The concept of "surplus production"

The change in a population biomass
(Ass. no immigration and emigration)

(Next year's biomass)

= (current biomass) + (Recruitment) + (Growth) – (Natural mortality) – (Catch)

= (current biomass) + (Surplus) – (Catch)

Equation 12

$$B_{t+1} = B_t + g(B_t) - C_t$$

The concept of "sustainable yield"

$$B_{t+1} = B_t + g(B_t) - C_t$$

$$C_t = g(B_t) \Rightarrow B_{t+1} = B_t$$

This is the amount of catch which can be taken to maintain the biomass at a constant level

Therefore, it is called "sustainable yield"

The maximum value of among possible values of "sustainable yield" is called "maximum sustainable yield (MSY)", and the biomass attaining MSY is called "MSY level (MSYL)"

A simple relationship between stock biomass and surplus production

Logistic model

Intrinsic rate of natural increase

Carrying capacity

Equation 13

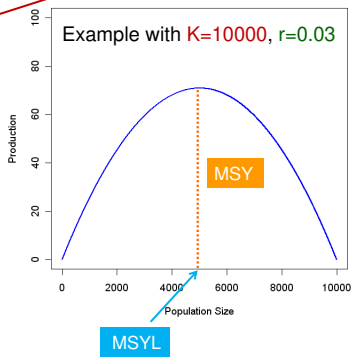
$$B_{t+1} - B_t = r B_t \left(1 - \frac{B_t}{K}\right)$$

$$B_{t+1} - B_t = 0$$

$$C_t = r B_t \left(1 - \frac{B_t}{K}\right)$$

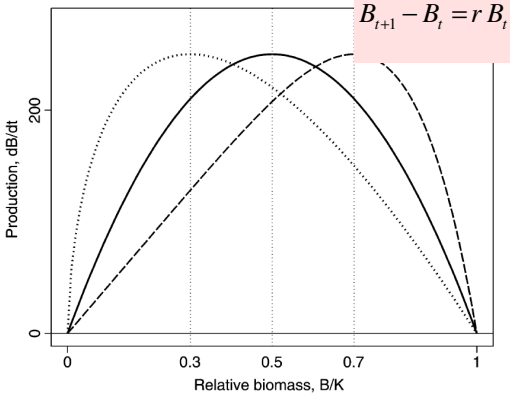
$$MSY = \frac{rK}{4}$$

$$MSYL = \frac{K}{2}$$



Other functions

$$B_{t+1} - B_t = r B_t \left(1 - \left(\frac{B_t}{K}\right)^z\right)$$



From Prager (2002)

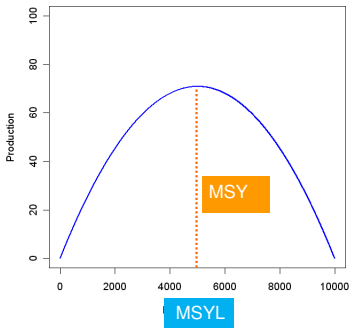
Use of MSY as a reference point

- MSY or MSYL
- FMSY

$$C = qEB = FB = F\frac{K}{2}$$

$$C = \frac{rK}{4}$$

$$F_{MSY} = \frac{r}{2}$$

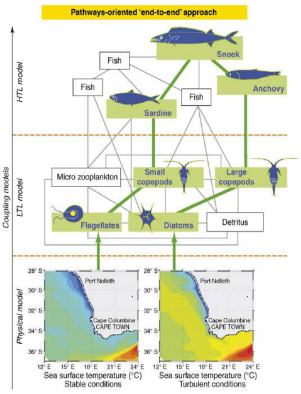


If the fishery is operated with FMSY level, then the stock level is approaching to its MSY level.

Concerns about MSY approaches

- Environmental variability
  (Are the carrying capacity and intrinsic rate of natural increase constant? Habitat quality might be influenced by environmental factors)
- Ecosystem perspective
  (e.g. Competition to other stocks may change carrying capacity)

$$C = \frac{rK}{4}, \quad F_{MSY} = \frac{r}{2}$$



From Curry et al. (2008)