[5] studbookR: Population projection

Frank PG Princee

Draft 2016-12-29

Introduction

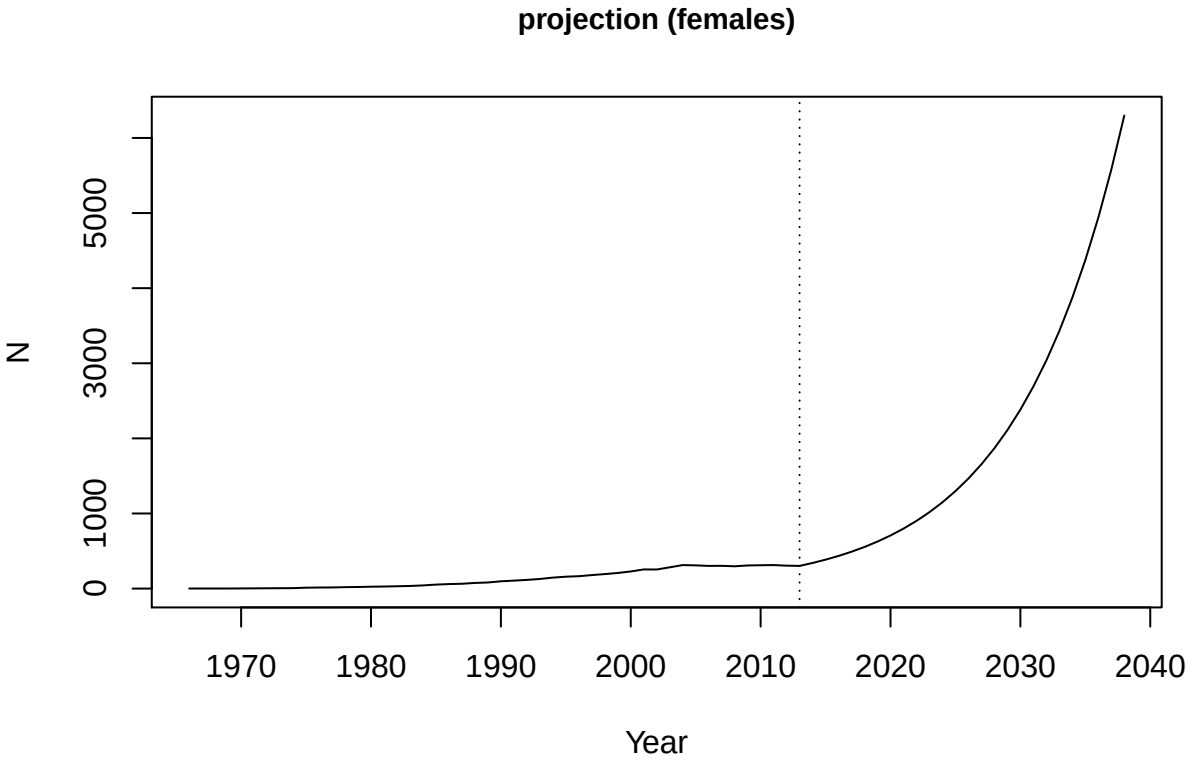
The following population projections are supported:

- Annual growth rate and census data
- Time series on census data
- Leslie matrix (deterministic and stochastic)

Projection from census

```
projection.census(sex='female')
```

```
## idx: 2
##             MEAN    LOWER    UPPER
## FEMALES 1.129188 1.080246 1.180346
```

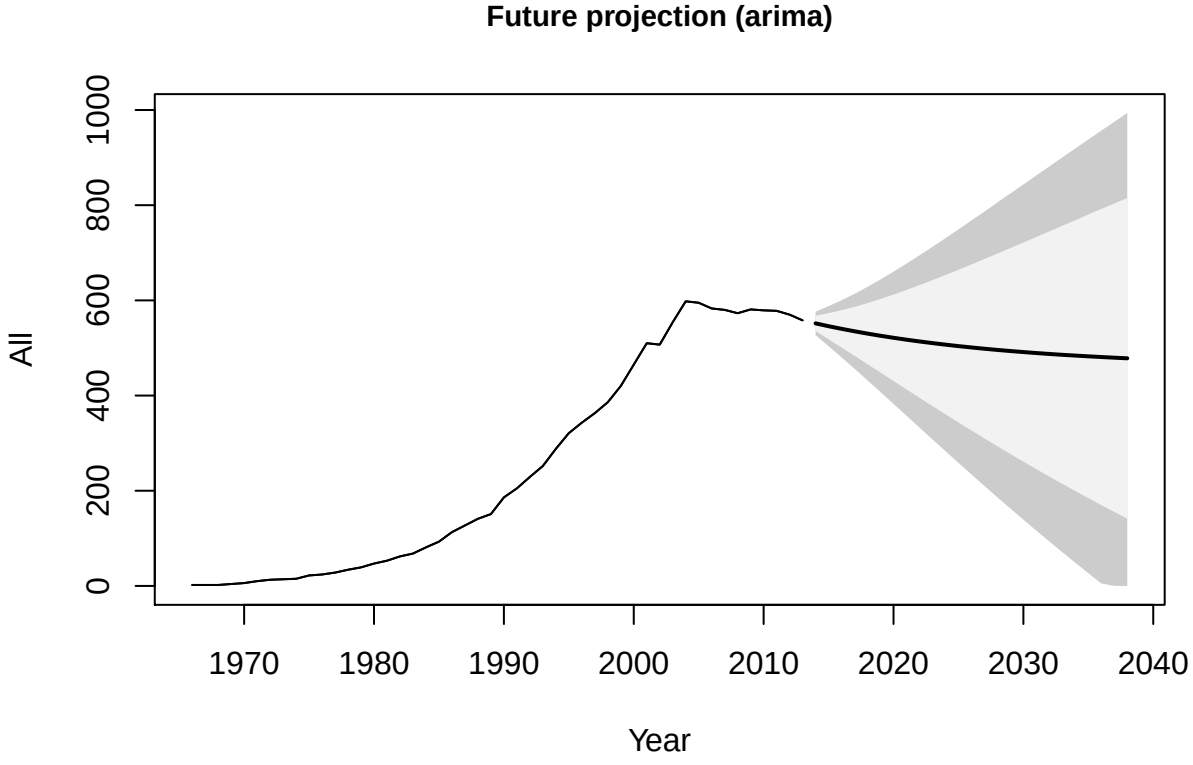


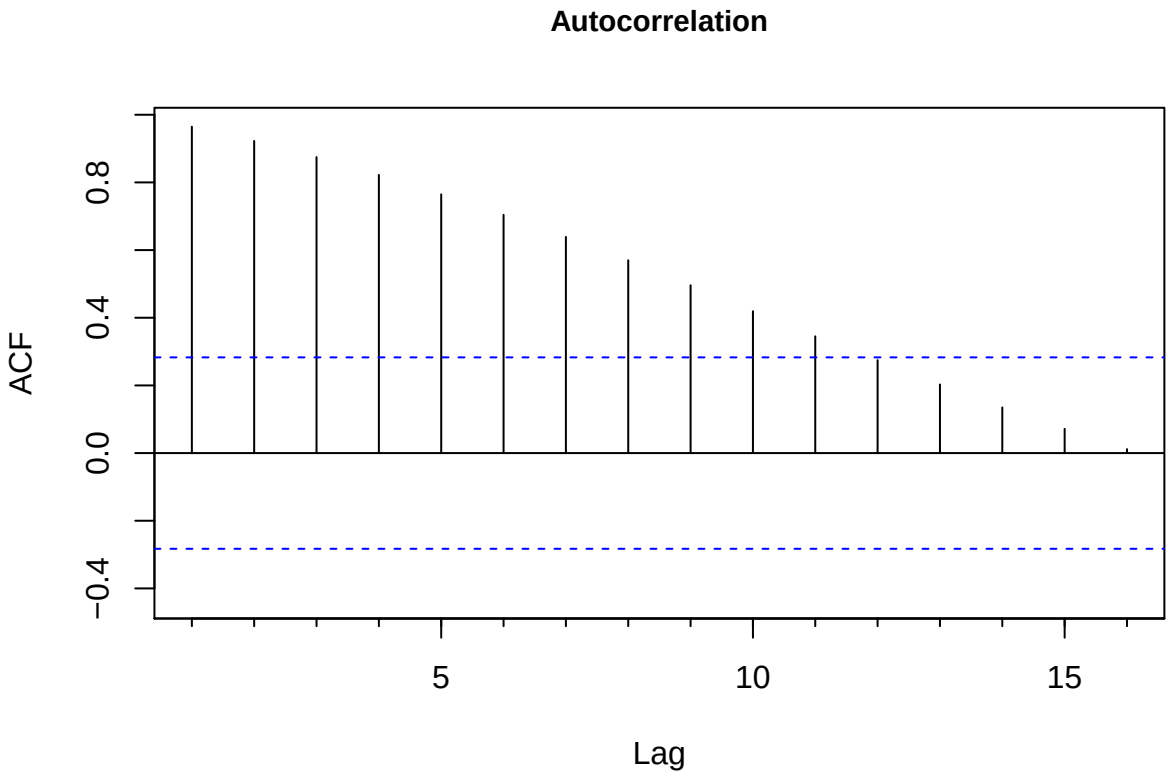

```
## [1] FALSE
```

Time series projection

```
projection.arima(sex='all')
```

```
## ================================================
## Time series analysis of ALL
## ================================================
##
## Series: window(census.ts[, sex], start = first, end = last)
## ARIMA(1,1,1)
##
## Coefficients:
##          ar1      ma1
##       0.9356  -0.5536
## s.e.  0.0508   0.1335
##
## sigma^2 estimated as 157.8:  log likelihood=-185.1
## AIC=376.21   AICc=376.77   BIC=381.76
##
## [Forecast accuracy]
##                     ME     RMSE     MAE      MPE     MAPE      MASE
## Training set 1.371735 12.16301 7.71616 3.811571 5.858797 0.5511543
##                     ACF1
## Training set 0.04178928
## ------------------------------------------------
## ME  : mean error                        RMSE: root mean squared error
## MAE : mean absolute error               MPE : mean percentage error
## MAPE: mean absolute percentage error    MASE: mean absolute scaled error
## ACF1: autocorrelation at lag 1
```





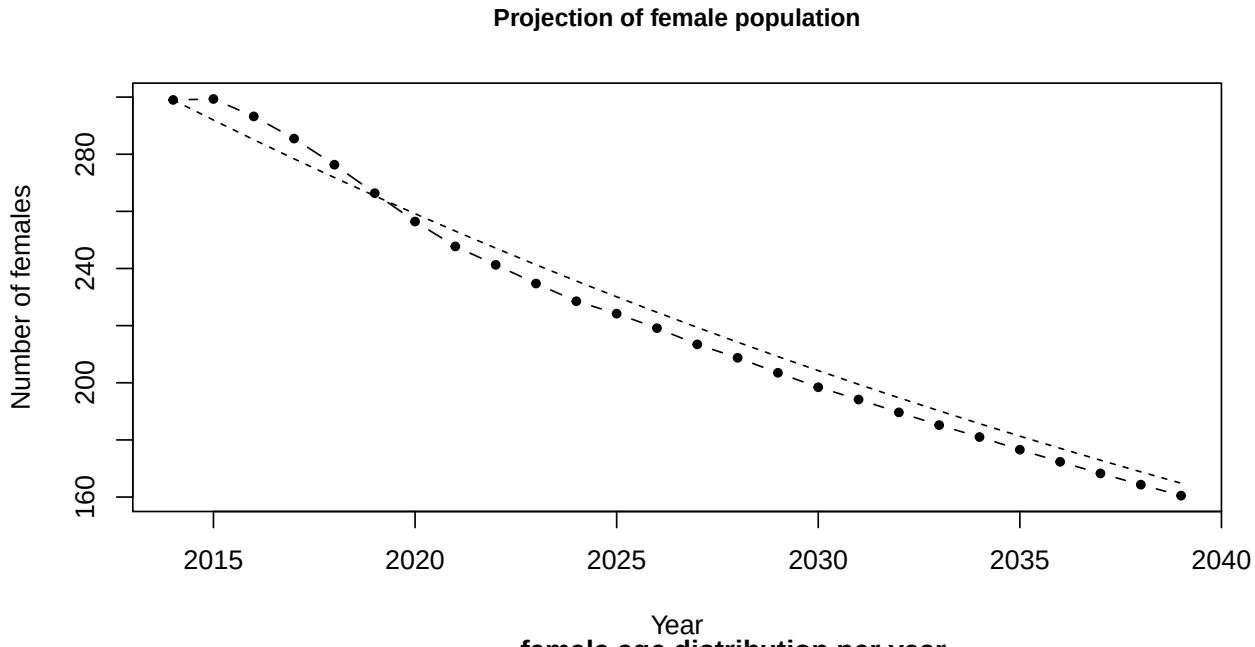
Leslie matrix

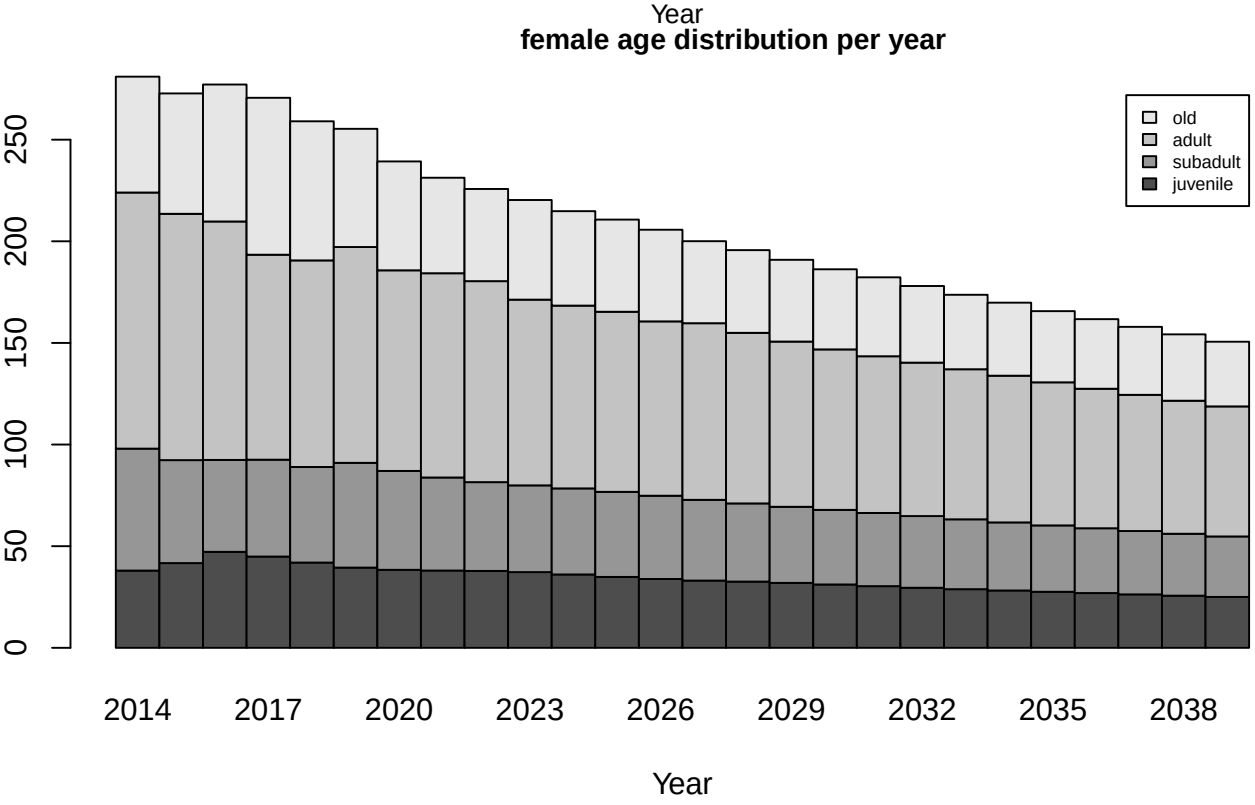
The R package `popbio` is used to project population size using the *Leslie matrix*. This package includes conversions of the *Matlab* source that is used in Matrix Population Models by Hal Caswell (Caswell, 2001). The function `projection.leslie()` is a wrapper around functions in `popbio`.

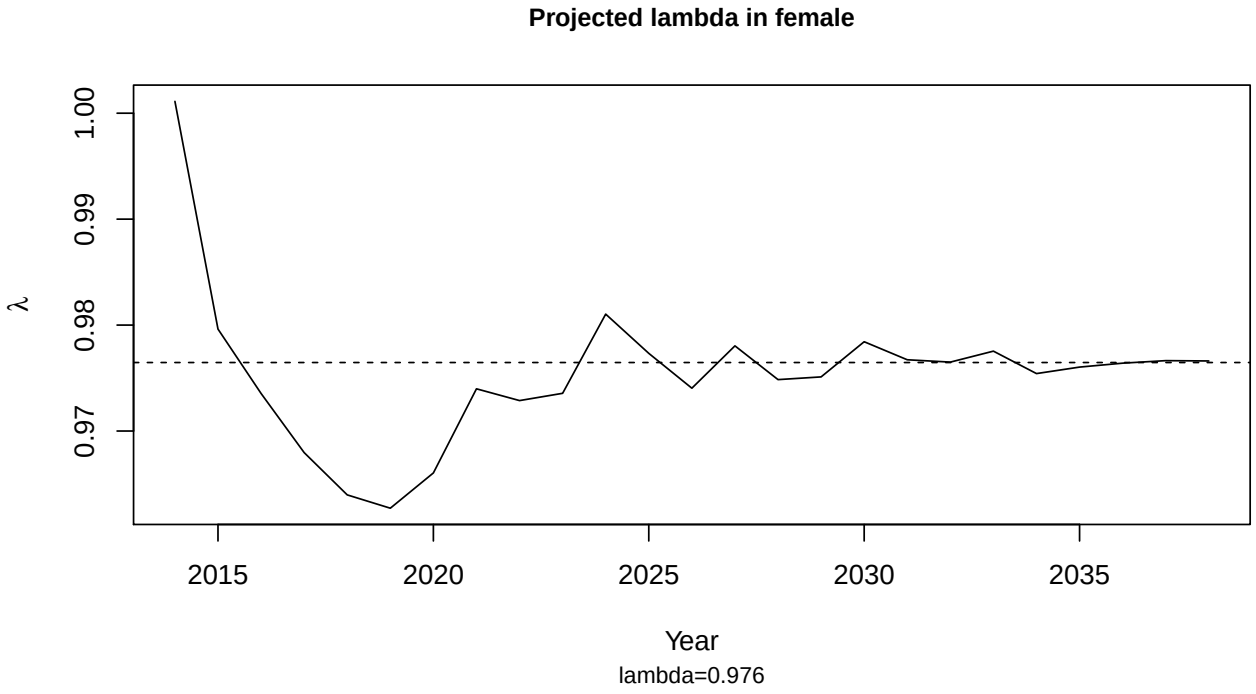
The data are presented as stages which are bound by ages e.g. `juvenile` 0-1 year, `subadult` 2-4 years, `adult` 6 to 12 years and `old` as 13 years and older.

```
stage.list <- list(juvenile=0:1,subadult=2:4,adult=6:12,old=13)
projection.leslie(sex='female',field='OBSERVED',season='pulse',census='post',
                  stage.list=stage.list)
```

```
## ================================================
## Characteristics of Leslie matrix
## ================================================
##
## Sex                          : female
## Breeding season              : birth-pulse
## Census                       : postbreeding
## Net reproductive rate     R0 = 0.8252806
## Generation time            G ~ 8.063025
## Finite rate of change lambda ~ 0.976465
## Intrinsic rate of change   r ~ -0.02381634
##
## Damping ratio            rho = 1.23231
## Convergence time           t = 9.936145
##
## [1] "20140519"
```


Projection of female population
Number of females
160
200
240
280
2015
2020
2025
2030
2035
2040
Year


female age distribution per year
old
adult
subadult
juvenile
0
50
100
150
200
250
2014
2017
2020
2023
2026
2029
2032
2035
2038
Year




```
## [1] FALSE
```

Stochastic Leslie matrix

The package `popbio`* also supports stochastic Leslie matrices. Function `projection.stochastic()` is a wrapper around the `popbio` functions.

```
projection.stochastic(sex='female')
```

```
##      mean min max lower upper
## 2014  299 299 299   299   299
## 2015  299 283 317   288   312
## 2016  294 263 317   277   313
## 2017  286 257 309   266   303
## 2018  278 245 298   257   295
## 2019  267 228 290   247   288
## 2020  257 219 285   231   281
## 2021  247 211 279   225   275
## 2022  241 213 279   214   268
## 2023  235 196 278   205   268
## 2024  229 187 272   197   264
## 2025  225 176 272   189   264
## 2026  219 162 270   182   262
## 2027  214 165 277   171   259
## 2028  210 166 278   170   260
## 2029  205 157 276   163   260
## 2030  199 145 265   157   252
## 2031  195 138 260   147   248
## 2032  189 134 257   142   242
## 2033  185 126 253   135   239
## 2034  180 121 247   132   236
## 2035  176 119 253   128   241
```

```
## 2036   171 113 254    120    233
## 2037   166 112 238    115    230
## 2038   162  99 246    111    225
## 2039   158  94 234    110    221
```