# Equilibrium size distribution for terminally-molting (i.e. Tanner) crab

Population states (subscripted by size)

*in*– immature new shell crab (numbers-at-size vector)

*io*– immature old shell crab (numbers-at-size vector)

*mn* – mature new shell crab (numbers-at-size vector)

*mo* – mature old shell crab (numbers-at-size vector)

Population processes (subscripted by size)

*S1* – survival from start of year to time of molting/growth of immature crab (diagonal matrix)

*S2* – survival after time of molting/growth of immature crab to end of year (diagonal matrix)

– probability of an immature crab molting (pr(molt|z), where z is pre-molt size; diagonal matrix)

– probability that a molt is terminal (pr(molt to maturity|z, molt), where z is pre-molt size; diagonal matrix)

*T* – size transition matrix (non-diagonal matrix)

*1* – identity matrix

*R* –number of recruits by size (vector)

In the following, the above (except for the identity matrix and *R*) are subscripted by population state (*in*, *io*, *mn*, *mo*) for generality. In particular, I wonder if survival of immature crab differs between those that molted and those that skipped.

Dynamics

(1)

(2)

(3)

(4)

R above is numbers recruiting-at-size vector (all of which are assumed immature, new shell), “+” indicates year+1.

Equilibrium equations

(6)

(7)

(8)

(9)

R above is equilibrium number of recruits-at-size vector

Equilibrium solution

Rewrite the above equilibrium equations as:

(10)

(11)

(12)

(13)

where *A*, *B*, *C*, *D*, *E*, *F*, *G*, and *H* are square matrices.

Solving for *io* in terms of *in* in eq. 11, one obtains

(14)

Plugging 14 into 10 and solving for *in* yields

(15)

Equations 14 for *io* and 15 for *in* can simply be plugged into eq. 12 to yield *mn* while eq. 13 can then be solved for *mo*, yielding

(16)

where (for completeness):

(17)

(18)

(19)

(20)

(21)

(22)

(23)

(24)