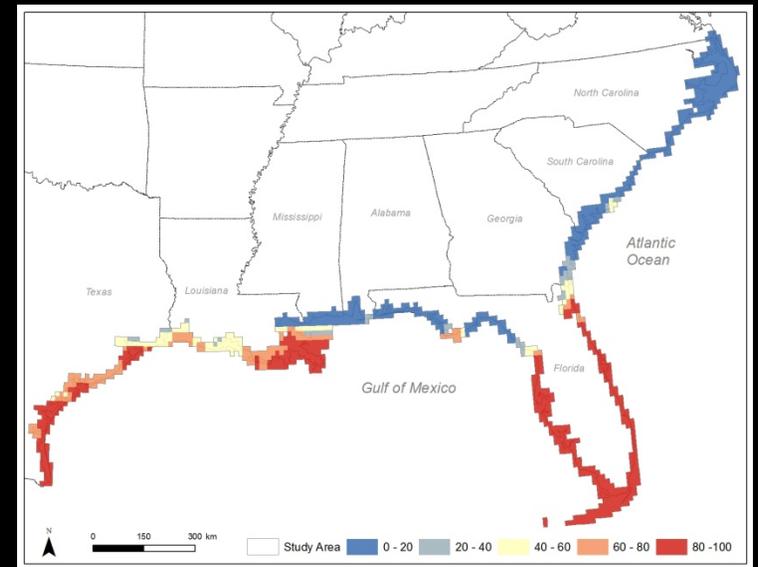


Distribution Modeling

Unit 3: Approaches to Vulnerability Assessment



A rose by any other name...

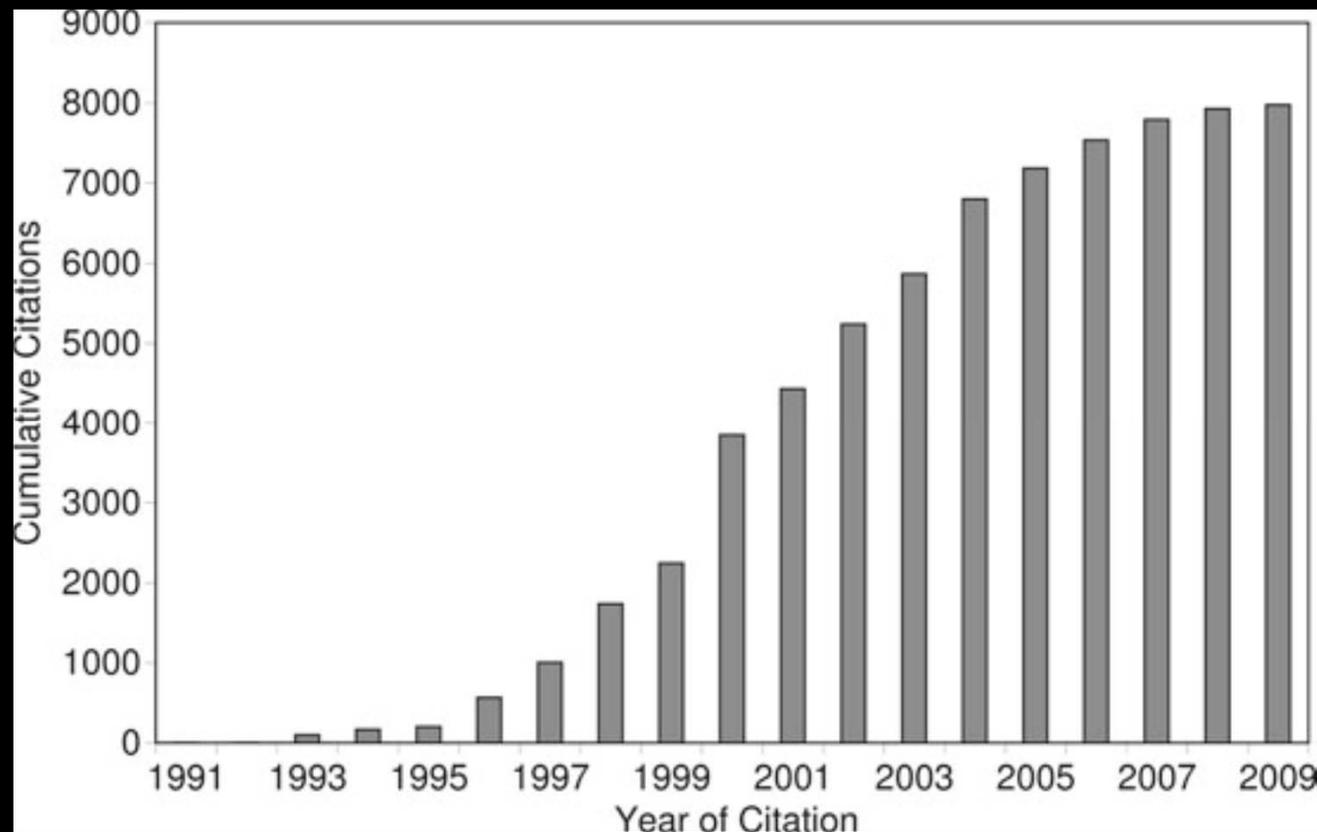
- Ecological niche modeling
- Element distribution modeling
- Predictive range mapping
- Habitat suitability modeling
- Climate envelope modeling

A rose by any other name...

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THE GOAL: capture species-environment relationships that characterize where the species can occur on the landscape

Species distribution modeling is widely used



From Johnson et al. 2012. in A.H. Perera et al. (eds.), *Expert Knowledge and Its Application in Landscape Ecology*

Common uses

- Discovery of new populations
- Risk of species invasions
- Reserve selection and design
- Restoration, translocation, reintroductions
- Climate change impacts on biodiversity

Methods for modeling species responses to climate change

- Forecasting distribution responses

Correlative models (PATTERNS):

- Phenomenological
- Relate current distributions to environmental variables

Mechanistic models (PROCESSES):

- Use explicit relationships between environmental variables and organismal performance
- Estimated independently of species current distribution



Methods for modeling species responses to climate change



ECOLOGICAL LETTERS
 Range Letters, 2010, 13, 104–109
 doi: 10.1111/j.1461-0248.2010.01715.x

REVIEW AND SYNTHESIS
 Can mechanism inform species' distribution models?

Abstract
 Two major approaches address the need to predict species distributions in response to environmental change. Correlative models measure phenological shifts by relating current distributions to environmental conditions. By contrast, mechanistic models incorporate explicit relationships between environmental conditions and organismal performance, instead of independence of current distributions. Mechanistic approaches include models that measure environmental conditions via biologically relevant metrics (e.g. growth duration of animals), models that capture environmental complexities of seasonality and seasonality, and models that are sensitive to the environmental conditions and geography. We compared how two correlative and three mechanistic models predicted the range of one species at eight levels of climate complexity and a lower level (climatic variables). Correlative and mechanistic models performed similarly in predicting current distributions, but mechanistic models predicted larger range shifts in response to climate change. Although mechanistic models demonstrably should provide more accurate distribution predictions, there is a need for research to improve their flexibility and performance.

Keywords
 Biophysical model, climate change, climate envelope model, demography, Endemism, niche, phenology, seed and niche, species' range model.

Introduction
 Rapid anthropogenic changes in climate conditions and associated environmental conditions are expected to impact species distributions. Despite this, we still lack a general understanding of how species distributions will change in response to environmental change. Despite this, we still lack a general understanding of how species distributions will change in response to environmental change. Despite this, we still lack a general understanding of how species distributions will change in response to environmental change.

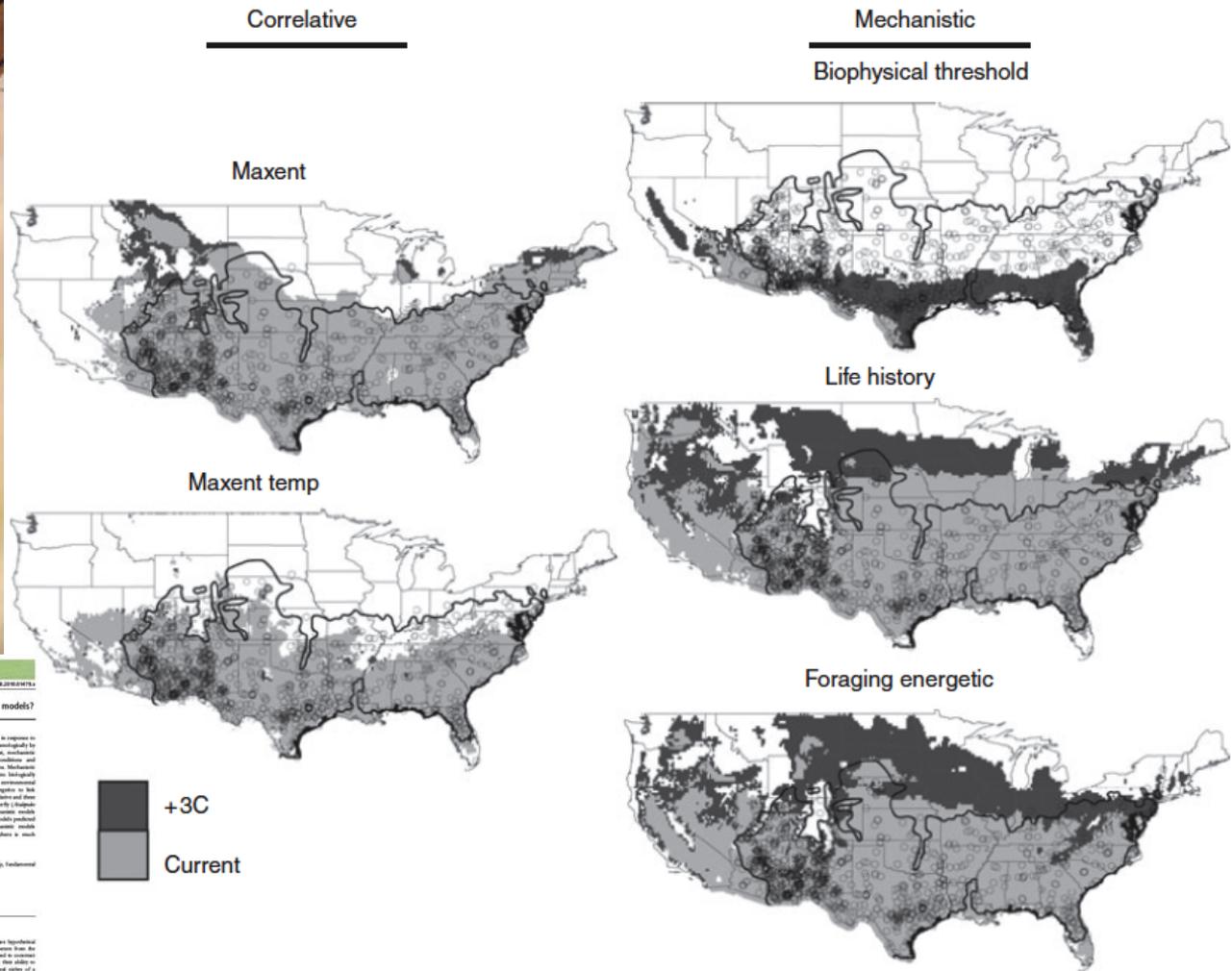
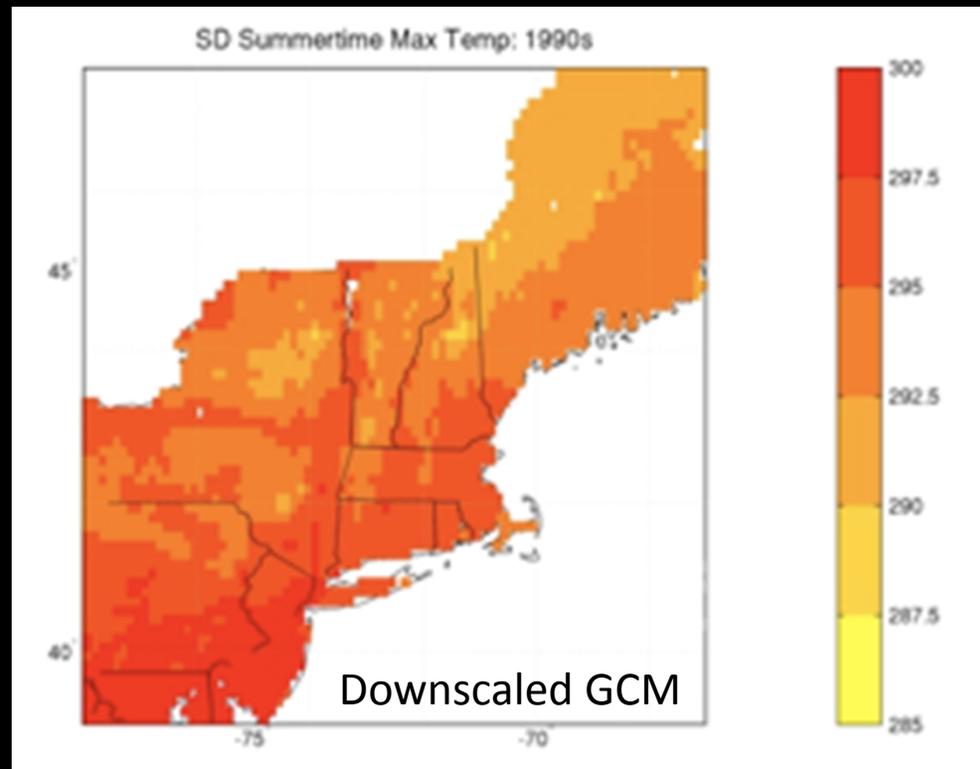


Fig. 1 Range predictions for *Sceloporus undulatus* in current climates (light gray) and predicted range expansions following a uniform 3 °C temperature increase (dark gray). Localities (o) and the atlas range polygon are shown.

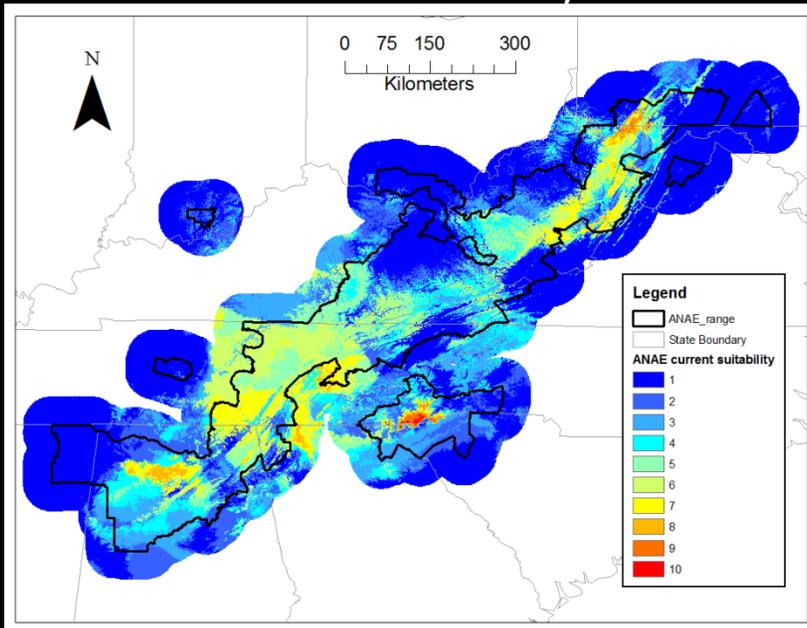
How can distribution models contribute to a vulnerability assessment?



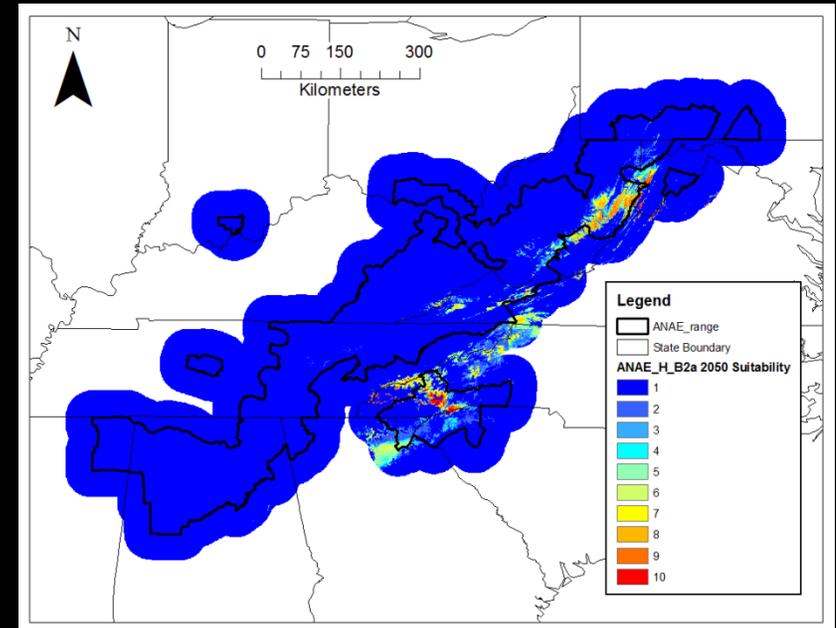
Qualitative assessment – estimate exposure qualitatively and piecemeal

How can distribution models contribute to a vulnerability assessment?

Current suitability

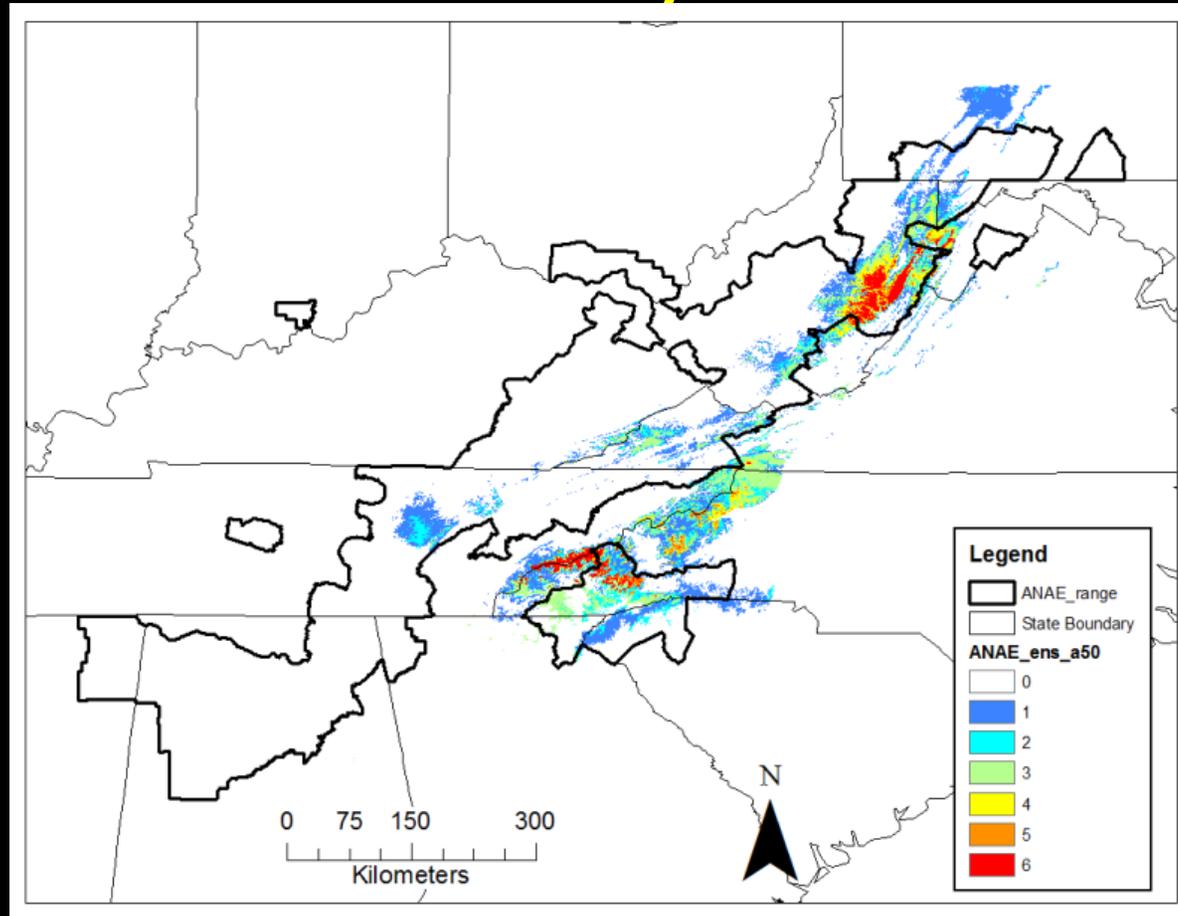


Suitability in 2050



Exposure can be assessed in a quantitative and spatially explicit manner

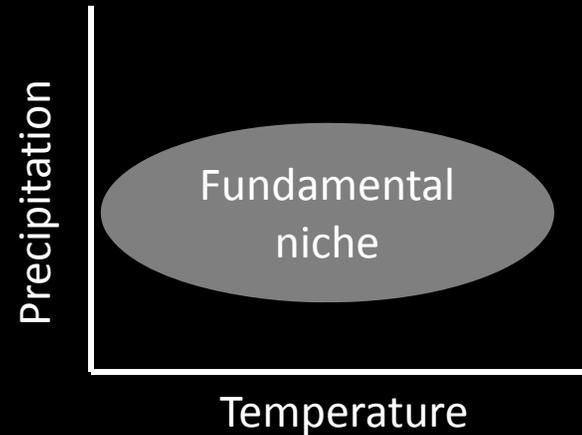
How can distribution models contribute to a vulnerability assessment?



Uncertainty also addressed and conveyed to stakeholders in a clear and spatially explicit way

Issues to consider

- In many cases we only know the realized niche of a species



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