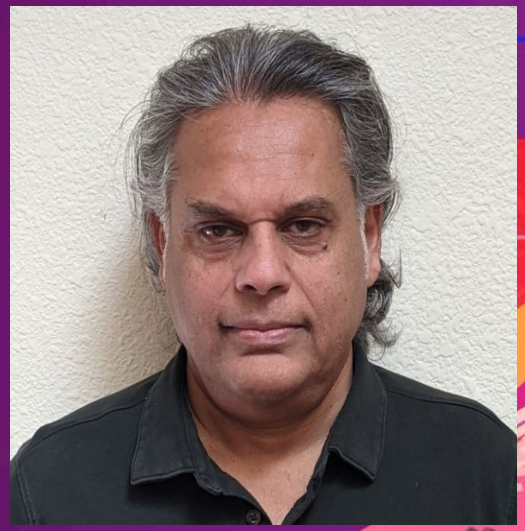
ArcGIS Spatial Analyst: Suitability Modeler

Kevin Johnston

Steve Lynch



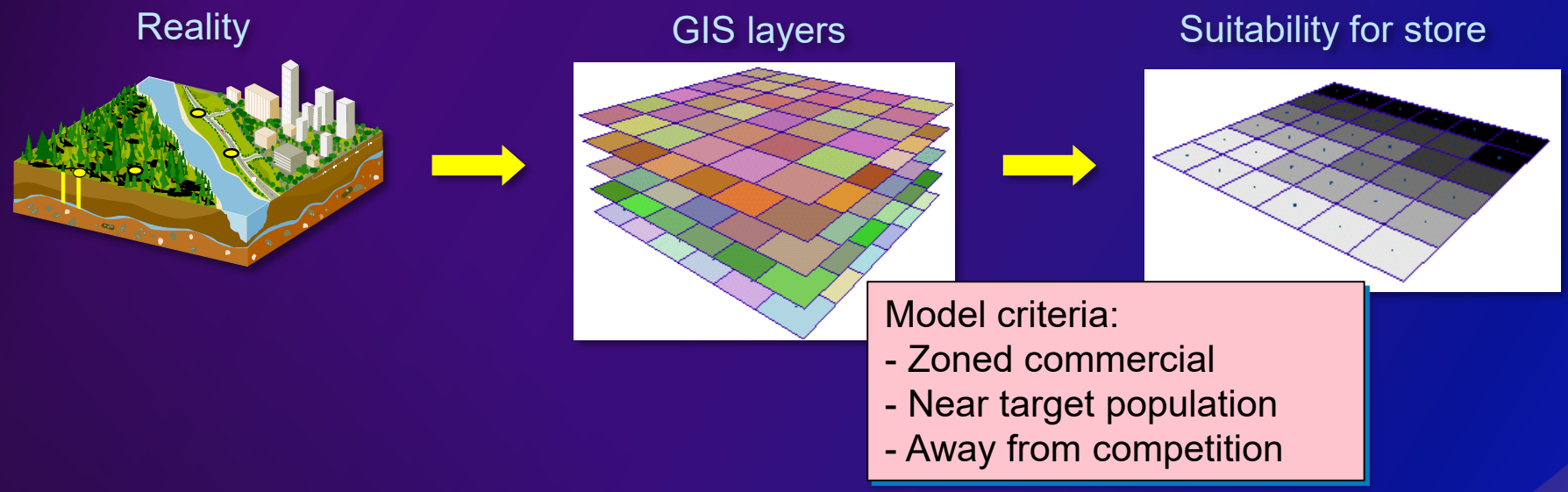
Ajit George

Tong Jiao

esri THE SCIENCE OF WHERE

Suitability modeling

- Where to site a new housing development?
- Which locations are better for deer habitat?
- Where is economic growth most likely to occur?
- Where the population is at greatest risk if a chemical spill happens?



The presentation outline

- Overview of creating a suitability model
- Creating a suitability model with ModelBuilder
- The Suitability Modeler
- The Suitability Modeler – Demonstration
- Additional information
- Demonstration – other ways to assign transformations and weights
- Where we are going

Ski area
Housing development
Logging operation
Park network
Best farm land
At risk from disaster

Conserving Bobcats as an example

Think from the perspective of the subject

Define goal

- Most important and most time consuming
- Measurable
- Locate a ski resort – make enough money to stay in business
- Logging operation – sustainable operation to make profit
- Park network – optimal experience and serve the community
- Bobcat – minimum viable population for 100 years maintaining genetic diversity

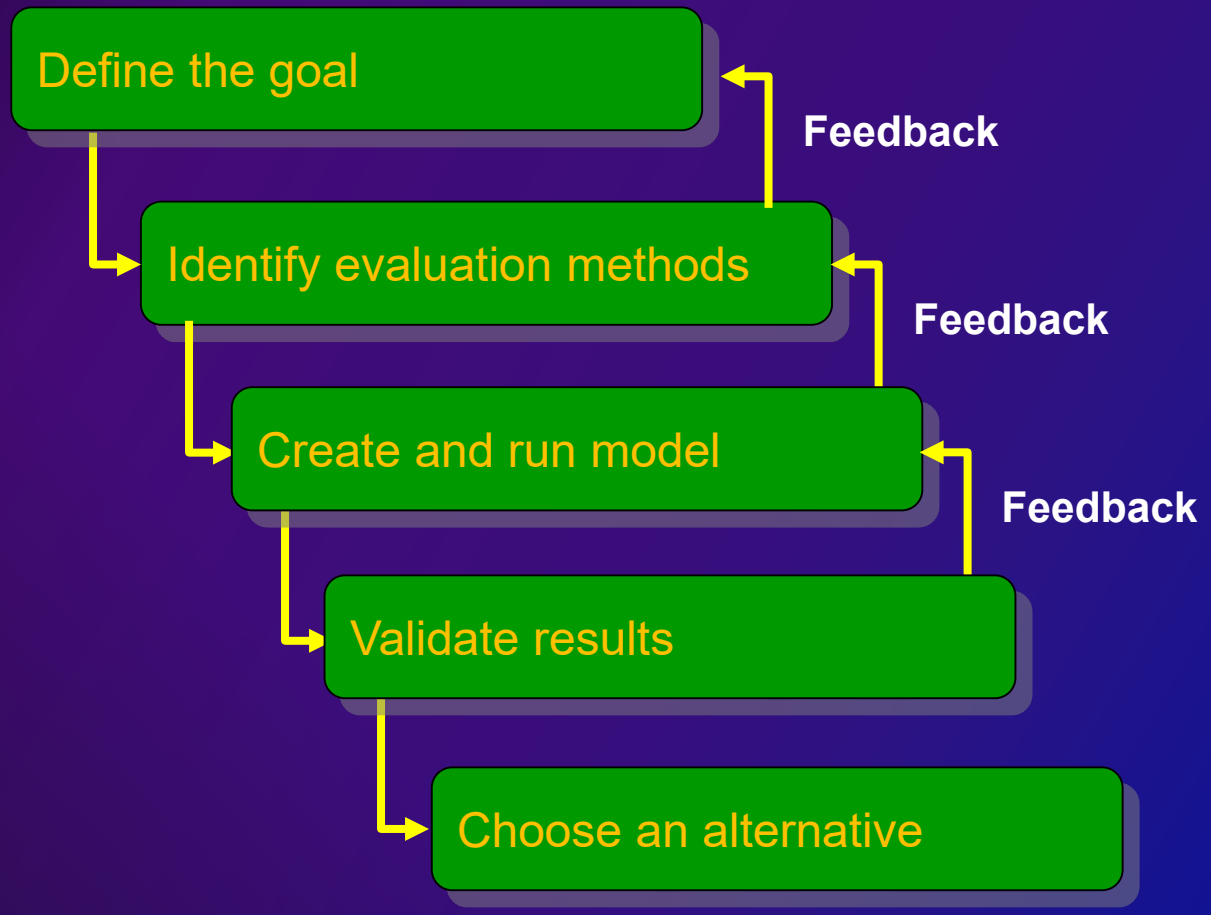
Identify evaluation methods

- How will you know if the model is successful?
- Evaluation should relate back to the overall goal
- Locate a ski resort – does it make money
- Logging operation – covers costs and have a low impact
- Park network – evaluate quality of experience and track number of visitors
- Bobcat – monitor the population and genetic diversity

Overall goal

Identifying Bobcat conservation goals

General suitability modeling methodology



The criteria

What Bobcat are responding to

Identifying bobcat habitat

Slopes

Land use types

Streams

Tradeoff between the features within the criteria

Suitability Model

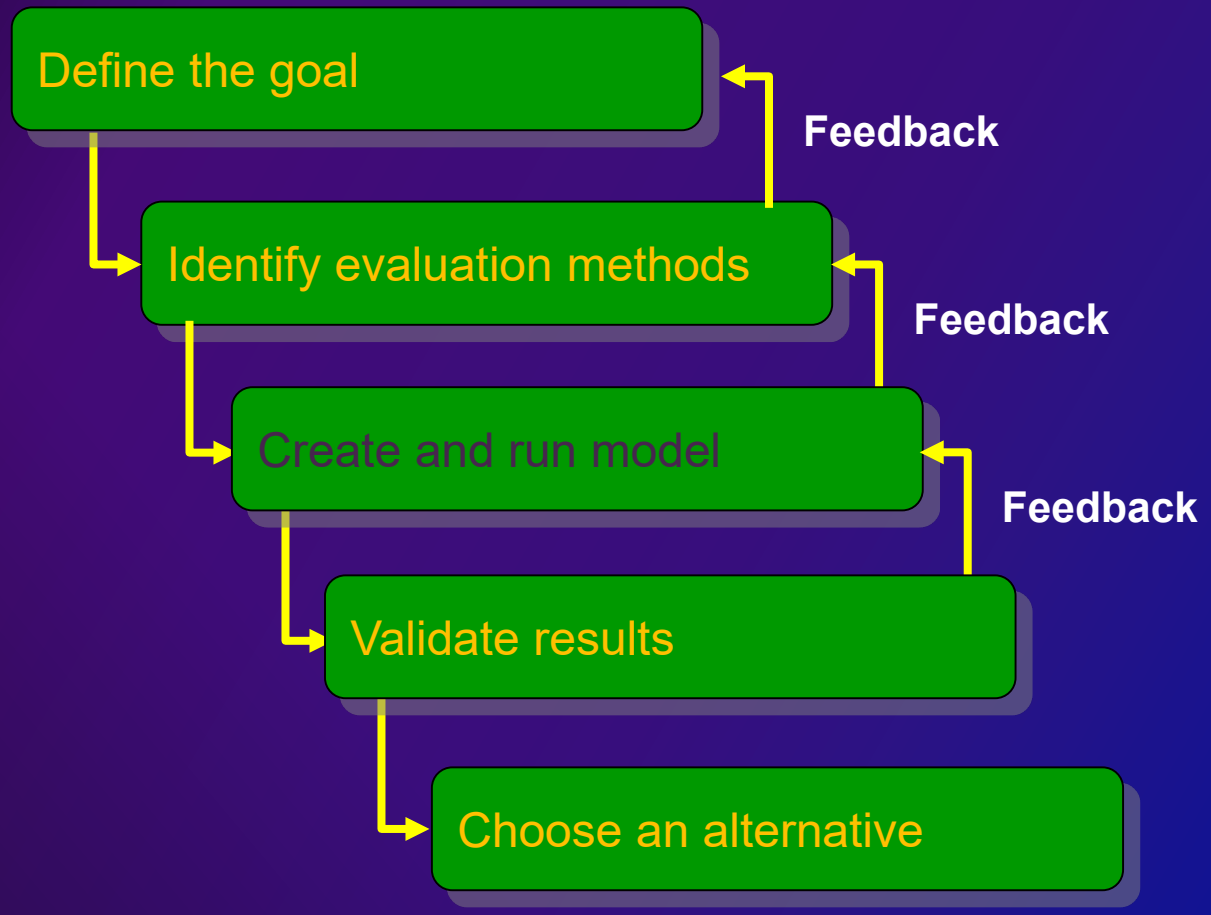
Slopes

Land use types

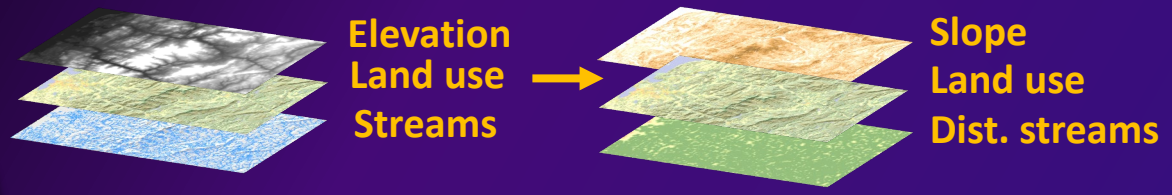
Streams

Tradeoff between the the criteria

General suitability modeling methodology



Determine significant
(Possibly derive data)

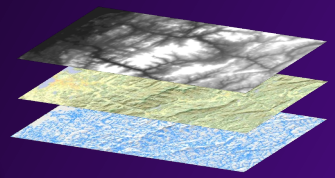


The suitability modeling workflow

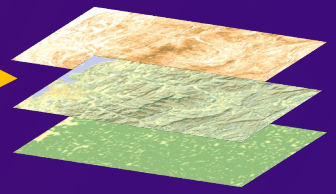
Determining significant criteria

- Same process happens for any suitability model

- Locate a ski resort
  - Steep and varied terrain for skiing
  - Access to ponds to make snow
  - Near population and road network
- Logging operation
  - Large trees
  - Access to roads
- Park network
  - Near population centers
  - Locations of natural features



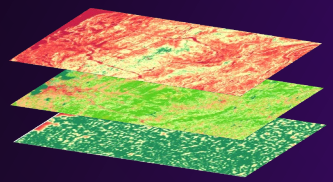
Elevation
Land use
Streams



Slope
Land use
Dist. streams

Determine significant
(Possibly derive data)

Transform values
within criterion

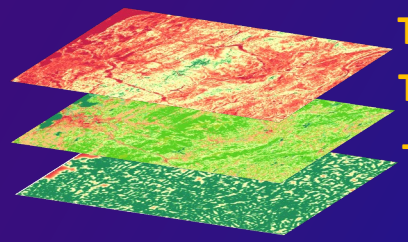


Transformed Slope
Transformed Land use
Transformed Dist. streams

The suitability modeling workflow

Transform values – Define a scale of suitability

- **Define a scale for suitability**
  - Several scales; typically 1 to 10 (worst to best)
  - Transform all criteria values to relative scale
  - Use the same scale for all criteria



Transformed Slope
Transformed Land use
Transformed Dist. streams

Transformed Slope

Slope for security

Best
10 – Steep and most secure
9
8
7
6
5 – Moderate slope
4
3
2
Worst
1 – Flatter and least secure

Transformed Land use

Land use preferences

Best
10 – Forest most preferred
9
8
7
6
5 – Residential moderate
4
3
2
Worst
1 – Industrial: avoid

Transformed Dist.streams

Access to water - time

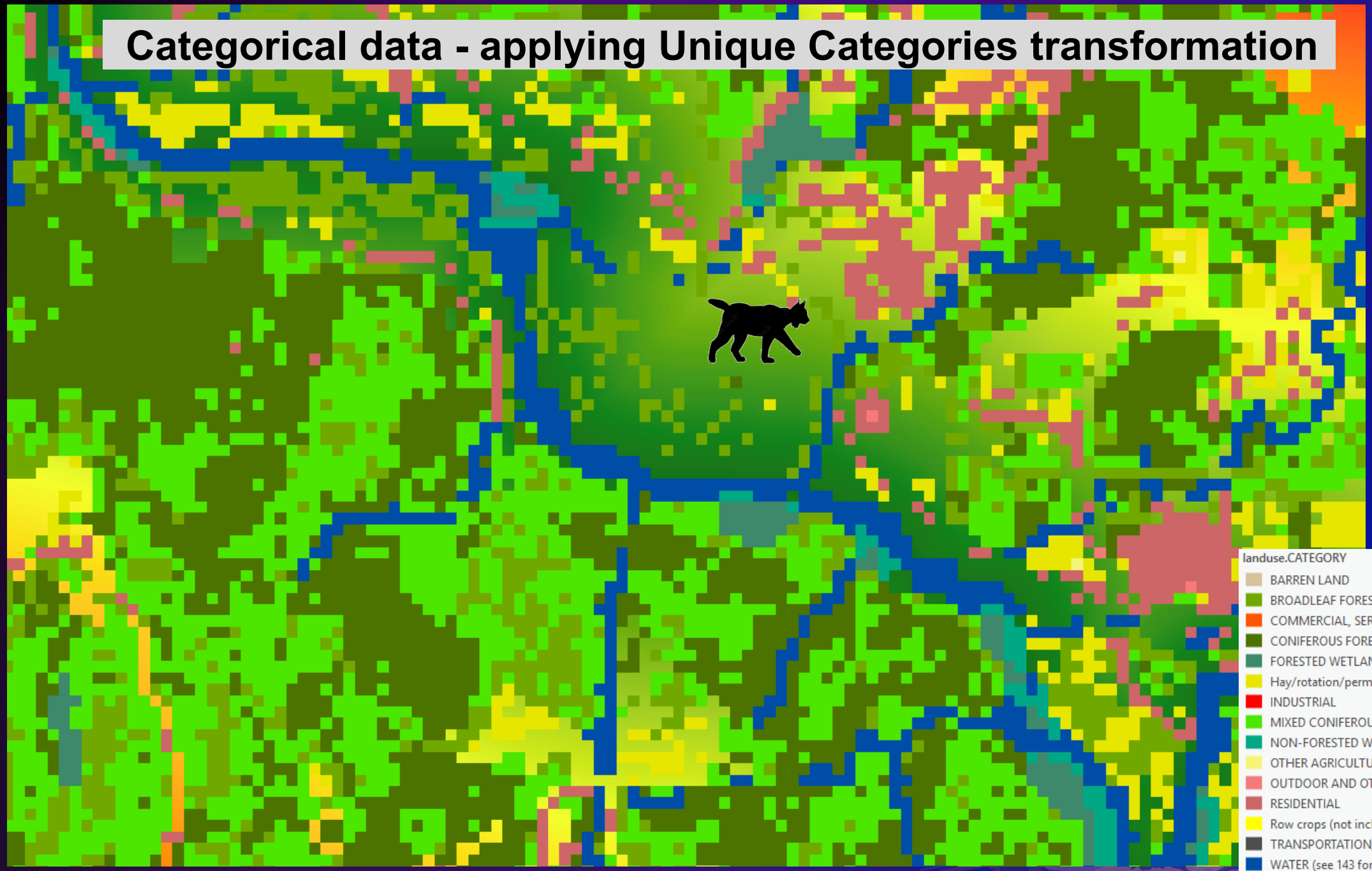
Best
10 – Close streams
9
8
7
6
5 – Moderate distances
4
3
2
Worst
1 – Far from streams

Within and between layers

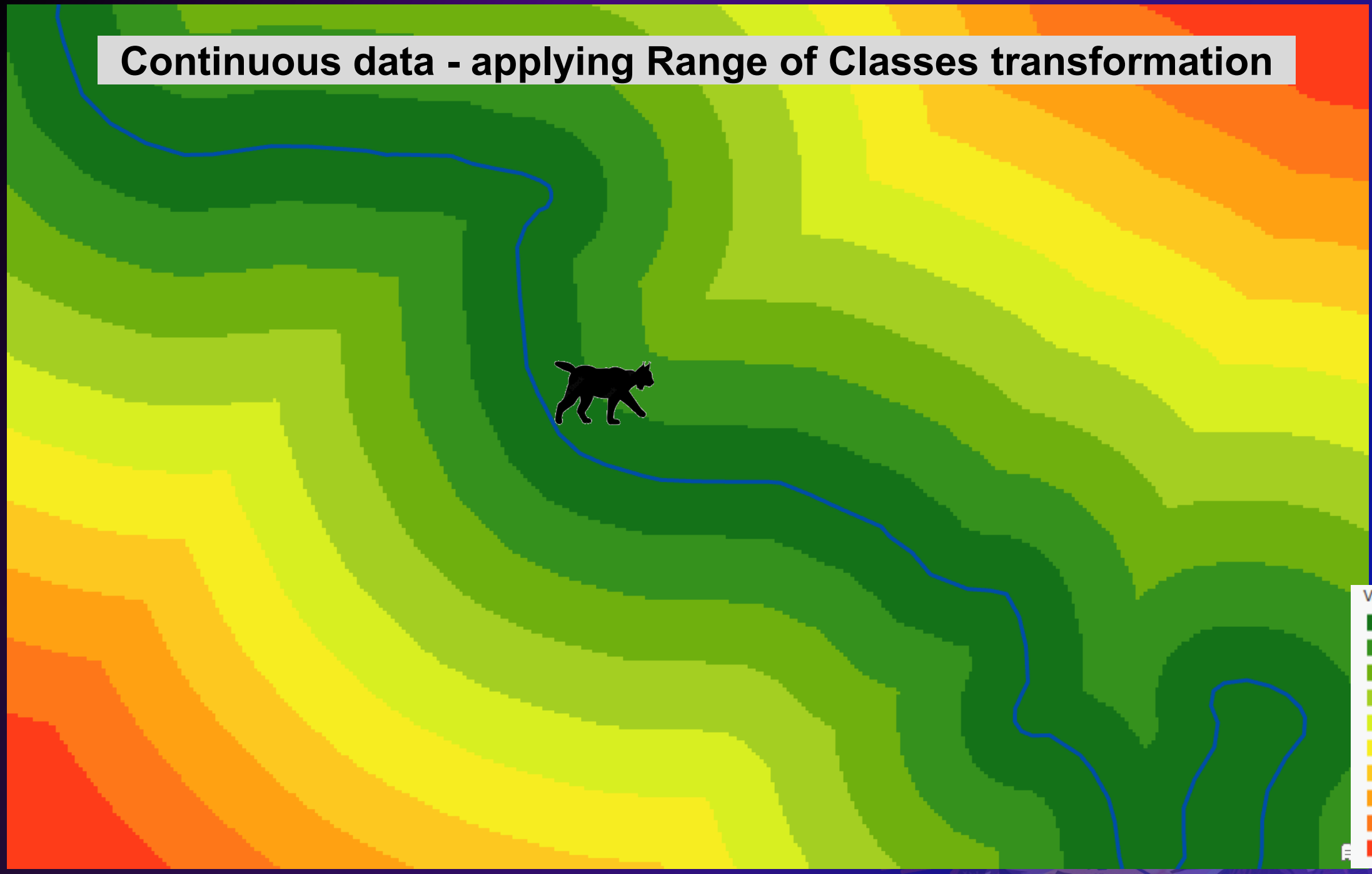
Applying a transformation

- Capture how the subject is responding to the criteria
- Transformation depends on the input data and the response to it
- Input data is either categorical or continuous
- Response is either one to one or continuously changing preference
- Unique Categories
  - Categorical data – one to one response
- Range of Classes
  - Continuous data – responds to ranges
- Continuous Function
  - Continuous data – continuously changing preference

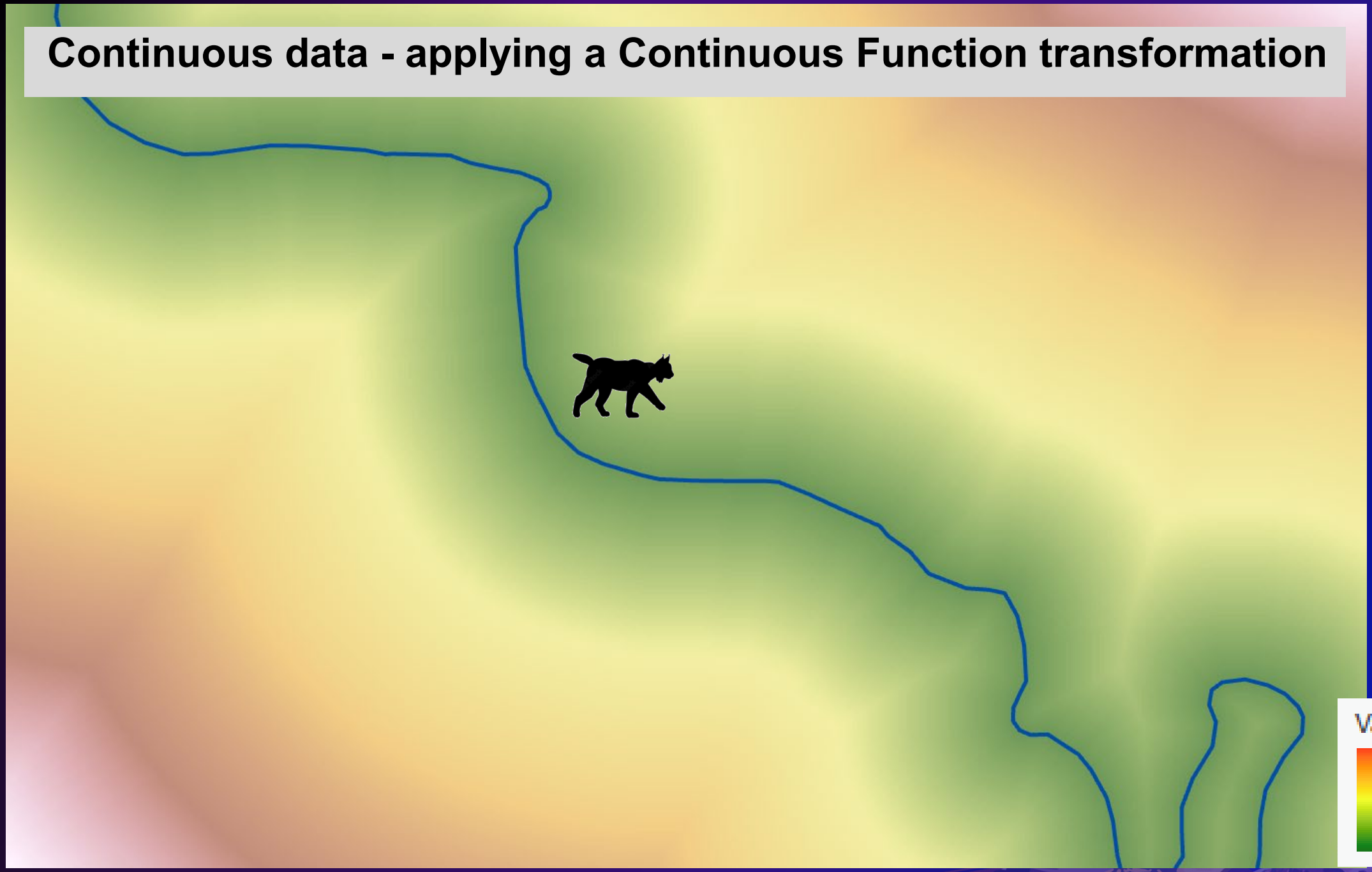
Categorical data - applying Unique Categories transformation

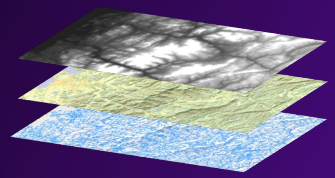


Continuous data - applying Range of Classes transformation

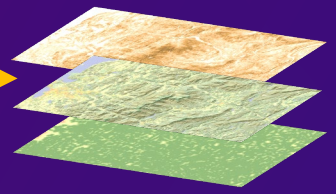


Continuous data - applying a Continuous Function transformation





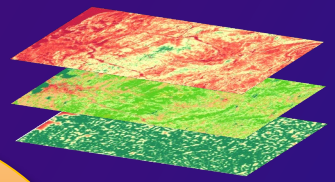
Elevation
Land use
Streams



Slope
Land use
Dist. streams

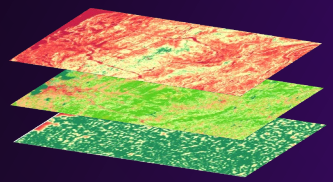
Determine significant
(Possibly derive data)

Transform values
within criterion



1.25 x Transformed Slope
1 x Transformed Land use
1 x Transformed Dist. streams

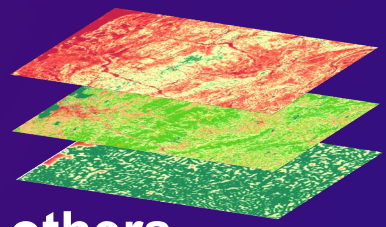
Weight criteria
relative to one another



Transformed Slope
Transformed Land use
Transformed Dist. streams

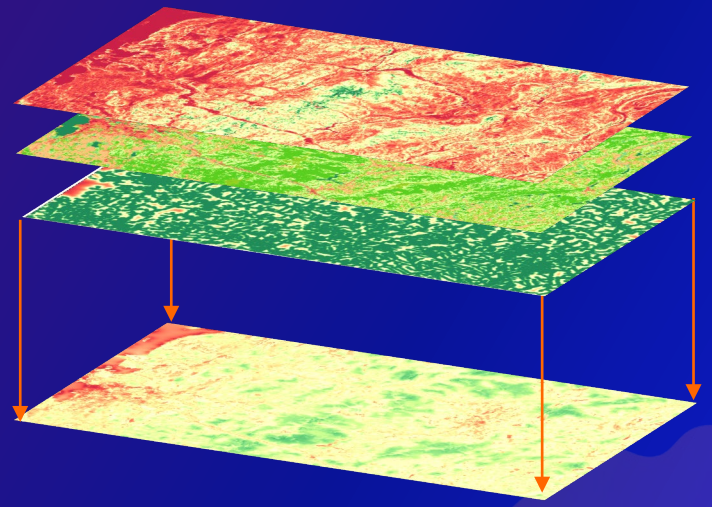
The suitability modeling workflow

Weight and combine the layers



1.25 x Transformed Slope
1 x Transformed Land use
1 x Transformed Dist. streams

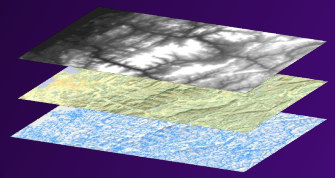
- Certain criteria may be more significant than others
- Weighted appropriately before combining
- Ski resort – terrain
- Logging operation – tree quality
- Park network – unique features
- Bobcat – slopes for security



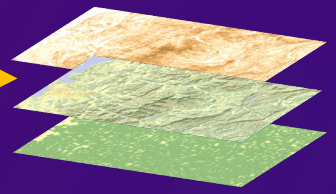
Suitability map

The suitability modeling workflow

Determine significant (Possibly derive data)

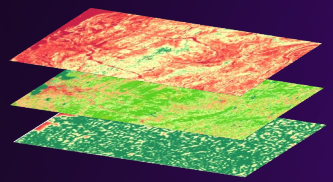


Elevation
Land use
Streams



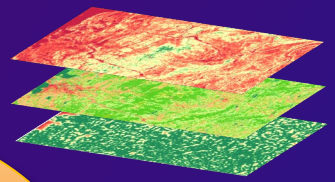
Slope
Land use
Dist. streams

Transform values within criterion



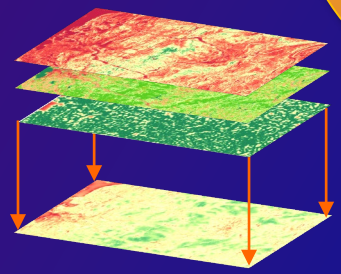
Transformed Slope
Transformed Land use
Transformed Dist. streams

Weight criteria relative to one another



1.25 x Transformed Slope
1 x Transformed Land use
1 x Transformed Dist. streams

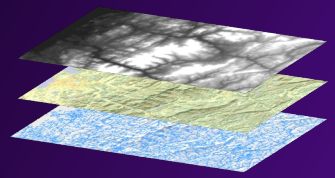
Combine criteria (Suitability map)



Suitability map

The suitability modeling workflow

Determine significant (Possibly derive data)

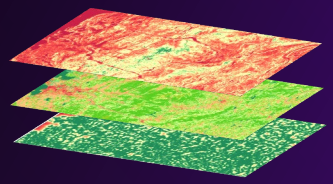


Elevation
Land use
Streams

Slope
Land use
Dist. streams

Transform values within criterion

1.25 x Transformed Slope
1 x Transformed Land use
1 x Transformed Dist. streams



Transformed Slope
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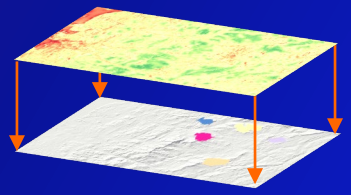
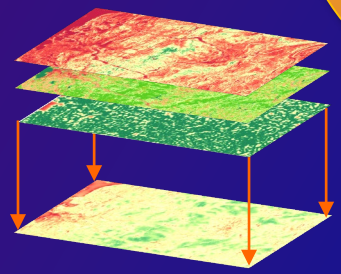
Weight criteria relative to one another

Combine criteria (Suitability map)



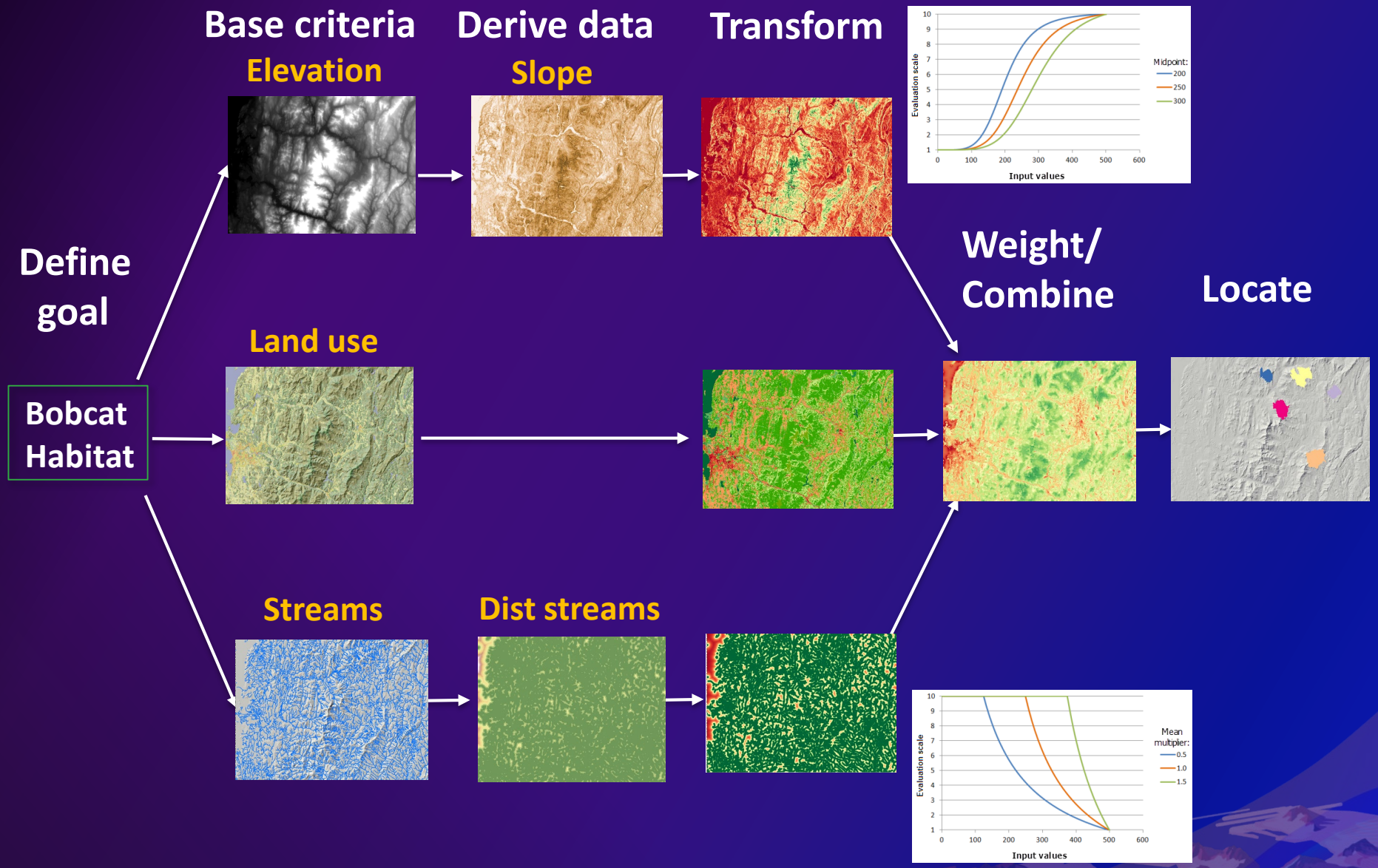
Locate



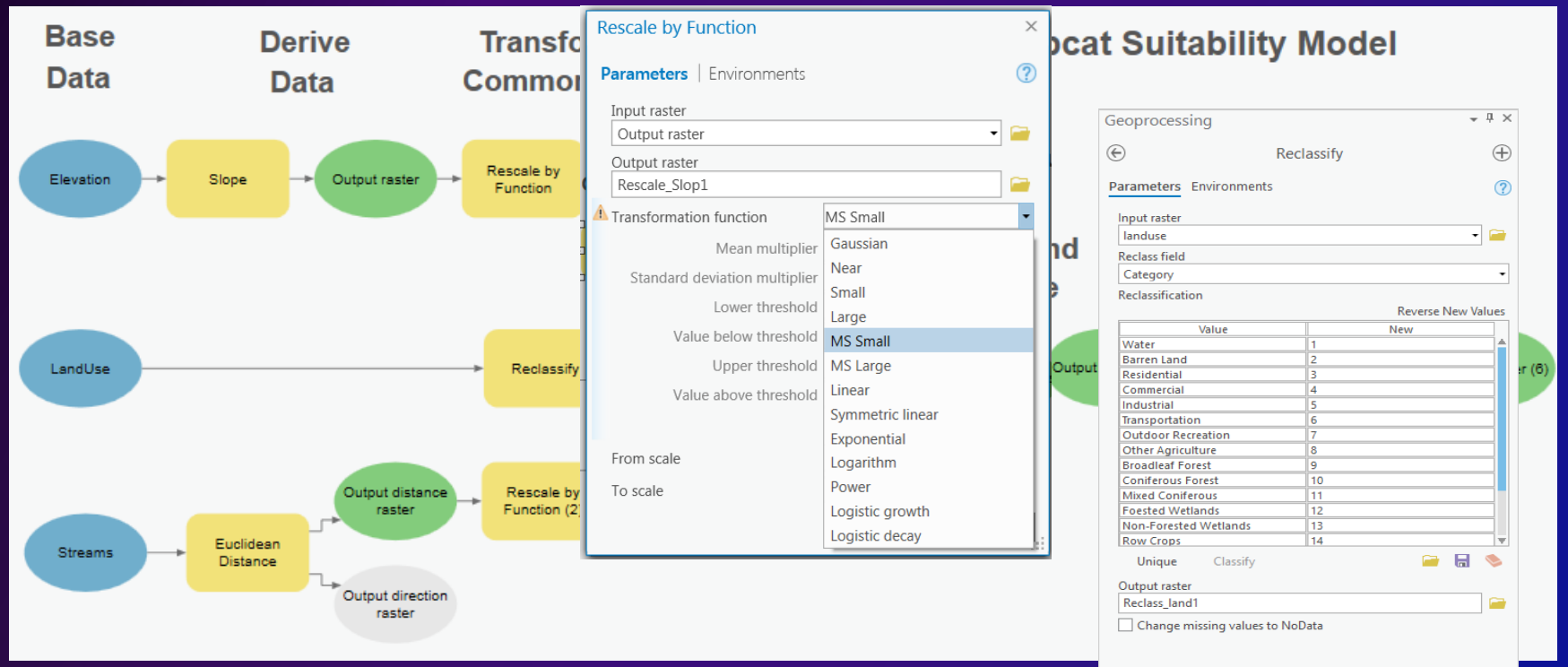
Suitability map

Locate sites

The suitability modeling workflow

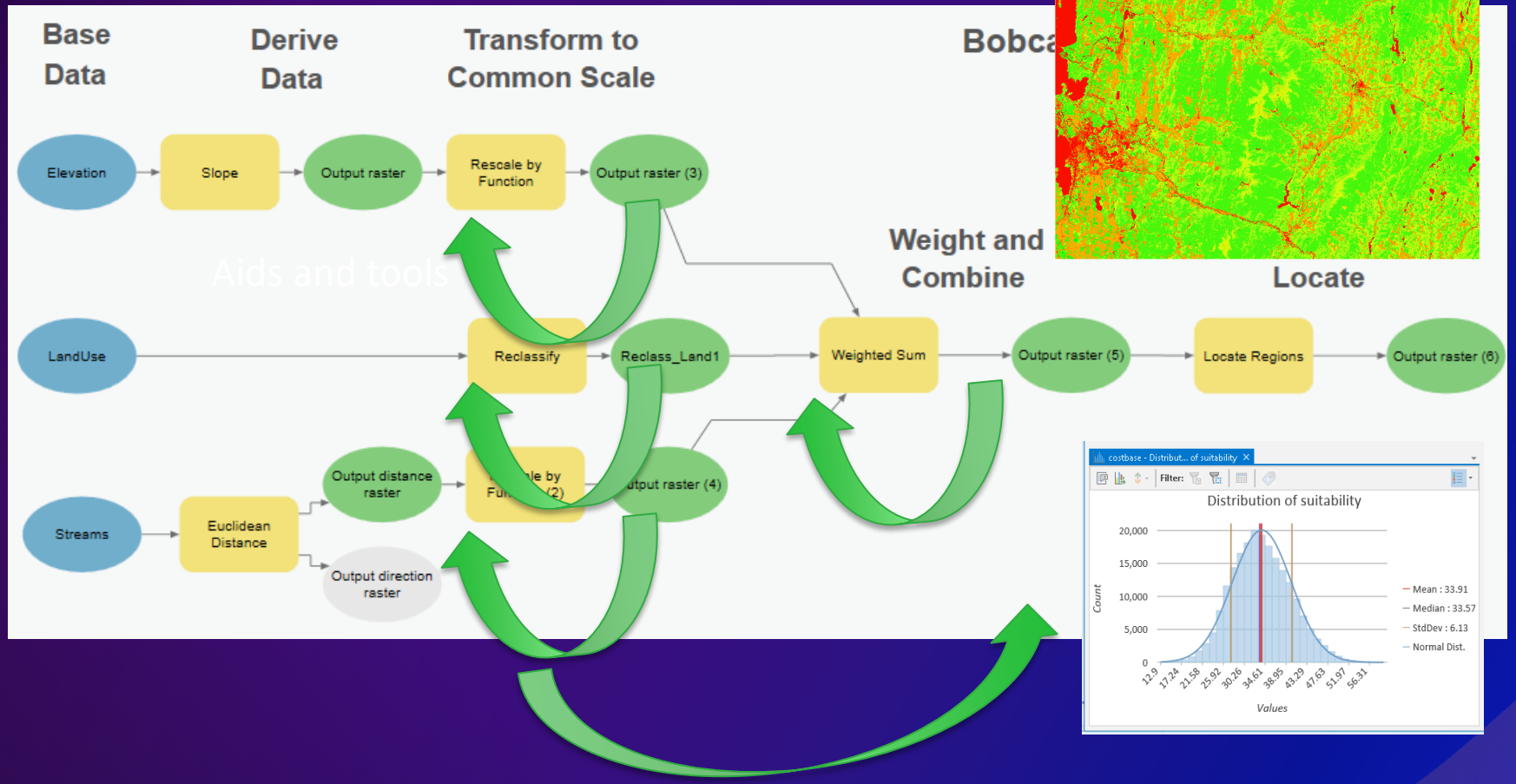


Building a suitability model in ModelBuilder



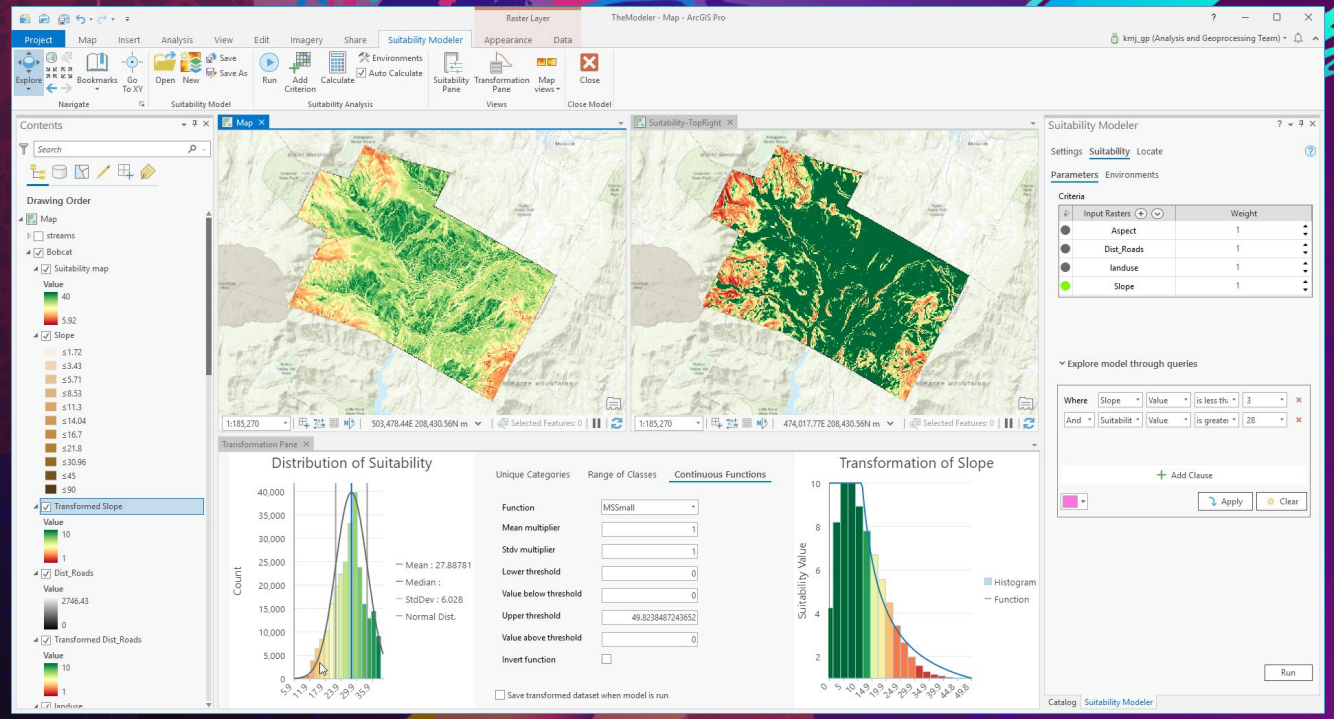
Building a suitability model in ModelBuilder

- A suitability model is an iterative exploratory process



The Suitability Modeler

- Building a suitability model is a dynamic iterative process
- Guides you through the workflow
- Interacting panes, plots, and maps
- Immediate feedback
- Move back and forth between steps
- Ways to decide on appropriate parameters
- Explore the influence of the parameter



The Suitability Modeler

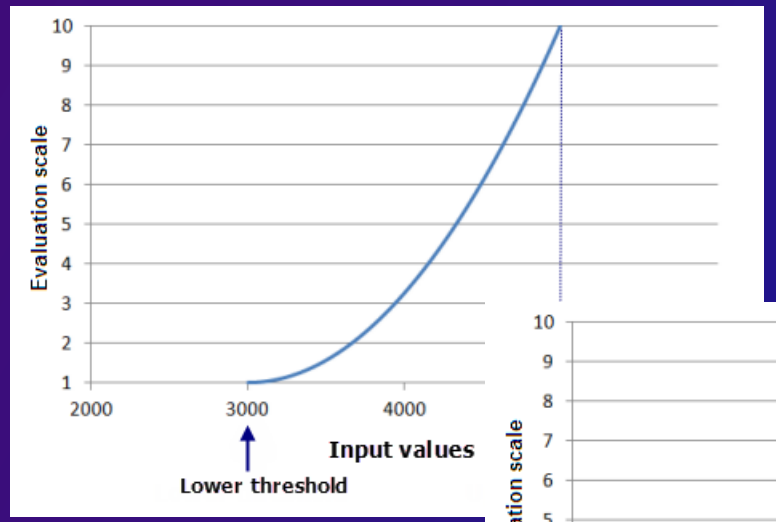
An interactive approach to modeling

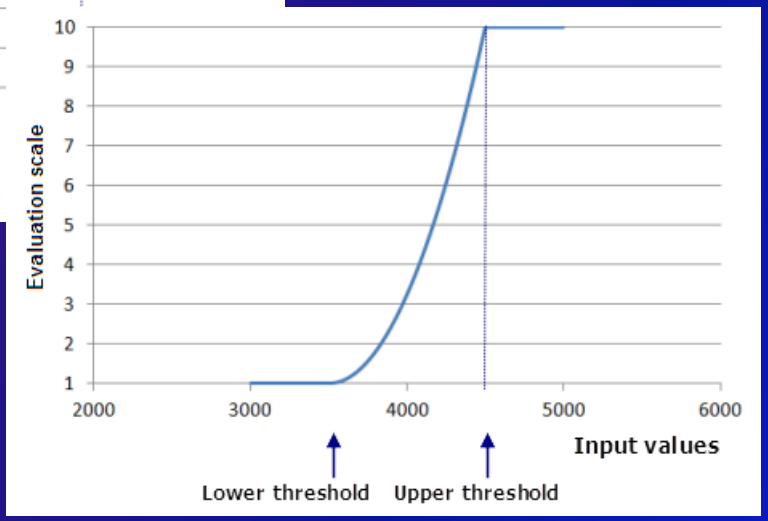
Limitation of a suitability model

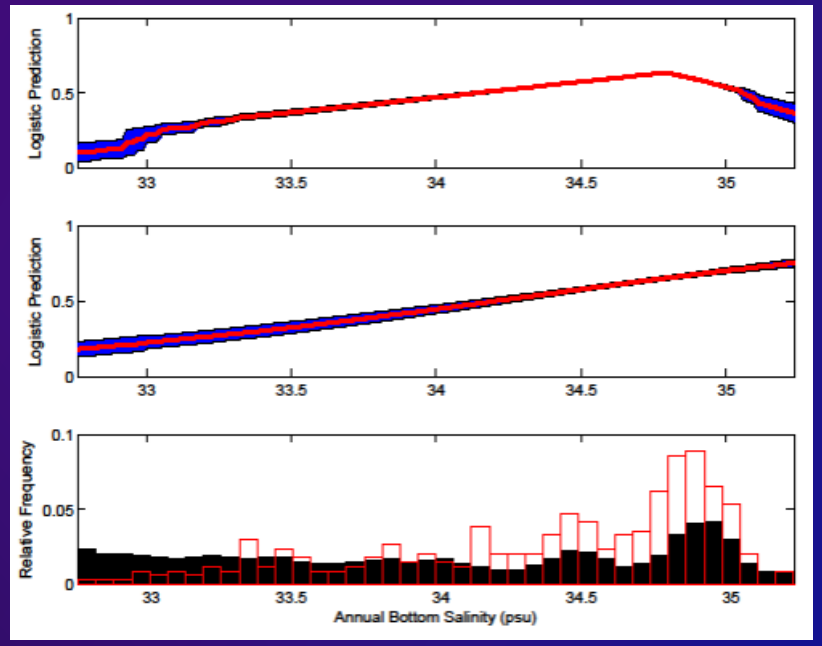
- Suitability surface indicating relative importance
- Does not give absolute values (can the animal live there or not)
- Does not account for spatial relation of the suitability values
  - Locations with high suitability values next to other locations with high suitability maybe more preferred
- Heavily dependent on transformation of criteria values and weights between criteria

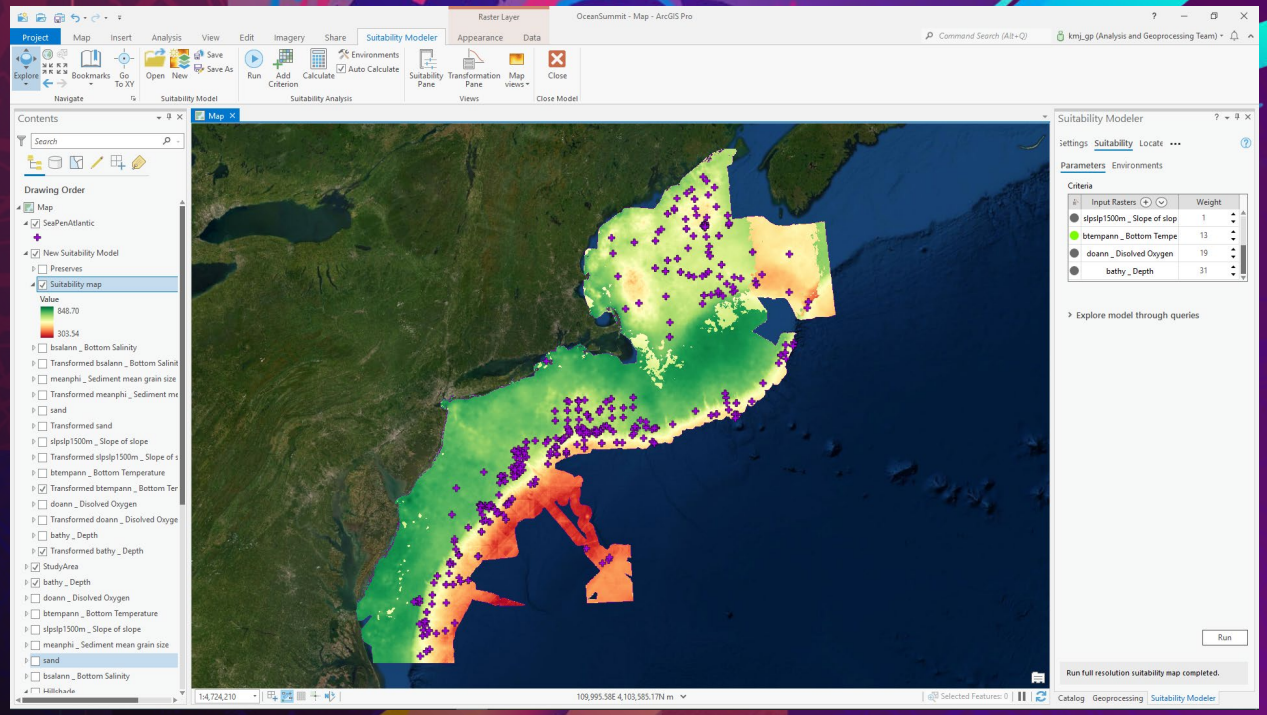
Defining transformation and weights

- From experts
- Research studies
- Pairwise
- From other modeling approaches
  - Maxent







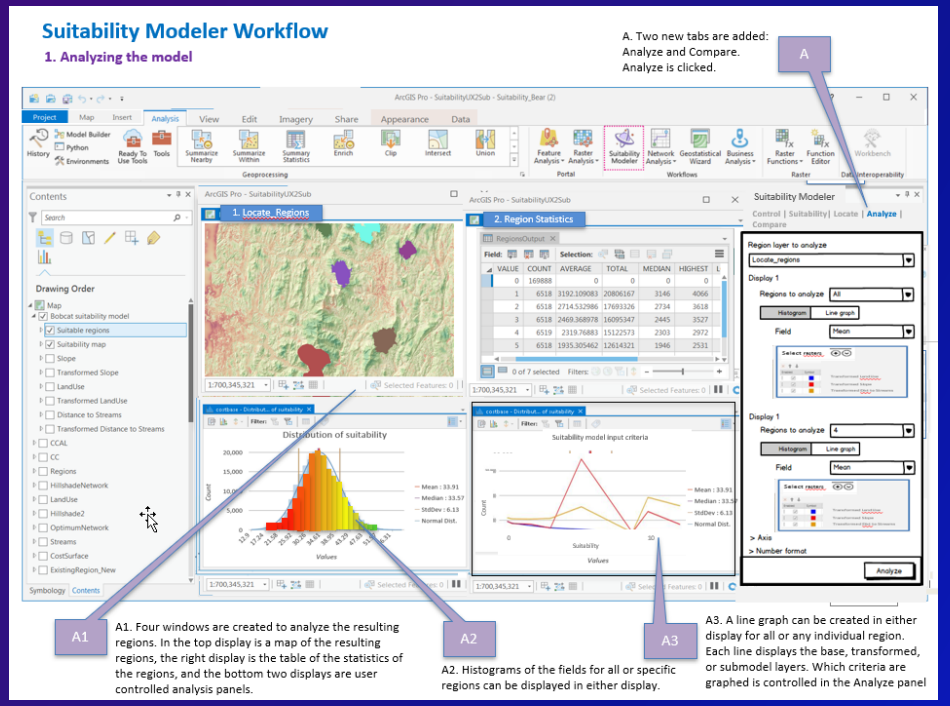


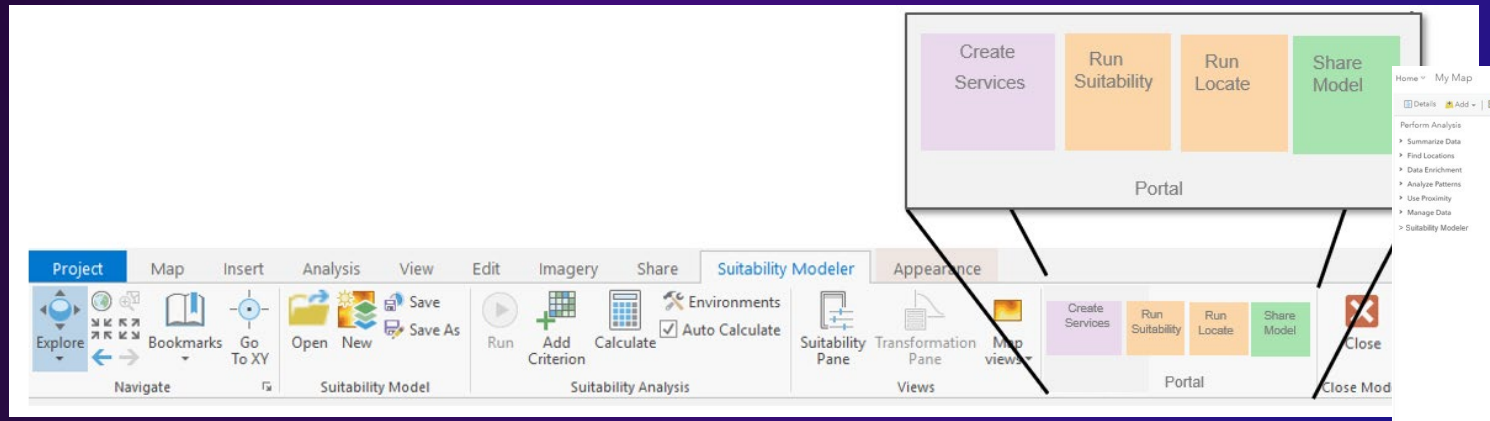
The Suitability Modeler

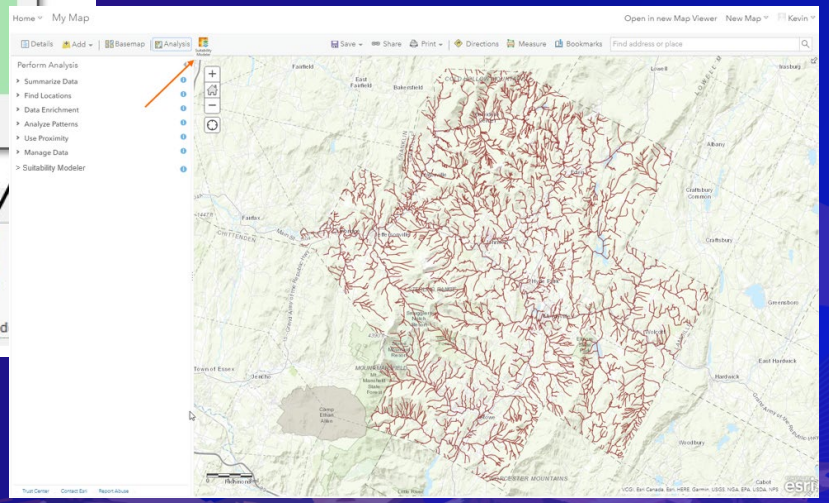
Defining the transformations and weights

The Suitability Modeler – where we are going

- Analyze tab – how good is the model
- Run in Raster Analytics as client
- User interface in the server/web environment





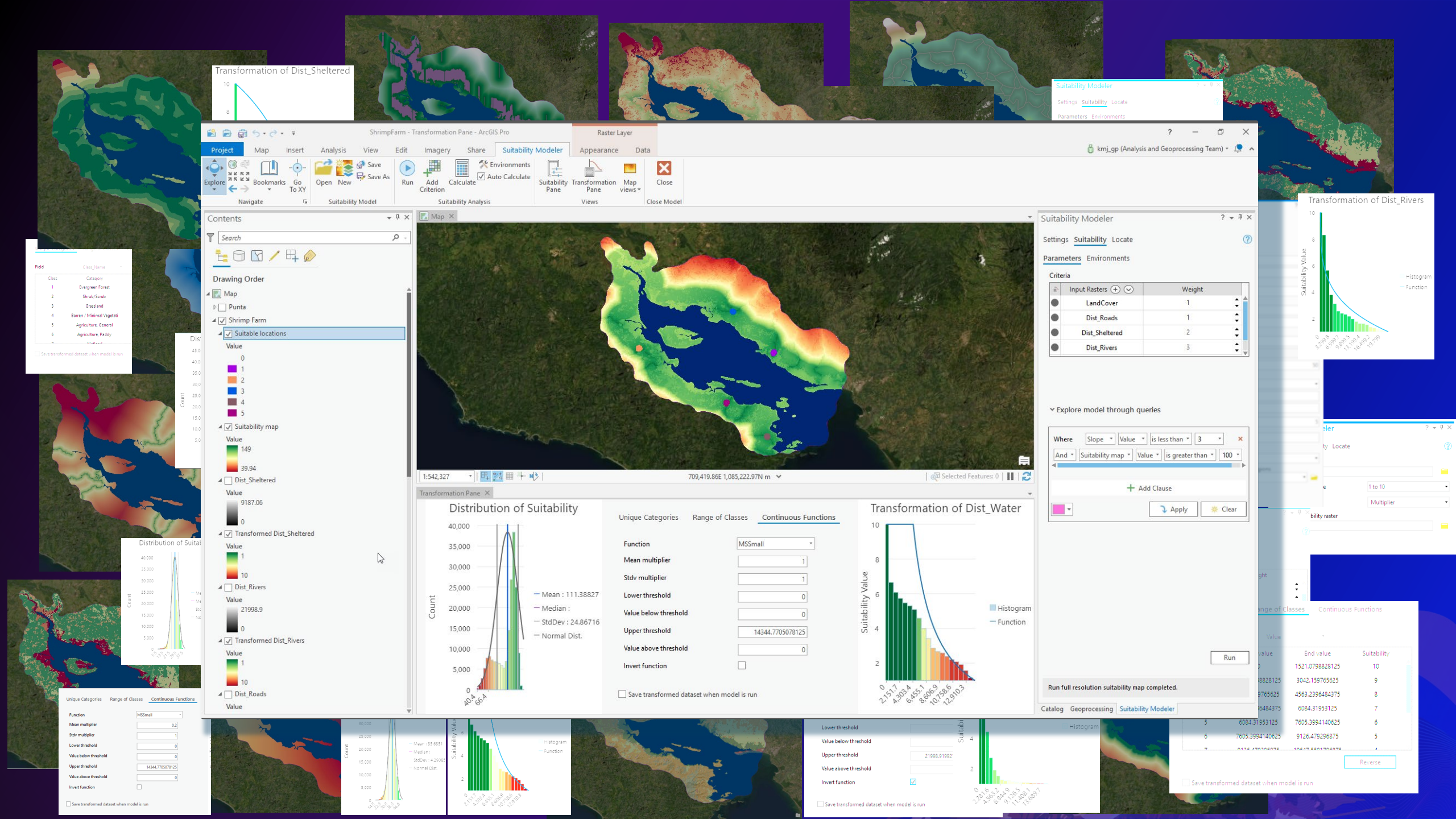


Summary

- Suitability modeling is an iterative nonlinear process
- Do not need detail knowledge of the workflow
- Provides continuous feedback
- Carefully think about how you transform the values within a criterion and weight between the criteria
- Make more informed decisions

The output is not a single static map but is the composite of decisions from hundreds of panes, plots, and maps

Acknowledgements: The Vermont Center for Geographic Information for the use of their data in this presentation


Transformation of Dist_Sheltered
ShrimpFarm - Transformation Pane - ArcGIS Pro
Raster Layer
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Suitability Modeler
Appearance
Data
Contents
Drawing Order
Map
Punta
Shrimp Farm
Suitable locations
Value
0
1
2
3
4
5
Suitability map
Value
149
39.94
Dist_Sheltered
Value
9187.06
0
Transformed Dist_Sheltered
Value
1
10
Dist_Rivers
Value
21998.9
0
Transformed Dist_Rivers
Value
1
10
Dist_Roads
Value
Map
1:542,327
709,419.86E 1,085,222.97N m
Selected Features: 0
Transformation Pane
Distribution of Suitability
Count
Mean : 111.38827
Median :
StdDev : 24.86716
Normal Dist.
Unique Categories
Range of Classes
Continuous Functions
Function
MSSmall
Mean multiplier
1
Stdv multiplier
1
Lower threshold
0
Value below threshold
0
Upper threshold
14344.7705078125
Value above threshold
0
Invert function
Save transformed dataset when model is run
Transformation of Dist_Water
Suitability Value
Histogram
Function
Suitability Modeler
Settings
Suitability
Locate
Parameters
Environments
Criteria
Input Rasters
Weight
LandCover
1
Dist_Roads
1
Dist_Sheltered
2
Dist_Rivers
3
Explore model through queries
Where
Slope
Value
is less than
3
And
Suitability map
Value
is greater than
100
Add Clause
Apply
Clear
Run
Run full resolution suitability map completed.
Catalog
Geoprocessing
Suitability Modeler
Transformation of Dist_Rivers
Suitability Value
Histogram
Function
Continuous Functions
End value
Suitability
1521.0798828125
10
3042.159765625
9
4563.2396484375
8
6084.31953125
7
6084.31953125
7605.3994140625
6
7605.3994140625
9126.479296875
5
Reverse
Save transformed dataset when model is run