

# Equations

Me  
Here

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## Appendix 1

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### Population dynamics

$$N_{a+1,y+1} = N_{a,y}e^{-Z_{a,y}} \quad (1)$$

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

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

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### Mortality rates

$$Z_{a,y} = F_{a,y} + D_{a,y} + M_{a,y} \quad (4)$$

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

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

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### Catch equation

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

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### Stock recruitment relationships

Beverton & Holt

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

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**Growth and maturity**

von Bertalanffy

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

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**Equilibrium Calculations**

Spawner-per-recruit

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

Yield-per-recruit

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

$$R = \frac{aS}{S + b} \quad (11)$$

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