SPiCT scenarios for the Greater silver smelt (*Argentina silus*) in Subareas 1, 2, and 4, and Division 3.a (Northeast Arctic, North Sea, Skagerrak and Kattegat)

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Introduction

This working document present a series of different assessments using the surplus production model in continous time (SPiCT; Pedersen and Berg (2017)) available as an R package (https://github.com/DTUAqua/spict).

Read in the data

```r
library(spict)

## Read in the data
dat <- readxl::read_xlsx("../data/GSS_indices270120_AK.xlsx")
## Sum up the catches from each area to get the total catch
dat$catchTOT <- dat$catch1and2 + dat$catch3 + dat$catch4

## run retro or not
runretro <- FALSE
```

Scenario 1

Table 1: Input data for Scenario 1

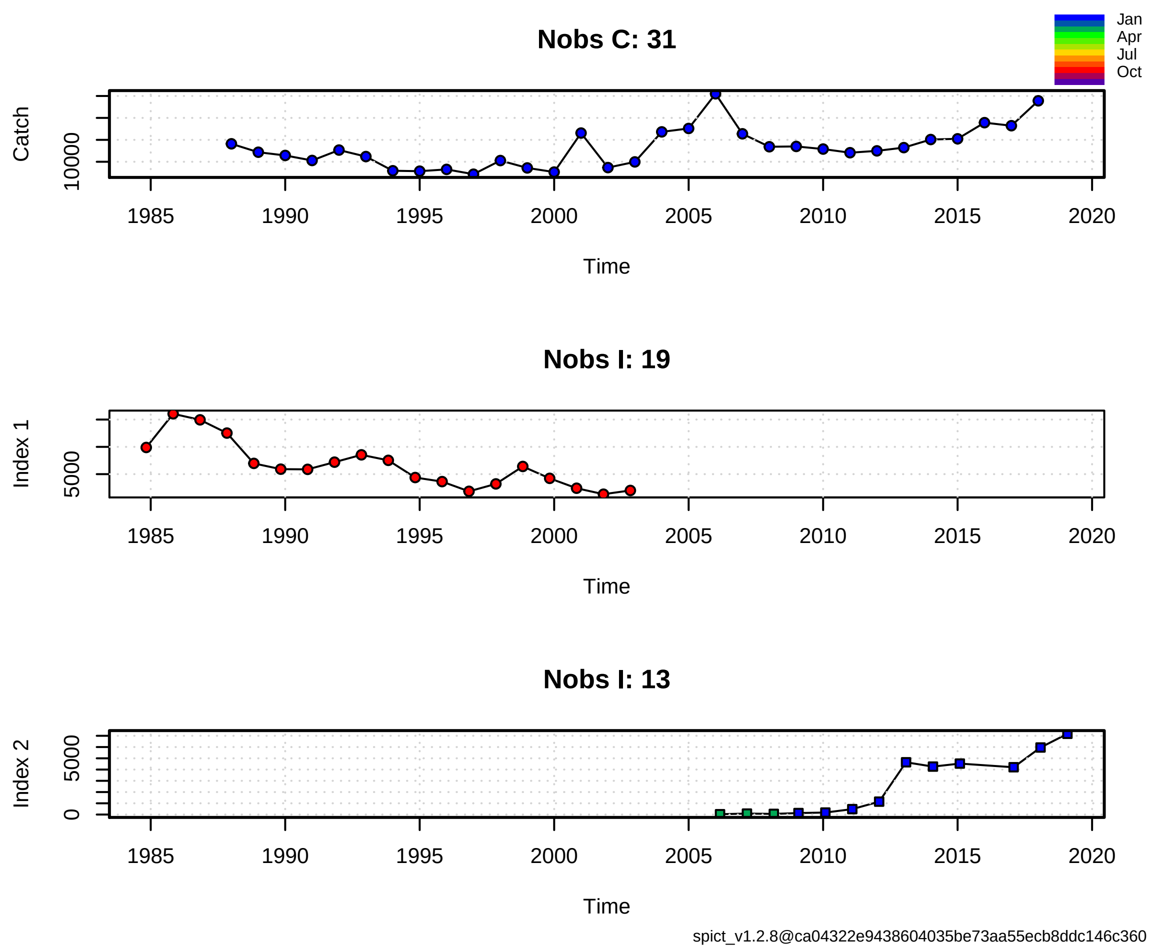
Input data	Name	Range	Notes
Catch	Total catch	1988-2018	
Biomass indices	Shrimp survey	1984–2002	Split in two periods
		2005–2018	
			Default priors

```r
## Choose only the years where the survey was in October
w <- !is.na(dat$northsea_month) & dat$northsea_month == 10
## Choose only the years where the survey was in January or February
v <- !is.na(dat$northsea_month) & dat$northsea_month %in% c(1, 2)
```

```
## Make the input list
inp_NS <- list(timeC = dat$year,                                    ## Timing of catch
               obsC = dat$catchTOT,                                 ## Observed catches
               timeI = list(dat$year[w] + dat$northsea_month[w] / 12, ## Timing of survey index
                            dat$year[v] + dat$northsea_month[v] / 12),
               obsI = list(dat$northsea_SA[w],                      ## Observed indices
                           dat$northsea_SA[v]),
               optimiser.control = list(iter.max = 1e5,             ## Optimiser options
                                        eval.max = 1e5),            ## sometimes help converge
               priors = list(                                       ## List of priors (empty, i.e. de
                                                                    ## see possible priors with list.
                 ))
## Check input time series, remove missing and zero observations
inp_NS <- check.inp(inp_NS)
```

```
## Removing zero, negative, and NAs in  C  series
```

```
## Plot input data
plotspict.data(inp_NS)
```

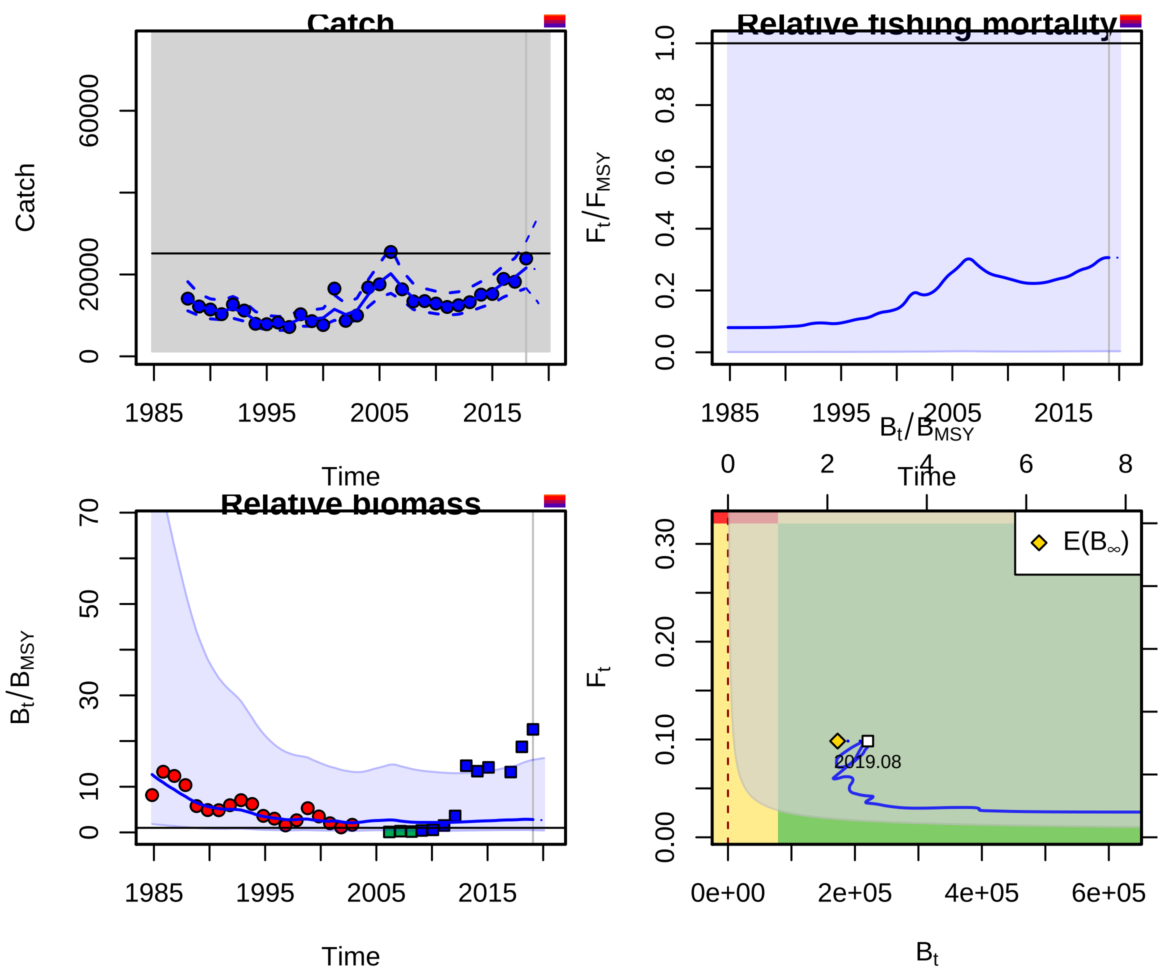


```r
## Fit spict
fit_NS <- fit.spict(inp_NS)

## Summary of the fit - in the vignette there is a line-by-line description of that summary
fit_NS
```

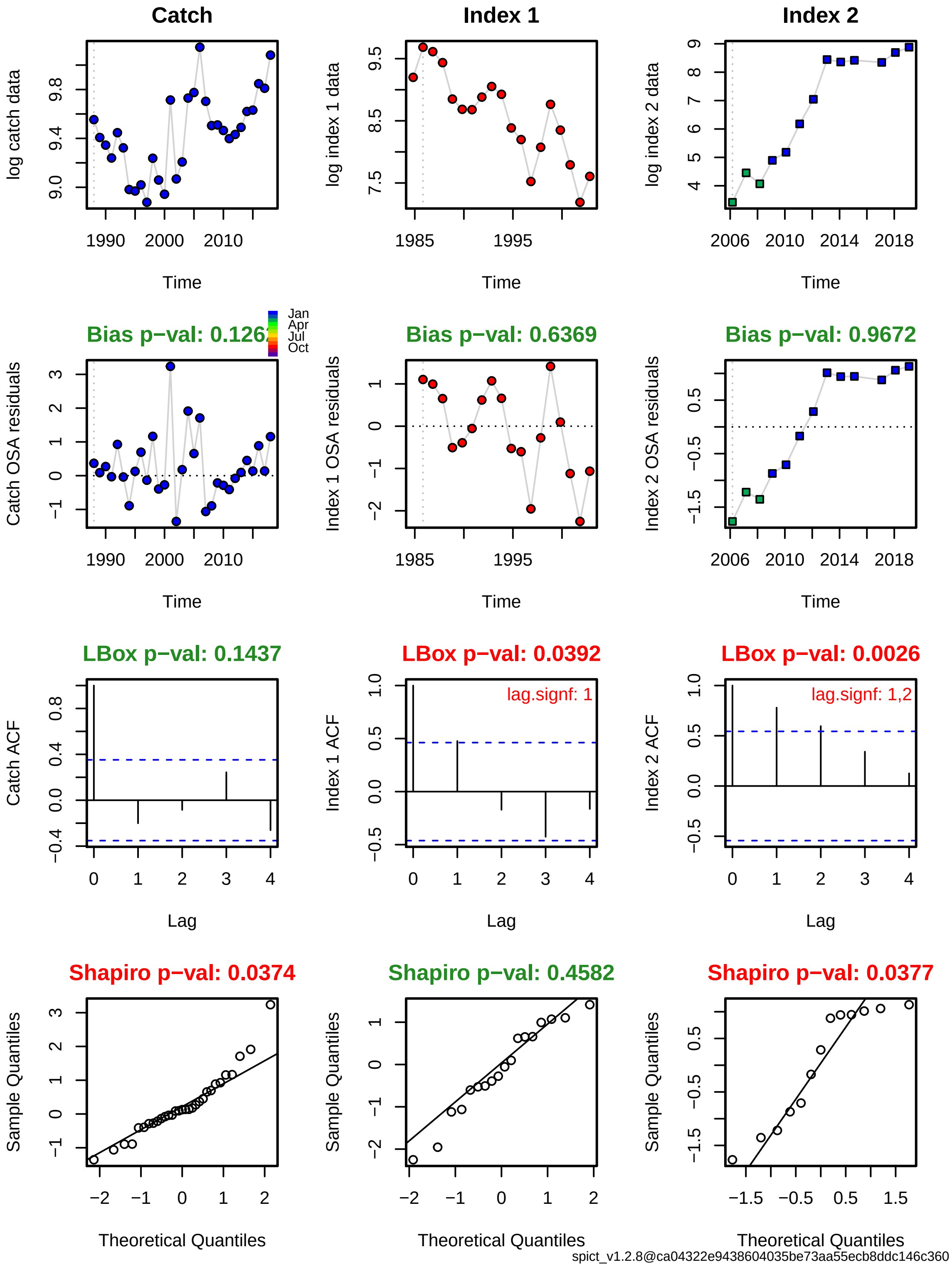
```
## Convergence: 0  MSG: relative convergence (4)
## Objective function at optimum: 57.3810526
## Euler time step (years):  1/16 or 0.0625
## Nobs C: 31,  Nobs I1: 19,  Nobs I2: 13
##
## Priors
##      logn  ~  dnorm[log(2), 2^2]
##  logalpha  ~  dnorm[log(1), 2^2]
##   logbeta  ~  dnorm[log(1), 2^2]
##
## Model parameter estimates w 95% CI
##             estimate        cilow        ciupp    log.est
##  alpha1 2.390221e+00    0.6561160 8.707540e+00  0.8713858
##  alpha2 1.185998e+01    3.5324126 3.981958e+01  2.4731699
##  beta   9.416977e-01    0.3601728 2.462137e+00 -0.0600710
##  r      1.999363e-01    0.0614380 6.506482e-01 -1.6097566
##  rc     6.376559e-01    0.0245182 1.658384e+01 -0.4499565
##  rold   5.361626e-01    0.0090055 3.192149e+01 -0.6233178
##  m      2.551782e+04 1202.3903144 5.415541e+05 10.1471325
##  K      2.797479e+05 4660.6209528 1.679152e+07 12.5416442
##  q1     1.544270e-02    0.0000792 3.010343e+00 -4.1706220
##  q2     4.063500e-03    0.0000136 1.210055e+00 -5.5057111
##  n      6.270977e-01    0.0459170 8.564407e+00 -0.4666529
##  sdb    1.576217e-01    0.0512043 4.852053e-01 -1.8475574
##  sdf    1.625876e-01    0.0768551 3.439552e-01 -1.8165384
##  sdi1   3.767507e-01    0.2468519 5.750051e-01 -0.9761716
##  sdi2   1.869391e+00    1.2648928 2.762781e+00  0.6256125
##  sdc    1.531084e-01    0.0978477 2.395782e-01 -1.8766094
##
## Deterministic reference points (Drp)
##            estimate        cilow        ciupp   log.est
##  Bmsyd 8.003635e+04  544.6157987 1.176209e+07 11.290236
##  Fmsyd 3.188279e-01    0.0122591 8.291918e+00 -1.143104
##  MSYd  2.551782e+04 1202.3903144 5.415541e+05 10.147132
## Stochastic reference points (Srp)
##            estimate        cilow        ciupp   log.est rel.diff.Drp
##  Bmsys 7.831263e+04  552.3441008 1.110335e+07 11.268464 -0.022010800
##  Fmsys 3.210608e-01    0.0122407 8.421108e+00 -1.136125  0.006954625
##  MSYs  2.514696e+04 1185.4485013 5.334435e+05 10.132492 -0.014747787
##
## States w 95% CI (inp$msytype: s)
##                    estimate       cilow        ciupp   log.est
##  B_2019.08      2.203227e+05 776.4156248 6.252077e+07 12.302849
##  F_2019.08      9.836480e-02   0.0003846 2.515559e+01 -2.319072
##  B_2019.08/Bmsy 2.813374e+00   0.4986872 1.587182e+01  1.034385
##  F_2019.08/Fmsy 3.063744e-01   0.0036177 2.594577e+01 -1.182947
##
```

```
## Predictions w 95% CI (inp$msytype: s)
##                    prediction        cilow        ciupp   log.est
##  B_2019.08      2.203227e+05 7.764156e+02 6.252077e+07 12.302849
##  F_2019.08      9.836480e-02 3.846000e-04 2.515559e+01 -2.319072
##  B_2019.08/Bmsy 2.813374e+00 4.986872e-01 1.587182e+01  1.034385
##  F_2019.08/Fmsy 3.063744e-01 3.617700e-03 2.594577e+01 -1.182947
##  Catch_2019.08  2.110211e+04 1.295520e+04 3.437222e+04  9.957128
##  E(B_inf)       1.727415e+05           NA           NA 12.059552
```

```r
## If the model converged, it reports convergence as 0
## Continue with plotting and diagnostics only if convergence was reached
converged <- fit_NS$opt$convergence == 0
if (converged) {
  ## Calculate the One Step Ahead (osa) residuals
  fit_NS <- calc.osa.resid((fit_NS))

  ## 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(fit_NS)
  plotspict.ffmsy(fit_NS)
  plotspict.bbmsy(fit_NS)
  plotspict.fb(fit_NS)
}
```




```r
if (converged) {
  plotspict.diagnostic(fit_NS)
}
```




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

Scenario 2

Scenario 3

Scenario 4

Referneces

Pedersen, Martin W., and Casper W. Berg. 2017. "A stochastic surplus production model in continuous time." *Fish and Fisheries* 18 (2): 226–43. https://doi.org/10.1111/faf.12174.