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05/02/2020

## Introduction

This working document present a series of different assessments using the surplus production model in continous time (SPiCT; Pedersen2016) available as an R package (<https://github.com/DTUAqua/spict>).

## Read in the data

# devtools::install\_github("DTUAqua/spict/spict")  
library(spict)  
  
## Read in the data  
dat <- readxl::read\_xlsx("D:/GIT/wk\_WKGSS/aru.27.5b6a/data/ARU\_indices 20200205.xlsx")  
  
## run retro or not   
runretro <- FALSE

## Scenario 1

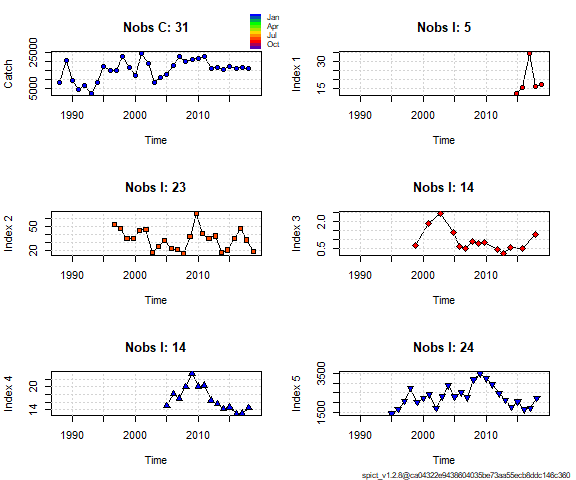
Input data for Scenario 1

|  |  |  |  |
| --- | --- | --- | --- |
| Input data | Name | Range | Notes |
| Catch | Total catch | 1988-2018 |  |
| Biomass indices | Faroe DW survey Faroe Summer survey Scottish DW survey CPUE\_comb CPUE\_FO | 2014-2018 2005-2018 2005-2018 2005-2018 1995-2018 | Some missing years |
|  |  |  | Default priors |

## Make the input list  
inp1 <- list(timeC = dat$year, ## Timing of catch  
 obsC = dat$catch, ## Observed catches  
 timeI = list(dat$year + dat$FO\_DW\_month / 12, ## Timing of FO\_DW survey index  
 dat$year + dat$FO\_SS\_month / 12,  
 dat$year + dat$SC\_DW\_month / 12,  
 dat$year,  
 dat$year),  
 obsI = list(dat$FO\_DW, ## Observed indices  
 dat$FO\_SS,  
 dat$SC\_DW,  
 dat$CPUE\_comb,  
 dat$CPUE\_FO),  
 optimiser.control = list(iter.max = 1e5, ## Optimiser options   
 eval.max = 1e5), ## sometimes help converge  
 priors = list( ## List of priors (empty, i.e. default priors)  
 ## see possible priors with  
 ## list.possible.priors()  
 ))  
## Check input time series, remove missing and zero observations  
inp1 <- check.inp(inp1)

## Removing zero, negative, and NAs in I series 1   
## Removing zero, negative, and NAs in I series 2   
## Removing zero, negative, and NAs in I series 3   
## Removing zero, negative, and NAs in I series 4   
## Removing zero, negative, and NAs in I series 5

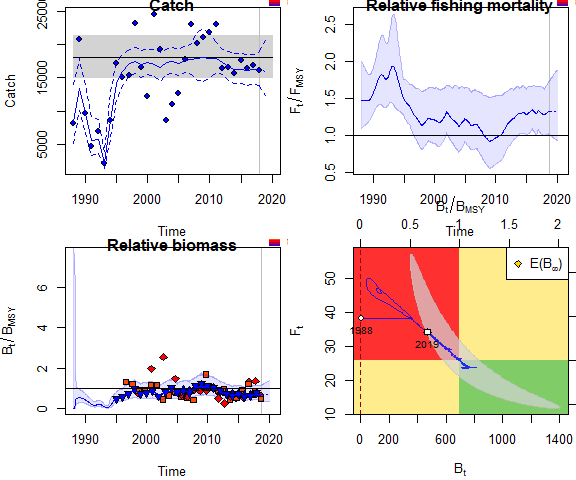
## Plot input data  
plotspict.data(inp1)



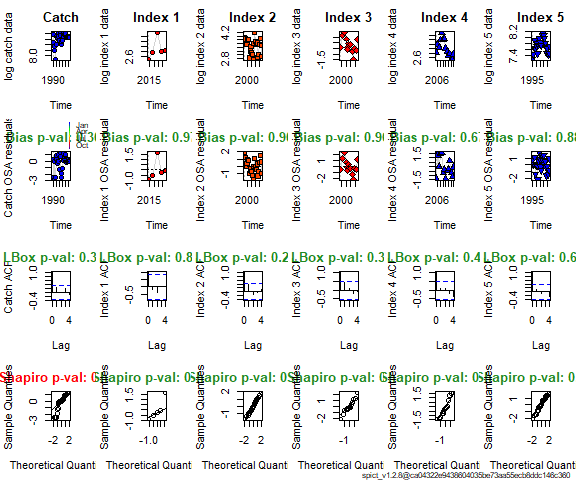
## Fit spict  
fit1<- fit.spict(inp1)  
  
## Summary of the fit - in the vignette there is a line-by-line description of that summary  
fit1

## Convergence: 0 MSG: relative convergence (4)  
## Objective function at optimum: 36.085824  
## Euler time step (years): 1/16 or 0.0625  
## Nobs C: 31, Nobs I1: 5, Nobs I2: 23, Nobs I3: 14, Nobs I4: 14, Nobs I5: 24  
##   
## Priors  
## logn ~ dnorm[log(2), 2^2]  
## logalpha ~ dnorm[log(1), 2^2]  
## logbeta ~ dnorm[log(1), 2^2]  
##   
## Model parameter estimates w 95% CI   
## estimate cilow ciupp log.est   
## alpha1 2.000034e+00 3.866928e-01 1.034448e+01 0.6931640   
## alpha2 2.146276e+00 4.564693e-01 1.009160e+01 0.7637345   
## alpha3 3.345173e+00 7.088712e-01 1.578591e+01 1.2075183   
## alpha4 1.348882e-01 1.466560e-02 1.240647e+00 -2.0033091   
## alpha5 4.757903e-01 9.630540e-02 2.350608e+00 -0.7427781   
## beta 2.465085e+00 9.321886e-01 6.518688e+00 0.9022265   
## r 5.294546e+01 2.360320e+01 1.187645e+02 3.9692623   
## rc 5.157375e+01 2.727307e+01 9.752668e+01 3.9430129   
## rold 5.027133e+01 2.568973e+01 9.837421e+01 3.9174350   
## m 1.797545e+04 1.509867e+04 2.140036e+04 9.7967625   
## K 1.380165e+03 7.580043e+02 2.512989e+03 7.2299586   
## q1 3.676630e-02 1.448000e-02 9.335380e-02 -3.3031735   
## q2 5.585900e-02 2.296470e-02 1.358703e-01 -2.8849251   
## q3 1.372200e-03 5.417000e-04 3.476400e-03 -6.5913175   
## q4 2.868890e-02 1.197550e-02 6.872820e-02 -3.5512457   
## q5 4.091386e+00 1.706005e+00 9.812067e+00 1.4088838   
## n 2.053194e+00 1.392503e+00 3.027357e+00 0.7193966   
## sdb 1.784238e-01 3.946010e-02 8.067645e-01 -1.7235939   
## sdf 1.033904e-01 4.044140e-02 2.643226e-01 -2.2692431   
## sdi1 3.568535e-01 1.862594e-01 6.836938e-01 -1.0304299   
## sdi2 3.829467e-01 2.801666e-01 5.234321e-01 -0.9598594   
## sdi3 5.968583e-01 4.097163e-01 8.694791e-01 -0.5160756   
## sdi4 2.406730e-02 4.308200e-03 1.344486e-01 -3.7269030   
## sdi5 8.489230e-02 5.450190e-02 1.322284e-01 -2.4663720   
## sdc 2.548662e-01 1.907223e-01 3.405830e-01 -1.3670167   
##   
## Deterministic reference points (Drp)  
## estimate cilow ciupp log.est   
## Bmsyd 697.07759 398.34305 1219.84598 6.546897   
## Fmsyd 25.78688 13.63654 48.76334 3.249866   
## MSYd 17975.45428 15098.67118 21400.35720 9.796762   
## Stochastic reference points (Srp)  
## estimate cilow ciupp log.est rel.diff.Drp   
## Bmsys 697.07502 398.34417 1219.83357 6.546893 -3.678284e-06   
## Fmsys 25.78835 13.63896 48.76024 3.249923 5.695452e-05   
## MSYs 17976.41202 15100.20970 21400.45704 9.796816 5.327777e-05   
##   
## States w 95% CI (inp$msytype: s)  
## estimate cilow ciupp log.est   
## B\_2018.75 468.1404476 185.6304089 1180.601174 6.1487684   
## F\_2018.75 34.1581803 15.2058838 76.732224 3.5310021   
## B\_2018.75/Bmsy 0.6715783 0.3901532 1.156001 -0.3981247   
## F\_2018.75/Fmsy 1.3245588 1.0115159 1.734482 0.2810794   
##   
## Predictions w 95% CI (inp$msytype: s)  
## prediction cilow ciupp log.est   
## B\_2019.00 468.101896 1.812300e+02 1209.068078 6.1486860   
## F\_2019.00 34.158252 1.510984e+01 77.220281 3.5310042   
## B\_2019.00/Bmsy 0.671523 3.754796e-01 1.200979 -0.3982070   
## F\_2019.00/Fmsy 1.324562 9.930553e-01 1.766733 0.2810815   
## Catch\_2019.00 15989.509668 1.241870e+04 20587.052016 9.6796881   
## E(B\_inf) 467.691835 NA NA 6.1478096

## If the model converged, it reports convergence as 0  
## Continue with plotting and diagnostics only if convergence was reached  
converged <- fit1$opt$convergence == 0  
  
if (converged) {  
 ## Calculate the One Step Ahead (osa) residuals   
 fit1 <- calc.osa.resid((fit1))  
   
 ## Make a plot showing relative F, relative B, Kobe plot catch   
 par(mfrow = c(2,2), ## 2x2 subplots  
 mar = c(4.1, 4.1, 0.5, 0.5)) ## Change default margins for the plots   
 plotspict.catch(fit1)  
 plotspict.ffmsy(fit1)  
 plotspict.bbmsy(fit1)  
 plotspict.fb(fit1)  
}



if (converged) {  
 plotspict.diagnostic(fit1)  
}



## If runretro is TRUE, run and plot the retrospective analysis  
 if (runretro & converged) {  
 fit1 <- retro(fit1)  
 plotspict.retro(fit1)  
 }

## Scenario 2

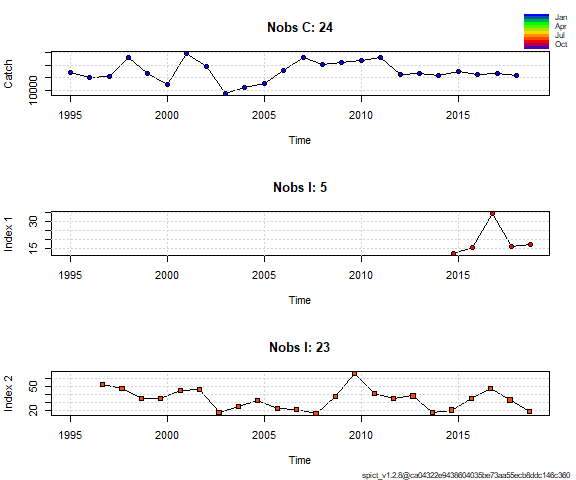
Input data for Scenario 2

|  |  |  |  |
| --- | --- | --- | --- |
| Input data | Name | Range | Notes |
| Catch | Total catch | 1995-2018 |  |
| Biomass indices | Faroe DW survey Faroe Summer survey | 2014-2018 2005-2018 |  |
|  |  |  | Default priors |

dat2 <- dplyr::filter(dat, year >= 1995)  
  
## Make the input list  
inp2 <- list(timeC = dat2$year, ## Timing of catch  
 obsC = dat2$catch, ## Observed catches  
 timeI = list(dat2$year + dat2$FO\_DW\_month / 12, ## Timing of FO\_DW survey index  
 dat2$year + dat2$FO\_SS\_month / 12),  
 obsI = list(dat2$FO\_DW, ## Observed indices  
 dat2$FO\_SS),  
 optimiser.control = list(iter.max = 1e5, ## Optimiser options   
 eval.max = 1e5), ## sometimes help converge  
 priors = list( ## List of priors (empty, i.e. default priors)  
 ## see possible priors with  
 ## list.possible.priors()  
 ))  
## Check input time series, remove missing and zero observations  
inp2 <- check.inp(inp2)

## Removing zero, negative, and NAs in I series 1   
## Removing zero, negative, and NAs in I series 2

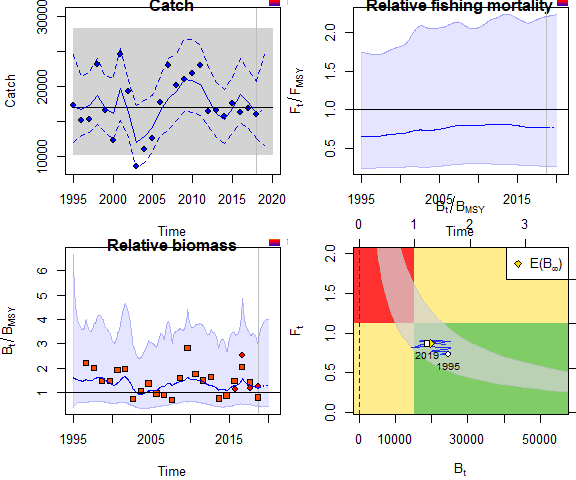
## Plot input data  
plotspict.data(inp2)



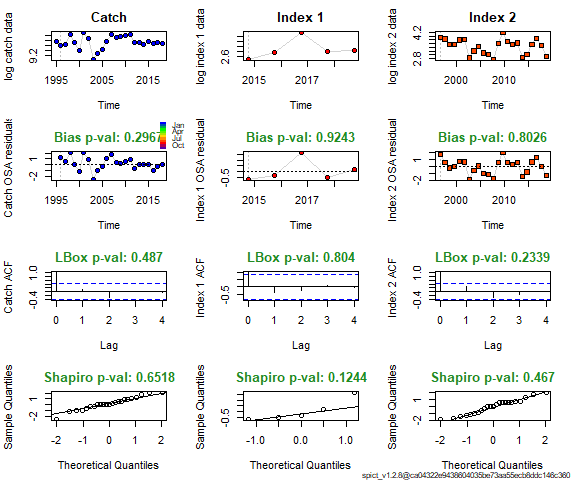
## Fit spict  
fit2 <- fit.spict(inp2)  
  
## Summary of the fit - in the vignette there is a line-by-line description of that summary  
fit2

## Convergence: 0 MSG: relative convergence (4)  
## Objective function at optimum: 29.0547601  
## Euler time step (years): 1/16 or 0.0625  
## Nobs C: 24, Nobs I1: 5, Nobs I2: 23  
##   
## Priors  
## logn ~ dnorm[log(2), 2^2]  
## logalpha ~ dnorm[log(1), 2^2]  
## logbeta ~ dnorm[log(1), 2^2]  
##   
## Model parameter estimates w 95% CI   
## estimate cilow ciupp log.est   
## alpha1 9.046111e-01 1.843659e-01 4.438572e+00 -0.1002501   
## alpha2 1.033889e+00 2.797207e-01 3.821406e+00 0.0333272   
## beta 2.726670e+00 3.852633e-01 1.929779e+01 1.0030811   
## r 2.538385e+00 2.705830e-01 2.381302e+01 0.9315280   
## rc 2.195022e+00 2.900727e-01 1.661005e+01 0.7861923   
## rold 1.933484e+00 1.037340e-01 3.603794e+01 0.6593234   
## m 1.937737e+04 1.156897e+04 3.245600e+04 9.8718611   
## K 3.343930e+04 4.507097e+03 2.480947e+05 10.4174871   
## q1 8.994000e-04 7.280000e-05 1.111240e-02 -7.0137299   
## q2 1.521800e-03 1.292000e-04 1.791950e-02 -6.4878862   
## n 2.312856e+00 3.255398e-01 1.643209e+01 0.8384830   
## sdb 3.201309e-01 9.819110e-02 1.043717e+00 -1.1390255   
## sdf 6.764390e-02 1.070960e-02 4.272525e-01 -2.6934974   
## sdi1 2.895939e-01 1.286649e-01 6.518066e-01 -1.2392756   
## sdi2 3.309797e-01 2.227826e-01 4.917240e-01 -1.1056982   
## sdc 1.844427e-01 1.100022e-01 3.092585e-01 -1.6904163   
##   
## Deterministic reference points (Drp)  
## estimate cilow ciupp log.est   
## Bmsyd 17655.735762 1.889688e+03 1.649611e+05 9.7788160   
## Fmsyd 1.097511 1.450364e-01 8.305026e+00 0.0930451   
## MSYd 19377.367815 1.156897e+04 3.245600e+04 9.8718611   
## Stochastic reference points (Srp)  
## estimate cilow ciupp log.est rel.diff.Drp   
## Bmsys 15284.046604 8.650359e+02 270048.99517 9.6345649 -0.15517416   
## Fmsys 1.113619 1.005156e-01 12.33786 0.1076153 0.01446463   
## MSYs 17058.811826 1.027238e+04 28328.67828 9.7444222 -0.13591544   
##   
## States w 95% CI (inp$msytype: s)  
## estimate cilow ciupp log.est   
## B\_2018.75 1.810999e+04 1390.6041623 2.358483e+05 9.8042188   
## F\_2018.75 8.684508e-01 0.0682085 1.105738e+01 -0.1410443   
## B\_2018.75/Bmsy 1.184895e+00 0.4472451 3.139164e+00 0.1696539   
## F\_2018.75/Fmsy 7.798454e-01 0.2762384 2.201572e+00 -0.2486596   
##   
## Predictions w 95% CI (inp$msytype: s)  
## prediction cilow ciupp log.est   
## B\_2019.00 1.872233e+04 1.459964e+03 2.400919e+05 9.8374722   
## F\_2019.00 8.684380e-01 6.815010e-02 1.106652e+01 -0.1410591   
## B\_2019.00/Bmsy 1.224959e+00 4.266800e-01 3.516744e+00 0.2029074   
## F\_2019.00/Fmsy 7.798339e-01 2.756616e-01 2.206113e+00 -0.2486744   
## Catch\_2019.00 1.688152e+04 1.164041e+04 2.448245e+04 9.7339749   
## E(B\_inf) 1.965418e+04 NA NA 9.8860453

## If the model converged, it reports convergence as 0  
## Continue with plotting and diagnostics only if convergence was reached  
converged <- fit2$opt$convergence == 0  
  
if (converged) {  
 ## Calculate the One Step Ahead (osa) residuals   
 fit2 <- calc.osa.resid((fit2))  
   
 ## Make a plot showing relative F, relative B, Kobe plot catch   
 par(mfrow = c(2,2), ## 2x2 subplots  
 mar = c(4.1, 4.1, 0.5, 0.5)) ## Change default margins for the plots   
 plotspict.catch(fit2)  
 plotspict.ffmsy(fit2)  
 plotspict.bbmsy(fit2)  
 plotspict.fb(fit2)  
}



if (converged) {  
 plotspict.diagnostic(fit2)  
}



## If runretro is TRUE, run and plot the retrospective analysis  
 if (runretro & converged) {  
 fit <- retro(fit2)  
 plotspict.retro(fit2)  
 }

## Scenario 3

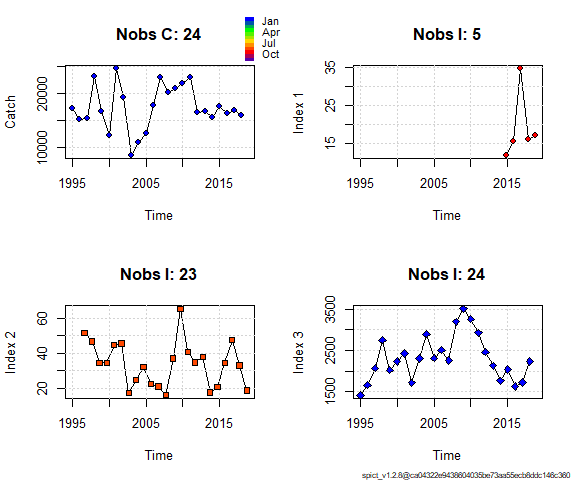
Input data for Scenario 3

|  |  |  |  |
| --- | --- | --- | --- |
| Input data | Name | Range | Notes |
| Catch | Total catch | 1995-2018 |  |
| Biomass indices | Faroe DW survey Faroe Summer survey CPUE\_FO | 2014-2018 2005-2018 1995-2018 |  |
|  |  |  | Default priors |

dat2 <- dplyr::filter(dat, year >= 1995)  
  
## Make the input list  
inp3 <- list(timeC = dat2$year, ## Timing of catch  
 obsC = dat2$catch, ## Observed catches  
 timeI = list(dat2$year + dat2$FO\_DW\_month / 12, ## Timing of FO\_DW survey index  
 dat2$year + dat2$FO\_SS\_month / 12,  
 dat2$year),  
 obsI = list(dat2$FO\_DW, ## Observed indices  
 dat2$FO\_SS,  
 dat2$CPUE\_FO),  
 optimiser.control = list(iter.max = 1e5, ## Optimiser options   
 eval.max = 1e5), ## sometimes help converge  
 priors = list( ## List of priors (empty, i.e. default priors)  
 ## see possible priors with  
 ## list.possible.priors()  
 ))  
## Check input time series, remove missing and zero observations  
inp3 <- check.inp(inp3)

## Removing zero, negative, and NAs in I series 1   
## Removing zero, negative, and NAs in I series 2

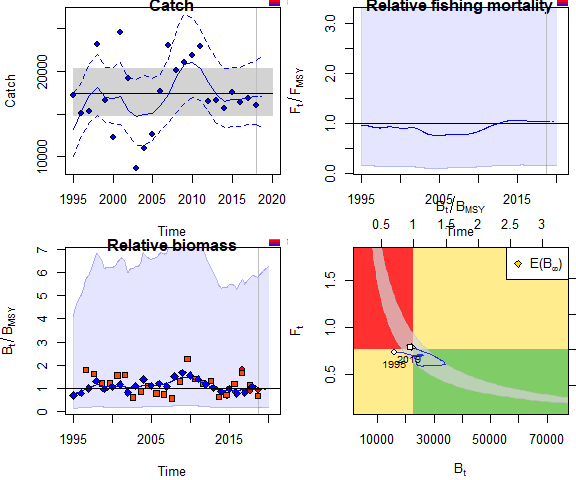
## Plot input data  
plotspict.data(inp3)



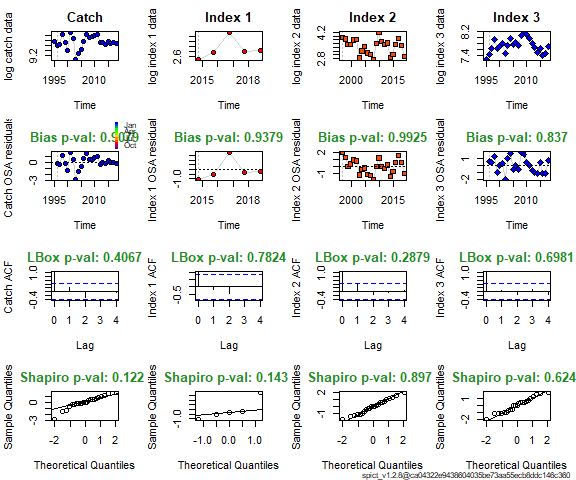
## Fit spict  
fit3 <- fit.spict(inp3)  
  
## Summary of the fit - in the vignette there is a line-by-line description of that summary  
fit3

## Convergence: 0 MSG: relative convergence (4)  
## Objective function at optimum: 27.2052913  
## Euler time step (years): 1/16 or 0.0625  
## Nobs C: 24, Nobs I1: 5, Nobs I2: 23, Nobs I3: 24  
##   
## Priors  
## logn ~ dnorm[log(2), 2^2]  
## logalpha ~ dnorm[log(1), 2^2]  
## logbeta ~ dnorm[log(1), 2^2]  
##   
## Model parameter estimates w 95% CI   
## estimate cilow ciupp log.est   
## alpha1 2.584176e+00 9.625893e-01 6.937506e+00 0.9494069   
## alpha2 2.877510e+00 1.226169e+00 6.752794e+00 1.0569254   
## alpha3 9.250290e-01 3.375593e-01 2.534899e+00 -0.0779302   
## beta 2.320833e+00 6.227148e-01 8.649653e+00 0.8419262   
## r 4.248426e-01 3.148660e-02 5.732320e+00 -0.8560365   
## rc 1.521300e+00 3.799989e-01 6.090422e+00 0.4195652   
## rold 9.623271e-01 3.603800e-03 2.569725e+02 -0.0384008   
## m 1.749688e+04 1.488849e+04 2.056224e+04 9.7697778   
## K 8.605135e+04 1.471882e+04 5.030861e+05 11.3626995   
## q1 8.401000e-04 1.725000e-04 4.091100e-03 -7.0819314   
## q2 1.265300e-03 2.731000e-04 5.861200e-03 -6.6724539   
## q3 9.241870e-02 2.010460e-02 4.248381e-01 -2.3814265   
## n 5.585258e-01 4.457710e-02 6.998016e+00 -0.5824545   
## sdb 1.349748e-01 6.323320e-02 2.881111e-01 -2.0026671   
## sdf 9.480270e-02 2.836330e-02 3.168727e-01 -2.3559577   
## sdi1 3.487987e-01 1.857140e-01 6.550964e-01 -1.0532602   
## sdi2 3.883914e-01 2.847293e-01 5.297939e-01 -0.9457417   
## sdi3 1.248556e-01 7.430640e-02 2.097926e-01 -2.0805973   
## sdc 2.200212e-01 1.554110e-01 3.114924e-01 -1.5140314   
##   
## Deterministic reference points (Drp)  
## estimate cilow ciupp log.est   
## Bmsyd 23002.53588 5.917208e+03 89419.987942 10.043360   
## Fmsyd 0.76065 1.899995e-01 3.045211 -0.273582   
## MSYd 17496.87863 1.488849e+04 20562.240102 9.769778   
## Stochastic reference points (Srp)  
## estimate cilow ciupp log.est rel.diff.Drp   
## Bmsys 2.284049e+04 5.913763e+03 88215.944675 10.0362903 -0.007094495   
## Fmsys 7.619033e-01 1.911406e-01 3.037014 -0.2719356 0.001644976   
## MSYs 1.740245e+04 1.484114e+04 20405.799162 9.7643663 -0.005426127   
##   
## States w 95% CI (inp$msytype: s)  
## estimate cilow ciupp log.est   
## B\_2018.75 2.137316e+04 4357.5969872 1.048312e+05 9.9698914   
## F\_2018.75 7.895716e-01 0.1680962 3.708730e+00 -0.2362648   
## B\_2018.75/Bmsy 9.357575e-01 0.1502881 5.826422e+00 -0.0663989   
## F\_2018.75/Fmsy 1.036315e+00 0.1597862 6.721159e+00 0.0356709   
##   
## Predictions w 95% CI (inp$msytype: s)  
## prediction cilow ciupp log.est   
## B\_2019.00 2.145688e+04 4.323464e+03 1.064882e+05 9.9738007   
## F\_2019.00 7.893627e-01 1.675548e-01 3.718743e+00 -0.2365294   
## B\_2019.00/Bmsy 9.394229e-01 1.486802e-01 5.935660e+00 -0.0624896   
## F\_2019.00/Fmsy 1.036040e+00 1.593108e-01 6.737646e+00 0.0354062   
## Catch\_2019.00 1.703921e+04 1.317226e+04 2.204137e+04 9.7432723   
## E(B\_inf) 2.204868e+04 NA NA 10.0010081

## If the model converged, it reports convergence as 0  
## Continue with plotting and diagnostics only if convergence was reached  
converged <- fit3$opt$convergence == 0  
  
if (converged) {  
 ## Calculate the One Step Ahead (osa) residuals   
 fit3 <- calc.osa.resid((fit3))  
   
 ## Make a plot showing relative F, relative B, Kobe plot catch   
 par(mfrow = c(2,2), ## 2x2 subplots  
 mar = c(4.1, 4.1, 0.5, 0.5)) ## Change default margins for the plots   
   
 plotspict.catch(fit3)  
 plotspict.ffmsy(fit3)  
 plotspict.bbmsy(fit3)  
 plotspict.fb(fit3)  
}



if (converged) {  
 plotspict.diagnostic(fit3)  
}



## If runretro is TRUE, run and plot the retrospective analysis  
 if (runretro & converged) {  
 fit <- retro(fit3)  
 plotspict.retro(fit3)  
 }

## Scenario 4

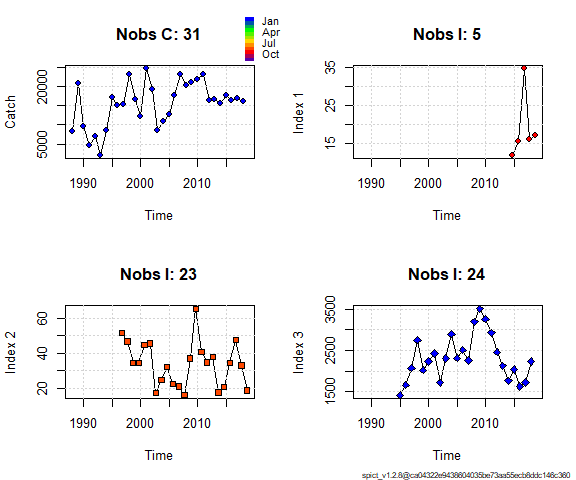
Input data for Scenario 3

|  |  |  |  |
| --- | --- | --- | --- |
| Input data | Name | Range | Notes |
| Catch | Total catch | 1988-2018 |  |
| Biomass indices | Faroe DW survey Faroe Summer survey CPUE\_FO | 2014-2018 2005-2018 1995-2018 |  |
|  |  |  | Default priors |

## Make the input list  
inp4 <- list(timeC = dat$year, ## Timing of catch  
 obsC = dat$catch, ## Observed catches  
 timeI = list(dat$year + dat$FO\_DW\_month / 12, ## Timing of FO\_DW survey index  
 dat$year + dat$FO\_SS\_month / 12,  
 dat$year),  
 obsI = list(dat$FO\_DW, ## Observed indices  
 dat$FO\_SS,  
 dat$CPUE\_FO),  
 optimiser.control = list(iter.max = 1e5, ## Optimiser options   
 eval.max = 1e5), ## sometimes help converge  
 priors = list( ## List of priors (empty, i.e. default priors)  
 ## see possible priors with  
 ## list.possible.priors()  
 ))  
## Check input time series, remove missing and zero observations  
inp4 <- check.inp(inp4)

## Removing zero, negative, and NAs in I series 1   
## Removing zero, negative, and NAs in I series 2   
## Removing zero, negative, and NAs in I series 3

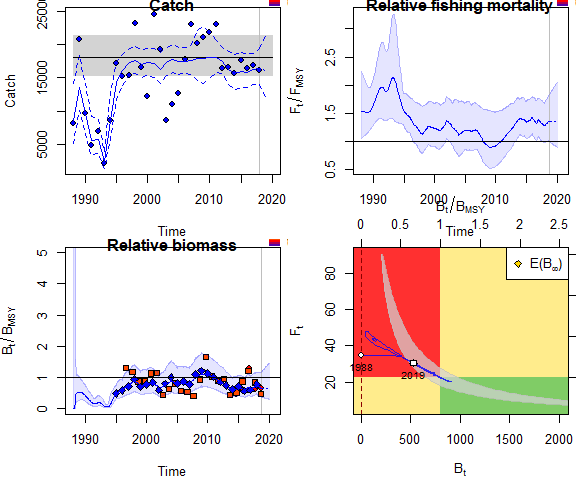
## Plot input data  
plotspict.data(inp4)



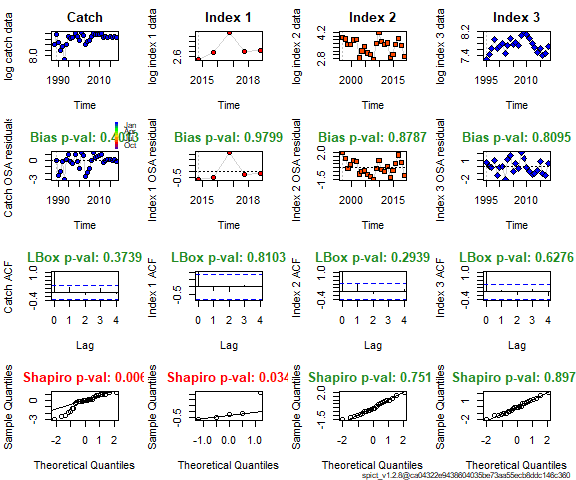
## Fit spict  
fit4<- fit.spict(inp4)  
  
## Summary of the fit - in the vignette there is a line-by-line description of that summary  
fit4

## Convergence: 0 MSG: relative convergence (4)  
## Objective function at optimum: 38.0387007  
## Euler time step (years): 1/16 or 0.0625  
## Nobs C: 31, Nobs I1: 5, Nobs I2: 23, Nobs I3: 24  
##   
## Priors  
## logn ~ dnorm[log(2), 2^2]  
## logalpha ~ dnorm[log(1), 2^2]  
## logbeta ~ dnorm[log(1), 2^2]  
##   
## Model parameter estimates w 95% CI   
## estimate cilow ciupp log.est   
## alpha1 2.000526e+00 2.601279e-01 1.538513e+01 0.6934099   
## alpha2 2.173176e+00 3.026325e-01 1.560537e+01 0.7761895   
## alpha3 4.565039e-01 3.667130e-02 5.682804e+00 -0.7841581   
## beta 2.001074e+00 7.233148e-01 5.536034e+00 0.6936838   
## r 4.150407e+01 1.058361e+01 1.627599e+02 3.7257914   
## rc 4.514179e+01 1.486387e+01 1.370963e+02 3.8098085   
## rold 4.947845e+01 1.778717e+01 1.376339e+02 3.9015373   
## m 1.807920e+04 1.528266e+04 2.138748e+04 9.8025176   
## K 1.655770e+03 5.197851e+02 5.274440e+03 7.4120216   
## q1 3.326970e-02 9.228200e-03 1.199445e-01 -3.4031075   
## q2 4.956030e-02 1.401410e-02 1.752678e-01 -3.0045656   
## q3 3.635913e+00 1.042181e+00 1.268481e+01 1.2908602   
## n 1.838831e+00 1.153873e+00 2.930391e+00 0.6091301   
## sdb 1.740550e-01 2.531220e-02 1.196862e+00 -1.7483837   
## sdf 1.281611e-01 4.750230e-02 3.457783e-01 -2.0544674   
## sdi1 3.482016e-01 1.767452e-01 6.859835e-01 -1.0549738   
## sdi2 3.782522e-01 2.737679e-01 5.226132e-01 -0.9721941   
## sdi3 7.945680e-02 1.559470e-02 4.048403e-01 -2.5325418   
## sdc 2.564597e-01 1.917805e-01 3.429525e-01 -1.3607836   
##   
## Deterministic reference points (Drp)  
## estimate cilow ciupp log.est   
## Bmsyd 800.9963 273.512403 2345.76203 6.685856   
## Fmsyd 22.5709 7.431937 68.54813 3.116661   
## MSYd 18079.2034 15282.659752 21387.48104 9.802518   
## Stochastic reference points (Srp)  
## estimate cilow ciupp log.est rel.diff.Drp   
## Bmsys 800.99834 273.508678 2345.80616 6.685859 2.597306e-06   
## Fmsys 22.57219 7.433481 68.54175 3.116719 5.739138e-05   
## MSYs 18080.28798 15284.158204 21387.95014 9.802578 5.998698e-05   
##   
## States w 95% CI (inp$msytype: s)  
## estimate cilow ciupp log.est   
## B\_2018.75 526.4844014 144.0375577 1924.399646 6.2662217   
## F\_2018.75 30.5324928 9.1394354 102.001171 3.4187915   
## B\_2018.75/Bmsy 0.6572853 0.3718344 1.161872 -0.4196372   
## F\_2018.75/Fmsy 1.3526597 1.0010982 1.827681 0.3020728   
##   
## Predictions w 95% CI (inp$msytype: s)  
## prediction cilow ciupp log.est   
## B\_2019.00 5.267328e+02 1.403771e+02 1976.443353 6.2666935   
## F\_2019.00 3.053230e+01 9.078561e+00 102.683839 3.4187852   
## B\_2019.00/Bmsy 6.575954e-01 3.533533e-01 1.223794 -0.4191654   
## F\_2019.00/Fmsy 1.352651e+00 9.761217e-01 1.874424 0.3020666   
## Catch\_2019.00 1.608238e+04 1.223945e+04 21131.894727 9.6854793   
## E(B\_inf) 5.263698e+02 NA NA 6.2660041

## If the model converged, it reports convergence as 0  
## Continue with plotting and diagnostics only if convergence was reached  
converged <- fit4$opt$convergence == 0  
  
if (converged) {  
 ## Calculate the One Step Ahead (osa) residuals   
 fit4 <- calc.osa.resid((fit4))  
   
 ## Make a plot showing relative F, relative B, Kobe plot catch   
 par(mfrow = c(2,2), ## 2x2 subplots  
 mar = c(4.1, 4.1, 0.5, 0.5)) ## Change default margins for the plots   
   
 plotspict.catch(fit4)  
 plotspict.ffmsy(fit4)  
 plotspict.bbmsy(fit4)  
 plotspict.fb(fit4)  
}



if (converged) {  
 plotspict.diagnostic(fit4)  
}



## If runretro is TRUE, run and plot the retrospective analysis  
 if (runretro & converged) {  
 fit1 <- retro(fit4)  
 plotspict.retro(fit4)  
 }

## References