

# Package ‘GenEst’

July 21, 2025

**Title** Generalized Mortality Estimator

**Version** 1.4.9

**Date** 2023-05-25

**Description** Command-line and 'shiny' GUI implementation of the GenEst models for estimating bird and bat mortality at wind and solar power facilities, following Dalthorp, et al. (2018) <[doi:10.3133/tm7A2](https://doi.org/10.3133/tm7A2)>.

**Depends** R (>= 3.5.0)

**License** CC0

**Encoding** UTF-8

**LazyData** true

**Imports** DT, gsl, gtools, hellno, htmltools, lubridate, MASS, matrixStats, mvtnorm, Rcpp, shiny (>= 1.4.0), shinyjs, survival

**RoxygenNote** 7.2.3

**Suggests** knitr, rmarkdown, testthat

**VignetteBuilder** knitr

**LinkingTo** Rcpp

**NeedsCompilation** yes

**Author** Daniel Dalthorp [aut, cre],  
Juniper Simonis [aut],  
Lisa Madsen [aut],  
Manuela Huso [aut],  
Paul Rabie [aut],  
Jeffrey Mintz [aut],  
Robert Wolpert [aut],  
Jared Studyvin [aut],  
Franzi Korner-Nievergelt [aut]

**Maintainer** Daniel Dalthorp <ddalthorp@protonmail.com>

**Repository** CRAN

**Date/Publication** 2023-05-25 16:10:03 UTC

## Contents

aicc	5
aicc.cpm	5
aicc.cpmSet	6
aicc.cpmSetSize	6
aicc.pkm	7
aicc.pkmSet	8
aicc.pkmSetSize	8
aicc.pkmSize	9
app_content	10
app_download_functions	11
app_msg_functions	12
app_output_utilities	13
app_panels	13
app_server	14
app_ui	15
app_ui_utilities	17
app_utilities	18
app_widgets	19
averageSS	20
calcg	21
calcRate	22
calcSplits	23
calcTsplit	25
checkComponents	26
checkDate	26
checkSpecificModelCP	27
checkSpecificModelSE	27
combinePreds	28
combinePredsAcrossModels	28
countCarcs	29
CO_DWP	29
CPcols	30
CPdistOptions	30
cpLogLik	30
cpm	31
cpmCPCellPlot	35
cpmFail	36
cpmSetFail	36
cpmSetFailRemove	37
cpmSetSizeFail	37
cpmSetSizeFailRemove	38
cpmSetSpecCPCellPlot	38
dateCols	39
dateToDay	39
defineUnitCol	40
desc	40

dlModTabSE . . . . .	41
DWPCols . . . . .	42
dwpm . . . . .	42
estg . . . . .	43
estgGeneric . . . . .	45
estgGenericSize . . . . .	46
estM . . . . .	47
expandModelSetCP . . . . .	49
GenEst . . . . .	49
logit . . . . .	54
ltranspose . . . . .	55
mock . . . . .	56
model_utility_functions . . . . .	56
obsCols_fta . . . . .	57
obsCols_ltp . . . . .	57
obsCols_SE . . . . .	58
pkLogLik . . . . .	58
pkm . . . . .	59
pkmFail . . . . .	64
pkmParamPlot . . . . .	64
pkmSECellPlot . . . . .	65
pkmSetAllFail . . . . .	66
pkmSetFail . . . . .	66
pkmSetFailRemove . . . . .	67
pkmSetSizeFail . . . . .	67
pkmSetSizeFailRemove . . . . .	68
pkmSetSpecParamPlot . . . . .	68
pkmSetSpecSECellPlot . . . . .	69
pllogis . . . . .	69
plot.cpm . . . . .	70
plot.cpmSet . . . . .	71
plot.estM . . . . .	71
plot.gGeneric . . . . .	72
plot.gGenericSize . . . . .	73
plot.pkm . . . . .	74
plot.pkmSet . . . . .	75
plot.splitFull . . . . .	75
plot.splitSummary . . . . .	76
plotCPCells . . . . .	77
plotCPFigure . . . . .	77
plotCPHeader . . . . .	78
plotSEBoxPlots . . . . .	78
plotSEBoxTemplate . . . . .	79
plotSECells . . . . .	79
plotSEFigure . . . . .	80
plotSEHeader . . . . .	80
ppersist . . . . .	81
predsCols . . . . .	81

prepPredictors . . . . .	82
prepSS . . . . .	82
prettyModTabCP . . . . .	83
prettyModTabSE . . . . .	84
prettySplitTab . . . . .	84
print.cpm . . . . .	85
print.pkm . . . . .	85
qpk . . . . .	86
rcp . . . . .	86
rdwp . . . . .	87
readCSV . . . . .	88
refMod . . . . .	88
removeCols . . . . .	89
rpk . . . . .	89
runGenEst . . . . .	90
SEcols . . . . .	90
SEpanel . . . . .	90
SEsi . . . . .	91
SEsi0 . . . . .	92
SEsi_left . . . . .	92
SEsi_right . . . . .	93
simpleMplot . . . . .	93
sizeCols . . . . .	94
solar_powerTower . . . . .	94
solar_PV . . . . .	97
solar_trough . . . . .	100
summary.estM . . . . .	102
summary.gGeneric . . . . .	103
summary.gGenericSize . . . . .	103
summary.splitFull . . . . .	105
tidyModelSetCP . . . . .	105
tidyModelSetSE . . . . .	106
transposeSplits . . . . .	106
trimSetSize . . . . .	107
update_input . . . . .	107
update_output . . . . .	108
update_rv . . . . .	108
wind_cleared . . . . .	109
wind_RP . . . . .	112
wind_RPbat . . . . .	114

---

aicc	<i>Generic S3 function for summarizing AICc</i>
------	---

---

**Description**

Extract AICc values from pkm, pkmSet, pkmSetSize, cpm, cpmSet, and cpmSetSize.

**Usage**

```
aicc(x, ...)
```

**Arguments**

x	Model or list of models to extract AICc values from.
...	further arguments passed to or from other methods

**Value**

list of models sorted by AICc

---

aicc.cpm	<i>Extract AIC and AICc for a carcass persistence model</i>
----------	---

---

**Description**

S3 function for generating AIC for [cpm](#) objects

**Usage**

```
## S3 method for class 'cpm'
aicc(x, ...)
```

**Arguments**

x	Carcass persistence model (cpm objects)
...	further arguments passed to or from other methods

**Value**

AIC, AICc vector

**Examples**

```
data(wind_RP)
mod <- cpm(formula_l = l ~ Season, formula_s = s ~ Season,
  data = wind_RP$CP, left = "LastPresent", right = "FirstAbsent")
aicc(mod)
```

---

aicc.cpmSet

---

*Create the AICc tables for a set of carcass persistence models*


---

### Description

S3 function to generate model comparison tables based on AICc values for a set of CP models generated by [cpmSet](#)

### Usage

```
## S3 method for class 'cpmSet'
aicc(x, ..., quiet = FALSE, app = FALSE)
```

### Arguments

x	Set of carcass persistence models fit to the same observations
...	further arguments passed to or from other methods
quiet	Logical indicating if messages should be printed
app	Logical indicating if the table should have the app model names

### Value

AICc table

### Examples

```
data(wind_RP)
mod <- cpmSet(formula_l = l ~ Season * Visibility, formula_s = s ~ Season,
  data = wind_RP$CP, left = "LastPresent", right = "FirstAbsent")
aicc(mod)
```

---

aicc.cpmSetSize

---

*Create the AICc tables for a list of sets of searcher efficiency models*


---

### Description

S3 function to generate model comparison tables for lists of sets of CP models of class [cpmSetSize](#)

### Usage

```
## S3 method for class 'cpmSetSize'
aicc(x, ...)
```

**Arguments**

- x                      List of sets of CP models fit to the same observations
- ...                    further arguments passed to or from other methods

**Value**

AICc table

**Examples**

```
cpmods <- cpm(formula_1 = 1 ~ Visibility, data = wind_RP$CP,
  left = "LastPresent", right = "FirstAbsent", sizeCol = "Size",
  allCombos = TRUE)
aicc(cpmods)
```

---

aicc.pkm	<i>extract AICc value from pkm object</i>
----------	---

---

**Description**

extract AICc value from pkm object

**Usage**

```
## S3 method for class 'pkm'
aicc(x, ...)
```

**Arguments**

- x                      object of class pkm
- ...                    further arguments passed to or from other methods

**Value**

Data frame with the formulas for p and k and the AICc of the model

---

`aicc.pkmSet`*Create the AICc tables for a set of searcher efficiency models*

---

**Description**

Generates model comparison tables based on AICc values for a set of pk models generated by `pkmSet`

**Usage**

```
## S3 method for class 'pkmSet'  
aicc(x, ..., quiet = FALSE, app = FALSE)
```

**Arguments**

<code>x</code>	Set of searcher efficiency models fit to the same observations
<code>...</code>	further arguments passed to or from other methods
<code>quiet</code>	Logical indicating if messages should be printed
<code>app</code>	Logical indicating if the table should have the app model names

**Value**

AICc table

**Examples**

```
data(wind_RP)  
mod <- pkmSet(formula_p = p ~ Season, formula_k = k ~ Season, data = wind_RP$SE)  
aicc(mod)
```

---

`aicc.pkmSetSize`*Create the AICc tables for a list of sets of searcher efficiency models*

---

**Description**

Generates model comparison tables based on AICc values for a set of pk models generated by `pkm` with `allCombos = TRUE` and a non-NULL `sizeCol`.

**Usage**

```
## S3 method for class 'pkmSetSize'  
aicc(x, ...)
```



**Arguments**

x                      List of set of searcher efficiency models fit to the same observations  
 ...                    further arguments passed to or from other methods

**Value**

AICc table

**Examples**

```
data(wind_RP)
mod <- pkmSet(formula_p = p ~ Season, formula_k = k ~ Season, data = wind_RP$SE)
aicc(mod)
```

---

aicc.pkmSize	<i>Create the AICc tables for a list of sets of searcher efficiency models</i>
--------------	--

---

**Description**

Generates model comparison tables based on AICc values for a set of pk models generated by [pkm](#) with allCombos = FALSE and a non-NULL sizeCol.

**Usage**

```
## S3 method for class 'pkmSize'
aicc(x, ...)
```

**Arguments**

x                      List of set of searcher efficiency models fit to the same observations  
 ...                    further arguments passed to or from other methods

**Value**

AICc table

**Examples**

```
data(wind_RP)
mod <- pkmSet(formula_p = p ~ Season, formula_k = k ~ Season, data = wind_RP$SE)
aicc(mod)
```

---

app_content	<i>GenEst Information</i>
-------------	---------------------------

---

**Description**

HTML generators for app information and content  
disclaimerUSGS creates the text for the USGS disclaimer.

**Usage**

createvtext(type = "Full")  
  
gettingStartedContent()  
  
aboutContent()  
  
GenEstAuthors()  
  
GenEstGUIauthors()  
  
GenEstLicense()  
  
GenEstAcknowledgements()  
  
GenEstLogos()  
  
disclaimersContent(appType = "base")  
  
disclaimerUSGS()  
  
disclaimerWEST(appType)

**Arguments**

type	"Full" or "Short" or "Name" or "NameDate"
appType	"base" (for local version) or "deploy" (for hosted version)

**Value**

Panels and text for displaying general information about GenEst

---

`app_download_functions`*GenEst app download funtions*

---

**Description**

Handle downloading of app data and figures

**Usage**

```
downloadCPFig(rv)

downloadCPmod(rv, input)

downloadSEFig(rv)

downloadSEmod(rv, input)

downloadgFig(rv, sc)

downloadMres(rv, input)

downloadMFig(rv, split = TRUE)

downloadTable(filename, tablename, csvformat)

downloadgres(rv, input)
```

**Arguments**

<code>rv</code>	the reactive values list
<code>input</code>	list of shiny input parameters
<code>sc</code>	size class
<code>split</code>	logical indicator to use the split or not
<code>filename</code>	the name for the file writing out
<code>tablename</code>	the name of the table in the rv list
<code>csvformat</code>	format for .csv file: "" or NULL for comma-separated, 2 for semi-colon separated

**Value**

download handler functions

---

app_msg_functions	<i>GenEst App Messages</i>
-------------------	----------------------------

---

**Description**

lists of messages used in the app

**Usage**

```

msgList()

clearNotifications(msgs = msgList(), clear = TRUE)

msgModRun(msgs, modelType, clear = TRUE)

msgModDone(msgs, rv, type = "SE", clear = TRUE)

msgModPartialFail(mods, type = "SE")

msgSampleSize(mods)

msgModWarning(mods, type = "SE", rv = NULL)

msgModSENoobs(rv)

msgModFail(mods, type = "SE", special = NULL)

msgSSavgFail(msgs, rv, clear = TRUE)

msgSSinputFail(msgs, rv, clear = TRUE)

msgSplitFail(type = NULL)

msgFracNote(fracNote)

```

**Arguments**

msgs	message list
clear	logical indicator if clearing should happen.
modelType	"SE", "CP", "g", or "M"
rv	reactive values list
type	"SE", "CP", "M", "split", or "g"
mods	Set Size list of models
special	indicator of a special type of message
fracNote	the note regarding the input

---

app_output_utilities	<i>app utilities for formatting text, tables, figs, etc. for display</i>
----------------------	--

---

**Description**

app utilities for formatting text, tables, figs, etc. for display

**Usage**

```
classText(rv, type = "SE")  
  
estText(rv, type = "SE")  
  
setNotSuspending(output, dontSuspend)  
  
reNULL(x, toNULL)  
  
initialOutput(rv, output)  
  
setFigW(modelSet)  
  
setFigH(modelSet, modType = "SE")
```

**Arguments**

rv	Reactive values list for the GenEst GUI.
type	Model type, either "SE" or "CP" or "g".
output	output list to have elements dontSuspend (re)set to having suspendWhenHidden = FALSE.
dontSuspend	Names of elements in output to (re)set to having suspendWhenHidden = FALSE.
x	list object to have elements toNULL reset to NULL.
toNULL	Names of elements in x to reset to NULL.
modelSet	Model set of class cpmSet or pkmSet.
modType	"SE" or "CP"

---

app_panels	<i>app panel utility functions</i>
------------	------------------------------------

---

**Description**

functions for formatting and displaying app panels

**Usage**

```
dataTabPanel(dataType)
```

```
selectedDataPanel(modType)
```

```
modelOutputPanel(outType)
```

**Arguments**

dataType	Toggle control for the model type of the panel. One of "SE", "CP", "SS", "DWP", or "CO".
modType	Toggle control for the model type of the panel. One of "SE", "CP", or "g".
outType	Toggle control for the model type of the panel. One of "SEFigures", "SEEstimates", "SEModComparison", "SEModSelection", "CPFigures", "CPEstimates", "CPModComparison", "CPModSelection", "gFigures", or "gSummary".

---

app\_server

*The GenEst server definition function*


---

**Description**

This suite of functions defines the server-side program for the GenEst user interface (UI). See the "GenEst Graphic User Interface" vignette for a more complete detailing of the codebase underlying the GenEst UI.

GenEstServer: main server function expressed within the application.

**Usage**

```
GenEstServer(input, output, session)
```

```
reaction(eventName)
```

```
reactionMessageRun(eventName)
```

```
reactionMessageDone(eventName)
```

```
eventReaction(eventName, rv, input, output, session)
```

**Arguments**

input	input list for the GenEst GUI.
output	output list for the GenEst GUI.
session	Environment for the GenEst GUI.

eventName	Character name of the event. One of "clear_all", "file_SE", "file_SE_clear", "file_CP", "file_CP_clear", "file_SS", "file_SS_clear", "file_DWP", "file_DWP_clear", "file_CO", "file_CO_clear", "class", "obsSE", "predsSE", "run_SE", "run_SE_clear", "outSEclass", "outSEp", "outSEk", "ltp", "fta", "predsCP", "run_CP", "run_CP_clear", "outCPclass", "outCPdist", "outCPI", "outCPs", "run_M", "run_M_clear", "split_M", "split_M_clear", "transpose_split", "run_g", "run_g_clear", or "outgclass".
rv	reactive variable

## Details

GenEstServer is used as the main server function, and is therefore included in the server.R script of the app. This function is not used in a standard R function sense, in that it does not return a value and is not used on its own to have side effects. The code of the function has two parts:

1. preamble that defines all the necessary variables and options
2. `observeEvent` calls, one for each event in the application. Each call to `observeEvent` includes the `eventExpr` (event expression) as the first argument and the `handlerExpr` (handler expression) as the second argument, which is an evaluated (via `eval`) block of code returned from reaction for the specific event, as well as any other control switch arguments needed (such as `ignoreNULL`).

---

app\_ui

---

*Create the GenEst User Interface HTML*


---

## Description

This suite of functions in `app_ui.R` create the HTML code underlying the GenEst user interface (UI). See the "GenEst Graphic User Interface" vignette for a more complete detailing of the code-base underlying the GenEst UI.

GenEstUI: whole application. Calls `dataInputPanel`, `analysisPanel`, and `helpPanel`.

## Usage

```
GenEstUI(appType = "base")
```

```
dataInputPanel()
```

```
dataInputSidebar()
```

```
loadedDataPanel()
```

```
analysisPanel()
```

```
GeneralInputsPanel()
```

```
GeneralInputSidebar()
```

```
SEPanel()  
SESidebar()  
SEMainPanel()  
CPPanel()  
CPSidebar()  
CPMainPanel()  
MPanel()  
MSidebar()  
MMainPanel()  
gPanel()  
gSidebar()  
gMainPanel()  
helpPanel(appType = "base")  
gettingStartedPanel()  
downloadsPanel()  
aboutPanel()  
disclaimersPanel(appType = "base")
```

### Arguments

appType	Toggle control for the app, "base" for local versions or "deploy" for hosted version. Currently only differentiates the disclaimer text.
---------	--

### Details

Currently there are few differences between the local and deployed versions of GenEst, and the appType toggle is only included as an argument for functions that can produce different versions of the HTML. At this point, the only content that is different is the disclaimer text on the Help panel.



**Value**

Each function returns a string of HTML code, either as a "shiny.tag.list" object (in the case of GenEstUI) or a "shiny.tag" object (in the case of the other functions).

GenEstUI: Full GenEst user interface.

---

app_ui_utilities	<i>HTML parameters</i>
------------------	------------------------

---

**Description**

utility functions for simple HTML tasks

**Usage**

```
navbar()

style(...)

ol(...)

ul(...)

li(...)

b(...)

u(...)

small(...)

big(text = NULL)

center(text = NULL)

GenEstInlineCSS(...)

GenEstShinyJS(...)

cButtonStyle(buttonType = "single")
```

**Arguments**

...	attributes and children of the element
text	text to wrap in the tag
buttonType	"single" (for clearing a single component) or "all" (for clearing everything).

app\_utilities

*app utilities***Description**

utility functions for simple app rv management

**Usage**

```

initialReactiveValues()

reVal(rv, toReVal)

setkNeed(rv)

updateColNames_size(rv)

selectData(data, cols)

modNameSplit(modNames, pos)

prepSizeclassText(sizeclasses)

modNamePaste(parts, type = "SE", tab = FALSE)

plotNA(type = "model")

updateSizeclasses(data, sizeCol)

pickSizeclass(sizeclasses, choice)

updatesizeCol(sizeCol, colNames_size)

```

**Arguments**

rv	Reactive values list for the GenEst GUI, created by <a href="#">initialReactiveValues</a> , which calls <a href="#">reactiveValues</a>
toReVal	Names of elements in rv to reset to their factory setting (as defined by <a href="#">initialReactiveValues</a> ).
data	data table
cols	column names to select
modNames	names of the model to be split off
pos	position in the name to split off
sizeclasses	names of the carcass classes
parts	the component parts of the model's name
type	"SE" or "CP"

tab	logical for if it's the table output for CP
sizeCol	carcass class column name
choice	carcass class chosen
colNames_size	updated vector of size column names in all needed tables

---

app_widgets	<i>Create and manage widgets for data input, function execution, data output</i>
-------------	--

---

## Description

This is a generalized function for creating a data input widget used in the GenEst GUI, based on the data type (dataType). Included within the widget is a conditional panel that allows removal of the specific data file (and clearing of all downstream models) once it has been loaded.

## Usage

```
dataInputWidget(dataType)

dataDownloadWidget(set)

modelInputWidget(inType)

widgetMaker(Condition, Name, Fun, Label, Args)

modelRunWidget(modType)

preTextMaker(modType)

modelOutputWidget(modType)

splitButtonWidget()

modelSelectionWidget(mods, modType)

modelSelectionWidgetHeader(mods)

modelSelectionWidgetRow(mods, modType, sci)

kFixedWidget(sizeclasses)

kFixedWidgetHeader(sizeclasses)

kFixedWidgetRow(sizeclasses, sci)
```

**Arguments**

dataType	Toggle control for the model type of the widget. One of "SE", "CP", "SS", "DWP", or "CO".
set	Name of data set. One of "RP", "RPbat", "cleared", "powerTower", "PV", "trough", "mock"
inType	Toggle control for the input type of the widget. One of "nsim", "CL", "class", "obsSE", "predsSE", "kFixed", "ltp", "fta", "predsCP", "dist", "xID", "frac", "DWPCol", "COdate", "gSearchInterval", or "gSearchMax".
Condition	Condition under which the widget is present to the user.
Name	Name (id) of the widget created.
Fun	Function name (as character) used to create the widget.
Label	Label presented to the user in the UI for the widget.
Args	List of any additional arguments to be passed to the widget creating function.
modType	Toggle control for the model type of the widget. One of "SE", "CP", "M", or "g".
mods	Model Set Size object (from the reactive values list).
sci	Name of carcass class element
sizeclasses	Vector of carcass class names (from the reactive values list).

**Value**

HTML for the data input widget.

---

averageSS	<i>Tabulate an average search schedule from a multi-unit SS data table</i>
-----------	--

---

**Description**

Given a multi-unit Search Schedule data table, produce an average search schedule for use in generic detection probability estimation.

**Usage**

```
averageSS(data_SS, SSdate = NULL)
```

**Arguments**

data_SS	a multi-unit SS data table, for which the average interval will be tabulated. It is assumed that data_SS is properly formatted, with a column of search dates and a column of 1s and 0s for each unit indicating whether the unit was searched on the given date). Other columns are optional, but optional columns should not all contain at least one value that is not a 1 or 0.
SSdate	Column name for the date searched data (optional). If no SSdate is provided, data_SS will be parsed to extract the dates automatically. If there is more than one column with dates, then an error will be thrown and the user will be required to provide the name of the desired dates column.

**Value**

vector of the average search schedule

**Examples**

```
data(mock)
avgSS <- averageSS(mock$SS)
```

---

calcg	<i>Calculate detection probability for given SE and CP parameters and search schedule.</i>
-------	--

---

**Description**

Calculate detection probability (g) given SE and CP parameters and a search schedule.

The g given by `calcg` is a generic aggregate detection probability and represents the probability of detecting a carcass that arrives at a (uniform) random time during the time spanned by the search schedule for the the given SE and CP parameters. This differs from the GenEst estimation of g when the purpose is to estimate total mortality (M), in which case the detection probability varies with carcass arrival interval and is difficult to summarize statistically. `calcg` provides a useful "big picture" summary of detection probability, but would be difficult to work with for estimating M with precision.

**Usage**

```
calcg(days, param_SE, param_CP, dist)
```

**Arguments**

<code>days</code>	Search schedule (vector of days searched)
<code>param_SE</code>	numeric array of searcher efficiency parameters (p and k); must have the name number of rows as the <code>param_CP</code> .
<code>param_CP</code>	numeric array of carcass persistence parameters (a and b) must have the name number of rows as the <code>param_SE</code> .
<code>dist</code>	distribution for the CP model

**Value**

a vector of detection probabilities for each

---

calcRate	<i>Estimate the number of fatalities in each search interval throughout the monitoring period.</i>
----------	--

---

### Description

A carcass that is observed in a given search may have arrived at any time prior to that search, so carcass discovery time is often not a reliable estimate of carcass arrival time. For each observed carcass, calcRate takes into account the estimated probability of arrival in each possible arrival interval, adjusts by detection probability, and sums to estimate the estimated number of carcass arrivals in every search interval.

### Usage

```
calcRate(M, Aj, days = NULL, searches_carcass = NULL, data_SS = NULL)
```

### Arguments

M	Numeric array (ncarc x nsim) of estimated number of fatalities by observed carcass and simulation rep
Aj	Integer array (ncarc x nsim) of simulated arrival intervals for each observed carcass. Arrival intervals are given as integers j, indicating that the given carcass (indexed by row) arrived in the jth search interval in the given simulation rep (indexed by column). Arrival interval indices (j) are relative to indexed carcasses' search schedules.
days	Vector of all dates that at least one unit was searched. Format is the number of days since the first search. For example, days = c(0, 7, 14, 28, 35) for a simple 7-day search schedule in which searches were conducted every once per week on the same day for 5 weeks. Not all units need be searched on every search date.
searches_carcass	An ncarc x length(days) array of 0s and 1s to indicate searches in which the indexed carcass could have been found. For example, row i = c(1, 0, 1, 0, 1) indicates that the search schedule for the location (unit) where carcass i was found would be days[c(1, 3, 5)].
data_SS	<a href="#">prepSS</a> object that contains formatted data for calculating splits. Optional argument. Alternatively, user may provide days and searches_carcass.

### Value

Numeric array (nsim x nsearch) of estimated fatalities in each search interval. NOTE: The search at time  $t = 0$  does not correspond to an interval, and all carcasses found at that time are assumed to have arrived prior to the monitoring period and are not included in mortality estimates so  $nsearch = \text{length(days)} - 1$ .

calcSplits

*Estimate the number of fatalities by up to two splitting covariates***Description**

Total mortality can be split into sub-categories, according to various splitting covariates such as species, visibility class, season, site, unit, etc. Given the carcass search data, estimated mortalities, and splitting covariates, `calcSplits()` gives the "splits" or summaries the estimated mortalities by levels of the splitting covariates. For example, user may specify "season" and "species" as splitting variables to see estimated mortalities by season and species. Input would be arrays of estimated mortalities and arrival intervals when `ncarc` carcass have been discovered and uncertainty in mortality estimates is captured via simulation with `nsim` simulation draws.

**Usage**

```
calcSplits(
  M,
  split_CO = NULL,
  data_CO = NULL,
  split_SS = NULL,
  data_SS = NULL,
  split_time = NULL,
  ...
)
```

**Arguments**

M	<code>estM</code> object, containing numeric array ( <code>ncarc</code> x <code>nsim</code> ) of estimated mortalities and other pieces
split_CO	Character vector of names of splitting covariates to be found in the <code>data_CO</code> data frame. No more than two <code>split_CO</code> variables are allowed. Use <code>split_CO</code> = <code>NULL</code> if no CO splits are desired.
data_CO	data frame that summarizes the carcass search data and must include columns specified by the <code>split_CO</code> arg. Each row includes search and discovery parameters associated with a single observed carcass. Columns include carcass ID, carcass discovery date, unit, and any number of covariates. <code>data_CO</code> is required if and only if <code>split_CO</code> is non- <code>NULL</code> .
split_SS	Character string giving the name of a splitting covariate in the <code>data_SS</code> list, with <code>data_SS[[split_SS]]</code> describing characteristics of the search intervals (e.g., "season"). Note that <code>length(data_SS[[split_SS]])</code> must equal <code>length(data_SS\$days) - 1</code> because no inference is made about carcass arrivals prior to time <code>t = 0</code> , and the "interval" prior to <code>t = 0</code> is not taken as a "search interval." If no <code>split_SS</code> split is desired, use <code>split_SS</code> = <code>NULL</code> .
data_SS	Search schedule data

split_time	Numeric vector that defines time intervals for splits. Times must be numeric, strictly increasing, and span the monitoring period [0, max(data_SS\$days)]. If no split_time is desired, use split_time = NULL. If split_time is NULL and split_SS is not NULL, data_SS is required.
...	arguments to be passed down

## Details

Arrival intervals ( $A_j$ ) are given as integers,  $j$ , that indicate which search interval the given carcass (indexed by row) arrived in the given simulation draw (indexed by column). Arrival interval indices ( $j$ ) are relative to indexed carcasses' search schedules.

No more than two splitting variables (split\_CO, split\_SS, and split\_time) in total may be used. split\_CO variables describe qualitative characteristics of the observed carcasses or where they were found. Some examples include searcher (DHD, JPS, MMH), carcass size (S, M, L), species, age (fresh/dry or immature/mature), unit, visibility class (easy, moderate, difficult), etc.

split\_SS variables describe characteristics of the search intervals, such as season (spring, summer, fall, winter) or treatment (pre- or post-minimization). Each search interval is assigned a level of the split\_SS variable. For example, for a search schedule with 5 searches (including a search at  $t = 0$ ), and the split\_SS variable would have values for each of the 4 search intervals. The levels of the split\_SS must be in contiguous blocks. For example, season = c("S", "S", "F", "F") would be acceptable, but season = c("S", "F", "S", "F") would not be.

split\_time variables are numeric vectors that split the monitoring period into distinct time intervals. For example, split\_time = c(0, 30, 60, 90, 120) would split the 120 monitoring period into 30-day intervals, and calcSplits() would return mortality estimates for each of the intervals.

## Value

An object of class splitFull is returned. If one splitting covariate is given, then the output will be an array of estimated mortality in each level of the splitting covariate, with one row for each covariate level and one column for each simulation draw. If two splitting covariates are given, output will be a list of arrays. Each array gives the estimated mortalities for one level of the second splitting covariate and all levels of the first splitting covariate.

Objects of class splitFull have attributes vars (which gives the name of the splitting covariate(s)) and type (which specifies whether the covariate(s) are of type split\_CO, split\_SS, or split\_time). A summary of a resulting splitFull object is returned from the S3 function summary(splits, CL = 0.90, ...), which gives the mean and a 5-number summary for each level of each covariate. The 5-number summary includes the alpha/2, 0.25, 0.5, 0.75, and 1 - alpha/2 quantiles, where alpha = 1 - CL. A graph summarizing the results can be drawn using plot(splits, CL, ...), which gives a graphical representation of the summary.

## Examples

```
model_SE <- pkm(p ~ 1, k ~ 1, data = wind_RPbat$SE)
model_CP <- cpm(l ~ 1, s ~ 1, data = wind_RPbat$CP, dist = "weibull",
  left = "LastPresent", right = "FirstAbsent")
Mhat <- estM(nsim = 1000, data_CO = wind_RPbat$CO,
  data_SS = wind_RPbat$SS, data_DWP = wind_RPbat$DWP,
  model_SE = model_SE, model_CP = model_CP,
```



```

unitCol = "Turbine", C0date = "DateFound")

M_spp <- calcSplits(M = Mhat, split_C0 = "Species",
  data_C0 = wind_RPbat$C0)
summary(M_spp)
plot(M_spp)

```

calcTsplit

*Estimate the number of fatalities by time interval***Description**

calcTsplit() is a lower-level function that requires the output of calcRate as input. See [calcSplits](#) for a more powerful, convenient, and flexible alternative.

**Usage**

```
calcTsplit(rate, days, tsplit)
```

**Arguments**

rate	Array (nsim x nsearch) of arrival rates as number of fatalities per search interval. Typically, rate will be the return value of the calcRate function.
days	A vector of times representing search dates when at least one unit was searched. Times are formatted as number of days since the first search, e.g., c(0, 7, 14, 28, 35) would indicate a schedule in at least one unit was searched every 7 days.
tsplit	A vector of times that splits the monitoring period into a set of time intervals for which calcTsplit will estimate the number of fatalities. For example, if tsplit = c(0, 14, 19, 35), then calcTsplit estimates the number of fatalities occurring in interval (0, 14], (14, 19], and (19, 35]. Times in tsplit must be increasing and between 0 and max(days), inclusive.

**Value**

A numeric array with dimensions `dim = c(length(tsplit) - 1, nsim)` giving the estimated number of fatalities that occurred in each time interval.

---

checkComponents	<i>Check for model components</i>
-----------------	-----------------------------------

---

**Description**

Check if all component terms and interactions are included in a formula. Terms are automatically alphabetized within interactions.

**Usage**

```
checkComponents(formula)
```

**Arguments**

formula	A formula object
---------	------------------

**Value**

a logical regarding complete set of terms and interactions

---

checkDate	<i>Checks whether a vector of data can be interpreted as dates</i>
-----------	--

---

**Description**

Checks whether the dates are in a standard format and sensible. If so, function returns the dates converted to ISO 8601 yyyy-mm-dd format. Acceptable formats are yyyy-mm-dd, yyyy/mm/dd, mm/dd/yyyy, and dd/mm/yyyy. If format is mm/dd/yyyy or dd/mm/yyyy, the dates must be interpretable unambiguously. Also, dates must be later than 1900-01-01. This additional check provides some protection against common data entry errors like entering a year as 0217 or 1017 instead of 2017.

**Usage**

```
checkDate(testdate)
```

**Arguments**

testdate	Date(s) to check and format.
----------	------------------------------

**Value**

dates formatted as yyyy-mm-dd (if possible) or NULL (if some value is not interpretable as a date after 1900-01-01).

**Examples**

```
checkDate("02/20/2018")  
checkDate("10/08/2018")
```

---

checkSpecificModelCP	<i>Error check a specific model selection for a CP plot</i>
----------------------	---

---

**Description**

Make sure it's available and good, update the name for usage

**Usage**

```
checkSpecificModelCP(modelSet, specificModel)
```

**Arguments**

modelSet	cp model set of class cpmSet
specificModel	the name of the specific model for the plot

**Value**

updated name of the model to use

---

checkSpecificModelSE	<i>Error check a specific model selection for an SE plot</i>
----------------------	--

---

**Description**

Make sure it's available and good, update the name for usage

**Usage**

```
checkSpecificModelSE(modelSet, specificModel)
```

**Arguments**

modelSet	pk model set of class pkmSet
specificModel	the name of the specific model for the plot

**Value**

updated name of the model to use

---

combinePreds	<i>Combine predictors</i>
--------------	---------------------------

---

**Description**

Create a table of combinations of factor levels for the the predictors in a searcher efficiency or carcass persistence analysis. This is a utility function called by `pkm0` and `cpm0`.

**Usage**

```
combinePreds(preds, data)
```

**Arguments**

<code>preds</code>	Vector of character strings with the names of predictor variables included in the model.
<code>data</code>	Searcher efficiency or carcass persistence data frame with columns for each predictor and rows corresponding to carcasses in the field trials.

**Value**

Data frame with columns for each predictor in `preds` and rows for each factor level combination among the predictors. In addition there is a column with `CellNames`, which are the combinations of predictor levels separated by periods ( . ).

---

combinePredsAcrossModels	<i>Combine predictors across models</i>
--------------------------	---

---

**Description**

Create a table of factor combinations of predictors in given searcher efficiency and carcass persistence models. This is a utility function called by `estgGeneric` and governs the cells for which detection probabilities are calculated.

**Usage**

```
combinePredsAcrossModels(preds_CP, preds_SE, data_CP, data_SE)
```

**Arguments**

<code>preds_CP</code>	Character vector with names of carcass persistence predictors.
<code>preds_SE</code>	Character vector with names of searcher efficiency predictors.
<code>data_CP</code>	data frame with columns for each predictor and rows corresponding to carcasses in the field trials.
<code>data_SE</code>	data frame with columns for each predictor and rows corresponding to carcasses in the field trials.

**Value**

Data frame with columns for each predictor in preds and rows for each factor level combination among the predictors. In addition there are column with CellNames, CellNames\_CP, and CellNames\_SE, which are the combinations of predictor levels for all predictors, CP predictors, and SE predictors (respectively), separated by periods ( . ).

---

countCarcs	<i>Count the minimum number of carcasses in the cells</i>
------------	---

---

**Description**

Count the minimum number of carcasses in all of the cells within a \_SetSize model complex

**Usage**

```
countCarcs(mods)
```

**Arguments**

mods                      model output from the \_SetSize version of a function

**Value**

the minimum number of carcasses in the cells

---

CO_DWP	<i>Associate CO carcasses with appropriate DWP values (by unit and carcass class)</i>
--------	---

---

**Description**

Calculate the conditional probability of observing a carcass at search oi as a function arrival interval (assuming carcass is not removed by scavengers before the time of the final search)

**Usage**

```
CO_DWP(dwpsim, data_CO, unitCol, sizeCol = NULL)
```

**Arguments**

dwpsim                      rdwp object  
 data\_CO                    data frame with results from carcass surveys  
 unitCol                    name of the unit column in data\_CO (required)  
 sizeCol                    name of the carcass class column in data\_CO (optional).

**Value**

numeric DWP array

---

CPcols	<i>Produce a named vector of standard CP plot colors</i>
--------	--

---

**Description**

Produce a named vector of standard CP plot colors

**Usage**

```
CPcols()
```

---

CPdistOptions	<i>Produce the options for the distributions in the CP model</i>
---------------	--

---

**Description**

Simply make the named list for the distributions in the CP model

**Usage**

```
CPdistOptions()
```

**Value**

list with named elements of the distributions

---

cpLogLik	<i>Calculate the negative log-likelihood of a carcass persistence model</i>
----------	---

---

**Description**

The function used to calculate the negative-loglikelihood of a given carcass persistence model ([cpm](#)) with a given data set

**Usage**

```
cpLogLik(t1, t2, beta, nbeta_1, cellByCarc, cellMM, dataMM, dist)
```

**Arguments**

t1	last times observed present
t2	first times observed absent
beta	Parameters to be optimized.
nbeta_l	Number of parameters associated with l.
cellByCarc	Which cell each observation belongs to.
cellMM	Combined model matrix.
dataMM	Combined model matrix expanded to the data.
dist	Name of distribution.

**Value**

Negative log likelihood of the observations, given the parameters.

---

cpm	<i>Fit cp carcass persistence models</i>
-----	--

---

**Description**

Carcass persistence is modeled as survival function where the one or both parameter(s) can depend on any number of covariates. Format and usage parallel that of common R functions such as `lm`, `glm`, and `gam`. However, the input data (`data`) are structured differently to accommodate the survival model approach (see "Details"), and model formulas may be entered for both `l` ("location") and `s` ("scale").

**Usage**

```
cpm(
  formula_l,
  formula_s = NULL,
  data,
  left,
  right,
  dist = "weibull",
  allCombos = FALSE,
  sizeCol = NULL,
  CL = 0.9,
  quiet = FALSE
)
```

```
cpm0(
  formula_l,
  formula_s = NULL,
  data = NULL,
```

```

    left = NULL,
    right = NULL,
    dist = "weibull",
    CL = 0.9,
    quiet = FALSE
)

cpmSet(
  formula_l,
  formula_s = NULL,
  data,
  left,
  right,
  dist = c("exponential", "weibull", "lognormal", "loglogistic"),
  CL = 0.9,
  quiet = FALSE
)

cpmSize(
  formula_l,
  formula_s = NULL,
  data,
  left,
  right,
  dist = c("exponential", "weibull", "lognormal", "loglogistic"),
  sizeCol = NULL,
  allCombos = FALSE,
  CL = 0.9,
  quiet = FALSE
)

```

### Arguments

formula_l	Formula for location; an object of class <code>"formula"</code> (or one that can be coerced to that class): a symbolic description of the model to be fitted. Details of model specification are given under "Details".
formula_s	Formula for scale; an object of class <code>"formula"</code> (or one that can be coerced to that class): a symbolic description of the model to be fitted. Details of model specification are given under "Details".
data	Data frame with results from carcass persistence trials and any covariates included in formula_l or formula_s (required).
left	Name of columns in data where the time of last present observation is stored.
right	Name of columns in data where the time of first absent observation is stored.
dist	Distribution name ("exponential", "weibull", "loglogistic", or "lognormal")
allCombos	logical. If allCombos = FALSE, then the single model expressed by formula_l and formula_s is fit using a call to <code>cpm0</code> . If allCombos = TRUE, a full set of <code>cpm</code> submodels derived from combinations of the given covariates for p and



	k is fit. For example, submodels of $\text{formula}_1 = p \sim A * B$ would be $p \sim A * B$ , $p \sim A + B$ , $p \sim A$ , $p \sim B$ , and $p \sim 1$ . Models for each pairing of a p submodel with a k submodel are fit via <code>cpmSet</code> , which fits each model combination using successive calls to <code>cpm0</code> , which fits a single model.
<code>sizeCol</code>	character string. The name of the column in data that gives the size class of the carcasses in the field trials. If <code>sizeCol = NULL</code> , then models are not segregated by size. If a <code>sizeCol</code> is provided, then separate models are fit for the data subsetted by <code>sizeCol</code> .
<code>CL</code>	confidence level
<code>quiet</code>	Logical indicator of whether or not to print messages

## Details

The probability of a carcass persisting to a particular time is dictated by the specific distribution chosen and its underlying location (*l*) and scale (*s*) parameters (for all models except the exponential, which only has a location parameter). Both *l* and *s* may depend on covariates such as ground cover, season, species, etc., and a separate model format (`formula_1` and `formula_s`) may be entered for each. The models are entered as they would be in the familiar `lm` or `glm` functions in R. For example, *l* might vary with *A*, *B*, and *C*, while *k* varies only with *A*. A user might then enter  $p \sim A + B + C$  for `formula_1` and  $k \sim A$  for `formula_s`. Other R conventions for defining formulas may also be used, with *A*:*B* for the interaction between covariates *A* and *B* and  $A * B$  as short-hand for  $A + B + A:B$ .

Carcass persistence data must be entered in a data frame with data in each row giving the fate of a single carcass in the trials. There must be a column for each of the last time the carcass was observed present and the first time the carcass was observed absent (or NA if the carcass was always present). Additional columns with values for categorical covariates (e.g., visibility = E, M, or D) may also be included.

## Value

an object of an object of class `cpm`, `cpmSet`, `cpmSize`, or `cpmSetSize`.

`cpm0()` returns a `cpm` object, which is a description of a single, fitted *pk* model. Due to the large number and complexity of components of `acpm` model, only a subset of them is printed automatically; the rest can be viewed/accessed via the `$` operator if desired. These are described in detail in the 'cpm Components' section.

`cpmSet()` returns a list of `cpm` objects, one for each of the submodels, as described with parameter `allCombos = TRUE`.

`cpmSize()` returns a list of `cpmSet` objects (one for each 'size') if `allCombos = T`, or a list of `cpm` objects (one for each 'size') if `allCombos = F`

`cpm` returns a `cpm`, `cpmSet`, `cpmSize`, or `cpmSetSize` object:

- `cpm` object if `allCombos = FALSE`, `sizeCol = NULL`
- `cpmSet` object if `allCombos = TRUE`, `sizeCol = NULL`
- `cpmSize` object if `allCombos = FALSE`, `sizeCol != NULL`
- `cpmSetSize` object if `allCombos = TRUE`, `sizeCol != NULL`

**cpm Components**

The following components of a cpm object are displayed automatically:

call the function call to fit the model  
 formula\_l the model formula for the p parameter  
 formula\_s the model formula for the k parameter  
 distribution distribution used  
 predictors list of covariates of l and/or s  
 AICc the AIC value as corrected for small sample size  
 convergence convergence status of the numerical optimization to find the maximum likelihood estimates of p and k. A value of 0 indicates that the model was fit successfully. For help in deciphering other values, see [optim](#).  
 cell\_ls summary statistics for estimated cellwise l and s, including the medians and upper & lower bounds on CIs for each parameter, indexed by cell (or combination of covariate levels).  
 cell\_ab summary statistics for estimated cellwise pda and pdb, including the medians and upper & lower bounds on CIs for each parameter, indexed by cell (or combination of covariate levels).  
 cell\_desc Descriptive statistics for estimated cellwise median persistence time and rI for search intervals of 1, 3, 7, 14, and 28 days, where rI is the probability of that carcass that arrives at a uniform random time in within a search interval of I days persists until the first search after arrival.

The following components are not printed automatically but can be accessed via the \$ operator:

data the data used to fit the model  
 betahat\_l parameter estimates for the terms in the regression model for l  
 betahat\_s parameter estimates for the terms in the regression model for s. If dist = "exponential", s is set at 1 and not calculated.  
 varbeta the variance-covariance matrix of the estimators for c(betahat\_l, betahat\_s).  
 cellMM\_l a cellwise model (design) matrix for covariate structure of l\_formula  
 cellMM\_s a cellwise model(design) matrix for covariate structure of s\_formula  
 levels\_l all levels of each covariate of l  
 levels\_s all levels of each covariate of s  
 nbeta\_l number of parameters fit for l  
 nbeta\_s number of parameters fit for s  
 cells cell structure of the cp-model, i.e., combinations of all levels for each covariate of p and k. For example, if covar1 has levels "a", "b", and "c", and covar2 has levels "X" and "Y", then the cells would consist of a.X, a.Y, b.X, b.Y, c.X, and c.Y.  
 ncell total number of cells  
 predictors\_l list of covariates of l  
 predictors\_s list of covariates of s  
 observations observations used to fit the model  
 carcCells the cell to which each carcass belongs  
 AIC the **AIC** value for the fitted model  
 CL the input CL

## Advanced

cpmSize may also be used to fit a single model for each size class if allCombos = FALSE. To do so, formula\_l, formula\_s, and dist be named lists with names matching the sizes listed in unique(data[, sizeCol]). The return value is then a list of cpm objects, one for each size.

## Examples

```
head(data(wind_RP))
mod1 <- cpm(formula_l = l ~ Season, formula_s = s ~ 1, data = wind_RP$CP,
  left = "LastPresent", right = "FirstAbsent")
class(mod1)
mod2 <- cpm(formula_l = l ~ Season, formula_s = s ~ 1, data = wind_RP$CP,
  left = "LastPresent", right = "FirstAbsent", allCombos = TRUE)
class(mod2)
names(mod2)
class(mod2[[1]])
mod3 <- cpm(formula_l = l ~ Season, formula_s = s ~ 1, data = wind_RP$CP,
  left = "LastPresent", right = "FirstAbsent",
  allCombos = TRUE, sizeCol = "Size")
class(mod3)
names(mod3)
class(mod3[[1]])
class(mod3[[1]][[1]])
```

---

cpmCPCellPlot

---

*Plot cell-specific decay curve for carcass persistence*


---

## Description

Produce the figure panel for a specific cell (factor level combination) including the specific fitted decay curves.

## Usage

```
cpmCPCellPlot(model, specificCell, col, axis_y = TRUE, axis_x = TRUE)
```

## Arguments

model	model of class cpm
specificCell	name of the specific cell to plot
col	color to use
axis_y	logical of whether or not to plot the y axis
axis_x	logical of whether or not to plot the x axis

---

cpmFail	<i>Check if a CP model is well-fit</i>
---------	--

---

**Description**

Run a check the arg is a well-fit cpm object

**Usage**

```
cpmFail(cpmobj)
```

**Arguments**

cpmobj            A [cpm](#) object to test

**Value**

logical value indicating a failed fit (TRUE) or successful (FALSE)

---

cpmSetFail	<i>Check if cpm models fail</i>
------------	---------------------------------

---

**Description**

Run a check on each model within a [cpmSet](#) object to determine if it failed or not

**Usage**

```
cpmSetFail(cpmSetToCheck)
```

**Arguments**

cpmSetToCheck    A [cpmSet](#) object to test

**Value**

A vector of logical values indicating if each of the models failed

---

cpmSetFailRemove	<i>Remove failed cpm models from a <a href="#">cpmSet</a> object</i>
------------------	--

---

**Description**

Remove all failed models within a [cpmSet](#) object

**Usage**

```
cpmSetFailRemove(cpmSetToTidy)
```

**Arguments**

cpmSetToTidy    A [cpmSet](#) object to tidy

**Value**

A [cpmSet](#) object with failed models removed

---

cpmSetSizeFail	<i>Check if all of the cpm models fail</i>
----------------	--

---

**Description**

Run a check on each model within a [cpmSetSize](#) object to determine if they all failed or not

**Usage**

```
cpmSetSizeFail(cpmSetSizeToCheck)
```

**Arguments**

cpmSetSizeToCheck  
A [cpmSetSize](#) object to test

**Value**

A list of vectors of logical values indicating if each of the models failed

---

`cpmSetSizeFailRemove`    *Remove failed cpm models from a cpmSetSize object*

---

### Description

Remove failed models from a `cpmSetSize` object

### Usage

```
cpmSetSizeFailRemove(cpmSetSizeToTidy)
```

### Arguments

`cpmSetSizeToTidy`  
A list of `cpmSetSize` objects to tidy

### Value

A list of `cpmSet` objects with failed models removed

---

`cpmSetSpecCPCellPlot`    *Plot cell-specific decay curve for carcass persistence*

---

### Description

Produce the figure panel for a specific cell (factor level combination) including the specific fitted decay curves.

### Usage

```
cpmSetSpecCPCellPlot(modelSet, specificModel, specificCell, cols, axes)
```

### Arguments

<code>modelSet</code>	modelSet of class <code>cpmSet</code>
<code>specificModel</code>	name of the specific submodel to plot
<code>specificCell</code>	name of the specific cell to plot
<code>cols</code>	named vector of the colors to use for the distributions
<code>axes</code>	named vector of logical values indicating whether or not to plot the x axis and the y axis

### Value

a specific cell plot panel

---

dateCols	Select the date columns from a data table
----------	---

---

**Description**

Simple function to facilitate selection of date columns from a data table

**Usage**

```
dateCols(data)
```

**Arguments**

data	data table potentially containing columns that could be coerced (via checkDate()) into a properly formatted date
------	--

**Value**

column names of columns that can be coerced to dates

---

dateToDay	Calculate day of study from calendar date
-----------	---

---

**Description**

Convert calendar date to integer day from a reference date (ref).

**Usage**

```
dateToDay(date, ref = NULL)
```

**Arguments**

date	A date or vector of dates to convert to days.
ref	Reference date.

**Value**

Numeric value(s) of days from ref.

**Examples**

```
x <- c("2018-01-01", "2018-02-01")
dateToDay(x, x[1])
```

---

defineUnitCol	<i>Auto-parsing to find the name of the unit column (unitCol)</i>
---------------	---

---

### Description

If a unit column is not explicitly defined by user in the arg list to estM or estg, then defineUnitCol parses the CO, DWP, and SS files to extract the unit column if possible.

Criteria that a column must meet to be a unit column are that it is found in both data\_CO and data\_DWP, all units in data\_CO must also be included among units in data\_DWP, all units in both data\_CO and data\_DWP must be included among the column names in data\_SS. If data\_DWP = NULL, then the unit column must be included in data\_CO and all its units must be included among the column names of data\_SS.

### Usage

```
defineUnitCol(data_CO, data_SS = NULL, data_DWP = NULL)
```

### Arguments

data_CO	carcass observation data (data frame)
data_SS	search schedule data (data frame)
data_DWP	density-weighted proportion data (data frame)

### Value

name of unit column (unitCol), if a unique unit column can be identified. If no unit column is present or there is more than one unit column, defineUnitCol stops with an error.

---

desc	<i>Descriptive statistics for a fitted CP model</i>
------	---

---

### Description

Given a cpm object, calculate convenient descriptive statistics, including the median CP, specified rI statistics, and pda and pdb statistics for the fitted model (EoA parameterization), and location and scale parameters for the fitted model (survival package parameterization) along with estimated CIs.

### Usage

```
desc(model_CP, Ir = c(1, 3, 7, 14, 28), CL = 0.9, nsim = 10000)
```



Arguments

model_CP	A fitted CP model (cpm object)
Ir	The intervals for which to calculate the r statistics
CL	The confidence level for the CIs.
nsim	Number of simulation draws for estimating CIs

Details

The CIs for the r statistics (and the medianCP for the Weibull) are based on simulation of the pda and pdb parameters, calculation of the statistics, and taking the empirical distribution of the simulated values. Other CIs are based on the assumed bivariate normal distributions of the appropriately transformed l and s parameters in the fitted model using beta\_hat and varbeta.

NOTE: rI is the probability that a carcass that arrives at a uniform random time in an interval of I days will persist until the first search after arrival.

Value

Matrix of point and interval estimates for the median CP and the r statistics for the specified intervals. The matrix is assigned to class descCP that is simply a matrix with dimensions ncell x (1 + 3\*(5 + length(Ir))), column names that give the number of observations in each cell, statistic name and upper and lower bounds (in triplets), and row names giving the names of the cells. CL, nsim, and the name of the fitted model (model\_CP) are included as object attributes.

See Also

[cpm](#), [rcp](#), [ppersist](#)

---

dlModTabSE	Create the download version of the Searcher Efficiency model table
------------	--

---

Description

Format a user-friendly version of the parameter table from a Searcher Efficiency model, based on confidence level of interest

Usage

```
dlModTabSE(modTab, CL = 0.9)
```

Arguments

modTab	model table
CL	Confidence level

Value

download version of the SE model table

---

DWPCols	<i>Select the DWP-ok columns from a data table</i>
---------	--

---

**Description**

Simple function to facilitate selection of columns that could be DWP values from a data table

**Usage**

```
DWPCols(data)
```

**Arguments**

data	data table
------	------------

**Value**

column names of columns that can be DWP values

---

dwpm	<i>Fit density-weighted proportion (DWP) models.</i>
------	--

---

**Description**

Carcass density is modeled as a function of distance from turbine. Format and usage parallel that of common R functions `lm`, `glm`, and `gam` and the GenEst functions `pkm` and `cpm`.

**Usage**

```
dwpm(data_DWP, type = "data", unitCol = NULL, dwpCols = NULL)
```

**Arguments**

data_DWP	data frame with structure depending on model type. In general, data_DWP would be a data frame if a model is to be fit or if point estimates only are provided as pre-simulated DWP data, and, if pre-simulated data with variation are provided, then a 2-d array (if one carcass class) or a list of 2-d arrays (if more than one carcass class). See "Details" for details.
type	model type may be rings, glm, TWL, or data. Currently, only the data type is supported.
unitCol	name of the column with the units, which must be non-numeric
dwpCols	name(s) of the columns with the DWP data

## Details

The fraction of carcasses falling in the area searched at a turbine may be a function of carcass class (e.g., large or small) and/or direction from the turbine. Data may be provided for fitting a distance model(s) or, alternatively, simulated turbine-wise DWP data from custom-fitted models may be provided. If pre-fit, pre-simulated data are used, then `glm` returns a `dwpm` object with `type = data`.

To fit a model, `data_DWP` should be a data frame with a row for each carcass and columns giving (at a minimum) unique carcass IDs, turbine ID, distance from turbine, and fraction of area searched at the given distance at the given turbine. Optional columns may include carcass class, covariates that may influence detection probability (e.g., visibility class), and direction. If covariates are to be included in the model, then the fraction of area column would give the fraction of the area in the given covariate level at that distance. Alternatively, `prefab` data may be provided in a dataframe, with structure depending on data type. The simplest case would be that point estimates only are provided. In that case, if there are no distinctions among carcass classes (e.g., size), then `data_DWP` should be a dataframe with one column giving the unit (e.g., turbine) and one column with the DWP at each unit; if distinctions are made among carcass classes, then `data_DWP` would be a data frame with a unit column and a DWP column for each carcass class. If the DWP estimates incorporate uncertainties, then `data_DWP` should be an array with `n_unit * nsim` rows and with columns for units and DWPs for each carcass class.

## Value

an object of an object of class `dwpm`, which is a list with model type (currently only `type = data` is supported) and `model`, which gives the simulated DWP values as an array (if there's only a single carcass class) or a list of arrays (if there are more than one carcass classes).

---

 estg

---

*Estimate all carcass-level detection rates and arrival intervals*


---

## Description

Estimate g values and arrival intervals for a set of carcasses from fitted `pk` and `cp` models and search data

## Usage

```
estg(
  data_CO,
  COdate,
  data_SS,
  SSdate = NULL,
  model_SE,
  model_CP,
  model_DWP = NULL,
  sizeCol = NULL,
  unitCol = NULL,
  IDcol = NULL,
```

```

    nsim = 1000,
    max_intervals = 8
  )

```

### Arguments

<code>data_CO</code>	Carcass Observation data
<code>COdate</code>	Column name for the date found data
<code>data_SS</code>	Search Schedule data
<code>SSdate</code>	Column name for the date searched data. Optional. If not provided, <code>estg</code> will try to find the <code>SSdate</code> among the columns in <code>data_SS</code> . See <a href="#">prepSS</a> .
<code>model_SE</code>	Searcher Efficiency model (or list of models if there are multiple carcass classes)
<code>model_CP</code>	Carcass Persistence model (or list of models if there are multiple carcass classes)
<code>model_DWP</code>	Density weighted proportion model (or list of models if there are multiple carcass classes)
<code>sizeCol</code>	Name of column in <code>data_CO</code> where the carcass classes are recorded. Optional. If not provided, no distinctions are made among sizes. <code>sizeCol</code> not only identifies what the name of the size segregating class
<code>unitCol</code>	Column name for the unit indicator
<code>IDcol</code>	Column name for unique carcass IDs (required)
<code>nsim</code>	the number of simulation draws
<code>max_intervals</code>	maximum number of arrival interval intervals to consider for each carcass. Optional. Limiting the number of search intervals can greatly increase the speed of calculations with only a slight reduction in accuracy in most cases.

### Value

list of [1]  $\hat{g}$  estimates ( $\hat{g}$ ) and [2] arrival interval estimates ( $A_j$ ) for each of the carcasses. The row names of the  $A_j$  matrix are the units at which carcasses were found. Row names of  $\hat{g}$  are the carcass IDs (in `data_CO`).

### Examples

```

data(mock)
model_SE <- pkm(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, dist = "weibull",
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays"
)
ghat <- estg(data_CO = mock$CO, COdate = "DateFound", data_SS = mock$SS,
  model_SE = model_SE, model_CP = model_CP, unitCol = "Unit", nsim = 100)

```

---

estgGeneric

*Estimate generic g*


---

## Description

Generic g estimation by simulation from given SE model and CP models under a specific search schedule.

The g estimated by estgGeneric is a generic aggregate detection probability and represents the probability of detecting a carcass that arrives at a (uniform) random time during the period monitored, for each of the possible cell combinations, given the SE and CP models. This is somewhat different from the GenEst estimation of g when the purpose is to estimate total mortality (M), in which case the detection probability varies with carcass arrival interval and is difficult to summarize statistically. The estgGeneric estimate is a useful "big picture" summary of detection probability, but would be difficult to work with for estimating M with precision.

## Usage

```
estgGeneric(days, model_SE, model_CP, nsim = 1000)
```

## Arguments

days	Search schedule data as a vector of days searched
model_SE	Searcher Efficiency model (pkm object)
model_CP	Carcass Persistence model (cpm object)
nsim	the number of simulation draws

## Value

gGeneric object that is a list of [1] a list of g estimates, with one element in the list corresponding to each of the cells from the cross-model combination and [2] a table of predictors and cell names associated with the gs

## Examples

```
data(mock)
model_SE <- pkm(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays")
avgSS <- averageSS(mock$SS)
ghatsGeneric <- estgGeneric(days = avgSS, model_SE = model_SE,
  model_CP = model_CP)
```

estgGenericSize

*Estimate generic detection probability for multiple carcass classes***Description**

Generic g estimation for a combination of SE model and CP model under a given search schedule

The g estimated by estgGenericSize is a generic aggregate detection probability and represents the probability of detecting a carcass that arrives at a (uniform) random time during the period monitored, for each of the possible cell combinations, given the SE and CP models. This is somewhat different from the GenEst estimation of g when the purpose is to estimate total mortality (M), in which case the detection probability varies with carcass arrival interval and is difficult to summarize statistically. The estgGeneric estimate is a useful "big picture" summary of detection probability, but would be difficult to work with for estimating M with precision.

**Usage**

```
estgGenericSize(
  days,
  modelSetSize_SE,
  modelSetSize_CP,
  modelSizeSelections_SE,
  modelSizeSelections_CP,
  nsim = 1000
)
```

**Arguments**

days	Search schedule data as a vector of days searched
modelSetSize_SE	Searcher Efficiency model set for multiple sizes
modelSetSize_CP	Carcass Persistence model set for multiple sizes
modelSizeSelections_SE	vector of SE models to use, one for each size. Size names are required, and names must match those of modelSetSize_SE. E.g., c(lrg = "p ~ Visibility; k ~ 1", sm1 = "p ~ 1; k ~ 1"). Model formulas are read as text and must have exact matches among models listed in modelSetSize_SE. For example, if one of the modelSizeSelections_SE elements is lrg = "p ~ Visibility; k ~ 1", then "p ~ Visibility; k ~ 1" must be in names(modelSizeSelections_SE)[["lrg"]].
modelSizeSelections_CP	vector of CP models to use, one for each size
nsim	the number of simulation draws

**Value**

list of g estimates, with one element in the list corresponding to each of the cells from the cross-model combination

## Examples

```

data(mock)
pkmModsSize <- pkm(formula_p = p ~ HabitatType,
  formula_k = k ~ HabitatType, data = mock$SE,
  obsCol = c("Search1", "Search2", "Search3", "Search4"),
  sizeCol = "Size", allCombos = TRUE)
cpmModsSize <- cpm(formula_l = l ~ Visibility,
  formula_s = s ~ Visibility, data = mock$CP,
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays",
  dist = c("exponential", "lognormal"),
  sizeCol = "Size", allCombos = TRUE)

pkMods <- c("S" = "p ~ 1; k ~ 1", "L" = "p ~ 1; k ~ 1",
  "M" = "p ~ 1; k ~ 1", "XL" = "p ~ 1; k ~ 1",
  )
cpMods <- c("S" = "dist: exponential; l ~ 1; NULL",
  "L" = "dist: exponential; l ~ 1; NULL",
  "M" = "dist: exponential; l ~ 1; NULL",
  "XL" = "dist: exponential; l ~ 1; NULL",
  )
avgSS <- averageSS(mock$SS)
gsGeneric <- estgGenericSize(nsim = 1000, days = avgSS,
  modelSetSize_SE = pkmModsSize,
  modelSetSize_CP = cpmModsSize,
  modelSizeSelections_SE = pkMods,
  modelSizeSelections_CP = cpMods
  )

```

---

estM

---

*Estimate mortality*


---

## Description

Given given fitted Searcher Efficiency and Carcass Persistence models; Search Schedule, Density Weighted Proportion, and Carcass Observation data; and information about the fraction of the the facility that was surveyed.

## Usage

```

estM(
  data_CO,
  data_SS,
  data_DWP = NULL,
  frac = 1,
  COdate = "DateFound",
  model_SE,
  model_CP,

```

```

    model_DWP = NULL,
    unitCol = NULL,
    SSdate = NULL,
    sizeCol = NULL,
    IDcol = NULL,
    DWPCol = NULL,
    nsim = 1000,
    max_intervals = 8
  )

```

### Arguments

data_CO	Carcass Observation data
data_SS	Search Schedule data
data_DWP	Survey unit (rows) by carcass class (columns) density weighted proportion table
frac	fraction carcasses on ground that was surveyed but not accounted for in DWP
COdate	Column name for the date found data
model_SE	Searcher Efficiency model (or list of models if there are multiple carcass classes)
model_CP	Carcass Persistence model (or list of models if there are multiple carcass classes)
model_DWP	fitted dwp model (optional)
unitCol	Column name for the unit indicator (optional)
SSdate	Column name for the date searched data
sizeCol	Name of colum in data_CO where the carcass classes are recorded. Optional. If none provided, it is assumed there is no distinctions among carcass classes.
IDcol	column with unique carcass (CO) identifier
DWPCol	Column name for the DWP values in the DWP table when no carcass class is used and there is more than one column in data_DWP that could be interpreted as DWP.
nsim	the number of simulation draws
max_intervals	maximum number of arrival intervals to consider for each carcass

### Value

list of Mhat, Aj, ghat, DWP (by carcass), and Xtot = total number of carcasses observe

### Examples

```

## Not run:
data(mock)
model_SE <- pkm(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE
)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, dist = "weibull",
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays"
)

```



```
    )
    eM <- estM(nsim = 1000, data_CO = mock$CO, data_SS = mock$SS,
              data_DWP = mock$DWP, frac = 1, model_SE = model_SE,
              model_CP = model_CP, COdate = "DateFound",
              DWPCol = "S", sizeCol = NULL
    )

    ## End(Not run)
```

---

expandModelSetCP	<i>Expand a CP model set for plotting</i>
------------------	---

---

**Description**

Expand the exponential models across the other distributions

**Usage**

```
expandModelSetCP(modelSet)
```

**Arguments**

modelSet            cp model set of class cpmSet

**Value**

updated model set

---

GenEst	<i>Generalized estimation of mortality</i>
--------	--

---

**Description**

This package is designed to analyze searcher efficiency, carcass persistence, search schedule, and carcass observation data for the estimation of bird and bat mortality at wind and solar power facilities.

**Information**

```
browseVignettes("GenEst")
packageDescription("GenEst")
disclaimerUSGS()
disclaimerWEST()
```

**Data sets**

mock  
wind\_cleared  
wind\_RP  
wind\_RPbat  
solar\_powerTower  
solar\_PV  
solar\_trough

**Main command-line functions**

`pkm`, `cpm`, `dwp` estimate searcher efficiency (pk), carcass persistence (cp), and (dwp) parameters  
`estM` estimate mortality given `pkm`, `cpm` and data  
`calcSplits` split mortality estimates by subcategories  
`plot` S3 function for `pkm`, `pkmSet`, `cpm`, `cpmSet`, `estM`, `splitFull`, `splitSummary`, `gGeneric`, and `gGenericSize` objects  
`transposeSplits` transpose 2-d splits  
`summary` S3 function for `estM`, `splitFull`, `gGeneric`, `gGenericSize` objects  
`aicc` S3 function for extracting models' AICc values from `pkm`, `pkmSet`, `pkmSize`, `pkmSetSize`, `cpm`, `cpmSet`, `cpmSize`, and `cpmSetSize` objects  
`desc` Calculate descriptive statistics for a fitted CP model  
`estgGeneric` estimate detection probability (g) for given searcher efficiency and carcass persistence model  
`runGenEst()` start the GUI

**Potentially useful calculation functions**

`rpk`, `qpk`, `rcp`, `rdwp`  
`estg`, `calcg`  
`ppersist`, `SEsi`  
`alogit`, `logit`  
`pkLogLik`, `cpLogLik`  
`calcRate`, `calcTsplit`, `ltranspose`  
`refMod`  
`countCarcs`  
`simpleMplot`

**Potentially useful editing functions**

`estgGenericSize`  
`prepSS`  
`averageSS`  
`tidyModelSetCP`  
`tidyModelSetSE`

checkDate  
dateCols  
dateToDay  
defineUnitCol  
dlModTabSE  
prettyModTabCP  
prettyModTabSE  
prettySplitTab

### Other functions

trimSetSize  
combinePreds  
combinePredsAcrossModels  
pkmSetSizeFailRemove  
pkmSetFailRemove  
cpmSetSizeFailRemove  
cpmSetSizeFail  
cpmSetFailRemove  
CO\_DWP  
CPcols  
cpmCPCellPlot  
cpmFail  
cpmSetFail  
cpmSetSpecCPCellPlot  
DWPCols  
expandModelSetCP  
obsCols\_SE  
pkmFail  
pkmSetAllFail  
pkmSetFail  
pkmSetSizeFail  
plotCPCells  
plotCPFigure  
plotCPHeader  
predsCols  
SEsi\_left  
SEsi\_right  
SEsi0  
sizeCols  
matchCells  
checkComponents  
checkSpecificModelCP  
checkSpecificModelSE  
combinePredsAcrossModels  
CPdistOptions  
obsCols\_fta  
obsCols\_ltp

pkmParamPlot  
pkmSECellPlot  
pkmSet  
pkmSetSpecParamPlot  
pkmSetSpecSECellPlot  
plotSEBoxPlots  
plotSEBoxTemplate  
plotSECells  
plotSEFigure  
plotSEHeader  
prepPredictors  
readCSV  
removeCols

### **Internal functions (not exported)**

\_GenEst\_calcRateC  
\_GenEst\_calcTsplitsC  
calcRateC  
calcTsplitsC  
aboutContent  
aboutPanel  
analysisPanel  
b  
big  
cButtonStyle  
center  
classText  
clearNotifications  
CPMainPanel  
CPPanel  
downloadCPFig  
estText  
CPSidebar  
initialReactiveValues  
createvtext  
dataDownloadWidget  
dataInputPanel  
dataInputSidebar  
dataInputWidget  
dataTabPanel  
disclaimersContent  
disclaimersPanel  
downloadCPFig  
downloadCPMod  
downloadCPMres  
downloadSEmod  
downloadgFig

downloadMFig  
downloadSEFig  
downloadsPanel  
downloadTable  
eventReaction  
GeneralInputSidebar  
GeneralInputsPanel  
GenEstAcknowledgements  
GenEstAuthors  
GenEstGUIauthors  
GenEstInlineCSS  
GenEstLicense  
GenEstLogos  
GenEstShinyJS  
GenEstUI  
GenEstServer  
gettingStartedContent  
gettingStartedPanel  
gMainPanel  
gPanel  
gSidebar  
helpPanel  
initialOutput  
kFixedWidget  
kFixedWidgetHeader  
kFixedWidgetRow  
li  
loadedDataPanel  
MMainPanel  
modelInputWidget  
modelOutputPanel  
modelOutputWidget  
modelRunWidget  
modelSelectionWidget  
modelSelectionWidgetHeader  
modelSelectionWidgetRow  
modelSetCells  
modelSetModelCells  
modelSetModelPredictors  
modelSetPredictors  
modelNamePaste  
modelNameSplit  
MPanel  
msgFracNote  
msgList  
msgModDone  
msgModFail  
msgModPartialFail

msgModRun  
msgModSEnobs  
msgModWarning  
msgSampleSize  
msgSplitFail  
msgSSavgFail  
msgSSinputFail  
MSidebar  
navbar  
ol  
pickSizeclass  
plotNA  
prepSizeclassText  
preTextMaker  
reaction  
reactionMessageDone  
reactionMessageRun  
reNULL  
reVal  
SEboxes  
SEcols  
selectData  
selectedDataPanel  
SEMainPanel  
SEPanel  
SEpanel  
SESidebar  
setkNeed  
setNotSuspending  
small  
splitButtonWidget  
style  
trimSetSize  
u  
ul  
update\_input  
update\_output  
update\_rv  
updateColNames\_size  
updateSizeclasses  
updatesizeCol  
widgetMaker

**Description**

Compute the logit or anti-logit

**Usage**

```
logit(x)
```

```
alogit(x)
```

**Arguments**

**x**                      A number. For logit, a probability (between 0 and 1, inclusive). For alogit, any real number.

**Value**

logit: The logit of x.

alogit: The anti-logit of x.

**Examples**

```
logit(0.5)
```

```
alogit(0)
```

---

ltranspose

*Transpose a list of arrays*


---

**Description**

A list of  $n$  arrays, each with dimension  $m \times k$  is redimensioned to a list of  $m$  arrays, each with dimension  $n \times k$ . NOTE: Attributes are not preserved.

**Usage**

```
ltranspose(M)
```

**Arguments**

**M**                      a list of  $n \times m \times k$  arrays

**Value**

a list of  $m \times n \times k$  arrays

mock	A mock example data set
<b>Description</b>	
A template dataset used for testing purposes. Dataset containing SE, CP, SS, DWP, and CO data. Data are mostly random without patterns.	
<b>Usage</b>	
mock	
<b>Format</b>	
A list with 5 items:	
<b>SE</b> Searcher efficiency trial data	
<b>CP</b> Carcass persistence trial data	
<b>SS</b> Search schedule data	
<b>DWP</b> Density weighted proportion of area searched data	
<b>CO</b> Carcass observations	
<b>Source</b>	
mock	
model_utility_functions	model utility functions (not exported)

**Description**

model utility functions that are not exported

**Usage**

```
matchCells(specific, modelSet)

modelSetModelPredictors(modelSet)

modelSetPredictors(modelSet)

modelSetModelCells(modelSet)

modelSetCells(modelSet)
```



**Arguments**

specific	specific model compared against the full set
modelSet	full model set to compare to the specific

---

obsCols_fta	<i>Select the columns from a data table that could be CP First Time Absent observations</i>
-------------	---

---

**Description**

Simple function to facilitate selection of columns that could be First Time Absent observations for a CP model

**Usage**

```
obsCols_fta(data)
```

**Arguments**

data	data table
------	------------

**Value**

column names of columns that can be observations

---

obsCols_ltp	<i>Select the columns from a data table that could be CP Last Time Present observations</i>
-------------	---

---

**Description**

Simple function to facilitate selection of columns that could be Last Time Present observations for a CP model

**Usage**

```
obsCols_ltp(data)
```

**Arguments**

data	data table
------	------------

**Value**

column names of columns that can be observations

---

obsCols_SE	Select the columns from a data table that could be SE observations
------------	--

---

**Description**

Simple function to facilitate selection of columns that could be observations for an SE model

**Usage**

```
obsCols_SE(data)
```

**Arguments**

data	data table
------	------------

**Value**

column names of columns that can be observations

---

pkLogLik	Calculate the negative log-likelihood of a searcher efficiency model
----------	--

---

**Description**

The function used to calculate the negative-loglikelihood of a given searcher efficiency model ([pkm](#)) with a given data set

**Usage**

```
pkLogLik(  
  misses,  
  foundOn,  
  beta,  
  nbeta_p,  
  cellByCarc,  
  maxmisses,  
  cellMM,  
  kFixed = NULL  
)
```

**Arguments**

misses	Number of searches when carcass was present but not found.
foundOn	Search on which carcass was found.
beta	Parameters to be optimized.
nbeta_p	Number of parameters associated with p.
cellByCarc	Which cell each observation belongs to.
maxmisses	Maximum possible number of misses for a carcass.
cellMM	Combined pk model matrix.
kFixed	Value of k if fixed.

**Value**

Negative log likelihood of the observations, given the parameters.

---

pkm	<i>Fit pk searcher efficiency models.</i>
-----	---

---

**Description**

Searcher efficiency is modeled as a function of the number of times a carcass has been missed in previous searches and any number of covariates. Format and usage parallel that of common R functions `lm`, `glm`, and `gam`. However, the input data (`data`) is structured differently to accommodate the multiple-search searcher efficiency trials (see Details), and model formulas may be entered for both `p` (akin to an intercept) and `k` (akin to a slope).

**Usage**

```
pkm(
  formula_p,
  formula_k = NULL,
  data,
  obsCol = NULL,
  kFixed = NULL,
  allCombos = FALSE,
  sizeCol = NULL,
  CL = 0.9,
  kInit = 0.7,
  quiet = FALSE,
  ...
)

pkm0(
  formula_p,
  formula_k = NULL,
```

```

    data,
    obsCol = NULL,
    kFixed = NULL,
    kInit = 0.7,
    CL = 0.9,
    quiet = FALSE
)

pkmSet(
  formula_p,
  formula_k = NULL,
  data,
  obsCol = NULL,
  kFixed = NULL,
  kInit = 0.7,
  CL = 0.9,
  quiet = FALSE
)

pkmSize(
  formula_p,
  formula_k = NULL,
  data,
  kFixed = NULL,
  obsCol = NULL,
  sizeCol = NULL,
  allCombos = FALSE,
  kInit = 0.7,
  CL = 0.9,
  quiet = FALSE
)

```

### Arguments

formula_p	Formula for p; an object of class <code>formula</code> (or one that can be coerced to that class): a symbolic description of the model to be fitted. Details of model specification are given under "Details".
formula_k	Formula for k; an object of class <code>formula</code> (or one that can be coerced to that class): a symbolic description of the model to be fitted. Details of model specification are given under "Details".
data	Data frame with results from searcher efficiency trials and any covariates included in formula_p or formula_k (required).
obsCol	Vector of names of columns in data where results for each search occasion are stored (optional). If obsCol is not provided, pkm uses as obsCol all columns with names that begin with an "s" or "S" and end with a number, e.g., "s1", "s2", "s3", etc. This option is included as a convenience for the user, but care must be taken that other data are not stored in columns with names matching that pattern. Alternatively, obsCol may be entered as a vector of names, like <code>c("s1", "s2",</code>

	<p>"s3"), paste0("s", 1:3), or c("initialSearch", "anotherSearch", "lastSearch"). The columns must be in chronological order, that is, it is assumed that the first column is for the first search after carcass arrival, the second column is for the second search, etc.</p>
kFixed	<p>Parameter for user-specified k value (optional). If a value is provided, formula_k is ignored and the model is fit under the assumption that the k parameter is fixed and known to be <math>k_{\text{Fixed}} \in [0, 1]</math>. If a sizeCol is provided, kFixed may either be NULL, a single number in <math>[0, 1]</math>, or a vector with kFixed values for two or more of the carcass size classes. For example, if there are three sizes (S, M, and L), kFixed could be <code>c(S = 0.3, M = 0.8, L = 1.0)</code> to assign fixed k values to each size. To fit k for size S and to assign values of 0.8 and 1.0 to sizes M and L, resp., use <code>kFixed = c(S = 0.3, M = 0.8, L = 1.0)</code>. If there are more than one size classes and kFixed is a scalar, then all size classes are assigned the same kFixed value (unless kFixed is named, e.g., <code>kFixed = c(S = 0.5)</code>, in which case only the named size is assigned the kFixed).</p>
allCombos	<p>logical. If allCombos = FALSE, then the single model expressed by formula_p and formula_k is fit using a call to <code>pkm0</code>. If allCombos = TRUE, a full set of <code>pkm</code> submodels derived from combinations of the given covariates for p and k is fit. For example, submodels of <code>formula_p = p ~ A * B</code> would be <code>p ~ A * B</code>, <code>p ~ A + B</code>, <code>p ~ A</code>, <code>p ~ B</code>, and <code>p ~ 1</code>. Models for each pairing of a p submodel with a k submodel are fit via <code>pkmSet</code>, which fits each model combination using successive calls to <code>pkm0</code>, which fits a single model.</p>
sizeCol	<p>character string. The name of the column in data that gives the carcass class of the carcasses in the field trials. If sizeCol = NULL, then models are not segregated by size. If a sizeCol is provided, then separate models are fit for the data subsetted by sizeCol.</p>
CL	<p>numeric value in (0, 1). confidence level</p>
kInit	<p>numeric value in (0, 1). Initial value used for numerical optimization of k. Default is <code>kInit = 0.7</code>. It is rarely (if ever) necessary to use an alternative initial value.</p>
quiet	<p>Logical indicator of whether or not to print messages</p>
...	<p>additional arguments passed to subfunctions</p>

## Details

The probability of finding a carcass that is present at the time of search is  $p$  on the first search after carcass arrival and is assumed to decrease by a factor of  $k$  each time the carcass is missed in searches. Both  $p$  and  $k$  may depend on covariates such as ground cover, season, species, etc., and a separate model format (`formula_p` and `formula_k`) may be entered for each. The models are entered as they would be in the familiar `lm` or `glm` functions in R. For example,  $p$  might vary with  $A$  and  $B$ , while  $k$  varies only with  $A$ . A user might then enter `p ~ A + B` for `formula_p` and `k ~ A` for `formula_k`. Other R conventions for defining formulas may also be used, with  $A:B$  for the interaction between covariates  $A$  and  $B$  and  $A * B$  as short-hand for  $A + B + A:B$ .

Search trial data must be entered in a data frame with data in each row giving the fate of a single carcass in the field trials. There must be a column for each search occasion, with 0, 1, or NA depending on whether the carcass was missed, found, or not available (typically because it was found

and removed on a previous search, had been earlier removed by scavengers, or was not searched for) on the given search occasion. Additional columns with values for categorical covariates (e.g., visibility = E, M, or D) may also be included.

When all trial carcasses are either found on the first search or are missed on the first search after carcass placement, pkm effects a necessary adjustment to the for accuracy; otherwise, the model would not be able to determine the uncertainty and would substantially over-estimate the variance of the parameter estimates, giving  $\hat{p}$  essentially equal to 0 or 1 with approximately equal probability. The adjustment is to fit the model on an adjusted data set with duplicated copies of the original data ( $2n$  observations) but with one carcass having the opposite fate of the others. For example, in field trials with very high searcher efficiency and  $n = 10$  carcasses, all of which are found in the first search after carcass placement, the original data set would have a carcass observation column consisting of 1s (`rep(1, 10)`). The adjusted data set would have an observation column consisting of  $2n - 1$  1s and one 0. In this case, the point estimate of  $p$  is  $1/(2n)$  with distribution that closely resembling the Bayesian posterior distributions of  $p$  with a uniform or a Jeffreys prior. The adjustment is applied on a cellwise basis in full cell models (e.g., 1, A, B, A \* B). In the additive model with two predictors (A + B), the adjustment is made only when a full level of covariate A or B is all 0s or 1s.

## Value

an object of an object of class pkm, pkmSet, pkmSize, or pkmSetSize.

`pkm0()` returns a pkm object, which is a description of a single, fitted pk model. Due to the large number and complexity of components of apkm model, only a subset of them is printed automatically; the rest can be viewed/accessed via the `$` operator if desired. These are described in detail in the 'pkm Components' section.

`pkmSet()` returns a list of pkm objects, one for each of the submodels, as described with parameter `allCombos = TRUE`.

`pkmSize()` returns a list of pkmSet objects (one for each 'size') if `allCombos = T`, or a list of pkm objects (one for each 'size') if `allCombos = F`

`pkm` returns a pkm, pkmSet, pkmSize, or pkmSetSize object:

- pkm object if `allCombos = FALSE`, `sizeCol = NULL`
- pkmSet object if `allCombos = TRUE`, `sizeCol = NULL`
- pkmSize object if `allCombos = FALSE`, `sizeCol != NULL`
- pkmSetSize object if `allCombos = TRUE`, `sizeCol != NULL`

## pkm Components

The following components of a pkm object are displayed automatically:

`call` the function call to fit the model

`formula_p` the model formula for the  $p$  parameter

`formula_k` the model formula for the  $k$  parameter

`predictors` list of covariates of  $p$  and/or  $k$

`AICc` the AIC value as corrected for small sample size

convergence convergence status of the numerical optimization to find the maximum likelihood estimates of p and k. A value of 0 indicates that the model was fit successfully. For help in deciphering other values, see [optim](#).

cell\_pk summary statistics for estimated cellwise estimates of p and k, including the number of carcasses in each cell, medians and upper & lower bounds on CIs for each parameter, indexed by cell (or combination of covariate levels).

The following components are not printed automatically but can be accessed via the \$ operator:

data the data used to fit the model

data0 \$data with NA rows removed

betahat\_p, betahat\_k parameter estimates for the terms in the regression model for p and k (logit scale). If k is fixed or not provided, then betahat\_k is not calculated.

varbeta the variance-covariance matrix of the estimators for c(betahat\_p, betahat\_k).

cellMM\_p, cellMM\_k cellwise model (design) matrices for covariate structures of p\_formula and k\_formula

levels\_p, levels\_k all levels of each covariate of p and k

nbeta\_p, nbeta\_k number of parameters to fit the p and k models

cells cell structure of the pk-model, i.e., combinations of all levels for each covariate of p and k. For example, if covar1 has levels "a", "b", and "c", and covar2 has levels "X" and "Y", then the cells would consist of a.X, a.Y, b.X, b.Y, c.X, and c.Y.

ncell total number of cells

predictors\_k, predictors\_p covariates of p and k

observations observations used to fit the model

kFixed the input kFixed

AIC the **AIC** value for the fitted model

carcCells the cell to which each carcass belongs

CL the input CL

loglik the log-likelihood for the maximum likelihood estimate

pOnly a logical value telling whether k is included in the model. pOnly = TRUE if and only if length(obsCol) == 1) and kFixed = NULL.

data\_adj data0 as adjusted for the 2n fix to accommodate scenarios in which all trial carcasses are either found or all are not found on the first search occasion (uncommon)

fixBadCells vector giving the names of cells adjusted for the 2n fix

## Advanced

pkmSize may also be used to fit a single model for each carcass class if allCombos = FALSE. To do so, formula\_p and formula\_k must be a named list of formulas with names matching the sizes listed in unique(data[, sizeCol]). The return value is then a list of pkm objects, one for each size.

## See Also

[rpk](#), [qpk](#), [aicc](#), [plot.pkm](#)

Examples

```
head(data(wind_RP))
mod1 <- pkm(formula_p = p ~ Season, formula_k = k ~ 1, data = wind_RP$SE)
class(mod1)
mod2 <- pkm(formula_p = p ~ Season, formula_k = k ~ 1, data = wind_RP$SE,
  allCombos = TRUE)
class(mod2)
names(mod2)
class(mod2[[1]])
mod3 <- pkm(formula_p = p ~ Season, formula_k = k ~ 1, data = wind_RP$SE,
  allCombos = TRUE, sizeCol = "Size")
class(mod3)
names(mod3)
class(mod3[[1]])
class(mod3[[1]][[1]])
```

---

pkmFail	<i>Check if a pk model is well-fit</i>
---------	--

---

Description

Run a check the arg is a well-fit pkm object

Usage

```
pkmFail(pkmod)
```

Arguments

pkmod                    A **pkm** object to test

Value

logical value indicating a failed fit (TRUE) or successful (FALSE)

---

pkmParamPlot	<i>Plot parameter box plots for each cell for either p or k</i>
--------------	---

---

Description

Boxplot for pk model cells (soon to be deprecated)

Usage

```
pkmParamPlot(model, pk = "p", col)
```



**Arguments**

model	model of class pkm
pk	character of "p" or "k" to delineate between parameter graphed
col	color to use

**Value**

a parameter plot panel

---

pkmSECellPlot	<i>Plot cell-specific decay curve for searcher efficiency</i>
---------------	---

---

**Description**

Plot cell-specific decay curve for searcher efficiency

**Usage**

```
pkmSECellPlot(model, specificCell, col, axis_y = TRUE, axis_x = TRUE)
```

**Arguments**

model	model of class pkm
specificCell	name of the specific cell to plot (soon to be deprecated)
col	color to use
axis_y	logical of whether or not to plot the y axis
axis_x	logical of whether or not to plot the x axis

**Value**

a cell plot panel

---

pkmSetAllFail	<i>Check if all of the pkm models fail within a given set</i>
---------------	---

---

**Description**

Run a check on each model within a [pkmSet](#) object to determine if they all failed or not

**Usage**

```
pkmSetAllFail(pkmSetToCheck)
```

**Arguments**

pkmSetToCheck    A [pkmSet](#) object to test

**Value**

A logical value indicating if all models failed in the set

---

pkmSetFail	<i>Check if pkm models fail</i>
------------	---------------------------------

---

**Description**

Run a check on each model within a [pkmSet](#) object to determine if it failed or not

**Usage**

```
pkmSetFail(pkmSetToCheck)
```

**Arguments**

pkmSetToCheck    A [pkmSet](#) object to test

**Value**

A vector of logical values indicating if each of the models failed

---

pkmSetFailRemove	<i>Remove failed pkm models from a pkmSet object</i>
------------------	--

---

**Description**

Remove all failed models within a [pkmSet](#) object

**Usage**

```
pkmSetFailRemove(pkmSetToTidy)
```

**Arguments**

pkmSetToTidy    A [pkmSet](#) object to tidy

**Value**

A [pkmSet](#) object with failed models removed

---

pkmSetSizeFail	<i>Check if all of the pkm models fail</i>
----------------	--

---

**Description**

Run a check on each model within a [pkmSetSize](#) object to determine if they all failed or not

**Usage**

```
pkmSetSizeFail(pkmSetSizeToCheck)
```

**Arguments**

pkmSetSizeToCheck  
A [pkmSetSize](#) object to test

**Value**

A list of logical vectors indicating which models failed

---

<code>pkmSetSizeFailRemove</code>	<i>Remove failed pkm models from a pkmSetSize object</i>
-----------------------------------	--

---

**Description**

Remove failed models from a `pkmSetSize` object

**Usage**

```
pkmSetSizeFailRemove(pkmSetSizeToTidy)
```

**Arguments**

`pkmSetSizeToTidy`  
A list of `pkmSetSize` objects to tidy

**Value**

A list of `pkmSet` objects with failed models removed

---

<code>pkmSetSpecParamPlot</code>	<i>p or k box plots for an SE model set</i>
----------------------------------	---

---

**Description**

Plot parameter box plots for each cell within a model for either p or k with comparison to the cellwise model (soor to be deprecated)

**Usage**

```
pkmSetSpecParamPlot(modelSet, specificModel, pk = "p", cols)
```

**Arguments**

<code>modelSet</code>	modelSet of class <code>pkmSet</code>
<code>specificModel</code>	name of the specific submodel to plot
<code>pk</code>	character of "p" or "k" to delineate between parameter graphed
<code>cols</code>	named vector of colors to use for the specific and reference models

**Value**

a specific parameter plot panel

---

`pkmSetSpecSECellPlot` *Plot cell-specific decay curve for searcher efficiency for a specific model with comparison to the cellwise model*

---

### Description

Plot cell-specific decay curve for searcher efficiency for a specific model with comparison to the cellwise model

### Usage

```
pkmSetSpecSECellPlot(modelSet, specificModel, specificCell, cols, axes)
```

### Arguments

<code>modelSet</code>	modelSet of class <code>pkmSet</code> (soon to be deprecated)
<code>specificModel</code>	name of the specific submodel to plot
<code>specificCell</code>	name of the specific cell to plot
<code>cols</code>	named vector of colors to use for the specific and reference models
<code>axes</code>	named vector of logical values indicating whether or not to plot the x axis and the y axis

### Value

a specific cell plot panel

---

`pllogis` *The CDF of the loglogistic distribution*

---

### Description

The CDF of the loglogistic distribution

### Usage

```
pllogis(q, pda, pdb)
```

### Arguments

<code>q</code>	a numeric vector of quantiles
<code>pda</code>	the $\alpha$ parameter
<code>pdb</code>	the $\beta$ parameter

Details

There are several common parameterizations of the loglogistic distribution. The one used here gives the following:

**CDF**  $\Pr(X \leq x) = 1 / (1 + (x/\beta)^{-\alpha})$

**PDF**  $\Pr(X = x) = (\alpha/\beta) * (x/\beta)^{(\alpha - 1)} / (1 + (x/\beta)^{\alpha})^2$

Value

$\Pr(X \leq q \mid pda, pdb)$

---

plot.cpm	<i>Plot results of a single CP model</i>
----------	--

---

Description

Plot a single [cpm](#) model

Usage

```
## S3 method for class 'cpm'
plot(x, col = "black", ...)
```

Arguments

- x                    model of class cpm
- col                  color to use
- ...                  to be passed down

Examples

```
data(wind_RP)
mod <- cpm(formula_l = l ~ Season, formula_s = s ~ Season,
            data = wind_RP$CP, left = "LastPresent", right = "FirstAbsent")
plot(mod)
```

---

plot.cpmSet	<i>Plot results of a set of CP models</i>
-------------	---

---

**Description**

Produce a set of figures for a set of CP models, as fit by [cpmSet](#)

**Usage**

```
## S3 method for class 'cpmSet'
plot(x, specificModel = NULL, cols = NULL, ...)
```

**Arguments**

x	pk model set of class pkmSet
specificModel	the name(s) or index number(s) of specific model(s) to restrict the plot
cols	named vector of the colors to use for the distributions
...	to be passed down

**Examples**

```
data(wind_RP)
mod <- cpmSet(formula_l = l ~ Season, formula_s = s ~ Season,
               data = wind_RP$CP, left = "LastPresent", right = "FirstAbsent")
plot(mod)
```

---

plot.estM	<i>Plot total mortality estimation</i>
-----------	--

---

**Description**

plot defined for class estM objects

**Usage**

```
## S3 method for class 'estM'
plot(x, ..., CL = 0.9)
```

**Arguments**

x	estM object
...	arguments to pass down
CL	confidence level

**Examples**

```
## Not run:
data(mock)
model_SE <- pkM(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, dist = "weibull",
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays")
eM <- estM(nsim = 1000, data_CO = mock$CO, data_SS = mock$SS,
  data_DWP = mock$DWP, frac = 1, model_SE = model_SE,
  model_CP = model_CP, COdate = "DateFound",
  DWPCol = "S", sizeCol = NULL)
plot(eM)

## End(Not run)
```

plot.gGeneric

*Plot results of a single generic ghat estimation***Description**

Plot method for a single generic ghat estimation

**Usage**

```
## S3 method for class 'gGeneric'
plot(x, CL = 0.9, ...)
```

**Arguments**

x	<a href="#">estgGeneric</a> output
CL	confidence level to use
...	to be passed down

**Value**

generic detection probability plot

**Examples**

```
data(mock)
model_SE <- pkM(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays")
```



```

avgSS <- averageSS(mock$SS)
ghatsGeneric <- estgGeneric(nsim = 1000, avgSS, model_SE, model_CP)
plot(ghatsGeneric)

```

---

plot.gGenericSize	<i>Plot results of a set of size-based generic ghat estimations</i>
-------------------	---

---

## Description

Plot method for a size-based generic ghat estimation

## Usage

```

## S3 method for class 'gGenericSize'
plot(x, CL = 0.9, ...)

```

## Arguments

x	<code>estgGenericSize</code> output
CL	confidence level to use
...	to be passed down

## Value

size-based detection probability plot

## Examples

```

data(mock)
pkmModsSize <- pkM(formula_p = p ~ HabitatType,
  formula_k = k ~ HabitatType, data = mock$SE,
  obsCol = c("Search1", "Search2", "Search3", "Search4"),
  sizeCol = "Size", allCombos = TRUE)
cpmModsSize <- cpm(formula_l = l ~ Visibility,
  formula_s = s ~ Visibility, data = mock$CP,
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays",
  dist = c("exponential", "lognormal"),
  sizeCol = "Size", allCombos = TRUE)
pkMods <- c("S" = "p ~ 1; k ~ 1", "L" = "p ~ 1; k ~ 1",
  "M" = "p ~ 1; k ~ 1", "XL" = "p ~ 1; k ~ 1"
)
cpMods <- c("S" = "dist: exponential; l ~ 1; NULL",
  "L" = "dist: exponential; l ~ 1; NULL",
  "M" = "dist: exponential; l ~ 1; NULL",
  "XL" = "dist: exponential; l ~ 1; NULL"
)
avgSS <- averageSS(mock$SS)

```

```

gsGeneric <- estgGenericSize(nsim = 1000, days = avgSS,
                             modelSetSize_SE = pkmModsSize,
                             modelSetSize_CP = cpmModsSize,
                             modelSizeSelections_SE = pkMods,
                             modelSizeSelections_CP = cpMods
                             )
plot(gsGeneric)

```

---

plot.pkm

*Plot results of a single pk model*


---

## Description

Plot a single [pkm](#) model

## Usage

```

## S3 method for class 'pkm'
plot(x, col = NULL, CL = NULL, ...)

```

## Arguments

x	model of class pkm
col	color to use
CL	confidence level to show in boxplots and confidence bounds
...	arguments to be passed to sub functions

## Value

a plot

## Examples

```

data(wind_RP)
mod <- pkm(formula_p = p ~ Season, formula_k = k ~ 1, data = wind_RP$SE)
plot(mod)

```

---

plot.pkmSet

*Plot results of a set of SE models*


---

**Description**

Produce a set of figures for a set of SE models, as fit by [pkmSet](#)

**Usage**

```
## S3 method for class 'pkmSet'
plot(x, specificModel = NULL, cols = NULL, CL = NULL, ...)
```

**Arguments**

x	pk model set of class pkmSet
specificModel	the name(s) or index number(s) of specific model(s) to restrict the plot
cols	named vector of colors to use for the specific and reference models
CL	confidence level
...	to be sent to subfunctions

**Value**

a set of plots

**Examples**

```
data(wind_RP)
mod <- pkmSet(formula_p = p ~ Season, formula_k = k ~ Season,
              data = wind_RP$SE
            )
plot(mod)
```

---

plot.splitFull

*Plot summary statistics for splits of mortality estimates*


---

**Description**

The S3 plot method for splitFull objects constructs boxplots of the mortality estimates for all combinations of splitting covariates summarized in the splits variable. This is a simple wrapper function for creating a splitSummary object by calling [summary.splitFull](#) and plotting the result via [plot.splitSummary](#).

**Usage**

```
## S3 method for class 'splitFull'
plot(x, rate = FALSE, CL = 0.9, commonScale = FALSE, ...)
```

**Arguments**

x	A splitSummary object (result of <a href="#">calcSplits</a> ) that includes summary statistics for simulated mortality estimates for all combinations of levels of 1 or 2 splitting covariates.
rate	logical scalar indicating whether the figures should be plotted as number of fatalities per split category (rate = TRUE) or fatality rates per unit time (rate = TRUE). If the splits do not include either a split_SS or split_time variable, the rate arg is ignored.
CL	desired confidence level to show in box plots
commonScale	Boolean: Should panels share a common y-axis scale? Relevant only when there are two splitting variables.
...	to be passed down

---

plot.splitSummary	<i>Plot summary statistics for splits of mortality estimates</i>
-------------------	--

---

**Description**

The S3 plot method for splitSummary objects constructs boxplots of the mortality estimates for all combinations of splitting covariates summarized in the splits variable.

For 1-covariate splits, box plots showing median, IQR, and confidence intervals (for the CL attribute for the splits object). For 2-covariate splits, the box plots are in an array with levels of the temporal split (split\_SS or split\_time) arranged horizontally (if present) and the levels of the split\_CO variable arranged vertically. If no temporal splits are present, then the box plots along the levels of the first split\_CO variable are arranged horizontally and the levels of the second variable are arranged vertically.

**Usage**

```
## S3 method for class 'splitSummary'
plot(x, rate = FALSE, commonScale = FALSE, ...)
```

**Arguments**

x	A splitSummary object (result of <a href="#">calcSplits</a> ) that includes summary statistics for simulated mortality estimates for all combinations of levels of 1 or 2 splitting covariates.
rate	logical scalar indicating whether the figures should be plotted as number of fatalities per split category (rate = TRUE) or fatality rates per unit time (rate = TRUE). If the splits do not include either a split_SS or split_time variable, the rate arg is ignored.

commonScale	boolean to indicate whether to plot separate splits panels with a common scale on their y-axes (or have y-axes scaled to fit each graph separately)
...	additional arguments to be passed down

---

plotCPCells	<i>Plot the cellwise results of a single model in a set of CP models</i>
-------------	--

---

**Description**

Produce a set of cellwise figures for a specific CP model, as fit by [cpmSet](#)

**Usage**

```
plotCPCells(modelSet, specificModel, cols)
```

**Arguments**

modelSet	cp model set of class cpmSet
specificModel	the name of the specific model for the plot
cols	named vector of the colors to use for the distributions

**Value**

a plot

---

plotCPFigure	<i>Plot results of a single CP model in a set</i>
--------------	---

---

**Description**

Produce a figures for a specific CP model, as fit by [cpmSet](#)

**Usage**

```
plotCPFigure(modelSet, specificModel, cols = CPcols())
```

**Arguments**

modelSet	cp model set of class cpmSet
specificModel	the name of the specific model for the plot
cols	named vector of the colors to use for the distributions

**Value**

a plot

---

plotCPHeader	<i>The CP plot header</i>
--------------	---------------------------

---

**Description**

Produce the header for a CP plot

**Usage**

```
plotCPHeader(modelSet, specificModel, cols = CPcols())
```

**Arguments**

modelSet	cp model set of class cpmSet
specificModel	the name of the specific model for the plot
cols	named vector of the colors to use for the distributions

**Value**

a plot

---

plotSEBoxPlots	<i>p and k box plots for an SE model set</i>
----------------	--

---

**Description**

Plot parameter box plots for each cell within a model for both p and k with comparison to the cellwise model (soon to be deprecated)

**Usage**

```
plotSEBoxPlots(modelSet, specificModel, cols)
```

**Arguments**

modelSet	modelSet of class pkmSet
specificModel	name of the specific submodel to plot
cols	named vector of colors to use for the specific and reference models

**Value**

a set of parameter plot panels

---

plotSEBoxTemplate	<i>template box plot</i>
-------------------	--------------------------

---

**Description**

Plot template box plot (soon to be deprecated)

**Usage**

```
plotSEBoxTemplate(modelSet, specificModel, cols)
```

**Arguments**

modelSet	modelSet of class <code>pkmSet</code>
specificModel	name of the specific submodel to plot
cols	named vector of colors to use for the specific and reference models

**Value**

a template box plot

---

plotSECells	<i>Plot the cellwise results of a single model in a set of SE models</i>
-------------	--

---

**Description**

Produce a set of cellwise figures for a specific SE model, as fit by `pkmSet` (soon to be deprecated)

**Usage**

```
plotSECells(modelSet, specificModel, cols)
```

**Arguments**

modelSet	pk model set of class <code>pkmSet</code>
specificModel	the name of the specific model for the plot
cols	named vector of colors to use for the specific and reference models

**Value**

a plot

---

plotSEFigure	<i>Plot results of a single SE model in a set</i>
--------------	---

---

**Description**

Produce a figures for a specific SE model, as fit by [pkmSet](#) (soon to be deprecated)

**Usage**

```
plotSEFigure(modelSet, specificModel, app, cols)
```

**Arguments**

modelSet	pk model set of class pkmSet
specificModel	the name of the specific model for the plot
app	logical indicating if the plot is for the app
cols	named vector of colors to use for the specific and reference models

**Value**

a plot

---

plotSEHeader	<i>The SE plot header</i>
--------------	---------------------------

---

**Description**

Produce the header for an SE plot (soon to be deprecated)

**Usage**

```
plotSEHeader(modelSet, specificModel, app = FALSE, cols = SEcols())
```

**Arguments**

modelSet	pk model set of class pkmSet
specificModel	the name of the specific model for the plot
app	logical indicating if the plot is for the app
cols	named vector of colors to use for the specific and reference models

**Value**

a plot



---

ppersist	<i>Calculate the probability of persistence to detection</i>
----------	--

---

**Description**

Given a set of CP parameters (of "ppersist" type), calculate the probability of persistence to detection for a carcass.

**Usage**

```
ppersist(pda, pdb, dist, t_arrive0, t_arrive1, t_search)
```

**Arguments**

pda	parameter a.
pdb	parameter b.
dist	Distribution used.
t_arrive0	Beginning of arrival window.
t_arrive1	End of arrival window.
t_search	Search time.

**Value**

Probability of persistence of detection to at t\_search, given arrival between t\_arrive0 and t\_arrive1

---

predsCols	<i>Select the predictor-ok columns from a data table</i>
-----------	--

---

**Description**

Simple function to facilitate selection of columns that could be predictors for SE or CP models from a data table

**Usage**

```
predsCols(data)
```

**Arguments**

data	data table
------	------------

**Value**

column names of columns that can be predictors

---

prepPredictors	<i>Prepare predictors based on inputs</i>
----------------	---

---

**Description**

Prepare predictor inputs from the app for use in the model function

**Usage**

```
prepPredictors(preds = NULL)
```

**Arguments**

preds	predictors, as input to the app
-------	---------------------------------

**Value**

prepared predictors (or 1 if no predictors)

---

prepSS	<i>Create search schedule data into an prepSS object for convenient splits analyses</i>
--------	---

---

**Description**

Since data\_SS columns largely have a specific, required format, the prepSS function can often automatically decipher the data, but the user may specify explicit instructions for parsing the data for safety if desired. If the data are formatted properly, the automatic parsing is reliable in most cases. There are two exceptions. (1) If there is more than one column with possible dates (formatted as formal dates (as class Date, POSIXlt or POSIXct) or character strings or factors that can be unambiguously interpreted as dates (with assumed format "2018-05-15" or "2018/5/15"). In that case, the user must specify the desired dates as dateColumn. (2) If there is a covariate column consisting entirely of 0s and 1s. In that case, the user must specify the column(s) in covars.

**Usage**

```
prepSS(data_SS, SSdate = NULL, preds = NULL)
```

**Arguments**

data_SS	data frame or matrix with search schedule parameters, including columns for search dates, covariates (describing characteristics of the search intervals), and each unit (with 1s and 0s to indicate whether the given unit was searched (= 1) or not (= 0) on the given date)
---------	--

SSdate	name of the column with the search dates in it (optional). If no SSdate is given, prepSS will try to find the date column based on data formats. If there is exactly one column that can be interpreted as dates, that column will be taken as the dates searched. If more than one date column is found, prepSS exits with an error message.
preds	vector of character strings giving the names of columns to be interpreted as potential covariates (optional). Typically, it is not necessary for a user to provide a value for preds. It is used only to identify specific columns of 1s and 0s as covariates rather than as search schedules.

**Value**

prepSS object that can be conveniently used in the splitting functions.

**Examples**

```
data(mock)
prepSS(mock$SS)
```

---

prettyModTabCP	<i>Create the pretty version of the Carcass Persistence model table</i>
----------------	---

---

**Description**

Format a reader-friendly version of the parameter table from a carcass persistence model showing CIs for medianCP and for rI's for intervals of Ir

**Usage**

```
prettyModTabCP(modTab)
```

**Arguments**

modTab	descCP object or NULL
--------	-----------------------

**Value**

pretty version of the CP model table in a data frame with point and interval estimates for medianCP and rI statistics. Output table is ready for rendering in shiny and posting in the GUI

---

prettyModTabSE	<i>Create the pretty versions of model and summary tables</i>
----------------	---

---

**Description**

Format reader-friendly versions of results summary tables for searcher efficiency (GUI display and download), carcass persistence, and splits.

**Usage**

```
prettyModTabSE(modTab, CL = 0.9)
```

**Arguments**

modTab	model table
CL	Confidence level

**Value**

pretty version of the SE model table

---

prettySplitTab	<i>Create the pretty version of the split summary table</i>
----------------	---

---

**Description**

Format a reader-friendly version of the split summary table a mortality estimation

**Usage**

```
prettySplitTab(splitSummary)
```

**Arguments**

splitSummary	a split summary
--------------	-----------------

**Value**

split pretty table

---

print.cpm	<i>Print a <a href="#">cpm</a> model object</i>
-----------	---

---

**Description**

Print a [cpm](#) model object

**Usage**

```
## S3 method for class 'cpm'  
print(x, ...)
```

**Arguments**

x	a <a href="#">cpm</a> model object
...	to be passed down

---

print.pkm	<i>Print a <a href="#">pkm</a> model object</i>
-----------	---

---

**Description**

Print a [pkm](#) model object

**Usage**

```
## S3 method for class 'pkm'  
print(x, ...)
```

**Arguments**

x	a <a href="#">pkm</a> model object
...	to be passed down

qpk

*Quantiles of marginal distributions of  $\hat{p}$  and  $\hat{k}$* **Description**

Calculate quantiles of marginal distributions of  $\hat{p}$  and  $\hat{k}$  for a [pkm](#) model object

**Usage**

```
qpk(p, model)
```

**Arguments**

`p` vector of probabilities  
`model` A [pkm](#) object (which is returned from `pkm()`)

**Value**

either a list of  $n_{\text{cell}} \times \text{length}(p)$  matrices of quantiles for  $p$  and  $k$  for cells defined by the model object (if `model$poOnly == FALSE`) or a  $n_{\text{cell}} \times \text{length}(p)$  matrix of quantiles for  $p$

**See Also**

[rpk](#), [pkm](#)

**Examples**

```
# 90% confidence intervals for \code{p} and \code{k}
mod <- pkm(formula_p = p ~ Visibility * Season, formula_k = k ~ Season,
  data = wind_cleared$SE)
qpk(p = c(0.05, 0.95), model = mod)
```

rcp

*Simulate parameters from a fitted cp model***Description**

Simulate parameters from a [cpm](#) model object, and format them as either type "survreg" or "ppersist"

**Usage**

```
rcp(n, model, type = "survreg")
```

**Arguments**

n	the number of simulation draws
model	A cpm object (which is returned from <a href="#">cpm</a> )
type	The type of parameters requested. "survreg" or "ppersist"

**Value**

list of two matrices of n simulated l and s (if type = "survreg") or a and b (if type = "ppersist") for cells defined by the model object.

**Examples**

```
data(wind_RP)
mod <- cpm(formula_1 = l ~ 1, data = wind_RP$CP, left = "LastPresent",
           right = "FirstAbsent"
)
rcp(n = 10, model = mod, type = "survreg")
rcp(n = 10, model = mod, type = "ppersist")
```

rdwp

*Simulate parameters from a fitted dwp model***Description**

Simulate parameters from a [dwpm](#) model object

**Usage**

```
rdwp(n, model)
```

**Arguments**

n	the number of simulation draws
model	A <a href="#">dwpm</a> object (which is returned from <a href="#">dwpm()</a> )

**Details**

If the model type = data, then the number of simulated columns must be either  $\geq n$  (in which case the first n columns are taken as the simulated DWP) or 1 (in which case, DWP is assumed constant).

**Value**

array of n simulated dwp values for each unit. Dimensions = c(n, number of units).

---

readCSV	<i>Read in csv files in either format</i>
---------	---

---

**Description**

Handle reading in of a csv that is either comma-decimal or semicolon-comma separation style

**Usage**

```
readCSV(path)
```

**Arguments**

path	file path
------	-----------

**Value**

read in data table

---

refMod	<i>Return the model with the greatest log-likelihood</i>
--------	--

---

**Description**

Compares all fitted models in a list and returns the model with the greatest log-likelihood

**Usage**

```
refMod(modelSet)
```

**Arguments**

modelSet	a list of fitted models with a loglik element. Models may be pkm, cpm, survreg objects or any objects with a loglik component.
----------	--

**Value**

The model object with the greatest log-likelihood among the models in modelSet



---

removeCols	<i>Remove selected columns from column names</i>
------------	--

---

**Description**

Simple function to facilitate removal of columns selected

**Usage**

```
removeCols(colNames, selCols)
```

**Arguments**

colNames	column names from which some could be removed
selCols	selected columns to be removed

**Value**

column names without selected columns

---

rpk	<i>Simulate parameters from a fitted pk model</i>
-----	---

---

**Description**

Simulate parameters from a [pkm](#) model object

**Usage**

```
rpk(n, model)
```

**Arguments**

n	the number of simulation draws
model	A <a href="#">pkm</a> object (which is returned from <code>pkm()</code> )

**Value**

list of pairs of matrices of n simulated p and k for cells defined by the model object.

**See Also**

[rpk](#), [pkm](#)

**Examples**

```
data(wind_RP)
mod <- pkm(formula_p = p ~ 1, formula_k = k ~ Season, data = wind_RP$SE)
rpk(n = 10, model = mod)
```

---

**runGenEst***Launch the GenEst Application*

---

**Description**

Launches a local version of the GenEst application by running [runApp](#) pointed to the app subdirectory in the local GenEst package folder.

**Usage**

```
runGenEst()
```

---

**SEcols***Produce a named vectory with standard SE plot colors*

---

**Description**

Produce a named vectory with standard SE plot colors. soon to be deprecated.

**Usage**

```
SEcols()
```

---

**SEpanel***Produce a single panel in an SE summary/diagnostic plot*

---

**Description**

Each call to SEpanel produces a single panel showing searcher efficiency as a function of number of searches. Includes raw data (found and available) and model fits for a specific model (y\_spc) and for the reference model (y\_ref) for the pkmSet object from the reference model was extracted. For internal use only, for producing figs for plot.pkmSet.

**Usage**

```
SEpanel(found, available, y_spc, y_ref, xends, cols_SE)
```

**Arguments**

found	vector of number carcasses found on the ith attempt
available	vector of number carcasses found on the ith attempt
y_spc	vector of model fits for the specific model
y_ref	vector of model fits for the reference model
xends	x-axis buffer (numeric scalar) on sides of figs
cols_SE	named vector of colors (character)

**Value**

NULL inserts a panel with no labels into a preformatted figure

---

SEsi	<i>Calculate decayed searcher efficiency</i>
------	--

---

**Description**

Calculate searcher efficiency after some searches under pk values

**Usage**

SEsi(days, pk)

**Arguments**

days	search days
pk	p and k values

**Value**

searcher efficiency that matches the output of ppersist

---

SEsi0	<i>Calculate decayed searcher efficiency for a single pk</i>
-------	--

---

**Description**

Calculate searcher efficiency after some searches for a single pk combination

**Usage**

```
SEsi0(days, pk)
```

**Arguments**

days	search days
pk	pk combination

**Value**

searcher efficiency that matches the output of ppersist

---

SEsi_left	<i>Calculate conditional probability of observation at a search</i>
-----------	---

---

**Description**

Calculate the conditional probability of observing a carcass at search oi as a function arrival interval (assuming carcass is not removed by scavengers before the time of the final search)

**Usage**

```
SEsi_left(oi, pk, rng = NULL)
```

**Arguments**

oi	number of searches after arrival
pk	numeric array of searcher efficiency p and k parameters (p = pk[ , 1] and k = pk[ , 2])
rng	optional parameter giving the range of intervals to consider

**Value**

numeric array of probability of observing a carcass at oi for given that it arrived in intervals 1:oi if rng = NULL (or in intervals rng), assuming the carcass had not been previously discovered or removed by scavengers

---

SEsi_right	<i>Calculate conditional probability of observation after a series of searches</i>
------------	--

---

**Description**

Calculate the conditional probability of observing a carcass after  $i = 1:nsi$  searches (assuming carcass is not previous discovered by searchers or removed by scavengers)

**Usage**

```
SEsi_right(nsi, pk)
```

**Arguments**

nsi	number of searches after arrival
pk	numeric array of searcher efficiency $p$ and $k$ parameters ( $p = pk[, 1]$ and $k = pk[, 2]$ )

**Value**

numeric  $nsi \times \dim(pk)[1]$  array of probabilities of observing a carcass after  $1:nsi$  searches (assuming that the carcass had not been previously discovered or removed by scavengers)

---

simpleMplot	<i>Plot a total mortality estimation for a simple situation</i>
-------------	---

---

**Description**

Function underneath [plot.estM](#), which defines the plot method for a mortality object, composed of a hisogram with the empirical PDF and summary statistics

**Usage**

```
simpleMplot(M, ..., Xmin = 0, CL = 0.9)
```

**Arguments**

M	Mortality object
...	arguments to pass down
Xmin	minimum number of observable carcasses
CL	confidence level

---

sizeCols	Select the potential carcass class columns from a data table
----------	--

---

**Description**

Simple function to facilitate selection of columns that could be carcass class values from a data table.

**Usage**

sizeCols(data)

**Arguments**

data                      data table

**Value**

column names of columns that can be carcass class values

---

solar_powerTower	Power Tower Example Dataset
------------------	-----------------------------

---

**Description**

An example data set for estimating fatalities from a concentrating solar-thermal (power tower) generation facility.

The simulated site consists of a single tower generating approximately 130 MW. The tower is surrounded by a 250 meter radius circular inner field of heliostats, searched on a weekly schedule. From the inner circle, 18 concentric rings of heliostats 50 meters deep extend to the boundaries of the simulated site. Rings are subdivided into 8 arcs each, with arcs 1-8 immediately adjacent to the central circle. Arcs are search using distance sampling techniques on a weekly schedule, with 29 arcs searched per weekday.

There are two sources of mortality simulated: flux and non-flux (collision or unknown cause). Flux carcasses are generated (weibull) about the tower, with 5% to be found in the outer field. Non-flux mortality is assumed uniform across the site.

The dataset consists of five parts: Data on carcass observations (CO) from inner and outer heliostat searches, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS), and density weighted proportion (DWP) of area searched at each turbine (which is an area adjustment factor to account for incomplete search coverage).

**Usage**

solar\_powerTower

**Format**

solar\_powerTower is a list with 5 elements:

SE Searcher efficiency trial data  
 CP Carcass persistence trial data  
 SS Search schedule parameters  
 DWP Density weighted proportion of area searched  
 CO Carcass observations

**Searcher Efficiency (SE)**

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

Field indicates carcass placed in inner or outer heliostat field, with levels "inner" or outer.

"Search1", ..., "Search5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.

**Carcass Persistence (CP)**

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

cpID unique ID for each carcass

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

### Search Schedule (SS)

\$SS is a data frame with a row for each date an arc at the site was searched, a column of SearchDates, and a column for each arc, and one column at the end for the inner heliostat field, labeled center. In addition, there is a column to indicate the Season. A column with search dates and columns for each distinct area (arcs and center) searched are required. Other columns are optional.

SearchDate columns of dates on which an arc was searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

Season "winter", "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

### Density Weighted Proportion (DWP)

\$DWP is a data frame with a row for each arc and columns for each carcass size class (labels must match those of the class factors in the carcass observation file). Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area). In this example, within the inner field (center) observers are unobstructed in ability to discover carcasses, for a DWP of 1. In the outer heliostat field observers walk along transects separated by 50 meters, but the entire area is surveyed, so DWP = 1.

Unit unique ID for each arc, plus one labeled center for the inner heliostat field. IDs match those used in the \$CO data frame and the column names in the \$SS data.

bat DWP associated with size class Bat

sml DWP associated with size class Small

med DWP associated with size class Medium

lrg DWP associated with size class Large

### Carcass Observations (CO)

\$CO is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

carcID unique identifier for each carcass.

Unit identifier for which unit the given carcass was found at: "arc19", "arc65", etc, for arcs in the outer heliostat field, or "center", indicating the inner heliostat field.

Species species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

Size size: "bat", "lrg", "med", "sml"

Season "winter", "spring", "summer", or "fall"

Flux An optional field indicating whether there Was evidence the animal was killed by flux. "TRUE", or "False".

Field Optional indicator of whether the animal found in the "inner" or "outer" heliostat field?

Ring Optional note animals found in the outer heliostat field indicating which concentric ring the carcass was found in.



- Distance Optional note animals found in the outer heliostat field representing the perpendicular distance from the searcher the carcass was discovered at.
- DateFound dates entered in the same format as in \$\$\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$\$\$SearchDate
- X Distance in meters from the Western edge of the facility.
- Y Distance in meters from the Southern edge of the facility.

Source

solar\_powerTower

---

solar_PV	Photovoltaic Example Dataset
----------	------------------------------

---

Description

An example data set for estimating fatalities from a large photovoltaic solar generation facility.

The simulated site is organized into 300 arrays of panels. As observers walk north-south along paths between arrays, they look east or west down rows between solar panels 150 meters long, with 38 searchable rows per array. Observers consistently look for animals down one cardinal direction, making this a one-sided distance sample. Searches are scheduled on a seven day rotation, with 60 arrays searched per weekday. A sitewide clearout search is implemented before the first scheduled winter search.

The dataset consists of five parts: Data on carcass observations (CO) from array searches, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS), and density weighted proportion (DWP) of area searched at each array (which is an area adjustment factor to account for incomplete search coverage).

Usage

solar\_PV

Format

- solar\_PV is a list with 5 elements:
- SE Searcher efficiency trial data
  - CP Carcass persistence trial data
  - SS Search schedule parameters
  - DWP Density weighted proportion of area searched
  - CO Carcass observations

### Searcher Efficiency (SE)

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

"Search1", ..., "Search5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.

Distance the distance a carcass was placed from the observer's transect. Used in determining probability to detect with distance sampling.

### Carcass Persistence (CP)

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

Index unique ID for each carcass

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

### Search Schedule (SS)

\$SS is a data frame with a row for each date an array at the site was searched, a column of SearchDates, and a column for each array. In addition, there is an optional column to indicate the Season. The columns for distinct area (array) and the date column are required, and the names of the columns for search areas must match the names of areas used in the DWP and CO files.

SearchDate columns of dates when arrays were searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

Season "winter", "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

**Density Weighted Proportion (DWP)**

\$DWP is a data frame with a row for each array and columns for each carcass size class (labels must match those of the class factors in the carcass observation file). Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area). In this example, observers walk along transects separated by 150 meters, and search coverage is assumed to be 100 DWP = 1 for each unit. This requires that carcasses be placed at random locations in the field, even at distances from the transects that would make it unlikely to observe small carcasses.

**Unit** unique ID for each array. IDs match those used in the \$CO data frame and the column names in the \$SS data.

**bat** DWP associated with size class Bat

**sml** DWP associated with size class Small

**med** DWP associated with size class Medium

**lrg** DWP associated with size class Large

**Carcass Observations (CO)**

\$CO is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

**Index** unique identifier for each carcass.

**Unit** identifier for which unit the given carcass was found at: "arc19", "arc65", etc, for arcs in the outer heliostat field, or "center", indicating the inner heliostat field.

**Species** species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

**Size** size: "bat", "lrg", "med", "sml"

**Row** Optional indicator of which row within an array a carcass was found at.

**Distance** The perpendicular distance from the searcher's transect at which the carcass was discovered at.

**DateFound** dates entered in the same format as in \$\$\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$\$\$SearchDate

**X** UTM Easting of carcass.

**Y** UTM Northing of carcass.

**Source**

solar\_PV

solar\_trough

*Trough-based solar thermal power simulated example***Description**

An example data set for estimating fatalities from a trough-based solar thermal electric power generation facility. The simulated site is inspected daily along ten 2000 meter long transects, which run north-south. Observers look up to 150 meters away down the rows created by troughs (east-west). One sided distance sampling will be used, with observers looking consistently in one cardinal direction as they travel through the facility. A sitewide clearout search is implemented before the first scheduled winter search.

The dataset consists of five parts: Data on carcass observations (CO) from daily searches, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS), and density weighted proportion (DWP) of area searched for the rows within each transect (which is an area adjustment factor to account for incomplete search coverage).

**Usage**

solar\_trough

**Format**

solar\_trough is a list with 5 elements:

SE Searcher efficiency trial data

CP Carcass persistence trial data

SS Search schedule parameters

DWP Density weighted proportion of area searched

CO Carcass observations

**Searcher Efficiency (SE)**

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

"Search1", ..., "Search5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.

Distance the distance a carcass was placed from the observer's transect.

**Carcass Persistence (CP)**

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

Index unique ID for each carcass

Season "winter", "spring", "summer", or "fall"

Size "bat"; or "lrg", "med", or "sml" bird

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

**Search Schedule (SS)**

\$SS is a data frame with a row for each date a transect at the site was searched, a column of SearchDates, and a column for each transect. In addition, there is an optional column to indicate the Season. The columns for distinct area (array) and the date column are required, and the names of the columns for search areas must match the names of areas used in the DWP and CO files.

SearchDate columns of dates when a transect was searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

Season "winter", "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

**Density Weighted Proportion (DWP)**

\$DWP is a data frame with a row for each transect and columns for each carcass size class (labels must match those of the class factors in the carcass observation file). Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area). Since the whole site was searched, DWP is uniformly set equal to 1.

Unit unique ID for each transect. IDs match those used in the \$CO data frame and the column names in the \$SS data.

bat DWP associated with size class Bat

sml DWP associated with size class Small

med DWP associated with size class Medium

lrg DWP associated with size class Large

**Carcass Observations (CO)**

\$CO is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

Index unique identifier for each carcass.

Unit identifier for which transect the given carcass was found at. Values must match with DWP Transect values Search Schedule column names.

Species species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

Size size: "bat", "lrg", "med", "sml"

Row Optional indicator of which row within an array a carcass was found at.

Distance The perpendicular distance from the searcher's transect at which the carcass was discovered at.

DateFound dates entered in the same format as in \$\$\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$\$\$SearchDate)

X UTM Easting of carcass.

Y UTM Northing of carcass.

Source

solar\_trough

---

summary.estM	<i>Summarize total mortality estimation</i>
--------------	---

---

Description

summary defined for class estM objects

Usage

```
## S3 method for class 'estM'  
summary(object, ..., CL = 0.9)
```

Arguments

object	estM object
...	arguments to pass down
CL	confidence level

---

summary.gGeneric	<i>Summarize the gGeneric list to a simple table</i>
------------------	--

---

**Description**

methods for summary applied to a gGeneric list

**Usage**

```
## S3 method for class 'gGeneric'
summary(object, ..., CL = 0.9)
```

**Arguments**

object	gGeneric output list (each element is a named vector of gGeneric values for a cell in the model combinations)
...	arguments to be passed down
CL	confidence level

**Value**

a summary table of g values (medians and confidence bounds) for each cell combination within the gGeneric list

**Examples**

```
data(mock)
model_SE <- pkm(formula_p = p ~ HabitatType, formula_k = k ~ 1,
  data = mock$SE)
model_CP <- cpm(formula_l = l ~ Visibility, formula_s = s ~ Visibility,
  data = mock$CP, left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays")
avgSS <- averageSS(mock$SS)
ghatsGeneric <- estgGeneric(nsim = 1000, avgSS, model_SE, model_CP)
summary(ghatsGeneric)
```

---

summary.gGenericSize	<i>Summarize the gGenericSize list to a list of simple tables</i>
----------------------	---

---

**Description**

methods for summary applied to a gGenericSize list

**Usage**

```
## S3 method for class 'gGenericSize'
summary(object, ..., CL = 0.9)
```

**Arguments**

object	gGenericSize output list (each element is a size-named list of named vectors of gGeneric values for a cell in the model combinations)
...	arguments to be passed down
CL	confidence level

**Value**

a list of summary tables of g values (medians and confidence bounds) for each cell combination within the gGeneric list

**Examples**

```
data(mock)
pkmModsSize <- pkm(formula_p = p ~ HabitatType,
  formula_k = k ~ HabitatType, data = mock$SE,
  obsCol = c("Search1", "Search2", "Search3", "Search4"),
  sizeCol = "Size", allCombos = TRUE)
cpmModsSize <- cpm(formula_l = l ~ Visibility,
  formula_s = s ~ Visibility, data = mock$CP,
  left = "LastPresentDecimalDays",
  right = "FirstAbsentDecimalDays",
  dist = c("exponential", "lognormal"),
  sizeCol = "Size", allCombos = TRUE)
pkMods <- c("S" = "p ~ 1; k ~ 1", "L" = "p ~ 1; k ~ 1",
  "M" = "p ~ 1; k ~ 1", "XL" = "p ~ 1; k ~ 1"
)
cpMods <- c("S" = "dist: exponential; l ~ 1; NULL",
  "L" = "dist: exponential; l ~ 1; NULL",
  "M" = "dist: exponential; l ~ 1; NULL",
  "XL" = "dist: exponential; l ~ 1; NULL"
)
avgSS <- averageSS(mock$SS)
gsGeneric <- estgGenericSize(nsim = 1000, days = avgSS,
  modelSetSize_SE = pkmModsSize,
  modelSetSize_CP = cpmModsSize,
  modelSizeSelections_SE = pkMods,
  modelSizeSelections_CP = cpMods
)
summary(gsGeneric)
```



---

summary.splitFull	<i>Summarize results of mortality estimate splits</i>
-------------------	---

---

**Description**

Mortality estimates can be calculated for the various levels of splitting covariates such as season, species, or visibility class using [calcSplits](#), which gives full arrays of simulated M estimates (i.e., for each level of each splitting covariate, each discovered carcass, and each simulation draw). summary(splits, CL = 0.90, ...) gives summary statistics of the estimates.

**Usage**

```
## S3 method for class 'splitFull'
summary(object, CL = 0.9, ...)
```

**Arguments**

object	A splitFull object ( <a href="#">calcSplits</a> ) that gives simulated mortality estimates for all combinations of levels of 1 or 2 splitting covariates.
CL	desired confidence level for summary CIs (numeric scalar in (0, 1))
...	to be passed down

**Value**

an object of class splitSummary, which gives 5-number summaries for all combinations of levels among the splitting covariates in the splits. The 5-number summaries include the mean and alpha/2, 0.25, 0.5, 0.75, and 1 - alpha/2 quantiles of mortality estimates, where alpha = 1 - CL. A graphical representation of the results can be produced using plot(splits, CL, ...). For splits along CO covariates, the levels are organized alphabetically (but with numeric suffixes appearing in numeric order, e.g., "t1", "t2", "t10" rather than "t1", "t10", "t2").

---

tidyModelSetCP	<i>Tidy a CP model set</i>
----------------	----------------------------

---

**Description**

Remove bad fit models

**Usage**

```
tidyModelSetCP(modelSet)
```

**Arguments**

modelSet	cp model set of class cpmSet
----------	------------------------------

**Value**

a trimmed model set

---

tidyModelSetSE	<i>Tidy an SE model set</i>
----------------	-----------------------------

---

**Description**

Remove bad fit models

**Usage**

tidyModelSetSE(modelSet)

**Arguments**

modelSet            pk model set of class pkmSet

**Value**

a trimmed model set

---

transposeSplits	<i>Transpose a splitFull array (preserving attributes)</i>
-----------------	--

---

**Description**

Transpose a splitFull array (preserving attributes)

**Usage**

transposeSplits(splits)

**Arguments**

splits            a splitFull object, which is a list of n m x k arrays with attributes describing characteristics of the splits

**Value**

a list of m n x k arrays as a splitFull object

---

trimSetSize	<i>Trim a Model-Set-Size Complex to a Single Model Per Size</i>
-------------	---

---

**Description**

Select a single model from each carcass class (based on the model names).

**Usage**

```
trimSetSize(modSetSize, mods)
```

**Arguments**

modSetSize	modSetSize complex (cpm or pkm)
mods	named (according to carcass classes) vector of model names to use

**Value**

modSetSize reduced to a single model per carcass class

---

update_input	<i>Update the inputs when an event occurs</i>
--------------	---

---

**Description**

When an event occurs in the GenEst GUI, the input values may need to be updated. This function contains all of the possible updates based on the event options (or lacks any updates if the event doesn't require any).

**Usage**

```
update_input(eventName, rv, input, session)
```

**Arguments**

eventName	Character name of the event. One of "clear_all", "file_SE", "file_SE_clear", "file_CP", "file_CP_clear", "file_SS", "file_SS_clear", "file_DWP", "file_DWP_clear", "file_CO", "file_CO_clear", "class", "obsSE", "predsSE", "run_SE", "run_SE_clear", "outSEclass", "outSEp", "outSEk", "ltp", "fta", "predsCP", "run_CP", "run_CP_clear", "outCPclass", "outCPdist", "outCPI", "outCPs", "run_M", "run_M_clear", "split_M", "split_M_clear", "transpose_split", "run_g", "run_g_clear", or "outgclass".
rv	Reactive values list for the GenEst GUI.
input	input list for the GenEst GUI.
session	Environment for the GenEst GUI.

---

update_output	<i>Update the outputs when an event occurs</i>
---------------	--

---

**Description**

When an event occurs in the GenEst GUI, the output values may need to be updated. This function contains all of the possible updates based on the event options (or lacks any updates if the event doesn't require any).

**Usage**

```
update_output(eventName, rv, output, input)
```

**Arguments**

eventName	Character name of the event. One of "clear_all", "file_SE", "file_SE_clear", "file_CP", "file_CP_clear", "file_SS", "file_SS_clear", "file_DWP", "file_DWP_clear", "file_CO", "file_CO_clear", "class", "obsSE", "predsSE", "run_SE", "run_SE_clear", "outSEclass", "outSEp", "outSEk", "ltp", "fta", "predsCP", "run_CP", "run_CP_clear", "outCPclass", "outCPdist", "outCPI", "outCPs", "run_M", "run_M_clear", "split_M", "split_M_clear", "transpose_split", "run_g", "run_g_clear", or "outgclass".
rv	Reactive values list for the GenEst GUI.
output	output list for the GenEst GUI.
input	input list for the GenEst GUI

**Value**

Updated output list.

---

update_rv	<i>Update the reactive value list when an event occurs</i>
-----------	--

---

**Description**

When an event occurs in the GenEst GUI, the reactive values need to be updated. This function contains all of the possible updates based on the event options.

**Usage**

```
update_rv(eventName, rv, input)
```

Arguments

eventName	Character name of the event. One of "clear_all", "file_SE", "file_SE_clear", "file_CP", "file_CP_clear", "file_SS", "file_SS_clear", "file_DWP", "file_DWP_clear", "file_CO", "file_CO_clear", "class", "obsSE", "predsSE", "run_SE", "run_SE_clear", "outSEclass", "outSEp", "outSEk", "ltp", "fta", "predsCP", "run_CP", "run_CP_clear", "outCPclass", "outCPdist", "outCPI", "outCPs", "run_M", "run_M_clear", "split_M", "split_M_clear", "transpose_split", "run_g", "run_g_clear", "outgclass", "load_RP", "load_RPbat", "load_cleared", "load_PV", "load_trough", "load_powerTower", or "load_mock"
rv	Reactive values list for the GenEst GUI, created by <a href="#">initialReactiveValues</a> , which calls <a href="#">reactiveValues</a>
input	input list for the GenEst GUI.

Value

Updated rv list.

---

wind_cleared	<i>Wind cleared plot (60m) Search Example</i>
--------------	---

---

Description

A complete example data set for estimating fatalities from 60 m cleared plots at 23 out of 100 searches at a wind power facility. Data on carcass observations (CO) from a search of all terrain out to 60m from each of 100 turbines at a theoretical site, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS) parameters (for example, which turbines were searched on which days), and density weighted proportion (DWP) of area searched at each turbine (which is an area adjustment factor to account for incomplete search coverage).

Usage

wind\_cleared

Format

- wind\_cleared is a list with 5 elements:
- SE Searcher efficiency trial data
  - CP Carcass persistence trial data
  - SS Search schedule parameters
  - DWP Density weighted proportion of area searched
  - CO Carcass observations

### Searcher Efficiency (SE)

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

pkID unique ID for each carcass

Size "bat"; or "lrg", "med", or "sml" bird

Season "spring", "summer", or "fall"

Visibility indicator for visibility class of the ground, with "RP" for carcasses placed on a road or turbine pad, "M" for moderate visibility (e.g., plowed field; short, sparse vegetation), or "D" for difficult visibility

"s1", ..., "s5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "SN" could be used to indicate that the turbine was not searched because of snow, or "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.

### Carcass Persistence (CP)

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

cpID unique ID for each carcass

Size "bat"; or "lrg", "med", or "sml" bird

Season "spring", "summer", or "fall"

Visibility indicator for visibility class of the ground, with "RP" for carcasses placed on a road or turbine pad, "M" for moderate visibility (e.g., plowed field; short, sparse vegetation), or "D" for difficult visibility.

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

### Search Schedule (SS)

\$SS is a data frame with a row for each date a turbine at the site was searched, a column of SearchDates, and a column for each turbine. In addition, there is a column to indicate the Season. A column with search dates and columns for each turbine searched are required. Other columns are optional.

**SearchDate** columns of dates on which at least one turbine was searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

**Season** "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

**t1, etc.** unique ID for all turbines that were searched on at least one search date. Values are either 1 or 0, indicating whether the given turbine (column) was searched or not on the given date (row).

### Density Weighted Proportion (DWP)

**\$DWP** is a data frame with a row for each turbine and columns for each carcass size class. Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area).

**Turbine** unique ID for each turbine. IDs match those used in the \$CO data frame and the column names in the \$SS data.

**Size** bat, sml, med, lrg

**Season** "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

### Carcass Observations (CO)

**\$CO** is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

**carcID** unique identifier for each carcass: "x30", "x46", etc.

**Turbine** identifier for which turbine the given carcass was found at: "t19", "t65", "t49", etc.

**TurbineType** the type of turbine: "X", "Y" or "Z".

**DateFound** dates entered in the same format as in \$\$\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$\$\$SearchDate)

**Visibility** visibility class: "RP", "M", or "D", as described in \$CP and \$SE

**Species** species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

**SpeciesGroup** species group: "bat0", "bat1", "brd1", "brd2", "brd3"

**Size** size: "bat", "lrg", "med", "sml"

**Distance** distance from the turbine

### Source

wind\_cleared

wind\_RP

*Wind Road and Pad (120m) Example***Description**

This example dataset is based on 120 m radius road and pad searches of all 100 turbines at a theoretical site. The simulated site consists of 100 turbines, searched on roads and pads only, out to 120 meters. Search schedule differs by turbine and season, with more frequent searches in the fall, and a subset of twenty turbines searched at every scheduled search.

Data on carcass observations (CO) from searches, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS) parameters (for example, which turbines were searched on which days), and density weighted proportion (DWP) of area searched at each turbine (which is an area adjustment factor to account for incomplete search coverage).

**Usage**

wind\_RP

**Format**

wind\_RP is a list with 5 elements:

SE Searcher efficiency trial data

CP Carcass persistence trial data

SS Search schedule parameters

DWP Density weighted proportion of area searched

CO Carcass observations

**Searcher Efficiency (SE)**

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

pkID unique ID for each carcass

Size "bat"; or "lrg", "med", or "sml" bird

Season "spring", "summer", or "fall"

"s1", ..., "s5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "SN" could be used to indicate that the turbine was not searched because of snow, or "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.



### Carcass Persistence (CP)

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

cpID unique ID for each carcass

Size "bat"; or "lrg", "med", or "sml" bird.

Season "spring", "summer", or "fall"

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

### Search Schedule (SS)

\$SS is a data frame with a row for each date a turbine at the site was searched, a column of SearchDates, and a column for each turbine. In addition, there is a column to indicate the Season. A column with search dates and columns for each turbine searched are required. Other columns are optional.

SearchDate columns of dates on which at least one turbine was searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

Season "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

t1, etc. unique ID for all turbines that were searched on at least one search date. Values are either 1 or 0, indicating whether the given turbine (column) was searched or not on the given date (row).

### Density Weighted Proportion (DWP)

\$DWP is a data frame with a row for each turbine and columns for each carcass size class. Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area).

Turbine unique ID for each turbine. IDs match those used in the \$CO data frame and the column names in the \$SS data.

bat DWP associated with size class Bat.

sml DWP associated with size class Small.

med DWP associated with size class Medium.

lrg DWP associated with size class Large.

**Carcass Observations (CO)**

\$CO is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

carcID unique identifier for each carcass: "x30", "x46", etc.

Turbine identifier for which turbine the given carcass was found at: "t19", "t65", "t49", etc.

TurbineType the type of turbine: "X", "Y" or "Z".

DateFound dates entered in the same format as in \$\$\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$\$\$SearchDate

Species species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

SpeciesGroup species group: "bat0", "bat1", "brd1", "brd2", "brd3"

Size size: "bat", "lrg", "med", "sml"

Distance distance from the turbine

**Source**

wind\_RP

---

wind_RPbat	<i>Wind Bat-Only Road and Pad (120m) Example</i>
------------	--

---

**Description**

This example dataset considers only bats found on 120 m radius road and pad searches of all 100 turbines at a theoretical site. The simulated site consists of 100 turbines, searched on roads and pads only, out to 120 meters. Search schedule differs by turbine and season, with more frequent searches in the fall, and a subset of twenty turbines searched at every scheduled search.

Data on carcass observations (CO) from searches, field trials for estimating carcass persistence (CP) and searcher efficiency (SE), search schedule (SS) parameters (for example, which turbines were searched on which days), and density weighted proportion (DWP) of area searched at each turbine (which is an area adjustment factor to account for incomplete search coverage).

**Usage**

wind\_RPbat

**Format**

wind\_RPbat is a list with 5 elements:

SE Searcher efficiency trial data

CP Carcass persistence trial data

SS Search schedule parameters

DWP Density weighted proportion of area searched

CO Carcass observations

### Searcher Efficiency (SE)

\$SE is a data frame with each row representing the fate of a single carcass in the searcher efficiency trials. There are columns for:

pkID unique ID for each carcass

Season "spring", "summer", or "fall"

"s1", ..., "s5" fate of carcass on the 1st, 2nd, 3rd, 4th, and 5th search after placement. A value of 1 implies that a carcass was discovered by searchers, 0 implies the carcass was present but not discovered, and any other value is interpreted as "no search" or "carcass not present" and ignored in the model. In this data set, NA indicates that a carcass had been previously discovered and removed from the field. A user may use a variety of values to differentiate different reasons no search was conducted or the carcass was not present. For example, "SN" could be used to indicate that the turbine was not searched because of snow, or "NS" to indicate the search was not scheduled in that location at that time, or "SC" to indicate the carcass had been removed by scavengers prior to the search.

### Carcass Persistence (CP)

\$CP is a data frame with each row representing the fate of a single carcass in the carcass persistence trials. There are columns for:

cpID unique ID for each carcass

Season "spring", "summer", or "fall"

LastPresent, FirstAbsent endpoints of the interval bracketing the time the carcass was scavenged or otherwise removed from the field. For example, LastPresent = 2.04, FirstAbsent = 3.21 indicates that the carcass was last observed 2.04 days after being placed in the field and was noted missing 3.21 days after being placed. If the precise time of carcass removal is known (e.g., recorded by camera), then LastPresent and FirstAbsent should be set equal to each other. If a carcass persists beyond the last day of the field trial, LastPresent is the last time it was observed and FirstAbsent is entered as Inf or NA.

### Search Schedule (SS)

\$SS is a data frame with a row for each date a turbine at the site was searched, a column of SearchDates, and a column for each turbine. In addition, there is a column to indicate the Season. A column with search dates and columns for each turbine searched are required. Other columns are optional.

SearchDate columns of dates on which at least one turbine was searched. Format in this data is "%Y-%m-%d CDT", but time zone (CDT) is optional. A time stamp may be included if desired (e.g., 2018-03-20 02:15:41). Alternatively, \ can be used in place of -.

Season "spring", "summer", or "fall" to indicate which season the search was conducted in. Season is optional but may be used as a temporal covariate for fatality estimates.

t1, etc. unique ID for all turbines that were searched on at least one search date. Values are either 1 or 0, indicating whether the given turbine (column) was searched or not on the given date (row).

**Density Weighted Proportion (DWP)**

\$DWP is a data frame with a row for each turbine and columns for each carcass size class. Values represent the density-weighted proportion of the searched area for each size (or the fraction of carcasses that fall in the searched area).

Turbine unique ID for each turbine. IDs match those used in the \$CO data frame and the column names in the \$SS data.

bat Contains the DWP for each turbine, with respect to size class (in this case, bats only).

**Carcass Observations (CO)**

\$CO is a data frame with a row for carcass observed in the carcass searches and a number of columns giving information about the given carcass (date found, size, species, etc.)

carcID unique identifier for each carcass: "x30", "x46", etc.

Turbine identifier for which turbine the given carcass was found at: "t19", "t65", "t49", etc.

TurbineType the type of turbine: "X", "Y" or "Z".

DateFound dates entered in the same format as in \$SS\$SearchDate. Every date entered here is (and must be) included in the search schedule (\$SS\$SearchDate

Species species of the carcass: "BA", "BB", "BC", "BD", "BE", "LA", "LB", "LD", "LE", "MA", "MB", "SA", "SB", "SC", "SD", "SE", "SF", "SG"

SpeciesGroup species group: "bat0", "bat1", "brd1", "brd2", "brd3"

Distance Distance from the turbine.

**Source**

wind\_RPbat

# Index

## \* datasets

- mock, 56
- solar\_powerTower, 94
- solar\_PV, 97
- solar\_trough, 100
- wind\_cleared, 109
- wind\_RP, 112
- wind\_RPbat, 114

## \* package

- GenEst, 49

aboutContent (app\_content), 10

aboutPanel (app\_ui), 15

aicc, 5, 50, 63

aicc.cpm, 5

aicc.cpmSet, 6

aicc.cpmSetSize, 6

aicc.pkm, 7

aicc.pkmSet, 8

aicc.pkmSetSize, 8

aicc.pkmSize, 9

alogit, 50

alogit (logit), 54

analysisPanel (app\_ui), 15

app\_content, 10

app\_download\_functions, 11

app\_msg\_functions, 12

app\_output\_utilities, 13

app\_panels, 13

app\_server, 14

app\_ui, 15

app\_ui\_utilities, 17

app\_utilities, 18

app\_widgets, 19

averageSS, 20, 50

b (app\_ui\_utilities), 17

big (app\_ui\_utilities), 17

calcg, 21, 50

calcRate, 22, 50

calcSplits, 23, 25, 50, 76, 105

calcTsplits, 25, 50

cButtonStyle (app\_ui\_utilities), 17

center (app\_ui\_utilities), 17

checkComponents, 26

checkDate, 26, 51

checkSpecificModelCP, 27

checkSpecificModelSE, 27

classText (app\_output\_utilities), 13

clearNotifications (app\_msg\_functions),  
12

CO\_DWP, 29, 51

combinePreds, 28, 51

combinePredsAcrossModels, 28, 51

countCarcs, 29, 50

CPcols, 30, 51

CPdistOptions, 30

cpLogLik, 30, 50

cpm, 5, 30, 31, 32, 36, 41, 50, 70, 85–87

cpm0 (cpm), 31

CPMainPanel (app\_ui), 15

cpmCPCellPlot, 35, 51

cpmFail, 36, 51

cpmSet, 6, 36–38, 50, 71, 77

cpmSet (cpm), 31

cpmSetFail, 36, 51

cpmSetFailRemove, 37, 51

cpmSetSize, 6, 37, 38, 50

cpmSetSizeFail, 37, 51

cpmSetSizeFailRemove, 38, 51

cpmSetSpecCPCellPlot, 38, 51

cpmSize, 50

cpmSize (cpm), 31

CPPanel (app\_ui), 15

CPSidebar (app\_ui), 15

createvtext (app\_content), 10

dataDownloadWidget (app\_widgets), 19

dataInputPanel (app\_ui), 15

- dataInputSidebar (app\_ui), 15
- dataInputWidget (app\_widgets), 19
- dataTabPanel (app\_panels), 13
- dateCols, 39, 51
- dateToDay, 39, 51
- defineUnitCol, 40, 51
- desc, 40, 50
- disclaimersContent (app\_content), 10
- disclaimersPanel (app\_ui), 15
- disclaimerUSGS (app\_content), 10
- disclaimerWEST (app\_content), 10
- d1ModTabSE, 41, 51
- downloadCPFig (app\_download\_functions), 11
- downloadCPmod (app\_download\_functions), 11
- downloadgFig (app\_download\_functions), 11
- downloadgres (app\_download\_functions), 11
- downloadMFig (app\_download\_functions), 11
- downloadMres (app\_download\_functions), 11
- downloadSEFig (app\_download\_functions), 11
- downloadSEmod (app\_download\_functions), 11
- downloadsPanel (app\_ui), 15
- downloadTable (app\_download\_functions), 11
- DWPCols, 42, 51
- dwpm, 42, 50, 87
- estg, 43, 50
- estgGeneric, 45, 50, 72
- estgGenericSize, 46, 50, 73
- estM, 23, 47, 50
- estText (app\_output\_utilities), 13
- eval, 15
- eventReaction (app\_server), 14
- expandModelSetCP, 49, 51
- formula, 32, 60
- GeneralInputSidebar (app\_ui), 15
- GeneralInputsPanel (app\_ui), 15
- GenEst, 49
- GenEstAcknowledgements (app\_content), 10
- GenEstAuthors (app\_content), 10
- GenEstGUIauthors (app\_content), 10
- GenEstInlineCSS (app\_ui\_utilities), 17
- GenEstLicense (app\_content), 10
- GenEstLogos (app\_content), 10
- GenEstServer (app\_server), 14
- GenEstShinyJS (app\_ui\_utilities), 17
- GenEstUI (app\_ui), 15
- gettingStartedContent (app\_content), 10
- gettingStartedPanel (app\_ui), 15
- gGeneric, 50
- gGenericSize, 50
- gMainPanel (app\_ui), 15
- gPanel (app\_ui), 15
- gSidebar (app\_ui), 15
- helpPanel (app\_ui), 15
- initialOutput (app\_output\_utilities), 13
- initialReactiveValues, 18, 109
- initialReactiveValues (app\_utilities), 18
- kFixedWidget (app\_widgets), 19
- kFixedWidgetHeader (app\_widgets), 19
- kFixedWidgetRow (app\_widgets), 19
- li (app\_ui\_utilities), 17
- loadedDataPanel (app\_ui), 15
- logit, 50, 54
- ltranspose, 50, 55
- matchCells, 51
- matchCells (model\_utility\_functions), 56
- MMainPanel (app\_ui), 15
- mock, 50, 56
- model\_utility\_functions, 56
- modelInputWidget (app\_widgets), 19
- modelOutputPanel (app\_panels), 13
- modelOutputWidget (app\_widgets), 19
- modelRunWidget (app\_widgets), 19
- modelSelectionWidget (app\_widgets), 19
- modelSelectionWidgetHeader (app\_widgets), 19
- modelSelectionWidgetRow (app\_widgets), 19
- modelSetCells (model\_utility\_functions), 56
- modelSetModelCells (model\_utility\_functions), 56

- modelSetModelPredictors
  - (model\_utility\_functions), 56
- modelSetPredictors
  - (model\_utility\_functions), 56
- modNamePaste (app\_utilities), 18
- modNameSplit (app\_utilities), 18
- MPanel (app\_ui), 15
- msgFracNote (app\_msg\_functions), 12
- msgList (app\_msg\_functions), 12
- msgModDone (app\_msg\_functions), 12
- msgModFail (app\_msg\_functions), 12
- msgModPartialFail (app\_msg\_functions), 12
- msgModRun (app\_msg\_functions), 12
- msgModSENObs (app\_msg\_functions), 12
- msgModWarning (app\_msg\_functions), 12
- msgSampleSize (app\_msg\_functions), 12
- msgSplitFail (app\_msg\_functions), 12
- msgSSavgFail (app\_msg\_functions), 12
- msgSSinputFail (app\_msg\_functions), 12
- MSidebar (app\_ui), 15
- navbar (app\_ui\_utilities), 17
- obsCols\_fta, 57
- obsCols\_ltp, 57
- obsCols\_SE, 51, 58
- observeEvent, 15
- ol (app\_ui\_utilities), 17
- optim, 34, 63
- pickSizeclass (app\_utilities), 18
- pkLogLik, 50, 58
- pkm, 8, 9, 50, 58, 59, 61, 64, 74, 85, 86, 89
- pkm0 (pkm), 59
- pkmFail, 51, 64
- pkmParamPlot, 64
- pkmSECellPlot, 65
- pkmSet, 8, 50, 66, 67, 75, 79, 80
- pkmSet (pkm), 59
- pkmSetAllFail, 51, 66
- pkmSetFail, 51, 66
- pkmSetFailRemove, 51, 67
- pkmSetSize, 50, 67, 68
- pkmSetSizeFail, 51, 67
- pkmSetSizeFailRemove, 51, 68
- pkmSetSpecParamPlot, 68
- pkmSetSpecSECellPlot, 69
- pkmSize, 50
- pkmSize (pkm), 59
- pllogis, 69
- plot.cpm, 70
- plot.cpmSet, 71
- plot.estM, 71, 93
- plot.gGeneric, 72
- plot.gGenericSize, 73
- plot.pkm, 63, 74
- plot.pkmSet, 75
- plot.splitFull, 75
- plot.splitSummary, 75, 76
- plotCPCells, 51, 77
- plotCPFigure, 51, 77
- plotCPHeader, 51, 78
- plotNA (app\_utilities), 18
- plotSEBoxPlots, 78
- plotSEBoxTemplate, 79
- plotSECells, 79
- plotSEFigure, 80
- plotSEHeader, 80
- ppersist, 41, 50, 81
- predsCols, 51, 81
- prepPredictors, 82
- prepSizeclassText (app\_utilities), 18
- prepSS, 22, 44, 50, 82
- preTextMaker (app\_widgets), 19
- prettyModTabCP, 51, 83
- prettyModTabSE, 51, 84
- prettySplitTab, 51, 84
- print.cpm, 85
- print.pkm, 85
- qpk, 50, 63, 86
- rcp, 41, 50, 86
- rdwp, 50, 87
- reaction (app\_server), 14
- reactionMessageDone (app\_server), 14
- reactionMessageRun (app\_server), 14
- reactiveValues, 18, 109
- readCSV, 88
- refMod, 50, 88
- removeCols, 89
- reNULL (app\_output\_utilities), 13
- reVal (app\_utilities), 18
- rpkm, 50, 63, 86, 89, 89
- runApp, 90
- runGenEst, 90

SEcols, [90](#)  
selectData (app\_utilities), [18](#)  
selectedDataPanel (app\_panels), [13](#)  
SEMainPanel (app\_ui), [15](#)  
SEPanel (app\_ui), [15](#)  
SEpanel, [90](#)  
SEsi, [50](#), [91](#)  
SEsi0, [51](#), [92](#)  
SEsi\_left, [51](#), [92](#)  
SEsi\_right, [51](#), [93](#)  
SESidebar (app\_ui), [15](#)  
setFigH (app\_output\_utilities), [13](#)  
setFigW (app\_output\_utilities), [13](#)  
setkNeed (app\_utilities), [18](#)  
setNotSuspending  
    (app\_output\_utilities), [13](#)  
simpleMplot, [50](#), [93](#)  
sizeCols, [51](#), [94](#)  
small (app\_ui\_utilities), [17](#)  
solar\_powerTower, [50](#), [94](#)  
solar\_PV, [50](#), [97](#)  
solar\_trough, [50](#), [100](#)  
splitButtonWidget (app\_widgets), [19](#)  
splitFull, [50](#)  
splitSummary, [50](#)  
style (app\_ui\_utilities), [17](#)  
summary.estM, [102](#)  
summary.gGeneric, [103](#)  
summary.gGenericSize, [103](#)  
summary.splitFull, [75](#), [105](#)  
  
tidyModelSetCP, [50](#), [105](#)  
tidyModelSetSE, [50](#), [106](#)  
transposeSplits, [50](#), [106](#)  
trimSetSize, [51](#), [107](#)  
  
u (app\_ui\_utilities), [17](#)  
ul (app\_ui\_utilities), [17](#)  
update\_input, [107](#)  
update\_output, [108](#)  
update\_rv, [108](#)  
updateColNames\_size (app\_utilities), [18](#)  
updateSizeclasses (app\_utilities), [18](#)  
updatesizeCol (app\_utilities), [18](#)  
  
widgetMaker (app\_widgets), [19](#)  
wind\_cleared, [50](#), [109](#)  
wind\_RP, [50](#), [112](#)  
wind\_RPbat, [50](#), [114](#)