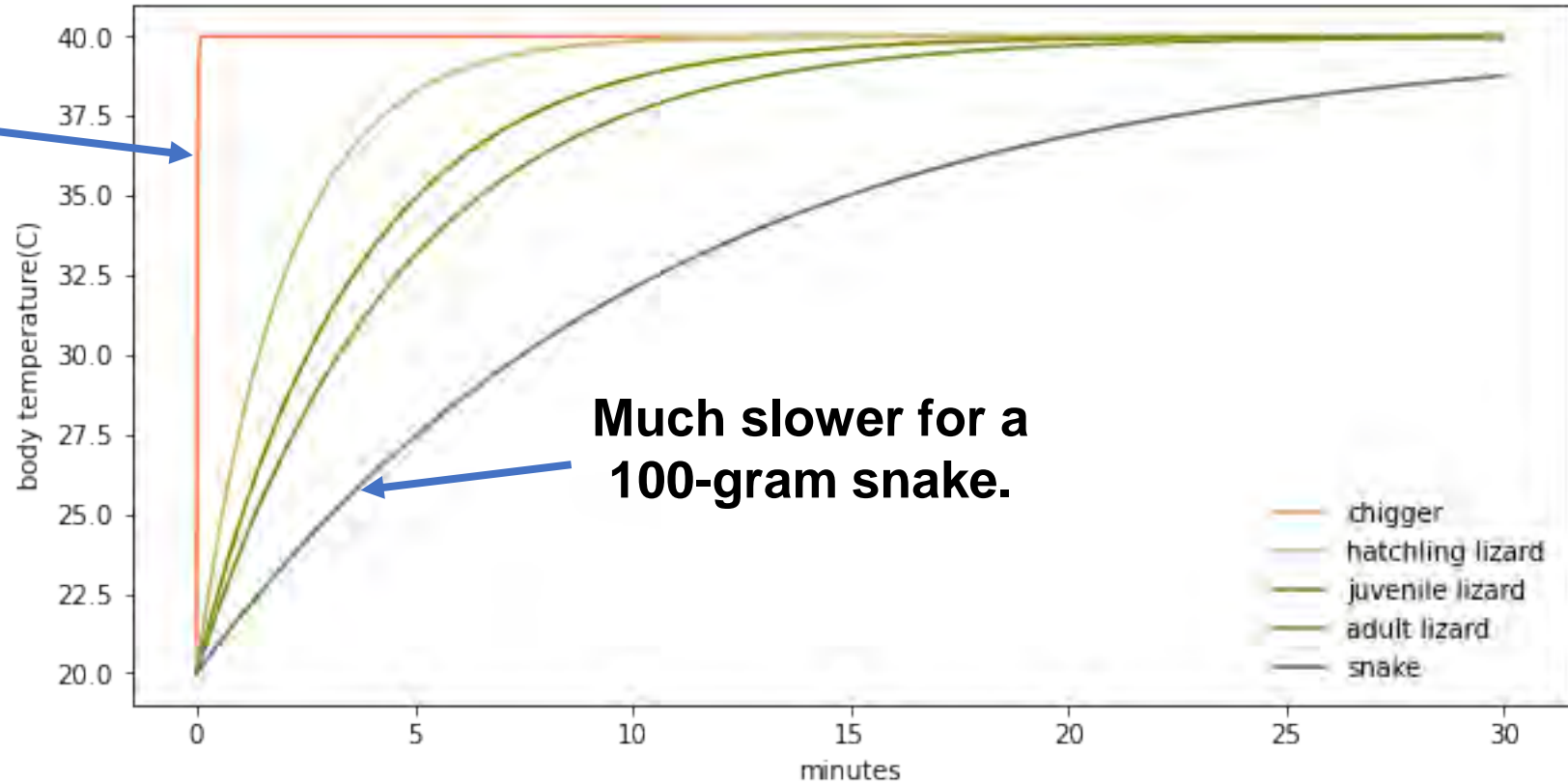
Forest canopy and understory affect wind speed, sunlight, water availability, and temperature.

In turn, wind speed, sunlight, water availability, and temperature affect, heat exchange between animals and their environments.



The relevant scale of microclimate depends on an animal's size.

Nearly instantaneous
for a tiny chigger mite.



In part, because ...

Heat exchange and temperature equilibration depend on body size.

And in part, because ...

The world we see is very different to a very small animal.

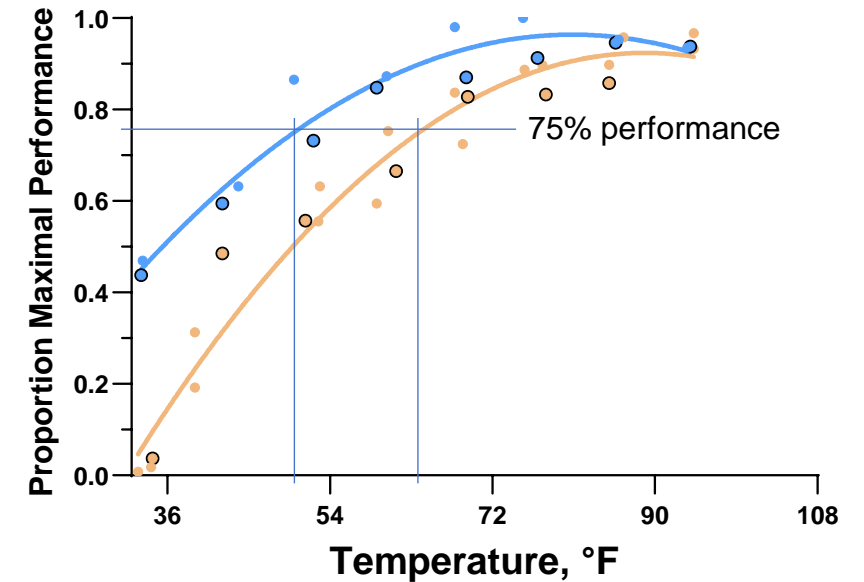
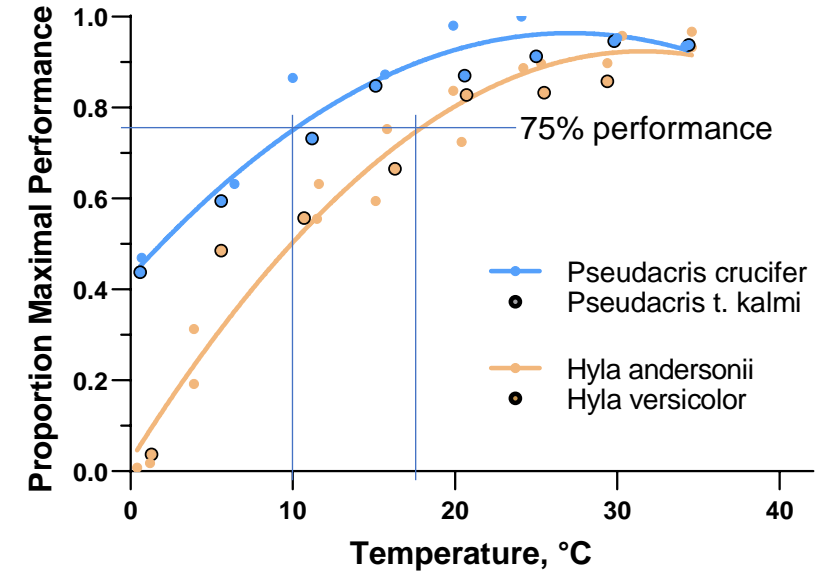


Tiny chigger mite on the edge of a deep, cool canyon –
or an insignificant crack in the smooth surface of a log.

Thus, the relevant scale of microclimate depends on an animal's size.

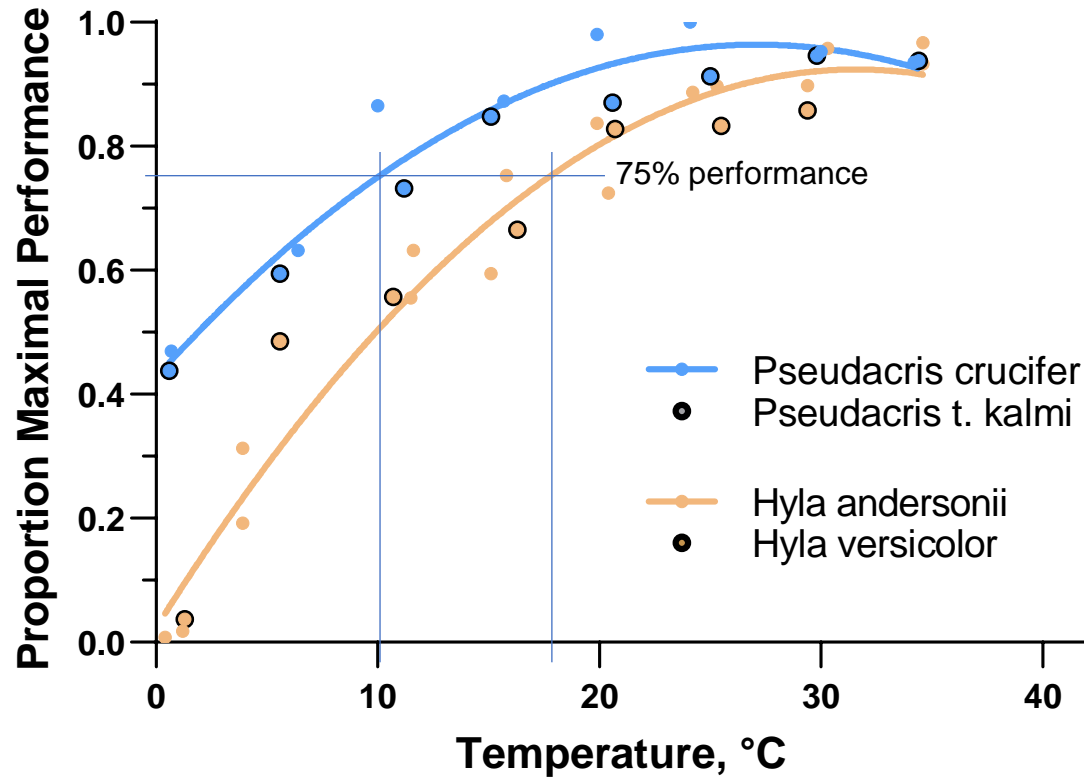
AMPHIBIANS

Spring peepers and chorus frogs (early breeders) achieve high performance at lower temperatures than gray tree frogs and Pine Barrens tree frogs (late breeders).



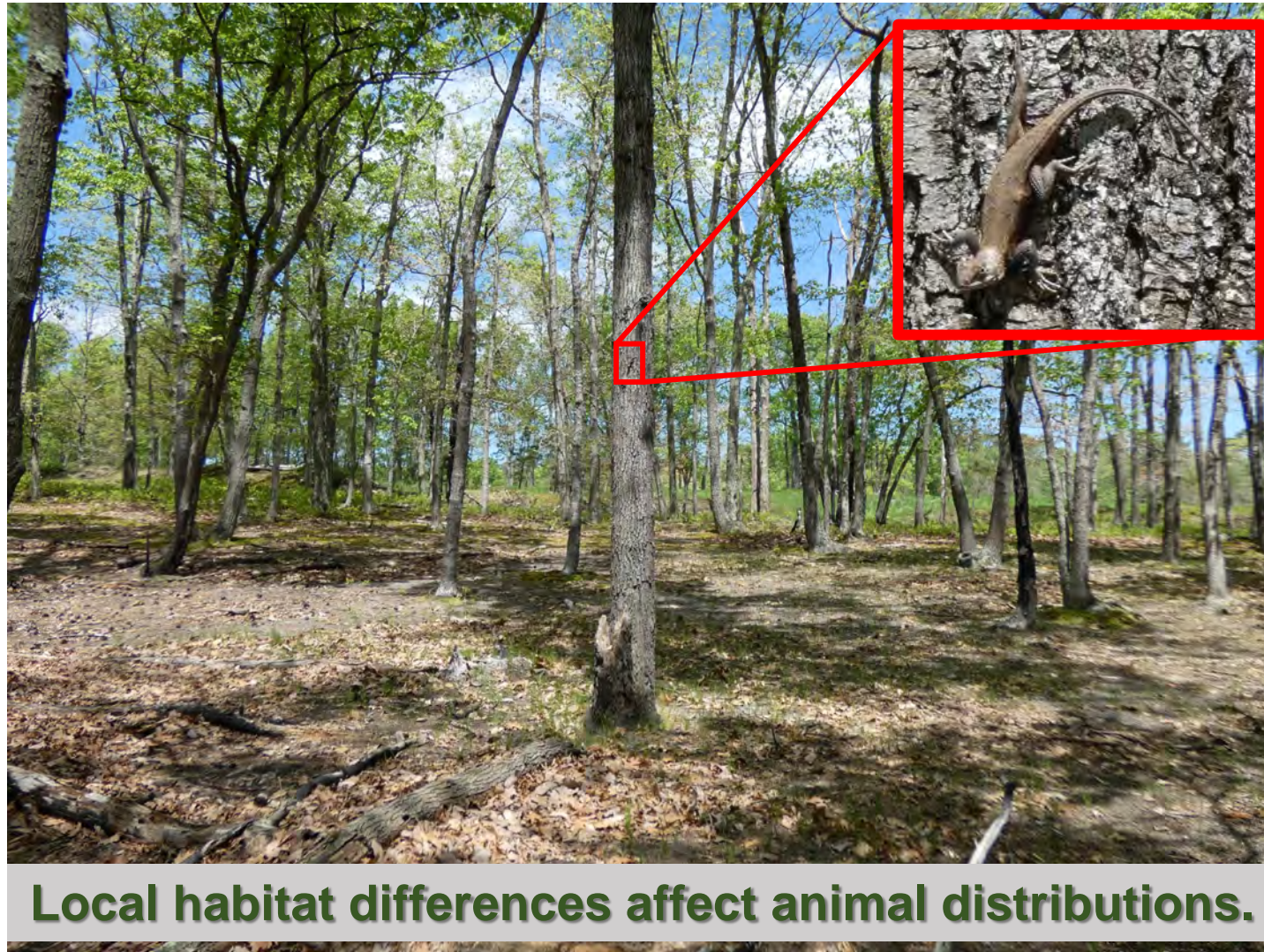
AMPHIBIANS

Warmer winters and springs may result in shifts in phenology. Gray tree frogs and Pine Barrens tree frogs may breed earlier, and this may lead to novel species assemblages in breeding ponds.



Eastern Fence Lizards

Fence lizards prefer to be quite warm (~92 °F) and increase their body temperature by basking in the sun even on cool days.

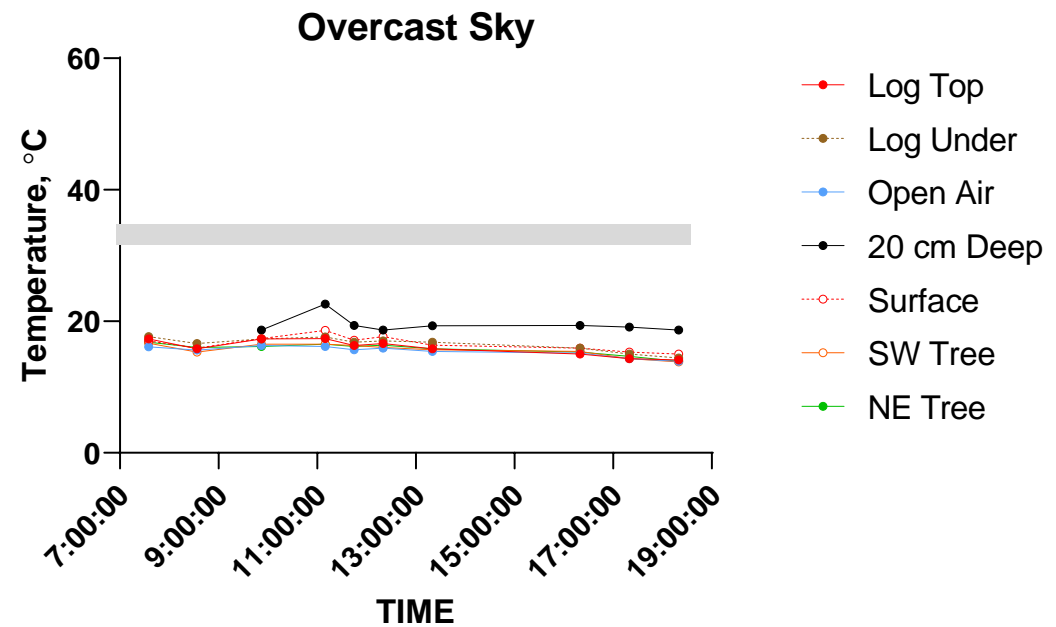
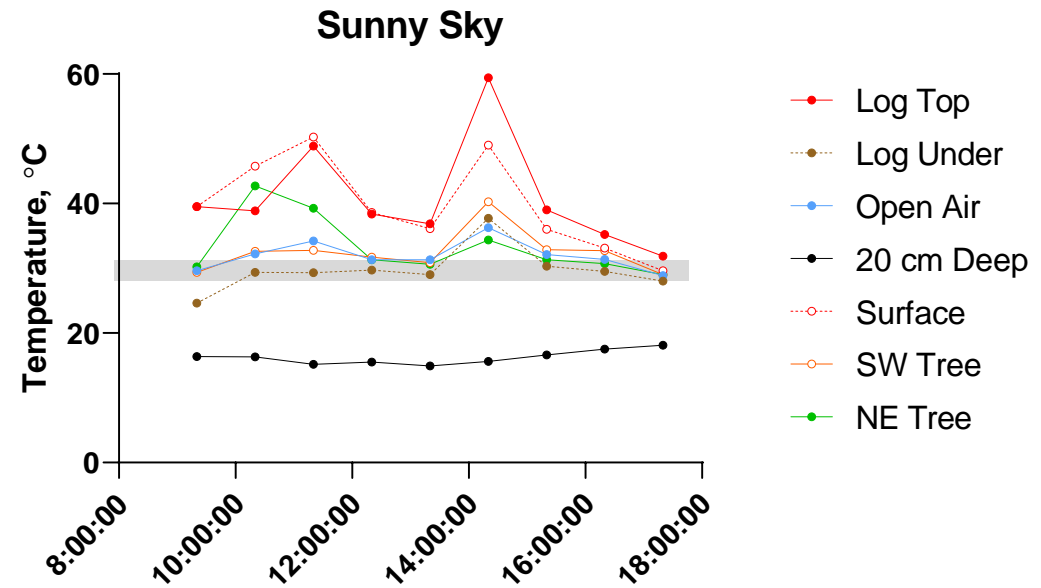


Local habitat differences affect animal distributions.

Sunlight drives thermal heterogeneity in oak-pine forest

On sunny days, temperature varies in time and in space

Operative temperature range for fence lizards



Eastern Fence Lizards

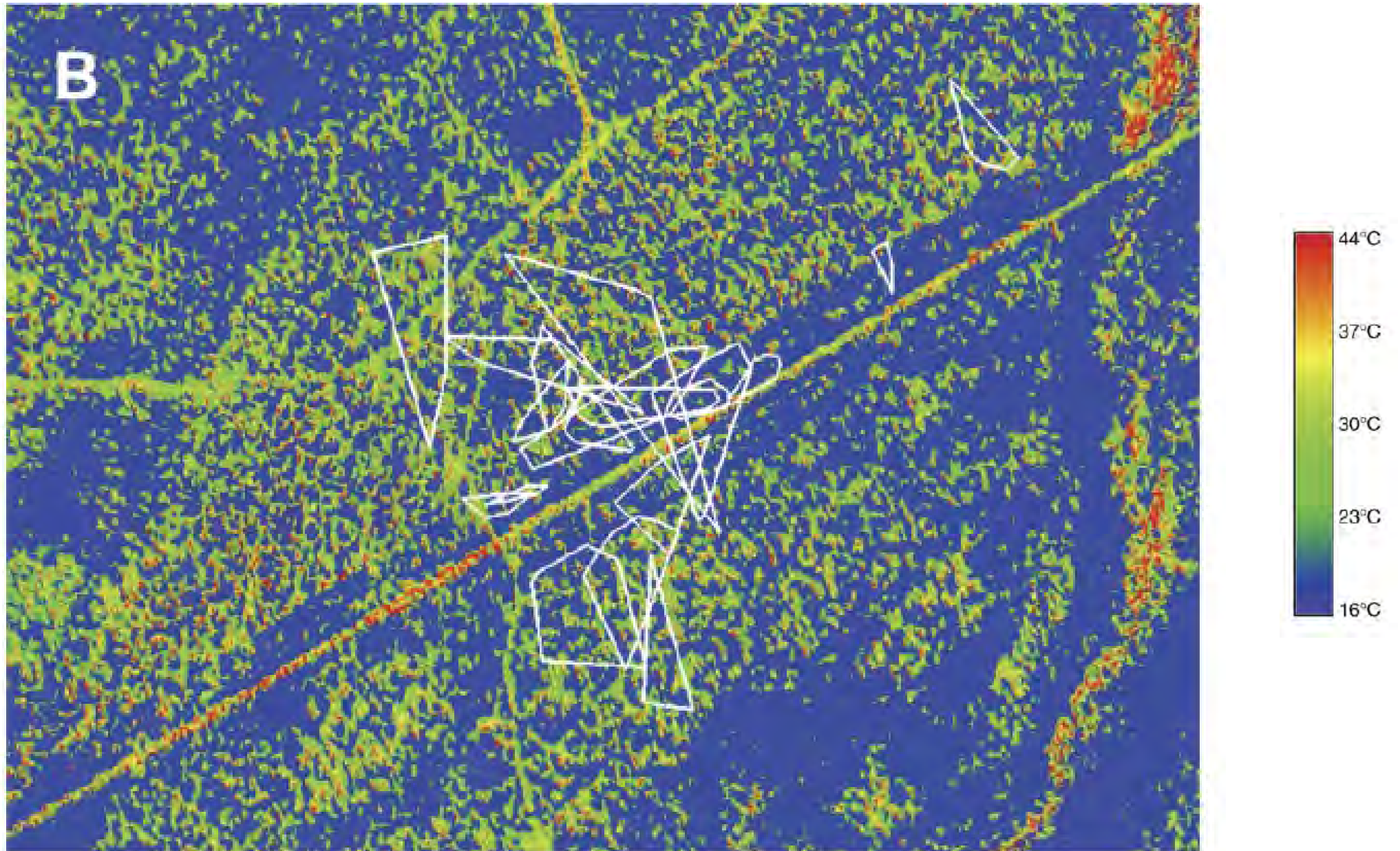
On very hot days, fence lizards seek thermal refuge under the closed canopy.



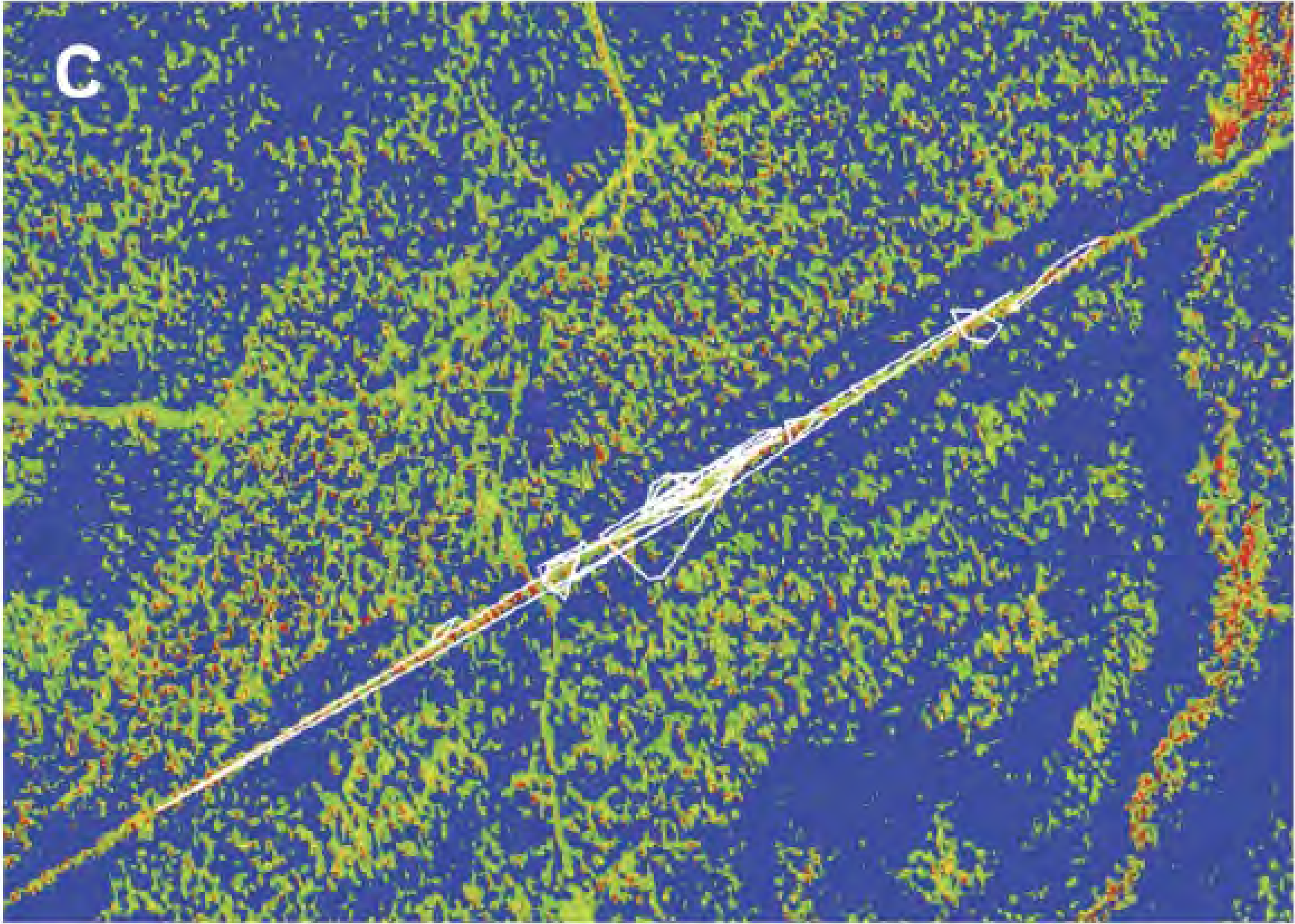
Fence lizards select nest sites for beneficial thermal properties.

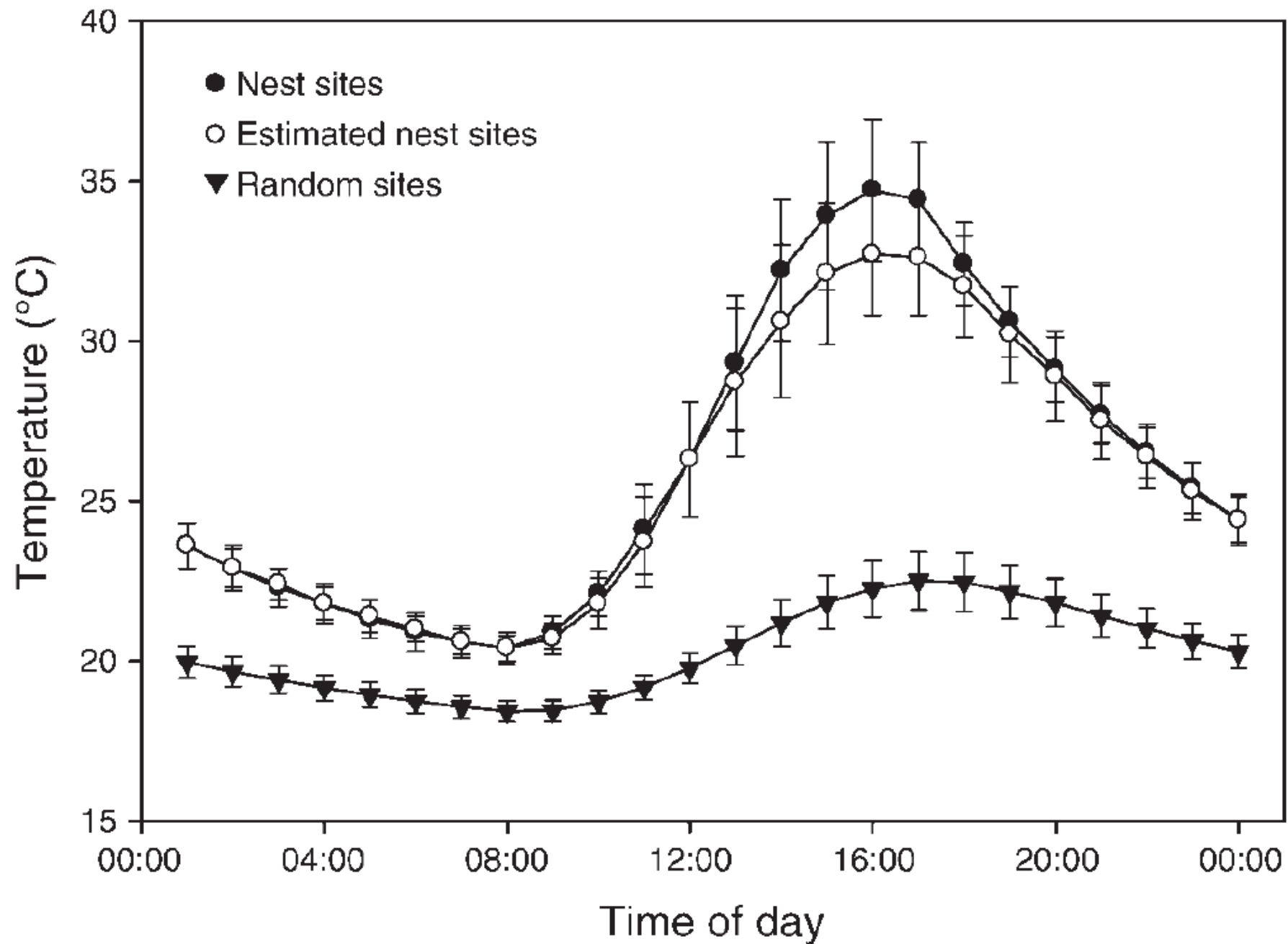


Eastern fence lizards: non-breeding home ranges.



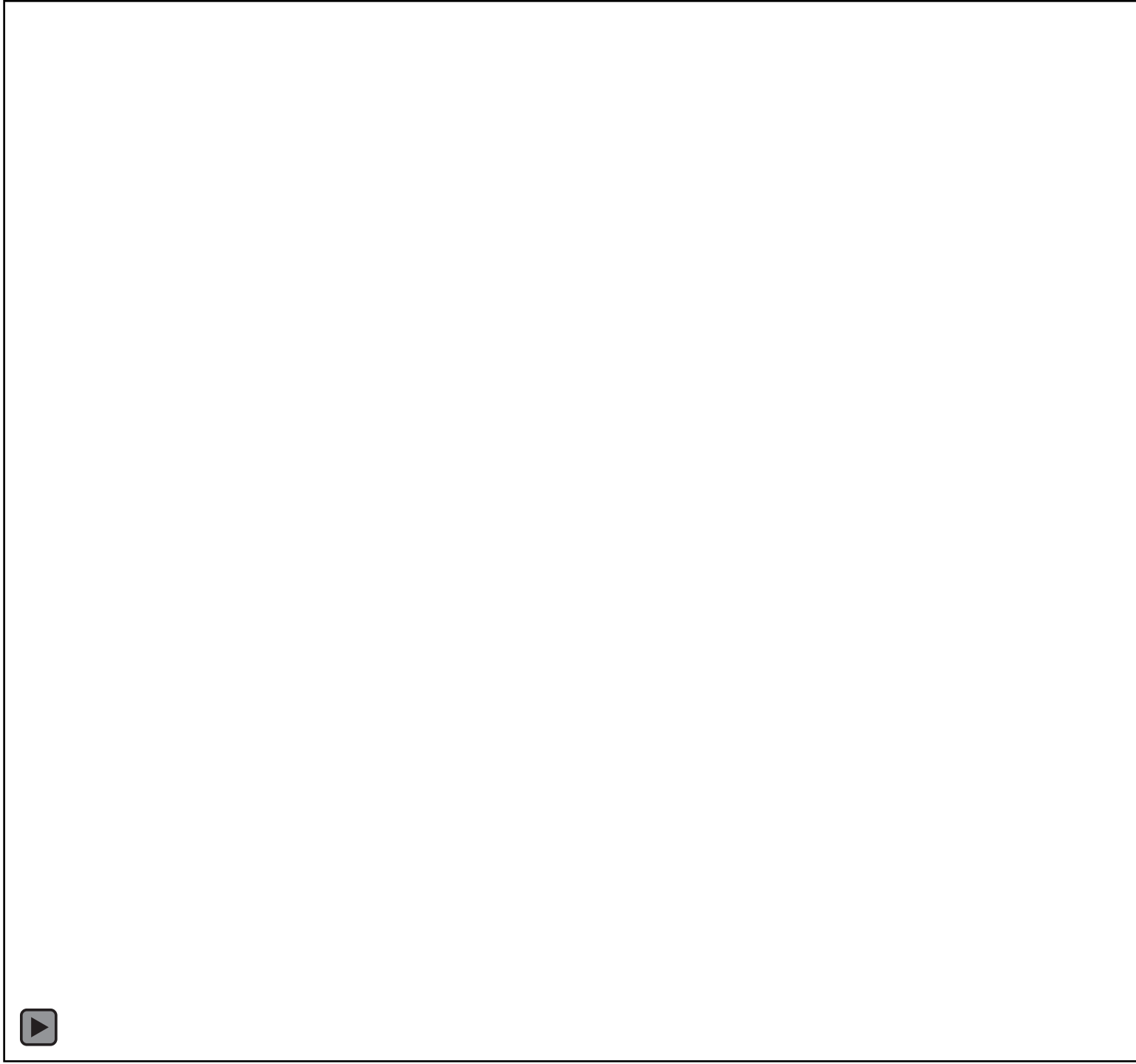
Eastern fence lizards shift microhabitats to build nests with beneficial thermal properties.





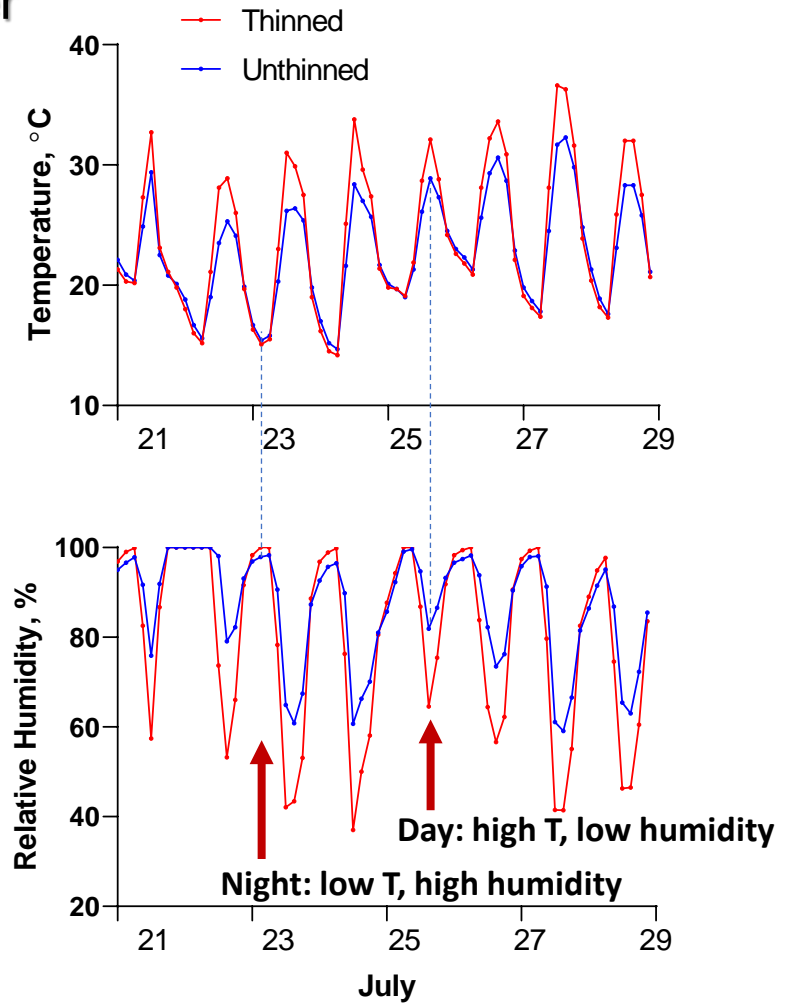
Summary

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2. Relevant **scale of microclimate depends on body size**.
3. Amphibians: breeding phenology is constrained by thermal ecophysiology. Climate change may result in **loss of breeding habitat and shifts in phenology**, with possible changes in species assemblages in breeding ponds.
4. Lizards: Local distribution and nest site selection are constrained by thermal ecophysiology. In near-term climate change, lizards may experience **longer growth seasons, faster development, and shortened generation times**. By the end of the century, **local extinctions** could occur.



Ticks

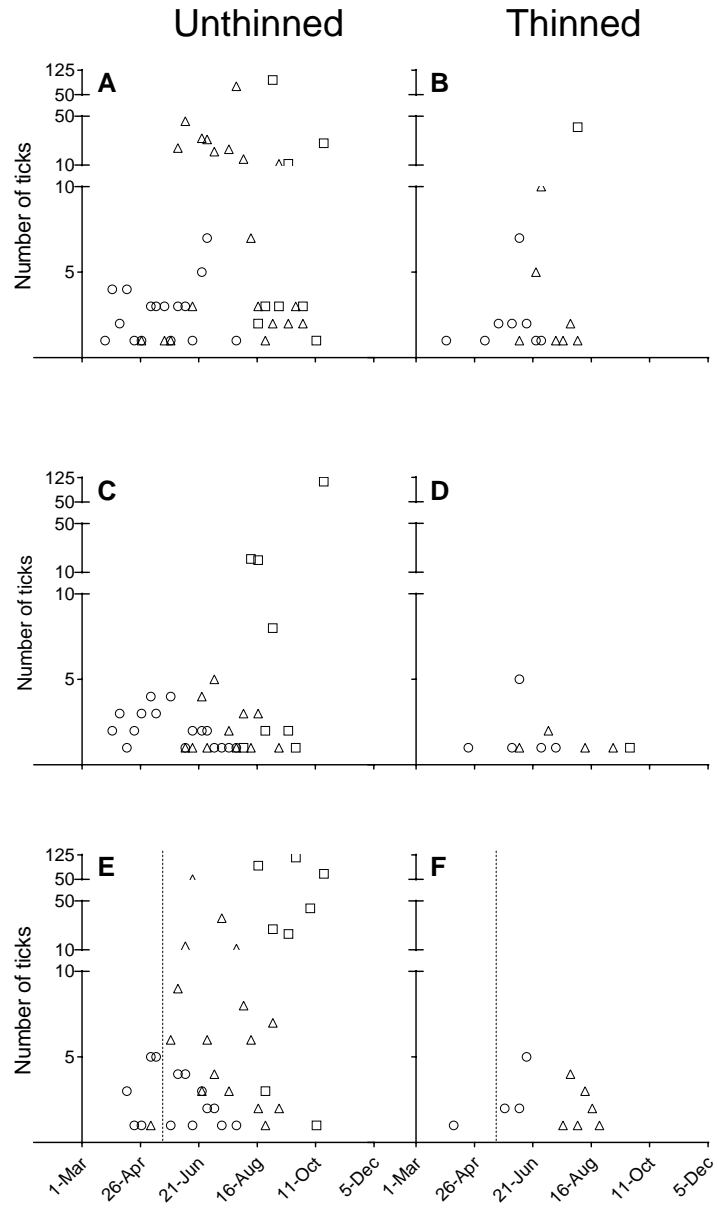
Forest thinning: 78% →→ 46% canopy cover



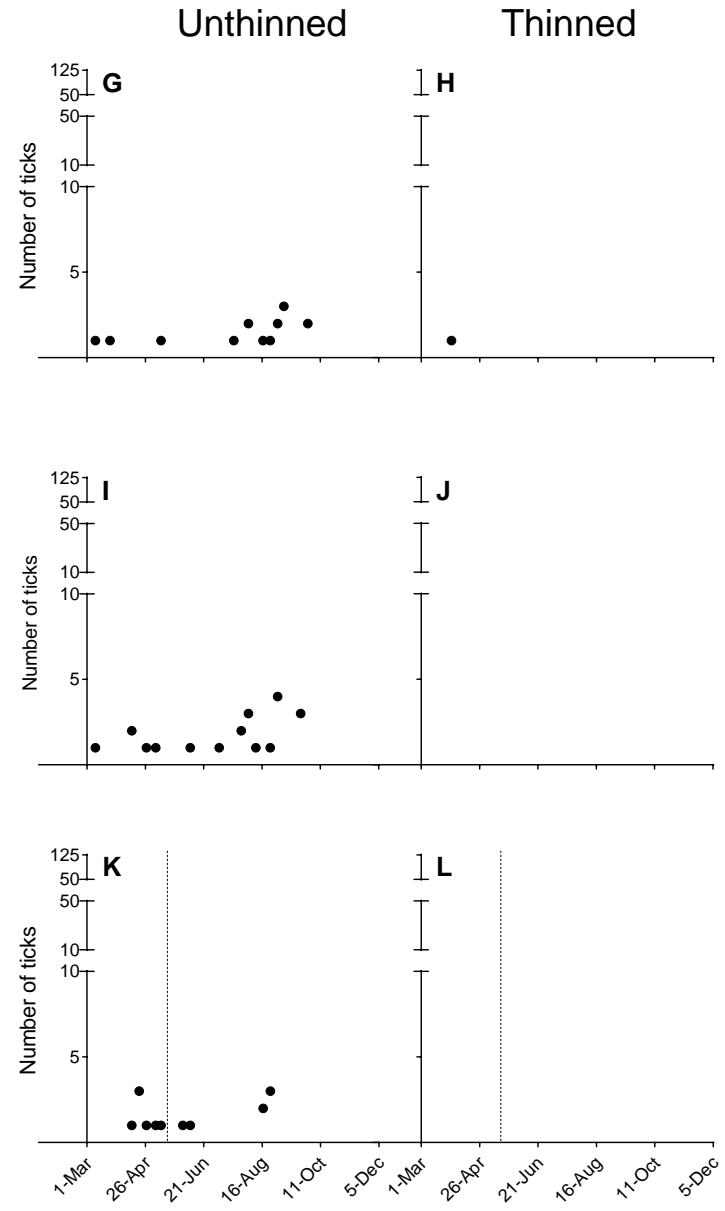
Forest thinning →→ hotter, drier microclimate

Forest thinning →→ hotter, drier →→ ↓ questing behavior of ticks

Lone star ticks

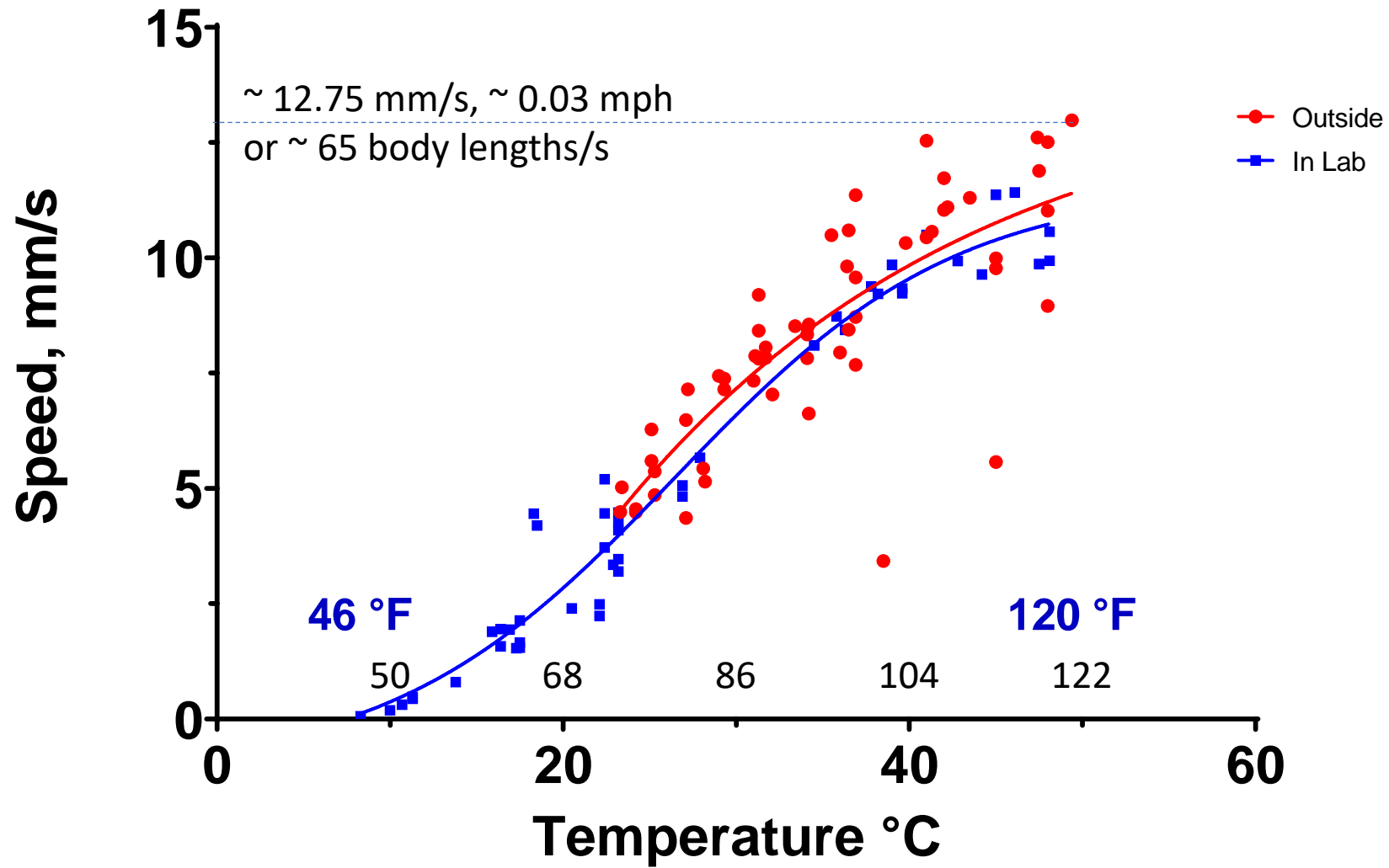


Black-legged ticks





Chigger mites thrive at high temperatures.



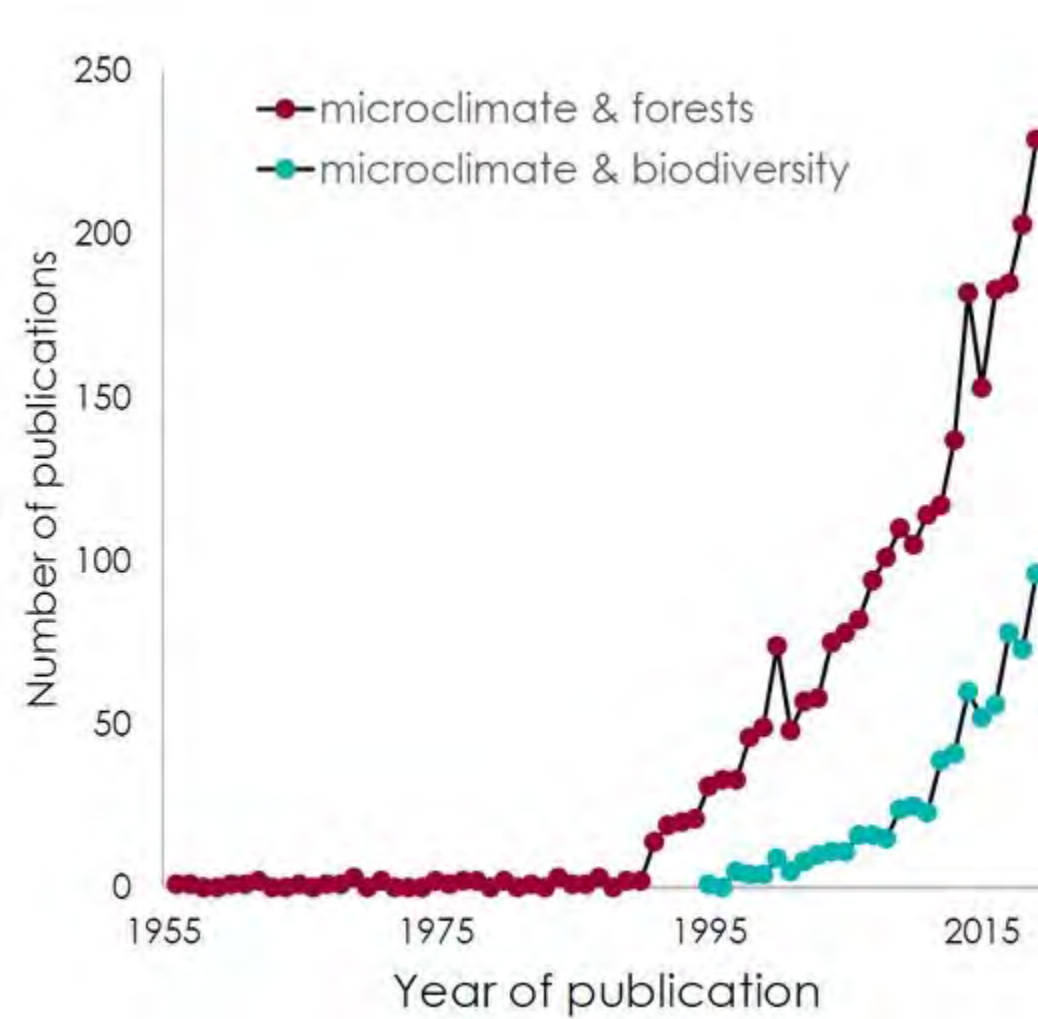
Summary

1. **Relevant scale of microclimate** depends on body size and thermal ecophysiology.
2. Amphibians: climate change may result in loss of breeding habitat and **shifts in phenology**, with possible changes in species assemblages in breeding ponds.
3. Lizards: In near-term climate change, lizards may experience **longer growth seasons and shortened generation times**. By the end of the century, local extinctions could occur.
4. Ticks: **Reduced questing behavior** in warmer, drier conditions.
5. Chigger mites: These ubiquitous little creatures are **likely to thrive**.



8.3° c

The Climate Near the Ground. Rudolf Geiger. 1923.

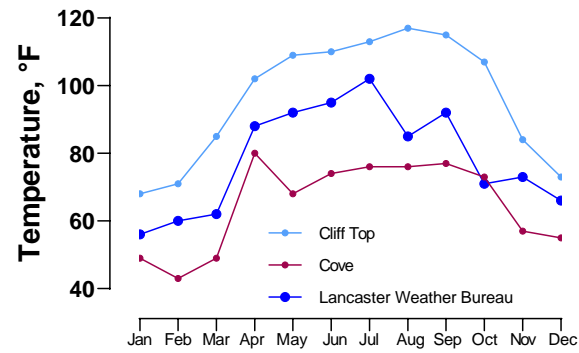


Pinelands animals vary over many orders of magnitude in size.

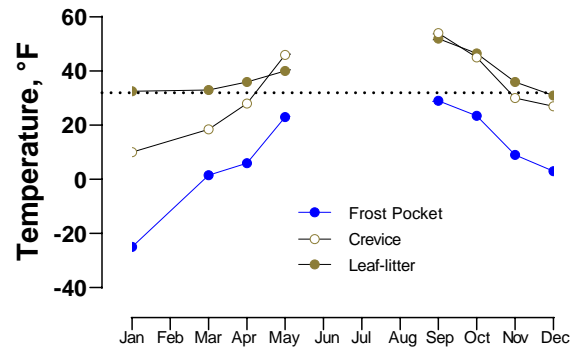
Fauna	Length (mm)	Mass (kg)
Human (torso)	760	75
Lizard (SVL)	70	0.01
Lone star tick	3-4	4×10^{-6}
Chigger	0.2	8×10^{-9}

Comparison	Length Ratio	Mass Ratio
Human / Lizard	11	7,500
Human / Tick	~225	~20 million
Human / Chigger	3800	9.4 billion
Lizard / Chigger	350	1.25 million

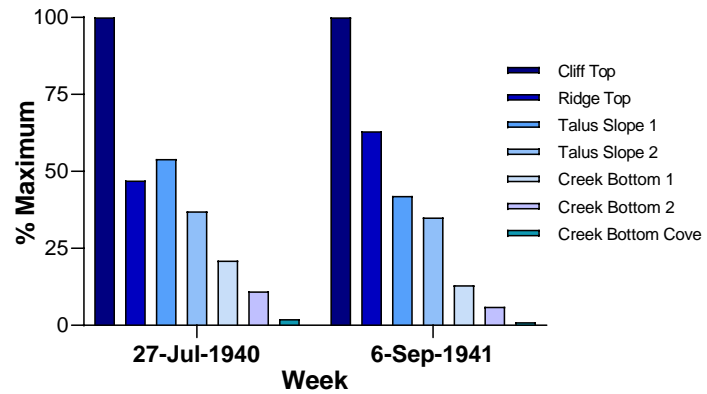
Monthly Maximum Temperature



Monthly Minimum Temperature

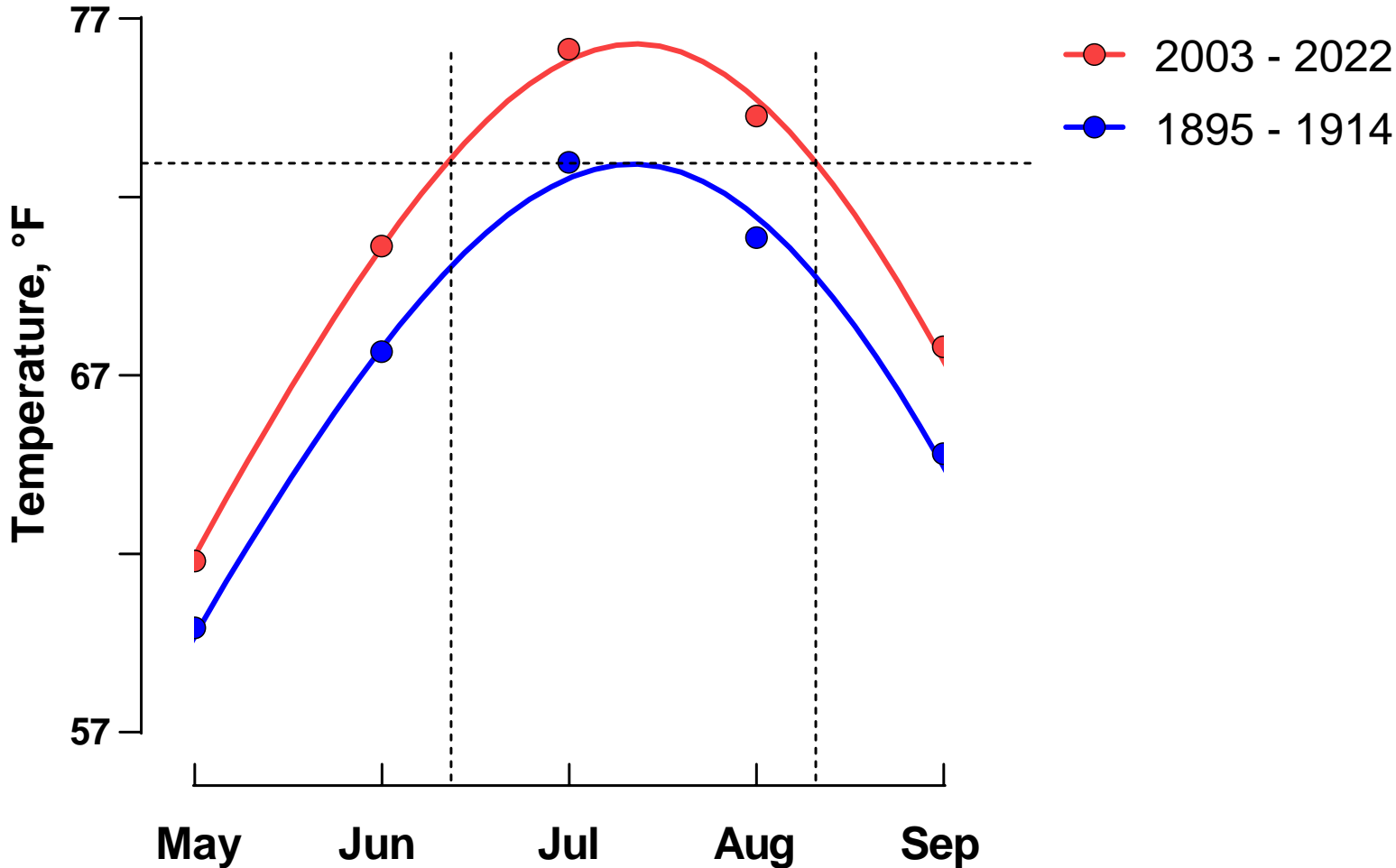


Relative Evaporation



In the summer, average temperatures are warmer now than they ever were 125 years ago.

Average Monthly Temperatures



In turn, wind speed, sunlight, water availability, and temperature affect heat exchange between organisms and the environment.

