Deck 10 – Spatial Modeling

Habitat Suitability, Disaster Planning, Final Projects

Intro to GIS – UMass Amherst – Michael F. Nelson

Overview

Model Thinking

- Decomposition
- Pattern Recognition
- Abstraction: Reducing Complexity

Spatial Modeling

- Habitat Classification: Binary, Ranked, Continuous
- Tortoise Habitat Modeling
- Disaster Modeling

Final Projects

- Examples, Ideas, Data Sources
- Overview: Rubrics

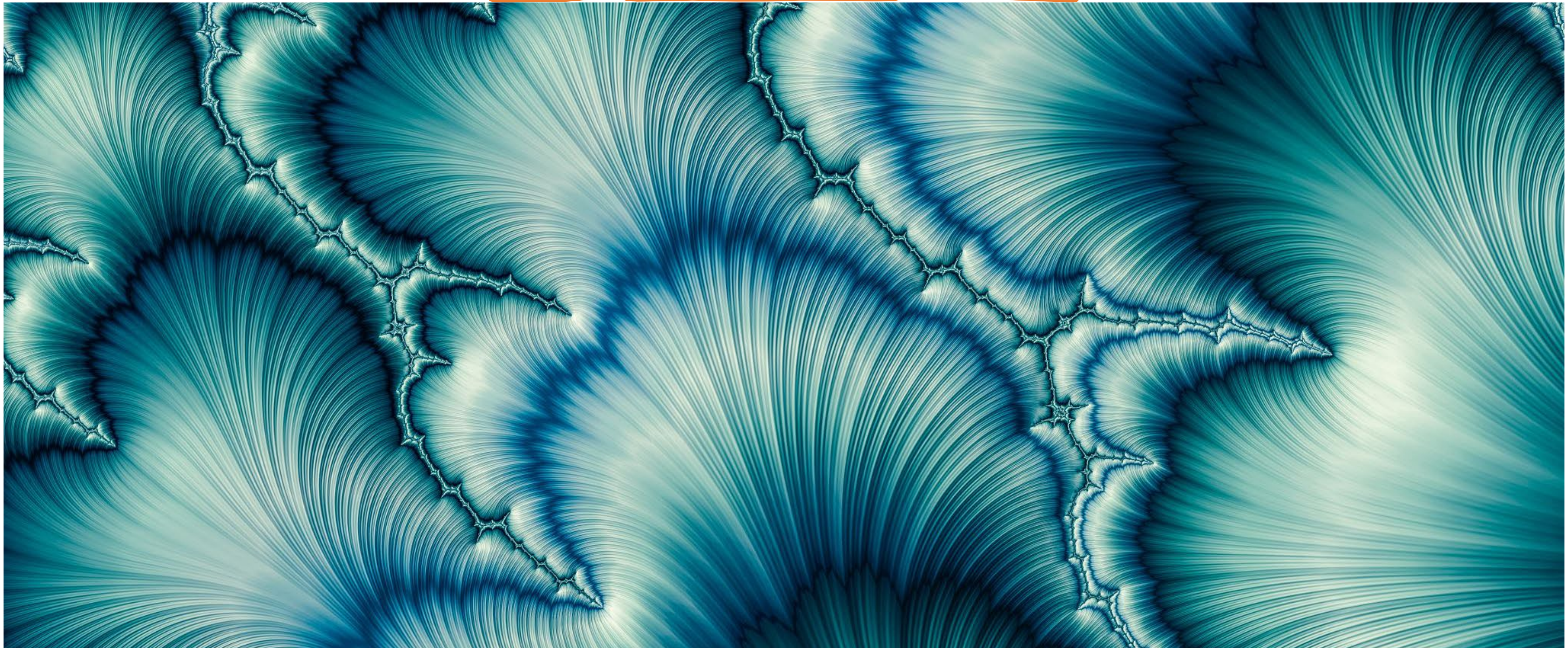
Midterm Earn Back

- Questions are posted on Moodle!
- You can earn back to 100%
- Submit responses by end of course

Model Thinking

"All models are wrong; some models are useful."

Decomposition



Decomposition

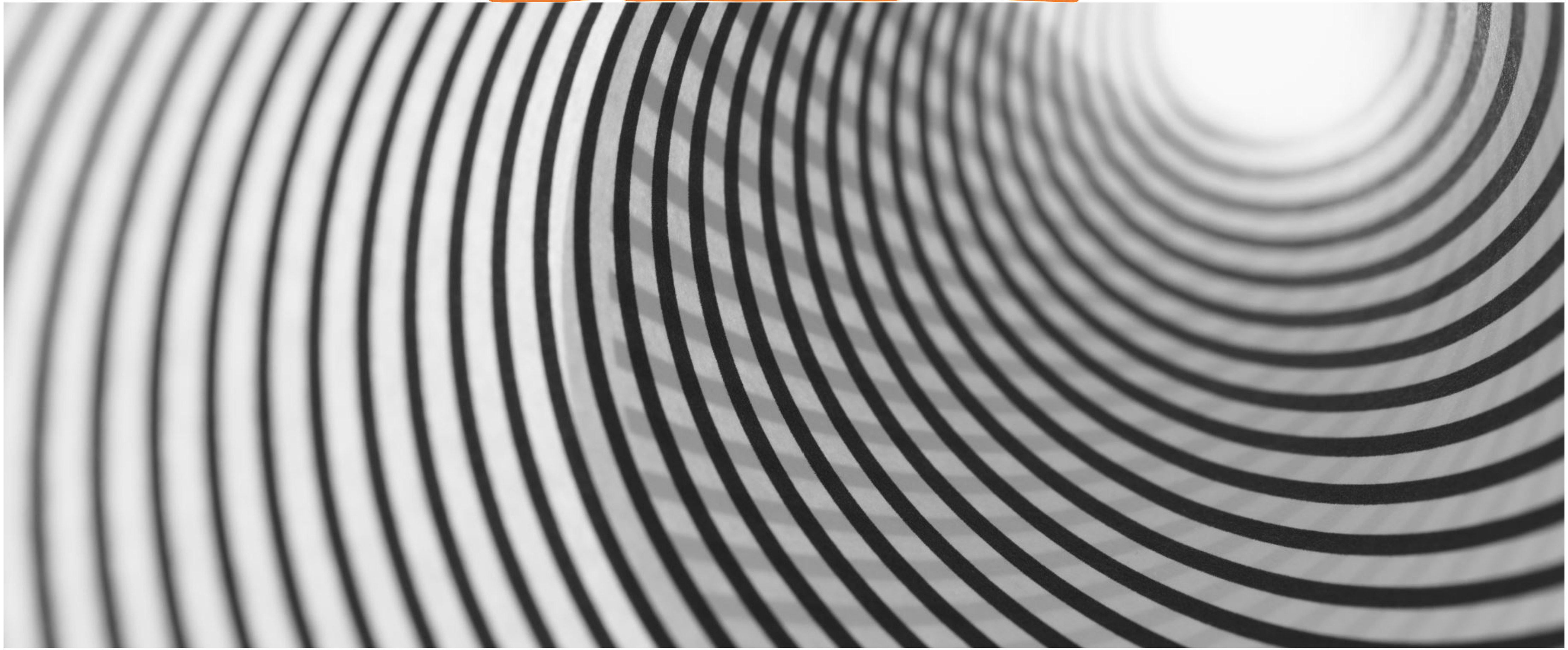
ArcGIS is not the same as GIS!!!

- I can’t stress this enough.
- Remember the separation of concepts from implementation.
- If you know the concepts, you can implement them anywhere.
- If you only know one implementation, you miss the bigger picture and you become irrelevant when software changes.

Decomposition and Model Thinking

- Involves breaking down a complex problem or system into smaller parts that are more manageable and easier to understand.
- A natural problem-solving activity.
- Model thinking perspective: ask yourself what are components of your system of problem.
  - What parts are likely to be important?
  - What parts might you be able to ignore or simplify?
  - What are the unknowns (known or unknown unknowns)?
  - What are sources of randomness

Pattern Recognition



Pattern Recognition

- Involves finding the similarities or patterns among small, decomposed problems that can help us solve more complex problems more efficiently.
- Humans are (too) good at spotting certain kinds of patterns.
  - How often do you recognize faces where they aren't?

Patterns

What are patterns?

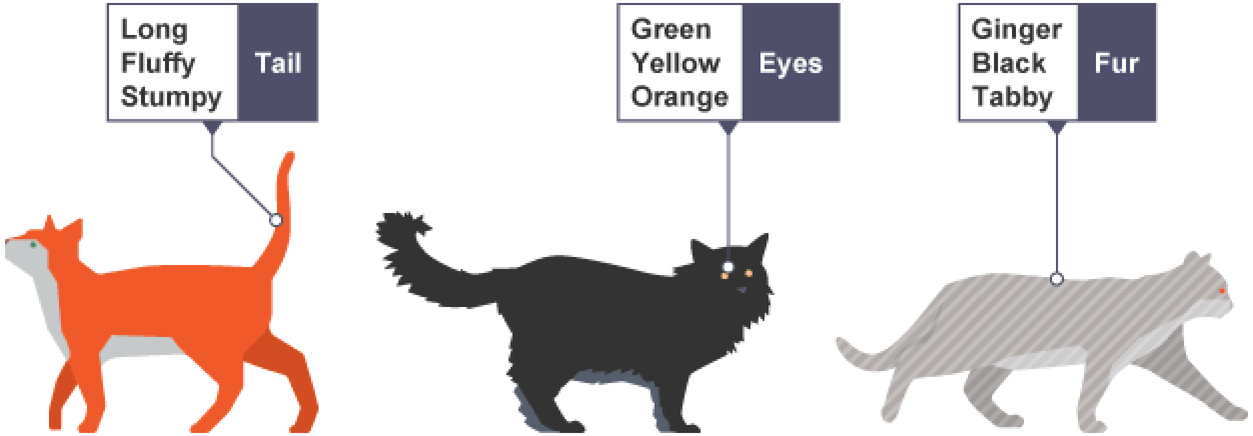
Imagine that we want to draw a series of cats.

All cats share common characteristics. Among other things **they all have eyes, tails and fur**. They also like to eat fish and make meowing sounds.

Because we know that all cats have eyes, tails and fur, we can make a good attempt at drawing a cat, simply by including these common characteristics.

In **computational thinking**, these characteristics are known as patterns. **Once we know how to describe one cat we can describe others, simply by following this pattern.** The only things that are different are the specifics:

- one cat may have green **eyes**, a long **tail** and black **fur**
- another cat may have yellow **eyes**, a short **tail** and striped **fur**



Power of Patterns

Identifying patterns allows us to understand common features and apply common processes.

Patterns exist among different problems and within individual problems. We need to look for both.

Abstraction

Abstraction

The process of filtering out – ignoring - the characteristics of patterns that we don't need in order to concentrate on those that we do.

It is also the filtering out of specific details. From this we create a representation (idea) of what we are trying to solve.

Reducing Complexity

Abstraction gathers the general characteristics we need and filters out the details and characteristics that we do not need.

Abstraction lets us overcome issues with specifics by outlining general processes.

Abstraction: A Tasty Example

Cake Recipe Abstraction

General Cake Pattern/Concept	Specific Cake Details
We need to know that a cake recipe has a list specific ingredients.	Flour, eggs, oil, …
We know each ingredient has a specified quantity.	2.5 cups flour, 6 eggs, …
We know that each cake has a specific baking time.	350 degrees for 35 minutes

Spatial Modeling 1

Suitability Analysis and Habitat Modeling

Habitat Suitability Modeling

- Habitat modeling (or, more broadly, site selection) attempts to quantify where something is or should be.
- What information do we need?
  - Expert knowledge?
  - Physiological tolerances?
  - Occurrence/abundance?
  - Spatial data: biotic and abiotic environment?

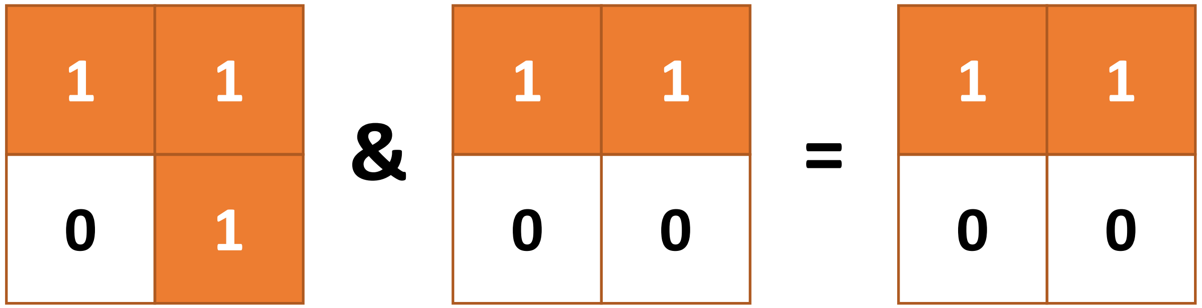
Habitat Suitability Modeling: How to Model?

- Categories or ranks?
  - Binary: uitable/non-suitable or habitat/non-habitat
  - Ranked: bad/good/better
  - Continuous: habitat score
  - Deterministic models – no measure of uncertainty
- Statistical methods: Species Distribution Models/Environmental Niche Models?
  - Linear models
  - Machine Learning
  - Presence vs absence vs abundance
  - Deterministic + stochastic models – includes uncertainty

Why Binary Rasters Are Awesome

- Echoes of Lab 7….
- Boolean = binary

Boolean AND

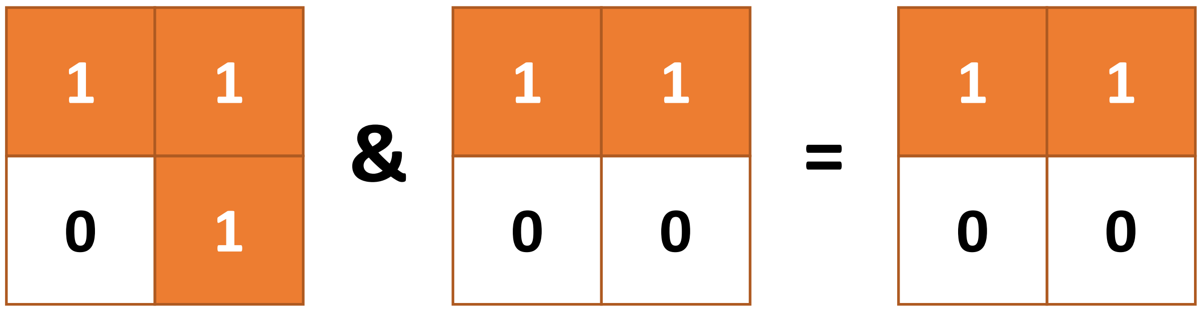


Boolean values
are binary

Why Binary Rasters Are Awesome

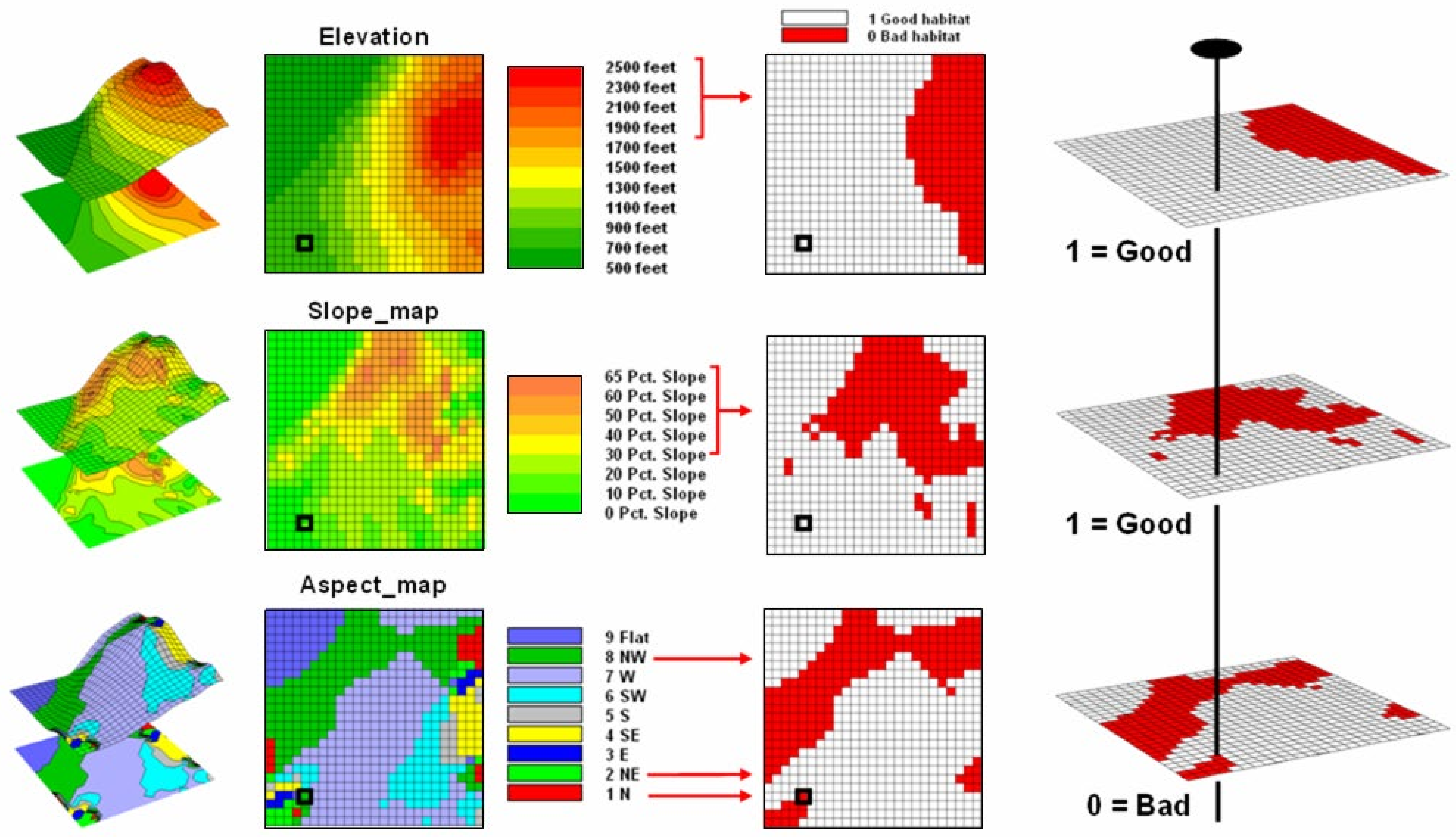
- They make binary classifications with multiple layers easy!
- They are conceptually simpler than multi-valued rasters!
- They help keep your workflow simple and logical!
- They are very easy to work with in Raster Calculator!

Boolean AND



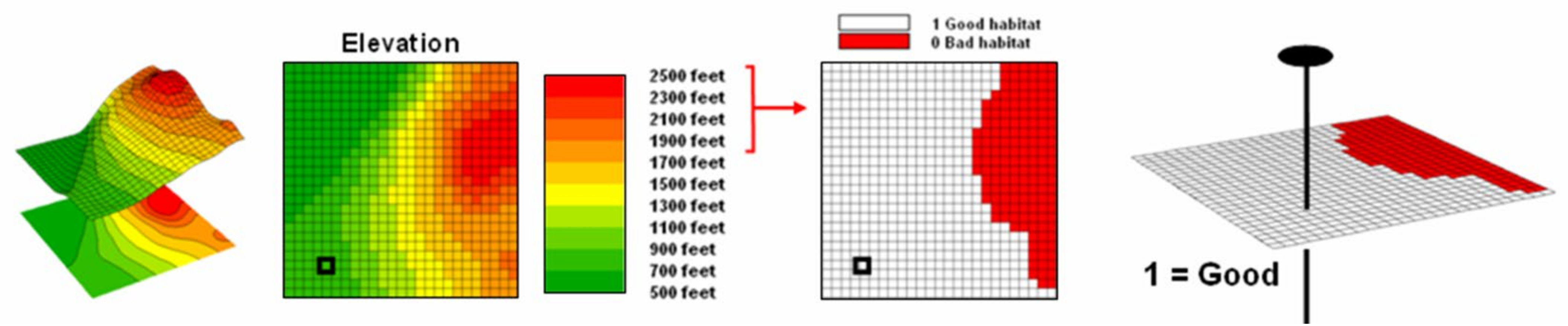
Boolean values are binary

Habitat Predictors: Binary Classification



Binary Classification: Habitat Variable Thresholds

How could we define the boundary between habitat and non-habitat?



Remember Your Boolean ANDs!

Boolean AND

$$\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix} \;\&\; \begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix} = \begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix}$$

Boolean values are binary

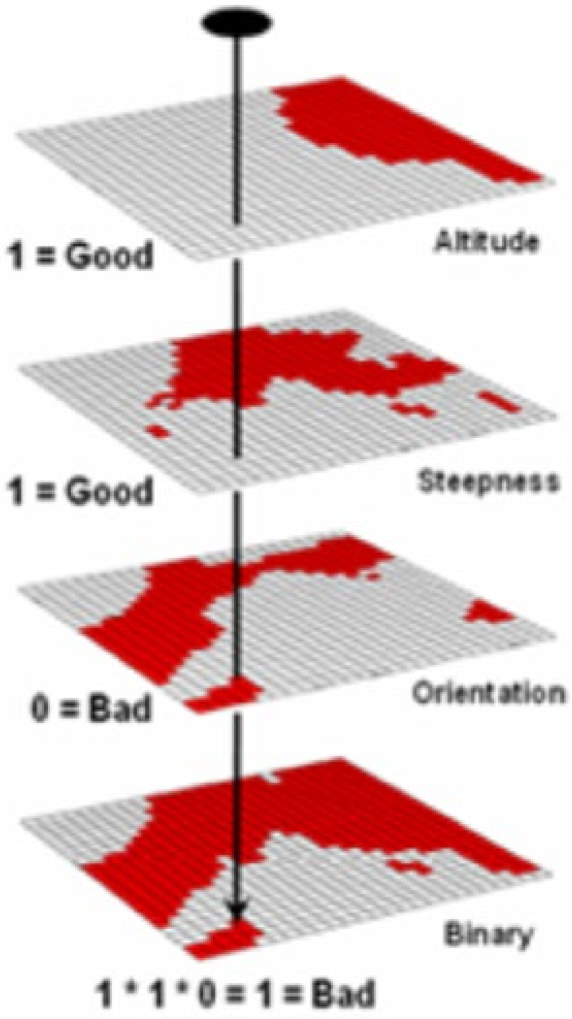
Raster Multiply

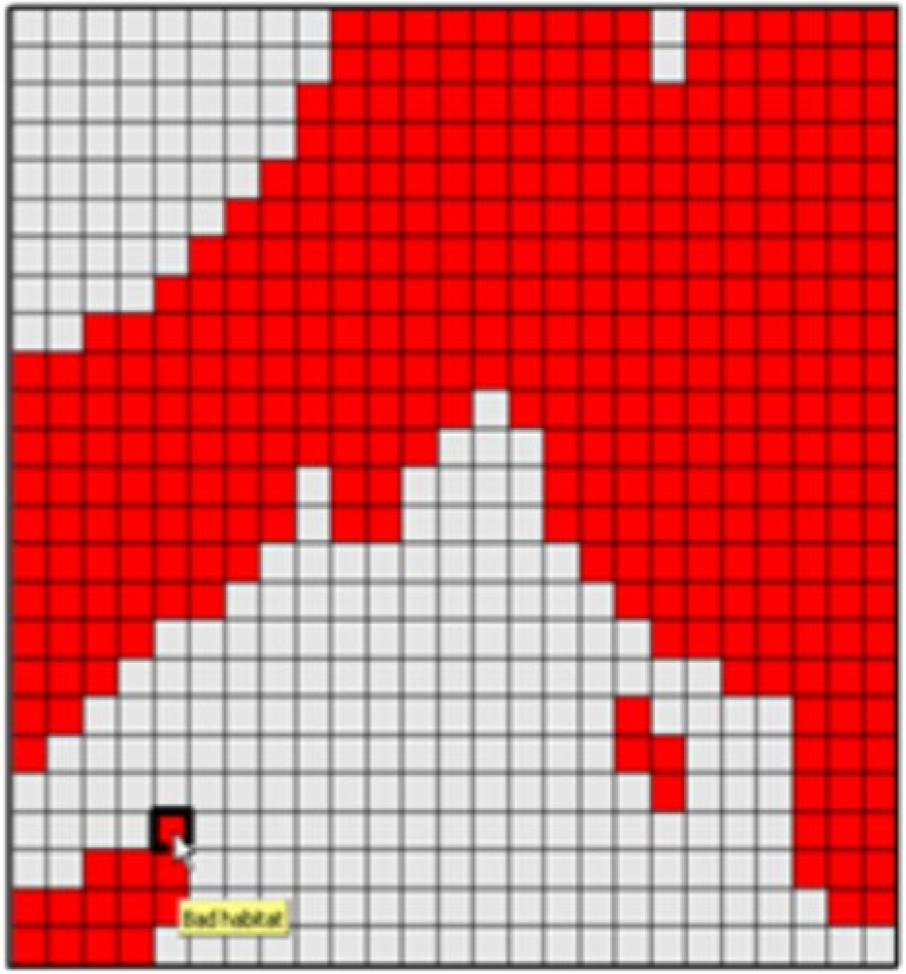
$$\begin{bmatrix}1 & 1\\ 0 & 1\end{bmatrix} * \begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix} = \begin{bmatrix}1 & 1\\ 0 & 0\end{bmatrix}$$

$$\begin{bmatrix}1 & 1\\ 0 & 2\end{bmatrix} * \begin{bmatrix}2 & 1\\ 0 & 3\end{bmatrix} = \begin{bmatrix}2 & 1\\ 0 & 6\end{bmatrix}$$

Binary (yes/no): habitat and non-habitat

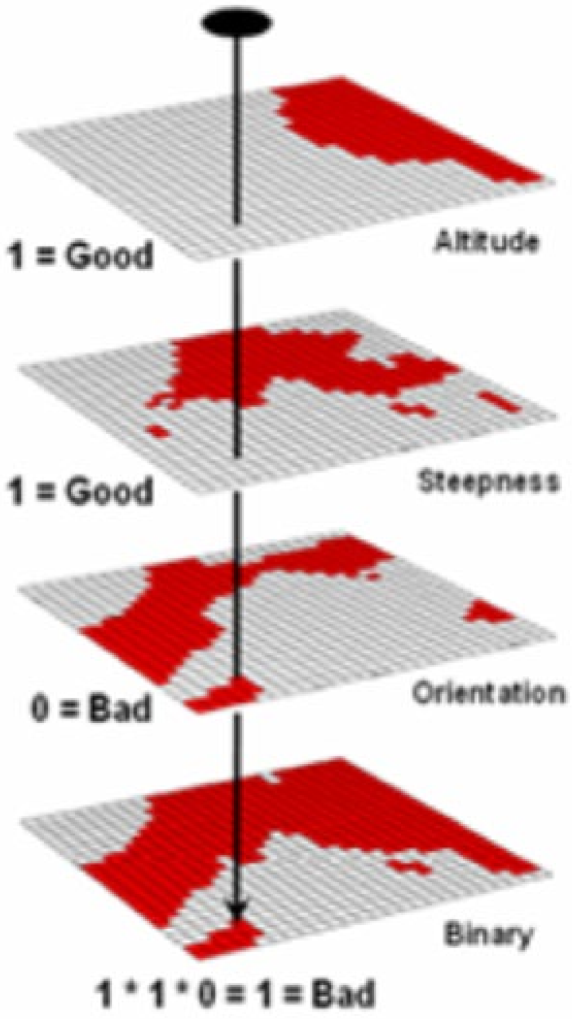
- 0 = False: Non-Habitat
- 1 = True: Habitat

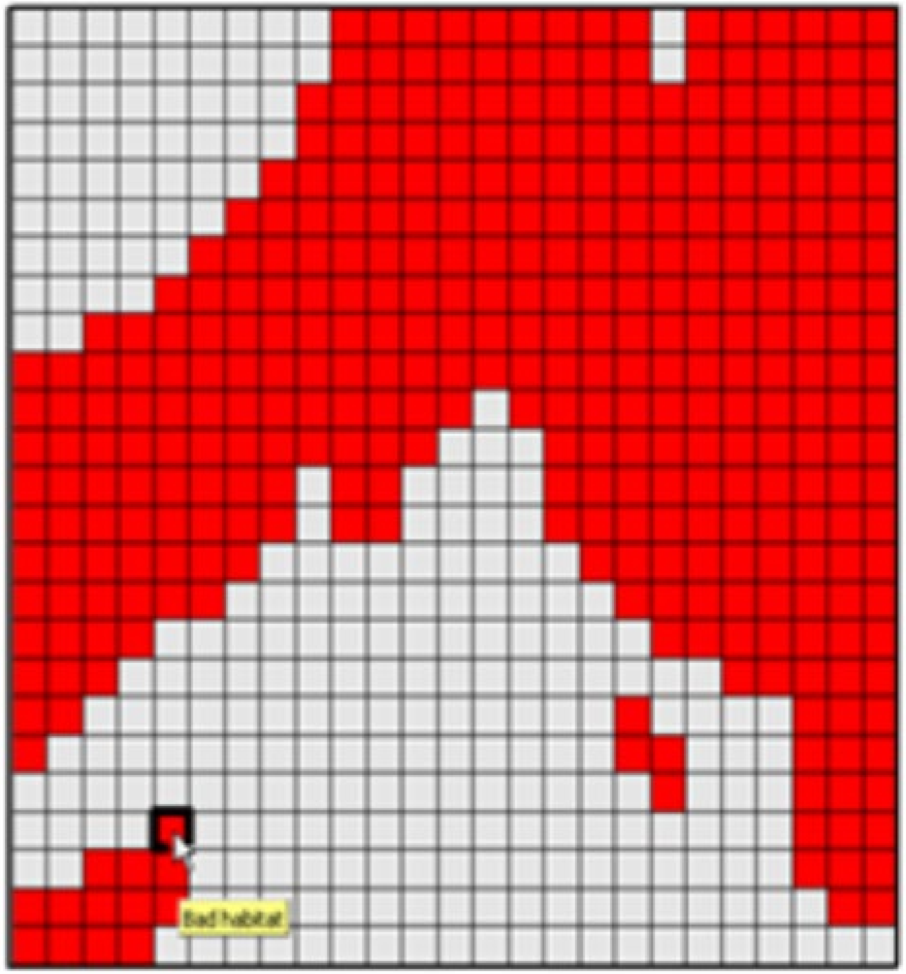




Binary (yes/no): habitat and non-habitat

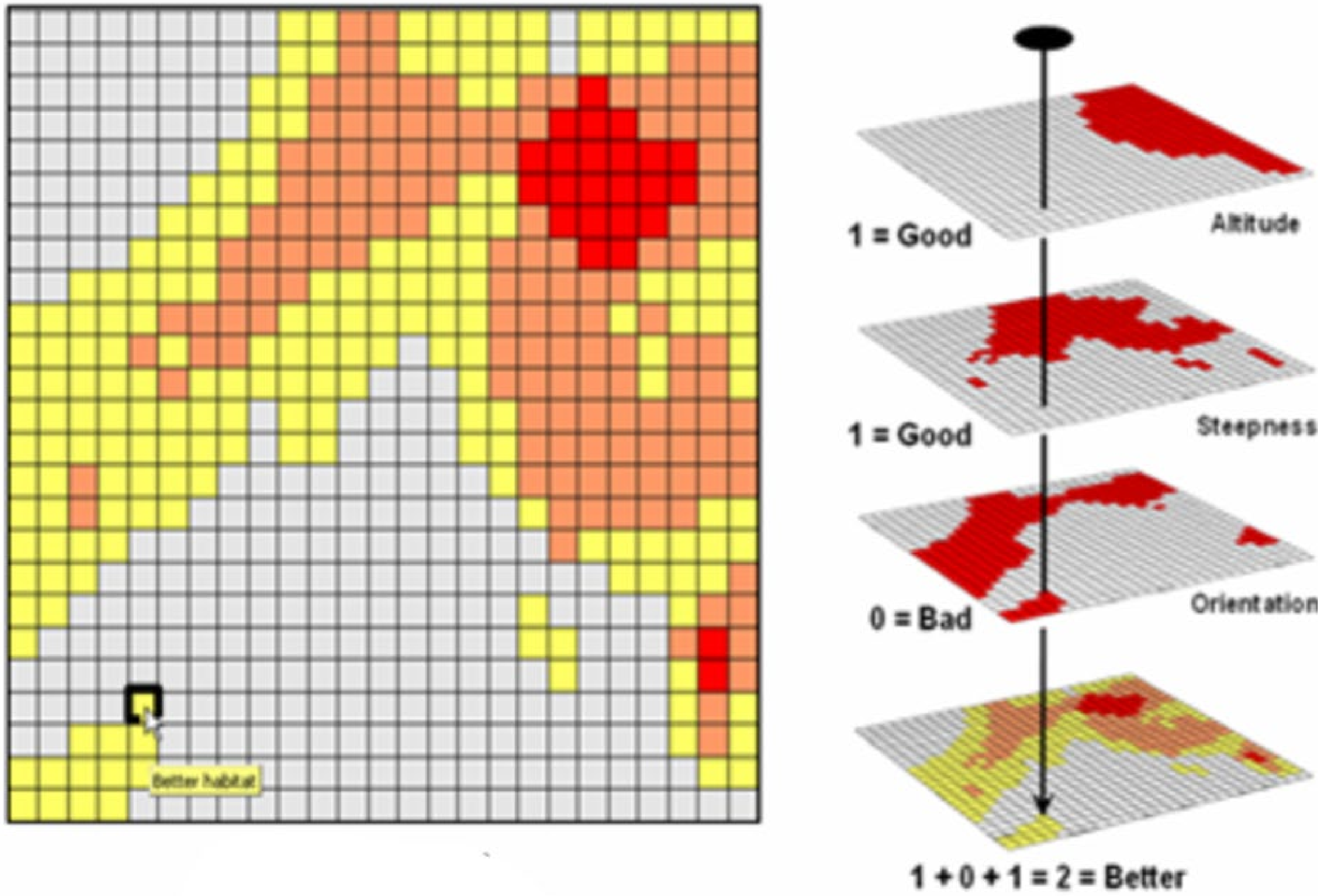
Raster AND





- 0 = False: Non-Habitat
- 1 = True: Habitat

Ranked Suitability

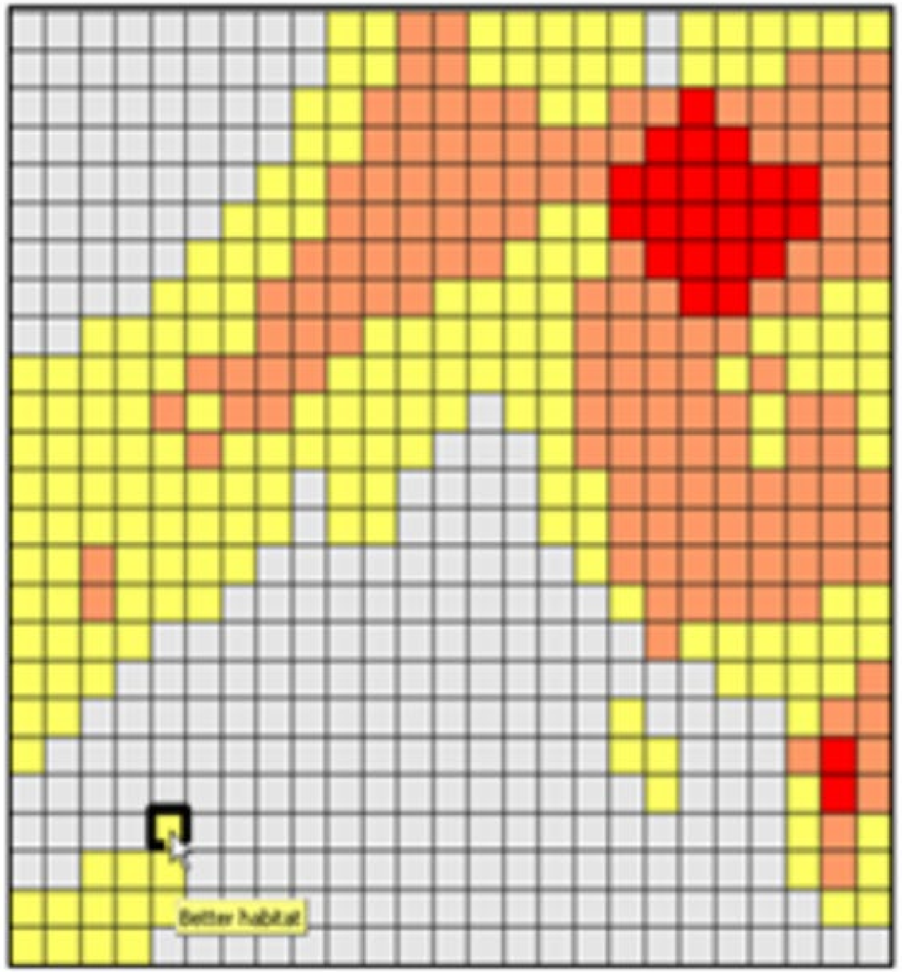


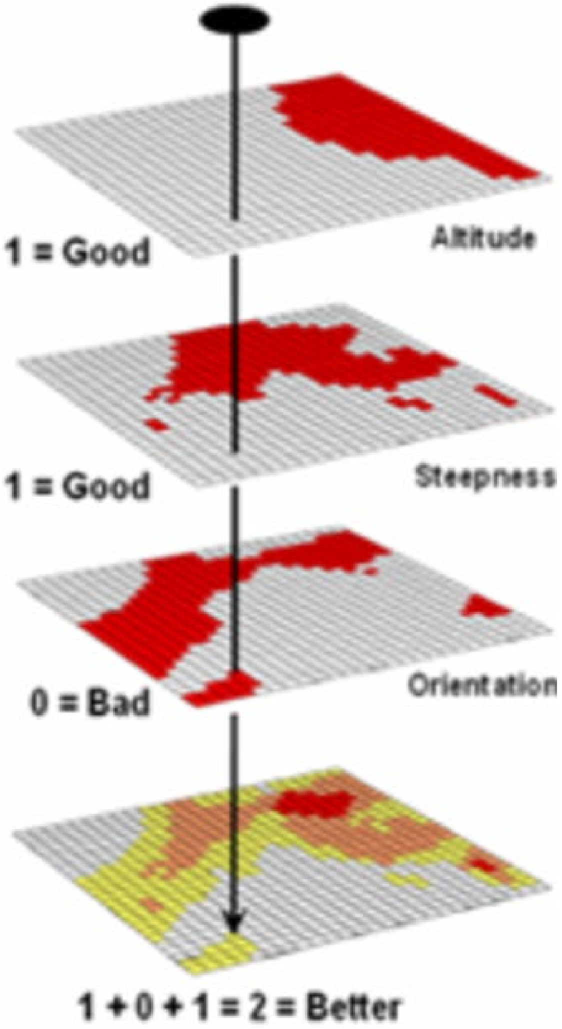
- 0 = Bad Habitat
- 1 = Marginal
- 3 = Better
- 4 = Best

Ranked Suitability

Raster add

- 0 = Bad Habitat
- 1 = Marginal
- 3 = Better
- 4 = Best





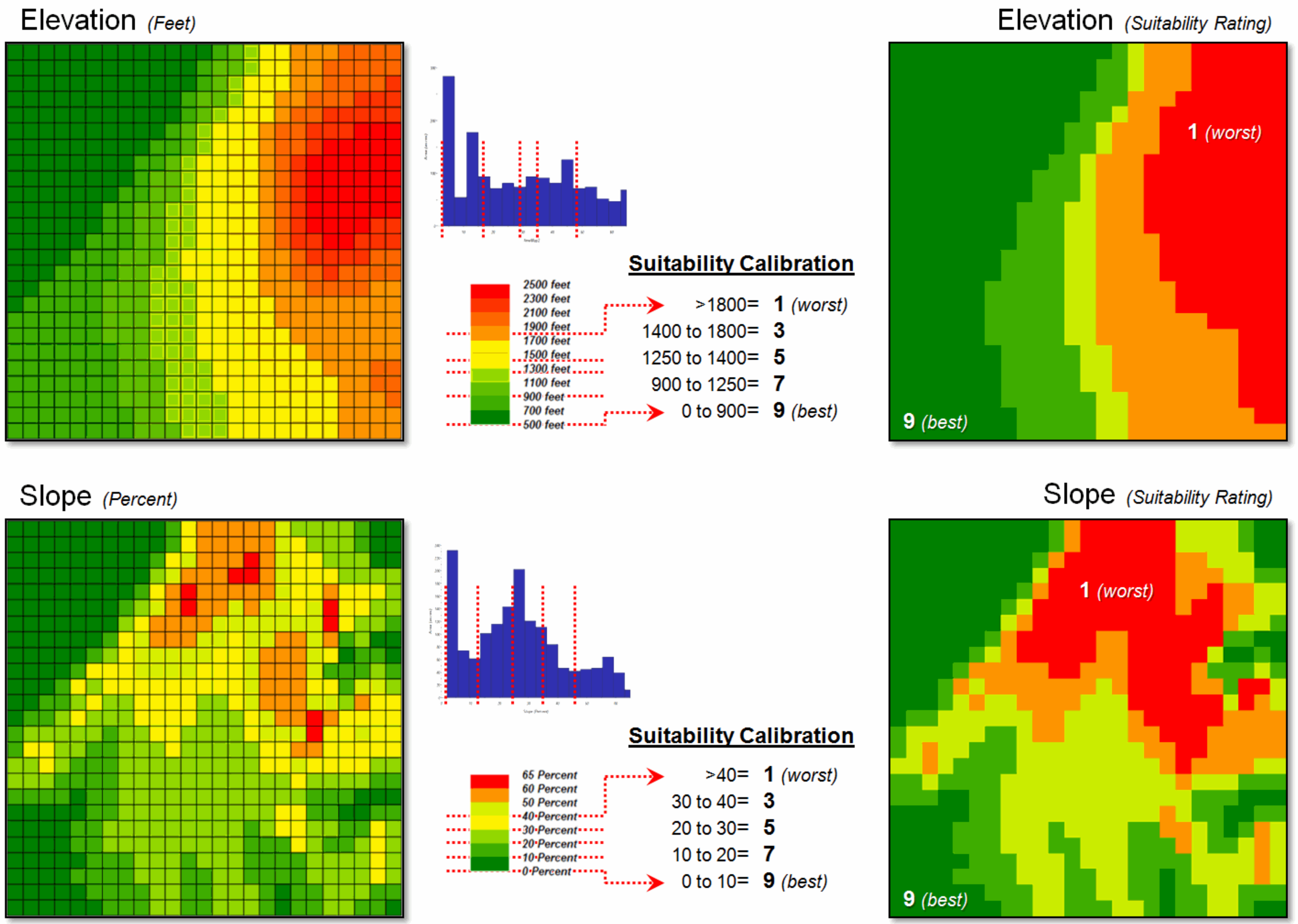
Ranked Suitability: Habitat Predictors

How should we decide the thresholds or cutoffs of the ranks?

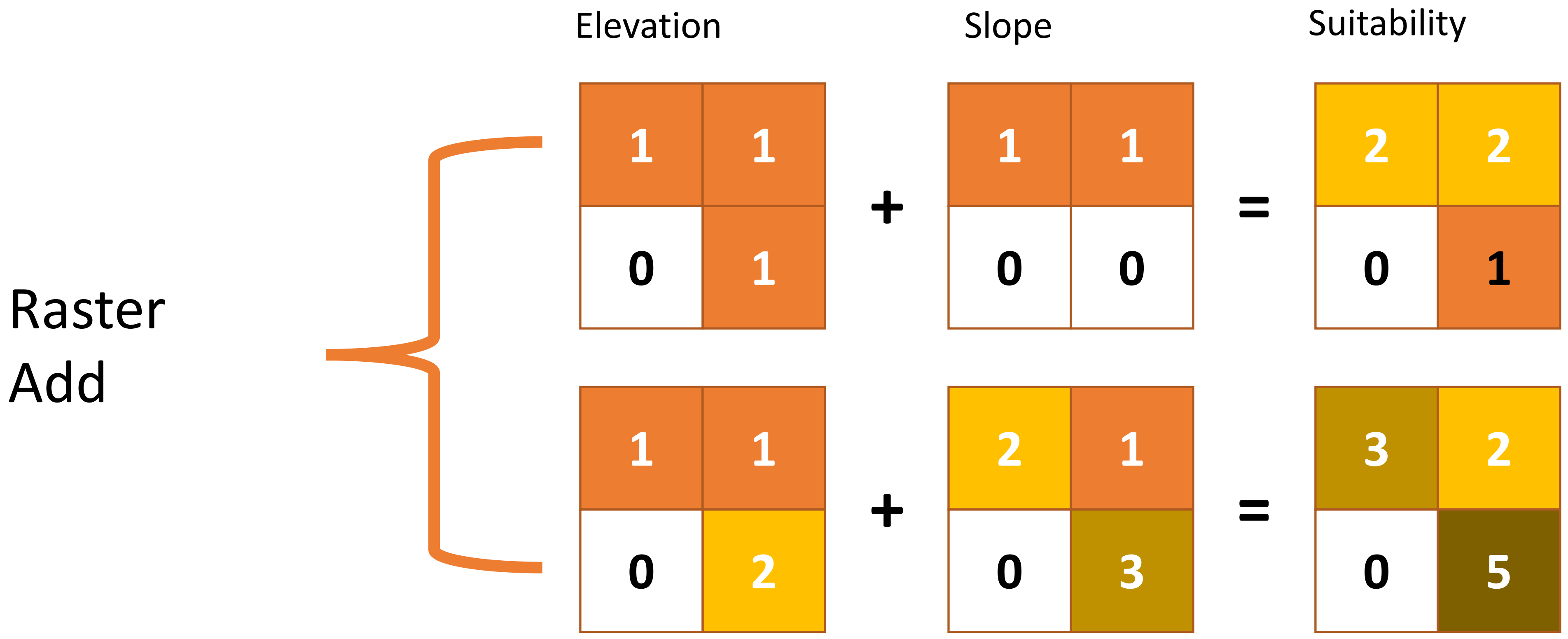
Ranked Suitability: Habitat Predictors

Some possible ranking methods:

- Quantiles
- Ranges
- Expert knowledge
- Physiological tolerances

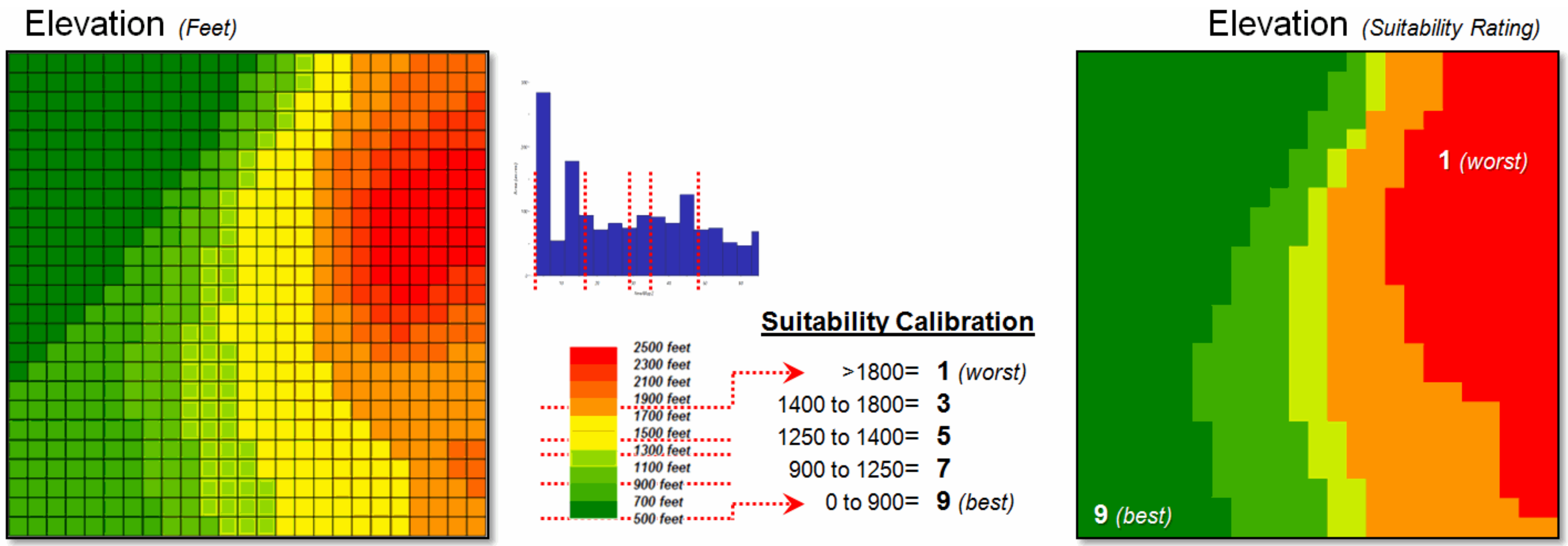


Raster Add: Ranking Habitats



Ranked Suitability: Defining Categories

How could we define the boundary between categories?



Combining Predictors

How could we combine the suitability categories from different predictors?

- Sum of individual habitat variable scores?
- Weighted sum of scores?
- Decision tree?

How do we know which predictors are more important?

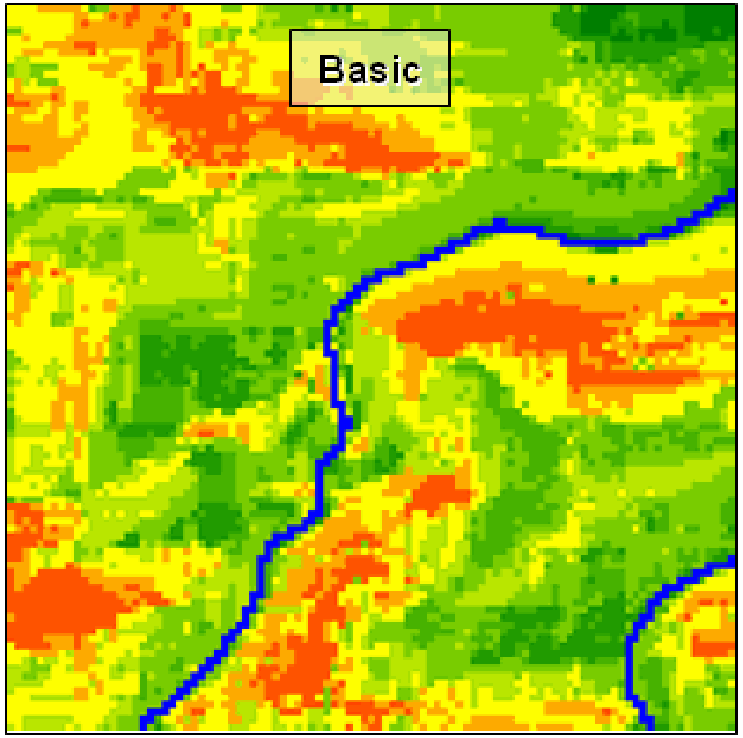
- Expert opinion
- Experiments
- Statistics and machine learning.

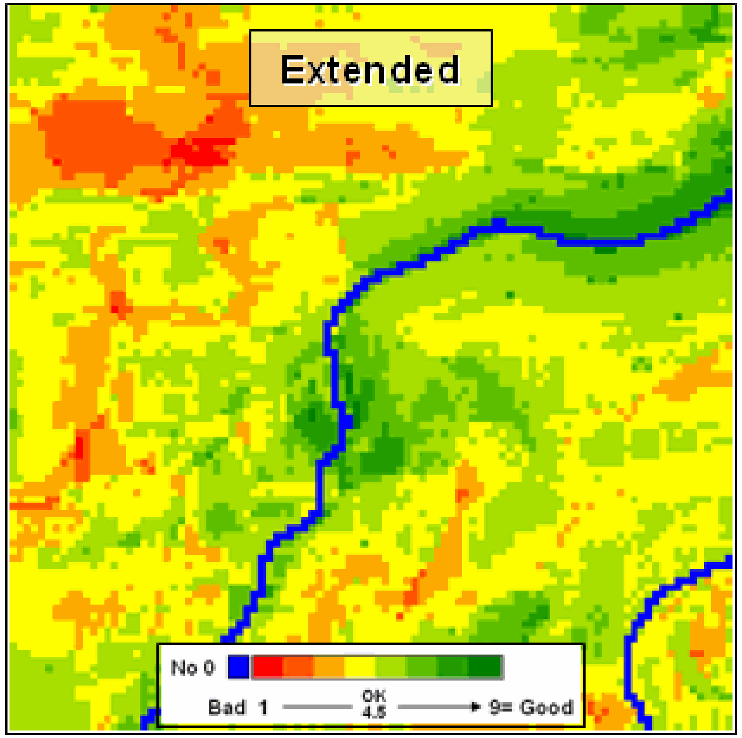
Basic→ Extended→ Weighted

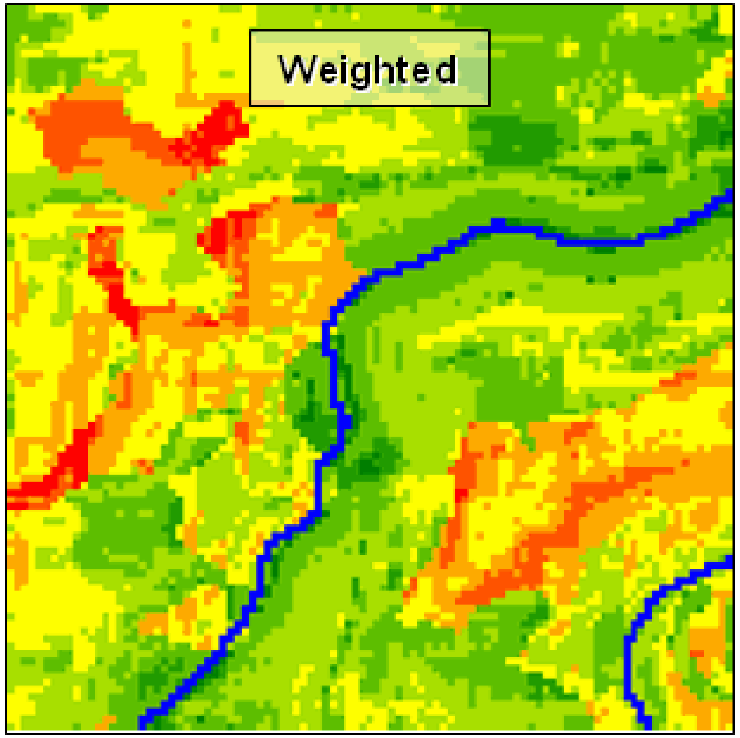
Hugags prefer gentle slopes, southerly aspects and lower elevations but cannot survive in open water

Hugags prefer gentle slopes, southerly aspects, lower elevations, forest cover, near water and far from roads but cannot survive in open water

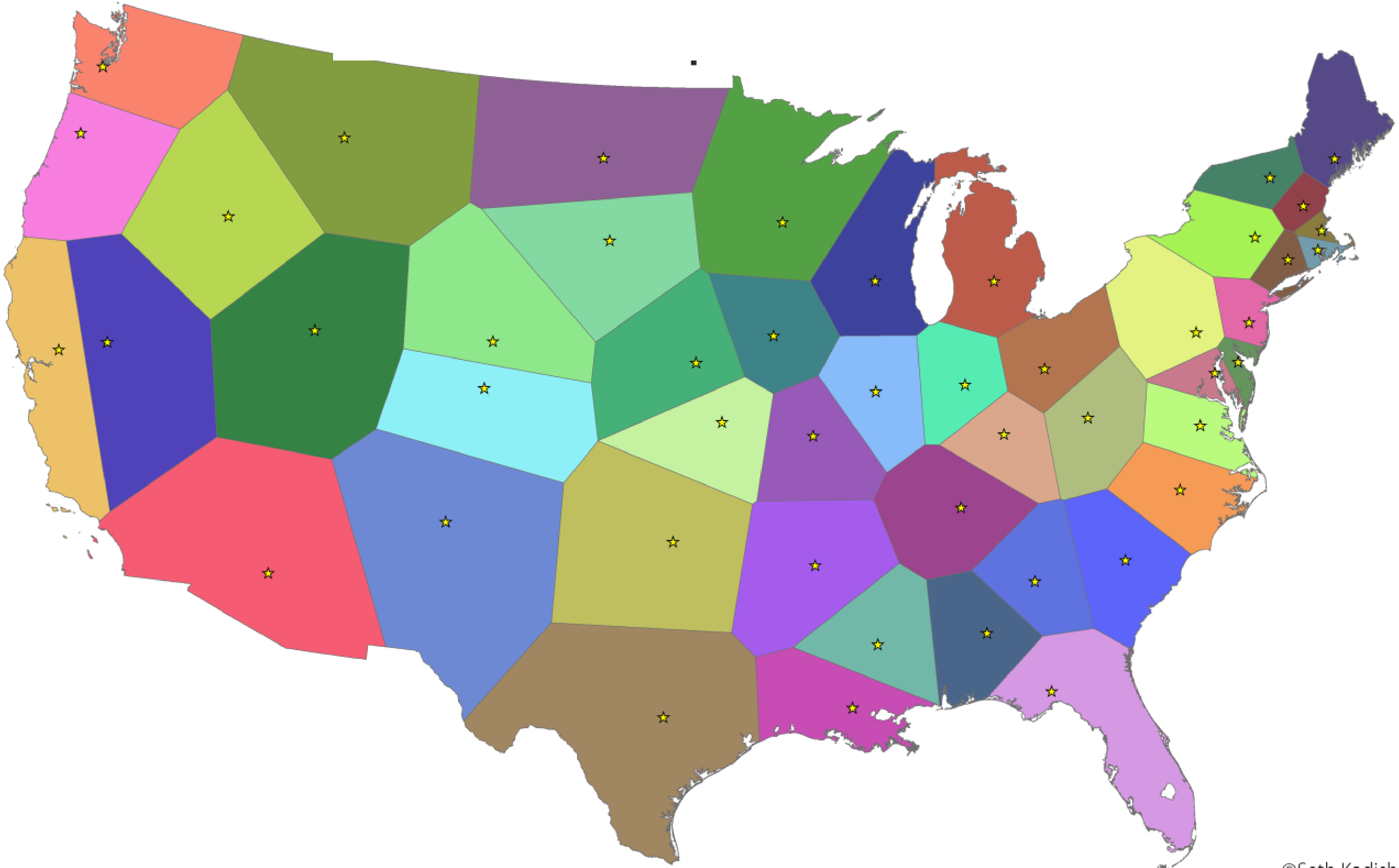
Hugags are 10 times more concerned about slope, forest and water criteria than aspect, elevation and roads criteria …*weighted average*



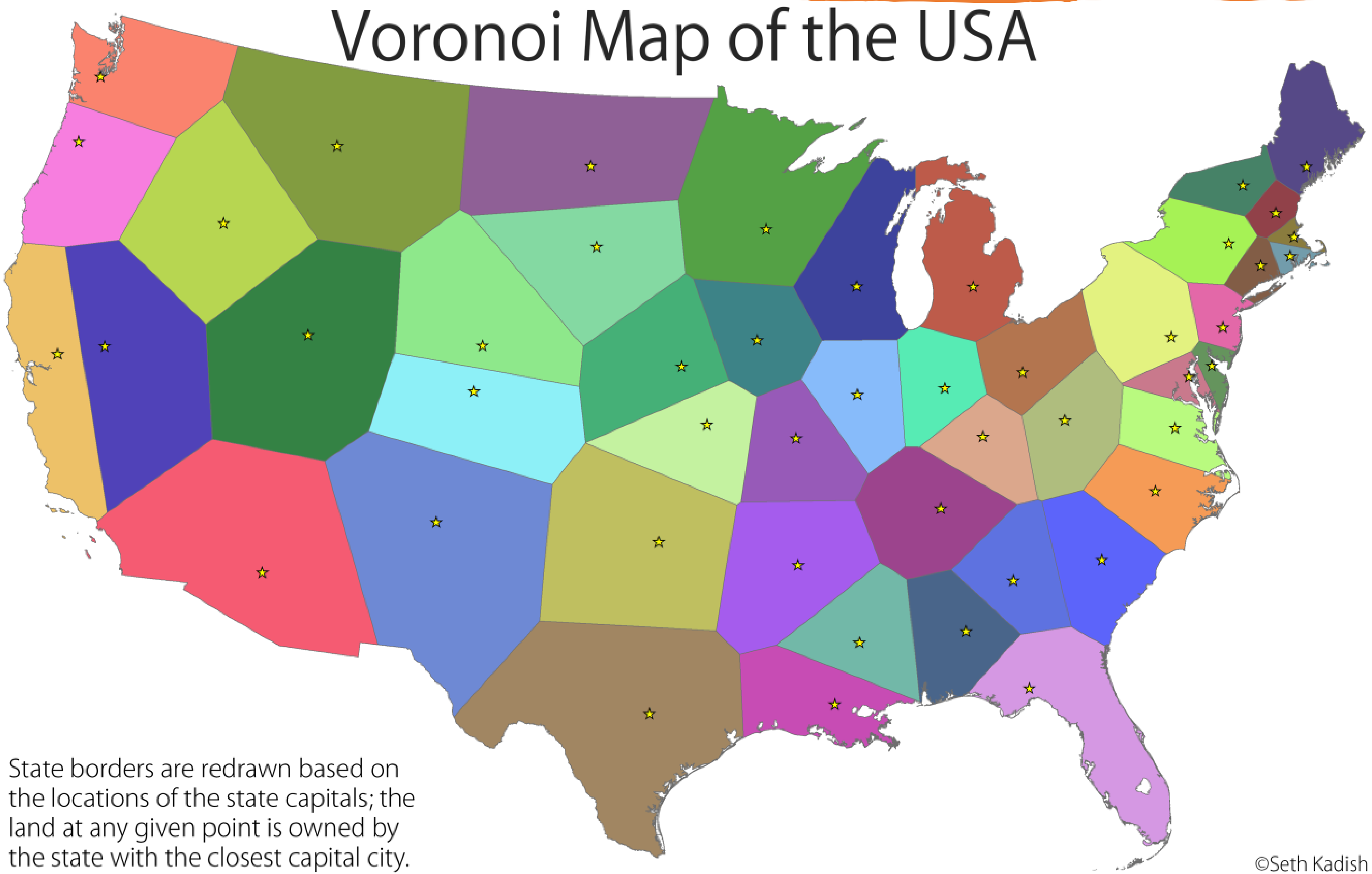




Map Puzzler



Map Puzzler

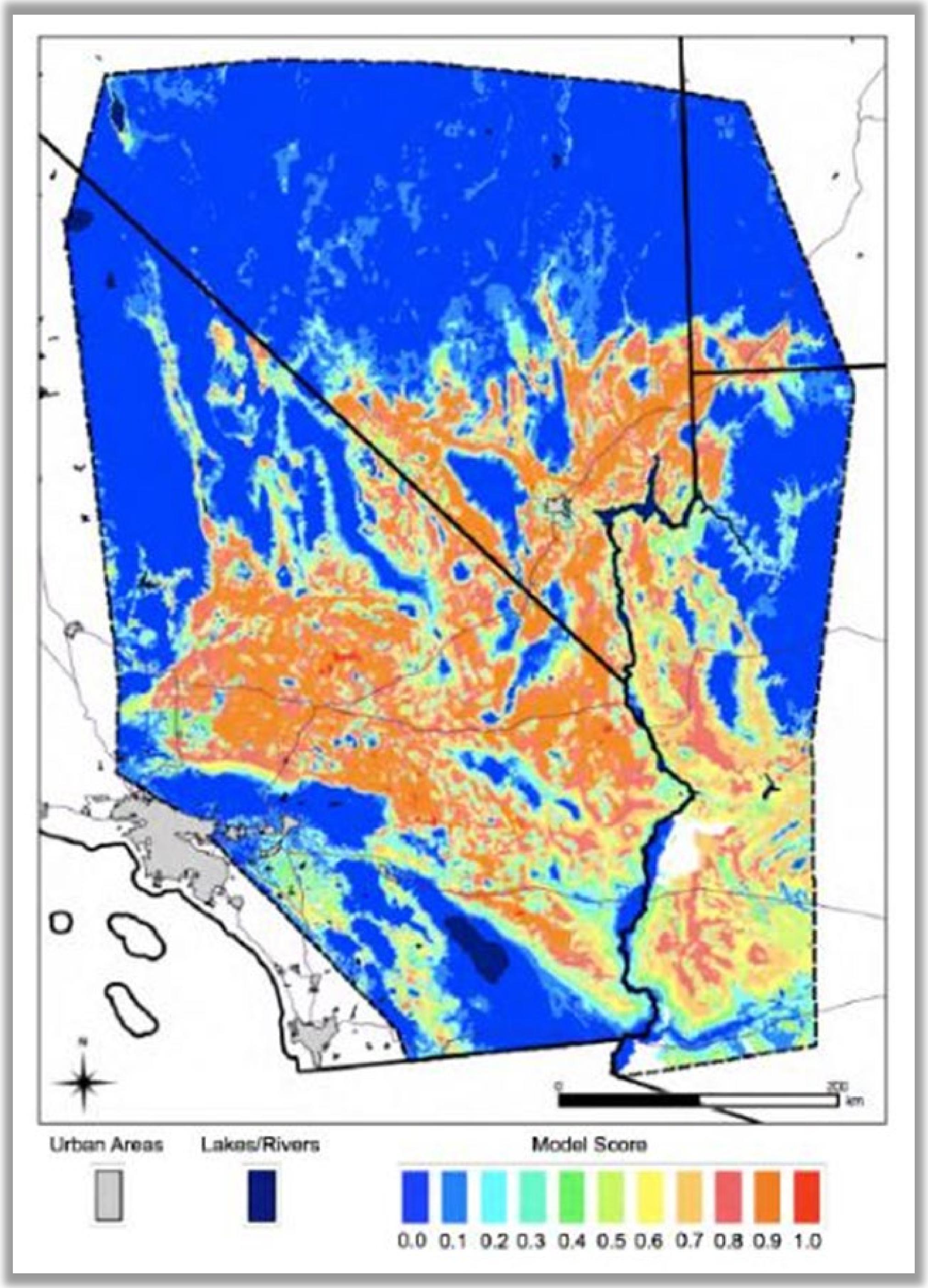

Voronoi Map of the USA
State borders are redrawn based on the locations of the state capitals; the land at any given point is owned by the state with the closest capital city.
©Seth Kadish

Modeling Habitat

The super cute desert tortoise

The Desert Tortoise

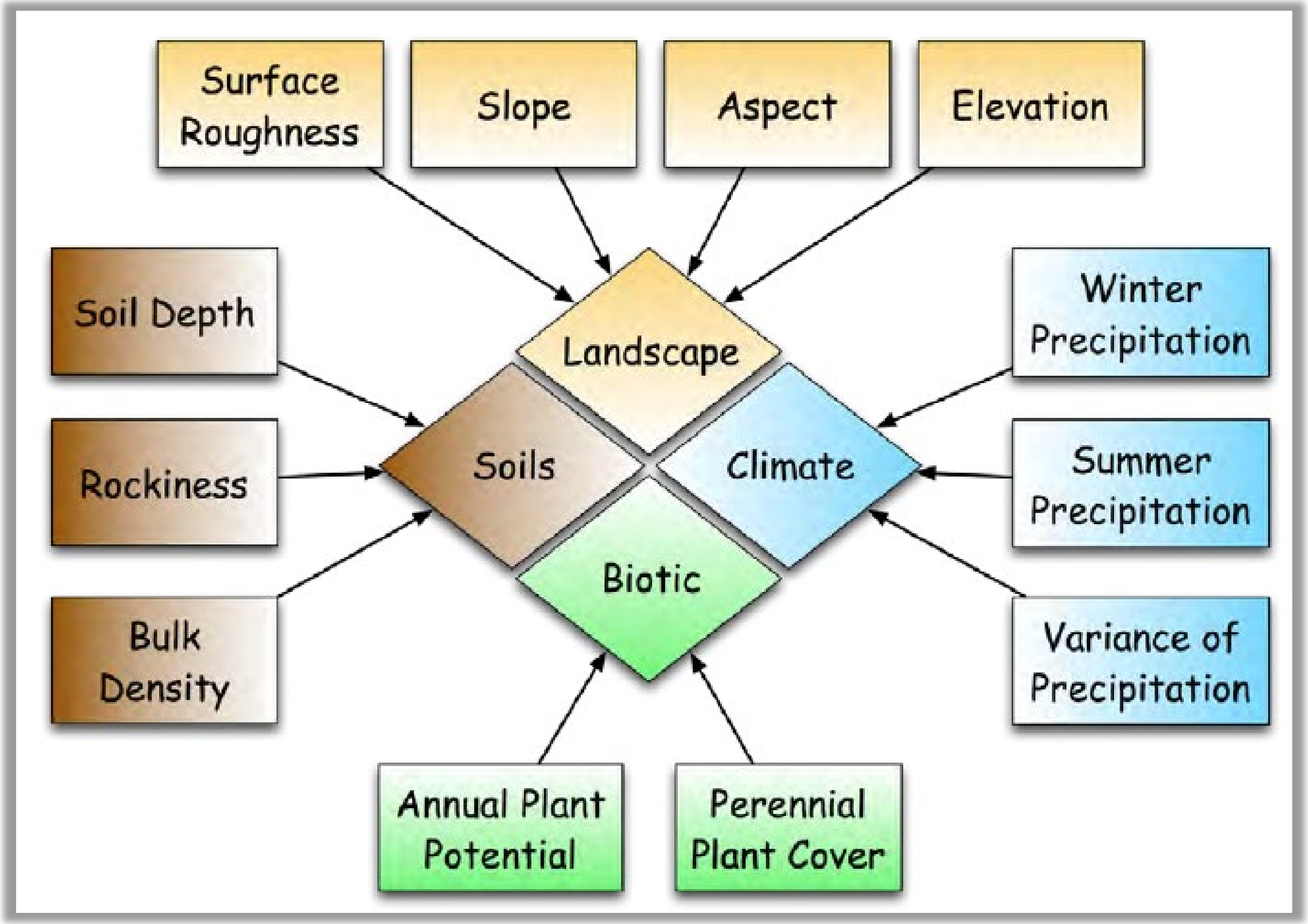
Kenneth E. Nussear et al., "Modeling Habitat of the Desert Tortoise (2009) USGS Numbered Series Open-File Report 2009-1102 https://doi.org/10.3133/ofr20091102.



How do we know desert tortoise habitat?

Think like a tortoise, of course!

What matters to a desert tortoise?



How do we know desert tortoise habitat?

Field studies of desert tortoise

Desert Tortoise Habitat Model Includes:

Annual forb cover

- Evidence that tortoises eat annual flowering plants based on field studies

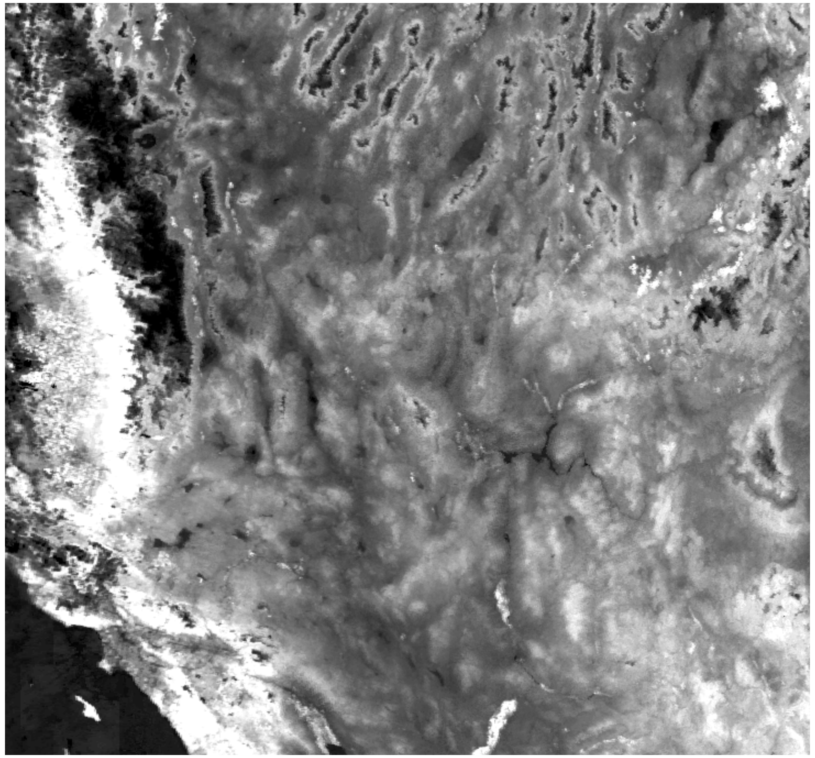
Desert Tortoise Habitat Model Includes:

Annual forb cover

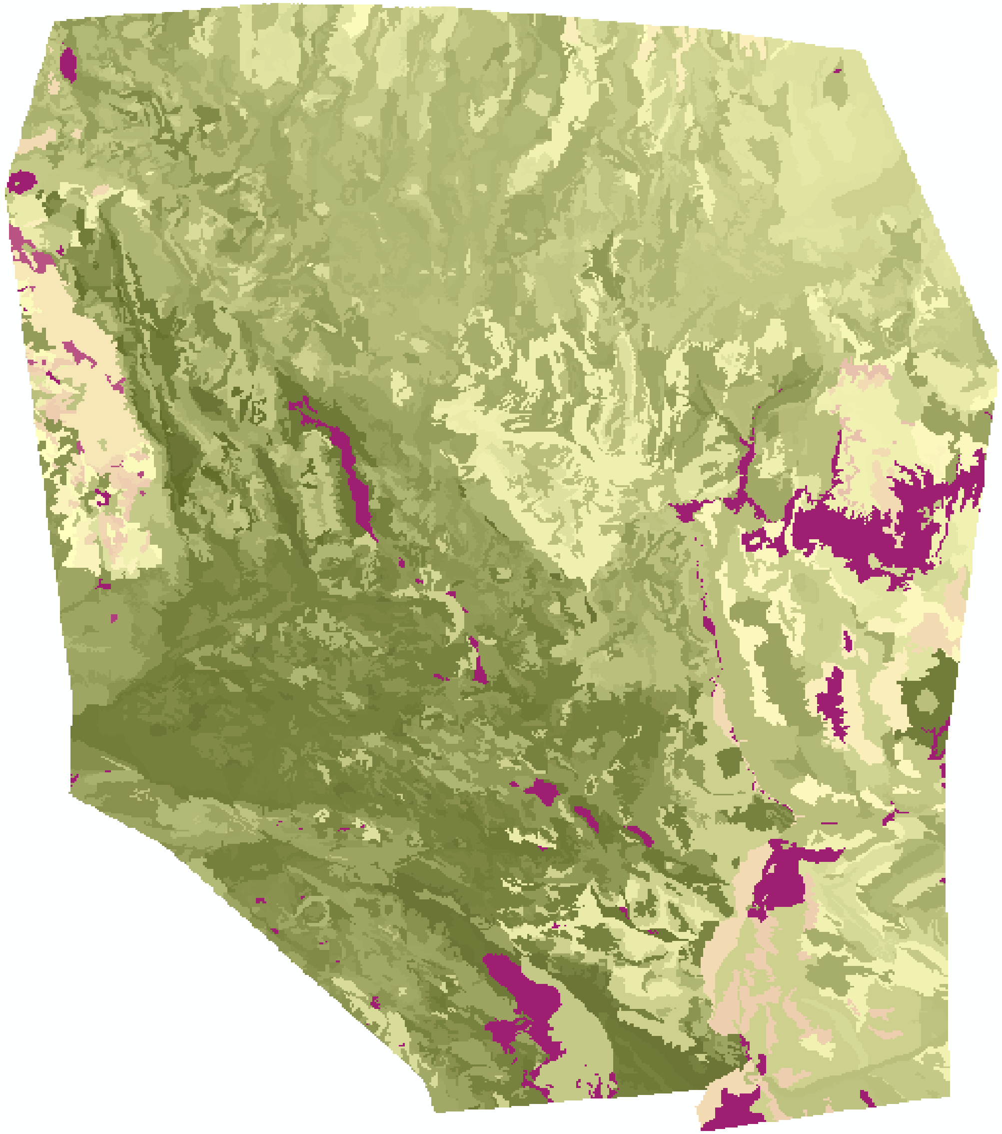
Soils must be sufficient strength

- Necessary soil bulk density for tortoise burrows based on field studies

Applying spatial knowledge from field studies



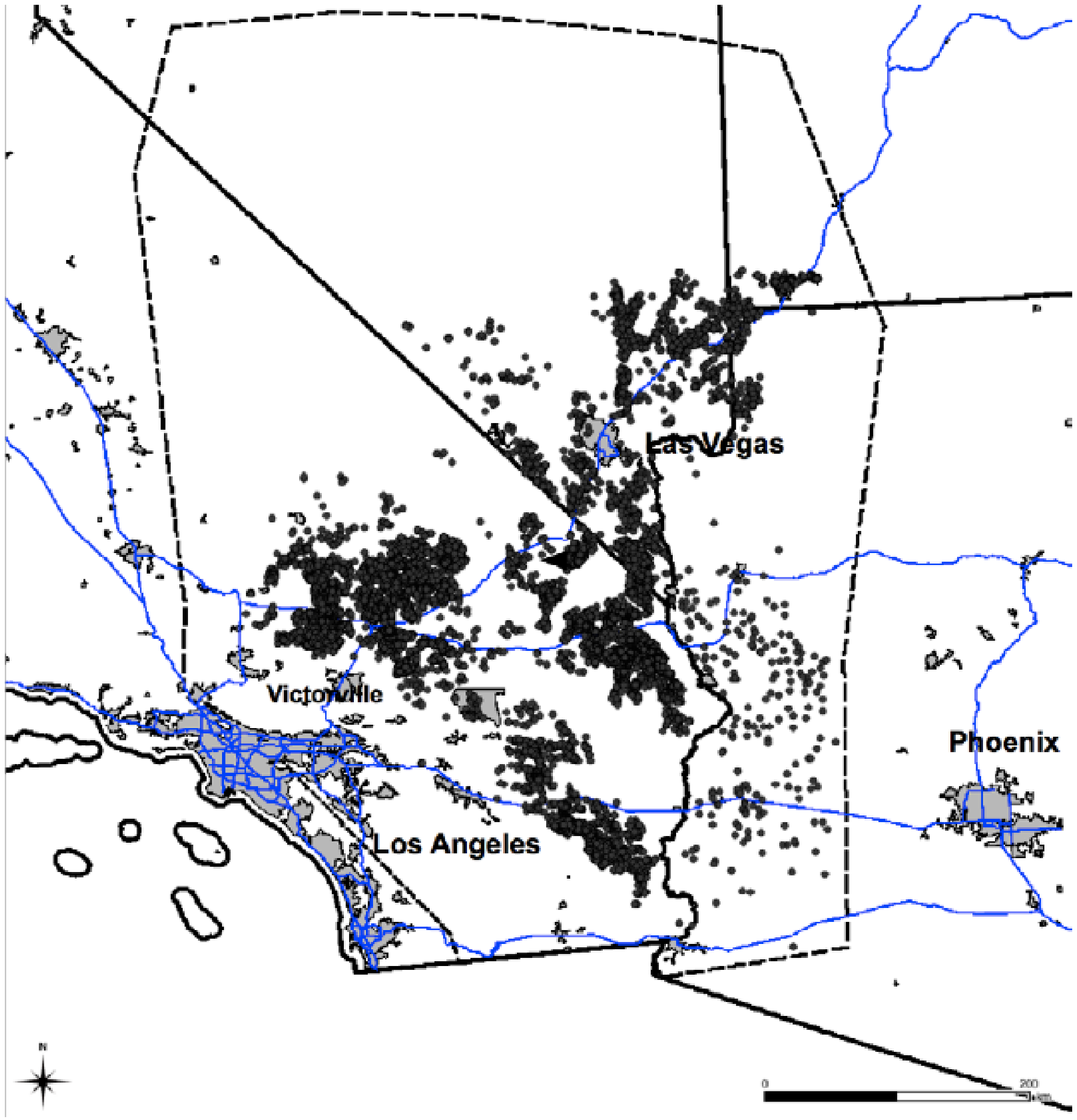
Satellite NDVI: Vegetaion



Soil Bulk Density from STATSGO

How do we know desert tortoise habitat?

- Observations of desert tortoise occurrence



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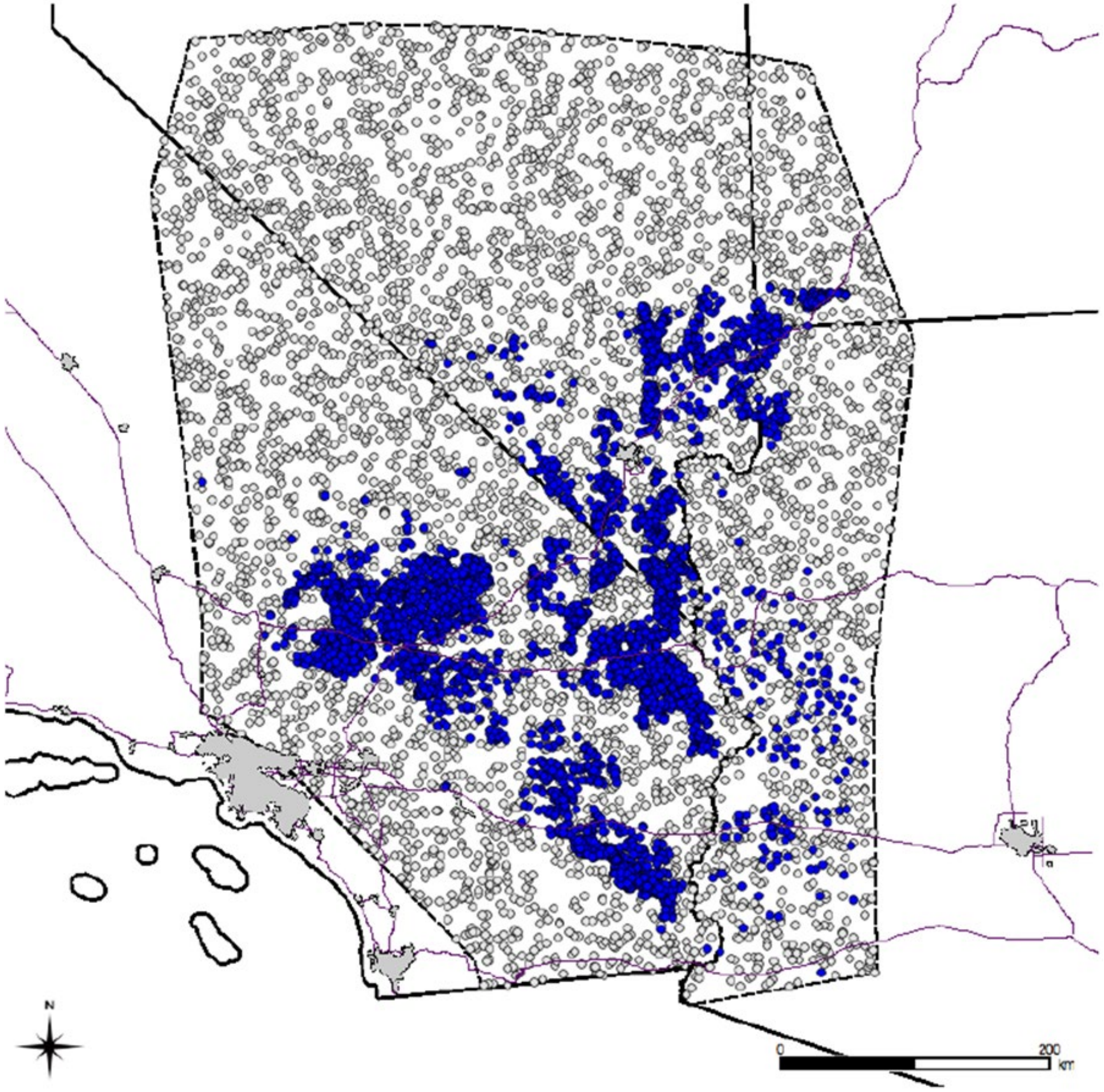
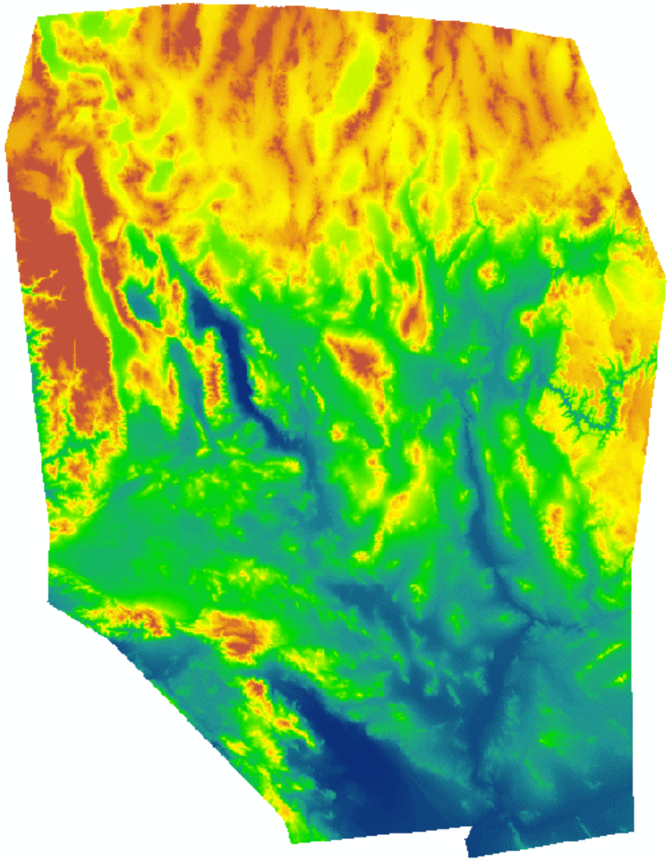


Applying spatial knowledge from field studies

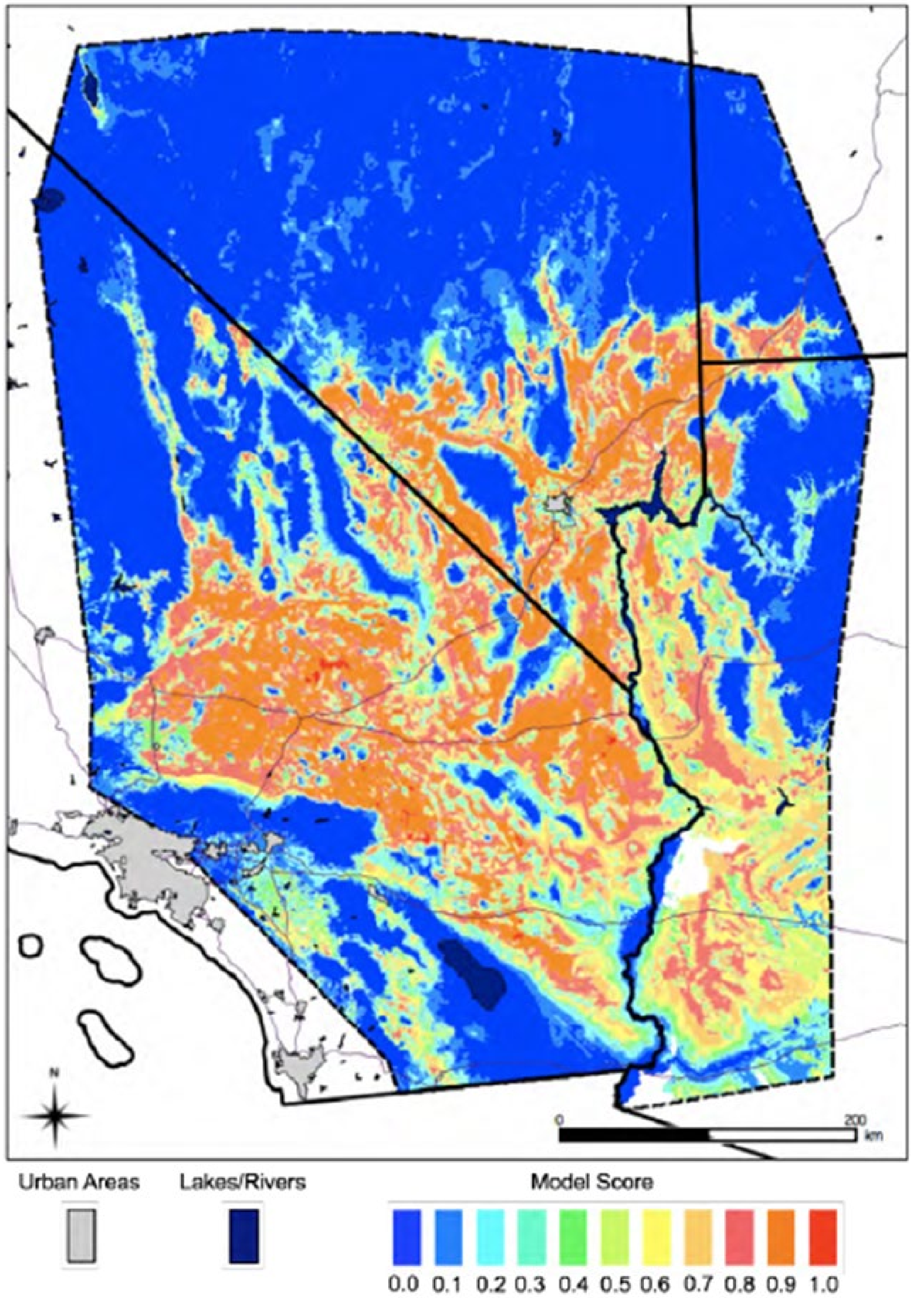
Slope

Elevation



How do we know desert tortoise habitat?

- Observations of desert tortoise occurrence
- Terrain



Quick Recap I

Options with habitat modeling

Option 1:

- Define "suitability" based on prior knowledge or expert opinion

If you choose this option, you must provide justification for your choices!

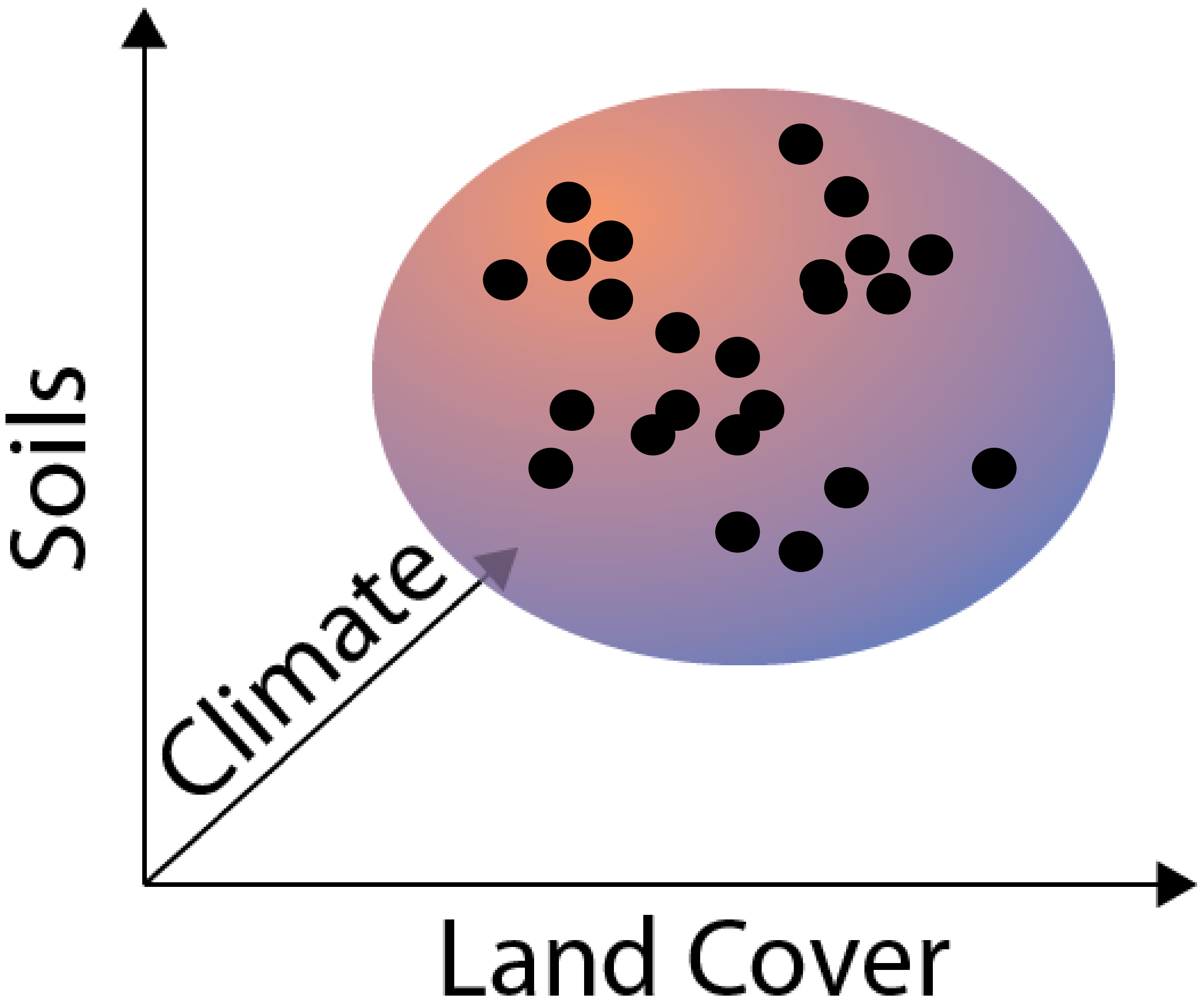
- Who did you consult?
- What is the citation?

Spatial Approach to Defining Habitat: Envelope Models

The **habitat envelope** encloses the region of parameter space in which the organism can persist, or in which the organism is found.

The habitat envelope is like the **niche** concept in ecology.

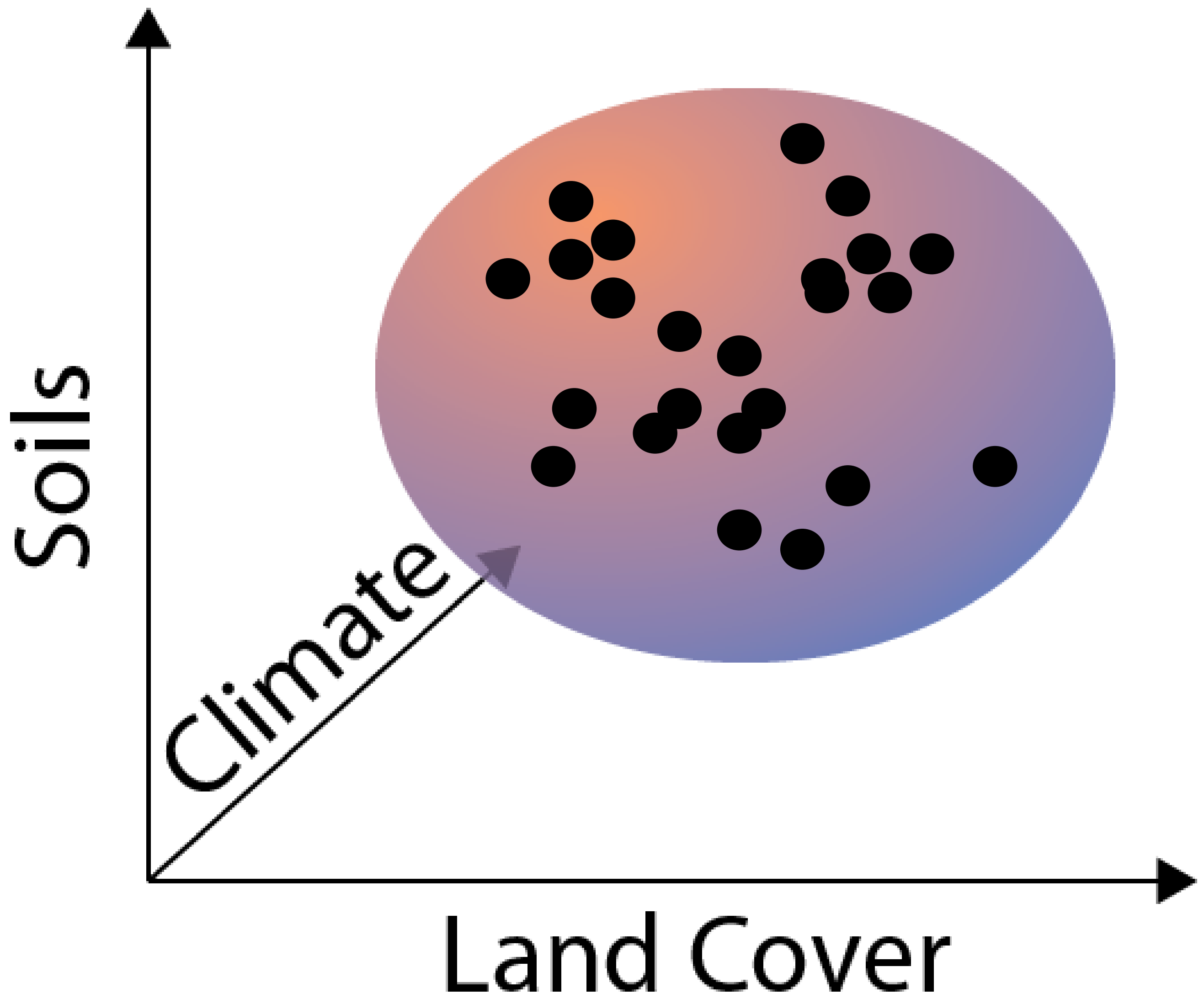
Climate space: The combinations of climate factors in which an organism is found or can persist.



Spatial Approach to Defining Habitat: Envelope Models

In practice, we often have:

- Distribution data:
  - Occurrence or
  - Abundance
  - What is the difference?
- Poorly known physiological limitations of the target species (this is typical)



Quick Recap

Two options with habitat modeling

Option 1:

- Define “suitability” based on prior knowledge or expert opinion

Option 2:

- Define suitable habitat based on spatial (and statistical) relationships.

If you choose this option, you need data!

Where do distribution data come from?

GBIF.org – digitized museum records (many are spatial)

EDDMapS.org – spatial occurrences of invasive species

EDDMapS
Early Detection & Distribution Mapping System

Researchers

Bioclimatic Envelope Models

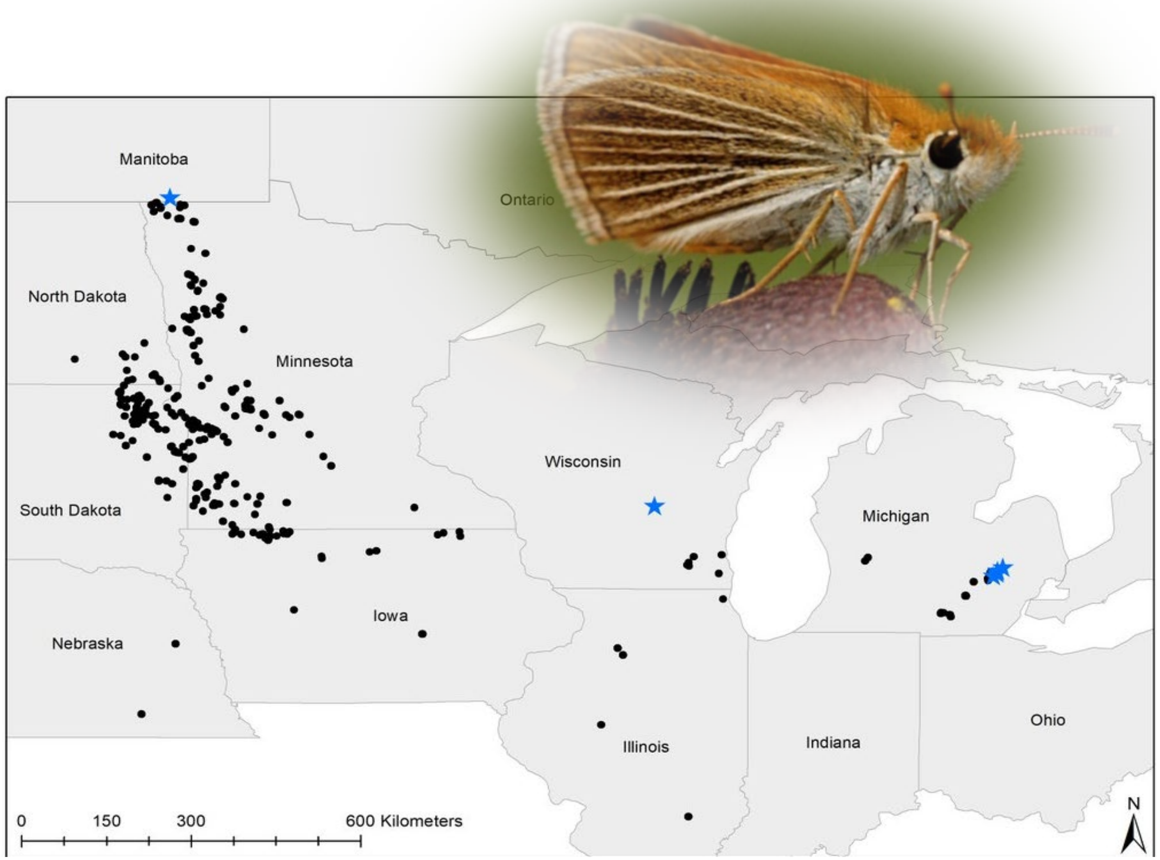
What’s in a climate?

What’s in a climate?

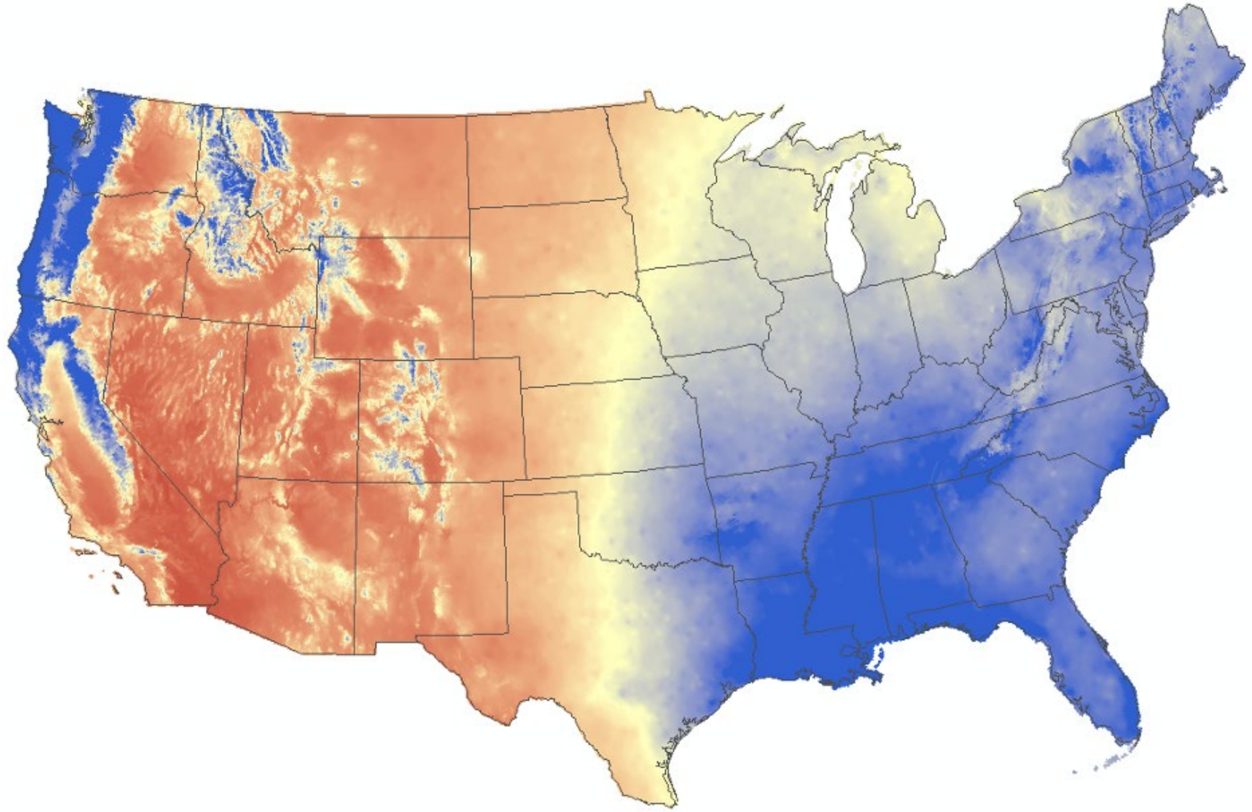
Perhaps the most obvious components are temperature and precipitation, but how should we measure them?

- Mean annual temperature
- Mean winter low temperature
- Mean daily high temperature during growing/active season
- Mean monthly precipitation
- Mean monthly precipitation during dry season
- Inter-annual variability
- Others?

Bioclimatic Envelope Models aim to identify suitable climate conditions for a species (the climate envelope)

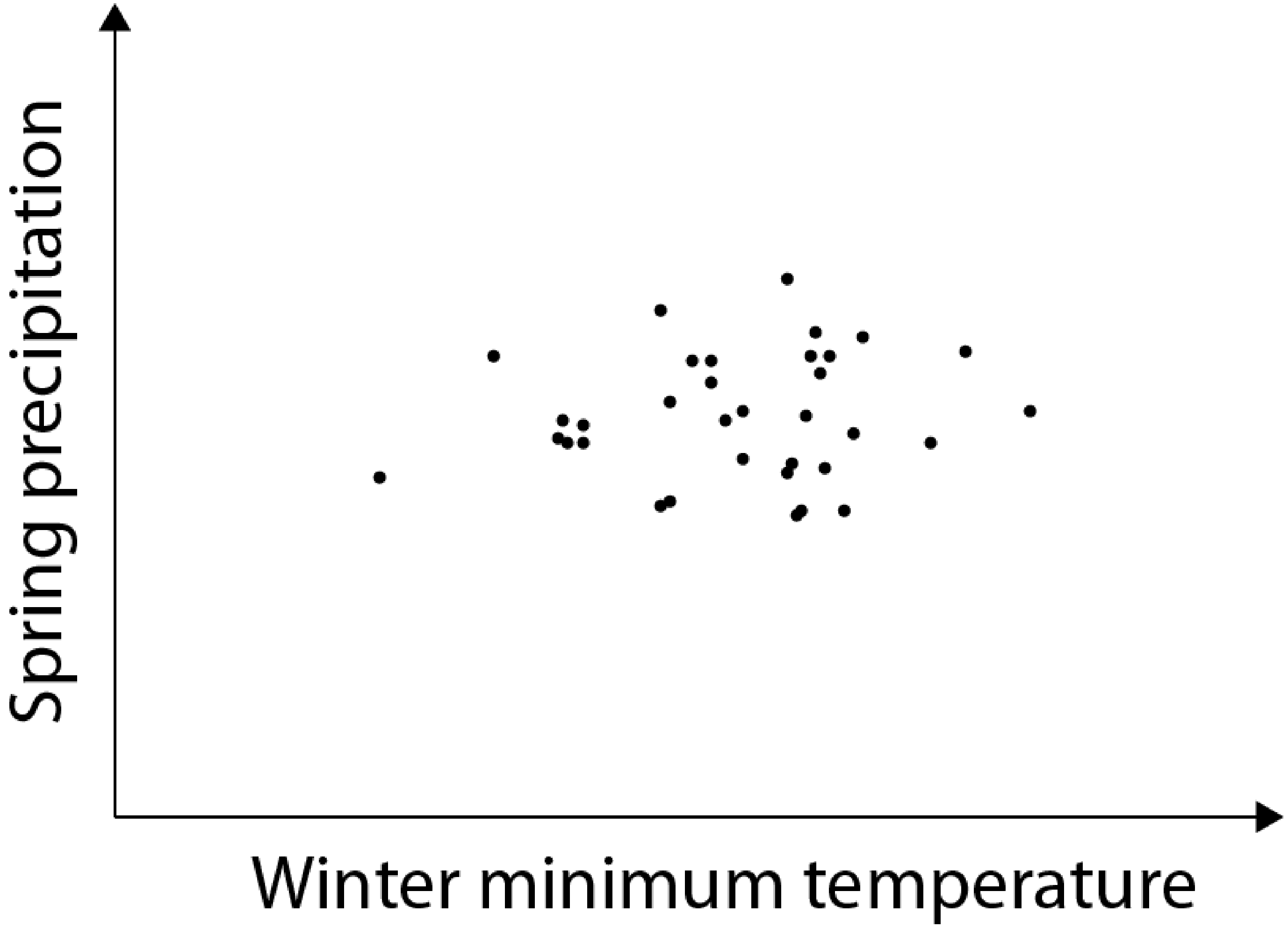


Skipperling butterfly occurrences

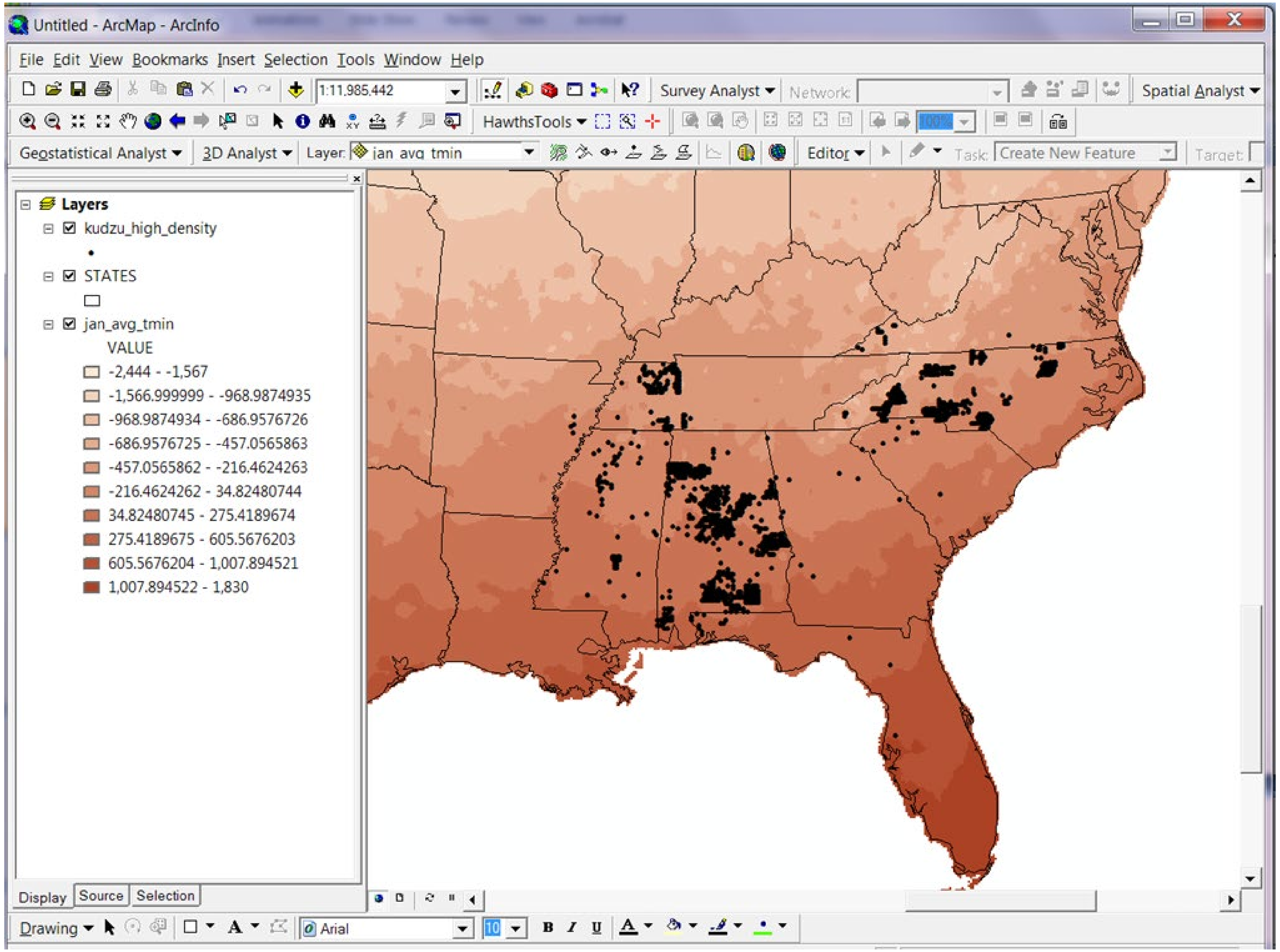


Average spring precipitation

Bioclimatic Envelope Models



How do I describe the climate at a point?



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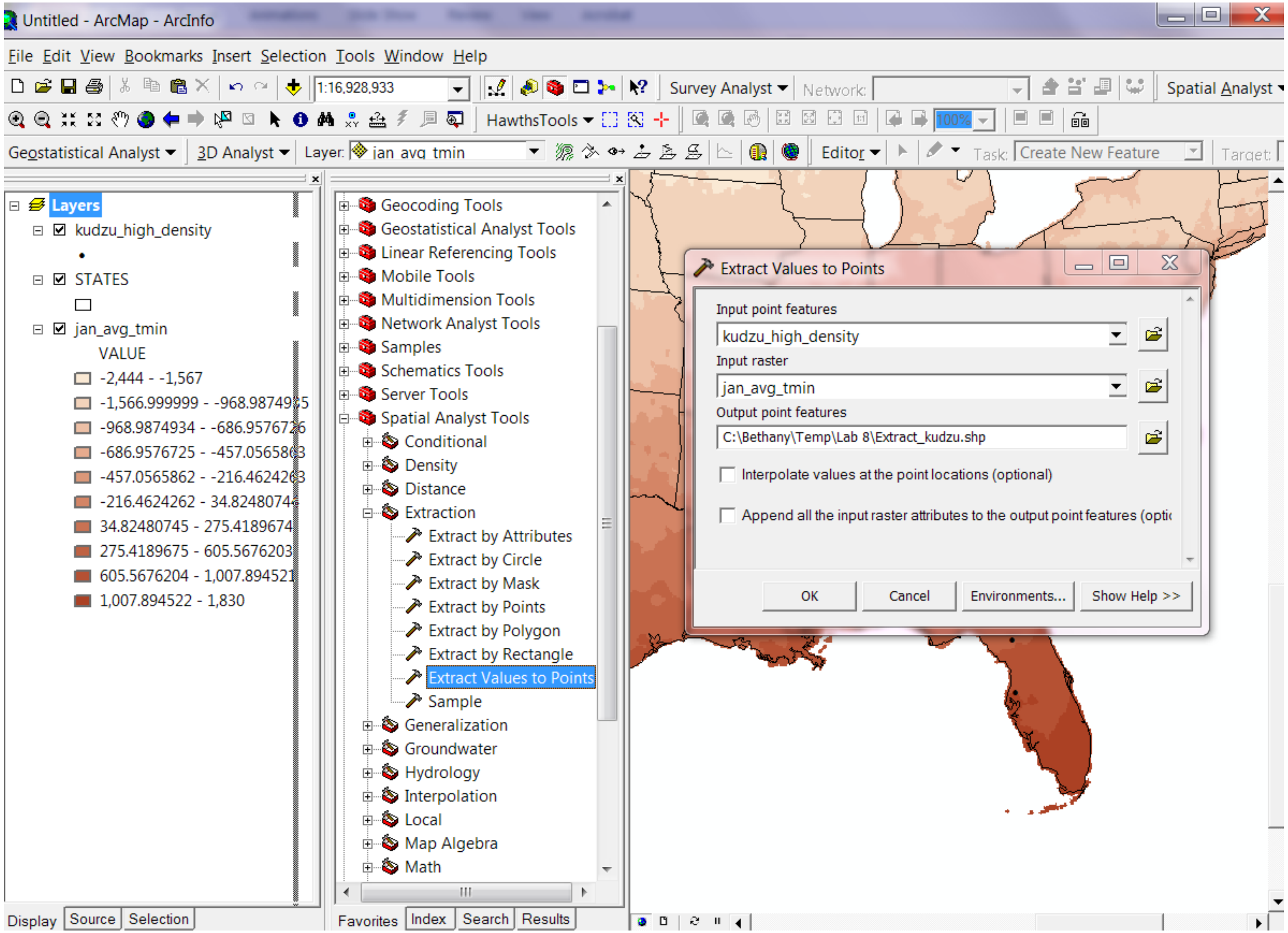


How do I describe the climate at a point?

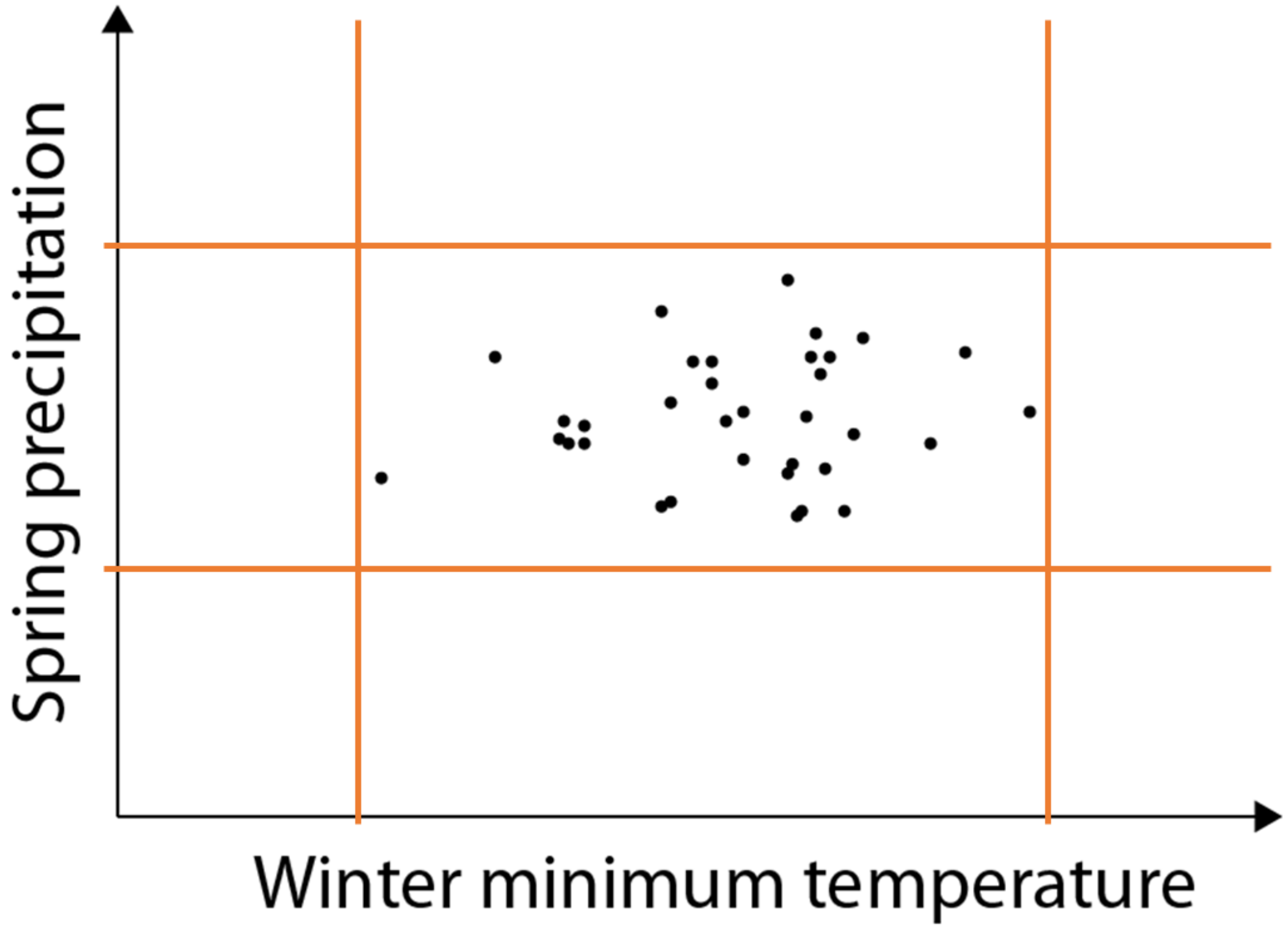
Attributes of Extract_kudzu_ann_ppt

FID	Shape *	NAME	STATE	KUD_PRS	ANNUAL_	JAN_AVG	RASTERVALU
343	Point	Old Fort	NC	1	158247	-747	158247
320	Point	Montreat	NC	1	137720	-705	137720
990	Point	Pennington Gap	VA	1	131147	-577	131147
187	Point	Celo	NC	1	151812	-566	151812
975	Point	Keen Mountain	VA	1	118918	-561	118918
344	Point	Old Fort	NC	1	134190	-552	134190
981	Point	Vansant	VA	1	119021	-545	119021
305	Point	McGrady	NC	1	127660	-543	127660
980	Point	Stickleyville	VA	1	133062	-529	133062
345	Point	Old Fort	NC	1	120623	-527	120623
976	Point	Moll Creek	VA	1	116618	-524	116618
281	Point	Little Switzerland	NC	1	145847	-518	145847
306	Point	McGrady	NC	1	125970	-516	125970
280	Point	Linville Falls	NC	1	140144	-514	140144
978	Point	Saint Paul	VA	1	116265	-513	116265

Record: 0 Show: All Selected Records (0 out of 1058 Selected) Options

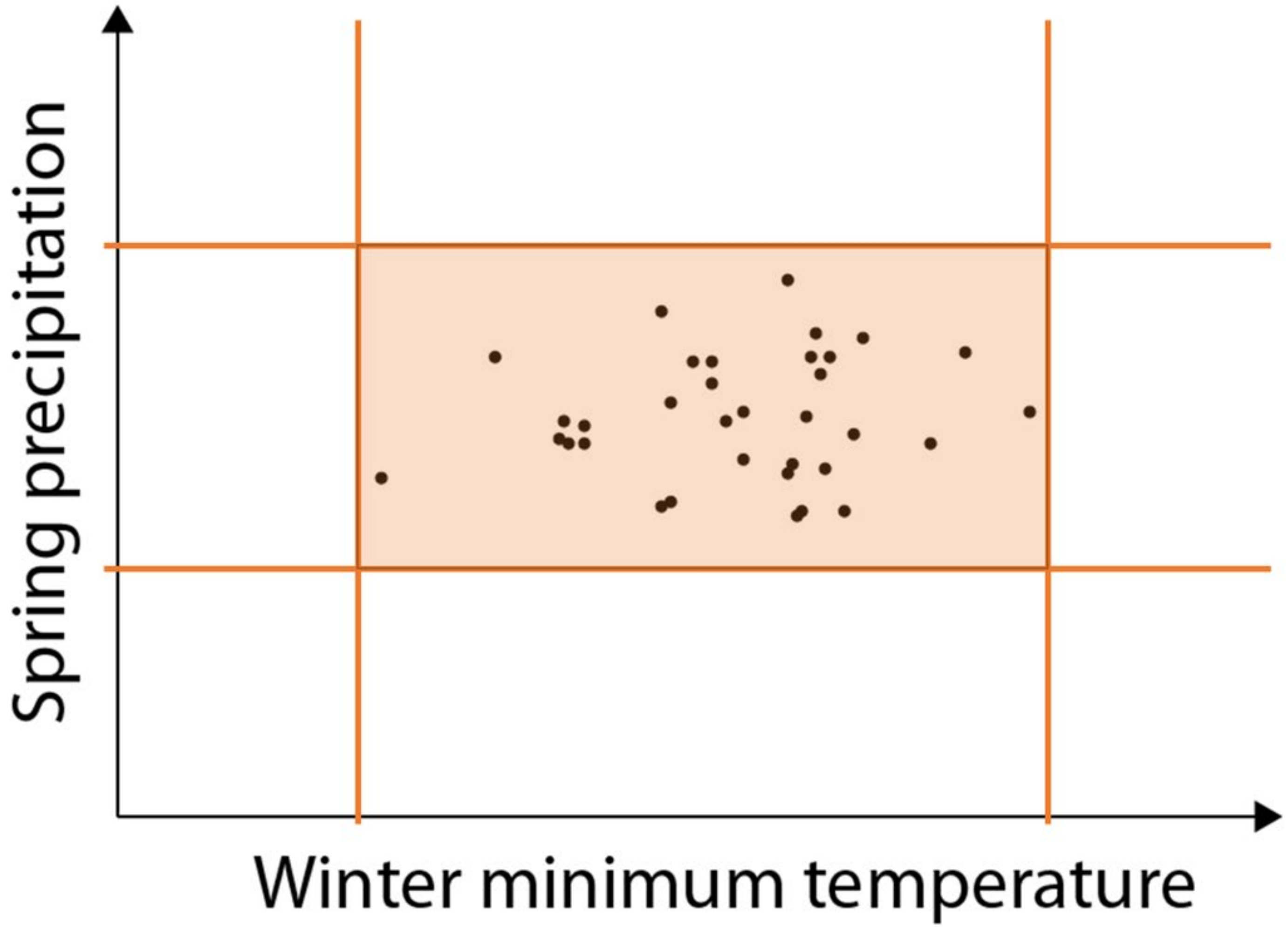
Bioclimatic Envelope Models

1. Use occurrence data to determine climate variable ranges



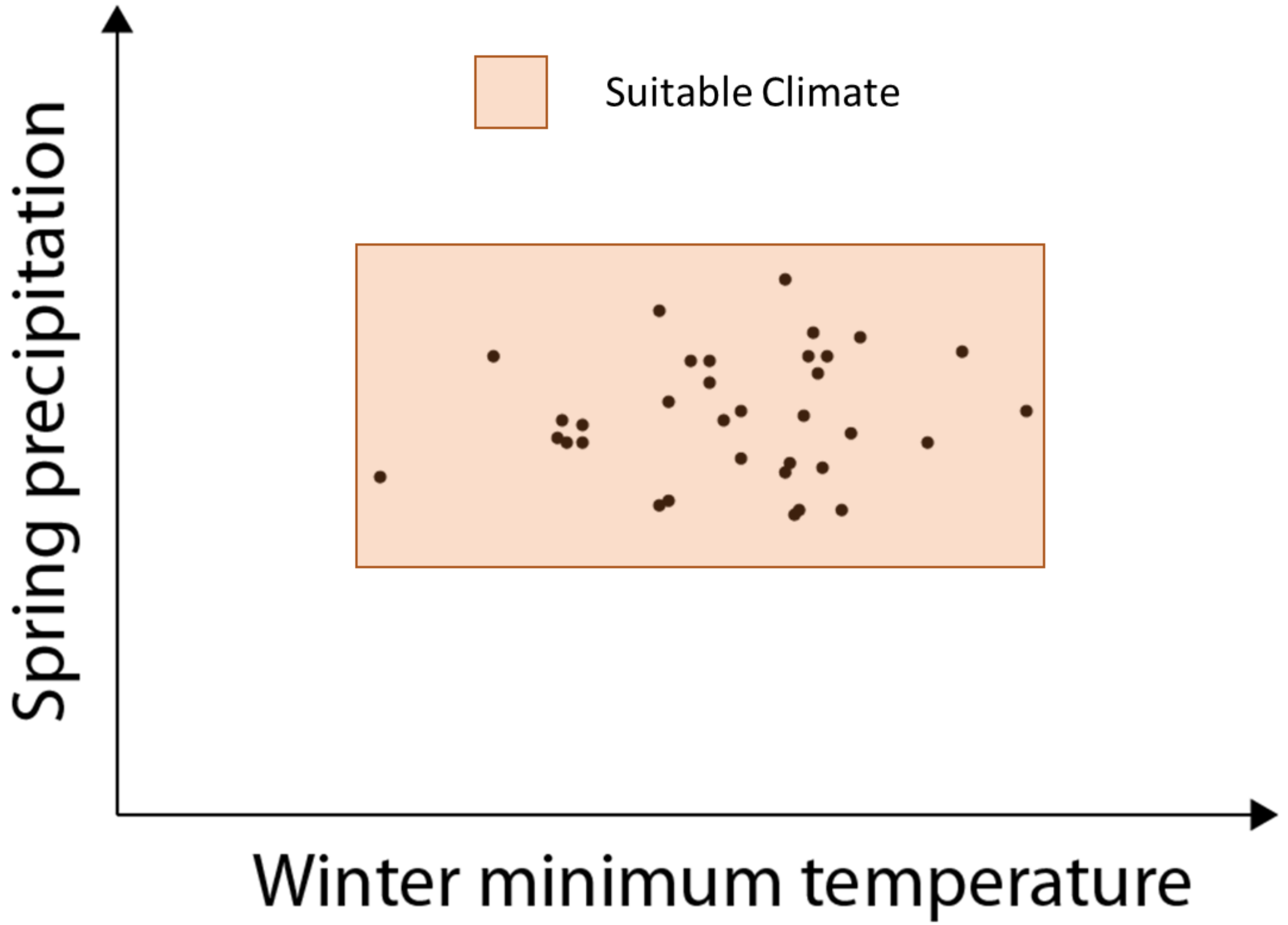
Bioclimatic Envelope Models

1. Use occurrence data to determine climate variable ranges

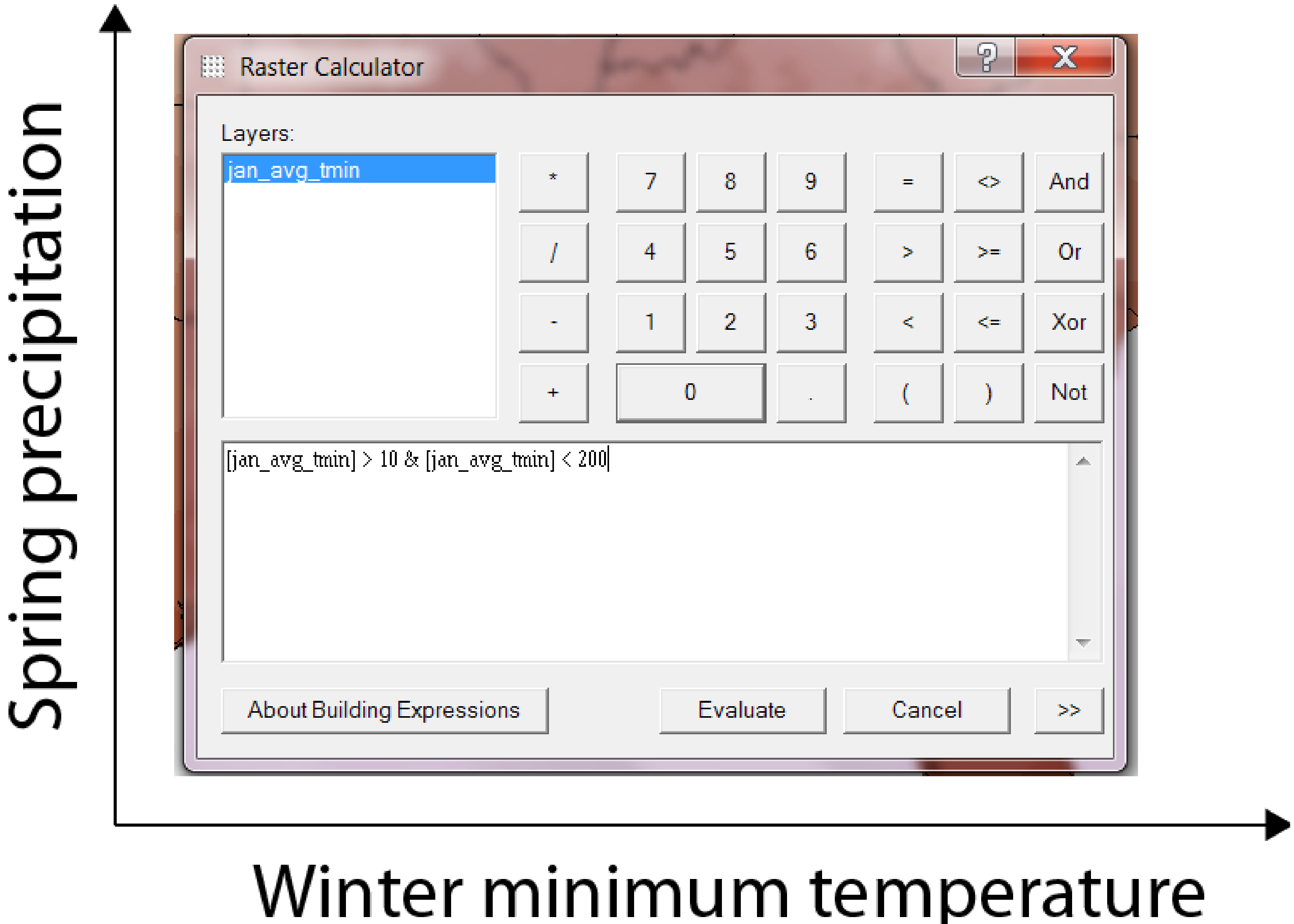


Bioclimatic Envelope Models

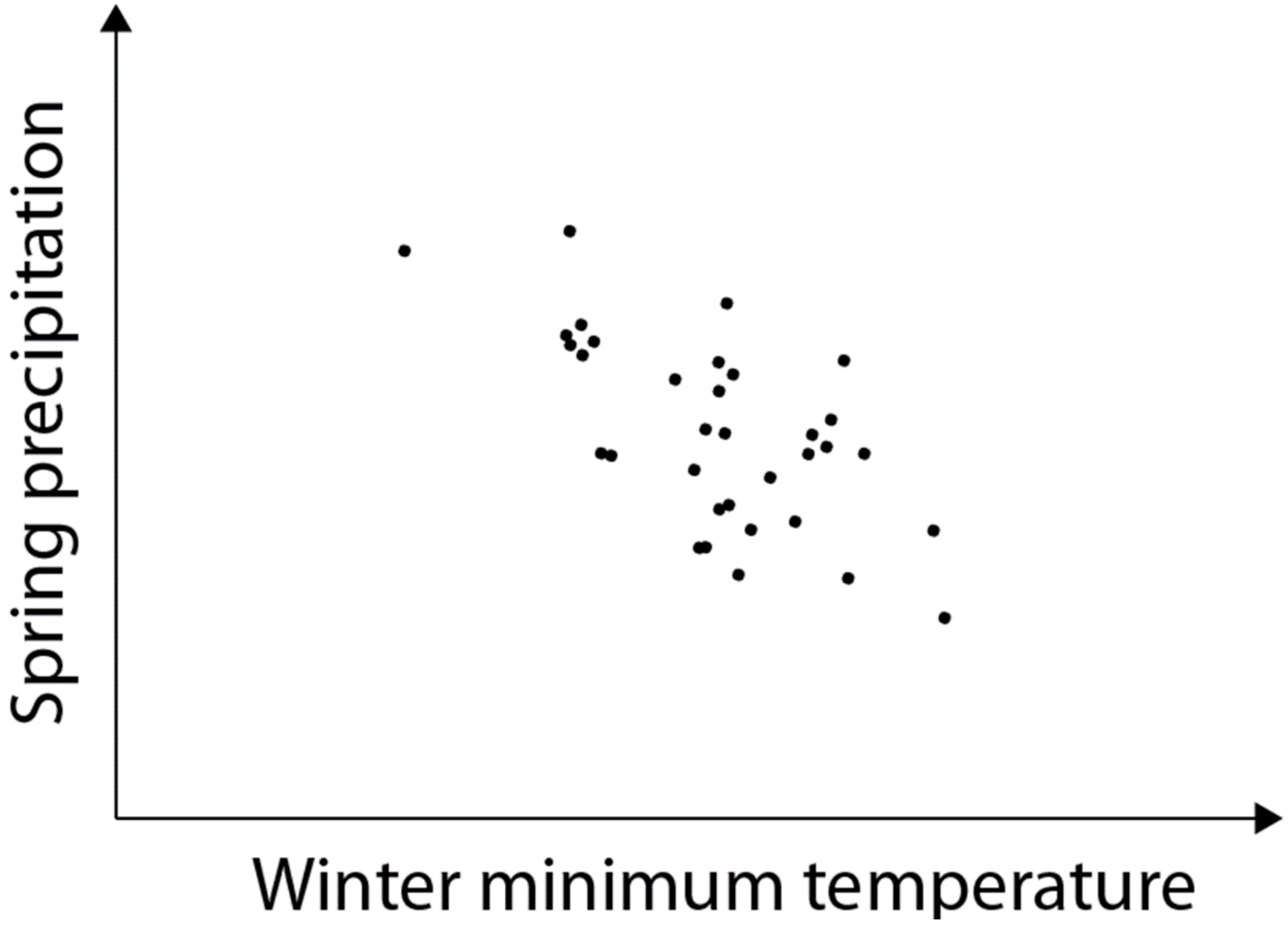
1. Use occurrence data to determine climate limits.
2. Estimate suitable climate from observed occurrences



How do we do this in GIS?



Are climate envelopes rectangular?



Bioclimatic Envelope Models

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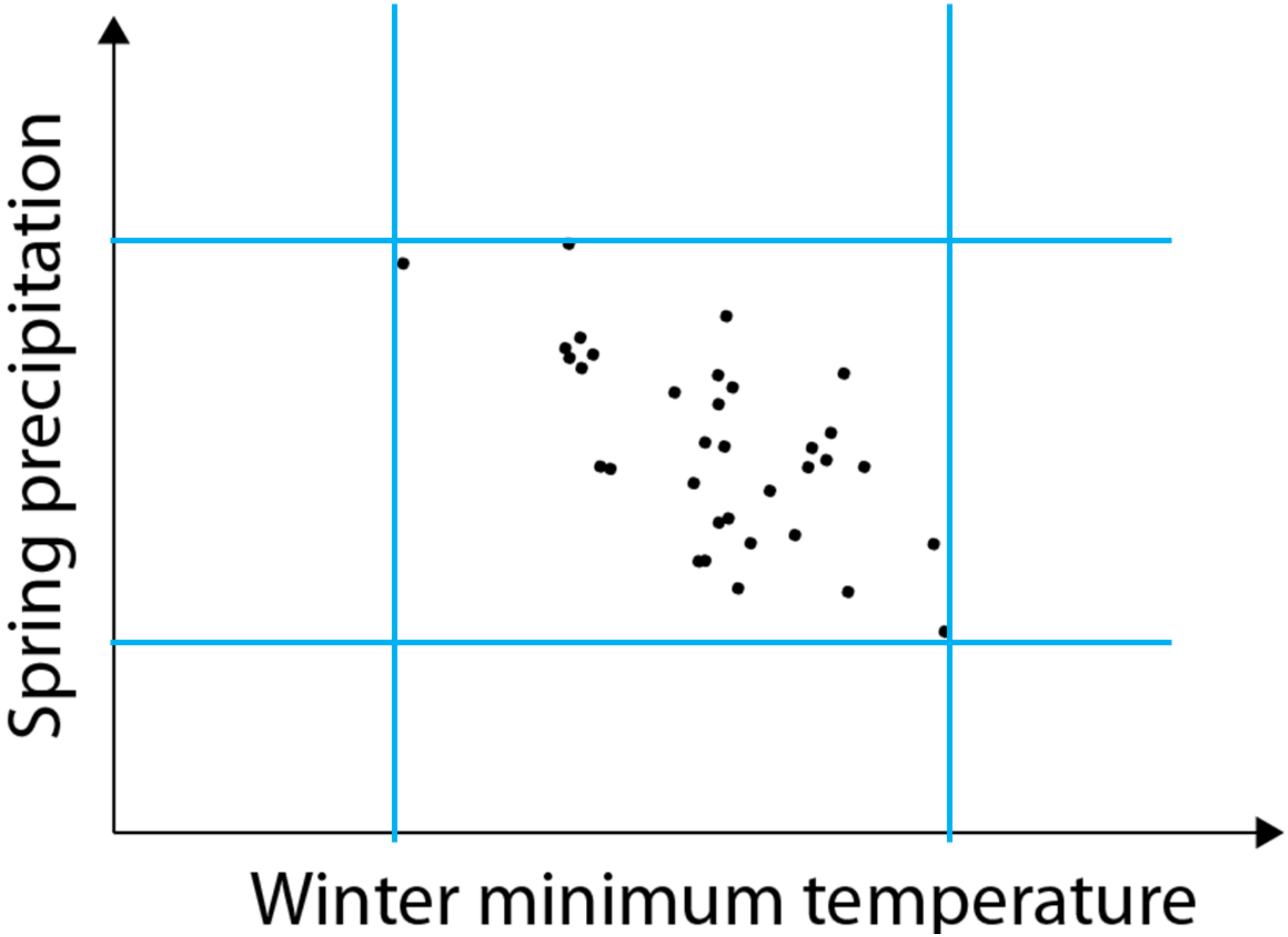
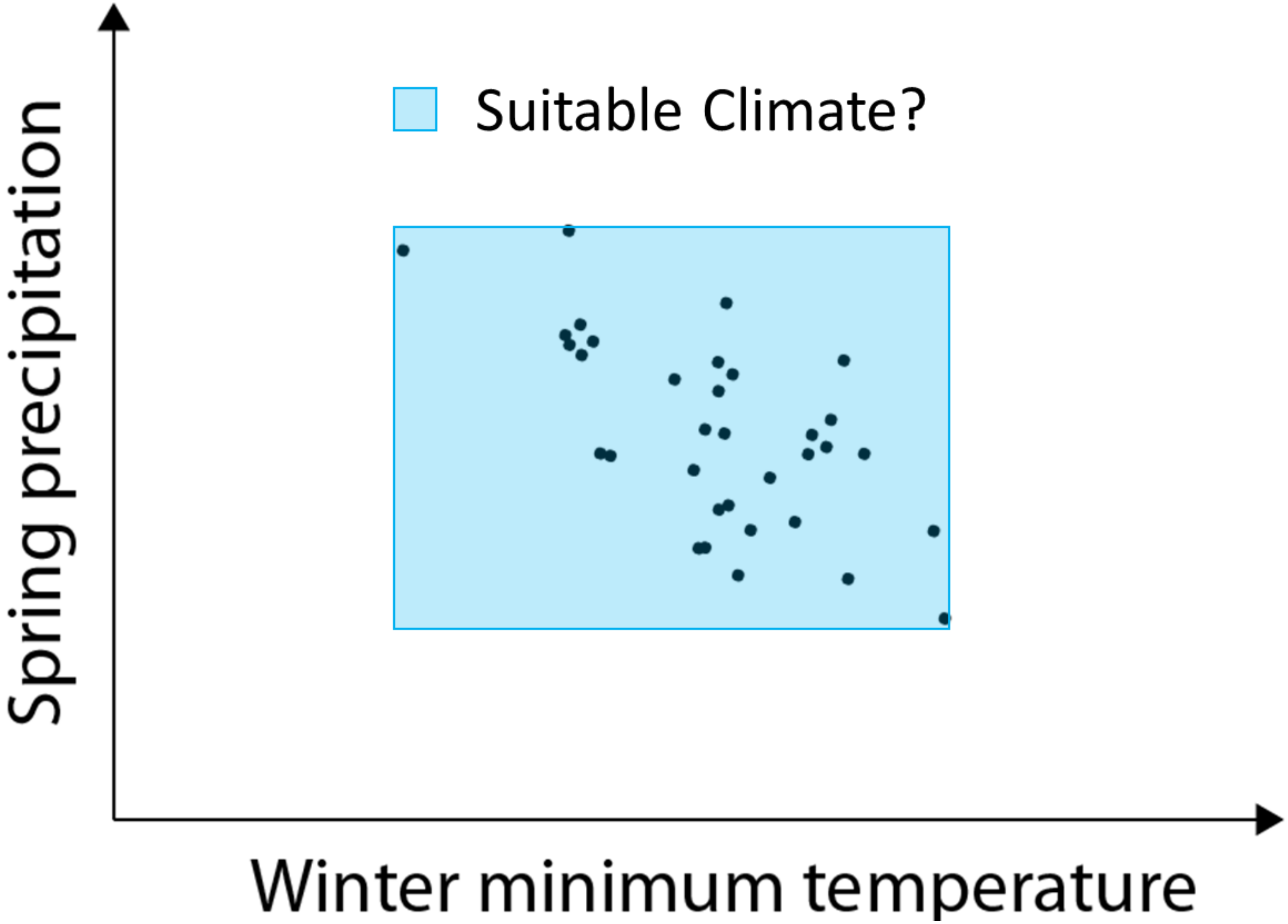


Bioclimatic Envelope Models

1. Use occurrence data to determine climate variable ranges



Bioclimatic Envelope Models

Correlations or interactions between climate variables along species distributions

Interaction between temperature and precipitation

Plants do not wilt in areas with high precipitation.

Plants wilt in hot temperatures with low precipitation

Plants do not wilt in hot temperatures with high precipitation.

Correlation between elevation and temperature

High elevation areas tend to be colder

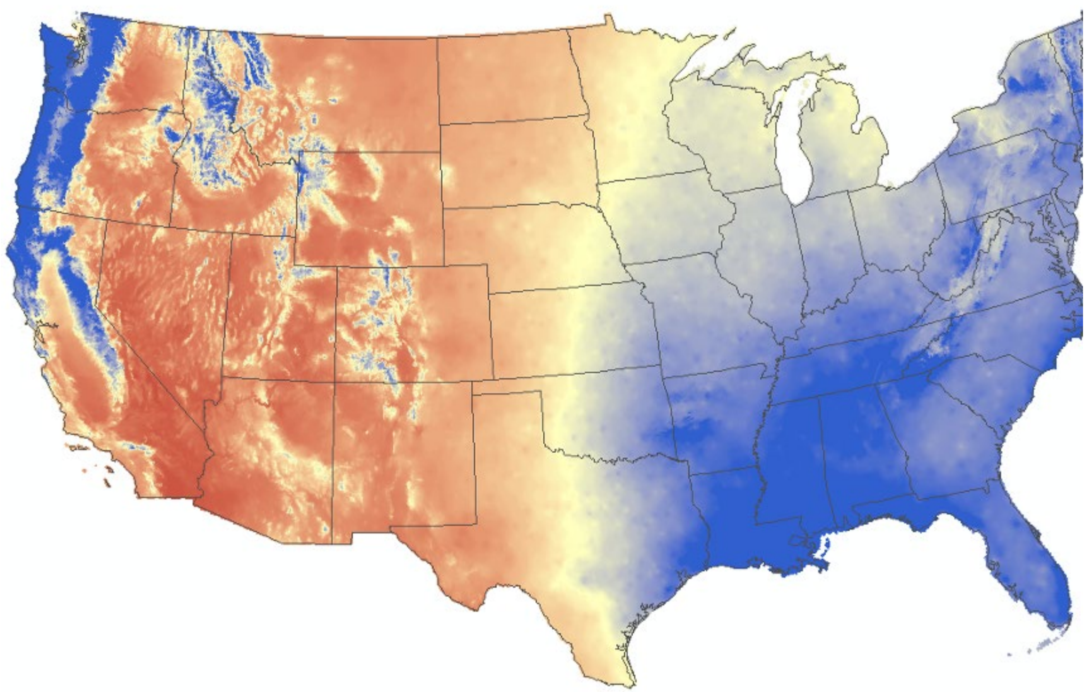
Bioclimatic Envelope Models

- Standard GIS approaches can’t account for statistical correlations and interactions among climate predictors.
- There are advanced statistical, simulation, and machine learning approaches that can.

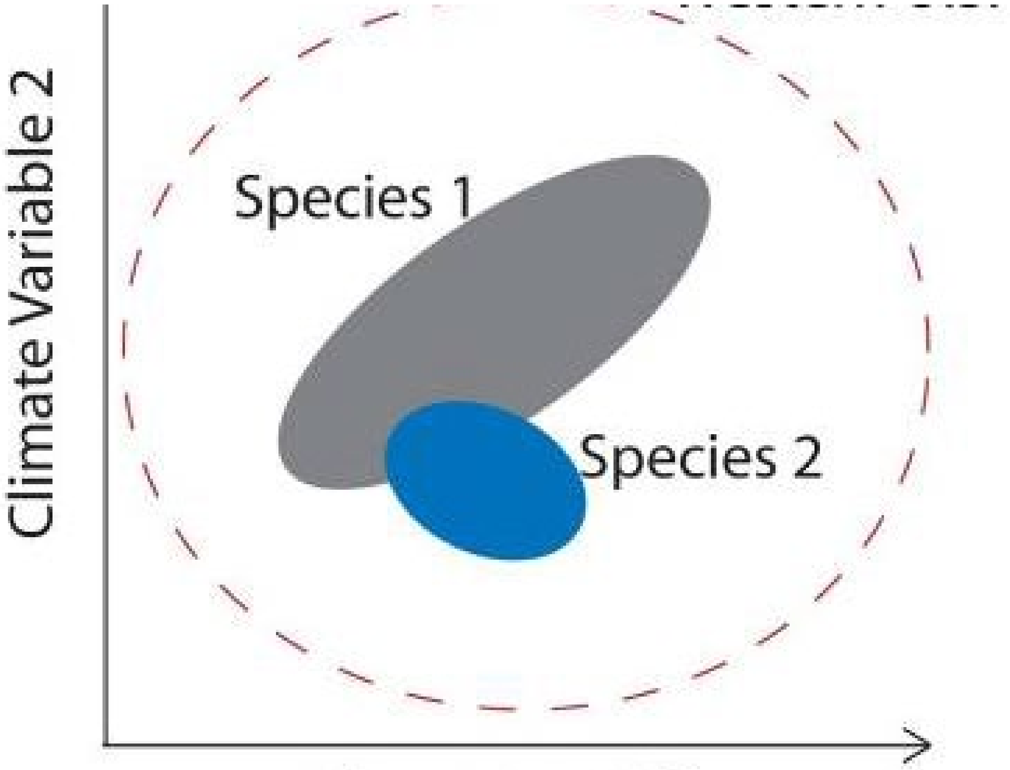
- Species Distribution Models
- MAXENT
- Mahalanobis Distance
- GARP
- Biomod
- CLIMEX
- Random Forests
- Support Vector Machines

Bioclimatic envelope models only consider climatic constraints

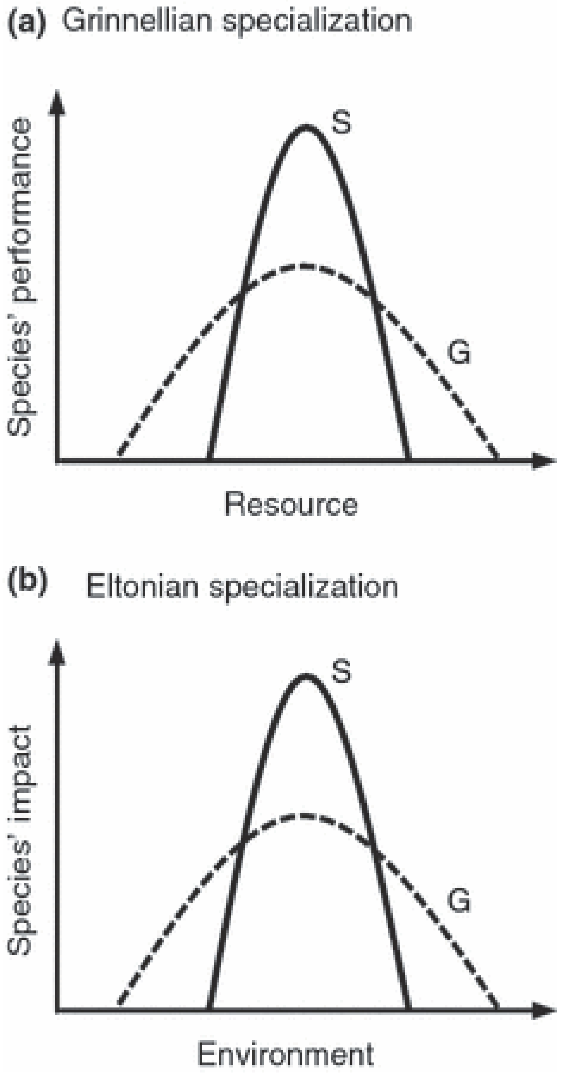
United States



Example Climate Variable
(Avg ppt)



Niche Concepts



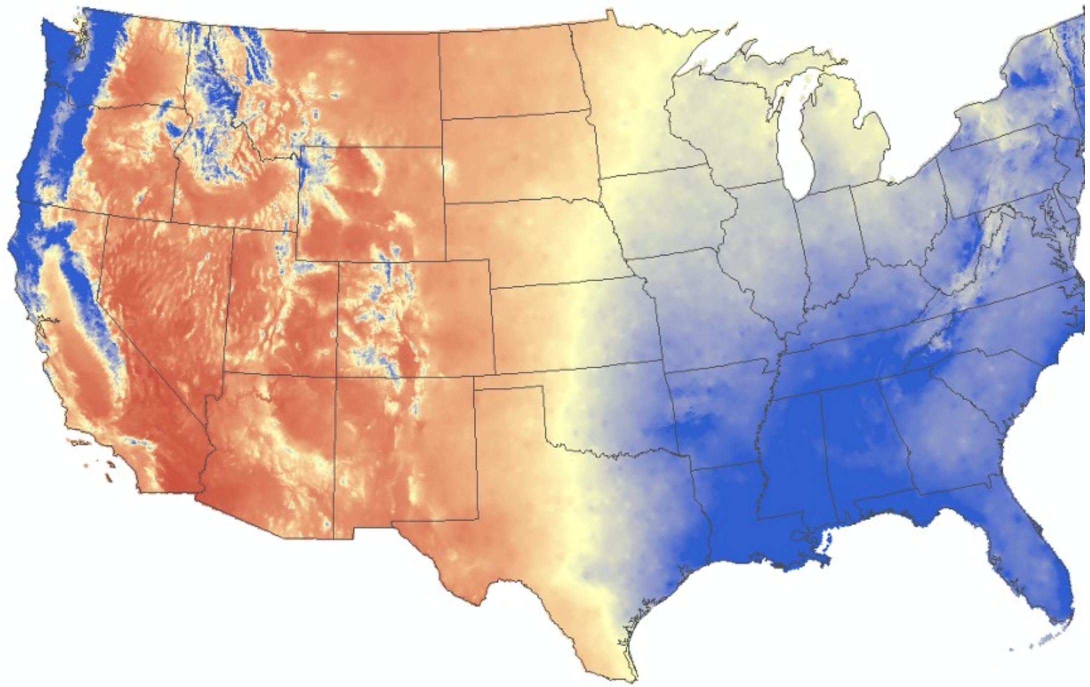
- Abiotic and biotic factors
- Fundamental niche
- Niche breadth
- Niche conservatism
- Realized niche
- Source, sink habitats

Figure 1 in Devictor et al, 2010

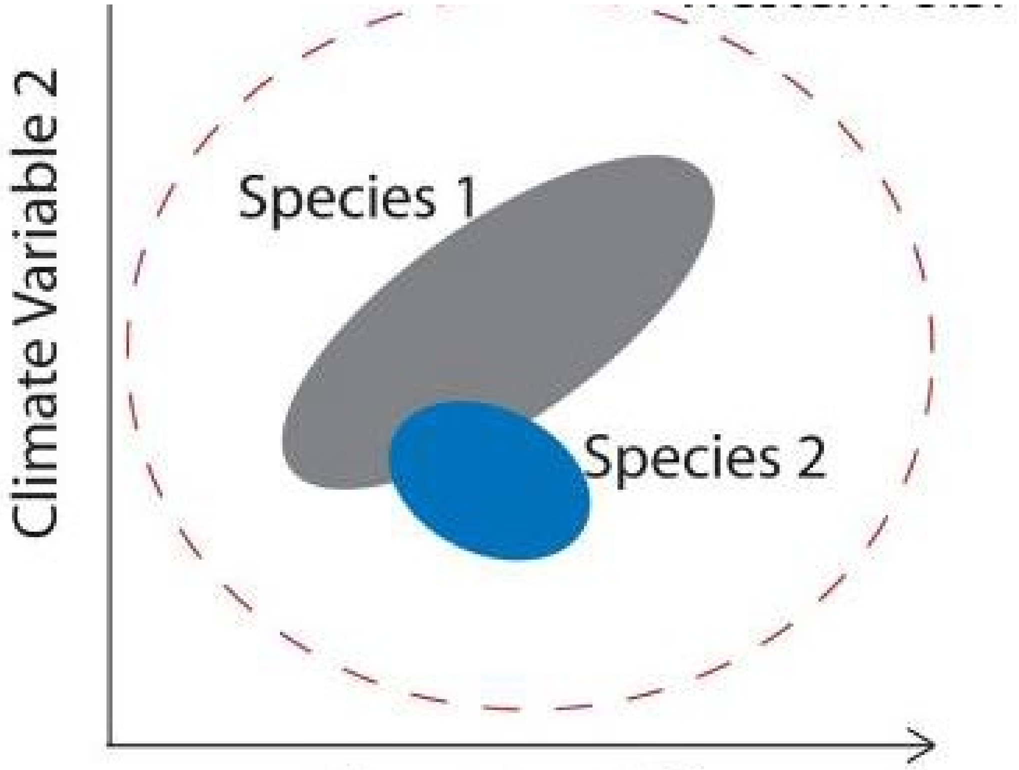
Definition of Grinnellian vs. Eltonian specialization. (a) The Grinnellian specialization of a given species can be described by its variance in performance across a given range of resources. For a given mean performance, the dashed line describes the performance of a generalist species (generalist, G) and the solid line of a more specialist species (specialist, S). (b) Eltonian specialization is defined as the variance in the species' impact (instead of performance) on the environment. For a given mean impact, the species' impact can be distributed through a large part of the environment (G) or be more restricted (S).

Species 1 has greater niche breadth

United States



Example Climate Variable
(Avg ppt)

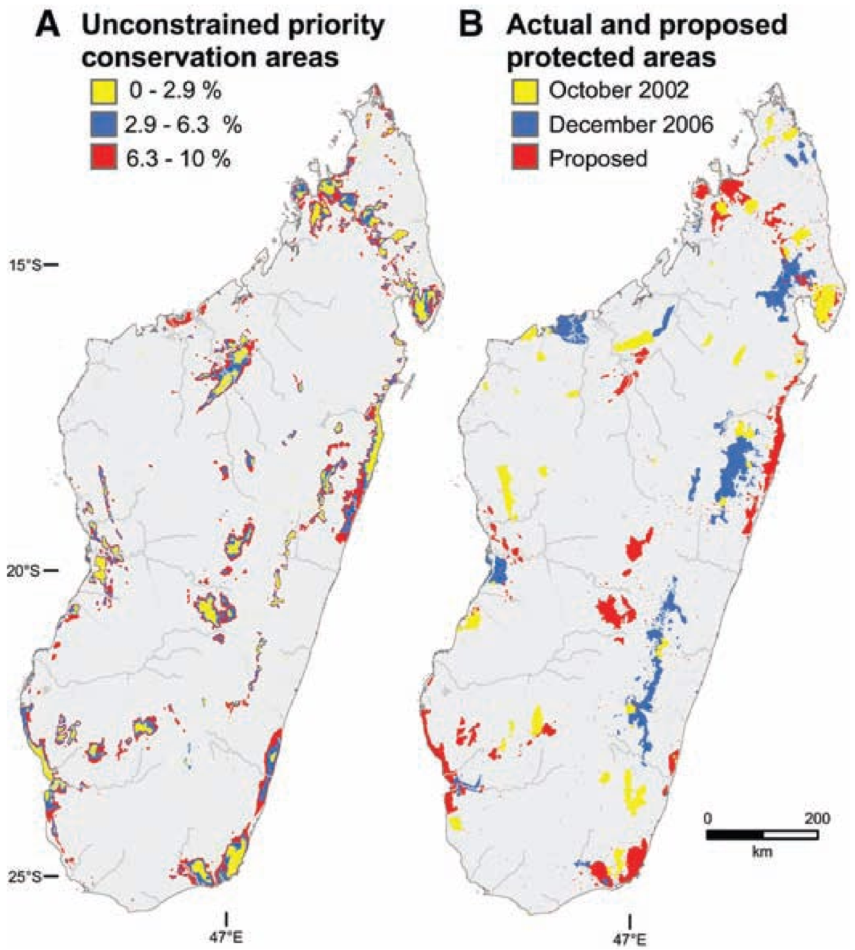


Take home points

- Habitat modeling is designed to help us better understand and predict species distribution
- Models can be built on ancillary/expert knowledge, educated guesses, or spatial relationships (or a combination of all three)

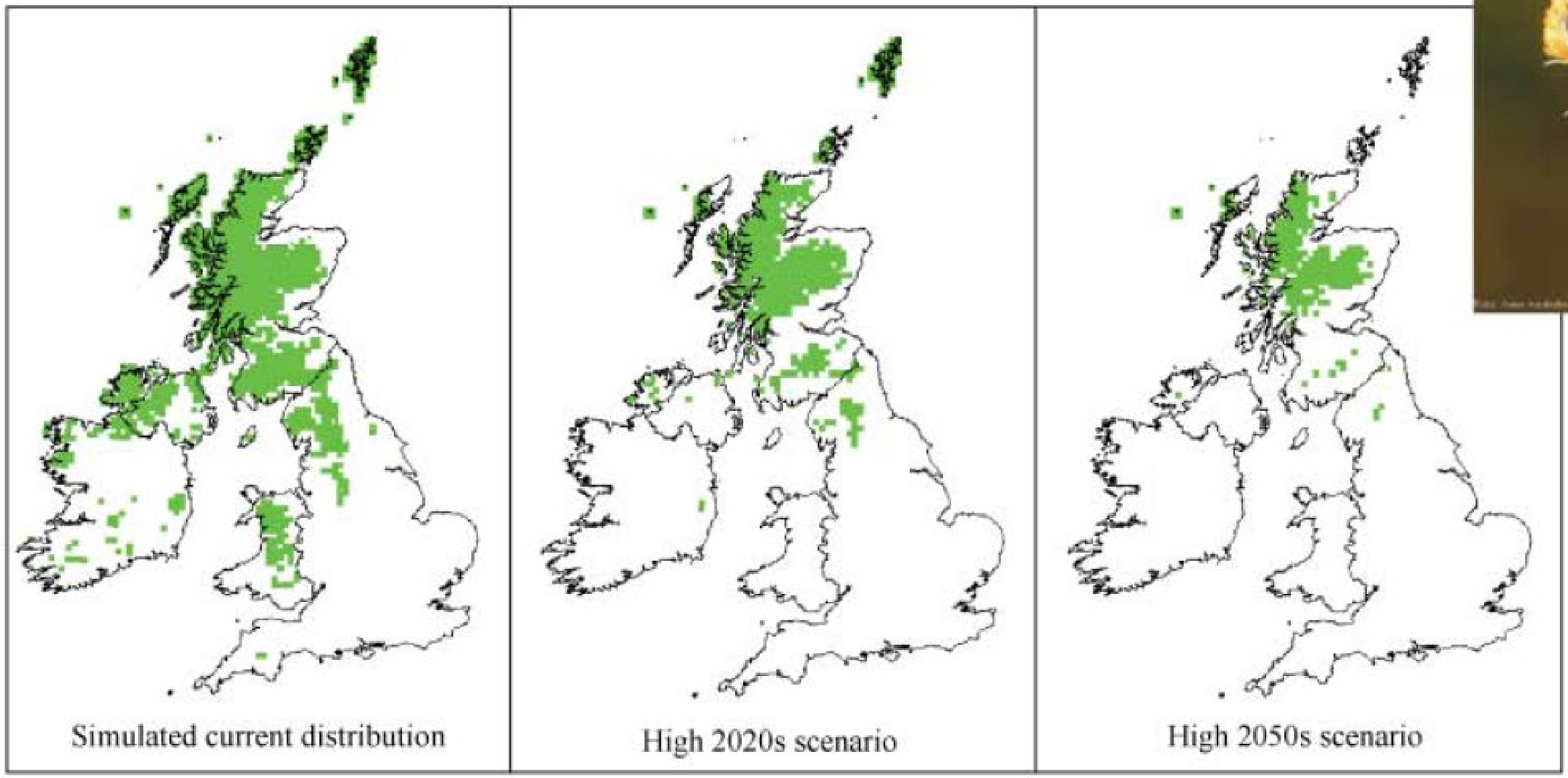
Habitat Model Examples

Habitat Modeling: Reserve Planning



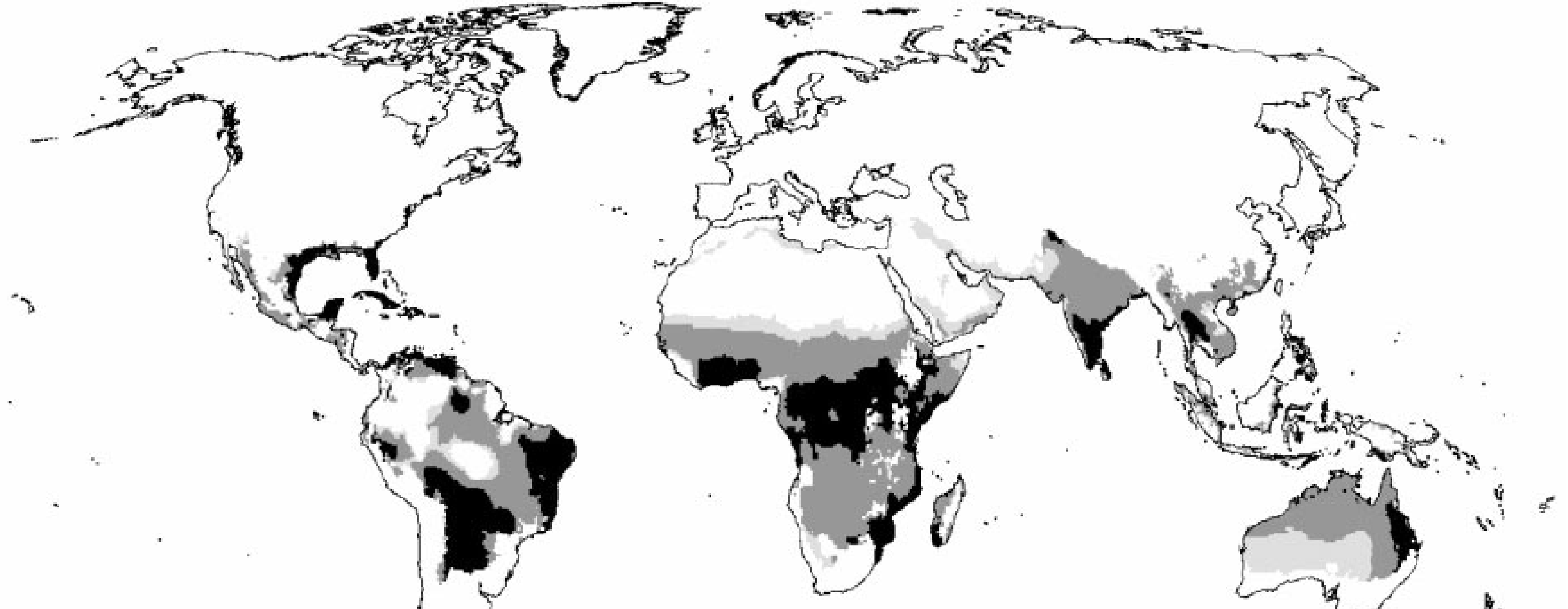
Kremen et al., 2008 **Aligning Conservation Priorities Across Taxa in Madagascar with High-Resolution Planning Tools**

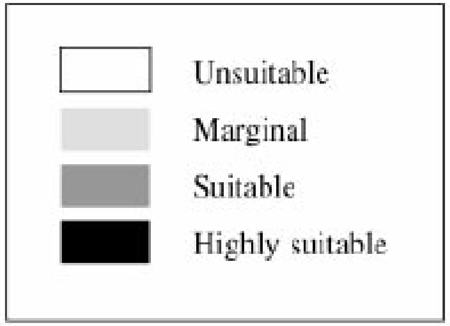
Risk from Climate Change: Bioclmatic Modeling and Spatial Simulation



Pearson & Dawson, 2003, Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful?

Bioclimatic Envelope Modeling:
Invasion risk from non-native species





Prickly Acacia
Native to Africa & India

Kriticos et al., 2003, SPAnDX: a process-based population dynamics model to explore management and climate change impacts on an invasive alien plant, *Acacia nilotica*

Final Poster

Final Poster Content

Scientific papers/reports/presentations have a very specific organization

Introduction Tells us why the topic is interesting

Methods Tell us what you did

Results Tell us what you found

Discussion Tells us why what you found is interesting

Consider this organization for your final poster

Final Poster: Introduction

Information to Include

- Why is the topic important?
- Relevant background.
- Your motivating question or goal

Figures to Include

- Study Area Map
- A picture

Final Poster: Methods

Information to Include

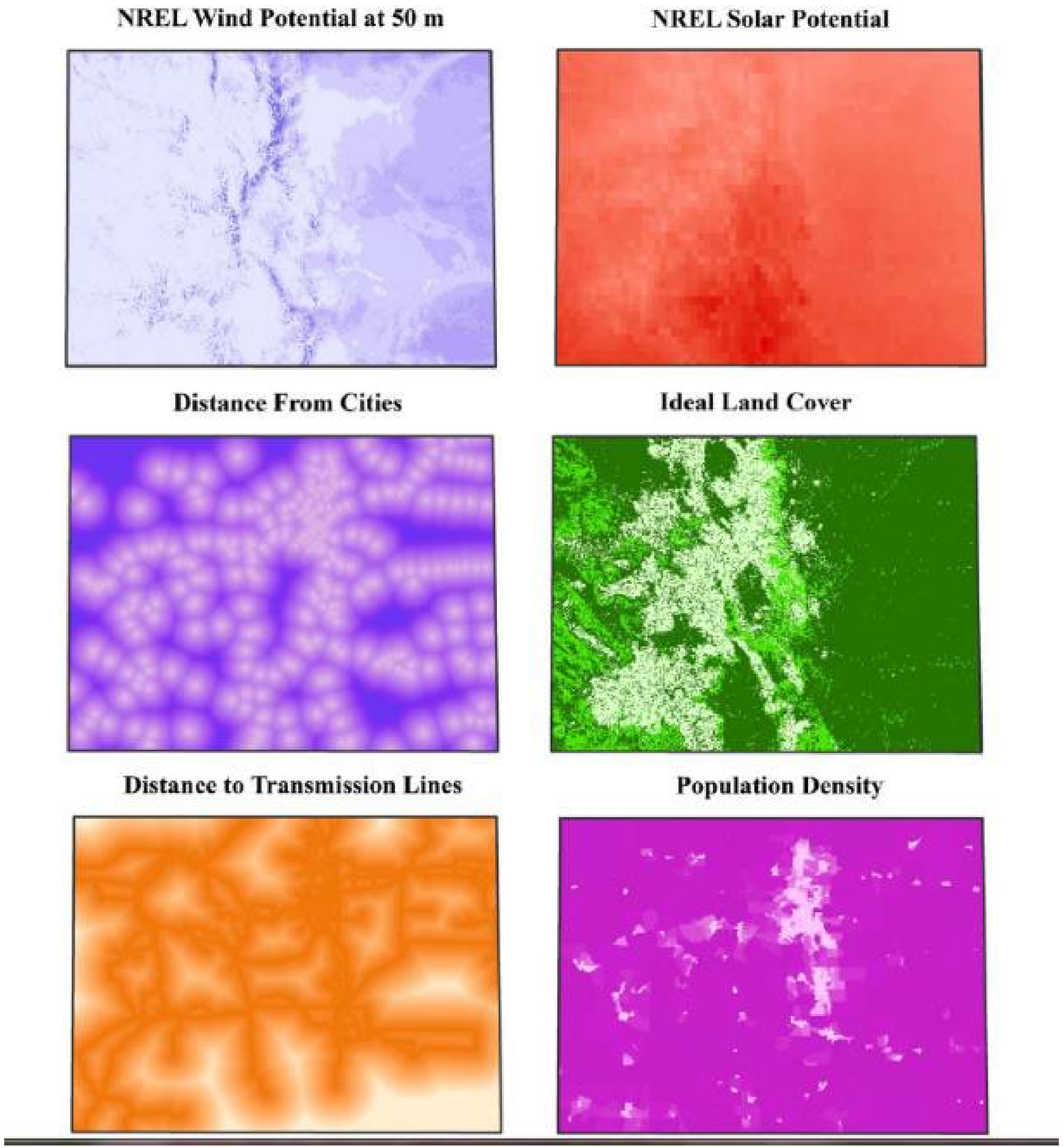
- General goal or research question.
- General approach
- Important decisions you made in your anaysis

Figures to Include

- Method steps that are easier to represent as a figure.
- Table of data layers

Final Poster Content: Methods

- Highlight any important intermediate steps



Final Poster: Results

Information to Include

- Description of major findings, such as:
  - Statistical or numeric results
  - Graphical results
  - Charts
  - Tables

Figures to Include

- Maps!
- Plot or tables of important results:
  - Histograms
  - Scatterplots
  - Boxplots
- Maps!

Final Poster: Discussion

- Were there any notable limitations?
- Summarize important take-home points.
- What are the big-picture conclusions?
- What are the next steps?

Final Poster: Level of Detail

Be efficient with text

- You have limited real estate on your poster!
- Keep text simple, use bullet points whenever possible.
- Summarize your analyses, you don’t need to reproduce every detail.
- Extensive text is for the journal article version of your poster!

Graphics should be the main feature

- Your graphics should tell the main story.
- Plot or tables of important results:
    - Histograms
    - Scatterplots
    - Boxplots
- Maps will be the most important feature for most posters.

Some Example Poster Ideas

Ivory Billed Woodpecker Conservation

Your Name Here
Department of Environmental Conservation

Introduction:
Text about why bird conservation is important and some history on the ivory billed woodpecker (Figure 1). Define your question here.

Fig. 1: Woodpecker

Methods:
Criteria used to define woodpecker habitat. How you did what you did (Figures 2-4).

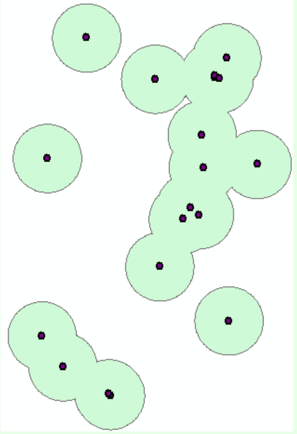


Fig. 2: Buffer

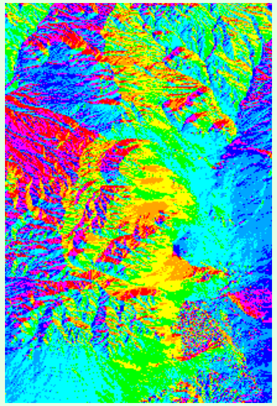


Fig. 3: Aspect

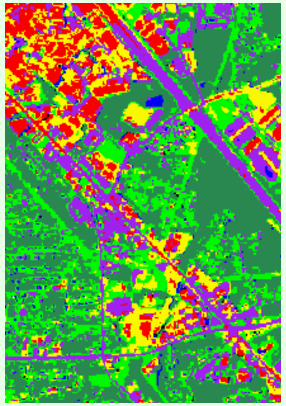
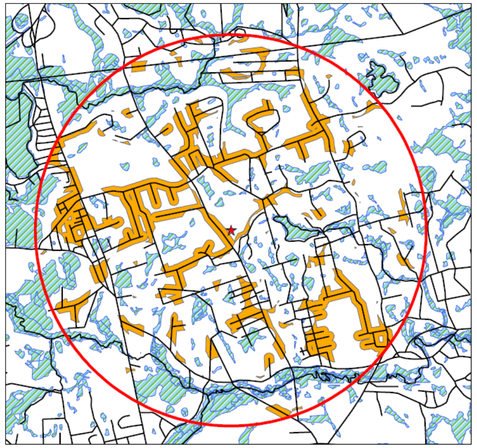


Fig. 4: Land Cover

Results & Discussion:
Woodpecker habitat. Final map or maps, final analysis (Figures 5-6). Discuss why these results are interesting.



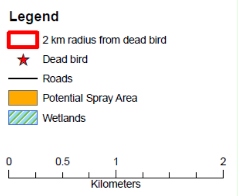


Fig. 5: Map result

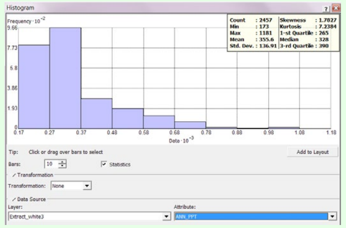


Fig. 6: Graph result

Ivory Billed Woodpecker Conservation

Your Name Here
Department of Environmental Conservation

Introduction:
Text about why bird conservation is important and some history on the ivory billed woodpecker (Figure 1). Define your question here.

Fig. 1: Woodpecker

Methods:
How you did what you did (Figures 2-4)

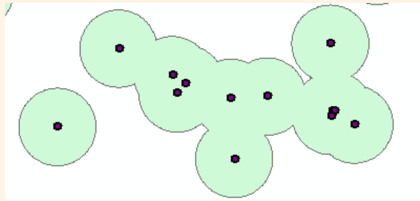


Fig. 2: Buffer

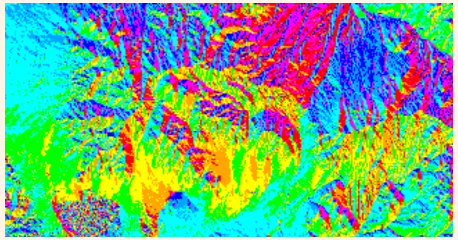


Fig. 3: Aspect

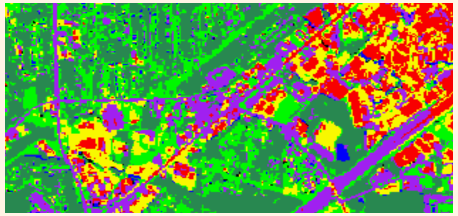


Fig. 4: Land Cover

Results & Discussion:
Final map or maps, final analysis (Figures 5-6).
Discuss why these results are

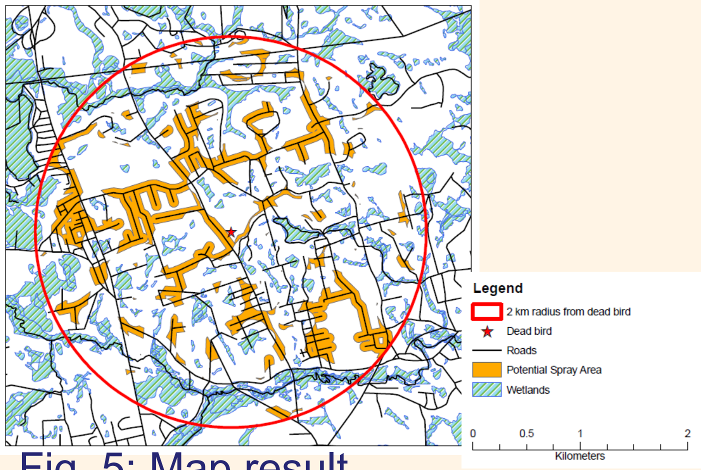


Fig. 5: Map result

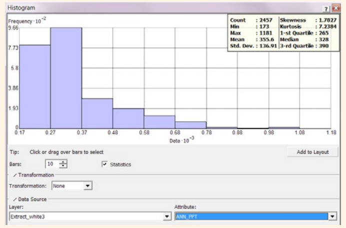


Fig. 6: Graph result

Ivory Billed Woodpecker Conservation

Your Name Here
Department of Environmental Conservation

Introduction

Why your topic is important (Figure 1). Define your question

Fig. 1: Woodpecker

Methods

How you did what you did (Figure 2)

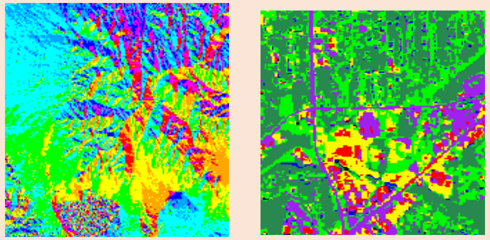


Fig. 2: Aspect & Land cover

Results & Discussion:

Final map or maps, final analysis (Figure 5). Discuss why these results are interesting

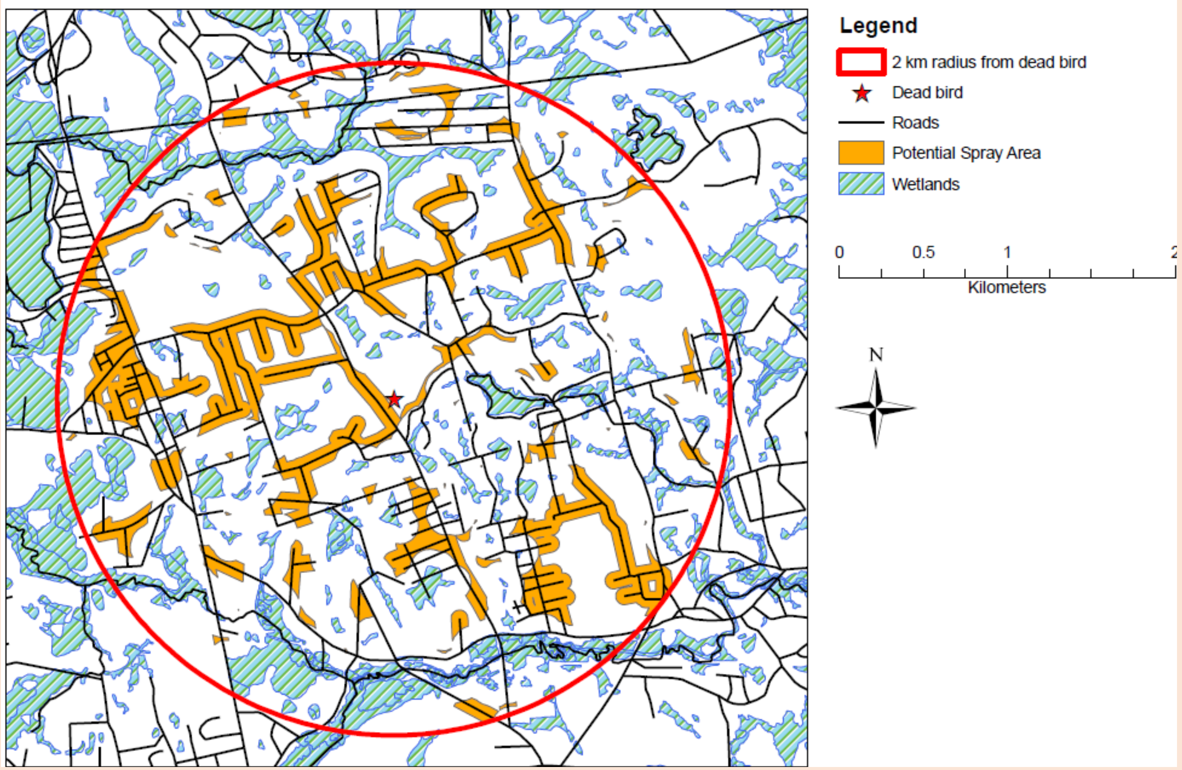


Fig. 3: Final awesome map

Lion Habitat Suitability Analysis based on Vegetation Type and Proximity to Water

Anna Garvin

Global Classroom – Big Cat Research Project

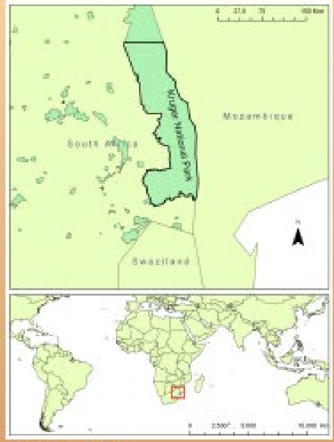


Figure 1: Study Area

Introduction

Lions are a threatened species: habitat loss and conflict with humans has led to population decline over the last several decades. In 1950, there were an estimated 400,000 lions in the wild. By 2003, the number had fallen to somewhere between 16,500 and 47,000 lions. Something must be done about the conservation of these animals in order to prevent the species from suffering extreme endangerment and possible extinction.

Kruger National Park (Fig. 1) is one of the largest game reserves in Africa. Located in South Africa, it is home to around 2,000 lions. It is therefore an ideal place to study these big cats and determine how best to move forward with the conservation effort.

Figure 2: Transvaal lion – *Panthera Leo krugeri*

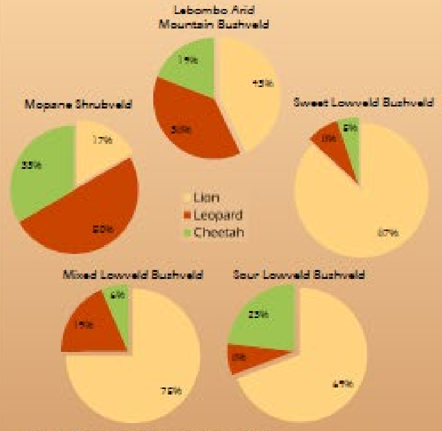


Figure 6: Proportion of cats by vegetation type

Results and Discussion

Upon performing a count of the lions, leopards, and cheetahs in each of the five vegetation types of our study area, I found that the ratio of lions to other cats was highest in Sweet Lowveld Bushveld and Mixed Lowveld Bushveld areas, with 87% lions and 75% lions, respectively. This could mean that leopards and cheetahs harbor a dislike for these vegetation types, but more likely, lions have a preference for those vegetation types. Therefore, these areas would be most suitable for lions when considering expansion of conserved land (Fig. 7).

Upon calculating proximity of cats to bodies of water, I found that cats were sighted on average within 0.27 km of water. This is not a surprise: lions naturally would be found near water to be near a source of hydration and to be near their prey. Also worth mentioning is the fact that our study was conducted during the dry seasons, when most bodies of water were dried up. This would make it even more likely that lions would spend most of their time in areas where water is readily available.

Most cats were found within 3.07 km of water. (Specifically, 3.07 km is the mean distance to water plus one standard deviation.) By making a 3.07 km buffer around rivers and bodies of water, and restricting those areas to vegetation types Sweet Lowveld Bushveld and Mixed Lowveld Bushveld (Fig. 8), you can see what areas around Kruger Park would be good candidates for conservation expansion, as lions have demonstrated a preference for land close to water in Sweet Lowveld Bushveld areas or Mixed Lowveld Bushveld areas.

Given more time and resources, I would expand my study area northward, to include the entirety of Kruger National Park. Our study is spatially limited, and lion conservation efforts would benefit from a larger study area. I would also radio-collar lions, rather than rely on sightings for data collection. This would eliminate the problem caused by the lack of absence data, and allow us to conduct a study that truly only involved lions, rather than having to compare their locations to those of leopards and cheetahs. Additionally, I would begin to look at the land usage for my proposed areas of conservation, to see if any of it is eligible for conversion to conserved land for lions.

Methods

Over the course of three summers my team collected observation data on the big cats of Kruger National Park. The bulk of our data focused on the Transvaal Lion – *Panthera Leo krugeri* (Fig. 2). We collected presence data, but not absence data. Additionally, data collection did not occur uniformly throughout the park: we spent more time in some areas than others. Because of the nature of our data, it was a challenge to analyze it objectively.

- Attained spatial vegetation data.
- Performed a count of lion, leopard, and cheetah numbers in each of the five vegetation types.
- Created a bar graph of raw numbers of cats in each vegetation type (Fig. 3).
- Created a pie chart for each vegetation type illustrating the ratios of lions to leopards and cheetahs (Fig. 6).
- Calculated nearness of cats to rivers and wetlands.
- Created a buffer around rivers and wetlands in areas of appropriate vegetation, using the mean distance of cats from bodies of water plus one standard deviation, assuming a log-normal distribution.

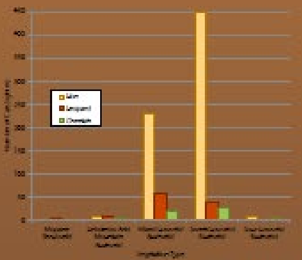


Figure 3: Count of cats in study area

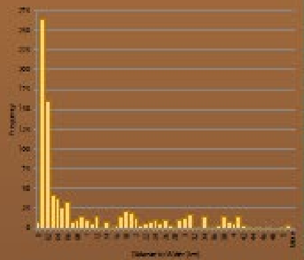


Figure 4: Histogram – distance of cats to water

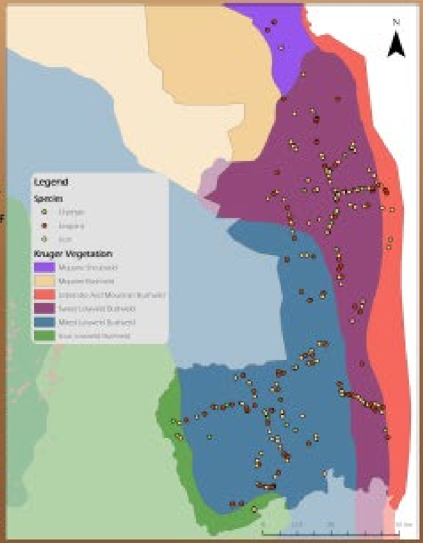


Figure 5: Cat sightings and vegetation types in Kruger National Park

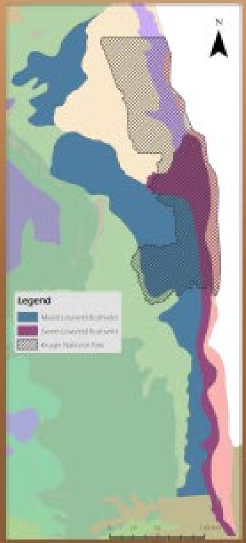


Figure 7: Lions' preferred vegetation types

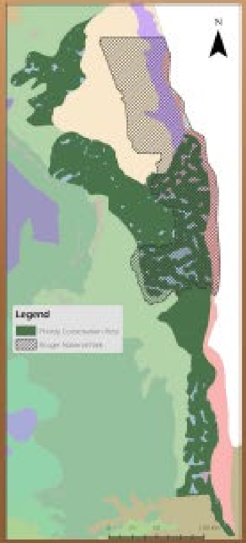


Figure 8: Priority Conservation Area

Coastal Erosion on Crane Beach, Ipswich MA

Stephanie Berkman
Department of Environmental Conservation

Introduction

Crane Beach is a popular recreation and conservation site in Ipswich Massachusetts. Crane Beach includes over 4 miles of shoreline, 5 miles of trails through the dunes and the North Shore's largest pitch pine forest.

Fig.1: Crane Beach boardwalk

This area has been recognized for its successful shorebird protection program and is a very important nesting site for piping plovers, a threatened bird species. In order to continue protecting the bird species and cater towards the recreational needs of the beach, the size and stability of the shoreline needs to be maintained. This leads me to ask the question: is the Crane Beach coastline eroding?

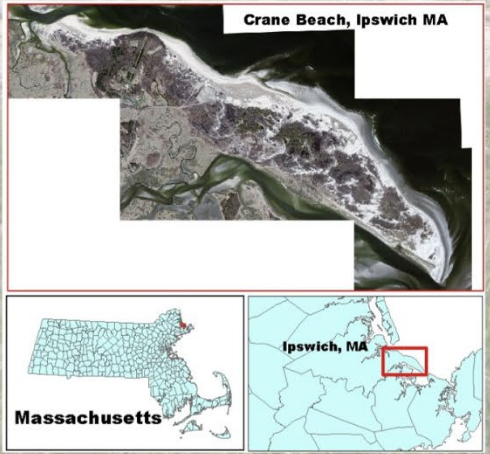
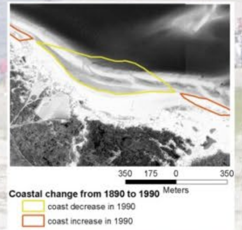


Fig. 2: Study area map

Methods

To conduct my research I acquired all of the orthophotos of the Crane Beach area for the years: 1990, 1994, 2001, 2005 and 2008 as well as a historic coastal topographic map image from 1890 from MassGIS. To answer my research question I followed these steps:

- Created a new line shape file for each year and traced the coastline of that year (taking into consideration differences in tides).
- Compared the coastline of each year with that of 1990 by creating new polygon shape files for areas where coastline increased and decreased since 1990.
- Found the area of the polygons for each year.



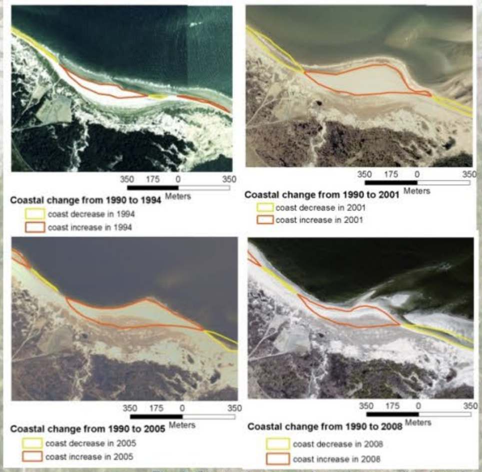


Fig. 3: Shows the area where the coastline has the most variance and different polygons for increased and decreased coast.

Results & Discussion

In doing my research I found that the coastline of Crane Beach is eroding. When comparing the coastline of each year to that of 1990, there is a visible decrease in coast starting in 2001(figure 5). 1994 was the only year that showed an increase in coastline and 2008 showed the most coastline loss. When comparing coastline in 1890 and 1990, a decreased is seen overall as well (figure 6). This large decrease in coastline from 1990 may be of concern to conservationalists of Crane beach.

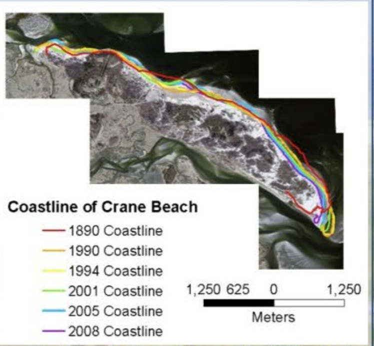


Fig. 4:Coastline for each year on the 2008 orthophoto

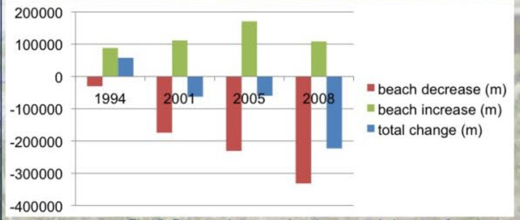


Fig. 5: Bar graph comparing the coastal change of each year

The species that inhabit the beach like the piping plovers need nesting habitat and space for their population to grow.

The increase in tourism to the beach is also putting more pressure on the recreational availability of the site. This yearly decrease in coastline should be taken into consideration while managing the site for recreation as well as conservation, ensuring that the needs of both be met. To track this coastal erosion, yearly coastline measures should be taken to assess if this is a random occurrence due to weather variance through the years, or if the coast is decreasing at a steady rate which would require additional management.

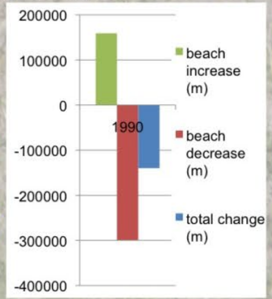
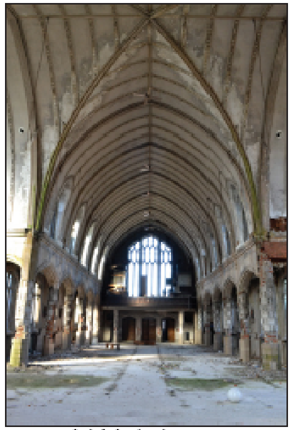


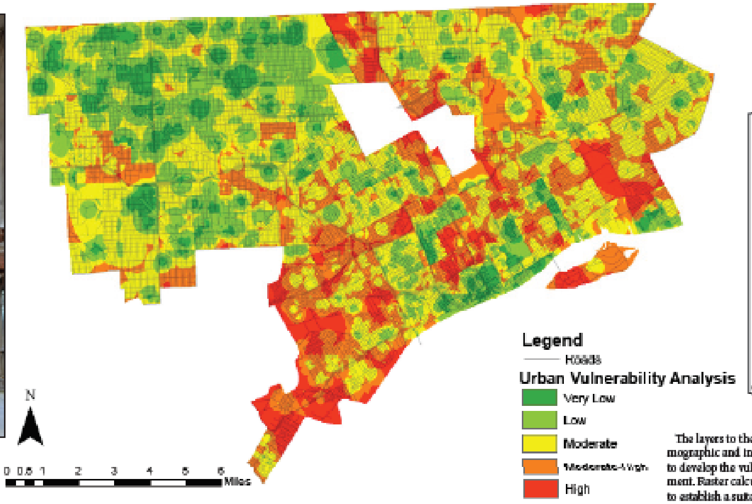
Fig. 6: Bar graph comparing the 1990 coastline change to the 1890 topograph map

Detroit: A Demographic and Infrastructure Analysis

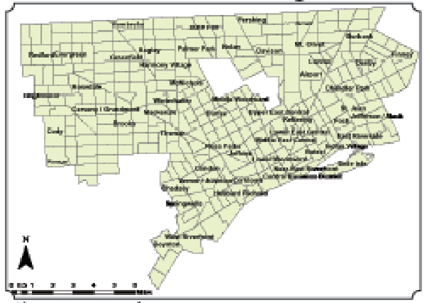
UMassAmherst

Tyler Osborne Gagné

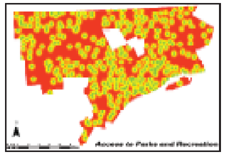

St. Agnes Cathedral, abandoned since 2006

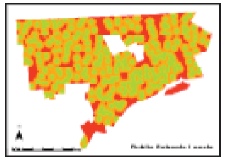


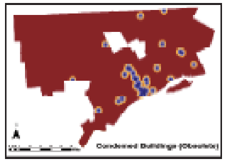
Detroit, Michigan

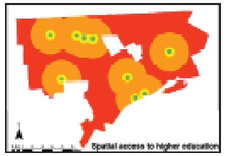

The Greater Detroit, Michigan area.

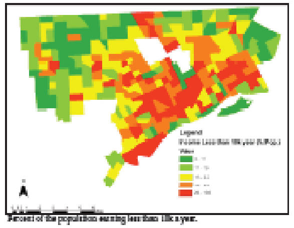
The layers to the right show the demographic and infrastructure files used to develop the vulnerability assessment. Raster calculator was then used to establish a suitability analysis for the Detroit urban area. *Data was collected from the Detroit ITS Department.*

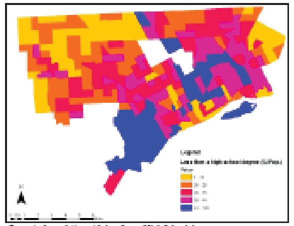









Percent of the population earning less than 15k a year.


Percent of population with less than a High School degree.


The Detroit Boat Club, abandoned since 1996.


Central Michigan Train Station, abandoned since 1988.

Introduction

In January of 2012 several acquaintances and I took a trip to Detroit, Michigan. Our goal was to experience firsthand the decay and fall from grace that Detroit has become so well known for. What we saw was worse then we could have even expected, entire blocks of burned out and abandoned houses, auto factories six blocks long abandoned and gutted, twenty story hotels from the golden age now standing as skeletons, schools, universities, hospitals, zoos, parks, mills, factories and more, all left to wither. Detroit in the past hundred years has experienced more growth and decline than any other US city, from a population in 1910 of 285,000 to a high in 1950 of 1.8 million, to an unmatched decline of over 500,000 to 713,000 in 2010. This project aims to analyze the relationships between demographic factors and infrastructure factors to look for relationships and discrepancies that may be detrimental to the social justice and equity of the city.

Results & Discussion

The outputs that were obtained from the raster calculations showed the hotspots around the city that had varying levels of risk. These various hotspots are areas that the resulting demographic factors such as low levels of high school graduation, and poverty levels may be a result of the infrastructure composition of the area. In order to gain a more accurate understanding of the social equity related to the infrastructure of Detroit, more extensive research should be conducted on the spatial influence of positive and negative factors of a city, crime rates, police station locale effectiveness, public school and higher education proximity influence, and other pressures.

Methods

Data was obtained from the City of Detroit Information Technology Services Department, the data primarily contained shapefiles that consisted of police stations, colleges, parks and recreational sites, condemed buildings, and census data for education and income per census block. A literature review was conducted on the social-urban equity landscape; to calculate the best methods for classification of spatial vulnerability, relative to distances from the particular variables and data collected. This research permitted the data to to be classified into quantifiable values, which then allowed for raster calculation to be employed to search for connections amoung the particular infrastructure, demographic, and economic data.

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