MAR580: Models for Marine Ecosystem-Based Management Fall 2022

TMB Workshop, State-space modeling

Linear state-space model in TMB, Gompertz model of lingcod

Fit a state-space version of the Gompertz model of population dynamics to the abundance data for lingcod found in `lingcod.dat` (from Schnute 1994). The process equation for this model is:

$$B_{t+1} = B_t e^{(r+\beta * ln(B_t))} e^{\eta_t} \text{ where } \eta_t \sim N(0, \tau^2)$$

Assume that the log-abundances are normally distributed around their predicted values with variance σ^2. i.e., the observation model is:

$$ln(y_t) = ln(B_t) + \epsilon_t \text{ where } \epsilon_t \sim N(0, \sigma^2)$$

Rather than estimate as a model parameter, set the initial state to the model's stationary distribution (i.e. value for B_t when $B_{t+1} = B_t$).
Hint For non-chaotic behavior, the density dependence parameter β should be constrained to lie in the interval $-2 < \beta < 0$ (i.e. $-1 < 1 + \beta < 1$).
Report the maximum likelihood estimates (and variances) for the model parameters: the growth rate (r), magnitude of density dependence (β), and the standard deviations for the process and observation error (τ & σ).
Plot the fit of the model to the data.
What do the results mean for the estimated population dynamics?