vulture_megamatrix_example.R

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```
# MATRIX POPULATION MODEL FOR AFRICAN WHITE BACKED VULTURES
```

```
# useful link http://www.mbr-pwrc.usgs.gov/workshops/uf2016/

# clean everything first
rm(list=ls())

# load required packages
library(popbio)
library(diagram)
```

```
## Loading required package: shape
```

```
# PARAMETERS
```

```
# fecundity calculation, (Gauthier & Lebreton (2004) Population models for Greater Snow Geese)
bp <- 0.85 # breeding propensity
cs <- 1 # clutch size
hs <- 0.76 # hatching success
fs <- 0.6 # fledging success
f1 <- bp * (cs/2) * hs * fs # divide by 2 to get females only

# survival
s0 <- 0.42 # first year survival # this value should probably be modified to account for
# lower adult survival in KZN
s1Kr <- 0.82 # juvenile survival Kruger
s2Kr <- 0.89 # subadult survival Kruger
s3Kr <- 1.0 # adult survival Kruger
```

```
# KRUGER PRE-BREEDING CENSUS
```

```
MKrpre <- c(0,0,0,0,s0*f1,
          s1Kr,0,0,0,0,
          0,s1Kr,0,0,0,
          0,0,s2Kr,0,0,
          0,0,0,s2Kr,s3Kr)
MKrpre <- matrix ((MKrpre), ncol=5, byrow = TRUE)

# previous function is wrapped up into pop.projection
popKrugerPre<-eigen.analysis(MKrpre, zero=TRUE)
popKrugerPre$lambda1
```

```
## [1] 1.037427
```

```
# KZN SURVIVAL RATES
```

```
s1Kz <-  0.86 # juvenile survival KZN
s2Kz <- 0.51 # subadult survival KZN
s3Kz <- 0.57 # adult survival KZN
```

```
# KZN PRE-BREEDING CENSUS
```

```
MKZpre <- c(0,0,0,0,s0*f1,
          s1Kz,0,0,0,0,
          0,s1Kz,0,0,0,
          0,0,s2Kz,0,0,
          0,0,0,s2Kz,s3Kz)
MKZpre <- matrix ((MKZpre), ncol=5, byrow = TRUE)

# previous function is wrapped up into pop.projection
popKZPre<-eigen.analysis(MKZpre, zero=TRUE)
popKZPre$lambda1
```

```
## [1] 0.6550459
```

```
# MEGAMATRIX TEST FOR AGE-SPECIFIC EMIGRATION/IMMIGRATION
```

```
# Effective migration rates (dispersal * stage-specific survival)
gb0 <- 0.05 # These are the values I'm querying
bg0 <- 0.05 # # These are the values I'm querying
gb <- 0.02 # Disperal from Kruger to KZN
bg <- 0.02 # Disperal from KZN to Kruger
gbA <- 0.05
bgA <- 0.05
# resight proportions from data
# Kruger origin birds - 75 within 701 outside ~ 10% stay within the park
# KZN origin birds - 22 within 201 outside ~ 10% stay within KZN

Amig <- matrix(c(
  0,  0,  0,  0,  s0*(1-gb0)*f1,  0,  0,  0,  0, s0*bg0,
  s1Kr*(1-gb), 0, 0, 0, 0, s1Kz*bg, 0, 0, 0, 0,
  0, s1Kr*(1-gb), 0, 0, 0, 0, s1Kz*bg, 0, 0, 0,
  0, 0, s2Kr*(1-gb), 0, 0, 0, 0, s2Kz*bg, 0, 0,
  0, 0, 0, s2Kr*(1-gb), s3Kr*(1-gbA), 0, 0, 0, s2Kz*bg, s3Kz*bgA,
  0, 0, 0, 0, 0, 0, 0, 0, 0, s0*(1-bg0)*f1,
  s1Kr*gb, 0, 0, 0, s0*gb0, s1Kz*(1-bg), 0, 0, 0, 0,
  0, s1Kr*gb, 0, 0, 0, 0, s1Kz*(1-bg), 0, 0, 0,
  0, 0, s2Kr*gb, 0, 0, 0, 0, s2Kz*(1-bg), 0, 0,
  0, 0, 0, s2Kr*gb, s3Kr*gbA, 0, 0, 0, s2Kz*(1-bg), s3Kz*(1-bgA)), nrow = 10, byrow = TRUE)

Amig
```

```
##         [,1]   [,2]   [,3]   [,4]      [,5]   [,6]   [,7]   [,8]   [,9]
##  [1,] 0.0000 0.0000 0.0000 0.0000 0.0773262 0.0000 0.0000 0.0000 0.0000
##  [2,] 0.8036 0.0000 0.0000 0.0000 0.0000000 0.0172 0.0000 0.0000 0.0000
##  [3,] 0.0000 0.8036 0.0000 0.0000 0.0000000 0.0000 0.0172 0.0000 0.0000
##  [4,] 0.0000 0.0000 0.8722 0.0000 0.0000000 0.0000 0.0000 0.0102 0.0000
##  [5,] 0.0000 0.0000 0.0000 0.8722 0.9500000 0.0000 0.0000 0.0000 0.0102
##  [6,] 0.0000 0.0000 0.0000 0.0000 0.0000000 0.0000 0.0000 0.0000 0.0000
##  [7,] 0.0164 0.0000 0.0000 0.0000 0.0210000 0.8428 0.0000 0.0000 0.0000
##  [8,] 0.0000 0.0164 0.0000 0.0000 0.0000000 0.0000 0.8428 0.0000 0.0000
##  [9,] 0.0000 0.0000 0.0178 0.0000 0.0000000 0.0000 0.0000 0.4998 0.0000
## [10,] 0.0000 0.0000 0.0000 0.0178 0.0500000 0.0000 0.0000 0.0000 0.4998
##           [,10]
##  [1,] 0.0210000
```

```
##  [2,] 0.0000000
##  [3,] 0.0000000
##  [4,] 0.0000000
##  [5,] 0.0285000
##  [6,] 0.0773262
##  [7,] 0.0000000
##  [8,] 0.0000000
##  [9,] 0.0000000
## [10,] 0.5415000
```

```
lambda(Amig)
```

```
## [1] 0.9947176
```