Construction of a Black Sea Bass fishery-independent sampling design using a simulation model and survey data

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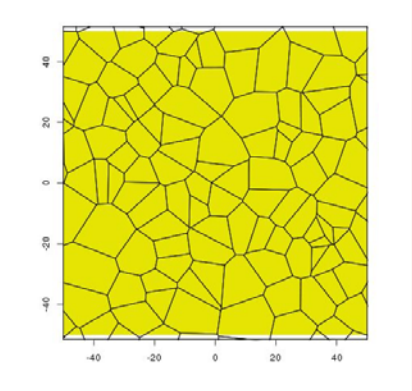
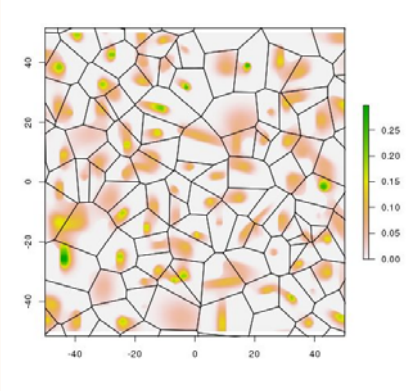
- The **objective** of this simulation analysis is to examine how sample allocation strategy effects the precision of population estimates and to use this information to refine Black Sea Bass survey design.

- The simulation consists of a number of components including:
  - Initialize the two-dimensional heterogeneous **spatial landscape** at two scales: the landscape and smaller patches.
  - Create particles that are the **target entities** of the sampling (the fish targeted in the simulation).
  - Construct **sampling units** used to estimate the fish density.

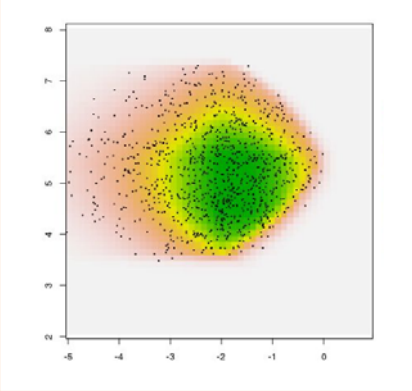
- A tesselation algorithm is used to divide the landscape into randomly placed and randomly sized patches (n = 100).
- Density of patches can be altered by the user.



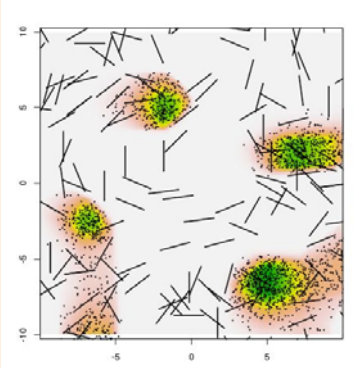
- Random parameter, bivariate skewed-normal distribution within patches determine the probability of occurrence of a particle at that location.
- The parameters that define the variance of the distribution control patchiness.



- Particles are assigned to the landscape based on probability set within a patch.
- Base model comprises 25 million particles that can occupy any of 1 of 1 x 10^{38} locations in the landscape.



- Trawls paths were constructed using rectangular polygons with an aspect ratio of width = 35 and a length of 2,000; a simulation of a 35 m wide trawl traveling over 2 km of fishing ground.
- In the base model, polygon orientation is randomly assigned.
- Trawl tracks are polygons that are independent of the scale and orientation of the landscape grid.



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Confronting the model with data

- The observed distribution and abundance of an organism is a conditional probability that is determined by its abundance, scale of aggregation, and availability to the sampling gear.
- To evaluate the adequacy of alternative sampling designs we will:
  1.) Compare the observed BSB distribution and abundance from the Supplemental Finfish Survey conducted in the mid-Atlantic Bight to that in the model base run.
  2.) Alter the parameters in the base model that control the distribution and abundance of particles to match that observed in the field survey. These parameters include:
    - Number of clusters of fish density in the study
    - Number of trawls (samples)
    - Parameters to control the kurtosity and skew of the frequency of occurrence distributions
    - Number of particles
    - Trawl dimension as a fraction of the current grid extent what is the trawl length as a fraction of grid size
  3.) Derive a set of alternative sampling strategies that can be employed in future surveys.
  4.) Evaluate the ability of each of the alternative sampling strategies provide precision estimates of fish density.

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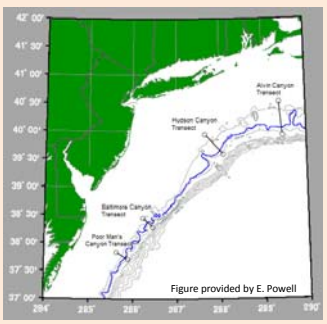
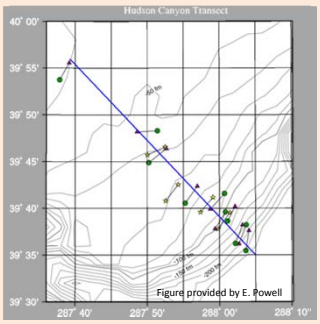


Figure provided by E. Powell



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