Modeling and Controlling the Spread of Invasive Species over Heterogeneous Landscapes

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Modelling the Spread of Invasive Species

Why did Melaleuca thrive in FL wetlands but not in those of PR?

Melaleuca

Major problem in PR

Not in FL

… and yet

Mimosa pigra

Major problem in PR

Why?

Modelling the Spread of Invasive Species

Different Spreading Strategies

Melaleuca

Floats

Mostly downhill

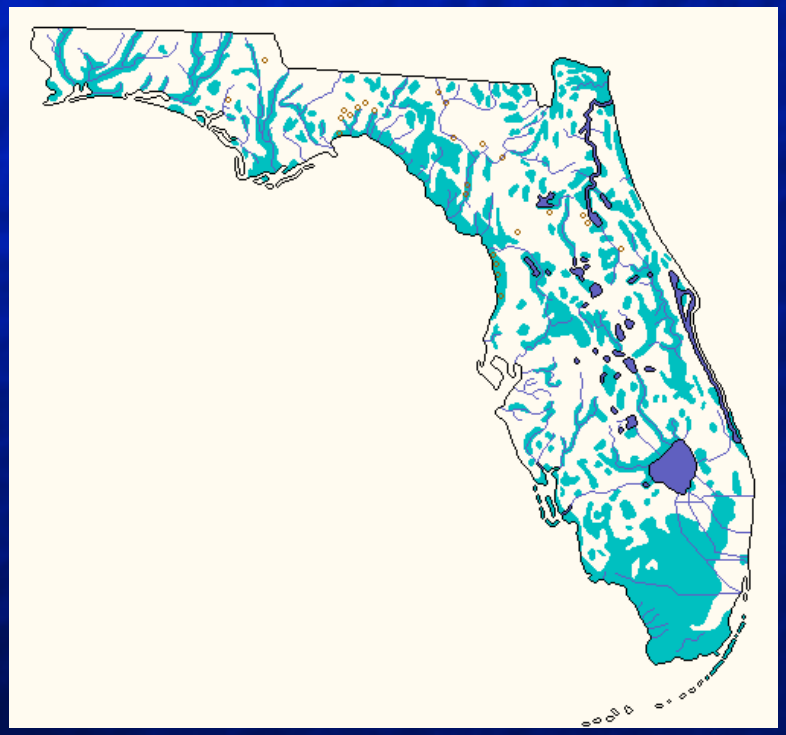
Mimosa pigra

Clings

Can move up or downhill

Modelling the Spread of Invasive Species

Different Kinds of Wetlands

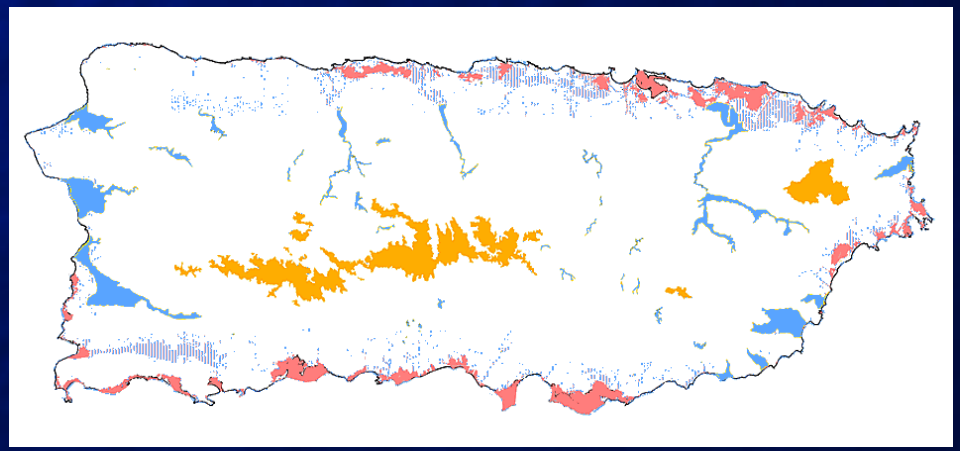


Florida

Contiguous

Puerto Rico

Patchy



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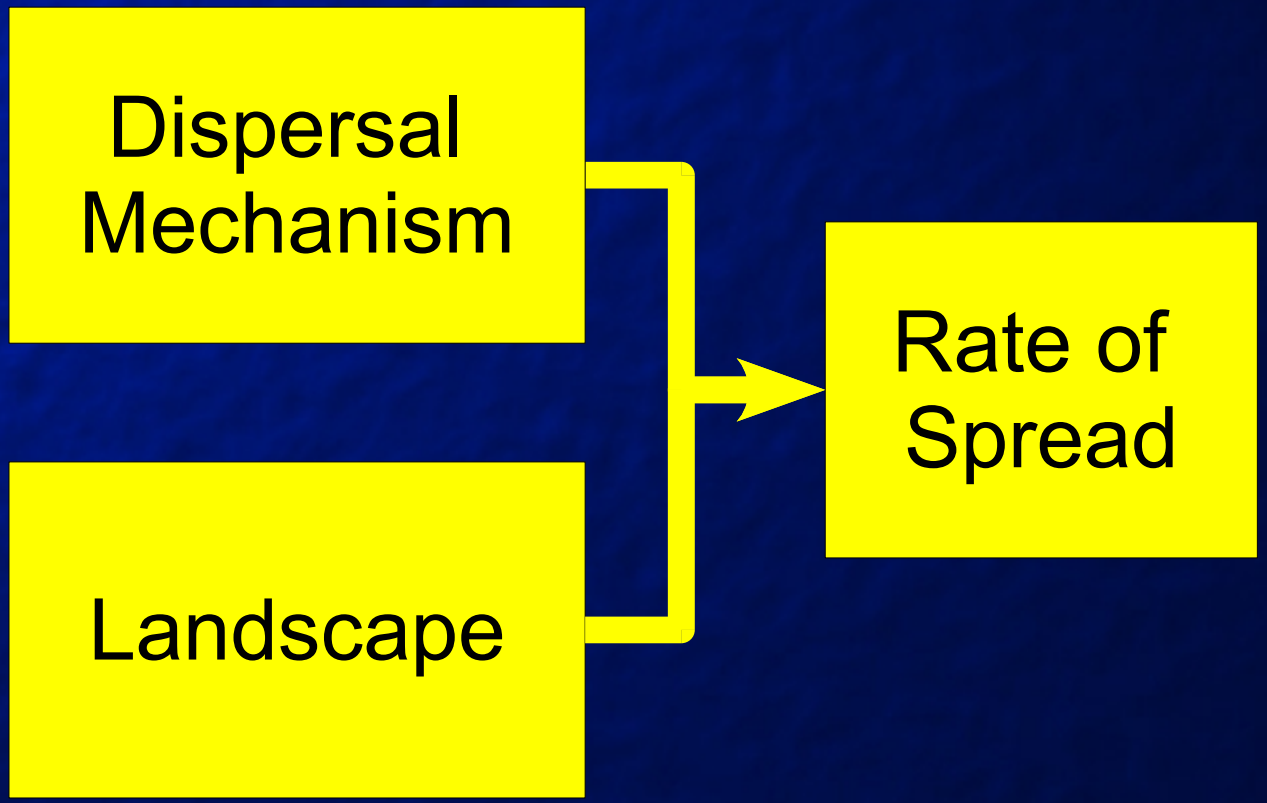
Relations



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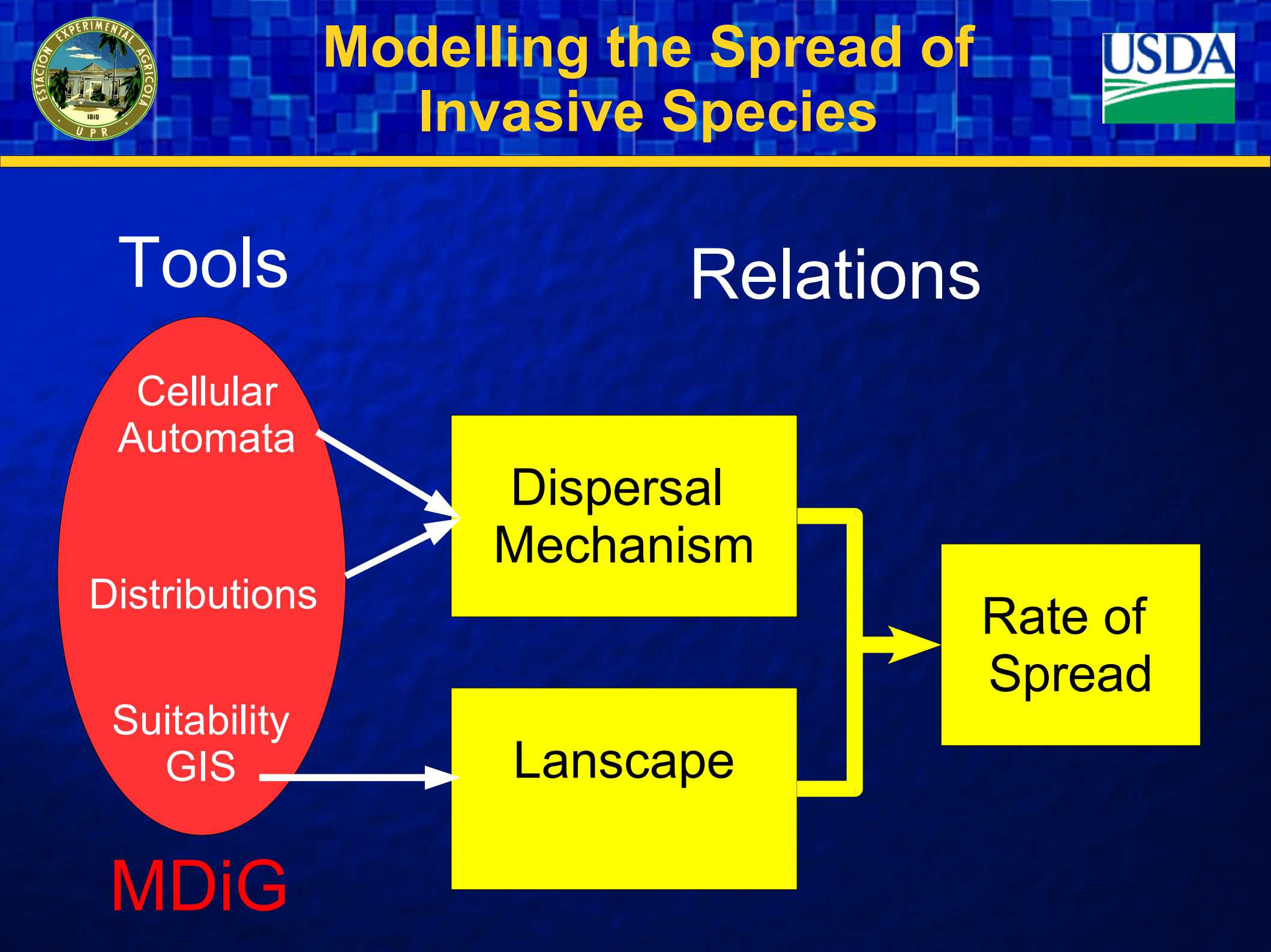
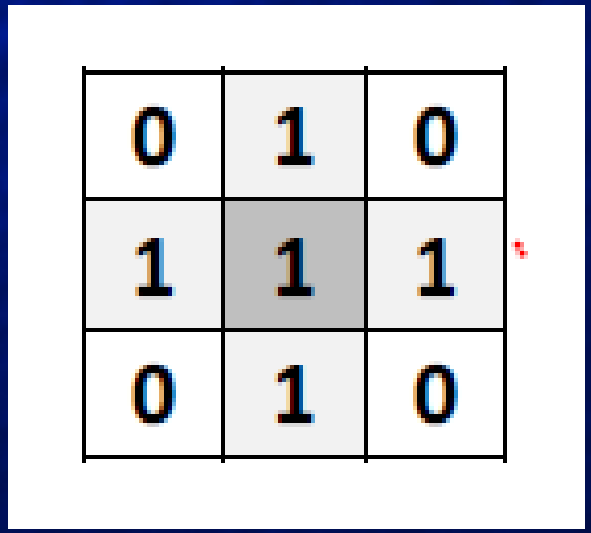


Modelling the Spread of Invasive Species

Cellular Automata to Model Diffusion

1. Presence/absence model
2. The state of each cell in period t+1 depends on the state of its neighboring cells in period t



Distributions to Model Long-Distance Dispersal

1. Could have used coarser CA instead, followed by finer CA
2. Here, for each cell, three consecutive draws are made from the following distributions:
    1. Poisson to get the number of LDD events
    2. Uniform to get the direction
    3. Cauchy to get the distance

Modelling the Spread of Invasive Species

GIS / Suitability Maps to Model Landscape

1. Each cell is assigned a number from 0 to 1 depending on how suitable it is for the species
2. These numbers are obtanied by constructing a suitability map
3. In each occupied cell at time t, the likelihood of survival at time t+1 is assessed

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Simulating a Presence/Absence map for t+1

1. Start with presence/absence map for t
2. Run CA module
3. Run LDD module
4. Run Survival module
5. The resulting map is our simulated Presence/Absence map for period t+1

Modelling the Spread of Invasive Species

Key Tasks

1. Compute suitability maps
2. Estimate model parameters
3. Obtain initial presence/absence for base year
4. Calibrate the model
5. Monte Carlo excercises
6. Policy scenarios
7. Write module for other spread mechanisms

Modelling the Spread of Invasive Species

Where are we now?

1. Collecting maps
2. Collecting presence/absence data
3. Learning ArcGIS and GRASS
4. First attempts at suitability maps using Temperature and precipitation
    1. Expert index based
    2. Statistical

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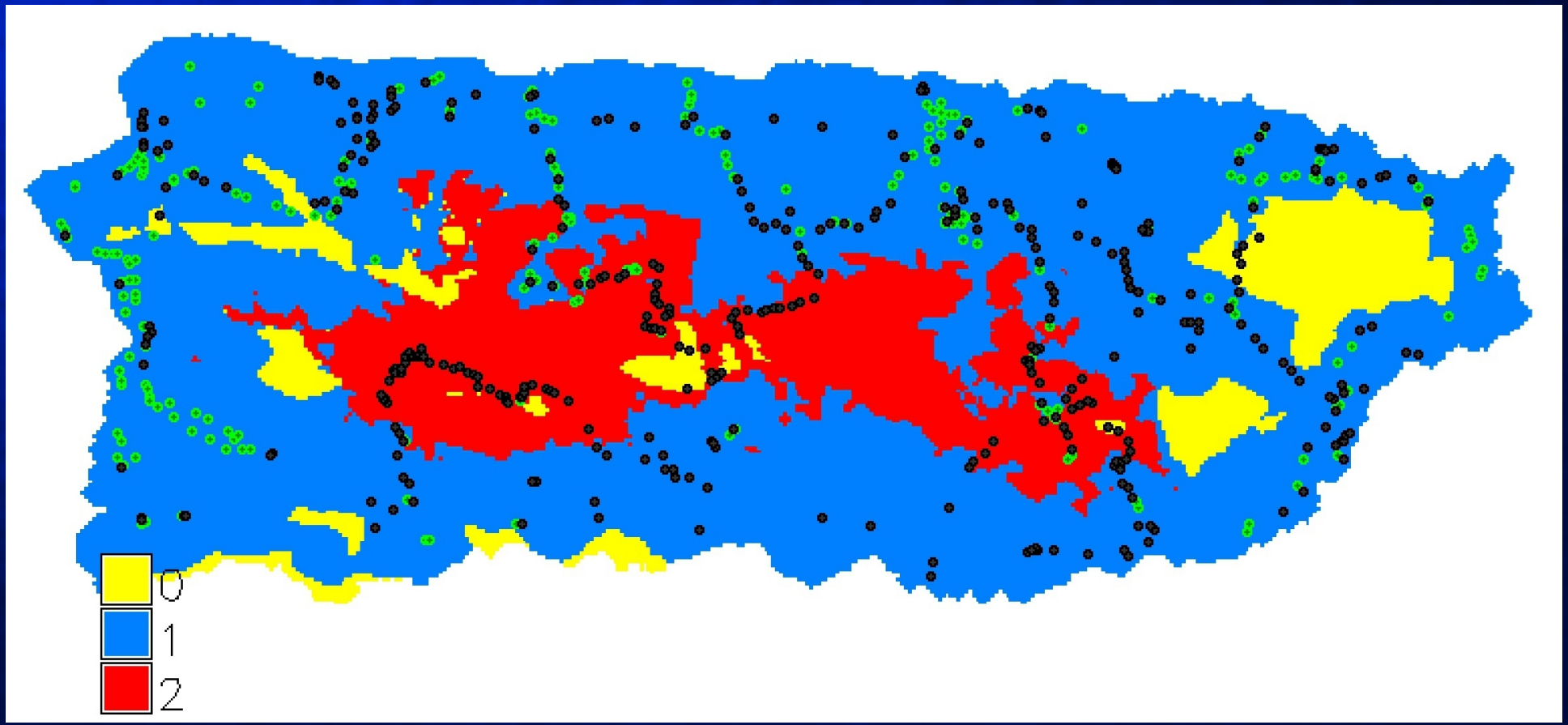
Expert Based Index / GRASS



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Statistical Based / ArcGIS

1. Logistic regression of presence/absence on minimum temperature, maximum temperature, and precipitation

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Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -2.080e+01  2.680e+00  -7.761 8.44e-15 ***
tempmin     -9.768e-04  6.911e-04  -1.413   0.1575
tempmax      7.033e-03  8.919e-04   7.885 3.14e-15 ***
precip       6.969e-06  3.228e-06   2.159   0.0308 *
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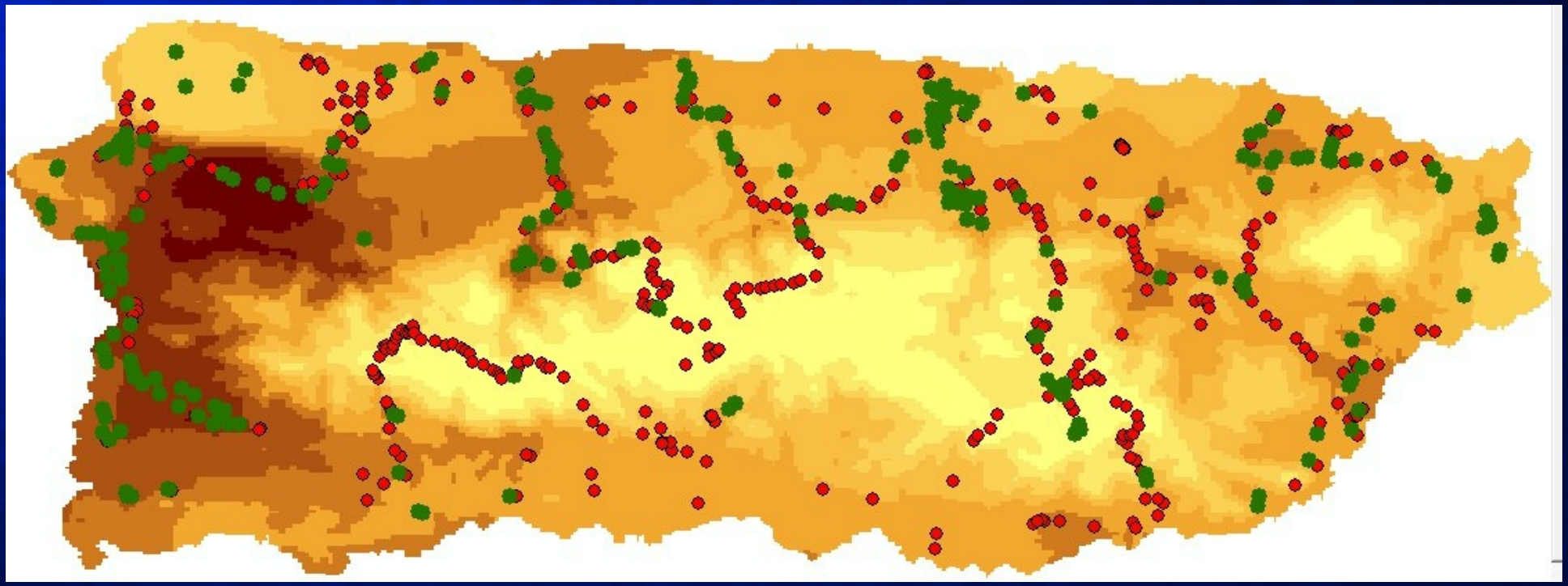
Modelling the Spread of Invasive Species

Statistical Based / ArcGIS



Suitability Map – To Dos

1. Include other layers (e.g. wetlands)
2. Deal with sampling issues (nonrandom sampling, presence only)
3. Deal with statistical issues (Spatial correlation)
4. Introduce some index of model fit
5. Try other alternatives (algorithmic approaches)

Acknowledgements

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