Pollack in ICES Divisions 89a

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Background information

Pollack.27.89a is a stock in ICES Category 5. Currently, the management advice is based on commercial landings.

Pollack is a bentopelagic species. Main commercial fleets included gillnetters and longliners from France (80% landings) and gillnetters and longliners from Spain (17% landings). Recreational landings are supposed to be high (at the same level as commercial landings, they have been estimated.

Available data

1. Annual commercial landings (in tonnes): 1986-2018.
2. Abundance Index "France gillneters mesh > 90 mm, operating in div 8a, 2nd semester" (tonnes/fishing sequence): 2005-2018.

Fitting SPICT model

Starting session and download libraries

```
# Package from github: devtools::install_github('mawp/spict/spict')
# library(remotes) install_github('DTUAqua/spict/spict')

rm(list = ls(all = TRUE))

# Download libraries
library(spict)
library(icesAdvice)
library(ellipse)
library(formatR)
```

Creating data object

```
# Catch data: Only Commercial Landings. *Year 1999: mean of 1998 and 2000 as
# French landings were missing

pol89aC <- data.frame(obsC = c(2806, 2918, 2582, 1973, 1900, 2168, 1958, 1513, 1955,
    1679, 1354, 1378, 1165, 1322, 1479, 1746, 1972, 1663, 1726, 1986, 2126, 1847,
```

```
    2313, 1812, 1682, 2032, 1520, 1811, 1959, 1610, 1661, 1481, 1512), timeC = 1986:2018)

# Index data: Commercial index FR-GNS>90mm-8a-2s (tonnes/fishing sequence)
pol89aI <- data.frame(obsI = c(0.1151, 0.0663, 0.1292, 0.1289, 0.1244, 0.1079, 0.1966,
    0.1743, 0.1565, 0.15, 0.1438, 0.1205, 0.1222, 0.1117), timeI = c(2005:2018) +
    0.5)

# Create a list for input data
pol89a <- list(timeC = pol89aC$timeC, obsC = pol89aC$obsC, timeI = list(pol89aI$timeI),
    obsI = list(pol89aI$obsI))

# Check list
pol89a <- check.inp(pol89a)
```

Plot Raw data:

```
plotspict.data(pol89a)
```

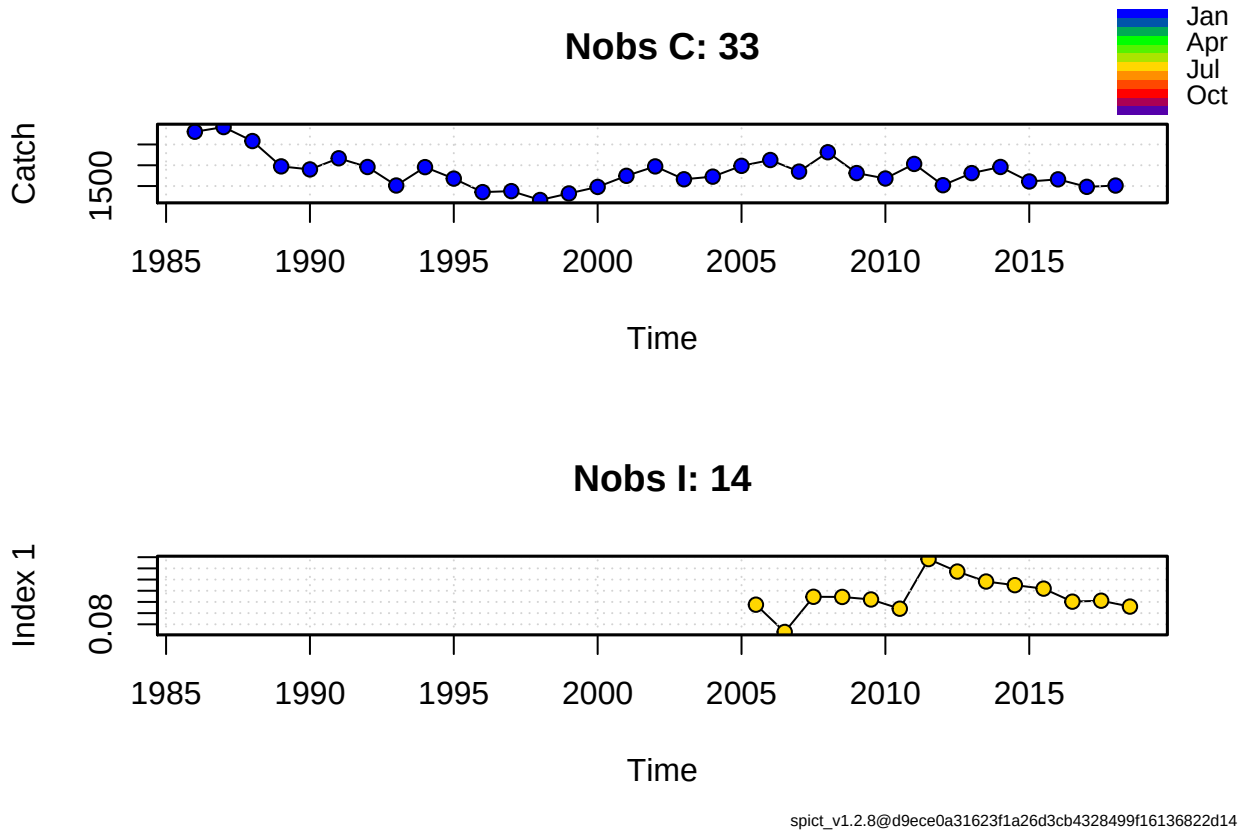


Figure 1: Raw data

To highlight:

- Catch and abundance series are overlapped only for a short period of time (14 years).
- There is not contrast in catch series during 2005-2018.

Plot Fitting linear regression:

```
plotspict.ci(pol89a)
```

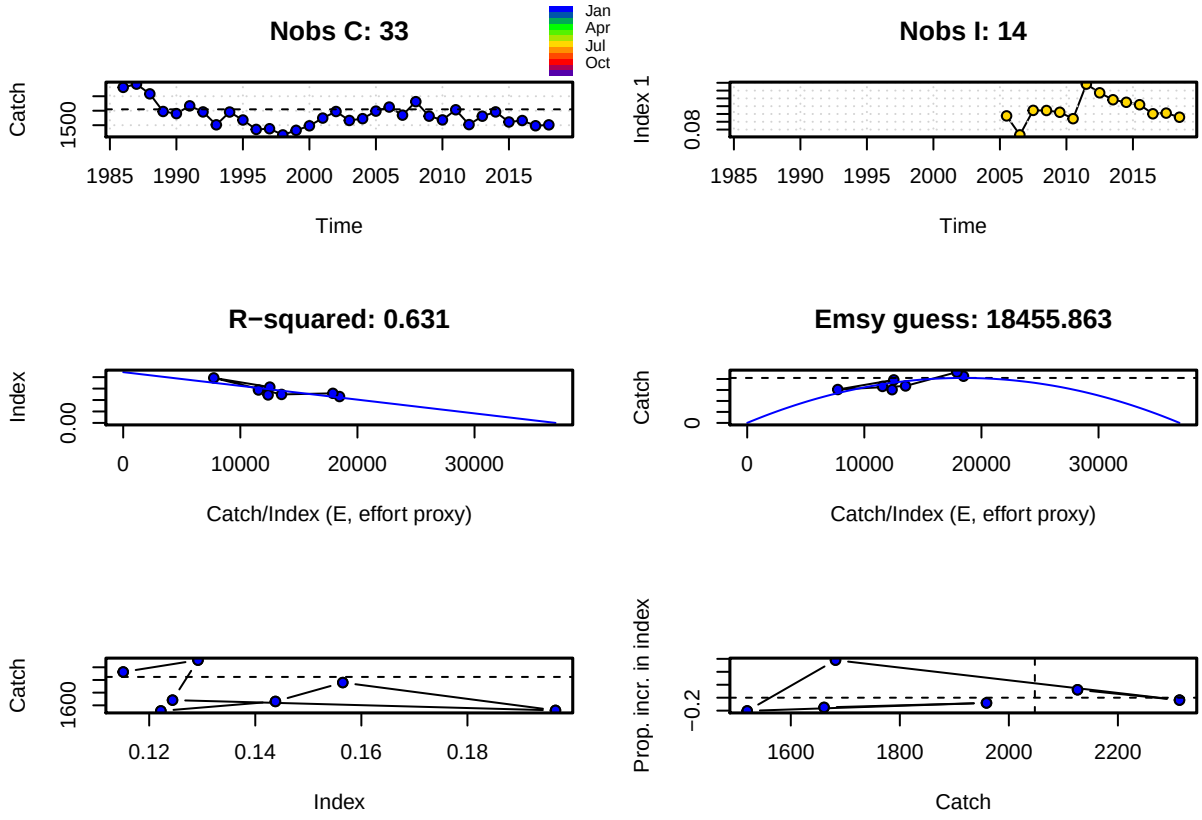


Figure 2: Fitting linear regression

Model Fitting

Run 1. Default priors and all parameters estimated

Not converged. Model did not obtain proper convergence!

```
res_pol89aDefault <- fit.spict(pol89a)
```

Run 2. Shorten Catch series to 2005-2018, overlapping with abundance index.

Not converged. Shorten series gave totally unrealistic estimates, testing different configurations:

```
pol89aShorten = shorten.inp(pol89a, 2005, 2018)
res_pol89aShorten <- fit.spict(pol89aShorten)
```

Run 3. Fix parameter to Schaefer production curve (initial parameter). Symmetric productive curve (BMSY/K=0.5)

No converged:

```
pol89aSchaefer <- pol89a
pol89aSchaefer$ini$logn <- log(2)
pol89aSchaefer$phases$logn <- -1
res_pol89aSchaefer <- fit.spict(pol89aSchaefer)
res_pol89aSchaefer
```

```
## Convergence: 1  MSG: false convergence (8)
## WARNING: Model did not obtain proper convergence! Estimates and uncertainties are most likely invali
## Gradient at current parameter vector
##        logm       logK       logq     logsdb     logsdf     logsdi     logsdc
##   243530990 -114100200 -103330547  -45350665    3185902   19201573   14537482
##
## Objective function: -4.8534143
## Euler time step (years):  1/16 or 0.0625
## Nobs C: 33,  Nobs I1: 14
##
## Priors
##      logn  ~  dnorm[log(2), 2^2]
##  logalpha  ~  dnorm[log(1), 2^2]
##   logbeta  ~  dnorm[log(1), 2^2]
##
## Fixed parameters
##    fixed.value
##  n           2
##
## Model parameter estimates w 95% CI
##             estimate     cilow     ciupp     log.est
##  alpha  1.724414e+00 1.5535251 1.9141018   0.5448875
##  beta   8.661552e-01 0.7702417 0.9740122  -0.1436912
##  r      7.180673e-01       NaN       NaN  -0.3311920
##  rc     7.180673e-01       NaN       NaN  -0.3311920
##  rold   7.180673e-01       NaN       NaN  -0.3311920
##  m      2.065420e+03       NaN       NaN   7.6330889
##  K      1.150544e+04       NaN       NaN   9.3505753
##  q      1.590000e-05       NaN       NaN -11.0479791
##  sdb    1.261693e-01       NaN       NaN  -2.0701308
##  sdf    8.675190e-02 0.0858679 0.0876449  -2.4447030
##  sdi    2.175681e-01 0.2011795 0.2352918  -1.5252433
##  sdc    7.514060e-02 0.0674759 0.0836760  -2.5883942
##
## Deterministic reference points (Drp)
##            estimate cilow ciupp   log.est
##  Bmsyd 5752.7201188   NaN   NaN  8.657428
##  Fmsyd    0.3590336   NaN   NaN -1.024339
##  MSYd  2065.4199636   NaN   NaN  7.633089
## Stochastic reference points (Srp)
##            estimate cilow ciupp   log.est rel.diff.Drp
##  Bmsys 5657.9991900   NaN   NaN  8.640826  -0.01674106
##  Fmsys    0.3552445   NaN   NaN -1.034949  -0.01066625
```

```
##  MSYs  2009.6139816   NaN   NaN  7.605698  -0.02776950
##
## States w 95% CI (inp$msytype: s)
##                     estimate        cilow        ciupp    log.est
##  B_2018.50      7701.8620853 6427.3964547 9229.0369824  8.9492174
##  F_2018.50         0.1958824    0.1600968    0.2396669 -1.6302408
##  B_2018.50/Bmsy    1.3612342    1.0824193    1.7118677  0.3083918
##  F_2018.50/Fmsy    0.5514017    0.4300376    0.7070168 -0.5952918
##
## Predictions w 95% CI (inp$msytype: s)
##                    prediction        cilow        ciupp    log.est
##  B_2019.00      7817.7345592 6338.2962452 9642.4924420  8.9641501
##  F_2019.00         0.1958628    0.1561393    0.2456922 -1.6303410
##  B_2019.00/Bmsy    1.3817136    1.0757361    1.7747220  0.3233245
##  F_2019.00/Fmsy    0.5513464    0.4213261    0.7214908 -0.5953919
##  Catch_2019.00  1547.7675977 1219.5329747 1964.3458489  7.3445689
##  E(B_inf)       8075.9135370           NA           NA  8.9966413
```

Run 4. Set priors for the ratio between biomass in the initial year relative to K, mean of log(0.5) and sd of 0.2

```
pol89aBkfrac <- pol89a
pol89aBkfrac$priors$logbkfrac <- c(log(0.5), 0.2, 1)
res_pol89aBkfrac <- fit.spict(pol89aBkfrac)
res_pol89aBkfrac
```

```
## Convergence: 0  MSG: relative convergence (4)
## Objective function at optimum: -4.5509311
## Euler time step (years):  1/16 or 0.0625
## Nobs C: 33,  Nobs I1: 14
##
## Priors
##       logn  ~  dnorm[log(2), 2^2]
##   logalpha  ~  dnorm[log(1), 2^2]
##    logbeta  ~  dnorm[log(1), 2^2]
##  logbkfrac  ~  dnorm[log(0.5), 0.2^2]
##
## Model parameter estimates w 95% CI
##              estimate        cilow        ciupp     log.est
##  alpha  2.697054e+00    0.7705388 9.440279e+00   0.9921602
##  beta   1.234193e+00    0.2062127 7.386703e+00   0.2104172
##  r      2.788867e-01    0.0617423 1.259716e+00  -1.2769498
##  rc     5.878453e-01    0.1943692 1.777865e+00  -0.5312914
##  rold   5.451653e+00    0.0000000 2.726796e+10   1.6959189
##  m      1.823525e+03 1418.6280869 2.343986e+03   7.5085269
##  K      1.731712e+04 6004.6937680 4.994137e+04   9.7594509
##  q      1.790000e-05    0.0000057 5.610000e-05 -10.9286187
##  n      9.488437e-01    0.3013288 2.987780e+00  -0.0525112
##  sdb    8.535570e-02    0.0301167 2.419125e-01  -2.4609280
##  sdf    7.710060e-02    0.0164420 3.615431e-01  -2.5626445
##  sdi    2.302090e-01    0.1398924 3.788352e-01  -1.4687678
##  sdc    9.515700e-02    0.0604641 1.497558e-01  -2.3522273
##
```

```
## Deterministic reference points (Drp)
##            estimate        cilow        ciupp   log.est
##  Bmsyd 6204.0989196 2202.4784482 1.747615e+04  8.732966
##  Fmsyd    0.2939227    0.0971846 8.889323e-01 -1.224439
##  MSYd  1823.5252595 1418.6280869 2.343986e+03  7.508527
## Stochastic reference points (Srp)
##            estimate       cilow        ciupp   log.est  rel.diff.Drp
##  Bmsys 6159.4267006 2187.651388 1.734213e+04  8.725739 -0.0072526586
##  Fmsys    0.2940131    0.097157 8.897324e-01 -1.224131  0.0003076041
##  MSYs  1810.9559985 1410.495313 2.325113e+03  7.501610 -0.0069406772
##
## States w 95% CI (inp$msytype: s)
##                     estimate        cilow        ciupp    log.est
##  B_2018.50      7053.0819195 2077.6339581 2.394357e+04  8.8612200
##  F_2018.50         0.2178450    0.0627155 7.566943e-01 -1.5239715
##  B_2018.50/Bmsy    1.1450874    0.4284152 3.060641e+00  0.1354810
##  F_2018.50/Fmsy    0.7409364    0.2165474 2.535181e+00 -0.2998405
##
## Predictions w 95% CI (inp$msytype: s)
##                   prediction        cilow        ciupp    log.est
##  B_2019.00      7159.6995777 2122.3017467 2.415363e+04  8.8762233
##  F_2019.00         0.2175625    0.0623706 7.589069e-01 -1.5252689
##  B_2019.00/Bmsy    1.1623971    0.4323251 3.125349e+00  0.1504843
##  F_2019.00/Fmsy    0.7399758    0.2151627 2.544884e+00 -0.3011379
##  Catch_2019.00  1578.5293427 1271.2707568 1.960051e+03  7.3642489
##  E(B_inf)       7964.4879541           NA           NA  8.9827479
```

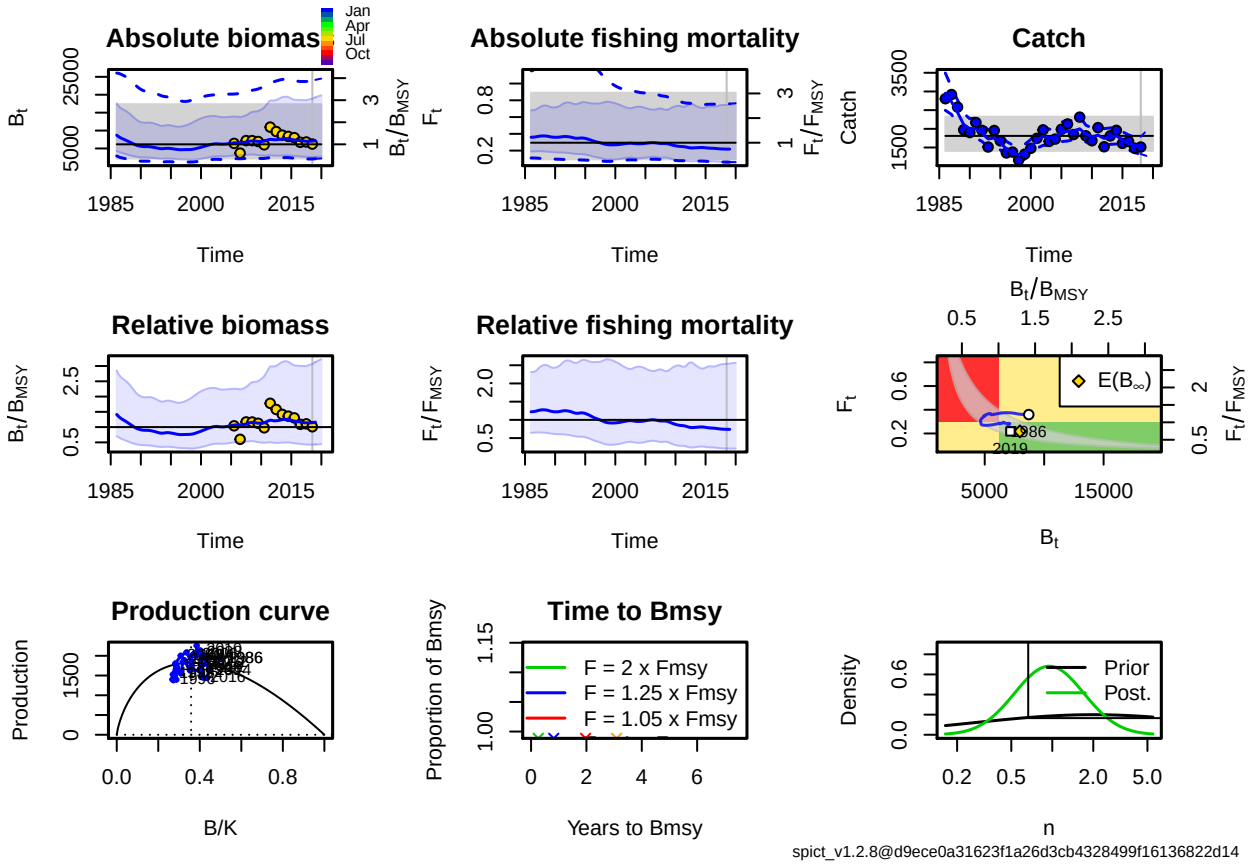
```
# Summary of estimates
round(sumspict.parest(res_pol89aBkfrac), 2)
```

```
##        estimate   cilow        ciupp log.est
## alpha      2.70    0.77 9.440000e+00    0.99
## beta       1.23    0.21 7.390000e+00    0.21
## r          0.28    0.06 1.260000e+00   -1.28
## rc         0.59    0.19 1.780000e+00   -0.53
## rold       5.45    0.00 2.726796e+10    1.70
## m       1823.53 1418.63 2.343990e+03    7.51
## K      17317.12 6004.69 4.994137e+04    9.76
## q          0.00    0.00 0.000000e+00  -10.93
## n          0.95    0.30 2.990000e+00   -0.05
## sdb        0.09    0.03 2.400000e-01   -2.46
## sdf        0.08    0.02 3.600000e-01   -2.56
## sdi        0.23    0.14 3.800000e-01   -1.47
## sdc        0.10    0.06 1.500000e-01   -2.35
```

```
# Reference points
sumspict.drefpoints(res_pol89aBkfrac)
```

```
##           estimate        cilow        ciupp   log.est
## Bmsyd 6204.0989196 2202.4784482 1.747615e+04  8.732965
## Fmsyd    0.2939227    0.0971846 8.889323e-01 -1.224439
## MSYd  1823.5252595 1418.6280869 2.343986e+03  7.508527
```

```
# Basic plotting of the results
plot(res_pol89aBkfrac)
```



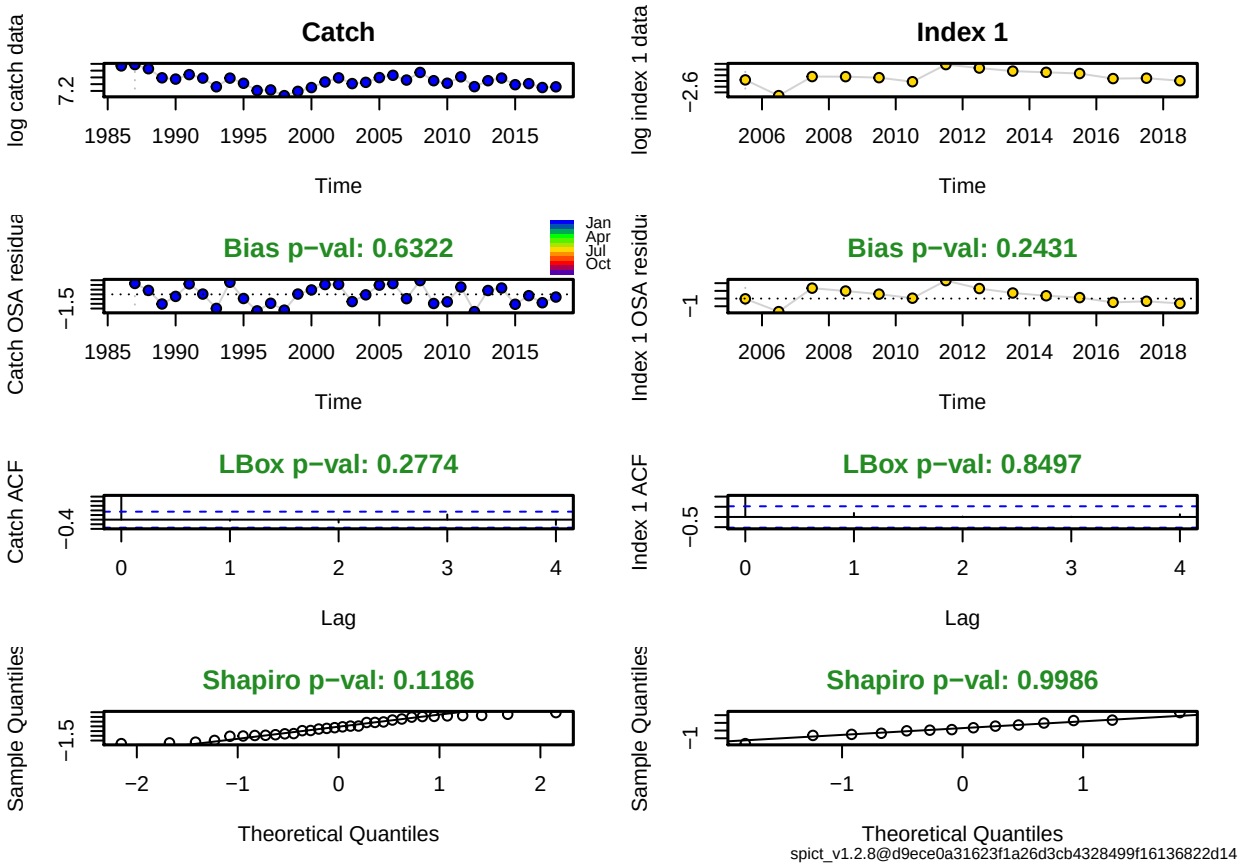

```
# Convergence checks

# Convergence
res_pol89aBkfrac$opt$convergence
```

```
## [1] 0
```

```
# All the sd were estimated
all(is.finite(res_pol89aBkfrac$sd))
```

```
## [1] TRUE
```

```
# No violation of assumptions: bias, correlation and normality:
res_pol89aBkfrac <- calc.osa.resid(res_pol89aBkfrac)
plotspict.diagnostic(res_pol89aBkfrac)
```



Retrospective: no trends and all runs inside the confidence intervals

Problems of convergence:

```
rep <- retro(res_pol89aBkfrac, nretroyear = 5)
```

```
## Error in calc.osa.resid(rep) :
##   Could not calculate OSA residuals because estimation did not converge.
```

Run 5:

- Fix parameter to Schaefer production curve (initial parameter). Symmetric productive curve (BMSY/K=0.5)
- Set priors for the ratio between biomass in the initial year relative to K, mean of log(0.5) and sd of 0.2

```
pol89aSchaefBkfrac <- pol89a
# Set priors for B/K
pol89aSchaefBkfrac$priors$logbkfrac <- c(log(0.5), 0.2, 1)
# Fixing n at 2
pol89aSchaefBkfrac$ini$logn <- log(2)
pol89aSchaefBkfrac$phases$logn <- -1

# Fit the model
```

```r
res_pol89aSchaefBkfrac <- fit.spict(pol89aSchaefBkfrac)
# Results
res_pol89aSchaefBkfrac
```

```
## Convergence: 0  MSG: relative convergence (4)
## Objective function at optimum: -4.0203638
## Euler time step (years):  1/16 or 0.0625
## Nobs C: 33,  Nobs I1: 14
##
## Priors
##       logn  ~  dnorm[log(2), 2^2]
##   logalpha  ~  dnorm[log(1), 2^2]
##    logbeta  ~  dnorm[log(1), 2^2]
##  logbkfrac  ~  dnorm[log(0.5), 0.2^2]
##
## Fixed parameters
##    fixed.value
##  n           2
##
## Model parameter estimates w 95% CI
##             estimate        cilow        ciupp     log.est
##  alpha  2.812626e+00    0.7084745 1.116606e+01   1.0341187
##  beta   1.076296e+00    0.3701895 3.129247e+00   0.0735260
##  r      5.874390e-01    0.1286586 2.682171e+00  -0.5319829
##  rc     5.874390e-01    0.1286586 2.682171e+00  -0.5319829
##  rold   5.874390e-01    0.1286586 2.682171e+00  -0.5319829
##  m      1.986494e+03 1581.8809432 2.494598e+03   7.5941264
##  K      1.352647e+04 3354.5637616 5.454221e+04   9.5124036
##  q      1.620000e-05    0.0000044 5.990000e-05 -11.0278153
##  sdb    7.838730e-02    0.0245496 2.502915e-01  -2.5460940
##  sdf    8.671620e-02    0.0366904 2.049499e-01  -2.4451146
##  sdi    2.204741e-01    0.1376418 3.531544e-01  -1.5119753
##  sdc    9.333230e-02    0.0608191 1.432268e-01  -2.3715886
##
## Deterministic reference points (Drp)
##            estimate        cilow        ciupp   log.est
##  Bmsyd 6763.2340197 1677.2818808 27271.107456  8.819256
##  Fmsyd    0.2937195    0.0643293     1.341086 -1.225130
##  MSYd  1986.4936495 1581.8809432  2494.597989  7.594126
## Stochastic reference points (Srp)
##            estimate        cilow        ciupp   log.est rel.diff.Drp
##  Bmsys 6714.6367749 1668.7061176 27018.746166  8.812045 -0.007237509
##  Fmsys    0.2922289    0.0636834     1.340974 -1.230218 -0.005100763
##  MSYs  1962.1382732 1548.5980763  2486.110930  7.581790 -0.012412671
##
## States w 95% CI (inp$msytype: s)
##                     estimate        cilow        ciupp    log.est
##  B_2018.50      8139.8643740 2369.9006831 2.795788e+04  9.0045288
##  F_2018.50         0.1890012    0.0541582 6.595765e-01 -1.6660020
##  B_2018.50/Bmsy    1.2122568    0.7340462 2.002008e+00  0.1924838
##  F_2018.50/Fmsy    0.6467574    0.3156222 1.325303e+00 -0.4357840
##
## Predictions w 95% CI (inp$msytype: s)
```

```
##                   prediction        cilow        ciupp    log.est
##  B_2019.00      8288.8393687 2458.2527164 2.794866e+04  9.0226652
##  F_2019.00         0.1886476    0.0539088 6.601503e-01 -1.6678744
##  B_2019.00/Bmsy    1.2344434    0.7446432 2.046417e+00  0.2106202
##  F_2019.00/Fmsy    0.6455475    0.3121745 1.334931e+00 -0.4376565
##  Catch_2019.00  1587.5324336 1269.3603387 1.985456e+03  7.3699362
##  E(B_inf)       9018.2679948           NA           NA  9.1070076
```

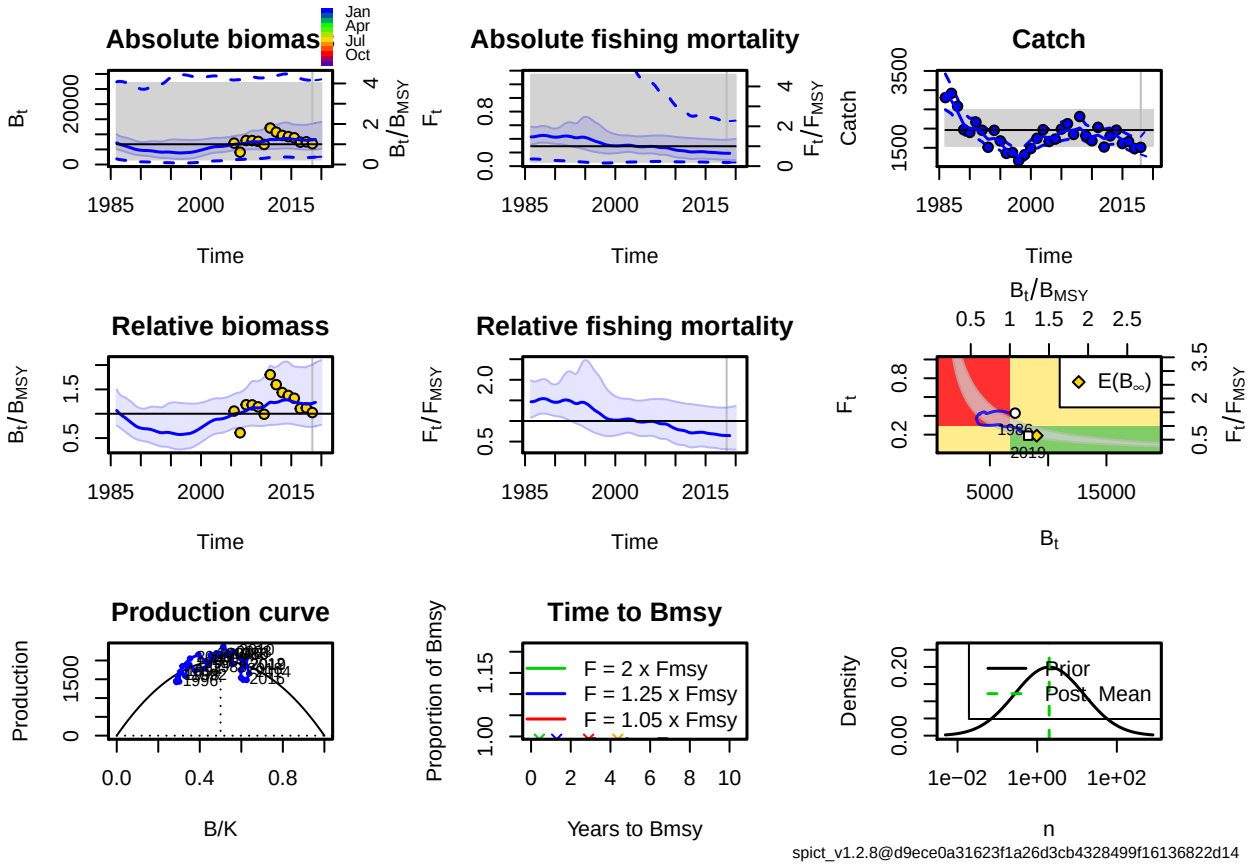
```
# Summary of estimates
round(sumspict.parest(res_pol89aSchaefBkfrac), 2)
```

```
##        estimate   cilow    ciupp log.est
## alpha      2.81    0.71    11.17    1.03
## beta       1.08    0.37     3.13    0.07
## r          0.59    0.13     2.68   -0.53
## rc         0.59    0.13     2.68   -0.53
## rold       0.59    0.13     2.68   -0.53
## m       1986.49 1581.88  2494.60    7.59
## K      13526.47 3354.56 54542.21    9.51
## q          0.00    0.00     0.00  -11.03
## sdb        0.08    0.02     0.25   -2.55
## sdf        0.09    0.04     0.20   -2.45
## sdi        0.22    0.14     0.35   -1.51
## sdc        0.09    0.06     0.14   -2.37
```

```
# Reference points
sumspict.drefpoints(res_pol89aSchaefBkfrac)
```

```
##           estimate        cilow        ciupp   log.est
## Bmsyd 6763.2340197 1.677282e+03 27271.107456  8.819256
## Fmsyd    0.2937195 6.432932e-02     1.341086 -1.225130
## MSYd  1986.4936495 1.581881e+03  2494.597989  7.594126
```

```
# Basic plotting of the results
plot(res_pol89aSchaefBkfrac)
```



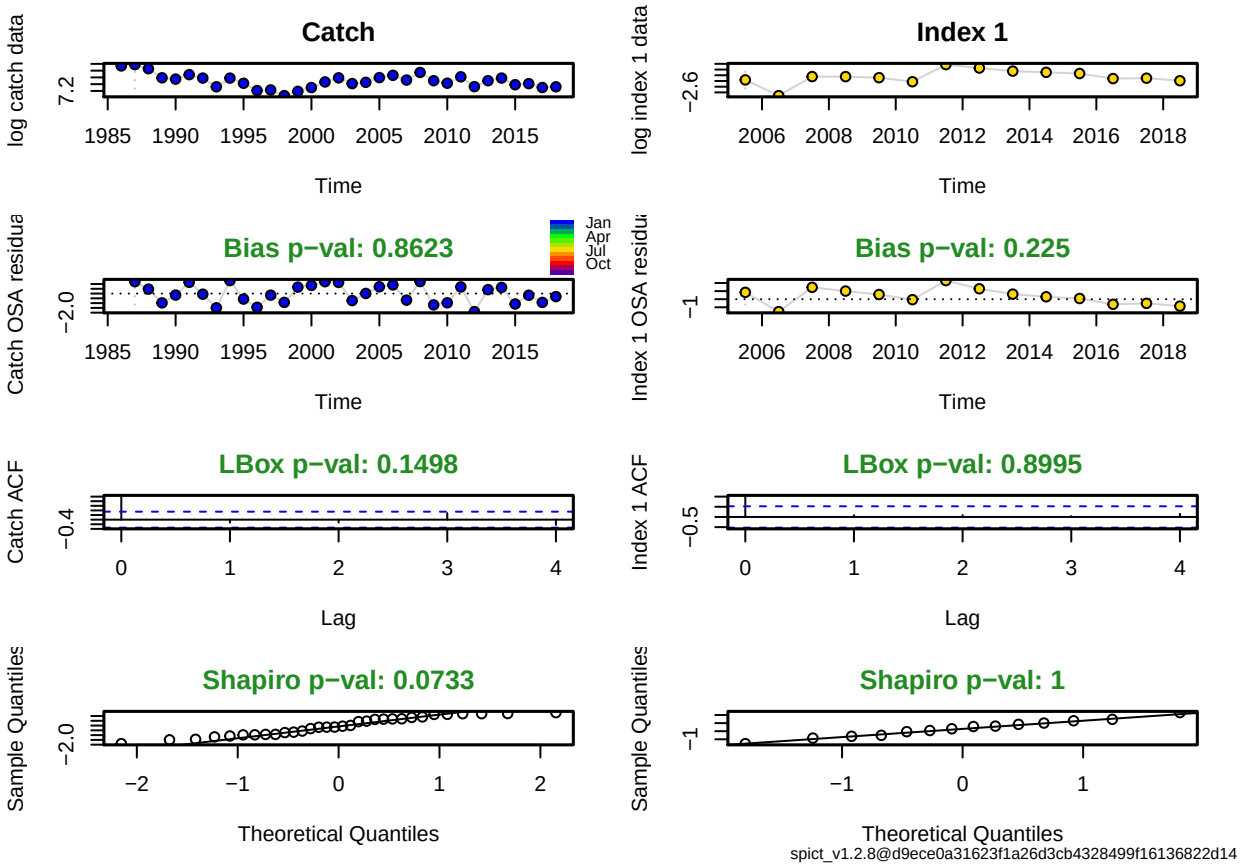

```
# Convergence checks

# Convergence
res_pol89aSchaefBkfrac$opt$convergence
```

```
## [1] 0
```

```
# All the sd were estimated
all(is.finite(res_pol89aSchaefBkfrac$sd))
```

```
## [1] TRUE
```

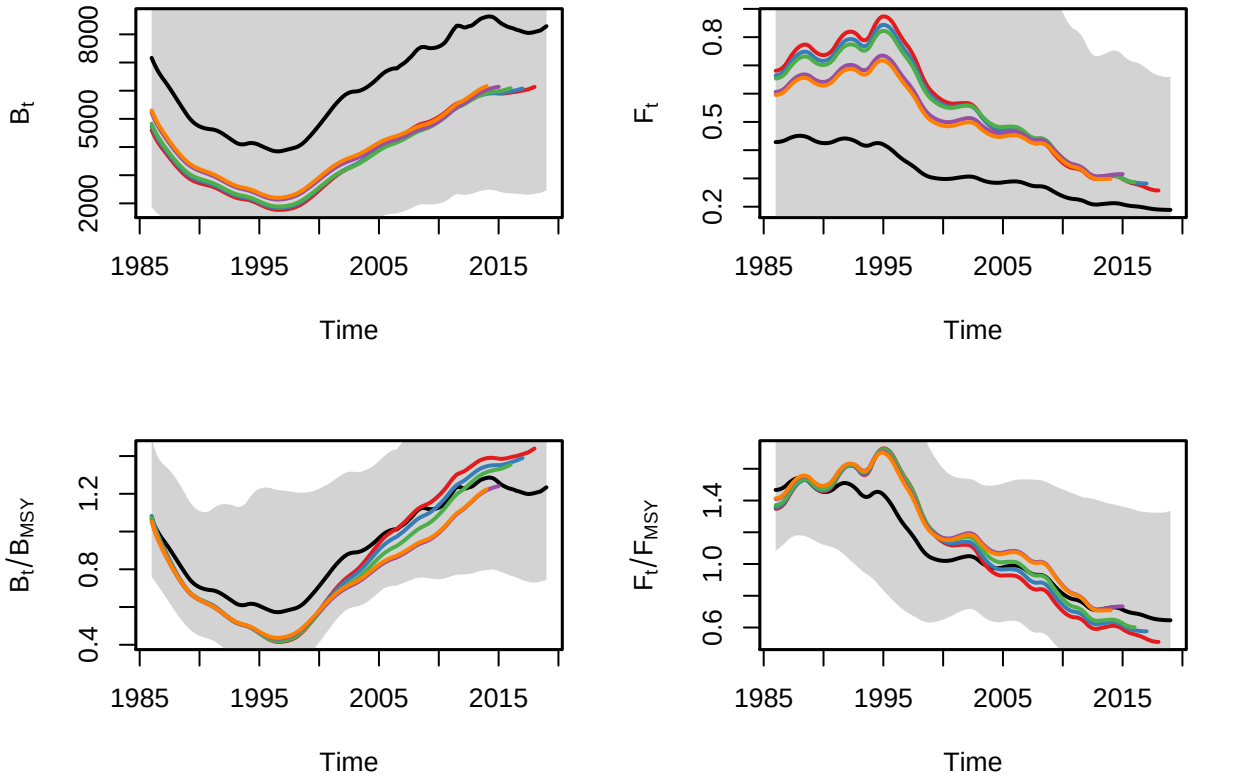
```
# No violation of assumptions: bias, correlation and normality:
res_pol89aSchaefBkfrac <- calc.osa.resid(res_pol89aSchaefBkfrac)
plotspict.diagnostic(res_pol89aSchaefBkfrac)
```



Retrospective: no trends and all runs inside the confidence intervals

All runs converge and estimates are inside the confidence intervals.
Problem with last year?. Trend changed relative to previous runs.

```
rep <- retro(res_pol89aSchaefBkfrac, nretroyear = 5)
plotspict.retro(rep)
```



Checking robustness to initial parameter values

All runs converged. It seems that there are two optima (see $resmat). 18 runs with the same realistic estimates; but 12 converged models with unrealistic estimates.

```
set.seed(123)
check.ini(pol89aSchaefBkfrac, ntrials = 30)
```

```
## Checking sensitivity of fit to initial parameter values...
##  Trial 1 ... model fitted!
##  Trial 2 ... model fitted!
##  Trial 3 ... model fitted!
##  Trial 4 ... model fitted!
##  Trial 5 ... model fitted!
##  Trial 6 ... model fitted!
##  Trial 7 ... model fitted!
##  Trial 8 ... model fitted!
##  Trial 9 ... model fitted!
##  Trial 10 ... model fitted!
##  Trial 11 ... model fitted!
##  Trial 12 ... model fitted!
##  Trial 13 ... model fitted!
##  Trial 14 ... model fitted!
##  Trial 15 ... model fitted!
##  Trial 16 ... model fitted!
```

```
##  Trial 17 ... model fitted!
##  Trial 18 ... model fitted!
##  Trial 19 ... model fitted!
##  Trial 20 ... model fitted!
##  Trial 21 ... model fitted!
##  Trial 22 ... model fitted!
##  Trial 23 ... model fitted!
##  Trial 24 ... model fitted!
##  Trial 25 ... model fitted!
##  Trial 26 ... model fitted!
##  Trial 27 ... model fitted!
##  Trial 28 ... model fitted!
##  Trial 29 ... model fitted!
##  Trial 30 ... model fitted!
## $propchng
##           logm  logK  logq logsdb logsdf logsdi logsdc
## Trial 1  -0.10  0.17  0.04  -1.10  -1.26   1.30  -0.08
## Trial 2   0.19  0.03  0.02  -1.31   0.13  -0.51  -0.21
## Trial 3  -0.20  0.24  0.11   1.31   0.49  -1.30  -1.11
## Trial 4   0.09  0.08 -0.21  -0.45  -0.60  -0.13  -0.27
## Trial 5  -0.10 -0.21 -0.19  -1.15  -0.55  -0.85   1.36
## Trial 6  -0.01  0.16  0.12   0.52   0.77   1.02   0.24
## Trial 7  -0.04 -0.08  0.15   1.03   0.76   0.10   0.67
## Trial 8   0.18 -0.27  0.02  -0.86   1.08  -0.17   0.84
## Trial 9  -0.18  0.15 -0.17   0.36  -0.47   1.16   0.33
## Trial 10 -0.11  0.19  0.02  -0.89  -0.89  -0.84   0.17
## Trial 11  0.13  0.08 -0.09   1.43   0.07   0.80   0.34
## Trial 12  0.06 -0.09  0.16   0.73  -0.48   0.24  -0.82
## Trial 13 -0.20 -0.04 -0.20  -1.12  -1.11   0.93   1.06
## Trial 14  0.08 -0.09 -0.07   0.51   0.89  -0.81   1.16
## Trial 15 -0.02  0.01 -0.04   0.48   0.03  -1.30   0.05
## Trial 16  0.19  0.25 -0.05   0.26   1.01  -1.25   0.57
## Trial 17 -0.22  0.27 -0.09   1.02  -0.14  -1.30  -0.24
## Trial 18 -0.05  0.09  0.08   0.55   0.80   0.37  -1.39
## Trial 19 -0.17 -0.25  0.15  -0.54  -0.34  -1.12  -0.50
## Trial 20  0.12  0.01 -0.07  -0.92  -0.82  -1.37   0.17
## Trial 21 -0.09 -0.05  0.21   0.90  -0.98   0.77   0.75
## Trial 22 -0.21 -0.15 -0.10  -0.99   0.01   0.32   0.73
## Trial 23 -0.19 -0.07 -0.03   0.81   0.16   0.81  -0.01
## Trial 24 -0.07  0.09  0.05   0.41  -0.10  -0.69   0.80
## Trial 25 -0.04 -0.14 -0.05   0.90  -1.04  -0.71  -0.48
## Trial 26  0.06 -0.08 -0.01  -1.07  -0.23  -0.97   0.54
## Trial 27  0.10 -0.14 -0.04   0.05   0.67  -0.18  -1.18
## Trial 28  0.20 -0.14  0.07  -1.39  -0.34  -1.25   0.10
## Trial 29 -0.05  0.10  0.15  -0.21   0.75  -1.32  -0.29
## Trial 30  0.01 -0.06 -0.16   0.39   0.61   0.94   0.94
##
## $inimat
##          Distance  logK logm   logq logsdb logsdf logsdi logsdc
## Basevec      0.00  9.36 7.62 -10.99  -1.61  -1.61  -1.61  -1.61
## Trial 1      3.81  8.39 8.95 -11.41   0.15   0.42  -3.70  -1.48
## Trial 2      2.94 11.17 7.86 -11.19   0.49  -1.82  -0.79  -1.27
## Trial 3      4.56  7.54 9.47 -12.16  -3.72  -2.40   0.48   0.18
## Trial 4      2.84 10.25 8.27  -8.72  -0.89  -0.65  -1.41  -1.18
```

```
## Trial 5      4.36  8.39 6.00  -8.86   0.24  -0.73  -0.25  -3.80
## Trial 6      2.87  9.26 8.81 -12.30  -2.45  -2.85  -3.25  -2.00
## Trial 7      2.92  8.97 7.02 -12.59  -3.27  -2.84  -1.77  -2.69
## Trial 8      3.74 11.01 5.53 -11.26  -0.23  -3.35  -1.33  -2.96
## Trial 9      3.51  7.65 8.79  -9.17  -2.19  -0.85  -3.48  -2.14
## Trial 10     3.04  8.33 9.07 -11.23  -0.18  -0.17  -0.25  -1.89
## Trial 11     3.15 10.54 8.22 -10.02  -3.91  -1.72  -2.90  -2.16
## Trial 12     2.80  9.88 6.94 -12.78  -2.79  -0.84  -1.99  -0.28
## Trial 13     4.47  7.54 7.32  -8.76   0.20   0.17  -3.11  -3.31
## Trial 14     3.08 10.07 6.90 -10.27  -2.44  -3.05  -0.31  -3.48
## Trial 15     2.28  9.21 7.68 -10.53  -2.38  -1.66   0.48  -1.69
## Trial 16     3.85 11.16 9.53 -10.49  -2.02  -3.23   0.40  -2.52
## Trial 17     4.08  7.34 9.69  -9.98  -3.26  -1.38   0.48  -1.22
## Trial 18     3.02  8.93 8.31 -11.82  -2.49  -2.90  -2.21   0.62
## Trial 19     3.71  7.77 5.74 -12.64  -0.73  -1.06   0.19  -0.81
## Trial 20     3.26 10.46 7.72 -10.26  -0.13  -0.29   0.60  -1.89
## Trial 21     3.69  8.50 7.21 -13.25  -3.07  -0.03  -2.85  -2.81
## Trial 22     3.24  7.42 6.45  -9.92  -0.01  -1.62  -2.13  -2.78
## Trial 23     2.65  7.57 7.12 -10.66  -2.91  -1.86  -2.91  -1.60
## Trial 24     2.15  8.69 8.32 -11.57  -2.28  -1.45  -0.50  -2.89
## Trial 25     2.92  8.96 6.55 -10.39  -3.07   0.07  -0.47  -0.83
## Trial 26     2.64  9.91 7.04 -10.85   0.12  -1.23  -0.04  -2.47
## Trial 27     2.68 10.32 6.54 -10.56  -1.70  -2.69  -1.31   0.29
## Trial 28     3.82 11.22 6.58 -11.81   0.63  -1.06   0.40  -1.76
## Trial 29     3.10  8.94 8.36 -12.59  -1.27  -2.81   0.52  -1.14
## Trial 30     3.03  9.43 7.18  -9.24  -2.24  -2.58  -3.13  -3.12
##
## $resmat
##          Distance       m        K q  sdb  sdf  sdi  sdc
## Basevec      0.00 1986.49 13526.47 0 0.08 0.09 0.22 0.09
## Trial 1      0.00 1986.49 13526.46 0 0.08 0.09 0.22 0.09
## Trial 2      0.12 1986.49 13526.59 0 0.08 0.09 0.22 0.09
## Trial 3  13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 4      0.03 1986.49 13526.50 0 0.08 0.09 0.22 0.09
## Trial 5      0.05 1986.49 13526.51 0 0.08 0.09 0.22 0.09
## Trial 6      0.06 1986.49 13526.53 0 0.08 0.09 0.22 0.09
## Trial 7      0.12 1986.49 13526.59 0 0.08 0.09 0.22 0.09
## Trial 8      0.00 1986.49 13526.47 0 0.08 0.09 0.22 0.09
## Trial 9  13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 10 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 11     0.01 1986.49 13526.48 0 0.08 0.09 0.22 0.09
## Trial 12     0.03 1986.49 13526.43 0 0.08 0.09 0.22 0.09
## Trial 13 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 14     0.04 1986.49 13526.50 0 0.08 0.09 0.22 0.09
## Trial 15     0.01 1986.49 13526.45 0 0.08 0.09 0.22 0.09
## Trial 16 13108.71 3358.29   489.73 0 0.23 0.13 0.23 0.09
## Trial 17 13108.71 3358.29   489.73 0 0.23 0.13 0.23 0.09
## Trial 18 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 19     0.00 1986.49 13526.47 0 0.08 0.09 0.22 0.09
## Trial 20     0.01 1986.49 13526.47 0 0.08 0.09 0.22 0.09
## Trial 21 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 22 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 23 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 24 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
```

```
## Trial 25 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 26     0.03 1986.49 13526.50 0 0.08 0.09 0.22 0.09
## Trial 27     0.09 1986.49 13526.38 0 0.08 0.09 0.22 0.09
## Trial 28     0.11 1986.49 13526.58 0 0.08 0.09 0.22 0.09
## Trial 29 13108.71 3358.30   489.74 0 0.23 0.13 0.23 0.09
## Trial 30     0.04 1986.49 13526.43 0 0.08 0.09 0.22 0.09

## Catch observations:
##  [1] 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
## [16] 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
## [31] 2016 2017 2018
##  [1] 2806 2918 2582 1973 1900 2168 1958 1513 1955 1679 1354 1378 1165 1322 1479
## [16] 1746 1972 1663 1726 1986 2126 1847 2313 1812 1682 2032 1520 1811 1959 1610
## [31] 1661 1481 1512
## Index observations:
## [[1]]
##  [1] 2005.5 2006.5 2007.5 2008.5 2009.5 2010.5 2011.5 2012.5 2013.5 2014.5
## [11] 2015.5 2016.5 2017.5 2018.5
##
## [[1]]
##  [1] 0.1151 0.0663 0.1292 0.1289 0.1244 0.1079 0.1966 0.1743 0.1565 0.1500
## [11] 0.1438 0.1205 0.1222 0.1117
```

Questions for Workshop - September2020:

Run 5, that fixes n of productive curve (BMSY/K= 0.5) and uses priors for B1/K, converged well and the output estimates are realistic. However, the model is sensitive to initial values and the confidence intervals are quite wide.

1. How the robustness can be improved?. To address the sensitivity to initial values.
2. Acting (fixing, set priors) on alfa and/or beta could help to narrow the confidence intervals?