Schnute (1985)

$$R_t = \alpha S_{t-1}(1 - \beta\gamma S_{t-1})^{1/\gamma}$$

$$P_t = R_t + (1-\delta) S_{t-1} \qquad \begin{cases} \delta = 1 - e^{-M} \\ f = 1 - e^{-F} \\ S_t = P_t - C_t \\ C_t = f P_t \end{cases}$$

$$\frac{P_t - P_{t-1}}{1} = R_t + (1-\delta)(P_{t-1} - f P_{t-1}) - P_{t-1}$$

$$= R_t + \cancel{P_{t-1}} - f P_{t-1} - \delta P_{t-1} + \delta f P_{t-1} - \cancel{P_{t-1}}$$

$$= R_t - (f P_{t-1} + \delta P_{t-1} - \delta f P_{t-1})$$

$$= R_t - (\underbrace{f + \delta - \delta f}_{Pr(\text{fishing} \cup \text{natural Mortality})}) P_{t-1}$$

$$\frac{dP}{dt} = R - (f + \delta - \delta f) P$$

Mangel et.al. (2012)

$$\frac{dP}{dt} = \underset{①}{\frac{\alpha P}{1 + \beta P}} - \underset{②}{(M+F)P}$$

① Schnute has recruitment in terms of S instead of Biomass (as above).

② Schnute uses a probability scale to describe total mortality. What is the scale for M & F? Something like negative logProbability?

$$\begin{matrix} \delta = 1 - e^{-M} \\ f = 1 - e^{-F} \end{matrix} \iff \begin{matrix} M = -\log(1-\delta) \\ F = -\log(1-f) \end{matrix}$$

M+F is a union of ~~Probabilities~~ Mortalities

$f + \delta - \delta f$ is Probability of union of Morts.

$$f + \delta - \delta f = 1 - e^{-(M+F)}$$

$$P_t = R_t + (1-\delta) S_{t-1}$$

$$\frac{P_t - P_{t-1}}{1} = R_t + (1-\delta)(P_{t-1} - f P_{t-1}) - P_{t-1} \qquad \left(\begin{array}{l} \delta = 1 - e^{-M} \\ f = 1 - e^{-F} \end{array} \right.$$

$$= R_t + (\cancel{1} - (\cancel{1} - e^{-M}))(P_{t-1} - (1 - e^{-F}) P_{t-1}) - P_{t-1}$$

$$= R_t + e^{-M}(\cancel{P_{t-1}} - \cancel{P_{t-1}} + e^{-F} P_{t-1}) - P_{t-1}$$

$$= R_t + P_{t-1} e^{-(F+M)} - P_{t-1}$$

$$= R_t - (1 - e^{-(F+M)}) P_{t-1}$$

$$\frac{dP}{dt} = R - (1 - e^{-(M+F)}) P$$