Aplicación de Stochastic Production Model in Continuous Time (SPiCT) (Pedersen et al., 2017) en brótula y cojinoba moteada

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Contents

Breve descripción del keystone paper (Pedersen & Berg, 2016)

Este documento provee una guía (casi traducida de Pedersen et al.,2017) para el uso del modelo de producción estatocastico contrinuo en tiempo (SPiCT) y que está dividido en tres partes

Este es un documento vivo que estará en permanente cambio. Todos los avances y actualizaciones pueden ser seguidas y obtenidas de https://github.com/DTUAqua/spict/commits/master. El SPiCT packahe esta siendo activamente actualizado y se pueden reportar errores aquí: https://github.com/DTUAqua/spict/releases.

El modelo de excedente de producción tiene una larga historia como método para manejar las poblaciones de peces con datos limitados. Los avances recientes han arrojado modelos de producción excedente como modelos de espacio de estado que separan la variabilidad aleatoria de la dinámica del stock del error en los índices observados de biomasa. Pedersen & Berg (2016) presentan un modelo de producción excedente estocástico en tiempo continuo (SPiCT), que además de la dinámica del stock también modela la dinámica de las pesquerías. Esto permite que el error en el proceso de captura se refleje en la incertidumbre de los parámetros estimados del modelo y las cantidades de manejo.

La formulación del modelo de espacio de estado de tiempo continuo incluye la capacidad de proporcionar estimaciones de biomasa explotable y mortalidad por pesca en cualquier momento a partir de datos muestreados a intervalos arbitrarios y posiblemente irregulares.

Esta guía es un ejemplo de applicación del modelo con los datos de la librería y también propone utilizar datos propios.

Principales supuestos y requerimiento de datospara SPiCT.

- Serie de tiempo en dato que contenga cambios forzantes en la población
- Contraste en los datos (Hilborn & Walters, 1989)

-Extreme observations or outliers in index and catch are commonly encountered problem in fisheries data (Chen et al. 1994).

Carga de librerias necesarias.

Lo primero es cargar TMB usando el GitHub usando devtools Package. Aqui se explica como; (https://github.com/kaskr/adcomp/wiki/Download)

```
install.packages("devtools")
install.packages("TMB")
#si hay problemas, instalarlo desde el github
devtools::install_github("kaskr/adcomp", subdir = "TMB")
```

Una vez cargado eso se llama de la misma forma al SPiCT package

```
devtools::install_github("DTUAqua/spict/spict")
#devtools::install_github("DTUAqua/spict/spict", ref = "1.2.8")
# aqui algunas dependencias tambien necesitan ser instaladas
install.packages("Rcpp")
install.packages("ellipse")
```

Aqui a veces hay problemas para acceder a GitHub por problemas en las credenciales. Para ello se debe obtener un token de GitHub (deben tener una cuenta) y hacer un proceso como lo planteado acá: https://www.r-bloggers.com/using-travis-make-sure-you-use-a-github-pat/

Una vez solucianando e instalnando dependencias, llamamos las librerias:

```
library(usethis)
library(devtools)
library(ellipse)
library(spict) #comprobar esta versión de spict_v1.2.8
library(tidyverse)
library(patchwork)
```

Main assumptions and input data for SPiCT

- Catch data should be representative of both landings and bycatch. It is also possible to use landings only, but then the interpretation of the results changes. If available, seasonal catches should be used as input. Catches are assumed to be taken over a time interval (e.g. years or quarters), thus the associated time vector in SPiCT `inp$timeC` should reflect the beginning of each catch interval (e.g. 2002.25 and 2002.75 for the second and fourth quarter catches, respectively). Additionally, the vector `inp$dtc` should reflect the length of each time interval (e.g. 1 for annual and 0.25 for quarterly catches, respectively).
- Stock size indices should be in terms of biomass (not numbers) and representative of the part of the stock vulnerable to the commercial fleets, the so called exploitable stock biomass (ESB). In many cases, the gear selectivity of the commercial and scientific fleets do not coincide and thus the stock size indices have to be corrected to exclude individuals that are not represented in the commercial fleets.
- Biomass indices are assumed to be snapshots at given points in time. Therefore, the timing of survey indices `inp$timeI` has to be given as decimal years reflecting the timing of the survey (e.g. 1995.5 for the middle of the year). The timing of the survey will be matched to the closest model time which is dependent on `inp$dteuler` (see below). Commercial CPUE index should be associated with the midpoint of the interval of the corresponding catches, i.e. middle of the year if they are based on yearly aggregated catches and effort.

Incorporando la propia data

Leo el directorio donde contengo los datos

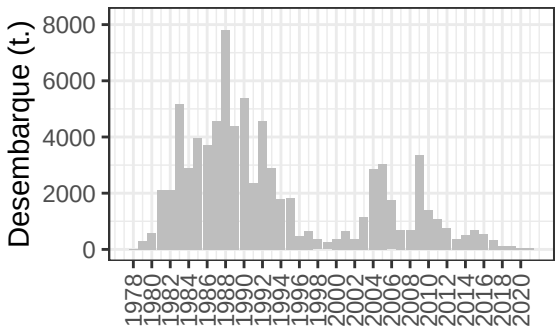
```
setwd('~/IFOP/CBA/BROTULA_COJINOVA/2022/SAM')
```

Usaré el ejemplop de datos de erizo de la zona X Norte. Este ejemplo no tiene mucho contraste de datos y veremos los problemas que ello acarrea.

Puedo tener un .txt ó un .csv pero deben ser transformados en formato lista.

```
brotula <- read.table("data_brotula2.txt", sep="", header = T)

#un plot simple de indice y desembarque
```

```
bro <- ggplot(brotula,aes(timeC,obsC))+
  geom_bar(stat="identity", fill="gray")+
  ylim(0, 8200) +
  xlab("") +
  ylab("Desembarque (t.)")+
  theme_bw()+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5)) +
  scale_x_continuous(breaks = seq(from = 1978, to = 2021, by = 2))
bro
```



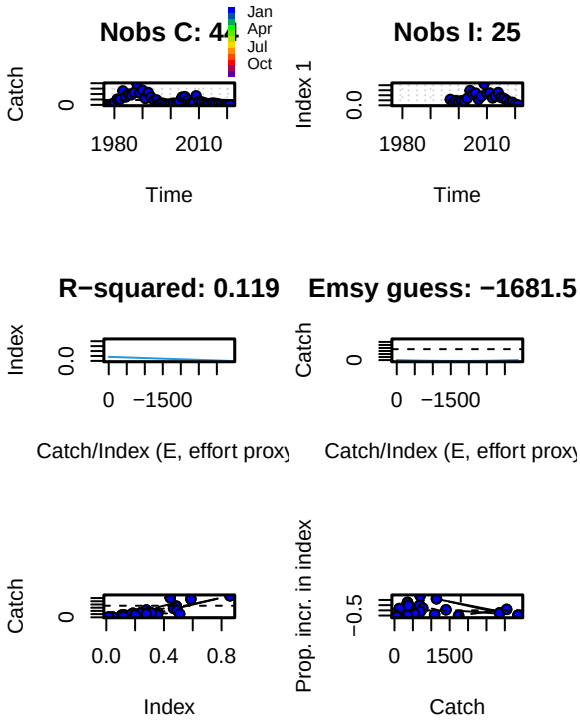
Convierto los datos como lista para ser lidos por las fiunciones del SPiCT

```
brotula <- as.list(brotula)
#compruebo
class(brotula)
   [1] "list"
```

Primero un vistazo a mis datos y compruebo el contraste, el que desde tya nos dirá que tan robusta es la estimación

```
plotspict.data(brotula)
```

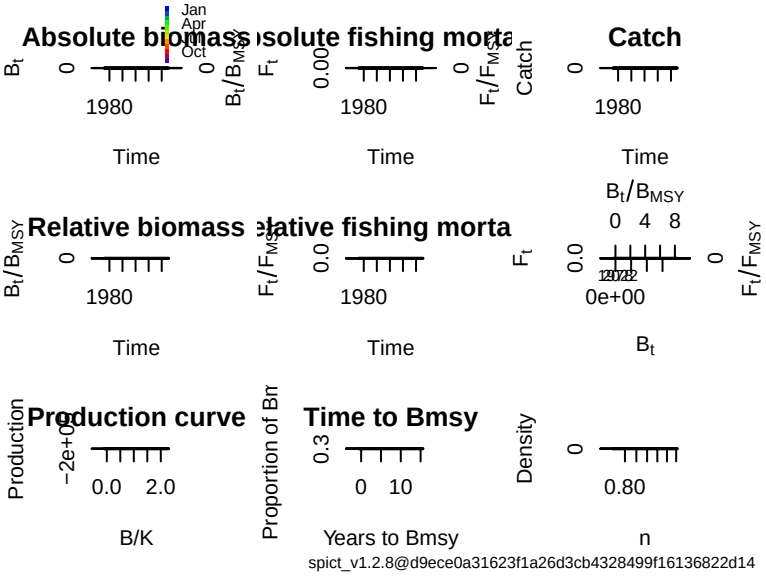
```
plotspict.ci(brotula)
   Removing zero, negative, and NAs in  I  series  1
```



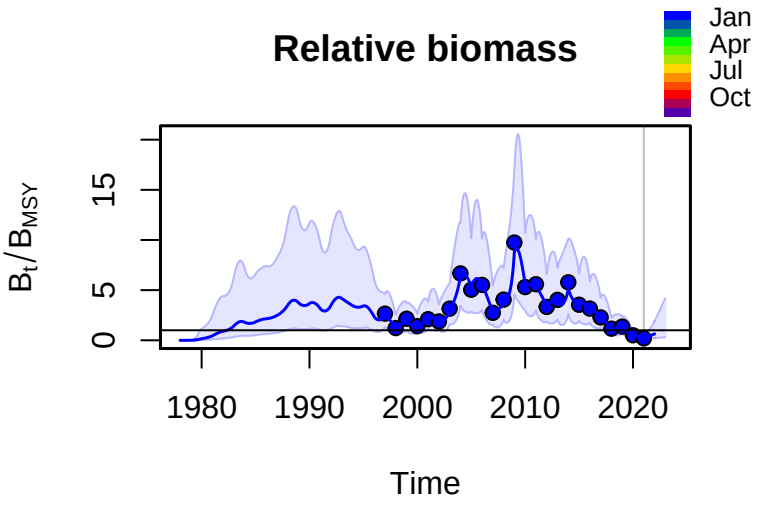
ahora aplico el modelo

```
resbro <- fit.spict(brotula)
   Removing zero, negative, and NAs in  I  series  1
```

```
plot(resbro)
   Warning in if (class(cl) == "try-error") {: the condition has length > 1 and
   only the first element will be used
```

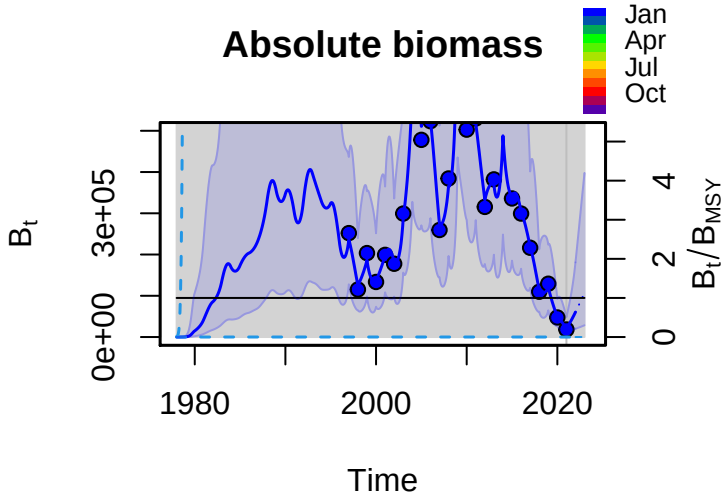


```
a <-plotspict.bbmsy(resbro)
```



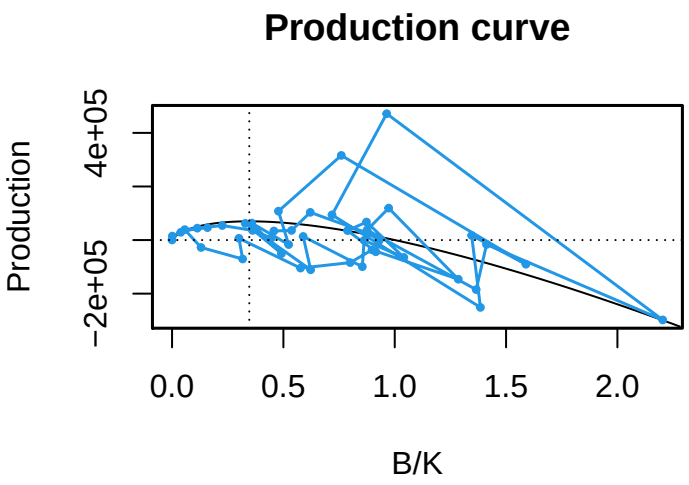
spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
#b <-  plotspict.ffmsy(resbro)
b<- plotspict.biomass(resbro, ylim=c(0, 500000))
```

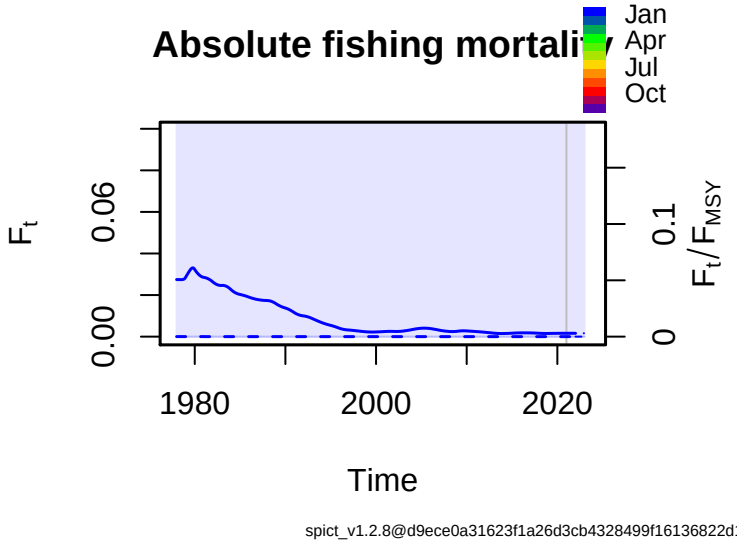


spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
#d <-  plotspict.fb(resbro, ylim=c(0, 3), xlim=c(0, 100000))
plotspict.production(resbro)
```



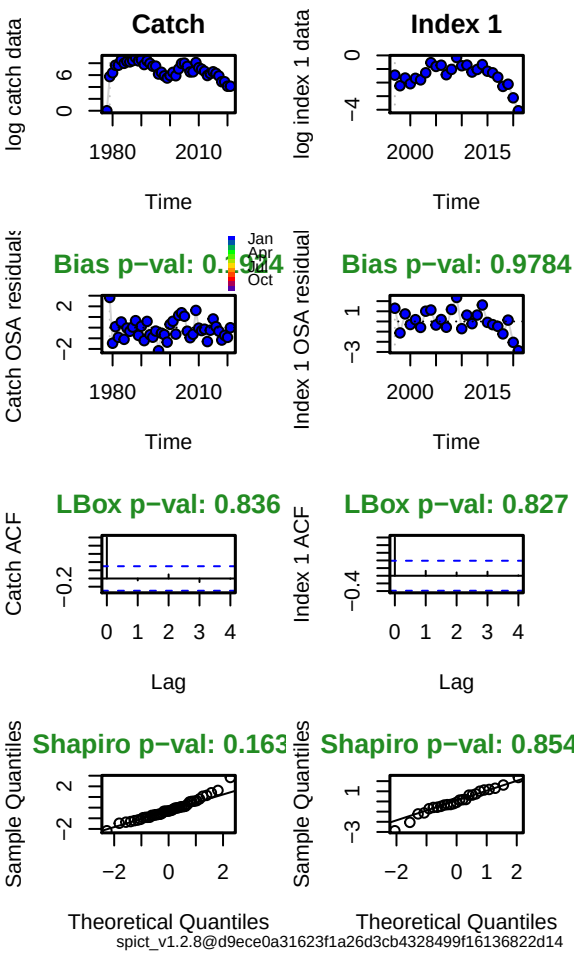

```
c <- plotspict.f(resbro)
```




```
a/b/c
   numeric(0)
```

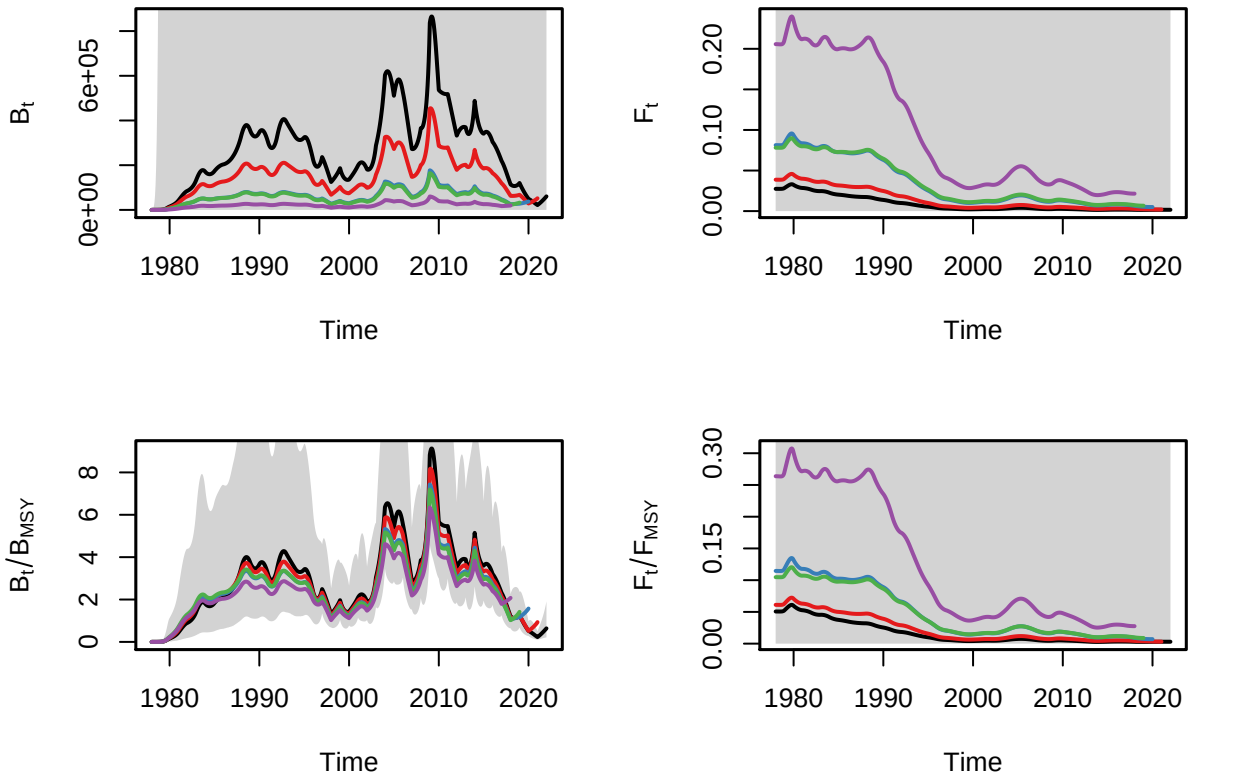
#diagnostico y residuos

```
resbrod <- calc.osa.resid(resbro)
plotspict.diagnostic(resbrod)
```



Extrear parametros estimados

```
resbro1 <- retro(resbro, nretroyear = 4)
plotspict.retro(resbro1)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

Lo primero es ver los estimados en una lista

```
list.quantities(resbro1)
```

```
    [1] "Bmsy"                "Bmsy2"               "BmsyB0"
    [4] "Bmsyd"               "Bmsys"               "Cp"
    [7] "Emsy"                "Emsy2"               "Fmsy"
   [10] "Fmsyd"               "Fmsys"               "gamma"
   [13] "isdb2"               "isdc2"               "isde2"
   [16] "isdf2"               "isdi2"               "K"
   [19] "logalpha"            "logB"                "logBBmsy"
   [22] "logbeta"             "logbkfrac"           "logBl"
   [25] "logBlBmsy"           "logBlK"              "logBmsy"
   [28] "logBmsyd"            "logBmsyPluslogFmsy"  "logBmsys"
   [31] "logBp"               "logBpBmsy"           "logBpK"
   [34] "logCp"               "logCpred"            "logEmsy"
   [37] "logEmsy2"            "logEp"               "logF"
   [40] "logFFmsy"            "logFFmsynotS"        "logFl"
   [43] "logFlFmsy"           "logFmsy"             "logFmsyd"
   [46] "logFmsys"            "logFnotS"            "logFp"
   [49] "logFpFmsy"           "logFs"               "logIp"
   [52] "logIpred"            "logK"                "logm"
   [55] "logMSY"              "logMSYd"             "logMSYs"
   [58] "logn"                "logq"                "logq2"
   [61] "logr"                "logrc"               "logrold"
   [64] "logsdb"              "logsdc"              "logsdf"
   [67] "logsdi"              "m"                   "MSY"
   [70] "MSYd"                "MSYs"                "p"
```

```
   [73] "q"                  "r"                  "rc"
   [76] "rold"               "sdb"                "sdc"
   [79] "sde"                "sdf"                "sdi"
   [82] "seasonsplinefine"
```

Ahora los saco por separado

```
get.par('MSY', resbro)
             ll      est       ul     sd       cv
   MSY -417665.5 51754.53 521174.5 239500 4.627614
```

```
capture.output(summary(resbro))
    [1] "Convergence: 0  MSG: relative convergence (4)"
    [2] "Objective function at optimum: 76.9489305"
    [3] "Euler time step (years):  1/16 or 0.0625"
    [4] "Nobs C: 44,  Nobs I1: 25"
    [5] ""
    [6] "Priors"
    [7] "     logn  ~  dnorm[log(2), 2^2]"
    [8] " logalpha  ~  dnorm[log(1), 2^2]"
    [9] "  logbeta  ~  dnorm[log(1), 2^2]"
   [10] ""
   [11] "Model parameter estimates w 95% CI "
   [12] "            estimate      cilow        ciupp     log.est  "
   [13] " alpha  2.559502e-01  0.0468656 1.397838e+00  -1.3627724  "
   [14] " beta   1.151236e+00  0.4875594 2.718323e+00   0.1408361  "
   [15] " r      4.730405e-01  0.2237210 1.000207e+00  -0.7485742  "
   [16] " rc     1.062063e+00  0.5465897 2.063663e+00   0.0602129  "
   [17] " rold   4.331710e+00  0.9414884 1.992984e+01   1.4659625  "
   [18] " m      6.990630e+04  8.0698072 6.055772e+08  11.1549111  "
   [19] " K      3.795644e+05 40.8925152 3.523117e+09  12.8467794  "
   [20] " q      9.000000e-07  0.0000000 9.088100e-03 -13.8894386  "
   [21] " n      8.907959e-01  0.8034958 9.875812e-01  -0.1156399  "
   [22] " sdb    6.743627e-01  0.4572094 9.946537e-01  -0.3939871  "
   [23] " sdf    3.069157e-01  0.1593971 5.909594e-01  -1.1811822  "
   [24] " sdi    1.726033e-01  0.0364154 8.181120e-01  -1.7567595  "
   [25] " sdc    3.533323e-01  0.2284149 5.465657e-01  -1.0403462  "
   [26] " "
   [27] "Deterministic reference points (Drp)"
   [28] "           estimate      cilow        ciupp    log.est  "
   [29] " Bmsyd 1.316425e+05 14.2880649 1.212883e+09 11.7878453  "
   [30] " Fmsyd 5.310313e-01  0.2732949 1.031832e+00 -0.6329343  "
   [31] " MSYd  6.990630e+04  8.0698072 6.055772e+08 11.1549111  "
   [32] "Stochastic reference points (Srp)"
   [33] "           estimate     cilow        ciupp    log.est rel.diff.Drp  "
   [34] " Bmsys 9.478481e+04 10.262824 8.754082e+08 11.4593645  -0.38885665  "
   [35] " Fmsys 5.418244e-01  0.285072 1.029823e+00 -0.6128133   0.01991986  "
   [36] " MSYs  5.175453e+04  5.954480 4.498346e+08 10.8542673  -0.35072812  "
   [37] ""
   [38] "States w 95% CI (inp$msytype: s)"
   [39] "                    estimate     cilow        ciupp   log.est  "
   [40] " B_2021.00      2.163324e+04 2.1624614 2.164187e+08  9.981986  "
   [41] " F_2021.00      1.611000e-03 0.0000002 1.586787e+01 -6.430914  "
   [42] " B_2021.00/Bmsy 2.282353e-01 0.1026998 5.072194e-01 -1.477378  "
```

```
[43] " F_2021.00/Fmsy 2.973200e-03 0.0000003 2.788375e+01 -5.818101  "
[44] ""
[45] "Predictions w 95% CI (inp$msytype: s)"
[46] "                  prediction      cilow        ciupp    log.est  "
[47] " B_2022.00      6.043383e+04  6.2166092 5.874983e+08 11.0093043  "
[48] " F_2022.00      1.610100e-03  0.0000002 1.594978e+01 -6.4314786  "
[49] " B_2022.00/Bmsy 6.375898e-01  0.2129173 1.909290e+00 -0.4500602  "
[50] " F_2022.00/Fmsy 2.971600e-03  0.0000003 2.809278e+01 -5.8186653  "
[51] " Catch_2022.00  1.322022e+02 41.1013866 4.252269e+02  4.8843323  "
[52] " E(B_inf)       2.196003e+05         NA           NA 12.2995644  "
```

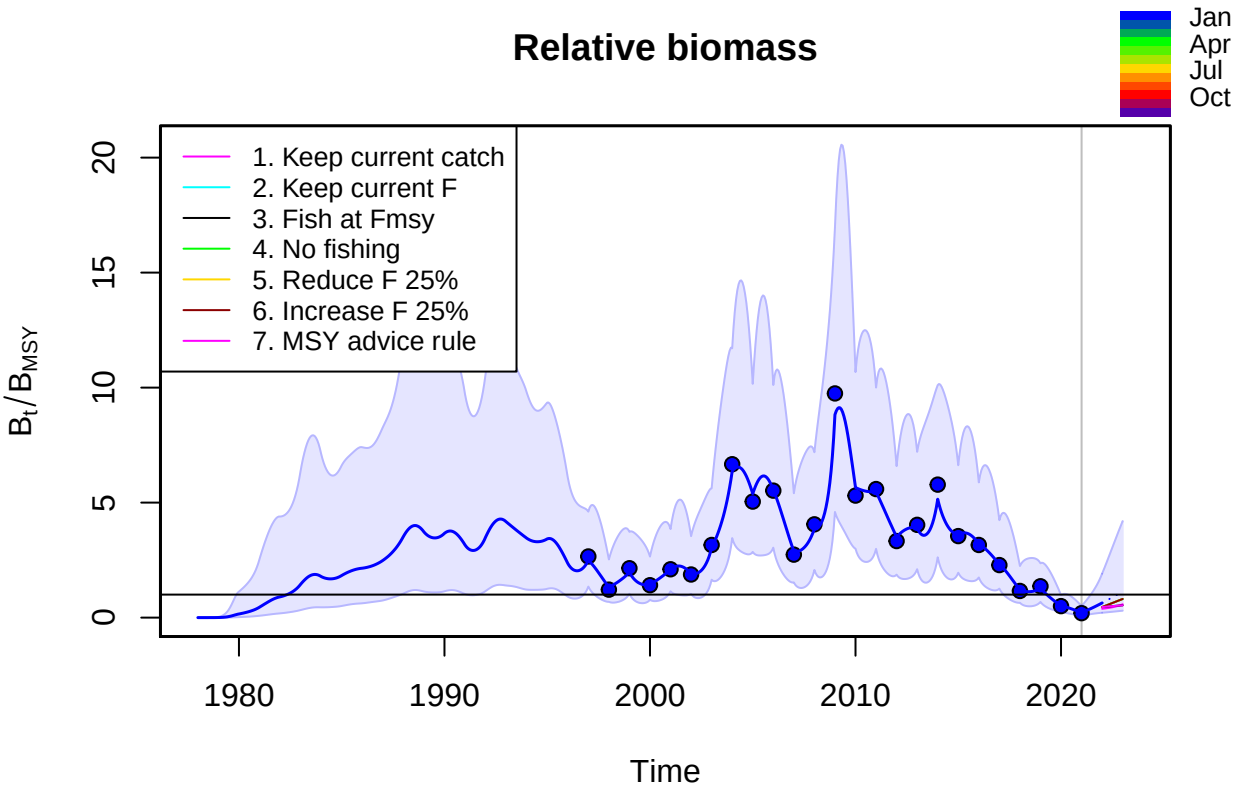
Tambien se pueden usar mas indices que incorporaremos despues. Otro aspeto que se puede trabajar es datos estacionales

```
resbro2 <- manage(resbro)
```

```
mansummary(resbro2)
   Observed interval, index:  1997.00 - 2021.00
   Observed interval, catch:  1978.00 - 2022.00

   Fishing mortality (F) prediction: 2023.00
   Biomass (B) prediction:           2023.00
   Catch (C) prediction interval:    2022.00 - 2023.00

   Predictions
                              C        B     F B/Bmsy F/Fmsy perc.dB perc.dF
   1. Keep current catch    77.0  76465.5 0.001  0.581  0.002    26.5   -22.3
   2. Keep current F       132.2 106623.0 0.002  0.810  0.003    76.4     0.0
   3. Fish at Fmsy       35400.6  70146.7 0.542  0.533  1.000    16.1 33552.3
   4. No fishing             0.1 106756.6 0.000  0.811  0.000    76.7   -99.9
   5. Reduce F 25%          99.2 106656.4 0.001  0.810  0.002    76.5   -25.0
   6. Increase F 25%       165.2 106589.6 0.002  0.810  0.004    76.4    25.0
   7. MSY advice rule    35400.6  70146.7 0.542  0.533  1.000    16.1 33552.3

   95% CIs of absolute predictions
                           C.lo     C.hi B.lo        B.hi F.lo     F.hi
   1. Keep current catch   41.9    141.2  7.0   829639868    0   13.392
   2. Keep current F       41.1    425.2 10.9  1041127607    0   16.253
   3. Fish at Fmsy       3771.0 332324.2  0.2 30692731991    0 5473.928
   4. No fishing            0.0      0.5 11.1  1030643111    0    0.008
   5. Reduce F 25%         30.8    319.0 11.0  1038493919    0   12.186
   6. Increase F 25%       51.4    531.4 10.9  1043767986    0   20.319
   7. MSY advice rule    3771.0 332324.2  0.2 30692731991    0 5473.928

   95% CIs of relative predictions
                         B/Bmsy.lo B/Bmsy.hi F/Fmsy.lo F/Fmsy.hi
   1. Keep current catch     0.169     1.994         0    23.772
   2. Keep current F         0.211     3.114         0    28.630
   3. Fish at Fmsy           0.009    31.530         0  9642.343
   4. No fishing             0.211     3.117         0     0.014
   5. Reduce F 25%           0.211     3.115         0    21.466
   6. Increase F 25%         0.211     3.113         0    35.793
   7. MSY advice rule        0.009    31.530         0  9642.343
```

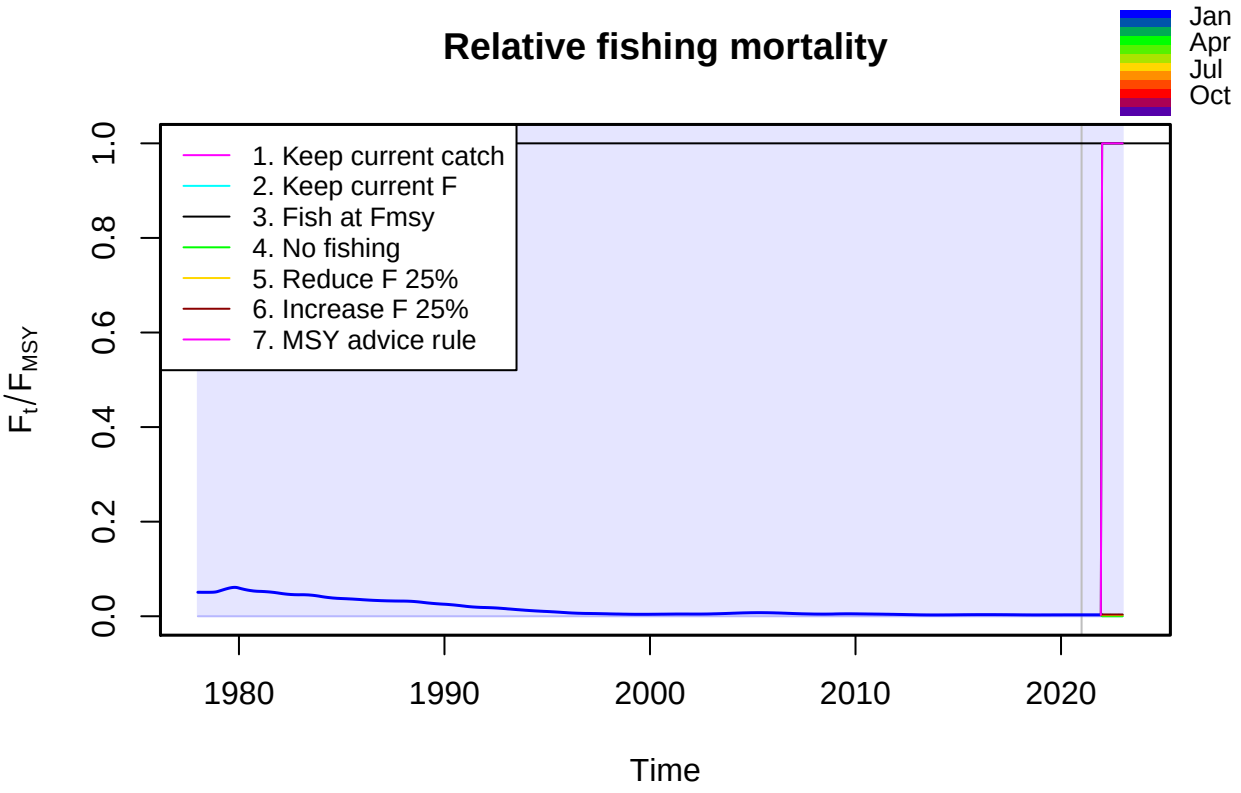
Ploteo de escenarios

```
plotspict.bbmsy(resbro2)
```

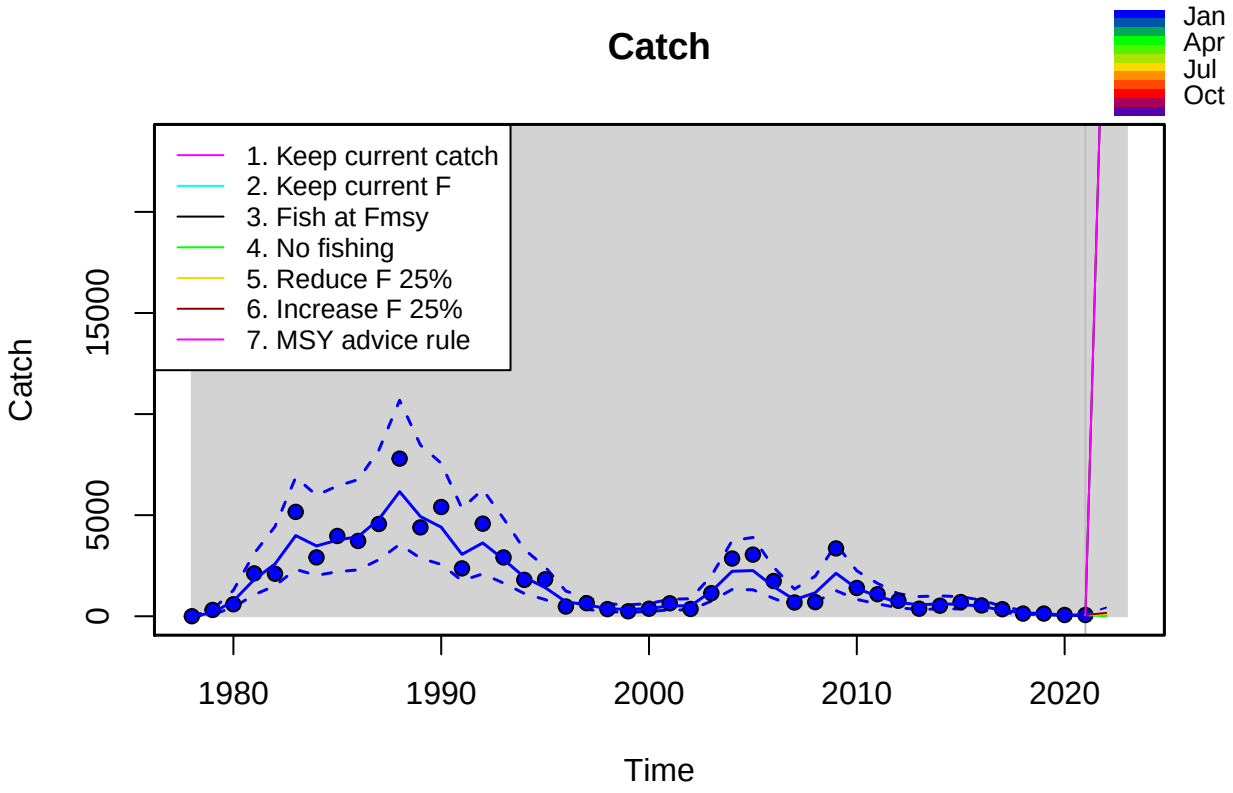


spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.ffmsy(resbro2)
```

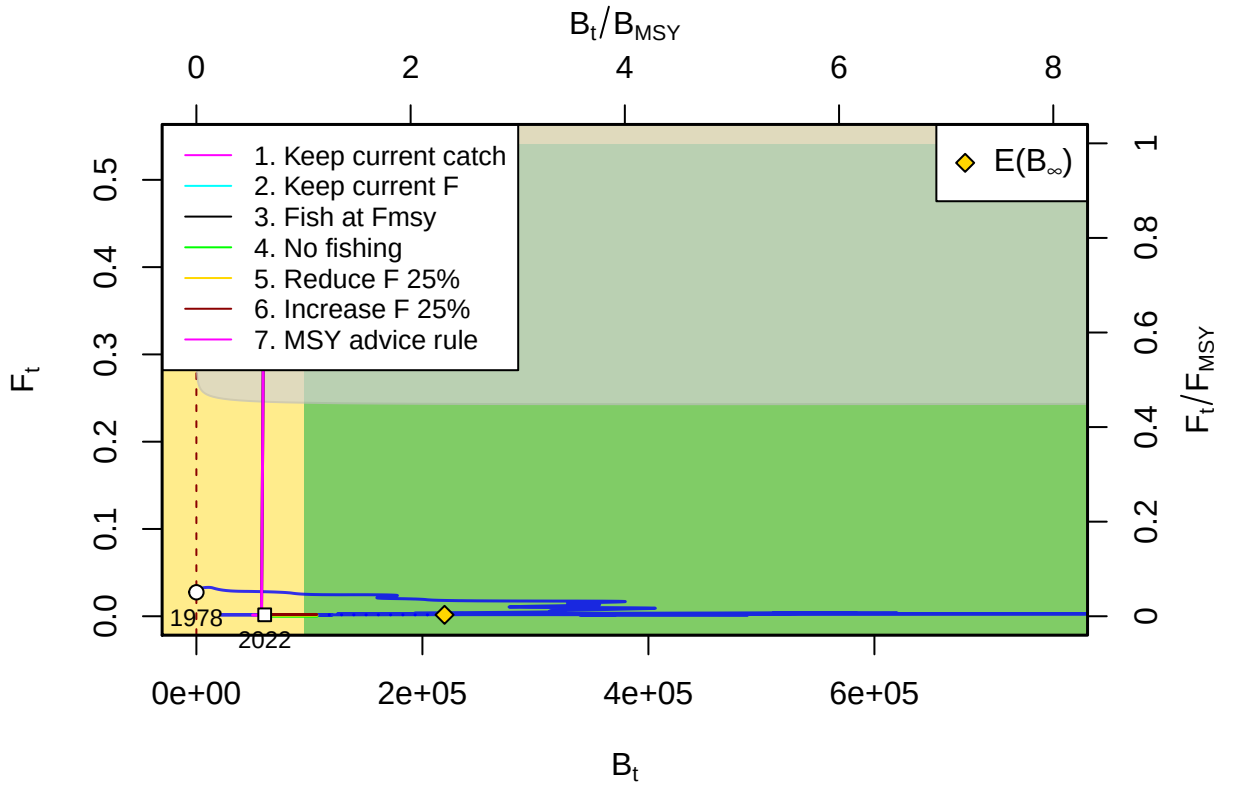



```
plotspict.catch(resbro2)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.fb(resbro2)
   Warning in if (class(cl) == "try-error") {: the condition has length > 1 and
   only the first element will be used
```

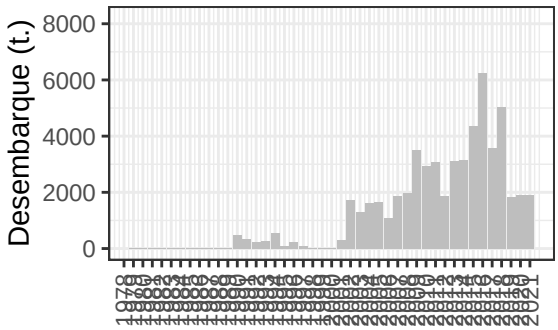


Cojinoba moteada

Puedo tener un .txt ó un .csv pero deben ser transformados en formato list.

```
cojmo <- read.table("data_CojiMot2.txt", sep="", header = T)
```

```
com <- ggplot(cojmo,aes(timeC,obsC))+
  geom_bar(stat="identity", fill="gray")+
  ylim(0, 8200) +
  xlab("") +
  ylab("Desembarque (t.)")+
  theme_bw()+
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5)) +
  scale_x_continuous(breaks = seq(from = 1978, to = 2021, by = 1))
com
```

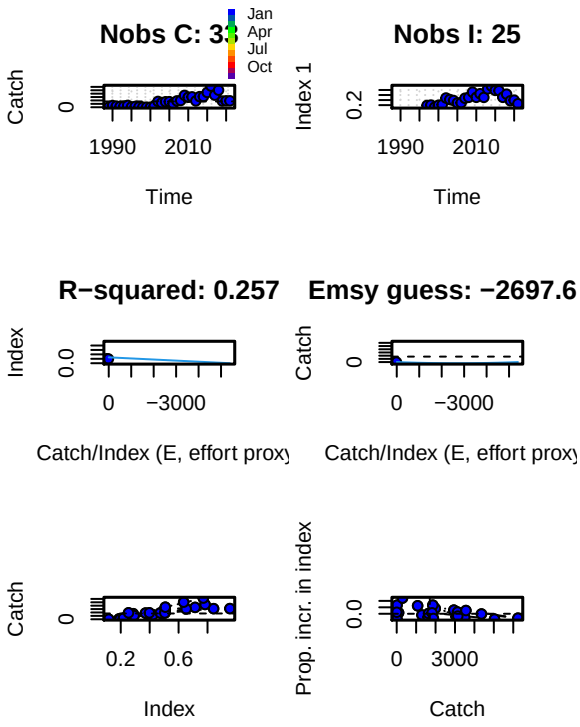


Convierto los datos como lista para ser lidos por las fiunciones del SPiCT

```
cojmo <- as.list(cojmo)
#compruebo
class(cojmo)
   [1] "list"
```

Primero un vistazo a mis datos y compruebo el contraste, el que desde tya nos di´ra que tan robusta es la estimación

```
plotspict.ci(cojmo)
   Removing zero, negative, and NAs in  C  series
   Removing zero, negative, and NAs in  I  series  1
```



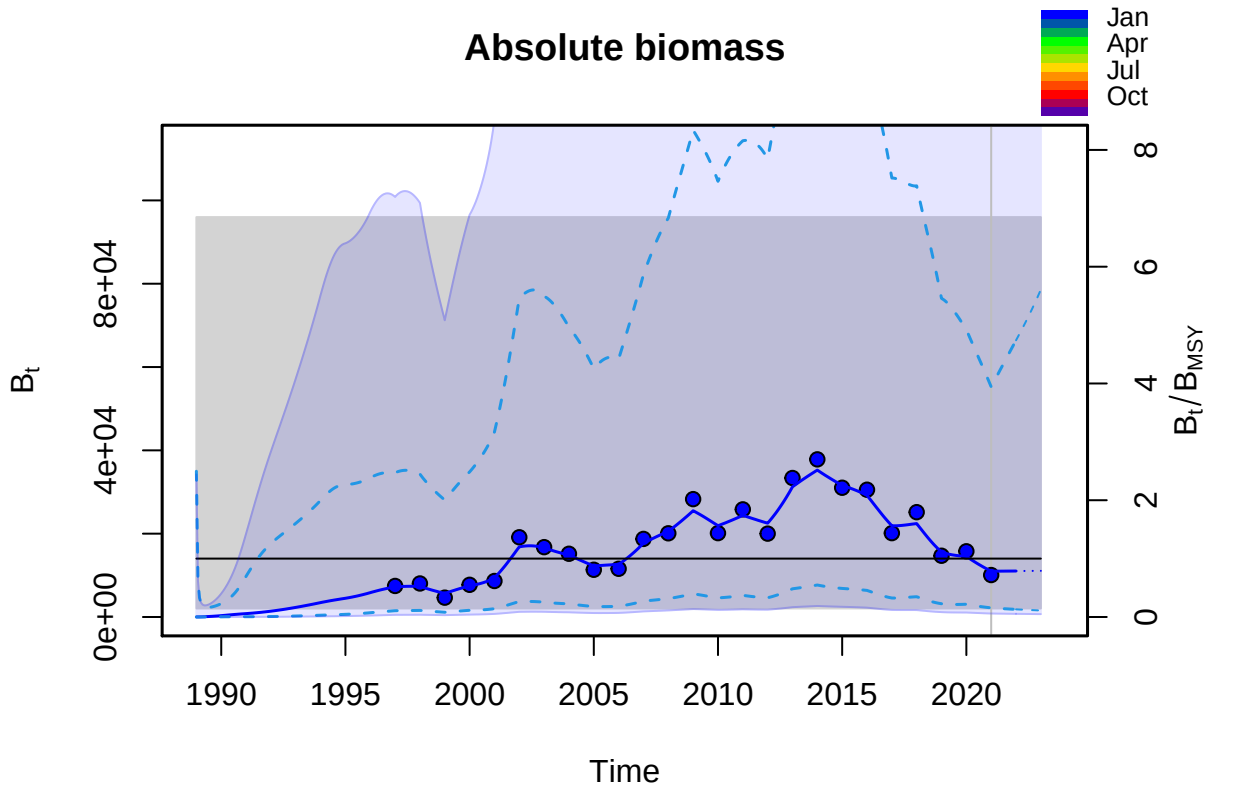
Ahora aplico el modelo

```
rescojmo <- fit.spict(cojmo)
   Removing zero, negative, and NAs in  C  series
```

```
   Removing zero, negative, and NAs in  I  series  1
```

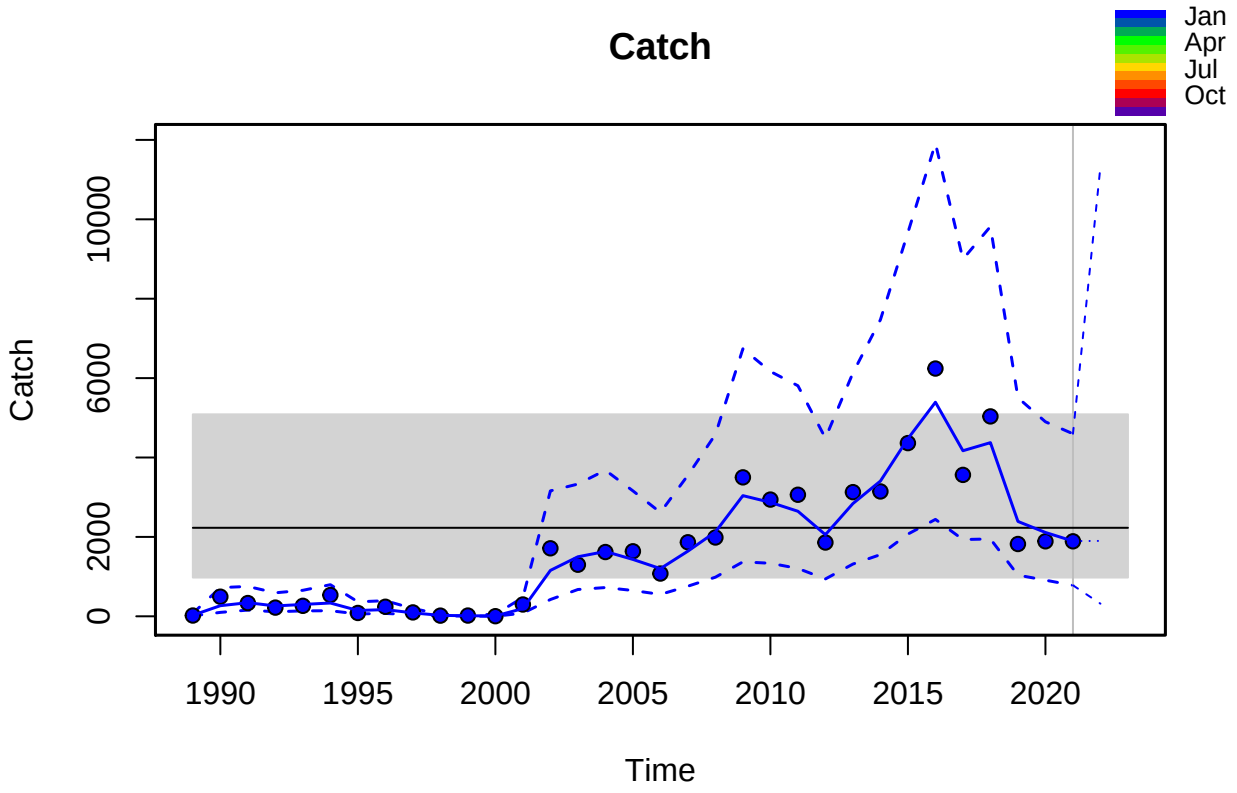
```
par(mfrow=c(2, 2))
a <-plotspict.bbmsy(rescojmo)
#b <-  plotspict.ffmsy(resbro)
c <- plotspict.biomass(rescojmo, ylim=c(0, 200000))
#d <-  plotspict.fb(resbro, ylim=c(0, 3), xlim=c(0, 100000))
plotspict.production(rescojmo)
plotspict.f(rescojmo)
```

```
plotspict.biomass(rescojmo)
```



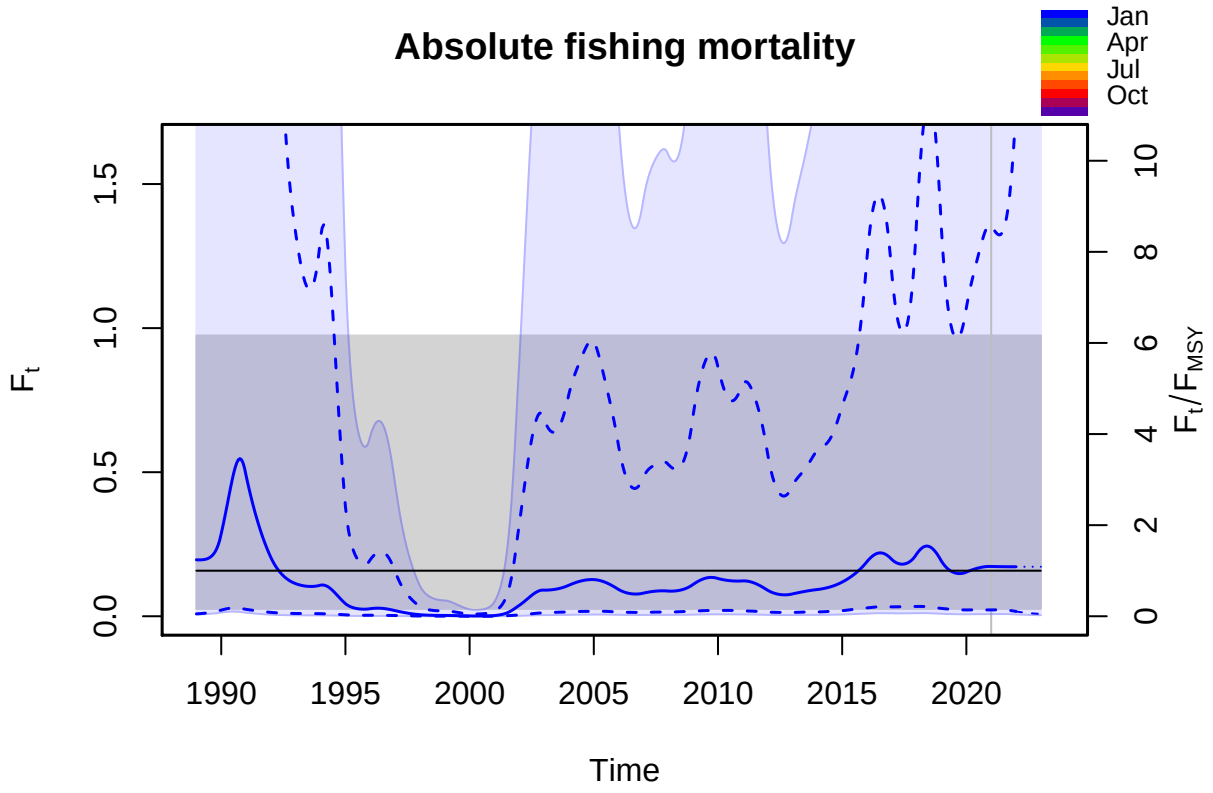
spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.catch(rescojmo)
```



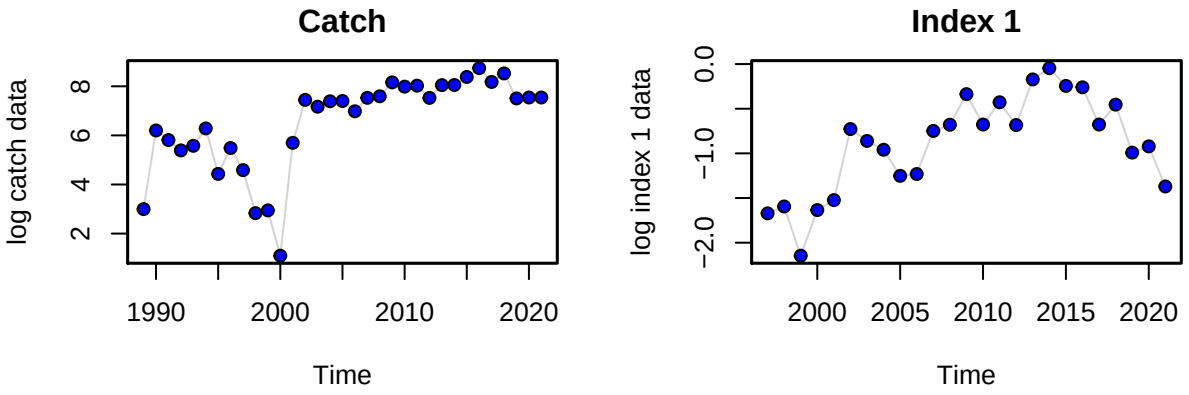
spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.f(rescojmo)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

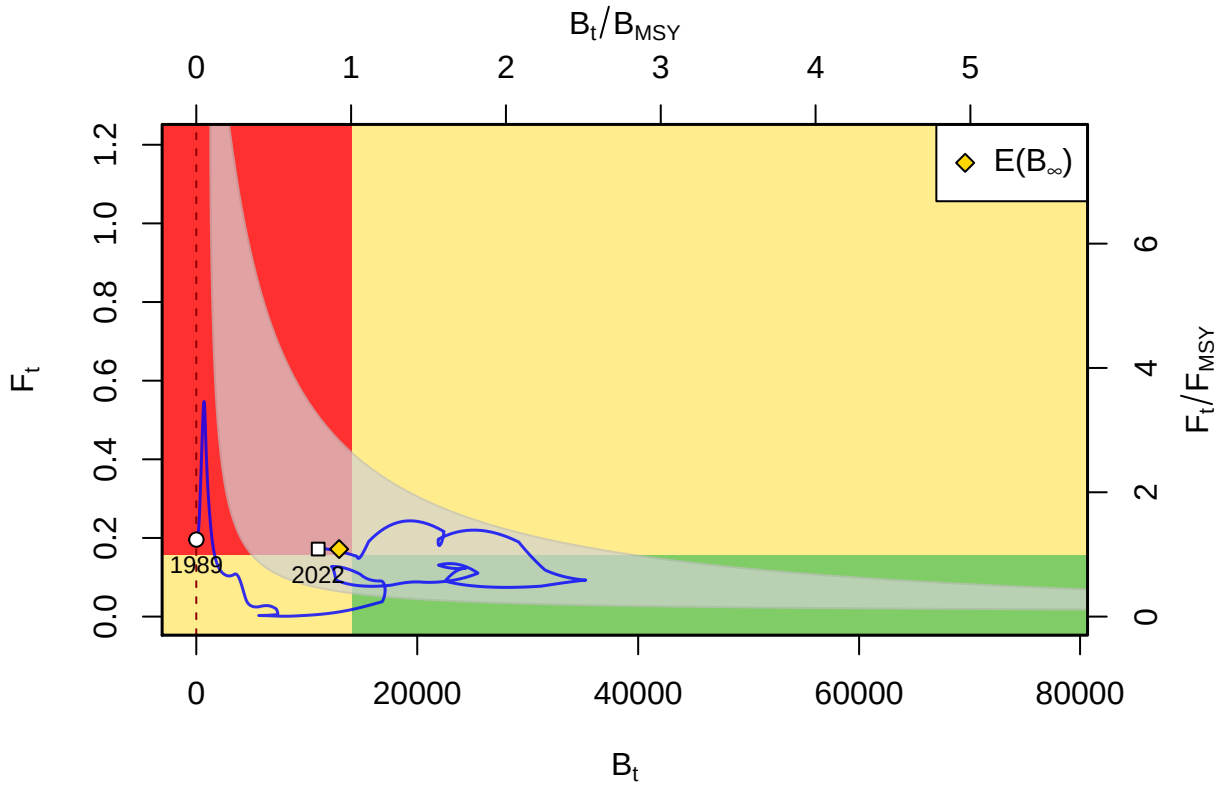
```
plotspict.diagnostic(rescojmo)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

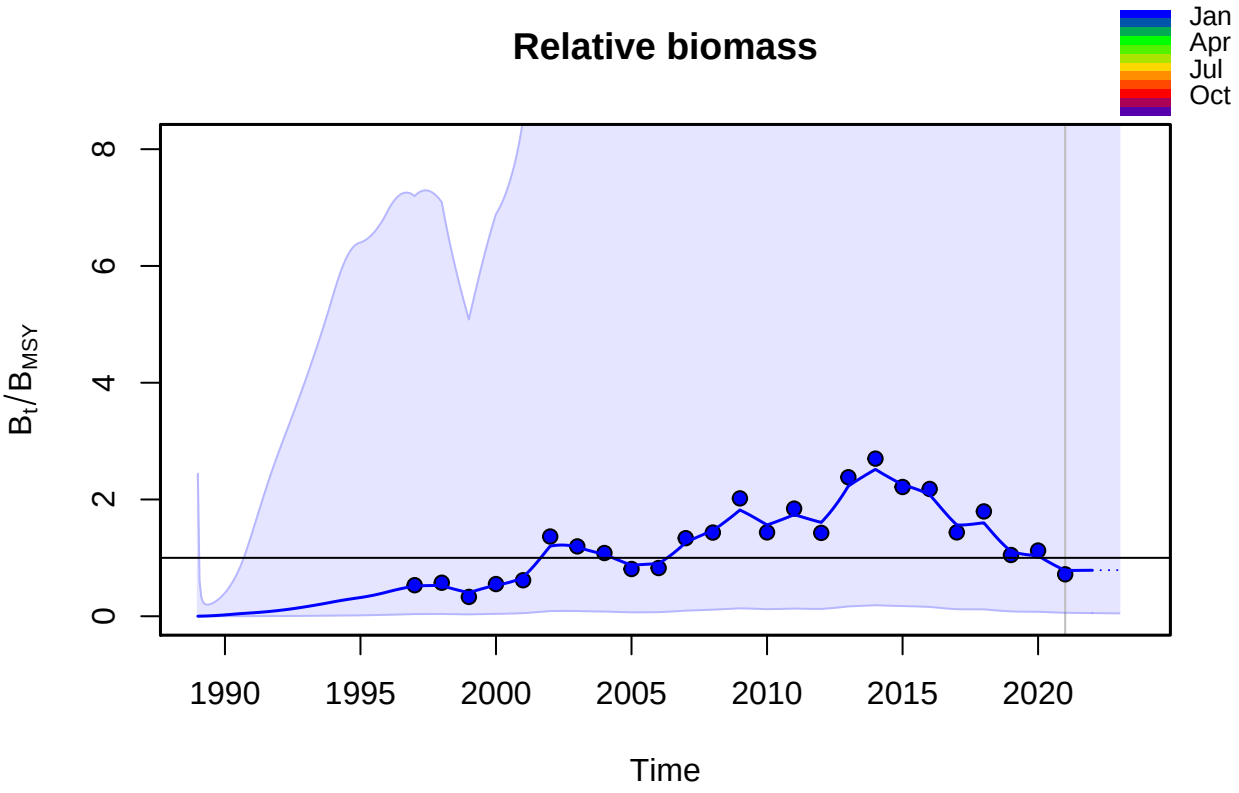
```
plotspict.fb(rescojmo)
```

```
   Warning in if (class(cl) == "try-error") {: the condition has length > 1 and
   only the first element will be used
```



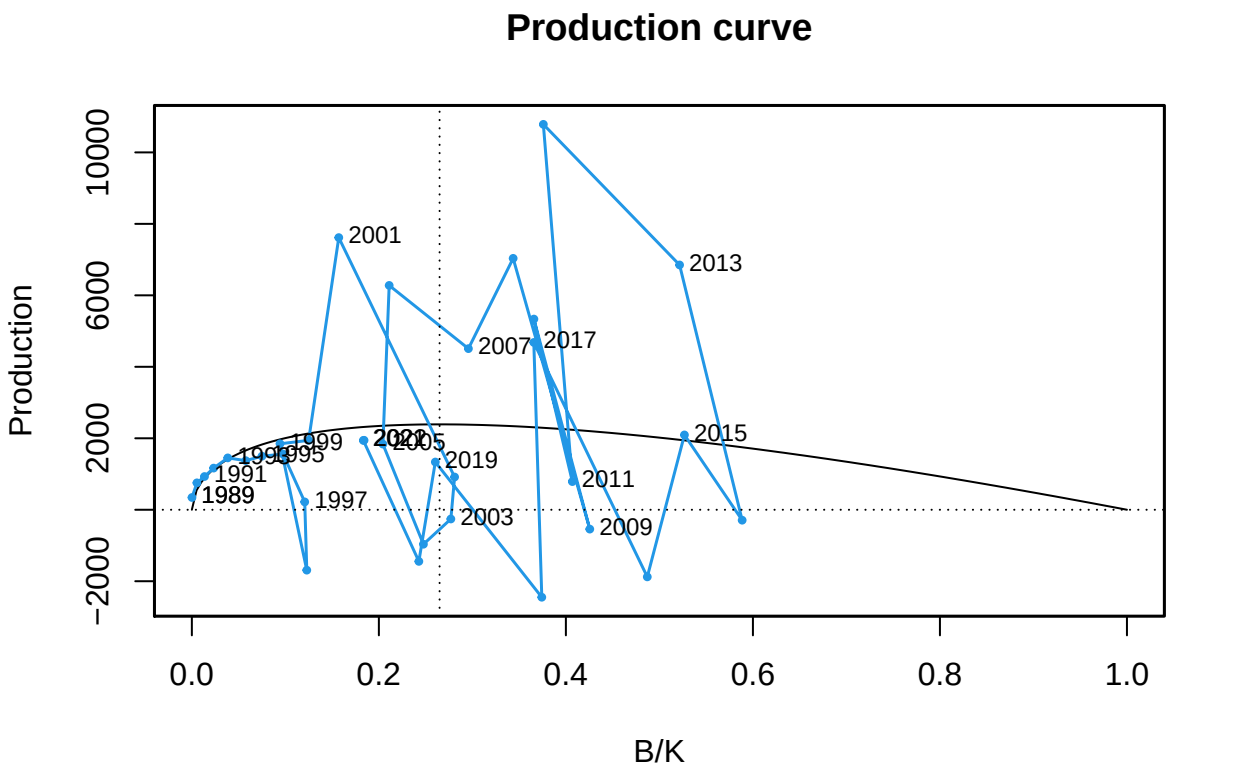
spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.bbmsy(rescojmo)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.production(rescojmo)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

Ahora los saco por separado

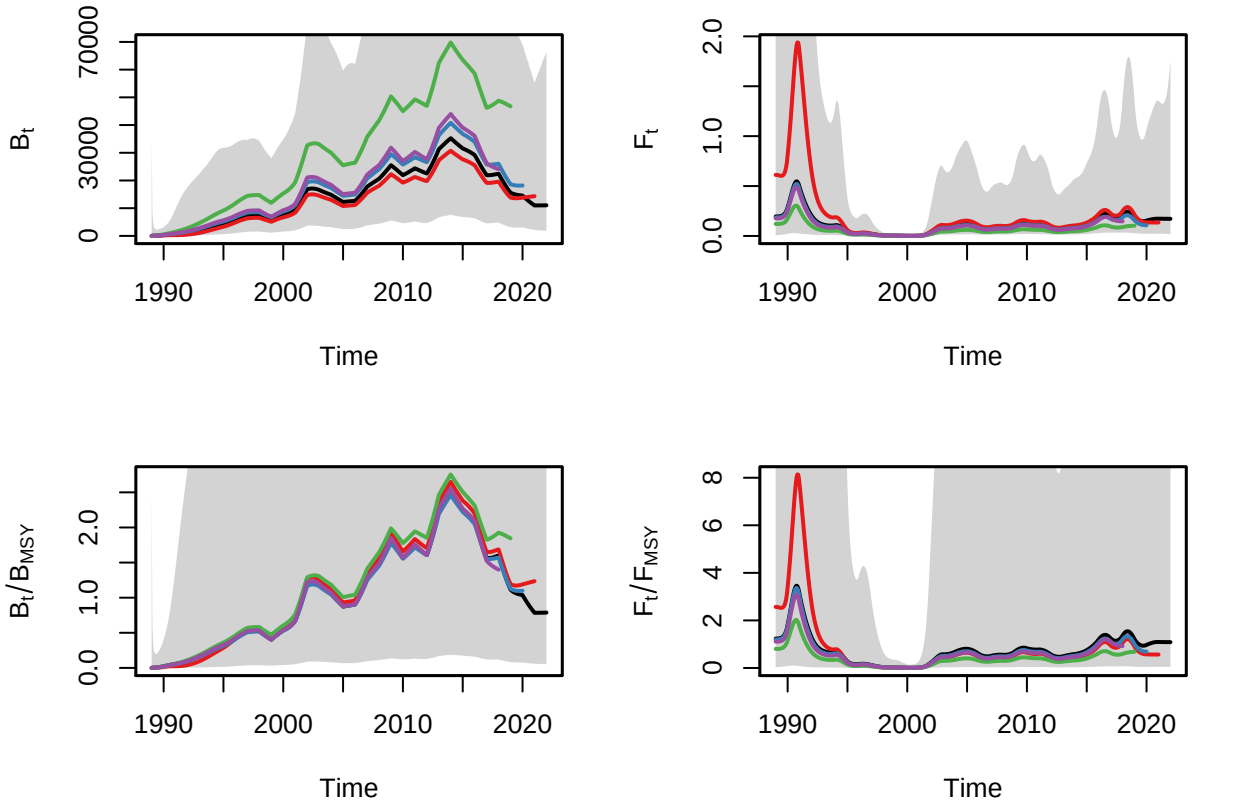
```
get.par('MSY', rescojmo)
            ll      est       ul       sd        cv
   MSY 390.2853 2229.531 4068.777 938.3907 0.4208915
```

```
capture.output(summary(rescojmo))
    [1] "Convergence: 0  MSG: relative convergence (4)"
    [2] "Objective function at optimum: 67.6723015"
    [3] "Euler time step (years):  1/16 or 0.0625"
    [4] "Nobs C: 33,  Nobs I1: 25"
    [5] ""
    [6] "Priors"
    [7] "     logn  ~  dnorm[log(2), 2^2]"
    [8] " logalpha  ~  dnorm[log(1), 2^2]"
    [9] "  logbeta  ~  dnorm[log(1), 2^2]"
   [10] ""
   [11] "Model parameter estimates w 95% CI "
   [12] "            estimate        cilow        ciupp     log.est  "
   [13] " alpha  5.665139e-01    0.1290173 2.487558e+00  -0.5682537  "
   [14] " beta   5.000096e-01    0.1586324 1.576030e+00  -0.6931281  "
   [15] " r      8.281720e-02    0.0070724 9.697864e-01  -2.4911190  "
   [16] " rc     3.010515e-01    0.0441799 2.051429e+00  -1.2004739  "
   [17] " rold   1.841146e-01    0.0076531 4.429325e+00  -1.6921969  "
   [18] " m      2.389313e+03 1034.2792582 5.519609e+03   7.7787612  "
   [19] " K      5.991643e+04 5703.6613602 6.294165e+05  11.0007060  "
   [20] " q      2.520000e-05    0.0000055 1.166000e-04 -10.5871480  "
```

```
 [21] " n      5.501865e-01    0.2862261 1.057574e+00  -0.5974980  "
 [22] " sdb    2.601459e-01    0.1391371 4.863974e-01  -1.3465125  "
 [23] " sdf    1.028727e+00    0.6001327 1.763408e+00   0.0283218  "
 [24] " sdi    1.473763e-01    0.0558376 3.889813e-01  -1.9147662  "
 [25] " sdc    5.143732e-01    0.2510359 1.053952e+00  -0.6648063  "
 [26] " "
 [27] "Deterministic reference points (Drp)"
 [28] "           estimate      cilow        ciupp   log.est  "
 [29] " Bmsyd 1.587312e+04 1962.47610 1.283867e+05  9.672382  "
 [30] " Fmsyd 1.505258e-01    0.02209 1.025715e+00 -1.893621  "
 [31] " MSYd  2.389313e+03 1034.27926 5.519609e+03  7.778761  "
 [32] "Stochastic reference points (Srp)"
 [33] "           estimate        cilow        ciupp   log.est rel.diff.Drp  "
 [34] " Bmsys 1.401442e+04 2046.0885918 9.598991e+04  9.547842  -0.13262778  "
 [35] " Fmsys 1.580857e-01    0.0256491 9.743471e-01 -1.844618   0.04782178  "
 [36] " MSYs  2.229531e+03  977.1099372 5.087256e+03  7.709547  -0.07166621  "
 [37] ""
 [38] "States w 95% CI (inp$msytype: s)"
 [39] "                    estimate        cilow        ciupp    log.est  "
 [40] " B_2021.00      1.098934e+04 2186.1565929 55241.077368  9.3046812  "
 [41] " F_2021.00      1.727491e-01    0.0220404     1.353976 -1.7559151  "
 [42] " B_2021.00/Bmsy 7.841456e-01    0.0599225    10.261322 -0.2431606  "
 [43] " F_2021.00/Fmsy 1.092756e+00    0.0479895    24.882818  0.0887026  "
 [44] ""
 [45] "Predictions w 95% CI (inp$msytype: s)"
 [46] "                  prediction        cilow        ciupp    log.est  "
 [47] " B_2022.00      1.103414e+04 1833.1537103 66416.842968  9.3087495  "
 [48] " F_2022.00      1.717772e-01    0.0167204     1.764752 -1.7615568  "
 [49] " B_2022.00/Bmsy 7.873422e-01    0.0541123    11.455945 -0.2390923  "
 [50] " F_2022.00/Fmsy 1.086608e+00    0.0409397    28.840394  0.0830610  "
 [51] " Catch_2022.00  1.899115e+03  318.2397413 11333.089857  7.5491435  "
 [52] " E(B_inf)       1.292750e+04           NA           NA  9.4671121  "
```

Extrear parametros estimados

```
rescom1 <- retro(rescojmo, nretroyear = 4)
plotspict.retro(rescom1)
   Warning in sqrt(rep$diag.cov.random[indran]): NaNs produced
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

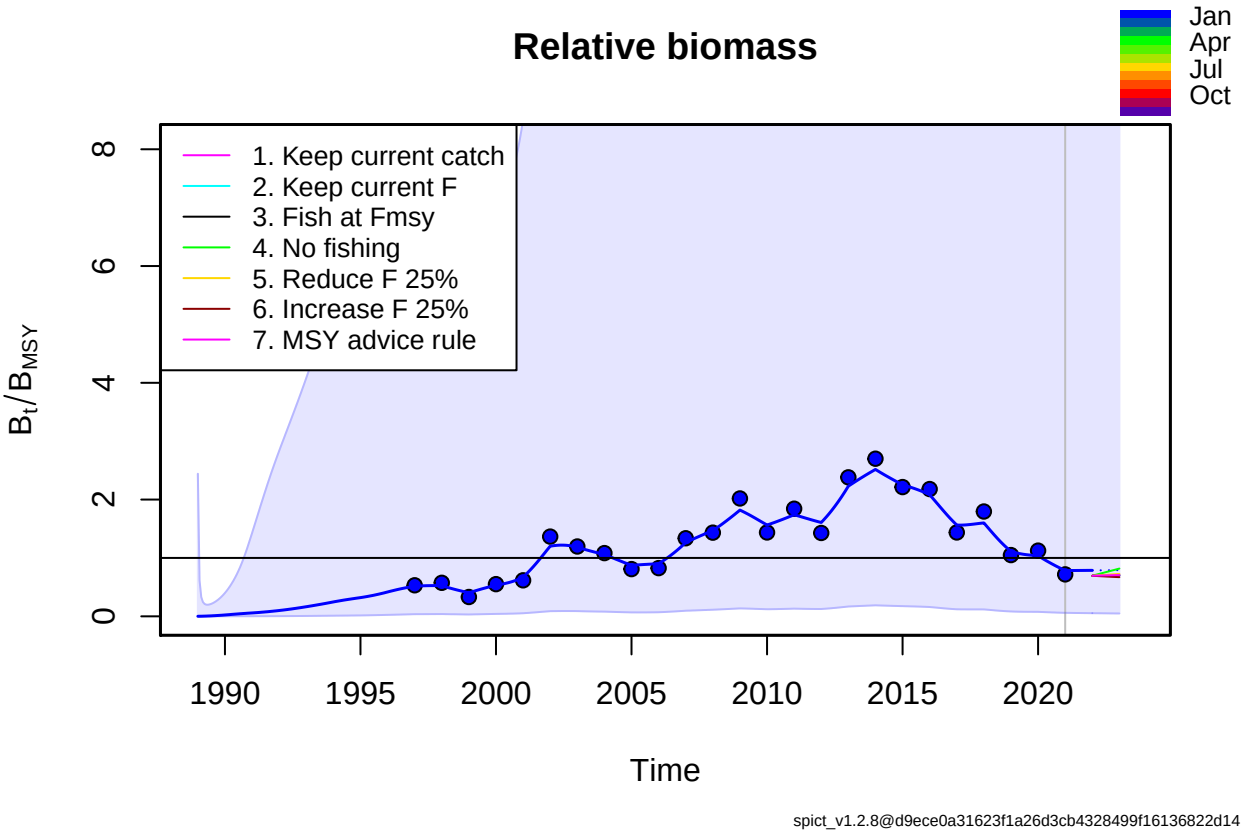
```
rescom2 <- manage(rescojmo)
```

```
df <- mansummary(rescom2)
   Observed interval, index:  1997.00 - 2021.00
   Observed interval, catch:  1989.00 - 2022.00

   Fishing mortality (F) prediction: 2023.00
   Biomass (B) prediction:           2023.00
   Catch (C) prediction interval:    2022.00 - 2023.00

   Predictions
                              C       B     F B/Bmsy F/Fmsy perc.dB perc.dF
   1. Keep current catch 1891.4 11084.9 0.171  0.698  1.081     0.5    -0.5
   2. Keep current F     1899.1 11078.7 0.172  0.698  1.087     0.4     0.0
   3. Fish at Fmsy       1758.5 11219.4 0.158  0.707  1.000     1.7    -8.0
   4. No fishing            2.1 12979.9 0.000  0.818  0.001    17.6   -99.9
   5. Reduce F 25%       1452.0 11526.0 0.129  0.726  0.815     4.5   -25.0
   6. Increase F 25%     2329.1 10649.2 0.215  0.671  1.358    -3.5    25.0
   7. MSY advice rule    1758.5 11219.4 0.158  0.707  1.000     1.7    -8.0

   95% CIs of absolute predictions
                           C.lo    C.hi   B.lo    B.hi  F.lo  F.hi
   1. Keep current catch 786.0  4551.5 1488.2 82567.3 0.014 2.048
   2. Keep current F     318.2 11333.1 1561.0 78626.7 0.008 3.741
   3. Fish at Fmsy       291.5 10607.0 1619.9 77705.2 0.007 3.443
   4. No fishing           0.3    14.1 2436.9 69134.3 0.000 0.004
```

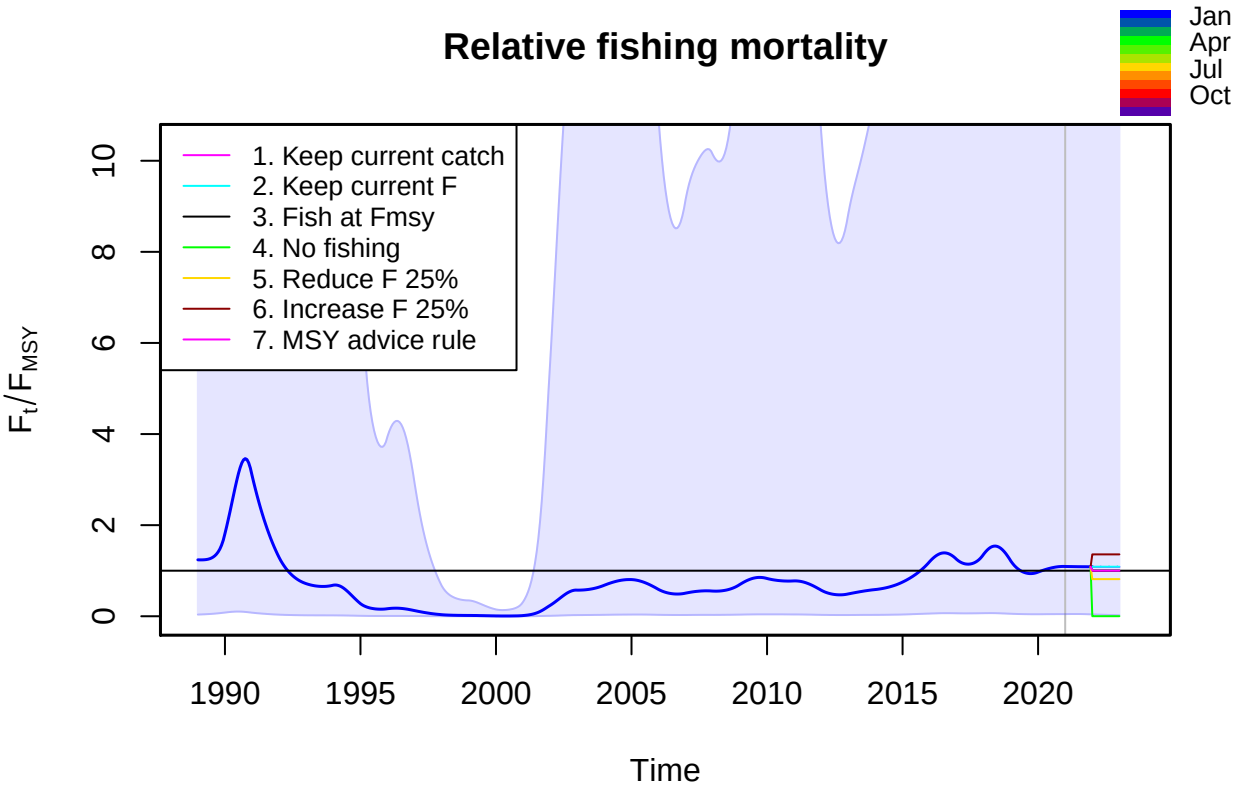
```
5. Reduce F 25%       235.2  8965.2 1751.9 75830.9 0.006 2.806
6. Increase F 25%     403.3 13448.6 1388.1 81700.5 0.010 4.677
7. MSY advice rule    291.5 10607.0 1619.9 77705.2 0.007 3.443

95% CIs of relative predictions
                      B/Bmsy.lo B/Bmsy.hi F/Fmsy.lo F/Fmsy.hi
1. Keep current catch     0.034    14.268     0.035    33.875
2. Keep current F         0.036    13.477     0.023    51.016
3. Fish at Fmsy           0.037    13.404     0.021    46.950
4. No fishing             0.052    12.828     0.000     0.051
5. Reduce F 25%           0.040    13.260     0.017    38.262
6. Increase F 25%         0.033    13.729     0.029    63.770
7. MSY advice rule        0.037    13.404     0.021    46.950
```

Ploteo de escenarios

```
plotspict.bbmsy(rescom2)
```

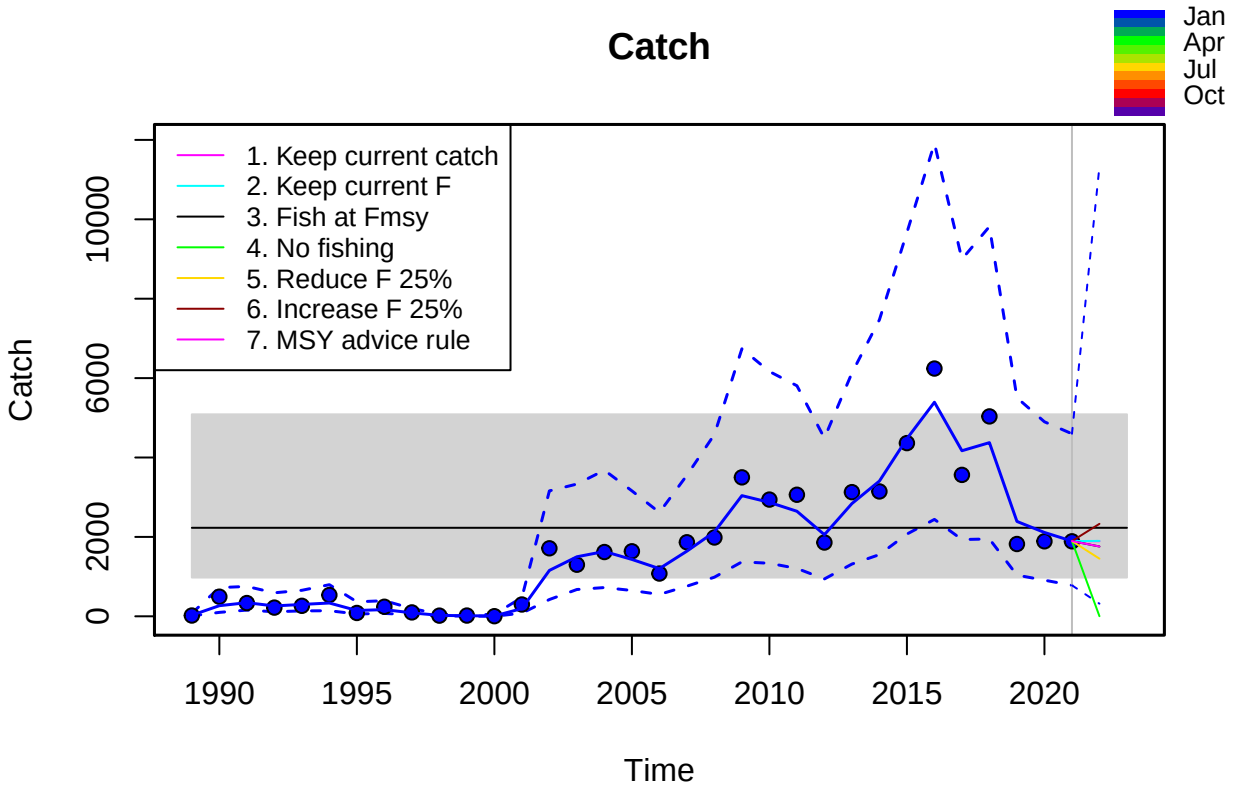



```
plotspict.ffmsy(rescom2)
```



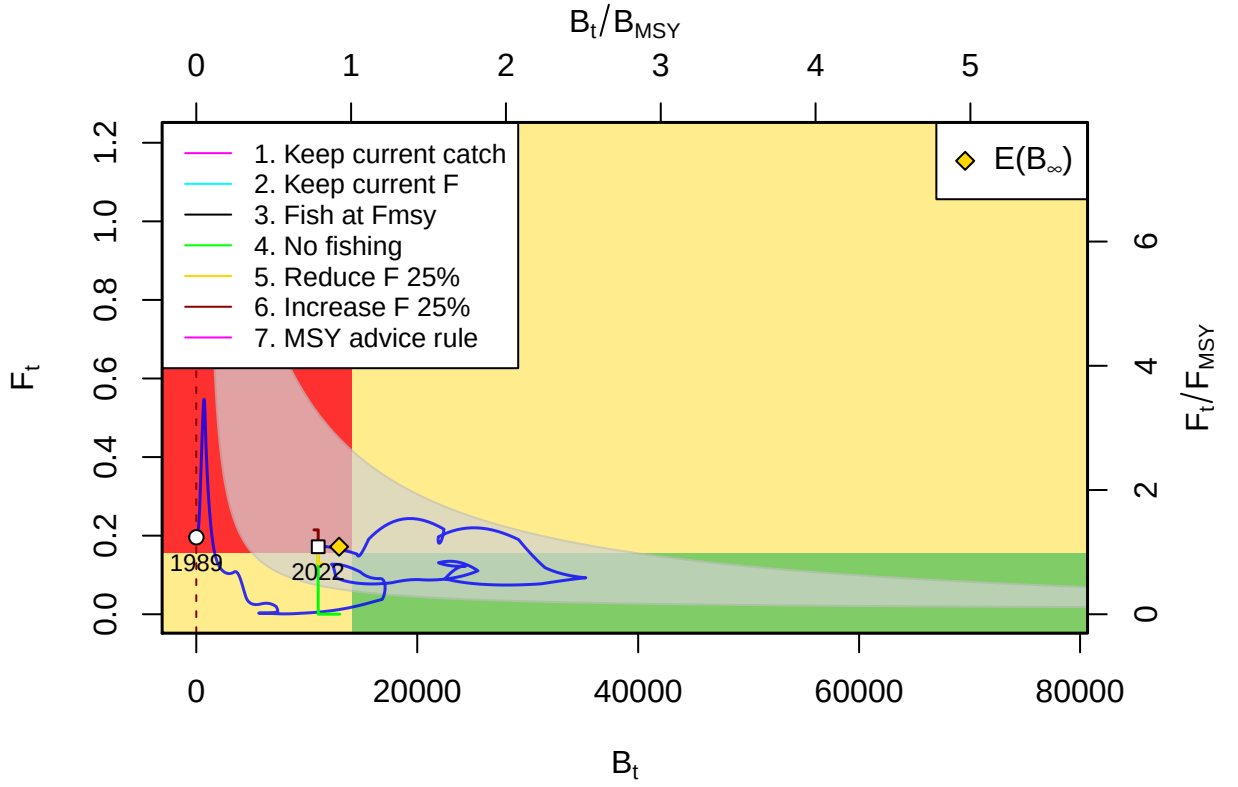
spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.catch(rescom2)
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

```
plotspict.fb(rescom2)
   Warning in if (class(cl) == "try-error") {: the condition has length > 1 and
   only the first element will be used
```



spict_v1.2.8@d9ece0a31623f1a26d3cb4328499f16136822d14

analisis futuros

- Como se estima F, m.?
- Como se condicionan las priors?
- predicciones. Identificar condiciones sobre las cuales se generan, por ejemplo, capturas, F , B, etc.
- Identificar claramente los escenarios por default