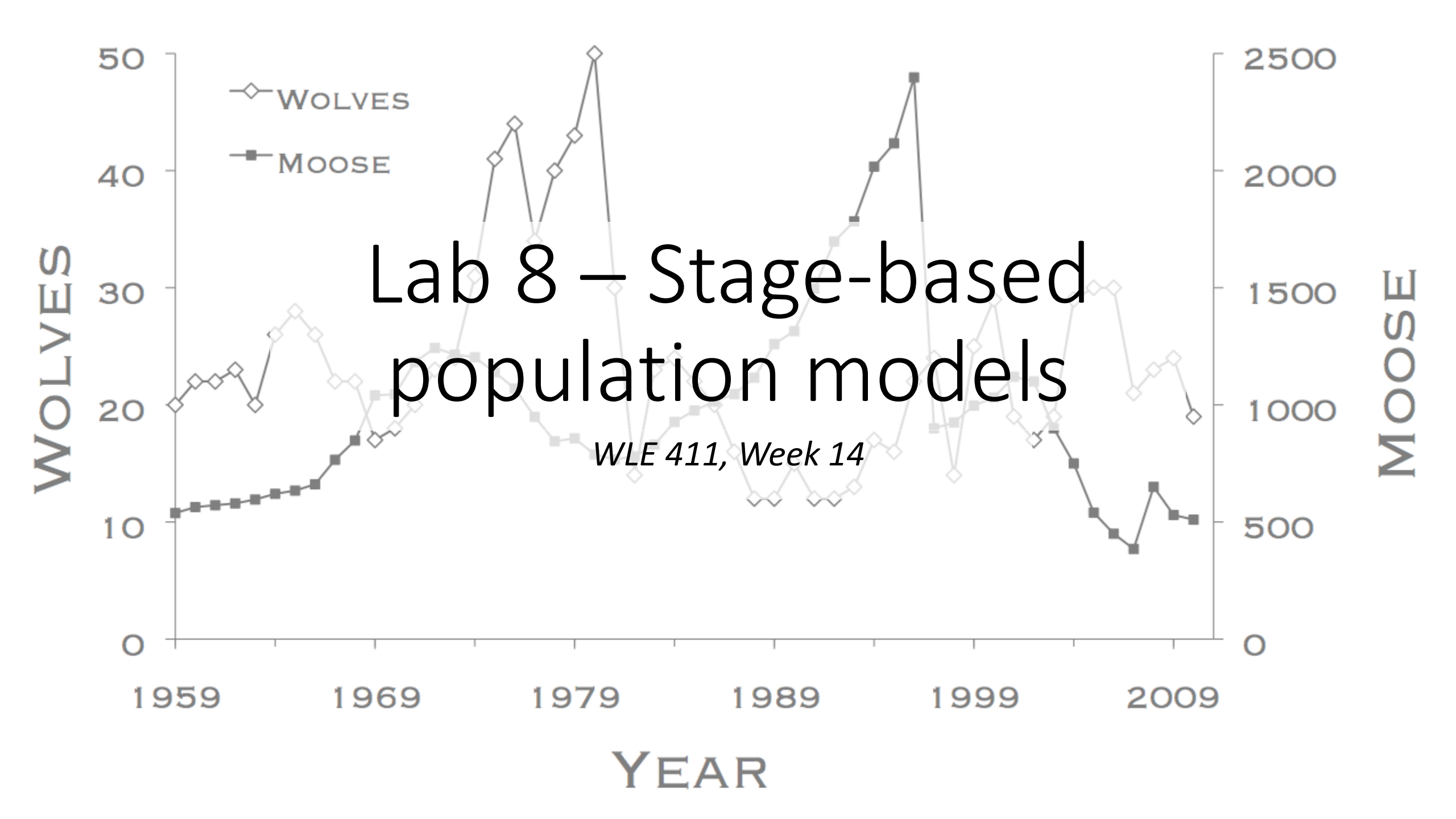
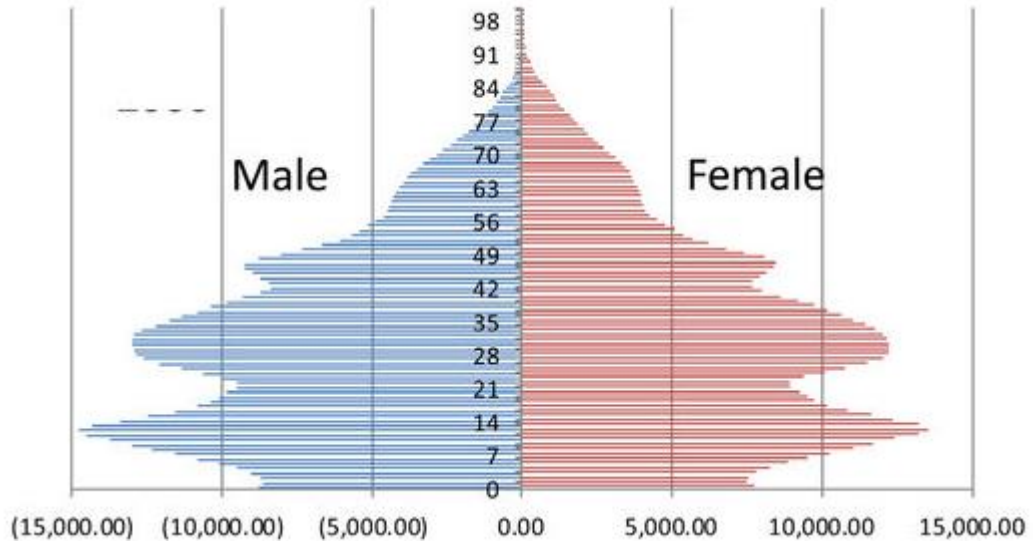


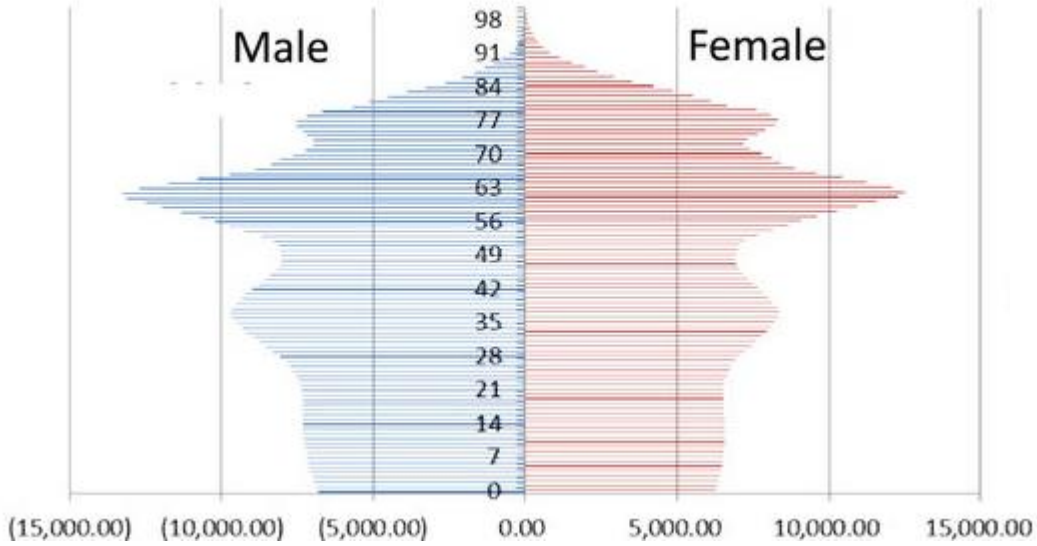
Lab 8 – Stage-based population models

WLE 411, Week 14

Which national population will grow faster?



China (2000)



China (predicted 2050)

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

Three age classes:

- First Year (FY)
- Second Year (SY)
- Adult

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\left[\begin{array}{c|c|c} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{array}\right]$$

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

… add to FY N_{t+1}

… add to SY N_{t+1}

… add to Adult N_{t+1}

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

… add to FY N_{t+1}

… add to SY N_{t+1}

… add to Adult N_{t+1}

Example A: FY population size in N_{t+1} is the sum of FY, SY, and Adult reproduction in N_t

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

… add to FY N_{t+1}

… add to SY N_{t+1}

… add to Adult N_{t+1}

Example B: SY population size in N_{t+1} is equal to FY survival (S_1) times the number of FY individuals in N_t

What would it look like if the first age class wasn't reproductive?

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

… add to FY N_{t+1}

… add to SY N_{t+1}

… add to Adult N_{t+1}

What would it look like if the first age class wasn't reproductive?

Contributions from FY N_t …

Contributions from SY N_t …

Contributions from Adult N_t …

$$\begin{bmatrix} 0 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix}$$

… add to FY N_{t+1}

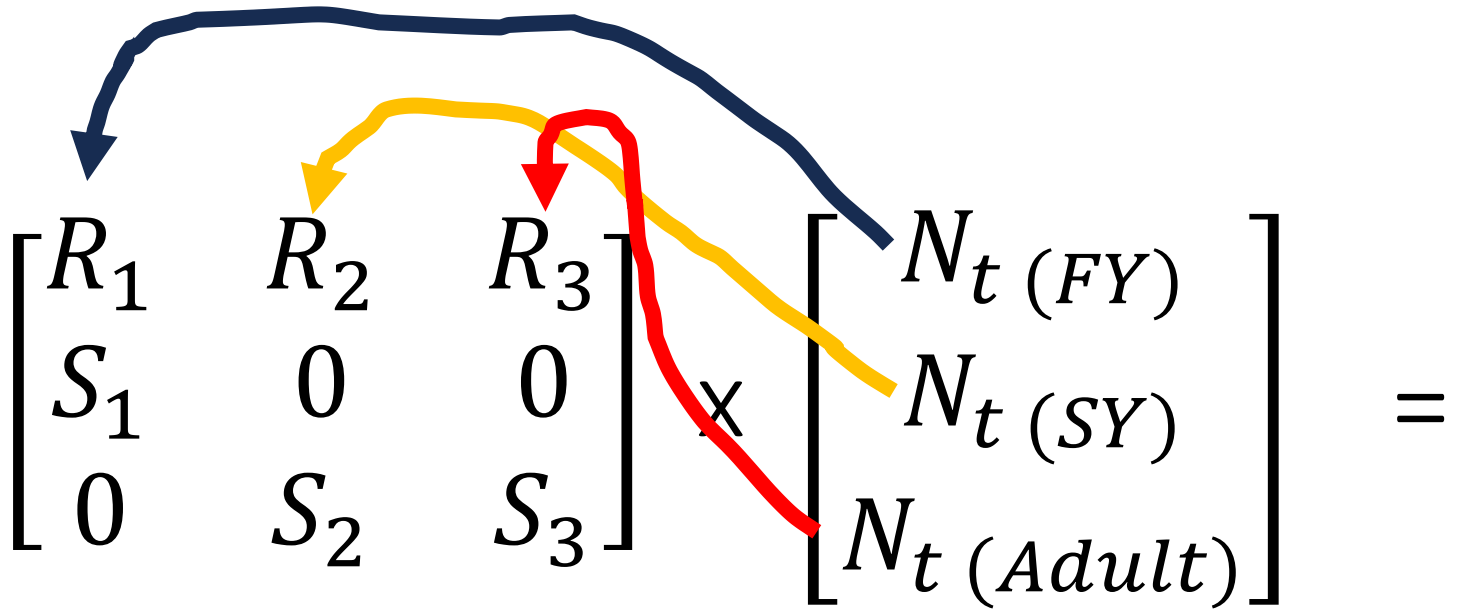
… add to SY N_{t+1}

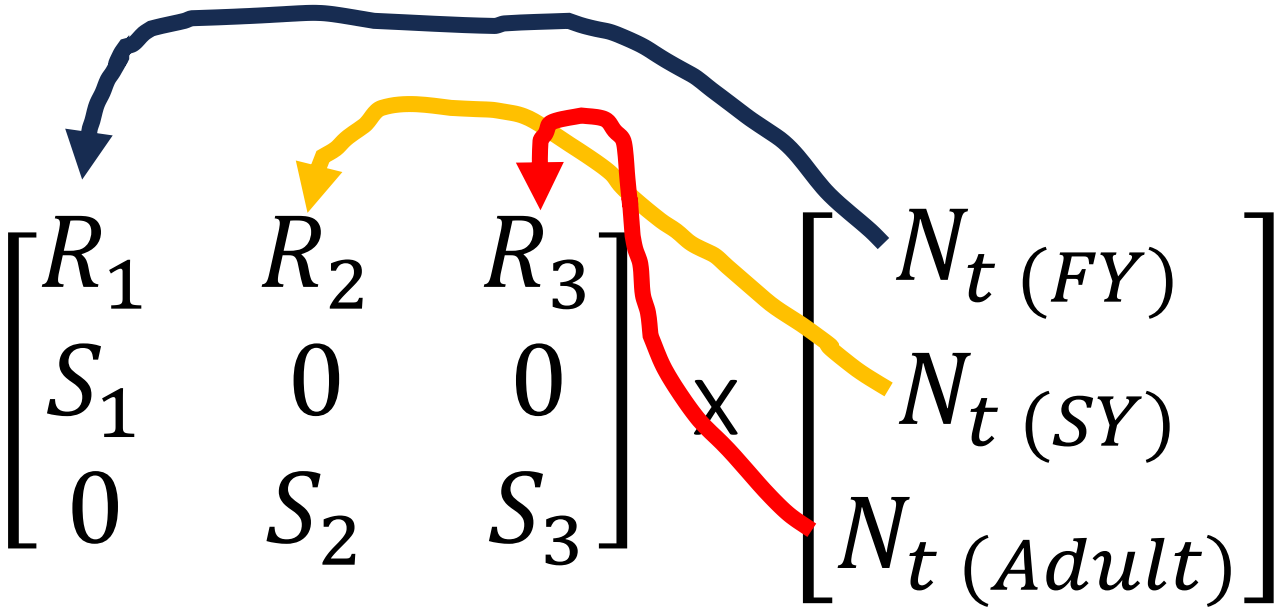
… add to Adult N_{t+1}

Basics of matrix multiplication

$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix} \times \begin{bmatrix} N_{t\,(FY)} \\ N_{t\,(SY)} \\ N_{t\,(Adult)} \end{bmatrix} =$$

Basics of matrix multiplication





$$\begin{bmatrix} R_1 & R_2 & R_3 \\ S_1 & 0 & 0 \\ 0 & S_2 & S_3 \end{bmatrix} \times \begin{bmatrix} N_{t\,(FY)} \\ N_{t\,(SY)} \\ N_{t\,(Adult)} \end{bmatrix} =$$

$$\begin{bmatrix} R_1 * N_{t\,(FY)} & R_2 * N_{t\,(SY)} & R_3 * N_{t\,(Adult)} \\ S_1 * N_{t\,(FY)} & 0 & 0 \\ 0 & S_2 * N_{t\,(SY)} & S_3 * N_{t\,(Adult)} \end{bmatrix}$$

What goes into the *R* term?

- *R*: reproductive contribution from a given age class to the initial age class (which, in our case, is FY)
- To join the FY age class, individuals must do two things:
  - Be born/hatched
  - Survive until the time of the survey
- These two metrics are represented by the symbols *F*, representing fecundity, and S_0, representing initial survival
  - $R_1 = F_1 * S_0$

Final notes

- This lab can be done on Mac computers (doesn’t require MARK)
- Extra credit is available for this lab
  - Translate Part 3 from Excel to R