

# Package ‘acmeR’

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**Title** Implements ACME Estimator of Bird and Bat Mortality by Wind Turbines

**Version** 1.1.0

**Description** Implementation of estimator ACME, described in Wolpert (2015), ACME: A Partially Periodic Estimator of Avian & Chiropteran Mortality at Wind Turbines (submitted). Unlike most other models, this estimator supports decreasing-hazard Weibull model for persistence; decreasing search proficiency as carcasses age; variable bleed-through at successive searches; and interval mortality estimates. The package provides, based on search data, functions for estimating the mortality inflation factor in Frequentist and Bayesian settings.

**Depends** R (>= 3.1.1)

**Imports** foreign (>= 0.8-63), grDevices (>= 3.1.1), graphics (>= 3.1.1), stats (>= 3.1.1), utils (>= 3.1.1)

**License** MIT + file LICENSE

**LazyData** true

**Suggests** knitr, devtools

**VignetteBuilder** knitr

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acme.est	<i>Parameter Estimation for Persistence and Search Proficiency</i>
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### Description

Finds Maximum Likelihood Estimates Weibull persistence parameters, and for exponentially decreasing search proficiency.

### Usage

```
acme.est(rd, fname = "acme.est")
```

### Arguments

rd	list output from acme::read.data()
fname	file name to which the output parameters are saved

### Value

acme.est returns a list with the following components:

params	5-element vector: alpha and rho parameters for the Weibull persistence distribution, a and b parameters for the exponentially decreasing search proficiency, and bt as the bleed-through rate
info	list of select system information inherited from acme::read.data() output

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acme.post	<i>Posterior Calculation of Mortality</i>
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### Description

Calculates and plots the posterior distribution of mortality count.

### Usage

```
acme.post(C = 0, Rstar = 0.2496, T = 0.174, gam = c(0.5, 0.9), I = 7,
  xlim, Mmax = 200, xi = 1/2, lam = 0, ps = "", plotit = TRUE)
```

**Arguments**

C	Observed mortality count. Non-negative integer.
Rstar	ACME inverse-inflation factor $R^*$ , reported by <code>acme.summary()</code> as "Rstar."
T	The first term in recursive calculation of Rstar, from <code>acme.summary</code> .
gam	Values for highest posterior density credible interval.
I	Interval length, days.
xlim	2-element vector of plotting ranges. Default first element of 0, second element of 2 greater than maximum calculated for larger hpd.
Mmax	Maximum value for which posterior probability is calculated.
xi	First parameter of gamma prior. Default is 1/2 for Objective prior.
lam	Second parameter of gamma prior. Default is 0 for Objective prior.
ps	Postscript message. Default empty string suppresses output.
plotit	Boolean to determine if plot should be created. Default is TRUE.

**Details**

Assuming a  $\text{Gamma}(\xi, \lambda)$  on the average daily mortality rate  $m$ , this model treats the mortality  $M$  for the current period as Poisson-distributed with mean  $m \cdot I$ . The carcass count  $C$  will include "new" carcasses with a  $\text{Bi}(M, T)$  distribution as well as "old" carcasses (if  $bt > 0$ ). For derivation of resulting conditional pdf see Wolpert (2015).

**Value**

The function invisibly returns a vector with input  $C$ , ACME estimate, posterior mean, and credible interval ranges. If `plotit = TRUE`, it also plots the posterior probabilities for values in the range of `xlim`, and prints a short summary including the true coverage probabilities.

The parameter `plotit` should almost never be set to `FALSE` - if the user desires the vector that is invisibly returned, it is suggested to use the wrapper function `acme.table`.

**Examples**

```
acme.post(C=5, Rstar = .25, T = .2, gam = c(.9, .95), I = 5, xi = .5, lam = 0)
```

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`acme.summary`

*Report Summary of ACME Dataset*

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**Description**

Provide various summaries for an event-level dataset, including estimates and plots.

**Usage**

```
acme.summary(fname, spec = "", blind = TRUE, ps = "", plot_scav = FALSE,
  plot_srch = FALSE)
```

**Arguments**

<code>fname</code>	Data, either a string for csv files or a data frame name
<code>spec</code>	Species subset. Default (empty string) includes all species in data set.
<code>blind</code>	Logical. If TRUE, assumes FT are unaware of carcasses.
<code>ps</code>	Character string, name of Postscript file generated. Default (empty string) displays plots on console and does not generate postscript file.
<code>plot_scav</code>	Logical. If TRUE, persistence plot is output. Default is FALSE.
<code>plot_srch</code>	Logical. If TRUE, search efficiency plot is output. Default is FALSE.

**Details**

This function takes in an event-level dataset of placement and searches, and reports various statistics related to ACME. This includes empirical information such as search intervals, carcass information summaries, and available scavenger information. This function also reports on estimated values  $R^*$  and bleed-through rate. All information is printed to the console.

Users have the option of creating plots of empirical data overlaid on estimated distributions for both persistence and search efficiency.

**Value**

`acme.summary` returns a list with the following components:

<code>params</code>	5-element vector: alpha and rho parameters for the Weibull persistence distribution, a and b parameters for the exponentially decreasing search proficiency, and bt as the bleed-through parameter.
<code>Rstar</code>	Reduction factor (inverse of the inflation factor for mortality counts).
<code>T</code>	First component of $R^*$ - carcass fraction found on first search.
<code>I</code>	Average interval length, in days.

**Examples**

```
## Not run:
#If altamont is a file in the working directory
acme.summary('altamont.csv', spec = "BHCO")

#To include plots
acme.summary('altamont.csv',spec = "BHCO", plot_scav = TRUE, plot_srch = TRUE)

## End(Not run)
```

acme.table

*Posterior Summary of Mortality***Description**

Calculates and summarizes the posterior distribution of mortality count.

**Usage**

```
acme.table(C = 0, Rstar = 0.2496, T = 0.174, gam = c(0.5, 0.9), I = 7,
           Mmax = 200, xi = 1/2, lam = 0)
```

**Arguments**

C	Observed mortality count. Non-negative integer or vector.
Rstar	ACME inverse-inflation factor $R^*$ , reported by <code>acme.summary()</code> as "Rstar."
T	The first term in recursive calculation of Rstar, from <code>acme.summary</code> .
gam	Values for highest posterior density credible interval.
I	Interval length, days.
Mmax	Maximum value for which posterior probability is calculated.
xi	First parameter of gamma prior. Default is 1/2 for Objective prior.
lam	Second parameter of gamma prior. Default is 0 for Objective prior.

**Details**

Assuming a  $\text{Gamma}(\xi, \text{lam})$  on the average daily mortality rate  $m$ , this model treats the mortality  $M$  for the current period as Poisson-distributed with mean  $m \cdot I$ . The carcass count  $C$  will include "new" carcasses with a  $\text{Bi}(M, T)$  distribution as well as "old" carcasses (if  $bt > 0$ ). For derivation of resulting conditional pdf see Wolpert (2015).

This function calls `acme.post` but suppresses plotting.

**Value**

`acme.table` returns a table which includes ACME estimate ( $M_{\text{hat}}$ ), posterior mean, and highest posterior credible intervals for probabilities as specified by the parameter `gam`.

**Examples**

```
acme.table(C=0:5, Rstar = 0.2496, T = 0.174)
```

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altamont

*Placement and Searches for Carcasses at Altamont*


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### Description

An event-level dataset containing information pertinent to the ACME model, from Warren-Hicks et al. (2012), "Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities."

### Usage

```
altamont
```

### Format

A data frame with 3984 observations and 6 variables:

**Date** character - Date of the event

**Time** character - Time of the event

**ID** character - ID of the carcass

**Species** character - 4-letter AOU species code

**Event** character - Type of event - Check, Place, or Search

**Found** logical - TRUE if carcass was discovered

### Source

Warren-Hicks, W., Newman, J., Wolpert, R. L., Karas, B., and Tran, L. (2012), Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities, California Wind Energy Association publication CEC-500-2012-086.

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read.data

*Construct ACME Sufficient Statistics*


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### Description

Reads in an event-level dataset of carcass placements and searches and constructs a carcass-level and search-level table of sufficient statistics.

### Usage

```
read.data(fname = "acme-sim.csv", spec = "", blind = TRUE,
          tz = "PST8PDT")
```

**Arguments**

fname	Data, either a string for csv files or a data frame name
spec	Species subset. Default is empty string.
blind	logical. If TRUE, ensures FT are always unaware of carcasses
tz	Time Zone. Default is US West Coast

**Value**

read.data returns an invisible list with components:

scav	carcass-level table of removal data
srch	event-level table or searcher proficiency data
Ik	summary (count, average, sd) of FT Search Intervals
Sk	summary (count, average, sd) PFM check intervals
NP.Spec	number of without a "Placed" event
NP.ID	number of birds without a "Placed" event
fn	name of data - parameter fname
Info	list of select system information

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Rst

*Evaluate ACME Reduction Factor R\**


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**Description**

Calculates  $R^*$ , the reduction factor (inverse of inflation factor for mortality estimates), based on parameter estimates and maximum number of previous search intervals to consider.

**Usage**

```
Rst(Iij = 7, arabt = c(alp = 0.4695, rho = 0.0809, a = 1.0322, b = 0.0706,
  bt = 0.9573), kmax = 5, v = FALSE)
```

**Arguments**

Iij	Search interval length (days)
arabt	5-element vector: alpha and rho parameters for the Weibull persistence distribution, a and b parameters for the Exponential search proficiency distribution, and bt as the bleed-through parameter
kmax	number of intervals to use in calculation - includes current interval and number of look-back intervals. Minimum is 1 (only current interval).
v	logical. Verbose flag - see Value for what is reported

**Value**

If verbose, returns upper bound on truncation error (total and as a fraction of  $R^*$ ),  $R^*$  calculated from only current interval, and expected fraction of "old" carcasses discovered. If not verbose, returns only  $R^*$ .



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