Merrill Rudd

FSH 507 Spatio-temporal modeling

Project proposal

**Data**

I have coral reef fishery landings data from the Kenyan coast, from Tim McClanahan and his research group at the Wildlife Conservation Society. This dataset includes a census of the species, length of individuals, port at which they were landed, date, and other details from 1998-2012. I currently have catch data and species composition sampled through 2015, but no length composition data yet. The dataset through 2012 includes 23 landing sites, 27 gears, 77 taxonomic families, 297 species. Each observation of a species landed on a particular day has the associated lengths of each individual, and the number of fishers on the vessel that captured that species. The data collection occurred approximately 21 times within 11 years over the 15 year period.

The owners of this data are anxious for it to be used in a more quantitative/stock assessment context. There is great interest in some estimate of stock status, and any spatially explicit estimates would also be very useful. One of my main goals of this project is initial data exploration and simulation to understand what biases I could expect given spatial differences in the species dynamics, even if the sample size at each site or the movement of fleets between areas might not be informative to formally assess spatial differences.

**Question**

1. What are the observed length differences between landing sites?
2. What is the bias in estimates of stock status when assuming a single growth curve for a species across areas, when growth for that species is heterogeneous between regions?
3. What is the bias in estimates of stock status when assuming all landings come from a single stock with a single exploitation history, when each region has a different fishing mortality history (i.e. level of depletion)?

**Structure of spatial/temporal processes**

At the lowest level of spatial and temporal definition, I would assume the spatial dynamics are homogenous and the reef fish populations are in equilibrium (recruitment and fishing mortality not changing over time).

The first step away from these dynamics would be changes in temporal processes, removing the assumption of equilibrium dynamics by letting recruitment and fishing mortality change over time within the operating model.

Another step away from the simplest dynamics would be changes in spatial processes only; that the fishing mortality and recruitment are the same in each area, but that growth processes vary between areas.

The most complex dynamics would be changes in temporal and spatial processes. This would be differences in growth between spatial areas, with shared fishing mortality across areas but letting recruitment vary within the estimation model. The alternative would be having shared growth processes between areas, with different fishing mortality rates between areas, and letting recruitment vary between areas.

**Modeling methods overview**

I would use my recently developed length-based state-space assessment model for both the operating model and estimation model. This flexible framework could be simplified to assume only one estimate of fishing mortality over time and one value for recruitment (or fixed at 1 to estimate relative scale of the population size annually). I would focus on using the length frequency data for one commercially important species, *Lethrinus harak*, and ignore the use of catch and effort data since this would require extrapolation of the total catch and standardizing catch-per-unit-effort data that may be beyond the scope of this study. Any simulation modeling would mimic the life history of *Lethrinus harak*. Using only the length frequency data and biological information from FishBase would allow me to explore the accuracy and precision under different scenarios of spatial variation in growth and fishing pressure, in a scenario of data limitation that is common across coral reef fisheries.

Estimate fishing mortality from mean-length mortality estimator method assuming a spatial trend vs. no spatial trend in Lmat (or random effect on Lmat based on area)

What would the bias associated with lumping vs. splitting?