Simple model for HI-WCPO shared stock

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Simple model

- Two zones: Here (1) and There (2).
- Logistic population dynamics Here; unknown population dynamics There.
- Fishing occurs Here
- Emigration from Here to There (T_{12}) and immigration from There to Here (T_{21}).
- Immigrants subject to logistic population constraints.
- Track origins of fish residing Here.

Model Variables

State Variables

N_{11} Fish originating Here and residing Here.

N_{21} Fish originating There and residing Here.

P Proportion local fish Here; ~ 0.9, Wells et al.

Parameters

K Equilibrium population size ("carrying capacity") – unknown assume 1.0

r Instantaneous rate of change – unknown, assume 0.5 yr^{-1}

F Fishing mortality – unknown, assume F_{msy}

T_{12} Emigration rate from Here to There – unknown ~ 0.024, Adam et al.

T_{21} Immigration rate from There to Here – unknown (stochastic time series?)

Model Equations

$$\begin{aligned}\frac{d}{dt}(N_{11}+N_{21}) &= (N_{11}+N_{21})\left[r\left(1-\frac{N_{11}+N_{21}}{K}\right)-F-T_{12}\right]+T_{21} \qquad (1)\\ &= \frac{dN_{11}}{dt}+\frac{dN_{21}}{dt}\end{aligned}$$

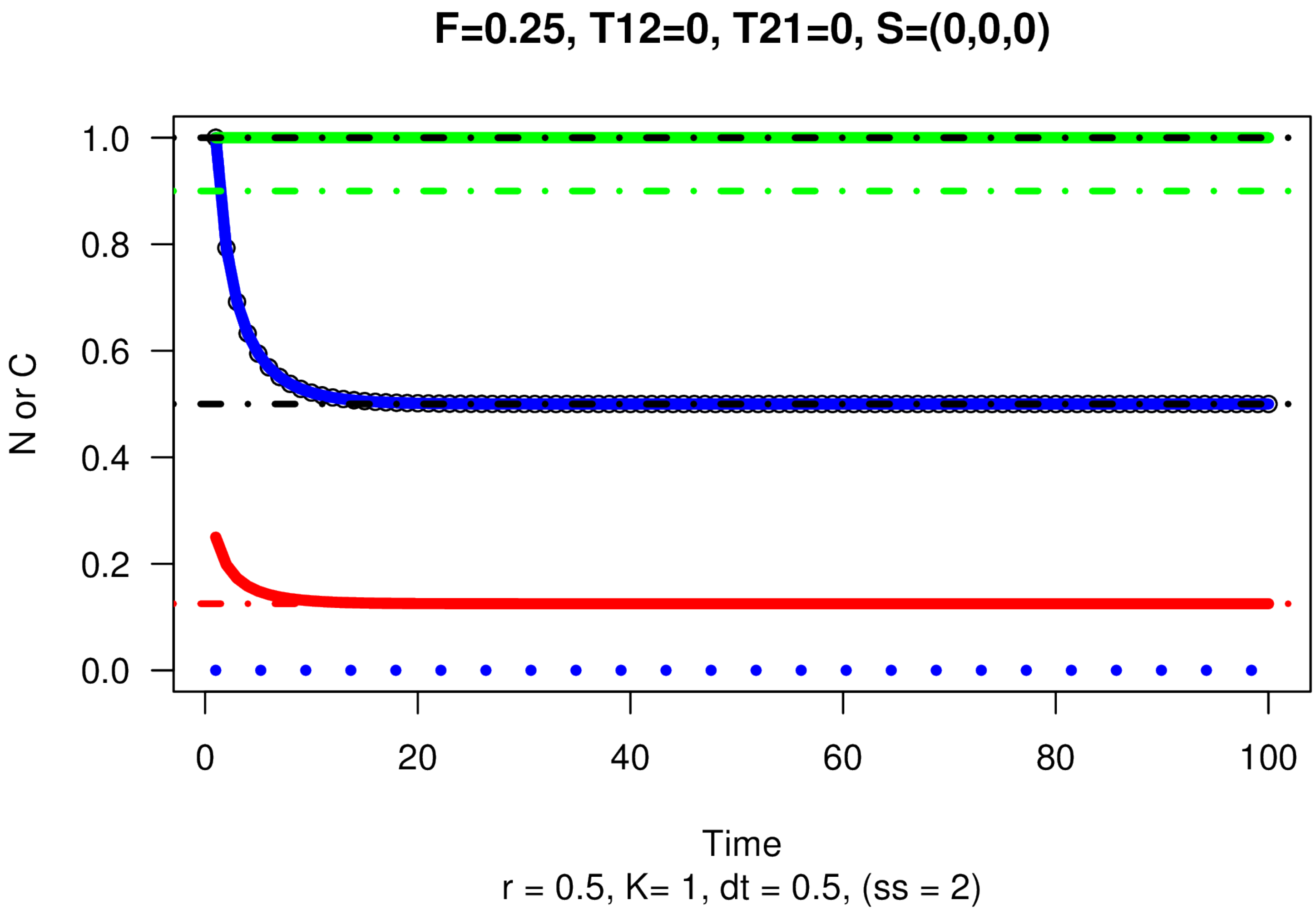
$$\frac{dN_{11}}{dt} = N_{11}\left[r\left(1-\frac{N_{11}}{K}\right)-F-T_{12}\right]-\frac{r}{K}T_{12}N_{11}N_{21} \qquad (2)$$

$$\frac{dN_{21}}{dt} = N_{21}\left[r\left(1-\frac{N_{21}}{K}\right)-F-T_{12}\right]-\frac{r}{K}T_{12}N_{11}N_{21}+T_{21} \qquad (3)$$

$$C = F\cdot(N_{11}+N_{21}) \qquad (4)$$

$$P = \frac{N_{11}}{N_{11}+N_{21}} \qquad (5)$$

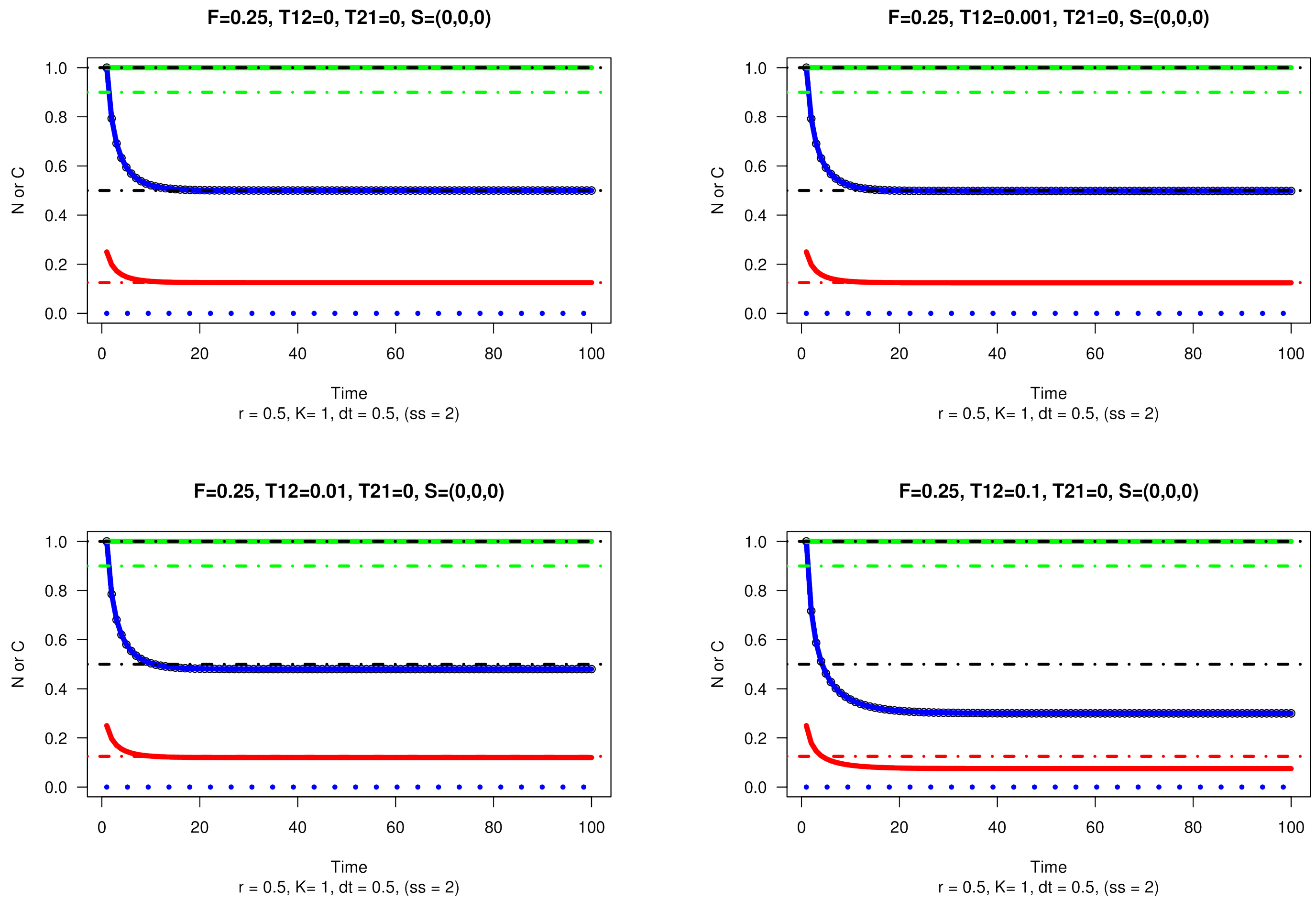
No Transfer



F=0.25, T12=0, T21=0, S=(0,0,0)
1.0
0.8
0.6
0.4
0.2
0.0
N or C
0
20
40
60
80
100
Time
r = 0.5, K= 1, dt = 0.5, (ss = 2)

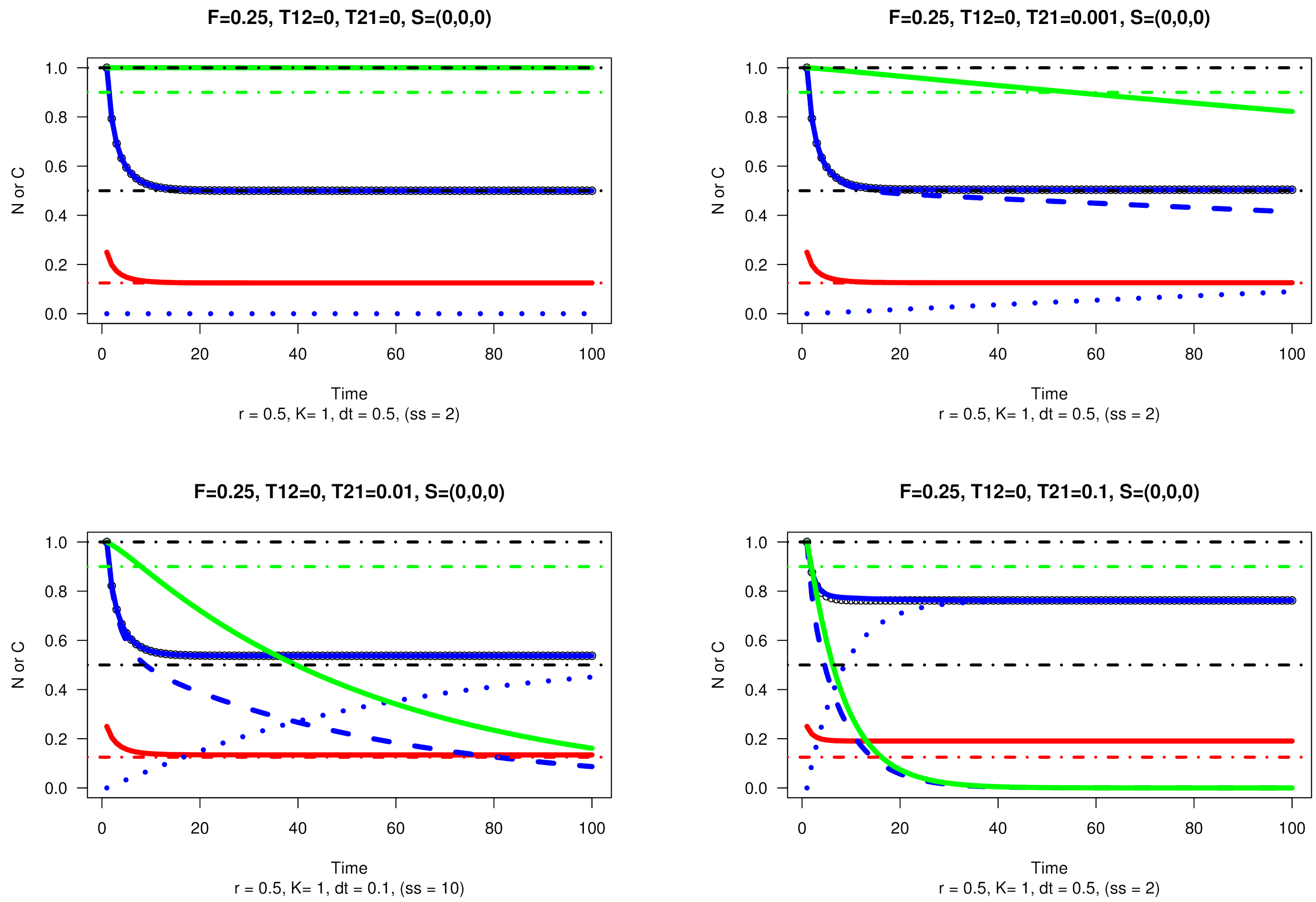
Emigration

Decrease total stock and catch; proportion local unchanged.

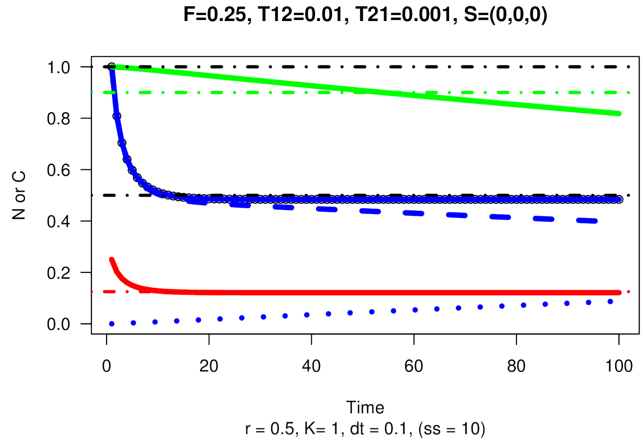


Immigration

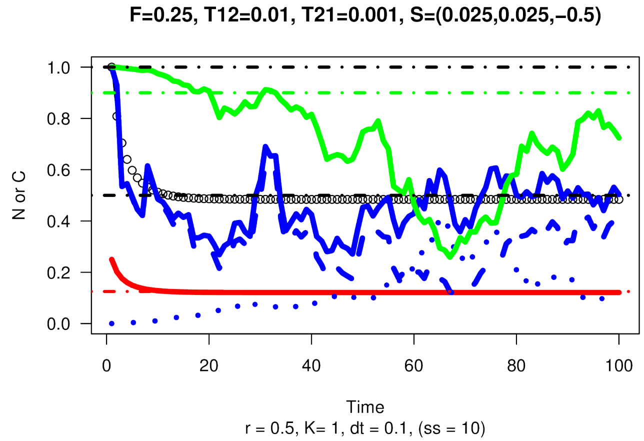
Increase total stock and catch; reduce proportion local.



Emigration, immigration and variability?



Correlated log-normal random errors in N_{11} and N_{21}



Next steps?

Is there a fishery management question here?

Implement state space model

- Complete simulator (state equation) to include autocorrelated process error.
- Find and explore some data.
- Write observation equation.
- Test the model on simulated "data".
- Estimate some parameters.

Zzzzzz ...