

# DLMtool CHEAT SHEET 1



## Getting Started

**Install package:** `install.packages('DLMtool')`

**User Guide:** `userguide()`

**Cheat Sheets:** `cheatsheets()`

**Website:** <http://datalimitedtoolkit.org>

**Report Issues:** <https://github.com/DLMtool/DLMtool/issues>

## Acronyms

DLMtool	Data-Limited Methods Toolkit
MP	Management Procedure
MSE	Management Strategy Evaluation
OM	Operating Model
PM	Performance Metrics

## Main Object Classes

Class	Contents
Stock	Biological Properties
Fleet	Exploitation Properties
Obs	Observation Error
Imp	Implementation Error
OM	Operating Model
MSE	Management Strategy Evaluation Results
MP	Management Procedure

**Find Available Objects:** `avail('Object Class')`

e.g.      `avail('Stock')`  
          `avail('Fleet')`  
          `avail('Obs')`            **More Objects:** `DLMextra()`  
          `...`  
          `avail('MP')`

**Slot Names:** `slotNames('Object Class')`

e.g.      `slotNames('Stock')`

## Create New OM

**Blank OM:** `OM <- new('OM')`

**New OM from available objects:** `OM <- new('OM', 'Stock', 'Fleet', 'Obs', 'Imp')`

e.g.      `OM <- new('OM', Albacore, Generic_Fleet, Generic_Obs, Perfect_Imp)`

**Initialize Excel OM and OM Report:** `OMinit('myOM')`

**Import OM from Excel:** `OM <- XL2OM('myOM')`

**Generate OM Report:** `OMdoc()`

## Customize OM

**Sketch Historical Fishing:** `Fleet/OM <- ChooseEffort(Fleet/OM)`

**Sketch Selectivity:** `Fleet <- ChooseSelect(Fleet, FstYr = ...)`

**Sketch Age Specific *M*:** `OM <- ChooseM(OM)`

**Sketch Length Specific *M*:** `OM <- ChooseM(OM, 'Length')`

**Predicting Life-History Parameters:**

e.g.      `OM <- new('OM')`  
          `OM@Species <- 'Scomber japonicus'`  
          `OM <- LH2OM(OM)`

**Custom Parameters:**

e.g.      `OM <- new('OM', Albacore, Generic_Fleet, Generic_Obs, Perfect_Imp)`  
          `OM@cpars$M <- rlnorm(OM@nsim, log(0.2), 0.05)`

**Remove Process and Observation Error:** `OM <- tinyErr(OM)`

**Replace OM Component:** `OM <- Replace(OM, Blue_shark)`

## Examine OM

**Plot OM Components:**

e.g.      `plot(Albacore)`  
          `plot(Generic_Fleet)`

**Plot OM:** `plot(OM)`

**Plot Existing MPA:** `plotMPA(OM)`

**Plot *M*:** `plotM(OM)`

**Plot Selectivity:** `plotSelect(OM)`

**OM Excel:** myOM.xlsx    **OM Report:** myOM.rmd

	A	B	C	D
1	Slot			
2	Name			
3	Common_Name			
4	Species			
5	maxage			
6	RO			
7	M			
8	M2			
9	Mexp			
10	Msd			
11	Mgrad			
12	h			
13	SRrel			
14	Perr			
15	AC			
16	Period			
17	Amplitude			
18	Linf			
19	K			
20	t0			
21	LenCV			
22	Ksd			
23	Kgrad			
24	Linfsd			
25	Linfgrad			
26	L50			
27	L50_95			
28	D			
29	a			
30	b			
31	Size_area_1			
32	Frac_area_1			
33	Prob_staying			
34	Fdisc			
35	Source			
36				

1	# Title
2	Include name and Location of the Fishery. One line only.
3	
4	# Subtitle
5	Subtitle, one line only.
6	
7	# Author(s)
8	Name and contact details (e.g email, affiliation) for each author.
9	One line per author.
10	
11	# Date
12	Optional, date that the operating model was created. If none provided, today's date will be used.
13	
14	# Introduction
15	
16	
17	## Completing the OM Documentation
18	This document is used to generate a HTML OM report document.
19	
20	The document is separated into 7 sections:
21	1. Introduction (this section)
22	2. Custom Parameters (optional)
23	3. Stock Parameters
24	4. Fleet Parameters
25	5. Obs (Observation) Parameters
26	6. Imp (Implementation) Parameters
27	7. References
28	
29	The Introduction section is used to briefly describe the fishery and the details of the operating model.
30	It should include an explanation for the OM parameters:
31	* nsim: the number of simulations.
32	* proyears: the number of projectio years.
33	* interval: the management interval.
34	* pstar: the percentile of the sample of the management recommendation for each method.
35	* mmaxf: the maximum instantaneous fishing mortality rate that may be simulated for any given age class.
36	* reps: the number of samples of the management recommendation for each method.
37	

## Management Procedures

MP Type	Returns
Output	TAC (total allowable catch)
Input	TAE, SL, Spatial (total allowable effort, size limit, spatial closure)
Mixed	Combination of Output and Input
Reference	TAC (assuming perfect data)

**Find MP type:** `MPtype()`

e.g.      `MPtype(c('AvC', 'curE', 'matlenlim', 'FMSYref'))`

## Run MSE

**Run MSE:** `runMSE()`

e.g. `MSE <- runMSE(OM, MP=c('AvC', 'curE', 'matlenlim', 'FMSYref'))`

**Run MSE in parallel:** `runMSE(parallel=TRUE)`

e.g. `MSE <- runMSE(OM, MP=c('AvC', 'curE', 'matlenlim', 'FMSYref'), parallel=TRUE)`

**Check Convergence:** `Converge(MSE)`

**Run Historical Simulations:**

`Hist <- runMSE(OM, Hist=TRUE)`



## Performance Metrics

**Available PM Functions:** avail('PM')

**Calculate PM:**

e.g.     MSE <- runMSE()  
          P50(MSE)

**Example Custom PM:**

```
Calculate Probability F < 2 x FMSY in first 5 years:
myPM <- function(MSEobj=NULL, Ref=2, Yrs=5) {
  Yrs <- ChkYrs(Yrs, MSEobj) # validate years
  PMobj <- new('PMobj') # create empty PM object
  PMobj@Name <- paste0('Probability F/FMSY < ', Ref) # name of PM
  PMobj@Caption <- paste0('Probability F/FMSY < ', Ref) # caption
  PMobj@Stat <- MSEobj@F_FMSY[, , Yrs[1]:Yrs[2]] # statistic
  PMobj@Ref <- Ref # save Reference
  PMobj@Prob <- calcProb(PMobj@Stat < PMobj@Ref, MSEobj) # prob.
  PMobj@Mean <- calcMean(PMobj@Prob) # average prob.
  PMobj@MPs <- MSEobj@MPs # record MPs
  PMobj # return PM object
}
class(myPM) <- 'PM' # assign to class 'PM'

summary(MSE, 'myPM') # calculate performance
TradePlot(MSE, 'myPM', 'P50') # trade-off plot with new PM
```

## Examine MSE Results

<b>Summary Results:</b> summary(MSE)	<b>Value of Information:</b>
<b>Trade-Off Plots:</b> TradePlot(MSE, PMs)	VOI(MSE)
e.g.     TradePlot(MSE, 'P50', 'AAVY')	VOI2(MSE)
	Tplot(MSE)
	Tplot2(MSE)
	NOAA_plot(MSE)
<b>Projection Plots:</b>	<b>Other Plots:</b>
	COSEWIC_Hplot(MSE)
Pplot(MSE)	Cplot(MSE)
Pplot2(MSE)	DFO_plot(MSE)
<b>Kobe Plot:</b> Kplot(MSE)	DFO_plot2(MSE)
	DFO_proj(MSE)
	IOTC_plot(MSE)
	PWhisker(MSE)
	wormplot(MSE)

## Subset MSE

**Subset by MP:** MSE2 <- Sub(MSE, MPs= ...)

e.g.     MSE <- runMSE()  
  
          stats <- summary(MSE)  
  
          accept <- which(stats\$P50 > 0.7)  
  
          acceptMPs <- stats[accept, 'MP']  
  
          subMSE <- Sub(MSE, MPs=acceptMPs)

**Subset by Simulation:** MSE2 <- Sub(MSE, sims= ...)

e.g.     below <- MSE@OM\$M < median(MSE@OM\$M)  
  
          subMSE <- Sub(MSE, sims=below)

## Fishery Data Object

**Example Data:** avail('Data')

**Blank Data:** Data <- new('Data')

**Initialize Data Excel:** DataInit()

**Import Data from Excel:** Data <- XL2Data()

**Plot Data:** summary(Data)

## Evaluating OM

**Compare Simulated and Actual Data:**

Turing(OM, Data)

## Management Procedures

**Available MPs:** Can(Data)

**Unavailable MPs:** Cant(Data)

**Feasible MPs:** ?Fease

e.g. All Management Options: Fease(Data) = Can(Data)

TAC Only: Fease(Data, TAE=FALSE,  
  SL=FALSE, Spatial=FALSE)

Size Reg. Only: Fease(Data, TAC=FALSE,  
  TAE=FALSE, Spatial=FALSE)

## Custom MPs

**Averaging MPs:** myMP <- makeMeanMP(MP Names)

e.g.     avgMP <- makeMeanMP(c('BK', 'DBSRA', 'Fadapt', 'Rcontrol'))  
  
          MSE <- runMSE(DLMtool::testOM, MPs=c ('BK', 'DBSRA',  
  'Fadapt', 'Rcontrol', 'avgMP'))  
  
          Tplot(MSE)

**Pseudo-Code to create new MP:**

```
AvCatchMP <- function(x, Data, reps=100, plot=FALSE) {
  AvC <- Data@AvC[x] # access element x from Data object slot
  ...
  Rec <- new('Rec') # create object of class Rec
  # slotNames("Rec")
  Rec@TAC <- AvC # populate one or more Rec slots
  Rec # return Rec object
}
class('AvCatchMP') <- 'MP'
```

## Apply MPs

**Apply MP:** runMP(Data, 'MP Name')

e.g.     All Available MPs: runMP(Atlantic\_mackerel)  
  
          TAC <- runMP(Atlantic\_mackerel, 'AvC')@TAC

**Plot TACs:**

e.g.     Atlantic\_mackerel <- runMP(Atlantic\_mackerel)  
  
          boxplot(Atlantic\_mackerel)

## Posterior Predicted Data

**Generate Predicted Data from MP application:**

e.g.     MSE <- runMSE(MPs="DCAC", PPD=TRUE)  
  
          Predicted\_Ind <- MSE@Misc[[1]]@Ind  
  
          matplot(t(Predicted\_Ind), type='l',  
  xlab='Projected Year', ylab='Index value')