Appendix 17.1 The discrete-time analogue of the continuous-time fishery models examined in Chapter 17

The analysis in the chapter text uses *continuous-time* notation. However, when a spreadsheet is used for dynamic simulation (as in *exploit5.xls*) we necessarily adopt *discrete-time*, as spreadsheets are set up to do calculation recursively in discrete time intervals. Tables 17.7 and 17.8 present discrete-time analogues of the continuous-time equations (with the latter reproduced from Table 17.1 for convenience).

Table 17.7 The fishery models: general function specification

	Continuous-time model	Discrete-time model
Biological growth	$dS/dt = G(S)$	$S_{t+1} - S_t = G(S_t)$
Fishery production function	$H = H(E, S)$	$H_t = H(E_t, S_t)$
Net growth of fish stock	$dS/dt = G(S) - H$	$S_{t+1} - S_t = G(S_t) - H_t$
Fishery costs	$C = C(E)$	$C_t = C(E_t)$
Fishery revenue	$B = PH$, P constant	$B_t = PH_t$, P constant
Fishery profit	$NB = B - C$	$NB_t = B_t - C_t$
FISHING EFFORT DYNAMICS		
Open-access entry rule	$dE/dt = \delta NB$	$E_{t+1} - E_t = \delta NB_t$
Private-property entry rule	$dE/dt = \delta(dNB/dE) \times E$	$E_{t+1} - E_t = \delta(dNB_t/dE_t) \times E$
STEADY-STATE CONDITIONS		
Biological equilibrium	$G = H$	$G_t = H_t$
Economic equilibrium	$E(t) = E^*$	$E_{t+1} = E_t = E^*$

Table 17.8 The fishery models: with assumed functional forms

	Continuous-time model	Discrete-time model
Pure biological growth	$G(S) = g\left(1 - \frac{S}{S_{\text{MAX}}}\right)S$	$S_{t+1} - S_t = g\left(1 - \frac{S_t}{S_{\text{MAX}}}\right)S_t$
Fishery production function	$H = eES$	$H_t = eE_tS_t$
Net growth of fish stock	$G(S) = g\left(1 - \frac{S}{S_{\text{MAX}}}\right)S - H$	$S_{t+1} - S_t = g\left(1 - \frac{S_t}{S_{\text{MAX}}}\right)S_t - H_t$
Fishery costs	$C = wE$	$C_t = wE_t$
Fishery revenue	$B = PH$, P constant	$B_t = PH_t$, P constant
Fishery profit	NB $= B - C = PeES - wE$	NB$_t = B_t - C_t = PeE_tS_t - wE_t$
FISHING EFFORT DYNAMICS		
Open-access entry rule	$dE/dt = \delta\ (PeES - wE)$	$E_{t+1} - E_t = \delta\ (PeE_tS_t - wE_t)$
Private-property entry rule	$dE/dt = \delta\ (dNB/dE) \times E$	$E_{t+1} - E_t = \delta\ (dNB_t/dE_t) \times E_t$