Supplementary Table 1. Key equations used in the operating model to generate age-structured population dynamics, indices of relative abundance, and age composition data.

1. Life history schedules	
E1.1	$l_a = l_\infty \times (1 - e^{(-K(a-t_0))})$
E1.2	$w_a = \theta_1 \times {l_a}^{\theta_2}/1000$
E1.3	$m_a = \frac{1}{1+e^{(-\theta_3(a-a_{50}))}}$
2. Spawner–recruit relationships	
E2.1	$\phi_0 = r_1 m_1 w_1 + \sum_{a=2}^{A-1} e^{-M_{a-1}} r_a m_a w_a + \frac{exp^{-M_{A-1}} r_A m_A w_A}{1-e^{-M_A}}$
E2.2	$R_{y+1} = \frac{0.8 \times R0 \times h \times SSB_y}{0.2 \times R0 \times \phi_0 \times (1-h) + SSB_y \times (h-0.2)}$
3. Initial condition	
E3.1	$Z_{a,1} = Fmult_1 S_{F_a} + M_a$
E3.2	$\Phi_a = \begin{cases} 1 & a = 1 \\ \Phi_{a-1} e^{-Z_{a-1,1}} & 1 < a < A \\ \frac{\Phi_{A-1} e^{-Z_{A-1,1}}}{1-e^{-Z_{A,1}}} & a = A \end{cases}$
E3.3	$\phi_F = \sum_{a=1}^{A} \Phi_a r_a m_a w_a$
E3.4	$R_{eq} = \frac{R0(4h\phi_F - (1-h)\phi_0)}{(5h-1)\phi_F}$
E3.5	$N_{a,1} = R_{eq} \phi_{F_a}$
E3.6	$SSB_1 = \sum_{a=1}^{A} N_{a,1} r_a m_a w_a$
4. Basic abundance dynamics	
E4.1	$N_{1,y} = R_y e^{Rdev_y}$
E4.2	$Z_{a,y} = Fmult_y S_{F_a} + M_a$
E4.3	$N_{a+1,y+1} = N_{a,y} e^{-Z_{a,y}} \quad where\ a < A-1$
E4.4	$N_{A,y+1} = N_{A-1,y} e^{-Z_{A-1,y}} + N_{A,y} e^{-Z_{A,y}}$
E4.5	$SSB_y = \sum_{a=1}^{A} N_{a,y} r_a m_a w_a$
E4.6	$A_y = \sum_{a=1}^{A} N_{a,y}$
E4.7	$B_y = \sum_{a=1}^{A} N_{a,y} w_a$
5. One fleet	
E5.1	$S_{F_a} = \frac{1}{1+e^{-x_1(a-x_2)}}$
E5.2	$L_{a,y} = \frac{Fmult_y S_{F_a}}{Z_{a,y}} N_{a,y}(1 - e^{-Z_{a,y}})$
E5.3	$L_{W_y} = \sum_{a=1}^{A} L_{a,y} w_a$

(*Continued on next page*)

Supplementary Table 1 (*continued*)

6. One survey	
E6.1	$S_{I_a} = \frac{1}{1+e^{-x_3(a-x_4)}}$
E6.2	$q = \frac{1}{mean(\sum_{a=1}^{A} N_{a,y} S_{I_a})}$
E6.3	$I_{a,y} = N_{a,y} S_{I_a}$
E6.4	$I_y = q \sum_{a=1}^{A} I_{a,y}$
7. Time series of *F*	
E7.1	$Fmult_y = f_y e^{fdev_y}$
8. Observed data	
E8.1	$L'_{W_y} = L_{W_y} e^{\varepsilon_{1y}}$
E8.2	$P_{L_{a,y}} = L_{a,y} / \sum_{a=1}^{A} L_{a,y}$
E8.3	$C_{L_{a,y}} \sim Multinomial(\varphi_F, P_{L_{a,y}})$
E8.4	$I'_y = I_y e^{\varepsilon_{2y}}$
E8.5	$P_{I_{a,y}} = I_{a,y} / \sum_{a=1}^{A} I_{a,y}$
E8.6	$C_{I_{a,y}} \sim Multinomial(\varphi_I, P_{I_{a,y}})$