Package: bbouretro (via r-universe)

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Title Traditional Survival, Recruitment and Population Growth Methods

Version 0.1.0

Description Estimates annual survival, recruitment and population growth using the traditional methods. This package is part of the bbou suite of tools.

License Apache License (>= 2)

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BugReports https://github.com/poissonconsulting/bbouretro/issues

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Contents

`bbr_calf_cow_ratio` *Estimate Calf-Cow Ratio.*

Description

Estimate Calf-Cow Ratio.

Usage

```
bbr_calf_cow_ratio(
  x,
  adult_female_proportion = 0.65,
  sex_ratio = 0.5,
  variance = "bootstrap",
  year_start = 4L
)
```

Arguments

`x`	A data frame that has recruitment data.
`adult_female_proportion`	Assumed or estimated proportion of females in the population used to assign unknown sex caribou. Values must be between 0 and 1. Can be set to 0 to exclude unknown sex caribou from recruitment estimates. The default is set at 0.65.
`sex_ratio`	Sex ratio of caribou at birth used to assign calves and yearlings as male or female. Sex ratio is defined as the proportion females at birth. Values must be between 0 and 1. The default is set at 0.5.
`variance`	Estimate variance using "binomial" or "bootstrap". The default is set as "bootstrap".
`year_start`	A whole number between 1 and 12 indicating the month of the start of the caribou (i.e., biological) year. By default, April is set as the start of the caribou year.

Format

The return object has these columns:

PopulationName Population name

Year Year sampled

estimate Calf-Cow ratio estimate

lower Confidence limit

upper Confidence limit

groups Groups sampled

female_calves Estimated female calves

females Estimated adult females

Details

x needs to be formatted in a certain manner. To confirm the input data frame is in the right format you can use the bbd_chk_data_recruitment function. See the `vignette("methods", package = "bbouretro")` for the equations used in this function.

User's can input the assumed proportion of females in the population (to estimate females from adult caribou that have unknown sex) as well as sex ratio at birth.

Value

A data frame. The columns are listed in the format section.

Examples

```
calfcow_est <- bbr_calf_cow_ratio(
  bboudata::bbourecruit_a,
  adult_female_proportion = 0.65,
  sex_ratio = 0.5,
  variance = "binomial"
)
calfcow_est <- bbr_calf_cow_ratio(
  bboudata::bbourecruit_a,
  adult_female_proportion = 0.60,
  sex_ratio = 0.65,
  variance = "bootstrap"
)
```

bbr_cc_to_rec *Calf Cow Ratio to Recruitment*

Description

The calf cow ratios is simply the number of calves divided by the number of cows. As described by DeCesare et al. (2012) in order to convert the calf cow ratio to the female recruitment rate it is necessary to multiple the calf cow ratio by the sex ratio to get the female calf to cow ratio and then divide that number by itself plus 1 to get the female recruitment rate ie female calves divided by all females. To perform the inverse conversion see `bbr_rec_to_cc()`

Usage

```
bbr_cc_to_rec(x, sex_ratio = 0.5)
```

Arguments

`x`	A numeric vector of the calf:cow ratio
`sex_ratio`	A

Value

A numeric vector of the equivalent recruitment rate

See Also

`bbr_rec_to_cc()`

Examples

```
bbr_cc_to_rec(c(0, 1, 0.5, NA))
```

bbr_growth *Simulate population growth*

Description

This function uses the output of `bbr_survival()` and `bbr_recruitment()` to estimate population growth (λ) using the Hatter-Bergerud equation (Hatter and Bergerud, 1991). Monte Carlo simulation is used to generate confidence limits.

Usage

```
bbr_growth(survival, recruitment)
```

Arguments

survival	A data frame generated by bbr_survival().
recruitment	A data frame generated by bbr_recruitment().

Details

See the vignette("methods", package = "bbouretro") for descriptions of the equations used. The raw_values can be plotted using bbr_plot_growth_distributions() and the summary data frame can be output using bbr_growth_summarize() or plotted using bbr_plot_growth().

Value

A data.frame.

References

Hatter, Ian, and Wendy Bergerud. 1991. "Moose Recruitment, Adult Mortality and Rate of Change" 27: 65–73.

Examples

```
## Not run:
recruitment_est <- bbr_recruitment(bboudata::bbourecruit_a)
survival_est <- bbr_survival(bboudata::bbousurv_a)

growth_est <- bbr_growth(survival_est, recruitment_est)

## End(Not run)
```

---

bbr_growth_summarize *Summarize population growth*

Description

Provides a summary of yearly population growth (λ) estimates from simulations.

Usage

```
bbr_growth_summarize(growth)
```

Arguments

growth	A data frame generated by bbr_growth().

Format

The return object has these columns:

PopulationName Population name

Year Year sampled

S Estimated survival

R Estimated recruitment

estimate Estimated population growth (lambda)

se SE

lower Percentile 95% confidence limits

upper Percentile 95% confidence limits

prop_lgt1 Proportion simulations where lambda>1

mean_sim_survival Mean simulated survival value

mean_sim_recruitment Mean simulated recruitment value

mean_sim_growth Mean simulated population growth (lambda) value

median_sim_growth Median simulated population growth (lambda) value

Value

A data frame. The columns are listed in the format section.

Examples

```
## Not run:
recruitment_est <- bbr_recruitment(bboudata::bbourecruit_a)
survival_est <- bbr_survival(bboudata::bbousurv_a)
growth_est <- bbr_growth(survival_est, recruitment_est)

bbr_growth_summarize(growth_est)

## End(Not run)
```

---

bbr_plot_growth *Plot population growth*

Description

A plot of population growth (λ) estimates is given for the population unit.

Usage

```
bbr_plot_growth(growth)
```

Arguments

growth	A data frame generated by bbr_growth().

Value

A ggplot object.

Examples

```
## Not run:
recruitment_est <- bbr_recruitment(bboudata::bbourecruit_a)
survival_est <- bbr_survival(bboudata::bbousurv_a)
growth_est <- bbr_growth(survival_est, recruitment_est)

bbr_plot_growth(growth_est)

## End(Not run)
```

---

bbr_plot_growth_distributions

Plot population growth distributions

Description

Create histograms of simulated population growth (λ) values.

Usage

```
bbr_plot_growth_distributions(growth)
```

Arguments

growth	A data frame generated by bbr_growth().

Details

Plots are generated that show the distribution of simulated population growth (λ) values, the mean estimate (red line). In addition, a hashed line indicates where $\lambda = 1$. Plots allow users to evaluate the symmetry of the distributions of λ.

Value

A ggplot object.

Examples

```
## Not run:
recruitment_est <- bbr_recruitment(bboudata::bbourecruit_a)
survival_est <- bbr_survival(bboudata::bbousurv_a)
growth_est <- bbr_growth(survival_est, recruitment_est)

bbr_plot_growth_distributions(growth_est)

## End(Not run)
```

---

bbr_plot_recruitment *Plot recruitment*

Description

A plot of yearly survival is given for each population unit.

Usage

```
bbr_plot_recruitment(recruitment)
```

Arguments

recruitment	A data frame generated by bbr_recruitment().

Value

A ggplot object.

Examples

```
## Not run:
recruitment_est <- bbr_recruitment(bboudata::bbourecruit_a)

bbr_plot_recruitment(recruitment_est)

## End(Not run)
```

bbr_plot_survival *Plot survival*

Description

A plot of yearly survival is given for each population unit.

Usage

```
bbr_plot_survival(survival)
```

Arguments

survival	A data frame generated by bbr_survival().

Value

A ggplot object.

Examples

```
## Not run:
survival_est <- bbr_survival(bboudata::bbousurv_a)

bbr_plot_survival(survival_est)

## End(Not run)
```

bbr_recruitment *Estimate recruitment*

Description

Estimate recruitment using DeCesare et al. (2012) methods.

Usage

```
bbr_recruitment(
  x,
  adult_female_proportion = 0.65,
  sex_ratio = 0.5,
  variance = "bootstrap",
  year_start = 4L
)
```

Arguments

x	A data frame that has recruitment data.
adult_female_proportion	Assumed or estimated proportion of females in the population used to assign unknown sex caribou. Values must be between 0 and 1. Can be set to 0 to exclude unknown sex caribou from recruitment estimates. The default is set at 0.65.
sex_ratio	Sex ratio of caribou at birth used to assign calves and yearlings as male or female. Sex ratio is defined as the proportion females at birth. Values must be between 0 and 1. The default is set at 0.5.
variance	Estimate variance using "binomial" or "bootstrap". The default is set as "bootstrap".
year_start	A whole number between 1 and 12 indicating the month of the start of the caribou (i.e., biological) year. By default, April is set as the start of the caribou year.

Format

The return object has these columns:

PopulationName Population name

Year Year sampled

estimate Recruitment estimate

se SE

lower Confidence limit

upper Confidence limit

groups Groups sampled

female_calves Estimated female calves

females Estimated adult females

Details

x needs to be formatted in a certain manner. To confirm the input data frame is in the right format you can use the bbd_chk_data_recruitment function. See the `vignette("methods", package = "bbouretro")` for the equations used in this function.

User's can input the assumed proportion of females in the population (to estimate females from adult caribou that have unknown sex) as well as sex ratio at birth.

Value

A data frame. The columns are listed in the format section.

References

DeCesare, Nicholas J., Mark Hebblewhite, Mark Bradley, Kirby G. Smith, David Hervieux, and Lalenia Neufeld. 2012 "Estimating Ungulate Recruitment and Growth Rates Using Age Ratios." The Journal of Wildlife Management 76 (1): 144–53 https://doi.org/10.1002/jwmg.244.

Examples

```
recruitment_est <- bbr_recruitment(
  bboudata::bbourecruit_a,
  adult_female_proportion = 0.65,
  sex_ratio = 0.5,
  variance = "binomial"
)
recruitment_est <- bbr_recruitment(
  bboudata::bbourecruit_a,
  adult_female_proportion = 0.60,
  sex_ratio = 0.65,
  variance = "bootstrap"
)
```

---

bbr_rec_to_cc *Recruitment to Calf Cow Ratio*

Description

Converts the female recruitment rate to the calf cow ratio. For further information see bbr_cc_to_rec().

Usage

```
bbr_rec_to_cc(x, sex_ratio = 0.5)
```

Arguments

x	A numeric vector of the recruitment rate
sex_ratio	A

Value

A numeric vector of the equivalent calf:cow ratio

See Also

bbr_cc_to_rec()

Examples

```
bbr_rec_to_cc(c(0, 1, 0.5, NA))
```

`bbr_survival` *Estimate survival*

Description

Estimate survival rates based on the Kaplan-Meier survival rate estimator (Pollock et al. 1989).

Usage

```
bbr_survival(
  x,
  include_uncertain_morts = TRUE,
  variance = "greenwood",
  year_start = 4L
)
```

Arguments

`x`	A data frame that has survival data.
`include_uncertain_morts`	A flag indicating whether to include uncertain mortalities in total mortalities. The default value is TRUE.
`variance`	Variance type to estimate. Can be the Greenwood estimator `"greenwood"` or Cox Oakes estimator `"cox_oakes"`. The default is "greenwood".
`year_start`	A whole number between 1 and 12 indicating the month of the start of the caribou (i.e., biological) year. By default, April is set as the start of the caribou year.

Format

The return object has these columns:

PopulationName Population name

Year Year sampled

estimate Survival estimate

se SE

lower Confidence limit

upper Confidence limit

mean_monitored Mean number of caribou monitored each month

sum_dead Total number of mortalities in a year

sum_alive Total number of caribou-months in a year

status Indicates less than 12 months monitored or if there were 0 mortalities in a given year

Details

x needs to be formatted in a certain manner. To confirm the input data frame is in the right format you can use the bbd_chk_data_survival function. See the vignette("methods", package = "bbouretro") for the equations used in this function.

Value

A data frame. The columns are listed in the format section.

References

Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. Journal of Wildlife Management 53:7-15.

Examples

```
survival_est <- bbr_survival(
  bboudata::bbousurv_a,
  include_uncertain_morts = TRUE,
  variance = "greenwood"
)
survival_est <- bbr_survival(
  bboudata::bbousurv_b,
  include_uncertain_morts = FALSE,
  variance = "cox_oakes"
)
```

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