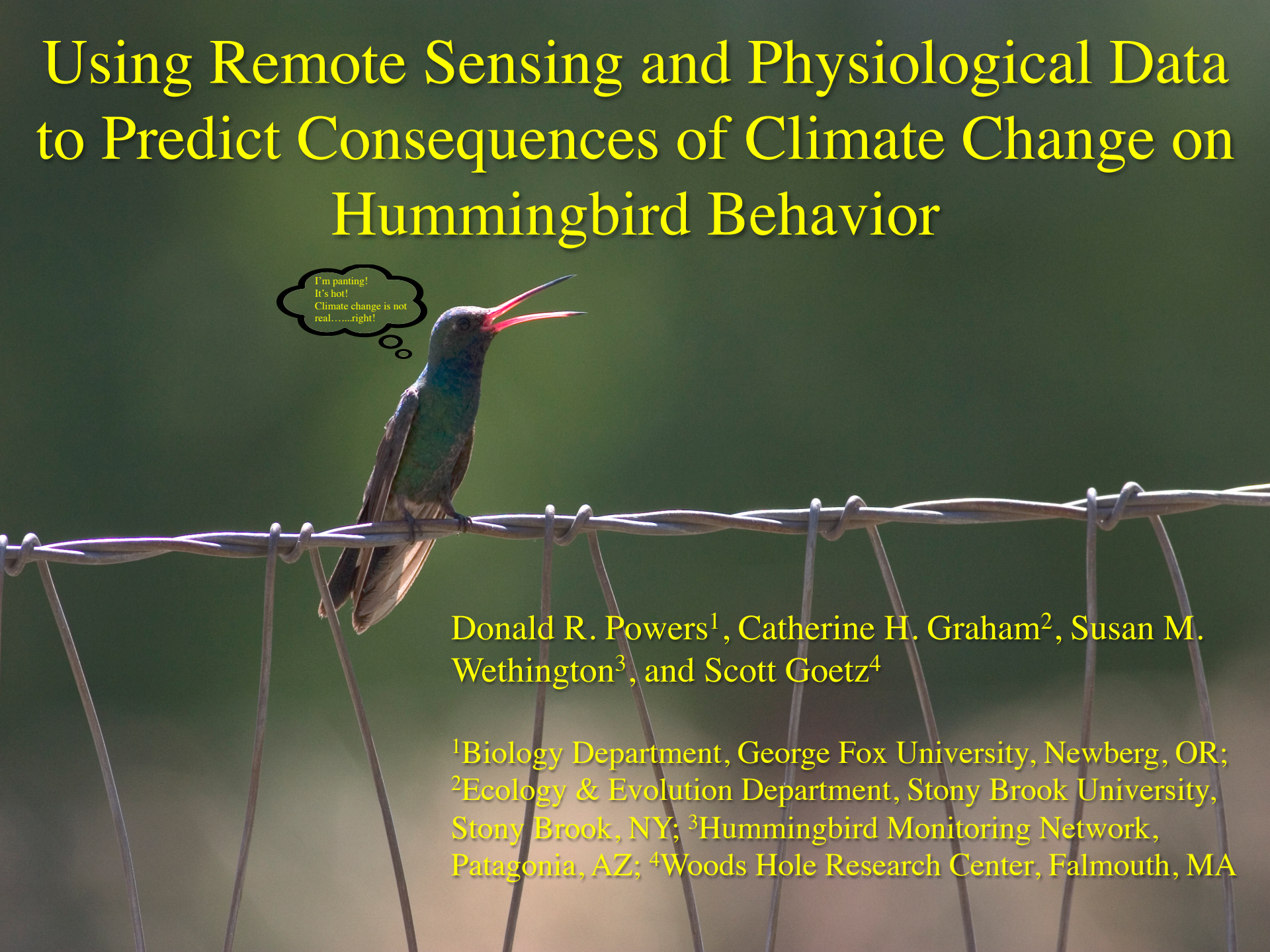
Using Remote Sensing and Physiological Data to Predict Consequences of Climate Change on Hummingbird Behavior



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Why Hummingbirds?

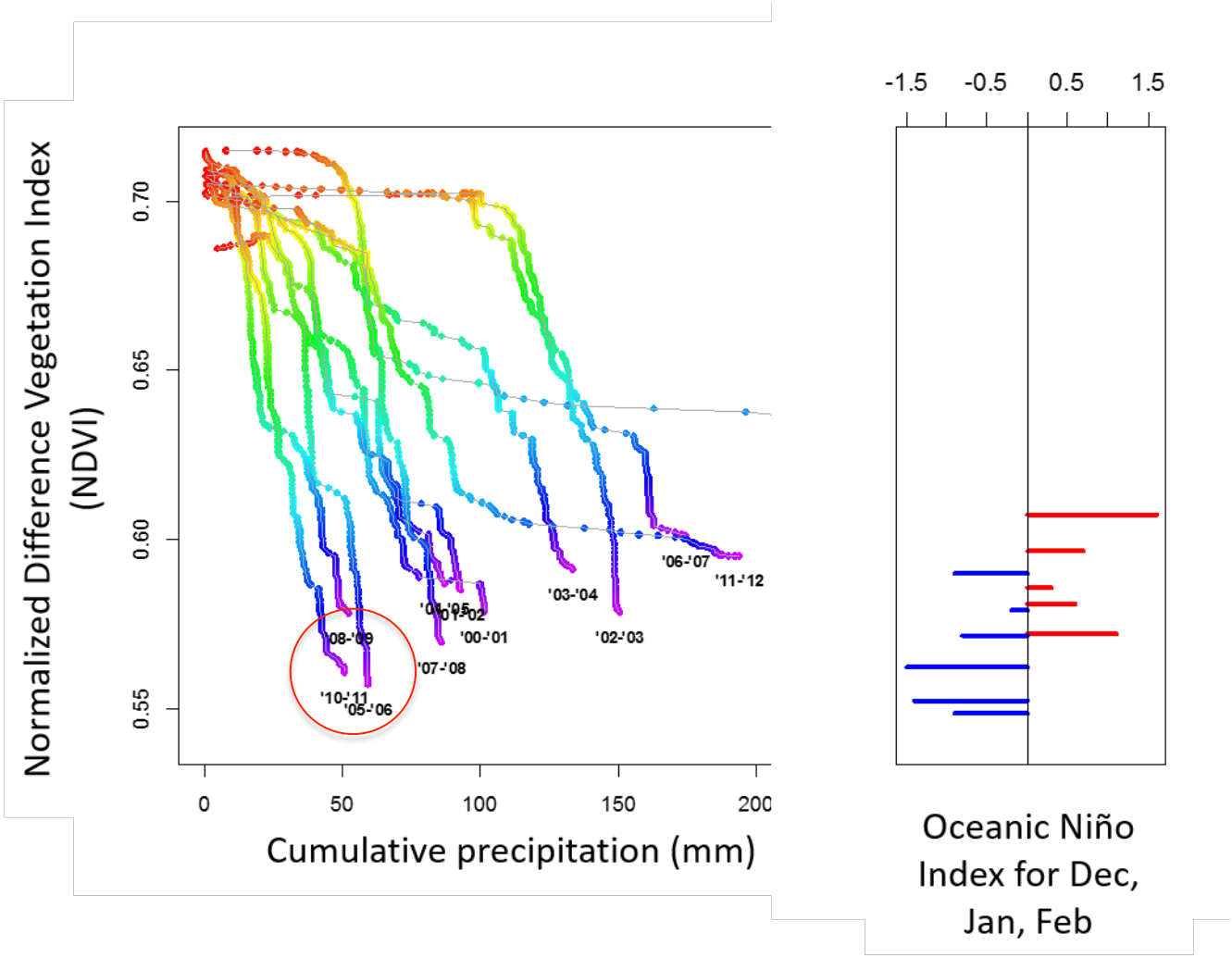
Physiological Sensitivity to Climate Change:

- Hummingbirds exist at the small-size extreme of endothermy.
- Hummingbirds store little fat and thus live day-to-day.

Resource Sensitivity to Climate Change:

- Many plants critical to hummingbird natural history (e.g. foraging, reproductive behaviors, etc.) will also be impacted by increasing temperature.
- Hummingbirds are key pollinators in many ecosystems making them vital to plant reproduction.

Example: Resources drive behavioral shift



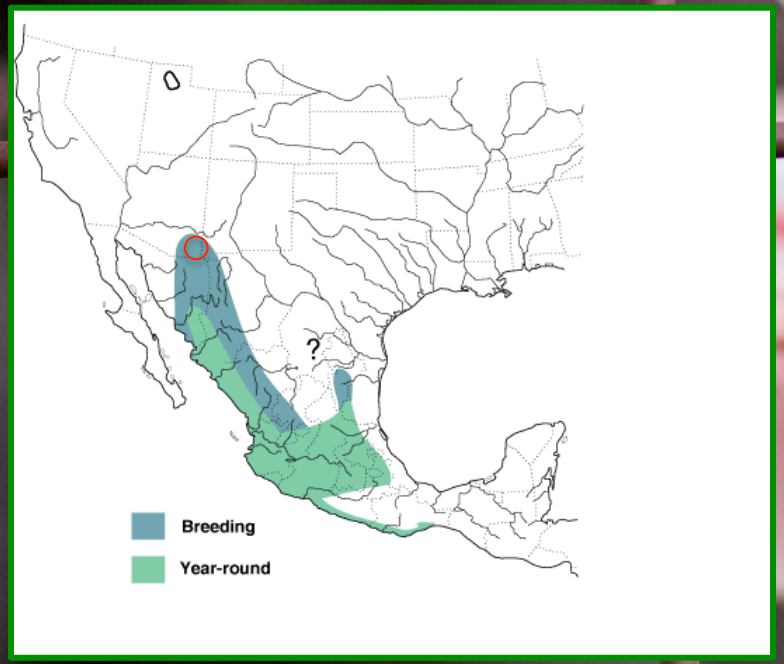
Low NDVI → hummingbirds migrate in earlier stage of molt

Three physiological response variables that appear impacted by high temperature

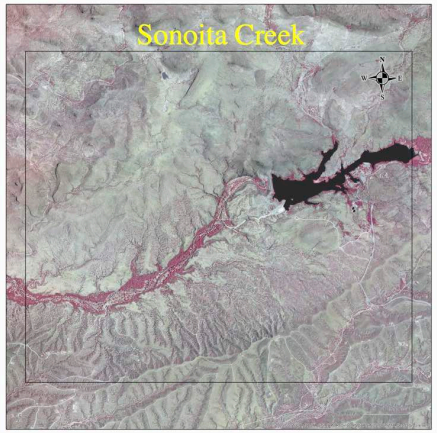
Broad-billed Hummingbird
Cynanthus latirostris

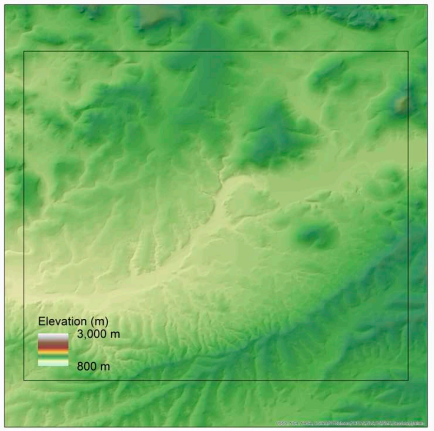
Weight: 3.2 g

Roughly the same weight as a penny!



Patagonia Study Sites



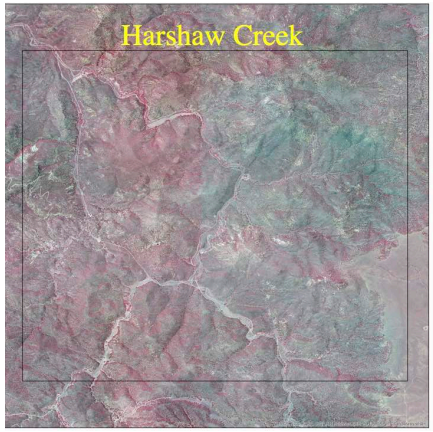


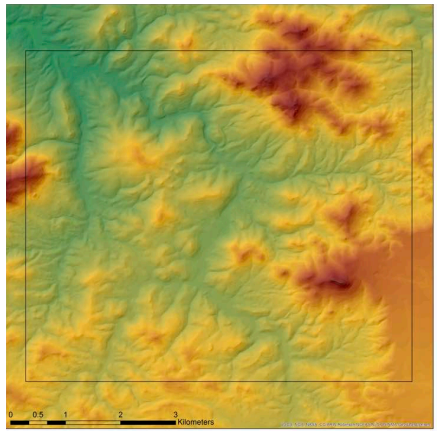
Vegetation coverage = 5.5%

Mostly in Riparian Zone

Low Topographic Diversity

Higher Mean Temperature/Lower Variation





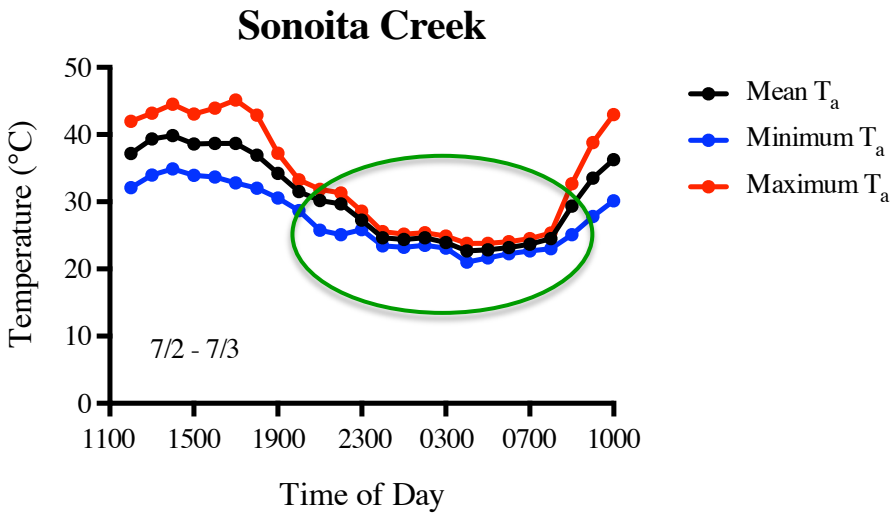
Vegetation coverage = 11.9%

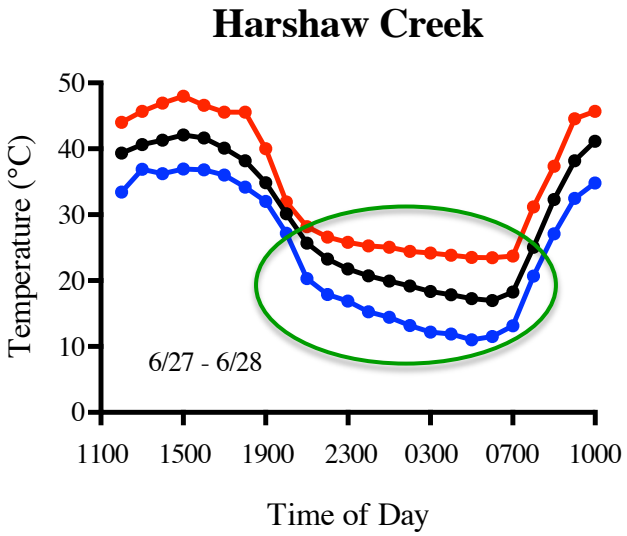
Mostly in Riparian Zone

High Topographic Diversity

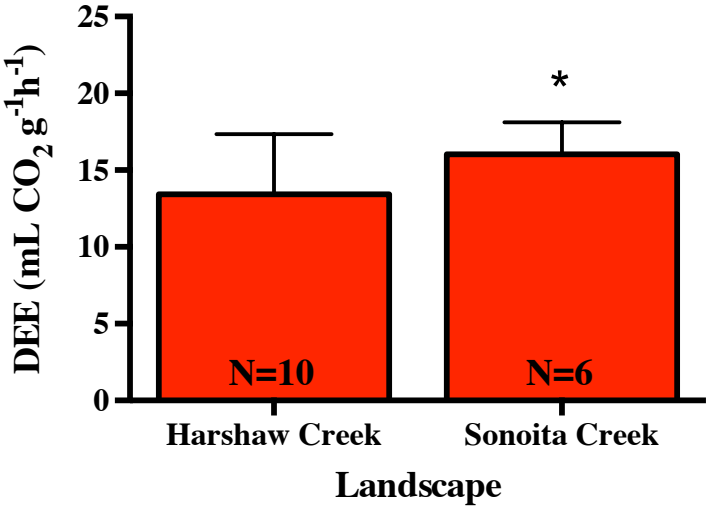
Lower Mean Temperature/Elevational Gradients

1) Landscape Thermal Diversity: Daily Energy Expenditure

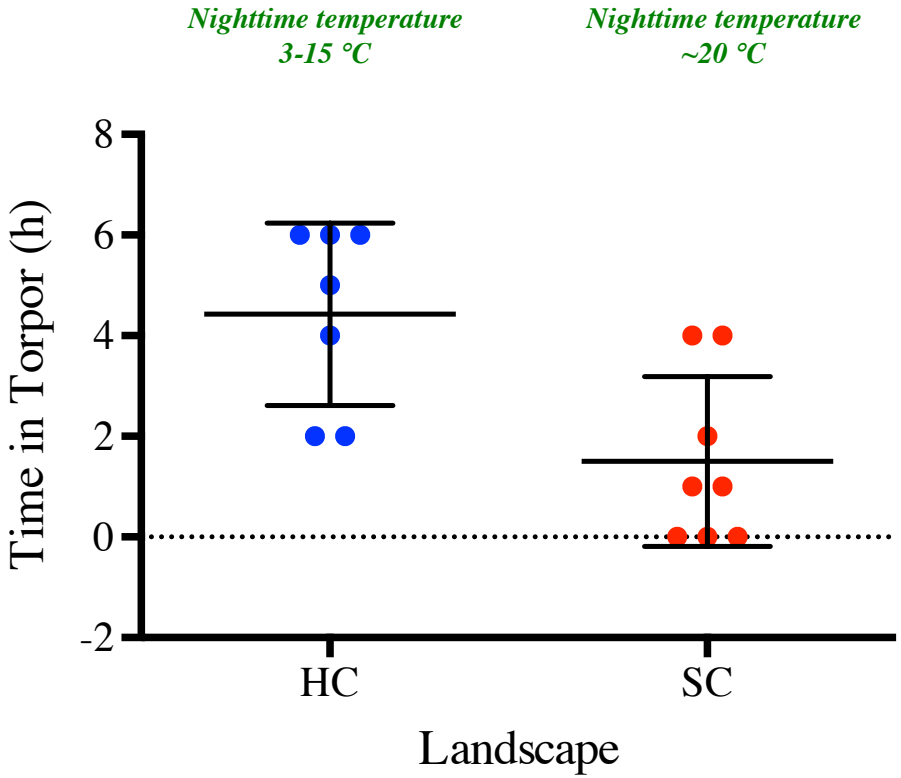


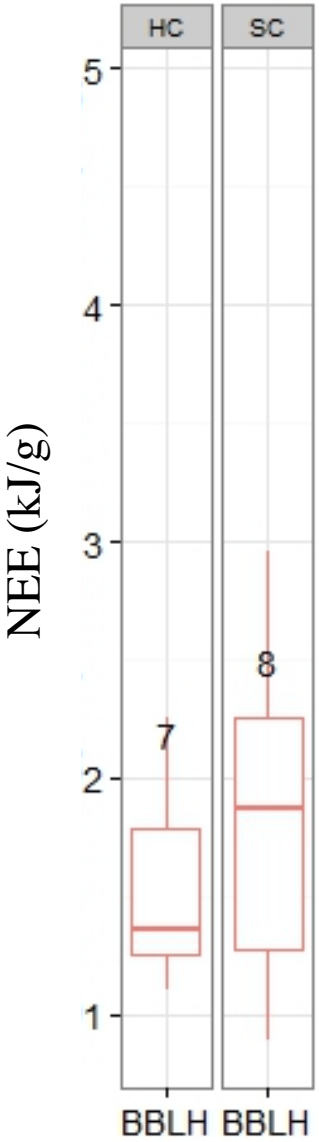


- DEE 16% higher at Sonoita Creek.
- Possibilities: 1) nighttime energy costs, 2) activity costs.



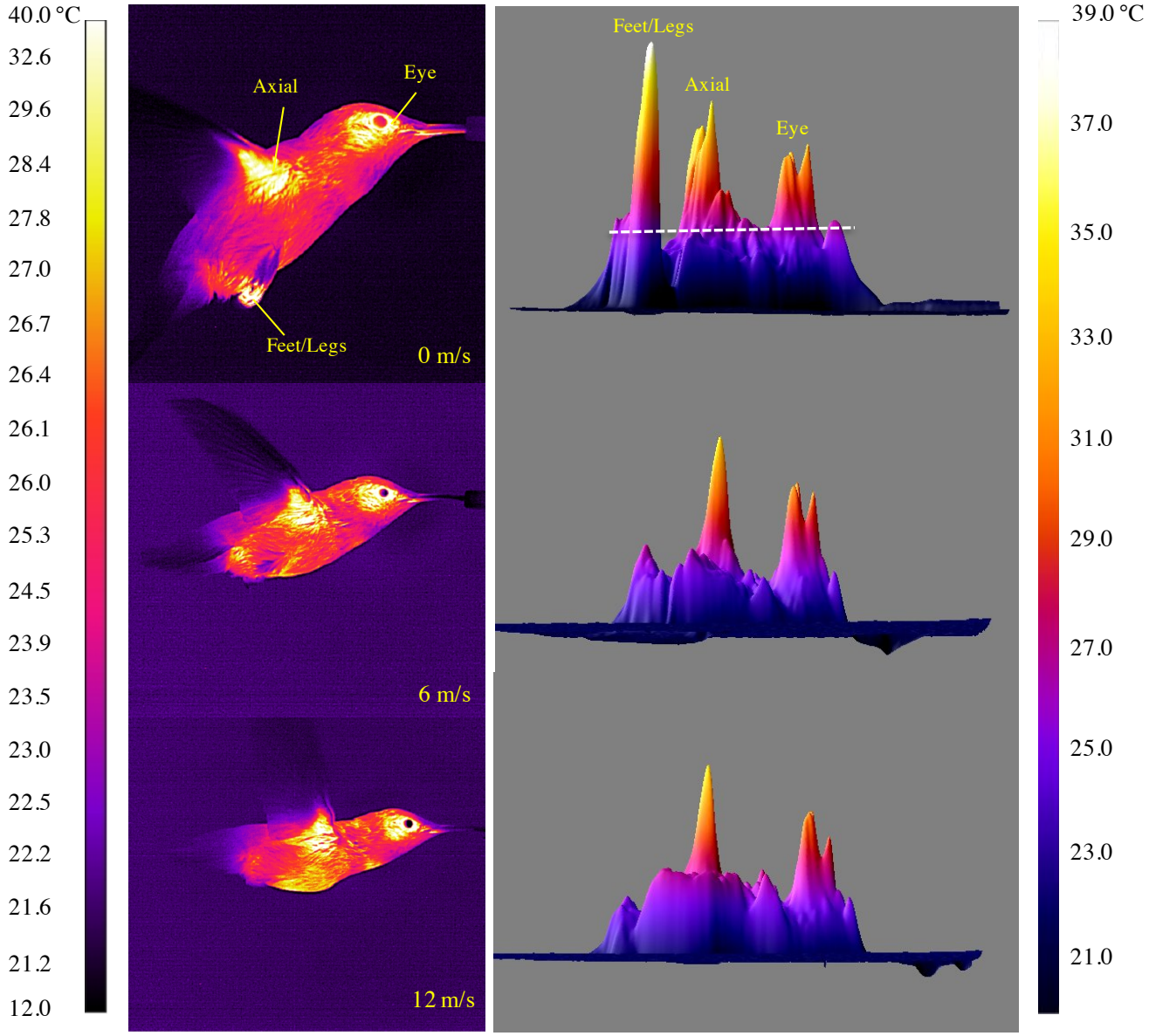
2) Landscape Thermal Diversity: Nighttime Energy Cost (Torpor)

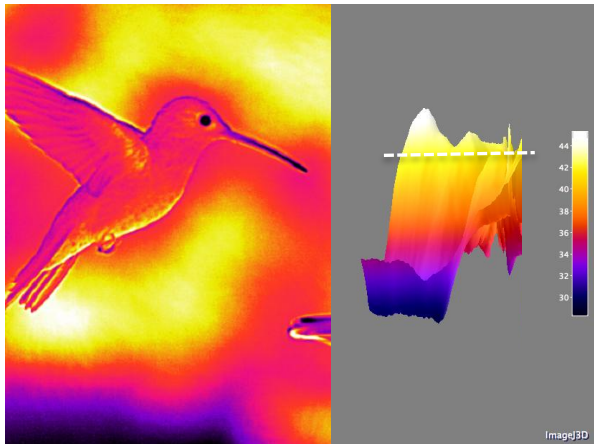




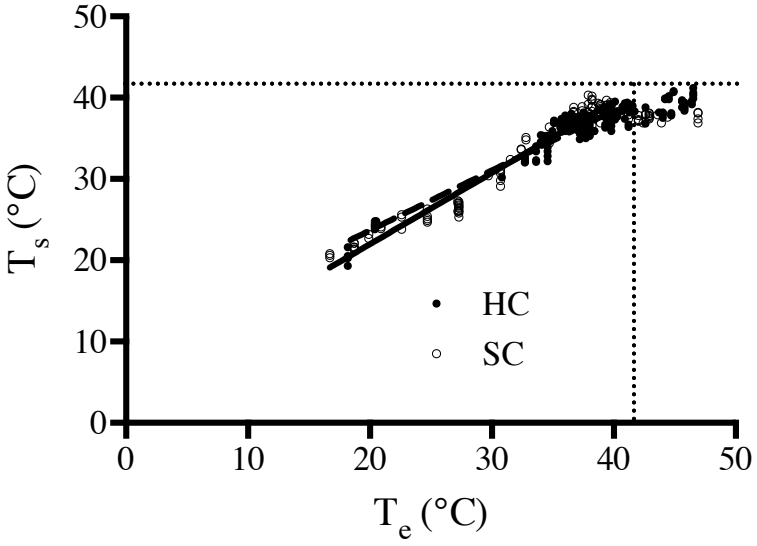
- Torpor use higher at HC.
- Nighttime energy expenditure (NEE) was ~45% higher at SC.
- Do higher nighttime temperatures reduce the value of torpor?

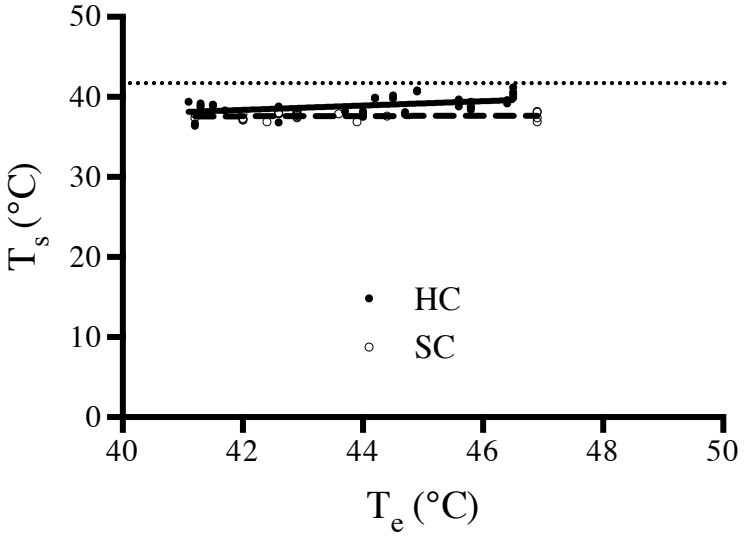
3) Landscape Thermal Diversity: Heat Balance and Activity





- Behavioral regulation of surface temperature at high environmental temperature.
- Activity costs associated with this could be dependent on habitat structure.





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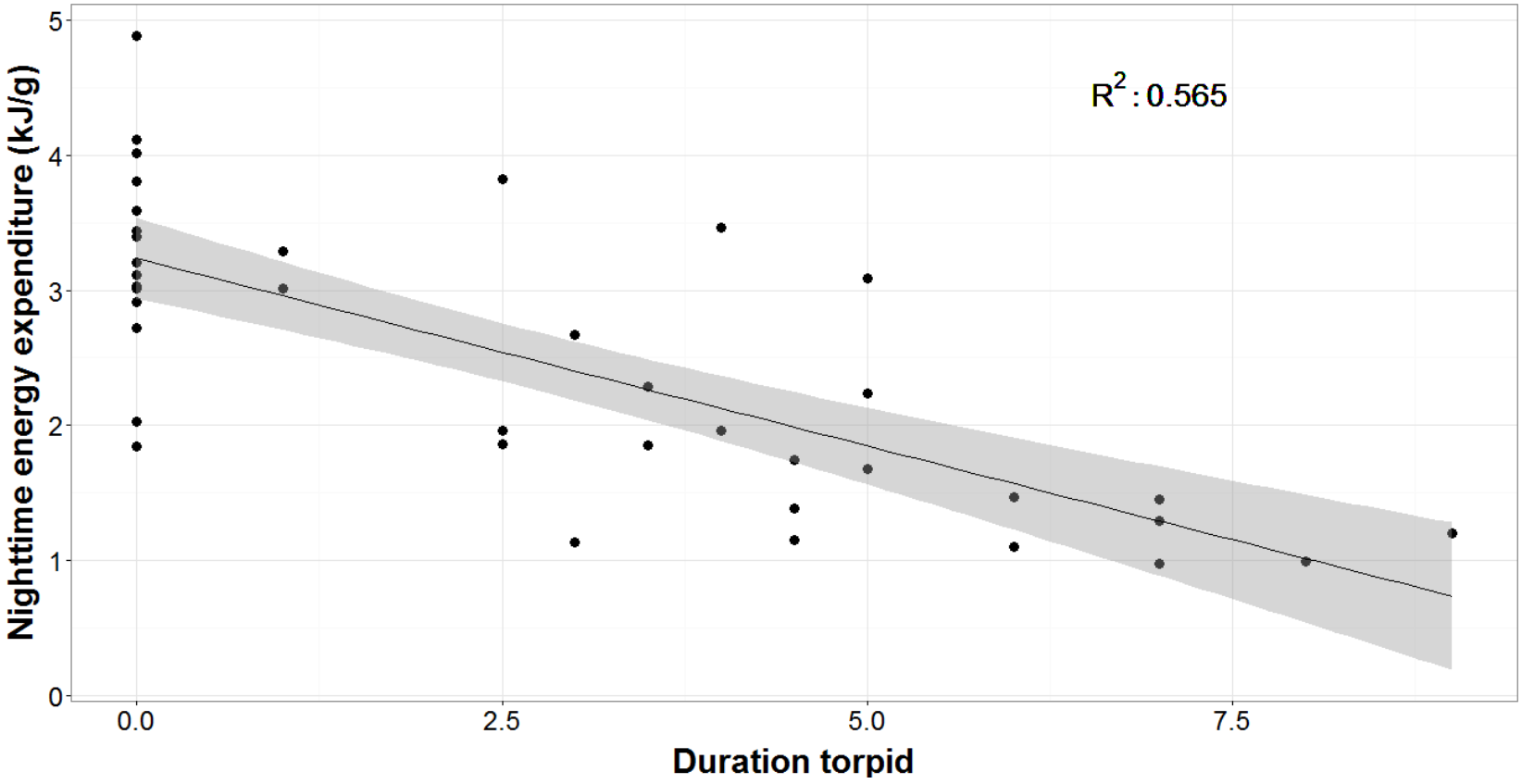
Questions???


R^2: 0.565
Nighttime energy expenditure (kJ/g)
Duration torpid
0
1
2
3
4
5
0.0
2.5
5.0
7.5

Energy Consumption: Maximum Feeding Rate

- *Climate change predicted to reduce floral nectar production.*
- *Hummingbirds will likely become more feeder dependent.*