

Including Ecological Function into Habitat Networks Using Numerical Modeling: Assessing Performance and Cost

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Ecosystem-Based Management

- **Protect habitat**
- **Protect biodiversity**
- **Protect spawning stock**
- **Protect trophic structures**
- **Protect fish spawning aggregations**

Marxan Area Selection

- **Representation**
 - Usually by habitat (surrogate for species distributions)

Marxan Selection Criteria

- **Representation**
 - Usually by habitat
- **Replication**
 - Stratification, Clustering

Marxan Selection Criteria

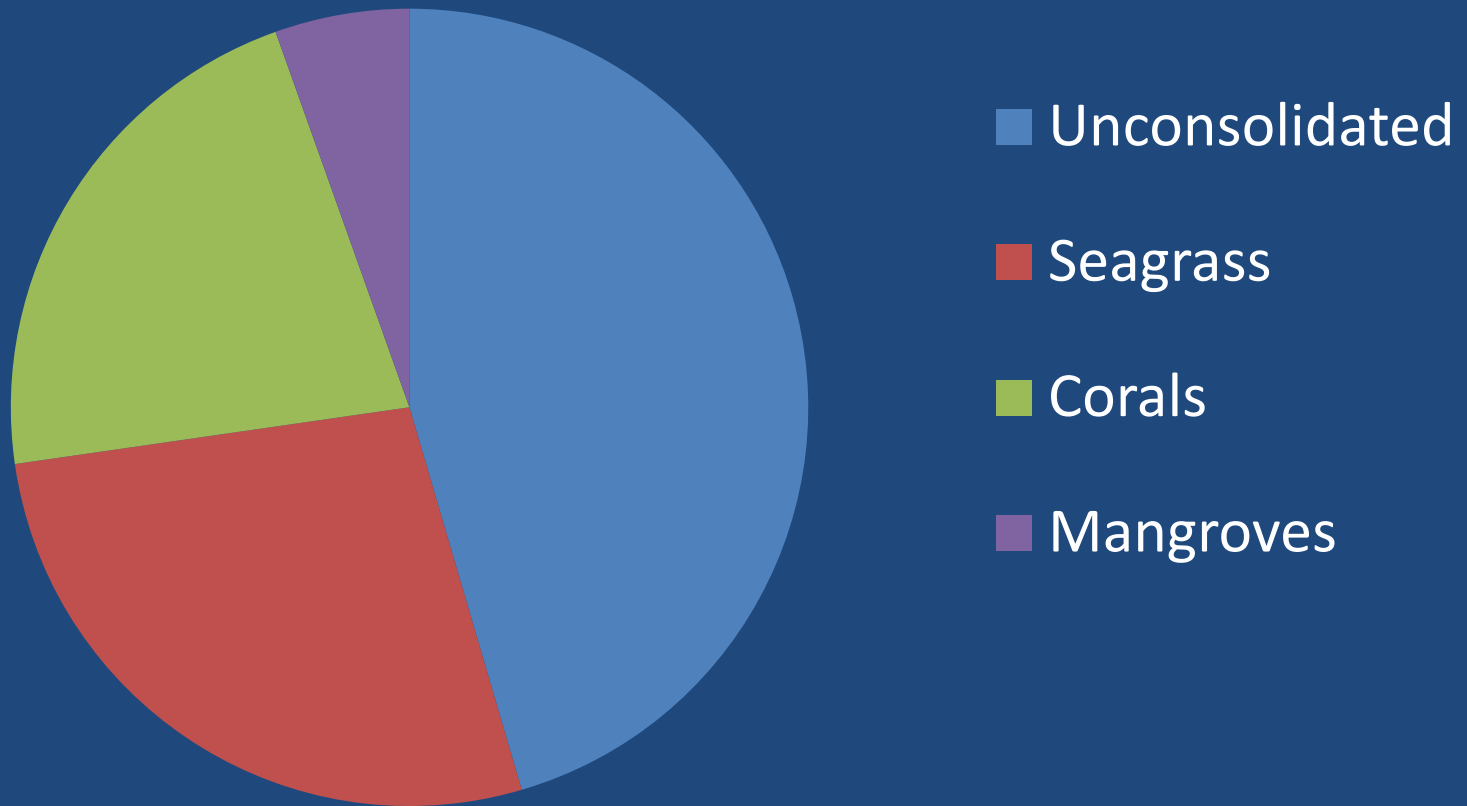
- **Representation**
 - Usually by habitat
- **Replication**
 - Stratification, Clustering
- **Self-Sustaining Network → Close proximity**
 - Size of Planning Unit (small scale)
 - Representation + Clustering (medium scale)
 - Replication + Stratification, Maximum Spacing (large scale)

Theoretical Application using data from Puerto Rico

- Data Sources
 - NOAA Habitat Maps (Area)
 - minimum mapping unit = one acre ($\sim 4000 \text{ m}^2$)
 - NOAA Environmental Sensitivity Maps (e.g, Wetlands, Linear Coastlines)

Basic Habitats

Basic Habitat Types (Null)



Habitats

- **13 Reef + Colonized Hardbottom**
- **4 Uncolonized Hardbottom**
- **2 Unconsolidated Substrate**
- **3 Sea Grass**
- **3 Mangrove**

Sub-divided Habitats

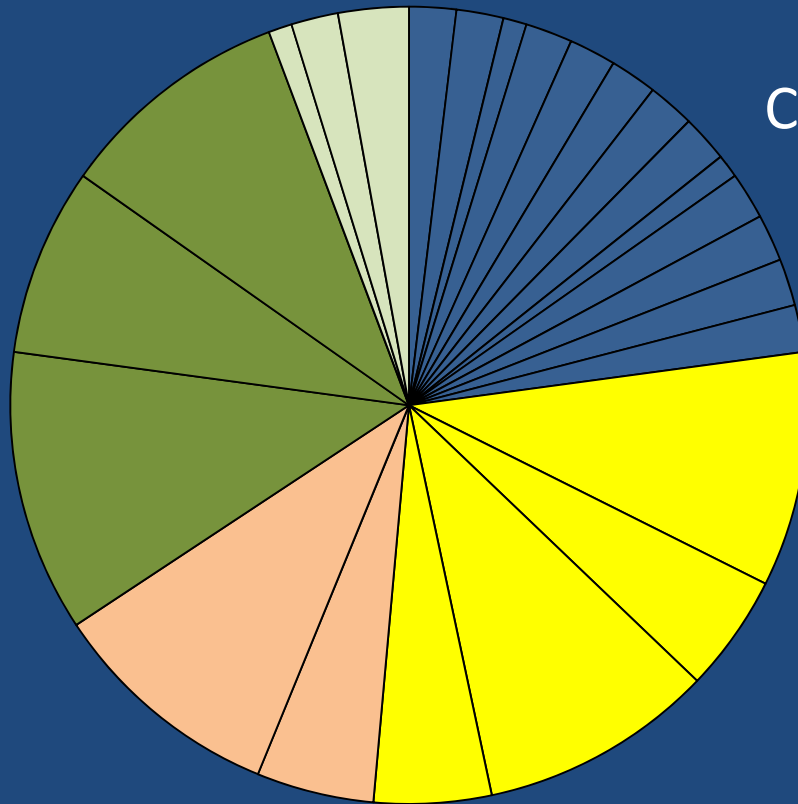
Habitat %

Mangroves

Corals

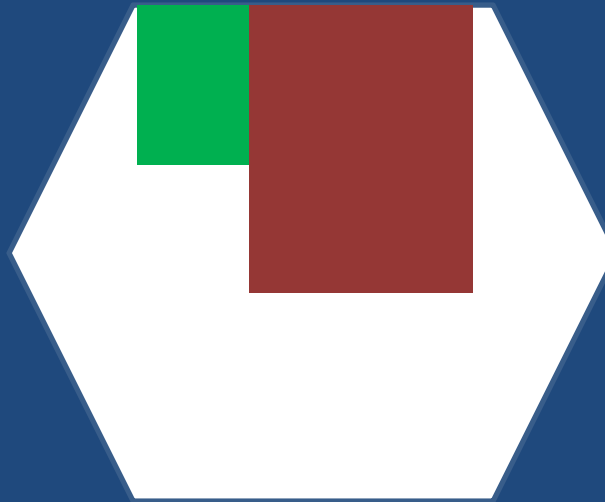
Seagrass

Unconsolidated



Marxan Planning Unit

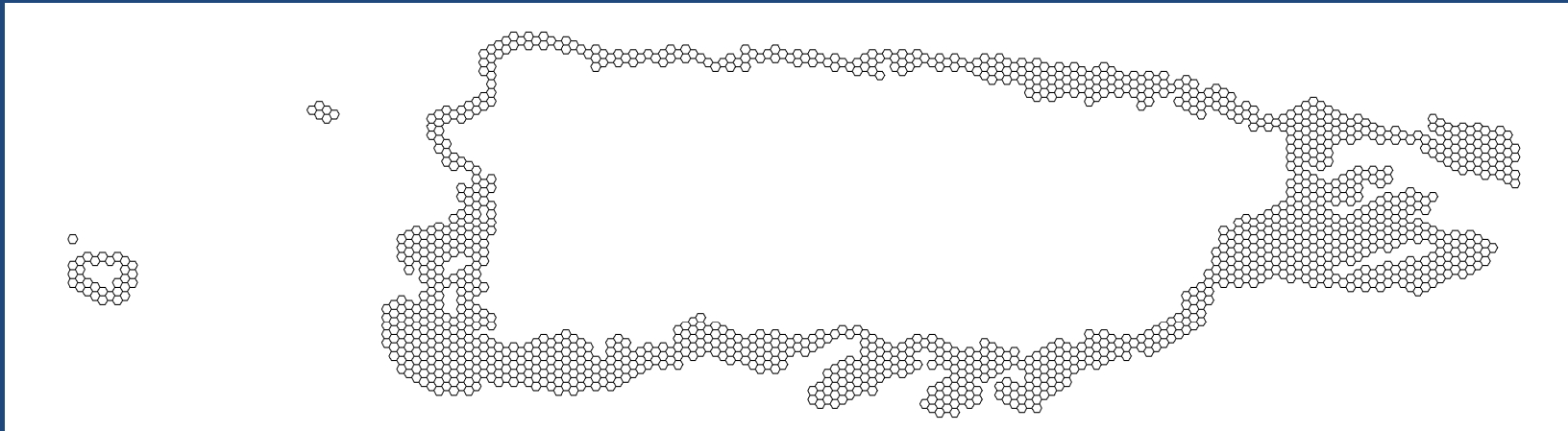
- Hexagons (other shapes could be used)
- Edge effect



Planning Units

Hexagons – 1 km/side

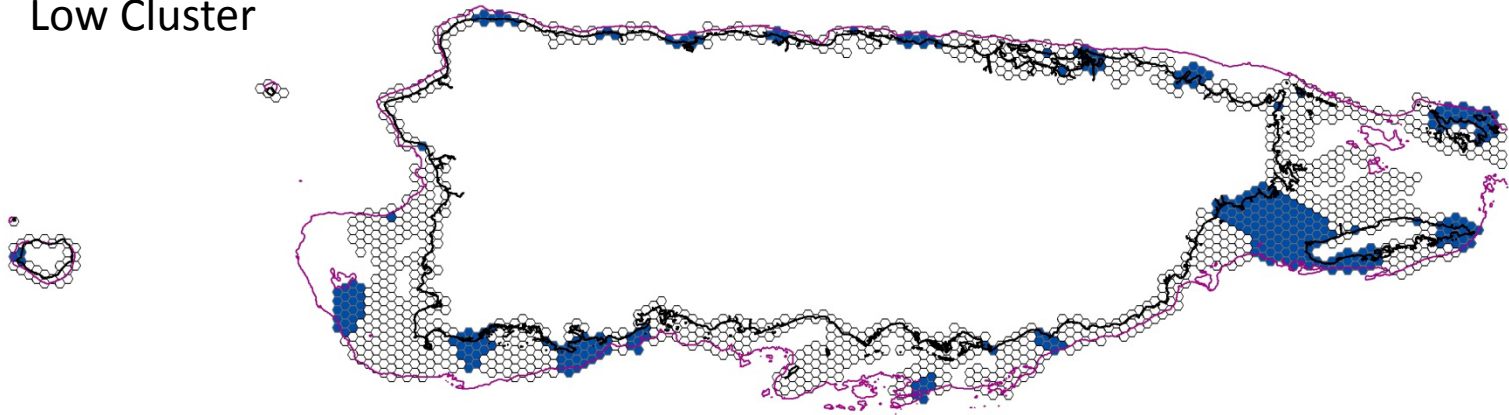
Target: 30% Protection of all habitat types



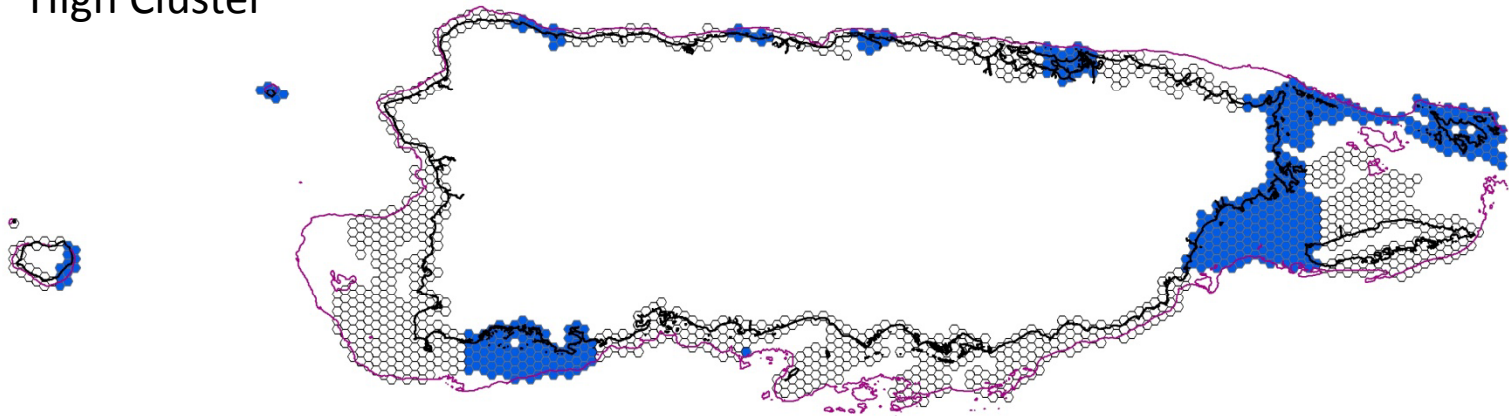
Marxan tries to minimize the total number of planning units selected to reach target goal

Best selection from Marxan

Low Cluster



High Cluster



Important Criteria

- Shoreline to shelf edge inclusion
- 40km between selected areas for larval connectivity
- Replication of targets

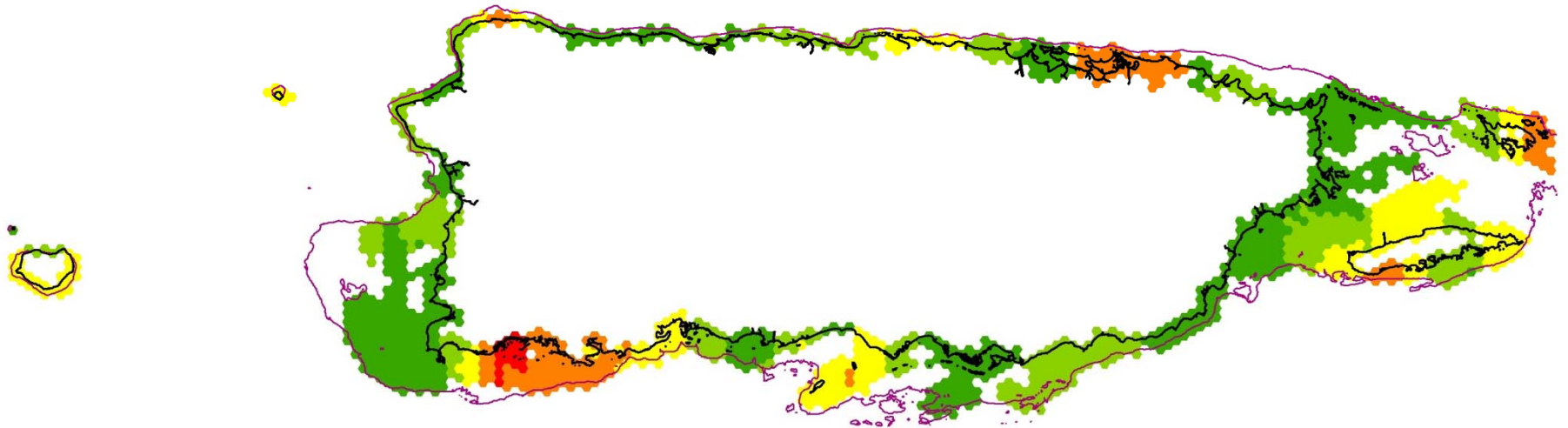
Does this approach work?

Is ecological function incorporated?

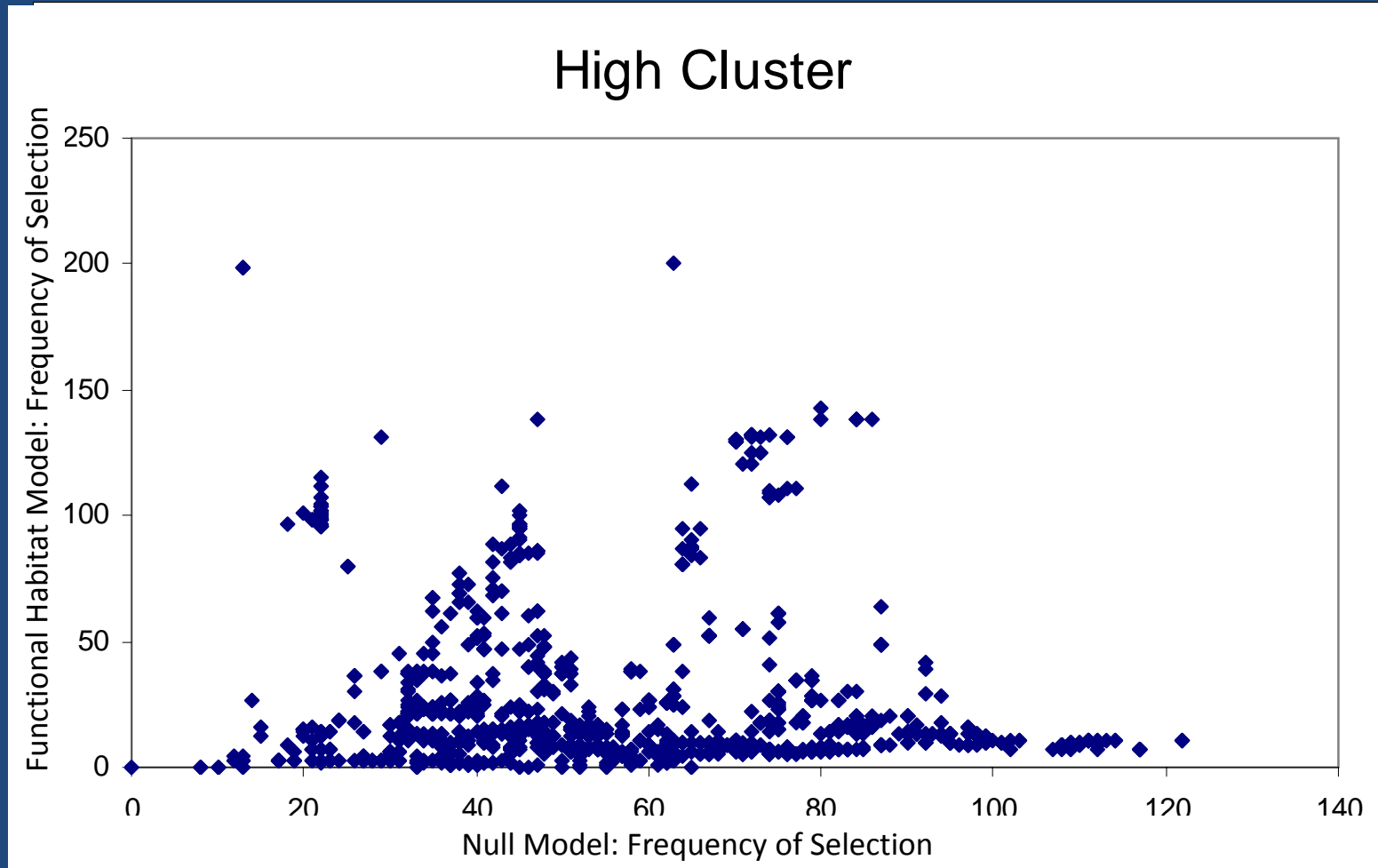
- Principles consistent with model function
- But – Marxan has no true null model
- Can test to see if results are different
 - Compare with basic model as null case
 - Mangrove, Sea grass, Reef, Sediment
 - i.e., All sub-habitats and locations are equal

Frequency of Selection

High Cluster



Model Comparison



No Significant Correlation

Cost to Functionality

Marxan Run	Total Planning Units	Planning Units Selected	% Area	% Above Null
Low Cluster				
Null Habitat	1353	230	17.00	
Functional Habitat	1353	299	22.10	30.0
High Cluster				
Null Habitat	1353	346	25.57	
Functional Habitat	1353	455	33.63	31.5

Remarks

Regardless of the degree of clustering, results show little correlation between the areas chosen by the two models, and patterns of frequency count are significantly different, indicating that significant adjustments in area selection were made.

However, the adjustments made to meet design principles come with significant cost. Not only does more area need to be protected under high cluster scenario that best meet connectivity criteria, the resulting number of planning units targeted for conservation under the detailed relative to the null model increased by 30%, regardless of the degree of clustering.

Acknowledgements

- Anthony Chatwin, PhD
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- NOAA/CSCOR

Questions?