Random Search

October 31, 2018

Contents

1 Supplementary Material

1.1 Operating Model

Population dynamics

$$N_{a+1,y+1} = N_{a,y} e^{-Z_{a,y}} \tag{1}$$

$$N_{p,y} = N_{p-1,y-1} e^{-Z_{p-1,y-1}} + N_{p,y} e^{-Z_{p,y-1}} \tag{2}$$

$$N_{r,y} = f(B_{y-r}) \tag{3}$$

Mortality rates

$$Z_{a,y} = F_{a,y} + D_{a,y} + M_{a,y} \tag{4}$$

$$F_{a,y} = \sum_{i=1}^{f} P_{i,a,y} S_{i,a,y} E_{i,y} \tag{5a}$$

$$D_{a,y} = \sum_{i=1}^{f} \left(1 - P_{i,a,y}\right) S_{i,a,y} E_{i,y} \tag{5b}$$

Catch equation

$$C_{f,a,y} = N_{a,y} \frac{F_{f,a,y}}{Z_{f,a,y}} \left(1 - e^{-Z_{a,y}}\right) \tag{6}$$

Stock recruitment relationships

Beverton & Holt

$$N_{r,y} = \frac{B_{y-r}}{\alpha B_{y-r} + \beta} \tag{7}$$

Growth and maturity

von Bertalanffy

$$N_{r,y} = \frac{B_{y-r}}{\alpha B_{y-r} + \beta} \tag{8}$$

Equilibrium Calculations

Spawner-per-recruit

$$S/R = \sum_{a=r}^{n-1} e^{\sum_{i=r}^{a-1} -F_i - M_i} W_a Q_a + e^{\sum_{i=r}^{n-1} -F_n - M_n} \frac{W_n Q_n}{1 - e_{-F_n - M_n}} \tag{9}$$

Yield-per-recruit

$$Y/R = \sum_{a=r}^{n-1} e^{\sum_{i=r}^{a-1} -F_i - M_i} W_a \frac{F_a}{F_a + M_a} \left(1 - e^{-F_i - M_i}\right) + e^{\sum_{i=r}^{n-1} -F_n - M_n} W_n \frac{F_n}{F_n + M_n} \tag{10}$$

$$R = \frac{aS}{S + b} \tag{11}$$

1.2 Management Procedures

A derivative control rule (D) is so called as the control signal is derived from the trend in the signal, i.e. to the derivative of the error.

$$TAC^1_{y+1} = TAC_y \times \begin{cases} 1 - k_1|\lambda|^\gamma & \text{for} \quad \lambda < 0 \\ 1 + k_2\lambda & \text{for} \quad \lambda \geq 0 \end{cases} \tag{12}$$

where λ is the slope in the regression of $\ln I_y$ against year for the most recent n years and k_1 and k_2 are *gain* parameters and γ actions asymmetry so that decreases in the index do not result in the same relative change as as an increase.

The TAC is then the average of the last TAC and the value output by the HCR.

$$TAC_{y+1} = 0.5 \times \left(TAC_y + C^{\text{targ}}_y\right) \tag{13}$$

Table 2: Derivative MP tunable parameters

Parameter	Symbol	Description	Default
Gain term	k_1	Sets decrease level when stock declines	1.5
Gain term	k_2	Sets increase level when stock increases	3.0
Exponent	γ	Additional decrease control	1

References