3.1.7. Camera trapping (CT) without individual recognition

Beyond CMR, several models to estimate the size of a population where animals are unmarked has recently been published. Observation of animals with CTs was recently identified as a promising method to estimate a relative abundance (Rovero & Marshall 2009) and population density (which we will focus on) (Rowcliffe et al. 2008). Recently, promising results were obtained applying CT to estimate wild ungulate population density without the need for individual recognition (Marcon et al. 2019a, Pfeffer et al. 2018). Some different methods of analysing photo-data and calculating densities/abundances have been recently tested in several species. Assumptions for cam-trapping methods (deviation written below at specific method): random placement of cam-traps and/or probability of contacting any individual of the population, closed population, no influence of cam-trap on behaviour, cameras settings must be known (e.g., angle of detection, effective range). Evaluation of these methods can be seen in Table 1.

3.1.7.1.1. Random encounter model (REM)

This method was developed and tested in several species (Rowcliffe et al. 2008, Rovero & Marshall 2009, Rovero et al. 2010, Rowcliffe et al. 2011, Rovero et al. 2013, Rowcliffe et al. 2013), including wild ungulates (Rovero & Marshall 2009, Zero et al. 2013, Pfeffer et al. 2018, Marcon et al. 2019b). This method has been successfully tested in wild boar (Eversmann 2014, Keuling et al. 2014, Massei et al. 2017, Palencia et al. 2021a) and other wild ungulates. This method rescales the trapping rate (y / t) to population density using the day range (DR, i.e., daily distance travelled by an individual), and camera-related parameters (radius and angle of camera detection).

$$D\ (\text{density}) = \frac{y}{t} \cdot \frac{\pi}{v \cdot r \cdot (2+\propto)}$$

Where ∞ is the angle and r the radius of detection of the cameras, v = DR, i.e. the daily range of displacement.

The model assumes the following:

• CTs can capture animals in any direction, and animal signals are detectable from any direction
• The model assumes that animals randomly move with respect to CTs. The animals are in a homogeneous environment and move in straight lines of random direction with velocity
• CTs can capture animals at a detection distancer and that if an animal moves within this detection zone, they are captured with a probability of one.

We recommend estimating all the needed parameters to apply the REM for each sampled population. Especially considering the lack of comparative studies that have tested these parameters in different species and environmental conditions.

The DR is the parameter most costly and time-consuming to be measured, but it can be estimated from photo trapping data (Rowcliffe et al. 2016) rather than relying on fine resolution GPS or radio-tracking data (see our recommendations below). However, comparative studies to finely describe the distances travelled among different regions, habitats and seasons are required to evaluate the potential practicability of REM. A recent study has evidenced to classify behaviours observed with the cameras into two or more categories (feeding, i.e., exploiting resources; and moving between habitats; i.e. searching resources) in order to estimate reliable and more accurate DR estimates (Palencia et al. 2019; 2021b) for species that behave differently (moving or feeding) in front of the CTs. This approach has been successfully applied in a range of wild ungulates: e.g., red deer, fallow deer, roe deer, wild boar, chamois (e.g. Kavčić et al. 2021; Palencia et al. 2021a).

Considering a scenario of high variance in trapping rate, a practical limitation of REM is that a minimum of 60 CT placements should be sampled to obtain a CV lower than 20%. Density precision heavily depends on the variance in trapping rate. Increasing the sampling effort or to considering a stratified design could improve the overall variance.

3.1.7.1.2. Random encounter rate and staying time (REST)

REST is an extension of REM (Nakashima et al. 2018). The REST describes the relationship among population density, trapping rate and staying time (amount of time that detected animals remain within a specific area with probability of detection of 1 within the field of view of a CT) of animals in a predetermined detection zone. This allows a full likelihood approach and probably a good coverage of confidence limits (not available in REM). To estimate the detection zone, it is necessary to do a pilot study to estimate the area in which the probability of detect an individual of the target species (and with a specific cam-trap model) is 1 (see our recommendations below).

The REST have been proposed as more efficiency and feasibility than REM because DR it is not needed. Despite the REST has been published recently, it has been applied to some ungulate populations (Nakashima et al. 2020; Palencia et al. 2021a).


#541

3.1.7.1.3. Point transects using camera traps (CT-DS)

Recently, Howe et al. (2017) adapted standard point transect distance sampling methods to CTs (CT-DS). This method can have great potential in low-density population because the continuous monitoring of the cameras allows to record more than one distance of detection for each detected animal enlarging the sampling size and optimizing the sampling effort. Distances from animal to camera must be measured, and this approach has been validated against other methods for ungulates (Palencia et al. 2021a).

Like REM, the CT-DS precision is usually low because of the high variance in encounter rate among cameras. Sampling more locations or stratifying the density estimates are useful to improve the precision.

3.1.7.1.4. CT without individual recognition in general

Objective:

Converting tap rates into estimates of the size of a population (local density), with or without, the need for individual identification.

Measure estimated:

Density.

Applicability:

All ungulates.

Methodology:

See protocol (Annex)

Evaluation

(REM, REST, CT-DS):

· Pro: (CT in general): different analysis-methods adaptable to local conditions (REM, REST and CT-DS recommended), medium effort, moderate costs, high precision and accuracy (also in low densities), adaptable to local and perhaps to regional studies (if the study design is stratified), all year, little delay, practicable, becoming more affordable, conductible (for several species at the same time), photos might be collected via online-photo-databases, all species in one method. Possibiility to incorporate artificial intelligence to image processing, which reduces workload.

· Con: assumptions needed for CT, theft of cameras in some locations, manpower required to analyse photo/ video material, however automatic identification is progressing fast.

· Accuracy: high.

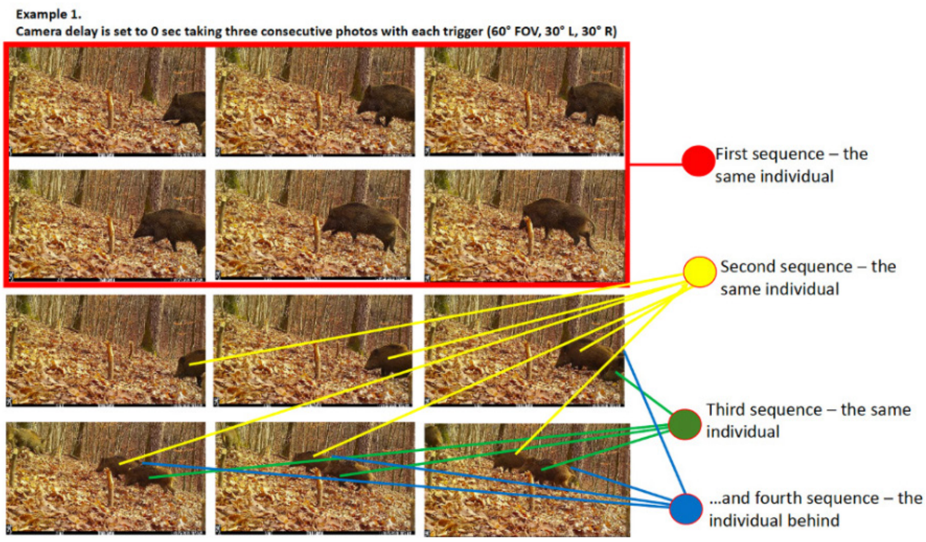
· Habitat: All. Performs well in forest areas, where other methods are not possible! Higher loss of cameras in open habitats.

Recommendations to improve comparability and accuracy:

• Further studies are required to define an adequate camera-trapping protocol to monitor different wild ungulate populations- for which precise data on movement parameters, activities, and other requirements in a range of different situations in the European context need to be gathered. Protocols for REM and REST already evaluated and available (see below).

• Evaluate missing detections with your specific camera model and under your study circumstances (camera did not release although animal was there, Amelin 2014, Fischer 2018). All assumptions should be stated in literature (see Palencia et al. 2021b)


Bushnell
B2
35°F1°C
12-15-2018 04:57:54


Example 1.
Camera delay is set to 0 sec taking three consecutive photos with each trigger (60° FOV, 30° L, 30° R)
First sequence – the same individual
Second sequence – the same individual
Third sequence – the same individual
...and fourth sequence – the individual behind