StructuredPoplations

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This is how you can access the data on Westslope cutthroat trout including how to access the paper

```
load("COMADRE_v.3.0.0.RData")
 comadre$metadata[134,]
```

```
##                            SpeciesAuthor
## 134 Oncorhynchus_clarkii_subsp._lewisi_2
##                         SpeciesAccepted                CommonName
## 134 Oncorhynchus clarkii subsp. lewisi Westslope cutthroat trout
##            Genus     Family         Order          Class   Phylum  Kingdom
## 134 Oncorhynchus Salmonidae Salmoniformes Actinopterygii Chordata Animalia
##       OrganismType DicotMonoc AngioGymno          Authors
## 134 Actinopterygii       <NA>       <NA> Spromberg; Birge
##                   Journal YearPublication         DOI.ISBN AdditionalSource
## 134 Environ Toxicol Chem            2005 10.1897/04-160.1             <NA>
##     StudyDuration StudyStart StudyEnd ProjectionInterval NumberPopulations
## 134          <NA>       <NA>     <NA>              FRANK              <NA>
##     MatrixCriteriaSize MatrixCriteriaOntogeny MatrixCriteriaAge
## 134                 No                    Yes               Yes
##     MatrixPopulation Lat Lon Altitude Country Continent Ecoregion
## 134             <NA>  NA  NA     <NA>    <NA>      <NA>      <NA>
##     StudiedSex MatrixComposite MatrixTreatment MatrixCaptivity
## 134          F          Pooled   Unmanipulated            <NA>
##     MatrixStartYear MatrixStartSeason MatrixStartMonth MatrixEndYear
## 134            <NA>              <NA>             <NA>          <NA>
##     MatrixEndSeason MatrixEndMonth MatrixSplit MatrixFec
## 134            <NA>           <NA>     Divided       Yes
##
## 134 FRANK; Data from literature, standardized elements to allow comparisons,  two species used to co
##     MatrixDimension SurvivalIssue
## 134               4          0.25
```

HW Assignment 3

1. I chose to study westslope cutthroat trout. I wanted to study trout species because I have experience studying trout life stages and was excited to give some of the observations I have made in the field some mathmatical context.
2. Does toxicity affect cutthroat trout differently according to age class?
3.

```
# get the matrix from the data from the cutthroat trout data
matrix <- comadre$mat[134][[1]]$matA
#this gives us our eigen values and vectors
eigen(comadre$mat[134][[1]]$matA)
```

```
## eigen() decomposition
## $values
## [1]  1.0864401+0.0000000i -0.0364845+0.9762419i -0.0364845-0.9762419i
## [4] -0.8634711+0.0000000i
##
## $vectors
##                  [,1]                       [,2]                       [,3]
## [1,] -0.998882798+0i -0.998601986+0.000000000i -0.998601986+0.000000000i
## [2,] -0.045970450+0i  0.001908754+0.051073876i  0.001908754-0.051073876i
## [3,] -0.010578229+0i  0.013042721-0.000976239i  0.013042721+0.000976239i
## [4,] -0.002824054+0i -0.000856759-0.003176372i -0.000856759+0.003176372i
##                  [,4]
## [1,] -0.998179351+0i
## [2,]  0.057800393+0i
## [3,] -0.016734896+0i
## [4,]  0.004128114+0i
```

```
#get the first eigen vector
eigen(comadre$mat[134][[1]]$matA)
```

```
## eigen() decomposition
## $values
## [1]  1.0864401+0.0000000i -0.0364845+0.9762419i -0.0364845-0.9762419i
## [4] -0.8634711+0.0000000i
##
## $vectors
##                  [,1]                       [,2]                       [,3]
## [1,] -0.998882798+0i -0.998601986+0.000000000i -0.998601986+0.000000000i
## [2,] -0.045970450+0i  0.001908754+0.051073876i  0.001908754-0.051073876i
## [3,] -0.010578229+0i  0.013042721-0.000976239i  0.013042721+0.000976239i
## [4,] -0.002824054+0i -0.000856759-0.003176372i -0.000856759+0.003176372i
##                  [,4]
## [1,] -0.998179351+0i
## [2,]  0.057800393+0i
## [3,] -0.016734896+0i
## [4,]  0.004128114+0i
```

```
eigen1 <- (eigen(comadre$mat[134][[1]]$matA))
#sum the vector 1
sum(eigen1$vector[,1])
```

```
## [1] -1.058256+0i
```

3. I used the eigenvector associated with the dominant eigen value (1.09) to calculate the stable age distribution. To do this, take the sum of the eigen vector and then create a proportion associated with each age class.

```
 eigen1$vector[,1]/sum(eigen1$vector[,1])
```

```
## [1] 0.943895656+0i 0.043439839+0i 0.009995912+0i 0.002668594+0i
```

This means that ~94% of the population is held in stage one- "YOY" young of year trout, and then the age distrubution decreases as the age classes get older.

3: Calculating Elacticity

Use the popbio package in R to calculate elasticity which assess the effect of a proportional change in lambda.

```
library(popbio)
elasticity(matrix)
```

```
##            A1       A2         A3         A4
## [1,] 0.000000 0.000000 0.05615297 0.19988098
## [2,] 0.256034 0.000000 0.00000000 0.00000000
## [3,] 0.000000 0.256034 0.00000000 0.00000000
## [4,] 0.000000 0.000000 0.19988098 0.03201715
```

add here what elasticity means

3: Calculating Sensitivity- which refers to the rate of change of the eigen values in the context of the rest of the matrix.

```
sensitivity(matrix)
```

```
##             A1         A2          A3           A4
## [1,]  0.256034 0.01178316 0.002711415 0.0007238624
## [2,]  5.563311 0.25603395 0.058915801 0.0157286624
## [3,] 24.176817 1.11266222 0.256033954 0.0683529983
## [4,] 82.023598 3.77487898 0.868634862 0.2318981382
```

This calculation reveals that changes to the number of YOY individuals exerts the largest change on the eigen value.

Notes about Git note: clone the folder git add git commit 'changes we comited' git status git remote add origin (get origin from the website) git push origin master