Contributing to Systematic Conservation Planning Through a Sensitivity Analysis of IUCN KBA Thresholds

Lana Kurakina,
Eric Nutt
& Christy Sandberg

Systematic Conservation Planning is a field of research that uses GIS and Python for spatial analysis, with the purpose of strategically identifying areas that meet a given conservation goal

Results are shared with key stakeholders, who are enabled to efficiently direct resources towards solutions with lower costs and greatest chance for long-term ecological success

Sensitivity Analysis of IUCN KBA Thresholds

A2 Threatened ecosystem types		
IUCN Red List **Criteria** for Ecosystems		**Threshold** to Define KBA Site
	COLLAPSED	
CR	CRITICALLY ENDANGERED	≥ 5% of Global Extent
EN	ENDANGERED	
VU	VULNERABLE	≥ 10% of Global Extent
	NEAR THREATENED	
	LEAST CONCERN	
	DATA DEFICIENT	

Marxan is a complex annealing function used to find the best outcomes from a variety of variables

$$minimize \sum_i^{N_s} x_i\, c_i + b \sum_i^{N_s} \sum_{ii}^{N_s} x_i(1 - x_h) cv_{ih}$$

subject to meeting all conservation targets and x_i is either 0 or 1

$$\sum_i^{N_f} x_i\, r_{ij} \geq T_j \forall\, j \qquad x_i \in \{0,1\} \forall\, i$$

where r_{ij} is the occurrence level of conservation feature j in planning unit i, c_i is the cost of planning unit i, N_s is the number of planning units, N_f is the number of conservation features, and T_j is the target for conservation feature j. The variable x_i has value '1' for planning units selected to form part of the reserve network, and value '0' for sites not selected.

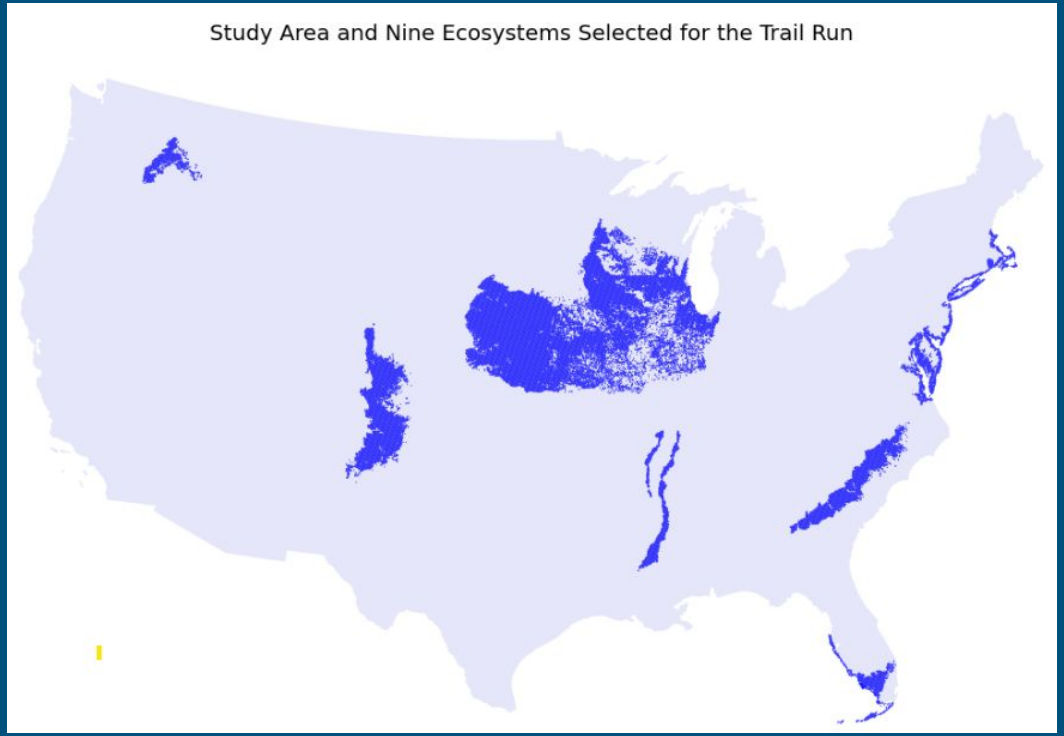
The first term in Equation 1 is a penalty associated with the cost of the network. The second term is a penalty associated with the spatial configuration or shape of the network, also known as boundary cost. The parameter cv_{ih} reflects the cost of the connection between planning unit i and planning unit h, typically measured as the shared boundary between these two planning units. If one planning unit is in the reserve system, and the other is not, then a connection cost is applied. If both planning units are out or in, the connection cost is not paid. The parameter b is the boundary multiplier (or the boundary length modifier, BLM), a user-defined parameter that controls the importance of minimizing the boundary cost (or total boundary length) of the reserve system. The higher the b value, the more importance is given to achieve a more compact reserve configuration. The units of b have to be set in a way that allow the boundary length to be comparable to the cost measure of the planning units in order to have an effect. For example, if the most costly planning unit is 100 and typical values of cv are 1000, then the BLM should start at 0.01 in order to see an effect on the spatial configuration of the reserve system.

In Equation 2, T_j is the target for a given biodiversity feature.

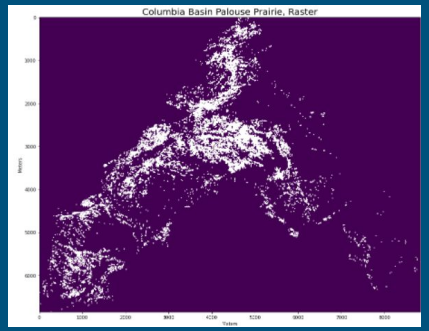
Serra, N., Kockel, A., Game, E. T., Grantham H., Possingham H.P., & McGowan, J. (2020). **Marxan User Manual**: For Marxan version 2.43 and above.

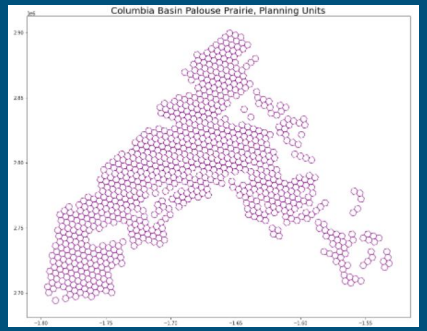
Input File	Input Parameter	Description	Value	Notes
bound.dat	boundary	measured length of the shared boundaries between adjacent planning units	n/a	
	id1	hex id	1, 2, 3 etc.	
input.dat	NUMPERS	number of repetitions	100	Number of solutions Marxan will find each time you run it
	SCENNAME	identifies scenario name	text	
pu.dat	cost	cost of selection, equal for each hex	1	
	id	hex id	1, 2, 3 etc.	
	status	each hex is available for selection	0	Other values are "2" - locked in, "3" - locked out
puvsp.dat	amount	area of the ecosystem which falls within each hex, calculated based on number of raster cells	900, 1800, etc.	Min value is 900 since once raster cell is 30 by 30 m, i.e. 900 sq. meters
	pu	hex id	1, 2, 3 etc.	
	species	species id included into analysis	1	We have only nine "species" i.e. ecosystem, but there can be few
spec.dat	id	species id included into analysis	1	Conservation feature
	name	name of the ecosystem	text	Do not use dash symbol
	spf	species penalty factor, penalty applied if targets are not met	1	I used 1 since that what was advised for tutorial, as I understand it, it means no penalty for not meeting the target

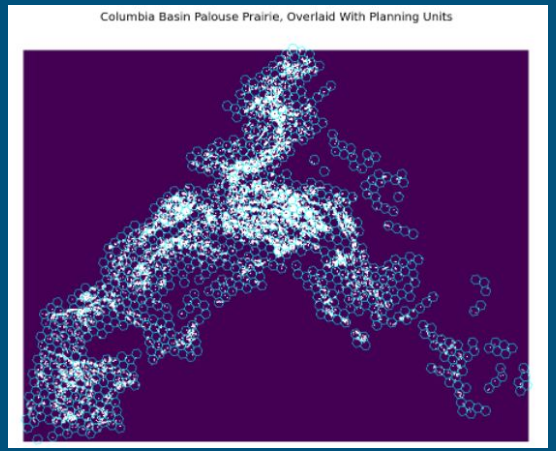
Study Area: Nine Ecosystems distributed across the Continental United States

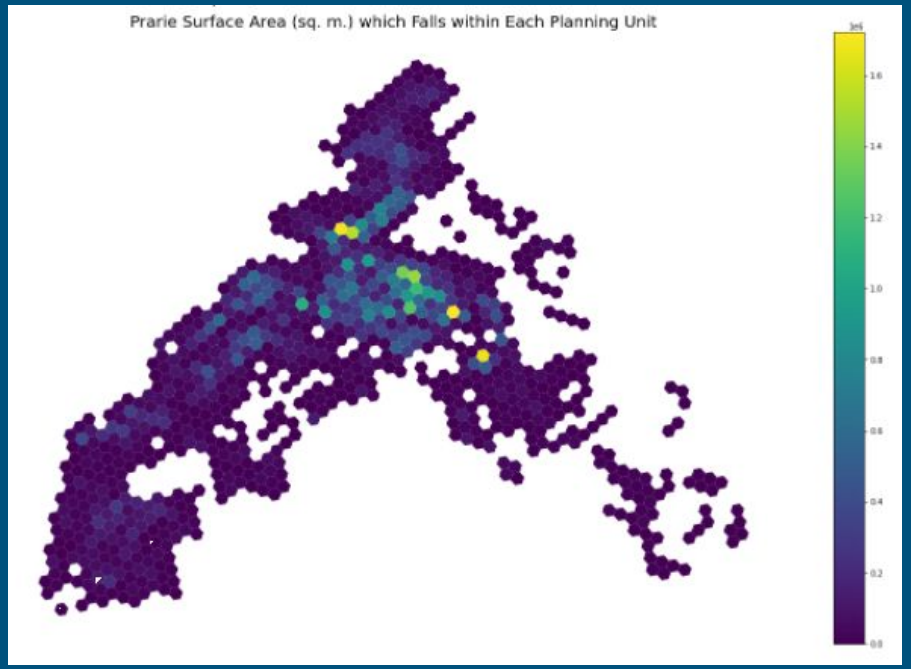


Data Preparation: Columbia Basin Palouse Prairie

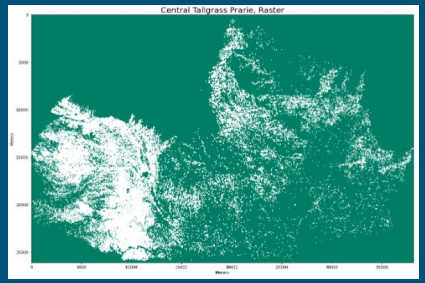


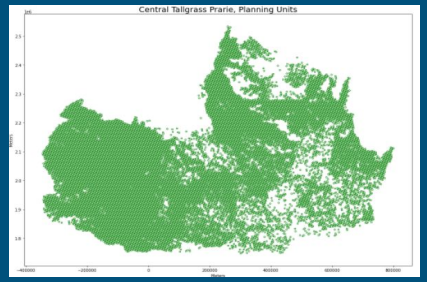


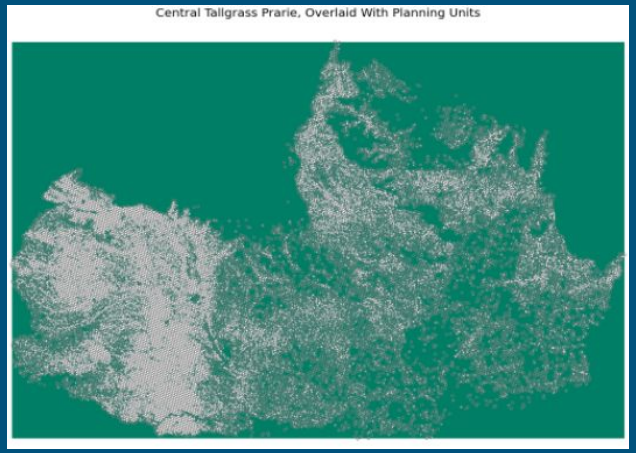


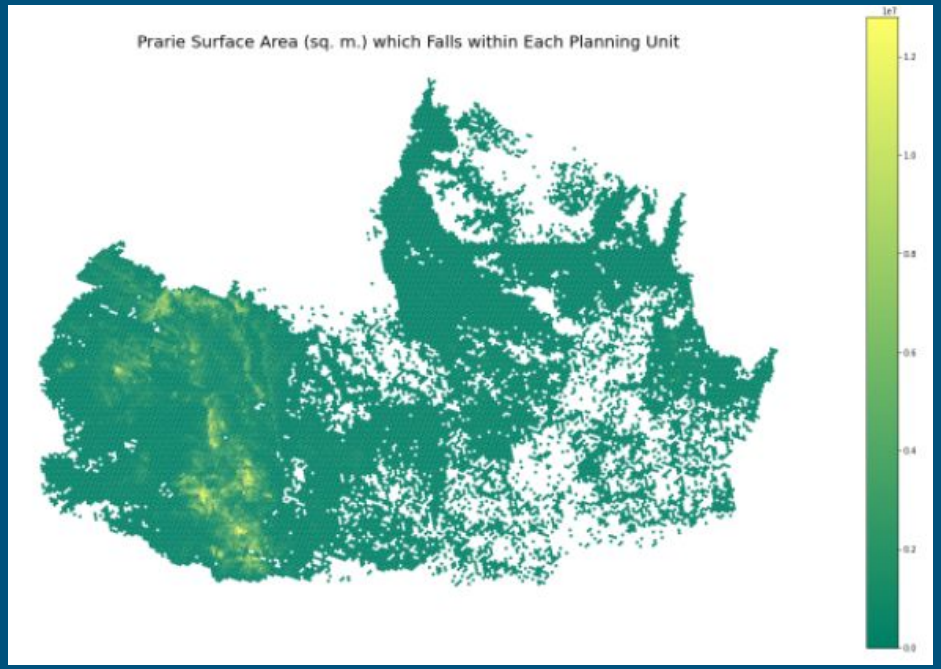


Data Preparation: Central Tallgrass Prairie









Questions to Explore

We are left with several questions at the end of this initial project phase:

- How can we improve the workflow?
- Can the entire workflow be completed in Python, or will some version of GIS software necessary?
- How will the spatial characteristics of the ecosystems we analyze respond to our sensitivity analysis?

Moving Forward

1. Investigate API capabilities at http://www.landfire/viewer
2. Test CLUZ (QGIS plugin) capabilities to prepare Marxan Input files and visualize results
3. Execute Marxan runs directly in Python using marxanconpy
4. Develop a reproducible workflow to visualize results of Marxan runs.
5. Set a publicly accessible data storage, if needed

Thank you !