Package ‘DLMtool’

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R topics documented:

DLMtool-package ................................................................. 8
Albacore ........................................................................... 9
alphaconv ....................................................................... 9
R topics documented:

Atlantic_mackerel .................................................. 10
avail ................................................................. 10
AvC ................................................................. 11
barplot.MSE ......................................................... 11
betaconv ............................................................. 12
BK ................................................................. 13
BK_CC ............................................................... 13
BK_ML ............................................................... 14
Blow_opt ............................................................. 15
Bluefin_tuna ......................................................... 16
Bluefin_tuna_WAtl .................................................. 16
Blue_shark ........................................................... 16
boxplot.Data ......................................................... 17
boxplot.MSE ......................................................... 17
Butterfish ............................................................. 18
CalcOutput ........................................................... 19
Can ................................................................. 20
Cant ................................................................. 20
CC1 ................................................................. 21
CC4 ................................................................. 22
CheckConverg ......................................................... 23
checkMSE ........................................................... 23
China_rockfish ......................................................... 24
ChkDatNA ............................................................. 24
ChkObj ............................................................... 25
ChooseEffort .......................................................... 25
ChooseM ............................................................. 26
ChooseSelect ........................................................ 26
Cobia ................................................................. 27
compplot ............................................................. 27
CompSRA .............................................................. 28
CompSRA4010 ......................................................... 29
condmet .............................................................. 29
Converge ............................................................. 30
COSEWIC_plot ....................................................... 30
cparscheck .......................................................... 31
Cplot ................................................................. 31
CSRA ................................................................. 32
CSRAfunc ............................................................ 33
curE ................................................................. 34
curE75 ............................................................... 34
cv ................................................................. 35
DAAC ................................................................. 36
Data-class ............................................................ 36
Data_xl ............................................................... 39
DBSRA ............................................................... 40
DBSRA4010 .......................................................... 41
DBSRA_40 ........................................................... 41
<table>
<thead>
<tr>
<th>R topics documented:</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBSRA_ML</td>
<td>42</td>
</tr>
<tr>
<td>DCAC</td>
<td>43</td>
</tr>
<tr>
<td>DCAC4010</td>
<td>44</td>
</tr>
<tr>
<td>DCAC_40</td>
<td>44</td>
</tr>
<tr>
<td>DCAC_ML</td>
<td>45</td>
</tr>
<tr>
<td>DD</td>
<td>46</td>
</tr>
<tr>
<td>DD4010</td>
<td>47</td>
</tr>
<tr>
<td>DDe</td>
<td>47</td>
</tr>
<tr>
<td>DDe75</td>
<td>48</td>
</tr>
<tr>
<td>DDes</td>
<td>49</td>
</tr>
<tr>
<td>DecE_Dom</td>
<td>50</td>
</tr>
<tr>
<td>DecE_HDom</td>
<td>50</td>
</tr>
<tr>
<td>DecE_NDom</td>
<td>50</td>
</tr>
<tr>
<td>DepF</td>
<td>51</td>
</tr>
<tr>
<td>derive_beta_par</td>
<td>51</td>
</tr>
<tr>
<td>DFO_hist</td>
<td>52</td>
</tr>
<tr>
<td>DFO_plot</td>
<td>52</td>
</tr>
<tr>
<td>DFO_plot2</td>
<td>53</td>
</tr>
<tr>
<td>DFO_proj</td>
<td>53</td>
</tr>
<tr>
<td>DLMDataDir</td>
<td>54</td>
</tr>
<tr>
<td>DOM</td>
<td>54</td>
</tr>
<tr>
<td>DTc40</td>
<td>55</td>
</tr>
<tr>
<td>DTc50</td>
<td>55</td>
</tr>
<tr>
<td>DynF</td>
<td>56</td>
</tr>
<tr>
<td>EtargetLopt</td>
<td>57</td>
</tr>
<tr>
<td>Example_datafile</td>
<td>57</td>
</tr>
<tr>
<td>Fadapt</td>
<td>58</td>
</tr>
<tr>
<td>Fdem</td>
<td>59</td>
</tr>
<tr>
<td>Fdem_CC</td>
<td>59</td>
</tr>
<tr>
<td>Fdem_ML</td>
<td>60</td>
</tr>
<tr>
<td>Fease</td>
<td>61</td>
</tr>
<tr>
<td>Fease-class</td>
<td>61</td>
</tr>
<tr>
<td>Fease_xl</td>
<td>62</td>
</tr>
<tr>
<td>Feasibility</td>
<td>63</td>
</tr>
<tr>
<td>Feasibility2</td>
<td>64</td>
</tr>
<tr>
<td>fetch.file.names</td>
<td>64</td>
</tr>
<tr>
<td>FlatE_Dom</td>
<td>65</td>
</tr>
<tr>
<td>FlatE_HDom</td>
<td>65</td>
</tr>
<tr>
<td>FlatE_NDom</td>
<td>65</td>
</tr>
<tr>
<td>Fleet-class</td>
<td>66</td>
</tr>
<tr>
<td>FMSYref</td>
<td>67</td>
</tr>
<tr>
<td>FMSYref50</td>
<td>68</td>
</tr>
<tr>
<td>FMSYref75</td>
<td>68</td>
</tr>
<tr>
<td>ForceCor</td>
<td>69</td>
</tr>
<tr>
<td>Fratio</td>
<td>70</td>
</tr>
<tr>
<td>Fratio4010</td>
<td>71</td>
</tr>
<tr>
<td>Fratio_CC</td>
<td>71</td>
</tr>
<tr>
<td>Fratio_ML</td>
<td>72</td>
</tr>
</tbody>
</table>
R topics documented:

GB_CC ................................................................. 73
GB_slope ............................................................ 74
GB_target ........................................................... 75
Gcontrol ............................................................... 75
Generic_DecE ....................................................... 76
Generic_FlatE ....................................................... 76
Generic_fleet ....................................................... 77
Generic_IncE ....................................................... 77
Generic_obs ......................................................... 77
genLenComp ......................................................... 78
getAFC ............................................................... 78
getBH ................................................................. 79
getBlow .............................................................. 80
class ................................................................. 81
getFMSY3 ............................................................ 81
getFref3 ............................................................. 82
getGpars ............................................................. 84
GetMoreData ....................................................... 84
getmov ............................................................... 85
getmov2 .............................................................. 86
getq3 ................................................................. 87
Gulf_blue_tilefish ................................................ 88
HDAAC ............................................................... 88
Herring .............................................................. 89
hist2 ................................................................. 89
ICI ................................................................... 90
ICI2 ................................................................. 90
Imp-class .......................................................... 91
Imprecise_Biased .................................................. 92
Imprecise_Unbiased ............................................... 92
IncE_HDom ........................................................ 93
IncE_NDom ........................................................ 93
initialize-methods ............................................... 93
Input ............................................................... 94
InputRec-class ................................................... 95
IOTC_plot ........................................................ 95
Iratio ............................................................... 96
iSCAM2Data ....................................................... 97
iSCAM2DLM ....................................................... 98
iSCAMcomps ...................................................... 98
iSCAMinds ........................................................ 99
Islope1 ............................................................. 100
Islope4 ............................................................. 101
IT10 ............................................................... 102
IT5 ................................................................. 102
Itarget1 ............................................................ 103
Itarget4 ............................................................ 104
ItargetE1 ........................................................... 105
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITE4</td>
<td>106</td>
</tr>
<tr>
<td>ITE10</td>
<td>107</td>
</tr>
<tr>
<td>ITE5</td>
<td>107</td>
</tr>
<tr>
<td>ITM</td>
<td>108</td>
</tr>
<tr>
<td>joinMSE</td>
<td>109</td>
</tr>
<tr>
<td>Jplot</td>
<td>109</td>
</tr>
<tr>
<td>Kplot</td>
<td>110</td>
</tr>
<tr>
<td>L2A</td>
<td>111</td>
</tr>
<tr>
<td>L95target</td>
<td>112</td>
</tr>
<tr>
<td>LBSPR</td>
<td>113</td>
</tr>
<tr>
<td>LBSPR_ItEff</td>
<td>113</td>
</tr>
<tr>
<td>LBSPR_ItSel</td>
<td>114</td>
</tr>
<tr>
<td>LBSPR_ItTAC</td>
<td>114</td>
</tr>
<tr>
<td>LinInterp</td>
<td>115</td>
</tr>
<tr>
<td>load.iscam.files</td>
<td>115</td>
</tr>
<tr>
<td>Low_Effort_Non_Target</td>
<td>116</td>
</tr>
<tr>
<td>L.ratio_BHI</td>
<td>116</td>
</tr>
<tr>
<td>L.ratio_BHI2</td>
<td>117</td>
</tr>
<tr>
<td>LSRA</td>
<td>118</td>
</tr>
<tr>
<td>LSRA2</td>
<td>118</td>
</tr>
<tr>
<td>LSRA_MCMC_sim</td>
<td>119</td>
</tr>
<tr>
<td>LSRA_opt</td>
<td>120</td>
</tr>
<tr>
<td>L.stepCC1</td>
<td>121</td>
</tr>
<tr>
<td>L.stepCC4</td>
<td>122</td>
</tr>
<tr>
<td>L.stepCE1</td>
<td>123</td>
</tr>
<tr>
<td>L.stepCE2</td>
<td>124</td>
</tr>
<tr>
<td>L.target1</td>
<td>125</td>
</tr>
<tr>
<td>L.target4</td>
<td>126</td>
</tr>
<tr>
<td>L.targetE1</td>
<td>127</td>
</tr>
<tr>
<td>L.targetE4</td>
<td>127</td>
</tr>
<tr>
<td>Mackerel</td>
<td>128</td>
</tr>
<tr>
<td>makePerf</td>
<td>128</td>
</tr>
<tr>
<td>makeTransparent</td>
<td>129</td>
</tr>
<tr>
<td>matlenlim</td>
<td>129</td>
</tr>
<tr>
<td>matlenlim2</td>
<td>130</td>
</tr>
<tr>
<td>MCD</td>
<td>131</td>
</tr>
<tr>
<td>MCD4010</td>
<td>131</td>
</tr>
<tr>
<td>mconv</td>
<td>132</td>
</tr>
<tr>
<td>minlenLopt1</td>
<td>132</td>
</tr>
<tr>
<td>ML2D</td>
<td>133</td>
</tr>
<tr>
<td>movdistil</td>
<td>134</td>
</tr>
<tr>
<td>movfit</td>
<td>134</td>
</tr>
<tr>
<td>movfit_Rcpp</td>
<td>135</td>
</tr>
<tr>
<td>MPStats</td>
<td>136</td>
</tr>
<tr>
<td>MRnoreal</td>
<td>136</td>
</tr>
<tr>
<td>MRreal</td>
<td>137</td>
</tr>
<tr>
<td>MSE-class</td>
<td>137</td>
</tr>
<tr>
<td>NAor0</td>
<td>140</td>
</tr>
</tbody>
</table>
### R topics documented:

- `Needed` .......................... 141
- `negcorlogspace` .................. 141
- `NRef` ............................ 142
- `NOAA_plot` ....................... 142
- `Obs-class` ....................... 143
- `OM-class` ......................... 145
- `OM_xl` .......................... 149
- `optBH` ........................... 150
- `optF` .............................. 151
- `optMSY` ............................ 151
- `optQ` ............................... 152
- `ourReefFish` ...................... 154
- `Overages` ......................... 154
- `Perfect_Imp` ...................... 155
- `Perfect_Info` ..................... 155
- `plot,Data,ANY-method` .......... 155
- `plot,MSE,ANY-method` .......... 156
- `plot,OM` .......................... 156
- `plotFleet` ......................... 157
- `plotFun` ........................... 157
- `plotImp` ........................... 158
- `plotM` .............................. 159
- `plotObs` ........................... 159
- `plotOFL` ........................... 160
- `plotSelect` ....................... 160
- `plotStock` ......................... 161
- `popdyn` ............................ 162
- `Porgy` ............................. 163
- `Pplot` ............................. 163
- `Pplot2` ............................ 164
- `Precise_Biased` .................. 165
- `Precise_Unbiased` ............... 165
- `Range` ............................. 166
- `Rcontrol` .......................... 166
- `Rcontrol2` ......................... 167
- `read.control.file` ............... 168
- `read.data.file` ................... 168
- `read.mcmc` ....................... 169
- `read.par.file` ..................... 169
- `read.projection.file` .......... 170
- `read.report.file` ............... 170
- `Red_snapper` ..................... 171
- `Replace` ........................... 171
- `replic8` ........................... 172
- `Required` .......................... 172
- `Rockfish` .......................... 173
- `runInMP` ........................... 173
- `runMSE` ............................ 174
R topics documented:

runMSErobust .................................................. 175
Sam ................................................................. 176
SampleCpars ..................................................... 177
SampleFleetPars ............................................... 178
SampleImpPars .................................................. 178
SampleObsPars .................................................. 179
SampleStockPars ............................................... 179
sample_steepness2 ............................................. 180
sampy ............................................................. 180
SBT1 ............................................................... 181
SBT2 ............................................................... 182
sdconv ............................................................ 183
Sense .............................................................. 183
SetRecruitCycle ................................................ 184
setup ............................................................. 185
Simulation_1 ..................................................... 185
simYears ........................................................ 185
SketchFun ......................................................... 187
slotlim ............................................................ 187
Snapper ........................................................... 188
Sole ................................................................. 188
Splot ............................................................... 189
SPmod ............................................................. 190
SPMSY ............................................................. 191
SPslope ........................................................... 192
SPSRA ............................................................. 193
SPSRA_ML ........................................................ 193
SRAscomp ........................................................ 194
SRAsim ............................................................ 195
SRopt ............................................................... 196
SS2Data ........................................................... 196
SS2DLM ............................................................ 197
StochasticSRA ................................................... 198
StochasticSRA2 .................................................. 199
Stock-class ......................................................... 201
Sub ................................................................. 202
SubCpars .......................................................... 203
SubOM ............................................................. 204
summary,Data-method ........................................ 204
summary,MSE-method ......................................... 205
TAC ................................................................. 205
TACfilter .......................................................... 206
Targeting_Small_Fish .......................................... 206
Target_All_Fish .................................................. 207
tdlnorm ............................................................ 207
testOM ............................................................. 208
Toothfish .......................................................... 208
Tplot ............................................................... 208
Description

Simulation testing and implementation of data-limited fishery stock assessment methods

Additional Information

See the DLMtool User Guide for a detailed description of how to use the DLMtool package.

The help documentation for the DLMtool package can also be accessed here.

See the Data-Limited Toolkit Website for more information on the DLMtool, including an interactive demo of the main features of the toolkit, information on case studies where the toolkit has been applied, and more about the history and development of the DLMtool.

Author(s)

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References


Albacore Stock

Description

An object of class Stock

Usage

Albacore

Format

An object of class Stock of length 1.

alphaconv

Calculate alpha parameter for beta distribution from mean and standard deviation

Description

Calculate alpha parameter for beta distribution from mean and standard deviation

Usage

alphaconv(m, sd)

Arguments

m mean
sd standard deviation

Value

numeric

Author(s)

T. Carruthers
**Atlantic_mackerel**  
*Atlantic_mackerel Data*

**Description**

An object of class Data

**Usage**

Atlantic_mackerel

**Format**

An object of class Data of length 1.

---

**avail**  
*What objects of this class are available*

**Description**

Generic class finder

**Usage**

avail(classy)

**Arguments**

classy  
A class of object (character string, e.g. 'Fleet')

**Details**

Finds objects of the specified class in the global environment or the package:DLMtool

**Author(s)**

T. Carruthers
AvC

**Average Catch**

**Description**

A simple average catch MP that is included to demonstrate a 'status quo' management option.

**Usage**

```r
AvC(x, Data, reps = 100)
```

**Arguments**

- **x**: A position in a data-limited methods data object.
- **Data**: A data-limited methods data object.
- **reps**: The number of stochastic samples of the TAC recommendation.

**Author(s)**

T. Carruthers

---

**barplot.MSE**

**Plot a barplot of MSE results**

**Description**

Plot a barplot of MSE results.

**Usage**

```r
## S3 method for class 'MSE'
barplot(height, MSEobj = NULL, PMs = list(B_BMSY = 0.5,
     SSB_SSB0 = 0.2), PLim = 0.8, lastYrs = 10, maxMP = 14, MPs = NA,
     Title = NULL, sims = NULL, msg = TRUE, cex.names = 1.3,
     incRef = FALSE, ...)
```

**Arguments**

- **height**: An object of class MSE. Generic function must have argument height. But note that this must be an MSE object.
- **MSEobj**: Optional. An object of class MSE. Overides height.
- **PMs**: List of performance metrics. Options are c('SSB_SSB0', 'B_BMSY', 'F_FMSY', 'AAVE', 'AAVY')
- **PLim**: Probability threshold.
- **lastYrs**: Last number of years in projection to calculate statistics.
betaconv

Maximum number of MPs to include in each plot

Optional subset MSE object by MP

Optional title for plot

Optional subset MSE object by simulation

Logical. Print out messages?

Size of names

Logical. Include the reference methods?

Optional additional arguments passed to barplot

Author(s)

A. Hordyk

---

betaconv

Calculate beta parameter for beta distribution from mean and standard deviation

Description

Calculate beta parameter for beta distribution from mean and standard deviation

Usage

betaconv(m, sd)

Arguments

m mean

sd standard deviation

Value

numeric

Author(s)

T. Carruthers
**Beddington and Kirkwood life-history MP (simple version)**

**Description**

Sets an OFL according to current abundance and an approximation of Fmax based on length at first capture.

**Usage**

`BK(x, Data, reps = 100)`

**Arguments**

- **x**: A position in a data-limited methods data object.
- **Data**: A data-limited methods data object.
- **reps**: The number of stochastic samples of the TAC recommendation

**Note**

This is the simple version of the BK MP. The paper has a more complex approach that might work better.

**Author(s)**

T. Carruthers.

**References**


---

**Beddington and Kirkwood life-history method combined with catch curve analysis**

**Description**

Calculates an OFL using a catch curve estimate of current F and an approximation of FMSY based on length at first capture.

**Usage**

`BK_CC(x, Data, reps = 100, Fmin=0.005)`
**Arguments**

- **x**: Position in a data-limited methods data object  
- **Data**: A data-limited methods data object (class Data)  
- **reps**: The number of samples of the TAC recommendation  
- **fmin**: The minimum fishing mortality rate that is derived from the catch-curve (interval censor)

**Author(s)**

T. Carruthers

**References**


---

**Description**

Uses an approximation to FMSY based on length at first capture and an estimate of current abundance based on a mean-length estimator.

**Usage**

`BK_ML(x, Data, reps = 100)`

**Arguments**

- **x**: Position in a data-limited methods data object  
- **Data**: A data-limited methods data object (class Data)  
- **reps**: The number of samples of the TAC recommendation

**Note**

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'

**Author(s)**

T. Carruthers

**References**

**Blow_opt**

*Blow internal parallel optimization function*

**Description**

Find the current biomass at which it would take HZN mean generation times to reach Bfrac x SSBMSY biomass level given zero catches

**Usage**

```
Blow_opt(lnq, SSBMSYc, MGThorizon, Fc, Perrc, Mc, hc, Mac, Wac, R0c, Vc, nyears, maxage, movc, Spat_targc, SRrelc, aRc, bRc, Bfrac, mode = 1)
```

**Arguments**

- `lnq` number: estimate of log catchability
- `SSBMSYc` number: spawning biomass at MSY
- `MGThorizon` number: MGT x HZN
- `Fc` vector nyears long of fishing mortality rate
- `Perrc` vector nyears-maxage-1 long of recruitment deviations
- `Mc` matrix maxage by nyears+proyears of natural mortality rate
- `hc` number: steepness values
- `Mac` vector nages long of maturity at age
- `Wac` vector nages long of weight at age
- `R0c` number: unfished recruitment
- `Vc` matrix of vulnerability maxage x nyears
- `nyears` integer: number of historical years
- `maxage` integer: maximum age
- `mvc` matrix of movement 2 x 2
- `Spat_targc` number: spatial targetting parameters
- `SRrelc` integer representing recruitmentn dynamics type 1: Bev Holt 2: Ricker
- `aRc` number: recruitment parameter
- `bRc` number: recruitment parameter
- `Bfrac` fraction of SSBMSY that is the target
- `mode` 1: find Blow 2:report blow 3:plot results

**Author(s)**

T. Carruthers
Bluefin_tuna  

Description  
An object of class Stock  

Usage  
Bluefin_tuna  

Format  
An object of class Stock of length 1.

Bluefin_tuna_WAtl  

Description  
An object of class Stock  

Usage  
Bluefin_tuna_WAtl  

Format  
An object of class Stock of length 1.

Blue_shark  

Description  
An object of class Stock  

Usage  
Blue_shark  

Format  
An object of class Stock of length 1.
boxplot.Data

**Boxplot of TAC recommendations**

**Description**

Boxplot of TAC recommendations

**Usage**

```r
## S3 method for class 'Data'
boxplot(x, upq = 0.9, lwq = 0.1, outline = FALSE, ...)
```

**Arguments**

- `x`: An object of class MSE
- `upq`: Upper quantile of TACs for max ylim
- `lwq`: Lower quantile of TACs for min ylim
- `outline`: Logical. Include outliers in plot?
- `...`: Optional additional arguments passed to `boxplot`

**Value**

Returns a data frame containing the information shown in the plot

**Author(s)**

A. Hordyk

boxplot.MSE

**Boxplot of MP performance from MSE object**

**Description**

Boxplot of MP performance from MSE object

**Usage**

```r
## S3 method for class 'MSE'
boxplot(x, MP = NA, maxMP = 8, PMRefs = list(B_BMSY = 1, SSB_SSB0 = 0.2, F_FMSY = 1, AAVY = 30, AAVE = 30), lastYrs = 10, cex.lab = 1.2, cex.PM = 0.75, canMPs = NULL, cols = TRUE, outline = FALSE, CexName = 1.25, incLine = TRUE, incref = FALSE, Names = TRUE, ...)
```
Arguments

- **x**: An object of class MSE
- **MPs**: Optional subset MSE object by MP
- **maxMP**: Maximum number of MPs to plot
- **PMRefs**: List containing the Performance Metrics reference points. Options are 'SSB_SSB0', 'B_BMSY', 'F_FMSY', 'G_GMSY', 'G_GMSY_in', 'G_GMSY_out', 'G_GMSY_avg', 'G_GMSY_avg_in', 'G_GMSY_avg_out', 'G_GMSY_avg_ssb', 'G_GMSY_avg_ssb_in', 'G_GMSY_avg_ssb_out', 'G_GMSY_avg_ssb0', 'G_GMSY_avg_ssb0_in', 'G_GMSY_avg_ssb0_out', 'G_GMSY_avg_ssb0_ssb', 'G_GMSY_avg_ssb0_ssb_in', 'G_GMSY_avg_ssb0_ssb_out', 'G_GMSY_avg_ssb0_ssb0', 'G_GMSY_avg_ssb0_ssb0_in', 'G_GMSY_avg_ssb0_ssb0_out', 'G_GMSY_avg_ssb0_ssb0_ssb', 'G_GMSY_avg_ssb0_ssb0_ssb_in', 'G_GMSY_avg_ssb0_ssb0_ssb_out'.
- **lastYrs**: Last number of years in projection to calculate statistics
- **cex.lab**: Size of axis label text
- **cex.PM**: Size of performance metric text
- **canMPs**: Optional character vector of MPs that can be applied (plotted in different colour)
- **cols**: Optional vector of colours
- **outline**: Logical. Include outliers in boxplot?
- **CexName**: Size of the names
- **inclLine**: Logical. Include vertical line?
- **incRef**: Logical. Include reference methods?
- **Names**: Logical. Include MP names in plot?
- **...**: Additional arguments to be passed to plotting functions

Author(s)

A. Hordyk

---

Butterfish Stock

Description

An object of class Stock

Usage

Butterfish

Format

An object of class Stock of length 1.
CalcOutput

Apply output control recommendations and calculate population dynamics

Description

Apply output control recommendations and calculate population dynamics

Usage


Arguments

y Projection year
TACused TAC recommendation
TAC_f Implementation error on TAC
lastCatch Catch from last year
availB Total available biomass
maxF Maximum fishing mortality
Biomass_P Numeric array (nsim, maxage, proyears, nareas) with Biomass at age
VBiomass_P Numeric array (nsim, maxage, proyears, nareas) with Vulnerable Biomass at age
CB_P Numeric array (nsim, maxage, proyears, nareas) with Catch Biomass at age
CB_Pret Numeric array (nsim, maxage, proyears, nareas) with Retained catch biomass at age
FM_P Numeric array (nsim, maxage, proyears, nareas) with fishing mortality at age
Z_P Numeric array (nsim, maxage, proyears, nareas) with total mortality at age
Spat_targ Spatial targeting
V_P Numeric array (nsim, maxage, nyears+proyears) with vulnerability at age
retA_P Numeric array (nsim, maxage, nyears+proyears) with retention at age
M_ageArray Numeric array (nsim, maxage, nyears+proyears) Natural mortality at age
qs Catchability coefficient
nyears Number of historical years
nsim Number of simulations
maxage Maximum age
nareas Number of areas

Author(s)

A. Hordyk
What data-limited methods can be applied to this Data object?

Description

An diagnostic tool that looks up the slot requirements of each method and compares this to the data available to limit the analysis to methods that have the correct data, do not produce errors and run within a time limit. Time limit is the maximum time taken to carry out five reps (stochastic samples) of a given method and is in units of seconds.

Usage

Can(Data, timelimit = 1)

Arguments

- **Data**: A data-limited methods data object (class Data)
- **timelimit**: The maximum time (seconds) taken for a method to undertake 10 reps (this filters out methods that are too slow)

What methods can’t be applied to this DLM data object

Description

The methods that don’t have sufficient data, lead to errors or don’t run in time along with a list of their data requirements.

Usage

Cant(Data, timelimit = 1)

Arguments

- **Data**: A data-limited methods data object (class Data)
- **timelimit**: The maximum time (seconds) taken for a method to undertake 10 reps (this filters out methods that are too slow)
**Constant catch management procedure of Geromont and Butterworth (2014)**

**Description**

The TAC is the average catch over last yrsmth years.

**Usage**

`CC1(x, Data, reps = 100, yrsmth = 5, xx=0)`

**Arguments**

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrsmth**: Years over which to calculate mean catches
- **xx**: Parameter controlling the TAC. Mean catches are multiplied by (1-xx)

**Details**

This is one of four constant catch rules of Geromont and Butterworth 2014.

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

**References**

**Description**

The TAC is the average catch over last yrmth years reduced by 30

**Usage**

\[
\text{CC4}(x, \text{Data}, \text{reps} = 100, \text{yrmth} = 5, xx=0.3)
\]

**Arguments**

- `x`: A position in data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of TAC samples
- `yrmth`: Years over which to average catches
- `xx`: Parameter controlling the TAC. Mean catches are multiplied by (1-xx)

**Details**

This is one of four constant catch MPs of Geromont and Butterworth 2014.

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

**References**

CheckConverg

MSE convergence diagnostic

**Description**

Have I undertaken enough simulations (nsim)? Has my MSE converged on stable (reliable) performance metrics?

**Usage**

CheckConverg(MSEobj, thresh=2, Plot=TRUE)

**Arguments**

- **MSEobj**: An object of class 'MSE'
- **thresh**: The convergence threshold (percentage). If mean performance metrics are within thresh percent of the second to last iteration, the MSE can be considered to have converged.
- **Plot**: Should figures be plotted?

**Author(s)**

A. Hordyk

---

checkMSE

Check that MSE object includes all slots

**Description**

Check that an MSE object includes all slots in the latest version of DLMtool Use 'updateMSE' to update the MSE object

**Usage**

checkMSE(MSEobj)

**Arguments**

- **MSEobj**: A MSE object.

**Author(s)**

A. Hordyk
China_rockfish  China_rockfish Data

**Description**
An object of class Data

**Usage**
China_rockfish

**Format**
An object of class Data of length 1.

---

ChkDatNA  Check Data object is valid for a MP

**Description**
Checks that all slots in Data object required by the MP contain finite values

**Usage**
ChkDatNA(Data, dependencies)

**Arguments**
- Data: An object of class Data
- dependencies: A string of slots in the Data object required for the MP

**Author(s)**
A. Hordyk
**ChkObj**

*Check that a DLM object is valid*

---

**Description**

Check that all slots in Object are valid and contain values

**Usage**

`ChkObj(OM)`

**Arguments**

- `OM` An object of class OM, Stock, Fleet, Obs, or Imp

---

**ChooseEffort**

*Manually map the historical relative fishing effort trajectory.*

---

**Description**

Interactive plot which allows users to specify the relative trajectory and variability in the historical fishing effort and populates Fleet object.

**Usage**

`ChooseEffort(FleetObj, Years=NULL)`

**Arguments**

- `FleetObj` A fleet object.
- `Years` An optional vector of years. Should be `nyears` long.

**Author(s)**

A. Hordyk
ChooseM

Manually map natural mortality at age or size.

Description
Interactive plot which allows users to specify M by age or size class

Usage
ChooseM(OM, type = c("age", "length"), x = NULL, y = NULL)

Arguments
- OM: An object of class 'OM'
- type: A character string - is M to be mapped by 'age' or 'length'?
- x: Optional vector for x-axis
- y: Optional vector for y-axis

Author(s)
A. Hordyk

ChooseSelect
Manually choose the historical selectivity pattern

Description
Input the first historical year, and all years where selectivity pattern changed (separated by comma). Interactive plot which allows users to specify a range for the length at 5% and full selection (LFS), as well as selectivity at maximum length for each year. Produces a simple plot which shows the range in selectivity pattern for each break-point year. Selectivity-at-length is fixed in between break-point years. Note that this function replaces 'nyears' in the Fleet object with the value defined here (FstYr:current year).

Usage
ChooseSelect(Fleet, Stock, FstYr = NULL, SelYears = NULL)

Arguments
- Fleet: A fleet object.
- Stock: Optional Stock object. If provided, average length-at-maturity is included on plot for reference.
- FstYr: Optional value for first historical year. If empty, user must specify the year in console.
- SelYears: Optional vector of values for each year where selectivity pattern changed. If empty, user must specify the years in console (comma separated).
Description
An object of class Data

Usage
Cobia

Format
An object of class Data of length 1.

compplot

Generic comparison plot for simulation testing of Stochastic SRA method

Description
Plots simulation variables versus estimation variables for Stochastic SRA methods of conditioning operating models.

Usage
compplot(simy, samy, xlab = "", ylab = "", maxplot = 10, type = "l")

Arguments
- simy: The simulated time series
- samy: The matrix of estimated time series from of StochasticSRA() function.
- xlab: The x axis label for the plot
- ylab: The y axis label for the plot
- maxplot: The total number of individual simulations to be plotted in the first plot
- type: Should a line 'l' or points 'p' be plotted?

Value
A plot
Author(s)

T. Carruthers (Canadian DFO grant)

Examples

```r
nyears<-100
zeims<-200
simy<-sin(seq(0,2,length.out=nyears))
samy<-array(rep(simy,each=nsims)*rnorm(nsims,1,0.2)*rnorm(nsims*nyears,1,0.1),c(nsims,nyears))
par(mfrow=c(1,2))
compplot(simy,samy,xlab="Year",ylab="Some time varying parameter")
```

Description

Estimates an OFL based on a Stock Reduction analysis fitted to current age-composition data. Knife-edge vulnerability at age at maturity allows for an FMSY estimate. OFL=FMSY*F/C

Usage

```r
CompSRA(x, Data, reps = 100)
```

Arguments

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of stochastic samples of the TAC.

Note

Given a fixed historical F, What level of depletion gives you this length composition?

Author(s)

T. Carruthers
CompSRA4010

Age-composition-based estimate of current stock depletion given constant Z linked to an FMSY estimate to provide OFL (with a 40-10 rule)

Description

Estimates an OFL based on a Stock Reduction analysis fitted to current age-composition data. Knife-edge vulnerability at age at maturity allows for an FMSY estimate. OFL=FMSY*F/C

Usage

CompSRA4010(x, Data, reps = 100)

Arguments

x
A position in a data-limited methods data object

Data
A data-limited methods data object

reps
The number of stochastic samples of the TAC.

Note

Given a fixed historical F, What level of depletion gives you this length composition?

Author(s)

T. Carruthers

condmet

Condition met?

Description

Condition met?

Usage

condmet(vec)

Arguments

vec
vector of logical values
**Converge**: *Check Convergence*

**Description**

Have I undertaken enough simulations (nsim)? Has my MSE converged on stable (reliable) performance metrics?

**Usage**

```
Converge(MSEobj, thresh = 2, Plot = TRUE)
```

**Arguments**

- **MSEobj**: An MSE object of class 'MSE'
- **thresh**: The convergence threshold (percentage). If mean performance metrics are within thresh percent of the second to last iteration, the MSE can be considered to have converged.
- **Plot**: Should figures be plotted?

**Author(s)**

A. Hordyk

---

**COSEWIC_plot**: *COSEWIC forward projection plot*

**Description**

Projection of biomass under three scenarios: no catch, FMSY fishing and status quo fishing. This plot is for an MSE object created from runMSE with the argument MPs=c("NFref","FMSYref","curE")

**Usage**

```
COSEWIC_plot(MSEobj, syear = 2015)
```

**Arguments**

- **MSEobj**: An object of class MSE created from runMSE() with the argument MPs=c("NFref","FMSYref","curE")
- **syear**: Starting year of the projection for graphing purposes

**Value**

A plot

**Author(s)**

T. Carruthers
**cparscheck**

*Internal function of runMSE for checking that the OM slot cpars slot is formatted correctly*

**Description**

Internal function of runMSE for checking that the OM slot cpars slot is formatted correctly

**Usage**

cparscheck(cpars)

**Arguments**

cpars a list of model parameters to be sampled (single parameters are a vector nsim long, time series are matrices nsim x nyers)

**Value**

either an error and the length of the first dimension of the various cpars list items or passes and returns the number of simulations

**Author(s)**

T. Carruthers

---

**Cplot**

*Plot the median biomass and yield relative to last historical year*

**Description**

Compare median biomass and yield in first year and last 5 years of projection

**Usage**

Cplot(MSEobj, MPs = NA, lastYrs = 5, XMin = NULL, YMin = NULL, ShowLabs = FALSE)

**Arguments**

- **MSEobj** An object of class MSE
- **MPs** Optional subset by MP
- **lastYrs** Last number of years of projection to calculate median
- **XMin** Optional minimum for the x-axis
- **YMin** Optional minimum for the y-axis
- **ShowLabs** Logical. Show the MP labels? Otherwise only plot points
Value
Invisibly returns a data frame containing information shown in the plot

Author(s)
A. Hordyk

CSRA Catch at size reduction analysis

Description
What depletion level and corresponding equilibrium F arise from data regarding mean length of current catches, natural mortality rate, steepness of the stock recruitment curve, maximum length, maximum growth rate, age at maturity, age based vulnerability, maturity at age, maximum age and number of historical years of fishing.

Usage
CSRA(M,h,linf,K,t0,AM,a,b,vuln,mat,ML,CAL,CAA,maxage,nyears)

Arguments
M A vector of natural mortality rate estimates
h A vector of sampled steepness (Beverton-Holt stock recruitment)
linf A vector of maximum length (von Bertalanffy growth)
K A vector of maximum growth rate (von Bertalanffy growth)
t0 A vector of theoretical age at length zero (von Bertalanffy growth)
AM A vector of age at maturity
a Length-weight conversion parameter a (W=aL^b)
b Length-weight conversion parameter b (W=aL^b)
vuln A matrix nsim x nage of the vulnerability at age (max 1) to fishing.
mat A matrix nsim x nage of the maturity at age (max 1)
ML A vector of current mean length estimates
CAL A catch-at-length matrix nyears x (1 Linf unit) length bins
CAA A catch-at-age matrix nyears x maximum age
maxage Maximum age
nyears Number of historical years of fishing

Author(s)
T. Carruthers
CSRAfunc

Optimization function for CSRA

Description

What depletion level and corresponding equilibrium \( F \) arise from data regarding mean length of current catches, natural mortality rate, steepness of the stock recruitment curve, maximum length, maximum growth rate, age at maturity, age based vulnerability, maturity at age, maximum age and number of historical years of fishing.

Usage

\[
\text{CSRAfunc}(\ln F, Mc, hc, maxage, nyears, AFSc, AFCc, Linfc, Kc, t0c, AMc, ac, bc, vulnc, matc, MLc, CAL, CAA, \text{ opt}=T, \text{meth}='ML')
\]

Arguments

- \( \ln F \): A proposed value of current instantaneous fishing mortality rate
- \( Mc \): Natural mortality rate estimates
- \( hc \): Steepness (Beverton-Holt stock recruitment)
- \( maxage \): Maximum age
- \( nyears \): Number of historical years of fishing
- \( AFSc \): Age at full selection
- \( AFCc \): Age at first capture
- \( Linfc \): Maximum length (von Bertalanffy growth)
- \( Kc \): Maximum growth rate (von Bertalanffy growth)
- \( t0c \): Theoretical age at length zero (von Bertalanffy growth)
- \( AMc \): Age at maturity
- \( ac \): Length-weight conversion parameter \( a \) \((W=aL^b)\)
- \( bc \): Length-weight conversion parameter \( b \) \((W=aL^b)\)
- \( vulnc \): A vector (nage long) of the vulnerability at age \((\text{max} 1)\) to fishing.
- \( matc \): A vector (nage long) of the maturity at age \((\text{max} 1)\)
- \( MLc \): A current mean length estimates
- \( CAL \): A catch-at-length matrix \text{ nyears} \times (1 \text{ Linf unit}) length bins
- \( CAA \): A catch-at-age matrix \text{ nyears} \times \text{ maximum age}
- \( opt \): Should the measure of fit be returned?
- \( meth \): Are we fitting to mean length or catch composition?

Author(s)

T. Carruthers
curE

Fishing at current effort levels

Description

Constant fishing effort set at final year of historical simulations subject to changes in catchability determined by OM@qinc and interannual variability in catchability determined by OM@qcv. This MP is intended to represent a ‘status quo’ management approach.

Usage

curE(x, Data, ...)

Arguments

x A position in a data-limited methods data object.
Data A data-limited methods data object.
... Optional additional arguments that are ignored. Note arguments reps or ... are required for all input controls

Note

Made up for this package.

Author(s)

T. Carruthers.

curE75

Fishing at 75 per cent of current effort levels

Description

Constant fishing effort set at 75 per cent of final year of historical simulations subject to changes in catchability determined by OM@qinc and interannual variability in catchability determined by OM@qcv. This MP is intended to represent a ‘status quo’ management approach.

Usage

curE75(x, Data, ...)

Note

Made up for this package.

Author(s)

T. Carruthers.
Arguments

- **x**: A position in a data-limited methods data object.
- **Data**: A data-limited methods data object.
- **...**: Optional additional arguments that are ignored. Note arguments `reps` or `...` are required for all input controls.

Note

Made up for this package.

Author(s)

T. Carruthers.

---

**cv**  
*Calculate CV from vector of values*

Description

Calculate CV from vector of values

Usage

`cv(x)`

Arguments

- **x**: vector of numeric values

Value

numeric

Author(s)

T. Carruthers
**Data-class**

---

**DAAC**  
*Depletion Adjusted Average Catch*

**Description**
Essentially DCAC multiplied by 2*depletion and divided by BMSY/B0 (Bpeak)

**Usage**

```r
DAAC(x, Data, reps = 100)
```

**Arguments**

- `x` A position in a data-limited methods data object
- `Data` A data-limited methods data object
- `reps` The number of stochastic samples of the TAC recommendation

**Author(s)**

W. Harford and T. Carruthers

**References**


---

**Data-class**  
*Class 'Data'*

**Description**
An object for storing data for analysis using data-limited methods

**Slots**

- `Name` The name of the case-study
- `Year` A vector of years that correspond to catch and relative abundance data
- `Cat` Total annual catches
- `Ind` Relative abundance index
- `t` The number of years corresponding to AvC and Dt
- `AvC` Average catch over time t
- `Dt` Depletion over time t e.g. Bnow/Bthen
**Data-class**

ML Mean length time series
Mort Natural mortality rate
FMSY M An assumed ratio of FMSY to M
BMSY B0 The most productive stock size relative to unfished
L50 Length at 50 percent maturity
L95 Length at 95 percent maturity
Lbar Mean length of catches over Lc (modal length)
Lc Modal length
LFC Length at first capture
LFS smallest Length at full selection
CAA Catch at Age data
Dep Stock depletion Bnow/Bunfished (total stock)
Abun An estimate of absolute current vulnerable abundance
SpAbun An estimate of absolute current spawning stock abundance
vbk The von Bertalanffy growth coefficient
vblinf Maximum length
vbt0 Theoretical age at length zero
LenCV Coefficient of variation of length-at-age (assumed constant for all age classes)
w1a Weight-Length parameter alpha
w1b Weight-Length parameter beta
steep Steepness of the Beverton Holt stock-recruitment relationship
CV Cat Coefficient of variation in annual catches
CV Dt Coefficient of variation in depletion over time t
CV AvC Coefficient of variation in average catches over time t
CV Ind Coefficient of variation in the relative abundance index
CV Mort Coefficient of variation in natural mortality rate
CV FMSY M Coefficient of variation in the ratio in FMSY/M
CV BMSY B0 Coefficient of variation in the position of the most productive stock size relative to unfished
CV Dep Coefficient of variation in current stock depletion
CV Abun Coefficient of variation in estimate of absolute current stock size
CV vbk Coefficient of variation in the von Bert. k parameter
CV vblinf Coefficient of variation in maximum length
CV vbt0 Coefficient of variation in age at length zero
CV L50 Coefficient of variation in length at 50 per cent maturity
CV LFC Coefficient of variation in length at first capture
CV LFS Coefficient of variation in length at full selection
CV_wla  Coefficient of variation in weight-length parameter a
CV_wlb  Coefficient of variation in weight-length parameter b
CV_stee  Coefficient of variation in steepness
sigma  Assumed observation error of the length composition data
MaxAge  Maximum age
Units  Units of the catch/absolute abundance estimates
Ref  A reference quota level
Ref_type  Its type
Log  A log of events
params  A place to store estimated parameters
PosMPs  The methods that can be applied to these data
MPs  The methods that were applied to these data
OM  A table of operating model conditions
Obs  A table of observation model conditions
TAC  The calculated TAC
TACbias  The known bias in the calculated TAC
Sense  The results of the sensitivity analysis
CAL_bins  The length bins for the catch-at-length data
CAL  Catch-at-length data
Cref  Reference or target catch level
Iref  Reference or target relative abundance index level
Bref  Reference or target biomass level
CV_Cref  CV for reference or target catch level
CV_Iref  CV for reference or target relative abundance index level
CV_Bref  CV for reference or target biomass level
CV_Rec  CV for recent recruitment strength
Rec  Recent recruitment strength
MPrev  The previous recommendation of a management procedure
MPeff  The current level of effort
LHYear  The last historical year of the simulation (before projection)
nareas  Number of fishing areas
Misc  Optional list which is passed to MPs

**Objects from the Class**

Objects can be created by calls of the form `new('Data', stock)`

**Author(s)**

T. Carruthers
Data_xl

Examples

newdata<-new('Data')

Data_xl  Read in Data object from Excel spreadsheet

Description

A function to read in Data object from an Excel spreadsheet with tabs named following specific convention.

Usage

Data_xl(fname, stkname, fpath = '', saveCSV = FALSE)

Arguments

  fname         Name of the Excel spreadsheet file. Must include file extension.
  stkname       Name of the Stock.
  fpath         Full file path, if file is not in current working directory
  saveCSV       Do you also want to the Data parameters to a CSV file?

Details

The Excel spreadsheet must have tabs named with the following convention. For example if
stkname is 'myFish', the Data parameters are in a tab named 'myFishData'.

Value

A object of class Data

Author(s)

A. Hordyk

Examples

## Not run:
OM <- OM_xl(fname='OMTables.xlsx', stkname='myFish')

## End(Not run)
Depletion-Based Stock Reduction Analysis

Description

User prescribed BMSY/B0, M, FMSY/M are used to find B0 and therefore the OFL by backconstructing the stock to match a user specified level of stock depletion \( \text{OFL} = M \times \text{FMSY}/M \times \text{depletion} \times B0 \).

Usage

\[
\text{DBSRA}(x, \text{Data}, \text{reps} = 100)
\]

Arguments

\begin{itemize}
  \item \texttt{x} \hspace{1cm} A position in a data-limited methods object.
  \item \texttt{Data} \hspace{1cm} A data-limited methods object.
  \item \texttt{reps} \hspace{1cm} The number of samples of the TAC (OFL) recommendation.
\end{itemize}

Details

You specify a range of stock depletion and, given historical catches DB-SRA calculates what unfished biomass must have been to get you here given samples for M, FMSY relative to M and also BMSY relative to Bunfished.

Value

A vector of TAC (OFL) values.

Note

This is set up to return the OFL (FMSY \times \text{current biomass}).

You may have noticed that you -the user- specify three of the factors that make the quota recommendation. So this can be quite a subjective method.

Also the DB-SRA method of this package isn’t exactly the same as the original method of Dick and MacCall (2011) because it has to work for simulated depletions above BMSY/B0 and even on occasion over B0. Also it doesn’t have the modification for flatfish life histories that has previously been applied by Dick and MacCall.

Author(s)

T. Carruthers

References

**Depletion-Based Stock Reduction Analysis paired with 40-10 harvest control rule**

**Description**

User prescribed BMSY/B0, M, FMSY/M are used to find B0 and therefore the OFL by back-construction the stock to match a user specified level of stock depletion (OFL = M * FMSY/M * depletion* B0). In this method DBSRA is paried with the 40-10 rule that throttles back the OFL to zero at 10 percent of unfished biomass.

**Usage**

DBSRA4010(x, Data, reps = 100)

**Arguments**

- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the TAC recommendation

**Author(s)**

T. Carruthers

**References**


**Depletion-Based Stock Reduction Analysis assuming 40 per cent stock depletion**

**Description**

DBSRA assuming that current stock depletion is exactly 40 per cent of unfished stock levels.

**Usage**

DBSRA_40(x, Data, reps = 100)
Arguments

- **x**: A position in a data-limited methods data object
- **data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the TAC recommendation

**Note**

A 40 percent assumption for current depletion is more or less the most optimistic state for a stock (i.e., very close to BMSY/B0 for many stocks).

**Author(s)**

T. Carruthers.

**References**


---

**DBSRA_ML**

*Depletion-Based Stock Reduction Analysis using mean length estimator of stock depletion*

**Description**

DBSRA using the mean length estimator to calculate current stock depletion.

**Usage**

```r
DBSRA_ML(x, data, reps = 100)
```

Arguments

- **x**: A position in a data-limited methods data object
- **data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the quota recommendation

**Note**

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'.

**Author(s)**

T. Carruthers
References


DCAC

Depletion Corrected Average Catch

Description

A method of calculating an MSY proxy (FMSY * BMSY and therefore the OFL at most productive stock size) based on average catches accounting for the windfall catch that got the stock down to BMSY levels.

Usage

DCAC(x, Data, reps = 100)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>A position in a data-limited methods data object</td>
</tr>
<tr>
<td>Data</td>
<td>A data-limited methods data object</td>
</tr>
<tr>
<td>reps</td>
<td>The number of stochastic samples of the TAC recommendation</td>
</tr>
</tbody>
</table>

Note

It’s probably worth noting that DCAC TAC recommendations do not tend to zero as depletion tends to zero. It adjusts for depletion only in calculating historical average catch. It follows that at stock levels much below BMSY, DCAC tends to chronically overfish.

Author(s)

T. Carruthers

References

**DCAC4010**  
*Depletion Corrected Average Catch paired with the 40-10 rule*

**Description**

A method of calculating an MSY proxy (FMSY * BMSY and therefore the OFL at most productive stock size) based on average catches accounting for the windfall catch that got the stock down to BMSY levels. In this method DCAC is paired with the 40-10 rule that throttles back the OFL to zero at 10 percent of unfished stock size (the OFL is not subject to downward adjustment above 40 percent unfished).

**Usage**

```
DCAC4010(x, Data, reps = 100)
```

**Arguments**

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of stochastic samples of the TAC recommendation

**Note**

DCAC can overfish below BMSY levels. The 40-10 harvest control rule largely resolves this problem providing an MP with surprisingly good performance even at low stock levels.

**Author(s)**

T. Carruthers

**References**


---

**DCAC_40**  
*Depletion Corrected Average Catch assuming 40 per cent stock depletion*

**Description**

DCAC assuming that current stock biomass is exactly 40 per cent of unfished levels.

**Usage**

```
DCAC_40(x, Data, reps = 100)
```
**Arguments**

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of stochastic samples of the TAC recommendation

**Note**

The 40 percent depletion assumption doesn’t really affect DCAC that much as it already makes TAC recommendations that are quite MSY-like.

**Author(s)**

T. Carruthers

**References**


---

**Description**

DCAC that uses the mean length estimator to calculate current stock depletion.

**Usage**

```r
DCAC_ml(x, Data, reps = 100)
```

**Arguments**

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of stochastic samples of the TAC recommendation

**Note**

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'.

**Author(s)**

T. Carruthers
References


Description

A simple delay-difference assessment that estimates the TAC using a time-series of catches and a relative abundance index.

Usage

\[
\text{DD}(x, \text{Data}, \text{reps} = 100)
\]

Arguments

\[
\begin{align*}
\text{x} & \quad \text{A position in a data-limited methods data object} \\
\text{Data} & \quad \text{A data-limited methods data object} \\
\text{reps} & \quad \text{The number of stochastic samples of the TAC recommendation}
\end{align*}
\]

Value

A numeric vector of TAC recommendations

Note

This DD model is observation error only and has does not estimate process error (recruitment deviations). Similar to many other assessment models it depends on a whole host of dubious assumptions such as temporally stationary productivity and proportionality between the abundance index and real abundance. Unsurprisingly the extent to which these assumptions are violated tends to be the biggest driver of performance for this method.

Author(s)

T. Carruthers

References

Method based on equations of Carl Walters (bug him with questions and expect colourful responses)
Description

A simple delay-difference assessment that estimates the OFL using a time-series of catches and a relative abundance index. In this version of the DD MP a 40-10 rule is imposed over the OFL recommendation.

Usage

```
DD4010(x, Data, reps = 100)
```

Arguments

- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the TAC recommendation

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References

Method based on equations of Carl Walters

---

**DDe**

*Effort control version of DD - Delay - Difference Stock Assessment with UMSY and MSY leading*

Description

A simple delay-difference assessment that estimates and recommends FMSY using a time-series of catches and a relative abundance index.

Usage

```
DDe(x, Data, reps = 100)
```
Arguments

`x`  A position in a data-limited methods data object

`data`  A data-limited methods data object

`reps`  The number of stochastic samples of the TAC recommendation

Note

This DD model is observation error only and has does not estimate process error (recruitment deviations). Similar to many other assessment models it depends on a whole host of dubious assumptions such as temporally stationary productivity and proportionality between the abundance index and real abundance. Unsurprisingly the extent to which these assumptions are violated tends to be the biggest driver of performance for this method.

Author(s)

T. Carruthers

References

Method based on equations of Carl Walters (bug him with questions and expect colourful responses)

---

**DDe75**

*Effort control version of DD - Delay - Difference Stock Assessment with UMSY and MSY leading that fishes at 75 per cent of FMSY*

Description

A simple delay-difference assessment that estimates and recommends 75 per cent FMSY using a time-series of catches and a relative abundance index.

Usage

`DDe75(x, data, reps = 100)`

Arguments

`x`  A position in a data-limited methods data object

`data`  A data-limited methods data object

`reps`  The number of stochastic samples of the TAC recommendation

Note

This DD model is observation error only and has does not estimate process error (recruitment deviations). Similar to many other assessment models it depends on a whole host of dubious assumptions such as temporally stationary productivity and proportionality between the abundance index and real abundance. Unsurprisingly the extent to which these assumptions are violated tends to be the biggest driver of performance for this method.
Description

A simple delay-difference assessment that estimates FMSY using a time-series of catches and a relative abundance index. The MP provides a change in effort in the direction of FMSY up to a maximum change of 10 percent.

Usage

\[ \text{DDes}(x, \text{Data}, \text{reps} = 100, \text{LB}=0.9, \text{UB}=1.1) \]

Arguments

- \( x \): A position in a data-limited methods data object
- \( \text{Data} \): A data-limited methods data object
- \( \text{reps} \): The number of stochastic samples of the TAC recommendation
- \( \text{LB} \): The lowest permitted factor of previous fishing effort
- \( \text{UB} \): The highest permitted factor of previous fishing effort

Note

This DD model is observation error only and has does not estimate process error (recruitment deviations). Similar to many other assessment models it depends on a whole host of dubious assumptions such as temporally stationary productivity and proportionality between the abundance index and real abundance. Unsurprisingly the extent to which these assumptions are violated tends to be the biggest driver of performance for this method.

Author(s)

T. Carruthers

References

Method based on equations of Carl Walters (bug him with questions and expect colourful responses)
DecE_Dom Fleet

Description
An object of class Fleet

Usage
DecE_Dom

Format
An object of class Fleet of length 1.

DecE_HDom Fleet

Description
An object of class Fleet

Usage
DecE_HDom

Format
An object of class Fleet of length 1.

DecE_NDom Fleet

Description
An object of class Fleet

Usage
DecE_NDom

Format
An object of class Fleet of length 1.
**DepF**

*Depletion Corrected Fratio*

**Description**

The Fratio MP with a harvest control rule that reduces F according to the production curve given an estimate of current stock depletion.

**Usage**

`DepF(x, Data, reps = 100)`

**Arguments**

- `x` A position in data-limited methods data object DLM
- `Data` A data-limited methods data object
- `reps` The number of TAC samples

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

**References**

Made-up for this package.

---

**derive_beta_par**

*This function reduces the CV by 5 per cent until steepness values can be sampled without error*

**Description**

This function reduces the CV by 5 per cent until steepness values can be sampled without error

**Usage**

`derive_beta_par(mu, sigma)`

**Arguments**

- `mu` mean h
- `sigma` sd of h
**Author(s)**

Q. Huynh

---

**DFO_hist**

*Department of Fisheries and Oceans historical plot*

**Description**


**Usage**

```
DFO_hist(OM, panel = T, nsim = 48)
```

**Arguments**

- **OM**: An operating model object of class OM
- **panel**: should the plots be separate or in two panels?
- **nsim**: how many simulations should be plotted (over-ridden by OM@nsim where cpars is specified)

**Author(s)**

T. Carruthers

---

**DFO_plot**

*Department of Fisheries and Oceans trade-off plot*

**Description**

A plot of mean biomass relative to BMSY and fishing mortality rate relative to FMSY over the final 5 years of the projection [http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm](http://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/precaution-eng.htm)

**Usage**

```
DFO_plot(MSEobj)
```

**Arguments**

- **MSEobj**: An MSE object of class MSE produced by DLMtool function runMSE

**Author(s)**

T. Carruthers
DFO_plot2

Department of Fisheries and Oceans default plot 2

Description
A preliminary plot for returning trade-offs plots and performance table for probability of obtaining half reference (FMSY) yield and probability of biomass dropping below 50 per cent BMSY

Usage
DFO_plot2(MSEobj, nam = NA, panel = T, Bcut = 50, Ycut = 50)

Arguments
- MSEobj: An object of class MSE
- nam: Title of plot
- panel: Should the plots be organized in many panels in a single figure
- Bcut: The cutoff biomass for satisficing (relative to BMSY)
- Ycut: the cutoff yield for satisficing (relative to reference yield)

Value
A table of performance metrics.

Author(s)
T. Carruthers

DFO_proj

Department of Fisheries and Oceans projection plot

Description

Usage
DFO_proj(MSEobj, maxplot = 3)

Arguments
- MSEobj: An operating model object of class MSE
- maxplot: The maximum number of MPs to be plotted per figure
**Author(s)**

T. Carruthers

---

**DLMDatadir**

*Directory of the installed package on your computer*

**Description**

A way of locating where the package was installed so you can find example data files and code etc.

**Usage**

`DLMDatadir(stock=NA)`

**Arguments**

- `stock` Character string representing the name of a .csv file e.g. 'Snapper', 'Rockfish'

**Author(s)**

T. Carruthers

---

**DOM**

*How dominant is an MP?*

**Description**

The DOM function examines how consistently an MP outperforms another. For example DCAC might provide higher yield than AvC on average but outperforms AvC in less than half of simulations.

**Usage**

`DOM(MSEobj, MPtg=NA)`

**Arguments**

- `MSEobj` An object of class 'MSE'
- `MPtg` A character vector of management procedures for cross examination

**Value**

A matrix of performance comparisons length(MPtg) rows by MSE@nMPs columns

**Author(s)**

A. Hordyk
**DTe40**  
*Effort searching MP aiming for 40 per cent stock depletion*

**Description**
A very simple MP that modifies effort to reach 40 percent stock depletion

**Usage**
```
DTe40(x, Data, reps = 100, alpha=0.4, LB=0.9, UB=1.1)
```

**Arguments**
- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the TAC recommendation
- **alpha**: The target level of depletion
- **LB**: The lowest permitted factor of previous fishing effort
- **UB**: The highest permitted factor of previous fishing effort

**Author(s)**
T. Carruthers

---

**DTe50**  
*Effort searching MP aiming for 50 per cent stock depletion*

**Description**
A very simple MP that modifies effort to reach 50 percent stock depletion

**Usage**
```
DTe50(x, Data, reps = 100, alpha=0.5, LB=0.9, UB=1.1)
```

**Arguments**
- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the TAC recommendation
- **alpha**: The target level of depletion
- **LB**: The lowest permitted factor of previous fishing effort
- **UB**: The highest permitted factor of previous fishing effort
Description

The Fratio MP with a controller that changes the level of F according to the relationship between Surplus production and biomass. I.e lower F when dSP/dB is positive and higher F when dSP/dB is negative.

Usage

DynF(x, Data, yrsmth=10, gg=2, reps = 100)

Arguments

- x: A position in a data-limited methods object
- Data: A data-limited methods object
- yrsmth: The number of historical recent years used for smoothing catch and biomass data
- gg: A gain parameter that modifies F according to the gradient in surplus production with biomass
- reps: The number samples of the TAC

Details

The method smoothes historical catches and biomass and then infers the relationship between surplus production and biomass (as suggested by Mark Maunder and Carl Walters). The approach then regulates a F based policy according to this gradient in which F may range between two different fractions of natural mortality rate.

The core advantage is the TAC(t) is not strongly determined by TAC(t-1) and therefore errors are not as readily propagated. The result is method that tends to perform alarmingly well and therefore requires debunking ASAP.

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References

Made-up for this package.
**Description**

Effort MP: adjust effort up/down if mean length above/below Ltarget

**Usage**

```r
targetLopt(x, Data, reps = 100, yrsmth=3, buffer=0.1)
```

**Arguments**

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrsmth**: Number of years to calculate average length
- **buffer**: Parameter controlling the fraction of mean catch to set the reference (or target) TAC level - acts as a precautionary buffer

**Value**

An adjustment for fishing effort

**Author(s)**

HF Geromont

---

**Example_datafile**

**Example_datafile Data**

**Description**

An object of class Data

**Usage**

```r
Example_datafile
```

**Format**

An object of class Data of length 1.
An adaptive MP that uses trajectory in inferred surplus production and fishing mortality rate to update a TAC

Description

Fishing rate is modified each year according to the gradient of surplus production with biomass (aims for zero). F is bounded by FMSY/2 and 2FMSY and walks in the logit space according to dSP/dB. This is derived from the theory of Maunder 2014.

Usage

fadapt(x, Data, reps = 100, yrsmth = 7, gg=1)

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of TAC samples
yrsmth Years over which to smooth recent estimates of surplus production
gg A gain parameter controlling the speed in update in TAC.

Details

Tested in Carruthers et al. 2015.

Value

A numeric vector of quota recommendations

Author(s)

T. Carruthers

References

**Fdem**

*Demographic FMSY method*

**Description**

FMSY is calculated as \( r/2 \) where \( r \) is calculated from a demographic approach (inc steepness). Coupled with an estimate of current abundance that gives you the OFL.

**Usage**

\[
\text{Fdem}(x, \text{Data}, \text{reps} = 100)
\]

**Arguments**

- \( x \): A position in data-limited methods data object
- \( \text{Data} \): A data-limited methods data object
- \( \text{reps} \): The number of TAC samples

**Details**

Made up for this package. This uses Murdoch McAllister’s demographic \( r \) method to derive FMSY \((r/2)\) and then makes the quota \( r \times \text{current biomass} / 2 \). Easy.

**Author(s)**

T. Carruthers

**References**


---

**Fdem_CC**

*Demographic FMSY method using catch-curve analysis to estimate recent Z*

**Description**

FMSY is calculated as \( r/2 \) from a demographic \( r \) prior method, current abundance is estimated from naive catch curve analysis.

**Usage**

\[
\text{Fdem_CC}(x, \text{Data}, \text{reps} = 100, \text{Fmin}=0.005)
\]
**Arguments**

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **Fmin**: The minimum fishing mortality rate derived from the catch-curve analysis

**Author(s)**

T. Carruthers

**References**


---

**Description**

Demographic F (r/2) method using the mean length estimator to calculate current abundance.

**Usage**

\[
\text{Fdem\_ML}(x, \text{Data, reps = 100})
\]

**Arguments**

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples

**Note**

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'

**Author(s)**

T. Carruthers

**References**

Fease MP feasibility diagnostic

Description
What MPs may be run (best case scenario) for various data-availability scenarios?

Usage
Fease(feaseobj, outy='table')

Arguments
feaseobj An object of class 'Fease'
outy Determines whether you would like a full table or some column of the table for a specific case of the feasibility object. When set equal to table, the full table is produced. When set equal to an integer number the names of MPs that are feasible for that case are returned.

Author(s)
T. Carruthers

Fease-class Class 'Fease'

Description
An object for storing information about what data are available or might be available

Slots
Name The name of the data feasibility object
Case The names of the data feasibility cases
Catch Total annual catches
Index An index of relative abundance, catch per unit effort data or of fishing mortality rate (effort)
Natural_mortality_rate From Maximum age, Tagging data, early fishery catch composition data
Maturity_at_length From gonadal analysis, growth and natural mortality rate estimates
Growth Paired length and age observations, maximum length and an estimate of natural mortality rate
Length_weight_conversion Paired weight and length observations, equivalent data from a similar species
Fleet_selectivity Length composition of catches with growth curve and natural mortality rate, estimates from a similar fleet type targeting a similar species
Catch_at_length Length composition of catches (length samples)
Catch_at_age Age composition of catches (age samples)
Recruitment_index Spawn survey, estimates from a stock assessment, VPA analysis of catch composition data
Stock_recruitment_relationship Stock assessment, a stock assessment of a similar species
Target_catch An agreed annual catch target, MSY proxy
Target_biomass An agreed absolute biomass target, mean historical biomass estimate
Target_index An agreed catch rate target
Abundance Fishery independent survey, current fishing mortality rate from recent length composition, natural mortality rate, maturity at age, growth and stock recruitment relationship, habitat and relative density extrapolation

Objects from the Class

Objects can be created by calls of the form new('Fease', stock)

Author(s)

T. Carruthers

Examples

newdata <- new('Fease')

---

Fease_xl

Read in feasibility parameters from Excel spreadsheet

Description

A function to read in feasibility parameters from an Excel spreadsheet with tabs named following specific convention

Usage

Fease_xl(fname, stkname, fpath = '', saveCSV = FALSE)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fname</td>
<td>Name of the Excel spreadsheet file. Must include file extension.</td>
</tr>
<tr>
<td>stkname</td>
<td>Name of the Stock.</td>
</tr>
<tr>
<td>fpath</td>
<td>Full file path, if file is not in current working directory</td>
</tr>
<tr>
<td>saveCSV</td>
<td>Do you also want to save the Stock, Fleet and Observation parameters to CSV files?</td>
</tr>
</tbody>
</table>
Details

The Excel spreadsheet must have tabs named with the following convention. For example if stkname is ‘myFish’, the tab must be named ‘myFishFease’.

Value

A object of class Fease

Author(s)

A. Hordyk

Examples

```r
## Not run:
myFease <- Fease_xl(fname='FeaseTables.xlsx', stkname='myFish')

## End(Not run)
```

---

**Feasibility**  |  **Feasibility Fease**

Description

An object of class Fease

Usage

Feasibility

Format

An object of class Fease of length 1.
Feasibility2

Description

An object of class Fease

Usage

Feasibility2

Format

An object of class Fease of length 1.

fetch.file.names

Description

Reads iSCAM Data, Control and Projection files

Usage

fetch.file.names(path, filename)

Arguments

- path: File path
- filename: The filename

Author(s)

Chris Grandin (DFO PBS)
FlatE_Dom

---

**FlatE_Dom**  
*FlatE_Dom Fleet*

**Description**  
An object of class Fleet

**Usage**  
FlatE_Dom

**Format**  
An object of class Fleet of length 1.

---

FlatE_HDom  

---

**FlatE_HDom**  
*FlatE_HDom Fleet*

**Description**  
An object of class Fleet

**Usage**  
FlatE_HDom

**Format**  
An object of class Fleet of length 1.

---

FlatE_NDom  

---

**FlatE_NDom**  
*FlatE_NDom Fleet*

**Description**  
An object of class Fleet

**Usage**  
FlatE_NDom

**Format**  
An object of class Fleet of length 1.
Fleet-class

Description

The component of the operating model that controls fishing dynamics

Slots

Name  Name of the Fleet object
nyears  The number of years for the historical simulation
Spat_targ  Distribution of fishing in relation to spatial biomass: F is proportional to B^Spat_targ
           (uniform distribution)
Esd  Inter-annual variability in fishing mortality rate
EffYears  Vector of vertices, years at which to simulate varying relative effort
EffLower  Lower bound on relative effort corresponding to EffYears (uniform distribution)
EffUpper  Upper bound on relative effort corresponding to EffYears (uniform distribution)
LFS  Shortest length that is fully vulnerable to fishing (uniform distribution)
L5  Shortest length corresponding to 5 percent vulnerability (uniform distribution)
Vmaxlen  The vulnerability of the longest (oldest) fish (uniform distribution)
LR5  Shortest length corresponding to 5 percent retention (uniform distribution)
LFR  Shortest length that is fully retained (uniform distribution)
Rmaxlen  The retention of the longest (oldest) fish (uniform distribution)
DR  Discard rate - fraction of caught fish that are discarded (must be <= 1) (uniform distribution)
SelYears  Vector of vertices, index for years at which historical selectivity pattern changed. If left empty, historical selectivity is constant
AbsSelYears  Optional values for SelYears, used for plotting only. Must be of same length as SelYears
L5Lower  Optional vector of values of length SelYears, specifying lower limits of L5 (use ChooseSelect function to set these)
L5Upper  Optional vector of values of length SelYears, specifying upper limits of L5 (use ChooseSelect function to set these)
LFSLower  Optional vector of values of length SelYears, specifying lower limits of LFS (use ChooseSelect function to set these)
LFSUpper  Optional vector of values of length SelYears, specifying upper limits of LFS (use ChooseSelect function to set these)
VmaxLower  Optional vector of values of length SelYears, specifying lower limits of Vmaxlen (use ChooseSelect function to set these)
VmaxUpper  Optional vector of values of length SelYears, specifying upper limits of Vmaxlen (use ChooseSelect function to set these)
FMSYref

Parameter Descriptions

- qinc: Average percentage change in fishing efficiency (uniform distribution) (applicable only to forward projection and input controls)
- qcv: Inter-annual variability in fishing efficiency (uniform distribution) (applicable only to forward projection and input controls)
- isRel: Are the selectivity parameters relative to size-of-maturity? TRUE or FALSE
- currentYr: The current calendar year (final year) of the historical simulations (e.g., 2011)

Objects from the Class

Objects can be created by calls of the form `new('Fleet')`

Author(s)

T. Carruthers

Examples

```r
showClass('Fleet')
```

FMSYref

A reference FMSY method (uses perfect information about FMSY)

Description

FMSY is taken from the operating model stored at DLM@OM$FMSY

Usage

```r
FMSYref(x, Data, reps = 100)
```

Arguments

- `x`: A position in data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of TAC samples

Details

Note that you can outperform this MP even though it has perfect information of FMSY and current abundance. The requirement for fixed F is actually quite strict and is by no means the upper limit in terms of yield. Don’t panic if your method beats this one for yield, especially for short-lived species of high temporal variability in productivity!

Author(s)

T. Carruthers
FMSYref50  A reference FMSY method that fishes at half of FMSY (uses perfect information about FMSY)

Description

FMSY is taken from the operating model stored at DLM@OM$FMSY

Usage

FMSYref50(x, Data, reps = 100)

Arguments

x  A position in data-limited methods data object
Data  A data-limited methods data object
reps  The number of TAC (OFL) samples

Details

Note that you can out-performmm this method easily. The requirement for fixed F is actually quite strict and is by no means the upper limit in terms of yield. Don’t panic if your method beats this one for yield!

Interesting that the reduction in yield is no way near commensurate with the reduction in F - as predicted by a yield curve and expressed in the pretty good yield theory.

Author(s)

T. Carruthers

FMSYref75  A reference FMSY method that fishes at three quarters of FMSY (uses perfect information about FMSY)

Description

FMSY is taken from the operating model stored at DLM@OM$FMSY

Usage

FMSYref75(x, Data, reps = 100)
Arguments

- x: A position in data-limited methods data object
- Data: A data-limited methods data object
- reps: The number of TAC samples

Details

Note that you can out-perform this method easily. The requirement for fixed F is actually quite strict and is by no means the upper limit in terms of yield. Don’t panic if your method beats this one for yield!

Interesting that the reduction in yield is no way near commensurate with the reduction in F as predicted by a yield curve and expressed in the pretty good yield theory.

Author(s)

T. Carruthers

Description

Uses typical correlations among estimated parameters to generate realistic samples for natural mortality rate (M), growth rate (K), maximum length (Linf) and length at 50

Usage

ForceCor(OM, nsim = 48, plot = T)

Arguments

- OM: An operating model object with M, growth, stock-recruitment and maturity parameters specified.
- nsim: The number of simulated values to create (note that OM@nsim will be used preferentially).
- plot: Should the sampled parameters and distributions be plotted?

Value

An object of class OM with a populated (or appended) cpars slot

Author(s)

T. Carruthers (Canadian DFO grant)
Examples

```r
testOM<--FratioCor(testOM)
```

---

**Fratio**

*An FMSY/M ratio method*

Description

Calculates the OFL based on a fixed ratio of FMSY to M multiplied by a current estimate of abundance.

Usage

```r
Fratio(x, Data, reps = 100)
```

Arguments

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of samples of the TAC recommendation

Details

A simple method that tends to outperform many other approaches alarmingly often even when current biomass is relatively poorly known. The low stock crash potential is largely due to the quite large difference between Fmax and FMSY for most stocks.

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References

Description

Calculates the OFL based on a fixed ratio of FMSY to M multiplied by a current estimate of abundance. In this method DBSRA is paired with the 40-10 rule that throttles back the OFL to zero at 10 percent of unfished biomass.

Usage

Fratio4010(x, Data, reps = 100)

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of TAC samples

Author(s)

T. Carruthers

References


Fratio_CC A data-limited method that uses FMSY/M ratio and a naive catch-curve estimate of recent Z

Description

Calculates the OFL based on a fixed ratio of FMSY to M and a catch curve estimate of current stock size.

Usage

Fratio_CC(x, Data, reps = 100, Fmin = 0.005)
Arguments

\begin{itemize}
\item \texttt{x} \hspace{1cm} A position in data-limited methods data object
\item \texttt{Data} \hspace{1cm} A data-limited methods data object
\item \texttt{reps} \hspace{1cm} The number of TAC samples
\item \texttt{Fmin} \hspace{1cm} Minimum current fishing mortality rate for the catch-curve analysis
\end{itemize}

Author(s)

T. Carruthers

References


\begin{center}
\begin{tabular}{ll}
\textbf{Fratio\_ML} & An FMSY/M ratio MP that uses a mean length estimator of recent Z \\
\end{tabular}
\end{center}

Description

Calculates the OFL based on a fixed ratio of FMSY/M and an estimate of current stock size from a mean-length estimator.

Usage

\begin{verbatim}
Fratio\_ML(x, Data, reps = 100)
\end{verbatim}

Arguments

\begin{itemize}
\item \texttt{x} \hspace{1cm} A position in data-limited methods data object
\item \texttt{Data} \hspace{1cm} A data-limited methods data object
\item \texttt{reps} \hspace{1cm} The number of TAC samples
\end{itemize}

Note

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'

Author(s)

T. Carruthers
GB_CC

Germonont and Butterworth Constant Catch Harvest Control Rule

Description

A simple MP that aims for average historical catches (as a proxy for MSY) subject to imperfect information.

Usage

GB_CC(x, Data, reps = 100)

Arguments

x  A position in data-limited methods data object
Data  A data-limited methods data object
reps  The number of TAC samples

Details

Note that this is my interpretation of their MP and is now stochastic. Currently it is generalized and is not ‘tuned’ to more detailed assessment data which might explain why in some cases it leads to stock declines.

Author(s)

T. Carruthers

References


References


GB_slope

Geromont and Butterworth index slope Harvest Control Rule

Description

An MP similar to SBT1 that modifies a time-series of catch recommendations and aims for a stable catch rates.

Usage

GB_slope(x, Data, reps = 100, yrsmth = 5, lambda = 1)

Arguments

- x: A position in data-limited methods data object
- Data: A data-limited methods data object
- reps: The number of TAC samples
- yrsmth: Number of years for evaluating slope in relative abundance index
- lambda: A gain parameter

Details

Note that this is my interpretation of their approach and is now stochastic. Currently it is generalized and is not ‘tuned’ to more detailed assessment data which might explain why in some cases it leads to stock declines.

Author(s)

T. Carruthers

References

**Description**

An MP similar to SBT2 that modifies a time-series of catch recommendations and aims for target catch rate and catch level based on BMSY/B0 and MSY, respectively.

**Usage**

\[
\text{GB\_target}(x, \text{Data}, \text{reps} = 100, w = 0.5)
\]

**Arguments**

- \(x\): A position in data-limited methods data object
- \(\text{Data}\): A data-limited methods data object
- \(\text{reps}\): The number of quota samples
- \(w\): A gain parameter

**Details**

Note that this is my interpretation of their MP and is now stochastic. Currently it is generalized and is not 'tuned' to more detailed assessment data which might explain why in some cases it leads to stock declines.

**Author(s)**

T. Carruthers

**References**


---

**Gcontrol**

**G-control MP**

**Description**

A harvest control rule proposed by Carl Walters that uses trajectory in inferred surplus production to make upward/downward adjustments to TAC recommendations

**Usage**

\[
\text{Gcontrol}(x, \text{Data}, \text{reps} = 100, \text{yrsmth} = 10, \text{gg} = 2, \text{glim} = c(0.5, 2))
\]
Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of quota samples
yrsmth The number of years over which to smooth catch and biomass data
gg A gain parameter
glim A constraint limiting the maximum level of change in quota recommendations

Author(s)

C. Walters and T. Carruthers

References


---

Generic_DecE

Generic_DecE Fleet

Description

An object of class Fleet

Usage

Generic_DecE

Format

An object of class Fleet of length 1.

---

Generic_FlatE

Generic_FlatE Fleet

Description

An object of class Fleet

Usage

Generic_FlatE

Format

An object of class Fleet of length 1.
**Generic_fleet**

<table>
<thead>
<tr>
<th>Generic_fleet</th>
<th></th>
</tr>
</thead>
</table>

**Description**

An object of class Fleet

**Usage**

`Generic_fleet`

**Format**

An object of class `Fleet` of length 1.

---

**Generic_IncE**

<table>
<thead>
<tr>
<th>Generic_IncE</th>
<th></th>
</tr>
</thead>
</table>

**Description**

An object of class Fleet

**Usage**

`Generic_IncE`

**Format**

An object of class `Fleet` of length 1.

---

**Generic_obs**

<table>
<thead>
<tr>
<th>Generic_obs</th>
<th></th>
</tr>
</thead>
</table>

**Description**

An object of class Obs

**Usage**

`Generic_obs`

**Format**

An object of class `Obs` of length 1.
---

**genLenComp**

*Generate length composition of catch*

**Description**

Generate size composition of catch given sample of catch-at-age, expected length-at-age, and standard deviation of length-at-age. Model assumes length-at-age is normally distributed, and that selectivity is size-dependant.

**Usage**

`genLenComp(CAL_bins, CAL_binsmid, SL, CAL_ESS, CAL_nsamp, CN, LaA, LaASD, truncSD)`

**Arguments**

- `CAL_bins` : vector of catch-at-length size bins
- `CAL_binsmid` : vector (nbins = length(CAL_bins) - 1) of mid-points for catch-at-length size bins
- `SL` : matrix (nbins, nyears) of selectivity-at-length class for each year
- `CAL_ESS` : effective sample size of catch-at-length data
- `CAL_nsamp` : sample size of catch-at-length data
- `CN` : matrix (nyears, maxage) of catch-at-age for each year
- `LaA` : matrix (maxage, nyears) of expected length-at-age for each year
- `LaASD` : matrix (maxage, nyears) of standard deviation of length-at-age for each year
- `truncSD` : optional argument to truncate the length-at-age distribution at `truncSD` standard deviations e.g., a value of 2 truncates the length-at-age distribution at two standard deviations (set to 0 to ignore (default))

---

**getAFC**

*Calculate age at first capture from length at first capture and growth*

**Description**

As title.

**Usage**

`getAFC(t0c, Linfc, Kc, LFC, maxage)`

---
getBH

Arguments

- **tPc**: A vector of theoretical age at length zero (von Bertalanffy growth)
- **Linfc**: A vector of maximum length (von Bertalanffy growth)
- **Kc**: A vector of maximum growth rate (von Bertalanffy growth)
- **LFC**: A vector of length at first capture
- **maxage**: Maximum age

Author(s)

T. Carruthers

---

**getBH**

*Predict Beverton-Holt recruitment and return fit to S-R observations*

Description

Internal function to optBH

Usage

```
getBH(pars, SSB, rec, SSBpR, mode = 1, plot = F)
```

Arguments

- **pars**: an initial guess at model parameters steepness and R0
- **SSB**: 'observations' of spawning biomass
- **rec**: 'observations' (model predictions) of recruitment
- **SSBpR**: spawning stock biomass per recruit at unfished conditions
- **mode**: should fit or recruitment deviations be returned
- **plot**: should a plot of the model fit be produced?

Author(s)

T. Carruthers
**getBlow**  
*Blow parallel optimization function*

**Description**

Find the current biomass at which it would take HZN mean generation times to reach $B_{frac} \times SSBMSY$ biomass level given zero catches.

**Usage**

```r
getBlow(x, SSBMSY, MGThorizon, Find, Perr, M_ageArray, hs, Mat_age, Wt_age, R0, 
V, nyears, maxage, mov, Spat_targ, SRrel, aR, bR, Bfrac = 0.5, ploty = F)
```

**Arguments**

- `x` position in a vector
- `SSBMSY` vector nsim long of spawning biomass at MSY
- `MGThorizon` vector nsim long of MGT x HZN
- `Find` matrix of fishing mortality rate nsim x nyears
- `Perr` matrix of recruitment deviations nsim x nyears + maxage -1
- `M_ageArray` array of natural mortality rate nsim x maxage x nyears + proyears
- `hs` vector nsim long of steepness values
- `Mat_age` matrix nsim x nages of maturity at age
- `Wt_age` matrix nsim x nages of weight at age
- `R0` vector nsim long of unfished recruitment
- `V` array of vulnerability nsim x maxage x nyears
- `nyears` integer: number of historical years
- `maxage` integer: maximum age
- `mov` array of movement nsim x 2 x 2
- `Spat_targ` vector of spatial targeting parameters
- `SRrel` integer representing recruitment dynamics type 1: Bev Holt 2: Ricker
- `aR` vector of recruitment parameters
- `bR` vector of recruitment parameters
- `Bfrac` fraction of SSBMSY that is the target
- `ploty` logical: should a plot be produced

**Author(s)**

T. Carruthers
**getclass**

*get object class*

**Description**

Internal function for determining if object is of classy

**Usage**

```
getclass(x, classy)
```

**Arguments**

- `x` Character string object name
- `classy` A class of object (character string, e.g. 'Fleet')

**Value**

TRUE or FALSE

**Author(s)**

T. Carruthers

---

**getFMSY3**

*Calculate FMSY and related metrics using Rcpp code*

**Description**

Calculate FMSY and related metrics using Rcpp code

**Usage**

```
getFMSY3(x, nareas, maxage, N, pyears, M_ageArray, Mat_age, Wt_age, V, retA, Perr, mov, SRrel, Find, Spat_targ, hs, R0a, SSBr, aR, bR, SSB0, B0, maxF, useCPP = TRUE)
```

**Arguments**

- `x` Integer, the simulation number
- `nareas` The number of spatial areas
- `maxage` The maximum age
- `N` Array of the numbers-at-age in population. Dimensions are nsim, maxage, nyears, nareas. Only values from the first year (i.e N[,1,]) are used, which is the current N-at-age.
getFref3

Calculate Reference Yield

Description

Calculate Reference Yield
**Usage**

getFref3(x, nareas, maxage, N, pyears, M_ageArray, Mat_age, Wt_age, V, retA, Perr, mov, SRrel, Find, Spat_targ, hs, R0a, SSbpR, aR, bR, maxF, useCPP = TRUE)

**Arguments**

- **x**: Integer, the simulation number
- **nareas**: The number of spatial areas
- **maxage**: The maximum age
- **N**: Array of the numbers-at-age in population. Dimensions are nsim, maxage, nyears, nareas. Only values from the first year (i.e. N[1,]) are used, which is the current N-at-age.
- **pyears**: The number of years to project forward. Equal to 'nyears' for optimizing for q.
- **M_ageArray**: An array (dimensions nsim, maxage, nyears+pyears) with the natural mortality-at-age and year
- **Mat_age**: A matrix (dimensions nsim, maxage) with the proportion mature for each age-class
- **Wt_age**: An array (dimensions nsim, maxage, nyears+pyears) with the weight-at-age and year
- **V**: An array (dimensions nsim, maxage, nyears+pyears) with the vulnerability-at-age and year
- **retA**: An array (dimensions nsim, maxage, nyears+pyears) with the probability retained-at-age and year
- **Perr**: A matrix (dimensions nsim, nyears+pyears) with the recruitment deviations
- **mov**: An array (dimensions nsim, nareas, nareas) with the movement matrix
- **SRrel**: A numeric vector nsim long specifying the recruitment curve to use
- **Find**: A matrix (dimensions nsim, nyears) with the historical fishing effort
- **Spat_targ**: A numeric vector nsim long with the spatial targeting
- **hs**: A numeric vector nsim long with the steepness values for each simulation
- **R0a**: A matrix (dimensions nsim, nareas) with the unfished recruitment by area
- **SSbpR**: A matrix (dimensions nsim, nareas) with the unfished spawning-per-recruit by area
- **aR**: A numeric vector nareas long with the Ricker SRR a values
- **bR**: A numeric vector nareas long with the Ricker SRR b values
- **maxF**: A numeric value specifying the maximum fishing mortality for any single age class
- **useCPP**: logical - use the CPP code? For testing purposes only

**Author(s)**

A. Hordyk

A. Hordyk
getGpars  

Extracts growth parameters from a SS3 r4ss replist

Description

Extracts growth parameters from a SS3 r4ss replist

Usage

getGpars(replist, seas = 1)

Arguments

replist  the list output of the r4ss SS_output function (a list of assessment inputs / outputs)
seas  The reference season for the growth (not actually sure what this does yet)

Author(s)

T. Carruthers

GetMoreData  

Load more data from DLMdata package

Description

Downloads the DLMdata package from GitHub

Usage

GetMoreData(silent = FALSE)

Arguments

silent  Logical. Should messages to printed?
getmov

Optimization function to find a movement model that matches user specified movement characteristics.

Description
The user specifies the probability of staying in the same area and spatial heterogeneity (both in the unfished state).

Usage
getmov(x, Prob_staying, Frac_area_1)

Arguments
- **x**: A position in vectors Prob_staying and Frac_area_1
- **Prob_staying**: User specified probability that individuals in area 1 remain in that area (unfished conditions)
- **Frac_area_1**: User specified fraction of individuals found in area 1 (unfished conditions)

Details
This is paired with movfit to find the correct movement model.

Value
A markov movement matrix

Author(s)
T. Carruthers

Examples
```
Prob_staying<-0.8 # probability that individuals remain in area 1 between time-steps
Frac_area_1<-0.35 # the fraction of the stock found in area 1 under equilibrium conditions
markovmat<-getmov(1, Prob_staying, Frac_area_1)
vec<-c(0.5, 0.5) # initial guess at equilibrium distribution (2 areas)
for(i in 1:300)vec<-apply(vec*markovmat, 2, sum) # numerical approximation to stable distribution
c(markovmat[1,1], vec[1]) # pretty close right?
```
getmov2  

*Optimization function to find a movement model that matches user specified movement characteristics modified for Rcpp.*

**Description**

The user specifies the probability of staying in the same area and spatial heterogeneity (both in the unfished state).

**Usage**

getmov2(x, Prob_staying, Frac_area_1)

**Arguments**

- **x**  
  A position in vectors Prob_staying and Frac_area_1
- **Prob_staying**  
  User specified probability that individuals in area 1 remain in that area (unfished conditions)
- **Frac_area_1**  
  User specified fraction of individuals found in area 1 (unfished conditions)

**Details**

This is paired with movfit to find the correct movement model.

**Value**

A markov movement matrix

**Author(s)**

T. Carruthers

**Examples**

```r
Prob_staying<-0.8  # probability that individuals remain in area 1 between time-steps
Frac_area_1<-0.35  # the fraction of the stock found in area 1 under equilibrium conditions
markovmat<-getmov(1,Prob_staying, Frac_area_1)
vec<-c(0.5,0.5)  # initial guess at equilibrium distribution (2 areas)
for(i in 1:300)vec<-apply(vec*markovmat,2,sum)  # numerical approximation to stable distribution
c(markovmat[1,1],vec[1])  # pretty close right?
```
**getq3**

*optimize for catchability (q)*

---

**Description**

Function optimizes catchability \((q\text{,}\text{ where } F=qE)\) required to get to user-specified stock depletion

**Usage**

\[
\text{getq3}(x, \text{dep}, \text{SSB0}, \text{nareas, maxage, N, pyears, M_ageArray, Mat_age, Wt_age, V,}
\text{retA, Perr, mov, SRrel, Find, Spat_targ, hs, R0a, SSBrP, aR, bR,}
\text{bounds = c(1e-05, 15), maxF, useCPP = TRUE)}
\]

**Arguments**

- \(x\) Integer, the simulation number
- \(\text{dep}\) A numeric vector nsim long of sampled depletion
- \(\text{SSB0}\) A numeric vector nsim long of total unfished spawning biomass
- \(\text{nareas}\) The number of spatial areas
- \(\text{maxage}\) The maximum age
- \(N\) Array of the numbers-at-age in population. Dimensions are nsim, maxage, nyears, nareas. Only values from the first year (i.e \(N[1,\ldots,1]\)) are used, which is the current \(N\)-at-age.
- \(\text{pyears}\) The number of years to project forward. Equal to ‘nyears’ for optimizing for \(q\).
- \(\text{M_ageArray}\) An array (dimensions nsim, maxage, nyears+proyears) with the natural mortality-at-age and year
- \(\text{Mat_age}\) A matrix (dimensions nsim, maxage) with the proportion mature for each age-class
- \(\text{Wt_age}\) An array (dimensions nsim, maxage, nyears+proyears) with the weight-at-age and year
- \(\text{V}\) An array (dimensions nsim, maxage, nyears+proyears) with the vulnerability-at-age and year
- \(\text{retA}\) An array (dimensions nsim, maxage, nyears+proyears) with the probability retained-at-age and year
- \(\text{Perr}\) A matrix (dimensions nsim, nyears+proyears) with the recruitment deviations
- \(\text{mov}\) An array (dimensions nsim, nareas, nareas) with the movement matrix
- \(\text{SRrel}\) A numeric vector nsim long specifying the recruitment curve to use
- \(\text{Find}\) A matrix (dimensions nsim, nyears) with the historical fishing effort
- \(\text{Spat_targ}\) A numeric vector nsim long with the spatial targeting
- \(\text{hs}\) A numeric vector nsim long with the steepness values for each simulation
- \(\text{R0a}\) A matrix (dimensions nsim, nareas) with the unfished recruitment by area
SSBpR: A matrix (dimensions nsim, nareas) with the unfished spawning-per-recruit by area.

aR: A numeric vector nareas long with the Ricker SRR a values.

bR: A numeric vector nareas long with the Ricker SRR b values.

bounds: A numeric vector of length 2 with bounds for the optimizer.

maxF: A numeric value specifying the maximum fishing mortality for any single age class.

useCPP: logical - use the CPP code? For testing purposes only.

Author(s)
A. Hordyk

Gulf_blue_tilefish Gulf_blue_tilefish Data

Description
An object of class Data.

Usage
Gulf_blue_tilefish

Format
An object of class Data of length 1.

HDAAC Hybrid Depletion Adjusted Average Catch

Description
Essentially DCAC multiplied by 2*depletion and divided by BMSY/B0 (Bpeak) when below BMSY, and DCAC above BMSY.

Usage
HDAAC(x, Data, reps = 100)

Arguments
x A position in a data-limited methods data object
Data A data-limited methods data object
reps The number of stochastic samples of the TAC recommendation.
Author(s)

W. Harford and T. Carruthers

References


Herring

Herring Stock

Description

An object of class Stock

Usage

Herring

Format

An object of class Stock of length 1.

histR

Wrapper for histogram function

Description

Produces a blank plot if all values in x are equal

Usage

hist2(x, col, axes = FALSE, main = "", breaks = 10, cex.main = 1)

Arguments

x A vector of values
col Colour of the histogram
axes Logical - should axes be included?
main Character - main title
breaks Number of breaks. See ?hist for more details
cex.main Text size of the main title
ICI  

*Index Confidence Interval (ICI) MP by Jardim et al. (2015)*

**Description**

The MP adjusts catch based on the value of the index in the current year relative to the time series mean and standard error.

The mean and standard error of the index time series is calculated. There are two thresholds which delineates whether catch is reduced, held constant, or increased. The catch is reduced by 0.75 if the Z-score of the current year’s index is less than -0.44. The catch is increased by 1.05 if the Z-score of the current year’s index is greater than 1.96. Otherwise, the catch is held constant.

**Usage**

ICI(x, Data, reps)

**Arguments**

- **x** A position in data-limited methods data object
- **Data** A data-limited methods data object
- **reps** The number of TAC samples

**Author(s)**

Coded by Q. Huynh. Developed by Jardim et al. (2015)

**References**


ICI2  

*Less Precautionary Index Confidence Interval (ICI) MP by Jardim et al. (2015)*

**Description**

The MP adjusts catch based on the value of the index in the current year relative to the time series mean and standard error. This method is less precautionary of the two ICI MPs by allowing for a larger increase in TAC and a lower threshold of the index to decrease the TAC (see Jardim et al. 2015).
Usage

ICI2(x, Data, reps)

Arguments

x  A position in data-limited methods data object
Data  A data-limited methods data object
reps  The number of TAC samples

Details

The mean and standard error of the index time series is calculated. There are two thresholds which
delineates whether catch is reduced, held constant, or increased. The catch is reduced by 0.75 if the
Z-score of the current year’s index is less than -1.96. The catch is increased by 1.25 if the Z-score
of the current year’s index is greater than 1.96. Otherwise, the catch is held constant.

Author(s)

Coded by Q. Huynh. Developed by Jardim et al. (2015)

References

Ernesto Jardim, Manuela Azevedo, Nuno M. Brites, Harvest control rules for data limited stocks
using length-based reference points and survey biomass indices, Fisheries Research, Volume 171,

Imp-class  

Class ’Imp’

Description

An operating model component that specifies the degree of adherence to management recommend-
dations (Implementation error)

Slots

Name  The name of the Implementation error object
TACSD  lognormal standard deviation in fraction of TAC taken (uniform distribution)
TACFrac  Mean fraction of TAC taken (uniform distribution) (can be an improper fraction greater
than 1)
ESD  lognormal standard deviation in fraction of TAE taken(uniform distribution)
Efrac  Mean fraction of recommended effort taken (uniform distribution)
SizeLimSD  lognormal error in size limit implementation (uniform distribution)
SizeLimFrac  Mean fraction of the size limit (uniform distribution) (can be an improper fraction
greater than 1)
Source  A reference to a website or article form which parameters were taken to define the operating
model
Objects from the Class

Objects can be created by calls of the form `new('Imp')`

Author(s)

T. Carruthers

Examples

```r
showClass('Imp')
```

---

**Imprecise_Biased**  
**Imprecise_Biased Obs**

Description

An object of class Obs

Usage

Imprecise_Biased

Format

An object of class Obs of length 1.

---

**Imprecise_Unbiased**  
**Imprecise_Unbiased Obs**

Description

An object of class Obs

Usage

Imprecise_Unbiased

Format

An object of class Obs of length 1.
IncE_HDom

Description
An object of class Fleet

Usage
IncE_HDom

Format
An object of class Fleet of length 1.

IncE_NDom

Description
An object of class Fleet

Usage
IncE_NDom

Format
An object of class Fleet of length 1.

initialize-methods

Description
~~ Methods for function initialize ~~
Methods

- `list('signature(.Object = 'DLM')')`
- `list('signature(.Object = 'Fleet')')`
- `list('signature(.Object = 'MSE')')`
- `list('signature(.Object = 'Obs')')`
- `list('signature(.Object = 'OM')')`
- `list('signature(.Object = 'Stock')')`
- `list('signature(.Object = 'Fease')')`
- `list('signature(.Object = 'DLM_general')')`

**Input**

*Function to run a set of input control methods*

---

**Description**

Runs a set of input control methods and returns the output in a single table.

**Usage**

`Input(data, MPs = NA, reps = 100, timelimit = 10, CheckMPs = TRUE, msg = TRUE)`

**Arguments**

- **Data**: A Data object
- **MPs**: A list of input MPs, if NA all available input MPs are run
- **reps**: Number of repetitions (for those methods that use them)
- **timelimit**: Maximum timelimit to run MP (in seconds)
- **CheckMPs**: Logical, the Can function is run if this is TRUE
- **msg**: Logical. Should messages be printed?

**Author(s)**

A. Hordyk
**InputRec-class**

**Class 'InputRec'**

---

**Description**

An object for storing the recommendation for an input control MP

**Slots**

- **Effort** A numeric value with the effort recommendation as a fraction of current (nyear) fishing effort
- **Spatial** A boolean vector of length 'nareas' specifying if area is open (1) or closed (0) to fishing
- **Allocate** A boolean value describing if effort should be re-allocated from close to open areas
- **LR5** smallest length at 5 per cent retention
- **LFR** smallest length at full retention
- **HS** upper harvest slot (no retention above this)
- **Rmaxlen** retention of the largest size class
- **Misc** An empty list that can be used to store information and pass on to MPs in future

**Objects from the Class**

Objects can be created by calls of the form `new('InputRec')`

**Author(s)**

A. Hordyk

---

**IOTC_plot**

*Indian Ocean Tuna Commission trade-off plot*

---

**Description**

A one-panel trade-off plot showing the probability of exceeding a biomass reference level and a yield reference level

**Usage**

```r
IOTC_plot(MSEobj, Bref = 0.75, Yref = 0.75, Bsat = 0.8, Ysat = 0.8, 
  xlim = c(0, 1.1), ylim = c(0, 1.1))
```
Arguments

- **MSEobj**: An object of class MSE created by the function runMSE()
- **Bref**: A biomass reference level (an improper fraction of BMSY)
- **Yref**: A yield reference level (an improper fraction of yield given FMSY management)
- **Bsat**: The satisficing level for biomass (required fraction of simulations exceeding Bref)
- **Ysat**: The satisficing level for yield (required fraction of simulations exceeding Yref)
- **xlim**: The limits of the x axis plotting
- **ylim**: The limits of the y axis plotting

Author(s)

T. Carruthers

---

**Iratio**

*Mean index ratio MP from Jardim et al. 2015*

Description

The TAC is adjusted by the ratio alpha, where the numerator being the mean index in the most recent two years of the time series and the denominator being the mean index in the three years prior to those in the numerator.

Usage

```
Iratio(x, Data, reps, yrs = c(2, 5))
```

Arguments

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrs**: Vector of length 2 specifying the reference years

Details

This MP is the stochastic version of Method 3.2 used by ICES for Data-Limited Stocks (ICES 2012).

Author(s)

Coded by Q. Huynh. Developed by Jardim et al. (2015)
References


---

**iscam2Data**

*Reads data from iSCAM file structure into a DLMtool Data object*

**Description**

A function that uses the file location of a fitted iSCAM model including input files to population the various slots of an data object. iSCAM2DLM relies on several functions written by Chris Grandin (DFO PBS).

**Usage**

```r
iscam2Data(iSCAMdir, Name = NULL, Source = "No source provided", length_timestep = 1, Author = "No author provided")
```

**Arguments**

- **iSCAMdir**: A folder with iSCAM input and output files in it
- **Name**: The name of the operating model
- **Source**: Reference to assessment documentation e.g. a url
- **length_timestep**: How long is a model time step in years (e.g. a quarterly model is 0.25, a monthly model 1/12)
- **Author**: Who did the assessment

**Author(s)**

T. Carruthers
iscamRdlm

Description
A function that uses the file location of a fitted iSCAM model including input files to population the various slots of an operating model parameter estimates. iSCAM2DLM relies on several functions written by Chris Grandin (DFO PBS).

Usage
iscamRdlm(iscamdir, nsim = 48, proyears = 50, Name = NULL, Source = "No source provided", length_timestep = 1, Author = "No author provided")

Arguments
iscamdir       A folder with iSCAM input and output files in it
nsim            The number of simulations to take for parameters with uncertainty (for OM@cpars custom parameters)
proyears        The number of MSE projection years
Name             The name of the operating model
Source          Reference to assessment documentation e.g. a url
length_timestep How long is a model time step in years (e.g. a quarterly model is 0.25, a monthly model 1/12)
Author           Who did the assessment

Author(s)
T. Carruthers

iscAMcomps

Description
iSCAM assessments are often fitted to numerous fleets that have differing age selectivities. iSCAMcomps is a simple way of providing the aggregate catch at age data. It should be noted that this process is important and in a real application would require due diligence (ie peer reviewed data workshop).
iSCAMinds

Usage

iscamcomps(replist, Year)

Arguments

replist S3 class object: the output from a read from an iSCAM data folder
Year Integer vector: the years of the DLMtool data object ie Data@Year

Author(s)

T. Carruthers

iSCAMinds

Combines indices into a single index using linear modelling

Description

iSCAM assessments often make use of multiple indices of abundance. The DLMtool data object and MPs currently only make use of a single index. combiSCAMinds is a function that creates a single index from many using linear modelling. It is a simple way of providing initial calculations of management recommendations and it should be noted that this process is important and in a real application would require due diligence (ie peer reviewed data workshop).

Usage

iscaminds(idata, Year, fleeteffect = T)

Arguments

idata List: the indices recorded in a read from an iSCAM data folder, e.g. replist$data$indices
Year Integer vector: the years of the DLMtool data object ie Data@Year
fleeteffect Logical: should a fleet effect be added to the linear model?

Author(s)

T. Carruthers
**Islope1**

A management procedure that incrementally adjusts the TAC to maintain a constant CPUE or relative abundance index

**Description**

The least biologically precautionary of two constant index / CPUE methods proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

**Usage**

\[
\text{Islope1}(x, \text{Data, reps} = 100, \text{yrsmth} = 5, \lambda = 0.4, \text{xx} = 0.2)
\]

**Arguments**

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrsmth**: Years over which to smooth recent estimates of surplus production
- **\lambda**: A gain parameter controlling the speed in update in TAC.
- **xx**: Parameter controlling the fraction of mean catch to start using in first year

**Details**

Tested by Carruthers et al. 2015.

**Value**

A numeric vector of quota recommendations

**Author(s)**

T. Carruthers

**References**


Islope4

A management procedure that incrementally adjusts the TAC to maintain a constant CPUE or relative abundance index

Description

The most biologically precautionary of two constant index / CPUE methods proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage

Islope4(x, Data, reps = 100, yrsmth = 5, lambda=0.2,xx=0.4)

Arguments

x 
A position in data-limited methods data object

Data 
A data-limited methods data object

reps 
The number of TAC samples

yrsmth 
Years over which to smooth recent estimates of surplus production

lambda 
A gain parameter controlling the speed in update in TAC.

xx 
Parameter controlling the fraction of mean catch to start using in first year

Details

Tested by Carruthers et al. 2015.

Value

A numeric vector of quota recommendations

Author(s)

T. Carruthers

References


**Index Target 10**

**Description**

An index target MP where the TAC is modified according to current index levels (mean index over last 5 years) relative to a target level. Maximum annual changes are 10 per cent.

**Usage**

\[ \text{IT10}(x, \text{Data}, \text{reps} = 100, \text{yrsmth}=5, \text{mc}=0.1) \]

**Arguments**

- \( x \) A position in a data-limited methods data object
- \( \text{Data} \) A data-limited methods data object
- \( \text{reps} \) The number of stochastic samples of the quota recommendation
- \( \text{yrsmth} \) The number of historical years over which to average the index
- \( \text{mc} \) The maximum fractional change in the TAC among years.

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

**Index Target 5**

**Description**

An index target MP where the TAC is modified according to current index levels (mean index over last 5 years) relative to a target level. Maximum annual changes are 5 per cent.

**Usage**

\[ \text{IT5}(x, \text{Data}, \text{reps} = 100, \text{yrsmth}=5, \text{mc}=0.05) \]
**Arguments**

- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of stochastic samples of the quota recommendation
- **yrsmth**: The number of historical years over which to average the index
- **mc**: The maximum fractional change in the TAC among years.

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

---

**Description**

The least biologically precautionary of two index/CPUE target MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

**Usage**

```r
ItargetQH(x, Data, reps = 100, yrsmth = 5, xx=0, Imulti=1.5)
```

**Details**

Tested by Carruthers et al. 2015.
Value
A numeric vector of TAC recommendations

Author(s)
T. Carruthers

References

Itarget4
A management procedure that incrementally adjusts the TAC (starting from reference level that is a fraction of mean recent catches) to reach a target CPUE / relative abundance index

Description
The most biologically precautionary of two index/CPUE target MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage
Itarget4(x, Data, reps = 100, yrsmth = 5, xx=0.3, Imulti=2.5)

Arguments
x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of TAC samples
yrsmth Years over which to smooth recent estimates of surplus production
xx Parameter controlling the fraction of mean catch to start using in first year
Imulti Parameter controlling how much larger target CPUE / index is compared with recent levels.

Details
Tested by Carruthers et al. 2015.

Value
A numeric vector of TAC recommendations
Author(s)
T. Carruthers

References

A management procedure that incrementally adjusts the effort to reach a target CPUE / relative abundance index

Description
An effort-based version of the least biologically precautionary of two index/CPUE target MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage
ITargetE1(x, Data, reps = 100, yrsmth = 5, xx = 0, Imulti = 1.5)

Arguments
x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of samples
yrsmth Years over which to smooth recent estimates of surplus production
xx Parameter controlling the fraction of mean catch to start using in first year
Imulti Parameter controlling how much larger target CPUE / index is compared with recent levels.

Details
Tested by Carruthers et al. 2015.

Value
A numeric vector of input controls

Author(s)
T. Carruthers
References


ItargetE4

A management procedure that incrementally adjusts the Effort to reach a target CPUE / relative abundance index

Description

An effort-based version of the most biologically precautionary of two index/CPUE target MPs proposed by Geromont and Butterworth 2014.

Usage

ItargetE4(x, Data, reps = 100, yrsmtth = 5, xx = 0, Imulti = 2.5)

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of samples
yrsmtth Years over which to smooth recent estimates of surplus production
xx Parameter controlling the fraction of mean catch to start using in first year
Imulti Parameter controlling how much larger target CPUE / index is compared with recent levels.

Details

Tested by Carruthers et al. 2015.

Value

A numeric vector of input controls

Author(s)

T. Carruthers

References

**Description**

An index target MP where the Effort is modified according to current index levels (mean index over last 5 years) relative to a target level. Maximum annual changes are 10 per cent.

**Usage**

\[ \text{ITe10}(x, \text{Data}, \text{reps} = 100, \text{yrsmth} = 5, \text{mc} = 0.1) \]

**Arguments**

- \( x \): A position in a data-limited methods data object
- \( \text{Data} \): A data-limited methods data object
- \( \text{reps} \): The number of stochastic samples of the quota recommendation
- \( \text{yrsmth} \): The number of historical years over which to average the index
- \( \text{mc} \): The maximum fractional change in the Effort among years

**Value**

A numeric vector of input controls

**Author(s)**

T. Carruthers

---

**Description**

An index target MP where the Effort is modified according to current index levels (mean index over last 5 years) relative to a target level. Maximum annual changes are 5 per cent.

**Usage**

\[ \text{ITe5}(x, \text{Data}, \text{reps} = 100, \text{yrsmth} = 5, \text{mc} = 0.05) \]
Arguments

x  A position in a data-limited methods data object
Data  A data-limited methods data object
reps  The number of stochastic samples of the quota recommendation
yrsmth  The number of historical years over which to average the index
mc  The maximum fractional change in the effort among years.

Value

A numeric vector of input controls

Author(s)

T. Carruthers

**Description**

An index target MP where the TAC is modified according to current index levels (mean index over last yrsmth years) relative to a target level. Maximum fractional annual changes are mc. mc=(5+M*25)/100 yrsmth=4*(1/M)^0.25

**Usage**

ITM(x, Data, reps = 100)

Arguments

x  A position in a data-limited methods data object
Data  A data-limited methods data object
reps  The number of stochastic samples of the quota recommendation

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers
joinMSE

Join multiple MSE objects together

Description
Joins two or more MSE objects together. MSE objects must have identical number of historical years, and projection years.

Usage
joinMSE(MSEobjs = NULL)

Arguments
MSEobjs A list of MSE objects. Must all have identical operating model and MPs. MPs which don’t appear in all MSE objects will be dropped.

Value
An object of class MSE

Author(s)
A. Hordyk

Jplot
Joint probability plot

Description
Calculates and plots the joint probability of meeting all performance metrics simultaneously.

Usage
Jplot(MSEobj, PLim = 0.8, YVar = c('LYT', 'STY', 'avgSSB_SSB0', 'avgB_BMSY'), PMRefs = list(B_BMSY = 0.5, SSB_SSB0 = 0.2), UseMean = TRUE, lastYrs = 10, AvailMPs = NULL, XLim = NULL, ShowCols = TRUE, ShowLabs = FALSE, All = TRUE)
Arguments

MSEobj  An object of class MSE
P.Lim Probability limit (acceptable risk threshold; e.g., 0.8 for 80 percent)
Y.Var What to plot of the y-axis: choose from c('TY', 'STY', 'avgSSB_SSB0', 'avgB_BMSY')
PM.Refs List containing the reference limits for each metric
UseMean Logical. Calculate mean (TRUE) or median (FALSE)
lastYrs Last number of years in projection period to calculate summary statistics
Avail.MPs Optional character vector of available MPs (plotted in a different colour)
XLim Optional limits for the x-axis
Show.Cols Logical. Show the background colours?
Show.Labs Logical. Show the MP labels?
All Logical. Plot all MPs (TRUE) or only those above the probability limit (P.Lim)?

Value
Invisibly returns data frame containing statistics shown in the plot

Author(s)
A. Hordyk

Kplot KOBE plot: a projection by projection plot of F/FMSY and B/BMSY

Description
A standard KOBE plot by each method that also shows the percentage of methods that ended up in each quadrant.

Usage
Kplot(MSEobj, maxsim=60, MPs=NA, sims=NULL, maxMP=9, nam=NA, cex.leg=1.5)

Arguments
MSEobj An object of class MSE
maxsim Maximum number of simulations (lines) to plot on each panel.
MPs Optional subset MSE object by MP
sims Optional subset MSE object by simulation
maxMP Maximum number of MPs to include in plot
nam The name of the plot
cex.leg Size of legend
Note

Apologies for the nauseating shading.

Author(s)

T. Carruthers with some additions from A. Hordyk

---

**L2A**

*Length to age conversion*

---

**Description**

Simple deterministic length to age conversion given inverse von Bertalanffy growth.

**Usage**

```r
L2A(t0c,Linf,Kc,Len,maxage)
```

**Arguments**

- `t0c`: Theoretical age at length zero
- `Linf`: Maximum length
- `Kc`: Maximum growth rate
- `Len`: Length
- `maxage`: Maximum age

**Value**

An age (vector of ages, matrix of ages) corresponding with `Len`

**Author(s)**

T. Carruthers
A management procedure that adjusts the TAC up/down from reference (target) level (that is a fraction of mean recent premanagement catches) to reach a target mean length of fish caught.

Description

This MP is based on Ltarget1 proposed by Geromont and Butterworth 2014, but here the target and limit mean lengths are based on the length at maturity distribution rather than an arbitrary multiplicative of the mean length.

Usage

L95target(x, Data, reps = 100, yrsmth = 5, buffer=0)

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of TAC samples
yrsmth Years over which to calculate the mean historical catch
buffer Parameter controlling the fraction of mean catch to set the reference (or target) TAC level - acts as a precautionary buffer

Value

A numeric vector of TAC recommendations

Author(s)

HF Geromont

References

Apply the Length-based SPR model to DLMtool Data Object

**Description**
Apply the Length-based SPR model to DLMtool Data Object

**Usage**
```
LBSPR(x, Data, yrsmtth = 1, reps = 1, lstyrs = 10)
```

**Arguments**
- `x`: Simulation number
- `Data`: Data object
- `yrsmtth`: Number of years to smooth length data - not currently used
- `reps`: Number of repetitions
- `lstyrs`: Last number of years to run model

**Author(s)**
A. Hordyk

---

**LBSPR_ItEff**  
*Length-based SPR model with HCR that iteratively adjusts Effort*

**Description**
Iteratively adjusts Effort based on distance between estimated and target SPR (40%), and slope of recent SPR estimates.

**Usage**
```
LBSPR_ItEff(x, Data, yrsmtth=1, reps=5, ...)
```

**Arguments**
- `x`: Simulation number
- `Data`: Data object
- `yrsmtth`: Number of years to smooth length data - not currently used
- `reps`: Number of repetitions. Not currently used
- `...`: ignored

**Author(s)**
A. Hordyk
**Description**

Management Procedure which adjusts size-at-selection based on estimated SPR. Entirely untested, and included at to demonstrate MPs of this type.

**Usage**

LBSPR_ItSel(x, Data, yrsmth=1, reps=5, ...)

**Arguments**

- \( x \) Simulation number
- Data Data object
- yrsmth Number of years to smooth length data - not currently used
- reps Number of repetitions. Not currently used
- ... ignored

**Author(s)**

A. Hordyk

---

**Description**

Iteratively adjusts TAC based on distance between estimated and target SPR (40%), and slope of recent SPR estimates.

**Usage**

LBSPR_ItTAC(x, Data, yrsmth=1, reps=5, ...)

**Arguments**

- \( x \) Simulation number
- Data Data object
- yrsmth Number of years to smooth length data - not currently used
- reps Number of repetitions
- ... ignored
Author(s)
A. Hordyk

Description
Linear interpolation of a y value at level xlev based on a vector x and y

Usage
\texttt{LinInterp(x, y, xlev, ascending = F, zeroint = F)}

Arguments
- \texttt{x} A vector of x values
- \texttt{y} A vector of y values (identical length to x)
- \texttt{xlev} A the target level of x from which to guess y
- \texttt{ascending} Are the the x values supposed to be ordered before interpolation
- \texttt{zeroint} is there a zero-zero x-y intercept?

Author(s)
T. Carruthers

Description
Reads iSCAM files into a hierarchical R list object

Usage
\texttt{load.iscam.files(model.dir, burnin = 1000, thin = 1, verbose = FALSE)}

Arguments
- \texttt{model.dir} An iSCAM directory
- \texttt{burnin} The initial mcmc samples to be discarded
- \texttt{thin} The degree of chain thinning 1 in every thin iterations is kept
- \texttt{verbose} Should detailed outputs be provided.
Author(s)

Chris Grandin (DFO PBS)

Description

An object of class Fleet

Usage

Low_Effort_Non_Target

Format

An object of class Fleet of length 1.

Lratio_BHI

Mean length-based indicator MP of Jardim et al. 2015 using Beverton-Holt invariant M/K ratio = 1.5 and assumes FMSY = M.

Description

The TAC is adjusted by the ratio alpha, where the numerator is the mean length of the catch (of lengths larger than Lc) and the denominator is the mean length expected when FMSY = M and M/K = 1.5. Natural mortality M and von Bertalanffy K are not used in this MP (see Appendix A of Jardim et al. 2015). Here, Lc is the length at full selection (LFS).

Usage

Lratio_BHI(x, Data, reps, yrmsth = 3)

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of TAC samples
yrmsth The most recent years of data to smooth the calculation of the mean length

Details

Argument yrmsth currently takes the mean length of the most recent 3 years of data as a smoother.
The more general version of the mean length-based indicator MP of Jardim et al. 2015.

Description

The TAC is adjusted by the ratio alpha, where the numerator is the mean length of the catch (of lengths larger than Lc) and the denominator is the mean length as a function of Linf, FMSY/M, and M/K (see Appendix A of Jardim et al. 2015). Here, Lc is the length at full selection (LFS).

Usage

\texttt{lratio\_BHI2(x, Data, reps, yrsmth = 3)}

Arguments

- \texttt{x}: A position in data-limited methods data object
- \texttt{Data}: A data-limited methods data object
- \texttt{reps}: The number of TAC samples
- \texttt{yrsmth}: The most recent years of data to smooth the calculation of the mean length

Details

Argument \texttt{yrsmth} currently takes the mean length of the most recent 3 years of data as a smoother.

Author(s)

Coded by Q. Huynh. Developed by Jardim et al. (2015)

References

**Estimates R\(\theta\) using SRA to match current F estimates and avoid penalties for low stock sizes**

**Description**

Estimates R\(\theta\) using SRA to match current F estimates and avoid penalties for low stock sizes

**Usage**

```
LSRA(x, FF, Chist_arr, M, Mat_age, Wt_age, sel, Recdevs, h)
```

**Arguments**

- `x`: a position in the various arrays and vectors that corresponds with a simulation (for use with sapply)
- `FF`: a vector of recent fishing mortality rates (apical Fs)
- `Chist_arr`: a vector of historical catch observations [nyears]
- `M`: a vector of natural mortality rates [nsim]
- `Mat_age`: a matrix of maturity at age [nsim x nage]
- `Wt_age`: a matrix of weight at age [nsim x nage]
- `sel`: a matrix of selectivity at age [nsim x nage]
- `Recdevs`: a matrix of recruitment deviations [nsim x nyears]
- `h`: a vector of steepness values of the Bev-Holt Stock-Recruitment relationship

**Value**

All package data objects are placed in the global namespace dir

**Author(s)**

T. Carruthers

---

**Alternative version of LSRA that’s a wrapper for LSRA_opt to return the right type of output (mode) using sapply**

**Description**

Alternative version of LSRA that’s a wrapper for LSRA_opt to return the right type of output (mode) using sapply
**Usage**

LSRA2(x, lnR0s, FF, Chist, M, Mat_age, Wt_age, sel, Recdevs, h, mode = 2)

**Arguments**

- **x**: a position in the various arrays and vectors that corresponds with a simulation (for use with sapply)
- **lnR0s**: a vector nsim long that are estimated R0 values
- **FF**: a vector of recent fishing mortality rates (apical Fs)
- **Chist**: a vector of historical catch observations [nyears]
- **M**: a vector of natural mortality rates [nsim]
- **Mat_age**: a matrix of maturity at age [nsim x nage]
- **Wt_age**: a matrix of weight at age [nsim x nage]
- **sel**: a matrix of selectivity at age [nsim x nage]
- **Recdevs**: a matrix of recruitment deviations [nsim x nyears]
- **h**: a vector of steepness values of the Bev-Holt Stock-Recruitment relationship
- **mode**: optimization or plotting

**Value**

all package data objects are placed in the global namespace dir

**Author(s)**

T. Carruthers

---

**Description**

Rcpp version of R code

**Usage**

```
LSRA_MCMC_sim(nits, pars, JumpCV, adapt, parLB, parUB, R0ind, inflind, slpind, RDind, nyears, maxage, M, Mat_age, Wt_age, Chist_a, Umax, h, CAA, CAAadj, sigmaR)
```
Arguments

- **nits**: number of iterations
- **pars**: vector of parameters
- **JumpCV**: jump cv vector
- **adapt**: adapt vector
- **parLB**: lower bounds
- **parUB**: upper bounds
- **R0ind**: index for R0
- **inflind**: index for inflection
- **slpind**: index for slope
- **RDind**: index for recruitment deviations
- **nyears**: number of projection years
- **maxage**: maximum age
- **M**: Natural mortality
- **Mat_age**: A vector of maturity at age
- **Wt_age**: A vector of weight at age
- **Chist_a**: A vector of historical catch observations (nyears long) going back to unfished conditions
- **Umax**: A numeric value representing the maximum harvest rate for any age class (rejection of sims where this occurs)
- **h**: steepness of SRR
- **CAA**: A matrix nyears (rows) by nages (columns) of catch at age (age 1 to maxage in length)
- **CAAadj**: internal parameter
- **sigmaR**: A numeric value representing the prior standard deviation of log space recruitment deviations

Author(s)

A. Hordyk

**LSRA_opt**

*Internal estimation function for LSRA and LSRA2 functions*

Description

Internal estimation function for LSRA and LSRA2 functions

Usage

```
LSRA_opt(param, FF_a, Chist, M_a, Mat_age_a, Wt_age_a, sel_a, Recdevs_a, h_a, Umax = 0.5, mode = 1)
```
Arguments

- **param**: a numeric value representing log(R0)
- **FF_a**: numeric value, recent fishing mortality rate (apical F)
- **Chist**: a vector of historical catch observations [nyears]
- **M_a**: numeric value, natural mortality rate
- **Mat_age_a**: a vector of maturity at age [nage]
- **Wt_age_a**: a vector of weight at age [nage]
- **sel_a**: a vector of selectivity at age [nage]
- **Recdevs_a**: a vector of recruitment deviations [nyears]
- **h_a**: a numeric value of steepness values of the Bev-Holt Stock-Recruitment relationship
- **Umax**: maximum harvest rate per year
- **mode**: 1-5 see below

Value

depends on mode but could be 1: objective function 2: trajectory of Fs 3: SSB depletion 4: log(R0) 5: diagnostic plots

Author(s)

T. Carruthers

---

**LstepCC1**  
_A management procedure that incrementally adjusts the TAC according to the mean length of recent catches._

Description

The least biologically precautionary of four adaptive length-based MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage

LstepCC1(x, Data, reps = 100, yrsmth = 5, xx=0, stepsz=0.05,  
lim=c(0.96,0.98,1.05))
Arguments

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrsmth**: Years over which to smooth recent estimates of surplus production
- **xx**: Parameter controlling the fraction of mean catch to start using in first year
- **stepsz**: Parameter controlling the size of the TAC update increment.
- **llim**: A vector of length reference points that determine the conditions for increasing, maintaining or reducing the TAC.

Details

Tested by Carruthers et al. 2015.

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References


Description

The most biologically precautionary of four adaptive length-based MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage

```r
LstepCC4(x, Data, reps = 100, yrsmth = 5, xx=0.3, stepsz=0.05, llim=c(0.96,0.98,1.05))
```
Arguments

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of TAC samples
- **yrsmth**: Years over which to smooth recent estimates of surplus production
- **xx**: Parameter controlling the fraction of mean catch to start using in first year
- **stepsz**: Parameter controlling the size of the TAC update increment.
- **llim**: A vector of length reference points that determine the conditions for increasing, maintaining or reducing the TAC.

Details

Tested by Carruthers et al. 2015.

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References


Description

A effort-based version of least biologically precautionary of four adaptive length-based MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage

```
LstepCE1(x, Data, reps = 100, yrsmth = 5, xx = 0, stepsz = 0.05, llim = c(0.96, 0.98, 1.05))
```
Arguments

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of effort samples
- **yrsmth**: Years over which to smooth recent estimates of surplus production
- **xx**: Parameter controlling the fraction of mean catch to start using in first year
- **stepsz**: Parameter controlling the size of the effort update increment.
- **llim**: A vector of length reference points that determine the conditions for increasing, maintaining or reducing the effort.

Value

A numeric vector of input controls

Author(s)

T. Carruthers

---

**LstepCE2**

A management procedure that incrementally adjusts the Effort according to the mean length of recent catches.

Description

A effort-based version of one of the four adaptive length-based MPs proposed by Geromont and Butterworth 2014.

Usage

```r
LstepCE2(x, Data, reps = 100, yrsmth = 5, xx = 0, stepsz = 0.1, llim = c(0.96, 0.98, 1.05))
```

Arguments

- **x**: A position in data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of samples
- **yrsmth**: Years over which to smooth recent estimates of surplus production
- **xx**: Parameter controlling the fraction of mean catch to start using in first year
- **stepsz**: Parameter controlling the size of the effort update increment.
- **llim**: A vector of length reference points that determine the conditions for increasing, maintaining or reducing the effort.
**Value**
A numeric vector of input controls

**Author(s)**
T. Carruthers

---

**Description**
The least biologically precautionary of four target length MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

**Usage**

```
Ltarget1(x, Data, reps = 100, yrsmth = 5, xx=0, xL=1.05)
```

**Arguments**
- `x` A position in data-limited methods data object
- `Data` A data-limited methods data object
- `reps` The number of TAC samples
- `yrsmth` Years over which to smooth recent estimates of surplus production
- `xx` Parameter controlling the fraction of mean catch to start using in first year
- `xL` Parameter controlling the magnitude of the target mean length of catches relative to average length in catches.

**Details**
Tested by Carruthers et al. 2015.

**Value**
A numeric vector of TAC recommendations

**Author(s)**
T. Carruthers

**References**
Ltarget4  

A management procedure that incrementally adjusts the TAC to reach a target mean length in catches.

Description

The most biologically precautionary of four target length MPs proposed by Geromont and Butterworth 2014. Tested by Carruthers et al. 2015

Usage

Ltarget4(x, Data, reps = 100, yrsmth = 5, xx=0.2, xl=1.15)

Arguments

x  
A position in data-limited methods data object

Data  
A data-limited methods data object

reps  
The number of TAC samples

yrsmth  
Years over which to smooth recent estimates of surplus production

xx  
Parameter controlling the fraction of mean catch to start using in first year

xl  
Parameter controlling the magnitude of the target mean length of catches relative to average length in catches.

Details

Tested by Carruthers et al. 2015.

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

References


LtargetE1

A management procedure that incrementally adjusts the Effort to reach a target mean length in catches.

Description

A effort based version of the least biologically precautionary of four target length MPs proposed by Geromont and Butterworth 2014.

Usage

LtargetE1(x, Data, reps = 100, yrsmth = 5, xx = 0, xL = 1.05)

Arguments

- x: A position in data-limited methods data object
- Data: A data-limited methods data object
- reps: The number of samples
- yrsmth: Years over which to smooth recent estimates of surplus production
- xx: Parameter controlling the fraction of mean catch to start using in first year
- xL: Parameter controlling the magnitude of the target mean length of catches relative to average length in catches.

Value

A numeric vector of input controls

Author(s)

T. Carruthers

LtargetE4

A management procedure that incrementally adjusts the Effort to reach a target mean length in catches.

Description

A effort based version of the most biologically precautionary of four target length MPs proposed by Geromont and Butterworth 2014.

Usage

LtargetE4(x, Data, reps = 100, yrsmth = 5, xx = 0, xL = 1.15)
**Arguments**

- `x`: A position in data-limited methods data object
- `data`: A data-limited methods data object
- `reps`: The number of samples
- `yrsmth`: Years over which to smooth recent estimates of surplus production
- `xx`: Parameter controlling the fraction of mean catch to start using in first year
- `xl`: Parameter controlling the magnitude of the target mean length of catches relative to average length in catches.

**Value**

A numeric vector of input controls

**Author(s)**

T. Carruthers

---

**Mackerel Stock**

**Description**

An object of class `Stock`

**Usage**

`Mackerel`

**Format**

An object of class `Stock` of length 1.

---

**Convert a OM object to one without observation or process error**

**Description**

Takes an existing OM object and converts it to one without any observation error, and very little process error. Used for debugging and testing that MPs perform as expected under perfect conditions.

**Usage**

`makePerf(OMin, except = NULL)`
**Arguments**

- `OMin` An object of class `OM`
- `except` An optional vector of slot names in the OM that will not be changed (not tested perfectly so watch out!)

**Value**

A new OM object

**Author(s)**

A. Hordyk

---

**makeTransparent**

*Make colors transparent*

**Description**

Make colors transparent

**Usage**

```r
colour <- makeTransparent(someColor, alpha = 100)
```

**Arguments**

- `someColor` Character string describing color
- `alpha` transparency

**Author(s)**

T. Carruthers

---

**matlenlim**

*A data-limited method in which fishing retention is set according to the maturity curve*

**Description**

An example of the implementation of input controls in the DLM toolkit, where retention-at-length is set equivalent to maturity-at-length

**Usage**

```r
matlenlim(x, Data, ...)```

**Arguments**

- `x` A position in a data-limited methods object
- `Data` A data-limited methods object
- ... Optional additional arguments that are ignored. Note arguments `reps` or ... are required for all input controls

**Value**

A input control recommendation object

**Author(s)**

T. Carruthers

**References**

Made-up for this package

---

**matlenlim2**

A data-limited method in which fishing vulnerability is set slightly higher than the maturity curve

---

**Description**

An example of the implementation of input controls in the DLM toolkit, where selectivity-at-length is set slightly higher than the maturity-at-length

**Usage**

`matlenlim2(x, Data, ...)`

**Arguments**

- `x` A position in a data-limited methods object
- `Data` A data-limited methods object
- ... Optional additional arguments that are ignored. Note arguments `reps` or ... are required for all input controls

**Value**

A vector of input control recommendations, with values for length at first capture and full selection

**Author(s)**

A. Hordyk
References

Made-up for this package

MCD

Mean Catch Depletion

Description

A simple average catch-depletion MP that was included to demonstrate just how informative an estimate of current stock depletion can be. TAC=2*\(D*\text{AvC}\)

Usage

MCD(x, Data, reps = 100)

Arguments

- \(x\): A position in a data-limited methods data object
- \(\text{Data}\): A data-limited methods data object
- \(\text{reps}\): The number of stochastic samples of the quota recommendation

Value

A numeric vector of TAC recommendations

Author(s)

T. Carruthers

MCD4010

Mean Catch Depletion

Description

A simple average catch-depletion MP linked to a 40-10 harvest control rule that was included to demonstrate just how informative an estimate of current stock depletion can be. TAC=\(d(1-d)\text{AvC}\)

Usage

MCD4010(x, Data, reps = 100)

Arguments

- \(x\): A position in a data-limited methods data object
- \(\text{Data}\): A data-limited methods data object
- \(\text{reps}\): The number of stochastic samples of the quota recommendation
Value
A numeric vector of TAC recommendations

Author(s)
T. Carruthers

mconv

Get log normal mean from transformed space mean and standard deviation

Description
Get log normal mean from transformed space mean and standard deviation

Usage
mconv(m, sd)

Arguments
m
mean
sd
standard deviation

Value
numeric

Author(s)
T. Carruthers

minlenLopt

This input control sets the minimum length of fish caught to a fraction of the length that maximises the biomass, Lopt.

Description
This aim of this simple MP is restrict the catch of small fish to rebuild the stock biomass towards the optimal length, Lopt, expressed in terms of the growth parameters Lopt=b/(M/k+b) (Hordyk et al. (2014))

Usage
minlenLopt(x, Data, reps = 100, buffer = 0.1)
ML2D

Arguments

\begin{itemize}
\item \texttt{x} A position in data-limited methods data object
\item \texttt{Data} A data-limited methods data object
\item \texttt{reps} The number of TAC samples
\item \texttt{buffer} Parameter controlling the fraction of Lopt to set the minimum length of fish caught: \texttt{minlen=Lopt*(0.7+buffer)}.
\end{itemize}

Value

The length at first capture, LFC, and length at full selectivity

Author(s)

HF Geromont

References


\begin{tabular}{ll}
\textbf{ML2D} & \textit{Depletion and }F\textit{ estimation from mean length of catches} \\
\end{tabular}

Description

A highly dubious means of getting very uncertain estimates of current stock biomass and (equilibrium) fishing mortality rate from growth, natural mortality rate, recruitment and fishing selectivity.

Usage

\texttt{ML2D(OM,ML,nsim=100,ploty=T,Dlim=c(0.05,0.6))}

Arguments

\begin{itemize}
\item \texttt{OM} An object of class ’OM’
\item \texttt{ML} A estimate of current mean length of catches
\item \texttt{nsim} Number of simulations
\item \texttt{ploty} Produce a plot of depletion and F
\item \texttt{Dlim} Limits on the depletion that is returned as a fraction of unfished biomass.
\end{itemize}

Value

An object of class ’OM’ with ’D’ slot populated

Author(s)

T. Carruthers
movdistil

\textit{Simplified a multi-area transition matrix into the best 2 x 2 representation}

\textbf{Description}

A Function that takes a larger movement matrix, identifies the most parsimonious representation of 2 non-mixed areas and returns the final unfished movement matrix.

\textbf{Usage}

\begin{verbatim}
movdistil(movtab)
\end{verbatim}

\textbf{Arguments}

\begin{verbatim}
movtab a table of estimated movements
\end{verbatim}

\textbf{Author(s)}

T. Carruthers

movfit

\textit{Optimization function that returns the squared difference between user specified and calculated movement parameters. (deprecated: now in Rcpp)}

\textbf{Description}

The user specifies the probability of staying in the same area and spatial heterogeneity (both in the unfished state). This function returns the squared difference between these values and those produced by the three logit movement model.

\textbf{Usage}

\begin{verbatim}
movfit(par,prb,frac)
\end{verbatim}

\textbf{Arguments}

\begin{verbatim}
par Three parameters in the logit space that control the four probabilities of moving between 2 areas
prb User specified probability that individuals in area 1 remain in that area (unfished conditions)
frac User specified fraction of individuals found in area 1 (unfished conditions)
\end{verbatim}
movfit_Rcpp

Details

This is paired with getmov to find the correct movement model.

Author(s)

T. Carruthers

---

**movfit_Rcpp**

*Rcpp version of the Optimization function that returns the squared difference between user specified and calculated movement parameters.*

Description

The user specifies the probability of staying in the same area and spatial heterogeneity (both in the unfished state). This function returns the squared difference between these values and those produced by the three logit movement model.

Usage

`movfit_Rcpp(par, prb, frac)`

Arguments

- **par**
  Three parameters in the logit space that control the four probabilities of moving between 2 areas
- **prb**
  User specified probability that individuals in area 1 remain in that area (unfished conditions)
- **frac**
  User specified fraction of individuals found in area 1 (unfished conditions)

Details

This is paired with getmov to find the correct movement model.

Author(s)

T. Carruthers with an amateur attempt at converting to Rcpp by A. Hordyk (but it works!)
**MPStats**

*Calculate Statistics for MP Performance*

**Description**

Function calculates probabilities and other statistics for a range of performance metrics

**Usage**

```r
MPStats(MSEobj, PMRefs = list(B_BMSY = 0.5, SSB_SSB0 = 0.2, F_FMSY = 1,
AAVY = 30, AAVE = 30), lastYrs = 10, UseMean = TRUE, msg = TRUE)
```

**Arguments**

- **MSEobj**: An object of class MSE
- **PMRefs**: A list of reference points for the performance metrics (must be named)
- **lastYrs**: The last number of years in the projection to calculate the statistics
- **UseMean**: Logical. Calculate mean (TRUE) or median (FALSE)?
- **msg**: Logical. Print out messages?

**Author(s)**

A. Hordyk

---

**MRnoreal**

*An marine reserve in area 1 with no spatial reallocation of fishing effort*

**Description**

A spatial control that prevents fishing in area 1 and does not reallocate this fishing effort to area 2.

**Usage**

```r
MRnoreal(x, Data, ...)
```

**Arguments**

- **x**: A position in data / simulation object DLM
- **Data**: A data limited methods data object
- **...**: Optional additional arguments that are ignored. Note arguments reps or ... are required for all input controls

**Author(s)**

T. Carruthers
MRreal

An marine reserve in area 1 with full reallocation of fishing effort

Description

A spatial control that prevents fishing in area 1 and reallocates this fishing effort to area 2.

Usage

```
MRreal(x, Data, ...)
```

Arguments

- `x`: A position in data / simulation object DLM
- `Data`: A data limited methods data object
- `...`: Optional additional arguments that are ignored. Note arguments `reps` or `...` are required for all input controls

Author(s)

T. Carruthers

MSE-class

Class 'MSE'

Description

A Management Strategy Evaluation object that contains information about simulation conditions and performance of data-limited methods

Slots

- `Name`: Name of the MSE object
- `nyears`: The number of years for the historical simulation
- `proyears`: The number of years for the projections - closed loop simulations
- `nMps`: Number of management procedures simulation tested
- `Mps`: The names of the MPs that were tested
- `nsim`: Number of simulations
- `OM`: A table of nsim rows with a column for each sampled parameter of the operating model

  - RefY: reference yield, the highest long-term yield (mean over last five years of projection) obtained from a fixed F strategy. This is a useful reference point for framing performance of MPs because it standardizes for starting point and future productivity.
• M: instantaneous natural mortality rate
• Depletion: stock depletion (biomass / unfished biomass) in the final historical year (prior to projection)
• A: abundance (biomass) updated in each management update of projection
• BMSY_B0: most productive stock size relative to unfished
• FMSY_M: fishing mortality rate divided by natural mortality rate
• Mgrad: mean average percentage gradient in natural mortality rate (percentage per time step)
• Msd: interannual variability in natural mortality rate (lognormal CV)
• procsd: process error - CV in log-normal recruitment deviations
• Esd: interannual variability in historical effort (fishing mortality rate)
• dFfinal: gradient in fishing mortality rate over final five years of the historical simulation
• MSY: Maximum Sustainable Yield
• qinc: mean percentage increase in fishing efficiency (catchability) in projected years (input controls only)
• qcv: interannual variability in future fishing efficiency (catchability) in projected years (input controls only)
• CALcv: variability in lengths at age around the growth curve (normal CV)
• FMSY: Fishing mortality rate at Maximum Sustainable Yield
• Linf: maximum length (von Bertalanffy Linf parameter)
• K: maximum growth rate (von Bertalanffy K parameter)
• t0: theoretical length at age zero (von Bertalanffy t0 parameter)
• hs: steepness of the stock recruitment relationship (the fraction of unfished recruitment at a fifth of unfished stock levels)
• Linfgrad: mean gradient in maximum length (per cent per time step)
• Kgrad: mean gradient in maximum growth rate (per cent per time step)
• Linsd: interannual variability in maximum length (log normal CV)
• recgrad: gradient in recruitment strength (age 1 population numbers) over last 10 years of historical simulations
• Ksd: interannual variability in maximum growth rate (log normal CV)
• ageM: age at 50 per cent maturity
• LFS: length at full selection (the shortest length class where fishery selectivity is 100 per cent)
• age05: the age at 5 percent selectivity (ascending limb of selectivity curve)
• Vmaxage: the selectivity of the oldest age class (controls dome shape of selectivity curve)
• LFC: length at first capture, the smallest length that can be caught by the gear
• OFLreal: the true simulated Over Fishing Limit (FMSY x biomass) updated in each management update of the projection
• Spat_targ: spatial targetting parameter, fishing mortality rate across areas is proportional to vulnerable biomass raised to the power of this number.
• Frac_area_1: the fraction of unfished biomass inhabiting area 1 (can be seen as fraction of habitat in area 1 or relative size of area 1)
• Prob_staying: the probability that individuals in area 1 remain there between time-steps
• AC: autocorrelation in recruitment
A table of nsim rows with a column for each sampled parameter of the observation model:

- Cbias: bias in observed catches
- Csd: observation error in observed catches (lognormal CV)
- CAA_nsamp: the number of catch-at-age observations per time step
- CAA_ESS: the effective sample size of multinomial catch-at-age observation model (number of independent draws)
- CAL_nsamp: the number of catch-at-length observations per time step
- CAL_ESS: the effective sample size of multinomial catch-at-length observation model (number of independent draws)
- Isd: observation error in relative abundance index (lognormal CV)
- Dbias: bias in observed stock depletion (also applies to depletion Dt for DCAC)
- Mbias: bias in observed natural mortality rate
- FMSY_Mbias: bias in ratio of FMSY to natural mortality rate
- BMSY_B0bias: bias in ratio of most productive stock size relative to unfished
- AMbias: bias in age at 50 per cent maturity
- LFCbias: bias in length at first capture
- LFSbias: bias in length at full selection
- Abias: bias in observed current absolute stock biomass
- Kbias: bias in maximum growth rate (von Bertalanffy K parameter)
- t0bias: bias in theoretical length at age zero (von Bertalanffy t0 parameter)
- Linfbias: bias in maximum length (von Bertalanffy Linf parameter)
- hbias: bias in observed steepness of the stock recruitment relationship
- Irefbias: bias in abundance index corresponding to BMSY stock levels
- Crefbias: bias in MSY prediction (target or reference catch)
- Brefbias: bias in BMSY stock levels (target or reference biomass levels)

B_BMSY: Stored biomass relative to BMSY over the projection (an array with dimensions nsim, nMPs, proyears)
F_FMSY: Stored fishing mortality rate relative to FMSY over the projection (an array with dimensions nsim, nMPs, proyears)
B: Stored stock biomass over the projection (an array with dimensions nsim, nMPs, proyears)
SSB: Stored spawning stock biomass over the projection (an array with dimensions nsim, nMPs, proyears)
VB: Stored vulnerable biomass over the projection (an array with dimensions nsim, nMPs, proyears)
FM: Stored fishing mortality rate over the projection (an array with dimensions nsim, nMPs, proyears)
C: Stored catches (taken) over the projection (an array with dimensions nsim, nMPs, proyears)
TAC: Stored Total Allowable Catch (prescribed) over the projection (an array with dimensions nsim, nMPs, proyears)(note that this is NA for input controls)
SSB_hist: Stored historical spawning stock biomass (historical simulations - an array with dimensions nsim, nages, nyears, nareas)
CB_hist: Stored historical catches in weight (historical simulations - an array with dimensions nsim, nages, nyears, nareas)
Fm_hist  Stored historical fishing mortality rate (historical simulations - an array with dimensions nsim, nages, nyears, nareas)

Effort  Stored relative fishing effort in the projection years

PAA  Population at age in last projection year (an array with dimensions nsim, nMPs, nages)

CAA  Catch at age in last projection year (an array with dimensions nsim, nMPs, nages)

CAL  Catch at length in last projection year (an array with dimensions nsim, nMPs, nCALbins)

CALbins  Mid-points of the catch-at-length bins

**Objects from the Class**

Objects can be created by calls of the form `new('MSE', Name, nyears, proyears, nMPs, MPs, nsim, OMtable, Obs,B,R,M,...)

**Author(s)**

T. Carruthers

---

**NAor0**

*Is a value NA or zero.*

**Description**

As title

**Usage**

`NAor0(x)`

**Arguments**

- `x`  A numeric value.

**Value**

TRUE or FALSE

**Author(s)**

T. Carruthers
Data needed to get MPs running

Description

Wrapper function for DLMdiag that lists what data are needed to run data-limited methods that are current not able to run given a DLM_cdata object

Usage

```r
Needed(Data, timelimit=1)
```

Arguments

- **Data**: A data-limited methods data object
- **timelimit**: The maximum time (seconds) taken to complete 10 reps

Author(s)

T. Carruthers

---

A function that samples multivariate normal (logspace) variables

Description

A function that samples multivariate normal (logspace) variables

Usage

```r
negcorlogspace(xmu, ymu, xcv = 0.1, nsim, cor = -0.9, ploty = F)
```

Arguments

- **xmu**: The mean (normal space) of the first (x) variable
- **ymu**: The mean (normal space) of the second (y) variable
- **xcv**: The coefficient of variation (normal space, log normal sd) of the x variable
- **nsim**: The number of random draws
- **cor**: The off-diagonal (symmetrical) correlation among x and y
- **ploty**: Whether a plot of the sampled variables should be produced

Author(s)

T. Carruthers
### NFref

**No Fishing Reference MP**

**Description**

A reference MP that sets annual catch to zero (or very close to it). Used for looking at variability in stock with no fishing.

**Usage**

\[
\text{NFref}(x, \text{Data}, \text{reps} = 100)
\]

**Arguments**

- \text{x}: A position in a data-limited methods data object
- \text{Data}: A data-limited methods data object
- \text{reps}: The number of stochastic samples of the quota recommendation

**Value**

A TAC of 0.01

**Author(s)**

A. Hordyk

### NOAA_plot

**National Oceanographic and Atmospheric Administration default plot**

**Description**

A preliminary plot for returning trade-offs plots and performance table for total yield, variability in yield, probability of overfishing and likelihood of biomass dropping below 50 per cent BMSY.

**Usage**

\[
\text{NOAA_plot}(\text{MSEobj}, \text{nam}=\text{NA}, \text{type}=\text{NA}, \text{panel}=\text{T})
\]

**Arguments**

- \text{MSEobj}: An object of class MSE
- \text{nam}: Title of plot
- \text{type}: Plots full range of data if NA. Plots a subset that meet thresholds if not NA.
- \text{panel}: Should a two panel plot be made or should plots be made in sequence.
### Obs-class

**Value**

A table of performance metrics.

**Author(s)**

T. Carruthers

<table>
<thead>
<tr>
<th>Obs-class</th>
<th>Class 'Obs'</th>
</tr>
</thead>
</table>

### Description

An operating model component that controls the observation model.

### Slots

- **name** The name of the observation model object
- **cobs** Log-normal catch observation error expressed as a coefficient of variation (uniform distribution)
- **cbiascv** A coefficient of variation controlling the sampling of bias in catch observations for each simulation (uniform distribution)
- **CAA_nsamp** Number of catch-at-age observation per time step (uniform distribution)
- **CAA_ESS** Effective sample size (independent age draws) of the multinomial catch-at-age observation error model (uniform distribution)
- **CAL_nsamp** Number of catch-at-length observation per time step (uniform distribution)
- **CAL_ESS** Effective sample size (independent length draws) of the multinomial catch-at-length observation error model (uniform distribution)
- **CALcv** Lognormal, variability in the Cv of length-at-age (uniform distribution)
- **iobs** Observation error in the relative abundance indices expressed as a coefficient of variation (uniform distribution)
- **mcv** Persistent bias in the prescription of natural mortality rate sampled from a log-normal distribution with coefficient of variation (Mcv)(uniform distribution)
- **kcv** Persistent bias in the prescription of growth parameter k sampled from a log-normal distribution with coefficient of variation (Kcv)(uniform distribution)
- **t0cv** Persistent bias in the prescription of t0 sampled from a log-normal distribution with coefficient of variation (t0cv)(uniform distribution)
- **Linfcv** Persistent bias in the prescription of maximum length sampled from a log-normal distribution with coefficient of variation (Linfcv)(uniform distribution)
- **LFCcv** Persistent bias in the prescription of length at first capture sampled from a log-normal distribution with coefficient of variation (LFCcv)(uniform distribution)
- **LFScv** Persistent bias in the prescription of length-at-fully selection sampled from a log-normal distribution with coefficient of variation (LFScv)(uniform distribution)
\( B0cv \) Persistent bias in the prescription of maximum length unfished biomass sampled from a log-normal distribution with coefficient of variation \((B0cv)\) (uniform distribution)

\( \text{FMSYcv} \) Persistent bias in the prescription of FMSY sampled from a log-normal distribution with coefficient of variation \((\text{FMSYcv})\) (uniform distribution)

\( \text{FMSY}_{\text{Mcv}} \) Persistent bias in the prescription of FMSY/M sampled from a log-normal distribution with coefficient of variation \((\text{FMSY}_{\text{cv}})\) (uniform distribution)

\( \text{BMSY}_B0cv \) Persistent bias in the prescription of BMsY relative to unfished sampled from a log-normal distribution with coefficient of variation \((\text{BMSY}_B0cv)\) (uniform distribution)

\( rcv \) Persistent bias in the prescription of intrinsic rate of increase sampled from a log-normal distribution with coefficient of variation \((rcv)\) (uniform distribution)

\( \text{Len}\text{Mcv} \) Persistent bias in the prescription of length at 50 percent maturity sampled from a log-normal distribution with coefficient of variation \((\text{A50cv})\) (uniform distribution)

\( \text{Dbiascv} \) Persistent bias in the prescription of stock depletion sampled from a log-normal distribution with coefficient of variation \((\text{Linfcv})\) (uniform distribution)

\( dcv \) Imprecision in the prescription of stock depletion among years, expressed as a coefficient of variation (uniform distribution)

\( \text{Btbias} \) Persistent bias in the prescription of current stock biomass sampled from a uniform-log distribution with range \((\text{Btbias})\) (uniform distribution)

\( dbtcv \) Imprecision in the prescription of current stock biomass among years expressed as a coefficient of variation (uniform distribution)

\( \text{Fcurbiascv} \) Persistent bias in the prescription of current fishing mortality rate sampled from a log-normal distribution with coefficient of variation \((\text{Fcurcv})\) (uniform distribution)

\( fcurcv \) Imprecision in the prescription of current fishing mortality rate among years expressed as a coefficient of variation (uniform distribution)

\( hcv \) Persistent bias in steepness (uniform distribution)

\( icv \) Observation error in relative abundance index expressed as a coefficient of variation (uniform distribution)

\( \text{maxagecv} \) Bias in the prescription of maximum age (uniform distribution)

\( \beta \) A parameter controlling hyperstability/hyperdepletion. \( \beta \) therefore values below 1 lead to hyperstability (an index that decreases slower than true abundance) and values above 1 lead to hyperdepletion (an index that decreases more rapidly than true abundance) (uniform distribution)

\( \text{Recrcv} \) Bias in the knowledge of recent recruitment strength (uniform distribution)

\(erefcv \) Bias in the knowledge of the relative abundance index at BMsY (uniform distribution)

\( brefcv \) Bias in the knowledge of BMsY (uniform distribution)

\( crefcv \) Bias in the knowledge of MSY (uniform distribution)

**Objects from the Class**

Objects can be created by calls of the form `new('obs')`
Note

Its questionable whether the hyperstability/hyperdepletion should be categorised as an observation model characteristic as it is most often driven by fleet dynamics (and therefore should be in the fleet object). Oh well its here and you might want to make it hyperstable beta < 1 or hyperdeplete beta > 1, only.

Author(s)

T. Carruthers

Examples

```r
showClass('Obs')
```

---

**OM-class**  

**Class ‘OM’**

Description

An object containing all the parameters needed to control the MSE which can be build from component Stock, Fleet and Obs objects. Almost all of these inputs are a vector of length 2 which describes the upper and lower bounds of a uniform distribution from which to sample the parameter.

Slots

- **Name**  Name of the operating model
- **nsim**  The number of simulations
- **proyears**  The number of projected years
- **nyears**  The number of years for the historical simulation
- **maxage**  The maximum age of individuals that is simulated (there is no 'plus group': individuals die off beyone the maximum age so there isn’t a huge cost to simulating more older age classes)
- **R0**  The magnitude of unfished recruitment. This is normally fixed to some arbitrary value since it simply scales the simulated numbers)
- **M**  Natural mortality rate (uniform distribution)
- **M2**  Optional vector of M-at-age (must be length maxage)
- **Msd**  Inter-annual variability in natural mortality rate expressed as a coefficient of variation (uniform distribution)
- **Mgrad**  Mean temporal trend in natural mortality rate, expressed as a percentage change in M per year (uniform distribution)
- **Mexp**  Exponent of the Lorenzen function assuming an inverse relationship between M and weight (uniform distribution)
- **Fdisc**  Fraction of discarded fish that die
h  Steepness of the stock recruit relationship (uniform distribution)
SRrel  Type of stock-recruit relationship (1)Beverton-Holt (2) Ricker
Linf  Maximum length (uniform distribution)
K  von B. growth parameter k (uniform distribution)
T0  von B. theoretical age at length zero (uniform distribution)
LenCV  Coefficient of variation of length-at-age (assumed constant for all age classes (uniform distribution)
Ksd  Inter-annual variability in growth parameter k (uniform distribution)
Kgrad  Mean temporal trend in growth parameter k, expressed as a percentage change in k per year (uniform distribution)
LinfSd  Inter-annual variability in maximum length - uniform distribution
LinfGrad  Mean temporal trend in maximum length, expressed as a percentage change in Linf per year (uniform distribution)
RecGrad  Mean temporal trend in log-normal recruitment deviations (uniform distribution)
AC  Autocorrelation in recruitment deviations rec(t)=AC*rec(t-1)+(1-AC)*sigma(t) (uniform distribution)
a  Length-weight parameter alpha (uniform distribution)
b  Length-weight parameter beta (uniform distribution)
D  Current level of stock depletion (Bcurrent/Bunfished) (uniform distribution)
Size_area_1  The size of area 1 relative to area 2 (uniform distribution)
Frac_area_1  The fraction of the unfished biomass in stock 1 (uniform distribution)
Prob_staying  The probability of individuals in area 1 remaining in area 1 over the course of one year
Beta  A parameter controlling hyperstability/hyperdepletion. I^beta therefore values below 1 lead to hyperstability (an index that decreases slower than true abundance) and values above 1 lead to hyperdepletion (an index that decreases more rapidly than true abundance)(uniform distribution)
Spat_targ  Distribution of fishing in relation to spatial biomass: F is proportional to B^Spat_targ (uniform distribution)
Lfs  Shortest length that is fully vulnerable to fishing (uniform distribution)
L5  Shortest length at 5 percent vulnerability (uniform distribution)
Vmaxlen  The vulnerability of the longest (oldest) fish (uniform distribution)
LR5  Shortest length corresponding to 5 percent retention (uniform distribution)
LFR  Shortest length that is fully retained (uniform distribution)
Rmaxlen  The retention of the longest (oldest) fish (uniform distribution)
Dr  Discard rate - fraction of caught fish that are discarded (must be <= 1) (uniform distribution)
SelYears  Vector of vertices that index years where historical selectivity pattern changed. Leave empty to ignore
AbsSelYears  vector of absolute year values that correspond to year indices in SelYears. Used only for plotting
OM-class

L5Lower Optional vector of values of length SelYears, specifying lower limits of L5 (use ChooseSelect function to set these. Overrides L5 above)

L5Upper Optional vector of values of length SelYears, specifying upper limits of L5 (use ChooseSelect function to set these. Overrides L5 above)

LFSLower Optional vector of values of length SelYears, specifying lower limits of LFS (use ChooseSelect function to set these. Overrides LFS above)

LFSSupper Optional vector of values of length SelYears, specifying upper limits of LFS (use ChooseSelect function to set these. Overrides LFS above)

VmaxLower Optional vector of values of length SelYears, specifying lower limits of Vmaxlen (use ChooseSelect function to set these. Overrides Vmaxlen above)

VmaxUpper Optional vector of values of length SelYears, specifying upper limits of Vmaxlen (use ChooseSelect function to set these. Overrides Vmaxlen above)

isRel Are the selectivity parameters relative to size-of-maturity? TRUE or FALSE

L50 Length at 50 percent maturity (uniform distribution)

L50_95 Length increment from 50 to 95 percent maturity (uniform distribution)

Esdf Inter-annual variability in fishing mortality rate

EffYears Vector of vertices, years at which to simulate varying relative effort

EffLower Lower bound on relative effort corresponding to EffYears (uniform distribution)

EffUpper Upper bound on relative effort corresponding to EffYears (uniform distribution)

qinc Average percentage change in fishing efficiency (uniform distribution)(applicable only to forward projection and input controls)

qcv Inter-annual variability in fishing efficiency (uniform distribution)(applicable only to forward projection and input controls)

CurrentYr The current calendar year (final year) of the historical simulations (e.g. 2011)

Cobs Log-normal catch observation error expressed as a coefficient of variation (uniform distribution)

Cbiascv A coefficient of variation controlling the sampling of bias in catch observations for each simulation (uniform distribution)

CAA_nsamp Number of catch-at-age observation per time step (uniform distribution)

CAA_ESS Effective sample size (independent age draws) of the multinomial catch-at-age observation error model (uniform distribution)

CAL_nsamp Number of catch-at-length observation per time step (uniform distribution)

CAL_ESS Effective sample size (independent length draws) of the multinomial catch-at-length observation error model (uniform distribution)

CALcv Lognormal, variability in the length at age (uniform distribution)

Iobs Observation error in the relative abundance indices expressed as a coefficient of variation (uniform distribution)

Perr The extent of inter-annual log-normal recruitment variability (sigma R)(uniform distribution)

Period Period for cylical recruitment pattern in years (uniform distribution). Leave empty to ignore
Amplitude Amplitude in deviation from long-term average recruitment during recruitment cycle, both positive and negative (uniform distribution). E.g., a range from 0 to 0.5 means recruitment decreases or increases by up to 50% each cycle. Leave empty to ignore

Mcv Persistent bias in the prescription of natural mortality rate sampled from a log-normal distribution with coefficient of variation (Mcv)(uniform distribution)

Kcv Persistent bias in the prescription of growth parameter k sampled from a log-normal distribution with coefficient of variation (Kcv)(uniform distribution)

t0cv Persistent bias in the prescription of t0 sampled from a log-normal distribution with coefficient of variation (t0cv)(uniform distribution)

Linf cv Persistent bias in the prescription of maximum length sampled from a log-normal distribution with coefficient of variation (Linf cv)(uniform distribution)

LFCCv Persistent bias in the prescription of length at first capture sampled from a log-normal distribution with coefficient of variation (LFCCv)(uniform distribution)

LFScv Persistent bias in the prescription of length-at-fully selection sampled from a log-normal distribution with coefficient of variation (LFScv)(uniform distribution)

B0cv Persistent bias in the prescription of maximum length unfished biomass sampled from a log-normal distribution with coefficient of variation (B0cv)(uniform distribution)

FMSYcv Persistent bias in the prescription of FMSY sampled from a log-normal distribution with coefficient of variation (FMSYcv)(uniform distribution)

FMSY_MCv Persistent bias in the prescription of FMSY/M sampled from a log-normal distribution with coefficient of variation (FMSY cv)(uniform distribution)

BMSY_B0cv Persistent bias in the prescription of BMsY relative to unfished sampled from a log-normal distribution with coefficient of variation (BMSY_B0cv)(uniform distribution)

rcv Persistent bias in the prescription of intrinsic rate of increase sampled from a log-normal distribution with coefficient of variation (rcv)(uniform distribution)

LenMcv Persistent bias in the prescription of length at 50 percent maturity sampled from a log-normal distribution with coefficient of variation (A50cv)(uniform distribution)

Dbias cv Persistent bias in the prescription of stock depletion sampled from a log-normal distribution with coefficient of variation (Linfcv)(uniform distribution)

Dcv Imprecision in the prescription of stock depletion among years, expressed as a coefficient of variation (uniform distribution)

Bbias Persistent bias in the prescription of current stock biomass sampled from a uniform-log distribution with range (Bbias)(uniform distribution)

Btcv Imprecision in the prescription of current stock biomass among years expressed as a coefficient of variation (uniform distribution)

Fcurr bias Persistent bias in the prescription of current fishing mortality rate sampled from a log-normal distribution with coefficient of variation (Fcurr cv)(uniform distribution)

Fcurr cv Imprecision in the prescription of current fishing mortality rate among years expressed as a coefficient of variation (uniform distribution)

hcv Persistent bias in steepness (uniform distribution)

Icv Observation error in relative abundance index expressed as a coefficient of variation (uniform distribution)
maxagecv  Bias in the prescription of maximum age (uniform distribution)
Recvcv  Bias in the knowledge of recent recruitment strength (uniform distribution)
Irefcv  Bias in the knowledge of the relative abundance index at BMSY (uniform distribution)
Brefcv  Bias in the knowledge of BMSY (uniform distribution)
Crefcv  Bias in the knowledge of MSY (uniform distribution)

cpars  A list of custom parameters (single parameters are a vector nsim long, time series are a matrix nsim rows by nyears columns)
seed  A random seed to ensure users can reproduce results exactly
Source  A reference to a website or article form which parameters were taken to define the operating model
TACSD  lognormal standard deviation in fraction of TAC taken (uniform distribution)
TACFrac  Mean fraction of TAC taken (uniform distribution) (can be an improper fraction greater than 1)
ESD  lognormal standard deviation in fraction of TAE taken (uniform distribution)
EFrac  Mean fraction of recommended effort taken (uniform distribution)
SizeLimSD  lognormal error in size limit implementation (uniform distribution)
SizeLimFrac  Mean fraction of the size limit (uniform distribution) (can be an improper fraction greater than 1)

Objects from the Class

Objects can be created by calls of the form new('OM', Stock, Fleet, Obs, Imp).

Author(s)

T. Carruthers

OM_xl  Read in operating model parameters from Excel spreadsheet

Description

A function to read in operating model parameters from an Excel spreadsheet with tabs named following specific convention.

Usage

OM_xl(fname, stkname, fpath = '', saveCSV = FALSE)

Arguments

fname  Name of the Excel spreadsheet file. Must include file extension.
stkname  Name of the Stock.
fpath  Full file path, if file is not in current working directory
saveCSV  Do you also want to save the Stock, Fleet and Observation parameters to CSV files?
Details

The Excel spreadsheet must have tabs named with the following convention. For example if stkname is 'myFish', the Stock parameters are in a tab named 'myFishStock', Fleet parameters in a tab named 'myFishFleet', Observation parameters in a tab named 'myFishObs', and Implementation in 'myFishImp'. All tabs (Stock, Fleet, Obs, and Imp) must be present for a single stock. You can have multiple stocks in a single spreadsheet, provided that the stock names are different.

Value

A object of class OM

Author(s)

A. Hordyk

Examples

```r
## Not run:
OM <- OM_xl(fname='OMTables.xlsx', stkname='myFish')
## End(Not run)
```

optBH

Wrapper for estimating stock recruitment parameters from resampled stock-recruitment data

Description

Wrapper for estimating stock recruitment parameters from resampled stock-recruitment data

Usage

```r
optBH(x, SSB, rec, SSBpR, R0temp, pars, frac = 0.5, plot = F)
```

Arguments

- `x`  position (currently redundant)
- `SSB`  'observations' of spawning biomass
- `rec`  'observations' (model predictions) of recruitment
- `SSBpR`  spawning stock biomass per recruit at unfished conditions
- `R0temp`  an initial guess at the level of unfished recruitment
- `pars`  an initial guess at model parameters steepness and R0
- `frac`  the fraction of observations for resampling
- `plot`  should a plot of model fit be produced?
optF

**Author(s)**

T. Carruthers

---

**optF**

*Internal function to optimize for F*

---

**Description**

Internal function to optimize for F

**Usage**

```
optF(fapic, vuln, catch, bio, mort, fdist, maxage, nareas)
```

**Arguments**

- `fapic` Apical fishing mortality
- `vuln` Vulnerability
- `catch` Catch
- `bio` Biomass
- `mort` Natural mortality
- `fdist` Fishing distribution
- `maxage` Maximum age
- `nareas` Number of areas

**Author(s)**

A. Hordyk

---

**optMSY**

*Optimize yield for a single simulation*

---

**Description**

Optimize yield for a single simulation

**Usage**

```
optMSY(logFa, nareas, maxage, Ncurr, pyears, M_age, MatAge, WtAge, Vuln, Retc, prec, movc, SRRelc, Effind, Spat_targc, hc, R0c, SSBpRc, aRc, bRc, Qc, maxF, useCPP = TRUE)
```
Arguments

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>logF_a</td>
<td>log apical fishing mortality</td>
</tr>
<tr>
<td>n_areas</td>
<td>Number of area</td>
</tr>
<tr>
<td>max_age</td>
<td>Maximum age</td>
</tr>
<tr>
<td>N_curr</td>
<td>Current N-at-age</td>
</tr>
<tr>
<td>py_years</td>
<td>Number of projection years</td>
</tr>
<tr>
<td>M_age</td>
<td>M-at-age</td>
</tr>
<tr>
<td>MatAge</td>
<td>Maturity-at-age</td>
</tr>
<tr>
<td>WtAge</td>
<td>Weight-at-age</td>
</tr>
<tr>
<td>Vuln</td>
<td>Vulnerability-at-age</td>
</tr>
<tr>
<td>Retc</td>
<td>Retention-at-age</td>
</tr>
<tr>
<td>Prec</td>
<td>Recruitment error</td>
</tr>
<tr>
<td>movc</td>
<td>Movement matrix</td>
</tr>
<tr>
<td>SRrelc</td>
<td>SR Relationship</td>
</tr>
<tr>
<td>Effind</td>
<td>Historical effort</td>
</tr>
<tr>
<td>Spat_targc</td>
<td>Spatial targeting</td>
</tr>
<tr>
<td>hc</td>
<td>Steepness</td>
</tr>
<tr>
<td>R0c</td>
<td>Unfished recruitment by area</td>
</tr>
<tr>
<td>SSBpRc</td>
<td>Unfished spawning stock per recruit by area</td>
</tr>
<tr>
<td>aRc</td>
<td>Ricker aR</td>
</tr>
<tr>
<td>bRc</td>
<td>Ricker bR</td>
</tr>
<tr>
<td>Qc</td>
<td>Catchability</td>
</tr>
<tr>
<td>maxF</td>
<td>A numeric value specifying the maximum fishing mortality for any single age class</td>
</tr>
<tr>
<td>useCPP</td>
<td>logical - use the CPP code? For testing purposes only</td>
</tr>
</tbody>
</table>

Author(s)

A. Hordyk

optQ

Optimize q for a single simulation

Description

Optimize q for a single simulation
Usage

optQ(logQ, depc, SSB0c, nareas, maxage, Ncurr, pyears, M_age, MatAge, WtAge, 
Vuln, Retc, Prec, movc, SRrelc, Effind, Spat_targc, hc, R0c, SSBpRc, aRc, bRc, 
maxF, useCPP)

Arguments

- logQ: log q
- depc: Depletion value
- SSB0c: Unfished spawning biomass
- nareas: Number of areas
- maxage: Maximum age
- Ncurr: Current N-at-age
- pyears: Number of years to project population dynamics
- M_age: M-at-age
- MatAge: Maturity-at-age
- WtAge: Weight-at-age
- Vuln: Vulnerability-at-age
- Retc: Retention-at-age
- Prec: Recruitment error by year
- movc: movement matrix
- SRrelc: SR parameter
- Effind: Historical fishing effort
- Spat_targc: Spatial targetting
- hc: Steepness
- R0c: Unfished recruitment by area
- SSBpRc: Unfished spawning biomass per recruit by area
- aRc: Ricker aR
- bRc: Ricker bR
- maxF: maximum F
- useCPP: Logical. Use the CPP code?

Author(s)

A. Hordyk
overReefFish

Example data object

Description

Example data object with a number of output control MPs run on it, and includes resulting distributions of TACs

An object of class Data

Usage

data('overReefFish')

overReefFish

Format

An object of class Data of length 1.

Examples

## Not run:
data(overReefFish)
str(overReefFish)
plot(overReefFish)

## End(Not run)

Overages

Overages Imp

Description

An object of class Imp

Usage

Overages

Format

An object of class Imp of length 1.
**Perfect_Imp**

<table>
<thead>
<tr>
<th>Description</th>
<th>An object of class Imp</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage</strong></td>
<td>Perfect_Imp</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>An object of class Imp of length 1.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perfect_Info</th>
<th>Perfect_Info Obs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>An object of class Obs</td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td>Perfect_Info</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>An object of class Obs of length 1.</td>
</tr>
</tbody>
</table>

**plotLdataLanyMmethod**

<table>
<thead>
<tr>
<th>Description</th>
<th>Plot Data object</th>
</tr>
</thead>
</table>
| **Usage**   | # S4 method for signature 'Data,ANY'
plot(x, funcs = NA, maxlines = 6, perc = 0.5,
    xlims = NA) |
Arguments

x object of class Data

funcs MPs

maxlines maximum number of lines

perc percentile of TAC recommendation

xlims limits of x-axis

plot, MSE, ANY-method  

Plot MSE object

Description

Plot MSE object

Usage

## S4 method for signature 'MSE, ANY'
plot(x)

Arguments

x object of class MSE

plot.OM

Plot the operating model (OM) object parameters

Description

A function that plots the parameters and resulting time series of an operating model.

Usage

## S3 method for class 'OM'
plot(x, ...)

Arguments

x An object of class OM or a list with historical simulation information (ie runMSE(OM, Hist=TRUE))

... Optional additional arguments passed to plot

Author(s)

T. Carruthers
**plotFleet**

*Plot the Fleet object parameters*

**Description**

Plot the Fleet object parameters

**Usage**

```r
plotFleet(x, Stock = NULL, nsamp = 3, nsim = 500, proyears = 28,
   col = "darkgray", breaks = 10, lwd = 2, ...)
```

**Arguments**

- `x` An object of class Fleet (or of class OM)
- `Stock` An object of class Stock
- `nsamp` Number of random samples for time-series plots
- `nsim` Number of iterations for histograms
- `proyears` Number of projection years
- `col` Color of histograms
- `breaks` Number of breaks for histograms
- `lwd` line width
- `...` Optional additional arguments passed to `plot`

**Author(s)**

A. Hordyk

---

**plotFun**

*Print out plotting functions*

**Description**

This function prints out the available plotting functions for objects of class MSE or Data

**Usage**

```r
plotFun(class = c('MSE', 'Data'), msg=TRUE)
```

**Arguments**

- `class` Character string. Prints out the plotting functions for objects of this class.
- `msg` Logical. Should the functions be printed to screen?
Note

Basically the function looks for any functions in the DLMtool that have the word ‘plot’ in them. There is a chance that some plotting functions are missed. Let us know if you find any and we will add them.

Author(s)

A. Hordyk

```
plotImp

Plot the Implementation object parameters
```

Description

A function that plots histograms of samples from the implementation object parameters, and time-series plots of `nsamp` samples of time-series examples. Used to visually examine the parameter values and ranges entered into the Obs object.

Usage

```
plotImp(x, nsim = 500, nyears = 50, col = "darkgray", breaks = 10, ...)
```

Arguments

- `x` An object of class Imp (or of class OM)
- `nsim` Number of iterations for histograms
- `nyears` Number of historical years
- `col` Color of histograms
- `breaks` Number of breaks for histograms
- `...` Optional additional arguments passed to `plot`

Author(s)

T. Carruthers and A. Hordyk
**plotM**

*Plot M-at-Age and Size*

**Description**

Plot M-at-Age and Size

**Usage**

plotM(Stock, nsim = 5)

**Arguments**

- `Stock`: An object of class 'Stock' or 'OM'
- `nsim`: The number of simulations to plot

**Author(s)**

A. Hordyk

**Examples**

plotM(Albacore)

---

**plotObs**

*Plot the Observation object parameters*

**Description**

A function that plots histograms of samples from the observation object parameters, and time-series plots of ‘nsamp’ samples of time-series examples. Used to visually examine the parameter values and ranges entered into the Obs object.

**Usage**

plotObs(x, nsim = 500, nyears = 50, col = "darkgray", breaks = 10, ...)

**Arguments**

- `x`: An object of class Obs (or of class OM)
- `nsim`: Number of iterations for histograms
- `nyears`: Number of historical years
- `col`: Color of histograms
- `breaks`: Number of breaks for histograms
- `...`: Optional additional arguments passed to plot
**plotOFL**

A generic OFL plot for NOAA use

**Description**

As title.

**Usage**

```
plotOFL(Data, xlims = NA, perc = 0.5)
```

**Arguments**

- `Data`: An object of class `Data` that has been run through `TAC()`
- `xlims`: X axis limits
- `perc`: The percentile of the OFL distribution to be plotted

**Value**

A table of performance metrics.

---

**plotSelect**

Plot the vulnerability and retention curves

**Description**

Plot the vulnerability and retention curves

**Usage**

```
plotSelect(OM, pyears = 4, sim = NA, type = "l")
```

**Arguments**

- `OM`: An object of class 'OM'
- `pyears`: Number of years to plot
- `sim`: The simulation to plot. Default is NA to plot a random simulation. Set to 1 for reproducible plot
- `type`: Plot type - line "l", point "p", or both "b"
plotStock

**Author(s)**

A. Hordyk

---

### Description

A function that plots histograms of samples from the Stock object parameters, and time-series plots of `nsamp` samples of time-varying parameters. Used to visually examine the parameter values and ranges entered into the Stock object.

### Usage

```r
plotStock(x, nsamp = 3, nsim = 500, nyears = 50, proyears = 28,
           col = "darkgray", breaks = 10, lwd = 2, ask = FALSE, incVB = TRUE,
           ...)```

### Arguments

- **x**: An object of class Stock (or of class OM)
- **nsamp**: Number of random samples for time-series plots
- **nsim**: Number of iterations for histograms. Ignored if `x` is class 'OM'
- **nyears**: Number of historical years. Ignored if `x` is class 'OM'
- **proyears**: Number of projection years. Ignored if `x` is class 'OM'
- **col**: Color of histograms
- **breaks**: Number of breaks for histograms
- **lwd**: line width
- **ask**: Ask before displaying next page?
- **incVB**: Show the sampled von Bertalanffy growth curves on second page?
- **...**: Optional additional arguments passed to `plot`

### Author(s)

A. Hordyk
Description

Population dynamics model

Usage

```
popdyn(nareas, maxage, Ncurr, pyears, M_age, MatAge, WtAge, Vuln, Retc, Prec, movc, SRrelc, Effind, Spat_targc, hc, R0c, SSBpRc, aRc, bRc, Qc, Fapic = NULL, maxF, control = 1)
```

Arguments

- **nareas**: Integer. The number of spatial areas
- **maxage**: Integer. The maximum age
- **Ncurr**: Numeric matrix (dimensions maxage, nareas) with the current N-at-age
- **pyears**: Integer. Number of years to project the model forward
- **M_age**: Numeric matrix (dimensions maxage, pyears) with natural mortality at age
- **MatAge**: Numeric vector (length maxage) with proportion mature for each age-class
- **WtAge**: Numeric matrix (dimensions maxage, pyears) with weight-at-age
- **Vuln**: Numeric matrix (dimensions maxage, pyears) with proportion vulnerable-at-age
- **Retc**: Numeric matrix (dimensions maxage, pyears) with proportion retained-at-age
- **Prec**: Numeric vector (length pyears) with recruitment error
- **morc**: Numeric matrix (dimensions nareas, nareas) with movement matrix
- **SRrelc**: Integer. Stock-recruitment curve
- **Effind**: Numeric vector (length pyears) with the fishing effort by year
- **Spat_targc**: Integer. Value of spatial targeting
- **hc**: Numeric. Steepness of stock-recruit relationship
- **R0c**: Numeric vector of length nareas with unfished recruitment by area
- **SSBpRc**: Numeric vector of length nareas with unfished spawning per recruit by area
- **aRc**: Numeric. Ricker SRR a value
- **bRc**: Numeric. Ricker SRR b value
- **Qc**: Numeric. Catchability coefficient
- **Fapic**: Numeric. Apical F value
- **maxF**: A numeric value specifying the maximum fishing mortality for any single age class
- **control**: Integer. 1 to use q and effort to calculate F; 2 to use Fapic (apical F) and vulnerability to calculate F.
Value
A named list of length 8 containing with arrays (dimensions: maxage, pyears, nareas) containing numbers-at-age, biomass-at-age, spawning stock numbers, spawning biomass, vulnerable biomass, fishing mortality, retained fishing mortality, and total mortality

Author(s)
A. Hordyk

Description
An object of class Stock

Usage
Porgy

Format
An object of class Stock of length 1.

Pplot
A projection by projection plot of F/FMSY and B/BMSY

Description
A shorter version of the plot method for MSEs that just shows the projected trends in stock status and over exploitation

Usage
Pplot(MSEobj, nam=NA)

Arguments
MSEobj An object of class MSE
nam Title of plot

Author(s)
T. Carruthers
A projection by projection plot of F/FMSY, B/BMSY, B/B0, and yield

**Description**

A projection by projection plot of F/FMSY, B/BMSY, B/B0, and yield

**Usage**

```r
Pplot2(MSEobj, YVar = c("SSB_SSBMSY", "F_FMSY"), MPs = NA, sims = NULL,
       traj = c("all", "quant"), quants = c(0.1, 0.9), incquant = TRUE,
       quantcol = "lightgray", RefYield = c("lto", "curr"), LastYr = TRUE,
       maxMP = 6, alpha = 60, cex.axis = 1.35, cex.lab = 1.4, YLab = NULL,
       incMP = TRUE, MPcex = 1.4, incLeg = TRUE, cex.leg = 1.5,
       legPos = "topleft", yline = NULL, parOr = FALSE, xaxis = TRUE,
       yaxis = TRUE, oneIt = TRUE,...)
```

**Arguments**

- **MSEobj**: An object of class MSE
- **YVar**: What to plot on the y-axis? Options are: c("SSB_SSB0", "SSB_SSBMSY", "F_FMSY", 'Yield')
- **MPs**: Optional subset by MP
- **sims**: Optional subset by simulation
- **traj**: Plot all projections (all) or only quantiles (quant)
- **quants**: Numeric vector of length 2 specifying the quantiles (e.g., 10th and 90th. Median is always included)
- **incquant**: Logical. Include the quantiles or only plot median?
- **quantcol**: Colour of the quantile polygon
- **RefYield**: Should yield be relative to long-term optimum (lto) or last historical year (curr)
- **LastYr**: Logical. Include the last historical year in the yield projections?
- **maxMP**: Maximum number of MPs to plot
- **alpha**: Alpha for transparency of lines
- **cex.axis**: Size of axis text
- **cex.lab**: Size of axis label
- **YLab**: Optional label for y-axis
- **incMP**: Logical. Include name of MP?
- **MPcex**: Size of MP label
- **incLeg**: Logical. Include a legend?
- **cex.leg**: Size of legend text
- **legPos**: Legend position
- **yline**: Optional horizontal line
parOR Logical to over-ride the par parameters
xaxis Logical. Should x-axis labels be displayed?
yaxis Logical. Should y-axis labels be displayed?
oneIt Logical. Should one iteration be plotted on the quantile plot?
... Additional arguments to be passed to plotting functions

Author(s)
T. Carruthers & A. Hordyk

```
Precise_Biased Obs

Description
An object of class Obs

Usage
Precise_Biased

Format
An object of class Obs of length 1.

Precise_Unbiased Obs

Description
An object of class Obs

Usage
Precise_Unbiased

Format
An object of class Obs of length 1.
Range  |  Standardize values

Description
Function to standardize to value relative to minimum and maximum values

Usage
Range(x, Max, Min)
range01(x)

Arguments
- x: vector of values
- Max: Maximum value
- Min: Minimum value

Rcontrol  |  Harvest Control Rule using prior for intrinsic rate of increase

Description
An MP proposed by Carl Walters that modifies TACs according to trends in apparent surplus production that includes information from a demographically derived prior for intrinsic rate of increase

Usage
Rcontrol(x, Data, reps = 100, yrsmth = 10, gg = 2, glim = c(0.5, 2))

Arguments
- x: A position in data-limited methods data object
- Data: A data-limited methods data object
- reps: The number of quota samples
- yrsmth: The number of years for smoothing catch and biomass data
- gg: A gain parameters
- glim: Limits for the change in TAC among years

Author(s)
C. Walters and T. Carruthers
References

Made-up for this package.

Rcontrol2

MP using prior for intrinsic rate of increase with a quadratic approximation to surplus production

Description

An MP proposed by Carl Walters that modifies quotas according to trends in apparent surplus production that includes information from a demographically derived prior for intrinsic rate of increase. This is different from Rcontrol because it includes a quadratic approximation of recent trend in surplus production given biomass

Usage

\[ \text{Rcontrol2}(x, \text{Data, reps = 100, yrsmth = 10, gg = 2, glim = c(0.5, 2)}) \]

Arguments

- \( x \): A position in data-limited methods data object
- \( \text{Data} \): A data-limited methods data object
- \( \text{reps} \): The number of TAC samples
- \( \text{yrsmth} \): The number of years for smoothing catch and biomass data
- \( \text{gg} \): A gain parameters
- \( \text{glim} \): Limits for the change in TAC among years

Author(s)

C. Walters and T. Carruthers

References

Made-up for this package.
read.control.file  

*Reads iSCAM control file*

**Description**

A function for returning the results of the iscam control file

**Usage**

```r
read.control.file(file = NULL, num.gears = NULL, num.age.gears = NULL, verbose = FALSE)
```

**Arguments**

- `file`  File location
- `num.gears`  The number of gears
- `num.age.gears`  The number age-gears
- `verbose`  should detailed results be printed to console

**Author(s)**

Chris Grandin (DFO PBS)

---

read.data.file  

*Reads iSCAM dat file*

**Description**

A function for returning the results of the .dat iscam file

**Usage**

```r
read.data.file(file = NULL, verbose = FALSE)
```

**Arguments**

- `file`  File location
- `verbose`  should detailed results be printed to console

**Author(s)**

Chris Grandin (DFO PBS)
read.mcmc

Reads iSCAM mcmc output files

Description
A function for returning the results of the iscam mcmc files

Usage
read.mcmc(model.dir = NULL, verbose = TRUE)

Arguments
model.dir Folder name
verbose should detailed results be printed to console

Author(s)
Chris Grandin (DFO PBS)

read.par.file

Reads iSCAM parameter file

Description
A function for returning the results of the iscam .par file

Usage
read.par.file(file = NULL, verbose = FALSE)

Arguments
file File location
verbose should detailed results be printed to console

Author(s)
Chris Grandin (DFO PBS)
**read.projection.file**  \textit{Reads iSCAM projection file}

**Description**
A function for returning the results of the iscam projection file

**Usage**
```
read.projection.file(file = NULL, verbose = FALSE)
```

**Arguments**
- **file**: File location
- **verbose**: should detailed results be printed to console

**Author(s)**
Chris Grandin (DFO PBS)

---

**read.report.file**  \textit{Reads iSCAM Rep file}

**Description**
A function for returning the results of the .rep iscam file

**Usage**
```
read.report.file(fn)
```

**Arguments**
- **fn**: File location

**Author(s)**
Chris Grandin (DFO PBS)
Red_snapper

Red_snapper Data

Description
An object of class Data

Usage
Red_snapper

Format
An object of class Data of length 1.

Replace
Replace an existing Stock, Fleet, Obs, or Imp object

Description
A function that replaces a Stock, Fleet, Obs, or Imp object from an OM with one from another OM. Mainly used for internal functions.

Usage
Replace(OM, from, Sub = c("Stock", "Fleet", "Obs", "Imp"))

Arguments

OM
An operating model object (class OM) which will be updated with a sub-model from another OM

from
The OM object from which the sub-model is being taken

Sub
A character string specifying what object type to replace "Stock", "Fleet", "Obs" or "Imp" (default is all four which is probably not what you want to do)

Value
An object of class OM

Author(s)
A. Hordyk
**replic8**

_Enlarge (replicate) a DLM data object to create an additional dimension for simulation / sensitivity testing_

### Description

Replicates position 1 data to multiple positions for sensitivity testing etc

### Usage

```r
replic8(Data, nrep)
```

### Arguments

- **Data**
  - A data-limited methods data object
- **nrep**
  - The number of positions to expand the DLM object to

### Author(s)

T. Carruthers

---

**required**

_What methods need what data_

### Description

A function that finds all methods in the environment and searches the function text for slots in the DLM data object

### Usage

```r
required(funcs = NA)
```

### Arguments

- **funcs**
  - A character vector of possible methods of class DLM quota, DLM space or DLM size

### Author(s)

T. Carruthers
Description
An object of class Stock

Usage
Rockfish

Format
An object of class Stock of length 1.

runInMP

Runs input control MPs on a Data object.

Description
Function runs a MP (or MPs) of class 'Input' and returns a list: input control recommendation(s) in element 1 and Data object in element 2.

Usage
runInMP(Data, MPs = NA, reps = 100)

Arguments

Data A object of class Data
MPs A vector of MPs of class 'Input'
reps Number of stochastic repetitions - often not used in input control MPs.

Author(s)
A. Hordyk
runMSE

**Run a Management Strategy Evaluation**

**Description**

A function that runs a Management Strategy Evaluation (closed-loop simulation) for a specified operating model.

**Usage**

```r
runMSE(OM = DLMtool::testOM, MPs = c("AvC", "DCAC", "FMSYref", "curE", "matlenlim"), nsim = 48, proyears = 50, interval = 4, pstar = 0.5, maxF = 0.8, timelimit = 1, reps = 1, CheckMPs = FALSE, Hist = FALSE, ntrials = 50, fracD = 0.05, CalcBlow = FALSE, HZN = 2, Bfrac = 0.5)
```

**Arguments**

- **OM**
  - An operating model object (class 'OM')

- **MPs**
  - A vector of methods (character string) of class Output or Input.

- **nsim**
  - Number of simulations. Note that in DLMtool V4.1+ 'nsim' is ignored if OM object contains the slot 'nsim'.

- **proyears**
  - Number of projected years. Note that in DLMtool V4.1+ 'proyears' is ignored if OM object contains the slot 'proyears'.

- **interval**
  - The assessment interval - how often would you like to update the management system?

- **pstar**
  - The percentile of the sample of the management recommendation for each method

- **maxF**
  - Maximum instantaneous fishing mortality rate that may be simulated for any given age class

- **timelimit**
  - Maximum time taken for a method to carry out 10 reps (methods are ignored that take longer)

- **reps**
  - Number of samples of the management recommendation for each method. Note that when this is set to 1, the mean value of the data inputs is used.

- **CheckMPs**
  - Logical to indicate if Can function should be used to check if MPs can be run.

- **Hist**
  - Should model stop after historical simulations? Returns a list containing all historical data

- **ntrials**
  - Maximum of times depletion and recruitment deviations are resampled to optimize for depletion. After this the model stops if more than percent of simulations are not close to the required depletion

- **fracD**
  - maximum allowed proportion of simulations where depletion is not close to sampled depletion from OM before model stops with error

- **CalcBlow**
  - Should low biomass be calculated where this is the spawning biomass at which it takes HZN mean generation times of zero fishing to reach Bfrac fraction of SSBMSY
The number of mean generation times required to reach Bfrac SSBMSY in the Blow calculation

Bfrac
The target fraction of SSBMSY for calculating Blow

Value
An object of class MSE

Author(s)
T. Carruthers and A. Hordyk

runMSErobust
Run a Management Strategy Evaluation

Description
Run a Management Strategy Evaluation and save out the results to a Rdata file. To increase speed and efficiency, particularly for runs with a large number simulations (nsim), the simulations are split into a number of packets. The functions loops over the packets and combines the output into a single MSE object. If the MSE model crashes during a run, the MSE is run again until it is successfully completed. The MSE is stopped if the number of consecutive crashes exceeds maxCrash. There is an option to save the packets as Rdata files to the current working directory (default is FALSE). By default, the functions saves the completed MSE object as a Rdata file (to the current working directory).

Usage
runMSErobust(OM = DLMtool::testOM, MPs = c("AvC", "DCAC", "FMSYref", "curE", "matlenlim"), nsim = 256, proyears = 50, interval = 4, pstar = 0.5, maxF = 0.8, timelimit = 1, reps = 1, CheckMPs = FALSE, Hist = FALSE, ntrials = 50, fracD = 0.05, CalcBlow = FALSE, HZN = 2, Bfrac = 0.5, maxsims = 64, name = NULL, unique = FALSE, maxCrash = 10, saveMSE = TRUE, savePack = FALSE)

Arguments
OM
An operating model object (class OM)

MPs
A vector of methods (character string) of class Output or Input.

nsim
Number of simulations

proyears
Number of projected years

interval
The assessment interval - how often would you like to update the management system?

pstar
The percentile of the sample of the management recommendation for each method

maxF
Maximum instantaneous fishing mortality rate that may be simulated for any given age class
timelimit  Maximum time taken for a method to carry out 10 reps (methods are ignored that take longer)
reps  Number of samples of the management recommendation for each method. Note that when this is set to 1, the mean value of the data inputs is used.
CheckMPs  Logical to indicate if Can function should be used to check if MPs can be run.
Hist  Should model stop after historical simulations? Returns a list containing all historical data
ntrials  Maximum of times depletion and recruitment deviations are resampled to optimize for depletion. After this the model stops if more than percent of simulations are not close to the required depletion
fracD  maximum allowed proportion of simulations where depletion is not close to sampled depletion from OM before model stops with error
CalcBlow  Should low biomass be calculated where this is the spawning biomass at which it takes HZN mean generation times of zero fishing to reach
HZN  The number of mean generation times required to reach Bfrac SSBMSY in the Blow calculation
Bfrac  fraction of SSBMSY
maxsims  Maximum number of simulations per packet
name  Character string for name of saved MSE packets (if savePack=TRUE) and final MSE object. If none provided, it uses the first five letters from the OM name
unique  Logical. Should the name be unique? Current date and time appended to name.
maxCrash  Maximum number of consecutive crashes before the MSE stops
saveMSE  Logical to indicate if final MSE object should be saved to current working directory (this is probably a good idea)
savePack  Logical to indicate if packets should be save to current working directory

Value

An object of class MSE

Author(s)

A. Hordyk and T. Carruthers

---

**Conduct stock assessment**

Description

A wrapper function that gets the OFL recommendation in cases where a method of DLM quota has been specified
SampleCpars

Usage

```r
Sam(Data, MPs = NA, reps = 100, perc = 0.5)
```

Arguments

- **Data**: A data-limited methods data object
- **MPs**: A character vector of methods of DLM quota, DLM space or DLM size
- **reps**: The number of samples of quota recommendations by method
- **perc**: Quantile of the recommendation to use

Author(s)

T. Carruthers

---

SampleCpars   Sample custom pars

Description

Sample custom pars

Usage

```r
SampleCpars(cpars, nsim = 48, msg = TRUE)
```

Arguments

- **cpars**: A named list containing custom parameters for the OM
- **nsim**: Number of simulations
- **msg**: Logical - print the names of the cpars? Turn off when using the function in a loop

Value

A named list of sampled custom parameters
Sample Fleet Parameters

Description

Sample Fleet Parameters

Usage

SampleFleetPars(Fleet, Stock = NULL, nsim = NULL, nyears = NULL, proyears = NULL, cpars = NULL)

Arguments

- Fleet: An object of class 'Fleet' or class 'OM'
- Stock: An object of class 'Stock' or a list of sampled Stock parameters. Ignored if 'Fleet' is class 'OM'
- nsim: Number of simulations. Ignored if 'Fleet' is class 'OM'
- nyears: Number of historical years. Ignored if 'Fleet' is class 'OM'
- proyears: Number of projection years. Ignored if 'Fleet' is class 'OM'
- cpars: Optional named list of custom parameters. Ignored if 'Fleet' is class 'OM'

Value

A named list of sampled Fleet parameters

Sample Implementation Error Parameters

Description

Sample Implementation Error Parameters

Usage

SampleImpPars(Imp, nsim = NULL)

Arguments

- Imp: An object of class 'Imp' or class 'OM'
- nsim: Number of simulations. Ignored if 'Stock' is class 'OM'

Value

A named list of sampled Implementation Error parameters
SampleObsPars  
*Sample Observation Parameters*

**Description**
Sample Observation Parameters

**Usage**
SampleObsPars(Obs, nsim = NULL)

**Arguments**
- **Obs**: An object of class 'Obs' or class 'OM'
- **nsim**: Number of simulations. Ignored if 'Obs' is class 'OM'

**Value**
A named list of sampled Observation parameters

SampleStockPars  
*Sample Stock parameters*

**Description**
Sample Stock parameters

**Usage**
SampleStockPars(Stock, nsim = 48, nyears = 80, proyears = 50, cpars = NULL)

**Arguments**
- **Stock**: An object of class 'Stock' or class 'OM'
- **nsim**: Number of simulations. Ignored if 'Stock' is class 'OM'
- **nyears**: Number of historical years. Ignored if 'Stock' is class 'OM'
- **proyears**: Number of projection years. Ignored if 'Stock' is class 'OM'
- **cpars**: Optional named list of custom parameters. Ignored if 'Stock' is class 'OM'

**Value**
A named list of sampled Stock parameters
sample_steepness2  
Sample steepness given mean and cv

Description
Sample steepness given mean and cv

Usage
sample_steepness2(n, mu, cv)

Arguments
n  number of samples
mu mean h
cv cv of h

Author(s)
Q. Huynh

sampy  
Sample vector

Description
Sample vector

Usage
sampy(x)

Arguments
x  vector of values
**SBT simple MP**

**Description**

An MP that makes incremental adjustments to TAC recommendations based on the apparent trend in CPUE

**Usage**

```r
SBT1(x, Data, reps = 100, yrsmth=10, k1=1.5, k2=3, gamma=1)
```

**Arguments**

- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object
- `reps`: The number of samples of the TAC
- `yrsmth`: The number of years for evaluating trend in relative abundance indices
- `k1`, `k2`, `gamma`: Control parameters

**Details**

This isn’t exactly the same as the proposed methods and is stochastic in this implementation. The method doesn’t tend to work too well under many circumstances possibly due to the lack of ‘tuning’ that occurs in the real SBT assessment environment. You could try asking Rich Hillary at CSIRO about this approach.

**Author(s)**

T. Carruthers

**References**

http://www.ccsbt.org/site/recent_assessment.php
Description

An MP that makes incremental adjustments to TAC recommendations based on index levels relative to target levels (BMSY/B0) and catch levels relative to target levels (MSY)

Usage

SBT2(x, Data, reps = 100,
epsB=0.25,epsR=0.75,tauR=5,tauB=7, gamma=1)

Arguments

x A position in a data-limited methods data object
Data A data-limited methods data object
reps The number of samples of the TAC
epsB Control parameter
epsR Control parameter
tauR Control parameter
tauB Control parameter
gamma Control parameter

Details

This isn’t exactly the same as the proposed methods and is stochastic in this implementation. The method doesn’t tend to work too well under many circumstances possibly due to the lack of ‘tuning’ that occurs in the real SBT assessment environment. You could try asking Rich Hillary at CSIRO about this approach.

Author(s)

T. Carruthers

References

http://www.ccsbt.org/site/recent_assessment.php
sdconv

Get log normal standard deviation from transformed space mean and standard deviation

Usage

sdconv(m, sd)

Arguments

m  mean
sd standard deviation

Value

numeric

Author(s)

T. Carruthers

Sense  Sensitivity analysis

Description

A function that determines the inputs for a given data-limited method of class Output and then analyses the sensitivity of TAC estimates to marginal differences in each input. The range used for sensitivity is based on the user-specified CV for that input (e.g. CV_Mort, Mort)

Usage

Sense(Data, MP, nsense = 6, reps = 100, perc = c(0.05, 0.5, 0.95), ploty = T)

Arguments

Data  A data-limited methods data object
MP  A character string representing an MP applied in calculating the TAC recommendations in the DLM object
nsense  The number of points over which to calculate the TAC (resolution)
reps  The number of samples of the quota taken for the calculation of the TAC
perc  The percentile of the sample TAC
ploty  A logical switch, (T/F, should a plot be drawn?)
SetRecruitCycle  

Function to calculate cyclic recruitment pattern given user-specified values of period and amplitude.

Description

Calculates cyclic pattern in recruitment deviations for a simulation. Ranges for Period and Amplitude are specified by user, and function produces cyclic pattern from within these ranges. Default is a sine wave.

Usage

SetRecruitCycle(x=1, Period, Amplitude, TotYears, Shape=c('sin', 'shift'))

Arguments

x  Simulation number.
Period  A vector of length 2 specifying the minimum and maximum values for the period of the recruitment cycles. e.g., if Period = c(10,10), then recruitment cycle occurs every 10 years exactly.
Amplitude  A vector of length 2 specifying the minimum and maximum values for the amplitude of the recruitment cycles. e.g., if Amplitude = c(0,0.5), the average recruitment will increase (or decrease) by a factor between 0 and 0.5 each cycle.
TotYears  A numeric value specifying the total number of years (should be nyears + proyears).
Shape  Specifies whether cyclic recruitment pattern is sine wave (default) or a step-change (shift).

Author(s)

A. Hordyk
**setup**  

*Setup parallel processing*

---

**Description**

Sets up parallel processing using the snowfall package

**Usage**

```r
setup(cpus = parallel::detectCores())
```

**Arguments**

- `cpus` number of CPUs

---

**Simulation_1**  

*Simulation_1 Data*

---

**Description**

An object of class `Data`

**Usage**

```r
Simulation_1
```

**Format**

An object of class `data` of length 1.

---

**simYears**  

*Simulate population dynamics for historical years*

---

**Description**

Simulate population dynamics for historical years

**Usage**

```r
simYears(x, nareas, maxage, N, pyears, M_ageArray, Mat_age, Wt_age, V, retA, 
Perr, mov, SRrel, Find, Spat_tar, hs, R0a, SSBpR, aR, bR, qs, maxf, 
useCPP = TRUE)
```
Arguments

x  Integer, the simulation number
nareas  The number of spatial areas
maxage  The maximum age
N  Array of the numbers-at-age in population. Dimensions are nsim, maxage, nyears, nareas. Only values from the first year (i.e N[,1,]) are used, which is the current N-at-age.
pyears  The number of years to project forward. Equal to 'nyears' for optimizing for q.
M_ageArray  An array (dimensions nsim, maxage, nyears+proyears) with the natural mortality-at-age and year
Mat_age  A matrix (dimensions nsim, maxage) with the proportion mature for each age-class
Wt_age  An array (dimensions nsim, maxage, nyears+proyears) with the weight-at-age and year
V  An array (dimensions nsim, maxage, nyears+proyears) with the vulnerability-at-age and year
retA  An array (dimensions nsim, maxage, nyears+proyears) with the probability retained-at-age and year
Perr  A matrix (dimensions nsim, nyears+proyears) with the recruitment deviations
mov  An array (dimensions nsim, nareas, nareas) with the movement matrix
SRrel  A numeric vector nsim long specifying the recruitment curve to use
Find  A matrix (dimensions nsim, nyears) with the historical fishing effort
Spat_targ  A numeric vector nsim long with the spatial targeting
hs  A numeric vector nsim long with the steepness values for each simulation
R0a  A matrix (dimensions nsim, nareas) with the unfished recruitment by area
SSBPtR  A matrix (dimensions nsim, nareas) with the unfished spawning-per-recruit by area
aR  A numeric vector nsim long with the Ricker SRR a values
bR  A numeric vector nsim long with the Ricker SRR b values
qs  A numeric vector nsim long with catchability coefficients
maxF  A numeric value specifying the maximum fishing mortality for any single age class
useCPP  logical - use the CPP code? For testing purposes only

Author(s)

A. Hordyk
SketchFun

Manually map the historical relative fishing effort trajectory.

Description

Internal function for interactive plot which allows users to specify the relative trajectory and variability in the historical fishing effort.

Usage

SketchFun(nyears, Years=NULL)

Arguments

nyears Number of years
Years An optional vector of years. Should be nyears long.

Author(s)

A. Hordyk

slotlim

An data-limited method which sets a slot limit

Description

An example of the implementation of input controls in the DLM toolkit, where selectivity-at-length is set using a slot limit; that is, a minimum and maximum legal length. The maximum limit is set here, quite arbitrarily, as the 75th percentile between the new minimum legal length and the estimated asymptotic length.

Usage

slotlim(x, Data, ...)

Arguments

x A position in a data-limited methods object
Data A data-limited methods object
... Optional additional arguments that are ignored. Note arguments reps or ... are required for all input controls

Value

An object of class 'InputRec'
Author(s)
A. Hordyk

References
Made-up for this package

---

Snapper  *Snapper Stock*

**Description**
An object of class Stock

**Usage**
Snapper

**Format**
An object of class Stock of length 1.

---

Sole  *Sole Stock*

**Description**
An object of class Stock

**Usage**
Sole

**Format**
An object of class Stock of length 1.
Splot

Scatter plot of B/BMSY or B/B0 and F/FMSY for lastYrs

Description

Scatter plot of B/BMSY or B/B0 and F/FMSY for lastYrs

Usage

Splot(MSEobj = NULL, MPs = NA, All = TRUE, Var = c('B_BMSY', 'SSB_SSB0'),
lastYrs = 10, Fref = 1, BMSYref = 1, B0ref = 0.4, cex.MP = 1, Fbg = FALSE,
Bbg = FALSE, Props = FALSE, TP = FALSE)

Arguments

MSEobj An object of class MSE
MPs Optional subset by MP
All Logical. Plot all points or just the mean?
Var What to plot on the y-axis: B_BMSY or SSB_SSB0
lastYrs Last number of years in projection to calculate statistics
Fref Location of F statistic reference line
BMSYref Location of B_MSY statistic reference line
B0ref Location of B_0 statistic reference line
cex.MP size of MP label
Fbg Logical. Include background colours for F-statistic?
Bbg Logical. Include background colours for B-statistic?
Props Logical. Display the proportion of points in each quadrant?
TP Logical. Use transparent colours?

Author(s)

A. Hordyk
**SPmod**  
*Surplus production based catch-limit modifier*

**Description**

An MP that makes incremental adjustments to TAC recommendations based on the apparent trend in surplus production. Based on the theory of Mark Maunder (IATTC)

**Usage**

```r
SPmod(x, Data, reps = 100, alp = c(0.8, 1.2), bet = c(0.8, 1.2))
```

**Arguments**

- **x**  
  A position in data-limited methods data object
- **Data**  
  A data-limited methods data object
- **reps**  
  The number of quota samples
- **alp**  
  Condition for modifying the TAC (bounds on change in abundance)
- **bet**  
  Limits for how much the TAC can change among years

**Details**

Note that this isn’t exactly what Mark has previously suggested and is stochastic in this implementation.

**Value**

A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

**References**

Description

An MP that uses Martell and Froese (2012) method for estimating MSY to determine the OFL. Since their approach estimates stock trajectories based on catches and a rule for intrinsic rate of increase it also returns depletion. Given their surplus production model predicts K, r and depletion it is straightforward to calculate the OFL based on the Schaefer productivity curve. \( \text{OFL} = \text{dep} \times (1 - \text{dep}) \times r \times K \times 2 \)

Usage

\( \text{SPMSY}(x, \text{Data}, \text{reps} = 100) \)

Arguments

- \( x \)  
  A position in a data-limited methods data object
- \( \text{Data} \)  
  A data-limited methods data object
- \( \text{reps} \)  
  The number of samples of the TAC

Details

Requires the assumption that catch is proportional to abundance. Occasionally the rule that limits r and K ranges does not allow r-K pairs to be found that lead to the depletion inferred by the catch trajectories. In this case this method widens the search.

Author(s)

T. Carruthers

References

SPslopе

Slope in surplus production MP

Description

A management procedure that makes incremental adjustments to TAC recommendations based on the apparent trend in recent surplus production. Based on the theory of Mark Maunder (IATTC)

Usage

SPslopе(x, Data, reps = 100, yrsmth = 4, alp = c(0.9, 1.1), bet = c(1.5, 0.9))

Arguments

x A position in data-limited methods data object
Data A data-limited methods data object
reps The number of quota samples
yrsmth Years over which to smooth recent estimates of surplus production
alp Condition for modifying the Data (bounds on change in abundance)
bet Limits for how much the Data can change among years

Details

Note that this isn’t exactly what Mark has previously suggested and is stochastic in this implementation.

Value

A numeric vector of Data recommendations

Author(s)

T. Carruthers

References

SPSRA

*Surplus Production Stock Reduction Analysis*

**Description**
A surplus production equivalent of DB-SRA that uses a demographically derived prior for intrinsic rate of increase (McAllister method, below)

**Usage**
```r
SPSRA(x, Data, reps = 100)
```

**Arguments**
- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object (class DLM)
- `reps`: The number of samples of the TAC taken for the calculation of the quota

**Author(s)**
T. Carruthers

**References**

---

**SPSRA_ML**

*Surplus Production Stock Reduction Analysis using a mean-length estimate of current stock depletion*

**Description**
A surplus production equivalent of DB-SRA that uses a demographically derived prior for intrinsic rate of increase. A prior for depletion is calculated from a mean-length estimator.

**Usage**
```r
SPSRA_ML(x, Data, reps = 100)
```

**Arguments**
- `x`: A position in a data-limited methods data object
- `Data`: A data-limited methods data object (class DLM)
- `reps`: The number of samples of the TAC taken
Note

The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'.

Author(s)

T. Carruthers

References


SRAComp

Plot simulation test of Stochastic SRA method

Description

Plots simulation variables versus estimation variables for Stochastic SRA methods of conditioning operating models.

Usage

SRAComp(sim, OM, outfile = NA, maxplot = 10)

Arguments

sim
The output list object of SRAsim() function.
OM
The output object of StochasticSRA() function.
outfile
The name of the figure (something.jpg) you wish to make using SRAComp
maxplot
The maximum number of simulations to plot

Author(s)

T. Carruthers (Canadian DFO grant)

Examples

## Not run:
sim<-SRAsim(testOM,qmult=1,patchy=0.8)
CAAsim<-sim$CAA
Chist<-sim$Chist
testOM<-StochasticSRA(testOM,CAA,Chist,nsim=30,nits=500)
SRAComp(sim,testOM)

## End(Not run)
SRAsim

Simulates catch at age and catch history data for testing SRA methods

Description

Catch at age and catch simulator.

Usage

SRAsim(OM, qmult = 0.5, patchy = 0.2, nCAA = 100, sigmaE = 0.25)

Arguments

OM An operating model object with M, growth, stock-recruitment and maturity parameters specified.
qmult Fraction of natural mortality rate that is mean fishing mortality (Fishing catchability multiplier)
patchy The fraction of years that have catch at age data
nCAA The number of independent annual catch at age observations (same among all years)
sigmaE Level of simulated interannual variability in effort (F) expressed as a lognormal SD

Value

A list: Chist = historical catch series, Recdevs = historical recruitment deviations (mean = 1), CAA = catch at age matrix, N = numbers at age matrix, SSB = annual spawning biomass, FM = Fishing mortality rate at age matrix, M = natural mortality rate classy

Author(s)

T. Carruthers (Canadian DFO grant)

Examples

out<-SRAsim(testOM)
**SRopt**

*Function that returns a stochastic estimate of steepness given observed stock recruitment data*

**Description**

Function that returns a stochastic estimate of steepness given observed stock recruitment data

**Usage**

```r
SRopt(nsim, SSB, rec, SSBpR, plot = F, type = "BH")
```

**Arguments**

- `nsim`: number of samples of steepness to generate
- `SSB`: 'observations' of spawning biomass
- `rec`: 'observations' (model predictions) of recruitment
- `SSBpR`: spawning stock biomass per recruit at unfished conditions
- `plot`: should plots of model fit be produced?
- `type`: what type of stock recruitment curve is being fitted BH = Beverton-Holt

**Author(s)**

T. Carruthers

---

**SS2Data**

*Reads data Stock Synthesis file structure into an data object using package r4ss*

**Description**

A function that uses the file location of a fitted SS3 model including input files to population the various slots of an data object

**Usage**

```r
SS2Data(SSdir, Source = "No source provided", length_timestep = NA,
        Name = "", Author = "No author provided", printstats = F, verbose = T)
```
SS2DLM

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssdir</td>
<td>A folder with Stock Synthesis input and output files in it</td>
</tr>
<tr>
<td>Source</td>
<td>Reference to assessment documentation e.g. a url</td>
</tr>
<tr>
<td>length_timestep</td>
<td>The duration (in years) of each timestep in the model (if a quarterly model is used this is 0.25)</td>
</tr>
<tr>
<td>Name</td>
<td>The name of the operating model</td>
</tr>
<tr>
<td>Author</td>
<td>Who did the assessment</td>
</tr>
<tr>
<td>printstats</td>
<td>Should the r4ss function SS_output return info on data that was read in?</td>
</tr>
<tr>
<td>verbose</td>
<td>Should the r4ss function SS_output return detailed messages?</td>
</tr>
</tbody>
</table>

Author(s)

T. Carruthers

SS2DLM

Reads MLE estimates from Stock Synthesis file structure into an operating model using package r4ss

Description

A function that uses the file location of a fitted SS3 model including input files to population the various slots of an operating model with MLE parameter estimates.

Usage

SS2DLM(ssdir, nsim = 48, proyears = 50, length_timestep = NA,
       Name = NULL, Source = "No source provided",
       Author = "No author provided", printstats = F, verbose = T)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssdir</td>
<td>A folder with Stock Synthesis input and output files in it</td>
</tr>
<tr>
<td>nsim</td>
<td>The number of simulations to take for parameters with uncertainty (for OM@cpars custom parameters)</td>
</tr>
<tr>
<td>proyears</td>
<td>The number of projection years for MSE</td>
</tr>
<tr>
<td>length_timestep</td>
<td>The duration (in years) of each timestep in the model (if a quarterly model is used this is 0.25)</td>
</tr>
<tr>
<td>Name</td>
<td>The name of the operating model</td>
</tr>
<tr>
<td>Source</td>
<td>Reference to assessment documentation e.g. a url</td>
</tr>
<tr>
<td>Author</td>
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<td>verbose</td>
<td>Should the r4ss function SS_output return detailed messages?</td>
</tr>
</tbody>
</table>
Author(s)

T. Carruthers

StochasticSRA  Stochastic SRA construction of operating models

Description

Specify an operating model, using catch composition data and a historical catch series. Returns and operating model with depletion (D), selectivity parameters (L5, LFS) and effort trajectory (Effyears, EffLower, EffUpper) filled. Modified version using cpp code.

Usage

StochasticSRA(OM, CAA, Chist, Cobs = 0.1, sigmaR = 0.5, Umax = 0.9, nsim = 48, proyears = 50, Jump_fac = 1, nits = 20000, burnin = 1000, thin = 50, ESS = 300, ploty = T, nplot = 6, SRADir = NA)

Arguments

OM  An operating model object with M, growth, stock-recruitment and maturity parameters specified.
CAA  A matrix nyears (rows) by nages (columns) of catch at age (age 1 to maxage in length)
Chist  A vector of historical catch observations (nyears long) going back to unfished conditions
Cobs  A numeric value representing catch observation error as a log normal sd
sigmaR  A numeric value representing the prior standard deviation of log space recruitment deviations
Umax  A numeric value representing the maximum harvest rate for any age class (rejection of sims where this occurs)
nsim  The number desired draws of parameters / effort trajectories
proyears  The number of projected MSE years
Jump_fac  A multiplier of the jumping distribution variance to increase acceptance (lower Jump_fac) or decrease acceptance rate (higher Jump_fac)
nits  The number of MCMC iterations
burnin  The number of initial MCMC iterations to discard
thin  The interval over which MCMC samples are extracted for use in graphing / statistics
ESS  Effective sample size - the weighting of the catch at age data
ploty  Do you want to see diagnostics plotted?
nplot  how many MCMC samples should be plotted in convergence plots?
SRADir  A directory where the SRA diagnostics / fit are stored
**Value**

A list with three positions. Position 1 is the filled OM object, position 2 is the custompars data.frame that may be submitted as an argument to runMSE() and position 3 is the matrix of effort histories [nyears x nsim] vector of objects of class classy.

**Author(s)**

T. Carruthers (Canadian DFO grant)

**References**


**Examples**

```r
## Not run:
sim<-SRAsim(testOM, patchy=0.8)
CAA<-sim$CAA
Chist<-sim$Chist
testOM<-StochasticSRA(testOM, CAA, Chist, nsim=30, nits=1000)
runMSE(testOM)
## End(Not run)
```

---

**StochasticSRA2**

*Stochastic SRA construction of operating models*

**Description**

Specify an operating model, using catch composition data and a historical catch series. Returns and operating model with depletion (D), selectivity parameters (L5, LFS) and effort trajectory (Effyears, EffLower, EffUpper) filled.

**Usage**

```r
StochasticSRA2(OM, CAA, Chist, Cobs = 0.1, sigmaR = 0.5, Umax = 0.9, 
nsim = 48, proyears = 50, Jump_fac = 1, nits = 4000, burnin = 500, 
thin = 10, ESS = 300, ploty = T, nplot = 6, SRAdir = NA)
```

**Arguments**

- **OM**
  - An operating model object with M, growth, stock-recruitment and maturity parameters specified.

- **CAA**
  - A matrix nyears (rows) by nages (columns) of catch at age (age 1 to maxage in length)
Chist  A vector of historical catch observations (nyears long) going back to unfished conditions

Cobs  A numeric value representing catch observation error as a log normal sd

sigmaR  A numeric value representing the prior standard deviation of log space recruitment deviations

Umax  A numeric value representing the maximum harvest rate for any age class (rejection of sims where this occurs)

nsim  The number desired draws of parameters / effort trajectories

proyears  The number of projected MSE years

Jump_fac  A multiplier of the jumping distribution variance to increase acceptance (lower Jump_fac) or decrease acceptance rate (higher Jump_fac)

nits  The number of MCMC iterations

burnin  The number of initial MCMC iterations to discard

thin  The interval over which MCMC samples are extracted for use in graphing / statistics

ESS  Effective sample size - the weighting of the catch at age data

ploty  Do you want to see diagnostics plotted?

nplot  how many MCMC samples should be plotted in convergence plots?

SRAdir  A directory where the SRA diagnostics / fit are stored

Value

A list with three positions. Position 1 is the filled OM object, position 2 is the custompars data.frame that may be submitted as an argument to runMSE() and position 3 is the matrix of effort histories [nyears x nsim] vector of objects of class classy

Author(s)

T. Carruthers (Canadian DFO grant)

References


Examples

```r
## Not run:
sim<-$SRasim(testOM,patchy=0.8)
CAA<sim$CAA
Chist<sim$Chist
testOM<-StochasticSRA(testOM,CAA,Chist,nsim=30,nits=1000)
runMSE(testOM)
```

## End(Not run)
Description

An operating model component that specifies the parameters of the population dynamics model

Slots

name The name of the Stock object
maxage The maximum age of individuals that is simulated (there is no 'plus group': individuals die off beyone the maximum age so there isn't a huge cost to simulating more older age classes)
R₀ The magnitude of unfished recruitment. This is normally fixed to some arbitrary value since it simply scales the simulated numbers
M Natural mortality rate (uniform distribution)
M₂ Optional vector of M-at-age (must be length maxage)
Mₘd Inter-annual variability in natural mortality rate expressed as a coefficient of variation (uniform distribution)
Mₘgrad Mean temporal trend in natural mortality rate, expressed as a percentage change in M per year (uniform distribution)
Mₑxp Exponent of the Lorenzen function assuming an inverse relationship between M and weight (uniform distribution)
F₉isc Fraction of discarded fish that die
h Steepness of the stock recruit relationship (uniform distribution)
S₀rre₁ Type of stock-recruit relationship (1)Beverton-Holt (2) Ricker
Linf Maximum length (uniform distribution)
K von B. growth parameter k (uniform distribution)
t₀ von B. theoretical age at length zero (uniform distribution)
LɛncV Coefficient of variation of length-at-age (assumed constant for all age classes (uniform distribution)
Kₘd Inter-annual variability in growth parameter k (uniform distribution)
Kₘgrad Mean temporal trend in growth parameter k, expressed as a percentage change in k per year (uniform distribution)
Linfsd Inter-annual variability in maximum length - uniform distribution
Linfgₘd Mean temporal trend in maximum length, expressed as a percentage change in Linf per year (uniform distribution)
recgrad Mean temporal trend in log-normal recruitment deviations (uniform distribution)
Aₖ Autocorrelation in recruitment deviations rec(t)=Aₖ*rec(t-1)+(1-Aₖ)*σ(t) (uniform distribution)
a Length-weight parameter alpha (uniform distribution)
b  Length-weight parameter beta (uniform distribution)
L50  Length-at- 50 percent maturity (uniform distribution)
L50_95  Length increment from 50 percent to 95 percent maturity
D  Current level of stock depletion (Bcurrent/Bunfished) (uniform distribution)
Perr  Process error, the CV of lognormal recruitment deviations (uniform distribution)
Period  Period for cyclical recruitment pattern in years (uniform distribution). Leave empty to ignore
Amplitude  Amplitude in deviation from long-term average recruitment during recruitment cycle, both positive and negative (uniform distribution). E.g., a range from 0 to 0.5 means recruitment decreases or increases by up to 50% each cycle. Leave empty to ignore
Size_area_1  The size of area 1 relative to area 2 (uniform distribution)
Frac_area_1  The fraction of the unfished biomass in stock 1 (uniform distribution)
Prob_staying  The probability of individuals in area 1 remaining in area 1 over the course of one year
Source  A reference to a website or article from which parameters were taken to define the operating model

Objects from the Class

Objects can be created by calls of the form new('Stock')

Author(s)

T. Carruthers

Examples

showClass('Stock')

---

<table>
<thead>
<tr>
<th>Sub</th>
<th>Subset MSE object by management procedure (MP) or simulation.</th>
</tr>
</thead>
</table>

Description

Subset the MSE object by particular MPs (either MP number or name), or particular simulations, or a subset of the projection years (e.g., 1: < projection years).

Usage

Sub(MSEobj, MPs=NULL, sims=NULL, years=NULL)
SubCpars

Arguments

MSEobj A MSE object.
MPS A vector MPs names or MP numbers to subset the MSE object. Defaults to all MPs.
sims A vector of simulation numbers to subset the MSE object. Can also be a logical vector. Defaults to all simulations.
years A numeric vector of projection years. Should start at 1 and increase by one to some value equal or less than the total number of projection years.

Author(s)

A. Hordyk

SubCpars Subset an OM cpars slot

Description

Subset the custom parameters of an operating model

Usage

SubCpars(OM, sims)

Arguments

OM An object of class OM
sims A logical vector OM@nsim long of simulations to either retain (TRUE) or remove (FALSE)

Value

An object of class OM

Author(s)

T. Carruthers
SubOM  

Subset a Stock, Fleet, Obs, or Imp object from an OM object

Description

A function that strips out a Stock, Fleet, Obs, or Imp object from a complete OM object. Mainly used for internal functions.

Usage

SubOM(OM, Sub = c("Stock", "Fleet", "Obs", "Imp"))

Arguments

OM  An operating model object (class OM)
Sub  A character string specifying what object type to strip out "Stock", "Fleet", "Obs", or "Imp"

Value

An object of class Stock, Fleet, Obs, or Imp

Author(s)

A. Hordyk

summary,Data-method  

Summary of Data object

Description

Summary of Data object

Usage

## S4 method for signature 'Data'
summary(object)

Arguments

object  object of class Data
**summary.MSE-method**

Summary of MSE object

**Description**
Summary of MSE object

**Usage**

```r
## S4 method for signature 'MSE'
summary(object)
```

**Arguments**

- `object` object of class MSE

---

**TAC**

Calculate TAC recommendations for more than one MP

**Description**

A function that returns the stochastic TAC recommendations from a vector of data-limited MPs (Output) given a data-limited data object Data

**Usage**

```r
TAC(Data, MPs = NA, reps = 100, timelimit = 1)
```

**Arguments**

- `Data` A data-limited methods data object
- `MPs` optional vector of MP names
- `reps` Number of repititions
- `timelimit` The maximum time (seconds) taken to complete 10 reps

**Author(s)**

T. Carruthers
**TACfilter**  
*TAC Filter*

**Description**

Filters vector of TAC recommendations by replacing negatives with NA and and values beyond five standard deviations from the mean as NA

**Usage**

TACfilter(TAC)

**Arguments**

TAC  
A numeric vector of TAC recommendations

**Author(s)**

T. Carruthers

---

**Targeting_Small_Fish**  
*Targeting_Small_Fish Fleet*

**Description**

An object of class Fleet

**Usage**

Targeting_Small_Fish

**Format**

An object of class Fleet of length 1.
Target_All_Fish

**Target_All_Fish Fleet**

**Description**
An object of class Fleet

**Usage**
Target_All_Fish

**Format**
An object of class Fleet of length 1.

---

tdlnorm

*Calculate density of log-normally distributed random numbers*

**Description**
Calculate density of log-normally distributed random numbers

**Usage**

```
tdlnorm(x, mu, cv)
```

**Arguments**
- `x` vector
- `mu` mean
- `cv` coefficient of variation

**Value**
numeric

**Author(s)**
T. Carruthers
### testOM

**Description**

An object of class OM

**Usage**

```r
testOM
```

**Format**

An object of class OM of length 1.

### Toothfish

**Description**

An object of class Stock

**Usage**

```r
Toothfish
```

**Format**

An object of class Stock of length 1.

### tplot

**Description**

A shorter version of the plot method for MSEs that just shows the overall trade-offs

**Usage**

```r
tplot(MSEobj,nam=NA)
```

**Arguments**

- `MSEobj` An object of class 'MSE'
- `nam` Name of the plot
**Tplot2**

*A shorter version of the plot method for MSEs that just shows the overall trade-offs*

**Description**

A trade-off plot for an MSE object that compares long-term yield (LTY: fraction of simulations getting over half FMSY yield in the last ten years of the projection), short-term yield (STY: fraction of simulations getting over half FMSY yield in the first ten years of the projection), variability in yield (VY: fraction of simulations where average annual variability in yield is less than 10 per cent) and biomass level (B10: the fraction of simulations in which biomass stays above 10 percent of BMSY).

**Usage**

\[ \text{Tplot2(MSEobj, nam=NA)} \]

**Arguments**

- **MSEobj**: An object of class 'MSE'
- **nam**: Name of the plot

**Author(s)**

T. Carruthers

---

**TradePlot**

*Generic Trade-off Plot*

**Description**

Creates a trade-off plot (up to four panels) of built-in performance metrics.

**Usage**

\[ \text{TradePlot(MSEobj, XAxis=c('Overfishing', 'Biomass:BMSY'), YAxis=c('Long-term Yield', 'AnnualVar'), XThresh=c(30, 80), YThresh=c(0,50), maxVar=15, BmsyRef=0.5, B0Ref=0.2, AvailMPs=NULL, ShowLabs=FALSE, ShowCols=TRUE)} \]
Arguments

MSEobj Object of class MSE, output of the runMSE function
XAxis Character string describing the performance metrics for the x-axis (or x-axes if vector; max 4). Must be chosen for list of existing PMs and same length as YAxis. See PMs
YAxis Character string describing the performance metrics for the y-axis (or y-axes if vector; max 4). Must be chosen for list of existing PMs and same length as XAxis. See PMs
XThresh Minimum threshold values in percent (i.e., 50 = 50%) for the x-axes (must be same length as XAxis)
YThresh Minimum threshold values in percent (i.e., 50 = 50%) for the y-axes (must be same length as YAxis)
maxVar Reference for average annual variability in yield in percent
BmsyRef Reference level of BMSY, in proportion, i.e., 0.5 = 0.5BMSY
B0Ref Reference level of B0, in proportion, i.e., 0.2 = 0.2B0
AvailMPs vector of MPs that *could* be applied to the fishery, i.e., sufficient data exists. These a plotted with different symbol
ShowLabs Logical to specify if MP labels are shown
ShowCols Logical to specify if background colors are shown

Details

Returns a list containing the names of performance metrics that meet the minimum performance metrics for each trade-off, and ranks the MPs by increasing distance from the top-right corner.

Author(s)

A. Hordyk

trlnorm Generate log-normally distributed random numbers

Description

Generate log-normally distributed random numbers

Usage

trlnorm(reps, mu, cv)

Arguments

reps number of random numbers
mu mean
cv coefficient of variation
updateMSE

Value
numeric

Author(s)
T. Carruthers

Description
Updates an existing MSE object (class MSE) from a previous version of the DLMtool to include the new slots. The slots will be empty, but avoids the 'slot doesn't exist' error that sometimes occurs. Also works with Stock, Fleet, Obs, Imp, and Data objects.

Usage
updateMSE(MSEobj)

Arguments
MSEobj A MSE object from a previous version of the DLMtool. Also works with Stock, Fleet, Obs, Imp, and Data objects.

Value
An object of class matching class(MSEobj)

Author(s)
A. Hordyk

userguide
Open the DLMtool User Guide

Description
Opens the DLMtool User Guide website (requires internet connection)

Usage
userguide()
Examples

```r
## Not run:
userguide()

## End(Not run)
```

---

### validcpars

**Valid custom parameters (cpars)**

---

**Description**

Valid custom parameters (cpars)

**Usage**

`validcpars(print = TRUE)`

**Arguments**

- `print`  
  Print the valid names for cpars?

**Value**

invisibly returns vector of valid cpars names

---

### VOI

**Calculate Value Of Information**

---

**Description**

A function that relates operating model parameters and parameters of the observation model to yield (by default). A user can also specify their own utility values (Ut) which is arranged in a matrix of `nsim` rows and `nMP` columns.

**Usage**

```r
VOI(MSEobj, ncomp = 6, nbins = 8, maxrow = 8, Ut = NA, Utnam = 'Utility')
```
**Arguments**

- **mseobj**: An object of class MSE
- **ncomp**: Maximum number of variables to examine per MP
- **nbins**: Number of percentile bins for sampled parameters of the operating model or observation model, which is used for calculating variability in utility across the sampled range of each parameter
- **maxrow**: Maximum number of MPs per plot
- **ut**: A matrix of user-specified utility values of nsim rows and nMPs columns
- **utnam**: The name of the utility measure for plotting

**Author(s)**

T. Carruthers

---

**Description**

A function that relates operating model parameters and parameters of the observation model to relative yield (yield over last 5 years of projection relative to a 'best F' scenario that maximizes yield).

**Usage**

```r
VOI2(mseobj, ncomp = 6, nbins = 4, ut = NA, utnam = 'yield', lay = F)
```

**Arguments**

- **mseobj**: An object of class MSE
- **ncomp**: Maximum number of observation variables to examine per MP
- **nbins**: Number of bins for sampled observation variables used for calculating variability in utility across the sampled range of each parameter
- **ut**: A matrix of user-specified utility values of nsim rows and nMPs columns
- **utnam**: The name of the utility measure for plotting
- **lay**: Controls whether labels are in lay terms or not

**Note**

VOI2 assumes that relative cost for each type of improvement in data is linearly related to the number of samples (e.g. nCAAobs) or square function of improved precision and bias e.g.: relative cost= 1/(newCV/oldCV)^2

**Author(s)**

T. Carruthers
VOIplot

Yet another Value of Information Plot

Description

A function that relates parameters of the observation model and the operating model parameters to yield.

Usage

```r
VOIplot(MSEobj, MPs=NA, nvars=5, nMP=4, Par=c('Obs', 'OM'),
YVar=c('Y', 'B'), doplot=TRUE, incStat=FALSE, availMP=NULL, acceptMP=NULL,
incNames=TRUE, labcex=0.8, quants=c(0.05, 0.95))
```

Arguments

- `MSEobj`: An object of class MSE
- `MPs`: The MPs to plot. If NA it will plot the first nMP from MSEobj
- `nvars`: The number of observation or operating model parameters to plot (number of columns)
- `nMP`: The maximum number of MPs to plot (number of rows)
- `Par`: Plot Operating Model (OM) or Observation (Obs) parameters?
- `YVar`: Variable for Y-Axis: Yield (Y) or Biomass (B) (relative to BMSY)
- `doplot`: Output the plot?
- `incStat`: Include a print out of statistic describing the curviness of the line?
- `availMP`: Optional character string of MPs that are available. These names are colored black
- `acceptMP`: Optional character string of MPs that are acceptable. These names are colored green if they are also in availMP
- `incNames`: Include the names?
- `labcex`: Character size of the label
- `quants`: Quantiles to calculate

Value

A list of all the information included in the plot

Author(s)

A. Hordyk
**Biomass wormplot**

**Description**

A worm plot for plotting the likelihood of meeting biomass targets in future years.

**Usage**

```
wormplot(MSEobj, Bref=0.5, LB=0.25, UB=0.75)
```

**Arguments**

- `MSEobj`: Object of class MSE, output of the runMSE function
- `Bref`: The reference fraction of BMSY (to evaluate the probability of exceeding this level)
- `LB`: The lower bound probability that separates red (bad) and yellow (O.K.) colored segments
- `UB`: The upper bound probability that separates yellow (O.K.) and green (good) colored segments

**Details**

Returns a matrix of nMPs rows and proyears columns which is the fraction of simulations for which biomass was above Bref.

**Author(s)**

T. Carruthers

**writeCSV**

*Internal function to write CSVs for objects*

**Description**

Used internally in the DLMtool package to write CSV files from an existing DLMtool object

**Usage**

```
writeCSV(inobj, tempfile = NULL, objtype = c("Stock", "Fleet", "Obs", "Imp", "Data", "OM", "Fease"))
```
Arguments

inobj  A object of class Stock, Fleet, Obs, Imp, Data, OM, or Fease
tmpfile  The full file path and name for the saved CSV file
objtype  The class corresponding to the inobj

Author(s)

A. Hordyk

---

YPR  \textit{Yield Per Recruit analysis to get FMSY proxy F01}

Description

A simple yield per recruit approximation to FMSY (F01) which is the position of the ascending YPR curve for which \( \frac{d\text{YPR}}{dF} = 0.1 \left( \frac{d\text{YPR}}{d0} \right) \)

Usage

\texttt{YPR(x, Data, reps = 100)}

Arguments

\begin{itemize}
  \item \texttt{x}  A position in a data-limited methods data object
  \item \texttt{Data}  A data-limited methods data object
  \item \texttt{reps}  The number of samples of the TAC
\end{itemize}

Value

A numeric vector of TAC samples

Note

Based on the code of Meaghan Bryan

Author(s)

Meaghan Bryan and Tom Carruthers

References

Beverton and Holt. 1954.
YPR_CC

Yield Per Recruit analysis to get FMSY proxy F01 paired to a naive catch curve estimate of recent Z

Description

A simple yield per recruit approximation to FMSY (F01) which is the position of the ascending YPR curve for which \( \frac{dYPR}{dF} = 0.1 \left( \frac{dYPR}{d0} \right) \) A naive catch-curve analysis is used to determine recent Z which given M (Mort) gives F and thus abundance = Ct/(1-exp(-F))

Usage

YPR_CC(x, Data, reps = 100, Fmin=0.005)

Arguments

- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object (class DLM)
- **reps**: The number of samples of the TAC
- **Fmin**: The minimum fishing mortality rate inferred from the catch-curve analysis

Author(s)

Meaghan Bryan and T. Carruthers

YPR_ML

Yield Per Recruit analysis to get FMSY proxy F01 paired with a mean-length estimate of current stock size

Description

A simple yield per recruit approximation to FMSY (F01) which is the position of the ascending YPR curve for which \( \frac{dYPR}{dF} = 0.1 \left( \frac{dYPR}{d0} \right) \) A mean-length estimate of recent Z is used to infer current abundance

Usage

YPR_ML(x, Data, reps = 100)

Arguments

- **x**: A position in a data-limited methods data object
- **Data**: A data-limited methods data object
- **reps**: The number of samples of the TAC
Note
The mean length extension was programmed by Gary Nelson as part of his excellent R package 'fishmethods'.

Author(s)
Meaghan Bryan and T. Carruthers
initialize-methods, 93

*Topic **stock**
  DLMtool-package, 8

*Topic **strategy**
  DLMtool-package, 8

Albacore, 9
alphaconv, 9
Atlantic_mackerel, 10
avail, 10
AvC, 11

barplot.MSE, 11
betaconv, 12
BK, 13
BK_CC, 13
BK_ML, 14
Blow_opt, 15
Blue_shark, 16
Bluefin_tuna, 16
Bluefin_tuna_WAtl, 16
boxplot.Data, 17
boxplot.MSE, 17
Butterfish, 18

CalcOutput, 19
Can, 20
Cant, 20
CC1, 21
CC4, 22
CheckConverg, 23
checkMSE, 23
China_rockfish, 24
ChkDatNA, 24
ChkObj, 25
ChooseEffort, 25
ChooseM, 26
ChooseSelect, 26
Cobia, 27
compplot, 27
CompSRA, 28
CompSRA4010, 29
condmet, 29
Converge, 30
COSEWIC_plot, 30
cparscheck, 31
Cplot, 31
CSRA, 32
CSRAfunc, 33
curE, 34
curE75, 34
cv, 35
DAAC, 36
Data-class, 36
Data_xl, 39
DBSRA, 40
DBSRA4010, 41
DBSRA_40, 41
DBSRA_ML, 42
DCAC, 43
DCAC4010, 44
DCAC_40, 44
DCAC_ML, 45
DD, 46
DD4010, 47
DDe, 47
DDe75, 48
DDes, 49
DecE_Dom, 50
DecE_HDom, 50
DecE_NDom, 50
DepF, 51
derive_beta_par, 51
DFO_hist, 52
DFO_plot, 52
DF0_plot2, 53
DF0_proj, 53
DLMDatDir, 54
DLMtool (DLMtool-package), 8
DLMtool-package, 8
DOM, 54
DTE40, 55
DTE50, 55
DynF, 56

EtargetLopt, 57
Example_datafile, 57

Fadapt, 58
Fdem, 59
Fdem_CC, 59
Fdem_ML, 60
Fease, 61
Fease-class, 61
Fease_xl, 62
Feasibility, 63
Feasibility2, 64
fetch.file_names, 64
FlatE_Dom, 65
FlatE_HDom, 65
FlatE_NDom, 65
Fleet-class, 66
FMSYref, 67
FMSYref50, 68
FMSYref75, 68
ForceCor, 69
Fratio, 70
Fratio40, 71
Fratio_CC, 71
Fratio_ML, 72
GB_CC, 73
GB_slope, 74
GB_target, 75
Gcontrol, 75
Generic_DecE, 76
Generic_FlatE, 76
Generic_fleet, 77
Generic_IncE, 77
Generic_obs, 77
genLenComp, 78
getAFC, 78
getBH, 79
getBlow, 80
getcode, 81
getFMSY3, 81
getFref3, 82
getGpars, 84
GetMoreData, 84
getmov, 85
getmov2, 86
getq, 87
Gulf_blue_tilefish, 88
HDAAC, 88
Herring, 89
hist2, 89
ICI, 90
ICI2, 90
Imp-class, 91
Imprecise_Biased, 92
Imprecise_Unbiased, 92
IncE_HDom, 93
IncE_NDom, 93
initialize (initialize-methods), 93
initialize, Data-method (initialize-methods), 93
initialize, DLM_general-method (initialize-methods), 93
initialize, Fease-method (initialize-methods), 93
initialize, Fleet-method (initialize-methods), 93
initialize, MSE-method (initialize-methods), 93
initialize, Obs-method (initialize-methods), 93
initialize, OM-method (initialize-methods), 93
initialize, Stock-method (initialize-methods), 93
Input, 94
InputRec-class, 95
IOTC_plot, 95
Iratio, 96
iSCAM2Data, 97
iSCAM2DLM, 98
iSCAMcomps, 98
iSCAMinds, 99
Islope1, 100
Islope4, 101
IT10, 102
IT5, 102
Itarget1, 103
Itarget4, 104
ItargetE1, 105
ItargetE4, 106
ITe10, 107
ITe5, 107
ITM, 108
joinMSE, 109
Jplot, 109
Kplot, 110
load.iscam.files, 115
Low_Effort_Non_Target, 116
Lratio_BHI, 116
Lratio_BH2, 117
LSRA, 118
LSRA2, 118
LSRA_MCMC_sim, 119
LSRA_opt, 120
LstepCC1, 121
LstepCC4, 122
LstepCE1, 123
LstepCE2, 124
Ltarget1, 125
Ltarget4, 126
LtargetE1, 127
LtargetE4, 127
Mackerel, 128
makePerf, 128
makeTransParent, 129
matlenlim, 129
matlenlim2, 130
MCD, 131
MCD4010, 131
mconv, 132
minlenlopt, 132
ML2D, 133
movdistil, 134
movfit, 134
movfit_Rcpp, 135
MPStats, 136
Mnoreal, 136
MRreal, 137
MSE_class, 137
NAor0, 140
Needed, 141
negcorlogspace, 141
NFref, 142
NOAA_plot, 142
Obs_class, 143
OM_class, 145
OM_xl, 149
optBH, 150
optF, 151
optMSY, 151
optQ, 152
ourReefFish, 154

Overages, 154
Perfect_Imp, 155
Perfect_Info, 155
plot.Data, ANY_method, 155
plot.MSE, ANY_method, 156
plot.OM, 156
plotFleet, 157
plotFun, 157
plotImp, 158
plotM, 159
plotObs, 159
plotOFL, 160
plotSelect, 160
plotStock, 161
popdyn, 162
Porgy, 163
Pplot, 163
Pplot2, 164
Precise_Biased, 165
Precise_Unbiased, 165
Range, 166
range01(Range), 166
Rcontrol, 166
Rcontrol2, 167
read.control.file, 168
read.data.file, 168
read.mcmc, 169
read.par.file, 169
read.projection.file, 170
read.report.file, 170
Red_snapper, 171
Replace, 171
replic8, 172
Required, 172
Rockfish, 173
runInMP, 173
runMSE, 174
runMSErobust, 175
Sam, 176
sample_steepness2, 180
SampleCpars, 177
SampleFleetPars, 178
SampleImpPars, 178
SampleObsPars, 179
SampleStockPars, 179
sampy, 180
INDEX

SBT1, 181
SBT2, 182
sdconv, 183
Sense, 183
SetRecruitCycle, 184
setup, 185
Simulation_1, 185
simYears, 185
SketchFun, 187
slotlim, 187
Snapper, 188
Sole, 188
Splot, 189
SPmod, 190
SPMSY, 191
SPslope, 192
SPSRA, 193
SPSRA_ML, 193
SRAcomp, 194
SRAsim, 195
SROpt, 196
SS2Data, 196
SS2DLM, 197
StochasticSRA, 198
StochasticSRA2, 199
Stock-class, 201
Sub, 202
SubCpars, 203
SubOM, 204
summary, Data-method, 204
summary, MSE-method, 205

TAC, 205
TACfilter, 206
Target_All_Fish, 207
Targeting_Small_Fish, 206
tdlnorm, 207
testOM, 208
Toothfish, 208
Tplot, 208
Tplot2, 209
TradePlot, 209
trlnorm, 210

updateMSE, 211
userguide, 211

validcpars, 212
VOI, 212