Problem Set 3

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```r
library(popbio)
library(popdemo)
```

```
## Welcome to popdemo! This is version 1.3-0
## Use ?popdemo for an intro, or browseVignettes('popdemo') for vignettes
## Citation for popdemo is here: doi.org/10.1111/j.2041-210X.2012.00222.x
## Development and legacy versions are here: github.com/iainmstott/popdemo
```

```r
load("COMADRE_v.4.20.9.0.rdata")
```

1) What species (and location if available) did you choose? Why did you choose the species?

We chose the peregrine falcon population studied in Capetown, South Africa. As both team members were familiar with peregrine falcons and their conservation history in the U.S, they thought it would be interesting to study effect of introducing nestboxes to peregrine falcon and determining their effect on population status.

2) What question do you want to answer about this population (e.g. population status, best management strategies)?

Are nestboxes an effective strategy to increase Peregrine Falcon population in the Cape region of South Africa? If nest boxes were an effective strategy, we would expect to see a higher proportion of Subadults and Breeders age classes in the stable distribution of the "nestbox" population as compared to the natural breeding population.

3) Calculate eigenvalue, stable age distribution, elasticity, and sensitivity. What does this tell you about the population?

```r
# Calculations for Nestbox Data:

comadre$mat[[835]]$matA #835 is 1997-2010 for Nestbox data
```

```
##             A1       A2       A3       A4       A5
## [1,] 0.000000 0.394491 0.588316 0.904475 0.904475
## [2,] 0.297347 0.000000 0.000000 0.000000 0.000000
## [3,] 0.000000 0.344396 0.000000 0.000000 0.000000
```

```
## [4,] 0.000000 0.000000 0.000000 0.000000 0.000000
## [5,] 0.000000 0.371604 0.659448 0.852000 0.852000
```

```
lambdaVal_nestbox <-eigs(comadre$mat[[835]]$matA, what="lambda") #dominant eigenvalue
#   -0.14969159346691008 for other lambda value
rightVal_nestbox <-eigs(comadre$mat[[835]]$matA, what="ss") #eigen vector (aka stable age distribution)


sense<-sensitivity(comadre$mat[[835]]$matA)
elast<-elasticity(comadre$mat[[835]]$matA)
#Sensitivity-
```

```
# Calculations for Unmanipulated Data:

comadre$mat[[849]]$matA #849 is 1997-2010 for unmanipulated data data
```

```
##            A1       A2       A3       A4       A5
## [1,] 0.000000 0.193384 0.343178 0.443383 0.443383
## [2,] 0.225096 0.000000 0.000000 0.000000 0.000000
## [3,] 0.000000 0.344396 0.000000 0.000000 0.000000
## [4,] 0.000000 0.000000 0.192552 0.000000 0.000000
## [5,] 0.000000 0.371604 0.659448 0.852000 0.852000
```

```
lambdaVal_unmanipulated <-eigs(comadre$mat[[849]]$matA, what="lambda") #eigenvalue

rightVal_unmanipulated <-eigs(comadre$mat[[849]]$matA, what="ss") #eigen vector (aka stable age distrib

sense2<-sensitivity(comadre$mat[[849]]$matA)
elast2<-elasticity(comadre$mat[[849]]$matA)
```

Eigenvalues for nestboxes and unmanipulated populations were 1.03127, and 0.9368. The stable age distributions, or right eigenvector, are shown below:

```
rightVal_nestbox
```

```
## [1] 0.42800402 0.12340563 0.04121133 0.00000000 0.40737901
```

```
rightVal_unmanipulated
```

```
## [1] 0.305964927 0.073515638 0.027025774 0.005554775 0.587938887
```

```
sum(rightVal_nestbox[2:5])
```

```
## [1] 0.571996
```

```
sum(rightVal_unmanipulated[2:5])
```

```
## [1] 0.6940351
```

```
sense #nestbox
```

```
##             A1         A2         A3 A4        A5
## [1,] 0.1395188 0.04022721 0.01343388  0 0.1327956
## [2,] 0.4838889 0.13951881 0.04659233  0 0.4605708
## [3,] 0.5296848 0.15272307 0.05100189  0 0.5041599
## [4,] 0.7038796 0.20294835 0.06777463  0 0.6699605
## [5,] 0.7038796 0.20294835 0.06777463  0 0.6699605
```

```
sense2 #unmanipulated
```

```
##               A1          A2           A3           A4         A5
```

```
## [1,] 0.07942162 0.01908301 0.007015284 0.001441895 0.1526157
## [2,] 0.33054507 0.07942162 0.029196929 0.006001026 0.6351718
## [3,] 0.40663138 0.09770324 0.035917606 0.007382369 0.7813785
## [4,] 0.41512648 0.09974440 0.036667975 0.007536597 0.7977025
## [5,] 0.41512648 0.09974440 0.036667975 0.007536597 0.7977025
```

```
elast #nestbox
```

```
##             A1         A2          A3 A4        A5
## [1,] 0.0000000 0.01538794 0.007663652  0 0.1164672
## [2,] 0.1395188 0.00000000 0.000000000  0 0.0000000
## [3,] 0.0000000 0.05100189 0.000000000  0 0.0000000
## [4,] 0.0000000 0.00000000 0.000000000  0 0.0000000
## [5,] 0.0000000 0.07312897 0.043338243  0 0.5534933
```

```
elast2 #unmanipulated
```

```
##              A1          A2          A3           A4         A5
## [1,] 0.00000000 0.003939197 0.002569834 0.0006824219 0.07223017
## [2,] 0.07942162 0.000000000 0.000000000 0.0000000000 0.00000000
## [3,] 0.00000000 0.035917606 0.000000000 0.0000000000 0.00000000
## [4,] 0.00000000 0.000000000 0.007536597 0.0000000000 0.00000000
## [5,] 0.00000000 0.039564821 0.025811176 0.0068541747 0.72547238
```

4) Using the calculations in part (c), or additional calculations, address the question you proposed in part (b).

If the end goal ultimately is to increase the population of Peregrine Falcons in the Cape region, nestboxes can be an effective or ineffective strategy depending on what other strategies you plan to use in conjunction with them.

If the singular goal is to increase the breeding population (ie Subadult 1-3 and Breeders) of Peregrine Falcons in the Cape region, nestboxes are not an effective strategy. When compared to natural breeding populations (read "unmanipulated"), the stable distribution of the nestbox population has a higher proportion of juveniles (non-breeding) as compared to the natural population. Additionally, the natural population has both a higher proportion of Breeders (the group with the highest fecundity) and a higher proportion of all age classes with a fecundity rate of >0, as compared to the nestbox population. This means that dynamics within the natural population facilitate a larger percentage of individuals reaching sexual maturity which is most important for a functional population and the long-term survival of the species.

If additional interventions were used, such as captive rearing of young, nestboxes could be an effective strategy to support increased breeding by wild populations. Captive rearing as an additional intervention paired with nestboxes could help address the limited progression through the upper age classes seen in the nestbox population stable age distribution.

We are unclear about what the sensitivity and elasticity mean for manipulating Peregrine Falcon populations through intervention. Based on our understanding of sensitivity (and elasticity), if you change a single vital rate in the Leslie Matrix by a small absolute amount (or percentage amount), the resulting eigenvalue will change by a factor of the amount listed in the sensitivity or elasticity matrix. So in the case of the sense matrix, if we were to change the value comadre*mat*[[835]]matA[1,1] by a small amount, then the eigenvalue would change by a factor of 0.1395188 (NOTE: I edited the code here to have in-line code display the calculation. This has the advantage of not needing to write out the number in the text.). Because 0.1395188 is less than 1, then, any small change to the vital value in comadre*mat*[[835]]matA[1,1] will lead to a decrease in the eigenvalue.

We are unclear about what this means for manipulating vital rates in Peregrine Falcon populations because, since all the values in our sensitivity and elasticity matrices are equal to 0 or are less than 1, any manipulation of vital rates would either result in an unchanged or a decreased eigenvalue. This suggests that any change in vital rates would ultimately decrease the population of Peregrine Falcons.

```
my_mat <- comadre$mat[[835]]$matA

original_lamda <- as.numeric(eigen(my_mat)$values[1])

my_mat[2,1] = 2*my_mat[2,1]

experimental_lamda <-as.numeric(eigen(my_mat)$values[1])
```

We discussed this in class a bit, but the sensitivity only deals with small changes in a parameter and its effect on lambda. Another approach instead of sensitivity would be to simply increase a parameter in the matrix and see how this affects the eigenvalue. For example, if we double the parameter in the second row, first column of A, this increases the eigenvalue from 1.0312796 to 1.1572701.

10/10 Good job overall on this assignment. I thought it was really cool that you found a study with a nest box manipulation. Note that you can use various code chunk options (e.g., ‘echo=F‘ or ‘messages=F‘) to clean up outputs of thee code.