Source: https://unsplash.com/@satyadeep_d

Solution

A distance sampling approach to the analysis of camera trapping data offers the potential advantage that individual animal identification is not required. However, accurate animal-to-camera detection distances are required. This requires calibration prior to the survey with images of objects of known size taken at known distances from the camera. See details in (Howe et al., 2017) for description of the field work and data analysis. Here we present analysis of data from (Howe et al., 2017) using Distance for Windows (Thomas et al., 2010).

1 Data input

A data set for recording of detections during daytime are in the Distance for Windows project associated with this practical. The data themselves are in an online repository (Howe et al., 2018)

Access duiker project

Open the DistWin project `DuikerDaytime` found in the Sample Projects folder. This project was installed when you installed the DistWin software. We will make some modifications to the basic project.

Glance through the data window, noting one camera station (E4) had no detections. Also inspect the field included in the Global layer labelled *Sampling fraction*. This is the proportion of the full field of view that the camera can "see" ($42°$; 42/360=0.11667). We will address the other fields in the Global layer in a later practical.

1.1 Distance recording: binning and truncation

Distance bins are set to be narrow out to 8m, then increasing in width to the maximum detection distance of 21m as shown in the Intervals tab of the Data Filter (Fig. 1)
Data will also be altered for consistency with (Howe et al., 2017) by invoking truncation both at very small distances and at large distances.
As described in Howe et al. (2017)

> a paucity of observations between 1 and 2 m but not between 2 and 3 m, so we left-truncated at 2 m. Fitted detection functions and probability density functions were heavy-tailed when distances >15 m were included, so we right truncated at 15 m.

Note that because the data have been binned, the left and right truncation distances can only be selected from the binning cutpoints (Fig. 2).

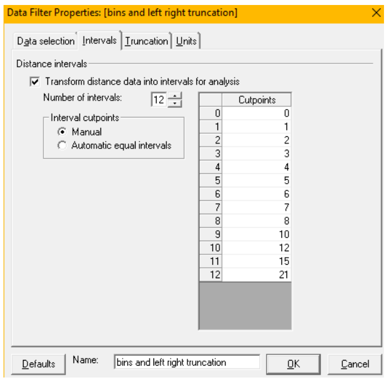

Figure 1: Specifying the cutpoints for the distance bins.

2 Detection function modelling

Before constructing any detection function models, we will organise our project suited to our needs for this practical: create an analysis set and alter the *Results Browser*.

2.1 Create a new analysis set

So as not to mingle the analyses you will be performing with analyses present in the Sample Project, create a new analysis set. This is accomplished by pressing the *New Set* button (Fig. 3). Give it a memorable name, e.g. *detection function models*. This analysis set will store all of the candidate models described below.

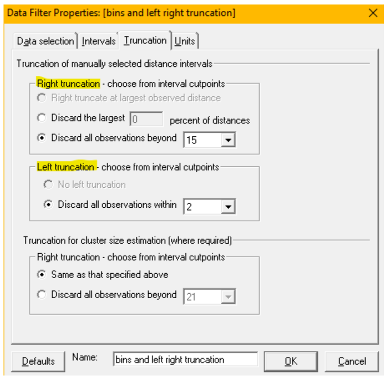

Figure 2: The *Data Filter* defining left and right truncation.

2.2 Adjust columns of *Results Browser*

For detection function model fitting, we need only have the following statistics in the *Results Browser*

- number of model parameters
  - total
  - key function parameters
  - adjustment term parameters
- Delta AIC
- AIC
- P-value of χ^2 goodness of fit test
- probability of detection P
- $CV(P)$

These statistics can be selected from the list of available statistics using the *Column browser* (Fig. 4).

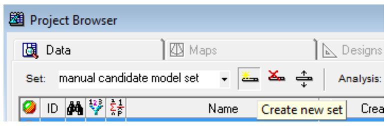

Figure 3: Create a new analysis set.

2.3 Model construction and fitting

Following the adjustments to the data and organising your Distance for Windows project, creation of detection function models begins. Specify the set of models to be fitted to the binned and truncated data. We restrict our candidate models to those with three or fewer parameters and we only consider one type of adjustment for each of the key functions. These criteria lead to a slightly different set of candidate models than that used in Howe et al. (2017).

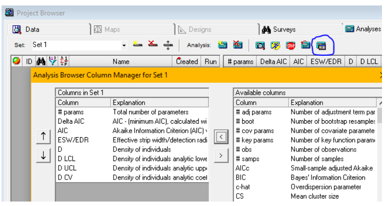

Figure 4: Select statistics to appear in *Results Browser*.

Candidate models include

- uniform key with 1, 2 and 3 cosine adjustments,
- half normal key with 0, 1 and 2 cosine adjustments and
- hazard rate key with 0 and 1 simple polynomial adjustments.

Note, rather than allow Distance for Windows to perform within-key function model selection of adjustment terms, we explicitly fit each adjustment term model. To convince Distance for Windows to fit a model with a fixed number of adjustment terms, we manually choose the number of adjustment terms for the model being specified (shown in Fig. 5).

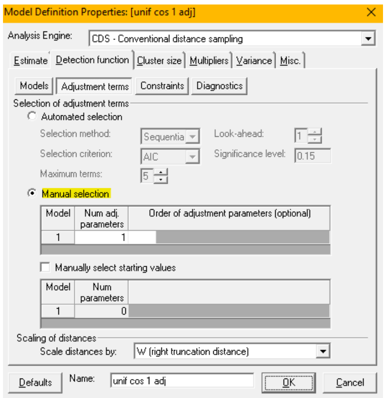

Figure 5: Manual specification of the number of adjustment terms.

We are not yet interested in estimates of duiker density, that field is not visible in our Results Browser. Therefore the effect of multipliers is not visible at this stage of the analysis. Nevertheless check the *Multipliers* button noting the *Sampling fraction* is incorporated into the analysis.

3 Model criticism

Having fitted the eight models described above, use the methods described in Practical 1 to evaluate the fitted models. If any models return an amber (warning) or red (error) status light, understand the reason(s) for the warnings or errors.

Elements of this assessment should include goodness of fit (with binned data, the χ^2 test is the only test available) and the AIC metrics both found in the *Results Browser*.

At the moment, we are not interested in the density estimates produced by these analyses, because there are additional elements yet to be incorporated. We have removed the density estimates from the *Results Browser* for this phase of the analysis.

Results browser for fitted models

Name	Par	Key par	Adj par	ΔAIC	AIC	GOF Chi-p	P	CV(P)
uniform cosine 1adj	1	0	1	80.3	44092.5	0.000	0.300	0.005
uniform cosine 2adj	2	0	2	74.6	44086.8	0.000	0.284	0.019
uniform cosine 3adj	3	0	3	0.0	44012.2	0.000	0.329	0.039
halfnorm cosine 0adj	1	1	0	133.0	44145.2	0.000	0.257	0.012
halfnorm cosine 1adj	2	1	1	20.4	44032.6	0.000	0.326	0.037
halfnorm cosine 2adj	3	1	2	19.4	44031.6	0.000	0.334	0.060
hazard simple 0adj	2	2	0	20.5	44032.7	0.000	0.375	0.012
hazard simple 1adj	3	2	1	9.6	44021.8	0.000	0.366	0.015

4 Questions about this analysis

- What might be justification for left truncation?

  Left truncation

  If animals close to the detector respond, detections (or lack thereof) may not be representative of the detection process. Similarly, if the vertical field of view of the detectors do not detect animals short in stature close to the detector, then left truncation might be justified.

  – What are the dangers of such truncation?

    Left truncation challenges

    The truncation distance is subjective. Remember it is detections at small distances that are fundamental to estimating $\hat{h}(0)$: slope of the PDF at distance 0. This estimate is estimated via extrapolation when left truncation is used.

- Initial assessment of fit of models?

  Model fit

  Note the P-values for all goodness of fit tests are effectively zero, meaning none of the models fit the data because of overdispersion.

- What is your preliminary model choice?

Model selection

Using traditional AIC for model selection, we conclude the uniform key function with 3 cosine adjustments is the preferred model of the eight models fitted. This differs from the analysis reported in (Howe et al., 2017) because the uniform key with three cosine adjustments was not included in the candidate model set those authors fitted to these data.

References

Howe, Eric J., Stephen T. Buckland, Marie-Lyne Després-Einspenner, and Hjalmar S. Kühl (2017). "Distance sampling with camera traps". In: *Methods in Ecology and Evolution* 8.11, pp. 1558–1565. DOI: 10.1111/2041-210X.12790.

Howe, Eric J., Steven T. Buckland, Marie-Lyne Després-Einspenner, and Hjalmar S. Kühl (2018). *Data from: Distance sampling with camera traps*. en. DOI: 10.5061/dryad.b4c70.

Thomas, Len, Stephen T. Buckland, Eric A. Rexstad, Jeff L. Laake, Samantha Strindberg, Sharon L. Hedley, Jon R.B. Bishop, Tiago A. Marques, and Kenneth P. Burnham (2010). "Distance software: design and analysis of distance sampling surveys for estimating population size". In: *Journal of Applied Ecology* 47, pp. 5–14. DOI: 10.1111/j.1365-2664.2009.01737.x.