Beispiel 11.X-Ring Ringfundanalysen zur Mortalitätsschätzung von juvenilen und adulten Stockenten (Anas platyrhynchos)

Kapitel 11 aus Henle, K., A. Grimm-Seyfarth & B. Gruber: Erfassung und Analyse von Tierpopulationen. Ulmer Verlag

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2025-03-17

Beispiel Ringfund (7.32 im Kap. 11)

Einführungstext...

KLAUS: nur als Beispiel, siehe Kommentar im Text - rein oder nicht? Dann schreib ich noch einen kurzen Einführungstext

```
# check.packages function: install and load multiple R packages.
# Function from: https://gist.github.com/smithdanielle/9913897
check.packages <- function(pkg){
  new.pkg <- pkg[!(pkg %in% installed.packages()[, "Package"])]
  if (length(new.pkg))
    install.packages(new.pkg, dependencies = TRUE, type = "source")
  sapply(pkg, require, character.only = TRUE)
}

# benoetigte R pakete
pakete <- c("RMark", "ggplot2")

# Pruefe und installiere
check.packages(pakete)
```

```
##   RMark ggplot2
##    TRUE    TRUE
```

Weitere Informationen zur Nutzung des Paketes finden sich hier:

https://cran.r-project.org/web/packages/RMark/RMark.pdf

Beim diesem Datensatz werden Jung- und Alttiere unterschieden [Modell H1 von BROWNIE et al. (1985)]. Die Annahmen des Modells entsprechen denjenigen von Kap. 11. 11 Modell 1, außer dass Jungvögel im ersten Lebensjahr und adulte Vögel eine unterschiedliche Überlebens- und Rückmelderate aufweisen. Damit kann dem Umstand Rechnung getragen werden, dass Jungvögel häufig eine erheblich höhere Mortalität aufweisen als Altvögel.

Der Datensatz ist im RMark Paket als Beispeil integriert.

```
data("brownie")
head(brownie)
```

```
##                    ch freq ReleaseAge
## 1 100000000000000000  194      Adult
## 2 110000000000000000   10      Adult
## 3 100100000000000000   13      Adult
## 4 100001000000000000    6      Adult
## 5 100000010000000000    1      Adult
## 6 100000000100000000    1      Adult
```

Die Standardsortierreihenfolge von RealeaseAge (also Alter der Beringung) ist alphabetisch, folglich: Adult, Young. Daher ist initial.ages=c(1,0)

Seber Modell

wird indiziert mit model = "Recovery"

```
br <- process.data(brownie,model="Recovery",groups="ReleaseAge",
                age.var=1,initial.ages=c(1,0))
br.ddl <- make.design.data(br,parameters=list(S=list(age.bins=c(0,1,10)),
                                              r=list(age.bins=c(0,1,10))),right=FALSE)
mod <- mark(br,br.ddl,
         model.parameters=list(S=list(formula=~-1+age:time,link="sin"),
                               r=list(formula=~-1+age:time,link="sin")),delete=TRUE)
```

```
##
## Output summary for Recovery model
## Name : S(~-1 + age:time)r(~-1 + age:time)
##
## Npar :  36  (unadjusted=34)
## -2lnL:  20650.4
## AICc :  20722.57  (unadjusted=20718.554)
##
## Beta
##                      estimate        se        lcl        ucl
## S:age[0,1):time1  -0.0524422 0.1197360 -0.2871248  0.1822404
## S:age[1,10]:time1  0.1587910 0.2310324 -0.2940325  0.6116145
## S:age[0,1):time2   0.0179450 0.1404892 -0.2574139  0.2933039
## S:age[1,10]:time2  0.2819136 0.1581189 -0.0279994  0.5918267
## S:age[0,1):time3   0.1068958 0.1348956 -0.1574996  0.3712912
## S:age[1,10]:time3  0.2546993 0.1520851 -0.0433876  0.5527862
## S:age[0,1):time4   0.1901312 0.1467219 -0.0974438  0.4777062
## S:age[1,10]:time4  0.8299177 0.3112315  0.2199040  1.4399313
## S:age[0,1):time5  -0.0396180 0.1226790 -0.2800688  0.2008328
## S:age[1,10]:time5  0.3112329 0.1528194  0.0117068  0.6107591
## S:age[0,1):time6   0.3152910 0.1527867  0.0158290  0.6147530
## S:age[1,10]:time6  0.1102410 0.1174256 -0.1199132  0.3403952
## S:age[0,1):time7  -0.0661525 0.1368479 -0.3343743  0.2020694
## S:age[1,10]:time7  0.1528413 0.1352256 -0.1122010  0.4178835
## S:age[0,1):time8  -0.1810555 0.2405947 -0.6526212  0.2905102
```

```
## S:age[1,10]:time8  0.1312970 0.2709540 -0.3997730  0.6623669
## S:age[0,1):time9  -0.9704075 0.0000000 -0.9704075 -0.9704075
## S:age[1,10]:time9  0.6348851 0.0000000  0.6348851  0.6348851
## r:age[0,1):time1  -0.7370072 0.0657534 -0.8658839 -0.6081306
## r:age[1,10]:time1 -0.9178808 0.1342331 -1.1809776 -0.6547839
## r:age[0,1):time2  -0.4141168 0.1048338 -0.6195911 -0.2086426
## r:age[1,10]:time2 -0.5535649 0.1401776 -0.8283130 -0.2788168
## r:age[0,1):time3  -0.7418334 0.0782929 -0.8952874 -0.5883793
## r:age[1,10]:time3 -0.7539230 0.1036715 -0.9571191 -0.5507268
## r:age[0,1):time4  -0.3808179 0.1262967 -0.6283593 -0.1332764
## r:age[1,10]:time4  0.0279097 0.8754164 -1.6879064  1.7437259
## r:age[0,1):time5  -0.7078708 0.0662433 -0.8377075 -0.5780340
## r:age[1,10]:time5 -0.7753296 0.1107999 -0.9924973 -0.5581618
## r:age[0,1):time6  -0.4475529 0.1393160 -0.7206123 -0.1744935
## r:age[1,10]:time6 -0.7975261 0.0750974 -0.9447170 -0.6503352
## r:age[0,1):time7  -0.6293785 0.0755380 -0.7774330 -0.4813241
## r:age[1,10]:time7 -0.6785647 0.0940936 -0.8629882 -0.4941412
## r:age[0,1):time8  -0.7004668 0.1019671 -0.9003222 -0.5006114
## r:age[1,10]:time8 -0.6326258 0.1738164 -0.9733059 -0.2919456
## r:age[0,1):time9  -0.8696024 0.0000000 -0.8696024 -0.8696024
## r:age[1,10]:time9 -0.3451764 0.0000000 -0.3451764 -0.3451764
##
##
## Real Parameter S
## Group:ReleaseAgeAdult
##           1         2         3         4         5         6         7       8
## 1 0.5790623 0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 2           0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 3                     0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 4                               0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 5                                         0.6531163 0.5550089 0.5761235 0.56546
## 6                                                   0.5550089 0.5761235 0.56546
## 7                                                             0.5761235 0.56546
## 8                                                                       0.56546
## 9
##           9
## 1 0.7965425
## 2 0.7965425
## 3 0.7965425
## 4 0.7965425
## 5 0.7965425
## 6 0.7965425
## 7 0.7965425
## 8 0.7965425
## 9 0.7965425
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.4737909 0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235
## 2           0.5089720 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235
## 3                     0.5533462 0.8689379 0.6531163 0.5550089 0.5761235
## 4                               0.5944939 0.6531163 0.5550089 0.5761235
## 5                                         0.4801962 0.5550089 0.5761235
## 6                                                   0.6550466 0.5761235
```

```
## 7                                                       0.4669479
## 8
## 9
##          8         9
## 1 0.565460 0.7965425
## 2 0.565460 0.7965425
## 3 0.565460 0.7965425
## 4 0.565460 0.7965425
## 5 0.565460 0.7965425
## 6 0.565460 0.7965425
## 7 0.565460 0.7965425
## 8 0.409966 0.7965425
## 9          0.0874420
##
##
## Real Parameter r
## Group:ReleaseAgeAdult
##          1         2         3         4         5         6         7
## 1 0.102842 0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 2          0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 3                    0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 4                              0.5139531 0.1500243 0.1421849 0.1861618
## 5                                        0.1500243 0.1421849 0.1861618
## 6                                                  0.1421849 0.1861618
## 7                                                            0.1861618
## 8
## 9
##          8         9
## 1 0.2043678 0.3308187
## 2 0.2043678 0.3308187
## 3 0.2043678 0.3308187
## 4 0.2043678 0.3308187
## 5 0.2043678 0.3308187
## 6 0.2043678 0.3308187
## 7 0.2043678 0.3308187
## 8 0.2043678 0.3308187
## 9           0.3308187
##
## Group:ReleaseAgeYoung
##          1         2         3         4         5         6         7
## 1 0.1639626 0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 2           0.2988092 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 3                     0.1621797 0.5139531 0.1500243 0.1421849 0.1861618
## 4                               0.3141601 0.1500243 0.1421849 0.1861618
## 5                                         0.1748912 0.1421849 0.1861618
## 6                                                   0.2836196 0.1861618
## 7                                                             0.2056788
## 8
## 9
##          8         9
## 1 0.2043678 0.3308187
## 2 0.2043678 0.3308187
## 3 0.2043678 0.3308187
## 4 0.2043678 0.3308187
```

```
## 5 0.2043678 0.3308187
## 6 0.2043678 0.3308187
## 7 0.2043678 0.3308187
## 8 0.1777127 0.3308187
## 9           0.1179638
```

```
summary(mod)
```

```
## Output summary for Recovery model
## Name : S(~-1 + age:time)r(~-1 + age:time)
##
## Npar :  36  (unadjusted=34)
## -2lnL:  20650.4
## AICc :  20722.57  (unadjusted=20718.554)
##
## Beta
##                      estimate        se        lcl        ucl
## S:age[0,1):time1  -0.0524422 0.1197360 -0.2871248  0.1822404
## S:age[1,10]:time1  0.1587910 0.2310324 -0.2940325  0.6116145
## S:age[0,1):time2   0.0179450 0.1404892 -0.2574139  0.2933039
## S:age[1,10]:time2  0.2819136 0.1581189 -0.0279994  0.5918267
## S:age[0,1):time3   0.1068958 0.1348956 -0.1574996  0.3712912
## S:age[1,10]:time3  0.2546993 0.1520851 -0.0433876  0.5527862
## S:age[0,1):time4   0.1901312 0.1467219 -0.0974438  0.4777062
## S:age[1,10]:time4  0.8299177 0.3112315  0.2199040  1.4399313
## S:age[0,1):time5  -0.0396180 0.1226790 -0.2800688  0.2008328
## S:age[1,10]:time5  0.3112329 0.1528194  0.0117068  0.6107591
## S:age[0,1):time6   0.3152910 0.1527867  0.0158290  0.6147530
## S:age[1,10]:time6  0.1102410 0.1174256 -0.1199132  0.3403952
## S:age[0,1):time7  -0.0661525 0.1368479 -0.3343743  0.2020694
## S:age[1,10]:time7  0.1528413 0.1352256 -0.1122010  0.4178835
## S:age[0,1):time8  -0.1810555 0.2405947 -0.6526212  0.2905102
## S:age[1,10]:time8  0.1312970 0.2709540 -0.3997730  0.6623669
## S:age[0,1):time9  -0.9704075 0.0000000 -0.9704075 -0.9704075
## S:age[1,10]:time9  0.6348851 0.0000000  0.6348851  0.6348851
## r:age[0,1):time1  -0.7370072 0.0657534 -0.8658839 -0.6081306
## r:age[1,10]:time1 -0.9178808 0.1342331 -1.1809776 -0.6547839
## r:age[0,1):time2  -0.4141168 0.1048338 -0.6195911 -0.2086426
## r:age[1,10]:time2 -0.5535649 0.1401776 -0.8283130 -0.2788168
## r:age[0,1):time3  -0.7418334 0.0782929 -0.8952874 -0.5883793
## r:age[1,10]:time3 -0.7539230 0.1036715 -0.9571191 -0.5507268
## r:age[0,1):time4  -0.3808179 0.1262967 -0.6283593 -0.1332764
## r:age[1,10]:time4  0.0279097 0.8754164 -1.6879064  1.7437259
## r:age[0,1):time5  -0.7078708 0.0662433 -0.8377075 -0.5780340
## r:age[1,10]:time5 -0.7753296 0.1107999 -0.9924973 -0.5581618
## r:age[0,1):time6  -0.4475529 0.1393160 -0.7206123 -0.1744935
## r:age[1,10]:time6 -0.7975261 0.0750974 -0.9447170 -0.6503352
## r:age[0,1):time7  -0.6293785 0.0755380 -0.7774330 -0.4813241
## r:age[1,10]:time7 -0.6785647 0.0940936 -0.8629882 -0.4941412
## r:age[0,1):time8  -0.7004668 0.1019671 -0.9003222 -0.5006114
## r:age[1,10]:time8 -0.6326258 0.1738164 -0.9733059 -0.2919456
## r:age[0,1):time9  -0.8696024 0.0000000 -0.8696024 -0.8696024
## r:age[1,10]:time9 -0.3451764 0.0000000 -0.3451764 -0.3451764
##
```

```
##
## Real Parameter S
## Group:ReleaseAgeAdult
##           1         2         3         4         5         6         7       8
## 1 0.5790623 0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 2           0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 3                     0.6259772 0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 4                               0.8689379 0.6531163 0.5550089 0.5761235 0.56546
## 5                                         0.6531163 0.5550089 0.5761235 0.56546
## 6                                                   0.5550089 0.5761235 0.56546
## 7                                                             0.5761235 0.56546
## 8                                                                       0.56546
## 9
##           9
## 1 0.7965425
## 2 0.7965425
## 3 0.7965425
## 4 0.7965425
## 5 0.7965425
## 6 0.7965425
## 7 0.7965425
## 8 0.7965425
## 9 0.7965425
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.4737909 0.6390971 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235
## 2           0.5089720 0.6259772 0.8689379 0.6531163 0.5550089 0.5761235
## 3                     0.5533462 0.8689379 0.6531163 0.5550089 0.5761235
## 4                               0.5944939 0.6531163 0.5550089 0.5761235
## 5                                         0.4801962 0.5550089 0.5761235
## 6                                                   0.6550466 0.5761235
## 7                                                             0.4669479
## 8
## 9
##          8         9
## 1 0.565460 0.7965425
## 2 0.565460 0.7965425
## 3 0.565460 0.7965425
## 4 0.565460 0.7965425
## 5 0.565460 0.7965425
## 6 0.565460 0.7965425
## 7 0.565460 0.7965425
## 8 0.409966 0.7965425
## 9          0.0874420
##
##
## Real Parameter r
## Group:ReleaseAgeAdult
##           1         2         3         4         5         6         7
## 1 0.102842 0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 2          0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 3                    0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 4                              0.5139531 0.1500243 0.1421849 0.1861618
```

```
## 5                                          0.1500243 0.1421849 0.1861618
## 6                                                    0.1421849 0.1861618
## 7                                                              0.1861618
## 8
## 9
##           8         9
## 1 0.2043678 0.3308187
## 2 0.2043678 0.3308187
## 3 0.2043678 0.3308187
## 4 0.2043678 0.3308187
## 5 0.2043678 0.3308187
## 6 0.2043678 0.3308187
## 7 0.2043678 0.3308187
## 8 0.2043678 0.3308187
## 9           0.3308187
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.1639626 0.2371385 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 2           0.2988092 0.1577481 0.5139531 0.1500243 0.1421849 0.1861618
## 3                     0.1621797 0.5139531 0.1500243 0.1421849 0.1861618
## 4                               0.3141601 0.1500243 0.1421849 0.1861618
## 5                                         0.1748912 0.1421849 0.1861618
## 6                                                   0.2836196 0.1861618
## 7                                                             0.2056788
## 8
## 9
##           8         9
## 1 0.2043678 0.3308187
## 2 0.2043678 0.3308187
## 3 0.2043678 0.3308187
## 4 0.2043678 0.3308187
## 5 0.2043678 0.3308187
## 6 0.2043678 0.3308187
## 7 0.2043678 0.3308187
## 8 0.1777127 0.3308187
## 9           0.1179638
```

```
# konkret die Schätzwerte aufrufen
mod.seber <- mod$results$real
```

Die Überlebensraten der adulten beringten Vögel ist höher als der jung beringten Vögel.

Brownie Modell

wird indiziert mit model = “Brownie”

```
br=process.data(brownie,model="Brownie",groups="ReleaseAge",
                age.var=1,initial.ages=c(1,0))
br.ddl=make.design.data(br,
                        parameters=list(S=list(age.bins=c(0,1,10)),
```

```
f=list(age.bins=c(0,1,10))),right=FALSE)
mod=mark(br,br.ddl,
         model.parameters=list(S=list(formula=~-1+age:time,link="sin"),

f=list(formula=~-1+age:time,link="sin")),delete=TRUE)
```

```
##
## Output summary for Brownie model
## Name : S(~-1 + age:time)f(~-1 + age:time)
##
## Npar :  34
## -2lnL:  20650.4
## AICc :  20718.55
##
## Beta
##                      estimate        se        lcl        ucl
## S:age[0,1):time1   3.1940360 0.1197358  2.9593539  3.4287181
## S:age[1,10]:time1  0.1587907 0.2310334 -0.2940348  0.6116162
## S:age[0,1):time2   0.0179451 0.1404896 -0.2574145  0.2933046
## S:age[1,10]:time2  0.2819125 0.1581183 -0.0279993  0.5918243
## S:age[0,1):time3   0.1068986 0.1348942 -0.1574939  0.3712912
## S:age[1,10]:time3  0.2547038 0.1520830 -0.0433789  0.5527864
## S:age[0,1):time4   2.9514639 0.1467210  2.6638908  3.2390371
## S:age[1,10]:time4  0.8299043 0.3112137  0.2199253  1.4398832
## S:age[0,1):time5  -0.0396188 0.1226789 -0.2800695  0.2008318
## S:age[1,10]:time5  0.3112362 0.1528195  0.0117100  0.6107625
## S:age[0,1):time6   0.3152911 0.1527866  0.0158293  0.6147530
## S:age[1,10]:time6  3.0313525 0.1174257  2.8011982  3.2615068
## S:age[0,1):time7  -0.0661528 0.1368479 -0.3343746  0.2020690
## S:age[1,10]:time7  2.9887502 0.1352261  2.7237071  3.2537933
## S:age[0,1):time8   3.3226480 0.2405944  2.8510830  3.7942129
## S:age[1,10]:time8  0.1312962 0.2709544 -0.3997745  0.6623668
## f:age[0,1):time1  -0.9745385 0.0322413 -1.0377314 -0.9113456
## f:age[1,10]:time1 -1.1516088 0.0657952 -1.2805673 -1.0226503
## f:age[0,1):time2  -0.7846149 0.0377426 -0.8585903 -0.7106395
## f:age[1,10]:time2 -0.9770170 0.0328456 -1.0413943 -0.9126396
## f:age[0,1):time3  -1.0257894 0.0297219 -1.0840443 -0.9675344
## f:age[1,10]:time3 -1.0800837 0.0259161 -1.1308793 -1.0292882
## f:age[0,1):time4  -0.8408532 0.0288555 -0.8974099 -0.7842964
## f:age[1,10]:time4 -1.0457101 0.0287228 -1.1020069 -0.9894134
## f:age[0,1):time5  -0.9582416 0.0288795 -1.0148455 -0.9016376
## f:age[1,10]:time5 -2.0310996 0.0226914 -2.0755747 -1.9866244
## f:age[0,1):time6  -0.9345453 0.0294245 -0.9922173 -0.8768733
## f:age[1,10]:time6 -2.0793328 0.0225826 -2.1235948 -2.0350709
## f:age[0,1):time7  -0.8958253 0.0297351 -0.9541060 -0.8375446
## f:age[1,10]:time7 -2.1402778 0.0224472 -2.1842743 -2.0962813
## f:age[0,1):time8  -0.9112772 0.0332228 -0.9763938 -0.8461605
## f:age[1,10]:time8 -2.1759968 0.0282602 -2.2313867 -2.1206069
## f:age[0,1):time9  -0.9022161 0.0532246 -1.0065364 -0.7978958
## f:age[1,10]:time9 -1.0459179 0.0566140 -1.1568814 -0.9349544
##
##
## Real Parameter S
```

```
## Group:ReleaseAgeAdult
##           1         2         3         4         5         6        7
## 1 0.5790621 0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 2           0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 3                     0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 4                               0.8689334 0.6531178 0.5550085 0.576124
## 5                                         0.6531178 0.5550085 0.576124
## 6                                                   0.5550085 0.576124
## 7                                                             0.576124
## 8
##           8
## 1 0.5654596
## 2 0.5654596
## 3 0.5654596
## 4 0.5654596
## 5 0.5654596
## 6 0.5654596
## 7 0.5654596
## 8 0.5654596
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.4737904 0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.5761240
## 2           0.5089721 0.6259794 0.8689334 0.6531178 0.5550085 0.5761240
## 3                     0.5533476 0.8689334 0.6531178 0.5550085 0.5761240
## 4                               0.5944926 0.6531178 0.5550085 0.5761240
## 5                                         0.4801958 0.5550085 0.5761240
## 6                                                   0.6550466 0.5761240
## 7                                                             0.4669477
## 8
##           8
## 1 0.5654596
## 2 0.5654596
## 3 0.5654596
## 4 0.5654596
## 5 0.5654596
## 6 0.5654596
## 7 0.5654596
## 8 0.4099661
##
##
## Real Parameter f
## Group:ReleaseAgeAdult
##         1        2         3         4         5        6         7        8
## 1 0.04329 0.085584 0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 2         0.085584 0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 3                  0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 4                            0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 5                                      0.0520411 0.063271 0.0789097 0.088806
## 6                                                0.063271 0.0789097 0.088806
## 7                                                         0.0789097 0.088806
## 8                                                                   0.088806
## 9
##           9
```

```
## 1 0.0673076
## 2 0.0673076
## 3 0.0673076
## 4 0.0673076
## 5 0.0673076
## 6 0.0673076
## 7 0.0673076
## 8 0.0673076
## 9 0.0673076
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.0862786 0.0855840 0.0590014 0.0673596 0.0520411 0.0632710 0.0789097
## 2           0.1467236 0.0590014 0.0673596 0.0520411 0.0632710 0.0789097
## 3                     0.0724382 0.0673596 0.0520411 0.0632710 0.0789097
## 4                               0.1273938 0.0520411 0.0632710 0.0789097
## 5                                         0.0909091 0.0632710 0.0789097
## 6                                                   0.0978355 0.0789097
## 7                                                             0.1096375
## 8
## 9
##           8         9
## 1 0.0888060 0.0673076
## 2 0.0888060 0.0673076
## 3 0.0888060 0.0673076
## 4 0.0888060 0.0673076
## 5 0.0888060 0.0673076
## 6 0.0888060 0.0673076
## 7 0.0888060 0.0673076
## 8 0.1048565 0.0673076
## 9           0.1076487
```

```
#mod=mark(br,br.ddl,model.parameters=list(S=list(formula=~-1+age,link="sin"),
#
#f=list(formula=~-1+age,link="sin")),delete=TRUE)
summary(mod)
```

```
## Output summary for Brownie model
## Name : S(~-1 + age:time)f(~-1 + age:time)
##
## Npar :  34
## -2lnL:  20650.4
## AICc :  20718.55
##
## Beta
##                      estimate        se        lcl        ucl
## S:age[0,1):time1   3.1940360 0.1197358  2.9593539  3.4287181
## S:age[1,10]:time1  0.1587907 0.2310334 -0.2940348  0.6116162
## S:age[0,1):time2   0.0179451 0.1404896 -0.2574145  0.2933046
## S:age[1,10]:time2  0.2819125 0.1581183 -0.0279993  0.5918243
## S:age[0,1):time3   0.1068986 0.1348942 -0.1574939  0.3712912
## S:age[1,10]:time3  0.2547038 0.1520830 -0.0433789  0.5527864
## S:age[0,1):time4   2.9514639 0.1467210  2.6638908  3.2390371
## S:age[1,10]:time4  0.8299043 0.3112137  0.2199253  1.4398832
```

```
## S:age[0,1):time5  -0.0396188 0.1226789 -0.2800695  0.2008318
## S:age[1,10]:time5  0.3112362 0.1528195  0.0117100  0.6107625
## S:age[0,1):time6   0.3152911 0.1527866  0.0158293  0.6147530
## S:age[1,10]:time6  3.0313525 0.1174257  2.8011982  3.2615068
## S:age[0,1):time7  -0.0661528 0.1368479 -0.3343746  0.2020690
## S:age[1,10]:time7  2.9887502 0.1352261  2.7237071  3.2537933
## S:age[0,1):time8   3.3226480 0.2405944  2.8510830  3.7942129
## S:age[1,10]:time8  0.1312962 0.2709544 -0.3997745  0.6623668
## f:age[0,1):time1  -0.9745385 0.0322413 -1.0377314 -0.9113456
## f:age[1,10]:time1 -1.1516088 0.0657952 -1.2805673 -1.0226503
## f:age[0,1):time2  -0.7846149 0.0377426 -0.8585903 -0.7106395
## f:age[1,10]:time2 -0.9770170 0.0328456 -1.0413943 -0.9126396
## f:age[0,1):time3  -1.0257894 0.0297219 -1.0840443 -0.9675344
## f:age[1,10]:time3 -1.0800837 0.0259161 -1.1308793 -1.0292882
## f:age[0,1):time4  -0.8408532 0.0288555 -0.8974099 -0.7842964
## f:age[1,10]:time4 -1.0457101 0.0287228 -1.1020069 -0.9894134
## f:age[0,1):time5  -0.9582416 0.0288795 -1.0148455 -0.9016376
## f:age[1,10]:time5 -2.0310996 0.0226914 -2.0755747 -1.9866244
## f:age[0,1):time6  -0.9345453 0.0294245 -0.9922173 -0.8768733
## f:age[1,10]:time6 -2.0793328 0.0225826 -2.1235948 -2.0350709
## f:age[0,1):time7  -0.8958253 0.0297351 -0.9541060 -0.8375446
## f:age[1,10]:time7 -2.1402778 0.0224472 -2.1842743 -2.0962813
## f:age[0,1):time8  -0.9112772 0.0332228 -0.9763938 -0.8461605
## f:age[1,10]:time8 -2.1759968 0.0282602 -2.2313867 -2.1206069
## f:age[0,1):time9  -0.9022161 0.0532246 -1.0065364 -0.7978958
## f:age[1,10]:time9 -1.0459179 0.0566140 -1.1568814 -0.9349544
##
##
## Real Parameter S
## Group:ReleaseAgeAdult
##           1         2         3         4         5         6         7
## 1 0.5790621 0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 2           0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 3                     0.6259794 0.8689334 0.6531178 0.5550085 0.576124
## 4                               0.8689334 0.6531178 0.5550085 0.576124
## 5                                         0.6531178 0.5550085 0.576124
## 6                                                   0.5550085 0.576124
## 7                                                             0.576124
## 8
##           8
## 1 0.5654596
## 2 0.5654596
## 3 0.5654596
## 4 0.5654596
## 5 0.5654596
## 6 0.5654596
## 7 0.5654596
## 8 0.5654596
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.4737904 0.6390966 0.6259794 0.8689334 0.6531178 0.5550085 0.5761240
## 2           0.5089721 0.6259794 0.8689334 0.6531178 0.5550085 0.5761240
## 3                     0.5533476 0.8689334 0.6531178 0.5550085 0.5761240
```

```
## 4                                0.5944926 0.6531178 0.5550085 0.5761240
## 5                                          0.4801958 0.5550085 0.5761240
## 6                                                    0.6550466 0.5761240
## 7                                                              0.4669477
## 8
##           8
## 1 0.5654596
## 2 0.5654596
## 3 0.5654596
## 4 0.5654596
## 5 0.5654596
## 6 0.5654596
## 7 0.5654596
## 8 0.4099661
##
##
## Real Parameter f
## Group:ReleaseAgeAdult
##         1        2         3         4         5        6         7        8
## 1 0.04329 0.085584 0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 2         0.085584 0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 3                  0.0590014 0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 4                            0.0673596 0.0520411 0.063271 0.0789097 0.088806
## 5                                      0.0520411 0.063271 0.0789097 0.088806
## 6                                                0.063271 0.0789097 0.088806
## 7                                                         0.0789097 0.088806
## 8                                                                   0.088806
## 9
##           9
## 1 0.0673076
## 2 0.0673076
## 3 0.0673076
## 4 0.0673076
## 5 0.0673076
## 6 0.0673076
## 7 0.0673076
## 8 0.0673076
## 9 0.0673076
##
## Group:ReleaseAgeYoung
##           1         2         3         4         5         6         7
## 1 0.0862786 0.0855840 0.0590014 0.0673596 0.0520411 0.0632710 0.0789097
## 2           0.1467236 0.0590014 0.0673596 0.0520411 0.0632710 0.0789097
## 3                     0.0724382 0.0673596 0.0520411 0.0632710 0.0789097
## 4                               0.1273938 0.0520411 0.0632710 0.0789097
## 5                                         0.0909091 0.0632710 0.0789097
## 6                                                   0.0978355 0.0789097
## 7                                                             0.1096375
## 8
## 9
##           8         9
## 1 0.0888060 0.0673076
## 2 0.0888060 0.0673076
## 3 0.0888060 0.0673076
```

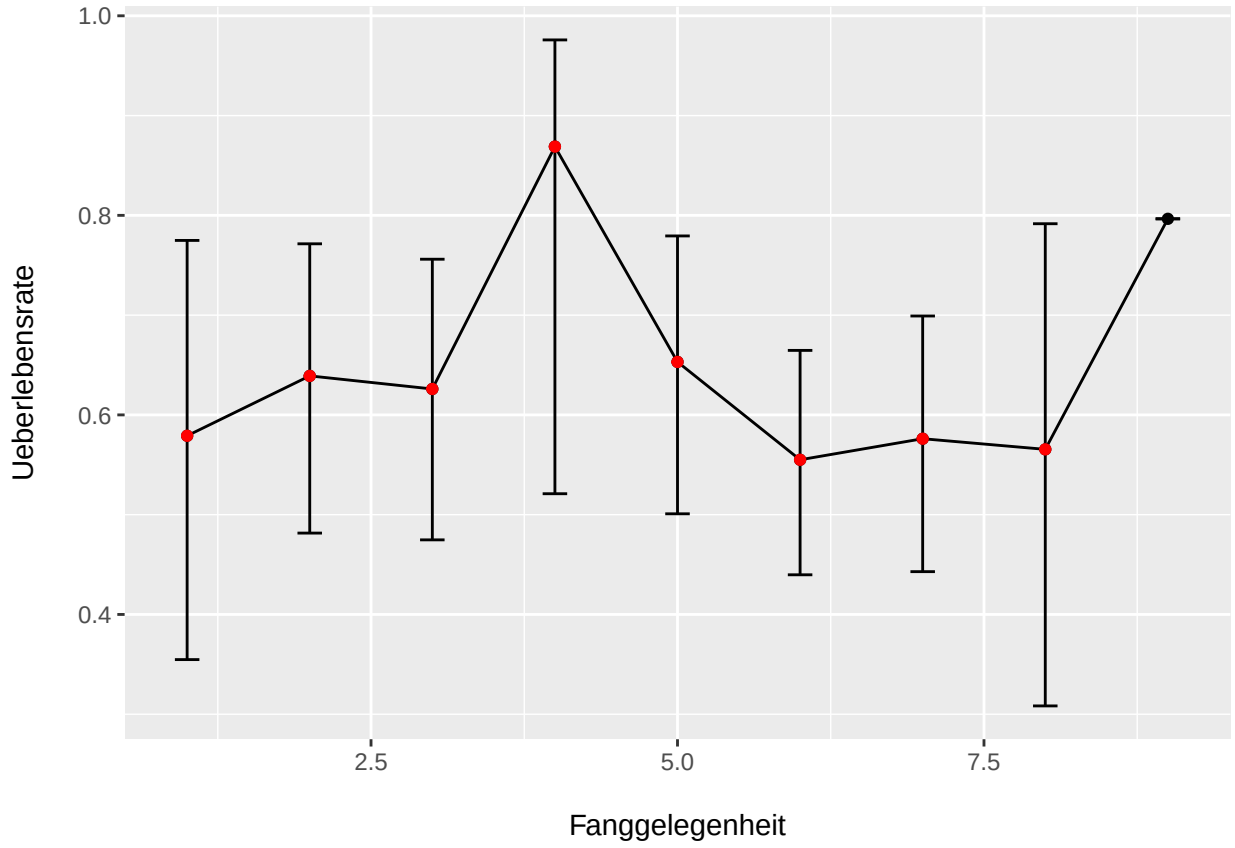
```
## 4 0.0888060 0.0673076
## 5 0.0888060 0.0673076
## 6 0.0888060 0.0673076
## 7 0.0888060 0.0673076
## 8 0.1048565 0.0673076
## 9           0.1076487
```

```
# konkret die Schätzwerte aufrufen
mod.brownie <- mod$results$real
```

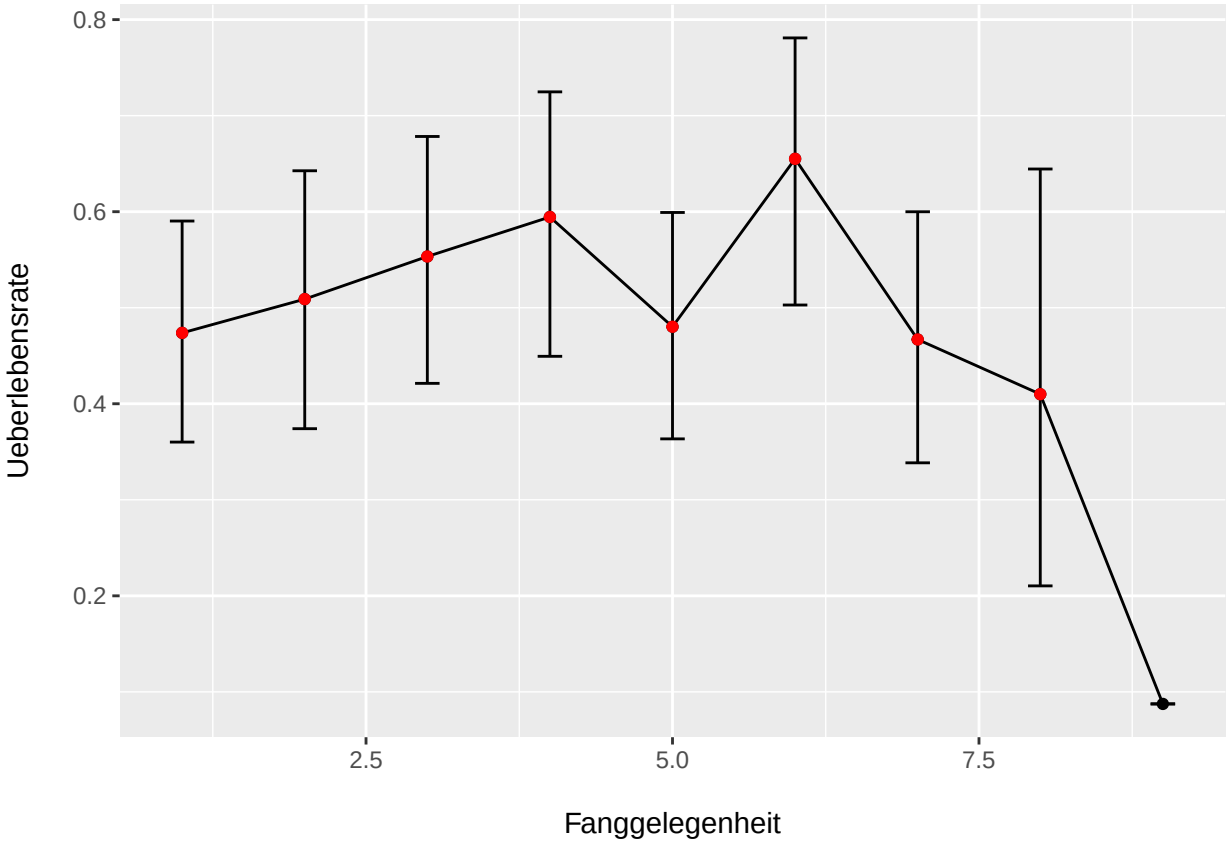
Vergleichen wir die Daten aus beiden Modellen miteinander. Dazu nutzen wir das Paket ggplot2 (Wickham 2016).

```
mod.seber.adult <- mod.seber[1:9,]
mod.seber.adult$Occasion <- 1:9
mod.seber.young <- mod.seber[10:18,]
mod.seber.young$Occasion <- 1:9
mod.brownie.adult <- mod.brownie[1:8,]
mod.brownie.adult$Occasion <- 1:8
mod.brownie.young <- mod.brownie[9:16,]
mod.brownie.young$Occasion <- 1:8

# Adult markierte Tiere
ggplot(mod.seber.adult,aes(Occasion,estimate,
                    ymin=lcl,ymax=ucl))+
       geom_errorbar(width=0.2)+geom_point()+geom_line()+
       geom_point(data=mod.brownie.adult,
                  aes(Occasion, estimate, ymin=lcl,ymax=ucl), color="red") +
       xlab("\nFanggelegenheit")+ylab("Ueberlebensrate\n")
```




```
# Juvenil markierte Tiere
ggplot(mod.seber.young,aes(Occasion,estimate,
                      ymin=lcl,ymax=ucl))+
       geom_errorbar(width=0.2)+geom_point()+geom_line()+
       geom_point(data=mod.brownie.young,
                  aes(Occasion, estimate, ymin=lcl,ymax=ucl), color="red") +
       xlab("\nFanggelegenheit")+ylab("Ueberlebensrate\n")
```



Die berechneten Überlebensraten sind nahezu identisch.

Literaturverzeichnis

Brownie

Laake, J. & E. Rexstad. 2013. RMark – an alternative approach to building linear models in MARK. In: Program MARK: A Gentle Introduction, edited by E. Cooch & G.C. White.

Laake, J.L. (2013). RMark: An R Interface for Analysis of Capture-Recapture Data with MARK. AFSC Processed Rep 2013-01, 25p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle WA 98115.

Seber

Wickham, H. 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag, New York.