Package 'distance.sample.size'

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Type Package

Title Calculates Study Size Required for Distance Sampling

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Description Calculates the study size (either number of detections, or proportion of region that should be covered) to achieve a target precision for the estimated abundance. The calculation allows for the penalty due to unknown detection function, and for overdispersion. The user must specify a guess at the true detection function.

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LazyData TRUE

Imports MASS

RoxygenNote 5.0.1

NeedsCompilation no

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R topics documented:

`calculate.mean.detection.prob` *Mean detection probability.*

Description

Calculates the mean detection probability over the range of observation.

Usage

```
calculate.mean.detection.prob(theta = theta, w, detection.function)
```

Arguments

`theta`	The detection function parameters. A single value for halfnormal, or a vector of two values for hazard rate.
`w`	The maximum range of observation. Objects at distance greater than w from the observer are assumed to never be recorded.
`detection.function`	The detection function. Only "halfnormal" and "hazard" (hazard rate) are supported at present.

Value

The mean detection probability over the distance range [0,w].

References

Buckland S, Anderson D, Burnham K, Laake J and Borchers D (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

Clark, R. G. (2016), "Statistical efficiency in distance sampling," PLoS One, forthcoming, www.plosone.org

Examples

```
calculate.mean.detection.prob(detection.function="hazard",theta=c(0.448,2),w=1) # should be 0.6
```

`calculate.theta.given.mean.detection.prob` *Function for internal use only.*

Description

Calculates the value of the first element of the detection parameters theta based on a supplied value of the average detection rate. Primarily for internal use.

Usage

```
calculate.theta.given.mean.detection.prob(detection.function, theta2, w,
  mean.detection.prob.value, stop = F)
```

Arguments

`detection.function`	The detection function. Only "halfnormal" and "hazard" (hazard rate) are supported at present.
`theta2`	The second detection parameter for the hazard rate model (the shape parameter). Not required for halfnormal.
`w`	The maximum range of observation. Objects at distance greater than w from the observer are assumed to never be recorded.
`mean.detection.prob.value`	The mean detection probability over the range of observation.
`stop`	Set to T to open a browser window (for debugging purposes)

Value

The value of the first parameter of theta.

References

Buckland S, Anderson D, Burnham K, Laake J and Borchers D (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

Clark, R. G. (2016), "Statistical efficiency in distance sampling," PLoS One, forthcoming, www.plosone.org

Examples

```
calculate.theta.given.mean.detection.prob(detection.function="hazard",theta2=2,w=1,
mean.detection.prob.value=0.6) # should equal 0.448
calculate.theta.given.mean.detection.prob(detection.function="halfnormal",w=1,
mean.detection.prob.value=0.6) # should equal 0.502
```

`detection.prob` *Calculate detection probabilities.*

Description

Calculates the detection probability at one or more distances.

Usage

```
detection.prob(d, detection.function = c("halfnormal", "hazard"), theta,
  deriv, stop = F)
```

Arguments

`d`	The distance or distances of interest.
`detection.function`	The detection function. Only "halfnormal" and "hazard" (hazard rate) are supported at present.
`theta`	The detection function parameters. A single value for halfnormal, or a vector of two values for hazard rate.
`deriv`	Optional numeric value specifying whether a derivative is required. If missing, the function returns the detection probabilities at distances d. If deriv is equal to 1 or 2, the derivatives of the detection function with respect to theta[deriv] at d are returned. Note that the halfnormal detection function has only one parameter, so setting deriv=2 and detection.function="halfnormal" will result in an error.
`stop`	Set to T to open a browser window (for debugging purposes)

Value

A vector of detection probabilities corresponding to the distances in d.

References

Buckland S, Anderson D, Burnham K, Laake J and Borchers D (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

Clark, R. G. (2016), "Statistical efficiency in distance sampling," PLoS One, forthcoming, www.plosone.org

Examples

```
dvalues <- seq(from=0,to=1,by=0.001)
dprobs <- detection.prob(d=dvalues,detection.function="hazard",theta=c(0.448,2))
plot(dvalues,dprobs,type="l",ylim=c(0,1))
```

`distance.sample.size` *Required study size in distance sampling.*

Description

Calculates the study size needed to achieve a target coefficient of variation for the abundance estimator in conventional distance sampling.

Usage

```
distance.sample.size(cv.pct, N = Inf, overdispersion = 2,
  detection.function, theta, mean.detection.prob.value,
  shape.hazard = c("verynarrow", "narrow", "wide"), w, stop = F)
```

Arguments

`cv.pct`	The required cv expressed as a percentage. For example, use cv=15 for a coefficient of variation of 15%.
`N`	Optional. The total abundance of the objects or animals of interest in the whole region of interest. In practice may not be known, in which either a rough estimate can be used, or N can be set to infinity (the default) which is equivalent to assuming that the fraction of all animals observed is small. Setting N to Inf results in an over-estimation (usually slight) of the required sample size.
`overdispersion`	The factor by which the variance of the number of objects observed is inflated due to overdispersion. Burnham, Anderson and Laake (1985) suggest that a value of 2 may be fairly typical in practice.
`detection.function`	The detection function. Only "halfnormal" and "hazard" (hazard rate) are supported at present.
`theta`	The detection function parameters. A single value for halfnormal, or a vector of two values for hazard rate.
`mean.detection.prob.value`	An optional value specifying the mean detection probability over the range of observation. If this is supplied, the first element of theta should be set to NA, and theta[1] will be calculated using mean.detection.prob.value and detection.function.
`shape.hazard`	Can be used to specify theta according to 3 preset hazard rate models (the ones used in the simulation in Clark 2016). If shape.hazard is supplied, detection.function should be "hazard", theta need not be supplied, and w need not be supplied as is set to 1 (results in detection probabilities of 0.1 to 0.15 at w). All three options have an average detection rate of 0.6.
`w`	The maximum range of observation. Objects at distance greater than w from the observer are assumed to never be recorded.
`stop`	Set to T to open a browser window (for debugging purposes)

Details

It may be impossible to achieve the target precision, even if the expected sample size is equal to its maximum possible value of N divided by the mean detection probability. In this case, missing values are returned for the required sample size and coverage proportion, and a warning is issued.

Value

A vector with named values giving: the required expected sample size, the required coverage rate (i.e. the proportion P of the region falling within distance w of an observer's path), the penalty due to unknown detection parameters when P«1, and the penalty due to unknown detection parameters for the required value of P. The user can then use either the required coverage rate to determine how closely to space transect lines (or how many points to select in a point transect study)

References

Buckland S, Anderson D, Burnham K, Laake J and Borchers D (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

Burnham KP, Anderson DR, Laake JL (1985), "Efficiency and bias in strip and line transect sampling". The Journal of Wildlife Management, pp. 1012-1018.

Clark, R. G. (2016), "Statistical efficiency in distance sampling," PLoS One, forthcoming, www.plosone.org

Examples

```
distance.sample.size(cv.pct=15,N=1000,detection.function="hazard",shape.hazard="narrow")
```

DS.penalty *Variance penalty due to unknown detection parameters.*

Description

Calculates the variance penalty factor due to unknown detection parameters in conventional distance sampling.

Usage

```
DS.penalty(detection.function = c("halfnormal", "hazard"), theta,
  mean.detection.prob.value, w, P = 0, stop = F)
```

Arguments

`detection.function`	The detection function. Only "halfnormal" and "hazard" (hazard rate) are supported at present.
`theta`	The detection function parameters. A single value for halfnormal, or a vector of two values for hazard rate.

`mean.detection.prob.value`
: An optional value specifying the mean detection probability over the range of observation. If this is supplied, the first element of theta should be set to NA, and theta[1] will be calculated using mean.detection.prob.value and detection.function.

`w`
: The maximum range of observation. Objects at distance greater than w from the observer are assumed to never be recorded.

`P`
: The proportion of the region of interest that is within w of an observer's path. P=0 may be assumed if the region is large relative to the observed area.

`stop`
: Set to T to open a browser window (for debugging purposes)

Value

A single numeric value giving the asymptotic factor by which the variance is inflated due to unknown detection parameters.

References

Buckland S, Anderson D, Burnham K, Laake J and Borchers D (2001). Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford: Oxford University Press.

Clark, R. G. (2016), "Statistical efficiency in distance sampling," PLoS One, forthcoming, www.plosone.org

Examples

```
DS.penalty(detection.function="hazard",theta=c(NA,2),mean.detection.prob.value=0.6,w=1)
```

Index