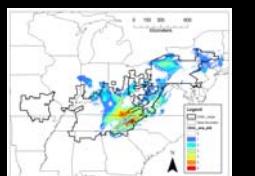


## Distribution Modeling

### 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

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

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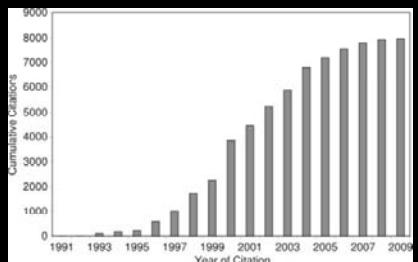
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## Species distribution modeling is widely used



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

## Methods for modeling species responses to climate change

- Forecasting distribution responses

Correlative models:

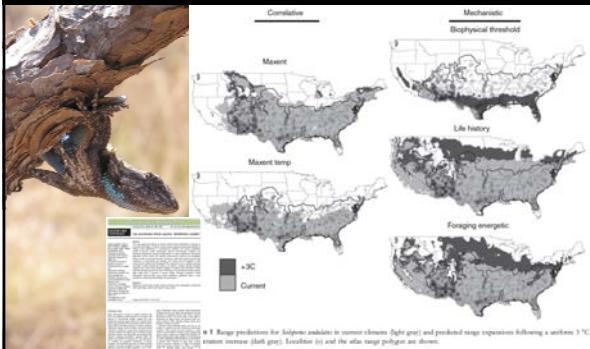
- Phenomenological
- Relate current distributions to environmental variables



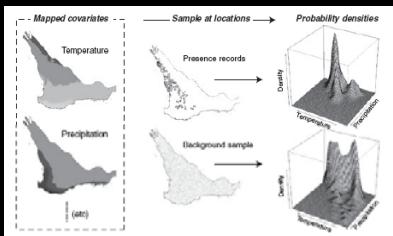
Mechanistic models:

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

## Methods for modeling species responses to climate change

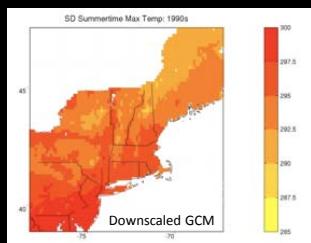


How can correlative distribution models contribute to a vulnerability assessment?



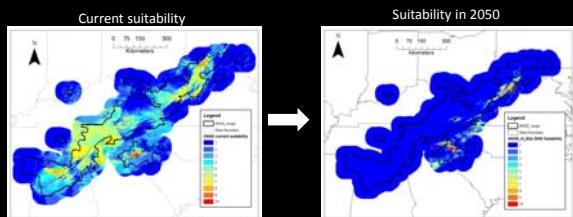
Current species - environment relationships are projected onto forecasted climate scenarios

How can distribution models contribute to a vulnerability assessment?



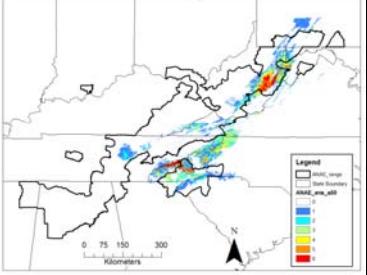
Qualitative assessment – estimate exposure  
qualitatively and piecemeal

## How can distribution models contribute to a vulnerability assessment?



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

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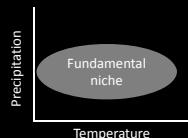
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**Issues to consider**

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




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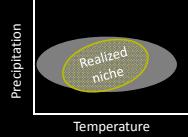
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### Issues to consider

- In many cases we only know the realized niche of a species
- There may not be current analogs of future climate or future communities

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## Categories of correlative distribution modeling

- Deductive
  - Typically based on expert knowledge
  - Identify key habitat/environmental requirements and map them
  - National GAP program



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## Categories of correlative distribution modeling

- Deductive
  - Typically based on expert knowledge
  - Identify key habitat/environmental requirements and map them
  - National GAP program
- Inductive
  - Requires knowledge of species occurrence data
  - Uses an algorithm to identify species-environment relationship



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## Selecting a tool for correlative modeling

<b>DOMAIN</b> Logistic regression MaxEnt GARP Random Forests Mahalanobis Distance	 <p><b>Novel methods improve prediction of species' distributions from occurrence data</b></p> <p>John R. Elith, Christopher D. Graham, Robert P. Anderson, Michael Dudik, Steven Ferrier, Samuel Guisan, Robert J. Hijmans, Folk Meentemeyer, John R. Leemans, Bo Li, Lucie G. Lohmann, Bo Liu, Luis A. Louzada, Michael Manion, Craig Maron, Miguel Nakamura, Yoshinori Nakamura, David M.C. Ovalle, Jorge Silveira, Stephen Williams, Mary S. Wise and Nicholas E. Zimmerman</p> <p>Ecological Applications, Vol. 19, No. 7, 2009, pp. 1765–1778</p> <p><b>Prediction of species' distributions is a disease application in ecology: evolution and innovation</b> There is increasing demand to make use of occurrence records in environmental models to predict the potential distribution of species. This paper compares the accuracy of numerous approaches for modelling distributions. To meet this need, we compared 16 different methods for predicting species distributions. We used 10 datasets to compare the performance of each method. We found that the best performing methods were those that used a combination of presence and absence data to estimate the predictions. Along with well-established modelling methods such as logistic regression and maximum entropy, we found that more recent methods have been developed mainly or have rarely been applied to modelling species distributions. These new methods include random forests, Mahalanobis distance, and various forms of boosted regression trees. We found that the new methods were often more accurate than the traditional methods. Previously, data were efficient for modelling species distributions for most models, but this was not true for all models. In this study, we found that the new methods were more accurate than the traditional methods for the first time.</p>
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