Off the sand and onto the asphalt: Does the urban heat island impact desert lizards?

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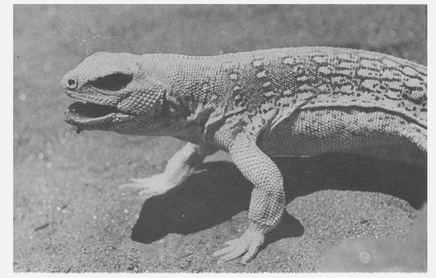
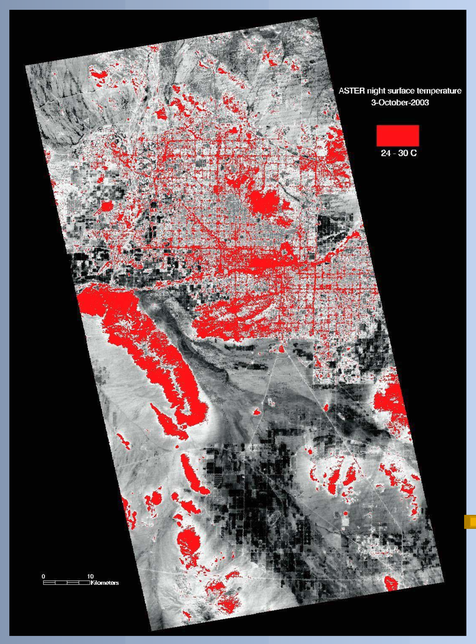
A cold stressed Horned Lizard is unable to move off the authors finger. Anthropogenic heat can benefit ectotherms in some circumstances. Image: Author



A Desert Iguana showing signs of extreme heat stress. Thermoregulatory behaviors include open mouth breathing and elevating the abdomen. Image: Cowels and Bogert 1944

Spatial Impacts (+/-)



Surface temperature map of Phoenix from NASA ASTER satellite (9 m^2 resolution).
Figure:: CAP LTER

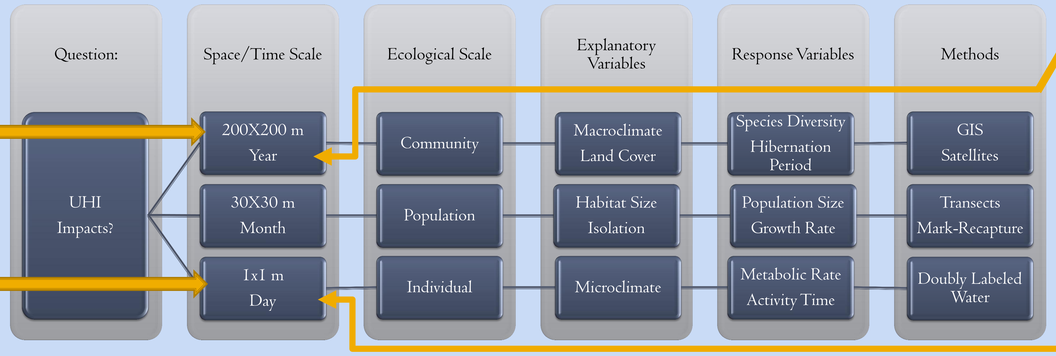
Global warming is predicted to drive almost 40% of lizard populations extinct by 2080 (Sinervo et al. 2010).
In Phoenix, AZ, urban heat island (UHI) "hot spots" greatly exceed global warming predictions.

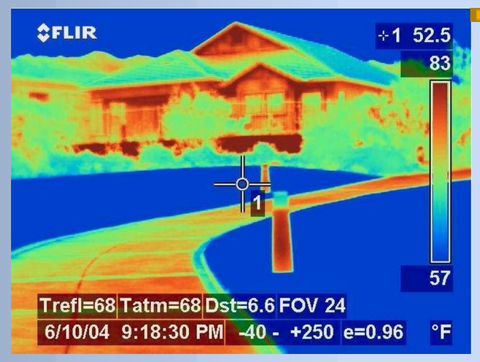
Research goals:

- *measure the spatial and temporal structure of the UHI at scales relevant to individual organisms.*
- *identify how the UHI impacts the daily activity and population viability of lizards.*
- *provide a basis for determining the relative significance of the UHI and other urban variables.*

Hypotheses

- **Spatial:** If the UHI is a primary factor influencing lizards, then environmental temperature (T_E) should explain a large portion of the variance in lizard distribution, diversity, and abundance across Phoenix.
- **Temporal:** At hotter sites, low potential activity times will impact behavior and metabolism of individual lizards, ultimately limiting population growth.
- **Alternative:** Variation in reptile communities will be best explained by non-thermal urban habitat characteristics (e.g. road densities, land cover/use types, habitat size, isolation, and fragmentation).

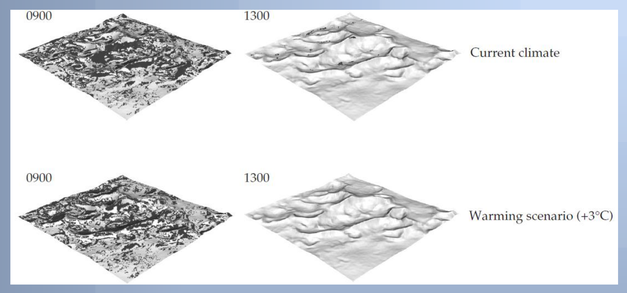




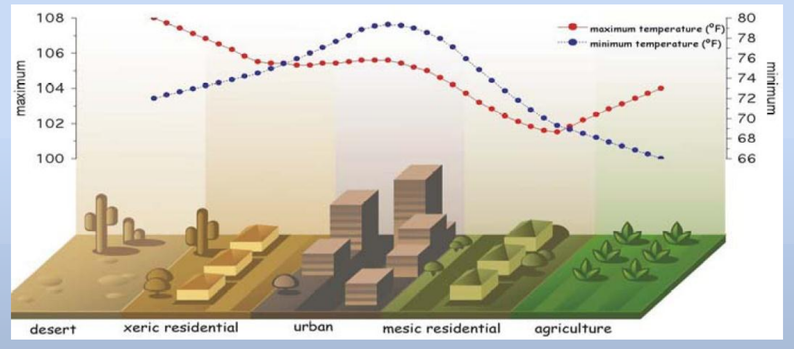
Surface temperature image of a house, sidewalk, and irrigated grass (blue area).
Figure: CAP LTER

Predicted Results:

- **Spatial:** Diversity and abundance will be lowest in areas where cool microclimate refugia are not available.
  - Species absent from the hottest areas will be those with a low physiological tolerance of high T_E.
- **Temporal:** Summer activity periods will end earlier in the morning and begin later in the afternoon at hotter sites.
  - Winter hibernations will be shorter at hotter sites.

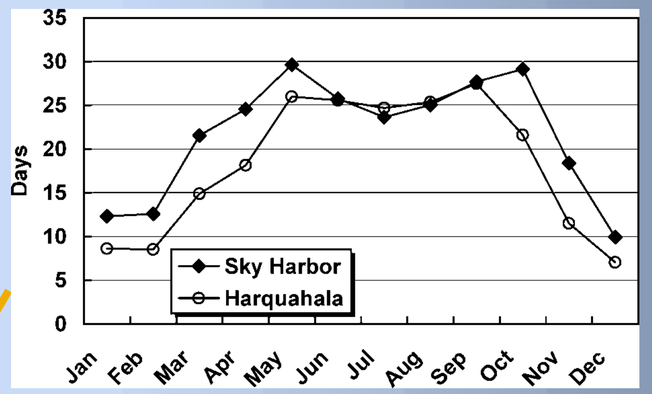


Warming reduces spatial availability of tolerable T_E (darker area). **Top:** By 1300 hours, tolerable T_E is almost nonexistent in the current climate. **Bottom: A** warming scenario reduces tolerable T_E at 0900 hours, and eliminates it at 1300. (Figure: Angilletta 2009)

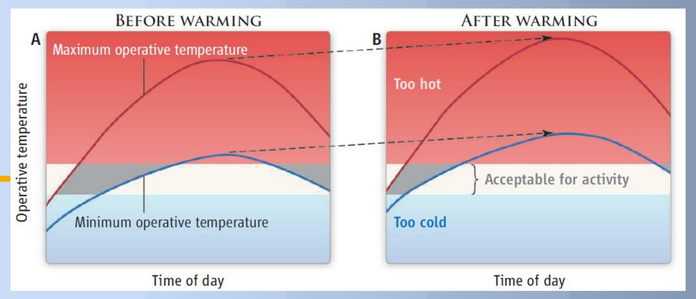


Ornate Tree Lizards are the only species that persists across all of Phoenix.
Is the UHI a limiting factor in lizard distribution and abundance or are urban habitat characteristics more important?
Figure: CAP LTER

Temporal Impacts (+/-)



In winter, monthly potential activity time may be higher at hotter urban sites (Sky Harbor Airport) than in rural areas (Harquahala).
Figure: Baker et al. 2002



In summer, daily potential activity time (grey shaded area) may be lower at urban sites (after warming) than in rural areas (before warming). If the UHI has a positive influence on lizards in winter, can they adapt to the negative impacts in summer?
Figure: Huey et al. 2010

Significance

- Integrates ecology, physiology, geography, and climatology at multiple scales.
- Enhances our understanding of the UHI, supports urban environmental management, and informs research on global warming.

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