Hierarchical stock-recruitment modeling

10 total points

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NOTE: date above is the due date

Background

The relationship between stock or spawning stock biomass and recruitment is perhaps the most important relationship in fisheries science. In age or stage-structured fisheries population models this relationship describes the maximum expected recruitment rate and the degree of density dependence in recruitment, and thus can be used to calculate both the maximum sustainable yield (MSY) and the maximum sustainable exploitation *rate* thought to achieve MSY (F_{MSY}).

Rockfishes (*Sebastes* spp.) are a important species complex off the coast of western North America (Fig. 1). Rockfish are infrequently caught, difficult to tell apart, and commercially valuable. Rockfish are are also delectable in omlettes when served with a tasty beer on a rainy morning in Seattle. In this assignment, your goal is to estimate stock-recruitment relationships for these species by sharing information about stock-recruit α across the species complex using a hierarchical model. The results from your analysis will be used as informative priors for stock-recruitment α for future stock assessments for Rockfishes off the west coast of North America. The reason you are interested in among-species variation in α is because this parameter is directly correlated with F_{MSY}, and thus estimating α should provide insights into the resilience of different species to exploitation.

The Ricker stock-recruitment model can be parameterized as:

$$R_t = \frac{\alpha}{sbro} \cdot SSB_t \cdot e^{-\beta \cdot SSB_t}$$

- where
  - R_t is recruitment in year t
  - SSB_t is spawning stock biomass in year t
  - $sbro$ is spawner biomass per recruit in the unfished condition (no exploitation)

- α , β are the parameters of the stock-recruitment relationship

Your task is to develop a hierarchical model for Rockfish stock-recruitment, where

Fishery trawl data are often plagued by a large number of zeros–in essence, one often catches zero or no fish and then occassionally encounters many fish. As a general rule, when $>$ 20-30% of the data are zeros, traditional modeling techniques often fail and more specialized tools are needed to model the data.